Drainage Analysis

FOR

Northpoint Commerce Center
Northpoint Parkway at Thunderbolt Way
Santa Rosa, CA 95407

APNs: 035-530-023, -024, -025, -057

September 2023

Prepared by

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Drainage Study Narrative

This drainage study was conducted for a proposed warehouse building located on Northpoint Parkway, in between Thunderbolt Way and Kingfisher Way in Santa Rosa, CA. The subject parcel has a total area of 6.80 acres. The site is zoned General Industrial.

The site is located on an undeveloped lot. A portion of the site contains hardscaping from an old airport runway which runs through the center of the lot. The remaining portion of the site contains native vegetation. The northern half of the site sheet flows northeast to an existing drainage swale and culvert, which transports stormwater to the existing storm drain located in Kingfisher Way. There are two existing drop inlets located on the northern half of the site which transport stormwater west to the existing storm drain network located in Thunderbolt Way. The southern half of the site sheet flows to the south to an existing swale that runs along the southern property line. This swale outfalls into two separate drop inlets, and it is assumed that these drop inlets transport the stormwater to the existing creek located along the southern property line.

The purpose of this report is to support the grading and drainage improvements associated with the proposed warehouse and parking lot. Bioretention basins will be located throughout the parking lot, and storm drain inlets will be located intermittently throughout them to capture storm water and direct it to the underground storm drain system.

Hydrology Analysis

The overall tributary area is 6.80 ac and is therefore classified as a "minor waterway" per Sonoma Water's Flood Management Design Manual. Per the criteria, the rational method shall be used to determine the design discharge (Q) in cubic feet per second (cfs) for the 10-year design storm. A total of 11 hydrology areas were analyzed, refer to the attached Hydrology Map in Appendix A for area designations and locations.

Factors used in the hydrology and hydraulic calculations for the 10-year storm event are based on the Sonoma Water's Flood Management Design Manual:

2.79	Intensity (Inches / hour, NOAA Website)
0.79-0.85	C-factor (Table C-1)
7	Time of Concentration (Minutes, Table 3-3)
D	Soil Site Class

The same factors were used in the hydrology and hydraulic calculations for the 100-year storm event, except for the intensity. Per the NOAA website, the intensity was increased to 4.13 in/hr. Each storm was modeled using an intensity curve created with the data provided by NOAA in relation the recurrence interval and duration of the storm.

See Appendix B for hydrology calculations and IDF curve and reference tables.

Hydraulic Analysis:

Hydraulic calculations were performed for the 10-year storm event utilizing Autodesk's Storm and Sanitary Analysis. The analysis uses a starting HGL elevation of 1' below gutter flow line at all catch basin tie in locations, per the request of Phil Wadsworth at Sonoma Water. Email confirmation of this request can be found in Appendix B. Proposed drainage infrastructure will be tying into the existing infrastructure at points shown on the Hydrology Map in Appendix A. Manning's coefficients were taken from Table D.2-4 of the Flood Management Design Manual. Refer to Appendix B for pipe network calculations. Rational method calculations were performed for the proposed drainage areas to determine if the proposed drainage infrastructure is adequately designed when performing the analysis for the 10-year storm event.

Hydraulic calculations were not performed for the 100-year storm. In areas where underground pipe capacity is not sufficient, stormwater will either flow overland towards Thunderbolt Way, Kingfisher Way, or south into Roseland Creek where the site currently sheet flows. The overland release route of the 100-year storm can be seen in the exhibit included in Appendix A.

Open Channel Flow Analysis

Open channel flow analysis was completed using the Federal Highway Administration Hydraulic Toolbox. Storm drain pipes were sized to the 10-year storm event flows. Pipe diameters and slopes are shown on the grading and drainage plans. See Appendix C for storm drain pipe sizing calculations.

Energy grade line and hydraulic grade line calculations for the 10-year storm event are provided in the Hydraulic Analysis. Refer to Appendix B.

Conclusion

These calculations demonstrate that the proposed storm drain pipes have the capacity to transport the 10-year storm event, allowing for overland release for the 100-year storm event, and that the proposed development will not increase the existing volume of stormwater runoff when compared to previously existing conditions.

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Appendix A: Hydrology Map

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LINETYPE LEGEND

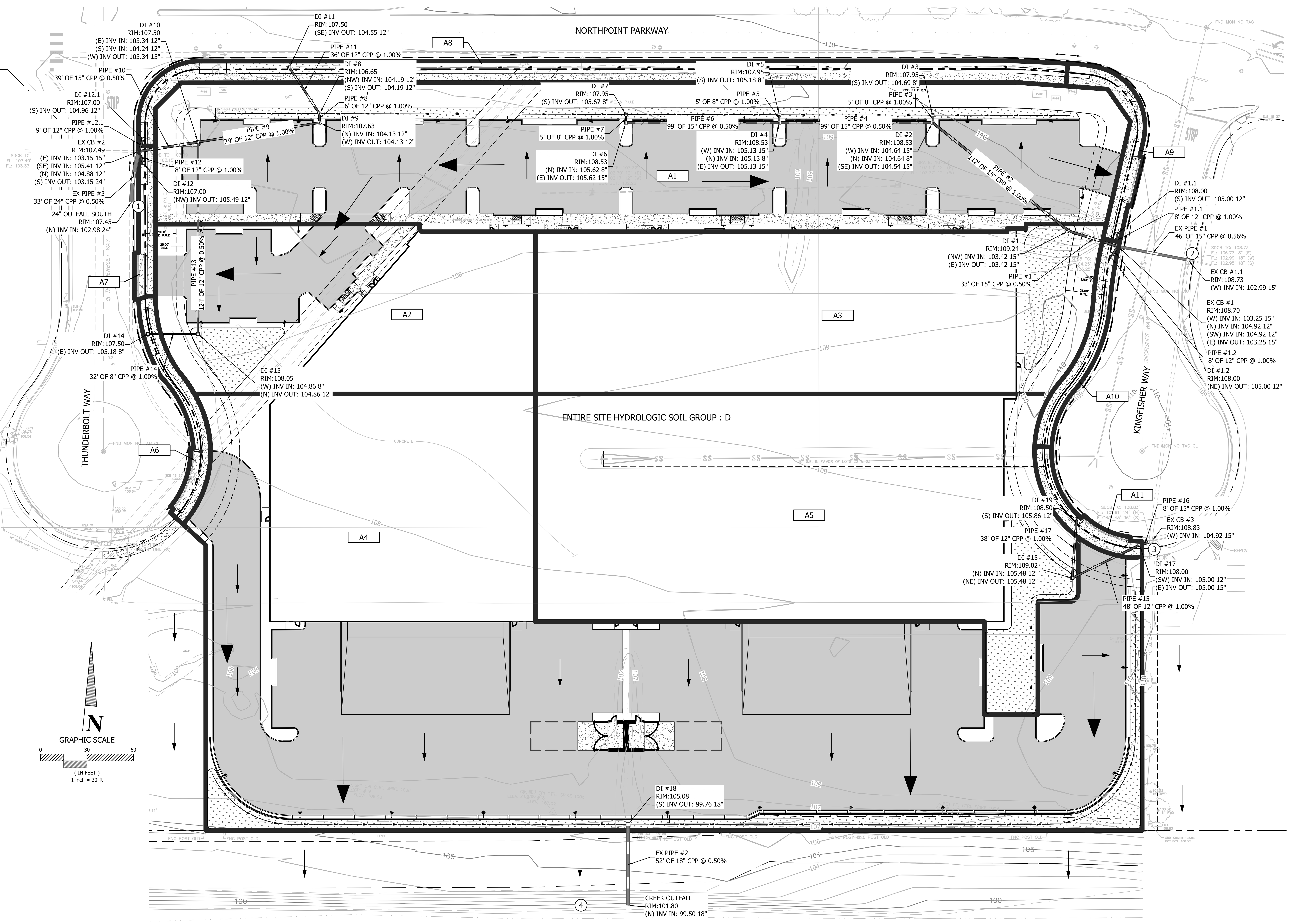
A#	DRAINAGE CALCULATION AREA (A)
	DRAINAGE AREA BOUNDARY
	DRAINAGE FLOW.
	OVERLAND RELEASE DIRECTION
	DROP INLET
	FLOWLINE
	GRADE BREAK
	STORM DRAIN
	CONCRETE
	ASPHALT
	BIORETENTION

DRAINAGE AREA LEGEND

A#	DRAINAGE CALCULATION AREA (A)
	DRAINAGE AREA BOUNDARY
	FLOW DIRECTION
	LINE OF ANALYSIS
1	POINT OF CONCENTRATION

ABBREVIATIONS

APN	ASSESSOR'S PARCEL NUMBER
DI	DROP INLET
INV	INVERT
SD	STORM DRAIN
SDMH	STORM DRAIN MANHOLE



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REV.	DESCRIPTION	BY	DATE

NORTHPOINT COMMERCE CENTER

MCNEILL REAL ESTATE SERVICES, INC.
1408 THUNDERBOLT WAY
SANTA ROSA, CA 95401

REGISTERED PROFESSIONAL ENGINEER · THOMAS & BAXTER · CIVIL · STATE OF CALIFORNIA
PRELIMINARY

Date:	SEE COVER
Job:	1979-20
Drawn:	TSL/MD
Scale:	AS SHOWN
APN:	035-530-023
Permit #:	
Sheet:	HYD 1 of 1

S:\Clients\1979-20 Charlie Traboulsi - Thunderbolt Way (Northpoint Commerce Center), Santa Rosa, CA\CAD\Civil Engineering\Exhibits\1979-20 Hydro.dwg
9/8/2023 12:09 PM Plotted by: Trevor

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Appendix B: Rational Method Calculations

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Project #: 1979-20
Designed by: TSL

Composite Runoff Coefficient

Project: **Northpoint Commerce Center**

Factors:

A_P	Impervious area	C=	0.90
A_V	Vegetated Area	C=	0.50
A_T	Total Area		
C_T	Weighted Runoff Coefficient		

DMA #	Areas						C_T
	A_T (sqft)	A_T (acres)	A_P	A_P	A_V	A_V	
1	58,523	1.344	42,708	0.980	22,302	0.512	0.85
2	26,056	0.598	20,333	0.467	6,504	0.149	0.83
3	37,595	0.863	33,148	0.761	5,199	0.119	0.86
4	113,316	2.601	100,090	2.298	14,067	0.323	0.86
5	51,290	1.177	45,027	1.034	6,886	0.158	0.86
6	1,809	0.042	1,809	0.042	-	0.000	0.90
7	1,152	0.026	1,152	0.026	-	0.000	0.90
8	8,642	0.198	8,642	0.198	-	0.000	0.90
9	1,707	0.039	1,707	0.039	-	0.000	0.90
10	1,563	0.036	1,563	0.036	-	0.000	0.90
11	1,200	0.028	1,200	0.028	-	0.000	0.90

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Project: **Northpoint Commerce Center**

Area #	Point of Conc	Area (Acre)	C-Factor	Tc (min)	Intensity (in/hr)		Full Intensity Runoff (ft^3/s)		Notes
					I_{10}	I_{100}	Q_{10}	Q_{100}	
1	1	1.34	0.85	7	2.790	4.130	3.18	4.70	To Pipe #10, and Ex Pipe #1
2	1	0.60	0.83	7	2.790	4.130	1.38	2.04	To Pipe #11, and Pipe #10
3	2	0.86	0.86	7	2.790	4.130	2.08	3.08	To Ex Pipe #1
4	4	2.60	0.86	7	2.790	4.130	6.22	9.21	Total Flows to Ex Pipe #2
5	3	1.18	0.86	7	2.790	4.130	2.82	4.17	To Pipe #4, and Pipe #5
6	1	0.04	0.90	7	2.790	4.130	0.10	0.15	To Pipe #14 and Pipe #10
7	1	0.03	0.90	7	2.790	4.130	0.07	0.10	To Pipe #12, and Ex Pipe #3
8	1	0.20	0.90	7	2.790	4.130	0.50	0.74	To Pipe #11 Pipe 12.1, and Pipe #10
9	2	0.04	0.90	7	2.790	4.130	0.10	0.15	To Pipe #1.1 and Ex Pipe 1
10	2	0.04	0.90	7	2.790	4.130	0.09	0.13	To Pipe #1.2, and Ex Pipe #1
11	3	0.03	0.90	7	2.790	4.130	0.07	0.10	To Pipe #17, and Pipe #16

1, 3, 9, & 10	2			7	2.79	4.13	4.65	6.88	Total Flows to Ex Pipe #1
1, 2, 6, 7, & 8	1			7	2.79	4.13	2.84	4.21	Total Flows to Ex Pipe #3
5 & 11	3			7	2.79	4.13	2.89	4.27	Total Flows to Pipe #16

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10 year Interpolation:

Time (x)	7	5	10
Intensity (y)	**2.789852**	3.28	2.35

a	7.113821
b	-0.48104

25 year Interpolation:

Time (x)	7	5	10
Intensity (y)	**3.300261**	3.88	2.78

a	8.414272
b	-0.48097

5

Time (x)	7	5	10
Intensity (y)	**4.128206**	4.85	3.48

a	10.48279
b	-0.4789

Table C-1. Runoff Coefficients (*Cs*) (Incremental Rational Method)

Land Use	Lot Size (acres)	Impervious Fraction	Average Slope (%)			
			0-2	>2-6	>6-12	>12
Soil Type A						
Residential[1]						
Rural		0.03	0.24	0.28	0.34	0.38
Very low density	2	0.11	0.29	0.34	0.38	0.42
	1	0.24	0.38	0.42	0.46	0.49
Low density	1/2	0.32	0.43	0.47	0.50	0.53
	1/3	0.41	0.50	0.53	0.56	0.58
Medium-low density	1/4	0.49	0.55	0.58	0.60	0.62
Medium density	1/8	0.70	0.70	0.71	0.73	0.74
Medium-high density	1/18	1	0.90	0.90	0.90	0.90
Business, commercial, etc.		1	0.90	0.90	0.90	0.90
General industrial		1	0.90	0.90	0.90	0.90
Parks and recreation		0.05	0.25	0.25	0.30	0.35
Ag and open space		0.02	0.23	0.23	0.28	0.33
Soil Type B						
Residential[1]						
Rural		0.03	0.28	0.33	0.39	0.43
Very low density	2	0.11	0.34	0.38	0.43	0.47
	1	0.24	0.42	0.45	0.50	0.53
Low density	1/2	0.32	0.47	0.50	0.54	0.57
	1/3	0.41	0.53	0.56	0.59	0.61
Medium-low density	1/4	0.49	0.58	0.60	0.63	0.65
Medium density	1/8	0.70	0.71	0.73	0.74	0.76
Medium-high density	1/18	1	0.90	0.90	0.90	0.90
Business, commercial, etc.		1	0.90	0.90	0.90	0.90
General industrial		1	0.90	0.90	0.90	0.90
Parks and recreation		0.05	0.25	0.30	0.34	0.40
Ag and open space		0.02	0.23	0.28	0.33	0.38
Soil Type C						
Residential[1]						
Rural		0.03	0.33	0.38	0.43	0.47
Very low density	2	0.11	0.38	0.42	0.47	0.51
	1	0.24	0.45	0.49	0.53	0.57
Low density	1/2	0.32	0.50	0.53	0.57	0.60

Land Use	Lot Size (acres)	Impervious Fraction	Average Slope (%)			
			0-2	>2-6	>6-12	>12
	1/3	0.41	0.56	0.59	0.62	0.64
Medium-low density	1/4	0.49	0.60	0.63	0.65	0.68
Medium density	1/8	0.70	0.73	0.74	0.76	0.77
Medium-high density	1/18	1	0.90	0.90	0.90	0.90
Business, commercial, etc.		1	0.90	0.90	0.90	0.90
General industrial		1	0.90	0.90	0.90	0.90
Parks and recreation		0.05	0.34	0.39	0.44	0.48
Ag and open space		0.02	0.33	0.38	0.43	0.47
Soil Type D						
Residential[1]						
Rural		0.03	0.38	0.43	0.48	0.52
Very low density	2	0.11	0.42	0.47	0.52	0.55
	1	0.24	0.49	0.53	0.57	0.60
Low density	1/2	0.32	0.54	0.57	0.61	0.63
	1/3	0.41	0.59	0.62	0.65	0.67
Medium-low density	1/4	0.49	0.63	0.65	0.68	0.70
Medium density	1/8	0.70	0.74	0.76	0.77	0.78
Medium-high density	1/18	1	0.90	0.90	0.90	0.90
Business, commercial		1	0.90	0.90	0.90	0.90
General industrial		1	0.90	0.90	0.90	0.90
Parks and recreation		0.05	0.39	0.44	0.49	0.53
Ag and open space		0.02	0.38	0.42	0.48	0.52

[1] *Percent impervious values are based on analysis conducted by ESA for Sonoma County Water Agency (Sonoma Water) in 2014, using a sample of existing developed areas.*

[2] *For residential areas, composite* C *values were developed as follows:* C *values for soil type from Los Angeles County Hydrology Manual (1991) were modified for slope using the vegetated areas curve from Plate B-1 of SCWA (1983) for pervious areas within a given slope range and a* C *of 0.90 for all impervious areas.*

Source: Approach adapted from McCuen 1989

NOAA Atlas 14, Volume 6, Version 2
Location name: Santa Rosa, California, USA*
Latitude: 38.4159°, Longitude: -122.7403°
Elevation: m/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	**1.92** (1.72-2.18)	**2.32** (2.05-2.63)	**2.83** (2.51-3.24)	**3.28** (2.87-3.77)	**3.88** (3.26-4.64)	**4.36** (3.58-5.35)	**4.85** (3.88-6.13)	**5.38** (4.15-7.02)	**6.11** (4.50-8.36)	**6.68** (4.73-9.54)
10-min	**1.38** (1.22-1.57)	**1.66** (1.48-1.88)	**2.03** (1.80-2.32)	**2.35** (2.06-2.70)	**2.78** (2.34-3.33)	**3.12** (2.57-3.83)	**3.48** (2.78-4.40)	**3.85** (2.98-5.03)	**4.37** (3.22-6.00)	**4.79** (3.39-6.83)
15-min	**1.11** (0.988-1.26)	**1.34** (1.19-1.52)	**1.64** (1.45-1.87)	**1.89** (1.66-2.18)	**2.24** (1.89-2.68)	**2.52** (2.07-3.09)	**2.80** (2.24-3.54)	**3.11** (2.40-4.06)	**3.53** (2.60-4.84)	**3.86** (2.73-5.51)
30-min	**0.772** (0.686-0.876)	**0.928** (0.824-1.05)	**1.14** (1.01-1.30)	**1.31** (1.15-1.51)	**1.55** (1.31-1.86)	**1.75** (1.44-2.15)	**1.95** (1.55-2.46)	**2.16** (1.67-2.82)	**2.45** (1.80-3.35)	**2.68** (1.90-3.82)
60-min	**0.534** (0.475-0.606)	**0.642** (0.570-0.730)	**0.787** (0.697-0.898)	**0.908** (0.796-1.05)	**1.08** (0.907-1.29)	**1.21** (0.994-1.49)	**1.35** (1.08-1.70)	**1.49** (1.15-1.95)	**1.69** (1.25-2.32)	**1.85** (1.31-2.65)
2-hr	**0.399** (0.355-0.453)	**0.478** (0.426-0.544)	**0.582** (0.515-0.664)	**0.664** (0.582-0.765)	**0.774** (0.653-0.928)	**0.858** (0.706-1.05)	**0.942** (0.752-1.19)	**1.03** (0.794-1.34)	**1.14** (0.840-1.56)	**1.23** (0.868-1.75)
3-hr	**0.335** (0.298-0.381)	**0.402** (0.357-0.457)	**0.487** (0.431-0.555)	**0.554** (0.486-0.638)	**0.642** (0.541-0.769)	**0.707** (0.581-0.869)	**0.772** (0.617-0.976)	**0.837** (0.647-1.09)	**0.922** (0.679-1.26)	**0.986** (0.698-1.41)
6-hr	**0.251** (0.223-0.285)	**0.301** (0.267-0.342)	**0.363** (0.322-0.414)	**0.411** (0.361-0.474)	**0.474** (0.399-0.568)	**0.520** (0.427-0.638)	**0.564** (0.451-0.713)	**0.608** (0.470-0.794)	**0.664** (0.489-0.911)	**0.706** (0.500-1.01)
12-hr	**0.175** (0.156-0.199)	**0.211** (0.187-0.240)	**0.255** (0.226-0.291)	**0.289** (0.254-0.333)	**0.333** (0.281-0.399)	**0.365** (0.300-0.448)	**0.396** (0.316-0.501)	**0.426** (0.330-0.557)	**0.465** (0.343-0.638)	**0.494** (0.350-0.705)
24-hr	**0.119** (0.107-0.135)	**0.145** (0.130-0.165)	**0.177** (0.158-0.201)	**0.201** (0.179-0.231)	**0.232** (0.201-0.274)	**0.255** (0.216-0.307)	**0.277** (0.230-0.340)	**0.298** (0.242-0.376)	**0.326** (0.254-0.427)	**0.346** (0.262-0.467)
2-day	**0.078** (0.070-0.089)	**0.097** (0.087-0.110)	**0.120** (0.107-0.136)	**0.137** (0.122-0.157)	**0.159** (0.138-0.188)	**0.175** (0.149-0.211)	**0.191** (0.158-0.234)	**0.206** (0.166-0.259)	**0.225** (0.175-0.294)	**0.238** (0.180-0.321)
3-day	**0.060** (0.054-0.068)	**0.075** (0.067-0.085)	**0.093** (0.084-0.106)	**0.108** (0.096-0.123)	**0.125** (0.108-0.148)	**0.138** (0.117-0.166)	**0.150** (0.125-0.185)	**0.162** (0.131-0.204)	**0.177** (0.138-0.231)	**0.188** (0.142-0.253)
4-day	**0.049** (0.044-0.056)	**0.063** (0.056-0.071)	**0.079** (0.070-0.090)	**0.091** (0.081-0.104)	**0.106** (0.091-0.125)	**0.117** (0.099-0.140)	**0.127** (0.105-0.156)	**0.137** (0.111-0.173)	**0.149** (0.117-0.195)	**0.158** (0.120-0.214)
7-day	**0.035** (0.032-0.040)	**0.045** (0.040-0.051)	**0.056** (0.050-0.064)	**0.065** (0.058-0.074)	**0.076** (0.065-0.089)	**0.083** (0.071-0.100)	**0.090** (0.075-0.111)	**0.097** (0.079-0.123)	**0.106** (0.083-0.139)	**0.112** (0.085-0.152)
10-day	**0.028** (0.025-0.032)	**0.036** (0.032-0.041)	**0.045** (0.040-0.051)	**0.052** (0.046-0.059)	**0.060** (0.052-0.071)	**0.066** (0.056-0.080)	**0.072** (0.060-0.089)	**0.077** (0.063-0.098)	**0.084** (0.066-0.110)	**0.089** (0.067-0.120)
20-day	**0.019** (0.017-0.021)	**0.024** (0.021-0.027)	**0.030** (0.027-0.034)	**0.034** (0.030-0.039)	**0.040** (0.034-0.047)	**0.044** (0.037-0.052)	**0.047** (0.039-0.058)	**0.050** (0.041-0.064)	**0.055** (0.043-0.071)	**0.057** (0.043-0.077)
30-day	**0.015** (0.013-0.017)	**0.019** (0.017-0.022)	**0.024** (0.021-0.027)	**0.027** (0.024-0.032)	**0.032** (0.027-0.038)	**0.035** (0.029-0.042)	**0.037** (0.031-0.046)	**0.040** (0.032-0.050)	**0.043** (0.034-0.056)	**0.045** (0.034-0.061)
45-day	**0.012** (0.011-0.014)	**0.016** (0.014-0.018)	**0.019** (0.017-0.022)	**0.022** (0.020-0.025)	**0.026** (0.022-0.030)	**0.028** (0.024-0.033)	**0.030** (0.025-0.037)	**0.032** (0.026-0.040)	**0.034** (0.027-0.045)	**0.036** (0.027-0.048)
60-day	**0.011** (0.010-0.012)	**0.014** (0.012-0.016)	**0.017** (0.015-0.019)	**0.020** (0.017-0.022)	**0.022** (0.019-0.026)	**0.024** (0.021-0.029)	**0.026** (0.022-0.032)	**0.028** (0.022-0.035)	**0.030** (0.023-0.039)	**0.031** (0.023-0.042)

[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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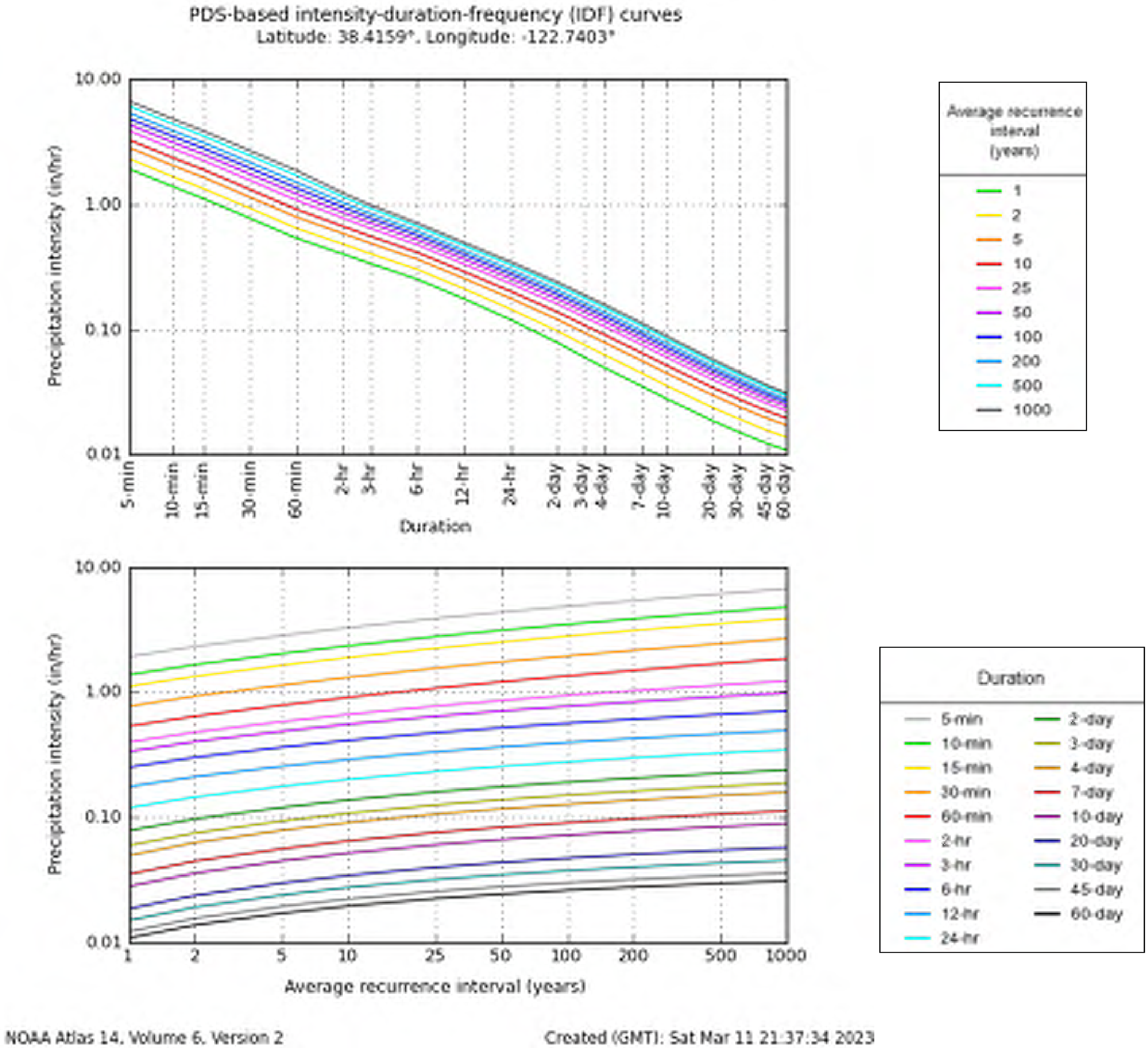
PF graphical



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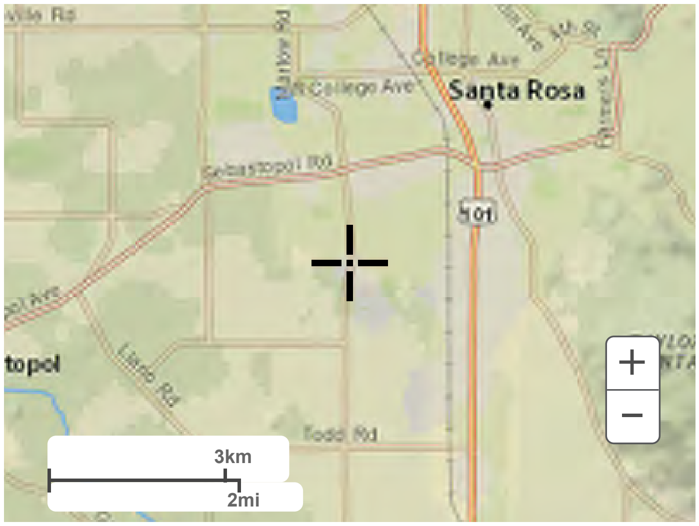
Maps & aerials

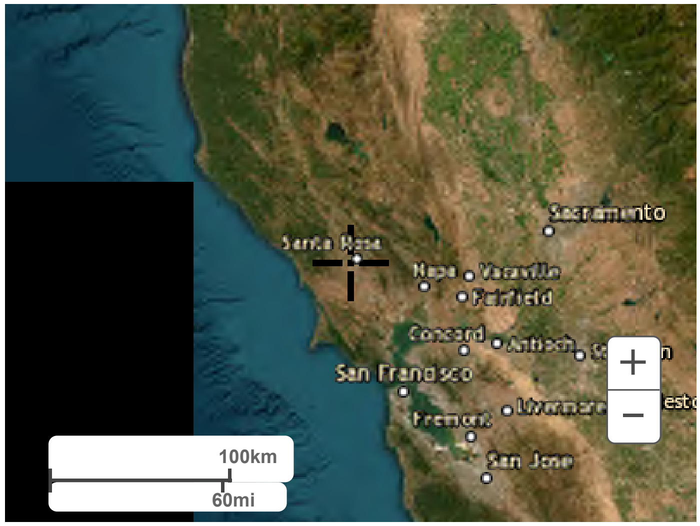
Small scale terrain



Large scale terrain

Large scale map

Large scale aerial



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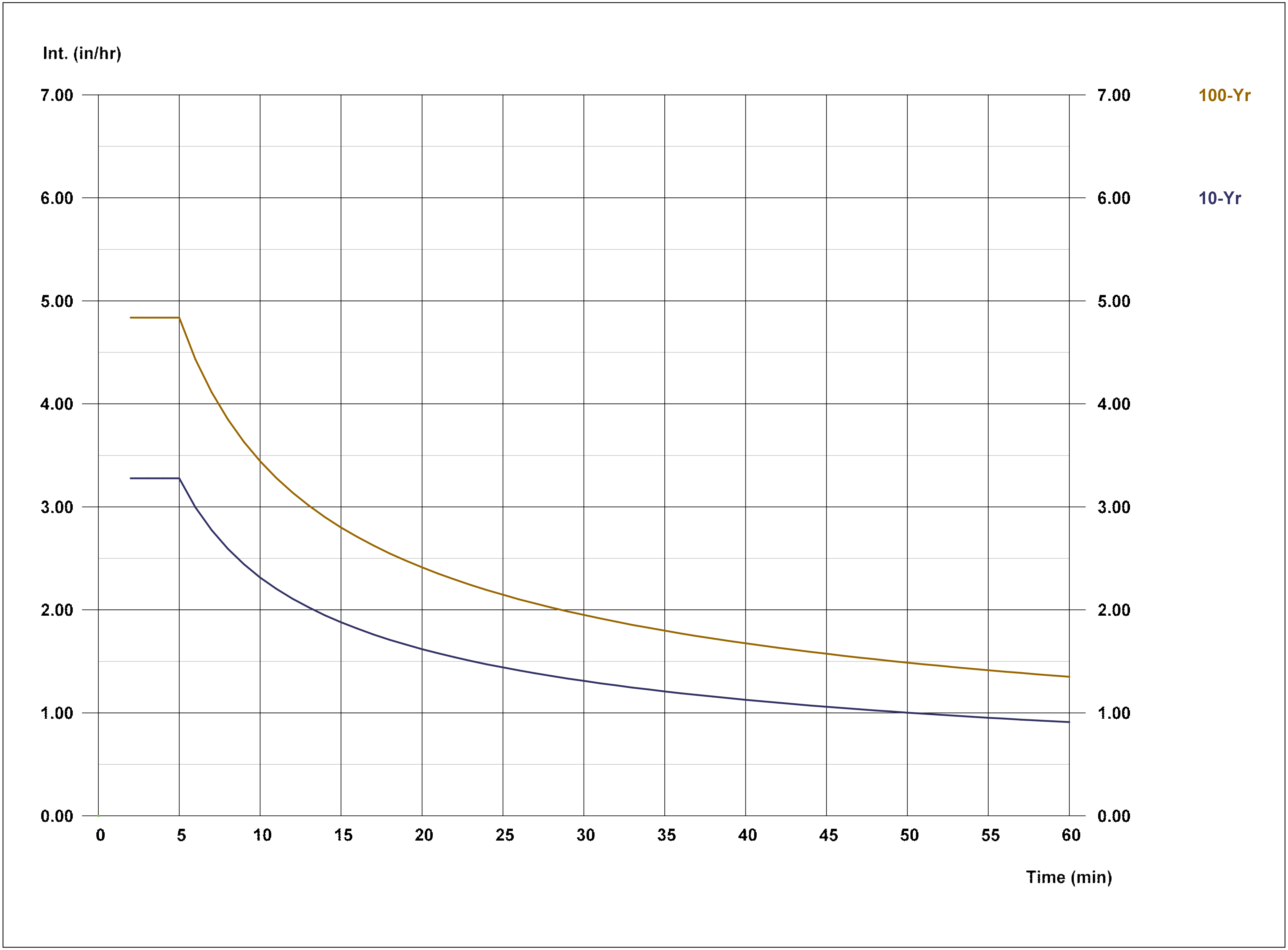
US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Storm Sewer IDF Curves

IDF file: 1978-20_IDF.IDF



Hydraflow IDF Report

Return Period (Yrs)	Equation Coefficients (FHA)			
	B	D	E	(N/A)
1	0.0000	0.0000	0.0000	--------
2	0.0000	0.0000	0.0000	--------
3	0.0000	0.0000	0.0000	--------
5	0.0000	0.0000	0.0000	--------
10	8.0206	0.4000	0.5307	--------
25	0.0000	0.0000	0.0000	--------
50	0.0000	0.0000	0.0000	--------
100	12.3667	0.7000	0.5394	--------

S:\Clients\1978-20 Charlie Traboulsi - Mariner Way (Heritage Commerce Center), Santa Rosa, CA\Calculations Reports Documents\Reports\Drainage Report\Final Report\Model\1978-20_IDF.IDF

Intensity = B / (Tc + D)^E

Return Period (Yrs)	Intensity Values (in/hr)											
	5 min	10	15	20	25	30	35	40	45	50	55	60
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	3.28	2.31	1.88	1.62	1.44	1.31	1.21	1.13	1.06	1.00	0.95	0.91
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
100	4.84	3.44	2.80	2.41	2.15	1.95	1.80	1.67	1.57	1.49	1.41	1.35

Tc = time in minutes. Min Tc = 5

Pipes

Line No.	Line ID	Dnstr Line No.	Line Length (ft)	Defl Angle (deg)	Junction Type	Known Q (cfs)	Drnge Area (ac)	Runoff Coeff (C)	Tc Method	Inlet Time (min)	Invert Elev Dn (ft)	Line Slope (%)	Invert Elev Up (ft)	Line Rise (in)	Line Type	Line Span (in)	No. Barrels	N Value (n)	J-Loss Coeff (K)	Inl/Rim Elev Dn (ft)	Inl/Rim Elev Up (ft)
1	PIPE #16	Outfall	7.634	159.641	Drop Grate	0.00	0.03	0.90	User	7.0	104.92	1.05	105.00	15	Cir	15	1	0.012	0.50	108.83	108.00
2	PIPE #15	1	48.331	-11.482	Drop Grate	0.00	1.18	0.90	User	7.0	105.00	0.99	105.48	12	Cir	12	1	0.012	1.50	108.00	109.02
3	PIPE #17	2	38.341	120.501	Drop Grate	0.00	0.03	0.90	User	7.0	105.48	0.99	105.86	12	Cir	12	1	0.012	1.00	109.02	108.50
4	EX PIPE #1	Outfall	46.193	-174.580	Curb Inlet	0.00	0.00	0.00	User	0.0	102.99	0.56	103.25	15	Cir	15	1	0.012	2.15	108.73	108.70
5	PIPE #1	4	33.032	6.474	Drop Grate	0.00	0.86	0.90	User	7.0	103.25	0.51	103.42	15	Cir	15	1	0.012	0.62	108.70	109.24
6	PIPE #2	5	112.398	21.053	Drop Grate	0.00	0.00	0.00	User	0.0	103.42	1.00	104.54	15	Cir	15	1	0.012	1.23	109.24	108.53
7	PIPE #4	6	99.000	-38.520	Drop Grate	0.00	0.00	0.00	User	0.0	104.64	0.51	105.14	15	Cir	15	1	0.012	1.50	108.53	108.53
8	PIPE #6	7	99.000	0.000	Drop Grate	0.00	0.00	0.00	User	0.0	105.13	0.51	105.63	15	Cir	15	1	0.012	1.50	108.53	108.53
9	PIPE #7	8	5.372	90.138	Drop Grate	0.00	0.34	0.90	User	7.0	105.62	0.93	105.67	12	Cir	12	1	0.012	1.00	108.53	107.95
10	EX PIPE #3	Outfall	33.002	-86.970	Curb Inlet	0.00	0.00	0.00	User	0.0	102.98	0.52	103.15	24	Cir	24	1	0.012	2.16	107.45	107.49
11	PIPE #12	10	7.987	151.685	Drop Grate	0.00	0.03	0.90	User	7.0	105.41	1.00	105.49	12	Cir	12	1	0.012	1.00	107.49	107.00
12	PIPE #5	7	5.133	90.138	Drop Grate	0.00	0.34	0.90	User	7.0	105.13	0.97	105.18	12	Cir	12	1	0.012	1.00	108.53	107.95
13	PIPE #1.1	4	8.087	75.237	Drop Grate	0.00	0.04	0.90	User	7.0	104.92	0.99	105.00	12	Cir	12	1	0.012	1.00	108.70	108.00
14	PIPE #1.2	4	8.089	-71.230	Drop Grate	0.00	0.04	0.90	User	7.0	104.92	0.99	105.00	12	Cir	12	1	0.012	1.00	108.70	108.00
15	PIPE #12.1	10	8.532	9.325	Drop Grate	0.00	0.20	0.90	User	7.0	104.88	0.94	104.96	12	Cir	12	1	0.012	1.00	107.49	107.00
16	PIPE #10	10	38.639	72.432	Drop Grate	0.00	0.00	0.00	User	0.0	103.15	0.49	103.34	15	Cir	15	1	0.012	1.50	107.49	107.50
17	PIPE #13	16	124.051	99.049	Drop Grate	0.00	0.60	0.90	User	7.0	104.24	0.50	104.86	12	Cir	12	1	0.012	1.50	107.50	108.05
18	PIPE #14	17	32.177	89.998	Drop Grate	0.00	0.04	0.90	User	7.0	104.86	0.99	105.18	8	Cir	8	1	0.012	1.00	108.05	107.50
19	PIPE #3	6	4.895	51.618	Drop Grate	0.00	0.34	0.90	User	7.0	104.64	1.02	104.69	12	Cir	12	1	0.012	1.00	108.53	107.95
20	PIPE #9	16	79.389	-0.138	Drop Grate	0.00	0.00	0.00	User	0.0	103.34	1.00	104.13	12	Cir	12	1	0.012	1.48	107.50	107.63
21	PIPE #8	20	5.850	-80.759	Drop Grate	0.00	0.34	0.90	User	7.0	104.13	1.03	104.19	12	Cir	12	1	0.012	0.90	107.63	106.65
22	PIPE #11	21	35.796	-33.241	Drop Grate	0.00	0.20	0.90	User	7.0	104.19	1.01	104.55	12	Cir	12	1	0.012	1.00	106.65	107.50
23	EX PIPE #2	Outfall	52.257	-95.571	Drop Grate	0.00	2.60	0.90	User	7.0	99.50	0.50	99.76	18	Cir	18	1	0.012	1.00	101.80	105.08

Structures

Line No.	Inlet ID	Inlet Type	Location	Bypass Line No.	Curb Length (ft)	Curb Tht. Ht. (in)	Grate Area (sqft)	Grate Width (ft)	Grate Length (ft)	Generic Capac. (cfs)	Rd. Cross Slope, Sx (ft/ft)	Gtr. Cross Slope, Sw (ft/ft)	Local Depression (in)	Gutter Width (ft)	Long. Slope (ft/ft)	Gutter n-value	Struct Shape	Struct Length	Struct Width
1	DI #17	Drop Grate	Sag	----	----	----	2.25	1.50	1.50	----	0.020	----	----	2.00	----	----	Rect	1.5	1.5
2	DI #15	Drop Grate	Sag	----	----	----	2.25	1.50	1.50	----	0.020	----	----	2.00	----	----	Rect	1.5	1.5
3	DI #19	Drop Grate	Sag	----	----	----	2.25	1.50	1.50	----	0.020	----	----	2.00	----	----	Rect	1.5	1.5
4	EX CB #1	Curb Inlet	Sag	----	1.50	4.0	----	----	----	----	0.020	0.050	0.00	2.00	----	----	Rect	4	0.5
5	DI #1	Drop Grate	Sag	----	----	----	2.25	1.50	1.50	----	0.020	----	----	2.00	----	----	Rect	1.5	1.5
6	DI #2	Drop Grate	Sag	----	----	----	2.25	1.50	1.50	----	0.020	----	----	2.00	----	----	Rect	1.5	1.5
7	DI #4	Drop Grate	Sag	----	----	----	2.25	1.50	1.50	----	0.020	----	----	2.00	----	----	Rect	1.5	1.5
8	DI #6	Drop Grate	Sag	----	----	----	2.25	1.50	1.50	----	0.020	----	----	2.00	----	----	Rect	1.5	1.5
9	DI #7	Drop Grate	Sag	----	----	----	2.25	1.50	1.50	----	0.020	----	----	2.00	----	----	Rect	1.5	1.5
10	EX CB #2	Curb Inlet	Sag	----	1.50	4.0	----	----	----	----	0.020	0.050	0.00	2.00	----	----	Rect	4	0.5
11	DI #12	Drop Grate	Sag	----	----	----	2.25	1.50	1.50	----	0.020	----	----	2.00	----	----	Rect	1.5	1.5
12	DI #5	Drop Grate	Sag	----	----	----	2.25	1.50	1.50	----	0.020	----	----	2.00	----	----	Rect	1.5	1.5
13	DI #1.1	Drop Grate	Sag	----	----	----	2.25	1.50	1.50	----	0.020	----	----	2.00	----	----	Rect	1.5	1.5
14	DI #1.2	Drop Grate	Sag	----	----	----	2.25	1.50	1.50	----	0.020	----	----	2.00	----	----	Rect	1.5	1.5
15	DI #12.1	Drop Grate	Sag	----	----	----	2.25	1.50	1.50	----	0.020	----	----	2.00	----	----	Rect	1.5	1.5
16	DI #10	Drop Grate	Sag	----	----	----	2.25	1.50	1.50	----	0.020	----	----	2.00	----	----	Rect	1.5	1.5
17	DI #13	Drop Grate	Sag	----	----	----	2.25	1.50	1.50	----	0.020	----	----	2.00	----	----	Rect	1.5	1.5
18	DI #14	Drop Grate	Sag	----	----	----	5.06	2.00	2.53	----	0.020	----	----	2.00	----	----	Rect	1.5	1.5
19	DI #3	Drop Grate	Sag	----	----	----	2.25	1.50	1.50	----	0.020	----	----	2.00	----	----	Rect	1.5	1.5
20	DI #9	Drop Grate	Sag	----	----	----	2.25	1.50	1.50	----	0.020	----	----	2.00	----	----	Rect	1.5	1.5
21	DI #8	Drop Grate	Sag	----	----	----	2.25	1.50	1.50	----	0.020	----	----	2.00	----	----	Rect	1.5	1.5
22	DI #11	Drop Grate	Sag	----	----	----	2.25	1.50	1.50	----	0.020	----	----	2.00	----	----	Rect	1.5	1.5
23	DI #18	Drop Grate	Sag	----	----	----	4.00	2.00	2.00	----	0.020	----	----	2.00	----	----	Rect	2	2

Storm Sewer Inventory Report

Line No.	Alignment				Flow Data				Physical Data								Line ID
	Dnstr Line No.	Line Length (ft)	Defl angle (deg)	Junc Type	Known Q (cfs)	Drng Area (ac)	Runoff Coeff (C)	Inlet Time (min)	Invert El Dn (ft)	Line Slope (%)	Invert El Up (ft)	Line Size (in)	Line Shape	N Value (n)	J-Loss Coeff (K)	Inlet/ Rim El (ft)	
1	End	7.634	159.641	DrGrt	0.00	0.03	0.90	7.0	104.92	1.05	105.00	15	Cir	0.012	0.50	108.00	PIPE #16
2	1	48.331	-11.482	DrGrt	0.00	1.18	0.90	7.0	105.00	0.99	105.48	12	Cir	0.012	1.50	109.02	PIPE #15
3	2	38.341	120.501	DrGrt	0.00	0.03	0.90	7.0	105.48	0.99	105.86	12	Cir	0.012	1.00	108.50	PIPE #17
4	End	46.193	-174.580	Curb	0.00	0.00	0.00	0.0	102.99	0.56	103.25	15	Cir	0.012	2.15	108.70	EX PIPE #1
5	4	33.032	6.474	DrGrt	0.00	0.86	0.90	7.0	103.25	0.51	103.42	15	Cir	0.012	0.62	109.24	PIPE #1
6	5	112.398	21.053	DrGrt	0.00	0.00	0.00	0.0	103.42	1.00	104.54	15	Cir	0.012	1.23	108.53	PIPE #2
7	6	99.000	-38.520	DrGrt	0.00	0.00	0.00	0.0	104.64	0.51	105.14	15	Cir	0.012	1.50	108.53	PIPE #4
8	7	99.000	0.000	DrGrt	0.00	0.00	0.00	0.0	105.13	0.51	105.63	15	Cir	0.012	1.50	108.53	PIPE #6
9	8	5.372	90.138	DrGrt	0.00	0.34	0.90	7.0	105.62	0.93	105.67	12	Cir	0.012	1.00	107.95	PIPE #7
10	End	33.002	-86.970	Curb	0.00	0.00	0.00	0.0	102.98	0.52	103.15	24	Cir	0.012	2.16	107.49	EX PIPE #3
11	10	7.987	151.685	DrGrt	0.00	0.03	0.90	7.0	105.41	1.00	105.49	12	Cir	0.012	1.00	107.00	PIPE #12
12	7	5.133	90.138	DrGrt	0.00	0.34	0.90	7.0	105.13	0.97	105.18	12	Cir	0.012	1.00	107.95	PIPE #5
13	4	8.087	75.237	DrGrt	0.00	0.04	0.90	7.0	104.92	0.99	105.00	12	Cir	0.012	1.00	108.00	PIPE #1.1
14	4	8.089	-71.230	DrGrt	0.00	0.04	0.90	7.0	104.92	0.99	105.00	12	Cir	0.012	1.00	108.00	PIPE #1.2
15	10	8.532	9.325	DrGrt	0.00	0.20	0.90	7.0	104.88	0.94	104.96	12	Cir	0.012	1.00	107.00	PIPE #12.1
16	10	38.639	72.432	DrGrt	0.00	0.00	0.00	0.0	103.15	0.49	103.34	15	Cir	0.012	1.50	107.50	PIPE #10
17	16	124.051	99.049	DrGrt	0.00	0.60	0.90	7.0	104.24	0.50	104.86	12	Cir	0.012	1.50	108.05	PIPE #13
18	17	32.177	89.998	DrGrt	0.00	0.04	0.90	7.0	104.86	0.99	105.18	8	Cir	0.012	1.00	107.50	PIPE #14
19	6	4.895	51.618	DrGrt	0.00	0.34	0.90	7.0	104.64	1.02	104.69	12	Cir	0.012	1.00	107.95	PIPE #3
20	16	79.389	-0.138	DrGrt	0.00	0.00	0.00	0.0	103.34	1.00	104.13	12	Cir	0.012	1.48	107.63	PIPE #9
21	20	5.850	-80.759	DrGrt	0.00	0.34	0.90	7.0	104.13	1.03	104.19	12	Cir	0.012	0.90	106.65	PIPE #8
22	21	35.796	-33.241	DrGrt	0.00	0.20	0.90	7.0	104.19	1.01	104.55	12	Cir	0.012	1.00	107.50	PIPE #11
23	End	52.257	-95.571	DrGrt	0.00	2.60	0.90	7.0	99.50	0.50	99.76	18	Cir	0.012	1.00	105.08	EX PIPE #2

Project File: 1979-20.stm | Number of lines: 23 | Date: 9/8/2023

Storm Sewer Tabulation

Station Line	To Line	Len (ft)	Drng Area Incr (ac)	Drng Area Total (ac)	Rnoff coeff (C)	Area x C Incr	Area x C Total	Tc Inlet (min)	Tc Syst (min)	Rain (I) (in/hr)	Total flow (cfs)	Cap full (cfs)	Vel (ft/s)	Pipe Size (in)	Pipe Slope (%)	Invert Elev Dn (ft)	Invert Elev Up (ft)	HGL Elev Dn (ft)	HGL Elev Up (ft)	Grnd / Rim Elev Dn (ft)	Grnd / Rim Elev Up (ft)	Line ID
1	End	7.634	0.03	1.23	0.90	0.03	1.11	7.0	14.5	1.9	2.12	7.16	1.73	15	1.05	104.92	105.00	107.15	107.16	108.83	108.00	PIPE #16
2	1	48.331	1.18	1.21	0.90	1.06	1.08	7.0	14.2	1.9	2.10	3.84	2.67	12	0.99	105.00	105.48	107.18	107.32	108.00	109.02	PIPE #15
3	2	38.341	0.03	0.03	0.90	0.03	0.03	7.0	7.0	2.8	0.07	3.84	0.09	12	0.99	105.48	105.86	107.49	107.49	109.02	108.50	PIPE #17
4	End	46.193	0.00	1.96	0.00	0.00	1.76	0.0	12.2	2.1	3.69	5.25	3.01	15	0.56	102.99	103.25	107.06	107.19	108.73	108.70	EX PIPE #1
5	4	33.032	0.86	1.88	0.90	0.78	1.69	7.0	12.0	2.1	3.57	5.02	2.91	15	0.51	103.25	103.42	107.49	107.58	108.70	109.24	PIPE #1
6	5	112.398	0.00	1.02	0.00	0.00	0.92	0.0	10.9	2.2	2.04	6.98	1.66	15	1.00	103.42	104.54	107.66	107.75	109.24	108.53	PIPE #2
7	6	99.000	0.00	0.68	0.00	0.00	0.61	0.0	9.5	2.4	1.46	4.97	1.19	15	0.51	104.64	105.14	107.81	107.85	108.53	108.53	PIPE #4
8	7	99.000	0.00	0.34	0.00	0.00	0.31	0.0	7.1	2.8	0.84	4.97	0.69	15	0.51	105.13	105.63	107.88	107.90	108.53	108.53	PIPE #6
9	8	5.372	0.34	0.34	0.90	0.31	0.31	7.0	7.0	2.8	0.85	3.72	1.08	12	0.93	105.62	105.67	107.91	107.91	108.53	107.95	PIPE #7
10	End	33.002	0.00	1.40	0.00	0.00	1.26	0.0	10.3	2.3	2.87	17.59	0.91	24	0.52	102.98	103.15	106.19	106.19	107.45	107.49	EX PIPE #3
11	10	7.987	0.03	0.03	0.90	0.02	0.02	7.0	7.0	2.8	0.06	3.86	0.80	12	1.00	105.41	105.49	106.22	105.59	107.49	107.00	PIPE #12
12	7	5.133	0.34	0.34	0.90	0.31	0.31	7.0	7.0	2.8	0.85	3.81	1.08	12	0.97	105.13	105.18	107.88	107.89	108.53	107.95	PIPE #5
13	4	8.087	0.04	0.04	0.90	0.04	0.04	7.0	7.0	2.8	0.10	3.84	0.12	12	0.99	104.92	105.00	107.49	107.49	108.70	108.00	PIPE #1.1
14	4	8.089	0.04	0.04	0.90	0.04	0.04	7.0	7.0	2.8	0.10	3.84	0.12	12	0.99	104.92	105.00	107.49	107.49	108.70	108.00	PIPE #1.2
15	10	8.532	0.20	0.20	0.90	0.18	0.18	7.0	7.0	2.8	0.49	3.74	0.63	12	0.94	104.88	104.96	106.22	106.22	107.49	107.00	PIPE #12.1
16	10	38.639	0.00	1.18	0.00	0.00	1.06	0.0	10.0	2.3	2.45	4.91	2.00	15	0.49	103.15	103.34	106.22	106.27	107.49	107.50	PIPE #10
17	16	124.051	0.60	0.64	0.90	0.54	0.58	7.0	8.9	2.5	1.42	2.73	1.80	12	0.50	104.24	104.86	106.36	106.53	107.50	108.05	PIPE #13
18	17	32.177	0.04	0.04	0.90	0.04	0.04	7.0	7.0	2.8	0.10	1.30	0.29	8	0.99	104.86	105.18	106.61	106.61	108.05	107.50	PIPE #14
19	6	4.895	0.34	0.34	0.90	0.31	0.31	7.0	7.0	2.8	0.85	3.90	1.08	12	1.02	104.64	104.69	107.81	107.81	108.53	107.95	PIPE #3
20	16	79.389	0.00	0.54	0.00	0.00	0.48	0.0	8.0	2.6	1.25	3.85	1.60	12	1.00	103.34	104.13	106.36	106.45	107.50	107.63	PIPE #9
21	20	5.850	0.34	0.54	0.90	0.31	0.48	7.0	7.9	2.6	1.26	3.91	1.60	12	1.03	104.13	104.19	106.51	106.51	107.63	106.65	PIPE #8
22	21	35.796	0.20	0.20	0.90	0.18	0.18	7.0	7.0	2.8	0.49	3.87	0.63	12	1.01	104.19	104.55	106.55	106.55	106.65	107.50	PIPE #11

Project File: 1979-20.stm | Number of lines: 23 | Run Date: 9/8/2023

NOTES:Intensity = 8.02 / (Inlet time + 0.40) ^ 0.53; Return period =Yrs. 10 ; c = cir e = ellip b = box

Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line		Incr	Total		Incr	Total	Inlet	Syst					Size	Slope	Dn	Up	Dn	Up	Dn	Up	
		(ft)	(ac)	(ac)	(C)			(min)	(min)	(in/hr)	(cfs)	(cfs)	(ft/s)	(in)	(%)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	
23	End	52.257	2.60	2.60	0.90	2.34	2.34	7.0	7.0	2.8	6.49	8.02	3.67	18	0.50	99.50	99.76	104.08	104.25	101.80	105.08	EX PIPE #2

Project File: 1979-20.stm | Number of lines: 23 | Run Date: 9/8/2023

NOTES:Intensity = 8.02 / (Inlet time + 0.40) ^ 0.53; Return period =Yrs. 10 ; c = cir e = ellip b = box

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
			Invert elev	HGL elev	Depth	Area	Vel	Vel head	EGL elev	Sf		Invert elev	HGL elev	Depth	Area	Vel	Vel head	EGL elev	Sf	Ave Sf	Enrgy loss		
	(in)	(cfs)	(ft)	(ft)	(ft)	(sqft)	(ft/s)	(ft)	(ft)	(%)	(ft)	(ft)	(ft)	(ft)	(sqft)	(ft/s)	(ft)	(ft)	(%)	(%)	(ft)	(K)	(ft)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
1	15	2.12	104.92	107.15	1.25	1.23	1.73	0.05	107.20	0.092	7.634	105.00	107.16	1.25	1.23	1.73	0.05	107.20	0.092	0.092	0.007	0.50	0.02
2	12	2.10	105.00	107.18	1.00	0.79	2.67	0.11	107.29	0.296	48.331	105.48	107.32	1.00	0.79	2.67	0.11	107.43	0.296	0.296	0.143	1.50	0.17
3	12	0.07	105.48	107.49	1.00	0.79	0.09	0.00	107.49	0.000	38.341	105.86	107.49	1.00	0.79	0.09	0.00	107.49	0.000	0.000	0.000	1.00	0.00
4	15	3.69	102.99	107.06	1.25	1.23	3.01	0.14	107.20	0.279	46.193	103.25	107.19	1.25	1.23	3.01	0.14	107.33	0.279	0.279	0.129	2.15	0.30
5	15	3.57	103.25	107.49	1.25	1.23	2.91	0.13	107.62	0.261	33.032	103.42	107.58	1.25	1.23	2.91	0.13	107.71	0.261	0.261	0.086	0.62	0.08
6	15	2.04	103.42	107.66	1.25	1.23	1.66	0.04	107.70	0.085	112.398	104.54	107.75	1.25	1.23	1.66	0.04	107.80	0.085	0.085	0.095	1.23	0.05
7	15	1.46	104.64	107.81	1.25	1.23	1.19	0.02	107.83	0.043	99.000	105.14	107.85	1.25	1.23	1.19	0.02	107.87	0.043	0.043	0.043	1.50	0.03
8	15	0.84	105.13	107.88	1.25	1.23	0.69	0.01	107.89	0.015	99.000	105.63	107.90	1.25	1.23	0.69	0.01	107.90	0.015	0.015	0.014	1.50	0.01
9	12	0.85	105.62	107.91	1.00	0.79	1.08	0.02	107.93	0.048	5.372	105.67	107.91	1.00	0.79	1.08	0.02	107.93	0.048	0.048	0.003	1.00	0.02
10	24	2.87	102.98	106.19	2.00	3.14	0.91	0.01	106.20	0.014	33.002	103.15	106.19	2.00	3.14	0.91	0.01	106.21	0.014	0.014	0.005	2.16	0.03
11	12	0.06	105.41	106.22	0.81	0.04	0.09	0.04	106.26	0.000	7.987	105.49	105.59	0.10**	0.04	1.51	0.04	105.63	0.000	0.000	n/a	1.00	0.04
12	12	0.85	105.13	107.88	1.00	0.79	1.08	0.02	107.90	0.048	5.133	105.18	107.89	1.00	0.79	1.08	0.02	107.90	0.048	0.048	0.002	1.00	0.02
13	12	0.10	104.92	107.49	1.00	0.79	0.12	0.00	107.49	0.001	8.087	105.00	107.49	1.00	0.79	0.12	0.00	107.49	0.001	0.001	0.000	1.00	0.00
14	12	0.10	104.92	107.49	1.00	0.79	0.12	0.00	107.49	0.001	8.089	105.00	107.49	1.00	0.79	0.12	0.00	107.49	0.001	0.001	0.000	1.00	0.00
15	12	0.49	104.88	106.22	1.00	0.79	0.63	0.01	106.23	0.016	8.532	104.96	106.22	1.00	0.79	0.63	0.01	106.23	0.016	0.016	0.001	1.00	0.01
16	15	2.45	103.15	106.22	1.25	1.23	2.00	0.06	106.28	0.123	38.639	103.34	106.27	1.25	1.23	2.00	0.06	106.33	0.123	0.123	0.047	1.50	0.09
17	12	1.42	104.24	106.36	1.00	0.79	1.80	0.05	106.41	0.135	124.051	104.86	106.53	1.00	0.79	1.80	0.05	106.58	0.135	0.135	0.167	1.50	0.08
18	8	0.10	104.86	106.61	0.67	0.35	0.29	0.00	106.61	0.006	32.177	105.18	106.61	0.67	0.35	0.29	0.00	106.61	0.006	0.006	0.002	1.00	0.00
19	12	0.85	104.64	107.81	1.00	0.79	1.08	0.02	107.83	0.048	4.895	104.69	107.81	1.00	0.79	1.08	0.02	107.83	0.048	0.048	0.002	1.00	0.02
20	12	1.25	103.34	106.36	1.00	0.79	1.60	0.04	106.40	0.106	79.389	104.13	106.45	1.00	0.79	1.60	0.04	106.49	0.106	0.106	0.084	1.48	0.06
21	12	1.26	104.13	106.51	1.00	0.79	1.60	0.04	106.55	0.107	5.850	104.19	106.51	1.00	0.79	1.60	0.04	106.55	0.107	0.107	0.006	0.90	0.04

Project File: 1979-20.stm	Number of lines: 23	Run Date: 9/8/2023

Notes: ; ** Critical depth. ; c = cir e = ellip b = box

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
			Invert elev	HGL elev	Depth	Area	Vel	Vel head	EGL elev	Sf		Invert elev	HGL elev	Depth	Area	Vel	Vel head	EGL elev	Sf	Ave Sf	Enrgy loss		
	(in)	(cfs)	(ft)	(ft)	(ft)	(sqft)	(ft/s)	(ft)	(ft)	(%)	(ft)	(ft)	(ft)	(ft)	(sqft)	(ft/s)	(ft)	(ft)	(%)	(%)	(ft)	(K)	(ft)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
22	12	0.49	104.19	106.55	1.00	0.79	0.63	0.01	106.55	0.016	35.796	104.55	106.55	1.00	0.79	0.63	0.01	106.56	0.016	0.016	0.006	1.00	0.01
23	18	6.49	99.50	104.08	1.50	1.77	3.67	0.21	104.29	0.325	52.257	99.76	104.25	1.50	1.77	3.67	0.21	104.46	0.325	0.325	0.170	1.00	0.21

Project File: 1979-20.stm	Number of lines: 23	Run Date: 9/8/2023

Notes: ; ** Critical depth. ; c = cir e = ellip b = box

Hydraflow HGL Computation Procedure

General Procedure:

Hydraflow computes the HGL using the Bernoulli energy equation. Manning's equation is used to determine energy losses due to pipe friction. In a standard step, iterative procedure, Hydraflow assumes upstream HGLs until the energy equation balances. If the energy equation cannot balance, supercritical flow exists and critical depth is temporarily assumed at the upstream end. A supercritical flow Profile is then computed using the same procedure in a downstream direction using momentum principles.

Col. 1 The line number being computed. Calculations begin at Line 1 and proceed upstream.

Col. 2 The line size. In the case of non-circular pipes, the line rise is printed above the span.

Col. 3 Total flow rate in the line.

Col. 4 The elevation of the downstream invert.

Col. 5 Elevation of the hydraulic grade line at the downstream end. This is computed as the upstream HGL + Minor loss of this line's downstream line.

Col. 6 The downstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 7 Cross-sectional area of the flow at the downstream end.

Col. 8 The velocity of the flow at the downstream end, (Col. 3 / Col. 7).

Col. 9 Velocity head (Velocity squared / 2g).

Col. 10 The elevation of the energy grade line at the downstream end, HGL + Velocity head. (Col. 5 + Col. 9).

Col. 11 The friction slope at the downstream end (the S or Slope term in Manning's equation).

Col. 12 The line length.

Col. 13 The elevation of the upstream invert.

Col. 14 Elevation of the hydraulic grade line at the upstream end.

Col. 15 The upstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 16 Cross-sectional area of the flow at the upstream end.

Col. 17 The velocity of the flow at the upstream end, (Col. 3 / Col. 16).

Col. 18 Velocity head (Velocity squared / 2g).

Col. 19 The elevation of the energy grade line at the upstream end, HGL + Velocity head, (Col. 14 + Col. 18) .

Col. 20 The friction slope at the upstream end (the S or Slope term in Manning's equation).

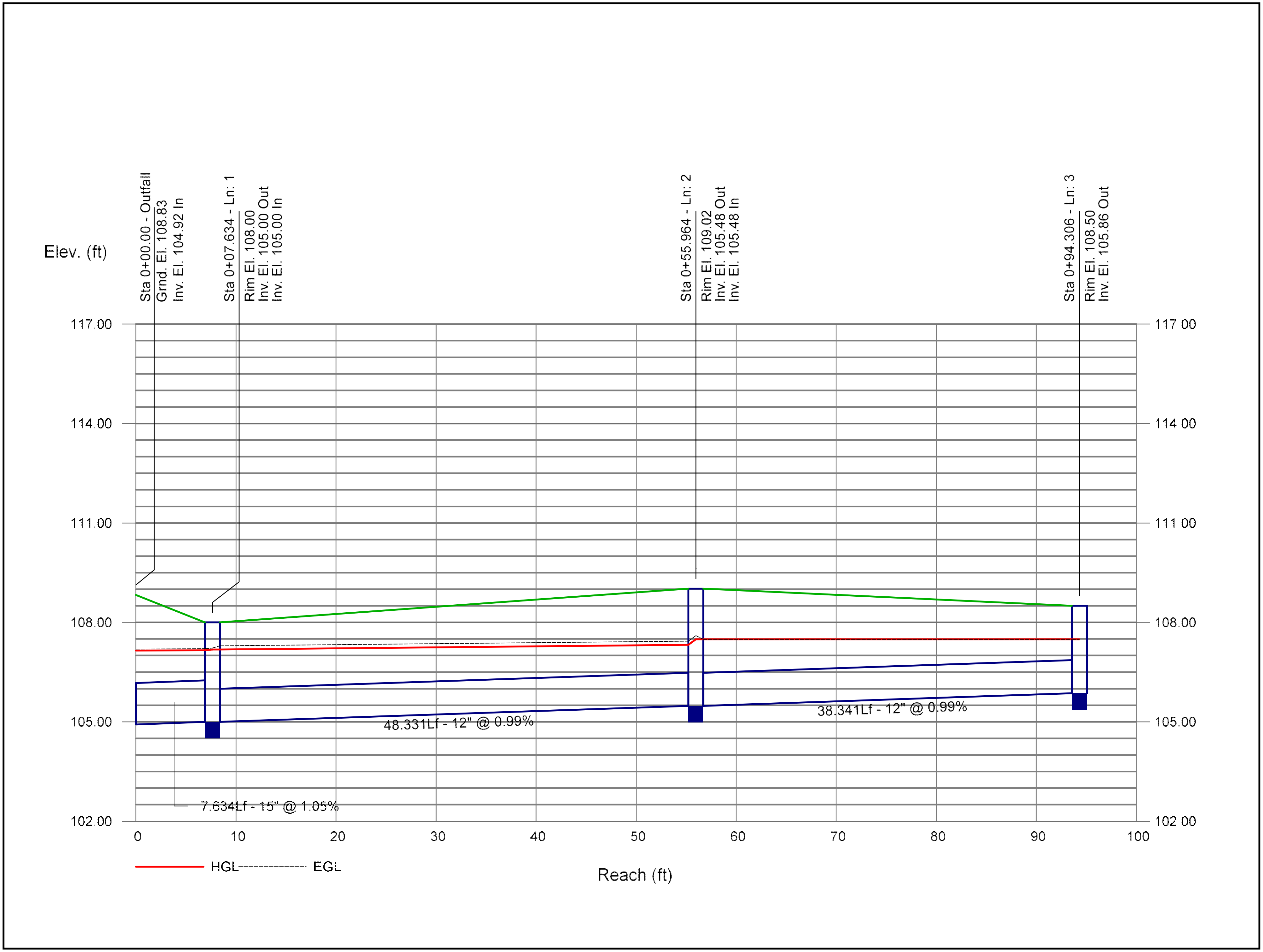
Col. 21 The average of the downstream and upstream friction slopes.

Col. 22 Energy loss. Average Sf/100 x Line Length (Col. 21/100 x Col. 12). Equals (EGL upstream - EGL downstream) +/- tolerance.

Col. 23 The junction loss coefficient (K).

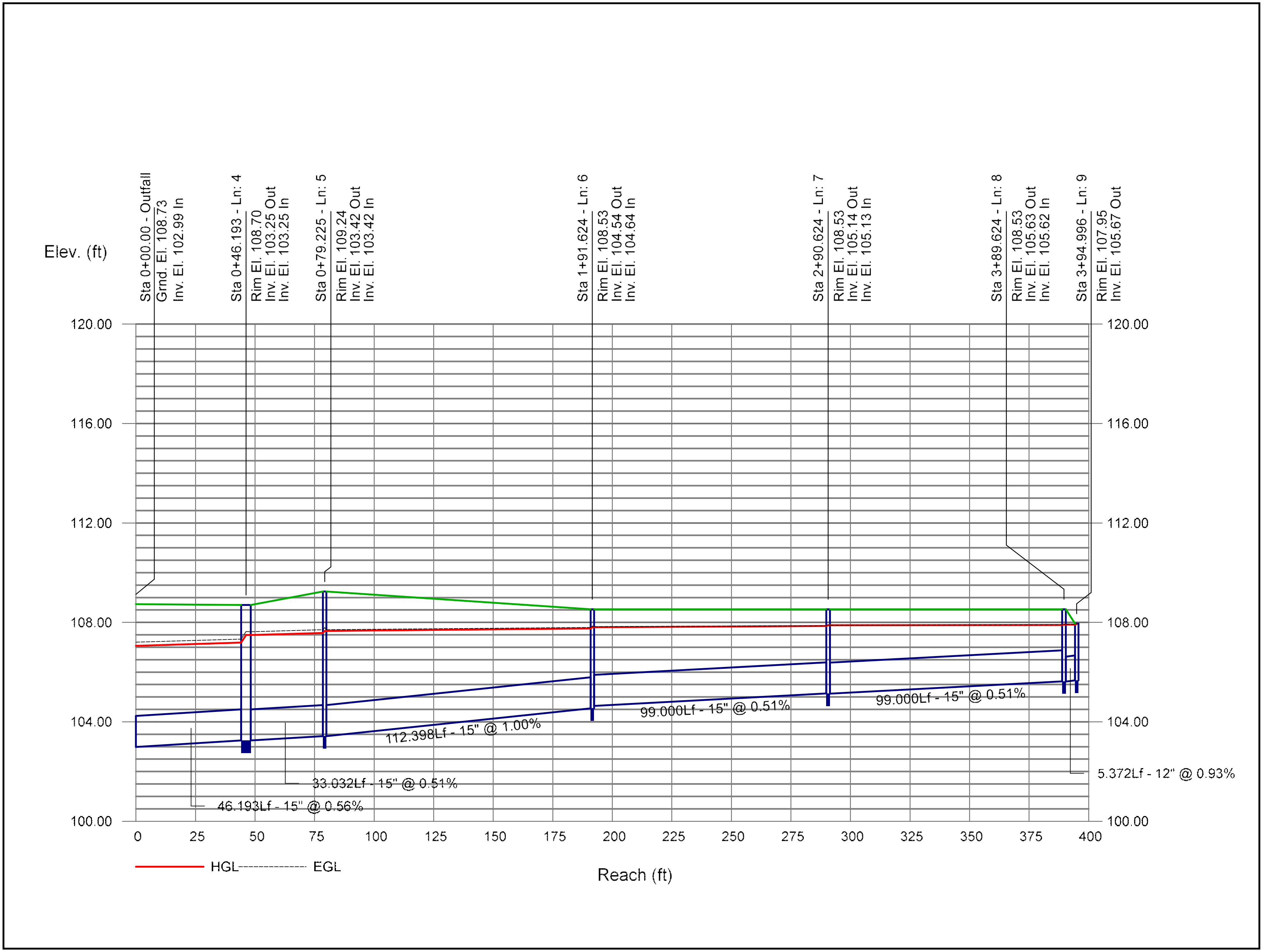
Col. 24 Minor loss. (Col. 23 x Col. 18). Is added to upstream HGL and used as the starting HGL for the next upstream line(s).

Storm Sewer Profile



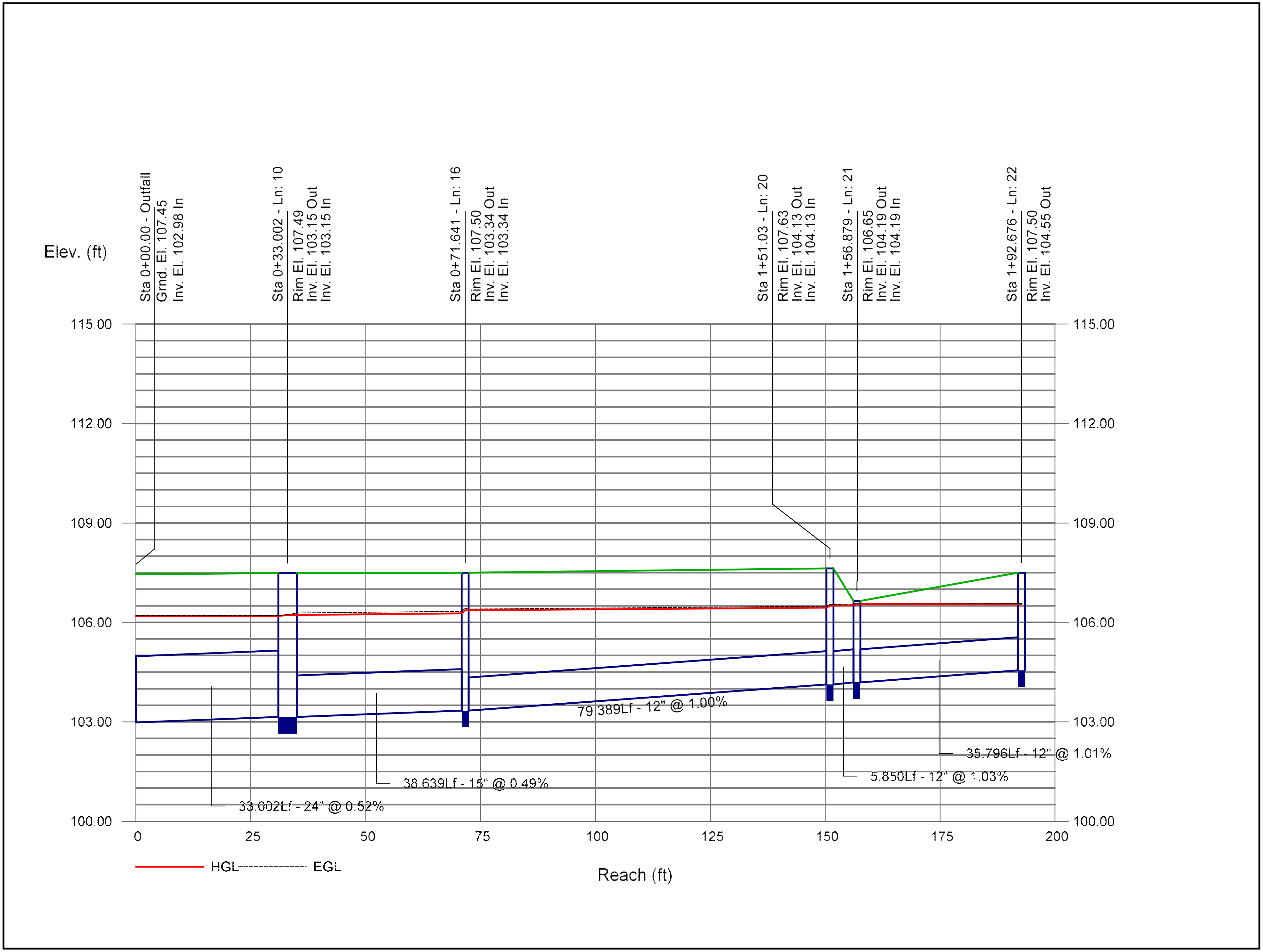
Storm Sewer Profile

Proj. file: 1979-20 SD.stm



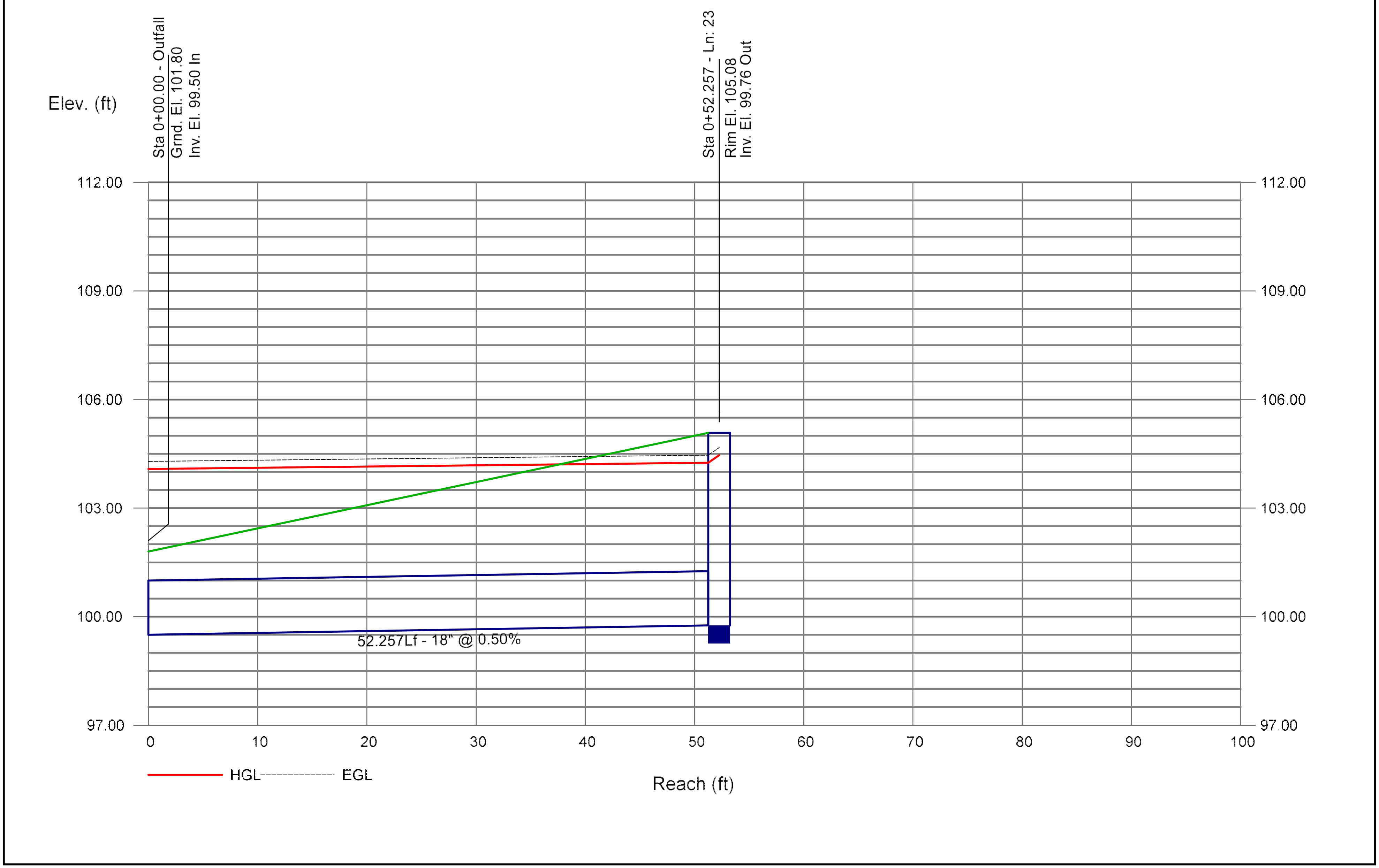
Storm Sewer Profile

Proj. file: 1979-20 SD.stm



Storm Sewer Profile

Proj. file: 1979-20 SD.stm



tl@bcengineeringgroup.com

From:	md@bcengineeringgroup.com
Sent:	Thursday, August 31, 2023 1:35 PM
To:	tl@bcengineeringgroup.com
Subject:	FW: Northpoint Parkway Drainage

Best Regards,

Marcel Delagnes, QSP, CESSWI – Project Manager
md@bcengineeringgroup.com

BC Engineering Group Inc.
707-542-4321
2800 Cleveland Ave, Suite B Santa Rosa, CA 95403
www.bcengineeringgroup.com

From: Phil Wadsworth <Phil.Wadsworth@scwa.ca.gov>
Sent: Thursday, July 27, 2023 12:38 PM
To: md@bcengineeringgroup.com
Subject: RE: Northpoint Parkway Drainage

Marcel,

Per our phone discussion today, I wasn't able to find any information for the two projects along Northpoint Parkway. We discussed the option of using 1.0 below the catch basin or manhole tie-in elevation but you indicated that might be problematic. I'll give it another try and see if I can find any information.

Good day,

Philip Wadsworth
Sonoma Water

From: md@bcengineeringgroup.com <md@bcengineeringgroup.com>
Sent: Monday, July 10, 2023 1:23 PM
To: Phil Wadsworth <Phil.Wadsworth@scwa.ca.gov>
Subject: Northpoint Parkway Drainage

Hello Phil,

We are working on two new projects located on Northpoint Parkway in Santa Rosa. Please see the attached AP map for reference. Both sites are outlined in red.

We received the following comment from the City of Santa Rosa on our preliminary drainage report for the project with APNs 035-530-16 and 035-530-55:

- Reach out to Sonoma Water for record drainage reports and calculations for what this SD system was designed to handle. Include the report in this submittal and clarify how the proposed project compares to that design runoff coefficient.

- Verify the public downstream outflow facilities have adequate capacity for the post development project flows.

Can you please provide the information needed to update our drainage analysis and address these comments? Please let me know if you have any questions.

Best Regards,

Marcel Delagnes, QSP, CESSWI – Project Manager
md@bcengineeringgroup.com

BC Engineering Group Inc.
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BC Engineering Group
Civil Engineering & Land Planning

Appendix C: Open Channel Flow Calculations

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Table D.2-4. Manning's Roughness Coefficients for Closed Conduits and Culverts

Conduit/Culvert Material	**Manning's *n***
Concrete	
Smooth forms	0.014
Rough	0.015-0.017
Corrugated-metal pipe -- (2-1/2 in x 1/2 in corrugations)	
Plain	0.022-0.026
Paved invert	0.018-0.022
Spun asphalt lined	0.012-0.015
Plastic pipe (smooth)	0.012-0.015
Corrugated-metal pipe -- (2-2/3 in x 1/2 in annular)	0.022-0.027
Corrugated-metal pipe -- (2-2/3 in x 1/2 in helical)	0.012-0.023
Corrugated-metal pipe -- (6 in x 1 in helical)	0.022-0.025
Corrugated-metal pipe -- (5 in x 1 in helical)	0.025–0.026
Corrugated-metal pipe -- (3 in x 1 in helical)	0.027–0.028
Corrugated-metal pipe -- (6 in x 2 in structural plate)	0.033–0.035
Corrugated-metal pipe -- (9 in x 2-1/2 in structural plate)	0.033–0.037
Polyethylene	
Smooth	0.012-0.015
Corrugated	0.018–0.025
Spiral rib metal pipe (smooth)	0.012-0.013
Polyvinyl chloride (PVC) (smooth)	0.012-0.011

Sources: ASCE 1982, FHWA 2001; modified to show minimum values of 0.012-0.014.

Hydraulic Analysis Report

Project Data

Project Title: 1979-20

Designer: TSL

Project Date: See Cover

Project Units: U.S. Customary Units

Notes:

Channel Analysis: Ex Pipe #1

Notes: A1, A3 , A9, & A10

Input Parameters

Channel Type: Circular

Pipe Diameter 1.25 ft

Longitudinal Slope: 0.0050 ft/ft

Manning's n: 0.0120

Flow 4.6500 cfs

Result Parameters

Depth 0.9628 ft

Area of Flow 1.0143 ft^2

Wetted Perimeter 2.6772 ft

Hydraulic Radius 0.3788 ft

Average Velocity 4.5847 ft/s

Top Width 1.0517 ft

Froude Number: 0.8227

Critical Depth 0.8740 ft

Critical Velocity 5.0741 ft/s

Critical Slope: 0.0063 ft/ft

Critical Top Width 1.15 ft

Calculated Max Shear Stress 0.3004 lb/ft^2

Calculated Avg Shear Stress 0.1182 lb/ft^2

Channel Analysis: Ex Pipe #2

Notes: A4

Input Parameters

Channel Type: Circular

Pipe Diameter 1.50 ft

Longitudinal Slope: 0.0050 ft/ft

Manning's n: 0.0120

Flow 6.2200 cfs

Result Parameters

Depth 0.9901 ft

Area of Flow 1.2374 ft^2

Wetted Perimeter 2.8449 ft

Hydraulic Radius 0.4350 ft

Average Velocity 5.0266 ft/s

Top Width 1.4211 ft

Froude Number: 0.9493

Critical Depth 0.9639 ft

Critical Velocity 5.1835 ft/s

Critical Slope: 0.0054 ft/ft

Critical Top Width 1.44 ft

Calculated Max Shear Stress 0.3089 lb/ft^2

Calculated Avg Shear Stress 0.1357 lb/ft^2

Channel Analysis: Ex Pipe #3

Notes: A1, A2, A6, A7, & A8

Input Parameters

Channel Type: Circular

Pipe Diameter 2.00 ft

Longitudinal Slope: 0.0050 ft/ft

Manning's n: 0.0120

Flow 2.8400 cfs

Result Parameters

Depth 0.5476 ft

Area of Flow 0.6979 ft^2

Wetted Perimeter 2.2027 ft

Hydraulic Radius 0.3168 ft

Average Velocity 4.0694 ft/s

Top Width 1.7836 ft

Froude Number: 1.1464

Critical Depth 0.5874 ft

Critical Velocity 3.6900 ft/s

Critical Slope: 0.0038 ft/ft

Critical Top Width 1.82 ft

Calculated Max Shear Stress 0.1709 lb/ft^2

Calculated Avg Shear Stress 0.0989 lb/ft^2

Channel Analysis: Pipe #16

Notes: A5 & A11

Input Parameters

Channel Type: Circular

Pipe Diameter 1.00 ft

Longitudinal Slope: 0.0100 ft/ft

Manning's n: 0.0120

Flow 2.8900 cfs

Result Parameters

Depth 0.6454 ft

Area of Flow 0.5360 ft^2

Wetted Perimeter 1.8659 ft

Hydraulic Radius 0.2873 ft

Average Velocity 5.3915 ft/s

Top Width 0.9568 ft

Froude Number: 1.2694

Critical Depth 0.7285 ft

Critical Velocity 4.7146 ft/s

Critical Slope: 0.0072 ft/ft

Critical Top Width 0.89 ft

Calculated Max Shear Stress 0.4027 lb/ft^2

Calculated Avg Shear Stress 0.1793 lb/ft^2

BC Engineering Group
Civil Engineering & Land Planning

Appendix D: Soil Analysis

418 B Street, 3rd Floor
Santa Rosa, CA 95401
707-542-4321
www.bcengineeringgroup.com

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

Sonoma County, California

March 11, 2023

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map

Map Scale: 1:1,500 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0, 20, 40, 80, 120

Feet: 0, 50, 100, 200, 300

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

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

Soil Survey Area: Sonoma County, California
Survey Area Data: Version 16, Sep 14, 2022

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 26, 2022—Apr 25, 2022

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
CfA	Clear Lake clay, ponded, 0 to 2 percent slopes	10.6	98.5%
WhA	Wright loam, wet, 0 to 2 percent slopes	0.2	1.5%
Totals for Area of Interest		**10.8**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Sonoma County, California

CfA—Clear Lake clay, ponded, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 2y8vg
Elevation: 50 to 210 feet
Mean annual precipitation: 27 to 40 inches
Mean annual air temperature: 57 to 58 degrees F
Frost-free period: 265 to 315 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Clear lake and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Clear Lake

Setting

Landform: Basin floors
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Alluvium derived from volcanic and sedimentary rock

Typical profile

Apg - 0 to 8 inches: clay
Assg - 8 to 25 inches: clay
Bssg - 25 to 46 inches: clay
Bkssg - 46 to 52 inches: clay
2Bkg - 52 to 60 inches: clay loam
2Btg - 60 to 72 inches: clay loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Calcium carbonate, maximum content: 7 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 10.0
Available water supply, 0 to 60 inches: High (about 9.7 inches)

Interpretive groups

Land capability classification (irrigated): 2s
Land capability classification (nonirrigated): 3s
Hydrologic Soil Group: C/D
Ecological site: R014XG907CA - Loamy Bottom

Hydric soil rating: Yes

Minor Components

Huichica

Percent of map unit: 6 percent
Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Concave
Across-slope shape: Linear
Hydric soil rating: No

Wright

Percent of map unit: 6 percent
Landform: Stream terraces
Landform position (three-dimensional): Tread
Down-slope shape: Concave
Across-slope shape: Linear
Hydric soil rating: No

Zamora

Percent of map unit: 3 percent
Landform: Alluvial fans
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

WhA—Wright loam, wet, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: hfkm
Elevation: 60 to 300 feet
Mean annual precipitation: 30 inches
Mean annual air temperature: 55 degrees F
Frost-free period: 240 to 260 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Wright and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Wright

Setting

Landform: Terraces
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear

Parent material: Alluvium

Typical profile

H1 - 0 to 7 inches: loam
H2 - 7 to 25 inches: loam
H3 - 25 to 62 inches: clay
H4 - 62 to 73 inches: sandy clay loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 3.8 inches)

Interpretive groups

Land capability classification (irrigated): 3w
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: D
Ecological site: R014XG912CA - Loamy Terrace
Hydric soil rating: Yes

Minor Components

Unnamed

Percent of map unit: 5 percent
Landform: Flood plains
Hydric soil rating: Yes

Zamora

Percent of map unit: 3 percent
Hydric soil rating: No

Huichica

Percent of map unit: 3 percent
Hydric soil rating: No

Yolo

Percent of map unit: 3 percent
Hydric soil rating: No

Clear lake

Percent of map unit: 1 percent
Landform: Flood plains
Hydric soil rating: Yes

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