Park Apartments – Phase II

Storm Drainage Report / April 2023

McAdams

PARK APARTMENTS – PHASE II

CHAPEL HILL, NORTH CAROLINA

STORM DRAINAGE
CALCULATIONS REPORT

PROJECT NUMBER: **WDF-22001**
DESIGNED BY: **MICHAEL OTTESON, PE**

DATE: **APRIL 17, 2023**

MCADAMS
621 HILLSBOROUGH ST, SUITE 500
RALEIGH, NORTH CAROLINA 27603
NC LLC. # C-0293

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Park Apartments – Phase II

Form District Permit

Storm Drainage Report

GENERAL DESCRIPTION

The proposed development is located at the northwest of the intersection of Elliott Road and Bennett Way in Chapel Hill, North Carolina as Phase II of the overall Park Apartments development. The existing site vacant with existing storm sewer infrastructure routing off-site. The project will be disturbing approximately 2.44 acres.

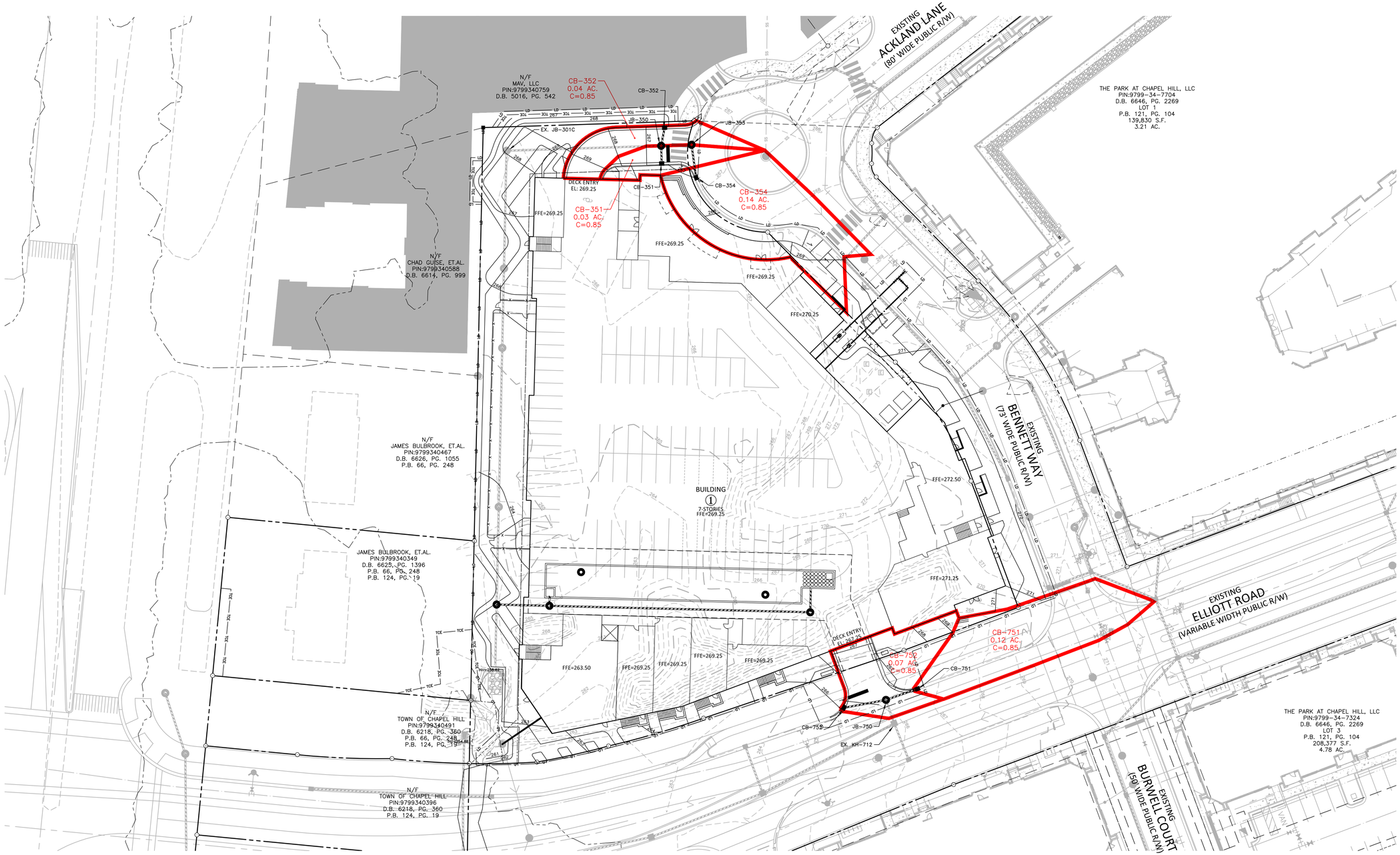
CALCULATION METHODOLOGY

- For each individual storm drainage inlet, a drainage area was measured as well as assigning impervious surface percentage. From this impervious percentage, a rational c factor was calculated based on 0.95 for impervious areas. For drainage areas with a combination of both pervious (Open Space and Lawns, C=0.30) and impervious areas, a composite "c" factor was interpolated.
- The pipes were sized using Hydraflow Storm Sewers extension for Autodesk Civil 3D - 2020. This program accepts the input data from each inlet, as well as physical characteristics of the storm system to be designed and calculates flow rates and pipe sizes throughout the system. For rainfall data, an IDF curve describing the Cary, NC region was used. The final results of this program as well as calculated pipe sizes and hydraulic grade lines may be found in the appropriate section of this report. The minimum pipe size was 15" unless otherwise shown on the plans. Pipe material is RCP unless otherwise noted on the plans.
- The various inlet types are shown on the stormwater detail sheet, within the plan set.
- The storm sewer network was analyzed for the 10- and 25-year storm event using a time of concentration of 5 minutes.
- In situations where the 10-year pond elevation was controlling the HGL, the HGL was allowed to exceed the top of pipe elevation and O-Ring gasketed joint RCP was specified.
- For pipe segments where the 10-year HGL exceeds the elevation of the crest of pipe, the pipe shall have watertight joints to 10 psi.

621 Hillsborough St, Suite 500, Raleigh, NC 27603 / 919. 361. 5000

Drainage Area Map and IDF Rainfall Tables

Park Apartments – Phase II
Form District Permit
WDF-22001



PRELIMINARY DRAWING - NOT RELEASED FOR CONSTRUCTION

McADAMS

The John R. McAdams Company, Inc.
2905 Meridian Parkway
Durham, NC 27713

phone 919. 361. 5000
fax 919. 361. 2269
license number: C-0293, C-187

www.mcadamsco.com

CLIENT

WOODFIELD INVESTMENTS
11425 HORSEMANS TRAIL
RALEIGH, NC 27613
PHONE: 919. 535. 8947

PARK APARTMENTS - PHASE II

PHASE II FORM DISTRICT PERMIT
0 ELLIOTT ROAD
CHAPEL HILL, NORTH CAROLINA, 27517

REVISIONS

NO.	DATE

PLAN INFORMATION

PROJECT NO.	WDF22001
FILENAME	WDF22001x-C3D
CHECKED BY	DCB
DRAWN BY	MRO
SCALE	1"=30'
DATE	04. 14. 2023

SHEET

DRAINAGE AREA MAP

DA1.00

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NOAA Atlas 14, Volume 2, Version 3
Location name: Chapel Hill, North Carolina, USA*
Latitude: 35.9329°, Longitude: -79.0217°
Elevation: m/ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

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	**4.91** (4.49-5.36)	**5.77** (5.29-6.30)	**6.62** (6.07-7.22)	**7.33** (6.71-7.99)	**8.05** (7.33-8.77)	**8.58** (7.79-9.35)	**9.04** (8.16-9.85)	**9.43** (8.46-10.3)	**9.85** (8.76-10.8)	**10.2** (8.98-11.1)
10-min	**3.92** (3.59-4.28)	**4.61** (4.23-5.04)	**5.30** (4.86-5.78)	**5.86** (5.36-6.40)	**6.42** (5.84-7.00)	**6.83** (6.20-7.44)	**7.18** (6.48-7.82)	**7.48** (6.71-8.15)	**7.79** (6.93-8.51)	**8.02** (7.07-8.77)
15-min	**3.27** (2.99-3.57)	**3.86** (3.54-4.22)	**4.47** (4.10-4.88)	**4.94** (4.52-5.39)	**5.42** (4.94-5.91)	**5.77** (5.23-6.28)	**6.05** (5.46-6.60)	**6.29** (5.64-6.86)	**6.54** (5.81-7.14)	**6.71** (5.92-7.34)
30-min	**2.24** (2.05-2.45)	**2.67** (2.45-2.92)	**3.18** (2.91-3.47)	**3.58** (3.28-3.91)	**4.02** (3.66-4.38)	**4.34** (3.94-4.73)	**4.63** (4.18-5.05)	**4.89** (4.39-5.34)	**5.20** (4.63-5.68)	**5.44** (4.79-5.94)
60-min	**1.40** (1.28-1.53)	**1.68** (1.54-1.83)	**2.04** (1.87-2.22)	**2.33** (2.13-2.54)	**2.68** (2.44-2.91)	**2.94** (2.67-3.20)	**3.19** (2.88-3.48)	**3.43** (3.08-3.75)	**3.73** (3.32-4.07)	**3.97** (3.50-4.34)
2-hr	**0.835** (0.762-0.918)	**1.00** (0.920-1.10)	**1.23** (1.13-1.35)	**1.42** (1.30-1.56)	**1.65** (1.50-1.81)	**1.84** (1.66-2.01)	**2.02** (1.81-2.21)	**2.20** (1.96-2.40)	**2.43** (2.14-2.66)	**2.63** (2.29-2.88)
3-hr	**0.592** (0.542-0.650)	**0.714** (0.655-0.783)	**0.879** (0.805-0.963)	**1.02** (0.931-1.12)	**1.20** (1.08-1.30)	**1.34** (1.21-1.46)	**1.48** (1.33-1.62)	**1.63** (1.45-1.78)	**1.82** (1.60-1.99)	**1.99** (1.73-2.18)
6-hr	**0.357** (0.329-0.391)	**0.430** (0.396-0.470)	**0.530** (0.487-0.578)	**0.616** (0.564-0.671)	**0.726** (0.661-0.790)	**0.819** (0.740-0.890)	**0.912** (0.817-0.990)	**1.01** (0.893-1.09)	**1.14** (0.994-1.24)	**1.25** (1.08-1.36)
12-hr	**0.210** (0.194-0.229)	**0.253** (0.233-0.275)	**0.313** (0.288-0.341)	**0.367** (0.336-0.398)	**0.436** (0.397-0.472)	**0.496** (0.448-0.535)	**0.557** (0.497-0.600)	**0.621** (0.548-0.669)	**0.709** (0.615-0.764)	**0.787** (0.671-0.849)
24-hr	**0.123** (0.116-0.132)	**0.149** (0.140-0.159)	**0.186** (0.174-0.199)	**0.215** (0.201-0.229)	**0.254** (0.237-0.272)	**0.285** (0.265-0.305)	**0.317** (0.293-0.339)	**0.349** (0.322-0.375)	**0.394** (0.362-0.424)	**0.429** (0.392-0.463)
2-day	**0.072** (0.068-0.077)	**0.087** (0.081-0.093)	**0.108** (0.101-0.115)	**0.124** (0.116-0.132)	**0.145** (0.135-0.155)	**0.162** (0.150-0.173)	**0.179** (0.166-0.192)	**0.196** (0.181-0.211)	**0.220** (0.202-0.237)	**0.239** (0.218-0.258)
3-day	**0.051** (0.048-0.054)	**0.061** (0.057-0.065)	**0.075** (0.071-0.081)	**0.086** (0.081-0.092)	**0.101** (0.094-0.109)	**0.113** (0.105-0.121)	**0.125** (0.116-0.134)	**0.138** (0.127-0.148)	**0.154** (0.141-0.166)	**0.168** (0.153-0.181)
4-day	**0.040** (0.038-0.043)	**0.048** (0.045-0.052)	**0.059** (0.056-0.063)	**0.068** (0.064-0.073)	**0.080** (0.074-0.085)	**0.089** (0.082-0.095)	**0.098** (0.091-0.106)	**0.108** (0.099-0.116)	**0.121** (0.111-0.131)	**0.132** (0.120-0.143)
7-day	**0.026** (0.025-0.028)	**0.031** (0.030-0.034)	**0.038** (0.036-0.041)	**0.044** (0.041-0.046)	**0.051** (0.048-0.054)	**0.056** (0.053-0.060)	**0.062** (0.058-0.067)	**0.068** (0.063-0.073)	**0.077** (0.071-0.082)	**0.083** (0.076-0.090)
10-day	**0.021** (0.020-0.022)	**0.025** (0.024-0.027)	**0.030** (0.028-0.032)	**0.034** (0.032-0.036)	**0.039** (0.037-0.042)	**0.043** (0.041-0.046)	**0.047** (0.044-0.051)	**0.052** (0.048-0.055)	**0.058** (0.053-0.062)	**0.062** (0.057-0.067)
20-day	**0.014** (0.013-0.015)	**0.017** (0.016-0.018)	**0.020** (0.018-0.021)	**0.022** (0.021-0.023)	**0.025** (0.024-0.027)	**0.028** (0.026-0.029)	**0.030** (0.028-0.032)	**0.033** (0.031-0.035)	**0.036** (0.034-0.039)	**0.039** (0.036-0.042)
30-day	**0.012** (0.011-0.012)	**0.014** (0.013-0.014)	**0.016** (0.015-0.017)	**0.018** (0.017-0.019)	**0.020** (0.019-0.021)	**0.022** (0.020-0.023)	**0.023** (0.022-0.025)	**0.025** (0.023-0.027)	**0.027** (0.025-0.029)	**0.029** (0.027-0.031)
45-day	**0.010** (0.009-0.010)	**0.012** (0.011-0.012)	**0.013** (0.013-0.014)	**0.015** (0.014-0.015)	**0.016** (0.015-0.017)	**0.017** (0.017-0.018)	**0.019** (0.018-0.020)	**0.020** (0.019-0.021)	**0.022** (0.020-0.023)	**0.023** (0.021-0.024)
60-day	**0.009** (0.008-0.009)	**0.010** (0.010-0.011)	**0.012** (0.011-0.012)	**0.013** (0.012-0.013)	**0.014** (0.013-0.015)	**0.015** (0.014-0.016)	**0.016** (0.015-0.017)	**0.017** (0.016-0.018)	**0.018** (0.017-0.019)	**0.019** (0.018-0.020)

[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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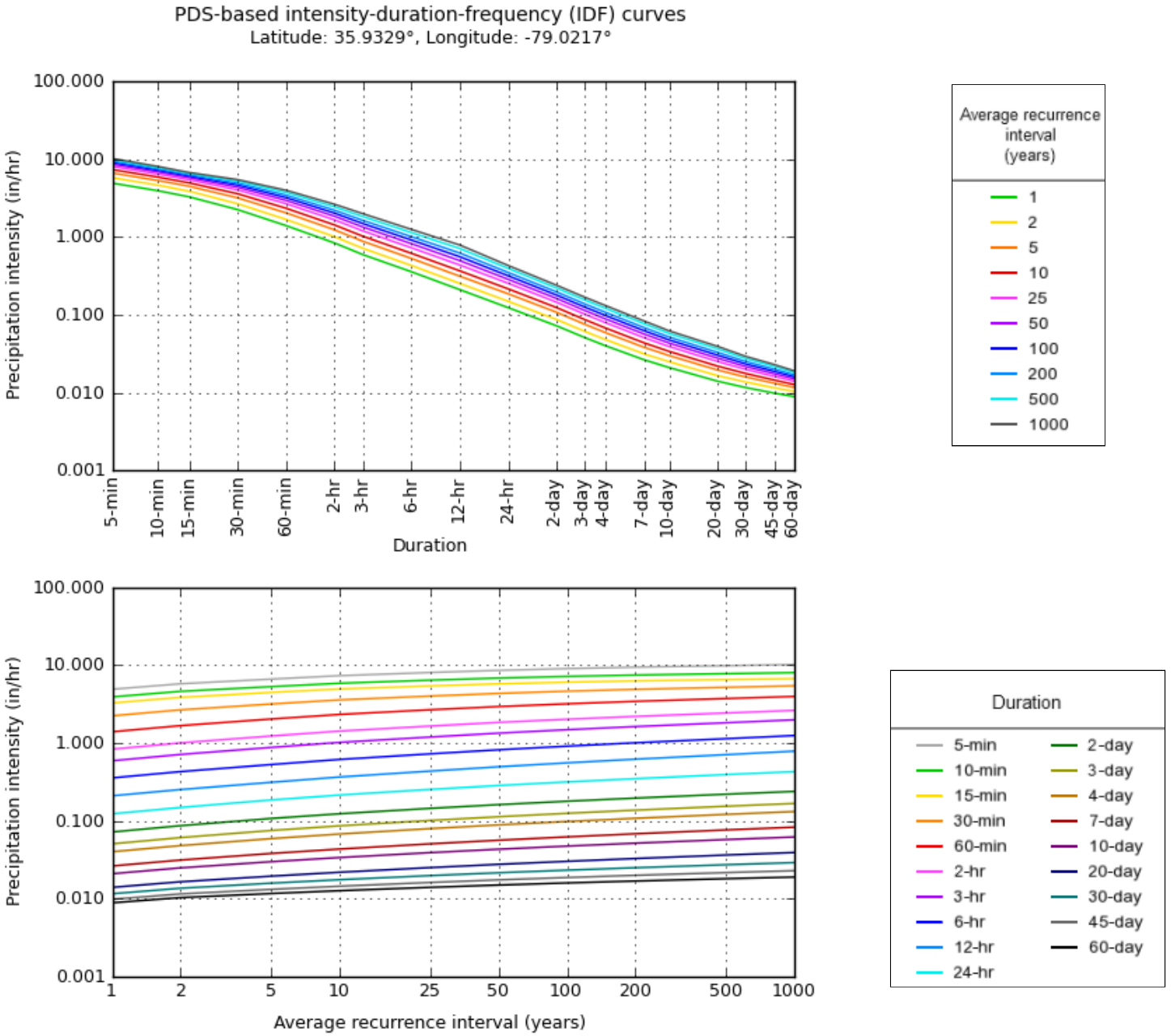
PF graphical



NOAA Atlas 14, Volume 2, Version 3

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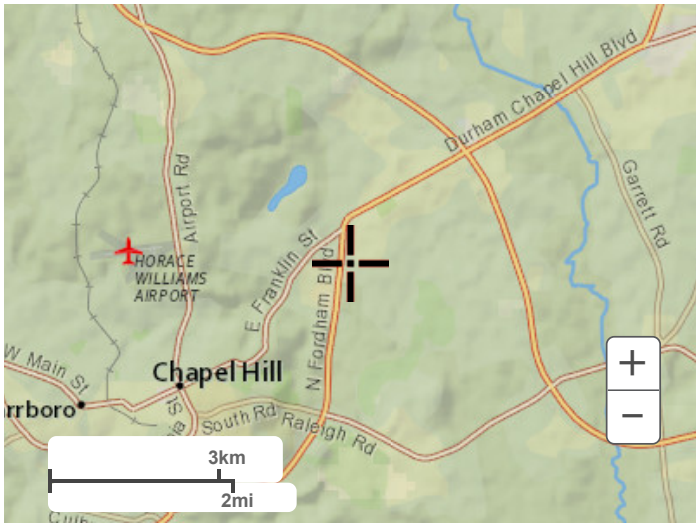
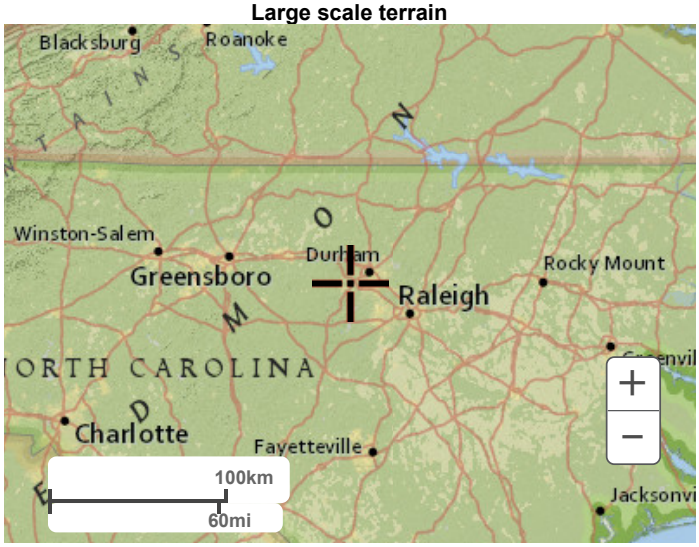
Maps & aerials

Small scale terrain



Large scale terrain



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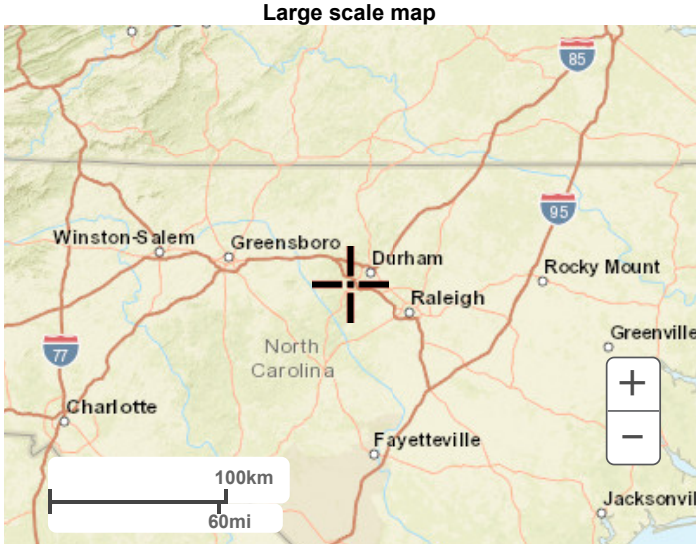
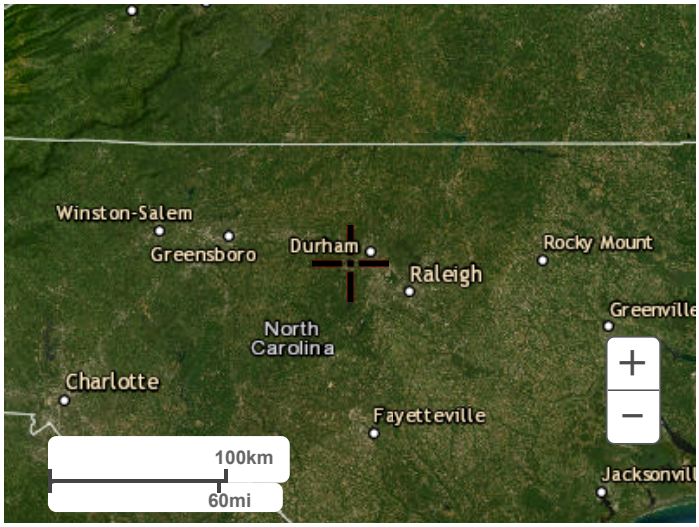


Large scale aerial



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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

10-Year Storm Drainage and Calculation Analysis

Park Apartments – Phase II
Form District Permit
WDF-22001

Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
1	301C-350	1.15	36	Cir	97.222	261.00	261.50	0.514	262.70	261.83	0.11	261.83	End	Manhole
2	350-351	0.19	15	Cir	11.132	263.25	263.35	0.899	263.40	263.52	n/a	263.52	1	Combination
3	350-352	0.25	15	Cir	11.643	263.35	263.45	0.873	263.52	263.64	n/a	263.64	1	Combination
4	350-353	0.85	36	Cir	19.103	261.50	261.60	0.524	261.83	261.89	n/a	261.89	1	Manhole
5	353-354	0.87	15	Cir	20.863	263.35	263.50	0.724	263.69	263.87	0.13	263.87	4	Combination
6	712-750	1.12	15	Cir	15.628	263.13	263.26	0.832	263.76	263.68	n/a	263.68	End	Manhole
7	750-751	0.75	15	Cir	20.971	263.46	263.58	0.571	263.79	263.92	n/a	263.92	6	Combination
8	750-752	0.44	15	Cir	26.839	263.36	263.50	0.521	263.68	263.76	0.09	263.85	6	Combination

Project File: WDF22001.stm | Number of lines: 8 | Run Date: 4/17/2023

NOTES: Return period = 10 Yrs.

Storm Sewer Tabulation

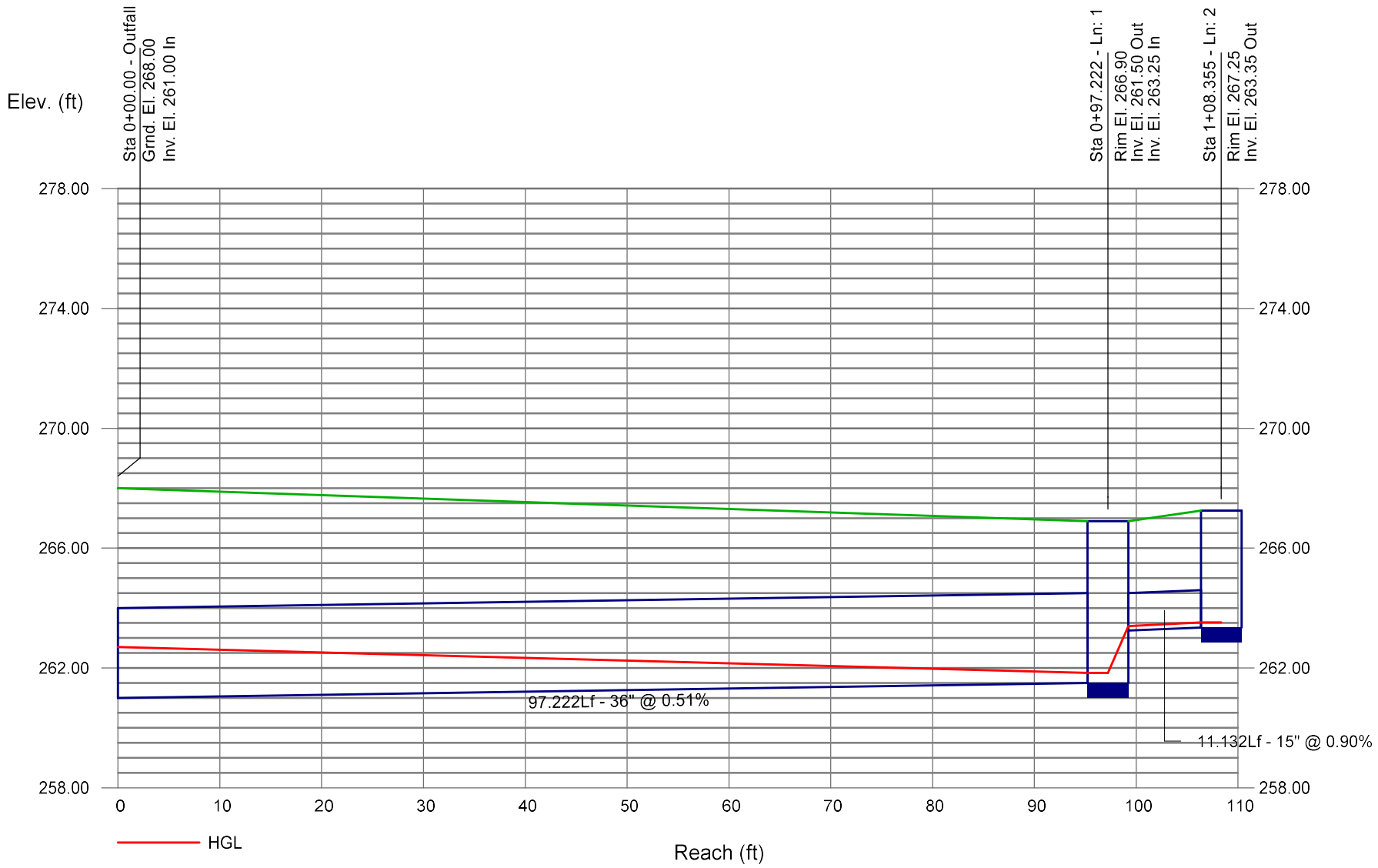
Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
1	End	97.222	0.01	0.23	0.01	0.00	0.18	5.0	8.1	6.4	1.15	47.83	1.49	36	0.51	261.00	261.50	262.70	261.83	268.00	266.90	301C-350
2	1	11.132	0.03	0.03	0.85	0.03	0.03	5.0	5.0	7.3	0.19	6.12	2.08	15	0.90	263.25	263.35	263.40	263.52	266.90	267.25	350-351
3	1	11.643	0.04	0.04	0.85	0.03	0.03	5.0	5.0	7.3	0.25	6.03	2.24	15	0.87	263.35	263.45	263.52	263.64	266.90	267.20	350-352
4	1	19.103	0.01	0.15	0.01	0.00	0.12	5.0	5.5	7.2	0.85	48.26	2.25	36	0.52	261.50	261.60	261.83	261.89	266.90	269.46	350-353
5	4	20.863	0.14	0.14	0.85	0.12	0.12	5.0	5.0	7.3	0.87	5.50	3.09	15	0.72	263.35	263.50	263.69	263.87	269.46	267.00	353-354
6	End	15.628	0.01	0.20	0.01	0.00	0.16	5.0	6.3	6.9	1.12	5.89	2.47	15	0.83	263.13	263.26	263.76	263.68	266.47	266.29	712-750
7	6	20.971	0.12	0.12	0.85	0.10	0.10	5.0	5.0	7.3	0.75	4.88	2.83	15	0.57	263.46	263.58	263.79	263.92	266.29	267.25	750-751
8	6	26.839	0.07	0.07	0.85	0.06	0.06	5.0	5.0	7.3	0.44	4.66	2.08	15	0.52	263.36	263.50	263.68	263.76	266.29	266.00	750-752

Project File: WDF22001.stm | Number of lines: 8 | Run Date: 4/17/2023

NOTES:Intensity = 71.94 / (Inlet time + 12.30) ^ 0.80; Return period =Yrs. 10 ; c = cir e = ellip b = box

Storm Sewer Profile

Proj. file: WDF22001.stm



Storm Sewer Profile

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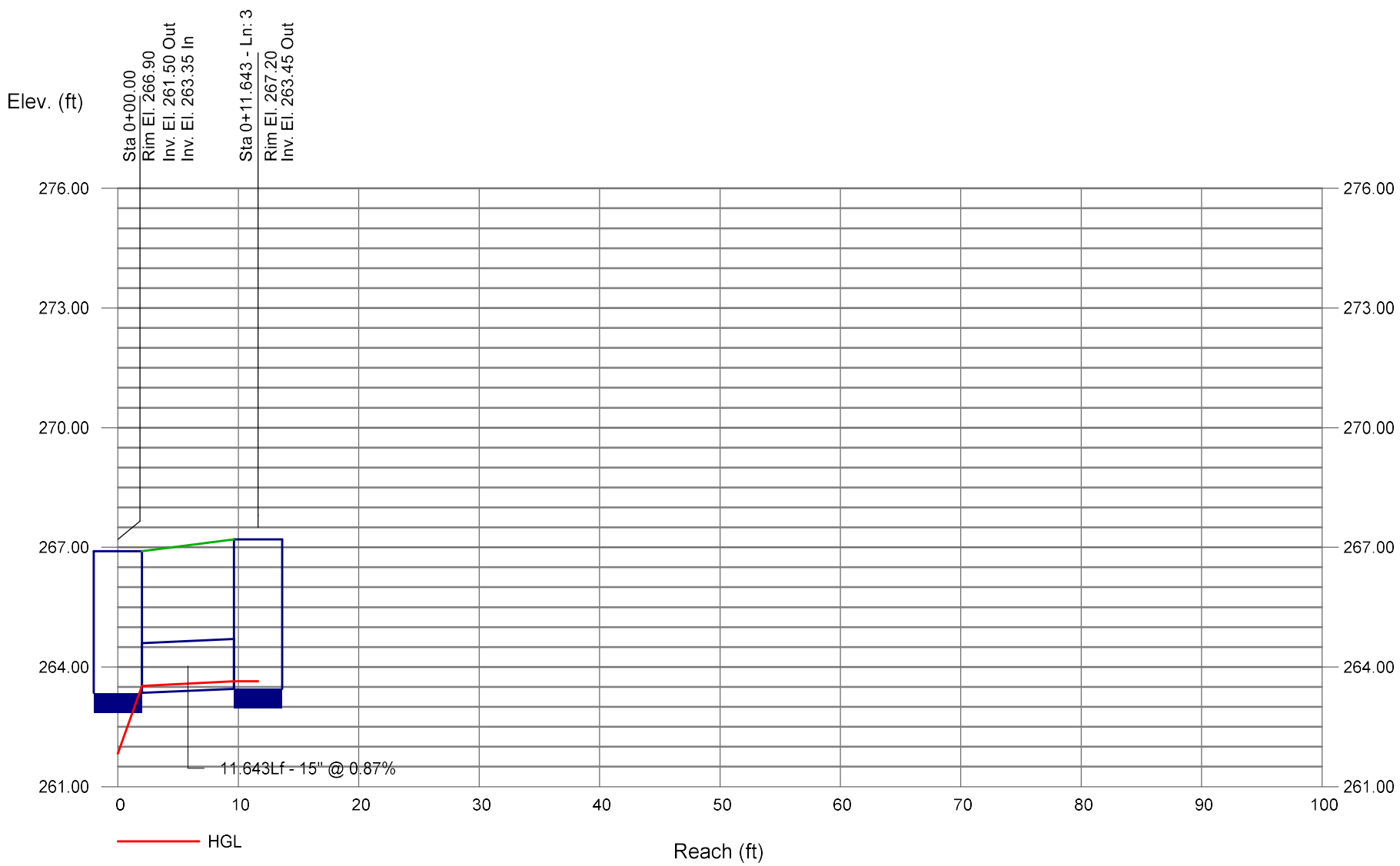

Storm Sewer Profile

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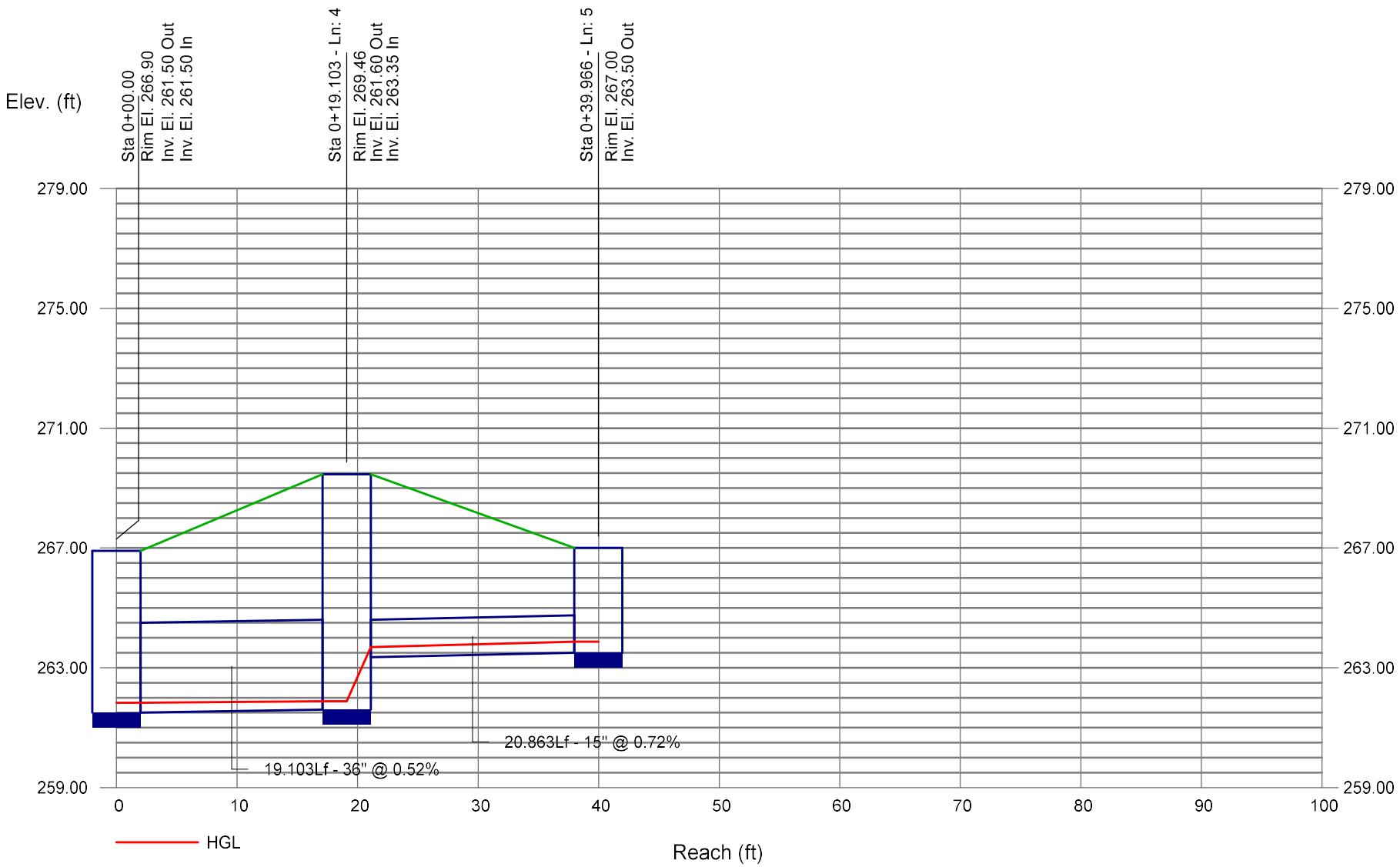

Storm Sewer Profile

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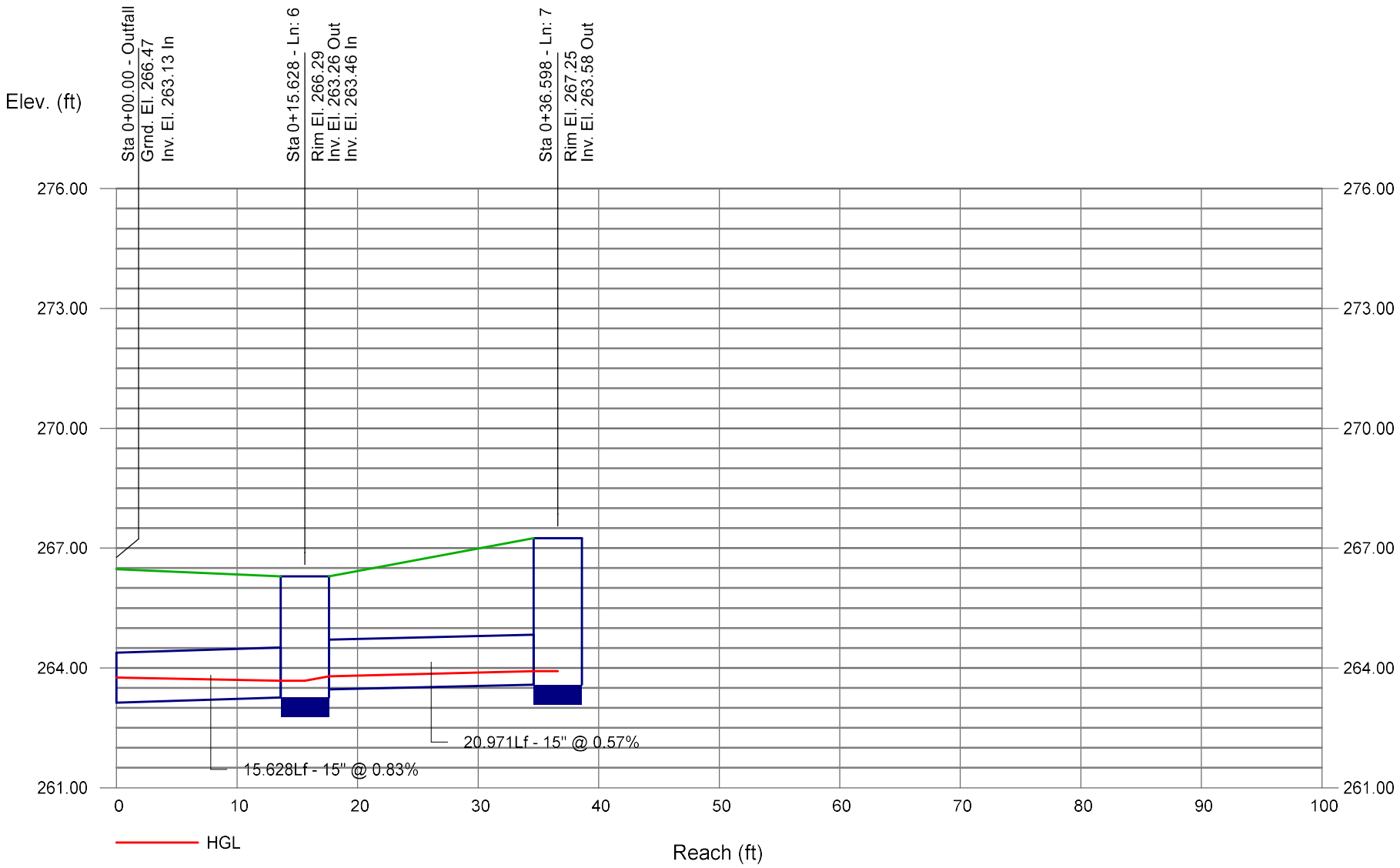

Storm Sewer Profile

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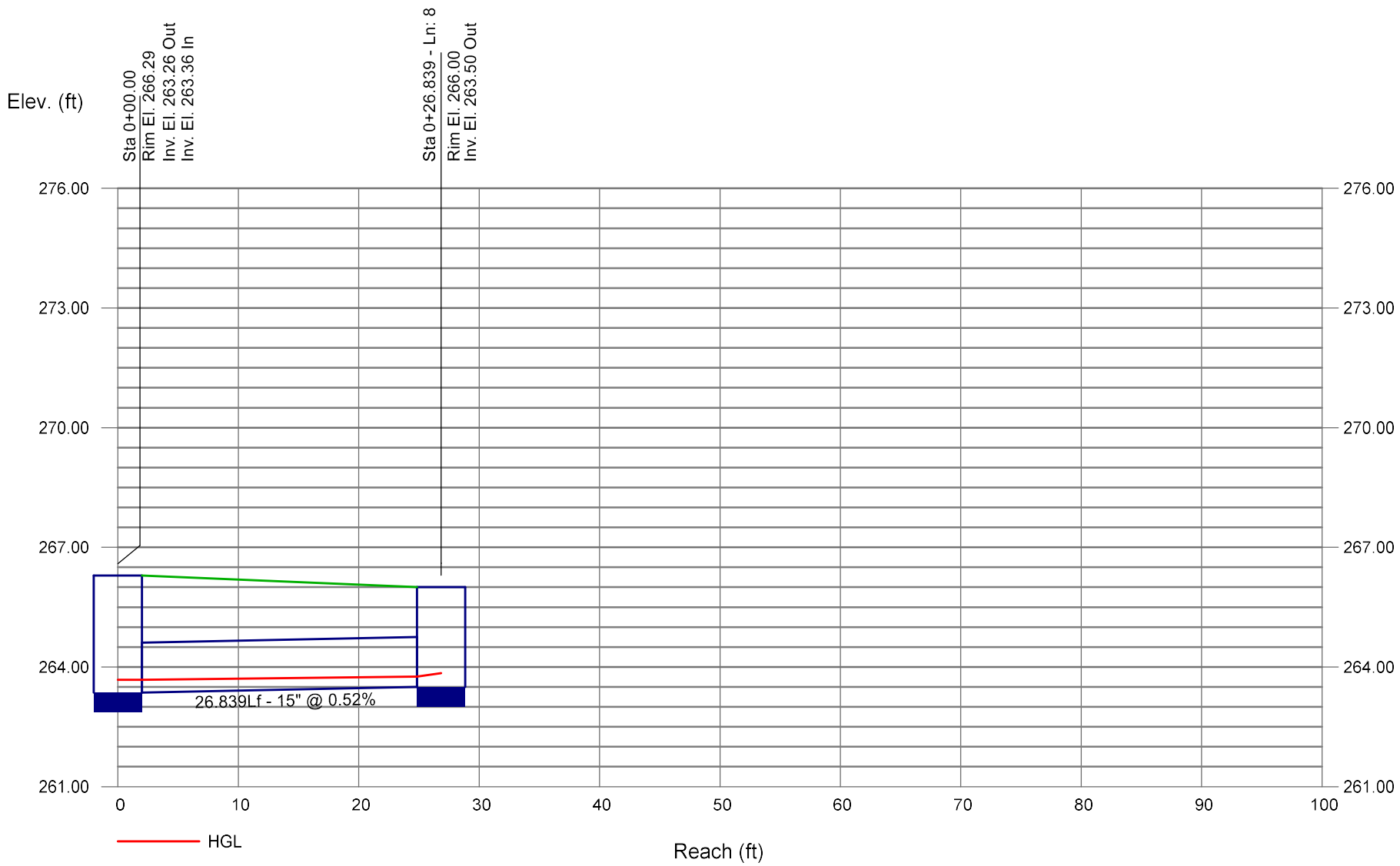


25-Year Storm Drainage and Calculation Analysis

Park Apartments – Phase II
Form District Permit
WDF-22001

Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
1	301C-350	1.28	36	Cir	97.222	261.00	261.50	0.514	262.79	261.85	n/a	261.85	End	Manhole
2	350-351	0.21	15	Cir	11.132	263.25	263.35	0.899	263.41	263.52	n/a	263.52	1	Combination
3	350-352	0.27	15	Cir	11.643	263.35	263.45	0.873	263.53	263.65	0.07	263.65	1	Combination
4	350-353	0.94	36	Cir	19.103	261.50	261.60	0.524	261.85	261.90	n/a	261.90 j	1	Manhole
5	353-354	0.96	15	Cir	20.863	263.35	263.50	0.724	263.70	263.88	0.14	263.88	4	Combination
6	712-750	1.23	15	Cir	15.628	263.13	263.26	0.832	263.76	263.70	n/a	263.70	End	Manhole
7	750-751	0.82	15	Cir	20.971	263.46	263.58	0.571	263.81	263.93	0.13	263.93	6	Combination
8	750-752	0.48	15	Cir	26.839	263.36	263.50	0.521	263.70	263.77	0.09	263.86	6	Combination

Project File: WDF22001.stm | Number of lines: 8 | Run Date: 4/17/2023

NOTES: Return period = 25 Yrs. ; j - Line contains hyd. jump.

Storm Sewer Tabulation

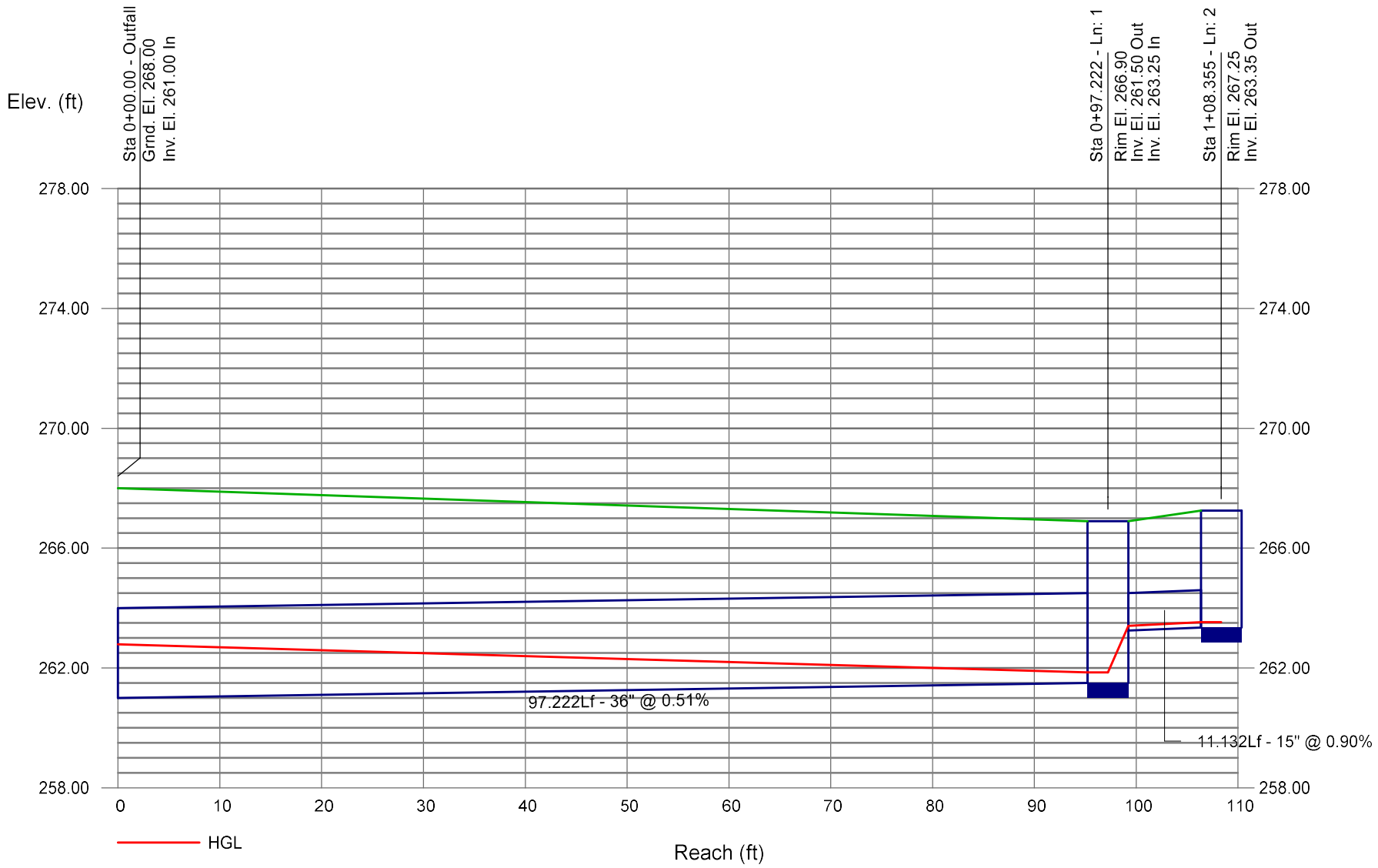
Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
1	End	97.222	0.01	0.23	0.01	0.00	0.18	5.0	7.8	7.1	1.28	47.83	1.53	36	0.51	261.00	261.50	262.79	261.85	268.00	266.90	301C-350
2	1	11.132	0.03	0.03	0.85	0.03	0.03	5.0	5.0	8.0	0.21	6.12	2.14	15	0.90	263.25	263.35	263.41	263.52	266.90	267.25	350-351
3	1	11.643	0.04	0.04	0.85	0.03	0.03	5.0	5.0	8.0	0.27	6.03	2.30	15	0.87	263.35	263.45	263.53	263.65	266.90	267.20	350-352
4	1	19.103	0.01	0.15	0.01	0.00	0.12	5.0	5.4	7.9	0.94	48.26	2.30	36	0.52	261.50	261.60	261.85	261.90	266.90	269.46	350-353
5	4	20.863	0.14	0.14	0.85	0.12	0.12	5.0	5.0	8.0	0.96	5.50	3.18	15	0.72	263.35	263.50	263.70	263.88	269.46	267.00	353-354
6	End	15.628	0.01	0.20	0.01	0.00	0.16	5.0	6.1	7.6	1.23	5.89	2.61	15	0.83	263.13	263.26	263.76	263.70	266.47	266.29	712-750
7	6	20.971	0.12	0.12	0.85	0.10	0.10	5.0	5.0	8.0	0.82	4.88	2.91	15	0.57	263.46	263.58	263.81	263.93	266.29	267.25	750-751
8	6	26.839	0.07	0.07	0.85	0.06	0.06	5.0	5.0	8.0	0.48	4.66	2.11	15	0.52	263.36	263.50	263.70	263.77	266.29	266.00	750-752

Project File: WDF22001.stm | Number of lines: 8 | Run Date: 4/17/2023

NOTES:Intensity = 62.83 / (Inlet time + 11.10) ^ 0.74; Return period =Yrs. 25 ; c = cir e = ellip b = box

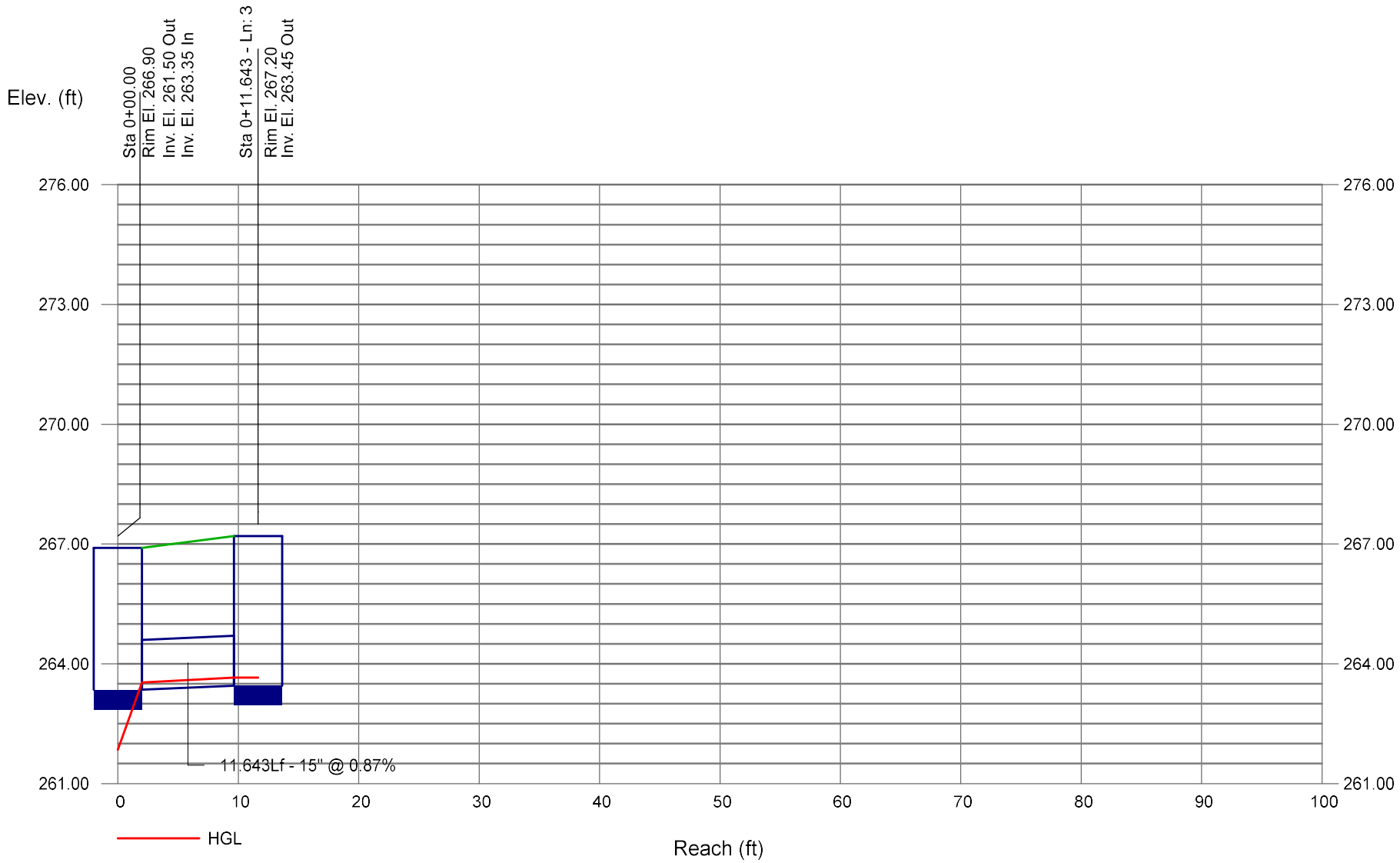
Storm Sewer Profile

Proj. file: WDF22001.stm



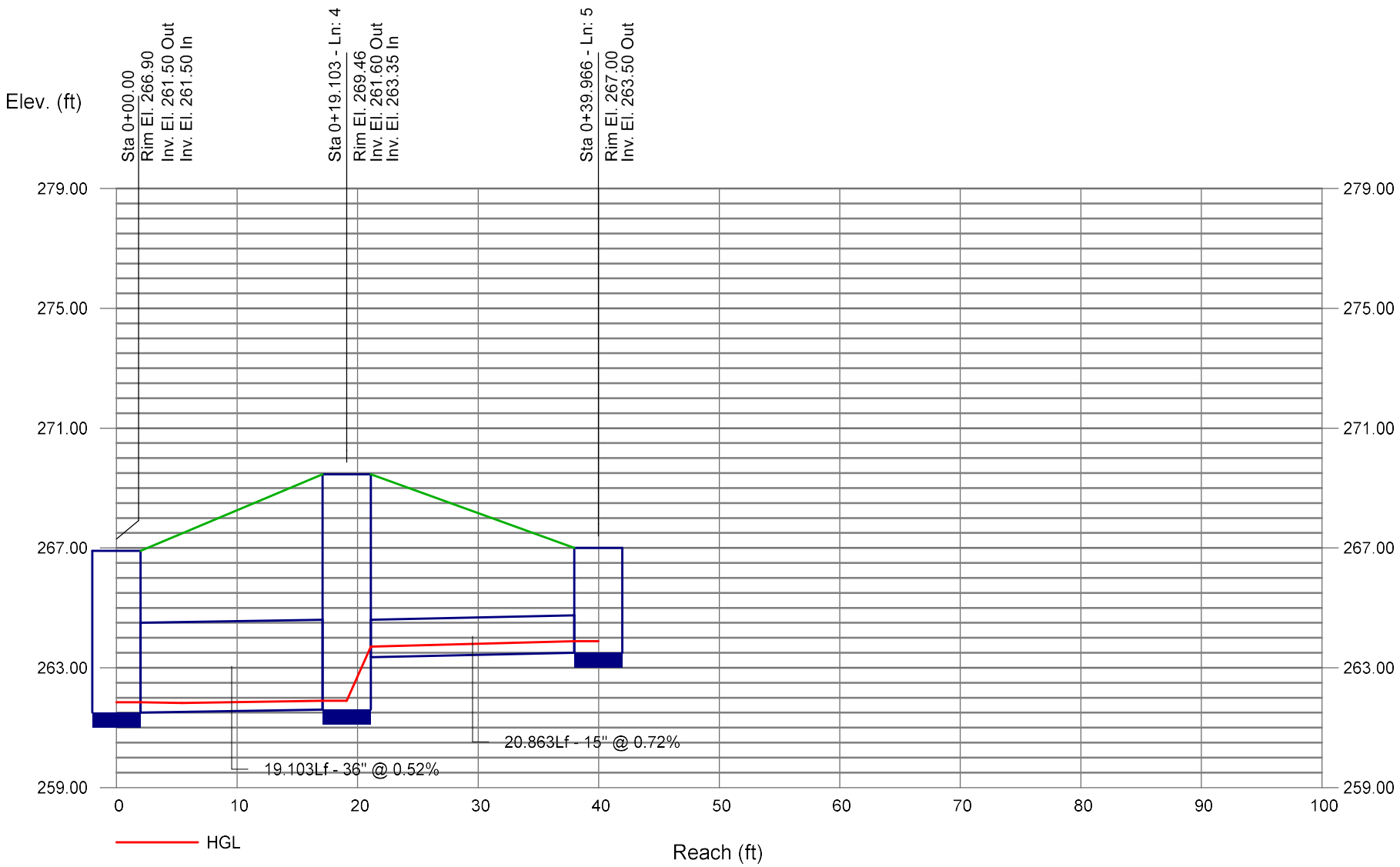
Storm Sewer Profile

Proj. file: WDF22001.stm



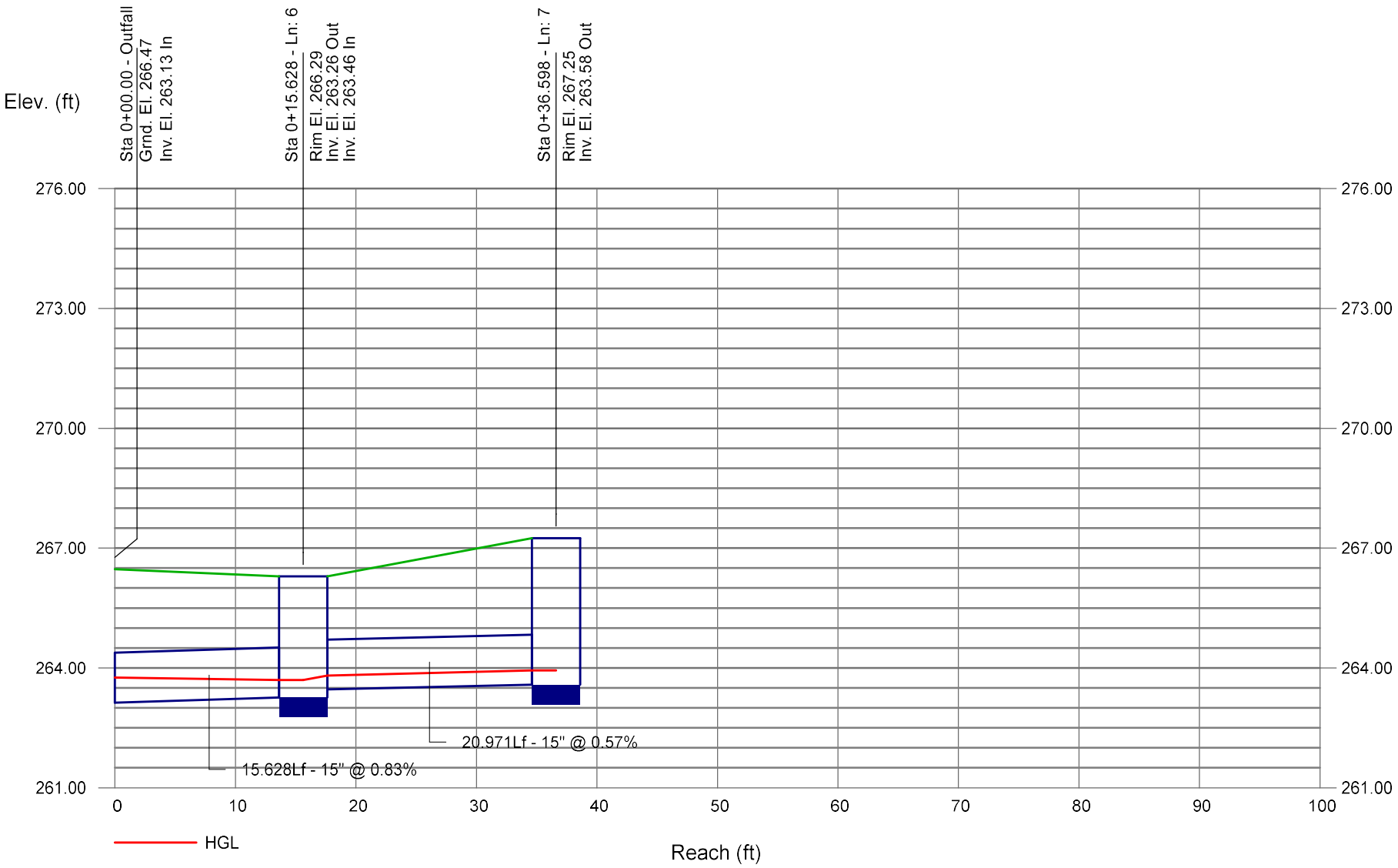
Storm Sewer Profile

Proj. file: WDF22001.stm



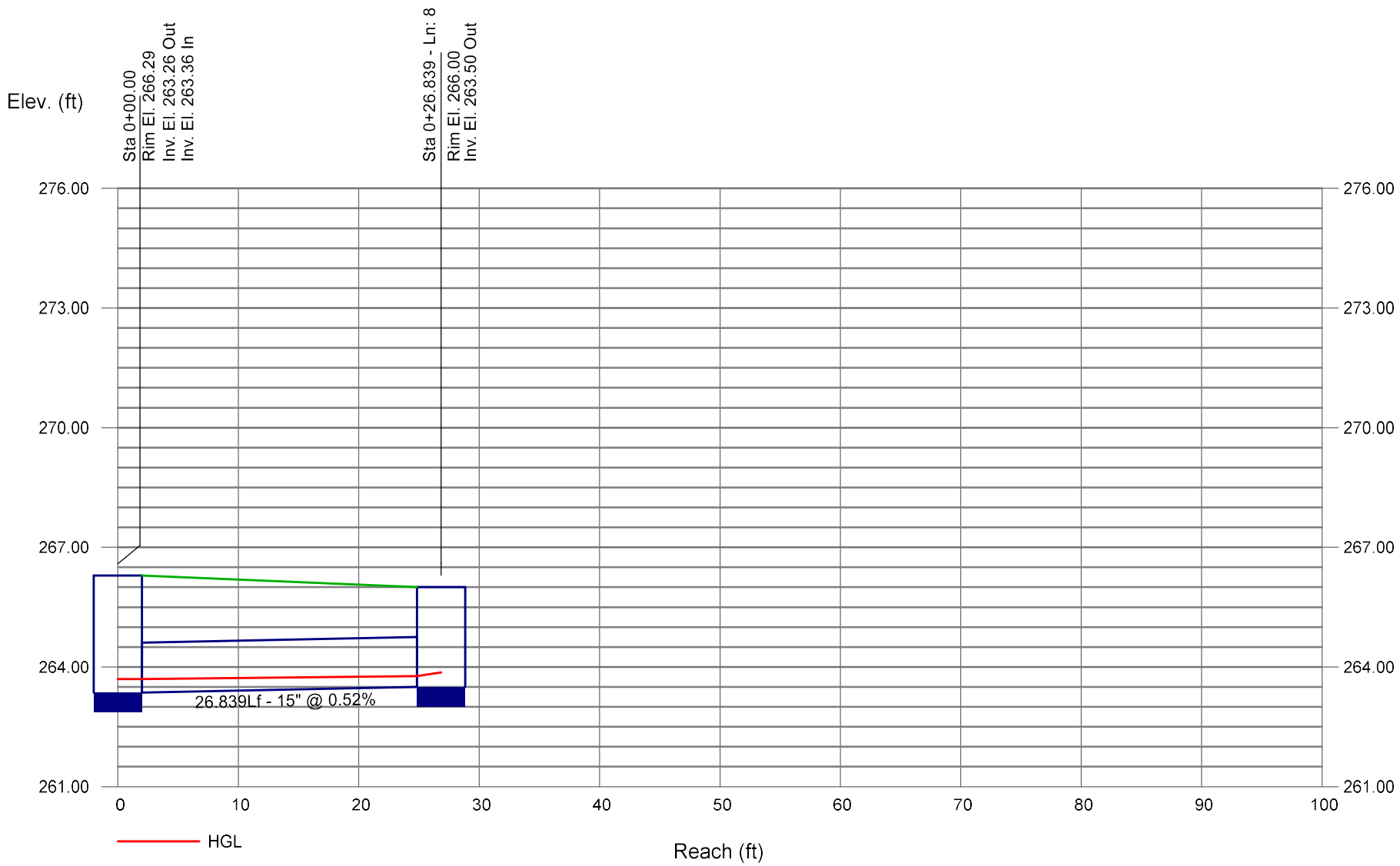
Storm Sewer Profile

Proj. file: WDF22001.stm



Storm Sewer Profile

Proj. file: WDF22001.stm



Gutter Spread Analysis

Park Apartments – Phase II
Form District Permit
WDF-22001

Inlet Report

Line No	Inlet ID	Q = CIA (cfs)	Q carry (cfs)	Q capt (cfs)	Q Byp (cfs)	Junc Type	Curb Inlet		Grate Inlet			Gutter							Inlet			Byp Line No
							Ht (in)	L (ft)	Area (sqft)	L (ft)	W (ft)	So (ft/ft)	W (ft)	Sw (ft/ft)	Sx (ft/ft)	n	Depth (ft)	Spread (ft)	Depth (ft)	Spread (ft)	Depr (in)	
1	JB-350	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	1.50	0.042	0.021	0.013	0.00	0.00	0.00	0.00	0.0	Off
2	CB-351	0.10	0.00	0.10	0.00	Comb	3.0	3.00	0.00	3.00	2.00	0.036	1.50	0.042	0.021	0.013	0.06	1.40	0.21	0.00	2.5	Off
3	CB-352	0.14	0.00	0.14	0.00	Comb	3.0	3.00	0.00	3.00	2.00	0.036	1.50	0.042	0.021	0.013	0.07	1.63	0.21	0.00	2.5	Off
4	JB-353	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	1.50	0.042	0.021	0.013	0.00	0.00	0.00	0.00	0.0	Off
5	CB-354	0.48	0.00	0.48	0.00	Comb	3.0	3.00	1.50	3.00	2.00	Sag	1.50	0.042	0.021	0.013	0.02	1.24	0.22	1.24	2.5	Off
6	JB-750	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	1.50	0.042	0.021	0.013	0.00	0.00	0.00	0.00	0.0	Off
7	CB-751	0.41	0.00	0.37	0.04	Comb	3.0	3.00	0.00	3.00	2.00	0.032	1.50	0.042	0.021	0.013	0.10	3.20	0.25	1.02	2.5	Off
8	CB-752	0.24	0.00	0.23	0.01	Comb	3.0	3.00	0.00	3.00	2.00	0.032	1.50	0.042	0.021	0.013	0.08	2.41	0.23	0.52	2.5	Off

Project File: WDF22001.stm | Number of lines: 8 | Run Date: 4/17/2023

NOTES: Inlet N-Values = 0.016; Intensity = 3.97 / (Inlet time + 0.10) ^ 0.00; Return period = 3 Yrs. ; * Indicates Known Q added. All curb inlets are Horiz throat.