100th Anniversary
LEADING THROUGH THE NEXT 100 YEARS

Elmwood & Arbor Drainage Study

PREPARED FOR

City of Edgewood, KY

385 Dudley Road
Edgewood, KY 41017
859.331.5910

ISSUED: 08.22.2022

PROJECT: 220398

PREPARED BY: Robert Seitzinger, P.E.

REVIEWED BY: Marty Hellmann, P.E.

100th Anniversary
LEADING THROUGH THE NEXT 100 YEARS

CONTENTS PAGE

INTRODUCTION

The City of Edgewood has identified a recurring flooding problem in the vicinity of Elmwood Drive and Arbor Drive. It is our understanding that the primary flooding seen occurs in the yards between Elmwood and Arbor. There is an existing natural swale line that run approximately midway between the rears of the houses. The swale line picks up direct surface runoff from the yards as well as the runoff collected by the pair of street inlets located near 3079 Elmwood. Additionally, runoff gathered from the street inlets on Arbor Drive and Ashley Drive enter the swale line just before the 24" pipe intended to drain the swale line. The system then continues for a long way downstream across Elmwood and Swarthmore, before outletting into a creek along the rear yards of Lyndale Court. The water then re-enters the storm system and creek along Edgewood and Lyndale Roads.

ANALYSIS

The Storm Sewer Extension of the Hydraflow software was used to model the storm sewer system. Information about the location, elevation, type, and size of the elements include as part of the study section were obtained through SD1's GIS website. All topographic and boundary information used of the analysis and shown on the exhibit are based on GIS data from PDS. The Storm Sewer Extension software utilizes the Rational Method to calculate the peak runoff into each storm sewer element, and can be used to evaluate any design frequency storm event. Drainage areas tributary to each of the inlets was calculated using GIS contour data, aerial imagery and visual observations. Weighted runoff coefficients were calculated for each drainage area. C values of 0.40 and 0.95 were used for open areas and impervious areas respectively. Times of concentration were calculated using TR55, and no times of concentration were less than 6 minutes.

Additionally, the Hydrographs Extension of the Hydraflow software was used to model the ponding effect of the basins and streams located along the rear yards of Swarthmore and Lyndale Courts. GIS data and survey data from the Edgewood & Lyndale project were utilized to model the system. The Hydrograph Extension software utilizes the SCS Runoff Curve Number Method. Curve numbers were calculated for the drainage areas based on soil and surface conditions. Times of concentration were calculated using TR55, and no times of concentration were less than 6 minutes.

The models evaluated the 10 year events to determine capacity deficiencies and determine the appropriate sizing to meet the design storm event. Additionally, the 25 year storm event was analyzed to confirm that the hydraulic grade line generated would stay within the system. As system also contain several inlets that have large areas of water draining towards them, an inlet capacity analysis of the existing system was run.

EXISTING CONDITIONS

Approximately 27 acres drain toward the swale line located between the Elmwood and Arbor. This includes the direct runoff from the yards from 3113 Elmwood to 3053 Elmwood and the yards along Abor for this same stretch. Additionally, a pair of double grate inlets pick up the street runoff between 3113 Elmwood and 3079 Elmwood. A set of three curb inlets located at the intersection of Ashley and Marcel pick of the runoff on the street from 3068 Ashley to 3050 Ashley. The storm system continues to the set of three double grate inlets located at the intersection of Arbor and Marcel, which collect the runoff on the street from 3075 Arbor to the cul-de-sac. The storm system continues towards the swale and outlets just before the 24 inch pipe. Note that the area around the 24 inch pipe has been experiencing flooding.

The 24 inch pipe continues between 3053 Elmwood and 3055 Elmwood and then between 3050 Elmwood and 3052 Elmwood. In this stretch, the system picks up a series pf four double grate inlets located in front of 3053 Elmwood. These inlets collect the runoff in the streets from 3079 Elmwood to 5 Roberts. The system outlets near the rear property line of 3050 Elmwood.

Approximately 25 feet away, the water is then picked up by a private 42 inch corrugated metal pipe. The private pipe then runs along the front of 12 & 14 Swarthmore and outlets into the creek. After flowing through the creek, the stormwater enters the Edgewood Road/Lyndale Road storm system. This portion of the system was replaced in 2015/2016. The primary outlet for this portion of the system is located at the end of the 29"x45" elliptical pipe where it connects to the 12'x3' box culvert. The system also has a secondary outlet just north of the Edgewood Road/Lyndale Road intersection. This pipe outlet is approximately 2 ft higher than the main flow line of system, and allows for excess water in the system to be outlet into the creek that runs along the east side of Edgewood Road.

An analysis of the existing system upstream of the Swarthmore/Lyndale creek indicates several areas that are undersized. The 12" line between the pair of catch basin in front of 3079 Elmwood is undersized. Note that this pair of basin is located on grade and that water not captured by the system could continue down Elmwood to the sets of inlets in front of 3053 Elmwood. The analysis also showed that the entire portion of the system from the Ashley/Marcel intersection to the outlet behind 3060 Arbor is undersized. Al water not captured by the system would pool at the Arbor/Marcel intersection until it could over top the curb and continue to the backyard areas between Arbor and Elmwood. It should also be noted that the inlets at the Ashley/Marcel intersection are old curb inlet and have no grate, which reduce the potential amount of water that can be captured. The existing 15" culvert located in the backyard of 3079 Elmwood is undersized. However, SD1 data did not include a slope for this pipe and a 1% slope was assumed. Additionally, cover on this pipe is minimal

and excess water can continue to flow over the pipe and continue along the channel between Arbor and Elmwood.

The existing 24" line that starts between Elmwood and Arbor and outlets behind 3050 Elmwood is undersized. The existing pipe only has a capacity of approximately 27 cfs. Calculations show that approximately 63 cfs flows to the start of the 24" pipe run. This water will initially back up in the existing channel that run behind the house on Elmwood and Arbor. However, the channel does not provide much storage and water eventually come out of the channel and can flow towards 3059 and 3055 Elmwood. This undersized section has be the cause of the most noticeable flooding. The existing run of 24" inch pipe also picks up the runoff picked up by the set of four inlets located in front of 3053 Elmwood. In addition to the problems caused by the undersized downstream system, portions of the 12" system are undersized. While four inlets are located within this sag, and inlet analysis indicates that they are not sufficient to handle the flow generated from the large tributary drainage areas. When the elevation of the water in the street exceeds the curb height, it then flows between 3050 and 3052 towards the 24" pipe outlet.

Analysis of the private 42" CMP culvert indicates that if the upstream system was capable of passing the all of the runoff generated to this point, then the pipe would be undersized. However, the upstream 24" pipe restricts the actual flow to the pipe to approximately 30 cfs and the existing pipe has a capacity of approximately 35 cfs.

PROPOSED CONDITIONS

Base System Improvements

To address flooding concerns in the backyards between Elmwood and Arbor. The existing run of 24" pipe that starts between Elmwood and Arbor and outlets behind 3050 Elmwood can be upsized as shown in the attached exhibit. In addition, improvements to the sets of inlets along Elmwood and Arbor should be considered. This includes upsizing undersized pipes, replacing curb inlets with new double grate inlets, and adding additional inlets in front of 3053 Elmwood. To prevent flooding from occurring between 3050 Elmwood and 18 Swarthmore, the existing 42" private CMP pipe would need to be replaced with a new 48" diameter smooth walled pipe. The proposed improvement have the capacity for the 10 year storm event and can contain the 25 year storm event HGL.

Preliminary Opinion of Construction Cost: $531,840.00

Additional Considerations

Beyond this point the water will enter into the creek before entering the Edgewood Road/Lyndale Road storm system. A Hydraflow Hydrographs model was created to analyze the ponding effects of the creek and determine the flows being handled by the Edgewood Road/Lyndale Road storm system. A mix of GIS and survey data was used to model the Swarthmore Pond and the Lyndale Court Pond (creek). The primary outlet for the Lyndale Court Pond is the 24" diameter pipe that connects to the Edgewood Road/Lyndale Road storm system. Approximately 6 feet about the pipe flow line, there is an approximately 50 ft. wide spillway. The capacity of the 24" pipe is limited to approximately 32 cfs. The analysis shows that the pond/creek would be able to handle the 2 year storm event without the use if the spillway. However, during the 10 year storm event, the water elevation gets to be approximately 8" above the spillway, which results in approximately 69 cfs of water released through the spillway. During the 25 year storm event, the elevation reaches approximately 1 ft. above the spillway, and the spillway release at approximately 110 cfs. To keep the 10 yr storm from exceeding the spillway elevation, the pipe would need to be upsized to 42 inch diameter. Alternatively, the pipe would need to be upsized to 54 inch diameter to keep the 25 year storm below the spillway elevation.

A storm sewer analysis of the Edgewood Road/Lyndale Road system indicates that if the flow from the creek is limited by the 24" pipe, the capacity of the main line would be exceeded and water would flow out of the system through the secondary outlet. Given the depth of the other utilities in along Edgewood Road, elliptical pipe had to be installed, and as such there is not much room to allow for larger pipe. However, to allow for a large pipe from the creek, the pipe between the manholes on the north and south side of the Edgewood/Lyndale intersection would need to be upsized. A 34"x53" elliptical pipe should allow the pipe form the creek to be increased to a 42" diameter pipe. Note that most of the additional water would outlet through the secondary outlet and into the creek on the east side of Edgewood Road.

Another option for keeping the 25 year storm event runoff below the spillway elevation is to increase the storage volume of the pond. Keeping the flow limited to the 24 inch pipe, initial estimate would require approximately 500,000 cubic feet of storage for the 25 year event. Note that the existing pond only provides approximately 45,000 cubic feet of storage below the spillway. To do this would require the acquisition and clearing of land. The cost of just the excavation required would be in the range of $400,000-$500,000.

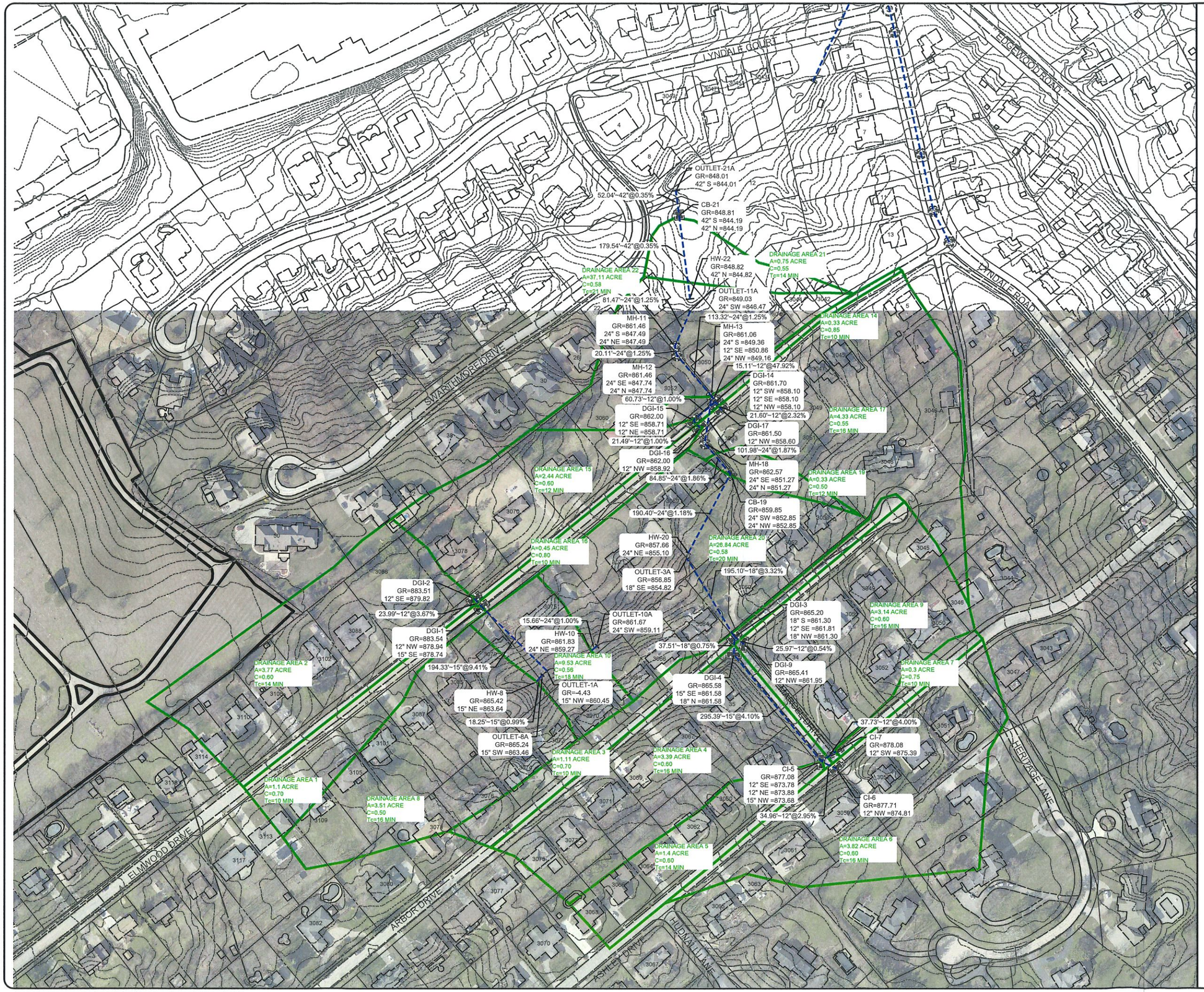
In order to keep the 24" pipe between Elmwood and Arbor, a dotation basin would need to be constructed. Initial estimates would require that the basin have approximately 200,000 cubic feet of storage. Additional survey data would be needed to determine how this could fit within the area between Elmwood and Arbor, but it should be noted that it will require a significant amount of land and homeowners will still see water in the backyards.

CONCULSIONS

To alleviate the flooding issues in the Elmwood/Arbor Vicinity the City could implement the changes described as part of the base system improvements. Note that doing so will significantly increase the amount of water flowing into the creek near Swarthmore/Lyndale. If the City does not make any modifications to the Edgewood/Lyndale storm system, water will overflow from the creek and continue down Lyndale Court and Edgewood Road. Increasing the pipe size of the Edgewood/Lyndale system form the creek south of Lyndale Court to the creek to the east of Edgewood Road will reduce the amount of water that overflow the creek. The estimated cost of doing all of these improvements is $751,560.00.

The next steps will be to survey the project limits, confirm pipe size, location and material, and prepare construction drawings and specifications. All proposed design of the proposed options are subject to SD1 review and approval.

APPENDIX A
EXISTING CONDITIONS



N

0' 100' 200'

SCALE: 1" = 100' (22X34)
SCALE: 1" = 200' (11X17)

LEGEND

DRAINAGE AREA

EXISTING STORM SEWER

NOTE: PIPE SIZES, MATERIAL, SLOPES AND DEPTHS ARE BASED ON SD1 GIS INFORMATION, AND HAVE NOT BEEN CONFIRMED WITH FIELD SURVEY.

PRELIMINARY

your trusted advisor consultants engineers architects planners

NO	REVISION	DATE

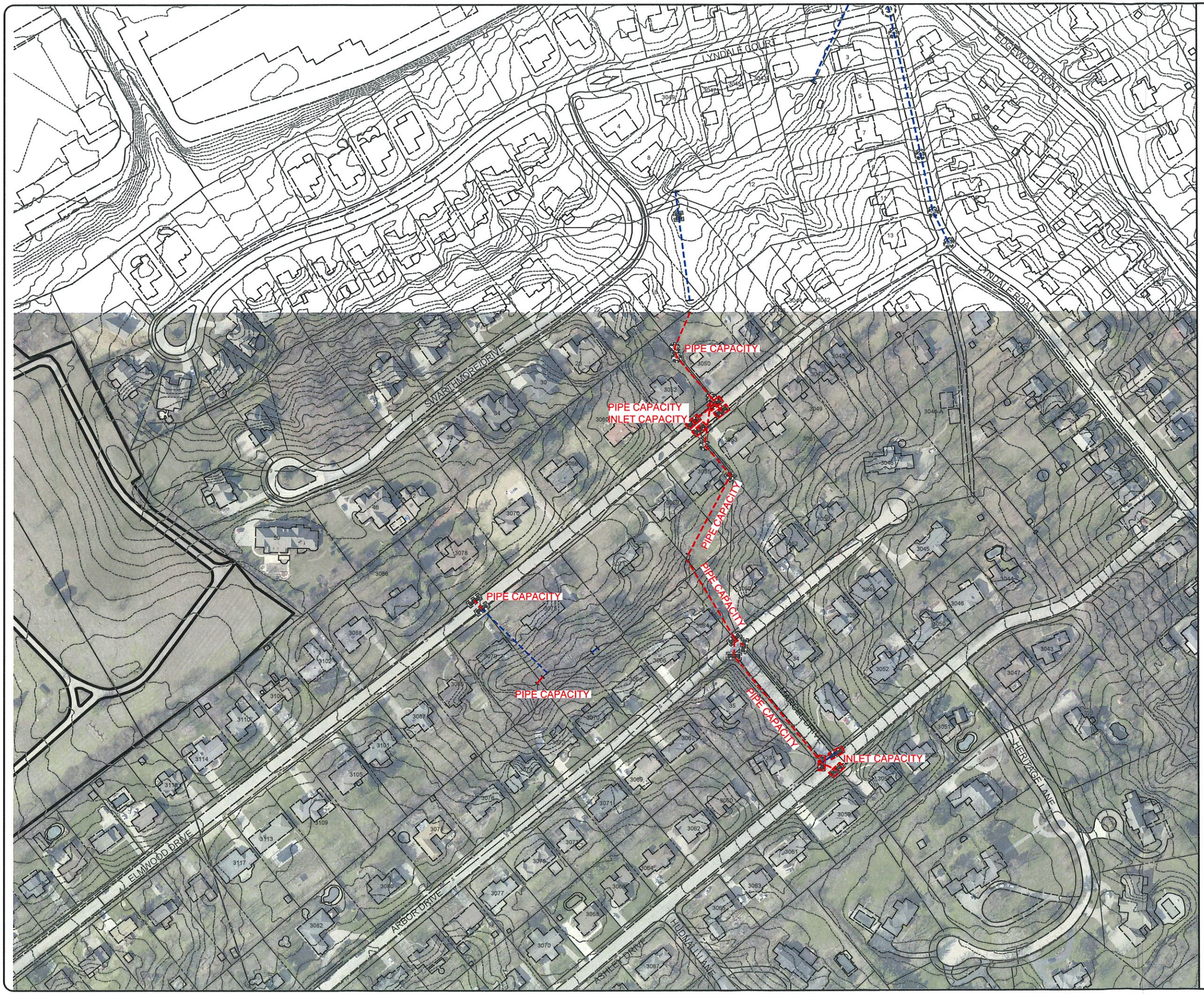
SCALE: AS NOTED
DATE: 08/22/2022
DESIGNED BY: MHEL
DRAWN BY: RSEI
CHECKED BY: MHEL

ELMWOOD & ARBOR DRAINAGE STUDY
CITY OF EDGEWOOD
KENTON COUNTY, KENTUCKY

EXISTING CONDITIONS DRAINAGE AREA

PROJECT NO: 220398
DRAWING NAME: EX. COND
SHEET 1 OF 1

C:\CTICAD_DRIVE\$_H2022\220398\DWG\BASE\C_220398 - X-BASE - ELMWOOD 2.DWG - LAYOUT1 - 8/22/2022 5:24:07 AM - ROBERT SEITZINGER



N

0' 100' 200'

SCALE: 1" = 100' (22X34)
SCALE: 1" = 200' (11X17)

LEGEND

EXISTING STORM SEWER

UNDERSIZED SYSTEM

NOTE: PIPE SIZES, MATERIAL, SLOPES AND DEPTHS ARE BASED ON SD1 GIS INFORMATION, AND HAVE NOT BEEN CONFIRMED WITH FIELD SURVEY.

PRELIMINARY

your trusted advisor consultants engineers architects planners

NO	REVISION	DATE

SCALE: AS NOTED
DATE: 08/22/2022
DESIGNED BY: MHEL
DRAWN BY: RSEI
CHECKED BY: MHEL

ELMWOOD & ARBOR DRAINAGE STUDY
CITY OF EDGEWOOD
KENTON COUNTY, KENTUCKY

UNDERSIZED SYSTEM MAP

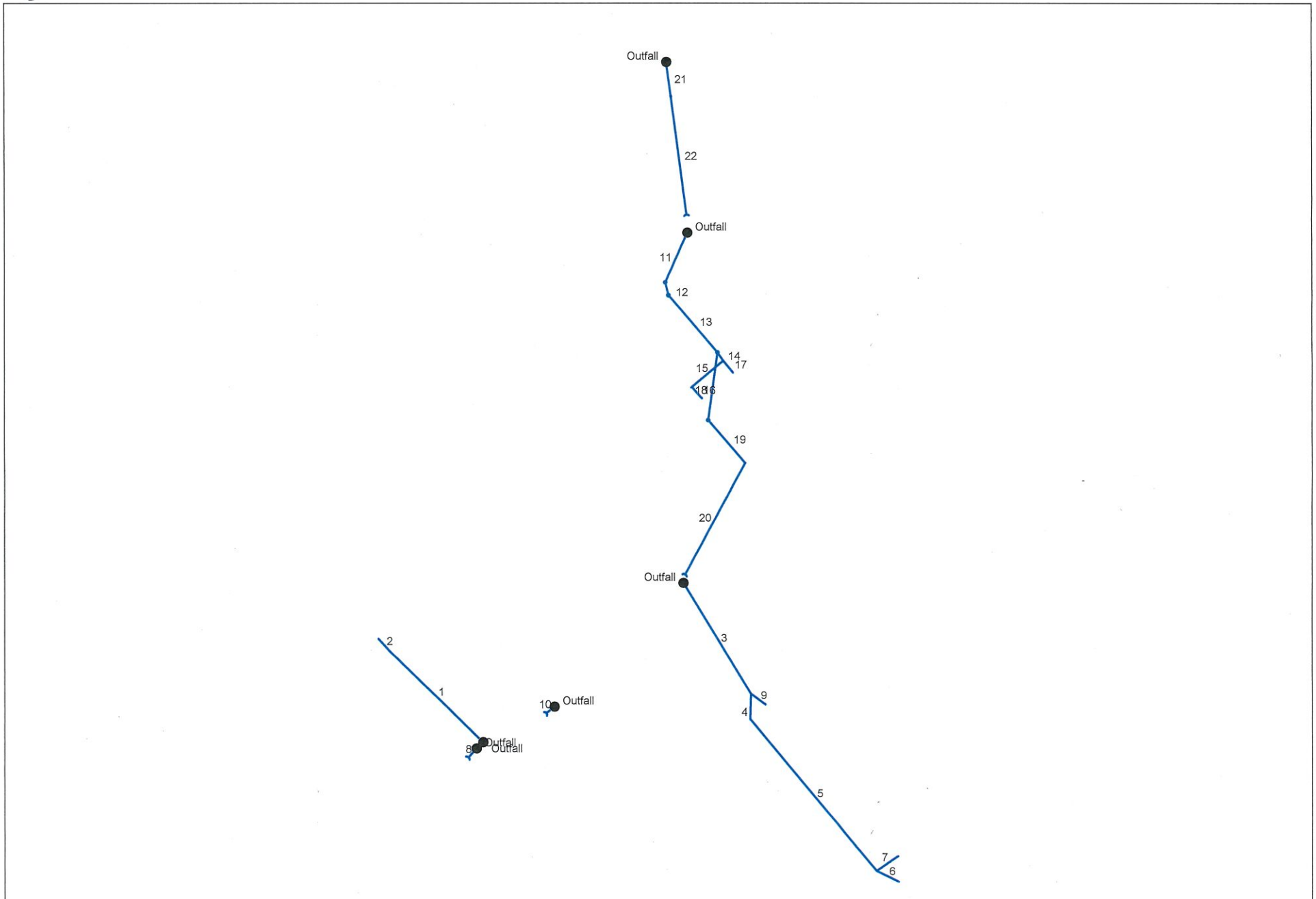
PROJECT NO: 220398

DRAWING NAME: ISSUE

SHEET 1 OF 1

Existing Base System
10 Year Storm Analysis

Hydraflow Storm Sewers Extension for Autodesk® AutoCAD® Civil 3D® Plan



Project File: 220398_Elmwood-Storm Sewer.stm	Number of lines: 22	Date: 8/22/2022

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	194.334	1.10	4.87	0.70	0.77	3.03	10.0	14.0	4.8	14.60	21.46	11.92	15	9.41	860.45	878.74	861.69	879.97	863.00	883.54	STM-1
2	1	23.989	3.77	3.77	0.60	2.26	2.26	14.0	14.0	4.8	10.91	7.39	13.89	12	3.67	878.94	879.82	879.97	881.89	883.54	883.51	STM-2
3	End	195.102	1.11	13.16	0.70	0.78	8.05	10.0	16.5	4.4	35.76	20.73	20.24	18	3.32	854.82	861.30	856.32	875.61	856.85	865.20	STM-3
4	3	37.512	3.39	8.91	0.60	2.03	5.39	16.0	16.4	4.4	23.98	9.83	13.57	18	0.75	861.30	861.58	881.79	883.45	865.20	865.58	STM-4
5	4	295.386	1.40	5.52	0.60	0.84	3.36	14.0	16.0	4.5	15.12	14.16	12.33	15	4.10	861.58	873.68	886.49	900.30	865.58	877.08	STM-5
6	5	34.956	3.82	3.82	0.60	2.29	2.29	16.0	16.0	4.5	10.34	6.62	13.17	12	2.95	873.78	874.81	903.84	906.35	877.08	877.71	STM-6
7	5	37.731	0.30	0.30	0.75	0.23	0.23	10.0	10.0	5.6	1.26	7.72	1.61	12	4.00	873.88	875.39	903.84	903.88	877.08	878.08	STM-7
8	End	18.250	3.51	3.51	0.50	1.76	1.76	16.0	16.0	4.5	7.92	6.95	6.67	15	0.99	863.46	863.64	864.58	864.85	865.24	865.42	STM-8
9	3	25.971	3.14	3.14	0.60	1.88	1.88	16.0	16.0	4.5	8.50	2.83	10.82	12	0.54	861.81	861.95	881.79	883.05	865.20	865.41	STM-9
10	End	15.660	9.53	9.53	0.56	5.34	5.34	18.0	18.0	4.2	22.64	24.77	8.22	24	1.02	859.11	859.27	860.70	860.96	861.67	861.83	STM-10
11	End	81.470	0.00	34.72	0.00	0.00	20.22	0.0	20.4	4.0	80.09	27.42	25.50	24	1.25	846.47	847.49	848.47	857.18	849.03	861.46	STM-11
12	11	20.114	0.00	34.72	0.00	0.00	20.22	0.0	20.4	4.0	80.12	27.32	25.51	24	1.24	847.49	847.74	863.65	865.80	861.46	861.46	STM-12
13	12	113.317	0.00	34.72	0.00	0.00	20.22	0.0	20.3	4.0	80.29	27.43	25.56	24	1.25	847.74	849.16	871.06	883.23	861.46	861.06	STM-13
14	13	15.110	0.33	7.55	0.85	0.28	4.49	10.0	16.0	4.5	20.22	26.71	25.75	12	47.91	850.86	858.10	891.15	895.31	861.06	861.70	STM-14
15	14	60.732	2.44	2.89	0.60	1.46	1.82	12.0	12.0	5.2	9.45	3.87	12.04	12	1.00	858.10	858.71	911.18	914.83	861.70	862.00	STM-15
16	15	21.493	0.45	0.45	0.80	0.36	0.36	10.0	10.0	5.6	2.02	3.81	2.57	12	0.98	858.71	858.92	918.21	918.27	862.00	862.00	STM-16
17	14	21.595	4.33	4.33	0.55	2.38	2.38	16.0	16.0	4.5	10.74	5.87	13.68	12	2.32	858.10	858.60	911.18	912.86	861.70	861.50	STM-17
18	13	101.978	0.00	27.17	0.00	0.00	15.73	0.0	20.2	4.0	62.63	33.53	19.94	24	1.87	849.36	851.27	891.15	897.82	861.06	862.57	STM-18
19	18	84.851	0.33	27.17	0.50	0.17	15.73	12.0	20.2	4.0	62.75	33.44	19.98	24	1.86	851.27	852.85	902.64	908.21	862.57	859.85	STM-19
20	19	190.395	26.84	26.84	0.58	15.57	15.57	20.0	20.0	4.0	62.37	26.64	19.85	24	1.18	852.85	855.10	916.95	929.29	859.85	857.66	STM-20
21	End	52.040	0.75	37.86	0.55	0.41	21.94	14.0	21.3	3.9	84.75	34.96	9.32	42	0.35	844.01	844.19	846.95	848.28	848.01	848.81	STM-21

Project File: 220398_Elmwood-Storm Sewer.stm | Number of lines: 22 | Run Date: 8/22/2022

NOTES:Intensity = 65.69 / (Inlet time + 9.80) ^ 0.82 ; Return period =Yrs. 10 ; c = cir e = ellip b = box

Storm Sewer Tabulation

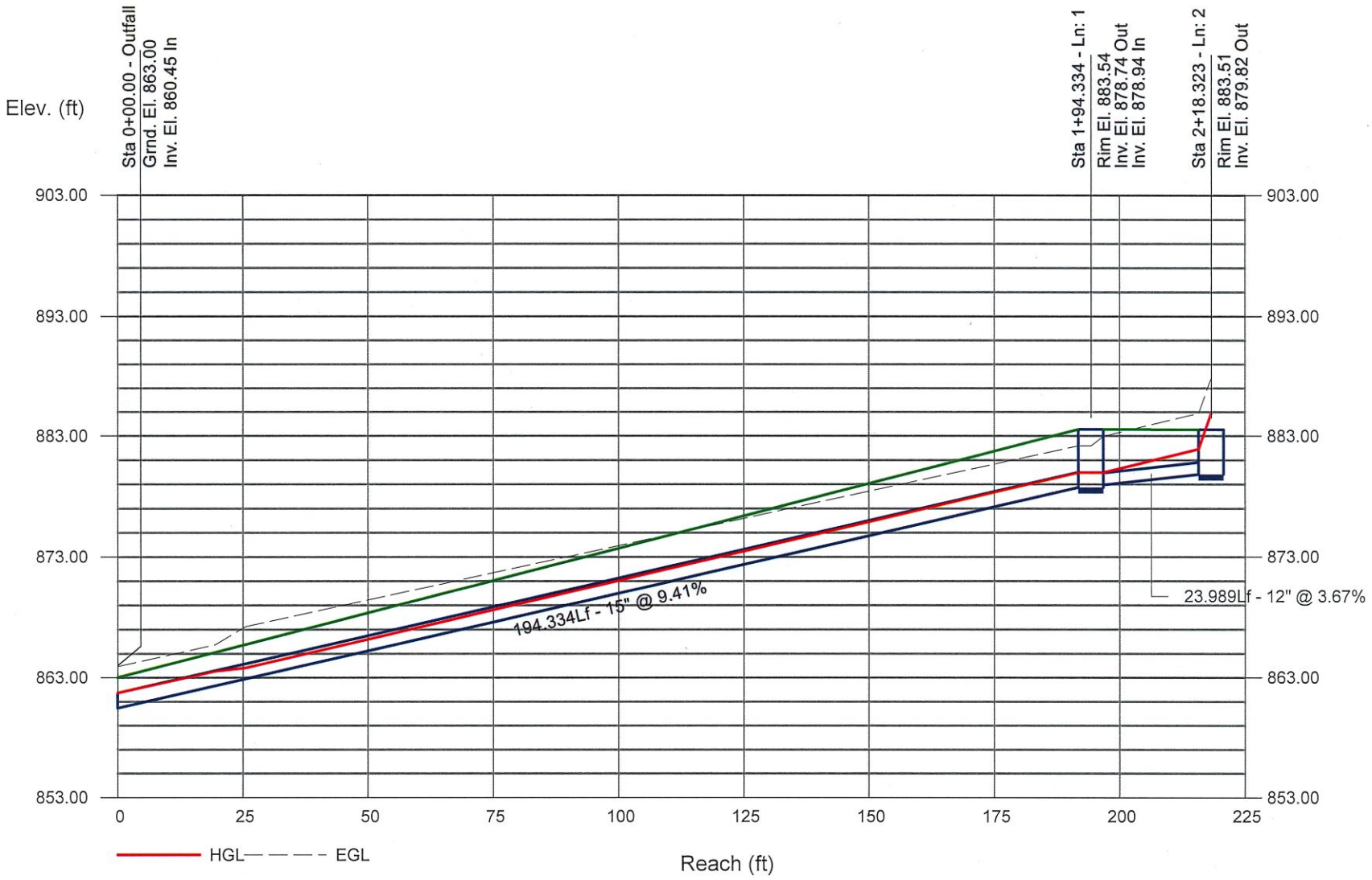
Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
22	21	179.545	37.11	37.11	0.58	21.52	21.52	21.0	21.0	3.9	83.92	35.22	8.72	42	0.35	844.19	844.82	848.88	852.46	848.81	848.82	STM-22

Project File: 220398_Elmwood-Storm Sewer.stm | Number of lines: 22 | Run Date: 8/22/2022

NOTES:Intensity = 65.69 / (Inlet time + 9.80) ^ 0.82 ; Return period =Yrs. 10 ; c = cir e = ellip b = box

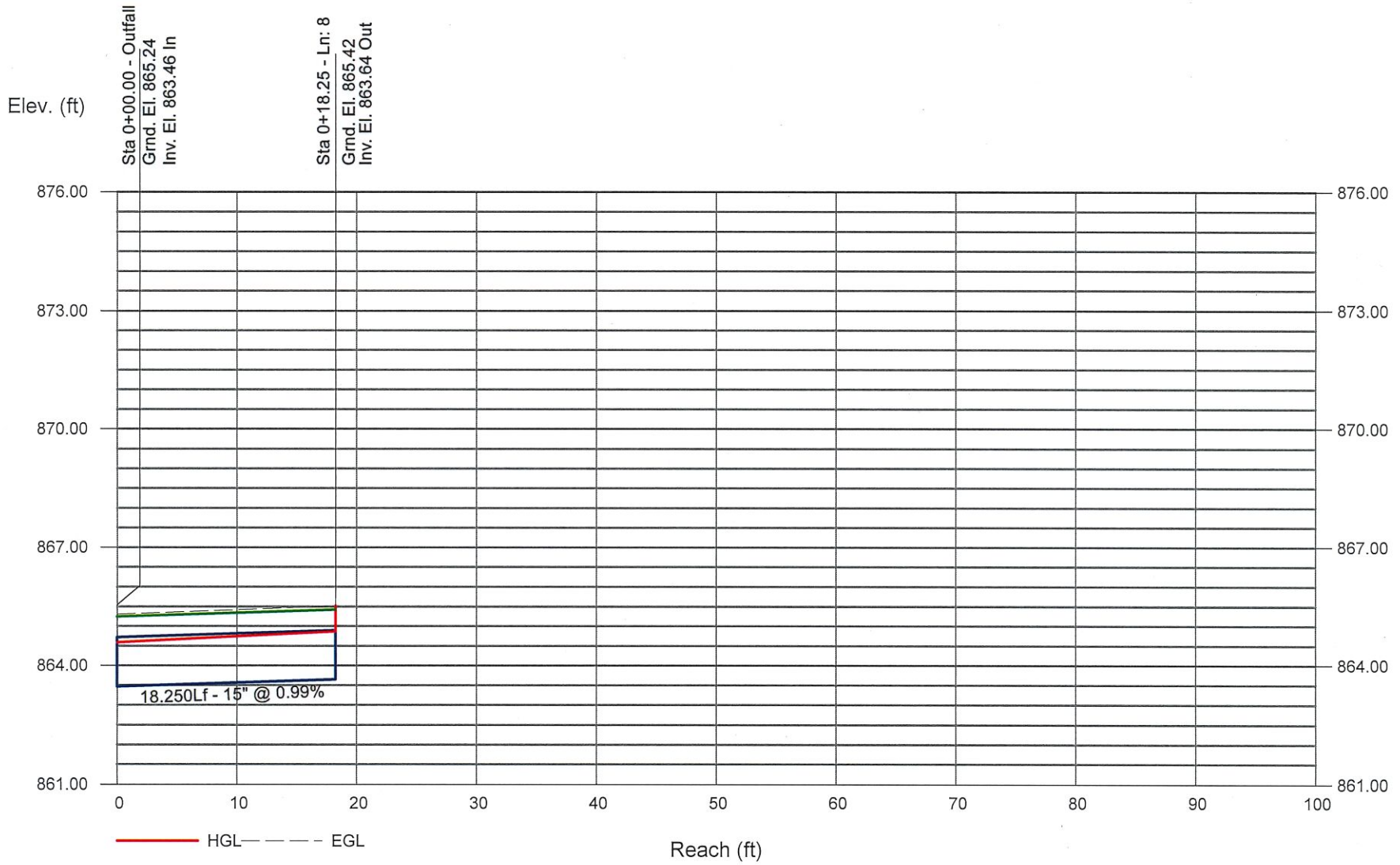
Storm Sewer Profile

Proj. file: 220398_Elmwood-Storm Sewer.stm



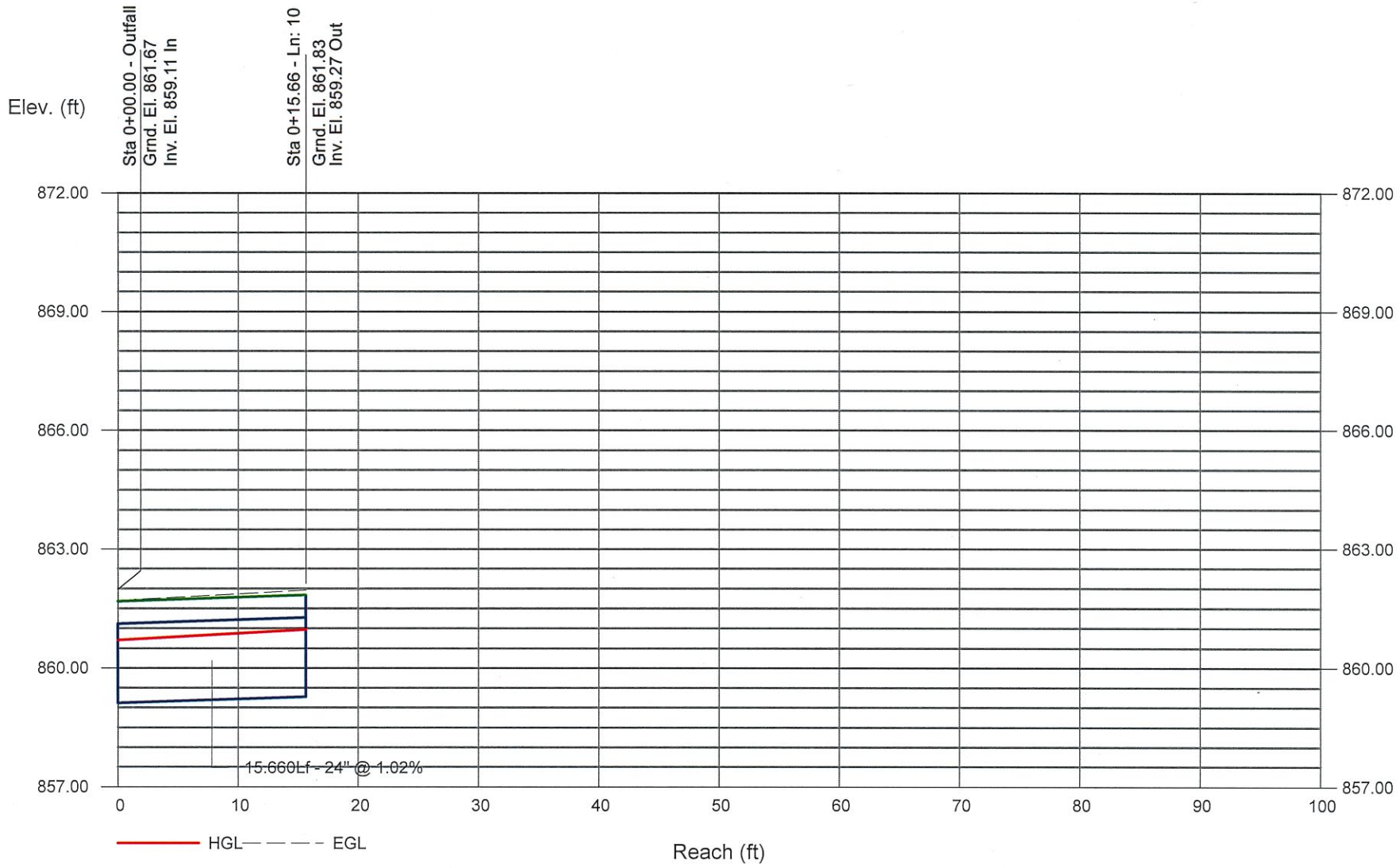
Storm Sewer Profile

Proj. file: 220398_Elmwood-Storm Sewer.stm



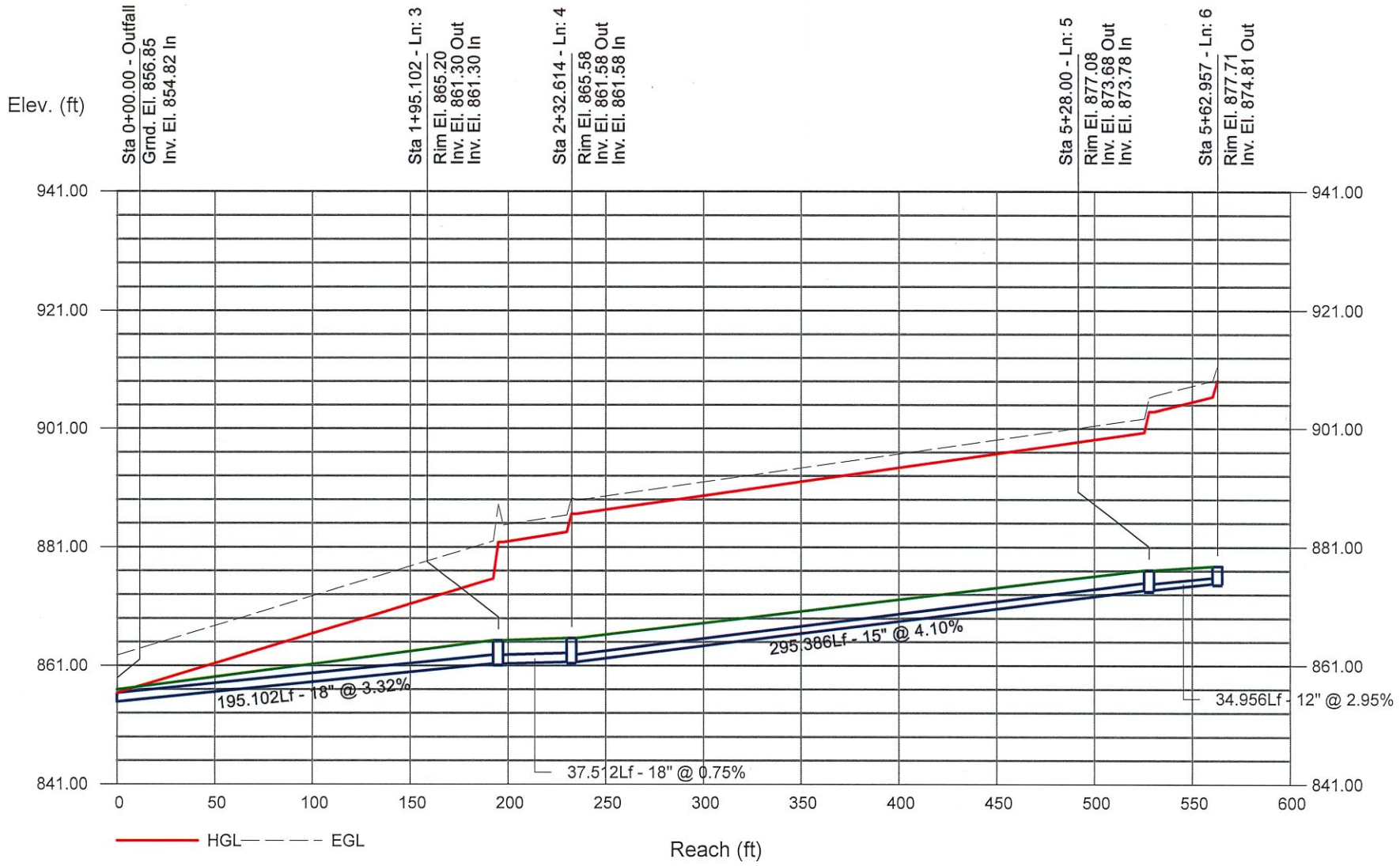
Storm Sewer Profile

Proj. file: 220398_Elmwood-Storm Sewer.stm



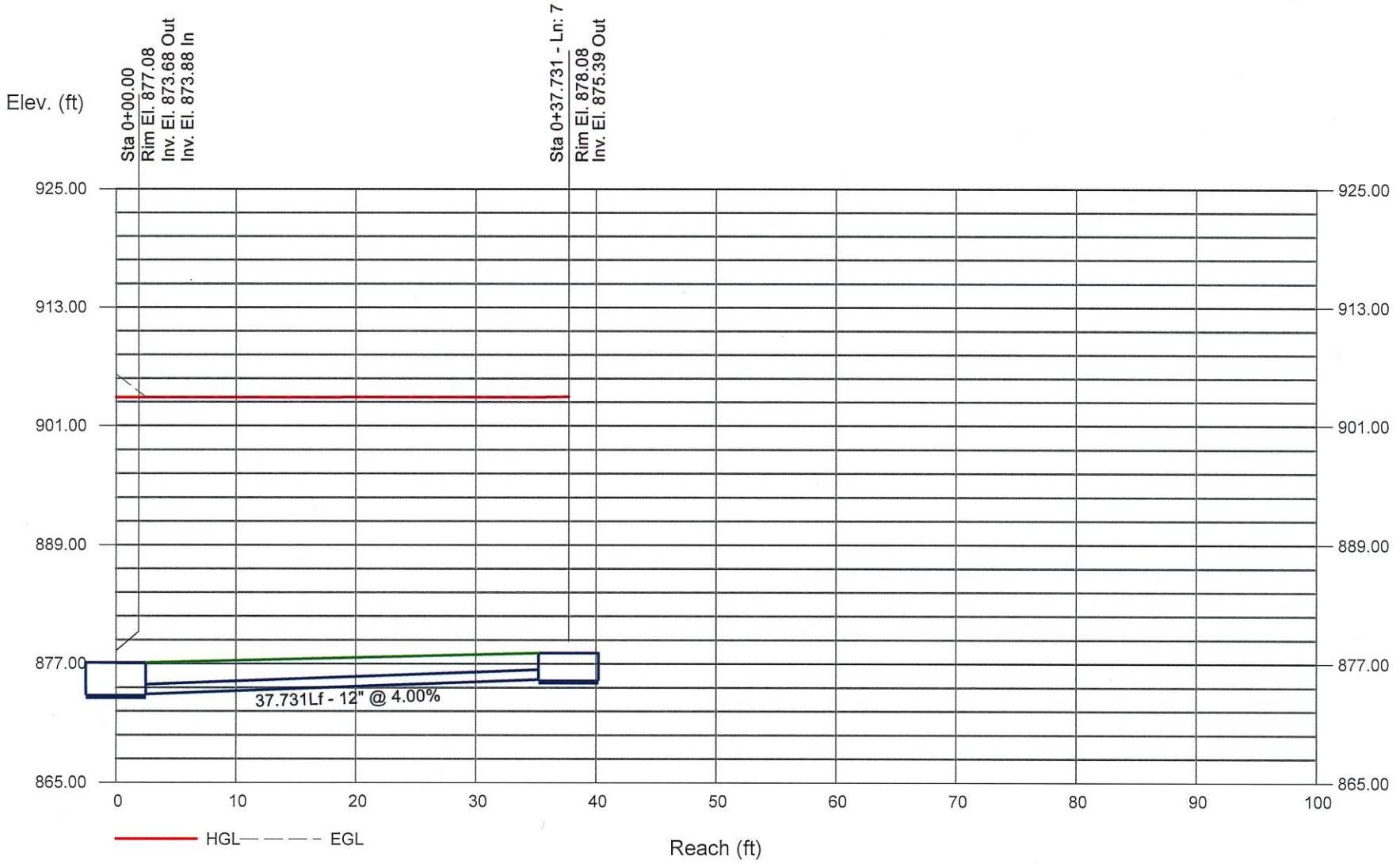
Storm Sewer Profile

Proj. file: 220398_Elmwood-Storm Sewer.stm



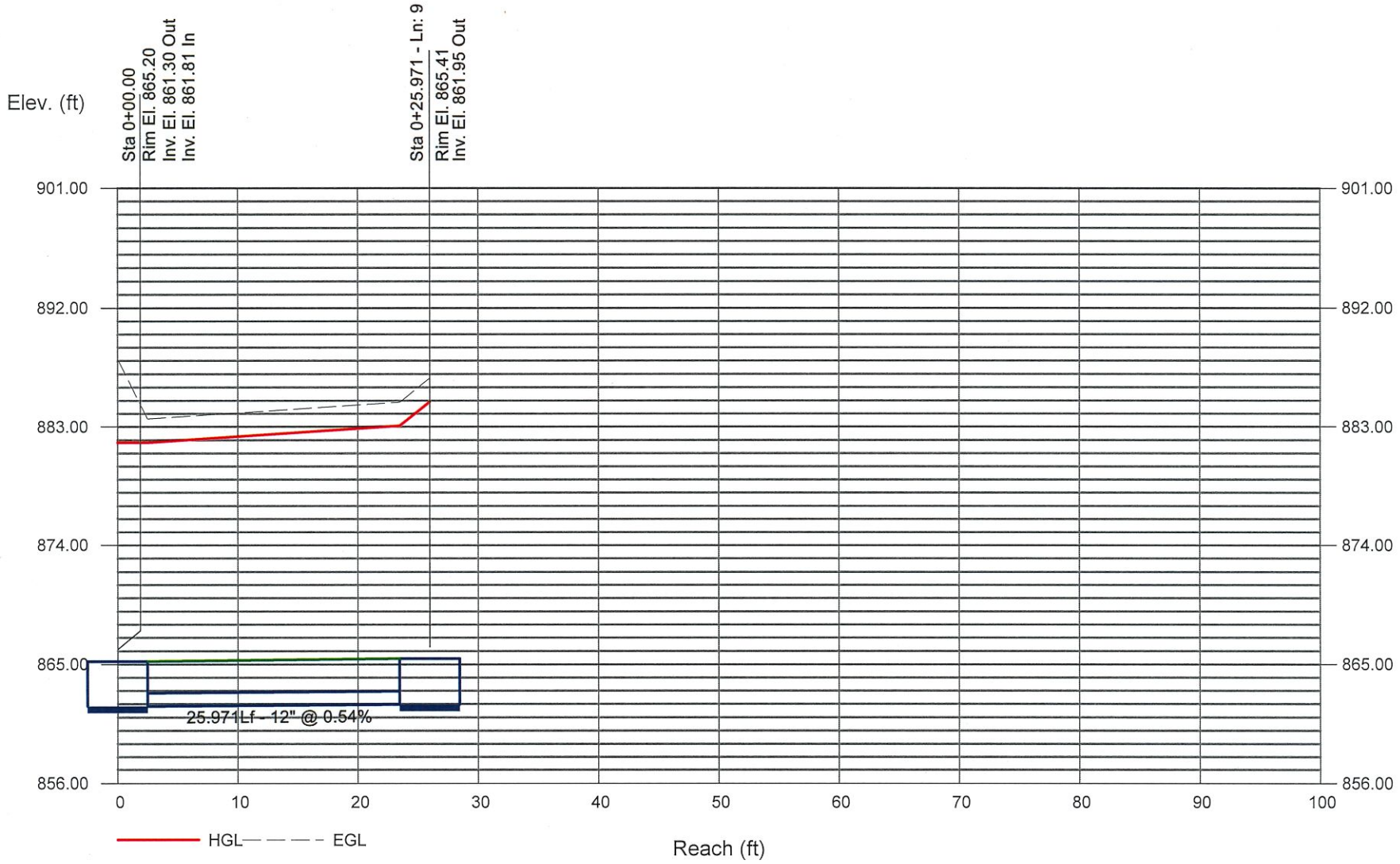
Storm Sewer Profile

Proj. file: 220398_Elmwood-Storm Sewer.stm



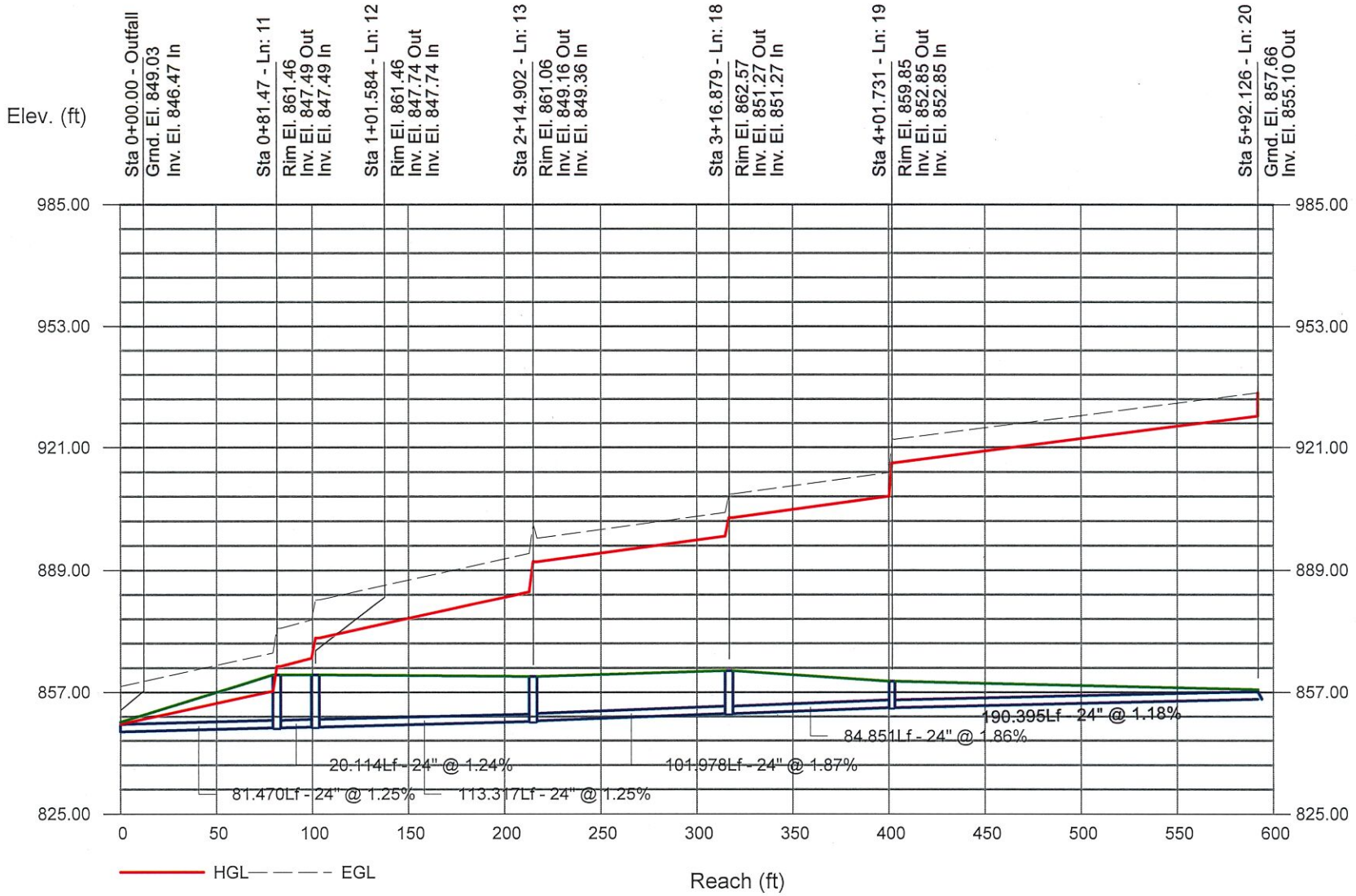
Storm Sewer Profile

Proj. file: 220398_Elmwood-Storm Sewer.stm



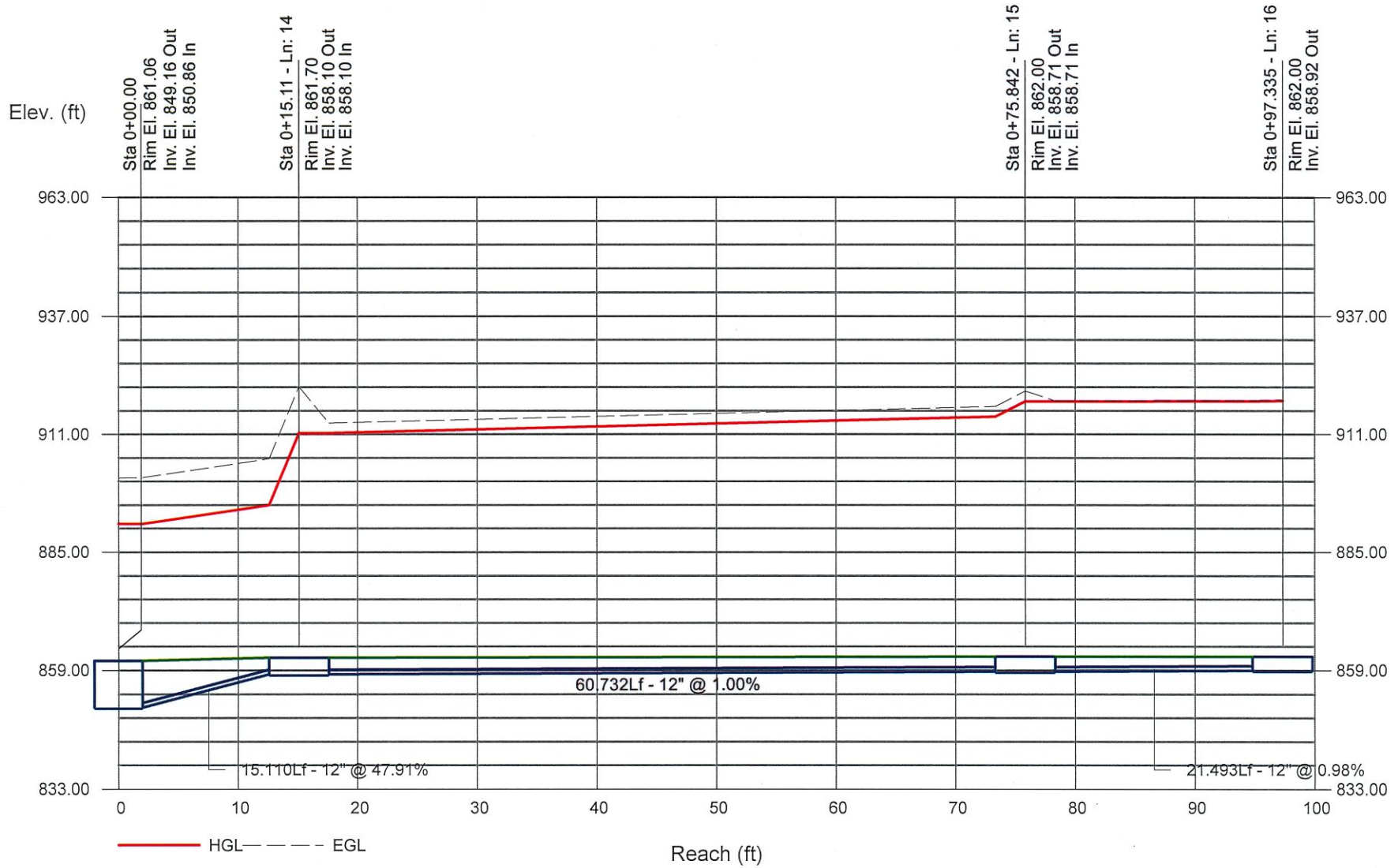
Storm Sewer Profile

Proj. file: 220398_Elmwood-Storm Sewer.stm



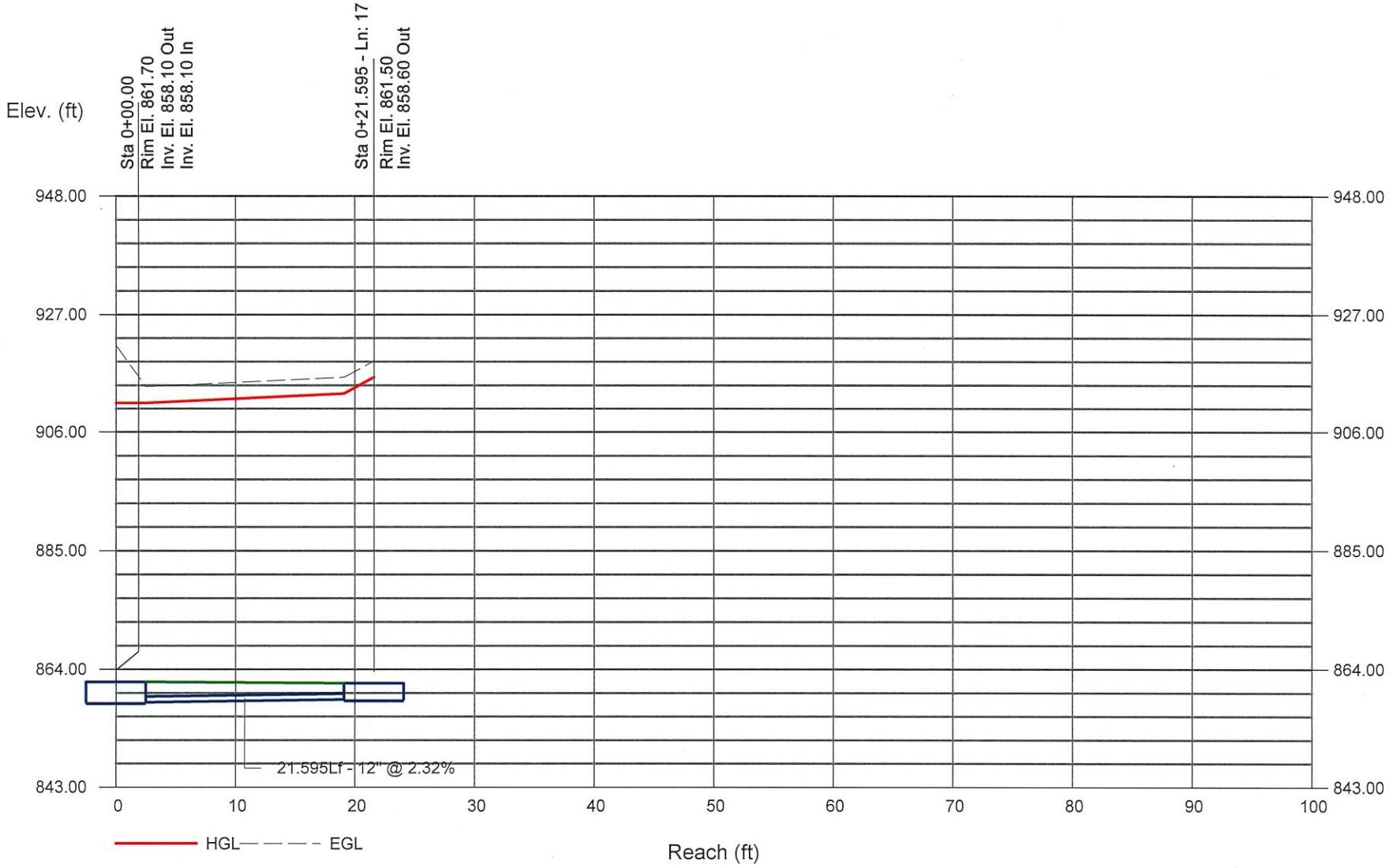
Storm Sewer Profile

Proj. file: 220398_Elmwood-Storm Sewer.stm



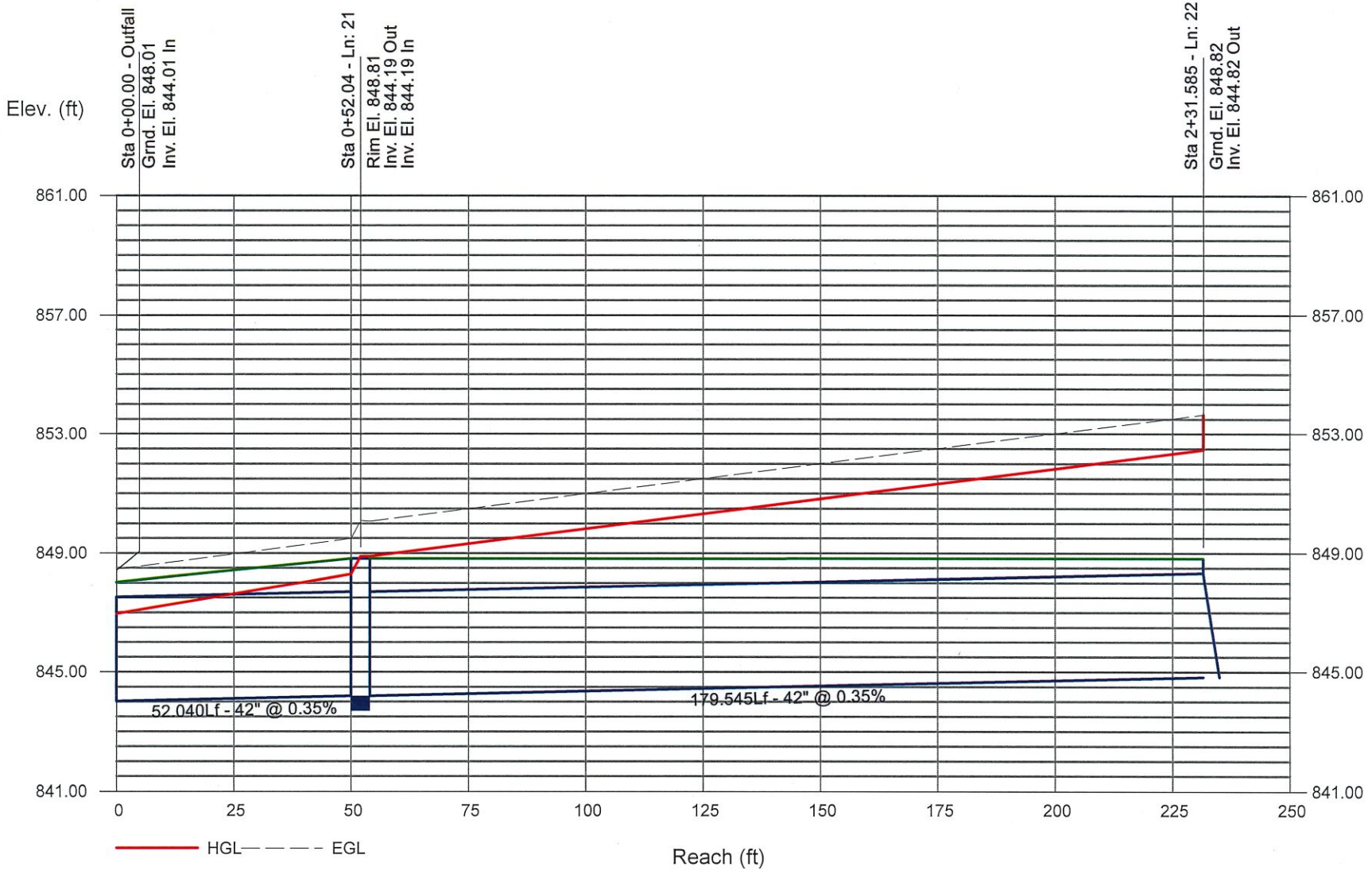
Storm Sewer Profile

Proj. file: 220398_Elmwood-Storm Sewer.stm

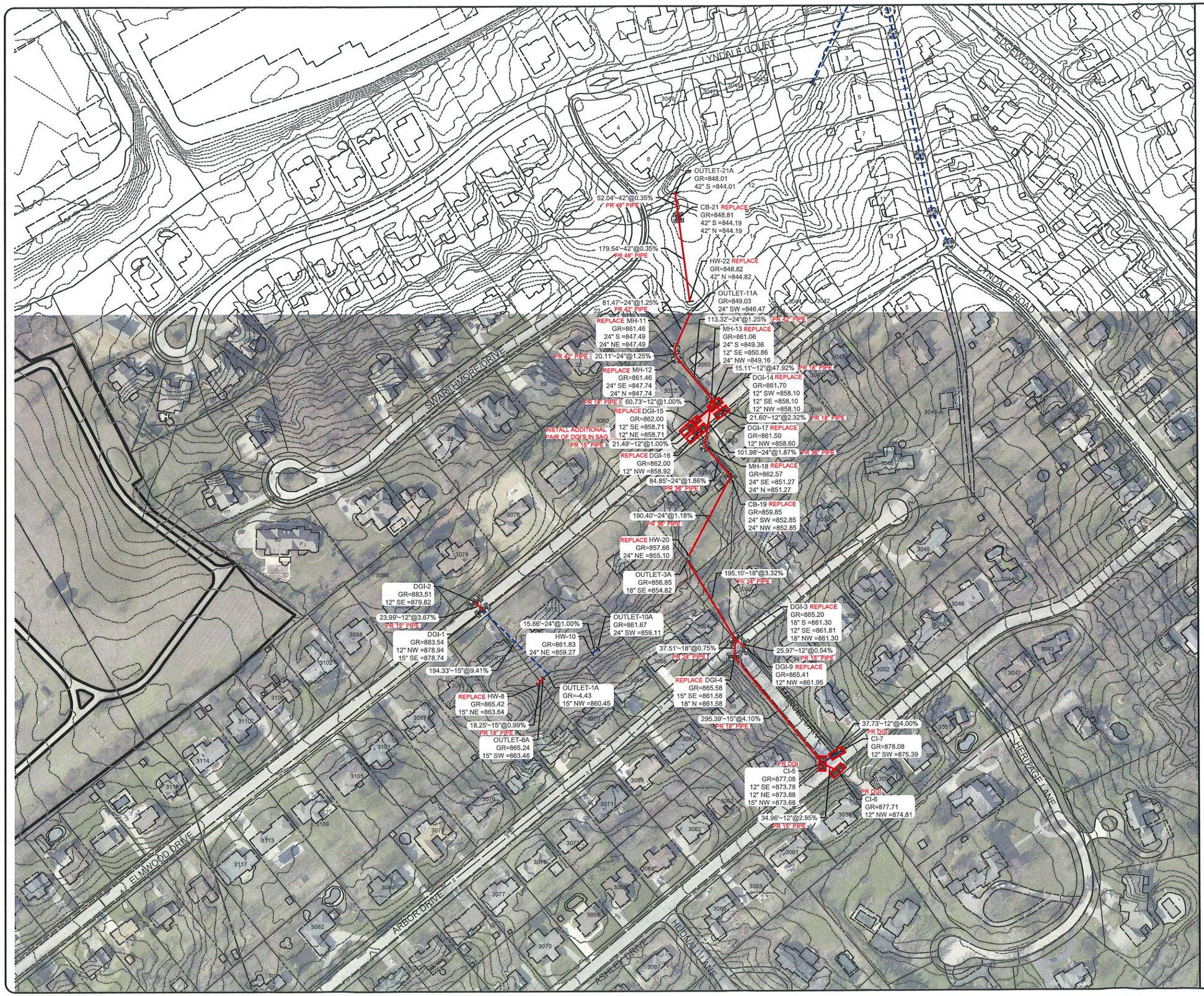


Storm Sewer Profile

Proj. file: 220398_Elmwood-Storm Sewer.stm



APPENDIX B
PROPOSED CONDITIONS



SCALE: 1" = 100' (22X34)
SCALE: 1" = 200' (11X17)

LEGEND

EXISTING STORM SEWER

PROPOSED IMPROVEMENTS (OPTION 1)

NOTE: PIPE SIZES, MATERIAL, SLOPES AND DEPTHS ARE BASED ON SD1 GIS INFORMATION, AND HAVE NOT BEEN CONFIRMED WITH FIELD SURVEY.

PRELIMINARY

your trusted advisor consultants engineers architects planners

NO	REVISION	DATE

SCALE: AS NOTED
DATE: 08/22/2022
DESIGNED BY: MHEL
DRAWN BY: RSEI
CHECKED BY: MHEL

ELMWOOD & ARBOR DRAINAGE STUDY
CITY OF EDGEWOOD
KENTON COUNTY, KENTUCKY

PROPOSED CONDITIONS BASE SYSTEM IMPROVEMENTS

PROJECT NO: 220398
DRAWING NAME: IMPROVE
SHEET: 1 OF: 1

C:\CTCAD_DRIVE\$_H2022\220398\DWG\BASE\C_220398 - P-BASE - ELMWOOD 2.DWG - LAYOUT1 - 8/23/2022 4:38:33 AM - ROBERT SEITZINGER

REPLACE STM-9A
GR=838.07
29" S =830.82
29" N =830.82

94.76'~29"@0.50%
PR 34"x53" ELLIPTICAL PIPE

18.38'~24"@5.22%
PR 42" PIPE

REPLACE STM 10
GR=838.79
24" SW =834.63
24" E =834.63

STM-12 REPLACE
GR=838.67
24" S =831.67
24" W =833.67
29" N =831.29

272.49'~24"@1.86%
PR 42" PIPE

REPLACE 1279
GR=842.44
24" NE =839.69

EDGEWOOD ROAD

LYNDALE COURT

LYNDALE ROAD

29 31 43 40 42 46 50 1 3046 3045 3043 3047 3049 2 3 4 5 55 6 57 7

0' 30' 60'
SCALE: 1" = 30' (22X34)
SCALE: 1" = 60' (11X17)

LEGEND
EXISTING STORM SEWER
PROPOSED IMPROVEMENTS (OPTION 1)

NOTE: PIPE SIZES, MATERIAL, SLOPES AND DEPTHS ARE BASED ON SD1 GIS INFORMATION, AND HAVE NOT BEEN CONFIRMED WITH FIELD SURVEY.

PRELIMINARY

your trusted advisor consultants engineers architects planners

NO	REVISION	DATE

SCALE: AS NOTED
DATE: 08/22/2022
DESIGNED BY: MHEL
DRAWN BY: RSEI
CHECKED BY: MHEL

ELMWOOD & ARBOR DRAINAGE STUDY
CITY OF EDGEWOOD
KENTON COUNTY, KENTUCKY

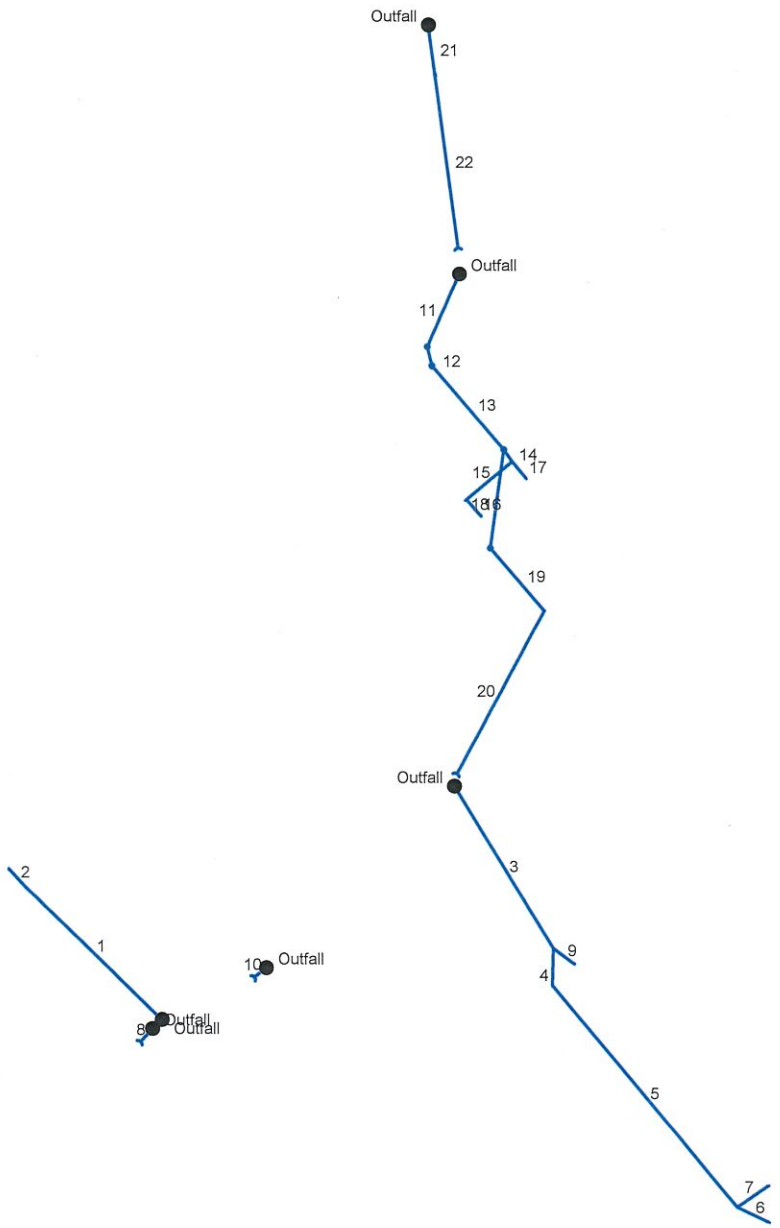
PROPOSED CONDITIONS
EDGEWOOD/LYNDALE SYSTEM IMPROVEMENTS

PROJECT NO: 220398
DRAWING NAME: IMPROVE
SHEET 1 OF 1

C:\CTCAD_DRIVE5_H2022\220398\DWG\BASE\C_220398 - P-BASE - ELMWOOD \.DWG - LAYOUT1 - 8/22/2022 5:23:47 AM - ROBERT SEITZINGER

Base System Improvements
10 Year Storm Analysis

Hydraflow Storm Sewers Extension for Autodesk® AutoCAD® Civil 3D® Plan



Project File: 220398_Elmwood-Storm Sewer-Improvemets Opt 1.stm	Number of lines: 22	Date: 8/22/2022

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	194.334	1.10	4.87	0.70	0.77	3.03	10.0	14.0	4.8	14.60	21.46	11.92	15	9.41	860.45	878.74	861.69	879.97	863.00	883.54	STM-1
2	1	23.989	3.77	3.77	0.60	2.26	2.26	14.0	14.0	4.8	10.91	13.40	9.52	15	3.67	878.94	879.82	879.97	881.02	883.54	883.51	STM-2
3	End	195.102	1.11	13.16	0.70	0.78	8.05	10.0	16.7	4.4	35.50	42.90	12.74	24	3.07	854.82	860.80	856.32	862.72	856.85	865.20	STM-3
4	3	37.512	3.39	8.91	0.60	2.03	5.39	16.0	16.6	4.4	23.83	35.33	7.97	24	2.08	860.80	861.58	862.72	863.31	865.20	865.58	STM-4
5	4	295.386	1.40	5.52	0.60	0.84	3.36	14.0	16.1	4.5	15.11	23.02	8.66	18	4.10	861.58	873.68	863.31	875.09	865.58	877.08	STM-5
6	5	34.956	3.82	3.82	0.60	2.29	2.29	16.0	16.0	4.5	10.34	12.01	8.50	15	2.95	873.78	874.81	875.09	876.00	877.08	877.71	STM-6
7	5	37.731	0.30	0.30	0.75	0.23	0.23	10.0	10.0	5.6	1.26	7.72	2.53	12	4.00	873.88	875.39	875.09	875.86	877.08	878.08	STM-7
8	End	18.250	3.51	3.51	0.50	1.76	1.76	16.0	16.0	4.5	7.92	11.30	5.68	18	0.99	863.46	863.64	864.58	864.73	865.24	865.42	STM-8
9	3	25.971	3.14	3.14	0.60	1.88	1.88	16.0	16.0	4.5	8.50	10.98	7.09	15	2.46	861.31	861.95	862.72	863.09	865.20	865.41	STM-9
10	End	15.660	9.53	9.53	0.56	5.34	5.34	18.0	18.0	4.2	22.64	24.77	8.07	24	1.02	859.11	859.27	860.76	860.96	861.67	861.83	STM-10
11	End	81.470	0.00	34.72	0.00	0.00	20.22	0.0	21.0	3.9	78.82	122.0	9.55	42	1.25	846.47	847.49	849.30	850.26	849.03	861.46	STM-11
12	11	20.114	0.00	34.72	0.00	0.00	20.22	0.0	21.0	3.9	78.91	121.5	9.65	42	1.24	847.49	847.74	850.26	850.51	861.46	861.46	STM-12
13	12	113.317	0.00	34.72	0.00	0.00	20.22	0.0	20.7	3.9	79.42	122.0	9.70	42	1.25	847.74	849.16	850.51	851.94	861.46	861.06	STM-13
14	13	15.110	0.33	7.55	0.85	0.28	4.49	10.0	16.1	4.5	20.20	78.75	13.14	18	47.91	850.86	858.10	851.94	859.57	861.06	861.70	STM-14
15	14	60.732	2.44	2.89	0.60	1.46	1.82	12.0	12.0	5.2	9.45	11.40	5.84	18	1.00	858.10	858.71	859.57	859.90	861.70	862.00	STM-15
16	15	21.493	0.45	0.45	0.80	0.36	0.36	10.0	10.0	5.6	2.02	3.81	2.57	12	0.98	858.71	858.92	859.90	859.92	862.00	862.00	STM-16
17	14	21.595	4.33	4.33	0.55	2.38	2.38	16.0	16.0	4.5	10.74	17.31	6.45	18	2.32	858.10	858.60	859.57	859.86	861.70	861.50	STM-17
18	13	101.978	0.00	27.17	0.00	0.00	15.73	0.0	20.5	3.9	62.13	98.88	9.67	36	1.87	849.36	851.27	851.94	853.81	861.06	862.57	STM-18
19	18	84.851	0.33	27.17	0.50	0.17	15.73	12.0	20.4	4.0	62.41	98.59	9.78	36	1.86	851.27	852.85	853.81	855.39	862.57	859.85	STM-19
20	19	190.395	26.84	26.84	0.58	15.57	15.57	20.0	20.0	4.0	62.37	78.54	9.77	36	1.18	852.85	855.10	855.39	857.64	859.85	857.66	STM-20
21	End	52.040	0.75	37.86	0.55	0.41	21.94	14.0	21.4	3.9	84.51	91.52	8.46	48	0.35	844.01	844.19	846.95	847.18	848.01	848.81	STM-21

Project File: 220398_Elmwood-Storm Sewer-Improvemets Opt 1.stm | Number of lines: 22 | Run Date: 8/22/2022

NOTES:Intensity = 65.69 / (Inlet time + 9.80) ^ 0.82 ; Return period =Yrs. 10 ; c = cir e = ellip b = box

Storm Sewer Tabulation

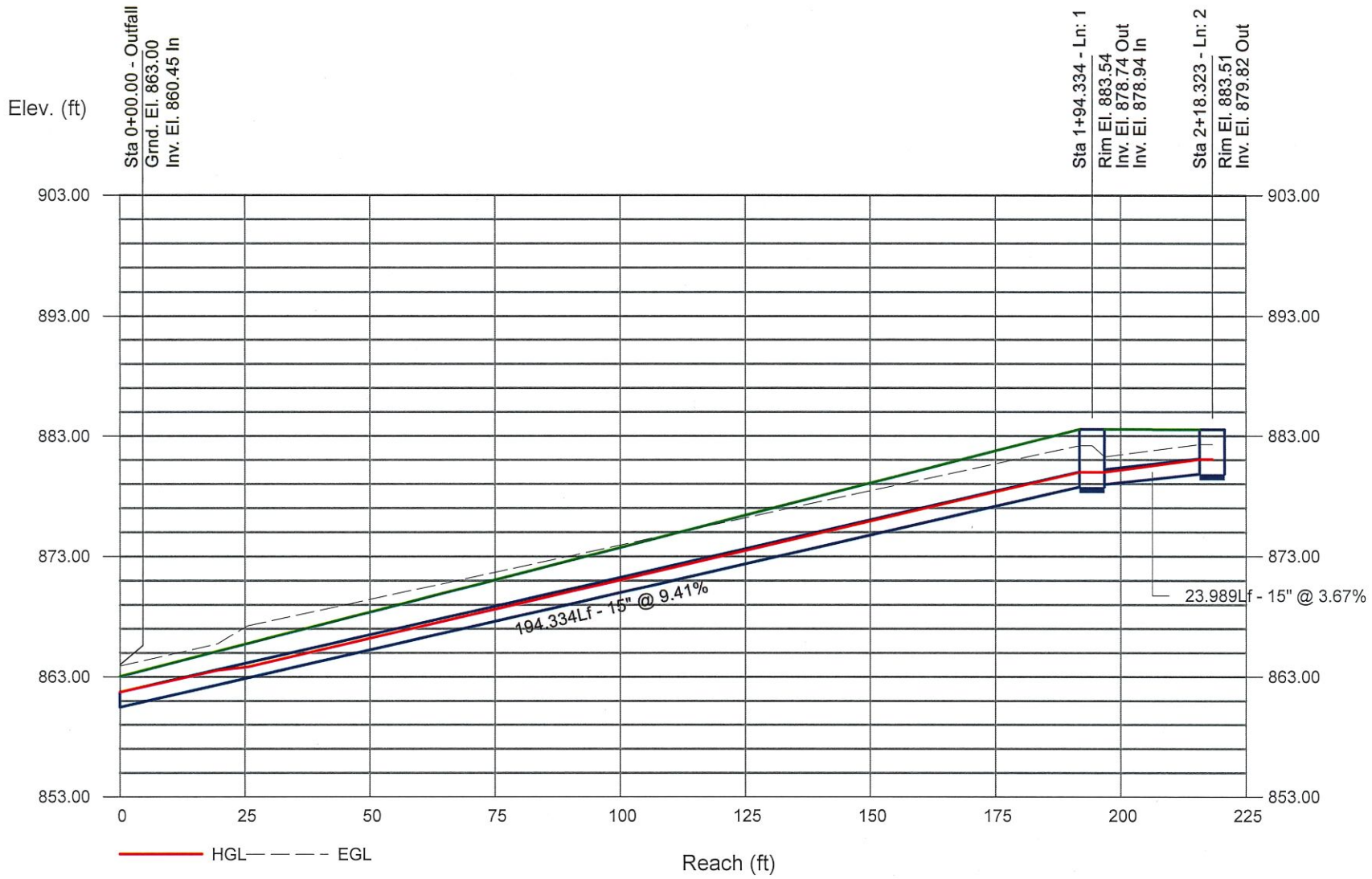
Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
22	21	179.545	37.11	37.11	0.58	21.52	21.52	21.0	21.0	3.9	83.92	92.18	7.35	48	0.35	844.19	844.82	847.73	848.12	848.81	848.82	STM-22

Project File: 220398_Elmwood-Storm Sewer-Improvemets Opt 1.stm | Number of lines: 22 | Run Date: 8/22/2022

NOTES:Intensity = 65.69 / (Inlet time + 9.80) ^ 0.82 ; Return period =Yrs. 10 ; c = cir e = ellip b = box

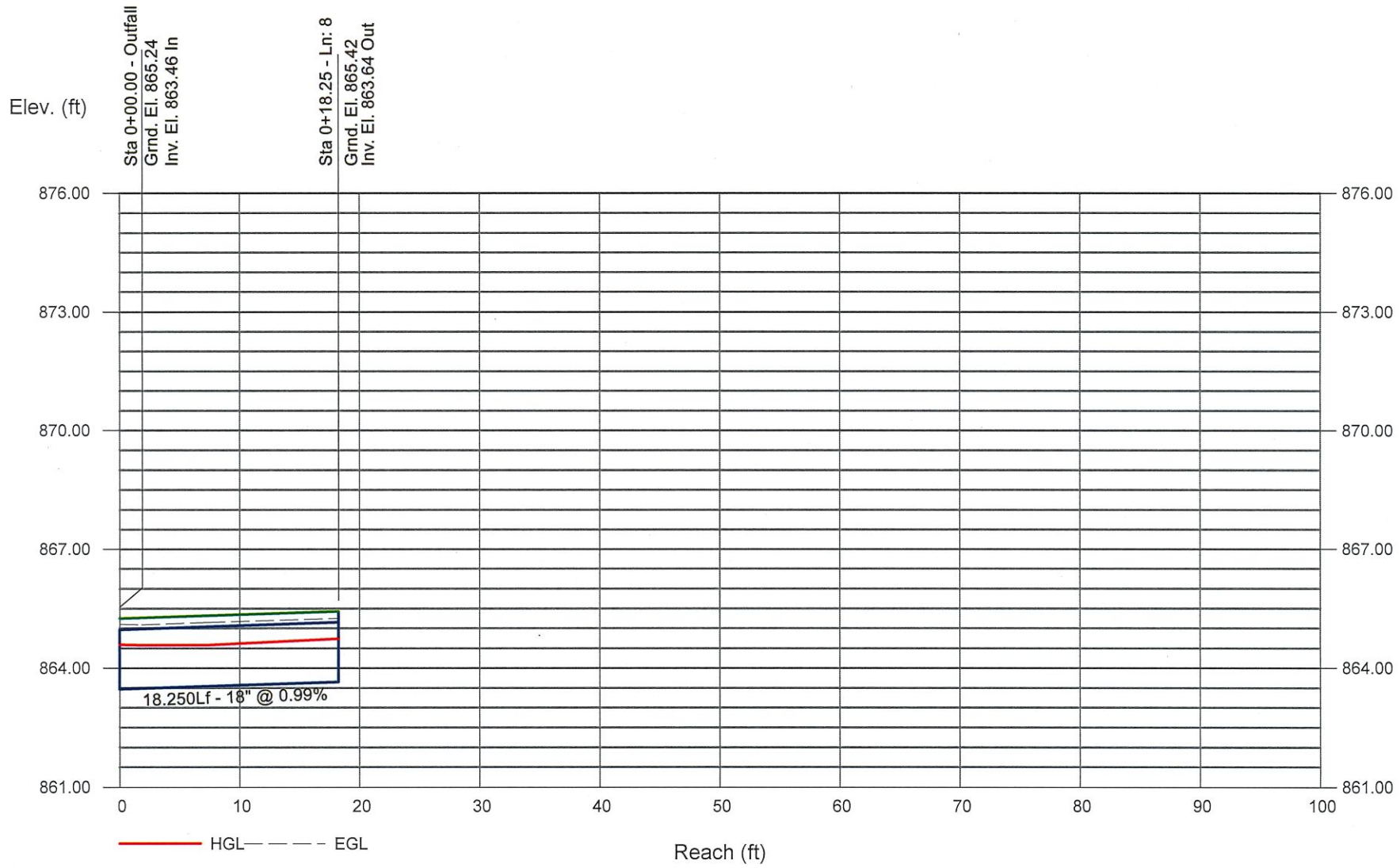
Storm Sewer Profile

Proj. file: 220398_Elmwood-Storm Sewer-Improvemets Opt 1.stm



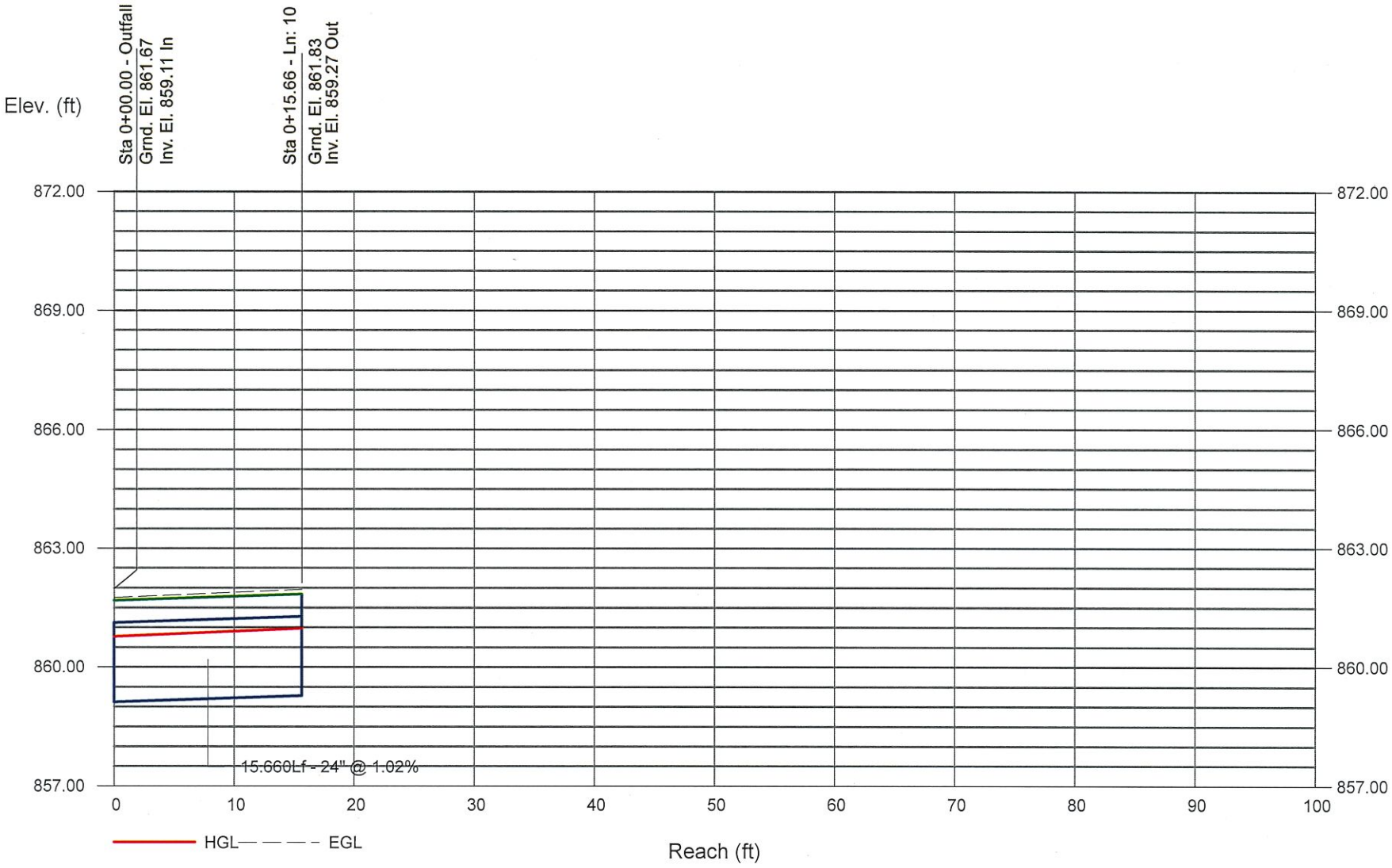
Storm Sewer Profile

Proj. file: 220398_Elmwood-Storm Sewer-Improvemets Opt 1.stm



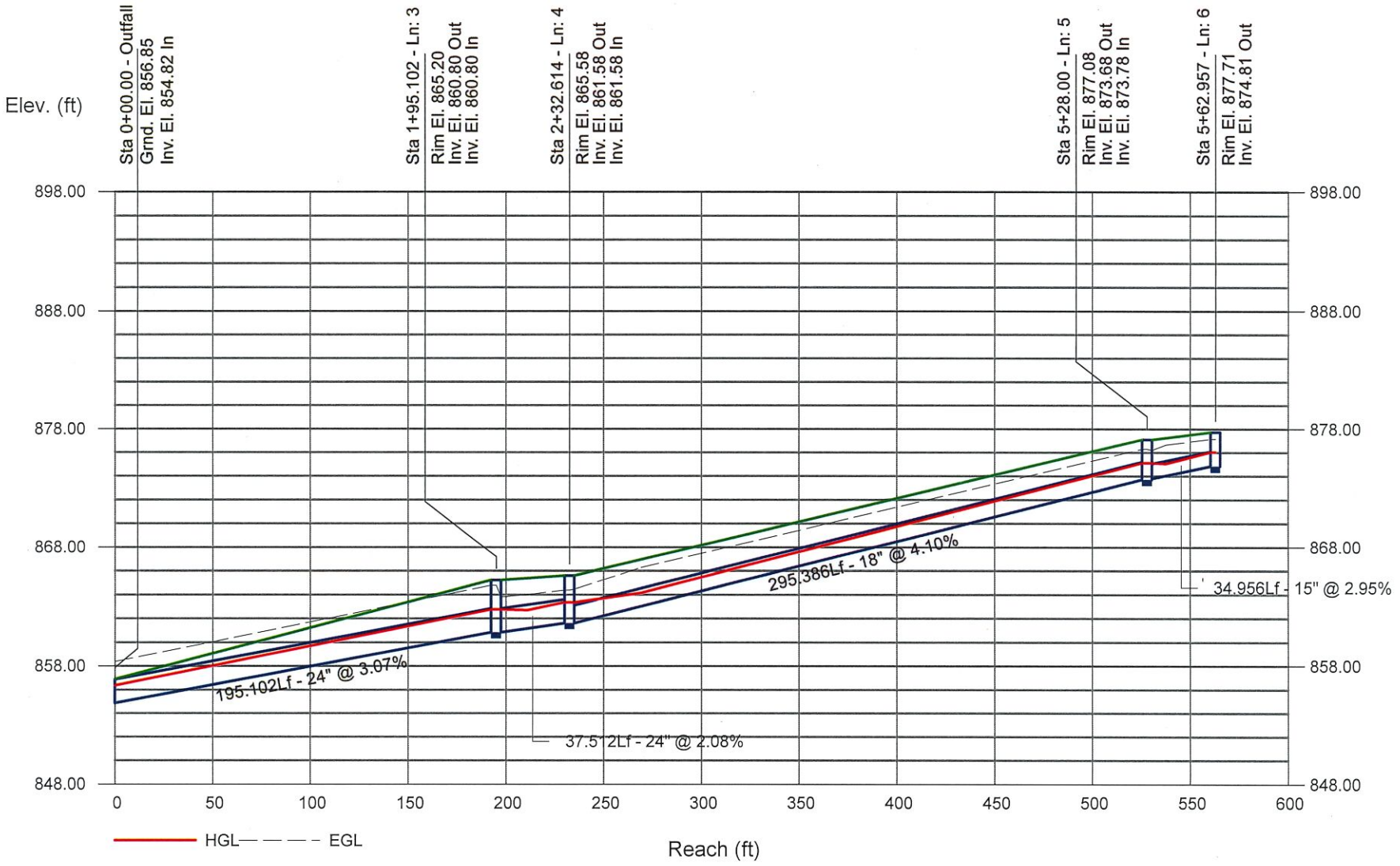
Storm Sewer Profile

Proj. file: 220398_Elmwood-Storm Sewer-Improvemets Opt 1.stm



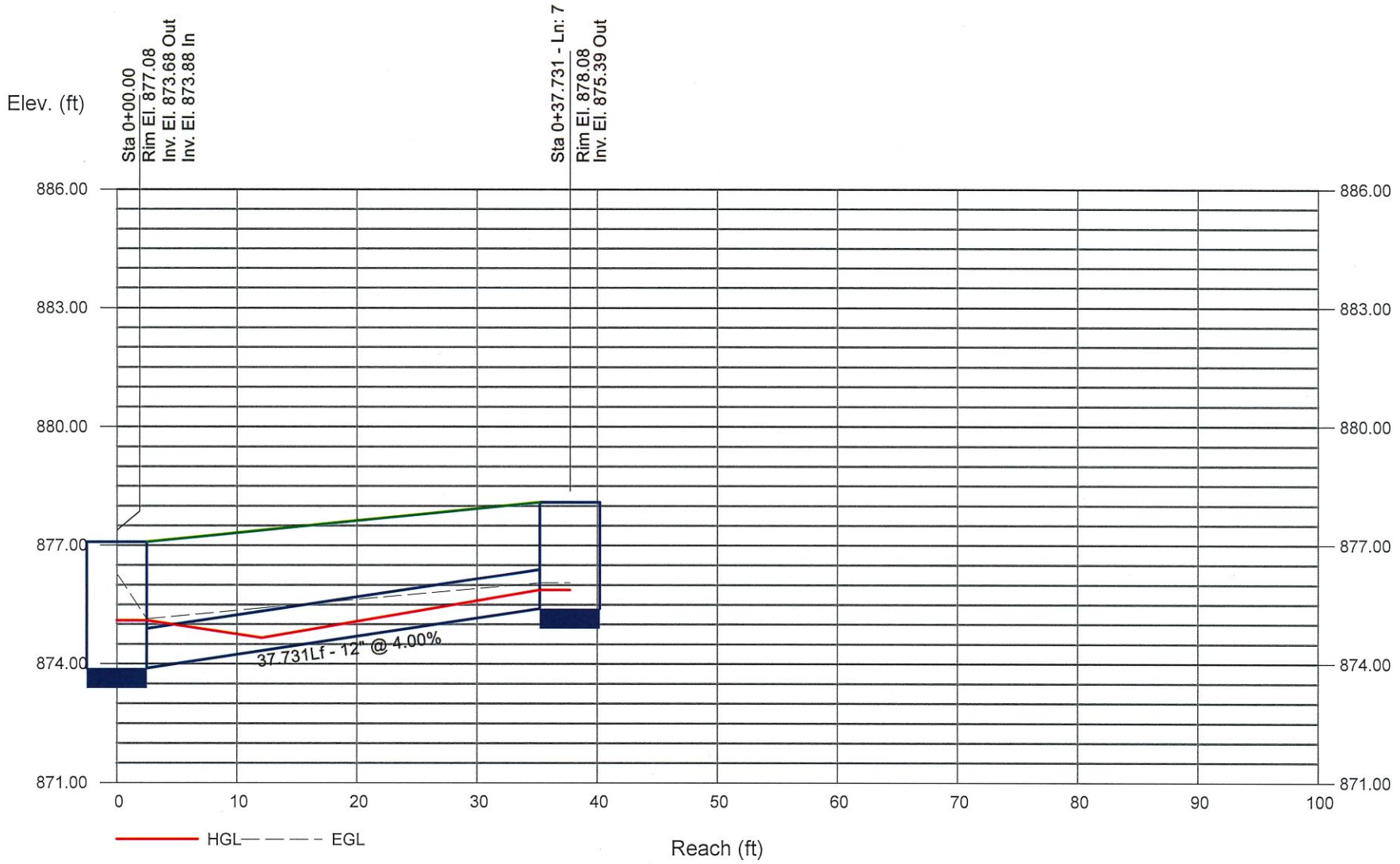
Storm Sewer Profile

Proj. file: 220398_Elmwood-Storm Sewer-Improvemets Opt 1.stm



Storm Sewer Profile

Proj. file: 220398_Elmwood-Storm Sewer-Improvemets Opt 1.stm



Storm Sewer Profile

Proj. file: 220398_Elmwood-Storm Sewer-Improvemets Opt 1.stm