DEVELOPMENT ENGINEERING, INC.
Professional Engineering Consultants

Hydraulic Grade Line Calculations
10-Year Storm

For

Goodwill Community Foundation, Inc.
1745 Sir Tyler Drive
Wilmington, NC

05-08-13

NORTH CAROLINA PROFESSIONAL SEAL 12550 ENGINEER DAVID H. BLEVINS

Prepared by:

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ABSTRACT

This Hydraulic Grade Line Report is in support of the on-site stormwater infrastructure design. There is an existing stormwater detention pond on the adjacent property north of the Goodwill site. The stormwater discharge from the proposed Goodwill improvements are captured and conveyed to the existing pond. There is an existing 30" RCP that discharges onto the Goodwill site. This stormwater discharge is intercepted and conveyed around the proposed building to the pond with a 36" RCP. A flow of approximately 2/3 capacity of the 30" storm pipe was assumed for the 36" storm pipe system design. A portion of the Goodwill site drainage is captured and included with the 36" RCP system. The remaining storm drainage from the Goodwill site is captured and conveyed to the existing pond via separate piping systems. Also an allowance was made for the adjacent 0.73 acre site east of the Goodwill property to connect their stormwater design system to the proposed Goodwill junction box (JB #18) located on the common property line. A projected flow of 4.22 CFS was allowed for within the Goodwill storm system. This was based on the 0.73 acre site to be developed at 80% impervious coverage.

The calculations were done using the Hydraflow Storm Sewer program. The stormwater discharge volumes to each storm structure were entered into the hydraflow storm program. See enclosed stormwater design chart indicating the breakdown of the individual impervious and pervious surface areas being captured at each storm structure.

STORM SEWER DESIGN (Q=CIA) 10-YR STORM

DRAINAGE AREA AND RUNOFF								PIPE DESIGN							
INLET NO.	RUN OFF AREAS, C				AVG. C	I_{10}	RUNOFF IN Q_{10}	PIPE NO.	FROM INLET	FROM PREV. PIPE	TOTAL TO PIPE	DIA.	PIPE SLOPE %	Q (MAX) CFS	V MAX FPS
		0.95	0.22	TOTAL											
CI 30		0.03		0.03	0.95	7.22	0.21								
								30-24	0.21	0.00	0.21	15"	2.19	9.58	7.8
CI 24						7.22	0.00								
CI 28		0.04		0.04	0.95	7.22	0.27								
								28-26	0.27	0.00	0.27	15"	0.83	5.90	4.8
CI 26		0.08	0.04	0.12	0.71	7.22	0.61								
								26-24	0.61	0.27	0.89	15"	0.83	5.90	4.8
CI 24		0.12		0.12	0.95	7.22	0.82								
								24-22	0.82	1.09	1.92	15"	0.69	5.38	4.4
HW 22						7.22	0.00								
CI 20		0.07		0.07	0.95	7.22	0.48								
								20-18	0.48	0.00	0.48	15"	0.83	5.90	4.8
**JB 18		0.58	0.15	0.73	0.80	7.22	4.22								
								18-16	4.22	0.48	4.70	15"	1.14	6.91	5.6
JB 16						7.22	0.00								
								16-14	0.00	4.70	4.70	15"	1.14	6.91	5.6
JB 14		0.29		0.29	0.95	7.22	1.99								
								14-12	1.99	4.70	6.69	18"	1.04	10.74	6.1
FES 12						7.22	0.00								
*EX CI 10						7.22	21.00								
								10-6	21.00	0.00	21.00	30"	0.46	27.89	5.7
JB 6						7.22	0.00								
CI 8		0.23		0.23	0.95	7.22	1.58								
								8-6	1.58	0.00	1.58	15"	0.60	5.02	4.1
JB 6						7.22	0.00								
								6-4	0.00	22.58	22.58	36"	0.46	45.35	6.4
JB 4						7.22	0.00								
								4-2	0.00	22.58	22.58	36"	0.43	43.85	6.2
HW 2						7.22	0.00								

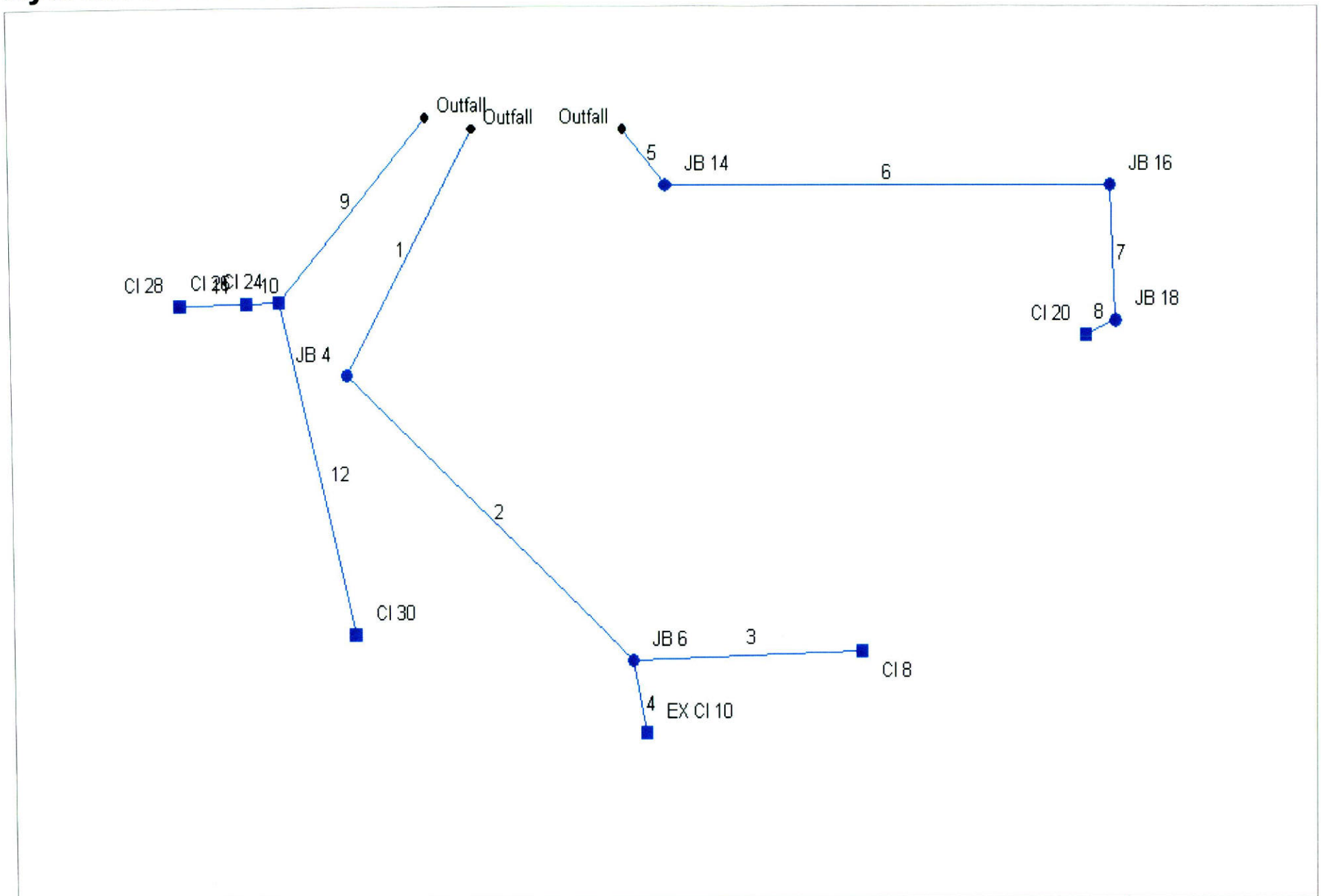
NOTE: Q MAX = THE MAXIMUM FLOW PIPE CAN HANDLE AT DESIGNED SLOPE.
V MAX BASED ON FULL FLOW AT DESIGNED SLOPE

C = 0.95 =IMPERVIOUS
C = 0.22 = GRASS / LANDSCAPED
FES= FLARED END SECTION

HW = HEADWALL PIPE
JB = JUNCTION BOX
CI = CURB INLET

* MINIMUM FLOW AT EXISTING CI 10 ASSUMED TO BE AT LEAST 2/3 CAPACITY OF 30" RCP.
** NEW ADJOINING LOT 2 (0.73 AC) PROJECTED TO BE DEVELOPED AT 80% IMPERVIOUS.
SEE STORMWATER VOLUME COLLECTED AT JB 18.

Hydraflow Plan View



Project File: 05-01-13_GCF Wilmington.stm	No. Lines: 12	05-08-2013

Hydraflow Storm Sewers 2005

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 type	N value (n)	J-loss coeff (K)	Inlet/ Rim El (ft)	
1	End	92.0	120.0	MH	0.00	0.00	0.00	0.0	12.00	0.43	12.40	36	Cir	0.013	0.98	19.00	HW 2 - JB 4
2	1	140.0	-78.0	MH	0.00	0.00	0.00	0.0	12.50	0.46	13.15	36	Cir	0.013	0.74	19.00	JB 4 - JB 6
3	2	84.0	-44.0	Curb	1.58	0.00	0.00	0.0	14.80	0.60	15.30	15	Cir	0.013	1.00	18.60	JB 6 - CI 8
4	2	24.0	36.0	Curb	21.00	0.00	0.00	0.0	13.20	0.46	13.31	30	Cir	0.013	1.00	18.05	JB 6 - EX CI 10
5	End	24.0	49.0	MH	1.99	0.00	0.00	0.0	12.00	1.04	12.25	18	Cir	0.013	0.79	16.50	FES 12 - JB 14
6	5	162.0	-49.0	MH	0.00	0.00	0.00	0.0	12.45	1.14	14.30	15	Cir	0.013	1.00	17.50	JB 14 - JB 16
7	6	44.0	87.0	MH	4.22	0.00	0.00	0.0	14.40	1.14	14.90	15	Cir	0.013	0.95	17.50	JB 16 - JB 18
8	7	12.0	69.0	Curb	0.48	0.00	0.00	0.0	15.00	0.83	15.10	15	Cir	0.013	1.00	18.20	JB 18 - CI 20
9	End	80.0	132.0	Curb	0.82	0.00	0.00	0.0	12.60	0.69	13.15	15	Cir	0.013	1.29	18.80	HW 22 - CI 24
10	9	12.0	47.0	Curb	0.61	0.00	0.00	0.0	13.25	0.83	13.35	15	Cir	0.013	0.50	17.15	CI 24 - CI 26
11	10	24.0	0.0	Curb	0.27	0.00	0.00	0.0	13.45	0.83	13.65	15	Cir	0.013	1.00	17.15	CI 26 - CI 28
12	9	112.0	-56.0	Curb	0.21	0.00	0.00	0.0	13.25	2.19	15.70	15	Cir	0.013	1.00	19.20	CI 24 - CI 30

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Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line size (in)	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.
1	HW 2 - JB 4	22.58	36 c	92.0	12.00	12.40	0.435	13.53	13.92	0.60	14.52	End
2	JB 4 - JB 6	22.58	36 c	140.0	12.50	13.15	0.464	14.97	15.05	0.26	15.31	1
3	JB 6 - CI 8	1.58	15 c	84.0	14.80	15.30	0.595	15.64	15.81	n/a	15.98 j	2
4	JB 6 - EX CI 10	21.00	30 c	24.0	13.20	13.31	0.458	15.31	15.35	0.37	15.72	2
5	FES 12 - JB 14	6.69	18 c	24.0	12.00	12.25	1.042	12.88	13.24	0.36	13.24	End
6	JB 14 - JB 16	4.70	15 c	162.0	12.45	14.30	1.142	13.47	15.17	n/a	15.17 j	5
7	JB 16 - JB 18	4.70	15 c	44.0	14.40	14.90	1.136	15.36	15.77	n/a	15.77 j	6
8	JB 18 - CI 20	0.48	15 c	12.0	15.00	15.10	0.833	16.17	16.17	0.00	16.17	7
9	HW 22 - CI 24	1.91	15 c	80.0	12.60	13.15	0.687	13.12	13.70	n/a	13.70	End
10	CI 24 - CI 26	0.88	15 c	12.0	13.25	13.35	0.833	13.84	13.83	0.03	13.86	9
11	CI 26 - CI 28	0.27	15 c	24.0	13.45	13.65	0.833	13.86	13.87	0.05	13.92	10
12	CI 24 - CI 30	0.21	15 c	112.0	13.25	15.70	2.188	13.91	15.88	n/a	15.88 j	9

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NOTES: c = cir; e = ellip; b = box; Return period = 10 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 (%)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	
1	End	92.0	0.00	0.00	0.00	0.00	0.00	0.0	1.8	0.0	22.58	43.98	6.25	36	0.43	12.40	12.00	13.92	13.53	19.00	15.50	HW 2 - JB 4
2	1	140.0	0.00	0.00	0.00	0.00	0.00	0.0	1.1	0.0	22.58	45.44	4.20	36	0.46	13.15	12.50	15.05	14.97	19.00	19.00	JB 4 - JB 6
3	2	84.0	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	1.58	4.98	2.59	15	0.60	15.30	14.80	15.81	15.64	18.60	19.00	JB 6 - CI 8
4	2	24.0	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	21.00	27.77	4.82	30	0.46	13.31	13.20	15.35	15.31	18.05	19.00	JB 6 - EX CI 10
5	End	24.0	0.00	0.00	0.00	0.00	0.00	0.0	1.4	0.0	6.69	10.72	5.83	18	1.04	12.25	12.00	13.24	12.88	16.50	14.00	FES 12 - JB 14
6	5	162.0	0.00	0.00	0.00	0.00	0.00	0.0	0.7	0.0	4.70	6.90	4.78	15	1.14	14.30	12.45	15.17	13.47	17.50	16.50	JB 14 - JB 16
7	6	44.0	0.00	0.00	0.00	0.00	0.00	0.0	0.5	0.0	4.70	6.88	4.92	15	1.14	14.90	14.40	15.77	15.36	17.50	17.50	JB 16 - JB 18
8	7	12.0	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.48	5.89	0.42	15	0.83	15.10	15.00	16.17	16.17	18.20	17.50	JB 18 - CI 20
9	End	80.0	0.00	0.00	0.00	0.00	0.00	0.0	10.9	0.0	1.91	5.35	3.82	15	0.69	13.15	12.60	13.70	13.12	18.80	14.00	HW 22 - CI 24
10	9	12.0	0.00	0.00	0.00	0.00	0.00	0.0	1.8	0.0	0.88	5.89	1.78	15	0.83	13.35	13.25	13.83	13.84	17.15	18.80	CI 24 - CI 26
11	10	24.0	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.27	5.89	1.31	15	0.83	13.65	13.45	13.87	13.86	17.15	17.15	CI 26 - CI 28
12	9	112.0	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.21	9.55	1.10	15	2.19	15.70	13.25	15.88	13.91	19.20	18.80	CI 24 - CI 30

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Number of lines: 12

Run Date: 05-08-2013

NOTES: Intensity = 105.70 / (Inlet time + 16.80) ^ 0.87; Return period = 10 Yrs.

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
	(in)	(cfs)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	(ft)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)	(K)	(ft)
1	36	22.58	12.00	13.53	1.53	3.62	6.24	0.60	14.13	0.430	92.0	12.40	13.92	1.52**	3.60	6.27	0.61	14.53	0.436	0.433	0.399	0.98	0.60
2	36	22.58	12.50	14.97	2.47	6.24	3.62	0.20	15.18	0.113	140	13.15	15.05	1.90	4.72	4.78	0.36	15.41	0.216	0.165	0.231	0.74	0.26
3	15	1.58	14.80	15.64	0.84	0.88	1.79	0.05	15.69	0.094	84.0	15.30	15.81 j	0.51**	0.47	3.39	0.18	15.98	0.504	0.299	0.251	1.00	0.18
4	30	21.00	13.20	15.31	2.11	4.43	4.75	0.35	15.66	0.249	24.0	13.31	15.35	2.04	4.29	4.89	0.37	15.72	0.264	0.256	0.062	1.00	0.37
5	18	6.69	12.00	12.88	0.88	1.07	6.24	0.61	13.48	0.685	24.0	12.25	13.24	0.99**	1.23	5.42	0.46	13.69	0.685	0.685	n/a	0.79	0.36
6	15	4.70	12.45	13.47	1.02	1.07	4.40	0.30	13.77	0.537	162	14.30	15.17 j	0.87**	0.91	5.17	0.42	15.58	0.773	0.655	n/a	1.00	n/a
7	15	4.70	14.40	15.36	0.96	1.01	4.67	0.34	15.69	0.611	44.0	14.90	15.77 j	0.87**	0.91	5.17	0.42	16.18	0.773	0.692	n/a	0.95	n/a
8	15	0.48	15.00	16.17	1.17	1.19	0.40	0.00	16.17	0.005	12.0	15.10	16.17	1.07	1.12	0.43	0.00	16.17	0.005	0.005	0.001	1.00	0.00
9	15	1.91	12.60	13.12	0.52	0.48	4.00	0.25	13.36	0.535	80.0	13.15	13.70	0.55**	0.52	3.65	0.21	13.91	0.535	0.535	n/a	1.29	n/a
10	15	0.88	13.25	13.84	0.59	0.57	1.54	0.04	13.88	0.090	12.0	13.35	13.83	0.48	0.44	2.02	0.06	13.90	0.187	0.139	0.017	0.50	0.03
11	15	0.27	13.45	13.86	0.41	0.35	0.76	0.01	13.87	0.031	24.0	13.65	13.87	0.22	0.15	1.86	0.05	13.92	0.386	0.209	0.050	1.00	0.05
12	15	0.21	13.25	13.91	0.66	0.66	0.32	0.00	13.91	0.004	112	15.70	15.88 j	0.18**	0.11	1.88	0.05	15.94	0.491	0.247	n/a	1.00	0.05

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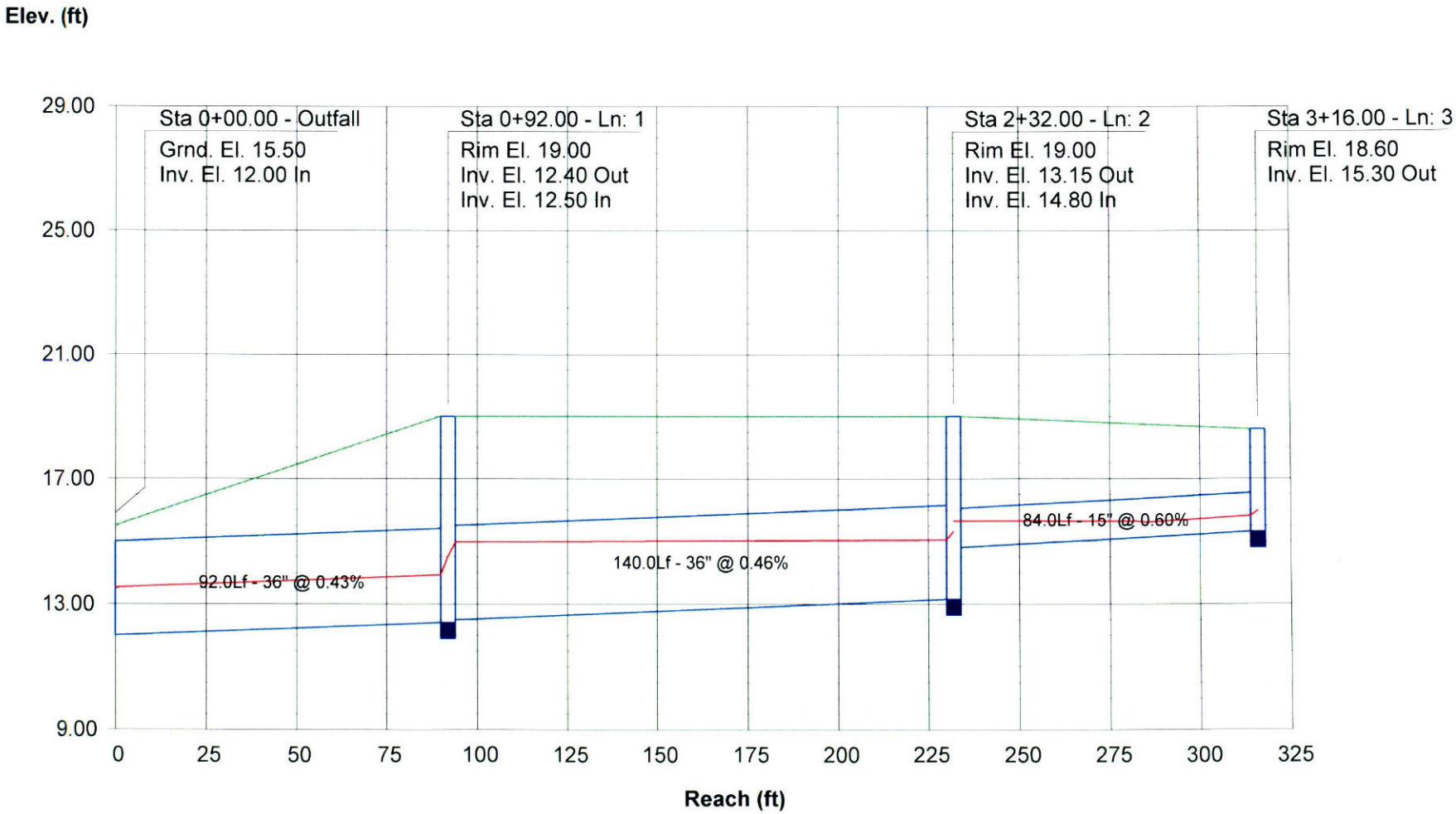
Notes: ; ** Critical depth.; j-Line contains hyd. jump.

Storm Sewer Profile

Proj. file: 05-01-13_GCF Wilmington.stm



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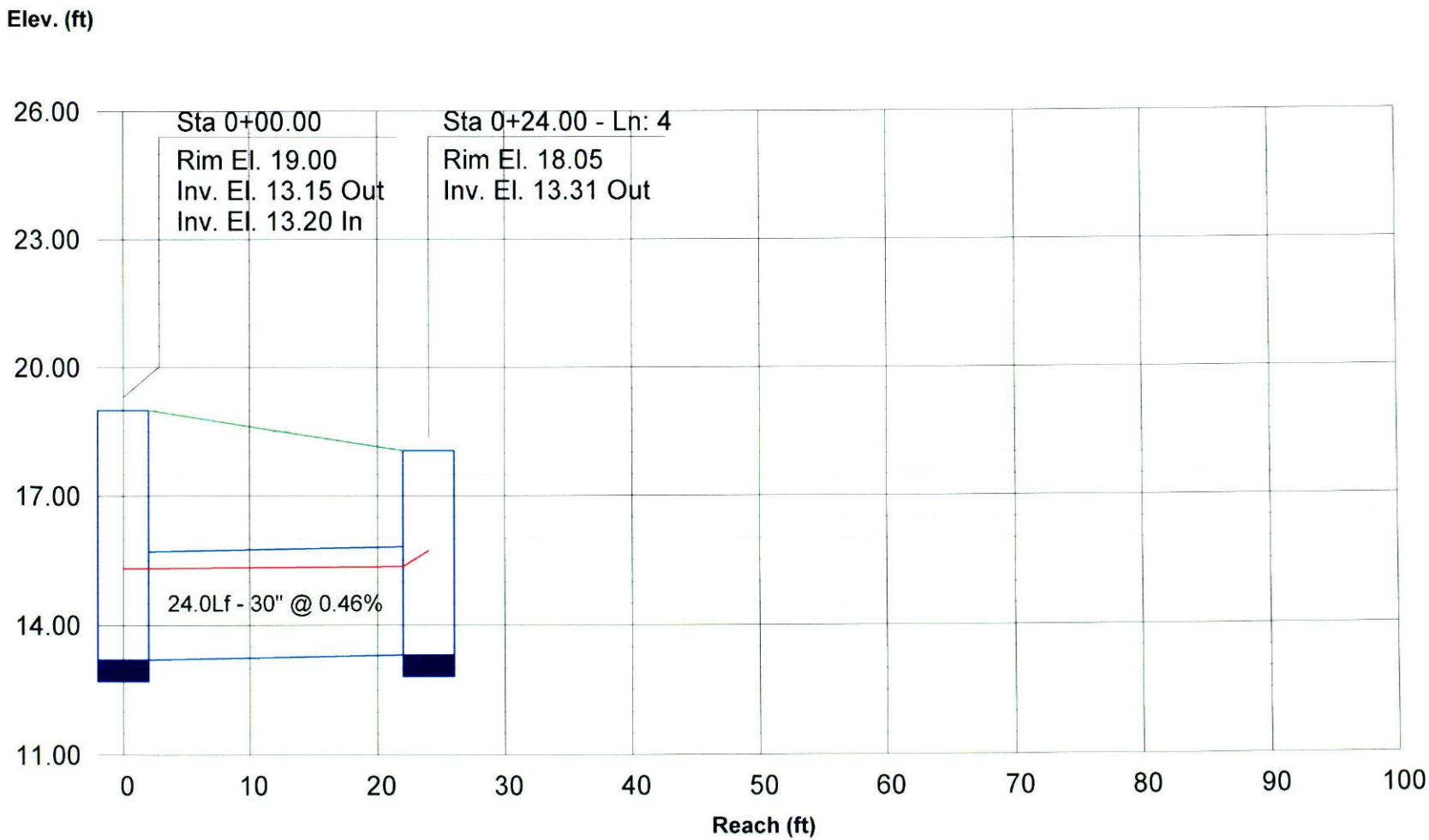

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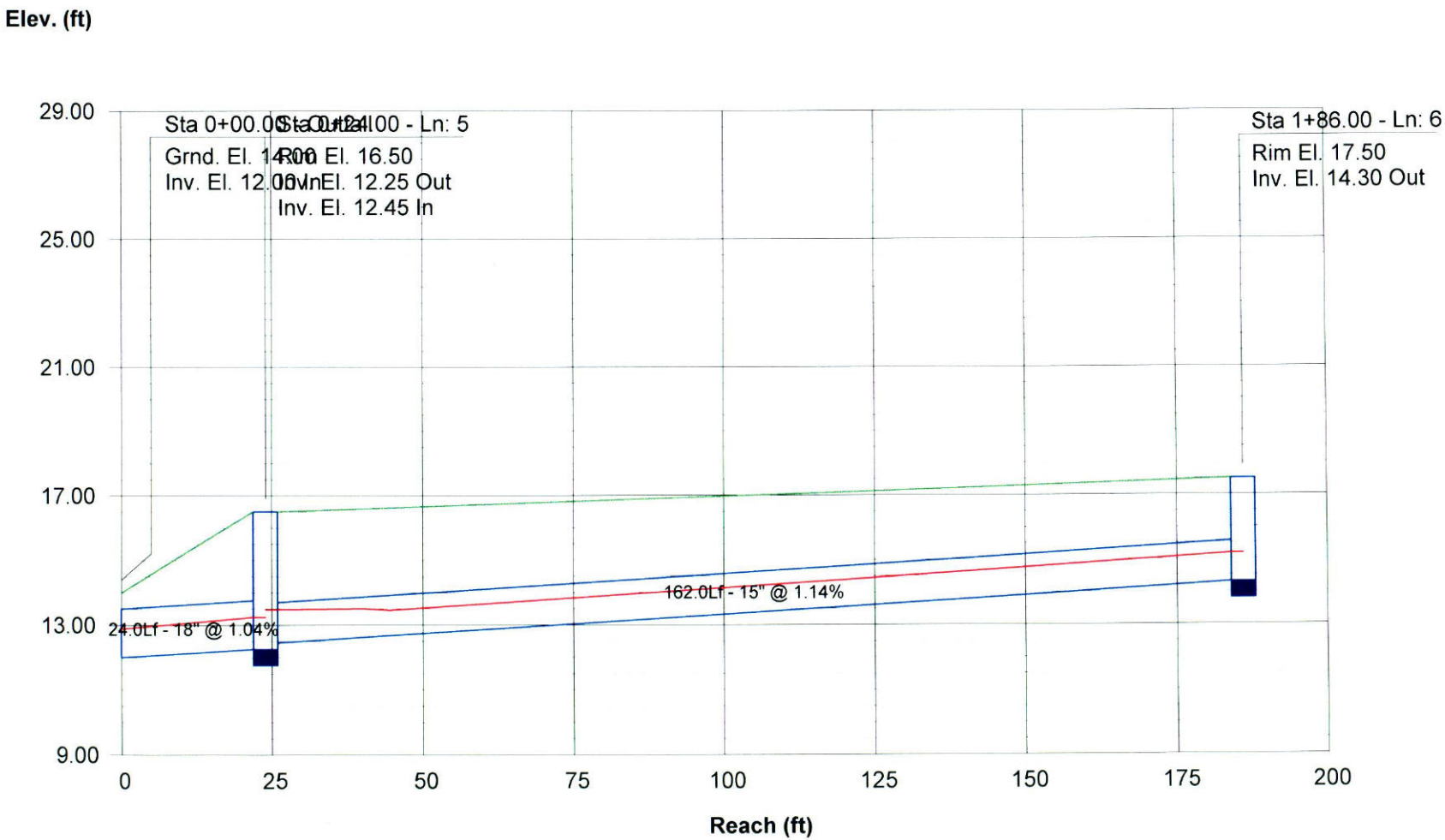

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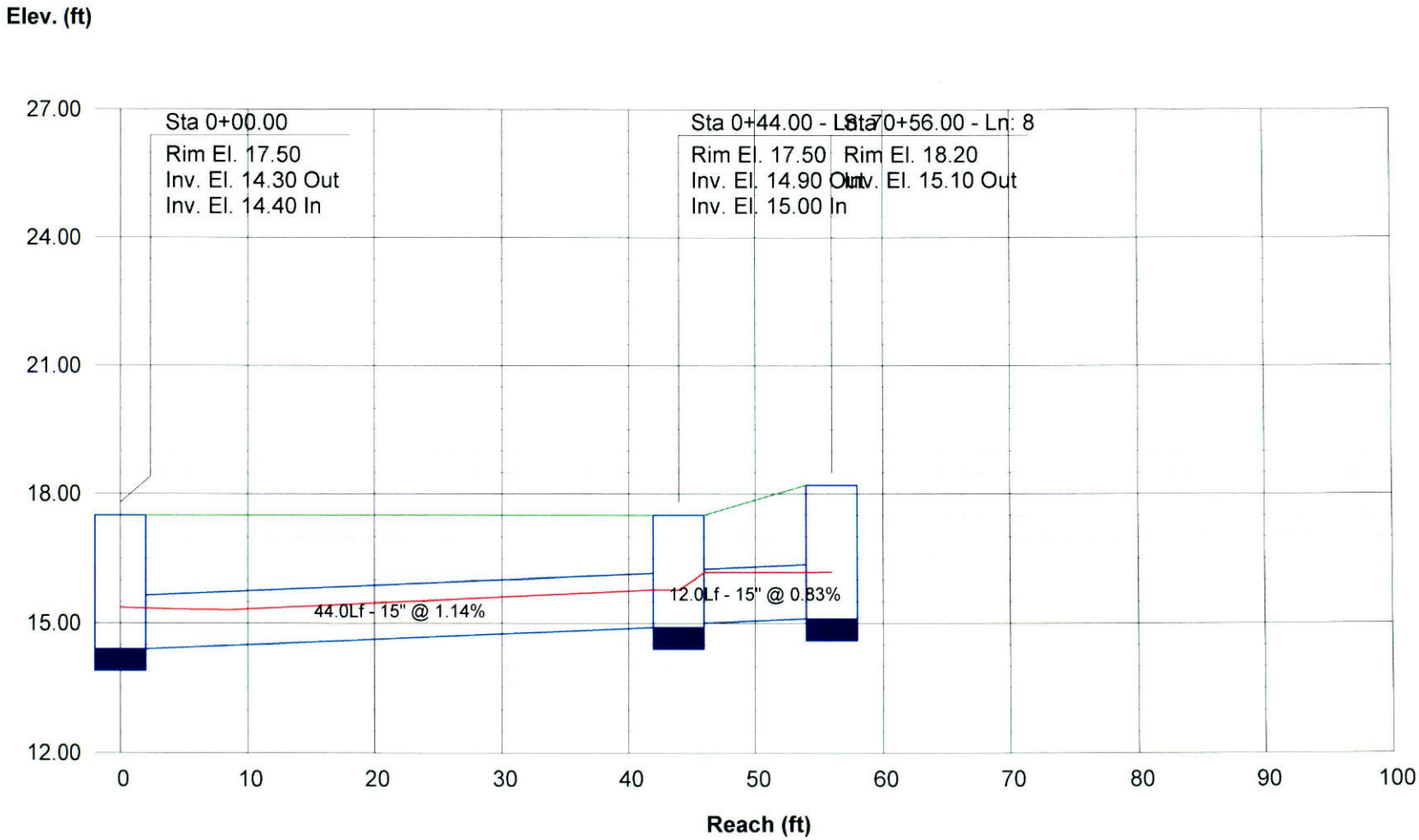

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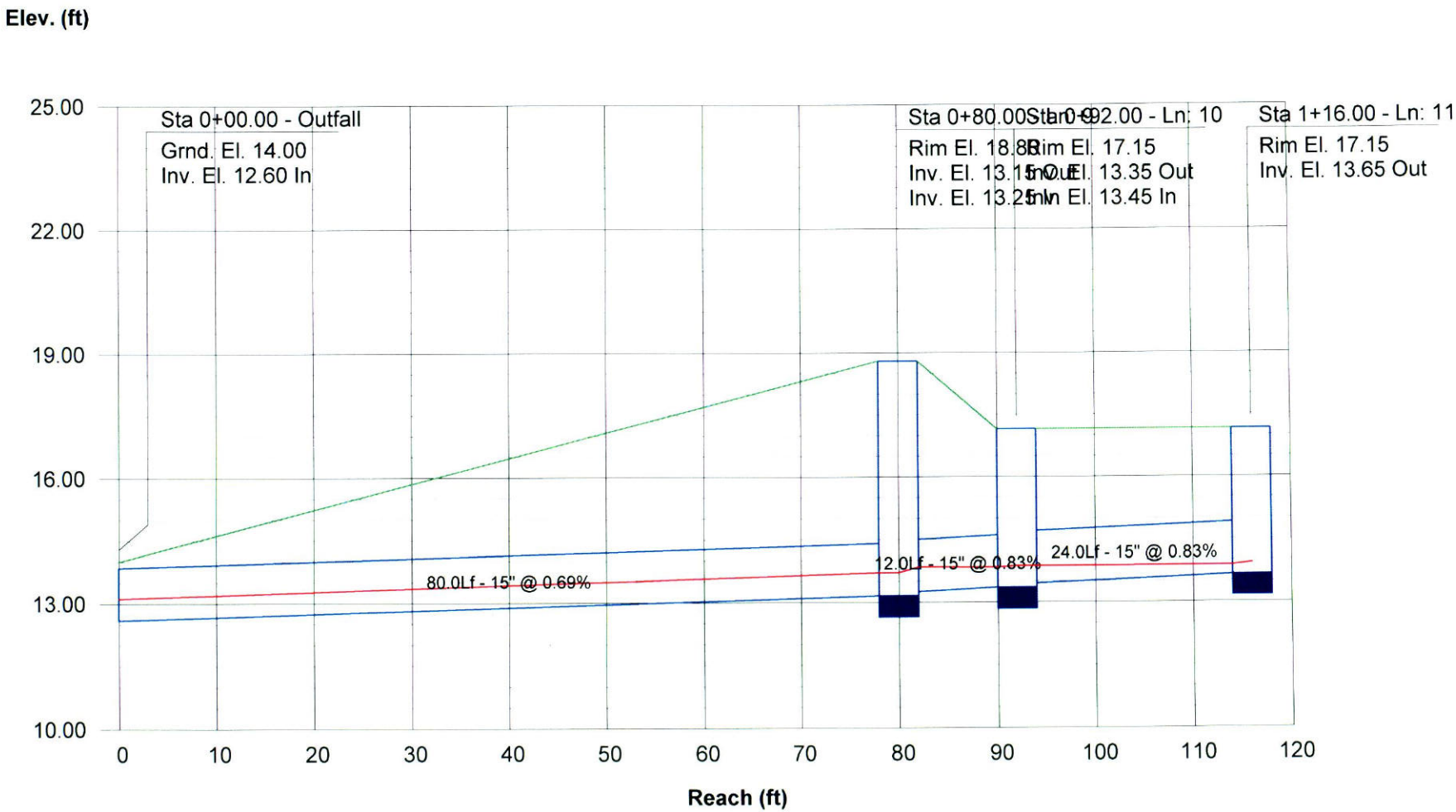

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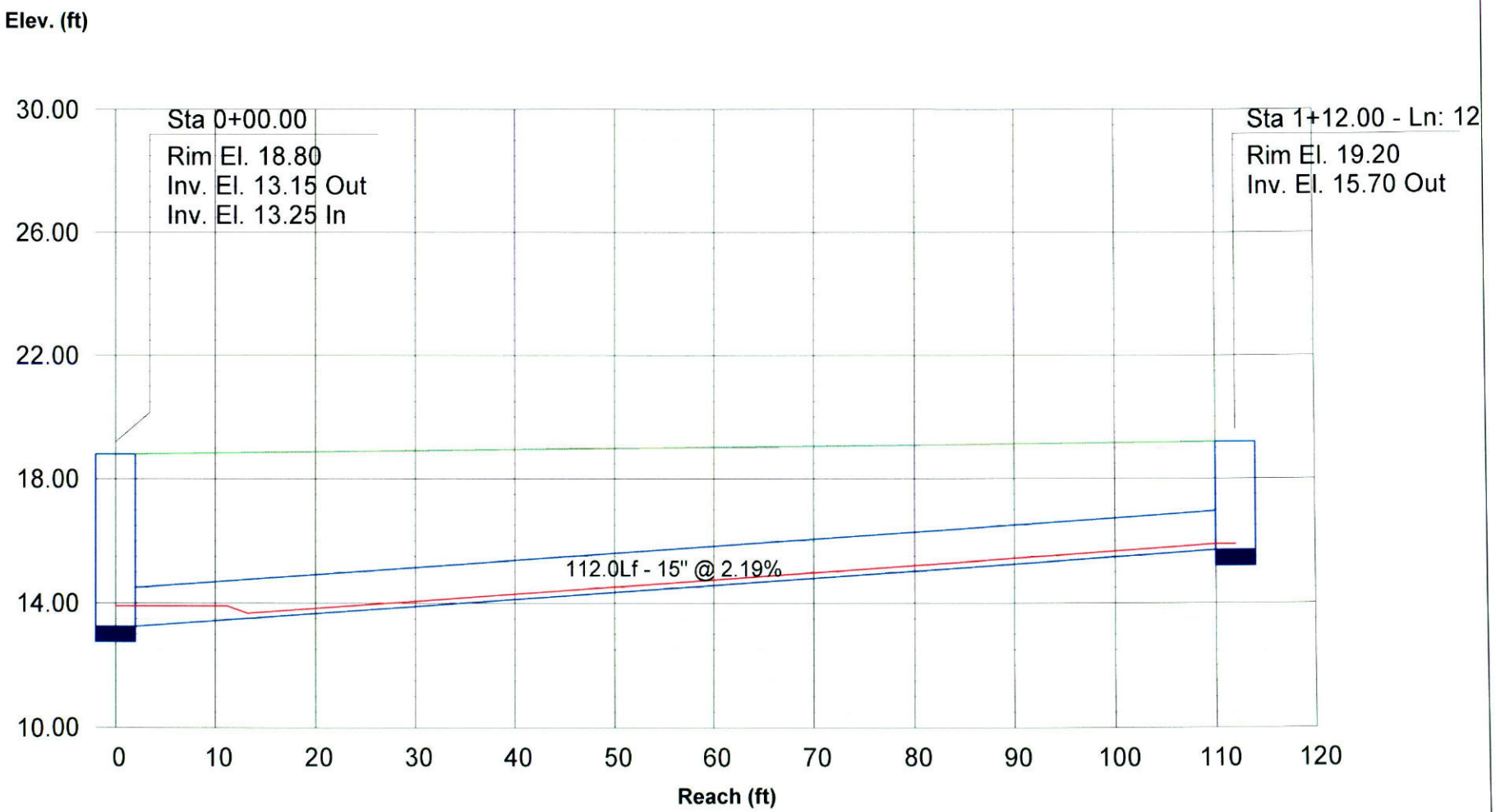
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