



WithersRavenel

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STORM DRAINAGE CALCULATIONS

KNIGHTDALE ATHLETIC PARK – PHASE I Knightdale, NC

Prepared For:

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WR No. 02180875.00



NOAA Atlas 14, Volume 2, Version 3
 Location name: Raleigh, North Carolina, USA*
 Latitude: 35.8126°, Longitude: -78.4914°
 Elevation: 291.25 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 & aerals](#)

PF tabular

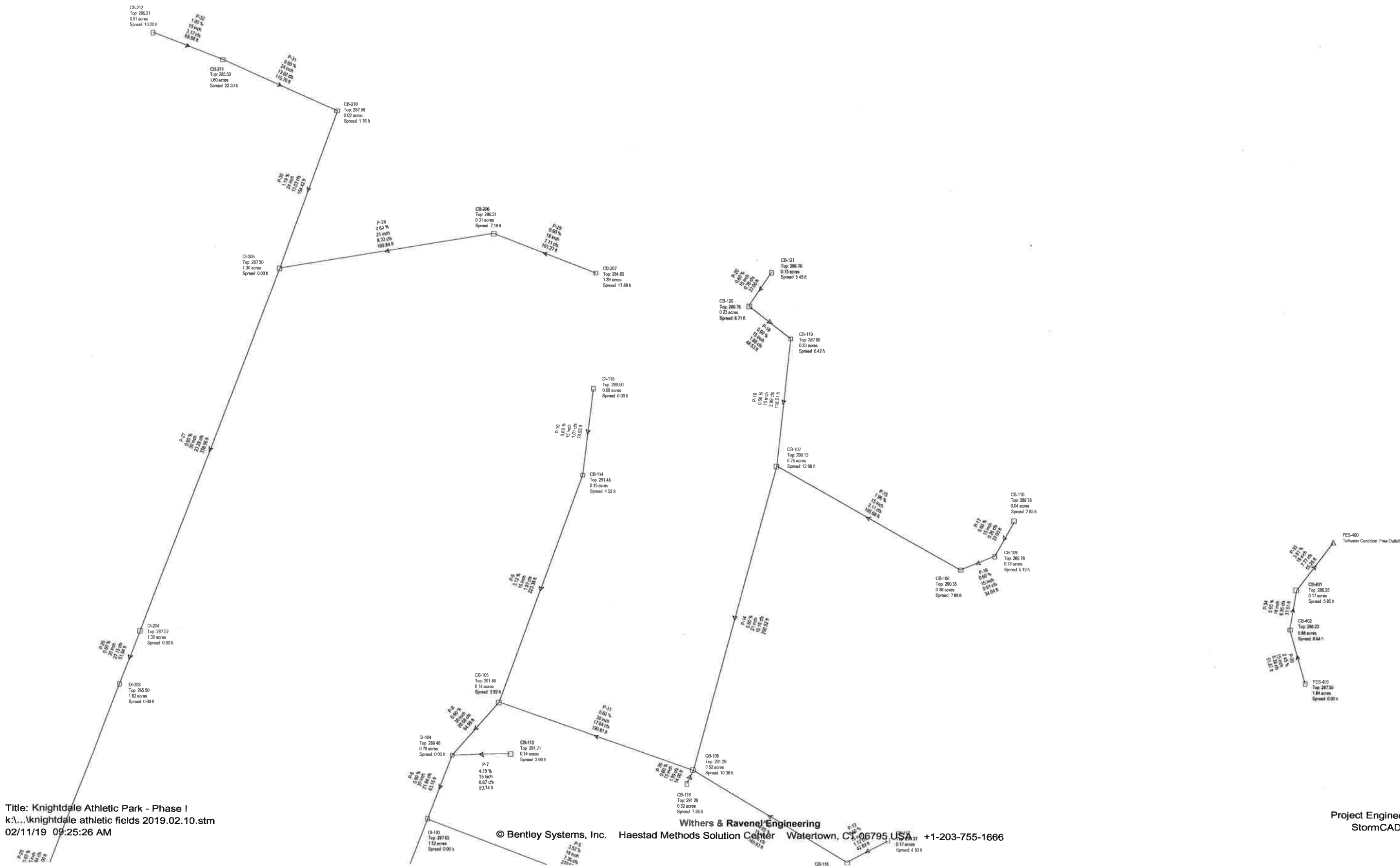
PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour) ¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	4.87 (4.46-5.33)	5.66 (5.20-6.19)	6.47 (5.94-7.07)	7.25 (6.64-7.91)	8.04 (7.33-8.76)	8.66 (7.86-9.43)	9.22 (8.32-10.0)	9.71 (8.70-10.6)	10.2 (9.11-11.2)	10.7 (9.46-11.7)
10-min	3.89 (3.56-4.26)	4.54 (4.16-4.95)	5.18 (4.75-5.66)	5.80 (5.31-6.32)	6.41 (5.84-6.98)	6.90 (6.26-7.51)	7.32 (6.61-7.97)	7.69 (6.90-8.39)	8.11 (7.21-8.84)	8.45 (7.45-9.23)
15-min	3.24 (2.97-3.55)	3.80 (3.48-4.15)	4.37 (4.01-4.77)	4.89 (4.48-5.33)	5.42 (4.94-5.90)	5.82 (5.28-6.34)	6.17 (5.56-6.72)	6.47 (5.80-7.05)	6.80 (6.05-7.42)	7.07 (6.23-7.72)
30-min	2.22 (2.03-2.43)	2.62 (2.41-2.87)	3.10 (2.85-3.39)	3.54 (3.24-3.86)	4.01 (3.65-4.37)	4.39 (3.98-4.78)	4.72 (4.26-5.14)	5.04 (4.52-5.49)	5.41 (4.81-5.90)	5.72 (5.05-6.26)
60-min	1.39 (1.27-1.52)	1.65 (1.51-1.80)	1.99 (1.83-2.17)	2.31 (2.11-2.52)	2.67 (2.43-2.91)	2.97 (2.70-3.24)	3.25 (2.94-3.54)	3.53 (3.17-3.85)	3.88 (3.45-4.23)	4.18 (3.68-4.57)
2-hr	0.812 (0.737-0.896)	0.968 (0.882-1.06)	1.18 (1.08-1.30)	1.39 (1.26-1.52)	1.63 (1.47-1.79)	1.84 (1.65-2.01)	2.04 (1.82-2.23)	2.25 (1.99-2.46)	2.52 (2.21-2.76)	2.75 (2.40-3.02)
3-hr	0.572 (0.520-0.634)	0.683 (0.624-0.753)	0.838 (0.764-0.924)	0.989 (0.898-1.09)	1.17 (1.06-1.29)	1.34 (1.20-1.47)	1.50 (1.33-1.64)	1.67 (1.47-1.83)	1.90 (1.66-2.08)	2.10 (1.81-2.31)
6-hr	0.344 (0.314-0.380)	0.411 (0.376-0.452)	0.505 (0.461-0.554)	0.596 (0.543-0.653)	0.711 (0.643-0.777)	0.813 (0.731-0.888)	0.915 (0.816-0.998)	1.02 (0.903-1.11)	1.17 (1.02-1.27)	1.30 (1.12-1.42)
12-hr	0.202 (0.184-0.222)	0.240 (0.221-0.264)	0.297 (0.271-0.326)	0.353 (0.321-0.386)	0.423 (0.383-0.462)	0.487 (0.437-0.530)	0.552 (0.491-0.601)	0.622 (0.547-0.676)	0.718 (0.621-0.780)	0.806 (0.687-0.877)
24-hr	0.120 (0.112-0.130)	0.145 (0.135-0.157)	0.183 (0.170-0.198)	0.213 (0.197-0.230)	0.254 (0.235-0.275)	0.288 (0.264-0.311)	0.322 (0.294-0.348)	0.357 (0.326-0.386)	0.406 (0.368-0.440)	0.446 (0.402-0.484)
2-day	0.070 (0.065-0.075)	0.084 (0.078-0.091)	0.105 (0.097-0.113)	0.121 (0.112-0.131)	0.144 (0.133-0.156)	0.162 (0.149-0.175)	0.181 (0.166-0.195)	0.200 (0.183-0.217)	0.227 (0.206-0.246)	0.248 (0.224-0.270)
3-day	0.049 (0.046-0.053)	0.059 (0.055-0.064)	0.074 (0.068-0.079)	0.085 (0.079-0.091)	0.101 (0.093-0.108)	0.113 (0.104-0.122)	0.126 (0.116-0.136)	0.139 (0.128-0.150)	0.158 (0.144-0.170)	0.172 (0.156-0.186)
4-day	0.039 (0.036-0.042)	0.047 (0.044-0.050)	0.058 (0.054-0.062)	0.067 (0.062-0.072)	0.079 (0.073-0.085)	0.089 (0.082-0.095)	0.099 (0.091-0.106)	0.109 (0.100-0.117)	0.123 (0.112-0.132)	0.134 (0.122-0.145)
7-day	0.026 (0.024-0.028)	0.031 (0.029-0.033)	0.038 (0.035-0.040)	0.043 (0.040-0.046)	0.051 (0.047-0.054)	0.057 (0.053-0.061)	0.063 (0.058-0.067)	0.069 (0.064-0.074)	0.078 (0.071-0.084)	0.085 (0.077-0.091)
10-day	0.021 (0.019-0.022)	0.025 (0.023-0.026)	0.030 (0.028-0.032)	0.034 (0.031-0.036)	0.039 (0.036-0.042)	0.043 (0.040-0.046)	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)	0.016 (0.015-0.017)	0.019 (0.018-0.021)	0.022 (0.020-0.023)	0.025 (0.023-0.027)	0.028 (0.026-0.029)	0.030 (0.028-0.032)	0.033 (0.030-0.035)	0.036 (0.034-0.039)	0.039 (0.036-0.042)
30-day	0.011 (0.011-0.012)	0.013 (0.013-0.014)	0.016 (0.015-0.017)	0.017 (0.016-0.019)	0.020 (0.018-0.021)	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)	0.011 (0.011-0.012)	0.013 (0.012-0.014)	0.014 (0.014-0.015)	0.016 (0.015-0.017)	0.017 (0.016-0.018)	0.019 (0.017-0.020)	0.020 (0.019-0.021)	0.021 (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.

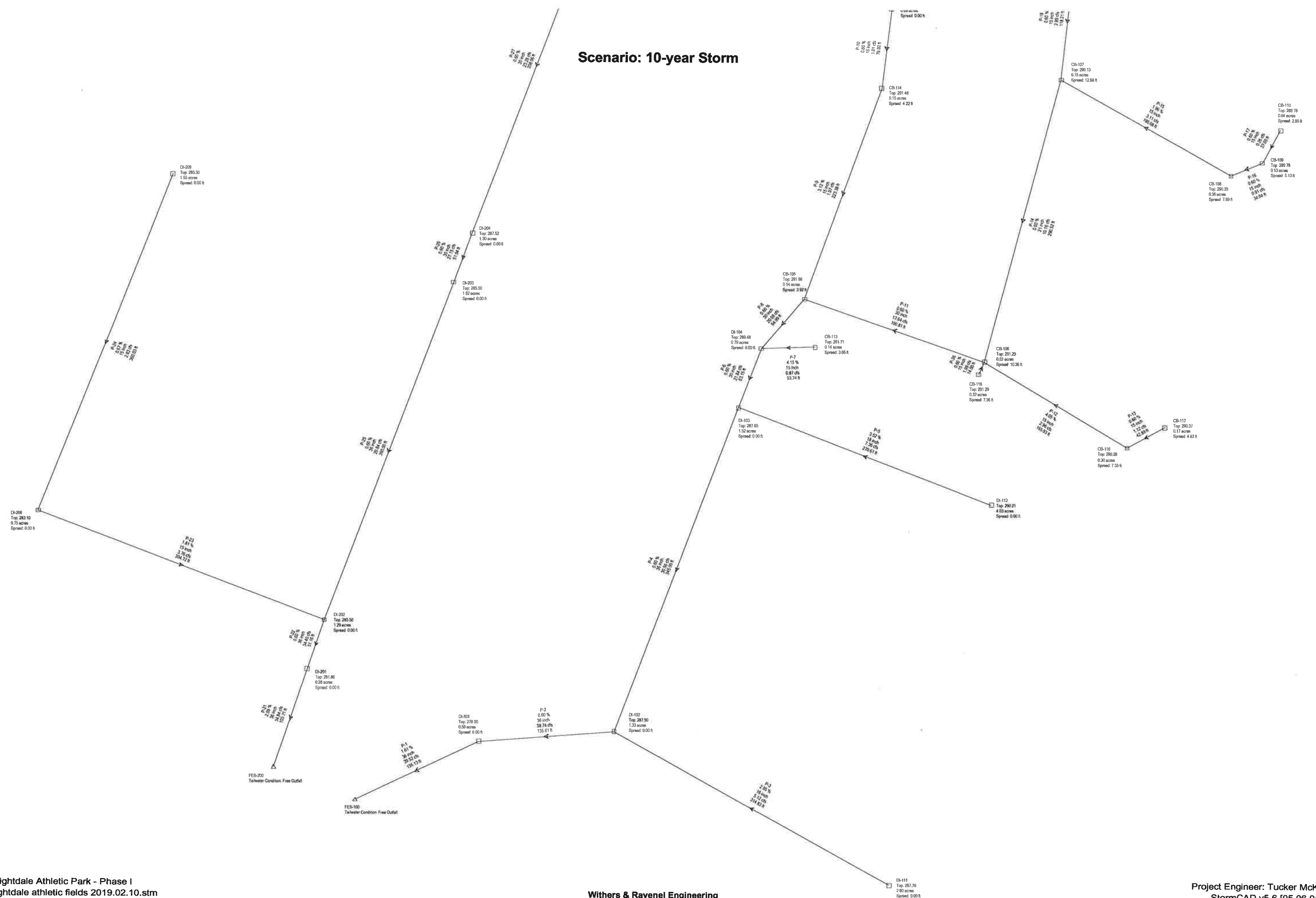
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10-YEAR STORM

Scenario: 10-year Storm



Scenario: 10-year Storm



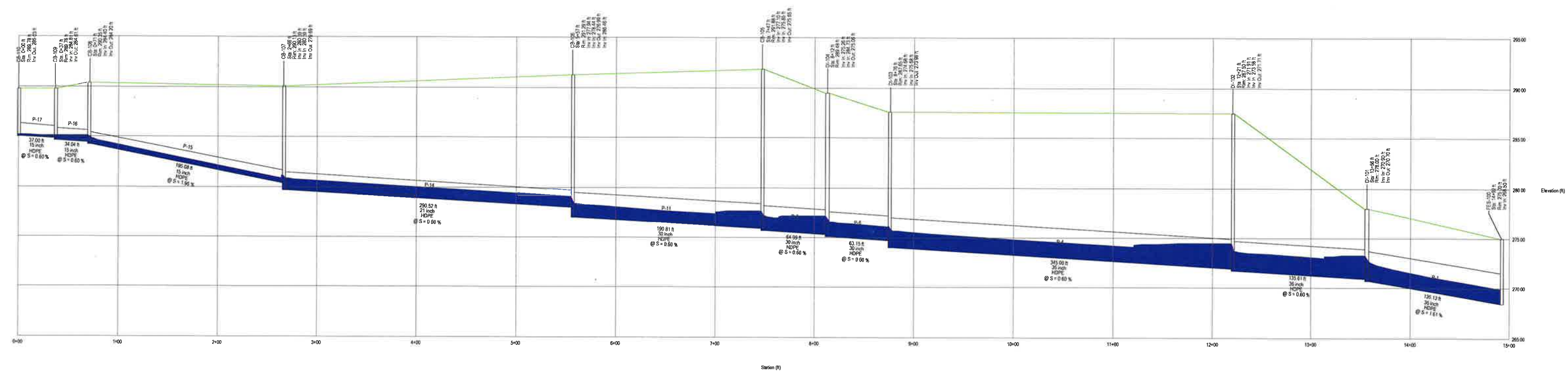
Scenario: 10-year Storm

Storm Drainage Design Report

Upstream Node	Downstream Node	Section Size	Length (ft)	Slope (%)	Upstream Invert (ft)	Downstream Invert (ft)	Upstream Inlet Area (acres)	Rational Coefficient	Upstream Inlet CA (acres)	Upstream Calculated System CA (acres)	System Intensity (in/hr)	Total System Flow (cfs)	Full Capacity (cfs)	Mannings n	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)	Upstream Ground Elevation (ft)	Downstream Ground Elevation (ft)
CB-106	CB-105	30 inch	190.81	0.60	276.99	275.85	0.52	0.85	0.44	2.55	6.85	17.64	34.42	0.012	278.42	277.68	291.29	291.88
CB-114	CB-105	15 inch	223.38	3.12	284.07	277.10	0.15	0.90	0.14	0.27	7.16	1.97	12.36	0.012	284.63	277.68	291.48	291.88
CB-107	CB-106	21 inch	290.52	0.60	279.69	277.94	0.75	0.80	0.60	1.43	7.04	10.16	13.30	0.012	280.87	279.09	290.13	291.29
CB-116	CB-106	15 inch	165.93	4.05	285.16	278.44	0.30	0.85	0.26	0.41	7.20	2.96	14.08	0.012	285.85	278.83	290.29	291.29
CB-118	CB-106	15 inch	14.00	0.60	286.54	286.46	0.32	0.85	0.27	0.27	7.25	1.99	5.42	0.012	287.10	286.98	291.29	291.29
CB-119	CB-107	15 inch	118.21	0.60	281.10	280.39	0.33	0.60	0.20	0.40	7.16	2.89	5.42	0.012	281.78	281.19	287.50	290.13
CB-108	CB-107	15 inch	195.08	1.96	284.20	280.39	0.36	0.85	0.31	0.43	7.15	3.11	9.79	0.012	284.91	281.19	290.35	290.13
CB-109	CB-108	15 inch	34.04	0.60	284.61	284.40	0.13	0.85	0.11	0.13	7.19	0.91	5.42	0.012	285.08	285.09	289.78	290.35
CB-110	CB-109	15 inch	37.00	0.60	285.03	284.81	0.04	0.90	0.04	0.04	7.25	0.26	5.42	0.012	285.23	285.12	289.78	289.78
DI-115	CB-114	15 inch	79.92	0.60	284.75	284.27	0.69	0.20	0.14	0.14	7.25	1.01	5.42	0.012	285.14	284.74	289.50	291.48
CB-117	CB-116	15 inch	42.89	0.60	285.62	285.36	0.17	0.90	0.15	0.15	7.25	1.12	5.42	0.012	286.04	286.02	290.37	290.29
CB-120	CB-119	15 inch	48.53	0.60	281.59	281.30	0.23	0.70	0.16	0.26	7.20	1.88	5.42	0.012	282.13	281.95	286.76	287.50
CB-121	CB-120	15 inch	37.00	0.60	282.01	281.79	0.15	0.90	0.14	0.11	7.25	0.78	5.42	0.012	282.36	282.30	286.76	286.76
CB-207	CB-206	18 inch	101.27	0.60	279.60	278.99	1.39	0.70	0.97	0.97	7.25	7.11	8.81	0.012	280.63	280.01	284.60	286.51
CB-211	CB-210	24 inch	115.76	0.60	279.82	279.13	1.60	0.85	1.36	1.79	7.20	13.02	18.98	0.012	281.12	280.68	285.52	287.59
CB-212	CB-211	15 inch	68.98	1.00	281.46	280.77	0.51	0.85	0.43	0.43	7.25	3.17	7.00	0.012	282.18	281.36	286.21	285.52
CB-402	CB-401	18 inch	37.01	0.60	281.03	280.81	0.88	0.40	0.35	0.95	7.23	6.95	8.81	0.012	282.05	281.99	286.23	286.25
FES-403	CB-402	15 inch	51.87	2.45	282.75	281.48	1.84	0.40	0.74	0.74	7.25	5.38	10.95	0.012	283.69	282.12	287.50	286.23
DI-102	DI-101	36 inch	135.61	0.60	271.71	270.90	1.33	0.50	0.67	5.91	6.51	38.74	55.97	0.012	273.74	273.30	287.50	278.00
DI-103	DI-102	36 inch	345.00	0.60	273.98	271.91	1.52	0.20	0.30	4.54	6.67	30.56	55.97	0.012	275.77	274.46	287.65	287.50
DI-111	DI-102	16 inch	314.83	2.95	282.87	273.58	2.80	0.25	0.70	0.70	7.25	5.12	14.28	0.012	283.77	274.13	287.70	287.50
DI-104	DI-103	30 inch	63.15	0.60	275.06	274.68	0.79	0.20	0.16	3.23	6.71	21.84	34.42	0.012	276.65	276.13	289.48	287.65
DI-112	DI-103	18 inch	270.61	3.52	285.21	275.68	4.03	0.25	1.01	1.01	7.25	7.36	21.35	0.012	286.26	276.29	290.21	287.65
CB-105	DI-104	30 inch	64.99	0.60	275.65	275.26	0.14	0.90	0.13	2.95	6.74	20.08	34.42	0.012	277.17	277.20	291.88	289.48
CB-113	DI-104	15 inch	53.74	4.15	286.96	284.73	0.14	0.85	0.12	0.12	7.25	0.87	14.25	0.012	287.33	284.94	291.71	289.48
DI-202	DI-201	36 inch	51.16	0.60	270.67	270.37	1.29	0.20	0.26	5.13	6.66	34.40	55.97	0.012	272.58	272.50	285.50	281.86
DI-203	DI-202	36 inch	360.00	0.60	273.03	270.87	1.62	0.25	0.41	4.33	6.83	29.84	55.97	0.012	274.80	273.24	285.50	285.50
DI-208	DI-202	15 inch	304.72	1.81	278.15	272.62	0.75	0.20	0.15	0.54	6.95	3.76	9.42	0.012	278.93	273.17	283.10	285.50
DI-204	DI-203	30 inch	51.94	0.60	274.04	273.73	1.30	0.50	0.65	3.93	6.86	27.15	34.42	0.012	275.82	275.41	287.52	285.50
DI-205	DI-204	30 inch	358.06	0.60	276.39	274.24	1.30	0.20	0.26	3.28	7.04	23.28	34.42	0.012	278.04	276.23	287.50	287.52
CB-210	DI-205	24 inch	154.42	1.19	278.93	277.09	0.02	0.95	0.02	1.81	7.13	13.03	26.69	0.012	280.22	278.47	287.59	287.50
CB-206	DI-205	21 inch	199.84	0.60	278.54	277.34	0.31	0.75	0.23	1.21	7.18	8.72	13.30	0.012	279.64	278.47	286.51	287.50
DI-209	DI-208	15 inch	360.03	0.67	280.75	278.35	1.55	0.25	0.39	0.39	7.25	2.83	5.71	0.012	281.43	279.20	285.50	283.10
DI-101	FES-100	36 inch	136.13	1.61	270.70	268.50	0.59	0.30	0.18	6.08	6.44	39.52	91.79	0.012	272.74	269.92	278.00	275.00
DI-201	FES-200	36 inch	103.71	2.09	270.17	268.00	0.28	0.30	0.08	5.21	6.63	34.84	104.43	0.012	272.09	269.26	281.86	274.50
CB-401	FES-400	18 inch	55.26	3.81	280.61	278.50	0.17	0.90	0.15	1.07	7.20	7.77	22.22	0.012	281.69	279.14	286.25	283.50

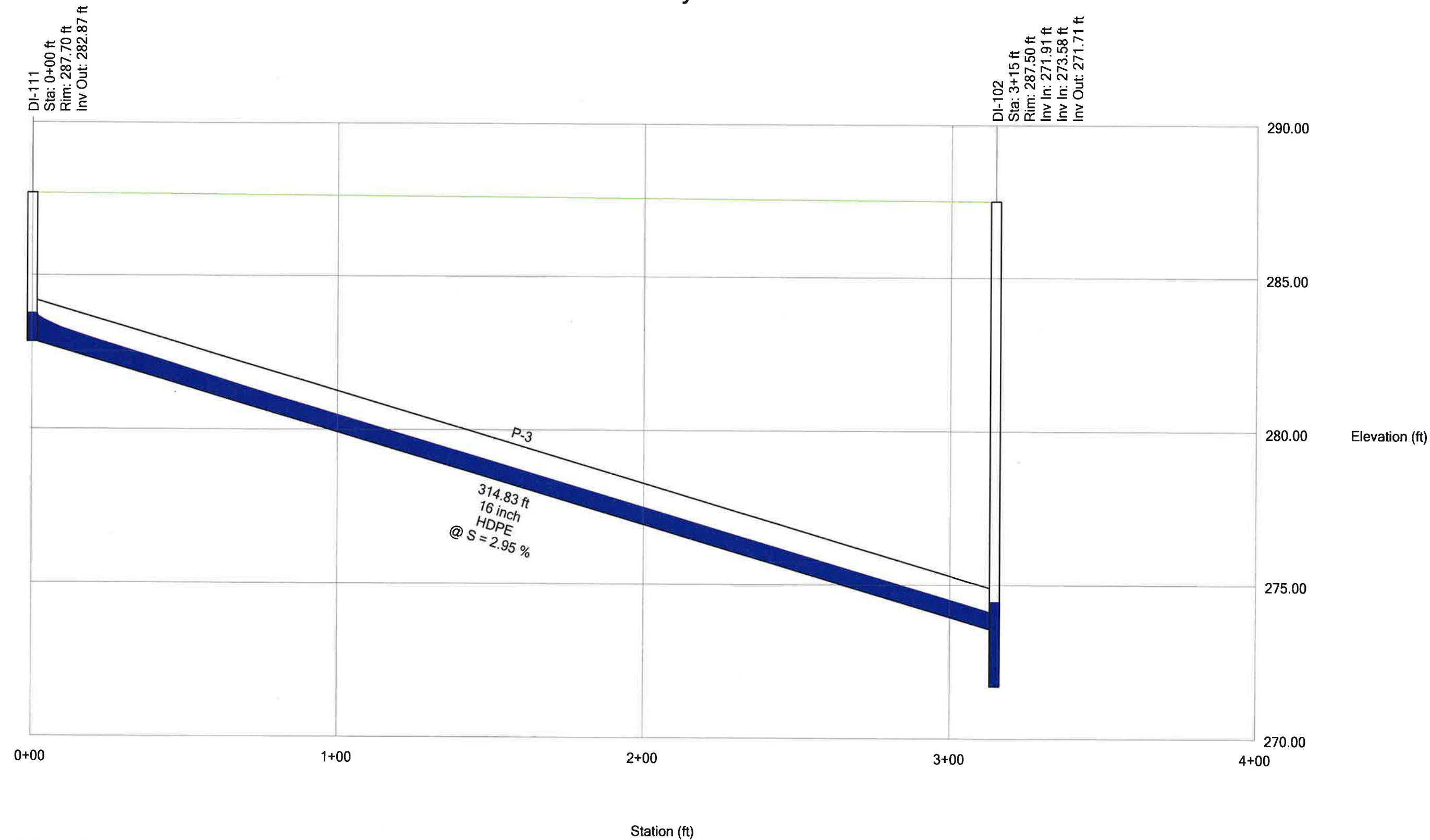
Profile
Scenario: 10-year Storm

Profile: Profile - 1
Scenario: 10-year Storm



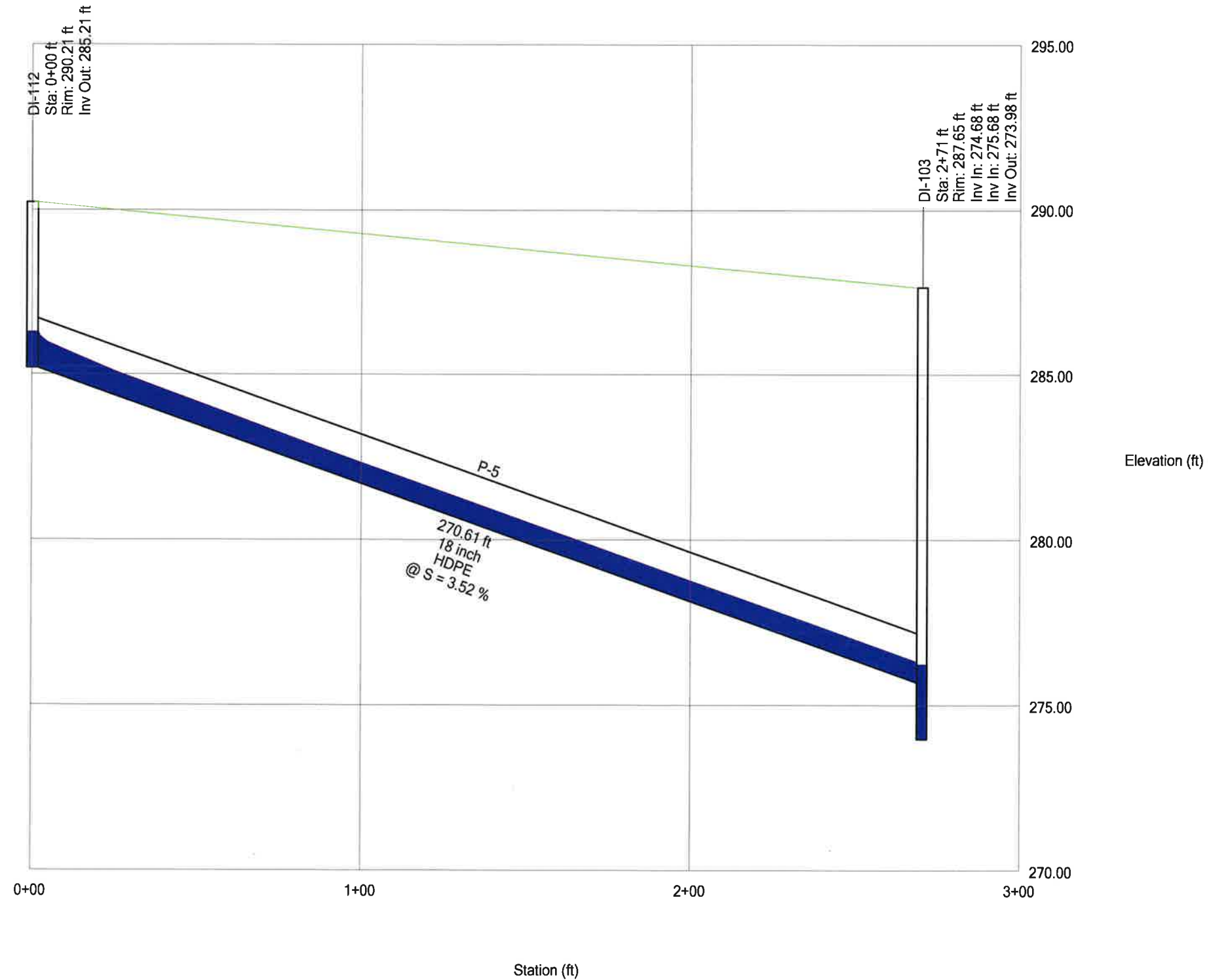
Profile
Scenario: 10-year Storm

Profile: Profile - 2
Scenario: 10-year Storm



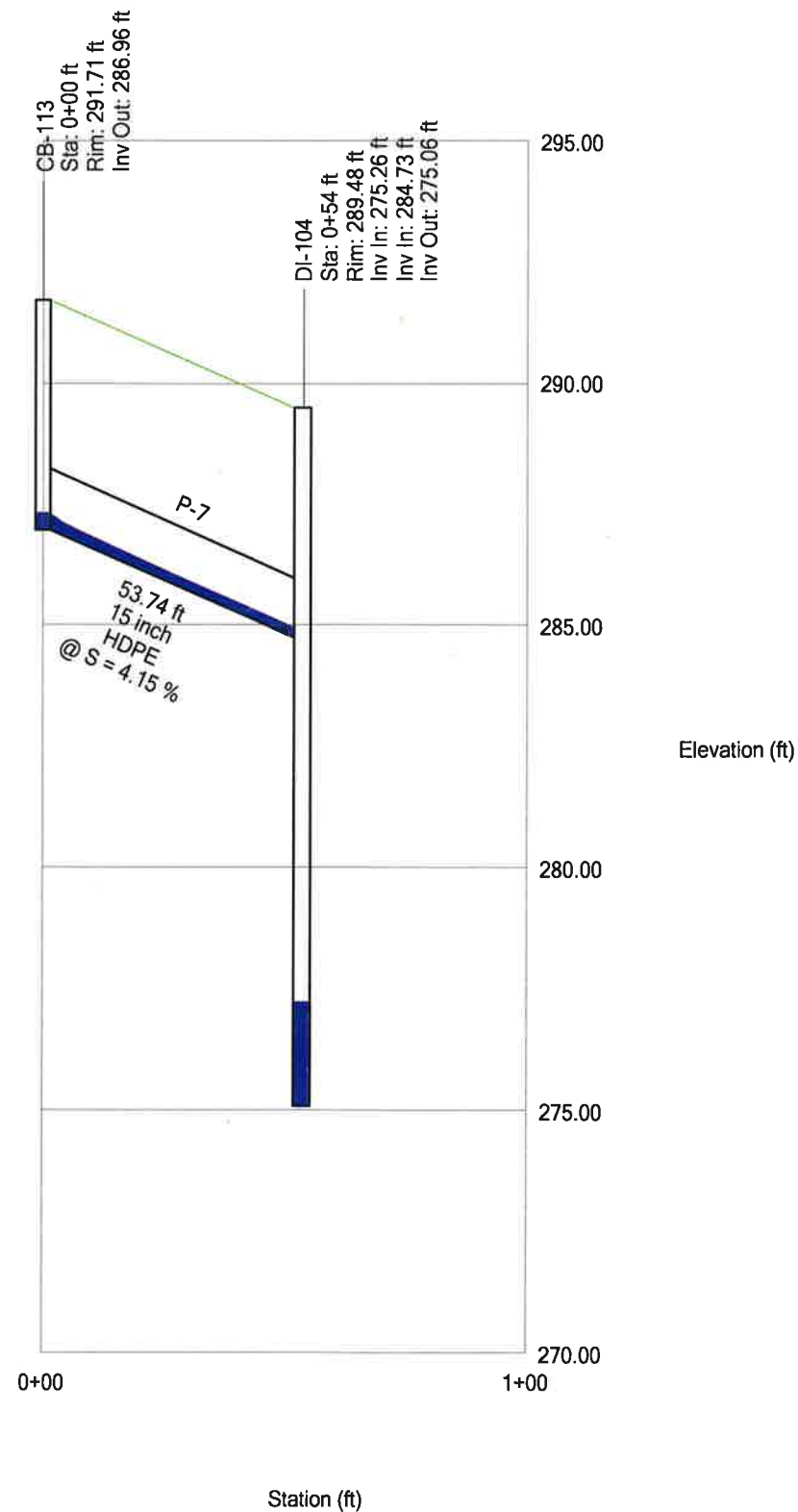
Profile
Scenario: 10-year Storm

Profile: Profile - 3
Scenario: 10-year Storm



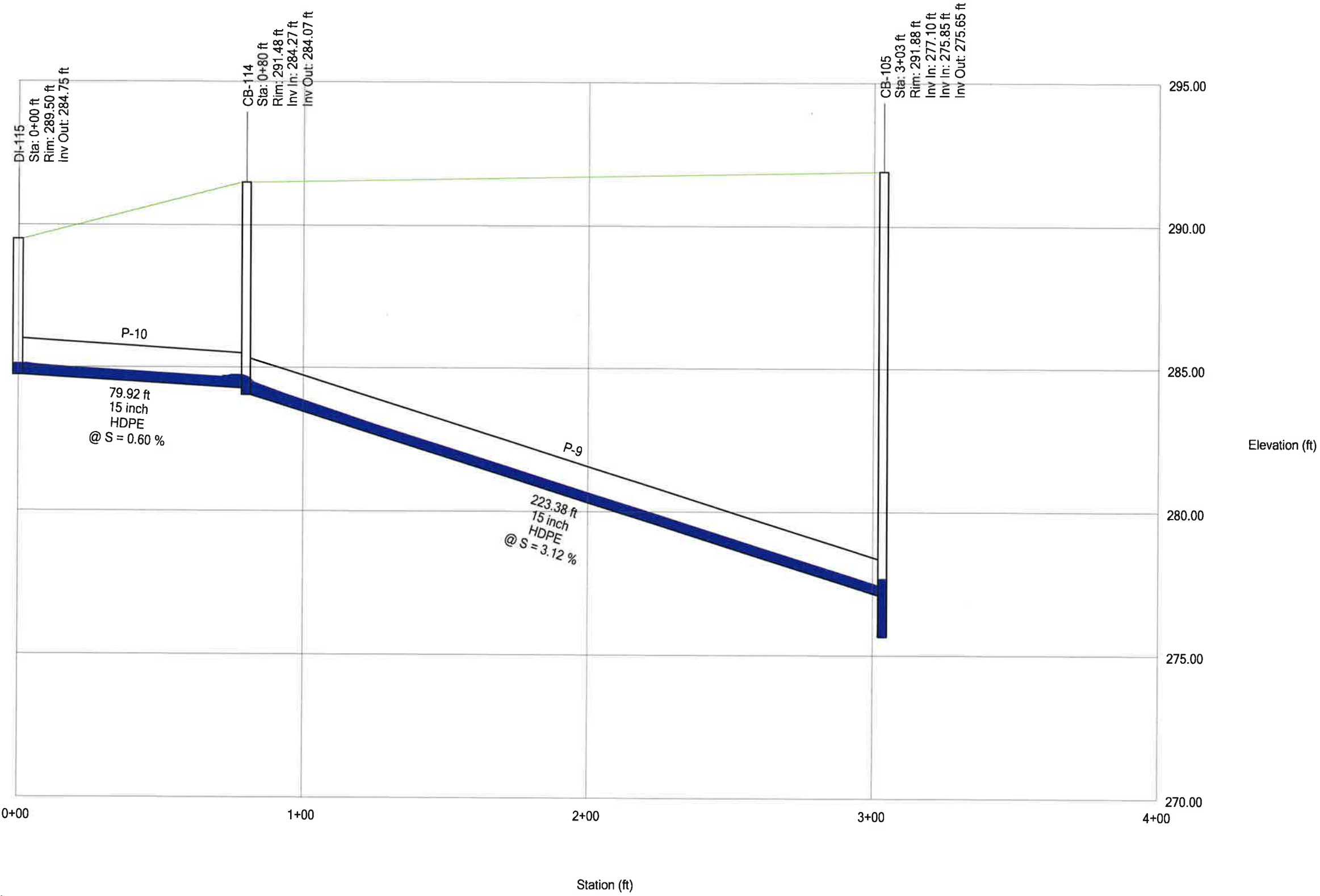
Profile
Scenario: 10-year Storm

Profile: Profile - 4
Scenario: 10-year Storm



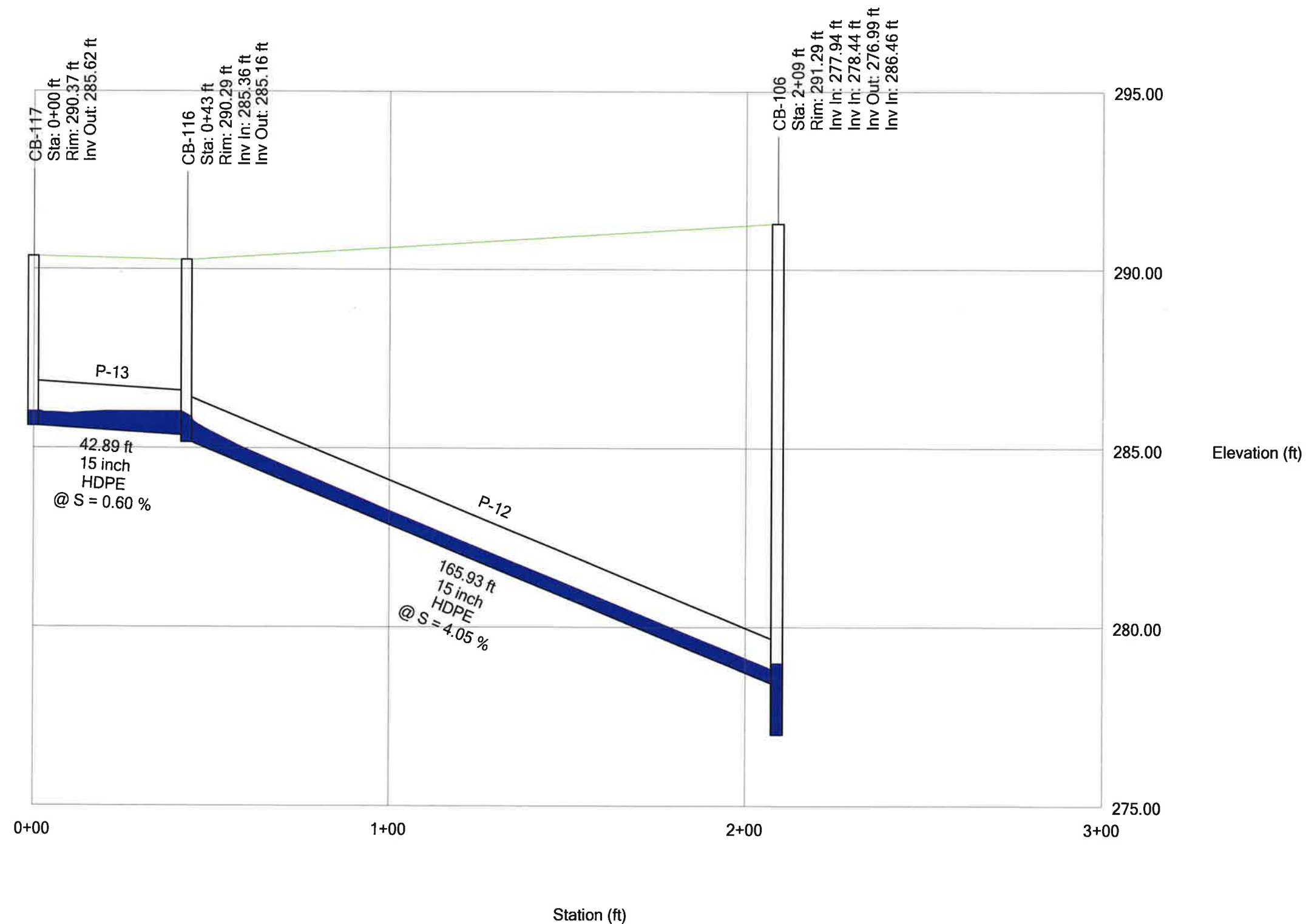
Profile
Scenario: 10-year Storm

Profile: Profile - 5
Scenario: 10-year Storm



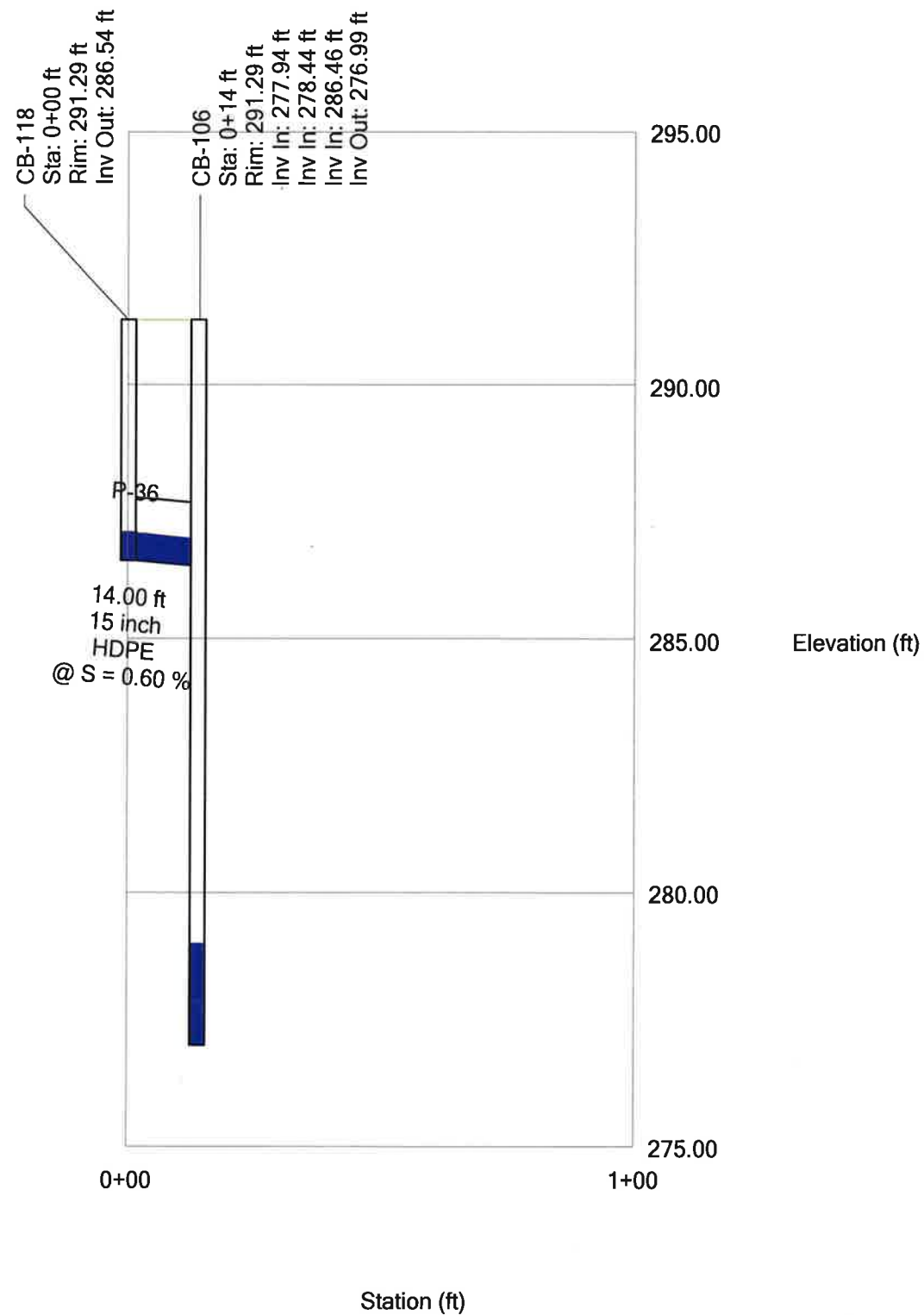
Profile
Scenario: 10-year Storm

Profile: Profile - 6
Scenario: 10-year Storm



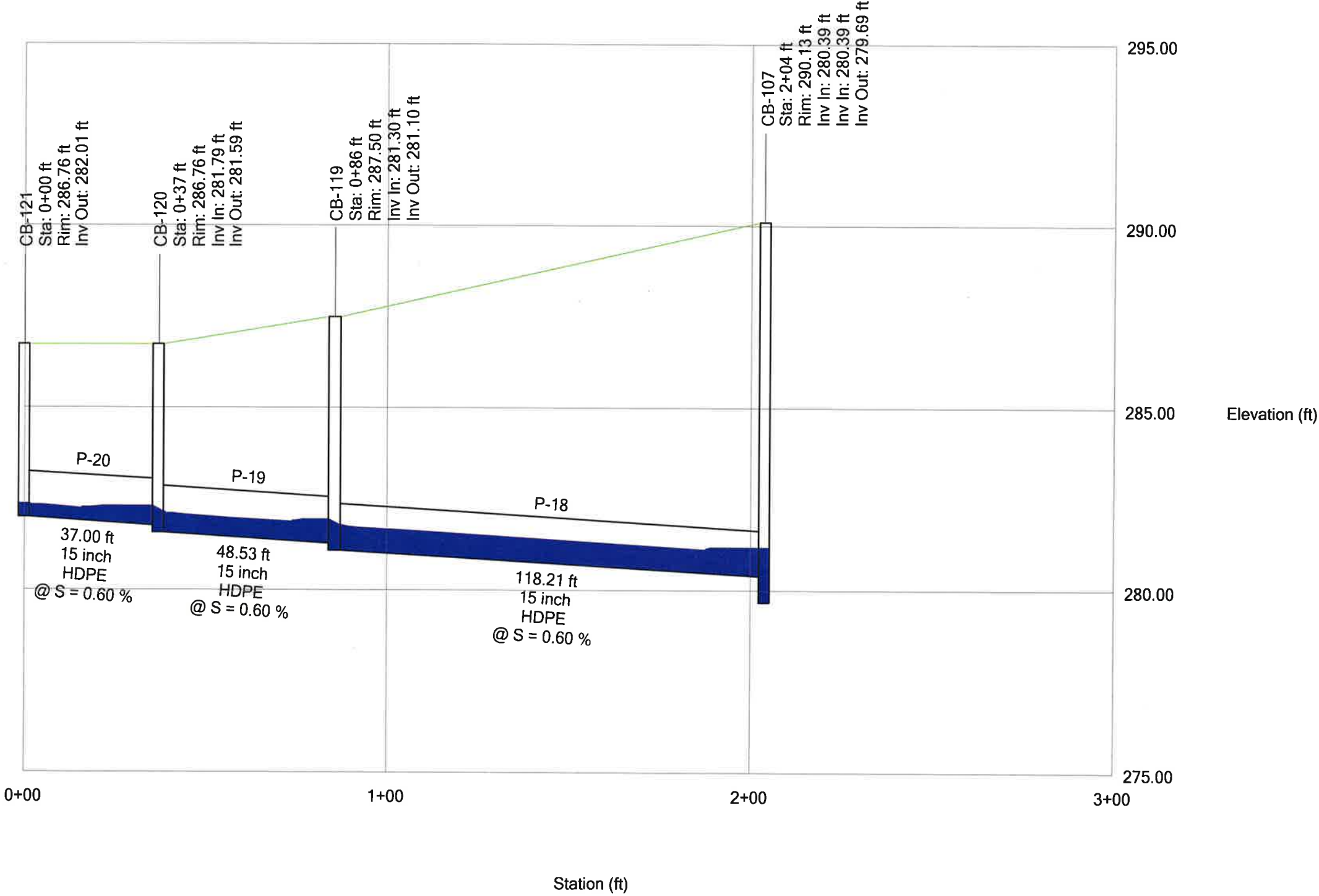
Profile
Scenario: 10-year Storm

Profile: Profile - 7
Scenario: 10-year Storm



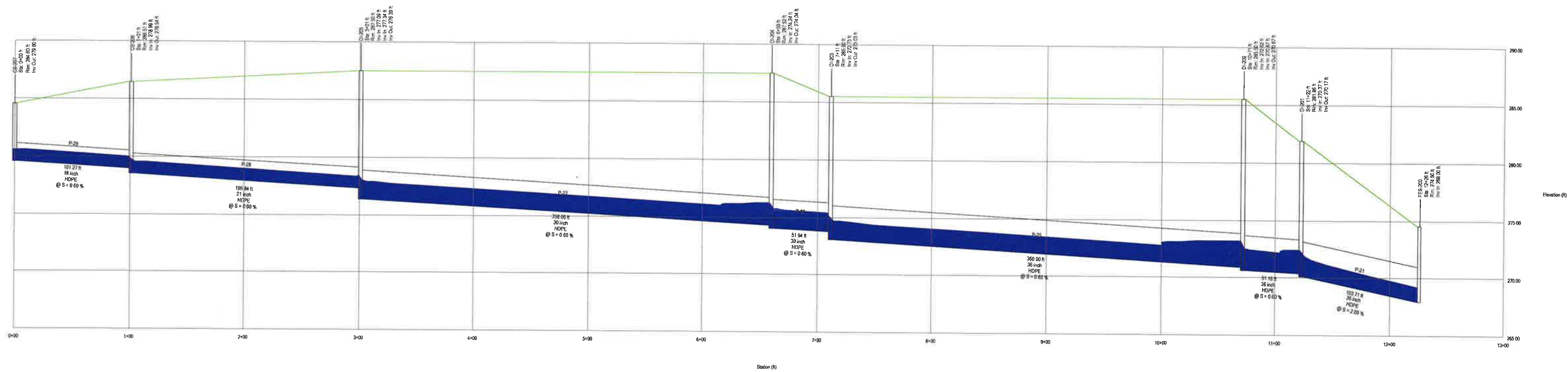
Profile
Scenario: 10-year Storm

Profile: Profile - 8
Scenario: 10-year Storm



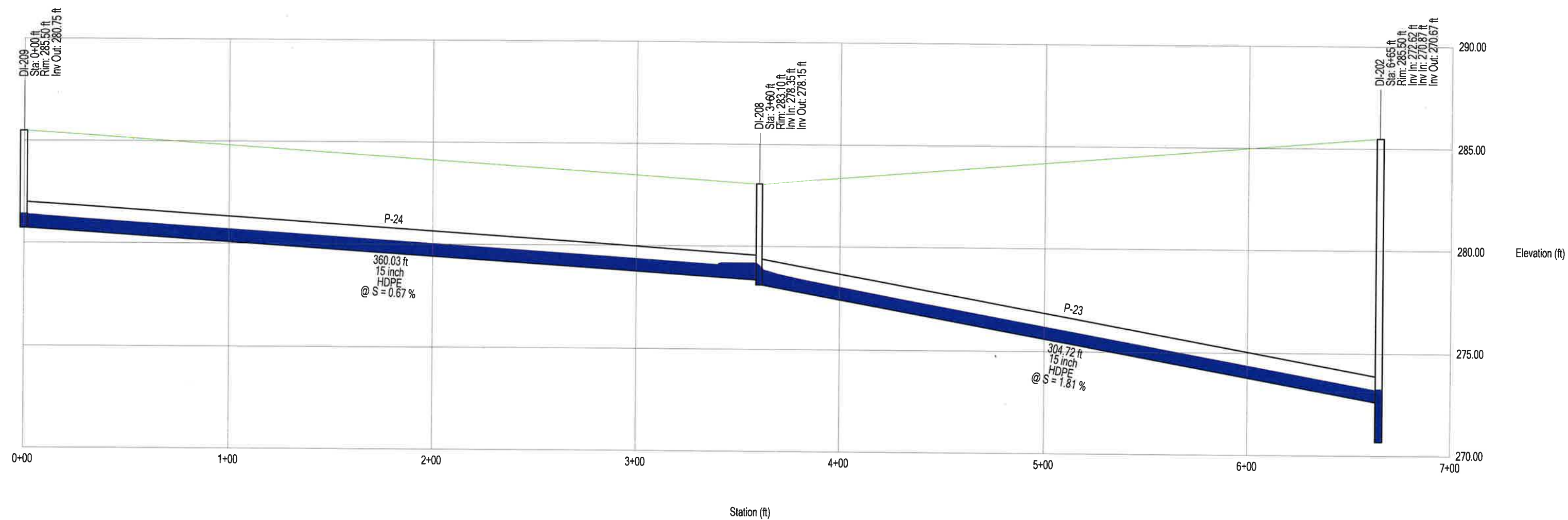
Profile
Scenario: 10-year Storm

Profile: Profile - 9
Scenario: 10-year Storm



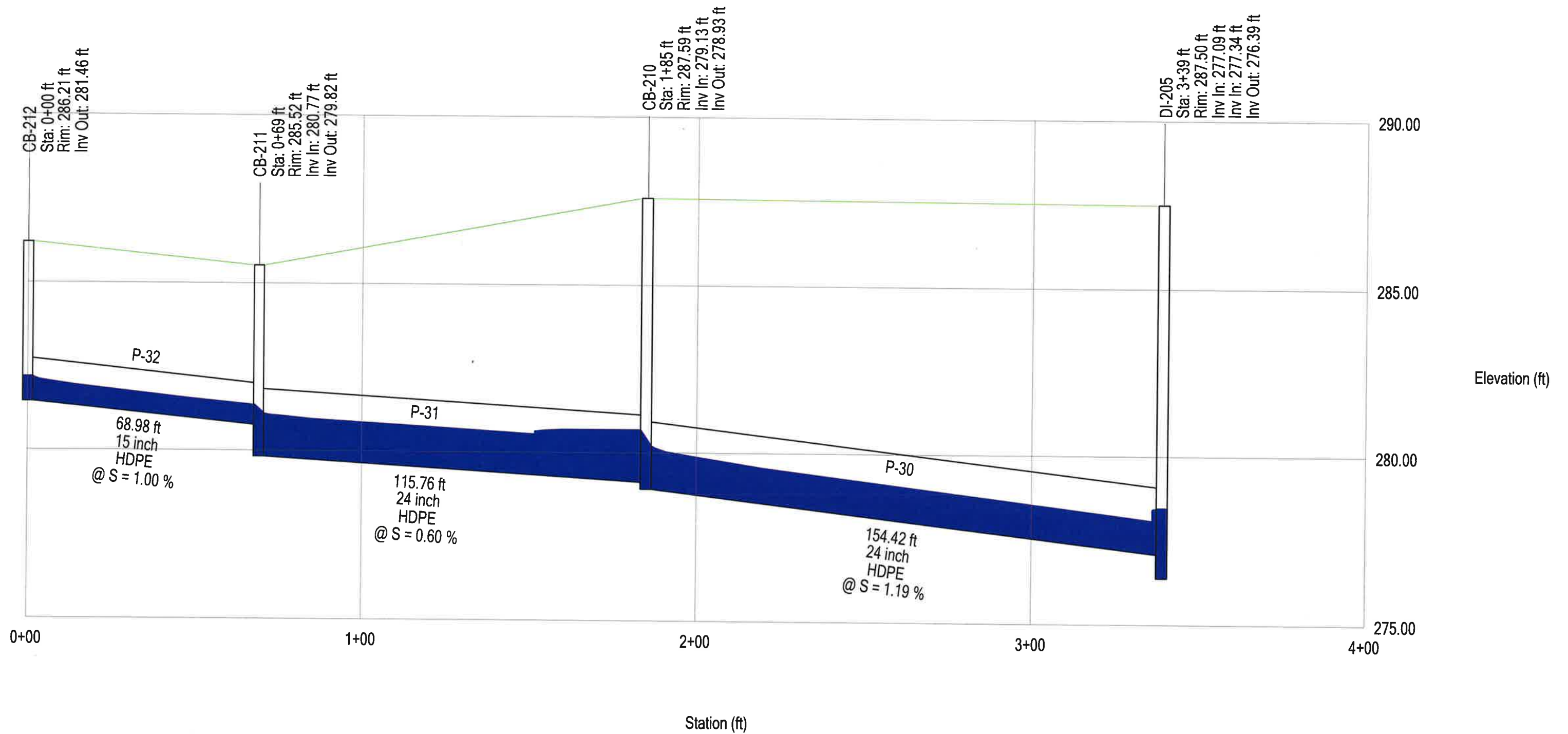
Profile
Scenario: 10-year Storm

Profile: Profile - 10
Scenario: 10-year Storm



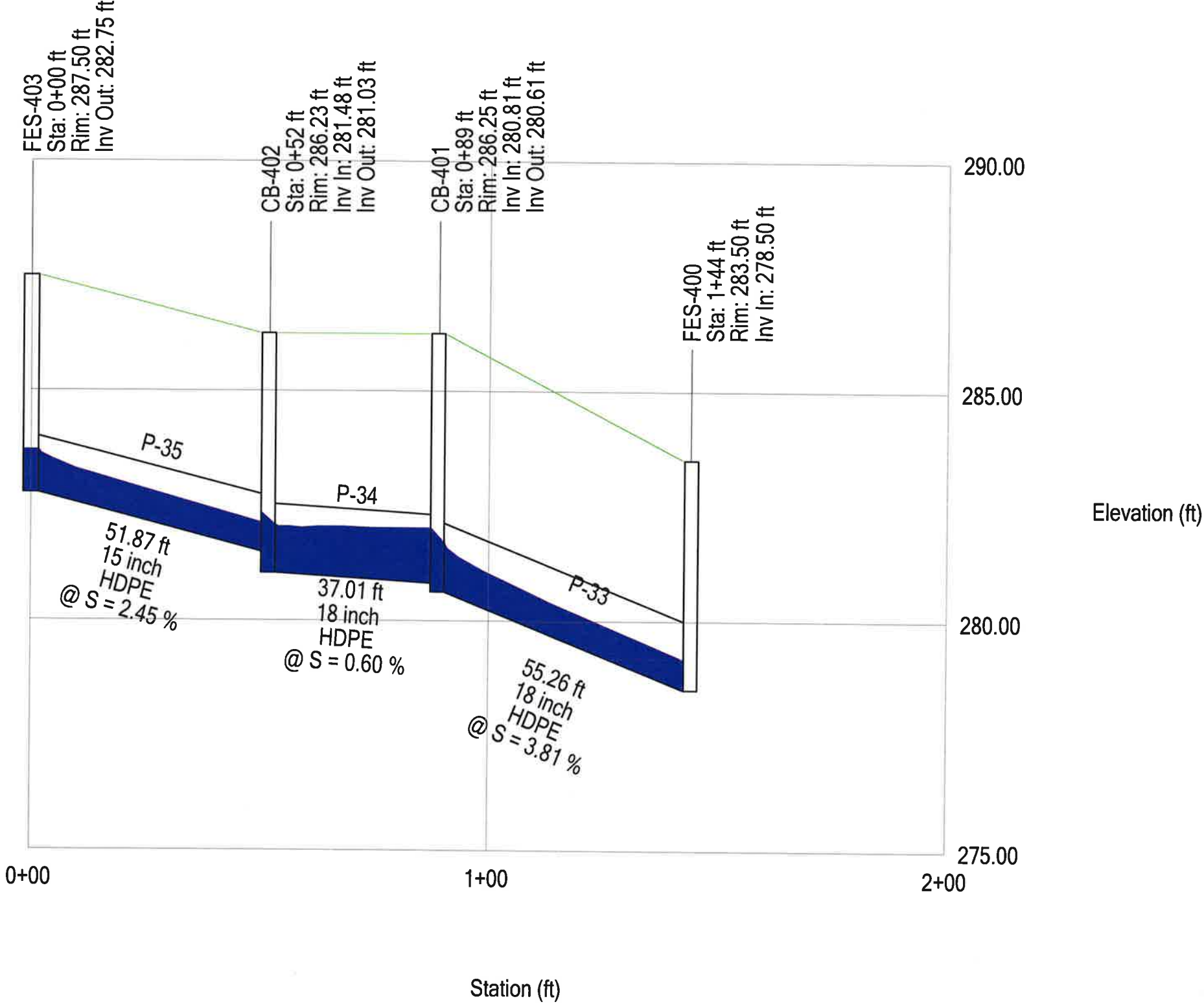
Profile
Scenario: 10-year Storm

Profile: Profile - 11
Scenario: 10-year Storm



Profile: Profile - 12

Scenario: 10-year Storm



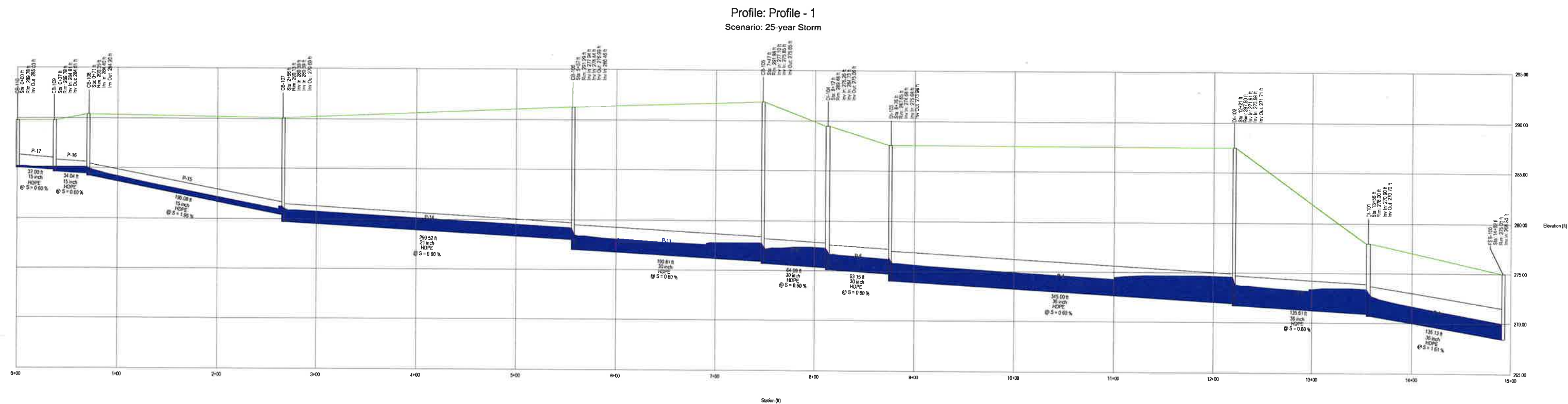
25-YEAR STORM

Scenario: 25-year Storm

Storm Drainage Design Report

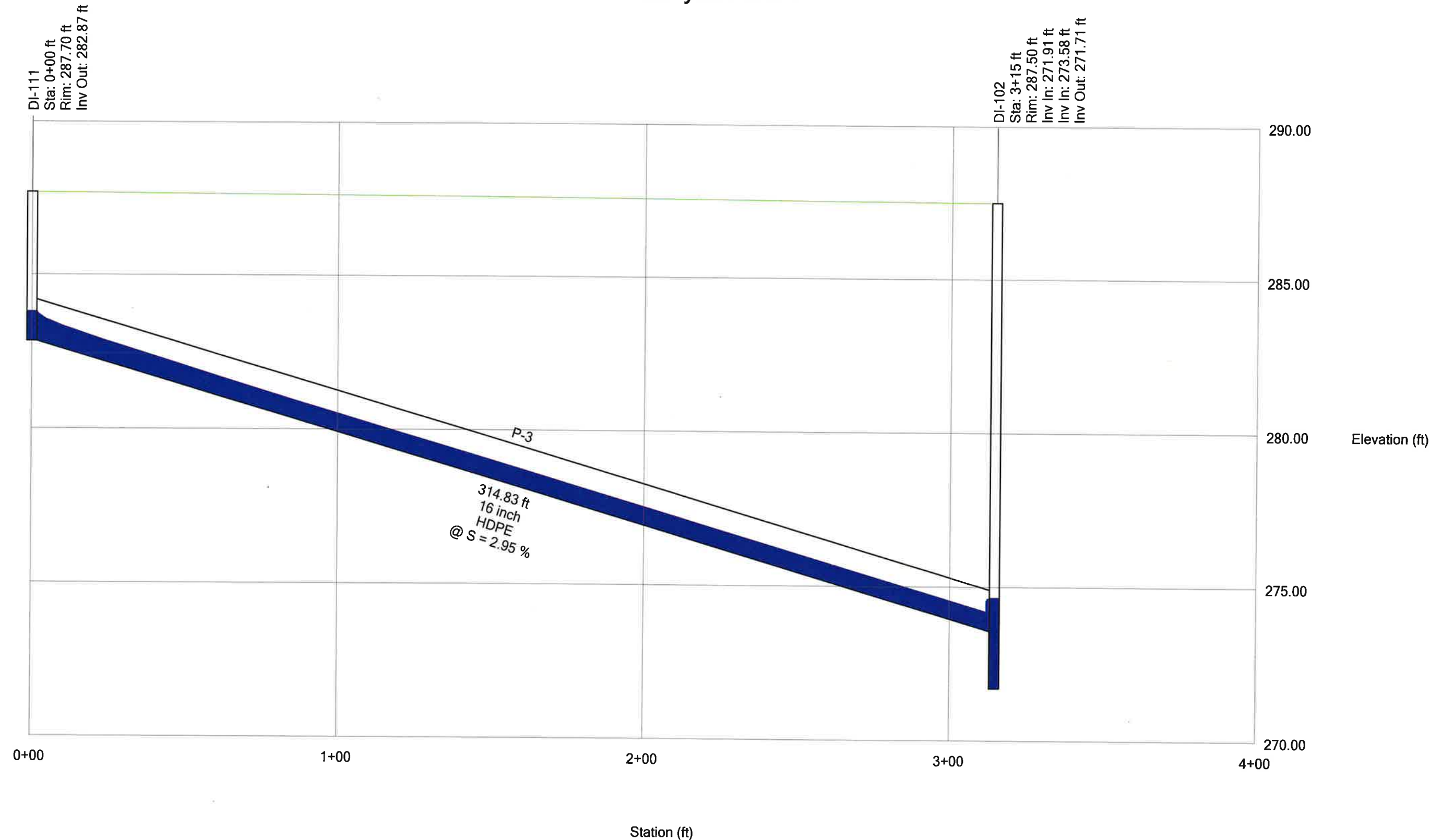
Upstream Node	Downstream Node	Section Size	Length (ft)	Slope (%)	Upstream Invert (ft)	Downstream Invert (ft)	Upstream Inlet Area (acres)	Rational Coefficient	Upstream Inlet CA (acres)	Upstream Calculated System CA (acres)	System Intensity (in/hr)	Total System Flow (cfs)	Full Capacity (cfs)	Manning's n	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)	Upstream Ground Elevation (ft)	Downstream Ground Elevation (ft)
CB-106	CB-105	30 inch	190.81	0.60	276.99	275.85	0.52	0.85	0.44	2.54	7.60	19.49	34.42	0.012	278.49	277.81	291.29	291.88
CB-114	CB-105	15 inch	223.38	3.12	284.07	277.10	0.15	0.90	0.14	0.27	7.94	2.18	12.36	0.012	284.66	277.81	291.48	291.88
CB-107	CB-106	21 inch	290.52	0.60	279.69	277.94	0.75	0.80	0.60	1.42	7.81	11.19	13.30	0.012	280.93	279.17	290.13	291.29
CB-116	CB-106	15 inch	165.93	4.05	285.16	278.44	0.30	0.85	0.26	0.41	7.99	3.29	14.08	0.012	285.89	278.86	290.29	291.29
CB-118	CB-106	15 inch	14.00	0.60	286.54	286.46	0.32	0.85	0.27	0.27	8.04	2.20	5.42	0.012	287.13	287.01	291.29	291.29
CB-119	CB-107	15 inch	118.21	0.60	281.10	280.39	0.33	0.60	0.20	0.39	7.94	3.13	5.42	0.012	281.81	281.28	287.50	290.13
CB-108	CB-107	15 inch	195.08	1.96	284.20	280.39	0.36	0.85	0.31	0.43	7.93	3.43	9.79	0.012	284.95	281.28	290.35	290.13
CB-109	CB-108	15 inch	34.04	0.60	284.61	284.40	0.13	0.85	0.11	0.12	7.97	0.99	5.42	0.012	285.13	285.14	289.78	290.35
CB-110	CB-109	15 inch	37.00	0.60	285.03	284.81	0.04	0.90	0.04	0.04	8.04	0.28	5.42	0.012	285.24	285.17	289.78	289.78
DI-115	CB-114	15 inch	79.92	0.60	284.75	284.27	0.69	0.20	0.14	0.14	8.04	1.12	5.42	0.012	285.17	284.77	289.50	291.48
CB-117	CB-116	15 inch	42.89	0.60	285.62	285.36	0.17	0.90	0.15	0.15	8.04	1.24	5.42	0.012	286.06	286.07	290.37	290.29
CB-120	CB-119	15 inch	48.53	0.60	281.59	281.30	0.23	0.70	0.16	0.25	7.99	2.04	5.42	0.012	282.16	281.98	286.76	287.50
CB-121	CB-120	15 inch	37.00	0.60	282.01	281.79	0.15	0.90	0.14	0.10	8.04	0.84	5.42	0.012	282.37	282.33	286.76	286.76
CB-207	CB-206	18 inch	101.27	0.60	279.60	278.99	1.39	0.70	0.97	0.97	8.04	7.89	8.81	0.012	280.71	280.08	284.60	286.51
CB-211	CB-210	24 inch	115.76	0.60	279.82	279.13	1.60	0.85	1.36	1.79	7.99	14.44	18.98	0.012	281.19	280.79	285.52	287.59
CB-212	CB-211	15 inch	68.98	1.00	281.46	280.77	0.51	0.85	0.43	0.43	8.04	3.51	7.00	0.012	282.22	281.40	286.21	285.52
CB-402	CB-401	18 inch	37.01	0.60	281.03	280.81	0.88	0.40	0.35	0.95	8.02	7.66	8.81	0.012	282.17	282.07	286.23	286.25
FES-403	CB-402	15 inch	51.87	2.45	282.75	281.48	1.84	0.40	0.74	0.74	8.04	5.96	10.95	0.012	283.74	282.16	287.50	286.23
DI-102	DI-101	36 inch	135.61	0.60	271.71	270.90	1.33	0.50	0.67	5.90	7.23	42.99	55.97	0.012	273.85	273.46	287.50	278.00
DI-103	DI-102	36 inch	345.00	0.60	273.98	271.91	1.52	0.20	0.30	4.53	7.42	33.86	55.97	0.012	275.87	274.64	287.65	287.50
DI-111	DI-102	16 inch	314.83	2.95	282.87	273.58	2.80	0.25	0.70	0.70	8.04	5.67	14.28	0.012	283.82	274.64	287.70	287.50
DI-104	DI-103	30 inch	63.15	0.60	275.06	274.68	0.79	0.20	0.16	3.22	7.45	24.18	34.42	0.012	276.73	276.23	289.48	287.65
DI-112	DI-103	18 inch	270.61	3.52	285.21	275.68	4.03	0.25	1.01	1.01	8.04	8.17	21.35	0.012	286.32	276.32	290.21	287.65
CB-105	DI-104	30 inch	64.99	0.60	275.65	275.26	0.14	0.90	0.13	2.94	7.49	22.21	34.42	0.012	277.25	277.33	291.88	289.48
CB-113	DI-104	15 inch	53.74	4.15	286.96	284.73	0.14	0.85	0.12	0.12	8.04	0.96	14.25	0.012	287.35	284.95	291.71	289.48
DI-202	DI-201	36 inch	51.16	0.60	270.67	270.37	1.29	0.20	0.26	5.13	7.39	38.22	55.97	0.012	272.69	272.64	285.50	281.86
DI-203	DI-202	36 inch	360.00	0.60	273.03	270.87	1.62	0.25	0.41	4.33	7.59	33.13	55.97	0.012	274.90	273.40	285.50	285.50
DI-208	DI-202	15 inch	304.72	1.81	278.15	272.62	0.75	0.20	0.15	0.54	7.71	4.18	9.42	0.012	278.98	273.21	283.10	285.50
DI-204	DI-203	30 inch	51.94	0.60	274.04	273.73	1.30	0.50	0.65	3.93	7.61	30.14	34.42	0.012	275.92	275.55	287.52	285.50
DI-205	DI-204	30 inch	358.06	0.60	276.39	274.24	1.30	0.20	0.26	3.28	7.82	25.83	34.42	0.012	278.13	276.37	287.50	287.52
CB-210	DI-205	24 inch	154.42	1.19	278.93	277.09	0.02	0.95	0.02	1.81	7.91	14.45	26.69	0.012	280.30	278.60	287.59	287.50
CB-206	DI-205	21 inch	199.84	0.60	278.54	277.34	0.31	0.75	0.23	1.21	7.96	9.67	13.30	0.012	279.70	278.60	286.51	287.50
DI-209	DI-208	15 inch	360.03	0.67	280.75	278.35	1.55	0.25	0.39	0.39	8.04	3.14	5.71	0.012	281.46	279.27	285.50	283.10
DI-101	FES-100	36 inch	136.13	1.61	270.70	268.50	0.59	0.30	0.18	6.07	7.17	43.86	91.79	0.012	272.85	270.02	278.00	275.00
DI-201	FES-200	36 inch	103.71	2.09	270.17	268.00	0.28	0.30	0.08	5.21	7.37	38.71	104.43	0.012	272.19	269.35	281.86	274.50
CB-401	FES-400	18 inch	55.26	3.81	280.61	278.50	0.17	0.90	0.15	1.06	7.99	8.54	22.22	0.012	281.74	279.18	286.25	283.50

Profile
Scenario: 25-year Storm



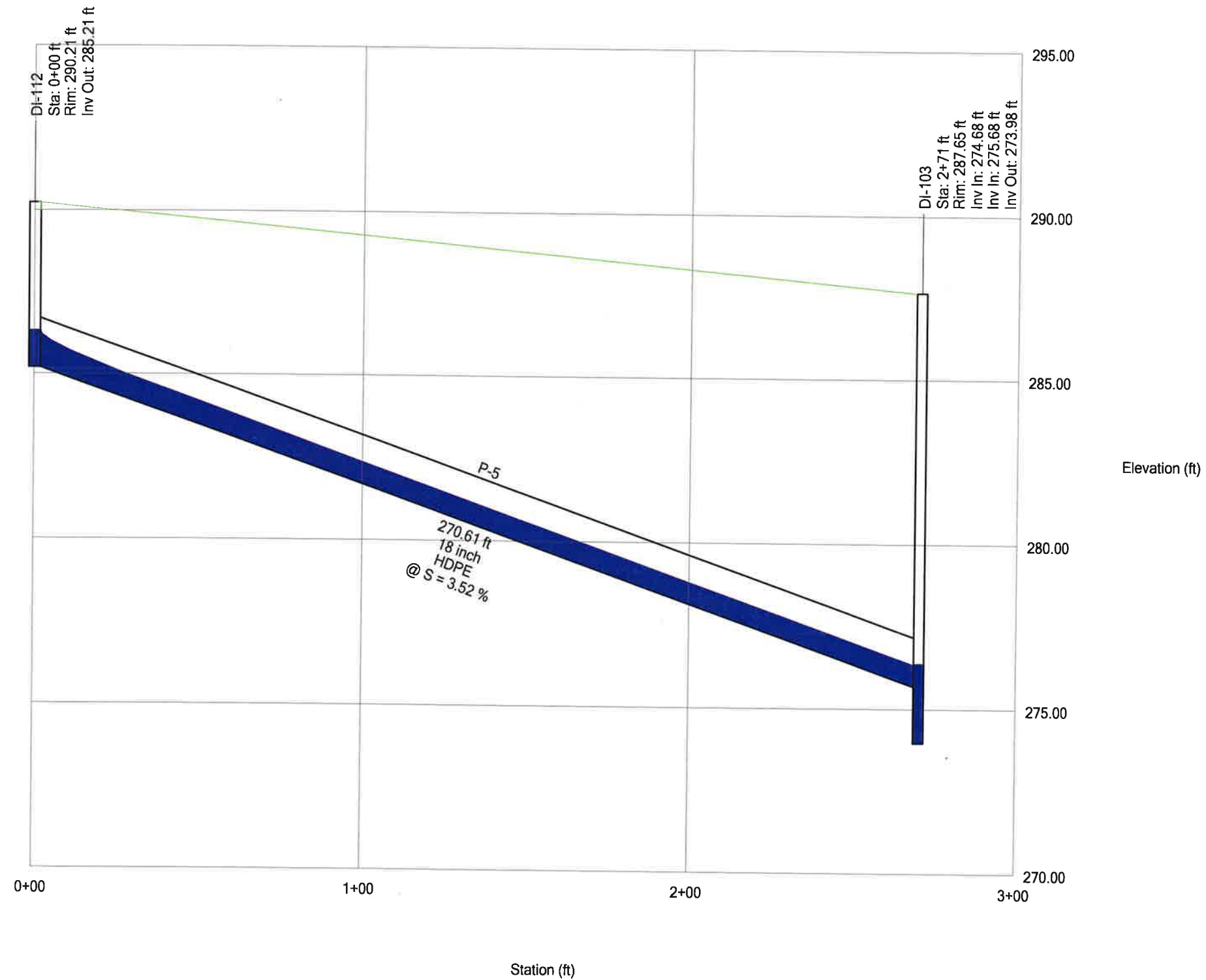
Profile
Scenario: 25-year Storm

Profile: Profile - 2
Scenario: 25-year Storm



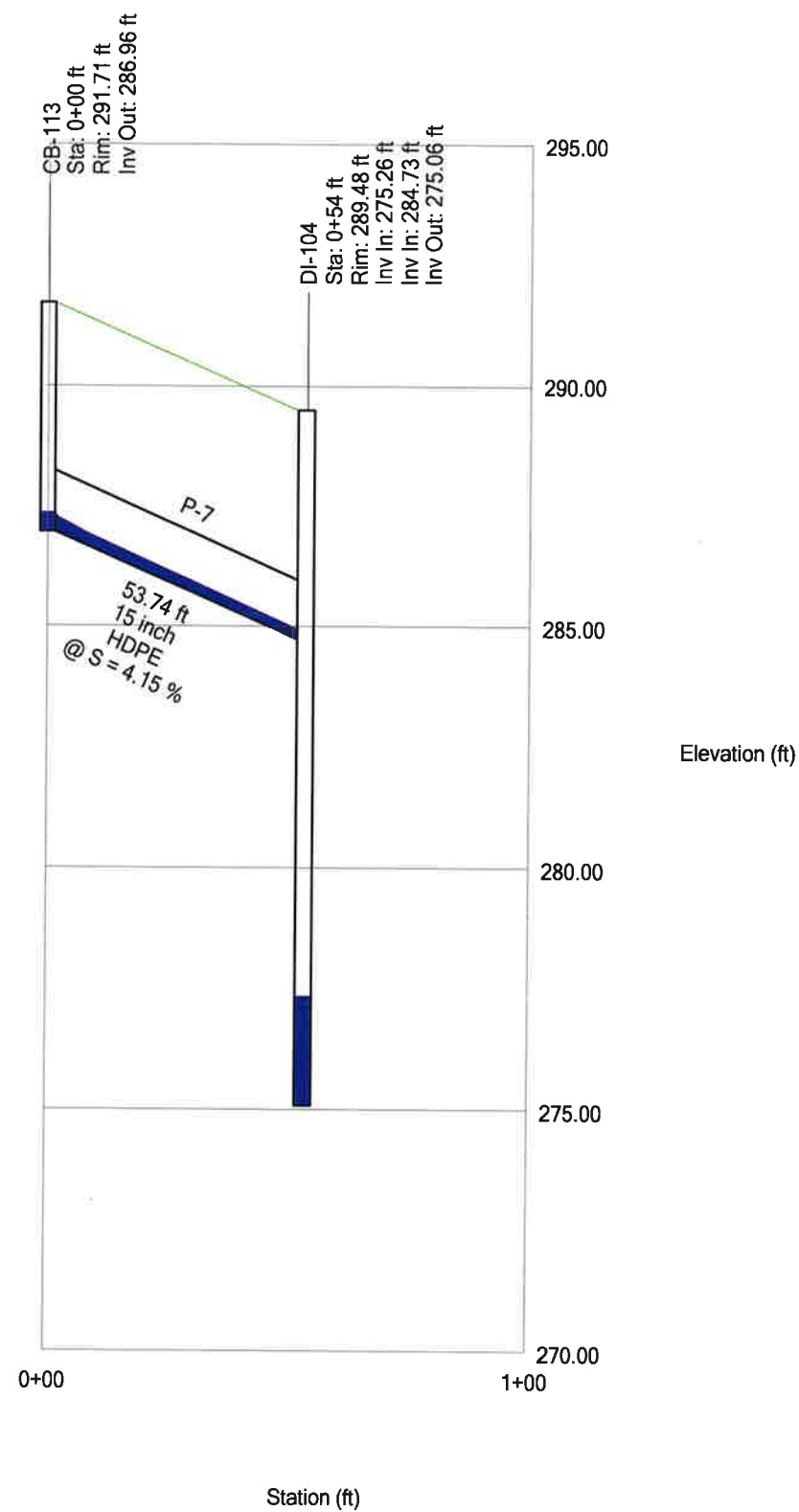
Profile
Scenario: 25-year Storm

Profile: Profile - 3
Scenario: 25-year Storm



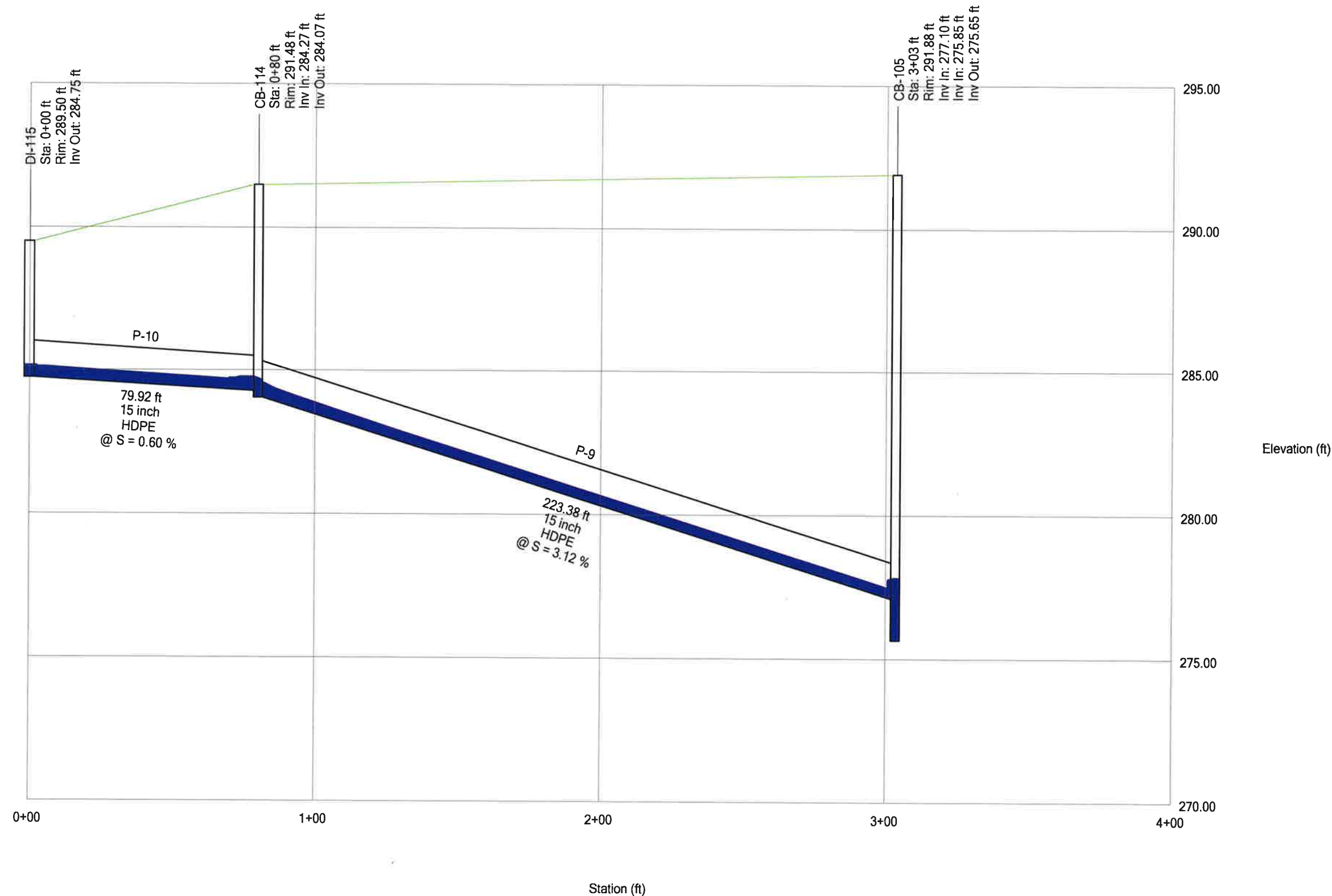
Profile
Scenario: 25-year Storm

Profile: Profile - 4
Scenario: 25-year Storm



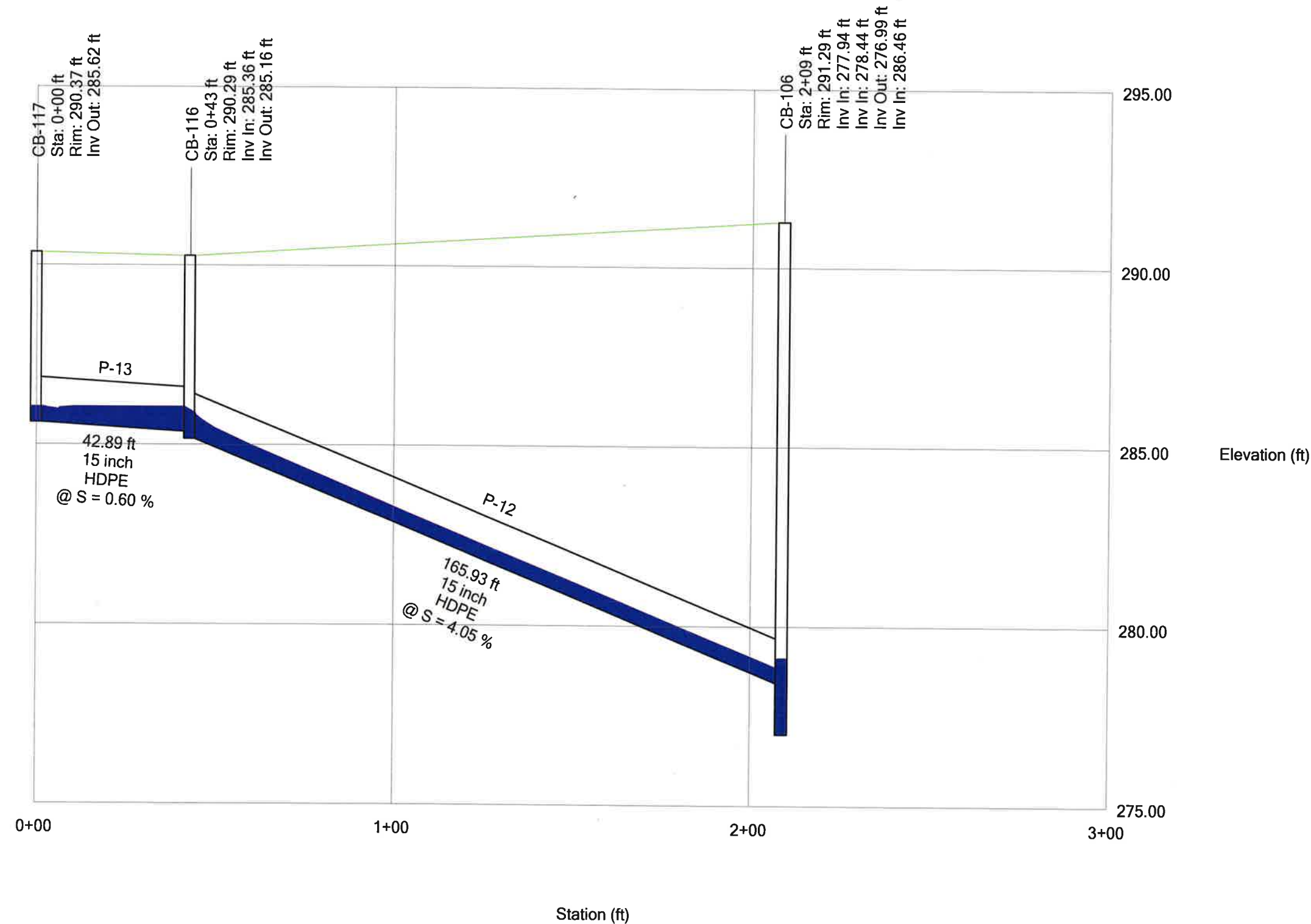
Profile
Scenario: 25-year Storm

Profile: Profile - 5
Scenario: 25-year Storm



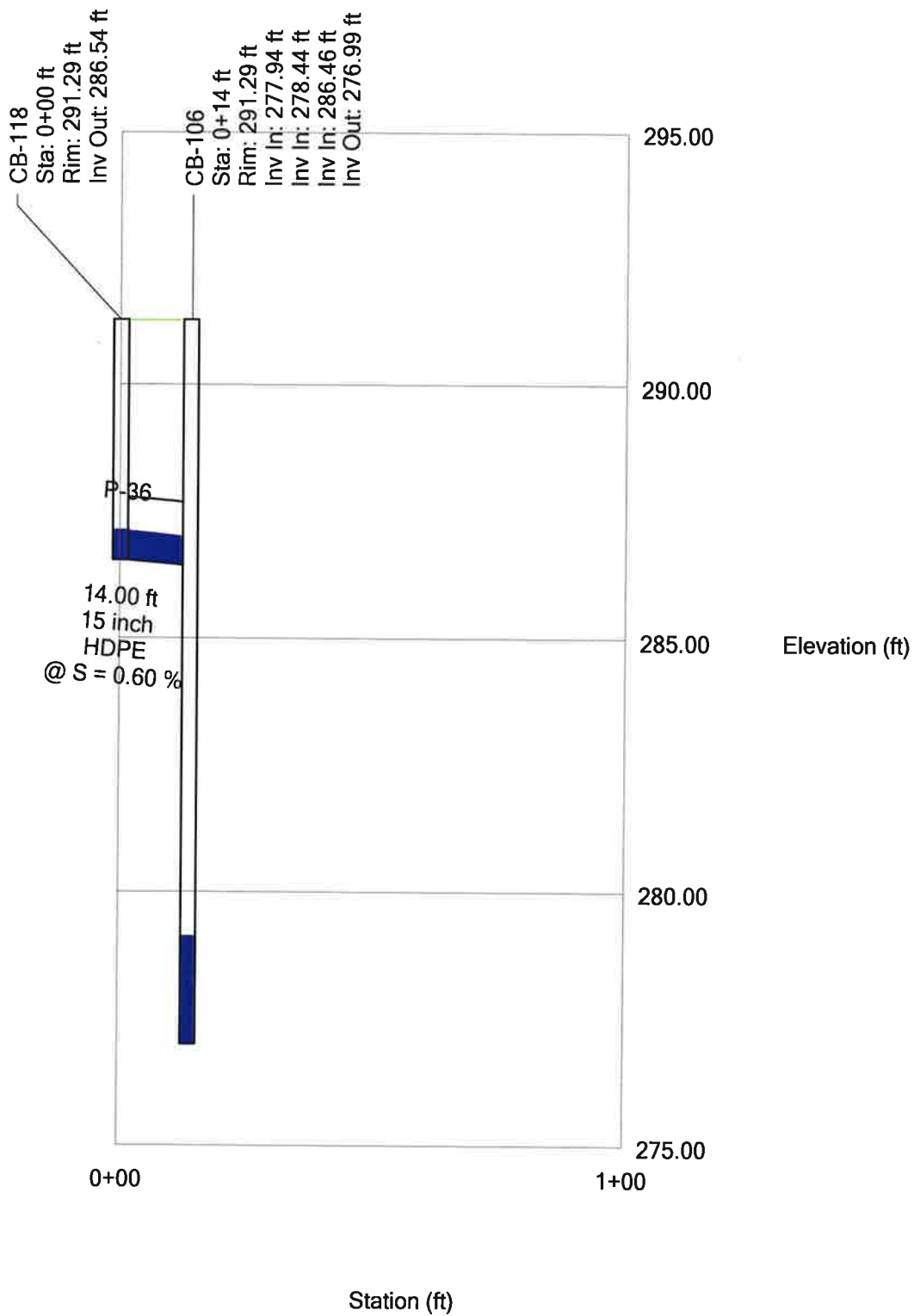
Profile
Scenario: 25-year Storm

Profile: Profile - 6
Scenario: 25-year Storm



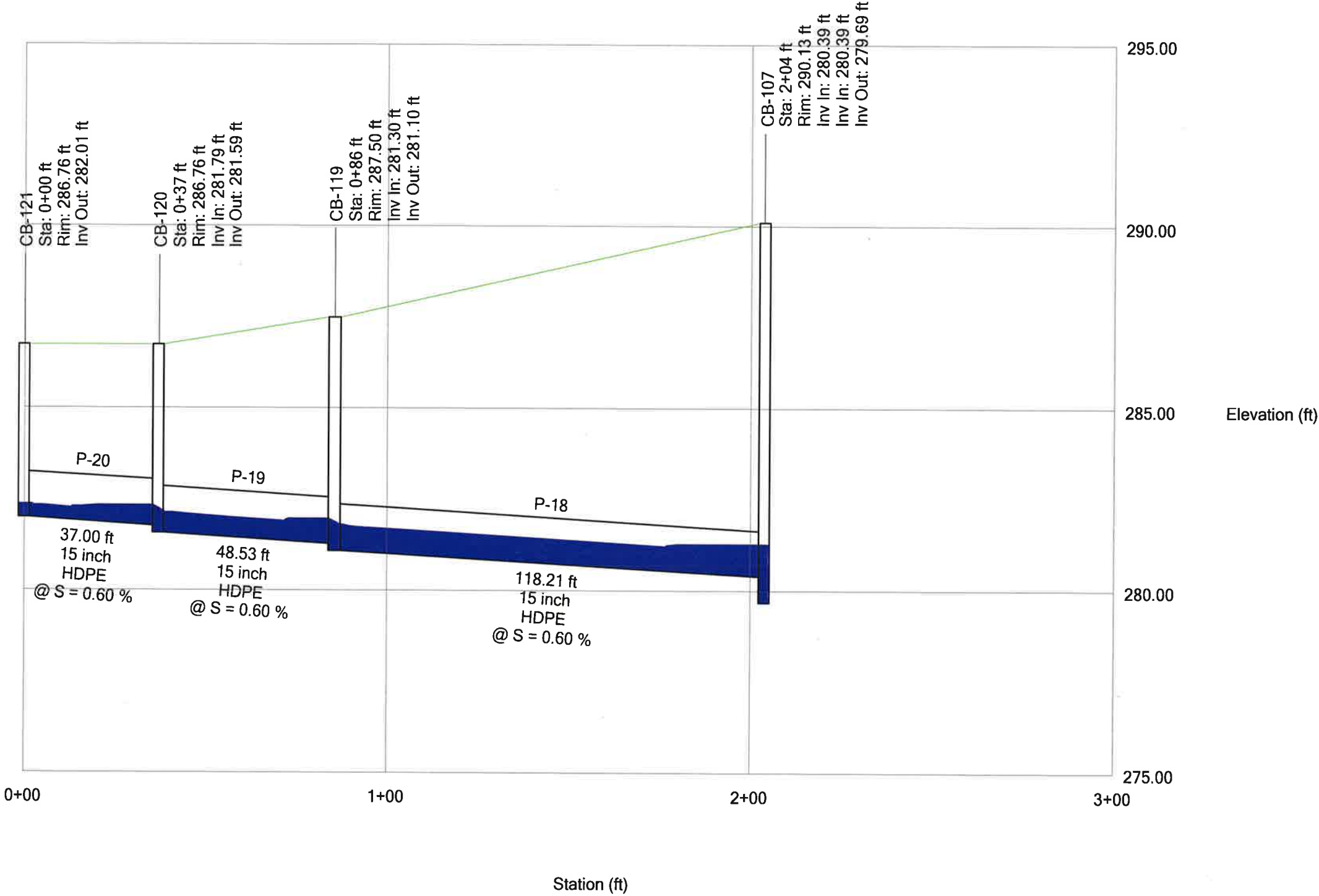
Profile
Scenario: 25-year Storm

Profile: Profile - 7
Scenario: 25-year Storm



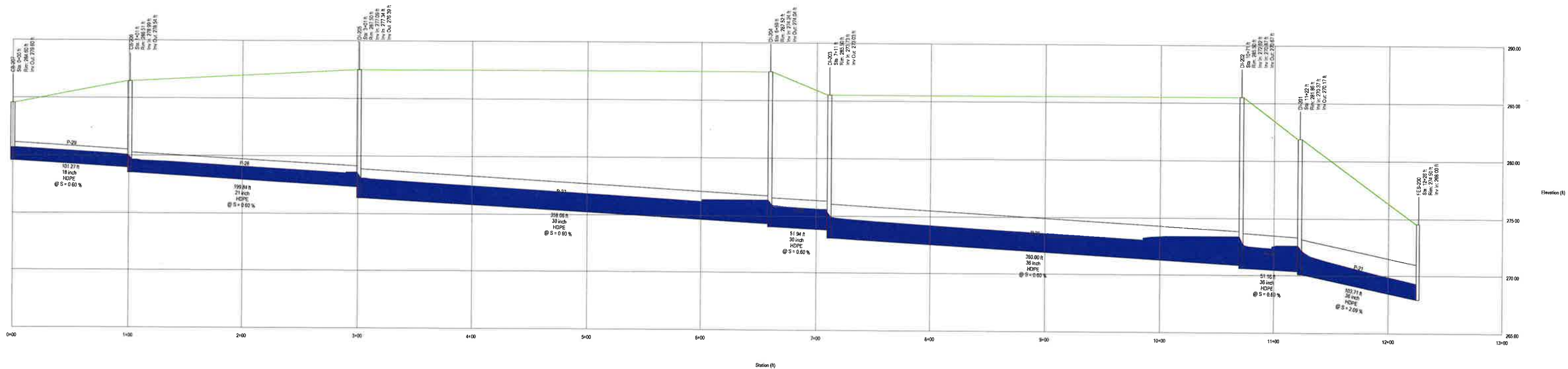
Profile
Scenario: 25-year Storm

Profile: Profile - 8
Scenario: 25-year Storm



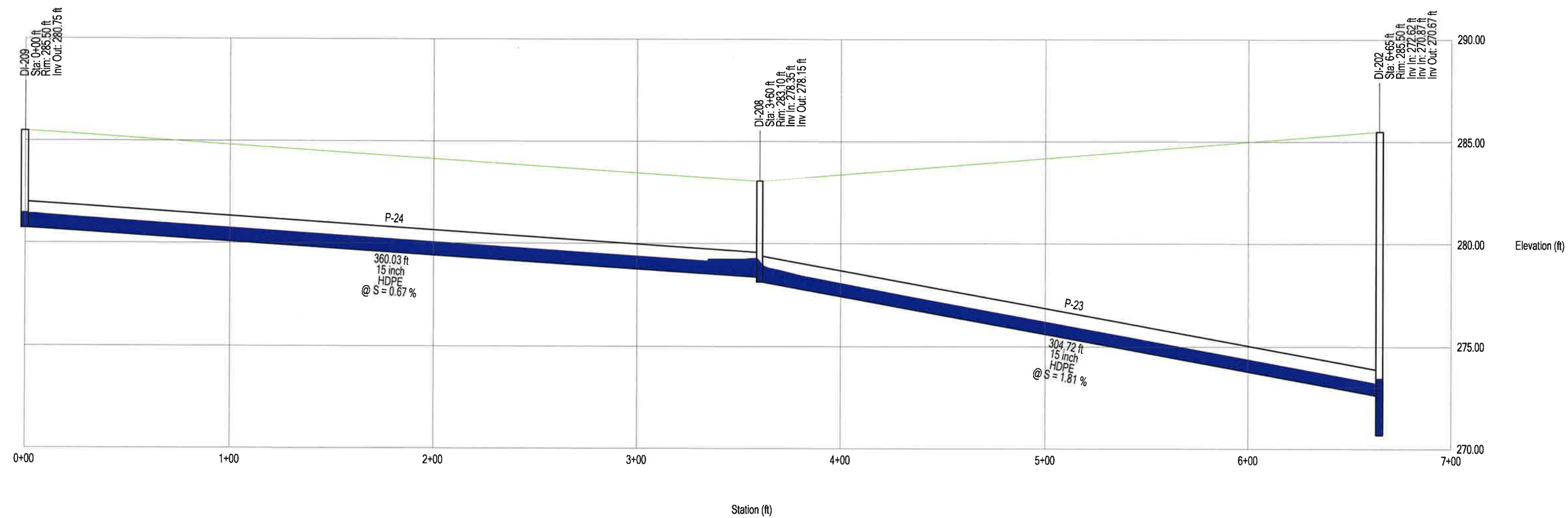
Profile
Scenario: 25-year Storm

Profile: Profile - 9
Scenario: 25-year Storm



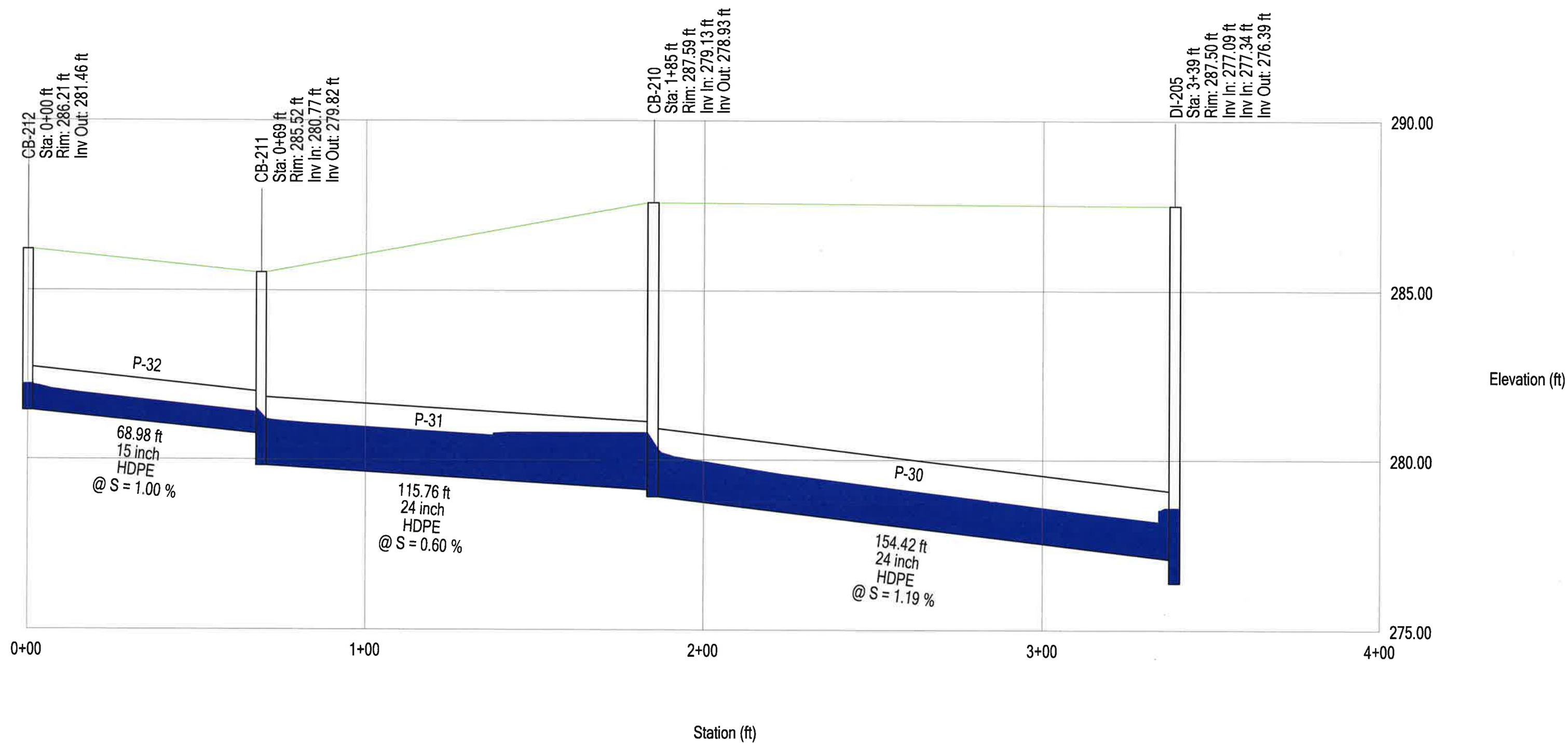
Profile
Scenario: 25-year Storm

Profile: Profile - 10
Scenario: 25-year Storm



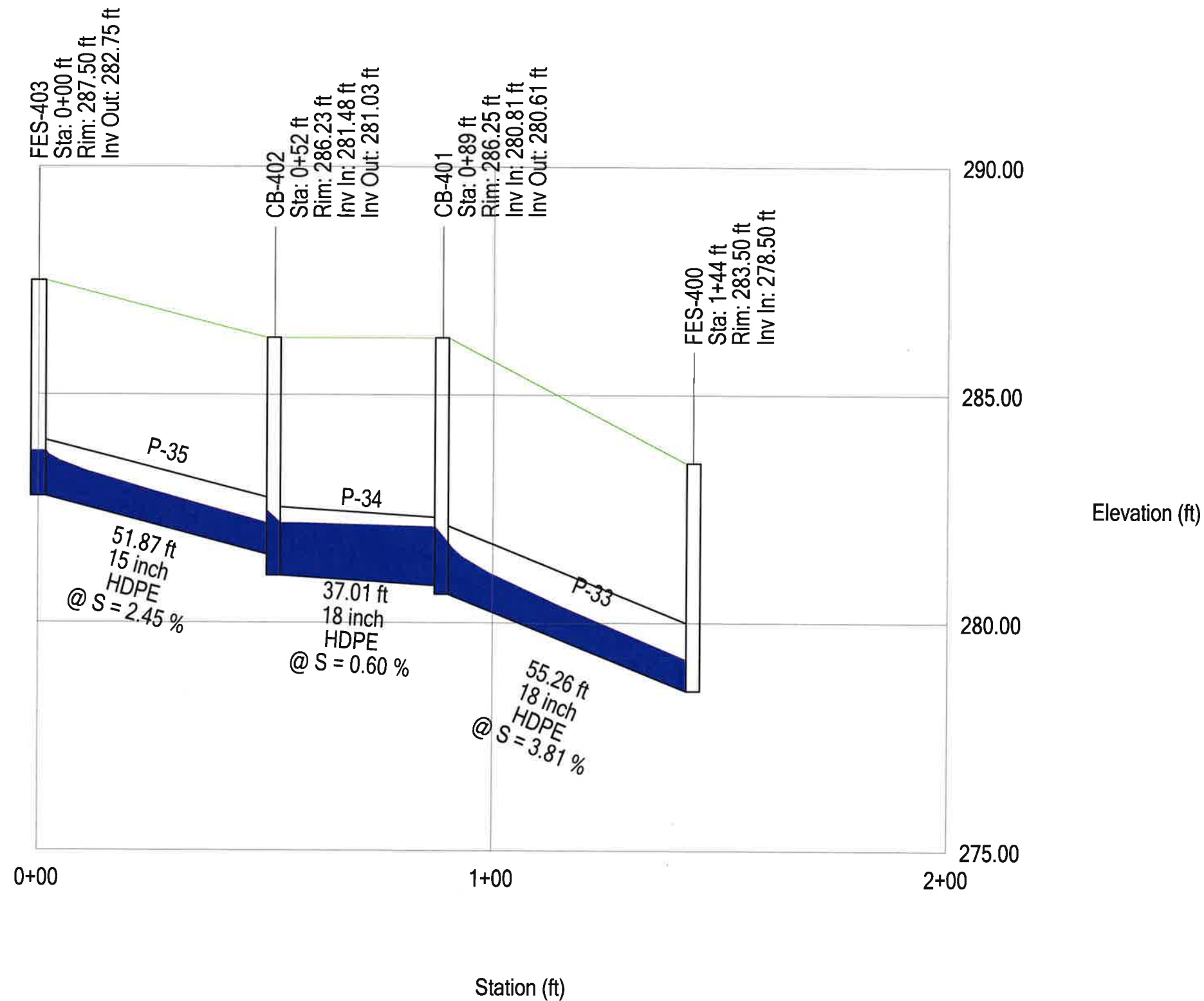
Profile: Profile - 11

Scenario: 25-year Storm



Profile: Profile - 12

Scenario: 25-year Storm



GUTTER SPREADS

INLET SPREAD REPORT

Label	Inlet Location	Road Longitudinal Slope (%)	Road Cross Slope (%)	Inlet Area (acres)	Inlet Rational C Value	NCDOT Storm Intensity (in/hr)	Inlet Rational Flow (cfs)	Total Inlet Rational Flow (cfs)	Intercepted Rational Flow (cfs)	Bypassed Rational Flow (cfs)	Gutter Ditch Spread (ft)	Bypass Target	Notes
CB-105	In Sag		2.00	0.14	0.90	4.00	0.51	0.51	0.51	0.00	1.86		
CB-106	In Sag		2.00	0.52	0.85	4.00	1.78	1.78	1.78	0.00	6.60		
CB-107	In Sag		2.00	0.75	0.80	4.00	2.42	2.42	2.42	0.00	8.37		
CB-108	In Sag		2.00	0.36	0.85	4.00	1.23	1.23	1.23	0.00	4.85		
CB-109	On Grade	1.28	2.00	0.13	0.85	4.00	0.45	0.45	0.41	0.03	3.83	CB-402	
CB-110	On Grade	1.28	2.00	0.04	0.90	4.00	0.15	0.15	0.15	0.00	1.95	CB-401	
CB-113	In Sag		2.00	0.14	0.85	4.00	0.48	0.48	0.48	0.00	1.82		
CB-114	In Sag		2.00	0.15	0.90	4.00	0.54	0.54	0.54	0.00	1.93		
CB-116	In Sag		2.00	0.30	0.85	4.00	1.03	1.03	1.03	0.00	4.27		
CB-117	In Sag		2.00	0.17	0.90	4.00	0.62	0.62	0.62	0.00	2.26		
CB-118	In Sag		2.00	0.32	0.85	4.00	1.10	1.10	1.10	0.00	4.41		
CB-119	On Grade	1.50	2.00	0.33	0.60	4.00	0.80	0.80	0.67	0.13	4.91	CB-120	
CB-120	On Grade	1.46	2.00	0.23	0.70	4.00	0.65	0.78	0.65	0.13	4.90	<Automatic	
CB-121	On Grade	1.46	2.00	0.15	0.90	4.00	0.54	0.54	0.49	0.05	4.11	<Automatic	
CB-206	In Sag		2.00	0.31	0.75	4.00	0.94	0.94	0.94	0.00	4.00		
CB-207	In Sag		2.00	1.39	0.70	4.00	3.92	3.92	3.92	0.00	11.90		
CB-210	On Grade	2.00	2.00	0.02	0.95	4.00	0.08	0.08	0.07	0.01	1.41	<Automatic	
CB-211	In Sag		2.00	1.60	0.85	4.00	5.48	5.48	5.48	0.00	15.01		
CB-212	In Sag		2.00	0.51	0.85	4.00	1.75	1.75	1.75	0.00	6.50		
CB-401	On Grade	1.28	2.00	0.17	0.90	4.00	0.62	0.62	0.54	0.08	4.51	<Automatic	
CB-402	On Grade	1.28	2.00	0.88	0.40	4.00	1.42	1.45	1.03	0.43	6.65	<Automatic	

ENTRANCE CULVERT

Knightdale Athletic Park Entrance Culvert Calculations

$Q_{10} = CIA$

$C = 0.25$

$I = 7.25$

$A = 2.69$

$Q_{10} =$

4.88 CFS

Entrance Culvert

Project Description

Friction Method	Manning Formula
Solve For	Full Flow Diameter

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00540	ft/ft
Normal Depth	1.26	ft
Diameter	1.26	ft
Discharge	4.88	ft ³ /s

Results

Diameter	1.26	ft
Normal Depth	1.26	ft
Flow Area	1.25	ft ²
Wetted Perimeter	3.97	ft
Hydraulic Radius	0.32	ft
Top Width	0.00	ft
Critical Depth	0.89	ft
Percent Full	100.0	%
Critical Slope	0.00750	ft/ft
Velocity	3.89	ft/s
Velocity Head	0.24	ft
Specific Energy	1.50	ft
Froude Number	0.00	
Maximum Discharge	5.25	ft ³ /s
Discharge Full	4.88	ft ³ /s
Slope Full	0.00540	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%

Entrance Culvert

GVF Output Data

Normal Depth Over Rise	100.00	%
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.26	ft
Critical Depth	0.89	ft
Channel Slope	0.00540	ft/ft
Critical Slope	0.00750	ft/ft

DISSIPATORS

OUTLET PROTECTION DESIGN		DATE	DESIGN PHASE
PROJECT NAME		02/11/19	PRELIM
Knightdale Athletic Park - Phase 1		PROJECT NO	CONSTR X
LOCATION		2180875	REVISION
Knightdale, North Carolina		BY	RECORD
ADDITIONAL INFORMATION		WR	OTHER
		CHECKED BY	(SPECIFY)
		WR	

Storm Outlet Structure

FES No.= FES - 100
 Pipe Dia= 36 in
 Q₁₀ = 38.69 cfs
 Q_{full} = 49.46 cfs
 V_{full} = 6.97 fps

of Barrels
 1

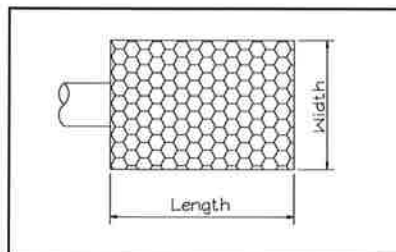
Q₁₀/Q_{full} = 0.78
 V/V_{full} = 1.10
 V = 7.7 fps

From Fig. 8.06.b.1:

Zone

Use 36in for chart
 = 2

From Fig. 8.06.b.2:



D₅₀ = 8 in
 D_{MAX} = 12 in
 Riprap Class = B
 Apron Thickness = 18 in
 Apron Length = 18.0 ft
 Apron Width = 3xDia = 9 ft

Q₁₀ is half of flow. For multiple barrels, Zone and length calcs include 1.25 factor of correction.

OUTLET PROTECTION DESIGN		DATE	DESIGN PHASE
PROJECT NAME		02/11/19	PRELIM
Knightdale Athletic Park - Phase 1		PROJECT NO	CONSTR <u>X</u>
LOCATION		2180875	REVISION
Knightdale, North Carolina		BY	RECORD
ADDITIONAL INFORMATION		WR	OTHER
		CHECKED BY	(SPECIFY)
		WR	

Storm Outlet Structure

FES No.= FES - 200
 Pipe Dia= 36 in
 Q₁₀ = 34.42 cfs
 Q_{full} = 65.35 cfs
 V_{full} = 9.21 fps

of Barrels
 1

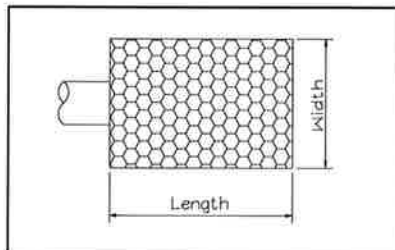
Q₁₀/Q_{full} = 0.53
 V/V_{full} = 1.01
 V = 9.3 fps

From Fig. 8.06.b.1:

Zone

Use 36in for chart
 = 2

From Fig. 8.06.b.2:



D₅₀ = 8 in
 D_{MAX} = 12 in
 Riprap Class = B
 Apron Thickness = 18 in
 Apron Length = 18.0 ft
 Apron Width = 3xDia = 9 ft

Q₁₀ is half of flow. For multiple barrels, Zone and length calcs include 1.25 factor of correction.

OUTLET PROTECTION DESIGN		DATE 02/11/19	DESIGN PHASE
PROJECT NAME Knightdale Athletic Park - Phase 1	PROJECT NO 2180875	PRELIM	X
LOCATION Knightdale, North Carolina	BY WR	CONSTR	
ADDITIONAL INFORMATION	CHECKED BY WR	REVISION RECORD OTHER (SPECIFY)	

Storm Outlet Structure

FES No.= FES - 300
 Pipe Dia= 18 in
 Q₁₀ = 4.88 cfs
 Q_{full} = 7.72 cfs
 V_{full} = 4.35 fps

of Barrels
1

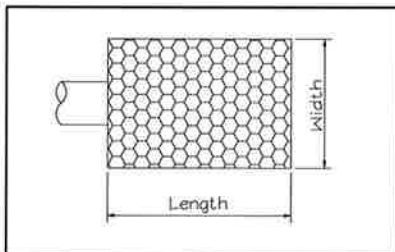
Q₁₀/Q_{full} = 0.63
 V/V_{full} = 1.06
 V = 4.6 fps

From Fig. 8.06.b.1:

Zone

Use 18in for chart
 = 1

From Fig. 8.06.b.2:



D₅₀ = 4 in
 D_{MAX} = 6 in
 Riprap Class = A
 Apron Thickness = 9 in
 Apron Length = 6.0 ft
 Apron Width = 3xDia = 4.5 ft

Q₁₀ is half of flow. For multiple barrels, Zone and length calcs include 1.25 factor of correction.

OUTLET PROTECTION DESIGN		DATE	DESIGN PHASE
PROJECT NAME		02/11/19	PRELIM
Knightdale Athletic Park - Phase 1		PROJECT NO	CONSTR X
LOCATION		2180875	REVISION
Knightdale, North Carolina		BY	RECORD
ADDITIONAL INFORMATION		WR	OTHER
		CHECKED BY	(SPECIFY)
		WR	

Storm Outlet Structure

FES No.= FES - 400
 Pipe Dia= 24 in
 Q₁₀ = 7.90 cfs
 Q_{full} = 16.62 cfs
 V_{full} = 5.27 fps

of Barrels
 1

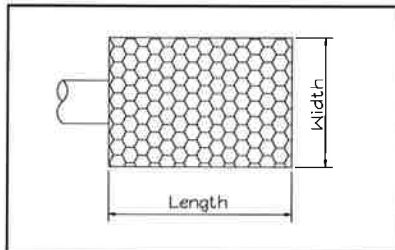
Q₁₀/Q_{full} = 0.48
 V/V_{full} = 0.99
 V = 5.2 fps

From Fig. 8.06.b.1:

Zone

Use 24in for chart
 = 2

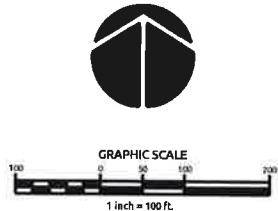
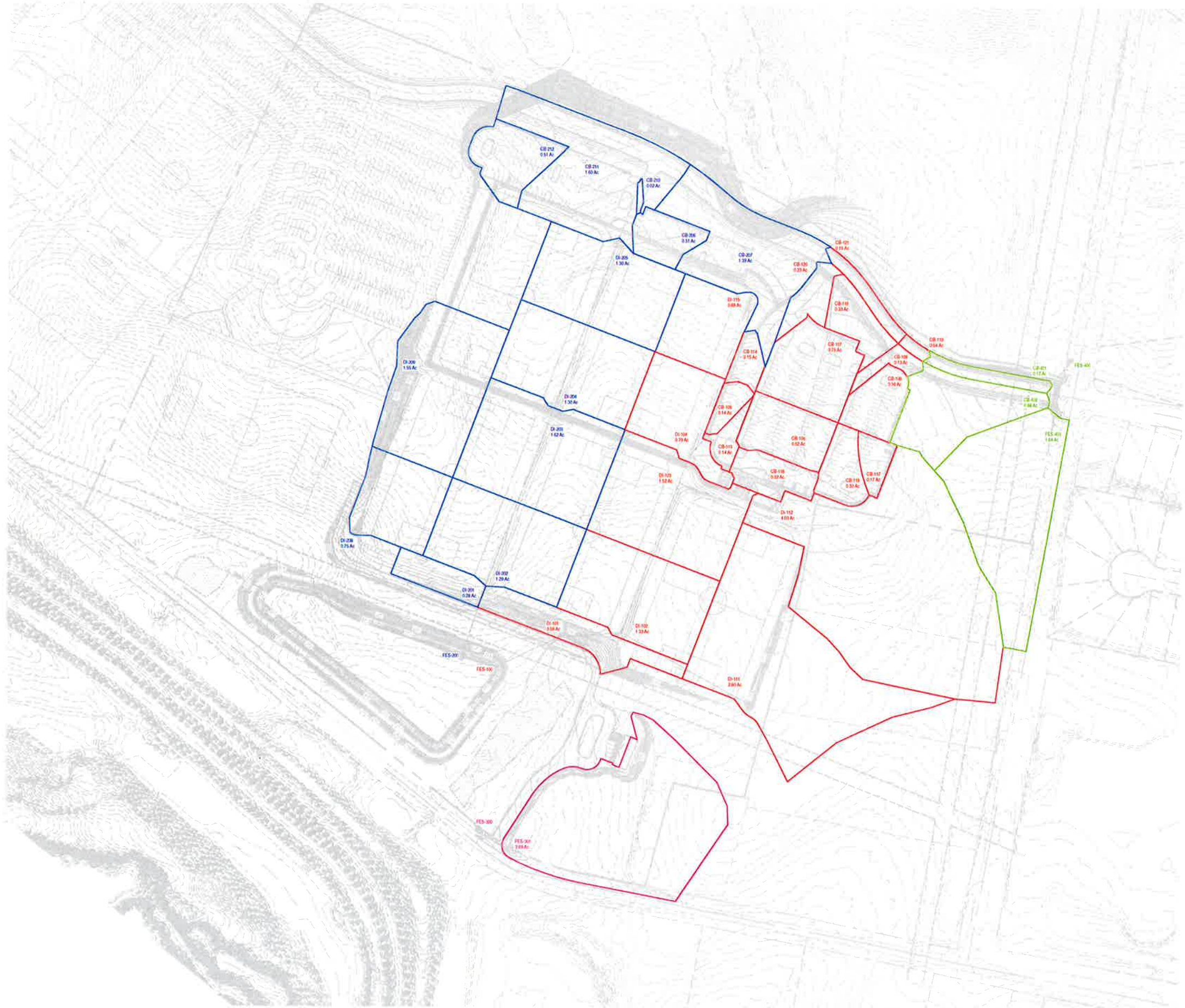
From Fig. 8.06.b.2:



D₅₀ = 8 in
 D_{MAX} = 12 in
 Riprap Class = B
 Apron Thickness = 18 in
 Apron Length = 12.0 ft
 Apron Width = 3xDia = 6 ft

Q₁₀ is half of flow. For multiple barrels, Zone and length calcs include 1.25 factor of correction.

K:\18\180675\180675 Project\180675 Knightdale Athletic Park\Storm Drainage Area Map.dwg, February 13, 2019 4:12:24 PM - WANDER THOMAS



KNIGHTDALE ATHLETIC PARK
PHASE 1

STORM DRAINAGE
AREA MAP

Job No.	02180875	Drawn By	W&R
Date	02/11/2019	Designed By	W&R

Revisions

Sheet No.
D-1