Cleveland Innerbelt Bridge
Tremont Roadway Package

DRAINAGE DESIGN REPORT

October 17, 2011
February 17, 2015

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REVISION HISTORY		
Revision	**Date**	**Comments**
--	May 11, 2011	Original report included with Interim Tremont Roadway Submittal to HDR.
1	June 15, 2011	Interim Tremont Roadway Compliance Set Submittal to HDR.
2	September 9, 2011	Final Tremont Roadway Submittal to HDR.
3	October 17, 2011	Final Tremont Roadway Submittal to ODOT.
4	February 17, 2015	CDSS calculations updated to reflect As-Built conditions. Non-Performed work has been hatched on drainage calculations and the drainage area maps. ODOT requested CDSS calculations be updated to reflect As-Built conditions.

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NON-PERFORMED

Introduction

The purpose of this report is to describe and document the design criteria and procedures used to complete the final design of the drainage and stormwater management facilities for the Tremont portion of the Innerbelt Bridge Project. Anticipated maintenance requirements are provided for drainage and stormwater treatment facilities. Design criteria and calculations are provided in the Appendices to this report.

Project Area

The project area of the Innerbelt Bridge extends over a distance of approximately 1.7 miles, with about 1.0 mile on the east bank of the Cuyahoga River, and the remaining 0.7 miles on the west bank of the river. The area within the project limits, about 80 acres, lies entirely within the City of Cleveland's combined sewer area. More specifically, the project area lies within five different combined sewersheds (CSO-80, CSO-81, CSO-90, CSO-94, CSO-95 and CSO-235). The northernmost portion of the project area, on the east bank of the Cuyahoga River, drains to Combined Sewer Overflows (CSO's) 94 and 95, which discharge to Lake Erie. The remainder of the project area on the east bank of the river and the entire project area on the west bank of the river, drain to CSO's 80, 81, 90 and 235, which discharge to the Cuyahoga River.

Roadway construction documents for the Innerbelt Bridge Project were prepared in three parts: the E. 9th Street Construction Package, which covered the new streets proposed for the Commercial region of the east bank project area; the Gateway Construction Package, which covered the mainline portion of the east bank project area; and the Tremont Construction Package, which covered the entire west bank project area. The Tremont portion of the project area consists of five drainage areas, or "outfalls", of stormwater runoff from the project area – Starkweather, Kenilworth, Fairfield, West Bank, and W. 13th Place.

Drainage and Stormwater Management Requirements

Both stormwater quantity and quality control requirements were established for the Innerbelt Bridge Project. Regarding stormwater quantity control, areas within the project limits could remain connected to the combined sewer system. However, peak flows and runoff volumes to the combined sewer system from major outfalls were limited according to requirements of ODOT and the Northeast Ohio Regional Sewer District (NEORSD).

For this project, ODOT required that the post-construction 5-, 10- and 25-year peak flow rates at any point in the existing combined sewer system be limited to pre-construction rates. The sewer district required that there be no increase in stormwater runoff volume discharged to any individual combined sewer overflow (CSO) area during their control storm event. To control stormwater quality for the project, post-construction Best Management Practices (BMPs) were required for all proposed storm-only sewer systems to which the project drains. It was also required that installation of new storm-only drainage systems be implemented to the greatest extent possible.

In general, the design criteria contained in Volume 2 of the ODOT L&D Manual were used for the drainage and stormwater management facilities. City of Cleveland standards were used to design the storm sewers for the local streets in the Tremont area and Commercial region. ODOT Form LD-35, which contains specific drainage design criteria, was completed for the Innerbelt Bridge Project and is included in this report as Appendix A. Specific spread requirements for roads in the Tremont area are shown in Table 1.

Drainage facilities for the mainline and ramps and the extended dry detention basin constructed under the Tremont Roadway Construction Package will be owned and maintained by ODOT. The remaining drainage facilities on local streets will be owned and maintained by the City of Cleveland after construction.

Drainage areas proposed to be connected to the existing NEORSD combined sewers are conveyed to either CSO-80 and/or CSO-81. These drainage areas are tributary to the overall drainage areas conveyed to CSO-80 and CSO-81 and each CSO's global drainage area are not presented herein.

Table 1

Spread Requirements for Roads in the Tremont Area

Road Name	No. of Lanes	Lane Width (feet)	Shoulder Width (feet)	Allowable Spread on Traveled Lane (feet)	Total Allowable Spread (feet)	Design Storm	ADT
I-90 Mainline/Ultimate Mainline/Bi-direct. Ramp A6 Ramp A7	 4 6-7 1 2	 12 11 18 12	 6.5/12 6.0/6.5 6 12	 0 3.33 0 0	 6.5/12 9.33/9.83 6 12	 10-year 2-year 10-year 10-year	 71,000 71,000 -- --
W. 14th Street Extension	2	12	0/3	6	6/9	2-year	3,600
Fairfield Avenue	2	12	2/3	6	8/9	2-year	1,500
Abbey Avenue	2	12	4	6	10	2-year	1,200
W. 13th Place	2	11	0	6	6	2-year	8,700[1]

[1] Estimate made by comparing to similar nearby roadways and considering the traffic that feeds the roadway.

Starkweather Outfall

Pre- and post-construction drainage area boundaries for the Starkweather Outfalls are shown in Figures 1 and 2, respectively. As shown in Figure 1, there are two separate analysis points within the Starkweather Outfall. Starkweather Outfall East is a catch basin EX-89 which receives pavement runoff from I-90 and has a storm sewer from the south connecting a total of 1.10 acres. The catch basin is being moved to the south by 18ft due to the new approach slab for the I-90 EB bridge over Starkweather Ave. 0.03 acres is being removed, and pre-post calculations are shown in Table 2. The 0.03 acres being removed will be taken into account in the proposed Kenilworth calculations. The second analysis point; Starkweather West is an area from Ramp A7 that under existing conditions, drained through scuppers and onto Starkweather Ave. then traveled to a catch basin D-3623 that connected to the Starkweather Ave. storm sewer trunk line . The area after the scuppers traveled down to catch basin EX-95. To reduce the number of scuppers on the bridge, the scuppers will be removed for proposed conditions, and a proposed catch basin D-1015 will capture the bridge runoff. Since the catch basin is off the bridge, a slight area increase of 0.03 acres will be added to the Starkweather storm sewer trunk line. This will cause a slight increase in flow to the combined sewer which has been approved by the City in the BL-1 Buildable Unit. The area being added to Starkweather is being removed from the downstream catch basin EX-95 which is also tributary to the Starkweather system through the Scranton combined sewer. Therefore a small decrease in volume between the two outfalls will be created that is tributary to CSO-080 (Table 5).

There is no stormwater quality control BMP provided for the Starkweather Outfall because it discharges to the existing combined sewer system. Anticipated maintenance requirements for this proposed drainage system consist of routine inspection and cleaning of inlets and pipes.

Drainage calculations carried out for pre- and post-construction discharge rates, spread and pipe hydraulics for the Starkweather Outfall is provided in Appendix B. Existing storm sewer plans and profiles for this are of I-90 will also be included in Appendix B.

Kenilworth Outfall

Pre- and post-construction drainage area boundaries for the Kenilworth Outfall are shown in Figures 3 and 4, respectively. As shown in Figure 3, the Kenilworth Outfall under existing conditions drains 2.58 acres of I-90 pavement to the EX-84A CB storm sewer system on the east side, and 0.20 acres of pavement that sheet flows down to EX-82 CB on the west side. Both systems are picked up by the Kenilworth combined sewer and are tributary to CSO-080. During proposed conditions, the area that sheet flows off to EX-82 CB is reduced to 0.18 acres for proposed conditions. Pre-Post flow rate calculations were not calculated for this area being removed due to the small decrease, but the area-C value will be accounted for in the Table 5. Due to the bi-directional traffic routing in this region, the existing barrier separating eastbound and westbound traffic will be removed from EX-87 to BL-3. The proposed drainage system for this area consist of an additional inlet after BL-1, trench drain located in the gore section between Ramp A7 and the mainline, new crossing of I-90 connecting the new inlet and trench drain to the existing storm sewer in the median of I-90, existing barrier inlet to be capped, two new manholes to move the existing storm sewer out of the BL-3 approach slab, and a CB-8 to drain a new milled gutter sump area. This will be added to the east edge of existing eastbound lanes, and will channel runoff to the proposed basin and overflow to an existing catch basin EX-84A. This runoff will come from the westbound lanes through the portable concrete barrier left in place for the bi-directional condition. The proposed area to the storm sewer system is 2.54 acres having a reduction in flow to the Kenilworth combined sewer (see Table 2). The reduction in area comes from area that previously flowed to EX-85 which is now tributary to the Fairfield proposed system. The area from Starkweather inlet relocation is also taken into account for the Kenilworth proposed area.

Pre- and post-construction peak flow rates are shown in Table 2, and indicate no increase in CSO discharge as a result of the Project (Table 5).

There is no stormwater quality control BMP provided for the Kenilworth Outfall because it discharges to the existing combined sewer system. Anticipated maintenance requirements for this proposed drainage system consist of routine inspection and cleaning of inlets and pipes.

Drainage calculations carried out for pre- and post-construction discharge rates, spread and pipe hydraulics for the Kenilworth Outfall is provided in Appendix C. Existing storm sewer plans and profiles for this area of I-90 will also be included in Appendix B.

Fairfield Outfall

Pre- and post-construction drainage area boundaries for the Fairfield Outfalls are shown in Figures 5, 6, 7 & 8. There are three locations that were evaluated, the first was the drainage south of Fairfield Ave tributary to D-5408, second was an area north of Fairfield Ave including W. 15th Street that is to be abandoned, and the third is an area that is connected to the Walworth Run Interceptor at 14th & Fairfield Ave. All three systems are tributary to CSO-080.

South Fairfield:
The proposed D-5408 outfall, shown in Figure 7 drains 6.50 acres of the new I-90 westbound lanes and existing westbound lanes between Fairfield Avenue and Kenilworth Avenue. This also takes into account an existing building that is being removed along Fairfield Ave. Pre- and post-construction peak flow rates at this outfall location are shown in Table 2, and indicate no increase in discharge as a result of the Project. The overall area has increased, but will be offset by the other outfalls tributary to CSO-080 (Table 5).

There is no stormwater quality control BMP provided for the Fairfield Outfall because it discharges to the existing combined sewer system. Anticipated maintenance requirements for this proposed drainage system consist of:

1. Routine inspection and cleaning of inlets and pipes.
2. Routine inspection and mowing of the roadside swale, and removal of woody vegetation.

Drainage calculations carried out for pre- and post-construction discharge rates, spread and pipe hydraulics for the South Fairfield Outfall is provided in Appendix D. Existing storm sewer plans and profiles for this are of I-90 will also be included in Appendix B.

North Fairfield Outfall:

The existing drainage area of this outfall north of Fairfield is shown in Figure 8 and lies within CSO-80. Under proposed conditions much of the existing area is reconstructed and will drain to the Ramp A6 detention basin. Figure 8 & 11 shows the proposed drainage map of this outfall. The proposed peak discharge rates from the Fairfield Outfall D-5438 are shown in Table 2 and indicate a reduction of peak flows to CSO-80 (Table 5).

There is no stormwater quality control BMP provided for the Fairfield Outfall D-5438 because it discharges to the existing combined sewer system. Anticipated maintenance requirements for this proposed drainage system consist of routine inspection and cleaning of the inlets and storm sewers. Drainage calculations carried out for spread and pipe hydraulics for the North Fairfield Outfall are provided in Appendix E.

W. 14th & Fairfield Outfall:

The W. 14th Street and Fairfield Ave Outfall will drain a portion of W. 14th Street reconstruction. The proposed drainage system modifications consist only of moving the existing inlet at this location. The existing drainage area of this outfall, 1.43 acres, is shown in Figure 6, and lies within CSO-80 and connects to the new Walworth Run Interceptor (see Walworth Run Interceptor Relocation Plans – Appendix H). The proposed drainage area of this outfall, 0.94 acres, is shown in Figure 8, and lies within CSO-80. Drainage calculations carried out for spread and pipe hydraulics for the W. 14th Street and Fairfield Ave Outfall are provided in Appendix H. Drainage calculations carried out for peak flows for the W. 14th Street and Fairfield Ave Outfalls are provided in Table 2 and 5.

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There is no stormwater quality control BMP provided for the W. 14th Street and Fairfield Ave Outfall because it discharges to the existing combined sewer system. Anticipated maintenance requirements for this proposed drainage system consist of routine inspection and cleaning of the inlets and storm sewers.

West Bank Outfall

The existing drainage boundary for the West Bank Outfall consists of three separate analysis points. These include University Road, NS Railroad Offsite, and West Bank Outfall WR-25. University Road outfall is sent to CSO-80 via WR27 through the existing University Road combined sewer. The NS Railroad Offsite area is tributary to the rail road right-of-way, but is not connect directly to a combined sewer. The existing West Bank Outfall is tributary to CSO-80 and CSO-081 via flow divider WR-25 located near W 14th and Abbey Rd intersection. At flow divider WR-25, flow is either routed to regulator WR- 27A or diverted to regulator WR-27. Overflow from WR-27A goes to CSO-081. Overflow from WR-27 goes to CSO-080. Table 4 provides an estimate of the flow split between CSO 080 and CSO 081. The flow divider typically sends lower flows towards WR-27, and higher flows towards WR-27A. Figures 9-12 shows drainage boundaries for each of the aforementioned outfalls. Table 2 provides the existing flows and estimated flow split for this outfall for 5, 10, and 25 year events.

Since a separate storm sewer system will drain the West Bank Outfall, stormwater BMPs must be provided to treat runoff prior to discharge to the Cuyahoga River. An extended dry detention basin will be constructed within Ramp A6 to treat runoff from 12.2 acres in the vicinity of Ramp A6. 1.2 acres of the new Innerbelt Bridge will be treated by a Type 1 Unistorm manufactured device on the West Bank slope. Figure 12 shows the proposed West Bank Outfall drainage areas. No proposed maps of the University Road or Rail Road/Offsite area are provided under proposed conditions because the University Road outfall sheet flows down the west bank into the River and the NS Railroad-Offsite outfall flows to the detention basin at Ramp A6. Table 2 provides the proposed flows and estimated WR-25 flow split reduction for this outfall.

A driveway is proposed that lies within the proposed west bank grading and is for NS Railroad which sheet flows on grass toward the Cuyahoga River with no concentrated flow routes. The sheet flow will be used for treatment and no erosion control will be needed.

Anticipated maintenance requirements for this proposed drainage system consist of:

1. Routine inspection and cleaning of inlets and pipes,
2. Routine inspection and mowing of roadside swales, and removal of woody vegetation.
3. Routine inspection and cleaning of the outlet control structure of the extended dry detention basin.
4. Routine inspection and cleaning of the Unistorm unit on the West Bank slope (instructions included in appendix and roadway plan set).

Drainage calculations carried out for spread and pipe hydraulics for the West Bank Outfall is provided in Appendix F. Drainage calculations carried out for peak flows for the West Bank Outfall are provided in Tables 2 and 5.

W 13th Place Outfall

The W. 13th Place Outfall will drain a portion of W. 13th Place at University Road which is to be reconstructed and widened. The proposed drainage system modifications consist only of moving the existing inlets at this location. The existing and proposed drainage areas of this outfall, 0.37 acres, are shown in Figures 10 and 12. This outfall lies within CSO-81.

The proposed peak discharge rates from the W. 13th Place Outfall are shown in Table 2, and indicate no increase of peak flows or volume increase to CSO-081 since the widening took place in an area that existing sidewalk was located.

There is no stormwater quality control BMP provided for the W. 13th Place Outfall because it discharges to the existing combined sewer system. Anticipated maintenance requirements for this proposed drainage system consist of routine inspection and cleaning of the inlet and lateral pipe. Drainage calculations carried out for peak discharge rates, spread and pipe hydraulics for the W. 13th Place Outfall is provided in Appendix G. Drainage calculations carried out for peak flows for the W. 13th Place Outfall are provided in Tables 2 and 5.

Table 2 - Peak Discharge Rates to the Combined Sewer System

Outfall	Existing Drainage Area (acres)	Proposed Drainage Area (acres)	Existing Coef. of Runoff, C	Prop. Coef. of Runoff, C	Inc. in C	Exist. Time of Conc. (min)	Prop. Time of Conc. (min)	Intensity, I, (in/hr)						Peak Flow, Q (cfs)						Receiving Pipe	
								Existing			Proposed			Existing			Proposed				
								5-yr	10-yr	25-yr	5-yr	10-yr	25-yr	5-yr	10-yr	25-yr	5-yr	10-yr	25-yr	Size	Cap.
Starkweather East	1.10	1.07	0.90	0.90	0	8.1	8.1	4.76	5.39	6.18	4.76	5.39	6.18	4.71	5.34	6.12	4.58	5.19	5.95	--	--
Starkweather West	0.20	0.23	0.90	0.90	0	4.1	3.9	5.74	6.56	7.50	5.79	6.62	7.56	1.03	1.18	1.35	1.20	1.37	1.56	12	3.2
Kenilworth EX-84A	2.58	2.54	0.90	0.90	0	8.0	7.9	4.78	5.42	6.21	4.81	5.45	6.24	11.10	12.59	14.42	11.00	12.46	14.26	--	--
South Fairfield 5408	6.16	6.50	0.71	0.79	.08	8.6	13.6	4.63	5.24	6.01	3.74	4.22	4.82	20.14	22.79	26.14	19.10	21.55	24.61	--	--
North Fairfield 5438	5.66	1.24	0.81	0.69	-.12	8.46	4.45	4.67	5.28	6.06	5.66	6.46	7.38	21.52	24.33	27.92	4.86	5.54	6.33	--	--
W. 13th Pl.	0.37	0.37	0.67	0.64	-.03	7.33	7.33	4.95	5.61	6.43	4.95	5.61	6.43	1.23	1.40	1.60	1.17	1.33	1.52	--	--
~~W. 14th and Fairfield~~	~~1.43~~	~~0.94~~	~~0.84~~	~~0.89~~	~~.05~~	~~4.89~~	~~4.89~~	~~5.55~~	~~6.33~~	~~7.24~~	~~5.55~~	~~6.33~~	~~7.24~~	~~6.67~~	~~7.62~~	~~8.70~~	~~4.66~~	NON-PERFORMED			
West Bank WR25[1,2]	6.34	12.23	0.70	0.69	-.01	4.12	15.90	5.74	6.56	7.49	3.42	3.87	4.42	25.47	29.11	33.24	5.11	6.32	15.97	--	--
University Road CS	3.37	--	0.81	--	--	3.07	--	5.99	6.87	7.84	--	--	--	16.30	18.69	21.33	--	--	--	--	--
NS RailRoad - Offsite	0.90	--	0.77	--	--	6.57	--	5.13	5.84	6.68	--	--	--	3.57	4.06	4.65	--	--	--	--	--

1.Using Table 4, flow split values for the 5, 10, and 25- year return intervals to CS0-81/80 are reduced , respectively, by 5.09/20.38, 5.24/23.87, and 5.32/27.92 cfs.
2. Proposed Conditions use PondPack flows for separated West Bank area to river.

Table 3 - Tremont Pre & Post Drainage Areas and Runoff Coefficients

HNTB	Made by: PNS Checked by: BH			Date: Date:	10/11/2011 10/11/2011			
Job Number: 49633								
Cleveland Innerbelt								
CN, Curve Number	79	98	77	74	94			
C, Rational Coefficient	0.7	0.9	0.5	0.3	0.85			
Terrain Description	Fair cond. ROW grass >=4:1	Pavement	Fair cond. ROW grass <4:1	Shallow Slope Grass	Industrial/ Commercial	Area	CN	C
Starkweather East Existing		1.10				1.10	98.00	0.90
Starkweather East Proposed		1.07				1.07	98.00	0.90
Starkweather West Existing		0.20				0.20	98.00	0.90
Starkweather West Proposed		0.23				0.23	98.00	0.90
Kenilworth - Existing EX-82		0.20				0.20	98.00	0.90
Kenilworth - Proposed EX-82		0.18				0.18	98.00	0.90
Kenilworth - Existing EX-84A		2.58				2.58	98.00	0.90
Kenilworth - Proposed EX-84A		2.54				2.54	98.00	0.90
Fairfield - Existing MH-5408	1.77	2.99		1.40		6.16	87.09	0.71
Fairfield - Proposed MH-5408	2.31	3.72		0.47		6.50	89.51	0.79
Fairfield - Existing D-5438	2.43	3.23				5.66	89.84	0.81
Fairfield - Proposed D-5438	1.11	0.07		0.06		1.24	79.83	0.69
W. 13th - Existing		0.23		0.14		0.37	88.92	0.67
W. 13th - Proposed		0.21		0.16		0.37	87.62	0.64
W. 14th & Fairfield Existing		1.29		0.14		1.43	95.67	0.84
W. 14th & Fairfield Proposed		0.93		0.01		0.94	97.74	0.89
Tremont West Bank - Existing WR-25	0.80	3.24	1.36	0.94		6.34	87.54	0.70
University Road CS Existing	1.56	1.81				3.37	89.20	0.81
NS Railroad Offsite Existing		0.71		0.19		0.90	92.93	0.77

Table 4 - Tremont Pre & Post TC Calculations

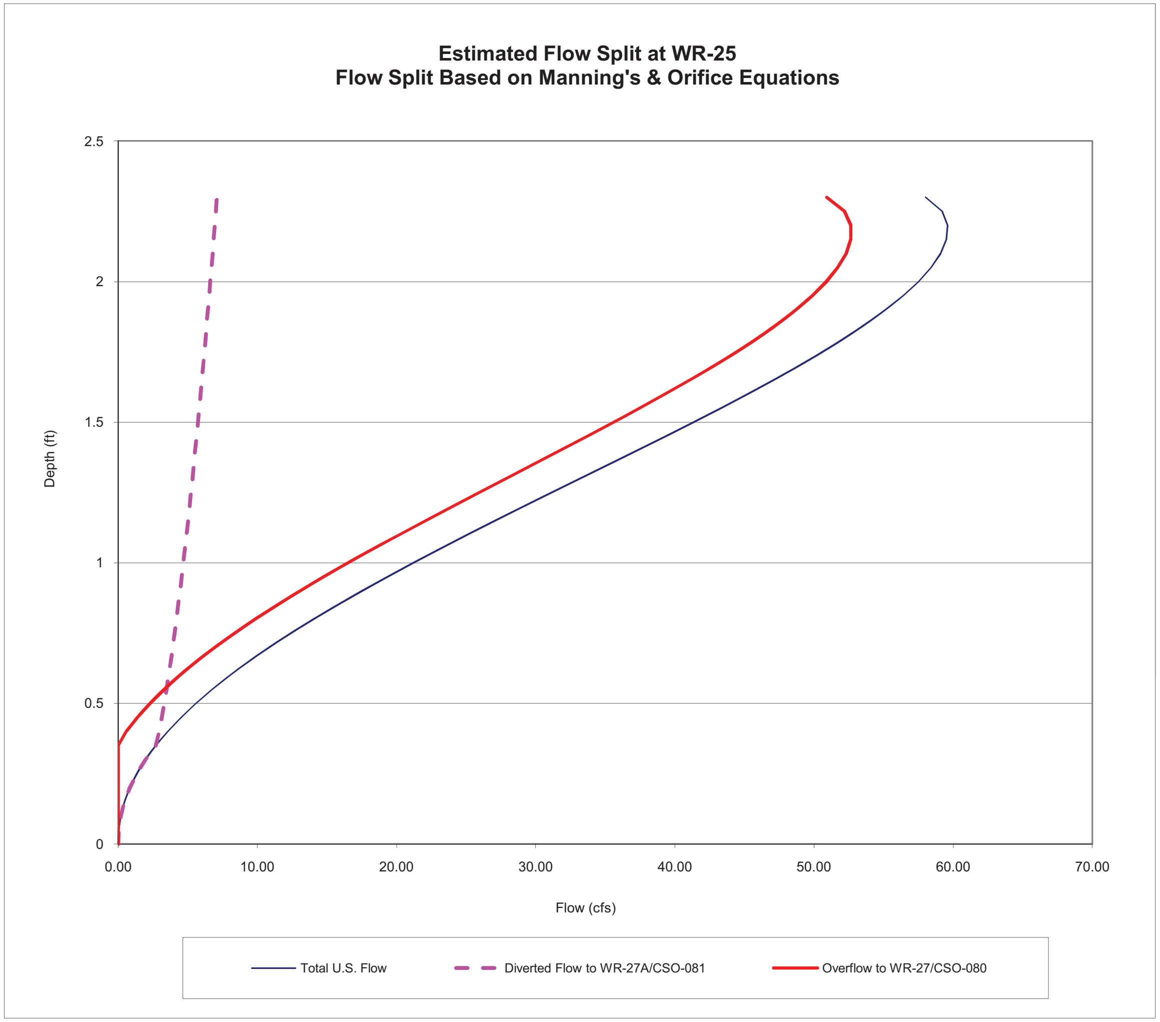
By: PNS 10/11/11 Checked: BH 10/11/	PROPOSED CONDITION	PROPOSED CONDITION	EXISTING CONDITOIN	PROPOSED CONDITION	EXISTING CONDITOIN	PROPOSED CONDITION	EXISTING CONDITOIN	PROPOSED CONDITION
Outfall Name	Starkweather East	Starkweather East	Starkweather West	Starkweather West	Kenilworth EX-84A	Kenilworth EX-84A	Fairfield MH-5408	Fairfield MH-5408
Sheetflow	Pavement	Pavement	Pavement	Pavement	Pavement	Pavement	Pavement	Grass
Runoff Coeffiecient	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.700
length, ft (<100)	38.000	38.000	49.000	49.000	42.000	42.000	70.000	10.000
dz, ft	0.300	0.300	0.710	0.710	1.250	1.250	2.100	0.300
slope	0.008	0.008	0.014	0.014	0.030	0.030	0.030	0.030
Tt, min	2.401	2.401	2.227	2.227	1.622	1.622	2.088	1.579
Sheetflow								
Runoff Coeffiecient								
length, ft (<100)								
dz, ft								
slope								
Tt, min								
Shallow Concentrated	PAVEMENT	PAVEMENT	PAVEMENT	PAVEMENT	PAVEMENT	PAVEMENT	PAVEMENT	
length, ft	330.000	330.000	198.000	240.000	400.000	249.000	400.000	
dz, ft	2.100	2.100	4.000	4.300	2.300	1.370	4.000	
slope	0.636	0.636	2.020	1.792	0.575	0.550	1.000	
Intercept Coefficient, k	0.619	0.619	0.619	0.619	0.619	0.619	0.619	
avg velocity, ft/s	1.620	1.620	2.887	2.718	1.540	1.506	2.031	
Tt, min	3.395	3.395	1.143	1.471	4.329	2.755	3.283	
Shallow Concentrated			PAVEMENT					
length, ft			57.000					
dz, ft			12.000					
slope			21.053					
Intercept Coefficient, k			0.619					`
avg velocity, ft/s			9.319					
Tt, min			0.102					
Channel flow			GUTTER					
side slope, X:1			0.010					
side slope, X:1			62.500					
bank full depth, ft			0.190					
dz, ft			1.000					
length, ft			83.000					
manning's, n			0.015					
cross-sectional area, ft^2			1.128					
wetted perimeter, ft			12.067					
hydraulic radius, ft			0.094					
slope			0.012					
velocity, ft/s			2.246					
Tt, min			0.616					
Pipe Flow				Proposed conduit	Existing conduit		Existing conduit	
Length				68.00	500.00		590.00	
Avg. Pipe Size				15.00	15.00		15.00	
Slope				0.345	0.007		0.010	
Velocity (Flowmaster or CDSS)				26.800	4.000		4.500	
Tt, min				0.042	2.083		2.185	
Pipe Flow				Proposed conduit			Existing conduit	
Length				65.00			480.00	
Avg. Pipe Size				15.00			15.00	
Slope				0.04			0.03	
Velocity (Flowmaster or CDSS)				5.820			7.500	
							1.067	
Tt, min	CDSS TC was used with subtracting time to inlet and using actual	CDSS TC was used with subtracting time to inlet and using actual		0.186		CDSS TC was used with subtracting time to inlet and using actual		CDSS TC was used with subtracting time to inlet and using actual
	Southwest SS - Stark	Southwest SS - Stark				Kenilworth Outfall SS		D-119 Storm Calc
CDSS TC, min	2.350	2.350				3.480		12.000
Total Tc, min	8.1	8.1	4.1	3.9	8.0	7.9	8.6	13.6
Area, acres	1.10	1.07	0.20	0.23	2.58	2.54	6.16	6.50
C weighted	0.90	0.90	0.90	0.90	0.90	0.90	0.71	0.79
Intesities, in/hr	NEORSD	NEORSD	NEORSD	NEORSD	NEORSD	NEORSD	NEORSD	NEORSD
I 5	4.76	4.76	5.74	5.79	4.78	4.81	4.63	3.74
I 10	5.39	5.39	6.56	6.62	5.42	5.45	5.24	4.22
I 25	6.18	6.18	7.50	7.56	6.21	6.24	6.01	4.82
Flows, cfs								
Q5	4.71	4.58	1.03	1.20	11.10	11.00	20.14	19.10
Q10	5.34	5.19	1.18	1.37	12.59	12.46	22.79	21.55
Q25	6.12	5.95	1.35	1.56	14.42	14.26	26.14	24.61

By: PNS 10/11/11 Checked: BH 10/11/	EXISTING CONDITOIN	PROPOSED CONDITOIN	EXISTING CONDITOIN	PROPOSED CONDITION	EXISTING CONDITOIN	PROPOSED CONDITOIN	EXISTING CONDITOIN	EXISTING CONDITOIN	EXISTING CONDITOIN
Outfall Name	Fairfield D-5438	Fairfield D-5438	W. 13th D-1190	W. 13th D-1190	W. 14th&Fairfield CB-5766	W. 14th&Fairfield MH-5766	West Bank WR-25	University Road CS	NS Railroad Offsite Area
Sheetflow	Pavement	Pavement	GRASS	GRASS	Pavement	Pavement	GRASS	Pavement	Pavement
Runoff Coeffiecient	0.900	0.900	0.300	0.300	0.900	0.900	0.700	0.900	0.900
length, ft (<100)	100.000	15.000	47.000	47.000	64.000	64.000	25.000	20.000	156.000
dz, ft	0.660	0.250	1.500	1.500	0.500	0.500	7.000	0.500	0.500
slope	0.007	0.017	0.032	0.032	0.008	0.008	0.280	0.025	0.003
Tt, min	4.135	1.176	6.705	6.705	3.127	3.127	1.186	1.186	6.570
Sheetflow		Grass							
Runoff Coeffiecient		0.700							
length, ft (<100)		20.000							
dz, ft		6.000							
slope		0.300							
Tt, min		1.036							
Shallow Concentrated	Pavement	swale							
length, ft	180.000	127.000							
dz, ft	0.830	35.000							
slope	0.461	27.559							
Intercept Coefficient, k	0.900	0.700							
avg velocity, ft/s	2.005	12.057							
Tt, min	1.496	0.176							
Shallow Concentrated									
length, ft									
dz, ft									
slope									
Intercept Coefficient, k									
avg velocity, ft/s									
Tt, min									
Channel flow			GUTTER	GUTTER	GUTTER	GUTTER	SWALE	GUTTER	
side slope, X:1			0.01	0.01	0.01	0.01	4.00	0.01	
side slope, X:1			62.50	62.50	62.50	62.50	4.00	62.50	
bank full depth, ft			0.50	0.50	0.50	0.50	1.00	0.50	
dz, ft			0.40	0.40	2.38	2.38	4.00	7.38	
length, ft			95.00	95.00	238.00	238.00	206.00	524.00	
manning's, n			0.015	0.02	0.015	0.015	0.024	0.015	
cross-sectional area, ft^2			7.81	7.81	7.81	7.81	4.00	7.81	
wetted perimeter, ft			31.75	31.75	31.75	31.75	8.25	31.75	
hydraulic radius, ft			0.25	0.25	0.25	0.25	0.49	0.25	
slope			0.004	0.00	0.010	0.010	0.02	0.014	
velocity, ft/s			2.53	2.53	3.90	3.90	5.34	4.63	
Tt, min			0.63	0.63	1.02	1.02	0.64	1.89	
Pipe Flow	EX CONDUIT				EX CONDUIT	EX CONDUIT	EX CONDUIT		
Length	1356.000				180.00	180.00	549.00		
Avg. Pipe Size	12"-30"				15.00	15.00	12.00		
Slope	0.008				15.000	15.000	0.010		
Velocity (Flowmaster or CDSS)	8.000				4.000	4.000	4.000		
Tt, min	2.825				0.750	0.750	2.288		
Pipe Flow									
Length									
Avg. Pipe Size									
Slope									
Velocity (Flowmaster or CDSS)									
Tt, min		CDSS TC was used with subtracting time to inlet and using actual							
		D-933/Wall C Ditch							
CDSS TC, min		2.060							
Total Tc, min	8.46	4.45	7.33	7.33	4.89	4.89	4.12	3.07	6.57
Area, acres	5.66	1.24	0.37	0.37	1.43	0.94	6.34	3.37	0.90
C weighted	0.81	0.69	0.67	0.64	0.84	0.89	0.70	0.81	0.77
Intesities, in/hr	NEORSD	NEORSD	NEORSD	NEORSD	NEORSD	NEORSD	NEORSD	NEORSD	NEORSD
I 5	4.67	5.66	4.95	4.95	5.55	5.55	5.74	5.99	5.13
I 10	5.28	6.46	5.61	5.61	6.33	6.33	6.56	6.87	5.84
I 25	6.06	7.38	6.43	6.43	7.24	7.24	7.49	7.84	6.68
Flows, cfs									
Q5	21.52	4.86	1.23	1.17	6.67	4.66	25.47	16.30	3.57
Q10	24.33	5.54	1.40	1.33	7.62	5.32	29.11	18.69	4.06
Q25	27.92	6.33	1.60	1.52	8.70	6.08	33.24	21.33	4.65

Table 5 - CSO-081/CSO-080 Split Flow Estimator (NEORSD, 2011)

Estimated Flow Split at WR-25

Calculated Flow Split (cfs)		
Total U.S.	To WR-27A/CSO-081 Orifice	To WR-27/CSO-080 Overflow
0.00	0.00	0.00
0.04	0.04	0.00
0.19	0.19	0.00
0.46	0.46	0.00
0.84	0.84	0.00
1.34	1.34	0.00
1.96	1.96	0.00
2.70	2.70	0.00
3.55	2.96	0.59
4.52	3.14	1.38
5.59	3.31	2.28
6.77	3.47	3.30
8.05	3.63	4.42
9.42	3.77	5.65
10.88	3.92	6.96
12.43	4.05	8.37
14.05	4.19	9.86
15.75	4.32	11.43
17.51	4.44	13.07
19.34	4.56	14.77
21.21	4.68	16.53
23.14	4.80	18.34
25.10	4.91	20.19
27.10	5.02	22.08
29.12	5.13	23.99
31.16	5.23	25.93
33.21	5.34	27.88
35.26	5.44	29.82
37.31	5.54	31.77
39.34	5.64	33.70
41.34	5.73	35.60
43.30	5.83	37.48
45.23	5.92	39.31
47.09	6.01	41.08
48.89	6.10	42.79
50.61	6.19	44.42
52.24	6.28	45.96
53.76	6.37	47.39
55.15	6.45	48.70
56.41	6.54	49.87
57.50	6.62	50.88
58.41	6.70	51.70
59.09	6.78	52.31
59.51	6.86	52.64
59.59	6.94	52.64
59.21	7.02	52.18
58.02	7.10	50.92

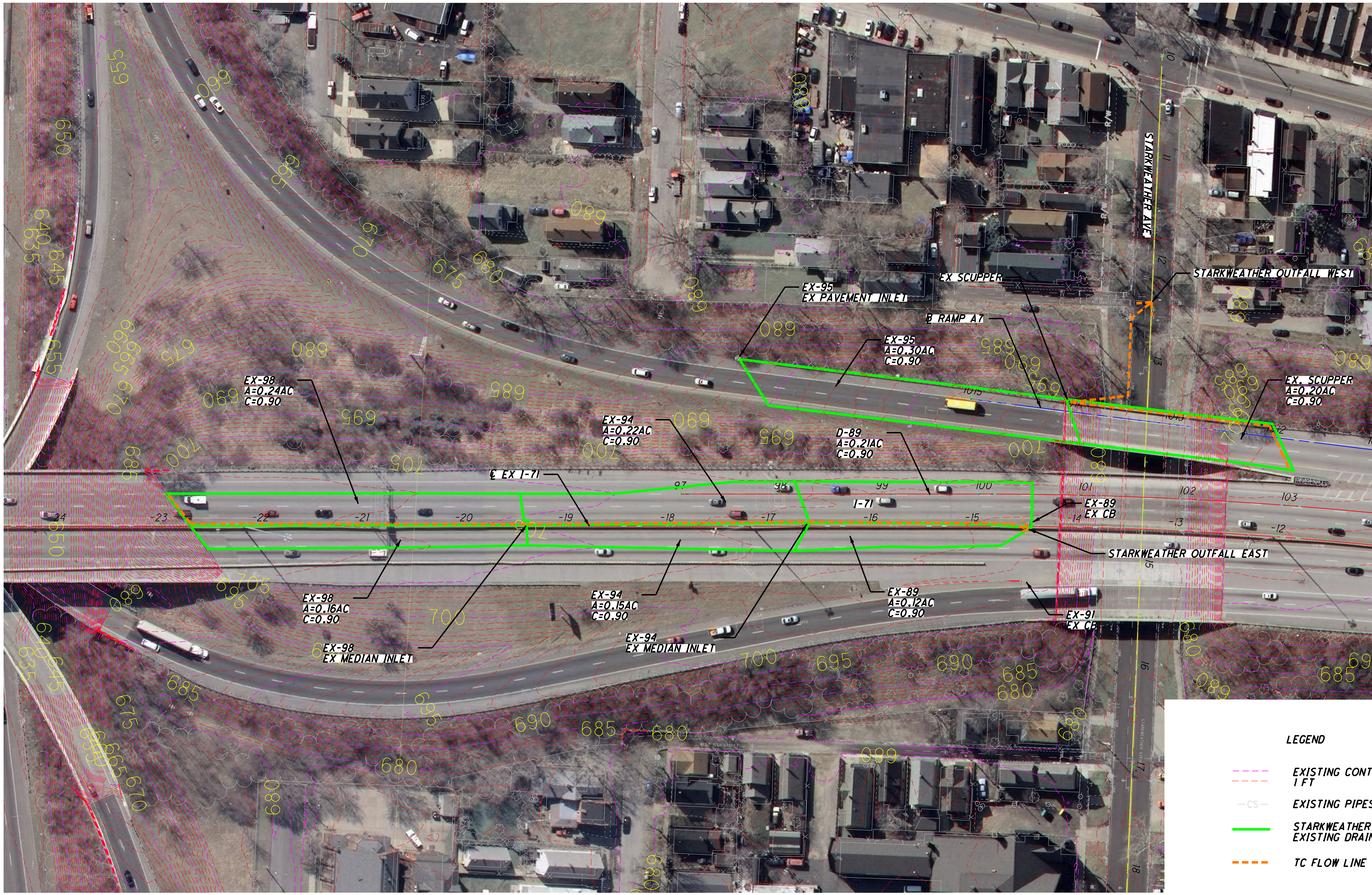


Pipe Size	No 2 Egg
Pipe Slope	4.54%
Orifice Opening	14" x 10" = 0.97 ft^2

Table 6 – Tributary Impacts on CSO Areas

Combined Sewer System ID	Project Drainage Area ID	Existing Drainage Area (A in acres)	Proposed Drainage Area (A in acres)	Existing Coefficient of Runoff (C)	Proposed Coefficient of Runoff (C)	Existing C x A	Proposed C x A	Percent Change in Runoff Volume
CSO-80	Starkweather Combined Sewer System	1.60	1.57	0.90	0.90	1.44	1.41	-1.88%
	Kenilworth Combined Sewer System	2.78	2.72	0.90	0.90	2.50	2.45	-2.08%
	Fairfield Combined Sewer System	11.82	7.74	0.76	0.77	8.96	5.99	-33.15%
	W. 14^{th} and Fairfield Combined Sewer System NON-PERFORMED	1.43	0.94	0.84	0.89	1.20	0.84	-5.62%
	West Bank Outfall[1] Combined Sewer System	5.33	--	0.70	--	3.73	--	-100%
	Total	**22.96**	**12.97**	**0.78**	**0.82**	**17.83**	**10.69**	**-40.04%**
CSO-81	W. 13^{th} Pl. Outfall[1] Combined Sewer System	0.37	0.37	0.67	0.64	0.25	0.24	-4.00%
	West Bank Outfall Combined Sewer System	1.01	--	0,70	--	0.71	--	-100%
	Total	**1.38**	**0.37**	**0.70**	**0.64**	**0.96**	**0.24**	**-75.00%**

1. Table 4- 25-year split flow ratio used to determine areas conveyed to CSO-80 and CSO-81 for West Bank Outfall.



LEGEND

EXISTING CONTOURS 1 FT

EXISTING PIPES

STARKWEATHER EXISTING DRAINAGE AREA

TC FLOW LINE

HORIZONTAL SCALE IN FEET 0 25 50 100

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DESIGN AGENCY

WALSH CONSTRUCTION

HNTB

CLEVELAND'S INNERBELT BRIDGE 90

OHIO DEPARTMENT OF TRANSPORTATION

FIGURE 1
EXISTING DRAINAGE AREA MAP
STARKWEATHER OUTFALL

CUY-90-14.90

DWG. NO. AM-001

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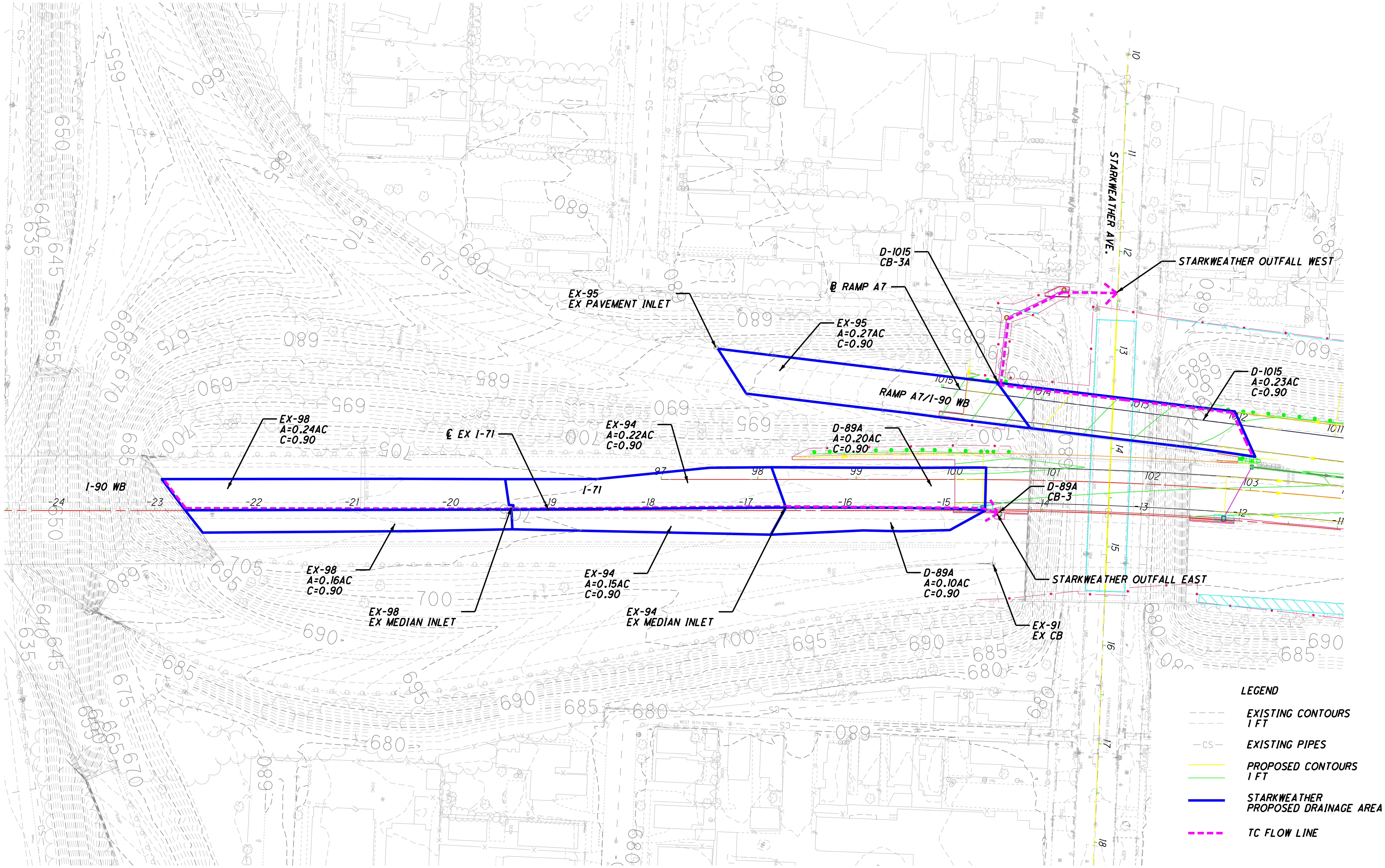

FIGURE 2
PROPOSED DRAINAGE AREA MAP
STARKWEATHER OUTFALL

CUY-90-14.90

DWG. NO. AM-002

2 / 12

DESIGNED PNS

CHECKED ELJ

HORIZONTAL SCALE IN FEET

0 25 50 100

DESIGN AGENCY WALSH HNTB

WALSH CONSTRUCTION

CLEVELAND'S INNERBELT BRIDGE

OHIO DEPARTMENT OF TRANSPORTATION

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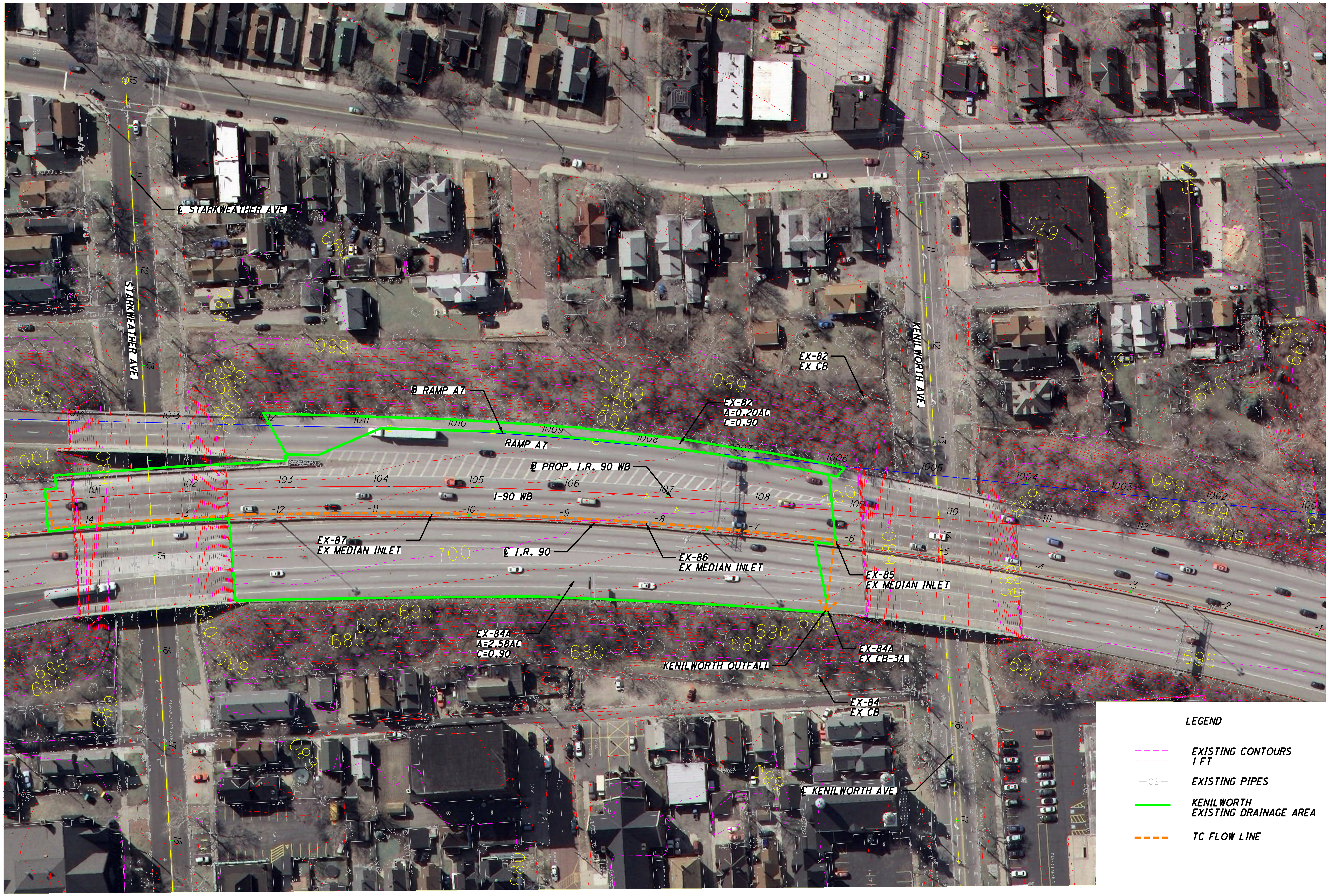

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WALSH CONSTRUCTION
HNTB

CLEVELAND'S INNERBELT BRIDGE
OHIO DEPARTMENT OF TRANSPORTATION

FIGURE 3
EXISTING DRAINAGE AREA MAP
KENILWORTH OUTFALL

HORIZONTAL SCALE IN FEET
0 25 50 100

CUY-90-14.90

DWG. NO. AM-003

DESIGNED PNS
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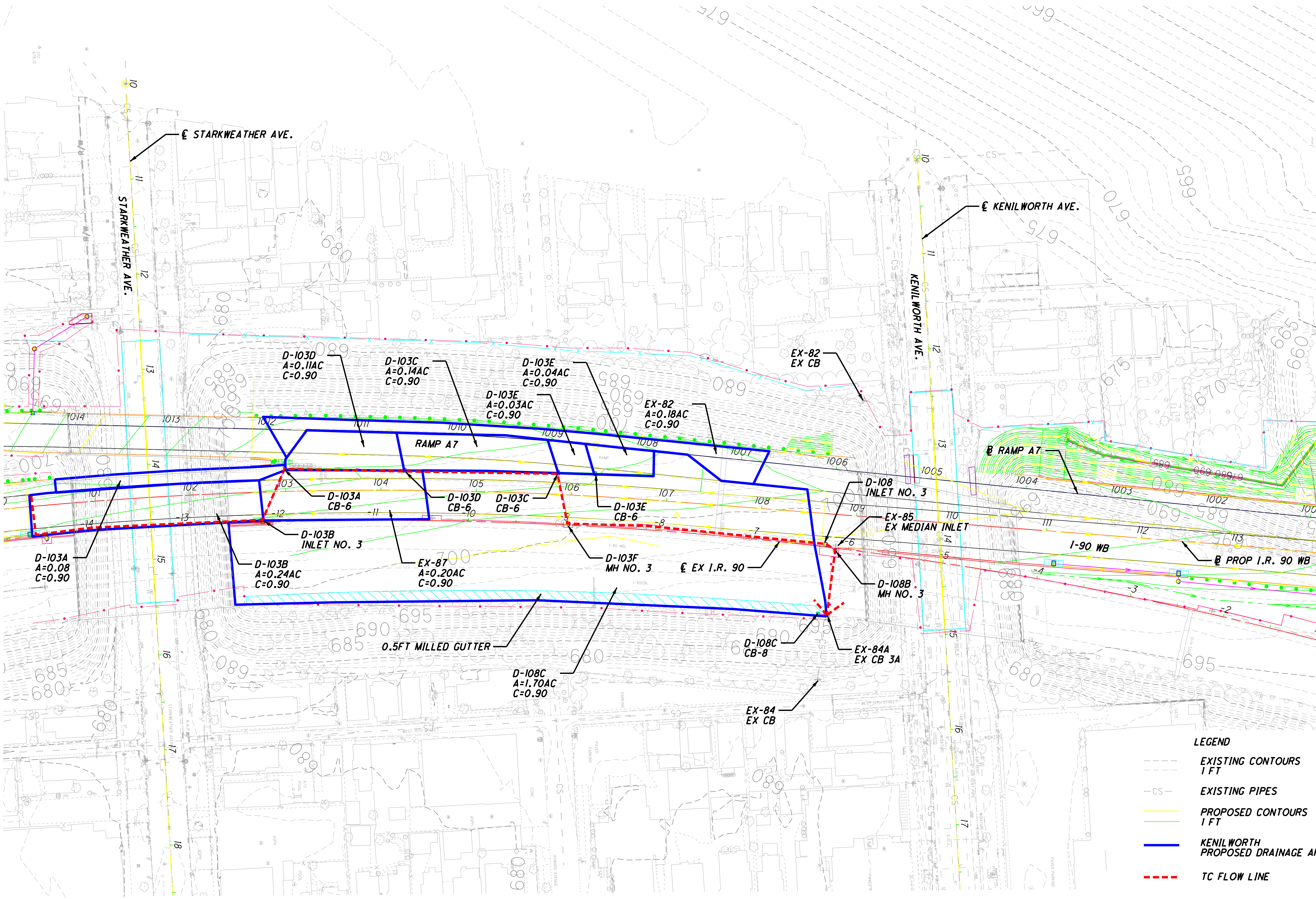

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HNTB
CLEVELAND'S INNERBELT BRIDGE
OHIO DEPARTMENT OF TRANSPORTATION

FIGURE 4
PROPOSED DRAINAGE AREA MAP
KENILWORTH OUTFALL

HORIZONTAL SCALE IN FEET
0 25 50 100

CUY-90-14.90

DWG. NO. AM-004

DESIGNED PNS
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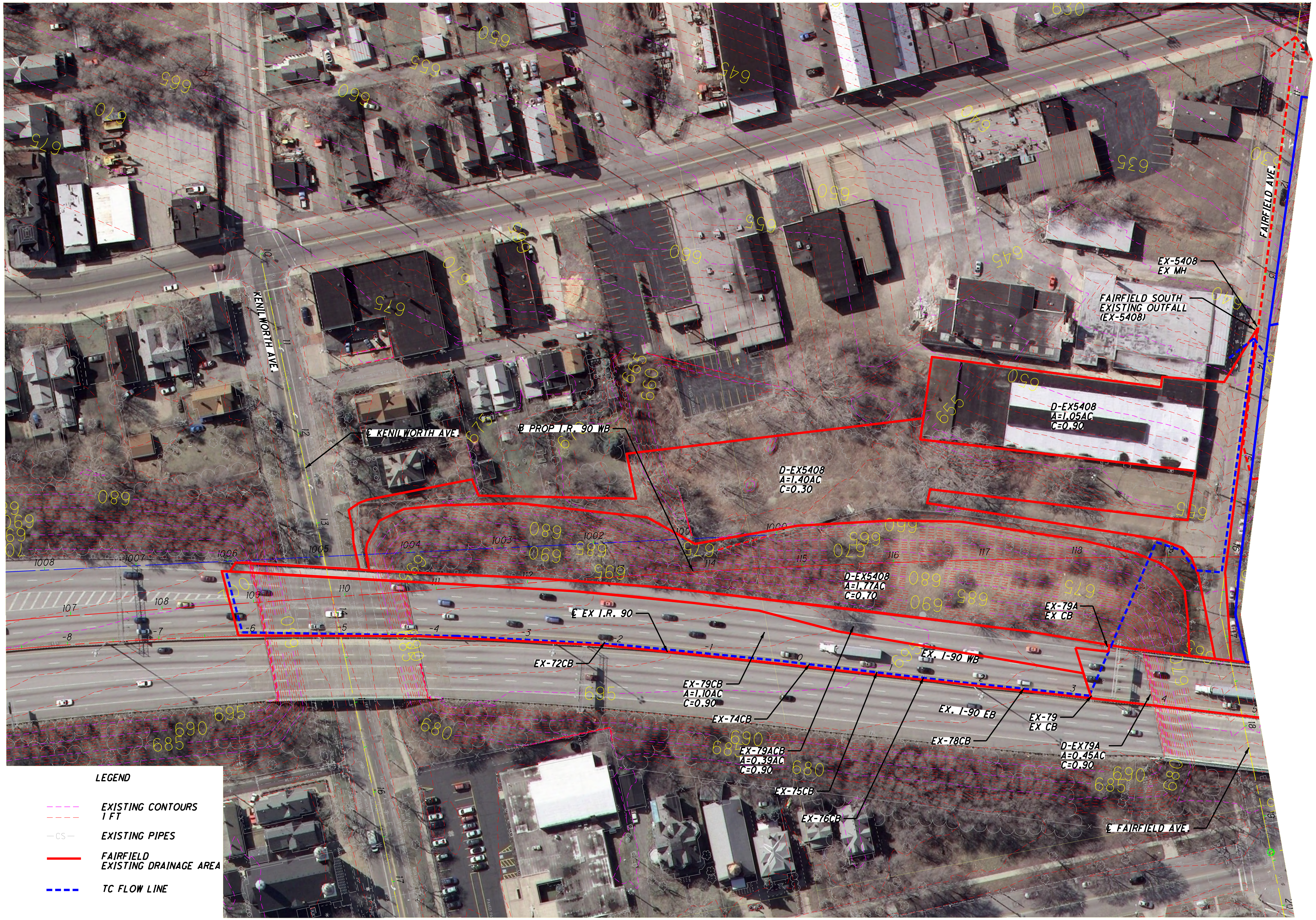

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WALSH CONSTRUCTION
HNTB

CLEVELAND'S INNERBELT BRIDGE
OHIO DEPARTMENT OF TRANSPORTATION

FIGURE 5
EXISTING DRAINAGE AREA MAP
FAIRFIELD OUTFALL

HORIZONTAL SCALE IN FEET
0 25 50 100

CUY-90-14.90

DWG. NO. AM-005

DESIGNED PNS
CHECKED ELJ

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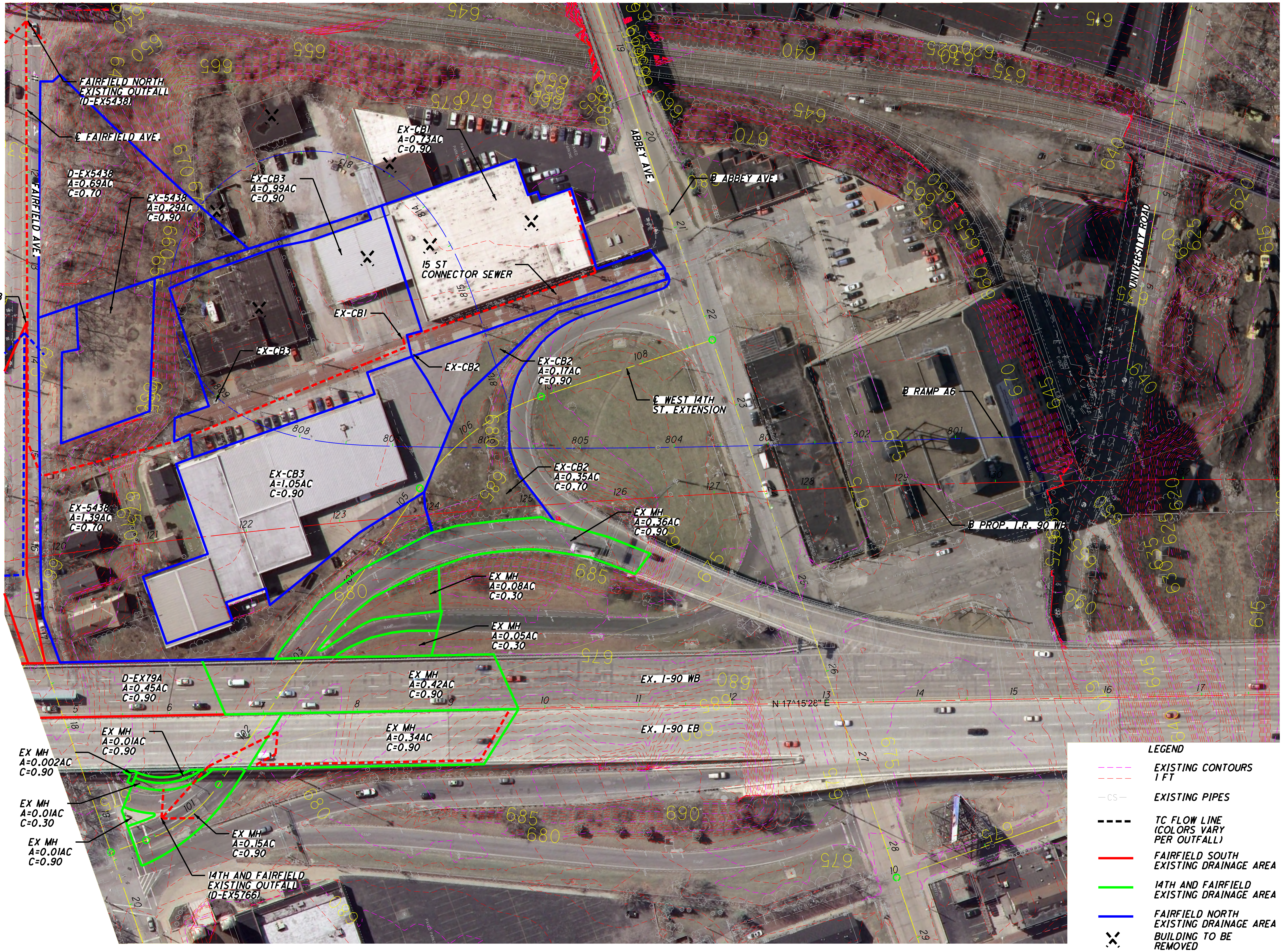

FIGURE 6
EXISTING DRAINAGE AREA MAP
FAIRFIELD OUTFALL

CUY-90-14.90

HORIZONTAL SCALE IN FEET
0 25 50 100

DESIGN AGENCY
WALSH
HNTB

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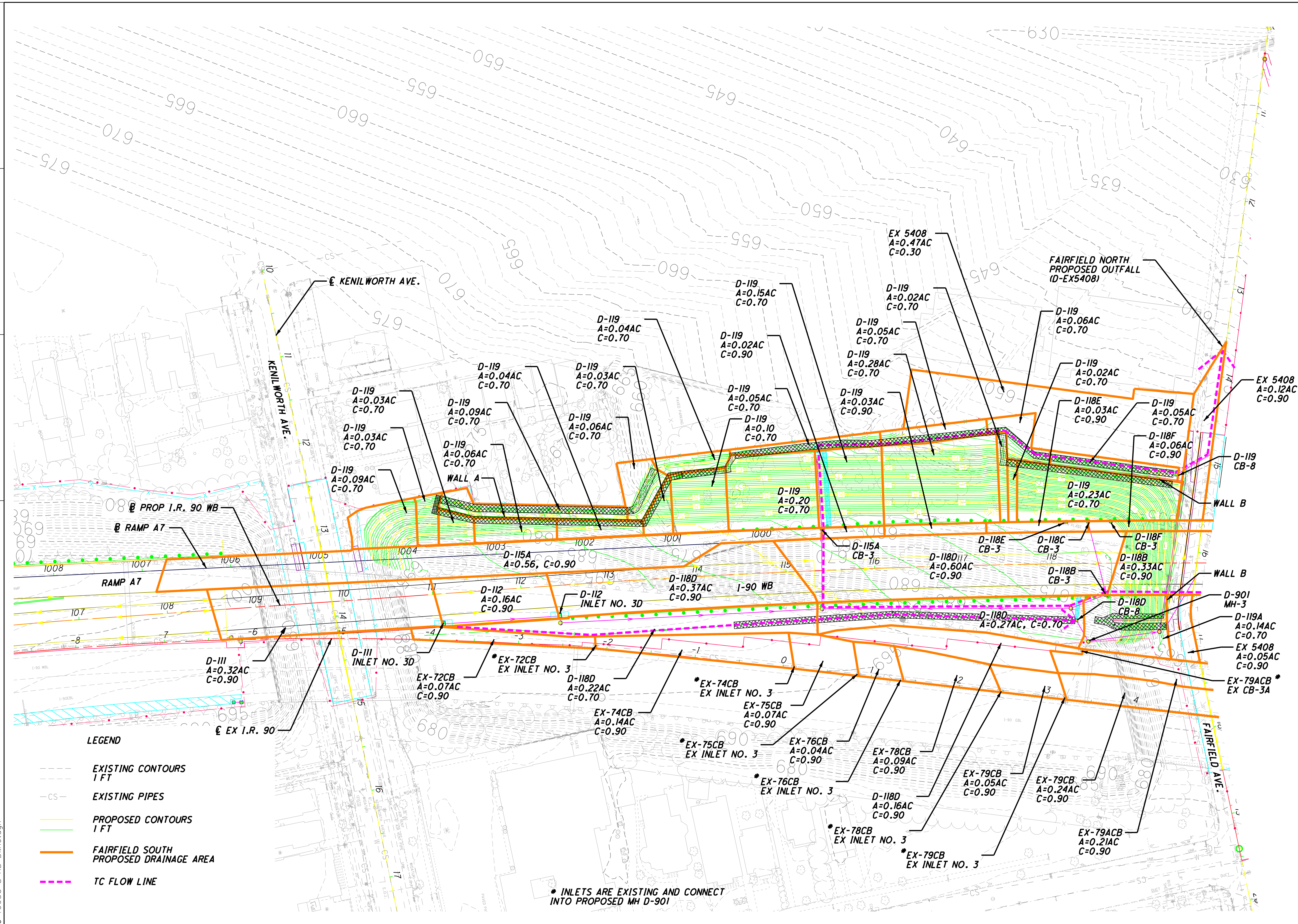

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CLEVELAND'S INNERBELT BRIDGE — OHIO DEPARTMENT OF TRANSPORTATION

FIGURE 7
PROPOSED DRAINAGE AREA MAP
FAIRFIELD OUTFALL

HORIZONTAL SCALE IN FEET: 0 25 50 100

CUY-90-14.90

DWG. NO. AM-007

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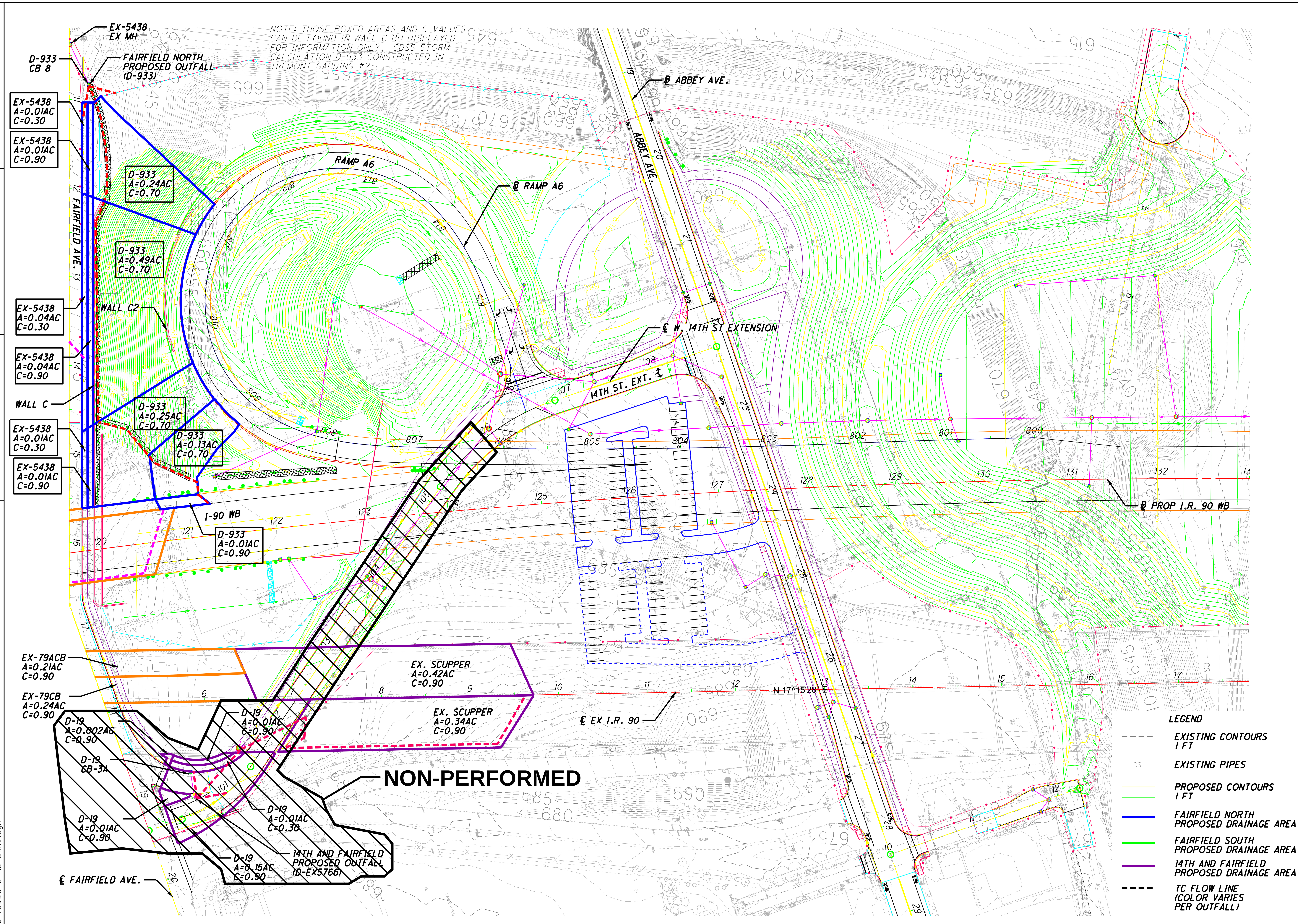

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HNTB

CLEVELAND'S INNERBELT BRIDGE 90
OHIO DEPARTMENT OF TRANSPORTATION

FIGURE 8
PROPOSED DRAINAGE AREA MAP
FAIRFIELD OUTFALL

CUY-90-14.90

DWG. NO. AM-008

DESIGNED PNS
CHECKED ELJ

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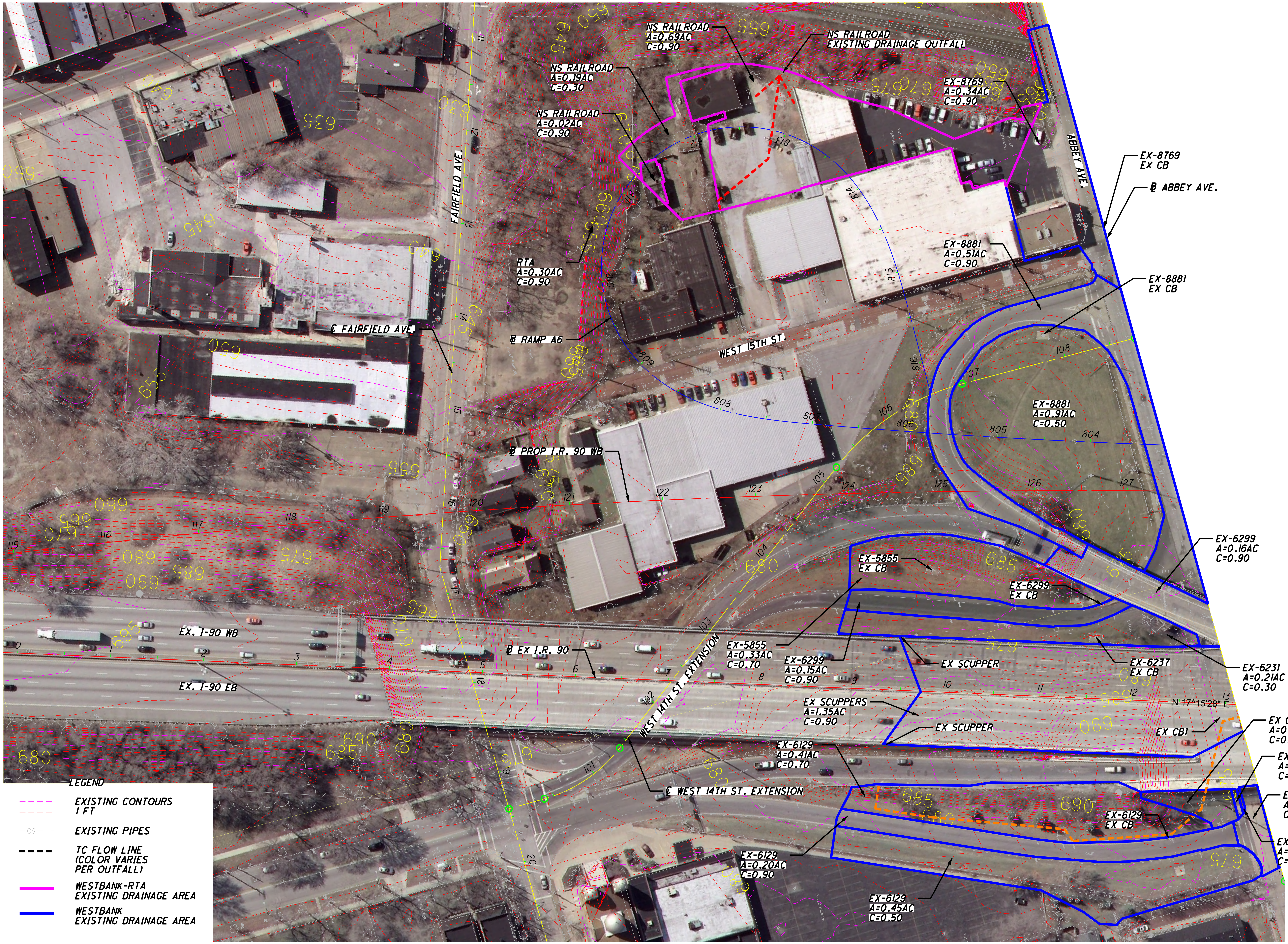

LEGEND

EXISTING CONTOURS 1 FT

EXISTING PIPES

TC FLOW LINE (COLOR VARIES PER OUTFALL)

WESTBANK-RTA EXISTING DRAINAGE AREA

WESTBANK EXISTING DRAINAGE AREA

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CLEVELAND'S INNERBELT BRIDGE
OHIO DEPARTMENT OF TRANSPORTATION

FIGURE 9
EXISTING DRAINAGE AREA MAP
WESTBANK OUTFALL

HORIZONTAL SCALE IN FEET
0 25 50 100

CUY-90-14.90

DWG. NO.
AM-009

DESIGNED PNS
CHECKED ELJ

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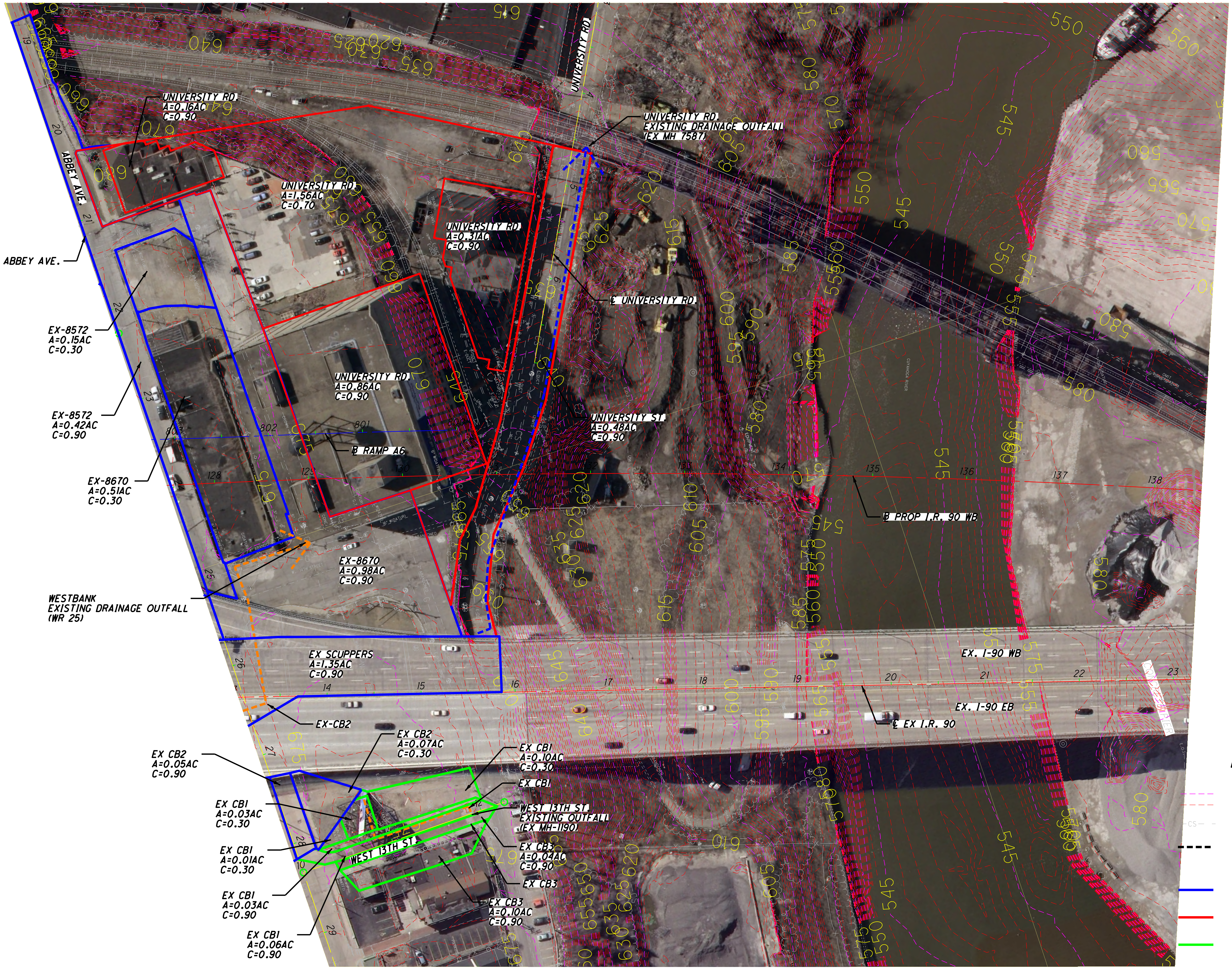

LEGEND

EXISTING CONTOURS 1 FT

EXISTING PIPES

TC FLOW LINE (COLORS VARY PER OUTFALL)

WEST BANK EXISTING DRAINAGE AREA

WEST BANK-UNIVERSITY EXISTING DRAINAGE AREA

WEST 13TH STREET EXISTING DRAINAGE AREA

FIGURE 10
EXISTING DRAINAGE AREA MAP
WESTBANK OUTFALL

CUY-90-14.90

HORIZONTAL SCALE IN FEET: 0 25 50 100

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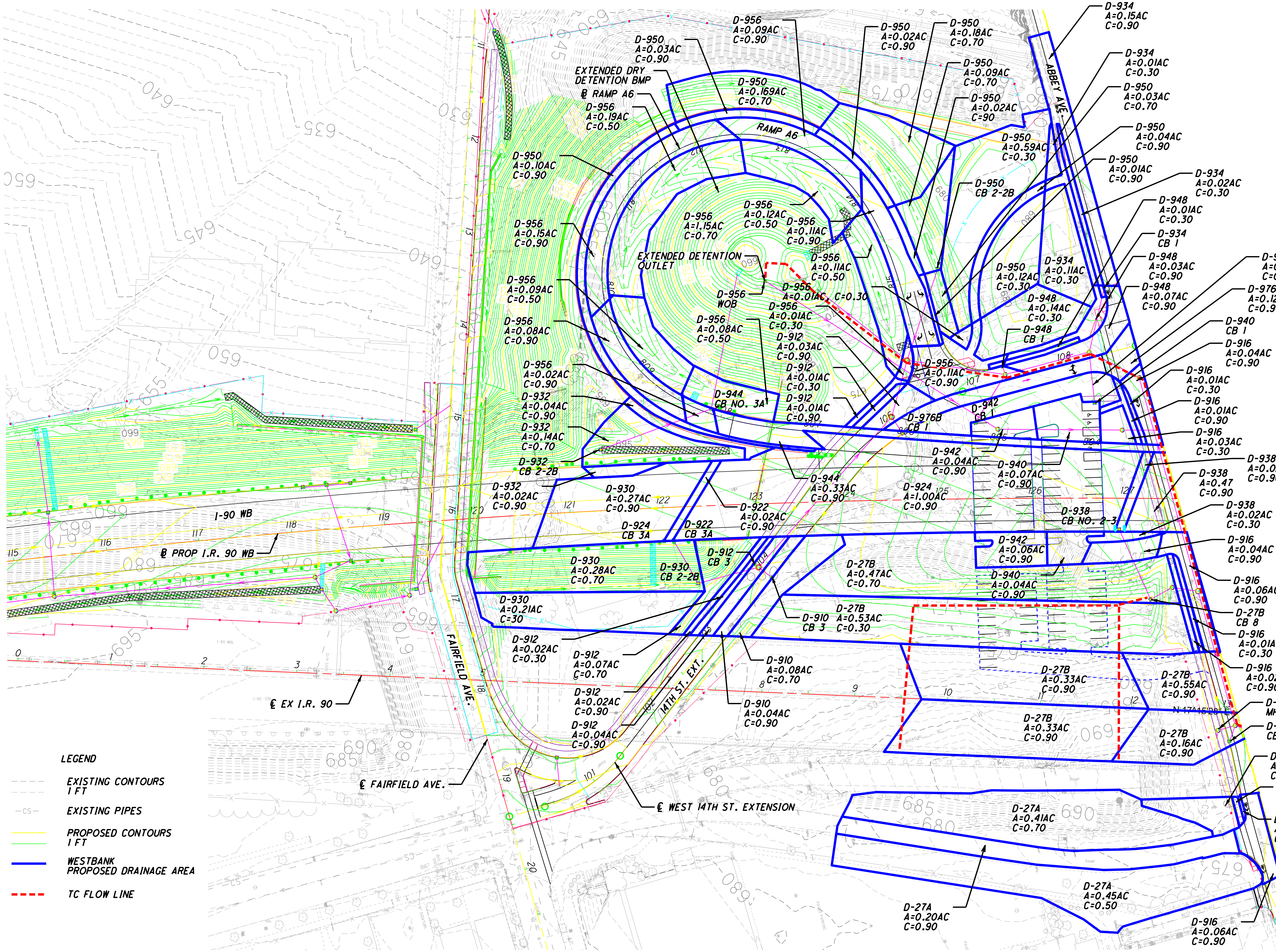

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CLEVELAND'S INNERBELT BRIDGE 90 OHIO DEPARTMENT OF TRANSPORTATION

FIGURE 11
PROPOSED DRAINAGE AREA MAP WESTBANK OUTFALL

0 25 50 100
HORIZONTAL SCALE IN FEET

CUY-90-14.90

DESIGNED PNS
CHECKED ELJ

DWG. NO. AM-011

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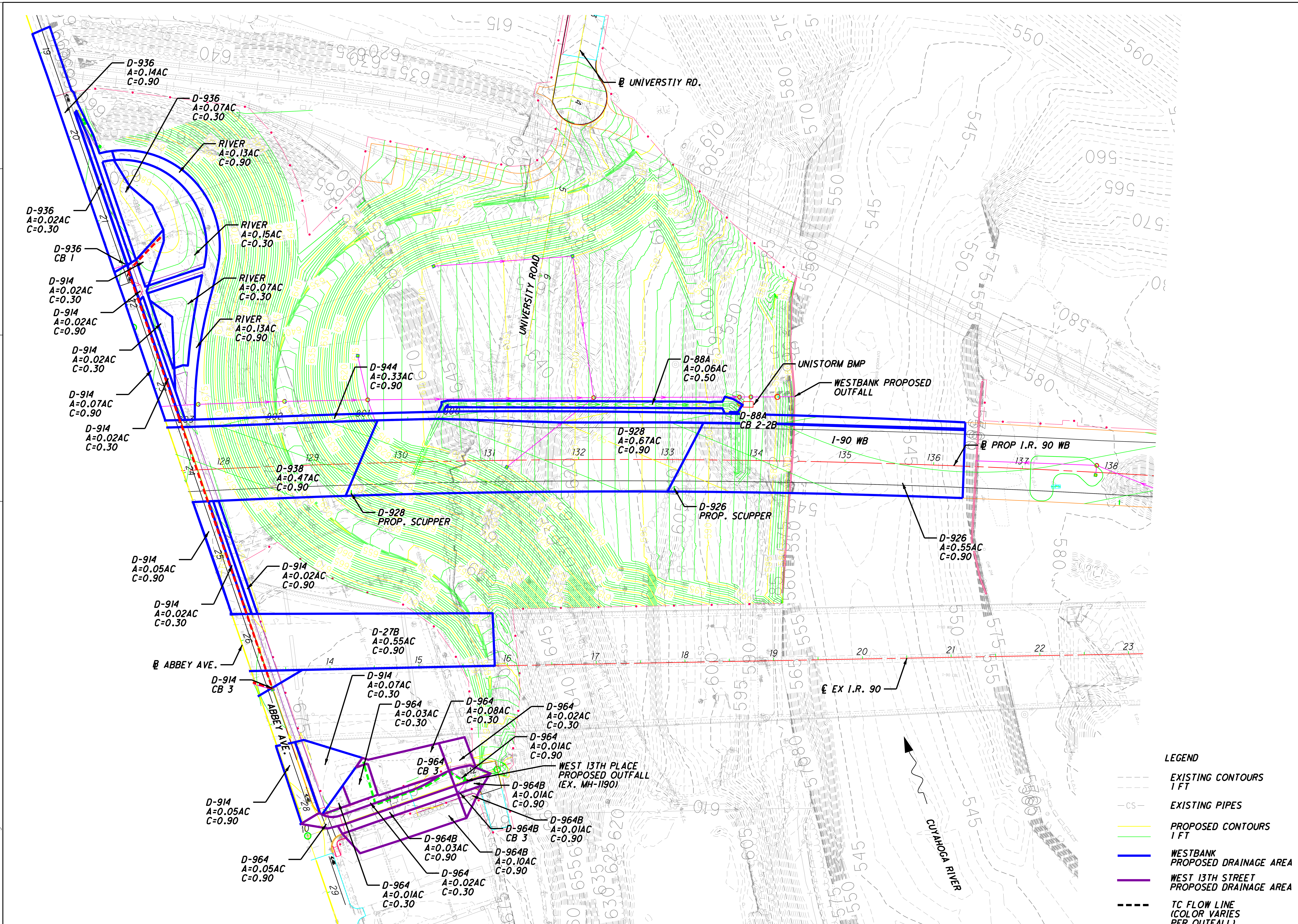

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CLEVELAND'S INNERBELT BRIDGE
OHIO DEPARTMENT OF TRANSPORTATION

FIGURE 12 PROPOSED DRAINAGE AREA MAP WESTBANK OUTFALL

CUY-90-14.90

DESIGNED PNS
CHECKED ELJ

DWG. NO. AM-012

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12

APPENDIX A

Form LD-35
Revised January 2006

GENERAL PROJECT INFORMATION

CUY	90	14.90
County	Route	Section

Attach Typical Section)

AFFECTED ROADWAYS:	Route	Average Daily Traffic	Rural / Urban
INTERSTATE OR OTHER L/A FACILITIES	I-90 Innerbelt Bridge	71,000	Urban Interstate
ARTERIALS AND COLLECTORS	Orange Ave	23,300	Urban Arterial
	Fairfield Ave	1,500	Urban Collector
	Abbey Ave	1,200	Urban Collector
	Canal Rd	--	Urban Collector
	Ontario St	33,200	Urban Arterial
	Carnegie Ave	24,000	Urban Arterial
	E. 9th St	32,300/3,600	Urban Arterial Under I-90, Future Urban Collector (extension)
	Broadway	12,400	Urban Arterial
	E. 14th St	19,100	Urban Arterial, Future Urban Collector (extension)
LOCALS	Starkweather Ave	2,000[1]	Urban Local
	Kenilworth Ave	2,000[1]	Urban Local
	Central Viaduct Way	1,000[1]	Urban Local
	Commercial Rd	1,000[1]	Urban Collector, Future Urban Local (realigned portion)
CLEAR ZONE	See L&D Manual, Vol. 1, Section 600.2		

[1] Estimate made by comparing to similar nearby roadways and considering the traffic that feeds the roadway.

All Units are English:

PIPE POLICY:

The Pipe Policy of <u>ODOT and the City of Cleveland</u> will be used for this project. (See Section 1002 for additional information)

If a policy other than ODOT's is being used, the following material types are permitted:

<u>For drainage conduit owned and maintained by the city of Cleveland:</u>

1. <u>Use Vitrified Clay Pipe (VCP), Extra Strength (ES), C-700, with premium joints, ODOT item 706.08 for all proposed main sewer pipe 18" and smaller.</u>

2. <u>Use Reinforced Concrete Pipe (RCP) with premium joints, ODOT Item 706.02 for all proposed main sewer pipe 21" and larger.</u>

3. Ductile Iron Pipe (DIP) may be used if approved by the WPC engineer.

(Please attach a copy of the written pipe policy. In lieu of a written policy, documentation of locally funded construction practices may be provided)
See Attachment A.

POST CONSTRUCTION BMP POLICY:

The Post Construction BMP Policy of ODOT will be used for this project.

If a policy other than ODOT's is being used, the following BMP's are permitted:

____

____

____

PROJECT SPECIFIC INFORMATION AFFECTING DRAINAGE:

See Attachment B - Project Scope, Central Viaduct, CUY-90-14.90, Innerbelt Bridge, Section 13, Drainage

Section A. Roadway Culverts (Type A Conduits)

1. DESIGN STORM FREQUENCY (1004.2):

    a. Mainline 50- Year

    b. Crossroads 10- Year

2. BANKFULL DESIGN Yes No (Circle yes if at least one culvert has bankfull design) *attach a list of culverts with bankfull designs* Culvert across driveway entrance on south side of proposed E. 9th Street extension.

3. FLOOD PLAIN CULVERT(S) NEEDED? Yes No (Circle yes if at least one culvert has flood plain culverts) *attach a list of culverts with flood plain culverts*

4. DURABILITY SERVICE LIFE ______50_______ Year *attach a list of culverts with their durability service life if multiple culverts have different frequencies.*

5. ABRASIVE SITE? Yes No (Circle yes if at least one culvert has an abrasive site) *attach a list of culverts with their abrasive site assumptions if multiple culverts are different*

6. MAXIMUM ALLOWABLE HEADWATER FOR DESIGN STORM (1006.2):

    a. 2 feet below the near, low edge of the pavement for drainage areas 1000 acres or greater and 1 foot below for culverts draining less than 1000 acres.

    b. 2 feet above the inlet crown of the culvert or above a tailwater elevation that submerges the inlet crown in flat to rolling terrain.

    c. 4 feet above the inlet crown of a culvert in a deep ravine.

    d. 1 foot below the near edge of pavement for bicycle pathways.

7. METHOD USED TO ESTIMATE DESIGN DISCHARGE (Q) (1003):

    a. For rural streams, use USGS Water Resources Investigations Report 89-4126 "Techniques for Estimating Flood-Peak Discharges of Rural Unregulated Streams in Ohio".

b. For urban streams, use USGS Open File Report 93-135 “Estimation of Peak-Frequency Relations, Flood Hydrographs, and Volume–Duration–Frequency Relations of Ungaged Small Urban Streams in Ohio”.

8. SCALE OF TOPOGRAPHIC MAPPING USED TO DELINEATE DRAINAGE AREAS (1101.1):

a. >100 acres: 1” = 2000’

b. $\leq$ 100 acres: 1” = 50 to 800’

9. MANNING’S “n” USED FOR (1105.6.5):

a. Smooth pipe 0.012

b. Corrugated pipe:

2-$^{2}/_{3}$" x $^{1}/_{2}$":	Full flow	0.0225-0.0250
3" x 1":	Full flow	~~0.0260-0.0281~~
6" x 2":	Full flow	~~0.0300-0.0332~~

Section A. Roadway Culverts - Continued

10. ENTRANCE LOSS COEFFICIENT (k_e) (1105.6.6, table 1105-1):

a.	Corrugated pipe:	HW-4 Headwall 0.90	Full Headwall 0.25*
b.	Smooth Concrete pipe	HW-4 Headwall 0.20	Full Headwall 0.20
d.	Box Shape	Full Headwall ___________	*with beveled entrance

11. MINIMUM COVER (top of pipe to subgrade) FOR (1008):

a. Rigid pipe 9”

b. Flexible pipe 12”

12. MAXIMUM COVER FOR (1008):

a. Rigid pipe See Figures 1008-10 to 1008-14, L&D Vol.2

b. Flexible pipe Thermoplastic - 20’; Corrugated Steel – See Figures 1008-1 - 1008-9 and 1008-15 – 1008-21

13. MAXIMUM ALLOWABLE CULVERT OUTLET VELOCITY (1002.2.2) :

a. Bare earth channel 5 fps

b. Rock channel protection 20 fps

c. Use energy dissipator for velocities in excess of 20 f.p.s.

14. HEADWALL TYPE (1106.2):

a. Half-Height Headwall – Std Dwg HW-2.1 and 2.2

b. Full-Height Headwall – Std Dwg HW-1.1

c. Concrete Apron – provide special detail drawing

15. CONTACT WILL BE MADE WITH COUNTY ENGINEER TO ESTABLISH:

a. Contact shall be made with the County Engineer at the beginning of the design process to ascertain ditch cleanout grades and watersheds, and the design shall be based on that information.

b. Form LD-33 (available in the L&D, Vol 2, Appendix) shall be used to document approval.

16. MINIMUM PIPE SIZE (1002.3.1, Figure 1002-1) :

a. Freeway or limited access facility 24”

b. Other highways 15”

Section B. Storm Sewers (Type B & C Conduits)

1. DESIGN FREQUENCY (Just Full) (1104.4.1) - 10-year, ODOT and City

2. HYDRAULIC GRADIENT SHALL NOT EXCEED (1104.4.2):

a. 12 inches below edge of pavement for 25- year frequency storm (ODOT only).

b. Pavement catch basin grate or lip of inlet for 25- year frequency storm (ODOT only).

c. A point in a depressed pavement sag that would result in an impassible highway for a 50- year frequency storm (ODOT only).

d. Other: Storm sewers for all highways shall satisfy a 50-yr check to preclude flooding of buildings or extensive flooding of private property. One-directional lane of a multiple-lane highway or one-half of a lane on a two-lane highway shall be passable when the sewer system is discharging the 50-year storm.

e. The above is based on:

i. A pipe roughness “n” = 0.015 for pipe sizes 60" and under and 0.013 for larger sizes.

ii. ____

3. METHOD USED TO ESTIMATE DESIGN DISCHARGE (Q) (1003):

a. Rational Method for pavement drainage, storm sewer and ditches.

i. Use ODOT rainfall data for design of pavement drainage and storm sewers.

ii. Use NEORSD rainfall data to compute discharge rates to the existing combined sewer system (Attachment C).

b. TR-55 for detention analysis.

i. Use ODOT rainfall data for detention facilities discharging to surface waters.

ii. Use NEORSD rainfall data for detention facilities discharging to the combined sewer system.

4. COEFFICIENT OF RUNOFF “C” FOR (1101.2.3):

a. Pavement and paved shoulders 0.9

b. Berms and slopes (4:1 and flatter) 0.5

c. Berms and slopes (steeper than 4:1) 0.7

d. Contributing areas:

Residential 0.3 – 0.5 (single family), 0.4-0.7(multi-family) Woods 0.3 Cultivated 0.3 – 0.6
Grassed Terrace (adjacent to sidewalks) 0.30

5. METHOD USED TO DETERMINE TIME TO FIRST CATCH BASIN OR PAVEMENT INLET (1101.2):

a. The summation of the time of overland flow, the time of shallow concentrated flow and the time of pipe or open channel flow.

6. MINIMUM TIME TO (1104.4.4):

a. Ditch catch basin 15 minutes

b. Pavement inlet or catch basin 10 minutes

c. When connecting to combined sewer, actual Tc calculated for pre/post flow analysis.

Section B. Storm Sewers (Type B & C Conduits) - Continued

7. MINIMUM COVER OVER SEWERS (1104.2.1): (see Attachment B)

a. Rigid pipe:

i. Type B conduit (under pavement or paved shoulder) 9” (top of pipe to subgrade). In no installation shall the distance from the top of pipe to pavement surface be <15”.

ii. Type C conduit (beyond pavement or paved shoulder) 18” (top of pipe to finish grade)

b. Flexible pipe:

i. Type B conduit (under pavement or paved shoulder) 12” (top of pipe to subgrade). In no installation shall the distance from the top of pipe to pavement surface be <24”.

ii. Type C conduit (beyond pavement or paved shoulder) 24” (top of pipe to finish grade)

c. City requirement: 3 feet for all main sewers

8. DESIRABLE MINIMUM VELOCITY FOR DESIGN FLOW 3 f.p.s (1104.2.1). City sewers 3 f.p.s.

9. MAXIMUM LENGTH BETWEEN MANHOLES OR SUITABLE CLEANOUT POINTS (1104.2.2) :

a. ODOT: Under 36"diameter – 300’ City: Under 42” diameter - 300’

b. ODOT: 36" - 60" diameter - 500’ City: 42” diameter and larger – 500’

c. ODOT: Over 60" diameter - 750-1000’

10. MINIMUM PIPE SIZE UNDER PAVEMENT (1104.4.6):

a. Freeway or limited access facility 15 inches

d. Other highways 12 inches

e. City storm sewer pipe: 12 inches

11. PROCEDURE TO FOLLOW WHEN EXISTING PRIVATE DRAINS ARE CUT BY PROPOSED

SEWERS OR DITCHES: Connect through the curb or into a drainage structure as per general note in construction plans.

Section C. Roadway Ditches

1. METHOD USED TO ESTIMATE DESIGN DISCHARGE (Q) (1003):

a. Rational Method

b.

2. DESIGN FREQUENCY TO DETERMINE (1102.3.1 or 1102.4):

ADT >2000:

a. Depth of flow determination 10- year

b. Shear Stress determination (for protection and width of protection) 5- year

ADT <2000:

c. Depth of flow determination 5- year

d. Shear Stress determination (for protection and width of protection) 2- year

3. METHOD USED TO DETERMINE TIME OF FLOW TO DITCH (1101.2):

The summation of the time of overland flow, the time of shallow concentrated flow and the time of pipe or open channel flow.

4. ALLOWABLE SHEAR STRESS FOR DITCH LINING (1102.3):

Permanent Ditch Protection:

a. Seed lining 0.40 psf.

b. Sod or other temporary ditch protection 1.0 psf.

c. Turf Reinforcing Mat (SS836), Type 1 2.00 psf.

d. Turf Reinforcing Mat (SS836), Type 2 3.00 psf.

e. Turf Reinforcing Mat (SS836), Type 3 5.00 psf.

f. RCP, Type B 6 psf.

g. RCP, Type C 4 psf.

h. RCP, Type D 2 psf.

Temporary Ditch Protection (Item 670):

a. Mat, Type A 1.25 psf.

b. Mat, Type B 1.50 psf.

c. Mat, Type C 2.00 psf.

d. Mat, Type E 2.25 psf.

e. Mat, Type F 0.45 psf.

Section C. Roadway Ditches - Continued

f. Mat, Type G 1.75 psf.

Tied Concrete Block Mat (Item 601)

a. Type 1 3 psf.

b. Type 2 5 psf.

c. Type3 7 psf.

5. MANNING'S "n" USED FOR (1102.3):

a. Seed lining 0.03

b. Sod, jute, or other temporary linings 0.04

c. Turf reinforcing mats 0.04

d. Tied Concrete Block Matting 0.03

e. Rock channel protection 0.06 for ditches, 0.04 for large channels

6. DITCH CONFIGURATION (1102.2):

a. Std roadside ditch radius for roadway, with 12- inch minimum depth

b. Trapezoidal for toe of embankment, with 12- inch minimum depth

6. TYPE OF DITCH CATCH BASIN (1102.3.4):

a. ODOT Std No.2-2A and B, No.2-3, No.2-4, No.2-5, No.2-6, No.4, No.5, No.8 and side ditch inlets

8. MINIMUM LONGITUDINAL SLOPE OF DITCHES IN CUT SECTIONS (1102.1):

a. 0.50% desirable minimum

b. 0.25% absolute minimum

9. METHOD USED TO LOCATE EXISTING FARM TILE CROSSED BY HIGHWAYS?

a. Contact the appropriate County Engineer's office for assistance in locating existing farm tile.

b. Through field observations.

Section C. Roadway Ditches – Continued

10. MINIMUM WIDTH OF DITCH LININGS (1102.3.1) :

    a. Sod 7.5 ft.

    b. Temporary linings 7.5 ft.

    c. Turf reinforcing mats 7.5 ft.

11. DESIGN FREQUENCY DEPTH SHALL NOT EXCEED (1102.3.1):

    a. An elevation 1 foot below edge of pavement for the design discharge.

    b. The depth of flow in toe of slope ditches shall be limited such that the design year discharge does not overtop the ditch bank.

Section D. Median Ditches NA

1. DITCH CONFIGURATIONS (1102.3):

    a. Depressed ____________________

    b. Type of barrier ____________________

2. WIDTH BETWEEN PAVEMENT EDGES _______________ ft.

3. ALLOWABLE SHEAR STRESS FOR DITCH LINING (1102.3):

    Permanent Ditch Protection:

    a. Seed lining __________ psf.

    i. Sod or other temporary ditch protection __________ psf.

    j. Turf Reinforcing Mat (SS836), Type 1 __________ psf.

    k. Turf Reinforcing Mat (SS836), Type 2 __________ psf.

    l. Turf Reinforcing Mat (SS836), Type 3 __________ psf.

    Temporary Ditch Protection (Item 670):

    d. Mat, Type A __________ psf.

    e. Mat, Type B __________ psf.

    f. Mat, Type C __________ psf.

    g. Mat, Type E __________ psf.

    h. Mat, Type F __________ psf.

    i. Mat, Type G __________ psf.

    Tied Concrete Block Mat (Item 601)

    a. Type 1 __________ psf.

b. Type 2 __________ psf.

c. Type 3 __________ psf.

4. METHOD USED TO ESTIMATE DESIGN DISCHARGE (Q) (1101.2):
   a.

   b.

5. CATCH BASIN SPACING WILL BE DETERMINED BY HYDRAULIC ANALYSIS USING (1102.3.4):

   a. __________ year frequency and “n” = __________ for velocity

   b. __________ year frequency and “n” = __________ for depth

   c. Controls:
      i. Design frequency depth shall not exceed:

         (1)

         (2)

   d. Catch basin spacing, depressed median, fill section:

	Median Width	84'	60'	40'
i.	Desirable maximum			
ii.	Absolute maximum			

5. TYPE OF MEDIAN CATCH BASIN OR INLET (1102.3.4):

   a.

7. MINIMUM LONGITUDINAL SLOPE OF DEPRESSED EARTH MEDIAN:

Section E. Drainage for Curbed Pavements

1. CONTROLS FOR THE DETERMINATION OF INLET OR CATCH BASIN SPACING (1103):

   a. Design storm frequency: <u>10- year ODOT, 5-year ADT Urban >9000, other 2-year</u>

   b. Check storm frequency: <u>50-</u> year for freeways, high volume highways and high volume City streets; <u>25-</u> year for other multi-lane highways and City streets (for underpasses or depressed roadways where the storm sewer is the only outlet)

   c. METHOD USED TO DETERMINE TIME TO FIRST CATCH BASIN OR PAVEMENT INLET:

      i. <u>The summation of the time of overland flow, the time of shallow concentrated flow and the time of pipe or open channel flow.</u>

      ii. <u>Absolute minimum time of concentration of 10 minutes</u>

   d. Maximum spread of flow into traveled lane (use ODOT L&D Manual Table 1103-1 and ADT):

      i. Freeways <u>0</u> ft

ii. 2-lane City Streets 6 ft

iii. 4-lane City Streets 8 ft

Outside lane width greater than 12 feet ____0_____ft. (freeways)

Total allowable spread on pavement shoulder width ft. (freeways, see Table 1103-1 for other highway types)

e. Maximum depth of flow at curb 1 in below top of curb for the design discharge, 5 in max. depth. 6- in max. along barrier wall ODOT.

f. Manning's "n" for:

i. Reinforced concrete pavement 0.015

ii. Asphaltic concrete pavement 0.015

iii. Paved shoulders 0.015

2. TYPE OF INLET OR CATCH BASIN PROPOSED FOR (1103):

a. Continuous grades ODOT Std 6' pavement inlet or CB No.3A. City CB-1 on city streets.

c. Sags ODOT Std CB No.3. For drives, Std No.6 with flanking No.3A catch basins - see 1103.7. City sags use a CB-3(single CB-1 adjacent a IB-1)

3. INLET LIP OF CURB OPENING INLET WILL BE DEPRESSED ____2.0____ INCHES BELOW NORMAL GUTTER.

a. A local depression of ____0.5____ inches will be used to determine spacing of combination grate and curb opening catch basins for a curb pavement section.

b. A local depression of ____0.0____ inches will be used to determine spacing of combination grate and curb opening catch basins for a combination curb and gutter section.

4. BRIDGE DECK DRAINAGE

a. The design frequency of bridge deck drainage in the Scope of Work (14.2.4) and the L&D was intended to be the 10-year event for the Interim and Future condition and a 2-year event for the Bi-Directional Condition. Due to the poor condition of the deck on several existing bridges, these bridge decks or bridge superstructures will be replaced now. When Innerbelt Contract CCG-3 is constructed these bridges will be completely replaced or will no longer be needed. In an attempt to reduce the number of scuppers on bridges in accordance with ODOT's L&D Section 1103.1, it was agreed to use the 2-year storm for the design frequency for the re-decked bridges. That requirement is to confine the 2-year design storm to the Interim Condition shoulder width, and limit the extent to which the 10-year storm spread exceeds the shoulder width.

Attachment A – City of Cleveland Standards

CITY OF CLEVELAND

DIVISION OF WATER POLLUTION CONTROL (WPC)

STANDARDS FOR PREPARATION OF PLANS FOR NEW SEWERS

A plan of existing and/or proposed sewers shall be submitted for all projects involving new sewer systems or substantial additions to existing sewer systems. When preparing the sewer plan, the following are to be taken into consideration:

General information

1. The sewer plans should be legible and clear, otherwise the plan review cannot proceed.
2. Use 24”x36” size
3. North arrow
4. Legend for utilities
5. Label the existing and/or proposed streets and indicate their status: public, private, dedicated, vacated, existing public or private sewer easement, etc.
6. Show the sewer or utility easement if it exists and provide copies of the easement records. Show the owner of the easement.
7. Show the location and width of all existing or proposed utility easements.
8. Label the right of way (in bold type), curb, underground utilities and property lines.
9. Show the addresses and names of the existing and/or proposed properties if available.
10. Show on the plan and profile views the location and type of all utility lines.
11. Show the elevation of the finished floor and/or basement floor on the property in relation to the existing and/or proposed sewer.
12. It is highly recommended to check the availability of sewer records for the plan and profile views and location of sewer connections during the design stage.
13. Include a list of all file numbers and sewer records that have been provided by WPC on the plans.
14. Plans should be prepared with 1:20 horizontal scale and 1:5 vertical (elevations) scale.
15. The sewer plans should show the plan view with its respective profile view on the same sheet. Also, cross section views are required for the proposed catch basins.

Sewer Bulkheads

If a sewer bulkhead is required, show the location on the plans. Indicate that a masonry bulkhead should be constructed, by the contractor, for all existing sewers to be cut and abandoned.

Sewer Abandoned

If sewer pipes are to be abandoned, show the location and size of the pipes. Indicate if the pipes will be sandfilled or grouted in place, or removed.

Main Sewer

The following are required when preparing plans for proposed main sewers located in the City right of way or public easement:

1. Show all existing and proposed underground utilities on both plan and profile views.

2. A minimum horizontal clearance of 8 ft is required between the main sewer and any underground utility line.

3. Show the actual width of the existing and proposed main sewers.

4. Show the new main sewers in bold type.
5. Storm and sanitary main sewers are required in proposed public roadways. In addition to WPC approval, approval of the new sewers should be granted by the Ohio EPA and the Northeast Ohio Regional Sewer District (NEORSD). Approved copies of the plans and/or correspondence should be submitted to WPC. The NEORSD phone number is (216) 881-6600.

6. If the main sewer is not owned by the City, show its ownership.

7. If the proposed main sewer is private, an encroachment permit approved by the City Council is required.

8. All new main sewers and manholes should be located within the public roadway.

9. All proposed main sewers should flow by gravity.

10. Show the length, size, material type and slope of the proposed main sewer. Also indicate if the sewer is combined, sanitary or storm.

11. The minimum depth of a proposed main sewer is 9 ft. It can be shallower if it is intended for street drainage only.

12. A minimum cover of 3 ft is required for all proposed main sewers.

13. Use a minimum size of 12” for proposed storm and/or sanitary main sewers.

14. Use a minimum size of 15” for proposed combined main sewers.

15. Use Vitrified Clay Pipe (VCP), Extra Strength (ES), C-700, with premium joints, ODOT item 706.08 for all proposed main sewer pipe 18” and smaller.

16. Use Reinforced Concrete Pipe (RCP) with premium joints, ODOT Item 706.02 for all proposed main sewer pipe 21” and larger.

17. Ductile Iron Pipe (DIP) may be used if approved by the WPC engineer.

18. No horizontal bends are allowed in the main sewers.

19. Use a minimum slope of 0.50% for all proposed main sewers.

20. Submit sewer calculations for any proposed main sewer. For the design of sewers, the velocity of water cannot exceed 15 ft/s but not less than 3 ft/s.

21. If a sewer easement is required for the proposed main sewer, it should be labeled on the plans along with its width. Generally, the sewer easement should not be less than 50 ft and it should be accessible at all times.

22. Show locations of all special sewers such as inverted siphons, concrete encasements, culverts, etc.

23. Include the EPA requirements for sewer testing.

24. If a storm sewer is discharging to a body of water (i.e. river, creek or lake) the plans should be approved by the authorizing agency (i.e. Ohio EPA, Ohio Department of Natural Resources (ODNR), US Army Corps of Engineers)

25. The following notes should be included in the plans when a public sewer is built:

    a. The contractor should notify the Division of Water Pollution Control (WPC) prior to start of construction. Call the engineering office at (216) 664-2756 or (216) 664-2787 to coordinate the sewer work.

    b. The contractor is required to submit sewer shop drawings to WPC prior to sewer installation. The drawings should include the sewer pipes, manholes, catch basins and other sewer appurtenances.

    c. WPC will inspect the City sewer installation. The cost of the full time inspection shall be paid by the contractor. An inspection deposit shall be submitted to WPC prior to the start of construction.

    d. The proposed sewers should be constructed in accordance to the plans and specifications approved by WPC. Any deviations from the approved plans or specifications require a new plan submittal reflecting the changes. Upon review of the revised items, WPC will re-issue a new approval. It is strictly prohibited to construct any sewers unless they are approved by WPC.

    e. Upon completion of the sewer installation, the contractor is required to submit a hard copy and an electronic copy of as-built plans, and a CCTV copy of the new City sewers. WPC reserves the right not to approve any sewer that does not meet the City requirements.

    f. The contractor is responsible for the plan review fees of the new City main sewers.
    g. The contractor is required to obtain permits for all proposed or existing sewer connections that will service any property.

Sewer Connection (or Lateral)

The following are required for all proposed sewer connections located in the City right of way.

1. All proposed sewer connections should flow by gravity in the City right of way.

2. Show on the plan view the station of each proposed sewer connection.

3. Use a minimum size of 6” for all proposed sewer connections.

4. In general, use a 6” pipe for new house sewer connections.

5. Use a minimum slope of 1% for proposed 6” and 8” sewer connections.

6. The size and the slope of a proposed sewer connection should be based on its capacity.

7. If the proposed sewer connection will damage the structural integrity of a main sewer, a new manhole is needed. This requires special approval from WPC.

8. A minimum cover of 3 ft is required for all proposed sewer connections.

9. Label the sewer connections as “combined”, “storm” or “sanitary”.

10. If the proposed sewer connection is private, an encroachment permit approved by the City Council is required.

11. Use Vitrified Clay Pipe (VCP), ASTM C-700 ES, with premium joints, (ODOT item 706.08) for all proposed sewer connections 18” and smaller.

12. Use Reinforced Concrete Pipe (RCP) with premium joints, (ODOT Item 706.0) for all sewer connections 21” and larger.

13. Ductile Iron Pipe (DIP) may be used if approved by the WPC engineer.

14. Per the City standards, a test tee is required for each proposed sanitary and storm connection. Two test tees are required for a proposed combined sewer connection. The test tee should be located inside the property at 1 to 2 ft from the right of way. In commercial projects, a test tee can be replaced with a manhole.

15. It is preferred to tie the sewer connection to a manhole in the street. If this is not possible, the size of the sewer connection must be reviewed and approved by WPC to avoid structural damage of the main line.

16. No horizontal bends are allowed for sewer connections.

17. It is strictly prohibited to tie a sanitary sewer connection to a storm main sewer and vice versa.

18. Use a VCP Wye or Tee for sewer connections that tie to a VCP main sewer.

19. Use a saddle for sewer connections that tie to a brick or RCP main sewer.

20. Protrusion

Manhole

The following are required for all proposed sewer manholes located in the City right of way or public easement:

1. Show the type of material (brick or concrete), station, actual size, rim and invert elevations of existing and proposed manholes, including invert elevations of all pipes connecting to the manholes.

2. Indicate the station of the manhole on both plan and profile views.

3. Indicate the rim elevation of the manhole and the invert elevation of each sewer pipe that ties to the manhole with its respective direction and type (storm, sanitary or combined).

4. Indicate if the manhole is storm, sanitary, combined, regulator, chamber, dual, etc.

5. Indicate the type and size of the special manhole when it is required (i.e. large manhole, drop manhole, baffle manhole, junction chamber, etc.).

6. The difference of invert elevations between a manhole and a sanitary or combined sewer pipe that ties to this manhole should not exceed 2 ft. Special approval is required for a drop manhole.

7. The difference of invert elevations between a manhole and a storm sewer pipe that ties to this manhole should not exceed 10 ft. Special approval is required for a drop storm manhole.

8. It is prohibited to propose a drop pipe inside the manhole.

9. For the manhole cover and casting, use EJIW 1700 **with vented holes**, or approved equal.

10. All proposed manholes should be accessible for maintenance purposes.

11. For main sewers 36” in diameter and less, manholes should be spaced at a maximum of 300 ft.

12. For main sewers 42” in diameter and larger, manholes should be spaced at a maximum of 500 ft.

Catch Basin

The following are required for all proposed catch basins that are located in the City right of way.

1. Show the station, rim and invert elevations of existing and proposed catch basins, including invert elevations of all pipes connecting to the catch basins.

2. All proposed catch basins should be located in the public roadway.

3. It is preferred to tie a proposed catch basin to a manhole.

4. Use 12” VCP Extra Strength (ES), C-700, with premium joints, ODOT item 706.08, for all catch basin connections.

5. Use 1% minimum slope for all proposed catch basin connections.

6. It is prohibited to tie a service sewer connection to the City catch basin.

7. Use the City of Cleveland standard rectangular catch basin detail CB-1 for all proposed catch basins in the roadway unless another detail is required by a WPC engineer. This detail requires a trap and 24” minimum sump. For the trap use EJIW 5964-12 or approved equal. For the casting and grate, use EJIW 7350 or approved equal.

8. In a special project, WPC may require a 36” minimum sump.

9. It is prohibited to propose a catch basin within the limits of an ADA ramp.

10. It is prohibited to propose a catch basin within the limits of a driveway apron.

11. No more than two catch basins can be tied in series.

Water Pollution Control Address and Contacts:

Address:
Division of Water Pollution Control
12302 Kirby Avenue
Cleveland, Ohio 44108

Engineering Office:
(216) 664-2787
(216) 664-3638
(216) 664-3783
(216) 664-2052
(216) 664-2756

Customer Service:
(216) 664-2513

Fax Number:
(216) 664-3477

Plan Review Process:
It is highly recommended that the consultant contact WPC Engineering office prior to the start of the sewer design to receive every available sewer record and guidelines.

Estimated review of each plan submittal is approximately three (3) weeks. WPC Engineering office will issue all comments in writing.

Addressee's response to WPC comments must be in writing and included with the revised plan submittal.

Additional Reference Information:

- WPC Standard Details for Sewer Appurtenances (see attached)
- Cuyahoga County Book of Uniform Standard Sewer Details
  To receive a copy contact Cuyahoga County Engineer's Office at (216) 348-3800
- Cuyahoga County Book of Uniform Standards for Sewerage Improvements
  To receive a copy contact Cuyahoga County Engineer's Office at (216) 348-3800
- ODOT Book of Construction and Material Specifications
- To receive an electronic copy of the WPC Standards for Preparation of Plans for New Sewers contact WPC Engineering Office

Attachment B – Project Scope

Revision Date: July 28, 2010

CUY-90-14.90

PID 77332/85531

PROJECT SCOPE

State of Ohio
Department of Transportation
Jolene M. Molitoris, Director

Innerbelt Bridge
Construction Contract Group 1 (CCG1)

Approved ___________________________
Date __________ District Deputy Director

Approved ___________________________
Date _________ Director, Department of Transportation

Drainage Scope Only

1.17 GOVERNING REGULATIONS

It is the responsibility of the DBT to acquire and utilize the necessary manuals that apply to the design and construction work required to complete this Project.

The Standard Specifications of the State of Ohio, Department of Transportation (Construction and Materials Specifications [C&MS]), and Supplemental Specifications shall govern this Project.

(See Section 2.6.8 for modifications of the approval requirements of the governing regulations listed in this section.)

The DBT shall design and construct Interstate and NHS elements of the construction Project in conformance with the standards, policies, and standard specification cited in 23 CFR 625.4, and use the latest edition of each enumerated provision.

The following listing of governing regulations is alphabetical. Utility and railroad work shall comply with appropriate governing regulation. ODOT Standards and Manuals take precedence over others listed unless noted otherwise in the Project scope. The current edition, including updates released on or before May 15, 2010, of the following shall be met or exceeded in the performance of the design and construction work required to complete this Project: (except as noted below)

A. American Association of State Highway and Transportation Officials (AASHTO) Publications:
    a. A Policy on Design Standards - Interstate System
    b. A Policy on Geometric Design of Highways and Streets
    c. Bridge Welding Code
    d. Guide Design Specifications for Bridge Temporary Works
    e. Guide for the Development of Bicycle Facilities
    f. Guide Specifications for Design and Construction of Segmental Concrete Bridges
    g. Guide Specifications for Thermal Effects in Concrete Bridge Superstructures
    h. Laboratory Specifications
    i. LRFD Bridge Construction Specifications
    j. LRFD Bridge Design Specifications
    k. Manual for Bridge Evaluation
    l. Manual on Subsurface Investigations
    m. Roadside Design Guide
    n. Roadway Lighting Design Guide
    o. Standard Specifications, 17th Edition (for existing structures only)
B. ADA Accessibility Guideline US Access Board
C. American Traffic Safety Services Association (ATSSA) Portable Changeable Message Sign (PCMS) Handbook
D. American Railway Engineering and Maintenance-of-Way Association (AREMA) Manual for Railway Engineering
E. CEB/fip Model Code for Concrete Structures, Appendix E, Time Dependent Behavior of Concrete, Creep and Shrinkage
F. City of Cleveland Publications:
    a. Cleveland Water Standards at: (http://www.clevelandwater.com/system_overview/standard_details06.aspx)
    b. Standard Construction Drawings (including Drainage Design Standards) at: (http://www.city.cleveland.oh.us/CityofCleveland/Home/Government/CityAgencies/PublicService/Public%20Service%20Publications)
G. Cleveland Public Power (CPP) Street Light Standards and General Construction Notes
H. CSX Publications:
    a. Criteria for Overhead Bridges
    b. Design & Construction Standard Specifications
I. Federal Highway Administration (FHWA) Publications:
    a. HEC-21 Design of Bridge Deck Drainage
    b. HEC-22 Urban Drainage Design Manual

   c. Manual of Uniform Traffic Control Devices (MUTCD)

J. Illuminating Engineering Society of North America (IESNA)
   a. Roadway Lighting RP-8-00 (Reaffirmed 2005)
   b. Lighting for Parking Facilities (Parking Lots)
   c. Recommended Practice for Tunnel Lighting (Underpass Lighting)

K. National Cooperative Highway Research Program (NCHRP) 350 Hardware Report

L. National Electric Code (NEC)

M. National Electric Safety Code (NESC)

N. Norfolk Southern's (NS) Guidelines for Design of Highway Separation Structures over Railroad (Overhead Grade Separation)

O. Ohio Department of Transportation (ODOT) Publications:
   a. Aesthetic Design Guidelines
   b. Bridge Design Manual (2007 edition for new structures and 2004 edition for existing structures) (BDM)
   c. CADD Engineering Standards Manual
   d. Construction Inspection Manual of Procedures
   e. Construction and Material Specifications
   f. Design Guidance for Independent Bicycle Facilities
   g. Design Guidance for Roadway-Based Bicycle Facilities
   h. Ecological Manual
   i. Ecological Resources and Permits - Technical Guidance Documents
   j. Environmental Services Handbooks and Guidelines
   k. Geotechnical Bulletins
      i. GB1-Plan Subgrades (Dated July 15, 2010)
      ii. GB1: Subgrade Analysis Spreadsheet (Dated July 15, 2010)
      iii. GB2-Special Benching and Sidehill Embankment Fills
      iv. GB4-Guidelines for the use of Geotechnical Instrumentation
      v. GB9-Geotechnical Software
   l. Geotechnical Engineering Checklists
   m. Location and Design Manuals
      i. Volume One - Roadway Design
      ii. Volume Two - Drainage Design
      iii. Volume Three - Plan Preparation
   n. Mapping Specifications – Office of Aerial Engineering
   o. Ohio Manual of Uniform Traffic Control Devices (OMUTCD)
   p. Pavement Design & Rehabilitation Manual
   q. Plan Insert Sheets
   r. Quality Standard for Temporary Traffic Control Devices
   s. Qualified Products List (QPL) (http://www.dot.state.oh.us/divisions/constructionmgt/materials/pages/qpl.aspx)
   t. Railroad Coordination Policy and Procedures Manual
   u. Real Estate Policies and Procedures Manuals
   v. Roadway Safety Landscaping Guidelines
   w. Sign Design Manual (SDM)
   x. Specifications for Geotechnical Explorations (SGE)
   y. Standard Construction Drawings – All Series (SCD)
      i. The following SCD shall use the 7/16/2010 revision: TC-16.21, TC-81.21, TC-82.10
   z. State Highway Access Management Manual
   aa. Survey Manual
   bb. Traffic Engineering Manual (TEM)
   cc. Quality Standards for Temporary Traffic Control Devices
   dd. Utility Manual "Procedure for Utility Relocations, Adjustments and Reimbursement"
   ee. Wireless Communication Tower Manual

ff. Waterway Permit Manual

P. Transportation Research Board (TRB)
   a. Highway Capacity Manual

Q. United States Coast Guard (USCG)
   a. Bridge Permit Application Guide
   b. Bridge Lighting and Other Signals

1.18 SUPPLEMENTAL SPECIFICATIONS

The DBT is directed to perform work as applicable in accordance with the supplemental specifications listed below. Supplemental Specifications modified specifically for this contract have been included in Appendices. Other supplemental specifications govern depending on DBT design and construction. (See Section 2.6.8 for modifications of the approval requirements.)

A. SS800 – Revisions to the C&MS
B. Modified SS832 Temporary Sediment And Erosion Control
C. SS835 - Exfiltration Trench
D. SS836 - Seeding and Erosion Control with Turf Reinforcing Mat
E. SS837 - Liner Pipe
F. SS839 - Trench Drain System
G. Modified SS840 - Mechanically Stabilized Earth Wall
H. SS850 - Cement Treated Free Draining Base (for exfiltration trench applications only)
I. Modified SS878 – Inspection and Compaction Testing of Unbound Materials
J. Modified SS879 – QC/QA Embankment
K. SS895 - Manufactured Water Quality Structure
L. Modified SS898 - QC/QA Concrete for Structures
M. SS902 - Conduit Inspection Equipment
N. SS937 - Polyethylene Liner Pipe
O. SS939 - Precast Trench Drain
P. SS995 - Precast Water Quality Structure

1.9 DESIGN DESIGNATIONS and MAINTAINING AGENCIES

Table 0-1 below indicates the functional classification, design speeds, legal speeds and maintaining agencies of roadways and trails that are designed and constructed as part of this contract or will be crossed by a new bridge or other structure as part of this contract. Available traffic information is depicted in the Innerbelt Interchange Justification Study in Appendix TC-03. Additional traffic information required will be obtained by the DBT and certified as necessary.

The design speed for the Future Condition and Interim Condition of I-90 shall be as listed in Table 1-1. The design speed for the Bi-Directional Condition of I-90 will vary from the value listed in the table for the tie-ins as indicated in Section 12.3.

The existing legal speed for I-90 in the Project limits is 50 mph. The Bi-Directional Condition and Interim Condition will be posted for 50 mph. The Future Condition will be posted for 55 mph at the completion of all Innerbelt Construction Contract Groups.

The streets along the Ontario-Broadway-Orange corridor will be renamed as part of the Project. Currently Ontario terminates at Carnegie and becomes Broadway. Upon the realignment of Broadway, Ontario will extend south to a new E.9th Street intersection and Orange will extend north to the same new E.9th Street intersection. As such, the following intersections will be renamed: Carnegie/Ontario-Broadway will become Carnegie/Ontario, and E.9th Street/Broadway-Orange will become E.9th Street/Ontario-Orange.

Table 0-1: Design Designations and Maintaining Agencies

Roadway	Functional Classification	Other Designation	Design Speed (MPH)	Legal Speed (MPH)	Maintaining Agency
I-90	Urban Interstate	STRAHNET, NHS High Priority	60	50[1]	Ohio Department of Transportation (ODOT)
I-71	Urban Interstate	STRAHNET, NHS High Priority	60	50[1]	ODOT
E.14th Street Ramp to I-90 westbound (A3)	Diamond Ramp		30 (Minimum)	-	ODOT
E.9th Street Ramp to I-90 westbound (A4)	Diamond Ramp		30 (Minimum)	-	ODOT
Ontario Avenue Ramp to I-90 westbound (A5)	Diamond Ramp		30 (Minimum)	-	ODOT
I-90 westbound Ramp to W. 14th Street Extension (A6)	Loop Ramp		25 (Minimum)	-	ODOT
W.14th Street Extension	Future Urban Collector	City Street	25	25	City of Cleveland
University Road	Urban Local	City Street	30	25	City of Cleveland
E.9th Street (Between Canal and Broadway)	Future Urban Collector	City Street, Future NHS Intermodal Connector	30	25	City of Cleveland
E.14th Street	Urban Arterial	Future SR 14 and Future SR 43 between Orange and Broadway	30	25	City of Cleveland

[1] The existing speed zone will remain in place until the completion of all of the Innerbelt construction contract groups. Upon completion of final build out the existing speed zone will be revised and I-90 posted for 55 MPH. The speed zone revision is not part of this contract.

Roadway	Functional Classification	Other Designation	Design Speed (MPH)	Legal Speed (MPH)	Maintaining Agency
Broadway	Urban Arterial	SR 14 and SR 43	30	30	City of Cleveland
Commercial Road	Urban Collector, Future Urban Local	City Street, Existing NHS Intermodal Connector Pending E.9th Street	25	25	City of Cleveland
Central Viaduct Way	Urban Local	City Street	25	25	City of Cleveland
E.9th Street (under I-90)	Urban Arterial	City Street, Other NHS and NHS Intermodal Connector	30	30	City of Cleveland
Carnegie Avenue	Urban Arterial	SR 10 and NHS Intermodal Connector	30	30	City of Cleveland
Orange Avenue	Urban Arterial	SR 87, US 422, SR 8, NHS Intermodal Connector, Future SR 14,	30	30	City of Cleveland
Ontario Street	Urban Arterial	SR 87, US 422, SR 8, SR 14, SR43 and NHS Intermodal Connector	30	30	City of Cleveland
Canal Road	Urban Collector	NHS Intermodal Connector	30	25	City of Cleveland
West 3rd Street	Urban Collector	NHS Intermodal Connector	30	25	City of Cleveland
W.14th Street	Urban Collector	City Street	30	25	City of Cleveland
Abbey Avenue	Urban Collector	City Street	30	25	City of Cleveland
Fairfield Avenue	Urban Collector	City Street	30	25	City of Cleveland
Kenilworth Avenue	Urban Local	City Street	30	25	City of Cleveland
Starkweather Avenue	Urban Local	City Street	30	25	City of Cleveland

Roadway	Functional Classification	Other Designation	Design Speed (MPH)	Legal Speed (MPH)	Maintaining Agency
Towpath Trail	Shared Use Path	Independent Facility	20	-	Multi-Party Agreement[2]

5. ENVIRONMENTAL COMMITMENTS

PERMITTING PROJECT REQUIREMENTS

The DBT must ensure that the Project is constructed and maintained in accordance with all conditions of the environmental commitments and each applicable permit required for the Project. This includes the permits described in the scope and any additional permits needed that are not specifically identified in the scope.

If not already obtained by the Department, the DBT shall obtain all necessary permits and pay all charges, fees and taxes associated with these permits. The DBT shall be responsible for any fines levied by environmental regulatory agencies as a result of their construction activities or non-compliance with any permit special or general conditions.

Waterway Permits

It is required that the DBT be aware of Section 404/401 Permits/Certifications and U.S. Coast Guard (USCG) Section 9 Permit requirements for the Project.

The Office of Environmental Services (OES) will obtain the required waterway permits from the U.S. Army Corps of Engineers (USACE) and the Ohio Environmental Protection Agency (OEPA) based on assumptions established by the Department or other agents for the Department regarding the amount and location of fills. The DBT shall comply with the requirements and conditions of the approved waterway permits.

The Department will submit a draft USCG Section 9 Bridge Permit Application based on the 30% plan submission included with the Technical Proposal as discussed in Section 14.3.10. Excluding other applicable permit requirements, the DBT shall not construct viaduct foundations adjacent to the navigable channel until the USCG Section 9 Permit is obtained. The DBT shall be responsible for completing the final USCG Section 9 Bridge Permit Application. The Section 9 Bridge Permit application shall be prepared according to the ODOT Waterway Permits Manual. The Section 9 application shall be submitted by OES to the USCG for review and comment. The DBT shall address all the comments and submit the final Section 9 application with a list of the disposition of all comments to OES for coordination with the USCG. The DBT shall comply with the requirements and conditions of the approved permit. USCG Coordination information is provided in Appendix EC-08.

USCG Contact information:

Scot M. Striffler
Bridge Program Manager, Ninth Coast Guard District Bridge Program
U.S. Coast Guard
1240 E.9th Street
Cleveland, OH 44199
(216) 902-6087
Scot.M.Striffler@uscg.mil

OES coordinates any issues regarding USCG Section 9 Permits, USACE Section 404 Permits and OEPA 401 Water Quality Certification. At no time will the DBT coordinate waterway permit issues directly with the permitting agencies unless directed to do so by OES.

OES Permits Contact information:

William R. Cody
Assistant Environmental Administrator
Office of Environmental Services
Ohio Department of Transportation
1980 W. Broad Street

[2] City of Cleveland, Cleveland Metroparks, ODOT and Cuyahoga County

Columbus, OH 43223
(614) 466-5198
bill.cody@dot.state.oh.us

The Corps of Engineers issued Nationwide Permits #3 & #7 for the project on April 14, 2010. All design and construction shall be in accordance with the Nationwide Permits and the Special Conditions of the permit. The Nationwide Permits are in Appendix EC-22. The permits are valid until March 18, 2012. The DB Team shall prepare a re-evaluation application, in order to obtain a permit extension. The DB Team shall submit the re-evaluation application to ODOT by November 1, 2011.

If the DBT proposes any temporary and/or permanent fill(s) that have not been permitted through the 404/401 or Section 9 permit processes, permit modification(s) are required. The DBT shall coordinate the request for the permit(s) modification with the Project Engineer and OES. The Department makes no guarantee to granting the permit modification(s) request. The permit modification(s) shall be coordinated by OES with the USCG, USACE and OEPA where applicable. Supply the Project Engineer/OES with the following information:

A. A plan and profile drawing showing the temporary and/or permanent fill(s) with the Ordinary High Water Mark (OHWM) elevation. The OHWM elevation of the main navigation channel of the Cuyahoga River is 575.00 feet within the project limits.
B. Volume of temporary and/or permanent fill below the OHWM.
C. The surface area of temporary and/or permanent fill below the OHWM.
D. A restoration plan for the area affected by the causeway and access fill.
E. Time frames for placement and removal of the temporary and/or permanent fill.
F. A minimum of 60 days shall be allowed for OES to coordinate any proposed permit modification with the USCG, USACE and/or OEPA.

National Pollutant Discharge Elimination System (NPDES) Permit

ODOT obtains the Notice of Intent (NOI) from OEPA for the Project. The DBT and the IQF shall be co-permittees. All temporary sediment and erosion control is the responsibility of the DBT. Refer to Appendix EC-03: Modified SS832 for developing the Storm Water Pollution Prevention Plan (SWPPP) and locating, furnishing, installing, and maintaining temporary sediment and erosion control.

Earth disturbing activity is not permitted prior to the OEPA issuance of a Facility Permit Number and fully executed co-permittee Form. The SWPPP must be in place prior to the initiation of any earth disturbing activity. The DBT shall describe the effects of construction sequencing with respect to temporary sediment and erosion control in the SWPPP. In addition, the DBT shall describe the approach to temporary sediment and erosion control for the overall project and the implementation of temporary erosion and sediment practices or facilities to be employed during each operation of the construction sequence.

All temporary sediment and erosion control work and the SWPPP shall be according to Modified SS832. (For information about OEPA's NPDES permit requirements see http://www.epa.state.oh.us/dsw/permits/permits.aspx.)

Harbormaster Permit

The DBT shall be responsible for obtaining permits and paying any fees related to the permit for the City Harbormaster in accordance with Section 573 of the City Ordinances for the City of Cleveland.

Harbormaster contact information is:

Sandra Ambris
Harbor Master
1501 N. Marginal Rd.
Cleveland, Ohio 44114
(216) 664-5020
sambris@clevelandairport.com

The DBT shall forward a copy of any correspondence with the City Harbormaster to the OES Permits Contact.

Floodplain Impacts

Prior to construction of any and all drainage structures in a floodplain, the DBT shall be responsible for submitting a letter identifying any temporary or permanent impacts to the floodplain to the ODOT District 12 Environmental Coordinator for review and comment. The District will coordinate with the local flood plain coordinator for agreement.

Any additional impacts identified subsequent to the agreement from the floodplain coordinator require coordination by ODOT District 12. Allow 15 days for this further coordination.

Removal of Temporary Erosion Control Items

The DBT shall remove all temporary erosion control items before the Project is accepted. Removed temporary erosion control items become the property of the DBT. The DBT shall dispose of removed temporary erosion control items in accordance with the appropriate C&MS specifications.

Typical U.S. Coast Guard Conditions

The following is a list of typical conditions placed in Section 9 Bridge Permits by the USCG for the DBT's consideration. The final Section 9 Permit will contain specific conditions for the Cleveland Viaduct Project. The DBT shall comply with the final requirements and conditions of the approved permit. OES coordinates any issues regarding USCG Section 9 Permits. At no time will the DBT coordinate waterway permit issues directly with the permitting agencies unless directed to do so by OES.

A. Maintain free navigation of the waterway and navigable depths.

B. Two weeks prior to the scheduled demolition work on the bulkhead, notify the USCG office of the demolition schedule. Complete the Project Information Record and return it to the USCG office.

C. One week prior to demolition, schedule a pre-demolition meeting with the USCG and all involved parties to ensure that all equipment, manpower and materials are in place for the impending demolition.

D. Prior to commencing operations, furnish the Commander, Ninth Coast Guard District, evidence of a good and sufficient bond to insure compliance with USCG requirements.

E. Prevent the dropping of spark-producing, lighted and other objects on tows or vessels. Cease use of all flame-cutting, welding, and similar spark-producing operations over the channel when vessels are passing beneath the bridge.

F. Promptly remove any object dropped into the river which may constitute a hazard to navigation.

G. Where explosives or blasting is permitted and planned for use, immediately prior to the denotation of any underwater explosives, explode two or three blasting caps to frighten fish away from the demolition site.

H. If any objects causing an obstruction to navigation are placed or accidentally dropped into the river, mark such objects with one or more lighted buoys. Use buoys that are horizontally striped orange and white with the top stripe orange; align the buoys cross-river at intervals of about 25 feet or as close as practicable to the obstruction in the river. Light each buoy at night with a quick flashing white light (60 flashes per minute). If steel is extending above water, orange flags by day and quick flashing white lights by night may be displayed on the steel in lieu of any buoy.

I. Notify the Commander (dwb), Ninth Coast Guard District, at least 15 days in advance of any action that may impede navigation. Allow 15 days for issuance of revised notices caused by any revision of work schedule. Update notification by telephone if necessary to assure that navigation interests are aware of impending events that may affect the movement of river traffic.

J. The DBT agrees to be responsible for damages to persons or properties resulting from the work and save and hold harmless the United States from any claim for damages resulting from this operation.

K. Maintain the present navigation lighting on the bridge until all work is completed, and the navigation lights to be prescribed at a future time are installed and placed into operation. If work activities obscure the existing lights on the bridge from the river, the DBT shall relocate the existing lighting or install temporary navigation lights that meet USCG approval.

L. When using barges and other watercraft in demolition activities, use lights and signals for the barges and watercraft as required by the "Inland Navigational Rules of 1980."

M. Where explosives or blasting is permitted and planned for use, use flagmen to warn river traffic before blasting. Station flagmen in a radio-equipped boat approximately one-half mile upstream and downstream of the bridge not less than one hour prior to and during the detonation of explosives to warn approaching river traffic of the impending action and obstructions in the river. Provide such warning devices as may be necessary to keep boats out of the immediate danger area.

N. Any temporary fills, rubble, or similar material deposited in the river must be approved by the Commander, U.S. Army Engineer District 9, and Buffalo District pursuant to Section 404 of Public Law 95-217.

O. Coordinate and submit plans for any temporary causeways, work bridges or other falsework to be placed in the river to the Commander (dwb), Ninth Coast Guard District for approval.

P. Spoil all rubble in upland, non-wetland areas above ordinary high water. Obtain approval for disposal sites from the Commander, U.S. Army Engineer District, and Buffalo District.

Q. Submit requests to temporarily block the river and stop river traffic, in writing, for approval to the Commander (dwb), Ninth Coast Guard District.

R. Where explosives or blasting is permitted and planned for use, if, in the opinion of the person in charge of the explosive detonation, the use of radiotelephone or other electronic equipment in the area should be prohibited, at any time, advise the Coast Guard well in advance so that timely notices can be published.

S. Where explosives or blasting is permitted and planned for use, if explosives are to be transported by water, obtain permits in accordance with Title 49, Code of Federal Regulations. Submit applications to the USCG Marine Safety Office, 9th District.

T. When the Commander, Ninth Coast Guard District determines that hazardous conditions exist, provide a towboat (tug) to assist vessels through the bridge on demand. Provide a vessel of adequate capacity and design to assist tows through the work area. Make the towboat (tug) available 24 hours a day, seven days a week. The boat may also be used as the DBT's work tug, provided that the assistance of commercial tows through the area takes priority over the DBT's normal usage.

Typical Nationwide Permit Conditions

The following is a list of typical conditions placed on Nationwide Permits for the DBT's consideration. The final Nationwide Permit will contain specific conditions for the Cleveland Viaduct Project. The DBT shall comply with the final requirements and conditions of the approved permit. OES coordinates any issues regarding USACE Section 404 Permits and OEPA 401 Water Quality Certification. At no time will the DBT coordinate waterway permit issues directly with the permitting agencies unless directed to do so by OES.

A. Waterway Permit Time Restrictions: Complete all work in streams and wetlands depicted in the final approved permit by the date provided in the Permit.

   For work on streams and wetlands, the Department will consider the Contractor's submission of an extension to the waterway permit end date based on project constraints. In order to be considered, the Contractor must submit a justification to the Engineer at least two months prior to the waterway permit end date.

   The Engineer will submit the request for a time extension to the ODOT OES Waterway Permits Unit (614-466-7100) for consideration and coordination with the USACE and/or Ohio EPA.

B. Deviations from Permitted Construction Activities: Make no deviations from the requirements for work in streams and wetlands depicted in the plans and/or Final Permit unless a modification has been submitted to ODOT and approved by the appropriate agencies (i.e., USACE, OEPA, USCG, Ohio Department of Natural Resources [ODNR], U.S. Fish and Wildlife Service [USFWS]).

   For emergency situations resulting in unanticipated impacts to streams or wetlands, provide notification (verbal or written) to the Engineer as soon as possible following discovery of the situation. Written notification to the Engineer and notification to the ODOT OES Waterway Permits Unit must be made within 24 hours.

   For non-emergency situations, notify the Engineer in writing for submission to the ODOT OES Waterway Permits Unit (614-466-7100) for consideration and coordination with the appropriate agencies. Notification must be made at least two months prior to the planned non-permitted activities. Consideration of the requested deviation is at the discretion of the Director and must be coordinated with the appropriate regulatory agencies.

C. Bank Protection and Temporary/Permanent Fill Materials: For bank protection and temporary and permanent fills in or adjacent to streams and wetlands on the Project, use materials free from toxic contaminants in other than trace quantities. Broken asphalt is specifically excluded.

   Do not use cadmium, chromium, arsenate (CCA), creosote, and other pressure treated lumber in structures that are placed in wetlands and streams.

D. Cultural Resources: If archeological sites or human remains are discovered, cease all work in the immediate area and notify the Engineer who shall immediately contact OES. OES Cultural Resource Contact information:

   Paul Graham
   Assistant Environmental Administrator
   Office of Environmental Services
   Ohio Department of Transportation
   1980 W. Broad Street
   Columbus, OH 43223
   (614) 466-5099

paul.graham@dot.state.oh.us

In the event of human remains are discovered, the Engineer shall also contact the Cuyahoga County Sherriff's Office.

E. Water Resource Demarcation: Prior to site disturbance, demarcate all streams, wetlands, lakes, and ponds indicated on the plans in the field as per modified Supplemental Specification 832. Maintain demarcation fence throughout the construction process. Remove the demarcation fence and posts following the completion of the Project.
F. Blasting: Notify the ODNR if blasting is required within or near stream channels according to ORC 1533.58 and ODOT C&MS 107.07.
   Notify the Engineer, in writing, for submission to the ODOT OES Waterway Permits Unit (614-466-7100) for coordination with the ODNR.
G. Waterway Permits: Maintain a copy of the waterway permits (e.g., USACE 404, USCG Section 9 Bridge Permit and the OEPA WQC and/or Isolated Wetland Permit) at the work site at all times and make it available to all contractors and subcontractors.
H. Birds and Bats: Prior to the removal of bridge structures, examine the underside of the bridge for the presence of birds and bats. Should any birds or bats be found roosting on the underside of the bridge, notify the Engineer for coordination with ODOT OES (614-466-7100).
I. Construction Completion Certification: Upon Completion of the work, notify the Engineer. Complete the USACE Construction Completion Certification and obtain the signature of the Engineer. Forward this information to:

   U.S. Corps of Engineers
   DSCC
   Building 10, Section 10
   3990 East Broad Street
   Columbus, Ohio 43218

   The DBT shall forward a copy of the certification to the ODOT OES Permits Contact.

OTHER ENVIRONMENTAL COMMITMENTS

Noise Walls

(See Section 15 - Noise Analysis and Noise Barriers.)

Vibration Analysis

(See Section 9.3.4 - Vibration Monitoring and Control Requirements.)

Section 106/Historic Sites

The DBT shall comply with all provisions of the Programmatic Agreement (PA) among the Federal Highway Administration (FHWA), The Ohio State Historic Preservation Office, and ODOT regarding the Federal-Aid Highway Improvement of Interstate Routes 71, 77, and 90 in The City of Cleveland, Cuyahoga County, Ohio CUY-90 Innerbelt: PID 77510, Agreement Number 15498.

In accordance with the PA, FHWA and ODOT propose the following treatment plans to resolve the adverse effect on the three impacted historic properties:

A. Broadway Mills – Level II documentation as specified by the Historic American Building Survey (HABS) will be prepared. A commemorative display will be located at or near the existing mill site.
B. Marathon Gas station – Level II documentation as specified by the Historic American Building Survey (HABS)
C. Distribution Terminal Warehouse – a historic context will be prepared documenting the significance of the resource in relation to the City of Cleveland's food distribution industrial history.

The Level II documentation and historic context will be prepared by the Department and will be included in Appendix EC-07. The DBT is not permitted to begin demolition activities until the Level II documentation has been completed. A schedule indicating when the property is released for demolition/construction is included in Appendix RW-01.

The DBT shall ensure that the above mitigation/enhancement activities are included in the design of the Project. The six 30-inch diameter (approximate) medallions on the north face of the Broadway Mills Building shall be salvaged prior to demolition. The 10 architectural sandstone center pieces above each half circle window on the top floor shall also be salvaged prior to demolition. These salvaged materials shall be incorporated into the design of a commemorative display to showcase the historic value of the Broadway Mills Building to this area of Cleveland. The commemorative display will be located on the existing Broadway Mills site within the new overlook area. Other pieces of the Broadway Mills Building, (e.g. sandstone window sills, exterior bricks, cornices, etc.) may also be salvaged for reuse in the commemorative display and in the overall design of the overlook areas under the new bridge.

The DBT shall design three commemorative displays of the Broadway Mills Building. The DBT designer shall have Historic/Architecture Investigations prequalification.

See Section 16 – Aesthetics and Enhancements for additional requirements.

Asbestos on Bridges

Asbestos surveys were conducted on the bridges within the project limits by a certified asbestos hazard evaluation specialist. The surveys identified the asbestos containing materials (ACM) on the bridges. See Appendix EC-10, EC-21 and EC-28 for the inspection reports.
The removal and disposal of any ACM during the construction must comply with the Ohio Administrative Code, Occupational Safety and Health Administration (OSHA) regulations, and the National Emission Standard for Hazardous Air Pollutants (NESHAP) Standards for Asbestos.

The DBT shall complete the OEPA Notification of Demolition and Renovation forms and submit the completed form to the Local Air Authority at least ten (10) days prior to demolition of the bridges. The Contractor shall provide a copy of the completed forms to the Department. The Local Air Authority is:

City of Cleveland
Department of Health & Welfare
Division of the Environment
1925 St. Clair Avenue
Cleveland, Ohio 44114

The DBT shall provide an individual trained in the provisions of NESHAP that will be on-site during removal of the ACM. In addition to the ACM identified in the Asbestos Survey Report, any additional non-visible asbestos encountered within the project work limits shall also be monitored by this individual.
If unknown contamination is discovered during construction, the DBT shall notify ODOT immediately and shall follow the Spill Prevention Control and Countermeasure (SPCC) Plan as well as all appropriate regulations.
The DBT shall furnish all labor, equipment, and materials necessary to complete, submit, and comply with the OEPA Notification form and to remove, transport, and dispose of the materials containing asbestos from within the project work limits. The cost for this work shall be included in the overall lump sum price and is not to be compensated through force account as described in Section 0.

Materials Management

Before building demolition operations begin, the Department will conduct regulated materials inspections of all buildings subject to renovation or demolition. The findings of these inspections will be made available to the DBT. A list of property acquisitions is available in Appendix RW-01. The table in the appendix shows the status of individual parcels and buildings and the status of asbestos inspection.
Regulated materials can include but are not limited to: asbestos, mercury switches, fluorescent light bulbs, underground storage tanks (UST), and oil pits.
The DBT is responsible for abatement activities required for the buildings determined to contain regulated materials from the Department's inspections. All buildings, where the DBT is granted access to AND is in receipt the Department's regulated materials inspection findings prior to the bid submission are considered Known Abatements. The cost for these Known Abatements shall be included in the overall lump sum price and is not be compensated through force account.
It is expected that the Department will not have acquired or will not have provided an inspection report for some properties. The regulated material inspections on these properties will not be available to the DBT prior to bid. These are considered Unknown Abatements. Items used to implement the DBT's regulated material removal activities for Unknown Abatements shall be paid from the encumbered amount included in the proposal as Regulated Materials Removal and Disposal. The fixed amount represents the Department's estimate of the total cost of the Unknown Abatement activities for these buildings. Payment for the removal and disposal of regulated materials for Unknown Abatements shall be based on C&MS 109.05 - Force Account and is considered an excusable, non-compensable delay as per Item 108.06.B.7.
At least 10 Business Days before operations begin, the DBT shall complete an OEPA 'Notification of Demolition

and Renovation' form and submit this to the local air pollution control division, if delegated, or OEPA.
The DBT shall ensure that all suspect materials shall be removed and properly disposed of by a certified Asbestos Removal Professional in accordance with OAC 3745-20. An individual trained in the provisions of NESHAPS (40 CFR Part 61, subpart M) will be on site during the demolition or renovation of any structure with ACM and evidence that the required training has been accomplished by this person will be available during normal business hours.
If the DBT encounters an unknown or known UST within the right-of-way, the DBT shall decommission and remove the UST. This effort will be paid under C&MS 109.05 - Force Account and is considered an excusable, non-compensable delay as per Item 108.06.B.7. If a UST is encountered, ODOT and the DBT shall follow all applicable rules and regulations associated with UST removal activities.
The DBT shall meet all regulatory conditions imposed at properties with regulated materials associated with construction. These conditions could include ensuring that the surrounding properties and populations are not exposed to the regulated materials on the site. The DBT shall ensure that the site is properly contained during construction so that regulated materials do not migrate off site; and so that the health and safety of all on-site personnel are protected during work at the site, the DBT shall prepare an Spill Prevention Control and Countermeasures (SPCC) plan that provides specific guidance for managing regulated materials that may be encountered within the right-of-way.
If unknown regulated materials are discovered during construction, the DBT shall notify ODOT immediately and shall follow the SPCC Plan as well as all appropriate regulations.
The DBT shall dispose of construction waste material such as concrete or other harmful materials at approved sites in accordance with all appropriate regulations.
The DBTs shall review the environmental documentation for the project, including the Environmental Site Assessments completed by the Department. DBTs shall utilize this information to manage excavated materials on the project. DBTs shall use innovative and sustainable methods to reuse as much of the excavated materials as allowed by applicable regulations. Excess excavated materials that are regulated shall be appropriately managed by the DBT. This management may include transporting and paying for disposal at appropriate disposal facilities.
During the geotechnical investigation for the East 9th Street/Commercial Road realignment, off-colored and odd smelling soils were encountered in field samples. Based on these indications, soils were sampled and tested. The Phase II ESA analytical test results did not shows levels of compounds that would characterize excavated materials from this site as a hazardous waste. The test results along with the sample borings logs show that the soils contain weathered slag. The Phase II ESA Reports are available in Appendix EC-11.
Based on the Phase II ESA reports for the Norfolk Southern property (Parcel 632), the DBT can incorporate the excavated material into project. If the excavated material is not incorporated into the project, it shall be disposed of in a solid waste landfill.

13 DRAINAGE

The DBT shall design and construct drainage and storm water management facilities and systems including, but not limited to, catch basins, inlets, manholes, pipes, culverts, underdrains, outfalls, storm water Best Management Practices (BMPs) and associated items for the Project Drainage Area as defined in Section 13.2.5. Additional drainage requirements for structures can be found in Section 14.

GOVERNING REGULATIONS

The governing regulations for ODOT and local facilities are indicated in Section **Error! Reference source not found.** and 13.1.2. Table 13-1 indicates changes to Location and Design, Volume 2 that govern this Project.

Table 0-1: Location and Design, Volume 2 Revisions

Section	Subject	Revised Language
1002.3.1	Type A Conduits	Where durability requires increased thicknesses of the corrugated steel alternate, the 1-inch corrugation profile ~~should~~ ***shall*** be specified for pipe diameters over 48 inches.
1006.2.2.C	Culvert Allowable Headwater - Check Storm Controls	A replacement structure ~~should~~ ***shall*** be sized to prevent overtopping by the 100-year flood where such overtopping would not occur with the existing structure.

Section	Subject	Revised Language
1006.2.2.D	Culvert Allowable Headwater - Check Storm Controls	A replacement structure ~~should~~ ***shall*** be sized such that flooding of upstream productive land is not increased for the 100-year flood when compared to the existing structure.
1006.2.4	Culvert Allowable Headwater – Limitations	Where large structures (greater than or equal to 10 feet in span) are involved, the structure ~~should~~ ***shall*** be sized to pass the design storm while maintaining a free water surface through the structure.
1006.2.4	Culvert Allowable Headwater – Limitations	Where the overtopping point on the roadway is outside the watershed break, the ditch break overflow elevation ~~should~~ ***shall*** be utilized as a headwater control in lieu of 1006.2.1 A.
1007.1	Pipe Removal Policy	Use the following guidelines to determine whether an existing pipe, regardless of type, being taken out of service ~~should~~ ***shall*** be abandoned or removed.
1007.1	Pipe Removal Policy	Pipes 8 inches in diameter or rise, or less, regardless of depth or height of fill, ~~may~~ ***shall*** be abandoned in place.
1007.1	Pipe Removal Policy	Pipes 10 inches through 24 inches in diameter or rise with less than 3 feet of final cover ~~should~~ ***shall*** be removed or filled; with more than 3 feet of final cover they may be abandoned in place.
1007.1	Pipe Removal Policy	Pipes over 24 inches in diameter or rise ~~should~~ ***shall*** ~~generally~~ be removed.
1008.1.2	Corrugated and Spiral Rib Steel and Aluminum Pipes, and Corrugated Steel and Aluminum Pipe Arches	The thickness ~~should~~ ***shall*** be determined for the maximum height of cover and it shall be used for the full length of the structure.
1008.1.2	Corrugated and Spiral Rib Steel and Aluminum Pipes, and Corrugated Steel and Aluminum Pipe Arches	However, where a short length of conduit requiring a higher strength pipe is contiguous with a long run of pipe, then only that short length ~~should~~ ***shall*** be specified as requiring the higher strength pipe.
1008.1.3	Cambered Flow Line	Where soil conditions at the site indicate that appreciable settlement may be expected, a cambered flow line ~~should~~ ***shall*** be provided.
1008.2	Rigid Pipe	Where soil conditions at the site indicate that appreciable settlement may be expected, a cambered flow line ~~should~~ ***shall*** be provided.
1008.2.3.B	Rigid Pipe – Structural Design Criteria	The concrete pipe alternate ~~should~~ ***shall*** be specified as 706.02 with special design.

Section	Subject	Revised Language
1008.2.3.D	Rigid Pipe – Structural Design Criteria	The required pipe strength ~~should~~ ***shall*** be determined for the maximum height of cover and it shall be used for the full length of the pipe. However, where a short length of conduit requiring a higher strength pipe is contiguous with a long run of pipe, then only that short length ~~should~~ ***shall*** be specified as requiring the higher strength pipe.
1009.2.1	Pipe Underdrains	The depth of the rock cut underdrain ~~should~~ ***shall*** be 6 inches below the cut surface of the rock (Figure 1009-10).
1009.2.1	Pipe Underdrains	Underdrains which outlet to a slope ~~should~~ ***shall*** be provided with an outlet per SCD DM-1.1.
1009.2.1	Pipe Underdrains	A fabric filter wrap ~~should~~ ***shall*** be used when existing soils consist of a sandy or sandy-silt composition.
1009.2.4	Aggregate Drains	Aggregate drains ~~should~~ ***shall*** be located at 50 foot intervals on each side of the pavement and staggered so that each drain is 25 feet longitudinally apart from the adjacent drain on the opposite side.
1009.2.4	Aggregate Drains	For superelevated pavements, the drains ~~should~~ ***shall*** be located on the low side only, at each transverse joint in rigid pavement and at 25 foot intervals for other pavement.
Figures 1008-1 through 1008-9	General Notes	Before a pipe is used under a cover exceeding 100 feet, the structural maximum allowable height of cover and the required bearing pressure ~~should~~ ***shall*** be calculated and an investigation of the bearing capacity of the foundation material performed.
Figures 1008-10 through 1008-14	General Notes	Before a pipe is used under a cover exceeding 100 feet, the structural maximum allowable height of cover and the required bearing pressure ~~should~~ ***shall*** be calculated and an investigation of the bearing capacity of the foundation material performed.
Figures 1008-15 through 1008-21	General Notes	Before a pipe is used under a cover exceeding 100 feet, the structural maximum allowable height of cover and the required bearing pressure ~~should~~ ***shall*** be calculated and an investigation of the bearing capacity of the foundation material performed.
1102.3.4.D	Catch Basin Types	The basin ~~should~~ ***shall*** also be located outside the design clear zone or behind guardrail where the protruding feature of the basin is not objectionable.
1103.5	Drainage; Miscellaneous	Inlets or catch basins ~~should~~ ***shall*** ~~arbitrarily~~ be placed upstream of all intersections, bridges and pedestrian ramps.
1103.5	Flanking Inlets	The above is prevalent in long flat sag vertical curves, where a flanking inlet (or catch basin) ~~should~~ ***shall*** ~~arbitrarily~~ be provided on both sides of the low point in a pavement sag.
1103.6.2	Grate or Combination Grate and Curb Opening Inlet	The curb opening of a combination catch basin on a continuous grade will admit some flow, particularly if there is a partial clogging of the grate; however, the additional capacity ~~should~~ ***shall*** be considered as a factor of safety only.
1103.7	Grate Catch Basins and Curb Opening Inlets In Pavement Sags	The spread in the sag ~~should~~ ***shall*** be determined from the depth of flow at the edge of grate using Figure 1103-3 and ~~should~~ ***shall*** include the total flow (contributions from each side of the sag vertical curve) reaching the inlet or catch basin.

Section	Subject	Revised Language
1104.2.2	Storm Sewer Access	Small sewers (under 36 inches in diameter) located under or near the edge of pavement, ~~should~~ ***shall*** be accessible at intervals not to exceed 300 feet. For sewers sized 36 to 60 inches manholes ~~should~~ ***shall*** be spaced every 500 feet maximum. Manholes should be provided every 750 to 1000 feet maximum for larger sewers.
1104.4.2	Hydraulic Grade Line	Starting at the storm sewer system outlet and working upstream, the elevation of the hydraulic grade line at the upper end of each sewer run ~~should~~ ***shall*** be determined using a 25-year frequency.
1104.4.2	Hydraulic Grade Line	One directional lane of a multiple lane highway or one-half of a lane on a 2-lane highway ~~should~~ ***shall*** be passable when the sewer system is discharging the 50-year storm.
1106.1	End Treatments	Headwalls ~~should~~ ***shall*** also be provided for Type D conduits greater than 24 inches in diameter or rise.
1107.2	Rock Channel Protection	A filter ~~should~~ ***shall*** always be specified to prevent soil piping through the rock.
1107.2	Rock Channel Protection	An aggregate filter ~~should~~ ***shall*** be used when the RCP is under water.
1117.2	Manufactured Systems	As shown in the figure above, manufactured systems ~~should~~ ***shall*** not be provided on sewers that are carrying a water quality flow greater than 6 cfs.

ODOT Facilities

All plans and design for ODOT facilities are to be prepared in accordance with the latest standards provided in Section 0. ODOT drainage and post-construction storm water BMP facilities are considered to be those items that ODOT owns and maintains after construction. This is based on maintenance responsibility for the respective roadway. A list of roadways and their respective maintaining agencies is available in Section 1.8. Required supplemental specifications controlling drainage related work are listed in Section 0.

In the event of a conflict among the standards listed related to drainage, the Department's standards shall take precedence. For drainage components not addressed by the standards listed, other guidelines or specifications that reflect currently accepted industry practice can be used as agreed to by the Department.

For post-construction storm water BMP components not addressed by the standards listed, other guidelines or specifications that reflect currently accepted industry practice and meet the requirements of the Ohio EPA NPDES General Permit for Storm Water Discharge from Small and Large Construction Activities (OEPA Permit #OHC000003) can be used as agreed to by the Department.

Local Facilities

All plans and design for local facilities are to be prepared in accordance with the latest standards provided in Section 0. Local drainage and post-construction storm water BMP facilities are considered to be those items that the local public agency owns and maintains after construction. This is based on maintenance responsibility for the respective roadway. A list of roadways and their respective maintaining agencies is available in Section 0. Required supplemental specifications controlling drainage related work are listed in Section 0.

In the event of a conflict among the standards listed related to drainage, use this document (Project Scope) to determine the appropriate criteria. For drainage components not addressed by the standards listed, other guidelines or specifications that reflect currently accepted industry practice can be used as agreed to by the Department.

For post-construction storm water BMP components not addressed by the standards listed, other guidelines or specifications that reflect currently accepted industry practice and meet the requirements of the Ohio EPA NPDES General Permit for Storm Water Discharge from Small and Large Construction Activities (OEPA Permit #OHC000003) can be used as agreed to by the Department.

REQUIREMENTS

General Drainage Requirements

A. Use City of Cleveland Standards for drainage conduit and drainage structures owned and maintained by the City of Cleveland. For conduit sizes 18 inches and larger, use reinforced concrete pipe according to ODOT

C&MS 706.02. For conduit sizes smaller than 18 inches, use vitrified clay pipe according to ODOT C&MS 706.08. VCP must be Extra Strength. (See City of Cleveland drainage standards in Appendix DR-10.)

B. All drainage conduit crossing under any railroad, including any drainage conduit crossing under an elevated railroad shall be in accordance with railroad governing regulations. (See Section 1.17 and Section 7)

C. Adjusting rings are not permitted for casting adjustments in pavement. The DBT shall adjust the height of supporting walls per the C&MS.

D. Existing conduit to be abandoned shall be filled and plugged per L&D Vol. 2 note D103. Prior to filling and plugging, conduit shall be videotaped to ensure that unknown connections are not impacted.

E. The DBT shall remove sediment and debris from the existing drainage conduits and drainage structures to provide a functioning drainage system. All materials removed shall be disposed of as per C&MS 105.16 and 105.17. All sewers shall be cleaned out to the satisfaction of the engineer.

F. The DBT shall provide no less than five (5) feet of cover from the lower of existing or proposed ground on drainage conduit in the region bound by proposed westbound I-90, existing I-90, W.14th Street Extension, and Abbey Avenue. The purpose is to accommodate future parking construction.

G. Premium (water-tight) joints are required for submerged outfalls from outlet to nearest upstream drainage structure.

H. The DBT shall be responsible for appropriately designed pipe end treatments for all river outfalls.

I. Provide all final drainage calculations to the Department. Include both PDF and source files.

J. All underdrains shall have fabric wrap and shall be minimum 6 inch diameter.

K. The DBT shall design the parking lot drainage system such that ponding is limited to the landscaped areas for rainfall events up to and including the 5-year rainfall event. The maximum depth of ponding shall be 6 inches.

West Slope Drainage Requirements

All proposed storm sewer system facilities between Abbey Avenue and the Cuyahoga River shall meet the following requirements:

A. Minimum pipe cover shall be 5 feet for any pipe under a 4:1 or steeper slope.

B. Use mechanical connectors or flanged joints on 4:1 or steeper slope.

C. All proposed drainage structures shall have premium, water tight joints.

D. Maximum pipe velocity shall be 15 fps except for any pipe immediately prior to a ring chamber.

In order to introduce turbulence and improve oxygen levels of the West Bank storm water runoff, the DBT shall provide ring chambers in accordance with ODOT Plan Insert Sheets RC-2 and RS-2 (http://www.dot.state.oh.us/Divisions/HighwayOps/Structures/Hydraulic/Pages/Downloads.aspx) at the end of all West Bank storm sewer systems that outlet to the Cuyahoga River. In the case of a submerged outlet, the ring chamber section should be provided immediately prior to the section below elevation of 570 feet.

A drainage structure shall be provided to transition from the standard conduit to the ring chamber portion of the storm sewer. The DBT shall match the top of crown for the conduits entering and exiting the drainage structure.

The conduit type for the ring chamber portion shall be reinforced concrete pipe (C&MS 706.02 with premium joints per 706.11). The reinforced concrete conduit strength shall be based on the height of fill (L&D Volume 2, Figure 1008-10). The diameter of the conduit with ring chambers shall be a minimum of 36 inches, but shall be properly sized to meet the requirements of the FHWA/OH-84/007 Internal Energy Dissipaters for Culverts (included in Appendix DR-11) , and the length of ring chamber section shall correspond to Plan Insert Sheet RC-2. Additional design details for the ring chambers and corresponding conduit shall be in accordance with Plan Insert Sheets RC-2 and RS-2. The reinforced concrete pipe material shall be provided from the end of the ring chamber to the ultimate pipe outfall at the river.

E.9th Street (Commercial Road Hill Area) Storm Sewer

The proposed storm sewer outfall for the E. 9th Street system, from the CSX tracks to the Cuyahoga River, shall have the following requirements:

A. Provide a pipe design that considers all site conditions including, but not limited to, the following:

a. Maximum 110 feet height of cover over the pipe with an assumed material density of 140 lbs/cu. ft.
b. The proposed pipe will be subjected to varying pile heights/loads due to the temporary stockpiling of materials at this site.
c. Soil foundation, including pipe backfill and bedding.
d. Any needed dewatering during installation.

B. DBT shall provide design calculations with two (2) independent PE stamps from individuals qualified in structural design (double stamp does not remove requirement for IQF to verify design submission).

One underground or one above ground aerial sewer crossing across the GCRTA alignment is permissible in the region of the E.9th Street Bridge over GCRTA. The drainage system design shall consider ease of maintenance (vehicle accessibility, manholes on each side of crossing, etc.). In addition, the DBT shall refer to the railroad agreements in Appendix RR-01. If an aerial crossing is used see Appendix DR-12 – Aerial Crossing Requirements.

Structure Drainage

All of the drainage from all of the bridge decks is to be collected and conducted to the storm sewer system. The bridge deck drainage design shall conform to the following:

Bi-Directional Condition spread design

A. Two (2) year storm design frequency.
B. Spread is allowed into one-third (1/3) of the outside traveled lane.

Interim and Future Condition spread design

A. Ten (10) year storm design frequency per §1103.2 of ODOT L&D Volume 2.
B. Allowable spread of zero (0) feet into traveled lane per §1103.2 of ODOT L&D Volume 2.

Structure drainage requirements

Structure drainage requirements for the I-90 Viaduct and other structures may be found in Section 14 - Structures.

Storm Sewer

The existing drainage within the Project area is primarily conveyed through various combined sewer systems. The NEORSD relocation of their facilities will include temporary drainage connections to the relocated combined sewers. These temporary connections shall be removed by the DBT and the drainage directed into existing or new storm only systems.

Coordination with NEORSD's Walworth Run Interceptor Realignment project. The DBT shall be responsible for the design and construction of permanent storm sewer outfalls to pick up storm flows which previously entered the NEORSD Interceptor sewer system. The contributing drainage areas for these sewers include the area bounded by Fairfield, W13th, W15th and the Cuyahoga River. See the Sewer Abandonment plans in UT-03. These storm sewer systems shall include water quality BMPs as required in Section 13.2.6.

No net increase in peak flows (in the 5-, 10-, or 25-year design storm) shall occur to any point on the existing combined sewer system as a result of this Project. This does not preclude the DBT from removing upstream flow and adding an equivalent amount of downstream flow as this would pose no net increase to any point of the existing drainage system. This requirement has been established with Cleveland Water Pollution Control and North East Ohio Regional Sewer District.

Potential storm water outfall locations are shown in Appendix DR-02. Modifications to the planned outfall locations are allowable provided that they meet permit requirements. (See Section 0 - Environmental Commitments for further information.)

The DBT shall adjust or reconstruct catch basins, inlets, manholes and other castings as necessary to accommodate resurfacing.

The minimum Project Drainage Area is defined as follows:

A. All area within the construction limits or draining to the construction limits of the Project as finalized by the DBT. This includes areas within the construction limits but outside of existing or proposed ODOT right-of-way, including local streets.
B. All existing I-90 mainline and ramp pavement and bridge area between Starkweather Avenue and the east bank of the Cuyahoga River. This includes areas of I-90 (mainline and ramp) that previously drained into the combined sewer network but have experienced a severed connection to the combined sewer due to the NEORSD Walworth Run relocation project.

The installation of proposed storm-only drainage systems shall be implemented to the greatest extent possible.

Storm Water Best Management Practices (BMP)

General BMP Requirements

Post-construction storm water BMP treatment options are provided in Appendix DR-02. With respect to post-construction storm water BMPs, the Project is considered a "new construction" project as described in Section 1115.6 of Location and Design Manual, Volume 2.

The DBT shall provide post-construction storm water BMPs according to L&D Volume 2 and the Ohio EPA NPDES General Permit (OHC000003) for Storm Water Discharge from Small and Large Construction Activities to meet the storm water treatment requirements established in the NPDES Permit. Unless site conditions or safety issues preclude their use, use detention-based BMPs sized to treat the water quality volume as indicated in Appendix DR-02. The BMPs and storm sewer layouts proposed in Appendix DR-02 are for information purposes only and do not represent a prescriptive drainage design.

The DBT shall prepare slope stability analyses on pond side slopes and berms, and settlement analyses on berms. The DBT shall prepare geotechnical recommendations for infiltration zones. The DBT shall perform all detention pond and infiltration zone analyses.

Additional requirements:

A. For drainage areas tributary to the storm only systems, BMPs shall be sized based on the entire contributing drainage area (offsite and onsite) to the BMP. The treatment approach for BMP design shall be to provide 100% treatment for 100% of the project. If right-of-way, geotechnical, or structural issues do not allow 100% treatment, the DBT shall provide treatment to the maximum extent practicable. The treatment requirement shall not be reduced below the criteria established in the Section 1115.6.2 of Location and Design Manual, Volume 2. See Section **Error! Reference source not found.** for minimum Project Drainage Area.

B. Runoff from the Project Drainage Area directed to the combined sewer network is not required to be treated with a post-construction BMP.

C. Furnish a 6-inch layer of C&MS 601 Detention Basin Aggregate on the bottom of all detention basins.

D. If a bioretention cell is proposed, the bioretention cell storage area shall include the area above the planting soil and within the planting soil. Assume a porosity of 0.4.

E. If an extended detention pond is proposed, the pond shall have a sediment forebay and a length to width ratio of 3:1.

F. Prepare calculations and drainage area mapping for post-construction BMPs.

G. Provide vehicular access to accommodate equipment necessary for periodic maintenance of detention-based BMPs and manufactured systems. This shall include providing locking gates in fencing as necessary.

H. At the conclusion of construction activities when the site is stabilized, the DBT shall inspect and perform maintenance activities on any installed BMPs to allow the system to properly function to its full extent.

I. BMPs shall be located within right-of-way limits as indicated in the Final Right-of-Way Plans in Appendix RW-03 unless a maintenance agreement is in place with the property owner.

J. The DBT shall provide the following information regarding constructed BMP facilities:

   a. For Exfiltration Trenches, provide station (downstream edge of box structure), offset, RT/LT, length, and Type (A, B, or C).

   b. For Manufactured Systems, provide station (mainline manhole location), offset, RT/LT, and Type (1, 2, 3 or 4).

   c. For Vegetated Biofilter, provide station (begin and end station of VBF), offset, RT/LT, bottom width, and protective lining (selected according to L&D Volume 2, Section 1102). Protective linings include seed (CMS 659), sodding (CMS 660), ditch erosion protection mat (Type A, B, C, D, E, F, or G), and turf reinforcing mat (Type 1, 2, or 3).

   d. For Extended Detention, provide station (outlet structure), offset, RT/LT, and Type (A – above ground, or B – below ground).

   e. For Bioretention Cell, Infiltration Basin, or Constructed Wetland, provide station (outlet structure or downstream edge of bank), offset, and RT/LT.

   f. For Infiltration Trench, provide station (downstream edge of bank), offset, RT/LT, length, depth, and top width.

Prohibited BMP Systems

Retention Basins (permanent wet pond) are prohibited from being used as post-construction storm water BMP on this Project.

Detention-based BMPs and infiltration BMPs are not permitted in west slope between Abbey Avenue and the Cuyahoga River.

Permitted BMP Systems –Locally Maintained Facilities

Any BMP meeting the requirements of Section 13.2.6.1 and Section 13.2.6.2 is considered an acceptable storm water BMP for proposed E.9th Street and any proposed city street drainage facilities within the Project Drainage Area.

Permitted BMP Systems – West Bank

Any BMP meeting the requirements of Section 13.2.6.1 and Section 13.2.6.2 is considered an acceptable storm water BMP for the West Bank (all Project Drainage Area west/south of the Cuyahoga River). One or more extended detention ponds or bio-retention cell BMPs shall be used to treat the water quality volume associated with at least seven (7) acres of the West Bank.

Permitted BMP Systems – East Bank

Bioretention cells or extended detention basins designed to ODOT L&D Vol. 2 standards are the only acceptable storm water BMP's for any proposed storm-only drainage system receiving runoff from the mainline or ramps (non-local streets) on the East Bank (all Project Drainage Area east/north of the Cuyahoga River).

14.3.8 Drainage System

In addition to the requirements of Section 13 - Drainage, the bridge deck surface drainage design shall conform to the following:

A. Deck drainage shall be collected at the gutter lines (toe of parapet) by scuppers. Over-the-side drainage is not permitted.
B. Transverse deck drains are not permitted.
C. Welding of scuppers, downspouts, or drainage supports shall not be allowed in tension areas of main steel members.
D. The drainage system shall consist of closed conduit from the deck elevation to the point of discharge into the ground drainage system. Dropping drainage directly from the deck elevation to the ground elevation is not permitted.
E. Conduit enclosed within box type superstructures is not permitted.
F. Conduit enclosed in substructures is not permitted.
G. The conduit shall be polyvinyl chloride (PVC) plastic pipe per ODOT material specification 707.45.
H. The minimum conduit diameter is 15 inches.
I. The conduit shall have sufficient slope to maintain a minimum velocity of three (3) feet per second. Provide slopes as steep as can be practically incorporated with the geometry of the structure. The slope of horizontal conductors shall not be less than 15 percent.
J. Vertical conduit runs to the ground drainage system shall only be located at piers.
K. All bridge drainage inlets/scuppers shall be located within 20 feet of a substructure unit.
L. Vertical conduit runs to the ground drainage system shall consist of closed conduit except for a free fall of two (2) feet above the ground. The drainage shall be controlled at the point of discharge (i.e. bottom of the vertical conduit) by permanent features that completely contain the discharge and prevent erosion to the adjacent ground while discharging up to the 25-year design storm.
M. The maximum conduit bend angle is 45 degrees.
N. Cleanouts shall be provided immediately upstream of each bend, on vertical downspouts accessible from the ground, and at the end of each horizontal segment.

Attachment C – NEORSD Rainfall Data

APPENDIX A

Table A-1. Rainfall Depth-Duration.

Tc (min)	Rainfall Depth (in)											
	2-Month	3-Month	4-Month	6-Month	9-Month	1-Year	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
5	**0.13**	**0.15**	**0.17**	**0.19**	**0.22**	**0.32**	**0.39**	**0.46**	**0.53**	**0.60**	**0.67**	**0.73**
10	**0.24**	**0.28**	**0.30**	**0.35**	**0.40**	**0.50**	**0.60**	**0.72**	**0.81**	**0.93**	**1.01**	**1.10**
15	**0.30**	**0.35**	**0.38**	**0.45**	**0.51**	**0.61**	**0.74**	**0.88**	**1.00**	**1.14**	**1.25**	**1.36**
20	0.34	0.39	0.43	0.50	0.57	0.68	0.82	0.99	1.12	1.29	1.42	1.56
25	0.37	0.44	0.47	0.56	0.63	0.74	0.90	1.10	1.25	1.45	1.60	1.76
30	**0.41**	**0.48**	**0.52**	**0.61**	**0.69**	**0.81**	**0.98**	**1.21**	**1.38**	**1.61**	**1.78**	**1.96**
35	0.43	0.50	0.55	0.64	0.72	0.84	1.01	1.26	1.44	1.69	1.87	2.07
40	0.45	0.52	0.57	0.67	0.75	0.87	1.05	1.31	1.51	1.77	1.97	2.18
45	0.47	0.55	0.60	0.70	0.79	0.90	1.09	1.36	1.57	1.85	2.06	2.29
50	0.49	0.57	0.62	0.72	0.82	0.93	1.13	1.41	1.63	1.93	2.16	2.40
55	0.51	0.59	0.65	0.75	0.85	0.96	1.17	1.46	1.69	2.01	2.25	2.51
60	**0.53**	**0.61**	**0.67**	**0.78**	**0.88**	**0.99**	**1.21**	**1.51**	**1.76**	**2.09**	**2.35**	**2.62**
65	0.54	0.62	0.68	0.80	0.90	1.00	1.22	1.53	1.78	2.12	2.39	2.67
70	0.55	0.64	0.70	0.81	0.92	1.01	1.24	1.55	1.81	2.15	2.43	2.72
75	0.56	0.65	0.71	0.83	0.93	1.03	1.25	1.57	1.83	2.18	2.47	2.76
80	0.57	0.66	0.72	0.84	0.95	1.04	1.27	1.59	1.86	2.22	2.51	2.81
85	0.58	0.67	0.74	0.86	0.97	1.05	1.28	1.61	1.88	2.25	2.55	2.86
90	0.59	0.69	0.75	0.87	0.99	1.07	1.30	1.64	1.91	2.28	2.59	2.91
95	0.60	0.70	0.76	0.89	1.00	1.08	1.31	1.66	1.93	2.31	2.63	2.95
100	0.61	0.71	0.78	0.90	1.02	1.09	1.33	1.68	1.96	2.35	2.67	3.00
105	0.62	0.72	0.79	0.92	1.04	1.11	1.34	1.70	1.98	2.38	2.71	3.05
110	0.63	0.74	0.80	0.93	1.06	1.12	1.36	1.72	2.01	2.41	2.75	3.10
115	0.64	0.75	0.82	0.95	1.07	1.13	1.37	1.74	2.03	2.44	2.79	3.14
120	**0.65**	**0.76**	**0.83**	**0.96**	**1.09**	**1.15**	**1.39**	**1.76**	**2.06**	**2.48**	**2.83**	**3.19**
180	**0.72**	**0.84**	**0.92**	**1.06**	**1.21**	**1.23**	**1.49**	**1.89**	**2.21**	**2.68**	**3.06**	**3.48**
360	**0.84**	**0.98**	**1.07**	**1.24**	**1.41**	**1.45**	**1.75**	**2.21**	**2.61**	**3.20**	**3.70**	**4.25**
720	**0.97**	**1.13**	**1.24**	**1.43**	**1.63**	**1.67**	**2.01**	**2.52**	**2.96**	**3.61**	**4.17**	**4.79**
1440	**1.12**	**1.31**	**1.43**	**1.65**	**1.88**	**1.95**	**2.33**	**2.92**	**3.40**	**4.09**	**4.66**	**5.28**

Bolded numbers indicate values taken directly from rainfall atlas references. Rainfall estimates for 2-month through 9-month frequencies were taken from the Illinois State Water Survey's *Rainfall Frequency Atlas of the Midwest (Bulletin 71)* by Huff and Angel dated 1992. Rainfall estimates for the 1-year through 100-year frequencies are based on average estimates obtained from the NOAA Atlas 14 website (http://hdsc.nws.noaa.gov/hdsc/pfds/orb/oh_pfds.html). Two observation sites (Cleveland WSO AP 33-1657 and Cleveland Easterly 33-1651) were used to develop the average estimates shown in the table above. Non-bolded numbers were derived by means of linear interpretation between the two rainfall atlas references for estimates.

Table A-2. Rainfall Intensity-Duration.

Tc (min)	Rainfall Intensity (in/hr)											
	2-Month	3-Month	4-Month	6-Month	9-Month	1-Year	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
5	1.56	1.80	2.04	2.28	2.64	3.84	4.62	5.52	6.30	7.20	7.98	8.70
10	1.44	1.68	1.80	2.10	2.40	3.00	3.60	4.29	4.83	5.55	6.03	6.57
15	1.20	1.40	1.52	1.80	2.04	2.44	2.94	3.52	3.98	4.54	4.98	5.44
20	1.01	1.18	1.28	1.51	1.71	2.03	2.45	2.97	3.37	3.88	4.27	4.68
25	0.90	1.05	1.14	1.34	1.51	1.78	2.15	2.63	3.00	3.48	3.84	4.22
30	0.82	0.96	1.04	1.22	1.38	1.61	1.95	2.41	2.76	3.21	3.56	3.92
35	0.74	0.86	0.93	1.09	1.24	1.43	1.74	2.15	2.47	2.89	3.21	3.55
40	0.68	0.79	0.86	1.00	1.13	1.30	1.58	1.96	2.26	2.65	2.95	3.27
45	0.63	0.73	0.79	0.93	1.05	1.19	1.45	1.81	2.09	2.46	2.75	3.05
50	0.59	0.68	0.74	0.87	0.98	1.11	1.35	1.69	1.96	2.31	2.59	2.88
55	0.56	0.64	0.70	0.82	0.93	1.04	1.27	1.59	1.85	2.19	2.46	2.74
60	0.53	0.61	0.67	0.78	0.88	0.99	1.21	1.51	1.76	2.09	2.35	2.62
65	0.50	0.57	0.63	0.73	0.83	0.92	1.13	1.41	1.64	1.95	2.20	2.46
70	0.47	0.54	0.60	0.69	0.78	0.87	1.06	1.33	1.55	1.84	2.08	2.33
75	0.45	0.52	0.57	0.66	0.75	0.82	1.00	1.26	1.46	1.75	1.97	2.21
80	0.43	0.50	0.54	0.63	0.71	0.78	0.95	1.20	1.39	1.66	1.88	2.11
85	0.41	0.47	0.52	0.60	0.68	0.74	0.91	1.14	1.33	1.59	1.80	2.02
90	0.39	0.46	0.50	0.58	0.66	0.71	0.87	1.09	1.27	1.52	1.72	1.94
95	0.38	0.44	0.48	0.56	0.63	0.68	0.83	1.05	1.22	1.46	1.66	1.86
100	0.37	0.43	0.47	0.54	0.61	0.66	0.80	1.01	1.17	1.41	1.60	1.80
105	0.35	0.41	0.45	0.52	0.59	0.63	0.77	0.97	1.13	1.36	1.55	1.74
110	0.34	0.40	0.44	0.51	0.58	0.61	0.74	0.94	1.09	1.31	1.50	1.69
115	0.33	0.39	0.43	0.49	0.56	0.59	0.72	0.91	1.06	1.27	1.45	1.64
120	0.33	0.38	0.42	0.48	0.55	0.57	0.70	0.88	1.03	1.24	1.41	1.60
180	0.24	0.28	0.31	0.35	0.40	0.41	0.50	0.63	0.74	0.89	1.02	1.16
360	0.14	0.16	0.18	0.21	0.24	0.24	0.29	0.37	0.43	0.53	0.62	0.71
720	0.08	0.09	0.10	0.12	0.14	0.14	0.17	0.21	0.25	0.30	0.35	0.40
1440	0.05	0.05	0.06	0.07	0.08	0.08	0.10	0.12	0.14	0.17	0.19	0.22

APPENDIX B

INLET SPACING DESIGN

PID : 49633 **Date :** 08/24/2011 **Project :** CUY-90-14.90 **Location :** Ramp A7 to Existing CB95 Inlet

Description : Ramp A7 **Designer :** BAH

Rainfall Area: A **Storm Frequency (yr.) :** 10 **Total Allow. Spread (ft.) :** 10.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)
1012+00	Begin																	
1014+45	CB-3A	245.00	0.90	0.23	1.00	1.43	10.00	0.0287	0.0331	0.0331	12.00	0.0417	5.10	0.81	0.22	1.04	0.141	4.27
* 1017+31	I-2-8	286.00	0.90	0.28	1.00	1.28	10.00	0.0400	0.0420	0.0305	10.00	0.1670	5.10	1.06	0.43	1.49	0.166	3.96

*Sta. 1017+31, I-2-8 (EXCB95) is an existing inlet in EX-80 CUY-071-1854 and CUY-090-1381-1 plans.

**Allowable spread is 12ft in project limits, and 10ft at EXCB95

INLET SPACING DESIGN

PID : 49633 **Date :** 08/24/2011 **Project :** CUY-90-14.90 **Location :** Ramp A7 to Existing CB95 Inlet

Description : Ramp A7 **Designer :** BAH

Rainfall Area: A **Storm Frequency (yr.) :** 50 **Total Allow. Spread (ft.) :** 10.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)
1012+00	Begin																	
1014+45	CB-3A	245.00	0.90	0.23	1.00	1.29	10.00	0.0287	0.0331	0.0331	12.00	0.0417	6.79	1.01	0.37	1.38	0.157	4.76
1017+31	I-2-8	286.00	0.90	0.28	1.00	1.15	10.00	0.0400	0.0420	0.0305	10.00	0.1670	6.79	1.28	0.78	2.06	0.188	4.48

INLET SPACING DESIGN

PID : 49633 **Date :** 08/24/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, Ohio

Description : Starkweather-Kenilworth Inlet Spacing I-90 WB 95+48_104+54 RT **Designer :** BAH

Rainfall Area: A **Storm Frequency (yr.) :** 10 **Total Allow. Spread (ft.) :** 6.50 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)
92+18	Begin																	
95+48	I-3C	330.00	0.90	0.24	1.80	3.41	10.00	0.0064	0.0354	0.0192	6.50	0.1667	5.10	1.12	0.00	1.12	0.198	5.58
* 98+26	I-3C	278.00	0.90	0.22	1.75	3.62	10.00	0.0051	0.0273	0.0201	6.50	0.1667	5.10	1.02	0.00	1.02	0.181	6.67
100+29	I-3C	203.00	0.90	0.20	2.10	2.66	10.00	0.0035	0.0400	0.0328	6.50	0.1667	5.10	0.92	0.00	0.92	0.215	5.38
102+75	I-3D	246.00	0.90	0.24	1.80	3.09	10.00	0.0035	0.0400	0.2500	6.50	0.1667	5.10	1.10	0.00	1.10	0.230	5.76
104+54	I-3C	179.00	0.90	0.20	1.60	2.16	10.00	0.0042	0.0400	0.1860	6.50	0.1667	5.10	0.92	0.00	0.92	0.208	5.21

*Inlet at 98+26 is outside of project limits and is the existing spread

INLET SPACING DESIGN

PID : 49633 **Date :** 08/24/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, Ohio

Description : Starkweather-Kenilworth Inlet Spacing I-90 WB 95+48_104+54 RT **Designer :** BAH

Rainfall Area: A **Storm Frequency (yr.) :** 50 **Total Allow. Spread (ft.) :** 6.50 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)
92+18	Begin																	
95+48	I-3C	330.00	0.90	0.24	1.80	3.12	10.00	0.0064	0.0354	0.0192	6.50	0.1667	6.79	1.49	0.01	1.49	0.220	6.22
98+26	I-3C	278.00	0.90	0.22	1.75	3.38	10.00	0.0051	0.0273	0.0201	6.50	0.1667	6.79	1.36	0.01	1.37	0.202	7.71
100+29	I-3C	203.00	0.90	0.20	2.10	2.43	10.00	0.0035	0.0400	0.0328	6.50	0.1667	6.79	1.23	0.00	1.23	0.240	6.01
102+75	I-3D	246.00	0.90	0.24	1.80	2.82	10.00	0.0035	0.0400	0.2500	6.50	0.1667	6.79	1.47	0.00	1.47	0.257	6.41
104+54	I-3C	179.00	0.90	0.20	1.60	1.96	10.00	0.0042	0.0400	0.1860	6.50	0.1667	6.79	1.23	0.00	1.23	0.232	5.81

STORM SEWER SYSTEM

PID : 49633 **Date :** 08/24/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, OH

Description : Starkweather Outfall - Ramp A7 1014+45 RT **Designer :** BAH

Rainfall Area: A **Just Full Capacity Frequency (yrs.) :** 10 **Hydraulic Gradient Frequency (yrs.) :** 25

Minimum Pipe Size : 15.00 **Tailwater Elevation (ft.):** 673.25

JUNCTION From To	STATION From To	ΔAREA ΣAREA (acres)	ΔCA ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	(25 yrs.)	DISCHARGE (cfs.) (10 yrs.)	(25 yrs.)	PIPE DIAM. (in.)	LENGTH (ft.)	SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
1015 015B	1014+46	0.23	0.20	10.00	5.10	6.18	1.0	1.3	15	83.0	0.2475 *	695.10	10.77	29.96	0.0005	695.28	698.00	2.72	1.65	CB 3A
begin	1014+47	0.23	0.20									674.56				675.41	678.96			0.015
015B 3988	1014+47	0.00	0.00	10.13	5.07	6.16	1.0	1.3	15	16.0	0.0525	674.56	6.26	13.80	0.0005	674.82	678.96	4.14	3.15	MH 3
final	1014+45	0.23	0.20									673.72				674.57	678.97			0.015

* Pipe is a broken back pipe and the slope reflects the overall slope from the invert of the pipe at structure D-1015 to the invert at structure D-1015B (shown as 015B above). See storm sewer profile for actual pipe lengths and slopes for the individual components of the broken back pipe (sheet 158/271 in the BU 1020 plan set).

STORM SEWER SYSTEM

PID : 49633 **Date :** 08/24/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, OH

Description : I-90 WB - Southwest Storm Sewer - Proposed 100+29 R **Designer :** BAH

Rainfall Area: A **Just Full Capacity Frequency (yrs.) :** 10 **Hydraulic Gradient Frequency (yrs.) :** 25

Minimum Pipe Size : 15.00 **Tailwater Elevation (ft.):** 699.96

JUNCTION From	To	STATION From / To	ΔAREA / Σ AREA (acres)	ΔCA / ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	(25 yrs.)	DISCHARGE (cfs.) (10 yrs.)	(25 yrs.)	PIPE DIAM. (in.)	LENGTH (ft.)	SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
* 98CB	94CB	95+46	0.40	0.36	10.00	5.10	5.60	1.9	2.0	15	276.0	0.0060	701.78	3.39	4.66	0.0013	702.38	706.90	4.52	3.87	I 3C
begin		98+26	0.40	0.36									700.13				701.58	705.40			0.015
* 94CB	89A	98+26	0.37	0.33	11.36	4.81	5.60	3.4	3.9	15	202.0	0.0050	700.13	3.62	4.26	0.0048	701.58	705.40	3.82	4.02	I 3C
		100+29	0.77	0.70									699.12				700.60	702.92			0.015
89A	89B	100+29	0.30	0.27	12.29	4.64	5.60	4.5	5.4	15	18.0	0.0078	699.12	4.56	5.31	0.0093	700.60	702.92	2.32	2.55	I 3C
		100+46	1.07	0.97									698.98				700.44	702.66			0.015
* 89B	91CB	100+46	0.00	0.00	12.35	4.63	5.60	4.5	5.4	15	51.0	0.0056	698.98	3.64	4.50	0.0093	700.44	702.66	2.22	2.43	MH 3
final		100+46	1.07	0.97									698.70				699.96	703.20			0.015

* These are part of an existing drainage system, analyzed to verify capacity of 89A to 89B pipe.
There are no profiles for these existing pipes.

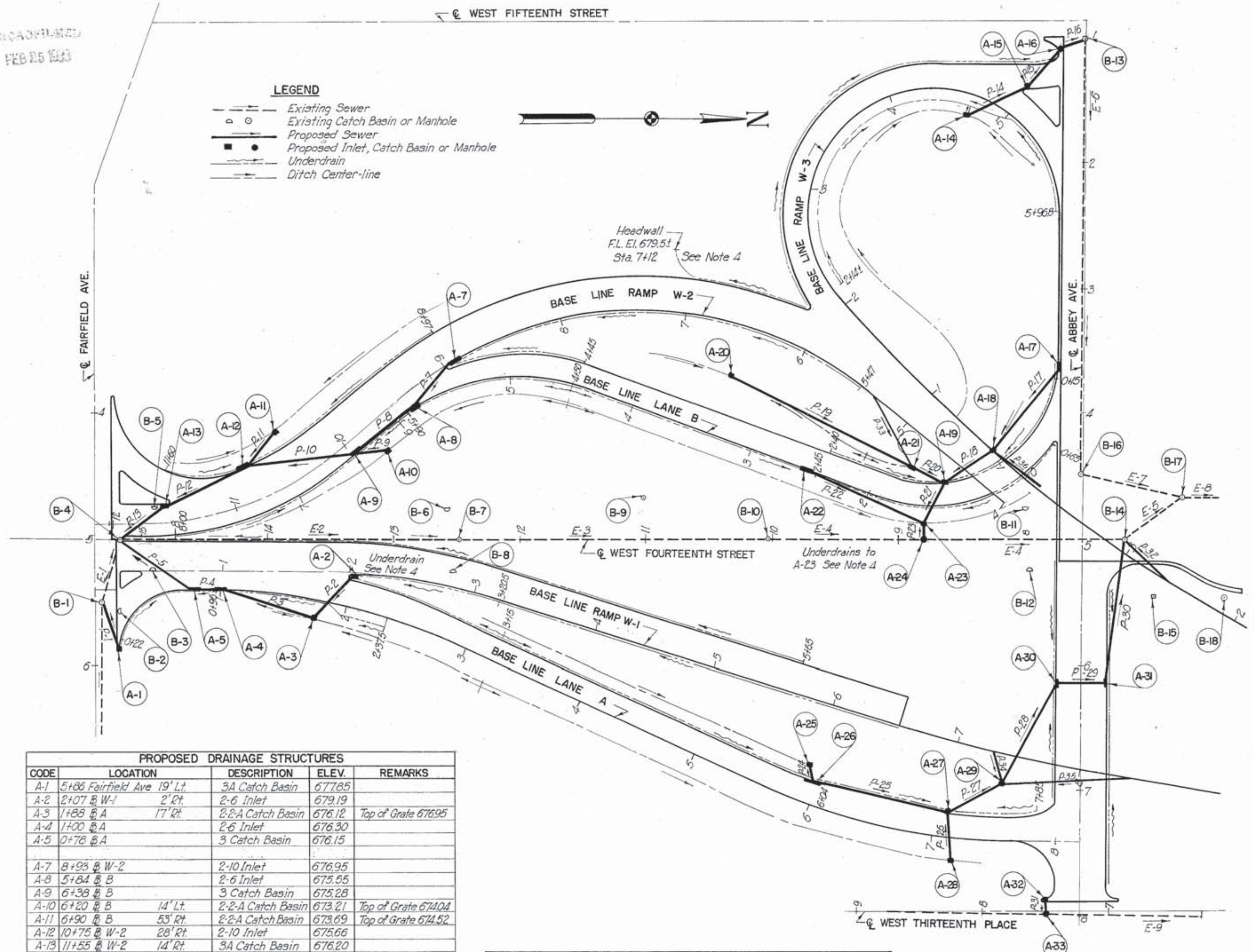
FED. ROAD DIV. NO.	STATE	FED. AID PROJ. NO.	TYPE FUNDS	17 / 67
2	OHIO			

CUYAHOGA COUNTY
CITY OF CLEVELAND

INNER BELT FREEWAY - PART 4
WEST APPROACH TO CENTRAL VIADUCT

CUY- 42 R -17.43

DRAINAGE PLAN



GENERAL NOTES

Sewers are designed by the Rational Formula based on a 10-year storm frequency flowing full.

Minimum Velocity of flow is 3.0 F.P.S. for main lines and 2.5 F.P.S. for laterals.

All stubs for bridge drainage are to be 12-inch diameter concrete pipe, set on line and grade as specified on the profiles and on the bridge plans. The stubs shall extend a minimum distance of 1 foot 0 inch outside the drainage structures.

Pipe sewers connected to existing catch basins are not shown on the plans. Where sewer pipes not shown are encountered during construction, the pipes shall be cut at the limits of construction and plugged to the satisfaction of the Engineer. Payment for cutting and plugging shall be included in the unit price bid for item E-1, "Excavation."

Payment for the removal and/or abandoning of pipe outlets necessitated by the abandoning of existing catch-basins or manholes, will be included in the unit price bid for Item I-16, "Manholes, Catch Basins, or Inlets Abandoned", unless payment is otherwised authorized specifically under other items in the plans.

Where it is necessary under Item I-8, "Manholes adjusted to grade" to replace unsatisfactory manhole frame and cover castings, payment for the new castings shall be made at the contract unit price bid per each for Item I-8 "Manhole Frame and Cover (Light)" and Item I-8 "Manhole Frame and Cover (Heavy)". Payment shall constitute full compensation for furnishing, hauling and placing all castings and any incidentals necessary to complete the item to the satisfaction of the Engineer.

PROPOSED DRAINAGE STRUCTURES

CODE	LOCATION		DESCRIPTION	ELEV.	REMARKS
A-1	5+86 Fairfield Ave	19' Lt.	3A Catch Basin	677.85	
A-2	2+07 BL W-1	2' Rt.	2-6 Inlet	679.19	
A-3	1+88 BL A	17' Rt.	2-2-A Catch Basin	676.12	Top of Grate 676.95
A-4	1+00 BL A		2-6 Inlet	676.30	
A-5	0+78 BL A		3 Catch Basin	676.15	
A-7	8+93 BL W-2		2-10 Inlet	676.95	
A-8	5+84 BL B		2-6 Inlet	675.55	
A-9	6+38 BL B		3 Catch Basin	675.28	
A-10	6+20 BL B	14' Lt.	2-2-A Catch Basin	673.21	Top of Grate 674.04
A-11	6+90 BL B	53' Rt.	2-2-A Catch Basin	673.69	Top of Grate 674.52
A-12	10+75 BL W-2	28' Rt.	2-10 Inlet	675.66	
A-13	11+55 BL W-2	14' Rt.	3A Catch Basin	676.20	
A-14	4+70 BL W-3	17' Rt.	2-2-A Catch Basin	675.17	Top of Grate 676.00
A-15	5+04 BL W-3	24.5' Lt.	3A Catch Basin	677.98	
A-16	1+11 Abbey Ave.	20' Rt. of ℄	3A Catch Basin	678.55	
A-17	0+10 BL B		2-10 Inlet	676.02	
A-18	1+00 BL B	11.5' Rt.	2-2-A Catch Basin	673.50	Top of Grate 674.33
A-19	1+48 BL B		3 Catch Basin	674.38	
A-20	3+35 BL B	49.5' Rt.	2-2-A Catch Basin	670.90	Top of Grate 671.73
A-21	1+75 BL B	11' Rt.	2-2-A Catch Basin	673.51	Top of Grate 674.34
A-22	2+50 BL B		2-10 Inlet	675.44	
A-23	1+62 BL B	32' Lt.	2-2-A Catch Basin	672.97	Top of Grate 673.80
A-24	1+61.5 BL B	45'± Lt.	2 Manhole	673.80	Top of Cover
A-25	5+90 BL A	30' Lt.	2-2-A Catch Basin	675.78	Top of Grate 676.61
A-26	6+00 BL A	17' Lt.	2-10 Inlet	675.97	
A-27	7+10 BL A	19' Lt.	3 Catch Basin	674.11	
A-28	7+18 BL A	18' Rt.	2-2-A Catch Basin	672.87	Top of Grate 673.10
A-29	7+55 BL A	45' Lt.	1 Manhole	678.0±	Top of Cover
A-30	6+14.52 Abbey Ave.	20' Rt. of ℄	3A Catch Basin	674.26	
A-31	6+14.52 Abbey Ave.	20' Lt. of ℄	3A Catch Basin	674.26	
A-32	7+49 W. 13th Pl.	10' Rt. of ℄	3A Catch Basin	675.61	
A-33	7+49 W. 13th Pl.	3' Rt. of ℄	1 Manhole	675.10±	Top of Cover

EXISTING DRAINAGE STRUCTURES

CODE	LOCATION		DESCRIPTION	ELEV.	REMARKS
B-1	5+50 Fairfield Ave.	6' Lt. ℄	Manhole		Undisturbed
B-2	5+57 Fairfield Ave.	18' Lt. ℄	Catch Basin		Abandon
B-3	14+92 W. 14th St.	22' Lt. ℄	Catch Basin		Abandon
B-4	5+00 Fairfield	19' Lt. ℄	Manhole	676.7±	Adjust to Grade
B-5	14+92 W. 14th St.	25' Rt. ℄	Catch Basin		Abandon
B-6	12+58 W. 14th St.	25' Rt. ℄	Catch Basin		Abandon
B-7	12+48 ℄ W. 14th St.		Manhole		Abandon
B-8	12+54 W. 14th St.	25' Lt. ℄	Catch Basin		Abandon
B-9	11+01 W. 14th St	33' Rt. ℄	Manhole (Sanitary)	675.8±	Adjust to Grade
B-10	10+03 ℄ W. 14th St.		Manhole	676.2±	Adjust to Grade
B-11	7+97 W. 14th St.	25' Rt. ℄	Catch Basin		Abandon
B-12	8+00 W. 14th St.	25' Lt. ℄	Catch Basin		Abandon
B-13	1+01 ℄ Abbey Ave.		Manhole		Undisturbed
B-14	7+20 ℄ W. 14th St.		Manhole		Undisturbed
B-15	6+98 W. 14th St	45' Lt. ℄	Catch Basin		Abandon
B-16	4+49 Abbey Ave.	1'± Rt. ℄	Manhole		Undisturbed
B-17	6+76 W. 14th St.	33' Rt. ℄	Manhole		Undisturbed
B-18	6+40 W. 14th St.	48' Lt. ℄	Manhole	675.1±	Adjust to Grade

EXISTING SEWERS

CODE	LOCATION STREET	FROM	TO	SIZE	LENGTH	REMARKS
E-1	Fairfield	B-1	B-4	18	48	Undisturbed
E-2	W. Fourteenth	B-4	B-7	No. 4 C	264	Undisturbed
E-3	W. Fourteenth	B-7	B-10	No. 4 C	241	Undisturbed
E-4	W. Fourteenth	B-10	B-14	No. 5 C	278	Undisturbed
E-5	W. Fourteenth	B-14	B-17	No. 5 C	51	Undisturbed
E-6	Abbey Ave.	B-13	B-16	12	345	Undisturbed
E-7	W. Fourteenth	B-16	B-17	12	78	Undisturbed
E-8	W. Fourteenth	B-17	North	24		Undisturbed
E-9	W. Thirteenth	A-31	North	12		Undisturbed

PROPOSED SEWERS

CODE	LOCATION STREET	FROM	TO	ITEM I-2 LIN. FT. CLASS A 12"	CLASS A 15"	CL. A. U.P. 12"	CL. A. U.P. 15"	CLASS B 12"	CLASS B 15"	CL. B. U.P. 12"	CL. B. U.P. 15"
P-1	Fairfield Ave.	A-1	B-1							35	
P-2	Lane A	A-2	A-3							42	
P-3	Rt. of Lane A	A-3	A-4					85			
P-4	Lane A	A-4	A-5							19	
P-5	Lane A - Ramp W-1	A-5	B-4							65	
P-7	Lane B	A-7	A-8							46	
P-8	Lane B	A-8	A-9							51	
P-9	Left of Lane B	A-10	A-9	21							
P-10	Lane B - Ramp W-2	A-9	A-12								85
P-11	Right of Ramp W-2	A-11	A-12	29							
P-12	Ramp W-2	A-12	A-13								72
P-13	Ramp W-2 - Lane B	A-13	B-4								45
P-14	Ramp W-3	A-14	A-15			52					
P-15	Ramp W-3	A-15	A-16								37
P-16	Abbey Ave.	A-16	B-13								19
P-17	Rt. of Lane B	A-17	A-18					81			
P-18	Rt. of Lane B	A-18	A-19					44			
P-19	Rt. of Lane B	A-20	A-21	157							
P-20	Rt. of Lane B	A-21	A-19	26							
P-21	Lane B	A-19	A-23								34
P-22	Lt. of Lane B	A-22	A-23					96			
P-23	Lt. of Lane B	A-23	A-24						10		
P-24	Lt. of Lane A	A-25	A-26	14							
P-25	Lane A	A-26	A-27							102	
P-26	Lane A	A-28	A-27			37					
P-27	Lt. of Lane A	A-27	A-29						47		
P-28	Rt. of Abbey Ave.	A-29	A-30						88		
P-29	Abbey Ave.	A-30	A-31								38
P-30	Lt. of Abbey Ave.	A-31	B-14								112
P-31	West 13th Pl.	A-32	A-33							10	
P-32	West 14th St.	Pier 2A	B-14							35	
P-33	Abutment W-2		A-21					50			
P-34	Lt. of Lane A	I-W-1	A-29					25			
P-35	Abbey Ave.	Pier 2A	A-29							90	
P-36	Lane B	I-W-2	A-18							50	

NOTES

1. Abbreviations:
   Rt. - Right
   Lt. - Left
   U.P. - Under Pavement
   Directions are noted as: E, W, So. & No.

2. Call-Letters:
   Drainage structures and pipes are prefixed with the following call letters.
   A - Proposed Structures
   P - Proposed Pipe Sewers
   B - Existing Structures
   E - Existing Pipe Sewers
   For sewer profiles see Sheets 18 and 19
   The direction of sewer flow is indicated by arrows.

3. Elevations:
   Elevations shown in the tables are normal grade or gutter elevations for the center-line of the structure at the curb face for 3, and 3A catch basins; normal ditch and center of structure for 2-2-A catch basins; top of cover at the center for manholes; normal grade at the intersection of the center-line of cover and at curb face for all 2-6 and 2-10 inlets.

4. Underdrain Connections:
   For details of Pipe Underdrain Outlet see Standard Construction Drawings I-1, 2, 3, 4 & 5

SCALE 1" = 50'
MADE SK. DATE 1-15-56
TRCD. BMQ DATE 2-15-56
CKD. HKM DATE 2-16-56

HOWARD, NEEDLES, TAMMEN & BERGENDOFF
CONSULTING ENGINEERS
KANSAS CITY, CLEVELAND, NEW YORK

914 SHEET 17

MICROFILMED
FEB 25 1958

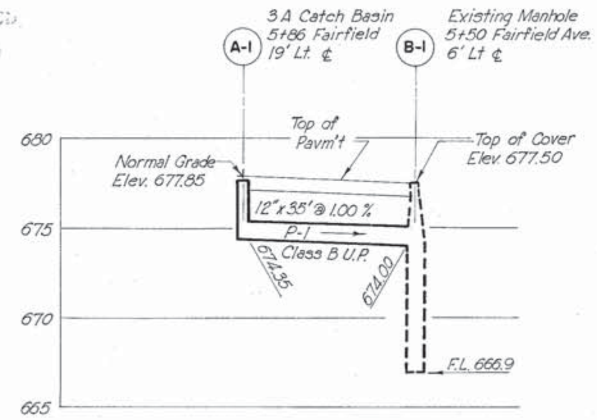
FED. ROAD DIV. NO.	STATE	FED. AID PROJ. NO.	TYPE FUNDS	18/67
2	OHIO			

CUYAHOGA COUNTY
CITY OF CLEVELAND

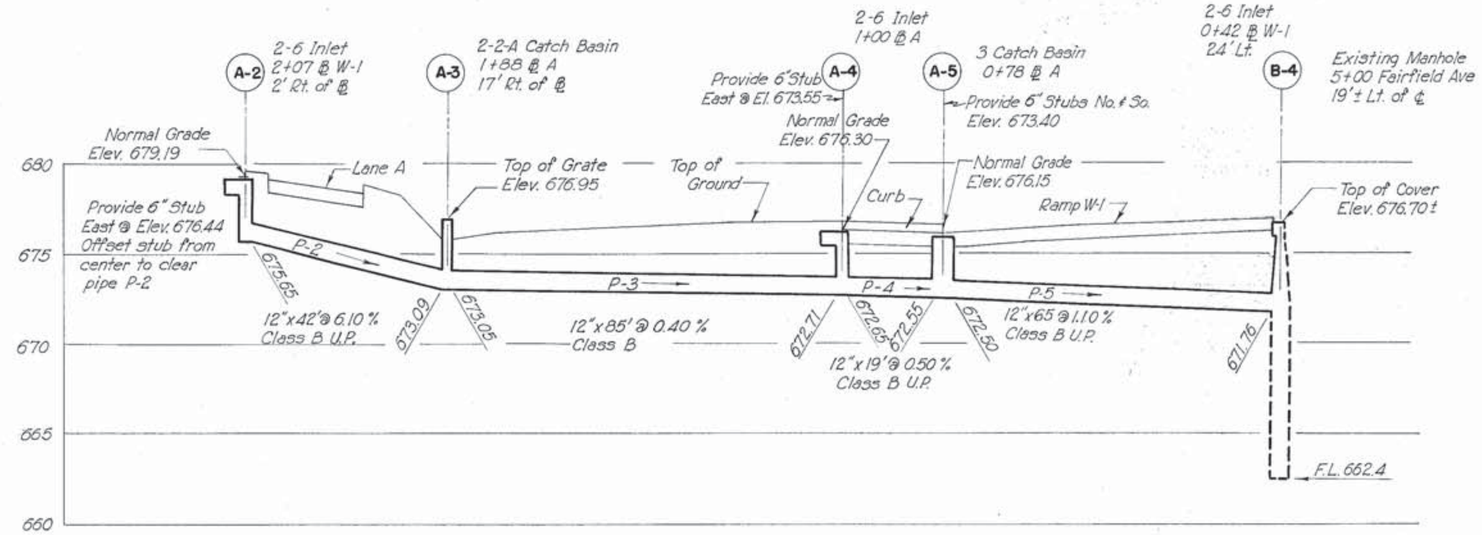
INNER BELT FREEWAY - PART 4
WEST APPROACH TO CENTRAL VIADUCT

CUY-42 R-17.43

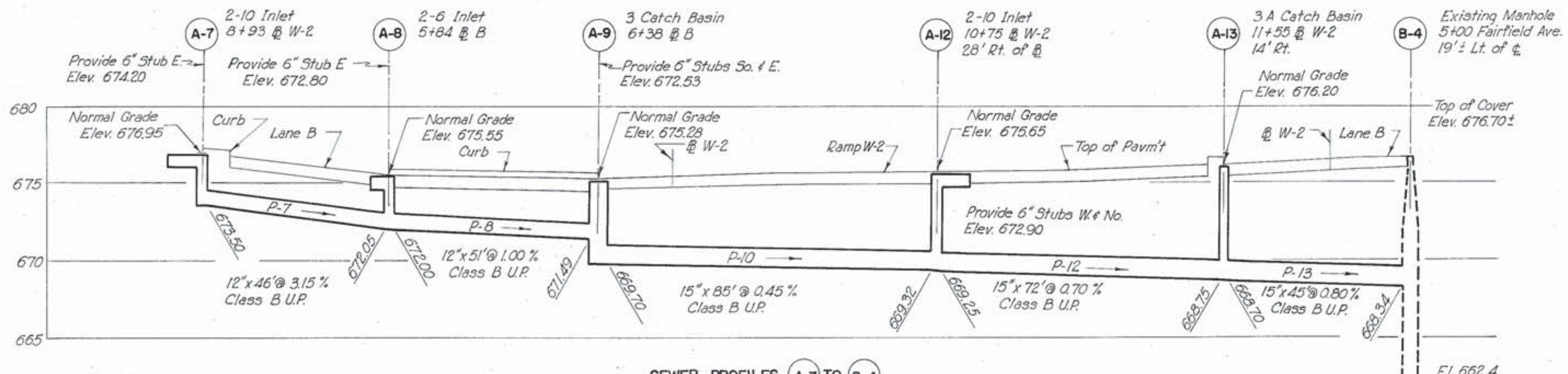
DRAINAGE PROFILES



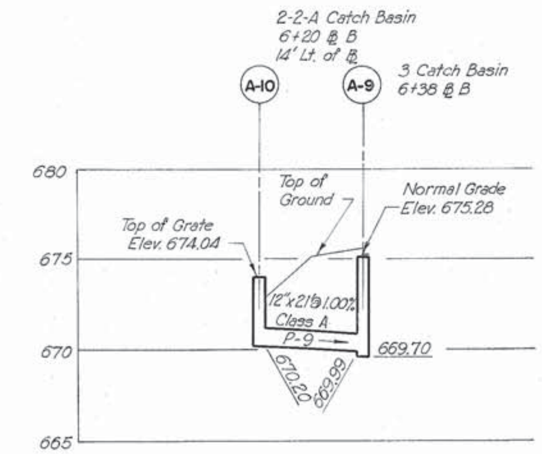
SEWER PROFILE (A-1) TO (B-1)



SEWER PROFILE (A-2) TO (B-4)

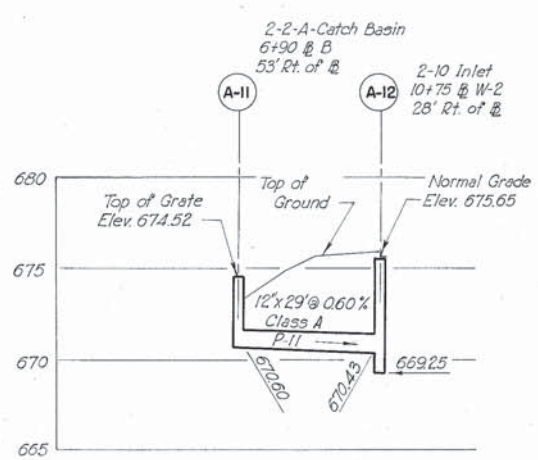


SEWER PROFILES (A-7) TO (B-4)

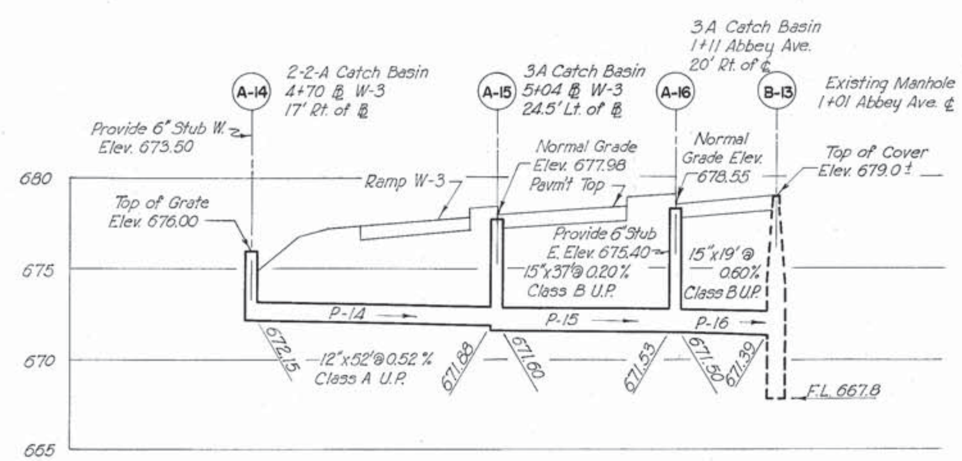


SEWER PROFILE (A-10) TO (A-9)

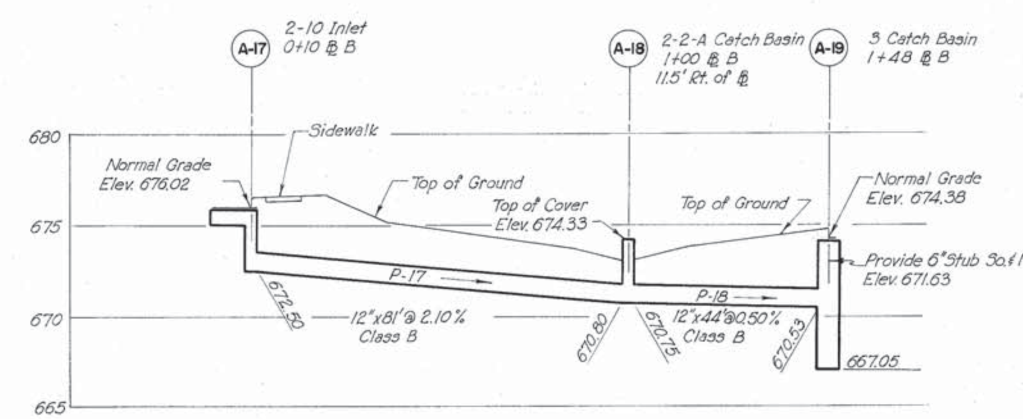
LIST OF SEWER PROFILES On This Sheet	
P-1	P-10
P-2	P-11
P-3	P-12
P-4	P-13
P-5	P-14
P-6	P-15
P-7	P-16
P-8	P-17
P-9	P-18



SEWER PROFILE (A-11) TO (A-12)



SEWER PROFILES (A-14) TO (B-13)



SEWER PROFILES (A-17) TO (A-19)

Note:
Scales: Horz. 1"=20'
Vert. 1"=5'

SCALE See Note	HOWARD, NEEDLES, TAMMEN & BERGENDOFF CONSULTING ENGINEERS
MADE S.K. DATE 2-3-56	KANSAS CITY CLEVELAND NEW YORK
TRCD. BMO DATE 2-8-56	914 SHEET 18
CKD. HHM DATE 2-9-56	

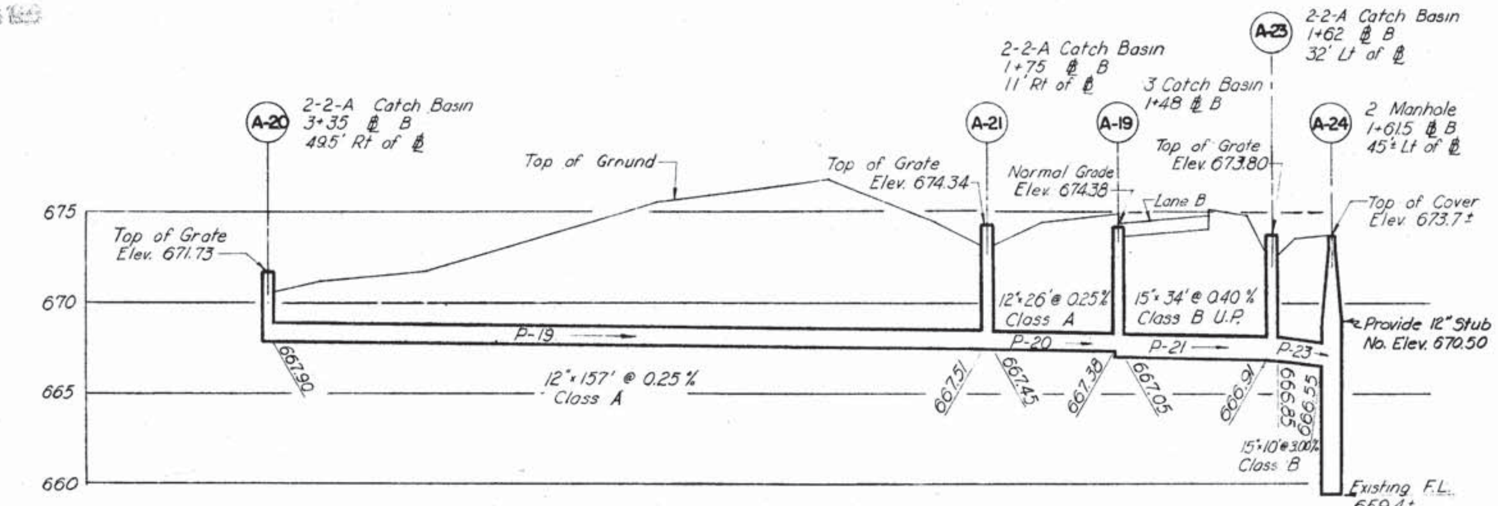
FED. ROAD DIV. NO.	STATE	FED. AID PROJ. NO.	TYPE FUNDS	19/67
2	OHIO			

CUYAHOGA COUNTY
CITY OF CLEVELAND

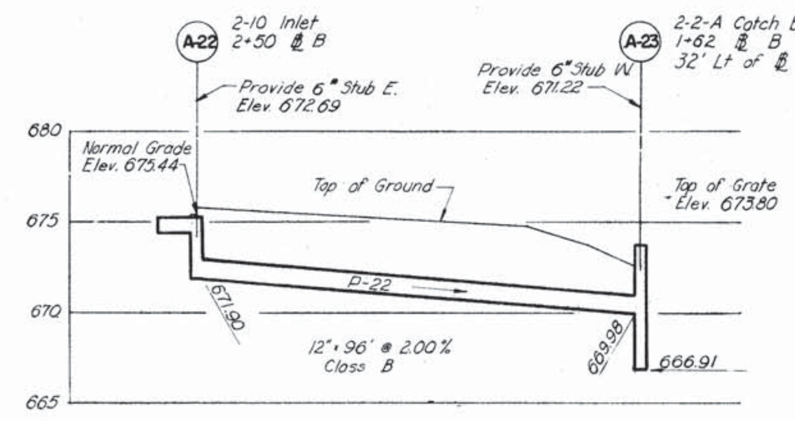
INNER BELT FREEWAY - PART 4
WEST APPROACH TO CENTRAL VIADUCT

CUY-42 R-17.43

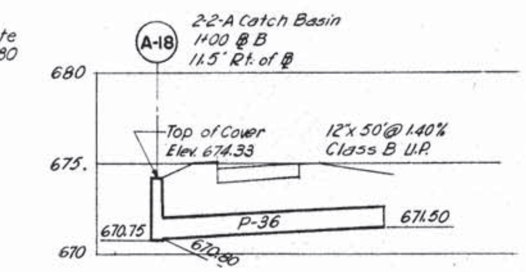
DRAINAGE PROFILES



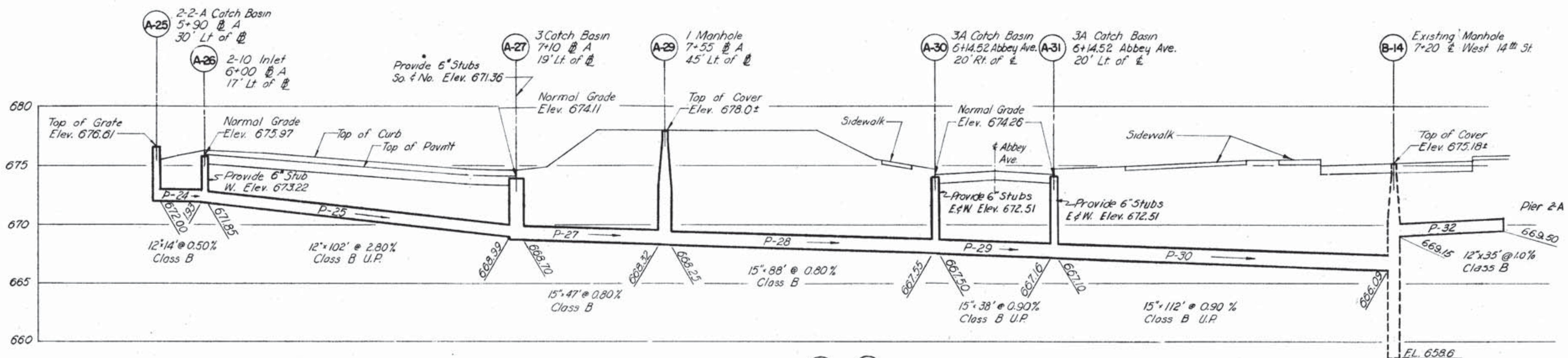
SEWER PROFILES (A-20) TO (A-24)



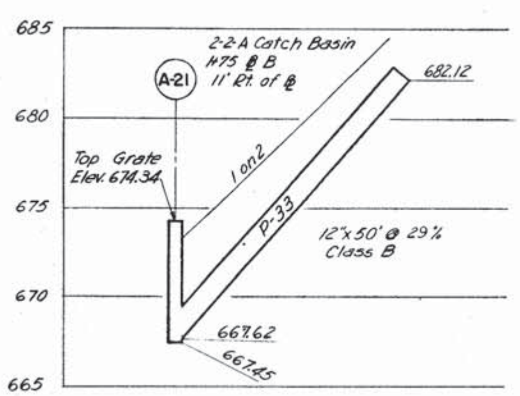
SEWER PROFILE (A-22) TO (A-23)



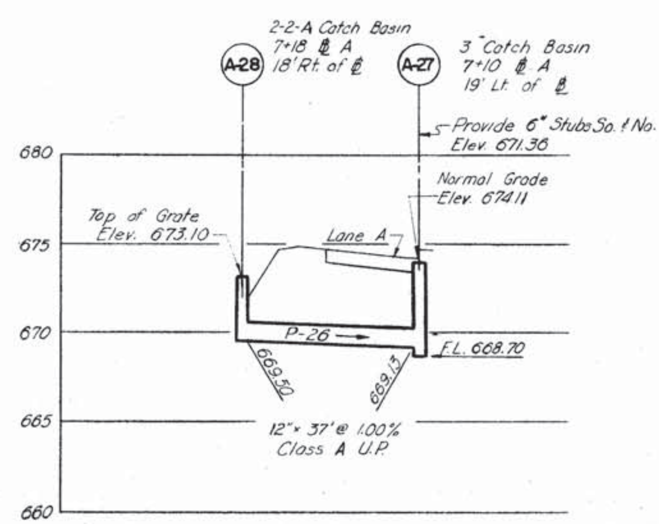
SEWER PROFILE (A-18) TO PIER 1-W-2



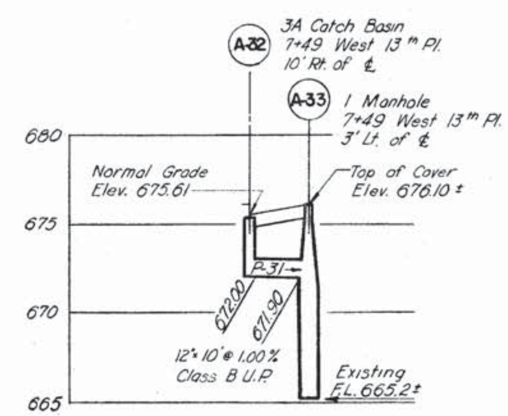
SEWER PROFILES (A-25) TO (B-14)



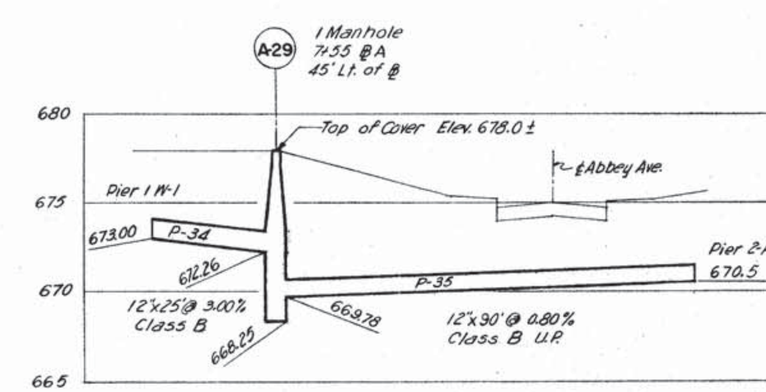
SEWER PROFILE (A-21) TO ABUTMENT W-2



SEWER PROFILE (A-28) TO (A-27)



SEWER PROFILE (A-32) TO (A-33)



SEWER PROFILE (A-29) TO PIER IWI AND PIER 2A

LIST OF SEWER PROFILES ON THIS SHEET	
P-19	P-25
P-20	P-26
P-21	P-27
P-22	P-28
P-23	P-29
P-24	P-30
	P-31
	P-32
	P-33
	P-34
	P-35
	P-36

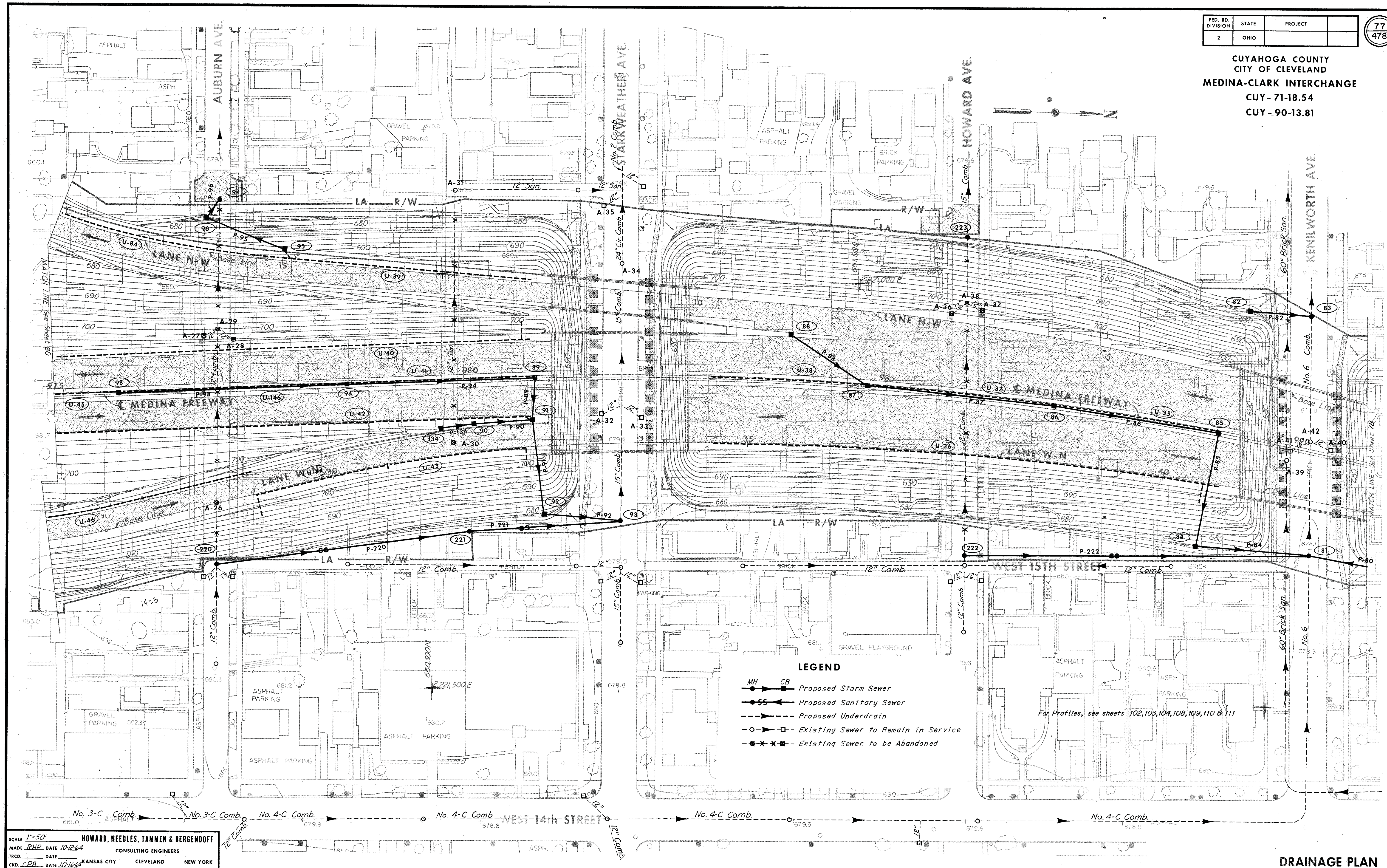
SCALE Hor. 1"=20', Ver. 1"=50'
MADE SK DATE 2-6-56
TRCD. SK DATE 2-6-56
CHKD. H.K.M. DATE 3-8-56

HOWARD, NEEDLES, TAMMEN & BERGENDOFF
CONSULTING ENGINEERS
KANSAS CITY, CLEVELAND, NEW YORK
914 SHEET: 19

FED. RD. DIVISION	STATE	PROJECT	
2	OHIO		

77
478

CUYAHOGA COUNTY
CITY OF CLEVELAND
MEDINA-CLARK INTERCHANGE
CUY-71-18.54
CUY-90-13.81



SCALE 1"=50'
MADE RHP DATE 10-12-64
TRCD. DATE
CKD. CPB DATE 10-16-64

HOWARD, NEEDLES, TAMMEN & BERGENDOFF
CONSULTING ENGINEERS
KANSAS CITY CLEVELAND NEW YORK

DRAINAGE PLAN

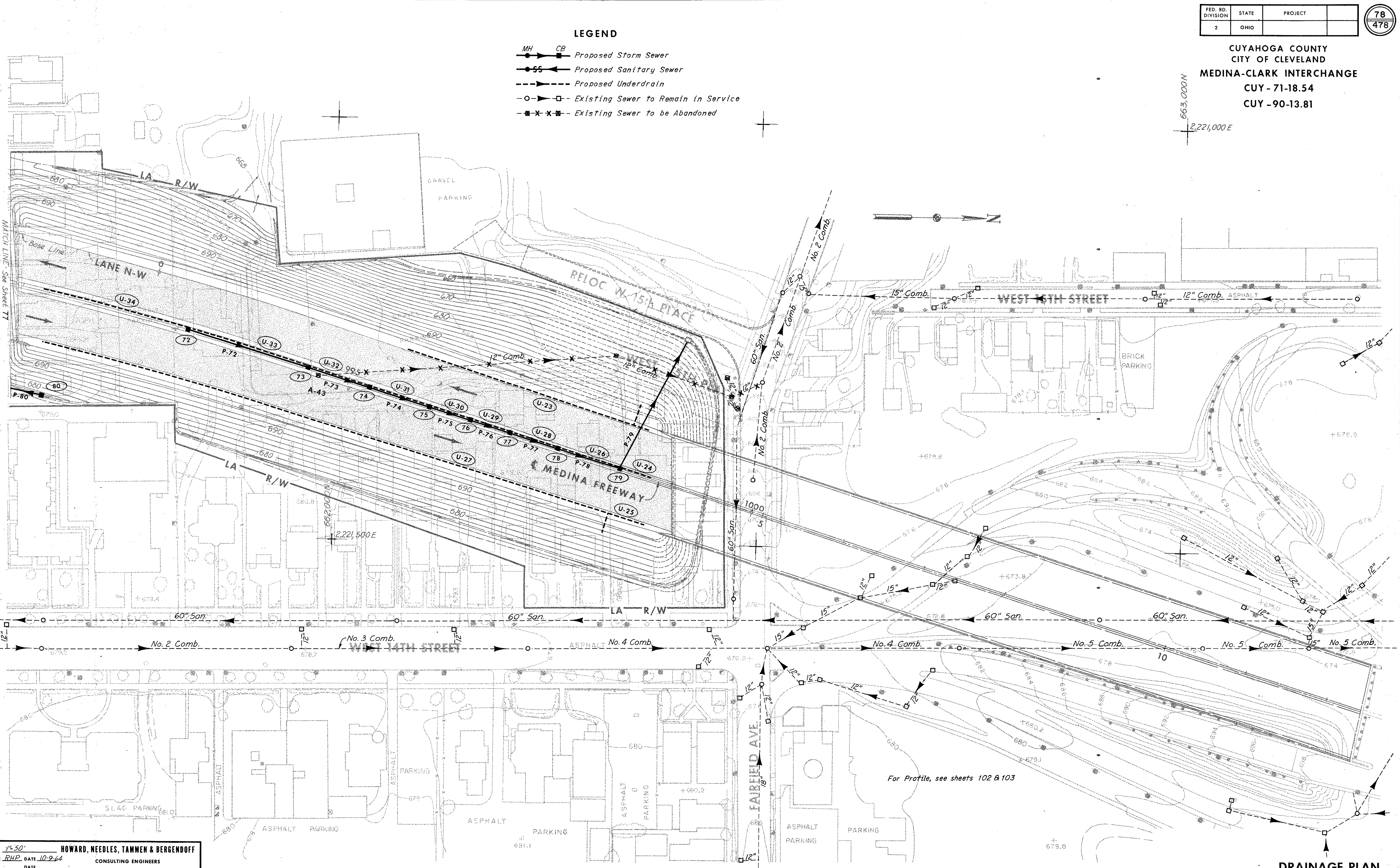
FED. RD. DIVISION	STATE	PROJECT	
2	OHIO		

78/478

CUYAHOGA COUNTY
CITY OF CLEVELAND
MEDINA-CLARK INTERCHANGE
CUY-71-18.54
CUY-90-13.81

LEGEND

- MH CB Proposed Storm Sewer
- SS Proposed Sanitary Sewer
- Proposed Underdrain
- Existing Sewer to Remain in Service
- Existing Sewer to be Abandoned



DRAINAGE PLAN

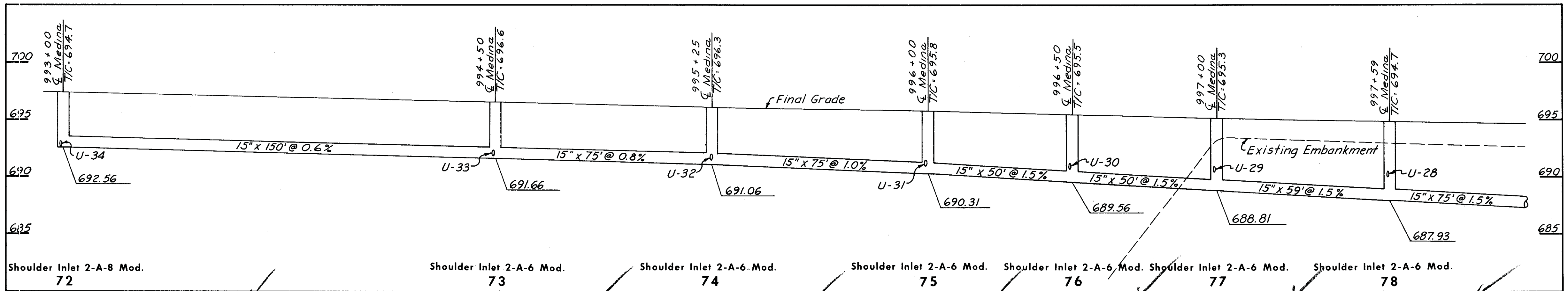
SCALE 1"=50'
MADE RHP DATE 10-9-64
TRCD DATE
CKD. CPB DATE 10-16-64

HOWARD, NEEDLES, TAMMEN & BERGENDOFF
CONSULTING ENGINEERS
KANSAS CITY CLEVELAND NEW YORK

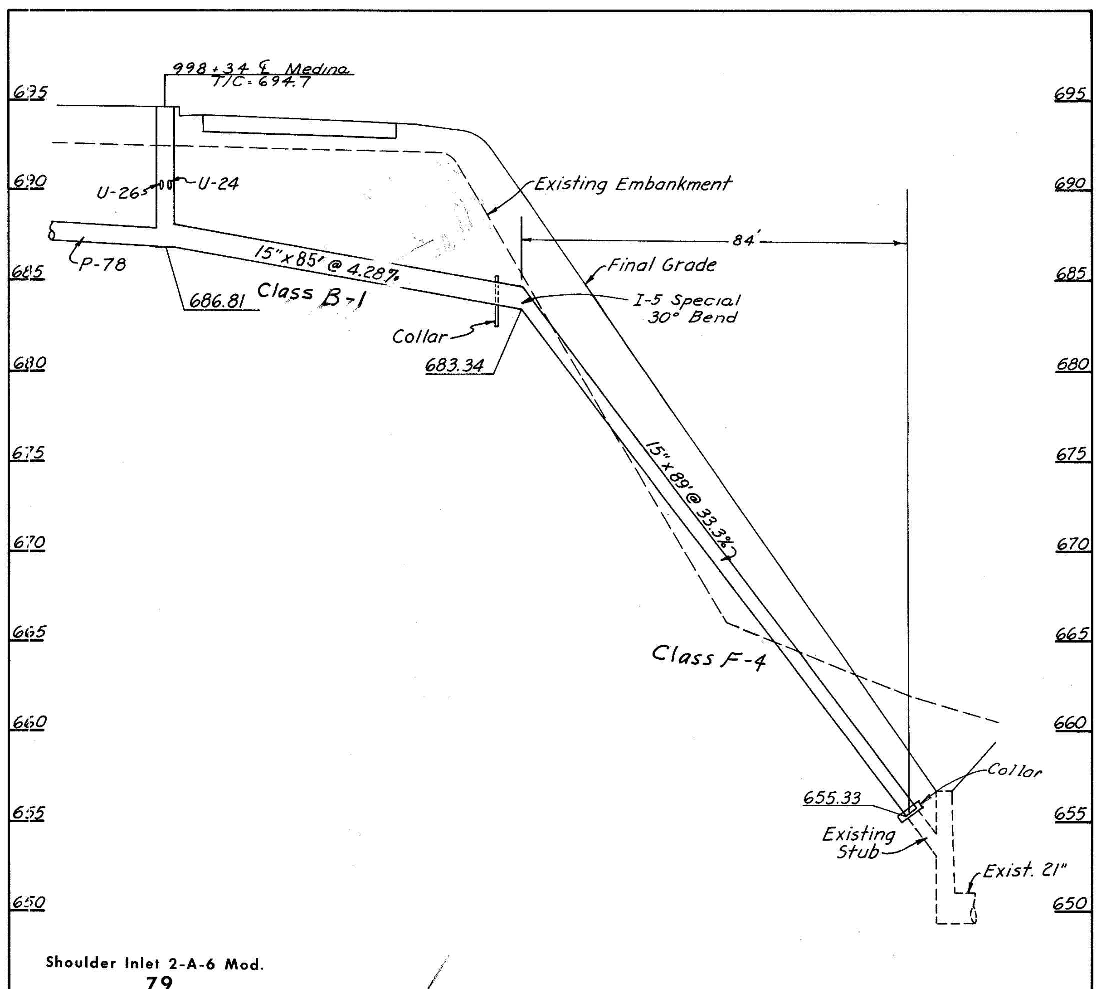
FED. RD. DIVISION	STATE	PROJECT	
2	OHIO		

102
478

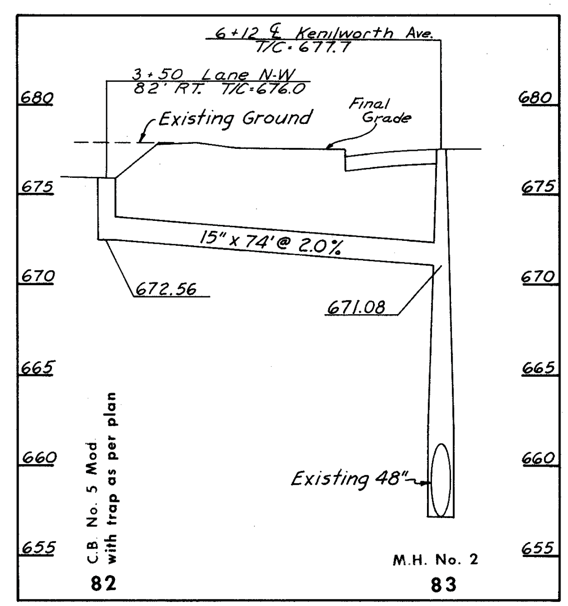
CUYAHOGA COUNTY
CITY OF CLEVELAND
MEDINA-CLARK INTERCHANGE
CUY-71-18.54
CUY-90-13.81



P-72 CLASS B-1 · **P-73** CLASS B-1 · **P-74** CLASS B-1 · **P-75** CLASS B-1 · **P-76** CLASS B-1 · **P-77** CLASS B-1 · **P-78** CLASS B-1



P-79



P-82
CLASS B-1

ESTIMATED QUANTITIES

CODE	LOCATION	I-8 STRUCTURES: Shoulder Inlet 2-A-6 Mod.	Shoulder Inlet 2-A-8 Mod.	C.B. 5 Mod. with trap	M.H. No. 2
72	993+00 Medina Freeway ℄ *		1 *		
73	994+50 Medina Freeway ℄ *	1 *			
74	995+25 Medina Freeway ℄ *	1 *			
75	996+00 Medina Freeway ℄ *	1 *			
76	996+50 Medina Freeway ℄ *	1 *			
77	997+00 Medina Freeway ℄ *	1 *			
78	997+59 Medina Freeway ℄ *	1 *			
79	998+34 Medina Freeway ℄ *	1 *			
82	3+50 Lane N-W 82' RT. *			1 *	
83	6+12 Kenilworth Avenue ℄ *				1 *
	CUY-90-13.81 TOTALS	7 *	1 *	1 *	1 *

CODE	ROADWAY	INLET CODE FROM	TO	I-1 Pipe CLASS B-1 15"	I-5 Pipe Class F-4 Sec. M-6.4(c) Special 15"x30°	I-1 Pipe Class F-4 M-6.4(c) 15"
P-72	Medina Freeway *	72	73	150' *		
P-73	Medina Freeway *	73	74	75' *		
P-74	Medina Freeway *	74	75	75' *		
P-75	Medina Freeway *	75	76	50' *		
P-76	Medina Freeway *	76	77	50' *		
P-77	Medina Freeway *	77	78	59' *		
P-78	Medina Freeway *	78	79	75' *		
P-79	Medina Freeway *	79	Ditch	85' *	1 *	89 *
P-82	Lane N-W *	82	83	74' *		
	CUY-90-13.81 Totals			693' *	1 *	89 *

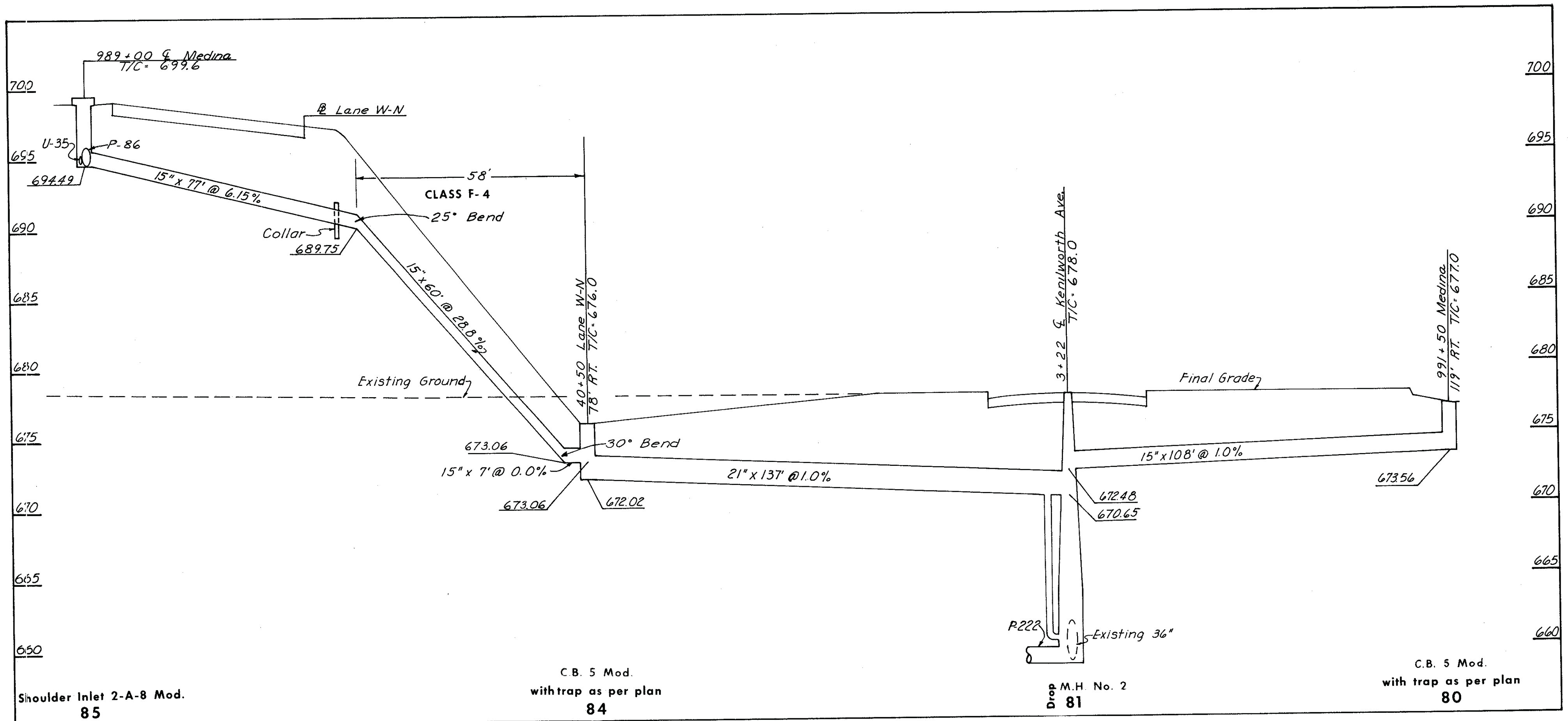
SCALE V-1"=5', H-1"=20' **HOWARD, NEEDLES, TAMMEN & BERGENDOFF**
CONSULTING ENGINEERS
KANSAS CITY CLEVELAND NEW YORK
MADE LEE DATE 10-26-64
TRCD. RHP DATE 10-27-64
CKD. CPB DATE 12-15-64

P-72 thru P-79,
P-82
SEWER PROFILES

FED. RD. DIVISION	STATE	PROJECT	
2	OHIO		

103
478

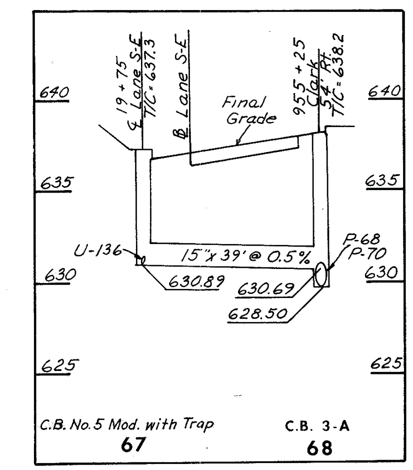
CUYAHOGA COUNTY
CITY OF CLEVELAND
MEDINA-CLARK INTERCHANGE
CUY-71-18.54
CUY-90-13.81



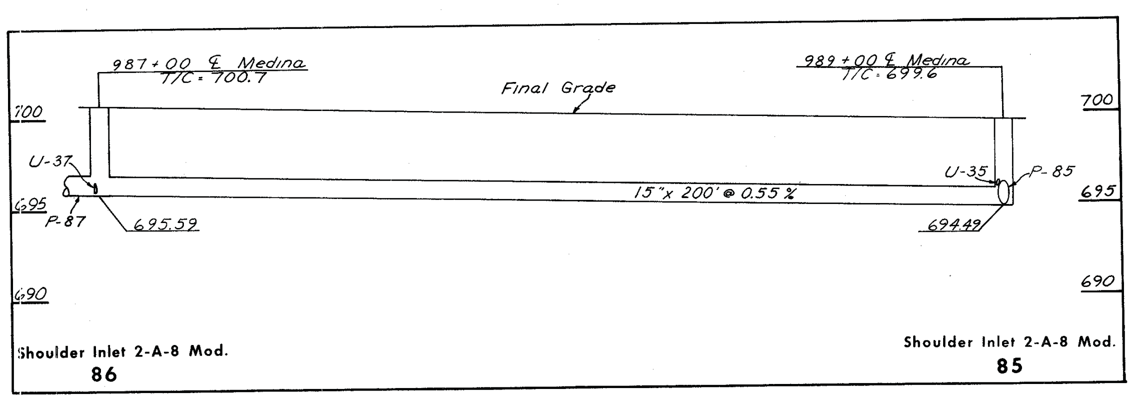
P-85
CLASS B-1

P-84
CLASS B-1

P-80
CLASS B-1



P-67
CLASS B-1



P-86
CLASS E-1

ESTIMATED QUANTITIES

CODE	LOCATION	I-8 STRUCTURES Shoulder Inlet 2-A-8 Mod.	Shoulder Inlet 2-A-10	C.B. 5 Mod. with trap	M.H. No. 2 with drop
67	19+75 Lane S-E ℄			1	
80	991+50 Medina Freeway 119' RT. *			1 *	
81	3+22 Kenilworth Avenue ℄ *				1 *
84	40+50 Lane W-N 78' RT. *			1 *	
85	989+00 Medina Freeway ℄ *	1 *			
86	987+00 Medina Freeway ℄ *		1 *		
	CUY-71-18.54 TOTALS			1	
	CUY-90-13.81 TOTALS	1 *	1 *	2 *	1 *

CODE	ROADWAY	INLET CODE FROM	TO	I-1 Pipe CLASS B-1 15"	CLASS F-4 15"	CLASS B-1 21"	I-5 Pipe Specials CLASS F-4 15"x 25°	CLASS F-4 15"x 30°
P-67	Lane S-E	67	68	39'				
P-80	Medina Freeway *	80	81	108' *				
P-84	Lane W-N *	84	81			137' *		
P-85	Medina Freeway *	85	84	77' *	67' *		1	1
	CUY-71-18.54 TOTALS			39'				
	CUY-90-13.81 TOTALS			185 *	67' *	137' *	1 *	1 *

CODE	ROADWAY	INLET CODE FROM	TO	I-1 Pipe CLASS E-1 15"
P-86	Medina Freeway *	86	85	200' *
	CUY-90-13.81 TOTALS			200' *

P-67, P-80,
P-84 thru P-86
SEWER PROFILES

SCALE V-1"=5', H-1"=20'	HOWARD, NEEDLES, TAMMEN & BERGENDOFF
MADE SNM DATE 10-26-64	CONSULTING ENGINEERS
TRCD. NAK DATE 10-27-64	
CKD. CPB DATE 12-15-64	KANSAS CITY CLEVELAND NEW YORK

APPENDIX C

INLET SPACING DESIGN

PID : 49633 **Date :** 08/24/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, Ohio

Description : Starkweather-Kenilworth Inlet Spacing I-90 WB 95+48_104+54 RT **Designer :** BAH

Rainfall Area: A **Storm Frequency (yr.) :** 10 **Total Allow. Spread (ft.) :** 6.50 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)
92+18	Begin																	
95+48	I-3C	330.00	0.90	0.24	1.80	3.41	10.00	0.0064	0.0354	0.0192	6.50	0.1667	5.10	1.12	0.00	1.12	0.198	5.58
* 98+26	I-3C	278.00	0.90	0.22	1.75	3.62	10.00	0.0051	0.0273	0.0201	6.50	0.1667	5.10	1.02	0.00	1.02	0.181	6.67
100+29	I-3C	203.00	0.90	0.20	2.10	2.66	10.00	0.0035	0.0400	0.0328	6.50	0.1667	5.10	0.92	0.00	0.92	0.215	5.38
102+75	I-3D	246.00	0.90	0.24	1.80	3.09	10.00	0.0035	0.0400	0.2500	6.50	0.1667	5.10	1.10	0.00	1.10	0.230	5.76
104+54	I-3C	179.00	0.90	0.20	1.60	2.16	10.00	0.0042	0.0400	0.1860	6.50	0.1667	5.10	0.92	0.00	0.92	0.208	5.21

*Inlet at 98+26 is outside of project limits and is the existing spread

INLET SPACING DESIGN

PID : 49633 **Date :** 08/24/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, Ohio

Description : Starkweather-Kenilworth Inlet Spacing I-90 WB 95+48_104+54 RT **Designer :** BAH

Rainfall Area: A **Storm Frequency (yr.) :** 50 **Total Allow. Spread (ft.) :** 6.50 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)
92+18	Begin																	
95+48	I-3C	330.00	0.90	0.24	1.80	3.12	10.00	0.0064	0.0354	0.0192	6.50	0.1667	6.79	1.49	0.01	1.49	0.220	6.22
98+26	I-3C	278.00	0.90	0.22	1.75	3.38	10.00	0.0051	0.0273	0.0201	6.50	0.1667	6.79	1.36	0.01	1.37	0.202	7.71
100+29	I-3C	203.00	0.90	0.20	2.10	2.43	10.00	0.0035	0.0400	0.0328	6.50	0.1667	6.79	1.23	0.00	1.23	0.240	6.01
102+75	I-3D	246.00	0.90	0.24	1.80	2.82	10.00	0.0035	0.0400	0.2500	6.50	0.1667	6.79	1.47	0.00	1.47	0.257	6.41
104+54	I-3C	179.00	0.90	0.20	1.60	1.96	10.00	0.0042	0.0400	0.1860	6.50	0.1667	6.79	1.23	0.00	1.23	0.232	5.81

STORM SEWER SYSTEM

PID : 49633 **Date :** 10/06/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, OH

Description : Kenilworth Drainage Area - Southwest Storm Sewer **Designer :** BAH

Rainfall Area: A **Just Full Capacity Frequency (yrs.) :** 10 **Hydraulic Gradient Frequency (yrs.) :** 25

Minimum Pipe Size : 15.00 **Tailwater Elevation (ft.):** 673.77

	JUNCTION From	To	STATION From To	ΔAREA Σ AREA (acres)	ΔCA ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	(25 yrs.)	DISCHARGE (cfs.) (10 yrs.)	(25 yrs.)	PIPE DIAM. (in.)	LENGTH (ft.)	SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
	103B	103A begin	102+75 103+00	0.24 0.24	0.22 0.22	10.00	5.10	6.12	1.1	1.3	15	59.0	0.0061	698.46 698.10	2.96 *	4.70	0.0006	698.99 698.95	701.90 703.07	2.91	2.19	I 3D 0.015
	103A	103D	103+00 104+25	0.08 0.32	0.07 0.28	10.33	5.02	5.95	1.4	1.7	15	126.0	0.0052	698.10 697.44	3.02	4.36	0.0009	698.66 698.32	703.07 702.91	4.41	3.72	CB 6 0.015
	103D	103C	104+25 105+85	0.11 0.43	0.10 0.38	11.03	4.88	5.75	1.9	2.2	15	161.0	0.0052	697.44 696.61	3.22	4.32	0.0016	698.10 697.53	702.91 702.16	4.81	4.22	CB 6 0.015
	103E	103C begin	106+24 105+85	0.07 0.50	0.06 0.45	10.00	5.10	6.14	0.3	0.4	15	41.0	0.0100	698.53 698.12	2.47 *	6.02	0.0000	698.87 698.87	702.01 702.16	3.14	2.23	CB 6 0.015
	103C	103F	105+85 105+98	0.14 0.64	0.13 0.57	11.86	4.72	5.70	2.7	3.3	15	54.9	0.0052	696.61 696.32	3.54	4.36	0.0034	697.50 697.31	702.16 700.57	4.66	4.30	CB 6 0.015
**	87CB	103F begin	104+54 105+98	0.20 0.84	0.18 0.75	10.00	5.10	5.62	0.9	1.0	15	143.3	0.0054	696.83 696.05	2.71 *	4.44	0.0003	697.25 697.10	701.22 700.57	3.97	3.14	I Barrier 0.015
**	103F	86CB	105+98 106+80	0.00 0.84	0.00 0.75	12.12	4.67	5.62	3.5	4.2	15	81.6	0.0054	696.03 695.59	3.76	4.42	0.0057	697.10 696.63	700.57 700.70	3.47	3.29	MH 3 0.015
	86CB	108B	106+80 108+80	0.00 0.84	0.00 0.75	12.48	4.60	5.44	3.5	4.1	15	200.2	0.0056	695.59 694.46	3.83	4.52	0.0054	696.59 695.49	700.70 698.32	4.11	3.86	I Barrier 0.015

* "Just full" velocities exceed the 3 fps requirement per L&D Volume 2, Section 1104.2.1 G (3.94 fps, 5.04 fps and 3.71 fps respectively).

** These are existing pipes that are to remain, be maintained and reconnected as part of system.

STORM SEWER SYSTEM

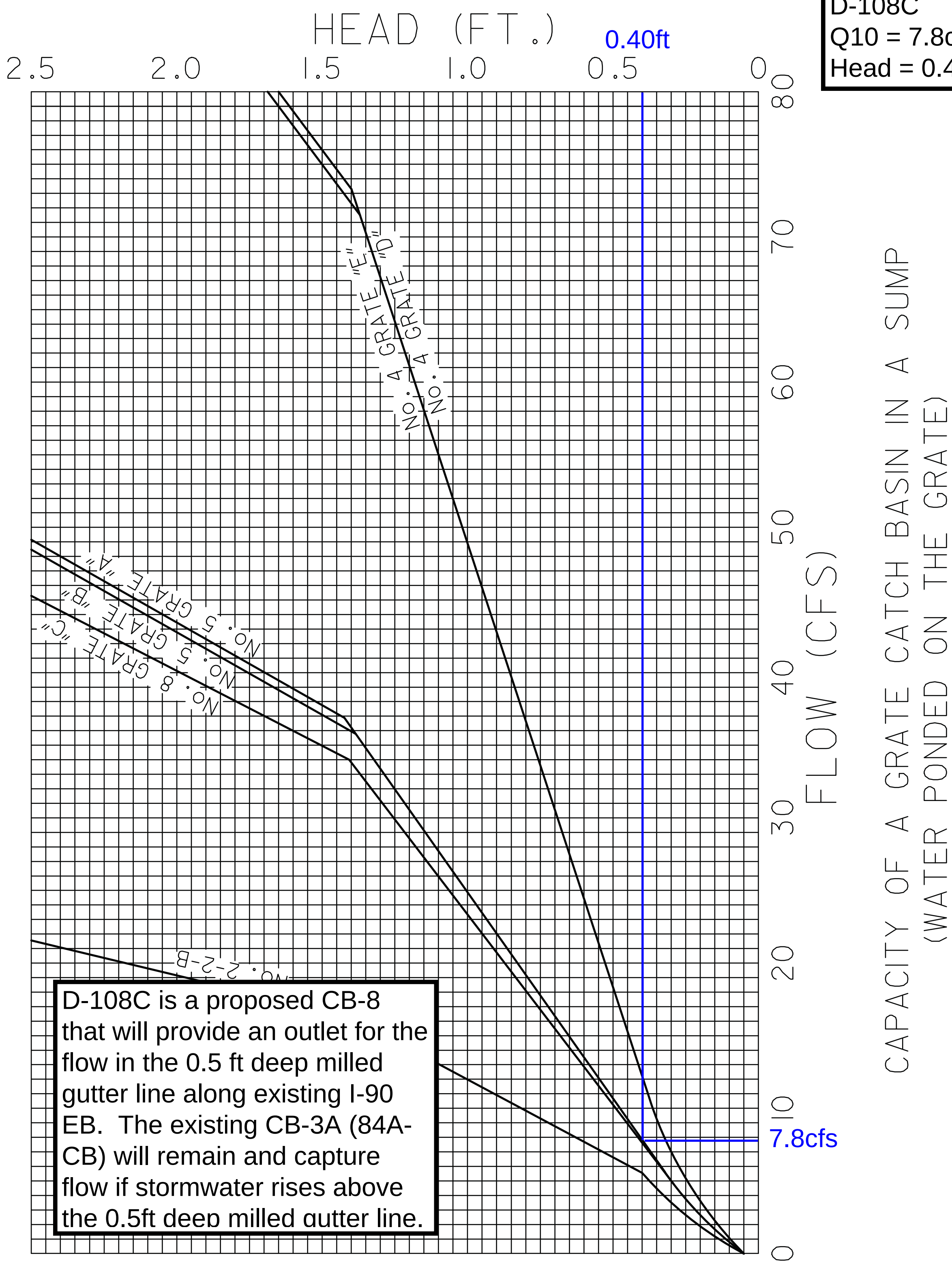
	JUNCTION From	To	STATION From To	ΔAREA Σ AREA (acres)	ΔCA Σ CA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	RAINFALL INTENSITY (25 yrs.)	DISCHARGE (cfs.) (10 yrs.)	DISCHARGE (cfs.) (25 yrs.)	PIPE DIAM. (in.)	PIPE LENGTH (ft.)	PIPE SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
**	108B	84A	108+80 108+76	0.00 0.84	0.00 0.75	13.35	4.46	5.41	3.4	4.1	15	68.7	0.0615	693.77 689.55	9.31	14.93	0.0053	694.23 690.58	698.32 695.88	4.09	3.30	MH 3 0.015
	108C begin	84A	108+67 108+76	1.70 2.54	1.53 2.28	10.00	5.10	6.21	7.8	9.5	15	9.0	0.0833	692.00 691.25	13.05	17.38	0.0287	692.72 692.46	695.82 695.88	3.10	2.57	CB 8 0.015
**	84A final	84	108+76 108+73	0.00 2.54	0.00 2.28	13.47	4.44	5.41	10.1	12.4	15	17.1	0.0615	689.55 688.50	12.34	14.93	0.0487	690.57 689.74	695.88 676.00	5.31	5.08	CB 3A 0.015

** These are existing pipes that are to remain, be maintained and be reconnected as part of the system.

D-108C Sump Calculation

CAPACITY OF A GRATE CATCH BASIN IN A SUMP	1102-1
	REFERENCE SECTION 1102.3.5

D-108C
Q10 = 7.8cfs
Head = 0.40ft



D-108C is a proposed CB-8 that will provide an outlet for the flow in the 0.5 ft deep milled gutter line along existing I-90 EB. The existing CB-3A (84A-CB) will remain and capture flow if stormwater rises above the 0.5ft deep milled gutter line.

APPENDIX D

INLET SPACING DESIGN

PID : 49633 **Date :** 10/07/2011 **Project :** CUY-90-14.90 **Location :** MAINLINE STA 111+10 RT

Description : Fairfield Drainage Area - I-90 WB STA 111+10 RT 2YR bidirectional **Designer :** BAH

Rainfall Area: A **Storm Frequency (yr.) :** 2 **Total Allow. Spread (ft.) :** 10.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)
108+51	Begin																	
111+10	I-3D	259.00	0.90	0.32	1.90	3.68	10.00	0.0042	0.0200	0.0200	6.00	0.1667	3.60	1.05	0.00	1.05	0.168	8.42
112+41	I-3D	131.00	0.90	0.16	1.80	2.16	10.00	0.0042	0.0200	0.0200	6.00	0.1667	3.60	0.52	0.00	0.52	0.130	6.50

INLET SPACING DESIGN

PID : 49633 **Date :** 10/07/2011 **Project :** CUY-90-14.90 **Location :** MAINLINE STA 111+10 RT

Description : Fairfield Drainage Area - I-90 WB STA 111+10 RT 10YR **Designer :** BAH

Rainfall Area: A **Storm Frequency (yr.) :** 10 **Total Allow. Spread (ft.) :** 12.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)
108+51	Begin																	
111+10	I-3D	259.00	0.90	0.32	1.90	3.37	10.00	0.0042	0.0200	0.0200	12.00	0.1667	5.10	1.37	0.11	1.48	0.192	9.59
112+41	I-3D	131.00	0.90	0.16	1.80	1.93	10.00	0.0042	0.0200	0.0200	12.00	0.1667	5.10	0.85	0.00	0.85	0.156	7.80

* No sodded flume required

INLET SPACING DESIGN

PID : 49633 **Date :** 10/07/2011 **Project :** CUY-90-14.90 **Location :** MAINLINE STA 111+10 RT

Description : Fairfield Drainage Area - I-90 WB STA 111+10 RT 50YR **Designer :** BAH

Rainfall Area: A **Storm Frequency (yr.) :** 50 **Total Allow. Spread (ft.) :** 12.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)
108+51	Begin																	
111+10	I-3D	259.00	0.90	0.32	1.90	3.09	10.00	0.0042	0.0200	0.0200	12.00	0.1667	6.79	1.65	0.32	1.98	0.214	10.69
112+41	I-3D	131.00	0.90	0.16	1.80	1.72	10.00	0.0042	0.0200	0.0200	12.00	0.1667	6.79	1.26	0.05	1.31	0.183	9.17

INLET SPACING DESIGN

PID : 49633 **Date :** 10/07/2011 **Project :** CUY-90-14.90 **Location :** ML Sta. 115+42 - 48FT LT

Description :BL-3 to Inlet D115A - 2 YR Bidirectional **Designer :** BAH

Rainfall Area: A **Storm Frequency (yr.) :** 2 **Total Allow. Spread (ft.) :** 8.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)
108+00	Begin																	
115+42	CB-3	742.00	0.90	0.56	1.00	8.11	10.00	0.0042	0.0400	0.0400	8.00	0.0417	3.60	1.53	0.28	1.81	0.268	6.71

INLET SPACING DESIGN

PID : 49633 **Date :** 10/07/2011 **Project :** CUY-90-14.90 **Location :** ML Sta. 115+42 - 48FT LT

Description : BL-3 to Inlet D115A - 10 YR **Designer :** BAH

Rainfall Area: A **Storm Frequency (yr.) :** 10 **Total Allow. Spread (ft.) :** 12.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)
108+00	Begin																	
115+42	CB-3	742.00	0.90	0.56	1.00	7.37	10.00	0.0042	0.0400	0.0400	12.00	0.0417	5.10	1.99	0.58	2.56	0.306	7.64

INLET SPACING DESIGN

PID : 49633 **Date :** 10/07/2011 **Project :** CUY-90-14.90 **Location :** ML Sta. 115+42 - 48FT LT

Description :BL-3 to Inlet D115A - 50 YR **Designer :** BAH

Rainfall Area: A **Storm Frequency (yr.) :** 50 **Total Allow. Spread (ft.) :** 12.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)
108+00	Begin																	
115+42	CB-3	742.00	0.90	0.56	1.00	6.78	10.00	0.0042	0.0400	0.0400	12.00	0.0417	6.79	2.45	0.97	3.42	0.340	8.51

INLET SPACING DESIGN

PID : 49633 **Date :** 08/25/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, Ohio

Description : Fairfield Drainage Area - I-90 WB Inlet Check _ 118+61- 2YR BIDIRECT **Designer :** BAH

Rainfall Area: A **Storm Frequency (yr.) :** 2 **Total Allow. Spread (ft.) :** 10.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)
120+57	Begin																	
118+61	CB-3	194.49	0.90	0.33	1.80	2.71	10.00	0.0042	0.0200	0.0200	6.00	0.0417	3.60	0.82	0.25	1.07	0.170	8.48

INLET SPACING DESIGN

PID : 49633 **Date :** 08/25/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, Ohio

Description : Fairfield Drainage Area - I-90 WB Inlet Check _ 118+61-10YR **Designer :** BAH

Rainfall Area: A **Storm Frequency (yr.) :** 10 **Total Allow. Spread (ft.) :** 12.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)
120+57	Begin																	
118+61	CB-3	194.49	0.90	0.33	1.80	2.49	10.00	0.0042	0.0200	0.0200	12.00	0.0417	5.10	1.05	0.46	1.51	0.193	9.66

INLET SPACING DESIGN

PID : 49633 **Date :** 08/25/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, Ohio

Description : Fairfield Drainage Area - I-90 WB Inlet Check _ 118+61-50YR **Designer :** BAH

Rainfall Area: A **Storm Frequency (yr.) :** 50 **Total Allow. Spread (ft.) :** 12.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)
120+57	Begin																	
118+61	CB-3	194.49	0.90	0.33	1.80	2.27	10.00	0.0042	0.0200	0.0200	12.00	0.0417	6.79	1.28	0.73	2.01	0.215	10.76

INLET SPACING DESIGN

PID : 49633 **Date :** 10/07/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, Ohio

Description : Mainline I90 LT D118C-2 YR Bidirectional **Designer :** BAH

Rainfall Area: A **Storm Frequency (yr.) :** 2 **Total Allow. Spread (ft.) :** 7.67 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)	
117+27	Begin																		
118+17	CB-3A	90.00	0.90	0.03	1.00	2.66	10.00	0.0017	0.0400	0.0400	4.00	0.0000	3.60	0.10	0.00	0.10	0.106	2.65	
118+42	CB-3	25.00	0.90	0.00	1.00	1.42	10.00	0.0017	0.0400	0.0400	4.00	0.0417	3.60	******	******	0.01	0.038	0.96	Sag
120+68	Begin																		
118+67	CB-3A	201.00	0.90	0.06	1.00	4.44	10.00	0.0025	0.0400	0.0400	4.00	0.0417	3.60	0.19	0.00	0.19	0.128	3.20	
118+42	CB-3	25.00	0.90	0.00	1.00	1.10	10.00	0.0025	0.0400	0.0400	4.00	0.0417	3.60	******	******	0.01	0.042	1.04	End

SUMP DATA

Total Flow (cfs) : 0.02 **Ponded Depth (ft.) :** 0.000 **Spread on Pavement (ft.) :** 0.00

INLET SPACING DESIGN

PID : 49633 **Date :** 10/07/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, Ohio

Description : Mainline I90 LT D118C-10 YR **Designer :** BAH

Rainfall Area: A **Storm Frequency (yr.) :** 10 **Total Allow. Spread (ft.) :** 12.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)	
117+27	Begin																		
118+17	CB-3A	90.00	0.90	0.03	1.00	2.44	10.00	0.0017	0.0400	0.0400	12.00	0.0000	5.10	0.14	0.00	0.14	0.121	3.02	
118+42	CB-3	25.00	0.90	0.00	1.00	1.31	10.00	0.0017	0.0400	0.0400	12.00	0.0417	5.10	******	******	0.01	0.044	1.09	Sag
120+68	Begin																		
118+67	CB-3A	201.00	0.90	0.06	1.00	4.06	10.00	0.0025	0.0400	0.0400	12.00	0.0417	5.10	0.28	0.00	0.28	0.146	3.65	
118+42	CB-3	25.00	0.90	0.00	1.00	1.02	10.00	0.0025	0.0400	0.0400	12.00	0.0417	5.10	******	******	0.01	0.047	1.19	End

SUMP DATA

Total Flow (cfs) : 0.02 **Ponded Depth (ft.) :** 0.000 **Spread on Pavement (ft.) :** 0.00

INLET SPACING DESIGN

PID : 49633 **Date :** 10/07/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, Ohio

Description : Mainline I90 LT D118C-50 YR **Designer :** BAH

Rainfall Area: A **Storm Frequency (yr.) :** 50 **Total Allow. Spread (ft.) :** 12.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)	
117+27	Begin																		
118+17	CB-3A	90.00	0.90	0.03	1.00	2.21	10.00	0.0017	0.0400	0.0400	12.00	0.0000	6.79	0.18	0.00	0.18	0.135	3.37	
118+42	CB-3	25.00	0.90	0.00	1.00	1.17	10.00	0.0017	0.0400	0.0400	12.00	0.0417	6.79	******	******	0.01	0.049	1.23	Sag
120+68	Begin																		
118+67	CB-3A	201.00	0.90	0.06	1.00	3.71	10.00	0.0025	0.0400	0.0400	12.00	0.0417	6.79	0.36	0.01	0.37	0.162	4.06	
118+42	CB-3	25.00	0.90	0.00	1.00	0.86	10.00	0.0025	0.0400	0.0400	12.00	0.0417	6.79	******	******	0.03	0.061	1.54	End

SUMP DATA

Total Flow (cfs) : 0.04 **Ponded Depth (ft.) :** 0.000 **Spread on Pavement (ft.) :** 0.00

DITCH ANALYSIS

PID : 49633 **Date :** 10/07/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, Ohio

Description : Mainline I90 RT Station 110+88 to 118+26 **Designer :** BAH

Rainfall Area : A

Allowable Shears

	Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
Permanent Mat	**Type 1:**	2.00	**Type 2:**	3.00	**Type 3:**	5.00
RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
111+22	111+50	R	28.00	0.00	3.00	4.00	0.0050	0.22	0.22	0.70	0.15	Seed	3.57	5	0.030	15.41	1.11	0.12	0.55	0.38	2.63
												Seed	4.13	10	0.040	15.50	0.94	0.14	0.64	0.44	3.08
111+50	112+50	R	100.00	0.00	5.30	4.00	0.0050	0.00	0.22	0.70	0.15	Seed	3.40	5	0.030	17.00	1.05	0.10	0.52	0.33	3.05
												Seed	3.88	10	0.040	17.40	0.86	0.12	0.60	0.39	3.60
112+50	114+38	R	188.00	0.00	15.00	4.00	0.0050	0.37	0.59	0.90	0.49	Seed	3.15	5	0.030	19.69	1.14	0.12	1.53	0.38	7.14
												Seed	3.52	10	0.040	20.63	0.95	0.14	1.72	0.44	8.29
114+38	116+97	R	259.21	0.00	10.50	4.00	0.0200	1.03	1.62	0.85	1.36	Seed	3.01	5	0.030	21.31	2.62	0.58	4.10	0.46	6.74
												Jute Mat	2.98	5	0.040	21.70	2.11	0.64	4.06	0.52	7.48
												Temp. Mat	2.98	5	0.040	21.70	2.11	0.64	4.06	0.52	7.48
												Temp. Mat	3.34	10	0.040	22.59	2.17	0.67	4.55	0.54	7.79
116+97	118+26	R	128.86	0.00	5.50	6.00	0.0258	0.00	1.62	0.90	1.36	Seed	2.93	5	0.030	22.41	3.04	0.77	3.99	0.48	5.50
												Jute Mat	2.91	5	0.040	22.58	2.44	0.86	3.97	0.53	6.11
												Temp. Mat	2.91	5	0.040	22.58	2.44	0.86	3.97	0.53	6.11

DITCH ANALYSIS

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
												Temp. Mat	3.26	10	0.040	23.44	2.52	0.89	4.45	0.55	6.38

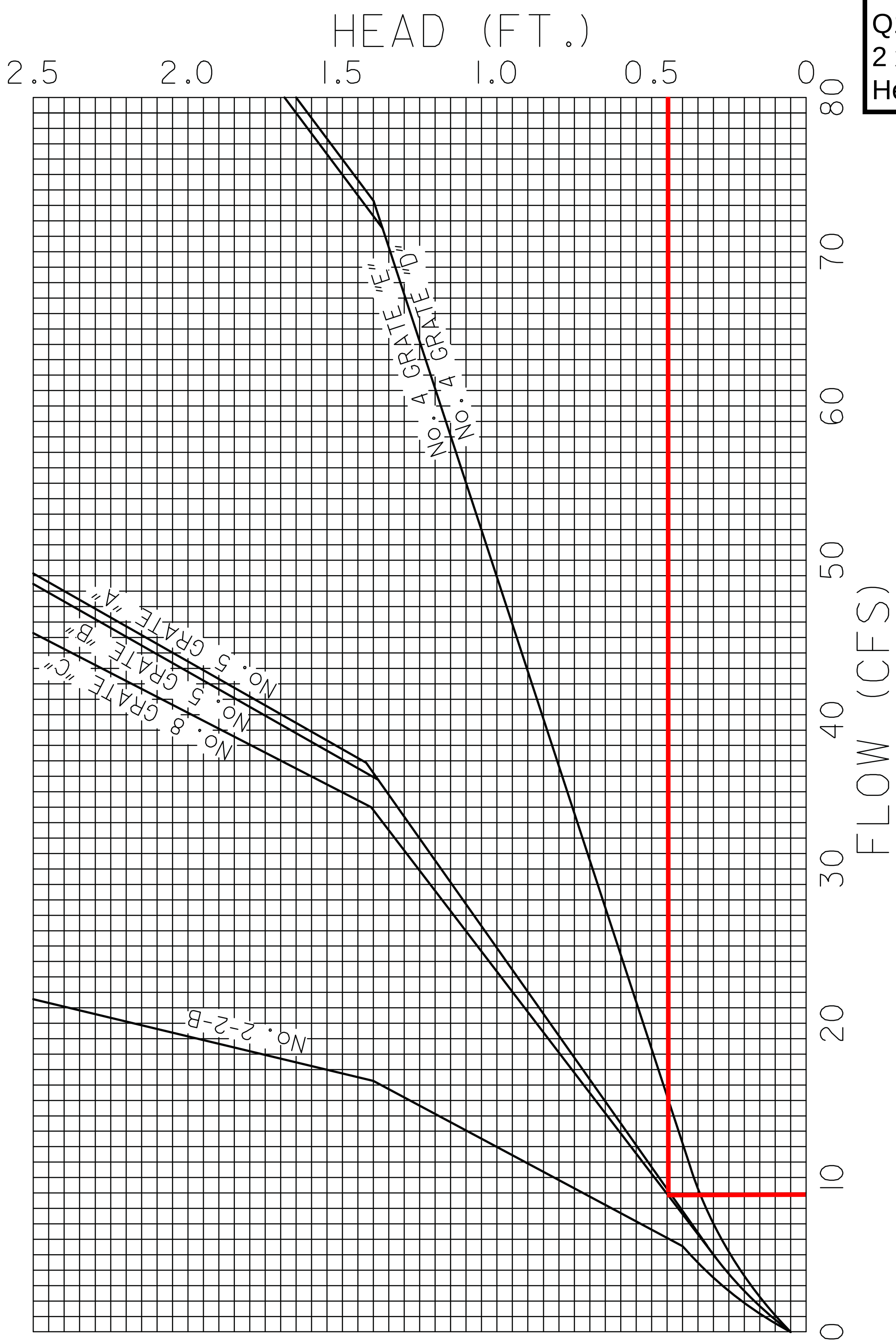
D-118D Sump Calculation

CAPACITY OF A GRATE CATCH BASIN IN A SUMP

1102-1

REFERENCE SECTION
1102.3.5

D-118D
Q10 = 4.45cfs
2 x 4.45 = 8.9 Check
Head = 0.45ft



CAPACITY OF A GRATE CATCH BASIN IN A SUMP
(WATER PONDED ON THE GRATE)

STORM SEWER SYSTEM

PID : 49633 **Date :** 10/07/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, OH

Description : Fairfield Drainage Area - Storm Sewer I-90 111+10 RT **Designer :** BAH

Rainfall Area: A **Just Full Capacity Frequency (yrs.) :** 10 **Hydraulic Gradient Frequency (yrs.) :** 25

Minimum Pipe Size : 15.00 **Tailwater Elevation (ft.):** 659.72

JUNCTION From	JUNCTION To	STATION From / To	ΔAREA / ΣAREA (acres)	ΔCA / ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	RAINFALL INTENSITY (25 yrs.)	DISCHARGE (cfs.) (10 yrs.)	DISCHARGE (cfs.) (25 yrs.)	PIPE DIAM. (in.)	PIPE LENGTH (ft.)	PIPE SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
* 72CB	74CB	112+80	0.07	0.06	10.00	5.10	5.77	0.3	0.3	15	225.2	0.0067	692.56	2.10	4.92	0.0000	692.79	694.70	1.91	0.89	I Barrier
begin		115+04	0.07	0.06									691.06				691.80	696.30			0.015
* 74CB	75CB	115+04	0.14	0.12	11.79	4.73	5.69	0.9	1.0	15	73.4	0.0102	691.06	3.33	6.09	0.0003	691.42	696.30	4.88	3.99	I Barrier
		115+77	0.20	0.18									690.31				691.13	695.80			0.015
* 75CB	76CB	115+77	0.07	0.07	12.16	4.66	5.64	1.2	1.4	15	50.8	0.0148	690.31	4.14	7.32	0.0006	690.70	695.80	5.10	4.24	I Barrier
		116+28	0.28	0.25									689.56				690.42	695.50			0.015
* 76CB	78CB	116+28	0.04	0.04	12.36	4.63	5.55	1.3	1.6	15	110.1	0.0148	689.56	4.30	7.33	0.0008	689.97	695.50	5.53	4.69	I Barrier
		117+39	0.32	0.28									687.93				688.80	694.70			0.015
* 78CB	79CB	117+39	0.09	0.08	12.79	4.55	5.50	1.7	2.0	15	74.8	0.0150	687.93	4.60	7.37	0.0013	688.39	694.70	6.31	5.52	I Barrier
		118+14	0.41	0.37									686.81				687.72	694.70			0.015
* 79CB	79AC	118+14	0.29	0.26	13.06	4.50	5.47	2.8	3.4	15	56.0	0.0414	686.81	7.69	12.26	0.0037	687.28	694.70	7.42	6.64	I Barrier
		118+32	0.70	0.63									684.49				685.49	691.75			0.015
* 79AC	901	118+32	0.21	0.19	13.18	4.48	5.47	3.7	4.5	15	11.8	0.0417	684.49	8.27	12.29	0.0063	685.13	691.75	6.62	6.01	CB 8
		118+40	0.91	0.82									684.00				685.05	692.00			0.015
901	118D	118+40	0.00	0.00	13.21	4.48	3.85	3.7	3.1	15	24.0	0.0071	682.58	4.24	5.07	0.0031	684.34	690.73	6.39	6.90	MH 3
		118+26	0.91	0.82									682.41				684.26	687.13			0.015

* These are existing pipes that are to remain, be maintained and be reconnected as part of the system.

STORM SEWER SYSTEM

JUNCTION From To	STATION From To	ΔAREA Σ AREA (acres)	ΔCA Σ CA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	RAINFALL INTENSITY (25 yrs.)	DISCHARGE (cfs.) (10 yrs.)	DISCHARGE (cfs.) (25 yrs.)	PIPE DIAM. (in.)	PIPE LENGTH (ft.)	PIPE SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
118D 118A	118+26 118+21	1.62 2.53	1.36 2.18	23.44	3.26	3.85	7.1	8.4	15 **Warning**	13.0	0.0054	682.41 682.34	5.78	4.42	0.0223	684.26 683.97	687.13 689.81	2.87	3.47	CB 8 0.015
118E 118C begin	118+17 118+42	0.03 2.56	0.03 2.20	10.00	5.10	6.16	0.1	0.2	15	24.7	0.0166	690.23 689.82	2.33 *	7.76	0.0000	690.53 690.53	693.73 693.65	3.20	2.25	CB 3A 0.015
118F 118C begin	118+67 118+42	0.06 2.62	0.05 2.26	10.00	5.10	6.15	0.3	0.3	15	25.7	0.0070	690.00 689.82	2.08 *	5.04	0.0000	690.56 690.56	693.67 693.56	3.11	2.42	CB 3A 0.015
118C 118B	118+42 118+60	0.00 2.62	0.00 2.26	10.21	5.05	6.06	0.4	0.5	15	85.6	0.0298	690.01 687.46	3.96	10.39	0.0001	690.21 688.22	693.56 692.26	3.35	2.30	CB 3 0.015
118B 118A	118+60 118+21	0.33 2.95	0.30 2.56	10.57	4.97	6.03	1.9	2.3	15	42.3	0.0229	687.46 686.49	5.57	9.12	0.0017	687.90 687.42	692.26 689.81	4.36	3.55	CB 3 0.015
118A 115	118+21 115+39	0.00 2.95	0.00 2.56	23.48	3.26	3.85	8.3	9.8	24	280.9	0.0025	682.31 681.62	3.47	10.45	0.0025	683.97 683.18	689.81 694.88	5.84	5.50	MH 3 0.015
111 112 begin	111+10 112+41	0.32 3.27	0.29 2.85	10.00	5.10	6.04	1.5	1.8	15	131.5	0.0063	694.95 694.12	3.26	4.78	0.0010	695.50 695.01	698.80 698.05	3.30	2.60	I Barrier 0.015
112 112A	112+41 112+41	0.16 3.43	0.15 2.99	10.67	4.95	6.03	2.2	2.6	15	7.8	0.0255	694.12 693.92	6.01	9.62	0.0022	694.89 694.87	698.05 697.55	3.16	2.68	I Barrier 0.015
112A 115	112+41 115+39	0.00 3.43	0.00 2.99	10.69	4.95	5.76	2.2	2.5	15	295.8	0.0100	693.92 690.97	4.26	6.01	0.0020	694.51 691.91	697.55 694.88	3.04	2.38	MH 3 0.015
115 115A	115+39 115+42	0.00 3.43	0.00 2.99	24.82	3.15	3.83	9.4	11.4	24	91.0	0.0108	681.62 680.64	6.36	21.89	0.0034	682.69 682.25	694.88 696.21	12.19	11.26	MH 3 0.015
** 115A HW final	115+42 115+40	0.56 3.99	0.50 3.50	25.06	3.13	3.82	10.9	13.3	24	86.0	0.2691	680.64 657.50	21.19	109.40	0.0046	681.13 659.72	696.21 659.50	15.08	13.57	CB 3 0.015

* Pipe velocity from existing pipe system and would exceed 3 ft/s flowing full.

** Pipe is a broken back pipe, slope reflects the overall slope for the invert of the pipe at structure D-115A to invert at outlet. See storm sewer profile for actual pipe lengths and slopes for the individual components of the broken back pipe (sheet 158/271 in the BU 1020 plan set).

DITCH ANALYSIS

PID : 49633 **Date :** 08/29/2011 **Project :** CUY-90-14.90 **Location :** Wall A

Description : Fairfield Drainage Area - Wall A Ditch A1, Top of Wall A 113+41 LT **Designer :** BAH

Rainfall Area : A

Allowable Shears

	Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
Permanent Mat	**Type 1:**	2.00	**Type 2:**	3.00	**Type 3:**	5.00
RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
113+41	112+61	L	81.00	0.00	4.00	2.00	0.0270	0.04	0.04	0.70	0.03	Seed	3.51	5	0.030	15.97	1.36	0.27	0.11	0.16	0.97
												Seed	4.05	10	0.040	16.07	1.22	0.31	0.12	0.18	1.10
112+61	111+53	L	109.00	0.00	4.00	2.00	0.0311	0.06	0.10	0.70	0.07	Seed	3.41	5	0.030	16.96	1.87	0.40	0.23	0.20	1.22
												Seed	3.90	10	0.040	17.27	1.52	0.47	0.27	0.24	1.45
111+53	111+23	L	31.00	1.00	4.00	2.00	0.1419 *	0.03	0.13	0.70	0.09	Seed	3.39	5	0.030	17.12	3.08	0.71	0.31	0.08	1.48
												Jute Mat	3.39	5	0.040	17.17	2.47	0.86	0.31	0.10	1.58
												Temp. Mat	3.39	5	0.040	17.17	2.47	0.86	0.31	0.10	1.58
												Temp. Mat	3.87	10	0.040	17.46	2.64	0.90	0.35	0.10	1.61
111+23	111+13	L	10.00	2.00	2.00	2.00	0.1900 *	0.00	0.13	0.00	0.09	Seed	3.38	5	0.030	17.22	2.87	0.60	0.31	0.05	2.20
												Jute Mat	3.38	5	0.040	17.24	2.34	0.73	0.31	0.06	2.25
												Temp. Mat	3.38	5	0.040	17.24	2.34	0.73	0.31	0.06	2.25
												Temp. Mat	3.86	10	0.040	17.53	2.51	0.78	0.35	0.07	2.26
111+13	111+11	L	5.00	1.50	12.00	2.00	0.1600 *	0.00	0.13	0.00	0.09	Seed	3.38	5	0.030	17.27	2.64	0.60	0.31	0.06	2.35

DITCH ANALYSIS

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
												Jute Mat	3.38	5	0.040	17.27	2.21	0.70	0.31	0.07	2.48
												Temp. Mat	3.38	5	0.040	17.27	2.21	0.70	0.31	0.07	2.48
												Temp. Mat	3.86	10	0.040	17.56	2.30	0.75	0.35	0.08	2.55
111+11	111+11	L	12.50	0.00	8.00	8.00	0.5000 *	0.00	0.13	0.00	0.09	Seed	3.37	5	0.030	17.32	4.60	2.85	0.31	0.09	1.46
												Jute Mat	3.37	5	0.040	17.33	3.68	3.18	0.31	0.10	1.63
												Temp. Mat	3.37	5	0.040	17.33	3.68	3.18	0.31	0.10	1.63
												Perm, Type 1	3.37	5	0.040	17.33	3.68	3.18	0.31	0.10	1.63
												Perm, Type 2	3.37	5	0.040	17.33	3.68	3.18	0.31	0.10	1.63
												Perm, Type 3	3.37	5	0.040	17.33	3.68	3.18	0.31	0.10	1.63
												Perm, Type 3	3.85	10	0.040	17.62	3.80	3.35	0.35	0.11	1.72

DITCH ANALYSIS

PID : 49633 **Date :** 08/29/2011 **Project :** CUY-90-14.90 **Location :** Wall A

Description : Fairfield Drainage Area - Wall A Ditch A2, Top 113+41 LT **Designer :** BAH

Rainfall Area : A

Allowable Shears

	Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
Permanent Mat	**Type 1:**	2.00	**Type 2:**	3.00	**Type 3:**	5.00
RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
113+41	113+74	L	59.00	2.00	2.00	2.00	0.4432 *	0.03	0.03	0.70	0.02	Seed	3.57	5	0.030	15.46	2.09	0.52	0.08	0.02	2.08
												Jute Mat	3.56	5	0.040	15.53	1.82	0.59	0.08	0.02	2.09
												Temp. Mat	3.56	5	0.040	15.53	1.82	0.59	0.08	0.02	2.09
												Temp. Mat	4.13	10	0.040	15.52	2.11	0.59	0.09	0.02	2.09
113+74	114+28	L	56.00	0.00	2.00	2.00	0.0410	0.10	0.13	0.70	0.09	Seed	3.52	5	0.030	15.93	2.43	0.66	0.32	0.26	1.03
												Jute Mat	3.51	5	0.040	16.01	1.91	0.74	0.32	0.29	1.16
												Temp. Mat	3.51	5	0.040	16.01	1.91	0.74	0.32	0.29	1.16
												Temp. Mat	4.06	10	0.040	15.98	1.99	0.78	0.37	0.31	1.22
114+28	114+38	L	10.00	0.00	2.00	2.00	0.1992 *	0.00	0.13	0.00	0.09	Seed	3.50	5	0.030	16.05	4.29	2.40	0.32	0.19	0.77
												Jute Mat	3.50	5	0.040	16.06	3.48	2.67	0.32	0.21	0.86
												Temp. Mat	3.50	5	0.040	16.06	3.48	2.67	0.32	0.21	0.86
												Perm, Type 1	3.50	5	0.040	16.06	3.48	2.67	0.32	0.21	0.86
												Perm, Type 2	3.50	5	0.040	16.06	3.48	2.67	0.32	0.21	0.86

DITCH ANALYSIS

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
												Perm, Type 2	4.06	10	0.040	16.03	3.65	2.80	0.37	0.23	0.90
114+38	114+47	L	15.00	0.00	2.00	2.00	0.2550 *	0.00	0.13	0.00	0.09	Seed	3.50	5	0.030	16.11	4.81	2.91	0.32	0.18	0.73
												Jute Mat	3.49	5	0.040	16.13	3.85	3.25	0.32	0.20	0.82
												Temp. Mat	3.49	5	0.040	16.13	3.85	3.25	0.32	0.20	0.82
												Perm, Type 1	3.49	5	0.040	16.13	3.85	3.25	0.32	0.20	0.82
												Perm, Type 2	3.49	5	0.040	16.13	3.85	3.25	0.32	0.20	0.82
												Perm, Type 3	3.49	5	0.040	16.13	3.85	3.25	0.32	0.20	0.82
												Perm, Type 3	4.05	10	0.040	16.09	4.02	3.42	0.37	0.21	0.86

DITCH ANALYSIS

PID : 49633 **Date :** 10/11/2011 **Project :** CUY-90-14.90 **Location :** TREMONT ROADWAY

Description : Fairfield Drainage Area - West Ditch - Wall A & B, Face **Designer :** BAH

Rainfall Area : A

Allowable Shears

	Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
Permanent Mat	**Type 1:**	2.00	**Type 2:**	3.00	**Type 3:**	5.00
RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
110+85	111+16	L	31.00	0.00	2.00	4.00	0.0269	0.12	0.12	0.70	0.08	Seed	3.59	5	0.030	15.28	1.84	0.39	0.29	0.23	1.39
												Seed	4.15	10	0.040	15.34	1.57	0.45	0.34	0.27	1.61
111+16	Concent							0.13		0.70	0.17					17.62					
111+16	111+59	L	43.00	0.00	2.00	2.00	0.0549	0.09	0.33	0.70	0.23	Seed	3.32	5	0.030	17.83	3.32	1.17	0.77	0.34	1.36
												Jute Mat	3.31	5	0.040	17.89	2.65	1.31	0.77	0.38	1.53
												Temp. Mat	3.31	5	0.040	17.89	2.65	1.31	0.77	0.38	1.53
												Perm, Type 1	3.31	5	0.040	17.89	2.65	1.31	0.77	0.38	1.53
												Perm, Type 1	3.82	10	0.040	17.88	2.77	1.37	0.89	0.40	1.60
111+59	111+92	L	33.00	0.00	2.00	2.00	0.0402	0.00	0.33	0.00	0.23	Seed	3.30	5	0.030	18.07	2.96	0.90	0.77	0.36	1.44
												Jute Mat	3.29	5	0.040	18.12	2.36	1.01	0.77	0.40	1.61
												Temp. Mat	3.29	5	0.040	18.12	2.36	1.01	0.77	0.40	1.61
												Perm, Type 1	3.29	5	0.040	18.12	2.36	1.01	0.77	0.40	1.61
												Perm, Type 1	3.79	10	0.040	18.10	2.45	1.06	0.88	0.42	1.70

DITCH ANALYSIS

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
111+92	112+04	L	12.00	0.00	2.00	2.00	0.0781	0.00	0.33	0.00	0.23	Seed	3.29	5	0.030	18.17	3.80	1.54	0.76	0.32	1.27
												Jute Mat	3.29	5	0.040	18.19	3.04	1.73	0.76	0.35	1.42
												Temp. Mat	3.29	5	0.040	18.19	3.04	1.73	0.76	0.35	1.42
												Perm, Type 1	3.29	5	0.040	18.19	3.04	1.73	0.76	0.35	1.42
												Perm, Type 1	3.79	10	0.040	18.17	3.16	1.82	0.88	0.37	1.49
112+04	112+25	L	21.00	0.00	2.00	2.00	0.0106	0.00	0.34	0.00	0.23	Seed	3.27	5	0.030	18.38	1.78	0.31	0.76	0.46	1.85
												Seed	3.76	10	0.040	18.40	1.48	0.36	0.87	0.54	2.17
112+25	112+63	L	38.00	0.00	2.00	2.00	0.0677	0.00	0.34	0.00	0.23	Seed	3.25	5	0.030	18.56	3.58	1.37	0.76	0.32	1.30
												Jute Mat	3.25	5	0.040	18.60	2.87	1.53	0.75	0.36	1.45
												Temp. Mat	3.25	5	0.040	18.60	2.87	1.53	0.75	0.36	1.45
												Perm, Type 1	3.25	5	0.040	18.60	2.87	1.53	0.75	0.36	1.45
												Perm, Type 1	3.74	10	0.040	18.61	2.99	1.61	0.87	0.38	1.53
112+63	113+26	L	63.00	0.00	2.00	2.00	0.0301	0.00	0.34	0.00	0.23	Seed	3.21	5	0.030	19.00	2.64	0.71	0.75	0.38	1.50
												Jute Mat	3.20	5	0.040	19.10	2.12	0.79	0.74	0.42	1.68
												Temp. Mat	3.20	5	0.040	19.10	2.12	0.79	0.74	0.42	1.68
												Temp. Mat	3.68	10	0.040	19.09	2.21	0.83	0.86	0.44	1.76
113+26	113+61	L	35.00	0.00	2.00	2.00	0.2641 *	0.06	0.40	0.70	0.27	Seed	3.19	5	0.030	19.19	6.20	4.38	0.88	0.27	1.06
												Jute Mat	3.19	5	0.040	19.21	4.93	4.91	0.88	0.30	1.19
												Temp. Mat	3.19	5	0.040	19.21	4.93	4.91	0.88	0.30	1.19
												Perm, Type 1	3.19	5	0.040	19.21	4.93	4.91	0.88	0.30	1.19

DITCH ANALYSIS

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
												Perm, Type 2	3.19	5	0.040	19.21	4.93	4.91	0.88	0.30	1.19
												Perm, Type 3	3.19	5	0.040	19.21	4.93	4.91	0.88	0.30	1.19
												Perm, Type 3	3.67	10	0.040	19.21	5.14	5.16	1.01	0.31	1.25
113+61	114+47	L	86.00	0.00	2.00	2.00	0.0025	0.04	0.43	0.70	0.30	Seed	3.08	5	0.030	20.52	1.09	0.10	0.92	0.65	2.60
												Seed	3.51	10	0.040	20.76	0.91	0.12	1.05	0.76	3.05
114+47	Concent							0.13		0.70	0.39					16.09					
114+47	115+56	L	109.00	1.00	2.00	2.00	0.0025	0.25	0.82	0.70	0.57	Seed	2.96	5	0.030	21.96	1.26	0.09	1.68	0.60	3.42
												Seed	3.35	10	0.040	22.48	1.04	0.11	1.90	0.74	3.94
115+56	Concent							3.99		0.89	4.12					24.84					
115+56	116+11	L	55.00	2.00	2.00	2.00	0.0410	0.15	4.96	0.70	4.22	Seed	2.74	5	0.030	25.00	5.67	1.60	11.57	0.63	4.51
												Jute Mat	2.74	5	0.040	25.04	4.60	1.86	11.56	0.73	4.91
												Temp. Mat	2.74	5	0.040	25.04	4.60	1.86	11.56	0.73	4.91
												Perm, Type 1	2.74	5	0.040	25.04	4.60	1.86	11.56	0.73	4.91
												Perm, Type 1	3.13	10	0.040	25.03	4.78	1.99	13.23	0.78	5.12
116+11	116+61	L	50.00	2.00	2.00	2.00	0.0269	0.33	5.29	0.73	4.46	Seed	2.73	5	0.030	25.21	4.94	1.20	12.17	0.72	4.87
												Jute Mat	2.72	5	0.040	25.25	4.00	1.39	12.16	0.83	5.32
												Temp. Mat	2.72	5	0.040	25.25	4.00	1.39	12.16	0.83	5.32
												Perm, Type 1	2.72	5	0.040	25.25	4.00	1.39	12.16	0.83	5.32
												Perm, Type 1	3.12	10	0.040	25.23	4.15	1.49	13.92	0.89	5.55
116+61	Concent							0.27		0.70	4.65					16.60					

DITCH ANALYSIS

STATION BEGIN	END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
116+61	117+39	L	79.00	2.00	2.00	2.00	0.0224	0.00	5.56	0.00	4.65	Seed	2.71	5	0.030	25.53	4.66	1.07	12.59	0.77	5.06
												Jute Mat	2.70	5	0.040	25.59	3.78	1.23	12.57	0.88	5.53
												Temp. Mat	2.70	5	0.040	25.59	3.78	1.23	12.57	0.88	5.53
												Perm, Type 1	2.70	5	0.040	25.59	3.78	1.23	12.57	0.88	5.53
												Perm, Type 1	3.09	10	0.040	25.57	3.91	1.32	14.39	0.95	5.78
117+39	118+72	L	133.00	2.00	2.00	2.00	0.0034	0.11	5.66	0.70	4.73	Seed	2.64	5	0.030	26.54	2.33	0.26	12.48	1.21	6.85
												Seed	3.01	10	0.040	26.70	1.94	0.31	14.22	1.48	7.91
118+72	119+44	L	72.00	2.00	2.00	2.00	0.0249	0.00	5.66	0.00	4.73	Seed	2.63	5	0.030	26.79	4.82	1.15	12.41	0.74	4.96
												Jute Mat	2.62	5	0.040	26.85	3.91	1.33	12.39	0.85	5.42
												Temp. Mat	2.62	5	0.040	26.85	3.91	1.33	12.39	0.85	5.42
												Perm, Type 1	2.62	5	0.040	26.85	3.91	1.33	12.39	0.85	5.42
												Perm, Type 1	2.99	10	0.040	27.00	4.05	1.42	14.13	0.91	5.65

DITCH ANALYSIS

PID : 49633 **Date :** 08/29/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, Ohio

Description : Fairfield Drainage Area - Wall B Ditch, Top 119+49 LT **Designer :** BAH

Rainfall Area : A

Allowable Shears

	Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
Permanent Mat	**Type 1:**	2.00	**Type 2:**	3.00	**Type 3:**	5.00
RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
119+49	117+62	L	190.00	2.00	2.00	2.00	0.0718	0.23	0.23	0.70	0.16	Seed	3.49	5	0.030	16.18	2.62	0.44	0.56	0.10	2.39
												Jute Mat	3.46	5	0.040	16.43	2.17	0.52	0.56	0.12	2.46
												Temp. Mat	3.46	5	0.040	16.43	2.17	0.52	0.56	0.12	2.46
												Temp. Mat	4.01	10	0.040	16.36	2.28	0.57	0.65	0.13	2.50
117+62	117+52	L	10.00	2.00	2.00	2.00	0.2800 *	0.02	0.25	0.70	0.17	Seed	3.46	5	0.030	16.47	4.19	1.17	0.60	0.07	2.27
												Jute Mat	3.46	5	0.040	16.48	3.45	1.41	0.60	0.08	2.32
												Temp. Mat	3.46	5	0.040	16.48	3.45	1.41	0.60	0.08	2.32
												Perm, Type 1	3.46	5	0.040	16.48	3.45	1.41	0.60	0.08	2.32
												Perm, Type 1	4.01	10	0.040	16.40	3.66	1.52	0.70	0.09	2.35
117+52	117+52	L	40.00	0.00	7.20	7.20	0.4000 *	0.02	0.27	0.70	0.19	Seed	3.44	5	0.030	16.61	5.14	3.32	0.65	0.13	1.91
												Jute Mat	3.44	5	0.040	16.64	4.16	3.69	0.65	0.15	2.13
												Temp. Mat	3.44	5	0.040	16.64	4.16	3.69	0.65	0.15	2.13
												Perm, Type 1	3.44	5	0.040	16.64	4.16	3.69	0.65	0.15	2.13

DITCH ANALYSIS

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
												Perm, Type 2	3.44	5	0.040	16.64	4.16	3.69	0.65	0.15	2.13
												Perm, Type 3	3.44	5	0.040	16.64	4.16	3.69	0.65	0.15	2.13
												Perm, Type 3	3.99	10	0.040	16.56	4.26	3.92	0.76	0.16	2.26

STORM SEWER SYSTEM

PID : 49633 **Date :** 10/11/2011 **Project :** CUY-90-12.90 **Location :** TREMONT

Description : TREMONT ROADWAY PLAN - Fairfield Outfall- w/o existing I-90 pavement **Designer :** BAH

Rainfall Area: A **Just Full Capacity Frequency (yrs.) :** 10 **Hydraulic Gradient Frequency (yrs.) :** 50

Minimum Pipe Size : 15.00 **Tailwater Elevation (ft.):** 644.33

JUNCTION From	JUNCTION To	STATION From / To	ΔAREA / ΣAREA (acres)	ΔCA / ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	RAINFALL INTENSITY (50 yrs.)	DISCHARGE (cfs.) (10 yrs.)	DISCHARGE (cfs.) (50 yrs.)	PIPE DIAM. (in.)	PIPE LENGTH (ft.)	PIPE SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE / MANNING'S 'n'
119	119C	15+15	5.66	4.73	27.00	2.99	3.86	14.1	18.3	15	35.4	0.0212	644.91	11.51	8.77	0.1062	649.17	649.21	0.04	3.05	CB 8
begin		15+16	5.66	4.73						**Warning**			644.16				645.41	650.86			0.015

* An additional 0.448 acres of pavement from existing I-90 was added to the drainage system creating a higher Q10 (1.21 cfs increase) than just full capacity which was designed for Tremont Grading. The additional area currently flows to three scuppers which were ignored due to the existing inlet being in a sag condition. Sump calcs show 1.2 ft of head with 50% clogging for the 10-year event, and the ditch is 2.5 feet at the sump.

STORM SEWER SYSTEM

PID : 49633 **Date :** 10/11/2011 **Project :** CUY-90-12.90 **Location :** TREMONT

Description : TREMONT ROADWAY PLAN - Fairfield Outfall- w/o existing I-90 pavement **Designer :** BAH

Rainfall Area: A **Just Full Capacity Frequency (yrs.) :** 25 **Hydraulic Gradient Frequency (yrs.) :** 50

Minimum Pipe Size : 15.00 **Tailwater Elevation (ft.):** 644.33

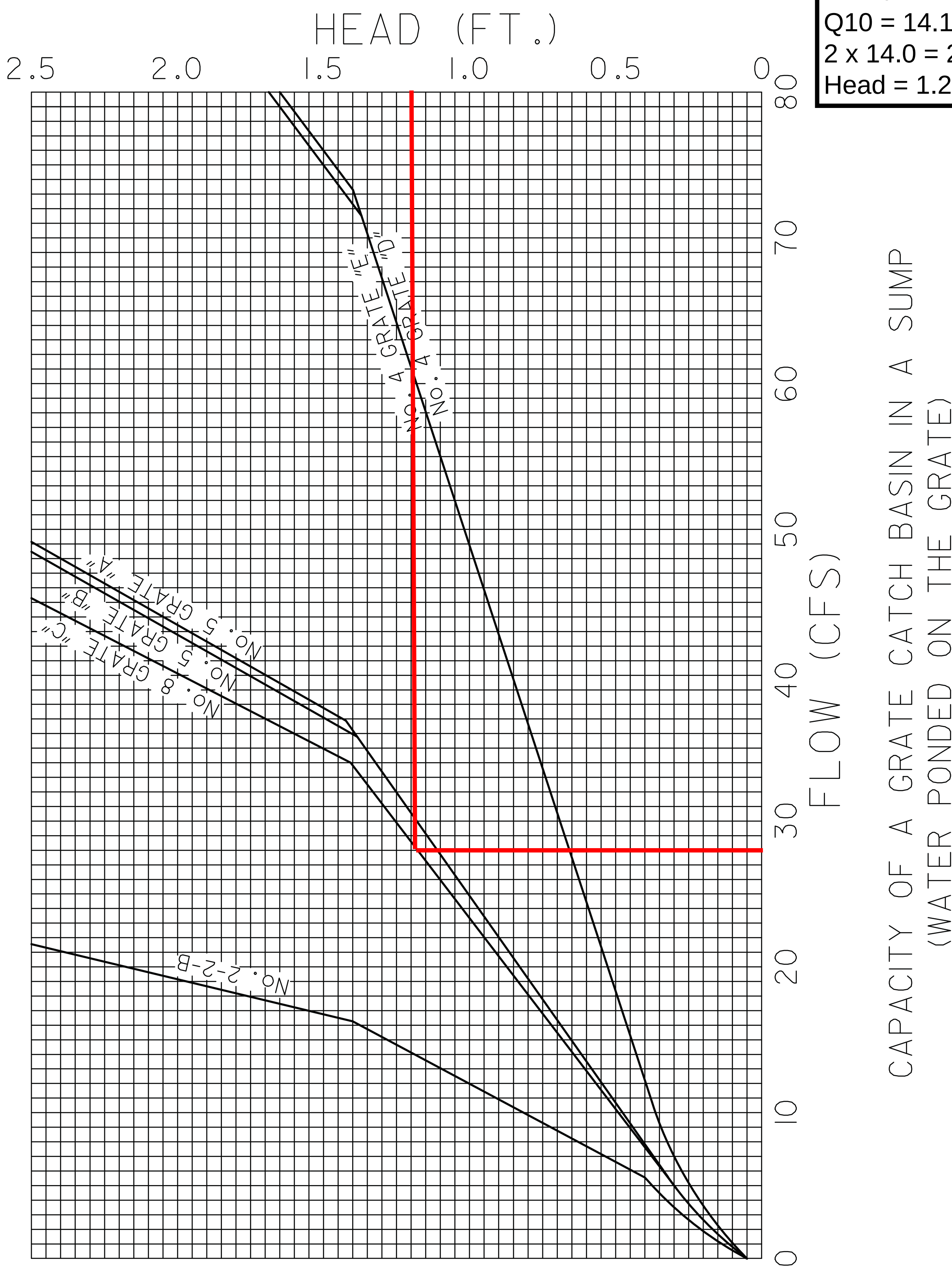
JUNCTION From	JUNCTION To	STATION From / To	ΔAREA / ΣAREA (acres)	ΔCA / ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (25 yrs.)	RAINFALL INTENSITY (50 yrs.)	DISCHARGE (cfs.) (25 yrs.)	DISCHARGE (cfs.) (50 yrs.)	PIPE DIAM. (in.)	PIPE LENGTH (ft.)	PIPE SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE / MANNING'S 'n'
119	119C	15+15	5.66	4.73	27.00	3.65	3.86	17.2	18.3	15	35.4	0.0212	644.91	14.06	8.77	0.1063	649.17	649.21	0.04	3.05	CB 8
begin		15+16	5.66	4.73						**Warning**			644.16				645.41	650.86			0.015

* An additional 0.448 acres of pavement from existing I-90 was added to the drainage system creating a higher Q10 (1.21 cfs increase) than just full capacity which was designed for Tremont Grading. The additional area currently flows to three scuppers which were ignored due to the existing inlet being in a sag condition. Sump calcs show 1.2 ft of head with 50% clogging for the 10-year event, and the ditch is 2.5 feet at the sump.

D-119 Sump Calculation

CAPACITY OF A GRATE CATCH BASIN IN A SUMP	1102-1 REFERENCE SECTION 1102.3.5

D-119
Q10 = 14.1cfs
2 x 14.0 = 28.2 Check
Head = 1.2ft



DITCH ANALYSIS

PID : 49633 **Date :** 08/26/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, Ohio

Description : Fairfield Drainage Area - Wall B Ditch, 119+26 RT **Designer :** BAH

Rainfall Area : A

Allowable Shears

	Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
Permanent Mat	**Type 1:**	2.00	**Type 2:**	3.00	**Type 3:**	5.00
RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
119+26	118+69	R	59.00	2.00	2.00	2.00	0.0070	0.04	0.04	0.70	0.03	Seed	4.08	5	0.030	11.44	0.65	0.03	0.11	0.08	2.30
												Seed	4.77	10	0.040	11.59	0.58	0.04	0.12	0.10	2.39
118+69	118+57	R	12.48	2.00	2.00	2.00	0.1023 *	0.01	0.04	0.70	0.03	Seed	4.06	5	0.030	11.56	1.71	0.22	0.12	0.03	2.14
												Seed	4.74	10	0.040	11.73	1.42	0.31	0.14	0.05	2.19
118+48	118+72	R	25.00	0.00	2.00	2.00	0.0395	0.04	0.08	0.70	0.06	Seed	4.03	5	0.030	11.75	2.11	0.58	0.24	0.24	0.95
												Jute Mat	4.03	5	0.040	11.79	1.77	0.64	0.24	0.26	1.03
												Temp. Mat	4.03	5	0.040	11.79	1.77	0.64	0.24	0.26	1.03
												Temp. Mat	4.70	10	0.040	11.96	1.83	0.68	0.27	0.27	1.10
118+72	119+29	R	57.00	2.00	2.00	2.00	0.4464 *	0.05	0.14	0.70	0.10	Seed	4.00	5	0.030	12.02	4.06	1.27	0.39	0.05	2.18
												Jute Mat	3.99	5	0.040	12.06	3.42	1.50	0.39	0.05	2.21
												Temp. Mat	3.99	5	0.040	12.06	3.42	1.50	0.39	0.05	2.21
												Perm, Type 1	3.99	5	0.040	12.06	3.42	1.50	0.39	0.05	2.21
												Perm, Type 1	4.65	10	0.040	12.22	3.60	1.65	0.45	0.06	2.24

STORM SEWER SYSTEM

PID : 49633 **Date :** 08/30/2011 **Project :** CUY-90-12.90 **Location :** TREMONT

Description : TREMONT ROADWAY PLAN - Fairfield Outfall D-119A **Designer :** BAH

Rainfall Area: A **Just Full Capacity Frequency (yrs.) :** 10 **Hydraulic Gradient Frequency (yrs.) :** 25

Minimum Pipe Size : 12.00 **Tailwater Elevation (ft.):** 655.50

JUNCTION From	JUNCTION To	STATION From / To	ΔAREA / ΣAREA (acres)	ΔCA / ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	RAINFALL INTENSITY (25 yrs.)	DISCHARGE (cfs.) (10 yrs.)	DISCHARGE (cfs.) (25 yrs.)	PIPE DIAM. (in.)	PIPE LENGTH (ft.)	PIPE SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE / MANNING'S 'n'
119A	5182	16+78	0.14	0.10	12.22	4.65	5.61	0.5	0.5	12	63.2	0.0226	655.62	3.78	5.00	0.0003	655.85	661.47	5.62	4.85	CB 2-2B
begin		16+29	0.14	0.10									654.19				655.50	658.69			0.015

STORM SEWER SYSTEM

PID : 49633 **Date :** 08/30/2011 **Project :** CUY-90-12.90 **Location :** TREMONT

Description : TREMONT ROADWAY PLAN - Fairfield Outfall D-119A **Designer :** BAH

Rainfall Area: A **Just Full Capacity Frequency (yrs.) :** 10 **Hydraulic Gradient Frequency (yrs.) :** 50

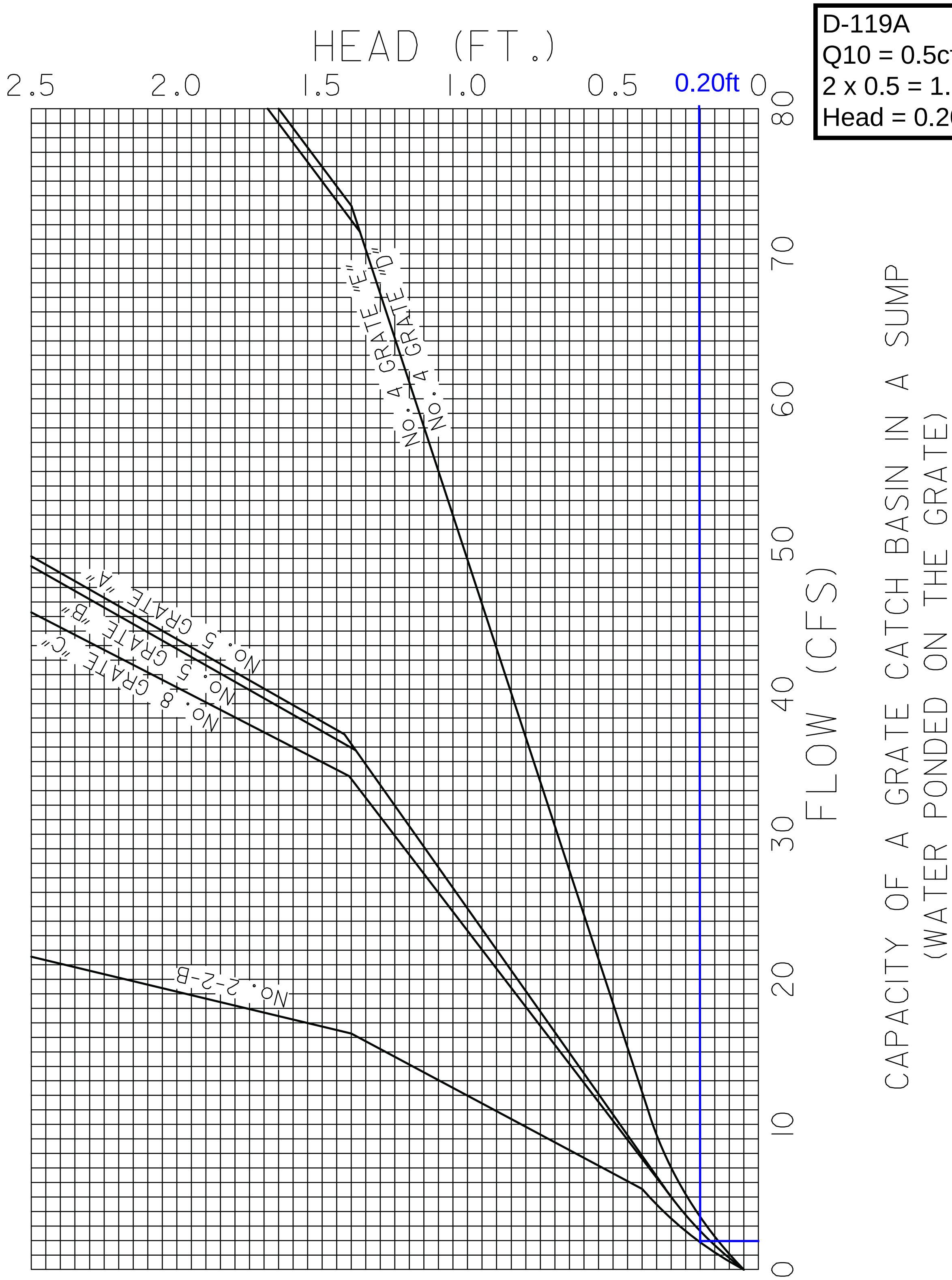
Minimum Pipe Size : 12.00 **Tailwater Elevation (ft.):** 655.50

JUNCTION From	JUNCTION To	STATION From / To	ΔAREA / ΣAREA (acres)	ΔCA / ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	RAINFALL INTENSITY (50 yrs.)	DISCHARGE (cfs.) (10 yrs.)	DISCHARGE (cfs.) (50 yrs.)	PIPE DIAM. (in.)	PIPE LENGTH (ft.)	PIPE SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE / MANNING'S 'n'
119A	5182	16+78	0.14	0.10	12.22	4.65	6.06	0.5	0.6	12	63.2	0.0226	655.62	3.78	5.00	0.0004	655.86	661.47	5.61	4.85	CB 2-2B
begin		16+29	0.14	0.10									654.19				655.50	658.69			0.015

D-119A Sump Calculation

CAPACITY OF A GRATE CATCH BASIN IN A SUMP	1102-1
	REFERENCE SECTION 1102.3.5

D-119A
Q10 = 0.5cfs
2 x 0.5 = 1.0 Check
Head = 0.20ft



APPENDIX E

DITCH ANALYSIS

PID : 49633 **Date :** 10/07/2011 **Project :** CIB **Location :** Tremont Temp. Grading 2 - Ditch 3

Description : Grading between Ramp A6 and Mainline (Fairfield Stationing) Wall C intercept **Designer :** AHR

Rainfall Area : A

Allowable Shears

	Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
Permanent Mat	**Type 1:**	2.00	**Type 2:**	3.00	**Type 3:**	5.00
RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
15+30	15+10	L	44.00	0.00	2.00	2.00	0.4100 *	0.14	0.14	0.70	0.10	Seed	3.61	5	0.030	15.13	5.80	4.47	0.35	0.17	0.70
												Jute Mat	3.60	5	0.040	15.15	4.72	4.95	0.35	0.19	0.77
												Temp. Mat	3.60	5	0.040	15.15	4.72	4.95	0.35	0.19	0.77
												Perm, Type 1	3.60	5	0.040	15.15	4.72	4.95	0.35	0.19	0.77
												Perm, Type 2	3.60	5	0.040	15.15	4.72	4.95	0.35	0.19	0.77
												Perm, Type 3	3.60	5	0.040	15.15	4.72	4.95	0.35	0.19	0.77
												Perm, Type 3	4.18	10	0.040	15.15	4.91	5.22	0.41	0.20	0.82
15+10	14+73	L	48.00	0.00	3.00	3.00	0.2700 *	0.25	0.39	0.70	0.28	Seed	3.59	5	0.030	15.29	5.97	3.96	0.99	0.23	1.41
												Jute Mat	3.58	5	0.040	15.32	4.80	4.41	0.99	0.26	1.57
												Temp. Mat	3.58	5	0.040	15.32	4.80	4.41	0.99	0.26	1.57
												Perm, Type 1	3.58	5	0.040	15.32	4.80	4.41	0.99	0.26	1.57
												Perm, Type 2	3.58	5	0.040	15.32	4.80	4.41	0.99	0.26	1.57
												Perm, Type 3	3.58	5	0.040	15.32	4.80	4.41	0.99	0.26	1.57

DITCH ANALYSIS

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
												Perm, Type 3	4.16	10	0.040	15.31	4.99	4.66	1.15	0.28	1.66
14+73	14+61	L	35.00	0.00	5.00	5.00	0.2300 *	0.00	0.39	1.00	0.28	Seed	3.57	5	0.030	15.44	4.99	2.85	0.98	0.20	1.99
												Jute Mat	3.57	5	0.040	15.47	4.06	3.16	0.98	0.22	2.20
												Temp. Mat	3.57	5	0.040	15.47	4.06	3.16	0.98	0.22	2.20
												Perm, Type 1	3.57	5	0.040	15.47	4.06	3.16	0.98	0.22	2.20
												Perm, Type 2	3.57	5	0.040	15.47	4.06	3.16	0.98	0.22	2.20
												Perm, Type 3	3.57	5	0.040	15.47	4.06	3.16	0.98	0.22	2.20
												Perm, Type 3	4.14	10	0.040	15.45	4.18	3.35	1.14	0.23	2.34

DITCH ANALYSIS

PID : 49633 **Date :** 10/07/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, Ohio

Description : Tremont Drainage Area - Wall C Ditch, Top (Fairfield Stationing) **Designer :** AHR

Rainfall Area : A

Allowable Shears

	Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
Permanent Mat	**Type 1:**	2.00	**Type 2:**	3.00	**Type 3:**	5.00
RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
15+60	12+15	L	346.00	0.00	2.00	2.00	0.0643	0.88	0.88	0.70	0.62	Seed	3.48	5	0.030	16.26	4.54	1.95	2.14	0.49	1.94
												Jute Mat	3.45	5	0.040	16.56	3.64	2.17	2.12	0.54	2.16
												Temp. Mat	3.45	5	0.040	16.56	3.64	2.17	2.12	0.54	2.16
												Perm, Type 1	3.45	5	0.040	16.56	3.64	2.17	2.12	0.54	2.16
												Perm, Type 2	3.45	5	0.040	16.56	3.64	2.17	2.12	0.54	2.16
												Perm, Type 2	3.99	10	0.040	16.50	3.79	2.28	2.46	0.57	2.28
12+15	11+98	L	20.00	1.00	2.00	2.00	0.2500 *	0.00	0.88	1.00	0.62	Seed	3.44	5	0.030	16.61	7.11	3.28	2.12	0.21	1.84
												Jute Mat	3.44	5	0.040	16.62	5.79	3.83	2.12	0.25	1.98
												Temp. Mat	3.44	5	0.040	16.62	5.79	3.83	2.12	0.25	1.98
												Perm, Type 1	3.44	5	0.040	16.62	5.79	3.83	2.12	0.25	1.98
												Perm, Type 2	3.44	5	0.040	16.62	5.79	3.83	2.12	0.25	1.98
												Perm, Type 3	3.44	5	0.040	16.62	5.79	3.83	2.12	0.25	1.98
												Perm, Type 3	3.99	10	0.040	16.56	6.05	4.14	2.46	0.27	2.06

DITCH ANALYSIS

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
11+98	10+83	L	118.00	0.00	2.00	2.00	0.0593	0.24	1.12	0.70	0.79	Seed	3.40	5	0.030	17.04	4.66	1.98	2.67	0.54	2.14
												Jute Mat	3.39	5	0.040	17.14	3.75	2.21	2.67	0.60	2.38
												Temp. Mat	3.39	5	0.040	17.14	3.75	2.21	2.67	0.60	2.38
												Perm, Type 1	3.39	5	0.040	17.14	3.75	2.21	2.67	0.60	2.38
												Perm, Type 2	3.39	5	0.040	17.14	3.75	2.21	2.67	0.60	2.38
												Perm, Type 2	3.92	10	0.040	17.06	3.89	2.33	3.09	0.63	2.52

STORM SEWER SYSTEM

PID : 49633 **Date :** 10/10/2011 **Project :** CIB **Location :** Fairfield RT - Tremont Temporary Grading

Description : Basin for Tremont Wall Drainage **Designer :** AHR

Rainfall Area: A **Just Full Capacity Frequency (yrs.) :** 10 **Hydraulic Gradient Frequency (yrs.) :** 25

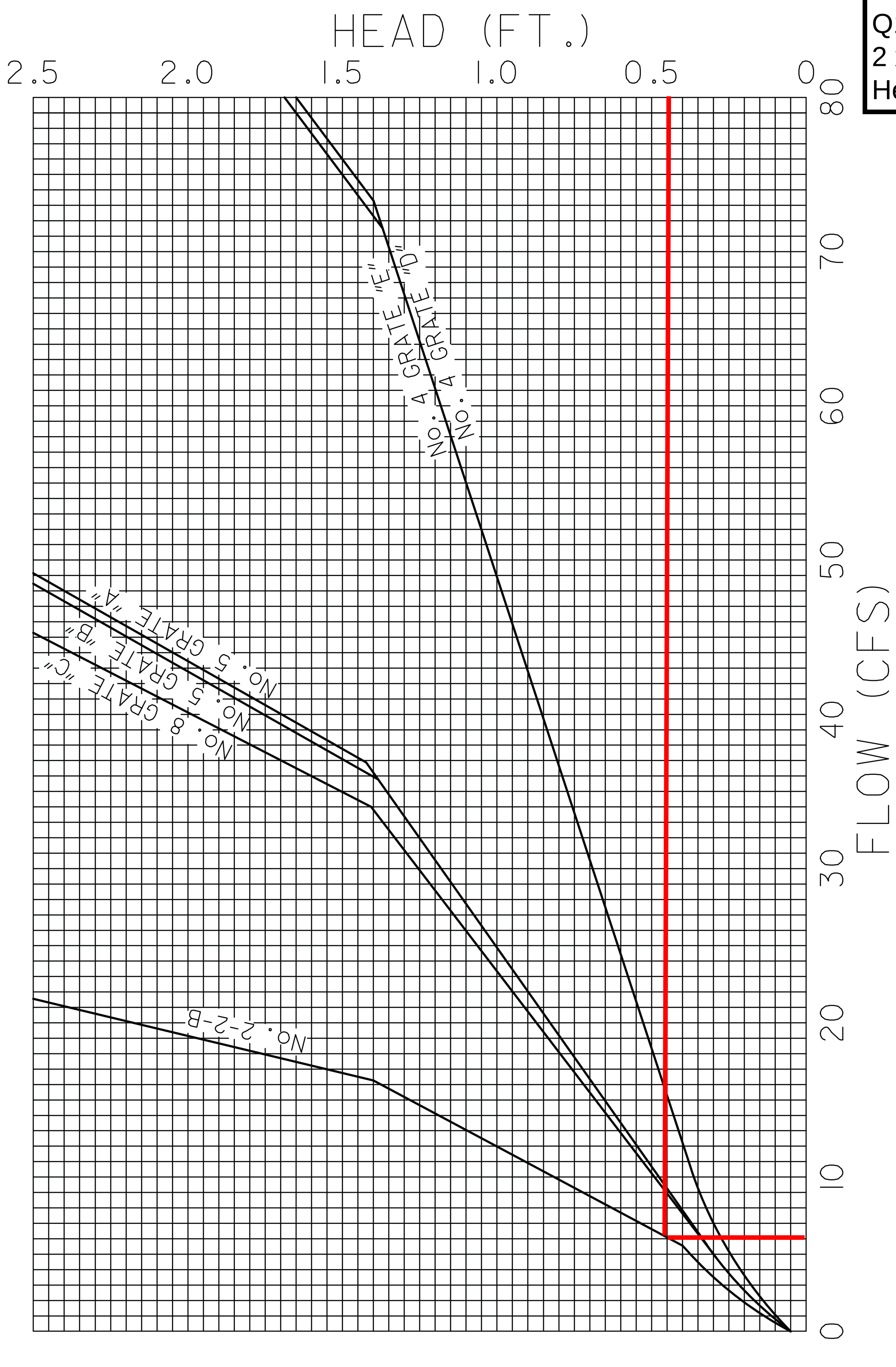
Minimum Pipe Size : 18.00 **Tailwater Elevation (ft.):** 619.19

JUNCTION From	JUNCTION To	STATION From / To	ΔAREA / ΣAREA (acres)	ΔCA / ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	RAINFALL INTENSITY (25 yrs.)	DISCHARGE (cfs.) (10 yrs.)	DISCHARGE (cfs.) (25 yrs.)	PIPE DIAM. (in.)	PIPE LENGTH (ft.)	PIPE SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
D933	D543	11+26	1.12	0.78	17.06	3.92	4.78	3.1	3.8	18	29.8	0.1768	621.89	12.96	41.18	0.0017	622.21	626.89	4.68	3.50	CB 8
begin		11+25	1.12	0.78									616.62				619.19	626.82			0.015

D-933 Sump Calculation

CAPACITY OF A GRATE CATCH BASIN IN A SUMP	1102-1 REFERENCE SECTION 1102.3.5

D-933
Q10 = 3.1cfs
2 x 3.1 = 6.2 Check
Head = 0.45ft



CAPACITY OF A GRATE CATCH BASIN IN A SUMP
(WATER PONDED ON THE GRATE)

APPENDIX F

DITCH ANALYSIS

PID : 49633 **Date :** 10/09/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, Ohio

Description : Mainline I90 RT Station 120+10 to 122+34 **Designer :** PNS

Rainfall Area : A

Allowable Shears

	Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
Permanent Mat	**Type 1:**	2.00	**Type 2:**	3.00	**Type 3:**	5.00
RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
120+10	122+34	R	224.00	2.00	2.00	2.00	0.0039	0.76	0.76	0.66	0.50	Seed	3.34	5	0.030	17.59	1.41	0.10	1.67	0.42	3.68
												Seed	3.80	10	0.040	18.05	1.19	0.13	1.90	0.52	4.09

DITCH ANALYSIS

PID : 49633 **Date :** 10/09/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, Ohio

Description : Mainline I90 RT Station 120+10 to 122+34 **Designer :** PNS

Rainfall Area : A

Allowable Shears

	Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
Permanent Mat	**Type 1:**	2.00	**Type 2:**	3.00	**Type 3:**	5.00
RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
120+10	122+34	R	224.00	2.00	2.00	2.00	0.0039	0.76	0.76	0.66	0.50	Seed	3.34	5	0.030	17.59	1.41	0.10	1.67	0.42	3.68
												Seed	4.97	50	0.040	17.83	1.28	0.15	2.49	0.60	4.42

DITCH ANALYSIS

PID : 49633 **Date :** 10/09/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, Ohio

Description : Mainline I90 LT Station 122+73 TO 121+36 LT **Designer :** PNS

Rainfall Area : A

Allowable Shears

	Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
Permanent Mat	**Type 1:**	2.00	**Type 2:**	3.00	**Type 3:**	5.00
RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
122+73	121+36	L	139.00	0.00	4.00	3.40	0.0300	0.20	0.20	0.76	0.15	Seed	3.50	5	0.030	16.08	2.16	0.48	0.53	0.26	1.91
												Jute Mat	3.47	5	0.040	16.34	1.73	0.54	0.53	0.29	2.13
												Temp. Mat	3.47	5	0.040	16.34	1.73	0.54	0.53	0.29	2.13
												Temp. Mat	4.02	10	0.040	16.28	1.79	0.57	0.61	0.30	2.25

DITCH ANALYSIS

PID : 49633 **Date :** 10/09/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, Ohio

Description : Mainline I90 LT Station 122+73 TO 121+36 LT **Designer :** PNS

Rainfall Area : A

Allowable Shears

	Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
Permanent Mat	**Type 1:**	2.00	**Type 2:**	3.00	**Type 3:**	5.00
RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
122+73	121+36	L	139.00	0.00	4.00	3.40	0.0300	0.20	0.20	0.76	0.15	Seed	3.50	5	0.030	16.08	2.16	0.48	0.53	0.26	1.91
												Jute Mat	3.47	5	0.040	16.34	1.73	0.54	0.53	0.29	2.13
												Temp. Mat	3.47	5	0.040	16.34	1.73	0.54	0.53	0.29	2.13
												Temp. Mat	5.26	50	0.040	16.20	1.92	0.63	0.80	0.34	2.48

DITCH ANALYSIS

PID : 46933 **Date :** 10/09/2011 **Project :** CUY-90-14.90 **Location :** Sta 124+00 to 127+25 RT

Description :future parking lot **Designer :** PNS

Rainfall Area : A

Allowable Shears

	Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
Permanent Mat	**Type 1:**	2.00	**Type 2:**	3.00	**Type 3:**	5.00
RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
124+00	127+25	R	325.00	0.00	4.00	13.00	0.0025	2.37	2.37	0.73	1.73	Seed	3.19	5	0.030	19.21	1.25	0.11	5.52	0.72	12.27
												Seed	3.58	10	0.040	20.03	1.04	0.13	6.20	0.84	14.27

DITCH ANALYSIS

PID : 46933 **Date :** 10/09/2011 **Project :** CUY-90-14.90 **Location :** Sta 124+00 to 127+25 RT

Description :future parking lot **Designer :** PNS

Rainfall Area : A

Allowable Shears

	Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
Permanent Mat	**Type 1:**	2.00	**Type 2:**	3.00	**Type 3:**	5.00
RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
124+00	127+25	R	325.00	0.00	4.00	13.00	0.0025	2.37	2.37	0.73	1.73	Seed	3.19	5	0.030	19.21	1.25	0.11	5.52	0.72	12.27
												Seed	4.69	50	0.040	19.70	1.11	0.14	8.11	0.93	15.78

DITCH ANALYSIS

PID : 49633 **Date :** 10/09/2011 **Project :** CI **Location :** Ramp A6

Description : Intersection flow from Ramp A6 and 14th St **Designer :** PNS

Rainfall Area : A

Allowable Shears

	Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
Permanent Mat	**Type 1:**	2.00	**Type 2:**	3.00	**Type 3:**	5.00
RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
815+70	815+70	R	15.00	2.00	1.00	1.00	0.1667 *	0.13	0.13	0.81	0.11	Seed	4.29	5	0.030	10.08	3.25	0.70	0.45	0.07	2.13
												Jute Mat	4.28	5	0.040	10.09	2.69	0.84	0.45	0.08	2.16
												Temp. Mat	4.28	5	0.040	10.09	2.69	0.84	0.45	0.08	2.16
												Temp. Mat	5.08	10	0.040	10.09	2.89	0.92	0.53	0.09	2.18

DITCH ANALYSIS

PID : 49633 **Date :** 10/09/2011 **Project :** CI **Location :** Ramp A6

Description : Intersection flow from Ramp A6 and 14th St **Designer :** PNS

Rainfall Area : A

Allowable Shears

	Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
Permanent Mat	**Type 1:**	2.00	**Type 2:**	3.00	**Type 3:**	5.00
RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
815+70	815+70	R	15.00	2.00	1.00	1.00	0.1667 *	0.13	0.13	0.81	0.11	Seed	4.29	5	0.030	10.08	3.25	0.70	0.45	0.07	2.13
												Jute Mat	4.28	5	0.040	10.09	2.69	0.84	0.45	0.08	2.16
												Temp. Mat	4.28	5	0.040	10.09	2.69	0.84	0.45	0.08	2.16
												Temp. Mat	6.77	50	0.040	10.08	3.19	1.10	0.71	0.11	2.21

DITCH ANALYSIS

PID : 49633 **Date :** 10/11/2011 **Project :** CI **Location :** Ramp A6

Description : End of Wall Ramp A6 Shoulder LT Sta 813+25 **Designer :** PNS

Rainfall Area : A **Allowable Shears**

	Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
Permanent Mat	**Type 1:**	2.00	**Type 2:**	3.00	**Type 3:**	5.00
RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
813+25	813+25	L	20.00	2.00	1.00	1.00	0.3300 *	0.13	0.13	0.90	0.12	Seed	4.29	5	0.030	10.08	4.12	1.22	0.50	0.06	2.12
												Jute Mat	4.28	5	0.040	10.10	3.47	1.44	0.50	0.07	2.14
												Temp. Mat	4.28	5	0.040	10.10	3.47	1.44	0.50	0.07	2.14
												Perm, Type 1	4.28	5	0.040	10.10	3.47	1.44	0.50	0.07	2.14
												Perm, Type 1	5.08	10	0.040	10.09	3.67	1.60	0.59	0.08	2.16

DITCH ANALYSIS

PID : 49633 **Date :** 10/09/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, Ohio

Description : Ramp A6 LT Long Ditch **Designer :** PNS

Rainfall Area : A

Allowable Shears

	Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
Permanent Mat	**Type 1:**	2.00	**Type 2:**	3.00	**Type 3:**	5.00
RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
811+90	813+25	L	135.00	4.00	3.00	3.00	0.0030	0.17	0.17	0.70	0.12	Seed	3.28	5	0.030	18.22	0.66	0.03	0.39	0.13	4.81
												Seed	3.72	10	0.040	18.74	0.57	0.03	0.44	0.17	5.03
813+25	Concent							0.13		0.90	0.24					10.00					
813+25	814+25	L	100.00	4.00	3.00	3.00	0.0300	0.20	0.50	0.72	0.38	Seed	3.21	5	0.030	19.02	2.10	0.25	1.21	0.13	4.79
												Seed	3.62	10	0.040	19.65	1.81	0.31	1.37	0.17	5.01
814+25	815+00	L	75.00	4.00	3.00	3.00	0.0141	0.70	1.20	0.37	0.64	Seed	3.15	5	0.030	19.65	1.94	0.19	2.01	0.22	5.33
												Seed	3.55	10	0.040	20.39	1.67	0.25	2.26	0.28	5.68

DITCH ANALYSIS

PID : 49633 **Date :** 10/09/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, Ohio

Description : Ramp A6 LT Long Ditch **Designer :** PNS

Rainfall Area : A

Allowable Shears

	Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
Permanent Mat	**Type 1:**	2.00	**Type 2:**	3.00	**Type 3:**	5.00
RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
811+90	813+25	L	135.00	4.00	3.00	3.00	0.0030	0.17	0.17	0.70	0.12	Seed	3.28	5	0.030	18.22	0.66	0.03	0.39	0.13	4.81
												Seed	4.88	50	0.040	18.44	0.64	0.04	0.58	0.20	5.19
813+25	Concent							0.13		0.90	0.24					10.00					
813+25	814+25	L	100.00	4.00	3.00	3.00	0.0300	0.20	0.50	0.72	0.38	Seed	3.21	5	0.030	19.02	2.10	0.25	1.21	0.13	4.79
												Seed	4.75	50	0.040	19.27	1.98	0.37	1.80	0.20	5.18
814+25	815+00	L	75.00	4.00	3.00	3.00	0.0141	0.70	1.20	0.37	0.64	Seed	3.15	5	0.030	19.65	1.94	0.19	2.01	0.22	5.33
												Seed	4.66	50	0.040	19.95	1.83	0.29	2.97	0.33	5.95

DITCH ANALYSIS

PID : 49633 **Date :** 10/09/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, Ohio

Description : Ramp A6 LT Short Ditch **Designer :** PNS

Rainfall Area : A

Allowable Shears

	Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
Permanent Mat	**Type 1:**	2.00	**Type 2:**	3.00	**Type 3:**	5.00
RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
815+66	815+00	L	66.00	4.00	6.00	6.00	0.0260	0.20	0.20	0.51	0.10	Seed	3.52	5	0.030	15.88	1.21	0.11	0.36	0.07	4.81
												Seed	4.06	10	0.040	16.00	1.07	0.14	0.41	0.09	5.03

DITCH ANALYSIS

PID : 49633 **Date :** 10/09/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, Ohio

Description : Ramp A6 LT Short Ditch **Designer :** PNS

Rainfall Area : A **Allowable Shears**

	Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
Permanent Mat	**Type 1:**	2.00	**Type 2:**	3.00	**Type 3:**	5.00
RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
815+66	815+00	L	66.00	4.00	6.00	6.00	0.0260	0.20	0.20	0.51	0.10	Seed	3.52	5	0.030	15.88	1.21	0.11	0.36	0.07	4.81
												Seed	5.31	50	0.040	15.93	1.18	0.16	0.54	0.10	5.19

DITCH ANALYSIS

PID : 49633 **Date :** 10/09/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, Ohio

Description : Ramp A6 RT **Designer :** PNS

Rainfall Area : A

Allowable Shears

	Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
Permanent Mat	**Type 1:**	2.00	**Type 2:**	3.00	**Type 3:**	5.00
RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
807+43	807+83	R	40.00	6.00	6.00	6.00	0.0387	0.10	0.10	0.58	0.06	Seed	3.55	5	0.030	15.66	0.99	0.08	0.21	0.03	6.40
												Seed	4.10	10	0.040	15.74	0.88	0.10	0.24	0.04	6.52
807+83	808+07	L	24.43	6.00	6.00	6.00	0.0147	0.00	0.10	0.00	0.06	Seed	3.48	5	0.030	16.23	0.75	0.04	0.20	0.04	6.52
												Seed	4.01	10	0.040	16.38	0.65	0.05	0.23	0.06	6.68
808+07	810+54	R	246.00	6.00	6.00	6.00	0.0330	0.17	0.27	0.69	0.18	Seed	3.20	5	0.030	19.07	1.39	0.13	0.57	0.06	6.77
												Seed	3.62	10	0.040	19.65	1.21	0.17	0.64	0.08	6.98
810+54	813+38	R	282.00	6.00	6.00	6.00	0.0424	0.34	0.61	0.68	0.41	Seed	3.01	5	0.030	21.38	1.99	0.25	1.23	0.09	7.13
												Seed	3.36	10	0.040	22.31	1.72	0.31	1.38	0.12	7.43
813+38	814+00	R	61.00	6.00	6.00	6.00	0.0431	0.21	0.82	0.67	0.55	Seed	2.97	5	0.030	21.84	2.23	0.30	1.63	0.11	7.32
												Seed	3.31	10	0.040	22.83	1.91	0.38	1.82	0.14	7.68
814+00	814+30	R	30.00	6.00	6.00	6.00	0.0772	0.00	0.82	0.00	0.55	Seed	2.96	5	0.030	22.03	2.68	0.45	1.63	0.09	7.11
												Jute Mat	2.95	5	0.040	22.07	2.21	0.53	1.62	0.11	7.32
												Temp. Mat	2.95	5	0.040	22.07	2.21	0.53	1.62	0.11	7.32

DITCH ANALYSIS

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
												Temp. Mat	3.30	10	0.040	23.05	2.32	0.56	1.81	0.12	7.40
814+30	Concent							0.35		0.74	0.81					15.00					
814+30	814+30	R	41.00	0.00	10.00	10.00	0.2500 *	0.00	1.17	0.00	0.81	Seed	2.94	5	0.030	22.19	5.46	3.26	2.38	0.21	4.18
												Jute Mat	2.94	5	0.040	22.22	4.41	3.62	2.38	0.23	4.65
												Temp. Mat	2.94	5	0.040	22.22	4.41	3.62	2.38	0.23	4.65
												Perm, Type 1	2.94	5	0.040	22.22	4.41	3.62	2.38	0.23	4.65
												Perm, Type 2	2.94	5	0.040	22.22	4.41	3.62	2.38	0.23	4.65
												Perm, Type 3	2.94	5	0.040	22.22	4.41	3.62	2.38	0.23	4.65
												Perm, Type 3	3.28	10	0.040	23.20	4.52	3.78	2.66	0.24	4.85

DITCH ANALYSIS

PID : 49633 **Date :** 10/09/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, Ohio

Description : Ramp A6 RT **Designer :** PNS

Rainfall Area : A

Allowable Shears

	Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
Permanent Mat	**Type 1:**	2.00	**Type 2:**	3.00	**Type 3:**	5.00
RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
807+43	807+83	R	40.00	6.00	6.00	6.00	0.0387	0.10	0.10	0.58	0.06	Seed	3.55	5	0.030	15.66	0.99	0.08	0.21	0.03	6.40
												Seed	5.35	50	0.040	15.67	0.96	0.12	0.31	0.05	6.61
807+83	808+07	L	24.43	6.00	6.00	6.00	0.0147	0.00	0.10	0.00	0.06	Seed	3.48	5	0.030	16.23	0.75	0.04	0.20	0.04	6.52
												Seed	5.25	50	0.040	16.24	0.71	0.06	0.30	0.07	6.81
808+07	810+54	R	246.00	6.00	6.00	6.00	0.0330	0.17	0.27	0.69	0.18	Seed	3.20	5	0.030	19.07	1.39	0.13	0.57	0.06	6.77
												Seed	4.76	50	0.040	19.20	1.33	0.20	0.85	0.10	7.16
810+54	813+38	R	282.00	6.00	6.00	6.00	0.0424	0.34	0.61	0.68	0.41	Seed	3.01	5	0.030	21.38	1.99	0.25	1.23	0.09	7.13
												Seed	4.44	50	0.040	21.61	1.90	0.37	1.82	0.14	7.68
813+38	814+00	R	61.00	6.00	6.00	6.00	0.0431	0.21	0.82	0.67	0.55	Seed	2.97	5	0.030	21.84	2.23	0.30	1.63	0.11	7.32
												Seed	4.38	50	0.040	22.09	2.10	0.44	2.41	0.16	7.97
814+00	814+30	R	30.00	6.00	6.00	6.00	0.0772	0.00	0.82	0.00	0.55	Seed	2.96	5	0.030	22.03	2.68	0.45	1.63	0.09	7.11
												Jute Mat	2.95	5	0.040	22.07	2.21	0.53	1.62	0.11	7.32
												Temp. Mat	2.95	5	0.040	22.07	2.21	0.53	1.62	0.11	7.32

DITCH ANALYSIS

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
												Temp. Mat	4.35	50	0.040	22.29	2.55	0.66	2.39	0.14	7.65
814+30	Concent							0.35		0.74	0.81					15.00					
814+30	814+30	R	41.00	0.00	10.00	10.00	0.2500 *	0.00	1.17	0.00	0.81	Seed	2.94	5	0.030	22.19	5.46	3.26	2.38	0.21	4.18
												Jute Mat	2.94	5	0.040	22.22	4.41	3.62	2.38	0.23	4.65
												Temp. Mat	2.94	5	0.040	22.22	4.41	3.62	2.38	0.23	4.65
												Perm, Type 1	2.94	5	0.040	22.22	4.41	3.62	2.38	0.23	4.65
												Perm, Type 2	2.94	5	0.040	22.22	4.41	3.62	2.38	0.23	4.65
												Perm, Type 3	2.94	5	0.040	22.22	4.41	3.62	2.38	0.23	4.65
												Perm, Type 3	4.34	50	0.040	22.43	4.87	4.19	3.51	0.27	5.37

DITCH ANALYSIS

PID : 49633 **Date :** 10/09/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, Ohio

Description : Ramp A6 RT **Designer :** PNS

Rainfall Area : A

Allowable Shears

	Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
Permanent Mat	**Type 1:**	2.00	**Type 2:**	3.00	**Type 3:**	5.00
RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
815+77	815+37	R	40.00	6.00	6.00	6.00	0.0500	0.35	0.35	0.74	0.26	Seed	3.58	5	0.030	15.35	1.89	0.24	0.93	0.08	6.91
												Seed	4.14	10	0.040	15.40	1.66	0.31	1.07	0.10	7.18
815+37	814+60	R	77.00	6.00	6.00	6.00	0.0050	0.00	0.35	0.00	0.26	Seed	3.43	5	0.030	16.77	0.89	0.05	0.89	0.15	7.74
												Seed	3.92	10	0.040	17.03	0.77	0.06	1.02	0.19	8.22
814+60	814+30	R	30.00	6.00	6.00	6.00	0.0361	0.00	0.35	0.00	0.26	Seed	3.40	5	0.030	17.07	1.68	0.18	0.88	0.08	6.97
												Seed	3.88	10	0.040	17.37	1.47	0.23	1.01	0.10	7.24

DITCH ANALYSIS

PID : 49633 **Date :** 10/09/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, Ohio

Description : Ramp A6 RT **Designer :** PNS

Rainfall Area : A

Allowable Shears

	Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
Permanent Mat	**Type 1:**	2.00	**Type 2:**	3.00	**Type 3:**	5.00
RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
815+77	815+37	R	40.00	6.00	6.00	6.00	0.0500	0.35	0.35	0.74	0.26	Seed	3.58	5	0.030	15.35	1.89	0.24	0.93	0.08	6.91
												Seed	5.41	50	0.040	15.36	1.84	0.36	1.40	0.11	7.37
815+37	814+60	R	77.00	6.00	6.00	6.00	0.0050	0.00	0.35	0.00	0.26	Seed	3.43	5	0.030	16.77	0.89	0.05	0.89	0.15	7.74
												Seed	5.14	50	0.040	16.86	0.84	0.07	1.33	0.22	8.59
814+60	814+30	R	30.00	6.00	6.00	6.00	0.0361	0.00	0.35	0.00	0.26	Seed	3.40	5	0.030	17.07	1.68	0.18	0.88	0.08	6.97
												Seed	5.08	50	0.040	17.17	1.62	0.27	1.32	0.12	7.45

DITCH ANALYSIS

PID : 46933 **Date :** 08/18/2011 **Project :** CUY-90-14.90 **Location :** Beneath Mainline adjacent pier 3

Description :scupper discharge to swale to D-88A **Designer :** PNS

Rainfall Area : A

Allowable Shears

	Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
Permanent Mat	**Type 1:**	2.00	**Type 2:**	3.00	**Type 3:**	5.00
RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
10+00	10+35	L	35.40	2.50	3.00	3.00	0.3954 *	0.67	0.67	0.90	0.60	Seed	4.29	5	0.030	10.08	7.16	3.10	2.58	0.13	3.25
												Jute Mat	4.28	5	0.040	10.10	5.91	3.66	2.58	0.15	3.39
												Temp. Mat	4.28	5	0.040	10.10	5.91	3.66	2.58	0.15	3.39
												Perm, Type 1	4.28	5	0.040	10.10	5.91	3.66	2.58	0.15	3.39
												Perm, Type 2	4.28	5	0.040	10.10	5.91	3.66	2.58	0.15	3.39
												Perm, Type 3	4.28	5	0.040	10.10	5.91	3.66	2.58	0.15	3.39
												Perm, Type 3	5.07	10	0.040	10.09	6.24	4.04	3.06	0.16	3.48
10+35	10+87	L	52.35	2.50	3.00	3.00	0.0239	0.00	0.67	0.00	0.60	Seed	4.23	5	0.030	10.41	2.77	0.41	2.55	0.28	4.16
												Jute Mat	4.22	5	0.040	10.48	2.27	0.48	2.55	0.32	4.44
												Temp. Mat	4.22	5	0.040	10.48	2.27	0.48	2.55	0.32	4.44
												Temp. Mat	5.00	10	0.040	10.46	2.38	0.53	3.01	0.35	4.63
10+87	11+46	R	59.99	2.50	2.50	2.50	0.0500	0.06	0.73	0.43	0.63	Seed	4.18	5	0.030	10.75	3.67	0.72	2.63	0.23	3.66
												Jute Mat	4.17	5	0.040	10.81	3.02	0.85	2.62	0.27	3.86

DITCH ANALYSIS

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
												Temp. Mat	4.17	5	0.040	10.81	3.02	0.85	2.62	0.27	3.86
												Temp. Mat	4.93	10	0.040	10.77	3.19	0.93	3.10	0.30	4.00
11+46	14+08	L	259.04	2.50	3.00	3.00	0.0661	0.00	0.73	0.00	0.63	Seed	4.01	5	0.030	11.91	3.91	0.85	2.52	0.21	3.74
												Jute Mat	3.98	5	0.040	12.14	3.20	1.00	2.50	0.24	3.95
												Temp. Mat	3.98	5	0.040	12.14	3.20	1.00	2.50	0.24	3.95
												Temp. Mat	4.69	10	0.040	12.03	3.37	1.09	2.94	0.27	4.09
14+08	14+20	L	13.57	2.50	3.00	3.00	0.0192	0.00	0.73	0.00	0.63	Seed	3.97	5	0.030	12.23	2.55	0.35	2.49	0.29	4.24
												Seed	4.67	10	0.040	12.14	2.18	0.44	2.93	0.37	4.73

DITCH ANALYSIS

PID : 46933 **Date :** 08/18/2011 **Project :** CUY-90-14.90 **Location :** Beneath Mainline adjacent pier 3

Description :scupper discharge to swale to D-88A **Designer :** PNS

Rainfall Area : A

Allowable Shears

	Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
Permanent Mat	**Type 1:**	2.00	**Type 2:**	3.00	**Type 3:**	5.00
RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
10+00	10+35	L	35.40	2.50	3.00	3.00	0.3954 *	0.67	0.67	0.90	0.60	Seed	4.29	5	0.030	10.08	7.16	3.10	2.58	0.13	3.25
												Jute Mat	4.28	5	0.040	10.10	5.91	3.66	2.58	0.15	3.39
												Temp. Mat	4.28	5	0.040	10.10	5.91	3.66	2.58	0.15	3.39
												Perm, Type 1	4.28	5	0.040	10.10	5.91	3.66	2.58	0.15	3.39
												Perm, Type 2	4.28	5	0.040	10.10	5.91	3.66	2.58	0.15	3.39
												Perm, Type 3	4.28	5	0.040	10.10	5.91	3.66	2.58	0.15	3.39
												Perm, Type 3	6.77	50	0.040	10.09	6.88	4.75	4.08	0.19	3.66
10+35	10+87	L	52.35	2.50	3.00	3.00	0.0239	0.00	0.67	0.00	0.60	Seed	4.23	5	0.030	10.41	2.77	0.41	2.55	0.28	4.16
												Jute Mat	4.22	5	0.040	10.48	2.27	0.48	2.55	0.32	4.44
												Temp. Mat	4.22	5	0.040	10.48	2.27	0.48	2.55	0.32	4.44
												Temp. Mat	6.66	50	0.040	10.42	2.59	0.62	4.01	0.41	4.99
10+87	11+46	R	59.99	2.50	2.50	2.50	0.0500	0.06	0.73	0.43	0.63	Seed	4.18	5	0.030	10.75	3.67	0.72	2.63	0.23	3.66
												Jute Mat	4.17	5	0.040	10.81	3.02	0.85	2.62	0.27	3.86

DITCH ANALYSIS

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
												Temp. Mat	4.17	5	0.040	10.81	3.02	0.85	2.62	0.27	3.86
												Temp. Mat	6.57	50	0.040	10.71	3.47	1.10	4.13	0.35	4.26
11+46	14+08	L	259.04	2.50	3.00	3.00	0.0661	0.00	0.73	0.00	0.63	Seed	4.01	5	0.030	11.91	3.91	0.85	2.52	0.21	3.74
												Jute Mat	3.98	5	0.040	12.14	3.20	1.00	2.50	0.24	3.95
												Temp. Mat	3.98	5	0.040	12.14	3.20	1.00	2.50	0.24	3.95
												Temp. Mat	6.23	50	0.040	11.86	3.68	1.28	3.91	0.31	4.36
14+08	14+20	L	13.57	2.50	3.00	3.00	0.0192	0.00	0.73	0.00	0.63	Seed	3.97	5	0.030	12.23	2.55	0.35	2.49	0.29	4.24
												Seed	6.20	50	0.040	11.96	2.37	0.52	3.90	0.43	5.09

DITCH ANALYSIS

PID : 46933 **Date :** 08/18/2011 **Project :** CUY-90-14.90 **Location :** Beneath Mainline adjacent pier 4

Description :scupper discharge to swale to D-88A **Designer :** PNS

Rainfall Area : A

Allowable Shears

	Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
Permanent Mat	**Type 1:**	2.00	**Type 2:**	3.00	**Type 3:**	5.00
RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
20+73	20+00	L	68.30	1.00	2.50	2.50	0.0028	0.55	0.55	0.90	0.50	Seed	4.17	5	0.030	10.85	1.33	0.11	2.06	0.61	4.06
												Seed	4.88	10	0.040	11.01	1.12	0.13	2.42	0.75	4.76

DITCH ANALYSIS

PID : 46933 **Date :** 08/18/2011 **Project :** CUY-90-14.90 **Location :** Beneath Mainline adjacent pier 4

Description :scupper discharge to swale to D-88A **Designer :** PNS

Rainfall Area : A

Allowable Shears

	Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
Permanent Mat	**Type 1:**	2.00	**Type 2:**	3.00	**Type 3:**	5.00
RCP	**Type B:**	6.00				

(*) Warning: Grade is steeper than allowable. If value is parantheses, design parameters have been exceeded. - See user manual.

STATION BEGIN	STATION END	SIDE	LENGTH (ft.)	RADIUS WIDTH (ft.)	IN SLOPE (ft./ft.)	BACK SLOPE (ft./ft.)	GRADE (ft./ft.)	AREA (acres)	AREA SUM (acres)	RUNOFF COEFF.	CA (Sum)	PROTECT TYPE	RAIN INT. (in./hr.)	STORM FREQ. (yrs.)	MANN. COEFF.	TIME FLOW (min.)	VEL. FLOW (fps.)	SHEAR (lbs./ sq.ft.)	DESIGN FLOW (cfs.)	DEPTH FLOW (ft.)	WIDTH FLOW (ft.)
20+73	20+00	L	68.30	1.00	2.50	2.50	0.0028	0.55	0.55	0.90	0.50	Seed	4.17	5	0.030	10.85	1.33	0.11	2.06	0.61	4.06
												Seed	6.50	50	0.040	10.94	1.20	0.15	3.22	0.85	5.27

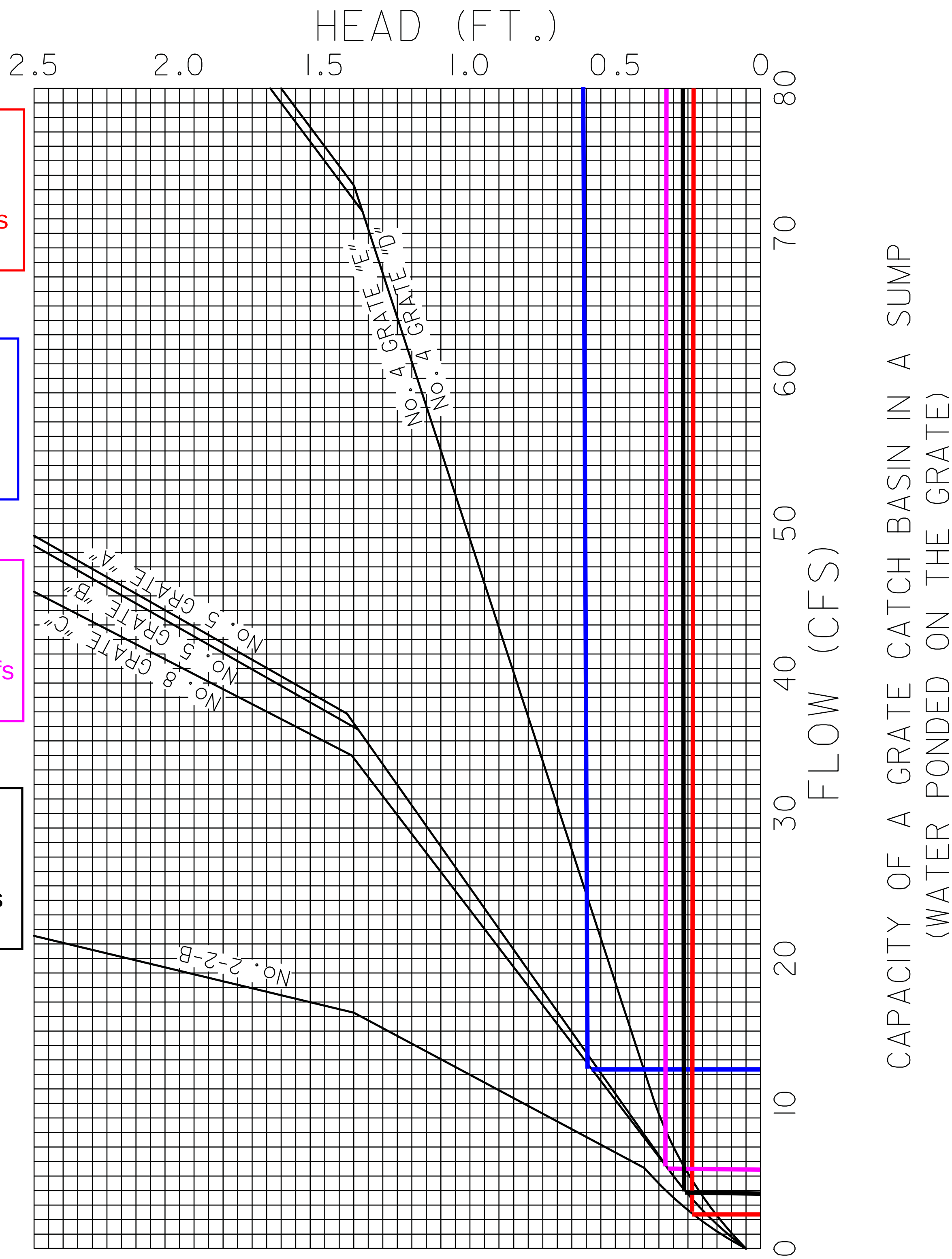
CAPACITY OF A GRATE CATCH BASIN IN A SUMP	1102-1
	REFERENCE SECTION 1102.3.5

D-27B
CB-8
Q_{10} = 6.2 cfs
$2*Q_{10}$ = 12.4 cfs
HW = 0.63 ft

D-932
CB-2-2B
Q_{10} = 0.6 cfs
$2*Q_{10}$ = 1.2 cfs
HW = 0.24 ft

D-950
CB-8
Q_{10} = 2.73cfs
$2*Q_{10}$ = 5.46 cfs
HW = 0.33 ft

D-930
CB-8
Q_{10} = 1.9 cfs
$2*Q_{10}$ = 3.8 cfs
HW = 0.27 ft



INLET SPACING DESIGN

PID : 49633 **Date :** 10/07/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, Ohio

Description : West Bank Drainage Area - Abbey Ave_Inlet Spacing 21+57 North curb **Designer :** PNS

Rainfall Area: A **Storm Frequency (yr.) :** 2 **Total Allow. Spread (ft.) :** 10.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)	
18+75	Begin																		
21+57	CB-3A	256.80	0.67	0.23	1.00	3.41	10.00	0.0085	0.0160	0.0160	0.00	0.0417	3.60	0.37	0.18	0.55	0.107	6.68	
26+63	CB-3	512.00	0.70	0.24	1.00	7.56	10.00	0.0060	0.0160	0.0160	0.00	0.0417	3.60	******	******	0.79	0.130	8.13	Sag
29+36	Begin																		
26+63	CB-3	267.00	0.55	0.12	1.00	6.31	10.00	0.0036	0.0160	0.0160	0.00	0.0417	3.60	******	******	0.24	0.091	5.71	End

SUMP DATA

Total Flow (cfs) : 1.02 **Ponded Depth (ft.) :** 0.089 **Spread on Pavement (ft.) :** 4.39

INLET SPACING DESIGN

PID : 49633 **Date :** 10/07/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, Ohio

Description : West Bank Drainage Area - Abbey Ave_Inlet Spacing 21+57 North curb **Designer :** PNS

Rainfall Area: A **Storm Frequency (yr.) :** 25 **Total Allow. Spread (ft.) :** 10.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)	
18+75	Begin																		
21+57	CB-3A	256.80	0.67	0.23	1.00	2.98	10.00	0.0085	0.0160	0.0160	0.00	0.0417	6.21	0.54	0.41	0.96	0.131	8.20	
26+63	CB-3	512.00	0.70	0.24	1.00	6.43	10.00	0.0060	0.0160	0.0160	0.00	0.0417	6.21	******	******	1.46	0.164	10.25	Sag
29+36	Begin																		
26+63	CB-3	267.00	0.55	0.12	1.00	5.46	10.00	0.0036	0.0160	0.0160	0.00	0.0417	6.21	******	******	0.41	0.112	7.01	End

SUMP DATA

Total Flow (cfs) : 1.87 **Ponded Depth (ft.) :** 0.152 **Spread on Pavement (ft.) :** 8.30

INLET SPACING DESIGN

PID : 49633 **Date :** 10/07/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, Ohio

Description : West Bank Drainage Area - Abbey-14th Ext_Inlet Spacing_21+57 **Designer :** PNS

Rainfall Area: A **Storm Frequency (yr.) :** 2 **Total Allow. Spread (ft.) :** 10.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)
18+75	Begin																	
21+57	CB-3A	281.00	0.61	0.29	1.00	3.62	10.00	0.0085	0.0160	0.0160	0.00	0.0417	3.60	0.41	0.22	0.64	0.113	7.04
107+34	CB-3A	157.50	0.54	0.25	1.00	2.39	10.00	0.0052	0.0160	0.0160	0.00	0.0417	3.60	0.44	0.27	0.71	0.129	8.04

INLET SPACING DESIGN

PID : 49633 **Date :** 10/07/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, Ohio

Description : West Bank Drainage Area - Abbey-14th Ext_Inlet Spacing_21+57 **Designer :** PNS

Rainfall Area: A **Storm Frequency (yr.) :** 25 **Total Allow. Spread (ft.) :** 10.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)
18+75	Begin																	
21+57	CB-3A	281.00	0.61	0.29	1.00	3.15	10.00	0.0085	0.0160	0.0160	0.00	0.0417	6.21	0.60	0.50	1.10	0.138	8.64
107+34	CB-3A	157.50	0.54	0.25	1.00	2.05	10.00	0.0052	0.0160	0.0160	0.00	0.0417	6.21	0.68	0.66	1.34	0.163	10.20

INLET SPACING DESIGN

PID : 49633 **Date :** 10/07/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, Ohio

Description : West Bank Drainage Area - Abbey Ave_Inlet Spacing 26+63 South curb **Designer :** PNS

Rainfall Area: A **Storm Frequency (yr.) :** 2 **Total Allow. Spread (ft.) :** 10.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)	
22+69	Begin																		
26+63	CB-3	400.00	0.76	0.22	1.00	6.18	10.00	0.0060	0.0160	0.0160	0.00	0.0417	3.60	******	******	0.60	0.118	7.36	Sag
29+36	Begin																		
26+63	CB-3	267.00	0.60	0.13	1.00	6.03	10.00	0.0036	0.0160	0.0160	0.00	0.0417	3.60	******	******	0.28	0.097	6.08	End

SUMP DATA

Total Flow (cfs) : 0.88 **Ponded Depth (ft.) :** 0.077 **Spread on Pavement (ft.) :** 3.63

INLET SPACING DESIGN

PID : 49633 **Date :** 10/07/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, Ohio

Description : West Bank Drainage Area - Abbey Ave_Inlet Spacing 26+63 South curb **Designer :** PNS

Rainfall Area: A **Storm Frequency (yr.) :** 25 **Total Allow. Spread (ft.) :** 10.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)	
22+69	Begin																		
26+63	CB-3	400.00	0.76	0.22	1.00	5.35	10.00	0.0060	0.0160	0.0160	0.00	0.0417	6.21	******	******	1.04	0.144	9.03	Sag
29+36	Begin																		
26+63	CB-3	267.00	0.60	0.13	1.00	5.22	10.00	0.0036	0.0160	0.0160	0.00	0.0417	6.21	******	******	0.48	0.119	7.46	End

SUMP DATA

Total Flow (cfs) : 1.52 **Ponded Depth (ft.) :** 0.128 **Spread on Pavement (ft.) :** 6.81

INLET SPACING DESIGN

PID : 49633 **Date :** 10/07/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, Ohio

Description : West Bank Drainage Area - Inlet Spacing - W 14th Ext 103+91East curb **Designer :** PNS

Rainfall Area: A **Storm Frequency (yr.) :** 2 **Total Allow. Spread (ft.) :** 6.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)	
108+77	Begin																		
106+05	CB-3A	200.00	0.60	0.24	1.00	2.15	10.00	0.0148	0.0160	0.0160	0.00	0.0417	3.60	0.36	0.16	0.52	0.094	5.87	
103+90	CB-3	53.00	0.77	0.06	1.00	0.90	10.00	0.0064	0.0160	0.0160	0.00	0.0417	3.60	******	******	0.32	0.092	5.76	Sag
100+00	Begin																		
103+90	CB-3	336.89	0.77	0.06	1.00	6.34	10.00	0.0084	0.0160	0.0160	0.00	0.0417	3.60	******	******	0.17	0.068	4.26	End

SUMP DATA

Total Flow (cfs) : 0.49 **Ponded Depth (ft.) :** 0.038 **Spread on Pavement (ft.) :** 1.76

INLET SPACING DESIGN

PID : 49633 **Date :** 10/07/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, Ohio

Description : West Bank Drainage Area - Inlet Spacing - W 14th Ext 103+91East curb **Designer :** PNS

Rainfall Area: A **Storm Frequency (yr.) :** 25 **Total Allow. Spread (ft.) :** 6.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)	
108+77	Begin																		
106+05	CB-3A	200.00	0.60	0.24	1.00	1.88	10.00	0.0148	0.0160	0.0160	0.00	0.0417	6.21	0.53	0.37	0.89	0.115	7.21	
103+90	CB-3	53.00	0.77	0.06	1.00	0.77	10.00	0.0064	0.0160	0.0160	0.00	0.0417	6.21	******	******	0.65	0.120	7.49	Sag
100+00	Begin																		
103+90	CB-3	336.89	0.77	0.06	1.00	5.48	10.00	0.0084	0.0160	0.0160	0.00	0.0417	6.21	******	******	0.29	0.084	5.23	End

SUMP DATA

Total Flow (cfs) : 0.94 **Ponded Depth (ft.) :** 0.082 **Spread on Pavement (ft.) :** 3.94

INLET SPACING DESIGN

PID : 49633 **Date :** 10/07/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, Ohio

Description : West Bank Drainage Area - Inlet Spacing - W 14th Ext 103+91 west curb **Designer :** PNS

Rainfall Area: A **Storm Frequency (yr.) :** 2 **Total Allow. Spread (ft.) :** 6.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)	
106+35	Begin																		
103+90	CB-3	253.29	0.75	0.13	1.00	4.30	10.00	0.0064	0.0160	0.0160	0.00	0.0417	3.60	******	******	0.34	0.094	5.85	Sag
100+00	Begin																		
103+90	CB-3	336.89	0.73	0.08	1.00	6.05	10.00	0.0084	0.0160	0.0160	0.00	0.0417	3.60	******	******	0.20	0.073	4.54	End

SUMP DATA

Total Flow (cfs) : 0.53 **Ponded Depth (ft.) :** 0.043 **Spread on Pavement (ft.) :** 1.80

INLET SPACING DESIGN

PID : 49633 **Date :** 10/07/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, Ohio

Description : West Bank Drainage Area - Inlet Spacing - W 14th Ext 103+91 west curb **Designer :** PNS

Rainfall Area: A **Storm Frequency (yr.) :** 25 **Total Allow. Spread (ft.) :** 6.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)	
106+35	Begin																		
103+90	CB-3	253.29	0.75	0.13	1.00	3.74	10.00	0.0064	0.0160	0.0160	0.00	0.0417	6.21	******	******	0.58	0.115	7.18	Sag
100+00	Begin																		
103+90	CB-3	336.89	0.73	0.08	1.00	5.24	10.00	0.0084	0.0160	0.0160	0.00	0.0417	6.21	******	******	0.34	0.089	5.58	End

SUMP DATA

Total Flow (cfs) : 0.92 **Ponded Depth (ft.) :** 0.081 **Spread on Pavement (ft.) :** 3.85

INLET SPACING DESIGN

PID : 49633 **Date :** 10/07/2011 **Project :** CUY-90-14.90 **Location :** MAINLINE STA 122+28 RT

Description : Main Viaduct Bridge Unit 1 at STA 122+28 RT **Designer :** PNS

Rainfall Area: A **Storm Frequency (yr.) :** 10 **Total Allow. Spread (ft.) :** 12.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)
127+09	Begin																	
122+10	CB-3	499.00	0.90	1.00	1.00	3.38	10.00	0.0085	0.0290	0.0230	12.00	0.0417	5.10	2.57	2.01	4.59	0.295	10.18
122+00	CB-3	10.00	0.90	0.02	1.00	0.09	10.00	0.0085	0.0290	0.0237	12.00	0.0417	5.10	1.50	0.61	2.11	0.221	7.60

INLET SPACING DESIGN

PID : 49633 **Date :** 10/07/2011 **Project :** CUY-90-14.90 **Location :** MAINLINE STA 122+28 RT

Description : Main Viaduct Bridge Unit 1 at STA 122+28 RT **Designer :** PNS

Rainfall Area: A **Storm Frequency (yr.) :** 50 **Total Allow. Spread (ft.) :** 12.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)
127+09	Begin																	
122+10	CB-3	499.00	0.90	1.00	1.00	3.08	10.00	0.0085	0.0290	0.0230	12.00	0.0417	6.79	3.12	2.99	6.11	0.329	11.34
122+00	CB-3	10.00	0.90	0.02	1.00	0.08	10.00	0.0085	0.0290	0.0237	12.00	0.0417	6.79	1.97	1.14	3.12	0.255	8.81

INLET SPACING DESIGN

PID : 49633 **Date :** 10/07/2011 **Project :** CUY-90-14.90 **Location :** MAINLINE STA 122+28 RT

Description : Main Viaduct Bridge Unit 1 at STA 122+28 RTBiDirectional **Designer :** PNS

Rainfall Area: A **Storm Frequency (yr.) :** 2 **Total Allow. Spread (ft.) :** 10.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)
127+09	Begin																	
122+10	CB-3	499.00	0.90	1.00	1.00	4.03	10.00	0.0085	0.0290	0.0230	6.00	0.0417	3.60	2.01	1.23	3.24	0.258	9.65
122+00	CB-3	10.00	0.90	0.02	1.00	0.10	10.00	0.0085	0.0290	0.0237	6.00	0.0417	3.60	1.05	0.25	1.29	0.184	6.41

INLET SPACING DESIGN

PID : 49633 **Date :** 08/24/2011 **Project :** CUY-90-14.90 **Location :** Ramp A6

Description : Main Viaduct Bridge Unit 1 at Ramp A6 CONSERVATIVE CHECK D/S OF BIDIRECTIONAL **Designer :** PNS

Rainfall Area: A **Storm Frequency (yr.) :** 2 **Total Allow. Spread (ft.) :** 12.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)
136+30	Begin																	
808+13	CB-3A	1390.00	0.90	0.33	0.01	9.84	10.00	0.0194	0.0400	0.0400	6.00	0.0417	3.60	0.87	0.20	1.07	0.165	4.13

INLET SPACING DESIGN

PID : 49633 **Date :** 08/24/2011 **Project :** CUY-90-14.90 **Location :** Ramp A6

Description : Main Viaduct Bridge Unit 1 at Ramp A6 **Designer :** PNS

Rainfall Area: A **Storm Frequency (yr.) :** 10 **Total Allow. Spread (ft.) :** 6.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)
136+30	Begin																	
808+13	CB-3A	1390.00	0.90	0.33	0.01	8.93	10.00	0.0194	0.0400	0.0400	6.00	0.0417	5.10	1.14	0.38	1.51	0.188	4.71

INLET SPACING DESIGN

PID : 49633 **Date :** 08/24/2011 **Project :** CUY-90-14.90 **Location :** Ramp A6

Description : Main Viaduct Bridge Unit 1 at Ramp A6 **Designer :** PNS

Rainfall Area: A **Storm Frequency (yr.) :** 50 **Total Allow. Spread (ft.) :** 6.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)
136+30	Begin																	
808+13	CB-3A	1390.00	0.90	0.33	0.01	8.22	10.00	0.0194	0.0400	0.0400	6.00	0.0417	6.79	1.41	0.61	2.02	0.210	5.24

STORM SEWER SYSTEM

PID : 49633 **Date :** 10/10/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, OH

Description : West Bank Drainage Area - Storm Sewer - P18, Ramp A6 808+95 **Designer :** pns

Rainfall Area: A **Just Full Capacity Frequency (yrs.) :** 10 **Hydraulic Gradient Frequency (yrs.) :** 25

Minimum Pipe Size : 15.00 **Tailwater Elevation (ft.):** 667.00

JUNCTION From	JUNCTION To	STATION From To	ΔAREA Σ AREA (acres)	ΔCA Σ CA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	RAINFALL INTENSITY (25 yrs.)	DISCHARGE (cfs.) (10 yrs.)	DISCHARGE (cfs.) (25 yrs.)	PIPE DIAM. (in.)	PIPE LENGTH (ft.)	PIPE SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
D924 begin	D922	122+00 122+10	1.00 1.00	0.90 0.90	10.00	5.10	6.20	4.6	5.6	15	9.1	0.0176	692.05 691.89	6.36	7.99	0.0099	693.08 692.99	695.94 696.15	2.86	2.64	CB 3 0.015
D922	932B	122+10 808+43	0.02 1.02	0.02 0.92	10.02	5.09	6.14	4.7	5.6	15	113.8	0.0296	691.89 688.52	7.80	10.36	0.0101	692.58 689.63	696.15 696.15	3.57	3.01	CB 3 0.015
D932 begin	932B	808+81 808+43	0.20 1.22	0.15 1.07	15.00	4.20	5.07	0.6	0.8	15	77.0	0.0160	689.75 688.52	3.59	7.61	0.0002	690.03 689.32	692.50 696.15	2.47	1.50	CB 2-2B 0.015
932B	D944	808+43 808+13	0.00 1.22	0.00 1.07	15.36	4.15	5.05	4.4	5.4	15	56.0	0.0534	688.52 685.53	9.56	13.92	0.0093	689.08 686.63	696.15 696.21	7.07	6.38	MH 3 0.015
D944	D945	808+13 808+48	0.33 1.55	0.29 1.36	15.46	4.13	5.03	5.6	6.8	15	110.0	0.1543	685.53 668.56	14.99	23.65	0.0148	686.01 669.71	696.21 672.50	10.20	9.43	CB 3A 0.015
D945 final	HW22	808+48 811+90	0.00 1.55	0.00 1.36	15.58	4.12	5.00	5.6	6.8	15 **Warning**	47.0	0.0085	661.80 661.40	4.55	5.56	0.0147	667.69 667.00	672.50 662.35	4.81	9.45	MH 3 0.015

STORM SEWER SYSTEM

PID : 49633 **Date :** 10/10/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, OH

Description : West Bank Drainage Area - Storm Sewer - P18, Ramp A6 808+95 **Designer :** pns

Rainfall Area: A **Just Full Capacity Frequency (yrs.) :** 10 **Hydraulic Gradient Frequency (yrs.) :** 50

Minimum Pipe Size : 15.00 **Tailwater Elevation (ft.):** 667.00

JUNCTION From	JUNCTION To	STATION From / To	ΔAREA / ΣAREA (acres)	ΔCA / ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	RAINFALL INTENSITY (50 yrs.)	DISCHARGE (cfs.) (10 yrs.)	DISCHARGE (cfs.) (50 yrs.)	PIPE DIAM. (in.)	PIPE LENGTH (ft.)	PIPE SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
D924	D922	122+00	1.00	0.90	10.00	5.10	6.79	4.6	6.1	15	9.1	0.0176	692.05	6.36	7.99	0.0119	693.12	695.94	2.82	2.64	CB 3
begin		122+10	1.00	0.90									691.89				693.01	696.15			0.015
D922	932B	122+10	0.02	0.02	10.02	5.09	6.71	4.7	6.2	15	113.8	0.0296	691.89	7.80	10.36	0.0121	692.62	696.15	3.53	3.01	CB 3
		808+43	1.02	0.92									688.52				689.65	696.15			0.015
D932	932B	808+81	0.20	0.15	15.00	4.20	5.42	0.6	0.8	15	77.0	0.0160	689.75	3.59	7.61	0.0002	690.04	692.50	2.46	1.50	CB 2-2B
begin		808+43	1.22	1.07									688.52				689.32	696.15			0.015
932B	D944	808+43	0.00	0.00	15.36	4.15	5.40	4.4	5.8	15	56.0	0.0534	688.52	9.56	13.92	0.0106	689.11	696.15	7.04	6.38	MH 3
		808+13	1.22	1.07									685.53				686.64	696.21			0.015
D944	D945	808+13	0.33	0.29	15.46	4.13	5.37	5.6	7.3	15	110.0	0.1543	685.53	14.99	23.65	0.0169	686.02	696.21	10.19	9.43	CB 3A
		808+48	1.55	1.36									668.56				669.72	672.50			0.015
D945	HW22	808+48	0.00	0.00	15.58	4.12	5.34	5.6	7.2	15	47.0	0.0085	661.80	4.55	5.56	0.0167	667.79	672.50	4.71	9.45	MH 3
final		811+90	1.55	1.36						**Warning**			661.40				667.00	662.35			0.015

STORM SEWER SYSTEM

PID : 49633 **Date :** 10/09/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, OH

Description : West Bank Drainage Area - Storm Sewer - P42, I-90 RT_14th Ext, & Abbey Rd **Designer :** PNS

Rainfall Area: A **Just Full Capacity Frequency (yrs.) :** 10 **Hydraulic Gradient Frequency (yrs.) :** 25

Minimum Pipe Size : 12.00 **Tailwater Elevation (ft.):** 663.75

JUNCTION From	JUNCTION To	STATION From / To	ΔAREA / ΣAREA (acres)	ΔCA / ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	RAINFALL INTENSITY (25 yrs.)	DISCHARGE (cfs.) (10 yrs.)	DISCHARGE (cfs.) (25 yrs.)	PIPE DIAM. (in.)	PIPE LENGTH (ft.)	PIPE SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
976B	D976	106+05	0.24	0.14	10.00	5.10	6.18	0.7	0.9	12	21.5	0.0116	670.68	3.40	3.58	0.0008	671.15	674.86	3.71	3.18	CB 3A
	begin	106+05	0.24	0.14									670.43				671.13	675.07			0.015
* D914	D27C	26+64	0.36	0.23	10.00	5.10	4.64	1.2	1.1	12	33.7	0.0107	666.26	3.77	3.43	0.0012	668.20	673.64	5.44	6.38	CB 3
	begin	26+44	0.60	0.38									665.90				668.16	673.89			0.015
* D916	D27C	26+63	0.35	0.25	10.00	5.10	6.19	1.3	1.6	12	19.2	0.0115	670.12	3.95	3.56	0.0026	670.71	673.58	2.87	2.46	CB 3
	begin	26+44	0.95	0.63									669.90				670.67	673.89			0.015
CS	D27C	27+36	1.06	0.69	15.00	4.20	4.64	2.9	3.2	15	102.0	0.0150	667.43	5.35	7.38	0.0033	668.50	675.71	7.21	7.03	MH 3
	begin	26+44	2.01	1.32									665.90				668.16	673.89			0.015
D27C	D27D	26+44	0.00	0.00	15.32	4.15	4.64	4.9	5.5	18	203.9	0.0040	665.81	3.67	6.21	0.0036	668.16	673.89	5.73	6.58	MH 3
		24+99	2.01	1.32									664.99				667.42	675.51			0.015
D938	D27G	24+12	0.51	0.45	10.00	5.10	4.64	2.3	2.1	15	26.8	0.1694	671.54	11.99	24.79	0.0014	671.80	678.38	6.58	5.59	CB 6
	begin	24+38	2.52	1.78									667.00				668.09	676.71			0.015
D27B	D27G	24+94	2.37	1.73	15.00	4.20	4.64	7.3	8.0	18	56.0	0.0134	667.50	6.42	11.33	0.0078	668.52	670.00	1.48	1.00	CB 8
	begin	24+38	4.89	3.51									666.75				668.09	676.71			0.015
D27G	D27D	24+38	0.00	0.00	15.15	4.18	4.64	9.1	10.1	18	53.6	0.0315	666.00	9.43	17.39	0.0124	668.09	676.71	8.62	9.21	MH 3
		24+40	4.89	3.51									664.31				667.42	675.51			0.015

NOTE: Non-performed W. 14th St. Extension structures removed from calculations: D930, D912, D946 & D910.

*** City cover requirements are not met due to utility conflicts and LDVII requirements used.**

STORM SEWER SYSTEM

JUNCTION From To	STATION From To	ΔAREA ΣAREA (acres)	ΔCA ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	RAINFALL INTENSITY (25 yrs.)	DISCHARGE (cfs.) (10 yrs.)	DISCHARGE (cfs.) (25 yrs.)	PIPE DIAM. (in.)	PIPE LENGTH (ft.)	PIPE SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
D27D D27E	24+40 22+60	0.00 4.89	0.00 3.51	16.24	4.03	4.64	13.5	15.6	24 Warning	180.0	0.0028	664.25 663.74	4.31	11.23	0.0063	667.42 666.29	675.51 677.09	8.09	9.26	MH 3 0.015
D27E D970	22+60 108+28	0.00 4.89	0.00 3.51	16.94	3.94	4.64	13.2	15.6	24	55.3	0.0054	663.74 663.44	5.21	15.53	0.0063	666.29 665.94	677.09 676.82	10.80	11.35	MH 3 0.015
D976 D978	106+05 106+44	0.00 4.89	0.00 3.51	10.11	5.07	4.64	0.7	0.7	24	63.5	0.0057	662.35 661.99	2.45	15.88	0.0000	664.20 664.20	675.07 675.09	10.87	10.72	MH 3 0.015
D936 D934 begin	21+56 21+56	0.23 5.12	0.15 3.66	10.00	5.10	6.17	0.8	1.0	12	31.7	0.0145	670.21 669.75	3.76	4.00	0.0009	670.55 670.45	677.66 677.75	7.11	6.45	CB 3A 0.015
D934 D970	21+56 108+28	0.29 5.41	0.18 3.84	10.14	5.06	6.13	1.7	2.0	15	72.3	0.0473	669.50 666.08	6.97	13.10	0.0013	669.84 666.99	677.75 676.82	7.91	7.00	CB 3A 0.015
D940 D970 begin	108+20 108+28	0.11 5.51	0.10 3.93	10.00	5.10	6.14	0.5	0.6	15	55.3	0.0190	670.75 669.70	3.51	8.30	0.0001	670.98 670.47	675.39 676.82	4.41	3.39	CB 3A 0.015
D970 D972	108+28 107+34	0.00 5.51	0.00 3.93	17.12	3.91	4.64	14.8	17.6	24 Warning	93.5	0.0024	663.44 663.22	4.72	10.23	0.0080	665.94 665.18	676.82 676.28	10.88	11.38	MH 3 0.015
D948 D972 begin	107+35 107+35	0.25 5.76	0.14 4.07	10.00	5.10	6.20	0.7	0.8	12	9.1	0.0714	671.64 670.99	6.41	8.88	0.0007	671.86 671.68	675.94 676.28	4.08	3.30	CB 3A 0.015
D942 D972 begin	106+90 107+35	0.10 5.87	0.09 4.16	10.00	5.10	6.13	0.5	0.6	12	60.8	0.0164	670.98 669.98	3.42	4.26	0.0003	671.24 670.64	675.83 676.28	4.59	3.85	CB 3A 0.015
D972 D978	107+35 106+44	0.00 5.87	0.00 4.16	17.45	3.87	4.64	15.6	18.7	24	108.4	0.0126	663.18 661.81	7.61	23.71	0.0090	665.18 664.20	676.28 675.09	11.10	11.10	MH 3 0.015
D950 D978 begin	815+01 106+44	1.41 7.28	0.55 4.71	15.00	4.20	5.08	2.3	2.8	15	104.0	0.0337	668.90 665.39	6.77	11.06	0.0025	669.34 666.35	671.50 675.09	2.16	1.35	CB 2-2B 0.015

STORM SEWER SYSTEM

JUNCTION From	JUNCTION To	STATION From / To	∆AREA / ΣAREA (acres)	∆CA / ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	RAINFALL INTENSITY (25 yrs.)	DISCHARGE (cfs.) (10 yrs.)	DISCHARGE (cfs.) (25 yrs.)	PIPE DIAM. (in.)	PIPE LENGTH (ft.)	PIPE SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
D978	HW22	106+44	0.00	0.00	17.68	3.84	4.64	18.1	21.9	30	120.0	0.0045	661.54	5.34	25.65	0.0038	664.20	675.09	10.89	11.05	MH 3
	final	814+78	7.28	4.71									661.00				663.75	663.50			0.015

STORM SEWER SYSTEM

PID : 49633 **Date :** 10/09/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, OH

Description : West Bank Drainage Area - Storm Sewer - P42, I-90 RT_14th Ext, & Abbey Rd **Designer :** PNS

Rainfall Area: A **Just Full Capacity Frequency (yrs.) :** 10 **Hydraulic Gradient Frequency (yrs.) :** 50

Minimum Pipe Size : 12.00 **Tailwater Elevation (ft.):** 663.75

	JUNCTION From	JUNCTION To	STATION From / To	ΔAREA / Σ AREA (acres)	ΔCA / ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	RAINFALL INTENSITY (50 yrs.)	DISCHARGE (cfs.) (10 yrs.)	DISCHARGE (cfs.) (50 yrs.)	PIPE DIAM. (in.)	PIPE LENGTH (ft.)	PIPE SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
	976B	D976	106+05	0.24	0.14	10.00	5.10	6.76	0.7	1.0	12	21.5	0.0116	670.68	3.40	3.58	0.0010	671.16	674.86	3.70	3.18	CB 3A
		begin	106+05	0.24	0.14									670.43				671.14	675.07			0.015
	D914	D27C	26+64	0.36	0.23	10.00	5.10	4.94	1.2	1.2	12	33.7	0.0107	666.26	3.77	3.43	0.0014	668.78	673.64	4.86	6.38	CB 3
		begin	26+44	0.60	0.38									665.90				668.74	673.89			0.015
*	D916	D27C	26+63	0.35	0.25	10.00	5.10	6.77	1.3	1.7	12	19.2	0.0115	670.12	3.95	3.56	0.0031	670.74	673.58	2.84	2.46	CB 3
		begin	26+44	0.95	0.63									669.90				670.68	673.89			0.015
	CS	D27C	27+36	1.06	0.69	15.00	4.20	4.94	2.9	3.4	15	102.0	0.0150	667.43	5.35	7.38	0.0037	669.12	675.71	6.59	7.03	MH 3
		begin	26+44	2.01	1.32									665.90				668.74	673.89			0.015
	D27C	D27D	26+44	0.00	0.00	15.32	4.15	4.94	4.9	5.8	18	203.9	0.0040	665.81	3.67	6.21	0.0041	668.74	673.89	5.15	6.58	MH 3
			24+99	2.01	1.32									664.99				667.91	675.51			0.015
	D938	D27G	24+12	0.51	0.45	10.00	5.10	4.94	2.3	2.2	15	26.8	0.1694	671.54	11.99	24.79	0.0016	671.80	678.38	6.58	5.59	CB 6
		begin	24+38	2.52	1.78									667.00				668.66	676.71			0.015
	D27B	D27G	24+94	2.37	1.73	15.00	4.20	4.94	7.3	8.5	18	56.0	0.0134	667.50	6.42	11.33	0.0088	669.15	670.00	0.85	1.00	CB 8
		begin	24+38	4.89	3.51									666.75				668.66	676.71			0.015
	D27G	D27D	24+38	0.00	0.00	15.15	4.18	4.94	9.1	10.8	18	53.6	0.0315	666.00	9.43	17.39	0.0140	668.66	676.71	8.05	9.21	MH 3
			24+40	4.89	3.51									664.31				667.91	675.51			0.015

NOTE: Non-performed W. 14th St. Extension structures removed from calculations: D930, D912, D946 & D910.

*** City cover requirements are not met due to utility conflicts and LDVII requirements used.**

STORM SEWER SYSTEM

JUNCTION From To	STATION From To	ΔAREA ΣAREA (acres)	ΔCA ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	RAINFALL INTENSITY (50 yrs.)	DISCHARGE (cfs.) (10 yrs.)	DISCHARGE (cfs.) (50 yrs.)	PIPE DIAM. (in.)	PIPE LENGTH (ft.)	PIPE SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
D27D D27E	24+40 22+60	0.00 4.89	0.00 3.51	16.24	4.03	4.94	13.5	16.6	24 Warning	180.0	0.0028	664.25 663.74	4.31	11.23	0.0072	667.91 666.62	675.51 677.09	7.60	9.26	MH 3 0.015
D27E D970	22+60 108+28	0.00 4.89	0.00 3.51	16.94	3.94	4.94	13.2	16.6	24	55.3	0.0054	663.74 663.44	5.21	15.53	0.0072	666.62 666.22	677.09 676.82	10.47	11.35	MH 3 0.015
D976 D978	106+05 106+44	0.00 4.89	0.00 3.51	10.11	5.07	4.94	0.7	0.7	24	63.5	0.0057	662.35 661.99	2.45	15.88	0.0000	664.26 664.26	675.07 675.09	10.81	10.72	MH 3 0.015
D936 D934 begin	21+56 21+56	0.23 5.12	0.15 3.66	10.00	5.10	6.75	0.8	1.0	12	31.7	0.0145	670.21 669.75	3.76	4.00	0.0011	670.57 670.46	677.66 677.75	7.09	6.45	CB 3A 0.015
D934 D970	21+56 108+28	0.29 5.41	0.18 3.84	10.14	5.06	6.69	1.7	2.2	15	72.3	0.0473	669.50 666.08	6.97	13.10	0.0016	669.86 667.00	677.75 676.82	7.89	7.00	CB 3A 0.015
D940 D970 begin	108+20 108+28	0.11 5.51	0.10 3.93	10.00	5.10	6.71	0.5	0.6	15	55.3	0.0190	670.75 669.70	3.51	8.30	0.0001	670.99 670.48	675.39 676.82	4.40	3.39	CB 3A 0.015
D970 D972	108+28 107+34	0.00 5.51	0.00 3.93	17.12	3.91	4.94	14.8	18.7	24 Warning	93.5	0.0024	663.44 663.22	4.72	10.23	0.0091	666.22 665.37	676.82 676.28	10.60	11.38	MH 3 0.015
D948 D972 begin	107+35 107+35	0.25 5.76	0.14 4.07	10.00	5.10	6.79	0.7	0.9	12	9.1	0.0714	671.64 670.99	6.41	8.88	0.0009	671.87 671.69	675.94 676.28	4.07	3.30	CB 3A 0.015
D942 D972 begin	106+90 107+35	0.10 5.87	0.09 4.16	10.00	5.10	6.70	0.5	0.6	12	60.8	0.0164	670.98 669.98	3.42	4.26	0.0004	671.25 670.64	675.83 676.28	4.58	3.85	CB 3A 0.015
D972 D978	107+35 106+44	0.00 5.87	0.00 4.16	17.45	3.87	4.94	15.6	19.8	24	108.4	0.0126	663.18 661.81	7.61	23.71	0.0102	665.37 664.26	676.28 675.09	10.91	11.10	MH 3 0.015
D950 D978 begin	815+01 106+44	1.41 7.28	0.55 4.71	15.00	4.20	5.44	2.3	3.0	15	104.0	0.0337	668.90 665.39	6.77	11.06	0.0028	669.36 666.36	671.50 675.09	2.14	1.35	CB 2-2B 0.015

STORM SEWER SYSTEM

JUNCTION From / To	STATION From / To	Δ AREA / Σ AREA (acres)	Δ CA / Σ CA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	RAINFALL INTENSITY (50 yrs.)	DISCHARGE (cfs.) (10 yrs.)	DISCHARGE (cfs.) (50 yrs.)	PIPE DIAM. (in.)	PIPE LENGTH (ft.)	PIPE SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
D978 HW22	106+44	0.00	0.00	17.68	3.84	4.94	18.1	23.3	30	120.0	0.0045	661.54	5.34	25.65	0.0043	664.26	675.09	10.83	11.05	MH 3
final	814+78	7.28	4.71									661.00				663.75	663.50			0.015

STORM SEWER SYSTEM

PID : 49633 **Date :** 09/21/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, OH

Description : West Bank Drainage Area - Storm Sewer, West Bank Outfall **Designer :** PNS

Rainfall Area: A **Just Full Capacity Frequency (yrs.) :** 10 **Hydraulic Gradient Frequency (yrs.) :** 25

Minimum Pipe Size : 15.00 **Tailwater Elevation (ft.):** 572.50

JUNCTION From	JUNCTION To	STATION From To	ΔAREA Σ AREA (acres)	Δ CA Σ CA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	RAINFALL INTENSITY (25 yrs.)	DISCHARGE (cfs.) (10 yrs.)	DISCHARGE (cfs.) (25 yrs.)	PIPE DIAM. (in.)	PIPE LENGTH (ft.)	PIPE SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
D956 begin	D47	814+20 125+61	12.23 12.23	8.44 8.44	172.0	0.75	0.88	6.3	7.4	18	298.9	0.0050	659.50 658.00	4.16	6.94	0.0067	661.46 659.47	668.03 676.80	6.57	7.03	CB 2-2B 0.015
D47	D48	125+61 126+94	0.00 12.23	0.00 8.44	173.2	0.74	0.88	6.3	7.4	18	134.3	0.0064	658.00 657.14	4.64	7.84	0.0067	659.47 658.57	676.80 677.14	17.33	17.30	MH 3 0.015
D48	D49	126+94 127+74	0.00 12.23	0.00 8.44	173.6	0.74	0.88	6.2	7.4	18	80.4	0.0049	657.07 656.68	4.09	6.82	0.0067	658.57 657.96	677.14 677.12	18.57	18.57	MH 3 0.015
D49	D80	127+74 128+71	0.00 12.23	0.00 8.44	174.0	0.74	0.88	6.2	7.4	18	97.0	0.2296	655.88 633.61	17.50	46.92	0.0067	656.30 634.89	677.12 644.75	20.82	19.74	MH 3 0.015
D80	D87	128+71 129+64	0.00 12.23	0.00 8.44	174.1	0.74	0.88	6.2	7.4	18	94.0	0.2351	627.60 605.50	17.68	47.48	0.0067	628.02 606.78	644.75 613.00	16.73	15.65	MH 3 0.015
GWC begin	D87	129+55 129+64	0.50 12.73	0.37 8.81	10.00	5.10	6.17	1.9	2.3	15	51.0	0.0310	610.61 609.03	6.21	10.60	0.0017	611.02 609.96	613.61 613.00	2.59	1.75	CB 2-2B 0.015
GWB begin	D87	129+72 129+64	0.24 12.97	0.17 8.98	10.00	5.10	6.18	0.9	1.0	15	27.0	0.0174	609.50 609.03	4.01	7.95	0.0003	609.86 609.86	612.50 613.00	2.64	1.75	CB 2-2B 0.015
GWD begin	GWE	130+41 131+29	0.55 13.52	0.41 9.39	10.00	5.10	6.16	2.1	2.5	15	93.0	0.0611	606.43 600.75	8.15	14.88	0.0021	606.79 601.69	609.43 603.65	2.64	1.75	CB 2-2B 0.015

STORM SEWER SYSTEM

JUNCTION From	To	STATION From To	ΔAREA Σ AREA (acres)	ΔCA Σ CA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	RAINFALL INTENSITY (25 yrs.)	DISCHARGE (cfs.) (10 yrs.)	DISCHARGE (cfs.) (25 yrs.)	PIPE DIAM. (in.)	PIPE LENGTH (ft.)	PIPE SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
GWE	D61	131+29 132+17	0.35 13.87	0.25 9.64	10.19	5.05	6.09	3.4	4.0	15	126.0	0.0344	600.75 596.42	7.55	11.16	0.0052	601.29 597.45	603.65 603.54	2.36	1.65	CB 2-2B 0.015
GWA begin	D61	131+19 132+17	0.50 14.37	0.35 9.99	10.00	5.10	6.16	1.8	2.2	15	81.0	0.0391	602.17 599.00	6.64	11.91	0.0015	602.54 599.92	605.08 603.54	2.54	1.66	CB 2-2B 0.015
D87	D61	129+64 132+17	0.00 14.37	0.00 9.99	174.1	0.74	0.88	6.6	7.9	18	180.0	0.0510	605.50 596.32	10.37	22.12	0.0075	606.15 597.61	613.00 603.54	6.85	6.00	MH 3 0.015
D61	D88D	132+41 133+80	0.00 14.37	0.00 9.99	174.4	0.74	0.88	7.4	8.8	18	238.0	0.0546	596.32 583.33	10.94	22.88	0.0093	596.99 584.65	603.54 587.53	6.55	5.72	MH 3 0.015
D88A begin	D88B	133+80 133+80	1.22 15.59	1.10 11.09	10.00	5.10	6.19	5.6	6.8	15	7.9	0.0088	583.90 583.83	4.56	5.65	0.0147	585.20 585.08	587.25 587.76	2.05	2.10	CB 2-2B 0.015
D88B	D88D	133+80 133+80	0.00 15.59	0.00 11.09	10.03	5.09	6.19	5.6	6.8	15	8.1	0.0099	583.83 583.75	5.17	5.98	0.0147	585.08 584.90	587.76 587.76	2.68	2.68	MH 3 0.015
D88D	D88E	133+83 133+93	0.00 15.59	0.00 11.09	174.8	0.74	0.88	8.2	9.7	18	13.0	0.0462	583.28 582.68	10.55	21.04	0.0114	584.18 584.03	587.53 586.93	3.35	2.75	MH 3 0.015
* D88E	D62	133+93 134+26	0.00 15.59	0.00 11.09	174.8	0.74	0.88	8.2	9.7	24	30.0	0.2550	582.18 574.53	19.06	106.50	0.0025	582.60 576.09	586.93 584.58	4.33	2.75	MH 3 0.015
D62 final	OUT	134+26 134+42	0.00 15.59	0.00 11.09	174.8	0.74	0.88	8.2	9.7	36	20.0	0.0050	573.16 573.06	4.51	43.97	0.0003	575.06 575.05	584.58 576.06	9.52	8.42	MH 3 0.015

* Velocity greater than 15 ft/s permissible per Scope based on ring chamber design.

Minimum pipe slope calculation for groundwater discharge collection system for GE-11.

GW Velocity Check.txt

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Analyzer Report

=====================================================================
Drainage Structure Analyzer

Pipe Hydraulic Analysis

Date:  Friday, October 14, 2011 7:33:12 AM
=====================================================================

Input Data
----------
Shape                                      Circular
Material                                     TYPE C
Roughness                                  0.015000
Method                                      Manning
Slope                                         0.48%
Max d/D                                      0.9000
Size (W x T):                         12.00 x 2.0000

Output Results
--------------
Flow Rate                                      2.28 cfs
Slope                                         0.48%
d/D                                          0.9000
Capacity                                       2.14 cfs
Velocity                                     3.0624 ft/s
Depth                                        0.9000 ft
Critical Depth                               0.6400 ft
Size (W x T):                         12.00 x 2.0000

Successful completion
```

InRoads Analysis:
Minimum pipe slope check necessary for Manning's full flow velocity meeting 3 ft/s.
All 15" pipe draining groundwater on west slope have slopes greater than 0.35%.

Minimum pipe slope calculation for groundwater discharge collection system for GE-11.

GW Velocity Check.txt

Analyzer Report

```
==================================================================
Drainage Structure Analyzer

Pipe Hydraulic Analysis

Date:  Friday, October 14, 2011 8:53:20 AM
==================================================================

Input Data
----------
Shape                                      Circular
Material                                     TYPE C
Roughness                                  0.015000
Method                                      Manning
Slope                                         0.35%
Max d/D                                      0.9000
Size (W x T):                        15.00 x 2.2500

Output Results
--------------
Flow Rate                                      3.53 cfs
Slope                                         0.35%
d/D                                          0.9000
Capacity                                       3.31 cfs
Velocity                                     3.0345 ft/s
Depth                                        1.1250 ft
Critical Depth                               0.7500 ft
Size (W x T):                        15.00 x 2.2500

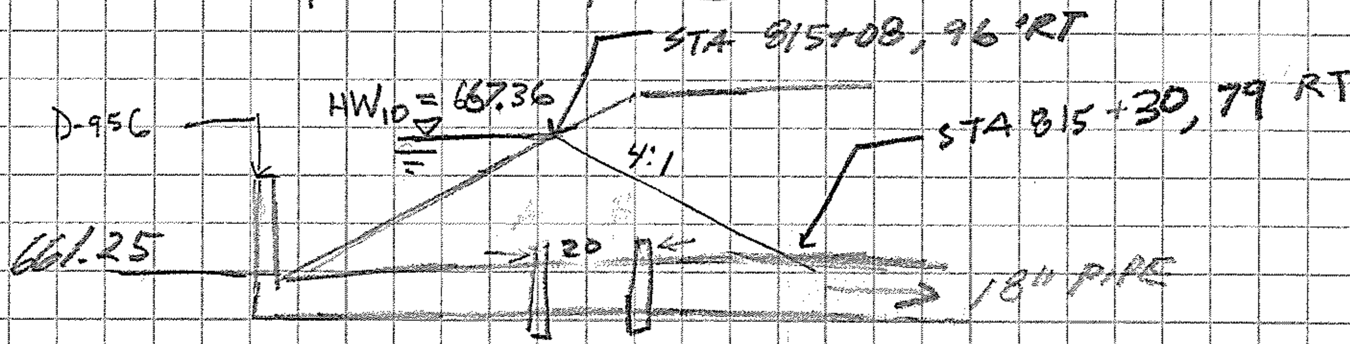
Successful completion
```

InRoads Analysis:
Minimum pipe slope check necessary for Manning's full flow velocity meeting 3 ft/s.
All 15" pipe draining groundwater on west slope have slopes greater than 0.35%.

For West Bank Pond Collar		Job no. 49633		Sheet no.	
Made by PN Shedivy		Checked by ERJohnson		Backchecked by PN Shedivy	
Date 10-11-12		Date 10/13/11		Date 10/13/11	

HNTB

Anti-seep collar per LDVN

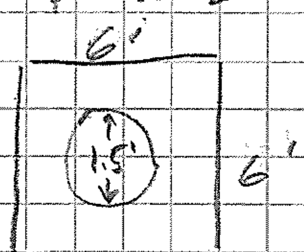


1. $L_s = Y(z+4)\left[1+\frac{S}{0.25-S}\right] = 6.11(4+4)\left[1+\frac{0.0050}{0.25-0.0050}\right]$
$= 49.9$ ft

slope varies from 16:1 → 4:1; Graphically $L_s = 95$ ft

2. $\Delta L_s = 0.15 L_s = 0.15 \times 95 = 14.3$ ft

3. $P = W - D = 6 - 1.92 = 4.08$



4. # collars $= \Delta L_s / P = 14.3 / 4.08 = 4$ collars with $w = 6'$

Spacing of collars:

Max spacing $= \frac{4}{2} \times 14 = 28$ ft use 25 ft

Min spacing $= 5 \times 2.0 = 10$ ft

use 4 collars spaced 20' @: RAMP A6

STA 814+76, 118 RT
STA 814+96, 105 RT
STA 815+14, 92 RT
STA 815+30, 78.6 RT

ME101-1204

West Bank Ring Chamber Design

By Peter Shedivy 9-15-11

Checked By Alysia Lorincz 9-21-11

Reference: Appendix DR-11 of Project Scope, and RS-2 and RC-2 of Plan Insert Sheets found at http://www.dot.state.oh.us/Divisions/Engineering/Hydraulic/Pages/Downloads.aspx

Calculation sequence based off example problem of Appendix DR-11.

1. CDSS Outlet Velocity=18.46 ft/s for 24” pipe, slope =24.77%.

   Manning’s normal depth=0.38 ft

2. Assume Ring Chamber Do=36”. D_o/D_i=36/24=1.5. From RC-2 Lo=16 ft.
3. Slope of Ring Chamber =0.005ft/ft.
4. Inlet Velocity=18.46ft/s since manhole required between transisiton and no collar used.
5. Check Figure 4.1.1 of Appendix DR-11. Assume Ring Chamber flowing full.

   Calculate Froude No: F=V/sqrt(gd)=18.46/sqrt(32.2*0.38)=5.28

   Allowable $d_i/D_i=2.617(5.28)^{-1.232}$ =0.34 for D_o/D_i=1.5.

   Actual d_i/D_i=0.38/2 =0.19 < 0.34 OKAY

6. Tailwater is not used since NWSE=572.5 and F/L of 36” outlet is 573.70.
7. Venting is required and a manhole lid with vents will be constructed on D-88E. This will allow venting of the ring chamber inlet pipe. An East Jordan Iron Works Series 1700 Type M manhole cover will be called out on plans which fit an ODOT MH No. 3 frame. Type M is a grated manhole lid.
8. Conjugate depth (see attached Figure 3.3, Sturm) of hydraulic jump in Ring Chamber is approximately 1.98 ft (normal depth of 0.88 ft). Since this is less than the flow full depth of pipe, the assumption made in step 5 is conservative. This is because the number of 6” steps in the ring chamber is designed for a conjugate depth of 3 ft (flowing full) and since the conjugate depth is approximately 2 ft, the number of 6” steps to induce a conjugate depth of 2 ft, i.e. a hydraulic jump, is less than designed.

Hydraulic Parameters per RS-2 and RC-2.

Do=36”
L1=3ft
L=3ft
Ls=16-3-3-3=7ft
Lo=16ft
K=6”
G=5”
W=4”

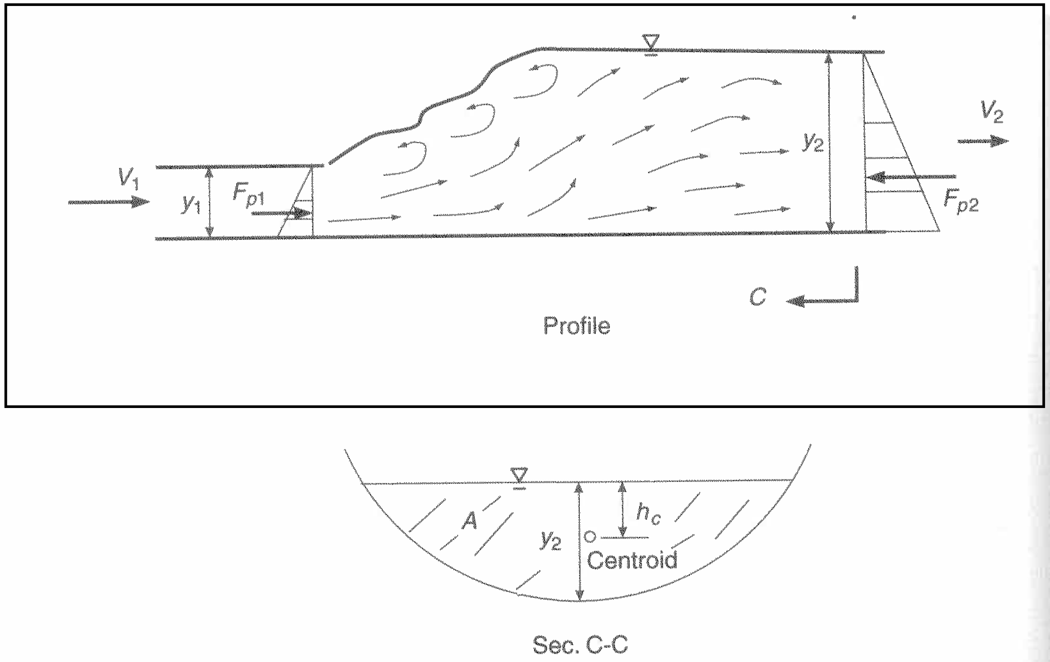


FIGURE 3.1
Application of the momentum equation to a hydraulic jump in a nonrectangular channel.

that the turbulent kinetic energy is small at the end of the jump. This complex flow situation is ideal for the application of the momentum equation, because precise mathematical description of the internal flow pattern is not possible.

If any general nonrectangular cross section is considered as shown in Figure 3.1, a control volume is chosen such that the hydraulic jump is enclosed at the upstream and downstream boundaries, where the flow is nearly parallel. This choice of control volume boundaries allows the assumption of a hydrostatic pressure force at the entrance and exit of the control volume. Also assumed is that the velocity profiles are nearly uniform at the upstream and downstream cross sections, with the result that the momentum correction coefficient $\beta = 1$. The boundary shear over the relatively short length of the jump is neglected in comparison to the change in pressure force. Finally, the jump is assumed to occur in a horizontal channel. Under these assumptions, the momentum equation in the flow direction becomes

$$F_{p1} - F_{p2} = \rho Q(V_2 - V_1) \tag{3.1}$$

in which F_p = hydrostatic force; ρQV = momentum flux; and the subscripts 1 and 2 refer to the upstream and downstream cross sections, respectively. The hydrostatic force is expressed as $\gamma h_c A$, in which h_c is the distance below the free surface to the centroid of the area on which the force acts, as shown in Figure 3.1, and the

dividing Equation 3.1 by the specific weight, γ, there results

$$A_1 h_{c1} + \frac{Q^2}{gA_1} = A_2 h_{c2} + \frac{Q^2}{gA_2} \tag{3.2}$$

We see from this rearrangement of the equation that, if we define a function M, which we will call the *momentum function*, as

$$M = Ah_c + \frac{Q^2}{gA} \tag{3.3}$$

then its equality upstream and downstream of the hydraulic jump can be used to determine the sequent depth, which is the depth after the jump, if the upstream conditions are given, or vice versa. More precisely, the momentum function is force plus momentum flux divided by the specific weight of the fluid, and this quantity is conserved across the hydraulic jump.

The distance from the free surface to the centroid of the flow section, h_c, is a unique function of the depth, y, and the geometry of the cross section. For example, the momentum function for the trapezoidal section is given by

$$M = \frac{by^2}{2} + \frac{my^3}{3} + \frac{Q^2}{gy(b + my)} \tag{3.4}$$

in which b = bottom width; m = sideslope ratio; and y = flow depth as defined in Table 3-1. The trapezoidal section has been divided into a rectangle and two triangles, and the additive property of the first moment of the area about the free surface has been used to obtain the expression for Ah_c. The momentum function definitions for several other prismatic cross sections also are given in Table 3-1.

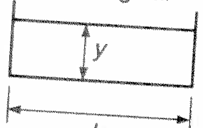
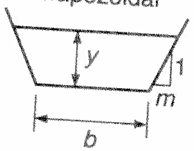
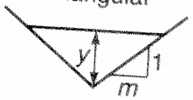
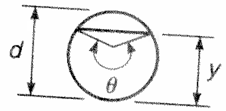
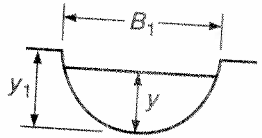
The momentum equation can be placed in dimensionless form and solved numerically for the sequent depth. If M_1 is known for the trapezoidal section from incoming flow conditions, for example, then setting $M_1 = M_2$ and nondimensionalizing results in

$$\frac{1.5\Lambda^2}{y_1'} + \Lambda^3 + \frac{3Z^2}{\Lambda y_1'^4(1 + \Lambda y_1')} = \frac{1.5}{y_1'} + 1 + \frac{3Z^2}{y_1'^4(1 + y_1')} \tag{3.5}$$

in which $\Lambda = y_2/y_1$; $y_1' = my_1/b$; and $Z^2 = Q^2m^3/gb^5$. Equation 3.5 can be solved directly for Z and then plotted as $y_2/y_1 = f(y_1', Z)$ as shown in Figure 3.2 where $Z = Z_{trap}$. Similarly, the solution for the sequent depth ratio for the circular case can be given as shown in Figure 3.3 with $Z^2_{\text{circ}} = Q^2/gd^5$. Implicit equations for y_2/y_1 and their graphical solutions in a form similar to that of Figures 3.2 and 3.3 for trapezoidal and circular channels were proposed by Massey (1961) and Thiruvengadam (1961), respectively.

To solve the nonlinear algebraic equations for the sequent depth ratio numerically, a function $F(y) = M_1 - M_2$ is defined and solved by interval halving or some other nonlinear algebraic equation solver. The critical depth must be found first, however, to limit the root search to the appropriate subcritical or supercritical solution.

Momentum function for channels of different shapes (y = flow depth)

Shape	Momentum function
Rectangular 	$by^2/2 + Q^2/(gby)$
Trapezoidal 	$by^2/2 + my^3/3 + Q^2/[gy(b + my)]$
Triangular 	$my^3/3 + Q^2/(gmy^2)$
Circular† 	$[3\sin(\theta/2) - \sin^3(\theta/2) - 3(\theta/2)\cos(\theta/2)]\,d^3/24 + Q^2/[gd^2(\theta - \sin\theta)/8]$
Parabolic‡ 	$(4/15)\zeta y^{5/2} + 1.5Q^2/(g\zeta y^{3/2})$

† $\theta = 2\cos^{-1}[1 - 2(y/d)]$
‡ $\zeta = B_1/y_1^{1/2}$

→ y_1 = upstream normal depth
d = upstream diameter
y_2 = conjugate depth

For the rectangular cross section, there is an exact solution for the sequent depth ratio that depends only on the upstream Froude number. Setting the values of the momentum function per unit width upstream and downstream of the jump equal and rearranging, we have

$$\frac{y_1^2}{2} - \frac{y_2^2}{2} = \frac{q^2}{g}\left[\frac{1}{y_2} - \frac{1}{y_1}\right] \tag{3.6}$$

With some algebraic manipulation and nondimensionalization, Equation 3.6 becomes a quadratic equation:

$$\Lambda^2 + \Lambda - 2\mathbf{F}_1^2 = 0 \tag{3.7}$$

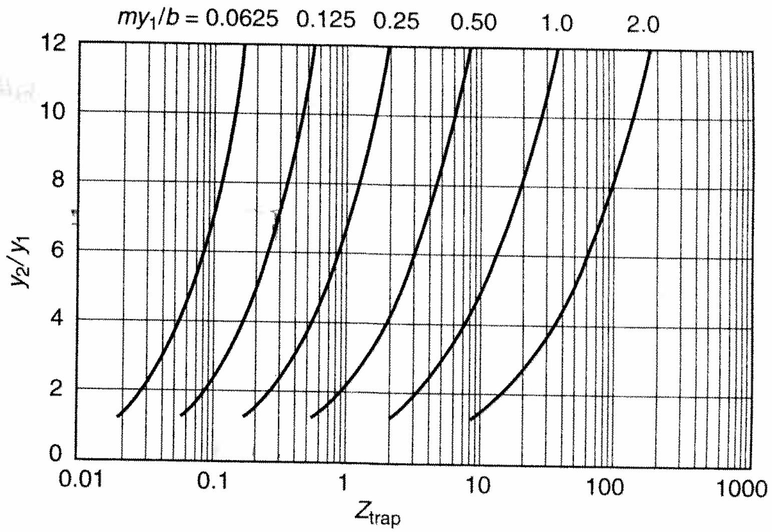


FIGURE 3.2
Sequent depth ratio for a hydraulic jump in a trapezoidal channel ($Z_{trap} = Qm^{3/2}/[g^{1/2}b^{5/2}]$).

y_1 = 0.38 ft
d = 24'' = 2 ft
$\frac{y_1}{d} = \frac{0.38}{2} = 0.19$

$Z_{circ} = \frac{7.6}{(32.2^{1/2}\, 2^{5/2})} = 0.24$

$\frac{y_2}{y_1} \xrightarrow{\text{chart}} = 5.2 \rightarrow y_2 = 5.2 y_1$
$= 5.2(0.38)$
$= 1.98$ ft

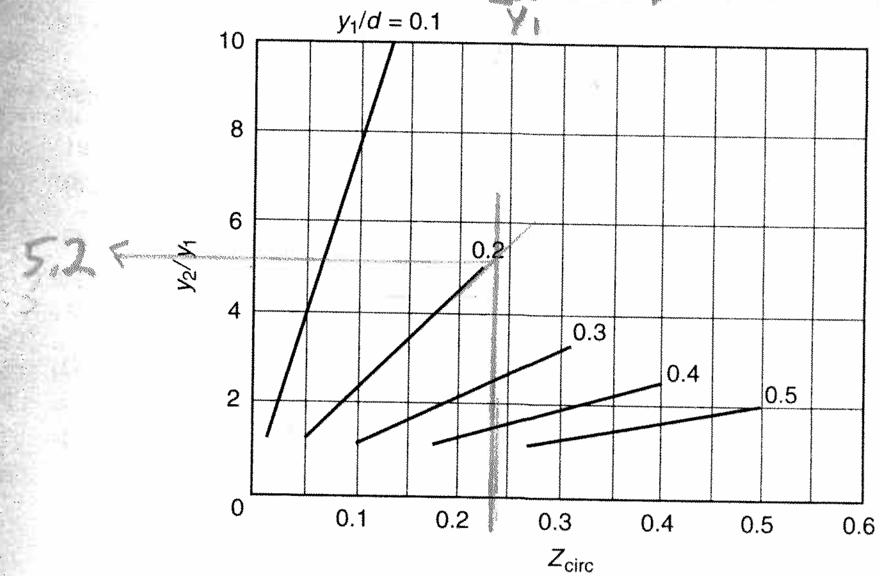


FIGURE 3.3
Sequent depth ratio for a hydraulic jump in a circular channel ($Z_{circ} = Q/[g^{1/2}d^{5/2}]$).

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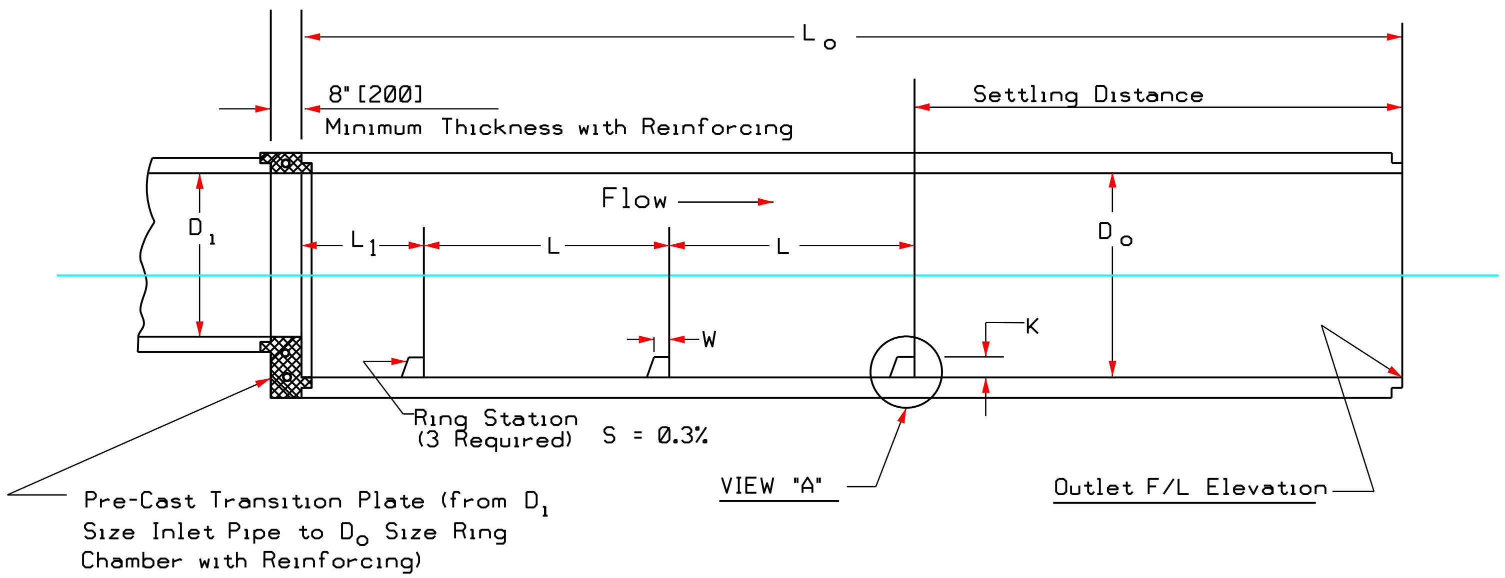
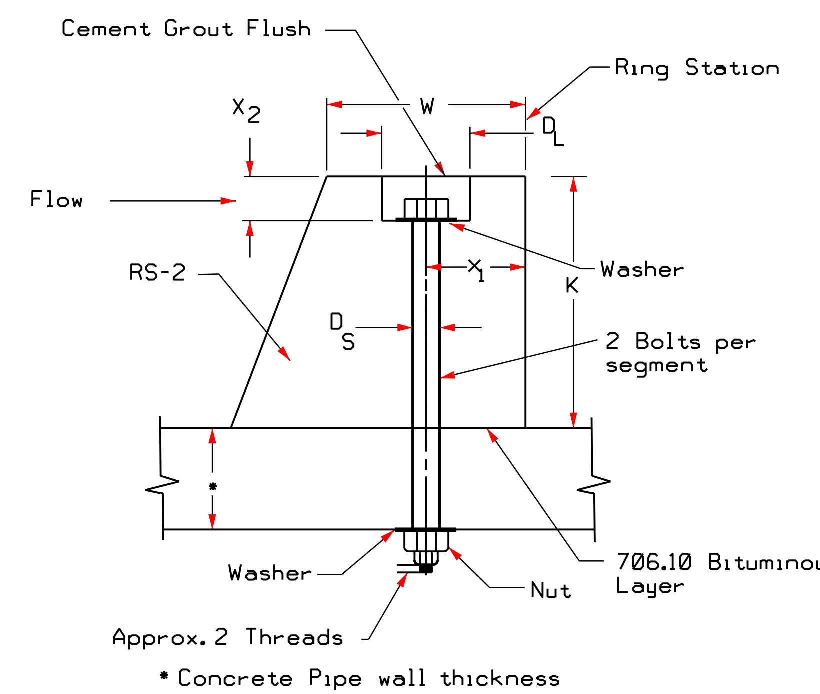


RING CHAMBER PROFILE



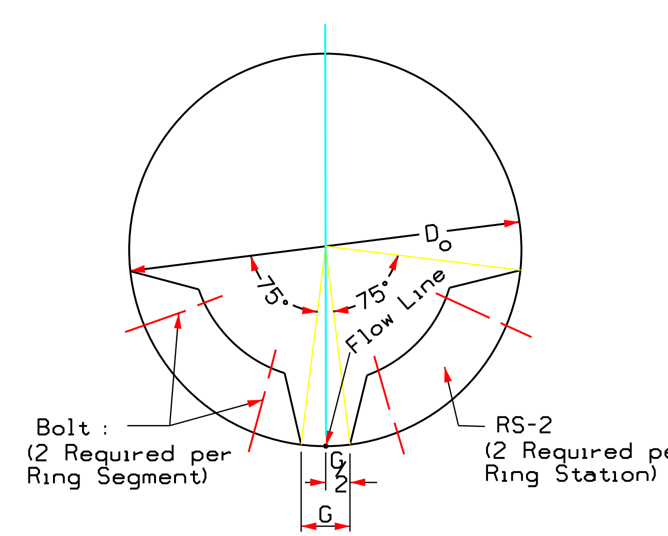
VIEW "A" @ BOLT : (Typical)

TABLE OF RING CHAMBER DATA FOR EACH PIPE SIZE (Do)

D_o		K		W		D_S		D_L		X_1		X_2		G		Bolt Size		L_o		L_1		L	
Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm	Feet	Meter	Ft.	m	Ft.	m
36	914	6	152	4	102	0.625	16	1.5	38	2.00	51	1.00	25	5	127	0.50	13	16	5	3	0.9	3	0.9
42	1067	7	178	5	127	0.625	16	2.0	51	2.50	64	1.00	25	5	127	0.50	13	24	7	5	1.5	5	1.5
48	1219	8	203	6	152	0.750	19	2.0	51	3.00	76	1.25	32	6	152	0.625	16			5	1.5		
54	1372	9	229	7	178	1.000	25	3.0	76	3.30	84	1.50	38	7	178	0.750	19			4	1.2		
60	1524	10	254	7	178					3.50	90			8	203			24	7	4	1.2	5	1.5
66	1676	11	279	8	203					4.00	102			8	203			32	10	6	1.8	6	1.8
72	1829	12	305	8	203	1.000	25			4.00	102			9	229	0.750	19	32	10	6	1.8	6	1.8
78	1981	13	330	8	203	1.250	32	3.0	76	4.00	102	1.50	38	10	254	1.00	25	40	12	7	2.1	7	2.1
84	2134	14	356	9	229	1.625	41	4.0	102	4.50	113	2.00	51	11	279	1.250	32					7	2.1
90	2286	15	381											11	279							8	2.4
96	2438	16	406											12	305			40	12	7	2.1	8	2.4
102	2591	17	432							4.50	113			12	305			48	15	10	3.0	10	3.0
108	2743	18	457	9	229					5.00	127			13	330			48	15				
114	2896	19	483	10	254									14	356			48	15				
120	3048	20	508			1.625	41					2.00	51	15	381	1.250	32	56	17	10	3.0	10	3.0
126	3200	21	533			1.750	44					2.50	64	16	406	1.50	38	56	17	11	3.4	11	3.4
132	3353	22	559											17	432			56	17			11	3.4
138	3505	23	584											17	432			64	20			11	3.4
144	3658	24	610							5.00	127			18	457			64	20			12	3.7
150	3810	25	635							5.50	140			19	483			64	20	11	3.4	12	3.7
156	3962	26	660	10	254			4.0	102	5.50	140			20	508			72	22	12	3.7	13	4.0
162	4115	27	686	12	305	1.750	44	5.0	127	6.00	152	2.50	64	20	508	1.50	38	72	22	12	3.7	13	4.0

NOTES:

The Ring Chamber is to be made from the strength and size of concrete pipe specified in the plans. The Ring segments shall be pre-cast according to RS-2 and assembled into pipe sections according to this drawing at the pre-cast facility. A 706.10 Bituminous coat will be placed between each Ring segment and the pipe section. Each bolt head cavity must be grouted flush with cement grout. All bolts, nuts, and washers must be galvanized as per section 711.02. The bolt lengths will permit full engagement of all threads of the nuts (minimum). The Ringed Sections must be delivered to the Project marked as needed and ready to lay similar to any other concrete pipe sections.



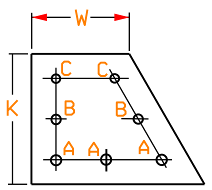
RING CHAMBER STATION (Typical)

DESIGNED: C.G.P.
CHECKED BY: C.G.P.
REVISIONS: 7/16/84 5/10/2000

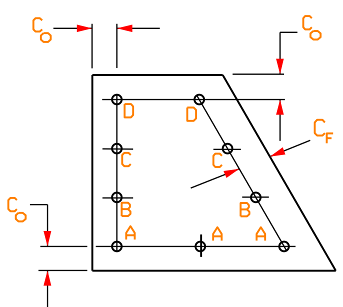
All metric dimensions (in brackets [ ]) are in millimeters unless otherwise noted.

RING CHAMBERS

RC-2

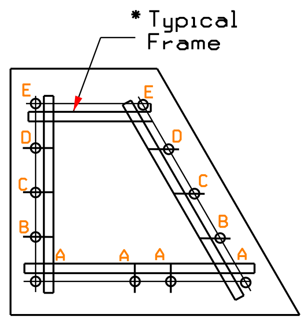


I

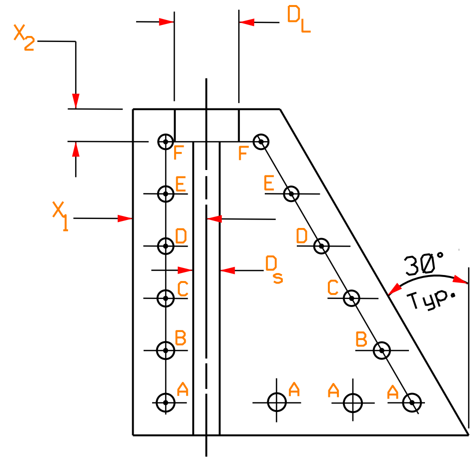


II

* Typical Frame



III



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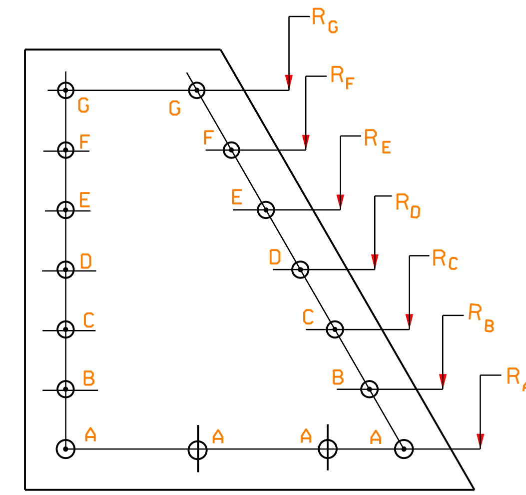
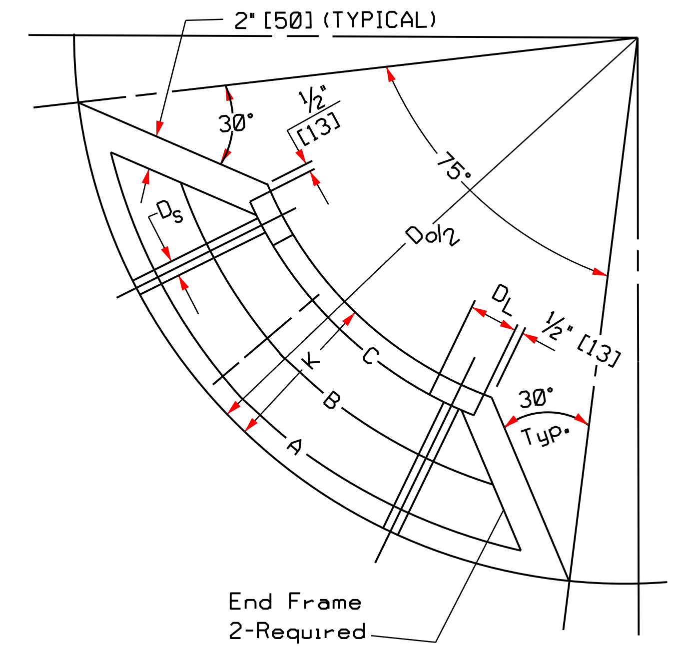


V



RING SEGMENT PROFILE

TABLE OF RING SEGMENT DATA FOR EACH PIPE SIZE (D_o)

D_o		K		W		D_S		D_L		X_1		X_2		Approx. Length of Curved Bars [Inches (mm)] A		B		C		D		E		F		G	
Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm
36	914	6	152	4	102	0.625	16	1.5	38	2.00	51	1.00	25	17.1	434	12.2	310	7.2	183	—	—	—	—	—	—	—	—
42	1067	7	178	5	127	0.625	16	2.0	51	2.50	64	1.00	25	21.0	533	14.9	378	8.7	221	—	—	—	—	—	—	—	—
48	1219	8	203	6	152	0.750	19	2.0	51	3.00	76	1.25	32	23.7	602	17.6	447	11.4	290	—	—	—	—	—	—	—	—
54	1372	9	229	7	178	1.000	25	3.0	76	3.30	84	1.50	38	27.6	701	20.3	516	12.9	328	—	—	—	—	—	—	—	—
60	1524	10	254	7	178					3.50	89			31.6	803	22.9	582	14.3	363	—	—	—	—	—	—	—	—
66	1676	11	279	8	203					4.00	102			35.5	902	28.9	734	22.4	569	15.8	401	—	—	—	—	—	—
72	1829	12	305	8	203	1.000	25			4.00	102			39.4	1001	32.0	813	24.6	625	17.2	437	—	—	—	—	—	—
78	1981	13	330	8	203	1.250	32	3.0	76	4.00	102	1.50	38	43.3	1100	37.2	945	31.0	787	24.9	632	18.7	475	—	—	—	—
84	2134	14	356	9	229	1.625	41	4.0	102	4.50	114	2.00	51	47.3	1201	40.5	1029	33.7	856	27.0	686	20.2	513	—	—	—	—
90	2286	15	381											51.2	1300	43.8	1113	36.4	925	29.0	737	21.6	549	—	—	—	—
96	2438	16	406											55.1	1400	48.7	1237	42.3	1074	35.9	912	29.5	749	23.1	587	—	—
102	2591	17	432							4.50	114			59.0	1499	52.2	1326	45.3	1151	38.4	975	31.5	800	24.6	625	—	—
108	2743	18	457	9	229					5.00	127			61.7	1567	54.8	1392	48.0	1219	41.0	1041	34.2	869	27.3	693	—	—
114	2896	19	483	10	254									65.7	1669	58.3	1481	51.0	1295	43.5	1105	36.1	917	28.7	729	—	—
120	3048	20	508			1.625	41					2.00	51	69.6	1768	61.7	1567	53.8	1367	46.0	1168	38.0	965	30.2	767	—	—
126	3200	21	533			1.750	44					2.50	64	73.5	1867	65.1	1654	56.8	1443	48.4	1229	40.0	1016	31.6	803	—	—
132	3353	22	559											77.5	1968	68.6	1742	59.7	1516	50.8	1290	42.0	1067	33.1	841	—	—
138	3505	23	584											81.4	2068	72.0	1829	62.7	1593	53.3	1354	44.0	1118	34.6	879	—	—
144	3658	24	610							5.00	127			85.3	2167	75.5	1918	65.6	1666	55.7	1415	46.0	1168	36.0	914	—	—
150	3810	25	635							5.50	140			89.2	2266	79.0	2007	68.5	1740	58.2	1478	48.0	1219	37.5	953	—	—
156	3962	26	660	10	254			4.0	102	5.50	140			93.2	2367	82.3	2090	71.5	1816	60.6	1539	49.8	1265	39.0	991	—	—
162	4115	27	686	12	305	1.750	44	5.0	127	6.00	152	2.50	64	97.0	2464	87.7	2228	78.2	1986	69.0	1753	59.3	1506	50.0	1270	40.4	1026

D_o	Approx. Radius of Curved Bars [Inches (mm)] R_A		R_B		R_C		R_D		R_E		R_F		R_G		Number of Frames	C_o		C_F		Reinforcing Bar Size		Section Number
Inches	Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm		Inches	mm	Inches	mm	Feet	m	
36	17.0	432	15.0	381	13.0	330	—	—	—	—	—	—	—	—	3	1.0	25	1.5	38	•4	•13	I
42	20.0	508	17.5	445	15.0	381	—	—	—	—	—	—	—	—		1.0	25	1.5	38	•4	•13	
48	22.5	572	20.0	508	17.5	445	—	—	—	—	—	—	—	—		1.5	38	1.5	38	•4	•13	
54	25.5	648	22.5	572	19.5	495	—	—	—	—	—	—	—	—				2.0	51	•5	•16	
60	28.5	724	25.0	635	21.5	546	—	—	—	—	—	—	—	—								I
66	31.5	800	28.8	732	26.2	665	23.5	597	—	—	—	—	—	—								II
72	34.5	876	31.5	800	28.5	724	25.5	648	—	—	—	—	—	—	3							II
78	37.5	953	35.0	889	32.5	825	30.0	762	27.5	699	—	—	—	—	4							III
84	40.5	1029	37.7	958	35.0	889	32.2	818	29.5	749	—	—	—	—								III
90	43.5	1105	40.5	1029	37.5	953	34.5	876	31.5	800	—	—	—	—								III
96	46.5	1181	43.9	1115	41.3	1049	38.7	983	36.1	917	33.5	851	—	—								IV
102	49.5	1257	46.7	1186	43.9	1115	41.1	1044	38.3	973	35.5	902	—	—		1.5	38			•5	•16	
108	52.0	1321	49.2	1250	46.4	1179	43.6	1107	41.0	1041	38.0	965	—	—		2.0	51			•6	•19	
114	55.0	1397	52.0	1321	49.0	1245	46.0	1168	43.0	1092	40.0	1016	—	—						•6	•19	
120	58.0	1473	54.8	1392	51.6	1311	48.4	1229	45.2	1148	42.0	1067	—	—	4					•6	•19	
126	61.0	1549	57.6	1463	54.2	1377	50.8	1290	47.4	1204	44.0	1118	—	—	5					•7	•22	
132	64.0	1626	60.4	1534	56.8	1443	53.2	1351	49.6	1260	46.0	1168	—	—								
138	67.0	1702	63.2	1605	59.4	1509	55.6	1412	51.8	1316	48.0	1219	—	—								
144	70.0	1778	66.0	1676	62.0	1575	58.0	1473	54.0	1372	50.0	1270	—	—								
150	73.0	1854	68.8	1748	64.6	1641	60.4	1534	56.2	1427	52.0	1321	—	—								
156	76.0	1930	71.6	1819	67.2	1707	62.8	1595	58.4	1483	54.0	1372	—	—								IV
162	79.0	2007	75.2	1910	71.3	1811	67.5	1715	63.7	1618	59.8	1519	56.0	1422	5	2.0	51	2.0	51	•7	•22	V

NOTES:

Ring Segments are to be pre-cast from Class C Concrete per 706.13.

* Frames of Item 709 reinforcing must be wired or resistance welded to the curved bars to form a cage. A frame must be placed at each end face. Frame bars must be made of the same size bars as the curved bars (A thru G). Frames are to be evenly spaced but may be adjusted to avoid the block out for the bolt holes. Frames may be made from a single bent bar rather than four individual bars as shown. The outside diameter D_o may be reduced to obtain a proper fit with the inside diameter of the pipe section.

DESIGNED: C.G.P.
CHECKED BY: C.G.P.

REVISIONS
3/28/83
7/13/84
5/10/2000

All metric dimensions (in brackets [ ]) are in millimeters unless otherwise noted.

RING SEGMENTS

RS-2

PROJECT SCOPE LANGUAGE

K. The DBT shall design the parking lot drainage system such that ponding is limited to the landscaped areas for rainfall events up to and including the 5-year rainfall event. The maximum depth of ponding shall be 6 inches.

13.2.2 West Slope Drainage Requirements

All proposed storm sewer system facilities between Abbey Avenue and the Cuyahoga River shall meet the following requirements:

A. Minimum pipe cover shall be 5 feet for any pipe under a 4:1 or steeper slope.
B. Use mechanical connectors or flanged joints on 4:1 or steeper slope.
C. All proposed drainage structures shall have premium, water tight joints.
D. Maximum pipe velocity shall be 15 fps except for any pipe immediately prior to a ring chamber.

In order to introduce turbulence and improve oxygen levels of the West Bank storm water runoff, the DBT shall provide ring chambers in accordance with ODOT Plan Insert Sheets RC-2 and RS-2 (http://www.dot.state.oh.us/Divisions/HighwayOps/Structures/Hydraulic/Pages/Downloads.aspx) at the end of all West Bank storm sewer systems that outlet to the Cuyahoga River. In the case of a submerged outlet, the ring chamber section should be provided immediately prior to the section below elevation of 570 feet.

A drainage structure shall be provided to transition from the standard conduit to the ring chamber portion of the storm sewer. The DBT shall match the top of crown for the conduits entering and exiting the drainage structure.

The conduit type for the ring chamber portion shall be reinforced concrete pipe (C&MS 706.02 with premium joints per 706.11). The reinforced concrete conduit strength shall be based on the height of fill (L&D Volume 2, Figure 1008-10). The diameter of the conduit with ring chambers shall be a minimum of 36 inches, but shall be properly sized to meet the requirements of the FHWA/OH-84/007 Internal Energy Dissipaters for Culverts (included in Appendix DR-11) , and the length of ring chamber section shall correspond to Plan Insert Sheet RC-2. Additional design details for the ring chambers and corresponding conduit shall be in accordance with Plan Insert Sheets RC-2 and RS-2. The reinforced concrete pipe material shall be provided from the end of the ring chamber to the ultimate pipe outfall at the river.

13.2.3 E.9th Street (Commercial Road Hill Area) Storm Sewer

The proposed storm sewer outfall for the E. 9th Street system, from the CSX tracks to the Cuyahoga River, shall have the following requirements:

A. Provide a pipe design that considers all site conditions including, but not limited to, the following:

Tremont Extended Dry Detention

Project Summary	
Title	Tremont West Bank Extended Detention
Engineer	PNS
Company	HNTB
Date	10/12/2011

Notes

Table of Contents

Tremont Extended Dry Detention

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft³/s)
Proposed Storm Sewer DA	wq	0	0.414	12.050	5.53
Proposed Storm Sewer DA	5 year	5	1.710	12.050	24.15
Proposed Storm Sewer DA	10 year	10	2.142	12.050	30.14
Proposed Storm Sewer DA	25 year	25	2.782	12.050	38.86
Proposed Storm Sewer DA	50 year	50	3.321	12.050	46.09

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft³/s)
Analysis Point Pro	wq	0	0.407	21.900	0.12
Analysis Point Pro	5 year	5	1.701	12.450	5.11
Analysis Point Pro	10 year	10	2.133	12.450	6.31
Analysis Point Pro	25 year	25	2.773	12.250	15.97
Analysis Point Pro	50 year	50	3.312	12.250	20.42

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft³/s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ac-ft)
Extended Detention (IN)	wq	0	0.414	12.050	5.53	(N/A)	(N/A)
Extended Detention (OUT)	wq	0	0.407	21.900	0.12	663.78	0.295
Extended Detention (IN)	5 year	5	1.710	12.050	24.15	(N/A)	(N/A)
Extended Detention (OUT)	5 year	5	1.701	12.450	5.11	666.46	0.790
Extended Detention (IN)	10 year	10	2.142	12.050	30.14	(N/A)	(N/A)

Tremont Extended Dry Detention

Subsection: Master Network Summary

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ac-ft)
Extended Detention (OUT)	10 year	10	2.133	12.450	6.31	667.36	1.006
Extended Detention (IN)	25 year	25	2.782	12.050	38.86	(N/A)	(N/A)
Extended Detention (OUT)	25 year	25	2.773	12.250	15.97	668.03	1.184
Extended Detention (IN)	50 year	50	3.321	12.050	46.09	(N/A)	(N/A)
Extended Detention (OUT)	50 year	50	3.312	12.250	20.42	668.59	1.347

Tremont Extended Dry Detention

Subsection: Time-Depth Curve
Return Event: 5 years
Label: ODOT TR-55
Storm Event: Type II 24 hour

Time-Depth Curve: Type II 24 hour	
Label	Type II 24 hour
Start Time	0.000 hours
Increment	0.100 hours
End Time	24.000 hours
Return Event	5 years

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
0.000	0.0	0.0	0.0	0.0	0.0
0.500	0.0	0.0	0.0	0.0	0.0
1.000	0.0	0.0	0.0	0.0	0.0
1.500	0.0	0.1	0.1	0.1	0.1
2.000	0.1	0.1	0.1	0.1	0.1
2.500	0.1	0.1	0.1	0.1	0.1
3.000	0.1	0.1	0.1	0.1	0.1
3.500	0.1	0.1	0.1	0.1	0.1
4.000	0.1	0.1	0.1	0.2	0.2
4.500	0.2	0.2	0.2	0.2	0.2
5.000	0.2	0.2	0.2	0.2	0.2
5.500	0.2	0.2	0.2	0.2	0.2
6.000	0.2	0.2	0.2	0.2	0.3
6.500	0.3	0.3	0.3	0.3	0.3
7.000	0.3	0.3	0.3	0.3	0.3
7.500	0.3	0.3	0.3	0.3	0.3
8.000	0.4	0.4	0.4	0.4	0.4
8.500	0.4	0.4	0.4	0.4	0.4
9.000	0.4	0.4	0.4	0.5	0.5
9.500	0.5	0.5	0.5	0.5	0.5
10.000	0.5	0.5	0.6	0.6	0.6
10.500	0.6	0.6	0.6	0.6	0.7
11.000	0.7	0.7	0.7	0.8	0.8
11.500	0.8	0.9	1.0	1.3	1.7
12.000	1.9	2.0	2.0	2.1	2.1
12.500	2.1	2.2	2.2	2.2	2.2
13.000	2.3	2.3	2.3	2.3	2.3
13.500	2.3	2.3	2.4	2.4	2.4
14.000	2.4	2.4	2.4	2.4	2.4
14.500	2.4	2.5	2.5	2.5	2.5
15.000	2.5	2.5	2.5	2.5	2.5
15.500	2.5	2.5	2.5	2.6	2.6
16.000	2.6	2.6	2.6	2.6	2.6
16.500	2.6	2.6	2.6	2.6	2.6

Tremont Extended Dry Detention

Subsection: Time-Depth Curve — Return Event: 5 years
Label: ODOT TR-55 — Storm Event: Type II 24 hour

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
17.000	2.6	2.6	2.6	2.7	2.7
17.500	2.7	2.7	2.7	2.7	2.7
18.000	2.7	2.7	2.7	2.7	2.7
18.500	2.7	2.7	2.7	2.7	2.7
19.000	2.7	2.7	2.7	2.8	2.8
19.500	2.8	2.8	2.8	2.8	2.8
20.000	2.8	2.8	2.8	2.8	2.8
20.500	2.8	2.8	2.8	2.8	2.8
21.000	2.8	2.8	2.8	2.8	2.8
21.500	2.8	2.8	2.8	2.8	2.8
22.000	2.9	2.9	2.9	2.9	2.9
22.500	2.9	2.9	2.9	2.9	2.9
23.000	2.9	2.9	2.9	2.9	2.9
23.500	2.9	2.9	2.9	2.9	2.9
24.000	2.9	(N/A)	(N/A)	(N/A)	(N/A)

Tremont Extended Dry Detention

Subsection: Time-Depth Curve | Return Event: 10 years
Label: ODOT TR-55 | Storm Event: Type II 24 hour

Time-Depth Curve: Type II 24 hour	
Label	Type II 24 hour
Start Time	0.000 hours
Increment	0.100 hours
End Time	24.000 hours
Return Event	10 years

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
0.000	0.0	0.0	0.0	0.0	0.0
0.500	0.0	0.0	0.0	0.0	0.0
1.000	0.0	0.0	0.0	0.0	0.1
1.500	0.1	0.1	0.1	0.1	0.1
2.000	0.1	0.1	0.1	0.1	0.1
2.500	0.1	0.1	0.1	0.1	0.1
3.000	0.1	0.1	0.1	0.1	0.1
3.500	0.1	0.1	0.1	0.2	0.2
4.000	0.2	0.2	0.2	0.2	0.2
4.500	0.2	0.2	0.2	0.2	0.2
5.000	0.2	0.2	0.2	0.2	0.2
5.500	0.2	0.2	0.3	0.3	0.3
6.000	0.3	0.3	0.3	0.3	0.3
6.500	0.3	0.3	0.3	0.3	0.3
7.000	0.3	0.3	0.4	0.4	0.4
7.500	0.4	0.4	0.4	0.4	0.4
8.000	0.4	0.4	0.4	0.4	0.4
8.500	0.4	0.5	0.5	0.5	0.5
9.000	0.5	0.5	0.5	0.5	0.5
9.500	0.6	0.6	0.6	0.6	0.6
10.000	0.6	0.6	0.6	0.7	0.7
10.500	0.7	0.7	0.7	0.8	0.8
11.000	0.8	0.8	0.9	0.9	0.9
11.500	1.0	1.0	1.2	1.5	1.9
12.000	2.3	2.3	2.4	2.4	2.5
12.500	2.5	2.5	2.6	2.6	2.6
13.000	2.6	2.6	2.7	2.7	2.7
13.500	2.7	2.7	2.7	2.8	2.8
14.000	2.8	2.8	2.8	2.8	2.8
14.500	2.8	2.9	2.9	2.9	2.9
15.000	2.9	2.9	2.9	2.9	2.9
15.500	2.9	3.0	3.0	3.0	3.0
16.000	3.0	3.0	3.0	3.0	3.0
16.500	3.0	3.0	3.0	3.1	3.1

Tremont Extended Dry Detention

Subsection: Time-Depth Curve   Return Event: 10 years
Label: ODOT TR-55   Storm Event: Type II 24 hour

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
17.000	3.1	3.1	3.1	3.1	3.1
17.500	3.1	3.1	3.1	3.1	3.1
18.000	3.1	3.1	3.1	3.1	3.2
18.500	3.2	3.2	3.2	3.2	3.2
19.000	3.2	3.2	3.2	3.2	3.2
19.500	3.2	3.2	3.2	3.2	3.2
20.000	3.2	3.2	3.2	3.2	3.3
20.500	3.3	3.3	3.3	3.3	3.3
21.000	3.3	3.3	3.3	3.3	3.3
21.500	3.3	3.3	3.3	3.3	3.3
22.000	3.3	3.3	3.3	3.3	3.3
22.500	3.3	3.3	3.3	3.4	3.4
23.000	3.4	3.4	3.4	3.4	3.4
23.500	3.4	3.4	3.4	3.4	3.4
24.000	3.4	(N/A)	(N/A)	(N/A)	(N/A)

Tremont Extended Dry Detention

Subsection: Time-Depth Curve | Return Event: 25 years
Label: ODOT TR-55 | Storm Event: Type II 24 hour

Time-Depth Curve: Type II 24 hour	
Label	Type II 24 hour
Start Time	0.000 hours
Increment	0.100 hours
End Time	24.000 hours
Return Event	25 years

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
0.000	0.0	0.0	0.0	0.0	0.0
0.500	0.0	0.0	0.0	0.0	0.0
1.000	0.0	0.0	0.1	0.1	0.1
1.500	0.1	0.1	0.1	0.1	0.1
2.000	0.1	0.1	0.1	0.1	0.1
2.500	0.1	0.1	0.1	0.1	0.1
3.000	0.1	0.1	0.2	0.2	0.2
3.500	0.2	0.2	0.2	0.2	0.2
4.000	0.2	0.2	0.2	0.2	0.2
4.500	0.2	0.2	0.2	0.2	0.3
5.000	0.3	0.3	0.3	0.3	0.3
5.500	0.3	0.3	0.3	0.3	0.3
6.000	0.3	0.3	0.3	0.3	0.4
6.500	0.4	0.4	0.4	0.4	0.4
7.000	0.4	0.4	0.4	0.4	0.4
7.500	0.4	0.5	0.5	0.5	0.5
8.000	0.5	0.5	0.5	0.5	0.5
8.500	0.5	0.6	0.6	0.6	0.6
9.000	0.6	0.6	0.6	0.6	0.7
9.500	0.7	0.7	0.7	0.7	0.7
10.000	0.7	0.8	0.8	0.8	0.8
10.500	0.8	0.9	0.9	0.9	0.9
11.000	1.0	1.0	1.0	1.1	1.1
11.500	1.2	1.3	1.4	1.8	2.3
12.000	2.7	2.8	2.9	2.9	3.0
12.500	3.0	3.0	3.1	3.1	3.1
13.000	3.2	3.2	3.2	3.2	3.2
13.500	3.3	3.3	3.3	3.3	3.3
14.000	3.4	3.4	3.4	3.4	3.4
14.500	3.4	3.4	3.5	3.5	3.5
15.000	3.5	3.5	3.5	3.5	3.5
15.500	3.5	3.6	3.6	3.6	3.6
16.000	3.6	3.6	3.6	3.6	3.6
16.500	3.6	3.7	3.7	3.7	3.7

Tremont Extended Dry Detention

Subsection: Time-Depth Curve — Return Event: 25 years
Label: ODOT TR-55 — Storm Event: Type II 24 hour

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
17.000	3.7	3.7	3.7	3.7	3.7
17.500	3.7	3.7	3.7	3.8	3.8
18.000	3.8	3.8	3.8	3.8	3.8
18.500	3.8	3.8	3.8	3.8	3.8
19.000	3.8	3.8	3.8	3.9	3.9
19.500	3.9	3.9	3.9	3.9	3.9
20.000	3.9	3.9	3.9	3.9	3.9
20.500	3.9	3.9	3.9	3.9	3.9
21.000	3.9	4.0	4.0	4.0	4.0
21.500	4.0	4.0	4.0	4.0	4.0
22.000	4.0	4.0	4.0	4.0	4.0
22.500	4.0	4.0	4.0	4.0	4.0
23.000	4.0	4.0	4.1	4.1	4.1
23.500	4.1	4.1	4.1	4.1	4.1
24.000	4.1	(N/A)	(N/A)	(N/A)	(N/A)

Tremont Extended Dry Detention

Subsection: Time-Depth Curve — Return Event: 50 years
Label: ODOT TR-55 — Storm Event: Type II 24 hour

Time-Depth Curve: Type II 24 hour	
Label	Type II 24 hour
Start Time	0.000 hours
Increment	0.100 hours
End Time	24.000 hours
Return Event	50 years

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
0.000	0.0	0.0	0.0	0.0	0.0
0.500	0.0	0.0	0.0	0.0	0.0
1.000	0.0	0.1	0.1	0.1	0.1
1.500	0.1	0.1	0.1	0.1	0.1
2.000	0.1	0.1	0.1	0.1	0.1
2.500	0.1	0.1	0.1	0.1	0.2
3.000	0.2	0.2	0.2	0.2	0.2
3.500	0.2	0.2	0.2	0.2	0.2
4.000	0.2	0.2	0.2	0.2	0.3
4.500	0.3	0.3	0.3	0.3	0.3
5.000	0.3	0.3	0.3	0.3	0.3
5.500	0.3	0.3	0.3	0.4	0.4
6.000	0.4	0.4	0.4	0.4	0.4
6.500	0.4	0.4	0.4	0.4	0.5
7.000	0.5	0.5	0.5	0.5	0.5
7.500	0.5	0.5	0.5	0.5	0.5
8.000	0.6	0.6	0.6	0.6	0.6
8.500	0.6	0.6	0.6	0.7	0.7
9.000	0.7	0.7	0.7	0.7	0.7
9.500	0.8	0.8	0.8	0.8	0.8
10.000	0.8	0.9	0.9	0.9	0.9
10.500	1.0	1.0	1.0	1.0	1.1
11.000	1.1	1.1	1.2	1.2	1.3
11.500	1.3	1.4	1.7	2.0	2.6
12.000	3.1	3.2	3.3	3.3	3.4
12.500	3.4	3.5	3.5	3.5	3.6
13.000	3.6	3.6	3.7	3.7	3.7
13.500	3.7	3.7	3.8	3.8	3.8
14.000	3.8	3.8	3.9	3.9	3.9
14.500	3.9	3.9	3.9	3.9	4.0
15.000	4.0	4.0	4.0	4.0	4.0
15.500	4.0	4.1	4.1	4.1	4.1
16.000	4.1	4.1	4.1	4.1	4.1
16.500	4.2	4.2	4.2	4.2	4.2

Tremont Extended Dry Detention

Subsection: Time-Depth Curve — Return Event: 50 years

Label: ODOT TR-55 — Storm Event: Type II 24 hour

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
17.000	4.2	4.2	4.2	4.2	4.2
17.500	4.2	4.3	4.3	4.3	4.3
18.000	4.3	4.3	4.3	4.3	4.3
18.500	4.3	4.3	4.3	4.4	4.4
19.000	4.4	4.4	4.4	4.4	4.4
19.500	4.4	4.4	4.4	4.4	4.4
20.000	4.4	4.4	4.4	4.5	4.5
20.500	4.5	4.5	4.5	4.5	4.5
21.000	4.5	4.5	4.5	4.5	4.5
21.500	4.5	4.5	4.5	4.5	4.5
22.000	4.6	4.6	4.6	4.6	4.6
22.500	4.6	4.6	4.6	4.6	4.6
23.000	4.6	4.6	4.6	4.6	4.6
23.500	4.6	4.6	4.6	4.6	4.7
24.000	4.7	(N/A)	(N/A)	(N/A)	(N/A)

Tremont Extended Dry Detention

Subsection: Time-Depth Curve | Return Event: 0 years
Label: ODOT TR-55 | Storm Event: WQstorm

Time-Depth Curve: WQstorm	
Label	WQstorm
Start Time	0.000 hours
Increment	0.100 hours
End Time	24.000 hours
Return Event	0 years

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
0.000	0.0	0.0	0.0	0.0	0.0
0.500	0.0	0.0	0.0	0.0	0.0
1.000	0.0	0.0	0.0	0.0	0.0
1.500	0.0	0.0	0.0	0.0	0.0
2.000	0.0	0.0	0.0	0.0	0.0
2.500	0.0	0.0	0.0	0.0	0.0
3.000	0.0	0.0	0.0	0.0	0.1
3.500	0.1	0.1	0.1	0.1	0.1
4.000	0.1	0.1	0.1	0.1	0.1
4.500	0.1	0.1	0.1	0.1	0.1
5.000	0.1	0.1	0.1	0.1	0.1
5.500	0.1	0.1	0.1	0.1	0.1
6.000	0.1	0.1	0.1	0.1	0.1
6.500	0.1	0.1	0.1	0.1	0.1
7.000	0.1	0.1	0.1	0.1	0.1
7.500	0.1	0.1	0.1	0.2	0.2
8.000	0.2	0.2	0.2	0.2	0.2
8.500	0.2	0.2	0.2	0.2	0.2
9.000	0.2	0.2	0.2	0.2	0.2
9.500	0.2	0.2	0.2	0.2	0.2
10.000	0.2	0.2	0.2	0.3	0.3
10.500	0.3	0.3	0.3	0.3	0.3
11.000	0.3	0.3	0.3	0.3	0.4
11.500	0.4	0.4	0.5	0.6	0.7
12.000	0.9	0.9	0.9	0.9	0.9
12.500	1.0	1.0	1.0	1.0	1.0
13.000	1.0	1.0	1.0	1.0	1.0
13.500	1.0	1.0	1.1	1.1	1.1
14.000	1.1	1.1	1.1	1.1	1.1
14.500	1.1	1.1	1.1	1.1	1.1
15.000	1.1	1.1	1.1	1.1	1.1
15.500	1.1	1.1	1.1	1.1	1.1
16.000	1.1	1.1	1.1	1.2	1.2
16.500	1.2	1.2	1.2	1.2	1.2

Tremont Extended Dry Detention

Subsection: Time-Depth Curve
Return Event: 0 years
Label: ODOT TR-55
Storm Event: WQstorm

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
17.000	1.2	1.2	1.2	1.2	1.2
17.500	1.2	1.2	1.2	1.2	1.2
18.000	1.2	1.2	1.2	1.2	1.2
18.500	1.2	1.2	1.2	1.2	1.2
19.000	1.2	1.2	1.2	1.2	1.2
19.500	1.2	1.2	1.2	1.2	1.2
20.000	1.2	1.2	1.2	1.2	1.2
20.500	1.2	1.2	1.2	1.3	1.3
21.000	1.3	1.3	1.3	1.3	1.3
21.500	1.3	1.3	1.3	1.3	1.3
22.000	1.3	1.3	1.3	1.3	1.3
22.500	1.3	1.3	1.3	1.3	1.3
23.000	1.3	1.3	1.3	1.3	1.3
23.500	1.3	1.3	1.3	1.3	1.3
24.000	1.3	(N/A)	(N/A)	(N/A)	(N/A)

Tremont Extended Dry Detention

Subsection: Time of Concentration Calculations — Return Event: 0 years
Label: Proposed Storm Sewer DA — Storm Event: Type II 24 hour

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	58.00 ft
Manning's n	(N/A)
Slope	0.026 ft/ft
2 Year 24 Hour Depth	2.3 in
Average Velocity	0.10 ft/s
Segment Time of Concentration	0.162 hours

Segment #2: TR-55 Shallow Concentrated Flow	
Hydraulic Length	500.00 ft
Is Paved?	True
Slope	0.010 ft/ft
Average Velocity	2.01 ft/s
Segment Time of Concentration	0.069 hours

Segment #3: TR-55 Channel Flow	
Flow Area	3.1 ft²
Hydraulic Length	765.00 ft
Manning's n	(N/A)
Slope	0.010 ft/ft
Wetted Perimeter	6.28 ft
Average Velocity	6.26 ft/s
Segment Time of Concentration	0.034 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.265 hours

==== SCS Channel Flow

Tc =	R = Qa / Wp V = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n (Lf / V) / 3600
Where:	R= Hydraulic radius Aq= Flow area, square feet Wp= Wetted perimeter, feet V= Velocity, ft/sec Sf= Slope, ft/ft n= Manning's n Tc= Time of concentration, hours Lf= Flow length, feet

==== SCS TR-55 Shallow Concentration Flow

Tc =	Unpaved surface: V = 16.1345 * (Sf**0.5) Paved Surface: V = 20.3282 * (Sf**0.5) (Lf / V) / 3600
Where:	V= Velocity, ft/sec Sf= Slope, ft/ft Tc= Time of concentration, hours Lf= Flow length, feet

==== SCS TR-55 Sheet Flow

Tc =	(0.007 * ((n * Lf)**0.8)) / ((P**0.5) * (Sf**0.4))
Where:	Tc= Time of concentration, hours n= Manning's n Lf= Flow length, feet P= 2yr, 24hr Rain depth, inches Sf= Slope, %

Tremont Extended Dry Detention

Subsection: Unit Hydrograph Equations

Unit Hydrograph Method (Computational Notes)
Definition of Terms

At	Total area (acres): At = Ai+Ap
Ai	Impervious area (acres)
Ap	Pervious area (acres)
CNi	Runoff curve number for impervious area
CNp	Runoff curve number for pervious area
fLoss	f loss constant infiltration (depth/time)
gKs	Saturated Hydraulic Conductivity (depth/time)
Md	Volumetric Moisture Deficit
Psi	Capillary Suction (length)
hK	Horton Infiltration Decay Rate (time^-1)
fo	Initial Infiltration Rate (depth/time)
fc	Ultimate(capacity)Infiltration Rate (depth/time)
Ia	Initial Abstraction (length)
dt	Computational increment (duration of unit excess rainfall) Default dt is smallest value of 0.1333Tc, rtm, and th (Smallest dt is then adjusted to match up with Tp)
UDdt	User specified override computational main time increment (only used if UDdt is => .1333Tc)
D(t)	Point on distribution curve (fraction of P) for time step t
K	2 / (1 + (Tr/Tp)): default K = 0.75: (for Tr/Tp = 1.67)
Ks	Hydrograph shape factor = Unit Conversions * K: = ((1hr/3600sec) * (1ft/12in) * ((5280ft)**2/sq.mi)) * K Default Ks = 645.333 * 0.75 = 484
Lag	Lag time from center of excess runoff (dt) to Tp: Lag = 0.6Tc
P	Total precipitation depth, inches
Pa(t)	Accumulated rainfall at time step t
Pi(t)	Incremental rainfall at time step t
qp	Peak discharge (cfs) for 1in. runoff, for 1hr, for 1 sq.mi. = (Ks * A * Q) / Tp (where Q = 1in. runoff, A=sq.mi.)
Qu(t)	Unit hydrograph ordinate (cfs) at time step t
Q(t)	Final hydrograph ordinate (cfs) at time step t
Rai(t)	Accumulated runoff (inches) at time step t for impervious area
Rap(t)	Accumulated runoff (inches) at time step t for pervious area
Rii(t)	Incremental runoff (inches) at time step t for impervious area
Rip(t)	Incremental runoff (inches) at time step t for pervious area
R(t)	Incremental weighted total runoff (inches)
Rtm	Time increment for rainfall table
Si	S for impervious area: Si = (1000/CNi) - 10
Sp	S for pervious area: Sp = (1000/CNp) - 10
t	Time step (row) number
Tc	Time of concentration
Tb	Time (hrs) of entire unit hydrograph: Tb = Tp + Tr
Tp	Time (hrs) to peak of a unit hydrograph: Tp = (dt/2) + Lag
Tr	Time (hrs) of receding limb of unit hydrograph: Tr = ratio of Tp

Tremont Extended Dry Detention

Subsection: Unit Hydrograph Equations

Unit Hydrograph Method
Computational Notes
Precipitation

Column (1)	Time for time step t
Column (2)	D(t) = Point on distribution curve for time step t
Column (3)	Pi(t) = Pa(t) - Pa(t-1): Col.(4) - Preceding Col.(4)
Column (4)	Pa(t) = D(t) x P: Col.(2) x P

Pervious Area Runoff (using SCS Runoff CN Method)

Column (5)	Rap(t) = Accumulated pervious runoff for time step t
	If (Pa(t) is <= 0.2Sp) then use: Rap(t) = 0.0
	If (Pa(t) is > 0.2Sp) then use:
	
	Rap(t) = (Col.(4)-0.2Sp)**2 / (Col.(4)+0.8Sp)

Column (6)	Rip(t) = Incremental pervious runoff for time step t Rip(t) = Rap(t) - Rap(t-1) Rip(t) = Col.(5) for current row - Col.(5) for preceding row.

Impervious Area Runoff

Column (7 & 8)...	Did not specify to use impervious areas.

Incremental Weighted Runoff

Column (9)	R(t) = (Ap/At) x Rip(t) + (Ai/At) x Rii(t) R(t) = (Ap/At) x Col.(6) + (Ai/At) x Col.(8)

SCS Unit Hydrograph Method

Column (10)	Q(t) is computed with the SCS unit hydrograph method using R(t) and Qu(t).

Tremont Extended Dry Detention

Subsection: Time vs. Elevation | Return Event: 0 years
Label: Extended Detention (OUT) | Storm Event: WQstorm

Time vs. Elevation (ft)

Output Time increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)
0.000	661.25	661.25	661.25	661.25	661.25
0.250	661.25	661.25	661.25	661.25	661.25
0.500	661.25	661.25	661.25	661.25	661.25
0.750	661.25	661.25	661.25	661.25	661.25
1.000	661.25	661.25	661.25	661.25	661.25
1.250	661.25	661.25	661.25	661.25	661.25
1.500	661.25	661.25	661.25	661.25	661.25
1.750	661.25	661.25	661.25	661.25	661.25
2.000	661.25	661.25	661.25	661.25	661.25
2.250	661.25	661.25	661.25	661.25	661.25
2.500	661.25	661.25	661.25	661.25	661.25
2.750	661.25	661.25	661.25	661.25	661.25
3.000	661.25	661.25	661.25	661.25	661.25
3.250	661.25	661.25	661.25	661.25	661.25
3.500	661.25	661.25	661.25	661.25	661.25
3.750	661.25	661.25	661.25	661.25	661.25
4.000	661.25	661.25	661.25	661.25	661.25
4.250	661.25	661.25	661.25	661.25	661.25
4.500	661.25	661.25	661.25	661.25	661.25
4.750	661.25	661.25	661.25	661.25	661.25
5.000	661.25	661.25	661.25	661.25	661.25
5.250	661.25	661.25	661.25	661.25	661.25
5.500	661.25	661.25	661.25	661.25	661.25
5.750	661.25	661.25	661.25	661.25	661.25
6.000	661.25	661.25	661.25	661.25	661.25
6.250	661.25	661.25	661.25	661.25	661.25
6.500	661.25	661.25	661.25	661.25	661.25
6.750	661.25	661.25	661.25	661.25	661.25
7.000	661.25	661.25	661.25	661.25	661.25
7.250	661.25	661.25	661.25	661.25	661.25
7.500	661.25	661.25	661.25	661.25	661.25
7.750	661.25	661.25	661.25	661.25	661.25
8.000	661.25	661.25	661.25	661.25	661.25
8.250	661.25	661.25	661.25	661.25	661.25
8.500	661.25	661.25	661.25	661.25	661.25
8.750	661.25	661.25	661.25	661.25	661.25
9.000	661.25	661.25	661.25	661.25	661.25
9.250	661.25	661.25	661.25	661.25	661.25
9.500	661.25	661.25	661.25	661.25	661.25
9.750	661.25	661.25	661.25	661.25	661.25
10.000	661.25	661.25	661.25	661.25	661.25

Tremont Extended Dry Detention

Subsection: Time vs. Elevation — Return Event: 0 years
Label: Extended Detention (OUT) — Storm Event: WQstorm

Time vs. Elevation (ft)

Output Time increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)
10.250	661.25	661.25	661.25	661.25	661.25
10.500	661.25	661.25	661.25	661.25	661.25
10.750	661.25	661.25	661.25	661.25	661.25
11.000	661.25	661.25	661.25	661.25	661.25
11.250	661.25	661.25	661.26	661.26	661.26
11.500	661.26	661.27	661.27	661.28	661.30
11.750	661.32	661.36	661.41	661.51	661.65
12.000	661.83	662.03	662.25	662.43	662.57
12.250	662.69	662.77	662.84	662.89	662.94
12.500	662.98	663.01	663.04	663.07	663.09
12.750	663.12	663.14	663.16	663.18	663.19
13.000	663.21	663.23	663.24	663.26	663.27
13.250	663.28	663.30	663.31	663.32	663.33
13.500	663.34	663.35	663.36	663.37	663.38
13.750	663.39	663.40	663.41	663.42	663.42
14.000	663.43	663.44	663.45	663.45	663.46
14.250	663.47	663.47	663.48	663.49	663.49
14.500	663.50	663.51	663.51	663.52	663.52
14.750	663.53	663.53	663.54	663.54	663.55
15.000	663.56	663.56	663.57	663.57	663.58
15.250	663.58	663.59	663.59	663.59	663.60
15.500	663.60	663.61	663.61	663.62	663.62
15.750	663.62	663.63	663.63	663.63	663.64
16.000	663.64	663.64	663.65	663.65	663.65
16.250	663.66	663.66	663.66	663.67	663.67
16.500	663.67	663.67	663.68	663.68	663.68
16.750	663.69	663.69	663.69	663.69	663.70
17.000	663.70	663.70	663.70	663.70	663.71
17.250	663.71	663.71	663.71	663.72	663.72
17.500	663.72	663.72	663.72	663.73	663.73
17.750	663.73	663.73	663.73	663.74	663.74
18.000	663.74	663.74	663.74	663.74	663.75
18.250	663.75	663.75	663.75	663.75	663.75
18.500	663.76	663.76	663.76	663.76	663.76
18.750	663.76	663.76	663.76	663.76	663.77
19.000	663.77	663.77	663.77	663.77	663.77
19.250	663.77	663.77	663.77	663.77	663.77
19.500	663.78	663.78	663.78	663.78	663.78
19.750	663.78	663.78	663.78	663.78	663.78
20.000	663.78	663.78	663.78	663.78	663.78
20.250	663.78	663.78	663.78	663.78	663.78

Tremont Extended Dry Detention

Subsection: Time vs. Elevation — Return Event: 0 years
Label: Extended Detention (OUT) — Storm Event: WQstorm

Time vs. Elevation (ft)

Output Time increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)
20.500	663.78	663.78	663.78	663.78	663.78
20.750	663.78	663.78	663.78	663.78	663.78
21.000	663.78	663.78	663.78	663.78	663.78
21.250	663.78	663.78	663.78	663.78	663.78
21.500	663.78	663.78	663.78	663.78	663.78
21.750	663.78	663.78	663.78	663.78	663.78
22.000	663.78	663.78	663.78	663.78	663.78
22.250	663.78	663.78	663.78	663.78	663.78
22.500	663.78	663.78	663.78	663.78	663.78
22.750	663.78	663.78	663.78	663.78	663.78
23.000	663.78	663.78	663.78	663.78	663.78
23.250	663.78	663.78	663.78	663.78	663.78
23.500	663.78	663.78	663.78	663.78	663.78
23.750	663.78	663.78	663.78	663.78	663.78
24.000	663.78	663.78	663.78	663.78	663.78
24.250	663.77	663.77	663.77	663.77	663.76
24.500	663.76	663.76	663.75	663.75	663.74
24.750	663.74	663.74	663.73	663.73	663.73
25.000	663.72	663.72	663.72	663.71	663.71
25.250	663.71	663.70	663.70	663.69	663.69
25.500	663.69	663.68	663.68	663.68	663.67
25.750	663.67	663.67	663.66	663.66	663.66
26.000	663.65	663.65	663.64	663.64	663.64
26.250	663.63	663.63	663.63	663.62	663.62
26.500	663.62	663.61	663.61	663.61	663.60
26.750	663.60	663.60	663.59	663.59	663.59
27.000	663.58	663.58	663.57	663.57	663.57
27.250	663.56	663.56	663.56	663.55	663.55
27.500	663.55	663.54	663.54	663.54	663.53
27.750	663.53	663.53	663.52	663.52	663.52
28.000	663.51	663.51	663.51	663.50	663.50
28.250	663.50	663.49	663.49	663.49	663.48
28.500	663.48	663.48	663.47	663.47	663.47
28.750	663.46	663.46	663.46	663.45	663.45
29.000	663.45	663.44	663.44	663.44	663.43
29.250	663.43	663.43	663.42	663.42	663.42
29.500	663.41	663.41	663.41	663.40	663.40
29.750	663.40	663.39	663.39	663.39	663.38
30.000	663.38	663.38	663.37	663.37	663.37
30.250	663.36	663.36	663.36	663.35	663.35
30.500	663.35	663.34	663.34	663.34	663.33

Tremont Extended Dry Detention

Subsection: Time vs. Elevation | Return Event: 0 years
Label: Extended Detention (OUT) | Storm Event: WQstorm

Time vs. Elevation (ft)

Output Time increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)
30.750	663.33	663.33	663.32	663.32	663.32
31.000	663.31	663.31	663.31	663.30	663.30
31.250	663.30	663.30	663.29	663.29	663.29
31.500	663.28	663.28	663.28	663.27	663.27
31.750	663.27	663.26	663.26	663.26	663.25
32.000	663.25	663.25	663.24	663.24	663.24
32.250	663.23	663.23	663.23	663.22	663.22
32.500	663.22	663.21	663.21	663.21	663.20
32.750	663.20	663.20	663.19	663.19	663.19
33.000	663.18	663.18	663.18	663.17	663.17
33.250	663.16	663.16	663.16	663.15	663.15
33.500	663.15	663.14	663.14	663.14	663.13
33.750	663.13	663.13	663.12	663.12	663.12
34.000	663.11	663.11	663.11	663.11	663.10
34.250	663.10	663.10	663.09	663.09	663.09
34.500	663.08	663.08	663.08	663.07	663.07
34.750	663.07	663.06	663.06	663.06	663.05
35.000	663.05	663.05	663.04	663.04	663.04
35.250	663.03	663.03	663.03	663.02	663.02
35.500	663.02	663.01	663.01	663.01	663.00
35.750	663.00	663.00	663.00	662.99	662.99
36.000	662.99	662.98	662.98	662.98	662.97
36.250	662.97	662.97	662.96	662.96	662.96
36.500	662.95	662.95	662.95	662.95	662.94
36.750	662.94	662.94	662.93	662.93	662.93
37.000	662.92	662.92	662.92	662.91	662.91
37.250	662.91	662.91	662.90	662.90	662.90
37.500	662.89	662.89	662.89	662.88	662.88
37.750	662.88	662.88	662.87	662.87	662.87
38.000	662.86	662.86	662.86	662.85	662.85
38.250	662.85	662.85	662.84	662.84	662.84
38.500	662.83	662.83	662.83	662.83	662.82
38.750	662.82	662.82	662.81	662.81	662.81
39.000	662.80	662.80	662.80	662.80	662.79
39.250	662.79	662.79	662.78	662.78	662.78
39.500	662.78	662.77	662.77	662.77	662.76
39.750	662.76	662.76	662.76	662.75	662.75
40.000	662.75	662.74	662.74	662.74	662.73
40.250	662.73	662.73	662.73	662.72	662.72
40.500	662.72	662.71	662.71	662.71	662.70
40.750	662.70	662.70	662.69	662.69	662.69

Tremont Extended Dry Detention

Subsection: Time vs. Elevation — Return Event: 0 years
Label: Extended Detention (OUT) — Storm Event: WQstorm

Time vs. Elevation (ft)

Output Time increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)
41.000	662.69	662.68	662.68	662.68	662.67
41.250	662.67	662.67	662.67	662.66	662.66
41.500	662.66	662.65	662.65	662.65	662.64
41.750	662.64	662.64	662.64	662.63	662.63
42.000	662.63	662.62	662.62	662.62	662.62
42.250	662.61	662.61	662.61	662.61	662.60
42.500	662.60	662.60	662.59	662.59	662.59
42.750	662.59	662.58	662.58	662.58	662.58
43.000	662.57	662.57	662.57	662.56	662.56
43.250	662.56	662.56	662.55	662.55	662.55
43.500	662.55	662.54	662.54	662.54	662.54
43.750	662.53	662.53	662.53	662.52	662.52
44.000	662.52	662.52	662.51	662.51	662.51
44.250	662.51	662.50	662.50	662.50	662.50
44.500	662.49	662.49	662.49	662.49	662.48
44.750	662.48	662.48	662.48	662.47	662.47
45.000	662.47	662.47	662.46	662.46	662.46
45.250	662.46	662.45	662.45	662.45	662.45
45.500	662.45	662.44	662.44	662.44	662.44
45.750	662.43	662.43	662.43	662.43	662.42
46.000	662.42	662.42	662.42	662.41	662.41
46.250	662.41	662.41	662.41	662.40	662.40
46.500	662.40	662.40	662.39	662.39	662.39
46.750	662.39	662.38	662.38	662.38	662.38
47.000	662.38	662.37	662.37	662.37	662.37
47.250	662.36	662.36	662.36	662.36	662.36
47.500	662.35	662.35	662.35	662.35	662.35
47.750	662.34	662.34	662.34	662.34	662.33
48.000	662.33	662.33	662.33	662.33	662.32
48.250	662.32	662.32	662.32	662.32	662.31
48.500	662.31	662.31	662.31	662.31	662.30
48.750	662.30	662.30	662.30	662.30	662.29
49.000	662.29	662.29	662.29	662.29	662.28
49.250	662.28	662.28	662.28	662.28	662.27
49.500	662.27	662.27	662.27	662.27	662.26
49.750	662.26	662.26	662.26	662.26	662.25
50.000	662.25	662.25	662.25	662.25	662.24
50.250	662.24	662.24	662.24	662.24	662.23
50.500	662.23	662.23	662.23	662.22	662.22
50.750	662.22	662.22	662.22	662.21	662.21
51.000	662.21	662.21	662.21	662.20	662.20

Tremont Extended Dry Detention

Subsection: Time vs. Elevation | Return Event: 0 years
Label: Extended Detention (OUT) | Storm Event: WQstorm

Time vs. Elevation (ft)

Output Time increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)
51.250	662.20	662.20	662.20	662.19	662.19
51.500	662.19	662.19	662.19	662.18	662.18
51.750	662.18	662.18	662.18	662.17	662.17
52.000	662.17	662.17	662.17	662.16	662.16
52.250	662.16	662.16	662.16	662.15	662.15
52.500	662.15	662.15	662.15	662.14	662.14
52.750	662.14	662.14	662.14	662.13	662.13
53.000	662.13	662.13	662.13	662.12	662.12
53.250	662.12	662.12	662.12	662.11	662.11
53.500	662.11	662.11	662.11	662.10	662.10
53.750	662.10	662.10	662.10	662.10	662.09
54.000	662.09	662.09	662.09	662.09	662.08
54.250	662.08	662.08	662.08	662.08	662.07
54.500	662.07	662.07	662.07	662.07	662.06
54.750	662.06	662.06	662.06	662.06	662.06
55.000	662.05	662.05	662.05	662.05	662.05
55.250	662.04	662.04	662.04	662.04	662.04
55.500	662.04	662.03	662.03	662.03	662.03
55.750	662.03	662.02	662.02	662.02	662.02
56.000	662.02	662.02	662.01	662.01	662.01
56.250	662.01	662.01	662.00	662.00	662.00
56.500	662.00	662.00	662.00	661.99	661.99
56.750	661.99	661.99	661.99	661.99	661.98
57.000	661.98	661.98	661.98	661.98	661.97
57.250	661.97	661.97	661.97	661.97	661.97
57.500	661.96	661.96	661.96	661.96	661.96
57.750	661.96	661.95	661.95	661.95	661.95
58.000	661.95	661.95	661.94	661.94	661.94
58.250	661.94	661.94	661.94	661.93	661.93
58.500	661.93	661.93	661.93	661.93	661.92
58.750	661.92	661.92	661.92	661.92	661.92
59.000	661.91	661.91	661.91	661.91	661.91
59.250	661.91	661.90	661.90	661.90	661.90
59.500	661.90	661.90	661.89	661.89	661.89
59.750	661.89	661.89	661.89	661.88	661.88
60.000	661.88	661.88	661.88	661.88	661.87
60.250	661.87	661.87	661.87	661.87	661.87
60.500	661.87	661.86	661.86	661.86	661.86
60.750	661.86	661.86	661.85	661.85	661.85
61.000	661.85	661.85	661.85	661.84	661.84
61.250	661.84	661.84	661.84	661.84	661.84

Tremont Extended Dry Detention

Subsection: Time vs. Elevation | Return Event: 0 years
Label: Extended Detention (OUT) | Storm Event: WQstorm

Time vs. Elevation (ft)

Output Time increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)
61.500	661.83	661.83	661.83	661.83	661.83
61.750	661.83	661.82	661.82	661.82	661.82
62.000	661.82	661.82	661.82	661.81	661.81
62.250	661.81	661.81	661.81	661.81	661.81
62.500	661.80	661.80	661.80	661.80	661.80
62.750	661.80	661.79	661.79	661.79	661.79
63.000	661.79	661.79	661.79	661.78	661.78
63.250	661.78	661.78	661.78	661.78	661.78
63.500	661.77	661.77	661.77	661.77	661.77
63.750	661.77	661.77	661.76	661.76	661.76
64.000	661.76	661.76	661.76	661.76	661.75
64.250	661.75	661.75	661.75	661.75	661.75
64.500	661.74	661.74	661.74	661.74	661.74
64.750	661.74	661.74	661.73	661.73	661.73
65.000	661.73	661.73	661.73	661.73	661.72
65.250	661.72	661.72	661.72	661.72	661.72
65.500	661.71	661.71	661.71	661.71	661.71
65.750	661.71	661.71	661.70	661.70	661.70
66.000	661.70	661.70	661.70	661.70	661.69
66.250	661.69	661.69	661.69	661.69	661.69
66.500	661.69	661.68	661.68	661.68	661.68
66.750	661.68	661.68	661.68	661.68	661.67
67.000	661.67	661.67	661.67	661.67	661.67
67.250	661.67	661.66	661.66	661.66	661.66
67.500	661.66	661.66	661.66	661.66	661.65
67.750	661.65	661.65	661.65	661.65	661.65
68.000	661.65	661.65	661.64	661.64	661.64
68.250	661.64	661.64	661.64	661.64	661.64
68.500	661.63	661.63	661.63	661.63	661.63
68.750	661.63	661.63	661.63	661.62	661.62
69.000	661.62	661.62	661.62	661.62	661.62
69.250	661.62	661.62	661.61	661.61	661.61
69.500	661.61	661.61	661.61	661.61	661.61
69.750	661.61	661.60	661.60	661.60	661.60
70.000	661.60	661.60	661.60	661.60	661.60
70.250	661.59	661.59	661.59	661.59	661.59
70.500	661.59	661.59	661.59	661.59	661.58
70.750	661.58	661.58	661.58	661.58	661.58
71.000	661.58	661.58	661.58	661.58	661.57
71.250	661.57	661.57	661.57	661.57	661.57
71.500	661.57	661.57	661.57	661.57	661.56

Tremont Extended Dry Detention

Subsection: Time vs. Elevation | Return Event: 0 years
Label: Extended Detention (OUT) | Storm Event: WQstorm

Time vs. Elevation (ft)

Output Time increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)
71.750	661.56	661.56	661.56	661.56	661.56
72.000	661.56	661.56	661.56	661.56	661.55
72.250	661.55	661.55	661.55	661.55	661.55
72.500	661.55	661.55	661.55	661.55	661.54
72.750	661.54	661.54	661.54	661.54	661.54
73.000	661.54	661.54	661.54	661.54	661.54
73.250	661.53	661.53	661.53	661.53	661.53
73.500	661.53	661.53	661.53	661.53	661.53
73.750	661.53	661.53	661.52	661.52	661.52
74.000	661.52	661.52	661.52	661.52	661.52
74.250	661.52	661.52	661.52	661.51	661.51
74.500	661.51	661.51	661.51	661.51	661.51
74.750	661.51	661.51	661.51	661.51	661.51
75.000	661.51	661.50	661.50	661.50	661.50
75.250	661.50	661.50	661.50	661.50	661.50
75.500	661.50	661.50	661.50	661.49	661.49
75.750	661.49	661.49	661.49	661.49	661.49
76.000	661.49	661.49	661.49	661.49	661.49
76.250	661.49	661.48	661.48	661.48	661.48
76.500	661.48	661.48	661.48	661.48	661.48
76.750	661.48	661.48	661.48	661.48	661.48
77.000	661.47	661.47	661.47	661.47	661.47
77.250	661.47	661.47	661.47	661.47	661.47
77.500	661.47	661.47	661.47	661.47	661.47
77.750	661.46	661.46	661.46	661.46	661.46
78.000	661.46	661.46	661.46	661.46	661.46
78.250	661.46	661.46	661.46	661.46	661.46
78.500	661.45	661.45	661.45	661.45	661.45
78.750	661.45	661.45	661.45	661.45	661.45
79.000	661.45	661.45	661.45	661.45	661.45
79.250	661.45	661.44	661.44	661.44	661.44
79.500	661.44	661.44	661.44	661.44	661.44
79.750	661.44	661.44	661.44	661.44	661.44
80.000	661.44	661.44	661.43	661.43	661.43
80.250	661.43	661.43	661.43	661.43	661.43
80.500	661.43	661.43	661.43	661.43	661.43
80.750	661.43	661.43	661.43	661.43	661.43
81.000	661.42	661.42	661.42	661.42	661.42
81.250	661.42	661.42	661.42	661.42	661.42
81.500	661.42	661.42	661.42	661.42	661.42
81.750	661.42	661.42	661.42	661.42	661.41

Tremont Extended Dry Detention

Subsection: Time vs. Elevation — Return Event: 0 years
Label: Extended Detention (OUT) — Storm Event: WQstorm

Time vs. Elevation (ft)

Output Time increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)
82.000	661.41	661.41	661.41	661.41	661.41
82.250	661.41	661.41	661.41	661.41	661.41
82.500	661.41	661.41	661.41	661.41	661.41
82.750	661.41	661.41	661.41	661.40	661.40
83.000	661.40	661.40	661.40	661.40	661.40
83.250	661.40	661.40	661.40	661.40	661.40
83.500	661.40	661.40	661.40	661.40	661.40
83.750	661.40	661.40	661.40	661.40	661.39
84.000	661.39	661.39	661.39	661.39	661.39
84.250	661.39	661.39	661.39	661.39	661.39
84.500	661.39	661.39	661.39	661.39	661.39
84.750	661.39	661.39	661.39	661.39	661.39
85.000	661.39	661.39	661.38	661.38	661.38
85.250	661.38	661.38	661.38	661.38	661.38
85.500	661.38	661.38	661.38	661.38	661.38
85.750	661.38	661.38	661.38	661.38	661.38
86.000	661.38	661.38	661.38	661.38	661.38
86.250	661.38	661.38	661.37	661.37	661.37
86.500	661.37	661.37	661.37	661.37	661.37
86.750	661.37	661.37	661.37	661.37	661.37
87.000	661.37	661.37	661.37	661.37	661.37
87.250	661.37	661.37	661.37	661.37	661.37
87.500	661.37	661.37	661.37	661.36	661.36
87.750	661.36	661.36	661.36	661.36	661.36
88.000	661.36	661.36	661.36	661.36	661.36
88.250	661.36	661.36	661.36	661.36	661.36
88.500	661.36	661.36	661.36	661.36	661.36
88.750	661.36	661.36	661.36	661.36	661.36
89.000	661.36	661.36	661.35	661.35	661.35
89.250	661.35	661.35	661.35	661.35	661.35
89.500	661.35	661.35	661.35	661.35	661.35
89.750	661.35	661.35	661.35	661.35	661.35
90.000	661.35	661.35	661.35	661.35	661.35
90.250	661.35	661.35	661.35	661.35	661.35
90.500	661.35	661.35	661.35	661.34	661.34
90.750	661.34	661.34	661.34	661.34	661.34
91.000	661.34	661.34	661.34	661.34	661.34
91.250	661.34	661.34	661.34	661.34	661.34
91.500	661.34	661.34	661.34	661.34	661.34
91.750	661.34	661.34	661.34	661.34	661.34
92.000	661.34	661.34	661.34	661.34	661.34

Tremont Extended Dry Detention

Subsection: Time vs. Elevation | Return Event: 0 years
Label: Extended Detention (OUT) | Storm Event: WQstorm

Time vs. Elevation (ft)

Output Time increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)
92.250	661.34	661.34	661.34	661.34	661.33
92.500	661.33	661.33	661.33	661.33	661.33
92.750	661.33	661.33	661.33	661.33	661.33
93.000	661.33	661.33	661.33	661.33	661.33
93.250	661.33	661.33	661.33	661.33	661.33
93.500	661.33	661.33	661.33	661.33	661.33
93.750	661.33	661.33	661.33	661.33	661.33
94.000	661.33	661.33	661.33	661.33	661.33
94.250	661.33	661.33	661.33	661.32	661.32
94.500	661.32	661.32	661.32	661.32	661.32
94.750	661.32	661.32	661.32	661.32	661.32
95.000	661.32	661.32	661.32	661.32	661.32
95.250	661.32	661.32	661.32	661.32	661.32
95.500	661.32	661.32	661.32	661.32	661.32
95.750	661.32	661.32	661.32	661.32	661.32
96.000	661.32	(N/A)	(N/A)	(N/A)	(N/A)

Tremont Extended Dry Detention

Subsection: Elevation-Area Volume Curve | Return Event: 50 years
Label: Extended Detention | Storm Event: Type II 24 hour

Elevation (ft)	Planimeter (ft^2)	Area (acres)	A1+A2+sqr(A1*A2) (acres)	Volume (ac-ft)	Volume (Total) (ac-ft)
661.25	0.0	0.089	0.000	0.000	0.000
662.00	0.0	0.104	0.289	0.072	0.072
663.00	0.0	0.127	0.346	0.115	0.188
664.00	0.0	0.153	0.419	0.140	0.327
665.00	0.0	0.181	0.500	0.167	0.494
666.00	0.0	0.210	0.586	0.195	0.690
667.00	0.0	0.243	0.679	0.226	0.916
668.00	0.0	0.278	0.781	0.260	1.176
669.00	0.0	0.314	0.887	0.296	1.472
670.00	0.0	0.354	1.001	0.334	1.806
671.00	0.0	0.414	1.151	0.384	2.189
675.00	0.0	0.414	1.242	1.656	3.845

Tremont Extended Dry Detention

Subsection: Volume Equations — Return Event: 50 years
Label: Extended Detention — Storm Event: Type II 24 hour

Pond Volume Equations
* Incremental volume computed by the Conic Method for Reservoir Volumes.

Volume = (1/3) * (EL2 - El1) * (Area1 + Area2 + sqr(Area1 * Area2))

where:	EL1, EL2	Lower and upper elevations of the increment
	Area1, Area2	Areas computed for EL1, EL2, respectively
	Volume	Incremental volume between EL1 and EL2

Tremont Extended Dry Detention

Subsection: Outlet Input Data | Return Event: 0 years

Label: Composite Outlet Structure | Storm Event: Type II 24 hour

Requested Pond Water Surface Elevations	
Minimum (Headwater)	661.25 ft
Increment (Headwater)	0.50 ft
Maximum (Headwater)	675.00 ft

Spot Elevations

SpotElevation (ft)
672.04
673.04

Outlet Connectivity

Structure Type	Outlet ID	Direction	Outfall	E1 (ft)	E2 (ft)
Orifice-Circular	Orifice - 2	Forward	Culvert - 1	662.25	675.00
Orifice-Circular	Orifice - 3	Forward	Culvert - 1	664.00	675.00
Inlet Box	Riser - 1	Forward	Culvert - 1	667.35	675.00
Orifice-Circular	Orifice - 1	Forward	Culvert - 1	661.25	675.00
Culvert-Circular	Culvert - 1	Forward	TW	661.25	675.00
Tailwater Settings	Tailwater			(N/A)	(N/A)

Tremont Extended Dry Detention

Subsection: Outlet Input Data | Return Event: 0 years

Label: Composite Outlet Structure | Storm Event: Type II 24 hour

Structure ID: Orifice - 2 Structure Type: Orifice-Circular	
Number of Openings	4
Elevation	662.25 ft
Orifice Diameter	0.50 in
Orifice Coefficient	0.660

Structure ID: Orifice - 1 Structure Type: Orifice-Circular	
Number of Openings	2
Elevation	661.25 ft
Orifice Diameter	1.00 in
Orifice Coefficient	0.660

Structure ID: Riser - 1 Structure Type: Inlet Box	
Number of Openings	1
Elevation	667.35 ft
Orifice Area	2.6 ft²
Orifice Coefficient	0.660
Weir Length	8.00 ft
Weir Coefficient	3.00 (ft^0.5)/s
K Reverse	1.000
Manning's n	0.000
Kev, Charged Riser	0.000
Weir Submergence	False
Orifice H to crest	False

Tremont Extended Dry Detention

Structure ID: Culvert - 1 Structure Type: Culvert-Circular	
Number of Barrels	1
Diameter	18.00 in
Length	10.00 ft
Length (Computed Barrel)	10.00 ft
Slope (Computed)	0.005 ft/ft

Outlet Control Data	
Manning's n	0.013
Ke	0.200
Kb	0.018
Kr	0.000
Convergence Tolerance	0.00 ft

Inlet Control Data	
Equation Form	Form 1
K	0.0045
M	2.0000
C	0.0317
Y	0.6900
T1 ratio (HW/D)	0.000
T2 ratio (HW/D)	1.195
Slope Correction Factor	-0.500

Use unsubmerged inlet control 0 equation below T1 elevation.
Use submerged inlet control 0 equation above T2 elevation

In transition zone between unsubmerged and submerged inlet control,
interpolate between flows at T1 & T2...

T1 Elevation	661.25 ft	T1 Flow	7.58 ft³/s
T2 Elevation	663.04 ft	T2 Flow	8.66 ft³/s

Tremont Extended Dry Detention

Subsection: Outlet Input Data	Return Event: 0 years
Label: Composite Outlet Structure	Storm Event: Type II 24 hour

Structure ID: Orifice - 3 Structure Type: Orifice-Circular	
Number of Openings	1
Elevation	664.00 ft
Orifice Diameter	11.00 in
Orifice Coefficient	0.660

Structure ID: TW Structure Type: TW Setup, DS Channel	
Tailwater Type	Free Outfall

Convergence Tolerances	
Maximum Iterations	30
Tailwater Tolerance (Minimum)	0.01 ft
Tailwater Tolerance (Maximum)	0.50 ft
Headwater Tolerance (Minimum)	0.01 ft
Headwater Tolerance (Maximum)	0.50 ft
Flow Tolerance (Minimum)	0.001 ft^3/s
Flow Tolerance (Maximum)	10.000 ft^3/s

Tremont Extended Dry Detention

Subsection: Individual Outlet Curves — Return Event: 0 years
Label: Composite Outlet Structure — Storm Event: Type II 24 hour

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Orifice - 2 (Orifice-Circular)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)	Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft³/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)
661.25	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
661.75	0.00	0.00	0.00	661.35	0.00	0.00	(N/A)	0.00
662.25	0.00	0.00	0.00	661.37	0.00	0.00	(N/A)	0.00
662.75	0.02	662.75	Free Outfall	661.40	0.00	0.00	(N/A)	0.00
663.25	0.03	663.25	Free Outfall	661.42	0.00	0.00	(N/A)	0.00
663.75	0.04	663.75	Free Outfall	661.43	0.00	0.00	(N/A)	0.00
664.00	0.04	664.00	Free Outfall	661.44	0.00	0.00	(N/A)	0.00
664.25	0.04	664.25	Free Outfall	661.55	0.00	0.00	(N/A)	0.00
664.75	0.05	664.75	Free Outfall	661.94	0.00	0.00	(N/A)	0.00
665.25	0.05	665.25	662.25	662.25	0.00	0.00	(N/A)	0.00
665.75	0.05	665.75	662.40	662.40	0.00	0.00	(N/A)	0.00
666.25	0.06	666.25	662.51	662.51	0.00	0.00	(N/A)	0.00
666.75	0.06	666.75	662.60	662.60	0.00	0.00	(N/A)	0.00
667.25	0.06	667.25	662.68	662.68	0.00	0.00	(N/A)	0.00
667.35	0.06	667.35	662.70	662.70	0.00	0.00	(N/A)	0.00
667.75	0.06	667.75	663.89	663.89	0.00	0.00	(N/A)	0.00
668.25	0.05	668.25	665.82	665.82	0.00	0.00	(N/A)	0.00
668.75	0.04	668.75	666.86	666.86	0.00	0.00	(N/A)	0.00
669.25	0.03	669.25	667.80	667.80	0.00	0.00	(N/A)	0.00
669.75	0.03	669.75	668.66	668.66	0.00	0.00	(N/A)	0.00
670.25	0.03	670.25	669.46	669.46	0.00	0.00	(N/A)	0.00
670.75	0.02	670.75	670.22	670.22	0.00	0.00	(N/A)	0.00
671.25	0.02	671.25	670.94	670.94	0.00	0.00	(N/A)	0.00
671.75	0.01	671.75	671.59	671.59	0.00	0.00	(N/A)	0.00
672.04	0.01	672.04	671.95	671.95	0.00	0.00	(N/A)	0.00
672.25	0.01	672.25	672.20	672.20	0.00	0.00	(N/A)	0.00
672.75	0.00	672.75	672.75	672.75	0.00	0.00	(N/A)	0.00
673.04	0.00	673.04	673.04	673.04	0.00	0.00	(N/A)	0.00
673.25	0.00	673.25	673.25	673.25	0.00	0.00	(N/A)	0.00
673.75	0.00	673.75	673.75	673.75	0.00	0.00	(N/A)	0.00
674.25	0.00	674.25	674.25	674.25	0.00	0.00	(N/A)	0.00
674.75	0.00	674.75	674.75	674.75	0.00	0.00	(N/A)	0.00
675.00	0.00	675.00	675.00	675.00	0.00	0.00	(N/A)	0.00

Message
WS below an invert; no flow.

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Orifice - 2 (Orifice-Circular)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Message
WS below an invert; no flow.
WS below an invert; no flow.
H =.48
H =.98
H =1.48
H =1.73
H =1.98
H =2.48
H =2.98
H =3.35
H =3.74
H =4.15
H =4.57
H =4.65
H =3.86
H =2.43
H =1.89
H =1.45
H =1.09
H =.79
H =.53
H =.31
H =.16
H =.09
H =.05
FLOW PRECEDENCE SET TO DOWNSTREAM CONTROLLING STRUCTURE
FLOW PRECEDENCE SET TO DOWNSTREAM CONTROLLING STRUCTURE
FLOW PRECEDENCE SET TO DOWNSTREAM CONTROLLING STRUCTURE
FLOW PRECEDENCE SET TO DOWNSTREAM CONTROLLING STRUCTURE
FLOW PRECEDENCE SET TO DOWNSTREAM CONTROLLING STRUCTURE

Tremont Extended Dry Detention

Subsection: Individual Outlet Curves — Return Event: 0 years
Label: Composite Outlet Structure — Storm Event: Type II 24 hour

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Orifice - 2 (Orifice-Circular)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Message
FLOW PRECEDENCE SET TO DOWNSTREAM CONTROLLING STRUCTURE
FLOW PRECEDENCE SET TO DOWNSTREAM CONTROLLING STRUCTURE

Tremont Extended Dry Detention

Subsection: Individual Outlet Curves — Return Event: 0 years

Label: Composite Outlet Structure — Storm Event: Type II 24 hour

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Orifice - 1 (Orifice-Circular)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)	Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft³/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)
661.25	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
661.75	0.04	661.75	661.35	661.35	0.00	0.00	(N/A)	0.00
662.25	0.05	662.25	661.37	661.37	0.00	0.00	(N/A)	0.00
662.75	0.07	662.75	661.40	661.40	0.00	0.00	(N/A)	0.00
663.25	0.08	663.25	661.42	661.42	0.00	0.00	(N/A)	0.00
663.75	0.09	663.75	661.43	661.43	0.00	0.00	(N/A)	0.00
664.00	0.09	664.00	661.44	661.44	0.00	0.00	(N/A)	0.00
664.25	0.09	664.25	661.55	661.55	0.00	0.00	(N/A)	0.00
664.75	0.10	664.75	661.94	661.94	0.00	0.00	(N/A)	0.00
665.25	0.10	665.25	662.25	662.25	0.00	0.00	(N/A)	0.00
665.75	0.11	665.75	662.40	662.40	0.00	0.00	(N/A)	0.00
666.25	0.11	666.25	662.51	662.51	0.00	0.00	(N/A)	0.00
666.75	0.12	666.75	662.60	662.60	0.00	0.00	(N/A)	0.00
667.25	0.12	667.25	662.68	662.68	0.00	0.00	(N/A)	0.00
667.35	0.12	667.35	662.70	662.70	0.00	0.00	(N/A)	0.00
667.75	0.11	667.75	663.89	663.89	0.00	0.00	(N/A)	0.00
668.25	0.09	668.25	665.82	665.82	0.00	0.00	(N/A)	0.00
668.75	0.08	668.75	666.86	666.86	0.00	0.00	(N/A)	0.00
669.25	0.07	669.25	667.80	667.80	0.00	0.00	(N/A)	0.00
669.75	0.06	669.75	668.66	668.66	0.00	0.00	(N/A)	0.00
670.25	0.05	670.25	669.46	669.46	0.00	0.00	(N/A)	0.00
670.75	0.04	670.75	670.22	670.22	0.00	0.00	(N/A)	0.00
671.25	0.03	671.25	670.94	670.94	0.00	0.00	(N/A)	0.00
671.75	0.02	671.75	671.59	671.59	0.00	0.00	(N/A)	0.00
672.04	0.02	672.04	671.95	671.95	0.00	0.00	(N/A)	0.00
672.25	0.01	672.25	672.20	672.20	0.00	0.00	(N/A)	0.00
672.75	0.00	672.75	672.75	672.75	0.00	0.00	(N/A)	0.00
673.04	0.00	673.04	673.04	673.04	0.00	0.00	(N/A)	0.00
673.25	0.00	673.25	673.25	673.25	0.00	0.00	(N/A)	0.00
673.75	0.00	673.75	673.75	673.75	0.00	0.00	(N/A)	0.00
674.25	0.00	674.25	674.25	674.25	0.00	0.00	(N/A)	0.00
674.75	0.00	674.75	674.75	674.75	0.00	0.00	(N/A)	0.00
675.00	0.00	675.00	675.00	675.00	0.00	0.00	(N/A)	0.00

Message
WS below an invert; no flow.

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Orifice - 1 (Orifice-Circular)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Message
H =.40
H =.88
H =1.35
H =1.83
H =2.32
H =2.56
H =2.70
H =2.81
H =3.00
H =3.35
H =3.74
H =4.15
H =4.57
H =4.65
H =3.86
H =2.43
H =1.89
H =1.45
H =1.09
H =.79
H =.53
H =.31
H =.16
H =.09
H =.05
FLOW PRECEDENCE SET TO DOWNSTREAM CONTROLLING STRUCTURE
FLOW PRECEDENCE SET TO DOWNSTREAM CONTROLLING STRUCTURE
FLOW PRECEDENCE SET TO DOWNSTREAM CONTROLLING STRUCTURE
FLOW PRECEDENCE SET TO DOWNSTREAM CONTROLLING STRUCTURE
FLOW PRECEDENCE SET TO DOWNSTREAM CONTROLLING STRUCTURE

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Orifice - 1 (Orifice-Circular)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Message
FLOW PRECEDENCE SET TO DOWNSTREAM CONTROLLING STRUCTURE
FLOW PRECEDENCE SET TO DOWNSTREAM CONTROLLING STRUCTURE

Tremont Extended Dry Detention

Subsection: Individual Outlet Curves — Return Event: 0 years
Label: Composite Outlet Structure — Storm Event: Type II 24 hour

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Riser - 1 (Inlet Box)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft^3/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)	Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft^3/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)
661.25	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
661.75	0.00	0.00	0.00	661.35	0.00	0.00	(N/A)	0.00
662.25	0.00	0.00	0.00	661.37	0.00	0.00	(N/A)	0.00
662.75	0.00	0.00	0.00	661.40	0.00	0.00	(N/A)	0.00
663.25	0.00	0.00	0.00	661.42	0.00	0.00	(N/A)	0.00
663.75	0.00	0.00	0.00	661.43	0.00	0.00	(N/A)	0.00
664.00	0.00	0.00	0.00	661.44	0.00	0.00	(N/A)	0.00
664.25	0.00	0.00	0.00	661.55	0.00	0.00	(N/A)	0.00
664.75	0.00	0.00	0.00	661.94	0.00	0.00	(N/A)	0.00
665.25	0.00	0.00	0.00	662.25	0.00	0.00	(N/A)	0.00
665.75	0.00	0.00	0.00	662.40	0.00	0.00	(N/A)	0.00
666.25	0.00	0.00	0.00	662.51	0.00	0.00	(N/A)	0.00
666.75	0.00	0.00	0.00	662.60	0.00	0.00	(N/A)	0.00
667.25	0.00	0.00	0.00	662.68	0.00	0.00	(N/A)	0.00
667.35	0.00	0.00	0.00	662.70	0.00	0.00	(N/A)	0.00
667.75	6.07	667.75	Free Outfall	663.89	0.00	0.00	(N/A)	0.00
668.25	13.06	668.25	Free Outfall	665.82	0.00	0.00	(N/A)	0.00
668.75	16.29	668.75	Free Outfall	666.86	0.00	0.00	(N/A)	0.00
669.25	18.97	669.25	667.80	667.80	0.00	0.00	(N/A)	0.00
669.75	21.33	669.75	668.66	668.66	0.00	0.00	(N/A)	0.00
670.25	23.44	670.25	669.46	669.46	0.00	0.00	(N/A)	0.00
670.75	25.38	670.75	670.22	670.22	0.00	0.00	(N/A)	0.00
671.25	27.18	671.25	670.94	670.94	0.00	0.00	(N/A)	0.00
671.75	28.87	671.75	671.59	671.59	0.00	0.00	(N/A)	0.00
672.04	29.81	672.04	671.95	671.95	0.00	0.00	(N/A)	0.00
672.25	30.47	672.25	672.20	672.20	0.00	0.00	(N/A)	0.00
672.75	31.99	672.75	672.75	672.75	0.00	0.00	(N/A)	0.00
673.04	32.84	673.04	673.04	673.04	0.00	0.00	(N/A)	0.00
673.25	33.44	673.25	673.25	673.25	0.00	0.00	(N/A)	0.00
673.75	34.82	673.75	673.75	673.75	0.00	0.00	(N/A)	0.00
674.25	36.16	674.25	674.25	674.25	0.00	0.00	(N/A)	0.00
674.75	37.45	674.75	674.75	674.75	0.00	0.00	(N/A)	0.00
675.00	38.07	675.00	675.00	675.00	0.00	0.00	(N/A)	0.00

Message
WS below an invert; no flow.

Tremont Extended Dry Detention

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Riser - 1 (Inlet Box)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Message
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
Weir: H =0.4ft
Orifice: H =.90; Riser orifice equation controlling.
Orifice: H =1.40; Riser orifice equation controlling.
FULLY CHARGED RISER: Orifice Equation Control to Crest; H=1.90
FULLY CHARGED RISER: Orifice Equation Control to Crest; H=2.40
FULLY CHARGED RISER: Orifice Equation Control to Crest; H=2.90
FULLY CHARGED RISER: Orifice Equation Control to Crest; H=3.40
FULLY CHARGED RISER: Orifice Equation Control to Crest; H=3.90
FULLY CHARGED RISER: Orifice Equation Control to Crest; H=4.40
FULLY CHARGED RISER: Orifice Equation Control to Crest; H=4.69
FULLY CHARGED RISER: Orifice Equation Control to Crest; H=4.90
FULLY CHARGED RISER, DOWNSTREAM CONTROL: Kev=0. Hev=0.000
FULLY CHARGED RISER: Orifice Equation Control to Crest; H=5.69

Tremont Extended Dry Detention

Subsection: Individual Outlet Curves | Return Event: 0 years
Label: Composite Outlet Structure | Storm Event: Type II 24 hour

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Riser - 1 (Inlet Box)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Message
FULLY CHARGED RISER: Orifice Equation Control to Crest; H=5.90
FULLY CHARGED RISER: Orifice Equation Control to Crest; H=6.40
FULLY CHARGED RISER: Orifice Equation Control to Crest; H=6.90
FULLY CHARGED RISER: Orifice Equation Control to Crest; H=7.40
FULLY CHARGED RISER: Orifice Equation Control to Crest; H=7.65

Tremont Extended Dry Detention

Subsection: Individual Outlet Curves — Return Event: 0 years

Label: Composite Outlet Structure — Storm Event: Type II 24 hour

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Culvert - 1 (Culvert-Circular)

Mannings open channel maximum capacity: 7.99 ft³/s
Upstream ID = Orifice - 2, Orifice - 3, Riser - 1, Orifice - 1
Downstream ID = Tailwater (Pond Outfall)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)	Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft³/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)
661.25	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
661.75	0.04	661.35	Free Outfall	Free Outfall	0.00	0.00	(N/A)	0.00
662.25	0.05	661.37	Free Outfall	Free Outfall	0.00	0.00	(N/A)	0.00
662.75	0.09	661.40	Free Outfall	Free Outfall	0.00	0.00	(N/A)	0.00
663.25	0.11	661.42	Free Outfall	Free Outfall	0.00	0.00	(N/A)	0.00
663.75	0.12	661.43	Free Outfall	Free Outfall	0.00	0.00	(N/A)	0.00
664.00	0.13	661.44	Free Outfall	Free Outfall	0.00	0.00	(N/A)	0.00
664.25	0.33	661.55	Free Outfall	Free Outfall	0.00	0.00	(N/A)	0.00
664.75	1.63	661.94	Free Outfall	Free Outfall	0.00	0.00	(N/A)	0.00
665.25	3.26	662.25	Free Outfall	Free Outfall	0.00	0.00	(N/A)	0.00
665.75	4.12	662.40	Free Outfall	Free Outfall	0.00	0.00	(N/A)	0.00
666.25	4.85	662.51	Free Outfall	Free Outfall	0.00	0.00	(N/A)	0.00
666.75	5.46	662.60	Free Outfall	Free Outfall	0.00	0.00	(N/A)	0.00
667.25	6.02	662.68	Free Outfall	Free Outfall	0.00	0.00	(N/A)	0.00
667.35	6.12	662.70	Free Outfall	Free Outfall	0.00	0.00	(N/A)	0.00
667.75	12.58	663.89	Free Outfall	Free Outfall	0.00	0.00	(N/A)	0.00
668.25	18.66	665.82	Free Outfall	Free Outfall	0.00	0.02	(N/A)	0.00
668.75	21.23	666.86	Free Outfall	Free Outfall	0.00	0.02	(N/A)	0.00
669.25	23.31	667.80	Free Outfall	Free Outfall	0.00	0.02	(N/A)	0.00
669.75	25.08	668.66	Free Outfall	Free Outfall	0.00	0.02	(N/A)	0.00
670.25	26.60	669.46	Free Outfall	Free Outfall	0.00	0.01	(N/A)	0.00
670.75	27.97	670.22	Free Outfall	Free Outfall	0.00	0.02	(N/A)	0.00
671.25	29.20	670.94	Free Outfall	Free Outfall	0.00	0.02	(N/A)	0.00
671.75	30.29	671.59	Free Outfall	Free Outfall	0.00	0.00	(N/A)	0.00
672.04	30.86	671.95	Free Outfall	Free Outfall	0.00	0.02	(N/A)	0.00
672.25	31.26	672.20	Free Outfall	Free Outfall	0.00	0.03	(N/A)	0.00
672.75	32.11	672.75	Free Outfall	Free Outfall	0.00	0.00	(N/A)	0.00
673.04	32.56	673.04	Free Outfall	Free Outfall	0.00	0.28	(N/A)	0.00
673.25	32.87	673.25	Free Outfall	Free Outfall	0.00	0.56	(N/A)	0.00
673.75	33.61	673.75	Free Outfall	Free Outfall	0.00	1.21	(N/A)	0.00
674.25	34.34	674.25	Free Outfall	Free Outfall	0.00	1.82	(N/A)	0.00
674.75	35.05	674.75	Free Outfall	Free Outfall	0.00	2.40	(N/A)	0.00
675.00	35.40	675.00	Free Outfall	Free Outfall	0.00	2.68	(N/A)	0.00

Message

Tremont Extended Dry Detention

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Culvert - 1 (Culvert-Circular)

Mannings open channel maximum capacity: 7.99 ft³/s
Upstream ID = Orifice - 2, Orifice - 3, Riser - 1, Orifice - 1
Downstream ID = Tailwater (Pond Outfall)

Message
WS below an invert; no flow.
BACKWATER CONTROL.. Vh= .019ft hwDi= .074ft Lbw= 10.0ft Hev= .00ft
BACKWATER CONTROL.. Vh= .023ft hwDi= .090ft Lbw= 10.0ft Hev= .00ft
BACKWATER CONTROL.. Vh= .032ft hwDi= .114ft Lbw= 10.0ft Hev= .00ft
BACKWATER CONTROL.. Vh= .036ft hwDi= .126ft Lbw= 10.0ft Hev= .00ft
BACKWATER CONTROL.. Vh= .038ft hwDi= .135ft Lbw= 10.0ft Hev= .00ft
BACKWATER CONTROL.. Vh= .040ft hwDi= .139ft Lbw= 10.0ft Hev= .00ft
BACKWATER CONTROL.. Vh= .064ft hwDi= .221ft Lbw= 10.0ft Hev= .00ft
CRIT.DEPTH CONTROL Vh= .174ft Dcr= .480ft CRIT.DEPTH Hev= .00ft
BACKWATER CONTROL.. Vh= .252ft hwDi= .701ft Lbw= 10.0ft Hev= .00ft
BACKWATER CONTROL.. Vh= .284ft hwDi= .804ft Lbw= 10.0ft Hev= .00ft
BACKWATER CONTROL.. Vh= .317ft hwDi= .878ft Lbw= 10.0ft Hev= .00ft
BACKWATER CONTROL.. Vh= .338ft hwDi= .944ft Lbw= 10.0ft Hev= .00ft
BACKWATER CONTROL.. Vh= .355ft hwDi= 1.005ft Lbw= 10.0ft Hev= .00ft
BACKWATER CONTROL.. Vh= .360ft hwDi= 1.014ft Lbw= 10.0ft Hev= .00ft
INLET CONTROL... Submerged: HW =2.64
INLET CONTROL... Submerged: HW =4.57
INLET CONTROL... Submerged: HW =5.61
INLET CONTROL... Submerged: HW =6.55
INLET CONTROL... Submerged: HW =7.41

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Culvert - 1 (Culvert-Circular)

Mannings open channel maximum capacity: 7.99 ft³/s
Upstream ID = Orifice - 2, Orifice - 3, Riser - 1, Orifice - 1
Downstream ID = Tailwater (Pond Outfall)

Message
INLET CONTROL... Submerged: HW =8.21
INLET CONTROL... Submerged: HW =8.97
INLET CONTROL... Submerged: HW =9.69
INLET CONTROL... Submerged: HW =10.34
INLET CONTROL... Submerged: HW =10.70
INLET CONTROL... Submerged: HW =10.95
INLET CONTROL... Submerged: HW =11.50
INLET CONTROL... Submerged: HW =11.79
INLET CONTROL... Submerged: HW =12.00
INLET CONTROL... Submerged: HW =12.50
INLET CONTROL... Submerged: HW =13.00
INLET CONTROL... Submerged: HW =13.50
INLET CONTROL... Submerged: HW =13.75

Tremont Extended Dry Detention

Subsection: Individual Outlet Curves — Return Event: 0 years

Label: Composite Outlet Structure — Storm Event: Type II 24 hour

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Orifice - 3 (Orifice-Circular)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft^3/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)	Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft^3/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)
661.25	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
661.75	0.00	0.00	0.00	661.35	0.00	0.00	(N/A)	0.00
662.25	0.00	0.00	0.00	661.37	0.00	0.00	(N/A)	0.00
662.75	0.00	0.00	0.00	661.40	0.00	0.00	(N/A)	0.00
663.25	0.00	0.00	0.00	661.42	0.00	0.00	(N/A)	0.00
663.75	0.00	0.00	0.00	661.43	0.00	0.00	(N/A)	0.00
664.00	0.00	0.00	0.00	661.44	0.00	0.00	(N/A)	0.00
664.25	0.19	664.25	Free Outfall	661.55	0.00	0.00	(N/A)	0.00
664.75	1.49	664.75	Free Outfall	661.94	0.00	0.00	(N/A)	0.00
665.25	3.11	665.25	Free Outfall	662.25	0.00	0.00	(N/A)	0.00
665.75	3.97	665.75	Free Outfall	662.40	0.00	0.00	(N/A)	0.00
666.25	4.68	666.25	Free Outfall	662.51	0.00	0.00	(N/A)	0.00
666.75	5.29	666.75	Free Outfall	662.60	0.00	0.00	(N/A)	0.00
667.25	5.84	667.25	Free Outfall	662.68	0.00	0.00	(N/A)	0.00
667.35	5.94	667.35	Free Outfall	662.70	0.00	0.00	(N/A)	0.00
667.75	6.34	667.75	Free Outfall	663.89	0.00	0.00	(N/A)	0.00
668.25	5.45	668.25	665.82	665.82	0.00	0.00	(N/A)	0.00
668.75	4.81	668.75	666.86	666.86	0.00	0.00	(N/A)	0.00
669.25	4.21	669.25	667.80	667.80	0.00	0.00	(N/A)	0.00
669.75	3.64	669.75	668.66	668.66	0.00	0.00	(N/A)	0.00
670.25	3.10	670.25	669.46	669.46	0.00	0.00	(N/A)	0.00
670.75	2.54	670.75	670.22	670.22	0.00	0.00	(N/A)	0.00
671.25	1.95	671.25	670.94	670.94	0.00	0.00	(N/A)	0.00
671.75	1.38	671.75	671.59	671.59	0.00	0.00	(N/A)	0.00
672.04	1.05	672.04	671.95	671.95	0.00	0.00	(N/A)	0.00
672.25	0.80	672.25	672.20	672.20	0.00	0.00	(N/A)	0.00
672.75	0.12	672.75	672.75	672.75	0.00	0.00	(N/A)	0.00
673.04	0.00	673.04	673.04	673.04	0.00	0.00	(N/A)	0.00
673.25	0.00	673.25	673.25	673.25	0.00	0.00	(N/A)	0.00
673.75	0.00	673.75	673.75	673.75	0.00	0.00	(N/A)	0.00
674.25	0.00	674.25	674.25	674.25	0.00	0.00	(N/A)	0.00
674.75	0.00	674.75	674.75	674.75	0.00	0.00	(N/A)	0.00
675.00	0.00	675.00	675.00	675.00	0.00	0.00	(N/A)	0.00

Message
WS below an invert; no flow.

Tremont Extended Dry Detention

Subsection: Individual Outlet Curves — Return Event: 0 years
Label: Composite Outlet Structure — Storm Event: Type II 24 hour

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Orifice - 3 (Orifice-Circular)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Message
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
CRIT.DEPTH CONTROL Vh= .064ft Dcr= .185ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .219ft Dcr= .531ft CRIT.DEPTH Hev= .00ft
H =.79
H =1.29
H =1.79
H =2.29
H =2.79
H =2.89
H =3.29
H =2.43
H =1.89
H =1.45
H =1.09
H =.79
H =.53
H =.31
H =.16
H =.09
H =.05
FLOW PRECEDENCE SET TO DOWNSTREAM CONTROLLING STRUCTURE
FLOW PRECEDENCE SET TO DOWNSTREAM CONTROLLING STRUCTURE
FLOW PRECEDENCE SET TO DOWNSTREAM CONTROLLING STRUCTURE
FLOW PRECEDENCE SET TO DOWNSTREAM CONTROLLING STRUCTURE

Tremont Extended Dry Detention

Subsection: Individual Outlet Curves — Return Event: 0 years
Label: Composite Outlet Structure — Storm Event: Type II 24 hour

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Orifice - 3 (Orifice-Circular)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Message
FLOW PRECEDENCE SET TO DOWNSTREAM CONTROLLING STRUCTURE
FLOW PRECEDENCE SET TO DOWNSTREAM CONTROLLING STRUCTURE
FLOW PRECEDENCE SET TO DOWNSTREAM CONTROLLING STRUCTURE

Tremont Extended Dry Detention

Subsection: Composite Rating Curve — Return Event: 0 years
Label: Composite Outlet Structure — Storm Event: Type II 24 hour

Composite Outflow Summary

Water Surface Elevation (ft)	Flow (ft^3/s)	Tailwater Elevation (ft)	Convergence Error (ft)
661.25	0.00	(N/A)	0.00
661.75	0.04	(N/A)	0.00
662.25	0.05	(N/A)	0.00
662.75	0.09	(N/A)	0.00
663.25	0.11	(N/A)	0.00
663.75	0.12	(N/A)	0.00
664.00	0.13	(N/A)	0.00
664.25	0.33	(N/A)	0.00
664.75	1.63	(N/A)	0.00
665.25	3.26	(N/A)	0.00
665.75	4.13	(N/A)	0.00
666.25	4.85	(N/A)	0.00
666.75	5.46	(N/A)	0.00
667.25	6.02	(N/A)	0.00
667.35	6.13	(N/A)	0.00
667.75	12.58	(N/A)	0.00
668.25	18.66	(N/A)	0.00
668.75	21.23	(N/A)	0.00
669.25	23.31	(N/A)	0.00
669.75	25.08	(N/A)	0.00
670.25	26.60	(N/A)	0.00
670.75	27.97	(N/A)	0.00
671.25	29.20	(N/A)	0.00
671.75	30.29	(N/A)	0.00
672.04	30.86	(N/A)	0.00
672.25	31.26	(N/A)	0.00
672.75	32.11	(N/A)	0.00
673.04	32.56	(N/A)	0.00
673.25	32.87	(N/A)	0.00
673.75	33.61	(N/A)	0.00
674.25	34.34	(N/A)	0.00
674.75	35.05	(N/A)	0.00
675.00	35.40	(N/A)	0.00

Contributing Structures
(no Q: Orifice - 2,Orifice - 3,Riser - 1,Orifice - 1,Culvert - 1)
Orifice - 1,Culvert - 1 (no Q: Orifice - 2,Orifice - 3,Riser - 1)
Orifice - 1,Culvert - 1 (no Q: Orifice - 2,Orifice - 3,Riser - 1)
Orifice - 2,Orifice - 1,Culvert - 1 (no Q: Orifice - 3,Riser - 1)

Tremont Extended Dry Detention

Subsection: Composite Rating Curve | Return Event: 0 years
Label: Composite Outlet Structure | Storm Event: Type II 24 hour

Composite Outflow Summary

Contributing Structures
Orifice - 2,Orifice - 1,Culvert - 1 (no Q: Orifice - 3,Riser - 1)
Orifice - 2,Orifice - 1,Culvert - 1 (no Q: Orifice - 3,Riser - 1)
Orifice - 2,Orifice - 1,Culvert - 1 (no Q: Orifice - 3,Riser - 1)
Orifice - 2,Orifice - 3,Orifice - 1,Culvert - 1 (no Q: Riser - 1)
Orifice - 2,Orifice - 3,Orifice - 1,Culvert - 1 (no Q: Riser - 1)
Orifice - 2,Orifice - 3,Orifice - 1,Culvert - 1 (no Q: Riser - 1)
Orifice - 2,Orifice - 3,Orifice - 1,Culvert - 1 (no Q: Riser - 1)
Orifice - 2,Orifice - 3,Orifice - 1,Culvert - 1 (no Q: Riser - 1)
Orifice - 2,Orifice - 3,Orifice - 1,Culvert - 1 (no Q: Riser - 1)
Orifice - 2,Orifice - 3,Orifice - 1,Culvert - 1 (no Q: Riser - 1)
Orifice - 2,Orifice - 3,Orifice - 1,Culvert - 1 (no Q: Riser - 1)
Orifice - 2,Orifice - 3,Riser - 1,Orifice - 1,Culvert - 1
Orifice - 2,Orifice - 3,Riser - 1,Orifice - 1,Culvert - 1
Orifice - 2,Orifice - 3,Riser - 1,Orifice - 1,Culvert - 1
Orifice - 2,Orifice - 3,Riser - 1,Orifice - 1,Culvert - 1
Orifice - 2,Orifice - 3,Riser - 1,Orifice - 1,Culvert - 1
Orifice - 2,Orifice - 3,Riser - 1,Orifice - 1,Culvert - 1
Orifice - 2,Orifice - 3,Riser - 1,Orifice - 1,Culvert - 1
Orifice - 2,Orifice - 3,Riser - 1,Orifice - 1,Culvert - 1
Orifice - 2,Orifice - 3,Riser - 1,Orifice - 1,Culvert - 1
Orifice - 2,Orifice - 3,Riser - 1,Orifice - 1,Culvert - 1
Orifice - 2,Orifice - 3,Riser - 1,Orifice - 1,Culvert - 1
Orifice - 2,Orifice - 3,Riser - 1,Orifice - 1,Culvert - 1

Tremont Extended Dry Detention

Subsection: Composite Rating Curve
Label: Composite Outlet Structure

Return Event: 0 years
Storm Event: Type II 24 hour

Composite Outflow Summary

Contributing Structures
Riser - 1,Culvert - 1 (no Q: Orifice - 2,Orifice - 3,Orifice - 1)
Riser - 1,Culvert - 1 (no Q: Orifice - 2,Orifice - 3,Orifice - 1)
Riser - 1,Culvert - 1 (no Q: Orifice - 2,Orifice - 3,Orifice - 1)
Riser - 1,Culvert - 1 (no Q: Orifice - 2,Orifice - 3,Orifice - 1)
Riser - 1,Culvert - 1 (no Q: Orifice - 2,Orifice - 3,Orifice - 1)
Riser - 1,Culvert - 1 (no Q: Orifice - 2,Orifice - 3,Orifice - 1)

Tremont Extended Dry Detention

Index

Pond Pack Area, CN, Water Quality Volume, and Forebay Volume Calculations

Description and Total Area (ac)	
Main SS	9.38
Ramp SS	0.53
Interior R6 Ditch	1.04
R6 and 14th Intersection Flow	0.13
Pond Footprint	1.15
Total Area	12.23
CN=98	6.68
CN=74	5.55
CN weighted=	87.11

Water Quality Volume Calc Total

P=	0.75	inches
A=	12.23	acres
i=f(Cq)	0.55	
Cq=	0.370	
WQV=	0.283	acre-feet
WQV +20%=	0.339	acre-feet
WQV=	14778	CFT

Forebay Volume Calc Ramp A6 SS

P=	0.75	inches
A=	0.53	acres
i=f(Cq)	0.66	
Cq=	0.46	
WQV=	0.015	acre-feet
WQV +20%=	0.018	acre-feet
Forebay Volume=	0.002	acre-feet
Forebay Volume=	79	CFT

Eleveation ft	Area SFT	Volume CFT	
660.00	0.0105		
661.00	0.0185	0.0664	
661.25	0.0224	0.0203	
		0.0867	>.002 ok

Forebay Volume Calc Remainder minus Pond Footprint

P=	0.75	inches
A=	10.55	acres
i=f(Cq)	0.54	
Cq=	0.367	
WQV=	0.242	acre-feet
WQV +20%=	0.290	acre-feet
Forebay Volume=	0.029	acre-feet
Forebay Volume=	1265	CFT

Eleveation ft	Area SFT	Volume CFT	
659.00	0.0073		
660.00	0.0155	0.0579	
661.00	0.0264	0.0822	
661.25	0.0294	0.0243	
		0.1645	>.029 ok

Time (hours)	Outlet-Culvert - wq - Flow (ft^3/s)			
0	0			
0.05	0			
0.1	0			
0.15	0			
0.2	0			
0.25	0			
0.3	0			
0.35	0			
0.4	0			
0.45	0			
0.5	0			
0.55	0			
0.6	0			
0.65	0			
0.7	0			
0.75	0			
0.8	0			
0.85	0			
0.9	0			
0.95	0			
1	0			
1.05	0			
1.1	0			
1.15	0			
1.2	0			
1.25	0			
1.3	0			
1.35	0			
1.4	0			
1.45	0			
1.5	0			
1.55	0			
1.6	0			
1.65	0			
1.7	0			
1.75	0			
1.8	0			
1.85	0			
1.9	0			
1.95	0			
2	0			
2.05	0			
2.1	0			
2.15	0			
2.2	0			
2.25	0			

2.3	0				
2.35	0				
2.4	0				
2.45	0				
2.5	0				
2.55	0				
2.6	0				
2.65	0				
2.7	0				
2.75	0				
2.8	0				
2.85	0				
2.9	0				
2.95	0				
3	0				
3.05	0				
3.1	0				
3.15	0				
3.2	0				
3.25	0				
3.3	0				
3.35	0				
3.4	0				
3.45	0				
3.5	0				
3.55	0				
3.6	0				
3.65	0				
3.7	0				
3.75	0				
3.8	0				
3.85	0				
3.9	0				
3.95	0				
4	0				
4.05	0				
4.1	0				
4.15	0				
4.2	0				
4.25	0				
4.3	0				
4.35	0				
4.4	0				
4.45	0				
4.5	0				
4.55	0				
4.6	0				

4.65	0			
4.7	0			
4.75	0			
4.8	0			
4.85	0			
4.9	0			
4.95	0			
5	0			
5.05	0			
5.1	0			
5.15	0			
5.2	0			
5.25	0			
5.3	0			
5.35	0			
5.4	0			
5.45	0			
5.5	0			
5.55	0			
5.6	0			
5.65	0			
5.7	0			
5.75	0			
5.8	0			
5.85	0			
5.9	0			
5.95	0			
6	0			
6.05	0			
6.1	0			
6.15	0			
6.2	0			
6.25	0			
6.3	0			
6.35	0			
6.4	0			
6.45	0			
6.5	0			
6.55	0			
6.6	0			
6.65	0			
6.7	0			
6.75	0			
6.8	0			
6.85	0			
6.9	0			
6.95	0			

7	0			
7.05	0			
7.1	0			
7.15	0			
7.2	0			
7.25	0			
7.3	0			
7.35	0			
7.4	0			
7.45	0			
7.5	0			
7.55	0			
7.6	0			
7.65	0			
7.7	0			
7.75	0			
7.8	0			
7.85	0			
7.9	0			
7.95	0			
8	0			
8.05	0			
8.1	0			
8.15	0			
8.2	0			
8.25	0			
8.3	0			
8.35	0			
8.4	0			
8.45	0			
8.5	0			
8.55	0			
8.6	0			
8.65	0			
8.7	0			
8.75	0			
8.8	0			
8.85	0			
8.9	0			
8.95	0			
9	0			
9.05	0			
9.1	0			
9.15	0			
9.2	0			
9.25	0			
9.3	0			

9.35	0			
9.4	0			
9.45	0			
9.5	0			
9.55	0			
9.6	0			
9.65	0			
9.7	0			
9.75	0			
9.8	0			
9.85	0			
9.9	0			
9.95	0			
10	0			
10.05	0			
10.1	0			
10.15	0			
10.2	0			
10.25	0			
10.3	0			
10.35	0			
10.4	0			
10.45	0			
10.5	0			
10.55	0			
10.6	0			
10.65	0			
10.7	0			
10.75	0			
10.8	0			
10.85	0			
10.9	0			
10.95	0			
11	0			
11.05	0			
11.1	0			
11.15	0			
11.2	0			
11.25	0			
11.3	0			
11.35	0			
11.4	0			
11.45	0			
11.5	0			
11.55	0			
11.6	0			
11.65	0			

11.7	0			
11.75	0.01			
11.8	0.01			
11.85	0.01			
11.9	0.02			
11.95	0.03			
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12.45	0.09			
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12.8	0.1			
12.85	0.1			
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12.95	0.1			
13	0.11			
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13.85	0.11			
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13.95	0.11			
14	0.11			

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94.2	0.01			
94.25	0.01			
94.3	0.01			
94.35	0.01			
94.4	0.01			
94.45	0.01			
94.5	0.01			
94.55	0.01			
94.6	0.01			
94.65	0.01			
94.7	0.01			
94.75	0.01			
94.8	0.01			
94.85	0.01			
94.9	0.01			
94.95	0.01			
95	0.01			
95.05	0.01			
95.1	0.01			
95.15	0.01			
95.2	0.01			
95.25	0.01			
95.3	0.01			
95.35	0.01			
95.4	0.01			
95.45	0.01			
95.5	0.01			
95.55	0			
95.6	0			
95.65	0			
95.7	0			
95.75	0			
95.8	0			
95.85	0			
95.9	0			
95.95	0			
96	0			

APPENDIX G

INLET SPACING DESIGN

PID : 49633 **Date :** 10/10/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, Ohio

Description : West Bank Drainage Area - Inlet Spacing - W 13th Widening LT **Designer :** PNS

Rainfall Area: A **Storm Frequency (yr.) :** 2 **Total Allow. Spread (ft.) :** 10.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)	
10+00	Begin																		
11+76	CB-3	86.00	0.46	0.19	1.00	1.56	10.00	0.0050	0.0160	0.0160	0.00	0.0417	3.60	******	******	0.31	0.096	5.97	Sag
12+08	Begin																		
11+76	CB-3	22.00	0.50	0.03	1.00	0.56	10.00	0.0062	0.0160	0.0160	0.00	0.0417	3.60	******	******	0.05	0.047	2.96	End

SUMP DATA

Total Flow (cfs) : 0.37 **Ponded Depth (ft.) :** 0.023 **Spread on Pavement (ft.) :** 1.62

INLET SPACING DESIGN

PID : 49633 **Date :** 10/10/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, Ohio

Description : West Bank Drainage Area - Inlet Spacing - W 13th Widening LT **Designer :** PNS

Rainfall Area: A **Storm Frequency (yr.) :** 25 **Total Allow. Spread (ft.) :** 10.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)	
10+00	Begin																		
11+76	CB-3	86.00	0.46	0.19	1.00	1.37	10.00	0.0050	0.0160	0.0160	0.00	0.0417	6.21	******	******	0.54	0.117	7.32	Sag
12+08	Begin																		
11+76	CB-3	22.00	0.50	0.03	1.00	0.49	10.00	0.0062	0.0160	0.0160	0.00	0.0417	6.21	******	******	0.09	0.058	3.63	End

SUMP DATA

Total Flow (cfs) : 0.64 **Ponded Depth (ft.) :** 0.054 **Spread on Pavement (ft.) :** 2.17

STORM SEWER SYSTEM

PID : 49633 **Date :** 10/10/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, OH

Description : West Bank Drainage Area - Storm Sewer -W13th Widening-RT **Designer :** pns

Rainfall Area: A **Just Full Capacity Frequency (yrs.) :** 10 **Hydraulic Gradient Frequency (yrs.) :** 25

Minimum Pipe Size : 12.00 **Tailwater Elevation (ft.):** 667.54

JUNCTION From To	STATION From To	ΔAREA ΣAREA (acres)	ΔCA ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	RAINFALL INTENSITY (25 yrs.)	DISCHARGE (cfs.) (10 yrs.)	DISCHARGE (cfs.) (25 yrs.)	PIPE DIAM. (in.)	PIPE LENGTH (ft.)	PIPE SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
964 1190 begin	11+77 11+89	0.22 0.22	0.10 0.10	10.00	5.10	6.15	0.5	0.6	12	20.4	0.0407	665.87 665.04	4.84	6.70	0.0004	667.55 667.54	674.07 674.44	6.52	7.20	CB 3 0.015
964B 1190 begin	11+75 11+89	0.15 0.37	0.14 0.24	10.00	5.10	6.15	0.7	0.8	12	16.5	0.0109	666.47 666.29	3.27	3.47	0.0007	667.55 667.54	674.12 674.44	6.57	6.65	CB 3 0.015
1190 CS final	11+89 12+05	0.00 0.37	0.00 0.24	10.08	5.08	6.15	1.2	1.5	24	26.0	0.0100	659.89 659.63	3.44	21.09	0.0001	667.54 667.54	674.44 674.60	6.90	12.55	MH 3 0.015

INLET SPACING DESIGN

PID : 49633 **Date :** 10/10/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, Ohio

Description : West Bank Drainage Area - Inlet Spacing - W 13th Widening RT **Designer :** PNS

Rainfall Area: A **Storm Frequency (yr.) :** 2 **Total Allow. Spread (ft.) :** 6.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)	
10+00	Begin																		
11+76	CB-3	86.00	0.90	0.13	1.00	1.44	10.00	0.0050	0.0160	0.0160	0.00	0.0417	3.60	******	******	0.42	0.107	6.66	Sag
12+08	Begin																		
11+76	CB-3	22.00	0.90	0.02	1.00	0.53	10.00	0.0062	0.0160	0.0160	0.00	0.0417	3.60	******	******	0.06	0.051	3.17	End

SUMP DATA

Total Flow (cfs) : 0.49 **Ponded Depth (ft.) :** 0.038 **Spread on Pavement (ft.) :** 1.75

INLET SPACING DESIGN

PID : 49633 **Date :** 10/10/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, Ohio

Description : West Bank Drainage Area - Inlet Spacing - W 13th Widening RT **Designer :** PNS

Rainfall Area: A **Storm Frequency (yr.) :** 25 **Total Allow. Spread (ft.) :** 6.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)	
10+00	Begin																		
11+76	CB-3	86.00	0.90	0.13	1.00	1.27	10.00	0.0050	0.0160	0.0160	0.00	0.0417	6.21	******	******	0.73	0.131	8.17	Sag
12+08	Begin																		
11+76	CB-3	22.00	0.90	0.02	1.00	0.47	10.00	0.0062	0.0160	0.0160	0.00	0.0417	6.21	******	******	0.11	0.062	3.89	End

SUMP DATA

Total Flow (cfs) : 0.84 **Ponded Depth (ft.) :** 0.073 **Spread on Pavement (ft.) :** 3.38

APPENDIX H
(NON-PERFORMED)

INLET SPACING DESIGN

PID : 49633 **Date :** 10/10/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, Ohio

Description : West Bank Drainage Area - Inlet Spacing - W 14th **Designer :** AHR

Rainfall Area: A **Storm Frequency (yr.) :** 2 **Total Allow. Spread (ft.) :** 6.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)	
101+55	Begin																		
100+77	CB-3	88.00	0.87	0.09	1.00	0.92	10.00	0.0110	0.0470	0.0470	0.00	0.0417	3.60	******	******	0.28	0.118	2.52	Sag
100+00	Begin																		
100+77	CB-3	22.00	0.87	0.09	1.00	0.33	10.00	0.0040	0.0470	0.0470	0.00	0.0417	3.60	******	******	0.28	0.143	3.05	End

SUMP DATA

Total Flow (cfs) : 0.56 **Ponded Depth (ft.) :** 0.046 **Spread on Pavement (ft.) :** 1.83

NON-PERFORMED

INLET SPACING DESIGN

PID : 49633 **Date :** 10/10/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, Ohio

Description : West Bank Drainage Area - Inlet Spacing - W 14th **Designer :** AHR

Rainfall Area: A **Storm Frequency (yr.) :** 25 **Total Allow. Spread (ft.) :** 6.00 **Allowable Depth (ft.)** 0.42

STATION	C.B. Type	GUTTER LENGTH (ft.)	RUNOFF COEF	RUNOFF AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTT. SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTT. WIDTH (ft.)	LOCAL DEPRESS. (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (ft.)	
101+55	Begin																		
100+77	CB-3	88.00	0.87	0.09	1.00	0.81	10.00	0.0110	0.0470	0.0470	0.00	0.0417	6.21	******	******	0.49	0.145	3.09	Sag
100+00	Begin																		
100+77	CB-3	22.00	0.87	0.09	1.00	0.29	10.00	0.0040	0.0470	0.0470	0.00	0.0417	6.21	******	******	0.49	0.176	3.74	End

SUMP DATA

Total Flow (cfs) : 0.97 **Ponded Depth (ft.) :** 0.085 **Spread on Pavement (ft.) :** 2.33

NON-PERFORMED

STORM SEWER SYSTEM

PID : 49633 **Date :** 10/10/2011 **Project :** CUY-90-14.90 **Location :** Cleveland, OH

Description : West Bank Drainage Area - Storm Sewer -W14th and Fairfield **Designer :** AHR

Rainfall Area: A **Just Full Capacity Frequency (yrs.) :** 10 **Hydraulic Gradient Frequency (yrs.) :** 25

Minimum Pipe Size : 12.00 **Tailwater Elevation (ft.):** 670.19

JUNCTION From	JUNCTION To	STATION From To	ΔAREA Σ AREA (acres)	ΔCA ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	RAINFALL INTENSITY (25 yrs.)	DISCHARGE (cfs.) (10 yrs.)	DISCHARGE (cfs.) (25 yrs.)	PIPE DIAM. (in.)	PIPE LENGTH (ft.)	PIPE SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
D19 begin	EXCS	100+77 100+63	0.18 0.18	0.16 0.16	10.00	5.10	6.17	0.8	1.0	12	29.4	0.0105	669.50 669.19	3.35	3.41	0.0010	670.22 670.19	673.56 675.05	3.34	3.06	CB 3 0.015

NON-PERFORMED