ENVIRONMENTAL, ENGINEERING & SCIENCE

DRAINAGE REPORT

SUM-IR-77-VACANT REST AREA TP
City of Green
Summit County, Ohio
PID 122880

Prepared for:

Ohio Department of Transportation (ODOT)

Prepared by:

CAP-STONE & Associates, Inc.
dba Stone Environmental Engineering and Science
3700 Corporate Drive, Suite 125
Columbus, OH 43231

December 22, 2025
250584027

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Project Descriptions

STONE was retained to prepare plans for trucking parking at SUM-I77 northbound vacant rest area. With the additions to the project area, a drainage assessment was conducted on the proposed roadway ditch, rock channel protection for the culvert extension, curb cuts in the truck parking area, and water quality within the project limits per the latest ODOT Location and Design Manual Volume 2.

Design Criteria

The drainage design criteria for this project follow the design standards found within the ODOT Location and Design Manual: Volume 2 dated July 18, 2025.

Hydrology

Existing plans and topography were used to determine the drainage areas used in this drainage assessment. Refer to **Table 1** for a summary of drainage areas, runoff coefficients, and time of concentration.

See **Appendix A** for Drainage Area Maps for the proposed Ditch and Truck Parking Curb Cuts.

See **Appendix B** for Time of Concentration Calculations used to analyze the ditch and curb cuts.

Table 1 – Drainage Data

	Area (acres)	Runoff Coefficient	Time of Concentration (min)
DA-1	2.08	0.79	21
DA-2a	2.42	0.71	20
DA-2b	0.63	0.71	15
DA-3	0.26	0.90	10
DA-4	0.24	0.90	10
DA-5	0.24	0.90	10
DA-6	0.24	0.90	10
DA-7	0.24	0.90	10
DA-8	0.24	0.90	10
DA-9	0.24	0.90	10
DA-10	0.45	0.90	10

Existing Culvert Data

A culvert analysis was not performed as culverts are being extended and not replaced. However, hydraulic data was retrieved from the existing plans to determine the Rock Channel Protection (RCP) required.

See **Appendix C** for Existing 48” Culvert Plan and Profile. The plan and profile include hydraulic data required to perform RCP calculations.

See **Appendix D** for Rock Channel Protection Calculations.

Ditch Analysis

A ditch analysis was performed on the proposed ditch using ODOT CDSS Software.

See **Appendix E** for the Ditch Analysis.

Post Construction Best Management Practices (BMPs) Calculations

For this project, the earth disturbed area (EDA) is greater than 1 acre. Therefore, post-construction BMPs are required. This project is located entirely within the existing right-of way; therefore, this is considered a "Redevelopment Project" as defined in L&D Volume 2. Water quality treatment is required. Vegetation-based water quality BMPs are the preferred option because they are cheaper and easier to maintain. Vegetated Filter Strips (VFS) is the preferred BMP option. Vegetated Filter Strips were designed based on L&D Volume 2 guidelines and requirements. Refer to **Table 2** for BMP treatment requirements.

Vegetated filter strips have been chosen as this project's BMP. See **Appendix F** for BMP Calculations.

Table 2 – BMP Treatment Requirements

Description	Area	Unit
Earth Disturbed Area (EDA)	7.60	Acre
Area to Treat = EDA - Sheet Flow Area	6.07	Acre
Required Treatment, T% (Redevelopment Project)	20%	
Required Treatment Area	1.21	Acre

Curb Cut Calculations

Curb cut calculations were performed in excel following L&D Volume 2 guidelines. The curb cut calculations were completed using excel to more accurately calculate flow and depth through the openings. The curb has a continuous slope of 0.50% with eight 5-foot-wide curb cuts along the curb.

See **Appendix G** for Truck Parking Curb Cut Calculations.

APPENDIX A

Drainage Area Map

DA	AREA	RUNOFF COEFFICIENT	TIME OF CONCENTRATION
1	2.08	0.79	21
2a	2.42	0.71	20
2b	0.63	0.71	15

DITCH DRAINAGE AREA MAP

DESIGN AGENCY
STONE ENVIRONMENTAL ENGINEERING & SCIENCE

DESIGNER
KLG

REVIEWER
CEQ 12-22-25

PROJECT ID
122880

SHEET P.1 TOTAL 2

SUM-IR-77-VACANT REST AREA TP

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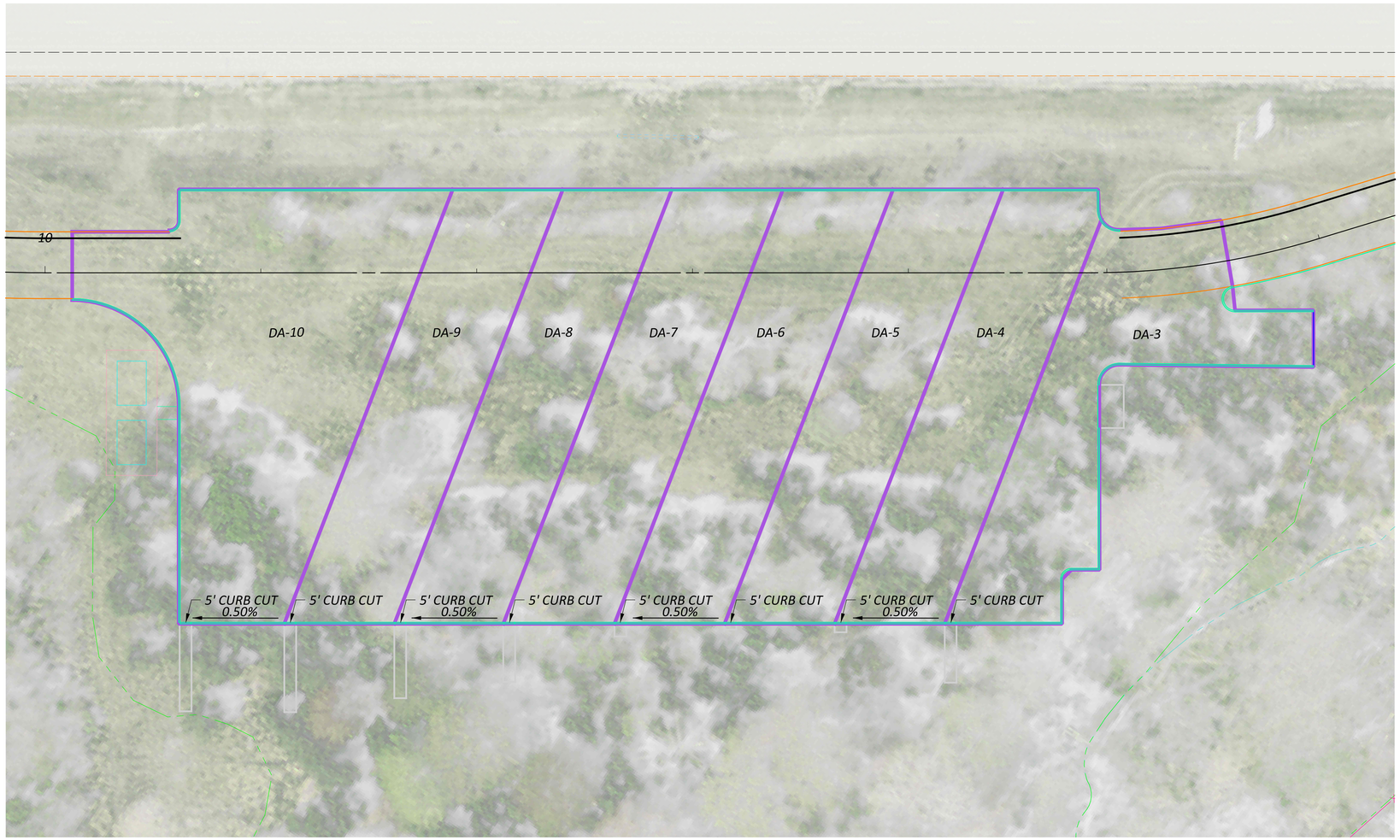

DA	AREA	RUNOFF COEFFICIENT	TIME OF CONCENTRATION
3	0.26	0.90	10
4	0.24	0.90	10
5	0.24	0.90	10
6	0.24	0.90	10
7	0.24	0.90	10
8	0.24	0.90	10
9	0.24	0.90	10
10	0.45	0.90	10

SUM-IR-77-VACANT REST AREA TP

TRUCK PARKING DRAINAGE AREA MAP

DESIGN AGENCY
STONE ENVIRONMENTAL ENGINEERING & SCIENCE

DESIGNER
KLG

REVIEWER
CEQ 10-31-25

PROJECT ID
122880

SHEET P.2 TOTAL 2

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APPENDIX B

Time of Concentration Calculations

TIME OF CONCENTRATION - DA-1

PID: 122880

AREA: 2.08

		C value	Area (ac)	C x A
	Woods	0.3		0.00
		0.35		0.00
		0.4		0.00
		0.45		0.00
	Residential	0.5		0.00
		0.55		0.00
	Cultivated	0.6	0.77	0.46
		0.65		0.00
		0.7		0.00
	Paved	0.9	1.31	1.18
C Average	0.79	Total Area	2.08	Total C x A 1.64

SHEET ELEVATIONS	
HIGH PT	LOW POINT
1166	1164

SHALLOW ELEVATIONS	
HIGH PT	LOW POINT

OPEN CHANNEL ELEVATIONS	
HIGH PT	LOW POINT
1164	1159.79

NEIGHBOR	SHEET	SHALLOW	OPEN CHANNEL
L (Length of flow, ft.)	300	0	683
S (Slope, %)	0.67	0	0.62
k (Intercept coeff.)		0	0.457
Velocity (fps)		0	1.18
Time of Concentration (min.)	11.0913961	0	9.61
Total Time of Concentration (min.)			20.71
Min. Tc (min.)	15		21

TIME OF CONCENTRATION - DA-2a

PID: 122880

AREA: 2.42

		C value	Area (ac)	C x A
	Woods	0.3		0.00
		0.35		0.00
		0.4		0.00
		0.45		0.00
	Residential	0.5		0.00
		0.55		0.00
	Cultivated	0.6	1.50	0.90
		0.65		0.00
		0.7		0.00
	Paved	0.9	0.91	0.82
C Average		0.71	Total Area 2.42	Total C x A 1.72

SHEET ELEVATIONS	
HIGH PT	LOW POINT
1165.00	1163.00

SHALLOW ELEVATIONS	
HIGH PT	LOW POINT
1163.00	1158.68

OPEN CHANNEL ELEVATIONS	
HIGH PT	LOW POINT
1158.68	1154.95

NEIGHBOR	SHEET	SHALLOW	OPEN CHANNEL
L (Length of flow, ft.)	282	488	186
S (Slope, %)	0.71	0.885246	2.01
k (Intercept coeff.)		0.457	0.457
Velocity (fps)		1.42	2.14
Time of Concentration (min.)	13.11	5.73	1.45
Total Time of Concentration (min.)			20
Min. Tc (min.)	15		20

TIME OF CONCENTRATION - DA-2b

PID: 122880

AREA: 0.63

		C value	Area (ac)		C x A
	Woods	0.3			0.00
		0.35			0.00
		0.4			0.00
		0.45			0.00
	Residential	0.5			0.00
		0.55			0.00
	Cultivated	0.6	0.41		0.24
		0.65			0.00
		0.7			0.00
	Paved	0.9	0.22		0.20
C Average		0.71	Total Area	0.63	Total C x A 0.44

SHEET ELEVATIONS	
HIGH PT	LOW POINT

SHALLOW ELEVATIONS	
HIGH PT	LOW POINT

OPEN CHANNEL ELEVATIONS	
HIGH PT	LOW POINT
1154.95	1151.69

NEIGHBOR	SHEET	SHALLOW	OPEN CHANNEL
L (Length of flow, ft.)	0	0	246
S (Slope, %)	0.00	0	1.33
k (Intercept coeff.)		0	0.457
Velocity (fps)		0	1.74
Time of Concentration (min.)	0.00	0	2.36
Total Time of Concentration (min.)			2.36
Min. Tc (min.)	15		15

TIME OF CONCENTRATION - DA-3

PID: 122880

AREA: 0.26

		C value	Area (ac)	C x A
	Woods	0.3		0.00
		0.35		0.00
		0.4		0.00
		0.45		0.00
	Residential	0.5		0.00
		0.55		0.00
	Cultivated	0.6		0.00
		0.65		0.00
		0.7		0.00
	Paved	0.9	0.26	0.23
C Average	0.90	Total Area	0.26	Total C x A 0.23

NEIGHBOR	SHEET	SHALLOW	OPEN CHANNEL
L (Length of flow, ft.)	38	0	162
S (Slope, %)	1.65	0	1.20
k (Intercept coeff.)		0	0.457
Velocity (fps)		0	1.65
Time of Concentration (min.)	1.88	0	1.63
Total Time of Concentration (min.)			3.51
Min. Tc (min.)	10		10

TIME OF CONCENTRATION - DA-4

PID: 122880

AREA: 0.23

		C value	Area (ac)		C x A
	Woods	0.3			0.00
		0.35			0.00
		0.4			0.00
		0.45			0.00
	Residential	0.5			0.00
		0.55			0.00
	Cultivated	0.6			0.00
		0.65			0.00
		0.7			0.00
	Paved	0.9	0.23		0.21
C Average	0.90	Total Area	0.23	Total C x A	0.21

NEIGHBOR	SHEET	SHALLOW	OPEN CHANNEL
L (Length of flow, ft.)	38	0	162
S (Slope, %)	1.65	0	1.20
k (Intercept coeff.)		0	0.457
Velocity (fps)		0	1.65
Time of Concentration (min.)	1.88	0	1.63
Total Time of Concentration (min.)			3.51
Min. Tc (min.)	10		10

TIME OF CONCENTRATION - DA-5 to DA-9

PID: 122880

AREA: 0.24

		C value	Area (ac)	C x A
	Woods	0.3		0.00
		0.35		0.00
		0.4		0.00
		0.45		0.00
	Residential	0.5		0.00
		0.55		0.00
	Cultivated	0.6		0.00
		0.65		0.00
		0.7		0.00
	Paved	0.9	0.24	0.21
C Average	0.90	Total Area	0.24	Total C x A 0.21

NEIGHBOR	SHEET	SHALLOW	OPEN CHANNEL
L (Length of flow, ft.)	38	0	162
S (Slope, %)	1.65	0	1.20
k (Intercept coeff.)		0	0.457
Velocity (fps)		0	1.65
Time of Concentration (min.)	1.88	0	1.63
Total Time of Concentration (min.)			3.51
Min. Tc (min.)	10		10

TIME OF CONCENTRATION - DA-10

PID: 122880

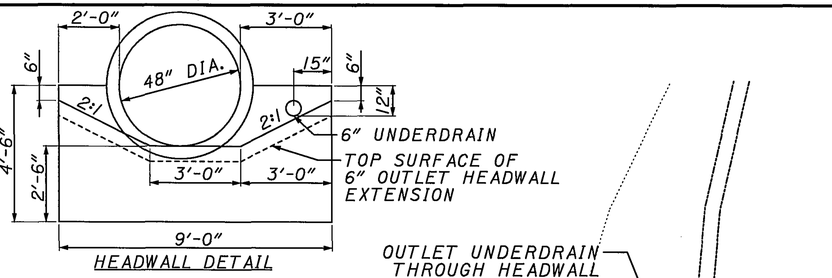
AREA: 0.45

		C value	Area (ac)		C x A
	Woods	0.3			0.00
		0.35			0.00
		0.4			0.00
		0.45			0.00
	Residential	0.5			0.00
		0.55			0.00
	Cultivated	0.6			0.00
		0.65			0.00
		0.7			0.00
	Paved	0.9	0.45		0.41
C Average	0.90	Total Area	0.45	Total C x A	0.41

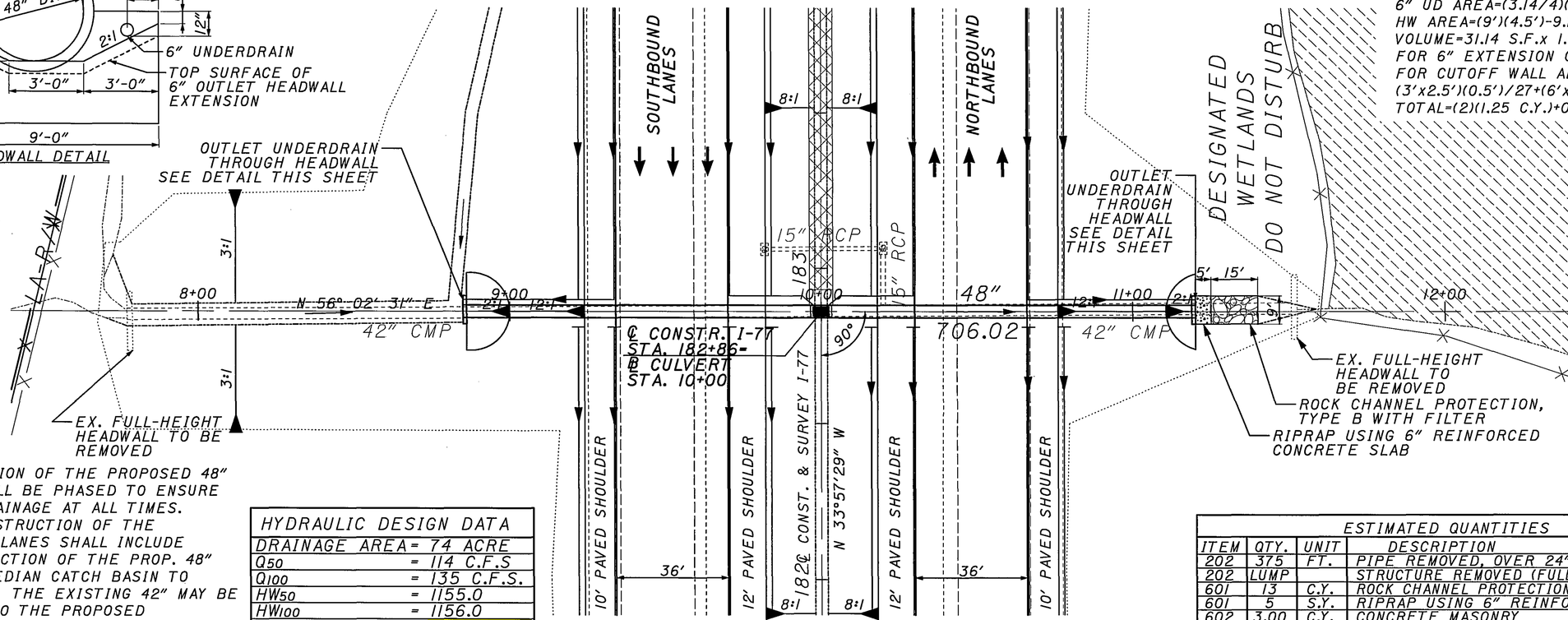
NEIGHBOR	SHEET	SHALLOW	OPEN CHANNEL
L (Length of flow, ft.)	38	0	162
S (Slope, %)	1.65	0	1.20
k (Intercept coeff.)		0	0.457
Velocity (fps)		0	1.65
Time of Concentration (min.)	1.88	0	1.63
Total Time of Concentration (min.)			3.51
Min. Tc (min.)	10		10

APPENDIX C

Existing 48” Culvert Plan and Profile



HEADWALL DETAIL



CONCRETE MASONRY CALCULATION

48" PIPE AREA=(3.14/8)(4.83')^2-9.16 S.F.
6" UD AREA=(3.14/4)(0.5')^2=0.20 S.F.
HW AREA=(9')(4.5')-9.16-0.20=31.14 S.F.
VOLUME=31.14 S.F.x 1.08'THK/27=1.25 C.Y.
FOR 6" EXTENSION ON HEADWALL
FOR CUTOFF WALL ADD:
(3'x2.5')(0.5')/27+(6'x3.25')(0.5')/27=0.50 C.Y.
TOTAL=(2)(1.25 C.Y.)+0.50 C.Y.=3.00 C.Y.

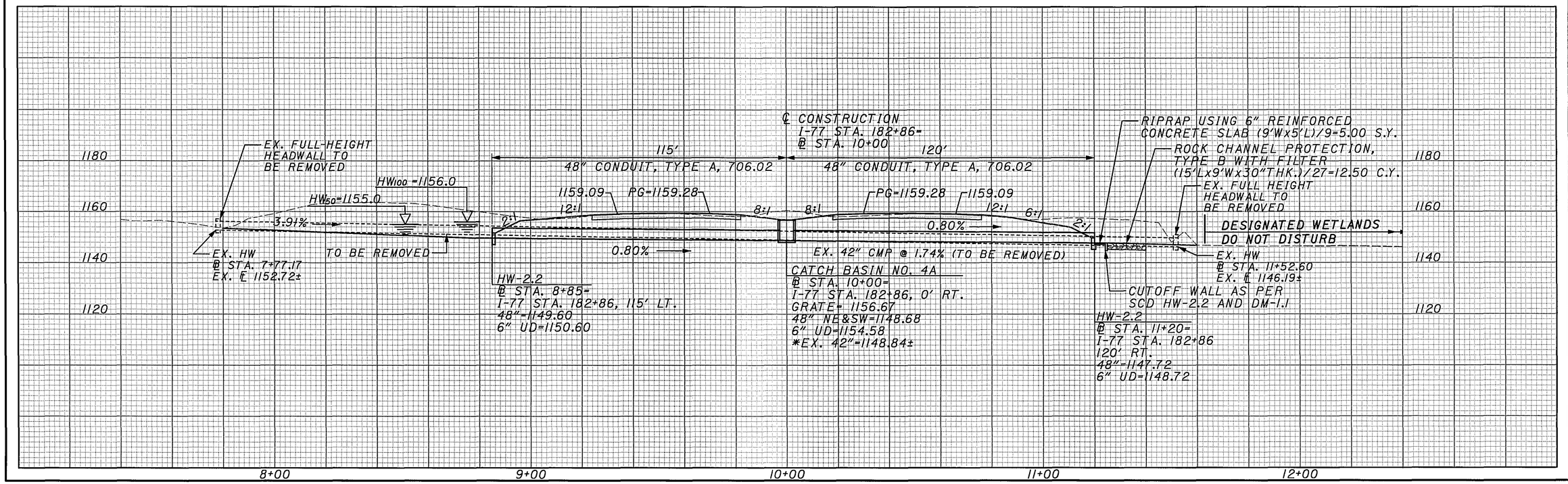
EXISTING STRUCTURE
TYPE: CMP
SIZE: 42" CIRCULAR
SKEW: 0°
ALIGNMENT: TANGENT
DATE BUILT: 1963
CONDITION: FAIR

* CONSTRUCTION OF THE PROPOSED 48" CONDUIT SHALL BE PHASED TO ENSURE POSITIVE DRAINAGE AT ALL TIMES. PHASE I CONSTRUCTION OF THE NORTHBOUND LANES SHALL INCLUDE THE CONSTRUCTION OF THE PROP. 48" FROM THE MEDIAN CATCH BASIN TO THE OUTLET. THE EXISTING 42" MAY BE CONNECTED TO THE PROPOSED MEDIAN CATCH BASIN AS NECCESSARY UNTIL CONSTRUCTION OF THE SOUTHBOUND LANES.

HYDRAULIC DESIGN DATA	
DRAINAGE AREA	= 74 ACRE
Q_{50}	= 114 C.F.S
Q_{100}	= 135 C.F.S.
HW_{50}	= 1155.0
HW_{100}	= 1156.0
V_{50}	= 12.3 F.P.S.
V_{100}	= 12.7 F.P.S.

QUANTITIES CARRIED TO GENERAL SUMMARY, SEE SHEETS NO. 114 & 115

ESTIMATED QUANTITIES			
ITEM	QTY.	UNIT	DESCRIPTION
202	375	FT.	PIPE REMOVED, OVER 24"
202	LUMP		STRUCTURE REMOVED (FULL-HEIGHT HEADWALL)
601	13	C.Y.	ROCK CHANNEL PROTECTION, TYPE B WITH FILTER
601	5	S.Y.	RIPRAP USING 6" REINFORCED CONCRETE SLAB
602	3.00	C.Y.	CONCRETE MASONRY
603	235	FT.	48" CONDUIT, TYPE A, 706.02
604	1	EA.	CATCH BASIN NO. 4A



PLAN AND PROFILE
CULVERT
STA. 182+86
SUM-77-1.40

HORIZONTAL SCALE IN FEET
0 10 20 40
CALCULATED L.M.B.
CHECKED A.R.N.

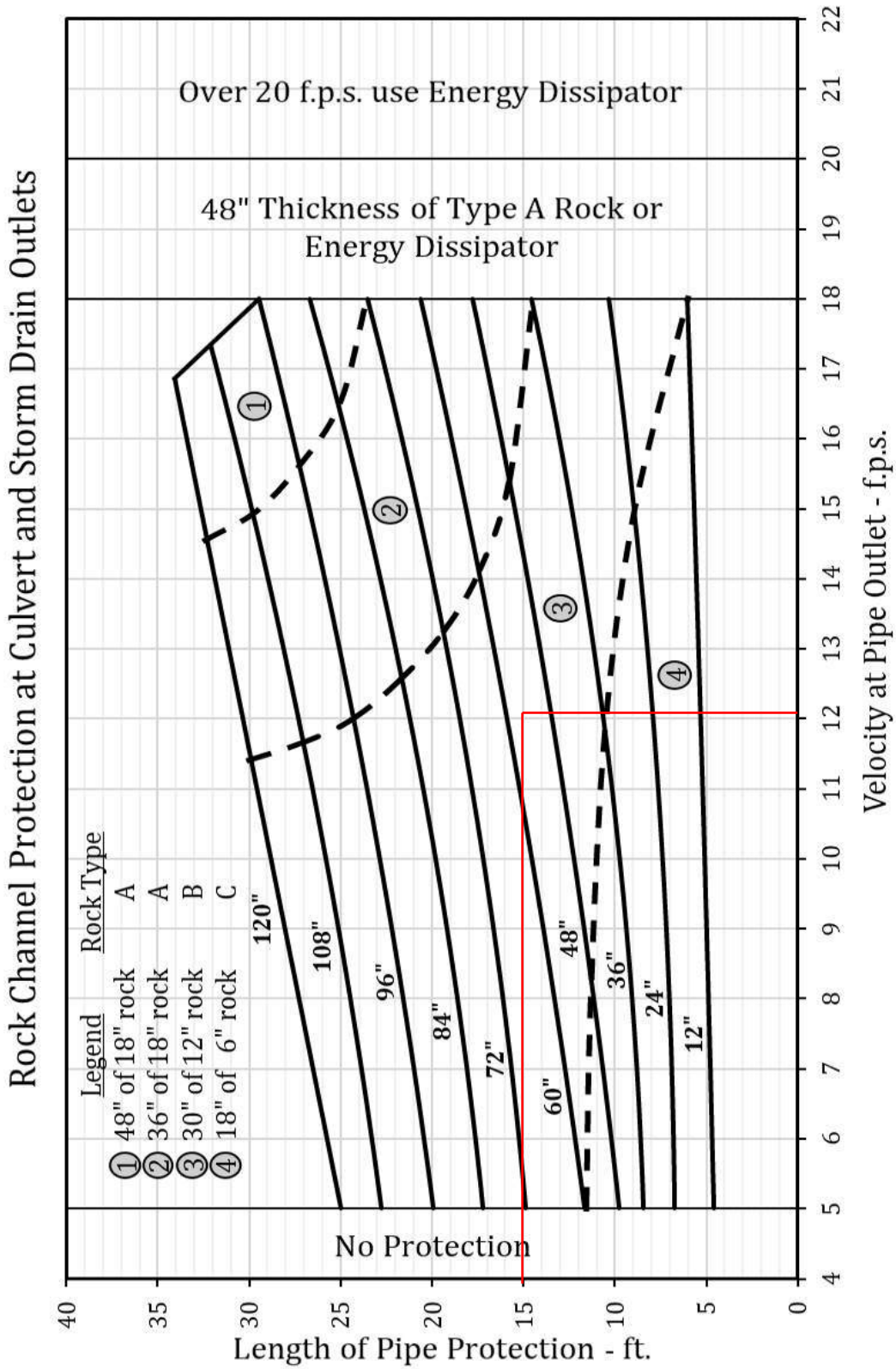
APPENDIX D

Rock Channel Protection Design

ROCK CHANNEL PROTECTION AT CULVERT AND STORM SEWER OUTLETS

1002-4

REFERENCE SECTION 1002.2.3



48" Conduit, Sta. 182+86
Design Velocity = 12.3 ft/s
RCP = 15' - 30" Type B

APPENDIX E

Ditch Analysis

DITCH ANALYSIS

PID : 122880 **Date :** 12/22/2025 **Project :** NE Truck Parking **Location :** SUM-IR-77-VACANT REST AREA TP

Description : Northeast Ohio Truck Parking - Summit County - Ramp S **Designer :** KLG

Rainfall Area : A

Allowable Shears

	Seed:	0.40	**Jute Mat:**	0.45	**Temporary Mat:**	1.00
Permanent Mat	**Type 1:**	3.00	**Type 2:**	4.00	**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.)
190+85	189+00	R	185.00	4.90	3.00	3.00	0.0146	2.42	2.42	0.71	1.72	Seed	2.47	2	0.030	21.26	2.42	0.28	4.24	0.30	6.71
												Seed	3.01	5	0.040	21.43	2.13	0.36	5.17	0.40	7.29
189+00	Concent							2.08		0.79	3.36					21.00					
189+00	186+54	R	246.00	4.90	3.00	3.00	0.0133	0.63	5.13	0.71	3.81	Seed	2.38	2	0.030	22.61	3.00	0.39	9.06	0.48	7.76
												Seed	2.89	5	0.040	22.98	2.61	0.52	11.01	0.62	8.64

APPENDIX F

Post Construction Best Management Practices (BMPs) Calculations

Ohio Department of Transportation - Office of Hydraulic Engineering

Post-Construction BMP Calculation Spreadsheet

Post Construction - Project Summary

Project Data

		Units
Project EDA	7.60	acres
Sheet Flow Area	1.53	acres
Project EDA - Sheet Flow Area	6.07	acres
Is the Project Routine Maintenance per L&D Vol. 2, Sec. 1112.2	No	
BMPs Required?	**BMPs Required**	NA
Ain (New Impervious Area in New Permanent R/W	0	acres
Does Entire Site Drain to Large River (>100 sq. miles)?	No	
Water Quality Treatment Required	**Yes**	
Water Quantity Treatment Required	**No**	

Treatment Percent and Treatment Requirement

Aix (Project EDA that is inside the existing right-of-way)	6.07	acres
Ain (New Impervious Area in New Permanent R/W)	0	acres
T% (Treatment Percent)	**20.00**	**%**
Treatment Requirement	**1.21**	**acres**

BMPs Provided

BMP Name	BMP Type	Contributing Drainage Area (acres)	Contributing Drainage Area in ODOT R/W (acres)
VFS1	Vegetated Filter Strip	0.84	0.84
VFS2	Vegetated Filter Strip	0.54	0.54

Treatment Provided

Total Area with ODOT R/W Treated (acres)	**1.37**
Treatment Requirements (acres)	**1.21**
Treatment Check	**Good**

BMP Submittal Requirements (Per L&D, Vol. 2, Sec. 1116.2)

1. Estimated Project Earth Disturbed Area	Yes	**Good**
2. Treatment Percent Calculation	Yes	**Good**
3. BMP Selected for use	Yes	**Good**
4. Drainage area mapping for post-construction BMPs that show the total contributing drainage area and the amount of contributing area within ODOT right-of-way	Yes	**Good**
5. Plan sheets showing locations of post-construction BMP	Yes	**Good**
6. Calculations for each BMP	Yes	**Good**
7. Explanation for any area that is not treated	Yes	**Good**

Spreadsheet Template
Updated January 2019

Ohio Department of Transportation - Office of Hydraulic Engineering

Post-Construction BMP Calculation Spreadsheet

Vegetated Filter Strip

Filter Strip	Route	Begin Station	End Station	Side	Pavement Width (FT)	Filter Strip Width (FT)	Filter Strip Slope (z:1)	Filter Strip Length (FT)	Drainage Area (acres)	Filter Strip Area (SF)	Item 659 Topsoil Volume (CY)	Item 670 Erosion Protection Area (SY)
Filter Strip #1	Ramp R	163+37	168+10	RT	48	25	6	473	0.84	11,823	146.0	1,313.7
Filter Strip #2	Ramp R	172+37	176+37	RT	28	20.5	6	400	0.54	8,193	101.2	910.4
Filter Strip #3								0			0.0	0.0
Filter Strip #4								0			0.0	0.0
Filter Strip #5								0			0.0	0.0
Filter Strip #6								0			0.0	0.0
Filter Strip #7								0			0.0	0.0
Filter Strip #8								0			0.0	0.0
Filter Strip #9								0			0.0	0.0
Filter Strip #10								0			0.0	0.0

Total Treatment Credit Earned from Vegetated Filter Strips 1.37 acres

(Treatment is for quality only, not quantity)

	BMP Design Considerations	Answer	Design Check
1	Is the min. filter strip width 15-25 ft wide depending on L&D Table 1117-3?	Yes	Good
2	Is the slope 3:1 or flatter for 34 ft or narrower pavement drainage width	Yes	Good
3	Is the slope 6:1 or flatter for 35 - 48 ft pavement drainage width	Yes	Good
4	Is the only contributing drainage to the filter strip from the road and shoulder?	Yes	Good
5	Does any concentrated flow or any outlets discharge to the filter strip?	No	Good
6	Is 4" of Item 659, Topsoil, included for the filter strip?	Yes	Good
7	Is Item 670, Slope Erosion Protection, included for the filter strip?	Yes	Good

APPENDIX G

Truck Parking – Curb Cut Calculations

CURB CUT SPACING DESIGN

PID: 122880 **Date:** 12/1/2025 **Project:** NE Truck Parking **Location:** SUM-IR-77-VACANT REST AREA TP

Description: NE Truck Parking - Site 12 - Truck Parking Lot **Designer:** KLG

Rainfall Area: A **Storm Frequency (yr.):** 2 **Total Allow. Spread (ft.):** 0.00 **Allowable Depth (ft.):** 0.75

STATION	CURB CUT WIDTH (ft.)	GUTTER LENGTH (ft.)	RUNOFF COEF	AREA (acres)	CONC. TIME (min.)	GUTTER TIME (min.)	TIME USED (min.)	LONG. SLOPE (ft./ft.)	GUTTER SLOPE (ft./ft.)	PAVT. SLOPE (ft./ft.)	GUTTER WIDTH (ft.)	LOCAL DEPRESS (ft.)	RAIN FALL (in./hrs.)	INTERCPTD FLOW (cfs.)	BYPASS FLOW (cfs.)	TOTAL FLOW (cfs.)	DEPTH FLOW (ft.)	PAVT. SPREAD (cfs.)	
0+00	Begin																		
0+48	5	51.00	0.90	0.26	10.00	0.59	10.59	0.0050	0.0120	0.0120	0.00	0.0000	3.59	0.30	0.52	0.82	0.12	10.25	
0+99	5	102.00	0.90	0.23	10.00	1.19	11.19	0.0050	0.0120	0.0120	0.00	0.0000	3.49	0.37	0.89	1.26	0.14	12.03	
1+50	5	153.00	0.90	0.24	10.00	1.78	11.78	0.0050	0.0120	0.0120	0.00	0.0000	3.41	0.43	1.18	1.61	0.16	13.19	
2+01	5	204.00	0.90	0.24	10.00	2.38	12.38	0.0050	0.0120	0.0120	0.00	0.0000	3.33	0.46	1.43	1.89	0.17	14.00	
2+52	5	255.00	0.90	0.24	10.00	2.97	12.97	0.0050	0.0120	0.0120	0.00	0.0000	3.25	0.49	1.63	2.12	0.18	14.61	
3+03	5	306.00	0.90	0.24	10.00	3.57	13.57	0.0050	0.0120	0.0120	0.00	0.0000	3.18	0.50	1.80	2.30	0.18	15.07	
3+54	5	357.00	0.90	0.24	10.00	4.16	14.16	0.0050	0.0120	0.0120	0.00	0.0000	3.11	0.51	1.95	2.46	0.19	15.46	
4+02	5	425.00	0.90	0.45	10.00	4.95	14.95	0.0050	0.0120	0.0120	0.00	0.0000	3.02	******	******	3.19	0.20	17.03	Sag