

**HYDROLOGIC AND HYDRAULIC ANALYSIS
FOR THE PROPOSED CONSTRUCTION OF
US 1 BRIDGE OVER I-20
LEXINGTON COUNTY, SOUTH CAROLINA**

ROUTE/ROAD NUMBER: US 1 / I-20

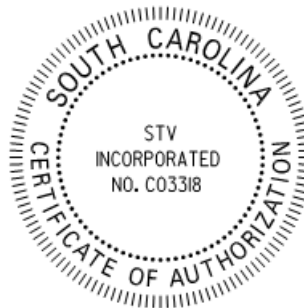
PREPARED BY: Jeff Becker, PE

CHECKED BY: Guy P. Peters, PE, CFM

Hydraulic Design Reference
for this study is the:

2009

Edition of SCDOT's
"Requirements for Hydraulic
Design Studies."



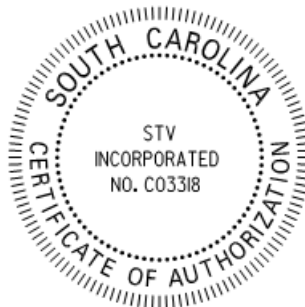
March 22, 2019

STV Incorporated
454 South Anderson Road, Suite 3, BTC 517
Rock Hill, South Carolina 29730-3392
stvinc.com

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FOR THE PROPOSED CONSTRUCTION OF
US 1 BRIDGE OVER I-20
LEXINGTON COUNTY, SOUTH CAROLINA**

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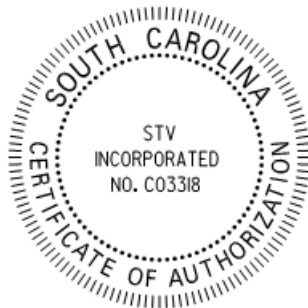
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INTRODUCTION

SCDOT has contracted STV Incorporated to provide professional engineering services for the proposed design build replacement of the US 1 bridge over Interstate 20 and associated interchange improvements in Lexington County. The purpose of this report is to document and define the design procedures that were used to analyze the hydrology and hydraulics for culverts and cross drains in the project area. The project includes bridge replacement and roadway and storm drain improvements with approximate bounding stations on US 1 from Station 292+00 to Station 355+00. It also includes reconfiguration of the interchange ramps and Brickyard Road, Cedar Road, Dooley Road and Monroe Lane in the vicinity of the interchange.

There are no FEMA Special Flood Hazard Areas included in the project area. The project area is contained in FEMA FIRM Panel 45063C0252G, included in Appendix A.

HYDROLOGY

Design Criteria

Culvert and cross drain analysis was performed in accordance with the SCDOT's "Requirements for Hydraulic Design Studies" dated May 26, 2009. The 2% annual chance (50-year) peak flows were used for the analysis and all locations were checked for the 1% annual chance (100-year) peak flow for overtopping.

Methodology (Rational Method)

The rational method was used to calculate peak discharges for all drainage systems with drainage areas up to 100 acres. A spreadsheet is used to calculate Q. The Rational formula is as follows:

$$Q = C \cdot I \cdot DA \cdot C_f$$

Where: Q = discharge in cubic feet per second (cfs)
C = the runoff coefficient
I = the rainfall intensity in inches per hour (in/hr)
DA = Drainage Area (ac), and where
C_f, Runoff Factor, is defined by:

Recurrence Interval,	Return Period,	Runoff Factor,
<u>Years</u>	<u>% annual chance</u>	<u>C_f</u>
2 – 10	50-10	1.0
25	4	1.1
50	2	1.2
100	1	1.25

Runoff Coefficient (C)

Runoff coefficients were determined from a visual inspection of the project area and the following table from HEC 22, "Urban Drainage Design Manual," publication No. NHI 01-021, August 2001.

Type of Drainage Area	Runoff Coefficient, C*
Business:	
Downtown areas	0.70 - 0.95
Neighborhood areas	0.50 - 0.70
Residential:	
Single-family areas	0.30 - 0.50
Multi-units, detached	0.40 - 0.60
Multi-units, attached	0.60 - 0.75
Suburban	0.25 - 0.40
Apartment dwelling areas	0.50 - 0.70
Industrial:	
Light areas	0.50 - 0.80
Heavy areas	0.60 - 0.90
Parks, cemeteries	0.10 - 0.25
Playgrounds	0.20 - 0.40
Railroad yard areas	0.20 - 0.40
Unimproved areas	0.10 - 0.30
Lawns:	
Sandy soil, flat, 2%	0.05 - 0.10
Sandy soil, average, 2 - 7%	0.10 - 0.15
Sandy soil, steep, 7%	0.15 - 0.20
Heavy soil, flat, 2%	0.13 - 0.17
Heavy soil, average, 2 - 7%	0.18 - 0.22
Heavy soil, steep, 7%	0.25 - 0.35
Streets:	
Asphalt	0.70 - 0.95
Concrete	0.80 - 0.95
Brick	0.70 - 0.85
Drives and walks	
	0.75 - 0.85
Roofs	
	0.75 - 0.95
*Higher values are usually appropriate for steeply sloped areas and longer return periods because infiltration and other losses have a proportionally smaller effect on runoff in these cases.	

Table 2: Runoff Coefficients for Rational Formula

Time of Concentration (Tc)

Time of Concentration is calculated using a spreadsheet based on the TR-55 method. All TOC values were derived from the existing conditions drainage area topographic map.

Rainfall intensity (I)

Rainfall intensities were determined using the following equation and the values indicated in the Rainfall Intensity Values charts provided by SCDOT.

$$i = \frac{a}{(b + t_c)^c}$$

The coefficients for Lexington County for the 2-, 5-, 10-, 25-, 50-, and 100-year rainfalls are given in the Table 3 below as well as the intensity values for the 5, 10, and 15 minute times of concentration.

Lexington County							
Frequency (Years)	% Annual Chance Return	a	b	c	i (t _c = 5)	i (t _c = 10)	i (t _c = 15)
2	50	243.38820	35.11116	1.03249	5.38	4.77	4.28
5	20	257.20585	32.95479	1.01898	6.32	5.58	4.98
10	10	266.59333	31.54121	1.00995	7.04	6.18	5.51
25	4	279.10068	29.68983	0.99799	8.10	7.08	6.29
50	2	287.98860	28.36995	0.98949	8.95	7.80	6.91
100	1	295.95202	27.15897	0.98180	9.80	8.51	7.51

Table 3: Rainfall Intensities for Lexington County, SC

Drainage Area (DA)

Drainage areas for closed systems, ditches, and etc. were delineated using “Microstation V8” and utilizing surveyed one foot contours, surveyed point elevations, and field observations. (See Appendix A for Drainage Area Map).

Methodology (SCS Method)

In accordance with SCDOT requirements, the SCS Method, as presented in SCS publication TR-55, was used to calculate peak discharges for all drainage systems with drainage areas between 100 and 640 acres (one square mile). The SCS method relies on determination of a composite Curve Number that represents the land uses/land covers in the subject drainage area. The peak flows computed by the SCS are most sensitive to this Curve Number, so much so that in fact many practitioners refer to this method as the Curve Number Method. A spreadsheet has been developed to calculate peak flows as described in TR-55.

Curve Numbers were determined from a visual inspection of the project area and from Tables 2.1 and 2.2 (below) from TR-55. Peak discharges were then computed from the graphical peak discharge method detailed in the spreadsheets in Appendix B.

Table 2-2a Runoff curve numbers for urban areas ^{1/}

Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	Average percent impervious area ^{2/}	A	B	C	D
<i>Fully developed urban areas (vegetation established)</i>					
Open space (lawns, parks, golf courses, cemeteries, etc.) ^{3/} :					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) ^{4/}		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
<i>Developing urban areas</i>					
Newly graded areas (pervious areas only, no vegetation) ^{5/}		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

^{1/} Average runoff condition, and $I_a = 0.2S$.^{2/} The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.^{3/} CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.^{4/} Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.^{5/} Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.**Figure 2.1** SCS Curve Numbers for urban land cover types

Table 2-2c Runoff curve numbers for other agricultural lands ^{1/}

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range—continuous forage for grazing. ^{2/}	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay.	—	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element. ^{3/}	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30 ^{4/}	48	65	73
Woods—grass combination (orchard or tree farm). ^{5/}	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods. ^{6/}	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30 ^{4/}	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	—	59	74	82	86

^{1/} Average runoff condition, and $I_a = 0.2S$.

^{2/} *Poor*: <50% ground cover or heavily grazed with no mulch.

Fair: 50 to 75% ground cover and not heavily grazed.

Good: > 75% ground cover and lightly or only occasionally grazed.

^{3/} *Poor*: <50% ground cover.

Fair: 50 to 75% ground cover.

Good: >75% ground cover.

^{4/} Actual curve number is less than 30; use CN = 30 for runoff computations.

^{5/} CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

^{6/} *Poor*: Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.

Fair: Woods are grazed but not burned, and some forest litter covers the soil.

Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

Figure 2.2 SCS Curve Numbers for rural and agricultural land cover types

CULVERT HYDRAULICS

Design Criteria

Culverts and cross drains were analyzed, and new drainage systems connected to them, in general accordance with the SCDOT's "Requirements for Hydraulic Design Studies" dated May 26, 2009, Section 2.3.D.1 (see Appendix B for calculations).

Methodology

HY-8 is the analysis tool of choice for analyzing culvert capacity and determining performance characteristics of culverts and cross drains. Appendix D presents detailed output for each location analyzed. Analysis accounts for flows routed to culverts from new median drainage systems.

BRIDGE DECK DRAINAGE

Design Criteria

Bridge deck drainage was evaluated or spread in order to determine if an on-structure drainage system would be required. With a high point located on the bridge, the bridge deck was divided into four quadrants and spread was computed at each approach slab corner for the 10% annual chance (10-year, computed by Rational Method) peak flow. In summary, we anticipate no need for an on-structure system to control spread. One quadrant indicated spread exceeding the gutter

width plus $\frac{1}{2}$ of the travel lane (7.5 feet), but spread can be controlled with scuppers located away from the I-20 travel lanes and shoulder below. Appendix C contains the output from the Hydraulic Toolbox calculations.

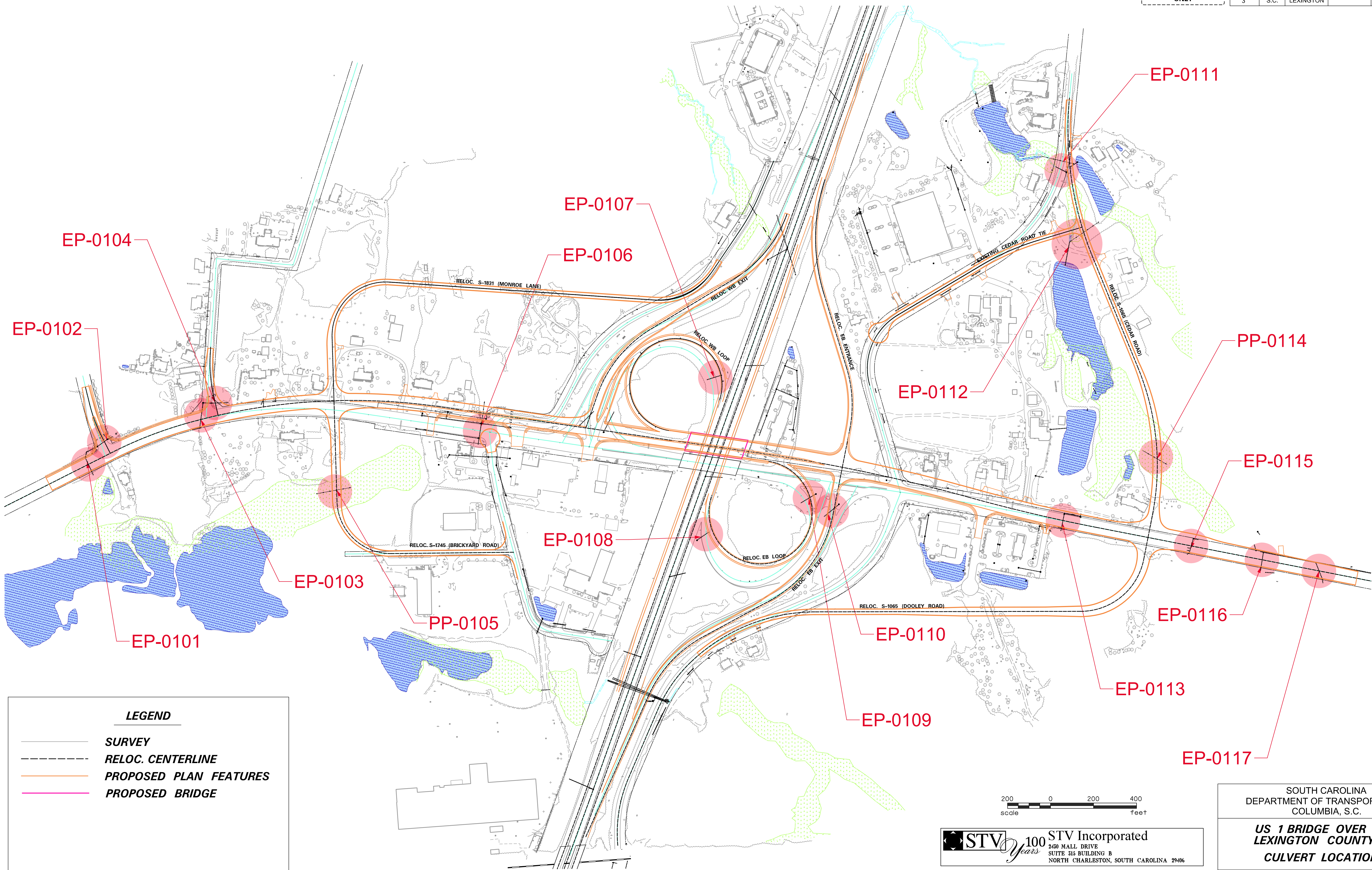
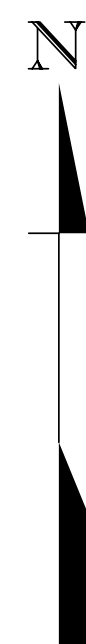
Appendix A

Project Maps

BeckerJM
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3/2/2019

FOR INFORMATION
ONLY

FED. ROAD DIV. NO.	STATE	COUNTY	PROJECT ID	RTE. NO.	SHEET NO.
3	S.C.	LEXINGTON		US 1	1



LEGEND

- SURVEY
- RELOC. CENTERLINE
- PROPOSED PLAN FEATURES
- PROPOSED BRIDGE



STV 100 Years
STV Incorporated
2450 MALL DRIVE
SUITE 315 BUILDING B
NORTH CHARLESTON, SOUTH CAROLINA 29406

SOUTH CAROLINA
DEPARTMENT OF TRANSPORTATION
COLUMBIA, S.C.

**US 1 BRIDGE OVER I-20
LEXINGTON COUNTY, SC
CULVERT LOCATIONS**

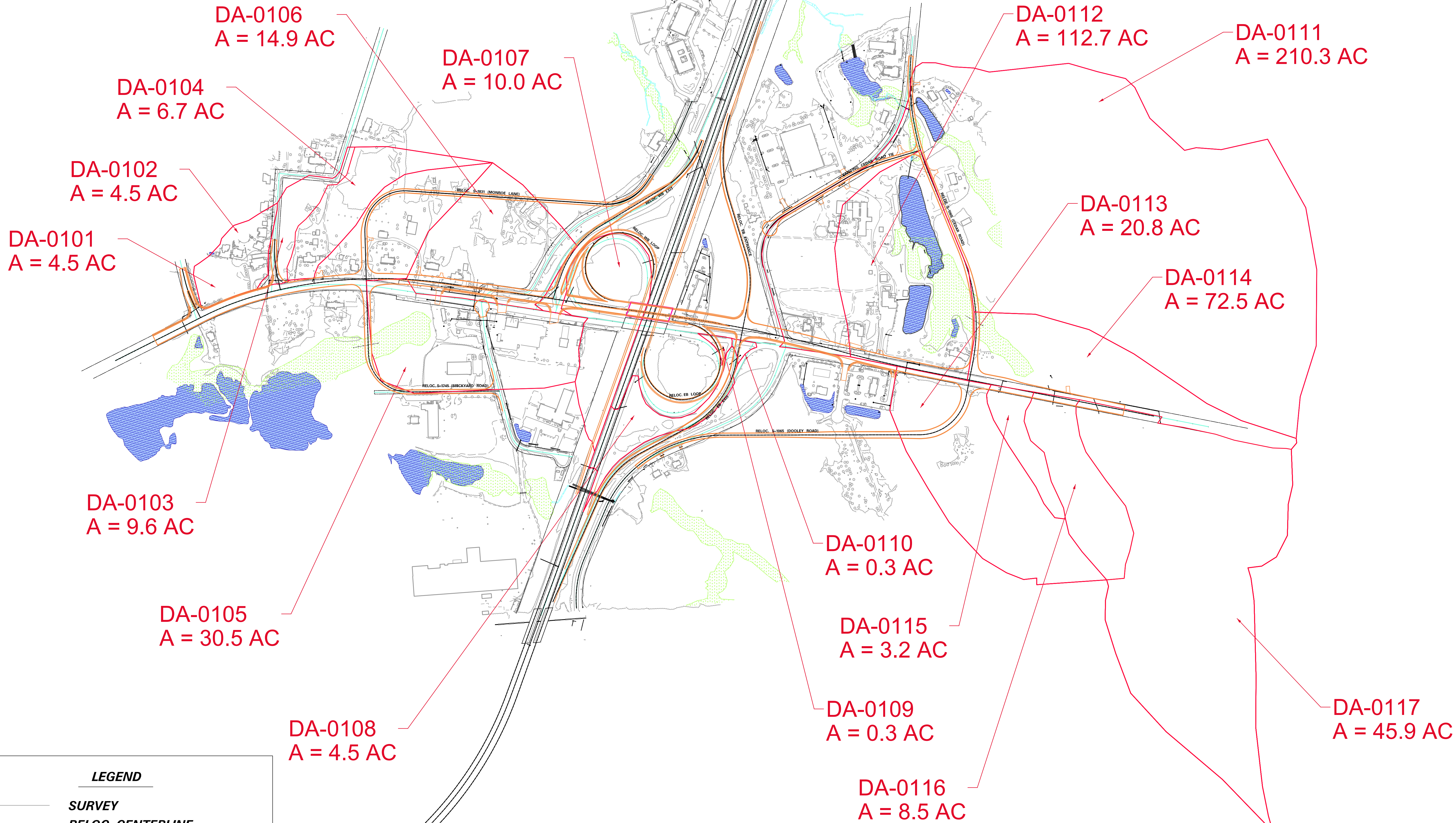
SCALE 1" = 200' RTE. DWG. NO. A2

A.1

BeckerJM
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3/22/2019

FOR INFORMATION
ONLY

FED. ROAD DIV. NO.	STATE	COUNTY	PROJECT ID	RTE. NO.	SHEET NO.
3	S.C.	LEXINGTON		US 1	2



LEGEND

- SURVEY
- RELOC. CENTERLINE
- PROPOSED PLAN FEATURES
- PROPOSED BRIDGE
- DRAINAGE AREA



STV 100 Years STV Incorporated
2450 MALL DRIVE
SUITE 315 BUILDING B
NORTH CHARLESTON, SOUTH CAROLINA 29406

SOUTH CAROLINA
DEPARTMENT OF TRANSPORTATION
COLUMBIA, S.C.

**US 1 BRIDGE OVER I-20
LEXINGTON COUNTY, SC
DRAINAGE AREAS**

SCALE 1" = 200' RTE. DWG. NO.

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program; it does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size, or all planimetric features outside Special Flood Hazard Areas. The community map repository should be consulted for possible updated flood hazard information prior to use of this map for property purchase or construction purposes.

Coastal base flood elevations apply only landward of 0.0' National Geodetic Vertical Datum of 1929 (NGVD), and include the effects of wave action; these elevations may also differ significantly from those developed by the National Weather Service for hurricane evacuation planning.

Areas of special flood hazard (100-year flood) include Zones A, AE, AH, AO, A99, V, and VE.

Certain areas not in Special Flood Hazard Areas may be protected by flood control structures.

Boundaries of the floodways were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the Federal Emergency Management Agency.

Floodway widths in some areas may be too narrow to show to scale. Floodway widths are provided in the Flood Insurance Study Report.

Corporate limits shown on this map are based on the best data available. The user should contact appropriate community officials to verify the corporate limit delineations shown on this map.

For community map revision history prior to countywide mapping, see section 6.0 of the Flood Insurance Study Report.

For adjoining map panels see separately printed Map Index.

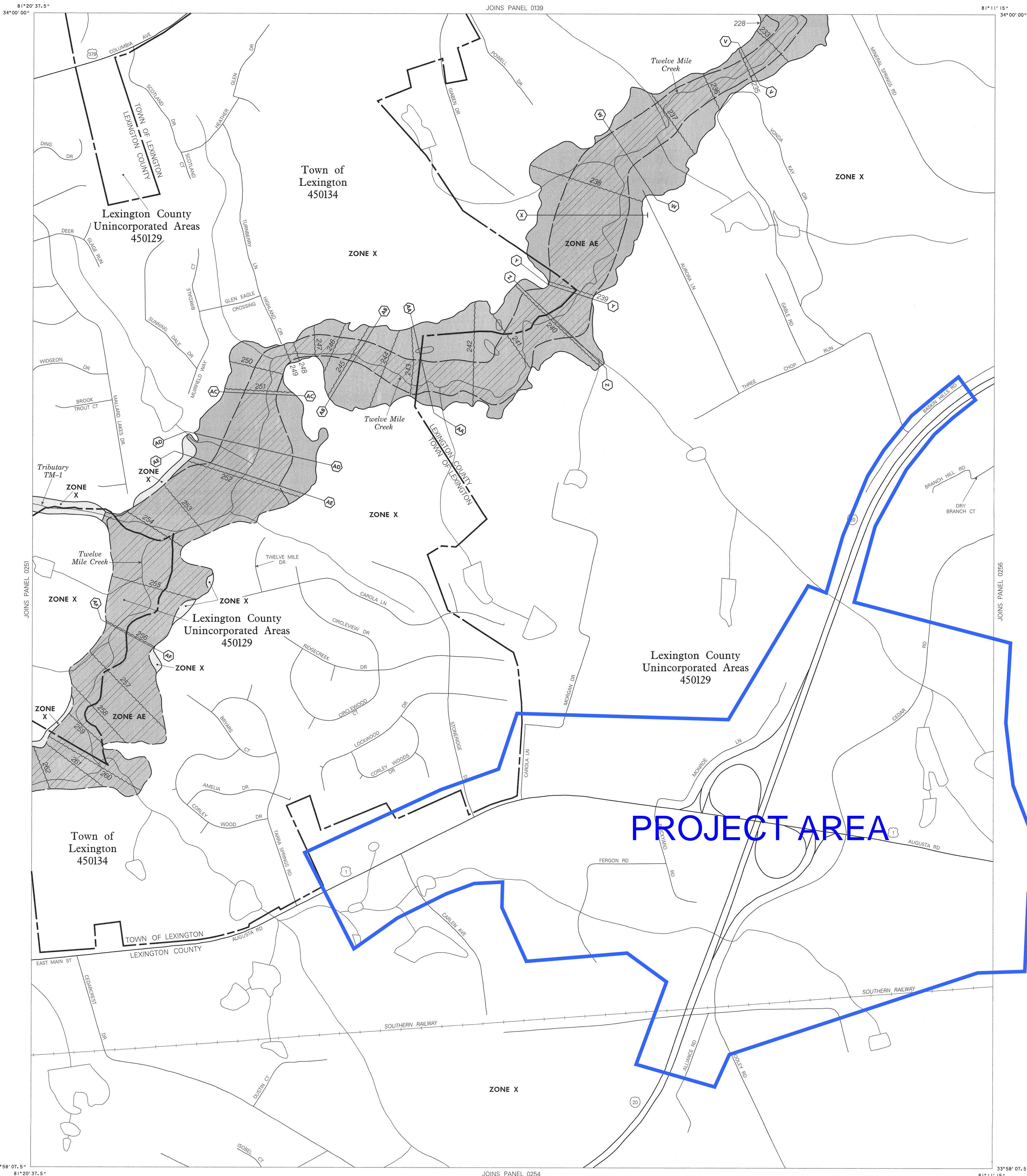
DIGITAL DATA AVAILABILITY: Digital files containing the thematic floodplain information shown on these maps are published by the Federal Emergency Management Agency in DLG-3 Optional format on CD-ROM. Requests for data should include the full name of the community or county and the Flood Insurance Rate Map panel numbers covered by the request. Contact the Federal Emergency Management Agency, Map Service Center, 6730 Santa Barbara Court, Baltimore, Maryland 21227-5832, Telephone 1-800-368-9616.

NOTE: The coordinate system used for the production of this Flood Insurance Rate Map (FIRM) is Universal Transverse Mercator (UTM), North American Datum of 1927 (NAD27), Clarke 1866 spheroid. Corner coordinates shown on the FIRM are in latitude and longitude referenced to the Universal Transverse Mercator projection, NAD27. Differences in the datum and spheroid used in the production of FIRMs for adjacent counties may result in slight positional differences in map features at the county boundaries. These differences do not affect the accuracy of the information shown on the FIRM.

ATTENTION: Flood elevations on this map are referenced to the National Geodetic Vertical Datum of 1929. These flood elevations must be compared to structure and ground elevations referenced to the same datum. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, contact the National Geodetic Survey at the following address:

Vertical Network Branch, N/CG13
National Geodetic Survey, NOAA
Silver Spring Metro Center 3
1315 East-West Highway
Silver Spring, Maryland 20910
(301) 713-3191

BASE MAP SOURCE: Planimetric base map files were provided in digital format by the Lexington County Department of Planning and Development. These files were compiled at scales of 1"=200' and 1"=400' from orthophotography dated March 1989.



LEGEND

- SPECIAL FLOOD HAZARD AREAS INUNDATED BY 100-YEAR FLOOD
 - ZONE A** No base flood elevations determined.
 - ZONE AE** Base flood elevations determined.
 - ZONE AH** Flood depths of 1 to 3 feet (usually areas of ponding); base flood elevations determined.
 - ZONE AO** Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
 - ZONE A99** To be protected from 100-year flood by Federal flood protection system under construction; no base flood elevations determined.
 - ZONE V** Coastal flood with velocity hazard (wave action); no base flood elevations determined.
 - ZONE VE** Coastal flood with velocity hazard (wave action); base flood elevations determined.
- FLOODWAY AREAS IN ZONE AE
- OTHER FLOOD AREAS
 - ZONE X** Areas of 500-year flood; areas of 100-year flood with average depths of less than 1 foot, or with drainage areas less than 1 square mile; and areas protected by levees from 100-year flood.
- OTHER AREAS
 - ZONE X** Areas determined to be outside 500-year floodplain.
 - ZONE D** Areas in which flood hazards are undetermined.
- UNDEVELOPED COASTAL BARRIERS*
 - Identified 1983
 - Identified 1990 or Later
 - Otherwise Protected Areas Identified 1991 or Later

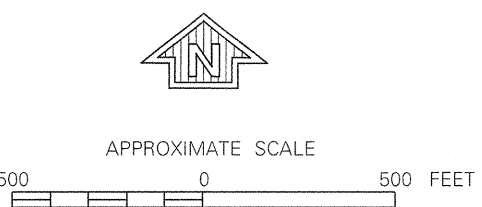
* Coastal barrier areas are normally located within or adjacent to Special Flood Hazard Areas.

- Floodplain Boundary
- Floodway Boundary
- Zone D Boundary
- Boundary Dividing Special Flood Hazard Zones, and Boundary Dividing Areas of Different Coastal Base Flood Elevations Within Special Flood Hazard Zones.
- Base Flood Elevation Line; Elevation in Feet**
- Cross Section Line
- Base Flood Elevation in Feet Where Uniform Within Zone**
- RM7
- M1.5
- Elevation Reference Mark
- River Mile

**Referenced to the National Geodetic Vertical Datum of 1929

- MAP REPOSITORY
 - Refer to Repository Listing on Map Index
- EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP
 - JULY 17, 1995
- EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
 - February 9, 2000 - to change base flood elevations, to add base flood elevations and special flood hazard areas, to change special flood hazard areas and zone designations, to add roads and road names, to incorporate previously issued letters of map revision and to reflect updated topographic information.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at (800) 638-6620.



NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP
LEXINGTON COUNTY,
SOUTH CAROLINA
AND INCORPORATED AREAS

PANEL 252 OF 575
(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
LEXINGTON TOWN OF	450134	0252	G
LEXINGTON COUNTY	450129	0252	G

Notice to User: The MAP NUMBER shown below should be used when placing map orders; the COMMUNITY NUMBER shown above should be used on insurance applications for the subject community.

MAP NUMBER
45063C0252 G

MAP REVISED:
FEBRUARY 9, 2000




Federal Emergency Management Agency


Appendix B

Culvert Calculations

<div><div><div>STV</div><div>100 Years</div></div><div>www.stvinc.com</div></div>																JOB: US-1 _ I-20 SUBJECT: Culvert Summary CALCD BY: JMB CHECKD BY: GPP				DATE: 20-Mar-19 DATE: 20-Mar-19				1 SHEET OF 2									
CULVERT SUMMARY SHEET - PRE-CONSTRUCTION FLOWS																																	
SITE DATA					RUNOFF Rational Method Q = C*I*A*C _f - (C _{f10} = 1.0, C _{f25} = 1.1, C _{f50} = 1.2, C _{f100} = 1.25) Q ₅₀₀ = Q ₁₀₀ * 1.7											PIPE DATA								RESULTS								NOTES	
Culvert ID	Road Name	Alignment	Station	Existing Crest Elevation	Runoff Coefficient 'C'	Drainage Area 'A' (ac)	Time of Conc. T _c ' (min)	Rainfall Intensity 10% annual chance (in/hr)	Rainfall Intensity 4% ann. chance (in/hr)	Rainfall Intensity 2% ann. chance (in/hr)	Rainfall Intensity 1% ann chance (in/hr)	Total Runoff 10% ann. chance (cfs)	Total Runoff 4% an. chance (cfs)	Total Runoff 2% ann. chance (cfs)	Total Runoff 1% ann. chance (cfs)	Total Runoff 0.2% ann chance (cfs)	Material	Number of Barrels	Span and Rise	Pipe Diameter (in)	Pipe Length (ft)	Invert Up	Invert Down	Pipe Slope (ft/ft)	10-yr storm HW Elev (ft)	10-yr storm HW / D	25-yr storm HW Elev (ft)	25-yr storm HW / D	50-yr storm HW Elev (ft)	50-yr storm HW / D	100-yr storm HW Elev (ft)	Flood / Overtop Frequency (-yr storm)	Hydraulic Notes
EP-0101	US-1	REL_US1	351+65	349.00	0.51	4.5	20	5.06	5.76	6.34	6.86	12	15	18	20	34	RCP	1	24	24	120	343.14	342.54	0.005	345.06	0.96	345.49	1.18	345.70	1.28	346.08	500	HW/D > 1.2 for the 50-yr storm, but there is no flooding potential for the 100-yr storm.
EP-0102	US-1	REL_US1	350+95	351.00	0.51	4.5	20	5.06	5.76	6.34	6.86	12	15	18	20	34	RCP	1	30	30	85	346.21	345.83	0.004	347.90	0.68	348.15	0.78	348.38	0.87	348.53	500	HW/D < 1.2 for 50-yr storm.
EP-0103	US-1	REL_US1	346+00	361.00	0.34	9.6	35	3.93	4.45	4.89	5.26	13	16	19	21	36	RCP	1	12	12	114	357.64	354.38	0.029	361.02	3.38	361.02	3.38	361.03	3.39	361.03	<10	HW/D > 1.2. Potential roadway flooding for the 100-yr storm.
EP-0104	US-1	REL_US1	345+35	363.00	0.35	6.7	40	3.70	4.19	4.60	4.94	9	11	13	14	25	RCP	1	12	12	39	358.36	358.31	0.001	363.01	4.65	363.01	4.65	363.02	4.66	363.02	<10	HW/D > 1.2. Potential roadway flooding for the 100-yr storm.
EP-0106	US-1	REL_US1	332+79	358.00	0.35	13.6	29	4.25	4.82	5.30	5.70	20	25	30	34	57	RCP	1	24	24	67	354.13	351.94	0.033	357.04	1.46	357.93	1.90	358.01	1.94	358.02	50	HW/D > 1.2. Potential roadway flooding for the 100-yr storm.
EP-0107	WB LOOPA	REL_LOOP_A	351+50	349.00	0.62	10.0	16	5.42	6.18	6.80	7.38	34	42	51	57	97	RCP	1	24	24	74	344.88	343.74	0.015	349.02	2.07	349.03	2.07	349.04	2.08	349.05	<10	HW/D > 1.2. Potential roadway flooding for the 100-yr storm.
EP-0108	EB LOOP C	REL_LOOP_C	363+43	354.00	0.53	4.5	9	6.35	7.28	8.03	8.77	15	19	23	26	45	RCP	1	18	18	64	350.59	349.54	0.016	354.01	2.28	354.01	2.28	354.02	2.29	354.03	<10	HW/D > 1.2. Potential roadway flooding for the 100-yr storm.
EP-0109	EB LOOP C	REL_LOOP_C	356+11	372.00	0.95	0.3	5	7.04	8.10	8.95	9.80	2	3	3	4	7	RCP	1	15	15	81	368.43	366.82	0.020	369.23	0.64	369.46	0.82	369.46	0.82	369.68	>500	HW/D < 1.2 for 50-yr storm.
EP-0110	EB LOOP C	REL_LOOP_C	356+14	372.00	0.61	0.3	5	7.04	8.10	8.95	9.80	1	1	2	2	3	RCP	1	15	15	89	369.08	368.77	0.003	369.68	0.48	369.68	0.48	369.96	0.70	369.96	>500	HW/D < 1.2 for 50-yr storm.
EP-0111	CEDAR RD	REL_CEDAR	27+75	333.00	63	209.9	60	SCS				149	223	303	391	665	RCP	1	40	40	54	322.65	322.17	0.009	333.04	3.12	333.10	3.14	333.15	3.15	333.20	<10	HW/D > 1.2. Potential roadway flooding for the 100-yr storm. Does not assume attenuation.
EP-0112	CEDAR RD CONNECTOR	REL_CEDAR_CON	268+87	341.00	61	112.7	48	SCS				71	107	145	190	323	RCP	1	18	18	108	339.00	329.00	0.093	341.08	1.39	341.10	1.40	341.13	1.42	341.15	<10	HW/D > 1.2. Potential roadway flooding for the 100-yr storm. Does not assume attenuation.
EP-0113	US-1	REL_US1	305+32	366.00	0.32	20.8	26	4.52	5.13	5.65	6.09	30	37	45	51	86	RCP	1	30	30	65	360.40	359.30	0.017	363.55	1.26	364.30	1.56	365.37	1.99	366.01	100	HW/D > 1.2. Potential roadway flooding for the 100-yr storm.
EP-0115	US-1	REL_US1	299+25	369.00	0.33	3.2	20	5.06	5.76	6.34	6.86	5	7	8	9	15	RCP	1	18	18	65	364.74	363.00	0.027	366.02	0.85	366.36	1.08	366.55	1.21	366.76	>500	HW/D < 1.2 for 50-yr storm.
EP-0116	US-1	REL_US1	295+88	369.00	0.33	8.5	25	4.61	5.24	5.76	6.22	35	49	64	75	234	RCP	1	36	36	86	362.31	359.38	0.034	365.25	0.98	366.18	1.29	367.50	1.73	368.72	500	HW/D > 1.2 for the 50-yr storm, but there is no flooding potential for the 100-yr storm.
EP-0117	US-1	REL_US1	293+15	368.00	0.31	45.9	49	3.29	3.72	4.08	4.38	47	58	70	78	132	RCP	1	24	24	101	364.30	361.44	0.028	368.04	1.87	368.05	1.88	368.06	1.88	368.07	<10	Overflow overtops berm elevation @ 368.00 and conveys to EP-0116 before overtopping roadway elevation of 370.00

<div><div><div>STV</div><div>100 Years</div></div><div>www.stvinc.com</div></div>																JOB: SUBJECT: US-1 _ I-20 Culvert Summary CALCD BY: JMB CHECKD BY: GPP				DATE: 20-Mar-19 DATE: 20-Mar-19				2 SHEET OF 2										
CULVERT SUMMARY SHEET - POST-CONSTRUCTION FLOWS																																		
SITE DATA					RUNOFF Rational Method Q = C*I*A*C _f - (C _{f10} = 1.0, C _{f25} = 1.1, C _{f50} = 1.2, C _{f100} = 1.25) Q ₅₀₀ = Q ₁₀₀ * 1.7											PIPE DATA								RESULTS								NOTES		
Culvert ID	Road Name	Alignment	Station	Existing Crest Elevation	Runoff Coefficient 'C'	Drainage Area 'A' (ac)	Time of Conc. T _c (min)	Rainfall Intensity 10% annual chance (in/hr)	Rainfall Intensity 4% ann. chance (in/hr)	Rainfall Intensity 2% ann. chance (in/hr)	Rainfall Intensity 1% ann chance (in/hr)	Total Runoff 10% ann. chance (cfs)	Total Runoff 4% an. chance (cfs)	Total Runoff 2% ann. chance (cfs)	Total Runoff 1% ann. chance (cfs)	Total Runoff 0.2% ann chance (cfs)	Material	Number of Barrels	Span and Rise	Pipe Diameter (in)	Pipe Length (ft)	Invert Up	Invert Down	Pipe Slope (ft/ft)	10-yr storm HW Elev (ft)	10-yr storm HW / D	25-yr storm HW Elev (ft)	25-yr storm HW / D	50-yr storm HW Elev (ft)	50-yr storm HW / D	100-yr storm HW Elev (ft)	Flood / Overtop Frequency (-yr storm)	Hydraulic Notes	
EP-0101	US-1	REL_US1	351+65	349.00	0.54	4.5	20	5.06	5.76	6.34	6.86	12	15	19	21	36	RCP	1	24	24	120	343.14	342.54	0.005	345.06	0.96	345.49	1.18	345.78	1.32	346.08	500	HW/D > 1.2 for the 50-yr storm, but there is no flooding potential for the 100-yr storm.	
EP-0102	US-1	REL_US1	350+95	351.00	0.54	4.5	20	5.06	5.76	6.34	6.86	12	15	19	21	36	RCP	1	30	30	85	346.21	345.83	0.004	347.90	0.68	348.15	0.78	348.38	0.87	348.53	> 500	HW/D < 1.2 for 50-yr storm.	
EP-0103	US-1	REL_US1	346+00	361.00	0.41	9.6	35	3.93	4.45	4.89	5.26	15	19	23	26	44	RCP	1	30	30	114	357.64	354.38	0.029	359.55	0.76	359.85	0.88	360.16	1.01	360.41	500	Propose to increase pipe size from 12" to 30" RCP	
EP-0104	US-1	REL_US1	345+35	363.00	0.42	6.7	40	3.70	4.19	4.60	4.94	10	13	16	17	30	RCP	1	30	30	39	358.36	358.31	0.001	359.99	0.65	360.26	0.76	360.50	0.86	360.58	> 500	Propose to increase pipe size from 12" to 30" RCP	
PP-0105	BRICKYARD RD	REL_BRICKYARD	20+00	356.00	0.55	30.5	33	4.02	4.56	5.01	5.38	67	84	101	113	191	RCP	1	54	54	165	342.00	338.00	0.024	345.50	0.78	346.04	0.90	346.59	1.02	347.00	500	Propose to add new 54" RCP under Brickyard Rd	
EP-0106	US-1	REL_US1	332+79	358.00	0.37	14.9	29	4.25	4.82	5.30	5.70	23	29	35	39	67	RCP	1	36	36	205	354.13	351.94	0.011	356.40	0.76	356.76	0.88	357.11	0.99	357.35	500	Propose to increase pipe size from 24" to 36" RCP	
EP-0107	WB LOOPA	REL_LOOP_A	351+50	349.00	0.65	10.0	16	5.42	6.18	6.80	7.38	35	44	53	60	102	RCP	1	42	42	74	344.88	343.74	0.015	347.58	0.77	348.00	0.89	348.42	1.01	348.77	500	Propose to increase pipe size from 24" to 42" RCP	
EP-0108	EB LOOP C	REL_LOOP_C	363+43	354.00	0.60	4.5	9	6.35	7.28	8.03	8.77	17	22	26	30	51	RCP	1	30	30	64	350.59	349.54	0.016	352.67	0.83	353.05	0.98	353.38	1.12	353.74	500	Propose to increase pipe size from 18" to 30" RCP	
EP-0109	EB LOOP C	REL_LOOP_C	356+11	372.00	0.57	0.3	5	7.04	8.10	8.95	9.80	1	2	2	2	4	RCP	1	15	15	81	368.43	366.82	0.020	369.23	0.64	369.46	0.82	369.46	0.82	369.68	> 500	HW/D < 1.2 for 50-yr storm.	
EP-0110	EB LOOP C	REL_LOOP_C	356+14	372.00	0.64	0.3	5	7.04	8.10	8.95	9.80	1	2	2	2	4	RCP	1	15	15	89	369.08	368.77	0.003	369.68	0.48	369.68	0.48	369.96	0.70	369.96	> 500	HW/D < 1.2 for 50-yr storm.	
EP-0111	CEDAR RD	REL_CEDAR	27+75	333.00	62.00	210.3	60	SCS				151	228	302	390	663	RCP	1	78	78	200	322.65	320.00	0.013	327.42	0.73	328.84	0.95	330.29	1.18	332.42	500	Propose to add new 78" RCP under Cedar Rd	
EP-0112	CEDAR RD CONNECTOR	REL_CEDAR_CON	268+87	341.00	62	112.7	48	SCS				79	118	156	201	342	RCP	1	60	60	275	332.75	330.00	0.010	336.44	0.74	337.51	0.95	338.61	1.17	340.22	500	Propose to increase pipe size from 18" to 60" RCP and add additional 60"RCP under Cedar Rd	
EP-0113	US-1	REL_US1	305+32	366.00	0.35	20.8	26	4.52	5.13	5.65	6.09	33	41	49	55	94	RCP	1	42	42	65	360.40	359.30	0.017	363.00	0.74	363.38	0.85	363.75	0.96	363.03	500	Propose to increase pipe size from 30" to 42" RCP	
PP-0114	CEDAR RD	REL_CEDAR	13+81	362.00	0.35	72.5	34	3.97	4.50	4.95	5.32	101	126	151	169	287	RCP	1	60	60	130	347.00	346.00	0.008	351.31	0.86	351.98	1.00	352.71	1.14	353.29	500	Propose to add new 54" RCP under Cedar Rd	
EP-0115	US-1	REL_US1	299+25	369.00	0.33	3.2	20	5.06	5.76	6.34	6.86	5	7	8	9	15	RCP	1	18	18	65	364.74	363.00	0.027	366.02	0.85	366.36	1.08	366.55	1.21	366.76	> 500	HW/D < 1.2 for 50-yr storm.	
EP-0116	US-1	REL_US1	295+88	369.00	0.33	8.5	25	4.61	5.24	5.76	6.22	35	49	64	75	234	RCP	1	36	36	86	362.31	359.38	0.034	365.25	0.98	366.18	1.29	367.50	1.73	368.72	500	HW/D > 1.2 for the 50-yr storm, but there is no flooding potential for the 100-yr storm.	
EP-0117	US-1	REL_US1	293+15	370.00	0.31	45.9	49	3.29	3.72	4.08	4.38	47	58	70	78	132	RCP	1	24	24	101	364.30	361.44	0.028	368.04	1.87	368.05	1.88	368.06	1.88	368.07	< 10	Overflow overtops berm elevation @ 368.00 and conveys to EP-0116 before overtopping roadway elevation of 370.00	

		JOB: US-1 _ I-20						1
		SUBJECT: C Value Calculations						SHEET
		CALC'D BY: JMB			DATE: 20-Mar-19			OF
		CHEK'D BY: GPP			DATE: 20-Mar-19			2
Pre Construction C Value Calcs								
Culvert #	Culvert ID	Woods (Ac)	Industrial (Ac)	Residential (Ac)	Open Space (Ac)	Impervious (Ac)	Total Area (Ac)	C Value
1	EP-0101	0	0	2.4353	1.8771	0.2068	4.5192	0.51
2	EP-0102	0	0	2.4353	1.8771	0.2068	4.5192	0.51
3	EP-0103	6.5162	0	1.8328	1.0129	0.2249	9.5868	0.34
4	EP-0104	4.002	0	1.6803	1.0129	0	6.6952	0.35
6	EP-0106	10.2736	0	1.5193	2.1499	0.9773	14.9201	0.35
7	EP-0107	2.672	3.485	0	2.1189	1.7338	10.0097	0.62
8	EP-0108	0.3809	0	0	2.7499	1.4055	4.5363	0.53
9	EP-0109	0	0	0	0	0.3344	0.3344	0.95
10	EP-0110	0	0	0	0.1543	0.1184	0.2727	0.61
13	EP-0113	9.6646	0.1653	0	10.4875	0.4463	20.7637	0.32
15	EP-0115	2.0507	0	0	1.0327	0.2363	3.3197	0.33
16	EP-0116	3.5213	0	0.3708	0.7087	0.2889	4.8897	0.33
17	EP-0117	40.89	3.3024	1.1217	0	0.5543	45.8684	0.31

		JOB: US-1 _ I-20						2
		SUBJECT: C Value Calulations						SHEET
		CALC'D BY: JMB			DATE: 20-Mar-19			OF
		CHEK'D BY: GPP			DATE: 20-Mar-19			2
Post-Construction C Value Calcs								
Culvert #	Culvert ID	Woods (Ac)	Industrial (Ac)	Residential (Ac)	Open Space (Ac)	Impervious (Ac)	Total Area (Ac)	C Value
1	EP-0101	0	0	2.4353	1.8771	0.518	4.8304	0.54
2	EP-0102	0	0	2.4353	1.8771	0.518	4.8304	0.54
3	EP-0103	5.9076	0	3.5313	0	0.432	9.8709	0.41
4	EP-0104	3.6543	0	3.0648	0	0.1105	6.8296	0.42
5	PP-0105	14.3391	9.2123	1.0386	3.6971	4.0695	32.3566	0.55
6	EP-0106	9.6978	0	1.0386	1.3212	1.695	13.7526	0.37
7	EP-0107	3.0606	3.288	0	1.3505	2.855	10.5541	0.65
8	EP-0108	0	0	0	2.8625	2.0803	4.9428	0.60
9	EP-0109	0	0	0	0.4101	0.2384	0.6485	0.57
10	EP-0110	0	0	0	0.2083	0.1899	0.3982	0.64
13	EP-0113	8.7613	0	0	10.4741	1.5283	20.7637	0.35
14	PP-0114	56.2698	3.431	6.6062	2.5398	3.6305	72.4773	0.35
15	EP-0115	2.0728	0	0	1.0327	0.2142	3.3197	0.33
16	EP-0116	3.5435	0	0.3708	0.7087	0.2667	4.8897	0.33
17	EP-0117	40.89	3.3024	1.1217	0	0.5543	45.8684	0.31

STV / RWA Consulting Engineers 1000 West Morehead Street, Suite 200 Charlotte, NC 28208 (704) 372-1885	JOB:	US 1 over I-20		SHEET
	SUBJECT:	EP-0101		1
	CALC'D BY:	JMB	DATE: 20-Mar-19	OF
	CHECK'D BY:	GPP	DATE: 20-Mar-19	15

TIME OF CONCENTRATION (T_c)
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Note: Space for as many as three segments per flow type can be used for each worksheet.
 Include a map, schematic, or description of flow segments.

Sheet flow

	Path #1	Path #2	Path #3
Segment ID	AB		
1. Surface Description (table 3-1)	Grass		
2. Manning's roughness coefficient, n (table 3-1)	0.240		
3. Flow length, L (total L ≤ 300 ft) ft.	100		
4. Two-year 24-hour rainfall, P ₂ in.	3.63		
5. Land slope, s ft./ft.	0.0180		
6. $T_t = \frac{.007 (nL)^{0.8}}{P_2^{0.5} s^{0.4}}$ Compute T _t hr.	0.2329	0.0000	0.0000

Shallow concentrated flow

	Path #1	Path #2	Path #3
Segment ID			
7. Surface description (Paved or Unpaved)	unpaved		
8. Flow length, L ft.	722		
9. Watercourse slope, s ft./ft.	0.0180		
10. Average velocity, V (figure 3-1) ft./sec.	2.16		
11. $T_t = \frac{L}{3600 V}$ Compute T _t hr.	0.0926	0.0000	0.0000

Channel flow

	Path #1	Path #2	Path #3
Segment ID			
12. Cross sectional flow area, a ft. ²	3.14		
13. Wetted perimeter, p _w ft.	6.28		
14. Hydraulic Radius, r = a / p _w Compute r ft.	0.5000		
15. Channel slope, s ft./ft.	0.0100		
16. Manning's roughness coefficient, n ft./ft.	0.0300		
17a. $V = \frac{1.49 r^{2/3} s^{1/2}}{n}$ Compute V ft./sec.	3.13		
17b. Input Velocity, FPS ft./sec.	3.13		
18. Flow length, L ft.	120		
19. $T_t = \frac{L}{3600 V}$ Compute T _t hr.	0.0106	0.0000	0.0000
20. Total, T _c (add T _t in steps 6, 11, and 19) hr.	0.3362	0.0000	0.0000

21. Watershed Total, T_c (maximum, Path #1, #2, or #3) **0.34** Hour
 20 min

STV / RWA Consulting Engineers 1000 West Morehead Street, Suite 200 Charlotte, NC 28208 (704) 372-1885	JOB:	US 1 over I-20		SHEET
	SUBJECT:	EP-0102		2
	CALC'D BY:	JMB	DATE: 20-Mar-19	OF
	CHECK'D BY:	GPP	DATE: 20-Mar-19	15

TIME OF CONCENTRATION (T_c)
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Note: Space for as many as three segments per flow type can be used for each worksheet.
 Include a map, schematic, or description of flow segments.

Sheet flow

	Path #1	Path #2	Path #3
Segment ID	AB		
1. Surface Description (table 3-1)	Grass		
2. Manning's roughness coefficient, n (table 3-1)	0.240		
3. Flow length, L (total L ≤ 300 ft) ft.	100		
4. Two-year 24-hour rainfall, P ₂ in.	3.63		
5. Land slope, s ft./ft.	0.0180		
6. $T_t = \frac{.007 (nL)^{0.8}}{P_2^{0.5} s^{0.4}}$ Compute T _t hr.	0.2329	0.0000	0.0000

Shallow concentrated flow

	Path #1	Path #2	Path #3
Segment ID			
7. Surface description (Paved or Unpaved)	unpaved		
8. Flow length, L ft.	722		
9. Watercourse slope, s ft./ft.	0.0180		
10. Average velocity, V (figure 3-1) ft./sec.	2.16		
11. $T_t = \frac{L}{3600 V}$ Compute T _t hr.	0.0926	0.0000	0.0000

Channel flow

	Path #1	Path #2	Path #3
Segment ID			
12. Cross sectional flow area, a ft. ²	8.00		
13. Wetted perimeter, p _w ft.	9.00		
14. Hydraulic Radius, r = a / p _w Compute r ft.	0.8889		
15. Channel slope, s ft./ft.	0.0100		
16. Manning's roughness coefficient, n	0.0300		
17a. $V = \frac{1.49 r^{2/3} s^{1/2}}{n}$ Compute V ft./sec.	4.59		
17b. Input Velocity, FPS ft./sec.	4.59		
18. Flow length, L ft.	0		
19. $T_t = \frac{L}{3600 V}$ Compute T _t hr.	0.0000	0.0000	0.0000
20. Total, T _c (add T _t in steps 6, 11, and 19)	0.3256	0.0000	0.0000

21. Watershed Total, T_c (maximum, Path #1, #2, or #3) **0.33** Hour
 20 min

STV / RWA Consulting Engineers 1000 West Morehead Street, Suite 200 Charlotte, NC 28208 (704) 372-1885	JOB:	US 1 over I-20		SHEET
	SUBJECT:	EP-0103		3
	CALC'D BY:	JMB	DATE: 20-Mar-19	OF
	CHECK'D BY:	GPP	DATE: 20-Mar-19	15

TIME OF CONCENTRATION (T_c)
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Note: Space for as many as three segments per flow type can be used for each worksheet.
 Include a map, schematic, or description of flow segments.

Sheet flow

	Path #1	Path #2	Path #3
Segment ID	AB		
1. Surface Description (table 3-1)	Woods		
2. Manning's roughness coefficient, n (table 3-1)	0.400		
3. Flow length, L (total L ≤ 300 ft) ft.	100		
4. Two-year 24-hour rainfall, P ₂ in.	3.63		
5. Land slope, s ft./ft.	0.0100		
6. $T_t = \frac{.007 (nL)^{0.8}}{P_2^{0.5} s^{0.4}}$ Compute T _t hr.	0.4434	0.0000	0.0000

Shallow concentrated flow

	Path #1	Path #2	Path #3
Segment ID			
7. Surface description (Paved or Unpaved)	unpaved		
8. Flow length, L ft.	969		
9. Watercourse slope, s ft./ft.	0.0150		
10. Average velocity, V (figure 3-1) ft./sec.	1.98		
11. $T_t = \frac{L}{3600 V}$ Compute T _t hr.	0.1362	0.0000	0.0000

Channel flow

	Path #1	Path #2	Path #3
Segment ID			
12. Cross sectional flow area, a ft. ²	8.00		
13. Wetted perimeter, p _w ft.	9.00		
14. Hydraulic Radius, r = a / p _w Compute r ft.	0.8889		
15. Channel slope, s ft./ft.	0.0100		
16. Manning's roughness coefficient, n ft.	0.0300		
17a. $V = \frac{1.49 r^{2/3} s^{1/2}}{n}$ Compute V ft./sec.	4.59		
17b. Input Velocity, FPS ft./sec.	4.59		
18. Flow length, L ft.	0		
19. $T_t = \frac{L}{3600 V}$ Compute T _t hr.	0.0000	0.0000	0.0000
20. Total, T _c (add T _t in steps 6, 11, and 19) hr.	0.5796	0.0000	0.0000

21. Watershed Total, T_c (maximum, Path #1, #2, or #3) 0.58 Hour
 35 min

STV / RWA Consulting Engineers 1000 West Morehead Street, Suite 200 Charlotte, NC 28208 (704) 372-1885	JOB:	US 1 over I-20		SHEET
	SUBJECT:	EP-0104		4
	CALC'D BY:	JMB	DATE: 20-Mar-19	OF
	CHECK'D BY:	GPP	DATE: 20-Mar-19	15

TIME OF CONCENTRATION (T_c)

Note: Space for as many as three segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segments.

Sheet flow

	Path #1	Path #2	Path #3
Segment ID	AB		
1. Surface Description (table 3-1)	Woods		
2. Manning's roughness coefficient, n (table 3-1)	0.400		
3. Flow length, L (total L ≤ 300 ft) ft.	100		
4. Two-year 24-hour rainfall, P ₂ in.	3.63		
5. Land slope, s ft./ft.	0.0100		
6. $T_t = \frac{.007 (nL)^{0.8}}{P_2^{0.5} s^{0.4}}$ Compute T _t hr.	0.4434	0.0000	0.0000

Shallow concentrated flow

	Segment ID		
7. Surface description (Paved or Unpaved)	unpaved		
8. Flow length, L ft.	1539		
9. Watercourse slope, s ft./ft.	0.0150		
10. Average velocity, V (figure 3-1) ft./sec.	1.98		
11. $T_t = \frac{L}{3600 V}$ Compute T _t hr.	0.2163	0.0000	0.0000

Channel flow

	Segment ID		
12. Cross sectional flow area, a ft. ²	8.00		
13. Wetted perimeter, p _w ft.	9.00		
14. Hydraulic Radius, r = a / p _w Compute r ft.	0.8889		
15. Channel slope, s ft./ft.	0.0100		
16. Manning's roughness coefficient, n ft.	0.0300		
17a. $V = \frac{1.49 r^{2/3} s^{1/2}}{n}$ Compute V ft./sec.	4.59		
17b. Input Velocity, FPS ft./sec.	4.59		
18. Flow length, L ft.	0		
19. $T_t = \frac{L}{3600 V}$ Compute T _t hr.	0.0000	0.0000	0.0000
20. Total, T _c (add T _t in steps 6, 11, and 19) hr.	0.6597	0.0000	0.0000

21. Watershed Total, T_c (maximum, Path #1, #2, or #3) 0.66 Hour
40 min

STV / RWA Consulting Engineers 1000 West Morehead Street, Suite 200 Charlotte, NC 28208 (704) 372-1885	JOB:	US 1 over I-20		SHEET
	SUBJECT:	EP-0105		5
	CALC'D BY:	JMB	DATE: 20-Mar-19	OF
	CHECK'D BY:	GPP	DATE: 20-Mar-19	15

TIME OF CONCENTRATION (T_c)
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Note: Space for as many as three segments per flow type can be used for each worksheet.
 Include a map, schematic, or description of flow segments.

Sheet flow

	Path #1	Path #2	Path #3
Segment ID	AB		
1. Surface Description (table 3-1)	Woods		
2. Manning's roughness coefficient, n (table 3-1)	0.400		
3. Flow length, L (total L ≤ 300 ft) ft.	100		
4. Two-year 24-hour rainfall, P ₂ in.	3.63		
5. Land slope, s ft./ft.	0.0150		
6. $T_t = \frac{.007 (nL)^{0.8}}{P_2^{0.5} s^{0.4}}$ Compute T _t hr.	0.3770	0.0000	0.0000

Shallow concentrated flow

	Path #1	Path #2	Path #3
Segment ID			
7. Surface description (Paved or Unpaved)	unpaved		
8. Flow length, L ft.	1100		
9. Watercourse slope, s ft./ft.	0.0150		
10. Average velocity, V (figure 3-1) ft./sec.	1.98		
11. $T_t = \frac{L}{3600 V}$ Compute T _t hr.	0.1546	0.0000	0.0000

Channel flow

	Path #1	Path #2	Path #3
Segment ID			
12. Cross sectional flow area, a ft. ²	12.00		
13. Wetted perimeter, p _w ft.	12.65		
14. Hydraulic Radius, r = a / p _w Compute r ft.	0.9486		
15. Channel slope, s ft./ft.	0.0100		
16. Manning's roughness coefficient, n ft.	0.0300		
17a. $V = \frac{1.49 r^{2/3} s^{1/2}}{n}$ Compute V ft./sec.	4.80		
17b. Input Velocity, FPS ft./sec.	4.80		
18. Flow length, L ft.	350		
19. $T_t = \frac{L}{3600 V}$ Compute T _t hr.	0.0203	0.0000	0.0000
20. Total, T _c (add T _t in steps 6, 11, and 19) hr.	0.5519	0.0000	0.0000

21. Watershed Total, T_c (maximum, Path #1, #2, or #3) 0.55 Hour
 33 min

STV / RWA Consulting Engineers 1000 West Morehead Street, Suite 200 Charlotte, NC 28208 (704) 372-1885	JOB:	US 1 over I-20		SHEET
	SUBJECT:	EP-0106		6
	CALC'D BY:	JMB	DATE: 20-Mar-19	OF
	CHECK'D BY:	GPP	DATE: 20-Mar-19	15

TIME OF CONCENTRATION (T_c)
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Note: Space for as many as three segments per flow type can be used for each worksheet.
 Include a map, schematic, or description of flow segments.

Sheet flow

	Path #1	Path #2	Path #3
Segment ID	AB		
1. Surface Description (table 3-1)	Woods		
2. Manning's roughness coefficient, n (table 3-1)	0.400		
3. Flow length, L (total L ≤ 300 ft) ft.	100		
4. Two-year 24-hour rainfall, P ₂ in.	3.63		
5. Land slope, s ft./ft.	0.0150		
6. $T_t = \frac{.007 (nL)^{0.8}}{P_2^{0.5} s^{0.4}}$ Compute T _t hr.	0.3770	0.0000	0.0000

Shallow concentrated flow

	Path #1	Path #2	Path #3
Segment ID			
7. Surface description (Paved or Unpaved)	unpaved		
8. Flow length, L ft.	780		
9. Watercourse slope, s ft./ft.	0.0150		
10. Average velocity, V (figure 3-1) ft./sec.	1.98		
11. $T_t = \frac{L}{3600 V}$ Compute T _t hr.	0.1096	0.0000	0.0000

Channel flow

	Path #1	Path #2	Path #3
Segment ID			
12. Cross sectional flow area, a ft. ²	12.00		
13. Wetted perimeter, p _w ft.	12.65		
14. Hydraulic Radius, r = a / p _w Compute r ft.	0.9486		
15. Channel slope, s ft./ft.	0.0100		
16. Manning's roughness coefficient, n	0.0300		
17a. $V = \frac{1.49 r^{2/3} s^{1/2}}{n}$ Compute V ft./sec.	4.80		
17b. Input Velocity, FPS ft./sec.	4.80		
18. Flow length, L ft.	0		
19. $T_t = \frac{L}{3600 V}$ Compute T _t hr.	0.0000	0.0000	0.0000
20. Total, T _c (add T _t in steps 6, 11, and 19)	0.4867	0.0000	0.0000

21. Watershed Total, T_c (maximum, Path #1, #2, or #3) 0.49 Hour
 29 min

STV / RWA Consulting Engineers 1000 West Morehead Street, Suite 200 Charlotte, NC 28208 (704) 372-1885	JOB:	US 1 over I-20		SHEET
	SUBJECT:	EP-0107		7
	CALC'D BY:	JMB	DATE: 20-Mar-19	OF
	CHECK'D BY:	GPP	DATE: 20-Mar-19	15

TIME OF CONCENTRATION (T_c)
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Note: Space for as many as three segments per flow type can be used for each worksheet.
 Include a map, schematic, or description of flow segments.

Sheet flow

	Path #1	Path #2	Path #3
Segment ID	AB		
1. Surface Description (table 3-1)	Woods		
2. Manning's roughness coefficient, n (table 3-1)	0.240		
3. Flow length, L (total L ≤ 300 ft) ft.	100		
4. Two-year 24-hour rainfall, P ₂ in.	3.63		
5. Land slope, s ft./ft.	0.0200		
6. $T_t = \frac{.007 (nL)^{0.8}}{P_2^{0.5} s^{0.4}}$ Compute T _t hr.	0.2233	0.0000	0.0000

Shallow concentrated flow

	Path #1	Path #2	Path #3
Segment ID			
7. Surface description (Paved or Unpaved)	unpaved		
8. Flow length, L ft.	350		
9. Watercourse slope, s ft./ft.	0.0200		
10. Average velocity, V (figure 3-1) ft./sec.	2.28		
11. $T_t = \frac{L}{3600 V}$ Compute T _t hr.	0.0426	0.0000	0.0000

Channel flow

	Path #1	Path #2	Path #3
Segment ID			
12. Cross sectional flow area, a ft. ²	12.00		
13. Wetted perimeter, p _w ft.	12.65		
14. Hydraulic Radius, r = a / p _w Compute r ft.	0.9486		
15. Channel slope, s ft./ft.	0.0100		
16. Manning's roughness coefficient, n	0.0300		
17a. $V = \frac{1.49 r^{2/3} s^{1/2}}{n}$ Compute V ft./sec.	4.80		
17b. Input Velocity, FPS ft./sec.	4.80		
18. Flow length, L ft.	0		
19. $T_t = \frac{L}{3600 V}$ Compute T _t hr.	0.0000	0.0000	0.0000
20. Total, T _c (add T _t in steps 6, 11, and 19)	0.2659	0.0000	0.0000

21. Watershed Total, T_c (maximum, Path #1, #2, or #3) **0.27** Hour
 16 min

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	SUBJECT:	EP-0108		8
	CALC'D BY:	JMB	DATE: 20-Mar-19	OF
	CHECK'D BY:	GPP	DATE: 20-Mar-19	15

TIME OF CONCENTRATION (T_c)
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Note: Space for as many as three segments per flow type can be used for each worksheet.
 Include a map, schematic, or description of flow segments.

Sheet flow

	Path #1	Path #2	Path #3
Segment ID	AB		
1. Surface Description (table 3-1)	Grass		
2. Manning's roughness coefficient, n (table 3-1)	0.240		
3. Flow length, L (total L ≤ 300 ft) ft.	100		
4. Two-year 24-hour rainfall, P ₂ in.	3.63		
5. Land slope, s ft./ft.	0.1000		
6. $T_t = \frac{.007 (nL)^{0.8}}{P_2^{0.5} s^{0.4}}$ Compute T _t hr.	0.1173	0.0000	0.0000

Shallow concentrated flow

	Path #1	Path #2	Path #3
Segment ID			
7. Surface description (Paved or Unpaved)	paved		
8. Flow length, L ft.	900		
9. Watercourse slope, s ft./ft.	0.1000		
10. Average velocity, V (figure 3-1) ft./sec.	6.43		
11. $T_t = \frac{L}{3600 V}$ Compute T _t hr.	0.0389	0.0000	0.0000

Channel flow

	Path #1	Path #2	Path #3
Segment ID			
12. Cross sectional flow area, a ft. ²	12.00		
13. Wetted perimeter, p _w ft.	12.65		
14. Hydraulic Radius, r = a / p _w Compute r ft.	0.9486		
15. Channel slope, s ft./ft.	0.0100		
16. Manning's roughness coefficient, n	0.0300		
17a. $V = \frac{1.49 r^{2/3} s^{1/2}}{n}$ Compute V ft./sec.	4.80		
17b. Input Velocity, FPS ft./sec.	4.80		
18. Flow length, L ft.	0		
19. $T_t = \frac{L}{3600 V}$ Compute T _t hr.	0.0000	0.0000	0.0000
20. Total, T _c (add T _t in steps 6, 11, and 19)	0.1562	0.0000	0.0000

21. Watershed Total, T_c (maximum, Path #1, #2, or #3) 0.16 Hour
 9 min

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	SUBJECT:	EP-0109		9
	CALC'D BY:	JMB	DATE: 20-Mar-19	OF
	CHECK'D BY:	GPP	DATE: 20-Mar-19	15

TIME OF CONCENTRATION (T_c)
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Note: Space for as many as three segments per flow type can be used for each worksheet.
 Include a map, schematic, or description of flow segments.

Sheet flow

	Path #1	Path #2	Path #3
Segment ID	AB		
1. Surface Description (table 3-1)	Grass		
2. Manning's roughness coefficient, n (table 3-1)	0.240		
3. Flow length, L (total L ≤ 300 ft) ft.	0		
4. Two-year 24-hour rainfall, P ₂ in.	3.63		
5. Land slope, s ft./ft.	0.0100		
6. $T_t = \frac{.007 (nL)^{0.8}}{P_2^{0.5} s^{0.4}}$ Compute T _t hr.	0.0000	0.0000	0.0000

Shallow concentrated flow

	Path #1	Path #2	Path #3
Segment ID			
7. Surface description (Paved or Unpaved)	paved		
8. Flow length, L ft.	250		
9. Watercourse slope, s ft./ft.	0.0100		
10. Average velocity, V (figure 3-1) ft./sec.	2.03		
11. $T_t = \frac{L}{3600 V}$ Compute T _t hr.	0.0342	0.0000	0.0000

Channel flow

	Path #1	Path #2	Path #3
Segment ID			
12. Cross sectional flow area, a ft. ²	12.00		
13. Wetted perimeter, p _w ft.	12.65		
14. Hydraulic Radius, r = a / p _w Compute r ft.	0.9486		
15. Channel slope, s ft./ft.	0.0100		
16. Manning's roughness coefficient, n	0.0300		
17a. $V = \frac{1.49 r^{2/3} s^{1/2}}{n}$ Compute V ft./sec.	4.80		
17b. Input Velocity, FPS ft./sec.	4.80		
18. Flow length, L ft.	0		
19. $T_t = \frac{L}{3600 V}$ Compute T _t hr.	0.0000	0.0000	0.0000
20. Total, T _c (add T _t in steps 6, 11, and 19) hr.	0.0342	0.0000	0.0000

21. Watershed Total, T_c (maximum, Path #1, #2, or #3) 0.03 Hour
 2 min

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	SUBJECT:	EP-0110		10
	CALC'D BY:	JMB	DATE: 20-Mar-19	OF
	CHECK'D BY:	GPP	DATE: 20-Mar-19	15

TIME OF CONCENTRATION (T_c)
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Note: Space for as many as three segments per flow type can be used for each worksheet.
 Include a map, schematic, or description of flow segments.

Sheet flow

	Path #1	Path #2	Path #3
Segment ID	AB		
1. Surface Description (table 3-1)	Grass		
2. Manning's roughness coefficient, n (table 3-1)	0.240		
3. Flow length, L (total L ≤ 300 ft) ft.	0		
4. Two-year 24-hour rainfall, P ₂ in.	3.63		
5. Land slope, s ft./ft.	0.1000		
6. $T_t = \frac{.007 (nL)^{0.8}}{P_2^{0.5} s^{0.4}}$ Compute T _t hr.	0.0000	0.0000	0.0000

Shallow concentrated flow

	Path #1	Path #2	Path #3
Segment ID			
7. Surface description (Paved or Unpaved)	paved		
8. Flow length, L ft.	250		
9. Watercourse slope, s ft./ft.	0.0100		
10. Average velocity, V (figure 3-1) ft./sec.	2.03		
11. $T_t = \frac{L}{3600 V}$ Compute T _t hr.	0.0342	0.0000	0.0000

Channel flow

	Path #1	Path #2	Path #3
Segment ID			
12. Cross sectional flow area, a ft. ²	12.00		
13. Wetted perimeter, p _w ft.	12.65		
14. Hydraulic Radius, r = a / p _w Compute r ft.	0.9486		
15. Channel slope, s ft./ft.	0.0100		
16. Manning's roughness coefficient, n ft.	0.0300		
17a. $V = \frac{1.49 r^{2/3} s^{1/2}}{n}$ Compute V ft./sec.	4.80		
17b. Input Velocity, FPS ft./sec.	4.80		
18. Flow length, L ft.	0		
19. $T_t = \frac{L}{3600 V}$ Compute T _t hr.	0.0000	0.0000	0.0000
20. Total, T _c (add T _t in steps 6, 11, and 19) hr.	0.0342	0.0000	0.0000

21. Watershed Total, T_c (maximum, Path #1, #2, or #3) 0.03 Hour
 2 min

STV / RWA Consulting Engineers 1000 West Morehead Street, Suite 200 Charlotte, NC 28208 (704) 372-1885	JOB:	US 1 over I-20		SHEET
	SUBJECT:	EP-0113		11
	CALC'D BY:	JMB	DATE: 20-Mar-19	OF
	CHECK'D BY:	GPP	DATE: 20-Mar-19	15

TIME OF CONCENTRATION (T_c)

Note: Space for as many as three segments per flow type can be used for each worksheet.
 Include a map, schematic, or description of flow segments.

Sheet flow

	Path #1	Path #2	Path #3
Segment ID	AB		
1. Surface Description (table 3-1)	Grass		
2. Manning's roughness coefficient, n (table 3-1)	0.240		
3. Flow length, L (total L ≤ 300 ft) ft.	100		
4. Two-year 24-hour rainfall, P_2 in.	3.63		
5. Land slope, s ft./ft.	0.0200		
6. $T_t = \frac{.007 (nL)^{0.8}}{P_2^{0.5} s^{0.4}}$ Compute T_t hr.	0.2233	0.0000	0.0000

Shallow concentrated flow

	Path #1	Path #2	Path #3
Segment ID			
7. Surface description (Paved or Unpaved)	unpaved		
8. Flow length, L ft.	1730		
9. Watercourse slope, s ft./ft.	0.0200		
10. Average velocity, V (figure 3-1) ft./sec.	2.28		
11. $T_t = \frac{L}{3600 V}$ Compute T_t hr.	0.2106	0.0000	0.0000

Channel flow

	Path #1	Path #2	Path #3
Segment ID			
12. Cross sectional flow area, a ft. ²	12.00		
13. Wetted perimeter, p_w ft.	12.65		
14. Hydraulic Radius, $r = a / p_w$ Compute r ft.	0.9486		
15. Channel slope, s ft./ft.	0.0100		
16. Manning's roughness coefficient, n	0.0300		
17a. $V = \frac{1.49 r^{2/3} s^{1/2}}{n}$ Compute V ft./sec.	4.80		
17b. Input Velocity, FPS ft./sec.	4.80		
18. Flow length, L ft.	0		
19. $T_t = \frac{L}{3600 V}$ Compute T_t hr.	0.0000	0.0000	0.0000
20. Total, T_c (add T_t in steps 6, 11, and 19) hr.	0.4339	0.0000	0.0000

21. Watershed Total, T_c (maximum, Path #1, #2, or #3) 0.43 Hour
 26 min

STV / RWA Consulting Engineers 1000 West Morehead Street, Suite 200 Charlotte, NC 28208 (704) 372-1885	JOB:	US 1 over I-20		SHEET
	SUBJECT:	PP-0114		12
	CALC'D BY:	JMB	DATE: 20-Mar-19	OF
	CHECK'D BY:	GPP	DATE: 20-Mar-19	15

TIME OF CONCENTRATION (T_c)

Note: Space for as many as three segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segments.

Sheet flow

	Path #1	Path #2	Path #3
Segment ID	AB		
1. Surface Description (table 3-1)	Woods		
2. Manning's roughness coefficient, n (table 3-1)	0.400		
3. Flow length, L (total L ≤ 300 ft) ft.	100		
4. Two-year 24-hour rainfall, P ₂ in.	3.63		
5. Land slope, s ft./ft.	0.0200		
6. $T_t = \frac{.007 (nL)^{0.8}}{P_2^{0.5} s^{0.4}}$ Compute T _t hr.	0.3360	0.0000	0.0000

Shallow concentrated flow

	Segment ID		
7. Surface description (Paved or Unpaved)	unpaved		
8. Flow length, L ft.	1880		
9. Watercourse slope, s ft./ft.	0.0200		
10. Average velocity, V (figure 3-1) ft./sec.	2.28		
11. $T_t = \frac{L}{3600 V}$ Compute T _t hr.	0.2289	0.0000	0.0000

Channel flow

	Segment ID		
12. Cross sectional flow area, a ft. ²	12.00		
13. Wetted perimeter, p _w ft.	12.65		
14. Hydraulic Radius, r = a / p _w Compute r ft.	0.9486		
15. Channel slope, s ft./ft.	0.0100		
16. Manning's roughness coefficient, n	0.0300		
17a. $V = \frac{1.49 r^{2/3} s^{1/2}}{n}$ Compute V ft./sec.	4.80		
17b. Input Velocity, FPS ft./sec.	4.80		
18. Flow length, L ft.	0		
19. $T_t = \frac{L}{3600 V}$ Compute T _t hr.	0.0000	0.0000	0.0000
20. Total, T _c (add T _t in steps 6, 11, and 19)	0.5649	0.0000	0.0000

21. Watershed Total, T_c (maximum, Path #1, #2, or #3) 0.56 Hour
34 min

STV / RWA Consulting Engineers 1000 West Morehead Street, Suite 200 Charlotte, NC 28208 (704) 372-1885	JOB:	US 1 over I-20		SHEET
	SUBJECT:	EP-0115		13
	CALC'D BY:	JMB	DATE: 20-Mar-19	OF
	CHECK'D BY:	GPP	DATE: 20-Mar-19	15

TIME OF CONCENTRATION (T_c)
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Note: Space for as many as three segments per flow type can be used for each worksheet.
 Include a map, schematic, or description of flow segments.

Sheet flow

	Path #1	Path #2	Path #3
Segment ID	AB		
1. Surface Description (table 3-1)	Grass		
2. Manning's roughness coefficient, n (table 3-1)	0.240		
3. Flow length, L (total L ≤ 300 ft) ft.	100		
4. Two-year 24-hour rainfall, P ₂ in.	3.63		
5. Land slope, s ft./ft.	0.0200		
6. $T_t = \frac{.007 (nL)^{0.8}}{P_2^{0.5} s^{0.4}}$ Compute T _t hr.	0.2233	0.0000	0.0000

Shallow concentrated flow

	Path #1	Path #2	Path #3
Segment ID			
7. Surface description (Paved or Unpaved)	unpaved		
8. Flow length, L ft.	850		
9. Watercourse slope, s ft./ft.	0.0200		
10. Average velocity, V (figure 3-1) ft./sec.	2.28		
11. $T_t = \frac{L}{3600 V}$ Compute T _t hr.	0.1035	0.0000	0.0000

Channel flow

	Path #1	Path #2	Path #3
Segment ID			
12. Cross sectional flow area, a ft. ²	12.00		
13. Wetted perimeter, p _w ft.	12.65		
14. Hydraulic Radius, r = a / p _w Compute r ft.	0.9486		
15. Channel slope, s ft./ft.	0.0100		
16. Manning's roughness coefficient, n ft.	0.0300		
17a. $V = \frac{1.49 r^{2/3} s^{1/2}}{n}$ Compute V ft./sec.	4.80		
17b. Input Velocity, FPS ft./sec.	4.80		
18. Flow length, L ft.	0		
19. $T_t = \frac{L}{3600 V}$ Compute T _t hr.	0.0000	0.0000	0.0000
20. Total, T _c (add T _t in steps 6, 11, and 19) hr.	0.3268	0.0000	0.0000

21. Watershed Total, T_c (maximum, Path #1, #2, or #3) 0.33 Hour
 20 min

STV / RWA Consulting Engineers 1000 West Morehead Street, Suite 200 Charlotte, NC 28208 (704) 372-1885	JOB:	US 1 over I-20		SHEET
	SUBJECT:	EP-0116		14
	CALC'D BY:	JMB	DATE: 20-Mar-19	OF
	CHECK'D BY:	GPP	DATE: 20-Mar-19	15

TIME OF CONCENTRATION (T_c)
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Note: Space for as many as three segments per flow type can be used for each worksheet.
 Include a map, schematic, or description of flow segments.

Sheet flow

	Path #1	Path #2	Path #3
Segment ID	AB		
1. Surface Description (table 3-1)	Woods		
2. Manning's roughness coefficient, n (table 3-1)	0.400		
3. Flow length, L (total L ≤ 300 ft) ft.	100		
4. Two-year 24-hour rainfall, P ₂ in.	3.63		
5. Land slope, s ft./ft.	0.0200		
6. $T_t = \frac{.007 (nL)^{0.8}}{P_2^{0.5} s^{0.4}}$ Compute T _t hr.	0.3360	0.0000	0.0000

Shallow concentrated flow

	Path #1	Path #2	Path #3
Segment ID			
7. Surface description (Paved or Unpaved)	unpaved		
8. Flow length, L ft.	700		
9. Watercourse slope, s ft./ft.	0.0200		
10. Average velocity, V (figure 3-1) ft./sec.	2.28		
11. $T_t = \frac{L}{3600 V}$ Compute T _t hr.	0.0852	0.0000	0.0000

Channel flow

	Path #1	Path #2	Path #3
Segment ID			
12. Cross sectional flow area, a ft. ²	12.00		
13. Wetted perimeter, p _w ft.	12.65		
14. Hydraulic Radius, r = a / p _w Compute r ft.	0.9486		
15. Channel slope, s ft./ft.	0.0100		
16. Manning's roughness coefficient, n ft.	0.0300		
17a. $V = \frac{1.49 r^{2/3} s^{1/2}}{n}$ Compute V ft./sec.	4.80		
17b. Input Velocity, FPS ft./sec.	4.80		
18. Flow length, L ft.	0		
19. $T_t = \frac{L}{3600 V}$ Compute T _t hr.	0.0000	0.0000	0.0000
20. Total, T _c (add T _t in steps 6, 11, and 19) hr.	0.4212	0.0000	0.0000

21. Watershed Total, T_c (maximum, Path #1, #2, or #3) 0.42 Hour
 25 min

STV / RWA Consulting Engineers 1000 West Morehead Street, Suite 200 Charlotte, NC 28208 (704) 372-1885	JOB:	US 1 over I-20		SHEET
	SUBJECT:	EP-0117		15
	CALC'D BY:	JMB	DATE: 20-Mar-19	OF
	CHECK'D BY:	GPP	DATE: 20-Mar-19	15

TIME OF CONCENTRATION (T_c)

Note: Space for as many as three segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segments.

Sheet flow

	Path #1	Path #2	Path #3
Segment ID	AB		
1. Surface Description (table 3-1)	Woods		
2. Manning's roughness coefficient, n (table 3-1)	0.400		
3. Flow length, L (total L ≤ 300 ft) ft.	100		
4. Two-year 24-hour rainfall, P ₂ in.	3.63		
5. Land slope, s ft./ft.	0.0100		
6. $T_t = \frac{.007 (nL)^{0.8}}{P_2^{0.5} s^{0.4}}$ Compute T _t hr.	0.4434	0.0000	0.0000

Shallow concentrated flow

	Segment ID		
7. Surface description (Paved or Unpaved)	unpaved		
8. Flow length, L ft.	1730		
9. Watercourse slope, s ft./ft.	0.0100		
10. Average velocity, V (figure 3-1) ft./sec.	1.61		
11. $T_t = \frac{L}{3600 V}$ Compute T _t hr.	0.2978	0.0000	0.0000

Channel flow

	Segment ID		
12. Cross sectional flow area, a ft. ²	12.00		
13. Wetted perimeter, p _w ft.	12.65		
14. Hydraulic Radius, r = a / p _w Compute r ft.	0.9486		
15. Channel slope, s ft./ft.	0.0100		
16. Manning's roughness coefficient, n	0.0300		
17a. $V = \frac{1.49 r^{2/3} s^{1/2}}{n}$ Compute V ft./sec.	4.80		
17b. Input Velocity, FPS ft./sec.	4.80		
18. Flow length, L ft.	1250		
19. $T_t = \frac{L}{3600 V}$ Compute T _t hr.	0.0724	0.0000	0.0000
20. Total, T _c (add T _t in steps 6, 11, and 19)	0.8137	0.0000	0.0000

21. Watershed Total, T_c (maximum, Path #1, #2, or #3) 0.81 Hour
49 min

**SCS Hydrologic
Analysis
(EP-0111 and EP-0112)**

STV / RWA Consulting Engineers 1000 West Morehead Street, Suite 200 Charlotte, NC 28208 (704) 372-1885	JOB:	US 1 over I-20		SHEET
	SUBJECT:	EP-0111		1
	CALC'D BY:	JMB	DATE: 20-Mar-19	OF
	CHECK'D BY:	GPP	DATE: 20-Mar-19	3

TIME OF CONCENTRATION (T_c)

Check One: ☒ Present ☐ Developed

Note: Space for as many as three segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segments.

Sheet flow

	Path #1	Path #2	Path #3
Segment ID	AB		
1. Surface Description (table 3-1)	Woods		
2. Manning's roughness coefficient, n (table 3-1)	0.400		
3. Flow length, L (total L ≤ 300 ft) ft.	100		
4. Two-year 24-hour rainfall, P_2 in.	3.12		
5. Land slope, s ft./ft.	0.0170		
6. $T_t = \frac{.007 (nL)^{0.8}}{P_2^{0.5} S^{0.4}}$ Compute T_t hr.	0.3868	0.0000	0.0000

Shallow concentrated flow

	Path #1	Path #2	Path #3
Segment ID			
7. Surface description (Paved or Unpaved)	unpaved		
8. Flow length, L ft.	4368		
9. Watercourse slope, s ft./ft.	0.0170		
10. Average velocity, V (figure 3-1) ft./sec.	2.10		
11. $T_t = \frac{L}{3600 V}$ Compute T_t hr.	0.5768	0.0000	0.0000

Channel flow

	Path #1	Path #2	Path #3
Segment ID			
12. Cross sectional flow area, a ft. ²	24.00		
13. Wetted perimeter, p_w ft.	14.00		
14. Hydraulic Radius, $r = a / p_w$ Compute r ft.	1.7143		
15. Channel slope, s ft./ft.	0.0150		
16. Manning's roughness coefficient, n	0.0300		
17a. $V = \frac{1.49 r^{2/3} S^{1/2}}{n}$ Compute V ft./sec.	8.71		
17b. Input Velocity, FPS ft./sec.	8.71		
18. Flow length, L ft.	400		
19. $T_t = \frac{L}{3600 V}$ Compute T_t hr.	0.0128	0.0000	0.0000
20. Total, T_c (add T_t in steps 6, 11, and 19) hr.	0.9763	0.0000	0.0000

21. Watershed Total, T_c (maximum, Path #1, #2, or #3) 0.98 Hour
59 min

STV/ RWA Consulting Engineers 1000 West Morehead Street, Suite 200 Charlotte, NC 28208 (704) 372-1885	JOB:	US 1 over I-20		SHEET
	SUBJECT:	EP-0111		2
	CALC'D BY:	JMB	DATE: 25-Sep-18	OF
	CHECK'D BY:	GPP	DATE: 25-Sep-18	3

RUNOFF CURVE NUMBER AND RUNOFF

Check one: ☒ Present ☐ Developed

Runoff Curve Number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN*			Area <input checked="" type="checkbox"/> acres <input type="checkbox"/> mi^2 <input type="checkbox"/> %	Product of CN x area
		Table 2-2	Figure 2-3	Figure 2-4		
B	Grass	61			30.8	1880.7
B	Woods	55			112.8	6203.0
B	Impervious	98			7.6	747.6
B	Residential	72			51.5	3704.7
B	Industrial	88			7.2	632.4
Totals ==>					209.9	13168.3

* Use only one CN source per line

CN (weighted) =

total product =

13168.3

total area

209.9

=
62.7

Use CN ==>>

63

Runoff

	Storm # 1	Storm # 2	Storm # 3	Storm # 4	Storm # 5
Frequency.....yr	2	10	25	50	100
Rainfall, P (24-hour)..... in	3.63	5.27	6.37	7.30	8.31
Runoff, Q..... in	0.72	1.68	2.44	3.13	3.91

(Use P and CN with table 2-1, figure 2-1, or equations 2-3 and 2-4)

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	SUBJECT:	EP-0111		3
	CALC'D BY:	JMB	DATE:	25-Sep-18
	CHECK'D BY:	GPP	DATE:	25-Sep-18
				OF
				3

GRAPHICAL PEAK DISCHARGE METHOD

Check one: ☒ Present ☐ Developed

1. Data

Drainage area..... A_m = 0.328 mi^2 (acres/640)

Runoff curve number..... CN = 63 (From CN & Runoff worksheet)

Time of concentration..... T_c = 1.0 hr (From T_c worksheet)

Rainfall distribution..... = II (I, IA, II, III)

Pond and swamp areas spread
thoroughout watershed..... = 1.3 percent of A_m (0.004263) acres or mi^2
covered)

	Storm #1	Storm #2	Storm #3	Storm #4	Storm #5
2. Frequency yr	2	10	25	50	100
3. Rainfall, P (24-hour) in	3.63	5.27	6.37	7.30	8.31
4. Initial abstraction, I_a in (Use CN with table 4-1)	1.175	1.175	1.175	1.175	1.175
5. Compute I_a/P	0.32	0.22	0.18	0.16	0.14
6. Unit peak discharge, q_u gsm/in (Use T_c and I_a/P with exhibit 4-II)	0	310	320	340	350
7. Runoff, Q in (From CN & Runoff worksheet)	0.72	1.68	2.44	3.13	3.91
8. Pond and swamp adjustment factor, F_p (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond and swamp area.)	0.87	0.87	0.87	0.87	0.87
9. Peak discharge, q_p ft^3/s (Where $q_p = q_u A_m Q F_p$)	0	149	223	303	391

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	SUBJECT:	EP-0111		1
	CALC'D BY:	JMB	DATE: 20-Mar-19	OF
	CHECK'D BY:	GPP	DATE: 20-Mar-19	3

TIME OF CONCENTRATION (T_c)

Check One: ☐ Present ☒ Developed

Note: Space for as many as three segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segments.

Sheet flow

	Path #1	Path #2	Path #3
Segment ID	AB		
1. Surface Description (table 3-1)	Woods		
2. Manning's roughness coefficient, n (table 3-1)	0.400		
3. Flow length, L (total L ≤ 300 ft) ft.	100		
4. Two-year 24-hour rainfall, P_2 in.	3.12		
5. Land slope, s ft./ft.	0.0170		
6. $T_t = \frac{.007 (nL)^{0.8}}{P_2^{0.5} S^{0.4}}$ Compute T_t hr.	0.3868	0.0000	0.0000

Shallow concentrated flow

	Path #1	Path #2	Path #3
Segment ID			
7. Surface description (Paved or Unpaved)	unpaved		
8. Flow length, L ft.	4368		
9. Watercourse slope, s ft./ft.	0.0170		
10. Average velocity, V (figure 3-1) ft./sec.	2.10		
11. $T_t = \frac{L}{3600 V}$ Compute T_t hr.	0.5768	0.0000	0.0000

Channel flow

	Path #1	Path #2	Path #3
Segment ID			
12. Cross sectional flow area, a ft. ²	24.00		
13. Wetted perimeter, p_w ft.	14.00		
14. Hydraulic Radius, $r = a / p_w$ Compute r ft.	1.7143		
15. Channel slope, s ft./ft.	0.0150		
16. Manning's roughness coefficient, n	0.0300		
17a. $V = \frac{1.49 r^{2/3} S^{1/2}}{n}$ Compute V ft./sec.	8.71		
17b. Input Velocity, FPS ft./sec.	8.71		
18. Flow length, L ft.	400		
19. $T_t = \frac{L}{3600 V}$ Compute T_t hr.	0.0128	0.0000	0.0000
20. Total, T_c (add T_t in steps 6, 11, and 19) hr.	0.9763	0.0000	0.0000

21. Watershed Total, T_c (maximum, Path #1, #2, or #3) 0.98 Hour
59 min

STV/ RWA Consulting Engineers 1000 West Morehead Street, Suite 200 Charlotte, NC 28208 (704) 372-1885	JOB:	US 1 over I-20		SHEET
	SUBJECT:	EP-0111		2
	CALC'D BY:	JMB	DATE: 25-Sep-18	OF
	CHECK'D BY:	GPP	DATE: 25-Sep-18	3

RUNOFF CURVE NUMBER AND RUNOFF

Check one: ☐ Present ☒ Developed

Runoff Curve Number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN*			Area <input checked="" type="checkbox"/> acres <input type="checkbox"/> mi^2 <input type="checkbox"/> %	Product of CN x area
		Table 2-2	Figure 2-3	Figure 2-4		
B	Grass	61			41.9	2555.9
B	Woods	55			109.5	6024.1
B	Impervious	98			10.3	1008.3
B	Residential	72			47.9	3446.9
B	Industrial	88			0.3	26.6
Totals ==>					209.9	13061.9

* Use only one CN source per line

CN (weighted) =

total product =

13061.9

total area

209.9

=

62.2

Use CN ==>

62

Runoff

	Storm # 1	Storm # 2	Storm # 3	Storm # 4	Storm # 5
Frequency.....yr	2	10	25	50	100
Rainfall, P (24-hour)..... in	3.63	5.27	6.37	7.30	8.31
Runoff, Q..... in	0.68	1.61	2.35	3.02	3.80

(Use P and CN with table 2-1, figure 2-1, or equations 2-3 and 2-4)

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	SUBJECT:	EP-0111		3
	CALC'D BY:	JMB	DATE:	25-Sep-18
	CHECK'D BY:	GPP	DATE:	25-Sep-18
				OF
				3

GRAPHICAL PEAK DISCHARGE METHOD

Check one: ☐ Present ☒ Developed

1. Data

Drainage area..... A_m = 0.328 mi^2 (acres/640)

Runoff curve number..... CN = 62 (From CN & Runoff worksheet)

Time of concentration..... T_c = 1.0 hr (From T_c worksheet)

Rainfall distribution..... = II (I, IA, II, III)

Pond and swamp areas spread
thoroughout watershed..... = 1.3 percent of A_m (0.004263) acres or mi^2
covered)

	Storm #1	Storm #2	Storm #3	Storm #4	Storm #5
2. Frequency yr	2	10	25	50	100
3. Rainfall, P (24-hour) in	3.63	5.27	6.37	7.30	8.31

4. Initial abstraction, I_a in (Use CN with table 4-1)	1.226	1.226	1.226	1.226	1.226
---	-------	-------	-------	-------	-------

5. Compute I_a/P	0.34	0.23	0.19	0.17	0.15
--------------------------	------	------	------	------	------

6. Unit peak discharge, q_u gsm/in (Use T_c and I_a/P with exhibit 4-II)	0	330	340	350	360
---	---	-----	-----	-----	-----

7. Runoff, Q in (From CN & Runoff worksheet)	0.68	1.61	2.35	3.02	3.80
---	------	------	------	------	------

8. Pond and swamp adjustment factor, F_p (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond and swamp area.)	0.87	0.87	0.87	0.87	0.87
---	------	------	------	------	------

9. Peak discharge, q_p ft^3/s (Where $q_p = q_u A_m Q F_p$)	0	151	228	302	390
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	SUBJECT:	EP-0112		1
	CALC'D BY:	JMB	DATE: 20-Mar-19	OF
	CHECK'D BY:	GPP	DATE: 20-Mar-19	3

TIME OF CONCENTRATION (T_c)

Check One: ☒ Present ☐ Developed

Note: Space for as many as three segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segments.

Sheet flow

	Path #1	Path #2	Path #3
Segment ID	AB		
1. Surface Description (table 3-1)	Woods		
2. Manning's roughness coefficient, n (table 3-1)	0.400		
3. Flow length, L (total L ≤ 300 ft) ft.	100		
4. Two-year 24-hour rainfall, P_2 in.	3.12		
5. Land slope, s ft./ft.	0.0170		
6. $T_t = \frac{.007 (nL)^{0.8}}{P_2^{0.5} S^{0.4}}$ Compute T_t hr.	0.3868	0.0000	0.0000

Shallow concentrated flow

	Path #1	Path #2	Path #3
Segment ID			
7. Surface description (Paved or Unpaved)	unpaved		
8. Flow length, L ft.	3083		
9. Watercourse slope, s ft./ft.	0.0170		
10. Average velocity, V (figure 3-1) ft./sec.	2.10		
11. $T_t = \frac{L}{3600 V}$ Compute T_t hr.	0.4071	0.0000	0.0000

Channel flow

	Path #1	Path #2	Path #3
Segment ID			
12. Cross sectional flow area, a ft. ²	24.00		
13. Wetted perimeter, p_w ft.	14.00		
14. Hydraulic Radius, $r = a / p_w$ Compute r ft.	1.7143		
15. Channel slope, s ft./ft.	0.0150		
16. Manning's roughness coefficient, n	0.0300		
17a. $V = \frac{1.49 r^{2/3} S^{1/2}}{n}$ Compute V ft./sec.	8.71		
17b. Input Velocity, FPS ft./sec.	8.71		
18. Flow length, L ft.	400		
19. $T_t = \frac{L}{3600 V}$ Compute T_t hr.	0.0128	0.0000	0.0000
20. Total, T_c (add T_t in steps 6, 11, and 19) hr.	0.8066	0.0000	0.0000

21. Watershed Total, T_c (maximum, Path #1, #2, or #3) 0.81 Hour
48 min

STV/ RWA Consulting Engineers 1000 West Morehead Street, Suite 200 Charlotte, NC 28208 (704) 372-1885	JOB:	US 1 over I-20		SHEET
	SUBJECT:	EP-0112		2
	CALC'D BY:	JMB	DATE:	20-Mar-19
	CHECK'D BY:	GPP	DATE:	20-Mar-19
				OF
				3

RUNOFF CURVE NUMBER AND RUNOFF

Check one: ☒ Present ☐ Developed

Runoff Curve Number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN*			Area <input checked="" type="checkbox"/> acres <input type="checkbox"/> mi^2 <input type="checkbox"/> %	Product of CN x area
		Table 2-2	Figure 2-3	Figure 2-4		
B	Grass	61			23.8	1448.8
B	Woods	55			71.2	3915.2
B	Impervious	98			5.7	558.6
B	Residential	72			9.4	679.4
B	Industrial	88			2.6	233.0
Totals ==>					112.7	6835.0

* Use only one CN source per line

CN (weighted) =

$$\frac{\text{total product}}{\text{total area}} = \frac{6835.0}{112.7} = 60.6$$
 Use CN =====>

61

Runoff

	Storm # 1	Storm # 2	Storm # 3	Storm # 4	Storm # 5
Frequency.....yr	2	10	25	50	100
Rainfall, P (24-hour)..... in	3.63	5.27	6.37	7.30	8.31
Runoff, Q..... in	0.63	1.53	2.26	2.92	3.68

(Use P and CN with table 2-1, figure 2-1, or equations 2-3 and 2-4)

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	SUBJECT:	EP-0112		3
	CALC'D BY:	JMB	DATE:	20-Mar-19
	CHECK'D BY:	GPP	DATE:	20-Mar-19
				OF
				3

GRAPHICAL PEAK DISCHARGE METHOD

Check one: ☒ Present ☐ Developed

1. Data

Drainage area..... A_m = 0.176 mi^2 (acres/640)

Runoff curve number..... CN = 61 (From CN & Runoff worksheet)

Time of concentration..... T_c = 0.8 hr (From T_c worksheet)

Rainfall distribution..... = II (I, IA, II, III)

Pond and swamp areas spread
thoroughout watershed..... = 2.2 percent of A_m (0.003875) acres or mi^2
covered)

	Storm #1	Storm #2	Storm #3	Storm #4	Storm #5
2. Frequency yr	2	10	25	50	100
3. Rainfall, P (24-hour) in	3.63	5.27	6.37	7.30	8.31
4. Initial abstraction, I_a in (Use CN with table 4-1)	1.279	1.279	1.279	1.279	1.279
5. Compute I_a/P	0.35	0.24	0.20	0.18	0.15
6. Unit peak discharge, q_u gsm/in (Use T_c and I_a/P with exhibit 4-II)		350	360	375	390
7. Runoff, Q in (From CN & Runoff worksheet)	0.63	1.53	2.26	2.92	3.68
8. Pond and swamp adjustment factor, F_p (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond and swamp area.)	0.75	0.75	0.75	0.75	0.75
9. Peak discharge, q_p ft^3/s (Where $q_p = q_u A_m Q F_p$)	0	71	107	145	190

STV / RWA Consulting Engineers 1000 West Morehead Street, Suite 200 Charlotte, NC 28208 (704) 372-1885	JOB:	US 1 over I-20		SHEET
	SUBJECT:	EP-0112		1
	CALC'D BY:	JMB	DATE: 20-Mar-19	OF
	CHECK'D BY:	GPP	DATE: 20-Mar-19	3

TIME OF CONCENTRATION (T_c)

Check One: ☐ Present ☒ Developed

Note: Space for as many as three segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segments.

Sheet flow

	Path #1	Path #2	Path #3
Segment ID	AB		
1. Surface Description (table 3-1)	Woods		
2. Manning's roughness coefficient, n (table 3-1)	0.400		
3. Flow length, L (total L ≤ 300 ft) ft.	100		
4. Two-year 24-hour rainfall, P_2 in.	3.12		
5. Land slope, s ft./ft.	0.0170		
6. $T_t = \frac{.007 (nL)^{0.8}}{P_2^{0.5} S^{0.4}}$ Compute T_t hr.	0.3868	0.0000	0.0000

Shallow concentrated flow

	Path #1	Path #2	Path #3
Segment ID			
7. Surface description (Paved or Unpaved)	unpaved		
8. Flow length, L ft.	3083		
9. Watercourse slope, s ft./ft.	0.0170		
10. Average velocity, V (figure 3-1) ft./sec.	2.10		
11. $T_t = \frac{L}{3600 V}$ Compute T_t hr.	0.4071	0.0000	0.0000

Channel flow

	Path #1	Path #2	Path #3
Segment ID			
12. Cross sectional flow area, a ft. ²	24.00		
13. Wetted perimeter, p_w ft.	14.00		
14. Hydraulic Radius, $r = a / p_w$ Compute r ft.	1.7143		
15. Channel slope, s ft./ft.	0.0150		
16. Manning's roughness coefficient, n	0.0300		
17a. $V = \frac{1.49 r^{2/3} S^{1/2}}{n}$ Compute V ft./sec.	8.71		
17b. Input Velocity, FPS ft./sec.	8.71		
18. Flow length, L ft.	400		
19. $T_t = \frac{L}{3600 V}$ Compute T_t hr.	0.0128	0.0000	0.0000
20. Total, T_c (add T_t in steps 6, 11, and 19) hr.	0.8066	0.0000	0.0000

21. Watershed Total, T_c (maximum, Path #1, #2, or #3) 0.81 Hour
48 min

STV/ RWA Consulting Engineers 1000 West Morehead Street, Suite 200 Charlotte, NC 28208 (704) 372-1885	JOB:	US 1 over I-20		SHEET
	SUBJECT:	EP-0112		2
	CALC'D BY:	JMB	DATE: 20-Mar-19	OF
	CHECK'D BY:	GPP	DATE: 20-Mar-19	3

RUNOFF CURVE NUMBER AND RUNOFF

Check one: ☐ Present ☒ Developed

Runoff Curve Number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN*			Area <input checked="" type="checkbox"/> acres <input type="checkbox"/> mi^2 <input type="checkbox"/> %	Product of CN x area
		Table 2-2	Figure 2-3	Figure 2-4		
B	Grass	61			24.1	1468.3
B	Woods	55			65.2	3586.0
B	Impervious	98			9.3	914.8
B	Residential	72			10.5	756.3
B	Industrial	88			3.6	316.9
Totals ==>					112.7	7042.4

* Use only one CN source per line

CN (weighted) =

$$\frac{\text{total product}}{\text{total area}} = \frac{7042.4}{112.7} = 62.5$$
 Use CN =====>

62

Runoff

	Storm # 1	Storm # 2	Storm # 3	Storm # 4	Storm # 5
Frequency.....yr	2	10	25	50	100
Rainfall, P (24-hour)..... in	3.63	5.27	6.37	7.30	8.31
Runoff, Q..... in	0.68	1.61	2.35	3.02	3.80

(Use P and CN with table 2-1, figure 2-1, or equations 2-3 and 2-4)

STV / RWA Consulting Engineers 1000 West Morehead Street, Suite 200 Charlotte, NC 28208 (704) 372-1885	JOB:	US 1 over I-20		SHEET
	SUBJECT:	EP-0112		3
	CALC'D BY:	JMB	DATE:	20-Mar-19
	CHECK'D BY:	GPP	DATE:	20-Mar-19
				OF
				3

GRAPHICAL PEAK DISCHARGE METHOD

Check one: ☐ Present ☒ Developed

1. Data

Drainage area..... A_m = 0.176 mi^2 (acres/640)

Runoff curve number..... CN = 62 (From CN & Runoff worksheet)

Time of concentration..... T_c = 0.8 hr (From T_c worksheet)

Rainfall distribution..... = II (I, IA, II, III)

Pond and swamp areas spread
thoroughout watershed..... = 2.2 percent of A_m (0.003874) acres or mi^2
covered)

	Storm #1	Storm #2	Storm #3	Storm #4	Storm #5
2. Frequency yr	2	10	25	50	100
3. Rainfall, P (24-hour) in	3.63	5.27	6.37	7.30	8.31
4. Initial abstraction, I_a in (Use CN with table 4-1)	1.226	1.226	1.226	1.226	1.226
5. Compute I_a/P	0.34	0.23	0.19	0.17	0.15
6. Unit peak discharge, q_u gsm/in (Use T_c and I_a/P with exhibit 4-II)	0	370	380	390	400
7. Runoff, Q in (From CN & Runoff worksheet)	0.68	1.61	2.35	3.02	3.80
8. Pond and swamp adjustment factor, F_p (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond and swamp area.)	0.75	0.75	0.75	0.75	0.75
9. Peak discharge, q_p ft^3/s (Where $q_p = q_u A_m Q F_p$)	0	79	118	156	201

HY-8

**Pre-Construction
Calculations**

Table 1 - Summary of Culvert Flows at Crossing: EP-0101

Headwater Elevation (ft)	Total Discharge (cfs)	EP-0101 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
345.06	12.00	12.00	0.00	1
345.49	15.00	15.00	0.00	1
345.78	18.00	18.00	0.00	1
346.08	20.00	20.00	0.00	1
349.01	34.00	32.21	1.52	45
349.00	32.18	32.18	0.00	Overtopping

Table 2 - Culvert Summary Table: EP-0101

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
12.00	12.00	345.06	1.915	0.0*	1-S2n	1.191	1.239	1.191	0.448	5.963	6.702
15.00	15.00	345.49	2.254	2.352	7-M2c	1.398	1.392	1.392	0.517	6.428	7.247
18.00	18.00	345.78	2.642	2.632	7-M2c	2.000	1.526	1.526	0.583	6.997	7.715
20.00	20.00	346.08	2.939	2.887	7-M2c	2.000	1.604	1.604	0.625	7.404	7.994
34.00	32.21	349.01	5.508	5.866	7-M2c	2.000	1.896	1.896	0.894	10.459	9.507

Straight Culvert
Inlet Elevation (invert): 343.14 ft, Outlet Elevation (invert): 342.54 ft
Culvert Length: 120.00 ft, Culvert Slope: 0.0050

Site Data - EP-0101

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 343.14 ft
Outlet Station: 120.00 ft
Outlet Elevation: 342.54 ft
Number of Barrels: 1

Culvert Data Summary - EP-0101

Barrel Shape: Circular
Barrel Diameter: 2.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall
Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: EP-0101)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
12.00	340.41	0.45	6.70	1.96	1.77
15.00	340.48	0.52	7.25	2.26	1.78
18.00	340.54	0.58	7.71	2.55	1.78
20.00	340.59	0.63	7.99	2.73	1.78
34.00	340.85	0.89	9.51	3.91	1.77

Tailwater Channel Data - EP-0101

Tailwater Channel Option: Rectangular Channel

Bottom Width: 4.00 ft

Channel Slope: 0.0700

Channel Manning's n: 0.0300

Channel Invert Elevation: 339.96 ft

Roadway Data for Crossing: EP-0101

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 1000.00 ft

Crest Elevation: 349.00 ft

Roadway Surface: Paved

Roadway Top Width: 50.00 ft

Table 4 - Summary of Culvert Flows at Crossing: EP-0102

Headwater Elevation (ft)	Total Discharge (cfs)	EP-0102 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
347.90	12.00	12.00	0.00	1
348.15	15.00	15.00	0.00	1
348.38	18.00	18.00	0.00	1
348.53	20.00	20.00	0.00	1
349.78	34.00	34.00	0.00	1
351.00	43.66	43.66	0.00	Overtopping

Table 5 - Culvert Summary Table: EP-0102

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
12.00	12.00	347.90	1.689	0.068	1-S2n	1.076	1.162	1.076	0.448	5.739	6.702
15.00	15.00	348.15	1.936	1.238	1-S2n	1.223	1.304	1.223	0.517	6.077	7.247
18.00	18.00	348.38	2.168	1.506	1-S2n	1.366	1.434	1.366	0.583	6.350	7.715
20.00	20.00	348.53	2.320	1.690	1-S2n	1.462	1.513	1.462	0.625	6.504	7.994
34.00	34.00	349.78	3.570	3.498	7-M2c	2.500	1.980	1.980	0.894	8.153	9.507

Straight Culvert
Inlet Elevation (invert): 346.21 ft, Outlet Elevation (invert): 345.83 ft
Culvert Length: 85.00 ft, Culvert Slope: 0.0045

Site Data - EP-0102

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 346.21 ft

Outlet Station: 85.00 ft

Outlet Elevation: 345.83 ft

Number of Barrels: 1

Culvert Data Summary - EP-0102

Barrel Shape: Circular

Barrel Diameter: 2.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 6 - Downstream Channel Rating Curve (Crossing: EP-0102)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
12.00	346.28	0.45	6.70	1.96	1.77
15.00	346.35	0.52	7.25	2.26	1.78
18.00	346.41	0.58	7.71	2.55	1.78
20.00	346.46	0.63	7.99	2.73	1.78
34.00	346.72	0.89	9.51	3.91	1.77

Tailwater Channel Data - EP-0102

Tailwater Channel Option: Rectangular Channel

Bottom Width: 4.00 ft

Channel Slope: 0.0700

Channel Manning's n: 0.0300

Channel Invert Elevation: 345.83 ft

Roadway Data for Crossing: EP-0102

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 1000.00 ft

Crest Elevation: 351.00 ft

Roadway Surface: Paved

Roadway Top Width: 50.00 ft

Table 7 - Summary of Culvert Flows at Crossing: EP-0103

Headwater Elevation (ft)	Total Discharge (cfs)	EP-0103 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
361.02	13.00	6.47	6.41	18
361.02	16.00	6.48	9.47	4
361.03	19.00	6.48	12.40	3
361.03	21.00	6.49	14.44	3
361.05	36.00	6.50	29.47	3
361.00	6.45	6.45	0.00	Overtopping

Table 8 - Culvert Summary Table: EP-0103

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
13.00	6.47	361.02	3.376	2.449	5-S2n	0.790	0.879	0.790	0.471	9.459	6.894
16.00	6.48	361.02	3.381	2.462	5-S2n	0.790	0.888	0.815	0.540	9.192	7.410
19.00	6.48	361.03	3.385	2.487	5-S2n	0.791	0.925	0.816	0.605	9.190	7.857
21.00	6.49	361.03	3.388	2.477	5-S2n	0.791	0.895	0.816	0.646	9.197	8.126
36.00	6.50	361.05	3.406	2.489	5-S2n	0.794	0.885	0.794	0.930	9.480	9.679

Straight Culvert
Inlet Elevation (invert): 357.64 ft, Outlet Elevation (invert): 354.38 ft
Culvert Length: 114.05 ft, Culvert Slope: 0.0286

Site Data - EP-0103

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 357.64 ft

Outlet Station: 114.00 ft

Outlet Elevation: 354.38 ft

Number of Barrels: 1

Culvert Data Summary - EP-0103

Barrel Shape: Circular

Barrel Diameter: 1.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 9 - Downstream Channel Rating Curve (Crossing: EP-0103)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
13.00	354.85	0.47	6.89	2.06	1.77
16.00	354.92	0.54	7.41	2.36	1.78
19.00	354.98	0.60	7.86	2.64	1.78
21.00	355.03	0.65	8.13	2.82	1.78
36.00	355.31	0.93	9.68	4.06	1.77

Tailwater Channel Data - EP-0103

Tailwater Channel Option: Rectangular Channel

Bottom Width: 4.00 ft

Channel Slope: 0.0700

Channel Manning's n: 0.0300

Channel Invert Elevation: 354.38 ft

Roadway Data for Crossing: EP-0103

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 1000.00 ft

Crest Elevation: 361.00 ft

Roadway Surface: Paved

Roadway Top Width: 50.00 ft

Table 10 - Summary of Culvert Flows at Crossing: EP-0104

Headwater Elevation (ft)	Total Discharge (cfs)	EP-0104 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
363.01	9.00	7.61	1.32	45
363.01	11.00	7.62	3.34	5
363.02	13.00	7.62	5.33	4
363.02	14.00	7.62	6.31	3
363.03	25.00	7.64	17.30	3
363.00	7.61	7.61	0.00	Overtopping

Table 11 - Culvert Summary Table: EP-0104

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
9.00	7.61	363.01	4.501	4.645	6-FFc	1.000	1.000	1.000	0.372	9.691	6.049
11.00	7.62	363.01	4.507	4.651	6-FFc	1.000	1.000	1.000	0.423	9.698	6.500
13.00	7.62	363.02	4.511	4.655	6-FFc	1.000	1.000	1.000	0.471	9.703	6.894
14.00	7.62	363.02	4.513	4.656	6-FFc	1.000	1.000	1.000	0.495	9.705	7.075
25.00	7.64	363.03	4.531	4.672	6-FFc	1.000	1.000	1.000	0.726	9.726	8.611

Straight Culvert
Inlet Elevation (invert): 358.36 ft, Outlet Elevation (invert): 358.31 ft
Culvert Length: 39.00 ft, Culvert Slope: 0.0013

Site Data - EP-0104

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 358.36 ft
Outlet Station: 39.00 ft
Outlet Elevation: 358.31 ft
Number of Barrels: 1

Culvert Data Summary - EP-0104

Barrel Shape: Circular
Barrel Diameter: 1.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall
Inlet Depression: None

Table 12 - Downstream Channel Rating Curve (Crossing: EP-0104)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
9.00	358.68	0.37	6.05	1.62	1.75
11.00	358.73	0.42	6.50	1.85	1.76
13.00	358.78	0.47	6.89	2.06	1.77
14.00	358.80	0.49	7.07	2.16	1.77
25.00	359.04	0.73	8.61	3.17	1.78

Tailwater Channel Data - EP-0104

Tailwater Channel Option: Rectangular Channel

Bottom Width: 4.00 ft

Channel Slope: 0.0700

Channel Manning's n: 0.0300

Channel Invert Elevation: 358.31 ft

Roadway Data for Crossing: EP-0104

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 1000.00 ft

Crest Elevation: 363.00 ft

Roadway Surface: Paved

Roadway Top Width: 50.00 ft

Table 13 - Summary of Culvert Flows at Crossing: EP-0106

Headwater Elevation (ft)	Total Discharge (cfs)	EP-0106 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
357.04	20.00	20.00	0.00	1
357.93	25.00	25.00	0.00	1
358.01	30.00	25.38	4.42	13
358.02	34.00	25.42	8.38	4
358.05	57.00	25.55	31.05	3
358.00	25.32	25.32	0.00	Overtopping

Table 14 - Culvert Summary Table: EP-0106

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
20.00	20.00	357.04	2.911	1.000	5-S2n	0.917	1.604	1.023	0.625	11.970	7.994
25.00	25.00	357.93	3.805	1.859	5-S2n	1.046	1.761	1.176	0.726	12.608	8.611
30.00	25.38	358.01	3.883	1.931	5-S2n	1.056	1.771	1.188	0.821	12.656	9.136
34.00	25.42	358.02	3.890	1.937	5-S2n	1.057	1.772	1.189	0.894	12.659	9.507
57.00	25.55	358.05	3.918	1.963	5-S2n	1.060	1.775	1.193	1.282	12.674	11.117

Straight Culvert
Inlet Elevation (invert): 354.13 ft, Outlet Elevation (invert): 351.94 ft
Culvert Length: 67.04 ft, Culvert Slope: 0.0327

Site Data - EP-0106

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 354.13 ft

Outlet Station: 67.00 ft

Outlet Elevation: 351.94 ft

Number of Barrels: 1

Culvert Data Summary - EP-0106

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 15 - Downstream Channel Rating Curve (Crossing: EP-0106)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
20.00	352.57	0.63	7.99	2.73	1.78
25.00	352.67	0.73	8.61	3.17	1.78
30.00	352.76	0.82	9.14	3.59	1.78
34.00	352.83	0.89	9.51	3.91	1.77
57.00	353.22	1.28	11.12	5.60	1.73

Tailwater Channel Data - EP-0106

Tailwater Channel Option: Rectangular Channel

Bottom Width: 4.00 ft

Channel Slope: 0.0700

Channel Manning's n: 0.0300

Channel Invert Elevation: 351.94 ft

Roadway Data for Crossing: EP-0106

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 1000.00 ft

Crest Elevation: 358.00 ft

Roadway Surface: Paved

Roadway Top Width: 50.00 ft

Table 16 - Summary of Culvert Flows at Crossing: EP-0107

Headwater Elevation (ft)	Total Discharge (cfs)	EP-0107 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
349.02	34.00	26.52	7.33	20
349.03	42.00	26.57	15.07	4
349.04	51.00	26.62	24.20	4
349.05	57.00	26.65	30.04	3
349.08	97.00	26.82	70.00	3
349.00	26.43	26.43	0.00	Overtopping

Table 17 - Culvert Summary Table: EP-0107

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
34.00	26.52	349.02	4.138	3.280	5-S2n	1.406	1.798	1.496	0.894	10.245	9.507
42.00	26.57	349.03	4.150	3.291	5-S2n	1.408	1.799	1.498	1.034	10.249	10.151
51.00	26.62	349.04	4.161	3.301	5-S2n	1.411	1.800	1.501	1.185	10.254	10.761
57.00	26.65	349.05	4.167	3.307	5-S2n	1.412	1.801	1.502	1.282	10.256	11.117
97.00	26.82	349.08	4.203	3.326	5-S2n	1.419	1.804	1.509	1.887	10.271	12.850

Straight Culvert
Inlet Elevation (invert): 344.88 ft, Outlet Elevation (invert): 343.74 ft
Culvert Length: 74.01 ft, Culvert Slope: 0.0154

Site Data - EP-0107

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 344.88 ft

Outlet Station: 74.00 ft

Outlet Elevation: 343.74 ft

Number of Barrels: 1

Culvert Data Summary - EP-0107

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 18 - Downstream Channel Rating Curve (Crossing: EP-0107)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
34.00	344.63	0.89	9.51	3.91	1.77
42.00	344.77	1.03	10.15	4.52	1.76
51.00	344.92	1.18	10.76	5.18	1.74
57.00	345.02	1.28	11.12	5.60	1.73
97.00	345.63	1.89	12.85	8.24	1.65

Tailwater Channel Data - EP-0107

Tailwater Channel Option: Rectangular Channel

Bottom Width: 4.00 ft

Channel Slope: 0.0700

Channel Manning's n: 0.0300

Channel Invert Elevation: 343.74 ft

Roadway Data for Crossing: EP-0107

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 1000.00 ft

Crest Elevation: 349.00 ft

Roadway Surface: Paved

Roadway Top Width: 50.00 ft

Table 19 - Summary of Culvert Flows at Crossing: EP-0108

Headwater Elevation (ft)	Total Discharge (cfs)	EP-0108 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
354.01	15.00	13.83	1.08	69
354.01	19.00	13.85	5.02	5
354.02	23.00	13.87	9.01	4
354.03	26.00	13.88	11.91	3
354.05	45.00	13.95	30.94	3
354.00	13.81	13.81	0.00	Overtopping

Table 20 - Culvert Summary Table: EP-0108

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
15.00	13.83	354.01	3.415	2.754	5-S2n	1.134	1.377	1.188	0.517	8.979	7.247
19.00	13.85	354.01	3.424	2.763	5-S2n	1.136	1.377	1.190	0.605	8.982	7.857
23.00	13.87	354.02	3.431	2.770	5-S2n	1.137	1.378	1.191	0.686	8.983	8.377
26.00	13.88	354.03	3.435	2.774	5-S2n	1.138	1.378	1.192	0.745	8.983	8.722
45.00	13.95	354.05	3.458	2.797	5-S2n	1.143	1.380	1.197	1.085	8.987	10.366

Straight Culvert
Inlet Elevation (invert): 350.59 ft, Outlet Elevation (invert): 349.54 ft
Culvert Length: 64.01 ft, Culvert Slope: 0.0164

Site Data - EP-0108

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 350.59 ft

Outlet Station: 64.00 ft

Outlet Elevation: 349.54 ft

Number of Barrels: 1

Culvert Data Summary - EP-0108

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 21 - Downstream Channel Rating Curve (Crossing: EP-0108)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
15.00	350.06	0.52	7.25	2.26	1.78
19.00	350.14	0.60	7.86	2.64	1.78
23.00	350.23	0.69	8.38	3.00	1.78
26.00	350.29	0.75	8.72	3.26	1.78
45.00	350.63	1.09	10.37	4.74	1.75

Tailwater Channel Data - EP-0108

Tailwater Channel Option: Rectangular Channel

Bottom Width: 4.00 ft

Channel Slope: 0.0700

Channel Manning's n: 0.0300

Channel Invert Elevation: 349.54 ft

Roadway Data for Crossing: EP-0108

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 1000.00 ft

Crest Elevation: 354.00 ft

Roadway Surface: Paved

Roadway Top Width: 50.00 ft

Table 22 - Summary of Culvert Flows at Crossing: EP-0109

Headwater Elevation (ft)	Total Discharge (cfs)	EP-0109 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
369.23	2.00	2.00	0.00	1
369.46	3.00	3.00	0.00	1
369.46	3.00	3.00	0.00	1
369.68	4.00	4.00	0.00	1
370.54	7.00	7.00	0.00	1
372.00	10.20	10.20	0.00	Overtopping

Table 23 - Culvert Summary Table: EP-0109

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
2.00	2.00	369.23	0.805	0.0*	1-S2n	0.371	0.563	0.371	0.145	6.326	3.450
3.00	3.00	369.46	1.035	0.0*	1-S2n	0.460	0.694	0.460	0.186	7.086	4.028
3.00	3.00	369.46	1.035	0.0*	1-S2n	0.460	0.694	0.460	0.186	7.086	4.028
4.00	4.00	369.68	1.253	0.0*	5-S2n	0.539	0.805	0.539	0.223	7.635	4.489
7.00	7.00	370.54	2.108	1.108	5-S2n	0.757	1.057	0.787	0.317	8.340	5.523

Straight Culvert
Inlet Elevation (invert): 368.43 ft, Outlet Elevation (invert): 366.82 ft
Culvert Length: 81.02 ft, Culvert Slope: 0.0199

Site Data - EP-0109

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 368.43 ft

Outlet Station: 81.00 ft

Outlet Elevation: 366.82 ft

Number of Barrels: 1

Culvert Data Summary - EP-0109

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 24 - Downstream Channel Rating Curve (Crossing: EP-0109)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
2.00	366.96	0.14	3.45	0.63	1.60
3.00	367.01	0.19	4.03	0.81	1.65
3.00	367.01	0.19	4.03	0.81	1.65
4.00	367.04	0.22	4.49	0.97	1.68
7.00	367.14	0.32	5.52	1.38	1.73

Tailwater Channel Data - EP-0109

Tailwater Channel Option: Rectangular Channel

Bottom Width: 4.00 ft

Channel Slope: 0.0700

Channel Manning's n: 0.0300

Channel Invert Elevation: 366.82 ft

Roadway Data for Crossing: EP-0109

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 1000.00 ft

Crest Elevation: 372.00 ft

Roadway Surface: Paved

Roadway Top Width: 50.00 ft

Table 25 - Summary of Culvert Flows at Crossing: EP-0110

Headwater Elevation (ft)	Total Discharge (cfs)	EP-0110 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
369.68	1.00	1.00	0.00	1
369.68	1.00	1.00	0.00	1
369.96	2.00	2.00	0.00	1
369.96	2.00	2.00	0.00	1
370.18	3.00	3.00	0.00	1
372.00	7.80	7.80	0.00	Overtopping

Table 26 - Culvert Summary Table: EP-0110

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
1.00	1.00	369.68	0.541	0.601	2-M2c	0.407	0.389	0.389	0.095	3.074	2.639
1.00	1.00	369.68	0.541	0.601	2-M2c	0.407	0.389	0.389	0.095	3.074	2.639
2.00	2.00	369.96	0.815	0.876	2-M2c	0.597	0.563	0.563	0.145	3.728	3.450
2.00	2.00	369.96	0.815	0.876	2-M2c	0.597	0.563	0.563	0.145	3.728	3.450
3.00	3.00	370.18	1.045	1.103	2-M2c	0.769	0.694	0.694	0.186	4.289	4.028

Straight Culvert
Inlet Elevation (invert): 369.08 ft, Outlet Elevation (invert): 368.77 ft
Culvert Length: 89.00 ft, Culvert Slope: 0.0035

Site Data - EP-0110

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 369.08 ft

Outlet Station: 89.00 ft

Outlet Elevation: 368.77 ft

Number of Barrels: 1

Culvert Data Summary - EP-0110

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 27 - Downstream Channel Rating Curve (Crossing: EP-0110)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
1.00	368.86	0.09	2.64	0.41	1.51
1.00	368.86	0.09	2.64	0.41	1.51
2.00	368.91	0.14	3.45	0.63	1.60
2.00	368.91	0.14	3.45	0.63	1.60
3.00	368.96	0.19	4.03	0.81	1.65

Tailwater Channel Data - EP-0110

Tailwater Channel Option: Rectangular Channel

Bottom Width: 4.00 ft

Channel Slope: 0.0700

Channel Manning's n: 0.0300

Channel Invert Elevation: 368.77 ft

Roadway Data for Crossing: EP-0110

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 1000.00 ft

Crest Elevation: 372.00 ft

Roadway Surface: Paved

Roadway Top Width: 50.00 ft

Table 28 - Summary of Culvert Flows at Crossing: EP-0111

Headwater Elevation (ft)	Total Discharge (cfs)	EP-0111 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
333.04	149.00	124.73	23.43	28
333.10	223.00	125.17	96.26	5
333.15	303.00	125.53	176.09	4
333.20	391.00	125.86	264.64	4
333.32	665.00	126.70	537.80	3
333.00	124.44	124.44	0.00	Overtopping

Table 29 - Culvert Summary Table: EP-0111

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
149.00	124.73	333.04	10.390	0.000	7-M2c	3.330	3.082	3.082	2.615	14.821	14.245
223.00	125.17	333.10	10.452	8.853	4-FFf	3.330	3.072	3.330	3.598	14.373	15.494
303.00	125.53	333.15	10.502	9.914	4-FFf	3.330	3.064	3.330	4.627	14.414	16.373
391.00	125.86	333.20	10.550	11.054	4-FFf	3.330	3.057	3.330	5.736	14.452	17.042
665.00	126.70	333.32	10.668	14.517	4-FFf	3.330	3.041	3.330	9.121	14.548	18.228

Straight Culvert
Inlet Elevation (invert): 322.65 ft, Outlet Elevation (invert): 322.17 ft
Culvert Length: 54.00 ft, Culvert Slope: 0.0089

Site Data - EP-0111

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 322.65 ft

Outlet Station: 54.00 ft

Outlet Elevation: 322.17 ft

Number of Barrels: 1

Culvert Data Summary - EP-0111

Barrel Shape: Circular

Barrel Diameter: 3.33 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 30 - Downstream Channel Rating Curve (Crossing: EP-0111)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
149.00	324.78	2.61	14.24	11.42	1.55
223.00	325.77	3.60	15.49	15.72	1.44
303.00	326.80	4.63	16.37	20.21	1.34
391.00	327.91	5.74	17.04	25.05	1.25
665.00	331.29	9.12	18.23	39.84	1.06

Tailwater Channel Data - EP-0111

Tailwater Channel Option: Rectangular Channel

Bottom Width: 4.00 ft

Channel Slope: 0.0700

Channel Manning's n: 0.0300

Channel Invert Elevation: 322.17 ft

Roadway Data for Crossing: EP-0111

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 1000.00 ft

Crest Elevation: 333.00 ft

Roadway Surface: Paved

Roadway Top Width: 50.00 ft

Table 31 - Summary of Culvert Flows at Crossing: EP-0112

Headwater Elevation (ft)	Total Discharge (cfs)	EP-0112 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
341.08	71.00	9.48	61.17	8
341.10	107.00	9.59	96.99	4
341.13	145.00	9.70	134.26	3
341.15	190.00	9.81	179.59	3
341.22	323.00	10.08	312.11	2
341.00	9.15	9.15	0.00	Overtopping

Table 32 - Culvert Summary Table: EP-0112

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
71.00	9.48	341.08	2.075	0.0*	5-S2n	0.522	1.188	0.522	1.501	16.751	11.827
107.00	9.59	341.10	2.102	0.0*	5-S2n	0.525	1.195	0.525	2.031	16.808	13.172
145.00	9.70	341.13	2.127	0.0*	5-S2n	0.528	1.201	0.528	2.560	16.859	14.158
190.00	9.81	341.15	2.154	0.0*	5-JS1f	0.531	1.207	1.500	3.165	5.550	15.008
323.00	10.08	341.22	2.222	0.0*	5-JS1f	0.540	1.222	1.500	4.880	5.706	16.546

Straight Culvert
Inlet Elevation (invert): 339.00 ft, Outlet Elevation (invert): 329.00 ft
Culvert Length: 108.46 ft, Culvert Slope: 0.0926

Site Data - EP-0112

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 339.00 ft

Outlet Station: 108.00 ft

Outlet Elevation: 329.00 ft

Number of Barrels: 1

Culvert Data Summary - EP-0112

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 33 - Downstream Channel Rating Curve (Crossing: EP-0112)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
71.00	330.50	1.50	11.83	6.56	1.70
107.00	331.03	2.03	13.17	8.87	1.63
145.00	331.56	2.56	14.16	11.18	1.56
190.00	332.16	3.16	15.01	13.82	1.49
323.00	333.88	4.88	16.55	21.32	1.32

Tailwater Channel Data - EP-0112

Tailwater Channel Option: Rectangular Channel

Bottom Width: 4.00 ft

Channel Slope: 0.0700

Channel Manning's n: 0.0300

Channel Invert Elevation: 329.00 ft

Roadway Data for Crossing: EP-0112

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 1000.00 ft

Crest Elevation: 341.00 ft

Roadway Surface: Paved

Roadway Top Width: 50.00 ft

Table 34 - Summary of Culvert Flows at Crossing: EP-0113

Headwater Elevation (ft)	Total Discharge (cfs)	EP-0113 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
363.55	30.00	30.00	0.00	1
364.30	37.00	37.00	0.00	1
365.37	45.00	45.00	0.00	1
366.01	51.00	49.07	1.50	63
366.05	86.00	49.36	36.38	4
366.00	49.03	49.03	0.00	Overtopping

Table 35 - Culvert Summary Table: EP-0113

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
30.00	30.00	363.55	3.146	1.929	5-S2n	1.244	1.865	1.384	0.821	10.418	9.136
37.00	37.00	364.30	3.897	2.951	5-S2n	1.415	2.058	1.578	0.948	10.993	9.762
45.00	45.00	365.37	4.970	3.883	5-S2n	1.614	2.225	1.792	1.085	11.629	10.366
51.00	49.07	366.01	5.606	4.410	5-S2n	1.721	2.288	1.898	1.185	11.948	10.761
86.00	49.36	366.05	5.654	4.448	5-S2n	1.729	2.292	1.906	1.726	11.968	12.455

Straight Culvert
Inlet Elevation (invert): 360.40 ft, Outlet Elevation (invert): 359.30 ft
Culvert Length: 65.01 ft, Culvert Slope: 0.0169

Site Data - EP-0113

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 360.40 ft

Outlet Station: 65.00 ft

Outlet Elevation: 359.30 ft

Number of Barrels: 1

Culvert Data Summary - EP-0113

Barrel Shape: Circular

Barrel Diameter: 2.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 36 - Downstream Channel Rating Curve (Crossing: EP-0113)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
30.00	360.12	0.82	9.14	3.59	1.78
37.00	360.25	0.95	9.76	4.14	1.77
45.00	360.39	1.09	10.37	4.74	1.75
51.00	360.48	1.18	10.76	5.18	1.74
86.00	361.03	1.73	12.46	7.54	1.67

Tailwater Channel Data - EP-0113

Tailwater Channel Option: Rectangular Channel

Bottom Width: 4.00 ft

Channel Slope: 0.0700

Channel Manning's n: 0.0300

Channel Invert Elevation: 359.30 ft

Roadway Data for Crossing: EP-0113

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 1000.00 ft

Crest Elevation: 366.00 ft

Roadway Surface: Paved

Roadway Top Width: 50.00 ft

Table 37 - Summary of Culvert Flows at Crossing: EP-0115

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	EP-0115 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
366.02	10	5.00	5.00	0.00	1
366.36	25	7.00	7.00	0.00	1
366.55	50	8.00	8.00	0.00	1
366.76	100	9.00	9.00	0.00	1
368.58	500	15.00	15.00	0.00	1
369.00	Overtopping	16.05	16.05	0.00	Overtopping

Table 38 - Culvert Summary Table: EP-0115

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)
10	5.00	5.00	366.02	1.281	0.0*	1-S2n	0.517	0.856	0.541	0.256	8.417
25	7.00	7.00	366.36	1.618	0.0*	5-S2n	0.620	1.021	0.658	0.317	9.080
50	8.00	8.00	366.55	1.806	0.149	5-S2n	0.669	1.092	0.711	0.345	9.370
100	9.00	9.00	366.76	2.016	0.597	5-S2n	0.716	1.156	0.766	0.372	9.604
500	15.00	15.00	368.58	3.843	2.515	5-S2n	0.993	1.407	1.069	0.517	10.822

Straight Culvert
Inlet Elevation (invert): 364.74 ft, Outlet Elevation (invert): 363.00 ft
Culvert Length: 65.02 ft, Culvert Slope: 0.0268

Site Data - EP-0115

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 364.74 ft

Outlet Station: 65.00 ft

Outlet Elevation: 363.00 ft

Number of Barrels: 1

Culvert Data Summary - EP-0115

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 39 - Downstream Channel Rating Curve (Crossing: EP-0115)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
5.00	363.26	0.26	4.88	1.12	1.70
7.00	363.32	0.32	5.52	1.38	1.73
8.00	363.34	0.34	5.80	1.51	1.74
9.00	363.37	0.37	6.05	1.62	1.75
15.00	363.52	0.52	7.25	2.26	1.78

Tailwater Channel Data - EP-0115

Tailwater Channel Option: Rectangular Channel

Bottom Width: 4.00 ft

Channel Slope: 0.0700

Channel Manning's n: 0.0300

Channel Invert Elevation: 363.00 ft

Roadway Data for Crossing: EP-0115

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 1000.00 ft

Crest Elevation: 369.00 ft

Roadway Surface: Paved

Roadway Top Width: 50.00 ft

Table 40 - Summary of Culvert Flows at Crossing: EP-0116

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	EP-0116 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
365.25	10	35.00	35.00	0.00	1
366.18	25	49.00	49.00	0.00	1
367.50	50	64.00	64.00	0.00	1
368.72	100	75.00	75.00	0.00	1
369.14	500	234.00	78.42	154.25	4
369.00	Overtopping	77.30	77.30	0.00	Overtopping

Table 41 - Culvert Summary Table: EP-0116

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)
10	35.00	35.00	365.25	2.943	0.0*	1-S2n	1.021	1.919	1.149	0.912	13.563
25	49.00	49.00	366.18	3.874	1.221	5-S2n	1.225	2.276	1.408	1.152	14.548
50	64.00	64.00	367.50	5.191	2.435	5-S2n	1.425	2.568	1.661	1.393	15.437
100	75.00	75.00	368.72	6.408	3.474	5-S2n	1.566	2.719	1.836	1.562	16.049
500	234.00	78.42	369.14	6.829	4.684	5-S2n	1.610	2.755	1.888	3.741	16.234

Straight Culvert
Inlet Elevation (invert): 362.31 ft, Outlet Elevation (invert): 359.38 ft
Culvert Length: 86.05 ft, Culvert Slope: 0.0341

Site Data - EP-0116

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 362.31 ft
Outlet Station: 86.00 ft
Outlet Elevation: 359.38 ft
Number of Barrels: 1

Culvert Data Summary - EP-0116

Barrel Shape: Circular
Barrel Diameter: 3.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall
Inlet Depression: None

Table 42 - Downstream Channel Rating Curve (Crossing: EP-0116)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
35.00	360.29	0.91	9.59	3.98	1.77
49.00	360.53	1.15	10.63	5.03	1.75
64.00	360.77	1.39	11.49	6.08	1.72
75.00	360.94	1.56	12.01	6.82	1.69
234.00	363.12	3.74	15.64	16.34	1.42

Tailwater Channel Data - EP-0116

Tailwater Channel Option: Rectangular Channel

Bottom Width: 4.00 ft

Channel Slope: 0.0700

Channel Manning's n: 0.0300

Channel Invert Elevation: 359.38 ft

Roadway Data for Crossing: EP-0116

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 1000.00 ft

Crest Elevation: 369.00 ft

Roadway Surface: Paved

Roadway Top Width: 50.00 ft

Table 43 - Summary of Culvert Flows at Crossing: EP-0117

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	EP-0117 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
368.04	10	47.00	24.49	22.15	15
368.05	25	58.00	24.55	33.25	4
368.06	50	70.00	24.61	44.88	3
368.07	100	78.00	24.65	53.06	3
368.11	500	132.00	24.85	107.06	3
368.00	Overtopping	24.30	24.30	0.00	Overtopping

Table 44 - Culvert Summary Table: EP-0117

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)
10	47.00	24.49	368.04	3.738	3.417	7-JA2t	-1.000	1.748	1.748	1.119	8.243
25	58.00	24.55	368.05	3.750	3.424	7-JA2t	-1.000	1.750	1.750	1.298	8.257
50	70.00	24.61	368.06	3.761	3.430	7-JA2t	-1.000	1.751	1.751	1.485	8.271
100	78.00	24.65	368.07	3.768	3.435	7-JA2t	-1.000	1.752	1.752	1.607	8.279
500	132.00	24.85	368.11	3.809	5.012	4-FFf	-1.000	1.758	2.000	2.382	7.910

Straight Culvert
Inlet Elevation (invert): 364.30 ft, Outlet Elevation (invert): 364.44 ft
Culvert Length: 101.00 ft, Culvert Slope: -0.0014

Site Data - EP-0117

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 364.30 ft

Outlet Station: 101.00 ft

Outlet Elevation: 364.44 ft

Number of Barrels: 1

Culvert Data Summary - EP-0117

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 45 - Downstream Channel Rating Curve (Crossing: EP-0117)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
47.00	365.56	1.12	10.50	4.89	1.75
58.00	365.74	1.30	11.17	5.67	1.73
70.00	365.93	1.49	11.78	6.49	1.70
78.00	366.05	1.61	12.13	7.02	1.69
132.00	366.82	2.38	13.86	10.40	1.58

Tailwater Channel Data - EP-0117

Tailwater Channel Option: Rectangular Channel

Bottom Width: 4.00 ft

Channel Slope: 0.0700

Channel Manning's n: 0.0300

Channel Invert Elevation: 364.44 ft

Roadway Data for Crossing: EP-0117

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 1000.00 ft

Crest Elevation: 368.00 ft

Roadway Surface: Paved

Roadway Top Width: 50.00 ft

HY-8

**Post-Construction
Calculations**

Table 1 - Summary of Culvert Flows at Crossing: EP-0101

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	EP-0101 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
345.06	10	12.00	12.00	0.00	1
345.49	25	15.00	15.00	0.00	1
345.78	50	18.00	18.00	0.00	1
346.08	100	20.00	20.00	0.00	1
349.01	500	34.00	32.21	1.52	45
349.00	Overtopping	32.18	32.18	0.00	Overtopping

Table 2 - Culvert Summary Table: EP-0101

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)
10	12.00	12.00	345.06	1.915	0.0*	1-S2n	1.191	1.239	1.191	0.448	5.963
25	15.00	15.00	345.49	2.254	2.352	7-M2c	1.398	1.392	1.392	0.517	6.428
50	18.00	18.00	345.78	2.642	2.632	7-M2c	2.000	1.526	1.526	0.583	6.997
100	20.00	20.00	346.08	2.939	2.887	7-M2c	2.000	1.604	1.604	0.625	7.404
500	34.00	32.21	349.01	5.508	5.866	7-M2c	2.000	1.896	1.896	0.894	10.459

Straight Culvert
Inlet Elevation (invert): 343.14 ft, Outlet Elevation (invert): 342.54 ft
Culvert Length: 120.00 ft, Culvert Slope: 0.0050

Site Data - EP-0101

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 343.14 ft

Outlet Station: 120.00 ft

Outlet Elevation: 342.54 ft

Number of Barrels: 1

Culvert Data Summary - EP-0101

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: EP-0101)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
12.00	340.41	0.45	6.70	1.96	1.77
15.00	340.48	0.52	7.25	2.26	1.78
18.00	340.54	0.58	7.71	2.55	1.78
20.00	340.59	0.63	7.99	2.73	1.78
34.00	340.85	0.89	9.51	3.91	1.77

Tailwater Channel Data - EP-0101

Tailwater Channel Option: Rectangular Channel

Bottom Width: 4.00 ft

Channel Slope: 0.0700

Channel Manning's n: 0.0300

Channel Invert Elevation: 339.96 ft

Roadway Data for Crossing: EP-0101

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 1000.00 ft

Crest Elevation: 349.00 ft

Roadway Surface: Paved

Roadway Top Width: 50.00 ft

Table 4 - Summary of Culvert Flows at Crossing: EP-0102

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	EP-0102 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
347.90	10	12.00	12.00	0.00	1
348.15	25	15.00	15.00	0.00	1
348.38	50	18.00	18.00	0.00	1
348.53	100	20.00	20.00	0.00	1
349.78	500	34.00	34.00	0.00	1
351.00	Overtopping	43.66	43.66	0.00	Overtopping

Table 5 - Culvert Summary Table: EP-0102

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)
10	12.00	12.00	347.90	1.689	0.068	1-S2n	1.076	1.162	1.076	0.448	5.739
25	15.00	15.00	348.15	1.936	1.238	1-S2n	1.223	1.304	1.223	0.517	6.077
50	18.00	18.00	348.38	2.168	1.506	1-S2n	1.366	1.434	1.366	0.583	6.350
100	20.00	20.00	348.53	2.320	1.690	1-S2n	1.462	1.513	1.462	0.625	6.504
500	34.00	34.00	349.78	3.570	3.498	7-M2c	2.500	1.980	1.980	0.894	8.153

Straight Culvert
Inlet Elevation (invert): 346.21 ft, Outlet Elevation (invert): 345.83 ft
Culvert Length: 85.00 ft, Culvert Slope: 0.0045

Site Data - EP-0102

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 346.21 ft

Outlet Station: 85.00 ft

Outlet Elevation: 345.83 ft

Number of Barrels: 1

Culvert Data Summary - EP-0102

Barrel Shape: Circular

Barrel Diameter: 2.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 6 - Downstream Channel Rating Curve (Crossing: EP-0102)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
12.00	346.28	0.45	6.70	1.96	1.77
15.00	346.35	0.52	7.25	2.26	1.78
18.00	346.41	0.58	7.71	2.55	1.78
20.00	346.46	0.63	7.99	2.73	1.78
34.00	346.72	0.89	9.51	3.91	1.77

Tailwater Channel Data - EP-0102

Tailwater Channel Option: Rectangular Channel

Bottom Width: 4.00 ft

Channel Slope: 0.0700

Channel Manning's n: 0.0300

Channel Invert Elevation: 345.83 ft

Roadway Data for Crossing: EP-0102

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 1000.00 ft

Crest Elevation: 351.00 ft

Roadway Surface: Paved

Roadway Top Width: 50.00 ft

Table 7 - Summary of Culvert Flows at Crossing: EP-0103

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	EP-0103 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
359.55	10	15.00	15.00	0.00	1
359.85	25	19.00	19.00	0.00	1
360.16	50	23.00	23.00	0.00	1
360.41	100	26.00	26.00	0.00	1
361.02	500	44.00	32.53	11.23	11
361.00	Overtopping	32.29	32.29	0.00	Overtopping

Table 8 - Culvert Summary Table: EP-0103

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)
10	15.00	15.00	359.55	1.906	0.0*	1-S2n	0.737	1.304	0.784	0.517	10.989
25	19.00	19.00	359.85	2.214	0.0*	1-S2n	0.834	1.474	0.887	0.605	11.761
50	23.00	23.00	360.16	2.524	0.0*	5-S2n	0.923	1.629	0.988	0.686	12.324
100	26.00	26.00	360.41	2.770	0.0*	5-S2n	0.987	1.733	1.065	0.745	12.604
500	44.00	32.53	361.02	3.384	0.591	5-S2n	1.119	1.939	1.217	1.068	13.275

Straight Culvert
Inlet Elevation (invert): 357.64 ft, Outlet Elevation (invert): 354.38 ft
Culvert Length: 114.05 ft, Culvert Slope: 0.0286

Site Data - EP-0103

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 357.64 ft

Outlet Station: 114.00 ft

Outlet Elevation: 354.38 ft

Number of Barrels: 1

Culvert Data Summary - EP-0103

Barrel Shape: Circular

Barrel Diameter: 2.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 9 - Downstream Channel Rating Curve (Crossing: EP-0103)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
15.00	354.90	0.52	7.25	2.26	1.78
19.00	354.98	0.60	7.86	2.64	1.78
23.00	355.07	0.69	8.38	3.00	1.78
26.00	355.13	0.75	8.72	3.26	1.78
44.00	355.45	1.07	10.30	4.67	1.76

Tailwater Channel Data - EP-0103

Tailwater Channel Option: Rectangular Channel

Bottom Width: 4.00 ft

Channel Slope: 0.0700

Channel Manning's n: 0.0300

Channel Invert Elevation: 354.38 ft

Roadway Data for Crossing: EP-0103

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 1000.00 ft

Crest Elevation: 361.00 ft

Roadway Surface: Paved

Roadway Top Width: 50.00 ft

Table 10 - Summary of Culvert Flows at Crossing: EP-0104

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	EP-0104 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
359.99	10	10.00	10.00	0.00	1
360.26	25	13.00	13.00	0.00	1
360.50	50	16.00	16.00	0.00	1
360.58	100	17.00	17.00	0.00	1
361.58	500	30.00	30.00	0.00	1
363.00	Overtopping	42.57	42.57	0.00	Overtopping

Table 11 - Culvert Summary Table: EP-0104

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)
10	10.00	10.00	359.99	1.512	1.634	2-M2c	1.398	1.054	1.054	0.398	5.084
25	13.00	13.00	360.26	1.778	1.895	2-M2c	1.672	1.212	1.212	0.471	5.510
50	16.00	16.00	360.50	2.018	2.139	2-M2c	2.500	1.348	1.348	0.540	5.930
100	17.00	17.00	360.58	2.095	2.218	2-M2c	2.500	1.389	1.389	0.562	6.069
500	30.00	30.00	361.58	3.166	3.216	7-M2c	2.500	1.865	1.865	0.821	7.640

Straight Culvert
Inlet Elevation (invert): 358.36 ft, Outlet Elevation (invert): 358.31 ft
Culvert Length: 39.00 ft, Culvert Slope: 0.0013

Site Data - EP-0104

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 358.36 ft

Outlet Station: 39.00 ft

Outlet Elevation: 358.31 ft

Number of Barrels: 1

Culvert Data Summary - EP-0104

Barrel Shape: Circular

Barrel Diameter: 2.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 12 - Downstream Channel Rating Curve (Crossing: EP-0104)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
10.00	358.71	0.40	6.28	1.74	1.75
13.00	358.78	0.47	6.89	2.06	1.77
16.00	358.85	0.54	7.41	2.36	1.78
17.00	358.87	0.56	7.57	2.45	1.78
30.00	359.13	0.82	9.14	3.59	1.78

Tailwater Channel Data - EP-0104

Tailwater Channel Option: Rectangular Channel

Bottom Width: 4.00 ft

Channel Slope: 0.0700

Channel Manning's n: 0.0300

Channel Invert Elevation: 358.31 ft

Roadway Data for Crossing: EP-0104

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 1000.00 ft

Crest Elevation: 363.00 ft

Roadway Surface: Paved

Roadway Top Width: 50.00 ft

Table 13 - Summary of Culvert Flows at Crossing: EP-0106

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	EP-0106 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
356.40	10	23.00	23.00	0.00	1
356.76	25	29.00	29.00	0.00	1
357.11	50	35.00	35.00	0.00	1
357.35	100	39.00	39.00	0.00	1
358.03	500	67.00	48.92	17.57	10
358.00	Overtopping	48.47	48.47	0.00	Overtopping

Table 14 - Culvert Summary Table: EP-0106

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)
10	23.00	23.00	356.40	2.274	0.0*	1-S2n	1.112	1.543	1.112	1.343	9.325
25	29.00	29.00	356.76	2.627	0.269	1-S2n	1.263	1.739	1.316	1.588	9.399
50	35.00	35.00	357.11	2.978	0.778	1-S2n	1.405	1.919	1.405	1.823	10.412
100	39.00	39.00	357.35	3.223	1.140	5-S2n	1.498	2.027	1.565	1.976	10.119
500	67.00	48.92	358.03	3.903	2.855	5-JS1t	1.723	2.274	2.996	2.996	6.920

Straight Culvert
Inlet Elevation (invert): 354.13 ft, Outlet Elevation (invert): 351.94 ft
Culvert Length: 205.01 ft, Culvert Slope: 0.0107

Site Data - EP-0106

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 354.13 ft

Outlet Station: 205.00 ft

Outlet Elevation: 351.94 ft

Number of Barrels: 1

Culvert Data Summary - EP-0106

Barrel Shape: Circular

Barrel Diameter: 3.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 15 - Downstream Channel Rating Curve (Crossing: EP-0106)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
23.00	353.28	1.34	4.28	0.84	0.65
29.00	353.53	1.59	4.57	0.99	0.64
35.00	353.76	1.82	4.80	1.14	0.63
39.00	353.92	1.98	4.93	1.23	0.62
67.00	354.94	3.00	5.59	1.87	0.57

Tailwater Channel Data - EP-0106

Tailwater Channel Option: Rectangular Channel

Bottom Width: 4.00 ft

Channel Slope: 0.0100

Channel Manning's n: 0.0300

Channel Invert Elevation: 351.94 ft

Roadway Data for Crossing: EP-0106

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 1000.00 ft

Crest Elevation: 358.00 ft

Roadway Surface: Paved

Roadway Top Width: 50.00 ft

Crossing Discharge Data

Discharge Selection Method: User Defined

Table 16 - Summary of Culvert Flows at Crossing: EP-0107

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	EP-0107 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
347.58	10	35.00	35.00	0.00	1
348.00	25	44.00	44.00	0.00	1
348.42	50	53.00	53.00	0.00	1
348.77	100	60.00	60.00	0.00	1
349.05	500	102.00	65.41	36.36	7
349.00	Overtopping	64.43	64.43	0.00	Overtopping

Table 17 - Culvert Summary Table: EP-0107

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)
10	35.00	35.00	347.58	2.701	1.076	1-S2n	1.182	1.832	1.318	1.823	10.201
25	44.00	44.00	348.00	3.120	1.631	1-S2n	1.336	2.062	1.504	2.164	10.759
50	53.00	53.00	348.42	3.540	2.236	5-S2n	1.481	2.273	1.678	2.495	11.242
100	60.00	60.00	348.77	3.886	2.736	5-S2n	1.588	2.425	1.810	2.747	11.570
500	102.00	65.41	349.05	4.173	4.421	1-S1f	1.670	2.532	3.500	4.204	6.799

Straight Culvert
Inlet Elevation (invert): 344.88 ft, Outlet Elevation (invert): 343.74 ft
Culvert Length: 74.01 ft, Culvert Slope: 0.0154

Site Data - EP-0107

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 344.88 ft

Outlet Station: 74.00 ft

Outlet Elevation: 343.74 ft

Number of Barrels: 1

Culvert Data Summary - EP-0107

Barrel Shape: Circular

Barrel Diameter: 3.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 18 - Downstream Channel Rating Curve (Crossing: EP-0107)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
35.00	345.56	1.82	4.80	1.14	0.63
44.00	345.90	2.16	5.08	1.35	0.61
53.00	346.23	2.49	5.31	1.56	0.59
60.00	346.49	2.75	5.46	1.71	0.58
102.00	347.94	4.20	6.07	2.62	0.52

Tailwater Channel Data - EP-0107

Tailwater Channel Option: Rectangular Channel

Bottom Width: 4.00 ft

Channel Slope: 0.0100

Channel Manning's n: 0.0300

Channel Invert Elevation: 343.74 ft

Roadway Data for Crossing: EP-0107

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 1000.00 ft

Crest Elevation: 349.00 ft

Roadway Surface: Paved

Roadway Top Width: 50.00 ft

Table 19 - Summary of Culvert Flows at Crossing: EP-0108

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	EP-0108 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
352.67	10	17.00	17.00	0.00	1
353.05	25	22.00	22.00	0.00	1
353.38	50	26.00	26.00	0.00	1
353.74	100	30.00	30.00	0.00	1
354.03	500	51.00	32.95	17.95	8
354.00	Overtopping	32.63	32.63	0.00	Overtopping

Table 20 - Culvert Summary Table: EP-0108

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)
10	17.00	17.00	352.67	2.076	0.711	1-S2n	0.911	1.389	0.993	0.562	9.043
25	22.00	22.00	353.05	2.460	1.166	1-S2n	1.050	1.592	1.157	0.666	9.574
50	26.00	26.00	353.38	2.786	1.554	5-S2n	1.154	1.733	1.278	0.745	9.971
100	30.00	30.00	353.74	3.147	1.975	5-S2n	1.255	1.865	1.396	0.821	10.310
500	51.00	32.95	354.03	3.443	2.575	5-S2n	1.328	1.951	1.480	1.185	10.558

Straight Culvert
Inlet Elevation (invert): 350.59 ft, Outlet Elevation (invert): 349.54 ft
Culvert Length: 64.01 ft, Culvert Slope: 0.0164

Site Data - EP-0108

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 350.59 ft

Outlet Station: 64.00 ft

Outlet Elevation: 349.54 ft

Number of Barrels: 1

Culvert Data Summary - EP-0108

Barrel Shape: Circular

Barrel Diameter: 2.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 21 - Downstream Channel Rating Curve (Crossing: EP-0108)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
17.00	350.10	0.56	7.57	2.45	1.78
22.00	350.21	0.67	8.25	2.91	1.78
26.00	350.29	0.75	8.72	3.26	1.78
30.00	350.36	0.82	9.14	3.59	1.78
51.00	350.72	1.18	10.76	5.18	1.74

Tailwater Channel Data - EP-0108

Tailwater Channel Option: Rectangular Channel

Bottom Width: 4.00 ft

Channel Slope: 0.0700

Channel Manning's n: 0.0300

Channel Invert Elevation: 349.54 ft

Roadway Data for Crossing: EP-0108

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 1000.00 ft

Crest Elevation: 354.00 ft

Roadway Surface: Paved

Roadway Top Width: 50.00 ft

Table 22 - Summary of Culvert Flows at Crossing: EP-0109

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	EP-0109 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
369.23	10	2.00	2.00	0.00	1
369.46	25	3.00	3.00	0.00	1
369.46	50	3.00	3.00	0.00	1
369.68	100	4.00	4.00	0.00	1
370.54	500	7.00	7.00	0.00	1
372.00	Overtopping	10.20	10.20	0.00	Overtopping

Table 23 - Culvert Summary Table: EP-0109

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)
10	2.00	2.00	369.23	0.805	0.0*	1-S2n	0.371	0.563	0.371	0.265	6.326
25	3.00	3.00	369.46	1.035	0.0*	1-S2n	0.460	0.694	0.460	0.343	7.086
50	3.00	3.00	369.46	1.035	0.0*	1-S2n	0.460	0.694	0.460	0.343	7.086
100	4.00	4.00	369.68	1.253	0.0*	5-S2n	0.539	0.805	0.539	0.413	7.635
500	7.00	7.00	370.54	2.108	1.108	5-S2n	0.757	1.057	0.787	0.594	8.340

Straight Culvert
Inlet Elevation (invert): 368.43 ft, Outlet Elevation (invert): 366.82 ft
Culvert Length: 81.02 ft, Culvert Slope: 0.0199

Site Data - EP-0109

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 368.43 ft

Outlet Station: 81.00 ft

Outlet Elevation: 366.82 ft

Number of Barrels: 1

Culvert Data Summary - EP-0109

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 24 - Downstream Channel Rating Curve (Crossing: EP-0109)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
2.00	367.09	0.27	1.88	0.17	0.64
3.00	367.16	0.34	2.19	0.21	0.66
3.00	367.16	0.34	2.19	0.21	0.66
4.00	367.23	0.41	2.42	0.26	0.66
7.00	367.41	0.59	2.94	0.37	0.67

Tailwater Channel Data - EP-0109

Tailwater Channel Option: Rectangular Channel

Bottom Width: 4.00 ft

Channel Slope: 0.0100

Channel Manning's n: 0.0300

Channel Invert Elevation: 366.82 ft

Roadway Data for Crossing: EP-0109

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 1000.00 ft

Crest Elevation: 372.00 ft

Roadway Surface: Paved

Roadway Top Width: 50.00 ft

Crossing Discharge Data

Discharge Selection Method: User Defined

Table 25 - Summary of Culvert Flows at Crossing: EP-0110

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	EP-0110 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
369.68	10	1.00	1.00	0.00	1
369.68	25	1.00	1.00	0.00	1
369.96	50	2.00	2.00	0.00	1
369.96	100	2.00	2.00	0.00	1
370.18	500	3.00	3.00	0.00	1
372.00	Overtopping	7.80	7.80	0.00	Overtopping

Table 26 - Culvert Summary Table: EP-0110

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)
10	1.00	1.00	369.68	0.541	0.601	2-M2c	0.407	0.389	0.389	0.172	3.074
25	1.00	1.00	369.68	0.541	0.601	2-M2c	0.407	0.389	0.389	0.172	3.074
50	2.00	2.00	369.96	0.815	0.876	2-M2c	0.597	0.563	0.563	0.265	3.728
100	2.00	2.00	369.96	0.815	0.876	2-M2c	0.597	0.563	0.563	0.265	3.728
500	3.00	3.00	370.18	1.045	1.103	2-M2c	0.769	0.694	0.694	0.343	4.289

Straight Culvert
Inlet Elevation (invert): 369.08 ft, Outlet Elevation (invert): 368.77 ft
Culvert Length: 89.00 ft, Culvert Slope: 0.0035

Site Data - EP-0110

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 369.08 ft
Outlet Station: 89.00 ft
Outlet Elevation: 368.77 ft
Number of Barrels: 1

Culvert Data Summary - EP-0110

Barrel Shape: Circular
Barrel Diameter: 1.25 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall
Inlet Depression: None

Table 27 - Downstream Channel Rating Curve (Crossing: EP-0110)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
1.00	368.94	0.17	1.45	0.11	0.62
1.00	368.94	0.17	1.45	0.11	0.62
2.00	369.04	0.27	1.88	0.17	0.64
2.00	369.04	0.27	1.88	0.17	0.64
3.00	369.11	0.34	2.19	0.21	0.66

Tailwater Channel Data - EP-0110

Tailwater Channel Option: Rectangular Channel

Bottom Width: 4.00 ft

Channel Slope: 0.0100

Channel Manning's n: 0.0300

Channel Invert Elevation: 368.77 ft

Roadway Data for Crossing: EP-0110

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 1000.00 ft

Crest Elevation: 372.00 ft

Roadway Surface: Paved

Roadway Top Width: 50.00 ft

Table 28 - Summary of Culvert Flows at Crossing: EP-0111

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	EP-0111 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
327.42	10	151.00	151.00	0.00	1
328.84	25	228.00	228.00	0.00	1
330.29	50	302.00	302.00	0.00	1
332.42	100	390.00	390.00	0.00	1
333.36	500	663.00	422.64	240.27	12
333.00	Overtopping	410.46	410.46	0.00	Overtopping

Table 29 - Culvert Summary Table: EP-0111

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)
10	151.00	151.00	327.42	4.765	1.671	1-S2n	2.067	3.256	2.264	3.698	14.173
25	228.00	228.00	328.84	6.188	3.970	1-S2n	2.578	4.037	2.878	5.199	15.548
50	302.00	302.00	330.29	7.640	6.453	5-JS1f	3.020	4.664	6.500	6.612	9.101
100	390.00	390.00	332.42	9.772	5.621	5-JS1f	3.519	5.275	6.500	8.271	11.753
500	663.00	422.64	333.36	10.710	15.586	4-FFf	3.702	5.463	6.500	13.357	12.737

Straight Culvert
Inlet Elevation (invert): 322.65 ft, Outlet Elevation (invert): 320.00 ft
Culvert Length: 200.02 ft, Culvert Slope: 0.0132

Site Data - EP-0111

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 322.65 ft

Outlet Station: 200.00 ft

Outlet Elevation: 320.00 ft

Number of Barrels: 1

Culvert Data Summary - EP-0111

Barrel Shape: Circular

Barrel Diameter: 6.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 30 - Downstream Channel Rating Curve (Crossing: EP-0111)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
151.00	323.70	3.70	10.21	6.92	0.94
228.00	325.20	5.20	10.96	9.73	0.85
302.00	326.61	6.61	11.42	12.38	0.78
390.00	328.27	8.27	11.79	15.48	0.72
663.00	333.36	13.36	12.41	25.00	0.60

Tailwater Channel Data - EP-0111

Tailwater Channel Option: Rectangular Channel

Bottom Width: 4.00 ft

Channel Slope: 0.0300

Channel Manning's n: 0.0300

Channel Invert Elevation: 320.00 ft

Roadway Data for Crossing: EP-0111

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 1000.00 ft

Crest Elevation: 333.00 ft

Roadway Surface: Paved

Roadway Top Width: 50.00 ft

Table 31 - Summary of Culvert Flows at Crossing: EP-0112

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	EP-0112 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
336.44	10	79.00	79.00	0.00	1
337.51	25	118.00	118.00	0.00	1
338.61	50	156.00	156.00	0.00	1
340.22	100	201.00	201.00	0.00	1
341.12	500	342.00	222.04	118.96	7
341.00	Overtopping	219.41	219.41	0.00	Overtopping

Table 32 - Culvert Summary Table: EP-0112

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)
10	79.00	79.00	336.44	3.692	0.357	1-S2n	1.761	2.515	1.843	1.622	11.609
25	118.00	118.00	337.51	4.759	1.668	1-S2n	2.195	3.098	2.309	2.187	12.875
50	156.00	156.00	338.61	5.862	3.133	5-S2n	2.583	3.577	2.728	2.710	13.791
100	201.00	201.00	340.22	7.468	5.601	5-S2n	3.035	4.045	3.211	3.310	14.642
500	342.00	222.04	341.12	8.367	7.042	5-JS1f	3.253	4.222	5.000	5.120	11.308

Straight Culvert
Inlet Elevation (invert): 332.75 ft, Outlet Elevation (invert): 330.00 ft
Culvert Length: 275.01 ft, Culvert Slope: 0.0100

Site Data - EP-0112

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 332.75 ft

Outlet Station: 275.00 ft

Outlet Elevation: 330.00 ft

Number of Barrels: 1

Culvert Data Summary - EP-0112

Barrel Shape: Circular

Barrel Diameter: 5.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 33 - Downstream Channel Rating Curve (Crossing: EP-0112)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
79.00	331.62	1.62	12.18	7.08	1.68
118.00	332.19	2.19	13.49	9.55	1.61
156.00	332.71	2.71	14.39	11.84	1.54
201.00	333.31	3.31	15.18	14.46	1.47
342.00	335.12	5.12	16.70	22.37	1.30

Tailwater Channel Data - EP-0112

Tailwater Channel Option: Rectangular Channel

Bottom Width: 4.00 ft

Channel Slope: 0.0700

Channel Manning's n: 0.0300

Channel Invert Elevation: 330.00 ft

Roadway Data for Crossing: EP-0112

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 1000.00 ft

Crest Elevation: 341.00 ft

Roadway Surface: Paved

Roadway Top Width: 50.00 ft

Crossing Discharge Data

Discharge Selection Method: User Defined

Table 34 - Summary of Culvert Flows at Crossing: EP-0113

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	EP-0113 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
363.00	10	33.00	33.00	0.00	1
363.38	25	41.00	41.00	0.00	1
363.75	50	49.00	49.00	0.00	1
364.03	100	55.00	55.00	0.00	1
366.02	500	94.00	87.99	5.57	10
366.00	Overtopping	87.78	87.78	0.00	Overtopping

Table 35 - Culvert Summary Table: EP-0113

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)
10	33.00	33.00	363.00	2.602	1.011	1-S2n	1.117	1.778	1.263	0.876	10.187
25	41.00	41.00	363.38	2.979	1.403	1-S2n	1.254	1.989	1.431	1.017	10.701
50	49.00	49.00	363.75	3.348	1.818	1-S2n	1.381	2.183	1.590	1.152	11.147
100	55.00	55.00	364.03	3.634	2.142	5-S2n	1.472	2.316	1.704	1.250	11.443
500	94.00	87.99	366.02	5.615	4.476	5-S2n	1.942	2.913	2.269	1.844	12.942

Straight Culvert
Inlet Elevation (invert): 360.40 ft, Outlet Elevation (invert): 359.30 ft
Culvert Length: 65.01 ft, Culvert Slope: 0.0169

Site Data - EP-0113

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 360.40 ft

Outlet Station: 65.00 ft

Outlet Elevation: 359.30 ft

Number of Barrels: 1

Culvert Data Summary - EP-0113

Barrel Shape: Circular

Barrel Diameter: 3.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 36 - Downstream Channel Rating Curve (Crossing: EP-0113)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
33.00	360.18	0.88	9.42	3.83	1.77
41.00	360.32	1.02	10.08	4.44	1.76
49.00	360.45	1.15	10.63	5.03	1.75
55.00	360.55	1.25	11.00	5.46	1.73
94.00	361.14	1.84	12.75	8.05	1.65

Tailwater Channel Data - EP-0113

Tailwater Channel Option: Rectangular Channel

Bottom Width: 4.00 ft

Channel Slope: 0.0700

Channel Manning's n: 0.0300

Channel Invert Elevation: 359.30 ft

Roadway Data for Crossing: EP-0113

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 1000.00 ft

Crest Elevation: 366.00 ft

Roadway Surface: Paved

Roadway Top Width: 50.00 ft

Table 37 - Summary of Culvert Flows at Crossing: EP-0115

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	EP-0115 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
366.02	10	5.00	5.00	0.00	1
366.36	25	7.00	7.00	0.00	1
366.55	50	8.00	8.00	0.00	1
366.76	100	9.00	9.00	0.00	1
368.58	500	15.00	15.00	0.00	1
369.00	Overtopping	16.05	16.05	0.00	Overtopping

Table 38 - Culvert Summary Table: EP-0115

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)
10	5.00	5.00	366.02	1.281	0.0*	1-S2n	0.517	0.856	0.541	0.381	8.417
25	7.00	7.00	366.36	1.618	0.0*	5-S2n	0.620	1.021	0.658	0.474	9.080
50	8.00	8.00	366.55	1.806	0.149	5-S2n	0.669	1.092	0.711	0.517	9.370
100	9.00	9.00	366.76	2.016	0.597	5-S2n	0.716	1.156	0.766	0.558	9.604
500	15.00	15.00	368.58	3.843	2.515	5-S2n	0.993	1.407	1.069	0.785	10.822

Straight Culvert
Inlet Elevation (invert): 364.74 ft, Outlet Elevation (invert): 363.00 ft
Culvert Length: 65.02 ft, Culvert Slope: 0.0268

Site Data - EP-0115

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 364.74 ft

Outlet Station: 65.00 ft

Outlet Elevation: 363.00 ft

Number of Barrels: 1

Culvert Data Summary - EP-0115

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 39 - Downstream Channel Rating Curve (Crossing: EP-0115)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
5.00	363.38	0.38	3.28	0.48	0.94
7.00	363.47	0.47	3.69	0.59	0.95
8.00	363.52	0.52	3.87	0.64	0.95
9.00	363.56	0.56	4.03	0.70	0.95
15.00	363.78	0.78	4.78	0.98	0.95

Tailwater Channel Data - EP-0115

Tailwater Channel Option: Rectangular Channel

Bottom Width: 4.00 ft

Channel Slope: 0.0200

Channel Manning's n: 0.0300

Channel Invert Elevation: 363.00 ft

Roadway Data for Crossing: EP-0115

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 1000.00 ft

Crest Elevation: 369.00 ft

Roadway Surface: Paved

Roadway Top Width: 50.00 ft

Table 40 - Summary of Culvert Flows at Crossing: EP-0116

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	EP-0116 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
365.25	10	35.00	35.00	0.00	1
366.18	25	49.00	49.00	0.00	1
367.50	50	64.00	64.00	0.00	1
368.72	100	75.00	75.00	0.00	1
369.14	500	234.00	78.42	154.25	4
369.00	Overtopping	77.30	77.30	0.00	Overtopping

Table 41 - Culvert Summary Table: EP-0116

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)
10	35.00	35.00	365.25	2.943	0.0*	1-S2n	1.021	1.919	1.149	0.912	13.563
25	49.00	49.00	366.18	3.874	1.221	5-S2n	1.225	2.276	1.408	1.152	14.548
50	64.00	64.00	367.50	5.191	2.435	5-S2n	1.425	2.568	1.661	1.393	15.437
100	75.00	75.00	368.72	6.408	3.474	5-S2n	1.566	2.719	1.836	1.562	16.049
500	234.00	78.42	369.14	6.829	4.684	5-S2n	1.610	2.755	1.888	3.741	16.234

Straight Culvert
Inlet Elevation (invert): 362.31 ft, Outlet Elevation (invert): 359.38 ft
Culvert Length: 86.05 ft, Culvert Slope: 0.0341

Site Data - EP-0116

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 362.31 ft

Outlet Station: 86.00 ft

Outlet Elevation: 359.38 ft

Number of Barrels: 1

Culvert Data Summary - EP-0116

Barrel Shape: Circular

Barrel Diameter: 3.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 42 - Downstream Channel Rating Curve (Crossing: EP-0116)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
35.00	360.29	0.91	9.59	3.98	1.77
49.00	360.53	1.15	10.63	5.03	1.75
64.00	360.77	1.39	11.49	6.08	1.72
75.00	360.94	1.56	12.01	6.82	1.69
234.00	363.12	3.74	15.64	16.34	1.42

Tailwater Channel Data - EP-0116

Tailwater Channel Option: Rectangular Channel

Bottom Width: 4.00 ft

Channel Slope: 0.0700

Channel Manning's n: 0.0300

Channel Invert Elevation: 359.38 ft

Roadway Data for Crossing: EP-0116

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 1000.00 ft

Crest Elevation: 369.00 ft

Roadway Surface: Paved

Roadway Top Width: 50.00 ft

Table 43 - Summary of Culvert Flows at Crossing: EP-0117

Headwater Elevation (ft)	Total Discharge (cfs)	EP-0117 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
368.04	47.00	24.49	22.15	15
368.05	58.00	24.55	33.25	4
368.06	70.00	24.61	44.88	3
368.07	78.00	24.65	53.06	3
368.11	132.00	24.85	107.06	3
368.00	24.30	24.30	0.00	Overtopping

Table 44 - Culvert Summary Table: EP-0117

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
47.00	24.49	368.04	3.738	3.417	7-JA2t	-1.000	1.748	1.748	1.119	8.243	10.503
58.00	24.55	368.05	3.750	3.424	7-JA2t	-1.000	1.750	1.750	1.298	8.257	11.172
70.00	24.61	368.06	3.761	3.430	7-JA2t	-1.000	1.751	1.751	1.485	8.271	11.781
78.00	24.65	368.07	3.768	3.435	7-JA2t	-1.000	1.752	1.752	1.607	8.279	12.135
132.00	24.85	368.11	3.809	5.012	4-FFf	-1.000	1.758	2.000	2.382	7.910	13.856

Straight Culvert
Inlet Elevation (invert): 364.30 ft, Outlet Elevation (invert): 364.44 ft
Culvert Length: 101.00 ft, Culvert Slope: -0.0014

Site Data - EP-0117

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 364.30 ft

Outlet Station: 101.00 ft

Outlet Elevation: 364.44 ft

Number of Barrels: 1

Culvert Data Summary - EP-0117

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 45 - Downstream Channel Rating Curve (Crossing: EP-0117)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
47.00	365.56	1.12	10.50	4.89	1.75
58.00	365.74	1.30	11.17	5.67	1.73
70.00	365.93	1.49	11.78	6.49	1.70
78.00	366.05	1.61	12.13	7.02	1.69
132.00	366.82	2.38	13.86	10.40	1.58

Tailwater Channel Data - EP-0117

Tailwater Channel Option: Rectangular Channel

Bottom Width: 4.00 ft

Channel Slope: 0.0700

Channel Manning's n: 0.0300

Channel Invert Elevation: 364.44 ft

Roadway Data for Crossing: EP-0117

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 1000.00 ft

Crest Elevation: 368.00 ft

Roadway Surface: Paved

Roadway Top Width: 50.00 ft

Table 49 - Summary of Culvert Flows at Crossing: PP-0105

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	PP-0105 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
345.50	10	67.00	67.00	0.00	1
346.04	25	84.00	84.00	0.00	1
346.59	50	101.00	101.00	0.00	1
347.00	100	113.00	113.00	0.00	1
350.02	500	191.00	180.22	9.86	9
350.00	Overtopping	179.82	179.82	0.00	Overtopping

Table 50 - Culvert Summary Table: PP-0105

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)
10	67.00	67.00	345.50	3.499	0.0*	1-S2n	1.334	2.381	1.450	2.996	14.594
25	84.00	84.00	346.04	4.039	0.493	1-S2n	1.503	2.681	1.651	3.588	15.341
50	101.00	101.00	346.59	4.586	1.478	5-S2n	1.658	2.951	1.839	4.170	15.956
100	113.00	113.00	347.00	4.996	2.212	5-S2n	1.762	3.125	1.967	4.575	16.347
500	191.00	180.22	350.02	8.023	7.375	5-S1f	2.301	3.886	4.500	7.157	11.332

Straight Culvert
Inlet Elevation (invert): 342.00 ft, Outlet Elevation (invert): 338.00 ft
Culvert Length: 165.05 ft, Culvert Slope: 0.0242

Site Data - PP-0105

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 342.00 ft

Outlet Station: 165.00 ft

Outlet Elevation: 338.00 ft

Number of Barrels: 1

Culvert Data Summary - PP-0105

Barrel Shape: Circular

Barrel Diameter: 4.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 51 - Downstream Channel Rating Curve (Crossing: PP-0105)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
67.00	341.00	3.00	5.59	1.87	0.57
84.00	341.59	3.59	5.85	2.24	0.54
101.00	342.17	4.17	6.06	2.60	0.52
113.00	342.58	4.58	6.17	2.86	0.51
191.00	345.16	7.16	6.67	4.47	0.44

Tailwater Channel Data - PP-0105

Tailwater Channel Option: Rectangular Channel

Bottom Width: 4.00 ft

Channel Slope: 0.0100

Channel Manning's n: 0.0300

Channel Invert Elevation: 338.00 ft

Roadway Data for Crossing: PP-0105

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 1000.00 ft

Crest Elevation: 350.00 ft

Roadway Surface: Paved

Roadway Top Width: 50.00 ft

Crossing Discharge Data

Discharge Selection Method: User Defined

Table 52 - Summary of Culvert Flows at Crossing: PP-0114

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	PP-0114 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
351.31	10	101.00	101.00	0.00	1
351.98	25	126.00	126.00	0.00	1
352.71	50	151.00	151.00	0.00	1
353.29	100	169.00	169.00	0.00	1
358.79	500	287.00	287.00	0.00	1
362.00	Overtopping	336.45	336.45	0.00	Overtopping

Table 53 - Culvert Summary Table: PP-0114

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)
10	101.00	101.00	351.31	4.306	0.503	1-S2n	2.165	2.855	2.327	1.503	10.911
25	126.00	126.00	351.98	4.985	3.425	1-S2n	2.459	3.208	2.649	1.738	11.549
50	151.00	151.00	352.71	5.712	4.267	5-S2n	2.745	3.519	2.957	1.959	12.109
100	169.00	169.00	353.29	6.291	4.911	5-S2n	2.951	3.722	3.170	2.112	12.493
500	287.00	287.00	358.79	11.790	10.093	7-M2c	5.000	4.616	4.616	3.029	15.152

Straight Culvert
Inlet Elevation (invert): 347.00 ft, Outlet Elevation (invert): 346.00 ft
Culvert Length: 130.00 ft, Culvert Slope: 0.0077

Site Data - PP-0114

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 347.00 ft

Outlet Station: 130.00 ft

Outlet Elevation: 346.00 ft

Number of Barrels: 1

Culvert Data Summary - PP-0114

Barrel Shape: Circular

Barrel Diameter: 5.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 54 - Downstream Channel Rating Curve (Crossing: PP-0114)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
101.00	347.50	1.50	5.60	0.94	0.80
126.00	347.74	1.74	6.04	1.08	0.81
151.00	347.96	1.96	6.42	1.22	0.81
169.00	348.11	2.11	6.67	1.32	0.81
287.00	349.03	3.03	7.90	1.89	0.80

Tailwater Channel Data - PP-0114

Tailwater Channel Option: Rectangular Channel

Bottom Width: 12.00 ft

Channel Slope: 0.0100

Channel Manning's n: 0.0300

Channel Invert Elevation: 346.00 ft

Roadway Data for Crossing: PP-0114

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 1000.00 ft

Crest Elevation: 362.00 ft

Roadway Surface: Paved

Roadway Top Width: 50.00 ft

Appendix C

Bridge Deck Drainage Calculations

Hydraulic Analysis Report

Bridge Deck Nominal Cross Section at curb (all quadrants)

Station (ft)	Elevation (ft)	Manning's n
0.00	100.50	0.0120
0.17	100.00	0.0120
39.17	100.78	

Project Data

Project Title: Spread US1 bridge over I-20

Designer: Guy P. Peters, PE, CFM

Project Date: Thursday, March 21, 2019

Project Units: U.S. Customary Units

Notes: This analysis examines spread at each of the four corners of the proposed US 1 bridge over I-20 in Lexington County. The purpose of the analysis is to verify that no on-structure drainage system will be required. For conservatism, the analysis point is at the end of the approach slab. **NOTE: THIS ANALYSIS IS BASED ON PRESUMED ALTERNATE 2 ALIGNMENT**

Channel Analysis: NE quad at STA 320+32.79 (RT)

Notes: High point on proposed bridge is at STA 322+01.69. Drainage area is 8052 ft².

Input Parameters

Channel Type: Custom Cross Section

Cross Section Data

Longitudinal Slope: 0.0065 ft/ft

10% AC Flow: 1.2400 cfs

Result Parameters

Depth: 0.1628 ft

Area of Flow: 0.6675 ft²

Wetted Perimeter: 8.3160 ft

Hydraulic Radius: 0.0803 ft

Average Velocity: 1.8577 ft/s

Top Width: 8.1977 ft

Froude Number: 1.1473

Critical Depth: 0.1720 ft

Critical Velocity: 1.6644 ft/s

Critical Slope: 0.0048 ft/ft

Critical Top Width: 8.66 ft

Calculated Max Shear Stress: 0.0661 lb/ft²

Calculated Avg Shear Stress: 0.0326 lb/ft²

Composite Manning's n Equation: Lotter method

Manning's n: 0.0120

Top width is equivalent to spread.
Allowable spread is gutter width plus ½ of the travel lane: $1.5' + (0.5 * 12) = 7.5'$
In this case, spread exceeds allowable, so scuppers will be required at a point where runoff can be safely discharged away from I-20 travel lanes below.

Channel Analysis: SE quad at STA 320+32.79

Notes: High point on proposed bridge is at STA 322+01.69. Drainage area is 5844 ft².

Input Parameters

Channel Type: Custom Cross Section

Cross Section Data

Longitudinal Slope: 0.0065 ft/ft

Flow: 0.8970 cfs

Result Parameters

Depth: 0.1442 ft

Area of Flow: 0.5236 ft²

Wetted Perimeter: 7.3651 ft

Hydraulic Radius: 0.0711 ft

Average Velocity: 1.7133 ft/s

Top Width: 7.2603 ft

Froude Number: 1.1243

Critical Depth: 0.1511 ft

Critical Velocity: 1.5600 ft/s

Critical Slope: 0.0051 ft/ft

Critical Top Width: 7.61 ft

Calculated Max Shear Stress: 0.0585 lb/ft²

Calculated Avg Shear Stress: 0.0288 lb/ft²

Composite Manning's n Equation: Lotter method

Manning's n: 0.0120

Top width is equivalent to spread.
Allowable spread is gutter width plus ½
of the travel lane: $1.5' + (0.5 \times 12) = 7.5'$
In this case, spread is less than
allowable, so no bridge drainage is
required.

Channel Analysis: SW quad at STA 323+17.00

Notes: High point on proposed bridge is at STA 322+01.69. Drainage area is 4763 ft².

Input Parameters

Channel Type: Custom Cross Section

Cross Section Data

Longitudinal Slope: 0.0176 ft/ft

Flow: 0.7310 cfs

Result Parameters

Depth: 0.1108 ft

Area of Flow: 0.3091 ft²

Wetted Perimeter: 5.6590 ft

Hydraulic Radius: 0.0546 ft

Average Velocity: 2.3650 ft/s

Top Width: 5.5785 ft

Froude Number: 1.7706

Critical Depth: 0.1393 ft

Critical Velocity: 1.4975 ft/s

Critical Slope: 0.0052 ft/ft

Critical Top Width: 7.01 ft

Calculated Max Shear Stress: 0.1217 lb/ft²

Calculated Avg Shear Stress: 0.0600 lb/ft²

Composite Manning's n Equation: Lotter method

Manning's n: 0.0120

Top width is equivalent to spread.
Allowable spread is gutter width plus ½
of the travel lane: $1.5' + (0.5 * 12) = 7.5'$
In this case, spread is less than
allowable, so no bridge drainage is
required.

Channel Analysis: NW quad at STA 323+17.00

Notes: High point on proposed bridge is at STA 322+01.69. Drainage area is 5625 ft².

Input Parameters

Channel Type: Custom Cross Section

Cross Section Data

Longitudinal Slope: 0.0176 ft/ft

Flow: 0.8600 cfs

Result Parameters

Depth: 0.1178 ft

Area of Flow: 0.3492 ft²

Wetted Perimeter: 6.0146 ft

Hydraulic Radius: 0.0581 ft

Average Velocity: 2.4631 ft/s

Top Width: 5.9290 ft

Froude Number: 1.7887

Critical Depth: 0.1486 ft

Critical Velocity: 1.5469 ft/s

Critical Slope: 0.0051 ft/ft

Critical Top Width: 7.48 ft

Calculated Max Shear Stress: 0.1294 lb/ft²

Calculated Avg Shear Stress: 0.0638 lb/ft²

Composite Manning's n Equation: Lotter method

Manning's n: 0.0120

Top width is equivalent to spread.
Allowable spread is gutter width plus ½
of the travel lane: $1.5' + (0.5 * 12) = 7.5'$
In this case, spread is less than
allowable, so no bridge drainage is
required.