A STORMWATER DETENTION ANALYSIS

OF THE PROPOSED DEVELOPMENT OF

ANIMAL HOSPITAL

IN

CITY OF O'FALLON, MISSOURI

FOR

HOERING VETERINARY SERVICES, LLC
25 SMETANA
WENTZVILLE, MO 63385

BAX PROJECT NO. 00-11214J

December 21, 2021

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INTRODUCTION:

The currently undeveloped site is located at the intersection of Mexico Road and Sonderen Street in the City of O'Fallon, Missouri and is comprised of 5.34 acres of land. Belleau Creek runs along the north side of the site. The site was analyzed for the construction of an animal hospital. Detention and water quality were designed to meet the City of O'Fallon design standards. The dry detention basin was designed so the peak rate of runoff leaving the tract under postdeveloped conditions is less than or equal to the peak rate of runoff under predeveloped conditions for the 2, 15, 25, and 100 year 20 minute design storms. The safe passage of the 100 year 20 minute design storm was designed assuming the low flow slot is blocked while providing a minimum of 1 foot of freeboard. Water quality for the development is provided by 2 snouts, which treats stormwater runoff prior to entering the dry detention basin.

GENERAL SITE DATA AND RUNOFF CALCULATIONS

The predeveloped runoff factors used for the analysis are:

Land Use	Percent Impervious	PI Factors (cfs/ac)			
		2 year	15 year	25 year	100 year
Greenspace	0-5%	1.15	1.70	2.00	2.29

The postdeveloped runoff factors used for the analysis are:

Land Use	Percent Impervious	PI Factors (cfs/ac)			
		2 year	15 year	25 year	100 year
Greenspace	0-5%	1.15	1.70	2.00	2.29
Impervious	100%	2.39	3.54	4.16	4.77

WATER QUALITY

To ensure that sedimentation and pollution in receiving streams due to proposed additions to the site are minimized, our design will consider the water quality volume requirement as described in "Georgia Stormwater Management Manual Volumes 1, 2 and 3". Water quality volume is defined as "The storage needed to capture and treat the runoff from 90% of the recorded daily rainfall events." Water quality treatment will be provided by two snouts.

Area Treated

		Impervious Area	Pervious Area
Greenspace	0% Impervious	-	0.38 ac
Impervious	100% Impervious	0.41 ac	-
Total		0.41 ac	0.38 ac

WATER QUALITY VOLUME

$WQ_v = PR_vA/12$

Where: P = 1.14"
$R_v = 0.05 + 0.009(I)$
I = % Impervious
A = Watershed Area = 0.79 ac
A_I = Impervious Area = 0.41 ac

$I = A_I/A$
I = 0.41 ac / 0.79 ac = 0.5190 = 51.90%
$R_v = 0.05 + 0.009(51.90) = 0.5171$
$WQ_v = 1.14(0.5171)(0.79)/12 = 0.0388$ ac-ft = 1,690 ft^3

The total water quality volume for this watershed is 1,690 ft^3.

GI 103 SNOUT

Stormwater runoff entering the dry detention basin will be treated by a snout located in GI 103. This will provide water quality for the area tributary to this inlet. For a 12" pipe and a peak flow of 1.95 cfs for the 100 year 20 minute storm, an 18" Snout (Unit 18R) capable of treating a maximum flow of 3.4 cfs will be used. See calculations below for peak flow to the snout.

Greenspace	0.37 ac x	2.29 cfs/ac	=	0.85 cfs
Impervious	0.23 ac x	4.77 cfs/ac	=	1.10 cfs
		Total	=	1.95 cfs

The sump depth should be a minimum of 3 ft for a 12" RCP. We are proposing a 3' sump to prevent sediment resuspension as recommended by the manufacturer.

The structure surface area shall be at least 6 to 7 times the flow area of the outfall pipe. For a 2 grate inlet, the surface area measures 30 in by 30 in. This equates to 6.25 ft^2 of structure area. The structure area is approximately 8 times larger than the 0.79 ft^2 flow area of the pipe.

The sump of the structure will provide 37.71 ft^3 of sediment storage volume.

GI 106 SNOUT

Stormwater runoff entering the dry detention basin will be treated by a snout located in GI 106. This will provide water quality for the area tributary to this inlet. For a 12" pipe and a peak flow of 0.88 cfs for the 100 year 20 minute storm, an 18" Snout (Unit 18R) capable of treating a maximum flow of 3.4 cfs will be used. See calculation below for peak flow to the snout.

Greenspace	0.01 ac x	2.29 cfs/ac	=	0.02 cfs
Impervious	0.18 ac x	4.77 cfs/ac	=	0.86 cfs
		Total	=	0.88 cfs

The sump depth should be a minimum of 3 ft for a 12" RCP. We are proposing a 3' sump to prevent sediment resuspension as recommended by the manufacturer.

The structure surface area shall be at least 6 to 7 times the flow area of the outfall pipe. For a 2 grate inlet, the surface area measures 30 in by 30 in. This equates to 6.25 ft^2 of structure area. The structure area is approximately 8 times larger than the 0.79 ft^2 flow area of the pipe.

The sump of the structure will provide 37.71 ft^3 of sediment storage volume.

DETENTION CALCULATIONS

PREDEVELOPED CONDITIONS:

There is one watershed (watershed A) to be analyzed for the total runoff from the site for the predeveloped conditions. Using the rational method to calculate the predeveloped runoff rates leaving the site, the predeveloped runoff for the 2, 15, 25, and 100 year 20 minute design storms was calculated for comparison to the postdeveloped runoff to determine the quantity of detention that will be required.

Watershed A

Stormwater runoff in Watershed A flows overland and discharges into Belleau Creek, located along the north area of the site.

2 Year				
Onsite Greenspace	5.34 ac	x 1.15 cfs/ac	=	6.14 cfs
15 Year				
Onsite Greenspace	5.34 ac	x 1.70 cfs/ac	=	9.08 cfs
25 Year				
Onsite Greenspace	5.34 ac	x 2.00 cfs/ac	=	10.68 cfs
100 Year				
Onsite Greenspace	5.34 ac	x 2.29 cfs/ac	=	12.23 cfs

2 year-20 minute storm:	6.14 cfs
15 year-20 minute storm:	9.08 cfs
25 year-20 minute storm:	10.68 cfs
100 year-20 minute storm:	12.23 cfs

POSTDEVELOPED CONDITIONS:

The postdeveloped site maintains the same watershed as described in the predeveloped conditions. For this analysis, the postdeveloped runoff for the 2, 15, 25, and 100 year 20 minute design storms was calculated for comparison to the previously calculated predeveloped runoff to calculate the quantity of detention that will be required.

Postdeveloped Watershed A

2 Year				
Onsite Greenspace	4.80 ac	x	1.15 cfs/ac	= 5.52 cfs
Onsite Impervious	0.54 ac	x	2.39 cfs/ac	= 1.29 cfs
			Total	= 6.81 cfs
15 Year				
Onsite Greenspace	4.80 ac	x	1.70 cfs/ac	= 8.16 cfs
Onsite Impervious	0.54 ac	x	3.54 cfs/ac	= 1.91 cfs
			Total	= 10.07 cfs
25 Year				
Onsite Greenspace	4.80 ac	x	2.00 cfs/ac	= 9.60 cfs
Onsite Impervious	0.54 ac	x	4.16 cfs/ac	= 2.25 cfs
			Total	= 11.85 cfs
100 Year				
Onsite Greenspace	4.80 ac	x	2.29 cfs/ac	= 10.99 cfs
Onsite Impervious	0.54 ac	x	4.77 cfs/ac	= 2.58 cfs
			Total	= 13.57 cfs

2 year-20 minute storm:	6.81 cfs
15 year-20 minute storm:	10.07 cfs
25 year-20 minute storm:	11.85 cfs
100 year-20 minute storm:	13.57 cfs

DIFFERENTIAL RUNOFF

The differential runoff is calculated by subtracting the predeveloped runoff from the postdeveloped runoff. A differential runoff of 1 cfs or more requires stormwater detention within that watershed.

Watershed A

Design Storm	Postdeveloped Runoff (cfs)	Predeveloped Runoff (cfs)	Differential Runoff (cfs)
2 Year	6.81	6.14	0.67
15 Year	10.07	9.08	0.99
25 Year	11.85	10.68	1.17
100 Year	13.57	12.23	1.34

Detention is required in Watershed A.

Basin A Peak Inflow

2 Year				
Onsite Greenspace	0.47 ac	x 1.15 cfs/ac	=	0.54 cfs
Onsite Impervious	0.46 ac	x 2.39 cfs/ac	=	1.10 cfs
		Total	=	1.64 cfs
15 Year				
Onsite Greenspace	0.47 ac	x 1.70 cfs/ac	=	0.80 cfs
Onsite Impervious	0.46 ac	x 3.54 cfs/ac	=	1.63 cfs
		Total	=	2.43 cfs
25 Year				
Onsite Greenspace	0.47 ac	x 2.00 cfs/ac	=	0.94 cfs
Onsite Impervious	0.46 ac	x 4.16 cfs/ac	=	1.91 cfs
		Total	=	2.85 cfs
100 Year				
Onsite Greenspace	0.47 ac	x 2.29 cfs/ac	=	1.08 cfs
Onsite Impervious	0.46 ac	x 4.77 cfs/ac	=	2.19 cfs
		Total	=	3.27 cfs

2 year-20 minute storm:	1.64 cfs
15 year-20 minute storm:	2.43 cfs
25 year-20 minute storm:	2.85 cfs
100 year-20 minute storm:	3.27 cfs

TIME OF CONCENTRATION:

Time of concentration is defined as the time required for stormwater to flow from the most remote point in a watershed to the proposed dry detention basin. The most remote point on this site tributary to the dry detention basin lies on the southwestern side of the site. Stormwater travels over grass for 76 feet. Next, stormwater enters a grass swale and travels 125 feet until it enters AI 104. Stormwater then travels through the storm sewer system for 199 feet until it enters the detention basin. Time of concentration is calculated below. Note that time of concentration for stormwater that travels 76 feet over grass is considered to be 1 minute since the given parameters do not intersect the time of concentration on the attached chart which can be found in Appendix A. It was interpolated out to 0.5 minutes and with a surface coefficient of 2, the 76 foot long time of concentration path is 1 minute.

Watershed A

$T_{overland}$:

L = 76 feet
Elevation difference = 8 feet
Surface Coefficient = 2.0 (grass)

L = 125 feet
Elevation difference = 2.3 feet
Surface Coefficient = 1.0 (grass swale)

$T_{overland}$ = 1.0 min + 1.5 min * 1.0 = 2.5 minutes

$T_{storm\ sewer}$:

L = 199 feet
Average Velocity = 7 ft/s
$T_{storm\ sewer}$ = 199 feet/7 ft/s/60 sec/min = 0.47 min

Total time = 2.5 + 0.47 = 2.97 min => **use 3 minutes**

ALLOWABLE RELEASE RATE

The allowable release rate is defined as the maximum amount of stormwater that can be released from the proposed dry detention basin for a specified storm event. This calculation was performed by subtracting the differential runoff from the basin inflow. The following table shows the calculated allowable release rate for the following storm events.

Storm Frequency (20 Minute Duration)	Basin Inflow (cfs)	Differential Runoff (cfs)	Allowable Release Rate (cfs)
2 year	1.64	0.67	0.97
15 year	2.43	0.99	1.44
25 year	2.85	1.17	1.68
100 year	3.27	1.34	1.93

STORM ROUTING CALCULATIONS AND RESULTS

The computer program Pondpack was used to route the 2, 15, 25 and 100 year 20 minute storms as well as the 100 year 20 minute storm with the low flow slots blocked on the outfall structure. The routing calculations from Pondpack can be found in Appendix B. The results are detailed below.

A tailwater condition was checked during the routing calculations. The base flood elevation for Belleau Creek downstream of the site is 494.00. This elevation was set as a constant tailwater elevation for stormwater exiting the basin. However, this tailwater had no effect on detention calculations so a free outfall tailwater condition was used for detention routing calculations.

The outfall structure used to release stormwater from the dry detention basin is a precast 48” manhole with grate top.

Storm Frequency (20 Minute Duration)	Basin Inflow (cfs)	Allowable Release Rate (cfs)	Calculated Release Rate (cfs)	Peak Elevation (ft)
2 Year	1.64	0.97	0.90	513.32
15 Year	2.43	1.44	1.39	513.98
25 Year	2.85	1.68	1.65	514.24
100 Year	3.27	1.93	1.83	514.49
100 Year LFB	1.64	N/A	N/A	514.95

SEDIMENT STORAGE CALCULATIONS

The City of O'Fallon design standards require that all detention basins are designed to accommodate two years of sediment storage. To calculate sediment storage, the volume of storage was calculated at the 100 year 20 minute storm high water elevation. Using the annual sediment storage nomograph included in Appendix A of this report, the volume of sediment delivered to the detention basin over a two year period was calculated by adding the volume of sediment to the storage volume in the dry detention basin for the 100 year 20 minute storm. The crest of the outfall structure was designed to be above the volume required for the 100 year 20 minute storm and the volume required for sediment storage. The results are detailed below.

100 year 20 minute storage volume	= 2,472 ft^3
Elevation at 100 year 20 minute storage volume	= 514.49 ft
2 year sediment storage volume	= 316 ft^3
Required sediment storage volume	= 2,788 ft^3
Elevation in basin with sediment storage volume	= 514.71 ft
Crest of outfall structure	= 514.75 ft

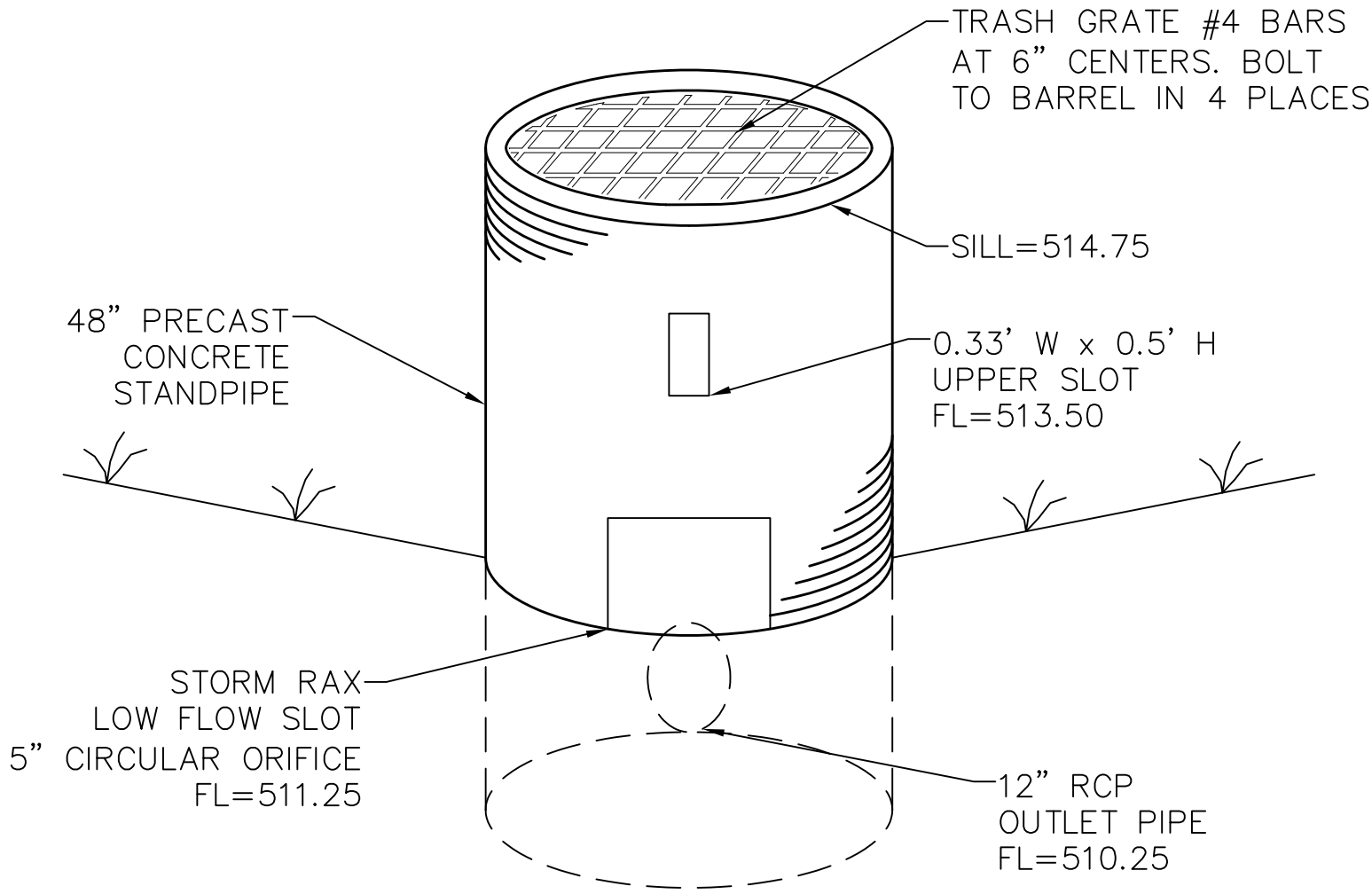
SUMMARY

Postdeveloped Watershed A

	Peak Basin Discharge	High Water
2 Year 20 Minute Storm	0.90 cfs	513.31
15 Year 20 Minute Storm	1.39 cfs	513.98
25 Year 20 Minute Storm	1.65 cfs	514.24
100 Year 20 Minute Storm	1.83 cfs	514.49
100 Year 20 Minute LFB Storm	3.27 cfs	514.95
Outfall Structure		Precast 48” Manhole
Crest Elevation		514.75
Low Flow Slot		5” circular orifice
Flow Line		511.25
Low Flow Slot		0.33' W x 0.50' H
Flow Line		513.50 ft
Top of Berm		516.00 ft
Freeboard		1.05 ft

Appendix A

-Structure Details
-Time of Concentration
-Sediment Storage
-Misc Figures



OVERFLOW STRUCTURE 101 DETAIL

NOT TO SCALE

2 YR 20 MIN HIGHWATER 513.32
15 YR 20 MIN HIGHWATER 513.98
25 YR 20 MIN HIGHWATER 514.24
100 YR 20 MIN HIGHWATER 514.49
100 YR 20 MIN (LFB) HIGHWATER 514.95

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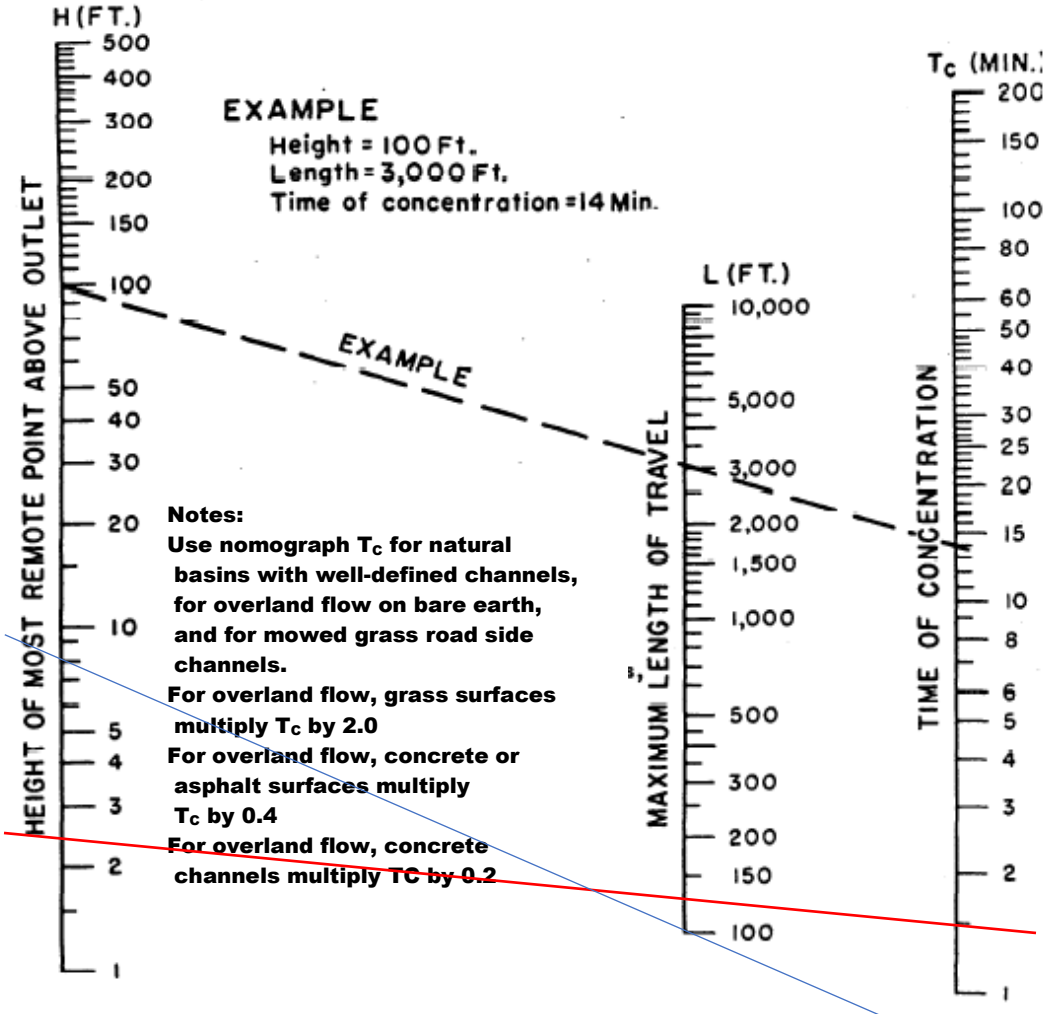
Date: 12-13-21 Project No: 00-11214J
Designer: MDS Checked: TCF

TIME OF CONCENTRATION FOR SMALL DRAINAGE BASINS



OVERLAND FLOW

Δ Height = 8 ft/ 2.3 ft

Length = 76 ft / 125 ft

$T_{Overland}$ = 1 min / 1.5 min

STORM SEWER TRAVEL TIME

T_{storm}=Pipe Length (L) * Assumed Velocity (V)

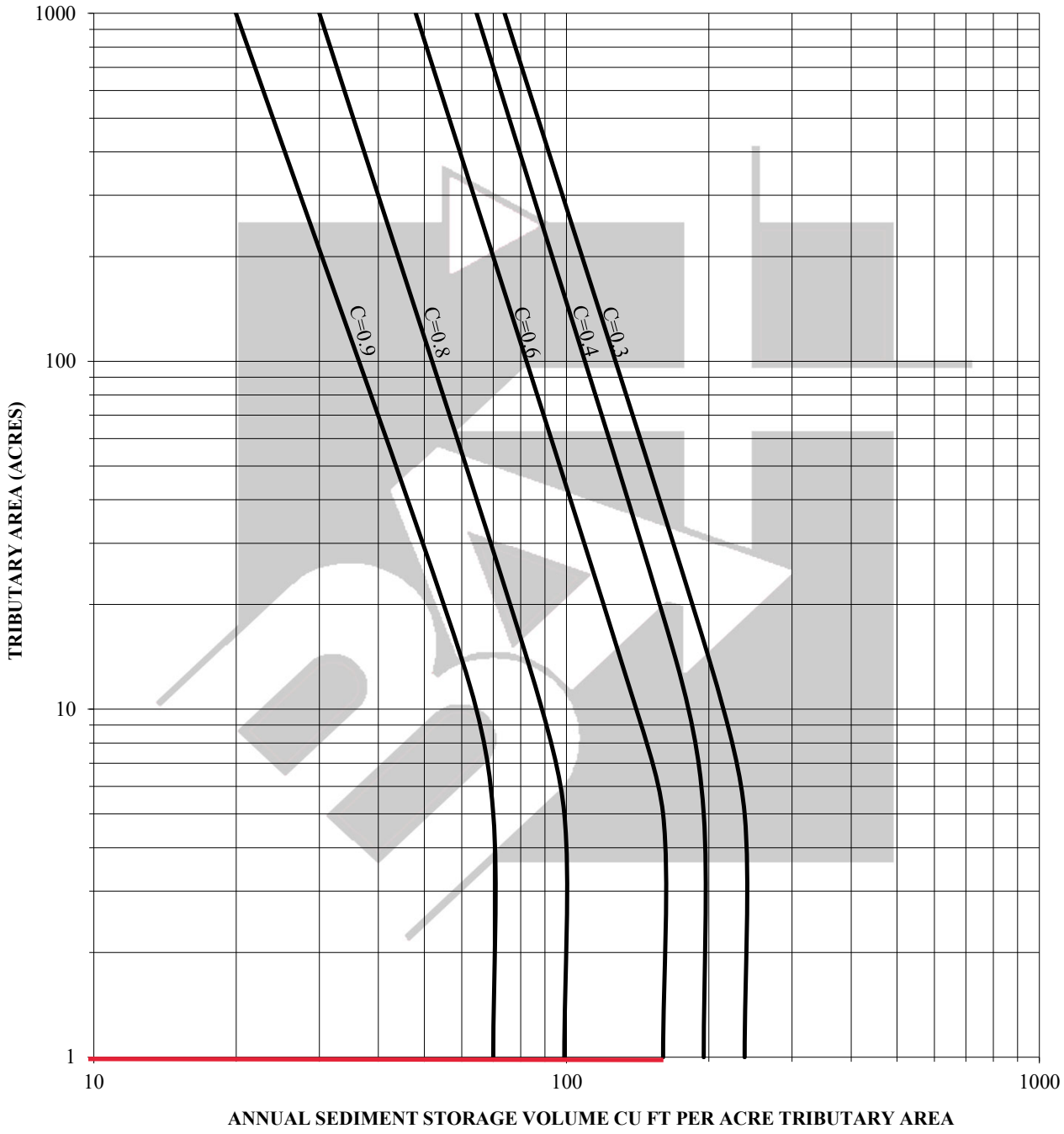
L = 199 ft

V = 7 ft/s

T_{storm} = 199 ft / 7 ft/s / 60 sec/min =0.47 min

Total Time of Concentration = $T_{Overland}$ + T_{storm} = 1 + 1.5 + 0.47 = 2.97 min → USE 3 min.

ANNUAL SEDIMENT STORAGE



RUNOFF C VALUE = 0.6

DRAINAGE AREA = 0.93 ac

ANNUAL SEDIMENT = 170 cu ft per acre

YEARS OF STORAGE = 2

STORAGE REQUIRED = 316 cu ft

Appendix B

Basin Routing

-2 year Detention Routing
-15 year Detention Routing
-25 year Detention Routing
-100 year Detention Routing

Table of Contents

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ft³)	Time to Peak (min)	Peak Flow (ft³/s)
Basin A Inflow	2 Year 20 Min	0	1,967	3	1.640
Basin A Inflow	15 Year 20 Min	0	2,915	3	2.430
Basin A Inflow	25 Year 20 Min	0	3,419	3	2.850
Basin A Inflow	100 Year 20 Min	0	3,923	3	3.270
Basin A Inflow	100 Yr LFB	0	3,923	3	3.270

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ft³)	Time to Peak (min)	Peak Flow (ft³/s)
Outfall A	2 Year 20 Min	0	1,967	21	0.895
Outfall A	15 Year 20 Min	0	2,915	21	1.385
Outfall A	25 Year 20 Min	0	3,419	21	1.652
Outfall A	100 Year 20 Min	0	3,923	21	1.825
Outfall A	100 Yr LFB	0	3,923	20	3.270

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ft³)	Time to Peak (min)	Peak Flow (ft³/s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ft³)
Basin A (IN)	2 Year 20 Min	0	1,967	3	1.640	(N/A)	(N/A)
Basin A (OUT)	2 Year 20 Min	0	1,967	21	0.895	513.32	1,055
Basin A (IN)	15 Year 20 Min	0	2,915	3	2.430	(N/A)	(N/A)
Basin A (OUT)	15 Year 20 Min	0	2,915	21	1.385	513.98	1,759
Basin A (IN)	25 Year 20 Min	0	3,419	3	2.850	(N/A)	(N/A)
Basin A (OUT)	25 Year 20 Min	0	3,419	21	1.652	514.24	2,082
Basin A (IN)	100 Year 20 Min	0	3,923	3	3.270	(N/A)	(N/A)
Basin A (OUT)	100 Year 20 Min	0	3,923	21	1.825	514.49	2,418
Basin A (IN)	100 Yr LFB	0	3,923	3	3.270	(N/A)	(N/A)
Basin A (OUT)	100 Yr LFB	0	3,923	20	3.270	514.95	3,102

Peak Discharge	1.640 ft³/s
Time to Peak	13 min
Hydrograph Volume	1,967 ft³

HYDROGRAPH ORDINATES (ft³/s)
Output Time Increment = 1 min
Time on left represents time for first value in each row.

Time (min)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)
0	0.000	0.541	1.094	1.640	1.640
5	1.640	1.640	1.640	1.640	1.640
10	1.640	1.640	1.640	1.640	1.640
15	1.640	1.640	1.640	1.640	1.640
20	1.640	1.094	0.541	0.000	0.000
25	0.000	0.000	0.000	0.000	0.000
30	0.000	0.000	0.000	0.000	0.000
35	0.000	0.000	0.000	0.000	0.000
40	0.000	0.000	0.000	0.000	0.000
45	0.000	0.000	0.000	0.000	0.000
50	0.000	0.000	0.000	0.000	0.000
55	0.000	0.000	0.000	0.000	0.000
60	0.000	0.000	0.000	0.000	0.000
65	0.000	0.000	0.000	0.000	0.000
70	0.000	0.000	0.000	0.000	0.000
75	0.000	0.000	0.000	0.000	0.000
80	0.000	0.000	0.000	0.000	0.000
85	0.000	0.000	0.000	0.000	0.000
90	0.000	(N/A)	(N/A)	(N/A)	(N/A)

Peak Discharge	2.430 ft³/s
Time to Peak	13 min
Hydrograph Volume	2,915 ft³

HYDROGRAPH ORDINATES (ft³/s)
Output Time Increment = 1 min
Time on left represents time for first value in each row.

Time (min)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)
0	0.000	0.802	1.621	2.430	2.430
5	2.430	2.430	2.430	2.430	2.430
10	2.430	2.430	2.430	2.430	2.430
15	2.430	2.430	2.430	2.430	2.430
20	2.430	1.621	0.802	0.000	0.000
25	0.000	0.000	0.000	0.000	0.000
30	0.000	0.000	0.000	0.000	0.000
35	0.000	0.000	0.000	0.000	0.000
40	0.000	0.000	0.000	0.000	0.000
45	0.000	0.000	0.000	0.000	0.000
50	0.000	0.000	0.000	0.000	0.000
55	0.000	0.000	0.000	0.000	0.000
60	0.000	0.000	0.000	0.000	0.000
65	0.000	0.000	0.000	0.000	0.000
70	0.000	0.000	0.000	0.000	0.000
75	0.000	0.000	0.000	0.000	0.000
80	0.000	0.000	0.000	0.000	0.000
85	0.000	0.000	0.000	0.000	0.000
90	0.000	(N/A)	(N/A)	(N/A)	(N/A)

Peak Discharge	2.850 ft³/s
Time to Peak	13 min
Hydrograph Volume	3,419 ft³

HYDROGRAPH ORDINATES (ft³/s)
Output Time Increment = 1 min
Time on left represents time for first value in each row.

Time (min)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)
0	0.000	0.941	1.901	2.850	2.850
5	2.850	2.850	2.850	2.850	2.850
10	2.850	2.850	2.850	2.850	2.850
15	2.850	2.850	2.850	2.850	2.850
20	2.850	1.901	0.941	0.000	0.000
25	0.000	0.000	0.000	0.000	0.000
30	0.000	0.000	0.000	0.000	0.000
35	0.000	0.000	0.000	0.000	0.000
40	0.000	0.000	0.000	0.000	0.000
45	0.000	0.000	0.000	0.000	0.000
50	0.000	0.000	0.000	0.000	0.000
55	0.000	0.000	0.000	0.000	0.000
60	0.000	0.000	0.000	0.000	0.000
65	0.000	0.000	0.000	0.000	0.000
70	0.000	0.000	0.000	0.000	0.000
75	0.000	0.000	0.000	0.000	0.000
80	0.000	0.000	0.000	0.000	0.000
85	0.000	0.000	0.000	0.000	0.000
90	0.000	(N/A)	(N/A)	(N/A)	(N/A)

Peak Discharge	3.270 ft³/s
Time to Peak	13 min
Hydrograph Volume	3,923 ft³

HYDROGRAPH ORDINATES (ft³/s)
Output Time Increment = 1 min
Time on left represents time for first value in each row.

Time (min)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)
0	0.000	1.079	2.181	3.270	3.270
5	3.270	3.270	3.270	3.270	3.270
10	3.270	3.270	3.270	3.270	3.270
15	3.270	3.270	3.270	3.270	3.270
20	3.270	2.181	1.079	0.000	0.000
25	0.000	0.000	0.000	0.000	0.000
30	0.000	0.000	0.000	0.000	0.000
35	0.000	0.000	0.000	0.000	0.000
40	0.000	0.000	0.000	0.000	0.000
45	0.000	0.000	0.000	0.000	0.000
50	0.000	0.000	0.000	0.000	0.000
55	0.000	0.000	0.000	0.000	0.000
60	0.000	0.000	0.000	0.000	0.000
65	0.000	0.000	0.000	0.000	0.000
70	0.000	0.000	0.000	0.000	0.000
75	0.000	0.000	0.000	0.000	0.000
80	0.000	0.000	0.000	0.000	0.000
85	0.000	0.000	0.000	0.000	0.000
90	0.000	(N/A)	(N/A)	(N/A)	(N/A)

Subsection: Elevation-Area Volume Curve
Label: Basin A

Return Event: 2 years
Storm Event:

Elevation (ft)	Planimeter (ft²)	Area (ft²)	A1+A2+sqr(A1*A2) (ft²)	Volume (ft³)	Volume (Total) (ft³)
511.25	0.00	0	0	0	0
512.00	0.00	498	498	124	124
513.00	0.00	820	1,957	652	777
514.00	0.00	1,199	3,011	1,004	1,780
515.00	0.00	1,634	4,233	1,411	3,191
516.00	0.00	2,126	5,624	1,875	5,066

Pond Volume Equations
* Incremental volume computed by the Conic Method for Reservoir Volumes.

Volume = (1/3) * (EL2 - El1) * (Area1 + Area2 + sqr(Area1 * Area2))

where:	EL1, EL2	Lower and upper elevations of the increment
	Area1, Area2	Areas computed for EL1, EL2, respectively
	Volume	Incremental volume between EL1 and EL2

Requested Pond Water Surface Elevations	
Minimum (Headwater)	511.25 ft
Increment (Headwater)	0.10 ft
Maximum (Headwater)	516.00 ft

Outlet Connectivity

Structure Type	Outlet ID	Direction	Outfall	E1 (ft)	E2 (ft)
Stand Pipe	Riser - 1	Forward	Culvert - 1	514.75	516.00
Culvert-Circular	Culvert - 1	Forward	TW	510.25	516.00
Tailwater Settings	Tailwater			(N/A)	(N/A)

Structure ID: Culvert - 1 Structure Type: Culvert-Circular	
Number of Barrels	1
Diameter	12.00 in
Length	80.85 ft
Length (Computed Barrel)	82.10 ft
Slope (Computed)	0.176 ft/ft

Outlet Control Data	
Manning's n	0.013
Ke	0.200
Kb	0.031
Kr	0.000
Convergence Tolerance	0.00 ft

Inlet Control Data	
Equation Form	Form 1
K	0.0045
M	2.0000
C	0.0317
Y	0.6900
T1 ratio (HW/D)	1.007
T2 ratio (HW/D)	1.109
Slope Correction Factor	-0.500

Use unsubmerged inlet control 0 equation below T1 elevation.
Use submerged inlet control 0 equation above T2 elevation

In transition zone between unsubmerged and submerged inlet control,
interpolate between flows at T1 & T2...

T1 Elevation	511.26 ft	T1 Flow	2.749 ft³/s
T2 Elevation	511.36 ft	T2 Flow	3.142 ft³/s

Structure ID: Riser - 1 Structure Type: Stand Pipe	
Number of Openings	1
Elevation	514.75 ft
Diameter	48.00 in
Orifice Area	12.57 ft²
Orifice Coefficient	0.600
Weir Length	12.57 ft
Weir Coefficient	3.00 (ft^0.5)/s
K Reverse	1.000
Manning's n	0.000
Kev, Charged Riser	0.000
Weir Submergence	False
Orifice H to crest	False

Structure ID: TW Structure Type: TW Setup, DS Channel	
Tailwater Type	Free Outfall

Convergence Tolerances	
Maximum Iterations	30
Tailwater Tolerance (Minimum)	0.01 ft
Tailwater Tolerance (Maximum)	0.50 ft
Headwater Tolerance (Minimum)	0.01 ft
Headwater Tolerance (Maximum)	0.50 ft
Flow Tolerance (Minimum)	0.001 ft³/s
Flow Tolerance (Maximum)	10.000 ft³/s

Subsection: Composite Rating Curve
Label: LFB 101

Return Event: 101 years
Storm Event:

Composite Outflow Summary

Water Surface Elevation (ft)	Flow (ft^3/s)	Tailwater Elevation (ft)	Convergence Error (ft)
511.25	0.000	(N/A)	0.00
511.35	0.000	(N/A)	0.00
511.45	0.000	(N/A)	0.00
511.55	0.000	(N/A)	0.00
511.65	0.000	(N/A)	0.00
511.75	0.000	(N/A)	0.00
511.85	0.000	(N/A)	0.00
511.95	0.000	(N/A)	0.00
512.05	0.000	(N/A)	0.00
512.15	0.000	(N/A)	0.00
512.25	0.000	(N/A)	0.00
512.35	0.000	(N/A)	0.00
512.45	0.000	(N/A)	0.00
512.55	0.000	(N/A)	0.00
512.65	0.000	(N/A)	0.00
512.75	0.000	(N/A)	0.00
512.85	0.000	(N/A)	0.00
512.95	0.000	(N/A)	0.00
513.05	0.000	(N/A)	0.00
513.15	0.000	(N/A)	0.00
513.25	0.000	(N/A)	0.00
513.35	0.000	(N/A)	0.00
513.45	0.000	(N/A)	0.00
513.55	0.000	(N/A)	0.00
513.65	0.000	(N/A)	0.00
513.75	0.000	(N/A)	0.00
513.85	0.000	(N/A)	0.00
513.95	0.000	(N/A)	0.00
514.05	0.000	(N/A)	0.00
514.15	0.000	(N/A)	0.00
514.25	0.000	(N/A)	0.00
514.35	0.000	(N/A)	0.00
514.45	0.000	(N/A)	0.00
514.55	0.000	(N/A)	0.00
514.65	0.000	(N/A)	0.00
514.75	0.000	(N/A)	0.00
514.85	1.192	(N/A)	0.00
514.95	3.374	(N/A)	0.00
515.05	6.196	(N/A)	0.00
515.15	9.143	(N/A)	0.00
515.25	9.251	(N/A)	0.00
515.35	9.355	(N/A)	0.00
515.45	9.459	(N/A)	0.00
515.55	9.561	(N/A)	0.00

Composite Outflow Summary

Water Surface Elevation (ft)	Flow (ft³/s)	Tailwater Elevation (ft)	Convergence Error (ft)
515.65	9.662	(N/A)	0.00
515.75	9.763	(N/A)	0.00
515.85	9.862	(N/A)	0.00
515.95	9.960	(N/A)	0.00
516.00	10.009	(N/A)	0.00

Contributing Structures
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
Riser - 1,Culvert - 1
Riser - 1,Culvert - 1

Subsection: Composite Rating Curve
Label: LFB 101

Return Event: 101 years
Storm Event:

Composite Outflow Summary

Contributing Structures
Riser - 1,Culvert - 1
Riser - 1,Culvert - 1
Riser - 1,Culvert - 1
Riser - 1,Culvert - 1
Riser - 1,Culvert - 1
Riser - 1,Culvert - 1
Riser - 1,Culvert - 1
Riser - 1,Culvert - 1
Riser - 1,Culvert - 1
Riser - 1,Culvert - 1
Riser - 1,Culvert - 1

Requested Pond Water Surface Elevations	
Minimum (Headwater)	511.25 ft
Increment (Headwater)	0.10 ft
Maximum (Headwater)	516.00 ft

Outlet Connectivity

Structure Type	Outlet ID	Direction	Outfall	E1 (ft)	E2 (ft)
Orifice-Area	Upper Orifice	Forward	Culvert - 1	514.00	516.00
Rectangular Weir	Upper Slot	Forward	Culvert - 1	513.50	514.00
Stand Pipe	Riser - 1	Forward	Culvert - 1	514.75	516.00
Orifice-Circular	Lower Slot	Forward	Culvert - 1	511.25	516.00
Culvert-Circular	Culvert - 1	Forward	TW	510.25	516.00
Tailwater Settings	Tailwater			(N/A)	(N/A)

Structure ID: Lower Slot Structure Type: Orifice-Circular	
Number of Openings	1
Elevation	511.25 ft
Orifice Diameter	5.00 in
Orifice Coefficient	0.600

Structure ID: Culvert - 1 Structure Type: Culvert-Circular	
Number of Barrels	1
Diameter	12.00 in
Length	80.85 ft
Length (Computed Barrel)	82.10 ft
Slope (Computed)	0.176 ft/ft

Outlet Control Data	
Manning's n	0.013
Ke	0.200
Kb	0.031
Kr	0.000
Convergence Tolerance	0.00 ft

Inlet Control Data	
Equation Form	Form 1
K	0.0045
M	2.0000
C	0.0317
Y	0.6900
T1 ratio (HW/D)	1.007
T2 ratio (HW/D)	1.109
Slope Correction Factor	-0.500

Use unsubmerged inlet control 0 equation below T1 elevation.
Use submerged inlet control 0 equation above T2 elevation

In transition zone between unsubmerged and submerged inlet control,
interpolate between flows at T1 & T2...

T1 Elevation	511.26 ft	T1 Flow	2.749 ft³/s
T2 Elevation	511.36 ft	T2 Flow	3.142 ft³/s

Structure ID: Riser - 1 Structure Type: Stand Pipe	
Number of Openings	1
Elevation	514.75 ft
Diameter	48.00 in
Orifice Area	12.57 ft²
Orifice Coefficient	0.600
Weir Length	12.57 ft
Weir Coefficient	3.00 (ft^0.5)/s
K Reverse	1.000
Manning's n	0.000
Kev, Charged Riser	0.000
Weir Submergence	False
Orifice H to crest	False

Structure ID: Upper Slot Structure Type: Rectangular Weir	
Number of Openings	1
Elevation	513.50 ft
Weir Length	0.33 ft
Weir Coefficient	3.00 (ft^0.5)/s

Structure ID: Upper Orifice Structure Type: Orifice-Area	
Number of Openings	1
Elevation	513.50 ft
Orifice Area	0.17 ft²
Top Elevation	514.00 ft
Datum Elevation	513.75 ft
Orifice Coefficient	0.600

Structure ID: TW Structure Type: TW Setup, DS Channel	
Tailwater Type	Free Outfall

Convergence Tolerances	
Maximum Iterations	30
Tailwater Tolerance (Minimum)	0.01 ft
Tailwater Tolerance (Maximum)	0.50 ft
Headwater Tolerance (Minimum)	0.01 ft
Headwater Tolerance (Maximum)	0.50 ft

Convergence Tolerances	
Flow Tolerance (Minimum)	0.001 ft³/s
Flow Tolerance (Maximum)	10.000 ft³/s

Subsection: Composite Rating Curve
Label: OS 101

Return Event: 2 years
Storm Event:

Composite Outflow Summary

Water Surface Elevation (ft)	Flow (ft^3/s)	Tailwater Elevation (ft)	Convergence Error (ft)
511.25	0.000	(N/A)	0.00
511.35	0.021	(N/A)	0.00
511.45	0.080	(N/A)	0.00
511.55	0.166	(N/A)	0.00
511.65	0.272	(N/A)	0.00
511.75	0.354	(N/A)	0.00
511.85	0.408	(N/A)	0.00
511.95	0.460	(N/A)	0.00
512.05	0.505	(N/A)	0.00
512.15	0.546	(N/A)	0.00
512.25	0.582	(N/A)	0.00
512.35	0.617	(N/A)	0.00
512.45	0.652	(N/A)	0.00
512.55	0.684	(N/A)	0.00
512.65	0.717	(N/A)	0.00
512.75	0.746	(N/A)	0.00
512.85	0.773	(N/A)	0.00
512.95	0.801	(N/A)	0.00
513.05	0.828	(N/A)	0.00
513.15	0.854	(N/A)	0.00
513.25	0.879	(N/A)	0.00
513.35	0.903	(N/A)	0.00
513.45	0.927	(N/A)	0.00
513.50	0.938	(N/A)	0.00
513.55	0.960	(N/A)	0.00
513.65	1.029	(N/A)	0.00
513.75	1.117	(N/A)	0.00
513.85	1.220	(N/A)	0.00
513.95	1.334	(N/A)	0.00
514.05	1.491	(N/A)	0.00
514.15	1.580	(N/A)	0.00
514.25	1.658	(N/A)	0.00
514.35	1.731	(N/A)	0.00
514.45	1.799	(N/A)	0.00
514.55	1.863	(N/A)	0.00
514.65	1.926	(N/A)	0.00
514.75	1.984	(N/A)	0.00
514.85	3.229	(N/A)	0.00
514.95	5.308	(N/A)	0.00
515.05	7.729	(N/A)	0.00
515.15	9.146	(N/A)	0.00
515.25	9.251	(N/A)	0.00
515.35	9.355	(N/A)	0.00
515.45	9.459	(N/A)	0.00

Composite Outflow Summary

Water Surface Elevation (ft)	Flow (ft³/s)	Tailwater Elevation (ft)	Convergence Error (ft)
515.55	9.561	(N/A)	0.00
515.65	9.662	(N/A)	0.00
515.75	9.763	(N/A)	0.00
515.85	9.862	(N/A)	0.00
515.95	9.960	(N/A)	0.00
516.00	10.009	(N/A)	0.00

Contributing Structures
(no Q: Upper Orifice,Upper Slot,Riser - 1,Lower Slot,Culvert - 1)
Lower Slot,Culvert - 1 (no Q: Upper Orifice,Upper Slot,Riser - 1)
Lower Slot,Culvert - 1 (no Q: Upper Orifice,Upper Slot,Riser - 1)
Lower Slot,Culvert - 1 (no Q: Upper Orifice,Upper Slot,Riser - 1)
Lower Slot,Culvert - 1 (no Q: Upper Orifice,Upper Slot,Riser - 1)
Lower Slot,Culvert - 1 (no Q: Upper Orifice,Upper Slot,Riser - 1)
Lower Slot,Culvert - 1 (no Q: Upper Orifice,Upper Slot,Riser - 1)
Lower Slot,Culvert - 1 (no Q: Upper Orifice,Upper Slot,Riser - 1)
Lower Slot,Culvert - 1 (no Q: Upper Orifice,Upper Slot,Riser - 1)
Lower Slot,Culvert - 1 (no Q: Upper Orifice,Upper Slot,Riser - 1)
Lower Slot,Culvert - 1 (no Q: Upper Orifice,Upper Slot,Riser - 1)
Lower Slot,Culvert - 1 (no Q: Upper Orifice,Upper Slot,Riser - 1)
Lower Slot,Culvert - 1 (no Q: Upper Orifice,Upper Slot,Riser - 1)
Lower Slot,Culvert - 1 (no Q: Upper Orifice,Upper Slot,Riser - 1)
Lower Slot,Culvert - 1 (no Q: Upper Orifice,Upper Slot,Riser - 1)
Lower Slot,Culvert - 1 (no Q: Upper Orifice,Upper Slot,Riser - 1)
Lower Slot,Culvert - 1 (no Q: Upper Orifice,Upper Slot,Riser - 1)
Lower Slot,Culvert - 1 (no Q: Upper Orifice,Upper Slot,Riser - 1)
Lower Slot,Culvert - 1 (no Q: Upper Orifice,Upper Slot,Riser - 1)
Lower Slot,Culvert - 1 (no Q: Upper Orifice,Upper Slot,Riser - 1)

Composite Outflow Summary

Contributing Structures
Lower Slot,Culvert - 1 (no Q: Upper Orifice,Upper Slot,Riser - 1)
Lower Slot,Culvert - 1 (no Q: Upper Orifice,Upper Slot,Riser - 1)
Lower Slot,Culvert - 1 (no Q: Upper Orifice,Upper Slot,Riser - 1)
Lower Slot,Culvert - 1 (no Q: Upper Orifice,Upper Slot,Riser - 1)
Upper Slot,Lower Slot,Culvert - 1 (no Q: Upper Orifice,Riser - 1)
Upper Slot,Lower Slot,Culvert - 1 (no Q: Upper Orifice,Riser - 1)
Upper Slot,Lower Slot,Culvert - 1 (no Q: Upper Orifice,Riser - 1)
Upper Slot,Lower Slot,Culvert - 1 (no Q: Upper Orifice,Riser - 1)
Upper Slot,Lower Slot,Culvert - 1 (no Q: Upper Orifice,Riser - 1)
Upper Orifice,Lower Slot,Culvert - 1 (no Q: Upper Slot,Riser - 1)
Upper Orifice,Lower Slot,Culvert - 1 (no Q: Upper Slot,Riser - 1)
Upper Orifice,Lower Slot,Culvert - 1 (no Q: Upper Slot,Riser - 1)
Upper Orifice,Lower Slot,Culvert - 1 (no Q: Upper Slot,Riser - 1)
Upper Orifice,Lower Slot,Culvert - 1 (no Q: Upper Slot,Riser - 1)
Upper Orifice,Lower Slot,Culvert - 1 (no Q: Upper Slot,Riser - 1)
Upper Orifice,Lower Slot,Culvert - 1 (no Q: Upper Slot,Riser - 1)
Upper Orifice,Lower Slot,Culvert - 1 (no Q: Upper Slot,Riser - 1)
Upper Orifice,Riser - 1,Lower Slot,Culvert - 1 (no Q: Upper Slot)
Upper Orifice,Riser - 1,Lower Slot,Culvert - 1 (no Q: Upper Slot)
Upper Orifice,Riser - 1,Lower Slot,Culvert - 1 (no Q: Upper Slot)
Riser - 1,Culvert - 1 (no Q: Upper Orifice,Upper Slot,Lower Slot)
Riser - 1,Culvert - 1 (no Q: Upper Orifice,Upper Slot,Lower Slot)
Riser - 1,Culvert - 1 (no Q: Upper Orifice,Upper Slot,Lower Slot)
Riser - 1,Culvert - 1 (no Q: Upper Orifice,Upper Slot,Lower Slot)

Subsection: Composite Rating Curve
Label: OS 101

Return Event: 2 years
Storm Event:

Composite Outflow Summary

Contributing Structures
Riser - 1,Culvert - 1 (no Q: Upper Orifice,Upper Slot,Lower Slot)
Riser - 1,Culvert - 1 (no Q: Upper Orifice,Upper Slot,Lower Slot)
Riser - 1,Culvert - 1 (no Q: Upper Orifice,Upper Slot,Lower Slot)
Riser - 1,Culvert - 1 (no Q: Upper Orifice,Upper Slot,Lower Slot)
Riser - 1,Culvert - 1 (no Q: Upper Orifice,Upper Slot,Lower Slot)
Riser - 1,Culvert - 1 (no Q: Upper Orifice,Upper Slot,Lower Slot)

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Water Surface, Initial)	511.25 ft
Volume (Initial)	0 ft³
Flow (Initial Outlet)	0.000 ft³/s
Flow (Initial Infiltration)	0.000 ft³/s
Flow (Initial, Total)	0.000 ft³/s
Time Increment	1 min

Elevation (ft)	Outflow (ft³/s)	Storage (ft³)	Area (ft²)	Infiltration (ft³/s)	Flow (Total) (ft³/s)	2S/t + O (ft³/s)
511.25	0.000	0	0	0.000	0.000	0.000
511.35	0.021	0	9	0.000	0.021	0.031
511.45	0.080	2	35	0.000	0.080	0.158
511.55	0.166	8	80	0.000	0.166	0.431
511.65	0.272	19	142	0.000	0.272	0.901
511.75	0.354	37	221	0.000	0.354	1.584
511.85	0.408	64	319	0.000	0.408	2.533
511.95	0.460	101	434	0.000	0.460	3.834
512.05	0.505	150	512	0.000	0.505	5.497
512.15	0.546	202	541	0.000	0.546	7.293
512.25	0.582	258	571	0.000	0.582	9.183
512.35	0.617	317	602	0.000	0.617	11.172
512.45	0.652	378	633	0.000	0.652	13.265
512.55	0.684	443	665	0.000	0.684	15.460
512.65	0.717	511	698	0.000	0.717	17.765
512.75	0.746	583	732	0.000	0.746	20.178
512.85	0.773	658	767	0.000	0.773	22.702
512.95	0.801	736	802	0.000	0.801	25.344
513.05	0.828	818	837	0.000	0.828	28.104
513.15	0.854	904	872	0.000	0.854	30.978
513.25	0.879	993	908	0.000	0.879	33.970
513.35	0.903	1,085	944	0.000	0.903	37.082
513.45	0.927	1,182	982	0.000	0.927	40.316
513.50	0.938	1,231	1,001	0.000	0.938	41.979
513.55	0.960	1,282	1,020	0.000	0.960	43.685
513.65	1.029	1,386	1,058	0.000	1.029	47.216
513.75	1.117	1,493	1,098	0.000	1.117	50.897
513.85	1.220	1,605	1,138	0.000	1.220	54.725
513.95	1.334	1,721	1,178	0.000	1.334	58.699
514.05	1.491	1,841	1,219	0.000	1.491	62.852
514.15	1.580	1,965	1,260	0.000	1.580	67.072

Elevation (ft)	Outflow (ft³/s)	Storage (ft³)	Area (ft²)	Infiltration (ft³/s)	Flow (Total) (ft³/s)	2S/t + O (ft³/s)
514.25	1.658	2,093	1,301	0.000	1.658	71.419
514.35	1.731	2,225	1,344	0.000	1.731	75.900
514.45	1.799	2,362	1,386	0.000	1.799	80.518
514.55	1.863	2,502	1,430	0.000	1.863	85.276
514.65	1.926	2,648	1,474	0.000	1.926	90.179
514.75	1.984	2,797	1,519	0.000	1.984	95.225
514.85	3.229	2,951	1,564	0.000	3.229	101.609
514.95	5.308	3,110	1,611	0.000	5.308	108.979
515.05	7.729	3,274	1,657	0.000	7.729	116.847
515.15	9.146	3,442	1,704	0.000	9.146	123.865
515.25	9.251	3,614	1,751	0.000	9.251	129.727
515.35	9.355	3,792	1,799	0.000	9.355	135.748
515.45	9.459	3,974	1,847	0.000	9.459	141.929
515.55	9.561	4,161	1,897	0.000	9.561	148.270
515.65	9.662	4,353	1,946	0.000	9.662	154.776
515.75	9.763	4,551	1,997	0.000	9.763	161.450
515.85	9.862	4,753	2,048	0.000	9.862	168.289
515.95	9.960	4,960	2,100	0.000	9.960	175.301
516.00	10.009	5,066	2,126	0.000	10.009	178.872

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Water Surface, Initial)	511.25 ft
Volume (Initial)	0 ft³
Flow (Initial Outlet)	0.000 ft³/s
Flow (Initial Infiltration)	0.000 ft³/s
Flow (Initial, Total)	0.000 ft³/s
Time Increment	1 min

Elevation (ft)	Outflow (ft³/s)	Storage (ft³)	Area (ft²)	Infiltration (ft³/s)	Flow (Total) (ft³/s)	2S/t + O (ft³/s)
511.25	0.000	0	0	0.000	0.000	0.000
511.35	0.021	0	9	0.000	0.021	0.031
511.45	0.080	2	35	0.000	0.080	0.158
511.55	0.166	8	80	0.000	0.166	0.431
511.65	0.272	19	142	0.000	0.272	0.901
511.75	0.354	37	221	0.000	0.354	1.584
511.85	0.408	64	319	0.000	0.408	2.533
511.95	0.460	101	434	0.000	0.460	3.834
512.05	0.505	150	512	0.000	0.505	5.497
512.15	0.546	202	541	0.000	0.546	7.293
512.25	0.582	258	571	0.000	0.582	9.183
512.35	0.617	317	602	0.000	0.617	11.172
512.45	0.652	378	633	0.000	0.652	13.265
512.55	0.684	443	665	0.000	0.684	15.460
512.65	0.717	511	698	0.000	0.717	17.765
512.75	0.746	583	732	0.000	0.746	20.178
512.85	0.773	658	767	0.000	0.773	22.702
512.95	0.801	736	802	0.000	0.801	25.344
513.05	0.828	818	837	0.000	0.828	28.104
513.15	0.854	904	872	0.000	0.854	30.978
513.25	0.879	993	908	0.000	0.879	33.970
513.35	0.903	1,085	944	0.000	0.903	37.082
513.45	0.927	1,182	982	0.000	0.927	40.316
513.50	0.938	1,231	1,001	0.000	0.938	41.979
513.55	0.960	1,282	1,020	0.000	0.960	43.685
513.65	1.029	1,386	1,058	0.000	1.029	47.216
513.75	1.117	1,493	1,098	0.000	1.117	50.897
513.85	1.220	1,605	1,138	0.000	1.220	54.725
513.95	1.334	1,721	1,178	0.000	1.334	58.699
514.05	1.491	1,841	1,219	0.000	1.491	62.852
514.15	1.580	1,965	1,260	0.000	1.580	67.072

Elevation (ft)	Outflow (ft³/s)	Storage (ft³)	Area (ft²)	Infiltration (ft³/s)	Flow (Total) (ft³/s)	2S/t + O (ft³/s)
514.25	1.658	2,093	1,301	0.000	1.658	71.419
514.35	1.731	2,225	1,344	0.000	1.731	75.900
514.45	1.799	2,362	1,386	0.000	1.799	80.518
514.55	1.863	2,502	1,430	0.000	1.863	85.276
514.65	1.926	2,648	1,474	0.000	1.926	90.179
514.75	1.983	2,797	1,519	0.000	1.983	95.224
514.85	3.229	2,951	1,564	0.000	3.229	101.609
514.95	5.308	3,110	1,611	0.000	5.308	108.979
515.05	7.729	3,274	1,657	0.000	7.729	116.847
515.15	9.146	3,442	1,704	0.000	9.146	123.865
515.25	9.251	3,614	1,751	0.000	9.251	129.727
515.35	9.355	3,792	1,799	0.000	9.355	135.748
515.45	9.459	3,974	1,847	0.000	9.459	141.929
515.55	9.561	4,161	1,897	0.000	9.561	148.270
515.65	9.662	4,353	1,946	0.000	9.662	154.776
515.75	9.763	4,551	1,997	0.000	9.763	161.450
515.85	9.862	4,753	2,048	0.000	9.862	168.289
515.95	9.960	4,960	2,100	0.000	9.960	175.301
516.00	10.009	5,066	2,126	0.000	10.009	178.872

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Water Surface, Initial)	511.25 ft
Volume (Initial)	0 ft³
Flow (Initial Outlet)	0.000 ft³/s
Flow (Initial Infiltration)	0.000 ft³/s
Flow (Initial, Total)	0.000 ft³/s
Time Increment	1 min

Elevation (ft)	Outflow (ft³/s)	Storage (ft³)	Area (ft²)	Infiltration (ft³/s)	Flow (Total) (ft³/s)	2S/t + O (ft³/s)
511.25	0.000	0	0	0.000	0.000	0.000
511.35	0.021	0	9	0.000	0.021	0.031
511.45	0.080	2	35	0.000	0.080	0.158
511.55	0.166	8	80	0.000	0.166	0.431
511.65	0.272	19	142	0.000	0.272	0.901
511.75	0.354	37	221	0.000	0.354	1.584
511.85	0.408	64	319	0.000	0.408	2.533
511.95	0.460	101	434	0.000	0.460	3.834
512.05	0.505	150	512	0.000	0.505	5.497
512.15	0.546	202	541	0.000	0.546	7.293
512.25	0.582	258	571	0.000	0.582	9.183
512.35	0.617	317	602	0.000	0.617	11.172
512.45	0.652	378	633	0.000	0.652	13.265
512.55	0.684	443	665	0.000	0.684	15.460
512.65	0.717	511	698	0.000	0.717	17.765
512.75	0.746	583	732	0.000	0.746	20.178
512.85	0.773	658	767	0.000	0.773	22.702
512.95	0.801	736	802	0.000	0.801	25.344
513.05	0.828	818	837	0.000	0.828	28.104
513.15	0.854	904	872	0.000	0.854	30.978
513.25	0.879	993	908	0.000	0.879	33.970
513.35	0.903	1,085	944	0.000	0.903	37.082
513.45	0.927	1,182	982	0.000	0.927	40.316
513.50	0.938	1,231	1,001	0.000	0.938	41.979
513.55	0.960	1,282	1,020	0.000	0.960	43.685
513.65	1.029	1,386	1,058	0.000	1.029	47.216
513.75	1.117	1,493	1,098	0.000	1.117	50.897
513.85	1.220	1,605	1,138	0.000	1.220	54.725
513.95	1.334	1,721	1,178	0.000	1.334	58.699
514.05	1.491	1,841	1,219	0.000	1.491	62.852
514.15	1.580	1,965	1,260	0.000	1.580	67.072

Elevation (ft)	Outflow (ft³/s)	Storage (ft³)	Area (ft²)	Infiltration (ft³/s)	Flow (Total) (ft³/s)	2S/t + O (ft³/s)
514.25	1.658	2,093	1,301	0.000	1.658	71.419
514.35	1.731	2,225	1,344	0.000	1.731	75.900
514.45	1.799	2,362	1,386	0.000	1.799	80.518
514.55	1.863	2,502	1,430	0.000	1.863	85.276
514.65	1.926	2,648	1,474	0.000	1.926	90.179
514.75	1.983	2,797	1,519	0.000	1.983	95.224
514.85	3.229	2,951	1,564	0.000	3.229	101.609
514.95	5.308	3,110	1,611	0.000	5.308	108.979
515.05	7.729	3,274	1,657	0.000	7.729	116.847
515.15	9.146	3,442	1,704	0.000	9.146	123.865
515.25	9.251	3,614	1,751	0.000	9.251	129.727
515.35	9.355	3,792	1,799	0.000	9.355	135.748
515.45	9.459	3,974	1,847	0.000	9.459	141.929
515.55	9.561	4,161	1,897	0.000	9.561	148.270
515.65	9.662	4,353	1,946	0.000	9.662	154.776
515.75	9.763	4,551	1,997	0.000	9.763	161.450
515.85	9.862	4,753	2,048	0.000	9.862	168.289
515.95	9.960	4,960	2,100	0.000	9.960	175.301
516.00	10.009	5,066	2,126	0.000	10.009	178.872

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Water Surface, Initial)	511.25 ft
Volume (Initial)	0 ft³
Flow (Initial Outlet)	0.000 ft³/s
Flow (Initial Infiltration)	0.000 ft³/s
Flow (Initial, Total)	0.000 ft³/s
Time Increment	1 min

Elevation (ft)	Outflow (ft³/s)	Storage (ft³)	Area (ft²)	Infiltration (ft³/s)	Flow (Total) (ft³/s)	2S/t + O (ft³/s)
511.25	0.000	0	0	0.000	0.000	0.000
511.35	0.021	0	9	0.000	0.021	0.031
511.45	0.080	2	35	0.000	0.080	0.158
511.55	0.166	8	80	0.000	0.166	0.431
511.65	0.272	19	142	0.000	0.272	0.901
511.75	0.354	37	221	0.000	0.354	1.584
511.85	0.408	64	319	0.000	0.408	2.533
511.95	0.460	101	434	0.000	0.460	3.834
512.05	0.505	150	512	0.000	0.505	5.497
512.15	0.546	202	541	0.000	0.546	7.293
512.25	0.582	258	571	0.000	0.582	9.183
512.35	0.617	317	602	0.000	0.617	11.172
512.45	0.652	378	633	0.000	0.652	13.265
512.55	0.684	443	665	0.000	0.684	15.460
512.65	0.717	511	698	0.000	0.717	17.765
512.75	0.746	583	732	0.000	0.746	20.178
512.85	0.773	658	767	0.000	0.773	22.702
512.95	0.801	736	802	0.000	0.801	25.344
513.05	0.828	818	837	0.000	0.828	28.104
513.15	0.854	904	872	0.000	0.854	30.978
513.25	0.879	993	908	0.000	0.879	33.970
513.35	0.903	1,085	944	0.000	0.903	37.082
513.45	0.927	1,182	982	0.000	0.927	40.316
513.50	0.938	1,231	1,001	0.000	0.938	41.979
513.55	0.960	1,282	1,020	0.000	0.960	43.685
513.65	1.029	1,386	1,058	0.000	1.029	47.216
513.75	1.117	1,493	1,098	0.000	1.117	50.897
513.85	1.220	1,605	1,138	0.000	1.220	54.725
513.95	1.334	1,721	1,178	0.000	1.334	58.699
514.05	1.491	1,841	1,219	0.000	1.491	62.852
514.15	1.580	1,965	1,260	0.000	1.580	67.072

Subsection: Elevation-Volume-Flow Table (Pond) Return Event: 100 years
Label: Basin A Storm Event:

Elevation (ft)	Outflow (ft³/s)	Storage (ft³)	Area (ft²)	Infiltration (ft³/s)	Flow (Total) (ft³/s)	2S/t + O (ft³/s)
514.25	1.658	2,093	1,301	0.000	1.658	71.419
514.35	1.731	2,225	1,344	0.000	1.731	75.900
514.45	1.799	2,362	1,386	0.000	1.799	80.518
514.55	1.863	2,502	1,430	0.000	1.863	85.276
514.65	1.926	2,648	1,474	0.000	1.926	90.179
514.75	1.983	2,797	1,519	0.000	1.983	95.224
514.85	3.229	2,951	1,564	0.000	3.229	101.609
514.95	5.308	3,110	1,611	0.000	5.308	108.979
515.05	7.729	3,274	1,657	0.000	7.729	116.847
515.15	9.146	3,442	1,704	0.000	9.146	123.865
515.25	9.251	3,614	1,751	0.000	9.251	129.727
515.35	9.355	3,792	1,799	0.000	9.355	135.748
515.45	9.459	3,974	1,847	0.000	9.459	141.929
515.55	9.561	4,161	1,897	0.000	9.561	148.270
515.65	9.662	4,353	1,946	0.000	9.662	154.776
515.75	9.763	4,551	1,997	0.000	9.763	161.450
515.85	9.862	4,753	2,048	0.000	9.862	168.289
515.95	9.960	4,960	2,100	0.000	9.960	175.301
516.00	10.009	5,066	2,126	0.000	10.009	178.872

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Water Surface, Initial)	514.75 ft
Volume (Initial)	2,797 ft³
Flow (Initial Outlet)	0.000 ft³/s
Flow (Initial Infiltration)	0.000 ft³/s
Flow (Initial, Total)	0.000 ft³/s
Time Increment	1 min

Elevation (ft)	Outflow (ft³/s)	Storage (ft³)	Area (ft²)	Infiltration (ft³/s)	Flow (Total) (ft³/s)	2S/t + O (ft³/s)
511.25	0.000	0	0	0.000	0.000	0.000
511.35	0.000	0	9	0.000	0.000	0.010
511.45	0.000	2	35	0.000	0.000	0.079
511.55	0.000	8	80	0.000	0.000	0.266
511.65	0.000	19	142	0.000	0.000	0.630
511.75	0.000	37	221	0.000	0.000	1.230
511.85	0.000	64	319	0.000	0.000	2.125
511.95	0.000	101	434	0.000	0.000	3.374
512.05	0.000	150	512	0.000	0.000	4.992
512.15	0.000	202	541	0.000	0.000	6.747
512.25	0.000	258	571	0.000	0.000	8.601
512.35	0.000	317	602	0.000	0.000	10.555
512.45	0.000	378	633	0.000	0.000	12.612
512.55	0.000	443	665	0.000	0.000	14.776
512.65	0.000	511	698	0.000	0.000	17.048
512.75	0.000	583	732	0.000	0.000	19.432
512.85	0.000	658	767	0.000	0.000	21.929
512.95	0.000	736	802	0.000	0.000	24.543
513.05	0.000	818	837	0.000	0.000	27.276
513.15	0.000	904	872	0.000	0.000	30.125
513.25	0.000	993	908	0.000	0.000	33.092
513.35	0.000	1,085	944	0.000	0.000	36.179
513.45	0.000	1,182	982	0.000	0.000	39.389
513.55	0.000	1,282	1,020	0.000	0.000	42.724
513.65	0.000	1,386	1,058	0.000	0.000	46.187
513.75	0.000	1,493	1,098	0.000	0.000	49.780
513.85	0.000	1,605	1,138	0.000	0.000	53.505
513.95	0.000	1,721	1,178	0.000	0.000	57.364
514.05	0.000	1,841	1,219	0.000	0.000	61.360
514.15	0.000	1,965	1,260	0.000	0.000	65.492
514.25	0.000	2,093	1,301	0.000	0.000	69.761

Subsection: Elevation-Volume-Flow Table (Pond) Return Event: 101 years
Label: Basin A Storm Event:

Elevation (ft)	Outflow (ft³/s)	Storage (ft³)	Area (ft²)	Infiltration (ft³/s)	Flow (Total) (ft³/s)	2S/t + O (ft³/s)
514.35	0.000	2,225	1,344	0.000	0.000	74.169
514.45	0.000	2,362	1,386	0.000	0.000	78.719
514.55	0.000	2,502	1,430	0.000	0.000	83.413
514.65	0.000	2,648	1,474	0.000	0.000	88.253
514.75	0.000	2,797	1,519	0.000	0.000	93.241
514.85	1.192	2,951	1,564	0.000	1.192	99.572
514.95	3.374	3,110	1,611	0.000	3.374	107.045
515.05	6.196	3,274	1,657	0.000	6.196	115.314
515.15	9.143	3,442	1,704	0.000	9.143	123.862
515.25	9.251	3,614	1,751	0.000	9.251	129.727
515.35	9.355	3,792	1,799	0.000	9.355	135.748
515.45	9.459	3,974	1,847	0.000	9.459	141.929
515.55	9.561	4,161	1,897	0.000	9.561	148.270
515.65	9.662	4,353	1,946	0.000	9.662	154.776
515.75	9.763	4,551	1,997	0.000	9.763	161.450
515.85	9.862	4,753	2,048	0.000	9.862	168.289
515.95	9.960	4,960	2,100	0.000	9.960	175.301
516.00	10.009	5,066	2,126	0.000	10.009	178.872

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Water Surface, Initial)	511.25 ft
Volume (Initial)	0 ft³
Flow (Initial Outlet)	0.000 ft³/s
Flow (Initial Infiltration)	0.000 ft³/s
Flow (Initial, Total)	0.000 ft³/s
Time Increment	1 min

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	1.640 ft³/s	Time to Peak (Flow, In)	3 min
Flow (Peak Outlet)	0.895 ft³/s	Time to Peak (Flow, Outlet)	21 min

Elevation (Water Surface, Peak)	513.32 ft
Volume (Peak)	1,055 ft³

Mass Balance (ft³)	
Volume (Initial)	0 ft³
Volume (Total Inflow)	1,967 ft³
Volume (Total Infiltration)	0 ft³
Volume (Total Outlet Outflow)	1,967 ft³
Volume (Retained)	0 ft³
Volume (Unrouted)	0 ft³
Error (Mass Balance)	0.0 %

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Water Surface, Initial)	511.25 ft
Volume (Initial)	0 ft³
Flow (Initial Outlet)	0.000 ft³/s
Flow (Initial Infiltration)	0.000 ft³/s
Flow (Initial, Total)	0.000 ft³/s
Time Increment	1 min

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	2.430 ft³/s	Time to Peak (Flow, In)	3 min
Flow (Peak Outlet)	1.385 ft³/s	Time to Peak (Flow, Outlet)	21 min

Elevation (Water Surface, Peak)	513.98 ft
Volume (Peak)	1,759 ft³

Mass Balance (ft³)	
Volume (Initial)	0 ft³
Volume (Total Inflow)	2,915 ft³
Volume (Total Infiltration)	0 ft³
Volume (Total Outlet Outflow)	2,915 ft³
Volume (Retained)	0 ft³
Volume (Unrouted)	0 ft³
Error (Mass Balance)	0.0 %

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Water Surface, Initial)	511.25 ft
Volume (Initial)	0 ft³
Flow (Initial Outlet)	0.000 ft³/s
Flow (Initial Infiltration)	0.000 ft³/s
Flow (Initial, Total)	0.000 ft³/s
Time Increment	1 min

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	2.850 ft³/s	Time to Peak (Flow, In)	3 min
Flow (Peak Outlet)	1.652 ft³/s	Time to Peak (Flow, Outlet)	21 min

Elevation (Water Surface, Peak)	514.24 ft
Volume (Peak)	2,082 ft³

Mass Balance (ft³)	
Volume (Initial)	0 ft³
Volume (Total Inflow)	3,419 ft³
Volume (Total Infiltration)	0 ft³
Volume (Total Outlet Outflow)	3,419 ft³
Volume (Retained)	0 ft³
Volume (Unrouted)	0 ft³
Error (Mass Balance)	0.0 %

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Water Surface, Initial)	511.25 ft
Volume (Initial)	0 ft³
Flow (Initial Outlet)	0.000 ft³/s
Flow (Initial Infiltration)	0.000 ft³/s
Flow (Initial, Total)	0.000 ft³/s
Time Increment	1 min

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	3.270 ft³/s	Time to Peak (Flow, In)	3 min
Flow (Peak Outlet)	1.825 ft³/s	Time to Peak (Flow, Outlet)	21 min

Elevation (Water Surface, Peak)	514.49 ft
Volume (Peak)	2,418 ft³

Mass Balance (ft³)	
Volume (Initial)	0 ft³
Volume (Total Inflow)	3,923 ft³
Volume (Total Infiltration)	0 ft³
Volume (Total Outlet Outflow)	3,923 ft³
Volume (Retained)	0 ft³
Volume (Unrouted)	0 ft³
Error (Mass Balance)	0.0 %

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Water Surface, Initial)	514.75 ft
Volume (Initial)	2,797 ft³
Flow (Initial Outlet)	0.000 ft³/s
Flow (Initial Infiltration)	0.000 ft³/s
Flow (Initial, Total)	0.000 ft³/s
Time Increment	1 min

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	3.270 ft³/s	Time to Peak (Flow, In)	3 min
Flow (Peak Outlet)	3.270 ft³/s	Time to Peak (Flow, Outlet)	20 min

Elevation (Water Surface, Peak)	514.95 ft
Volume (Peak)	3,102 ft³

Mass Balance (ft³)	
Volume (Initial)	2,797 ft³
Volume (Total Inflow)	3,923 ft³
Volume (Total Infiltration)	0 ft³
Volume (Total Outlet Outflow)	3,923 ft³
Volume (Retained)	2,797 ft³
Volume (Unrouted)	0 ft³
Error (Mass Balance)	0.0 %

Summary for Hydrograph Addition at 'Basin A'

Upstream Link	Upstream Node
<Catchment to Outflow Node>	Basin A Inflow

Node Inflows

Inflow Type	Element	Volume (ft³)	Time to Peak (min)	Flow (Peak) (ft³/s)
Flow (From)	Basin A Inflow	1,967	3	1.640
Flow (In)	Basin A	1,967	3	1.640

Summary for Hydrograph Addition at 'Basin A'

Upstream Link	Upstream Node
<Catchment to Outflow Node>	Basin A Inflow

Node Inflows

Inflow Type	Element	Volume (ft³)	Time to Peak (min)	Flow (Peak) (ft³/s)
Flow (From)	Basin A Inflow	2,915	3	2.430
Flow (In)	Basin A	2,915	3	2.430

Summary for Hydrograph Addition at 'Basin A'

Upstream Link	Upstream Node
<Catchment to Outflow Node>	Basin A Inflow

Node Inflows

Inflow Type	Element	Volume (ft³)	Time to Peak (min)	Flow (Peak) (ft³/s)
Flow (From)	Basin A Inflow	3,419	3	2.850
Flow (In)	Basin A	3,419	3	2.850

Summary for Hydrograph Addition at 'Basin A'

Upstream Link	Upstream Node
<Catchment to Outflow Node>	Basin A Inflow

Node Inflows

Inflow Type	Element	Volume (ft³)	Time to Peak (min)	Flow (Peak) (ft³/s)
Flow (From)	Basin A Inflow	3,923	3	3.270
Flow (In)	Basin A	3,923	3	3.270

Summary for Hydrograph Addition at 'Basin A'

Upstream Link	Upstream Node
<Catchment to Outflow Node>	Basin A Inflow

Node Inflows

Inflow Type	Element	Volume (ft³)	Time to Peak (min)	Flow (Peak) (ft³/s)
Flow (From)	Basin A Inflow	3,923	3	3.270
Flow (In)	Basin A	3,923	3	3.270

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Appendix C
Drainage Maps

EXHIBIT A
PREDEVELOPED DRAINAGE AREA MAP
ANIMAL HOSPITAL
00-11214J

GRAPHIC SCALE

20 0 10 20

(IN FEET)
1 inch = 20 ft.

ENGINEERING
PLANNING
SURVEYING

221 Point West Blvd.
St. Charles, MO 63301
636-928-5552
FAX 928-1718

PARCEL I.D. 2-0119-1766-00-0020.2120000
CITY OF O'FALLON
ZONED: C-2 GENERAL BUSINESS

PROPERTY N/F
AHOLT, JOHN
4091/1125
PARCEL I.D. 2-0119-1766-00-0020.2130000
CITY OF O'FALLON
ZONED: C-2 GENERAL BUSINESS

60" CHAIN LINK FENCE

TREE LINE

C-2 ZONING
(R-1 ZONING)

PREDEVELOPED WATERSHED A

LAND USE	ACRE	P.I. FACTOR
ONSITE GREENSPACE	5.34	1.70 CFS/AC

MEXICO ROAD
(80' WIDE PUBLIC ROADWAY)

CONC CURB

ASPHALT

CONCRETE

SONDEREN STREET
(60' WIDE)

EX 8" WATER MAIN

UGE

PROPERTY N/F
GREYSTONE HOLDINGS, L.L.C.
PARCEL I.D. 2-0119-1766-00-0023.4000000
CITY OF O'FALLON
ZONED: C-2 GENERAL BUSINESS

ZONE X
ZONE AE

ZONE AE FLOODWAY

BELLEFAIR CREEK

25' CREEK BANK SETBACK

GRATE INLET
TOP=502.59
FL=502.19

FLARED END
15" RCP
FL=502.46

15" RCP

STORM MANHOLE
TOP=508.81
FL=501.60

GRATE INLET
TOP=502.40
FL=502.80

GRATE INLET
TOP=503.14
FL=501.03

GRATE INLET
TOP=503.42
FL=503.16

UNDERGROUND UTILITIES HAVE BEEN PLOTTED FROM AVAILABLE INFORMATION AND THEREFORE THEIR LOCATIONS SHALL BE CONSIDERED APPROXIMATE ONLY. THE VERIFICATION OF THE LOCATION OF ALL UNDERGROUND UTILITIES, EITHER SHOWN OR NOT SHOWN ON THESE PLANS SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR, AND SHALL BE LOCATED PRIOR TO ANY GRADING OR CONSTRUCTION OF THE IMPROVEMENTS.

Todd C. Flauaus
Civil Engineer
2005000982
2021

EXHIBIT B
POSTDEVELOPED DRAINAGE AREA MAP
ANIMAL HOSPITAL
00-11214J

BASIN INFLOW WATERSHED A

LAND USE	ACRE	P.I. FACTOR
ONSITE GREENSPACE	0.47	1.70 CFS/AC
ONSITE IMPERVIOUS	0.46	3.54 CFS/AC
TOTAL	0.93	

DIRECT RUNOFF WATERSHED A

LAND USE	ACRE	P.I. FACTOR
ONSITE GREENSPACE	4.33	1.70 CFS/AC
ONSITE IMPERVIOUS	0.08	3.54 CFS/AC
TOTAL	4.41	

GRAPHIC SCALE

20 0 10 20

(IN FEET)
1 inch = 20 ft.

ENGINEERING
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SURVEYING

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St. Charles, MO 63301
636-928-5552
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