

STORM WATER MANAGEMENT

**VOICE OF AMERICA
PARK
PHASE 1**

PREPARED: 4-16-12

STORM WATER MANAGEMENT

VOICE OF AMERICA PARK, PHASE 1

Table of Contents

Summary.....	1 - 3
Pre-Developed Drainage Map.....	4
Post-Developed Drainage Map.....	5
Soils Map.....	6
Critical Storm Calculations.....	7 - 11
<u>Pre-Developed</u>	
Data (Area, CN, Time of Concentration, and Travel Time).....	12 - 16
Allowable Release Calculations.....	17 - 36
<u>Post-Developed:</u>	
Onsite Data (Area, CN, Time of Concentration, and Travel Time).....	37 - 41
Proposed Outlet Structure Details.....	42 - 56
Water Quality Calculations.....	57 - 61
Analysis Point #1 (Future Lake #1) Post-Developed Release Calculations	
1-Year Storm Event.....	62 - 65
5-Year Storm Event.....	66 - 67
10-Year Storm Event.....	68 - 69
25-Year Storm Event.....	70 - 71
50-Year Storm Event.....	72 - 73
100-Year Storm Event.....	74 - 75
Analysis Point #2 (Lakes #2 & 3) Post-Developed Release Calculations	
1-Year Storm Event.....	76 - 82
5-Year Storm Event.....	83 - 87
10-Year Storm Event.....	88 - 92
25-Year Storm Event.....	93 - 97
50-Year Storm Event.....	98 - 102
100-Year Storm Event.....	103 - 107

STORM WATER MANAGEMENT
VOICE OF AMERICA PARK, PHASE 1

Table of Contents

Analysis Point #3 (Lake #4) Post-Developed Release Calculations

1-Year Storm Event.....	108 - 111
5-Year Storm Event.....	112 - 113
10-Year Storm Event.....	114 - 117
25-Year Storm Event.....	118 - 119
50-Year Storm Event.....	120 - 121

Analysis Point #4 (Lake #5) Post-Developed Release Calculations

1-Year Storm Event.....	122 - 129
5-Year Storm Event.....	130 - 134
10-Year Storm Event.....	135 - 139
25-Year Storm Event.....	140 - 144
50-Year Storm Event.....	145 - 149
100-Year Storm Event.....	150 - 154

Emergency Spillway Calculations.....	155 - 156
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SUMMARY OF DATA

Method of Hydrograph Development: TR-55

Software: Hydraflow



Design Criteria: The proposed lakes/basins will be sized using the critical storm method. The post-development storms of a frequency between the one-year and the critical storm will be controlled, so as to be equal or less than the pre-development peak runoff rate for a 24-hour, one-year frequency storm. For all storm events greater than the critical storm, reduce the flow rate by one storm event. In addition the lakes/basins will also include volume meeting the Ohio EPA water quality regulations.

Critical Storm:

Lake #1 10 Year
 Lake #2 & 3 25 Year
 Lake #4 25 Year
 Lake #5 50 Year

Drainage Area Descriptions	Drainage Area (Acres)	CN	Tc (Min)
Pre-Developed Area #1, Onsite tributary to analysis point #1	32.57	67.2	25.2
Pre-Developed Area #2, Onsite tributary to analysis point #2	83.62	60.4	37.1
Pre-Developed Area #3, Onsite tributary to analysis point #3	32.22	61.3	31.3
Pre-Developed Area #4, Onsite tributary to analysis point #4	39.81	61.4	26.4
Offsite Miami University VOA	10.40	90.2	10.0
Post-Developed Area #1, Onsite tributary Lake #1 and analysis point #1	24.30	77.8	20.5
Post-Developed Area #2, Onsite tributary to Lake #2, then Lake #3 and analysis point #2	17.60	70.5	18.0
Post-Developed Area #3, Onsite tributary to Lake #3 and analysis point #2	63.50	65.1	17.1
Post-Developed Area #4, Onsite tributary to Lake #4 and analysis point #3	22.25	78.3	18.7
Post-Developed Area #5, Onsite tributary to Lake #5 analysis point #3	67.30	74.8	22.3

*No artificial
 but accounted
 for*

Future Lake #1 T/Dike=888.60		Detention Basin Outlet: O.D.O.T. Type 2-4 Catch Basin, with 6" Wide Window @ 883.75 and (4) 4'-0" Wide Windows @887.00 Required Water Quality Volume = 9,924 CF, Achieved @884.62			
Frequency (yr)	Inflow (cfs)	Outflow (cfs)	Storage (ft ³) (ac-ft)		Elevation (ft)
1	16.03	0.80	33,933	0.78	885.16
5	37.65	1.90	77,512	1.78	885.67
10	47.96	2.52	98,242	2.26	885.91
25	63.32	3.48	129,637	2.98	886.27
50	77.13	4.41	158,393	3.64	886.59
100	93.46	5.58	192,721	4.42	886.97

Lake #1 Release Rates (Analysis Point #1)		
Storm Frequency (yr)	Pre-Developed Allowable Release Rate (cfs)	Post-Developed Release Rate (cfs)
1	5.58	0.80
5	5.58	1.90
10	5.58	2.52
25	33.39	3.48
50	48.59	4.41
100	62.80	5.58

Lake #2 T/Dike=891.00		Detention Basin Outlet: O.D.O.T. Type 2-3 Catch Basin, with 4" Wide Window @ 887.70 and (4) 3'-0" Wide Windows @888.90 Required Water Quality Volume = 6,820 CF, Achieved @887.80			
Frequency	Inflow	Outflow	Storage		Elevation
(yr)	(cfs)	(cfs)	(ft ³)	(ac-ft)	(ft)
1	9.03	0.20	17,412	0.40	888.04
5	46.94	0.50	45,948	1.05	888.34
10	68.38	0.69	60,107	1.38	888.48
25	101.81	1.01	81,367	1.87	888.71
50	133.26	1.40	100,470	2.31	888.91
100	171.82	3.10	112,346	2.58	889.02

Lake #2 Release Rates (Part of Analysis Point #2)		
Storm Frequency	Pre-Developed Allowable Release Rate	Post-Developed Release Rate
(yr)	(cfs)	(cfs)
1	(See Lake #3)	0.20
5	(See Lake #3)	0.50
10	(See Lake #3)	0.69
25	(See Lake #3)	1.01
50	(See Lake #3)	1.40
100	(See Lake #3)	3.10

Lake #3 T/Dike=886.50		Detention Basin Outlet: O.D.O.T. Type 2-3 Catch Basin, with 3" Wide Window @ 881.50 and (4) 4'-0" Wide Windows @884.50 Required Water Quality Volume = 25,973 CF, Achieved @881.68			
Frequency	Inflow	Outflow	Storage		Elevation
(yr)	(cfs)	(cfs)	(ft ³)	(ac-ft)	(ft)
1	9.81	0.34	50,871	1.17	882.09
5	47.10	1.09	155,467	3.57	882.78
10	68.60	1.56	209,254	4.80	883.13
25	102.13	2.35	292,120	6.71	883.65
50	133.70	3.16	368,993	8.47	884.12
100	172.44	5.57	454,151	10.43	884.62

Lake #3 Release Rates (Analysis Point #2)		
Storm Frequency	Pre-Developed Allowable Release Rate	Post-Developed Release Rate
(yr)	(cfs)	(cfs)
1	2.62	0.34
5	2.62	1.09
10	2.62	1.56
25	2.62	2.35
50	61.30	3.16
100	85.37	5.57

Lake #4 T/Dike=893.50		Detention Basin Outlet: Weir Wall, with 3" Wide Wier @ 889.50 and 6'-0" Wide Wier @892.00 Required Water Quality Volume = 8,984 CF, Achieved @889.59			
Frequency (yr)	Inflow (cfs)	Outflow (cfs)	Storage (ft ³) (ac-ft)		Elevation (ft)
1	16.74	0.29	44,851	1.03	890.03
5	38.45	0.73	92,728	2.13	890.48
10	48.83	0.98	115,258	2.65	890.69
25	64.13	1.38	148,286	3.40	891.00
50	77.85	1.85	177,215	4.07	891.26
100	94.05	3.61	199,116	4.57	891.45

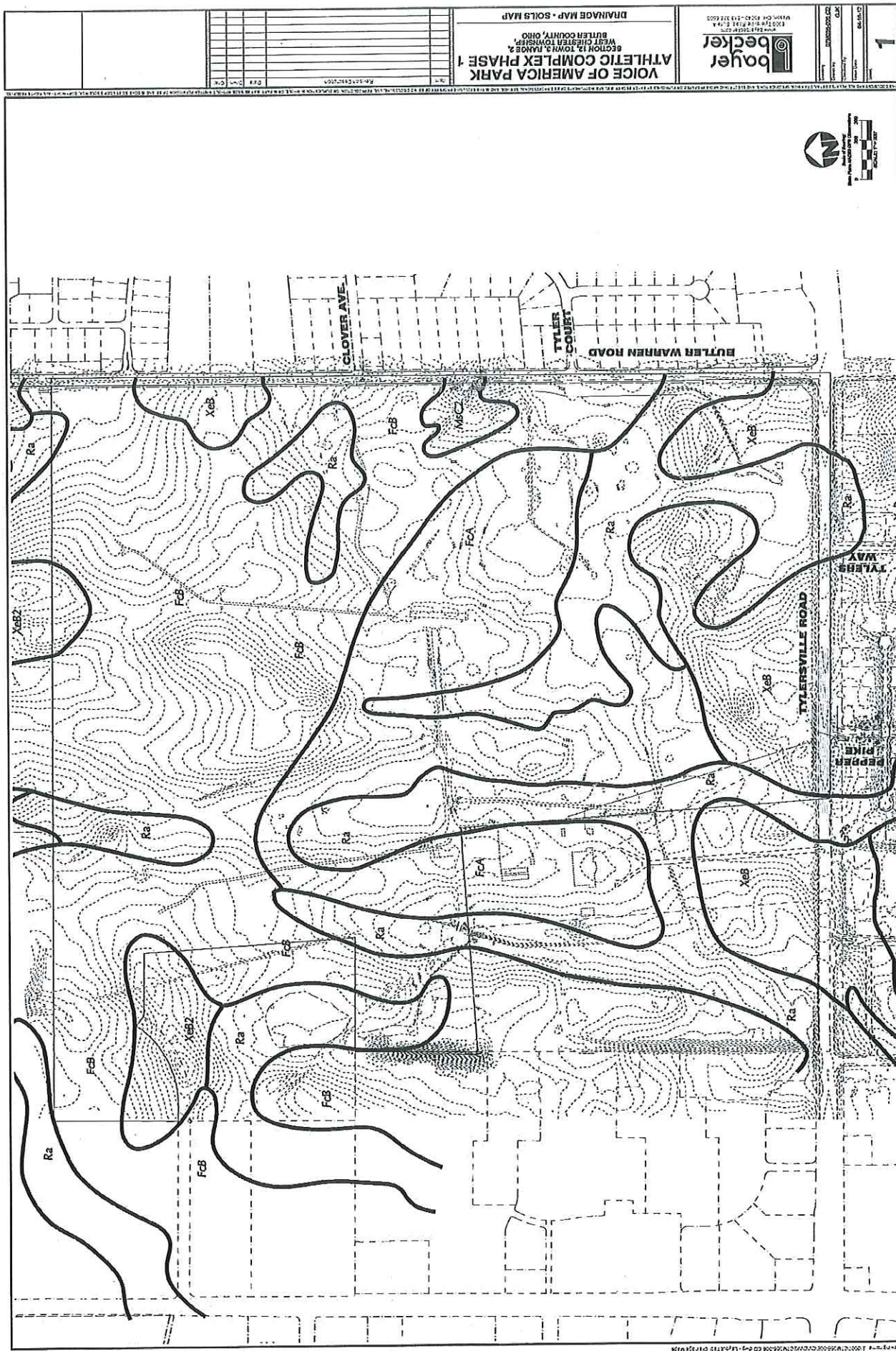
Lake #4 Release Rates (Analysis Point #3)		
Storm Frequency (yr)	Pre-Developed Allowable Release Rate (cfs)	Post-Developed Release Rate (cfs)
1	1.37	0.29
5	1.87	0.73
10	1.87	0.98
25	1.87	1.38
50	28.93	1.85
100	39.73	3.61

Lake #5 T/Dike=892.00		Detention Basin Outlet: Weir Wall, with 3" Wide Wier @ 887.50 and 10'-0" Wide Wier @891.00 Required Water Quality Volume = 27,484 CF, Achieved @887.58			
Frequency (yr)	Inflow (cfs)	Outflow (cfs)	Storage (ft ³) (ac-ft)		Elevation (ft)
1	37.00	0.36	173,230	3.98	888.11
5	93.90	0.99	369,967	8.49	888.70
10	127.27	1.35	462,524	10.62	888.98
25	172.21	1.93	598,925	13.75	889.37
50	210.21	4.55	670,655	15.40	889.58
100	255.41	9.07	734,539	16.86	889.77

Lake #5 Release Rates (Analysis Point #4)		
Storm Frequency (yr)	Pre-Developed Allowable Release Rate (cfs)	Post-Developed Release Rate (cfs)
1	24.38	0.36
5	24.38	0.99
10	24.38	1.35
25	24.38	1.93
50	24.38	4.55
100	57.14	9.07







Runoff curve number and runoff (TR-55)

Project: VOA Park
Analysis Point #1

By: GJK
 Checked: _____

Date: 2/4/2012
 Date: _____
 Job #: 07M056.006

On-site Pre-Developed

Drainage Area: 32.57 Ac
 Curve Number: 67.2
 Year storm: 1
 Intensity: 2.33
 $S=(1000/CN)-10$ S= 4.88
 $Q=(P-0.2S)^2/(P+0.8S)$ Q= 0.29 in
 $V=(Q/12*43560*A)$ V= 34,755 ft³
 0.80 Ac-ft

On-site Post-Developed (Area 1)

Drainage Area: 24.30 Ac
 Curve Number: 77.8
 Year storm: 1
 Intensity: 2.33
 $S=(1000/CN)-10$ S= 2.85
 $Q=(P-0.2S)^2/(P+0.8S)$ Q= 0.67 in
 $V=(Q/12*43560*A)$ V= 59,188 ft³
 1.36 Ac-ft

	CN	Yr Storm	S	Q (in)	V (ft ³)
Onsite Pre-developed	67.2	1	4.9	0.3	34755
Onsite Post-developed	77.8	1	2.9	0.7	59188

$$((V_{\text{post}}/V_{\text{pre}})-1)*100\% = \text{Runoff_Increase} \quad 70 \%$$

Between %'s		Storm Frequency
-	10	1
10.0	20	2
20.0	50	5
50.0	100	10
100.0	250	25
250.0	500	50
500.0	-	100

Critical Storm: 10 yr

Project: Voice of America Park

Drainage Area Description:

Critical Storm Calculation - Areas 2 and 3 combined, Onsite tributary to analysis point #2

Job #: 07M056.006

Initials: GJK

Date: 4/4/2012

Drainage Area: 81.10 Acres

Soil Types: 45 % Type B
55 % Type C

Land Use: Open Space 49 %
Lake 8 %
Impervious 19 %
Synthetic Turf Fields 23 % (9 Fields Total)

Composite Runoff Curve Number:

Ground Cover	Soil Type	CN	Soil Type %	Land Use %	
Open Space	B	61	45	49	13.55
Lake	B	100	45	8	3.81
Impervious	B	98	45	19	8.38
Synthetic Turf Fields	B	90	45	23	9.55
Open Space	C	74	55	49	19.94
Lake	C	100	55	8	4.62
Impervious	C	98	55	19	10.16
Synthetic Turf Fields	C	90	55	23	11.59

Composite CN = 70.0

Runoff curve number and runoff (TR-55)

Project: VOA Park
Analysis Point #2

By: GJK
 Checked: _____

Date: 2/4/2012
 Date: _____
 Job #: 07M056.006

Areas/Lakes 2+3 combined

On-site Pre-Developed

Drainage Area: 83.6 Ac

Curve Number: 60.4

Year storm: 1

Intensity: 2.33

$$S=(1000/CN)-10$$

$$S= 6.56$$

$$Q=(P-0.2S)^2/(P+0.8S)$$

$$Q= 0.14 \text{ in}$$

$$V=(Q/12*43560*A)$$

$$V= 41,587 \text{ ft}^3$$

0.95 Ac-ft

On-site Post-Developed (Areas 2 + 6)

Drainage Area: 81.1 Ac

Curve Number: 70.0 - *NO artificial turf*

Year storm: 1

Intensity: 2.33

$$S=(1000/CN)-10$$

$$S= 4.28$$

$$Q=(P-0.2S)^2/(P+0.8S)$$

$$Q= 0.38 \text{ in}$$

$$V=(Q/12*43560*A)$$

$$V= 111,046 \text{ ft}^3$$

2.55 Ac-ft

	CN	Yr Storm	S	Q (in)	V (ft ³)
Onsite Pre-developed	60.4	1	6.6	0.1	41587
Onsite Post-developed	70.0	1	4.3	0.4	111046

$$((V_{\text{post}}/V_{\text{pre}})-1)*100\% = \text{Runoff_Increase} \quad 167 \%$$

Between %'s		Storm Frequency
-	10	1
10.0	20	2
20.0	50	5
50.0	100	10
100.0	250	25
250.0	500	50
500.0	-	100

Critical Storm:	25 yr
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Runoff curve number and runoff (TR-55)

Project: VOA Park
Analysis Point #3 - Lake 4

By: GJK
 Checked: _____

Date: 2/4/2012
 Date: _____
 Job #: 07M056.006

On-site Pre-Developed

Drainage Area: 32.2 Ac
 Curve Number: 61.3
 Year storm: 1
 Intensity: 2.33
 S= 6.31
 Q= 0.15 in
 V= 18,054 ft³
 0.41 Ac-ft

$$S = (1000/CN) - 10$$

$$Q = (P - 0.2S)^2 / (P + 0.8S)$$

$$V = (Q/12 * 43560 * A)$$

On-site Post-Developed (Area 3)

Drainage Area: 22.0 Ac
 Curve Number: 78.3
 Year storm: 1
 Intensity: 2.33
 S= 2.77
 Q= 0.69 in
 V= 55,379 ft³
 1.27 Ac-ft

$$S = (1000/CN) - 10$$

$$Q = (P - 0.2S)^2 / (P + 0.8S)$$

$$V = (Q/12 * 43560 * A)$$

	CN	Yr Storm	S	Q (in)	V (ft ³)
Onsite Pre-developed	61.3	1	6.3	0.2	18054
Onsite Post-developed	78.3	1	2.8	0.7	55379

$$((V_{\text{post}}/V_{\text{pre}}) - 1) * 100\% = \text{Runoff_Increase} \quad 207\%$$

Between %'s		Storm Frequency
-	10	1
10.0	20	2
20.0	50	5
50.0	100	10
100.0	250	25
250.0	500	50
500.0	-	100

Critical Storm: 25 yr

Runoff curve number and runoff (TR-55)

Project: VOA Park
Analysis Point #4 - Lake 5

By: GJK
Checked: _____

Date: 2/4/2012
Date: _____
Job #: 07M056.006

On-site Pre-Developed

Drainage Area: 39.8 Ac
Curve Number: 61.4
Year storm: 1
Intensity: 2.33
 $S = (1000/CN) - 10$ $S = 6.29$
 $Q = (P - 0.2S)^2 / (P + 0.8S)$ $Q = 0.16$ in
 $V = (Q/12 * 43560 * A)$ $V = 22,594$ ft³
0.52 Ac-ft

On-site Post-Developed (Area 4)

Drainage Area: 67.3 Ac
Curve Number: 74.8
Year storm: 1
Intensity: 2.33
 $S = (1000/CN) - 10$ $S = 3.37$
 $Q = (P - 0.2S)^2 / (P + 0.8S)$ $Q = 0.55$ in
 $V = (Q/12 * 43560 * A)$ $V = 133,351$ ft³
3.06 Ac-ft

	CN	Yr Storm	S	Q (in)	V (ft ³)
Onsite Pre-developed	61.4	1	6.3	0.2	22594
Onsite Post-developed	74.8	1	3.4	0.5	133351

$$((V_{\text{post}}/V_{\text{pre}}) - 1) * 100\% = \text{Runoff_Increase} \quad 490\%$$

Between %'s		Storm Frequency
-	10	1
10.0	20	2
20.0	50	5
50.0	100	10
100.0	250	25
250.0	500	50
500.0	-	100

Critical Storm: 50 yr

Project: Voice of America Park

Drainage Area Description:

Pre-Developed Area #1, Onsite tributary to analysis point #1

Job #: 07M056.006

Initials: GJK

Date: 4/4/2012

Drainage Area: 32.57 Acres

Soil Types: 20 % Type B
80 % Type C

Land Use: Meadow 75 %
Brush (Good) 23 %
Gravel 2 %

Composite Runoff Curve Number:

Ground Cover	Soil Type	CN	Soil Type %	Land Use %	
Meadow	B	58	20	75	8.70
Brush (Good)	B	48	20	23	2.21
Gravel	B	85	20	2	0.34
Meadow	C	71	80	75	42.60
Brush (Good)	C	65	80	23	11.96
Gravel	C	89	80	2	1.42

Composite CN = 67.2

Time of Concentration:

Sheet Flow:

Length = 100

Slope(ft/ft) = 0.0200

Manning's, n = 0.17

Tc

0.19 hr

Shallow Concentrated Flow:

Length = 600

Slope(ft/ft) = 0.0120

Velocity (fps) = 1.8

0.09 hr

Channel Flow:

Length = 1225

Velocity (fps) = 2.5

0.14 hr

**Tc = 0.42 hr
25.2 min**

Project: Voice of America Park

Drainage Area Description:

Pre-Developed Area #2, Onsite tributary to analysis point #2

Job #: 07M056.006

Initials: GJK

Date: 4/4/2012

Drainage Area: 83.62 Acres

Soil Types: 50 % Type B
50 % Type C

Land Use: Meadow 45 %
Brush (Good) 54 %
Gravel 1 %

Composite Runoff Curve Number:

Ground Cover	Soil Type	CN	Soil Type %	Land Use %	
Meadow	B	58	50	45	13.05
Brush (Good)	B	48	50	54	12.96
Gravel	B	85	50	1	0.43
Meadow	C	71	50	45	15.98
Brush (Good)	C	65	50	54	17.55
Gravel	C	89	50	1	0.45

Composite CN = 60.4

Time of Concentration:

Sheet Flow:

Length = 100

Slope(ft/ft) = 0.0200

Manning's, n = 0.17

Tc

0.19 hr

Shallow Concentrated Flow:

Length = 820

Slope(ft/ft) = 0.0120

Velocity (fps) = 1.8

0.13 hr

Channel Flow:

Length = 2710

Velocity (fps) = 2.5

0.30 hr

Tc =

0.62 hr

37.1 min

Project: Voice of America Park

Drainage Area Description:

Pre-Developed Area #3, Onsite tributary to analysis point #3

Job #: 07M056.006

Initials: GJK

Date: 4/4/2012

Drainage Area: 32.22 Acres

Soil Types: 35 % Type B
65 % Type C

Land Use: Meadow 23 %
Brush (Good) 75 %
Gravel 2 %

Composite Runoff Curve Number:

Ground Cover	Soil Type	CN	Soil Type %	Land Use %	
Meadow	B	58	35	23	4.67
Brush (Good)	B	48	35	75	12.60
Gravel	B	85	35	2	0.60
Meadow	C	71	65	23	10.61
Brush (Good)	C	65	65	75	31.69
Gravel	C	89	65	2	1.16

Composite CN = 61.3

Time of Concentration:

Sheet Flow:

Length = 100

Slope(ft/ft) = 0.0150

Manning's, n = 0.17

Tc

0.21 hr

Shallow Concentrated Flow:

Length = 570

Slope(ft/ft) = 0.0120

Velocity (fps) = 1.8

0.09 hr

Channel Flow:

Length = 1980

Velocity (fps) = 2.5

0.22 hr

Tc =

0.52 hr

31.3 min

Project: Voice of America Park

Drainage Area Description:

Pre-Developed Area #4, Onsite tributary to analysis point #4

Job #: 07M056.006

Initials: GJK

Date: 4/4/2012

Drainage Area: 39.81 Acres

Soil Types: 45 % Type B
55 % Type C

Land Use: Meadow 44 %
Brush (Good) 54 %
Gravel 2 %

Composite Runoff Curve Number:

Ground Cover	Soil Type	CN	Soil Type %	Land Use %	
Meadow	B	58	45	44	11.48
Brush (Good)	B	48	45	54	11.66
Gravel	B	85	45	2	0.77
Meadow	C	71	55	44	17.18
Brush (Good)	C	65	55	54	19.31
Gravel	C	89	55	2	0.98

Composite CN = 61.4

Time of Concentration:

Sheet Flow:

Length = 100

Slope(ft/ft) = 0.0150

Manning's, n = 0.17

Tc

0.21 hr

Shallow Concentrated Flow:

Length = 950

Slope(ft/ft) = 0.0120

Velocity (fps) = 1.8

0.15 hr

Channel Flow:

Length = 720

Velocity (fps) = 2.5

0.08 hr

Tc =

0.44 hr

26.4 min

Project: Voice of America Park

Drainage Area Description:

Offsite Miami University VOA

Job #: 07M056.006

Initials: GJK

Date: 4/4/2012

Drainage Area: 10.4 Acres

Soil Types: 15 % Type B
85 % Type C

Land Use: Open Space 30 %
Impervious 70 %

Composite Runoff Curve Number:

Ground Cover	Soil Type	CN	Soil Type %	Land Use %	
Open Space	B	61	15	30	2.75
Impervious	B	98	15	70	10.29
Open Space	C	74	85	30	18.87
Impervious	C	98	85	70	58.31

Composite CN = 90.2

Time of Concentration:

Tc = 0.17 hr
10.0 min

Notes:

Drainage area and time of concentration are from calculations by Abercrombie and Associates, Inc. dated May 16, 2007 and received by fax on February 5, 2009.