WOODSIDE RIDGE SECOND PLAT MICRO DRAINAGE STUDY

Prepared for:

Clayton Properties Group, INC. dba Summit Homes

Lee's Summit, MO

April 2020

Olsson Project No. C18-1140

olsson

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

APPENDICES

1. GENERAL INFORMATION

The Woodside Ridge Second Plat development, 34.77 acres, is a proposed 55 lot single-family residential development and is the final plat within the approximate 112 acres of the Woodside Ridge development. The Woodside Ridge First Plat development is currently under construction. The project is located west of Woodside Ridge First Plat, which lies in the east half of Section 2, Township 47N, Range 32W, Lee's Summit, Jackson County, Missouri (Figure 1).

Stormwater from Woodside Ridge is conveyed into the Cedar Creek Watershed, primarily via two unnamed tributaries which flow east to west through the property. This drainage study is an update to the previously approved macro drainage study and will evaluate the hydrologic impact generated by the construction of the Woodside Ridge Second Plat (proposed conditions).

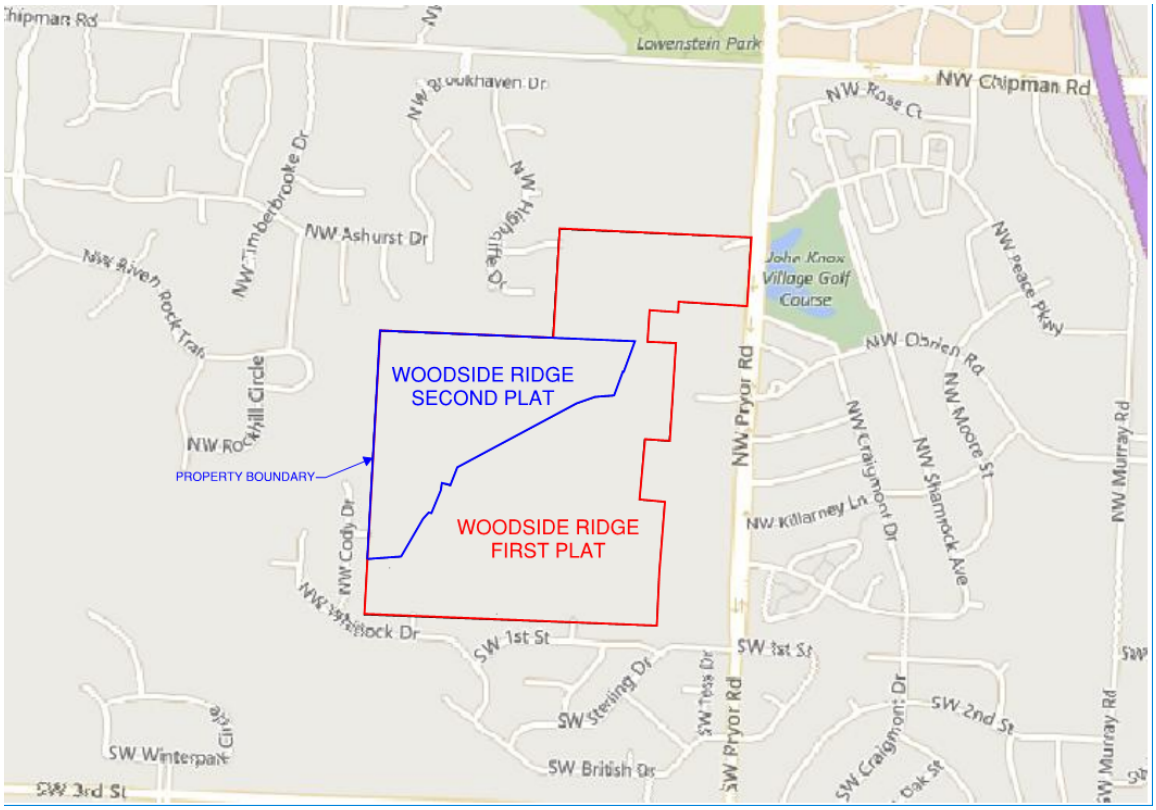


Figure 1. Woodside Ridge Location Map.

1.1. Federal Emergency Management Agency Floodplain Classification

The Federal Emergency Management Agency (FEMA) Flood Boundary and Floodway Map Community Panel Number 29095C0416G classifies the Woodside Ridge property as unshaded "Zone X" Area. Refer to Appendix A for location of site in relation to FEMA flood boundaries.

1.2. Soil Classifications

Soil maps published on the Natural Resources Conservation Service (NRCS) Web Soil Survey categorize soils on the Woodside Ridge property as shown in Table 1. Refer to Appendix B for a map of soils on the property.

Table 1. Soil Classifications.

Symbol	Name	Slopes	Hydrologic Soil Group
10128	Sharpsburg Urban land complex	2-5%	D
10141	Snead Rock outcrop complex	14-30%	D
10142	Snead Rock outcrop complex	5-14%	D
10143	Snead-Urban land complex	9-30%	D

1.3. Existing Stormwater Studies and Systems

The fully developed condition of this plat was accounted for in the previously approved "Woodside Ridge Macro and First Plat Micro Drainage Study", by Olsson, dated November 30, 2018 (Macro Study).

2. METHODOLOGY

This drainage study has been prepared to evaluate the hydrologic impact generated by development of Woodside Ridge Second Plat. The base data for the models prepared for this report has been obtained from available online maps and aerial imagery. Stormwater quantity management is based upon methods and objectives defined in the Kansas City Metropolitan Chapter of the American Public Works Association (KC-APWA) "Section 5600 Storm Drainage Systems & Facilities" (2011).

The following methods were used in this study to model existing and proposed (micro) conditions for stormwater runoff:

- Haestad Methods, Inc. "PondPack" v8i
    - TR55 Unit Hydrograph Method
        - 2-year, 10-year, and 100-year return frequency storms
        - Antecedent runoff condition (ARC) II soil moisture conditions
        - 24-Hour Soil Conservation Service (SCS) Type II rainfall distribution
        - SCS runoff curve numbers per SCS TR-55 (Tables 2-2a – 2-2c)
        - SCS TR-55 methods for determination of time of concentration and travel time. Where specific data pertaining to channel geometry is not available, "length & velocity" estimates for channel flow travel time is used per

Section 5600, Kansas City APWA Standard Specifications and Design Criteria.

Stormwater runoff models were created for the 2-, 10- and 100-year design storm events. The precipitation depths used in the analysis have been interpolated from the "Technical Paper No. 40 Rainfall Frequency Atlas of the United States" (TP-40) isopluvial maps (United States Weather Bureau 1961). Table 2 summarizes the rainfall depths used in this analysis:

Table 2. Precipitation Depths.

Return Period	24-Hour Precipitation Depth (in.)
2-Year (50% Storm)	3.60
10-Year (10% Storm)	5.34
100-Year (1% Storm)	7.90

3. EXISTING CONDITIONS ANALYSIS

The Woodside Ridge Second Plat site is currently undeveloped land. The Woodside Ridge First Plat will be calculated as existing conditions. To quantify the effects of this project, the following areas and points of interest have been used for existing conditions analysis. Refer to Appendix C for the existing conditions drainage area map.

Watershed A discharges to the west to an unnamed tributary to Cedar Creek. Total area modeled within this watershed is approximately 434 acres, less than 13% of which is within the Woodside Ridge overall property boundary and considered "onsite". Where development occurs along the ridgeline between this watershed and Watersheds B and C, less than one acre is expected to be redirected toward the adjacent watersheds.

The unnamed tributary into which Watershed A will discharge generally follows the northwest property line, and discharges from the property approximately 350' south of the NW property corner. Point A1 is a point approximately 450' downstream, where all of the onsite property discharging directly to this tributary converges. The majority of Watershed A is offsite and upstream of the property. Point A3 is a point approximately 250' upstream of Point A1, within a side tributary which collects only stormwater from an approximately 10-acre portion of Watershed A. This is the only other defined point within Watershed A where stormwater discharges from the property.

Watershed B discharges to the west to an existing underground storm sewer system leading to Cedar Creek. Total area modeled within this watershed is approximately 7 acres, about 90% of which is within the Woodside Ridge overall property boundary and considered "onsite". Where

development occurs along the ridgeline between this watershed and Watershed C, less than one acre is expected to be redirected toward the adjacent watershed to the south.

Watershed B discharges from the site via Point B1, approximately 200’ north of the SW property corner, directly to an existing field inlet. The outfall of the existing detention facility for Watershed B connects directly to this inlet, so only a small portion of the runoff from Watershed B continues to flow overland to the existing inlet. The downstream system was analyzed for capacity to ensure the adequacy of the detention facility installed with Woodside Ridge First Plat. The capacity of the existing 15” corrugated metal pipe (CMP) is 6.3 cfs; the proposed conditions peak flow from the existing detention facility is 5.74 cfs.

The following tables summarize the results of the existing conditions analysis. The proposed and future conditions data will be compared to these results in Sections 4 and 5 of this report. Refer to Appendix D for output from and a schematic of the existing conditions PondPack model.

Table 3

Table 3. Woodside Ridge Existing Conditions Subarea Data.

Subarea	On-site Area (acres)	Off-site Area (acres)	Total Area (acres)	T_C (hours)	Weighted Curve Number
A1	0.00	12.58	12.58	0.140	86
A2	0	8.49	8.49	0.126	80
A3	1.98	9.04	11.02	0.100	82
A4	0.07	177.50	177.57	0.237	87
A5	0.00	5.19	5.19	0.120	80
A6	0.25	3.55	3.80	0.121	87
A7	0.77	9.57	10.34	0.139	81
A8	9.03	6.93	15.96	0.100	87
A9	12.27	176.79	189.06	0.260	91
Total A	**24.37**	**409.63**	**434.00**		
B1	2.95	2.47	5.42	0.100	83
B1a	0.24	0.36	0.61	0.100	87
Total B	**3.20**	**2.83**	**6.03**		
C1	44.78	30.55	75.33	0.252	88
C1a	0.78	0.19	0.97	0.100	82
Total C	**45.56**	**30.74**	**76.30**		
Total	**73.12**	**443.20**	**516.33**		

Table 4. Woodside Ridge Existing Conditions Runoff Data: Subarea Peak Flow Rates.

Subarea	Q_2 (cfs)	Q_{10} (cfs)	Q_{100} (cfs)
A1	39	66	106
A2	21	39	67
A3	31	56	94
A4	493	821	1322
A5	13	24	41
A6	13	21	34
A7	26	48	81
A8	55	91	146
A9	576	913	1421
B1	16	28	47
B1a	2	4	6
C1	211	346	551
C1a	3	6	10

* cfs – cubic feet per second

Table 5. Woodside Ridge Existing Conditions Runoff Data: Point of Interest Peak Flow Rates.

Point of Interest	Q_2 (cfs)	Q_{10} (cfs)	Q_{100} (cfs)
A1	949	1,600	2,598
A3	31	56	94
B1	3	4	8
C1	47	119	207

* cfs = cubic feet per second

Table 6. Woodside Ridge Point of Interest Allowable Peak Flow Rates.

Point of Interest	Allowable Q_2 (cfs)	Allowable Q_{10} (cfs)	Allowable Q_{100} (cfs)
A1	881	1525	2437
A3	5	21	32
B1	5	16	25
C1	68	178	274

* cfs = cubic feet per second

The data presented in the previous tables provides the Existing Conditions for the watersheds that include the Woodside Ridge First Plat property. Section 4 of this report will provide analysis of Proposed Conditions, including stormwater detention analysis for the remaining undeveloped portions of the Woodside Ridge development.

4. PROPOSED CONDITIONS ANALYSIS

The proposed conditions section of analysis assumes completion of Woodside Ridge Second Plat, including construction of two new detention facilities in Watershed A. The difference between the existing conditions model and the proposed conditions model is a direct result of the construction of Woodside Ridge Second Plat. Refer to Appendix E for the proposed conditions drainage area map.

4.1. Effects of Development

With the proposed Woodside Ridge Second Plat improvements, Subbasins A3 and A7 will be fully developed, while Subareas A2, A3a, A5, and A7a will be partially developed. Accounting for the construction of the Woodside Ridge First Plat detention basins, proposed grading operations, and proposed storm sewer infrastructure will cause further shifts to Subbasins A3 and A7 from the assumptions made in the Macro Study. Table 7, below and Exhibit 1 in Appendix E show the updated Proposed Conditions Subarea data used in the model. Note that the Macro Study hydrologic data includes Woodside Ridge First Plat improvements within the ‘Proposed Conditions’ stormwater models. Subbasins B1 and C1 from Woodside Ridge First Plat remain unchanged.

Table 7. Woodside Ridge Proposed Conditions Subarea Data.

Subarea	Onsite Area (acres)	Offsite Area (acres)	Total Area (acres)	T_C (hours)	Weighted CN
A1	0.13	12.44	12.58	0.140	86
A2	6.69	1.80	8.49	0.126	82
A3	9.98	0.00	9.98	0.100	86
A3a	0.96	0.08	1.04	0.120	81
A4	0.12	177.45	177.57	0.237	87
A5	4.42	0.77	5.19	0.120	81
A6	0.25	3.55	3.80	0.121	87
A7	9.00	0.00	9.00	0.140	86
A7a	1.12	0.22	1.34	0.100	81
A8	11.52	4.43	15.96	0.100	87
A9	12.27	176.79	189.06	0.260	91
Total A	**56.46**	**377.54**	**434.00**		
B1	5.24	0.19	5.42	0.100	86
B1a	0.24	0.36	0.61	0.100	87
Total B	**5.48**	**0.55**	**6.03**		
C1	44.74	30.59	75.33	0.252	88
C1a	0.78	0.19	0.97	0.100	82
Total C	**45.52**	**30.77**	**76.30**		
Total	**107.46**	**408.86**	**516.33**		

Table 8. Woodside Ridge Proposed Conditions Runoff Data: Subarea Peak Discharge Rates.

Subarea	Q_2 (cfs)	Q_{10} (cfs)	Q_{100} (cfs)
A1	39	66	106
A2	23	41	69
A3	28	48	77
A3a	5	9	15
A4	493	822	1,322
A5	14	25	42
A6	13	21	34
A7	19	31	51
A7a	3	5	8
A8	57	94	152
A9	576	913	1,421
B1	19	31	51
B1a	2	3	6
C1	219	359	571
C1a	3	6	10

* cfs – cubic feet per second

Table 9. Woodside Ridge Proposed Conditions Runoff Data: Point of Interest Peak Flow Rates.

Point of Interest	Q_2 (cfs)	Q_{10} (cfs)	Q_{100} (cfs)
A1	920	1548	2528
A3	6	15	35
B1	3	4	9
C1	47	123	209

4.2 Proposed Detention Facilities

A detention requirements waiver was granted for Watershed A, relating specifically to Point A1, and is provided in Appendix G. The proposed peak flow rates will be reduced to less than existing conditions. This waiver was requested due to several challenges in relation to detention design, as outlined in the preliminary drainage study.

Two dry detention basins will be constructed within Watershed A. Basin A3 is upstream of Point A3, and Basin A7 is upstream of Point A1. Both basins are designed to capture and treat runoff within subareas of Watershed A. Descriptions of the two detention basins are as follows:

Basin A3:

Top of Dam Elevation = 931.10

Minimum Basin Elevation = 922.00

Storage Volume at Elev. 931.00: 3.273 ac-ft

Primary Outfall:

18” Pipe, Flowline In: Elevation = 919.00, Flowline Out: Elevation = 912.00

4’x4’ Riser: 4” circular orifice at 922.00 and 3’x1’ opening at 926.00

Basin A7:

Top of Dam Elevation = 938.50

Minimum Basin Elevation = 930.00

Storage Volume at Elev. 938.50: 2.657 ac-ft

Primary Outfall:

18” Pipe, Flowline In: Elevation = 928.00, Flowline Out: Elevation = 924.00

4’x4’ Riser: 4” circular orifice at 930.00 and 6” circular orifice at 933.25, and 3’x1’ opening at 934.00

Table 10 summarizes the computed detention facilities results from the PondPack model for proposed conditions.

Table 10. Woodside Ridge Proposed Conditions Detention Basin Data

	Peak Q In (cfs)	T_P In (hr.)	Peak Q Out (cfs)	T_P Out (hr.)	V_R (ac-ft)	Peak W.S.E. (ft)	Stored Volume (ac-ft)
Existing Pond							
2-Year	576	12.03	455	12.14	41.41	931.84	8.29
10-Year	913	12.03	742	12.13	67.15	932.95	11.45
100-Year	1,421	12.03	1,181	12.12	107.26	934.38	15.91
Basin A3							
2-Year	28	11.93	1	15.11	1.55	925.77	0.99
10-Year	48	11.93	11	12.13	2.66	926.73	1.33
100-Year	77	11.93	24	12.10	3.38	928.54	2.05
Basin A7							
2-Year	19	11.96	1	13.84	0.73	933.34	0.65
10-Year	31	11.95	7	12.20	1.89	934.36	0.94
100-Year	51	11.95	18	12.14	2.52	935.67	1.38
Basin B1							
2-Year	19	11.93	1.0	13.28	1.03	923.25	0.59
10-Year	32	11.93	1.5	13.25	1.76	925.16	1.06
100-Year	51	11.93	6.1	12.34	2.93	926.94	1.59
Basin C1 (In-Stream Detention)							
2-Year	219	12.05	47	12.41	15.26	921.76	4.95
10-Year	359	12.05	122	12.28	25.58	923.82	8.10
100-Year	571	12.02	208	12.27	41.86	926.18	12.98

* cfs = cubic feet per second; hr = hour; ac-ft = acre-feet

In addition to mitigation of peak flow rates, APWA Section 5608.4 also requires 40 hour extended detention of runoff from the local 90% mean annual event (1.37”/24-hour rainfall). The dry detention facilities in A3 and A7 will release the water quality event over a period of 40-72 hours. The Water Quality Volume is released in approximately 48 hours from Basin A3 and approximately 40 hours from Basin A7.

Points A1 and A3 see a decrease in flow rates from existing to proposed as a result of the construction of the new detention facilities. Table 11 provides a comparison of runoff data between existing and proposed conditions for Woodside Ridge Second Plat. Point A1 does not

meet detention criteria but the peak rates are kept at less than existing conditions, as was found acceptable with the above-mentioned Point A1 waiver request.

Table 11. Woodside Ridge Proposed Conditions Point of Interest Discharge Comparison.

Point of Interest		Q_2 (cfs)	Q_{10} (cfs)	Q_{100} (cfs)
A1	Proposed	920	1,548	2,528
	Existing	949	1,600	2,598
	Difference Proposed vs Existing	-29	-52	-70
	Allowable	881	1525	2437
	Difference Proposed vs Allowable	39	23	91
A3	Proposed	5	16	35
	Existing	25	45	76
	Difference Proposed vs Existing	-20	-29	-41
	Allowable	5	21	32
	Difference Proposed vs Allowable	0	-5	3
B1	Proposed	3	4	9
	Existing	3	4	8
	Difference Proposed vs Existing	0	0	1
	Allowable	5	16	25
	Difference Proposed vs Allowable	-2	-12	-16
C1	Proposed	47	122	209
	Existing	47	119	207
	Difference Proposed vs Existing	0	3	2
	Allowable	68	178	274
	Difference Proposed vs Allowable	-21	-56	-65

5. SUMMARY

This stormwater drainage study has been prepared to evaluate the hydrologic impact generated by the proposed development of Woodside Ridge Second Plat and to provide recommendations for a comprehensive stormwater management plan. Section 3 of this report determined the baseline conditions reflecting the existing conditions for the project site. Section 4 analyzes the site with the construction of the Second Plat and two detention facilities in Watershed A. Section 5 analyzes the site under fully developed conditions. Proposed condition flow rates were also compared to the allowable maximum release rates per APWA Section 5600.

Increases in peak flow rates caused by development will be mitigated using dry detention facilities.

6. CONCLUSIONS AND RECOMMENDATIONS

The Woodside Ridge Second Plat development, 34.77 acres, is a proposed 55 lot single-family residential development within the approximate 112-acre Woodside Ridge development.

This proposed stormwater management plan was designed to achieve compliance with current design criteria in effect for the City of Lee's Summit, Missouri, with a granted waiver requested for Point of Interest A1. Two detention facilities will be constructed in conjunction with development of Woodside Ridge Second Plat to reduce peak discharge rates.

The results of the analysis demonstrate that the proposed stormwater management plan for the project achieves compliance with design criteria. It is therefore requested that Lee's Summit, Missouri approve this "Woodside Ridge Second Plat Micro Drainage Study".

8. REFERENCES

KC-APWA (Kansas City Metropolitan Chapter of the American Public Works Association). (2011). “Section 5600 Storm Drainage & Facilities.”

United States Weather Bureau. “Technical Paper No. 40 Rainfall Frequency Atlas of the United States” (1961). Department of Commerce, Washington, D.C.

Olsson. (2018). “Woodside Ridge Macro and First Plat Micro Drainage Study.” A18-1140. Overland Park, KS.

APPENDIX A

Floodplain Map

APPENDIX B

Soils Map

APPENDIX C

Existing Conditions Drainage Area and Land Use Exhibits

APPENDIX D

Existing Conditions PondPack Model Input and Results

APPENDIX E

Proposed Conditions Drainage Area and Land Use Exhibits

APPENDIX F

Proposed Conditions PondPack Model Input and Results

APPENDIX G

Proposed Conditions Waiver for Point A1

(SIGNED AND DATED SEAL)

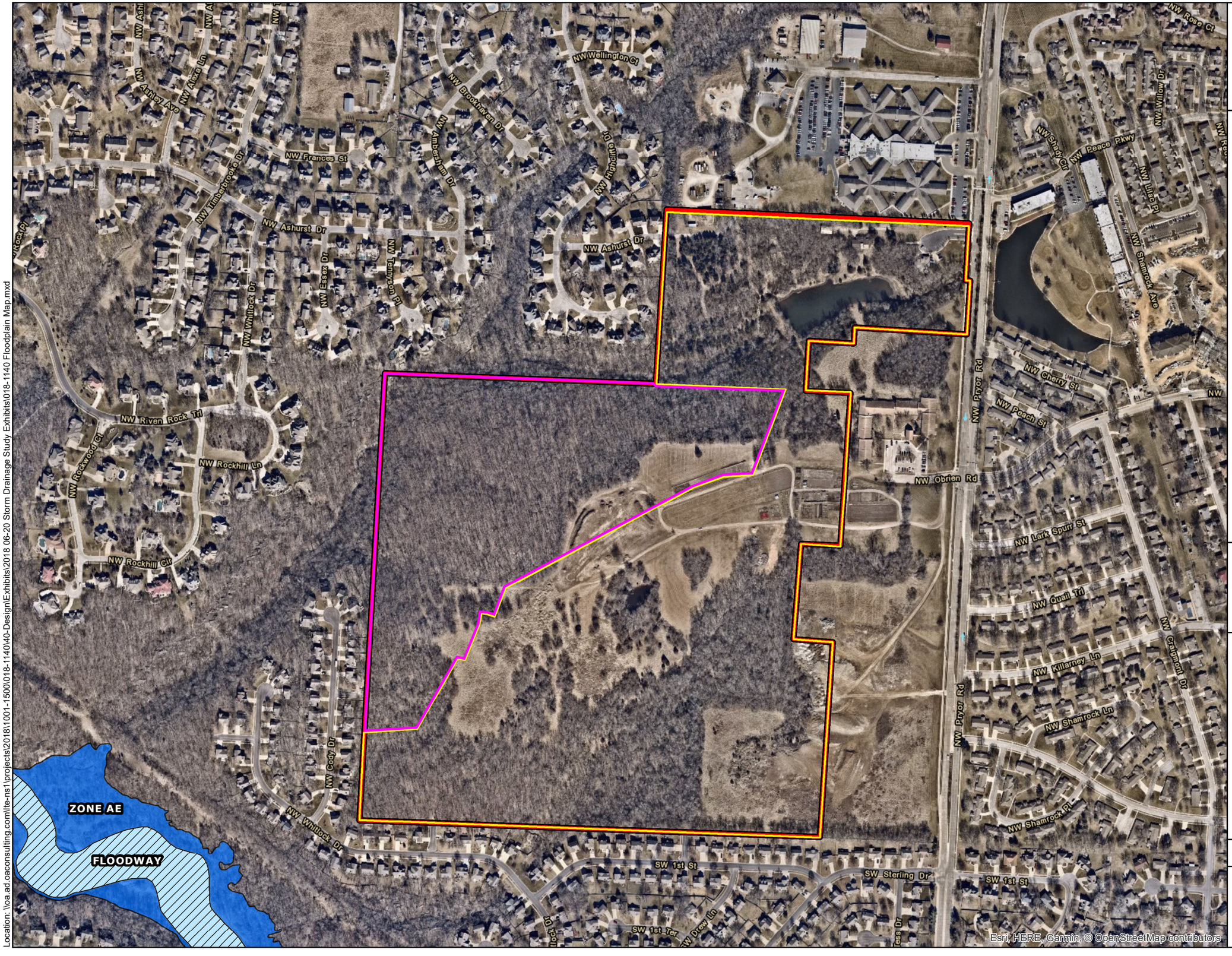
WOODSIDE RIDGE SECOND PLAT MICRO DRAINAGE STUDY

Lee's Summit, MO - 2020

April 2020

Olsson Project No. C18-1140

WOODSIDE RIDGE
FLOODPLAIN MAP



LEGEND

- FIRST PLAT BOUNDARY
- PROPERTY BOUNDARY
- FLOODWAY
- ZONE AE - 100-YEAR FLOODPLAIN
- SECOND PLAT BOUNDARY

Source:
FEMA Flood Boundary & Floodway Map
29095C0416G

Effective Date: 01/20/2017

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0 400 800 Feet

1 ' = 400 "

Drawn: ssaylor 4/24/2020

olsson

Location: \\oa.ad.oaconsulting.com\lte-ns1\projects\2018\1001-1500\018-1140\40-Design\Exhibits\2018 06-20 Storm Drainage Study Exhibits\018-1140 Floodplain Map.mxd

WOODSIDE RIDGE
SOIL MAP

LEGEND

- FIRST PLAT BOUNDARY
- PROPERTY BOUNDARY
- 10128 SHARPSBURG-URBAN LAND COMPLEX 2 to 5% SLOPES
- 10141 SNEAD-ROCK OUTCROP COMPLEX 14 to 30% SLOPES
- 10142 SNEAD-ROCK OUTCROP COMPLEX 5 to 14% SLOPES
- 10143 SNEAD-URBAN LAND COMPLEX 9 to 30% SLOPES
- SECOND PLAT BOUNDARY

Source:
Soil Survey of Jackson County, Missouri

N

0 400 800 Feet

1 ' = 400 "

Drawn: ssaylor 4/24/2020

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Esri, HERE, Garmin, © OpenStreetMap contributors

Location: \\oa.ad.oaconsulting.com\lte-ns1\projects\2018\1001-1500\018-1140\40-Design\Exhibits\2018 06-20 Storm Drainage Study Exhibits\018-1140 Soils Map.mxd

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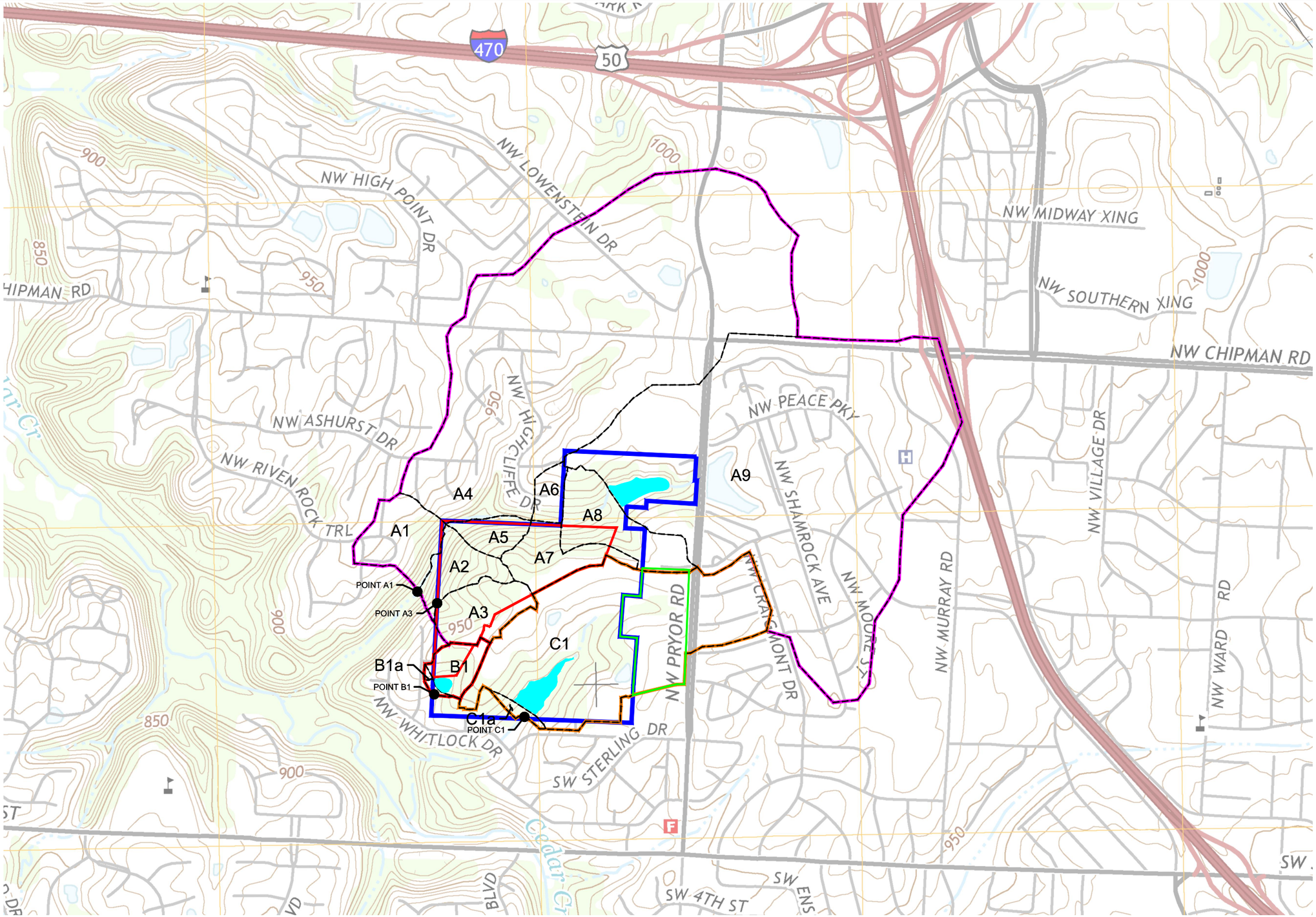

PROJECT NO: C18-1140	EXISTING CONDITIONS DRAINAGE AREA MAP	olsson	EXHIBIT
DRAWN BY: SMS		1301 Burlington Suite 100 North Kansas City, MO 64116 TEL 816.361.1177 FAX 816.361.1888	1
DATE: 04/24/2020			

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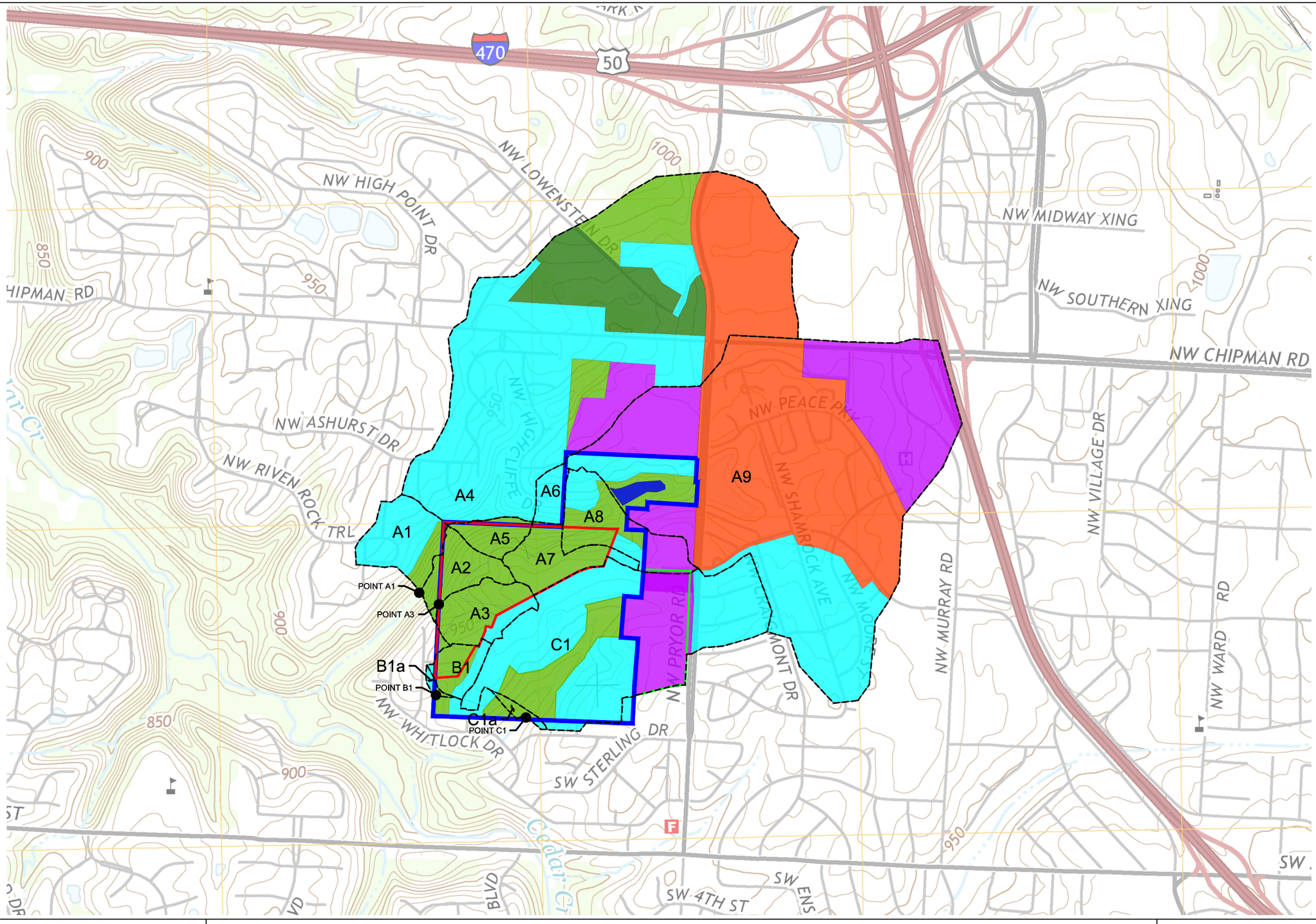
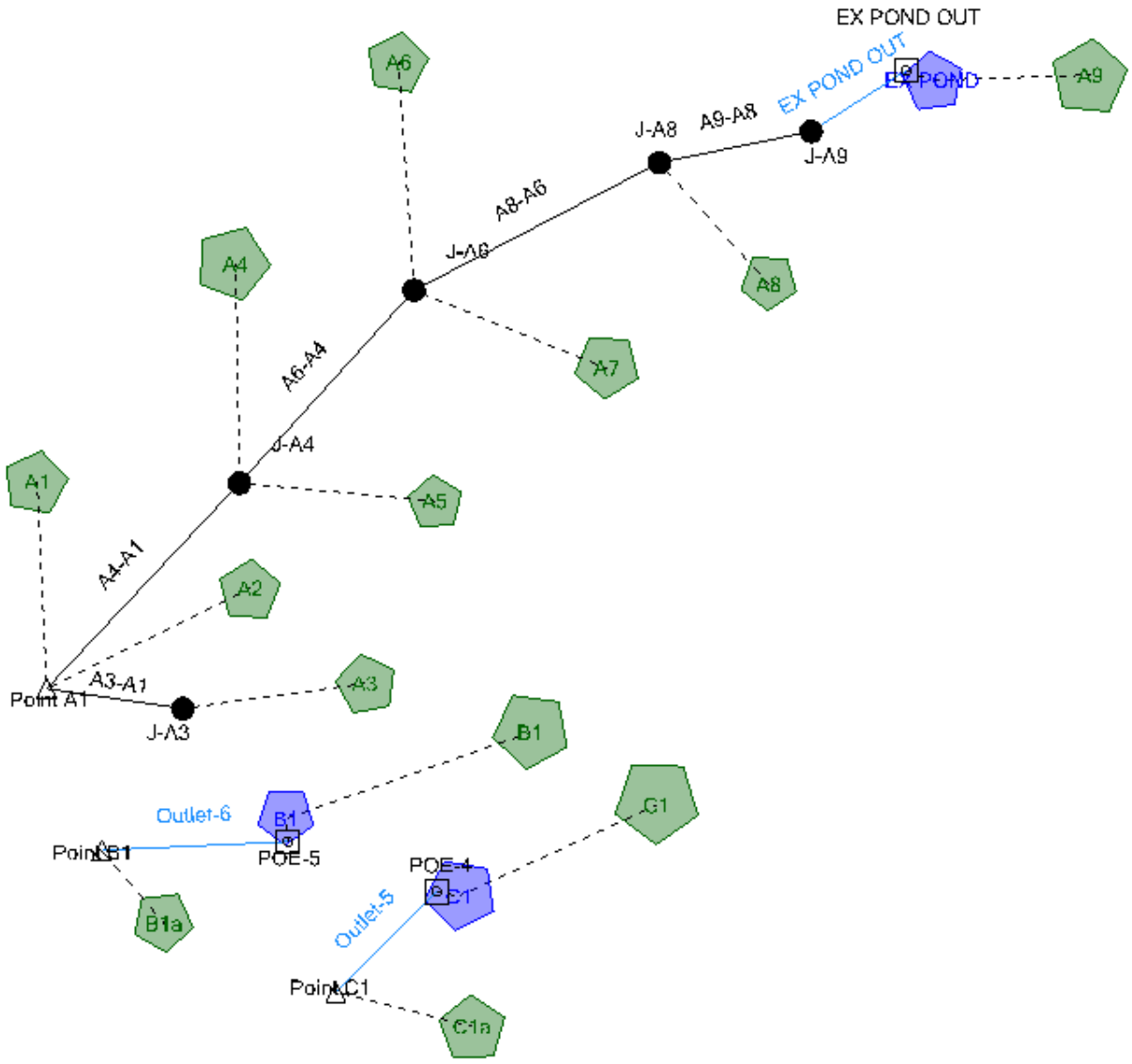


- WOODSIDE RIDGE PROPERTY BOUNDARY
- WOODSIDE RIDGE SECOND PLAT BOUNDARY
- FUTURE COMMERCIAL BOUNDARY
- RIDGELINE
- COMMERICAL
- OPEN
- PARK
- SINGLE FAMILY
- MULTIFAMILY
- OPEN WATER

PROJECT NO: C18-1140	EXISTING CONDITIONS LAND USE MAP	olsson	EXHIBIT
DRAWN BY: SMS		1304 Burlington Suite 100 North Kansas City, MO 64116 TEL 816.361.1177 FAX 816.361.1888	1A
DATE: 04/24/2020			

EXISTING CONDITIONS-PONDPACK MODEL



Existing Conditions

Project Summary	
Title	Woodside Ridge 2nd Plat- Existing Conditions
Engineer	JES
Company	Olsson
Date	4/23/2020

Notes

Table of Contents

Table of Contents

Existing Conditions

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
A3	2-Year	2	1.711	11.930	31.23
A3	10-Year	10	3.071	11.930	55.73
A3	100-Year	100	5.288	11.930	94.05
B1	2-Year	2	0.876	11.930	16.00
B1	10-Year	10	1.555	11.930	28.14
B1	100-Year	100	2.654	11.930	46.99
C1	2-Year	2	14.726	12.050	211.24
C1	10-Year	10	24.682	12.050	346.01
C1	100-Year	100	40.393	12.020	551.31
A1	2-Year	2	2.289	11.960	38.93
A1	10-Year	10	3.923	11.960	65.59
A1	100-Year	100	6.526	11.960	106.37
A2	2-Year	2	1.212	11.960	21.11
A2	10-Year	10	2.229	11.950	38.82
A2	100-Year	100	3.908	11.950	66.92
A4	2-Year	2	33.528	12.040	493.22
A4	10-Year	10	56.826	12.020	821.51
A4	100-Year	100	93.763	12.020	1,322.35
A5	2-Year	2	0.741	11.950	13.02
A5	10-Year	10	1.363	11.950	23.91
A5	100-Year	100	2.389	11.940	41.27
A6	2-Year	2	0.719	11.950	12.58
A6	10-Year	10	1.218	11.950	20.89
A6	100-Year	100	2.009	11.940	33.59
A9	2-Year	2	41.407	12.030	576.32
A9	10-Year	10	67.148	12.030	913.07
A9	100-Year	100	107.260	12.030	1,421.40
A7	2-Year	2	1.539	11.970	26.29
A7	10-Year	10	2.797	11.960	47.55
A7	100-Year	100	4.859	11.960	81.07
A8	2-Year	2	3.019	11.930	54.78
A8	10-Year	10	5.116	11.930	91.06
A8	100-Year	100	8.440	11.930	146.31
C1a	2-Year	2	0.177	11.940	3.23
C1a	10-Year	10	0.322	11.930	5.86
C1a	100-Year	100	0.559	11.930	9.99
B1a	2-Year	2	0.115	11.930	2.09
B1a	10-Year	10	0.196	11.930	3.48
B1a	100-Year	100	0.323	11.930	5.59

Node Summary

Existing Conditions

Subsection: Master Network Summary

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
Point A1	2-Year	2	84.240	12.070	949.48
Point A1	10-Year	10	141.655	12.070	1,599.81
Point A1	100-Year	100	232.235	12.070	2,598.30
Point B1	2-Year	2	0.772	11.940	2.55
Point B1	10-Year	10	1.293	11.930	4.34
Point B1	100-Year	100	2.291	12.040	7.95
Point C1	2-Year	2	14.901	12.370	46.73
Point C1	10-Year	10	25.000	12.280	118.77
Point C1	100-Year	100	40.943	12.250	207.49
J-A3	2-Year	2	1.711	11.930	31.23
J-A3	10-Year	10	3.071	11.930	55.73
J-A3	100-Year	100	5.288	11.930	94.05
J-A4	2-Year	2	79.054	12.080	897.68
J-A4	10-Year	10	132.470	12.070	1,503.29
J-A4	100-Year	100	216.572	12.060	2,431.66
J-A6	2-Year	2	44.806	12.160	476.59
J-A6	10-Year	10	74.313	12.140	783.70
J-A6	100-Year	100	120.468	12.140	1,256.03
J-A8	2-Year	2	42.555	12.150	465.14
J-A8	10-Year	10	70.308	12.140	762.46
J-A8	100-Year	100	113.615	12.130	1,218.52
J-A9	2-Year	2	39.549	12.140	454.20
J-A9	10-Year	10	65.211	12.130	743.57
J-A9	100-Year	100	105.203	12.120	1,187.24

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ac-ft)
EX POND (IN)	2-Year	2	41.407	12.030	576.32	(N/A)	(N/A)
EX POND (OUT)	2-Year	2	39.549	12.140	454.20	931.84	8.316
EX POND (IN)	10-Year	10	67.148	12.030	913.07	(N/A)	(N/A)
EX POND (OUT)	10-Year	10	65.211	12.130	743.57	932.96	11.447
EX POND (IN)	100-Year	100	107.260	12.030	1,421.40	(N/A)	(N/A)
EX POND (OUT)	100-Year	100	105.203	12.120	1,187.24	934.40	15.841
C1 (IN)	2-Year	2	14.726	12.050	211.24	(N/A)	(N/A)

Existing Conditions

Subsection: Master Network Summary

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ac-ft)
C1 (OUT)	2-Year	2	14.724	12.400	46.32	921.58	4.715
C1 (IN)	10-Year	10	24.682	12.050	346.01	(N/A)	(N/A)
C1 (OUT)	10-Year	10	24.678	12.280	117.95	923.65	7.805
C1 (IN)	100-Year	100	40.393	12.020	551.31	(N/A)	(N/A)
C1 (OUT)	100-Year	100	40.384	12.260	206.10	925.96	12.448
B1 (IN)	2-Year	2	0.876	11.930	16.00	(N/A)	(N/A)
B1 (OUT)	2-Year	2	0.657	13.310	0.85	922.78	0.489
B1 (IN)	10-Year	10	1.555	11.930	28.14	(N/A)	(N/A)
B1 (OUT)	10-Year	10	1.098	13.550	1.22	924.68	0.931
B1 (IN)	100-Year	100	2.654	11.930	46.99	(N/A)	(N/A)
B1 (OUT)	100-Year	100	1.968	12.380	5.22	926.48	1.443

Existing Conditions

Subsection: Time-Depth Curve
Label: KCMO TR-55

Return Event: 100 years
Storm Event: 100-YEAR

Time-Depth Curve: 100-YEAR	
Label	100-YEAR
Start Time	0.000 hours
Increment	0.100 hours
End Time	24.000 hours
Return Event	100 years

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
0.000	0.0	0.0	0.0	0.0	0.0
0.500	0.0	0.0	0.1	0.1	0.1
1.000	0.1	0.1	0.1	0.1	0.1
1.500	0.1	0.1	0.1	0.2	0.2
2.000	0.2	0.2	0.2	0.2	0.2
2.500	0.2	0.2	0.2	0.3	0.3
3.000	0.3	0.3	0.3	0.3	0.3
3.500	0.3	0.3	0.3	0.4	0.4
4.000	0.4	0.4	0.4	0.4	0.4
4.500	0.4	0.4	0.5	0.5	0.5
5.000	0.5	0.5	0.5	0.5	0.5
5.500	0.6	0.6	0.6	0.6	0.6
6.000	0.6	0.6	0.7	0.7	0.7
6.500	0.7	0.7	0.7	0.8	0.8
7.000	0.8	0.8	0.8	0.8	0.8
7.500	0.9	0.9	0.9	0.9	0.9
8.000	0.9	1.0	1.0	1.0	1.0
8.500	1.0	1.1	1.1	1.1	1.1
9.000	1.2	1.2	1.2	1.2	1.3
9.500	1.3	1.3	1.3	1.4	1.4
10.000	1.4	1.5	1.5	1.5	1.6
10.500	1.6	1.7	1.7	1.7	1.8
11.000	1.9	1.9	2.0	2.1	2.1
11.500	2.2	2.4	2.8	3.4	4.5
12.000	5.2	5.4	5.5	5.6	5.7
12.500	5.8	5.9	5.9	6.0	6.0
13.000	6.1	6.1	6.2	6.2	6.3
13.500	6.3	6.3	6.4	6.4	6.4
14.000	6.5	6.5	6.5	6.6	6.6
14.500	6.6	6.6	6.7	6.7	6.7
15.000	6.7	6.8	6.8	6.8	6.8
15.500	6.9	6.9	6.9	6.9	6.9
16.000	7.0	7.0	7.0	7.0	7.0
16.500	7.0	7.1	7.1	7.1	7.1

Existing Conditions

Subsection: Time-Depth Curve
Label: KCMO TR-55

Return Event: 100 years
Storm Event: 100-YEAR

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
17.000	7.1	7.1	7.2	7.2	7.2
17.500	7.2	7.2	7.2	7.2	7.3
18.000	7.3	7.3	7.3	7.3	7.3
18.500	7.3	7.4	7.4	7.4	7.4
19.000	7.4	7.4	7.4	7.4	7.5
19.500	7.5	7.5	7.5	7.5	7.5
20.000	7.5	7.5	7.5	7.6	7.6
20.500	7.6	7.6	7.6	7.6	7.6
21.000	7.6	7.6	7.6	7.7	7.7
21.500	7.7	7.7	7.7	7.7	7.7
22.000	7.7	7.7	7.7	7.7	7.8
22.500	7.8	7.8	7.8	7.8	7.8
23.000	7.8	7.8	7.8	7.8	7.8
23.500	7.9	7.9	7.9	7.9	7.9
24.000	7.9	(N/A)	(N/A)	(N/A)	(N/A)

Time-Depth Curve: 10-YEAR	
Label	10-YEAR
Start Time	0.000 hours
Increment	0.100 hours
End Time	24.000 hours
Return Event	10 years

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
0.000	0.0	0.0	0.0	0.0	0.0
0.500	0.0	0.0	0.0	0.0	0.0
1.000	0.1	0.1	0.1	0.1	0.1
1.500	0.1	0.1	0.1	0.1	0.1
2.000	0.1	0.1	0.1	0.1	0.1
2.500	0.1	0.2	0.2	0.2	0.2
3.000	0.2	0.2	0.2	0.2	0.2
3.500	0.2	0.2	0.2	0.2	0.2
4.000	0.3	0.3	0.3	0.3	0.3
4.500	0.3	0.3	0.3	0.3	0.3
5.000	0.3	0.3	0.4	0.4	0.4
5.500	0.4	0.4	0.4	0.4	0.4
6.000	0.4	0.4	0.4	0.5	0.5
6.500	0.5	0.5	0.5	0.5	0.5
7.000	0.5	0.5	0.5	0.6	0.6
7.500	0.6	0.6	0.6	0.6	0.6
8.000	0.6	0.6	0.7	0.7	0.7
8.500	0.7	0.7	0.7	0.7	0.8
9.000	0.8	0.8	0.8	0.8	0.8
9.500	0.9	0.9	0.9	0.9	0.9
10.000	1.0	1.0	1.0	1.0	1.1
10.500	1.1	1.1	1.1	1.2	1.2
11.000	1.2	1.3	1.3	1.4	1.4
11.500	1.5	1.6	1.9	2.3	3.0
12.000	3.5	3.6	3.7	3.8	3.8
12.500	3.9	3.9	4.0	4.0	4.1
13.000	4.1	4.1	4.2	4.2	4.2
13.500	4.2	4.3	4.3	4.3	4.3
14.000	4.3	4.4	4.4	4.4	4.4
14.500	4.4	4.5	4.5	4.5	4.5
15.000	4.5	4.5	4.6	4.6	4.6
15.500	4.6	4.6	4.6	4.6	4.7
16.000	4.7	4.7	4.7	4.7	4.7
16.500	4.7	4.7	4.7	4.8	4.8

Existing Conditions

Subsection: Time-Depth Curve
Label: KCMO TR-55

Return Event: 10 years
Storm Event: 10-YEAR

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
17.000	4.8	4.8	4.8	4.8	4.8
17.500	4.8	4.8	4.9	4.9	4.9
18.000	4.9	4.9	4.9	4.9	4.9
18.500	4.9	4.9	4.9	5.0	5.0
19.000	5.0	5.0	5.0	5.0	5.0
19.500	5.0	5.0	5.0	5.0	5.0
20.000	5.0	5.1	5.1	5.1	5.1
20.500	5.1	5.1	5.1	5.1	5.1
21.000	5.1	5.1	5.1	5.1	5.1
21.500	5.1	5.2	5.2	5.2	5.2
22.000	5.2	5.2	5.2	5.2	5.2
22.500	5.2	5.2	5.2	5.2	5.2
23.000	5.2	5.2	5.3	5.3	5.3
23.500	5.3	5.3	5.3	5.3	5.3
24.000	5.3	(N/A)	(N/A)	(N/A)	(N/A)

Time-Depth Curve: 2-YEAR	
Label	2-YEAR
Start Time	0.000 hours
Increment	0.100 hours
End Time	24.000 hours
Return Event	2 years

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
0.000	0.0	0.0	0.0	0.0	0.0
0.500	0.0	0.0	0.0	0.0	0.0
1.000	0.0	0.0	0.0	0.0	0.1
1.500	0.1	0.1	0.1	0.1	0.1
2.000	0.1	0.1	0.1	0.1	0.1
2.500	0.1	0.1	0.1	0.1	0.1
3.000	0.1	0.1	0.1	0.1	0.1
3.500	0.1	0.2	0.2	0.2	0.2
4.000	0.2	0.2	0.2	0.2	0.2
4.500	0.2	0.2	0.2	0.2	0.2
5.000	0.2	0.2	0.2	0.2	0.3
5.500	0.3	0.3	0.3	0.3	0.3
6.000	0.3	0.3	0.3	0.3	0.3
6.500	0.3	0.3	0.3	0.3	0.3
7.000	0.4	0.4	0.4	0.4	0.4
7.500	0.4	0.4	0.4	0.4	0.4
8.000	0.4	0.4	0.4	0.5	0.5
8.500	0.5	0.5	0.5	0.5	0.5
9.000	0.5	0.5	0.6	0.6	0.6
9.500	0.6	0.6	0.6	0.6	0.6
10.000	0.7	0.7	0.7	0.7	0.7
10.500	0.7	0.8	0.8	0.8	0.8
11.000	0.8	0.9	0.9	0.9	1.0
11.500	1.0	1.1	1.3	1.6	2.0
12.000	2.4	2.5	2.5	2.6	2.6
12.500	2.6	2.7	2.7	2.7	2.8
13.000	2.8	2.8	2.8	2.8	2.9
13.500	2.9	2.9	2.9	2.9	2.9
14.000	3.0	3.0	3.0	3.0	3.0
14.500	3.0	3.0	3.0	3.1	3.1
15.000	3.1	3.1	3.1	3.1	3.1
15.500	3.1	3.1	3.1	3.2	3.2
16.000	3.2	3.2	3.2	3.2	3.2
16.500	3.2	3.2	3.2	3.2	3.2

Existing Conditions

Subsection: Time-Depth Curve
Label: KCMO TR-55

Return Event: 2 years
Storm Event: 2-YEAR

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
17.000	3.2	3.3	3.3	3.3	3.3
17.500	3.3	3.3	3.3	3.3	3.3
18.000	3.3	3.3	3.3	3.3	3.3
18.500	3.3	3.4	3.4	3.4	3.4
19.000	3.4	3.4	3.4	3.4	3.4
19.500	3.4	3.4	3.4	3.4	3.4
20.000	3.4	3.4	3.4	3.4	3.4
20.500	3.5	3.5	3.5	3.5	3.5
21.000	3.5	3.5	3.5	3.5	3.5
21.500	3.5	3.5	3.5	3.5	3.5
22.000	3.5	3.5	3.5	3.5	3.5
22.500	3.5	3.5	3.5	3.6	3.6
23.000	3.6	3.6	3.6	3.6	3.6
23.500	3.6	3.6	3.6	3.6	3.6
24.000	3.6	(N/A)	(N/A)	(N/A)	(N/A)

Existing Conditions

Subsection: Time of Concentration Calculations
Label: A1

Return Event: 2 years
Storm Event: 2-YEAR

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	100.00 ft
Manning's n	0.150
Slope	0.050 ft/ft
2 Year 24 Hour Depth	3.6 in
Average Velocity	0.26 ft/s
Segment Time of Concentration	0.107 hours

Segment #2: TR-55 Shallow Concentrated Flow	
Hydraulic Length	300.00 ft
Is Paved?	False
Slope	0.070 ft/ft
Average Velocity	4.27 ft/s
Segment Time of Concentration	0.020 hours

Segment #3: Length and Velocity	
Hydraulic Length	740.00 ft
Velocity	15.00 ft/s
Segment Time of Concentration	0.014 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.140 hours

Existing Conditions

Subsection: Time of Concentration Calculations
Label: A1

Return Event: 2 years
Storm Event: 2-YEAR

==== User Defined Length & Velocity

Tc =	(Lf / V) / 3600
Where:	Tc= Time of concentration, hours Lf= Flow length, feet V= Velocity, ft/sec

==== SCS Channel Flow

Tc =	R = Qa / Wp V = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n (Lf / V) / 3600
Where:	R= Hydraulic radius Aq= Flow area, square feet Wp= Wetted perimeter, feet V= Velocity, ft/sec Sf= Slope, ft/ft n= Manning's n Tc= Time of concentration, hours Lf= Flow length, feet

==== SCS TR-55 Shallow Concentration Flow

Tc =	Unpaved surface: V = 16.1345 * (Sf**0.5) Paved Surface: V = 20.3282 * (Sf**0.5) (Lf / V) / 3600
Where:	V= Velocity, ft/sec Sf= Slope, ft/ft Tc= Time of concentration, hours Lf= Flow length, feet

Existing Conditions

Subsection: Time of Concentration Calculations
Label: A2

Return Event: 2 years
Storm Event: 2-YEAR

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	100.00 ft
Manning's n	0.150
Slope	0.080 ft/ft
2 Year 24 Hour Depth	3.6 in
Average Velocity	0.31 ft/s
Segment Time of Concentration	0.088 hours

Segment #2: TR-55 Shallow Concentrated Flow	
Hydraulic Length	300.00 ft
Is Paved?	False
Slope	0.070 ft/ft
Average Velocity	4.27 ft/s
Segment Time of Concentration	0.020 hours

Segment #3: Length and Velocity	
Hydraulic Length	970.00 ft
Velocity	15.00 ft/s
Segment Time of Concentration	0.018 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.126 hours

Existing Conditions

Subsection: Time of Concentration Calculations
Label: A2

Return Event: 2 years
Storm Event: 2-YEAR

==== User Defined Length & Velocity

Tc =	(Lf / V) / 3600
Where:	Tc= Time of concentration, hours Lf= Flow length, feet V= Velocity, ft/sec

==== SCS Channel Flow

Tc =	R = Qa / Wp V = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n (Lf / V) / 3600
Where:	R= Hydraulic radius Aq= Flow area, square feet Wp= Wetted perimeter, feet V= Velocity, ft/sec Sf= Slope, ft/ft n= Manning's n Tc= Time of concentration, hours Lf= Flow length, feet

==== SCS TR-55 Shallow Concentration Flow

Tc =	Unpaved surface: V = 16.1345 * (Sf**0.5) Paved Surface: V = 20.3282 * (Sf**0.5) (Lf / V) / 3600
Where:	V= Velocity, ft/sec Sf= Slope, ft/ft Tc= Time of concentration, hours Lf= Flow length, feet

Existing Conditions

Subsection: Time of Concentration Calculations
Label: A3

Return Event: 2 years
Storm Event: 2-YEAR

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	25.00 ft
Manning's n	0.150
Slope	0.030 ft/ft
2 Year 24 Hour Depth	3.6 in
Average Velocity	0.16 ft/s
Segment Time of Concentration	0.043 hours

Segment #2: TR-55 Shallow Concentrated Flow	
Hydraulic Length	90.00 ft
Is Paved?	True
Slope	0.020 ft/ft
Average Velocity	2.87 ft/s
Segment Time of Concentration	0.009 hours

Segment #3: Length and Velocity	
Hydraulic Length	880.00 ft
Velocity	15.00 ft/s
Segment Time of Concentration	0.016 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.100 hours

Existing Conditions

Subsection: Time of Concentration Calculations
Label: A3

Return Event: 2 years
Storm Event: 2-YEAR

==== User Defined Length & Velocity

Tc =	(Lf / V) / 3600
Where:	Tc= Time of concentration, hours Lf= Flow length, feet V= Velocity, ft/sec

==== SCS Channel Flow

Tc =	R = Qa / Wp V = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n (Lf / V) / 3600
Where:	R= Hydraulic radius Aq= Flow area, square feet Wp= Wetted perimeter, feet V= Velocity, ft/sec Sf= Slope, ft/ft n= Manning's n Tc= Time of concentration, hours Lf= Flow length, feet

==== SCS TR-55 Shallow Concentration Flow

Tc =	Unpaved surface: V = 16.1345 * (Sf**0.5) Paved Surface: V = 20.3282 * (Sf**0.5) (Lf / V) / 3600
Where:	V= Velocity, ft/sec Sf= Slope, ft/ft Tc= Time of concentration, hours Lf= Flow length, feet

Existing Conditions

Subsection: Time of Concentration Calculations
Label: A4

Return Event: 2 years
Storm Event: 2-YEAR

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	100.00 ft
Manning's n	0.011
Slope	0.020 ft/ft
2 Year 24 Hour Depth	3.6 in
Average Velocity	1.46 ft/s
Segment Time of Concentration	0.019 hours

Segment #2: TR-55 Shallow Concentrated Flow	
Hydraulic Length	300.00 ft
Is Paved?	True
Slope	0.020 ft/ft
Average Velocity	2.87 ft/s
Segment Time of Concentration	0.029 hours

Segment #3: Length and Velocity	
Hydraulic Length	4,750.00 ft
Velocity	7.00 ft/s
Segment Time of Concentration	0.188 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.237 hours

Existing Conditions

Subsection: Time of Concentration Calculations
Label: A4

Return Event: 2 years
Storm Event: 2-YEAR

==== User Defined Length & Velocity

Tc =	(Lf / V) / 3600
Where:	Tc= Time of concentration, hours Lf= Flow length, feet V= Velocity, ft/sec

==== SCS Channel Flow

Tc =	R = Qa / Wp V = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n (Lf / V) / 3600
Where:	R= Hydraulic radius Aq= Flow area, square feet Wp= Wetted perimeter, feet V= Velocity, ft/sec Sf= Slope, ft/ft n= Manning's n Tc= Time of concentration, hours Lf= Flow length, feet

==== SCS TR-55 Shallow Concentration Flow

Tc =	Unpaved surface: V = 16.1345 * (Sf**0.5) Paved Surface: V = 20.3282 * (Sf**0.5) (Lf / V) / 3600
Where:	V= Velocity, ft/sec Sf= Slope, ft/ft Tc= Time of concentration, hours Lf= Flow length, feet

Existing Conditions

Subsection: Time of Concentration Calculations
Label: A5

Return Event: 2 years
Storm Event: 2-YEAR

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	100.00 ft
Manning's n	0.150
Slope	0.080 ft/ft
2 Year 24 Hour Depth	3.6 in
Average Velocity	0.31 ft/s
Segment Time of Concentration	0.088 hours

Segment #2: TR-55 Shallow Concentrated Flow	
Hydraulic Length	300.00 ft
Is Paved?	False
Slope	0.080 ft/ft
Average Velocity	4.56 ft/s
Segment Time of Concentration	0.018 hours

Segment #3: Length and Velocity	
Hydraulic Length	740.00 ft
Velocity	15.00 ft/s
Segment Time of Concentration	0.014 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.120 hours

Existing Conditions

Subsection: Time of Concentration Calculations
Label: A5

Return Event: 2 years
Storm Event: 2-YEAR

==== User Defined Length & Velocity

Tc = (Lf / V) / 3600

Where:
Tc= Time of concentration, hours
Lf= Flow length, feet
V= Velocity, ft/sec

==== SCS Channel Flow

Tc =
R = Qa / Wp
V = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n

(Lf / V) / 3600

Where:
R= Hydraulic radius
Aq= Flow area, square feet
Wp= Wetted perimeter, feet
V= Velocity, ft/sec
Sf= Slope, ft/ft
n= Manning's n
Tc= Time of concentration, hours
Lf= Flow length, feet

==== SCS TR-55 Shallow Concentration Flow

Unpaved surface:
V = 16.1345 * (Sf**0.5)

Tc =
Paved Surface:
V = 20.3282 * (Sf**0.5)

(Lf / V) / 3600

Where:
V= Velocity, ft/sec
Sf= Slope, ft/ft
Tc= Time of concentration, hours
Lf= Flow length, feet

Existing Conditions

Subsection: Time of Concentration Calculations
Label: A6

Return Event: 2 years
Storm Event: 2-YEAR

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	100.00 ft
Manning's n	0.150
Slope	0.070 ft/ft
2 Year 24 Hour Depth	3.6 in
Average Velocity	0.30 ft/s
Segment Time of Concentration	0.093 hours

Segment #2: TR-55 Shallow Concentrated Flow	
Hydraulic Length	300.00 ft
Is Paved?	False
Slope	0.070 ft/ft
Average Velocity	4.27 ft/s
Segment Time of Concentration	0.020 hours

Segment #3: Length and Velocity	
Hydraulic Length	440.00 ft
Velocity	15.00 ft/s
Segment Time of Concentration	0.008 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.121 hours

Existing Conditions

Subsection: Time of Concentration Calculations
Label: A6

Return Event: 2 years
Storm Event: 2-YEAR

==== User Defined Length & Velocity

Tc =	(Lf / V) / 3600
Where:	Tc= Time of concentration, hours Lf= Flow length, feet V= Velocity, ft/sec

==== SCS Channel Flow

Tc =	R = Qa / Wp V = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n (Lf / V) / 3600
Where:	R= Hydraulic radius Aq= Flow area, square feet Wp= Wetted perimeter, feet V= Velocity, ft/sec Sf= Slope, ft/ft n= Manning's n Tc= Time of concentration, hours Lf= Flow length, feet

==== SCS TR-55 Shallow Concentration Flow

Tc =	Unpaved surface: V = 16.1345 * (Sf**0.5) Paved Surface: V = 20.3282 * (Sf**0.5) (Lf / V) / 3600
Where:	V= Velocity, ft/sec Sf= Slope, ft/ft Tc= Time of concentration, hours Lf= Flow length, feet

Existing Conditions

Subsection: Time of Concentration Calculations
Label: A7

Return Event: 2 years
Storm Event: 2-YEAR

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	65.00 ft
Manning's n	0.150
Slope	0.030 ft/ft
2 Year 24 Hour Depth	3.6 in
Average Velocity	0.19 ft/s
Segment Time of Concentration	0.093 hours

Segment #2: TR-55 Shallow Concentrated Flow	
Hydraulic Length	275.00 ft
Is Paved?	True
Slope	0.030 ft/ft
Average Velocity	3.52 ft/s
Segment Time of Concentration	0.022 hours

Segment #3: Length and Velocity	
Hydraulic Length	880.00 ft
Velocity	10.00 ft/s
Segment Time of Concentration	0.024 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.139 hours

Existing Conditions

Subsection: Time of Concentration Calculations
Label: A7

Return Event: 2 years
Storm Event: 2-YEAR

==== User Defined Length & Velocity

Tc = (Lf / V) / 3600

Where:
Tc= Time of concentration, hours
Lf= Flow length, feet
V= Velocity, ft/sec

==== SCS Channel Flow

Tc =
R = Qa / Wp
V = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n

(Lf / V) / 3600

Where:
R= Hydraulic radius
Aq= Flow area, square feet
Wp= Wetted perimeter, feet
V= Velocity, ft/sec
Sf= Slope, ft/ft
n= Manning's n
Tc= Time of concentration, hours
Lf= Flow length, feet

==== SCS TR-55 Shallow Concentration Flow

Unpaved surface:
V = 16.1345 * (Sf**0.5)

Tc =
Paved Surface:
V = 20.3282 * (Sf**0.5)

(Lf / V) / 3600

Where:
V= Velocity, ft/sec
Sf= Slope, ft/ft
Tc= Time of concentration, hours
Lf= Flow length, feet

Existing Conditions

Subsection: Time of Concentration Calculations
Label: A8

Return Event: 2 years
Storm Event: 2-YEAR

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	100.00 ft
Manning's n	0.150
Slope	0.128 ft/ft
2 Year 24 Hour Depth	3.6 in
Average Velocity	0.38 ft/s
Segment Time of Concentration	0.073 hours

Segment #2: TR-55 Shallow Concentrated Flow	
Hydraulic Length	200.00 ft
Is Paved?	False
Slope	0.150 ft/ft
Average Velocity	6.25 ft/s
Segment Time of Concentration	0.009 hours

Segment #3: Length and Velocity	
Hydraulic Length	640.00 ft
Velocity	10.00 ft/s
Segment Time of Concentration	0.018 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.100 hours

==== User Defined Length & Velocity

Tc =	(Lf / V) / 3600
Where:	Tc= Time of concentration, hours Lf= Flow length, feet V= Velocity, ft/sec

==== SCS Channel Flow

Tc =	R = Qa / Wp V = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n (Lf / V) / 3600
Where:	R= Hydraulic radius Aq= Flow area, square feet Wp= Wetted perimeter, feet V= Velocity, ft/sec Sf= Slope, ft/ft n= Manning's n Tc= Time of concentration, hours Lf= Flow length, feet

==== SCS TR-55 Shallow Concentration Flow

Tc =	Unpaved surface: V = 16.1345 * (Sf**0.5) Paved Surface: V = 20.3282 * (Sf**0.5) (Lf / V) / 3600
Where:	V= Velocity, ft/sec Sf= Slope, ft/ft Tc= Time of concentration, hours Lf= Flow length, feet

Existing Conditions

Subsection: Time of Concentration Calculations
Label: A9

Return Event: 2 years
Storm Event: 2-YEAR

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	100.00 ft
Manning's n	0.150
Slope	0.030 ft/ft
2 Year 24 Hour Depth	3.6 in
Average Velocity	0.21 ft/s
Segment Time of Concentration	0.131 hours

Segment #2: TR-55 Shallow Concentrated Flow	
Hydraulic Length	300.00 ft
Is Paved?	False
Slope	0.030 ft/ft
Average Velocity	2.79 ft/s
Segment Time of Concentration	0.030 hours

Segment #3: Length and Velocity	
Hydraulic Length	3,570.00 ft
Velocity	10.00 ft/s
Segment Time of Concentration	0.099 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.260 hours

==== User Defined Length & Velocity

Tc =	(Lf / V) / 3600
Where:	Tc= Time of concentration, hours Lf= Flow length, feet V= Velocity, ft/sec

==== SCS Channel Flow

Tc =	R = Qa / Wp V = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n (Lf / V) / 3600
Where:	R= Hydraulic radius Aq= Flow area, square feet Wp= Wetted perimeter, feet V= Velocity, ft/sec Sf= Slope, ft/ft n= Manning's n Tc= Time of concentration, hours Lf= Flow length, feet

==== SCS TR-55 Shallow Concentration Flow

Tc =	Unpaved surface: V = 16.1345 * (Sf**0.5) Paved Surface: V = 20.3282 * (Sf**0.5) (Lf / V) / 3600
Where:	V= Velocity, ft/sec Sf= Slope, ft/ft Tc= Time of concentration, hours Lf= Flow length, feet

Existing Conditions

Subsection: Time of Concentration Calculations
Label: B1

Return Event: 2 years
Storm Event: 2-YEAR

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	100.00 ft
Manning's n	0.150
Slope	0.120 ft/ft
2 Year 24 Hour Depth	3.6 in
Average Velocity	0.37 ft/s
Segment Time of Concentration	0.075 hours

Segment #2: TR-55 Shallow Concentrated Flow	
Hydraulic Length	90.00 ft
Is Paved?	False
Slope	0.080 ft/ft
Average Velocity	4.56 ft/s
Segment Time of Concentration	0.005 hours

Segment #3: Length and Velocity	
Hydraulic Length	550.00 ft
Velocity	15.00 ft/s
Segment Time of Concentration	0.010 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.100 hours

Existing Conditions

Subsection: Time of Concentration Calculations
Label: B1

Return Event: 2 years
Storm Event: 2-YEAR

==== User Defined Length & Velocity

Tc =	(Lf / V) / 3600
Where:	Tc= Time of concentration, hours Lf= Flow length, feet V= Velocity, ft/sec

==== SCS Channel Flow

Tc =	R = Qa / Wp V = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n (Lf / V) / 3600
Where:	R= Hydraulic radius Aq= Flow area, square feet Wp= Wetted perimeter, feet V= Velocity, ft/sec Sf= Slope, ft/ft n= Manning's n Tc= Time of concentration, hours Lf= Flow length, feet

==== SCS TR-55 Shallow Concentration Flow

Tc =	Unpaved surface: V = 16.1345 * (Sf**0.5) Paved Surface: V = 20.3282 * (Sf**0.5) (Lf / V) / 3600
Where:	V= Velocity, ft/sec Sf= Slope, ft/ft Tc= Time of concentration, hours Lf= Flow length, feet

Existing Conditions

Subsection: Time of Concentration Calculations
Label: B1a

Return Event: 2 years
Storm Event: 2-YEAR

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	100.00 ft
Manning's n	0.150
Slope	0.120 ft/ft
2 Year 24 Hour Depth	3.6 in
Average Velocity	0.37 ft/s
Segment Time of Concentration	0.075 hours

Segment #2: TR-55 Shallow Concentrated Flow	
Hydraulic Length	190.00 ft
Is Paved?	False
Slope	0.120 ft/ft
Average Velocity	5.59 ft/s
Segment Time of Concentration	0.009 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.100 hours

==== SCS Channel Flow

Tc =

R = Qa / Wp
V = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n

(Lf / V) / 3600

Where:

R= Hydraulic radius
Aq= Flow area, square feet
Wp= Wetted perimeter, feet
V= Velocity, ft/sec
Sf= Slope, ft/ft
n= Manning's n
Tc= Time of concentration, hours
Lf= Flow length, feet

==== SCS TR-55 Shallow Concentration Flow

Tc =

Unpaved surface:
V = 16.1345 * (Sf**0.5)

Paved Surface:
V = 20.3282 * (Sf**0.5)

(Lf / V) / 3600

Where:

V= Velocity, ft/sec
Sf= Slope, ft/ft
Tc= Time of concentration, hours
Lf= Flow length, feet

Existing Conditions

Subsection: Time of Concentration Calculations
Label: C1

Return Event: 2 years
Storm Event: 2-YEAR

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	100.00 ft
Manning's n	0.150
Slope	0.020 ft/ft
2 Year 24 Hour Depth	3.6 in
Average Velocity	0.18 ft/s
Segment Time of Concentration	0.154 hours

Segment #2: TR-55 Shallow Concentrated Flow	
Hydraulic Length	120.00 ft
Is Paved?	False
Slope	0.020 ft/ft
Average Velocity	2.28 ft/s
Segment Time of Concentration	0.015 hours

Segment #3: Length and Velocity	
Hydraulic Length	3,020.00 ft
Velocity	10.00 ft/s
Segment Time of Concentration	0.084 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.252 hours

==== User Defined Length & Velocity

Tc =	(Lf / V) / 3600
Where:	Tc= Time of concentration, hours Lf= Flow length, feet V= Velocity, ft/sec

==== SCS Channel Flow

Tc =	R = Qa / Wp V = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n (Lf / V) / 3600
Where:	R= Hydraulic radius Aq= Flow area, square feet Wp= Wetted perimeter, feet V= Velocity, ft/sec Sf= Slope, ft/ft n= Manning's n Tc= Time of concentration, hours Lf= Flow length, feet

==== SCS TR-55 Shallow Concentration Flow

Tc =	Unpaved surface: V = 16.1345 * (Sf**0.5) Paved Surface: V = 20.3282 * (Sf**0.5) (Lf / V) / 3600
Where:	V= Velocity, ft/sec Sf= Slope, ft/ft Tc= Time of concentration, hours Lf= Flow length, feet

Existing Conditions

Subsection: Time of Concentration Calculations
Label: C1a

Return Event: 2 years
Storm Event: 2-YEAR

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	100.00 ft
Manning's n	0.150
Slope	0.120 ft/ft
2 Year 24 Hour Depth	3.6 in
Average Velocity	0.37 ft/s
Segment Time of Concentration	0.075 hours

Segment #2: TR-55 Shallow Concentrated Flow	
Hydraulic Length	300.00 ft
Is Paved?	False
Slope	0.120 ft/ft
Average Velocity	5.59 ft/s
Segment Time of Concentration	0.015 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.100 hours

==== SCS Channel Flow

Tc =

R = Qa / Wp
V = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n

(Lf / V) / 3600

Where:

R= Hydraulic radius
Aq= Flow area, square feet
Wp= Wetted perimeter, feet
V= Velocity, ft/sec
Sf= Slope, ft/ft
n= Manning's n
Tc= Time of concentration, hours
Lf= Flow length, feet

==== SCS TR-55 Shallow Concentration Flow

Tc =

Unpaved surface:
V = 16.1345 * (Sf**0.5)

Paved Surface:
V = 20.3282 * (Sf**0.5)

(Lf / V) / 3600

Where:

V= Velocity, ft/sec
Sf= Slope, ft/ft
Tc= Time of concentration, hours
Lf= Flow length, feet

Existing Conditions

Subsection: Runoff CN-Area
Label: A1

Return Event: 2 years
Storm Event: 2-YEAR

Runoff Curve Number Data

Soil/Surface Description	CN	Area (acres)	C (%)	UC (%)	Adjusted CN
CN Description	86.000	12.580	0.0	0.0	86.000
COMPOSITE AREA & WEIGHTED CN --->	(N/A)	12.580	(N/A)	(N/A)	86.000

Existing Conditions

Subsection: Runoff CN-Area
Label: A2

Return Event: 2 years
Storm Event: 2-YEAR

Runoff Curve Number Data

Soil/Surface Description	CN	Area (acres)	C (%)	UC (%)	Adjusted CN
CN Description	80.000	8.490	0.0	0.0	80.000
COMPOSITE AREA & WEIGHTED CN --->	(N/A)	8.490	(N/A)	(N/A)	80.000

Existing Conditions

Subsection: Runoff CN-Area
Label: A3

Return Event: 2 years
Storm Event: 2-YEAR

Runoff Curve Number Data

Soil/Surface Description	CN	Area (acres)	C (%)	UC (%)	Adjusted CN
CN Description	82.000	11.020	0.0	0.0	82.000
COMPOSITE AREA & WEIGHTED CN --->	(N/A)	11.020	(N/A)	(N/A)	82.000

Existing Conditions

Subsection: Runoff CN-Area
Label: A4

Return Event: 2 years
Storm Event: 2-YEAR

Runoff Curve Number Data

Soil/Surface Description	CN	Area (acres)	C (%)	UC (%)	Adjusted CN
CN Description	87.000	177.570	0.0	0.0	87.000
COMPOSITE AREA & WEIGHTED CN --->	(N/A)	177.570	(N/A)	(N/A)	87.000

Existing Conditions

Subsection: Runoff CN-Area
Label: A5

Return Event: 2 years
Storm Event: 2-YEAR

Runoff Curve Number Data

Soil/Surface Description	CN	Area (acres)	C (%)	UC (%)	Adjusted CN
CN Description	80.000	5.190	0.0	0.0	80.000
COMPOSITE AREA & WEIGHTED CN --->	(N/A)	5.190	(N/A)	(N/A)	80.000

Existing Conditions

Subsection: Runoff CN-Area
Label: A6

Return Event: 2 years
Storm Event: 2-YEAR

Runoff Curve Number Data

Soil/Surface Description	CN	Area (acres)	C (%)	UC (%)	Adjusted CN
CN Description	87.000	3.800	0.0	0.0	87.000
COMPOSITE AREA & WEIGHTED CN --->	(N/A)	3.800	(N/A)	(N/A)	87.000

Existing Conditions

Subsection: Runoff CN-Area
Label: A7

Return Event: 2 years
Storm Event: 2-YEAR

Runoff Curve Number Data

Soil/Surface Description	CN	Area (acres)	C (%)	UC (%)	Adjusted CN
CN Description	81.000	10.340	0.0	0.0	81.000
COMPOSITE AREA & WEIGHTED CN --->	(N/A)	10.340	(N/A)	(N/A)	81.000

Existing Conditions

Subsection: Runoff CN-Area
Label: A8

Return Event: 2 years
Storm Event: 2-YEAR

Runoff Curve Number Data

Soil/Surface Description	CN	Area (acres)	C (%)	UC (%)	Adjusted CN
CN Description	87.000	15.960	0.0	0.0	87.000
COMPOSITE AREA & WEIGHTED CN --->	(N/A)	15.960	(N/A)	(N/A)	87.000

Existing Conditions

Subsection: Runoff CN-Area
Label: A9

Return Event: 2 years
Storm Event: 2-YEAR

Runoff Curve Number Data

Soil/Surface Description	CN	Area (acres)	C (%)	UC (%)	Adjusted CN
CN Description	91.000	189.060	0.0	0.0	91.000
COMPOSITE AREA & WEIGHTED CN --->	(N/A)	189.060	(N/A)	(N/A)	91.000

Existing Conditions

Subsection: Runoff CN-Area
Label: B1

Return Event: 2 years
Storm Event: 2-YEAR

Runoff Curve Number Data

Soil/Surface Description	CN	Area (acres)	C (%)	UC (%)	Adjusted CN
CN Description	83.000	5.420	0.0	0.0	83.000
COMPOSITE AREA & WEIGHTED CN --->	(N/A)	5.420	(N/A)	(N/A)	83.000

Existing Conditions

Subsection: Runoff CN-Area
Label: B1a

Return Event: 2 years
Storm Event: 2-YEAR

Runoff Curve Number Data

Soil/Surface Description	CN	Area (acres)	C (%)	UC (%)	Adjusted CN
CN Description	87.000	0.610	0.0	0.0	87.000
COMPOSITE AREA & WEIGHTED CN --->	(N/A)	0.610	(N/A)	(N/A)	87.000

Existing Conditions

Subsection: Runoff CN-Area
Label: C1

Return Event: 2 years
Storm Event: 2-YEAR

Runoff Curve Number Data

Soil/Surface Description	CN	Area (acres)	C (%)	UC (%)	Adjusted CN
CN Description	88.000	75.110	0.0	0.0	88.000
COMPOSITE AREA & WEIGHTED CN --->	(N/A)	75.110	(N/A)	(N/A)	88.000

Existing Conditions

Subsection: Runoff CN-Area
Label: C1a

Return Event: 2 years
Storm Event: 2-YEAR

Runoff Curve Number Data

Soil/Surface Description	CN	Area (acres)	C (%)	UC (%)	Adjusted CN
CN Description	81.000	1.190	0.0	0.0	81.000
COMPOSITE AREA & WEIGHTED CN --->	(N/A)	1.190	(N/A)	(N/A)	81.000

Existing Conditions

Index

Existing Conditions

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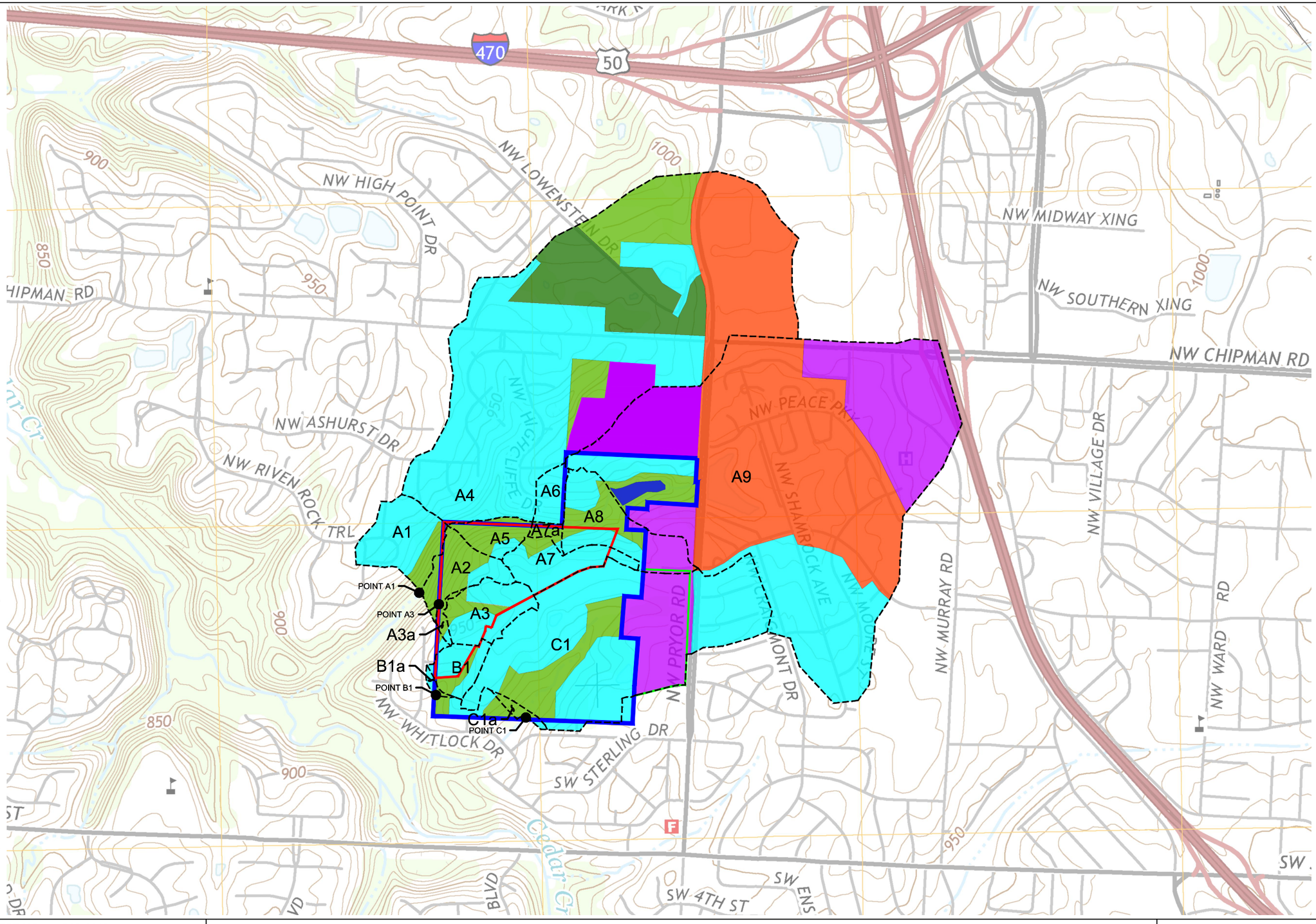

- WOODSIDE RIDGE PROPERTY BOUNDARY
- WOODSIDE RIDGE SECOND PLAT BOUNDARY
- FUTURE COMMERCIAL BOUNDARY
- RIDGELINE
- COMMERICAL
- OPEN
- PARK
- SINGLE FAMILY
- MULTIFAMILY
- OPEN WATER

N

0' 500' 1000'
SCALE IN FEET

PROJECT NO: C18-1140	PROPOSED LAND USE MAP	olsson	EXHIBIT
DRAWN BY: SMS		1301 Burlington Suite 100 North Kansas City, MO 64116 TEL 816.361.1177 FAX 816.361.1888	2A
DATE: 04/24/2020			

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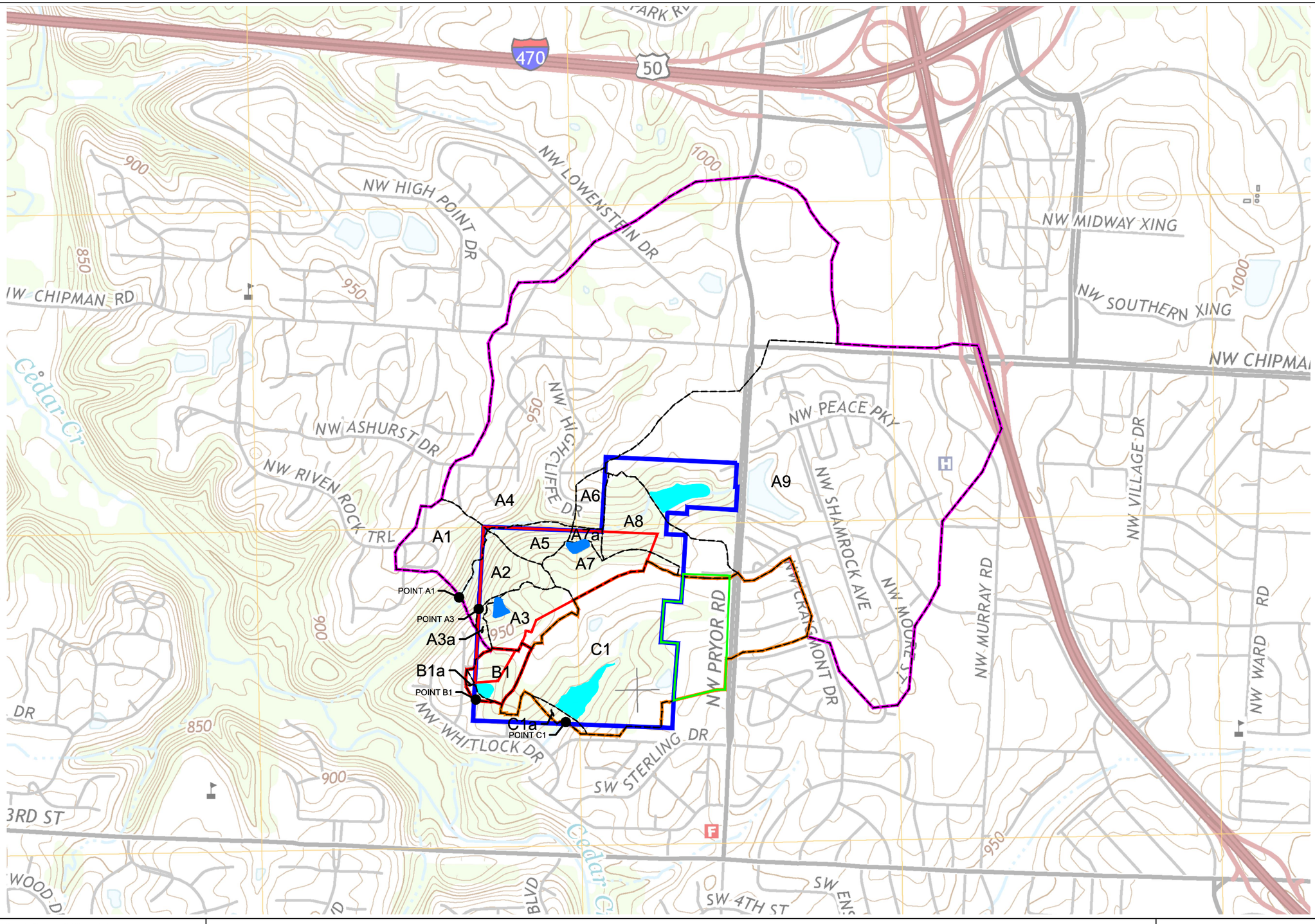


WOODSIDE RIDGE PROPERTY BOUNDARY
WOODSIDE RIDGE SECOND PLAT BOUNDARY
FUTURE COMMERCIAL BOUNDARY
RIDGELINE
WATERSHED A BOUNDARY
WATERSHED B BOUNDARY
WATERSHED C BOUNDARY
EXISTING POND/ EXISTING DETENTION
PROPOSED DETENTION

PROJECT NO: C18-1140	PROPOSED CONDITIONS DRAINAGE AREA MAP	olsson	EXHIBIT
DRAWN BY: SMS		1301 Burlington Suite 100 North Kansas City, MO 64116 TEL 816.361.1177 FAX 816.361.1888	2
DATE: 04/24/2020			

Proposed Conditions

Project Summary	
Title	Woodside Ridge 2nd Plat-Proposed Conditions
Engineer	JES
Company	Olsson
Date	4/22/2020

Notes

Proposed Conditions PondPack Schematic

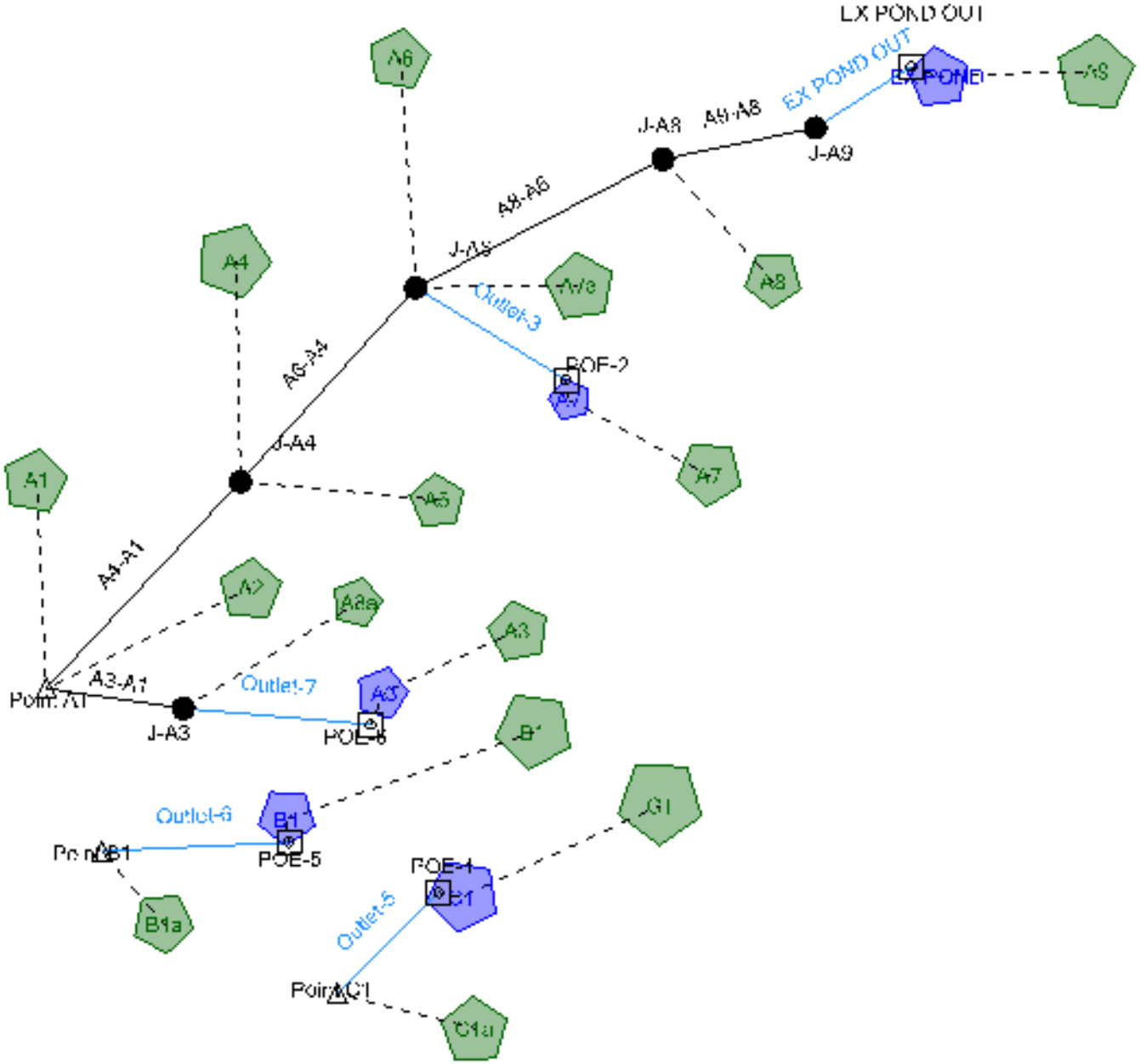


Table of Contents

Table of Contents

Proposed Conditions

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
A3	WQ Storm 1.37"	1	0.290	11.950	5.03
A3	2-Year	2	1.554	11.930	28.29
A3	10-Year	10	2.664	11.930	47.66
A3	100-Year	100	4.432	11.930	77.29
B1	WQ Storm 1.37"	1	0.192	11.950	3.32
B1	2-Year	2	1.027	11.930	18.68
B1	10-Year	10	1.759	11.930	31.48
B1	100-Year	100	2.927	11.930	51.05
C1	WQ Storm 1.37"	1	3.174	12.050	44.86
C1	2-Year	2	15.261	12.050	218.92
C1	10-Year	10	25.579	12.050	358.58
C1	100-Year	100	41.861	12.020	571.35
A1	WQ Storm 1.37"	1	0.428	12.000	7.02
A1	2-Year	2	2.289	11.960	38.93
A1	10-Year	10	3.923	11.960	65.59
A1	100-Year	100	6.526	11.960	106.37
A2	WQ Storm 1.37"	1	0.197	12.020	3.07
A2	2-Year	2	1.324	11.950	23.10
A2	10-Year	10	2.377	11.950	41.22
A2	100-Year	100	4.092	11.950	69.54
A4	WQ Storm 1.37"	1	6.617	12.050	94.85
A4	2-Year	2	33.524	12.040	493.17
A4	10-Year	10	56.819	12.020	821.42
A4	100-Year	100	93.753	12.020	1,322.20
A5	WQ Storm 1.37"	1	0.108	12.020	1.65
A5	2-Year	2	0.773	11.950	13.59
A5	10-Year	10	1.404	11.940	24.58
A5	100-Year	100	2.439	11.940	42.00
A6	WQ Storm 1.37"	1	0.142	11.970	2.40
A6	2-Year	2	0.719	11.950	12.58
A6	10-Year	10	1.218	11.950	20.89
A6	100-Year	100	2.009	11.940	33.59
A7a	WQ Storm 1.37"	1	0.020	12.010	0.31
A7a	2-Year	2	0.142	11.940	2.58
A7a	10-Year	10	0.257	11.930	4.68
A7a	100-Year	100	0.447	11.930	7.97
A9	WQ Storm 1.37"	1	10.017	12.060	143.11
A9	2-Year	2	41.407	12.030	576.32
A9	10-Year	10	67.148	12.030	913.07
A9	100-Year	100	107.260	12.030	1,421.40
A7	WQ Storm 1.37"	1	0.206	12.000	3.37
A7	2-Year	2	1.101	11.960	18.67
A7	10-Year	10	1.887	11.950	31.49

Proposed Conditions

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
A7	100-Year	100	3.139	11.950	51.18
A8	WQ Storm 1.37"	1	0.617	11.950	10.83
A8	2-Year	2	3.130	11.930	56.81
A8	10-Year	10	5.305	11.930	94.43
A8	100-Year	100	8.752	11.930	151.72
C1a	WQ Storm 1.37"	1	0.025	12.010	0.39
C1a	2-Year	2	0.179	11.940	3.26
C1a	10-Year	10	0.325	11.930	5.91
C1a	100-Year	100	0.564	11.930	10.07
B1a	WQ Storm 1.37"	1	0.023	11.950	0.40
B1a	2-Year	2	0.115	11.930	2.09
B1a	10-Year	10	0.196	11.930	3.48
B1a	100-Year	100	0.323	11.930	5.59
A3a	WQ Storm 1.37"	1	0.039	12.020	0.59
A3a	2-Year	2	0.275	11.950	4.85
A3a	10-Year	10	0.501	11.940	8.78
A3a	100-Year	100	0.870	11.940	14.99

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
Point A1	WQ Storm 1.37"	1	16.978	12.110	138.61
Point A1	2-Year	2	83.187	12.090	919.45
Point A1	10-Year	10	140.000	12.070	1,548.58
Point A1	100-Year	100	229.837	12.070	2,528.67
Point B1	WQ Storm 1.37"	1	0.214	11.960	0.44
Point B1	2-Year	2	0.888	11.940	2.71
Point B1	10-Year	10	1.421	11.930	4.44
Point B1	100-Year	100	2.541	12.030	9.23
Point C1	WQ Storm 1.37"	1	3.199	12.190	28.51
Point C1	2-Year	2	15.437	12.380	47.12
Point C1	10-Year	10	25.899	12.280	122.74
Point C1	100-Year	100	42.415	12.260	209.13
J-A3	WQ Storm 1.37"	1	0.329	12.020	0.79
J-A3	2-Year	2	1.076	11.960	5.45
J-A3	10-Year	10	2.218	12.060	16.08
J-A3	100-Year	100	4.246	12.010	35.46
J-A4	WQ Storm 1.37"	1	16.024	12.110	133.30
J-A4	2-Year	2	78.525	12.080	881.12
J-A4	10-Year	10	131.522	12.070	1,469.04
J-A4	100-Year	100	215.031	12.070	2,382.85
J-A6	WQ Storm 1.37"	1	9.298	12.260	76.28

Proposed Conditions

Subsection: Master Network Summary

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
J-A6	2-Year	2	44.250	12.160	470.48
J-A6	10-Year	10	73.331	12.150	774.13
J-A6	100-Year	100	118.887	12.140	1,242.24
J-A8	WQ Storm 1.37"	1	8.931	12.250	75.49
J-A8	2-Year	2	42.667	12.150	466.13
J-A8	10-Year	10	70.498	12.140	761.08
J-A8	100-Year	100	113.928	12.140	1,213.17
J-A9	WQ Storm 1.37"	1	8.314	12.230	73.54
J-A9	2-Year	2	39.549	12.140	454.72
J-A9	10-Year	10	65.211	12.130	741.59
J-A9	100-Year	100	105.203	12.120	1,180.76

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ac-ft)
EX POND (IN)	WQ Storm 1.37"	1	10.017	12.060	143.11	(N/A)	(N/A)
EX POND (OUT)	WQ Storm 1.37"	1	8.314	12.230	73.54	929.78	3.292
EX POND (IN)	2-Year	2	41.407	12.030	576.32	(N/A)	(N/A)
EX POND (OUT)	2-Year	2	39.549	12.140	454.72	931.84	8.290
EX POND (IN)	10-Year	10	67.148	12.030	913.07	(N/A)	(N/A)
EX POND (OUT)	10-Year	10	65.211	12.130	741.59	932.95	11.445
EX POND (IN)	100-Year	100	107.260	12.030	1,421.40	(N/A)	(N/A)
EX POND (OUT)	100-Year	100	105.203	12.120	1,180.76	934.38	15.914
A7 (IN)	WQ Storm 1.37"	1	0.206	12.000	3.37	(N/A)	(N/A)
A7 (OUT)	WQ Storm 1.37"	1	0.206	13.100	0.27	930.60	0.089
A7 (IN)	2-Year	2	1.101	11.960	18.67	(N/A)	(N/A)
A7 (OUT)	2-Year	2	0.729	13.840	0.79	933.34	0.650
A7 (IN)	10-Year	10	1.887	11.950	31.49	(N/A)	(N/A)
A7 (OUT)	10-Year	10	1.368	12.200	6.98	934.36	0.938
A7 (IN)	100-Year	100	3.139	11.950	51.18	(N/A)	(N/A)
A7 (OUT)	100-Year	100	2.519	12.140	18.41	935.67	1.380

Proposed Conditions

Subsection: Master Network Summary

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ac-ft)
C1 (IN)	WQ Storm 1.37"	1	3.174	12.050	44.86	(N/A)	(N/A)
C1 (OUT)	WQ Storm 1.37"	1	3.174	12.190	28.42	914.94	0.341
C1 (IN)	2-Year	2	15.261	12.050	218.92	(N/A)	(N/A)
C1 (OUT)	2-Year	2	15.258	12.410	46.72	921.76	4.950
C1 (IN)	10-Year	10	25.579	12.050	358.58	(N/A)	(N/A)
C1 (OUT)	10-Year	10	25.574	12.280	121.92	923.82	8.095
C1 (IN)	100-Year	100	41.861	12.020	571.35	(N/A)	(N/A)
C1 (OUT)	100-Year	100	41.851	12.270	207.75	926.18	12.979
B1 (IN)	WQ Storm 1.37"	1	0.192	11.950	3.32	(N/A)	(N/A)
B1 (OUT)	WQ Storm 1.37"	1	0.191	14.980	0.13	920.68	0.103
B1 (IN)	2-Year	2	1.027	11.930	18.68	(N/A)	(N/A)
B1 (OUT)	2-Year	2	0.772	13.280	0.96	923.25	0.590
B1 (IN)	10-Year	10	1.759	11.930	31.48	(N/A)	(N/A)
B1 (OUT)	10-Year	10	1.225	13.250	1.54	925.16	1.059
B1 (IN)	100-Year	100	2.927	11.930	51.05	(N/A)	(N/A)
B1 (OUT)	100-Year	100	2.218	12.340	6.07	926.94	1.589
A3 (IN)	WQ Storm 1.37"	1	0.290	11.950	5.03	(N/A)	(N/A)
A3 (OUT)	WQ Storm 1.37"	1	0.290	13.650	0.29	922.67	0.136
A3 (IN)	2-Year	2	1.554	11.930	28.29	(N/A)	(N/A)
A3 (OUT)	2-Year	2	0.801	15.110	0.80	925.77	0.987
A3 (IN)	10-Year	10	2.664	11.930	47.66	(N/A)	(N/A)
A3 (OUT)	10-Year	10	1.717	12.130	11.48	926.73	1.326
A3 (IN)	100-Year	100	4.432	11.930	77.29	(N/A)	(N/A)
A3 (OUT)	100-Year	100	3.377	12.100	23.91	928.54	2.053

Time-Depth Curve: 100-YEAR	
Label	100-YEAR
Start Time	0.000 hours
Increment	0.100 hours
End Time	24.000 hours
Return Event	100 years

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
0.000	0.0	0.0	0.0	0.0	0.0
0.500	0.0	0.0	0.1	0.1	0.1
1.000	0.1	0.1	0.1	0.1	0.1
1.500	0.1	0.1	0.1	0.2	0.2
2.000	0.2	0.2	0.2	0.2	0.2
2.500	0.2	0.2	0.2	0.3	0.3
3.000	0.3	0.3	0.3	0.3	0.3
3.500	0.3	0.3	0.3	0.4	0.4
4.000	0.4	0.4	0.4	0.4	0.4
4.500	0.4	0.4	0.5	0.5	0.5
5.000	0.5	0.5	0.5	0.5	0.5
5.500	0.6	0.6	0.6	0.6	0.6
6.000	0.6	0.6	0.7	0.7	0.7
6.500	0.7	0.7	0.7	0.8	0.8
7.000	0.8	0.8	0.8	0.8	0.8
7.500	0.9	0.9	0.9	0.9	0.9
8.000	0.9	1.0	1.0	1.0	1.0
8.500	1.0	1.1	1.1	1.1	1.1
9.000	1.2	1.2	1.2	1.2	1.3
9.500	1.3	1.3	1.3	1.4	1.4
10.000	1.4	1.5	1.5	1.5	1.6
10.500	1.6	1.7	1.7	1.7	1.8
11.000	1.9	1.9	2.0	2.1	2.1
11.500	2.2	2.4	2.8	3.4	4.5
12.000	5.2	5.4	5.5	5.6	5.7
12.500	5.8	5.9	5.9	6.0	6.0
13.000	6.1	6.1	6.2	6.2	6.3
13.500	6.3	6.3	6.4	6.4	6.4
14.000	6.5	6.5	6.5	6.6	6.6
14.500	6.6	6.6	6.7	6.7	6.7
15.000	6.7	6.8	6.8	6.8	6.8
15.500	6.9	6.9	6.9	6.9	6.9
16.000	7.0	7.0	7.0	7.0	7.0
16.500	7.0	7.1	7.1	7.1	7.1

Proposed Conditions

Subsection: Time-Depth Curve
Label: KCMO TR-55

Return Event: 100 years
Storm Event: 100-YEAR

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
17.000	7.1	7.1	7.2	7.2	7.2
17.500	7.2	7.2	7.2	7.2	7.3
18.000	7.3	7.3	7.3	7.3	7.3
18.500	7.3	7.4	7.4	7.4	7.4
19.000	7.4	7.4	7.4	7.4	7.5
19.500	7.5	7.5	7.5	7.5	7.5
20.000	7.5	7.5	7.5	7.6	7.6
20.500	7.6	7.6	7.6	7.6	7.6
21.000	7.6	7.6	7.6	7.7	7.7
21.500	7.7	7.7	7.7	7.7	7.7
22.000	7.7	7.7	7.7	7.7	7.8
22.500	7.8	7.8	7.8	7.8	7.8
23.000	7.8	7.8	7.8	7.8	7.8
23.500	7.9	7.9	7.9	7.9	7.9
24.000	7.9	(N/A)	(N/A)	(N/A)	(N/A)

Time-Depth Curve: 10-YEAR	
Label	10-YEAR
Start Time	0.000 hours
Increment	0.100 hours
End Time	24.000 hours
Return Event	10 years

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
0.000	0.0	0.0	0.0	0.0	0.0
0.500	0.0	0.0	0.0	0.0	0.0
1.000	0.1	0.1	0.1	0.1	0.1
1.500	0.1	0.1	0.1	0.1	0.1
2.000	0.1	0.1	0.1	0.1	0.1
2.500	0.1	0.2	0.2	0.2	0.2
3.000	0.2	0.2	0.2	0.2	0.2
3.500	0.2	0.2	0.2	0.2	0.2
4.000	0.3	0.3	0.3	0.3	0.3
4.500	0.3	0.3	0.3	0.3	0.3
5.000	0.3	0.3	0.4	0.4	0.4
5.500	0.4	0.4	0.4	0.4	0.4
6.000	0.4	0.4	0.4	0.5	0.5
6.500	0.5	0.5	0.5	0.5	0.5
7.000	0.5	0.5	0.5	0.6	0.6
7.500	0.6	0.6	0.6	0.6	0.6
8.000	0.6	0.6	0.7	0.7	0.7
8.500	0.7	0.7	0.7	0.7	0.8
9.000	0.8	0.8	0.8	0.8	0.8
9.500	0.9	0.9	0.9	0.9	0.9
10.000	1.0	1.0	1.0	1.0	1.1
10.500	1.1	1.1	1.1	1.2	1.2
11.000	1.2	1.3	1.3	1.4	1.4
11.500	1.5	1.6	1.9	2.3	3.0
12.000	3.5	3.6	3.7	3.8	3.8
12.500	3.9	3.9	4.0	4.0	4.1
13.000	4.1	4.1	4.2	4.2	4.2
13.500	4.2	4.3	4.3	4.3	4.3
14.000	4.3	4.4	4.4	4.4	4.4
14.500	4.4	4.5	4.5	4.5	4.5
15.000	4.5	4.5	4.6	4.6	4.6
15.500	4.6	4.6	4.6	4.6	4.7
16.000	4.7	4.7	4.7	4.7	4.7
16.500	4.7	4.7	4.7	4.8	4.8

Proposed Conditions

Subsection: Time-Depth Curve
Label: KCMO TR-55

Return Event: 10 years
Storm Event: 10-YEAR

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
17.000	4.8	4.8	4.8	4.8	4.8
17.500	4.8	4.8	4.9	4.9	4.9
18.000	4.9	4.9	4.9	4.9	4.9
18.500	4.9	4.9	4.9	5.0	5.0
19.000	5.0	5.0	5.0	5.0	5.0
19.500	5.0	5.0	5.0	5.0	5.0
20.000	5.0	5.1	5.1	5.1	5.1
20.500	5.1	5.1	5.1	5.1	5.1
21.000	5.1	5.1	5.1	5.1	5.1
21.500	5.1	5.2	5.2	5.2	5.2
22.000	5.2	5.2	5.2	5.2	5.2
22.500	5.2	5.2	5.2	5.2	5.2
23.000	5.2	5.2	5.3	5.3	5.3
23.500	5.3	5.3	5.3	5.3	5.3
24.000	5.3	(N/A)	(N/A)	(N/A)	(N/A)

Proposed Conditions

Subsection: Time-Depth Curve
Label: KCMO TR-55

Return Event: 2 years
Storm Event: 2-YEAR

Time-Depth Curve: 2-YEAR	
Label	2-YEAR
Start Time	0.000 hours
Increment	0.100 hours
End Time	24.000 hours
Return Event	2 years

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
0.000	0.0	0.0	0.0	0.0	0.0
0.500	0.0	0.0	0.0	0.0	0.0
1.000	0.0	0.0	0.0	0.0	0.1
1.500	0.1	0.1	0.1	0.1	0.1
2.000	0.1	0.1	0.1	0.1	0.1
2.500	0.1	0.1	0.1	0.1	0.1
3.000	0.1	0.1	0.1	0.1	0.1
3.500	0.1	0.2	0.2	0.2	0.2
4.000	0.2	0.2	0.2	0.2	0.2
4.500	0.2	0.2	0.2	0.2	0.2
5.000	0.2	0.2	0.2	0.2	0.3
5.500	0.3	0.3	0.3	0.3	0.3
6.000	0.3	0.3	0.3	0.3	0.3
6.500	0.3	0.3	0.3	0.3	0.3
7.000	0.4	0.4	0.4	0.4	0.4
7.500	0.4	0.4	0.4	0.4	0.4
8.000	0.4	0.4	0.4	0.5	0.5
8.500	0.5	0.5	0.5	0.5	0.5
9.000	0.5	0.5	0.6	0.6	0.6
9.500	0.6	0.6	0.6	0.6	0.6
10.000	0.7	0.7	0.7	0.7	0.7
10.500	0.7	0.8	0.8	0.8	0.8
11.000	0.8	0.9	0.9	0.9	1.0
11.500	1.0	1.1	1.3	1.6	2.0
12.000	2.4	2.5	2.5	2.6	2.6
12.500	2.6	2.7	2.7	2.7	2.8
13.000	2.8	2.8	2.8	2.8	2.9
13.500	2.9	2.9	2.9	2.9	2.9
14.000	3.0	3.0	3.0	3.0	3.0
14.500	3.0	3.0	3.0	3.1	3.1
15.000	3.1	3.1	3.1	3.1	3.1
15.500	3.1	3.1	3.1	3.2	3.2
16.000	3.2	3.2	3.2	3.2	3.2
16.500	3.2	3.2	3.2	3.2	3.2

Proposed Conditions

Subsection: Time-Depth Curve
Label: KCMO TR-55

Return Event: 2 years
Storm Event: 2-YEAR

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
17.000	3.2	3.3	3.3	3.3	3.3
17.500	3.3	3.3	3.3	3.3	3.3
18.000	3.3	3.3	3.3	3.3	3.3
18.500	3.3	3.4	3.4	3.4	3.4
19.000	3.4	3.4	3.4	3.4	3.4
19.500	3.4	3.4	3.4	3.4	3.4
20.000	3.4	3.4	3.4	3.4	3.4
20.500	3.5	3.5	3.5	3.5	3.5
21.000	3.5	3.5	3.5	3.5	3.5
21.500	3.5	3.5	3.5	3.5	3.5
22.000	3.5	3.5	3.5	3.5	3.5
22.500	3.5	3.5	3.5	3.6	3.6
23.000	3.6	3.6	3.6	3.6	3.6
23.500	3.6	3.6	3.6	3.6	3.6
24.000	3.6	(N/A)	(N/A)	(N/A)	(N/A)

Proposed Conditions

Subsection: Time of Concentration Calculations
Label: A1

Return Event: 2 years
Storm Event: 2-YEAR

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	100.00 ft
Manning's n	0.150
Slope	0.050 ft/ft
2 Year 24 Hour Depth	3.6 in
Average Velocity	0.26 ft/s
Segment Time of Concentration	0.107 hours

Segment #2: TR-55 Shallow Concentrated Flow	
Hydraulic Length	300.00 ft
Is Paved?	False
Slope	0.070 ft/ft
Average Velocity	4.27 ft/s
Segment Time of Concentration	0.020 hours

Segment #3: Length and Velocity	
Hydraulic Length	740.00 ft
Velocity	15.00 ft/s
Segment Time of Concentration	0.014 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.140 hours

==== User Defined Length & Velocity

Tc = (Lf / V) / 3600

Where:
Tc= Time of concentration, hours
Lf= Flow length, feet
V= Velocity, ft/sec

==== SCS Channel Flow

Tc =
R = Qa / Wp
V = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n

(Lf / V) / 3600

Where:
R= Hydraulic radius
Aq= Flow area, square feet
Wp= Wetted perimeter, feet
V= Velocity, ft/sec
Sf= Slope, ft/ft
n= Manning's n
Tc= Time of concentration, hours
Lf= Flow length, feet

==== SCS TR-55 Shallow Concentration Flow

Unpaved surface:
V = 16.1345 * (Sf**0.5)

Tc =
Paved Surface:
V = 20.3282 * (Sf**0.5)

(Lf / V) / 3600

Where:
V= Velocity, ft/sec
Sf= Slope, ft/ft
Tc= Time of concentration, hours
Lf= Flow length, feet

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	100.00 ft
Manning's n	0.150
Slope	0.080 ft/ft
2 Year 24 Hour Depth	3.6 in
Average Velocity	0.31 ft/s
Segment Time of Concentration	0.088 hours

Segment #2: TR-55 Shallow Concentrated Flow	
Hydraulic Length	300.00 ft
Is Paved?	False
Slope	0.070 ft/ft
Average Velocity	4.27 ft/s
Segment Time of Concentration	0.020 hours

Segment #3: Length and Velocity	
Hydraulic Length	970.00 ft
Velocity	15.00 ft/s
Segment Time of Concentration	0.018 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.126 hours

==== User Defined Length & Velocity

Tc = (Lf / V) / 3600

Where:
Tc= Time of concentration, hours
Lf= Flow length, feet
V= Velocity, ft/sec

==== SCS Channel Flow

Tc =
R = Qa / Wp
V = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n

(Lf / V) / 3600

Where:
R= Hydraulic radius
Aq= Flow area, square feet
Wp= Wetted perimeter, feet
V= Velocity, ft/sec
Sf= Slope, ft/ft
n= Manning's n
Tc= Time of concentration, hours
Lf= Flow length, feet

==== SCS TR-55 Shallow Concentration Flow

Unpaved surface:
V = 16.1345 * (Sf**0.5)

Tc =
Paved Surface:
V = 20.3282 * (Sf**0.5)

(Lf / V) / 3600

Where:
V= Velocity, ft/sec
Sf= Slope, ft/ft
Tc= Time of concentration, hours
Lf= Flow length, feet

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	25.00 ft
Manning's n	0.150
Slope	0.030 ft/ft
2 Year 24 Hour Depth	3.6 in
Average Velocity	0.16 ft/s
Segment Time of Concentration	0.043 hours

Segment #2: TR-55 Shallow Concentrated Flow	
Hydraulic Length	90.00 ft
Is Paved?	True
Slope	0.020 ft/ft
Average Velocity	2.87 ft/s
Segment Time of Concentration	0.009 hours

Segment #3: Length and Velocity	
Hydraulic Length	880.00 ft
Velocity	15.00 ft/s
Segment Time of Concentration	0.016 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.100 hours

==== User Defined Length & Velocity

Tc = (Lf / V) / 3600

Where:
Tc= Time of concentration, hours
Lf= Flow length, feet
V= Velocity, ft/sec

==== SCS Channel Flow

Tc =
R = Qa / Wp
V = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n

(Lf / V) / 3600

Where:
R= Hydraulic radius
Aq= Flow area, square feet
Wp= Wetted perimeter, feet
V= Velocity, ft/sec
Sf= Slope, ft/ft
n= Manning's n
Tc= Time of concentration, hours
Lf= Flow length, feet

==== SCS TR-55 Shallow Concentration Flow

Unpaved surface:
V = 16.1345 * (Sf**0.5)

Tc =
Paved Surface:
V = 20.3282 * (Sf**0.5)

(Lf / V) / 3600

Where:
V= Velocity, ft/sec
Sf= Slope, ft/ft
Tc= Time of concentration, hours
Lf= Flow length, feet

Proposed Conditions

Subsection: Time of Concentration Calculations
Label: A3a

Return Event: 2 years
Storm Event: 2-YEAR

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	100.00 ft
Manning's n	0.150
Slope	0.050 ft/ft
2 Year 24 Hour Depth	3.6 in
Average Velocity	0.26 ft/s
Segment Time of Concentration	0.107 hours

Segment #2: TR-55 Shallow Concentrated Flow	
Hydraulic Length	300.00 ft
Is Paved?	False
Slope	0.150 ft/ft
Average Velocity	6.25 ft/s
Segment Time of Concentration	0.013 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.120 hours

Proposed Conditions

Subsection: Time of Concentration Calculations
Label: A3a

Return Event: 2 years
Storm Event: 2-YEAR

==== SCS Channel Flow

Tc =

R = Qa / Wp
V = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n

(Lf / V) / 3600

Where:

R= Hydraulic radius
Aq= Flow area, square feet
Wp= Wetted perimeter, feet
V= Velocity, ft/sec
Sf= Slope, ft/ft
n= Manning's n
Tc= Time of concentration, hours
Lf= Flow length, feet

==== SCS TR-55 Shallow Concentration Flow

Tc =

Unpaved surface:
V = 16.1345 * (Sf**0.5)

Paved Surface:
V = 20.3282 * (Sf**0.5)

(Lf / V) / 3600

Where:

V= Velocity, ft/sec
Sf= Slope, ft/ft
Tc= Time of concentration, hours
Lf= Flow length, feet

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	100.00 ft
Manning's n	0.011
Slope	0.020 ft/ft
2 Year 24 Hour Depth	3.6 in
Average Velocity	1.46 ft/s
Segment Time of Concentration	0.019 hours

Segment #2: TR-55 Shallow Concentrated Flow	
Hydraulic Length	300.00 ft
Is Paved?	True
Slope	0.020 ft/ft
Average Velocity	2.87 ft/s
Segment Time of Concentration	0.029 hours

Segment #3: Length and Velocity	
Hydraulic Length	4,750.00 ft
Velocity	7.00 ft/s
Segment Time of Concentration	0.188 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.237 hours

==== User Defined Length & Velocity

Tc = (Lf / V) / 3600

Where:
Tc= Time of concentration, hours
Lf= Flow length, feet
V= Velocity, ft/sec

==== SCS Channel Flow

Tc =
R = Qa / Wp
V = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n

(Lf / V) / 3600

Where:
R= Hydraulic radius
Aq= Flow area, square feet
Wp= Wetted perimeter, feet
V= Velocity, ft/sec
Sf= Slope, ft/ft
n= Manning's n
Tc= Time of concentration, hours
Lf= Flow length, feet

==== SCS TR-55 Shallow Concentration Flow

Unpaved surface:
V = 16.1345 * (Sf**0.5)

Tc =
Paved Surface:
V = 20.3282 * (Sf**0.5)

(Lf / V) / 3600

Where:
V= Velocity, ft/sec
Sf= Slope, ft/ft
Tc= Time of concentration, hours
Lf= Flow length, feet

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	100.00 ft
Manning's n	0.150
Slope	0.080 ft/ft
2 Year 24 Hour Depth	3.6 in
Average Velocity	0.31 ft/s
Segment Time of Concentration	0.088 hours

Segment #2: TR-55 Shallow Concentrated Flow	
Hydraulic Length	300.00 ft
Is Paved?	False
Slope	0.080 ft/ft
Average Velocity	4.56 ft/s
Segment Time of Concentration	0.018 hours

Segment #3: Length and Velocity	
Hydraulic Length	740.00 ft
Velocity	15.00 ft/s
Segment Time of Concentration	0.014 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.120 hours

==== User Defined Length & Velocity

Tc = (Lf / V) / 3600

Where:
Tc= Time of concentration, hours
Lf= Flow length, feet
V= Velocity, ft/sec

==== SCS Channel Flow

Tc =
R = Qa / Wp
V = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n

(Lf / V) / 3600

Where:
R= Hydraulic radius
Aq= Flow area, square feet
Wp= Wetted perimeter, feet
V= Velocity, ft/sec
Sf= Slope, ft/ft
n= Manning's n
Tc= Time of concentration, hours
Lf= Flow length, feet

==== SCS TR-55 Shallow Concentration Flow

Unpaved surface:
V = 16.1345 * (Sf**0.5)

Tc =
Paved Surface:
V = 20.3282 * (Sf**0.5)

(Lf / V) / 3600

Where:
V= Velocity, ft/sec
Sf= Slope, ft/ft
Tc= Time of concentration, hours
Lf= Flow length, feet

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	100.00 ft
Manning's n	0.150
Slope	0.070 ft/ft
2 Year 24 Hour Depth	3.6 in
Average Velocity	0.30 ft/s
Segment Time of Concentration	0.093 hours

Segment #2: TR-55 Shallow Concentrated Flow	
Hydraulic Length	300.00 ft
Is Paved?	False
Slope	0.070 ft/ft
Average Velocity	4.27 ft/s
Segment Time of Concentration	0.020 hours

Segment #3: Length and Velocity	
Hydraulic Length	440.00 ft
Velocity	15.00 ft/s
Segment Time of Concentration	0.008 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.121 hours

==== User Defined Length & Velocity

Tc = (Lf / V) / 3600

Where:
Tc= Time of concentration, hours
Lf= Flow length, feet
V= Velocity, ft/sec

==== SCS Channel Flow

Tc =
R = Qa / Wp
V = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n

(Lf / V) / 3600

Where:
R= Hydraulic radius
Aq= Flow area, square feet
Wp= Wetted perimeter, feet
V= Velocity, ft/sec
Sf= Slope, ft/ft
n= Manning's n
Tc= Time of concentration, hours
Lf= Flow length, feet

==== SCS TR-55 Shallow Concentration Flow

Unpaved surface:
V = 16.1345 * (Sf**0.5)

Tc =
Paved Surface:
V = 20.3282 * (Sf**0.5)

(Lf / V) / 3600

Where:
V= Velocity, ft/sec
Sf= Slope, ft/ft
Tc= Time of concentration, hours
Lf= Flow length, feet

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	65.00 ft
Manning's n	0.150
Slope	0.030 ft/ft
2 Year 24 Hour Depth	3.6 in
Average Velocity	0.19 ft/s
Segment Time of Concentration	0.093 hours

Segment #2: TR-55 Shallow Concentrated Flow	
Hydraulic Length	300.00 ft
Is Paved?	True
Slope	0.030 ft/ft
Average Velocity	3.52 ft/s
Segment Time of Concentration	0.024 hours

Segment #3: Length and Velocity	
Hydraulic Length	850.00 ft
Velocity	10.00 ft/s
Segment Time of Concentration	0.024 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.140 hours

==== User Defined Length & Velocity

Tc = (Lf / V) / 3600

Where:
Tc= Time of concentration, hours
Lf= Flow length, feet
V= Velocity, ft/sec

==== SCS Channel Flow

Tc =
R = Qa / Wp
V = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n

(Lf / V) / 3600

Where:
R= Hydraulic radius
Aq= Flow area, square feet
Wp= Wetted perimeter, feet
V= Velocity, ft/sec
Sf= Slope, ft/ft
n= Manning's n
Tc= Time of concentration, hours
Lf= Flow length, feet

==== SCS TR-55 Shallow Concentration Flow

Unpaved surface:
V = 16.1345 * (Sf**0.5)

Tc =
Paved Surface:
V = 20.3282 * (Sf**0.5)

(Lf / V) / 3600

Where:
V= Velocity, ft/sec
Sf= Slope, ft/ft
Tc= Time of concentration, hours
Lf= Flow length, feet

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	100.00 ft
Manning's n	0.150
Slope	0.120 ft/ft
2 Year 24 Hour Depth	3.6 in
Average Velocity	0.37 ft/s
Segment Time of Concentration	0.075 hours

Segment #2: TR-55 Shallow Concentrated Flow	
Hydraulic Length	220.00 ft
Is Paved?	False
Slope	0.180 ft/ft
Average Velocity	6.85 ft/s
Segment Time of Concentration	0.009 hours

Segment #3: Length and Velocity	
Hydraulic Length	220.00 ft
Velocity	7.00 ft/s
Segment Time of Concentration	0.009 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.100 hours

==== User Defined Length & Velocity

Tc = (Lf / V) / 3600

Where:
Tc= Time of concentration, hours
Lf= Flow length, feet
V= Velocity, ft/sec

==== SCS Channel Flow

Tc =
R = Qa / Wp
V = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n

(Lf / V) / 3600

Where:
R= Hydraulic radius
Aq= Flow area, square feet
Wp= Wetted perimeter, feet
V= Velocity, ft/sec
Sf= Slope, ft/ft
n= Manning's n
Tc= Time of concentration, hours
Lf= Flow length, feet

==== SCS TR-55 Shallow Concentration Flow

Unpaved surface:
V = 16.1345 * (Sf**0.5)

Tc =
Paved Surface:
V = 20.3282 * (Sf**0.5)

(Lf / V) / 3600

Where:
V= Velocity, ft/sec
Sf= Slope, ft/ft
Tc= Time of concentration, hours
Lf= Flow length, feet

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	100.00 ft
Manning's n	0.150
Slope	0.128 ft/ft
2 Year 24 Hour Depth	3.6 in
Average Velocity	0.38 ft/s
Segment Time of Concentration	0.073 hours

Segment #2: TR-55 Shallow Concentrated Flow	
Hydraulic Length	200.00 ft
Is Paved?	False
Slope	0.150 ft/ft
Average Velocity	6.25 ft/s
Segment Time of Concentration	0.009 hours

Segment #3: Length and Velocity	
Hydraulic Length	640.00 ft
Velocity	10.00 ft/s
Segment Time of Concentration	0.018 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.100 hours

==== User Defined Length & Velocity

Tc = (Lf / V) / 3600

Where:
Tc= Time of concentration, hours
Lf= Flow length, feet
V= Velocity, ft/sec

==== SCS Channel Flow

Tc =
R = Qa / Wp
V = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n

(Lf / V) / 3600

Where:
R= Hydraulic radius
Aq= Flow area, square feet
Wp= Wetted perimeter, feet
V= Velocity, ft/sec
Sf= Slope, ft/ft
n= Manning's n
Tc= Time of concentration, hours
Lf= Flow length, feet

==== SCS TR-55 Shallow Concentration Flow

Unpaved surface:
V = 16.1345 * (Sf**0.5)

Tc =
Paved Surface:
V = 20.3282 * (Sf**0.5)

(Lf / V) / 3600

Where:
V= Velocity, ft/sec
Sf= Slope, ft/ft
Tc= Time of concentration, hours
Lf= Flow length, feet

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	100.00 ft
Manning's n	0.150
Slope	0.030 ft/ft
2 Year 24 Hour Depth	3.6 in
Average Velocity	0.21 ft/s
Segment Time of Concentration	0.131 hours

Segment #2: TR-55 Shallow Concentrated Flow	
Hydraulic Length	300.00 ft
Is Paved?	False
Slope	0.030 ft/ft
Average Velocity	2.79 ft/s
Segment Time of Concentration	0.030 hours

Segment #3: Length and Velocity	
Hydraulic Length	3,570.00 ft
Velocity	10.00 ft/s
Segment Time of Concentration	0.099 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.260 hours

==== User Defined Length & Velocity

Tc =	(Lf / V) / 3600
Where:	Tc= Time of concentration, hours Lf= Flow length, feet V= Velocity, ft/sec

==== SCS Channel Flow

Tc =	R = Qa / Wp V = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n (Lf / V) / 3600
Where:	R= Hydraulic radius Aq= Flow area, square feet Wp= Wetted perimeter, feet V= Velocity, ft/sec Sf= Slope, ft/ft n= Manning's n Tc= Time of concentration, hours Lf= Flow length, feet

==== SCS TR-55 Shallow Concentration Flow

Tc =	Unpaved surface: V = 16.1345 * (Sf**0.5) Paved Surface: V = 20.3282 * (Sf**0.5) (Lf / V) / 3600
Where:	V= Velocity, ft/sec Sf= Slope, ft/ft Tc= Time of concentration, hours Lf= Flow length, feet

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	100.00 ft
Manning's n	0.150
Slope	0.120 ft/ft
2 Year 24 Hour Depth	3.6 in
Average Velocity	0.37 ft/s
Segment Time of Concentration	0.075 hours

Segment #2: TR-55 Shallow Concentrated Flow	
Hydraulic Length	90.00 ft
Is Paved?	False
Slope	0.080 ft/ft
Average Velocity	4.56 ft/s
Segment Time of Concentration	0.005 hours

Segment #3: Length and Velocity	
Hydraulic Length	550.00 ft
Velocity	15.00 ft/s
Segment Time of Concentration	0.010 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.100 hours

==== User Defined Length & Velocity

Tc = (Lf / V) / 3600

Where:
Tc= Time of concentration, hours
Lf= Flow length, feet
V= Velocity, ft/sec

==== SCS Channel Flow

Tc =
R = Qa / Wp
V = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n

(Lf / V) / 3600

Where:
R= Hydraulic radius
Aq= Flow area, square feet
Wp= Wetted perimeter, feet
V= Velocity, ft/sec
Sf= Slope, ft/ft
n= Manning's n
Tc= Time of concentration, hours
Lf= Flow length, feet

==== SCS TR-55 Shallow Concentration Flow

Unpaved surface:
V = 16.1345 * (Sf**0.5)

Tc =
Paved Surface:
V = 20.3282 * (Sf**0.5)

(Lf / V) / 3600

Where:
V= Velocity, ft/sec
Sf= Slope, ft/ft
Tc= Time of concentration, hours
Lf= Flow length, feet

Proposed Conditions

Subsection: Time of Concentration Calculations
Label: B1a

Return Event: 2 years
Storm Event: 2-YEAR

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	100.00 ft
Manning's n	0.150
Slope	0.120 ft/ft
2 Year 24 Hour Depth	3.6 in
Average Velocity	0.37 ft/s
Segment Time of Concentration	0.075 hours

Segment #2: TR-55 Shallow Concentrated Flow	
Hydraulic Length	190.00 ft
Is Paved?	False
Slope	0.120 ft/ft
Average Velocity	5.59 ft/s
Segment Time of Concentration	0.009 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.100 hours

==== SCS Channel Flow

Tc =

R = Qa / Wp
V = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n

(Lf / V) / 3600

Where:

R= Hydraulic radius
Aq= Flow area, square feet
Wp= Wetted perimeter, feet
V= Velocity, ft/sec
Sf= Slope, ft/ft
n= Manning's n
Tc= Time of concentration, hours
Lf= Flow length, feet

==== SCS TR-55 Shallow Concentration Flow

Tc =

Unpaved surface:
V = 16.1345 * (Sf**0.5)

Paved Surface:
V = 20.3282 * (Sf**0.5)

(Lf / V) / 3600

Where:

V= Velocity, ft/sec
Sf= Slope, ft/ft
Tc= Time of concentration, hours
Lf= Flow length, feet

Proposed Conditions

Subsection: Time of Concentration Calculations
Label: C1

Return Event: 2 years
Storm Event: 2-YEAR

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	100.00 ft
Manning's n	0.150
Slope	0.020 ft/ft
2 Year 24 Hour Depth	3.6 in
Average Velocity	0.18 ft/s
Segment Time of Concentration	0.154 hours

Segment #2: TR-55 Shallow Concentrated Flow	
Hydraulic Length	120.00 ft
Is Paved?	False
Slope	0.020 ft/ft
Average Velocity	2.28 ft/s
Segment Time of Concentration	0.015 hours

Segment #3: Length and Velocity	
Hydraulic Length	3,020.00 ft
Velocity	10.00 ft/s
Segment Time of Concentration	0.084 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.252 hours

Proposed Conditions

Subsection: Time of Concentration Calculations
Label: C1

Return Event: 2 years
Storm Event: 2-YEAR

==== User Defined Length & Velocity

Tc =	(Lf / V) / 3600
Where:	Tc= Time of concentration, hours Lf= Flow length, feet V= Velocity, ft/sec

==== SCS Channel Flow

Tc =	R = Qa / Wp V = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n (Lf / V) / 3600
Where:	R= Hydraulic radius Aq= Flow area, square feet Wp= Wetted perimeter, feet V= Velocity, ft/sec Sf= Slope, ft/ft n= Manning's n Tc= Time of concentration, hours Lf= Flow length, feet

==== SCS TR-55 Shallow Concentration Flow

Tc =	Unpaved surface: V = 16.1345 * (Sf**0.5) Paved Surface: V = 20.3282 * (Sf**0.5) (Lf / V) / 3600
Where:	V= Velocity, ft/sec Sf= Slope, ft/ft Tc= Time of concentration, hours Lf= Flow length, feet

Proposed Conditions

Subsection: Time of Concentration Calculations
Label: C1a

Return Event: 2 years
Storm Event: 2-YEAR

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	100.00 ft
Manning's n	0.150
Slope	0.120 ft/ft
2 Year 24 Hour Depth	3.6 in
Average Velocity	0.37 ft/s
Segment Time of Concentration	0.075 hours

Segment #2: TR-55 Shallow Concentrated Flow	
Hydraulic Length	300.00 ft
Is Paved?	False
Slope	0.120 ft/ft
Average Velocity	5.59 ft/s
Segment Time of Concentration	0.015 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.100 hours

==== SCS Channel Flow

Tc =

R = Qa / Wp
V = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n

(Lf / V) / 3600

Where:

R= Hydraulic radius
Aq= Flow area, square feet
Wp= Wetted perimeter, feet
V= Velocity, ft/sec
Sf= Slope, ft/ft
n= Manning's n
Tc= Time of concentration, hours
Lf= Flow length, feet

==== SCS TR-55 Shallow Concentration Flow

Tc =

Unpaved surface:
V = 16.1345 * (Sf**0.5)

Paved Surface:
V = 20.3282 * (Sf**0.5)

(Lf / V) / 3600

Where:

V= Velocity, ft/sec
Sf= Slope, ft/ft
Tc= Time of concentration, hours
Lf= Flow length, feet

Proposed Conditions

Subsection: Channel Routing Summary
Label: A3-A1

Return Event: 2 years
Storm Event: 2-YEAR

Infiltration	
Infiltration Method	No Infiltration

Translation Routing Summary	
Flow (Base)	0.00 ft³/s
Translate	0.010 hours

	Inflow Hydrograph	Outflow Hydrograph
Time Start (hours)...	0.000	0.020
Time Step (hours)...	0.010	0.010
Time End (hours)...	24.000	24.020
Peak Time (hours)...	12.140	12.160
Peak Flow (ft³/s)...	454.72	454.72

Inflow/Outflow Volumes	
Volume (Routing, Inflow)	1.076 ac-ft
Volume (Routing, Unrouted)	0.000 ac-ft
Volume (Routing, Base Flow)	0.000 ac-ft
Volume (Routing, Infiltration)	0.000 ac-ft
Volume (Routing, Outflow)	1.076 ac-ft

Infiltration	
Infiltration Method	No Infiltration

Translation Routing Summary	
Flow (Base)	0.00 ft³/s
Translate	0.020 hours

	Inflow Hydrograph	Outflow Hydrograph
Time Start (hours)...	0.000	0.020
Time Step (hours)...	0.010	0.010
Time End (hours)...	24.000	24.020
Peak Time (hours)...	12.140	12.160
Peak Flow (ft³/s)...	454.72	454.72

Inflow/Outflow Volumes	
Volume (Routing, Inflow)	78.525 ac-ft
Volume (Routing, Unrouted)	0.000 ac-ft
Volume (Routing, Base Flow)	0.000 ac-ft
Volume (Routing, Infiltration)	0.000 ac-ft
Volume (Routing, Outflow)	78.525 ac-ft

Infiltration	
Infiltration Method	No Infiltration

Translation Routing Summary	
Flow (Base)	0.00 ft³/s
Translate	0.030 hours

	Inflow Hydrograph	Outflow Hydrograph
Time Start (hours)...	0.000	0.020
Time Step (hours)...	0.010	0.010
Time End (hours)...	24.000	24.020
Peak Time (hours)...	12.140	12.160
Peak Flow (ft³/s)...	454.72	454.72

Inflow/Outflow Volumes	
Volume (Routing, Inflow)	44.250 ac-ft
Volume (Routing, Unrouted)	0.000 ac-ft
Volume (Routing, Base Flow)	0.000 ac-ft
Volume (Routing, Infiltration)	0.000 ac-ft
Volume (Routing, Outflow)	44.250 ac-ft

Proposed Conditions

Subsection: Channel Routing Summary
Label: A8-A6

Return Event: 2 years
Storm Event: 2-YEAR

Infiltration	
Infiltration Method	No Infiltration

Translation Routing Summary	
Flow (Base)	0.00 ft³/s
Translate	0.010 hours

	Inflow Hydrograph	Outflow Hydrograph
Time Start (hours)...	0.000	0.020
Time Step (hours)...	0.010	0.010
Time End (hours)...	24.000	24.020
Peak Time (hours)...	12.140	12.160
Peak Flow (ft³/s)...	454.72	454.72

Inflow/Outflow Volumes	
Volume (Routing, Inflow)	42.667 ac-ft
Volume (Routing, Unrouted)	0.000 ac-ft
Volume (Routing, Base Flow)	0.000 ac-ft
Volume (Routing, Infiltration)	0.000 ac-ft
Volume (Routing, Outflow)	42.667 ac-ft

Proposed Conditions

Subsection: Channel Routing Summary
Label: A9-A8

Return Event: 2 years
Storm Event: 2-YEAR

Infiltration	
Infiltration Method	No Infiltration

Translation Routing Summary	
Flow (Base)	0.00 ft³/s
Translate	0.020 hours

	Inflow Hydrograph	Outflow Hydrograph
Time Start (hours)...	0.000	0.020
Time Step (hours)...	0.010	0.010
Time End (hours)...	24.000	24.020
Peak Time (hours)...	12.140	12.160
Peak Flow (ft³/s)...	454.72	454.72

Inflow/Outflow Volumes	
Volume (Routing, Inflow)	39.549 ac-ft
Volume (Routing, Unrouted)	0.000 ac-ft
Volume (Routing, Base Flow)	0.000 ac-ft
Volume (Routing, Infiltration)	0.000 ac-ft
Volume (Routing, Outflow)	39.549 ac-ft

Proposed Conditions

Subsection: Elevation-Area Volume Curve
Label: A3

Return Event: 2 years
Storm Event: 2-YEAR

Elevation (ft)	Planimeter (ft^2)	Area (acres)	A1+A2+sqr(A1*A2) (acres)	Volume (ac-ft)	Volume (Total) (ac-ft)
922.00	0.0	0.190	0.000	0.000	0.000
924.00	0.0	0.270	0.686	0.458	0.458
926.00	0.0	0.340	0.913	0.609	1.066
928.00	0.0	0.418	1.135	0.757	1.823
930.00	0.0	0.500	1.375	0.916	2.739

Proposed Conditions

Subsection: Elevation-Area Volume Curve
Label: A7

Return Event: 2 years
Storm Event: 2-YEAR

Elevation (ft)	Planimeter (ft²)	Area (acres)	A1+A2+sqr(A1*A2) (acres)	Volume (ac-ft)	Volume (Total) (ac-ft)
930.00	0.0	0.137	0.000	0.000	0.000
932.00	0.0	0.206	0.511	0.341	0.341
934.00	0.0	0.286	0.735	0.490	0.830
936.00	0.0	0.390	1.010	0.673	1.504
938.00	0.0	0.497	1.327	0.885	2.389

Proposed Conditions

Subsection: Elevation-Area Volume Curve
Label: B1

Return Event: 2 years
Storm Event: 2-YEAR

Elevation (ft)	Planimeter (ft^2)	Area (acres)	A1+A2+sqr(A1*A2) (acres)	Volume (ac-ft)	Volume (Total) (ac-ft)
920.00	0.0	0.145	0.000	0.000	0.000
930.00	0.0	0.427	0.821	2.736	2.736

Proposed Conditions

Subsection: Elevation-Area Volume Curve
Label: C1

Return Event: 2 years
Storm Event: 2-YEAR

Elevation (ft)	Planimeter (ft^2)	Area (acres)	A1+A2+sqr(A1*A2) (acres)	Volume (ac-ft)	Volume (Total) (ac-ft)
910.00	0.0	0.000	0.000	0.000	0.000
911.00	0.0	0.014	0.015	0.005	0.005
912.00	0.0	0.035	0.071	0.024	0.029
913.00	0.0	0.073	0.159	0.053	0.082
914.00	0.0	0.134	0.306	0.102	0.184
915.00	0.0	0.206	0.506	0.169	0.353
916.00	0.0	0.288	0.738	0.246	0.599
917.00	0.0	0.415	1.050	0.350	0.949
918.00	0.0	0.575	1.479	0.493	1.441
919.00	0.0	0.754	1.987	0.662	2.104
920.00	0.0	0.949	2.549	0.850	2.953
921.00	0.0	1.158	3.156	1.052	4.005
922.00	0.0	1.367	3.783	1.261	5.266
923.00	0.0	1.575	4.408	1.469	6.736
924.00	0.0	1.803	5.063	1.688	8.423
925.00	0.0	2.057	5.786	1.929	10.352
926.00	0.0	2.337	6.587	2.196	12.548
927.00	0.0	2.652	7.478	2.493	15.040
928.00	0.0	3.001	8.473	2.824	17.864
929.00	0.0	3.370	9.551	3.184	21.048

Proposed Conditions

Subsection: Elevation-Area Volume Curve
Label: EX POND

Return Event: 2 years
Storm Event: 2-YEAR

Elevation (ft)	Planimeter (ft^2)	Area (acres)	A1+A2+sqr(A1*A2) (acres)	Volume (ac-ft)	Volume (Total) (ac-ft)
928.00	0.0	1.487	0.000	0.000	0.000
929.00	0.0	1.929	5.109	1.703	1.703
930.00	0.0	2.218	6.215	2.072	3.775
931.00	0.0	2.466	7.023	2.341	6.115
932.00	0.0	2.756	7.830	2.610	8.725
933.00	0.0	2.981	8.604	2.868	11.593
934.00	0.0	3.199	9.269	3.090	14.683
935.00	0.0	3.454	9.976	3.325	18.008

Requested Pond Water Surface Elevations	
Minimum (Headwater)	922.00 ft
Increment (Headwater)	0.50 ft
Maximum (Headwater)	930.00 ft

Outlet Connectivity

Structure Type	Outlet ID	Direction	Outfall	E1 (ft)	E2 (ft)
Orifice-Circular	Orifice - 1	Forward	Culvert - 1	922.00	930.00
Orifice-Area	Orifice - 2	Forward	Culvert - 1	926.00	930.00
Culvert-Circular	Culvert - 1	Forward	TW	914.00	930.00
Tailwater Settings	Tailwater			(N/A)	(N/A)

Structure ID: Culvert - 1 Structure Type: Culvert-Circular	
Number of Barrels	1
Diameter	18.0 in
Length	110.00 ft
Length (Computed Barrel)	110.02 ft
Slope (Computed)	0.018 ft/ft

Outlet Control Data	
Manning's n	0.013
Ke	0.500
Kb	0.018
Kr	1.000
Convergence Tolerance	0.00 ft

Inlet Control Data	
Equation Form	Form 1
K	0.0078
M	2.0000
C	0.0379
Y	0.6900
T1 ratio (HW/D)	1.127
T2 ratio (HW/D)	1.287
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	915.69 ft	T1 Flow	7.58 ft³/s
T2 Elevation	915.93 ft	T2 Flow	8.66 ft³/s

Structure ID: Orifice - 1 Structure Type: Orifice-Circular	
Number of Openings	1
Elevation	922.00 ft
Orifice Diameter	4.0 in
Orifice Coefficient	0.600

Structure ID: Orifice - 2 Structure Type: Orifice-Area	
Number of Openings	1
Elevation	926.00 ft
Orifice Area	3.0 ft²
Top Elevation	927.00 ft
Datum Elevation	926.00 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
Flow Tolerance (Minimum)	0.001 ft³/s
Flow Tolerance (Maximum)	10.000 ft³/s

Requested Pond Water Surface Elevations	
Minimum (Headwater)	930.00 ft
Increment (Headwater)	0.50 ft
Maximum (Headwater)	938.00 ft

Outlet Connectivity

Structure Type	Outlet ID	Direction	Outfall	E1 (ft)	E2 (ft)
Orifice-Circular	Orifice - 1	Forward	Culvert - 1	930.00	938.00
Orifice-Circular	Orifice - 3	Forward	Culvert - 1	933.25	938.00
Orifice-Area	Orifice - 2	Forward	Culvert - 1	934.00	938.00
Culvert-Circular	Culvert - 1	Forward	TW	928.00	938.00
Tailwater Settings	Tailwater			(N/A)	(N/A)

Structure ID: Culvert - 1 Structure Type: Culvert-Circular	
Number of Barrels	1
Diameter	18.0 in
Length	140.00 ft
Length (Computed Barrel)	140.01 ft
Slope (Computed)	0.014 ft/ft

Outlet Control Data	
Manning's n	0.013
Ke	0.500
Kb	0.018
Kr	0.000
Convergence Tolerance	0.00 ft

Inlet Control Data	
Equation Form	Form 1
K	0.0078
M	2.0000
C	0.0379
Y	0.6900
T1 ratio (HW/D)	1.129
T2 ratio (HW/D)	1.289
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	929.69 ft	T1 Flow	7.58 ft³/s
T2 Elevation	929.93 ft	T2 Flow	8.66 ft³/s

Structure ID: Orifice - 1 Structure Type: Orifice-Circular	
Number of Openings	1
Elevation	930.00 ft
Orifice Diameter	4.0 in
Orifice Coefficient	0.600

Structure ID: Orifice - 2 Structure Type: Orifice-Area	
Number of Openings	1
Elevation	934.00 ft
Orifice Area	3.0 ft²
Top Elevation	935.00 ft
Datum Elevation	934.00 ft
Orifice Coefficient	0.600

Structure ID: Orifice - 3 Structure Type: Orifice-Circular	
Number of Openings	1
Elevation	933.25 ft
Orifice Diameter	6.0 in
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
Flow Tolerance (Minimum)	0.001 ft³/s
Flow Tolerance (Maximum)	10.000 ft³/s

Requested Pond Water Surface Elevations	
Minimum (Headwater)	920.00 ft
Increment (Headwater)	0.50 ft
Maximum (Headwater)	930.00 ft

Outlet Connectivity

Structure Type	Outlet ID	Direction	Outfall	E1 (ft)	E2 (ft)
Orifice-Circular	WQv Orifice 1	Forward	Culvert - 15" RCP	920.00	930.00
Orifice-Circular	WQv Orifice 2	Forward	Culvert - 15" RCP	920.33	930.00
Orifice-Circular	WQv Orifice 3	Forward	Culvert - 15" RCP	920.67	930.00
Orifice-Circular	WQv Orifice 4	Forward	Culvert - 15" RCP	921.00	930.00
Orifice-Circular	WQv Orifice 5	Forward	Culvert - 15" RCP	921.33	930.00
Orifice-Circular	WQv Orifice 6	Forward	Culvert - 15" RCP	921.66	930.00
Orifice-Circular	Secondary Orifice	Forward	Culvert - 15" RCP	925.00	930.00
Culvert-Circular	Culvert - 15" RCP	Forward	TW	918.00	930.00
Tailwater Settings	Tailwater			(N/A)	(N/A)

Structure ID: Culvert - 15" RCP Structure Type: Culvert-Circular	
Number of Barrels	1
Diameter	15.0 in
Length	100.00 ft
Length (Computed Barrel)	100.15 ft
Slope (Computed)	0.055 ft/ft

Outlet Control Data	
Manning's n	0.013
Ke	0.500
Kb	0.023
Kr	0.000
Convergence Tolerance	0.00 ft

Inlet Control Data	
Equation Form	Form 1
K	0.0098
M	2.0000
C	0.0398
Y	0.6700
T1 ratio (HW/D)	1.133
T2 ratio (HW/D)	1.279
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	919.42 ft	T1 Flow	4.80 ft³/s
T2 Elevation	919.60 ft	T2 Flow	5.49 ft³/s

Structure ID: Secondary Orifice Structure Type: Orifice-Circular	
Number of Openings	1
Elevation	925.00 ft
Orifice Diameter	12.0 in
Orifice Coefficient	0.600

Structure ID: WQv Orifice 1 Structure Type: Orifice-Circular	
Number of Openings	1
Elevation	920.00 ft
Orifice Diameter	2.0 in
Orifice Coefficient	0.600

Structure ID: WQv Orifice 2 Structure Type: Orifice-Circular	
Number of Openings	1
Elevation	920.33 ft
Orifice Diameter	2.0 in
Orifice Coefficient	0.600

Structure ID: WQv Orifice 3 Structure Type: Orifice-Circular	
Number of Openings	1
Elevation	920.67 ft
Orifice Diameter	2.0 in
Orifice Coefficient	0.600

Structure ID: WQv Orifice 4 Structure Type: Orifice-Circular	
Number of Openings	1
Elevation	921.00 ft
Orifice Diameter	2.0 in
Orifice Coefficient	0.600

Structure ID: WQv Orifice 5 Structure Type: Orifice-Circular	
Number of Openings	1
Elevation	921.33 ft
Orifice Diameter	2.0 in
Orifice Coefficient	0.600

Structure ID: WQv Orifice 6

Structure Type: Orifice-Circular	
Number of Openings	1
Elevation	921.66 ft
Orifice Diameter	2.0 in
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
Flow Tolerance (Minimum)	0.001 ft^3/s
Flow Tolerance (Maximum)	10.000 ft^3/s

Requested Pond Water Surface Elevations	
Minimum (Headwater)	928.00 ft
Increment (Headwater)	0.50 ft
Maximum (Headwater)	935.00 ft

Outlet Connectivity

Structure Type	Outlet ID	Direction	Outfall	E1 (ft)	E2 (ft)
User Defined Table	Existing Pond Ogee Rating Table	Forward	TW	0.00	935.00
Tailwater Settings	Tailwater			(N/A)	(N/A)

Structure ID: Existing Pond Ogee Rating Table
Structure Type: User Defined Table

Elevation (ft)	Flow (ft³/s)
928.00	0.00
929.00	0.00
930.00	94.40
931.00	266.90
932.00	490.30
933.00	754.80
934.00	1,054.90
935.00	1,386.70

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

Requested Pond Water Surface Elevations	
Minimum (Headwater)	910.00 ft
Increment (Headwater)	0.50 ft
Maximum (Headwater)	929.00 ft

Outlet Connectivity

Structure Type	Outlet ID	Direction	Outfall	E1 (ft)	E2 (ft)
Orifice-Area	Orifice - 3	Forward	Culvert - 1	922.25	929.00
Inlet Box	Riser - 1	Forward	Culvert - 1	924.00	929.00
Orifice-Circular	Orifice - 1	Forward	Culvert - 1	910.00	929.00
Culvert-Circular	Culvert - 1	Forward	TW	909.00	929.00
Tailwater Settings	Tailwater			(N/A)	(N/A)

Structure ID: Culvert - 1 Structure Type: Culvert-Circular	
Number of Barrels	1
Diameter	42.0 in
Length	118.00 ft
Length (Computed Barrel)	118.00 ft
Slope (Computed)	0.008 ft/ft

Outlet Control Data	
Manning's n	0.013
Ke	0.200
Kb	0.006
Kr	1.000
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)	1.091
T2 ratio (HW/D)	1.193
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	912.82 ft	T1 Flow	63.00 ft³/s
T2 Elevation	913.18 ft	T2 Flow	72.00 ft³/s

Structure ID: Orifice - 1 Structure Type: Orifice-Circular	
Number of Openings	1
Elevation	910.00 ft
Orifice Diameter	24.0 in
Orifice Coefficient	0.600

Structure ID: Riser - 1 Structure Type: Inlet Box	
Number of Openings	1
Elevation	924.00 ft
Orifice Area	64.0 ft²
Orifice Coefficient	0.600
Weir Length	32.00 ft
Weir Coefficient	3.00 (ft^0.5)/s
K Reverse	1.000
Manning's n	0.000
Kev, Charged Riser	0.000
Weir Submergence	False
Orifice H to crest	False

Structure ID: Orifice - 3 Structure Type: Orifice-Area	
Number of Openings	3
Elevation	922.25 ft
Orifice Area	4.5 ft²
Top Elevation	923.00 ft
Datum Elevation	922.25 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

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

Proposed Conditions

Index

LEE'S SUMMIT
MISSOURI

Aug. 21, 2018

Melissa DeGonia, P.E.
Olsson Associates
1301 Burlington St.
North Kansas City, MO 64116

RE: Request for Waiver – Woodside Ridge Preliminary Development Plan - PL2018-103
City Engineer Approval of Specified Items

References:
a) Woodside Ridge Preliminary Stormwater Drainage Study dated June 2018
b) Letter dated June 22, 2018 from Olsson Associates

The City of Lee's Summit approves your request for the design exceptions listed below based on the request in the referenced letter dated June 22, 2018. Specifically, 5608.4(C)1 of the Design and Construction Manual is waived in terms of the requirement that the applicant provide detention in accordance with the Comprehensive Control Strategy at Point A1 shown on Exhibit A of the waiver request dated June 22, 2018. These exceptions may be incorporated into subsequent submittals necessary to complete the standard review and approval of construction plans by City Staff.

1. The request is a waiver to the peak rate control during the 2, 10, and 100 year storm events, and 40 hour extended detention for the 90% mean annual event to Point of Interest A1 shown on Exhibit 4 of the "Preliminary Stormwater Drainage Study" dated June 2018, and Point A1 shown on Exhibit A (attached) of the letter dated June 22, 2018 (attached).
2. Future peak flow rates to the above-referenced Point of Interest A1 shall be less than the existing peak flow rates to Point A1. In summary, the future peak flow rates will be reduced by 35 cfs for the 2 year event, 55 cfs for the 10 year event, and 76 cfs for the 100 year event.
3. The waiver is based on the findings contained in the "Woodside Ridge Preliminary Stormwater Drainage Study" dated June 2018.

SIGNED:

George M. Binger III, P.E.
City Engineer / Deputy Director of Public Works

Cvwaiver_Detentiona1.Docx

OLSSON ®
ASSOCIATES

MEMO

☐	Overnight
☐	Regular Mail
☐	Hand Delivery
☐	Other: _____

TO:	City of Lee's Summit Development Center
FROM:	Melissa G. DeGonia, PE
RE:	Woodside Ridge Detention Requirements
DATE:	June 22, 2018
OA PROJECT #:	018-1140
PHASE:	400
TASK:	400006

STATE OF MISSOURI
MELISSA G. DEGONIA
NUMBER PE-2011000892
7-24-18
PROFESSIONAL ENGINEER

The following is a request for A waiver for detention requirements within Watershed A, relating specifically to Point A1. Refer to attached exhibit for watershed characteristics in relation to the property and proposed improvements.

Per APWA Section 5608.4 and City of Lee's Summit criteria, the performance criteria for detention is to provide detention to limit peak flow rates at downstream points of interest to maximum release rates:

- 50% storm peak rate less than or equal to 0.5 cfs per site acre
- 10% storm peak rate less than or equal to 2.0 cfs per site acre
- 1% storm peak rate less than or equal to 3.0 cfs per site acre

In lieu of matching these "allowable" release rates, the Future Conditions peak flow rates will be reduced to less than the Existing Conditions.

This waiver is requested due to several challenges in relation to detention design, described below. Due to these limitations, it is not possible to collect and detain as much runoff as would be necessary to reduce the peak flow rates fully to the standard onsite release rates.

- The watershed consists of steep slopes which are heavily vegetated, making detention basins difficult to construct.
- The tributary flowing through Watershed A generally follows the property line, which results in stormwater generally sheet flowing directly to the tributary, instead of channelizing to create points of discharge where detention can be effective.

1301 Burlington, Suite 100
North Kansas City, MO 64116
TEL 816.587.4320
FAX 816.587.1393
www.olssonassociates.com

- For several reasons, detention within the channel is not feasible or advisable.
    - The channel is protected by a stream setback zone, and should therefore not be disturbed without necessity.
    - The onsite area is a small portion of the watershed, so there is a significant amount of offsite bypass contributing to the main tributary.
    - Constructing a dam would capture most of the offsite runoff which would excessively cut back peak flow rates in the channel, possibly resulting in increased erosion in the channel and diminution of the existing natural habitat.
    - The channel straddles the property line in most places, so detention would be partially offsite, on several existing lots.
    - An existing sanitary sewer trunk main follows the channel, and would be located underneath any new detention facility in the channel.

While the "allowable" release rates will not be met at Point A1, peak flow rates will be reduced significantly from the Existing Conditions rates in all storm events. Additionally, over 90% of the paved areas within Watershed A are captured and diverted to a detention facility or the existing pond, providing runoff control for most of the new developed area in the watershed, and water quality treatment for most of the proposed streets.

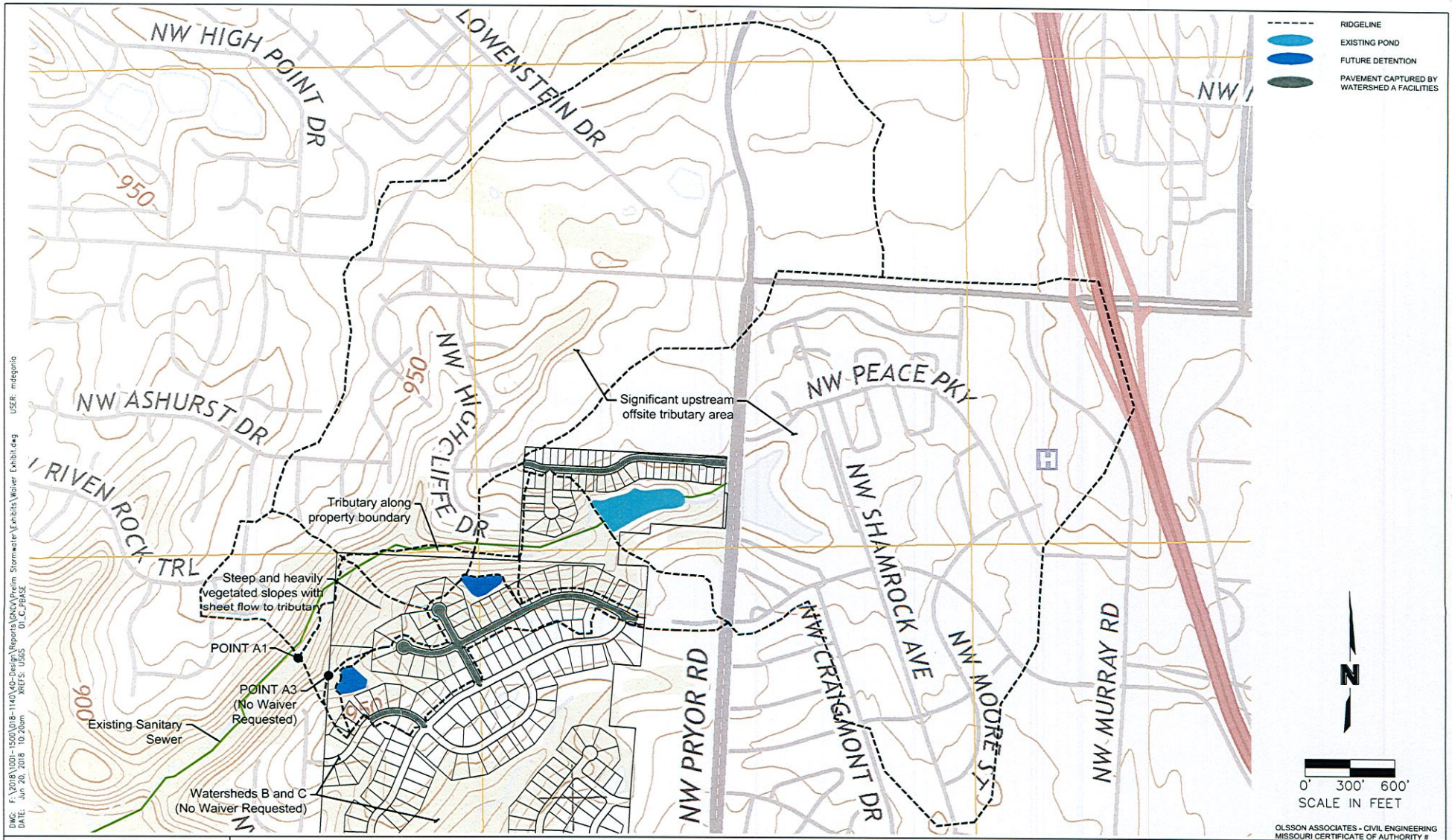
Below is a summary of proposed flow rates in relation to existing and the "allowable" release rates. For more information, reference the Woodside Ridge Preliminary Stormwater Drainage Study.

Table 1. Future vs. Allowable Release Rates

	Q_1 (cfs)	Q_{10} (cfs)	Q_{100} (cfs)
Future	898.31	1528.00	2519.41
Allowable	839.45	1489.65	2426.53
Difference	58.86	38.35	92.88

Table 2. Future vs. Existing Release Rates

	Q_1 (cfs)	Q_{10} (cfs)	Q_{100} (cfs)
Future	898.31	1528.00	2519.41
Existing	932.86	1582.99	2595.35
Difference	-34.55	-54.99	-75.94



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DATE: Jun 20, 2018 10:26am XREFS: USGS 01_C_BASE

PROJECT NO:	018-1140
DRAWN BY:	MGD
DATE:	06/20/2018

POINT A1 WAIVER REQUEST

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EXHIBIT
A