STORMWATER REPORT

Fire Station #4

5031 NE Lakewood Way
Lee's Summit, MO 64064

GLMVArchitecture

PREPARED BY: Derick Holmes, P.E.

Revision 0: January 5, 2022

Revision 1: February 11, 2022

STATE OF MISSOURI
DERICK M.
HOLMES
NUMBER
PE-2022005196
03/03/2022
PROFESSIONAL ENGINEER

REVISION NUMBER	DESCRIPTION	DATE	PROFESSIONAL	NOTES
0	INITIAL ISSUE	01/05/22	DERICK HOLMES	
1	REVISED PER CITY COMMENTS	02/11/22	DERICK HOLMES	STORMWATER NARRATIVE REVISED PER CITY COMMENTS PROVIDED 02/04/2022

CONTENTS

Appendices

References:

1. City of Lee's Summit, MO (January 13, 2022). *Section 5600 – Storm Drainage System & Facilities; City of Lee's Summit, Missouri Design Criteria*. Retrieved from https://cityofls.net/development-services/design/design-criteria/design-construction-manual-infrastructure
2. Kansas City Metropolitan Chapter of American Public Works Association (January 13, 2022). *Section 5600; Storm Drainage Systems & Facilities; February 16, 2011*. Retrieved from https://cityofls.net/development-services/design/design-criteria/design-construction-manual-infrastructure
3. City of Lee's Summit, MO (January 13, 2022). *City of Lee's Summit Watershed with Outfall Map.* Retrieved from https://cityofls.net/map-gallery/index.html?group=98ce512922a144cdbad6a03516df5897
4. NOAA. (January 5, 2022). *Point Precipitation Frequency (PF) Estimates*. Retrieved from https://hdsc.new.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=nc
5. United States Department of Agriculture Natural Resources Conservation Service. (January 5, 2022). *Web Soil Survey.* Retrieved from https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm
6. Autodesk Civil 3D 2021
7. Autodesk Storm and Sanitary Analysis 2021

1.0 INTRODUCTION

1.1 PURPOSE STATEMENT

The purpose of this Report is to document the steps taken to size the stormwater system for the proposed Fire Station #4 in Lee's Summit, MO.

1.2 PROJECT BACKGROUND

The purpose of this proposed Project is to construct a new Fire Station #4. The project will be located at 5031 NE Lakewood Way, Lee's Summit, MO 64064. As shown in Figure 1, the site is located at the intersection of Bowlin Road and NE Lakewood Way.

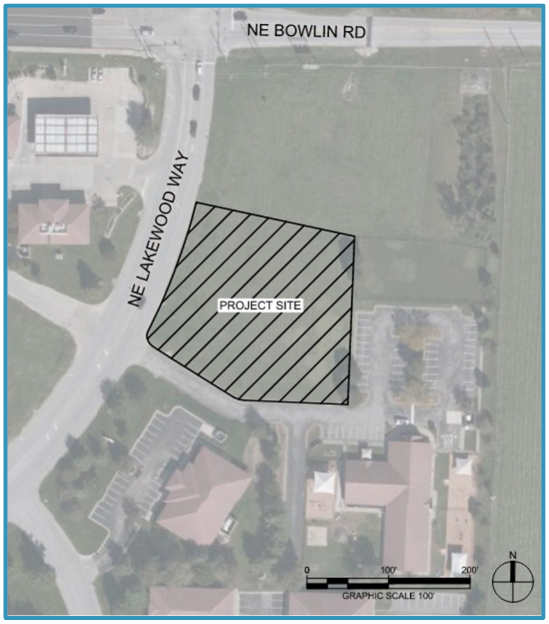

Figure 1 - Site Vicinity Map

1.3 EXISTING LAND USES

The Project currently consists of 1.17 acres of undeveloped grassland. Surrounding land uses consists of a mixture of both developed and undeveloped commercial properties. Adjacent properties that are developed include an animal health center, Montessori school, and a gas station.

This project will require a minor plat of Lot 6-A to acquire an additional 0.10 acres from Lot 7 to the north (see Appendix A).

1.4 EXISTING STORMWATER RUNOFF

The topography for the property generally slopes from southeast to northwest with elevations varying between 913 feet above mean sea level on the southeast side of the site to 907 feet at the site's lowest point at the northwest corner of the property.

Existing site runoff is primarily captured in the stormwater conveyance system on NE Lakewood Way. A curb inlet located at the NW corner of Lot 6-A then discharges stormwater east along Lot 6-A's northern property line. A stormwater manhole located east of the property then directs stormwater discharge to a regional detention basin located on Tract E (see Figure 2 and Appendix A).

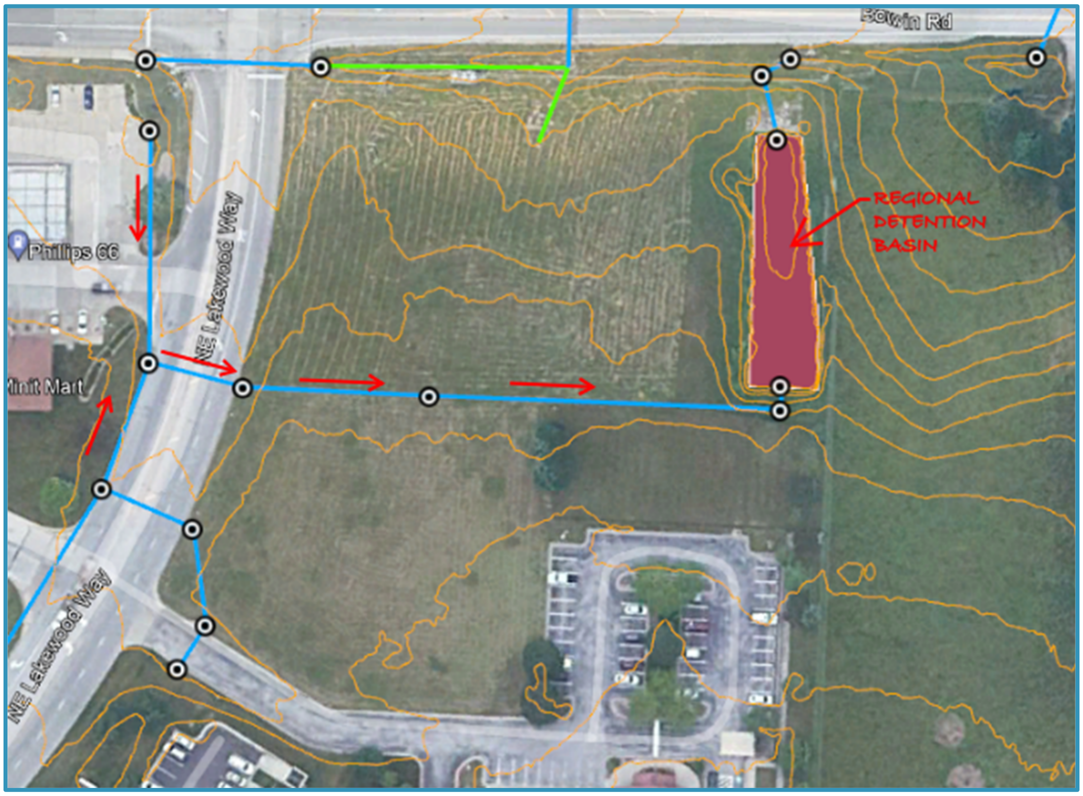

Figure 2 - Existing Stormwater Drainage

As shown in Appendix D, the Project is in the Blue Springs Watershed.

1.5 EXISTING SOIL CONDITIONS

A United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Web Soil Survey was performed and is documented in Appendix D. The report outlines the following soil classifications found:

Table 1 - USDA NRCS Web Soil Survey Soil Classifications

MAP UNIT SYMBOL	MAP UNIT NAME	HYDROLOGIC SOIL GROUP
10082	Arisburg-Urban land complex, 1 to 5 percent slopes	C
10113	Oska silty clay loam, 5 to 9 percent slopes, eroded	D

1.6 PROPOSED DRAINAGE CONCEPT

The proposed drainage concept is shown on Drawing C-104 (see Appendix A). A series of curb and area inlets will collect stormwater throughout the site. The Project's stormwater conveyance system will discharge stormwater to the existing detention basin on Tract E, east of the site. A new curb inlet will be installed on NE Lakewood Way to replace the existing curb inlet that will be converted to a junction box on the front apron of the fire station. The existing public stormwater pipes on the northern property line of Lot 6-A will be relocated to the new northern property line as part of the minor plat of Lots 6-A and 7. A new 15' utility easement will be established along the new property line (7.5' on each property). A new manhole will be installed on the northeast corner of Lot 6-A. This manhole will serve to collect the Project's stormwater runoff and to direct it east to the detention basin. A new stormwater conveyance pipe will be installed from this manhole to the existing manhole to the east, just upstream of the detention basin's inlet; the proposed invert elevation at the existing manhole will remain unchanged.

2.0 DESIGN BASIS

Per the City of Lee's Summit, MO (References 1 and 2), the following applies to stormwater design of the Project:

Table 2 - Design Basis

#	REFERENCE, SECTION	DESIGN BASIS ITEM	NOTES
1	2 5601.3 B2	***5601.3 General Requirements and Applicability*** *The design shall be accomplished under the direction of a Registered Professional Engineer qualified in the field of stormwater design. The design shall be based on land use in the tributary area as zoned, actually developed, or indicated by an adopted future land use plan, whichever basis produces the greatest runoff.* *This design criterion shall apply to all development, including subdivision, which alters the surface of the land to create additional impervious surfaces, including, but not limited to, pavement, buildings, and structures with the following exceptions:* ***B. New Construction Meeting the Following Criteria*** *2. Construction of any buildings, structures, and/or appurtenant service roads, drives, and walks on a site having previously provided stormwater management, as defined in Section 5601.5 A4 as part of a larger unit of development, OR a site previously relieved of stormwater management requirements.*	Because the existing regional detention basin exists, this project is not required to utilize the Comprehensive Protection Method, as outlined in 5601.5 of Reference 1, for stormwater design. A field review of the existing detention basin was conducted and documented in Appendix C (LTR).
2	2 5601.8	***5601.8 Levels of Service*** *A storm drainage system shall be provided that is capable of conveying the peak discharge generated by the 1% storm. If the in-system capacity established in this section is less the 1% storm peak discharge, then an overflow system as specified in Section 5601.5 -A-3 may provide the additional system capacity.* ***B. Protection for Streets*** ***1. Gutter Spread:*** *Water spread in streets shall meet the requirements in Section 5604.2 for the 10% design storm. These values are intended to establish a standard of accessibility for the widths (classes) of roadways listed during the 10% storm. When the local jurisdiction requires a higher standard for curb inlets, the conveyance system connected to the roadway must*	

<table>
<tr><td></td><td></td><td>also meet that higher standard. If the roadway conveyance system connects to an underground system with lesser capacity, the system must be constructed to allow the discharge of that excess capacity into the overflow system.</td><td></td></tr>
<tr><td>3</td><td>2
5602.2</td><td>5602.2 Computation Methods for Runoff
B. Baseline Unit Hydrograph Method: The following computer implementations of the unit hydrograph method are acceptable for all watersheds:
• SCS Technical Release No. 55 "Urban Hydrology for Small Watersheds", 2nd Edition, June 1986.</td><td></td></tr>
<tr><td>4</td><td>1
5603.1</td><td>Hydraulic Calculation for Pipes, Culverts, and Open Channels
“Enclosed systems will use the open channel, or gravity, flow design method for the appropriate design storm.”</td><td></td></tr>
<tr><td>5</td><td>2
5604.2</td><td>5604.2 Gutter Flow
Inlets shall be located to limit the width of flow in street gutters at the time of peak discharge for the design storm specified in 5601.8 B to the limits indicated in Table 5604-2.
Table 5604-2: Gutter Spread Criteria
<table>
<tr><th>Back to Back of Curb Street Width (feet)</th><th>Maximum Allowable Spread in Each Outside Curb Lane from Back of Curb* (feet)</th></tr>
<tr><td>28 or Less</td><td>12.0</td></tr>
<tr><td>Over 28 to 36</td><td>12.0</td></tr>
<tr><td>Over 36</td><td>12.0</td></tr>
<tr><td>Divided Roadways</td><td>As above for each direction roadway</td></tr>
</table>
* spread may exceed these limits within 50 feet of a sump inlet.</td><td></td></tr>
</table>

2.1 METHODOLOGY

To satisfy the requirements set forth in Table 2 above, the following design steps were taken:

1. Size the Project’s stormwater conveyance system for the 1 (100%), 10 (10%) and 100-year (1%), 24-hr storm event utilizing the SCS TR-55 Unit Hydrograph Method.
   a. The site’s post-development drainage characteristics were computed and documented in Appendix B.
      i. Each drainage area was assigned a composite curve number utilizing Table 5602-3 of Reference 2 (see Appendix D.2).
      ii. A minimum system time of concentration of 5 minutes was assumed per Reference 2 (Appendix D.2).
      iii. Point precipitation frequency estimates were found utilizing Reference 4 (Appendix D.4).

b. A stormwater model was created in AutoCAD Storm & Sanitary Analysis (SSA) (Reference 7). The peak discharges for the 1-, 10-, and 100-year, 24-hour storm events were documented in Appendix B. Gutter spreads for the system were checked for the 10-year, 24-hr storm event.

2. Conduct a field investigation to verify the existing regional detention basin is currently functioning. As per the City of Lee's Summit, the following items were documented (see Appendix C):
    a. The condition of the basin.
    b. Siltation within the basin and any measures needed to remove silt.
    c. Brush or vegetation within the basin that may need removal.
    d. Condition of the retaining wall within the basin to determine whether it is leaning or has other structural issues.
    e. The basin is working as intended.

3.0 SUMMARY

In summary, all stormwater conveyance pipes can safely pass the 100-year, 24-hour stormwater event. All inlet gutter spreads were checked against the 10-year, 24-hour storm event and were found to be satisfactory against the design criteria.

APPENDIX A

PROJECT DRAWINGS

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NOTE: THE DRAWINGS PRESENTED IN THIS APPENDIX ARE FOR REFERENCE ONLY AND ARE NOT TO BE USED AS THE BASIS OF CONSTRUCTION.

ALTA/NSPS LAND TITLE SURVEY

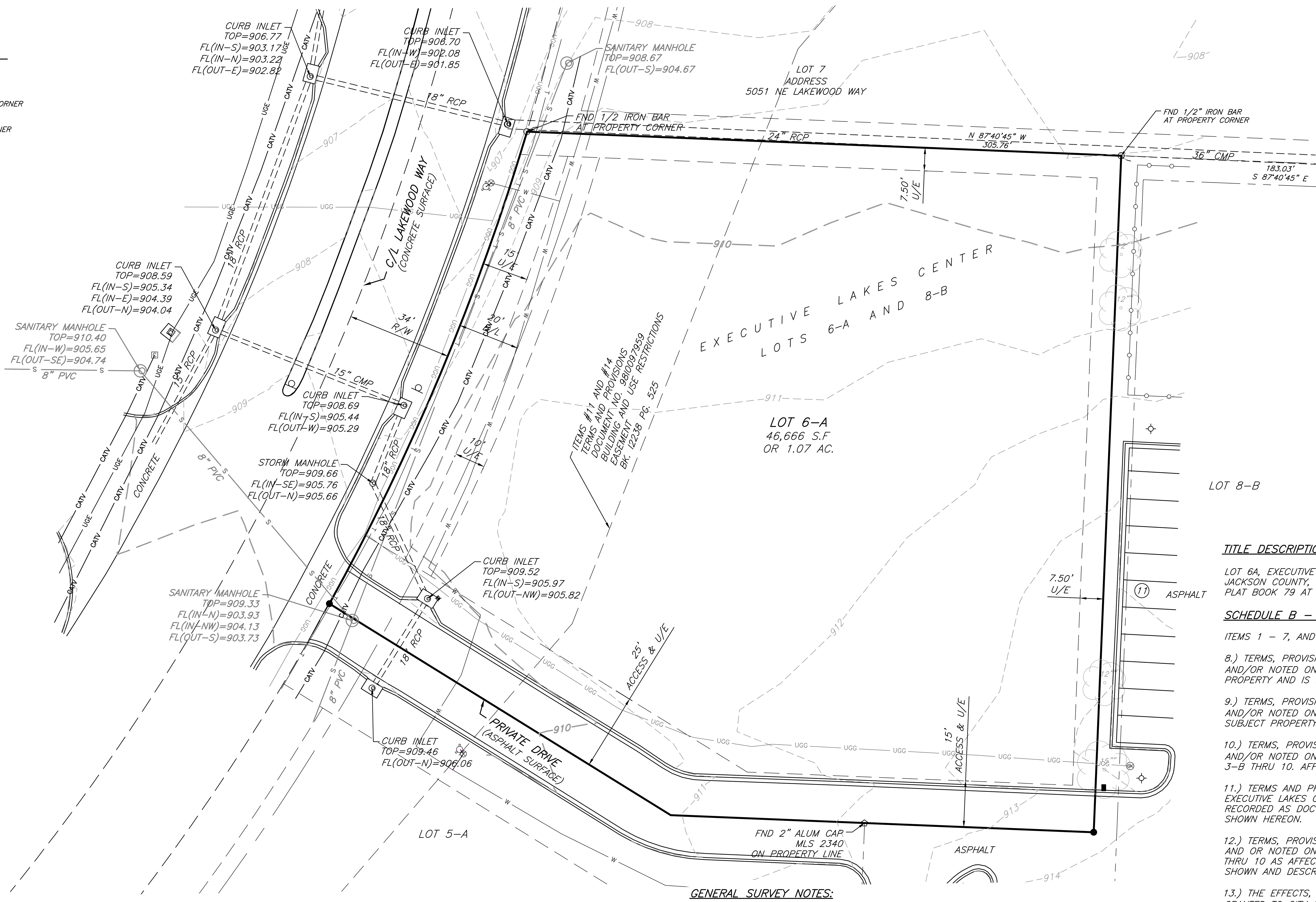
LOT 6-A; EXECUTIVE LAKES CENTER, LOTS 6-A and 8-B
LEE'S SUMMIT, JACKSON COUNTY, MISSOURI

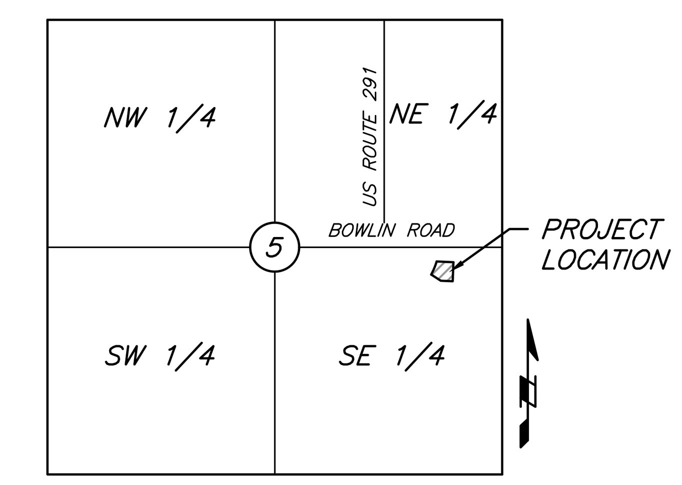
SCALE

0' 20' 40'

LEGEND

- BENCHMARK
- MONUMENT FOUND AS NOTED
- FOUND 1/2" IRON BAR AT CORNER UNLESS OTHERWISE NOTED
- SET 1/2" IRON BAR AT CORNER W/ J & J CAP
- (P) – PLATTED DISTANCE
- (M) – MEASURED DISTANCE
- B/L – BUILDING SETBACK LINE
- U/E – UTILITY EASEMENT
- EXISTING TREE
- LIGHT POLE
- W – WATER METER
- WATER VALVE
- FIRE HYDRANT
- ET – ELECTRIC TRANSFORMER
- C – CABLE TRANSFORMER
- GK – GAS PIPELINE MARKER
- SANITARY MANHOLE
- STORM MANHOLE
- MAILBOX
- SIGN AS NOTED
- 8 – PARKING STALL
- CHAIN LINK FENCE
- S – SANITARY SEWER LINE





VICINITY MAP
SEC. 5-48-31
N.T.S.

CLIENT:
GLMV
9229 Ward Parkway
Kansas City, Mo 64114

PROPERTY ADDRESS:
5031 NE Lakewood Way
Lee's Summit, Mo 64064

PROPERTY DESCRIPTION:
All of Lot 6-A, EXECUTIVE LAKES CENTER Lots 6-A and 8-B, a subdivision in the SE 1/4 of Section 5- T 48 N - R 31 W, Lee's Summit, Jackson County, Missouri

TITLE DESCRIPTION:

LOT 6A, EXECUTIVE LAKES CENTER LOTS 6A AND 8B, A SUBDIVISION IN LEE'S SUMMIT, JACKSON COUNTY, MISSOURI, ACCORDING TO THE RECORDED PLAT THEREOF; FILED IN PLAT BOOK 79 AT PAGE 65.

SCHEDULE B – PART II NOTES:

ITEMS 1 – 7, AND 17 – 20 ARE NON SURVEY RELATED ITEMS.

8.) TERMS, PROVISIONS, EASEMENTS, SET-BACK LINES AND FEATURES ALL AS SHOWN AND/OR NOTED ON THE COMMISSIONER'S PLAT OF BOWLIN ESTATE. AFFECTS SUBJECT PROPERTY AND IS BLANKET IN NATURE

9.) TERMS, PROVISIONS, EASEMENTS, SET-BACK LINES AND FEATURES ALL AS SHOWN AND/OR NOTED ON THE RECORDED PLAT OF EXECUTIVE LAKES CENTER. AFFECTS SUBJECT PROPERTY, NO DOCUMENT PROVIDED.

10.) TERMS, PROVISIONS, EASEMENTS, SET-BACK LINES AND FEATURES ALL AS SHOWN AND/OR NOTED ON THE RECORDED PLAT OF EXECUTIVE LAKES CENTER LOTS 3-A & 3-B THRU 10. AFFECTS SUBJECT PROPERTY.

11.) TERMS AND PROVISIONS OF ORDINANCE NO. 4703 ACCEPTING FINAL PLAT OF EXECUTIVE LAKES CENTER, LOTS 3-B & 4 THRU 10 AS SHOWN BY INSTRUMENT RECORDED AS DOCUMENT NO. 98I0097959. AFFECTS THE SUBJECT PROPERTY AND IS SHOWN HEREON.

12.) TERMS, PROVISIONS, EASEMENTS, SET-BACK LINES AND FEATURES ALL AS SHOWN AND OR NOTED ON THE RECORDED PLAT OF EXECUTIVE LAKES CENTER LOTS 3-B & 4 THRU 10 AS AFFECTED BY ORDINANCE NO. 4925 VACATING AN UTILITY EASEMENT AS SHOWN AND DESCRIBED THEREIN. DOES NOT AFFECT THE SUBJECT PROPERTY.

13.) THE EFFECTS, IF ANY, OF THE TERMS AND PROVISIONS OF THE UTILITY EASEMENT GRANTED TO CITY OF LEE'S SUMMIT, A MUNICIPAL CORPORATION AS SHOWN BY INSTRUMENT RECORDED AS DOCUMENT NO. 97-I4003 IN I2952 AT PAGE 1654. DOES NOT AFFECT THE SUBJECT PROPERTY.

14.) BUILDING AND USE RESTRICTIONS CREATED BY THE INSTRUMENT RECORDED AS DOCUMENT NO. I98I26317 IN BOOK I3177 AT PAGE 329. AND I103647 IN BOOK I2238 AT PAGE 525. AFFECTS THE SUBJECT PROPERTY AND IS SHOWN ON. AND AMENDED BY DOCUMENT NO. 98I90271 IN BOOK I3310 AT PAGE 1665. AND AS AFFECTED BY DECLARATION OF ANNEXATION RECORDED AS DOCUMENT NO. 2000I0010475. DOES NOT AFFECT THE SUBJECT PROPERTY. AND AMENDED BY DOCUMENT NO. 2000I26140. DOES NOT AFFECT THE SUBJECT PROPERTY. A VIOLATION OF WHICH WOULD NOT CAUSE A FORFEITURE OR REVERSION OF TITLE. NOTE, THIS EXCEPTION OMITS ANY COVENANT, CONDITION OR RESTRICTION BASED ON RACE, COLOR, RELIGION, SEX, HANDICAP, FAMILIAL STATUS OR NATIONAL ORIGIN, UNLESS AND ONLY TO THE EXTENT THAT RESTRICTION IS NOT IN VIOLATION OF STATE OR FEDERAL LAW OR RELATES TO A HANDICAP, BUT DOES NOT DISCRIMINATE AGAINST HANDICAPPED PEOPLE.

15.) TERMS AND PROVISIONS OF DEVELOPMENT AGREEMENT BY AND BETWEEN THE CITY OF LEE'S SUMMIT, MISSOURI AND LAKEWOOD DEVELOPMENT, L.P. AND FOUR BAR COMPANY, G.P. FILED JANUARY 13, 1999 AS DOCUMENT NO. 99I3356. AFFECTS THE SUBJECT PROPERTY AND IS BLANKET IN NATURE.

16.) TERMS AND PROVISIONS OF THE DEVELOPMENT AGREEMENT BY AND BETWEEN CITY OF LEE'S SUMMIT, MISSOURI, A MUNICIPAL CORPORATION AND LAKEWOOD DEVELOPMENT, L.P. AS SHOWN BY INSTRUMENT RECORDED AS DOCUMENT NO. 2000I0029662. DOES NOT AFFECT THE SUBJECT PROPERTY.

SURVEY CONTROL POINTS

Point #	Northing	Easting	Elevation	Description
2	1034478.67	2829553.65	944.23	JA-29
11	1032758.54	2830285.01	912.19	2" ALUM CAP MLS 2340
15	1032831.68	2830146.43	909.59	SQUARE CUT

BENCHMARKS:

STATION JA-29: Alum Disk Located about 5.5 miles North of Lee's Summit and between I-470 and the East outer Road of North Bound ramp #14

ELEVATION = 944.23

GENERAL SURVEY NOTES:

1.) The plat of EXECUTIVE LAKES CENTER is recorded in Plat Book I-79 at Page 65 in the Recorder of Deeds Office in Jackson County, Missouri.

2.) The plat of EXECUTIVE LAKES CENTER LOTS 3-B & 4 THRU 10 is recorded in Plat Book I-79 at Page 65 in the Recorder of Deeds Office in Jackson County, Missouri.

3.) Title Report No. MJ116323 dated November 24, 2020 at 8:00 AM was provided by First American Title Insurance Company.

4.) Bearings used on this survey are based on the Missouri State Plane coordinate system fro m GPS observation.

5.) The subject property is located in Zone X, areas determined to be outside the 0.2% annual chance floodplain, as shown on Flood Insurance Rate Map (FIRM) 29095C0313G, effective January 20, 2017.

6.) There are NO parking stalls identified on Subject Property at the time of this survey.

7.) Under Ground Utilities are shown as located by Missouri one call ticket No. 211930316 dated July 12, 2021

8.) There were no Wetland Delineations marked, at the time of survey.

9.) This Property is Zoned CP-2, Planned Community Commercial.

10.) There was no evidence of Earth moving work, building construction, or building additions observed in the process of conducting the fieldwork

UTILITY NOTE:

The utilities on this survey are shown based on source information from plans and markings and were combined with observed evidence of utilities pursuant to Section 5.E.iv. to develop a view of the underground utilities. However, lacking excavation, the exact location of underground features cannot be accurately, completely, and reliably depicted. In addition, in some jurisdictions, 811 or other similar utility locate requests from surveyors may be ignored or result in an incomplete response, in which case the surveyor shall note on the plat or map how this affected the surveyor's assessment of the location of the utilities. Where additional or more detailed information is required, the client is advised that excavation and/or a private utility locate request may be necessary.

CERTIFICATION:

To: First American Title Insurance Company, and Bahman Tehrani, D.D.S P.C., dba Lakewood Dental Center, and Jaleh Nikfarjam, his wife.

This is to certify that this map or plat and the survey on which it is based were made in accordance with the 2021 Minimum Standard Detail Requirements for ALTA/NSPS Land Title Surveys, jointly established and adopted by ALTA and NSPS, and includes Items 1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 13 and 16 of Table A thereof. The field work was completed on the 12th day of July, 2021.

STATE OF MISSOURI ★ JOHN B. YOUNG NUMBER PLS-2006016647 ★ PROFESSIONAL LAND SURVEYOR

12-3-21
Date

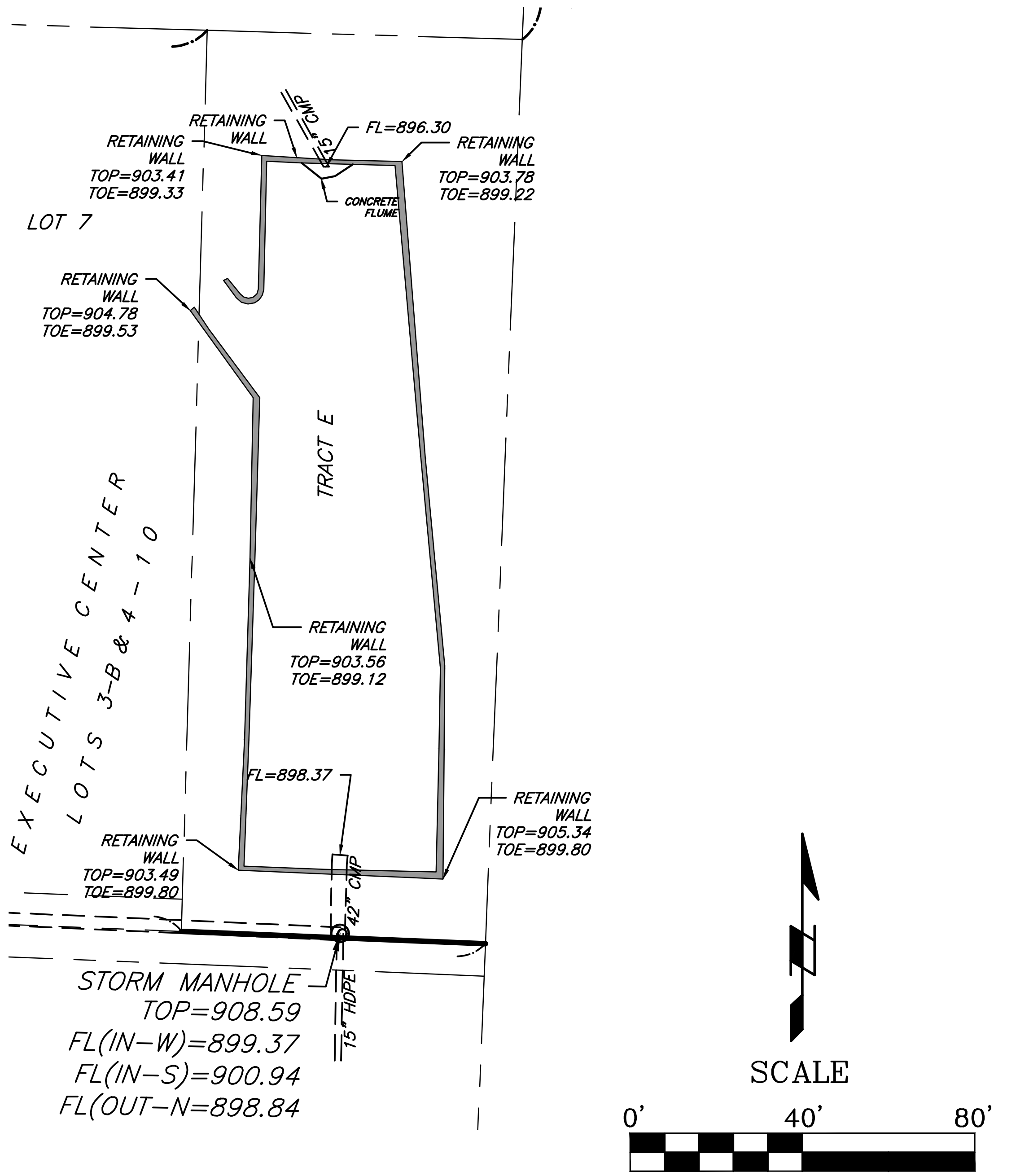
John B. Young PLS-2006016647

J & J SURVEY LLC
6500 NW TOWER DR., SUITE 102 • PLATTE WOODS, MO 64151
PHONE (816)741-1017 • FAX (816)741-1018

Location: S:\21.071 - Lees Summit Fire Stations\DRAWINGS\5031 NE LAKEWOOD WAY\21.071- 12-3-21\21.071-ALTA 12-3-21 LG.dwg-Dec 07, 2021-1:28pm

1	INITIAL SUBMITTAL	07-30-21
2	REVISED DWG	08-26-21
3	REVISED PER COMMENTS	12-3-21
4	REVISED PER COMMENTS	12-07-21

SHEET 1 OF 1

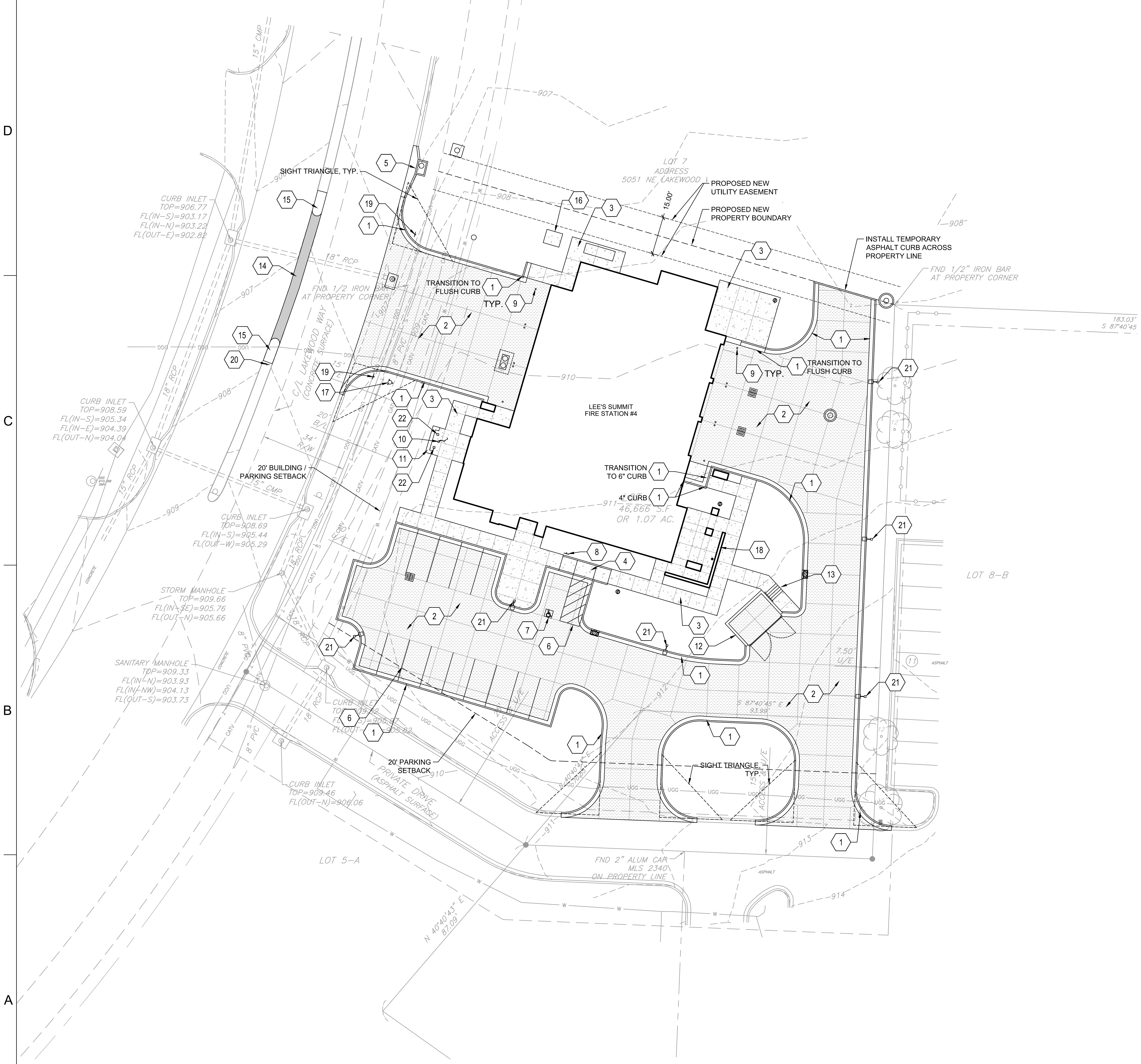


Location: S:\21.071 - Lees Summit Fire Stations\DRAWINGS\5031 NE LAKEWOOD WAY\21.071- 12-3-21\21.071-ALTA 12-3-21 LG.dwg-Dec 03, 2021-10:58am

J & J SURVEY LLC
6500 NW TOWER DR., SUITE 102 • PLATTE WOODS, MO 64151
PHONE (816)741-1017 • FAX (816)741-1018

DETENTION EXHIBIT

TRACT E, STORM WATER DETENTION, LEE'S SUMMIT, JACKSON COUNTY, MISSOURI



1 SITE PLAN

1" = 20'-0"

SITE NOTES

1. PRIOR TO STARTING CONSTRUCTION THE CONTRACTOR SHALL BE RESPONSIBLE TO MAKE SURE THAT ALL REQUIRED PERMITS AND APPROVALS HAVE BEEN OBTAINED. NO CONSTRUCTION OR FABRICATION SHALL BEGIN UNTIL THE CONTRACTOR HAS RECEIVED AND THOROUGHLY REVIEWED ALL PLANS AND OTHER DOCUMENTS APPROVED BY ALL OF THE PERMITTING AUTHORITIES.
2. ALL WORK SHALL BE PERFORMED IN ACCORDANCE WITH THESE PLANS, SPECIFICATIONS AND THE REQUIREMENTS AND STANDARDS OF THE LOCAL GOVERNING AUTHORITY.
3. CONTRACTOR SHALL CONTACT DIG SAFE PRIOR TO ANY EXCAVATION/DIGGING.
4. ALL EXISTING CONDITIONS, DIMENSIONS, AND GRADES SHOWN ON THE PLANS SHALL BE FIELD VERIFIED BY THE CONTRACTOR PRIOR TO CONSTRUCTION. CONTRACTOR SHALL NOTIFY THE CONSTRUCTION MANAGER IF ANY DISCREPANCIES EXIST, PRIOR TO PROCEEDING WITH CONSTRUCTION, FOR NECESSARY PLAN OR GRADE CHANGES. NO EXTRA COMPENSATION SHALL BE PAID TO THE CONTRACTOR FOR WORK HAVING TO BE REDONE DUE TO DIMENSIONS OR GRADES SHOWN INCORRECTLY ON THESE PLANS IF SUCH NOTIFICATION HAS NOT BEEN GIVEN.
5. CONTRACTOR SHALL REPAIR ALL DISTURBED LANDSCAPING.
6. COORDINATE IRRIGATION SLEEVE INSTALLATION WITH THE PAVING CONTRACTOR.

KEYNOTES

1	TYP. CURB & GUTTER LEE'S SUMMIT STANDARD DETAIL REF: 3/C502
2	TYP. CONCRETE PAVING REF: 1/C500
3	CONCRETE SIDEWALK PAVING REF: 2/C500
4	ADA SIDEWALK RAMP. REF: 4/C503
5	CURB INLET REF: 1/C530
6	PAVEMENT STRIPING REF: 5/C500
7	ADA PAVEMENT MARKING REF: 6/C500
8	ADA PARKING SIGN REF: 7/C500
9	TYP. SAFETY BOLLARD REF: 4/C500
10	FLAG POLE REF: 9/C500
11	MONUMENT SIGN REF: 10/C500
12	DUMPSTER ENCLOSURE REF: 1/C501
13	CONCRETE STEPS WITH RAILING REF: 14/C500
14	ROADWAY ASPHALT PATCH LEE'S SUMMIT STANDARD DETAIL REF: 2/C503
15	MEDIAN TRANSITION LEE'S SUMMIT STANDARD DETAIL REF: 3/C503
16	TRANSFORMER CONCRETE PAD REF: MEP
17	RELOCATED FIRE HYDRANT REF: 5/C520
18	SCREEN WALL REF: ARCH
19	DO NOT ENTER SIGN REF: 8/C500
20	NO LEFT/U-TURN SIGN REF: 3/C500
21	TYP. AREA LIGHTING REF: ELECTRICAL
22	TYP. FLAG POLE LIGHTING REF: ELECTRICAL

LEGEND

- TYP. CURB & GUTTER
- TYP. CONCRETE PAVING
- ASPHALT PATCH
- CONCRETE SIDEWALK

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MISSOURI STATE CERTIFICATE OF AUTHORITY
#000305

LANDSCAPE ARCHITECT
GLMV ARCHITECTURE, INC
MISSOURI COA #000008
9229 WARD PARKWAY, SUITE # 210
KANSAS CITY, MO 64114
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KANSAS CITY, MO 64114
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STRUCTURAL ENGINEER
LEIGH + O'KANE
MISSOURI COA # ____
250 NE MURBERRY, SUITE 201
LEE'S SUMMIT, MO, 64086
(816) 444-3144 PHONE

MECH., ELEC. & PLUMBING ENGINEERS
HOSS & BROWN ENGINEERS
MISSOURI COA # ____
15902 MIDLAND DRIVE
SHAWNEE, KS 66217
(913) 362-9090 PHONE

SECURITY & IT ENGINEERS
HENDERSON ENGINEERS
MISSOURI COA # ____
1801 MAIN STREET, SUITE 300
KANSAS CITY, MO 64108
(816) 663-8700 PHONE

FIRE STATION #4
CITY OF LEE'S SUMMIT

5031 NORTHEAST LAKEWOOD WAY
LEE'S SUMMIT, MISSOURI 64064

100% DESIGN DEVELOPMENT DRAWINGS

REVISIONS:

#	Description	Date
A	PDP Revision	2.21.2022

NOT FOR CONSTRUCTION

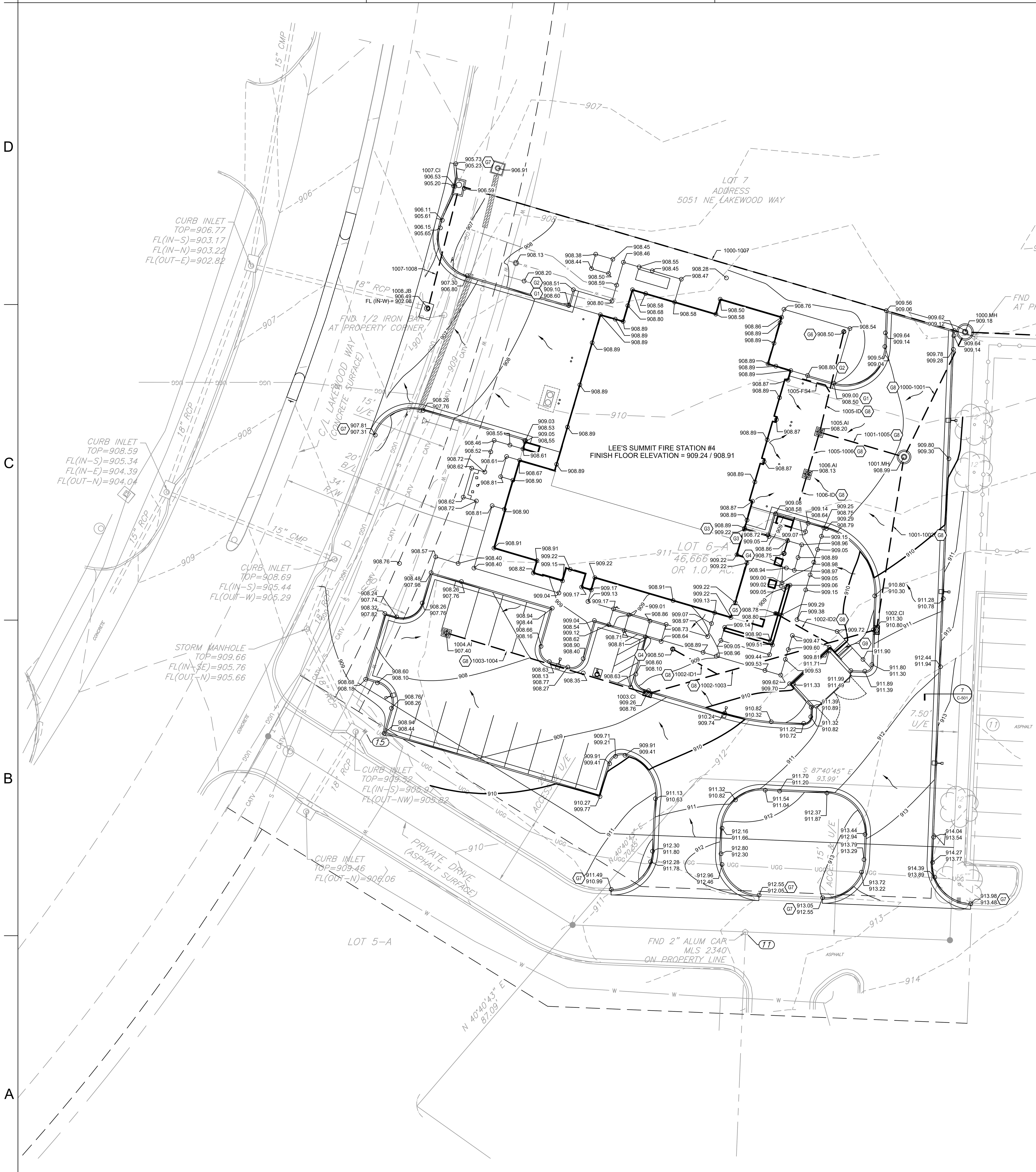
ANGIE MORGAN - CIVIL ENGINEER
MO# PE-2018031541

The Professional Engineers seal affixed to this sheet applies only to the material and items shown on this sheet. All drawings, instruments or other documents not exhibiting this seal shall not be considered prepared by this architect, and this architect expressly disclaims any and all responsibility for such plan, drawings, or documents not exhibiting this seal.

PROJECT NO:	18225R21001
DATE:	02.21.2022
DRAWN BY:	KDW
CHK'D BY:	ALM

SITE PLAN

C-100



GRADING & DRAINAGE PLAN

1" = 20'-0"

GRAPHIC SCALE 20'

GENERAL GRADING & DRAINAGE NOTES:

1. CONTRACTOR SHALL OBTAIN A COPY OF THE GEOTECHNICAL REPORT BEFORE STARTING CONSTRUCTION.
2. ALL PROPOSED CONTOUR LINES AND SPOT ELEVATIONS SHOWN ARE FINISH GROUND ELEVATIONS. CONTRACTOR SHALL ACCOUNT FOR PAVEMENT DEPTHS, BUILDING PADS, TOPSOIL, ETC. WHEN GRADING THE SITE.
3. ALL DISTURBED AREAS THAT ARE NOT TO BE PAVED (GREEN SPACES) SHALL BE FINISH GRADED WITH A MINIMUM OF SIX INCHES OF TOPSOIL.
4. ALL EXCAVATIONS AND EMBANKMENTS SHALL COMPLY WITH THE RECOMMENDATIONS PROVIDED BY THE GEOTECHNICAL ENGINEER.
5. FINISHED GRADES SHALL NOT BE STEEPER THAN 3:1, UNLESS NOTED OTHERWISE ON THE PLANS.
6. ALL SITE WORK FOR THIS PROJECT IS CONSIDERED "UNCLASSIFIED". THE TERM "UNCLASSIFIED" EXCAVATION SHALL BE DEFINED AS MEANING THE CONTRACTOR BEARS THE ENTIRE RISK OF THE SOIL QUANTITIES AND/OR TYPE (E.G. ROCK, CLAY, PEAT, SILT, SHALE, ETC.) ENCOUNTERED EITHER ABOVE OR BELOW PROPOSED SUBGRADES. IN THE EVENT IT BECOMES NECESSARY FOR UNSUITABLE SOIL TO BE HANDLED, REMOVED FROM THE SITE, OR FOR SUITABLE MATERIAL TO BE IMPORTED TO THE SITE, THE CONTRACTOR SHALL BEAR THE ENTIRE COST OF SUCH ADDITIONAL WORK. "UNSUITABLE" SOIL ALSO INCLUDES SATURATED SOILS THAT MAY NEED REPLACING AND/OR TREATING IN ORDER TO MEET SCHEDULE DATES. THIS DEFINITION OF "UNCLASSIFIED" SUPERCEDES ANY CONTRARY DEFINITIONS OR STATEMENTS WHICH MAY BE CONTAINED IN SPECIFICATIONS, PLANS, OR OTHER DOCUMENTS.
7. CONTRACTOR SHALL FIELD VERIFY ALL EXISTING ELEVATIONS OF CONNECTION POINTS AS SHOWN ON GRADING PLANS. NOTIFY ENGINEER IF DISCREPANCY EXISTS FOR DIRECTION.
8. ALL GRADES SHALL BE CONNECTED SMOOTHLY WITH GENTLE ROUNDING/SHAPING OF ALL AFFECTED LAND SURFACES. ABRUPT TRANSITIONS AT THE TOP OF SLOPES WHERE PROPOSED GRADES MEET EXISTING ARE NOT ACCEPTABLE. GRADING SHALL BE APPROVED BY THE OWNER'S REPRESENTATIVE PRIOR TO THE ADDITION OF THE TOPSOIL LAYER.
9. SEE DRAWINGS LTR-LTR FOR STORMWATER PROFILE DRAWINGS.

ADA NOTES

1. ANY AND ALL NEW SITE "ADA" FEATURES SHALL BE BUILT IN COMPLIANCE TO CURRENT FEDERAL, STATE, AND LOCAL ACCESSIBILITY RULES AND REGULATIONS. THE CONTRACTOR SHALL BE RESPONSIBLE TO KNOW AND UNDERSTAND ALL CURRENT ACCESSIBILITY REGULATIONS AS THEY PERTAIN TO THE CONSTRUCTION OF ACCESSIBLE SITE FEATURES.
2. ALL NEW CONCRETE SIDEWALK PAVEMENT SHALL BE INSTALLED WITH A MAXIMUM 5% RUNNING SLOPE AND A MAXIMUM 2% CROSS SLOPE.
3. SURFACES OF ALL NEW CONCRETE PAVEMENT PATHWAYS SHALL BE SMOOTH AND EVEN WITH NO ABRUPT CHANGES IN ELEVATION OF 1/4" OR GREATER AS REQUIRED BY THE ACCESSIBILITY DESIGN REGULATIONS.

GRADING & DRAINAGE KEYNOTES

- G1 TRANSITION FROM 6" CURB TO FLUSH CURB.
- G2 FLUSH CURB.
- G3 4" CURB.
- G4 INLINE DRAIN WITH 18" DOME GRATE. REF: C-532
- G5 INLINE DRAIN WITH 10" STANDARD GRATE. REF: C-531 AND C-532
- G6 INLINE DRAIN WITH 18" STANDARD GRATE. REF: C-531 AND C-532
- G7 (+/-) MATCH EXISTING ELEVATION. NOTIFY ENGINEER IF SIGNIFICANT DISCREPANCY EXISTS.
- G8 PRIVATE STORMWATER LINE. STORMWATER LINES NOT DENOTED WITH KEYNOTE G8 SHALL BE PUBLIC LINES.
- G9 CONCRETE STEPS REF: C-500

LEGEND

1289.00	SPOT ELEVATION	430	EXISTING CONTOUR
MEE	MATCH EXISTING ELEVATION		FLOWLINE ARROW
1289.00 / 1288.50	TOP OF CURB ELEVATION / FLOWLINE ELEVATION		PROPOSED STORM SEWER
1289.00 TW / 1279.00 BW	TOP OF RETAINING WALL / BOTTOM OF RETAINING WALL		PROPOSED CURB INLET
430	PROPOSED MAJOR CONTOUR		PROPOSED STORMWATER MANHOLE
429	PROPOSED MINOR CONTOUR		PROPOSED AREA INLET

STORMWATER PIPE TABLE

NAME	SIZE	3D LENGTH, SLOPE, & MATERIAL
EX MH-1000	36"	150.24 LF @ 0.50%, HDPP
1000-1007	36"	188.02 LF @ 0.40%
1000-1001	12"	46.18 LF @ 1.00%, HDPP
1001-1005	12"	28.61 LF @ 3.75%, HDPP
1001-1002	12"	60.86 LF @ 1.00%, HDPP
1002-ID2	12"	22.00 LF @ 3.00%*, HDPP
1002-ID1	12"	17.89 LF @ 3.00%*, HDPP
1002-1003	12"	84.59 LF @ 1.00%, HDPP
1003-1004	12"	74.52 LF @ 1.00%, HDPP
1005-FS4	6"	11.57 LF @ 3.00%, HDPP
1005-ID	12"	35.83 LF @ 3.00%*, HDPP
1005-1006	12"	13.75 LF @ 2.00%, HDPP
1006-ID	12"	28.17 LF @ 2.00%*, HDPP
1007-1008	24"	41.14 LF @ 0.70%

* LENGTH OF PIPE AND SLOPE SHOWN EXCLUDE VERTICAL PORTION OR INLINE DRAIN.

** EXISTING INCOMING OR OUTGOING PIPES TO REMAIN ARE NOT SHOWN IN TABLE FOR CLARITY. CONTRACTOR TO PLUG AND GROUT EXISTING PENETRATIONS IN STRUCTURE NO LONGER REQUIRED PER CITY OF LEE'S SUMMIT STANDARDS.

STORMWATER STRUCTURE TABLE

STRUCTURE NAME	GRATE / RIM ELEVATION	PIPES IN	PIPES OUT	CL NORTHING & EASTING	NOTES
1000.MH	909.18	1000-1001, 12" INV IN =900.62 1000-1007, 36" INV IN =900.32	EX MH-1000, 36" INV OUT =900.12	N: 1032977.21 E: 2830365.11	STANDARD PRECAST MANHOLE REF: DETAIL 3/C-540
1001.MH	908.99	1001-1002, 12" INV IN =901.28 1001-1005, 12" INV IN =901.58	1000-1001, 12" INV OUT =901.08	N: 1032931.67 E: 2830342.87	STANDARD PRECAST MANHOLE REF: DETAIL 3/C-540
1002.CI	910.80	1002-1003, 12" INV IN =902.39	1001-1002, 12" INV OUT =901.89	N: 1032868.61 E: 2830332.81	2'x3' CURB INLET REF: DETAIL 2/C-532
1003.CI	908.76	1003-1004, 12" INV IN =903.74	1002-1003, 12" INV OUT =903.24	N: 1032845.41 E: 2830249.41	2'x3' CURB INLET REF: DETAIL 2/C-532
1004.AI	907.40		1003-1004, 12" INV OUT =904.49	N: 1032867.55 E: 2830176.04	STANDARD DOUBLE GRATE INLET REF: DETAIL 5/C-530
1005.AI	908.20	1005-1006, 12" INV IN =903.15 1005-ID, 12" INV IN =903.25	1001-1005, 12" INV OUT =902.65	N: 1032940.69 E: 2830312.07	STANDARD DOUBLE GRATE INLET REF: DETAIL 5/C-530
1006.AI	908.13	1006-ID, 12" INV IN =903.62	1005-1006, 12" INV OUT =903.42	N: 1032925.34 E: 2830307.57	STANDARD DOUBLE GRATE INLET REF: DETAIL 5/C-530
1007.CI	906.56	1007-1008, 24" INV IN =901.56	1000-1007, 36" INV OUT =901.06	N: 1033029.98 E: 2830180.60	STANDARD CURB INLET REF: DETAIL 1/C-530
1008.JB	906.49		1007-1008, 24" INV OUT =901.85	N: 1032984.96 E: 2830168.78	CONVERT CI TO JUNCTION BOX** REF: DETAIL 2/C-530
EX MH	908.59	EX MH-1000, 36" INV IN =899.37		N: 1032970.53 E: 2830516.95	EXISTING MANHOLE**

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MECH., ELEC. & PLUMBING ENGINEERS
HOSS & BROWN ENGINEERS
MISSOURI COA # ________
15902 MIDLAND DRIVE
SHAWNEE, KS 66217
(913) 362-9090 PHONE

SECURITY & IT ENGINEERS
HENDERSON ENGINEERS
MISSOURI COA # ________
1801 MAIN STREET, SUITE 300
KANSAS CITY, MO 64108
(816) 663-8700 PHONE

FIRE STATION #4
CITY OF LEE'S SUMMIT
5031 NORTHEAST LAKEWOOD WAY
LEE'S SUMMIT, MISSOURI 64064

100% DESIGN DEVELOPMENT DRAWINGS

REVISIONS:

#	Description	Date
A	PDP Revision	2.21.2022

NOT FOR CONSTRUCTION

ANGIE MORGAN - CIVIL ENGINEER
MO# PE-2018031541

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PROJECT NO:	18225R21001
DATE:	02.21.2022
DRAWN BY:	DMH
CHK'D BY:	ALM

GRADING & DRAINAGE PLAN

C-104

APPENDIX B

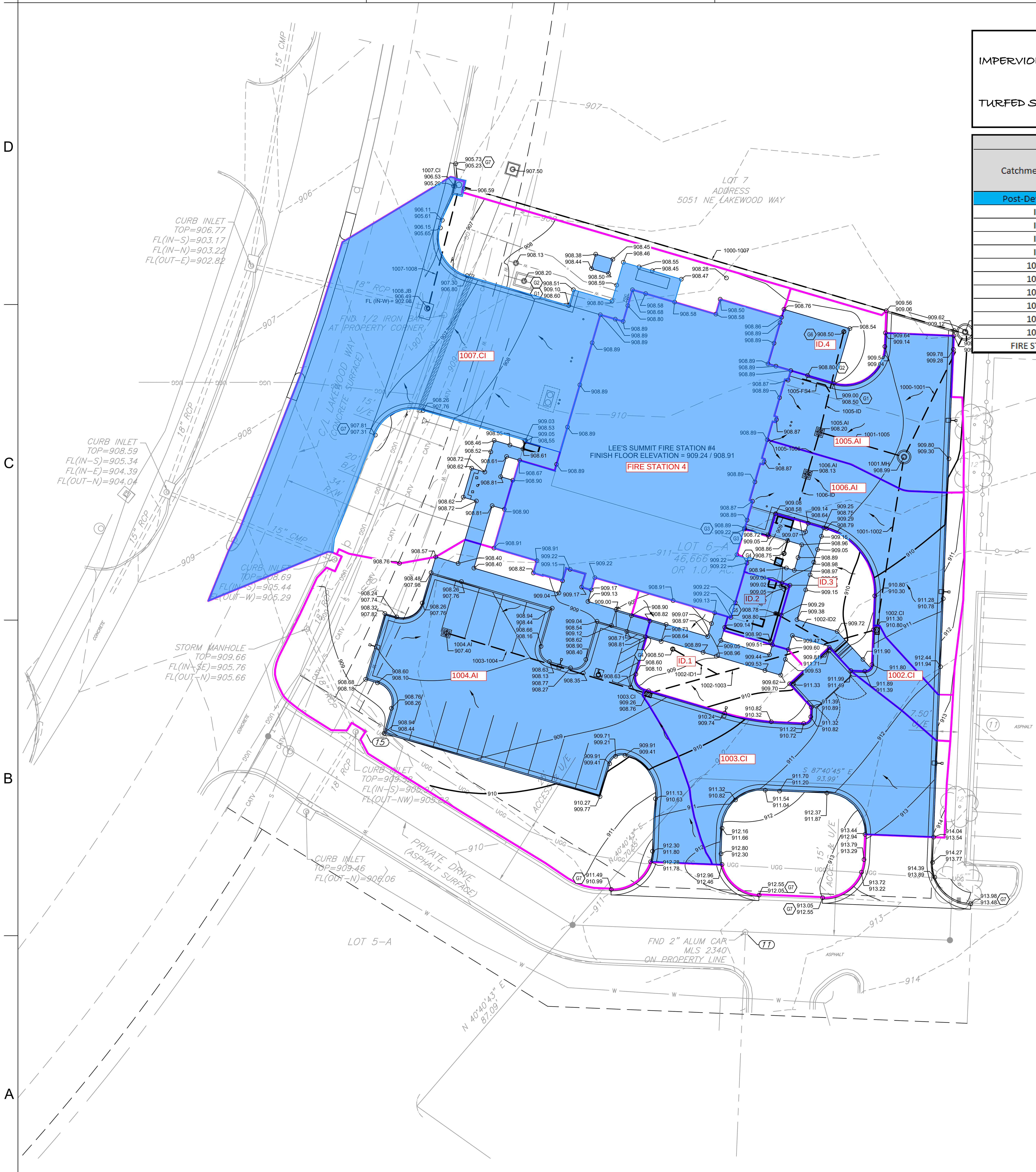
STORMWATER ANALYSIS

APPENDIX B.1

POST-DEVELOPMENT DRAINAGE MAPS

1 2 3 4 5

D C B A



1 GRADING & DRAINAGE PLAN

1" = 20'-0"

LEGEND

IMPERVIOUS SURFACE

TURFED SURFACES

SCS Unit Hydrograph Method, Curve Number				
Catchment Number	Total Area (ft^2)	Impervious Area C = 98 (ft^2)	Turfed Area C = 74 (ft^2)	Composite Curve Number
Post-Development				
ID.1	1885.56	377.90	1507.66	78.8
ID.2	398.97	398.97	0.00	98.0
ID.3	1806.92	647.32	1159.60	82.6
ID.4	1070.79	518.78	552.01	85.6
1002.CI	596.05	512.13	83.92	94.6
1003.CI	5893.44	3935.68	1957.76	90.0
1004.AI	12323.06	6894.18	5428.88	87.4
1005.AI	2718.33	2539.37	178.96	96.4
1006.AI	3301.67	2829.15	142.63	87.2
1007.CI	13887.57	9046.14	4841.43	89.6
FIRE STATION 4	8046.29	8046.29	0.00	98.0

GRADING & DRAINAGE KEYNOTES

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- G6 INLINE DRAIN WITH 18" STANDARD GRATE. REF: C-531 AND C-532
- G7 (+/-) MATCH EXISTING ELEVATION. NOTIFY ENGINEER IF SIGNIFICANT DISCREPANCY EXISTS.

GENERAL GRADING NOTES:

1. CONTRACTOR SHALL OBTAIN A COPY OF THE GEOTECHNICAL REPORT BEFORE STARTING CONSTRUCTION.
2. ALL PROPOSED CONTOUR LINES AND SPOT ELEVATIONS SHOWN ARE FINISH GROUND ELEVATIONS. CONTRACTOR SHALL ACCOUNT FOR PAVEMENT DEPTHS, BUILDING PADS, TOPSOIL, ETC. WHEN GRADING THE SITE.
3. ALL DISTURBED AREAS THAT ARE NOT TO BE PAVED (GREEN SPACES) SHALL BE FINISH GRADED WITH A MINIMUM OF SIX INCHES OF TOPSOIL.
4. ALL EXCAVATIONS AND EMBANKMENTS SHALL COMPLY WITH THE RECOMMENDATIONS PROVIDED BY THE GEOTECHNICAL ENGINEER.
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MEE	MATCH EXISTING ELEVATION		FLOWLINE ARROW
1289.00 / 1288.50	TOP OF CURB ELEVATION / FLOWLINE ELEVATION		PROPOSED STORM SEWER
1289.00 TW / 1279.00 BW	TOP OF RETAINING WALL / BOTTOM OF RETAINING WALL		PROPOSED CURB INLET
430	PROPOSED MAJOR CONTOUR		PROPOSED STORMWATER MANHOLE
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STORMWATER PIPE TABLE		
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1005-FS4	6"	11.57 LF @ 3.00%, HDPP
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STORMWATER STRUCTURE TABLE					
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1001.MH	908.99	1001-1002, 12" INV IN =901.28 1001-1005, 12" INV IN =901.58	1000-1001, 12" INV OUT =901.08	N: 1032931.67 E: 2830342.87	STANDARD PRECAST MANHOLE REF: DETAIL 3/C-540
1002.CI	910.80	1002-1003, 12" INV IN =902.39	1001-1002, 12" INV OUT =901.89	N: 1032868.61 E: 2830332.81	2'x3' CURB INLET REF: DETAIL 2/C-532
1003.CI	908.76	1003-1004, 12" INV IN =903.74	1002-1003, 12" INV OUT =903.24	N: 1032845.41 E: 2830249.41	2'x3' CURB INLET REF: DETAIL 2/C-532
1004.AI	907.40		1003-1004, 12" INV OUT =904.49	N: 1032867.55 E: 2830176.04	STANDARD DOUBLE GRATE INLET REF: DETAIL 5/C-530
1005.AI	908.20	1005-1006, 12" INV IN =903.15 1005-ID, 12" INV IN =903.25	1001-1005, 12" INV OUT =902.65	N: 1032940.69 E: 2830312.07	STANDARD DOUBLE GRATE INLET REF: DETAIL 5/C-530
1006.AI	908.13	1006-ID, 12" INV IN =903.62	1005-1006, 12" INV OUT =903.42	N: 1032925.34 E: 2830307.57	STANDARD DOUBLE GRATE INLET REF: DETAIL 5/C-530
1007.CI	906.56	1007-1008, 24" INV IN =901.64	1000-1007, 36" INV OUT =901.26	N: 1033029.98 E: 2830180.60	STANDARD CURB INLET REF: DETAIL 1/C-530
1008.JB	906.49		1007-1008, 24" INV OUT =901.85	N: 1032984.96 E: 2830168.78	CONVERT CI TO JUNCTION BOX** REF: DETAIL 2/C-530
EX MH	908.59	EX MH-1000, 36" INV IN =899.37		N: 1032970.53 E: 2830516.95	EXISTING MANHOLE**

* LENGTH OF PIPE AND SLOPE SHOWN EXCLUDE VERTICAL PORTION OR INLINE DRAIN.

** EXISTING INCOMING OR OUTGOING PIPES TO REMAIN ARE NOT SHOWN IN TABLE FOR CLARITY. CONTRACTOR TO PLUG AND GROUT EXISTING PENETRATIONS IN STRUCTURE NO LONGER REQUIRED PER CITY OF LEE'S SUMMIT STANDARDS.

0 20' 40'
GRAPHIC SCALE 20'

N

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SECURITY & IT ENGINEERS
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KANSAS CITY, MO 64108
(816) 663-8700 PHONE

FIRE STATION #4
CITY OF LEE'S SUMMIT
5031 NORTHEAST LAKEWOOD WAY
LEE'S SUMMIT, MISSOURI 64064

100% DESIGN DEVELOPMENT DRAWINGS

REVISIONS:

#	Description	Date

NOT FOR CONSTRUCTION

ANGIE MORGAN - CIVIL ENGINEER
MO# PE-2018031541

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PROJECT NO:	18225R21001
DATE:	01.20.2022
DRAWN BY:	DMH
CHK'D BY:	ALM

GRADING & DRAINAGE PLAN

C-104

1 2 3 4 5

APPENDIX B.2

1-YR, 24-HR STORM EVENT SSA REPORT

Project Description

File Name	18225R21001_FS4_R0_220112.SPF
Description	K:\18225R21001\06-Site_Design\Lakewood_FS4\Calculations\Stormwater\Working Files\Analysis\CAD Files\18225R21001_FS4_R0_220112.dwg C:\Users\DERICK~1.HOL\AppData\Local\Temp\18225R21001_FS4_R0_220112_1_32208_2325f38b.sv$

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	SCS TR-55
Time of Concentration (TOC) Method	SCS TR-55
Link Routing Method	Kinematic Wave
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods ...	NO

Analysis Options

Start Analysis On	Jan 04, 2022	00:00:00
End Analysis On	Jan 05, 2022	00:00:00
Start Reporting On	Jan 04, 2022	00:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	5	seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins..	11
Nodes..	18
Junctions	6
Outfalls	2
Flow Diversions	0
Inlets	10
Storage Nodes	0
Links..	18
Channels	2
Pipes	16
Pumps	0
Orifices	0
Weirs	0
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
1		Time Series	1-YR, 24-HR	Cumulative	inches					User Defined

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	{Site 1}.1002	0.01	484.00	94.60	3.10	1.95	0.03	0.01	0 00:06:00
2	{Site 1}.1003	0.14	484.00	90.00	3.10	2.07	0.28	0.09	0 00:06:00
3	{Site 1}.1004	0.28	484.00	87.40	3.10	1.86	0.52	0.17	0 00:06:00
4	{Site 1}.1005	0.06	484.00	96.40	3.10	2.68	0.17	0.05	0 00:06:00
5	{Site 1}.1006	0.08	484.00	87.20	3.10	1.83	0.14	0.05	0 00:06:00
6	{Site 1}.1007	0.32	484.00	89.60	3.10	2.04	0.65	0.20	0 00:06:00
7	{Site 1}.FS4	0.18	484.00	98.00	3.10	2.87	0.53	0.14	0 00:06:00
8	{Site 1}.ID.1	0.04	484.00	78.80	3.10	1.25	0.05	0.02	0 00:06:00
9	{Site 1}.ID.2	0.01	484.00	98.00	3.10	1.94	0.02	0.01	0 00:06:00
10	{Site 1}.ID.3	0.04	484.00	82.60	3.10	1.49	0.06	0.02	0 00:06:00
11	{Site 1}.ID.4	0.03	484.00	85.60	3.10	1.57	0.04	0.01	0 00:06:00

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft²)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	1000.MH	Junction	900.12	909.18	0.00	6.00	0.00	0.76	900.85	0.00	8.33	0 00:00	0.00	0.00
2	1001.MH	Junction	901.08	908.99	0.00	6.00	0.00	0.55	901.70	0.00	7.29	0 00:00	0.00	0.00
3	1008.JB	Junction	901.85	906.49	0.00	0.00	10.00	0.00	901.85	0.00	4.64	0 00:00	0.00	0.00
4	ELBOW.1	Junction	902.98	909.36	0.00	6.00	0.00	0.27	903.15	0.00	6.21	0 00:00	0.00	0.00
5	ELBOW.2	Junction	902.56	909.78	0.00	6.00	0.00	0.28	902.73	0.00	7.05	0 00:00	0.00	0.00
6	EX.MH	Junction	898.84	908.59	0.00	6.00	0.00	0.76	899.60	0.00	8.99	0 00:00	0.00	0.00
7	Out-01	Outfall	898.37					0.76	898.59					
8	Out-02	Outfall	0.00					0.00	901.46					

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Average Slope (%)	Diameter or Height (in)	Manning's Roughness	Peak Flow (cfs)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Reported Condition
1	1000-1001	Pipe	1001.MH	1000.MH	46.18	901.08	900.62	1.0000	12.000	0.0100	0.55	4.62	0.12	3.96	0.23	0.23	0.00	Calculated
2	1000-1007	Pipe	1007.CI	1000.MH	188.02	901.26	900.32	0.5000	36.000	0.0100	0.21	61.31	0.00	2.03	0.13	0.04	0.00	Calculated
3	1001-1002	Pipe	1002.CI	1001.MH	60.86	901.89	901.28	1.0000	12.000	0.0100	0.29	4.64	0.06	3.28	0.17	0.17	0.00	Calculated
4	1001-1005	Pipe	1005.AI	1001.MH	28.61	902.65	901.58	3.7400	12.000	0.0100	0.27	8.96	0.03	5.12	0.12	0.12	0.00	Calculated
5	1002-1003-A	Pipe	1003.CI	ELBOW.1	25.39	903.24	902.98	1.0200	12.000	0.0100	0.25	4.69	0.05	3.19	0.16	0.16	0.00	Calculated
6	1002-1003-B	Pipe	ELBOW.1	ELBOW.2	41.98	902.98	902.56	1.0000	12.000	0.0100	0.27	4.63	0.06	3.24	0.17	0.17	0.00	Calculated
7	1002-1003-C	Pipe	ELBOW.2	1002.CI	17.22	902.56	902.39	0.9900	12.000	0.0100	0.28	4.60	0.06	3.23	0.17	0.17	0.00	Calculated
8	1002-ID1	Pipe	ID1	ELBOW.1	17.89	903.52	902.98	3.0200	12.000	0.0100	0.02	8.05	0.00	2.16	0.04	0.04	0.00	Calculated
9	1002-ID2	Pipe	ID2	ELBOW.2	22.00	903.22	902.56	3.0000	12.000	0.0100	0.01	8.02	0.00	1.42	0.02	0.02	0.00	Calculated
10	1003-1004	Pipe	1004.AI	1003.CI	74.52	904.49	903.74	1.0100	12.000	0.0100	0.17	4.65	0.04	2.83	0.13	0.13	0.00	Calculated
11	1005-1006	Pipe	1006.AI	1005.AI	13.75	903.42	903.15	1.9600	12.000	0.0100	0.07	6.49	0.01	2.67	0.07	0.07	0.00	Calculated
12	1005-ID	Pipe	ID4	1005.AI	35.83	904.32	903.25	2.9900	12.000	0.0100	0.15	8.00	0.02	3.96	0.10	0.10	0.00	Calculated
13	1006-ID	Pipe	ID3	1006.AI	28.17	904.18	903.62	1.9900	12.000	0.0100	0.02	6.53	0.00	1.87	0.04	0.04	0.00	Calculated
14	1007-1008	Pipe	1008.JB	1007.CI	41.14	901.85	901.64	0.5100	24.000	0.0100	0.00	21.01	0.00	0.00	0.00	0.00	0.00	Calculated
15	EP1	Pipe	EX.MH	Out-01	18.25	898.84	898.37	2.5800	42.000	0.0210	0.76	99.95	0.01	3.07	0.22	0.06	0.00	Calculated
16	EX.MH-1000	Pipe	1000.MH	EX.MH	150.24	900.12	899.37	0.5000	36.000	0.0100	0.76	61.26	0.01	2.99	0.23	0.08	0.00	Calculated
17	BP_1006-1002	Channel	1002.CI	1006.AI	66.85	910.80	908.13	3.9900	6.000	0.0170	0.00	6.79	0.00	0.84	0.02	0.04	0.00	
18	BP_1007-Out-02	Channel	1007.CI	Out-02	10.00	901.56	901.46	1.0000	6.000	0.0320	0.00	12.90	0.00	0.00	0.00	0.00	0.00	

Inlet Summary

SN	Element ID	Inlet Manufacturer	Manufacturer Part Number	Inlet Location	Number of Inlets	Catchbasin Invert Elevation (ft)	Max (Rim) Elevation (ft)	Initial Water Elevation (ft)	Ponded Area (ft²)	Peak Flow (cfs)	Peak Flow Intercepted by Inlet (cfs)	Peak Flow Bypassing Inlet (cfs)	Inlet Efficiency during Peak Flow (%)	Allowable Spread (ft)	Max Gutter Spread during Peak Flow (ft)	Max Gutter Water Elev. during Peak Flow (ft)
1	1002.CI	FHWA HEC-22 GENERIC	N/A	On Grade	1	901.89	910.80	0.00	N/A	0.01	0.00	0.00	0.00	7.00	0.54	910.83
2	1003.CI	FHWA HEC-22 GENERIC	N/A	On Sag	1	903.24	908.76	0.00	10.00	0.09	N/A	N/A	N/A	7.00	1.27	908.83
3	1004.AI	FHWA HEC-22 GENERIC	N/A	On Sag	1	904.49	907.40	0.00	10.00	0.17	N/A	N/A	N/A	7.00	1.83	907.53
4	1005.AI	NEENAH FOUNDRY	R-3338-G	On Sag	1	902.65	908.20	0.00	10.00	0.05	N/A	N/A	N/A	7.00	0.00	908.21
5	1006.AI	NEENAH FOUNDRY	R-3338-G	On Sag	1	903.42	908.13	0.00	10.00	0.05	N/A	N/A	N/A	7.00	0.00	908.14
6	1007.CI	FHWA HEC-22 GENERIC	N/A	On Grade	1	901.26	906.56	0.00	N/A	0.20	0.20	0.00	100.00	7.00	3.45	906.67
7	ID1	GUTTER DEPTH CAPTURE CURVE	N/A	On Sag	1	903.52	908.50	0.00	10.00	0.02	N/A	N/A	N/A	7.00	0.29	908.51
8	ID2	GUTTER DEPTH CAPTURE CURVE	N/A	On Sag	1	903.22	908.78	0.00	10.00	0.01	N/A	N/A	N/A	7.00	0.14	908.78
9	ID3	GUTTER DEPTH CAPTURE CURVE	N/A	On Sag	1	904.18	908.75	0.00	10.00	0.02	N/A	N/A	N/A	7.00	0.29	908.76
10	ID4	GUTTER DEPTH CAPTURE CURVE	N/A	On Sag	1	904.32	908.50	0.00	10.00	0.15	N/A	N/A	N/A	7.00	2.39	908.55

Junction Input

SN	Element ID	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Ground/Rim (Max) Offset (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Surcharge Elevation (ft)	Surcharge Depth (ft)	Ponded Area (ft²)	Minimum Pipe Cover (in)
1	1000.MH	900.12	909.18	9.06	0.00	-900.12	6.00	-903.18	0.00	70.32
2	1001.MH	901.08	908.99	7.91	0.00	-901.08	6.00	-902.99	0.00	76.92
3	1008.JB	901.85	906.49	4.64	0.00	-901.85	0.00	-906.49	10.00	31.68
4	ELBOW.1	902.98	909.36	6.38	0.00	-902.98	6.00	-903.36	0.00	64.56
5	ELBOW.2	902.56	909.78	7.22	0.00	-902.56	6.00	-903.78	0.00	74.64
6	EX.MH	898.84	908.59	9.75	0.00	-898.84	6.00	-902.59	0.00	74.64

Junction Results

SN	Element ID	Peak Inflow (cfs)	Peak Lateral Inflow (cfs)	Max HGL Elevation Attained (ft)	Max HGL Depth Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Average HGL Elevation Attained (ft)	Average HGL Depth Attained (ft)	Time of Max HGL Occurrence (days hh:mm)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	1000.MH	0.76	0.00	900.85	0.73	0.00	8.33	900.69	0.57	0 12:05	0 00:00	0.00	0.00
2	1001.MH	0.55	0.00	901.70	0.62	0.00	7.29	901.62	0.54	0 12:05	0 00:00	0.00	0.00
3	1008.JB	0.00	0.00	901.85	0.00	0.00	4.64	901.85	0.00	0 00:00	0 00:00	0.00	0.00
4	ELBOW.1	0.27	0.00	903.15	0.17	0.00	6.21	903.02	0.04	0 12:05	0 00:00	0.00	0.00
5	ELBOW.2	0.28	0.00	902.73	0.17	0.00	7.05	902.60	0.04	0 12:05	0 00:00	0.00	0.00
6	EX.MH	0.76	0.00	899.60	0.76	0.00	8.99	899.44	0.60	0 12:05	0 00:00	0.00	0.00

Channel Input

SN	Element ID	Length (ft)	Inlet Invert Elevation (ft)	Inlet Invert Offset (ft)	Outlet Invert Elevation (ft)	Outlet Invert Offset (ft)	Total Drop (ft)	Average Slope (%)	Shape	Height (ft)	Width (ft)	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow (cfs)	Flap Gate
1	BP_1006-1002	66.85	910.80	8.91	908.13	4.71	2.67	3.9900	Triangular	0.500	4.000	0.0170	0.5000	0.5000	0.0000	0.00	No
2	BP_1007-Out-02	10.00	901.56	0.30	901.46	901.46	0.10	1.0000	Triangular	0.500	4.000	0.0320	0.5000	0.5000	0.0000	0.00	No

Channel Results

SN	Element ID	Peak Flow (cfs)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Travel Time (min)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Froude Number	Reported Condition
1	BP_1006-1002	0.00	0 12:05	6.79	0.00	0.84	1.33	0.02	0.04	0.00		
2	BP_1007-Out-02	0.00	0 00:00	12.90	0.00	0.00		0.00	0.00	0.00		

Pipe Input

SN	Element ID	Length (ft)	Inlet Invert Elevation (ft)	Inlet Invert Offset (ft)	Outlet Invert Elevation (ft)	Outlet Invert Offset (ft)	Total Drop (ft)	Average Slope (%)	Pipe Shape	Pipe Diameter or Height (in)	Pipe Width (in)	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow (cfs)	Flap Gate
1	1000-1001	46.18	901.08	0.00	900.62	0.50	0.46	1.0000	CIRCULAR	12.000	12.000	0.0100	0.5000	0.4000	0.0000	0.00	No
2	1000-1007	188.02	901.26	0.00	900.32	0.20	0.94	0.5000	CIRCULAR	36.000	36.000	0.0100	0.5000	0.4000	0.0000	0.00	No
3	1001-1002	60.86	901.89	0.00	901.28	0.20	0.61	1.0000	CIRCULAR	12.000	12.000	0.0100	0.5000	0.4000	0.0000	0.00	No
4	1001-1005	28.61	902.65	0.00	901.58	0.50	1.07	3.7400	CIRCULAR	12.000	12.000	0.0100	0.5000	0.4000	0.0000	0.00	No
5	1002-1003-A	25.39	903.24	0.00	902.98	0.00	0.26	1.0200	CIRCULAR	12.000	12.000	0.0100	0.5000	0.4000	0.0000	0.00	No
6	1002-1003-B	41.98	902.98	0.00	902.56	0.00	0.42	1.0000	CIRCULAR	12.000	12.000	0.0100	0.5000	0.4000	0.0000	0.00	No
7	1002-1003-C	17.22	902.56	0.00	902.39	0.50	0.17	0.9900	CIRCULAR	12.000	12.000	0.0100	0.5000	0.4000	0.0000	0.00	No
8	1002-ID1	17.89	903.52	0.00	902.98	0.00	0.54	3.0200	CIRCULAR	12.000	12.000	0.0100	0.5000	0.3000	0.0000	0.00	No
9	1002-ID2	22.00	903.22	0.00	902.56	0.00	0.66	3.0000	CIRCULAR	12.000	12.000	0.0100	0.5000	0.3000	0.0000	0.00	No
10	1003-1004	74.52	904.49	0.00	903.74	0.50	0.75	1.0100	CIRCULAR	12.000	12.000	0.0100	0.5000	0.4000	0.0000	0.00	No
11	1005-1006	13.75	903.42	0.00	903.15	0.50	0.27	1.9600	CIRCULAR	12.000	12.000	0.0100	0.5000	0.4000	0.0000	0.00	No
12	1005-ID	35.83	904.32	0.00	903.25	0.60	1.07	2.9900	CIRCULAR	12.000	12.000	0.0100	0.5000	0.4000	0.0000	0.00	No
13	1006-ID	28.17	904.18	0.00	903.62	0.20	0.56	1.9900	CIRCULAR	12.000	12.000	0.0100	0.5000	0.1500	0.0000	0.00	No
14	1007-1008	41.14	901.85	0.00	901.64	0.38	0.21	0.5100	CIRCULAR	24.000	24.000	0.0100	0.5000	0.4000	0.0000	0.00	No
15	EP1	18.25	898.84	0.00	898.37	0.00	0.47	2.5800	CIRCULAR	42.000	42.000	0.0210	0.5000	0.4000	0.0000	0.00	No
16	EX.MH-1000	150.24	900.12	0.00	899.37	0.53	0.75	0.5000	CIRCULAR	36.000	36.000	0.0100	0.5000	0.4000	0.0000	0.00	No

No. of Barrels
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1

Pipe Results

SN	Element ID	Peak Flow (cfs)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Travel Time (min)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Froude Number	Reported Condition
1	1000-1001	0.55	0 12:05	4.62	0.12	3.96	0.19	0.23	0.23	0.00		Calculated
2	1000-1007	0.21	0 12:05	61.31	0.00	2.03	1.54	0.13	0.04	0.00		Calculated
3	1001-1002	0.29	0 12:05	4.64	0.06	3.28	0.31	0.17	0.17	0.00		Calculated
4	1001-1005	0.27	0 12:05	8.96	0.03	5.12	0.09	0.12	0.12	0.00		Calculated
5	1002-1003-A	0.25	0 12:05	4.69	0.05	3.19	0.13	0.16	0.16	0.00		Calculated
6	1002-1003-B	0.27	0 12:05	4.63	0.06	3.24	0.22	0.17	0.17	0.00		Calculated
7	1002-1003-C	0.28	0 12:05	4.60	0.06	3.23	0.09	0.17	0.17	0.00		Calculated
8	1002-ID1	0.02	0 12:05	8.05	0.00	2.16	0.14	0.04	0.04	0.00		Calculated
9	1002-ID2	0.01	0 10:20	8.02	0.00	1.42	0.26	0.02	0.02	0.00		Calculated
10	1003-1004	0.17	0 12:05	4.65	0.04	2.83	0.44	0.13	0.13	0.00		Calculated
11	1005-1006	0.07	0 12:05	6.49	0.01	2.67	0.09	0.07	0.07	0.00		Calculated
12	1005-ID	0.15	0 12:05	8.00	0.02	3.96	0.15	0.10	0.10	0.00		Calculated
13	1006-ID	0.02	0 12:05	6.53	0.00	1.87	0.25	0.04	0.04	0.00		Calculated
14	1007-1008	0.00	0 00:00	21.01	0.00	0.00		0.00	0.00	0.00		Calculated
15	EP1	0.76	0 12:05	99.95	0.01	3.07	0.10	0.22	0.06	0.00		Calculated
16	EX.MH-1000	0.76	0 12:05	61.26	0.01	2.99	0.84	0.23	0.08	0.00		Calculated

Inlet Input

SN	Element ID	Inlet Manufacturer	Manufacturer Part Number	Inlet Location	Number of Inlets	Catchbasin Invert Elevation (ft)	Max (Rim) Elevation (ft)	Inlet Depth (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Ponded Area (ft²)	Grate Clogging Factor (%)
1	1002.CI	FHWA HEC-22 GENERIC	N/A	On Grade	1	901.89	910.80	8.91	0.00	0.00	N/A	0.00
2	1003.CI	FHWA HEC-22 GENERIC	N/A	On Sag	1	903.24	908.76	5.52	0.00	0.00	10.00	0.00
3	1004.AI	FHWA HEC-22 GENERIC	N/A	On Sag	1	904.49	907.40	2.91	0.00	0.00	10.00	0.00
4	1005.AI	NEENAH FOUNDRY	R-3338-G	On Sag	1	902.65	908.20	5.55	0.00	0.00	10.00	0.00
5	1006.AI	NEENAH FOUNDRY	R-3338-G	On Sag	1	903.42	908.13	4.71	0.00	0.00	10.00	0.00
6	1007.CI	FHWA HEC-22 GENERIC	N/A	On Grade	1	901.26	906.56	5.30	0.00	0.00	N/A	0.00
7	ID1	GUTTER DEPTH CAPTURE CURVE	N/A	On Sag	1	903.52	908.50	4.98	0.00	0.00	10.00	0.00
8	ID2	GUTTER DEPTH CAPTURE CURVE	N/A	On Sag	1	903.22	908.78	5.56	0.00	0.00	10.00	0.00
9	ID3	GUTTER DEPTH CAPTURE CURVE	N/A	On Sag	1	904.18	908.75	4.57	0.00	0.00	10.00	0.00
10	ID4	GUTTER DEPTH CAPTURE CURVE	N/A	On Sag	1	904.32	908.50	4.18	0.00	0.00	10.00	0.00

Roadway & Gutter Input

SN	Element ID	Roadway Longitudinal Slope (ft/ft)	Roadway Cross Slope (ft/ft)	Roadway Manning's Roughness	Gutter Cross Slope (ft/ft)	Gutter Width (ft)	Gutter Depression (in)	Allowable Spread (ft)
1	1002.CI	0.0396	0.0200	0.0170	0.0521	1.33	0.0272	7.00
2	1003.CI	N/A	0.0200	0.0170	0.0521	1.33	0.0272	7.00
3	1004.AI	N/A	0.0200	0.0170	0.0521	1.33	0.0656	7.00
4	1005.AI	N/A	0.0200	0.0160	0.0620	2.00	0.0656	7.00
5	1006.AI	N/A	0.0200	0.0160	0.0620	2.00	0.0656	7.00
6	1007.CI	0.0100	0.0200	0.0170	0.0521	1.33	0.2051	7.00
7	ID1	N/A	0.0200					
8	ID2	N/A	0.0200					
9	ID3	N/A	0.0200					
10	ID4	N/A	0.0200					

Inlet Results

SN	Element ID	Peak Flow (cfs)	Peak Lateral Inflow (cfs)	Peak Flow Intercepted by Inlet (cfs)	Peak Flow Bypassing Inlet (cfs)	Inlet Efficiency during Peak Flow (%)	Max Gutter Spread during Peak Flow (ft)	Max Gutter Water Elev. during Peak Flow (ft)	Max Gutter Water Depth during Peak Flow (ft)	Time of Max Depth Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	1002.CI	0.01	0.01	0.00	0.00	0.00	0.54	910.83	0.03	0 12:05	0.00	0.00
2	1003.CI	0.09	0.09	N/A	N/A	N/A	1.27	908.83	0.07	0 12:05	0.00	0.00
3	1004.AI	0.17	0.17	N/A	N/A	N/A	1.83	907.53	0.13	0 12:05	0.00	0.00
4	1005.AI	0.05	0.05	N/A	N/A	N/A	0.00	908.21	0.01	0 12:05	0.00	0.00
5	1006.AI	0.05	0.05	N/A	N/A	N/A	0.00	908.14	0.01	0 10:05	0.00	0.00
6	1007.CI	0.20	0.20	0.20	0.00	100.00	3.45	906.67	0.11	0 00:00	0.00	0.00
7	ID1	0.02	0.02	N/A	N/A	N/A	0.29	908.51	0.01	0 12:05	0.00	0.00
8	ID2	0.01	0.01	N/A	N/A	N/A	0.14	908.78	0.00	0 10:20	0.00	0.00
9	ID3	0.02	0.02	N/A	N/A	N/A	0.29	908.76	0.01	0 12:05	0.00	0.00
10	ID4	0.15	0.15	N/A	N/A	N/A	2.39	908.55	0.05	0 11:45	0.00	0.00

APPENDIX B.3

10-YR, 24-HR STORM EVENT SSA REPORT

Project Description

File Name .... 18225R21001_FS4_R0_220112.SPF
Description .... K:\18225R21001\06-Site_Design\Lakewood_FS4\Calculations\Stormwater\Working Files\Analysis\CAD Files\18225R21001_FS4_R0_220112.dwg

C:\Users\DERICK~1.HOL\AppData\Local\Temp\18225R21001_FS4_R0_220112_1_32208_2325f38b.sv$

Project Options

Flow Units .... CFS
Elevation Type .... Elevation
Hydrology Method .... SCS TR-55
Time of Concentration (TOC) Method .... SCS TR-55
Link Routing Method .... Kinematic Wave
Enable Overflow Ponding at Nodes .... YES
Skip Steady State Analysis Time Periods ..... NO

Analysis Options

Start Analysis On	Jan 04, 2022	00:00:00
End Analysis On	Jan 05, 2022	00:00:00
Start Reporting On	Jan 04, 2022	00:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	5	seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins..	11
Nodes..	18
Junctions	6
Outfalls	2
Flow Diversions	0
Inlets	10
Storage Nodes	0
Links..	18
Channels	2
Pipes	16
Pumps	0
Orifices	0
Weirs	0
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
1		Time Series	10-YR, 24-HR	Cumulative	inches				0.00	

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	{Site 1}.1002	0.01	484.00	94.60	5.66	4.58	0.06	0.02	0 00:06:00
2	{Site 1}.1003	0.14	484.00	90.00	5.66	4.51	0.61	0.17	0 00:06:00
3	{Site 1}.1004	0.28	484.00	87.40	5.66	4.23	1.19	0.35	0 00:06:00
4	{Site 1}.1005	0.06	484.00	96.40	5.66	5.23	0.32	0.09	0 00:06:00
5	{Site 1}.1006	0.08	484.00	87.20	5.66	4.21	0.32	0.10	0 00:06:00
6	{Site 1}.1007	0.32	484.00	89.60	5.66	4.47	1.42	0.41	0 00:06:00
7	{Site 1}.FS4	0.18	484.00	98.00	5.66	5.42	1.00	0.25	0 00:06:00
8	{Site 1}.ID.1	0.04	484.00	78.80	5.66	3.34	0.14	0.05	0 00:06:00
9	{Site 1}.ID.2	0.01	484.00	98.00	5.66	4.25	0.04	0.01	0 00:06:00
10	{Site 1}.ID.3	0.04	484.00	82.60	5.66	3.71	0.15	0.04	0 00:06:00
11	{Site 1}.ID.4	0.03	484.00	85.60	5.66	3.99	0.10	0.03	0 00:06:00

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft²)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	1000.MH	Junction	900.12	909.18	0.00	6.00	0.00	1.53	900.95	0.00	8.23	0 00:00	0.00	0.00
2	1001.MH	Junction	901.08	908.99	0.00	6.00	0.00	1.11	901.74	0.00	7.25	0 00:00	0.00	0.00
3	1008.JB	Junction	901.85	906.49	0.00	0.00	10.00	0.00	901.85	0.00	4.64	0 00:00	0.00	0.00
4	ELBOW.1	Junction	902.98	909.36	0.00	6.00	0.00	0.57	903.22	0.00	6.14	0 00:00	0.00	0.00
5	ELBOW.2	Junction	902.56	909.78	0.00	6.00	0.00	0.58	902.80	0.00	6.98	0 00:00	0.00	0.00
6	EX.MH	Junction	898.84	908.59	0.00	6.00	0.00	1.53	899.70	0.00	8.89	0 00:00	0.00	0.00
7	Out-01	Outfall	898.37					1.53	898.67					
8	Out-02	Outfall	0.00					0.00	901.46					

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Average Slope (%)	Diameter or Height (in)	Manning's Roughness	Peak Flow (cfs)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Reported Condition
1	1000-1001	Pipe	1001.MH	1000.MH	46.18	901.08	900.62	1.0000	12.000	0.0100	1.11	4.62	0.24	4.84	0.33	0.33	0.00	Calculated
2	1000-1007	Pipe	1007.CI	1000.MH	188.02	901.26	900.32	0.5000	36.000	0.0100	0.41	61.31	0.01	2.51	0.18	0.06	0.00	Calculated
3	1001-1002	Pipe	1002.CI	1001.MH	60.86	901.89	901.28	1.0000	12.000	0.0100	0.60	4.64	0.13	4.08	0.24	0.24	0.00	Calculated
4	1001-1005	Pipe	1005.AI	1001.MH	28.61	902.65	901.58	3.7400	12.000	0.0100	0.52	8.96	0.06	6.20	0.16	0.16	0.00	Calculated
5	1002-1003-A	Pipe	1003.CI	ELBOW.1	25.39	903.24	902.98	1.0200	12.000	0.0100	0.53	4.69	0.11	3.95	0.23	0.23	0.00	Calculated
6	1002-1003-B	Pipe	ELBOW.1	ELBOW.2	41.98	902.98	902.56	1.0000	12.000	0.0100	0.57	4.63	0.12	4.02	0.24	0.24	0.00	Calculated
7	1002-1003-C	Pipe	ELBOW.2	1002.CI	17.22	902.56	902.39	0.9900	12.000	0.0100	0.58	4.60	0.13	4.02	0.24	0.24	0.00	Calculated
8	1002-ID1	Pipe	ID1	ELBOW.1	17.89	903.52	902.98	3.0200	12.000	0.0100	0.05	8.05	0.01	2.80	0.06	0.06	0.00	Calculated
9	1002-ID2	Pipe	ID2	ELBOW.2	22.00	903.22	902.56	3.0000	12.000	0.0100	0.01	8.02	0.00	1.69	0.03	0.03	0.00	Calculated
10	1003-1004	Pipe	1004.AI	1003.CI	74.52	904.49	903.74	1.0100	12.000	0.0100	0.35	4.65	0.08	3.51	0.19	0.19	0.00	Calculated
11	1005-1006	Pipe	1006.AI	1005.AI	13.75	903.42	903.15	1.9600	12.000	0.0100	0.14	6.49	0.02	3.30	0.10	0.10	0.00	Calculated
12	1005-ID	Pipe	ID4	1005.AI	35.83	904.32	903.25	2.9900	12.000	0.0100	0.29	8.00	0.04	4.82	0.13	0.13	0.00	Calculated
13	1006-ID	Pipe	ID3	1006.AI	28.17	904.18	903.62	1.9900	12.000	0.0100	0.04	6.53	0.01	2.39	0.06	0.06	0.00	Calculated
14	1007-1008	Pipe	1008.JB	1007.CI	41.14	901.85	901.64	0.5100	24.000	0.0100	0.00	21.01	0.00	0.00	0.00	0.00	0.00	Calculated
15	EP1	Pipe	EX.MH	Out-01	18.25	898.84	898.37	2.5800	42.000	0.0210	1.53	99.95	0.02	3.79	0.30	0.09	0.00	Calculated
16	EX.MH-1000	Pipe	1000.MH	EX.MH	150.24	900.12	899.37	0.5000	36.000	0.0100	1.53	61.26	0.02	3.58	0.33	0.11	0.00	Calculated
17	BP_1006-1002	Channel	1002.CI	1006.AI	66.85	910.80	908.13	3.9900	6.000	0.0170	0.00	6.79	0.00	0.98	0.03	0.05	0.00	
18	BP_1007-Out-02	Channel	1007.CI	Out-02	10.00	901.56	901.46	1.0000	6.000	0.0320	0.00	12.90	0.00	0.00	0.00	0.00	0.00	

Inlet Summary

SN	Element ID	Inlet Manufacturer	Manufacturer Part Number	Inlet Location	Number of Inlets	Catchbasin Invert Elevation (ft)	Max (Rim) Elevation (ft)	Initial Water Elevation (ft)	Ponded Area (ft²)	Peak Flow (cfs)	Peak Flow Intercepted by Inlet (cfs)	Peak Flow Bypassing Inlet (cfs)	Inlet Efficiency during Peak Flow (%)	Allowable Spread (ft)	Max Gutter Spread during Peak Flow (ft)	Max Gutter Water Elev. during Peak Flow (ft)
1	1002.CI	FHWA HEC-22 GENERIC	N/A	On Grade	1	901.89	910.80	0.00	N/A	0.02	0.00	0.00	0.00	7.00	0.68	910.84
2	1003.CI	FHWA HEC-22 GENERIC	N/A	On Sag	1	903.24	908.76	0.00	10.00	0.17	N/A	N/A	N/A	7.00	1.60	908.83
3	1004.AI	FHWA HEC-22 GENERIC	N/A	On Sag	1	904.49	907.40	0.00	10.00	0.35	N/A	N/A	N/A	7.00	4.00	907.57
4	1005.AI	NEENAH FOUNDRY	R-3338-G	On Sag	1	902.65	908.20	0.00	10.00	0.09	N/A	N/A	N/A	7.00	0.00	908.22
5	1006.AI	NEENAH FOUNDRY	R-3338-G	On Sag	1	903.42	908.13	0.00	10.00	0.10	N/A	N/A	N/A	7.00	0.00	908.15
6	1007.CI	FHWA HEC-22 GENERIC	N/A	On Grade	1	901.26	906.56	0.00	N/A	0.41	0.41	0.00	100.00	7.00	4.83	906.70
7	ID1	GUTTER DEPTH CAPTURE CURVE	N/A	On Sag	1	903.52	908.50	0.00	10.00	0.05	N/A	N/A	N/A	7.00	0.71	908.51
8	ID2	GUTTER DEPTH CAPTURE CURVE	N/A	On Sag	1	903.22	908.78	0.00	10.00	0.01	N/A	N/A	N/A	7.00	0.25	908.78
9	ID3	GUTTER DEPTH CAPTURE CURVE	N/A	On Sag	1	904.18	908.75	0.00	10.00	0.04	N/A	N/A	N/A	7.00	0.66	908.76
10	ID4	GUTTER DEPTH CAPTURE CURVE	N/A	On Sag	1	904.32	908.50	0.00	10.00	0.29	N/A	N/A	N/A	7.00	3.55	908.57

Junction Input

SN	Element ID	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Ground/Rim (Max) Offset (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Surcharge Elevation (ft)	Surcharge Depth (ft)	Ponded Area (ft²)	Minimum Pipe Cover (in)
1	1000.MH	900.12	909.18	9.06	0.00	-900.12	6.00	-903.18	0.00	70.32
2	1001.MH	901.08	908.99	7.91	0.00	-901.08	6.00	-902.99	0.00	76.92
3	1008.JB	901.85	906.49	4.64	0.00	-901.85	0.00	-906.49	10.00	31.68
4	ELBOW.1	902.98	909.36	6.38	0.00	-902.98	6.00	-903.36	0.00	64.56
5	ELBOW.2	902.56	909.78	7.22	0.00	-902.56	6.00	-903.78	0.00	74.64
6	EX.MH	898.84	908.59	9.75	0.00	-898.84	6.00	-902.59	0.00	74.64

Junction Results

SN	Element ID	Peak Inflow (cfs)	Peak Lateral Inflow (cfs)	Max HGL Elevation Attained (ft)	Max HGL Depth Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Average HGL Elevation Attained (ft)	Average HGL Depth Attained (ft)	Time of Max HGL Occurrence (days hh:mm)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	1000.MH	1.53	0.00	900.95	0.83	0.00	8.23	900.72	0.60	0 12:05	0 00:00	0.00	0.00
2	1001.MH	1.11	0.00	901.74	0.66	0.00	7.25	901.63	0.55	0 12:05	0 00:00	0.00	0.00
3	1008.JB	0.00	0.00	901.85	0.00	0.00	4.64	901.85	0.00	0 00:00	0 00:00	0.00	0.00
4	ELBOW.1	0.57	0.00	903.22	0.24	0.00	6.14	903.05	0.07	0 12:05	0 00:00	0.00	0.00
5	ELBOW.2	0.58	0.00	902.80	0.24	0.00	6.98	902.63	0.07	0 12:05	0 00:00	0.00	0.00
6	EX.MH	1.53	0.00	899.70	0.86	0.00	8.89	899.47	0.63	0 12:05	0 00:00	0.00	0.00

Channel Input

SN	Element ID	Length (ft)	Inlet Invert Elevation (ft)	Inlet Invert Offset (ft)	Outlet Invert Elevation (ft)	Outlet Invert Offset (ft)	Total Drop (ft)	Average Slope (%)	Shape	Height (ft)	Width (ft)	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow (cfs)	Flap Gate
1	BP_1006-1002	66.85	910.80	8.91	908.13	4.71	2.67	3.9900	Triangular	0.500	4.000	0.0170	0.5000	0.5000	0.0000	0.00	No
2	BP_1007-Out-02	10.00	901.56	0.30	901.46	901.46	0.10	1.0000	Triangular	0.500	4.000	0.0320	0.5000	0.5000	0.0000	0.00	No

Channel Results

SN	Element ID	Peak Flow (cfs)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Travel Time (min)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Froude Number	Reported Condition
1	BP_1006-1002	0.00	0 12:05	6.79	0.00	0.98	1.14	0.03	0.05	0.00		
2	BP_1007-Out-02	0.00	0 00:00	12.90	0.00	0.00		0.00	0.00	0.00		

Pipe Input

SN	Element ID	Length (ft)	Inlet Invert Elevation (ft)	Inlet Invert Offset (ft)	Outlet Invert Elevation (ft)	Outlet Invert Offset (ft)	Total Drop (ft)	Average Slope (%)	Pipe Shape	Pipe Diameter or Height (in)	Pipe Width (in)	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow (cfs)	Flap Gate
1	1000-1001	46.18	901.08	0.00	900.62	0.50	0.46	1.0000	CIRCULAR	12.000	12.000	0.0100	0.5000	0.4000	0.0000	0.00	No
2	1000-1007	188.02	901.26	0.00	900.32	0.20	0.94	0.5000	CIRCULAR	36.000	36.000	0.0100	0.5000	0.4000	0.0000	0.00	No
3	1001-1002	60.86	901.89	0.00	901.28	0.20	0.61	1.0000	CIRCULAR	12.000	12.000	0.0100	0.5000	0.4000	0.0000	0.00	No
4	1001-1005	28.61	902.65	0.00	901.58	0.50	1.07	3.7400	CIRCULAR	12.000	12.000	0.0100	0.5000	0.4000	0.0000	0.00	No
5	1002-1003-A	25.39	903.24	0.00	902.98	0.00	0.26	1.0200	CIRCULAR	12.000	12.000	0.0100	0.5000	0.4000	0.0000	0.00	No
6	1002-1003-B	41.98	902.98	0.00	902.56	0.00	0.42	1.0000	CIRCULAR	12.000	12.000	0.0100	0.5000	0.4000	0.0000	0.00	No
7	1002-1003-C	17.22	902.56	0.00	902.39	0.50	0.17	0.9900	CIRCULAR	12.000	12.000	0.0100	0.5000	0.4000	0.0000	0.00	No
8	1002-ID1	17.89	903.52	0.00	902.98	0.00	0.54	3.0200	CIRCULAR	12.000	12.000	0.0100	0.5000	0.3000	0.0000	0.00	No
9	1002-ID2	22.00	903.22	0.00	902.56	0.00	0.66	3.0000	CIRCULAR	12.000	12.000	0.0100	0.5000	0.3000	0.0000	0.00	No
10	1003-1004	74.52	904.49	0.00	903.74	0.50	0.75	1.0100	CIRCULAR	12.000	12.000	0.0100	0.5000	0.4000	0.0000	0.00	No
11	1005-1006	13.75	903.42	0.00	903.15	0.50	0.27	1.9600	CIRCULAR	12.000	12.000	0.0100	0.5000	0.4000	0.0000	0.00	No
12	1005-ID	35.83	904.32	0.00	903.25	0.60	1.07	2.9900	CIRCULAR	12.000	12.000	0.0100	0.5000	0.4000	0.0000	0.00	No
13	1006-ID	28.17	904.18	0.00	903.62	0.20	0.56	1.9900	CIRCULAR	12.000	12.000	0.0100	0.5000	0.1500	0.0000	0.00	No
14	1007-1008	41.14	901.85	0.00	901.64	0.38	0.21	0.5100	CIRCULAR	24.000	24.000	0.0100	0.5000	0.4000	0.0000	0.00	No
15	EP1	18.25	898.84	0.00	898.37	0.00	0.47	2.5800	CIRCULAR	42.000	42.000	0.0210	0.5000	0.4000	0.0000	0.00	No
16	EX.MH-1000	150.24	900.12	0.00	899.37	0.53	0.75	0.5000	CIRCULAR	36.000	36.000	0.0100	0.5000	0.4000	0.0000	0.00	No

No. of Barrels
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1

Pipe Results

SN	Element ID	Peak Flow (cfs)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Travel Time (min)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Froude Number	Reported Condition
1	1000-1001	1.11	0 12:05	4.62	0.24	4.84	0.16	0.33	0.33	0.00		Calculated
2	1000-1007	0.41	0 12:05	61.31	0.01	2.51	1.25	0.18	0.06	0.00		Calculated
3	1001-1002	0.60	0 12:05	4.64	0.13	4.08	0.25	0.24	0.24	0.00		Calculated
4	1001-1005	0.52	0 12:05	8.96	0.06	6.20	0.08	0.16	0.16	0.00		Calculated
5	1002-1003-A	0.53	0 12:05	4.69	0.11	3.95	0.11	0.23	0.23	0.00		Calculated
6	1002-1003-B	0.57	0 12:05	4.63	0.12	4.02	0.17	0.24	0.24	0.00		Calculated
7	1002-1003-C	0.58	0 12:05	4.60	0.13	4.02	0.07	0.24	0.24	0.00		Calculated
8	1002-ID1	0.05	0 12:00	8.05	0.01	2.80	0.11	0.06	0.06	0.00		Calculated
9	1002-ID2	0.01	0 10:20	8.02	0.00	1.69	0.22	0.03	0.03	0.00		Calculated
10	1003-1004	0.35	0 12:05	4.65	0.08	3.51	0.35	0.19	0.19	0.00		Calculated
11	1005-1006	0.14	0 12:05	6.49	0.02	3.30	0.07	0.10	0.10	0.00		Calculated
12	1005-ID	0.29	0 11:50	8.00	0.04	4.82	0.12	0.13	0.13	0.00		Calculated
13	1006-ID	0.04	0 12:05	6.53	0.01	2.39	0.20	0.06	0.06	0.00		Calculated
14	1007-1008	0.00	0 00:00	21.01	0.00	0.00		0.00	0.00	0.00		Calculated
15	EP1	1.53	0 12:05	99.95	0.02	3.79	0.08	0.30	0.09	0.00		Calculated
16	EX.MH-1000	1.53	0 12:05	61.26	0.02	3.58	0.70	0.33	0.11	0.00		Calculated

Inlet Input

SN	Element ID	Inlet Manufacturer	Manufacturer Part Number	Inlet Location	Number of Inlets	Catchbasin Invert Elevation (ft)	Max (Rim) Elevation (ft)	Inlet Depth (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Ponded Area (ft²)	Grate Clogging Factor (%)
1	1002.CI	FHWA HEC-22 GENERIC	N/A	On Grade	1	901.89	910.80	8.91	0.00	0.00	N/A	0.00
2	1003.CI	FHWA HEC-22 GENERIC	N/A	On Sag	1	903.24	908.76	5.52	0.00	0.00	10.00	0.00
3	1004.AI	FHWA HEC-22 GENERIC	N/A	On Sag	1	904.49	907.40	2.91	0.00	0.00	10.00	0.00
4	1005.AI	NEENAH FOUNDRY	R-3338-G	On Sag	1	902.65	908.20	5.55	0.00	0.00	10.00	0.00
5	1006.AI	NEENAH FOUNDRY	R-3338-G	On Sag	1	903.42	908.13	4.71	0.00	0.00	10.00	0.00
6	1007.CI	FHWA HEC-22 GENERIC	N/A	On Grade	1	901.26	906.56	5.30	0.00	0.00	N/A	0.00
7	ID1	GUTTER DEPTH CAPTURE CURVE	N/A	On Sag	1	903.52	908.50	4.98	0.00	0.00	10.00	0.00
8	ID2	GUTTER DEPTH CAPTURE CURVE	N/A	On Sag	1	903.22	908.78	5.56	0.00	0.00	10.00	0.00
9	ID3	GUTTER DEPTH CAPTURE CURVE	N/A	On Sag	1	904.18	908.75	4.57	0.00	0.00	10.00	0.00
10	ID4	GUTTER DEPTH CAPTURE CURVE	N/A	On Sag	1	904.32	908.50	4.18	0.00	0.00	10.00	0.00

Roadway & Gutter Input

SN	Element ID	Roadway Longitudinal Slope (ft/ft)	Roadway Cross Slope (ft/ft)	Roadway Manning's Roughness	Gutter Cross Slope (ft/ft)	Gutter Width (ft)	Gutter Depression (in)	Allowable Spread (ft)
1	1002.CI	0.0396	0.0200	0.0170	0.0521	1.33	0.0272	7.00
2	1003.CI	N/A	0.0200	0.0170	0.0521	1.33	0.0272	7.00
3	1004.AI	N/A	0.0200	0.0170	0.0521	1.33	0.0656	7.00
4	1005.AI	N/A	0.0200	0.0160	0.0620	2.00	0.0656	7.00
5	1006.AI	N/A	0.0200	0.0160	0.0620	2.00	0.0656	7.00
6	1007.CI	0.0100	0.0200	0.0170	0.0521	1.33	0.2051	7.00
7	ID1	N/A	0.0200					
8	ID2	N/A	0.0200					
9	ID3	N/A	0.0200					
10	ID4	N/A	0.0200					

Inlet Results

SN	Element ID	Peak Flow (cfs)	Peak Lateral Inflow (cfs)	Peak Flow Intercepted by Inlet (cfs)	Peak Flow Bypassing Inlet (cfs)	Inlet Efficiency during Peak Flow (%)	Max Gutter Spread during Peak Flow (ft)	Max Gutter Water Elev. during Peak Flow (ft)	Max Gutter Water Depth during Peak Flow (ft)	Time of Max Depth Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	1002.CI	0.02	0.02	0.00	0.00	0.00	0.68	910.84	0.04	0 12:05	0.00	0.00
2	1003.CI	0.17	0.17	N/A	N/A	N/A	1.60	908.83	0.07	0 12:05	0.00	0.00
3	1004.AI	0.35	0.35	N/A	N/A	N/A	4.00	907.57	0.17	0 12:05	0.00	0.00
4	1005.AI	0.09	0.09	N/A	N/A	N/A	0.00	908.22	0.02	0 11:50	0.00	0.00
5	1006.AI	0.10	0.10	N/A	N/A	N/A	0.00	908.15	0.02	0 06:56	0.00	0.00
6	1007.CI	0.41	0.41	0.41	0.00	100.00	4.83	906.70	0.14	0 00:00	0.00	0.00
7	ID1	0.05	0.05	N/A	N/A	N/A	0.71	908.51	0.01	0 12:00	0.00	0.00
8	ID2	0.01	0.01	N/A	N/A	N/A	0.25	908.78	0.01	0 10:20	0.00	0.00
9	ID3	0.04	0.04	N/A	N/A	N/A	0.66	908.76	0.01	0 12:05	0.00	0.00
10	ID4	0.29	0.29	N/A	N/A	N/A	3.55	908.57	0.07	0 11:50	0.00	0.00

APPENDIX B.4

100-YR, 24-HR STORM EVENT SSA REPORT

Project Description

File Name	18225R21001_FS4_R0_220112.SPF
Description	K:\18225R21001\06-Site_Design\Lakewood_FS4\Calculations\Stormwater\Working Files\Analysis\CAD Files\18225R21001_FS4_R0_220112.dwg C:\Users\DERICK~1.HOL\AppData\Local\Temp\18225R21001_FS4_R0_220112_1_32208_2325f38b.sv$

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	SCS TR-55
Time of Concentration (TOC) Method	SCS TR-55
Link Routing Method	Kinematic Wave
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	NO

Analysis Options

Start Analysis On	Jan 04, 2022	00:00:00
End Analysis On	Jan 05, 2022	00:00:00
Start Reporting On	Jan 04, 2022	00:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	5	seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	11
Nodes	18
Junctions	6
Outfalls	2
Flow Diversions	0
Inlets	10
Storage Nodes	0
Links	18
Channels	2
Pipes	16
Pumps	0
Orifices	0
Weirs	0
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
1		Time Series	100-YR, 24-HR	Cumulative	inches				0.00	

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	{Site 1}.1002	0.01	484.00	94.60	9.25	8.48	0.12	0.03	0 00:06:00
2	{Site 1}.1003	0.14	484.00	90.00	9.25	8.04	1.08	0.29	0 00:06:00
3	{Site 1}.1004	0.28	484.00	87.40	9.25	7.72	2.18	0.61	0 00:06:00
4	{Site 1}.1005	0.06	484.00	96.40	9.25	8.81	0.55	0.14	0 00:06:00
5	{Site 1}.1006	0.08	484.00	87.20	9.25	7.69	0.58	0.17	0 00:06:00
6	{Site 1}.1007	0.32	484.00	89.60	9.25	7.99	2.54	0.70	0 00:06:00
7	{Site 1}.FS4	0.18	484.00	98.00	9.25	9.01	1.66	0.42	0 00:06:00
8	{Site 1}.ID.1	0.04	484.00	78.80	9.25	6.64	0.29	0.09	0 00:06:00
9	{Site 1}.ID.2	0.01	484.00	98.00	9.25	8.03	0.07	0.01	0 00:06:00
10	{Site 1}.ID.3	0.04	484.00	82.60	9.25	7.11	0.29	0.08	0 00:06:00
11	{Site 1}.ID.4	0.03	484.00	85.60	9.25	7.46	0.19	0.05	0 00:06:00

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft²)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	1000.MH	Junction	900.12	909.18	0.00	6.00	0.00	2.59	901.07	0.00	8.11	0 00:00	0.00	0.00
2	1001.MH	Junction	901.08	908.99	0.00	6.00	0.00	1.89	901.79	0.00	7.20	0 00:00	0.00	0.00
3	1008.JB	Junction	901.85	906.49	0.00	0.00	10.00	0.00	901.85	0.00	4.64	0 00:00	0.00	0.00
4	ELBOW.1	Junction	902.98	909.36	0.00	6.00	0.00	0.99	903.29	0.00	6.07	0 00:00	0.00	0.00
5	ELBOW.2	Junction	902.56	909.78	0.00	6.00	0.00	1.00	902.88	0.00	6.90	0 00:00	0.00	0.00
6	EX.MH	Junction	898.84	908.59	0.00	6.00	0.00	2.60	899.79	0.00	8.80	0 00:00	0.00	0.00
7	Out-01	Outfall	898.37					2.63	898.76					
8	Out-02	Outfall	0.00					0.00	901.46					

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Average Slope (%)	Diameter or Height (in)	Manning's Roughness	Peak Flow (cfs)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Reported Condition
1	1000-1001	Pipe	1001.MH	1000.MH	46.18	901.08	900.62	1.0000	12.000	0.0100	1.89	4.62	0.41	5.60	0.45	0.45	0.00	Calculated
2	1000-1007	Pipe	1007.CI	1000.MH	188.02	901.26	900.32	0.5000	36.000	0.0100	0.70	61.31	0.01	2.93	0.23	0.08	0.00	Calculated
3	1001-1002	Pipe	1002.CI	1001.MH	60.86	901.89	901.28	1.0000	12.000	0.0100	1.03	4.64	0.22	4.76	0.32	0.32	0.00	Calculated
4	1001-1005	Pipe	1005.AI	1001.MH	28.61	902.65	901.58	3.7400	12.000	0.0100	0.86	8.96	0.10	7.22	0.21	0.21	0.00	Calculated
5	1002-1003-A	Pipe	1003.CI	ELBOW.1	25.39	903.24	902.98	1.0200	12.000	0.0100	0.90	4.69	0.19	4.61	0.30	0.30	0.00	Calculated
6	1002-1003-B	Pipe	ELBOW.1	ELBOW.2	41.98	902.98	902.56	1.0000	12.000	0.0100	0.99	4.63	0.21	4.70	0.31	0.31	0.00	Calculated
7	1002-1003-C	Pipe	ELBOW.2	1002.CI	17.22	902.56	902.39	0.9900	12.000	0.0100	1.00	4.60	0.22	4.69	0.32	0.32	0.00	Calculated
8	1002-ID1	Pipe	ID1	ELBOW.1	17.89	903.52	902.98	3.0200	12.000	0.0100	0.09	8.05	0.01	3.39	0.07	0.07	0.00	Calculated
9	1002-ID2	Pipe	ID2	ELBOW.2	22.00	903.22	902.56	3.0000	12.000	0.0100	0.01	8.02	0.00	1.93	0.03	0.03	0.00	Calculated
10	1003-1004	Pipe	1004.AI	1003.CI	74.52	904.49	903.74	1.0100	12.000	0.0100	0.61	4.65	0.13	4.11	0.24	0.24	0.00	Calculated
11	1005-1006	Pipe	1006.AI	1005.AI	13.75	903.42	903.15	1.9600	12.000	0.0100	0.25	6.49	0.04	3.98	0.13	0.13	0.00	Calculated
12	1005-ID	Pipe	ID4	1005.AI	35.83	904.32	903.25	2.9900	12.000	0.0100	0.47	8.00	0.06	5.58	0.16	0.16	0.00	Calculated
13	1006-ID	Pipe	ID3	1006.AI	28.17	904.18	903.62	1.9900	12.000	0.0100	0.08	6.53	0.01	2.84	0.08	0.08	0.00	Calculated
14	1007-1008	Pipe	1008.JB	1007.CI	41.14	901.85	901.64	0.5100	24.000	0.0100	0.00	21.01	0.00	0.00	0.00	0.00	0.00	Calculated
15	EP1	Pipe	EX.MH	Out-01	18.25	898.84	898.37	2.5800	42.000	0.0210	2.63	99.95	0.03	4.50	0.40	0.11	0.00	Calculated
16	EX.MH-1000	Pipe	1000.MH	EX.MH	150.24	900.12	899.37	0.5000	36.000	0.0100	2.60	61.26	0.04	4.34	0.42	0.14	0.00	Calculated
17	BP_1006-1002	Channel	1002.CI	1006.AI	66.85	910.80	908.13	3.9900	6.000	0.0170	0.00	6.79	0.00	1.12	0.03	0.07	0.00	
18	BP_1007-Out-02	Channel	1007.CI	Out-02	10.00	901.56	901.46	1.0000	6.000	0.0320	0.00	12.90	0.00	0.00	0.00	0.00	0.00	

Inlet Summary

SN	Element ID	Inlet Manufacturer	Manufacturer Part Number	Inlet Location	Number of Inlets	Catchbasin Invert Elevation (ft)	Max (Rim) Elevation (ft)	Initial Water Elevation (ft)	Ponded Area (ft²)	Peak Flow (cfs)	Peak Flow Intercepted by Inlet (cfs)	Peak Flow Bypassing Inlet (cfs)	Inlet Efficiency during Peak Flow (%)	Allowable Spread (ft)	Max Gutter Spread during Peak Flow (ft)	Max Gutter Water Elev. during Peak Flow (ft)
1	1002.CI	FHWA HEC-22 GENERIC	N/A	On Grade	1	901.89	910.80	0.00	N/A	0.03	0.00	0.00	0.00	7.00	0.84	910.84
2	1003.CI	FHWA HEC-22 GENERIC	N/A	On Sag	1	903.24	908.76	0.00	10.00	0.29	N/A	N/A	N/A	7.00	1.98	908.84
3	1004.AI	FHWA HEC-22 GENERIC	N/A	On Sag	1	904.49	907.40	0.00	10.00	0.61	N/A	N/A	N/A	7.00	5.54	907.60
4	1005.AI	NEENAH FOUNDRY	R-3338-G	On Sag	1	902.65	908.20	0.00	10.00	0.14	N/A	N/A	N/A	7.00	0.00	908.23
5	1006.AI	NEENAH FOUNDRY	R-3338-G	On Sag	1	903.42	908.13	0.00	10.00	0.17	N/A	N/A	N/A	7.00	0.00	908.16
6	1007.CI	FHWA HEC-22 GENERIC	N/A	On Grade	1	901.26	906.56	0.00	N/A	0.70	0.70	0.00	100.00	7.00	6.10	906.72
7	ID1	GUTTER DEPTH CAPTURE CURVE	N/A	On Sag	1	903.52	908.50	0.00	10.00	0.09	N/A	N/A	N/A	7.00	1.32	908.53
8	ID2	GUTTER DEPTH CAPTURE CURVE	N/A	On Sag	1	903.22	908.78	0.00	10.00	0.01	N/A	N/A	N/A	7.00	0.39	908.79
9	ID3	GUTTER DEPTH CAPTURE CURVE	N/A	On Sag	1	904.18	908.75	0.00	10.00	0.08	N/A	N/A	N/A	7.00	1.18	908.77
10	ID4	GUTTER DEPTH CAPTURE CURVE	N/A	On Sag	1	904.32	908.50	0.00	10.00	0.47	N/A	N/A	N/A	7.00	5.07	908.60

Junction Input

SN	Element ID	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Ground/Rim (Max) Offset (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Surcharge Elevation (ft)	Surcharge Depth (ft)	Ponded Area (ft²)	Minimum Pipe Cover (in)
1	1000.MH	900.12	909.18	9.06	0.00	-900.12	6.00	-903.18	0.00	70.32
2	1001.MH	901.08	908.99	7.91	0.00	-901.08	6.00	-902.99	0.00	76.92
3	1008.JB	901.85	906.49	4.64	0.00	-901.85	0.00	-906.49	10.00	31.68
4	ELBOW.1	902.98	909.36	6.38	0.00	-902.98	6.00	-903.36	0.00	64.56
5	ELBOW.2	902.56	909.78	7.22	0.00	-902.56	6.00	-903.78	0.00	74.64
6	EX.MH	898.84	908.59	9.75	0.00	-898.84	6.00	-902.59	0.00	74.64

Junction Results

SN	Element ID	Peak Inflow (cfs)	Peak Lateral Inflow (cfs)	Max HGL Elevation Attained (ft)	Max HGL Depth Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Average HGL Elevation Attained (ft)	Average HGL Depth Attained (ft)	Time of Max HGL Occurrence (days hh:mm)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	1000.MH	2.59	0.00	901.07	0.95	0.00	8.11	900.76	0.64	0 12:05	0 00:00	0.00	0.00
2	1001.MH	1.89	0.00	901.79	0.71	0.00	7.20	901.65	0.57	0 12:05	0 00:00	0.00	0.00
3	1008.JB	0.00	0.00	901.85	0.00	0.00	4.64	901.85	0.00	0 00:00	0 00:00	0.00	0.00
4	ELBOW.1	0.99	0.00	903.29	0.31	0.00	6.07	903.08	0.10	0 12:05	0 00:00	0.00	0.00
5	ELBOW.2	1.00	0.00	902.88	0.32	0.00	6.90	902.66	0.10	0 12:05	0 00:00	0.00	0.00
6	EX.MH	2.60	0.00	899.79	0.95	0.00	8.80	899.51	0.67	0 12:05	0 00:00	0.00	0.00

Channel Input

SN	Element ID	Length (ft)	Inlet Invert Elevation (ft)	Inlet Invert Offset (ft)	Outlet Invert Elevation (ft)	Outlet Invert Offset (ft)	Total Drop (ft)	Average Slope (%)	Shape	Height (ft)	Width (ft)	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow (cfs)	Flap Gate
1	BP_1006-1002	66.85	910.80	8.91	908.13	4.71	2.67	3.9900	Triangular	0.500	4.000	0.0170	0.5000	0.5000	0.0000	0.00	No
2	BP_1007-Out-02	10.00	901.56	0.30	901.46	901.46	0.10	1.0000	Triangular	0.500	4.000	0.0320	0.5000	0.5000	0.0000	0.00	No

Channel Results

SN	Element ID	Peak Flow (cfs)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Travel Time (min)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Froude Number	Reported Condition
1	BP_1006-1002	0.00	0 12:05	6.79	0.00	1.12	0.99	0.03	0.07	0.00		
2	BP_1007-Out-02	0.00	0 00:00	12.90	0.00	0.00		0.00	0.00	0.00		

Pipe Input

SN	Element ID	Length (ft)	Inlet Invert Elevation (ft)	Inlet Invert Offset (ft)	Outlet Invert Elevation (ft)	Outlet Invert Offset (ft)	Total Drop (ft)	Average Slope (%)	Pipe Shape	Pipe Diameter or Height (in)	Pipe Width (in)	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow (cfs)	Flap Gate
1	1000-1001	46.18	901.08	0.00	900.62	0.50	0.46	1.0000	CIRCULAR	12.000	12.000	0.0100	0.5000	0.4000	0.0000	0.00	No
2	1000-1007	188.02	901.26	0.00	900.32	0.20	0.94	0.5000	CIRCULAR	36.000	36.000	0.0100	0.5000	0.4000	0.0000	0.00	No
3	1001-1002	60.86	901.89	0.00	901.28	0.20	0.61	1.0000	CIRCULAR	12.000	12.000	0.0100	0.5000	0.4000	0.0000	0.00	No
4	1001-1005	28.61	902.65	0.00	901.58	0.50	1.07	3.7400	CIRCULAR	12.000	12.000	0.0100	0.5000	0.4000	0.0000	0.00	No
5	1002-1003-A	25.39	903.24	0.00	902.98	0.00	0.26	1.0200	CIRCULAR	12.000	12.000	0.0100	0.5000	0.4000	0.0000	0.00	No
6	1002-1003-B	41.98	902.98	0.00	902.56	0.00	0.42	1.0000	CIRCULAR	12.000	12.000	0.0100	0.5000	0.4000	0.0000	0.00	No
7	1002-1003-C	17.22	902.56	0.00	902.39	0.50	0.17	0.9900	CIRCULAR	12.000	12.000	0.0100	0.5000	0.4000	0.0000	0.00	No
8	1002-ID1	17.89	903.52	0.00	902.98	0.00	0.54	3.0200	CIRCULAR	12.000	12.000	0.0100	0.5000	0.3000	0.0000	0.00	No
9	1002-ID2	22.00	903.22	0.00	902.56	0.00	0.66	3.0000	CIRCULAR	12.000	12.000	0.0100	0.5000	0.3000	0.0000	0.00	No
10	1003-1004	74.52	904.49	0.00	903.74	0.50	0.75	1.0100	CIRCULAR	12.000	12.000	0.0100	0.5000	0.4000	0.0000	0.00	No
11	1005-1006	13.75	903.42	0.00	903.15	0.50	0.27	1.9600	CIRCULAR	12.000	12.000	0.0100	0.5000	0.4000	0.0000	0.00	No
12	1005-ID	35.83	904.32	0.00	903.25	0.60	1.07	2.9900	CIRCULAR	12.000	12.000	0.0100	0.5000	0.4000	0.0000	0.00	No
13	1006-ID	28.17	904.18	0.00	903.62	0.20	0.56	1.9900	CIRCULAR	12.000	12.000	0.0100	0.5000	0.1500	0.0000	0.00	No
14	1007-1008	41.14	901.85	0.00	901.64	0.38	0.21	0.5100	CIRCULAR	24.000	24.000	0.0100	0.5000	0.4000	0.0000	0.00	No
15	EP1	18.25	898.84	0.00	898.37	0.00	0.47	2.5800	CIRCULAR	42.000	42.000	0.0210	0.5000	0.4000	0.0000	0.00	No
16	EX.MH-1000	150.24	900.12	0.00	899.37	0.53	0.75	0.5000	CIRCULAR	36.000	36.000	0.0100	0.5000	0.4000	0.0000	0.00	No

No. of Barrels
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1

Pipe Results

SN	Element ID	Peak Flow (cfs)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Travel Time (min)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Froude Number	Reported Condition
1	1000-1001	1.89	0 12:05	4.62	0.41	5.60	0.14	0.45	0.45	0.00		Calculated
2	1000-1007	0.70	0 12:05	61.31	0.01	2.93	1.07	0.23	0.08	0.00		Calculated
3	1001-1002	1.03	0 12:05	4.64	0.22	4.76	0.21	0.32	0.32	0.00		Calculated
4	1001-1005	0.86	0 12:05	8.96	0.10	7.22	0.07	0.21	0.21	0.00		Calculated
5	1002-1003-A	0.90	0 12:05	4.69	0.19	4.61	0.09	0.30	0.30	0.00		Calculated
6	1002-1003-B	0.99	0 12:05	4.63	0.21	4.70	0.15	0.31	0.31	0.00		Calculated
7	1002-1003-C	1.00	0 12:05	4.60	0.22	4.69	0.06	0.32	0.32	0.00		Calculated
8	1002-ID1	0.09	0 12:05	8.05	0.01	3.39	0.09	0.07	0.07	0.00		Calculated
9	1002-ID2	0.01	0 10:15	8.02	0.00	1.93	0.19	0.03	0.03	0.00		Calculated
10	1003-1004	0.61	0 12:05	4.65	0.13	4.11	0.30	0.24	0.24	0.00		Calculated
11	1005-1006	0.25	0 12:05	6.49	0.04	3.98	0.06	0.13	0.13	0.00		Calculated
12	1005-ID	0.47	0 11:40	8.00	0.06	5.58	0.11	0.16	0.16	0.00		Calculated
13	1006-ID	0.08	0 12:05	6.53	0.01	2.84	0.17	0.08	0.08	0.00		Calculated
14	1007-1008	0.00	0 00:00	21.01	0.00	0.00		0.00	0.00	0.00		Calculated
15	EP1	2.63	0 11:35	99.95	0.03	4.50	0.07	0.40	0.11	0.00		Calculated
16	EX.MH-1000	2.60	0 12:05	61.26	0.04	4.34	0.58	0.42	0.14	0.00		Calculated

Inlet Input

SN	Element ID	Inlet Manufacturer	Manufacturer Part Number	Inlet Location	Number of Inlets	Catchbasin Invert Elevation (ft)	Max (Rim) Elevation (ft)	Inlet Depth (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Ponded Area (ft²)	Grate Clogging Factor (%)
1	1002.CI	FHWA HEC-22 GENERIC	N/A	On Grade	1	901.89	910.80	8.91	0.00	0.00	N/A	0.00
2	1003.CI	FHWA HEC-22 GENERIC	N/A	On Sag	1	903.24	908.76	5.52	0.00	0.00	10.00	0.00
3	1004.AI	FHWA HEC-22 GENERIC	N/A	On Sag	1	904.49	907.40	2.91	0.00	0.00	10.00	0.00
4	1005.AI	NEENAH FOUNDRY	R-3338-G	On Sag	1	902.65	908.20	5.55	0.00	0.00	10.00	0.00
5	1006.AI	NEENAH FOUNDRY	R-3338-G	On Sag	1	903.42	908.13	4.71	0.00	0.00	10.00	0.00
6	1007.CI	FHWA HEC-22 GENERIC	N/A	On Grade	1	901.26	906.56	5.30	0.00	0.00	N/A	0.00
7	ID1	GUTTER DEPTH CAPTURE CURVE	N/A	On Sag	1	903.52	908.50	4.98	0.00	0.00	10.00	0.00
8	ID2	GUTTER DEPTH CAPTURE CURVE	N/A	On Sag	1	903.22	908.78	5.56	0.00	0.00	10.00	0.00
9	ID3	GUTTER DEPTH CAPTURE CURVE	N/A	On Sag	1	904.18	908.75	4.57	0.00	0.00	10.00	0.00
10	ID4	GUTTER DEPTH CAPTURE CURVE	N/A	On Sag	1	904.32	908.50	4.18	0.00	0.00	10.00	0.00

Roadway & Gutter Input

SN	Element ID	Roadway Longitudinal Slope (ft/ft)	Roadway Cross Slope (ft/ft)	Roadway Manning's Roughness	Gutter Cross Slope (ft/ft)	Gutter Width (ft)	Gutter Depression (in)	Allowable Spread (ft)
1	1002.CI	0.0396	0.0200	0.0170	0.0521	1.33	0.0272	7.00
2	1003.CI	N/A	0.0200	0.0170	0.0521	1.33	0.0272	7.00
3	1004.AI	N/A	0.0200	0.0170	0.0521	1.33	0.0656	7.00
4	1005.AI	N/A	0.0200	0.0160	0.0620	2.00	0.0656	7.00
5	1006.AI	N/A	0.0200	0.0160	0.0620	2.00	0.0656	7.00
6	1007.CI	0.0100	0.0200	0.0170	0.0521	1.33	0.2051	7.00
7	ID1	N/A	0.0200					
8	ID2	N/A	0.0200					
9	ID3	N/A	0.0200					
10	ID4	N/A	0.0200					

Inlet Results

SN	Element ID	Peak Flow (cfs)	Peak Lateral Inflow (cfs)	Peak Flow Intercepted by Inlet (cfs)	Peak Flow Bypassing Inlet (cfs)	Inlet Efficiency during Peak Flow (%)	Max Gutter Spread during Peak Flow (ft)	Max Gutter Water Elev. during Peak Flow (ft)	Max Gutter Water Depth during Peak Flow (ft)	Time of Max Depth Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	1002.CI	0.03	0.03	0.00	0.00	0.00	0.84	910.84	0.04	0 12:05	0.00	0.00
2	1003.CI	0.29	0.29	N/A	N/A	N/A	1.98	908.84	0.08	0 12:05	0.00	0.00
3	1004.AI	0.61	0.61	N/A	N/A	N/A	5.54	907.60	0.20	0 12:05	0.00	0.00
4	1005.AI	0.14	0.14	N/A	N/A	N/A	0.00	908.23	0.03	0 11:40	0.00	0.00
5	1006.AI	0.17	0.17	N/A	N/A	N/A	0.00	908.16	0.03	0 04:06	0.00	0.00
6	1007.CI	0.70	0.70	0.70	0.00	100.00	6.10	906.72	0.16	0 00:00	0.00	0.00
7	ID1	0.09	0.09	N/A	N/A	N/A	1.32	908.53	0.03	0 12:05	0.00	0.00
8	ID2	0.01	0.01	N/A	N/A	N/A	0.39	908.79	0.01	0 10:15	0.00	0.00
9	ID3	0.08	0.08	N/A	N/A	N/A	1.18	908.77	0.02	0 12:05	0.00	0.00
10	ID4	0.47	0.47	N/A	N/A	N/A	5.07	908.60	0.10	0 11:40	0.00	0.00

APPENDIX C

REGIONAL DETENTION BASIN FIELD REVIEW

(TO BE COMPLETED PRIOR TO FDP REVIEW)

APPENDIX D

TECHNICAL REFERENCES

APPENDIX C.1

SECTION 5600 – STORM DRAINAGE SYSTEMS & FACILITIES, CITY OF LEE'S SUMMIT, MO DESIGN CRITERIA

SECTION 5600 - STORM DRAINAGE SYSTEMS & FACILITIES
CITY OF LEE'S SUMMIT, MISSOURI
DESIGN CRITERIA

This is Lee's Summit, Missouri's supplement to Section 5600 of the Kansas City Metropolitan Chapter of APWA Design Criteria, current edition. The following additions, deletions and/or revisions are adopted as a part of Section 5600 for use within Lee's Summit, Missouri.

<u>5601.5 System Types and Applications, Under A. General Guidelines:</u>
DELETE the fourth paragraph and REPLACE it with the following:

The engineered drainage system shall begin where the tributary area reaches 2 acres.

<u>Table 5601-1: Level of Service for Street Crossings</u>
CHANGE Minimum Design Storm Capacity for Arterial Streets to the following:
"1%".

CHANGE Minimum Design Storm Capacity for Collector Streets to the following:
"2%".

ADD the following note at the bottom of Table 5601-1:
"Water backing up onto adjacent properties for 1% storm capacity will require an inundation (drainage) easement."

<u>5601.5.A.4.a Default Strategy: Comprehensive Protection</u>
Delete this section in its entirety and insert the following:

"The City has adopted the Default Strategy: Comprehensive Protection method. Under this strategy, peak runoff control will be required for the 1%, 10%, and 50% annual chance storm event. Peak runoff control is required where there are known downstream flooding problems or where an increase in the peak runoff from a development has the potential to create flooding of property, structures, stormwater infrastructure, roads, bridges, and dams. Under this strategy, volumetric and/or extended detention control of the 90% mean annual event storm event shall be provided for broad protection of the receiving system, including channel erosion protection and flood peak reductions over a range of return periods. Volumetric and/or extended detention control of the 90% mean annual event storm shall be implemented for all sites unless otherwise exempt by Section 5601.3. Performance standards and sizing criteria are provided in Section 5608."

<u>5601.8.A. Protection of Property</u>
ADD the following subparagraphs 3 and 4.

3. Master Drainage Plans

To address level of service issues on an individual building lot basis, the Developer shall submit a Master Drainage Plan with the engineering plans for each development. The plan shall cover all

portions of the development whether it is to be developed as single or multiple final plats, and shall cover all areas outside of the existing or proposed public rights-of-way. All lots must be graded in accordance with the approved Master Drainage Plan to the extent that swales, channels, diversion berms and grading activities are provided to establish the overall drainage patterns. The Master Drainage Plan is not intended to replace good lot grading practices during construction, but rather to establish overall drainage patterns for each lot and the development as a whole. Information on the plan shall include, but not be limited to, the following.

- ***a. Overall drainage map, including off-site tributary areas contributing to the runoff in the development.***
- ***b. Existing and proposed contours at two-foot or smaller contour intervals.***
- ***c. Property boundary, lot lines and numbers, and streets.***
- ***d. Location(s) of all existing and proposed swales and channels, either natural or improved, along with design flows, typical sections, details, upstream and downstream elevations, and approximate slope.***
- ***e. Limits of regulatory floodplain, where applicable.***
- ***f. Limits of 1% storm water surface elevation for all swales and channels not within regulatory floodplain.***
- ***g. Required buffer zones for natural streams.***
- ***h. The elevation of the minimum, or lowest, building opening elevation (MBOE) for each lot. If a lot is adjacent to or contains a designated swale or channel, the MBOE must be set at the 1% water surface elevation plus two feet. If there is significant change in elevation along a swale or channel, as determined by the City Engineer, multiple MBOEs may be required for different sides of the building.***
- ***i. Lots where walkout basements and daylight basement plans will be allowed.***
- ***j. Finished elevations at all corners of each lot with a minimum of four elevations per lot.***

4. The Developer shall include on the plats for the development covered by the Master Drainage Plan, a restriction that the individual lot owner(s) shall not change or obstruct the overall drainage flow lines or paths on the lots, as shown on the Master Drainage Plan, unless specific application is made and approved by the City Engineer.

<u>Section 5603.1 Hydraulic Calculation for Pipes, Culverts, and Open Channels</u>
Add the following:
"Enclosed systems will use the open channel, or gravity, flow design method for the appropriate design storm."

<u>5604.1.B Inlet Design - Type</u>
REVISE the dimension for opening length as follows:

Opening length, inside 4.0 ft (min), 8.0 ft. (max)

<u>5604.1.C Inlet Design – Design Method</u>
REVISE references to Figures 5604-37 and 5604-38 ***to Figures 5604-19 and 5604-21 respectively.***

ADD the following sentences to the paragraph:
Figures 5604-2 through 5604-19 apply to a curb inlet with a 10-inch throat opening height, similar to Standard Drawing CI-2. For curb inlets with different opening heights, specific design calculations must be submitted.

5604.1 Inlet Design
Add the following as Paragraph D:
D. Location: Curb inlets shall not be located in the radius of two intersecting streets. Maximum spacing of inlets shall be 400 feet.

Section 5608.7.B Additional Requirements, Underground Storage
Add the following:
"Underground detention systems typically allow some storage volume for voids in open-graded aggregate backfill around the storage chambers. Industry standard assumes the aggregate has 40% voids in the aggregate; the City will allow up to 30% voids in the aggregate. Storage in aggregate voids may be further reduced based on design conditions, maintenance programs, site conditions, etc. The Design Engineer will provide a maintenance program for underground detention systems to ensure the system will continue to function as intended."

Table 5603-1
Add the following under Closed Conduits

High Density Polyethylene Pipe (HDPE)	0.010

Section 5605.7.E Culverts, Bridges, and Above Grade Crossings
Delete the last sentence and replace with the following:

"Culverts shall be designed so the headwater to opening dimension ratio (i.e., generally referred to as HW/D) is no greater than 1.5 for the 4% design storm. All other design parameters, including the requirement that the 1% water surface elevation within the unregulated, non-special flood hazard area remain unchanged on adjacent properties unless appropriate easements are obtained, shall apply."

Section 5605.10 Floodplain Fills
Delete the entire paragraph and replace with the following:

"Fills placed within areas designated as special flood hazard areas by the Federal Emergency Management Agency (FEMA) shall comply with the City of Lee's Summit Unified Development Ordinance (UDO) "Floodplain Overlay District". Fills placed outside these limits shall not cause a rise in the 1% water surface elevation beyond the limits controlled by the developer or owner, unless appropriate easements have been obtained from adjacent property owners."

APPENDIX C.2

SELECT PAGES, APWA SECTION 5600

DIVISION V

SECTION 5600

STORM DRAINAGE SYSTEMS & FACILITIES

(February 16, 2011)

[DMH 4.20.2021] - ALL ADDITIONS, DELETIONS, AND REVISIONS TO THIS DOCUMENT ARE PER CITY OF LEE'S SUMMIT DESIGN CRITERIA, REVISED JULY 2020

DIVISION V

DESIGN CRITERIA

SECTION 5600 STORM DRAINAGE SYSTEMS & FACILITIES

SECTION 5601 ADMINISTRATIVE

5601.1 Introduction

These criteria provide uniform procedures for designing and checking the design of storm drainage systems under the rainfall and land characteristics typical of the Kansas City Metropolitan Area. This manual generally focuses on water quantity concerns including: conveyance, flow rates, and construction design parameters of stormwater systems. For an in-depth discussion of water quality design standards and Best Management Practices (BMPs) for the Kansas City Metropolitan area see the “Mid-America Regional Council and American Public Works Association; Manual for Best Management Practices for Stormwater Quality”.

Federal law requires that “Waters of the United States may be disturbed only after permission is received from the City/County and permitted by the U.S. Army Corps of Engineers, if applicable. A jurisdictional determination by the U.S. Army Corps of Engineers shall be obtained prior to beginning design.” Besides federal guidelines, specific criteria have been developed and are applicable to the types of drainage systems and facilities ordinarily encountered in local urban and suburban areas. Other special situations may be encountered that require added criteria or more complex technology than included herein such as maintaining or improving water quality. Any design procedure conforming to current accepted engineering practice may be used for the design of storm drainage systems in lieu of the computation methods presented in this manual, providing equivalent results are obtained and have been approved by the City/County Engineer. Drainage systems for all developments shall be designed assuming ultimate or built-out land-use conditions. The decision flowchart in Figure 5601-1, “Guide to Stormwater Management for Site Development”, shall be used to determine the appropriate runoff controls (see end of this section).

5601.2 Definitions

Best Management Practice (BMP): Stormwater management practice used to prevent or control the discharge of pollutants to water of the U.S. BMPs may include structural or non-structural solutions, a schedule of activities, prohibition of practices, maintenance procedures, or other management practices. For a comprehensive discussion on BMPs refer to the “Mid-America Regional Council and American Public Works Association; Manual for Best Management Practices for Stormwater Quality”.

City/County: The municipality or body having jurisdiction and authority to govern.

City/County Engineer: The municipal or county public works official or body having jurisdiction and authority to review and approve plans and designs for storm drainage systems.

Channel Lining: Includes any type of material used to stabilize the banks or bed of an engineered channel.

Design Storm: The combination of rainfall depth, duration, and distribution of a hypothetical rainfall event with a given likelihood of occurring in any year.

Detention Facility: A storm water management facility controlling storm water runoff from a site or watershed. The allowable runoff specified for detention facilities in Section 5608 is intended to manage maximum storm water release rates to minimize flooding and downstream erosion.

Detention Storage: The volume occupied by water above the level of the principal spillway crest during operation of a stormwater detention facility.

5601.3 General Requirements and Applicability

The design shall be accomplished under the direction of a Registered Professional Engineer qualified in the field of stormwater design. The design shall be based on land use in the tributary area as zoned, actually developed, or indicated by an adopted future land use plan, whichever basis produces the greatest runoff.

This design criterion shall apply to all development, including subdivision, which alters the surface of the land to create additional impervious surfaces, including, but not limited to, pavement, buildings, and structures with the following exceptions:

A. Redevelopment, Expansion, Renovation, Repair and Maintenance Activities Listed Below

1. Additions to, improvements, and repair of existing single-family and duplex dwellings.
2. Remodeling, repair, replacement, or other improvements to any existing structure or facility and appurtenances that does not cause an increased area of impervious surface on the site.
3. Remodeling, repair, replacement or other improvements to any existing structure or facility and appurtenances on sites smaller than two acres that does not cause an increased area of impervious surface on the site in excess of 10 percent of that previously existing.
4. Remodeling, repair, replacement, or other improvements to any existing structure or facility and appurtenances that does not cause an increased area of impervious surface on the site in excess of 10 percent of that previously existing, provided the total impervious area of the site is less than 5,000 square feet. (See “Site Planning for Urban Stream Protection” provided by the “Center for Watershed Protection” for a discussion on imperviousness and its effect on watershed health; http://www.cwp.org/SPSP/TOC.htm).

B. New Construction Meeting the Following Criteria

1. Construction of any one new single family or duplex dwelling unit, irrespective of the site area on which the structure may be situated, provided the total impervious area of the site is less than 5,000 square feet.
2. Construction of any buildings, structures, and/or appurtenant service roads, drives, and walks on a site having previously provided stormwater management, as defined in Section 5601.5 A4 as part of a larger unit of development, OR a site previously relieved of stormwater management requirements.

5601.4 Existing Drainage System

Existing drainage system component pipes, structures, and appurtenances within the project limits may be retained as elements of an improved system providing:

- They are in sound structural condition.
- Their hydraulic capacity, including surcharge, is equal to or greater than the capacity required by these criteria.
- Easements exist or are dedicated to allow operation and maintenance.

Discharge from an existing upstream storm drainage system shall be computed assuming its capacity is adequate to meet the performance criteria listed in Section 5601.8. The computed discharge shall be used to design the new downstream system even if the actual capacity of the existing upstream system is less.

5601.5 System Types and Applications

A. General Guidelines: Natural channels are to be preserved to the maximum extent practicable as site conditions permit. Design standards for natural channels are addressed in Section 5605. Engineered channels, the next highest priority system component, shall be designated and coordinated with the design of building lots and streets in accordance with the design criteria and performance standards addressed in section 5607.

To the maximum extent possible, drainage systems, street layout and grades, lot patterns and placement of curbs, inlets and site drainage, and overflow swales shall be concurrently designed in accordance with the design criteria and performance standards set forth in this document. Curb and gutter may be omitted or modified where approved by the City/County Engineer and deemed feasible in conjunction with other stormwater management practices including water quality BMPs.

Enclosed conveyance systems consisting of inlets, conduits, and manholes may be used to convey stormwater runoff where site conditions and open space requirements will not permit the use of natural or engineered channels. Where used, such systems must be designed in accordance with design criteria and performance standards addressed in section 5606.

Generally, a drainage system is engineered and constructed when the drainage area exceeds 2 acres.

1. **Open Systems:** Where feasible, open systems consisting of open or engineered channels shall be used if all of the following design criteria and the conditions of Section 5601.8 are met:
    - **a.** The channel slope is less than or equal to 5 percent or where appropriate armoring techniques are used to prevent erosion.
    - **b.** The 50% storm velocity is less than or equal to 5 feet per second (fps) or where appropriate armoring techniques are used to prevent erosion.
    - **c.** When 60 feet or farther away from top of bank to any existing or proposed habitable building, regardless of system design capacity.
2. **Enclosed Systems:** Enclosed systems consisting of underground pipes, culverts, and similar underground structures shall be used to convey stormwater at all locations whenever one of the following design criteria and the conditions of 5601.8 are met:
    - **a.** Where natural channels or open systems are not feasible per the requirements set forth in Section 5605 and Section 5601.5-A1
    - **b.** Within the right-of-way of streets with curbs, regardless of system design capacity.
3. **Overflow Systems:** Each conveyance element of the stormwater drainage system (whether open, enclosed, or detention) shall include an overflow element. Overflow systems shall:
    - **a.** Be designed to route downstream any amount of the 1% storm exceeding the in-system design capacity specified in Section 5601.8.
    - **b.** Include streets, engineered channels, redundant piping, spillways, parking lots, drives or combinations thereof.
    - **c.** Limit the maximum water surface elevation generated by the 1% storm as specified in Section 5601.8.
    - **d.** Conform to local standards regarding dedicated easements and/or restricted uses for overflow systems; consult with the local authority for requirements.
    - **e.** Be limited to the natural drainage basins, unless overflows transferred out of a natural drainage basin (e.g. a thoroughfare straight-graded through a drainage basin with a sump in another drainage basin) are added to the overflows in the receiving drainage basin and the combined overflow still meets the criteria at 5601.5 A 3C
4. **Stormwater Management:** New development or redevelopment as defined in Section 5601.2 shall incorporate stormwater management measures to control runoff from the site. Allowable runoff from a site may be limited by the need to minimize downstream flood damage, prevent erosion, and/or

"The City has adopted the Default Strategy: Comprehensive Protection method. Under this strategy, peak runoff control will be required for the 1%, 10%, and 50% annual chance storm event. Peak runoff control is required where there are known downstream flooding problems or where an increase in the peak runoff from a development has the potential to create flooding of property, structures, stormwater infrastructure, roads, bridges, and dams. Under this strategy, volumetric and/or extended detention control of the 90% mean annual event storm event shall be provided for broad protection of the receiving system, including channel erosion protection and flood peak reductions over a range of return periods. Volumetric and/or extended detention control of the 90% mean annual event storm shall be implemented for all sites unless otherwise exempt by Section 5601.3. Performance standards and sizing criteria are provided in Section 5608."

minimize impacts to the ecology and water quality of the downstream drainage system. It is recognized for site-level runoff controls to be effective, consistent application across a watershed is necessary to realize measurable benefits along the downstream system. This section presents four site runoff control strategies that can be applied to sites within a watershed based on watershed protection goals and identified problems. The City/County or local authority shall pre-determine which strategy is to be applied within its watersheds or subsheds. If watershed control strategies are not defined by the local authority, the default strategy for new development shall be the Comprehensive Protection strategy.

a. Default Strategy: Comprehensive Protection

Under this strategy, peak runoff control is provided for the 1%, 10% and 50% chance storms and volumetric and/or extended detention control of the 90% mean annual event storm for broad protection of the receiving system, including channel erosion protection and flood peak reductions over a range of return periods. This strategy shall be the default strategy unless otherwise designated or approved by the local authority. Performance standards and sizing criteria are provided in Section 5608.

b. Reduced Control Strategies

1) **Frequent Event Control for Stream Erosion Protection:** This strategy provides runoff control for the 10% and 50% chance storms and volumetric and/or extended detention control of the 90% mean annual event storm in order to protect downstream channels from erosion. This strategy is appropriate for largely undeveloped watersheds containing natural streams where downstream flooding of existing structures is not present and would not occur under future upstream full-development conditions.

2) **Extreme Flood Event Control Only:** Under this strategy, detention is provided solely to reduce peak runoff rates for the 10% and 1% storm events. Over-detention of the peak release rates at the discharge point (i.e. requiring the post-development rate to be less than the pre-development rate) is used to ensure a cumulative benefit for a reasonable distance downstream. If known flooding occurs downstream in flood events more frequent than the 10% event, the local authority may require control of these events.

   This strategy is not effective at protecting stream channels and banks from erosion. It is most applicable in certain redevelopment and in-fill situations where flooding problems are known, existing downstream stream conditions are already poor, and economic barriers to redevelopment preclude more extensive control.

3) **Special Locally-Defined Strategies:** The City/County may develop alternative strategies that are tailored to the unique circumstances of their watersheds. Such strategies may apply globally to the City/County or only to certain designated areas. The City/County will identify each alternative strategy with a unique descriptor and publish the requirements for each.

   Such alternative strategies may involve increased or decreased allowable release rates, relaxed or more stringent controls for certain storm return intervals, reliance on infiltration or low-impact development practices for added volume control, planning and open space controls, and/or special requirements to participate in regional control facilities instead of development-scale facilities.

   Stormwater management for site development may include structural facilities and/or non-structural solutions. Where runoff controls are required, low-impact development practices or, off-site control of runoff in addition to or instead of the standard wet or dry bottom basins may be used.

5601.6 Waivers

The Developer may submit a study by a registered professional engineer that quantifies the problems and demonstrates that a waiver (exemption) of the requirement to provide stormwater management is appropriate. The City/County Engineer may waive requirements to address *unique* conditions or constraints:

A. Stormwater Management Facilities: Stormwater management facilities may be waived and/or release rates other than those permitted by Section 5608 when supported by a developer's Drainage Study performed in accordance with Section 5609 and approved by the City/County Engineer.

B. Overflow Channels: In previously developed areas, requirements to provide for 1% storm conveyance may be reduced by the City/County Engineer in circumstances where flood protection for the 1% storm is not reasonably attainable due to the location of damageable improvements with respect to the drainage system and where non-attainment is supported by an approved Drainage Study.

5601.7 Other Requirements

Rules and regulations of other agencies also pertain to drainage systems which may or may not complement these criteria. When conflicts are encountered, the more stringent criteria shall govern.

The following agencies have jurisdiction over streams and/or drainage systems and often require permits. Other regulations, permits and requirements may not be limited to these agencies.

- Federal Emergency Management Agency.
- U.S. Army Corps of Engineers.
- Missouri Department of Natural Resources.
- Kansas Department of Agriculture – Division of Water Resources.
- Kansas Department of Health and Environment
- Municipal Ordinances.

5601.8 Levels of Service

Drainage systems shall be designed to meet all levels of service described below. In addition, natural streams include requirements specified in Section 5605.

A storm drainage system shall be provided that is capable of conveying the peak discharge generated by the 1% storm. If the in-system capacity established in this section is less the 1% storm peak discharge, then an overflow system as specified in Section 5601.5 -A-3 may provide the additional system capacity.

A. Protection of Property

1. Property not reserved or designed for conveying storm water shall be protected from frequent inundation**:**

a. When the total drainage area is less than 2 acres, protection may be provided by following good lot grading practices or by one of the conveyances described below.

b. When the total drainage area is 2 acres or more, one of the following conveyances must be used to convey the 10% storm:

1) Pipe system conveying the design storm under a regime of pressure flow with no overflow at inlets or manholes, or

2) An engineered open channel conveying the 10% storm at bank full

3) A street gutter

4) A natural stream

3. Master Drainage Plans
To address level of service issues on an individual building lot basis, the Developer shall submit a
Master Drainage Plan with the engineering plans for each development. The plan shall cover all portions of the development whether it is to be developed as single or multiple final plats, and shall cover all areas outside of the existing or proposed public rights-of-way. All lots must be graded in accordance with the approved Master Drainage Plan to the extent that swales, channels, diversion berms and grading activities are provided to establish the overall drainage patterns. The Master Drainage Plan is not intended to replace good lot grading practices during construction, but rather to establish overall drainage patterns for each lot and the development as a whole. Information on the plan shall include, but not be limited to, the following.
a. Overall drainage map, including off-site tributary areas contributing to the runoff in the development.
b. Existing and proposed contours at two-foot or smaller contour intervals.
c. Property boundary, lot lines and numbers, and streets.

d. Location(s) of all existing and proposed swales and channels, either natural or improved, along with design flows, typical sections, details, upstream and downstream elevations, and approximate slope.
e. Limits of regulatory floodplain, where applicable.
f. Limits of 1% storm water surface elevation for all swales and channels not within regulatory floodplain.
g. Required buffer zones for natural streams.
h. The elevation of the minimum, or lowest, building opening elevation (MBOE) for each lot. If a lot is adjacent to or contains a designated swale or channel, the MBOE must be set at the 1% water surface elevation plus two feet. If there is significant change in elevation along a swale or channel, as determined by the City Engineer, multiple MBOEs may be required for different sides of the building.
i. Lots where walkout basements and daylight basement plans will be allowed.
j. Finished elevations at all corners of each lot with a minimum of four elevations per lot.

4. The Developer shall include on the plats for the development covered by the Master Drainage Plan, a restriction that the individual lot owner(s) shall not change or obstruct the overall drainage flow lines or paths on the lots, as shown on the Master Drainage Plan, unless specific application is made and approved by the City Engineer.

2. Buildings shall be protected from infrequent flooding by:

   a. Providing a minimum of one-foot freeboard above the 1% storm stage, at any point along the drainage system, for openings in a building. For lakes and detention basins the 1% storm stage will be the water surface of flow through the emergency spillway.

   b. Flood-proofing a building below the 1% storm water surface elevation plus one foot of freeboard, in accordance with the current edition of the International Building Code or as required by the City/County.

   c. Non habitable accessory buildings are sometimes provided less protection by local City/County ordinances or policies. Consult the local authority for exceptions.

B. Protection for Streets

1. **Gutter Spread:** Water spread in streets shall meet the requirements in Section 5604.2 for the 10% design storm. These values are intended to establish a standard of accessibility for the widths (classes) of roadways listed during the 10% storm. When the local jurisdiction requires a higher standard for curb inlets, the conveyance system connected to the roadway must also meet that higher standard. If the roadway conveyance system connects to an underground system with lesser capacity, the system must be constructed to allow the discharge of that excess capacity into the overflow system.

2. **Street Crossings:** Concentrated flow not conveyed in the gutter system, shall be conveyed under streets to prevent vehicles from being swept from the roadway in infrequent storms. These crossings may be bridges, culverts or underground systems. A common practice is to construct the low point in the roadway so that it does not fall on the bridge or culvert. This practice protects the structure from damage in an overflow condition, but does not change this requirement. Crossings will be designed to completely convey flood flows without street overtopping in accordance with Table 5601-1.

Table 5601-1: Level of Service for Street Crossings

Street Classification	Min. Design Storm Capacity
Arterial	$\boxed{2\%}$ 1%
Collector	$\boxed{4\%}$ 2%
Residential	10%
Residential with open channel downstream	4%

* Water backing up onto adjacent properties for 1% storm capacity will require an inundation (drainage) easement.

Further, concentrated flow in excess of the minimum design storm may only overtop the roadway if the following conditions are met:

   a. The span of the structure opening is less than 20 feet.

   b. The peak stormwater runoff from the 1% storm is 250 cfs or less unless a guard fence is installed on the downstream side of the roadway.

   Such overflow depths at low points in roadways during the 1% storm will be limited to 7 inches measured at the high point in the roadway cross section; except that it also shall not exceed 14 inches at the deepest point in the roadway cross section. Depths may be limited where necessary by reverse grading the downstream right of way area, by lengthening the vertical curve of the roadway, by reducing roadway crown, or by other similar means. Roadway overtopping depths shall be determined by integrating the broad crested weir formula across the roadway profile. Each incremental flow can be determined by using the formula:

$$q = C \cdot l \cdot h^{2/3}$$

Where:

q = the flow for an increment of profile length (width of flow)

l = the incremental width

C = a flow coefficient that shall not exceed 3.0

h = the average depth of flow at each increment

The total flow Q is the sum of the incremental flows. Depth determinations can be made through an iterative process where successive depths are chosen; Q is calculated for each depth and then compared to the known Q at the overtopping point.

Overflow protection criteria provides additional accessibility criteria at major stream crossings for emergency personnel, and provides the public with protection against injury and property damage.

C. Downstream Impacts

1. The negative impacts of development on flooding problems in the downstream system shall be mitigated through detention as specified in Section 5601.5-A-4, or through other means approved by the City/County.

a. Impacts on natural channels are regulated in Section 5605.

b. Communities that have adopted the recommended "Manual of Best Management Practices (BMPs) for Stormwater Quality" should also mitigate the negative impact of development on natural channels through the installation of water quality BMPs and closely adhere to practices specified in Section 5605 on natural channels.

D. Adjoining Property: State and Federal regulations often establish requirements for a storm drainage project that impacts adjoining property, especially when a project causes a rise in water surface elevations. In addition to all Federal and State regulations the following shall be met:

1. Drainageways not designated a Special Flood Hazard Area (FEMA 1% Floodplain): Construction of a storm drainage system, including grading and filling within a natural drainage way, requires agreement from adjoining property owners if the work will cause a rise in the water surface elevation on the adjoining property for the 1% storm. Agreement shall be considered granted by recording a document which reserves the affected property for inundation during the 1% storm, or by other means approved by the City/County.

2. Drainageways designated a Special Flood Hazard Areas (FEMA 1% Floodplain) and City/County participates in the National Flood Insurance Program: When impacting adjoining properties, refer to the local community's adopted Floodplain Management Ordinance for any requirements, in addition to all current FEMA regulation.

SECTION 5602 HYDROLOGY

5602.1 Scope

This section sets forth the hydrologic parameters to be used for computations involving the definition of runoff mass and peak rates to be accommodated by the storm drainage system. The methods to be used for calculating runoff mass and peak rates are intended for the design of drainage systems. Refer to the “Mid-America Regional Council and American Public Works Association; Manual for Best Management Practices for Stormwater Quality” for design methods and calculations of runoff water quality.

5602.2 Computation Methods for Runoff

Runoff rates to be accommodated by each element of the proposed storm drainage system shall be calculated using the criteria of this section for land use runoff factors, rainfall, and system time. The following methods of computations are allowed:

A. Watersheds Less than 200 Acres: The Rational Method may be used to calculate peak rates of runoff to elements of enclosed and open channel systems, including inlets, when the total upstream area tributary to the point of consideration is less than 200 acres. The Rational Method is defined as follows:

$$Q = K \cdot C \cdot i \cdot A$$

Where:

Q = Peak rate of runoff to system in cfs

C = Runoff coefficient as determined in accordance with Paragraph 5602.3

i = Rainfall intensity in inches per hour as determined in accordance with Paragraph 5602.6

K = Dimensionless coefficient to account for antecedent precipitation as follows, except the product of C·K shall not exceed 1.0. See Table 5602-1.

Table 5602-1: Antecedent Coefficient

Design Storm	K
10% and more frequent	1.0
4%	1.1
2%	1.2
1%	1.25

B. Baseline Unit Hydrograph Method: The following computer implementations of the unit hydrograph method are acceptable for all watersheds:

- SCS Technical Release No. 55 "Urban Hydrology for Small Watersheds", 2nd Edition, June 1986.
- 2. SCS Technical Release No. 20 "Project Formulation - Hydrology", 2nd Edition, May 1983.
- 3. U.S. Army Corps of Engineers, Hydrologic Engineering Center - “HEC-1Flood Hydrograph Package”.
- 4. U.S. Army Corps of Engineers, Hydrologic Engineering Center - “HEC-HMS Hydrologic Modeling System”, current version.

Copies of the above publications and micro-computer programs based thereon are available for purchase through National Technical Information Service, U.S. Department of Commerce, Springfield, VA 22161.

Table 5602-2 Documented Extreme Stream Flows in Kansas City Area and Surrounding Region

ID No.	USGS Station Number	Station Name	Contributing Drainage Area (sq. miles)	Date of Max. Discharge	Max. Recorded Discharge (cfs)	Max. Discharge per Basin Area (cfs/acre)	Period of Record (Water Yr.)	References
45.	--	Stratton Creek near Washta, Iowa	1.9	9-Aug-61	11,000	9.0	--	2
46.	--	West Fork Big Blue River trib. near York, Nebr.	6.9	9-Jul-50	23,000	5.2	--	2
47.	08057140	Cottonwood Creek at Forest Lane, Dallas, Tx.	8.5	28-Apr-66	17,600	3.2	1962-78	5,7
48.	--	Ranch Creek near Halley, Okla.	17.1	4-Sep-40	32,400	3.0	--	2

References Cited:

1. Alexander and Wilson. Technique for Estimating the 2-to 500-Year Flood Discharges on Unregulated Streams in Rural Missouri. USGS WRIR 95-4231. 1995
2. Crippen and Bue. Maximum Floodflows in the Conterminous United States. USGS WSP 1887. 1977.
3. Hauth. Floods in Kansas City, Missouri and Kansas, September 12-13, 1977. USGS Prof. Paper 1169. 1981.
4. Rasmussen and Perry. Estimate of Peak Streamflows for Unregulated Rural Streams in Kansas. USGS WRIR 00-4079. 2000.
5. Sauer et al. Flood Characteristics of Urban Watersheds in the United States. USGS WSP 2207. 1983.
6. USGS. Kansas-Missouri - Floods of July 1951. USGS WSP 1139. 1952.
7. USGS. Surface-Water Data for the Nation. Peak flow database at http://waterdata.usgs.gov/nwis/sw. Queried January 2003.

5602.3 Runoff Coefficients

A. Basis of Curve Number Coefficients: All Curve Number coefficients in this section are values for Hydrologic Group "C" soils. For soils in other Hydrologic Groups, equivalent SCS Curve Numbers can be found in SCS Technical Release No. 55. No soil disturbed by construction shall be assigned a Hydrologic Group classification of 'A' or 'B'.

B. Standard Land Use/Zoning Classifications: Runoff Coefficients relative to development, undeveloped land and land use shall have the values indicated in Table 5602-3.

Table 5602-3: Runoff Parameters

Land Use / Zoning	Average Percent Impervious	Average Percent Pervious	Rational Method "C"	SCS Curve Number
Business				
Downtown Area	95	5	0.87	97
Neighborhood Areas	85	15	0.81	94
Residential				
Single Family Areas	35	65	0.51	82
Multifamily Areas	60	40	0.66	88
Churches & Schools	75	25	0.75	92

Table 5602-3: Runoff Parameters

Land Use / Zoning	Average Percent Impervious	Average Percent Pervious	Rational Method "C"	SCS Curve Number
Industrial				
Light Areas	60	40	0.66	88
Heavy Areas	80	20	0.78	93
Parks, Cemeteries	10	90	0.36	76
Railroad Yard Areas	25	75	0.45	80
Undeveloped Areas	0	100	0.30	74
All Surfaces				
Impervious: Asphalt, Concrete, Roofs, etc.	100	0	0.90	98
Turfed	0	100	0.30	74
Wet Detention Basins	100	0	0.90	98

C. **Rational Method "C" for Non-Standard Land Use/Zoning Classifications:** The "C" value can be calculated from any type of land use and known percent impervious surface from the following equation:

$$C = 0.3 + 0.6 \cdot I$$

Where:

I = percent impervious divided by 100

D. **Un-zoned, but Master Planned Areas:** Areas whose future land use is defined by an adopted land use plan shall be assigned runoff coefficients for the land use indicated on such plan.

E. **Agricultural and Unplanned Areas**

1. **Existing Conditions**: For purposes of determination of development impact, undeveloped areas whose current land use is agriculture (crops, pasture, meadow) shall be assigned a maximum of 0% impervious surface or a maximum Curve Number equivalent to good condition pasture, grassland or range (C=0.30, CN=74).

2. **Proposed Conditions:** Undeveloped areas designated as agricultural or those areas for which no specific land use is indicated shall be assigned a minimum of 35% impervious surface for purposes of the design of storm drainage systems (C=0.51, CN = 82).

F. **Composite Coefficients:** As an alternative to the above coefficients and for areas not listed above (office parks, shopping centers, trailer parks, etc.), a composite runoff coefficient based on the actual percentages of pervious and impervious surfaces shall be used.

5602.4 Rainfall Mass

The U.S. Soil Conservation Service (SCS) Type 2 twenty-four hour rainfall distribution shall be used for all computations that employ the use of rainfall mass. That rainfall distribution is reproduced in Table 5602-4.

Table 5602-4: Rainfall Mass

TOTAL RAINFALL DEPTH ACQUIRED FROM NOAA POINT PRECIPITATION FREQUENCY TABLES

Time in Hours	Accumulated Rainfall in Percent of 24-hour Rainfall
0.0	0.00
2.0	2.20
4.0	4.80
6.0	8.00
8.0	12.00
9.0	14.70
9.5	16.30
10.0	18.10
10.5	20.40
11.0	23.50
11.5	28.30
11.75	38.70
12.0	66.30
12.5	73.50
13.0	77.20
13.5	79.90
14.0	82.00
16.0	88.00
20.0	95.20
24.0	100.00

5602.5 Unit Hydrographs

The SCS Dimensionless Unit Hydrograph (either curvilinear or triangular) shall be the basis for computation of runoff hydrographs.

5602.6 Rainfall Intensity

Rainfall intensity shall be determined from Figure 5602-1 or Table 5602-5 using a calculated Time of Concentration.

Table 5602-5: Design Aide for Calculating Rainfall Intensity Kansas City Metropolitan Area

Return Period	Equation 1 $5 \le T_c \le 15$	Equation 2 $15 < T_c \le 60$
2 yr.	$i = \frac{119}{T_c + 17}$	$i = \frac{134}{T_c + 21.4}$
5 yr.	$i = \frac{154}{T_c + 18.8}$	$i = \frac{182}{T_c + 25}$

Table 5602-5: Design Aide for Calculating Rainfall Intensity Kansas City Metropolitan Area

Return Period	Equation 1 $5 \leq T_c \leq 15$	Equation 2 $15 < T_c \leq 60$
10 yr.	$i = \frac{175}{T_c + 18.8}$	$i = \frac{214}{T_c + 26.7}$
25 yr.	$i = \frac{203}{T_c + 18.8}$	$i = \frac{262}{T_c + 28.8}$
50 yr.	$i = \frac{233}{T_c + 19.8}$	$i = \frac{296}{T_c + 29.6}$
100 yr.	$i = \frac{256}{T_c + 19.8}$	$i = \frac{331}{T_c + 30}$

5602.7 Time of Concentration and Lag Time

Time of Concentration (T_C) is equal to the overland flow time to the most upstream inlet or other point of entry to the system, Inlet Time (T_I), plus the time for flow in the system to travel to the point under consideration, Travel Time (T_T).

$$T_C = T_I + T_T$$

A. Inlet Time: T_I shall be calculated by the following formula or determined graphically from Figure 5602-2, but shall not be less than 5.0 minutes nor greater than 15.0 minutes:

$$T_I = 1.8 \cdot (1.1 - C) \cdot \frac{D^{1/2}}{S^{1/3}}$$

Where:

T_I = Inlet Time in minutes

C = Rational Method Runoff Coefficient as determined in accordance with paragraph 5602.3

D = Overland flow distance parallel to slope in feet (100 feet shall be the maximum distance used for overland flow)

S = Slope of tributary area surface perpendicular to contour in percent.

"Enclosed systems will use the open channel, or gravity, flow design method for the appropriate design storm."

SECTION 5603 HYDRAULICS

5603.1 Hydraulic Calculations for Pipes, Culverts, and Open Channels

A. Gravity versus Pressure Flow for Enclosed Systems: Two design philosophies exist for sizing storm drains under the steady uniform flow assumption. The first is referred to as open channel, or gravity flow design, in which the water surface within the conduit remains open to atmospheric pressure. Pressure flow design, on the other hand, requires that the flow in the conduit be at a pressure greater than atmospheric. For a given flow rate, design based on open channel flow requires larger conduit sizes than those sized based on pressure flow. While it may be more expensive to construct storm drainage systems designed based on open channel flow, this design procedure provides a margin of safety by providing additional headroom in the conduit to accommodate an increase in flow above the design discharge. Under most ordinary conditions, it is recommended that storm drains be sized based on a gravity flow criteria at full flow or near full. Pressure flow design may be justified in certain instances. As hydraulic calculations are performed, frequent verification of the existence of the desired flow condition should be made.

Storm drainage systems can often alternate between pressure and open channel flow conditions from one section to another (U.S. Department of Transportation Federal Highway Administration, 1996).

For gravity flow conditions, Manning's formula shall be used as described below.

$$Q = \frac{1.486}{n} A\, R^{2/3}\, S^{1/2}$$

Where:

Q = Discharge, cubic feet per second

A = Cross sectional area of flow, square feet

n = Manning's roughness coefficient (see Table 5603-1)

R = Hydraulic radius, feet

$$R = \frac{A}{P}$$

S = Slope in feet per foot

P = Wetted perimeter in feet

In closed conduits flowing under pressure flow, the energy grade line (EGL) will be above the crown of the pipe. In this case, the Bernoulli equation shall be used to calculate pipe capacity:

$$\frac{p_1}{\gamma} + \frac{V_1{}^2}{2g} + z_1 = \frac{p_2}{\gamma} + \frac{V_2{}^2}{2g} + z_2 + h_f + h_m$$

Where:

$\frac{p_1}{\gamma}$ = pressure head in the upstream system segment, feet

$\frac{V_1{}^2}{2g}$ = velocity head in the upstream system segment, feet

z_1 = elevation of the system invert in the upstream system segment, feet

$\frac{p_2}{\gamma}$ = pressure head in the upstream system segment, feet

$\frac{V_2{}^2}{2g}$ = velocity head in the upstream system segment, feet

z_2 = elevation of the system invert in the upstream system segment, feet

h_f = friction loss in the downstream system segment in feet

h_m = minor system losses in the downstream segment in feet

Pipe friction losses, h_f, may be calculated the friction slope method.

B. Friction Slope Method

This derivation of Manning's equation is from (FHWA, 1996).

$$h_f = S_f L$$

$$S_f = \frac{(Q \cdot n)^2}{\left(1.486\, A \cdot R^{\frac{2}{3}}\right)^2}$$

S_f = friction slope, feet/foot (which is also the slope of the HGL)

Minor losses, h_m, shall be calculated by:

$$h_m = k \cdot \frac{v^2}{2g}$$

Where:

k = Coefficient as shown in Table 5603-2

A step-by-step procedure for manual calculation of the EGL using the energy loss method is presented in Section 7.5 of (FHWA, 1996). For most drainage systems, computer methods such as HYDRA, StormCAD, CulvertMaster, or SWMM are the most efficient means of evaluating the EGL and designing the system elements.

Table 5603-1: Manning's Roughness Coefficient

Type of Channel	n
Closed Conduits	
Reinforced Concrete Pipe (RCPs)	0.013
Reinforced Concrete Elliptical Pipe	0.013
Corrugated Metal Pipe (CMPs):	
2⅔ x ½in. Annular or Helical Corrugations unpaved - plain	0.024
2⅔ x ½in. Annular or Helical Corrugations paved invert	0.021
3x1 in. Annular or Helical Corrugations unpaved - plain	0.027
3x1 in. Annular or Helical Corrugations paved invert	0.023
6x2 in. Corrugations unpaved - plain	0.033
6x2 in. Corrugations paved invert	0.028
24" diameter and smaller with Helical Corrugations.*	0.020
Vitrified Clay Pipe	0.013
Asbestos Cement Pipe	0.012
High Density Polyethylene Pipe (HDPE)	0.010
Open Channels (Lined)	
Gabions	0.025
Concrete	
Trowel Finish	0.013

Table 5603-1: Manning's Roughness Coefficient

Type of Channel	n
Float Finish	0.015
Unfinished	0.017
Concrete, bottom float finished, with sides of	
Dressed Stone	0.017
Random Stone	0.020
Cement Rubble masonry	0.025
Dry Rubble or Riprap	0.030
Gravel bottom, side of	
Random Stone	0.023
Riprap	0.033
Grass (Sod)	0.030
Riprap	0.035
Grouted Riprap	0.030
Open Channels (Unlined) Excavated or Dredged	
Earth, straight and uniform	0.027
Earth, winding and sluggish	0.035
Channels, not maintained, weeds & brush uncut	0.090
Natural Stream	
Clean stream, straight	0.030
Stream with pools, sluggish reaches, heavy underbrush	0.100
Flood Plains	
Grass, no brush	0.030
With some brush	0.090
Street Curbing	0.014

*Allowed only when the pipe length between structures is at least 20 pipe diameters.

Table 5603-2: Head Loss Coefficients

Condition	k
Manhole, junction boxes and inlets with shaped inverts:	
Thru flow	0.15
Junction	0.40
Contraction transition	0.10
Expansion transition	0.20
90 degree bend	0.40
45 degree and less bends	0.30
Culvert Inlets:	
Pipe, Concrete	
Projecting from fill, socket end (grove end)	0.20

Table 5603-2: Head Loss Coefficients

Condition	k
Projecting from fill, sq. cut end	0.50
Headwall or headwall and wingwalls	
Socket end of pipe (groove end)	0.20
Square edge	0.50
Round (radius=1/12D)	0.20
Mitered to conform to fill slope	0.70
Standard end section	0.50
Beveled edges, 33.7º or 45º bevels	0.20
Side or slope-tapered inlet	0.20
Pipe, or Pipe-Arch, Corrugated Metal	
Projecting from fill (no headwall)	0.90
Headwall or headwall and wingwalls square edge	0.50
Mitered to conform to fill slope, paved or unpaved slope	0.70
Standard end section	0.50
Beveled edges, 33.7º or 45º bevels	0.20
Side or slope-tapered inlet	0.20
Box, Reinforced Concrete	
Headwall parallel to embankment (no wingwalls)	
Square edged on 3 edges	0.50
Rounded on 3 edges to radius of 1/12 barrel dim. or beveled edges on 3 sides	0.20
Wingwalls at 30º to 75º to barrel	
Square edged at crown	0.40
Crown edge rounded to radius of 1/12 barrel dimension or beveled top edge	0.20
Wingwalls at 10º to 25º to barrel - square edged at crown	0.50
Wingwalls parallel (extension of sides) - square edged at crown	0.70
Side or slope-tapered inlet	0.20

Note: When 50 percent or more of the discharge enters the structure from the surface, "k" shall be 1.0.

C. Culverts: Classified as having either entrance or outlet control. Either the inlet opening (entrance control), or friction loss within the culvert or backwater from the downstream system (outlet control) will control the discharge capacity.

1. **Entrance Control:** Entrance control occurs when the culvert is hydraulically short (when the culvert is not flowing full) and steep. Flow at the entrance would be critical as the water falls over the brink. If the tailwater covers the culvert completely (i.e., a submerged exit), the culvert will be full at that point, even though the inlet control forces the culvert to be only partially full at the inlet. The transition from partially full to full occurs in a hydraulic jump, the location of which depends on the flow resistance and water levels. If the flow resistance is very high, or if the headwater and tailwater levels are high

SECTION 5604 INLETS, MANHOLES AND JUNCTION BOXES

5604.1 Inlet Design

A. Type: Only curb opening inlets shall be used on public streets, except as approved by the City/County Engineer.

B. Configuration: These minimum dimensions (shown in Table 5604-1 and illustrated by Figure 5604-1) apply to either the lazy-back or steep-face type curbs:

Table 5604-1: Inlet Configuration Dimensions

Description	Dimension
Opening length, inside	4.0 ft (min), 8.0 ft. (max)
Width, perpendicular to curb line, inside	3.0 ft (min)
Setback curb line to face	1.0 ft (min)
Opening, clear height	6.0 in. (min)
Gutter depression at inlet	6 ¼ in. (min)
Gutter transition length	
(a) Both sides in sump and upstream side on slopes	5.0 ft (min)
(b) Downstream on slopes	3.0 ft (min)

5604.1.C Inlet Design – Design Method - - > [DMH 4.20.2021] I couldn't find these references.
REVISE references to Figures 5604-37 and 5604-38 to Figures 5604-19 and 5604-21 respectively.

C. Design Method: Inlets should be designed using the methods prescribed in Section 5604.8 and/or Figures 5604-2 through 5604-19. Note that the Theoretical Captured Discharge (right side of chart) is the design capacity, 80 percent clogging factor should not be used for inlets on grade, unless deemed necessary by the engineer. Figures 5604-2 through 5604-19 describe inlet efficiency as a function of street slope (See Figure 5604-3 for design example) and in most cases will require the designer to add bypassed flow to the next downstream inlet. Figure 5604-21 describes inlet capacity for sump regions using HEC-22 equation 4-31a. Inlet capacity for sump regions shall be rated at 80 percent of the theoretical capacity to allow for partial obstruction and clogging. "Type CG-2 Curb" and Type CG-1 Curb", as indicated on these figures, refers to the lazy-back and steep-face style curbs, respectively.

Figures 5604-2 through 5604-19 apply to a curb inlet with a 10-inch throat opening height, similar to Standard Drawing CI-2. For curb inlets with different opening heights, specific design calculations must be submitted.

5604.2 Gutter Flow

D. Location: Curb inlets shall not be located in the radius of two intersecting streets. Maximum spacing of inlets shall be 400 feet.

Inlets shall be located to limit the width of flow in street gutters at the time of peak discharge for the design storm specified in 5601.8 B to the limits indicated in Table 5604-2.

Table 5604-2: Gutter Spread Criteria

Back to Back of Curb Street Width (feet)	**Maximum Allowable Spread in Each Outside Curb Lane from Back of Curb*** (feet)
28 or Less	12.0
Over 28 to 36	12.0
Over 36	12.0
Divided Roadways	As above for each direction roadway

* spread may exceed these limits within 50 feet of a sump inlet.

In addition to the inlet spacing requirements for limiting width of flow, inlets shall be locate to limit gutter flow from crossing the street centerline at the time of peak discharge for the design storm to the limits shown in Table 5604-3.

Table 5604-3: Inlet Bypass Spread Criteria

Condition Causing Flow Crossing Street Centerline	**Maximum Discharge** (cfs)
Sump at intersection return*	1.0
Transitions to superelevation	1.0
Sump at midblock	Not Allowed
Overflow of non-gutter flow	Per 5601.8.B

* For new development, inlets at intersections shall be positioned outside the curb return.

5604.3 Gutter Capacity

Izzard's Formula shall be used to determine gutter capacity (see Figure 5604-20 for graphical solution):

$$Q = \frac{0.56z \cdot S^{1/2} \cdot D^{8/3}}{n}$$

Where:

Q = The gutter capacity in cubic feet per second

z = The reciprocal of the average cross-slope, including gutter section, in feet per foot

S = The longitudinal street grade in feet per foot

D = The depth of flow at curb face in feet

n = Manning's "n" (see Table 5603-1)

5604.4 Freeboard Requirements

Any opening which surface water is intended to enter (or may backflow from) the system shall be 0.5 feet or more above the hydraulic grade line in the inlet during the design storm, specified in Section 5601.8, where such calculation must include minor losses.

5604.5 Inverts and Pipes

The crown(s) of pipe(s) entering a drainage structure shall be at or above the crown of the pipe exiting from the structure and provide a minimum fall of the invert in the structure of 0.2 feet for straight flow through the structure or 0.5 feet fall for all other types of flow (bends more than 22.5 deflection angle, multiple lines entering, enlargement transition, etc.) through the structure. The desirable minimum fall across the invert is 0.5 feet. Alternatively, the crowns of the pipes may be at or above the EGL of normal flow at design frequency.

The maximum spacing between manholes shall be 500 feet.

5604.6 Loading Conditions for Structures

Loading shall be in accordance with Section 5710.3.

5604.7 Street Grade on Vertical Curves

The following formula shall be used to determine the street grade (S_x) at any point on a vertical curve using plus for grades ascending forward and minus for grades descending forward, in feet per foot.

$$S_x = S_1 + \frac{x \cdot (S_2 - S_1)}{L}$$

Where:

S_x = the street grade on a vertical curve at point x, in feet per foot

S_1 = the street grade at the PC of a vertical curve, in feet per foot

S_2 = the street grade at the PT of a vertical curve, in feet per foot

x = the distance measured from the PC to point x on a vertical curve, in feet

L = the total length of a vertical curve, in feet

5604.8 Curb Inlet Intercept Equations[1]

A. For any given set of conditions (curb type, inlet length, street grade and cross-slope), the relationship between the captured discharge and the total discharge can be approximated satisfactorily by an equation

$$Q_c = \left\{ \begin{array}{l} Q_t \quad for\ Q_t \le Q_o \\ Q_o + (Q_a - Q_o)\left\{ 1 - \exp\left[-\left(\dfrac{Q_t - Q_o}{Q_a - Q_o} \right) \right] \right\} for\ Q_t > Q_o \end{array} \right\}$$

of the form:

Q_o and Q_a are constants. The constant Q_o represents the largest discharge that is captured completely, and the constant Q_a represents the upper limit on the captured discharge, which is approached asymptotically with increasing total discharge. For a particular curb type and street cross-slope, Q_o and Q_a vary with inlet length (L_o) and street grade (S_o) according to the formulas

$$Q_o = (a + b \cdot L_o)(S_o)^x$$

$$Q_a = (c + d \cdot L_o)(S_o)^x$$

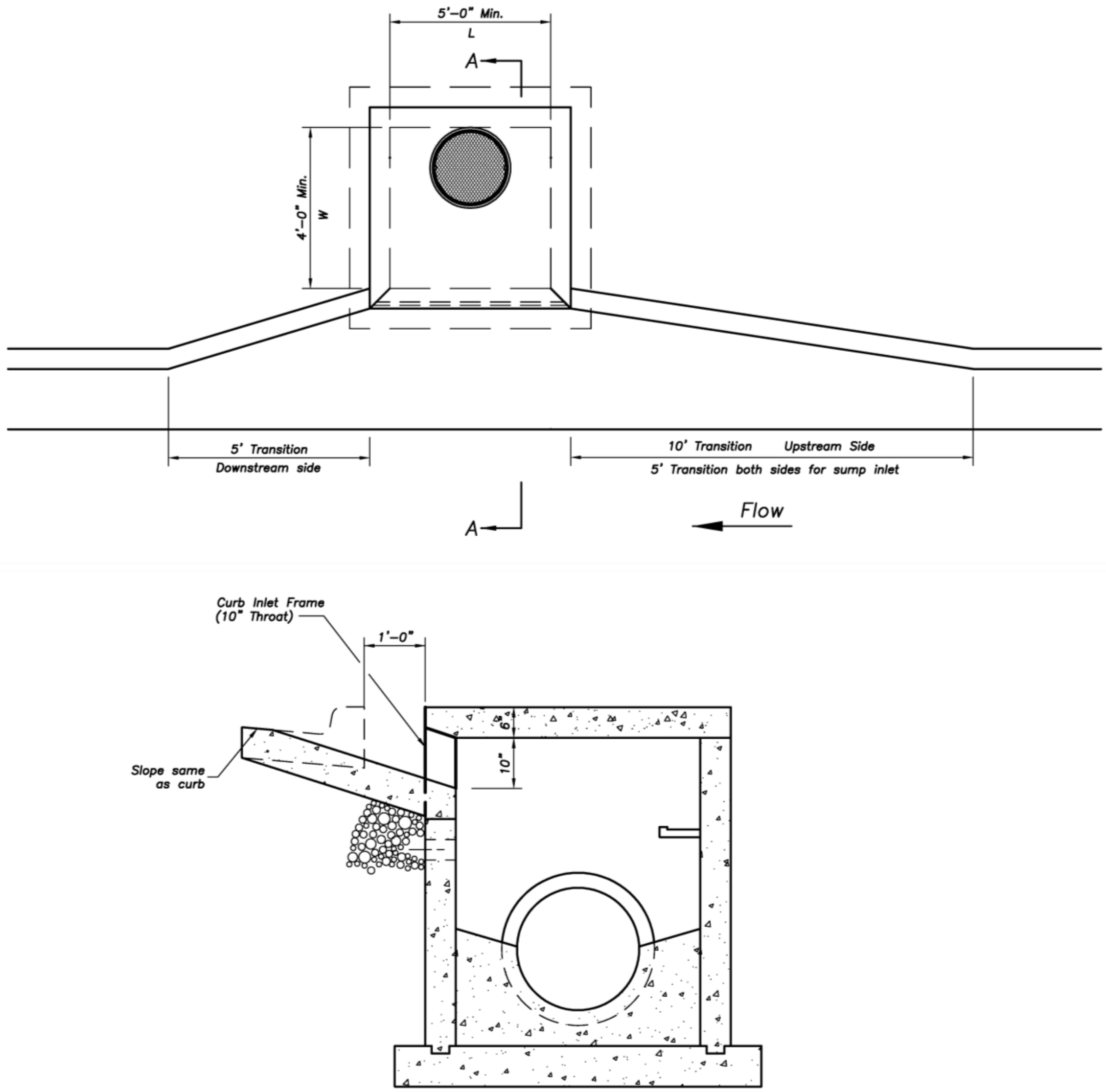
Where a, b, c, d and x are constants. Table 5604-4 shows these constants in U.S. customary units.

Table 5604-4: Values of Coefficients and Exponent

Curb Type	Sx,%	a	b	c	d	x
CG-1 (B)	2	1.0	0	3.2	1.7	-0.5
CG-1 (B)	4	1.5	0.5	2.6	1.9	-0.5
CG-2 (A)	2	-0.4	0.1	3.5	0.8	-0.7
CG-2 (A)	4	-0.3	0.3	4.3	2.5	-0.8

B. Appendix A provides a Microsoft Visual Basic function that can be added to a Microsoft Excel (97 or later) worksheet or template for inlet intercept calculations.

1 ."Hydraulic Performance of Set-Back Curb Inlets", McEnroe et al., University of Kansas, 1998.



SECTION A–A
Not to Scale

Figure 5604-1: Curb Inlet (10' Throat) Minimum Hydraulic Dimensions

SECTION 5606 ENCLOSED PIPE SYSTEMS

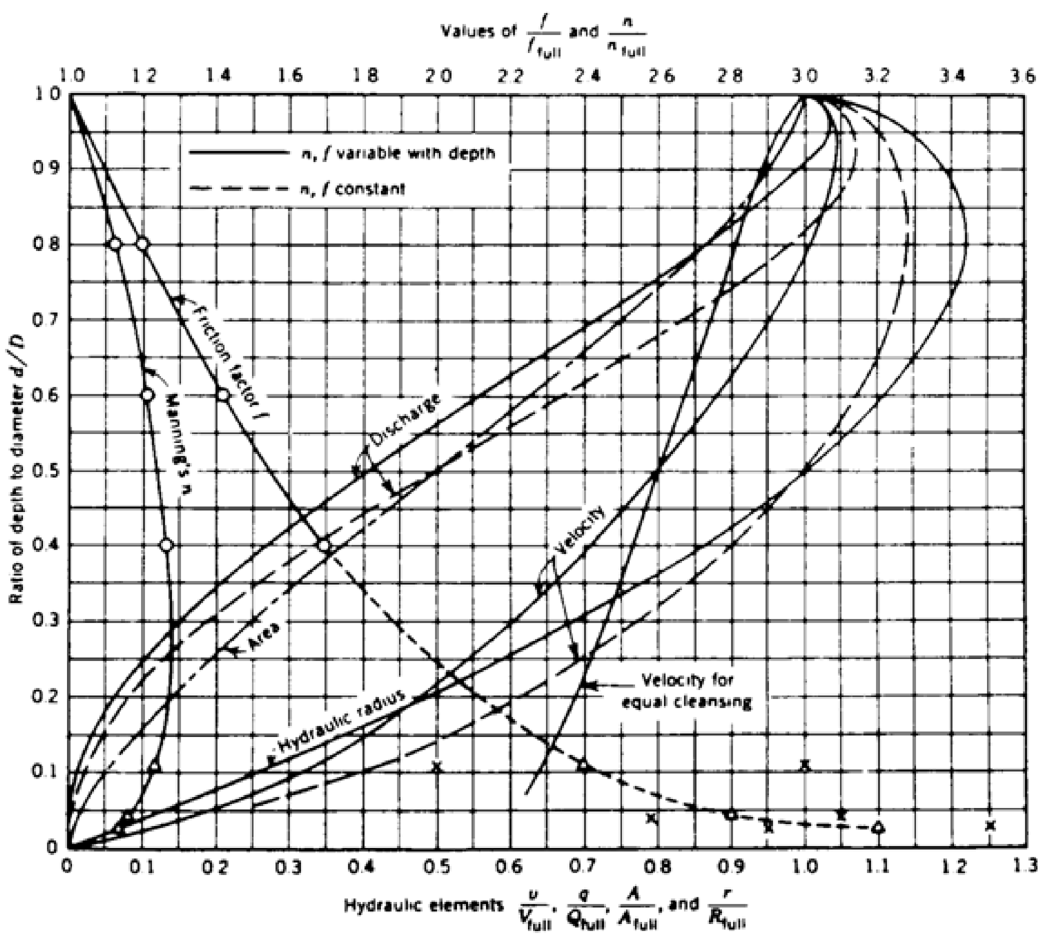
5606.1 Easements

Permanent easements shall be dedicated to the City/County for operation and maintenance of the storm drainage facilities. Easement width shall not be less than 15 feet, or the outside width of the pipe or conveyance structure plus 10 feet; whichever is greater. Easements shall be centered on the pipe.

- **A. Permanent:** The City/County Engineer may require wider easements when other utilities are located within the same easement and/or when the depth of cover is greater than 4 feet.
- **B. Temporary:** Temporary construction easements of sufficient width to provide access for construction shall be acquired when the proposed work is located in areas developed prior to construction.

5606.2 Capacity

Capacity shall be determined in accordance with Section 5603. Minimum design pipe size shall be 15-inch in diameter. For partially full pipe flow, Figure 5606-1 can be used to obtain hydraulic parameters of the flow.



v	=	Actual velocity of flow (fps)	A	=	Area occupied by flow (ft^2)
V_{full}	=	Velocity flowing full (fps)	A_{full}	=	Area of pipe (ft^2)
q	=	Actual quantity of flow (cfs)	r	=	Actual hydraulic radius (ft.)
Q_{full}	=	Capacity flowing full (cfs)	R_{full}	=	Hydraulic radius of full pipe (ft.)

Figure 5606-1: Hydraulic Elements of Circular Conduits

5606.3 Pressure Flow

After considering the discussion presented in Section 5603.1 A, an enclosed system may be designed to operate with pressure flow, for the design storms specified in Section 5601.8, if all the following conditions are met:

A. The Hydraulic Grade Line (HGL) must be 0.5 feet below any openings to the ground or street at all locations.

B. Watertight joints capable of withstanding the internal surcharge pressure are used in the construction.

C. Appropriate energy losses for bends, transitions, manholes, inlets, and outlets, are used in computing the HGL.

D. Energy methods (Bernoulli's equation) must be used for the computations.

5606.4 Energy Dissipation:

The outfall, as defined in Section 5605.6, of all enclosed systems shall include energy dissipation sufficient to transition outlet flows to velocities and applied shear stresses consistent with the normal flow conditions in the receiving channel for the range of flows up to and including the 1% storm. Calculations, at a minimum, should include the 100%, the 10% and the 1% storms.

Energy dissipation for lateral outflows to natural streams and edge of buffer outfalls to riparian buffers shall follow the guidance in Section 5605.6. Effective energy dissipating structures shall be provided if necessary to meet the requirements stated in Tables 5605-2 and 5606-1. Examples of energy dissipating structures are:

- Check Dams
- Level Spreaders
- Hydraulic Jump Basins
- Impact Baffle Basins
- Plunge Pool and Plunge Basin
- Slotted-Grating or Slotted Bucket Dissipaters
- Stilling Basins
- Rock Revetment
- Internal Pipe Rings

Grade control shall be provided downstream of the dissipator or shall be constructed integrally with it.

The suitability of each method is site dependent and subject to approval by the City/County Engineer. Table 5606-1 lists methods and applicability.

Table 5606-1: Energy Dissipation Counter Measures

	Functional Applications		Suitable Environment			
Counter Measure	Vertical Control	Horizontal Control	Dam Outlets	Small Culverts	Large Culvert	References
Check Dam	X	O	X	X	X	2, 6
Level Spreaders	X	X	O	X	O	1
Hydraulic Jump Basins	X	X	X	X	X	1, 3
Impact Baffle Basins	X	X	X	X	X	1
Plunge Pool & Plunge	X	O	X	X	X	1

Table 5606-1: Energy Dissipation Counter Measures

Counter Measure	Functional Applications: Vertical Control	Functional Applications: Horizontal Control	Suitable Environment: Dam Outlets	Suitable Environment: Small Culverts	Suitable Environment: Large Culvert	References
Basin						
Slotted-Grating or Slotted Bucket Dissipators	X	X	X	O	X	1
Stilling Basins	X	O	X	X	X	1, 2, 3, 4, 5, 6
Rock Revetment	X	X	X	X	X	1, 2, 6
Internal Pipe Rings	X	O	N/A	X	N/A	

LEGEND

X = Suitable Countermeasure

0 = Marginal Countermeasure

REFERENCES

1. Design of Small Dams 1987 United States Department of Interior
2. HEC 23
3. Hydraulic Design of Stilling Basins and Energy Dissipaters
4. HEC-14 FHWA Hydraulic Design of Energy Dissipaters for Culverts and Channels
5. U.S. Army Corps ff Engineers, 1994 Hydraulic Design of Flood Control Channels
6. Hydraulic Design Series (HDS-6)

NOTE: Other means may be used for Energy Dissipation and Stream Stability by designers as accepted by the local governing agency.

Energy dissipaters shall be designed according to the criteria and procedures defined in professionally acceptable references. Several such references include:

- United States. Department of the Interior. Bureau of Reclamation. Design of Small Dams. 1987 ed. Denver: GPO, 1987.
- United States. Department of the Interior. Bureau of Reclamation. A Water Resource Technical Publication. Engineering Monograph No. 25. Hydraulic Design of Stilling Basins and Energy Dissipaters. 1978 ed. GPO, 1978.
- Federal Highway Administration (FHA), 1983. Hydraulic Design of Energy Dissipaters for Culverts and Channels, Hydraulic Engineering Circular (HEC) No. 14.
- US Army Corps of Engineers, 1994. Hydraulic Design of Flood Control Channels, US Army Corps of Engineers Engineer Manual EM 1110-2-1601.
- Bridge Scour and Stream Instability Countermeasures Experience, Selection, and Design Guidance (Latest Edition), National Highway Institute, HEC No. 23.
- River Engineering for Highway Encroachments, Highways in the River Environment, U.S. Department of Transportation, Federal Highway Administration, Publication No. FHWA NHI 01-004, December 2001.

5606.5 Velocity within the System

The velocity within the system shall be between 3 and 20 feet per second.

5606.6 Loading

A. Cover: Minimum depth of cover shall be 18 inches.

B. Minimum Loading Conditions:

1. Live load: H-20.
2. Unit Weight of soil cover: 120 lbs/ft^3.
3. Rigid pipes shall be bedded and backfilled to provide a minimum factor of safety of 1.5 at the 0.01-inch crack loading condition.

APPENDIX C.3

CITY OF LEE'S SUMMIT WATERSHED & OUTFALL MAP

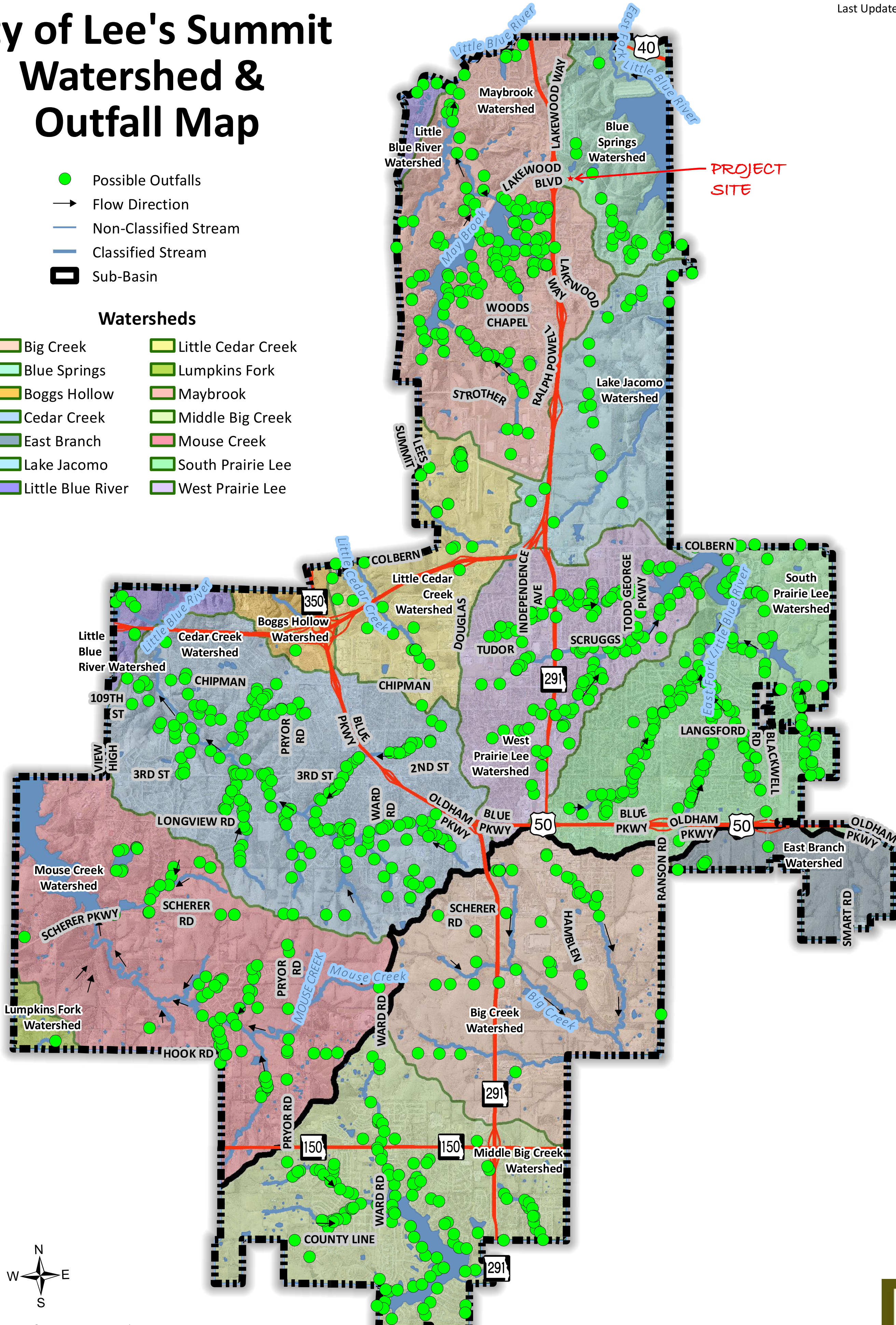
Last Updated: March 2021

City of Lee's Summit Watershed & Outfall Map

- Possible Outfalls
- Flow Direction
- Non-Classified Stream
- Classified Stream
- Sub-Basin

Watersheds

Big Creek	Little Cedar Creek
Blue Springs	Lumpkins Fork
Boggs Hollow	Maybrook
Cedar Creek	Middle Big Creek
East Branch	Mouse Creek
Lake Jacomo	South Prairie Lee
Little Blue River	West Prairie Lee



N S E W

1 0.5 0 1
Miles

APPENDIX C.4

NOAA POINT PRECIPITATION DATA

NOAA Atlas 14, Volume 8, Version 2
Location name: Lees Summit, Missouri, USA*
Latitude: 39.0033°, Longitude: -94.354°
Elevation: 911.22 ft**
* source: ESRI Maps
** source: USGS

NOTE: 24-HR RAINFALL DEPTHS HIGHLIGHTED WERE DISTRIBUTED PER TABLE 5602-4 IN APPENDIX C.2 TO CREATE THE DESIGN STORMS FOR THIS PROJECT.

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffery Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.413** (0.324-0.522)	**0.480** (0.376-0.608)	**0.594** (0.464-0.754)	**0.691** (0.537-0.880)	**0.828** (0.627-1.09)	**0.937** (0.695-1.25)	**1.05** (0.756-1.42)	**1.17** (0.811-1.62)	**1.32** (0.892-1.89)	**1.45** (0.952-2.09)
10-min	**0.604** (0.474-0.765)	**0.703** (0.551-0.891)	**0.870** (0.679-1.10)	**1.01** (0.786-1.29)	**1.21** (0.918-1.59)	**1.37** (1.02-1.82)	**1.54** (1.11-2.09)	**1.71** (1.19-2.37)	**1.94** (1.31-2.76)	**2.12** (1.39-3.05)
15-min	**0.737** (0.578-0.933)	**0.858** (0.672-1.09)	**1.06** (0.828-1.35)	**1.23** (0.959-1.57)	**1.48** (1.12-1.94)	**1.67** (1.24-2.22)	**1.87** (1.35-2.54)	**2.08** (1.45-2.89)	**2.37** (1.59-3.37)	**2.59** (1.70-3.72)
30-min	**1.02** (0.803-1.30)	**1.20** (0.937-1.52)	**1.48** (1.16-1.88)	**1.73** (1.34-2.20)	**2.08** (1.57-2.73)	**2.35** (1.74-3.12)	**2.63** (1.89-3.57)	**2.92** (2.03-4.05)	**3.31** (2.23-4.71)	**3.61** (2.38-5.21)
60-min	**1.34** (1.05-1.69)	**1.57** (1.23-1.99)	**1.96** (1.53-2.49)	**2.29** (1.78-2.92)	**2.77** (2.10-3.64)	**3.14** (2.33-4.18)	**3.53** (2.55-4.80)	**3.94** (2.74-5.48)	**4.49** (3.02-6.39)	**4.92** (3.24-7.09)
2-hr	**1.65** (1.30-2.08)	**1.94** (1.53-2.44)	**2.43** (1.91-3.07)	**2.86** (2.24-3.61)	**3.46** (2.64-4.52)	**3.94** (2.95-5.21)	**4.44** (3.22-5.99)	**4.96** (3.48-6.85)	**5.67** (3.85-8.03)	**6.23** (4.12-8.91)
3-hr	**1.86** (1.48-2.33)	**2.20** (1.74-2.76)	**2.77** (2.19-3.48)	**3.26** (2.56-4.11)	**3.97** (3.05-5.18)	**4.54** (3.41-5.99)	**5.14** (3.75-6.92)	**5.76** (4.06-7.94)	**6.62** (4.51-9.34)	**7.29** (4.85-10.4)
6-hr	**2.25** (1.80-2.80)	**2.67** (2.13-3.32)	**3.39** (2.69-4.22)	**4.02** (3.18-5.03)	**4.93** (3.82-6.40)	**5.68** (4.30-7.44)	**6.46** (4.75-8.65)	**7.28** (5.17-9.98)	**8.42** (5.78-11.8)	**9.32** (6.24-13.2)
12-hr	**2.66** (2.13-3.28)	**3.17** (2.55-3.91)	**4.05** (3.25-5.02)	**4.83** (3.85-6.01)	**5.97** (4.66-7.71)	**6.90** (5.27-9.00)	**7.88** (5.84-10.5)	**8.92** (6.38-12.2)	**10.4** (7.17-14.5)	**11.5** (7.77-16.2)
24-hr	**3.10** (2.52-3.81)	**3.70** (3.00-4.55)	**4.74** (3.83-5.84)	**5.66** (4.55-6.99)	**7.00** (5.50-8.98)	**8.10** (6.22-10.5)	**9.25** (6.90-12.2)	**10.5** (7.55-14.2)	**12.2** (8.48-16.9)	**13.5** (9.19-18.9)
2-day	**3.64** (2.97-4.44)	**4.29** (3.50-5.23)	**5.42** (4.41-6.62)	**6.42** (5.19-7.87)	**7.88** (6.24-10.0)	**9.08** (7.03-11.7)	**10.3** (7.77-13.6)	**11.7** (8.47-15.7)	**13.5** (9.50-18.6)	**15.0** (10.3-20.9)
3-day	**4.05** (3.32-4.91)	**4.69** (3.84-5.69)	**5.81** (4.74-7.06)	**6.80** (5.52-8.30)	**8.27** (6.58-10.5)	**9.48** (7.37-12.1)	**10.8** (8.13-14.1)	**12.1** (8.84-16.3)	**14.0** (9.90-19.3)	**15.6** (10.7-21.6)
4-day	**4.39** (3.61-5.31)	**5.02** (4.12-6.07)	**6.11** (5.01-7.42)	**7.10** (5.78-8.64)	**8.55** (6.83-10.8)	**9.76** (7.62-12.5)	**11.0** (8.36-14.4)	**12.4** (9.07-16.6)	**14.3** (10.1-19.6)	**15.9** (10.9-21.9)
7-day	**5.20** (4.30-6.26)	**5.85** (4.84-7.04)	**6.97** (5.75-8.41)	**7.96** (6.53-9.64)	**9.40** (7.54-11.8)	**10.6** (8.30-13.4)	**11.8** (9.00-15.3)	**13.1** (9.65-17.4)	**15.0** (10.6-20.3)	**16.4** (11.4-22.5)
10-day	**5.89** (4.89-7.06)	**6.61** (5.48-7.93)	**7.83** (6.47-9.40)	**8.87** (7.30-10.7)	**10.4** (8.31-12.9)	**11.6** (9.08-14.5)	**12.8** (9.76-16.4)	**14.1** (10.4-18.5)	**15.8** (11.3-21.4)	**17.2** (12.0-23.5)
20-day	**7.83** (6.55-9.32)	**8.84** (7.39-10.5)	**10.5** (8.72-12.5)	**11.8** (9.77-14.1)	**13.6** (10.9-16.6)	**14.9** (11.8-18.5)	**16.2** (12.4-20.6)	**17.6** (13.0-22.9)	**19.3** (13.8-25.7)	**20.5** (14.4-27.9)
30-day	**9.46** (7.95-11.2)	**10.7** (8.98-12.7)	**12.7** (10.6-15.0)	**14.2** (11.8-16.9)	**16.3** (13.1-19.8)	**17.8** (14.0-21.9)	**19.2** (14.7-24.2)	**20.6** (15.3-26.6)	**22.3** (16.0-29.6)	**23.5** (16.6-31.8)
45-day	**11.5** (9.74-13.6)	**13.0** (11.0-15.4)	**15.4** (12.9-18.2)	**17.2** (14.4-20.4)	**19.5** (15.8-23.6)	**21.2** (16.8-26.0)	**22.7** (17.5-28.5)	**24.2** (18.0-31.1)	**26.0** (18.7-34.2)	**27.2** (19.2-36.6)
60-day	**13.3** (11.3-15.7)	**15.0** (12.7-17.7)	**17.6** (14.8-20.8)	**19.6** (16.5-23.2)	**22.2** (17.9-26.7)	**24.0** (19.1-29.3)	**25.6** (19.8-32.0)	**27.1** (20.2-34.7)	**28.9** (20.8-38.0)	**30.1** (21.3-40.4)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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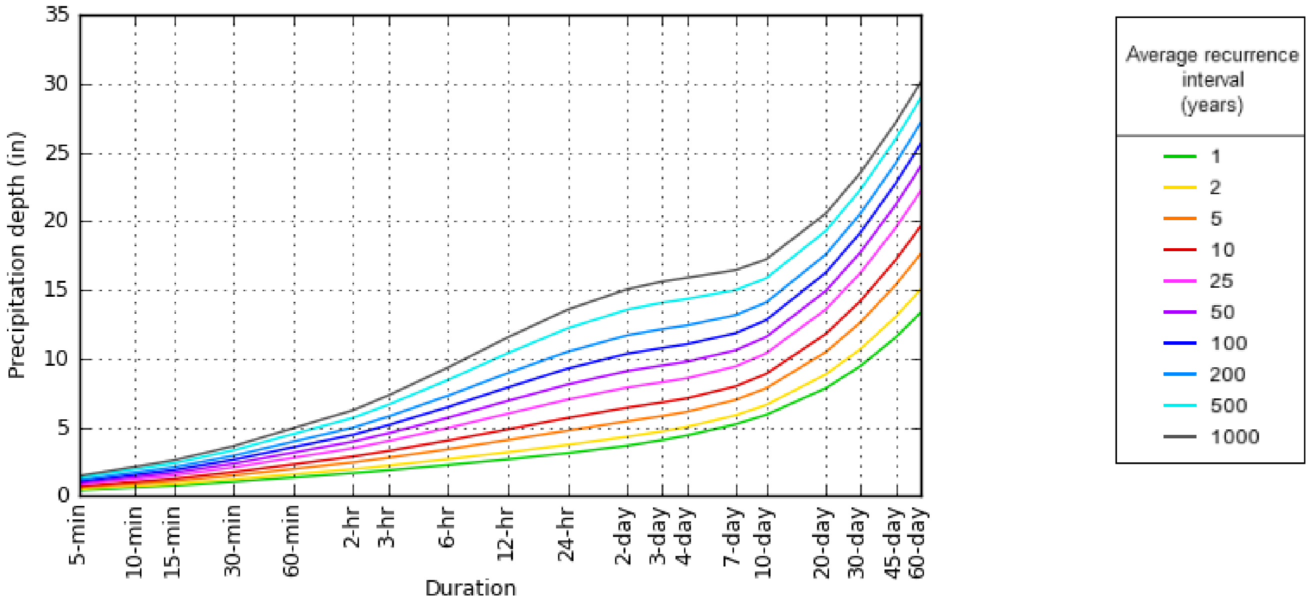
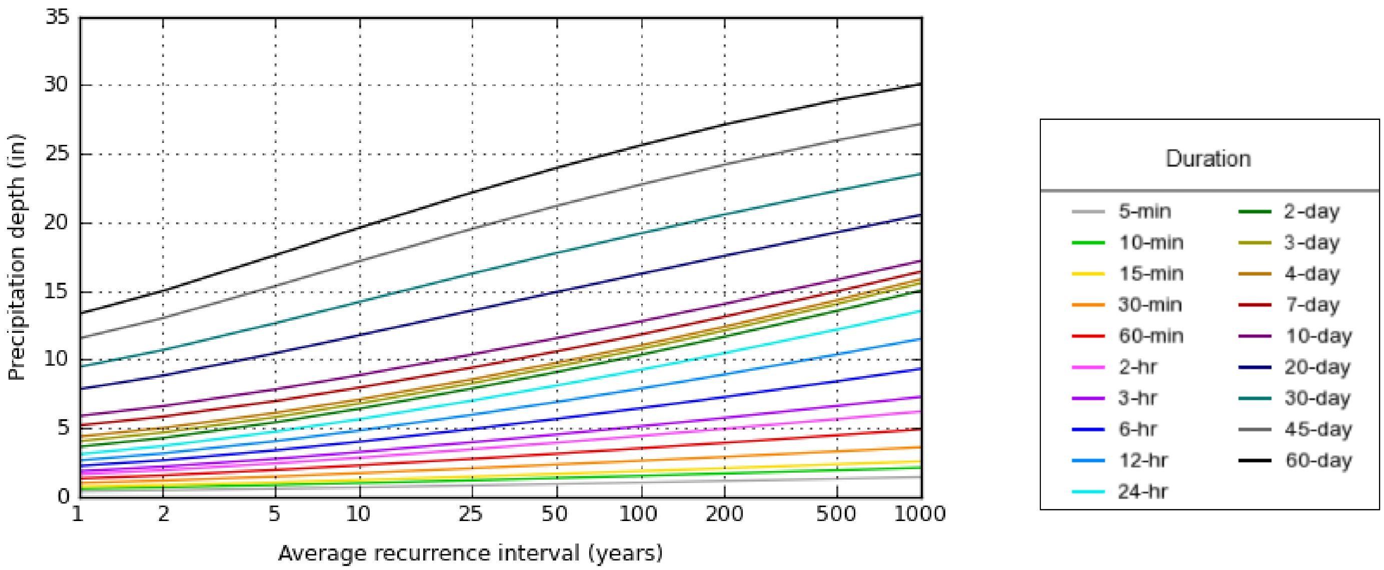
PF graphical

PDS-based depth-duration-frequency (DDF) curves
Latitude: 39.0033°, Longitude: -94.3540°





NOAA Atlas 14, Volume 8, Version 2

Created (GMT): Tue Jan 4 18:05:46 2022

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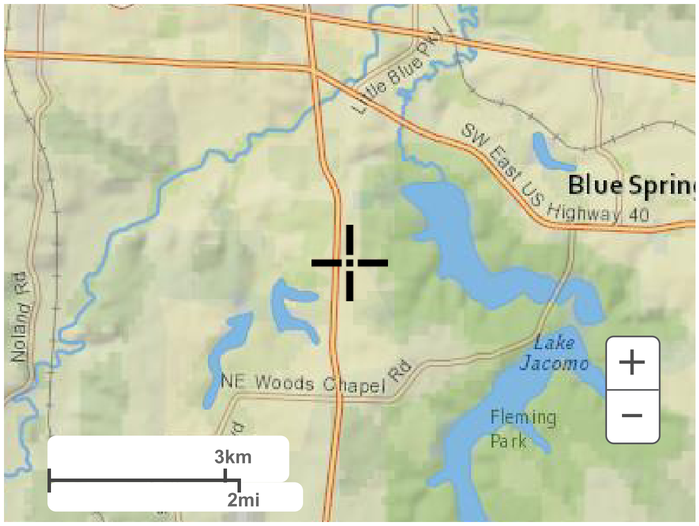
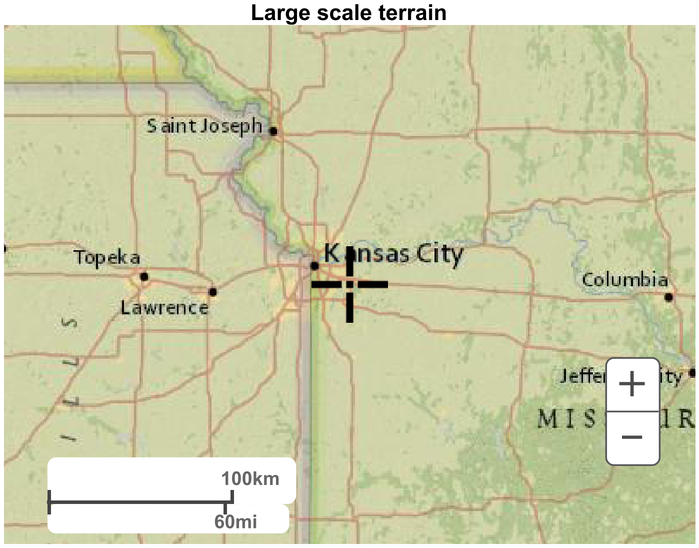
Maps & aerials

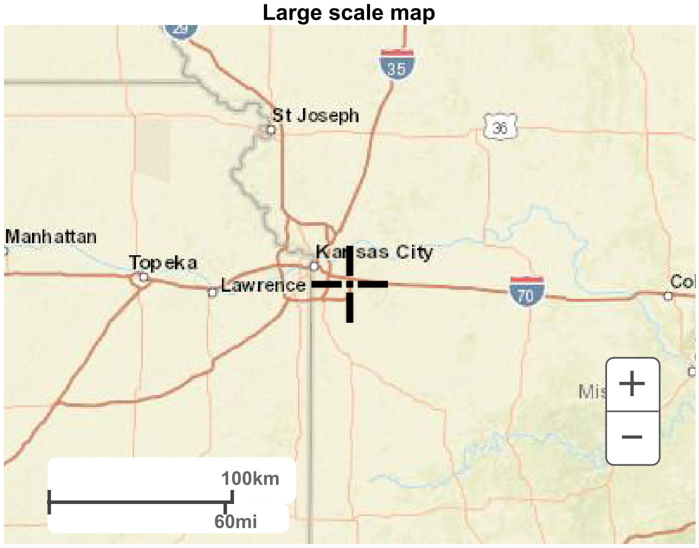
Small scale terrain



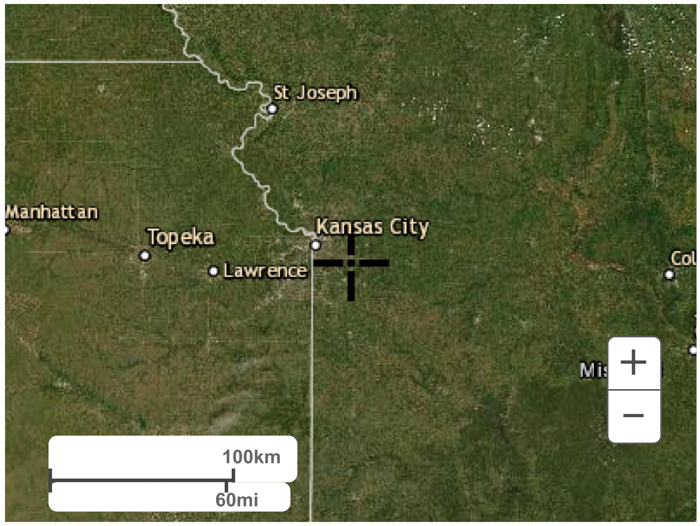
Large scale terrain



Large scale map



Large scale aerial



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US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

APPENDIX C.5

SELECT PAGES, NRCS WEB SOIL SURVEY

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

Jackson County, Missouri

January 5, 2022

Soil Map


94° 21' 16" W
94° 21' 11" W
39° 0' 12" N
39° 0' 10" N
382720
382730
382740
382750
382760
382770
382780
382790
382800
382810
382820
4318040
4318030
4318020
4318010
4318000
4317990
4317980
Lakewood
10113
10082
Soil Map may not be valid at this scale.
Map Scale: 1:501 if printed on A landscape (11" x 8.5") sheet.
N
Meters
0 5 10 20 30
Feet
0 20 40 80 120
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 15N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Jackson County, Missouri
Survey Area Data: Version 23, Sep 1, 2021

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 6, 2019—Nov 16, 2019

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
10082	Arisburg-Urban land complex, 1 to 5 percent slopes	0.2	21.2%
10113	Oska silty clay loam, 5 to 9 percent slopes, eroded	0.8	78.8%
Totals for Area of Interest		**1.0**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Jackson County, Missouri

10082—Arisburg-Urban land complex, 1 to 5 percent slopes

Map Unit Setting

National map unit symbol: 2w7ld
Elevation: 750 to 1,130 feet
Mean annual precipitation: 39 to 45 inches
Mean annual air temperature: 50 to 55 degrees F
Frost-free period: 177 to 220 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Arisburg and similar soils: 61 percent
Urban land: 30 percent
Minor components: 9 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Arisburg

Setting

Landform: Interfluves
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loess

Typical profile

Ap - 0 to 6 inches: silt loam
A - 6 to 13 inches: silt loam
Bt - 13 to 19 inches: silty clay loam
Btg - 19 to 56 inches: silty clay loam
BCg - 56 to 79 inches: silty clay loam

Properties and qualities

Slope: 1 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: About 18 to 30 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: High (about 11.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Ecological site: R107BY007MO - Loess Upland Prairie
Hydric soil rating: No

Description of Urban Land

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydric soil rating: No

Minor Components

Sampsel

Percent of map unit: 3 percent
Landform: Hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Concave
Ecological site: R109XY010MO - Interbedded Sedimentary Upland Savanna
Hydric soil rating: Yes

Greenton

Percent of map unit: 3 percent
Landform: Hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Ecological site: R109XY002MO - Loess Upland Prairie
Hydric soil rating: No

Sharpsburg

Percent of map unit: 3 percent
Landform: Ridges
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R109XY002MO - Loess Upland Prairie
Hydric soil rating: No

10113—Oska silty clay loam, 5 to 9 percent slopes, eroded

Map Unit Setting

National map unit symbol: yrm7
Elevation: 600 to 1,200 feet
Mean annual precipitation: 33 to 41 inches
Mean annual air temperature: 50 to 55 degrees F
Frost-free period: 177 to 220 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Oska and similar soils: 90 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Oska

Setting

Landform: Ridges
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Crest
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Residuum

Typical profile

A - 0 to 7 inches: silty clay loam
Bt - 7 to 34 inches: silty clay loam
R - 34 to 80 inches: bedrock

Properties and qualities

Slope: 5 to 9 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 5.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: D
Ecological site: R106XY015KS - Loamy Upland (PE 30-37)
Other vegetative classification: Grass/Prairie (Herbaceous Vegetation)
Hydric soil rating: No

Minor Components

Sampsel

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Concave
Ecological site: R109XY010MO - Interbedded Sedimentary Upland Savanna
Other vegetative classification: Grass/Prairie (Herbaceous Vegetation)
Hydric soil rating: No