MACRO STORM WATER DRAINAGE STUDY

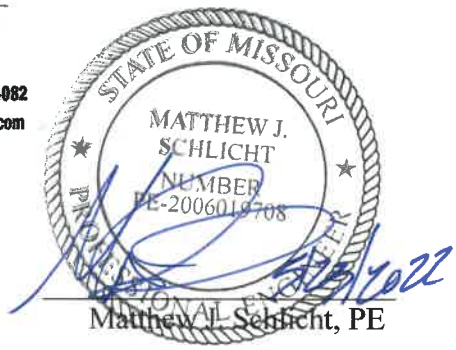
OFFICE/WAREHOUSE
950 NE POLLARD STREET

Site Acreage: 1.31 Acres

950 NE Pollard Street
Lee's Summit, MO

PREPARED BY:

ENGINEERING SOLUTIONS
ENGINEERING & SURVEYING
50 S.E. 30th Street Lee's Summit, MO 64082
816.623.9888 • engineeringsolutionskc.com



5/23/2022
Matthew J. Schlicht, PE

Revision

Date	Comment	By
5-23-22	Revised per City Comments Dated May, 9 2022	AEP

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TABLE OF CONTENTS

3. GENERAL INFORMATION

This storm study has been prepared to evaluate potential hydrologic and hydraulic impacts related to the proposed development and recommend improvements designed to mitigate any anticipated negative downstream impacts. The proposed office/warehouse development is to sit on 1.31 acres of currently undeveloped land. The improvements will consist of a new building, parking lot, drive aisles and associated utility infrastructure. The site generally drains in three primary directions being the northwest, Northeast and South via sheet and shallow concentrated flow. See Exhibit A for an aerial image of the proposed project site along with an aerial image of the surrounding area. The existing site does not contain any storm sewer, water bodies, wetlands nor BMPs. The site is located in Section 36, Township 47N, Range 32W, Lee's Summit, Jackson County, Missouri.

3.1 FEMA FLOODPLAIN DETERMINATION

The property is located in an Area of Minimal Flood Hazard, Zone X, according to FEMA Firm Map Number 29095C0430G, dated January 20, 2017.

See Exhibit B for a FIRMette which includes the proposed project site.

3.2 NRCS SOIL CLASSIFICATION

Soil classifications published by the United States Department of Agriculture/National Resources Conservation Service (USDA/NRCS) website for Jackson County, Missouri, Version 22, May 29, 2020. The existing site contains one major soil type:

10000	Arisburg Silt Loam, 1 to 5 Percent Slopes Hydrologic Soils Group (HSG): Type C

See Exhibit C for a detailed soils report of the proposed project site.

4. METHODOLOGY

A field topographical survey was completed and used to create the Existing Drainage Area Map. The study conforms to the requirements of the City of Lee's Summit, Missouri "Design and Construction Manual" and all applicable codes and criteria referred to therein.

Using the above criteria, the proposed site was evaluated using the Soil Conservation Service, SCS TR-55 method to calculate storm runoff volumes, peak rates of discharge, pre and post developed hydrographs and required storage volumes for detention facilities. TR-55 was first introduced in 1975 by the SCS particularly for small urbanizing watersheds. The analysis contains results for the 2, 10 and 100-year design storms.

Hydraflow Hydrographs Extension for AutoCAD Civil 3D was utilized to model the various SCS TR-55 stormwater rainfall runoff events. The following SCS TR-55 Unit Hydrograph variables were utilized;

- AMC II Soil Moisture Conditions
- 24-Hour SCS Type II Rainfall Distribution (Shape Factor 484)
- SCS Runoff Curve Numbers per SCS TR-55 (Tables 2-2a to 2-2c)
- Precipitation Data: SCS 24-hr Precip (in); 2-yr = 3.50, 10-yr = 5.20, 100-yr = 7.70

Time of Concentration has been calculated using the following formulas:

- Sheet Flow (Max. 100 LF): APWA 5602.5 Time Inlet, $T_I = 1.8 * (1.1-C) * L^{1/2} / S^{1/3}$

- Shallow Concentrated Flow: SCS TR-55 Appendix F: Unpaved V=16.1345(S)^0.5
  Paved V=20.3282(S)^0.5

  Shallow Concentrated Travel Time (min): SCS TR-55 Eq-3-1, T_t = L / V x 60
- Channel Flow Improved: Manning's Equation (Full Flow)
  Channel Flow Unimproved: APWA 5602.7.A. Travel Time, Table 5602-6

Avg. Channel Slope (%)	Velocity (fps)
< 2	7
2 to 5	10
>5	15

5. EXISTING CONDITIONS ANALYSIS

The existing site located at 950 NE Pollard Street is located in a planned community commercial and planned industrial area. The site is undergoing rezoning from planned community commercial to planned industrial. The site is currently undeveloped. The drainage on the site is split and generally drains in three directions. The west side of the site referred to as Sub-basin W drains to the northwest corner of the property to Point of Interest (POI) W via sheet and shallow concentrated flow. The southern portion of the property, Sub-basin S, drains via sheet flow to NE Pollard Street where it is collected by the north curb and gutter system for further conveyance downstream to the east. The remainder and majority of the site generally located in the east and referred to as Sub-basin E drains to the north east corner of the property to POI E via sheet and shallow concentrated flow. The Existing Drainage Area Map is located in Exhibit D.

The following tables summarize the results of the Existing Conditions analysis. Composite curve number calculations by sub-basin may be found in Exhibit E. Time of concentration calculations by sub-basin may be found in Exhibit F. A complete breakdown of TR-55 unit hydrographs may be found in Exhibit G.

Table 5-1 Existing Conditions Sub-basin Data

Sub-basin	Area (ac.)	CN	Tc (min.)
W	0.34	74	10.6
S	0.17	74	9.6
E	0.80	74	11.3

Table 5-2 Existing Conditions Sub-basin/Point of Interest Peak Discharge Rates

Sub-basin	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
W	0.64	1.31	2.40
S	0.34	0.69	1.26
E	1.49	3.09	5.65

Per APWA 5608.4 and City of Lee's Summit criteria, post development peak discharge rates from the site shall not exceed those indicated below:

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

Allowable release rates were calculated at POI W, S and E. The proposed Development (1.31 acres) runoff shall not be more than the peak discharge rates stated above.

Allowable Release Example Calculations:

Sub-basin W (2-Yr): (0.34 x 0.5) = 0.17 cfs

Table 5-3 Existing Conditions Sub-basin/Point of Interest Allowable Peak Discharge Release Rates

Sub-basin	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
W	0.17	0.68	1.02
S	0.08	0.34	0.51
E	0.40	1.60	2.40

6. PROPOSED CONDITIONS ANALYSIS

The Development will contain an office/warehouse facility as described in the general information section. A conceptual layout for the proposed Development may be found in Exhibit I which includes the proposed location of the earthen detention basin located in the north east section of the property. A single stage earthen detention basin will be utilized in Sub-basin E(1) to attenuate runoff at POI E below allowable peak discharge rates as shown in Table 5-3. The Proposed Drainage Area Map is located in Exhibit H.

Table 6-1 Proposed Conditions Sub-basin Data

Sub-basin	Area (ac.)	Composite CN	Tc (min.)
W	0.05	74	5.0
S	0.12	88	8.6
E	0.16	74	11.8
E(1)	0.97	88	7.1

Table 6-2 Proposed Conditions Sub-basin/Point of Interest Peak Discharge Rates

Sub-basin	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
W	0.12	0.23	0.42
S	0.43	0.71	1.12
E	0.28	0.57	1.05
E(1)	3.60	5.96	9.39

As shown above in Table 6-2 Sub-basins E + E(1) will require detention to attenuate peak discharge rates below Allowable Release Rates as shown in Table 5-3 for Sub-basin/POI E. Sub-basin W will be reduced below allowable for all design storms due to reduction in drainage area. Sub-basin S is peripheral to the site and is adjacent to NE Pollard Street. Sub-basin S includes minimal improvement consisting of portions of each entrance drive. Sub-basin S proposed runoff is below existing but does not meet allowable discharge rates however its location and consistent drainage pattern is not anticipated to negatively affect downstream drainage. A waiver will be requested for Sub-basin S peripheral to the site for the 2, 10 and 100-year allowable storm events.

6.1 DETENTION

A new single stage earthen detention basin is being proposed in Sub-basin E(1) to attenuate proposed peak discharge rates. Following are a list of design parameters for the detention system.

Designation: Detention Basin E(1)
Type: Earthen Basin
Side Slopes: 3:1 Max.
Bottom Slope: 1% Min., Turf Lined

Basin Bottom Elevation: 981.40 @ Influent Pipe
Basin Top Berm Elevation: 987.15
Basin Volume: 19,134 cf @ 987.00
Control Structure: 5'x6' Precast Concrete Box with Interior 6" Baffle/Weir Wall
Baffle Wall Orifices: (7) 1" Diameter on 4" Centers, FL=981.25 (Bottom Orifice)
(1) 6" Diameter, FL=984.25
Baffle Wall Crest Elevation: N/A
Control Structure Top Elevation: 986.05
Control Structure Overflow Weir Openings: N/A – NO Field Inlet Openings
Control Structure Influent Pipe: 24" HDPE, FL (In) = 981.40, FL (Out) = 981.35, L=51', S= 0.78%
Control Structure Effluent Pipe: 24" HDPE, FL (In) = 981.15, FL (Out) = 981.10, L=47', S=17.64%
Emergency Spillway: Earthen Broad Crested Weir, Crest Elevation=986.05, Crest Length=150'
Consecutive 100-YR Q=9.39 cfs, Emergency Spillway HGL=986.13', Freeboard=1.02'

The Detention Basin Plan may be found in Exhibit I. Basin E(1) emergency spillway calculations may be found in Exhibit G. See Table 6-4 for a summary of detention basin data.

Table 6-4 Proposed Conditions Detention Basin Data

	Peak Q In (cfs)	Tp In (min.)	Peak Q Out (cfs)	Tp Out (min)	Peak W.S.E.	Max. Storage Vol. (cf)
Basin E(1)						
2-Year	3.60	718	0.24	759	983.95	4,070
10-Year	5.96	718	0.71	738	984.66	6,680
100-Year	9.39	718	1.41	730	985.54	10,609

As shown in the table above all proposed peak flowrates have been attenuated. See Table 6-5 below for a summary of proposed peak discharge rates at Point of Interest E. Hydrographs tributary to each point of interest have been combined to determine subsequent peak discharge rates.

Table 6-5 Proposed Conditions Post Detention Point of Interest Peak Discharge Rates

Point of Interest	**Q2 (cfs)**	**Q10 (cfs)**	**Q100 (cfs)**
E	0.48	1.10	2.32

As can be seen in the above table all peak discharge rates attributable to the proposed development have been attenuated below allowable release rates outlined in Table 5-3 except for the 2-year.

Table 6-6 below provides a comparison of runoff data between Proposed and Existing Conditions in addition to Proposed Conditions and Allowable Release Rates at each Point of Interest.

Table 6-6 Point of Interest Discharge Comparison

	Condition	**Q2 (cfs)**	**Q10 (cfs)**	**Q100 (cfs)**
POI E	Proposed	109.51	246.78	372.35
	Existing	150.33	279.04	475.11
	Difference	-40.82	-32.26	-5.81
	Allowable	114.39	239.88	398.02
	Difference	-4.88	-6.9	-25.67

Peak discharge rates at Point E will be reduced below allowable for all design storms except the allowable 2-year. Both Sub-basins E and E(1) contribute to POI E. All improved land in Sub-basin E(1) is being captured and detained. No improvements are being made in Sub-basin E. The detention system has been designed to the

point of diminishing returns as shown by the reduction in all three storm events. Extended detention is being met with a series of vertical 1 inch orifices. The existing 2-year peak discharge at POI E will be reduced by 67.8%. Based on this information a waiver will be requested for the Allowable 2-year storm event.

7. 40 HOUR EXTENDED DETENTION/INFILTRATION BMP

In addition to mitigation of peak flow rates, APWA Section 5608.4 also requires 40 hour extended detention of runoff from the local 90% mean annual event (1.37"/24-hour rainfall). The proposed detention facility will release the water quality event over a period of 40-72 hours. See Exhibit J for Detention Basin E(1) extended detention calculations. The Water Quality Volume is released in approximately 40 hours from Basin E(1).

8. CONCLUSIONS & RECOMMENDATIONS

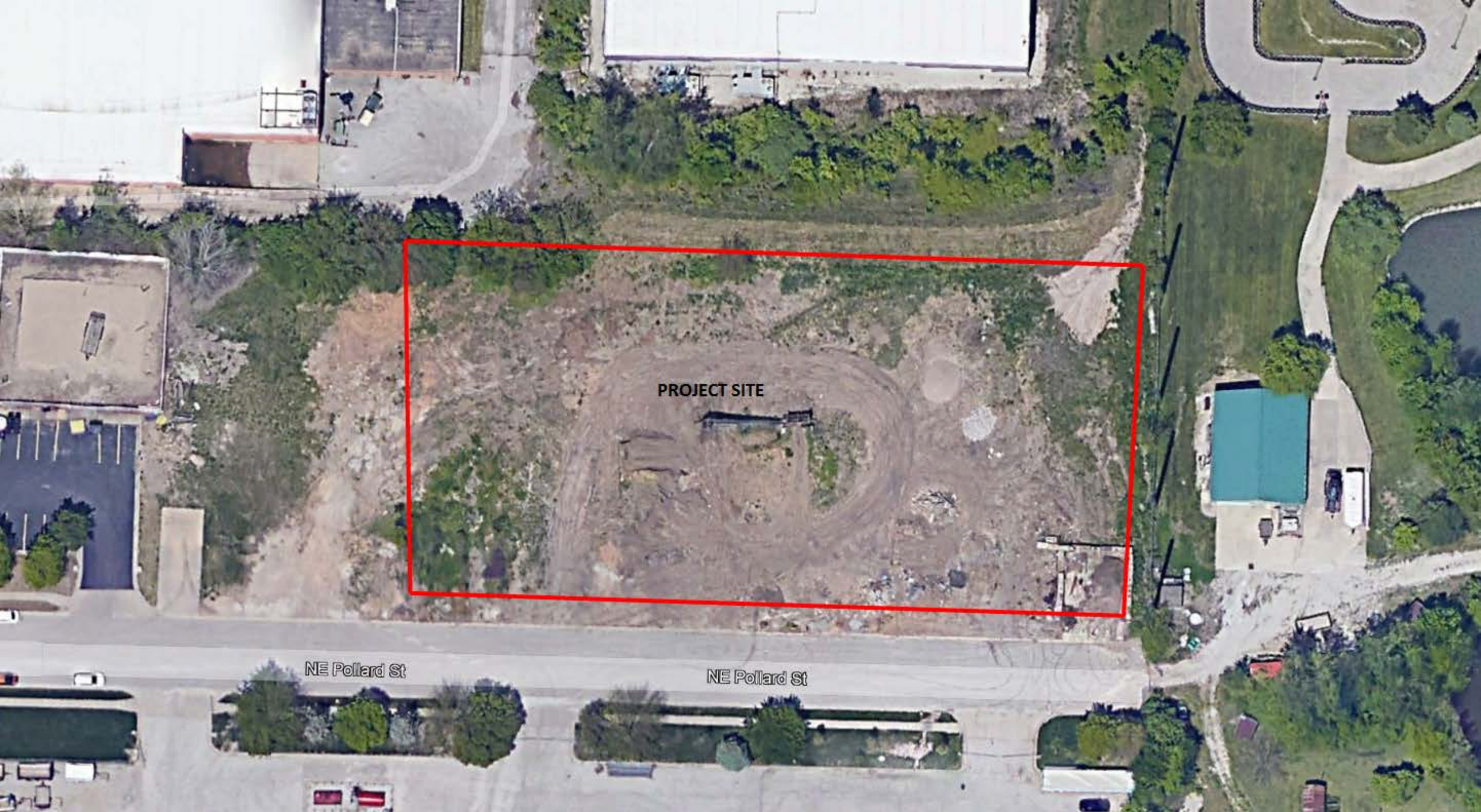
This macro storm water drainage study shows that the proposed development will not generate any negative downstream hydraulic impacts. A new earthen detention basin will be required to provide detention for the proposed development.

In conclusion, proposed peak discharge rates for POI E are below allowable release rates except for the 2-year. As discussed in the body of the report a Waiver will be requested for the POI E Allowable 2-year Event. The study is in conformance with all applicable City of Lee's Summit design standards and criteria therefore Engineering Solutions recommends approval of this macro storm water drainage study.

WAIVERS:
1) Sub-basin E 2-year allowable storm event. A 68% reduction has been achieved from the Existing Peak.
2) Sub-basin S peripheral to the site for the 2, 10 and 100-year allowable storm events. Minor area peripheral to the site and adjacent to the street right-of-way. Proposed peaks have been reduced below existing. The existing drainage pattern is not being affected.

Exhibit A

Aerial Image
&
Aerial Image of Surrounding Area


PROJECT SITE
NE Pollard St
NE Pollard St


NE Colbern Rd
NE Colbern Rd
NE Colbern Rd
NE Colbern Rd
NE Colbern Rd
NE Rice Rd
NE Independence Ave
NE Missouri Rd
NE Ball Dr
NE Ridgeview Dr
NE Cedar St
NE Cedar St
NE Mulberry St
470
470
291
SITE

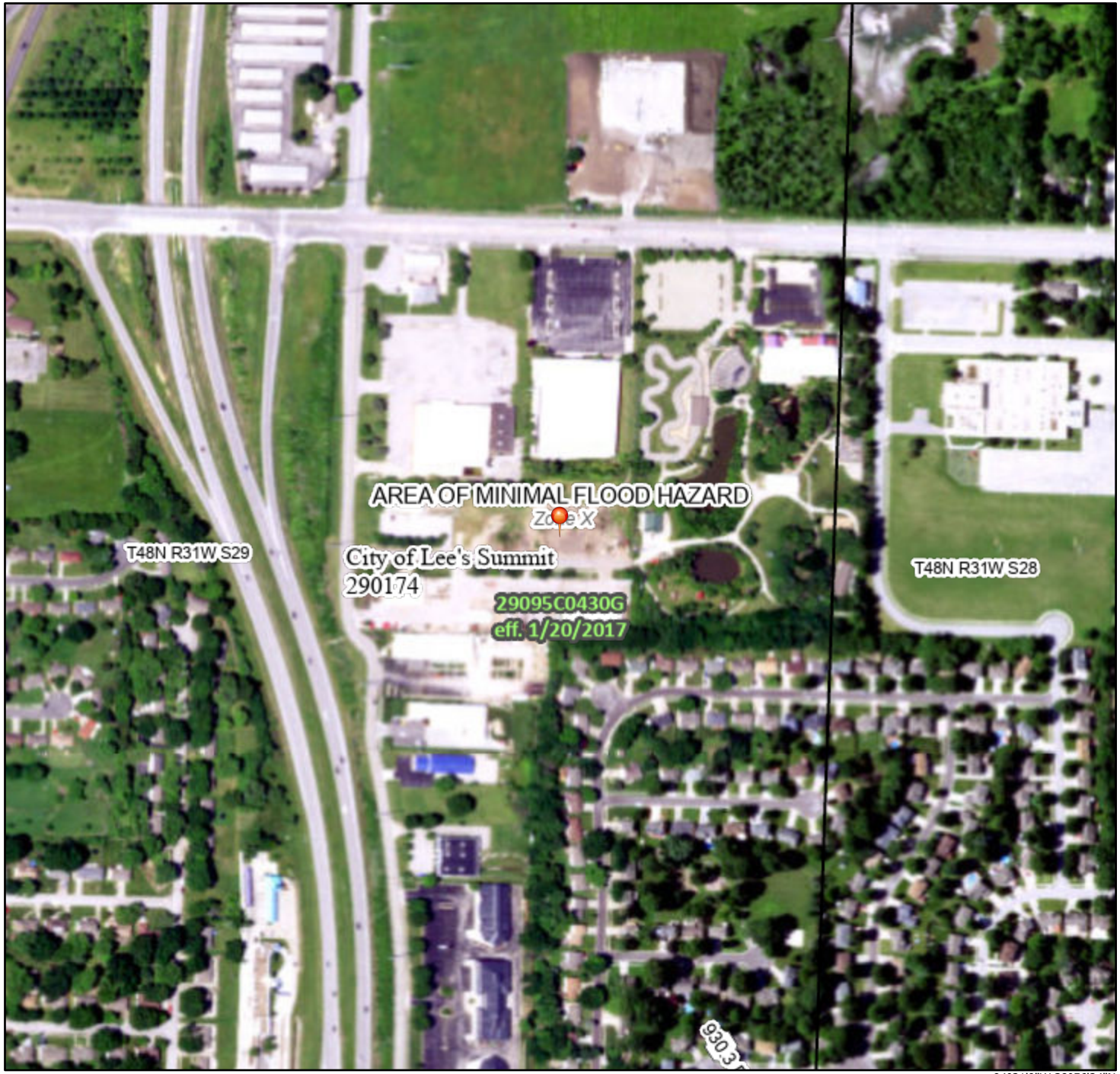
Exhibit B

FEMA FIRMette

National Flood Hazard Layer FIRMette

FEMA

94°21'46"W 38°56'52"N



94°21'9"W 38°56'24"N

Feet

0 250 500 1,000 1,500 2,000

1:6,000

Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN — Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 — Cross Sections with 1% Annual Chance
- 17.5 — Water Surface Elevation
- Coastal Transect
- Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 4/21/2022 at 5:45 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

Exhibit D

Existing Drainage Map

North

0 10' 20' 40'

EXISTING DRAINAGE MAP

SCALE: 1" = 20

POI W

POI E

POI S

W

E

S

NE Pollard Street

1 O.H. Doors

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Surveying 2005000319-D
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Engineering E-1695
Surveying LS-218
Oklahoma
Engineering 6254
Nebraska
Engineering CA2821

950 Pollard Street
LEE'S SUMMIT, JACKSON COUNTY, MISSOURI

Project: 950 Pollard
Issue Date: April 22, 2022

Existing Drainage Map
Preliminary Plans for:
950 Pollard Street
Lee's Summit, Jackson County, Missouri

Matthew J. Schlicht
MO PE 2006019708
KS PE 19071
OK PE 25226
NE PE E-14335

REVISIONS

Exhibit

Exhibit E

Composite Curve Number Calculations

950 NE POLLARD STREET
IMPERVIOUS AREA CALCUALTIONS

EXISTING	Area (ac.)	CN	Area x CN
Impervious Area	0.00	98	0
Pervious Area	1.31	74	96.94
Total Area	1.31		96.94
Composite CN	74		

PROPOSED	Area (ac.)	CN	Area x CN
Impervious Area	0.76	98	74.48
Pervious Area	0.55	74	40.7
Total Area	1.31		115.18
Composite CN	88		

Exhibit F

Time of Concentration Calculations

APWA STORM DRAINAGE "TC" COMPUTATIONS FOR : 950 NE POLLARD STREET

						Surface types:	Asph/Conc	Bus/Com	Dirt	Grass/Park	Lake	MultFam	SnglFam	Undev	Other							
		yellow areas are self computing				SURFACE CODES	A	B	D	G	L	M	S	U	Z							
		overwrite if necessary				"C" Values	0.90	0.87	0.60	0.30	0.90	0.66	0.51	0.3				TC COMPUTATION			
							Overwrite Length - DnElev or Slope				SURFACE	P=Paved		Overwrite Slope or Elevations							
			TOTAL WATERSHED				if necessary				CODE	U=Unpaved		if necessary			Cal	Used	Cal	Cal		
							OVERLAND FLOW - 100' MAX				P	CHANNEL FLOW - FIRST REACH					Overland	Min 5	Channel	Channel	Total	
AREA	TOTAL	TOTAL	WTRSHD	UP	DN	SURFACE	"C"	OVRLND	UP	DN	SLOPE	or	CHANNEL	UP	DN	SLOPE	VELOCITY	Flow	Max 15	One	Two		AREA
ID	SQ.FT.	ACRES	LENGTH	ELEV	ELEV	CODE	VALUE	LENGTH	ELEV	ELEV	%	U	LENGTH	ELEV	ELEV	%	F/S	T(I)	T(I)	T(T)	T(T)	T© 10	ID
EX.																							EX.
W	14594.93	0.34	149.39	989.65	980.95	U	0.30	100.0	989.7	987.00	2.6	U	49.4	987.0	981.0	12.25	5.6	10.4	10.4	0.1	0.0	10.6	W
S	7441.22	0.17	370.57	989.65	985.41	U	0.30	37.5	989.7	988.89	2.0	P	333.1	988.9	985.4	1.04	2.1	7.0	7.0	2.7	0.0	9.6	S
E	34961.40	0.80	333.07	989.05	980.00	U	0.30	100.0	989.1	985.85	3.2	U	233.1	985.9	980.0	2.51	2.6	9.8	9.8	1.5	0.0	11.3	E
PROP.																							PROP.
W	2328.19	0.05	44.67	988.00	984.00	U	0.30	44.7	988.0	984.00	9.0							4.6	5.0	0.0	0.0	5.0	W
S	5284.63	0.12	285.56	988.67	985.41	U	0.30	33.4	988.7	988.00	2.0	P	252.2	988.0	985.4	1.03	2.1	6.6	6.6	2.0	0.0	8.6	S
E	7058.56	0.16	429.50	988.00	980.00	U	0.30	87.0	988.0	985.00	3.4	U	342.5	985.0	980.0	1.46	1.9	8.9	8.9	2.9	0.0	11.8	E
E(1)	42319.93	0.97	446.50	988.25	980.00	Z	0.81	100.0	988.3	986.50	1.8	P	346.5	986.5	980.0	1.88	2.8	4.3	5.0	2.1	0.0	7.1	E(1)