MACRO STORM WATER DRAINAGE STUDY

OVATION
Multi-Family Development
SITE ACREAGE: 78.75 ACRES

Lee's Summit, MO

Prepared On:
1-26-2024

Prepared By:

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

Matthew J. Schlicht, PE

Revision

Date	Comment	By
2-16-2024	Revised Per City Comment	AEP
10-28-2024	Revised per New Usage	AEP

TABLE OF CONTENTS

3. GENERAL INFORMATION

The South LS Residential Development (Development) is a proposed mixed use single and multi-family residential development consisting of a combination of single family residences, duplex units, 4-plex units and apartment buildings to be constructed in multiple phases. The proposed development is located in the southern portion of the City just south of 150 Highway and 475 east of the east outer road of 291 Highway. The site is bounded by 150 Highway to the north, large lot single family residential to the east, Belmont Farms 1st Plat single-family residential development to the south, an open lot to the northwest and forthcoming Summit Creek Multi-family residential development to the southwest. The proposed development encompasses approximately 80 acres. The property is located in Section 8, Township 48N, Range 31 W, Lee's Summit, Jackson County, Missouri. The western portion of the property drains west to an unnamed branch of Tributary G1 to Lake Winnebago. The east portion drains south to an enclosed storm sewer system constructed with the Belmont Farms 1st Plat Development.

See Exhibit A for an aerial image of the proposed project site along with an aerial image of the watershed.

3.1 FEMA FLOODPLAIN DETERMINATION

The property is tributary to an Unnamed Branch of Tributary G1 and an enclosed storm system that outlets to Tributary G1 to Lake Winnebago. The site contains Areas of Minimal Flood Hazard, Zone X, according to FEMA Firm Map Numbers 29095C0551G, revised 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 23, September 1, 2021. The existing site contains three major soil types:

10000	Arisburg Silt Loam, 1 to 5 Percent Slopes Hydrologic Soil Group (HSG): Type C
10024	Greenton-Urban Land Complex, 5 to 9 Percent Slopes (HSG): Type D
30080	Greenton Silty Clay Loam, 5 to 9 Percent Slopes, Eroded (HSG): Type C/D

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

4. METHODOLOGY

This Macro Storm Drainage Study has been prepared to evaluate potential hydrologic impacts from the proposed development and recommend improvements to eliminate potential negative impacts downstream if anticipated. City contours were utilized to create the Existing Watershed Map, see Exhibit C. TR-55 was first introduced in 1975 by the SCS particularly for small urbanizing watersheds and has been utilized for this study per APWA 5602.2.B. The analysis contains results for the 2, 10 and 100-year design storms. This study conforms to KC Metro Area APWA Section 5600 requirements in addition to all other applicable codes and requirements of the City of Lee's Summit, Missouri.

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)

Time of Concentration has been calculated using the following formulas:

- Sheet Flow (Max. 100 LF): APWA Travel Time, $T_t = 1.8 \times (1.1 - C) \times (D^{0.5} / S^{0.33})$
  Sheet Flow Time: Minimum: 5 Minutes, Maximum: 15 Minutes
- 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, $T_t = L / V \times 60$
- 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 site is approximately 80.2 acres but will contain approximately 78.75 acres after right-of-way dedication for Highway 150. The site generally drains from the east to the southwest and consists of three sub-basins referred to as West, East and Southeast for the purposes of this report. The West Sub-basin encompasses the entire west side of the property and consists of good row crop land with some treed areas. The West sub-basin drains to the west via sheet and shallow concentrated flow where runoff is intercepted offsite by an Unnamed Tributary to Tributary G1 to Lake Winnebago. The West Sub-basin contains 32.38 acres which drain to POI W. The East Sub-basin encompasses nearly the entire east side of the property and consists of good pasture/row crop land with some treed areas. The East Sub-basin drains to the south via sheet, shallow concentrated and channel flow where runoff is intercepted and collected by an offsite enclosed storm sewer system. The East Sub-basin contains a total of 74.47 acres of which 45.86 acres are onsite. The East Sub-basin drains to POI E. The Southeast Sub-basin is a small sub-basin located in the southeast corner of the property. The sub-basin consists of good row crop land with some treed areas. The Southeast Sub-basin drains to the south via sheet flow where runoff is intercepted by the curb and gutter system located in Belmont Farms. The Southeast Sub-basin contains 0.64 acres and runoff will be accounted at POI SE. The Existing Drainage Map for the property may be found in Exhibit C.

The Existing Land Usage Map may be found in Exhibit D. A complete Hydraflow Report may be found in Exhibit E which contains both Existing and Proposed Hydrologic Data. The following table summarizes the results of the Existing Conditions Analysis.

Table 5.1 Existing Conditions Sub-basin & Hydrologic Data at the POI

Sub-basin	POI	Area (ac.)	CN	Tc (min.)	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
West	W	32.38	76	37.4	32.86	67.12	121.90
East	E	74.47	76	26.0	97.04	197.28	357.07
Comb W + E	W	106.85			129.90	264.40	478.97
Southeast	SE	0.64	76	10.0	1.40	2.77	4.94

The Southeast Sub-basin is a small peripheral area in the development and its drainage pattern will be unaffected by the proposed development with a negligible increase in runoff.

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

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

Allowable release rates are comprised of a combination of upstream offsite flows and allowable onsite post development peak flows at each point of interest. The following Table details allowable release rates at each Point of Interest.

Example Calculations:

Allowable Release Rate: POI E (2-Yr) = (Onsite East Sub-basin Area – Undeveloped Area) x 0.5 + (Offsite East Sub-basin Area / Total East Sub-basin Area) x Existing East Peak Discharge
Allowable Release Rate: POI E (2-Yr) = (45.86) x 0.5 + (28.61 / 74.47) x 97.04 = 60.21 cfs

Table 5.2 APWA Post Development Allowable Release Rates

POI	Total Area (ac.)	Onsite Area (ac.)	Offsite/Undev Area (ac.)	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
W	32.28	32.28	0	16.14	64.56	96.84
E1	74.47	45.86	28.61	60.21	167.51	274.76
Comb W + E1	106.75	78.14	28.61	76.35	232.07	371.60

POI W is located on an unnamed branch of Tributary G1 to Lake Winnebago. Runoff at POI W will meander along the unnamed branch to Tributary G1 where it will be combined with runoff from POI E1. The combined W + E1 peak discharge rates will be compared against existing and allowable peak discharge rates to confirm any potential adverse impacts have been mitigated.

6. PROPOSED CONDITIONS ANALYSIS

The proposed mixed use single and multi-family development is to consist of single family residences, duplexes, 4-plexes and apartment buildings. See Proposed Drainage Map, Exhibit H for a depiction of the development at full buildout. The north half will consist of multi-family and the south half will contain single family residences. The proposed Development was divided into three sub-basins W, E1 and SE corresponding to their geographic location. The SE sub-basin is a small peripheral basin that will no longer be discussed as stated earlier in the report. The W sub-basin is located along the west edge of the property and will be released to an unnamed branch of Tributary G1 to Lake Winnebago. The E1 sub-basin will contain the majority of the hard infrastructure improvements in addition to all of the offsite area to the east. The E1 sub-basin will utilize a retention pond to attenuate runoff for the development. Post attenuation runoff from POI E1 will be conveyed via a new enclosed storm sewer system running along the south property line before being released into Tributary G1 where it will be combined with Sub-basin W.

The Proposed Drainage Map for the property may be found in Exhibit F. The Proposed Land Usage Map may be found in Exhibit G. The following table summarizes the results of the Proposed Conditions Analysis.

Table 6-1 Proposed Conditions Sub-basin & Hydrologic Data at the POI for the Proposed Development

Sub-basin/POI	Area (ac.)	CCN	Tc (min.)	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
West, W	18.72	85	35.4	31.00	54.35	89.13
East 1, E1	88.02	82	25.1	159.65	292.15	492.80
Comb W + E1				190.65	346.50	581.93

As shown in Table 6.1 above the proposed peak discharge rates for Combined W + E1 will be significantly greater than allowable. The E1 (East 1) Sub-basin will require retention to attenuate proposed peak discharge rates below both Existing Conditions and Allowable at the Combined E + W POI.

6.1. RETENTION

A new single stage earthen retention basin is being proposed in Sub-basin E1 to attenuate proposed peak discharge rates. Following are a list of design parameters for the retention system.

Designation: Retention Basin E1
Type: Earthen Basin
Side Slopes: 3:1 Max.
Bottom Slope: Flat
Basin Bottom Elevation: 950.00
Permanent Pool Elevation: 958.00
Basin Top Berm Elevation: 972.00
Basin Detention Volume: 916,584 cf from 958 to 972
Control Structure: 10'x8' Box w/ Interior Baffle Wall
Orifices: (1) 4.5" Diameter, FL=957.90, (1) 12"Rx120"S, Crest El=963.00
Weir: Peripheral Weir, Crest EL=965.67
Effluent Pipe: 60" HDPE, FL (In) = 958.00, FL (Out) = TBD, S=0.30%
Emergency Overflow: 55'L x 4'W, 3' to 10' Deep, Crest Elevation=970.00, Crest Length Total =118 LF
Calculations do not include Control Structure Periphery Weir
Consecutive 100-YR Q=492.80 cfs, Emergency Spillway HGL=971.00, Freeboard=1.00'
Sediment Storage Required: 5-Year Accumulated per APWA Figure 5608-1 = 100 x 88 x 5 = 44,000 cf
Sediment Storage Provided: (27,156 cf + 30,280 cf)/2 x 2' = 57,436 cf @ El= 952.00

The permanent pool shall be 6' deep with 2'of sedimentation allowance. The pond will not support fish which requires a minimum 10' of depth plus sedimentation allowance. The Retention Basin Plan may be found in Exhibit H. Basin E1 emergency overflow calculations may be found in Exhibit I. See Table 6.2 below for a summary of retention basin data.

Table 6.2 Proposed Conditions Retention Basin E1 Data

	Peak Q In (cfs)	Tp In (min.)	Peak Q Out (cfs)	Tp Out (min)	Peak W.S.E.	Max. Storage Vol. (cf)
Basin E1						
2-Year	159.65	728	23.21	766	963.75	303,687
10-Year	292.15	728	123.09	746	966.31	470,276
100-Year	492.80	728	270.98	742	969.00	667,260

As shown in the table above all proposed peak flowrates have been attenuated. See Table 6.3 below for a summary of proposed peak discharge rates at POI W + E1. Hydrographs tributary to the POI have been combined to determine subsequent peak discharge rates.

Table 6.3 Proposed Conditions Post Retention Point of Interest Peak Discharge Rates

Point of Interest	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
E	38.15	166.09	354.22

As shown in the above Table all peak discharge rates attributable to the East POI have been attenuated below both Existing and Allowable Peak Discharge rates as outlined in Table 5.2 and Table 5.3 respectively.

Table 6.4 below provides a comparison of runoff data between Proposed, Existing and Allowable Conditions for the Proposed Development.

Table 6.4 Point of Interest Discharge Comparison

POI	Condition	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
Combined W + E1	Proposed	38.15	166.09	354.22
	Existing	129.90	264.40	478.97
	Difference	-91.75	-98.31	-124.75
	Allowable	76.35	232.07	371.60
	Difference	-38.20	-65.98	-17.38

Peak discharge rates at the Combined W + E1 POI in Tributary G1 for the proposed Development will be reduced below both Existing and Allowable Peak Discharge Rates for all regulatory design storms.

7. 40 HOUR EXTENDED DETENTION

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 retention facility will release the water quality event over a period of 40-72 hours. See Exhibit K for Retention Basin E1 extended detention calculations. The Water Quality Volume is anticipated to be released in approximately 40+ hours from Basin E1.

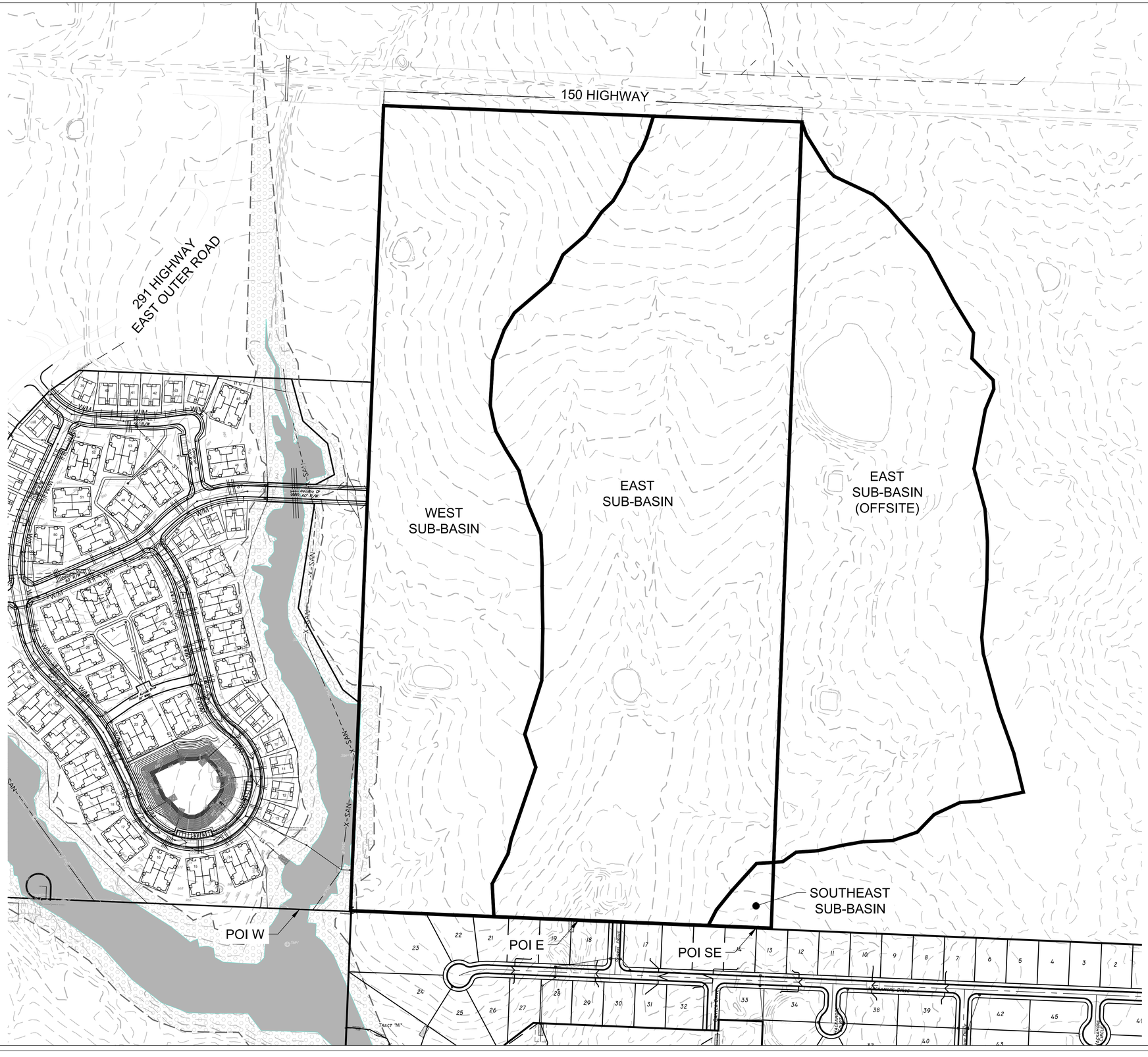
8. CONCLUSIONS & RECOMMENDATIONS

This macro storm water drainage study reveals that the Proposed Multi-Family Development consisting of 78.78 acres will not increase the peak discharge rate at the POI. The proposed peak discharge rates will be reduced below both Existing and Allowable peak discharge rates for all regulatory design storms. No additional negative impacts are anticipated downstream due to the proposed development.

In conclusion, no increase in peak discharge nor water surface elevation is anticipated downstream of the proposed development. A retention system will be employed in the E1 (East 1) Sub-basin to help attenuate Proposed Peak Discharge Rates below both Existing and Allowable. The retention basin will not only help alleviate any potential hydrologic/hydraulic issues downstream but it will also provide the community with a tranquil site amenity. No negative impacts are anticipated downstream due to the proposed development. We recommend standard enclosed storm sewer conveyance systems for the development. The study is in conformance with all applicable City of Lee’s Summit standards and criteria.

Waiver Requests:

1) N/A



North

0 75' 150' 300'

EXISTING DRAINAGE MAP

SCALE: 1" = 150'

ENGINEERING SOLUTIONS
ENGINEERING & SURVEYING
50 SE 30TH STREET
LEE'S SUMMIT, MO 64082
P:(816) 623-9888 F:(816)623-9849

Professional Registration
Missouri
Engineering 2005002186-D
Surveying 2005000319-D
Kansas
Engineering E-1695
Surveying LS-218
Oklahoma
Engineering 6254
Nebraska
Engineering CA2821

LS Development
LEE'S SUMMIT, JACKSON COUNTY, MISSOURI

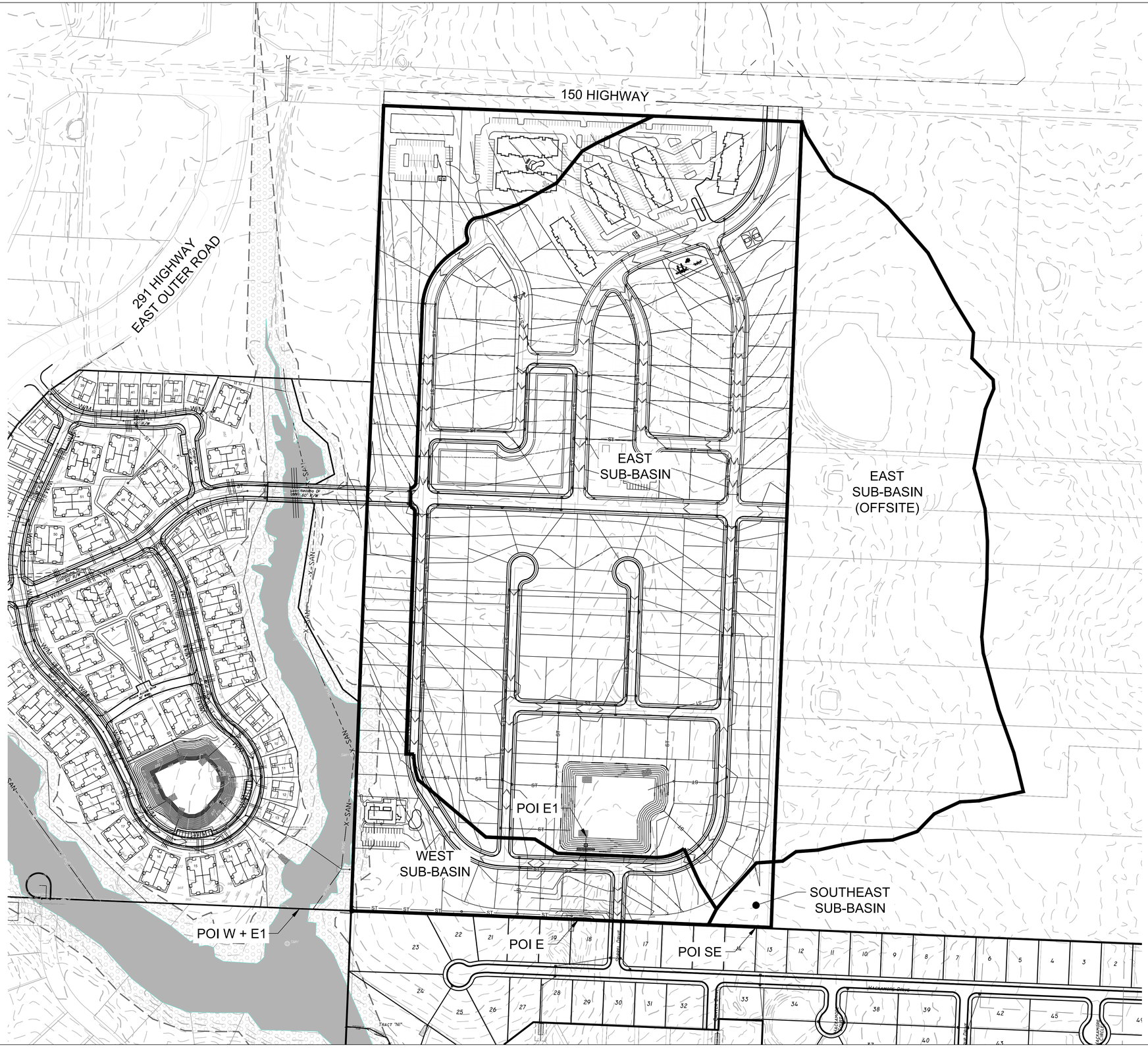
Project: South LS Residential
Issue Date: May 13, 2022

Existing Drainage Map
Construction Plans for:
South LS Residential
Lee's Summit, Jackson County, Missouri

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

REVISIONS

EXHIBIT



North

0 75' 150' 300'

PROPOSED DRAINAGE MAP

SCALE: 1" = 150'

ENGINEERING SOLUTIONS
ENGINEERING & SURVEYING
50 SE 30TH STREET
LEE'S SUMMIT, MO 64082
P:(816) 623-9888 F:(816)623-9849

Professional Registration
Missouri
Engineering 2005002186-D
Surveying 2005000319-D
Kansas
Engineering E-1695
Surveying LS-218
Oklahoma
Engineering 6254
Nebraska
Engineering CA2821

LS Development
LEE'S SUMMIT, JACKSON COUNTY, MISSOURI

Project: South LS Residential
Issue Date: May 13, 2022

Proposed Drainage Map
Construction Plans for:
South LS Residential
Lee's Summit, Jackson County, Missouri

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

REVISIONS

EXHIBIT