

MACRO STORM WATER DRAINAGE STUDY

The Townhomes of Chapel Ridge – 2nd Plat

Lots 9 - 30

The Estates of Chapel Ridge – 2nd Plat

Lots 23 – 31

SITE ACREAGE: 18.37 ACRES

Lee's Summit, MO

PREPARED BY:



Submittal Date: October 11, 2019



Matthew J. Schlicht, PE

Revision

Date	Comment	By
11-12-19	Revised Study Per City Comments	AEP

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Development Services

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3. GENERAL INFORMATION

This storm study has been prepared to evaluate the potential impacts of the revised Development Plan for The Estates of Chapel Ridge 2nd Plat and the Townhome of Chapel Ridge 2nd Plat. The previous Development Plan for this area consisted of 31 Estate style lots and 5 Townhome style lots, while the proposed Development Plan will provide 9 Estate style lots and 22 Townhome style lots. The existing retention facility that was constructed with the first phase will be utilized to serve as the storm water controls for the previously studied Development Plan. The existing Phase I drainage map and storm tables are provided as Exhibit "A" within the appendix of this report. The amount of offsite drainage area that was designed to be conveyed into the existing retention facility is shown in blue on both the Pre and Post Development Drainage Area Maps.

3.1 FEMA FLOODPLAIN DETERMINATION

The property is located in an Area of Minimal Flood Hazard, Zone X, according to FEMA Firm Map Number 29093C0430G, effective 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 18, September 16, 2017. The existing site contains five major soil types:

- 10024 Greenton-Urban Land Complex, 5 to 9 Percent Slopes
Hydrologic Soils Group (HSG): Type D
- 10129 Sharpsburg-Urban Land Complex, 5 to 9 Percent Slopes
(HSG): Type D
- 10136 Sibley-Urban Land Complex, 2 to 5 Percent Slopes
(HSG): Type C
- 10143 Snead-Urban Land Complex, 9 to 30 Percent Slopes
(HSG): Type D
- 10183 Udarents-Urban Land Polo-Complex, 5 to 9 Percent Slopes
(HSG): Type C

See Exhibit C 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. The study utilized existing city contours to create the Pre-Development 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 SCS Methods to calculate storm runoff volumes, peak rates of discharge, pre and post developed hydrographs and required storage volumes for detention facilities. The analysis contains results for the 2, 10 and 100-year design storms.

5. EXISTING CONDITIONS ANALYSIS

The site has four (4) drainage Subareas all consisting of meadow land that drain offsite with the following drainage patterns.

- Subarea A, 2.79 acres, drains to the Northwest and drains into an existing swale that conveys the storm water to an existing road crossing pipe that is located west of the development. Subarea A will be evaluated at Point of Interest A
- Subarea B, 5.76 acres, drains to the north and through an existing residential development area. Subarea B drains to a large swale area to the north for the purposes of this report the subarea will be evaluated at Point of Interest B. No flooding concerns have been raised downstream therefore the evaluation will focus solely on the land that is being proposed for development.
- Subarea C, 6.64 acres, drains to the Northeast and drains into an existing road side ditch channel for the old highway outer road that is no longer in use. A sizeable portion of the subarea consists of offsite property. Subarea C will be evaluated at the offsite roadside ditch known as Point of Interest C. See Exhibit D for details and calculations of composite curve numbers as required.
- Subarea D, 4.92 acres, drains to the southwest where it is intercepted and attenuated by the Phase I retention system.

A Pre-Development Drainage Map may be found in Exhibit E. Hydraflow Hydrograph software was utilized to calculate SCS Method peak discharge rates. A complete breakdown of Existing and Proposed hydrographs may be found in Exhibit F. The following tables summarize the results of the Existing Conditions analysis.

Table 5.1 Existing Conditions Subarea

Subarea	Area (ac.)	Curve Number	Tc (min)
A	2.79	74	11.9
B	5.76	74	12.5
C	6.64	76	10.1
D*	4.92		

*Subarea D consisting entirely of Proposed Phase II Development drains to the Existing Chapel Ridge Phase I Retention System. The Existing Chapel Ridge Phase I Retention System was designed to accept and convey 11.10 acres of the Chapel Ridge Phase II Development.

Table 5.2 Existing Conditions Runoff Data: Peak Discharge Rates

Subarea	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
A	4.80	9.96	18.26
B	9.90	20.57	37.70
C	13.75	27.40	48.96

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

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

Allowable release rates are comprised of a combination of peak offsite flows and allowable onsite post development peak flows at each point of interest. The area ratio method will be used to determine allowable release rates.

Allowable Release Example Calculation: Subarea C (2-Yr) = $4.90 \times 0.5 + 1.74 / 6.64 \times 13.75 = 6.05$ cfs

Table 5.3 Existing Conditions APWA Allowable Peak Discharge Release Rates

Subarea	Onsite Area (ac.)	Offsite Area (ac.)	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
A	2.79	0.003	1.40	2.80	8.39
B	5.76	0	2.88	11.52	17.28
C	4.90	1.74	6.05	16.98	27.53

6. PROPOSED CONDITIONS ANALYSIS

The Proposed Conditions analysis assumes completion of all new estate and townhome construction. The difference between Existing and Proposed Conditions is a direct result of new residential single and multi-family housing. Subareas A and B have been reduced significantly due to redirection of their tributary areas with the use of new streets and storm sewer systems. Subarea C increased slightly. A new detention system shall be used to attenuate post development runoff tributary to Point of Interest C. Subarea D represents area tributary to the Phase I retention system. A Post Development Drainage Map may be found in Exhibit G.

Post-Development Flow Rates

The post development flow rates were calculated with the use of composite curve numbers as applicable. The curve numbers were determined based on APWA Table 5602-3 for residential lots and multi-family lots. A curve number of 88 was used for multi-family areas and a curve number of 82 was used for single family areas.

Table 6.1 Proposed Conditions Subarea Data

Subarea	Area (ac.)	Composite CN	Tc (min)
A	0.83	88	9.8
B	1.60	88	7.3
C	2.98	85	10.1
C1	3.87	86	8.7
D*	10.84		

*Subarea D consisting entirely of Proposed Phase II Development contains 10.84 acres and drains to the Existing Chapel Ridge Phase I Retention System. The Existing Chapel Ridge Phase I Retention System was designed to accept and convey 11.10 acres of the Chapel Ridge Phase II Development. Subarea D will also contain 0.86 acres of Green Space which was not originally anticipated during the Phase I design of the Retention System (See Exhibit A). Conclusion Proposed Subarea D acreage is below that which was originally anticipated during the design of the Phase I Retention System therefore no adverse impacts are anticipated downstream due to the development of this Subarea. No further analysis will be provided for Subarea D.

Table 6.2 Proposed Conditions Runoff Data: Sub-Area Peak Discharge Rates

Subarea	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
A	2.97	4.92	7.76
B	5.94	9.82	15.49
C	9.14	15.82	25.68
C1	12.91	21.97	35.29

As shown in Table 6.2 above Subarea C1 will require detention to attenuate peak discharge rates below both Existing Conditions and Allowable.

6.1. DETENTION

A new earthen detention basin is being proposed in Sub-basin C1 to attenuate peak discharge rates. The basin shall be grass lined with maximum side slopes of 3:1 and a minimum bottom slope of 2%. The bottom elevation is 930.00 at the 30" HDPE inlet pipe. The top of berm elevation is 940.00. The basin has a maximum storage volume of 73,312 cubic feet. The outlet structure will consist of a 4' wide by 5' deep rectangular concrete box structure with 6" interior weir wall. Six (6) orifices will be placed in the weir wall. Five (5) 1" diameter orifices shall be placed in the wall to release the water quality storm event over a minimum 40 hour timeframe. The first orifice shall be placed at the control structure flowline elevation 929.40. The remaining four (4) water quality control orifices shall be placed on 4" centers for a total height of 1.42 feet. A 6" diameter orifice at elevation 936.00 will be utilized to attenuate the remaining storm events. The interior weir wall crest elevation shall be 938.55. The top of the structure shall be at 939.55. The control structure shall have three (3) 6" openings positioned on the northwest, southwest and southeast sides of the box. The effective crest length for the emergency spillway rectangular weir on the outlet control structure shall be 8.5'. The control structure outlet pipe shall be a 30" HDPE at 3.00% slope. The Detention Basin Plan may be found in Exhibit H.

An emergency spillway consisting of a 50 linear foot broad crested weir shall be located along the eastern berm of Detention Basin C1. The crest elevation for the broad crested weir shall be 938.55 which is more than 6 inches higher than the 100-yr water surface elevation of 938.02. The emergency spillway was analyzed to determine both flowrate and hydraulic grade line of the consecutive 100-yr storm event assuming the primary outlet structure is 100% plugged and there is zero available storage in the basin. The earthen broad crested weir will work in conjunction with the rectangular weir on the outlet control structure to convey the 100 year peak discharge of 35.29 cfs. To be conservative the control structure overflow weir was not included in the emergency spillway calculations. A freeboard of 1-foot is required from the spillway HGL to the top of berm. The proposed bypass HGL is 938.97 allowing 1.03 feet of freeboard to the top of basin. The maximum velocity from the earthen weir is 1.68 feet per second which may be turf lined. Basin C1 emergency spillway calculations may be found in Exhibit I. See Table 6.3 for a summary of detention basin data.

Table 6.3 Proposed Conditions Detention Basin C1 Data

	Peak Q In (cfs)	Tp In (min.)	Peak Q Out (cfs)	Tp Out (min)	Peak W.S.E.	Max. Storage Vol. (cf)
Basin C1						
2-Year	12.91	719	0.59	807	934.51	16,783
10-Year	21.97	719	1.12	788	936.24	29,908
100-Year	35.29	719	2.66	732	938.02	47,717

As shown in the table above all proposed peak flowrates have been attenuated. See Table 6.4 below for a summary of proposed peak discharge rates at point of interest C. Hydrographs tributary to each point of interest have been combined to determine subsequent peak discharge rates.

Table 6.4 Proposed Conditions Post Detention Point of Interest Peak Discharge Rates

Point of Interest	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
C	9.53	16.48	27.36

As shown in the above table all peak discharge rates attributable to Subareas C & C1 improvements have been attenuated below Existing Peak Discharge rates as outlined in Table 5.2.

Table 6.5 below provides a comparison of runoff data between Proposed, Existing and Allowable Conditions for the Proposed Phase II Development.

Table 6.5 Point of Interest Discharge Comparison

		Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
Point A	Proposed	2.97	4.92	7.76
	Existing	4.80	9.96	18.26
	Difference	-1.83	-5.04	-10.50
	Allowable	1.40	2.80	8.39
	Difference	1.57	2.12	-0.63
Point B	Proposed	5.94	9.82	15.49
	Existing	9.90	20.57	37.70
	Difference	-3.96	-10.75	-22.21
	Allowable	2.88	11.52	17.28
	Difference	3.06	-1.70	-1.79
Point C	Proposed	9.53	16.48	27.36
	Existing	13.75	27.40	48.96
	Difference	-4.22	-10.92	-21.60
	Allowable	6.05	16.98	27.53
	Difference	3.48	-0.50	-0.17

Peak discharge rates at Point A will be reduced below Existing Conditions for all design storms analyzed in addition to the 100-yr Allowable. The 2 and 10-yr Allowable Peak Discharge rates will not be met for this subarea however the tributary area consisting of three (3) estate lots and a portion of common area is minor being easily drained with good lot grading practices. Peak discharge rates at Point B will be reduced below Existing Conditions for all design storms analyzed in addition to the 10 and 100-yr Allowable. The 2-yr discharge is minor in comparison to other events and will be sufficiently conveyed downstream via existing drainage elements. Peak discharge rates at Point C will be reduced below Existing Conditions for all design storms analyzed in addition to the 10 and 100-yr Allowable. The 2-yr discharge is minor in comparison and will be sufficiently conveyed via existing drainage elements downstream.

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 detention facility will release the water quality event over a period of 40-72 hours. See Exhibit J for Detention Basin C1 extended detention calculations. The Water Quality Volume is released in approximately 40 hours from Basin C1.

8. CONCLUSIONS & RECOMMENDATIONS

Runoff from the proposed development will be reduced below existing for all subareas. A detention basin will be provided in Subarea C1 to attenuate peak discharge rates at Point of Interest C. Tributary area for Subarea D is below the original design for Phase I retention. No negative impacts are anticipated downstream from the proposed development. Allowable release rates which are peak discharge rate goals will not be met for the 2-yr storm for each subarea and the 10-yr storm for Subarea A. However as previously stated the downstream drainage system and property will not be adversely affected but overall storm drainage for the subarea will be improved by redirection of drainage and the construction of a detention basin. Engineering Solutions recommends approval of this macro storm water drainage study.

Waiver Requests:

A (2-Yr), (10-Yr) Allowable

B (2-Yr) Allowable

C (2-Yr) Allowable