

MACRO STORM WATER DRAINAGE STUDY

CULVER'S

Site Acreage: 3.44 Acres

1275 SE Oldham Parkway
Lee's Summit, MO

PREPARED BY:



Revision

Date	Comment	By
1-6-20	Revised Per City Comments	AEP

Matthew J. Schlicht, PE

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3. GENERAL INFORMATION

This storm study has been prepared to evaluate potential hydrologic impacts related to the proposed development and recommend improvements designed to mitigate any anticipated negative impacts. The proposed development will consist of a Culver's fast food restaurant in addition to a dedicated detention tract along with a second commercial lot for future development. The proposed development is located in the southwest quadrant of the intersection of SE Ranson Road and SE Oldham Parkway. The property is more particularly described as, "All of Lot 2, First Federal Bank Commercial Park, a subdivision as recorded in the Office of the Recorder, Jackson County, Missouri." The Culver's tract will be constructed first and consist of a restaurant, parking lot, drive aisles and associated utility infrastructure. The detention tract will also be developed in the initial phase of construction and provide adequate capacity to serve the future commercial lot which lies to the east. The development is bounded by First Federal Bank to the west, SE Oldham Parkway to the north, SE Ranson Road to the east and Oak Hill Estates a single family residential subdivision to the south. A significant portion of Oak Hill Estates drains through the proposed development via a drainage ditch where it is captured by a culvert and conveyed to the north under SE Oldham Parkway. Oak Hill Estates runoff will not be attenuated but will be routed through the proposed detention basin prior to conveyance downstream. See Exhibit A for an aerial image of the proposed project site along with an aerial image of the surrounding area. The development consists of approximately 3.44 acres+/- . The site is located in the SE 1/4 of Section 9, Township 47N, Range 31W, 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 29095C0439G, 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 20, September 16, 2019. The existing site contains one major soil types:

10082 Arisburg-Urban Land Complex, 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

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 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)

Time of Concentration has been calculated using the following formulas:

- Sheet Flow (Max. 100 LF): APWA 5602.5 Time Inlet, $T_1 = 1.8 * (1.1-C) * L^{1/2} / S^{1/3}$
- 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, $T_t = L / V * 60$

- Channel Flow Improved: Manning’s Equation (Full Flow)
Channel Flow Unimproved: APWA 5602.7.A. Travel Time, Table 5602-6

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

5. EXISTING CONDITIONS ANALYSIS

The existing site consists entirely of a turf field with a few trees lining an existing drainage ditch. The site contains two sub-basins referred to as Sub-basin A and Sub-basin B for the purposes of this report. Each Sub-basin drains to a Point of Interest which corresponds to its given sub-basin drainage area, i.e., Sub-basin A drains to Point of Interest A. Oak Hill Subdivision upstream has a small portion of property, 6.72 acres, which drains through the site via a drainage ditch. The Existing Drainage Area Map is located in Exhibit D. Following is a brief description of each sub-basin.

Sub-basin A is generally located on the west side of the property and discharges to the north via sheet and shallow concentrated flow. The drainage runs through First Federal Bank then onto a series of drainage culverts and grass lined ditches along Oldham Parkway. The sub-basin consists of 1.10 total acres all of which are onsite. Sub-basin A consists of a turf field which sheet flows onto the First Federal Bank Lot therefore, Point of Interest A will actually be a boundary in lieu of a specific discharge point. There is no advantage to analyzing flows downstream of our property in this case since the majority of runoff developed in Sub-basin A will be captured by a new enclosed storm sewer system and conveyed to the proposed detention basin.

Sub-basin B is generally located in the central and eastern portions of the property and discharges to a culvert running under Oldham Parkway. The discharge point is labeled as Point of Interest B. The sub-basin consists of turfed are and contains 2.34 acres. Sub-basin B contains the majority of the proposed development.

Oak Hill Sub-basin is part of a single family residential subdivision located to the south of the property and discharges via a flared end section to a drainage channel running through the central portion of the property. The sub-basin consists of 6.72 acres. The sub-basin is not currently detained. Runoff from the sub-basin will be routed through the proposed detention basin but will not be attenuated. The Point of Interest for this sub-basin will be at the exit of the flared end section.

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.)	Composite CN	Tc (min.)
Oak Hill	6.72*	82**	15.00*
A	1.10	75	10.30
B	2.34	74	11.60

*Taken from Oak Hill 2nd Plat As-Built Drainage Map, Exhibit H.

**APWA CN for Single Family Residential Subdivisions.

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

Sub-basin	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
Oak Hill	16.18	29.34	49.18
A	2.16	4.39	7.94
B	4.37	9.03	16.53
Oak Hill + B	20.43	38.11	65.35

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 each point of interest except for the Oak Hill Sub-basin which will not be detained but routed through Sub-basin B.

Allowable Release Example Calculations:

Sub-basin A (2-Yr): $(1.10 \times 0.5) = 0.55 \text{ cfs}$

Sub-basin B (2-Yr): $16.18 + (2.34 \times 0.5) = 17.35 \text{ cfs}$

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

Sub-basin	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
A	0.55	2.20	3.30
B	17.35	34.02	56.20

6. PROPOSED CONDITIONS ANALYSIS

A small area along the western property line, Sub-basin A, will continue to sheet flow from the property and onto the First Federal Bank Lot. The majority of the property, Sub-basin B1, will be drained to POI B a culvert located under Oldham Parkway. The Oak Hill Sub-basin will be routed through the property. The sub-basin does not actively employ detention measures nor will it be required to. The Oak Hill Sub-basin will be combined with Proposed Sub-basins B and B1 in order to determine if proposed peak flows are below allowable peak flows for Sub-basin B outlined in Table 5-3. A small portion of the property in the north, Sub-basin B, will not be captured by the proposed detention basin and will continue to drain offsite as it currently does. Sub-basins tributary to points of interest A, B and B1 will be analyzed in the proposed conditions analysis to ensure no negative impacts are developed downstream due to the new development. The Proposed Drainage Area Map is located in Exhibit I.

Table 6-1 Proposed Conditions Sub-basin Data

Sub-basin	Area (ac.)	Composite CN	Tc (min.)
A	0.22	81	5.00
B	0.40	74	5.70
B1	2.82	90	6.20

Oak Hill	6.72	82	15.00
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Table 6-2 Proposed Conditions Sub-basin/Point of Interest Peak Discharge Rates

Sub-basin	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
A	0.70	1.26	2.13
B	0.23	0.47	0.85
B1	12.26	19.76	30.65
Oak Hill + B + B1	26.40	45.96	75.22

As shown above in Table 6-2 Sub-basin (Oak Hill + B + B1) will require detention to attenuate peak discharge rates below Allowable Release Rates as shown in Table 5-3 for Sub-basin/POI B. The Oak Hill Sub-basin was broken out in this project for ease of tracking offsite contributions. The 2-yr runoff from Sub-basin A will be slightly above allowable however the peak discharge is well below existing conditions. A waiver will be requested for Sub-basin A, 2-yr allowable release rate.

6.1 DETENTION

A new single stage earthen detention basin is being proposed in Sub-basin B1 to attenuate proposed peak discharge rates. Following are a list of design parameters for the detention system.

Designation: Detention Basin B1

Type: Earthen Basin

Side Slopes: 3:1 Max.

Bottom Slope: 2% Min., Turf Lined

Basin Bottom Elevation: 1021.79 @ Influent Pipe

Basin Top Berm Elevation: 1028.00

Basin Volume: 71,685 cf @ 1028.00

Control Structure: 5'x5' deep precast concrete box, with interior 6" baffle wall

Baffle Wall Orifices: (1) 31.2" High x 27" Wide Rectangular, FL=1021.40

Weir Crest EL=1024.00, Crest Length 5'-0"

Baffle Wall Crest Elevation: 1024.00

Control Structure Top Elevation: 1027.40

Control Structure Overflow Weir Openings: Front & Both Sides, Effective Length=14.5', FL=1026.40

Control Structure Influent Pipe: 30" HDPE, FL (In) = 1021.79, FL (Out) = 1021.50, L=20.00', S=1.45%

Control Structure Effluent Pipe: 36" HDPE, FL (In) = 1021.30, FL (Out) = 1021.10, L=28.00', S=0.70%

Emergency Spillway: Earthen Broad Crested Weir, Crest Elevation=1026.40, Crest Length=50'

Consecutive 100-YR Q=74.42 cfs (B1 + Oak Hill), Emergency Spillway HGL=1026.98, Freeboard=1.02'

Emergency Spillway: Q=57.35 cfs

Control Structure Overflow: Q=17.07 cfs

The Detention Basin Plan is located in Exhibit J. 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 C1						
2-Year	26.18	719	17.01	726	1024.03	9,466
10-Year	45.52	719	29.99	726	1024.95	20,104
100-Year	74.42	719	49.77	726	1025.87	33,913

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 B. 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)
B	17.29	30.44	50.67

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.

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

		Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
Point A	Proposed	0.70	1.26	2.13
	Existing	2.16	4.39	7.94
	Difference	-1.46	-3.13	-5.81
	Allowable	0.55	2.20	3.30
	Difference	0.15	-0.94	-1.17
Point B	Proposed	17.29	30.44	50.67
	Existing	20.43	38.11	65.35
	Difference	-3.14	-7.67	-14.68
	Allowable	17.35	34.02	56.20
	Difference	-0.06	-3.58	-5.53

Peak discharge rates at Point A will be reduced below allowable for all design storms analyzed except the 2-yr. A waiver will be requested for this event since the proposed is well below existing. Peak discharge rates for Point B will be reduced below allowable for all storm events.

7. 40 HOUR EXTENDED DETENTION/INFILTRATION BMP

The large quantity of runoff contributing from Oak Hill Estates makes 40 hour extended detention unfeasible for the proposed development due to the existing geography and surrounding storm sewer systems. An infiltration type BMP is being proposed as an alternative to extended detention. The BMP will consist of 3,930 sf of 2.5' thick amended soil placed in the detention basin from the inlet to the 1023 contour. See the detention basin plan for proposed amended soil placement and details. See Exhibit K for infiltration calculations.

8. CONCLUSIONS & RECOMMENDATIONS

This macro storm water drainage study reveals 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 along with a potential future commercial development.

In conclusion, proposed peak discharge rates for each point of interest are below allowable release rates except for the 2-year at Point A which is negligible. A waiver is requested for this exception to the standard requirements. The study is in conformance with all applicable City of Lee's Summit standards and criteria therefore Engineering Solutions recommends approval of this macro storm water drainage study.

Waivers:

- POI A, Allowable 2-Yr