

OSAGE DEVELOPMENT PRELIMINARY STORMWATER DRAINAGE STUDY

Prepared for:

Clayton Properties Group, Inc. DBA Summit Homes
120 SE 30th Street
Lee's Summit, MO 64082



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Appendix B:	Existing Conditions Hydraflow Hydrographs Model Input and Results
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1.0 GENERAL INFORMATION

Osage is a proposed single-family residential development on approximately 36 acres, including a pool, amenity tract reserved for open space, and stormwater detention basin. This project is located in the southwest of the intersection of NW Pryor Road and Highway 150 in Lee's Summit, Missouri



Figure 1. Location Map

1.1 FEMA Floodplain Classification

FEMA Flood Boundary and Floodway Map Community Panel Number 29095C0531G classifies the Osage property as unshaded “Zone X” Area, which FEMA defines as an area of minimal flood hazard, usually above the 500-year flood level. See Exhibit 1—Floodplain Map in Appendix A for location of site in relation to FEMA flood boundaries.

1.2 Soil Classifications

Soil Maps published on the NRCS Web Soil Survey categorize soils on the Osage property as shown in Table 1. See Exhibit 2 in Appendix A for a map of soils on the property.

Table 1. Soil Classifications

Symbol	Name	Slopes	HSG
10082	Arisburg-Urban Land Complex	1-5%	C
10116	Sampsel Silty Clay Loam	2-5%	C/D
10117	Sampsel Silty Clay Loam	5-9%	C/D
10122	Sharpsburg Silt Loam	5-9%	C

2.0 METHODOLOGY

This drainage study has been prepared to evaluate the hydrologic impact generated by development of Osage. The base data for the models prepared for this report has been obtained from available online maps and aerial imagery. Stormwater management is based upon methods and objectives defined in “Kansas City Metropolitan Chapter American Public Works Association (KC-APWA) Section 5600 Storm Drainage Systems & Facilities” (2011).

The following methods were used in this study to model Existing and Proposed Conditions for stormwater runoff:

Hydraflow Hydrographs Extension Version 12

- SCS Unit Hydrograph Method
 - 2-year, 10-year and 100-year Return Frequency Storms
 - AMC II Soil Moisture Conditions
 - 24-Hour SCS Type II Rainfall Distribution
 - SCS Runoff Curve Numbers per SCS TR-55 (Tables 2-2a – 2-2c)
 - SCS TR-55 methods for determination of Time of Concentration and Travel Time. Where specific data pertaining to channel geometry is not available, “Length & Velocity” estimates for channel flow Travel Time is utilized per Section 5600, KC-APWA Standard Specifications and Design Criteria.

Stormwater runoff models were created for the 2-, 10- and 100-year design storm events. The precipitation depths used in the analysis have been interpolated from the “Technical Paper No. 40 Rainfall Frequency Atlas of the United States” (TP-40) isopluvial maps (May 1961). The following table summarizes the rainfall depths used in this analysis:

Table 2. Precipitation Depths

Return Period	24-Hour Precipitation Depth (in.)
2-Year (50% Storm)	3.60
10-year (10% Storm)	5.34
100-Year (1% Storm)	7.90

3.0 EXISTING CONDITIONS

To quantify the effects of development of this project, the following areas and points of interest have been used for existing and proposed conditions analysis. See Exhibit 3—Existing Conditions Drainage Map in Appendix A.

Drainage Area A represents the area in the southwest corner of the site, which bypasses the proposed detention location. In existing conditions, drainage area A has an area of 5.16 acres.

Drainage Area B represents the majority of the site in both the existing and proposed conditions models, which drains to the southeast corner of the site. In existing conditions, drainage area B has an area of 28.57 acres.

Drainage Area C is located in the northwest corner of the site and drains north to Highway 150. In existing conditions, drainage area C has an area of 11.27 acres.

Three points of interest were chosen for comparison between existing and proposed conditions based on the three points of discharge from the site. These points can be found in both Exhibits 3 and 4 in Appendix A.

Point of Interest A1 represents the southwest corner of the site and compares drainage area A for both models.

Point of Interest B1 represents a point near the southeast corner of the site, just upstream of the triple 30-inch CMP culverts crossing NW Pryor Road. Discharge to this point was compared between drainage area B in the existing conditions model and drainage areas B1 and B2 in the proposed conditions model at the outlet of the detention basin. Drainage area B2 bypasses the basin; flows from drainage areas B1 and B2 were combined before comparison with Existing Conditions. See Exhibit—4 Proposed Conditions Drainage Map and Section 4.0 of this report for a more detailed discussion of the Proposed Conditions drainage areas.

Point of Interest C1 represents the northwest corner of the site and compares drainage area C for existing and proposed conditions.

Bypass Area A was included in the model to account for area that does not pass through the site but drains to the culvert under NW Pryor Road near the southeast corner of the development. This area was included in the model to calculate tailwater elevations for the proposed detention basin.

The following tables summarize the results of the Existing Conditions analysis. The proposed conditions data is compared to these results in Sections 4 of this report. Refer to Appendix B for output and a schematic for the existing conditions model and detailed calculations for the time of concentration.

Curve Numbers were determined for existing and proposed conditions as shown in Table 3.

Table 3. Curve Numbers

Land Use	HSG*	CN
Straight Row Crop	C	85
Straight Row Crop	D	89
Multi-Family Residential	C	90
Multi-Family Residential	D	92
Pasture	C	79
Pasture	D	84
Paved Open Ditches with ROW	C	92
Paved Open Ditched with ROW	D	93

*Hydrologic Soil Group

Table 4. Existing Conditions Area Data

Area Name	Onsite Area (ac.)	Offsite Area (ac.)	Total Area (ac.)	T _C (hr.)	Weighted CN
A	2.10	3.06	5.16	0.33	82
B	25.26	3.31	28.57	0.36	84
C	4.02	7.25	11.27	0.33	83
Bypass A	0	2.86	2.86	0.18	87

Table 5. Existing Conditions Point of Interest Peak Flow Rates

Point of Interest	Q ₂ (cfs)	Q ₁₀ (cfs)	Q ₁₀₀ (cfs)
A1	11.1	20.2	33.9
B1	61.8	109	179
C1	25.4	45.3	75.2

Per APWA Section 5608.4 and the City of Lee's Summit criteria, the performance criteria for comprehensive control 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

Extended detention of the 90% mean annual event is also required for comprehensive control per APWA Section 5608.4.

Allowable release rates were calculated for the points of interest, allowing that offsite peak discharges would be permitted to bypass the detention. Offsite bypass peak flow rates were calculated as a percentage of the existing conditions, relating to the percentage of offsite area flowing to each point. The release rates for the proposed development on the development site were calculated based on the detention criteria. The development release rates were added to the bypass peak flow rates to calculate an allowable peak flow rate for each point of interest as follows.

Table 6. Point of Interest Onsite Area

Point of Interest	Total Area (ac)	Onsite Area (ac)	Percent Onsite
A1	5.16	2.10	40.7%
B1	28.57	25.26	88.4%
C1	11.27	4.02	35.7%

Table 7. Allowable Peak Flow Rates

Point of Interest	Allowable 2-Year Q (cfs)	Allowable 10-Year Q (cfs)	Allowable 100-Year Q (cfs)
A1	7.6	16.0	26.1
B1	19.8	63.2	96.5
C1	18.3	37.1	60.3

4.0 PROPOSED CONDITIONS

4.1 Effects of Development

The proposed conditions analysis assumes completion of the entire Osage development. The modeled subareas and points of interest are similar to the existing conditions model. However, throughout the site, some shifting of ridgelines will occur accommodating proposed detention facilities and anticipated grading activities, which will change the relative areas draining to each point of interest. The following is a summary of the proposed conditions drainage areas, see Exhibit 4—Proposed Conditions Drainage Map in Appendix A.

Drainage Area A in proposed conditions has an area of 0.43 acres. Proposed grading shifts 4.72 acres from drainage area A to drainage area B1.

Drainage Area B1 in proposed conditions has an area is 33.54 acres and will drain to the proposed detention basin. Drainage area from existing conditions is shifted from drainage areas A and C to area B1.

Drainage Area B2 was previously part of drainage area B in existing conditions. This area was separated in the proposed conditions model because it bypasses the detention basin. For

consistency, the sum of drainage areas B1 and B2 were compared at the same point of interest as drainage area B in existing conditions. Drainage Area B2 has an area of 2.73 acres.

Drainage Area C in proposed conditions has a drainage area of 8.30 acres. Proposed grading shifts area from drainage area C to drainage area B1.

The analysis provided in Section 3 established existing conditions of the development's drainage areas and analysis in this section will provide guidance for configuration of detention basin to meet the objectives established in Section 3.

The following tables summarize the results of the proposed conditions analysis. Tables 9 and 10 assume no detention is provided, to demonstrate the effects of development for each drainage area. Refer to Appendix C for output from and a schematic of the proposed conditions Hydraflow Hydrographs model.

Table 8. Proposed Conditions Area Data

Area Name	Area (ac.)	T _c (hr.)	Weighted CN
A	0.43	0.10	91
B1	33.54	0.35	88
B2	2.73	0.10	90
C	8.30	0.32	86
Bypass A	2.86	0.18	87

Table 9. Proposed (No Detention) Conditions Point of Interest Peak Flow Rates

Point of Interest	Q ₂ (cfs)	Q ₁₀ (cfs)	Q ₁₀₀ (cfs)
A1	1.7	2.8	4.3
B1	91.6	152.0	240.0
C1	21.0	35.9	57.9

The following table compares the results of the proposed conditions analysis to the existing conditions from Section 3 at the points of interest. Negative values indicate a reduction in peak flow rate, while positive values indicate an increase. Without detention, flow rates will increase at point B1, but decrease for A1 and C1. The decrease in flow rates at A1 and C1 is due to the proposed changes in grading, which shifts parts of each of these areas to drainage area B1.

Table 10. Proposed (No Detention) vs. Existing Conditions

Point of Interest	Q ₂ (cfs)	Q ₁₀ (cfs)	Q ₁₀₀ (cfs)
A1	-9.4	-17.4	-29.6
B1	29.8	43.0	61.0
C1	-4.4	-9.4	-17.3

4.2 Proposed Detention Facilities

To mitigate the increases in peak flows shown in the previous table and where possible, decrease further to the allowable release rates established in Section 3, detention will be provided for drainage area B1.

The detention facility was placed to capture most of the site runoff and to mitigate increases in peak discharge from the site. The detention facility will be located near the southeast corner of the site and will meet of the requirements outlined in Section 3. It will contain a multistage outlet structure and an independent 160-ft long broad crested weir graded into the east side of the berm. The following points summarize the multistage outlet structure and the emergency spillway:

- The structure itself will be a 5'x5' open-top concrete box with a top elevation of 1017.1, which generally controls the 100-year discharge.
- A 36" opening is present in the box at an elevation of 1012.6, which generally controls the 10-year and 100-year discharge.
- A 4.5" orifice is present in the box at the bottom elevation of the pond- 1010.0. This helps control the 90% mean annual storm event. The 2-year discharge is controlled by a combination of the 4.5" orifice and the 36" opening.
- The entire structure outlets to a 48" RCP, which carries the water to Pryor Road.
- The emergency spillway will consist of a 160-ft long broad crested weir set at an elevation of 1018.4.

A 4.5-inch orifice will be set at the bottom of the multi-stage outlet structure to comply with the KC-APWA requirement for 40-hour release of the 90% mean annual event. The total inflow volume from this event is 2.09 acre-feet for this site. This will be released over 40 hours at a rate of 0.63 cfs.

Table 11 includes a summary of the Proposed Detention Facility

Due to constrictions in lot grading, site size limitations, and the relatively small drainage area detention is not planned for drainage area C. The drainage area to this point is reduced from existing conditions with proposed grading. As a result, the peak discharge rates for the 2-, 10-, and 100-year storms are below the existing values shown in Table 5. Table 10 illustrates these reductions. For point C1, the peak discharge values meet the allowable release rates for the 10-year and 100-year storm but exceed the KC-APWA 5600 allowable release rates of 0.5 cfs per

acre for the 2-year storm. A comparison with allowable release rates can be seen in Table 13. To achieve these release rates at point C-1, a small detention facility would need to be placed in the northwest corner of the site. The benefit of installing this detention facility in order to reduce the 2-year peak discharge value by 3.0 cfs is outweighed by the impact the facility would have on the feasibility of the development, especially considering the substantial reduction in peak discharge values already achieved when compared to existing conditions. As such, a waiver is requested for the 2-year storm for point C-1.

Table 11. Proposed Conditions Detention Flow and Volume Data

	Peak Q In (cfs)	TP In (hr)	Peak Q Out (cfs)	TP Out (hr)	Peak W.S.E. (ft)	Stored Volume (ac-ft)
2-Year	84.4	12.10	5.9	13.53	1014.12	4.2
10-Year	141.0	12.10	39.5	12.47	1015.61	6.0
100-Year	223.0	12.10	92.4	12.37	1017.87	9.0

4.3 Effects of Proposed Detention

The following tables compares the results of the proposed conditions analysis with the detention described above to the existing conditions from Section 3 at the points of interest. In Table 13, negative values indicate a reduction in peak flows, while positive values indicate an increase.

Table 12. Proposed (with Detention) Point of Interest Peak Flow Rates

Point of Interest	Q ₂ (cfs)	Q ₁₀ (cfs)	Q ₁₀₀ (cfs)
A1	1.7	2.8	4.3
B1	10.3	41.4	95.7
C1	21.3	35.9	57.9

Table 13. Proposed (with Detention) vs. Allowable Release Rates

Point of Interest	Q ₂ (cfs)	Q ₁₀ (cfs)	Q ₁₀₀ (cfs)
A1	-5.9	-13.2	-21.8
B1	-9.5	-21.8	-0.9
C1	3.0	-1.2	-2.4

Table 14. Proposed (with Detention) vs. Existing Conditions

Point of Interest	Q ₂ (cfs)	Q ₁₀ (cfs)	Q ₁₀₀ (cfs)
A1	-9.4	-17.4	-29.6
B1	-51.5	-67.6	-83.3
C1	-4.1	-9.4	-17.3

5.0 SUMMARY

This stormwater drainage study was prepared to evaluate the hydrologic impact generated by the development of Osage and to provide recommendations for a comprehensive stormwater management plan. The project is a single-family residential development on approximately 36 acres, including a pool and amenity tract and open space which will be reserved for detention.

Increases in peak flow rates caused by development will be mitigated for all points of discharge through the site through a combination of dry detention and drainage area changes.

6.0 CONCLUSIONS AND RECOMMENDATIONS

This proposed stormwater management plan was designed to achieve compliance with current design criteria in effect for the City of Lee's Summit, Missouri; however, a waiver is requested at point of interest C1 for the 2-year storm. A final macro and first plat micro stormwater drainage study will be required with submittal of the first plat of this development.

The results of the analysis demonstrate that the proposed stormwater management plan for the project achieves compliance with design criteria, including extended detention of the 90% mean annual event, along with the requested waiver for drainage area C. We therefore request approval of this Osage Stormwater Drainage Study. This approval is conditional and should be substantiated with each future plat of Osage.