ARBORWALK WEST MACRO DRAINAGE STUDY

Prepared for:

Christie Development Associates, LLC

7217 W 110th Street

Overland Park, KS 66210

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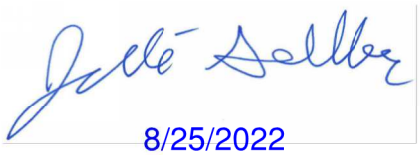
Olsson Project No. B21-04054



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1. GENERAL INFORMATION

Arborwalk West is a future 15.84-acre mixed-use area within the Arborwalk development. For the purpose of this study, we will analyze the west portion of the Arborwalk development in the watershed that affects Arborwalk West. This area has been partially developed; however, comprehensive stormwater management detail records were not locatable. Since Arborwalk West is at the bottom of the watershed, this study will analyze the total drainage area from predevelopment to ideal build out to better understand stormwater management needs. The development contains commercial, open space, residential, public right-of-way and utility main extensions required to serve the development. Most of Arborwalk drains south under Highway 150 to an unnamed tributary that drains to Raintree Lake. An undeveloped area northwest of Arborwalk drains northwest through a storm drainage system to Mouse Creek. The northwest area draining to Mouse Creek has not been analyzed for this study.

1.1 Project Location

Arborwalk West is in the City of Lee's Summit, Missouri. The area to be developed is bounded by SW Pryor Road to the west and Highway 150 to the south. Residential areas bound the area to the north and east.

Figure 1. Arborwalk West Location Map

1.2 Federal Emergency Management Agency Floodplain Classification

Arborwalk West lies entirely within areas determined to be outside the 0.2% annual chance floodplain (unshaded Zone X) as depicted on the FEMA Flood Insurance Rate Map (FIRM) Community Panel No 29095C0531G (City of Lee's Summit, Missouri), revised January 20, 2017. A copy of the FEMA FIRM panel is included in Appendix E.

1.3 Soil Classifications

A geotechnical investigation has not been completed for this site. Soil Maps published in the NRCS Web Soils Survey for Jackson County, Missouri categorize soils in the watershed as:

Table 1. Soil Classifications

Symbol	Name	Slopes	Hydrologic Soil Group
10000	Arisburg silt loam	1-5%	C
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
10128	Sharpsburg-Urban land complex	2-5%	D
10181	Udarents-Urban land-Sampsel complex	5-9%	C

NRCS Runoff Curve Numbers (CN's) in this study have been assigned to tributary areas onsite, based upon these Hydrologic Soil Groups and associated existing and proposed land use. Land uses were determined using zoning maps, aerial photos, and site visits. A copy of the NRCS printout is included in Appendix D.

1.4 Existing Stormwater Studies and Systems

An existing stormwater study for this area is believed to have been created. However, the existing stormwater study has not been located and therefore is being recreated with this study.

Design updates to Missouri State Highway 150 from Horridge Road to Market Street in Lee's Summit was commissioned by the Missouri Department of Transportation resulting in construction documents titled "Missouri Highways and Transportation Commission Plans for Proposed State Highway", June 10, 2009 by GBA Architects, job number J4U1130D. Highway updates include design information of a 6' x 4' reinforced concrete box (R.C.B.) culvert that drains stormwater from Arborwalk West.

2. METHODOLOGY

The storm drainage study will be analyzed in accordance with the February 16, 2011 edition of the Kansas City Metropolitan Chapter, American Public Works Association, (KCAPWA) Construction and Material Specifications, Section 5601.5.A.4, as currently adopted by the City of Kansas City, Missouri:

"New development or redevelopment as defined in Section 5601.2 shall incorporate stormwater management measures to control runoff from the site. Allowable runoff from a site may be limited by the need to minimize downstream flood damage, prevent erosion, and/or minimize impacts to the ecology and water quality of the downstream drainage system."

"…peak runoff control is provided for the 2%, 10%, and 100% chance storms and volumetric and/or extended detention control of the 90% mean annual event storm for broad protection of the receiving system."

The Existing Conditions hydrology will be evaluated in Section 3, and Future Conditions hydrology will be computed in Section 4. The Future Conditions discharge data for each stage of development will be compared to the Existing Conditions results; variations in quantity and rate of stormwater discharge between these models will represent the hydrologic impact generated by future development. The overall stormwater management plan will be designed utilizing this information. Section 3 assumes agricultural land use before development in 2004 within the tributary watershed, and pre-development conditions within the project boundary. Section 4 assumes future land use before development in 2004 within the tributary sub-watersheds, and fully developed conditions within the project area boundary.

Runoff rates and detention hydraulics were analyzed using Autodesk Storm and Sanitary Analysis 2022 (SSA). SSA utilizes the following approved methods to model Existing and Future Conditions for stormwater runoff.

- NRCS TR-55 Unit Hydrograph Method
- 2-,10-, and 100-year Return Frequency, 24-hr. Storm Precipitation Depths (TP-40)
- ARC Type II Soil Moisture Conditions
- 24-Hour NRCS Type II Rainfall Distribution
- Runoff Curve Numbers per NRCS TR-55 (Tables 2-2a - 2-2c) and KCAPWA Section 5602.3
- NRCS TR-55 Methods for determination of Time of Concentration and Travel Time.
  NOTE: SSA models use "Time of Concentration" rather than "Lag Time" for computing subarea hydrology.

Stormwater runoff models were created for the 2%, 10%, and 100% design storm events. The precipitation depths used in the analyses 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.)
1-Year (100% Storm)	3.5
10-Year (10% Storm)	5.3
100-Year (1% Storm)	7.7

3. EXISTING CONDITIONS

To quantify the effects of development of this project, the following area and point of interest has been used for Existing and Future Conditions analyses. See Exhibit "EX-300" in Appendix A, Existing Conditions Drainage Area Map.

Outfall 1

Project area tributary to Outfall 1 slopes from north to south to an existing R.C.B. under Highway 150, then flows south offsite to an unnamed tributary to Lake Winnebago. Water travels over the undeveloped site to Outfall 1 via sheet flow and shallow concentrated flow. Outfall 1 is the end of the R.C.B. as it flows to the tributary.

The design of the existing R.C.B. has been reviewed and found to be undersized. The drainage area for the R.C.B. from the existing plans in Appendix F shows 87 acres, while this study has determined an existing drainage area of 112 acres. The existing conditions analysis will not consider the design from the Highway 150 plan set.

Runoff Curve Numbers have been developed for the outfall area, based upon the past land use obtained from aerial photography of year 2003, before development of this area began. The site at that time was agriculture. Existing site model input data is summarized in Table 3, below. Refer to the Existing Conditions Drainage Area Map (EX-300) located in Appendix A for Runoff Curve Number (CN) values and model calculations located in Appendix C with Time of Concentration (Tc) calculations.

Table 3-1. Existing Site Data

Subbasin	Drainage Area (ac.)	CN	Tc (min)	Q_2	Q_{10}	Q_{100}
Subarea 1	112.03	82.00	25.54	193.20	362.61	595.19

These routings, drainage area, and CN and Tc values for the corresponding areas were used as input to the Existing Conditions model to evaluate the existing stormwater hydrology for the project. The resulting peak flows of the hydrologic routing are provided in Table 3-2, below. Hydrographs can be found in Appendix B and model output data can be found in its entirety in Appendix C.

Table 3-2. Existing Peak Discharge Rates

Outfall	Q_2 (cfs)	T_{P-1}	Q_{10} (cfs)	T_{P-10}	Q_{100} (cfs)	T_{P-100}
Outfall 1	192.80	12.15	362.34	12.15	517.78	12.03

The design flow capacity of Outfall 1 is 438.12 cfs. Outfall 1 can handle the 2-year and 10-year storms, but not the 100-year storm. Additionally, the 50-year existing storm event is 517.44 cfs through the pipe under pressure which overflows and will not completely be contained within the pipe. It is noted that the 50-year and 100-year flows through Outfall 1 are similar. This is due to the R.C.B. under pressure flow in both storm events. The R.C.B. was to be designed for the 50-year storm event, but the model shows that the R.C.B. is undersized.

4. FUTURE CONDITIONS ANALYSIS

Future development contains commercial, open space, residential, public right-of-way and utility main extensions required to serve each development. The sections below will provide updated model calculation results for Future Conditions.

4.1 Future Conditions Site Hydrology

The subarea in the existing model has been divided into subbasins due to the tributary shifts caused by site grading and sewer construction, as shown in Exhibit “EX-301” in Appendix A, Future Conditions Drainage Area Map. Table 4-1, below, provides a summary of the future site tributary areas. Refer to the Future Conditions Drainage Area Map (EX-301) located in Appendix A for Runoff CN values and model calculations located in Appendix C with Time of Concentration (Tc) calculations.

Subareas 1, 2, 3, and 4 are tributary to the single Outfall 1 as in existing conditions south of the site. Subarea 1 will flow to a proposed basin and be released from there through a storm system. Subareas 2, 3, and 4 will be routed through a storm system to Outfall 1. At the time of future development, further calculations will determine if additional stormwater measures need to be taken to control a possible increase in flows due to development.

As of the writing of this study, a dry detention basin is in operation for stormwater from Subarea 1 called Basin 1. Basin 1 collects stormwater from Subarea 1 and releases stormwater from an outlet structure to a storm system. Not all information for the outlet structure could be determined. The outlet structure must be revised to make the outlet structure useable. The additional measures are noted in the detail below.

Subarea 1 – Basin 1:

- Top of Dam: 1012.00
- Bottom Elevation: 1004.00
- Outlet Structure
    - 6’ x 8’ Outlet Structure, Top Elevation of 1009.49
    - Top Grate: 3’ x 6’ standard grate, 1009.49
    - Top Opening, 1 – Side: 14” V x 96” H, Bottom Elevation = 1007.99
    - Low Opening (to be added), 1 – Side: 30” V x 96” H, Bottom Elevation = 1004.00

Outfall 1:

- 6' x 4' R.C.B.
- 132' length, 2.00% Slope
    - Inlet Elevation: 991.73
    - Outlet Elevation: 989.00

Table 4-1. Future Site Data

Subarea	Drainage Area (ac.)	CN	Tc (min)	Q_2	T_{P-2} (hr)	Q_{10}	T_{P-10} (hr)	Q_{100}	T_{P-100} (hr)
Subarea 1	84.25	88.31	18.99	216.18	12.08	368.00	12.08	568.94	12.08
Subarea 2	5.65	88.24	16.52	15.33	12.07	26.07	12.08	40.33	12.08
Subarea 3	4.31	90.55	5.00	16.68	11.93	27.43	11.93	41.57	11.93
Subarea 4	8.69	89.28	5.00	32.31	11.93	54.05	11.93	82.72	11.93

Table 4-2. Future Conditions Detention Basin Data

	Peak Q In (cfs)	T_P In (hr.)	Peak Q Out (cfs)	T_P Out (hr.)	Max V_R (ac-ft)	Peak W.S.E. (ft)
Basin 1						
2-Year	215.64	12.08	84.98	12.50	4.11	1007.46
10-Year	366.28	12.17	105.56	12.50	8.53	1009.18
100-Year	566.28	12.17	129.09	12.50	14.96	1011.40

Although the future conditions increase the peak flows due to curve number for each subarea, Basin 1 decreases the Peak Out flows decreasing the amount of flow towards Outfall 1. The peak W.S.E. for a 100-year storm event is 0.60' from the dam. Since the outfall structure has already been built and modifications will be made, such as an additional opening and a headwall to reduce debris at the opening, it is asked that an exception to the 1' vertical separation from top of dam to W.S.E. be accepted.

From development within the subbasin areas and corresponding reactions from the stormwater detention basin, Table 4-3 below shows the updated runoff results to the outfalls for the watershed.

Table 4-3. Future Conditions Peak Discharge Rates

Outfall	Q_2 (cfs)	T_{P-2} (hr)	Q_{10} (cfs)	T_{P-10} (hr)	Q_{100} (cfs)	T_{P-100} (hr)
Outfall 1	116.55	12.05	171.10	12.03	236.05	11.95

Comparing the future flowrates for the outfall shown above with the outfall within the Existing Conditions results, it is shown that the flowrate is reduced from existing conditions. Cumulative runoff volume curves that depict the future effects of the stormwater management facilities and compare existing and proposed conditions hydrographs at the outfall locations are provided in Appendix B of this report. Refer to the tables below, and the Volume Comparison hydrographs provided in Appendix B for graphical representation of the existing and proposed conditions stormwater hydrology in comparison to the existing conditions peak flowrates.

5. RESULTS

As shown in the discussion and tables in the previous sections, the existing R.C.B. is undersized for existing conditions. Future development includes a detention basin for the residential development to the north that decreases the amount of flow to the R.C.B. The storm system and detention basin reduce the flow to the R.C.B. that the R.C.B. will be no longer undersized. Table 5-1, below, summarizes future conditions results and compares them with existing conditions.

Table 5-1. Future Conditions Outfall Discharge Comparison

Outfall		Q_2 (cfs)	Q_{10} (cfs)	Q_{100} (cfs)
1	Existing	192.80	362.34	517.78
	Future	116.55	171.10	236.05
	Difference	-76.25	-191.24	-281.73

6. CONCLUSION

This Macro Stormwater Drainage Study has been prepared for the future development to establish a comprehensive stormwater management plan for Arborwalk West. The stormwater management plan has been designed to achieve compliance with current design criteria in effect for the City of Lee's Summit, Missouri. A waiver is requested for the peak 100-year water surface elevation for the basin be accepted at a vertical separation of 0.60'.

This study demonstrated the overall compliance with LS Section 5600.

APPENDIX A
Exhibits

DWG: F:\2021\04001-04500\021-04054-B\40-Design\Reports\GNCV\Stormwater_Report_B2104054\Rev_0\Stormwater Report Exhibits\EX-300_Existing_Conditions.dwg USER: ssaylor
DATE: Aug 18, 2022 12:37pm XREFS: C_XBASE_02102689 C_PBNDY_02102689 C_FBASE_02102689

LAND COVER LEGEND

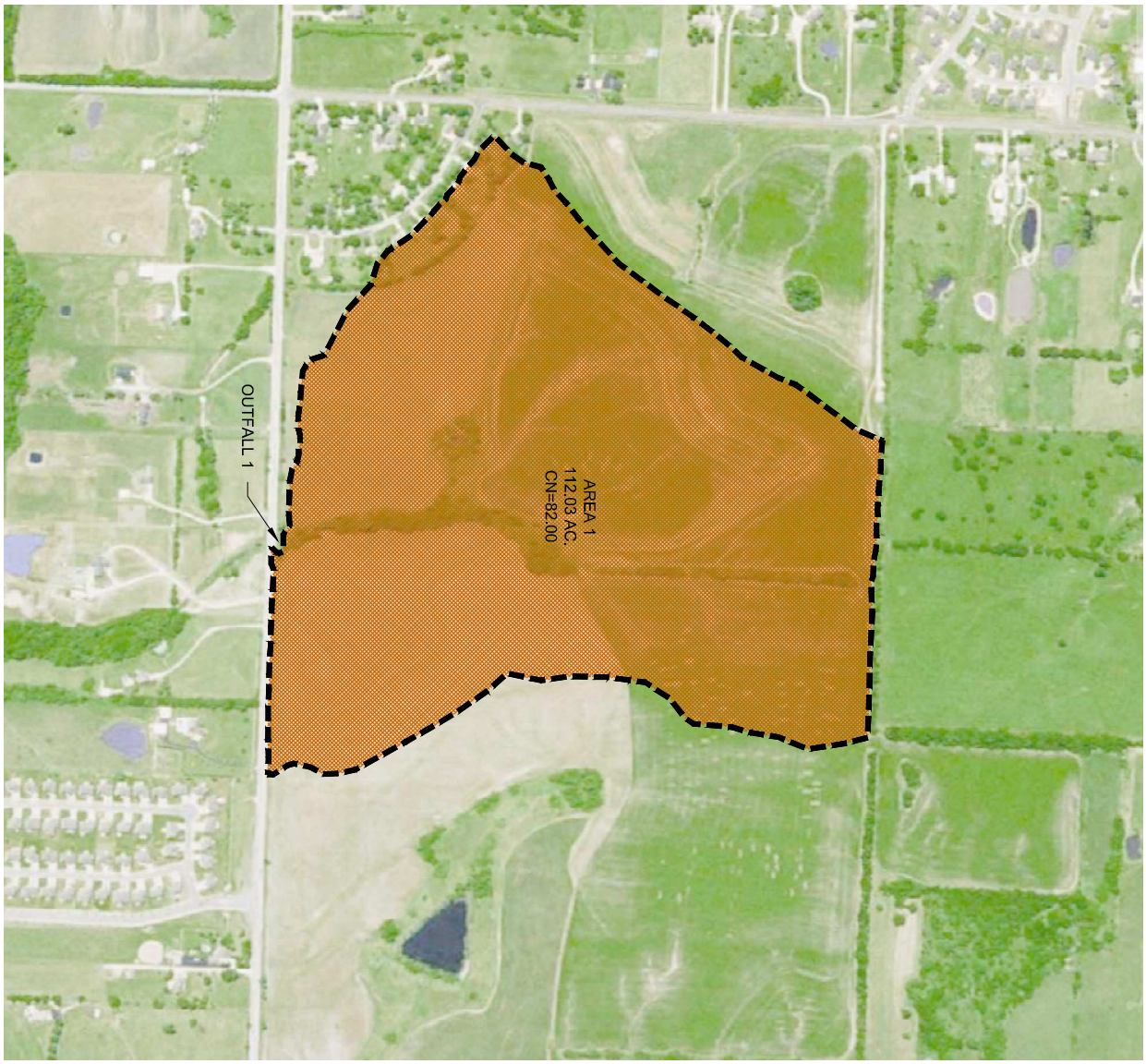
TREATMENT	AREA (AC.)	CN SOIL C
UNDEVELOPED CONTOURED CROPS	112.03	82

BOUNDARY LEGEND

TRIBUTARY DRAINAGE BOUNDARY

N

SCALE IN FEET
0' 250' 500' 1000'



EXISTING CONDITIONS DRAINAGE AREA MAP

ARBORWALK WEST

LEE'S SUMMIT, MISSOURI 2022

REV. NO.	DATE	REVISIONS DESCRIPTION

REVISIONS

SHEET EX-300

drawn by: MG
checked by: SS
approved by: JS
drawing no.: 054956

olsson

Olsson - Civil Engineering
Missouri Certificate of Authority #001592
1301 Burlington Street
North Kansas City, MO 64116 TEL 816.361.1177 www.olsson.com