Stormwater Management Report

U-Haul

Lee's Summit, Missouri

Date: June 14, 2022

ISG Project #:21-26154

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SIGNATURE SHEET

I HEREBY CERTIFY THAT THESE CALCULATIONS WERE PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MISSOURI.

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Engineer's Project Number: 21-26154

Dated this 14th day of June 2022

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INTRODUCTION

This stormwater management report was prepared in conjunction with site plans to facilitate construction of a new U-Haul moving and storage facility in Lee's Summit, Missouri. The project site is located at 1150 SE Blue Parkway, directly northeast of the intersection of SE Blue Parkway and SE Vista Drive. Development of the proposed site will include construction of a new self-storage building and U-Box building, as well as the associated site improvements including paved parking areas, stormwater management facilities, utilities, and landscaping.

Web soil survey online was used to determine the site's hydrological soil characteristics, which were determined to be Type C soils. They can be seen in the appendix.

In conjunction with completion of the site plans, hydraulic models and the associated drainage report were compiled to demonstrate the impacts of the proposed development on existing and proposed drainage conditions. Stormwater facilities were designed in conformance with the City of Lee's Summit ordinances and all applicable NPDES requirements.

PRE-DEVELOPMENT SITE DRAINAGE CONDITIONS

The site is currently undeveloped with a gravel turnaround at the southwest corner of the lot, containing approximately 4.11-acres. For stormwater calculations the entire site is assumed to be undeveloped, for a conservative design. The site prior to any development is assumed to have good vegetative cover with slopes of 3-4%. The existing soils on site were determined using geotechnical report (can be referenced in the appendix), which test results showed the site consisting of fat clay, medium to very stiff consistency. Therefore, the site's soil type is determined to be Type D soils. It was also determined that no wetlands were found on site. FEMA research resulted in the property being in a "Zone X" which has minimal flood hazard. The entire site's stormwater eventually flows to the NE corner of the to the primary point of interest in which this report analyzes the developments runoff. The pre-developed site has been separated into 3 specific drainage areas. A map depicting the pre-development drainage areas and pre-development stormwater analysis are provided in Appendix A and Appendix D, respectively.

- EX-1, and EX-2 stormwater contains the existing on-site stormwater discharge in the pre-development condition.

Table 1.1 below summarizes the characteristics of all drainage areas for the existing conditions as illustrated on the Existing Conditions Drainage Map in Appendix A.

Table 1.1 Existing Drainage Areas (Pre-Development Conditions)

DRAINAGE AREA	TOTAL AREA (AC)	CURVE NUMBER	TIME OF CONCENTRATION (MIN)	1-YR RUNOFF – 1.37" (CFS)	2-YR RUNOFF – 3.71" (CFS)	10-YR RUNOFF – 5.67" (CFS)	100-YR RUNOFF – 9.24" (CFS)
EX-1	0.415	80	23.4	0.07	0.76	1.48	2.83
EX-2	3.697	80	23.1	0.61	6.73	13.04	25.03
TOTAL EX	4.112						

The SE corner of the site has runoff coming from an offsite source discharging into it. This runoff will not impact this development and will flow through the site as pass through. According to coordination with the city staff, roughly 150-acres flows through the site through a box culvert that enters on the SE corner of the subject property, to the NE corner. The furthest east portion of this site where this water drains is remaining unchanged to ensure this existing water way is not negatively impacted. A runoff value will be coordinated with the city to allow a quantitative comparison of the total runoff coming and leaving the site in the existing and proposed conditions.

PROPOSED SITE DRAINAGE CONDITIONS

The proposed site development will accommodate construction of a multi-story Self-Storage Building and a U-Box Building, parking lot, and stormwater system, along with all other related site work. Stormwater will be directed via onsite storm sewer to the proposed underground detention system basin prior to outletting into the existing public storm sewer along the northeast edge of the property. The offsite flow from the box culvert on the SE corner of the property is still being allowed to enter and leave the site as it does in its current condition. This flow is being coordinated with the city to allow a quantitative review of all the water entering and leaving the site and will be provided once calculated. This flow will be the same in both the pre-developed and post developed conditions, as the U-Haul site runoff will be the only amount changing from the existing to proposed conditions and is being allowed to bypass as it is not being impeded by this site's development.

The project site has been divided into three drainage areas to account for stormwater runoff entering the stormwater system to be treated by the detention basin, and flowing off-site un-detained, as detailed in Table 2.1 below. The areas flowing in their original paths still retain their original Existing Drainage number. For example, DA-1 corresponds to the remaining area that is still flowing to Point of interest 1. DA-1 is being requested to the city to allow the area to be released undetained as this area does not flow to the detention area and area is being reduced in the proposed conditions, thus enhancing it from the pre-developed condition. DA-2 is the improved area that is detained. DA-3 is the combination of all the un-detained areas were created due to existing drainage paths making it difficult to capture and treat and have been given a new drainage area. DA-3 are undetained flows that have impacted the detention basin's release rate by reducing the amount of flow being allowed to exit the system by over detaining the post-developed runoff. This is to ensure requirements are met and no downstream infrastructure are impacted when looking at the site's overall release. A detailed map depicting the proposed drainage conditions is provided in Appendix B.

Table 2.1 Proposed Drainage Areas

DRAINAGE AREA	TOTAL AREA (AC)	IMPERVIOUS AREA (AC)	PERVIOUS AREA (AC)	CURVE NUMBER	TIME OF CONC. (MIN)	1-YR RUNOFF 1.37" (CFS)	2-YR RUNOFF 3.71" (CFS)	10-YR RUNOFF 5.67" (CFS)	100-YR RUNOFF 9.24" (CFS)
DA-1	0.143	0	0.143	80	5	0.05	0.48	0.90	1.70
DA-2	3.044	2.774	0.267	96	10	4.41	13.74	21.40	35.22
DA-3	0.925	0.014	0.914	80	10	0.26	2.57	4.91	9.30
TOTAL	**4.112**	**2.788**	**1.324**						

Using all the drainage area information calculated in the pre-developed and post developed conditions, a table can be made to compare the total runoff rates of the entire site in the pre-developed condition and post developed condition to determine the

need of detention. As seen in Table 2.2, a detention basin will need to be implemented to reduce the developed sites runoff to ensure the downstream storm network infrastructure is not inundated. See the Stormwater management section for how the post developed runoff rates will be maintained to reduce the increased amount of runoff by method of an underground detention basin.

Table 2.2 Pre-developed vs Post Developed Runoff Rates

DRAINAGE AREA	1-YR, (1.37")	2-YR, (3.71")	10-YR, (5.67")	100-YR, (9.24")
Total Existing Runoff (CFS)	0.68	7.49	14.52	27.86
Total Proposed Runoff (CFS)	4.70	16.68	27.01	45.83

STORMWATER REGULATIONS

The location of the project involves the City of Lee's Summit stormwater regulations, which references Section 5600 of the Kansas City Metropolitan Chapter of the American Public Works Association Standard Specifications & Design Criteria. The regulations and design criteria are outlined below in Table 3.1.

Table 3.1 Design Criteria

Performance Standard	Requirements
City of Lee's Summit City Code Section 5608.4 Stormwater Detention and Retention Performance Criteria	Time of Concentration and Travel Time: Refer to Section 5602 for acceptable hydrology methods.
	Temporary Storage Volume: A preliminary value of the storage requirement may be obtained through methods outlined in (SCS, 1986, Chapter 6) or other acceptable methods. The storage shall be checked during routing of design hydrographs through the basin and adjusted appropriately.
	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
	40-hour extended detention of runoff from the local 90% mean annual event (1.37"/24-hour rainfall). See Chapter 6 of the MARC/APWA BMP Manual for calculating this volume.
	Maintenance responsibility for all elements of the detention facility should be designated prior to construction of any detention facility. However, when no designation is made the property owner shall be considered the responsible party. Annual or more frequent inspections shall be made by the responsible party to assure that all inlet and outlet structures are fully functional, and the detention basin has full storage capacity.

STORMWATER MANAGEMENT SUMMARY

In conjunction with the completion of the construction plans, calculations were performed for the proposed stormwater facilities. Hydrographs for the pre-development and post-developed site conditions were generated and routed through this model using the rainfall amounts provided in the APWA Section 5600 Design Criteria Manual and the Lee's Summit Section 5600 Design Criteria. The rainfall events analyzed include the, 1-year/90%-storm (1.37"), 2-year/50%-storm (3.71"), 10-year/10%-storm (5.67"), and 100-year/1%-storm (9.24") design storms. The 40-hour extended detention is listed as TBD as further coordination with the city is on-going as the site's soil infiltration is very poor, thus creating difficult situations for the natural water absorption.

The Proposed HydroCAD model, using the TR55 method, can be seen in Appendix E. Summarizing what can be reviewed in the HydroCAD models, is a series of tables that can be seen in the following report. The allowable site release rate was obtained by using Lee's Summit required Detention Release rate calculations, which can be seen in Table 4.1 below. Table 4.2 details the detention basis's performance during each storm event, including the corresponding storm event ponding elevation and amount of storage provided within the detention basin at that elevation. Table 4.3 concludes that the site's post developed conditions are both within what is allowed by the city of Lee's Summit per the design criteria laid out in Table 4.1, and below the pre-developed conditions, which provides the downstream storm network even further relief.

Table 4.1 Lee's Summit Required Detention Release Rates

RAINFALL EVENT	REQUIRED DETENTION RELEASE RATE EQUATION (CFS)	REQUIRED DETENTION RELEASE RATE USING 4.11-ACRES (CFS)
1-YR, (1.37")	40 HOUR RELEASE	TBD
2-YR, (3.71")	0.50 CFS/ACRE	0.5 CFS/ACRE x 4.11 ACRES = 2.05
10-YR, (5.67")	2.0 CFS/ACRE	2.0 CFS/ACRE x 4.11 ACRES = 8.22
100-YR, (9.24")	3.0 CFS/ACRE	3.0 CFS/ACRE x 4.11 ACRES = 12.33

Table 4.2 Detention Basin Performance

RAINFALL EVENT	DETENTION BASIN INFLOW/OUTLFOW		UNDERGROUND SYSTEM #1 PEAK ELEVATION	UNDERGROUND SYSTEM #1 PROVIDED STORAGE (CF)
	BASIN INFLOW (CFS)	BASIN OUTFLOW (CFS)		
1-YR, 24-HR Storm (1.37")	4.41	0.03	981.84	9,502
2-YR, 24-HR Storm (3.71")	13.74	0.06	986.40	33,095
10-YR, 24-HR Storm (5.67")	21.40	2.55	987.00	36,246
100-YR, 24-HR Storm (9.24")	35.22	3.27	991.72	60,630

Table 4.3 Pre Vs. Post Runoff Site Runoff Calculations

RAINFALL EVENT	CONDITIONS				
	EX-2 TOTAL PRE-DEVELOPMENT PEAK FLOW (CFS)	ALLOWABLE RELEASE RATE FLOW (CFS)	DA-2 PROPOSED BASIN RELEASE (CFS)	DA-3 PROPOSED UNDETAINED (CFS)	TOTAL PROPOSED SITE RELEASE (CFS)
1-YR, 24-HR Storm (1.37")	0.61	TBD	0.03	0.26	0.27
2-YR, 24-HR Storm (3.71")	6.73	2.05	0.06	2.57	2.62
10-YR, 24-HR Storm (5.67")	13.04	8.22	2.55	4.91	4.97
100-YR, 24-HR Storm (9.24")	25.03	12.33	3.27	9.30	12.15

The series of tables in this section depict the series of calculations done to design a storm water management system that's intent is to meet the city of Lee's Summits detention requirements and provide a design that improves the post developed conditions in a way that leaves the site in a better situation than the pre-developed runoff conditions. Doing so allows the storm network that is downstream of this development to be aided by reduced runoff. This is done by reducing the runoff by restrictions within the site's underground detention basin, which is outlined below:

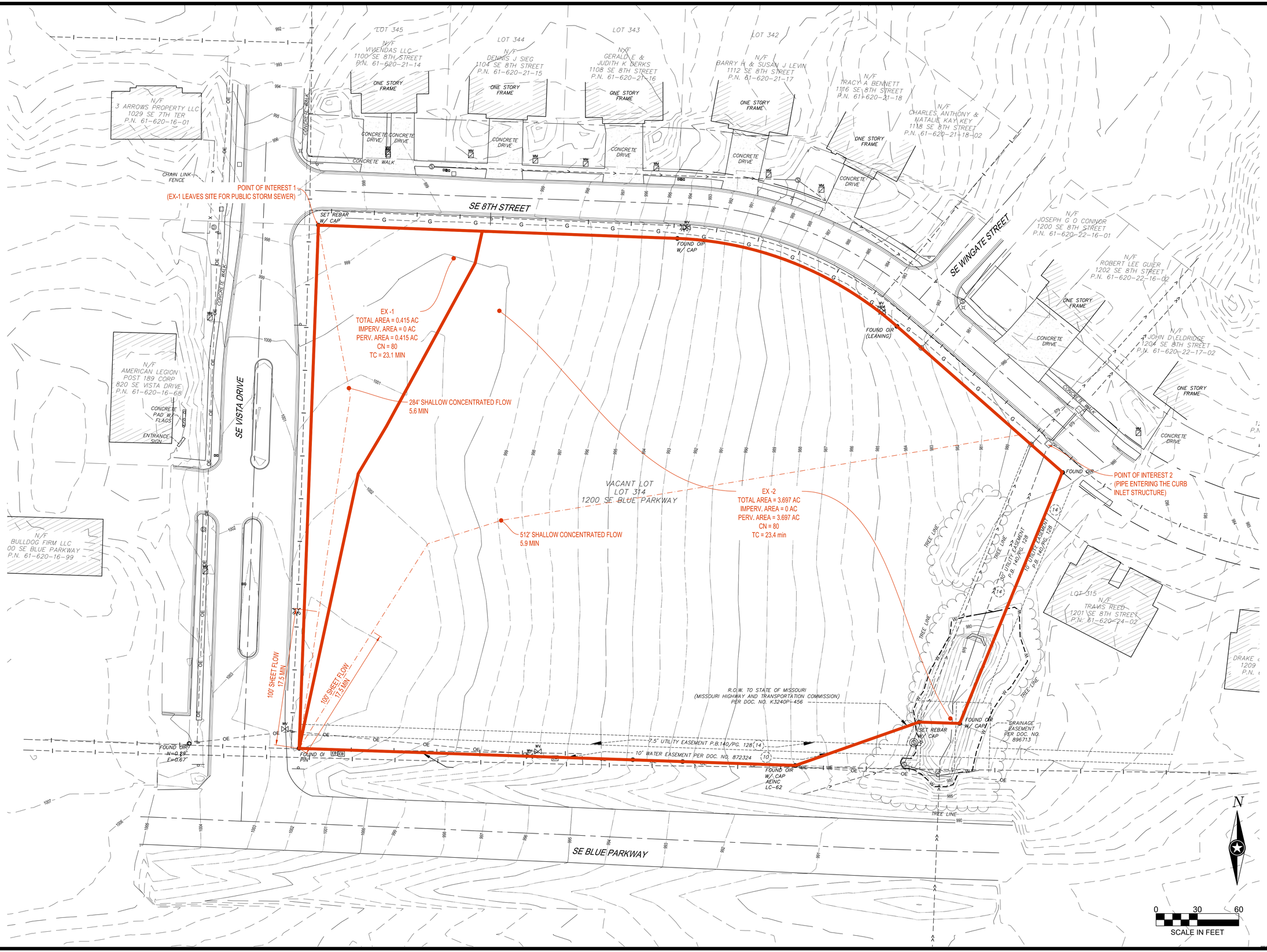
- The primary outlet device for the underground detention basin is a series of devices that are all contained within a storm sewer manhole that is connected to the detention basin. The primary control device is a 6" diameter circular orifice on the overall 15" outlet pipe from the detention control structure. The secondary outlet device is an internal weir wall that is 6.90' tall that has a series of small diameter orifices. At the bottom, starting at elevation 980.50, is one 1" diameter orifice that controls the release in the 1-YR and 2-YR events. This orifice size is the minimum allowable orifice size per City of Lee's Summit requirements, thus the 2-YR required detention release cannot be met. At elevation 986.40, stormwater is allowed to overtop the weir wall to be controlled by the 6" orifice on the systems overall outfall outlet for the 10-year and 100-year storm events. Water is allowed to pond 1' before reaching the first orifice to allow infiltration of smaller storm events to satisfy the water quality requirements.

CONCLUSIONS

Due to the proposed development by U-Haul, peak runoff rates needed to be analyzed and managed to provide a post developed condition that did not compromise the downstream structures that lead to the Little Blue River. This development's stormwater management facility attempts to meet the drainage requirements set forth in the City of Lee's Summit detention design set forth in Section 5600 Default Strategy, Comprehensive Protection, APWA Section 5600 which controls the 90% (1-year), 50% (2-year), 10% (10-year) and 1% (100-year) storm events. The minimum orifice of 1", utilized in the smaller storm events (1- and 2-year events), allows the post-developed conditions to be better than the predeveloped, but cannot meet the cities design criteria. The larger storm events (10- and 100-year events) both have storm runoff that are better than the predeveloped conditions and meet the city's design criteria. These post developed flows consider the flows that go uncaptured and over-detain within the detention facility to limit its impact.

U-Haul's development can therefore have the conclusion that its development will not have an adverse impact on the downstream storm network or the East Fork of the Little Blue River floodplain. Refer to the complete Site Plans provided in Appendix F for details of the stormwater basin and outlet structure.

Appendix A: Existing Conditions Drainage Map



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1	05/27/2022	AJR	REVISED SET PER CITY COMMENTS

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EXISTING CONDITIONS DRAINAGE MAP

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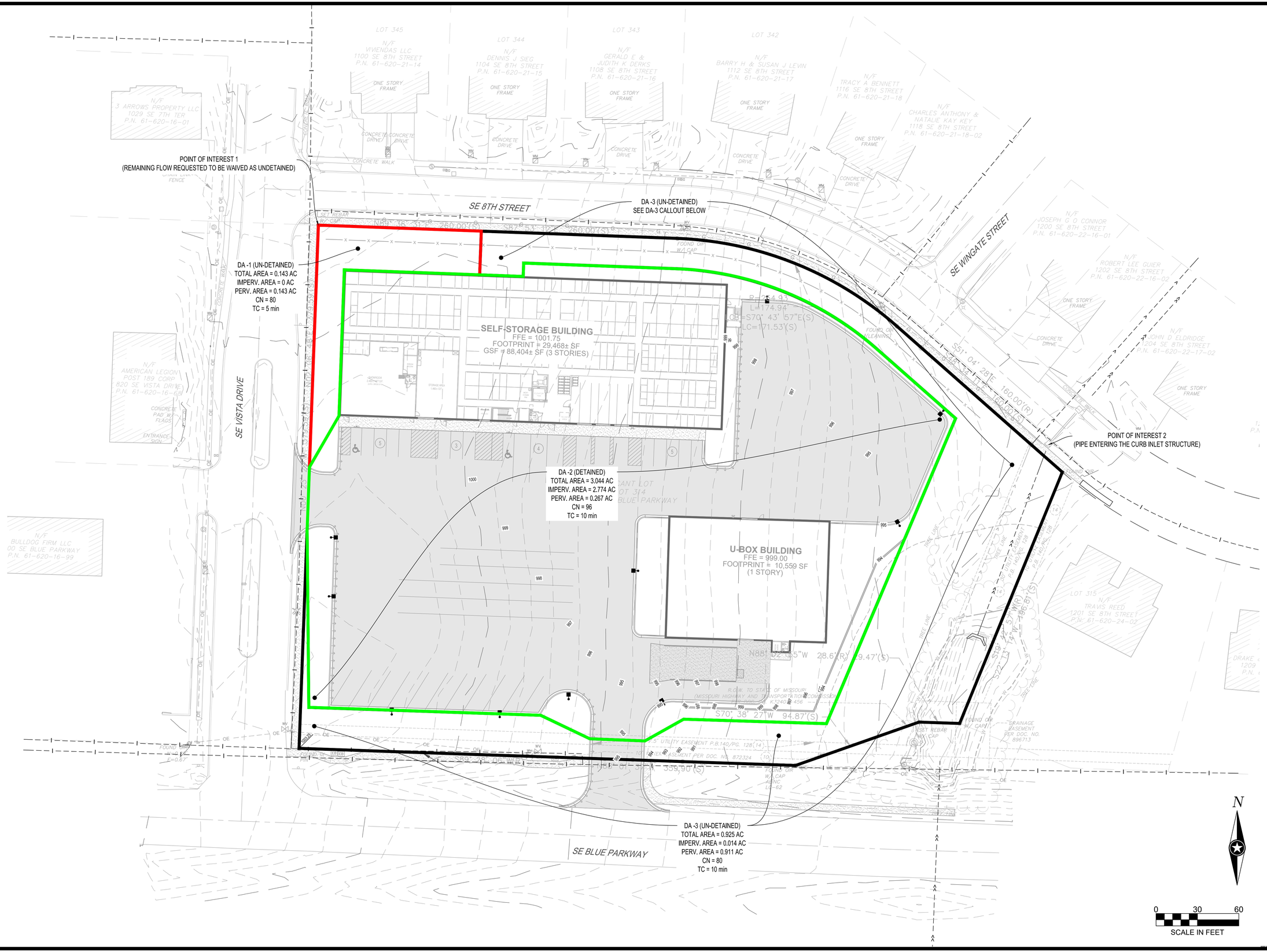
26154-DRAINAGE MAP

Appendix B: Proposed Conditions Drainage Map



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PROPOSED CONDITIONS DRAINAGE MAP

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26154-DRAINAGE MAP

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