

MACRO STORM WATER DRAINAGE STUDY

WINTERSET VALLEY 14TH PLAT

Site Acreage: 24.80 Acres

Lee's Summit, MO

PREPARED BY:



Revision

Date	Comment	By

TABLE OF CONTENTS

- 1. REPORT COVER SHEET**
- 2. TABLE OF CONTENTS**
- 3. GENERAL INFORMATION**
 - 3.1 FEMA FLOODPLAIN DETERMINATION**
 - 3.2 NRCS SOIL CLASSIFICATION**
- 4. METHODOLOGY**
- 5. EXISTING CONDITIONS ANALYSIS**
- 6. PROPOSED CONDITIONS ANALYSIS**
 - 6.1 DETENTION**
- 7. 40 HOUR EXTENDED DETENTION**
- 8. CONCLUSIONS & RECOMMENDATIONS**
- 9. EXHIBITS**

3. GENERAL INFORMATION

This storm study has been prepared to evaluate potential hydrologic impacts related to the proposed development of Winterset Valley 14th Plat and recommend improvements designed to mitigate any anticipated negative impacts. Winterset Valley 14th Plat (Development) is a proposed single family residential development consisting of thirty four (34) lots and undeveloped green space. The Development is located directly east of the Village at View High Development and adjacent to Winterset Valley 13th Plat on the east. The site currently consists of mainly prairie land with trees in the north and lining the property boundaries. The property is bounded by unnamed tributaries to Cedar Creek on the west and east. Future residential developments are planned to the south and north. The Village at View High retention basin is located along the west property line of the Development. Discharge from the subject retention basin is released and conveyed through the northwest corner of the property via a natural channel. Village at View High 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 24.80 acres.

3.1 FEMA FLOODPLAIN DETERMINATION

The property is located in an Area of Minimal Flood Hazard, Zone X, according to FEMA Firm Map Number 29095C0412G, 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 22, May 29, 2020. The existing site contains three major soil types:

- | | |
|-------|---|
| 10120 | Sharpsburg Silt Loam, 2 to 5 Percent Slopes
Hydrologic Soils Group (HSG): Type C |
| 10141 | Snead-Rock Outcrop Complex, 14 to 30 Percent Slopes
HSG: Type D |
| 30080 | Greenton Silty Clay Loam, 5 to 9 Percent Slopes
HSG: Type C/D |

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 of mainly prairie land with trees in the north and lining the property boundaries. The site contains three sub-basins referred to as the West Sub-basin, North Sub-basin and East Sub-basin 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., West Sub-basin drains to Point of Interest (POI) West. The Village at View High mixed use development captures and retains runoff from 64.33 acres. Offsite runoff drains through the western portion of the site after attenuation and is tributary to POI West. The Village at View High Storm Report and As-Built Retention Basin Plan may be found in Exhibit D for reference. The Existing Drainage Area Map is located in Exhibit E. Following is a brief description of each sub-basin.

West Sub-basin is generally located on the western half of the property and discharges to the north via sheet and shallow concentrated flow. The sub-basin consists of 10.33 total acres of which 10.00 acres are onsite. The West Sub-basin drains via sheet and shallow concentrated flow to a dry channel located along the western edge of the property. The West Sub-basin contains 2.92 acres onsite which will remain undeveloped along the west property line and will be accounted as such in the allowable discharge calculation. The West POI will be located at the channel flowline along the north property line. As discussed the Village at View High Development releases post attenuated runoff to the channel that runs along the western edge of the property. The existing peak discharge flow rates contributing from the Village at View High will be added to the West Sub-basin peak discharge rates to get a net or total peak discharge rate at the POI. Village at View High peak discharge rates have been taken directly from the approved storm report, see Exhibit D for reference.

North Sub-basin is generally located in the north central portion of the property and discharges via sheet and shallow concentrated flow to the north. The North Point of Interest will actually be a boundary in lieu of a specific discharge point due to the nature of the drainage. The sub-basin consists of treed area and contains 1.67 acres spread out along the north property line. The North Sub-basin is peripheral to the Development containing essentially zero improvement. The North Sub-basin being unimproved will continue its current drainage pattern via free release. Runoff from the North Sub-basin will not create any negative impacts downstream therefore it will not be discussed any further due to the purposes of this report.

East Sub-basin is generally located on the eastern portion of the property and discharges to Winterset Valley 13th Plat via sheet and shallow concentrated flow. Runoff from the East Sub-basin is collected and routed through the existing detention basin built in the 13th Phase. The approved storm report for Winterset Valley 13th Plat accounted for this flow and is included in Exhibit F for reference. The East sub-basin contains 13.13 acres onsite all of which are tributary to the 13th Phase detention basin. Runoff from the East Sub-basin will not create any negative impacts downstream therefore it will not be discussed any further due to the purposes of this report.

The following tables summarize the results of the Existing Conditions analysis. Composite curve number calculations by sub-basin may be found in Exhibit G. A complete breakdown of TR-55 unit hydrographs may be found in Exhibit H.

Table 5-1 Existing Conditions Sub-basin Data

Sub-basin	Area (ac.)	Composite CN	Tc (min.)
Village at View High	*	*	*
West	10.33	74	11.10

*See Village at View High Storm Study, Exhibit D.

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

Sub-basin	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
Village at View High (VVH)	28.84	83.95	189.68
West	19.28	39.85	72.97
Combined West + VVH	48.12	123.80	262.65

Peak discharge rates listed in Table 5-2 for the Village at View High are attenuated, see approved storm study in Exhibit D for reference.

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 Village at View High Sub-basin which will not be detained but routed through the West Sub-basin. Discharges from both offsite and undeveloped green space within the Development will be accounted for in accordance with the area-discharge ratio method. There are 2.92 acres in the West Sub-basin that will remain undeveloped and 0.33 acres that will contribute from offsite.

Allowable Release Example Calculations:

$$\text{West Sub-basin (2-Yr): } 28.84 + [(2.92+0.33)/10.33] \times 19.29 + ((10-2.92) \times 0.5) = \underline{17.35 \text{ cfs}}$$

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

Sub-basin	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
West	38.45	110.65	233.88

6. PROPOSED CONDITIONS ANALYSIS

The West Sub-basin will continue to drain to the wet property line via sheet and shallow concentrated flow in addition to an enclosed storm sewer system. An earthen detention basin is proposed along the west property line. The Village at View High retention basin will release directly into the new West Detention Basin. A 1.04 acre

undeveloped area just north of the detention basin will not be detained and will be free released. 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.)
West	10.33	80	9.20

Table 6-2 Proposed Conditions Sub-basin/Point of Interest Peak Discharge Rates

Sub-basin	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
West	27.12	50.46	85.99
Village at View High (VVH)	28.84	83.95	189.68
Combined West + VVH	55.96	134.41	275.67

As shown above in Table 6-2 Sub-basin Combined West + VVH will require detention to attenuate peak discharge rates below Allowable Release Rates as shown in Table 5-3 for Sub-basin/West POI.

6.1 DETENTION

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

Designation: West Detention Basin

Type: Earthen Basin

Side Slopes: 3:1 Max.

Bottom Slope: 2% Min., Turf Lined

Basin Bottom Elevation: 883.00 @ Influent Pipe

Basin Top Berm Elevation: 893.75

Basin Volume: 142,735 cf @ 892.00

Control Structure: 8'x5' deep precast concrete box, with interior 6" Weir wall

Weir Wall Orifices: (10) 1" Diameter on 4" Centers (Extended Detention) FL=882.50

Weir Crest EL=886.00, Crest Length 8'-0"

Weir Wall Crest Elevation: 886.00

Control Structure Top Elevation: 892.00

Control Structure Overflow Weir Openings: N/A

Control Structure Influent Pipe: 60" HDPE, FL (In) = 883.00, FL (Out) = 882.70, L=30.00', S=1.00%

Control Structure Effluent Pipe: 60" HDPE, FL (In) = 882.30, FL (Out) = 882.00, L=30.00', S=1.00%

Emergency Spillway: Earthen Broad Crested Weir, Crest Elevation=892.00, Crest Length=125'

Consecutive 100-YR Q=200.03 cfs Emergency Spillway HGL=892.72, Freeboard=1.03'

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	44.46	720	37.55	726	887.25	32,187
10-Year	89.86	740	82.13	749	888.46	54,747
100-Year	200.03	737	180.37	743	890.44	100,653

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 the West POI. 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)
West	38.25	82.57	181.27

As can be seen in the above table all peak discharge rates attributable to the 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, Existing and Allowable Release Rates at each Point of Interest.

Table 6-6 Point of Interest Peak Discharge Comparison

POI	Condition	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
West	Proposed	38.25	82.57	181.27
	Existing	48.12	123.80	262.65
	Difference	-9.87	-41.23	-81.38
	Allowable	38.45	110.65	233.88
	Difference	-0.20	-28.08	-52.61

Peak discharge rates at THE West POI will be reduced below allowable for all design storms analyzed.

7. 40 HOUR EXTENDED DETENTION/INFILTRATION BMP

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 K for 40 hour extended detention 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 attenuation of storm runoff for the Development in the West Sub-basin.

In conclusion, proposed peak discharge rates for each point of interest are below allowable release rates for all regulatory design storms with the addition of a detention Basin in the West Sub-basin. 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:

- 5:1 Side Slopes over 20% of the Basin