April 23rd, 2024

Stormwater Management & Drainage Report

Client

Clayton Properties Group
120 SE 30th Street
Lee's Summit, MO 64082

Project

Cobey Creek – 2nd Plat
Lee's Summit, MO

P.N. 21KC10060
& 24KC10002

04-23-2023

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1.0 - Introduction

This drainage study has been prepared for Clayton Properties Group DBA Summit Homes KC, to support the construction of Cobey Creek 2nd Plat, a mixed-use commercial and residential subdivision located in Lee's Summit, Missouri. The proposed construction activities consist of mass grading, roadway construction, utility installation, a wet detention basin construction, and improvements to the existing north basin. The total area for all five phases of the project is 97.3-acres, with Cobey Creek 2nd Plat (Phase 2) consisting of 43.8-acres.

The location of the Project Site can further be described as part of the southeast quarter of Section 29, Township 47 North, Range 31 West in the City of Lee's Summit, Jackson County, Missouri. The Cobey Creek 2nd Plat Project Site map can be seen in **Figure 1** and **Figure 2** below. The land is zoned Planned Mixed Use (PMIX). Adjacent properties to the north and west of the development are zoned Agricultural (AG). The adjacent property to the east is zoned Agricultural (A) and is located within the City limits of Greenwood, Missouri. The adjacent property to the south is located on the opposite side of MO Highway 150 and is zoned Agricultural (AG) and Planned Community Commercial (CP-2).

Figure 1: Project Location

Figure 2: Vicinity Map

2.0 – Master Drainage Study

2.1 Existing Conditions

2.1.1 General

Cobey Creek 2nd Plat is the second of five phases for the mixed-use development plan. A Macro stormwater report for the development was completed by Hg Consultants, Inc. in October of 2020, with a fourth and final addendum dated April 23, 2021 (together to be referred to herein as the "Master Drainage Study"). Refer to **Appendix H** for the Master Drainage Study.

Figure 3: Existing Site Condition (Nov. 05, 2021)

Phase 1 of Cobey Creek has been constructed and contains one dry detention basin in the northeast corner of the property and two of the three wet detentions basins that were originally approved at the south end. The wet detention basins are intended to function as a treatment train, acting in series as the upper basin(s) spill over into the lowest basin. The two existing wet detention basins from Phase 1 can be seen in **Figure 3**. A third wet detention basin (referred to as "Pond 1" in the Master Drainage Study and Phase 1 Wet Detention Basin As-Builts) was proposed for the Master Drainage Study that was not constructed in Phase 1. After a change in ownership of the property in 2021, OWN, Inc. was hired to finalize the design of the remaining phases of construction. After further investigation, it is assumed that the remaining wet detention basin was not constructed in Phase 1 due to a conflict with an existing 20" KCMO water main and easement that cuts across the southwest corner of the property. Upon this assessment, OWN, Inc. has re-designed the basin to avoid the existing water main conflict, while maintaining the functionality and intent of the originally approved wet detention basin.

Cobey Creek 2nd Plat (Phase 2) predominantly drains to the existing dry detention basin located at the northeast corner of the development (referred to herein as the "North Basin"), as intended in the Master Drainage Study and preliminary development plan. The Master Drainage Study indicates this basin was designed to serve as the primary measure of reducing stormwater discharge from the fully developed condition of the property using the Comprehensive Control Strategy defined in KCAPWA Section 5600 and provide 40-hour release of the 90 percent mean annual rainfall event for water quality. The Cobey Creek Layout Plan was revised slightly from the original Master Drainage Study. Due to this, a slight increase in curve number was realized for the contributing subbasin "P2". OWN, Inc. has revised the North Basin design to maintain the functionality and intent of the originally approved Master Drainage Study. Refer to **Appendix A** for the proposed drainage area map and Master Drainage Study drainage area map.

3.0 - Objective

This drainage study summarizes the hydrologic and hydraulic analyses of the third proposed wet detention basin and the existing north dry detention basin, performed by OWN, Inc. The third wet detention basin proposed in the Master Drainage Study was not constructed in Phase 1 and therefore will be constructed in Phase 2. The existing north basin constructed in Phase 1 will be regraded due to the increase in CN of drainage area "P2". The design and outfall conditions for the proposed wet detention basin and existing north dry detention basin will meet or exceed those of the previously completed Master Drainage Study. This report has two objectives, to demonstrate that the proposed uppermost wet detention basin will not cause any negative impacts on the two existing wet basins below, and that the lowermost wet basin and north dry basin will continue to meet the comprehensive control and water quality discharge requirements of the City of Lee's Summit, Missouri, as designed and outlined in the original Master Drainage Study.

4.0 – Mapping

The Project Site was surveyed by OWN, Inc. and is the source of the topographic mapping data that was utilized in this drainage analysis. This topographic information was also used in the civil engineering design of the proposed site improvements, performed by OWN, Inc. To view topographic contours of the pre-developed and post-developed site, refer to **Appendix A** of this report.

5.0 – Site Description

5.1 Existing Conditions

5.1.1 General

The existing Project Site consists of an undeveloped, open grassed space. The turf is in good condition and the drainage is split between two large areas. 16.73-acres drain southeast to the proposed wet detention basin, which outfalls to the two existing wet detention basins in series. The final basin in the wet detention series (existing) outfalls south of MO Highway 150 to an unnamed tributary to Lake Winnebego. 74.34-acres drain to the northeast to the existing north dry detention basin which outfalls northeast of the site to an unnamed tributary to Big Creek. The Project Site is located within an area of minimal flood hazard (Zone X) as shown of FEMA flood hazard map 29095C0551G effective 1/20/2017. Refer to Map in **Appendix C** for more information. Based on the Soil Survey of Jackson County by the USDA Natural Resource Conservation Service, the Project Site soil type is split between Arisburg Silt Loam (1 to 5 percent slopes, Hydrologic Soil Group C), and Sampsel Silty Clay Loam (2 to 5 percent slopes & 5 to 9 percent slopes, Hydrologic Soil Group C). For more information on the existing soil conditions, refer to the Soil Report included in **Appendix B** of this report.

5.1.2 Existing Drainage

The drainage area “EX1” collected by the existing wet detention basins is approximately 16.73-acres, in which 3.71-acres originates from offsite and flows onto

the property from the west. This drainage flows to the southeast via sheet flow and shallow concentrated flow, where it is collected by the series of two existing wet detention basins. The drainage area "EX2" collected by the existing north dry detention basin is approximately 74.34-acres, in which 8.47-acres originates from offsite and flows onto the property from the west and east. This drainage flows from the adjacent east and west properties via sheet flow and shallow concentrated flow where it is collected by the north basin. For more information on the existing drainage conditions of the site, refer to the Existing Drainage Map located in **Appendix A** of this report.

5.1.3 Watershed

The mixed-use development resides within an unnamed tributary of Big Creek Watershed. Stormwater leaves the project site in two locations. The majority of the development area drains northeast to the existing North Basin which outflows to an unnamed tributary to Big Creek. A smaller portion of the site drains south to the two existing wet detention basins in series, which outfalls south of MO Highway 150 to an unnamed tributary of Lake Winnebego.

5.2 Proposed Conditions

The proposed wet detention basin volume and outfall conditions are designed to meet or exceed those of the design and capacity of the original Master Drainage Study. The series of wet detention basins have been collectively designed for the 2-yr, 10-yr, 100-yr, and Water Quality design storm, per City of Lee's Summit, Missouri requirements. The location of the basin has been shifted slightly from its original location defined in the Master Drainage Study and Phase 1 plans, due to an existing water main and easement conflict that was identified to the southwest of the proposed basin.

The proposed drainage area “P1.1” collected by the third wet detention basin is 2.74-acres in size and follows the drainage pattern of existing conditions, since the majority of flow is from off-site. The stormwater runoff from the west will drain eastward to the proposed wet detention basin and be collected before it reaches the existing wet detention basins. This will provide an additional measure of water quality due to siltation, limit the peak runoff flowing from offsite, and provide a culvert for water flow under the proposed entry drive of SE Sunset Ridge. The proposed basin will outfall into the existing Phase 1 wet detention basins in series, as planned in the Master Drainage Study. Stormwater flowing out of the proposed wet detention basin will be controlled by a 24-inch flared end section as shown in **Figure 4**. The full plan and profile of the proposed wet detention basin can be found in **Appendix A.** Additional storage was added to the bottom of the wet detention basin to allow additional volume for silt accumulation, acting as a water quality pool to enhance sedimentation and pollutant removal of dissolved nutrients and urban pollutants.

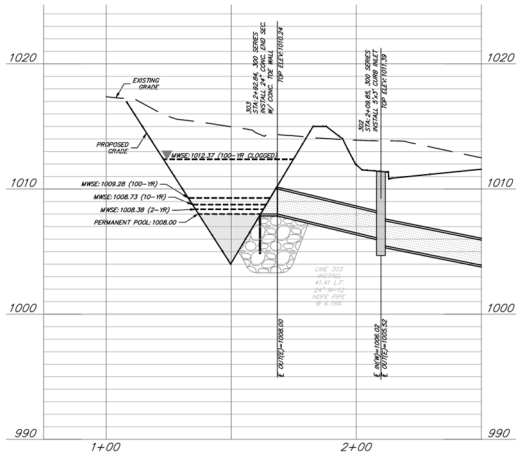


Figure 4: Proposed Wet Detention Basin Outlet Control Structure Visual

Due to the Cobey Creek Development increasing in density the curve number for the drainage area “P2” contributing to the existing north dry detention basin has increased. Therefore, the north dry detention basin was also examined in order to ensure it can adequately handle the 2-yr, 10-yr, 100-yr, and Water Quality design storm as originally designed.

The drainage area collected by the north basin is 91.00-acres in size. A majority of the site runoff, 80.42-acres, in “P2” is collected by a series of storm inlets throughout the site that flow to the north basin. 10.58-acres of the runoff flows from offsite via sheet flow and shallow concentrated flow to a series of storm inlets that take it to the north basin. The offsite flow was considered bypass flow and was not shown in the north basin performance calculations. The north basin has been regraded, keeping the overall limits of the basin the same, to increase storage in the basin. The outlet control structure has also been reworked to meet the release rates in the previously approved Master Drainage Study. The outfall for the existing basin will remain the same, two 48” HDPE pipes releasing the water northeast of the site. For more information on the proposed development drainage patterns, refer to the Proposed Drainage Map in **Appendix A**.

6.0 – Hydrologic Analysis

6.1 Methodology

The original drainage study submitted and approved with Phase 1 of Cobey Creek utilized Section 5600 – Storm Drainage Systems & Facilities, City of Lee’s Summit, Missouri, Design Criteria and the Kansas City Metropolitan Chapter of the American Public Works Association, Section 5600 (February 2011) as its guideline. This section of KCAPWA defines the “Comprehensive Control Strategy”, which includes a 40-hour extended detention for the 90 percent mean annual rain event. The release from drainage area defined as “P1” in the originally approved Master Drainage Study is controlled by an outlet control structure, which was designed and installed in the lowest of the existing wet detention basins to meet all KCAPWA requirements, as it is the ultimate release point for all three of the wet detention basins. Since no changes are being made to the existing outlet control structure of the lowest wet detention basin, the methodology is to prove that the drainage area captured by the third wet basin in the series will not produce any surcharging or negative impacts to the

functionality of the lower two existing wet basins. This Micro drainage analysis is contained within the drainage areas of “EX1” and “P1.1”. Since the Master Drainage Study has already considered this area in comprehensive control calculations, a Pre vs. Post analysis was utilized for the third and final wet detention basin. To complete this investigation, the SCS TR-55 method was used to calculate runoff curve numbers and *Hydraflow Hydragraphs* software extension for *AutoDesk Civil 3D* was used to evaluate storm drainage and storage requirements, as well as aid in the design/sizing of the outlet works of the proposed wet basin.

The release from drainage area defined as “P3” in the originally approved Master Drainage Study is controlled by an outlet control structure, which was designed and installed to meet all KCAPWA requirements. Since the Cobey Creek Development increased in density after the Master Drainage Study was approved, the methodology is to prove that the existing north basin after being regraded and the outlet structure reworked will improve upon the discharge rates of the previously approved Master Drainage Study and Comprehensive Control. To complete this investigation, the SCS TR-55 method was used to calculate runoff curve numbers and *Storm and Sanitary Analysis* software extension for *AutoDesk Civil 3D* was used to evaluate storm drainage and storage requirements, as well as aid in the design/sizing of the outlet works of the proposed wet basin. The *Storm and Sanitary Analysis* software was used to model the existing north dry detention basin due to the complexity of the existing outlet structure and the inability of *Hydraflows Hydrographs* software to correctly model it.

A Type II 24-hour rainfall distribution was used to develop all stormwater hydrographs. The 2-year, 10-year, and 100-year, 24-hour rainfall depths used within the model were determined from NOAA Atlas 14, Volume 8, Version 2. To view the NOAA data, refer to **Appendix D** of this report. The following rainfall depths were used for this study:

P_2 = 3.69 in.
P_{10} = 5.62 in.

P_{100} = 9.19 in.

6.2 Curve Number Calculations

Table 1 of this report summarizes the weighted curve number calculations that were used in this drainage analysis. The surface cover type for drainage areas "EX1" and "P1.1" is open grassed space, in good condition (CN=74). As the drainage area is primarily offsite and not being developed, the pre-development and post-development curve numbers are the same for "EX1" and "P1.1". The surface cover type for drainage area "EX2" is mixed with approximately 45.44-acres of the site undeveloped with open grassed space, in good condition (CN=74) and 28.9-acres of the site partially developed with ¼ acre lots (CN = 83). In the fully developed condition drainage area "P2" has approximately 50.5-acres of 1/8 acre lots (CN=90), 31.42-acres of ¼ acre lots (CN=83), 6-acres of open grassed space, in good condition (CN=74), and 4.5-acres of Row Crops contoured and terraced, in good condition (CN=78).

Table 1: SCS Curve Number Calculations

SCS CURVE NUMBER CALCULATIONS				
EXISTING & PROPOSED DRAINAGE AREAS				
Drainage Area	**EX1**	**P1.1**	**EX2**	**P2**
Hydrologic Soil Group	C	C	C	C
Total Area (acres)	2.8	2.8	74.34	92.42
Grassed Area, Good Condition (CN=74)	2.8	2.8	45.44	6
1/4 Lot Area (CN=83)			28.9	31.42
1/8 Lot Area (CN=90)				50.5
Row Crops, C&T (CN=78)				4.5
Composite Curve Number	**74**	**74**	**78**	**86**

6.3 Time of Concentration

The SCS TR-55 method was used to calculate the time of concentration for the existing and proposed drainage areas. **Table 2** of this report summarizes the time of concentration results that were found. For more information on the time of

concentration calculations, refer to the Time of Concentration Calculations located in **Appendix E**.

Table 2: Time of Concentration

EXISTING SUB-BASINS	
Drainage Area	**TC (Min)**
EX1	33.5
P1.1	33.5
EX2	39.1
P2	22.4

6.4 Detention Basin Performance

The proposed wet detention basin has a capacity of 2.86 acre-feet of storage and is designed to control the 100-year design storm with greater than 1.0-foot of freeboard. **Table 3** shows the performance of the detention basin for a 2-year, 10-year, and 100-year design storm. As shown in **Figure 4**, the 24-inch outfall limits the flow of water leaving the basin, which causes water to be temporarily stored and released at a controlled rate. The permanent pool elevation of the wet detention basin is 1008.00, which is the same elevation as the outlet pipe flowline. Additional storage was added to the bottom of the wet detention basin to allow for silt accumulation, acting as a water quality pool. The additional storage allows for at least 5-years of sediment accumulation at the bottom of the basin without impact to the intended functionality of the wet detention basin. The volume of the proposed wet detention basin is 1.39 acre-feet for the 100-year design storm with a maximum storage capacity of 2.86 acre-feet. Because no changes are being made to the existing outlet control structure of the lowest wet detention basin, the release rates will remain the same as the approved Mater Drainage Study. For more information about the proposed wet detention basin, refer to the *Hydraflow Hydrogrpahs* report located in **Appendix F**.

Table 3: Proposed South Wet Detention Basin Performance

PROPOSED SOUTH WET DETENTION BASIN					
BASIN PERFORMANCE					
DESIGN STORM	**Flow In (CFS)**	**Flow Out (CFS)**	**Peak Storage (AC-FT)**	**Peak Stage Over Permanent Pool (FT)**	**Peak Elevation (FT)**
2-YEAR	3.07	0.88	1.54	0.38	1008.38
10-YEAR	6.65	3.01	1.66	0.73	1008.73
100-YEAR	13.97	8.14	1.85	1.28	1009.28

The existing dry north detention basin has a capacity of 11.89 acre-feet of storage and is designed to control the 100-year design storm with greater than 1.0-foot of freeboard. **Table 4** shows the performance of the detention basin for a 2-year, 10-year, and 100-year design storm in comparison to the approved release rate from the Master Drainage Study and the allowable comprehensive control release rates.

As shown in **Appendix G**, the revised outlet control structure limits the flow of water leaving the basin, which causes water to be temporarily stored and released at a controlled rate. The existing basin has been regraded to maximize the storage capacity and limit the release of the 2-year, 10-year and 100-year design storm. As shown in **Table 4** the 2-year design storm releases at a rate that exceeds the 2-year comprehensive control rate, however, is 9% less than the approved Master Drainage Study. While many options have been explored to alleviate this, they have been unsuccessful due to the extents of the existing basin being locked in by the property line to the west and existing sanitary main to the east, as shown in **Appendix A**. As shown in **Table 4** all other design storms release at a rate that meets comprehensive control requirements. For more information about the existing north dry detention basin revisions, refer to the *Storm and Sanitary* report located in **Appendix G**.

Table 4: Existing North Dry Detention Basin Performance

EXISTING NORTH DRY DETENTION BASIN					
BASIN PERFORMANCE					
Design Storm	**Flow In (CFS)**	**Flow Out (CFS)**	**Flow Out from Master Drainage Study (CFS)**	**Comp. Control Allowable (CFS)**	**Max Water Surface Elevation (FT)**
WQv	22.73	6.10			
2-YEAR	172.54	62.74	68.55	40.21	973.68
10-YEAR	305.71	129.41	194.57	160.84	975.68
100-YEAR	484.44	233.80	272.78	241.26	977.62

Water Quality Event (1.37"/24 hours) releases over 48 hours as shown in **Appendix G*

6.5 Water Quality

The drainage analysis also looked at Water Quality per APWA 5600. This section of KCAPWA defines the "Comprehensive Control Strategy", which includes a 40-hour extended detention for the 90 percent mean annual rain event. Because the outlet structure for the existing lowest wet detention was not altered from the original Master Drainage Study, the 90 percent mean annual rain event will release over 40 hours as originally designed. The uppermost proposed wet detention basin was also designed to allow for 5 years of silt accumulation to improve the water quality. The existing north detention basin outlet structure was designed to release the 90 percent mean annual rain event over 48 hours as shown in **Appendix G**.

6.6 Peak Flow Rates

The drainage analysis performed on the proposed wet detention basin is intended to prove that the area flowing into the third proposed wet detention basin will not have any negative downstream impacts when compared to the originally approved master drainage study. To do this, pre-development and post-development peak flow rates were compared for the contributing area flowing into the middle wet detention basin as it exists today (most upstream basin without basin three) and when the proposed wet basin is installed. **Table 5** of this report summarizes the pre-

development and post-development flow rates for a 2, 10, and 100-year design storm.

Table 5: Peak Flow Rates of South Wet Detention Basin

PRE-DEVELOPMENT vs. POST-DEVELOPMENT	
2-YEAR PEAK FLOW RATE	
Existing (CFS)	**Proposed (CFS)**
3.12	0.97
10-YEAR PEAK FLOW RATE	
Existing (CFS)	**Proposed (CFS)**
6.77	3.29
100-YEAR PEAK FLOW RATE	
Existing (CFS)	**Proposed (CFS)**
14.23	8.71

7.0 – Downstream Impacts

Using the *Hydraflow Hydrographs* extension for *AutoDesk Civil 3D*, OWN, Inc. developed a drainage model that was able to assess the peak runoff and detention release rates of the third, uppermost wet detention basin for a 2-yr, 10-yr, and 100-yr design storm. The results of this analysis conclude that the proposed wet detention basin will reduce peak flow rates from the drainage area "P1.1" such that it will not have any negative downstream impacts on the two existing wet detention basins, and that the existing outlet control structure contained in the lowest of the three basins will continue functioning as designed in the originally approved Master Drainage Study, meeting all KCAPWA and City of Lee's Summit stormwater discharge requirements. For more information on the drainage model, refer to the full *Hydraflow Hydrographs* report in **Appendix F**.

Using the *Storm and Sanitary Analysis* extension for *AutoDesk Civil 3D*, OWN, Inc. developed a drainage model that was able to assess the peak runoff and detention release rates of the existing dry basin for a 2-yr, 10-yr, and 100-yr design storm. The results of this analysis conclude that the revised north dry detention basin will reduce peak flow rates from the previously approved Master Drainage Study for the 2-year,

10-year, and 100-year design storm. Overall, the revised north detention basin function will improve from the originally approved Master Drainage Study, meeting KCAPWA and City of Lee's Summit stormwater discharge requirements and reducing the 2-yr release rate by 9%. For more information on the drainage model, refer to the full *Storm and Sanitary Analysis* report in **Appendix G**.

8.0 – Peripheral Undetained Drainage

There are two peripheral undetained drainage areas on the northwest and southeast corners of the site labeled "EX3/P3" and "EX4/P4" in **Appendix A**. Due to the grading of the site the runoff from these areas is not feasible to capture. A Design Criteria Modification Request was made and approved in September of 2022 to allow these areas to drain offsite undetained, ensuring the post-development flow did not exceed the pre-development flow. The approved Lee's Summit Design & Construction Manual Design Criteria Modification Request can be found in **Appendix H**.

9.0 – Conclusion

Cobey Creek 2nd Plat is the second of five phases for the mixed-use development plan. A Master Drainage Study was completed by HG Consultants and was approved with Cobey Creek 1st Plat (Phase 1). The drainage study was designed for a majority of the drainage for the five-phase development to be conveyed to the existing north dry detention basin, which was constructed in the northeast corner of the property during Phase 1. The study also accounted for drainage on the south side of the development using a series of three wet detention basins. Two of the three wet detention basins were constructed with Phase 1, leaving the third and uppermost wet detention basin to be constructed in Phase 2. The configuration and outlet conditions for the existing lowermost wet detention basin was designed to release runoff from all three wet detention basin drainage areas and utilized the Comprehensive Control

Strategy defined by KCAPWA, including the 40-hour extended release of the 90 percent mean annual stormwater volume.

This drainage study has analyzed the drainage area contributing to the uppermost wet detention basin and concludes using the Pre vs. Post methodology, that the construction of the third wet detention basin will not negatively impact the existing wet detention basins, and that the existing outlet control structure will continue to function as designed to meet the Comprehensive Control Strategy and Water Quality volume release that the City of Lee's Summit requires.

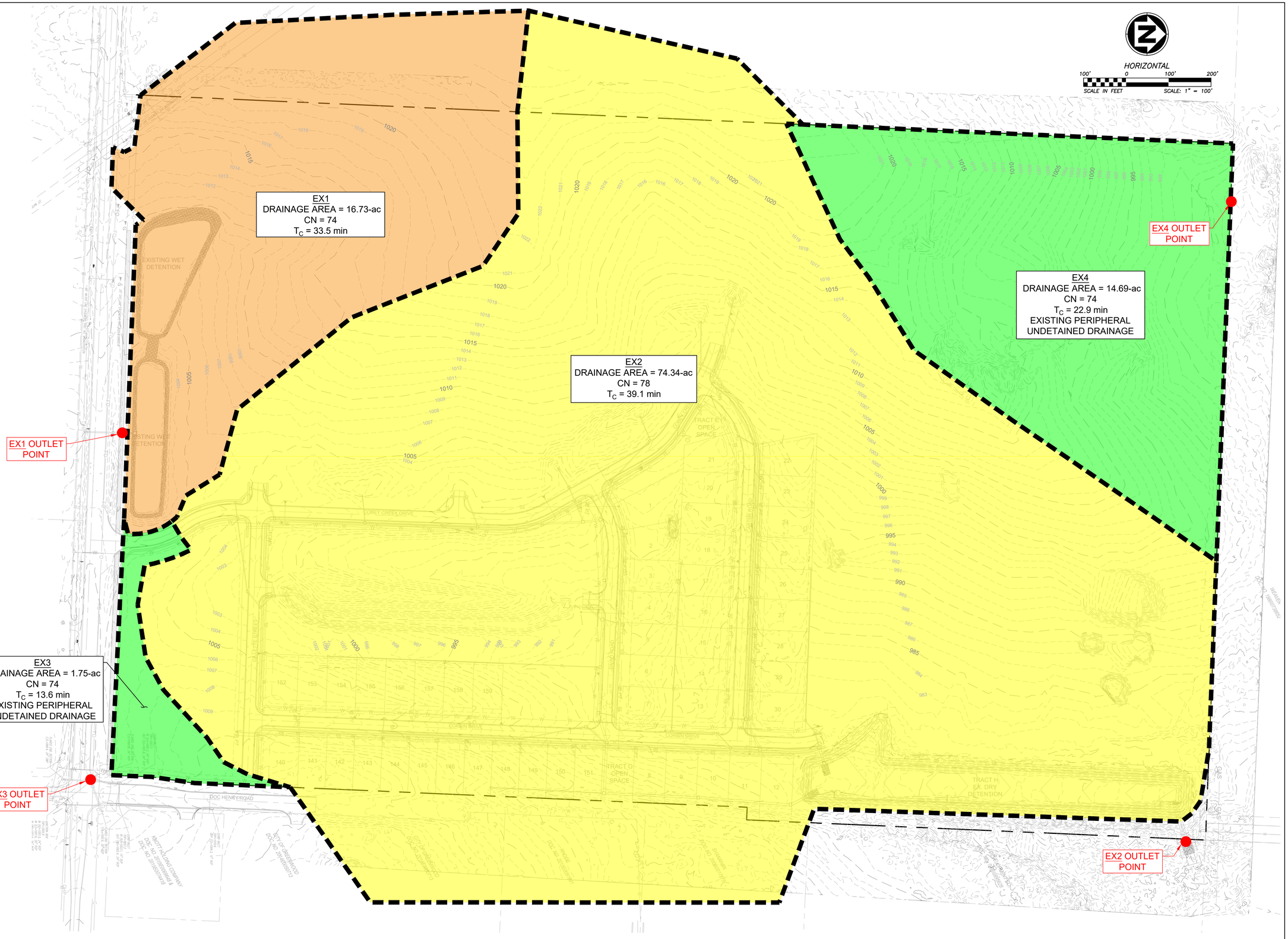
This drainage study also analyzed the drainage area contributing to the existing north dry detention basin. It was determined the north basin would need to be regraded and the outlet structure revised to meet the previously approved release rates. With the revisions to the north dry detention basin it was determined the function would improve with the grading and outlet changes and will release at a rate less than what was approved in the Master Drainage Study.

The majority of the site drains to the north and south detention basins. With the improvements to the north dry detention basin and construction of the south wet detention basin the runoff from a majority of the site will be contained and released at a rate lower than the previously approved Master Drainage Study, meeting KCAPWA and City of Lee's Summit stormwater discharge requirements. The stormwater from the two peripheral undetained drainage areas will release from the site at a lower rate than in the existing condition as was shown in the approved Lee's Summit Design & Construction Manual Design Criteria Modification Request from September 2022. The 2-year release rate from the north basin will flow 9% less than the previously approved Master Drainage Study.

10.0 – References

AutoDesk, Civil 3D, 2023
AutoDesk, Hydraflow Hydrographs Extension for AutoCAD Civil 3D, 2023
AutoDesk, Hydraflow Express Extension for AntoCAD Civil 3D, 2023
AutoDesk, Storm and Sanitary Analysis Extension for AntoCAD Civil 3D, 2023
City of Lee's Summit, Section 5600 - Storm Drainage Systems & Facilities, Design Criteria, 2020
APWA, Section 5600 - Storm Drainage Systems & Facilities, 2011
Google Earth, Geographic Information System, 2024
NOAA, Atlas 14, Volume 8, Version 2, 2024
USDA, Web Soil Survey, 2024

Appendix A



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FORMERLY ANDERSON ENGINEERING

CLAYTON PROPERTIES GROUP

COBEY CREEK - 2ND PLAT

S29, T47N, R31W
LEE'S SUMMIT, JACKSON COUNTY, MISSOURI

REVISIONS

NO.	DESCRIPTION	DATE

DRAWING INFORMATION

PROJECT NO: 21KC10060
DRAWN BY: JK
CHECK BY: TF
ISSUED FOR: FOR REVIEW
ISSUED DATE: 03/22/2024

PRELIMINARY
NOT FOR CONSTRUCTION OR PERMIT

ISSUED BY: TREVOR FOX
LICENSE NO:

A licensed Missouri Engineering Corporation
COA 00062

SHEET TITLE

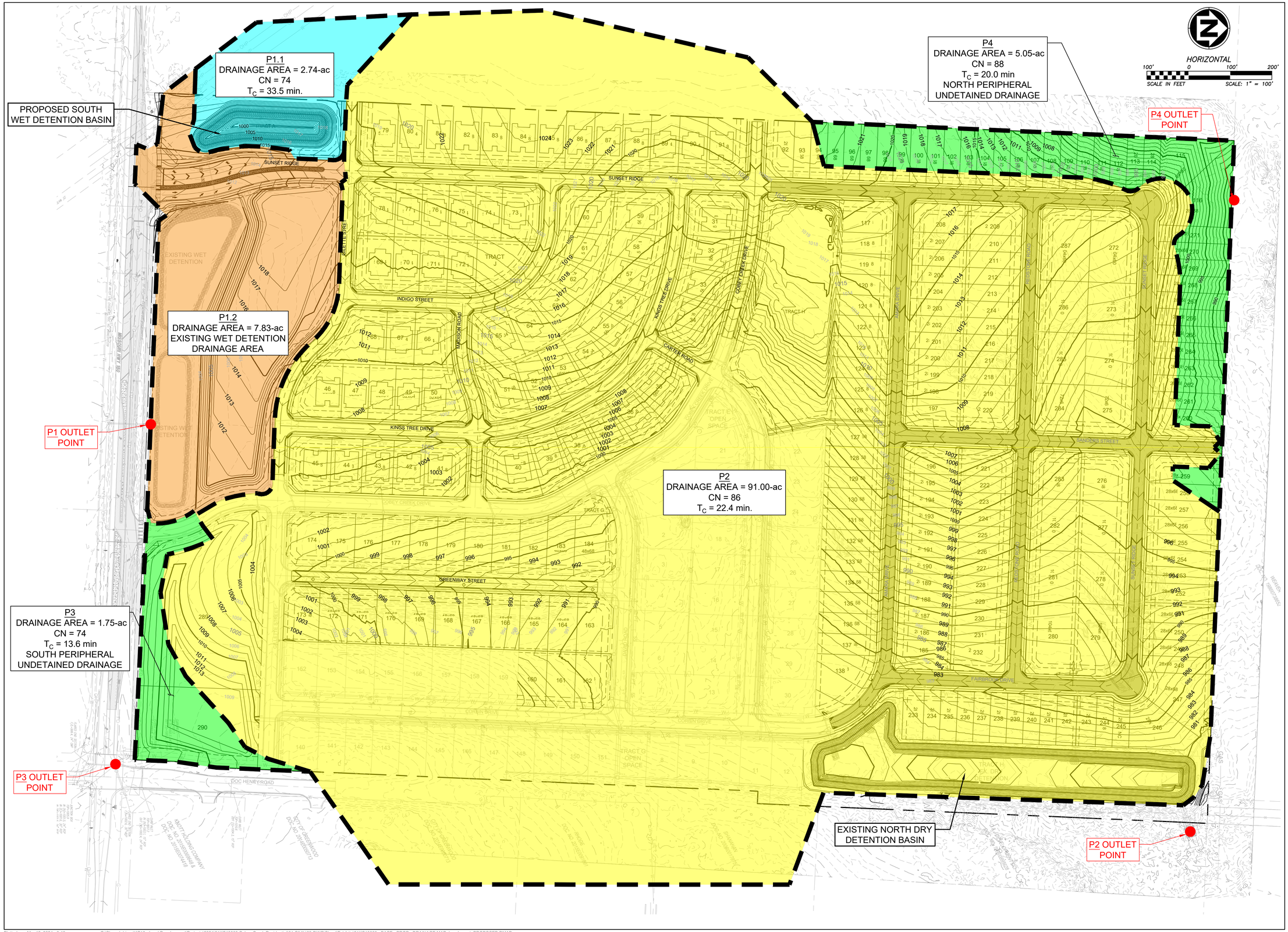
EXISTING DRAINAGE MAP

SHEET NUMBER

A1

Mar 19, 2024 - 3:44pm Plotted By: jkonnesky_ae-inc G:\Shared drives\KC10 - Land Development\Projects\2021\21KC10060 Cobey Creek Residential\01 CIVIL\03-DWG\Sheet\Exhibits\21KC10060 - BASE - PROP - DRAINAGE MAP.dwg Layout: EXISTING DMAP

Plotted on: Mar 19, 2024 - 3:44pm G:\Shared drives\KC10 - Land Development\Projects\2021\21KC10060 Cobey Creek Residential\01 CIVIL\03-DWG\Sheet\Exhibits\21KC10060 - BASE - PROP - DRAINAGE MAP.dwg Layout: EXISTING DMAP



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COBEY CREEK - 2ND PLAT

S29, T47N, R31W
LEE'S SUMMIT, JACKSON COUNTY, MISSOURI

REVISIONS

NO.	DESCRIPTION	DATE

DRAWING INFORMATION

PROJECT NO: 21KC10060
DRAWN BY: JK
CHECK BY: TF
ISSUED FOR: FOR REVIEW
ISSUED DATE: 03/22/2024

PRELIMINARY
NOT FOR CONSTRUCTION OR PERMIT

ISSUED BY: TREVOR FOX
LICENSE NO:

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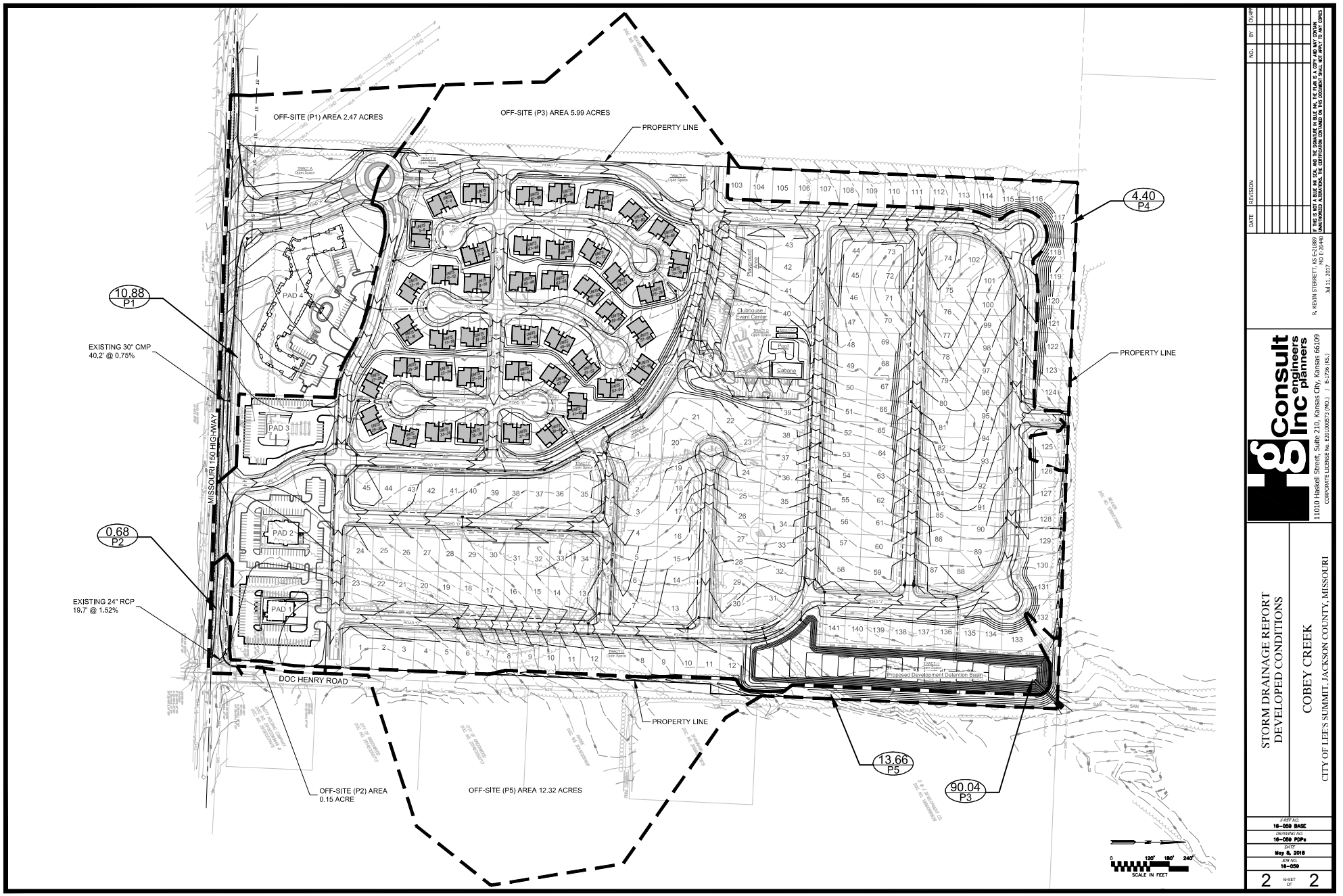
SHEET TITLE

PROPOSED DRAINAGE MAP

SHEET NUMBER

A2

Plotted on: Mar 19, 2024 - 3:46pm
G:\Shared drives\KC10 - Land Development\Projects\2021\21KC10060 Cobey Creek Residential\01 CIVIL\03-DWG\Sheet\Exhibits\21KC10060 - BASE - PROP - DRAINAGE MAP.dwg Layout: PROPOSED DMAP



DATE	REVISION	NO.	BY	CK/APP

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R. KEVIN STERRETT, KS E-21889
MO E-26440
Jul 11, 2017

Consult Inc engineers planners
11010 Haskell Street, Suite 210, Kansas City, Kansas 66109
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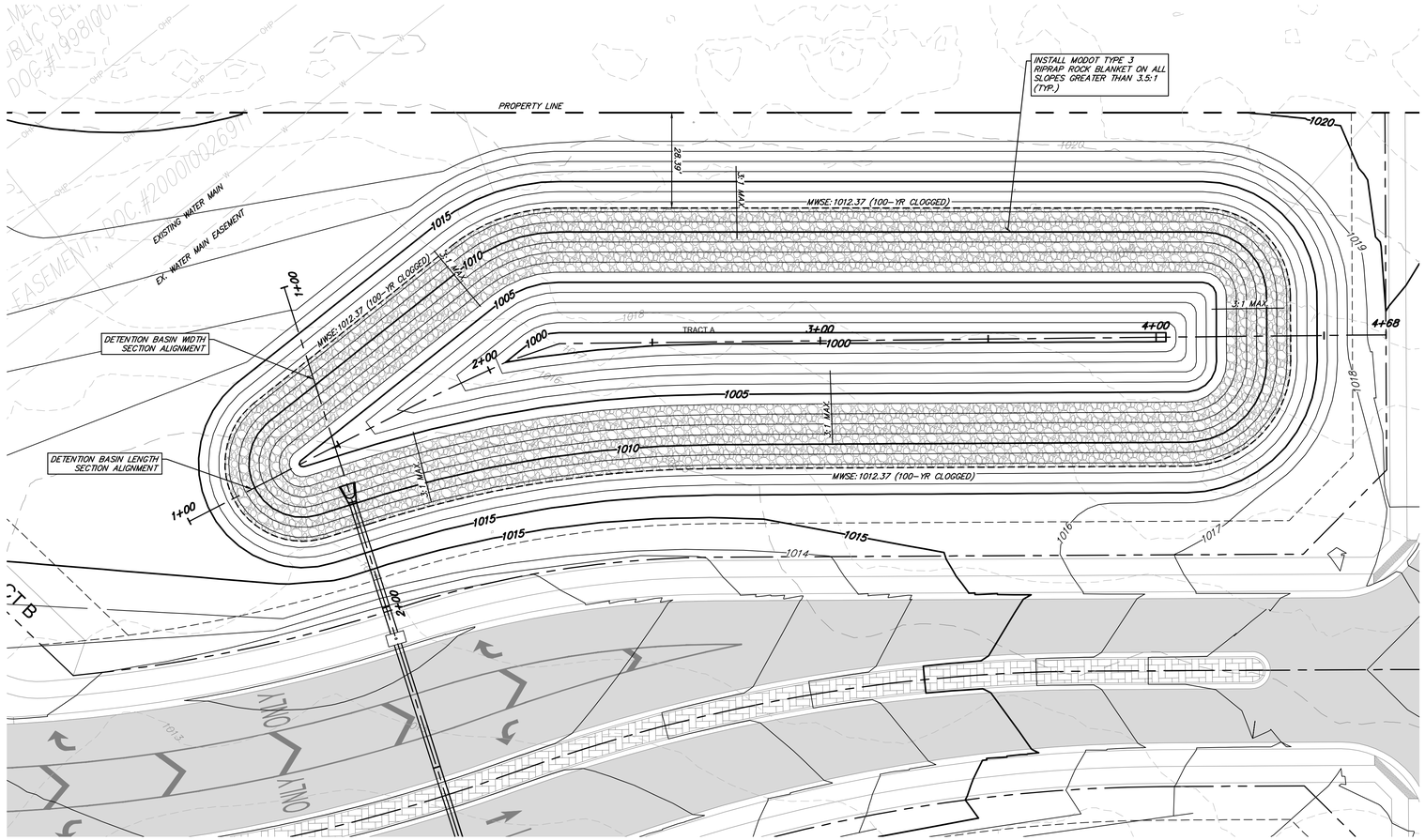
STORM DRAINAGE REPORT
DEVELOPED CONDITIONS

COBEY CREEK
CITY OF LEE'S SUMMIT, JACKSON COUNTY, MISSOURI

X-REF NO. 16-059 BASE
DRAWING NO. 16-059 PDPs
DATE May 8, 2018
JOB NO. 16-059
SHEET 2 OF 2

Appendix A3



WATER SURFACE ELEVATIONS:

PERM. POOL	– 1008.00
2–YR	– 1008.38
10–YR	– 1008.73
100–YR	– 1009.28
100–YR CLOGGED	– 1012.37

OUTLET DISCHARGE RATES:

2–YR	– 0.88 CFS
10–YR	– 3.01 CFS
100–YR	– 8.14 CFS
100–YR CLOGGED	– 0.00 CFS

LEGEND

- 900 — PROPOSED MAJOR CONTOUR
- 901 — PROPOSED MINOR CONTOUR
- 900 — EXISTING MAJOR CONTOUR
- 901 — EXISTING MINOR CONTOUR
- RIPRAP STABILIZATION
- RIGHT–OF–WAY
- ROAD CENTERLINE
- PROPERTY LINE

WET DETENTION BASIN GENERAL NOTES:

1. CONTRACTOR TO CONSTRUCT STORMWATER MANAGEMENT FACILITIES, SPECIFICALLY THOSE FEATURES RELATED TO DETENTION, PRIOR TO ANY LAND DISTURBANCE OF THE SITE AND PRIOR TO THE CONSTRUCTION OF ANY OTHER SITE DEVELOPMENT WORK AS NOT TO EFFECT DOWNSTREAM NEIGHBORS WITH UNDETAINED STORMWATER DISCHARGE.
2. AN AS–GRADED AND AS–BUILT DRAWING SHALL BE SUBMITTED TO AND REVIEWED BY THE CITY FOR THE DETENTION BASIN. THIS SHALL BE REQUIRED PRIOR TO ISSUANCE OF A CERTIFICATE OF SUBSTANTIAL COMPLETION. ALL PRECAUTIONS SHOULD BE TAKEN TO ENSURE DETENTION POND AND OUTLET STRUCTURE ARE CONSTRUCTED ACCORDING TO THE APPROVED PLANS; VOLUMES AND ELEVATIONS ARE CRITICAL FOR AS–BUILT APPROVAL. THE CITY SHALL BE PROVIDED WITH AN AS–BUILT SURVEY OF THE DETENTION BASIN, OUTLET STRUCTURE INCLUDING ALL WEIR ELEVATIONS AND STORM SYSTEM INCLUDING ALL THE INVERTS, STAMPED BY A MISSOURI LICENSED ENGINEER.
3. ALL SIDEWALK ADJACENT TO TRACTS SHALL BE CONSTRUCTED WITH PUBLIC IMPROVEMENTS, ALONG WITH ALL ADA ACCESSIBLE SIDEWALK RAMPS.
4. ALL SEDIMENT ACCUMULATED THROUGHOUT THE DURATION OF CONSTRUCTION SHALL BE DREDGED OR SKIMMED FROM BOTTOM OF WET POND PRIOR TO FINAL ACCEPTANCE. CONTRACTOR SHALL MAKE GREATEST EFFORT TO PREVENT SEDIMENT BUILDUP AND USE DEWATERING PRACTICES OUTLINED IN THE SWPPP UNTIL CONSTRUCTION IS COMPLETED.

EMERGENCY SPILLWAY NOTES:

24" OUTLET PIPE SHALL FUNCTION AS EMERGENCY SPILLWAY.

STORAGE VOLUME:

2–YR: 58,939 FT³

10–YR: 64,096 FT³

100–YR: 72,718 FT³

DESIGN MAX: 147,863 FT³

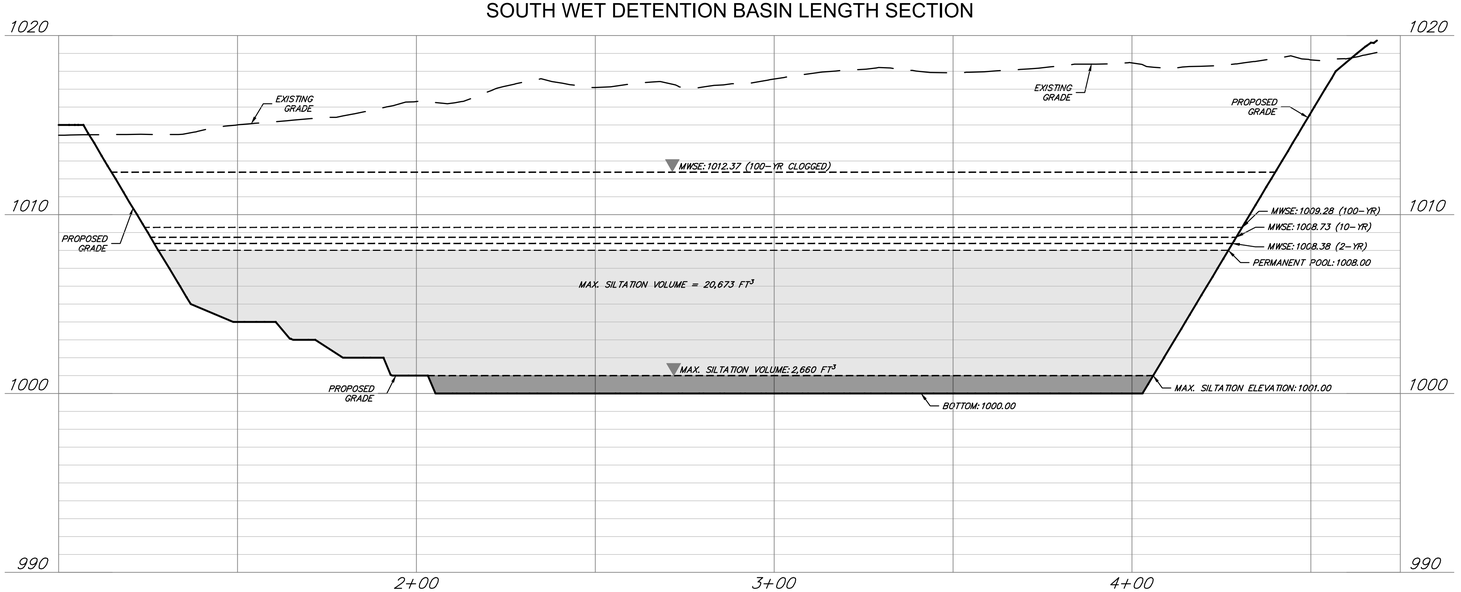
0 20 40

4 0

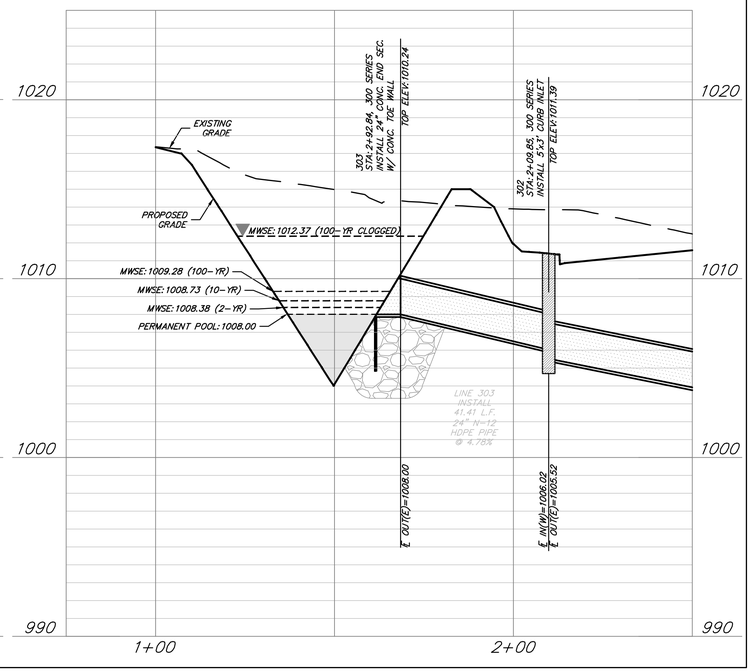
HORIZ.: 1"=20'

VERT.: 1"=4'

SOUTH WET DETENTION BASIN LENGTH SECTION



SOUTH WET DETENTION BASIN WIDTH SECTION



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COBEY CREEK - 2ND PLAT

S29, T47N, R31W
LEE'S SUMMIT, JACKSON COUNTY, MISSOURI

REVISIONS

NO.	DESCRIPTION	DATE

DRAWING INFORMATION

PROJECT NO: 21KC10060
DRAWN BY: JK
CHECK BY: TF
ISSUED FOR: FOR REVIEW
ISSUED DATE: 03/22/2024

PRELIMINARY NOT FOR CONSTRUCTION OR PERMIT

ISSUED BY: TREVOR FOX
LICENSE NO:

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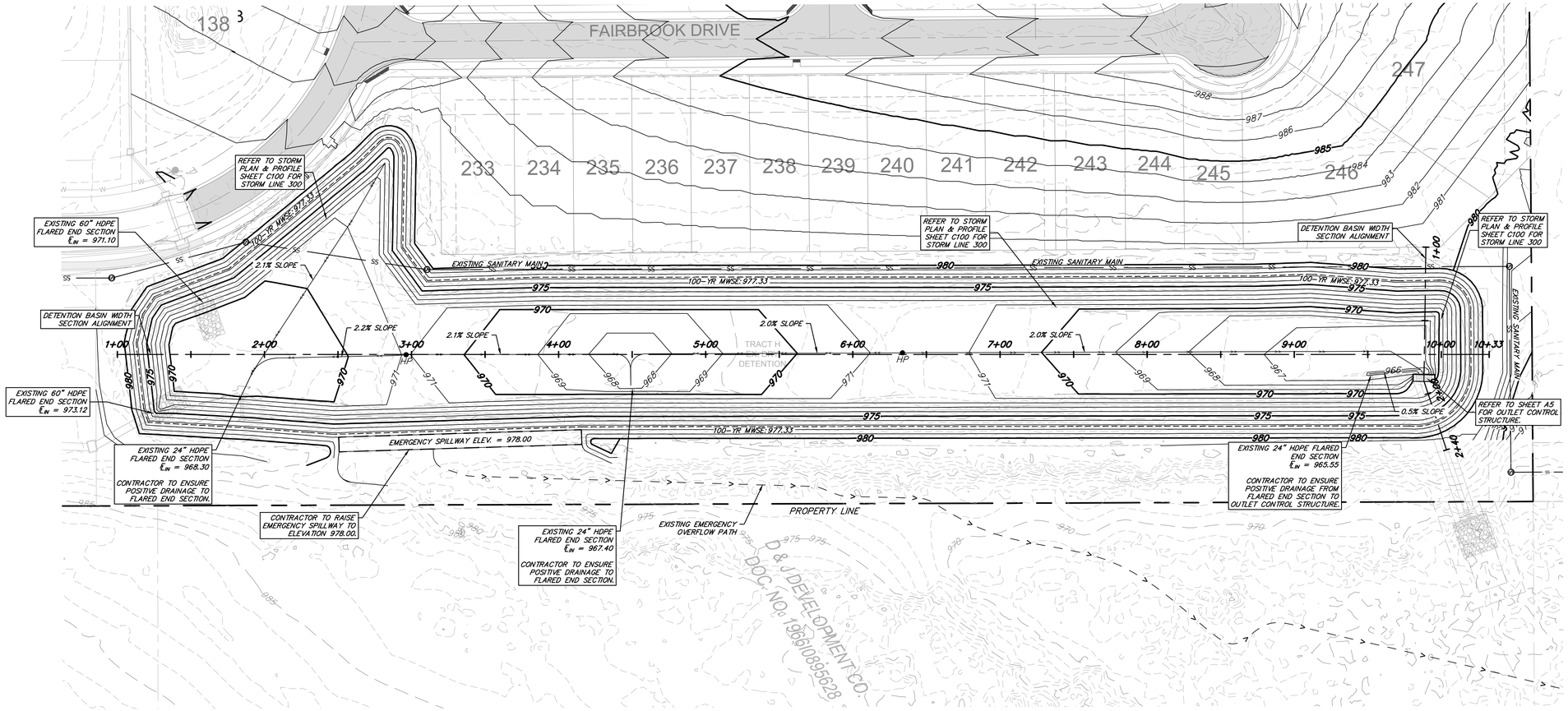
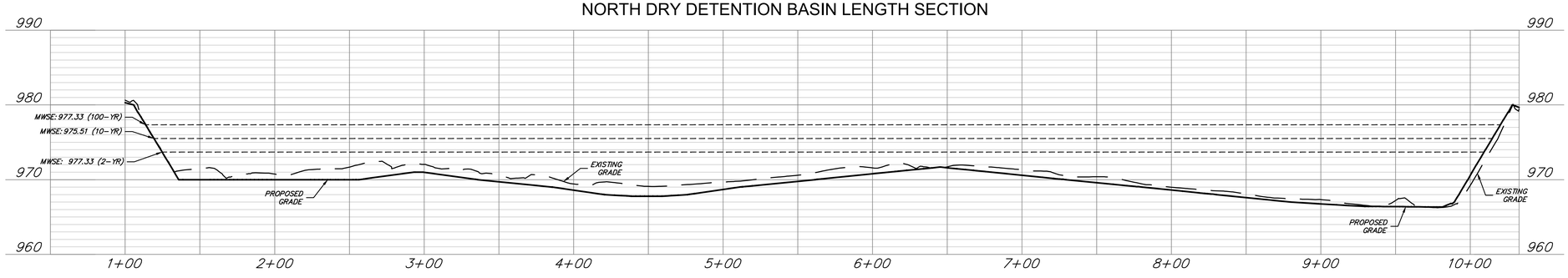
SHEET TITLE

SOUTH WET DETENTION BASIN PLAN & PROFILE

SHEET NUMBER

A4





WET DETENTION BASIN GENERAL NOTES:

1. CONTRACTOR TO CONSTRUCT STORMWATER MANAGEMENT FACILITIES, SPECIFICALLY THOSE FEATURES RELATED TO DETENTION, PRIOR TO ANY LAND DISTURBANCE OF THE SITE AND PRIOR TO THE CONSTRUCTION OF ANY OTHER SITE DEVELOPMENT WORK AS NOT TO EFFECT DOWNSTREAM NEIGHBORS WITH UNDETAINED STORMWATER DISCHARGE.
2. AN AS-GRADED AND AS-BUILT DRAWING SHALL BE SUBMITTED TO AND REVIEWED BY THE CITY FOR THE DETENTION BASIN. THIS SHALL BE REQUIRED PRIOR TO ISSUANCE OF A CERTIFICATE OF SUBSTANTIAL COMPLETION. ALL PRECAUTIONS SHOULD BE TAKEN TO ENSURE DETENTION POND AND OUTLET STRUCTURE ARE CONSTRUCTED ACCORDING TO THE APPROVED PLANS; VOLUMES AND ELEVATIONS ARE CRITICAL FOR AS-BUILT APPROVAL. THE CITY SHALL BE PROVIDED WITH AN AS-BUILT SURVEY OF THE DETENTION BASIN, OUTLET STRUCTURE INCLUDING ALL WEIR ELEVATIONS AND STORM SYSTEM INCLUDING ALL THE INVERTS, STAMPED BY A MISSOURI LICENSED ENGINEER.
3. ALL SIDEWALK ADJACENT TO TRACTS SHALL BE CONSTRUCTED WITH PUBLIC IMPROVEMENTS, ALONG WITH ALL ADA ACCESSIBLE SIDEWALK RAMPS.

WATER SURFACE ELEVATIONS:

2-YR – 973.58
10-YR – 975.44
100-YR – 977.27

OUTLET DISCHARGE RATES:

2-YR – 64.06 CFS
10-YR – 136.17 CFS
100-YR – 234.98 CFS

STORAGE VOLUME:

2-YR: 209,635 FT³

10-YR: 352,670 FT³

100-YR: 513,100 FT³

DESIGN MAX: 737,722 FT³

LEGEND

- 900 — PROPOSED MAJOR CONTOUR
- 901 — PROPOSED MINOR CONTOUR
- 900 — EXISTING MAJOR CONTOUR
- 901 — EXISTING MINOR CONTOUR
- RIGHT-OF-WAY
- ROAD CENTERLINE
- PROPERTY LINE

0 40 80
8 0
HORIZ.: 1"=40'
VERT.: 1"=8'

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COBEY CREEK - 2ND PLAT

S29, T47N, R31W
LEE'S SUMMIT, JACKSON COUNTY, MISSOURI

REVISIONS

NO.	DESCRIPTION	DATE

DRAWING INFORMATION

PROJECT NO: 21KC10060
DRAWN BY: JK
CHECK BY: TF
ISSUED FOR: FOR REVIEW
ISSUED DATE: 03/22/2024

PRELIMINARY
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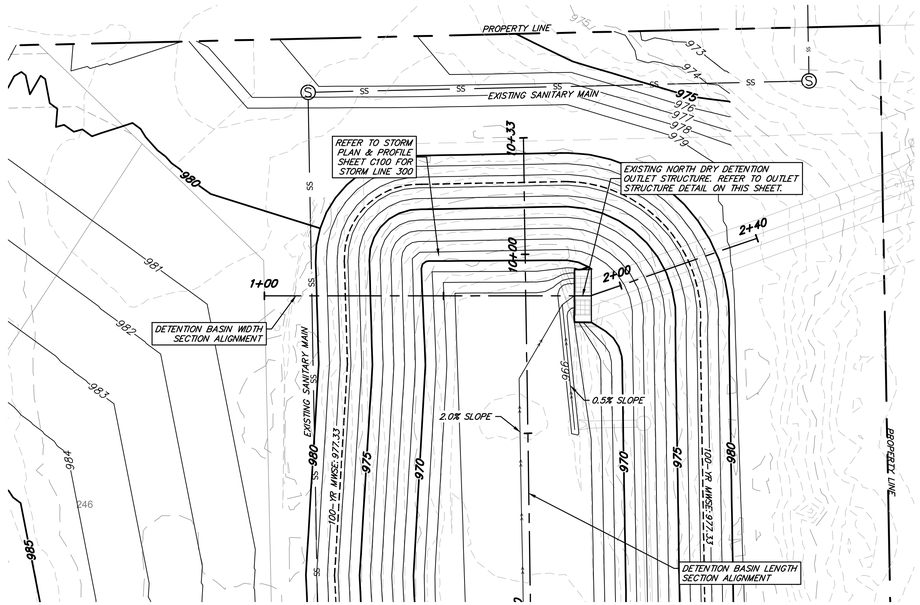
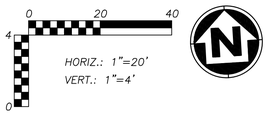
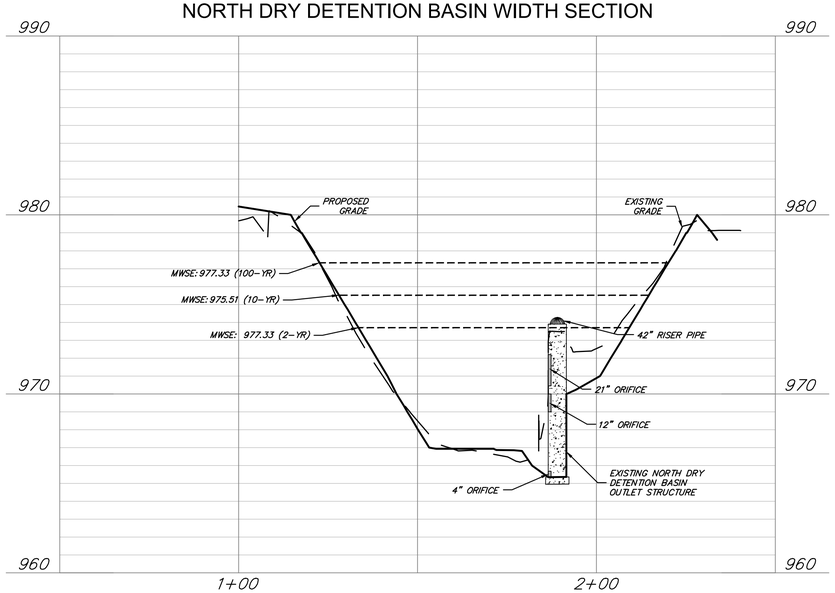
SHEET TITLE
NORTH DRY DETENTION BASIN PLAN & PROFILE

SHEET NUMBER
A5



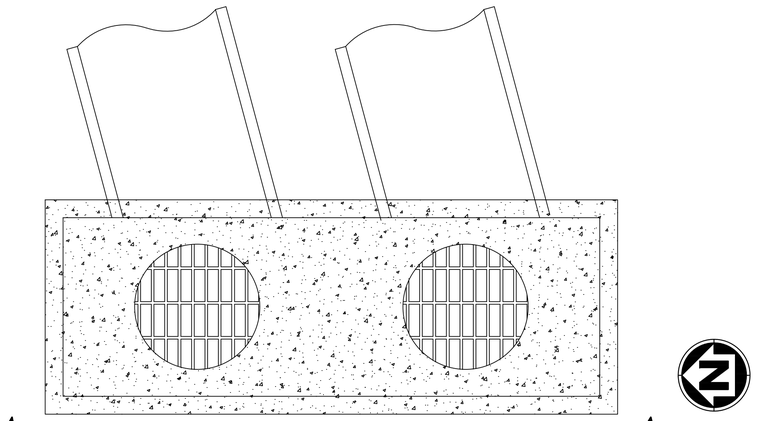


NORTH DRY DETENTION BASIN WIDTH SECTION

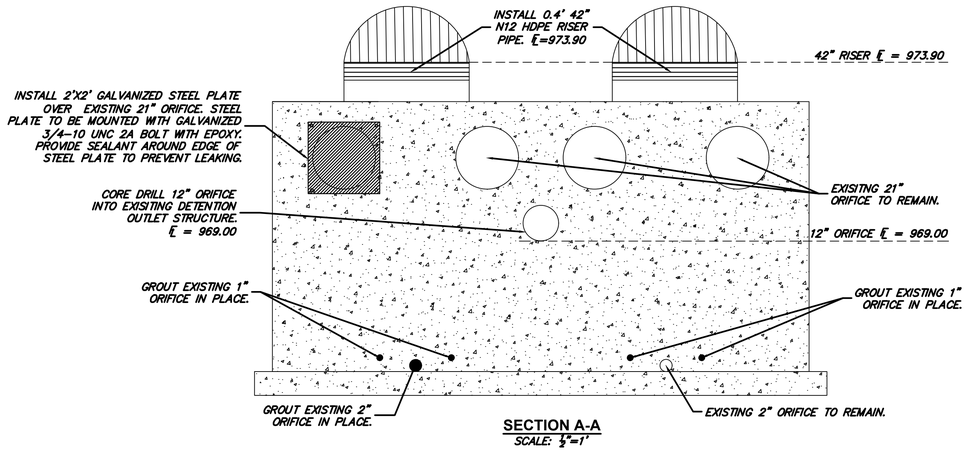


LEGEND

- 900 — PROPOSED MAJOR CONTOUR
- 901 — PROPOSED MINOR CONTOUR
- 900 — EXISTING MAJOR CONTOUR
- 901 — EXISTING MINOR CONTOUR
- RIGHT-OF-WAY
- ROAD CENTERLINE
- PROPERTY LINE



PLAN VIEW
SCALE: 1/2"=1'



SECTION A-A
SCALE: 1/2"=1'

EXISTING NORTH DRY DETENTION BASIN OUTLET STRUCTURE DETAIL

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COBEY CREEK - 2ND PLAT

S29, T47N, R31W
LEE'S SUMMIT, JACKSON COUNTY, MISSOURI

REVISIONS

NO.	DESCRIPTION	DATE

DRAWING INFORMATION

PROJECT NO: 21KC10060
DRAWN BY: JK
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ISSUED FOR: FOR REVIEW
ISSUED DATE: 03/22/2024

PRELIMINARY NOT FOR CONSTRUCTION OR PERMIT

ISSUED BY: TREVOR FOX
LICENSE NO:

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SHEET TITLE

NORTH DRY DETENTION BASIN OUTLET STRUCTURE

SHEET NUMBER

A6

Plotted on: Mar 21, 2024 - 11:51am G:\Shared drives\KC10 - Land Development\Projects\2021\21KC10060 Cobey Creek Residential\01 CIVIL\02-R&D\Drainage\STORMWATER REPORT\Appendix\21KC10060 - SHTS - DETENTION BASIN.dwg Layout: 3

Appendix B

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United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Jackson County, Missouri

February 7, 2024

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require

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10116—Sampsel silty clay loam, 2 to 5 percent slopes.....14
10117—Sampsel silty clay loam, 5 to 9 percent slopes.....16
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How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Map Scale: 1:4,760 if printed on A portrait (8.5" x 11") sheet.

N

Meters
0 50 100 200 300

Feet
0 200 400 800 1200

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 15N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Jackson County, Missouri
Survey Area Data: Version 25, Aug 22, 2023

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Aug 30, 2022—Sep 8, 2022

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
10000	Arisburg silt loam, 1 to 5 percent slopes	65.7	66.1%
10116	Sampsel silty clay loam, 2 to 5 percent slopes	9.7	9.8%
10117	Sampsel silty clay loam, 5 to 9 percent slopes	24.0	24.1%
Totals for Area of Interest		**99.4**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or

landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Jackson County, Missouri

10000—Arisburg silt loam, 1 to 5 percent slopes

Map Unit Setting

National map unit symbol: 2w22b
Elevation: 610 to 1,130 feet
Mean annual precipitation: 39 to 43 inches
Mean annual air temperature: 50 to 55 degrees F
Frost-free period: 177 to 220 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Arisburg and similar soils: 87 percent
Minor components: 13 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Arisburg

Setting

Landform: Interfluves
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loess

Typical profile

Ap - 0 to 6 inches: silt loam
A - 6 to 13 inches: silt loam
Bt - 13 to 19 inches: silty clay loam
Btg - 19 to 56 inches: silty clay loam
BCg - 56 to 79 inches: silty clay loam

Properties and qualities

Slope: 1 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: About 18 to 30 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: High (about 11.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Ecological site: R107XB007MO - Loess Upland Prairie
Hydric soil rating: No

Minor Components

Sharpsburg

Percent of map unit: 5 percent
Landform: Ridges
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R109XY002MO - Loess Upland Prairie
Hydric soil rating: No

Greenton

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Ecological site: R109XY002MO - Loess Upland Prairie
Hydric soil rating: No

Haig

Percent of map unit: 3 percent
Landform: Flats
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Convex
Ecological site: R109XY001MO - Claypan Summit Prairie
Hydric soil rating: Yes

10116—Sampsel silty clay loam, 2 to 5 percent slopes

Map Unit Setting

National map unit symbol: 2qkzy
Elevation: 600 to 1,300 feet
Mean annual precipitation: 33 to 41 inches
Mean annual air temperature: 50 to 55 degrees F
Frost-free period: 177 to 220 days
Farmland classification: Prime farmland if drained

Map Unit Composition

Sampsel and similar soils: 95 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Sampsel

Setting

Landform: Hillslopes
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Convex, concave
Parent material: Residuum weathered from shale

Typical profile

Ap - 0 to 11 inches: silty clay loam
Bt - 11 to 80 inches: silty clay

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 0 to 18 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Moderate (about 8.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C/D
Ecological site: R109XY010MO - Interbedded Sedimentary Upland Savanna
Other vegetative classification: Grass/Prairie (Herbaceous Vegetation)
Hydric soil rating: No

Minor Components

Grundy

Percent of map unit: 3 percent
Landform: Hillslopes
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Head slope, side slope
Down-slope shape: Concave
Across-slope shape: Concave
Ecological site: R109XY002MO - Loess Upland Prairie
Hydric soil rating: No

Snead

Percent of map unit: 2 percent
Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Ecological site: R109XY010MO - Interbedded Sedimentary Upland Savanna
Hydric soil rating: No

10117—Sampsel silty clay loam, 5 to 9 percent slopes

Map Unit Setting

National map unit symbol: 2qkzz
Elevation: 600 to 1,120 feet
Mean annual precipitation: 33 to 41 inches
Mean annual air temperature: 50 to 57 degrees F
Frost-free period: 177 to 220 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Sampsel and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Sampsel

Setting

Landform: Hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Concave
Across-slope shape: Convex, concave
Parent material: Residuum weathered from shale

Typical profile

Ap - 0 to 13 inches: silty clay loam
Bt - 13 to 80 inches: silty clay

Properties and qualities

Slope: 5 to 9 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 0 to 18 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Moderate (about 8.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C/D
Ecological site: R109XY010MO - Interbedded Sedimentary Upland Savanna
Other vegetative classification: Grass/Prairie (Herbaceous Vegetation)
Hydric soil rating: No

Minor Components

Greenton

Percent of map unit: 8 percent
Landform: Hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Ecological site: R109XY002MO - Loess Upland Prairie
Hydric soil rating: No

Snead

Percent of map unit: 7 percent
Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Ecological site: R109XY010MO - Interbedded Sedimentary Upland Savanna
Hydric soil rating: No

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Appendix C

Engineering beyond.™

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) Report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS Report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study Report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study Report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Missouri State Plane West Zone (FIPS zone 2403). The **horizontal datum** was NAD 83, GRS 1980 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713- 3242**, or visit its website at http://www.ngs.noaa.gov.

Base map information shown on this FIRM was derived from the U.S.D.A Farm Service National Agriculture ImageryProgram (NAIP) dated 2014. Produced at scale of 1:24,000.

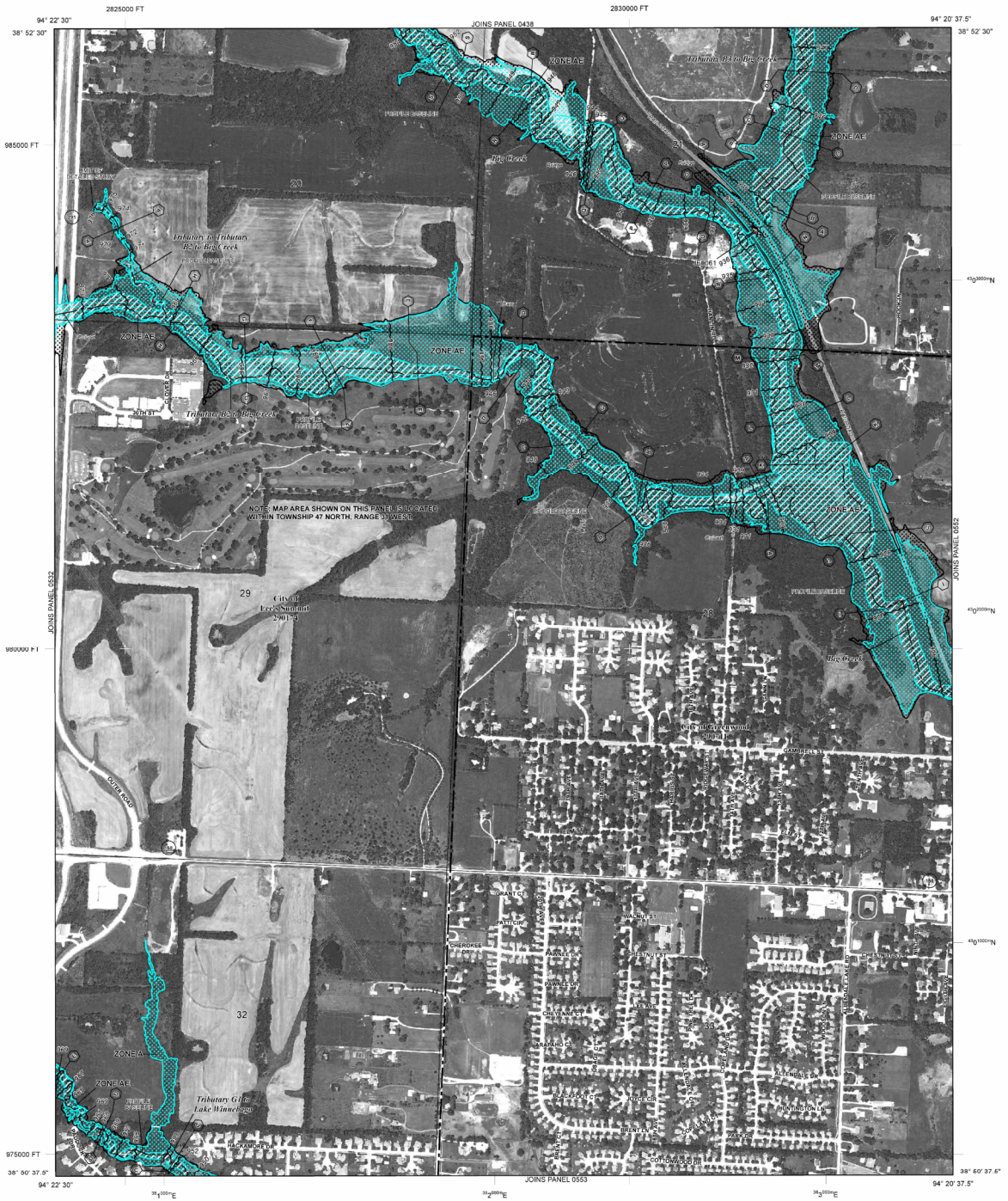
The **profile baselines** depicted on this map represent the hydraulic modeling baselines that match the flood profiles in the FIS report. As a result of improved topographic data, the **profile baseline**, in some cases, may deviate significantly from the channel centerline or appear outside the SFHA.

Based on updated topographic information, this map reflects more detailed and up-to-date **stream channel configurations and floodplain delineations** than those shown on the previous FIRM for this jurisdiction. As a result, the Flood Profiles and Floodway Data tables for multiple streams in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on the map. Also, the road to floodplain relationships for unrevised streams may differ from what is shown on previous maps.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

For information on available products associated with this FIRM visit the **Map Service Center (MSC)** website at http://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the MSC website.



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Areas formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% Annual Chance Floodplain Boundary

0.2% Annual Chance Floodplain Boundary

Floodway boundary

Zone D boundary

CBRS and OPA boundary

Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths, or flood velocities.

513 — Base Flood Elevation line and value; elevation in feet*

(EL 987) — Base Flood Elevation value where uniform within zone; elevation in feet*

*Referenced to the North American Vertical Datum of 1988

A — A — Cross section line

23 — 23 — Transect line

Culvert

Bridge

45° 02' 08", 93° 02' 12" — Geographic coordinates referenced to the North American Datum of 1983 (NAD 83) Western Hemisphere

3100000 FT — 5000-foot ticks: Missouri State Plane West Zone (FIPS Zone 2403), Transverse Mercator projection

DX5510 — Bench mark (see explanation in Notes to Users section of this FIRM panel)

M1.5 — River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP
September 29, 2006

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
January 20, 2017 - to change Special Flood Hazard Areas.

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'

250 0 500 1000 FEET

150 0 150 300 METERS

NFIP NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0551G

FIRM

FLOOD INSURANCE RATE MAP

JACKSON COUNTY, MISSOURI
AND INCORPORATED AREAS

PANEL 551 OF 625
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
GREENWOOD, CITY OF	290711	0551	G
LEE'S SUMMIT, CITY OF	290174	0551	G

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
29095C0551G

MAP REVISED
JANUARY 20, 2017

Federal Emergency Management Agency

Appendix D

Engineering beyond.™

NOAA Atlas 14, Volume 8, Version 2
Location name: Lees Summit, Missouri, USA*
Latitude: 38.8544°, Longitude: -94.3638°
Elevation: 1001 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffery Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.413** (0.326-0.522)	**0.483** (0.381-0.612)	**0.600** (0.472-0.761)	**0.698** (0.546-0.888)	**0.834** (0.632-1.09)	**0.940** (0.697-1.24)	**1.05** (0.752-1.42)	**1.16** (0.799-1.60)	**1.30** (0.869-1.85)	**1.42** (0.921-2.03)
10-min	**0.605** (0.477-0.765)	**0.708** (0.559-0.896)	**0.878** (0.691-1.12)	**1.02** (0.799-1.30)	**1.22** (0.925-1.60)	**1.38** (1.02-1.82)	**1.53** (1.10-2.07)	**1.69** (1.17-2.34)	**1.91** (1.27-2.70)	**2.07** (1.35-2.98)
15-min	**0.737** (0.582-0.933)	**0.863** (0.681-1.09)	**1.07** (0.843-1.36)	**1.25** (0.975-1.59)	**1.49** (1.13-1.95)	**1.68** (1.24-2.22)	**1.87** (1.34-2.53)	**2.07** (1.43-2.86)	**2.33** (1.55-3.30)	**2.53** (1.64-3.63)
30-min	**1.02** (0.806-1.29)	**1.20** (0.948-1.52)	**1.50** (1.18-1.90)	**1.75** (1.37-2.23)	**2.09** (1.59-2.74)	**2.36** (1.75-3.13)	**2.63** (1.89-3.56)	**2.91** (2.01-4.02)	**3.28** (2.18-4.64)	**3.56** (2.31-5.11)
60-min	**1.34** (1.06-1.69)	**1.57** (1.24-1.99)	**1.96** (1.54-2.49)	**2.29** (1.79-2.92)	**2.75** (2.09-3.61)	**3.12** (2.32-4.14)	**3.50** (2.51-4.73)	**3.88** (2.68-5.38)	**4.41** (2.94-6.25)	**4.81** (3.13-6.91)
2-hr	**1.65** (1.32-2.07)	**1.94** (1.54-2.43)	**2.42** (1.92-3.04)	**2.83** (2.23-3.58)	**3.42** (2.61-4.45)	**3.88** (2.90-5.11)	**4.36** (3.16-5.86)	**4.86** (3.39-6.69)	**5.54** (3.72-7.80)	**6.06** (3.97-8.65)
3-hr	**1.87** (1.49-2.33)	**2.19** (1.75-2.74)	**2.74** (2.18-3.43)	**3.21** (2.54-4.03)	**3.89** (3.00-5.06)	**4.44** (3.34-5.83)	**5.01** (3.65-6.72)	**5.61** (3.93-7.70)	**6.43** (4.35-9.04)	**7.08** (4.66-10.1)
6-hr	**2.25** (1.81-2.79)	**2.65** (2.13-3.28)	**3.34** (2.68-4.15)	**3.94** (3.14-4.92)	**4.82** (3.75-6.24)	**5.54** (4.21-7.24)	**6.29** (4.63-8.40)	**7.09** (5.02-9.69)	**8.20** (5.59-11.5)	**9.08** (6.03-12.8)
12-hr	**2.65** (2.15-3.25)	**3.15** (2.55-3.87)	**4.02** (3.24-4.95)	**4.78** (3.84-5.91)	**5.90** (4.62-7.58)	**6.82** (5.22-8.84)	**7.78** (5.76-10.3)	**8.80** (6.27-11.9)	**10.2** (7.02-14.2)	**11.3** (7.59-15.9)
24-hr	**3.10** (2.53-3.77)	**3.69** (3.01-4.49)	**4.71** (3.84-5.76)	**5.62** (4.55-6.89)	**6.95** (5.49-8.86)	**8.04** (6.20-10.4)	**9.18** (6.86-12.1)	**10.4** (7.48-14.0)	**12.1** (8.39-16.7)	**13.5** (9.08-18.8)
2-day	**3.65** (3.01-4.41)	**4.28** (3.52-5.17)	**5.38** (4.41-6.52)	**6.36** (5.19-7.73)	**7.80** (6.22-9.87)	**8.99** (6.99-11.5)	**10.2** (7.72-13.4)	**11.6** (8.40-15.5)	**13.5** (9.42-18.5)	**15.0** (10.2-20.7)
3-day	**4.05** (3.35-4.86)	**4.68** (3.87-5.63)	**5.79** (4.77-6.98)	**6.78** (5.56-8.20)	**8.24** (6.60-10.4)	**9.44** (7.38-12.0)	**10.7** (8.12-13.9)	**12.1** (8.80-16.1)	**14.0** (9.83-19.1)	**15.5** (10.6-21.4)
4-day	**4.37** (3.63-5.24)	**5.01** (4.16-6.01)	**6.13** (5.07-7.36)	**7.12** (5.85-8.58)	**8.58** (6.89-10.7)	**9.78** (7.67-12.4)	**11.0** (8.39-14.3)	**12.4** (9.06-16.5)	**14.3** (10.1-19.5)	**15.8** (10.8-21.7)
7-day	**5.18** (4.32-6.15)	**5.86** (4.89-6.97)	**7.02** (5.84-8.38)	**8.04** (6.65-9.62)	**9.50** (7.65-11.8)	**10.7** (8.41-13.4)	**11.9** (9.08-15.3)	**13.2** (9.69-17.4)	**15.0** (10.6-20.2)	**16.4** (11.3-22.4)
10-day	**5.87** (4.92-6.94)	**6.62** (5.55-7.84)	**7.88** (6.58-9.35)	**8.95** (7.43-10.7)	**10.5** (8.44-12.9)	**11.6** (9.20-14.5)	**12.9** (9.85-16.4)	**14.1** (10.4-18.5)	**15.8** (11.3-21.3)	**17.2** (11.9-23.4)
20-day	**7.84** (6.63-9.19)	**8.84** (7.47-10.4)	**10.5** (8.81-12.3)	**11.8** (9.88-13.9)	**13.6** (11.0-16.5)	**14.9** (11.9-18.4)	**16.3** (12.5-20.5)	**17.6** (13.1-22.8)	**19.3** (13.8-25.7)	**20.6** (14.4-27.9)
30-day	**9.49** (8.06-11.1)	**10.7** (9.09-12.5)	**12.7** (10.7-14.8)	**14.2** (12.0-16.7)	**16.3** (13.2-19.6)	**17.8** (14.2-21.7)	**19.2** (14.9-24.1)	**20.7** (15.4-26.5)	**22.4** (16.1-29.6)	**23.7** (16.7-32.0)
45-day	**11.6** (9.89-13.4)	**13.1** (11.1-15.2)	**15.4** (13.1-17.9)	**17.2** (14.6-20.1)	**19.6** (16.0-23.4)	**21.3** (17.0-25.8)	**22.9** (17.7-28.4)	**24.4** (18.2-31.1)	**26.2** (18.9-34.4)	**27.5** (19.4-36.9)
60-day	**13.4** (11.5-15.5)	**15.1** (12.9-17.5)	**17.7** (15.1-20.6)	**19.8** (16.8-23.0)	**22.4** (18.3-26.5)	**24.2** (19.4-29.2)	**25.9** (20.1-32.0)	**27.4** (20.5-34.8)	**29.3** (21.1-38.2)	**30.5** (21.6-40.8)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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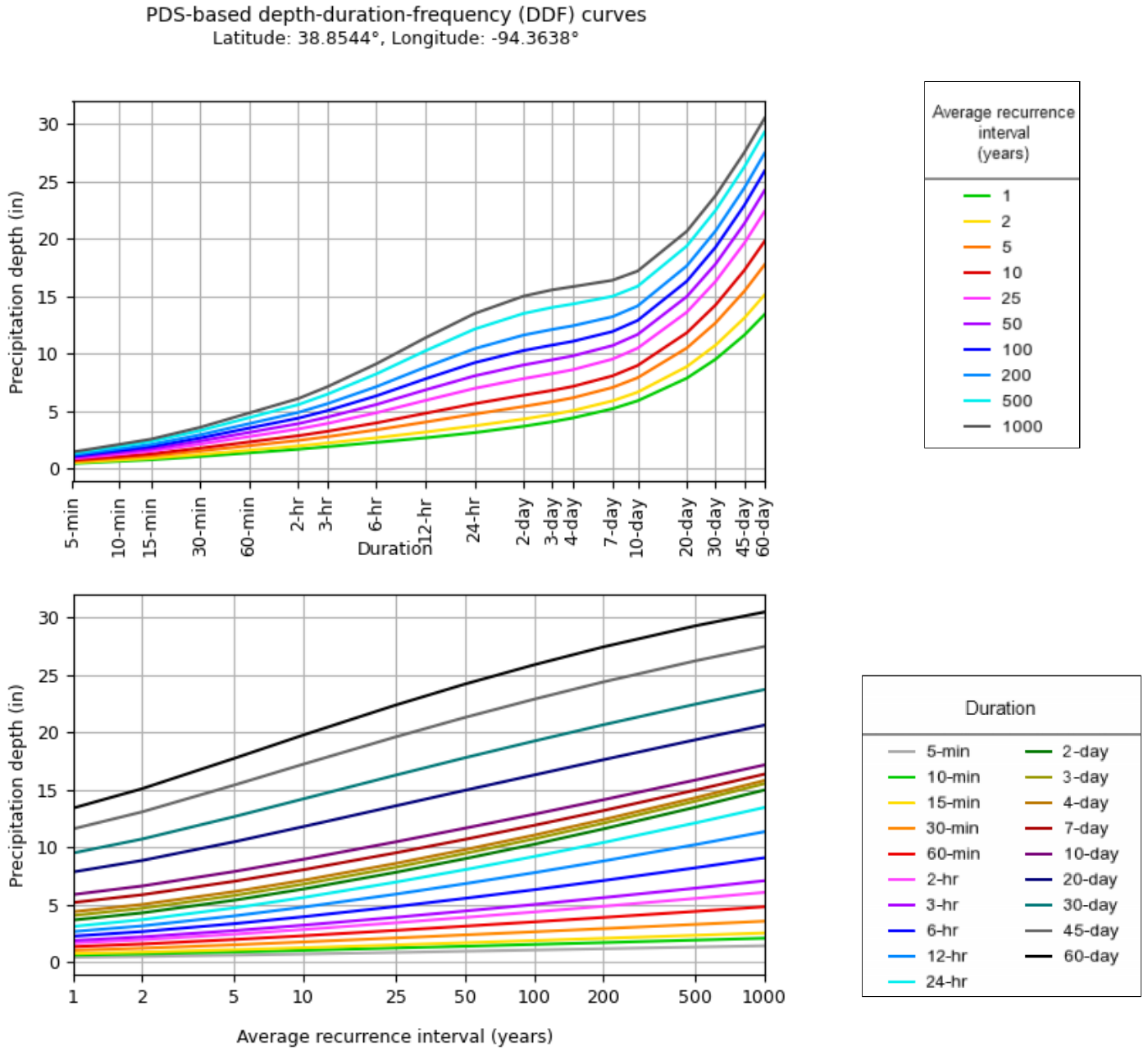
PF graphical



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Created (GMT): Wed Feb 7 16:05:17 2024

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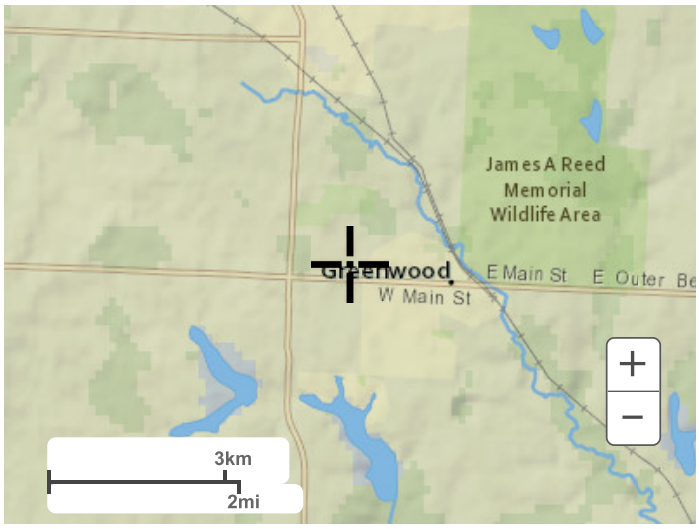
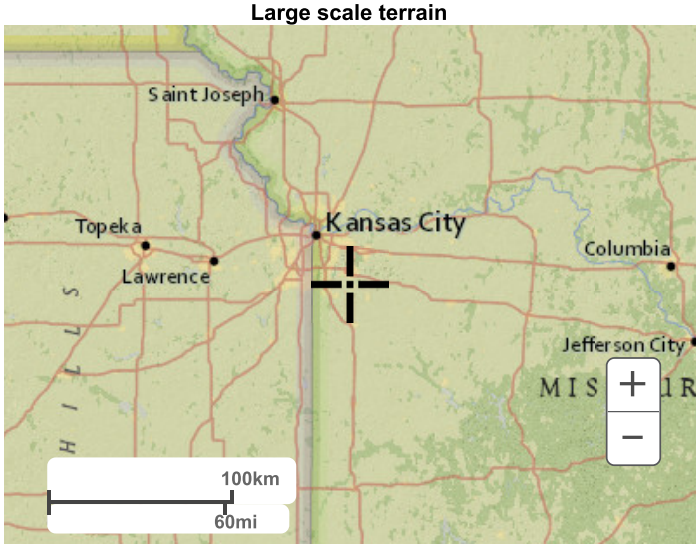
Maps & aerials

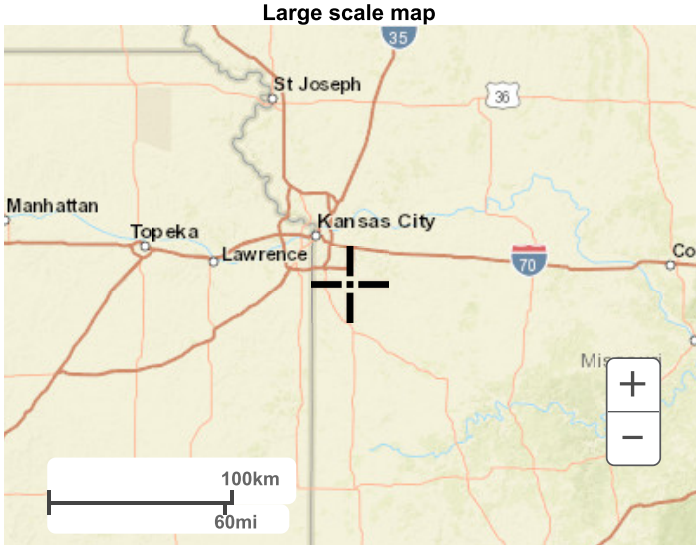
Small scale terrain



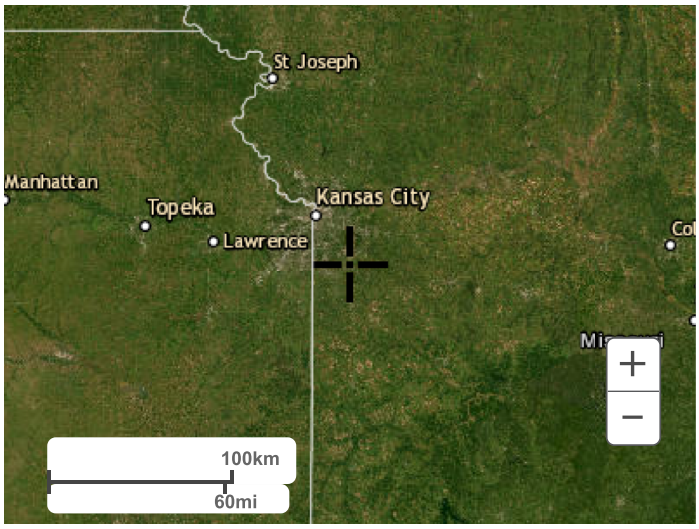
Large scale terrain



Large scale map



Large scale aerial



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National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

Appendix E

COBEY CREEK - LEE'S SUMMIT, MO

MACRO STORM DRAINAGE STUDY

TIME OF CONCENTRATION CALCULATIONS
PRE-DEVELOPMENT BASINS
TR-55 METHODOLOGY

	Overland Flow						Shallow Concentrated Flow						Channel Flow							Overall
Basin	n	Cover	L (ft)	delta H (ft)	S (ft/ft)	Tt (min)	L (ft)	delta H (ft)	S (ft/ft)	Cover	V (ft/s)	Tsc (min)	L (ft)	delta H (ft)	S (ft/ft)	n	R (ft)	V (ft/s)	Tch1 (min)	Overall Tc (min)
EX 1	0.24	Grass	300	6.34	0.02	31.26	310	6.25	0.02	unpaved	2.3	2.26	0	0	0.00	0	0	0.00	0.00	33.5
EX 2	0.24	Grass	300	5	0.02	34.38	477	15	0.03	unpaved	2.9	2.78	1425	24	0.02	0.012	0.67	12.34	1.92	39.1
EX 3	0.24	Grass	100	3	0.03	11.28	307	6	0.02	unpaved	2.3	2.27	0	0	0.00	0	0	0.00	0.00	13.6
EX 4	0.24	Grass	100	1	0.01	17.51	977	34	0.03	unpaved	3.0	5.41	0	0	0.00	0	0	0.00	0.00	22.9

COBEY CREEK - LEE'S SUMMIT, MO

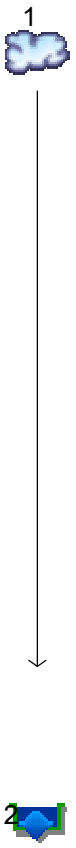
MACRO STORM DRAINAGE STUDY

TIME OF CONCENTRATION CALCULATIONS
POST-DEVELOPMENT BASINS
TR-55 METHODOLOGY

	Overland Flow						Shallow Concentrated Flow						Channel Flow							Overall
Basin	n	Cover	L (ft)	delta H (ft)	S (ft/ft)	Tt (min)	L (ft)	delta H (ft)	S (ft/ft)	Cover	V (ft/s)	Tsc (min)	L (ft)	delta H (ft)	S (ft/ft)	n	R (ft)	V (ft/s)	Tch1 (min)	Overall Tc (min)
P1.1	0.24	Grass	300	6.35	0.02	31.24	310	6.25	0.02	unpaved	2.3	2.26	0	0	0.00	0	0	0.00	0.00	33.5
P2	0.24	Grass	100	1.5	0.02	14.89	900	37	0.04	paved	4.1	3.64	2836	60	0.02	0.012	0.58	12.56	3.76	22.3
P3	0.24	Grass	100	3	0.03	11.28	307	6	0.02	unpaved	2.3	2.27	0	0	0.00	0	0	0.00	0.00	13.6
P4	0.24	Grass	100	1	0.01	17.51	584	34	0.06	unpaved	3.9	2.50	0	0	0.00	0	0	0.00	0.00	20.0

Appendix F

Watershed Model Schematic



Hydrograph Return Period Recap

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	------	0.095	3.070	-------	-------	6.645	-------	-------	13.97	Detention
2	Reservoir	1	0.019	0.876	-------	-------	3.014	-------	-------	8.144	Detention Routing

Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023

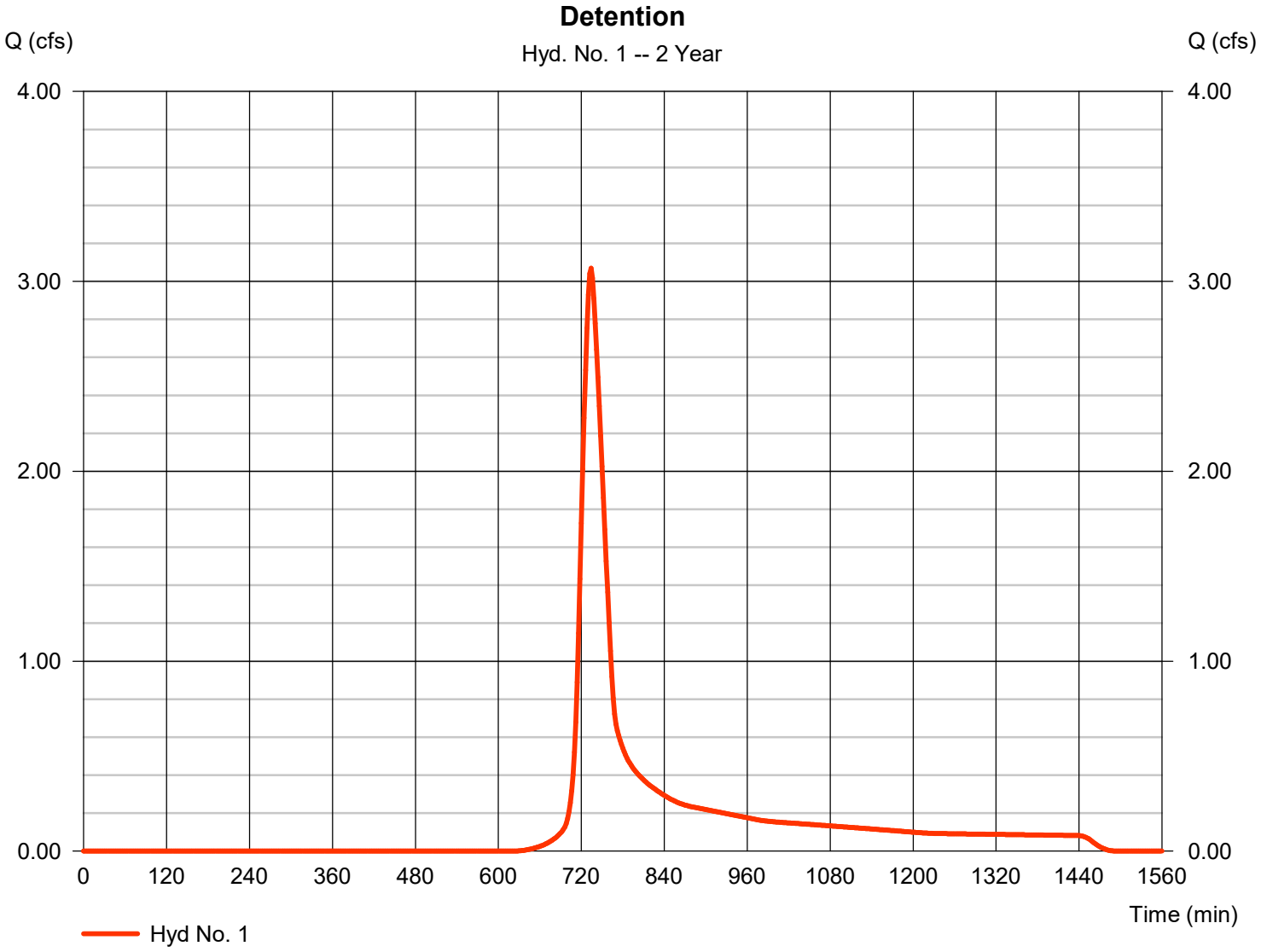
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	3.070	2	734	13,824	------	------	------	Detention
2	Reservoir	0.876	2	764	13,801	1	1008.38	58,939	Detention Routing

Hydrograph Report

Hyd. No. 1

Detention

Hydrograph type	=	SCS Runoff	Peak discharge	=	3.070 cfs
Storm frequency	=	2 yrs	Time to peak	=	734 min
Time interval	=	2 min	Hyd. volume	=	13,824 cuft
Drainage area	=	2.740 ac	Curve number	=	74
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	33.50 min
Total precip.	=	3.69 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



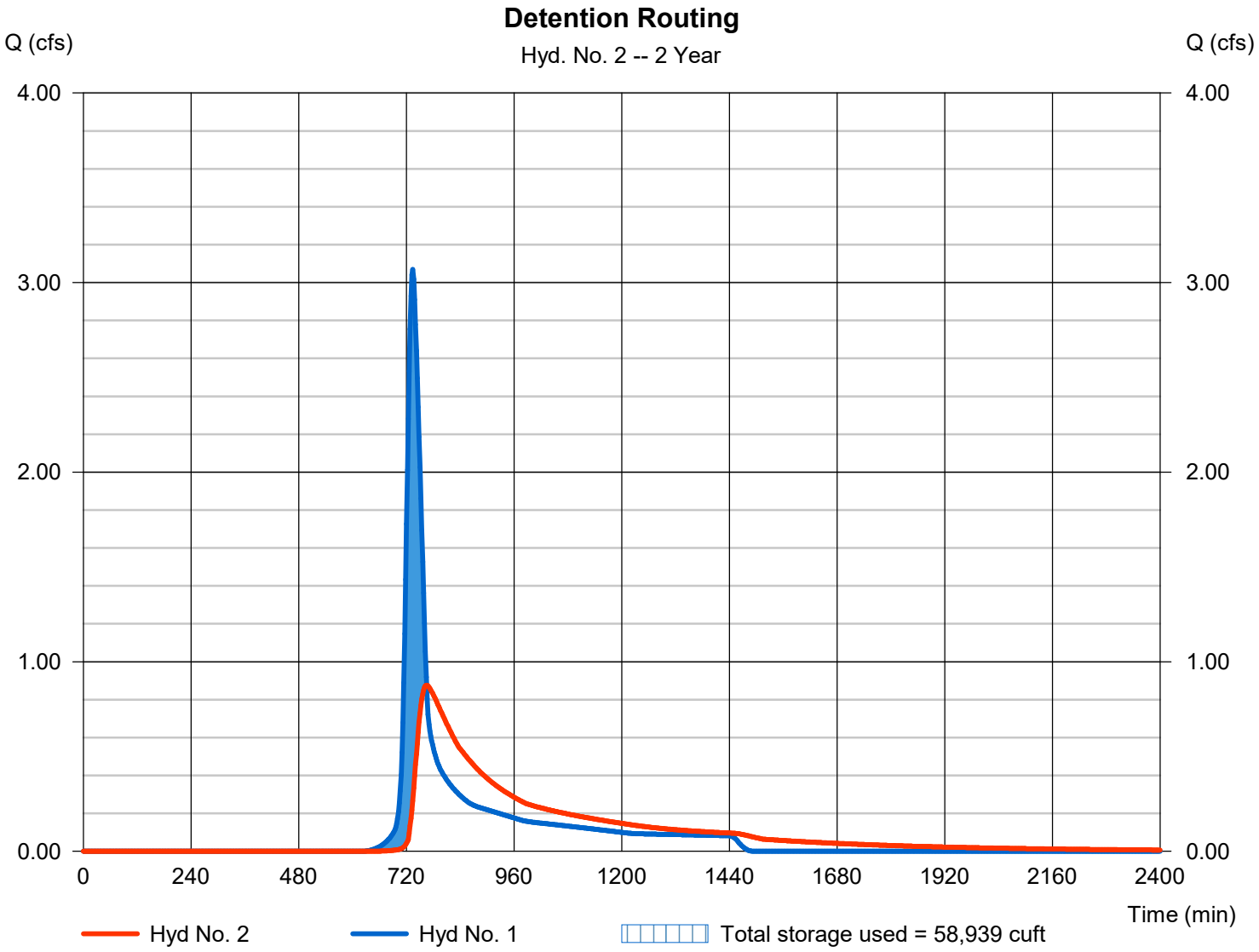
Hydrograph Report

Hyd. No. 2

Detention Routing

Hydrograph type	=	Reservoir	Peak discharge	=	0.876 cfs
Storm frequency	=	2 yrs	Time to peak	=	764 min
Time interval	=	2 min	Hyd. volume	=	13,801 cuft
Inflow hyd. No.	=	1 - Detention	Max. Elevation	=	1008.38 ft
Reservoir name	=	SW Detention Basin	Max. Storage	=	58,939 cuft

Storage Indication method used. Wet pond routing start elevation = 1008.00 ft.



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023

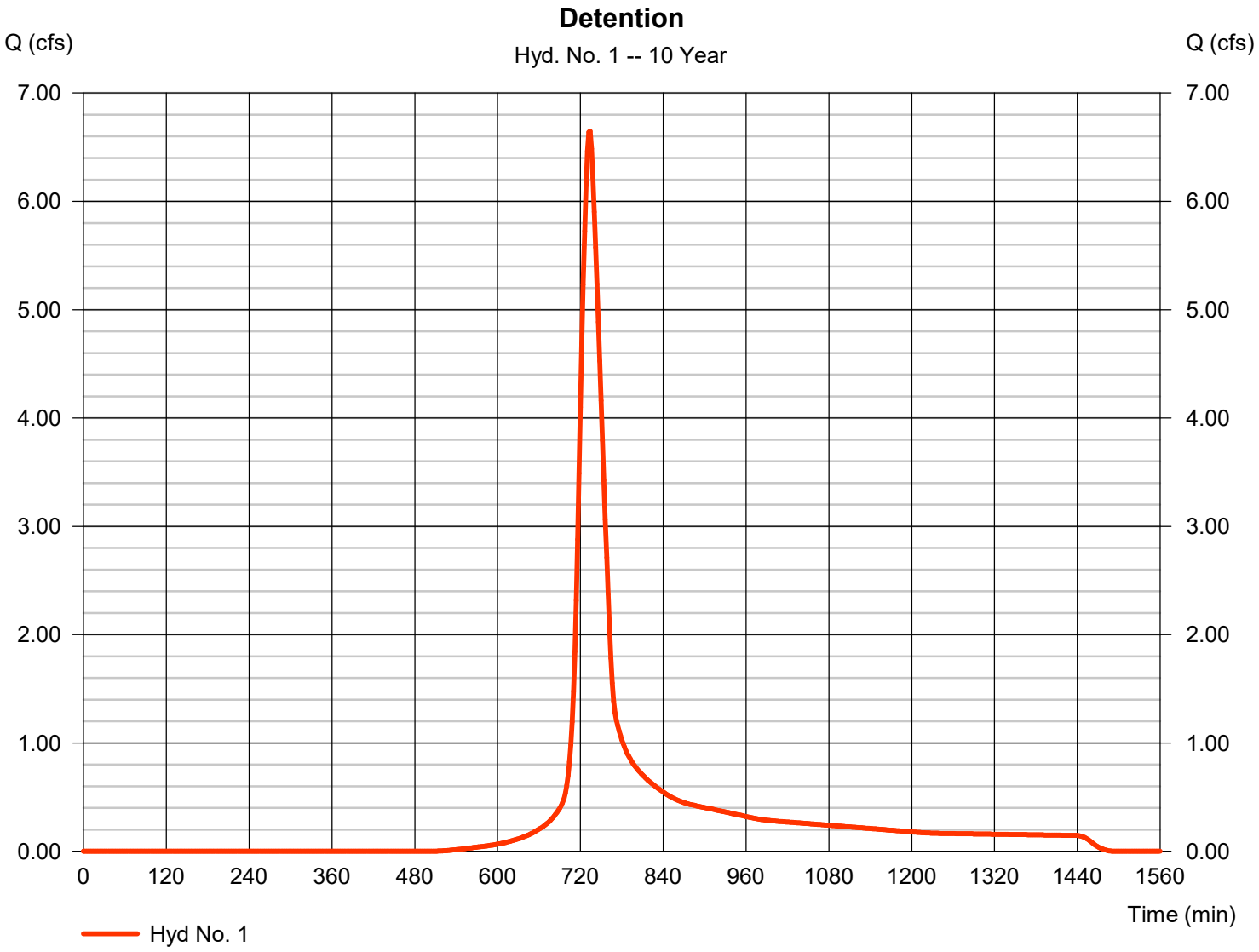
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	6.645	2	734	28,883	------	------	------	Detention
2	Reservoir	3.014	2	756	28,859	1	1008.73	64,096	Detention Routing

Hydrograph Report

Hyd. No. 1

Detention

Hydrograph type	=	SCS Runoff	Peak discharge	=	6.645 cfs
Storm frequency	=	10 yrs	Time to peak	=	734 min
Time interval	=	2 min	Hyd. volume	=	28,883 cuft
Drainage area	=	2.740 ac	Curve number	=	74
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	33.50 min
Total precip.	=	5.62 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



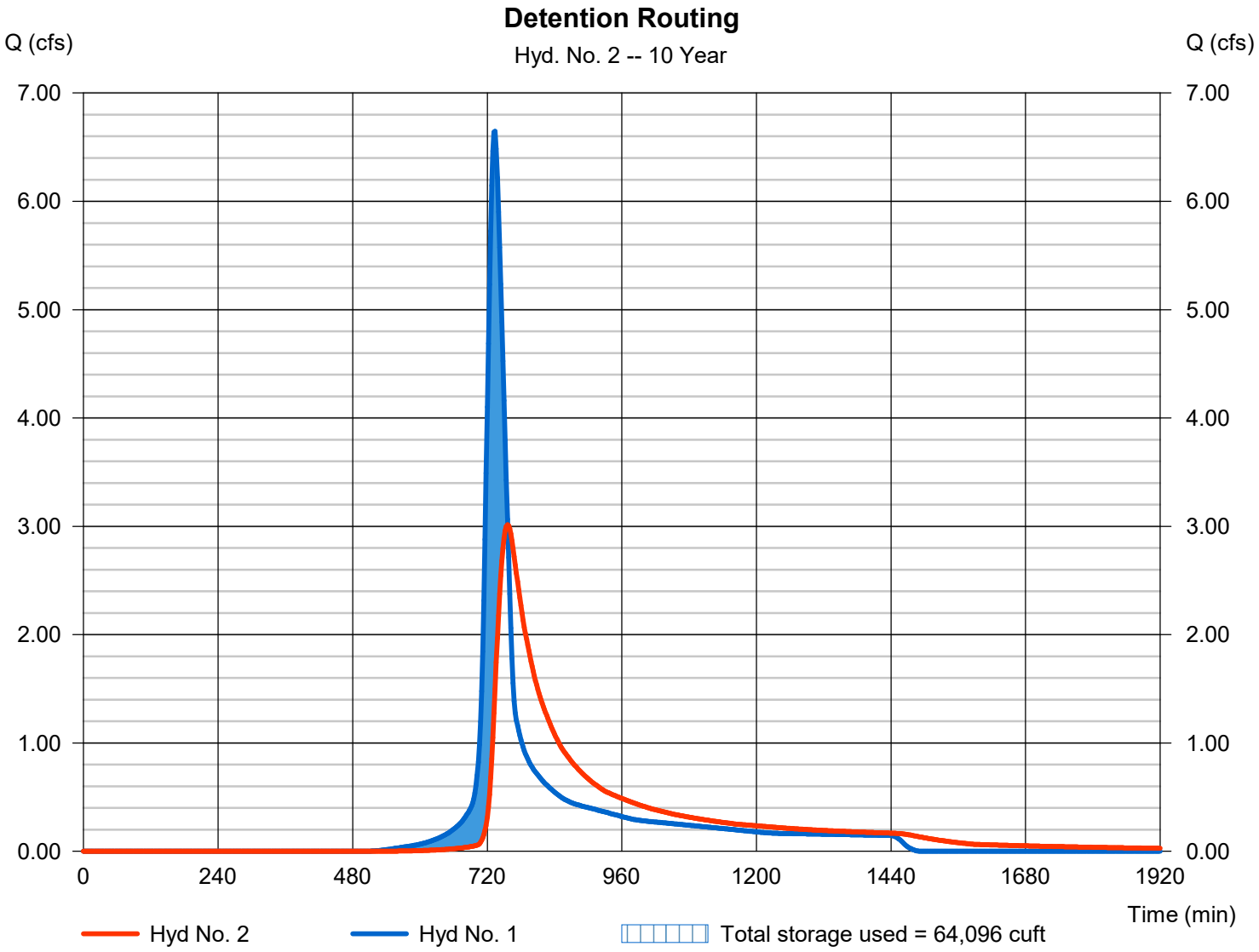
Hydrograph Report

Hyd. No. 2

Detention Routing

Hydrograph type	=	Reservoir	Peak discharge	=	3.014 cfs
Storm frequency	=	10 yrs	Time to peak	=	756 min
Time interval	=	2 min	Hyd. volume	=	28,859 cuft
Inflow hyd. No.	=	1 - Detention	Max. Elevation	=	1008.73 ft
Reservoir name	=	SW Detention Basin	Max. Storage	=	64,096 cuft

Storage Indication method used. Wet pond routing start elevation = 1008.00 ft.



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023

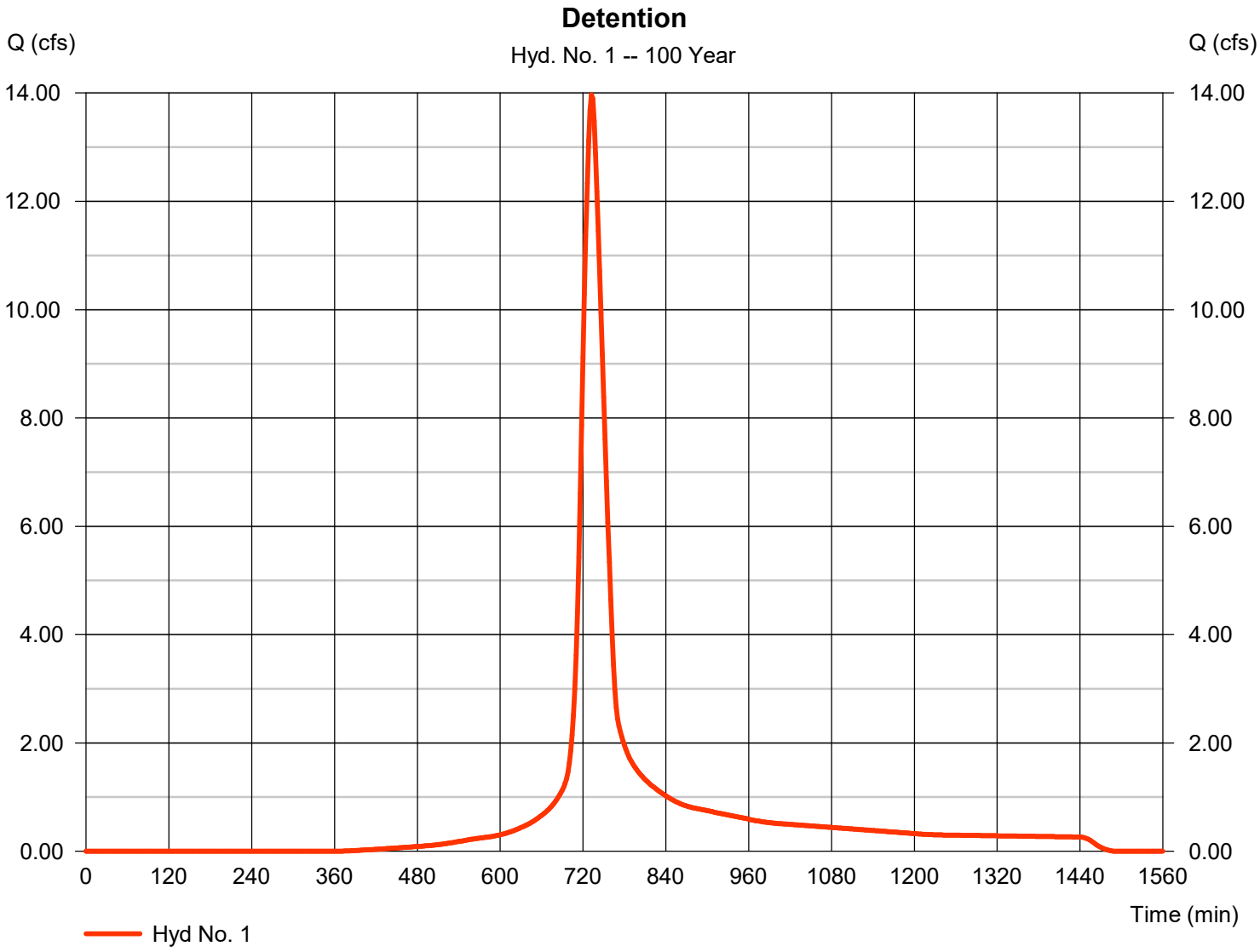
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	13.97	2	732	60,448	------	------	------	Detention
2	Reservoir	8.144	2	750	60,425	1	1009.28	72,718	Detention Routing

Hydrograph Report

Hyd. No. 1

Detention

Hydrograph type	=	SCS Runoff	Peak discharge	=	13.97 cfs
Storm frequency	=	100 yrs	Time to peak	=	732 min
Time interval	=	2 min	Hyd. volume	=	60,448 cuft
Drainage area	=	2.740 ac	Curve number	=	74
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	33.50 min
Total precip.	=	9.19 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



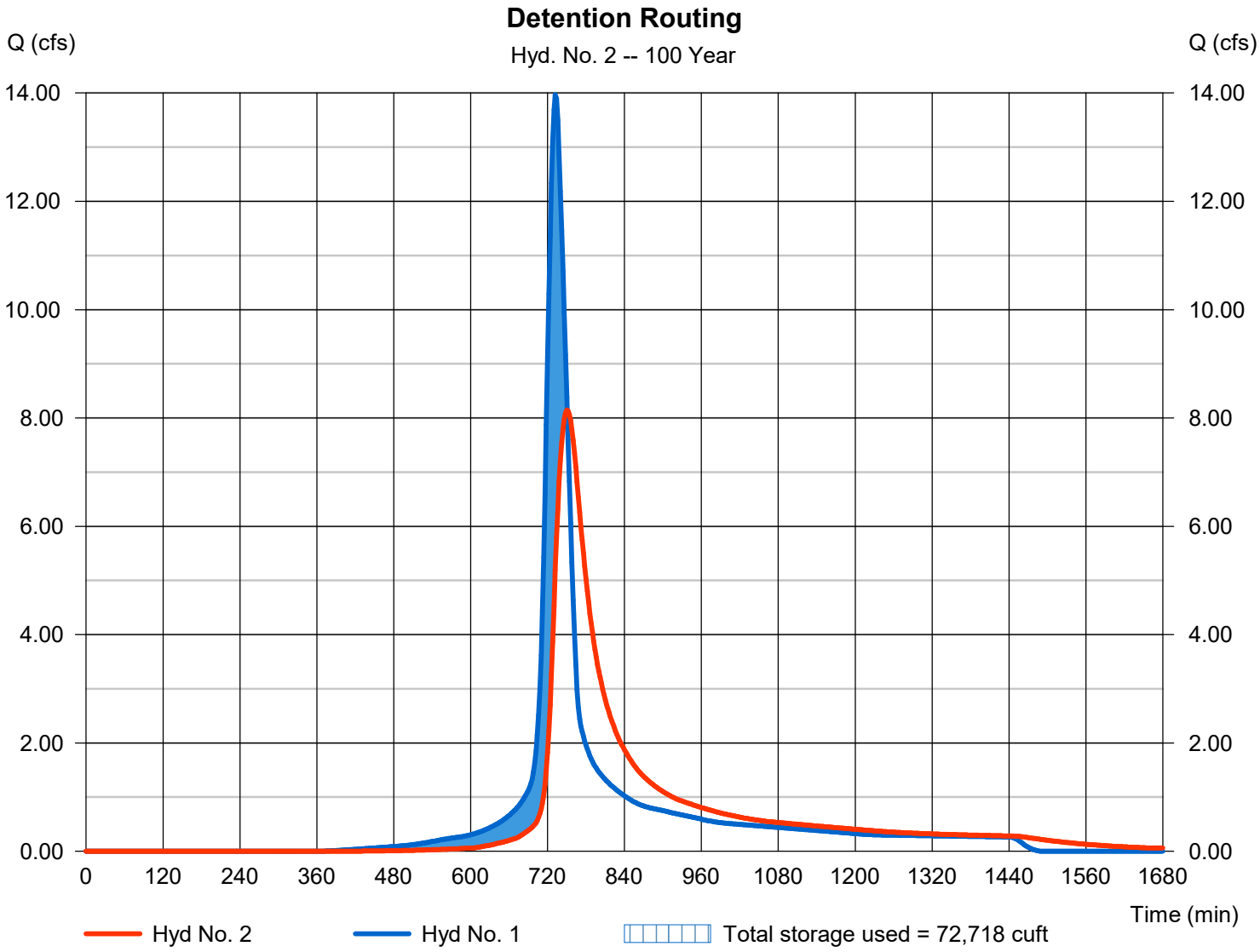
Hydrograph Report

Hyd. No. 2

Detention Routing

Hydrograph type	=	Reservoir	Peak discharge	=	8.144 cfs
Storm frequency	=	100 yrs	Time to peak	=	750 min
Time interval	=	2 min	Hyd. volume	=	60,425 cuft
Inflow hyd. No.	=	1 - Detention	Max. Elevation	=	1009.28 ft
Reservoir name	=	SW Detention Basin	Max. Storage	=	72,718 cuft

Storage Indication method used. Wet pond routing start elevation = 1008.00 ft.



Appendix G

2-Year Event

Project Description

File Name ..... CC Storm Model - North Basin.SPF

Project Options

Flow Units ..... CFS
Elevation Type ..... Elevation
Hydrology Method ..... SCS TR-55
Time of Concentration (TOC) Method ..... User-Defined
Link Routing Method ..... Kinematic Wave
Enable Overflow Ponding at Nodes ..... YES
Skip Steady State Analysis Time Periods ... NO

Analysis Options

Start Analysis On	Feb 07, 2024	00:00:00
End Analysis On	Feb 10, 2024	00:00:00
Start Reporting On	Feb 07, 2024	00:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	4
Subbasins.....	1
Nodes.....	2
Junctions	0
Outfalls	1
Flow Diversions	0
Inlets	0
Storage Nodes	1
Links.....	7
Channels	0
Pipes	0
Pumps	0
Orifices	7
Weirs	0
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
1		Time Series	2 yr	Cumulative	inches	Missouri	Jackson	2	3.50	SCS Type II 24-hr

2-Year Event

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	P4	80.42	484.00	85.99	3.50	2.10	168.72	175.18	0 00:22:24

2-Year Event

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft²)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-01	Outfall	965.40					62.74	965.40					
2	NORTH_POND	Storage Node	966.00	979.50	966.00		0.00	172.54	973.68				0.00	0.00

2-Year Event

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(in)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	12IN_WQ2	Orifice	NORTH_POND	Out-01		966.00	965.40		12.000		7.91							
2	21IN_10Y1	Orifice	NORTH_POND	Out-01		966.00	965.40		21.000		18.18							
3	21IN_10Y2	Orifice	NORTH_POND	Out-01		966.00	965.40		21.000		18.18							
4	21IN_10Y3	Orifice	NORTH_POND	Out-01		966.00	965.40		21.000		18.18							
5	2IN_WQ1	Orifice	NORTH_POND	Out-01		966.00	965.40		2.000		0.30							
6	42IN_100Y1	Orifice	NORTH_POND	Out-01		966.00	965.40		42.000		0.00							
7	42IN_100Y2	Orifice	NORTH_POND	Out-01		966.00	965.40		42.000		0.00							

2-Year Event

Subbasin Hydrology

Subbasin : P4

Input Data

Area (ac)	80.42
Peak Rate Factor	484.00
Weighted Curve Number	85.99
Rain Gage ID	2yr

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
1/8 acre lots, 65% impervious	50.52	C	90.00
1/4 acre lots, 38% impervious	31.33	C	83.00
> 75% grass cover, Good	6.02	C	74.00
Row crops, C&T, Good	4.55	C	78.00
Composite Area & Weighted CN	92.42		85.99

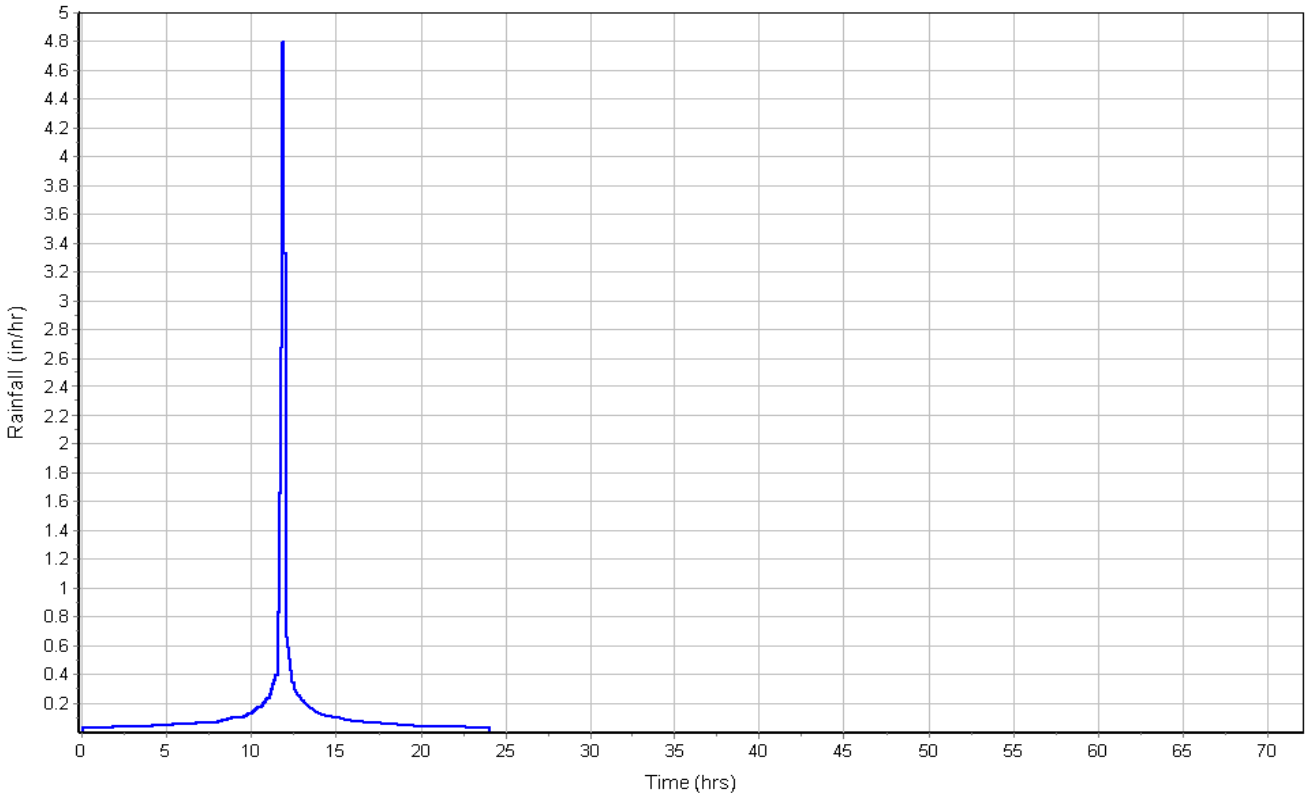
Subbasin Runoff Results

Total Rainfall (in)	3.50
Total Runoff (in)	2.10
Peak Runoff (cfs)	175.18
Weighted Curve Number	85.99
Time of Concentration (days hh:mm:ss)	0 00:22:24

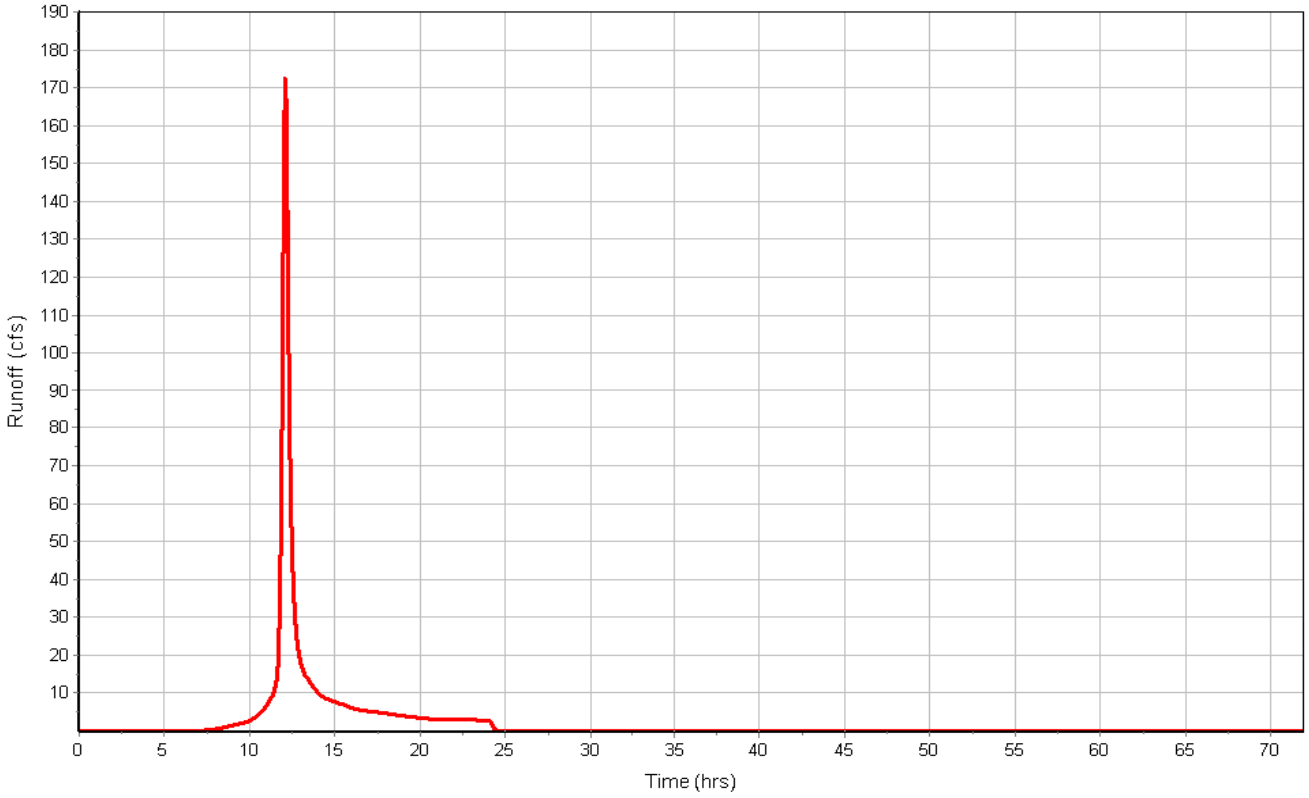
2-Year Event

Subbasin : P4

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : NORTH_POND

Input Data

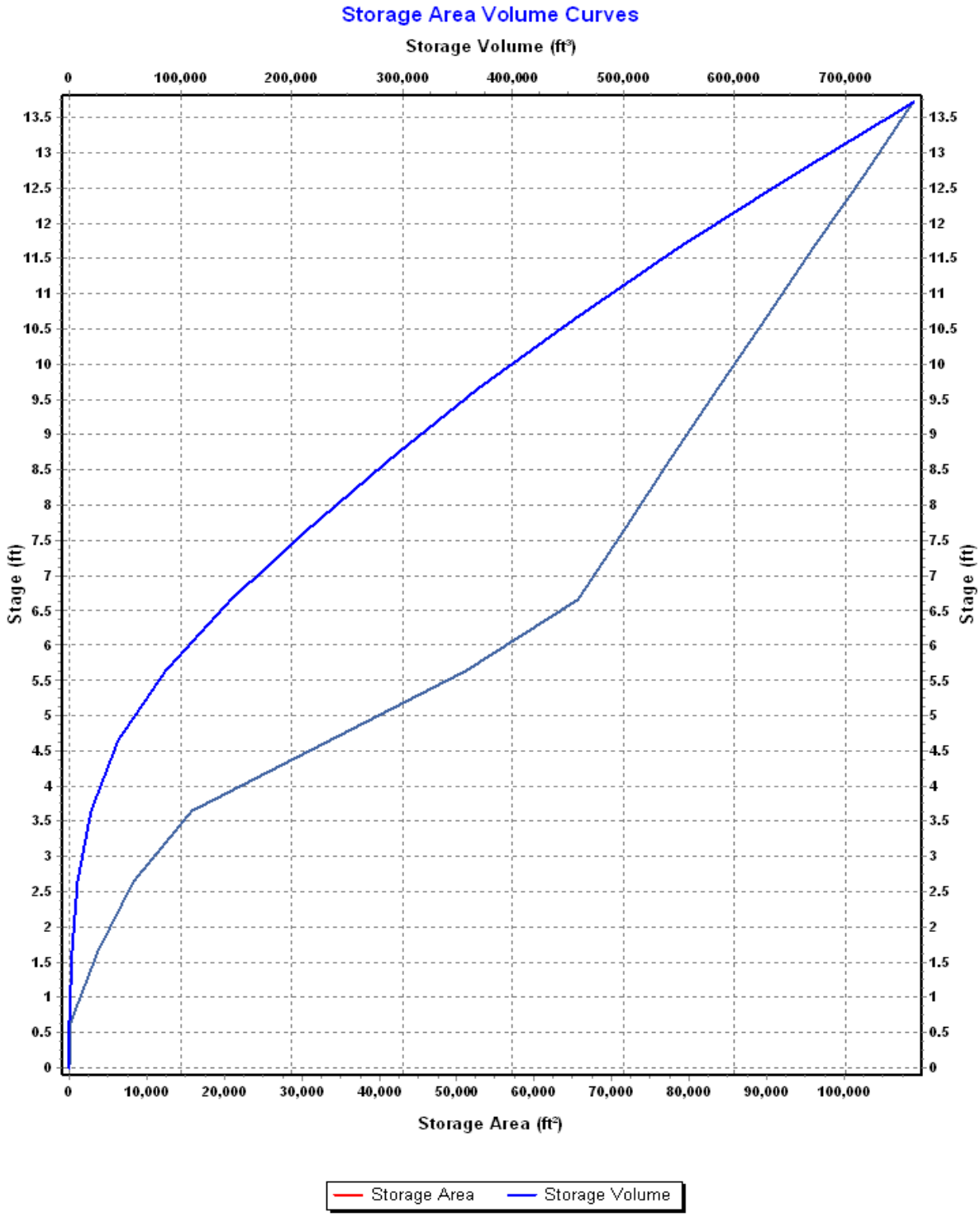
Invert Elevation (ft)	966.00
Max (Rim) Elevation (ft)	979.50
Max (Rim) Offset (ft)	13.50
Initial Water Elevation (ft)	966.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Proposed North Basin

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	0	0.000
.65	101	32.83
1.65	3610	1888.33
2.65	8289	7837.83
3.65	15857	19910.83
4.65	33682	44680.33
5.65	51251	87146.83
6.65	65730	145637.33
7.65	71679	214341.83
8.65	77656	289009.33
9.65	83715	369694.83
10.65	89833	456468.83
11.65	96012	549391.33
12.65	102259	648526.83
13.65	108556	753934.33
13.72	108999	761548.76

2-Year Event


Storage Area Volume Curves
Storage Volume (ft³)
0
100,000
200,000
300,000
400,000
500,000
600,000
700,000
Stage (ft)
13.5
13
12.5
12
11.5
11
10.5
10
9.5
9
8.5
8
7.5
7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Stage (ft)
0
10,000
20,000
30,000
40,000
50,000
60,000
70,000
80,000
90,000
100,000
Storage Area (ft²)
Storage Area
Storage Volume

Storage Node : NORTH_POND (continued)

Outflow Orifices

SN	Element ID	Orifice Type	Orifice Shape	Flap Gate	Circular Orifice Diameter (in)	Rectangular Orifice Height (in)	Rectangular Orifice Width (in)	Orifice Invert Elevation (ft)	Orifice Coefficient
1	12IN_WQ2	Side	CIRCULAR	No	12.00			969.00	0.61
2	21IN_10Y1	Side	CIRCULAR	No	21.00			970.45	0.61
3	21IN_10Y2	Side	CIRCULAR	No	21.00			970.45	0.61
4	21IN_10Y3	Side	CIRCULAR	No	21.00			970.45	0.61
5	2IN_WQ1	Side	CIRCULAR	No	2.00			965.35	0.61
6	42IN_100Y1	Side	CIRCULAR	No	42.00			973.90	0.61
7	42IN_100Y2	Side	CIRCULAR	No	42.00			973.90	0.61

Output Summary Results

Peak Inflow (cfs)	172.54
Peak Lateral Inflow (cfs)	172.54
Peak Outflow (cfs)	62.74
Peak Exfiltration Flow Rate (cfm)	0.00
Max HGL Elevation Attained (ft)	973.68
Max HGL Depth Attained (ft)	7.68
Average HGL Elevation Attained (ft)	967.88
Average HGL Depth Attained (ft)	1.88
Time of Max HGL Occurrence (days hh:mm)	0 12:31
Total Exfiltration Volume (1000-ft³)	0.000
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0.00

10-Year Event

Project Description

File Name	CC Storm Model - North Basin.SPF

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	SCS TR-55
Time of Concentration (TOC) Method	User-Defined
Link Routing Method	Kinematic Wave
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	NO

Analysis Options

Start Analysis On	Feb 07, 2024	00:00:00
End Analysis On	Feb 10, 2024	00:00:00
Start Reporting On	Feb 07, 2024	00:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	4
Subbasins	1
Nodes	2
Junctions	0
Outfalls	1
Flow Diversions	0
Inlets	0
Storage Nodes	1
Links	7
Channels	0
Pipes	0
Pumps	0
Orifices	7
Weirs	0
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
1		Time Series	10 yr	Cumulative	inches	Missouri	Jackson	10	5.30	SCS Type II 24-hr

10-Year Event

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	P4	80.42	484.00	85.99	5.30	3.75	301.33	309.03	0 00:22:24

10-Year Event

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft²)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-01	Outfall	965.40					129.41	965.40					
2	NORTH_POND	Storage Node	966.00	979.50	966.00		0.00	305.71	975.68				0.00	0.00

10-Year Event

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(in)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	12IN_WQ2	Orifice	NORTH_POND	Out-01		966.00	965.40		12.000		9.62							
2	21IN_10Y1	Orifice	NORTH_POND	Out-01		966.00	965.40		21.000		24.72							
3	21IN_10Y2	Orifice	NORTH_POND	Out-01		966.00	965.40		21.000		24.72							
4	21IN_10Y3	Orifice	NORTH_POND	Out-01		966.00	965.40		21.000		24.72							
5	2IN_WQ1	Orifice	NORTH_POND	Out-01		966.00	965.40		2.000		0.33							
6	42IN_100Y1	Orifice	NORTH_POND	Out-01		966.00	965.40		42.000		22.65							
7	42IN_100Y2	Orifice	NORTH_POND	Out-01		966.00	965.40		42.000		22.65							

10-Year Event

Subbasin Hydrology

Subbasin : P4

Input Data

Area (ac)	80.42
Peak Rate Factor	484.00
Weighted Curve Number	85.99
Rain Gage ID	10yr

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
1/8 acre lots, 65% impervious	50.52	C	90.00
1/4 acre lots, 38% impervious	31.33	C	83.00
> 75% grass cover, Good	6.02	C	74.00
Row crops, C&T, Good	4.55	C	78.00
Composite Area & Weighted CN	92.42		85.99

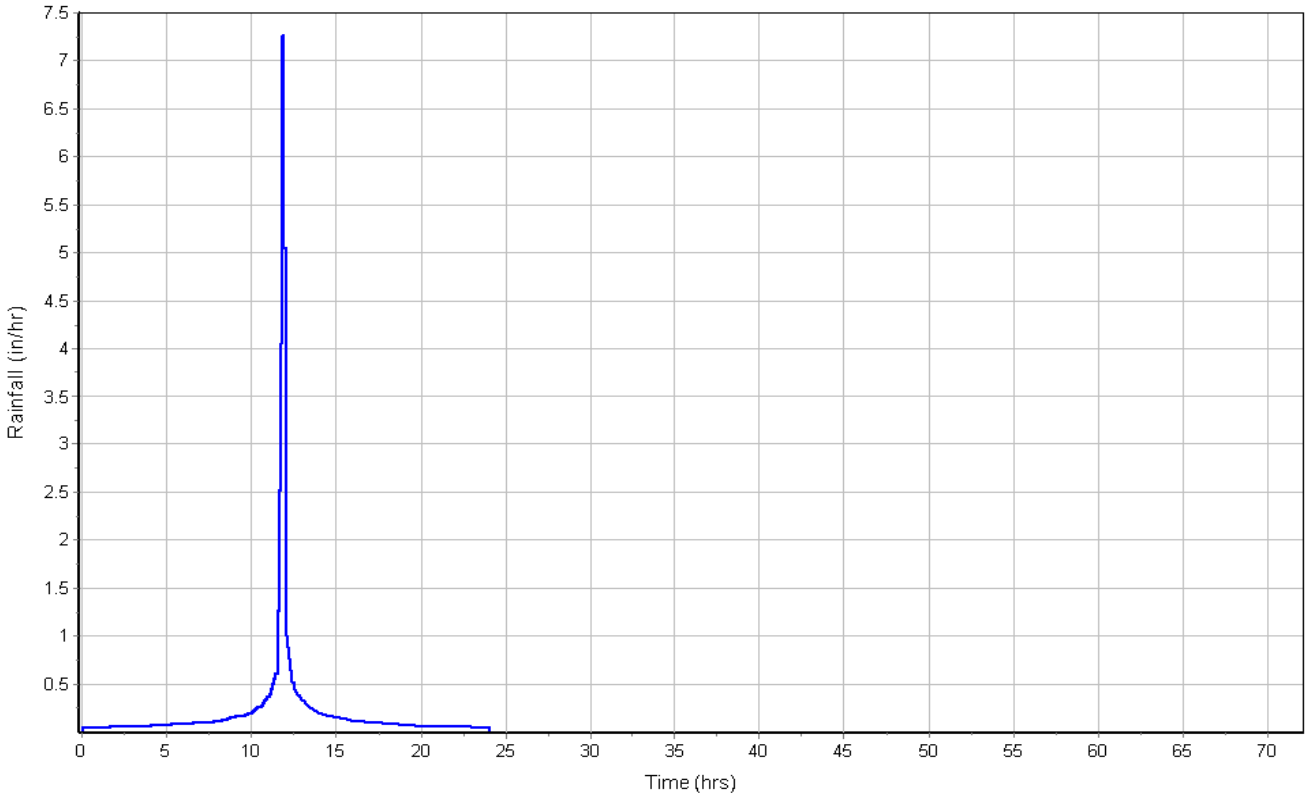
Subbasin Runoff Results

Total Rainfall (in)	5.30
Total Runoff (in)	3.75
Peak Runoff (cfs)	309.03
Weighted Curve Number	85.99
Time of Concentration (days hh:mm:ss)	0 00:22:24

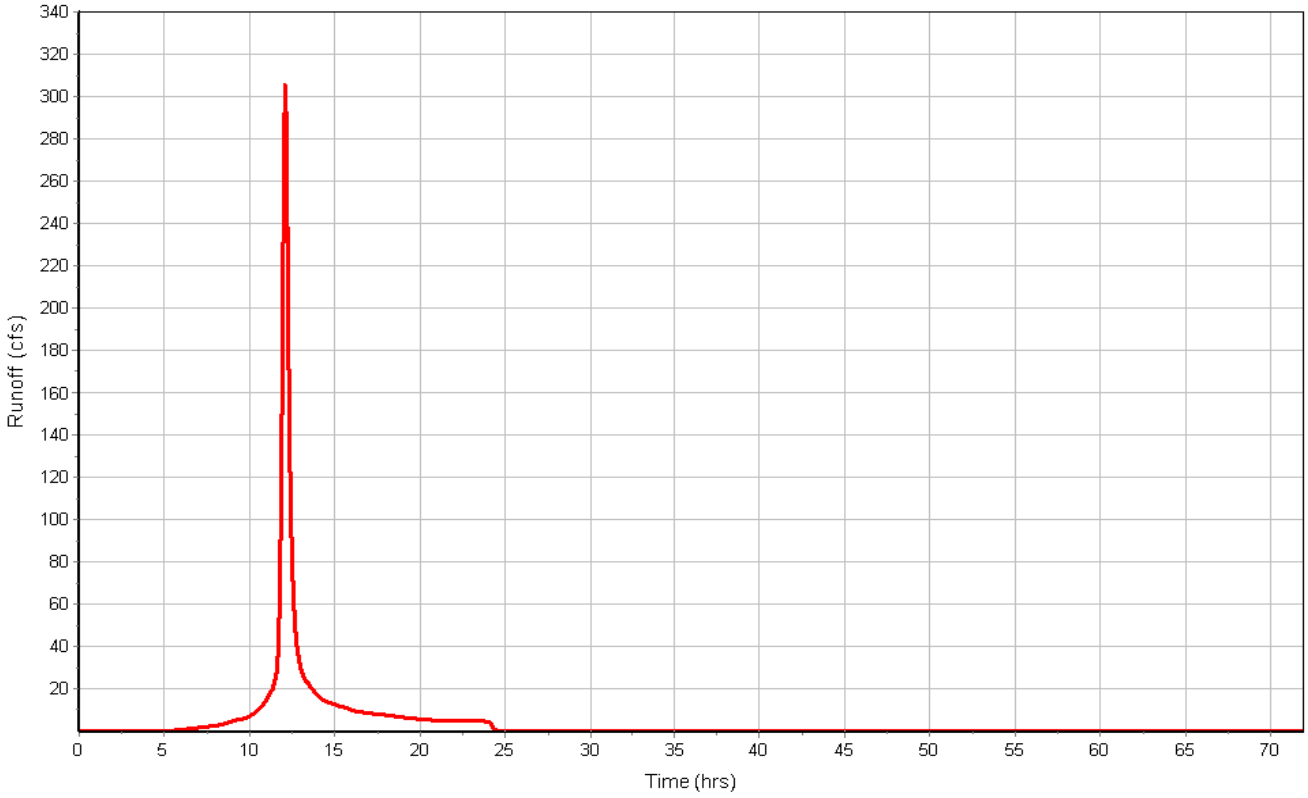
10-Year Event

Subbasin : P4

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : NORTH_POND

Input Data

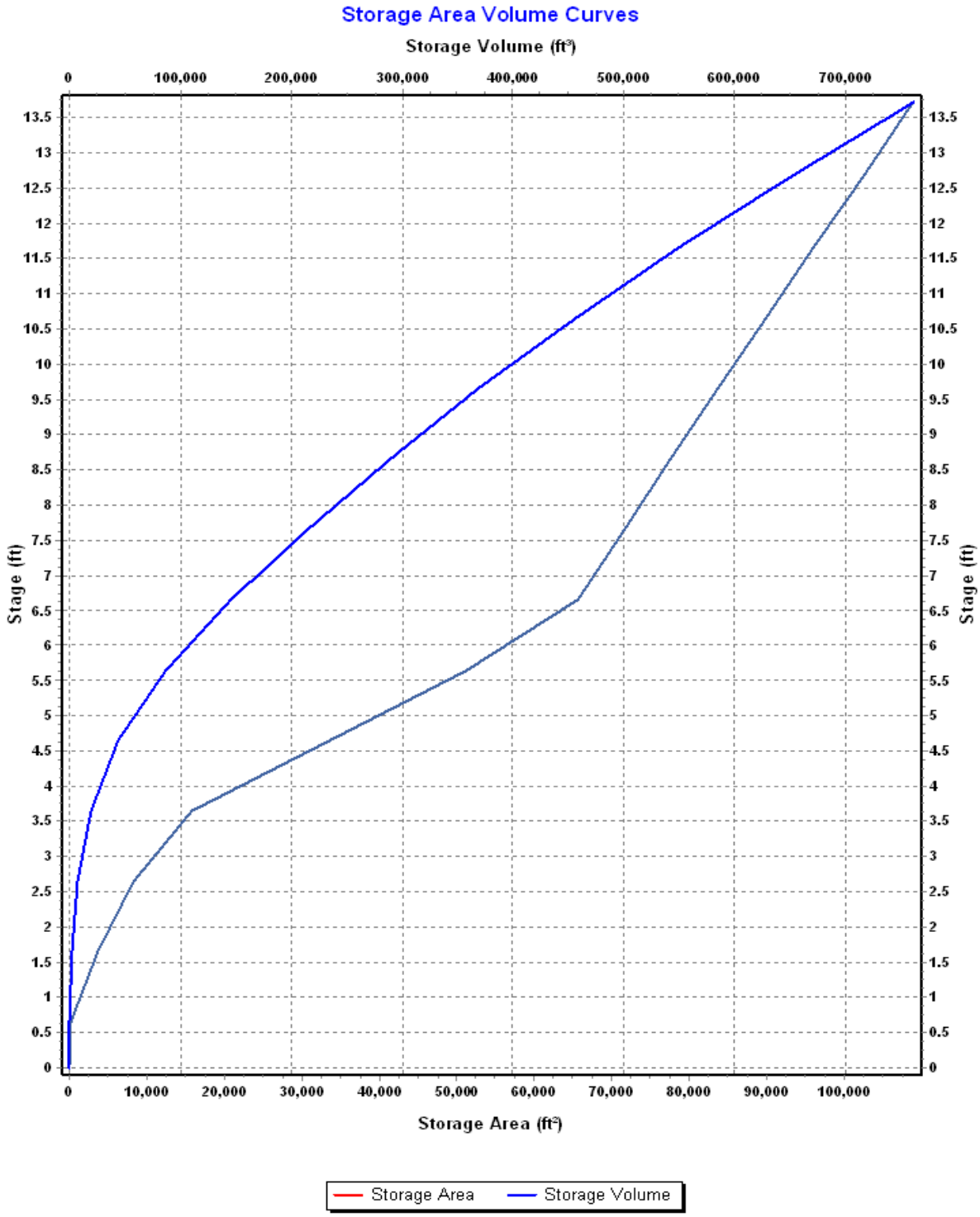
Invert Elevation (ft) 966.00
Max (Rim) Elevation (ft) 979.50
Max (Rim) Offset (ft) 13.50
Initial Water Elevation (ft) 966.00
Initial Water Depth (ft) 0.00
Ponded Area (ft²) 0.00
Evaporation Loss 0.00

Storage Area Volume Curves

Storage Curve : Proposed North Basin

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	0	0.000
.65	101	32.83
1.65	3610	1888.33
2.65	8289	7837.83
3.65	15857	19910.83
4.65	33682	44680.33
5.65	51251	87146.83
6.65	65730	145637.33
7.65	71679	214341.83
8.65	77656	289009.33
9.65	83715	369694.83
10.65	89833	456468.83
11.65	96012	549391.33
12.65	102259	648526.83
13.65	108556	753934.33
13.72	108999	761548.76

10-Year Event



Storage Node : NORTH_POND (continued)

Outflow Orifices

SN	Element ID	Orifice Type	Orifice Shape	Flap Gate	Circular Orifice Diameter (in)	Rectangular Orifice Height (in)	Rectangular Orifice Width (in)	Orifice Invert Elevation (ft)	Orifice Coefficient
1	12IN_WQ2	Side	CIRCULAR	No	12.00			969.00	0.61
2	21IN_10Y1	Side	CIRCULAR	No	21.00			970.45	0.61
3	21IN_10Y2	Side	CIRCULAR	No	21.00			970.45	0.61
4	21IN_10Y3	Side	CIRCULAR	No	21.00			970.45	0.61
5	2IN_WQ1	Side	CIRCULAR	No	2.00			965.35	0.61
6	42IN_100Y1	Side	CIRCULAR	No	42.00			973.90	0.61
7	42IN_100Y2	Side	CIRCULAR	No	42.00			973.90	0.61

Output Summary Results

Peak Inflow (cfs)	305.71
Peak Lateral Inflow (cfs)	305.71
Peak Outflow (cfs)	129.41
Peak Exfiltration Flow Rate (cfm)	0.00
Max HGL Elevation Attained (ft)	975.68
Max HGL Depth Attained (ft)	9.68
Average HGL Elevation Attained (ft)	968.15
Average HGL Depth Attained (ft)	2.15
Time of Max HGL Occurrence (days hh:mm)	0 12:28
Total Exfiltration Volume (1000-ft³)	0.000
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0.00

100-Year Event

Project Description

File Name	CC Storm Model - North Basin.SPF

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	SCS TR-55
Time of Concentration (TOC) Method	User-Defined
Link Routing Method	Kinematic Wave
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	NO

Analysis Options

Start Analysis On	Feb 07, 2024	00:00:00
End Analysis On	Feb 10, 2024	00:00:00
Start Reporting On	Feb 07, 2024	00:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	4
Subbasins	1
Nodes	2
Junctions	0
Outfalls	1
Flow Diversions	0
Inlets	0
Storage Nodes	1
Links	7
Channels	0
Pipes	0
Pumps	0
Orifices	7
Weirs	0
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
1		Time Series	100 YR	Cumulative	inches	Missouri	Jackson	100	7.70	SCS Type II 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	P4	80.42	484.00	85.99	7.70	6.04	485.74	488.59	0 00:22:24

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft²)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-01	Outfall	965.40					233.80	965.40					
2	NORTH_POND	Storage Node	966.00	979.50	966.00		0.00	484.44	977.62				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Average Slope (%)	Diameter or Height (in)	Manning's Roughness	Peak Flow (cfs)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Reported Condition
1	12IN_WQ2	Orifice	NORTH_POND	Out-01		966.00	965.40		12.000		11.03							
2	21IN_10Y1	Orifice	NORTH_POND	Out-01		966.00	965.40		21.000		29.74							
3	21IN_10Y2	Orifice	NORTH_POND	Out-01		966.00	965.40		21.000		29.74							
4	21IN_10Y3	Orifice	NORTH_POND	Out-01		966.00	965.40		21.000		29.74							
5	2IN_WQ1	Orifice	NORTH_POND	Out-01		966.00	965.40		2.000		0.37							
6	42IN_100Y1	Orifice	NORTH_POND	Out-01		966.00	965.40		42.000		66.59							
7	42IN_100Y2	Orifice	NORTH_POND	Out-01		966.00	965.40		42.000		66.59							

Subbasin Hydrology

Subbasin : P4

Input Data

Area (ac)	80.42
Peak Rate Factor	484.00
Weighted Curve Number	85.99
Rain Gage ID	100yr

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
1/8 acre lots, 65% impervious	50.52	C	90.00
1/4 acre lots, 38% impervious	31.33	C	83.00
> 75% grass cover, Good	6.02	C	74.00
Row crops, C&T, Good	4.55	C	78.00
Composite Area & Weighted CN	92.42		85.99

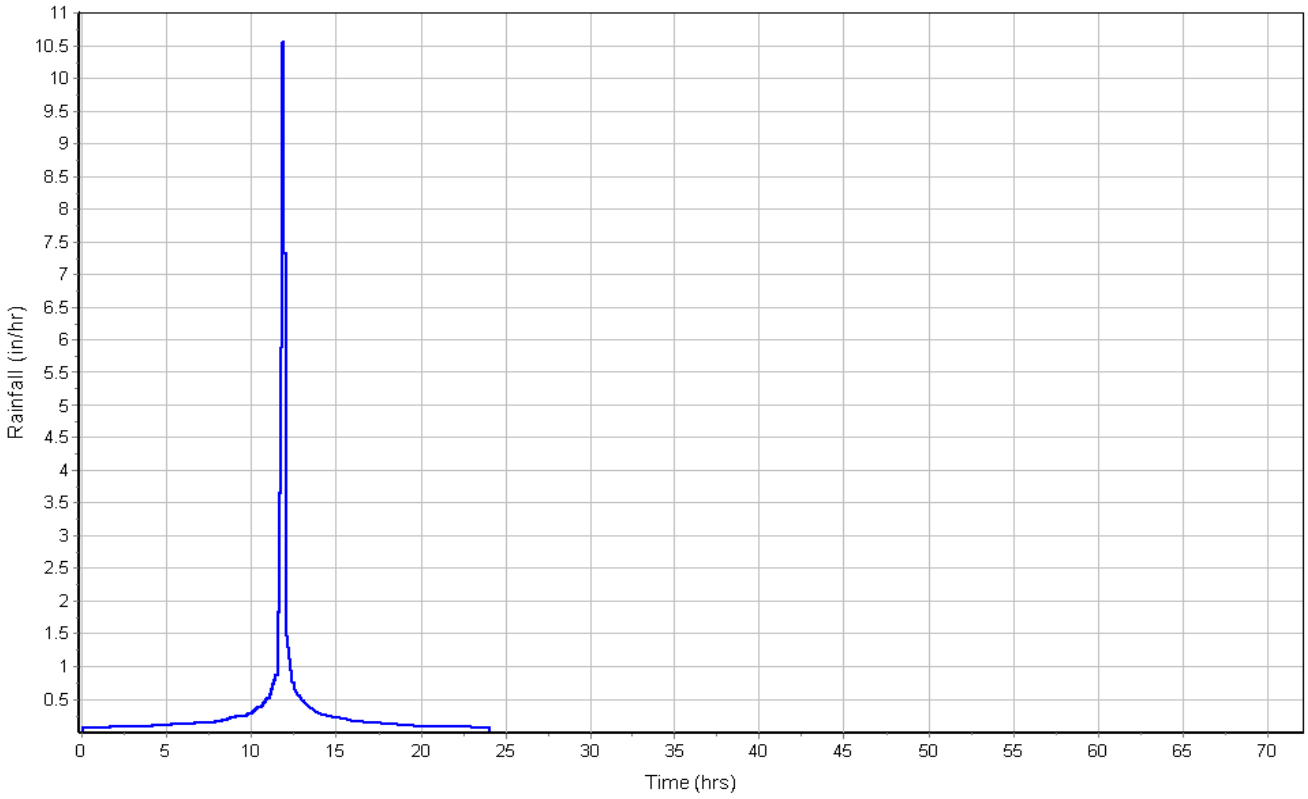
Subbasin Runoff Results

Total Rainfall (in)	7.70
Total Runoff (in)	6.04
Peak Runoff (cfs)	488.59
Weighted Curve Number	85.99
Time of Concentration (days hh:mm:ss)	0 00:22:24

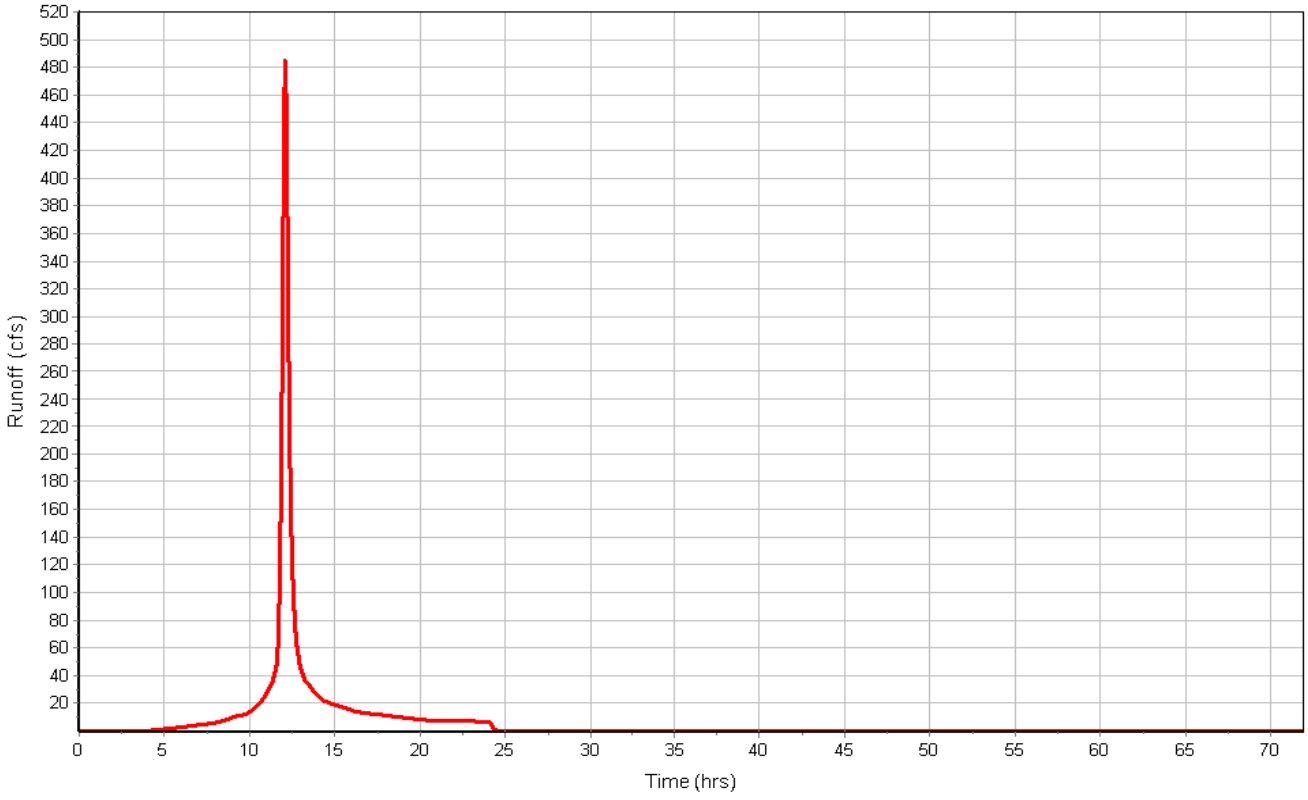
100-Year Event

Subbasin : P4

Rainfall Intensity Graph



Runoff Hydrograph



Storage Nodes

Storage Node : NORTH_POND

Input Data

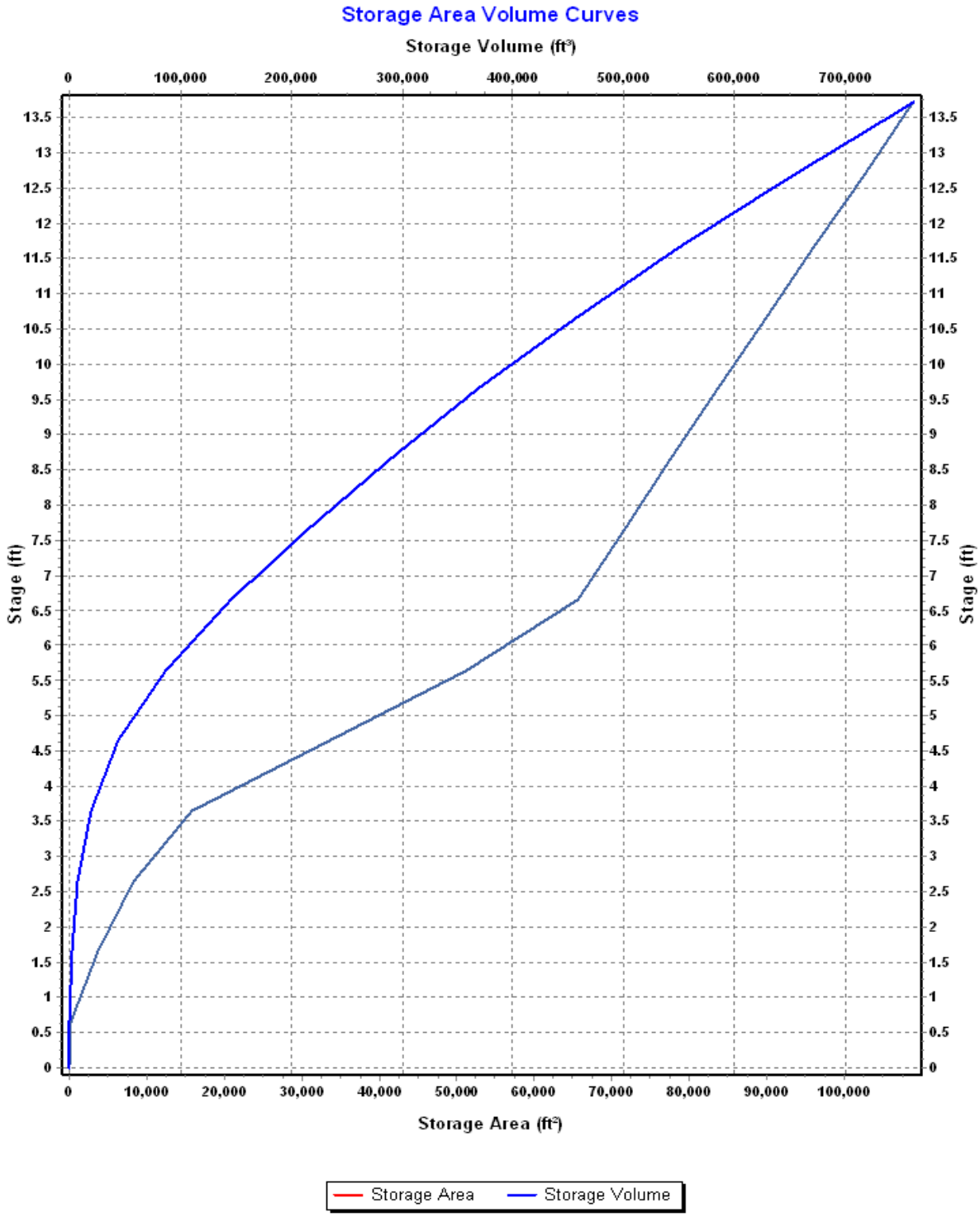
Invert Elevation (ft)	966.00
Max (Rim) Elevation (ft)	979.50
Max (Rim) Offset (ft)	13.50
Initial Water Elevation (ft)	966.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Proposed North Basin

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	0	0.000
.65	101	32.83
1.65	3610	1888.33
2.65	8289	7837.83
3.65	15857	19910.83
4.65	33682	44680.33
5.65	51251	87146.83
6.65	65730	145637.33
7.65	71679	214341.83
8.65	77656	289009.33
9.65	83715	369694.83
10.65	89833	456468.83
11.65	96012	549391.33
12.65	102259	648526.83
13.65	108556	753934.33
13.72	108999	761548.76

100-Year Event



Storage Node : NORTH_POND (continued)

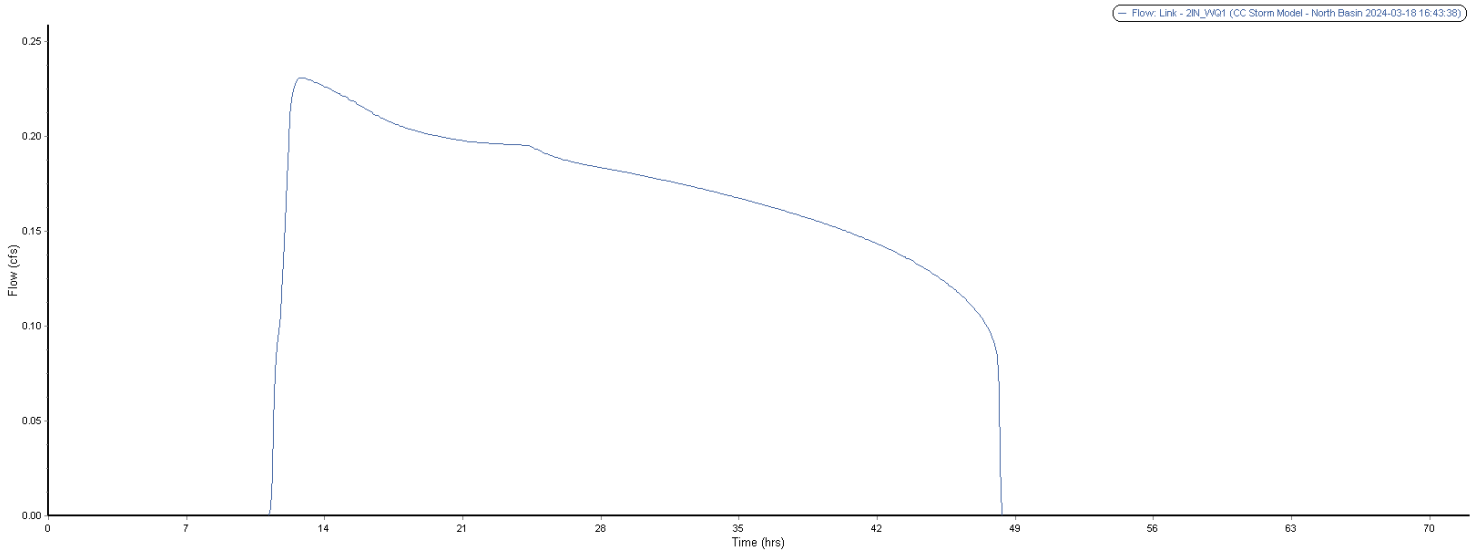
Outflow Orifices

SN	Element ID	Orifice Type	Orifice Shape	Flap Gate	Circular Orifice Diameter (in)	Rectangular Orifice Height (in)	Rectangular Orifice Width (in)	Orifice Invert Elevation (ft)	Orifice Coefficient
1	12IN_WQ2	Side	CIRCULAR	No	12.00			969.00	0.61
2	21IN_10Y1	Side	CIRCULAR	No	21.00			970.45	0.61
3	21IN_10Y2	Side	CIRCULAR	No	21.00			970.45	0.61
4	21IN_10Y3	Side	CIRCULAR	No	21.00			970.45	0.61
5	2IN_WQ1	Side	CIRCULAR	No	2.00			965.35	0.61
6	42IN_100Y1	Side	CIRCULAR	No	42.00			973.90	0.61
7	42IN_100Y2	Side	CIRCULAR	No	42.00			973.90	0.61

Output Summary Results

Peak Inflow (cfs)	484.44
Peak Lateral Inflow (cfs)	484.44
Peak Outflow (cfs)	233.80
Peak Exfiltration Flow Rate (cfm)	0.00
Max HGL Elevation Attained (ft)	977.62
Max HGL Depth Attained (ft)	11.62
Average HGL Elevation Attained (ft)	968.37
Average HGL Depth Attained (ft)	2.37
Time of Max HGL Occurrence (days hh:mm)	0 12:25
Total Exfiltration Volume (1000-ft³)	0.000
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0.00

Water Quality Event



Appendix H

STORM WATER REPORT

Cobey Creek

Mixed Use Development

Lee's Summit, MO

PREPARED FOR

JCM DEVELOPMENT,LLC

PREPARED BY

Hg Consult, Inc

Condensed Version

October, 2020

10/27/20

Content

1. Original Storm Report-May 22, 2018

2. Addendum 1- July 1, 2019- Effective Height and Energy Dissipation additions to North Pond

3. Addendum 2- August 3, 2020- Updated South Pond Outlet Structure-Pond Pack Print out.

4. Addendum 3- October 8, 2020- Approved Outlet Structure Geometric Changes from Circular to Square and Rectangular

Report Summary

As requested by the City of Lee's Summit, this condensed report has been prepared to chronicle the changes to the storm system during construction of the first phase of the project and since the storm report was approved. As provided on the content page, 3 addendums have been prepared, based on the 3 changes to the plans. A summary of those addendums and changes are as follows:

Addendum 1

This addendum was prepared prior to construction to address City comments in regard to the north pond design. The addendum addressed the usage of the skimmer and the 40 hour release from the pond , effective height of the pond and the need to design the pond to TR-60 requirements and the energy dissipation design at the out of the discharge ping from the pond.

Addendum 2

This addendum addressed the change of the geometric shape of the south detention pond outlet structure after construction began. The approved design called for a circular structure. It was found that the circular manhole could not be cast, based on the size and a square structure was to take its place. Calculations confirmed that the geometric shape change did not impact the hydraulic design or flow of the pond.

Addendum 3

This addendum addressed the change of the geometric shape of the outlet structure for the north pond after construction began. For the same reason on the change for the south pond, circular manholes couldn't be cast and a

rectangular structure was substituted for 2 side by side manholes, with again, no impact on the pond flow or hydraulic function.

STORM WATER DRAINAGE REPORT

Cobey Creek

Mixed Use Development

Lee's Summit, MO

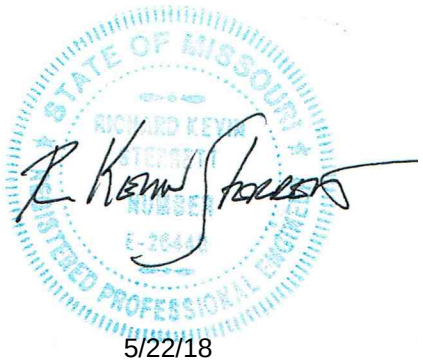
PREPARED FOR

JCM DEVELOPMENT, LLC

PREPARED BY HG

CONSULT, INC.

May 22, 2018



5/22/18

1. Project Overview

The proposed project is a mixed use development. The project will contain 12.7 acres of commercial development and 84.6 acres of mixed residential development and open space. The site is current undeveloped with a lone residential dwelling.

The topography of the site is a gentle slope south to the north, specifically to the north east corner to a creek. Some area along the highway frontage slopes to the south and drains through a culvert pipe under M-150 Highway.

2. Drainage Assessment of the Project Site

Storm drainage for the site will include a full underground system, designed for the 10-year storm event and overland routing of the higher storm events. The majority of the post development site drainage will be regulated at the north east corner of the site with a detention facility, sized for the 2-year, 10-year, and 100-year storm events with the 40-hour extended detention included.

3. Temporary Erosion and Sediment Control

During construction and prior to paving, it will be necessary to control erosion and sediment from the site during storms with in the construction timeframe. To insure that sediment does not enter the existing storm system or runs off to the existing street or creek, perimeter containment, silt fence, inlet protection, rock ditch checks will be used. The detention pond will utilized as a temporary sediment basin during construction of the early phases of the development. This will be fully addressed in the E, S&C plans with the Phase 1 construction plans. To keep construction traffic from tracking mud onto the adjacent citystreet, a stabilized rock construction entrance will need to be installed.

These erosion control devices, and their maintenance throughout the construction timeframe, are required by ordinance and the details for them are referenced by APWA 5600.

Post-development water quality will be addressed through the use a release structure sized for the 2-year, 10-year, and 100-year storm events with the 40-hour extended detention included. The owner will need to have a routine maintenance policy for the cleaning, repair and replacement of the detention release structure.

4. Soil Classifications

NRCS Web Soil Survey categorizes the soils on the Cobey Creek site below.

Table 4.1 – Soil Classification

Symbol	Name	Slopes	HSG
10000	Arisburg silt loam	1-5%	C
10082	Sampsel silty clay loam	2-5%	C/D
10117	Sampsel silty clay loam	5-9%	C/D

For this analysis, Soil group C was considered for the Cobey Creek site. Curve Numbers were used in accordance with the APWA 5600.

5. Methodology

The method for evaluating Cobey Creek was the use of a PondPack Model. Both Pre-Development and Post-Development conditions were considered:

PondPack V8i

- TR-55 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 APWA 5600 (Table 5602-3)
  - Time of Concentration developed per TR-55

6. Pre-Development Conditions

This section of the drainage study has been prepared to evaluate the Pre-Development Conditions related to stormwater runoff. The following tables summarize the Pre-Development Conditions Analysis. Refer to the Design Calculations for details regarding the analysis.

Table 6.1 – Pre-Development Watershed Data

Name	Area (acres)	Composite CN	Tc (hrs)
EX1	17.64	75	0.217
EX2	2.43	74	0.145
EX3	89.68	75	0.419
EX4	14.70	74	0.182

Table 6.1 – Pre-Development Discharges

Name	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
EX1	29.07	61.09	107.36
EX2	4.29	9.17	16.32
EX3	105.54	226.85	403.16
EX4	23.98	51.33	91.04

Per APWA Section 5608.4 and City of Lee's Summit criteria, the post-development 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

APWA allowable releases were calculated for the various points of discharge. Off-site flows were allowed to bypass detention. Off-site flows were calculated using a separate PondPack model. The off-site time of concentrations used the same existing time of concentrations located in Table 6.1 and the areas can be found in Table 6.3. Where detention was not possible, areas of the site were drained to the detention in P3 to reduce the outflow from EX1, EX2, and EX4. Release rates per APWA were added to the off-site discharges to produce the allowable rates.

Table 6.3 – Pre-Development Off-site Watershed Data

Name	Total Area (acres)	On-site Area (acres)	Off-site Area (acres)
EX1	17.82	13.42	4.38
EX2	2.43	2.24	0.19
EX3	89.68	68.35	21.33
EX4	14.70	14.7	0

Table 6.4 – Off-site flow rates

Name	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
EX1	8.30	16.50	28.11
EX2	0.33	0.70	1.24
EX3	32.55	63.46	106.65
EX4	0	0	0

Table 6.5 – Allowable Peak Flow Rates

Name	Allowable Q2 (cfs)	Allowable Q10 (cfs)	Allowable Q100 (cfs)
EX1	15.01	43.34	68.37
EX2	1.49	5.32	8.17
EX3	66.73	200.16	311.70
EX4	7.35	29.40	44.10

7. Post-Development Conditions

This section of the drainage study has been prepared to evaluate the Post-Development Conditions related to stormwater runoff. The following tables summarize the Post-Development Conditions Analysis. Refer to the Design Calculations for details regarding the analysis.

Table 7.1 – Post-Development Watershed Data

Name	Area (acres)	Composite CN	Tc (hrs)
P1	10.88	84	0.153
P2	0.68	81	0.112
P3	90.04	83	0.364
P4	4.40	82	0.165

Table 7.2 – Post-Development Discharges

Name	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
P1	29.29	58.87	84.76
P2	1.73	3.27	5.40
P3	56.27	194.07	282.73
P4	10.77	20.01	32.66

All storm events for Areas P2, P3, and P4 will see a decrease in the maximum release rates from Pre-Development Conditions to Post-Development Conditions. Area P1 is does not meet the release requirements. This area will be a separate development that will require detention. The developer will be required to size this separate detention to meeting the allowable release rates located in Table 6.4.

P2 and P4 are fringe areas that do not contain any detention. The 2-year flows for P2 and P4 do not meet the allowable release rates located in Table 6.4. A waiver to the Design and Construction manual will be submitted to the City of Lee's Summit.

P5 on the proposed drainage map is a small fringe area on the backside of the detention pond. This area will be routed to a diversion ditch along the east side of the property and converge with the outlet of the detention pond at the Northeast corner of the property.

APWA 5608.4 also requires a 40-hour extended release of the water quality storm event (1.37"/24-hour rainfall) per Section 8.10 of the BMP Manual. The detention facility will release the water quality event over a 40-hour period. The Time vs. Volume graph is located in the Design Calculations Section.

8. Post-Development 100-year Spillway

APWA 5600 also requires a spillway in the detention pond sized for the 100-year event, assuming 100% clogging of the primary outlet works and zero available storage in the detention pond. The 100-year water surface elevation is 976.0. The spillway was set at an elevation of 976.5 and was sized to provide 1-foot of freeboard. The spillway will be 475-feet in length and riprap will be sized and placed throughout the spillway.

9. Future Conditions

The Cobey Creek site does not have any future developments planned.

10. Conclusions

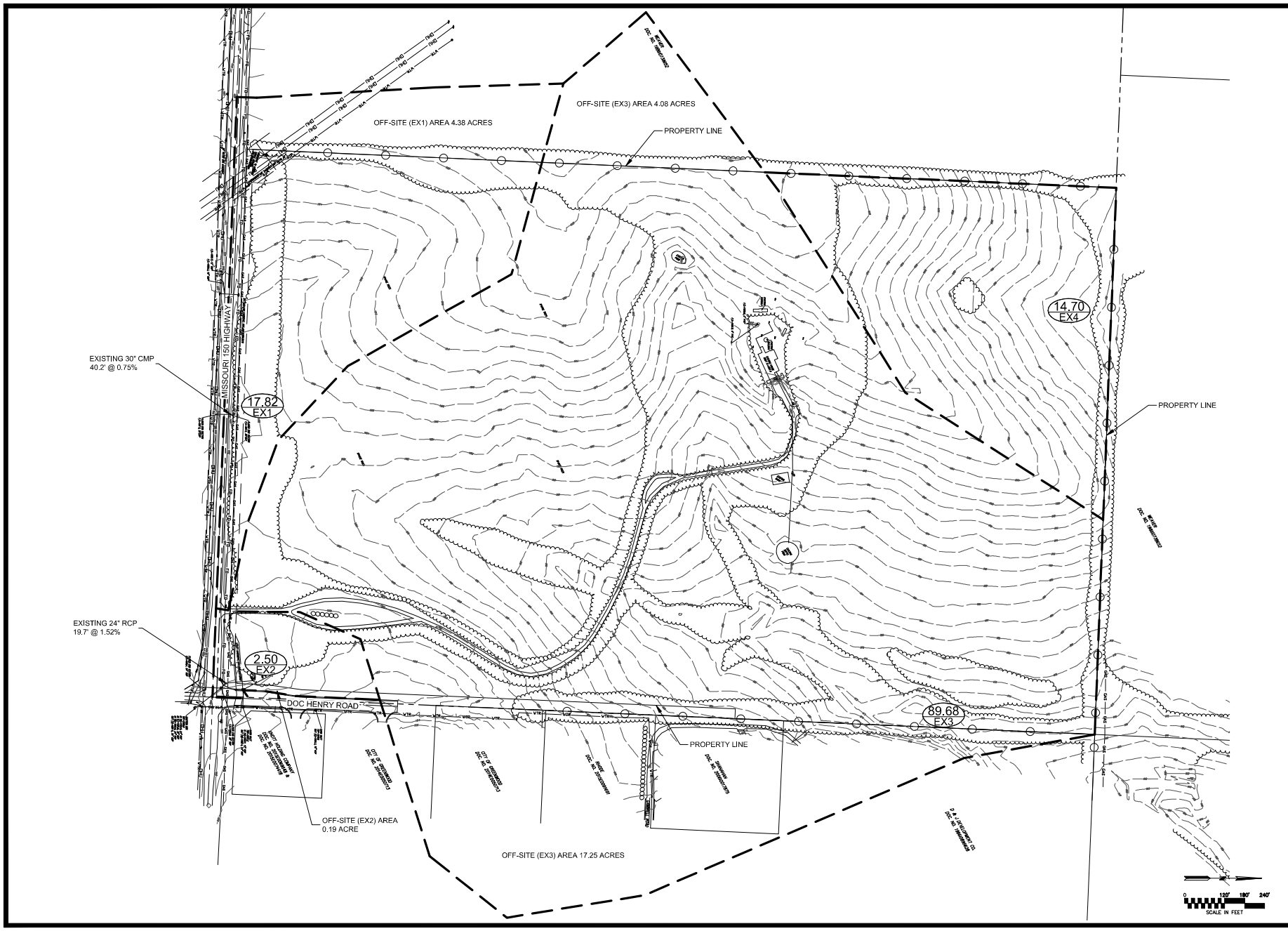
The Cobey Creek project is a mixed use development 186 single family lots, 44 multi-family lots, and 4 commercial lots. The project will contain 12.7 acres of commercial development and 84.6 acres of mixed residential development and open space. The report has been prepared to evaluate the stormwater discharge at the site to ensure the requirements of APWA 5600 are met. The detention pond and release structure was designed to not increase peak discharges from existing conditions as well as meeting the maximum releases from APWA 5600. It is not anticipated that the Cobey Creek Development will have any downstream impacts.

The 2-year flows for P2 and P4 do not meet the allowable release rates located in Table 6.4. A waiver to the Design and Construction manual will be submitted to the City of Lee's Summit.

11. Design Calculations

See the attached for drainage area maps and stormwater calculations.

DRAINAGE AREA MAPS



DATE	REVISION	NO.	BY	CK/APP

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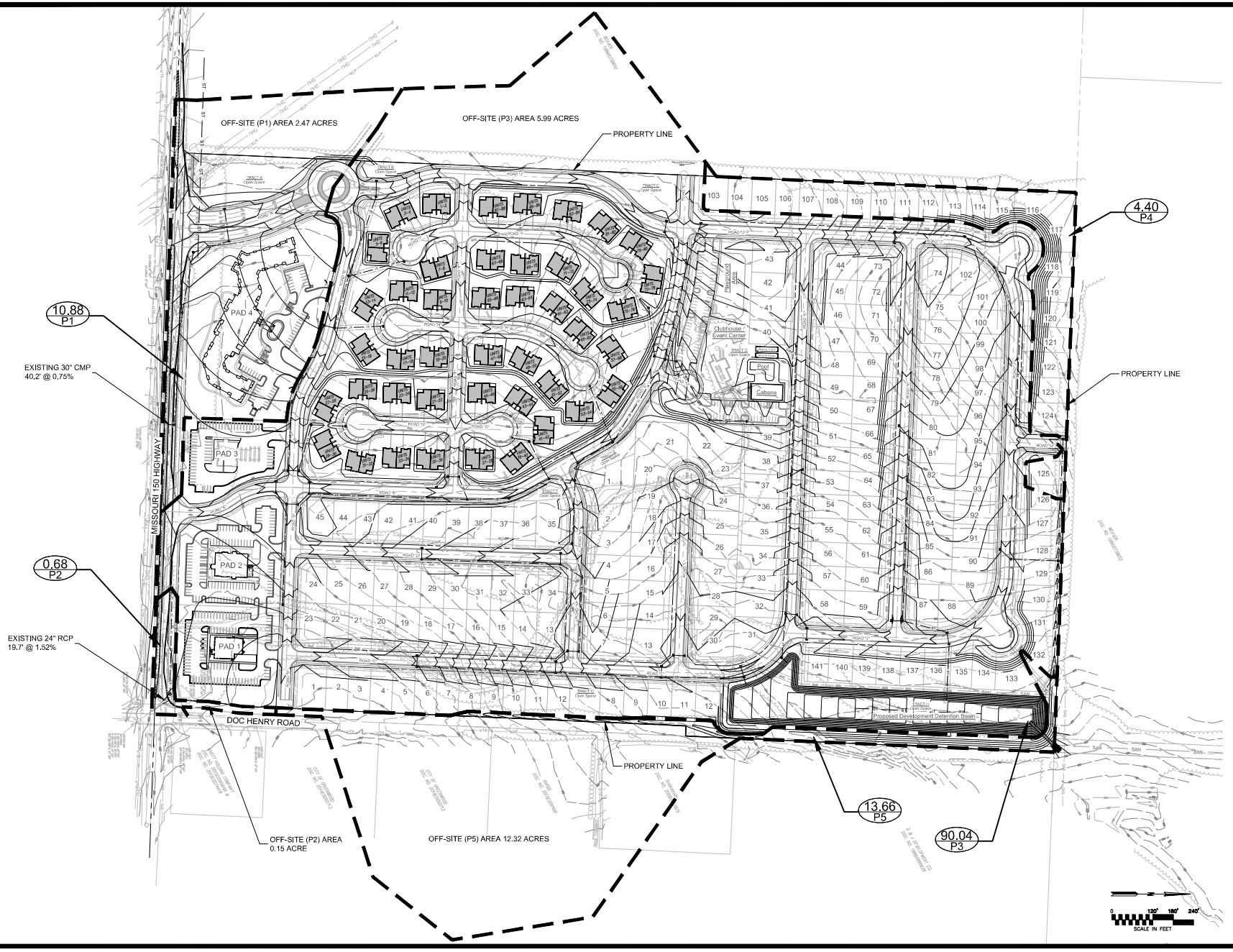
R. KEVIN STERRETT, KS E-21889
MO E-26440
Jul 11, 2017

Consult Inc engineers planners
11010 Haskell Street, Suite 210, Kansas City, Kansas 66109
CORPORATE LICENSE No. E201000573 (MO.) / E-1736 (KS.)

STORM DRAINAGE REPORT
EXISTING CONDITIONS

COBEY CREEK
CITY OF LEE'S SUMMIT, JACKSON COUNTY, MISSOURI

X-REF NO.
16-059 BASE
DRAWING NO.
16-059 STORM EXHIBIT
DATE
May 8, 2018
JOB NO.
16-059



NO.	BY	CHK'D	DATE	REVISION

IF THIS IS NOT A BLUE INK SEAL AND THE SIGNATURE IN BLUE INK, THE PLAN IS A COPY AND MAY CONTAIN UNAUTHORIZED ALTERATIONS. THE CERTIFICATION CONTAINED ON THIS DOCUMENT SHALL NOT APPLY TO ANY COPIES.

R. KEVIN STERRETT - KS E-21889 MO E-26440
Jul 11, 2017

Consult Inc engineers planners
11010 Haskell Street, Suite 210, Kansas City, Kansas 66109
CORPORATE LICENSE No. E2010057 (MO) / E-2796 (KS)

STORM DRAINAGE REPORT
DEVELOPED CONDITIONS

COBEY CREEK

CITY OF LEE'S SUMMIT, JACKSON COUNTY, MISSOURI

X-REF NO.	16-059 BASE
DRAWING NO.	16-059 PDPs
DATE	May 8, 2018
JOB NO.	16-059
SHEET	2
OF	2

SOIL CLASSIFICATIONS

Hydrologic Soil Group—Jackson County, Missouri

Map Scale: 1:4,680 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 50 100 200 300

Feet: 0 200 400 800 1200

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 15N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils

Soil Rating Polygons
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Jackson County, Missouri
Survey Area Data: Version 18, Sep 16, 2017

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Oct 14, 2014—Oct 10, 2016

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
10000	Arisburg silt loam, 1 to 5 percent slopes	C	60.8	66.3%
10116	Sampsel silty clay loam, 2 to 5 percent slopes	C/D	9.0	9.8%
10117	Sampsel silty clay loam, 5 to 9 percent slopes	C/D	21.9	23.8%
Totals for Area of Interest			**91.7**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

TIME OF CONCENTRATION CALCULATIONS

EX1

	Area	CN	Composite CN
Row Crop	4.4	78	19
Undeveloped	13.4	74	56
Total	**17.8**		**75**

P1

	Area	CN	Composite CN
Row Crop	2.5	78	18
Undeveloped	1.0	74	7
Mixed Use	7.4	88	60
Total	**10.9**		**84**

EX2

	Area	CN	Composite CN
Undeveloped	0.2	74	6
Undeveloped	2.3	74	68
Total	**2.5**		**74**

P2

	Area	CN	Composite CN
Undeveloped	0.2	74	16
Undeveloped	0.2	74	23
Mixed Use	0.3	88	41
Total	**0.7**		**81**

EX3

	Area	CN	Composite CN
Row Crop	4.1	78	4
Residential/Undeveloped	17.3	80	15
Undeveloped	68.4	74	56
Total	**89.7**		**75**

P3

	Area	CN	Composite CN
Row Crop	6.0	78	5
Undeveloped	3.3	74	3
Multi Family	25.8	88	25
Residential	55.0	82	50
Total	**90.0**		**83**

EX4

	Area	CN	Composite CN
Undeveloped	14.7	74	**74**
Total	**14.7**		

P4

	Area	CN	Composite CN
Residential	4.4	82	**82**
Total	**4.4**		

Cobey Creek
Existing
Jackson County, Missouri

Sub-Area Time of Concentration Details

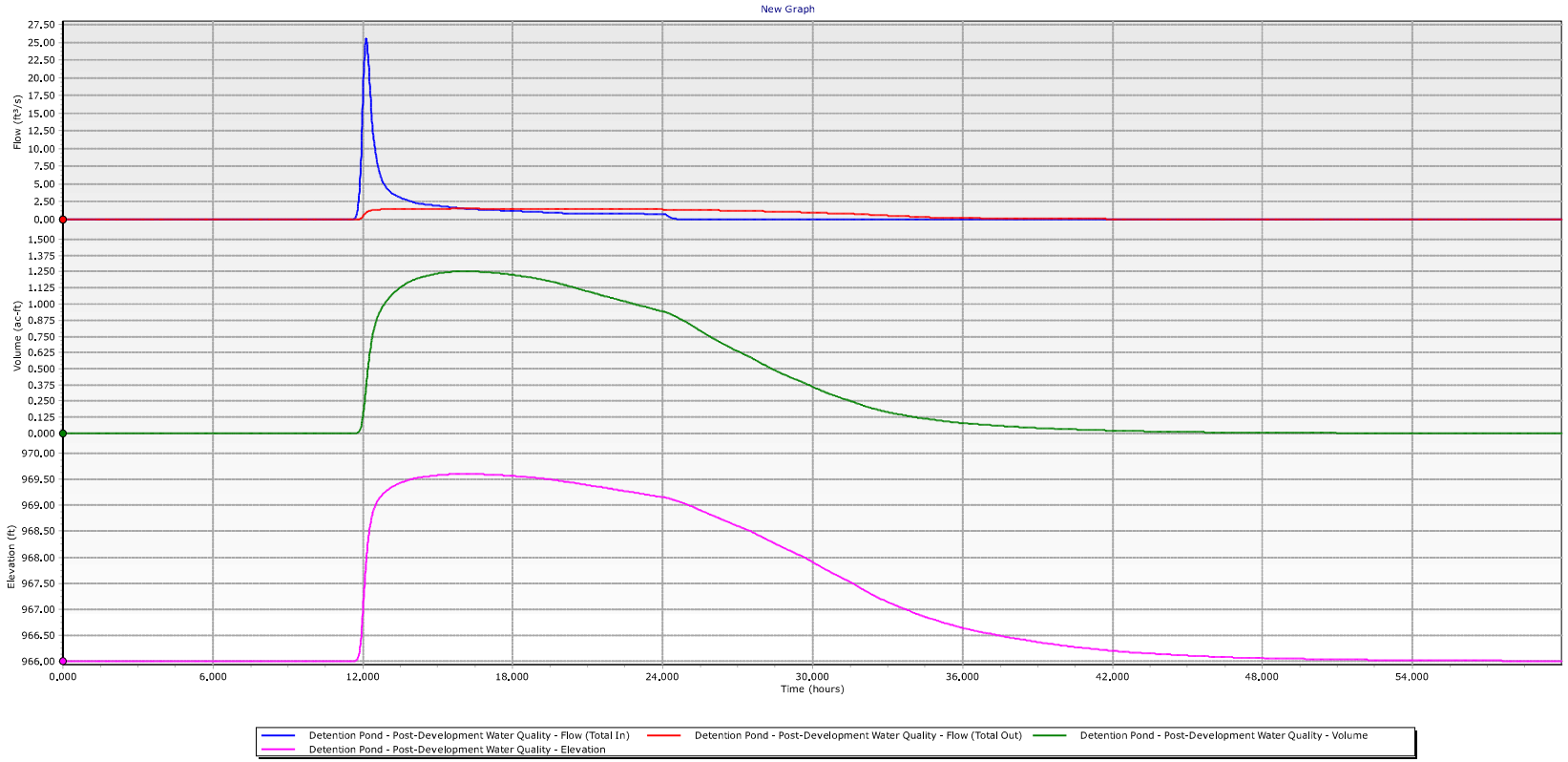
Sub-Area Identifier/	Flow Length (ft)	Slope (ft/ft)	Mannings's n	End Area (sq ft)	Wetted Perimeter (ft)	Velocity (ft/sec)	Travel Time (hr)
EX3							
SHEET	100	0.0100	0.170				0.228
SHALLOW	1400	0.0330	0.050				0.133
CHANNEL	1520	0.0160	0.030	22.00	17.60	7.280	0.058
					Time of Concentration		.419
EX1							
SHEET	50	0.0140	0.170				0.114
SHALLOW	500	0.0200	0.050				0.061
CHANNEL	910	0.0200	0.030	8.00	10.00	6.019	0.042
					Time of Concentration		.217
EX2							
SHEET	50	0.0150	0.150				0.101
SHALLOW	100	0.0220	0.050				0.012
CHANNEL	350	0.0220	0.050	4.50	8.00	3.038	0.032
					Time of Concentration		.145
EX4							
SHEET	50	0.0120	0.150				0.110
SHALLOW	340	0.0300	0.050				0.034
CHANNEL	730	0.0300	0.050	16.00	15.00	5.336	0.038
					Time of Concentration		.182

Cobey Creek
Proposed
Jackson County, Missouri

Sub-Area Time of Concentration Details

Sub-Area Identifier/	Flow Length (ft)	Slope (ft/ft)	Mannings's n	End Area (sq ft)	Wetted Perimeter (ft)	Velocity (ft/sec)	Travel Time (hr)
P3							
SHEET	100	0.0100	0.170				0.228
SHALLOW	600	0.0160	0.050				0.082
CHANNEL	2950	0.0175	0.013	12.60	12.60	15.175	0.054
					Time of Concentration		.364
P1							
SHEET	50	0.0140	0.170				0.114
SHALLOW	200	0.0200	0.025				0.019
CHANNEL	1000	0.0200	0.013	8.00	10.00	13.889	0.020
					Time of Concentration		.153
P2							
SHEET	50	0.0150	0.150				0.101
SHALLOW	50	0.0220	0.025				0.005
CHANNEL	250	0.0220	0.013	4.50	8.00	11.574	0.006
					Time of Concentration		.112
P4							
SHEET	50	0.0120	0.150				0.110
SHALLOW	100	0.0300	0.050				0.010
CHANNEL	1460	0.0300	0.030	16.00	15.00	9.012	0.045
					Time of Concentration		.165

WATER QUALITY EVENT EXTENDED RELEASE


New Graph
Flow (ft³/s)
27.50
25.00
22.50
20.00
17.50
15.00
12.50
10.00
7.50
5.00
2.50
0.00
Volume (ac-ft)
1.500
1.375
1.250
1.125
1.000
0.875
0.750
0.625
0.500
0.375
0.250
0.125
0.000
Elevation (ft)
970.00
969.50
969.00
968.50
968.00
967.50
967.00
966.50
966.00
0.000
6.000
12.000
18.000
24.000
30.000
36.000
42.000
48.000
54.000
Time (hours)
Detention Pond - Post-Development Water Quality - Flow (Total In)
Detention Pond - Post-Development Water Quality - Flow (Total Out)
Detention Pond - Post-Development Water Quality - Volume
Detention Pond - Post-Development Water Quality - Elevation

PONDPACK OUTPUT

COBEY CREEK

Project Summary	
Title	COBEY CREEK
Engineer	Kellen Huffman
Company	Hg Consult, Inc
Date	5/22/2018

Notes

COBEY CREEK

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
P3	Pre-Development Water Quality	1	0.988	12.240	5.37
P3	Post-Development Water Quality	1	2.422	12.130	25.54
P3	Pre-Development 2 year	2	9.729	12.130	105.54
P3	Post-Development 2 year	2	13.945	12.090	169.63
P3	Pre-Development 10 year	10	20.139	12.130	226.85
P3	Post-Development 10 year	10	25.862	12.090	314.25
P3	Pre-Development 100 year	100	35.662	12.120	403.16
P3	Post-Development 100 year	100	42.704	12.090	511.44
P1	Pre-Development Water Quality	1	0.196	12.090	1.62
P1	Post-Development Water Quality	1	0.322	12.010	5.06
P1	Pre-Development 2 year	2	1.933	12.040	29.07
P1	Post-Development 2 year	2	1.756	11.980	29.29
P1	Pre-Development 10 year	10	4.002	12.030	61.09
P1	Post-Development 10 year	10	3.215	11.970	52.87
P1	Pre-Development 100 year	100	7.086	12.010	107.36
P1	Post-Development 100 year	100	5.265	11.970	84.76
P2	Pre-Development Water Quality	1	0.024	12.050	0.21
P2	Post-Development Water Quality	1	0.015	12.010	0.23
P2	Pre-Development 2 year	2	0.258	11.990	4.29
P2	Post-Development 2 year	2	0.097	11.950	1.73
P2	Pre-Development 10 year	10	0.543	11.970	9.17
P2	Post-Development 10 year	10	0.184	11.940	3.27
P2	Pre-Development 100 year	100	0.970	11.970	16.32

COBEY CREEK

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft³/s)
P2	Post-Development 100 year	100	0.309	11.940	5.40
P4	Pre-Development Water Quality	1	0.141	12.080	1.11
P4	Post-Development Water Quality	1	0.107	12.030	1.58
P4	Pre-Development 2 year	2	1.519	12.010	23.98
P4	Post-Development 2 year	2	0.654	11.990	10.77
P4	Pre-Development 10 year	10	3.192	12.010	51.33
P4	Post-Development 10 year	10	1.228	11.990	20.01
P4	Pre-Development 100 year	100	5.706	11.990	91.04
P4	Post-Development 100 year	100	2.044	11.970	32.66

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft³/s)
O-3	Pre-Development Water Quality	1	0.988	12.240	5.37
O-3	Post-Development Water Quality	1	2.421	16.040	1.53
O-3	Pre-Development 2 year	2	9.729	12.130	105.54
O-3	Post-Development 2 year	2	13.944	12.470	56.27
O-3	Pre-Development 10 year	10	20.139	12.130	226.85
O-3	Post-Development 10 year	10	25.861	12.290	194.07
O-3	Pre-Development 100 year	100	35.662	12.120	403.16
O-3	Post-Development 100 year	100	42.703	12.310	282.73
O-1	Pre-Development Water Quality	1	0.196	12.090	1.62
O-1	Post-Development Water Quality	1	0.322	12.010	5.06
O-1	Pre-Development 2 year	2	1.933	12.040	29.07

COBEY CREEK

Subsection: Master Network Summary

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
O-1	Post-Development 2 year	2	1.756	11.980	29.29
O-1	Pre-Development 10 year	10	4.002	12.030	61.09
O-1	Post-Development 10 year	10	3.215	11.970	52.87
O-1	Pre-Development 100 year	100	7.086	12.010	107.36
O-1	Post-Development 100 year	100	5.265	11.970	84.76
O-2	Pre-Development Water Quality	1	0.024	12.050	0.21
O-2	Post-Development Water Quality	1	0.015	12.010	0.23
O-2	Pre-Development 2 year	2	0.258	11.990	4.29
O-2	Post-Development 2 year	2	0.097	11.950	1.73
O-2	Pre-Development 10 year	10	0.543	11.970	9.17
O-2	Post-Development 10 year	10	0.184	11.940	3.27
O-2	Pre-Development 100 year	100	0.970	11.970	16.32
O-2	Post-Development 100 year	100	0.309	11.940	5.40
O-4	Pre-Development Water Quality	1	0.141	12.080	1.11
O-4	Post-Development Water Quality	1	0.107	12.030	1.58
O-4	Pre-Development 2 year	2	1.519	12.010	23.98
O-4	Post-Development 2 year	2	0.654	11.990	10.77
O-4	Pre-Development 10 year	10	3.192	12.010	51.33
O-4	Post-Development 10 year	10	1.228	11.990	20.01
O-4	Pre-Development 100 year	100	5.706	11.990	91.04
O-4	Post-Development 100 year	100	2.044	11.970	32.66

Pond Summary

COBEY CREEK

Subsection: Master Network Summary

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ac-ft)
Detention Pond (IN)	Post-Development Water Quality	1	2.422	12.130	25.54	(N/A)	(N/A)
Detention Pond (OUT)	Post-Development Water Quality	1	2.421	16.040	1.53	969.60	1.254
Detention Pond (IN)	Post-Development 2 year	2	13.945	12.090	169.63	(N/A)	(N/A)
Detention Pond (OUT)	Post-Development 2 year	2	13.944	12.470	56.27	972.74	5.248
Detention Pond (IN)	Post-Development 10 year	10	25.862	12.090	314.25	(N/A)	(N/A)
Detention Pond (OUT)	Post-Development 10 year	10	25.861	12.290	194.07	974.17	7.988
Detention Pond (IN)	Post-Development 100 year	100	42.704	12.090	511.44	(N/A)	(N/A)
Detention Pond (OUT)	Post-Development 100 year	100	42.703	12.310	282.73	976.00	12.018

PONDPACK SPILLWAY OUTPUT

COBEY CREEK-SPILLWAY

Project Summary	
Title	COBEY CREEK-SPILLWAY
Engineer	Kellen Huffman
Company	Hg Consult, Inc
Date	5/22/2018

Notes

COBEY CREEK-SPILLWAY

Subsection: Master Network Summary

Catchments Summary

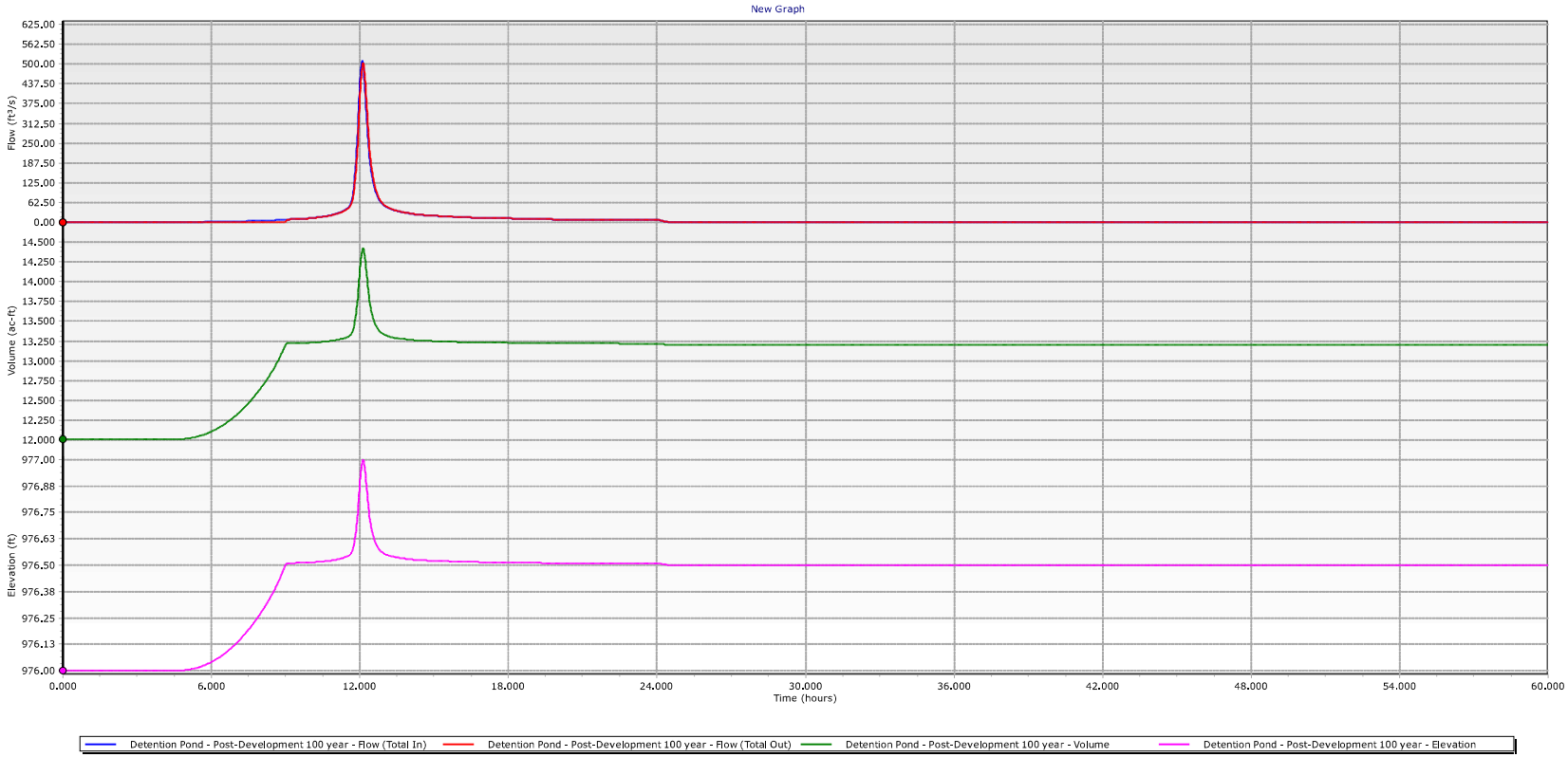
Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft³/s)
P3	Post-Development 100 year	100	42.704	12.090	511.44

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft³/s)
O-3	Post-Development 100 year	100	41.518	12.130	502.73

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft³/s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ac-ft)
Detention Pond (IN)	Post-Development 100 year	100	42.704	12.090	511.44	(N/A)	(N/A)
Detention Pond (OUT)	Post-Development 100 year	100	41.518	12.130	502.73	977.00	14.420


New Graph
Flow (ft³/s)
625.00
562.50
500.00
437.50
375.00
312.50
250.00
187.50
125.00
62.50
0.00
Volume (ac-ft)
14.500
14.250
14.000
13.750
13.500
13.250
13.000
12.750
12.500
12.250
12.000
Elevation (ft)
977.00
976.88
976.75
976.63
976.50
976.38
976.25
976.13
976.00
0.000
6.000
12.000
18.000
24.000
30.000
36.000
42.000
48.000
54.000
60.000
Time (hours)
Detention Pond - Post-Development 100 year - Flow (Total In)
Detention Pond - Post-Development 100 year - Flow (Total Out)
Detention Pond - Post-Development 100 year - Volume
Detention Pond - Post-Development 100 year - Elevation

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

Element Details			
Label	Composite Outlet Structure - 1	Notes	

Headwater Range			
Headwater Type	Use Pond for Headwater Range	Maximum (Headwater)	979.00 ft
Pond	Detention Pond	Increment (Headwater)	0.50 ft
Minimum (Headwater)	964.70 ft		

SpotElevation (ft)

Tailwater Setup	
Tailwater Type	Free Outfall

Tailwater Tolerances			
Maximum Iterations	30	Tailwater Tolerance (Maximum)	0.50 ft
Headwater Tolerance (Minimum)	0.01 ft	Flow Tolerance (Minimum)	0.001 ft³/s
Headwater Tolerance (Maximum)	0.50 ft	Flow Tolerance (Maximum)	10.000 ft³/s
Tailwater Tolerance (Minimum)	0.01 ft		

Outlet Structure			
Outlet Structure Type	Culvert	Culvert Type	Circular

Outlet Structure (IDs and Direction)			
Outlet ID	Culvert - 1	Downstream ID	Tailwater
Flow Direction	Forward Flow Only	Notes	

Outlet Structure (Advanced)			
Elevation (On)	0.00 ft	Elevation (Off)	0.00 ft

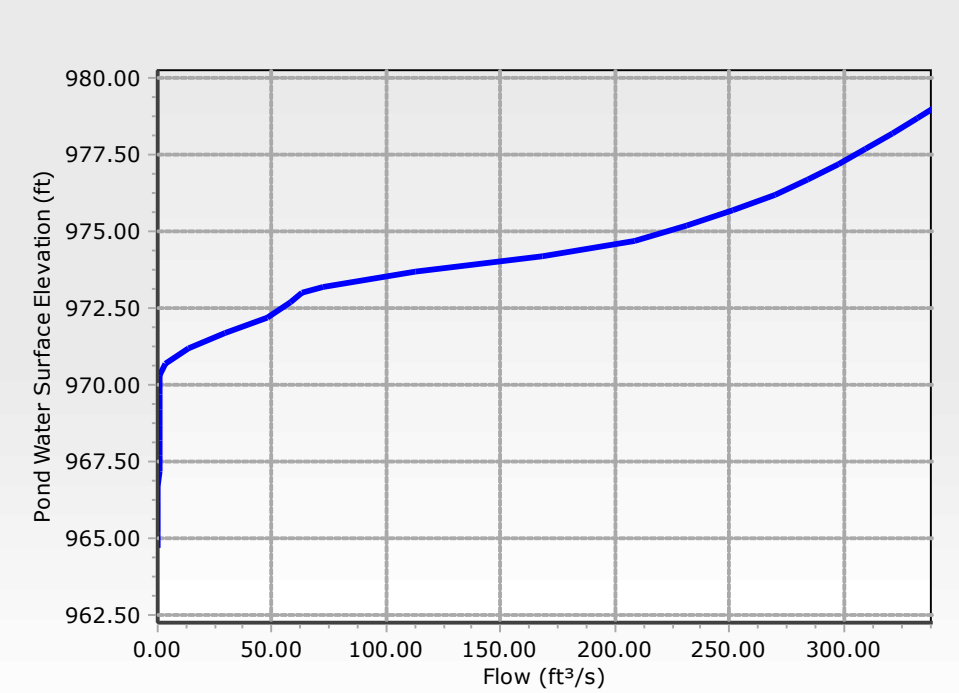
Culvert Data			
Number of Barrels	2	Downstream Invert	964.20 ft
Length	102.32 ft	Diameter	48.0 in
Upstream Invert	964.70 ft		

Unsubmerged->Submerged			
Specify Transitions	False	Compute Inlet Control Only	False

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

Culvert Coefficients			
Inlet Description	Concrete - Groove end projecting	C	0.0317
Chart	Chart 1	Y	0.6900
Nomograph	Nomograph 3	Manning's n	0.011
Equation Form	Form 1	Ke	0.200
K	0.0045	Kr	0.000
M	2.0000	Slope Correction Factor	-0.500

Culvert (Advanced)			
Convergence Tolerance	0.00 ft	Specify Number of Backwater Sections	False



RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Culvert - 1 (Culvert-Circular)

Mannings open channel maximum capacity: 127.65 ft³/s
Upstream ID = Orifice - 3, Riser - 2, Orifice - 1, Riser - 1, Orifice - 2
Downstream ID = Tailwater (Pond Outfall)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Culvert - 1 (Culvert-Circular)

Mannings open channel maximum capacity: 127.65 ft³/s
Upstream ID = Orifice - 3, Riser - 2, Orifice - 1, Riser - 1, Orifice - 2
Downstream ID = Tailwater (Pond Outfall)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)
964.70	0.00	0.00	0.00	Free Outfall
965.10	0.12	964.80	Free Outfall	Free Outfall
965.20	0.16	964.81	Free Outfall	Free Outfall
965.70	0.30	964.85	Free Outfall	Free Outfall
966.20	0.35	964.87	Free Outfall	Free Outfall
966.70	0.41	964.88	Free Outfall	Free Outfall
967.20	0.49	964.90	Free Outfall	Free Outfall
967.70	0.52	964.90	Free Outfall	Free Outfall
968.20	0.56	964.92	Free Outfall	Free Outfall
968.70	0.62	964.92	Free Outfall	Free Outfall
969.20	0.66	964.93	Free Outfall	Free Outfall
969.70	0.68	964.93	Free Outfall	Free Outfall
970.20	0.72	964.94	Free Outfall	Free Outfall
970.30	0.72	964.94	Free Outfall	Free Outfall
970.70	3.53	965.24	Free Outfall	Free Outfall
971.20	13.78	965.78	Free Outfall	Free Outfall
971.70	29.56	966.31	Free Outfall	Free Outfall
972.20	47.61	966.78	Free Outfall	Free Outfall
972.70	57.94	967.01	Free Outfall	Free Outfall
973.00	63.26	967.13	Free Outfall	Free Outfall
973.20	72.53	967.32	Free Outfall	Free Outfall
973.70	112.93	968.07	Free Outfall	Free Outfall
974.20	167.95	969.00	Free Outfall	Free Outfall
974.70	208.39	969.66	Free Outfall	Free Outfall
975.20	230.98	970.13	Free Outfall	Free Outfall
975.70	251.77	970.63	Free Outfall	Free Outfall
976.20	270.41	971.12	Free Outfall	Free Outfall
976.70	284.48	971.51	Free Outfall	Free Outfall
977.20	297.36	971.89	Free Outfall	Free Outfall
977.70	309.66	972.26	Free Outfall	Free Outfall
978.20	321.29	972.63	Free Outfall	Free Outfall
978.70	332.45	973.00	Free Outfall	Free Outfall
979.00	338.98	973.22	Free Outfall	Free Outfall

Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft³/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Culvert - 1 (Culvert-Circular)

Mannings open channel maximum capacity: 127.65 ft³/s
Upstream ID = Orifice - 3, Riser - 2, Orifice - 1, Riser - 1, Orifice - 2
Downstream ID = Tailwater (Pond Outfall)

Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft³/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.01	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.06	(N/A)	0.00
0.00	0.04	(N/A)	0.00
0.00	0.02	(N/A)	0.00
0.00	0.01	(N/A)	0.00
0.00	0.01	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00

Message
WS below an invert; no flow.
CRIT.DEPTH CONTROL Vh= .023ft Dcr= .068ft H.JUMP IN PIPE Hev= .00ft
CRIT.DEPTH CONTROL Vh= .026ft Dcr= .079ft CRIT.DEPTH Hev= .00ft

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Culvert - 1 (Culvert-Circular)

Mannings open channel maximum capacity: 127.65 ft³/s
Upstream ID = Orifice - 3, Riser - 2, Orifice - 1, Riser - 1, Orifice - 2
Downstream ID = Tailwater (Pond Outfall)

Message
CRIT.DEPTH CONTROL Vh= .037ft Dcr= .109ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .040ft Dcr= .119ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .044ft Dcr= .130ft CRIT.DEPTH Hev= .00ft
FLOW PRECEDENCE SET TO UPSTREAM CONTROLLING STRUCTURE
FLOW PRECEDENCE SET TO UPSTREAM CONTROLLING STRUCTURE
CRIT.DEPTH CONTROL Vh= .051ft Dcr= .151ft CRIT.DEPTH Hev= .00ft
FLOW PRECEDENCE SET TO UPSTREAM CONTROLLING STRUCTURE
FLOW PRECEDENCE SET TO UPSTREAM CONTROLLING STRUCTURE
FLOW PRECEDENCE SET TO UPSTREAM CONTROLLING STRUCTURE
FLOW PRECEDENCE SET TO UPSTREAM CONTROLLING STRUCTURE
CRIT.DEPTH CONTROL Vh= .058ft Dcr= .172ft CRIT.DEPTH Hev= .00ft
FLOW PRECEDENCE SET TO UPSTREAM CONTROLLING STRUCTURE
FLOW PRECEDENCE SET TO UPSTREAM CONTROLLING STRUCTURE
FLOW PRECEDENCE SET TO UPSTREAM CONTROLLING STRUCTURE
CRIT.DEPTH CONTROL Vh= .530ft Dcr= 1.440ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .597ft Dcr= 1.595ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .630ft Dcr= 1.670ft CRIT.DEPTH Hev= .00ft

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Culvert - 1 (Culvert-Circular)

Mannings open channel maximum capacity: 127.65 ft³/s
Upstream ID = Orifice - 3, Riser - 2, Orifice - 1, Riser - 1, Orifice - 2
Downstream ID = Tailwater (Pond Outfall)

Message
CRIT.DEPTH CONTROL Vh= .686ft Dcr= 1.793ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .924ft Dcr= 2.261ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= 1.264ft Dcr= 2.778ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= 1.554ft Dcr= 3.091ft CRIT.DEPTH Hev= .00ft
INLET CONTROL... Submerged: HW =5.43
INLET CONTROL... Submerged: HW =5.93
INLET CONTROL... Submerged: HW =6.42
INLET CONTROL... Submerged: HW =6.81
INLET CONTROL... Submerged: HW =7.19
INLET CONTROL... Submerged: HW =7.56
INLET CONTROL... Submerged: HW =7.93
INLET CONTROL... Submerged: HW =8.30
INLET CONTROL... Submerged: HW =8.52

Outlet Structure	
Outlet Structure Type	Orifice

Outlet Structure (IDs and Direction)			
Outlet ID	Orifice - 1	Downstream ID	Culvert - 1
Flow Direction	Forward Flow Only	Notes	

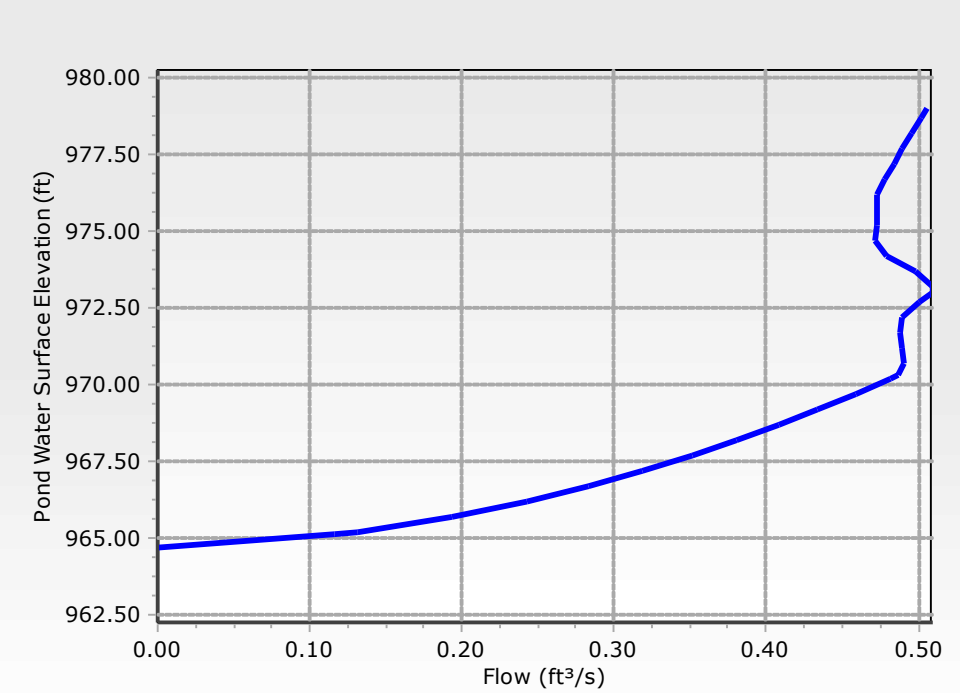
Outlet Structure (Advanced)			
Elevation (On)	0.00 ft	Elevation (Off)	0.00 ft

Outlet Structure (Orifice)			
Orifice	Circular Orifice	Orifice Coefficient	0.600

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

Outlet Structure (Orifice)			
Number of Openings	2	Orifice Diameter	2.0 in

Outlet Structure (Common)	
Elevation	964.70 ft



RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Orifice - 1 (Orifice-Circular)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)
964.70	0.00	0.00	0.00	0.00
965.10	0.12	965.10	964.80	964.80
965.20	0.13	965.20	964.81	964.81
965.70	0.19	965.70	964.85	964.85
966.20	0.24	966.20	964.87	964.87
966.70	0.28	966.70	964.88	964.88
967.20	0.32	967.20	964.90	964.90
967.70	0.35	967.70	964.90	964.90
968.20	0.38	968.20	964.91	964.92

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Orifice - 1 (Orifice-Circular)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)
968.70	0.41	968.70	964.92	964.92
969.20	0.43	969.20	964.93	964.93
969.70	0.46	969.70	964.93	964.93
970.20	0.48	970.20	964.94	964.94
970.30	0.49	970.30	964.94	964.94
970.70	0.49	970.70	965.24	965.24
971.20	0.49	971.20	965.78	965.78
971.70	0.49	971.70	966.31	966.31
972.20	0.49	972.20	966.78	966.78
972.70	0.50	972.70	967.01	967.01
973.00	0.51	973.00	967.13	967.13
973.20	0.51	973.20	967.32	967.32
973.70	0.50	973.70	968.07	968.07
974.20	0.48	974.20	968.99	969.00
974.70	0.47	974.70	969.66	969.66
975.20	0.47	975.20	970.13	970.13
975.70	0.47	975.70	970.63	970.63
976.20	0.47	976.20	971.12	971.12
976.70	0.48	976.70	971.51	971.51
977.20	0.48	977.20	971.89	971.89
977.70	0.49	977.70	972.26	972.26
978.20	0.50	978.20	972.63	972.63
978.70	0.50	978.70	973.00	973.00
979.00	0.51	979.00	973.22	973.22

Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft³/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Orifice - 1 (Orifice-Circular)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft^3/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00

Message
WS below an invert; no flow.
H =.30
H =.39
H =.85
H =1.33
H =1.82
H =2.30
H =2.80
H =3.29
H =3.78
H =4.27
H =4.77
H =5.26
H =5.36
H =5.46
H =5.42
H =5.39

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Orifice - 1 (Orifice-Circular)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Message
H =5.42
H =5.69
H =5.87
H =5.88
H =5.63
H =5.21
H =5.04
H =5.07
H =5.07
H =5.08
H =5.19
H =5.31
H =5.44
H =5.57
H =5.70
H =5.78

Outlet Structure	
Outlet Structure Type	Riser

Outlet Structure (IDs and Direction)			
Outlet ID	Riser - 1	Downstream ID	Culvert - 1
Flow Direction	Forward Flow Only	Notes	

Outlet Structure (Advanced)			
Elevation (On)	0.00 ft	Elevation (Off)	0.00 ft

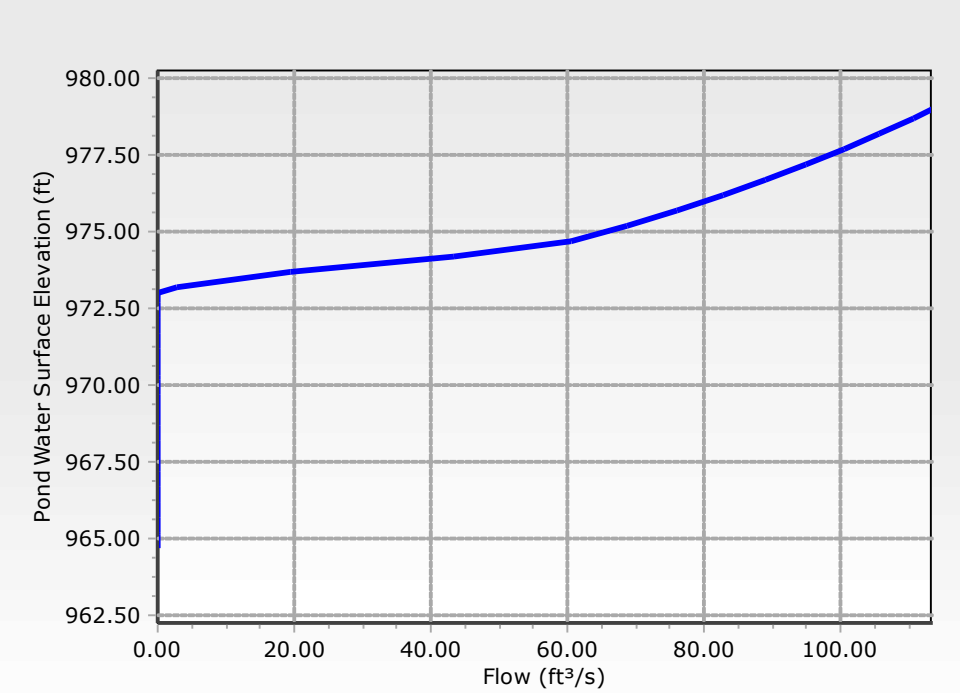
Outlet Structure (Riser)			
Riser	Stand Pipe	Transition Elevation	0.00 ft
Diameter	42.0 in	Transition Height	0.00 ft
Weir Coefficient	3.00 (ft^0.5)/s	K Reverse	1.000
Orifice Coefficient	0.600		

Outlet Structure (Common)	
Elevation	973.00 ft

Outlet Structure (Riser, Advanced)			
Use Orifice Depth to Crest?	True	Use Submerged Weir Equation?	False

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

Outlet Structure (Riser, Advanced)



RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Riser - 1 (Stand Pipe)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)
964.70	0.00	0.00	0.00	0.00
965.10	0.00	0.00	0.00	964.80
965.20	0.00	0.00	0.00	964.81
965.70	0.00	0.00	0.00	964.85
966.20	0.00	0.00	0.00	964.87
966.70	0.00	0.00	0.00	964.88
967.20	0.00	0.00	0.00	964.90
967.70	0.00	0.00	0.00	964.90
968.20	0.00	0.00	0.00	964.92
968.70	0.00	0.00	0.00	964.92
969.20	0.00	0.00	0.00	964.93
969.70	0.00	0.00	0.00	964.93
970.20	0.00	0.00	0.00	964.94

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Riser - 1 (Stand Pipe)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)
970.30	0.00	0.00	0.00	964.94
970.70	0.00	0.00	0.00	965.24
971.20	0.00	0.00	0.00	965.78
971.70	0.00	0.00	0.00	966.31
972.20	0.00	0.00	0.00	966.78
972.70	0.00	0.00	0.00	967.01
973.00	0.00	0.00	0.00	967.13
973.20	2.95	973.20	Free Outfall	967.32
973.70	19.32	973.70	Free Outfall	968.07
974.20	43.36	974.20	Free Outfall	969.00
974.70	60.38	974.70	Free Outfall	969.66
975.20	68.68	975.20	Free Outfall	970.13
975.70	76.09	975.70	Free Outfall	970.63
976.20	82.84	976.20	Free Outfall	971.12
976.70	89.07	976.70	Free Outfall	971.51
977.20	94.90	977.20	Free Outfall	971.89
977.70	100.39	977.70	Free Outfall	972.26
978.20	105.60	978.20	Free Outfall	972.63
978.70	110.56	978.70	Free Outfall	973.00
979.00	113.43	979.00	973.22	973.22

Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft³/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Riser - 1 (Stand Pipe)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft^3/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)	Message
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	Weir: H =0.2ft

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Riser - 1 (Stand Pipe)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Message
Weir: H =0.7ft
Weir: H =1.2ft
Orifice: H =1.70; Riser orifice equation controlling.
Orifice: H =2.20; Riser orifice equation controlling.
Orifice: H =2.70; Riser orifice equation controlling.
Orifice: H =3.20; Riser orifice equation controlling.
Orifice: H =3.70; Riser orifice equation controlling.
Orifice: H =4.20; Riser orifice equation controlling.
Orifice: H =4.70; Riser orifice equation controlling.
Orifice: H =5.20; Riser orifice equation controlling.
Orifice: H =5.70; Riser orifice equation controlling.
FULLY CHARGED RISER: Orifice Equation Control to Crest; H=6.00

Outlet Structure

Outlet Structure Type	Riser

Outlet Structure (IDs and Direction)

Outlet ID	Riser - 2	Downstream ID	Culvert - 1
Flow Direction	Forward Flow Only	Notes	

Outlet Structure (Advanced)

Elevation (On)	0.00 ft	Elevation (Off)	0.00 ft

Outlet Structure (Riser)

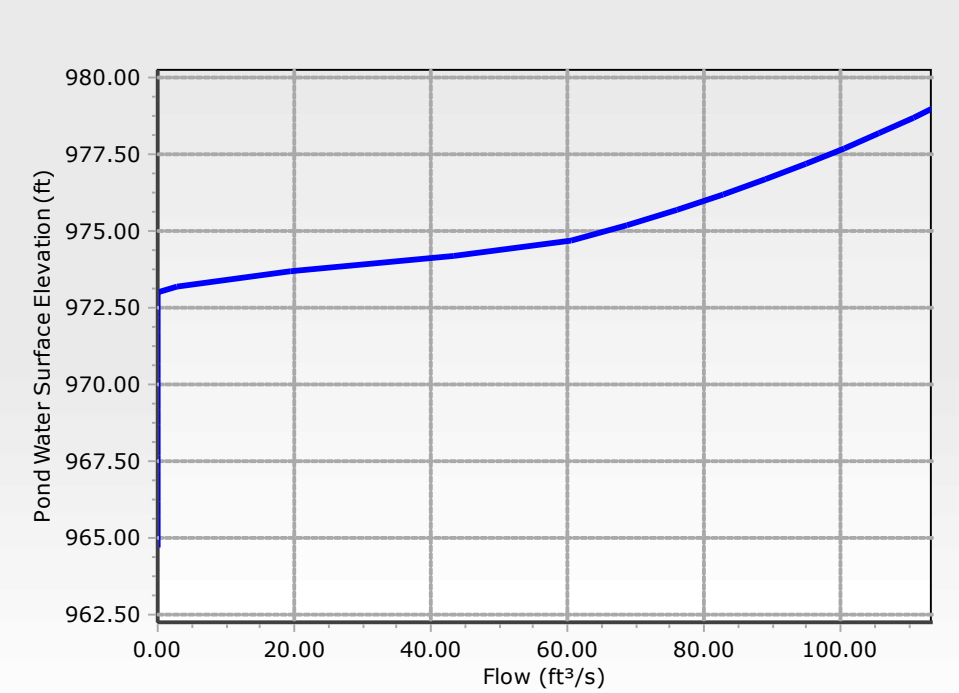
Riser	Stand Pipe	Transition Elevation	0.00 ft
Diameter	42.0 in	Transition Height	0.00 ft
Weir Coefficient	3.00 (ft^0.5)/s	K Reverse	1.000
Orifice Coefficient	0.600		

Outlet Structure (Common)

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

Outlet Structure (Common)	
Elevation	973.00 ft

Outlet Structure (Riser, Advanced)			
Use Orifice Depth to Crest?	True	Use Submerged Weir Equation?	False



RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Riser - 2 (Stand Pipe)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)
964.70	0.00	0.00	0.00	0.00
965.10	0.00	0.00	0.00	964.80
965.20	0.00	0.00	0.00	964.81
965.70	0.00	0.00	0.00	964.85
966.20	0.00	0.00	0.00	964.87
966.70	0.00	0.00	0.00	964.88
967.20	0.00	0.00	0.00	964.90
967.70	0.00	0.00	0.00	964.90

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Riser - 2 (Stand Pipe)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)
968.20	0.00	0.00	0.00	964.92
968.70	0.00	0.00	0.00	964.92
969.20	0.00	0.00	0.00	964.93
969.70	0.00	0.00	0.00	964.93
970.20	0.00	0.00	0.00	964.94
970.30	0.00	0.00	0.00	964.94
970.70	0.00	0.00	0.00	965.24
971.20	0.00	0.00	0.00	965.78
971.70	0.00	0.00	0.00	966.31
972.20	0.00	0.00	0.00	966.78
972.70	0.00	0.00	0.00	967.01
973.00	0.00	0.00	0.00	967.13
973.20	2.95	973.20	Free Outfall	967.32
973.70	19.32	973.70	Free Outfall	968.07
974.20	43.36	974.20	Free Outfall	969.00
974.70	60.38	974.70	Free Outfall	969.66
975.20	68.68	975.20	Free Outfall	970.13
975.70	76.09	975.70	Free Outfall	970.63
976.20	82.84	976.20	Free Outfall	971.12
976.70	89.07	976.70	Free Outfall	971.51
977.20	94.90	977.20	Free Outfall	971.89
977.70	100.39	977.70	Free Outfall	972.26
978.20	105.60	978.20	Free Outfall	972.63
978.70	110.56	978.70	Free Outfall	973.00
979.00	113.43	979.00	973.22	973.22

Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft³/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Riser - 2 (Stand Pipe)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft^3/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00

Message
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Riser - 2 (Stand Pipe)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Message
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
Weir: H =0.2ft
Weir: H =0.7ft
Weir: H =1.2ft
Orifice: H =1.70; Riser orifice equation controlling.
Orifice: H =2.20; Riser orifice equation controlling.
Orifice: H =2.70; Riser orifice equation controlling.
Orifice: H =3.20; Riser orifice equation controlling.
Orifice: H =3.70; Riser orifice equation controlling.
Orifice: H =4.20; Riser orifice equation controlling.
Orifice: H =4.70; Riser orifice equation controlling.
Orifice: H =5.20; Riser orifice equation controlling.
Orifice: H =5.70; Riser orifice equation controlling.
FULLY CHARGED RISER: Orifice Equation Control to Crest; H=6.00

Outlet Structure	
Outlet Structure Type	Orifice

Outlet Structure (IDs and Direction)			
Outlet ID	Orifice - 3	Downstream ID	Culvert - 1
Flow Direction	Forward Flow Only	Notes	

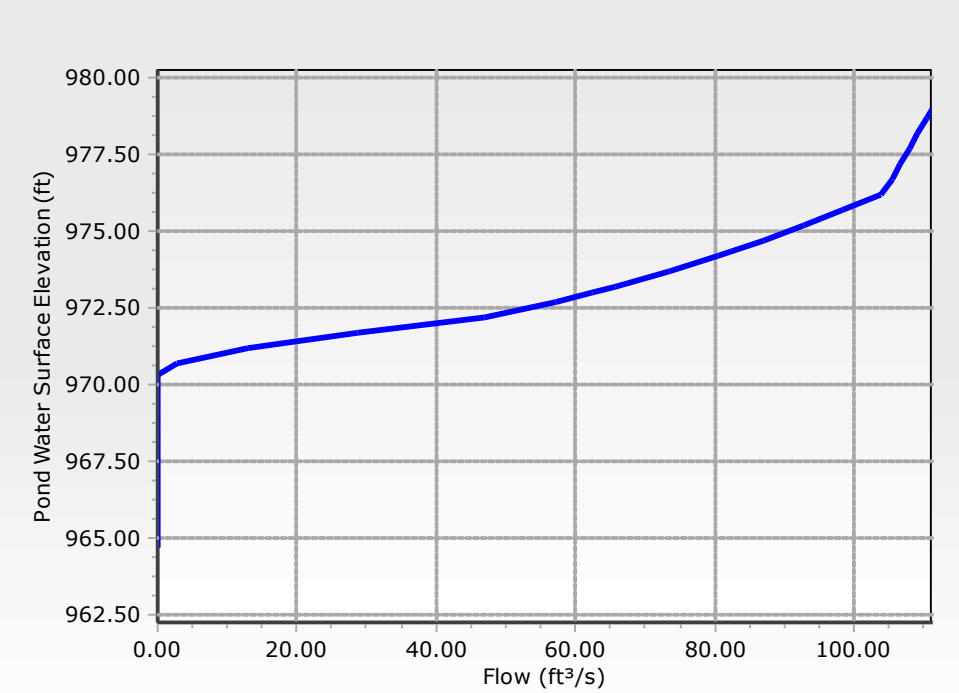
Outlet Structure (Advanced)			
Elevation (On)	0.00 ft	Elevation (Off)	0.00 ft

Outlet Structure (Orifice)			
Orifice	Circular Orifice	Orifice Coefficient	0.600

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

Outlet Structure (Orifice)			
Number of Openings	4	Orifice Diameter	21.0 in

Outlet Structure (Common)	
Elevation	970.30 ft



RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Orifice - 3 (Orifice-Circular)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)
964.70	0.00	0.00	0.00	0.00
965.10	0.00	0.00	0.00	964.80
965.20	0.00	0.00	0.00	964.81
965.70	0.00	0.00	0.00	964.85
966.20	0.00	0.00	0.00	964.87
966.70	0.00	0.00	0.00	964.88
967.20	0.00	0.00	0.00	964.90
967.70	0.00	0.00	0.00	964.90
968.20	0.00	0.00	0.00	964.92

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Orifice - 3 (Orifice-Circular)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft^3/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)
968.70	0.00	0.00	0.00	964.92
969.20	0.00	0.00	0.00	964.93
969.70	0.00	0.00	0.00	964.93
970.20	0.00	0.00	0.00	964.94
970.30	0.00	0.00	0.00	964.94
970.70	2.79	970.70	Free Outfall	965.24
971.20	13.03	971.20	Free Outfall	965.78
971.70	28.85	971.70	Free Outfall	966.31
972.20	46.88	972.20	Free Outfall	966.78
972.70	57.18	972.70	Free Outfall	967.01
973.00	62.56	973.00	Free Outfall	967.13
973.20	65.90	973.20	Free Outfall	967.32
973.70	73.58	973.70	Free Outfall	968.07
974.20	80.54	974.20	Free Outfall	969.00
974.70	86.94	974.70	Free Outfall	969.66
975.20	92.90	975.20	Free Outfall	970.13
975.70	98.50	975.70	970.63	970.63
976.20	103.80	976.20	971.12	971.12
976.70	105.48	976.70	971.51	971.51
977.20	106.72	977.20	971.89	971.89
977.70	107.99	977.70	972.26	972.26
978.20	109.27	978.20	972.63	972.63
978.70	110.59	978.70	973.00	973.00
979.00	111.36	979.00	973.22	973.22

Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft^3/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Orifice - 3 (Orifice-Circular)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft^3/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00

Message
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
CRIT.DEPTH CONTROL Vh= .103ft
Dcr= .297ft CRIT.DEPTH Hev= .00ft

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Orifice - 3 (Orifice-Circular)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Message
CRIT.DEPTH CONTROL Vh= .243ft Dcr= .656ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .407ft Dcr= .994ft CRIT.DEPTH Hev= .00ft
H =1.03
H =1.53
H =1.83
H =2.03
H =2.53
H =3.03
H =3.53
H =4.03
H =4.53
H =5.03
H =5.19
H =5.31
H =5.44
H =5.57
H =5.70
H =5.78

Outlet Structure			
Outlet Structure Type	Orifice		

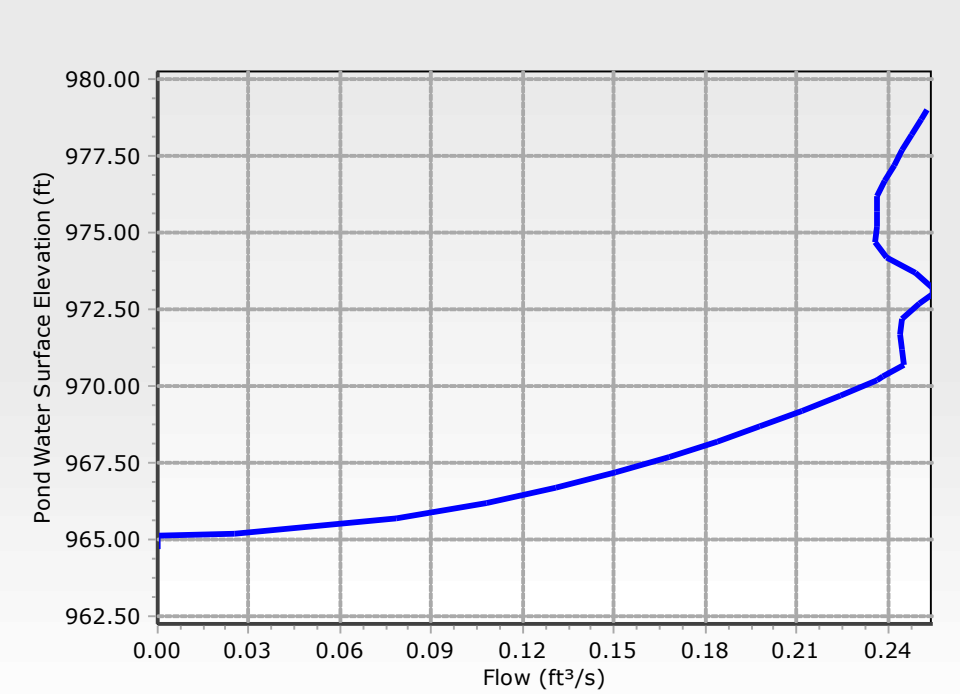
Outlet Structure (IDs and Direction)			
Outlet ID	Orifice - 2	Downstream ID	Culvert - 1
Flow Direction	Forward Flow Only	Notes	

Outlet Structure (Advanced)			
Elevation (On)	0.00 ft	Elevation (Off)	0.00 ft

Outlet Structure (Orifice)			
Orifice	Circular Orifice	Orifice Coefficient	0.600
Number of Openings	4	Orifice Diameter	1.0 in

Outlet Structure (Common)	
Elevation	965.10 ft

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1



RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Orifice - 2 (Orifice-Circular)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)
964.70	0.00	0.00	0.00	0.00
965.10	0.00	0.00	0.00	964.80
965.20	0.03	965.20	Free Outfall	964.81
965.70	0.08	965.70	Free Outfall	964.85
966.20	0.11	966.20	Free Outfall	964.87
966.70	0.13	966.70	Free Outfall	964.88
967.20	0.15	967.20	Free Outfall	964.90
967.70	0.17	967.70	Free Outfall	964.90
968.20	0.18	968.20	Free Outfall	964.92
968.70	0.20	968.70	Free Outfall	964.92
969.20	0.21	969.20	Free Outfall	964.93
969.70	0.22	969.70	Free Outfall	964.93
970.20	0.24	970.20	Free Outfall	964.94
970.30	0.24	970.30	Free Outfall	964.94
970.70	0.25	970.70	965.24	965.24
971.20	0.24	971.20	965.78	965.78

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Orifice - 2 (Orifice-Circular)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)
971.70	0.24	971.70	966.31	966.31
972.20	0.24	972.20	966.78	966.78
972.70	0.25	972.70	967.01	967.01
973.00	0.25	973.00	967.13	967.13
973.20	0.25	973.20	967.32	967.32
973.70	0.25	973.70	968.07	968.07
974.20	0.24	974.20	968.99	969.00
974.70	0.24	974.70	969.66	969.66
975.20	0.24	975.20	970.13	970.13
975.70	0.24	975.70	970.63	970.63
976.20	0.24	976.20	971.12	971.12
976.70	0.24	976.70	971.51	971.51
977.20	0.24	977.20	971.89	971.89
977.70	0.24	977.70	972.26	972.26
978.20	0.25	978.20	972.63	972.63
978.70	0.25	978.70	973.00	973.00
979.00	0.25	979.00	973.22	973.22

Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft³/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Orifice - 2 (Orifice-Circular)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft^3/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)	Message
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	H =.06
0.00	0.00	(N/A)	0.00	H =.56
0.00	0.00	(N/A)	0.00	H =1.06
0.00	0.00	(N/A)	0.00	H =1.56
0.00	0.00	(N/A)	0.00	H =2.06
0.00	0.00	(N/A)	0.00	H =2.56
0.00	0.00	(N/A)	0.00	H =3.06
0.00	0.00	(N/A)	0.00	H =3.56
0.00	0.00	(N/A)	0.00	H =4.06
0.00	0.00	(N/A)	0.00	H =4.56
0.00	0.00	(N/A)	0.00	H =5.06
0.00	0.00	(N/A)	0.00	H =5.16
0.00	0.00	(N/A)	0.00	H =5.46
0.00	0.00	(N/A)	0.00	H =5.42
0.00	0.00	(N/A)	0.00	H =5.39
0.00	0.00	(N/A)	0.00	H =5.42
0.00	0.00	(N/A)	0.00	H =5.69
0.00	0.00	(N/A)	0.00	H =5.87
0.00	0.00	(N/A)	0.00	H =5.88
0.00	0.00	(N/A)	0.00	H =5.63
0.00	0.00	(N/A)	0.00	H =5.21
0.00	0.00	(N/A)	0.00	H =5.04

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Orifice - 2 (Orifice-Circular)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Message
H =5.07
H =5.07
H =5.08
H =5.19
H =5.31
H =5.44
H =5.57
H =5.70
H =5.78

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

Composite Rating Table
Tailwater Elevation = Free Outfall (Composite Outlet Structure - 1)

Water Surface Elevation (ft)	Flow (ft³/s)	Tailwater Elevation (ft)	Convergence Error (ft)
964.70	0.00	(N/A)	0.00
965.10	0.12	(N/A)	0.00
965.20	0.16	(N/A)	0.00
965.70	0.27	(N/A)	0.00
966.20	0.35	(N/A)	0.00
966.70	0.41	(N/A)	0.00
967.20	0.47	(N/A)	0.00
967.70	0.52	(N/A)	0.00
968.20	0.56	(N/A)	0.00
968.70	0.61	(N/A)	0.00
969.20	0.65	(N/A)	0.00
969.70	0.68	(N/A)	0.00
970.20	0.72	(N/A)	0.00
970.30	0.72	(N/A)	0.00
970.70	3.53	(N/A)	0.00
971.20	13.76	(N/A)	0.00
971.70	29.58	(N/A)	0.00
972.20	47.61	(N/A)	0.00
972.70	57.94	(N/A)	0.00
973.00	63.26	(N/A)	0.00
973.20	72.53	(N/A)	0.00
973.70	112.95	(N/A)	0.00
974.20	167.97	(N/A)	0.00
974.70	208.40	(N/A)	0.00
975.20	230.98	(N/A)	0.00
975.70	251.39	(N/A)	0.00
976.20	270.19	(N/A)	0.00
976.70	284.34	(N/A)	0.00
977.20	297.25	(N/A)	0.00
977.70	309.51	(N/A)	0.00
978.20	321.21	(N/A)	0.00
978.70	332.45	(N/A)	0.00
979.00	338.97	(N/A)	0.00

Contributing Structures
(no Q: Orifice - 3,Riser - 2,Orifice - 1,Riser - 1,Orifice - 2,Culvert - 1)
Orifice - 1,Culvert - 1 (no Q: Orifice - 3,Riser - 2,Riser - 1,Orifice - 2)
Orifice - 1,Orifice - 2,Culvert - 1 (no Q: Orifice - 3,Riser - 2,Riser - 1)

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

Composite Rating Table
Tailwater Elevation = Free Outfall (Composite Outlet Structure - 1)

Contributing Structures
Orifice - 1,Orifice - 2,Culvert - 1 (no Q: Orifice - 3,Riser - 2,Riser - 1)
Orifice - 1,Orifice - 2,Culvert - 1 (no Q: Orifice - 3,Riser - 2,Riser - 1)
Orifice - 1,Orifice - 2,Culvert - 1 (no Q: Orifice - 3,Riser - 2,Riser - 1)
Orifice - 1,Orifice - 2,Culvert - 1 (no Q: Orifice - 3,Riser - 2,Riser - 1)
Orifice - 1,Orifice - 2,Culvert - 1 (no Q: Orifice - 3,Riser - 2,Riser - 1)
Orifice - 1,Orifice - 2,Culvert - 1 (no Q: Orifice - 3,Riser - 2,Riser - 1)
Orifice - 1,Orifice - 2,Culvert - 1 (no Q: Orifice - 3,Riser - 2,Riser - 1)
Orifice - 1,Orifice - 2,Culvert - 1 (no Q: Orifice - 3,Riser - 2,Riser - 1)
Orifice - 1,Orifice - 2,Culvert - 1 (no Q: Orifice - 3,Riser - 2,Riser - 1)
Orifice - 1,Orifice - 2,Culvert - 1 (no Q: Orifice - 3,Riser - 2,Riser - 1)
Orifice - 1,Orifice - 2,Culvert - 1 (no Q: Orifice - 3,Riser - 2,Riser - 1)
Orifice - 3,Orifice - 1,Orifice - 2,Culvert - 1 (no Q: Riser - 2,Riser - 1)
Orifice - 3,Orifice - 1,Orifice - 2,Culvert - 1 (no Q: Riser - 2,Riser - 1)

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

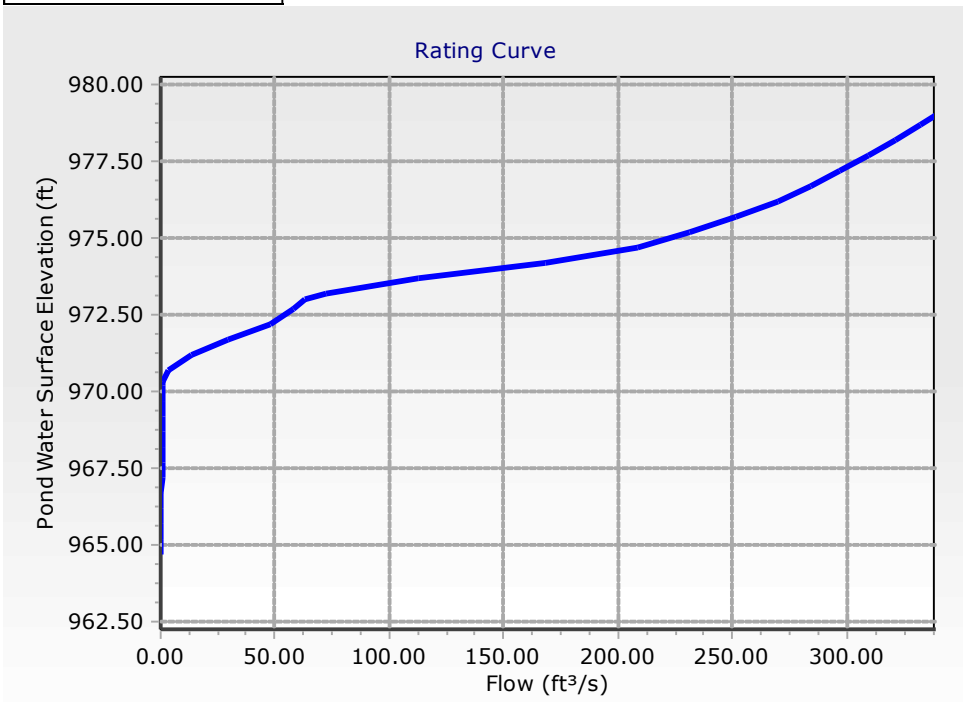
Composite Rating Table
Tailwater Elevation = Free Outfall (Composite Outlet Structure - 1)

Contributing Structures
Orifice - 3,Orifice - 1,Orifice - 2,Culvert - 1 (no Q: Riser - 2,Riser - 1)
Orifice - 3,Orifice - 1,Orifice - 2,Culvert - 1 (no Q: Riser - 2,Riser - 1)
Orifice - 3,Orifice - 1,Orifice - 2,Culvert - 1 (no Q: Riser - 2,Riser - 1)
Orifice - 3,Orifice - 1,Orifice - 2,Culvert - 1 (no Q: Riser - 2,Riser - 1)
Orifice - 3,Riser - 2,Orifice - 1,Riser - 1,Orifice - 2,Culvert - 1
Orifice - 3,Riser - 2,Orifice - 1,Riser - 1,Orifice - 2,Culvert - 1
Orifice - 3,Riser - 2,Orifice - 1,Riser - 1,Orifice - 2,Culvert - 1
Orifice - 3,Riser - 2,Orifice - 1,Riser - 1,Orifice - 2,Culvert - 1
Orifice - 3,Riser - 2,Orifice - 1,Riser - 1,Orifice - 2,Culvert - 1
Orifice - 3,Riser - 2,Orifice - 1,Riser - 1,Orifice - 2,Culvert - 1
Orifice - 3,Riser - 2,Orifice - 1,Riser - 1,Orifice - 2,Culvert - 1
Orifice - 3,Riser - 2,Orifice - 1,Riser - 1,Orifice - 2,Culvert - 1
Orifice - 3,Riser - 2,Orifice - 1,Riser - 1,Orifice - 2,Culvert - 1
Orifice - 3,Riser - 2,Orifice - 1,Riser - 1,Orifice - 2,Culvert - 1
Orifice - 3,Riser - 2,Orifice - 1,Riser - 1,Orifice - 2,Culvert - 1
Orifice - 3,Riser - 2,Orifice - 1,Riser - 1,Orifice - 2,Culvert - 1
Orifice - 3,Riser - 2,Orifice - 1,Riser - 1,Orifice - 2,Culvert - 1
Orifice - 3,Riser - 2,Orifice - 1,Riser - 1,Orifice - 2,Culvert - 1

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

Composite Rating Table
Tailwater Elevation = Free Outfall (Composite Outlet Structure - 1)

Contributing Structures
Orifice - 3,Riser - 2,Orifice - 1,Riser - 1,Orifice - 2,Culvert - 1



FINAL STORM REPORT

ADDENDUM 1

Cobey Creek, Phase 1

Mixed Use Development

Lee's Summit, MO

PREPARED FOR

JCM DEVELOPMENT, LLC

PREPARED BY

HG CONSULT, INC.

July 1, 2019

7/1/19

Contents

1. 40 Hour Extended Detention 3

2. Effective Height 3

3. Energy Dissipation 3

This addendum to the final storm report for Cobey Creek, Phase 1, is prepared to address comments from the City of Lee's Summit staff from a letter dated May 25th, 2019 in regard to specific stormwater issues. The three sections are intended to provide additional information to the first three comments of said letter.

1. 40 Hour Extended Detention

The 8" skimmer used for erosion control will be permanent and the coupling will be capped. After final construction, if it is determined the North Detention Pond does not drain in 48 hours; the cap will be removed to drain the detention pond.

2. Effective Height

TR-60 states the following for the effective height of the dam.

"Effective height of dam. The difference in elevation in feet between the lowest open channel auxiliary spillway crest and the lowest point in the original cross section on the centerline of the dam. If there is no open channel auxiliary spillway, the top of the dam becomes the upper limit."

The top of the auxiliary spillway is at El. 977.0. The lowest point in the original cross section on the centerline of the dam is El. 968.0. Therefore, TR-60 does not apply to this detention pond.

3. Energy Dissipation

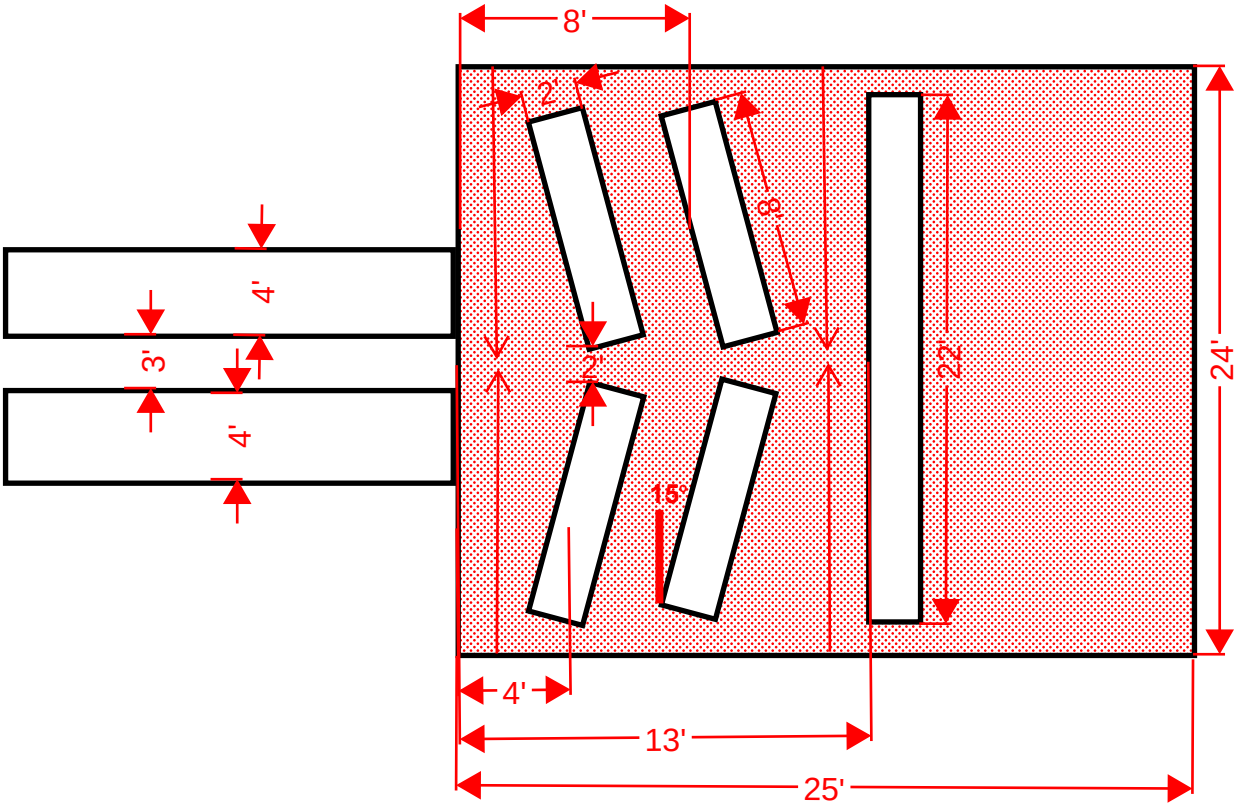
Additional energy dissipation has been added to the outlet structure at the request of the City of Lee's Summit. The outlet rip rap pad is fitted with a Contra Costa Design from HEC 14. The design details are included in the plans. The original 100-year outlet velocity is ~12.0 ft/s and the proposed 100-year outlet velocity is expected to be ~8.7 ft/s. Calculations are included in this Addendum.

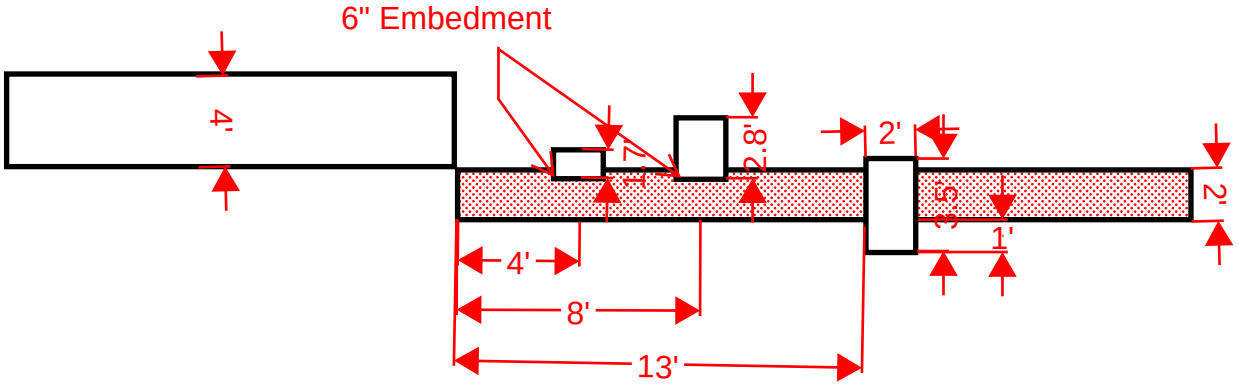
HY-8 Energy Dissipation Report

External Energy Dissipator

Parameter	Value	Units
Select Culvert and Flow		
Crossing	Crossing 1	
Culvert	Culvert 1	
Flow	280.00	cfs
Culvert Data		
Culvert Width (including multiple barrels)	8.0	ft
Culvert Height	4.0	ft
Outlet Depth	3.51	ft
Outlet Velocity	11.98	ft/s
Froude Number	1.13	
Tailwater Depth	0.00	ft
Tailwater Velocity	0.00	ft/s
Tailwater Slope (SO)	0.0049	
External Dissipator Data		
External Dissipator Category	Streambed Level Structures	
External Dissipator Type	Contra Costa	
Restrictions		
Froude Number	<3	
TailWater	<.5D	
Input Data		
Baffle Block Height Ratio		
Note:	2.5 < Baffle Block Height Ratio < 7	
Note:	Optimum Baffle Block Height Ratio = 3.5	
Ratio of Baffle Block Height to Block Distance from the Culvert	3.500	
End Sill Height to Maximum Depth Ratio		
Note:	Maximum Depth in the Dissipator is 4.794 feet	
Note:	0.06 < End Sill Height to Max Depth Ratio < 0.1	
Note:	0.1 is Recommended for End Sill Height to Max Depth Ratio	
Ratio to Determine End Sill Height from Maximum Depth	0.100	
Basin Width		
Note:	Channel Width is 8.000 feet	ft
Note:	4.000 < Basin Width < 12.000	ft
Note:	Channel Width is Recommended for Basin Width	
Basin Width	8.000	ft
Results		
Basin Depth (Y2)	4.794	ft
Basin Length (LB)	21.373	ft
Basin Width (WB)	8.000	ft
Exit Width (W3)	8.000	ft
Exit Depth (YC)	2.954	ft

Exit Velocity (VB=VC)	8.653	ft/s
First Baffle		
Height (H1)	1.174	ft
Width (WB)	8.000	ft
Space (L1)	4.111	ft
Second Baffle		
Height (H2)	2.349	ft
Width (WB)	8.000	ft
Space (L2)	8.221	ft
End Sill		
Height (H3)	0.479	ft
Top Width (W3)	8.000	ft
Location (L3)	13.152	ft


8'
2'
8'
4'
3'
4'
2'
15°
22'
24'
4'
13'
25'


6" Embedment
4'
1'
2.8'
2'
1.5'
2'
1'
4'
8'
13'

STORM WATER REPORT

Addendum 2

Cobey Creek

Mixed Use Development

Lee's Summit, MO

PREPARED FOR

JCM DEVELOPMENT,LLC

PREPARED BY

Hg Consult, Inc

August 3, 2020

This addendum to the final storm report for Cobey Creek, Phase 1, is prepared to address the updating of the Pond Pack information for the south pond outlet structure. The attached Pondpack print out addresses the flow characteristics associated with six- 12inch diameter holes shown on the new square outlet structure detail, also attached.

The structure was changed to square from a circular manhole due to the unavailability of the manhole in a 6 foot diameter, as designed and approved in the original plans. The Pond pack information is provided as confirmation that original release orifices (12” holes) on the circuler manhole when placed on the square version, shows no changes to the hydraulic function of the outlet structure within the pond.

STORM WATER REPORT

Addendum 3

Cobey Creek

Mixed Use Development

Lee's Summit, MO

PREPARED FOR

JCM DEVELOPMENT,LLC

PREPARED BY

Hg Consult, Inc

October 8, 2020

This addendum to the Final Storm Report for Cobey Creek, Phase 1 is prepared for addressing the change to the geometric shape of the outlet structure in the north pond from circular to rectangular, due to the unavailability of a six foot diameter manhole.

This change is the same as the change at the south pond, except that the north pond design called for 2 circular manholes side by side. The shape of the outlet structure has been redesigned to incorporate the 2 manholes into one larger and rectangular structure. All orifices that were shown for the manholes have been incorporated into the rectangular structure at the same elevations to provide the same hydraulic flows at the various storm events as originally designed. Details of the new and approved structure are attached.

AS-BUILTS STORM REPORT

ADDENDUM 4

Cobey Creek, Phase 1

Mixed Use Development Lee's

Summit, MO

PREPARED FOR

JCM DEVELOPMENT, LLC

PREPARED BY

HG CONSULT, INC.

April 23, 2021

4/23/21

This addendum to the final storm report for Cobey Creek, Phase 1, is prepared for the North Detention Pond for the as-built conditions.

Proposed orifices/risers were designed to handle the WQ, 2, 10, and 100 year events. The table below summarizes the proposed vs. the as-built orifice elevations.

Table 1– Design Water Surface Elevations

Name	Design Elevation	As-Built Elevation
2 – 48" Pipes	964.70	965.40
2 – 2" Orifices (WQ)	964.70	965.35
4 – 1" Orifices (WQ)	965.10	965.75
4 – 21" Orifices (2-Year and 10-Year)	970.30	970.45
2 – 42" Risers (10-Year and 100-Year)	973.00	972.90
165' Emergency Spillway	977.00	977.05

The North Detention Pond was designed with adequate storage volume to discharge the design storm events. The as-built storage volumes closely match the design storage volumes and are summarized below.

Table 2– North Detention Pond Volumes

Elevation	Design Volume (CF)	As-Built Volume (CF)
964.70	0.00	---
965.00	91.14	---
965.66	1078.69	0.00
966.00	1587.43	96.91
967.00	5221.71	2224.13
968.00	11887.61	7480.39
969.00	16284.71	11378.48
970.00	22239.80	17002.99
971.00	34243.52	27237.46
972.00	67231.45	57187.14
973.00	138511.05	124762.26
974.00	218096.48	201239.95
975.00	304146.11	285267.17
976.00	396454.77	376940.76
977.00	495081.75	476368.06
978.00	600087.34	583653.32
979.00	711528.98	698910.02
979.07	---	707297.84

APWA 5608.4 requires a 40-hour extended release of the water quality storm event (1.37"/24-hour rainfall) per Section 8.10 of the BMP Manual. The detention facility was designed with the 1" and 2" orifices to release the water quality event over a 40-hour period. Because the 1" and 2" orifices were constructed 0.65' higher the water quality event was slightly impacted. Below is a summary of those results.

Table 3 – Water Quality

Name	Max WSE (ft)	Max Pond Storage (ac-ft)	Peak Flow (cf/s)	Release Duration (hr)
Design	970.40	1.431	1.42	40.96
As-Built	970.74	1.114	2.72	34.24

As indicated in table the water quality event will discharge through the 21" orifices at a maximum depth of 0.29' (3.5") therefore slightly increasing the discharge for a short amount of time and thus reducing the maximum pond storage and the release duration. Although there is a slight impact the detention pond is able to release the water quality event for 34.24 hours. See water quality hydrographs in Appendix.

Per APWA Section 5608.4 and City of Lee's Summit criteria, the post-development 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

The table below summarizes the allowable, designed, and as-built discharge rates for the North Detention Pond.

Table 4 – North Detention Release Rates

Name	2-Year	10-Year	100-Year
Allowable Discharge (cfs)	66.73	200.16	311.70
Design Discharge (cfs)	65.08	194.74	278.44
As-Built Discharge 9cfs)	85.52	204.93	277.47

The highlighted items above indicate were the allowable flow rates were exceeded in the as-built conditions. The 2-year had a significant increase because the 2-Year WSE = 973.33 and therefore is discharging into the 42" risers. In order to get the 2-Year closer to the allowable we propose adding 0.6' risers to the 42" domes therefore raising the 42" domes to an elevation of 973.50. The additional riser lengths keep the 2-Year below the 42" risers and therefore discharging through 21" orifices. This proposed change has the following flow rates:

Table 5: Proposed North Detention Discharge Values

Name	2-Year	10-Year	100-Year
Allowable Discharge (cfs)	66.73	200.16	311.70
Proposed Discharge (cfs)	68.55	194.57	272.78

By making the aforementioned revision to the risers we exceed the allowable 2-Year by 3% and meet the 10 and 100-Year.

The proposed change increases the proposed 100-Year WSE from 976.50 to 976.82. The new WSE would be within 0.23' of the Spillway. In order to accommodate the 0.5' of freeboard the spillway would need to be raised an additional 4" which appears to be in a very limited section of the spillway based on the as-built information. The subsequent 100-Year WSE with the aforementioned changes is 978.31. The as-built top of dam elevation is very close to 979.00.

Table 6: Subsequent 100 Year Spillway Discharge Values and Elevations

Name	100-Year WSE	Subsequent 100-Year WSE	Spillway Elevation	Top of Dam Elevation
Designed	976.50	977.99	977.00	979.00
Proposed	976.82	978.31	977.32	978.99

In summary we propose adding a 7" extension to the 42" domes (ELEV = 973.50). Additionally we proposed raising the spillway elevation by 0.32' (ELEV = 977.32). By doing so the WQ, 2, 10, 100, and subsequent 100-Year events are within a close tolerance to the allowable. The PondPack results are contained within.

Table 7: Summary of Changes

Name	42" Risers Elevation	Spillway Elevation
As-Built	972.90	977.00
Proposed	973.50	977.32

The upstream pipes were analyzed to determine if the increased 10-Year WSE had an effect on the HGL in pipe systems 1 and 12. The 10-Year WSE elevation was used as the tailwater condition. The tailwater increased from 974.53 to 974.91 for the 10-Year event. Pipe system 1 has an invert into north pond of 973.12. Because the tailwater is only 1.79 deep inside the 60" diameter pipe (pipe HGL is above tailwater) the pipe system remains inlet controlled and therefore the HGL is not affected. The invert elevation into the pond for pipe system 12 is 971.10 therefore has a tailwater depth of 3.81. Because the tailwater depth is higher than the HGL in a free outfall condition the system is outlet controlled. Therefore the HGL changes by 0.38' at the outfall (12-A) and dissipates to "no-change" three structures upstream (structure 12-D – 245' upstream). In summary the increased 10-Year WSE had no-effect on system 1 and had minimal effect on system 12. System 12 continues to contain the HGL within the pipe.

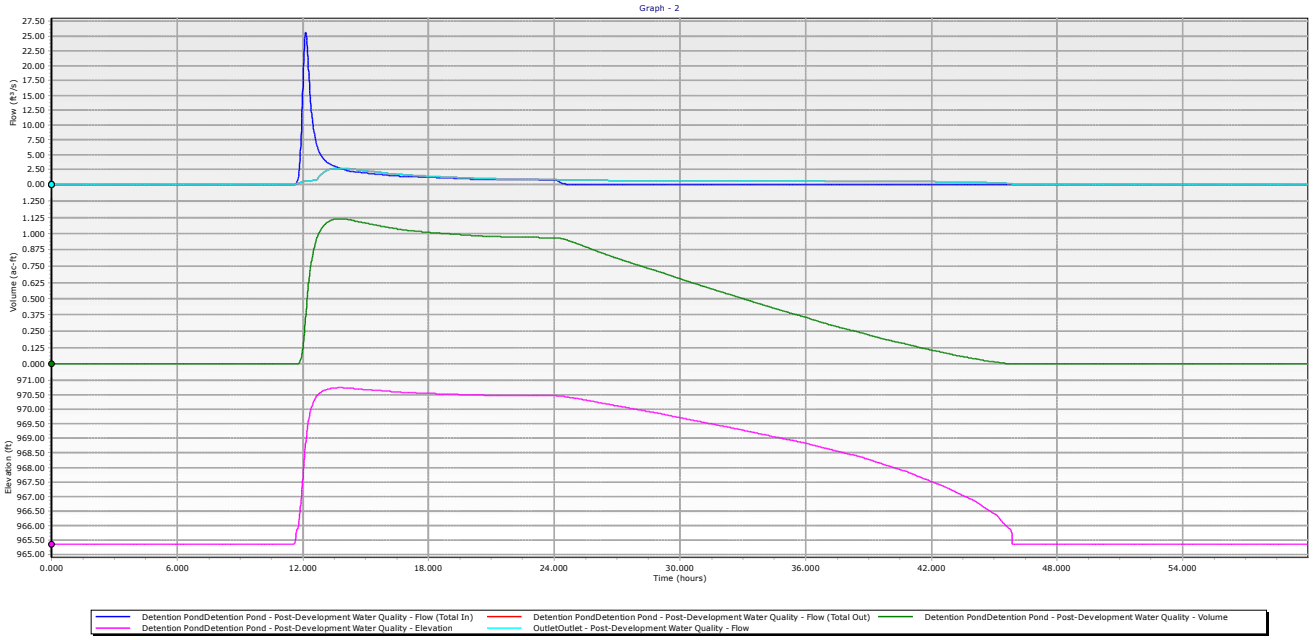
Appendix

WATER QUALITY EVENT EXTENDED RELEASE.....5

PONDPACK OUTPUT.....7

PONDPACK SPILLWAY OUTPUT.....44

WATER QUALITY EVENT EXTENDED RELEASE


Graph - 2
Flow (ft^3/s)
Volume (ac-ft)
Elevation (ft)
Time (hours)
0.000
6.000
12.000
18.000
24.000
30.000
36.000
42.000
48.000
54.000
Detention PondDetention Pond - Post-Development Water Quality - Flow (Total In)
Detention PondDetention Pond - Post-Development Water Quality - Elevation
Detention PondDetention Pond - Post-Development Water Quality - Flow (Total Out)
OutletOutlet - Post-Development Water Quality - Flow
Detention PondDetention Pond - Post-Development Water Quality - Volume

PONDPACK OUTPUT

COBEY CREEK - 2, 10, 100 YEAR (AS-BUILTS)

Project Summary	
Title	COBEY CREEK
Engineer	Matthew Castor
Company	Hg Consult, Inc
Date	4/6/2021

Notes

Table of Contents

Master Network Summary 2

COBEY CREEK - 2, 10, 100 YEAR (AS-BUILTS)

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft³/s)
P3	Post-Development 2 year	2	13.945	12.090	169.63
P3	Post-Development 10 year	10	25.862	12.090	314.25
P3	Post-Development 100 year	100	42.704	12.090	511.44
P1	Post-Development 2 year	2	1.756	11.980	29.29
P1	Post-Development 10 year	10	3.215	11.970	52.87
P1	Post-Development 100 year	100	5.265	11.970	84.76
P2	Post-Development 2 year	2	0.097	11.950	1.73
P2	Post-Development 10 year	10	0.184	11.940	3.27
P2	Post-Development 100 year	100	0.309	11.940	5.40
P4	Post-Development 2 year	2	0.654	11.990	10.77
P4	Post-Development 10 year	10	1.228	11.990	20.01
P4	Post-Development 100 year	100	2.044	11.970	32.66

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft³/s)
O-3	Post-Development 2 year	2	13.945	12.410	68.55
O-3	Post-Development 10 year	10	25.862	12.290	194.57
O-3	Post-Development 100 year	100	42.704	12.320	272.78
O-1	Post-Development 2 year	2	1.756	11.980	29.29
O-1	Post-Development 10 year	10	3.215	11.970	52.87
O-1	Post-Development 100 year	100	5.265	11.970	84.76
O-2	Post-Development 2 year	2	0.097	11.950	1.73
O-2	Post-Development 10 year	10	0.184	11.940	3.27

COBEY CREEK - 2, 10, 100 YEAR (AS-BUILTS)

Subsection: Master Network Summary

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
O-2	Post-Development 100 year	100	0.309	11.940	5.40
O-4	Post-Development 2 year	2	0.654	11.990	10.77
O-4	Post-Development 10 year	10	1.228	11.990	20.01
O-4	Post-Development 100 year	100	2.044	11.970	32.66

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ac-ft)
Detention Pond (IN)	Post-Development 2 year	2	13.945	12.090	169.63	(N/A)	(N/A)
Detention Pond (OUT)	Post-Development 2 year	2	13.945	12.410	68.55	973.47	4.636
Detention Pond (IN)	Post-Development 10 year	10	25.862	12.090	314.25	(N/A)	(N/A)
Detention Pond (OUT)	Post-Development 10 year	10	25.862	12.290	194.57	974.91	7.336
Detention Pond (IN)	Post-Development 100 year	100	42.704	12.090	511.44	(N/A)	(N/A)
Detention Pond (OUT)	Post-Development 100 year	100	42.704	12.320	272.78	976.82	11.475

COBEY CREEK - 2, 10, 100 YEAR (AS-BUILTS)

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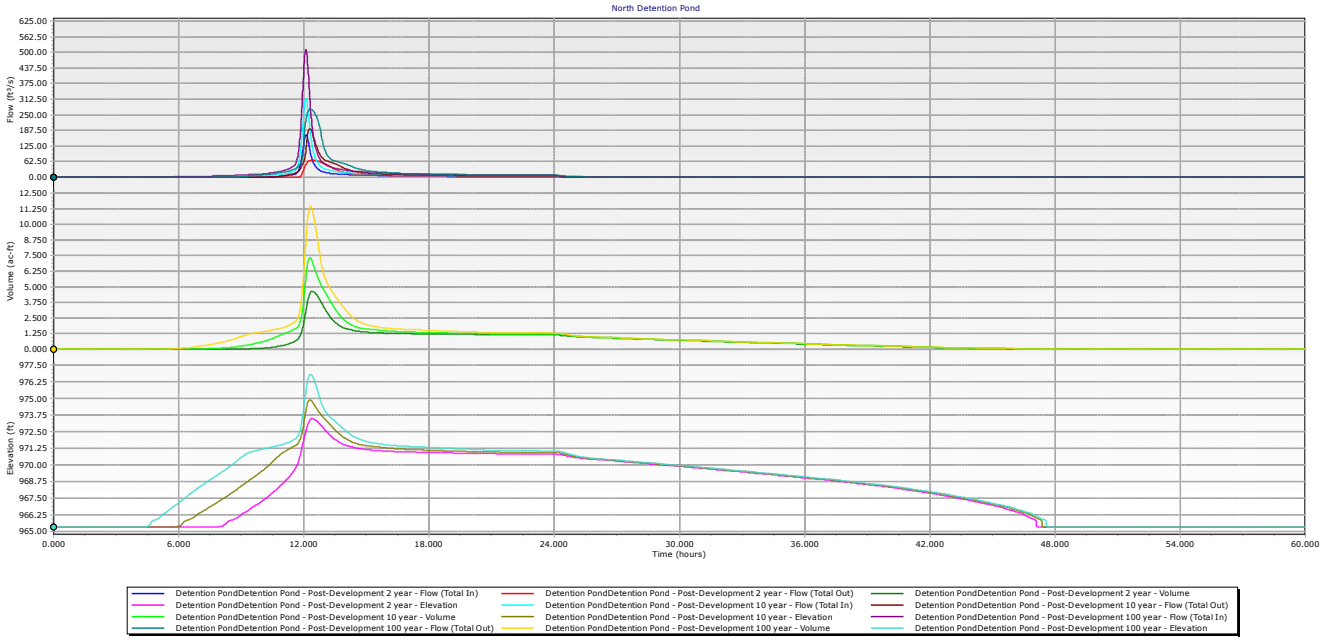
Master Network Summary...2, 3


North Detention Pond
Flow (ft³/s)
625.00
562.50
500.00
437.50
375.00
312.50
250.00
187.50
125.00
62.50
0.00
Volume (ac-ft)
12.500
11.250
10.000
8.750
7.500
6.250
5.000
3.750
2.500
1.250
0.000
Elevation (ft)
977.50
976.25
975.00
973.75
972.50
971.25
970.00
968.75
967.50
966.25
965.00
0.000
6.000
12.000
18.000
24.000
30.000
36.000
42.000
48.000
54.000
60.000
Time (hours)
Detention PondDetention Pond - Post-Development 2 year - Flow (Total In)
Detention PondDetention Pond - Post-Development 2 year - Elevation
Detention PondDetention Pond - Post-Development 10 year - Volume
Detention PondDetention Pond - Post-Development 100 year - Flow (Total Out)
Detention PondDetention Pond - Post-Development 2 year - Flow (Total Out)
Detention PondDetention Pond - Post-Development 10 year - Flow (Total In)
Detention PondDetention Pond - Post-Development 10 year - Elevation
Detention PondDetention Pond - Post-Development 100 year - Volume
Detention PondDetention Pond - Post-Development 2 year - Volume
Detention PondDetention Pond - Post-Development 10 year - Flow (Total Out)
Detention PondDetention Pond - Post-Development 100 year - Flow (Total In)
Detention PondDetention Pond - Post-Development 100 year - Elevation

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

Element Details			
Label	Composite Outlet Structure - 1	Notes	

Headwater Range			
Headwater Type	Use Pond for Headwater Range	Maximum (Headwater)	979.07 ft
Pond	Detention Pond	Increment (Headwater)	0.50 ft
Minimum (Headwater)	965.35 ft		

SpotElevation (ft)

Tailwater Setup			
Tailwater Type	Free Outfall		

Tailwater Tolerances			
Maximum Iterations	30	Tailwater Tolerance (Maximum)	0.50 ft
Headwater Tolerance (Minimum)	0.01 ft	Flow Tolerance (Minimum)	0.001 ft³/s
Headwater Tolerance (Maximum)	0.50 ft	Flow Tolerance (Maximum)	10.000 ft³/s
Tailwater Tolerance (Minimum)	0.01 ft		

Outlet Structure			
Outlet Structure Type	Culvert	Culvert Type	Circular

Outlet Structure (IDs and Direction)			
Outlet ID	Culvert - 1	Downstream ID	Tailwater
Flow Direction	Forward Flow Only	Notes	

Outlet Structure (Advanced)			
Elevation (On)	0.00 ft	Elevation (Off)	0.00 ft

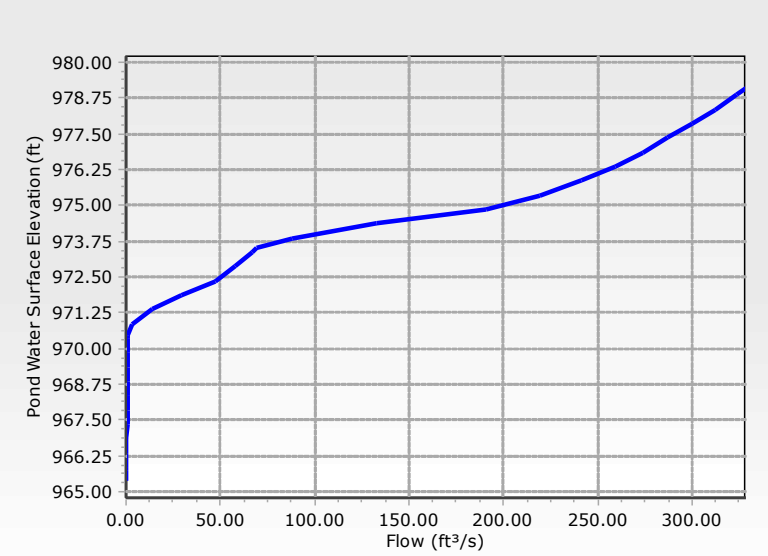
Culvert Data			
Number of Barrels	2	Downstream Invert	964.80 ft
Length	102.32 ft	Diameter	48.0 in
Upstream Invert	965.35 ft		

Unsubmerged->Submerged			
Specify Transitions	False	Compute Inlet Control Only	False

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

Culvert Coefficients			
Inlet Description	Concrete - Groove end projecting	C	0.0317
Chart	Chart 1	Y	0.6900
Nomograph	Nomograph 3	Manning's n	0.011
Equation Form	Form 1	Ke	0.200
K	0.0045	Kr	0.000
M	2.0000	Slope Correction Factor	-0.500

Culvert (Advanced)			
Convergence Tolerance	0.00 ft	Specify Number of Backwater Sections	False



RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Culvert - 1 (Culvert-Circular)

Mannings open channel maximum capacity: 133.88 ft³/s
Upstream ID = Orifice - 2, Riser - 2, Orifice - 1, Riser - 1, Copy of Orifice - 1
Downstream ID = Tailwater (Pond Outfall)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Culvert - 1 (Culvert-Circular)

Mannings open channel maximum capacity: 133.88 ft³/s
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Downstream ID = Tailwater (Pond Outfall)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)
965.35	0.00	0.00	0.00	Free Outfall
965.75	0.12	965.45	Free Outfall	Free Outfall
965.85	0.16	965.46	Free Outfall	Free Outfall
966.35	0.30	965.50	Free Outfall	Free Outfall
966.85	0.37	965.52	Free Outfall	Free Outfall
967.35	0.42	965.53	Free Outfall	Free Outfall
967.85	0.48	965.55	Free Outfall	Free Outfall
968.35	0.52	965.55	Free Outfall	Free Outfall
968.85	0.58	965.57	Free Outfall	Free Outfall
969.35	0.62	965.57	Free Outfall	Free Outfall
969.85	0.65	965.58	Free Outfall	Free Outfall
970.35	0.68	965.59	Free Outfall	Free Outfall
970.45	0.69	965.59	Free Outfall	Free Outfall
970.85	3.49	965.89	Free Outfall	Free Outfall
971.35	13.73	966.43	Free Outfall	Free Outfall
971.85	29.54	966.96	Free Outfall	Free Outfall
972.35	47.56	967.43	Free Outfall	Free Outfall
972.85	57.90	967.66	Free Outfall	Free Outfall
973.35	66.57	967.84	Free Outfall	Free Outfall
973.50	69.03	967.90	Free Outfall	Free Outfall
973.85	87.98	968.27	Free Outfall	Free Outfall
974.35	133.02	969.06	Free Outfall	Free Outfall
974.85	191.12	970.02	Free Outfall	Free Outfall
975.35	219.54	970.52	Free Outfall	Free Outfall
975.85	241.18	971.02	Free Outfall	Free Outfall
976.35	259.30	971.47	Free Outfall	Free Outfall
976.85	273.70	971.86	Free Outfall	Free Outfall
977.35	287.15	972.24	Free Outfall	Free Outfall
977.85	299.93	972.61	Free Outfall	Free Outfall
978.35	312.04	972.99	Free Outfall	Free Outfall
978.85	323.63	973.36	Free Outfall	Free Outfall
979.07	328.45	973.51	Free Outfall	Free Outfall

Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft³/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Culvert - 1 (Culvert-Circular)

Mannings open channel maximum capacity: 133.88 ft³/s
Upstream ID = Orifice - 2, Riser - 2, Orifice - 1, Riser - 1, Copy of Orifice - 1
Downstream ID = Tailwater (Pond Outfall)

Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft³/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.01	(N/A)	0.00
0.00	0.01	(N/A)	0.00
0.00	0.02	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.06	(N/A)	0.00
0.00	0.01	(N/A)	0.00
0.00	0.01	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.01	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.01	(N/A)	0.00

Message
WS below an invert; no flow.
CRIT.DEPTH CONTROL Vh= .023ft Dcr= .068ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .026ft Dcr= .079ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .037ft Dcr= .109ft CRIT.DEPTH Hev= .00ft

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Culvert - 1 (Culvert-Circular)

Mannings open channel maximum capacity: 133.88 ft³/s
Upstream ID = Orifice - 2, Riser - 2, Orifice - 1, Riser - 1, Copy of Orifice - 1
Downstream ID = Tailwater (Pond Outfall)

Message
FLOW PRECEDENCE SET TO UPSTREAM CONTROLLING STRUCTURE
FLOW PRECEDENCE SET TO UPSTREAM CONTROLLING STRUCTURE
FLOW PRECEDENCE SET TO UPSTREAM CONTROLLING STRUCTURE
FLOW PRECEDENCE SET TO UPSTREAM CONTROLLING STRUCTURE
FLOW PRECEDENCE SET TO UPSTREAM CONTROLLING STRUCTURE
FLOW PRECEDENCE SET TO UPSTREAM CONTROLLING STRUCTURE
FLOW PRECEDENCE SET TO UPSTREAM CONTROLLING STRUCTURE
CRIT.DEPTH CONTROL Vh= .056ft Dcr= .167ft CRIT.DEPTH Hev= .00ft
FLOW PRECEDENCE SET TO UPSTREAM CONTROLLING STRUCTURE
CRIT.DEPTH CONTROL Vh= .129ft Dcr= .379ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .265ft Dcr= .760ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .403ft Dcr= 1.125ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .530ft Dcr= 1.440ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .597ft Dcr= 1.595ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .650ft Dcr= 1.715ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .665ft Dcr= 1.748ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .777ft Dcr= 1.984ft CRIT.DEPTH Hev= .00ft

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Culvert - 1 (Culvert-Circular)

Mannings open channel maximum capacity: 133.88 ft³/s
Upstream ID = Orifice - 2, Riser - 2, Orifice - 1, Riser - 1, Copy of Orifice - 1
Downstream ID = Tailwater (Pond Outfall)

Message
CRIT.DEPTH CONTROL Vh= 1.043ft Dcr= 2.463ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= 1.424ft Dcr= 2.964ft CRIT.DEPTH Hev= .00ft
INLET CONTROL... Submerged: HW =5.17
INLET CONTROL... Submerged: HW =5.67
INLET CONTROL... Submerged: HW =6.12
INLET CONTROL... Submerged: HW =6.51
INLET CONTROL... Submerged: HW =6.89
INLET CONTROL... Submerged: HW =7.26
INLET CONTROL... Submerged: HW =7.64
INLET CONTROL... Submerged: HW =8.01
INLET CONTROL... Submerged: HW =8.16

Outlet Structure	
Outlet Structure Type	Orifice

Outlet Structure (IDs and Direction)			
Outlet ID	Orifice - 1	Downstream ID	Culvert - 1
Flow Direction	Forward Flow Only	Notes	

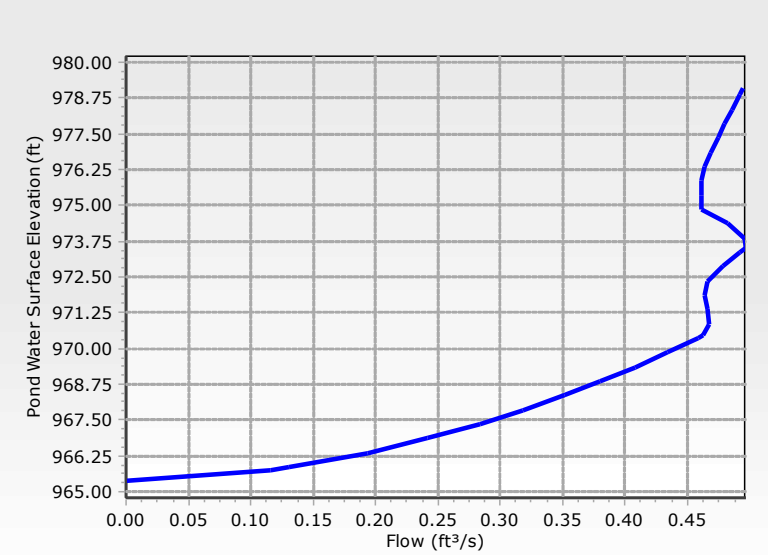
Outlet Structure (Advanced)			
Elevation (On)	0.00 ft	Elevation (Off)	0.00 ft

Outlet Structure (Orifice)			
Orifice	Circular Orifice	Orifice Coefficient	0.600
Number of Openings	2	Orifice Diameter	2.0 in

Outlet Structure (Common)

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

Outlet Structure (Common)	
Elevation	965.35 ft



RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Orifice - 1 (Orifice-Circular)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)
965.35	0.00	0.00	0.00	0.00
965.75	0.12	965.75	965.45	965.45
965.85	0.13	965.85	965.46	965.46
966.35	0.19	966.35	965.50	965.50
966.85	0.24	966.85	965.52	965.52
967.35	0.28	967.35	965.53	965.53
967.85	0.32	967.85	965.55	965.55
968.35	0.35	968.35	965.55	965.55
968.85	0.38	968.85	965.57	965.57
969.35	0.41	969.35	965.57	965.57
969.85	0.43	969.85	965.58	965.58
970.35	0.46	970.35	965.58	965.59

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Orifice - 1 (Orifice-Circular)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)
970.45	0.46	970.45	965.59	965.59
970.85	0.47	970.85	965.88	965.89
971.35	0.47	971.35	966.43	966.43
971.85	0.46	971.85	966.96	966.96
972.35	0.47	972.35	967.43	967.43
972.85	0.48	972.85	967.66	967.66
973.35	0.49	973.35	967.84	967.84
973.50	0.50	973.50	967.90	967.90
973.85	0.50	973.85	968.27	968.27
974.35	0.48	974.35	969.06	969.06
974.85	0.46	974.85	970.02	970.02
975.35	0.46	975.35	970.52	970.52
975.85	0.46	975.85	971.02	971.02
976.35	0.46	976.35	971.47	971.47
976.85	0.47	976.85	971.86	971.86
977.35	0.47	977.35	972.24	972.24
977.85	0.48	977.85	972.61	972.61
978.35	0.49	978.35	972.99	972.99
978.85	0.49	978.85	973.36	973.36
979.07	0.50	979.07	973.51	973.51

Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft³/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Orifice - 1 (Orifice-Circular)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft^3/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00

Message
WS below an invert; no flow.
H =.30
H =.39
H =.85
H =1.33
H =1.82
H =2.30
H =2.80
H =3.28
H =3.78
H =4.27
H =4.77
H =4.86
H =4.97
H =4.92
H =4.89
H =4.92
H =5.19
H =5.51
H =5.60
H =5.58
H =5.29

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Orifice - 1 (Orifice-Circular)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Message
H =4.83
H =4.83
H =4.83
H =4.88
H =4.99
H =5.11
H =5.24
H =5.36
H =5.49
H =5.56

Outlet Structure	
Outlet Structure Type	Riser

Outlet Structure (IDs and Direction)			
Outlet ID	Riser - 1	Downstream ID	Culvert - 1
Flow Direction	Forward Flow Only	Notes	

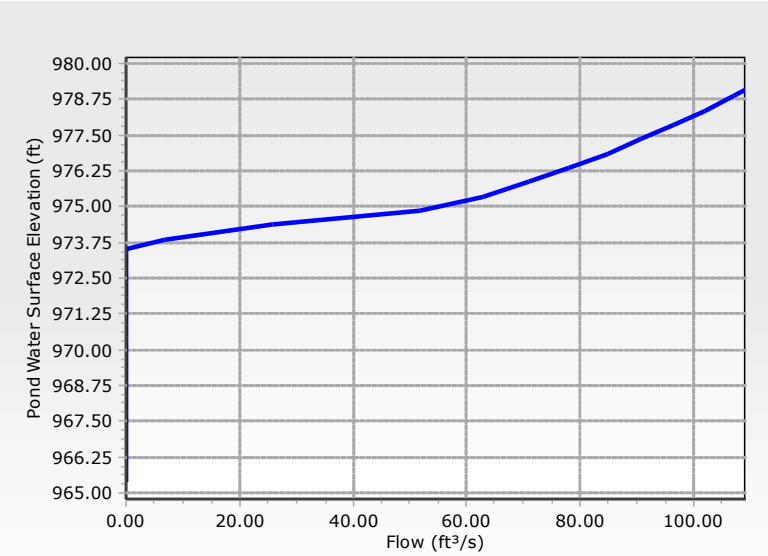
Outlet Structure (Advanced)			
Elevation (On)	0.00 ft	Elevation (Off)	0.00 ft

Outlet Structure (Riser)			
Riser	Stand Pipe	Transition Elevation	0.00 ft
Diameter	42.0 in	Transition Height	0.00 ft
Weir Coefficient	3.00 (ft^0.5)/s	K Reverse	1.000
Orifice Coefficient	0.600		

Outlet Structure (Common)	
Elevation	973.50 ft

Outlet Structure (Riser, Advanced)			
Use Orifice Depth to Crest?	True	Use Submerged Weir Equation?	False

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1



RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Riser - 1 (Stand Pipe)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)
965.35	0.00	0.00	0.00	0.00
965.75	0.00	0.00	0.00	965.45
965.85	0.00	0.00	0.00	965.46
966.35	0.00	0.00	0.00	965.50
966.85	0.00	0.00	0.00	965.52
967.35	0.00	0.00	0.00	965.53
967.85	0.00	0.00	0.00	965.55
968.35	0.00	0.00	0.00	965.55
968.85	0.00	0.00	0.00	965.57
969.35	0.00	0.00	0.00	965.57
969.85	0.00	0.00	0.00	965.58
970.35	0.00	0.00	0.00	965.59
970.45	0.00	0.00	0.00	965.59
970.85	0.00	0.00	0.00	965.89
971.35	0.00	0.00	0.00	966.43
971.85	0.00	0.00	0.00	966.96

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Riser - 1 (Stand Pipe)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)
972.35	0.00	0.00	0.00	967.43
972.85	0.00	0.00	0.00	967.66
973.35	0.00	0.00	0.00	967.84
973.50	0.00	0.00	0.00	967.90
973.85	6.83	973.85	Free Outfall	968.27
974.35	25.85	974.35	Free Outfall	969.06
974.85	51.74	974.85	Free Outfall	970.02
975.35	62.98	975.35	Free Outfall	970.52
975.85	70.99	975.85	Free Outfall	971.02
976.35	78.17	976.35	Free Outfall	971.47
976.85	84.76	976.85	Free Outfall	971.86
977.35	90.86	977.35	Free Outfall	972.24
977.85	96.58	977.85	Free Outfall	972.61
978.35	101.98	978.35	Free Outfall	972.99
978.85	107.11	978.85	Free Outfall	973.36
979.07	109.29	979.07	973.51	973.51

Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft³/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Riser - 1 (Stand Pipe)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft^3/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00

Message
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
Weir: H =0.35ft
Weir: H =0.85ft
Weir: H =1.35ft
Orifice: H =1.85; Riser orifice equation controlling.

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Riser - 1 (Stand Pipe)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Message
Orifice: H =2.35; Riser orifice equation controlling.
Orifice: H =2.85; Riser orifice equation controlling.
Orifice: H =3.35; Riser orifice equation controlling.
Orifice: H =3.85; Riser orifice equation controlling.
Orifice: H =4.35; Riser orifice equation controlling.
Orifice: H =4.85; Riser orifice equation controlling.
Orifice: H =5.35; Riser orifice equation controlling.
FULLY CHARGED RISER: Orifice Equation Control to Crest; H=5.57

Outlet Structure	
Outlet Structure Type	Riser

Outlet Structure (IDs and Direction)			
Outlet ID	Riser - 2	Downstream ID	Culvert - 1
Flow Direction	Forward Flow Only	Notes	

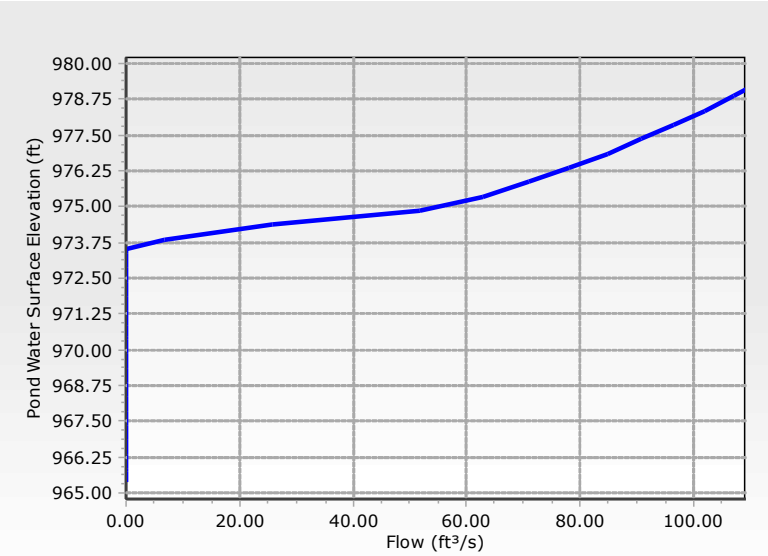
Outlet Structure (Advanced)			
Elevation (On)	0.00 ft	Elevation (Off)	0.00 ft

Outlet Structure (Riser)			
Riser	Stand Pipe	Transition Elevation	0.00 ft
Diameter	42.0 in	Transition Height	0.00 ft
Weir Coefficient	3.00 (ft^0.5)/s	K Reverse	1.000
Orifice Coefficient	0.600		

Outlet Structure (Common)	
Elevation	973.50 ft

Outlet Structure (Riser, Advanced)			
Use Orifice Depth to Crest?	True	Use Submerged Weir Equation?	False

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1



RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Riser - 2 (Stand Pipe)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)
965.35	0.00	0.00	0.00	0.00
965.75	0.00	0.00	0.00	965.45
965.85	0.00	0.00	0.00	965.46
966.35	0.00	0.00	0.00	965.50
966.85	0.00	0.00	0.00	965.52
967.35	0.00	0.00	0.00	965.53
967.85	0.00	0.00	0.00	965.55
968.35	0.00	0.00	0.00	965.55
968.85	0.00	0.00	0.00	965.57
969.35	0.00	0.00	0.00	965.57
969.85	0.00	0.00	0.00	965.58
970.35	0.00	0.00	0.00	965.59
970.45	0.00	0.00	0.00	965.59
970.85	0.00	0.00	0.00	965.89
971.35	0.00	0.00	0.00	966.43
971.85	0.00	0.00	0.00	966.96

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Riser - 2 (Stand Pipe)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)
972.35	0.00	0.00	0.00	967.43
972.85	0.00	0.00	0.00	967.66
973.35	0.00	0.00	0.00	967.84
973.50	0.00	0.00	0.00	967.90
973.85	6.83	973.85	Free Outfall	968.27
974.35	25.85	974.35	Free Outfall	969.06
974.85	51.74	974.85	Free Outfall	970.02
975.35	62.98	975.35	Free Outfall	970.52
975.85	70.99	975.85	Free Outfall	971.02
976.35	78.17	976.35	Free Outfall	971.47
976.85	84.76	976.85	Free Outfall	971.86
977.35	90.86	977.35	Free Outfall	972.24
977.85	96.58	977.85	Free Outfall	972.61
978.35	101.98	978.35	Free Outfall	972.99
978.85	107.11	978.85	Free Outfall	973.36
979.07	109.29	979.07	973.51	973.51

Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft³/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Riser - 2 (Stand Pipe)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft^3/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)	Message
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	Weir: H =0.35ft
0.00	0.00	(N/A)	0.00	Weir: H =0.85ft
0.00	0.00	(N/A)	0.00	Weir: H =1.35ft
0.00	0.00	(N/A)	0.00	Orifice: H =1.85; Riser orifice equation controlling.

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Riser - 2 (Stand Pipe)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Message
Orifice: H =2.35; Riser orifice equation controlling.
Orifice: H =2.85; Riser orifice equation controlling.
Orifice: H =3.35; Riser orifice equation controlling.
Orifice: H =3.85; Riser orifice equation controlling.
Orifice: H =4.35; Riser orifice equation controlling.
Orifice: H =4.85; Riser orifice equation controlling.
Orifice: H =5.35; Riser orifice equation controlling.
FULLY CHARGED RISER: Orifice Equation Control to Crest; H=5.57

Outlet Structure	
Outlet Structure Type	Orifice

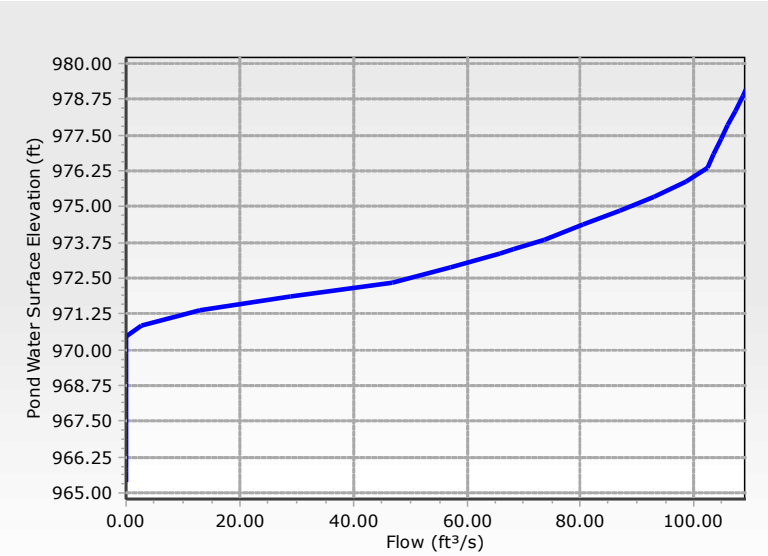
Outlet Structure (IDs and Direction)			
Outlet ID	Orifice - 2	Downstream ID	Culvert - 1
Flow Direction	Forward Flow Only	Notes	

Outlet Structure (Advanced)			
Elevation (On)	0.00 ft	Elevation (Off)	0.00 ft

Outlet Structure (Orifice)			
Orifice	Circular Orifice	Orifice Coefficient	0.600
Number of Openings	4	Orifice Diameter	21.0 in

Outlet Structure (Common)	
Elevation	970.45 ft

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1



RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Orifice - 2 (Orifice-Circular)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)
965.35	0.00	0.00	0.00	0.00
965.75	0.00	0.00	0.00	965.45
965.85	0.00	0.00	0.00	965.46
966.35	0.00	0.00	0.00	965.50
966.85	0.00	0.00	0.00	965.52
967.35	0.00	0.00	0.00	965.53
967.85	0.00	0.00	0.00	965.55
968.35	0.00	0.00	0.00	965.55
968.85	0.00	0.00	0.00	965.57
969.35	0.00	0.00	0.00	965.57
969.85	0.00	0.00	0.00	965.58
970.35	0.00	0.00	0.00	965.59
970.45	0.00	0.00	0.00	965.59
970.85	2.79	970.85	Free Outfall	965.89
971.35	13.03	971.35	Free Outfall	966.43
971.85	28.85	971.85	Free Outfall	966.96

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Orifice - 2 (Orifice-Circular)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)
972.35	46.88	972.35	Free Outfall	967.43
972.85	57.18	972.85	Free Outfall	967.66
973.35	65.90	973.35	Free Outfall	967.84
973.50	68.29	973.50	Free Outfall	967.90
973.85	73.58	973.85	Free Outfall	968.27
974.35	80.54	974.35	Free Outfall	969.06
974.85	86.94	974.85	Free Outfall	970.02
975.35	92.90	975.35	970.52	970.52
975.85	98.50	975.85	971.02	971.02
976.35	102.26	976.35	971.47	971.47
976.85	103.46	976.85	971.86	971.86
977.35	104.71	977.35	972.24	972.24
977.85	105.95	977.85	972.61	972.61
978.35	107.25	978.35	972.99	972.99
978.85	108.55	978.85	973.36	973.36
979.07	109.15	979.07	973.51	973.51

Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft³/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Orifice - 2 (Orifice-Circular)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft^3/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00

Message
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
CRIT.DEPTH CONTROL Vh= .103ft Dcr= .297ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .243ft Dcr= .656ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .407ft Dcr= .994ft CRIT.DEPTH Hev= .00ft
H =1.03
H =1.53
H =2.03
H =2.18
H =2.53
H =3.03
H =3.53

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Orifice - 2 (Orifice-Circular)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Message
H =4.03
H =4.53
H =4.88
H =4.99
H =5.11
H =5.24
H =5.36
H =5.49
H =5.56

Outlet Structure	
Outlet Structure Type	Orifice

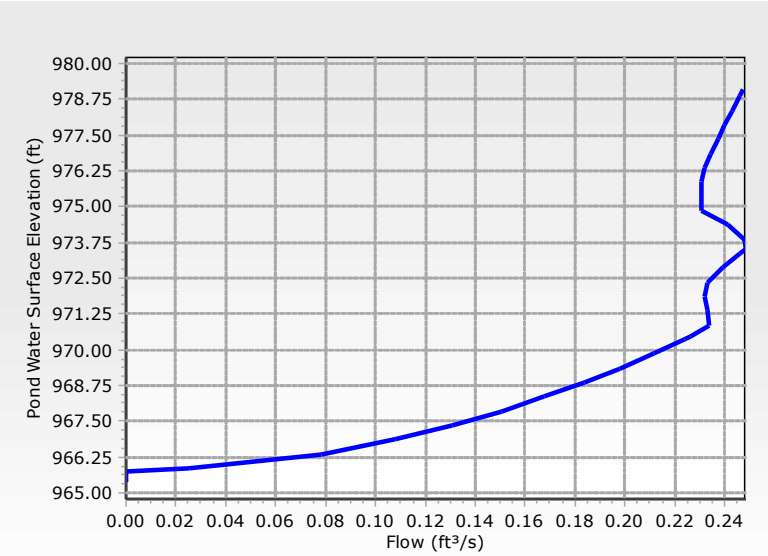
Outlet Structure (IDs and Direction)			
Outlet ID	Copy of Orifice - 1	Downstream ID	Culvert - 1
Flow Direction	Forward Flow Only	Notes	

Outlet Structure (Advanced)			
Elevation (On)	0.00 ft	Elevation (Off)	0.00 ft

Outlet Structure (Orifice)			
Orifice	Circular Orifice	Orifice Coefficient	0.600
Number of Openings	4	Orifice Diameter	1.0 in

Outlet Structure (Common)	
Elevation	965.75 ft

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1



RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Copy of Orifice - 1 (Orifice-Circular)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)
965.35	0.00	0.00	0.00	0.00
965.75	0.00	0.00	0.00	965.45
965.85	0.03	965.85	Free Outfall	965.46
966.35	0.08	966.35	Free Outfall	965.50
966.85	0.11	966.85	Free Outfall	965.52
967.35	0.13	967.35	Free Outfall	965.53
967.85	0.15	967.85	Free Outfall	965.55
968.35	0.17	968.35	Free Outfall	965.55
968.85	0.18	968.85	Free Outfall	965.57
969.35	0.20	969.35	Free Outfall	965.57
969.85	0.21	969.85	Free Outfall	965.58
970.35	0.22	970.35	Free Outfall	965.59
970.45	0.23	970.45	Free Outfall	965.59
970.85	0.23	970.85	965.88	965.89
971.35	0.23	971.35	966.43	966.43
971.85	0.23	971.85	966.96	966.96

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Copy of Orifice - 1 (Orifice-Circular)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)
972.35	0.23	972.35	967.43	967.43
972.85	0.24	972.85	967.66	967.66
973.35	0.25	973.35	967.84	967.84
973.50	0.25	973.50	967.90	967.90
973.85	0.25	973.85	968.27	968.27
974.35	0.24	974.35	969.06	969.06
974.85	0.23	974.85	970.02	970.02
975.35	0.23	975.35	970.52	970.52
975.85	0.23	975.85	971.02	971.02
976.35	0.23	976.35	971.47	971.47
976.85	0.23	976.85	971.86	971.86
977.35	0.24	977.35	972.24	972.24
977.85	0.24	977.85	972.61	972.61
978.35	0.24	978.35	972.99	972.99
978.85	0.25	978.85	973.36	973.36
979.07	0.25	979.07	973.51	973.51

Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft³/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Copy of Orifice - 1 (Orifice-Circular)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft^3/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)	Message
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	H =.06
0.00	0.00	(N/A)	0.00	H =.56
0.00	0.00	(N/A)	0.00	H =1.06
0.00	0.00	(N/A)	0.00	H =1.56
0.00	0.00	(N/A)	0.00	H =2.06
0.00	0.00	(N/A)	0.00	H =2.56
0.00	0.00	(N/A)	0.00	H =3.06
0.00	0.00	(N/A)	0.00	H =3.56
0.00	0.00	(N/A)	0.00	H =4.06
0.00	0.00	(N/A)	0.00	H =4.56
0.00	0.00	(N/A)	0.00	H =4.66
0.00	0.00	(N/A)	0.00	H =4.97
0.00	0.00	(N/A)	0.00	H =4.92
0.00	0.00	(N/A)	0.00	H =4.89
0.00	0.00	(N/A)	0.00	H =4.92
0.00	0.00	(N/A)	0.00	H =5.19
0.00	0.00	(N/A)	0.00	H =5.51
0.00	0.00	(N/A)	0.00	H =5.60
0.00	0.00	(N/A)	0.00	H =5.58
0.00	0.00	(N/A)	0.00	H =5.29
0.00	0.00	(N/A)	0.00	H =4.83
0.00	0.00	(N/A)	0.00	H =4.83
0.00	0.00	(N/A)	0.00	H =4.83
0.00	0.00	(N/A)	0.00	H =4.88

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Copy of Orifice - 1 (Orifice-Circular)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Message
H =4.99
H =5.11
H =5.24
H =5.36
H =5.49
H =5.56

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

Composite Rating Table
Tailwater Elevation = Free Outfall (Composite Outlet Structure - 1)

Water Surface Elevation (ft)	Flow (ft³/s)	Tailwater Elevation (ft)	Convergence Error (ft)
965.35	0.00	(N/A)	0.00
965.75	0.12	(N/A)	0.00
965.85	0.16	(N/A)	0.00
966.35	0.27	(N/A)	0.00
966.85	0.35	(N/A)	0.00
967.35	0.41	(N/A)	0.00
967.85	0.47	(N/A)	0.00
968.35	0.52	(N/A)	0.00
968.85	0.56	(N/A)	0.00
969.35	0.61	(N/A)	0.00
969.85	0.65	(N/A)	0.00
970.35	0.68	(N/A)	0.00
970.45	0.69	(N/A)	0.00
970.85	3.49	(N/A)	0.00
971.35	13.73	(N/A)	0.00
971.85	29.54	(N/A)	0.00
972.35	47.56	(N/A)	0.00
972.85	57.90	(N/A)	0.00
973.35	66.57	(N/A)	0.00
973.50	69.03	(N/A)	0.00
973.85	87.98	(N/A)	0.00
974.35	132.96	(N/A)	0.00
974.85	191.12	(N/A)	0.00
975.35	219.55	(N/A)	0.00
975.85	241.17	(N/A)	0.00
976.35	259.30	(N/A)	0.00
976.85	273.68	(N/A)	0.00
977.35	287.14	(N/A)	0.00
977.85	299.84	(N/A)	0.00
978.35	311.94	(N/A)	0.00
978.85	323.50	(N/A)	0.00
979.07	328.46	(N/A)	0.00

Contributing Structures
(no Q: Orifice - 2,Riser - 2,Orifice - 1,Riser - 1,Copy of Orifice - 1,Culvert - 1)
Orifice - 1,Culvert - 1 (no Q: Orifice - 2,Riser - 2,Riser - 1,Copy of Orifice - 1)
Orifice - 1,Copy of Orifice - 1,Culvert - 1 (no Q: Orifice - 2,Riser - 2,Riser - 1)

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

Composite Rating Table
Tailwater Elevation = Free Outfall (Composite Outlet Structure - 1)

Contributing Structures
Orifice - 1,Copy of Orifice - 1,Culvert - 1 (no Q: Orifice - 2,Riser - 2,Riser - 1)
Orifice - 1,Copy of Orifice - 1,Culvert - 1 (no Q: Orifice - 2,Riser - 2,Riser - 1)
Orifice - 1,Copy of Orifice - 1,Culvert - 1 (no Q: Orifice - 2,Riser - 2,Riser - 1)
Orifice - 1,Copy of Orifice - 1,Culvert - 1 (no Q: Orifice - 2,Riser - 2,Riser - 1)
Orifice - 1,Copy of Orifice - 1,Culvert - 1 (no Q: Orifice - 2,Riser - 2,Riser - 1)
Orifice - 1,Copy of Orifice - 1,Culvert - 1 (no Q: Orifice - 2,Riser - 2,Riser - 1)
Orifice - 1,Copy of Orifice - 1,Culvert - 1 (no Q: Orifice - 2,Riser - 2,Riser - 1)
Orifice - 1,Copy of Orifice - 1,Culvert - 1 (no Q: Orifice - 2,Riser - 2,Riser - 1)
Orifice - 1,Copy of Orifice - 1,Culvert - 1 (no Q: Orifice - 2,Riser - 2,Riser - 1)
Orifice - 1,Copy of Orifice - 1,Culvert - 1 (no Q: Orifice - 2,Riser - 2,Riser - 1)
Orifice - 2,Orifice - 1,Copy of Orifice - 1,Culvert - 1 (no Q: Riser - 2,Riser - 1)
Orifice - 2,Orifice - 1,Copy of Orifice - 1,Culvert - 1 (no Q: Riser - 2,Riser - 1)

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

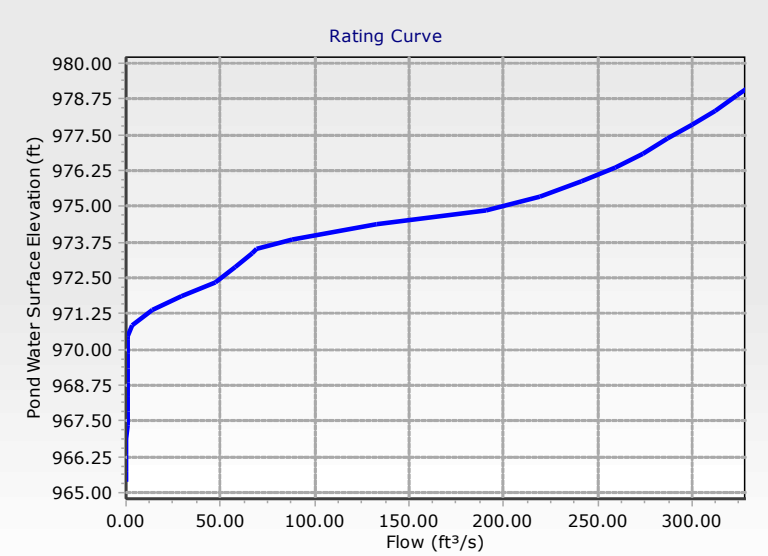
Composite Rating Table
Tailwater Elevation = Free Outfall (Composite Outlet Structure - 1)

Contributing Structures
Orifice - 2,Orifice - 1,Copy of Orifice - 1,Culvert - 1 (no Q: Riser - 2,Riser - 1)
Orifice - 2,Orifice - 1,Copy of Orifice - 1,Culvert - 1 (no Q: Riser - 2,Riser - 1)
Orifice - 2,Orifice - 1,Copy of Orifice - 1,Culvert - 1 (no Q: Riser - 2,Riser - 1)
Orifice - 2,Orifice - 1,Copy of Orifice - 1,Culvert - 1 (no Q: Riser - 2,Riser - 1)
Orifice - 2,Orifice - 1,Copy of Orifice - 1,Culvert - 1 (no Q: Riser - 2,Riser - 1)
Orifice - 2,Riser - 2,Orifice - 1,Riser - 1,Copy of Orifice - 1,Culvert - 1
Orifice - 2,Riser - 2,Orifice - 1,Riser - 1,Copy of Orifice - 1,Culvert - 1
Orifice - 2,Riser - 2,Orifice - 1,Riser - 1,Copy of Orifice - 1,Culvert - 1
Orifice - 2,Riser - 2,Orifice - 1,Riser - 1,Copy of Orifice - 1,Culvert - 1
Orifice - 2,Riser - 2,Orifice - 1,Riser - 1,Copy of Orifice - 1,Culvert - 1
Orifice - 2,Riser - 2,Orifice - 1,Riser - 1,Copy of Orifice - 1,Culvert - 1
Orifice - 2,Riser - 2,Orifice - 1,Riser - 1,Copy of Orifice - 1,Culvert - 1

Composite Outlet Structure Detailed Report: Composite Outlet Structure - 1

Composite Rating Table
Tailwater Elevation = Free Outfall (Composite Outlet Structure - 1)

Contributing Structures
Orifice - 2,Riser - 2,Orifice - 1,Riser - 1,Copy of Orifice - 1,Culvert - 1
Orifice - 2,Riser - 2,Orifice - 1,Riser - 1,Copy of Orifice - 1,Culvert - 1
Orifice - 2,Riser - 2,Orifice - 1,Riser - 1,Copy of Orifice - 1,Culvert - 1
Orifice - 2,Riser - 2,Orifice - 1,Riser - 1,Copy of Orifice - 1,Culvert - 1
Orifice - 2,Riser - 2,Orifice - 1,Riser - 1,Copy of Orifice - 1,Culvert - 1



PONDPACK SPILLWAY OUTPUT

COBEY CREEK - SPILLWAY (AS-BUILTS)

Project Summary	
Title	COBEY CREEK
Engineer	Matthew Castor
Company	Hg Consult, Inc
Date	4/6/2021

Notes

Table of Contents

Master Network Summary 2

COBEY CREEK - SPILLWAY (AS-BUILTS)

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft³/s)
P1	Post-Development 100 year	100	5.265	11.970	84.76
P2	Post-Development 100 year	100	0.309	11.940	5.40
P3	Post-Development 100 year	100	42.704	12.090	511.44
P4	Post-Development 100 year	100	2.044	11.970	32.66

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft³/s)
O-1	Post-Development 100 year	100	5.265	11.970	84.76
O-2	Post-Development 100 year	100	0.309	11.940	5.40
O-3	Post-Development 100 year	100	41.512	12.140	493.13
O-4	Post-Development 100 year	100	2.044	11.970	32.66

Pond Summary

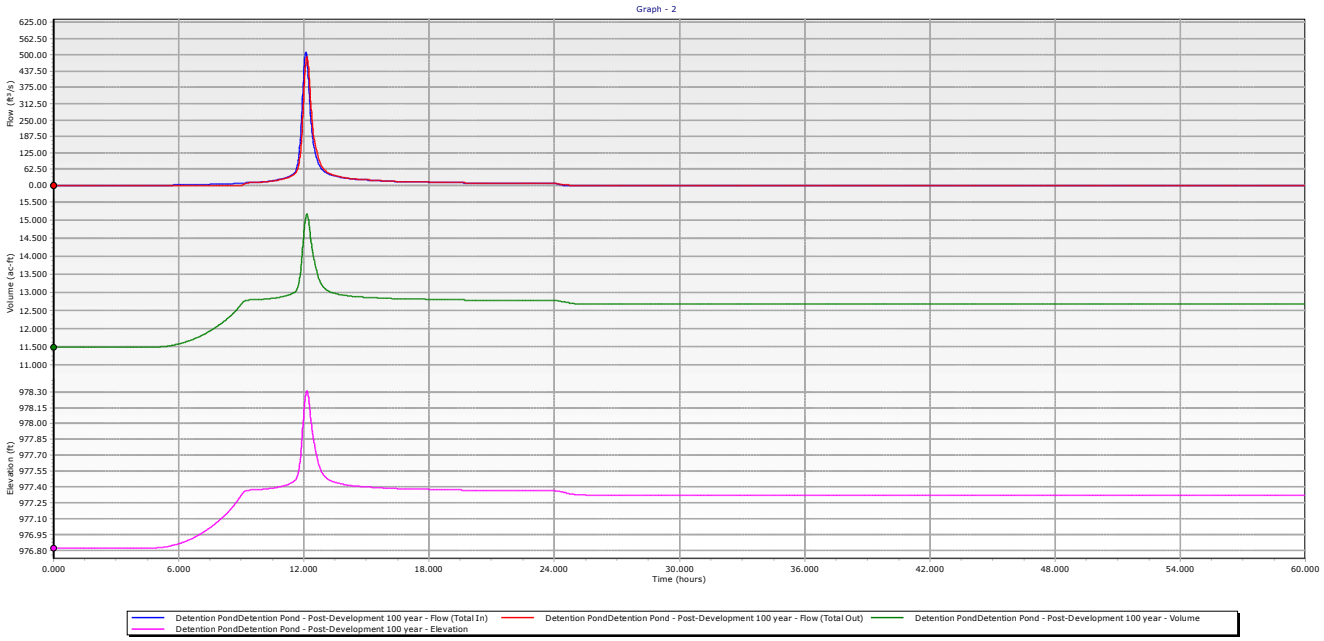
Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft³/s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ac-ft)
Detention Pond (IN)	Post-Development 100 year	100	42.704	12.090	511.44	(N/A)	(N/A)
Detention Pond (OUT)	Post-Development 100 year	100	41.512	12.140	493.13	978.31	15.173

COBEY CREEK - SPILLWAY (AS-BUILTS)

Index

M

Master Network Summary...2


Graph - 2
Flow (ft^3/s)
625.00
562.50
500.00
437.50
375.00
312.50
250.00
187.50
125.00
62.50
0.00
Volume (ac-ft)
15.500
15.000
14.500
14.000
13.500
13.000
12.500
12.000
11.500
11.000
Elevation (ft)
978.30
978.15
978.00
977.85
977.70
977.55
977.40
977.25
977.10
976.95
976.80
0.000
6.000
12.000
18.000
24.000
30.000
36.000
42.000
48.000
54.000
60.000
Time (hours)
Detention PondDetention Pond - Post-Development 100 year - Flow (Total In)
Detention PondDetention Pond - Post-Development 100 year - Flow (Total Out)
Detention PondDetention Pond - Post-Development 100 year - Volume
Detention PondDetention Pond - Post-Development 100 year - Elevation

LEE'S SUMMIT
MISSOURI

DESIGN & CONSTRUCTION MANUAL
DESIGN CRITERIA MODIFICATION REQUEST

PROJECT NAME: Cobey Creek 2nd Plat

ADDRESS: Intersection of Cobey Creek Drive and Hwy-150

PERMIT NUMBER: PL2022092

OWNER'S NAME: Clayton Properties Group DBA Summit Homes KC

TO: Deputy Director of Public Works / City Engineer

In accordance with the City of Lee's Summit's Design and Construction Manual (DCM), I wish to apply for a modification to one or more provisions of the code as I feel that the spirit and intent of the DCM is observed and the public health, welfare and safety are assured. The following articulates my request for your review and action. (NOTE: Cite specific code sections, justification and all appropriate supporting documents.)
Seeking relief from Section 5608.4(C)(1) for the "peripheral drainage issue" that is inherent in most residential subdivisions due to grading changes during construction to lessen the drainage area in a particular portion of the project, and hence the peak runoff from those particular areas when compared to the pre-developed condition.

SUBMITTED BY:
NAME: Garrett Cates - Anderson Engineering Inc.
ADDRESS: 941 W 141st Ter., Suite A
CITY, STATE, ZIP: Kansas City, MO 64145
Email: gcates@ae-inc.com

( ) OWNER (X) OWNER'S AGENT
PHONE #: (913) 284-9362
SIGNATURE: Garrett R Cates

KENT MONTER, P.E.
DEVELOPMENT ENGINEERING MANAGER (X) APPROVAL ( ) DENIAL
SIGNATURE: Kent Monter Kent Monter I have reviewed this document 2022.09.22 20:02:37-05'00' DATE: September 22, 2022

JEFF THORN, P.E.
WATER UTILITIES ASSITANT DIRECTOR OF ENGINEERING SERVICES ( ) APPROVED ( ) DENIAL
SIGNATURE: _____ DATE: _____

GEORGE M. BINGER III, P.E.
DEPUTY DIRECTOR OF PUBLIC WORKS/CITY ENGINEER (X) APPROVED ( ) DENIAL
SIGNATURE: George M Binger III Digitally signed by George Binger III Date: 2022.09.28 13:10:19 -05'00' DATE: September 28, 2022

COMMENTS: The Development Engineering Group has reviewed this request and we are recommending approval.

A COPY MUST BE ATTACHED TO THE APPROVED PLANS ON THE JOB SITE

ANDERSON ENGINEERING
EMPLOYEE OWNED

AndersonEngineeringInc.com
941 W 141st Terrace Suite A
Kansas City, MO 64145
816-777-0400

August 26, 2022

Deputy Director of Public Works/City Engineer
Public Works
220 SE Green Street
Lee's Summit, Missouri 64063

Re: Cobey Creek - Peripheral Drainage Waiver Request

Cobey Creek is a multi-phase mixed-use development that is made up of primarily single-family and two-family residential homes. The development was started by JCM Development, LLC in 2018, and hired HG Consultants to complete the Preliminary Development Plan, Master Drainage Study, and 1st Plat design drawings. Due to a change in ownership to Summit Homes KC following the completion of Phase 1 of the development, Anderson Engineering Inc. has been hired to develop the remaining design and construction documents necessary to complete the project. Discussed in the Master Drainage Plan that was completed and approved with the 1st Plat (Phase 1), is the inherent drainage issue referred to as "fringe drainage" or "peripheral drainage". This issue is a result of grading changes during construction to lessen the drainage area in a particular portion of the project, and hence, the peak runoff from those particular areas when compared to the pre-development condition. Due to the challenges meeting Section 5608.4(C)(1) of the City of Lee's Summit Design and Construction Manual, the developer is seeking a waiver relief to allow these peripheral drainage areas that cannot feasibly be captured by the provided wet and dry detention basins, and therefore allow them to be released to adjacent properties at flow rates that are still significantly less than the pre-developed condition. The following paragraphs summarize the results of a micro drainage analysis that was conducted to assess the pre-deevelopment, intermediate, and post-development drainage areas depicted in **Exhibit A** (pre-construction), **Exhibit B** (after phase 2 is completed) and **Exhibit C** (fully developed site), located in **Appendix A**.

There are two peripheral drainage areas located within the Cobey Creek development, which are referred to as the "North" and "South" peripheral drainage areas in this analysis. The composite curve numbers for each of these areas are set to increase due to an increase in impervious area. Even with this increase in composite curve numbers however, the overall runoff is being reduced because of a decrease in total area from pre-phase 2 construction to a fully developed site. The North peripheral drainage area is reducing in size from

14.7 acres pre-construction, to 3.74 acres after phase 2, and 2.51 acres once the site is fully developed. The South peripheral drainage area is reducing in size from 1.75 acres pre-construction to 1.12 acres once phase 2 is complete as well as once fully developed. Therefore, the total contributing drainage area is reducing by a total of 12.7 acres, or approximately 86%. This decrease in area is more than enough to account for the increase in the composite curve number, which ultimately results to a net decrease in runoff for the peripheral drainage areas.

To model the total runoff for the peripheral drainage areas, Hydraflow Hydragraphs software extension for AutoDesk Civil 3d was utilized. Using the SCS TR-55 method and a Type-ll 24-hour rainfall distribution, hydrographs for a 2-year, 10-year, and 100-year stormwater event were analyzed. **Table 1** and **Table 2** summarize the peak flow values from the Hydraflow model and can be further analyzed in the attached stormwater model output included in **Appendix B**. The analysis confirms that the stormwater runoff for each of the peripheral drainage areas decreases in the intermediate and fully-developed condition, due to the decrease in contributing drainage area.

Table 1: Pre vs Post North Runoff Summary					
	Pre	**Inter**	**Post**	**Percent Reduction Inter**	**Percent Reduction Post**
2-yr	28.5	8.48	7.69	70.2	73.0
10-yr	60.68	17.52	14.26	71.1	76.5
100-yr	125.76	35.62	26.57	71.7	78.9

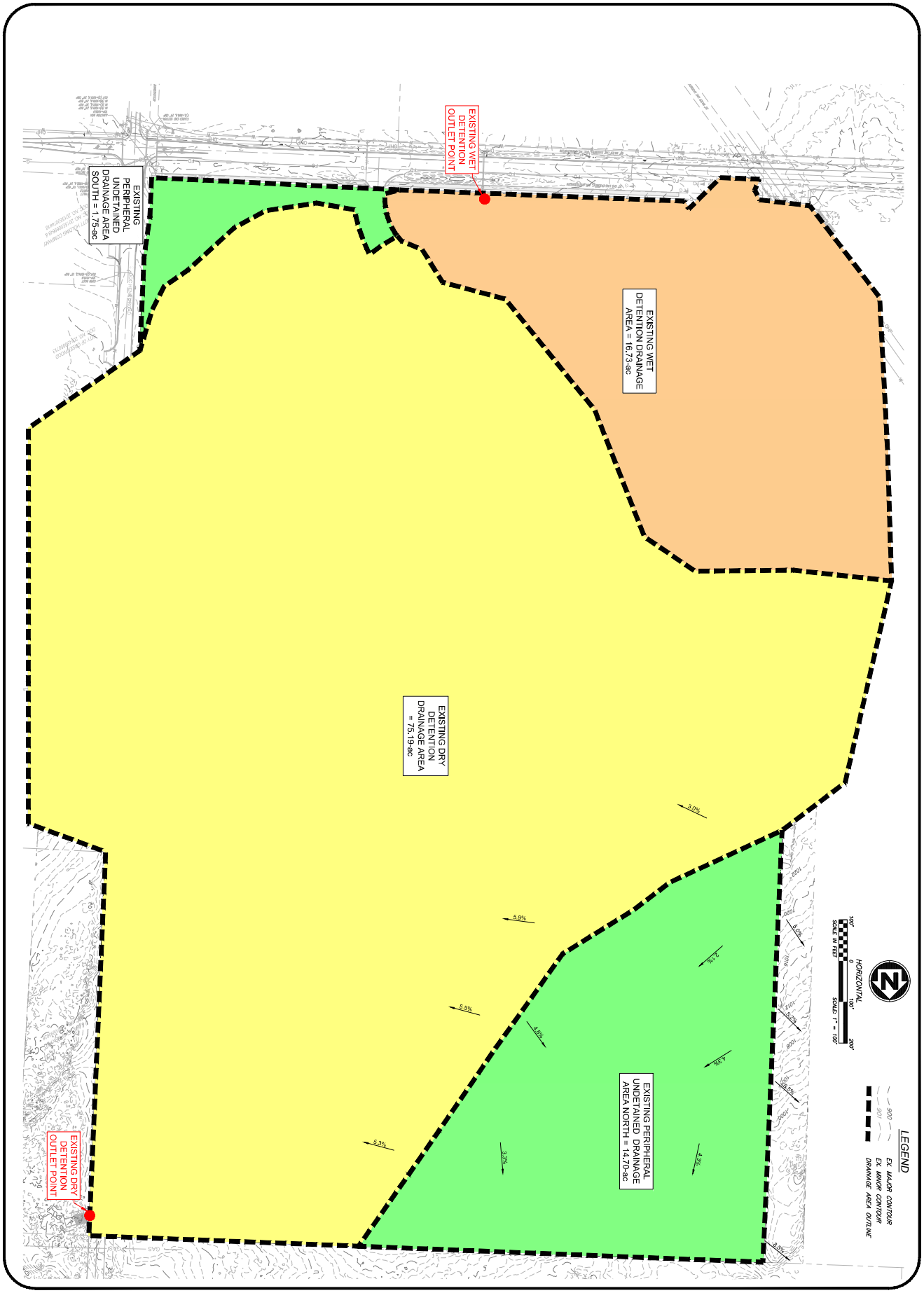
Table 2: Pre vs Post South Runoff Summary				
	Pre	**Inter**	**Post**	**Percent Reduction**
2-yr	3.10	2.78	2.78	10.3
10-yr	6.52	5.57	5.57	14.6
100-yr	13.35	11.03	11.03	17.4

Due to the decrease in runoff to the adjacent properties within the peripheral drainage areas identified in this analysis, no downstream impacts are anticipated once phase 2 is completed as well as once the site is fully developed, and a waiver to the comprehensive control measures defined under Section 5608.4(C)(1) is requested for the Cobey Creek Development.

Anderson Engineering, Inc.

Garrett Cates, P.E.
GCates@ae-inc.com

APPENDIX A



SHEET NUMBER
EXHIBIT A

CLAYTON PROPERTIES GROUP
COBEY CREEK - 2ND PLAT - STREET, STORM, & EROSION

EXISTING DRAINAGE AREAS
(BEFORE PHASE 2)

S29, T47N, R31W
LEE'S SUMMIT, JACKSON COUNTY, MISSOURI

REVISIONS			
NO.	DESCRIPTION	BY	DATE

DRAWING INFO.	
DRAWN BY:	GC
CHECK BY:	PJ
LICENSE NO.	PE-2021025089
DATE:	08/26/2022
ISSUED FOR:	FOR REVIEW
JOB NUMBER:	21KC10060

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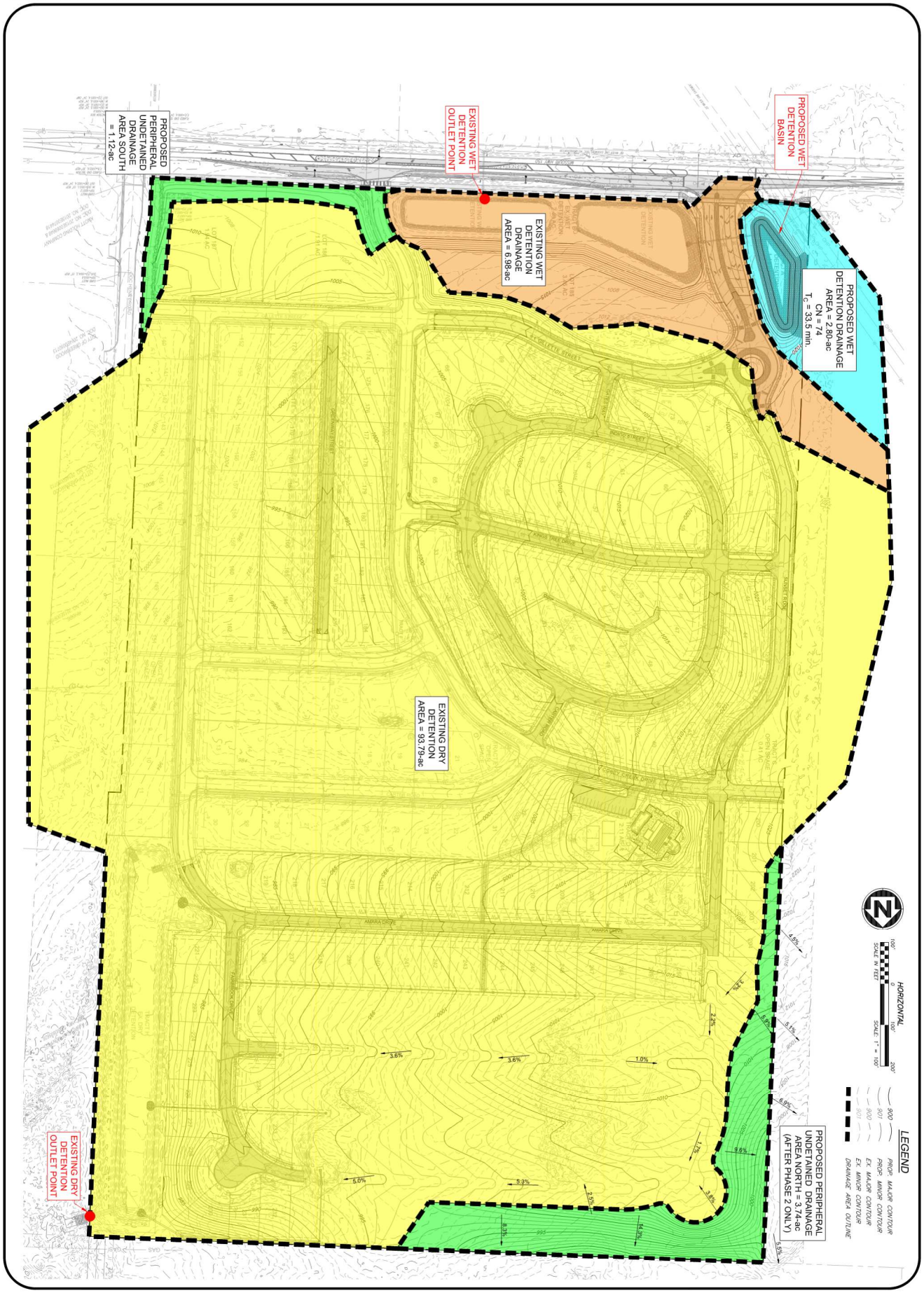
ANDERSON ENGINEERING
EMPLOYEE OWNED
ENGINEERS ▸SURVEYORS ▸LABORATORIES ▸DRILLING
941 W 141ST TERR, STE A ▸KANSAS CITY, MO 64145 ▸PHONE (816) 777-0400
A LICENSED MISSOURI ENGINEERING & SURVEYING CORPORATION - LC 82



CLAYTON PROPERTIES GROUP
COBEY CREEK - 2ND PLAT - STREET, STORM, & EROSION

PROPOSED DRAINAGE AREAS (AFTER PHASE 2)

S29, T47N, R31W
LEE'S SUMMIT, JACKSON COUNTY, MISSOURI

SHEET NUMBER
EXHIBIT B

REVISIONS			
NO.	DESCRIPTION	BY	DATE

DRAWING INFO.	
DRAWN BY:	GC
CHECK BY:	PJ
LICENSE NO.	PE-2021025089
DATE:	08/26/2022
ISSUED FOR:	FOR REVIEW
JOB NUMBER:	21KC10060

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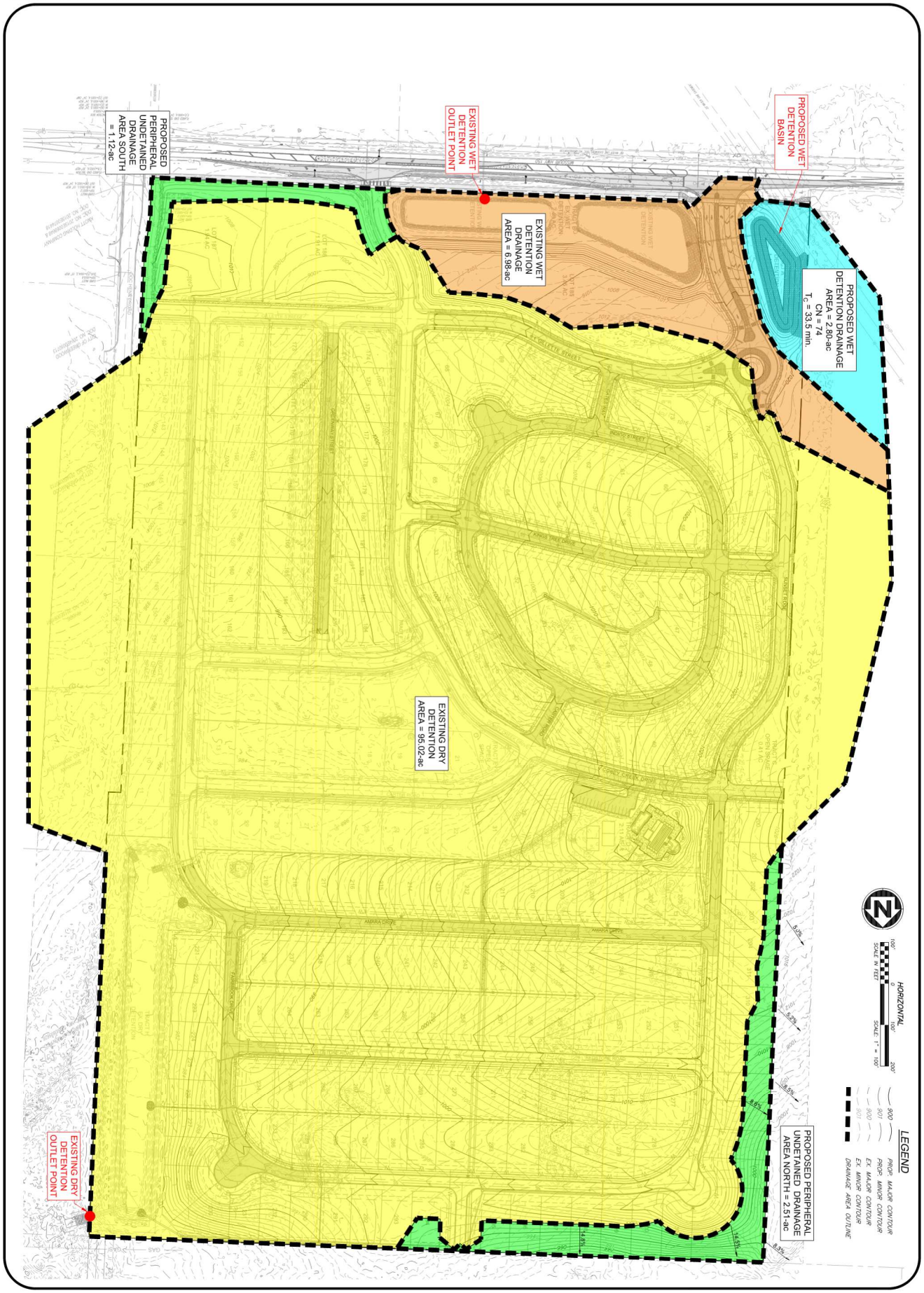

CLAYTON PROPERTIES GROUP
COBEY CREEK - 2ND PLAT - STREET, STORM, & EROSION

PROPOSED DRAINAGE AREAS
(FULLY DEVELOPED CONDITION)

S29, T47N, R31W
LEE'S SUMMIT, JACKSON COUNTY, MISSOURI

SHEET NUMBER
EXHIBIT C

REVISIONS			
NO.	DESCRIPTION	BY	DATE

DRAWING INFO.	
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