ATTACHMENT C

DRAINAGE REPORT

FOR

ARBOR CREEK 2ND ADDITION
LOTS 1 THRU 27 & OUTLOT "A" INCLUSIVE

College Road & Railroad Avenue
Council Bluffs, Iowa

Prepared By:

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E & A Project Number: P2020.240.001

March 16th, 2021

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1. Executive Summary

1.1 Project Description

Arbor Creek 2nd Addition is a new development that consists of developing 6.19 acres of open land into a single family residential development. This development falls under the jurisdiction of Pottawattamie County with an approximate location of College Road and Railroad Avenue (reference Appendix A - Site Vicinity Map). The project includes the following improvements:

- 27 Residential Lots
- (1) Detention Basins
- Sanitary Sewer Infrastructure
- Storm Sewer Infrastructure
- Domestic / Fire Water Service
- Grading / Paving

This report presents a hydrology and hydraulics (H & H) study of existing conditions and the proposed development with incorporated Best Management Practices (BMPs) for storm water runoff.

1.2 Pre-Developed Site

1.2.1 Existing Usage of Land

The existing site is vacant fair condition grass land.

1.2.2 Wetlands and Preservation of Natural Areas

There are no wetlands or natural areas within the project boundaries. This section does not apply.

1.2.3 Site Soil Information

Soil classification for stormwater runoff calculations is referenced from the USDA National Cooperative Soil Survey. The survey classifies the project site with hydrologic soil Type B. For additional information on soil type please reference Appendix B, Soil Information.

1.2.4 Existing Topography

Existing site topography was provided by the E & A, Survey Department. Existing topography of the surrounding areas was obtained using LIDAR information as provided by ArcGIS.

1.2.5 Pre-Development Site Hydrology

Calculation of runoff was performed using the Hydraflow Hydrographs modeling software. The model was set to use the SCS, TR-55 method with distributed Type II precipitation and a 6-minute minimum Time of Concentration.

The following assumptions were made in the calculation of pre-development runoff.

Table 1.0 – Referenced ORSDM 24-hr rainfall

24-Hour Design Rainfall	
Storm Event	**Rainfall (inches)**
2-Year	3.0
5-Year	3.96
10-Year	4.6

Table 2.0 – Used SCS Curve Numbers in Calculation of Pre-Development Runoff

SCS Method Curve Numbers (CN)	
Land Classification	**CN**
Open lawn fair condition	69

The following table summarizes the calculated pre-development runoff. For a visual representation of areas please reference Appendix C, Pre-Development Drainage Map. For details on calculated flows, reference Appendix I, PCSMP Hydraflow Software Model Report.

Table 3.0 – Pre-Development Runoff per Impact Point Summary

Impact Point	**Pre-Development Area (ID)**	**Area (acres)**	**CN**	**Time of Concentration**	**5-YR Peak Flow (cfs)**
A	EX. A	6.20	69	6 min.	13.04

1.3 Post Developed Site

1.3.1 Proposed Usage of Land

The proposed usage will be residential. It is best described as Residential District with average lot size being 1/4 ac or less.

1.3.2 Post-Development Site Hydrology

The proposed site is composed of new residential lots that drain into the public right of way. Maintaining similar flow direction as pre-development, the site was graded into one major watershed. Runoff is collected from the street and directed through a new storm drain system to a detention basin located at the southwest corner of the site. The basin then releases the runoff at controlled rates into an adjacent development to the south into a swale that was designed to handle our site.

The new storm drain system was sized using the Rational Method. This method was chosen as opposed to the SCS method for its natural computational factor of safety. Pipes and structures were designed to carry the 10-year storm while the worst case 100-year storm being carried with a combination of the pipe system and surface flow within the public right-of-way.

Table 4.0 – Summary of ORSDM Referenced Assumptions for Pipe Sizing Calculations.

Pipes Sizing Calculations		
Time of Concentration, Minimum (min.)	**Rainfall Intensity (in/hr)**	**Runoff Coefficient**
10	6.9	0.57

For a visual representation of the new storm drain system please reference Appendix D, Post Development Drainage Map. For calculation details reference Appendix E, Storm Drain Sizing Calculations

The following tables summarize the calculated Post Development runoff and assumptions made for calculations. For a visual representation of areas please see Appendix H, Post Construction Stormwater Management Plan. For details on calculated flows, reference Appendix I, PCSMP Hydraflow Software Model Report.

Table 5.0 – Used SCS Curve Numbers in Calculation of Post Development Runoff.

SCS Method Curve Numbers (CN)	
Land Classification	**CN**
Residential District, 1/4 ac or less	75

Table 6.0 – Post Development Runoff per Area Summary.

Impact Point	Post Development Area (ID)	Area (acres)	CN	TC (min.)	5-YR Peak Flow (cfs)
A	DEV A	20.30	75	6	0.31

Table 7.0 – Pre-Developed vs Developed Runoff per Impact Point Summary.

Impact Point	Tributary	5-YR Peak Flow (cfs)	5-YR Lower or Equal to Pre-Development Runoff?
A	EX A	13.04	YES
	DEV A	0.31	

1.3.3 Culverts

There are no culverts within the project limits. This section does not apply.

2. Post Construction Stormwater Management Plan (PCSMP)

2.1 Jurisdiction and Requirements

This project is located in Pottawattamie County and shall meet the following requirements:

- PCSMP that includes BMP's.
- Provide water quality control of the first 1-1/2-inch site runoff.
- Maintain runoff to equal or less than pre-project 5-year storm event.
- Maintain "No Adverse Impact" downstream.

2.2 Best Management Practices (BMPs)

2.2.1 Proposed Treatment BMPs

The installation of detention basins was the chosen BMP to mitigate the following requirements:

- Provide Water Quality Control of the 1-1/2-inch of site runoff.
- Maintain Post Development runoff to equal or less than Pre-Development.
- Maintain “No Adverse Impact” Downstream.

Basins are able to treat storm water pollutants and reduce the amount of suspended solids by detaining water and allowing the solids to settle while bacteria and established vegetation help remove hydrocarbons, phosphorus and nitrogen.

In addition, the basins were designed to control the discharge rates of Post Development. This was accomplished through the design of a multi-stage release system. The diagram below details the storm event and the orifice it is allowed to pass. The orifice is sized to discharge the corresponding storm event at a rate equal or less than Pre-Development. Appendix E, PCSMP Map shows the proposed basins and tributary areas. Reference Appendix I, PCSMP Hydraflow Software Model Report for detailed basin sizing calculations.

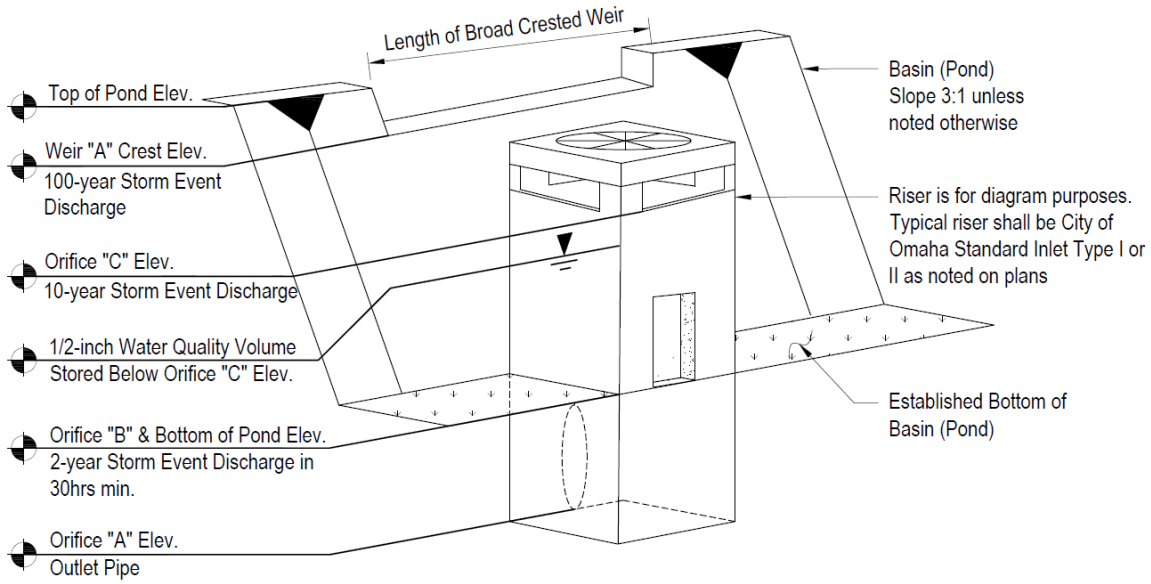


Figure 1.0 – Diagram of Multi-Stage Basin Release System and as modeled in Hydraflow.

2.2.2 Water Quality Control

The required Water Quality Volume (WQV) is calculated with the following formula:

WQV, ft^3 = (1-1/2-inch runoff) (1/12) x (Tributary Area, ft^2)

The following table summarizes the required and provided WQV per installed Basin.

Table 8.0 – Post Development Water Quality Volume (WQV) Summary.

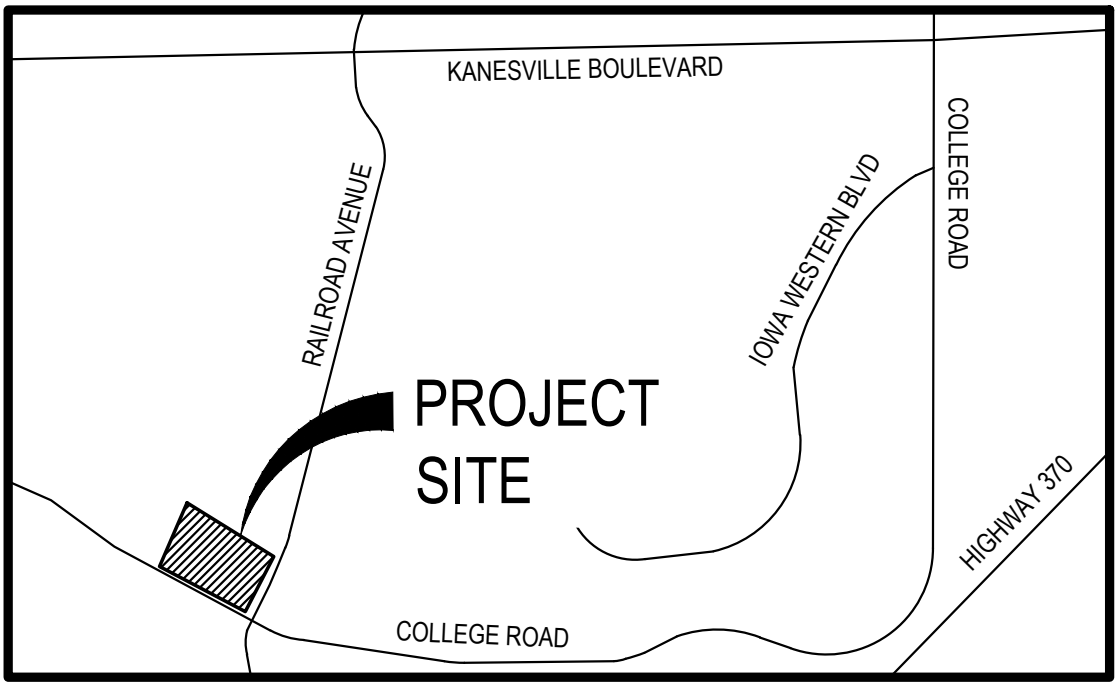
PCSMP - Water Quality Volume				
Basin	**Tributary Area (acres)**	**Water Quality Volume Required (ft^3)**	**Water Quality Volume Provided (ft^3)**	**Adequate?**
Basin A	6.20	33,759	34,934	YES

3. References

1. Agriculture, U. S. (n.d.). *Web Soil Survey*. Retrieved from Natural Resources Conservation Service: https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx

2. Iowa Statewide Urban Design and Specifications SUDAS (February 2021). Ames, IA, USA

Appendix A - Site Vicinity Map



VICINITY MAP

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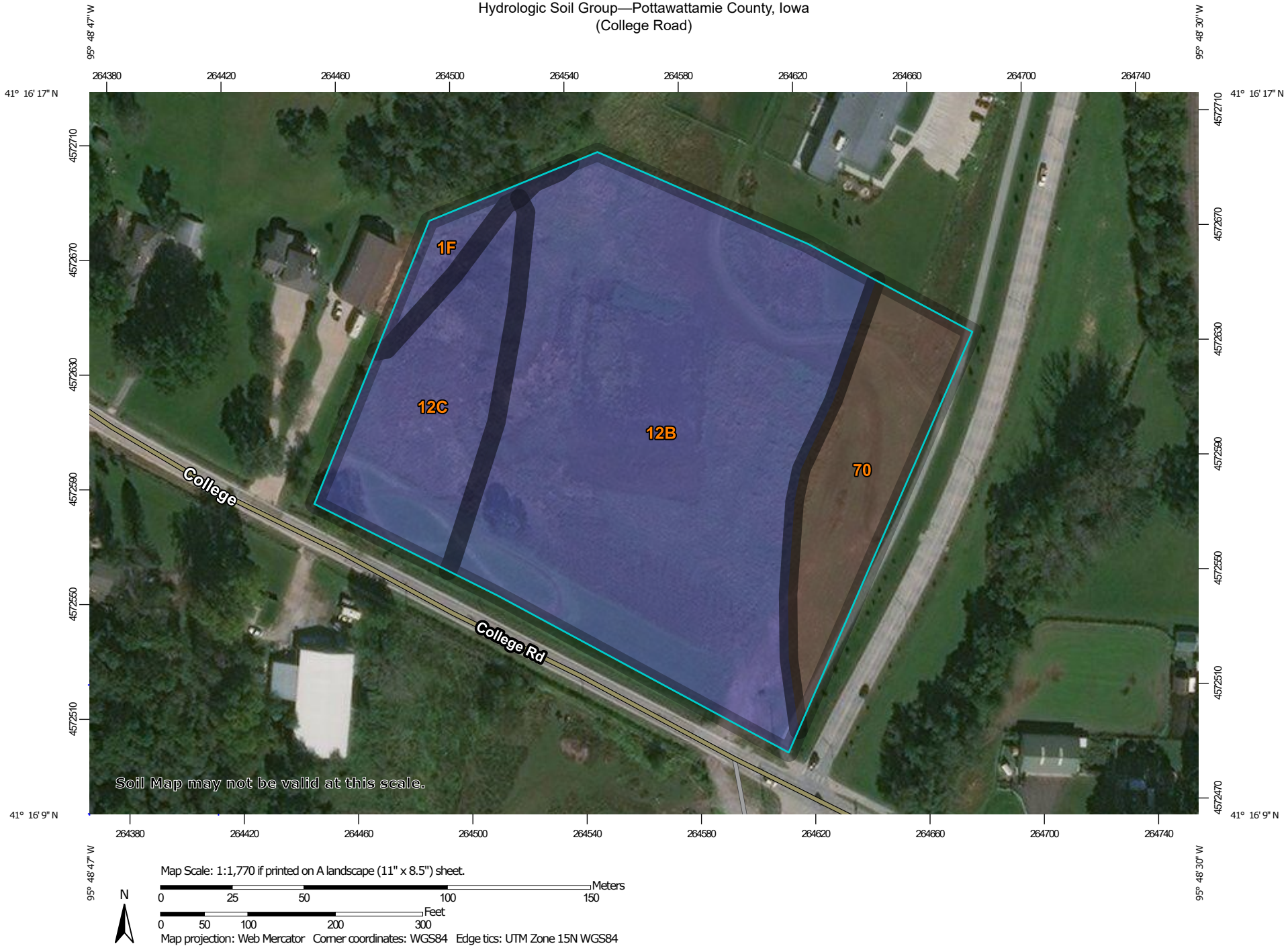
ARBOR CREEK 2ND ADDITION
LOTS 1 THRU 27 & OUTLOT "A" INCLUSIVE
POTTAWATTAMIE COUNTY, IOWA

Job No.: P2020.240.001		Date: 2/09/2021
Drawn by: JAS	Scale: AS SHOWN	Sht: 1 of 1

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Appendix B - Soil Information

Hydrologic Soil Group—Pottawattamie County, Iowa
(College Road)



Map Scale: 1:1,770 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 25 50 100 150

Feet: 0 50 100 200 300

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 1:15,800.

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: Pottawattamie County, Iowa
Survey Area Data: Version 26, Jun 10, 2020

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

Date(s) aerial images were photographed: Feb 1, 2014—Dec 1, 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
1F	Ida silt loam, 20 to 30 percent slopes	B	0.2	2.9%
12B	Napier silt loam, 2 to 5 percent slopes	B	4.7	66.1%
12C	Napier silt loam, 5 to 9 percent slopes	B	1.2	16.2%
70	McPaul silt loam, 0 to 2 percent slopes	B/D	1.1	14.8%
Totals for Area of Interest			**7.1**	**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.

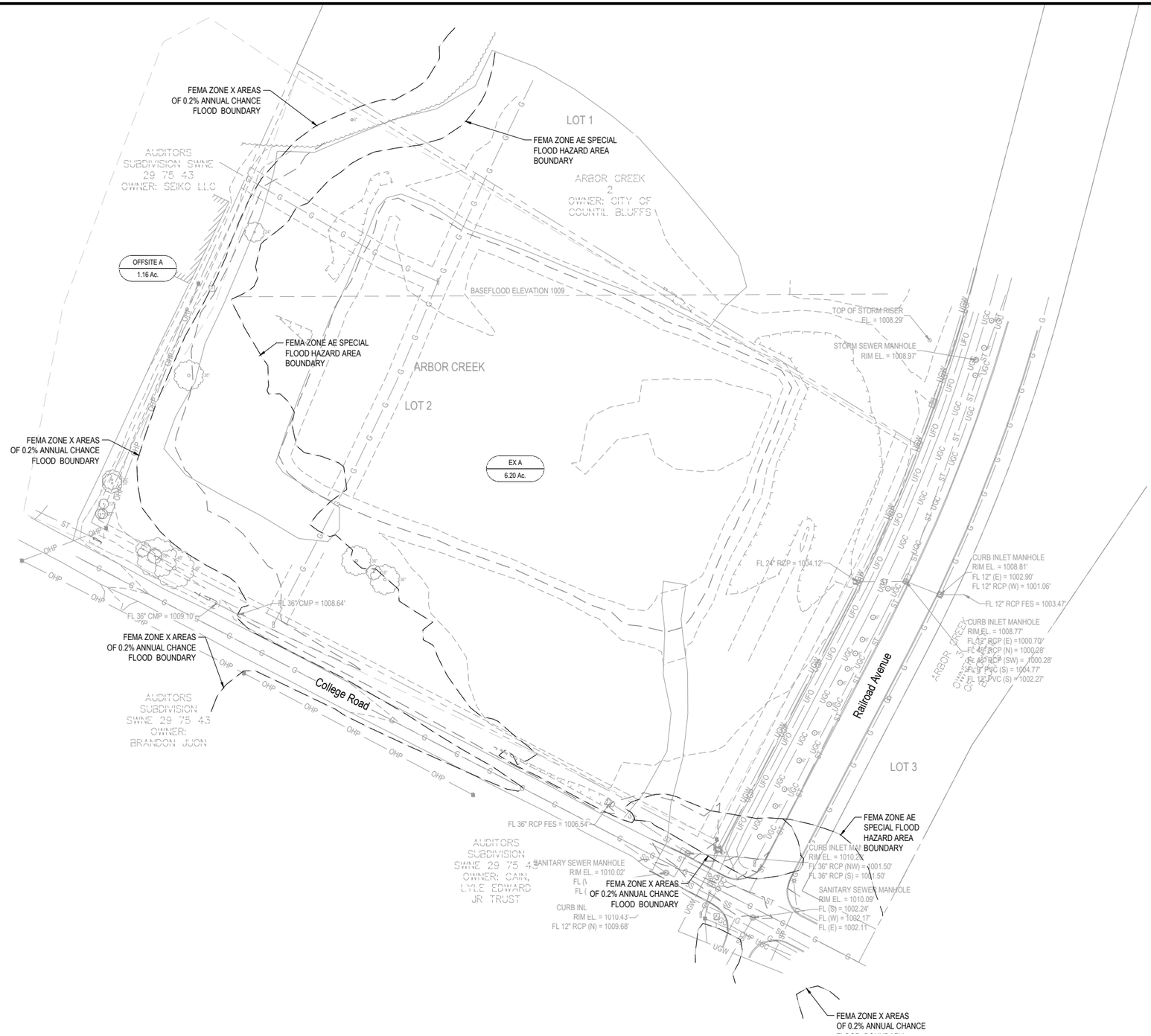
Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Appendix C - Pre-Development Drainage Map



50 0 50

1 inch = 50 ft.

LEGEND

- Proposed Storm Sewer System
- 1120 — Proposed Contours
- Proposed Drainage Area Boundary
- X / 0.00 Ac. — Drainage Area Label
- PCSMP Basin

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COUNCIL BLUFFS, IOWA

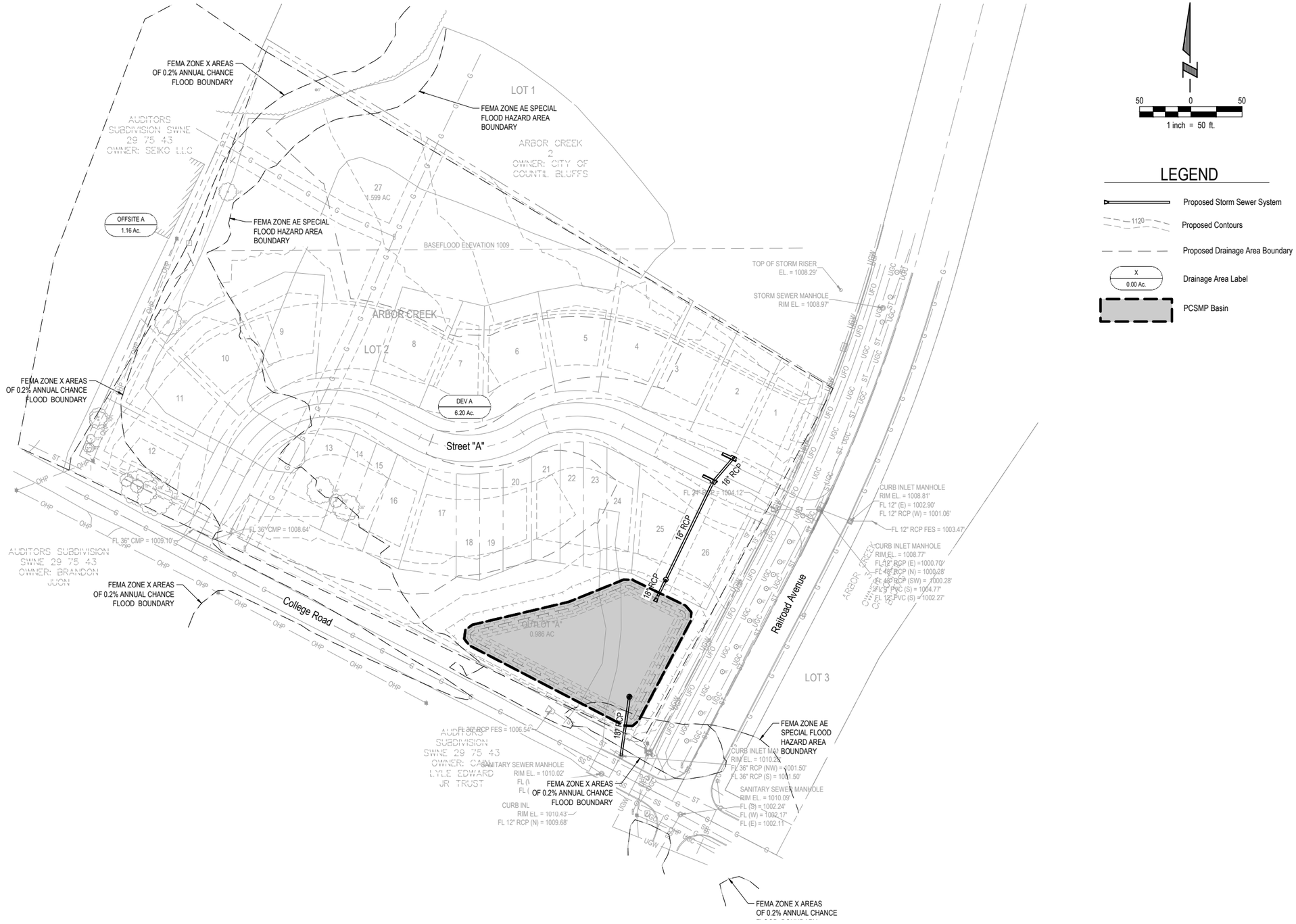
EXISTING EXHIBIT

No.	Date	Revisions Description
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Date:	1/26/2021
Designed By:	MAW
Drawn By:	ASB
Scale:	AS SHOWN
Sheet:	1 of 1

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Appendix D - PCSMP Map



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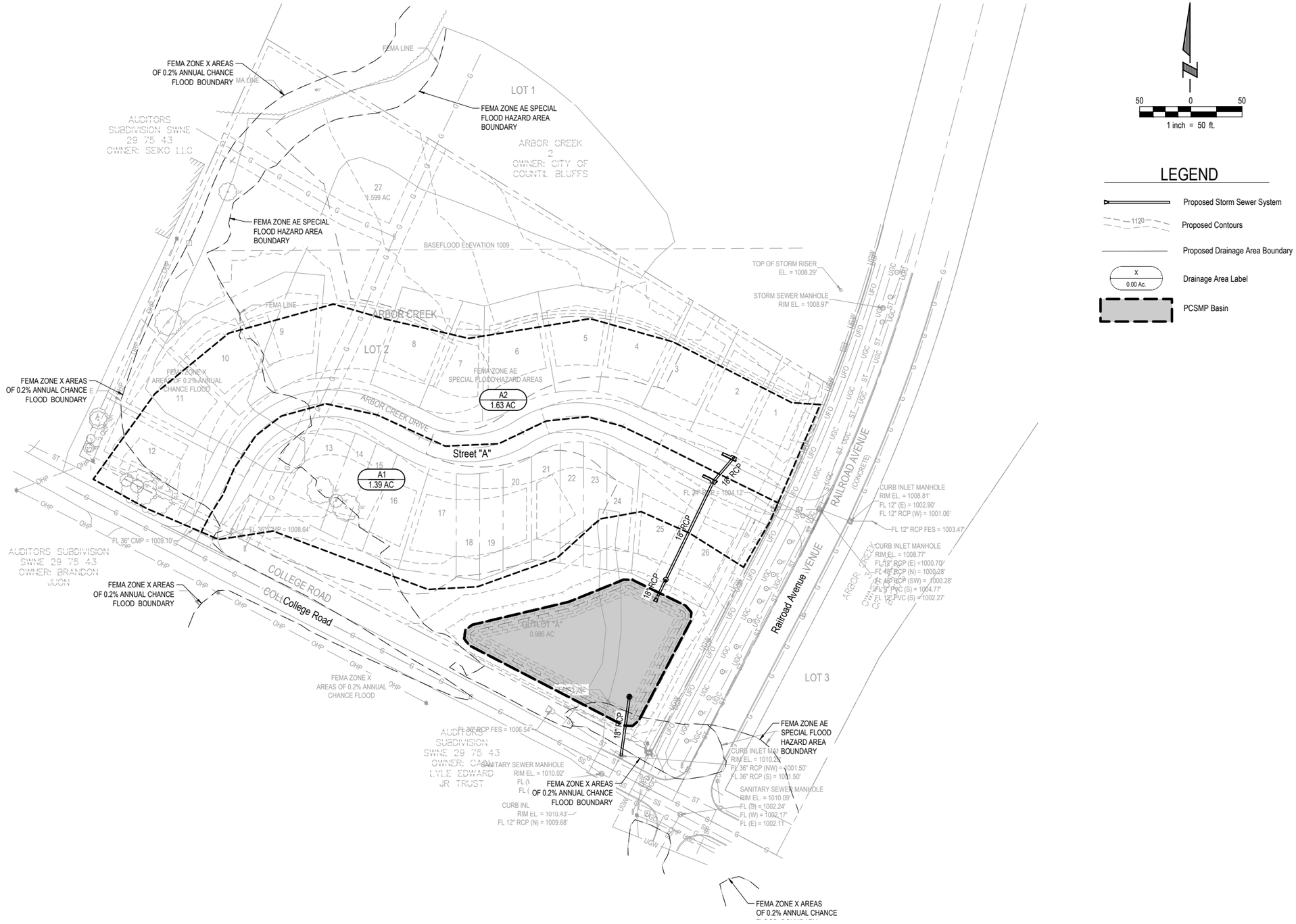
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Date:	1/26/2021
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Sheet:	1 of 1

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Appendix E - Post-Development Drainage Map



50 0 50

1 inch = 50 ft.

LEGEND

- Proposed Storm Sewer System
- 1120 — Proposed Contours
- Proposed Drainage Area Boundary
- X / 0.00 Ac. — Drainage Area Label
- PCSMP Basin

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INLET EXHIBIT

Revisions		
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Appendix F - Storm Drain Sizing Calculations

STORM DRAIN COMPUTATION FORM

BY THE RATIONAL METHOD AND MANNING'S PIPE FLOW EQUATION

Date: 2/8/2020
Calculated by: JAS
Basin A

Project Arbor Creek 2nd Add.
Project No. P2020.240
Design Storm: **10 Year**

Conveyance			Direct Runoff										System Design									Total Runoff					Remarks
														Pipe		Slope		V	Pipe	Pipe	time						
Pipe Id.	From	To	Sub Basin Id.	O.F.L. ft.	W.C. Type	S %	V f.p.s.	T_l min.	i in/hr.	A Ac.	C	q c.f.s.	System Q c.f.s	Size (in)	Type	min. %	design %	des. f.p.s.	Full Cap. c.f.s.	Length ft.	in pipe min.	T_c min.	i in/hr.	Comp C	Total A Ac.	Des Q c.f.s.	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)
P3			**A2**					10.0	6.9	1.63	0.57	6.41	6.41	18	RCP	0.38	1.00	6.24	10.50	30	0.08	10.0	6.9	0.57	1.6	6.41	
P2			**A1**					10.0	6.9	1.39	0.57	5.47	11.88	18	RCP	1.28	1.50	8.38	12.86	107	0.21	10.0	6.9	0.57	3.0	11.88	
P1								10.0	6.9	0.00	0.57	0.00	11.88	18	RCP	1.28	1.50	8.38	12.86	17	0.03	10.0	6.9	0.57	3.0	11.88	

* Watercourse Legend
FOR - Forest NBG - Near Bare Ground
FAL - Fallow GWW - Grass Waterway
GRA - Grass SGF - Shallow Gutter Flow

Notes:

Sheet 1 of 1

Appendix G - Hydraflow Software Model Report

Hydraflow Table of Contents

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Summary Report..... 3

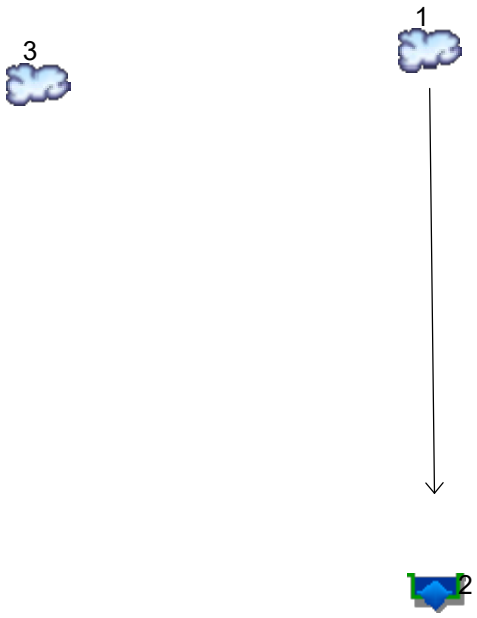
Hydrograph Reports..... 4

Hydrograph No. 1, SCS Runoff, Dev A..... 4

Hydrograph No. 2, Reservoir, Thru Pond A..... 5

Hydrograph No. 3, SCS Runoff, Existing A..... 6

Watershed Model Schematic



Legend

Hyd.	Origin	Description
1	SCS Runoff	Dev A
2	Reservoir	Thru Pond A
3	SCS Runoff	Existing A

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	------	-------	-------	-------	17.24	-------	-------	-------	-------	Dev A
2	Reservoir	1	-------	-------	-------	0.313	-------	-------	-------	-------	Thru Pond A
3	SCS Runoff	------	-------	-------	-------	13.04	-------	-------	-------	-------	Existing A

Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

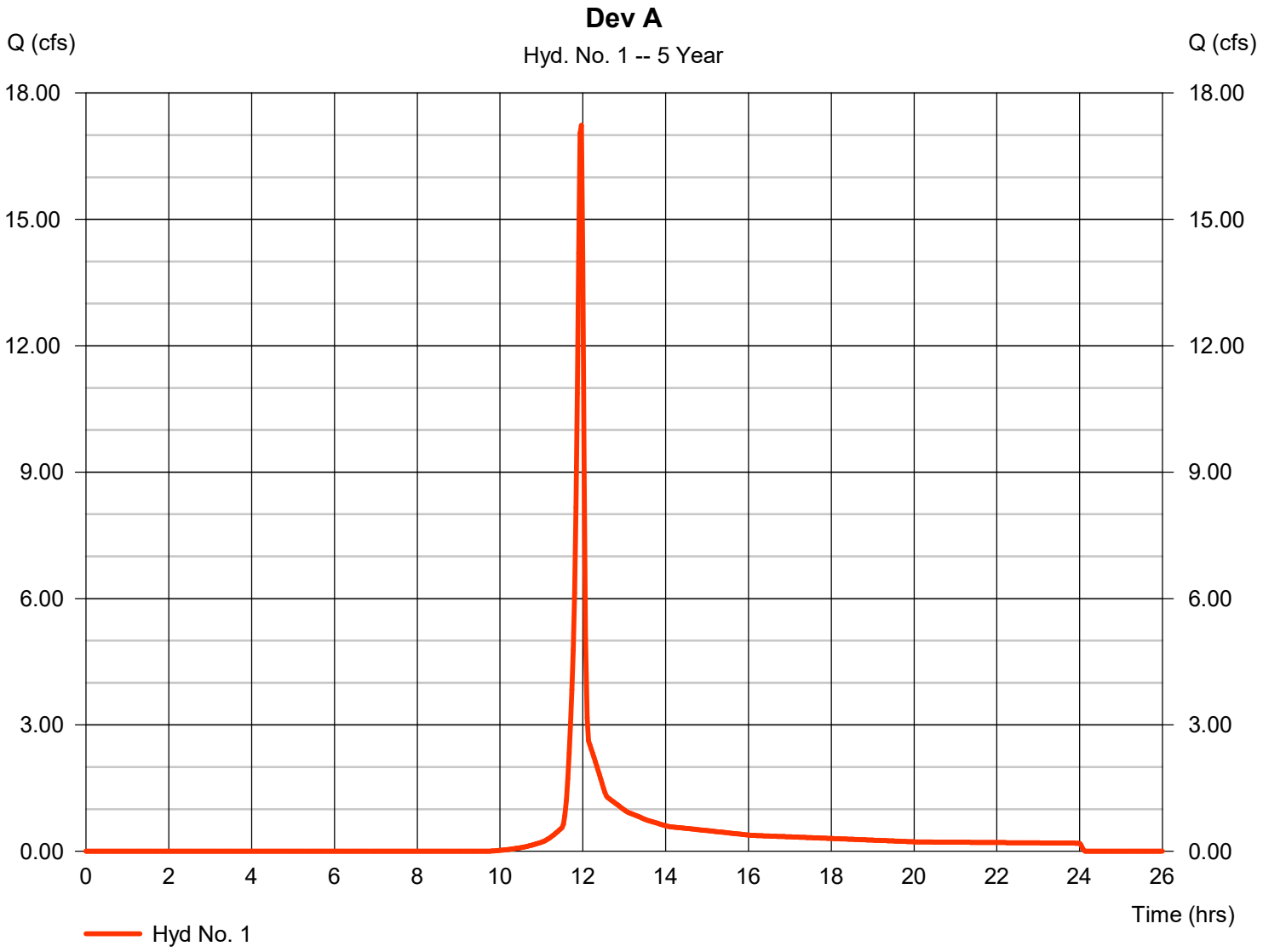
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	17.24	2	718	34,534	------	------	------	Dev A
2	Reservoir	0.313	2	1066	32,293	1	1006.13	23,038	Thru Pond A
3	SCS Runoff	13.04	2	718	26,178	------	------	------	Existing A

Hydrograph Report

Hyd. No. 1

Dev A

Hydrograph type	=	SCS Runoff	Peak discharge	=	17.24 cfs
Storm frequency	=	5 yrs	Time to peak	=	11.97 hrs
Time interval	=	2 min	Hyd. volume	=	34,534 cuft
Drainage area	=	6.200 ac	Curve number	=	75
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	6.00 min
Total precip.	=	3.96 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



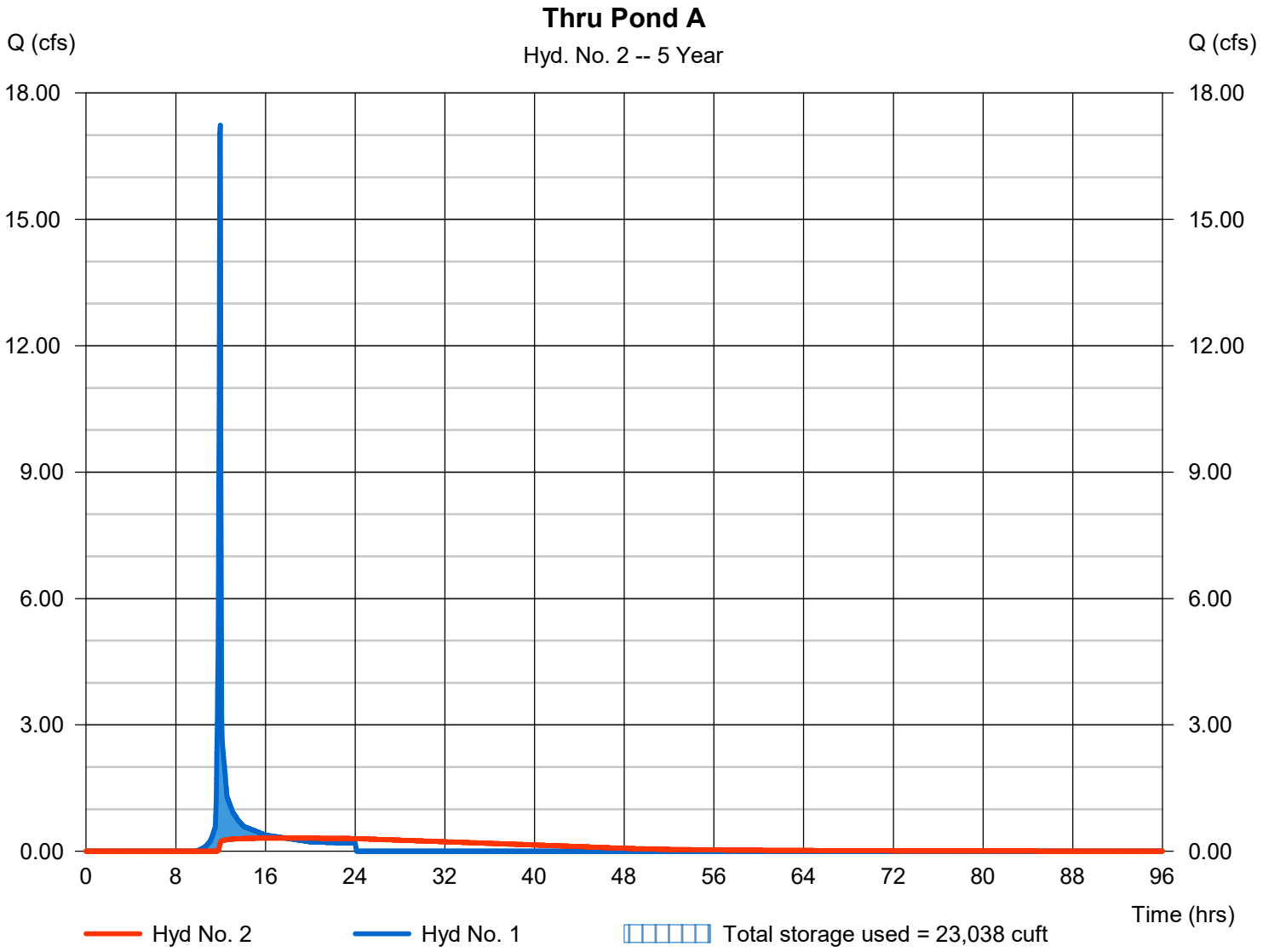
Hydrograph Report

Hyd. No. 2

Thru Pond A

Hydrograph type	=	Reservoir	Peak discharge	=	0.313 cfs
Storm frequency	=	5 yrs	Time to peak	=	17.77 hrs
Time interval	=	2 min	Hyd. volume	=	32,293 cuft
Inflow hyd. No.	=	1 - Dev A	Max. Elevation	=	1006.13 ft
Reservoir name	=	Pond A	Max. Storage	=	23,038 cuft

Storage Indication method used.

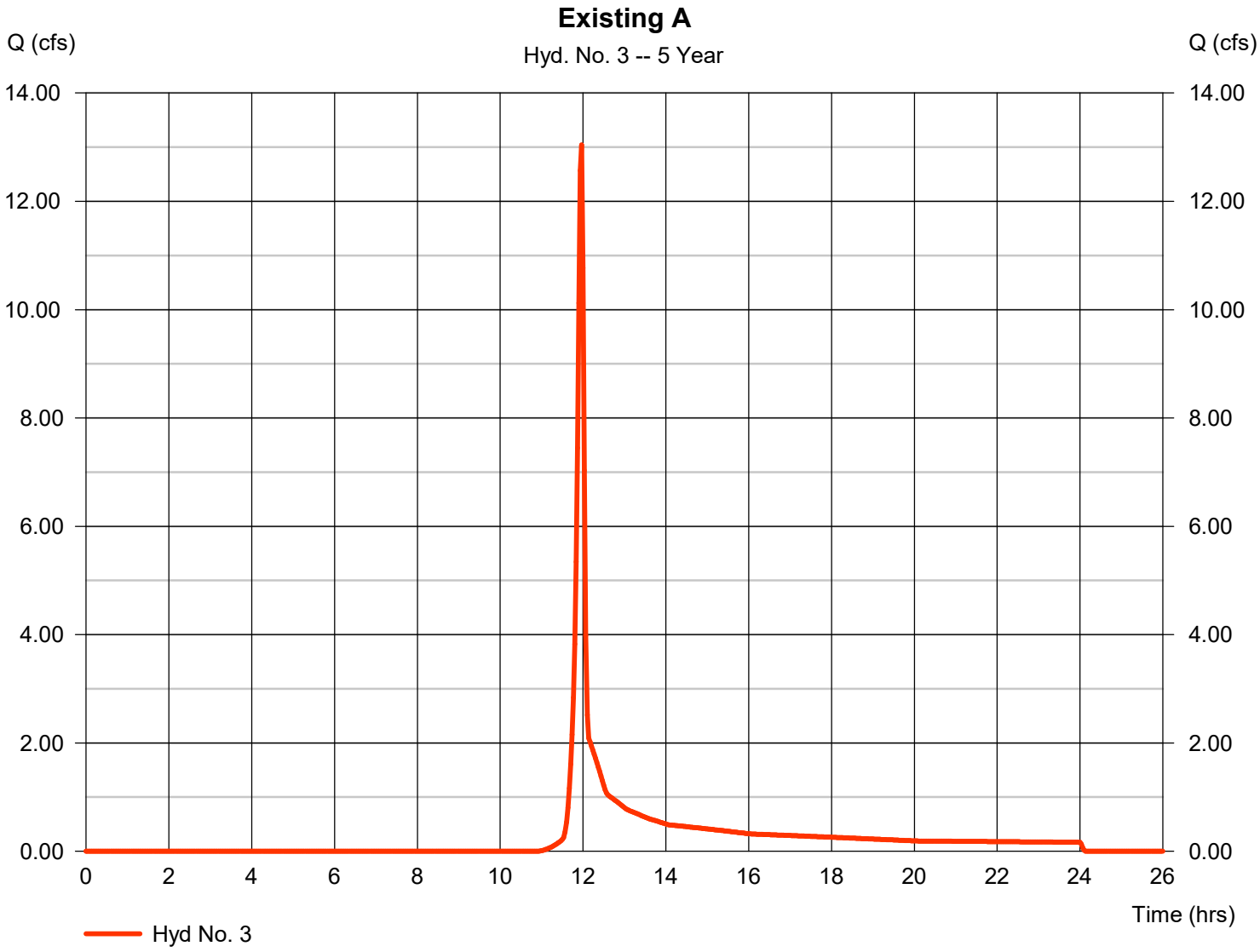


Hydrograph Report

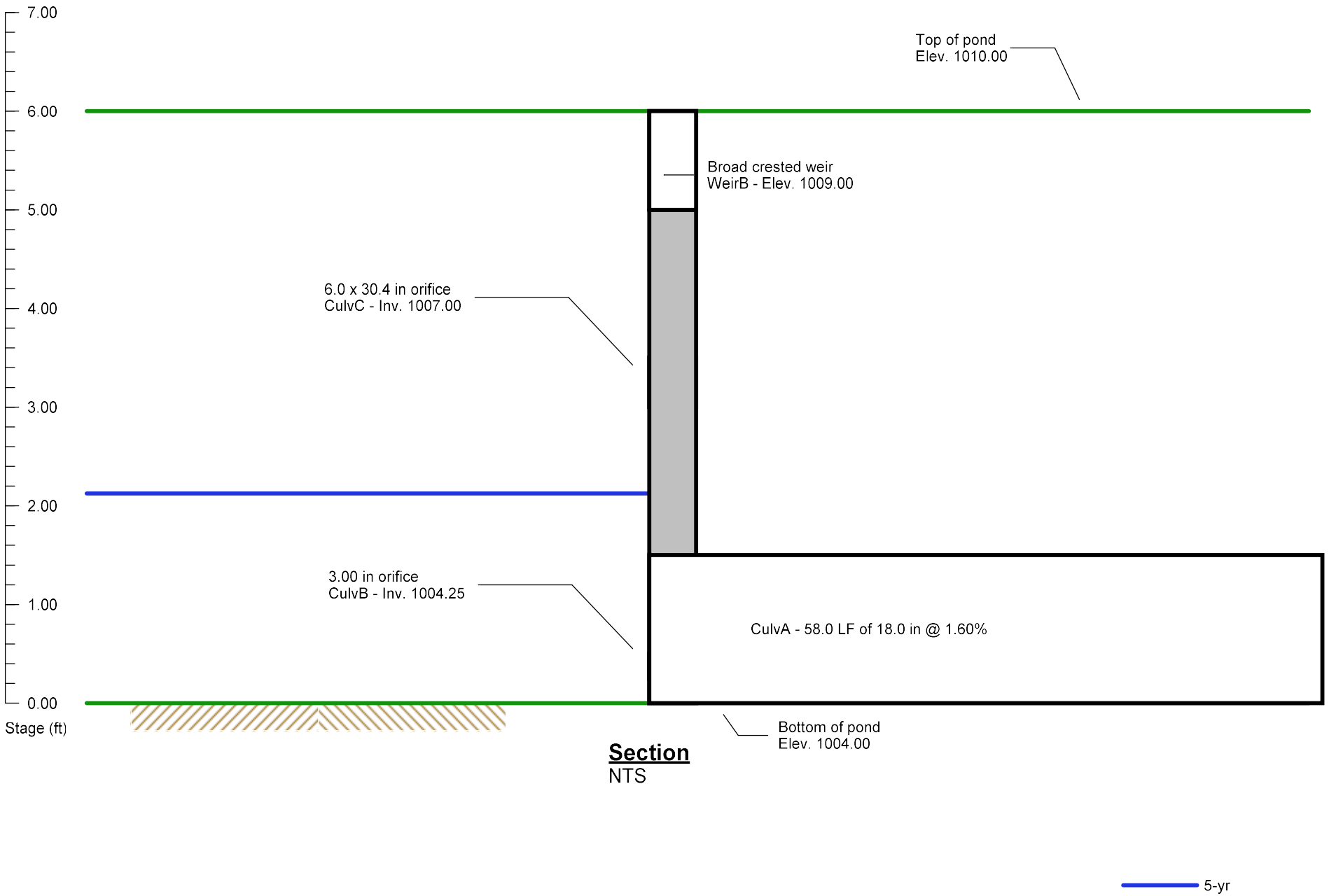
Hyd. No. 3

Existing A

Hydrograph type	= SCS Runoff	Peak discharge	= 13.04 cfs
Storm frequency	= 5 yrs	Time to peak	= 11.97 hrs
Time interval	= 2 min	Hyd. volume	= 26,178 cuft
Drainage area	= 6.200 ac	Curve number	= 69
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 3.96 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Pond No. 1 - Pond A



Section
NTS

Inflow hydrograph = 1. SCS Runoff - Dev A