

# MACRO STORM WATER DRAINAGE STUDY

**LIVING FAITH CHURCH**

**Site Acreage: 9.63 Acres**

**1121 SW Hook Road  
Lee's Summit, MO**

***PREPARED BY:***



**Revision**

Date	Comment	By
6-28-22	Revised per City Comments Dated 6-17-22	AEP

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Matthew J. Schlicht, PE

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### **3. GENERAL INFORMATION**

This storm study has been prepared to evaluate potential hydrologic and hydraulic issues related to the proposed project and recommend improvements designed to mitigate any anticipated negative downstream impacts. The proposed project will consist of the construction of a new parking lot. Living Faith Church is located at 1121 SW Hook Road and consists of 9.63 acres+/- . The existing site drains generally from north to south. An enclosed storm sewer system is located on the property which collects runoff from the north parking lot and conveys it to the south. It is unclear whether detention was required in previous phases. There does not appear to be a functioning detention basin onsite. Detention will be constructed to attenuate runoff from all phases including existing and planned future phases. Runoff from the site is tributary to Raintree Lake. See Exhibit A for an aerial image of the proposed project site along with an aerial image of the surrounding area. The site is located in Section 25, Township 47N, Range 32W, Lee's Summit, Jackson County, Missouri.

#### **3.1 FEMA FLOODPLAIN DETERMINATION**

The property is located in an Area of Minimal Flood Hazard, Zone X, according to FEMA Firm Map Number 29095C0532G, dated January 20, 2017.

See Exhibit B for a FIRMette which includes the proposed project site.

#### **3.2 NRCS SOIL CLASSIFICATION**

Soil classifications published by the United States Department of Agriculture/National Resources Conservation Service (USDA/NRCS) website for Jackson County, Missouri, Version 23, September 1, 2021. The existing site contains two major soil types:

10000	Arisburg Silt Loam, 1 to 5 Percent Slopes Hydrologic Soils Group (HSG): Type C
10116	Sampsel Silty Clay Loam, 2 to 5 Percent Slopes HSG: Type C/D

See Exhibit C for a detailed soils report of the proposed project site.

### **4. METHODOLOGY**

The study utilized a field topo to create the Existing Drainage Area Map. The study conforms to the requirements of the City of Lee's Summit, Missouri "Design and Construction Manual" and all applicable codes and criteria referred to therein.

Using the above criteria, the proposed site was evaluated using the Soil Conservation Service, SCS TR-55 method to calculate storm runoff volumes, peak rates of discharge, pre and post developed hydrographs and required storage volumes for detention facilities. TR-55 was first introduced in 1975 by the SCS particularly for small urbanizing watersheds. The analysis contains results for the 2, 10 and 100-year design storms.

Hydraflow Hydrographs Extension for AutoCAD Civil 3D was utilized to model the various SCS TR-55 stormwater rainfall runoff events. The following SCS TR-55 Unit Hydrograph variables were utilized;

- AMC II Soil Moisture Conditions
- 24-Hour SCS Type II Rainfall Distribution (Shape Factor 484)
- SCS Runoff Curve Numbers per SCS TR-55 (Tables 2-2a to 2-2c)

Time of Concentration has been calculated using the following formulas:

- Sheet Flow (Max. 100 LF): APWA 5602.5 Time Inlet,  $T_1 = 1.8 * (1.1-C) * L^{1/2} / S^{1/3}$
- Shallow Concentrated Flow: SCS TR-55 Appendix F:
 

Unpaved	$V=16.1345(S)^{0.5}$
Paved	$V=20.3282(S)^{0.5}$

Shallow Concentrated Travel Time (min): SCS TR-55 Eq-3-1,  $T_t = L / V \times 60$

- Channel Flow Improved: Manning's Equation (Full Flow)
- Channel Flow Unimproved: APWA 5602.7.A. Travel Time, Table 5602-6

<u>Avg. Channel Slope (%)</u>	<u>Velocity (fps)</u>
< 2	7
2 to 5	10
>5	15

## 5. EXISTING CONDITIONS ANALYSIS

A building and parking lot currently exist on the northern portion of the property adjacent to Hook Road. The remainder of the site consists mainly of meadow with some sparse trees sprinkled throughout. It is not clear whether detention was originally required nor to what degree for the initial improvements. The City is requiring that attenuation measures be utilized to meet current storm water regulations for the proposed project. The proposed detention system will be designed to accommodate existing, proposed and future improvements. The site contains one sub-basin which encompasses all of the existing proposed hard infrastructure improvements and a majority of the existing hard infrastructure. The sub-basin will be referred to as Sub-basin A for the purposes of this report. Sub-basin A contains 5.96 acres and drains to Point of Interest A located in the southeast portion of the site. The Existing Drainage Area Map is located in Exhibit D.

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

Table 5-1 Existing Conditions Sub-basin Data

<b>Sub-basin</b>	<b>Area (ac.)</b>	<b>Composite CN</b>	<b>Tc (min.)</b>
A	5.96	78	13.40

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

<b>Sub-basin</b>	<b>Q2 (cfs)</b>	<b>Q10 (cfs)</b>	<b>Q100 (cfs)</b>
A	12.56	24.26	42.38

Per APWA 5608.4 and City of Lee's Summit criteria, post development peak discharge rates from the site shall not exceed those indicated below:

- 50% storm peak rate less than or equal to 0.5 cfs per site acre
- 10% storm peak rate less than or equal to 2.0 cfs per site acre
- 1% storm peak rate less than or equal to 3.0 cfs per site acre

Per City direction all onsite area is to be multiplied by the above factors to determine allowable peak release rates. Any offsite area contributing shall utilize its percentage of existing peak discharge which will be added to allowable onsite to determine the total allowable peak discharge at the point of interest.

Allowable Release Example Calculations: Sub-basin A (2-Yr):  $(5.96 \times 0.5) = \underline{2.98 \text{ cfs}}$

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

Sub-basin	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
A	2.98	11.92	17.88

## 6. PROPOSED CONDITIONS ANALYSIS

The church plans to expand their existing facility by adding an additional parking lot. Sub-basin A will encompass the proposed improvements. Runoff will be conveyed to the proposed detention basin at POI A via the existing enclosed storm sewer system and a set of swales. Sub-basin A was analyzed in the proposed conditions analysis to determine if any negative impacts are anticipated downstream due to the new development. The proposed condition accounts for an additional 0.83 acres of impervious area. The Proposed Drainage Area Map is located in Exhibit H.

The following tables summarize the results of the Proposed Conditions analysis.

Table 6-1 Proposed Conditions Sub-basin Data

Sub-basin	Area (ac.)	Composite CN	Tc (min.)
A	5.96	81	13.40

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

Sub-basin	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
A	15.03	27.20	45.50

As shown above in Table 6-2 Sub-basin A will require detention to attenuate peak discharge rates below Allowable Release Rates as shown in Table 5-3 for Sub-basin A. The church has plans for future buildout on the site which would include the expansion of their existing and proposed facilities. The future improvements would consist of an additional 0.75 acres of impervious area beyond the proposed conditions accounting for an additional 1.58 acres total of impervious area. The future improvement areas have been identified with hatching on the Proposed Drainage Area Map.

The following tables summarize the results of the Future Conditions analysis.

Table 6-3 Future Conditions Sub-basin Data

Sub-basin	Area (ac.)	Composite CN	Tc (min.)
A	5.96	84	13.40

Table 6-4 Future Conditions Sub-basin/Point of Interest Peak Discharge Rates

Sub-basin	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
A	16.30	28.62	46.94

The proposed detention system will be designed to accommodate both the Proposed and Future development as currently planned.

### 6.1 DETENTION

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

Designation: Detention Basin A

Type: Earthen Basin

Side Slopes: 3:1 Max.

Bottom Slope: 2% Min., Turf Lined

Basin Bottom Elevation: 1006.00 @ Influent Pipe

Basin Top Berm Elevation: 1012.28

Basin Volume: 87,788 cf @ 1012.00

Control Structure: 5'x6' deep precast concrete box, with interior 6" baffle wall

Baffle Wall Orifices: (7) 1" Diameter on 4" Centers, FL=1005.70 (Bottom Orifice)

(1) 36" Wide x 12" High Rectangular Orifice, FL=1008.60

Baffle Wall Crest Elevation: N/A

Control Structure Top Elevation: 1012.00

Control Structure Overflow Weir Openings: 1011.00 All Sides

Control Structure Influent Pipe: 24" HDPE, FL (In) = 1006.00, FL (Out) = 1005.80, L=13.55', S=1.48%

Control Structure Effluent Pipe: 24" HDPE, FL (In) = 1005.60, FL (Out) = 1005.40, L=23.97', S=0.83%

Emergency Spillway: Earthen Broad Crested Weir, Crest Elevation=1011.00, Crest Length=100'

Consecutive 100-YR Q=46.94 cfs, Emergency Spillway HGL=1011.28, Freeboard=1.00'

Combination Emergency Spillway:

Earthen Broad Crested Weir: Q=39.30 cfs

Control Structure Overflow: Q=7.64 cfs

Total Discharge: Q=46.94 cfs

The Detention Basin Plan is located in Exhibit I. See Table 6-5 for a summary of detention basin data.

Table 6-5 Future Conditions Detention Basin Data

	Peak Q In (cfs)	Tp In (min.)	Peak Q Out (cfs)	Tp Out (min)	Peak W.S.E.	Max. Storage Vol. (cf)
Basin A						
2-Year	16.30	721	1.09	783	1008.78	23,828
10-Year	28.62	721	8.43	733	1009.47	35,439
100-Year	46.94	721	17.21	731	1010.49	54,908

As shown in the table above all anticipated future peak flowrates have been attenuated.

Table 6-6 below provides a comparison of runoff data between Proposed and Existing Conditions in addition to Proposed Conditions and Allowable Release Rates at each Point of Interest.

Table 6-6 Point of Interest Discharge Comparison

		Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
Point A	Proposed	1.09	8.43	17.21
	Existing	12.56	24.26	42.38
	Difference	-11.47	-15.83	-25.17
	Allowable	2.98	11.92	17.88
	Difference	-1.89	-3.49	-0.67

Peak discharge rates at Point A will be reduced below allowable for all design storms analyzed.

## 7. 40 HOUR EXTENDED DETENTION/INFILTRATION BMP

In addition to mitigation of peak flow rates, APWA Section 5608.4 also requires 40 hour extended detention of runoff from the local 90% mean annual event (1.37"/24-hour rainfall). The proposed detention facilities will release the water quality event over a period of 40-72 hours. See Exhibit J for 40 hour extended detention calculations for Basin A.

## **8. CONCLUSIONS & RECOMMENDATIONS**

This macro storm water drainage study reveals that the proposed development will not generate any negative downstream hydraulic impacts. A new earthen detention basin is being proposed to provide detention for the proposed development along with a potential future addition. In conclusion, both proposed and future peak discharge rates at POI A are below both existing and allowable release rates. The study is in conformance with all applicable City of Lee's Summit standards and criteria therefore Engineering Solutions recommends approval of this macro storm water drainage study.



# **Exhibit A**

## **Aerial Image & Aerial Image of Surrounding Area**

SW Hook Rd

SW Hook Rd

SW Ward Rd

SW Ward Rd

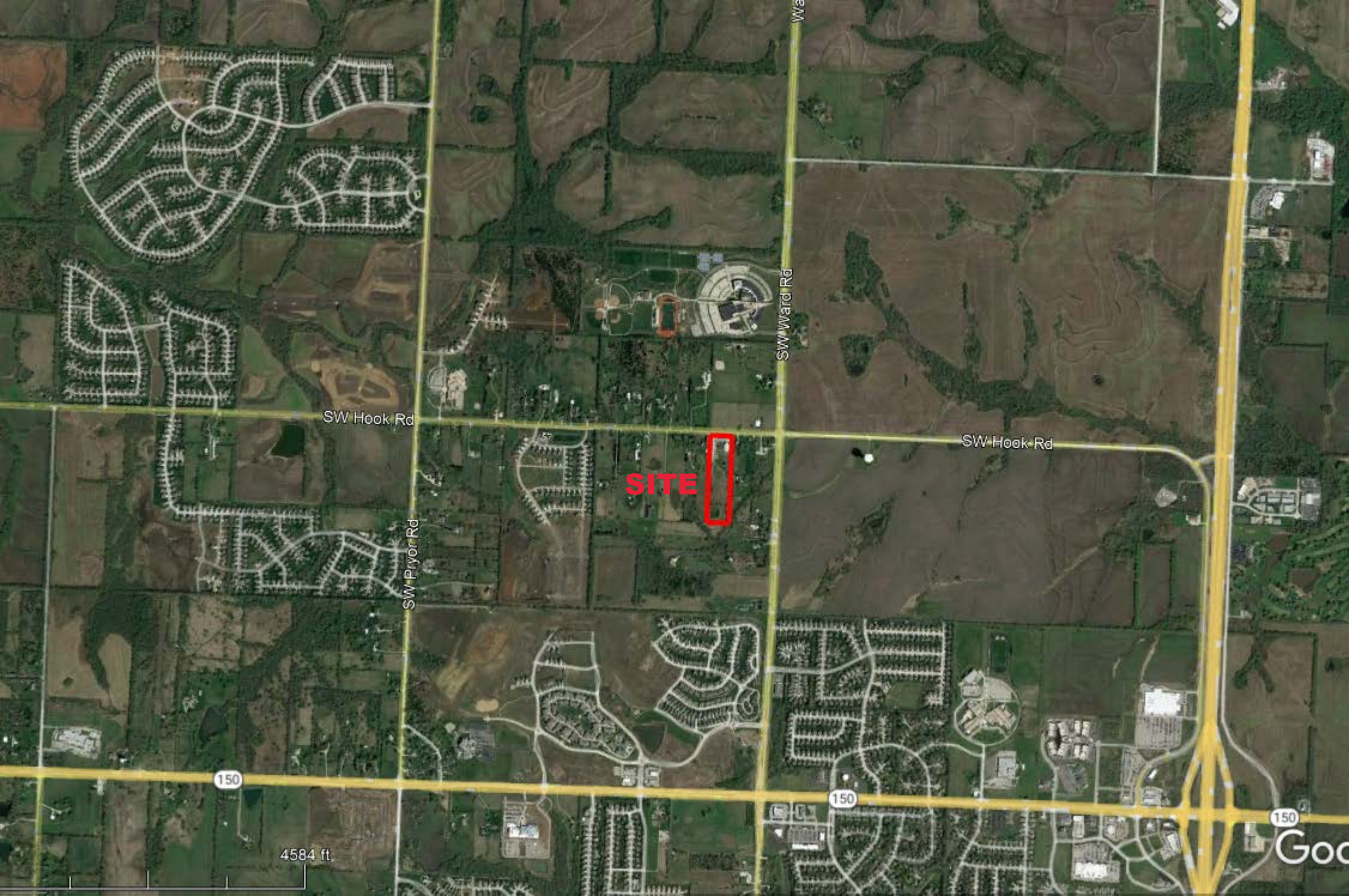
Ward Rd

**LIVING  
FAITH  
CHURCH**

504 ft







**SITE**

SW Hook Rd

SW Ward Rd

SW Pylon Rd

SW Hook Rd

150

150

150

4584 ft

Go

# **Exhibit B**

## **FEMA FIRMette**



# National Flood Hazard Layer FIRMette



94°24'21"W 38°52'13"N



0 250 500 1,000 1,500 2,000 Feet 1:6,000

Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020

## Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS		Without Base Flood Elevation (BFE) Zone A, V, A99
		With BFE or Depth Zone AE, AO, AH, VE, AR
		Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD		0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile Zone X
		Future Conditions 1% Annual Chance Flood Hazard Zone X
		Area with Reduced Flood Risk due to Levee. See Notes. Zone X
		Area with Flood Risk due to Levee Zone D
OTHER AREAS		NO SCREEN Area of Minimal Flood Hazard Zone X
		Effective LOMRs
GENERAL STRUCTURES		Area of Undetermined Flood Hazard Zone D
		Channel, Culvert, or Storm Sewer
		Levee, Dike, or Floodwall
OTHER FEATURES		20.2 Cross Sections with 1% Annual Chance Water Surface Elevation
		17.5
		Coastal Transect
		Base Flood Elevation Line (BFE)
		Limit of Study
		Jurisdiction Boundary
MAP PANELS		Coastal Transect Baseline
		Profile Baseline
		Hydrographic Feature
		Digital Data Available
		No Digital Data Available
		Unmapped



The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 3/4/2022 at 3:21 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

# **Exhibit C**

## **NRCS Soil Classification Report**





United States  
Department of  
Agriculture

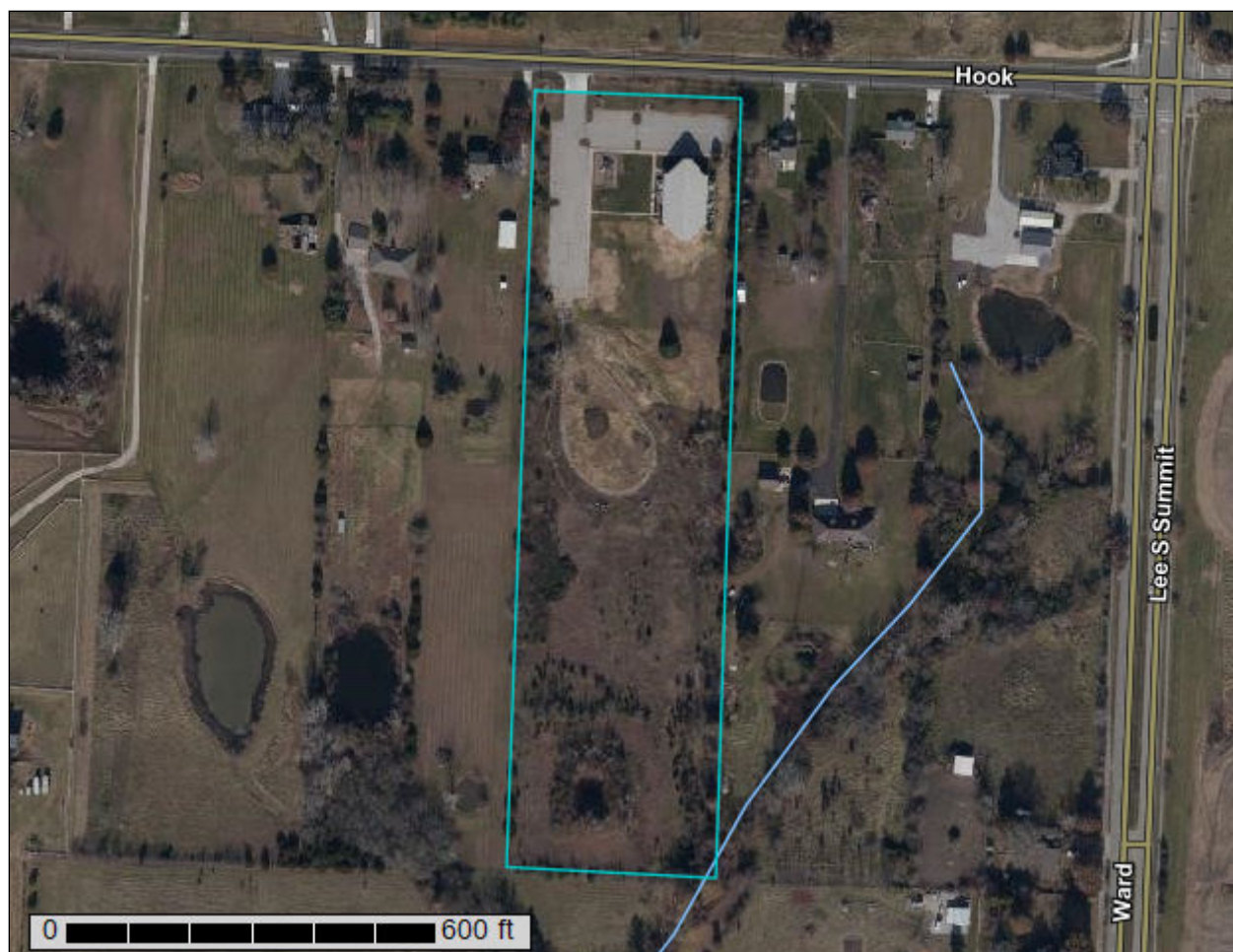
**NRCS**

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**

**LIVING FAITH CHURCH**



March 4, 2022

# Preface

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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](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.

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# How Soil Surveys Are Made

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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

## Custom Soil Resource Report

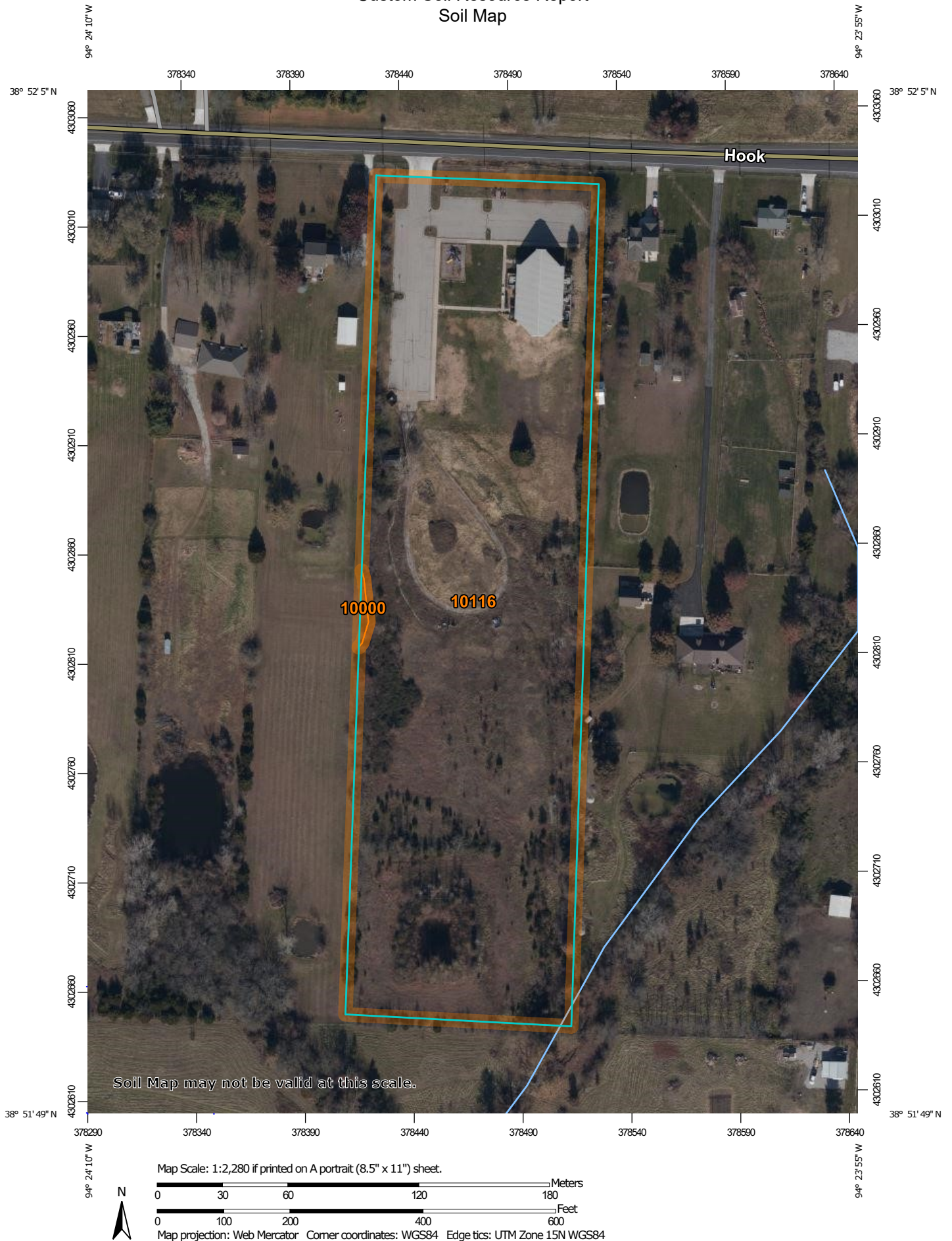
identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

# Soil Map

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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.


# Custom Soil Resource Report Soil Map



# Custom Soil Resource Report

## 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 23, Sep 1, 2021

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

Date(s) aerial images were photographed: Sep 6, 2019—Nov 16, 2019

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	0.0	0.2%
10116	Sampsel silty clay loam, 2 to 5 percent slopes	9.8	99.8%
<b>Totals for Area of Interest</b>		<b>9.8</b>	<b>100.0%</b>

## 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:* R107BY007MO - 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 900 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  
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Sampsel

#### Setting

*Landform:* Hillslopes

## Custom Soil Resource Report

*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

# References

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- American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.
- American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.
- Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.
- Federal Register. July 13, 1994. Changes in hydric soils of the United States.
- Federal Register. September 18, 2002. Hydric soils of the United States.
- Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.
- National Research Council. 1995. Wetlands: Characteristics and boundaries.
- Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. [http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2\\_054262](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262)
- Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. [http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2\\_053577](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577)
- Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. [http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2\\_053580](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580)
- Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.
- United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.
- United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. [http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2\\_053374](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374)
- United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. <http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084>

## Custom Soil Resource Report

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. [http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2\\_054242](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242)

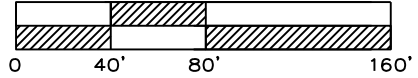
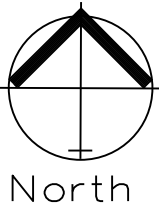
United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. [http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2\\_053624](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624)

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. [http://www.nrcs.usda.gov/Internet/FSE\\_DOCUMENTS/nrcs142p2\\_052290.pdf](http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf)

# **Exhibit D**

## **Existing Drainage Map**





EXISTING DRAINAGE MAP  
SCALE: 1" = 80'



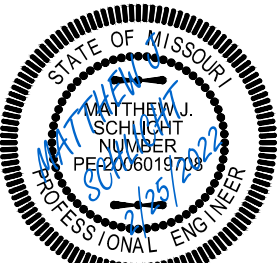
ENGINEERING & SURVEYING  
50 SE 30TH STREET  
LEES SUMMIT, MO 64082  
P:(816) 623-9888 F:(816) 623-9849

Professional Registration  
Missouri  
Engineering 2005002188-D  
Surveying 200500319-D  
Kansas  
Engineering E-1695  
Surveying LS-218  
Oklahoma  
Engineering 6254  
Nebraska  
Engineering CA2821

LIVING FAITH CHURCH  
LEE'S SUMMIT, JACKSON COUNTY, MISSOURI

Project:  
LIVING FAITH  
CHURCH LSWO  
Issue Date:  
January 28, 2022

Existing Drainage Map  
Construction Plans for:  
LIVING FAITH CHURCH  
Lee's Summit, Jackson County, Missouri



Matthew J. Schlicht  
MO PE 2006019708  
KS PE 19071  
OK PE 25226

REVISIONS

EXHIBIT

# **Exhibit E**

## **Composite Curve Number Calculations**

LIVING FAITH CHURCH  
COMPOSITE CURVE NUMBERS

A (Existing)	Area (ac.)	CN	Area x CN
IMPERVIOUS	0.97	98	95.14
PERVIOUS	4.99	74	369.20
			0.00
Total Area	5.96		464.34
Composite CN	78		

A (Proposed)	Area (ac.)	CN	Area x CN
IMPERVIOUS	2.00	98	195.54
PERVIOUS	3.96	74	293.38
			0.00
Total Area	5.96		488.93
Composite CN	82		

A (Future)	Area (ac.)	CN	Area x CN
IMPERVIOUS	2.55	98	249.79
PERVIOUS	3.41	74	252.42
			0.00
Total Area	5.96		502.21
Composite CN	84		

# **Exhibit F**

## **Time of Concentration Calculations**

APWA STORM DRAINAGE "TC" COMPUTATIONS FOR: LIVING FAITH CHURCH																						
	yellow areas are self computing overwrite if necessary				Surface types:	Asph/Conc	Bus/Com	Dirt	Grass/Park	Lake	MultFam	SnglFam	Undev	Other								
					SURFACE CODES	A	B	D	G	L	M	S	U	Z								
					"C" Values	0.90	0.87	0.60	0.30	0.90	0.66	0.51	0.3		TC COMPUTATION							
		TOTAL WATERSHED				Overwrite Length - DnElev or Slope if necessary					SURFACE CODE	P=Paved U=Unpaved		Overwrite Slope or Elevations if necessary			Cal	Used	Cal	Cal		
			OVERLAND FLOW - 100' MAX					P	CHANNEL FLOW - FIRST REACH			Overland	Min 5	Channel	Channel	Total						
AREA	TOTAL	WTRSHD	UP	DN	SURFACE	"C"	OVRLND	UP	DN	SLOPE	or	CHANNEL	UP	DN	SLOPE	VELOCITY	Flow	Max 15	One	Two		AREA
ID	ACRES	LENGTH	ELEV	ELEV	CODE	VALUE	LENGTH	ELEV	ELEV	%	U	LENGTH	ELEV	ELEV	%	F/S	T(I)	T(I)	T(T)	T(T)	T© 10	ID
A	5.96	1179.00	1033.00	1008.00	Z	0.40	52.0	1033.0	1031.90	2.1	P	1127.0	1031.9	1008.0	2.12	3.0	7.1	7.1	6.3	0.0	13.4	A

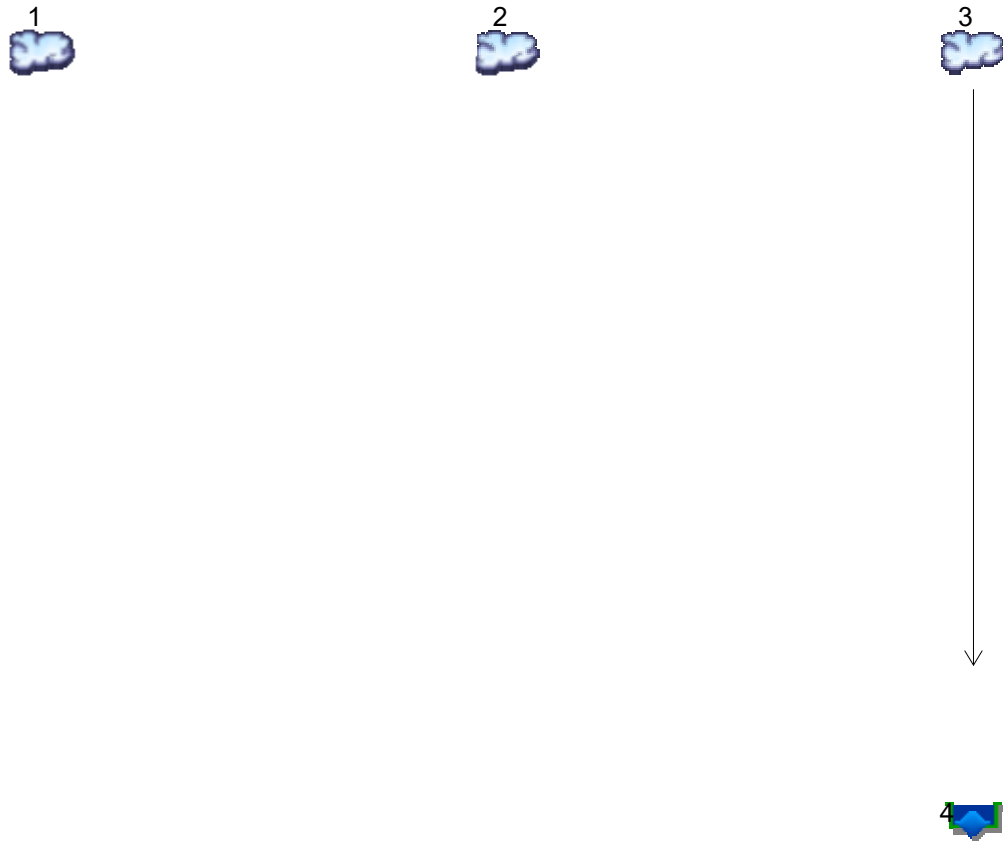
# **Exhibit G**

## **Complete Hydraflow Report Combination Emergency Spillway Analysis**

<b>Watershed Model Schematic.....</b>	<b>1</b>
<b>Hydrograph Return Period Recap.....</b>	<b>2</b>
<b>2 - Year</b>	
<b>Summary Report.....</b>	<b>3</b>
<b>Hydrograph Reports.....</b>	<b>4</b>
Hydrograph No. 1, SCS Runoff, EX. A.....	4
Hydrograph No. 2, SCS Runoff, PROP. A.....	5
Hydrograph No. 3, SCS Runoff, FUTURE A.....	6
Hydrograph No. 4, Reservoir, Future A Routed.....	7
Pond Report - Detention Pond.....	8
<b>10 - Year</b>	
<b>Summary Report.....</b>	<b>9</b>
<b>Hydrograph Reports.....</b>	<b>10</b>
Hydrograph No. 1, SCS Runoff, EX. A.....	10
Hydrograph No. 2, SCS Runoff, PROP. A.....	11
Hydrograph No. 3, SCS Runoff, FUTURE A.....	12
Hydrograph No. 4, Reservoir, Future A Routed.....	13
<b>100 - Year</b>	
<b>Summary Report.....</b>	<b>14</b>
<b>Hydrograph Reports.....</b>	<b>15</b>
Hydrograph No. 1, SCS Runoff, EX. A.....	15
Hydrograph No. 2, SCS Runoff, PROP. A.....	16
Hydrograph No. 3, SCS Runoff, FUTURE A.....	17
Hydrograph No. 4, Reservoir, Future A Routed.....	18
<b>IDF Report.....</b>	<b>19</b>

# Watershed Model Schematic

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2021



**Legend**

Hyd.	Origin	Description
1	SCS Runoff	EX. A
2	SCS Runoff	PROP. A
3	SCS Runoff	FUTURE A
4	Reservoir	Future A Routed





# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2021

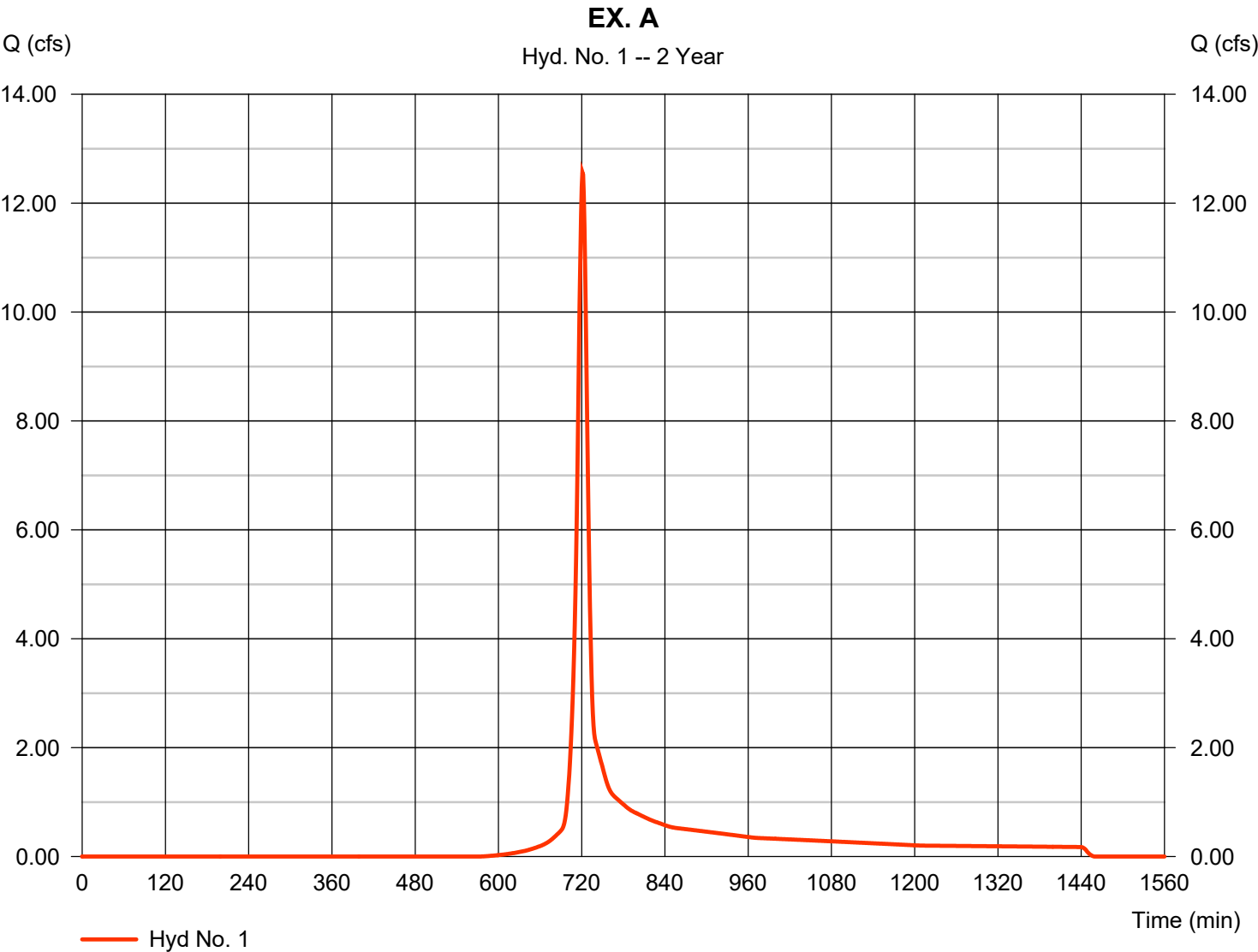
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	12.56	1	721	31,889	-----	-----	-----	EX. A
2	SCS Runoff	15.03	1	721	37,964	-----	-----	-----	PROP. A
3	SCS Runoff	16.30	1	721	41,241	-----	-----	-----	FUTURE A
4	Reservoir	1.092	1	783	34,627	3	1008.78	23,828	Future A Routed
LIVING FAITH CHURCH 220622.gpw					Return Period: 2 Year			Tuesday, 06 / 28 / 2022	

# Hydrograph Report

## Hyd. No. 1

EX. A

Hydrograph type	= SCS Runoff	Peak discharge	= 12.56 cfs
Storm frequency	= 2 yrs	Time to peak	= 721 min
Time interval	= 1 min	Hyd. volume	= 31,889 cuft
Drainage area	= 5.960 ac	Curve number	= 78
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 13.40 min
Total precip.	= 3.50 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



# Hydrograph Report

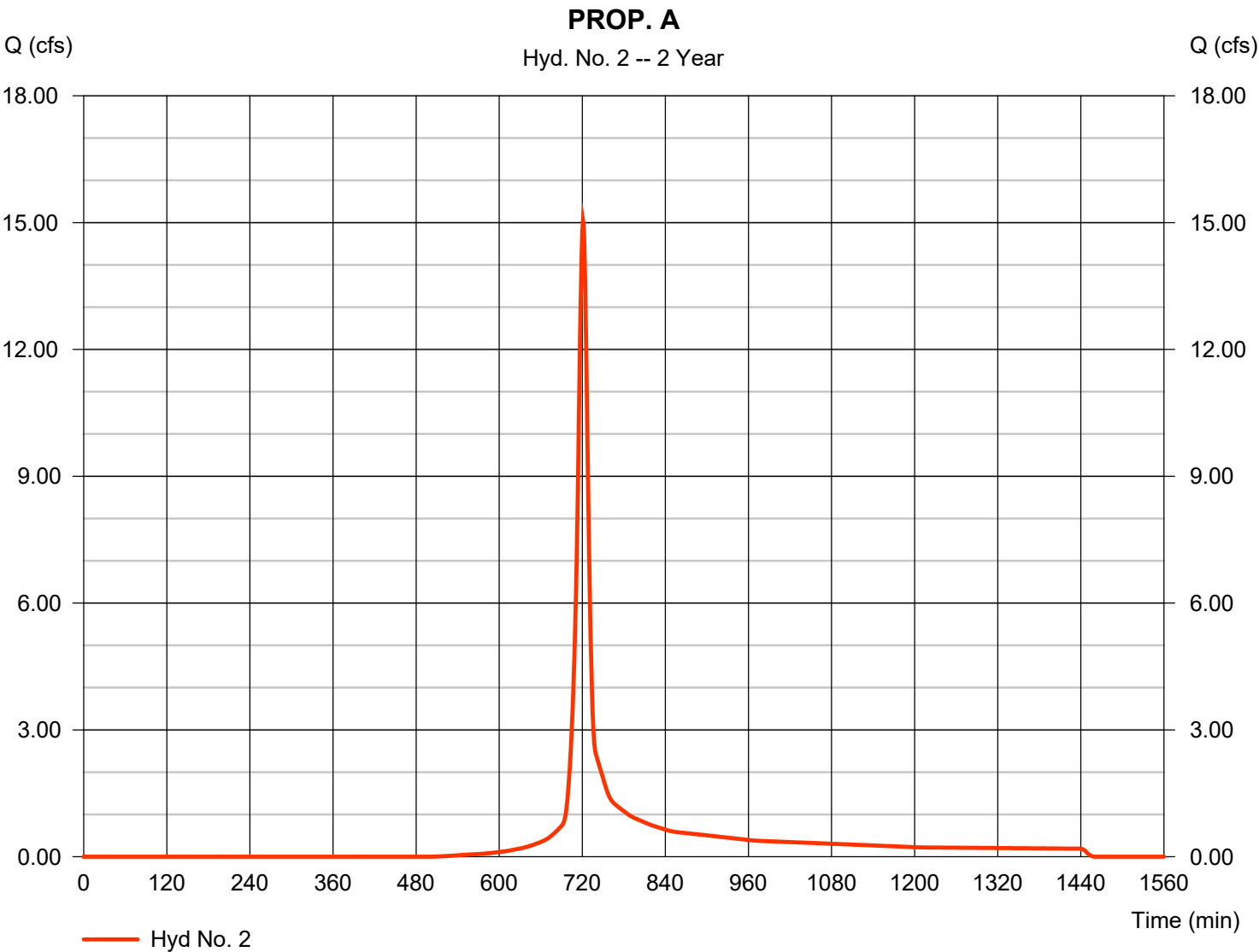
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2021

Tuesday, 06 / 28 / 2022

## Hyd. No. 2

PROP. A

Hydrograph type	= SCS Runoff	Peak discharge	= 15.03 cfs
Storm frequency	= 2 yrs	Time to peak	= 721 min
Time interval	= 1 min	Hyd. volume	= 37,964 cuft
Drainage area	= 5.960 ac	Curve number	= 82
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 13.40 min
Total precip.	= 3.50 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



# Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2021

Tuesday, 06 / 28 / 2022

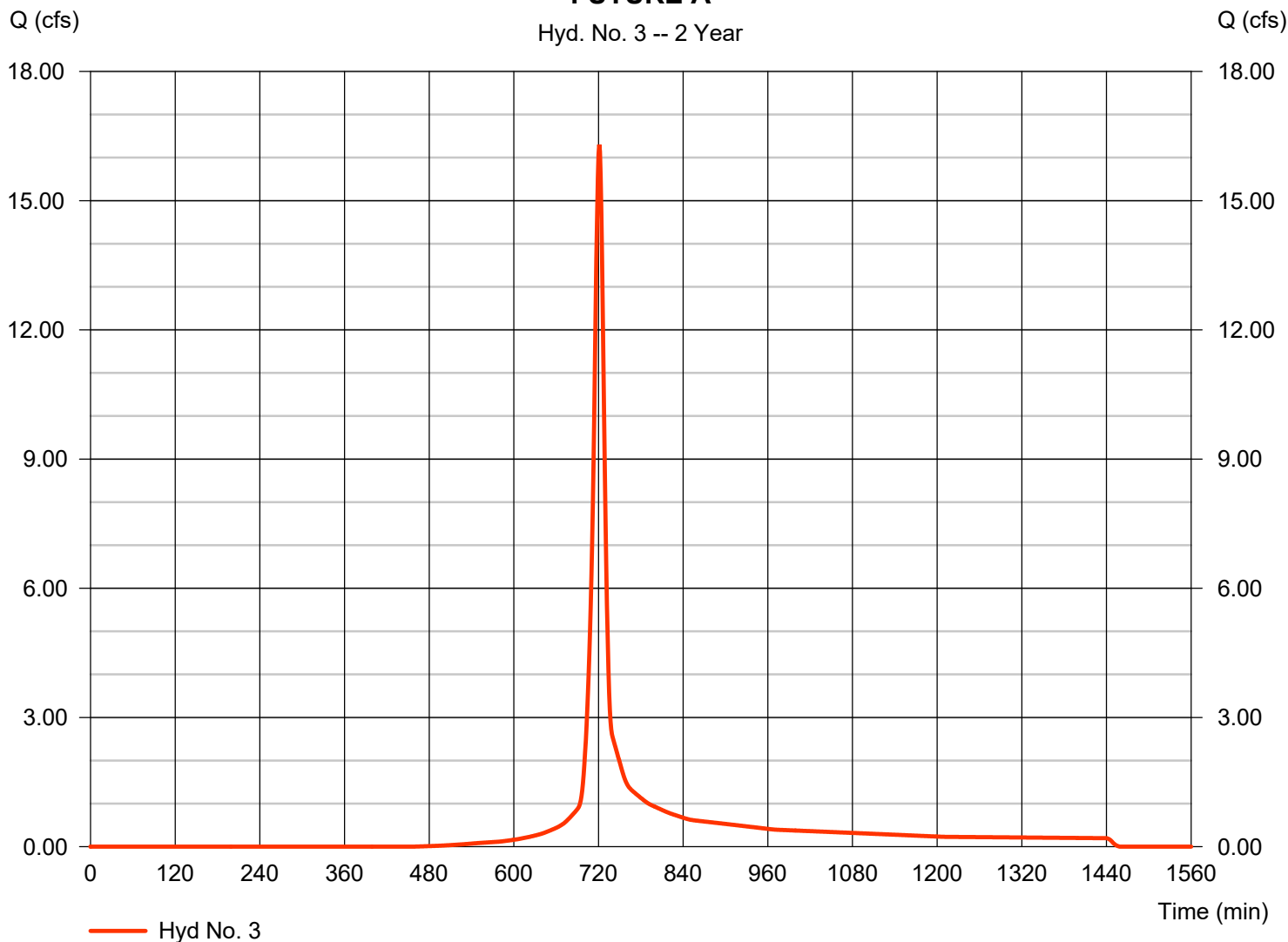
## Hyd. No. 3

### FUTURE A

Hydrograph type	= SCS Runoff	Peak discharge	= 16.30 cfs
Storm frequency	= 2 yrs	Time to peak	= 721 min
Time interval	= 1 min	Hyd. volume	= 41,241 cuft
Drainage area	= 5.960 ac	Curve number	= 84
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 13.40 min
Total precip.	= 3.50 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

### FUTURE A

Hyd. No. 3 -- 2 Year



# Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2021

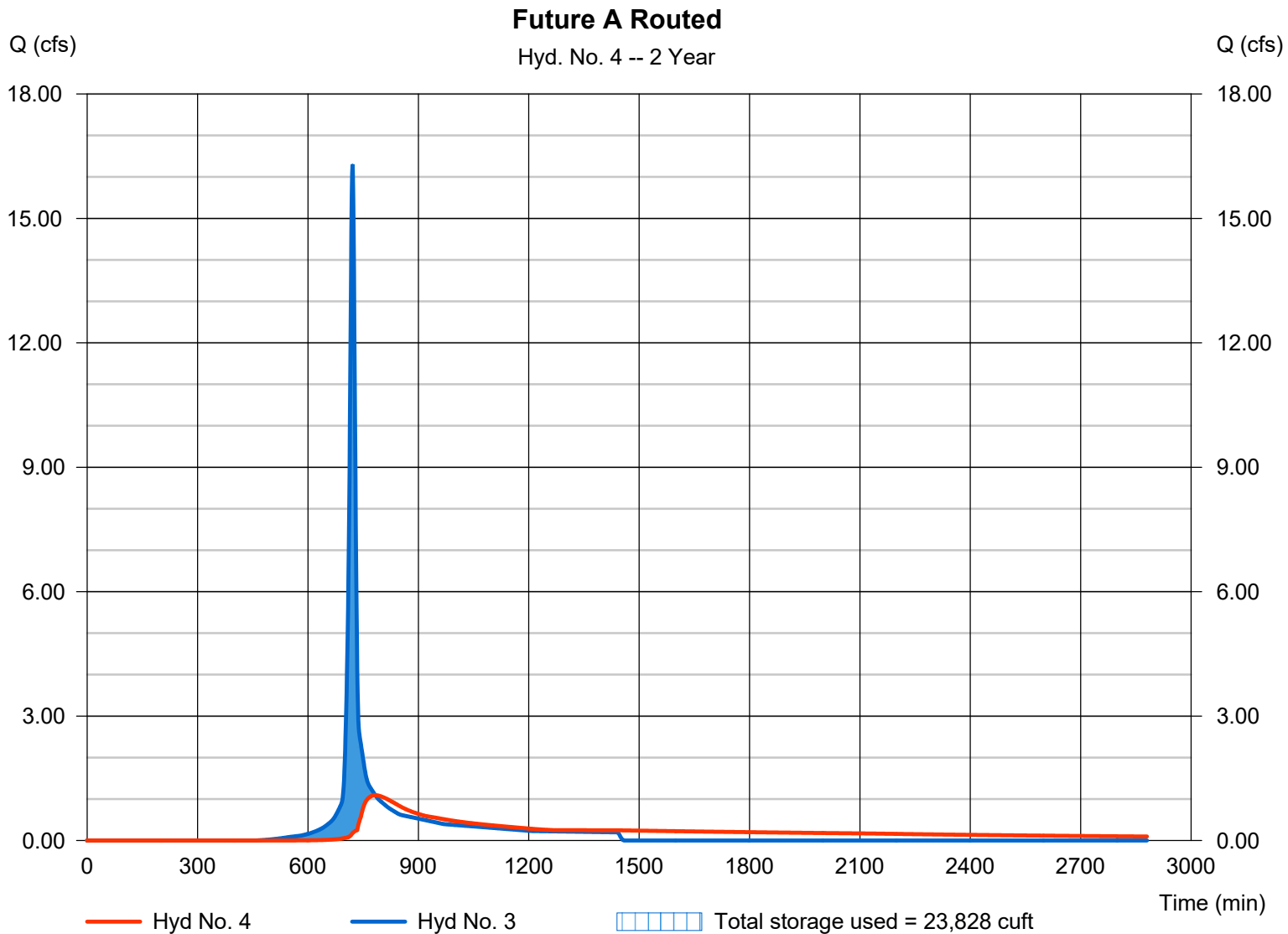
Tuesday, 06 / 28 / 2022

## Hyd. No. 4

Future A Routed

Hydrograph type	= Reservoir	Peak discharge	= 1.092 cfs
Storm frequency	= 2 yrs	Time to peak	= 783 min
Time interval	= 1 min	Hyd. volume	= 34,627 cuft
Inflow hyd. No.	= 3 - FUTURE A	Max. Elevation	= 1008.78 ft
Reservoir name	= Detention Pond	Max. Storage	= 23,828 cuft

Storage Indication method used.



# Pond Report

8

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2021

Tuesday, 06 / 28 / 2022

## Pond No. 1 - Detention Pond

### Pond Data

**Contours** -User-defined contour areas. Average end area method used for volume calculation. Beginning Elevation = 1006.00 ft

### Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	1006.00	00	0	0
1.00	1007.00	6,228	3,114	3,114
2.00	1008.00	12,250	9,239	12,353
3.00	1009.00	17,006	14,628	26,981
4.00	1010.00	19,143	18,075	45,056
5.00	1011.00	21,349	20,246	65,302
6.00	1012.00	23,623	22,486	87,788

### Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 24.00	12.00	0.00	1.00
Span (in)	= 24.00	36.00	0.00	1.00
No. Barrels	= 1	1	0	7
Invert El. (ft)	= 1005.60	1008.60	0.00	1005.70
Length (ft)	= 17.02	0.00	0.00	2.06
Slope (%)	= 0.98	0.00	0.00	n/a
N-Value	= .010	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	Yes	No	Yes

### Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No
Exfil.(in/hr)	= 0.000 (by Wet area)			
TW Elev. (ft)	= 0.00			

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

### Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	1006.00	0.00	0.00	---	0.00	---	---	---	---	---	---	0.000
1.00	3,114	1007.00	1.01 ic	0.00	---	0.06	---	---	---	---	---	---	0.059
2.00	12,353	1008.00	1.01 ic	0.00	---	0.17	---	---	---	---	---	---	0.168
3.00	26,981	1009.00	2.90 oc	2.58 ic	---	0.25	---	---	---	---	---	---	2.838
4.00	45,056	1010.00	13.88 oc	13.70 ic	---	0.18	---	---	---	---	---	---	13.88
5.00	65,302	1011.00	20.15 oc	19.91 ic	---	0.24	---	---	---	---	---	---	20.15
6.00	87,788	1012.00	24.42 ic	24.14 ic	---	0.28	---	---	---	---	---	---	24.42

# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2021

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	24.26	1	721	61,383	-----	-----	-----	EX. A
2	SCS Runoff	27.20	1	721	69,397	-----	-----	-----	PROP. A
3	SCS Runoff	28.62	1	721	73,556	-----	-----	-----	FUTURE A
4	Reservoir	8.427	1	733	66,650	3	1009.47	35,439	Future A Routed
LIVING FAITH CHURCH 220622.gpw					Return Period: 10 Year			Tuesday, 06 / 28 / 2022	



# Hydrograph Report

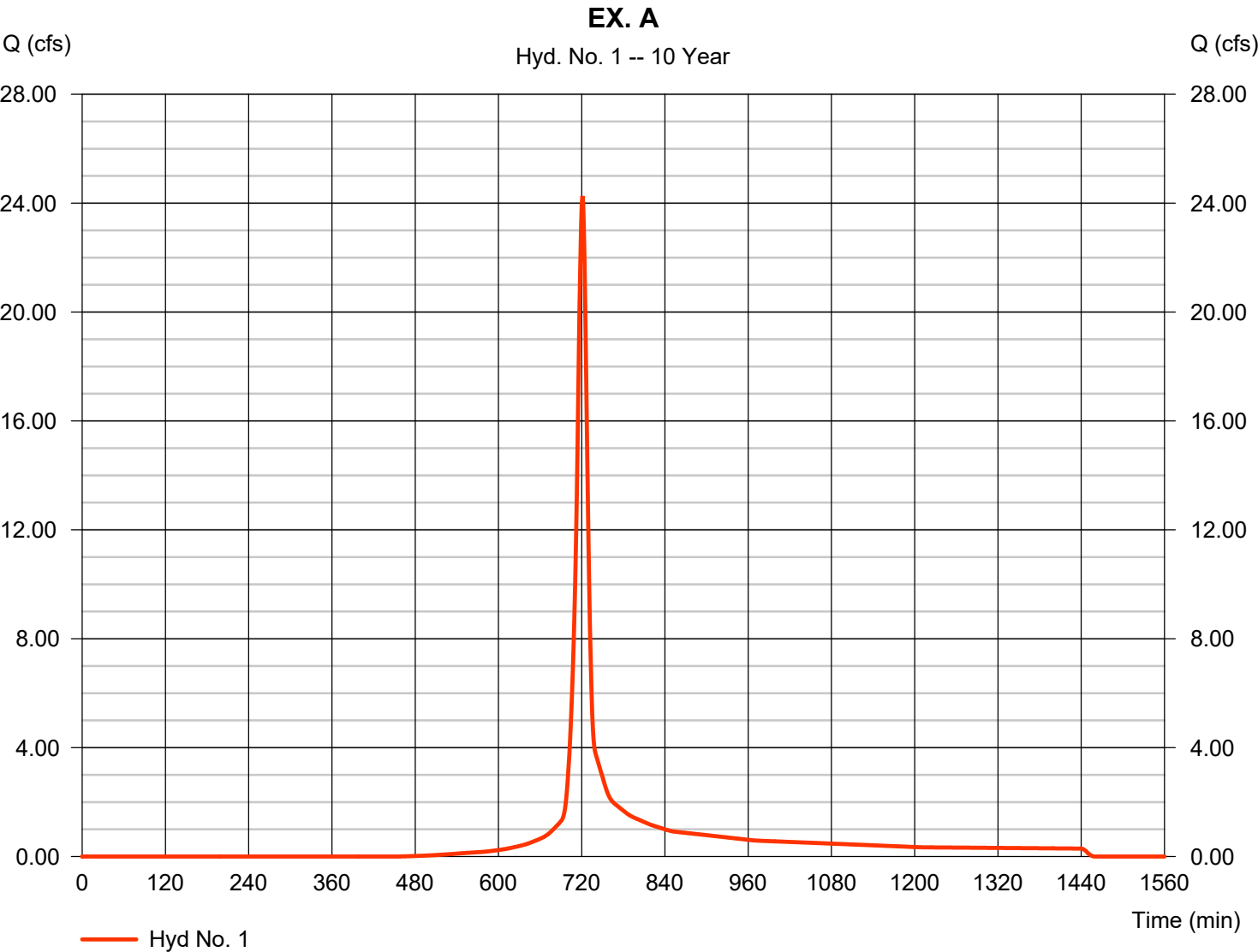
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2021

Tuesday, 06 / 28 / 2022

## Hyd. No. 1

EX. A

Hydrograph type	= SCS Runoff	Peak discharge	= 24.26 cfs
Storm frequency	= 10 yrs	Time to peak	= 721 min
Time interval	= 1 min	Hyd. volume	= 61,383 cuft
Drainage area	= 5.960 ac	Curve number	= 78
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 13.40 min
Total precip.	= 5.20 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



# Hydrograph Report

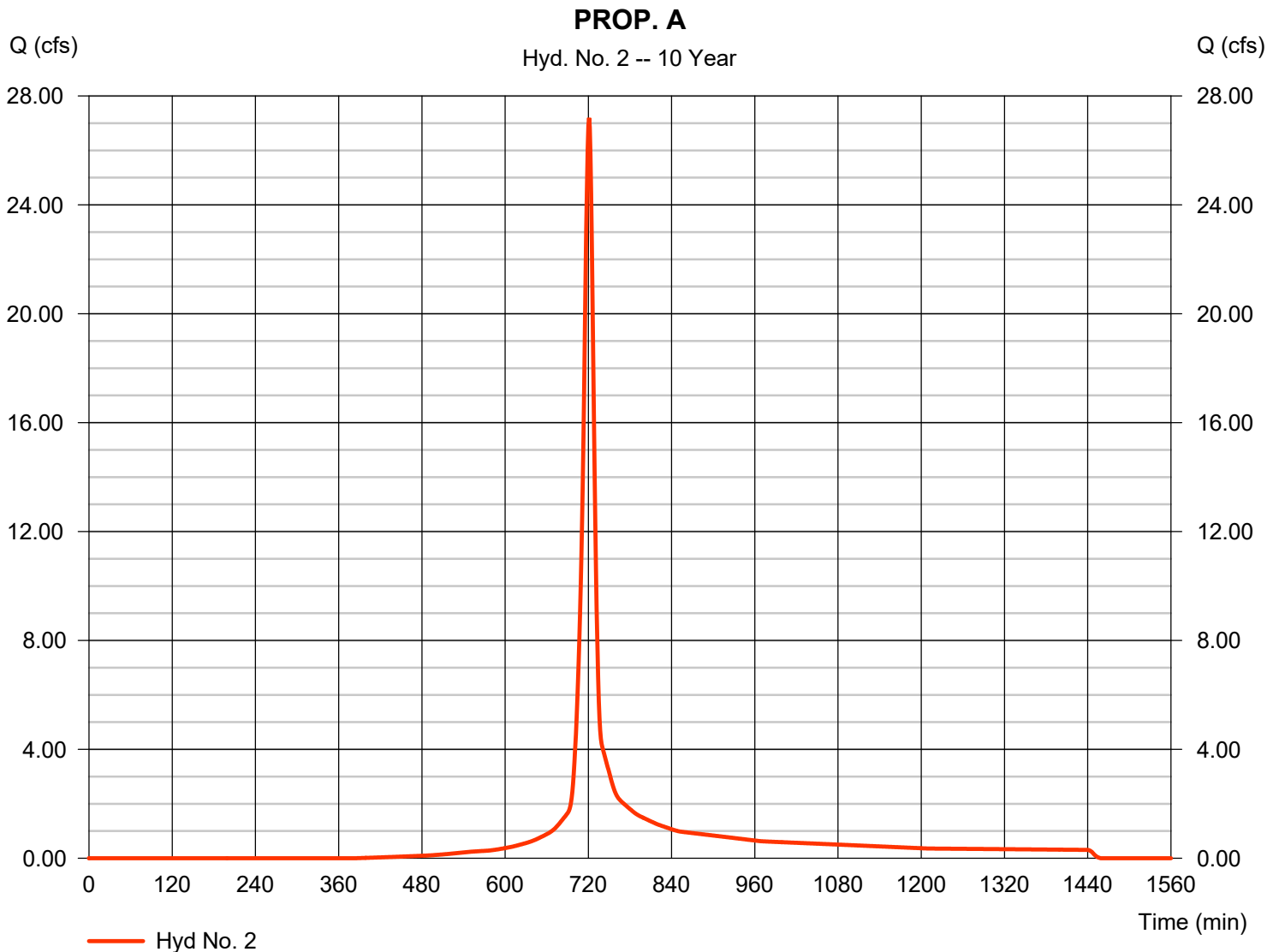
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2021

Tuesday, 06 / 28 / 2022

## Hyd. No. 2

PROP. A

Hydrograph type	= SCS Runoff	Peak discharge	= 27.20 cfs
Storm frequency	= 10 yrs	Time to peak	= 721 min
Time interval	= 1 min	Hyd. volume	= 69,397 cuft
Drainage area	= 5.960 ac	Curve number	= 82
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 13.40 min
Total precip.	= 5.20 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



# Hydrograph Report

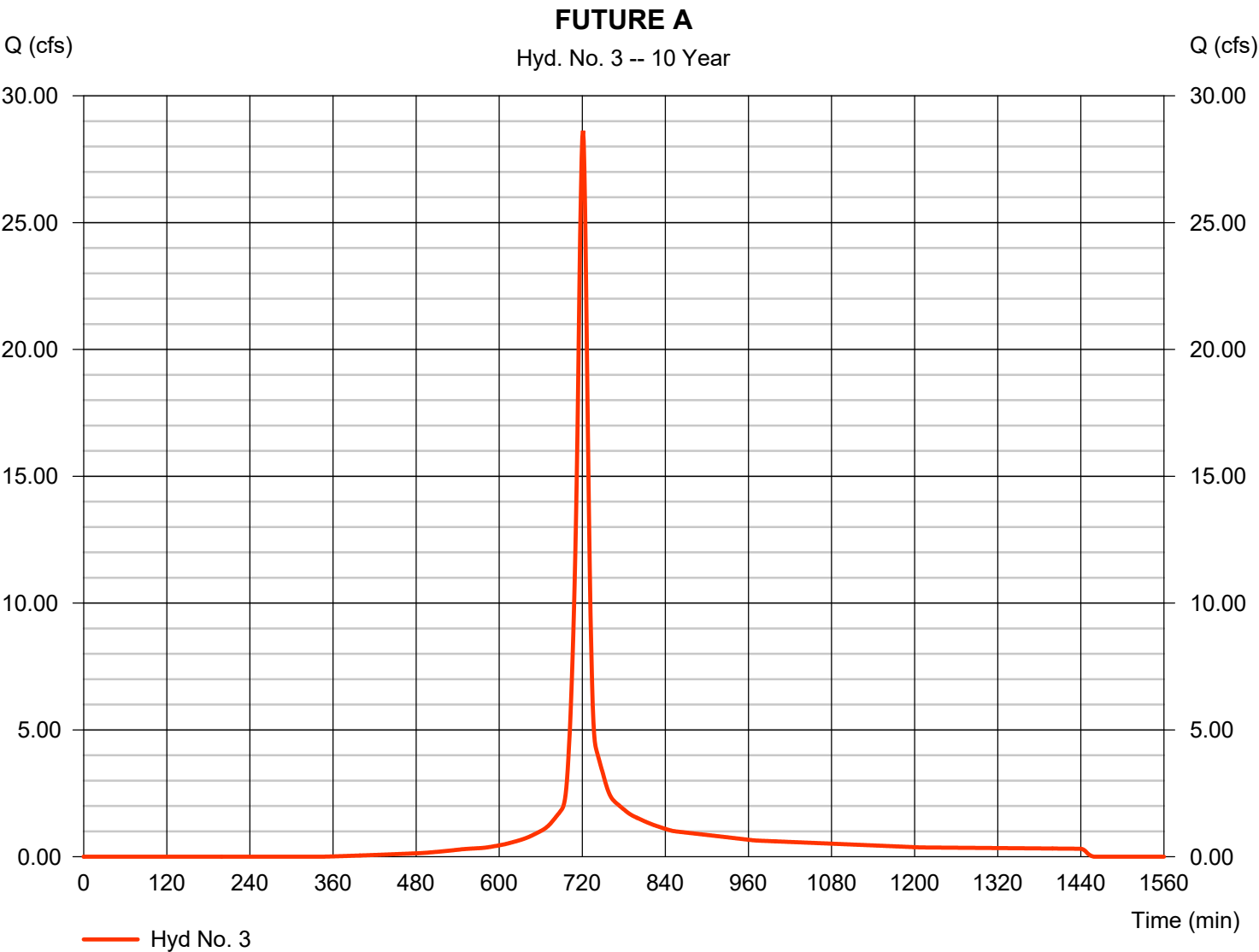
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2021

Tuesday, 06 / 28 / 2022

## Hyd. No. 3

FUTURE A

Hydrograph type	= SCS Runoff	Peak discharge	= 28.62 cfs
Storm frequency	= 10 yrs	Time to peak	= 721 min
Time interval	= 1 min	Hyd. volume	= 73,556 cuft
Drainage area	= 5.960 ac	Curve number	= 84
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 13.40 min
Total precip.	= 5.20 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



# Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2021

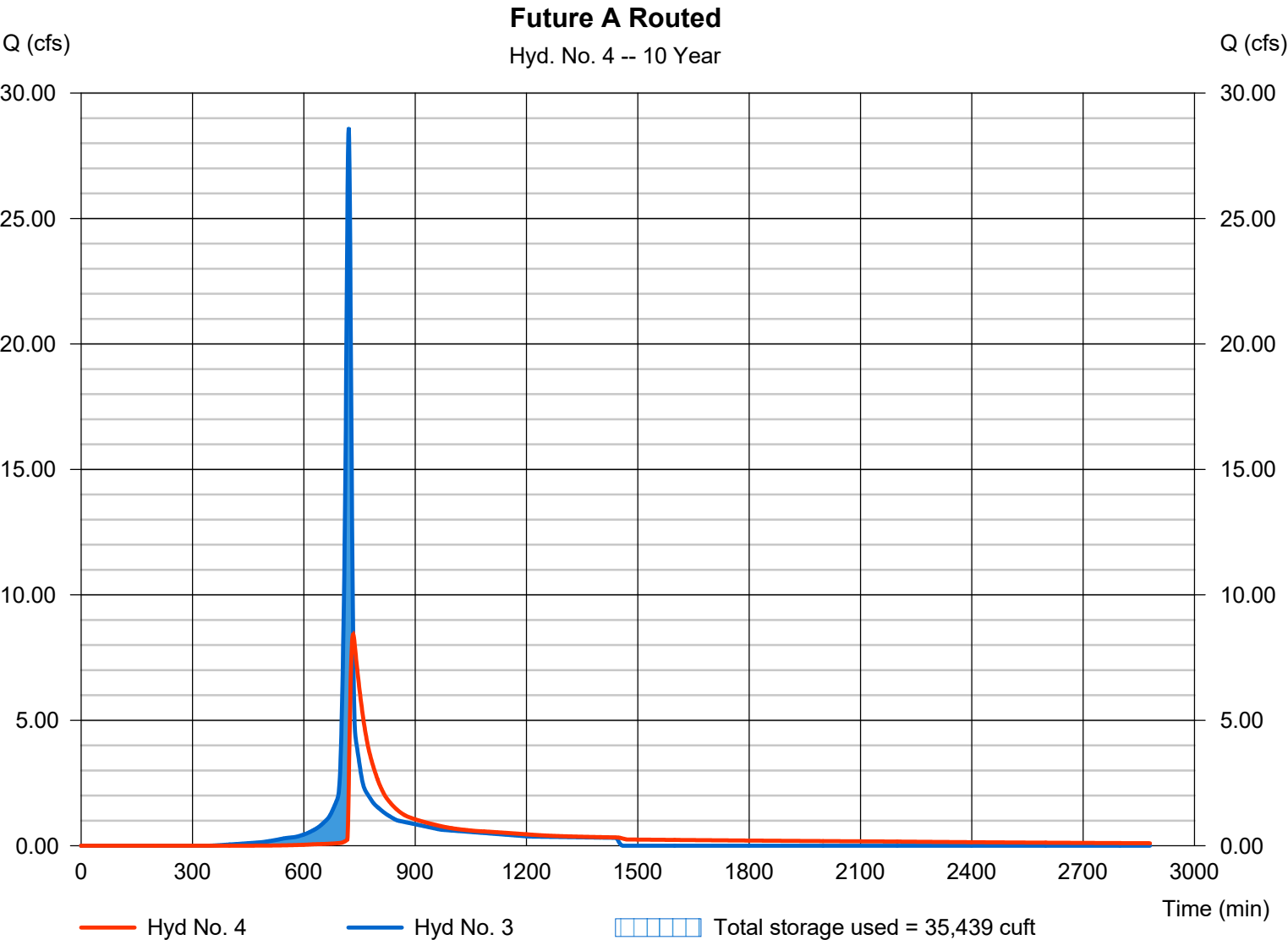
Tuesday, 06 / 28 / 2022

## Hyd. No. 4

Future A Routed

Hydrograph type	= Reservoir	Peak discharge	= 8.427 cfs
Storm frequency	= 10 yrs	Time to peak	= 733 min
Time interval	= 1 min	Hyd. volume	= 66,650 cuft
Inflow hyd. No.	= 3 - FUTURE A	Max. Elevation	= 1009.47 ft
Reservoir name	= Detention Pond	Max. Storage	= 35,439 cuft

Storage Indication method used.



# Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2021

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	42.38	1	721	108,920	-----	-----	-----	EX. A
2	SCS Runoff	45.50	1	721	118,739	-----	-----	-----	PROP. A
3	SCS Runoff	46.94	1	721	123,684	-----	-----	-----	FUTURE A
4	Reservoir	17.21	1	731	116,590	3	1010.49	54,908	Future A Routed
LIVING FAITH CHURCH 220622.gpw					Return Period: 100 Year			Tuesday, 06 / 28 / 2022	

# Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2021

Tuesday, 06 / 28 / 2022

## Hyd. No. 1

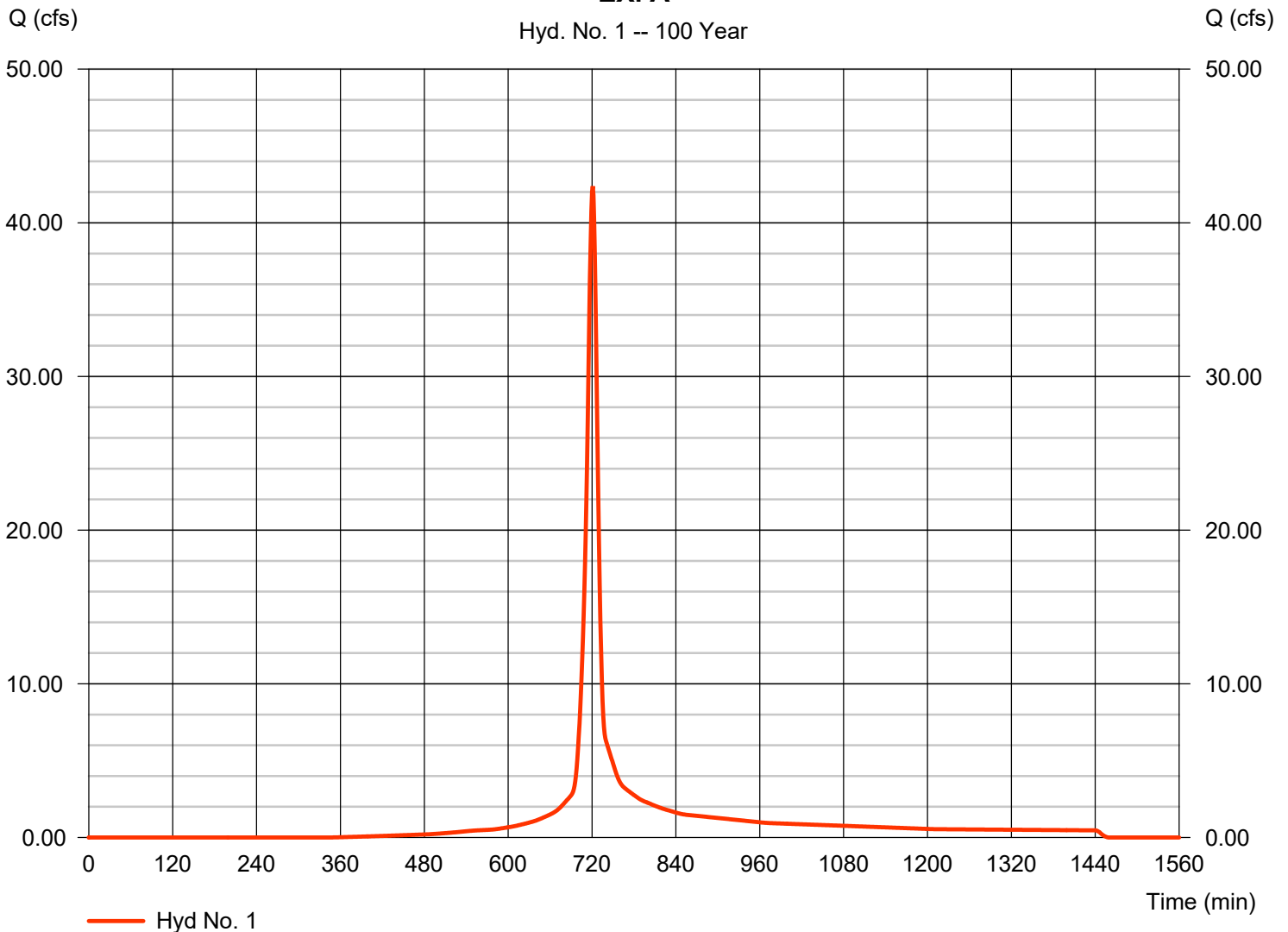
EX. A

Hydrograph type = SCS Runoff  
 Storm frequency = 100 yrs  
 Time interval = 1 min  
 Drainage area = 5.960 ac  
 Basin Slope = 0.0 %  
 Tc method = User  
 Total precip. = 7.70 in  
 Storm duration = 24 hrs

Peak discharge = 42.38 cfs  
 Time to peak = 721 min  
 Hyd. volume = 108,920 cuft  
 Curve number = 78  
 Hydraulic length = 0 ft  
 Time of conc. (Tc) = 13.40 min  
 Distribution = Type II  
 Shape factor = 484

### EX. A

Hyd. No. 1 -- 100 Year



# Hydrograph Report

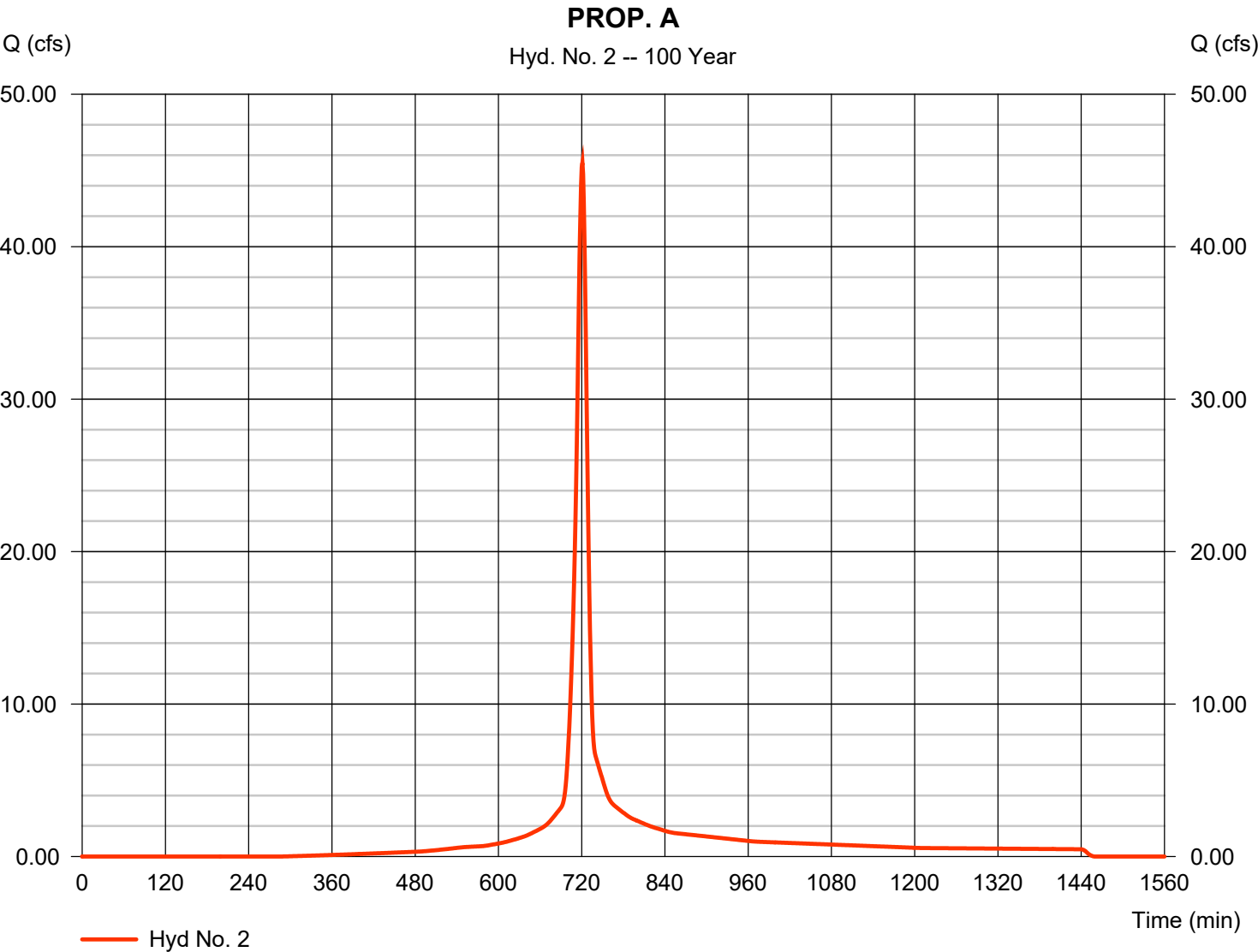
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2021

Tuesday, 06 / 28 / 2022

## Hyd. No. 2

PROP. A

Hydrograph type	= SCS Runoff	Peak discharge	= 45.50 cfs
Storm frequency	= 100 yrs	Time to peak	= 721 min
Time interval	= 1 min	Hyd. volume	= 118,739 cuft
Drainage area	= 5.960 ac	Curve number	= 82
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 13.40 min
Total precip.	= 7.70 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

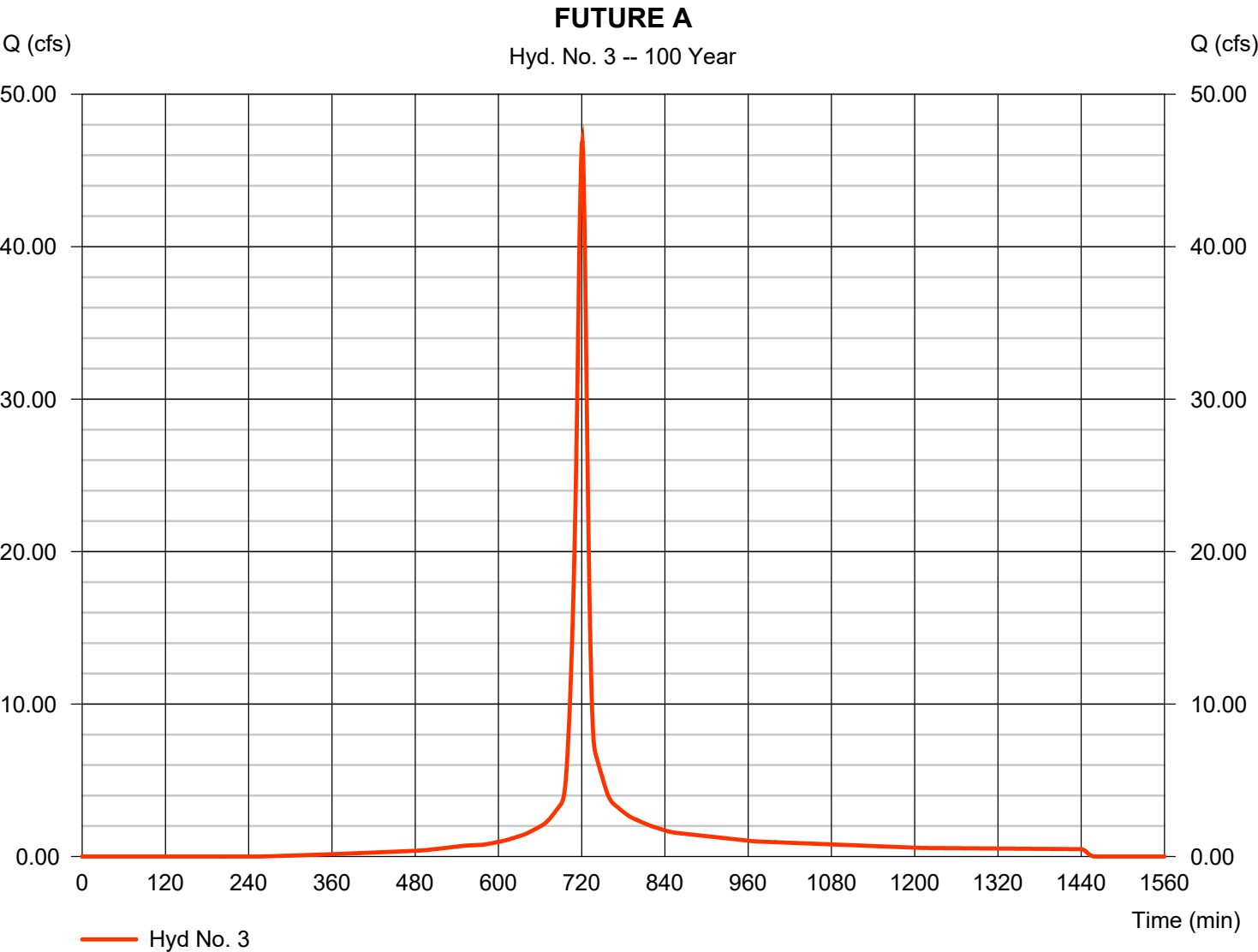


# Hydrograph Report

## Hyd. No. 3

### FUTURE A

Hydrograph type	= SCS Runoff	Peak discharge	= 46.94 cfs
Storm frequency	= 100 yrs	Time to peak	= 721 min
Time interval	= 1 min	Hyd. volume	= 123,684 cuft
Drainage area	= 5.960 ac	Curve number	= 84
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 13.40 min
Total precip.	= 7.70 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484





# Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2021

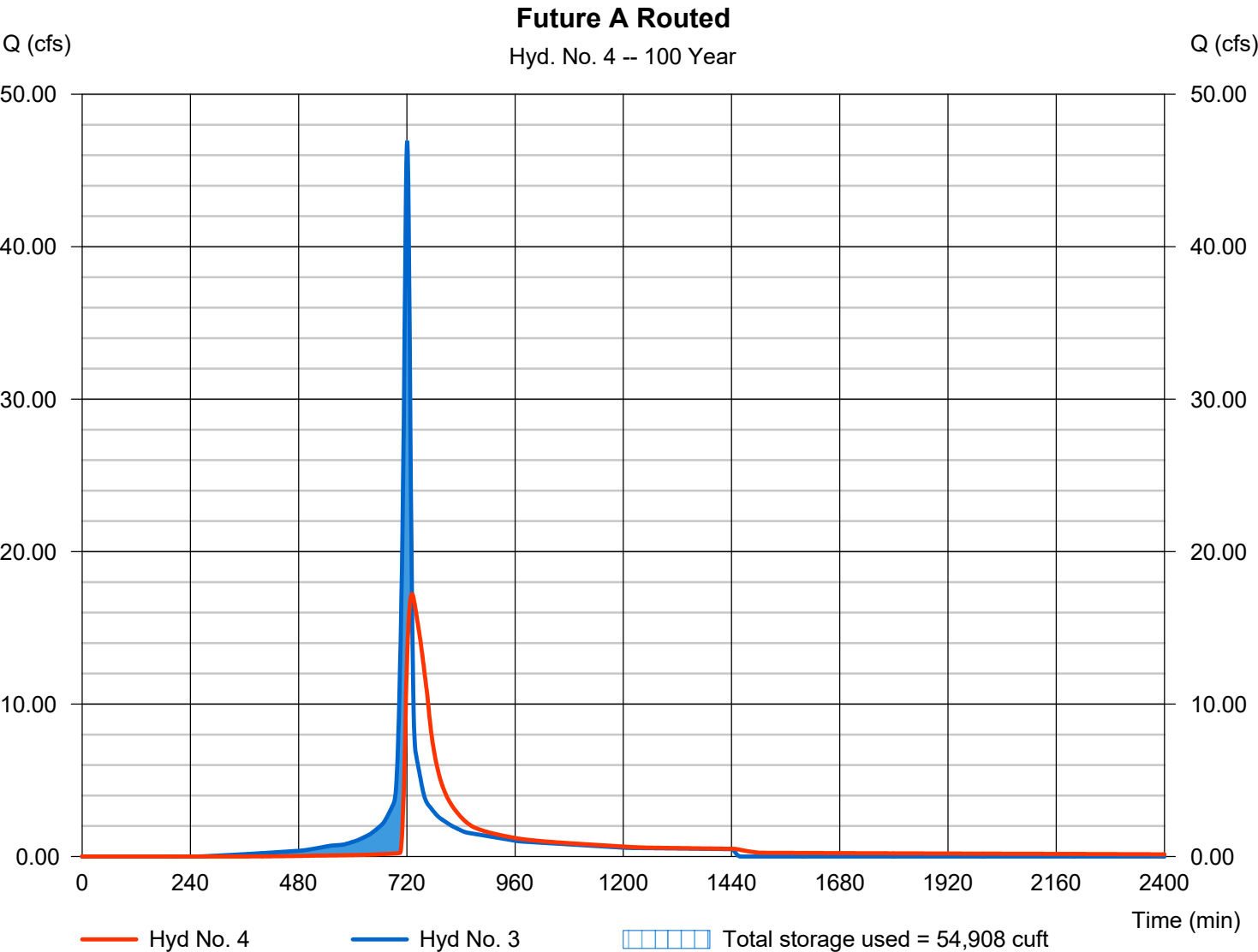
Tuesday, 06 / 28 / 2022

## Hyd. No. 4

Future A Routed

Hydrograph type	= Reservoir	Peak discharge	= 17.21 cfs
Storm frequency	= 100 yrs	Time to peak	= 731 min
Time interval	= 1 min	Hyd. volume	= 116,590 cuft
Inflow hyd. No.	= 3 - FUTURE A	Max. Elevation	= 1010.49 ft
Reservoir name	= Detention Pond	Max. Storage	= 54,908 cuft

Storage Indication method used.



# Hydraflow Rainfall Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2021

Tuesday, 06 / 28 / 2022

Return Period (Yrs)	Intensity-Duration-Frequency Equation Coefficients (FHA)			
	B	D	E	(N/A)
1	64.1474	17.7000	0.8922	-----
2	95.7859	19.2000	0.9317	-----
3	0.0000	0.0000	0.0000	-----
5	118.7799	19.1000	0.9266	-----
10	125.1300	18.2000	0.9051	-----
25	158.9867	18.7000	0.9180	-----
50	171.2459	18.3000	0.9078	-----
100	187.3624	18.1000	0.9031	-----

File name: KCMO.IDF

$$\text{Intensity} = B / (T_c + D)^E$$

Return Period (Yrs)	Intensity Values (in/hr)											
	5 min	10	15	20	25	30	35	40	45	50	55	60
1	3.96	3.31	2.86	2.52	2.25	2.04	1.87	1.72	1.60	1.49	1.40	1.32
2	4.92	4.13	3.56	3.14	2.81	2.54	2.32	2.14	1.98	1.85	1.73	1.63
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	6.23	5.23	4.51	3.98	3.56	3.22	2.94	2.71	2.52	2.35	2.20	2.07
10	7.27	6.09	5.26	4.63	4.14	3.75	3.43	3.16	2.93	2.74	2.57	2.42
25	8.70	7.30	6.30	5.54	4.96	4.49	4.10	3.78	3.51	3.27	3.07	2.89
50	9.83	8.24	7.11	6.26	5.60	5.07	4.64	4.27	3.97	3.70	3.47	3.27
100	11.00	9.21	7.95	7.00	6.26	5.67	5.19	4.78	4.44	4.14	3.89	3.66

Tc = time in minutes. Values may exceed 60.

Precip. file name: Z:\acad\KCMO.pcp

Storm Distribution	Rainfall Precipitation Table (in)							
	1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr
SCS 24-hour	3.50	3.50	0.00	3.30	5.20	6.00	6.80	7.70
SCS 6-Hr	0.00	1.80	0.00	0.00	2.60	0.00	0.00	4.00
Huff-1st	0.00	1.55	0.00	2.75	4.00	5.38	6.50	8.00
Huff-2nd	3.25	3.10	0.00	4.01	4.64	5.52	6.21	6.90
Huff-3rd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-4th	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-Indy	0.00	1.55	0.00	2.75	4.00	5.38	6.50	8.00
Custom	0.00	1.75	0.00	2.80	3.90	5.25	6.00	7.10

## Combination Emergency Spillway Calculations

### **Living Faith Church**

Peak Discharge (cfs)	46.94
----------------------	-------

#### **Broad Crested Weir**

Capacity (cfs)	39.3
Crest Length (ft)	100
Weir Coefficient, C	2.6
Required Head, H (ft)	0.28

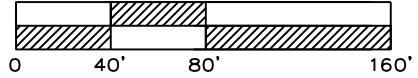
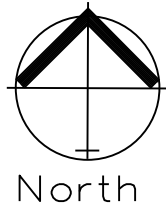
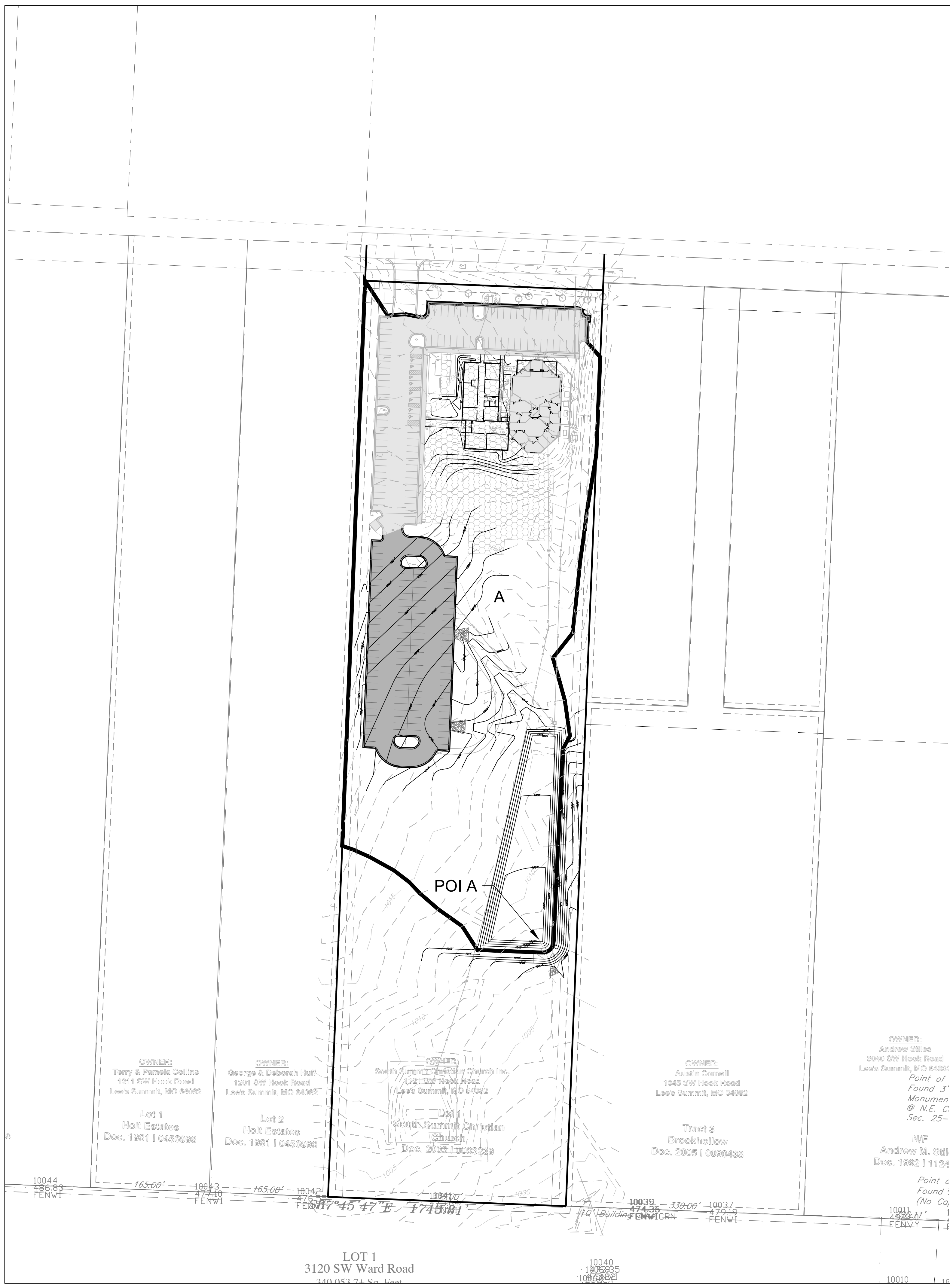
#### **Sharp Crested Weir**

Capacity (cfs)	7.64
Crest Length (ft)	15.5
Weir Coefficient, C	3.33
Required Head, H (Ft)	0.28

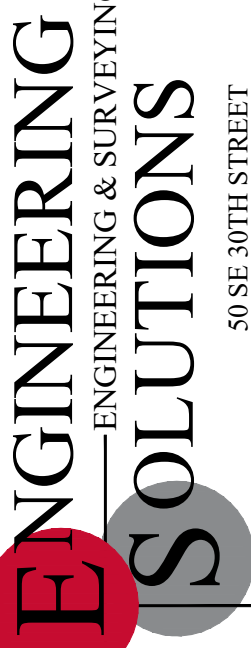
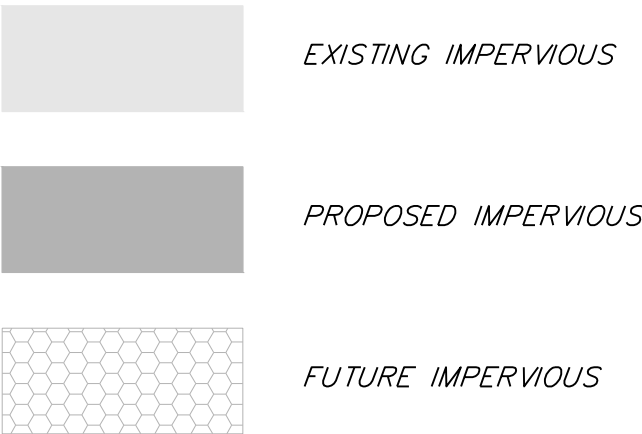
100-YR WSE	1010.49 (Hydraflow)
0.50' Freeboard Req'd	0.51
Required Head, H (ft)	0.28
Clogged 100-YR WSE	1011.28
1.00' Freeboard Req'd	1.00
Top of Dam	1012.28

# **Exhibit H**

## **Proposed Drainage Area Map**



PROPOSED DRAINAGE MAP  
SCALE: 1" = 80'

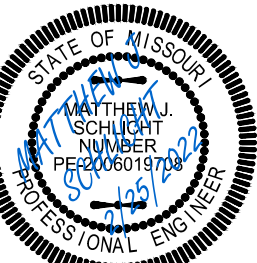


Professional Registration  
Missouri  
Engineering 2005002188-D  
Surveying 200500319-D  
Kansas  
Engineering E-1895  
Surveying LS-218  
Oklahoma  
Engineering 6254  
Nebraska  
Engineering CA2821

LIVING FAITH CHURCH  
LEE'S SUMMIT, JACKSON COUNTY, MISSOURI

Project:  
LIVING FAITH CHURCH LSWO  
Issue Date:  
January 28, 2022

Proposed Drainage Map  
Construction Plans for:  
LIVING FAITH CHURCH  
Lee's Summit, Jackson County, Missouri



Matthew J. Schlicht  
MO PE 2006019708  
KS PE 19071  
OK PE 25226

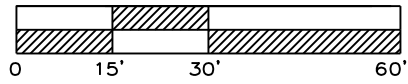
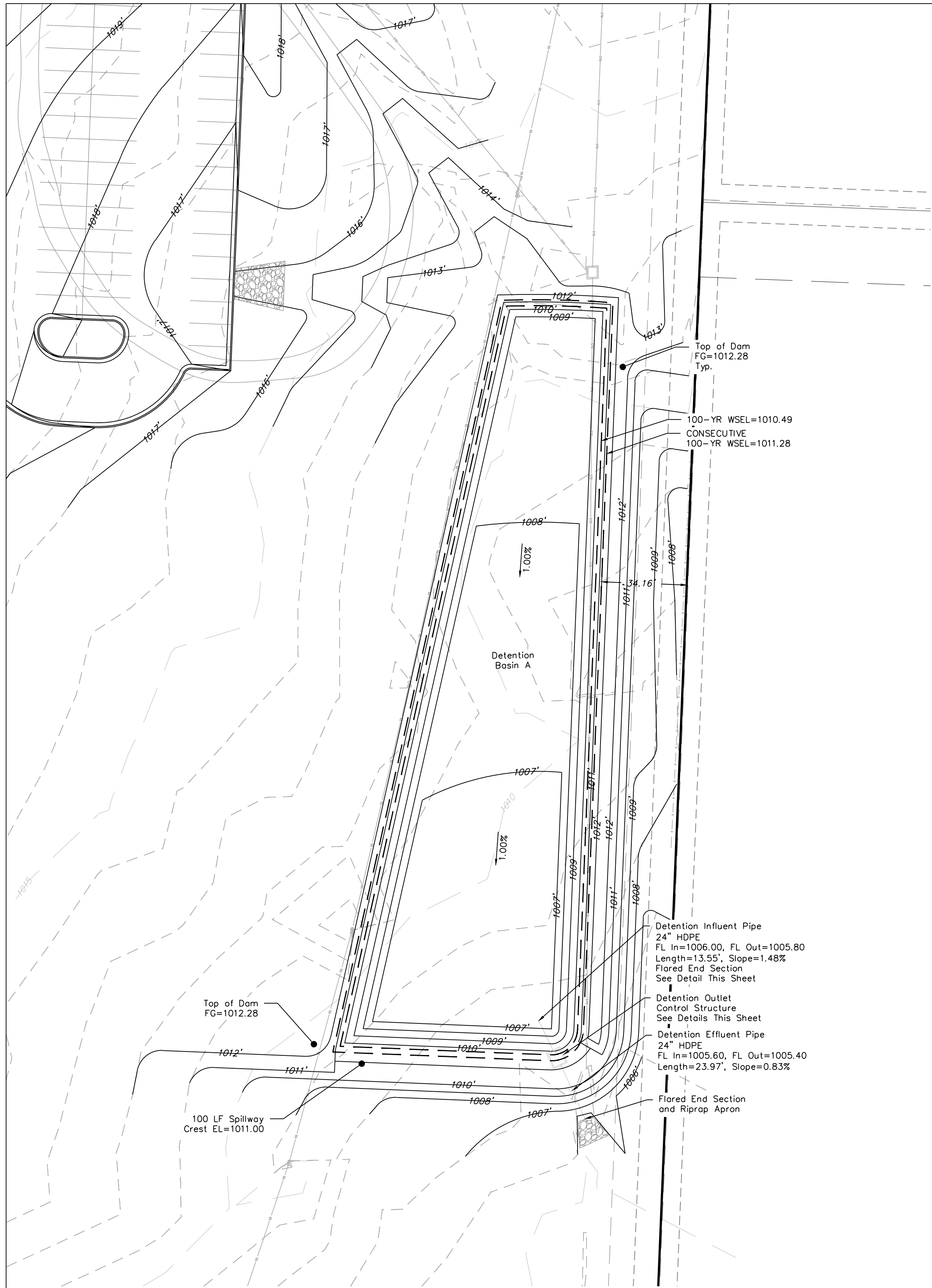
REVISIONS

EXHIBIT

# **Exhibit I**

## **Detention Basin Plan**

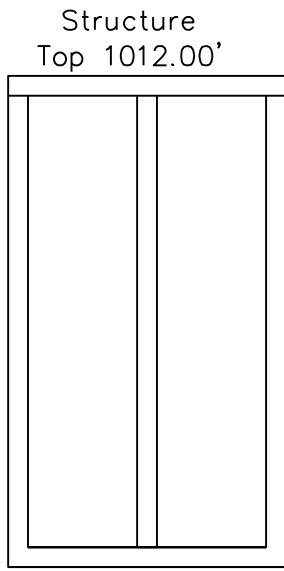




DETENTION BASIN PLAN

SCALE: 1" = 30'

- NOTES:
1. THE BASIN SHALL BE CONSTRUCTED WITH THE EROSION AND SEDIMENT CONTROL MEASURES.
  2. AN AS-BUILT DETENTION BASIN PLAN SHALL BE SUBMITTED AND ACCEPTED PRIOR TO ISSUANCE OF A CERTIFICATE OF SUBSTANTIAL COMPLETION, WITH AS-BUILT VERSUS PROPOSED STORAGE.

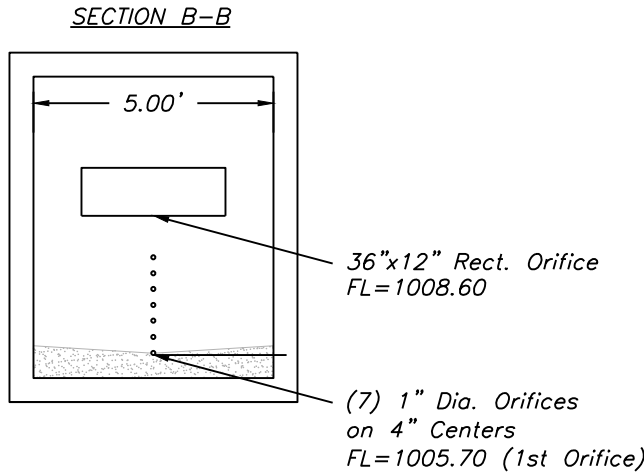
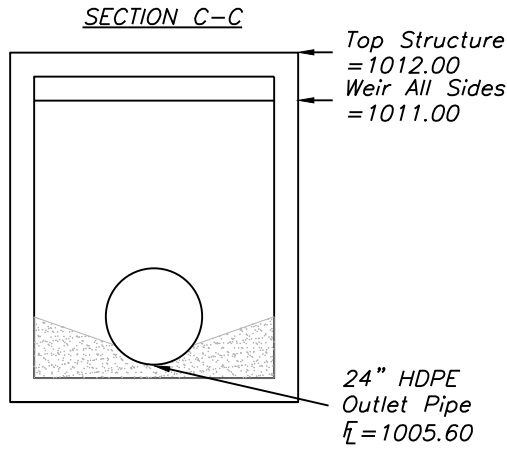
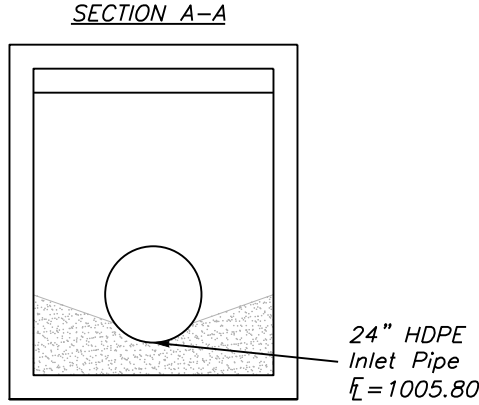
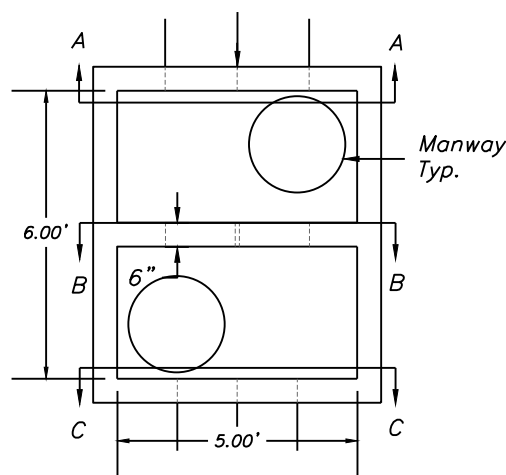
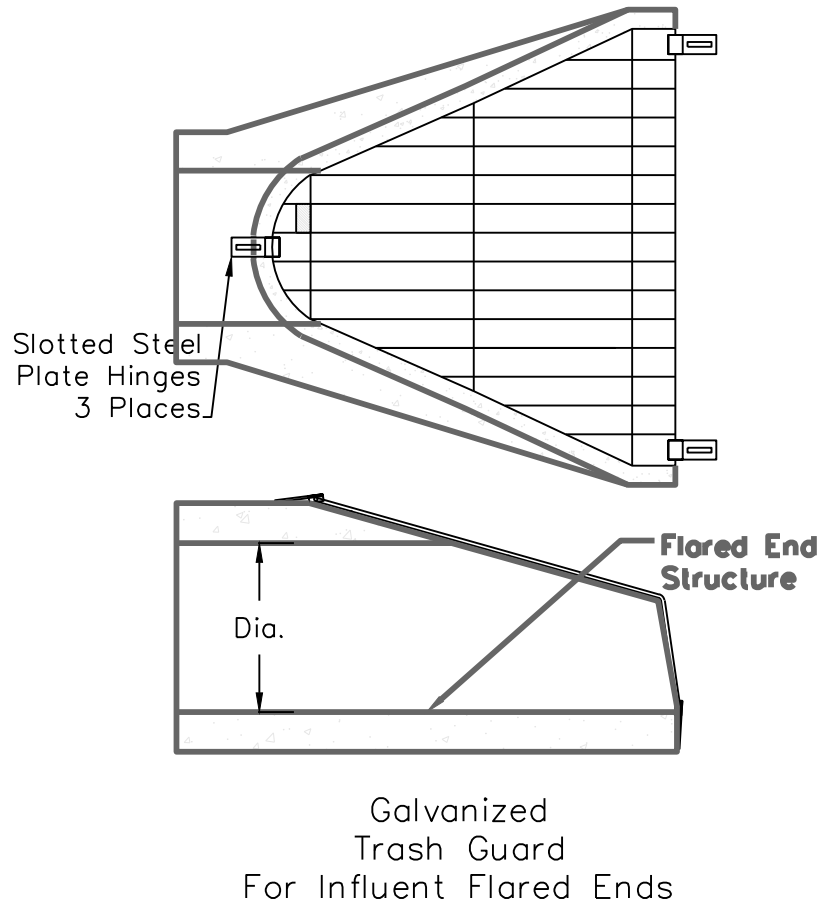


Top Pond EL 1012.28'  
Maximum Storage 87,788 c.f.

100 Year Clogged  
WSE=1011.28'  
100 Year  
WSE=1010.49'

SECTION VIEW - BASIN A  
N.T.S.

Category	2-YR	10-YR	100-YR
Nominal Storage (cf)	23,828	35,439	54,908
Allowable Release Rate POI-A (cfs)	2.98	11.92	17.88



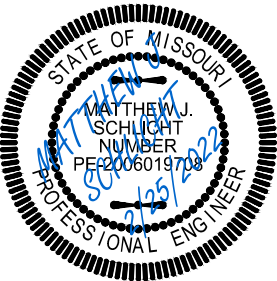
CONTROL STRUCTURE - BASIN A  
1/4" = 1'-0"

Professional Registration  
Missouri  
Engineering 2005002188-D  
Surveying 200500319-D  
Kansas  
Engineering E-1895  
Surveying LS-218  
Oklahoma  
Engineering 6254  
Nebraska  
Engineering CA2821

LIVING FAITH CHURCH  
LEES SUMMIT, JACKSON COUNTY, MISSOURI

Project:  
LIVING FAITH CHURCH LSWO  
Issue Date:  
January 28, 2022

Detention Basin Plan  
Construction Plans for:  
LIVING FAITH CHURCH  
Lee's Summit, Jackson County, Missouri



Matthew J. Schlicht  
MO PE 2006019708  
KS PE 19071  
OK PE 25226

REVISIONS



# **Exhibit J**

## **40 Hour Extended Detention Calculations**

## Calculate Water Quality for Storm Study

Project: LIVING FAITH CHURCH

Date: 6-24-27

To Calculate:  $WQ_v = P * R_v * A$

P (in) =	1.37
P (ft) =	0.11
Impervious Area (sq. ft.) =	108,182.65
Total Area (sq. ft.) =	259,617.60
Impervious Area (ac) =	2.48
Total Area (acre) =	5.96
$R_v = (0.05 * 0.009(I)) =$	0.43
Percent Impervious (I) =	41.67
$WQ_v$ (cu. ft.) =	12,598
$WQ_v$ (ac. ft.) =	0.289

Enter data in these Fields
Unit Conversions
1 Acre = 43,560 Sq. Ft.

CCN = 84

### Pond Volume

Elevation	Area (Sq. Ft.)	Volume (Cu. Ft.)
1,006.00	-	-
1,007.00	6,228.00	3,114.00
1,008.00	12,250.00	12,353.00
1,009.00	17,006.00	26,981.00
1,010.00	19,143.00	45,055.50
1,011.00	21,349.00	65,301.50
1,012.00	23,623.00	87,787.50

## 40 HOUR DETENTION CALC.

To Calculate: 40 Hour Detention (EDDB)

### I. Basin Water Quality Storage Volume

Step 1) Tributary area To EDDB,  $A_t$  (ac) =

$A_t$  (ac) = 5.96

Step 2) Calculate  $WQ_v$  using Sec. 6 (ac-ft) =

$WQ_v$  (ac. ft.) = 0.289

Step 3) Add 20 Percent to Step 2.

$V_{design}$  (ac-ft) = 0.347

### II.a. Water Quality Outlet Type

Step 1) Set water quality outlet type

Type 1 = single orifice

Type 2 = perforated riser or plate

Type 3 = v-notch weir

Outlet Type = 2

Step 2) Proceed to Step Iib, Iic, or Iid based on selection

### To Calculate $Z_{WQ}$ (ft) interpolate from Storm Study (Sheet 13)

Elevation 1 =	1008.00	Storage 1 =	12,353.00
Elevation X =		Storage X =	12,597.75
Elevation 2 =	1009.00	Storage 2 =	26,981.00
		Elevation X =	1008.02
Lowest Elevation of Pond =	1006.00		
Elevation X =	1008.02		
$Z_{WQ}$ (ft) =	2.02		

### Iic. Water Quality Outlet, Perforated Riser

Step 1) Depth at outlet above lowest perforation:	$Z_{WQ}$ (ft) =	2.02	Calculates the diameter of each hole given the depth of water and the area per row. Assuming 4" spacing. If less than 1" use 1" as $D_{perf}$ .
Step 2) Recommended maximum outlet area per row:	$A_0$ (in <sup>2</sup> ) =	0.729	
Step 3) Circular perforation diameter per row assuming a single column:	$D_1$ (in) =	0.392	
Step 5) Design circular perforation diameter (should be between 1 and 2 inches):	$n_c$ (unitless) =	1	
Step 6) Horizontal perforation column spacing when $n_c > 1$ , center to center:	$D_{perf}$ (in) =	1.000	
Note: If $D_{perf} \geq 1.0$ inch, $S_c = 4$	$S_c$ (in) =	4	
Step 7) Number of rows (4" vertical spacing between perforations, center to center):	$n_r$ (unitless) =	7	

Recommended Method:

Perforated Riser