MACRO STORM WATER DRAINAGE STUDY

Oldham Village

SW Quadrant SW Oldham Parkway & MO 291 South

Site Acreage: 49.68 Acres (Future Buildout)

Lee's Summit, MO

PREPARED BY:

ENGINEERING SOLUTIONS
ENGINEERING & SURVEYING
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Prepared On: May 22, 2024

Matthew J. Schlicht, PE

Revision

Date	Comment	By
6-25-24	Revised Per city Comment	AEP
11-1-24	Revised Design & per City Comment	AEP
3-4-25	Revised Design per City Comment	AEP

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3. GENERAL INFORMATION

The macro storm study has been prepared to evaluate potential negative downstream hydraulic impacts and propose potential mitigation measures associated with the redevelopment of the proposed Planned Mixed Use Development, Oldham Village. The proposed redevelopment will consist of three multi-family communities in addition to multiple commercial establishments. The site is located at the southwest corner of SW Oldham Parkway and MO 291 Highway. The proposed master development contains 45.41 acres with future potential up to 49.68 acres. The existing site is developed and contains primarily hard surface. An existing earthen detention basin is located on the southwest corner of the site. The detention basin drains into the upper most reach of Cedar Creek. The site consists of land located in Section 7, Township 47 North, and Range 31 West. See Exhibit A for an aerial view of the site along with a historical aerial of the site and surrounding area. A proposed site plan is also included in Exhibit A.

3.1 FEMA FLOODPLAIN DETERMINATION

The property is located in an Area of Minimal Flood Hazard, Zone X, according to Flood Emergency Management Agency (FEMA) Firm Map Number 29095C0419G, effective January 20, 2017.

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

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 24, August 31, 2022. The existing site contains three major soil types:

10082	Arisburg-Urban Land Complex, 1 to 5 Percent Slopes Hydrologic Soils Group (HSG): Type C
10181	Udarents-Urban Land-Sampsel Complex, 5 to 9 Percent Slopes (HSG): Type C
99033	Udarents-Urban Land Complex, 2 to 9 Percent Slopes (HSG): Type C

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

4. METHODOLOGY

This Macro Storm Drainage Study has been prepared to evaluate potential hydrologic impacts from the proposed redevelopment and recommend improvements to eliminate any potential negative impacts. The study utilized existing contours 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. If attenuation is to be employed it shall meet the Comprehensive Control Strategy with extended detention as outlined in APWA Section 5600.

Using the above criteria, the proposed site was evaluated using SCS Methods to calculate storm runoff volumes, peak rates of discharge, existing and proposed hydrographs and required storage volumes for attenuation facilities. The analysis contains results for the 2, 10 and 100-year design storms.

5. EXISTING CONDITIONS ANALYSIS

The site consists of one (1) drainage basin. The basin includes a substantial amount of offsite area to the north, south and east. The basin drains to Point of Interest A located approximately 260 feet west of the sites western

property boundary. POI A is the termination point for the FEMA FIS on Cedar Creek. The tributary area to the POI is 147.45+/- acres. The basin consists of 49.68 acres of proposed master development which includes potential future parcels and 97.77 acres of right-of-way and offsite area. The drainage basin has been essentially built out in the past and therefore currently has both open and enclosed storm sewer systems active throughout the basin. The basin generally drains to Cedar Creek located along the west central portion of the property. The basin is fairly symmetric with nearly equal portions draining from the north, east and south. The existing onsite detention basin area (Tract B) adjacent to Cedar Creek will continue to serve as detention for the proposed redevelopment.

An Existing Drainage Map may be found in Exhibit D. Hydraflow Hydrograph software was utilized to calculate SCS Method peak discharge rates. A complete breakdown of Existing and Proposed hydrographs may be found in Exhibit E. The following tables summarize the results of the Existing Conditions analysis.

Table 5.1 Existing Conditions Subarea

Subarea	Area (ac.)	Curve Number	Tc (min)
A	147.45	88	28.8

Table 5.2 Existing Conditions Runoff Data: Peak Discharge Rates

Subarea	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
A	303.47	508.68	809.50

Per APWA Section 5608.4 and City of Lee's Summit criteria, the performance criteria for detention is to provide detention to limit peak flow rates at downstream points of interest to maximum release rates:

- 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 allowable offsite contribution was determined by the area ratio method. The allowable offsite peak discharge is the product of the ratio of offsite area to onsite area multiplied by a given storms existing peak discharge rate. The allowable peak discharge rate is the sum of the offsite allowable plus the onsite allowable per APWA Section 5608.4. See allowable 100-year peak discharge rate calculation below.

Example (100-YR): [(97.77 / 147.45 x 809.50) + (49.68 x 3.0)] = 685.80 cfs

Table 5.3 Existing Conditions APWA Allowable Peak Discharge Release Rates

POI	Onsite Area (ac.)	Offsite Area (ac.)	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
A	49.68	97.77	226.06	436.65	685.80

There are a few very minor subareas that are peripheral (free release) areas on the site consisting primarily of turf with no hard infrastructure improvements. These areas are not being negatively impacted by the proposed improvements. Subarea A will be the focus of this report.

6. PROPOSED CONDITIONS ANALYSIS

The proposed conditions analysis will include potential future Oldham Village lots located along MO 291 Highway south of SW Oldham Parkway. The proposed onsite area including potential future lots is 49.68 acres. Tributary runoff will be conveyed via both open and enclosed storm sewer systems to POI "A". A new retention system

shall be constructed to attenuate post development runoff from Subarea A1 which includes a large percentage of right-of-way and offsite area. Detained peak discharge rates from Subarea A1 will be combined with peak discharge rates from Subarea A to determine the overall peak discharge rates at POI "A". The proposed peak discharge rates will be compared to allowable discharge rates to determine if they meet or exceed the City's Comprehensive Control Storm Water Management criteria. The Proposed Drainage Map may be found in Exhibit F.

Proposed Flow Rates

Existing Subarea A has been divided into two subareas to account for proposed attenuation. Subarea A1 is located generally in the north and accounts for all proposed and potential future improvements for Oldham Marketplace. Subarea 1 will drain via open and enclosed storm sewer systems to a new earthen detention basin located adjacent to Cedar Creek on a parcel of property labeled Tract B. The remainder of the property which will not be detained is generally located in the southern portion of the basin and will be referred to as Subarea B. The composite curve numbers utilized for Subareas A and B consist of the following classifications and land usage specific curve numbers; right-of-way and single family residential 82, multi-family residential 88 and commercial 94.

Table 6.1 Proposed Conditions Subarea Data

Subarea	Area (ac.)	Composite CN	Tc (min)
A1	128.42	88	28.8
A	19.02	82	15.7

Table 6.2 Proposed Conditions Runoff Data: Subarea Peak Discharge Rates

Subarea	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
A1	264.31	443.03	705.02
A	43.70	79.44	133.37
Combined (A1 + A)	294.69	498.80	799.42

As shown in Table 6.2 above Subarea A1 will require detention to attenuate storm runoff peak discharge rates at or below regulatory levels at POI A.

6.1. ATTENUATION

A new single stage earthen Retention basin A1 is being proposed in Subarea A1 to attenuate proposed peak discharge rates. The majority of runoff draining along the west property line and the retention basin will drain directly into the basin. A swale will be constructed beginning at elevation 1004 to convey the remainder of the tributary area to the existing stream. The proposed swale will mitigate any potential drainage impacts to the northern most three residential properties. Following are a list of design parameters for the attenuation system.

Designation: Retention Basin A1
Type: Earthen Basin
Side Slopes: 3:1 Max.
Bottom Slope: 0% (Retention)
Basin Bottom Elevation: 989.65
Permanent Pool Elevation: 995.00
Basin Top Berm Elevation: 1004.50 (Top crowned for drainage)
Basin Spillway Crest Width: 6.62' at 1002.23
Basin Volume: 1,103,968 cf @ 1004.50

Control Structure: (3) 8'x6' Precast Concrete Box with Interior 6" Baffle/Weir Wall
Baffle Wall Orifice: (1) 6.27" Sq. Rectangular Orifice (WQv Orifice) Screened
Weir Wall Crest Elevation: 996.55, L = 24'
Control Structure Top Elevation: 1002.00
Control Structure Emergency Overflow: N/A – Solid Top
Control Structure Influent Pipe: 60" HDPE, FL (In) = 995.00, FL (Out) = 994.90, L=14.48', S= 0.69%
Control Structure Effluent Pipe: 60" HDPE, FL (In) = 994.70, FL (Out) = 994.25, L=31.93', S=1.41%
Emergency Spillway: Earthen Broad Crested Weir, Crest Elevation=1002.23, Crest Length=190'
Consecutive 100-YR Q=705.02 cfs, Emergency Spillway HGL=1003.50, Freeboard=1.00'
Sediment Storage Required: 5-Year Accumulated per APWA Figure 5608-1 = 80 x 49.68 x 5 = 19,872 cf
Sediment Storage Provided: Bottom = 989.65, Depth = 0.35', V = 20,932 cf @ El = 990.00

The earthen broad crested weir emergency spillway location shall be located north of the residential subdivision to release solely onto City parkland adjacent to Cedar Creek in case of an emergency. The permanent pool shall be 5' deep with an additional 0.35'of sedimentation allowance. The pond will not support fish which requires a minimum 10' of depth plus sedimentation allowance. The Retention Basin Plan for the Development may be found in Exhibit G. Retention Basin A1 emergency spillway calculations may be found in Exhibit H. See Table 6.3 for a summary of detention basin data.

Table 6.3 Proposed Conditions Detention Basin A1 Data

	Peak Q In (cfs)	Tp In (min.)	Peak Q Out (cfs)	Tp Out (min)	Peak W.S.E.	Max. Storage Vol. (cf)
Basin A1						
2-Year	264.31	731	169.01	745	998.53	349,129
10-Year	443.03	731	275.71	745	1000.19	537,400
100-Year	705.02	731	503.51	742	1001.73	727,643

As shown in the table above all proposed peak discharge rates from Subarea A1 have been attenuated. See Table 6.4 below for a summary of proposed peak discharge rates at POI "A" which consists of combined subareas post detained A1 and A.

Table 6.4 Proposed Conditions Post Detention Point of Interest Peak Discharge Rates

Point of Interest	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
A	176.60	288.47	529.69

As shown in the above table all peak discharge rates attributable to Proposed POI "A" have been attenuated below both Existing and Allowable Peak Discharge rates as outlined in Tables 5.2 and 5.3, respectively.

Table 6.5 below provides a comparison of runoff data between Proposed, Existing and Allowable Conditions for the Proposed Development.

Table 6.5 Point of Interest Discharge Comparison

POI	Condition	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
A	Proposed	176.60	288.47	529.69
	Existing	303.47	508.68	809.50
	Difference	-126.87	-220.11	-279.81
	Allowable	226.06	436.65	685.80
	Difference	-49.46	-148.08	-156.11

All proposed peak discharge rates as shown in Table 6.5 will be significantly below allowable.

7. 40 HOUR EXTENDED DETENTION

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

8. DOWNSTREAM PEAK DISCHARGE EVALUATION

City personnel have requested a hydrology evaluation of peak discharge rates, downstream at the next major point of interest, to determine if attenuation on the subject project is efficacious for the watershed. FEMA completed a revised Flood Insurance Study (FIS) for Cedar Creek on January 20, 2017. As stated earlier in the report our drainage boundary for the project stormwater management analysis started at the termination of the recently revised FEMA FIS. To accommodate the City's request and to provide weight to our downstream analysis we consulted the FEMA FIS to select a downstream POI that could be corroborated. The first downstream POI in which peak discharge rates had been quantified in the FIS occurred approximately 580 feet downstream of Southwest Lakeview Boulevard. We selected said point, referred to as POI B for the purposes of this report, to determine and evaluate downstream peak discharge rates. See Exhibit J for FEMA FIS data and a Downstream Drainage Area Map.

The additional area (Subarea B) tributary to POI B downstream of POI A is 87.50 acres. Subarea B consists of park land, single family residential and a portion of Pleasant Lee Middle School Campus. The composite runoff coefficient for Subarea B equates to 0.51 or a curve number of 82. Composite curve number calculations may be found in Exhibit J along with time of concentration calculations. Hydraflow was used to generate existing and proposed peak discharge rates at POI B using SCS Methodology. Hydrographs pertaining to the downstream peak discharge evaluation may be found in Exhibit E.

In order to confirm the SCS model was calibrated to the FEMA FIS data for Subarea B was combined with data from Existing Subarea A. The combined data was used to generate hydrograph "EX POI B – FIS CALIBRATION" to determine if our data was generating results commensurate with the FEMA FIS. FEMA does not provide peak discharge rates for the 2-year storm event. The 10 and 100-year FEMA FIS peak discharge rates at POI B are 536 cfs and 869 cfs, respectively. The "POI B – NO DETENTION" hydrograph generated peak discharge rates for the 10 and 100-year storm events of 548 cfs and 892 cfs, respectively. The 10 and 100-year peak discharge rates are within 2.24% and 2.65%, respectively. Based on the aforementioned results obtained from the independently derived data both the data and the methodology utilized were determined to be accurate for planning and design.

In order to provide an accurate downstream peak discharge comparison at POI B we utilized the systematic combining of hydrographs for both existing and proposed conditions. Hydrograph EX POI B – NO DETENTION combines existing POI A hydrograph with existing Subarea B hydrograph to yield the existing 10 and 100 year peak discharge rates at POI B. Hydrograph PROP POI B – WITH DETENTION combines proposed POI A which accounts for detention as detailed in Section 6 with existing Subarea B hydrograph to yield the proposed 10 and 100 year peak discharge rates at POI B. This is the method used when breaking a watershed and detaining a portion.

Table 8.1 below provides a Point of Interest peak discharge rate comparison between Existing and Proposed conditions at POI B.

Table 8.1 Point of Interest Discharge Comparison

POI	Condition		Q10 (cfs)	Q100 (cfs)
B	Proposed		575.82	963.41
	Existing		804.35	1309.46
	Difference		-228.53	-346.05

The proposed condition in Table 8.1 above represents 49.68 acres of Subarea A1 being attenuated based on a comprehensive control strategy as outlined in Section 6.1. The data compiled in Table 8.1 confirms that attenuation as outlined earlier in the report reduces peak discharge rates at both Points of Interest therefore reducing the likelihood of any potential flooding in the watershed.

9. STREAM BUFFER DETERMINATION

The south east portion of Subarea A is conveyed to POI A by a natural stream which constitutes part of the headwater complex tributary to Cedar Creek. A retention basin is being proposed in the stream bed and surrounding area therefore a stream buffer evaluation is required. Stream buffers are provided for natural streams which contain wide swaths of riparian area consisting of mature trees and steep slopes. The buffer is formed to protect the natural stream and surrounding property from encroachment of permanent hard surface development and other construction activities. One factor used to determine if a natural stream requires a buffer is tributary area. The regulatory requirement according to APWA is 40 acres. See Exhibit F Proposed Drainage Map for tributary area (hatched) contributing to the natural stream at the west property line. The stream tributary at the centerline of the stream along the west property line is 34.21 acres. The tributary area is below the 40 acre threshold therefore a stream buffer is not required and in stream retention may be utilized for attenuation purposes.

10. WETLAND DETERMINATION

We have had several lengthy conversations with representatives from the United States Army Corp of Engineers (USACE) over the last several months for various projects concerning USACE jurisdiction of streams/creeks and wetlands. Mrs. Danielle Brunin with USACE Regulatory Branch in Kansas City, Missouri has been especially gracious in helping us better understand and determine potential USACE jurisdictional waters. The property in question makes up the headwaters for an unnamed tributary of Cedar Creek. The channel located on the property is ephemeral and connected to a non-navigable intrastate water therefore not under United States Army Corp of Engineers (USACE) jurisdiction. The property is not identified as wetlands in the National Wetlands Inventory. Based on site investigations no wetlands appear to be present. Jurisdiction extends to only those “wetlands with a continuous surface connection to bodies that are ‘waters of the united states’ in their own right,” so that they are “indistinguishable” from those waters. See Exhibit K for an aerial photo from the National Wetlands Inventory of the subject property and surrounding area. The main branch of Cedar Creek is identified as Riverine in the National Wetlands Inventory. It is our opinion that the subject property does not contain wetlands as defined by the USACE.

11. DAM BREACH EVALUATION

The City has requested that a dam breach analysis of the proposed retention basin be performed. The Point of Interest for the analysis will be at the existing culvert on Southwest Lakeview Boulevard, referred to as POI “C”. Exhibit L contains the downstream breach drainage map. The dam breach calculations for the proposed retention basin where performed using USDA TR-210-60 criteria. The document states to evaluate the dam failure at peak reservoir stage resulting from the Probable Maximum Flood (PMF). The 100-year clogged condition flood was utilized to determine the depth of water and storage volume at the time of dam failure. A water depth of 7.58 feet was calculated along with a storage volume of 20.17 ac-ft. The peak breach discharge

was calculated to be 545.62 cfs of which 128.42 acres are tributary. Peak breach discharge calculations may be found in Exhibit M.

Subarea A contains 147.45 acres of which 19.02 acres (70.37 cfs) are located southwest of the proposed development and are free released. Subarea C downstream and west of the proposed development contains 74.08 acres (274.10 cfs). Peak discharge rates for non-attenuated areas have been assigned peak discharge rates in accordance with the latest FEMA FIS, excerpts of said study may be found in Exhibit J. Peak discharge rates were calculated using a standard area-ratio method. Each acre in the FEMA Watershed represents 3.70 cfs/acre. The 128.42 acre tributary to the retention basin will be assigned the peak breach discharge rate of 545.62 cfs. The FEMA 100-year peak discharge rate at the SW Lakeview Boulevard Culvert is 819.62 cfs. The potential peak breach discharge at the POI is calculated to be 890.09 cfs.

The SW Lakeview Boulevard culvert consists of a dual cell RCB with cell 1 measuring 4’ wide by 4’ high and the second cell measuring 10’ wide by 4’ high. The RCB has wing walls with zero flare. The culvert capacity will be exceeded in the breach scenario. The peak breach discharge will overtop SW Lakeview Boulevard. APWA Figure 5603-1 Headwater Depth for Box Culverts with Inlet Control was used in conjunction with APWA Equation 5601.8.B.2.b. to determine the anticipated roadway overtopping depth if the Oldham Village Retention Basin is breached. Both the APWA Nomograph and overtopping calculations may be found in Exhibit N. The anticipated maximum water surface elevation (WSE) crossing SW Lakeview Boulevard during a breach event consisting of a 100-year storm in the tributary along with a clogged outlet structure is 976.60 equating to a maximum roadway overtopping depth of 1.41 feet at the crown.

There are two residences downstream (west) of SW Lakeview Boulevard that have potential to be compromised during low recurrence interval storms such as the 100-year or the breach event. They are 1016 SW Lakeview Blvd to the north of Cedar Creek and 1018 SW Lakeview Blvd south of Cedar Creek. 1016 SW Lakeview Blvd has a finish floor elevation of 977.54 which equates to a freeboard of 0.94 feet. 1018 SW Lakeview Blvd has a finish floor elevation of 981.20 which equates to a freeboard of 4.60 feet. Both residences should avoid flooding in the case of a 100-year storm in conjunction with a clogged outlet and subsequent dam breach at Oldham Village.

12. CONCLUSIONS & RECOMMENDATIONS

Runoff from the Development will be reduced below both existing and allowable for the Subarea. A retention basin is being proposed in Subarea A1 to attenuate peak discharge rates. Retention Basin A1 will attenuate all proposed peak discharge rates below both Existing and Allowable. Proposed peak discharge rates meet or exceed APWA Section 5600 Comprehensive Control Strategy targets. Onsite Attenuation utilizing comprehensive control strategy with extended detention as outlined will reduce peak discharge rates downstream. It is the opinion of the Professional Engineer that the proposed storm water management improvements outlined in the report will help mitigate any potential negative hydraulic impacts onsite and downstream and therefore recommends approval of said improvements and the storm study.

12. EXHIBITS

- **Exhibit A**
  - **Aerial View of Site**
  - **Historical Aerial View of Site & Surrounding Area**
  - **Overall Site Plan**
- **Exhibit B**
  - **FEMA FIRMette**
- **Exhibit C**
  - **NRCS Soils Report**
- **Exhibit D**
  - **Existing Drainage Area Map**
- **Exhibit E**
  - **Hydraflow Hydrograph Report**
- **Exhibit F**
  - **Proposed Drainage Area Map**
- **Exhibit G**
  - **Retention Basin Plan**
  - **Profile Riprap Energy Dissipator Basin & Retention Basin**
- **Exhibit H**
  - **Emergency Spillway Calculations**
- **Exhibit I**
  - **40 Hour Extended Detention Calculations**
- **Exhibit J (Downstream Peak Discharge Evaluation)**
  - **FEMA FIS Data**
  - **Downstream Drainage Area Maps**
    - **With Parcels**
    - **Without Parcels**
  - **Composite Curve Number Calculations**
  - **Time of Concentration Calculations**
- **Exhibit K**
  - **Aerial Photo National Wetlands Inventory**
- **Exhibit L**
  - **Downstream Breach Drainage Map**
- **Exhibit M**
  - **Peak Breach Discharge Calculations**
- **Exhibit N**
  - **SW Lakeview Blvd – Culvert Analysis**

Exhibit A

Aerial View of Site

&

Aerial View of Surrounding Area

&

Overall Site Plan

5/2023

SW Oldham Pkwy

SW Allendale Blvd

SW Stratford Rd

Oldham Pkwy

Oldham Pkwy

SE Blue Pkwy

50

50

50

50

SW Jefferson St

291

SW Persels Rd

SW Persels Rd

Image © 2023 Airbus

SE Bailey Rd

SE Brownlee St

1158 ft

8/2007

SW Oldham Pkwy

SE Blue Pkwy

SW Allendale Blvd

SW Stratford Rd

Oldham Pkwy

Oldham Pkwy

SW Walnut St

SW Jefferson St

SW Persels Rd

SW Persels Rd

Image USDA/FPAC/GEO

SE Bailey Rd

SE Browning St

1158 ft

50

50

50

291

North

GRAPHIC SCALE
0 50' 100' 200'

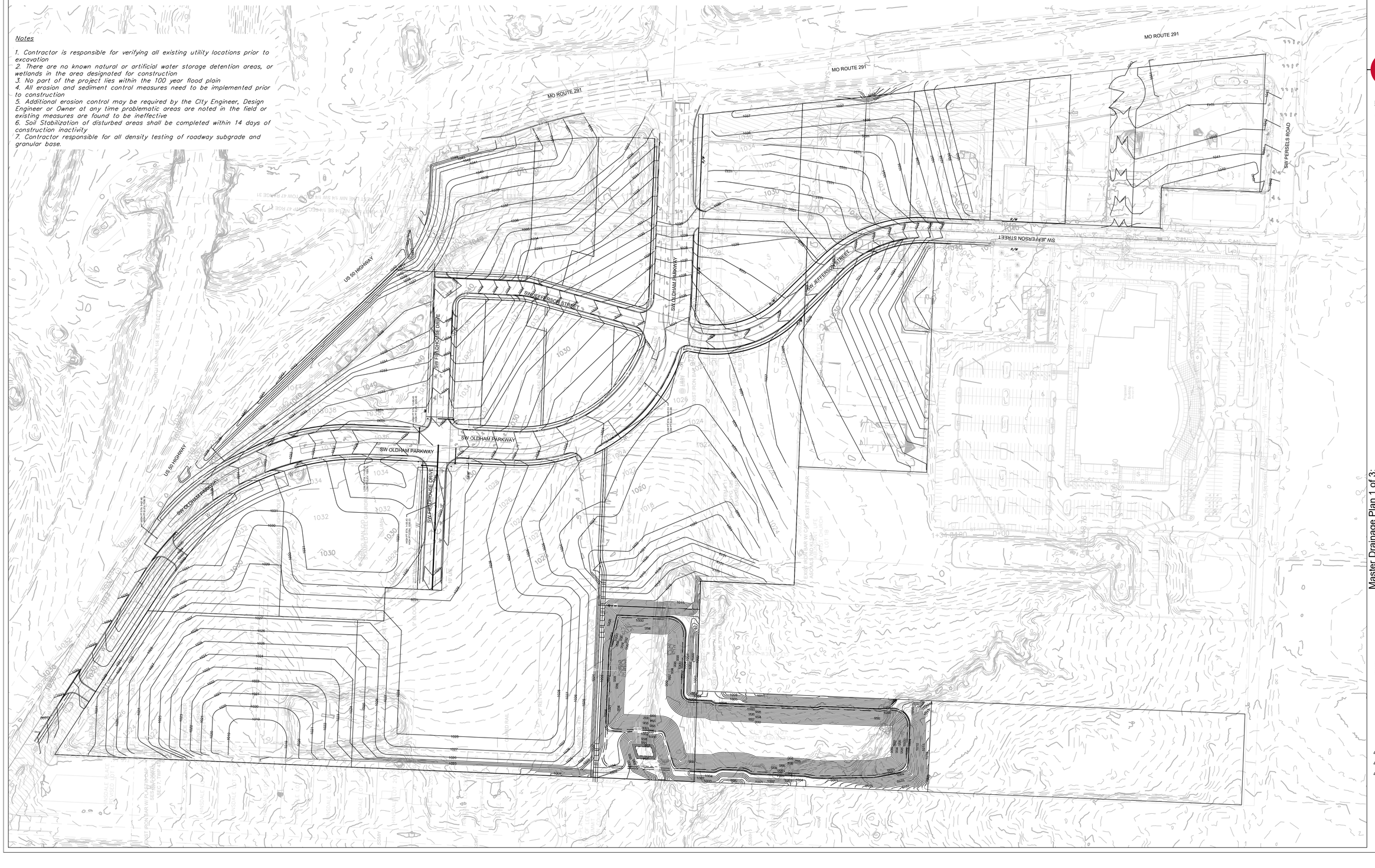
GRADING PLAN

SCALE: 1" = 100'

3 REVISED NORTH ARROW.

Notes

1. *Contractor is responsible for verifying all existing utility locations prior to excavation*
2. *There are no known natural or artificial water storage detention areas, or wetlands in the area designated for construction*
3. *No part of the project lies within the 100 year flood plain*
4. *All erosion and sediment control measures need to be implemented prior to construction*
5. *Additional erosion control may be required by the CIty Engineer, Design Engineer or Owner at any time problematic areas are noted in the field or existing measures are found to be ineffective*
6. *Soil Stabilization of disturbed areas shall be completed within 14 days of construction inactivity*
7. *Contractor responsible for all density testing of roadway subgrade and granular base.*



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Professional Registration
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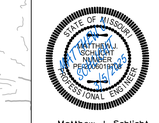
Surveying 2005008319-D
Kansas
Engineering E-1695
Surveying LS-218
Oklahoma
Engineering 6254
Nebraska
Engineering CA2821

Oldham Village
Lee's Summit, Jackson County, Missouri

Project: OLDHAM MASTERPLACE, LSMO

Issue Date: November 5, 2024

Master Drainage Plan 1 of 3:
Grading Plan
Construction Plans for:
Oldham Village
Lee's Summit, Jackson County, Missouri



Matthew J. Schlicht
MO PE 2006019708
KS PE 19071
OK PE 25226
NE PE E-14335

REVISIONS

1 REV. 12/10/2024
2 REV. 1/2/2025
3 REV. 2/6/2025
REV. 3/5/2025

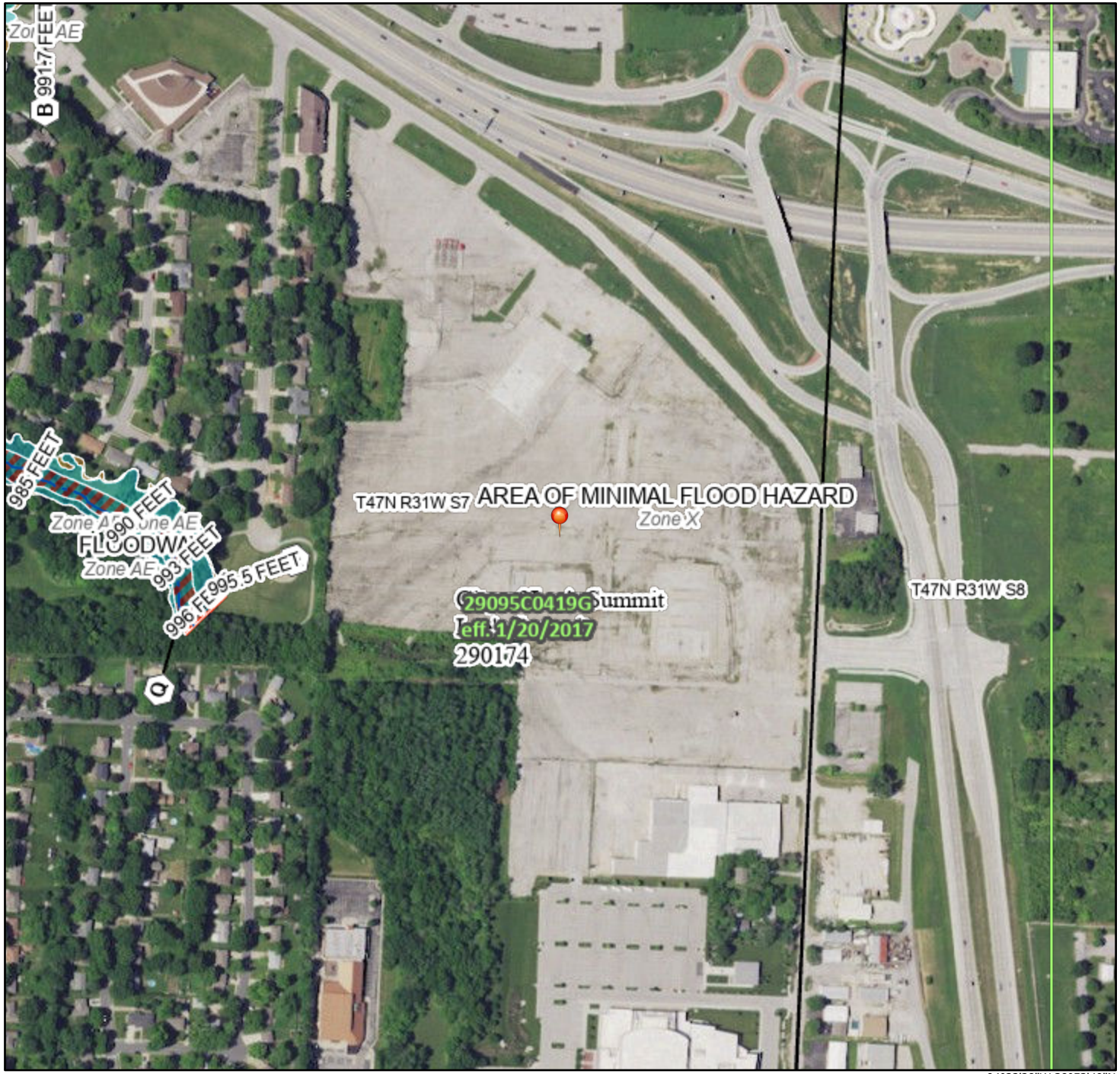
C.200

Exhibit B

FEMA FIRMette

National Flood Hazard Layer FIRMette

94°23'5"W 38°54'17"N



94°22'28"W 38°53'49"N

Feet 1:6,000

0 250 500 1,000 1,500 2,000

Basemap Imagery Source: USGS National Map 2023

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
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 Cross Sections with 1% Annual Chance
- 17.5 Water Surface Elevation
- Coastal Transect
- 513 Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

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 6/9/2023 at 12:56 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 Soils 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

Oldham Marketplace

June 9, 2023

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.

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Contents

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.

Custom Soil Resource Report
Soil Map

Map Scale: 1:3,200 if printed on A portrait (8.5" x 11") sheet.

N

Meters
0 45 90 180 270

Feet
0 150 300 600 900

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 24, Aug 31, 2022

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
10082	Arisburg-Urban land complex, 1 to 5 percent slopes	2.1	5.8%
10181	Udarents-Urban land-Sampsel complex, 5 to 9 percent slopes	10.2	28.2%
99033	Udarents-Urban land complex, 2 to 9 percent slopes	23.8	65.9%
Totals for Area of Interest		**36.1**	**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

10082—Arisburg-Urban land complex, 1 to 5 percent slopes

Map Unit Setting

National map unit symbol: 2w7ld
Elevation: 750 to 1,130 feet
Mean annual precipitation: 39 to 45 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: 61 percent
Urban land: 30 percent
Minor components: 9 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

Description of Urban Land

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydric soil rating: No

Minor Components

Sampsel

Percent of map unit: 3 percent
Landform: Hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Concave
Ecological site: R109XY010MO - Interbedded Sedimentary Upland Savanna
Hydric soil rating: Yes

Greenton

Percent of map unit: 3 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

Sharpsburg

Percent of map unit: 3 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

10181—Udarents-Urban land-Sampsel complex, 5 to 9 percent slopes

Map Unit Setting

National map unit symbol: 1n85g
Elevation: 600 to 900 feet
Mean annual precipitation: 33 to 43 inches
Mean annual air temperature: 50 to 57 degrees F
Frost-free period: 175 to 220 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Udarents and similar soils: 46 percent
Urban land: 39 percent
Sampsel and similar soils: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Udarents

Setting

Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Mine spoil or earthy fill

Typical profile

C1 - 0 to 5 inches: silt loam
C2 - 5 to 80 inches: silty clay loam

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 (0.14 to 0.57 in/hr)
Depth to water table: More than 80 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 9.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Ecological site: R107XB002MO - Deep Loess Upland Prairie
Other vegetative classification: Mixed/Transitional (Mixed Native Vegetation)
Hydric soil rating: No

Description of Urban Land

Setting

Landform: Hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Across-slope shape: Convex

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydric soil rating: No

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
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

99033—Udarents-Urban land complex, 2 to 9 percent slopes

Map Unit Setting

National map unit symbol: 1n85n
Elevation: 710 to 1,470 feet
Mean annual precipitation: 31 to 47 inches
Mean annual air temperature: 46 to 57 degrees F
Frost-free period: 170 to 220 days
Farmland classification: Not prime farmland

Map Unit Composition

Udarents and similar soils: 50 percent
Urban land: 45 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Udarents

Setting

Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Mine spoil or earthy fill

Typical profile

C1 - 0 to 5 inches: silt loam
C2 - 5 to 80 inches: silty clay loam

Properties and qualities

Slope: 2 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 (0.14 to 0.57 in/hr)
Depth to water table: More than 80 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 9.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Other vegetative classification: Mixed/Transitional (Mixed Native Vegetation)
Hydric soil rating: No

Description of Urban Land

Setting

Landform position (two-dimensional): Backslope
Across-slope shape: Convex

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydric soil rating: No

Minor Components

Knox

Percent of map unit: 3 percent
Landform: Hillslopes
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Ecological site: R107XB003MO - Deep Loess Exposed Backslope Savanna, F107XB004MO - Deep Loess Protected Backslope Woodland
Hydric soil rating: No

Sibley

Percent of map unit: 2 percent
Landform: Hillslopes
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Ecological site: R109XY002MO - Loess Upland Prairie
Hydric soil rating: No

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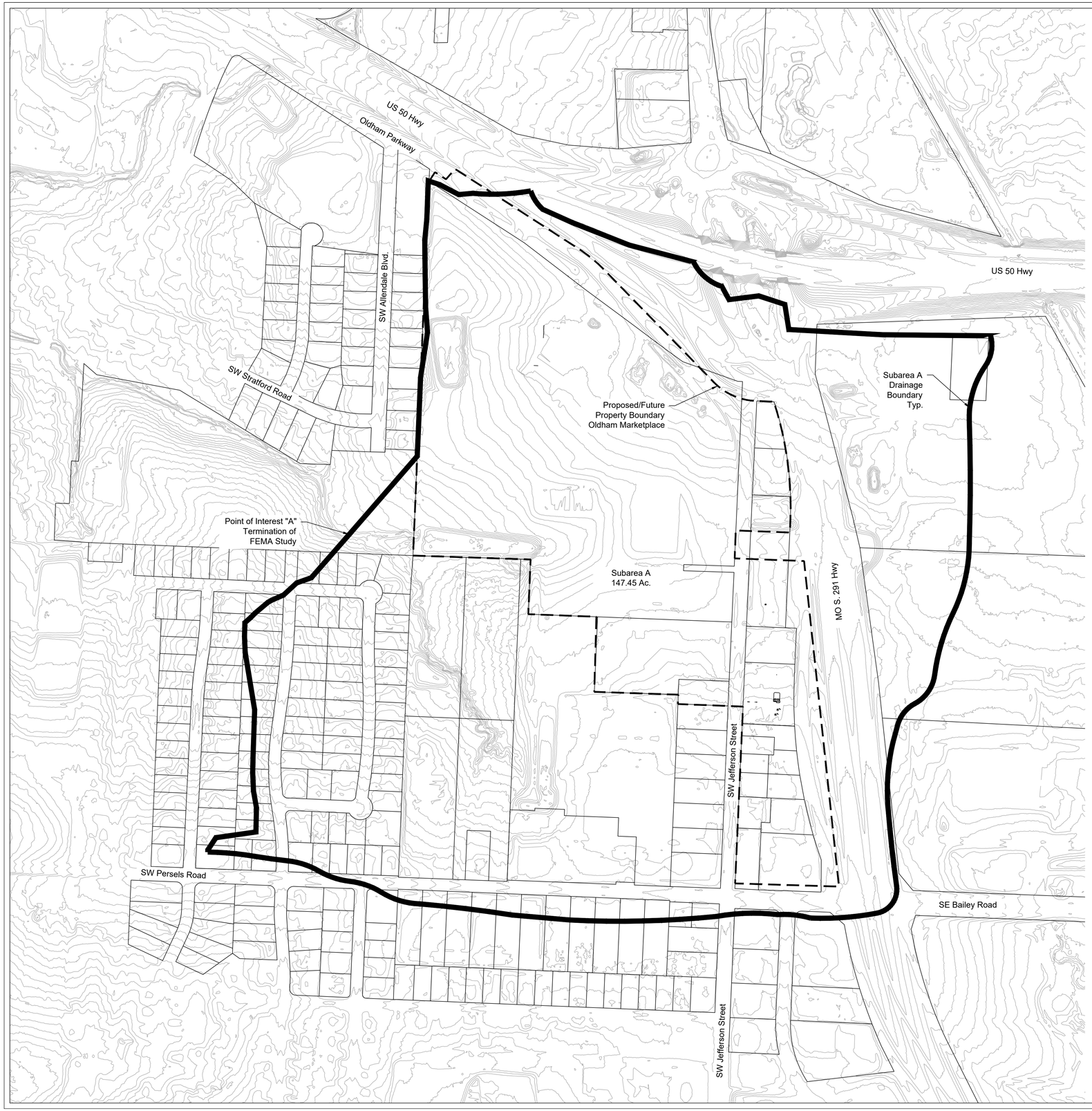
Exhibit D

Existing Drainage Area Map



North

0 100' 200' 400'

EXISTING DRAINAGE MAP

SCALE: 1" = 200'

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

Professional Registration
Missouri
Engineering 2005002186-D
Surveying 2005008319-D
Kansas
Engineering E-1695
Surveying LS-218
Oklahoma
Engineering 6254
Nebraska
Engineering CA2821

Oldham Marketplace
LEE'S SUMMIT, JACKSON COUNTY, MISSOURI

Project: Oldham Marketplace
Issue Date: October 20, 2022

EXISTING DRAINAGE MAP
Conceptual Drainage Plan for:
Oldham Marketplace
Lee's Summit, Jackson County, Missouri

Matthew J. Schlicht
MO PE 2006019708
KS PE 19071
OK PE 25226
NE PE E-14335

REVISIONS

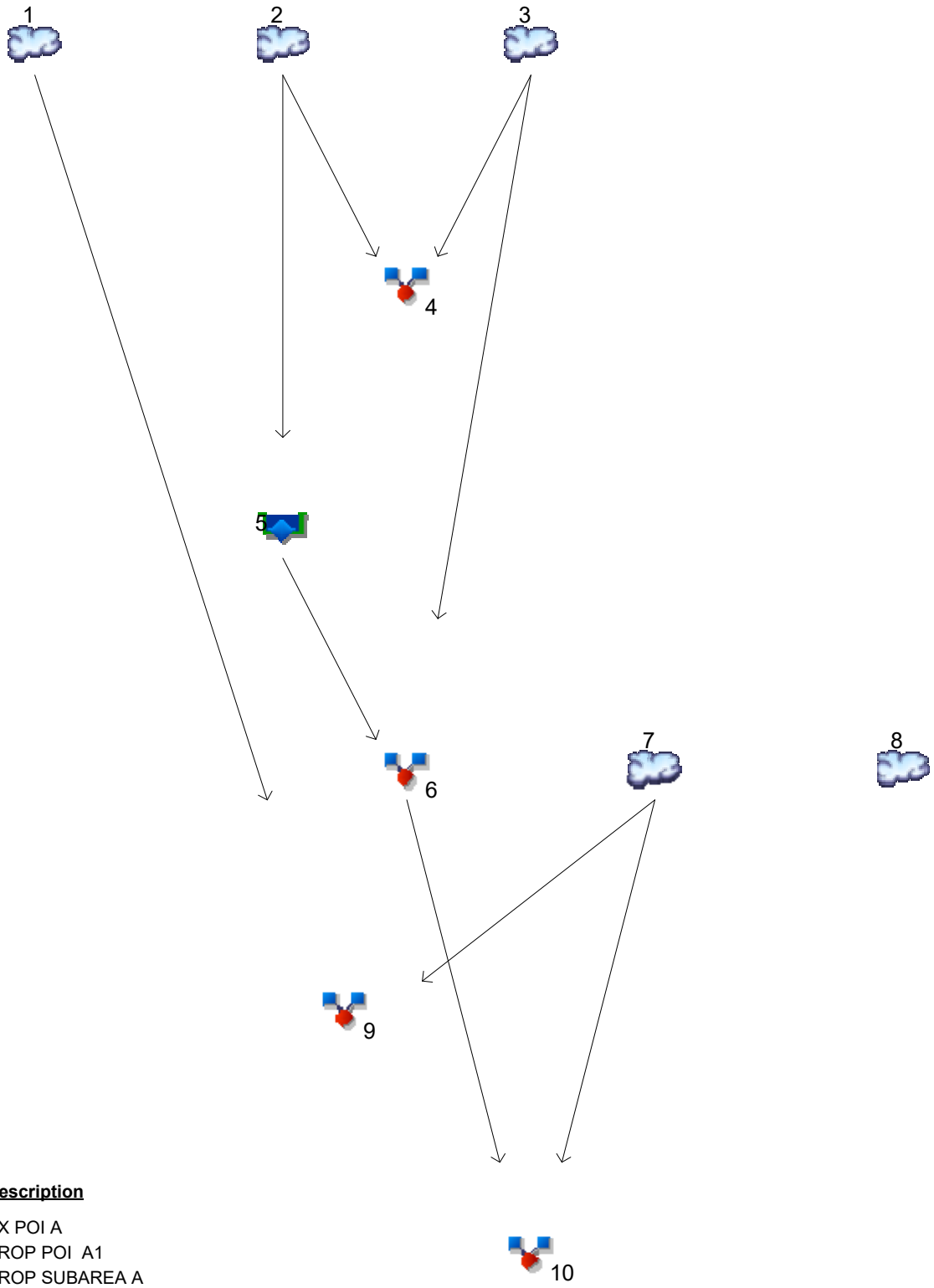
EXHIBIT

Exhibit E

Hydraflow Hydrograph Report

Hydraflow Table of Contents

Watershed Model Schematic



Legend

Hyd.	Origin	Description
1	SCS Runoff	EX POI A
2	SCS Runoff	PROP POI A1
3	SCS Runoff	PROP SUBAREA A
4	Combine	COMBINED (A1+A)
5	Reservoir	DETAINED SUBAREA A1
6	Combine	PROP POI A
7	SCS Runoff	SUBAREA B
8	SCS Runoff	EX POI B - FIS CALIBRATION
9	Combine	EX POI B - NO DETENTION
10	Combine	PROP POI B - WITH DETENTION

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	------	-------	303.47	-------	-------	508.68	-------	-------	809.50	EX POI A
2	SCS Runoff	------	-------	264.31	-------	-------	443.03	-------	-------	705.02	PROP POI A1
3	SCS Runoff	------	-------	43.70	-------	-------	79.44	-------	-------	133.37	PROP SUBAREA A
4	Combine	2, 3	-------	294.69	-------	-------	498.80	-------	-------	799.42	COMBINED (A1+A)
5	Reservoir	2	-------	169.01	-------	-------	275.71	-------	-------	503.51	DETAINED SUBAREA A1
6	Combine	3, 5	-------	176.60	-------	-------	288.47	-------	-------	529.69	PROP POI A
7	SCS Runoff	------	-------	173.67	-------	-------	317.20	-------	-------	534.31	SUBAREA B
8	SCS Runoff	------	-------	316.51	-------	-------	548.30	-------	-------	892.27	EX POI B - FIS CALIBRATION
9	Combine	1, 7,	-------	464.88	-------	-------	804.35	-------	-------	1309.46	EX POI B - NO DETENTION
10	Combine	6, 7,	-------	308.54	-------	-------	576.93	-------	-------	943.76	PROP POI B - WITH DETENTION

Hydrograph Summary Report

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

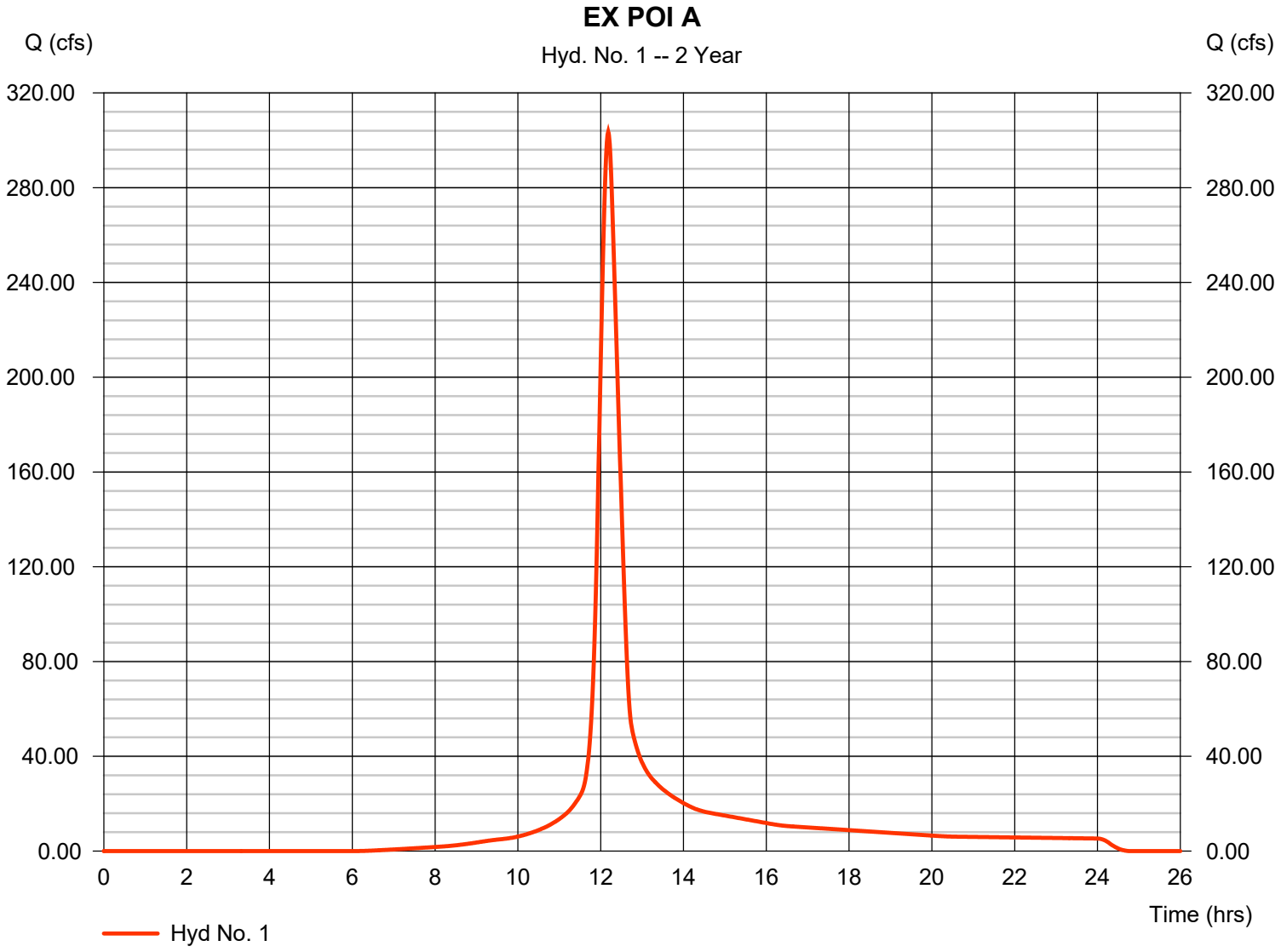
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	303.47	1	731	1,214,296	------	------	------	EX POI A
2	SCS Runoff	264.31	1	731	1,057,578	------	------	------	PROP POI A1
3	SCS Runoff	43.70	1	723	124,614	------	------	------	PROP SUBAREA A
4	Combine	294.69	1	730	1,182,192	2, 3	------	------	COMBINED (A1+A)
5	Reservoir	169.01	1	745	1,004,168	2	998.53	349,129	DETAINED SUBAREA A1
6	Combine	176.60	1	744	1,128,782	3, 5	------	------	PROP POI A
7	SCS Runoff	173.67	1	726	571,646	------	------	------	SUBAREA B
8	SCS Runoff	316.51	1	744	1,789,688	------	------	------	EX POI B - FIS CALIBRATION
9	Combine	464.88	1	729	1,785,939	1, 7,	------	------	EX POI B - NO DETENTION
10	Combine	308.54	1	730	1,700,425	6, 7,	------	------	PROP POI B - WITH DETENTION

Hydrograph Report

Hyd. No. 1

EX POI A

Hydrograph type	= SCS Runoff	Peak discharge	= 303.47 cfs
Storm frequency	= 2 yrs	Time to peak	= 12.18 hrs
Time interval	= 1 min	Hyd. volume	= 1,214,296 cuft
Drainage area	= 147.450 ac	Curve number	= 88
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 28.80 min
Total precip.	= 3.50 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

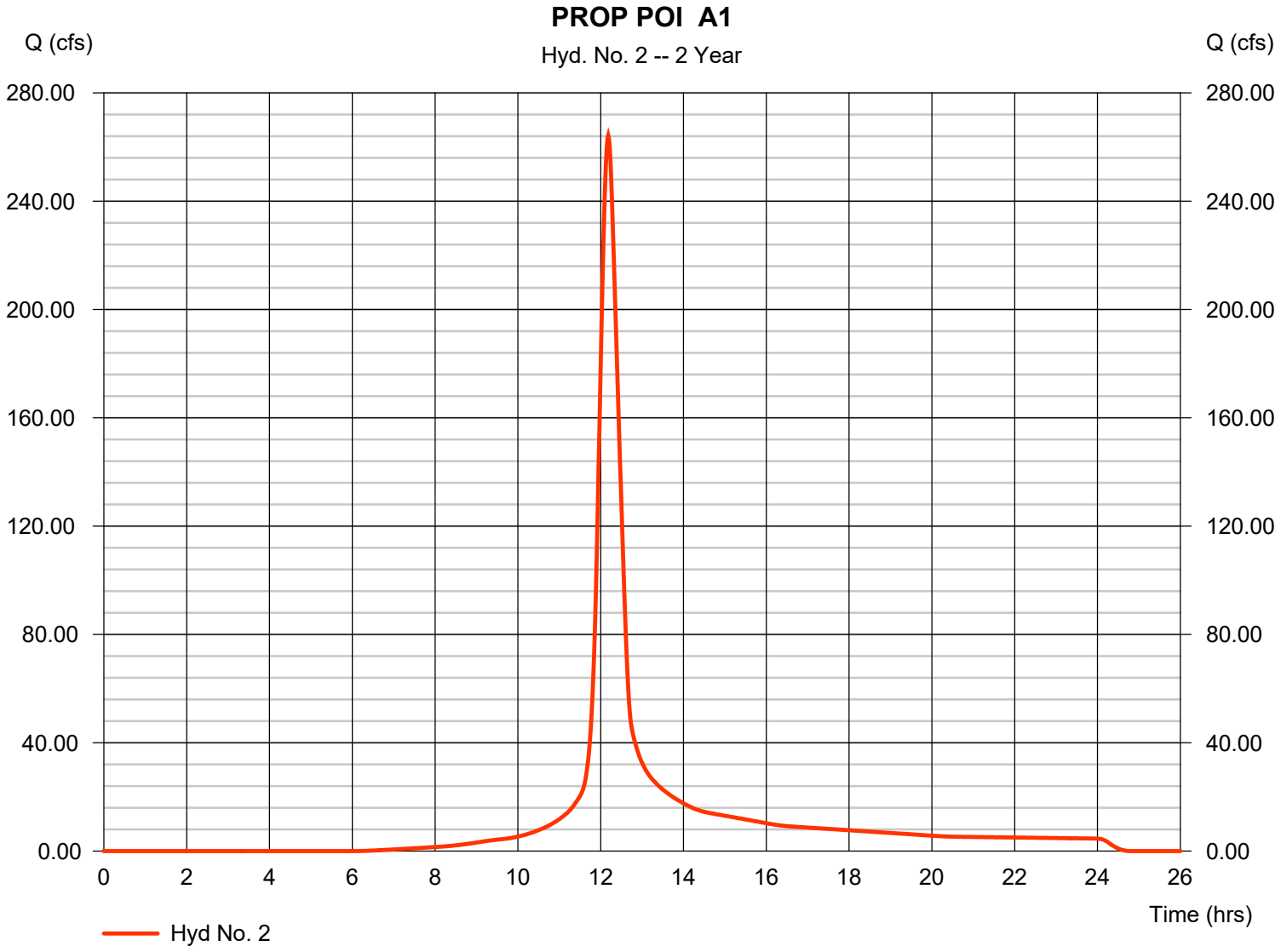


Hydrograph Report

Hyd. No. 2

PROP POI A1

Hydrograph type	= SCS Runoff	Peak discharge	= 264.31 cfs
Storm frequency	= 2 yrs	Time to peak	= 12.18 hrs
Time interval	= 1 min	Hyd. volume	= 1,057,578 cuft
Drainage area	= 128.420 ac	Curve number	= 88
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 28.80 min
Total precip.	= 3.50 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

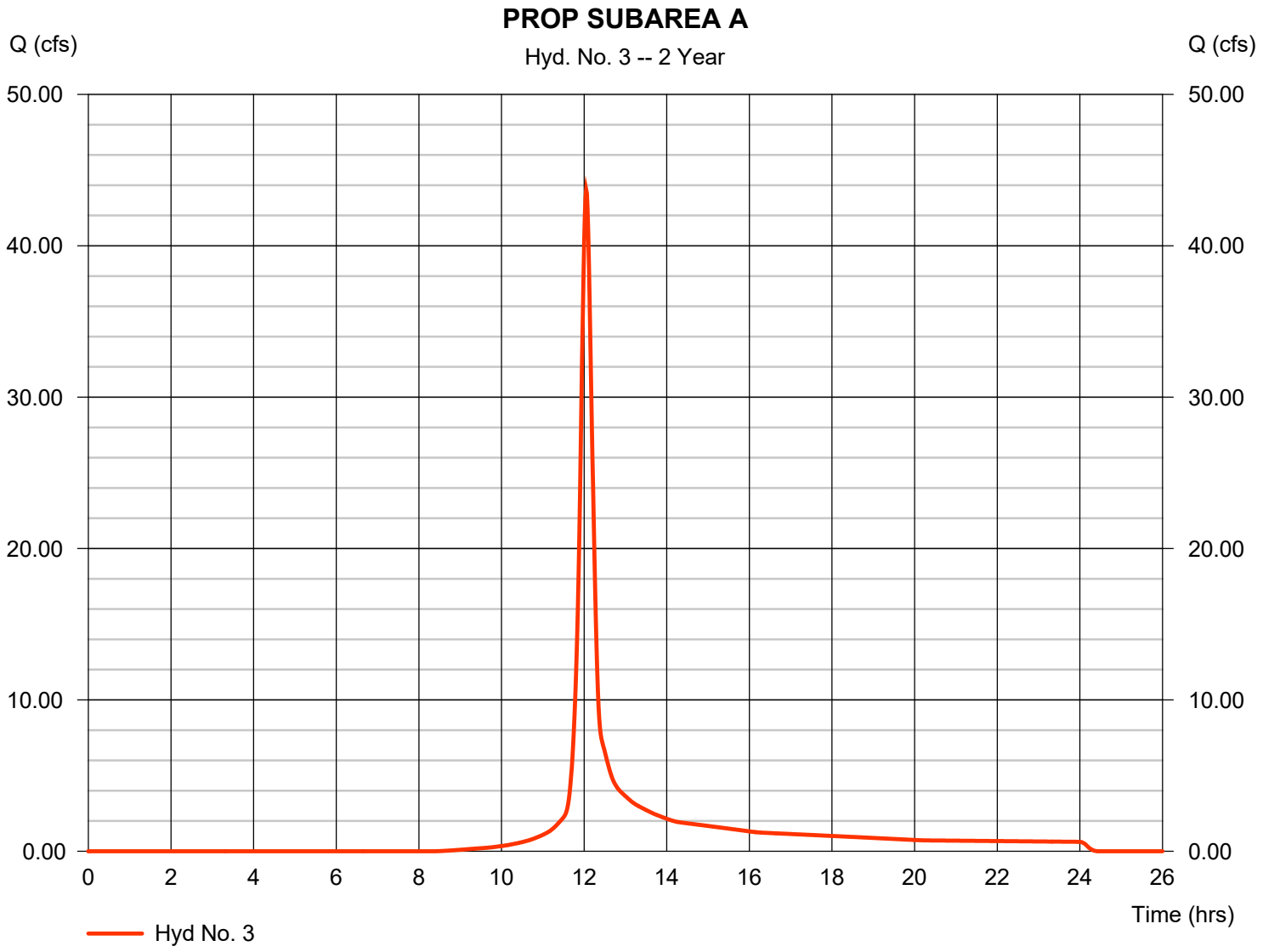


Hydrograph Report

Hyd. No. 3

PROP SUBAREA A

Hydrograph type	= SCS Runoff	Peak discharge	= 43.70 cfs
Storm frequency	= 2 yrs	Time to peak	= 12.05 hrs
Time interval	= 1 min	Hyd. volume	= 124,614 cuft
Drainage area	= 19.020 ac	Curve number	= 82
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 15.70 min
Total precip.	= 3.50 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

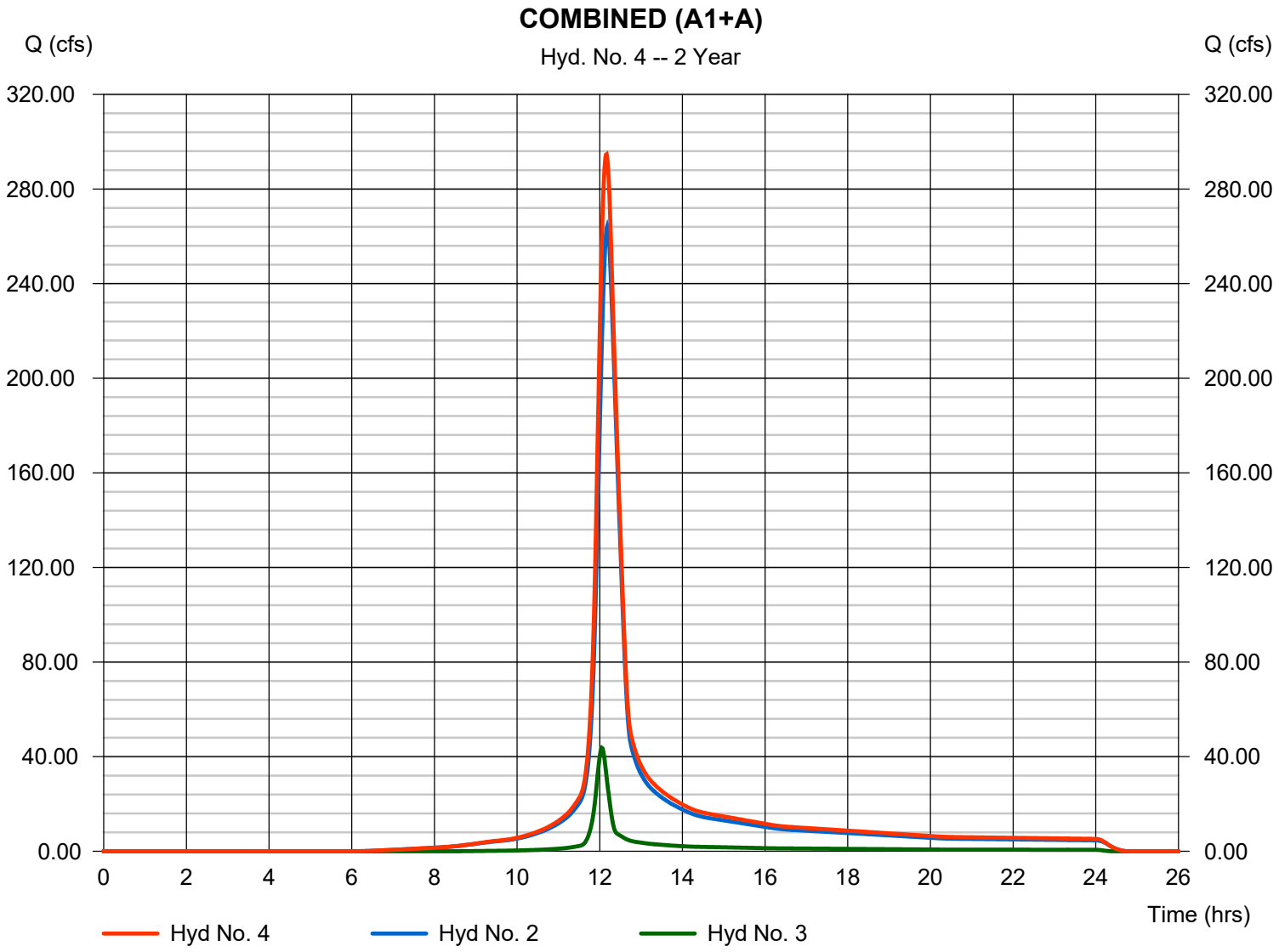


Hydrograph Report

Hyd. No. 4

COMBINED (A1+A)

Hydrograph type	=	Combine	Peak discharge	=	294.69 cfs
Storm frequency	=	2 yrs	Time to peak	=	12.17 hrs
Time interval	=	1 min	Hyd. volume	=	1,182,192 cuft
Inflow hyds.	=	2, 3	Contrib. drain. area	=	147.440 ac



Hydrograph Report

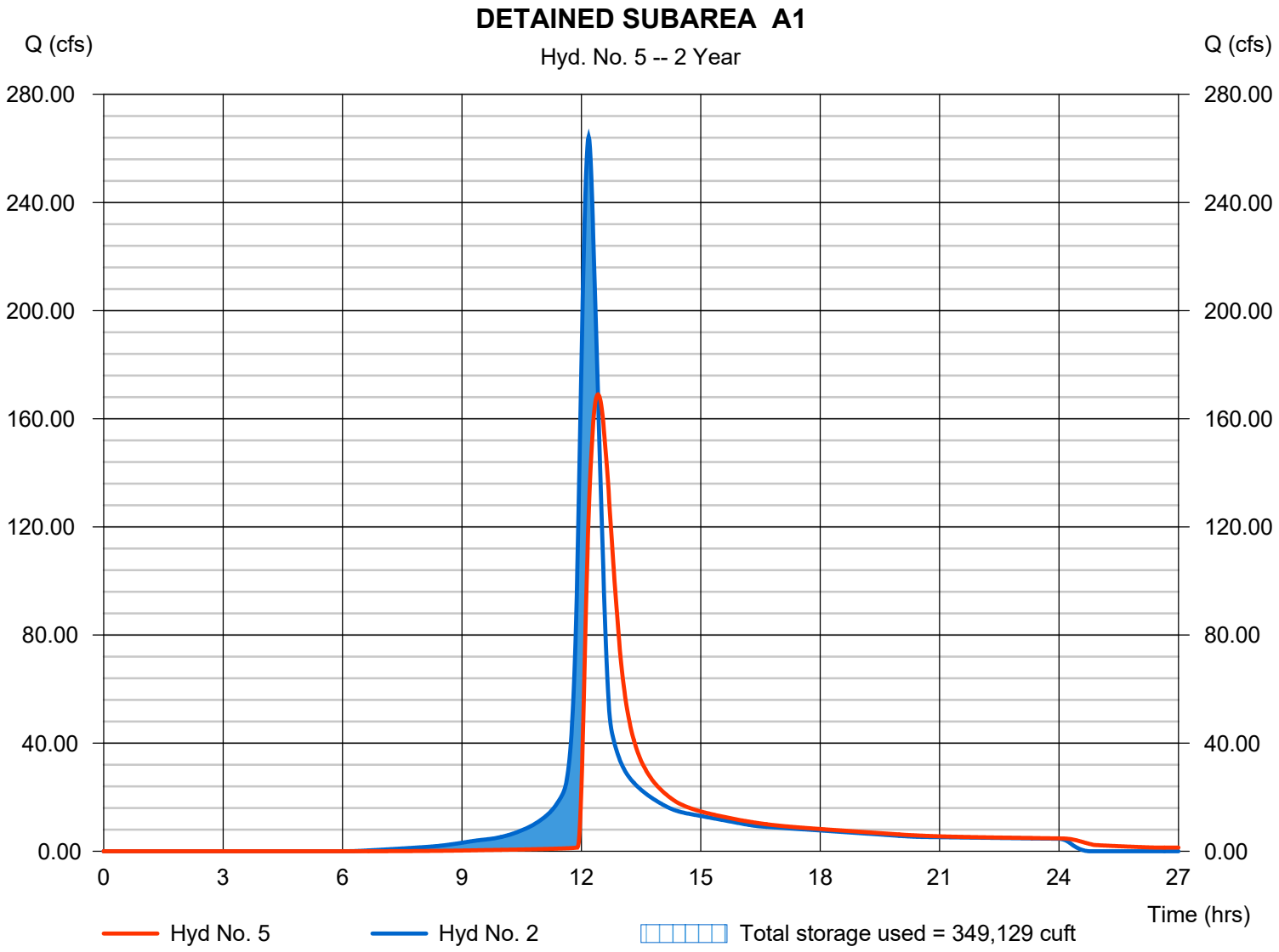
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023 Tuesday, 03 / 4 / 2025

Hyd. No. 5

DETAINED SUBAREA A1

Hydrograph type	=	Reservoir	Peak discharge	=	169.01 cfs
Storm frequency	=	2 yrs	Time to peak	=	12.42 hrs
Time interval	=	1 min	Hyd. volume	=	1,004,168 cuft
Inflow hyd. No.	=	2 - PROP POI A1	Max. Elevation	=	998.53 ft
Reservoir name	=	Retention Basin A1	Max. Storage	=	349,129 cuft

Storage Indication method used.



Pond Report

Pond No. 1 - Retention Basin A1

Pond Data

Contours -User-defined contour areas. Average end area method used for volume calculation. Begining Elevation = 995.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	995.00	88,607	0	0
1.00	996.00	94,268	91,438	91,438
2.00	997.00	100,005	97,137	188,574
3.00	998.00	105,792	102,899	291,473
4.00	999.00	111,639	108,716	400,188
5.00	1000.00	117,544	114,592	514,780
6.00	1001.00	123,509	120,527	635,306
7.00	1002.00	129,533	126,521	761,827
8.00	1003.00	135,616	132,575	894,402
9.00	1004.00	141,758	138,687	1,033,089
9.50	1004.50	141,758	70,879	1,103,968

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 60.00	6.27	0.00	0.00
Span (in)	= 60.00	6.27	0.00	0.00
No. Barrels	= 3	1	0	0
Invert El. (ft)	= 994.70	994.80	0.00	0.00
Length (ft)	= 31.93	0.00	0.00	0.00
Slope (%)	= 1.41	0.00	0.00	n/a
N-Value	= .010	.013	.013	n/a
Orifice Coeff.	= 0.60	0.67	0.60	0.60
Multi-Stage	= n/a	Yes	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 24.00	0.00	0.00	0.00
Crest El. (ft)	= 996.55	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= Rect	---	---	---
Multi-Stage	= Yes	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

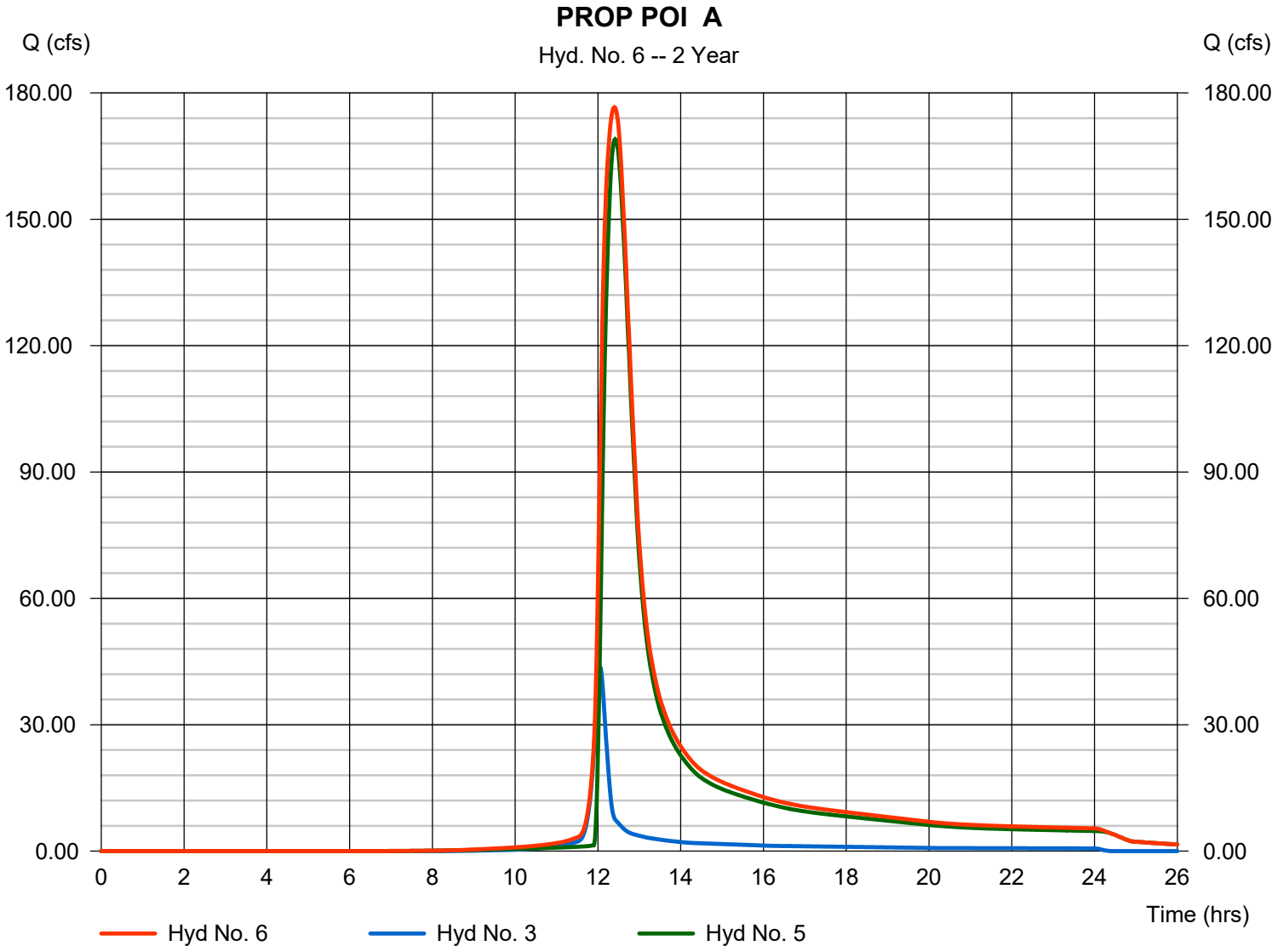
Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	995.00	0.00	0.00	---	---	0.00	---	---	---	---	---	0.000
1.00	91,438	996.00	2.81 ic	1.12 ic	---	---	0.00	---	---	---	---	---	1.117
2.00	188,574	997.00	26.37 ic	1.35 ic	---	---	24.13	---	---	---	---	---	25.47
3.00	291,473	998.00	126.62 oc	1.06 ic	---	---	123.40 s	---	---	---	---	---	124.45
4.00	400,188	999.00	204.08 oc	0.89 ic	---	---	202.65 s	---	---	---	---	---	203.54
5.00	514,780	1000.00	253.06 oc	0.71 ic	---	---	252.35 s	---	---	---	---	---	253.06
6.00	635,306	1001.00	403.14 oc	0.90 ic	---	---	402.21 s	---	---	---	---	---	403.11
7.00	761,827	1002.00	538.13 oc	0.98 ic	---	---	537.14 s	---	---	---	---	---	538.11
8.00	894,402	1003.00	641.11 ic	0.96 ic	---	---	640.14 s	---	---	---	---	---	641.10
9.00	1,033,089	1004.00	707.18 ic	0.88 ic	---	---	706.26 s	---	---	---	---	---	707.14
9.50	1,103,968	1004.50	737.54 ic	0.84 ic	---	---	736.69 s	---	---	---	---	---	737.53

Hydrograph Report

Hyd. No. 6

PROP POI A

Hydrograph type	=	Combine	Peak discharge	=	176.60 cfs
Storm frequency	=	2 yrs	Time to peak	=	12.40 hrs
Time interval	=	1 min	Hyd. volume	=	1,128,782 cuft
Inflow hyds.	=	3, 5	Contrib. drain. area	=	19.020 ac

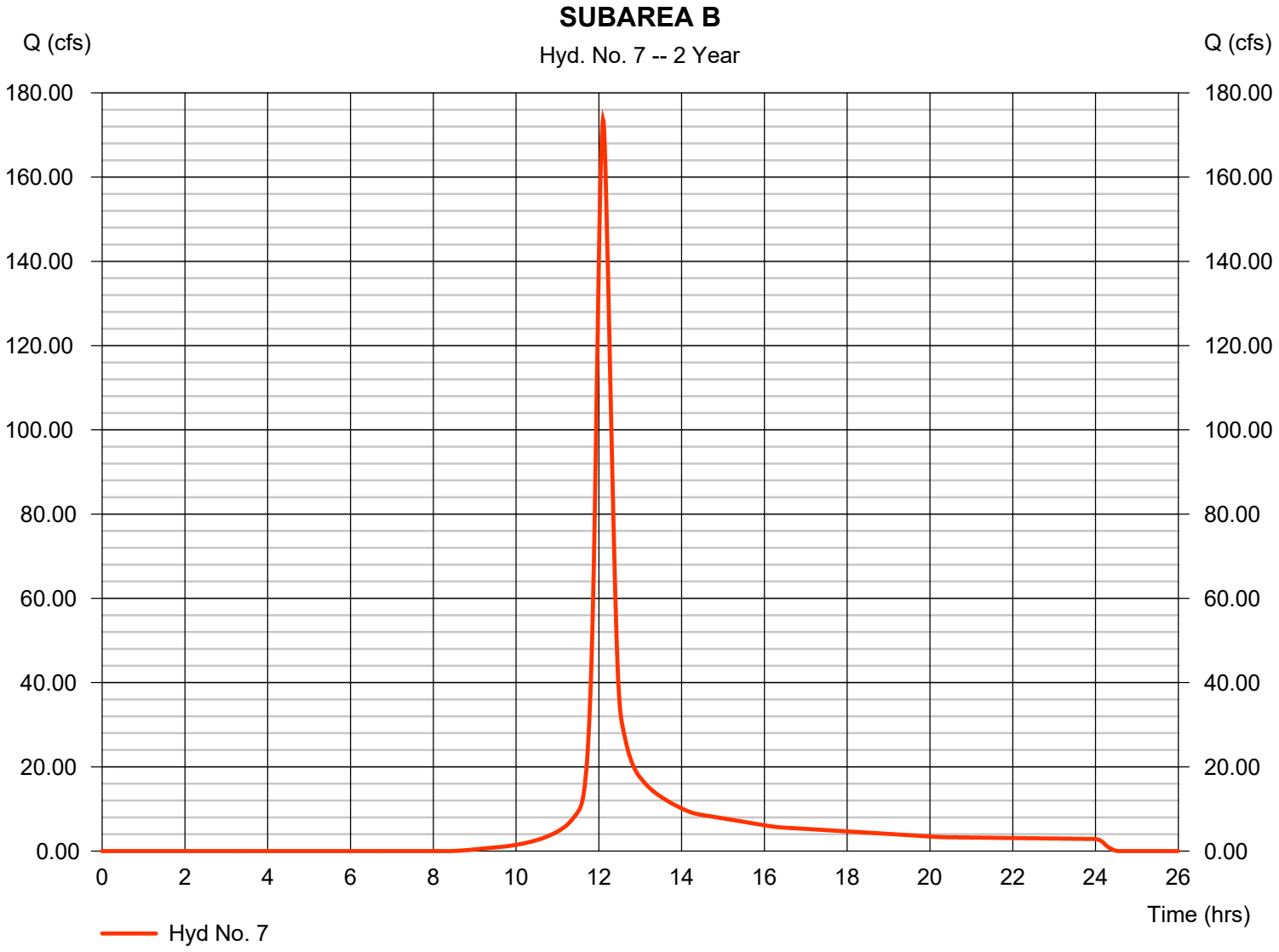


Hydrograph Report

Hyd. No. 7

SUBAREA B

Hydrograph type	=	SCS Runoff	Peak discharge	=	173.67 cfs
Storm frequency	=	2 yrs	Time to peak	=	12.10 hrs
Time interval	=	1 min	Hyd. volume	=	571,646 cuft
Drainage area	=	87.500 ac	Curve number	=	82
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	21.90 min
Total precip.	=	3.50 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

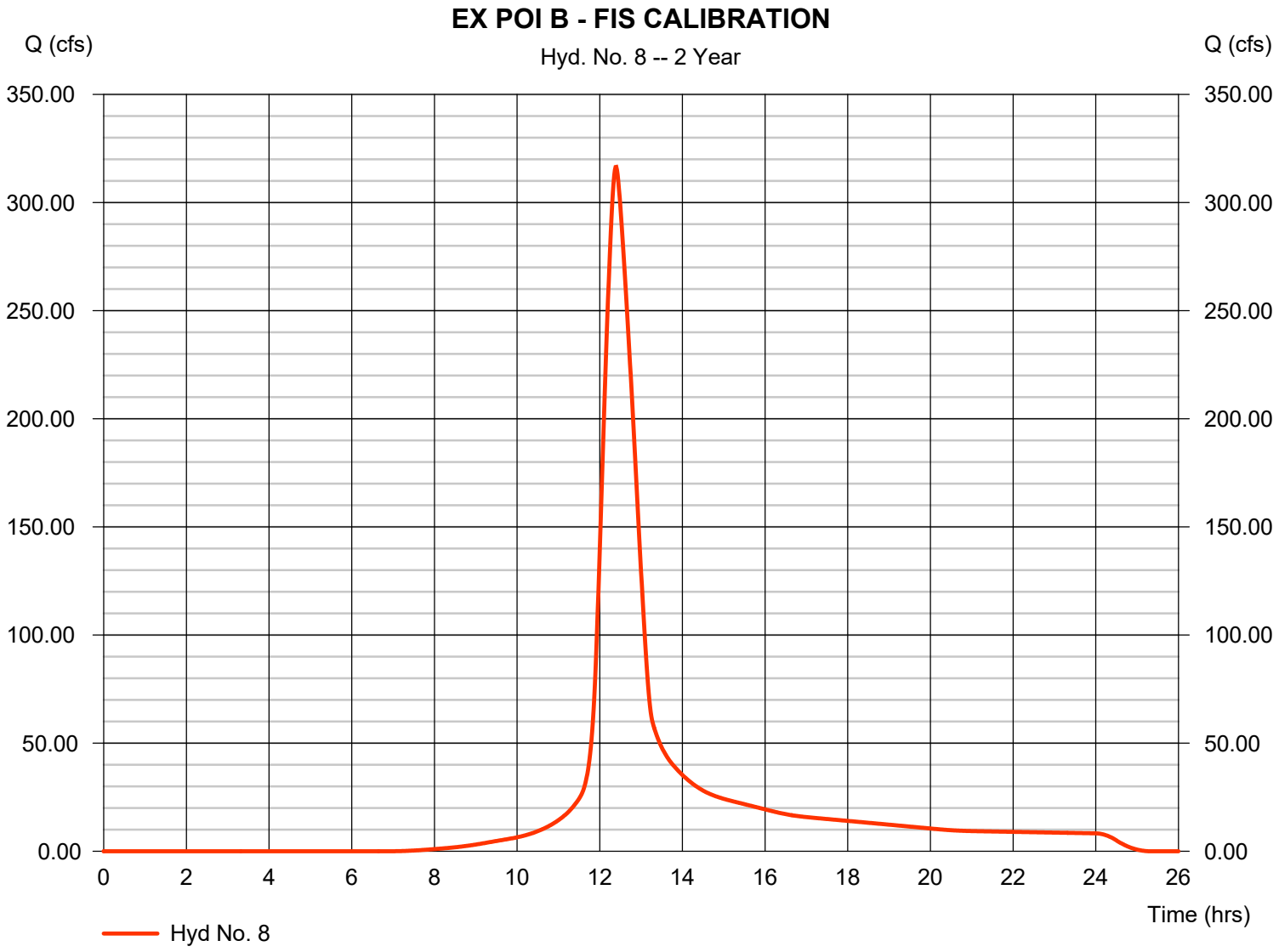


Hydrograph Report

Hyd. No. 8

EX POI B - FIS CALIBRATION

Hydrograph type	=	SCS Runoff	Peak discharge	=	316.51 cfs
Storm frequency	=	2 yrs	Time to peak	=	12.40 hrs
Time interval	=	1 min	Hyd. volume	=	1,789,688 cuft
Drainage area	=	234.960 ac	Curve number	=	86
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	49.40 min
Total precip.	=	3.50 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

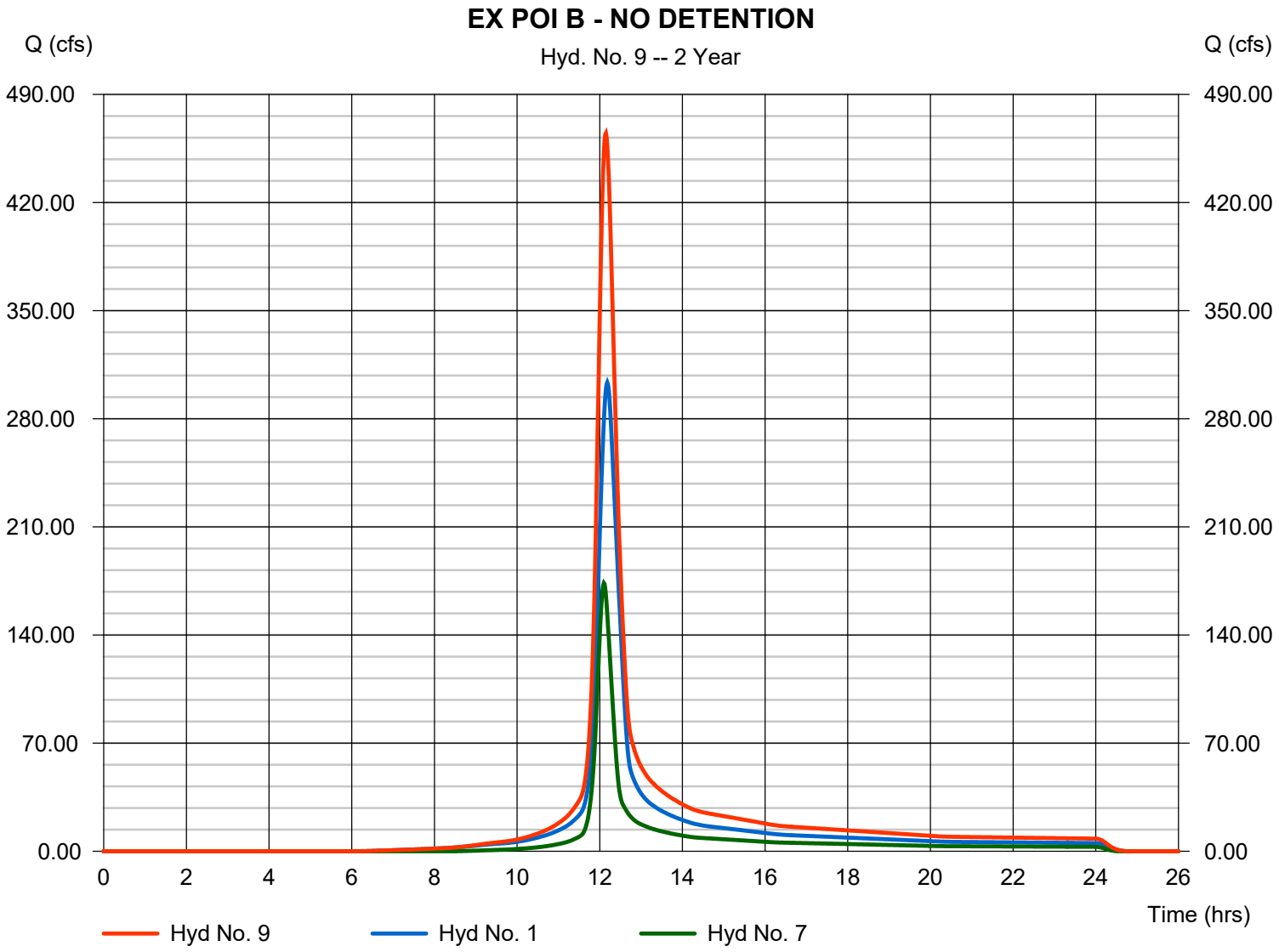


Hydrograph Report

Hyd. No. 9

EX POI B - NO DETENTION

Hydrograph type	=	Combine	Peak discharge	=	464.88 cfs
Storm frequency	=	2 yrs	Time to peak	=	12.15 hrs
Time interval	=	1 min	Hyd. volume	=	1,785,939 cuft
Inflow hyds.	=	1, 7	Contrib. drain. area	=	234.950 ac

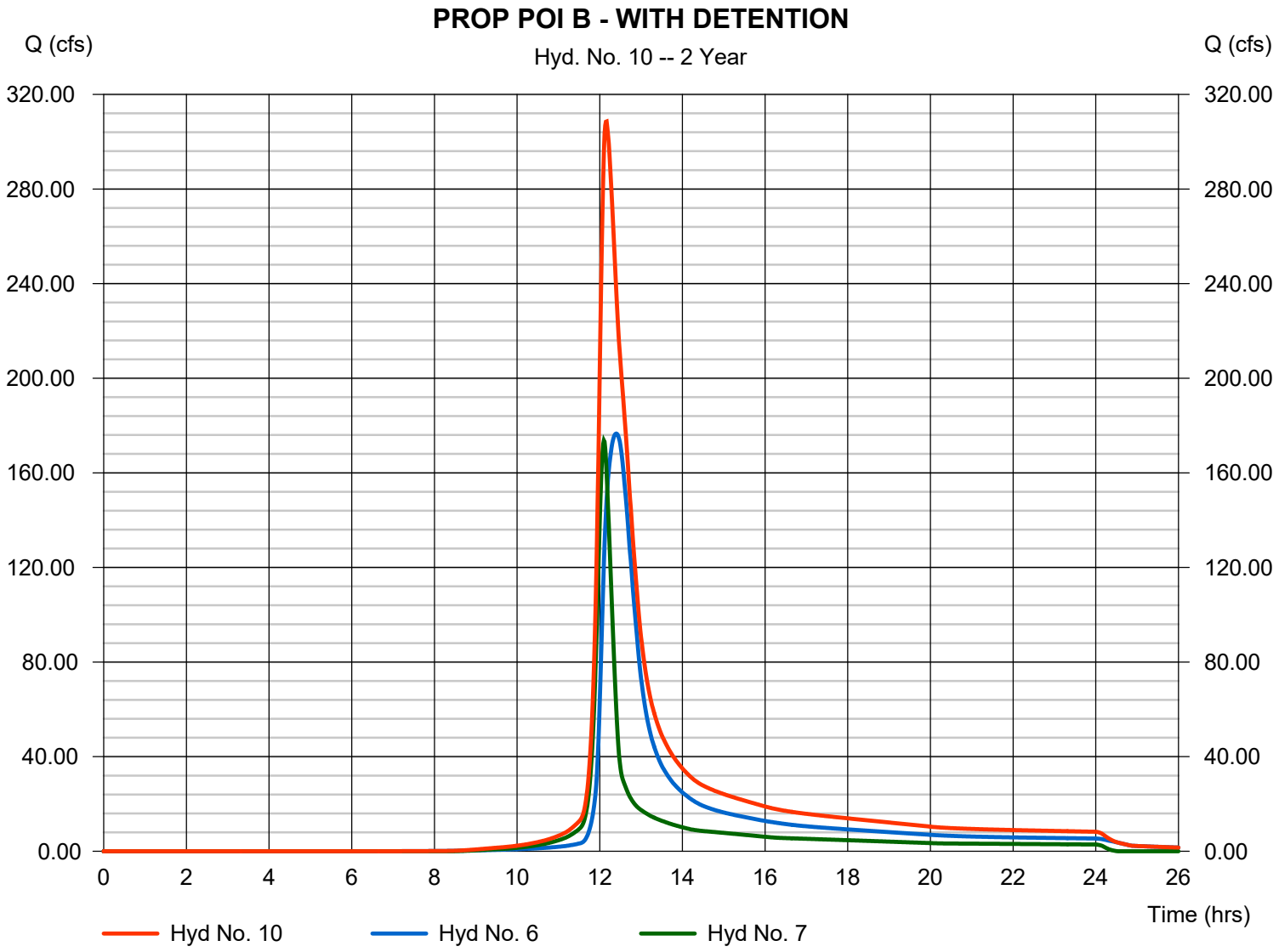


Hydrograph Report

Hyd. No. 10

PROP POI B - WITH DETENTION

Hydrograph type	=	Combine	Peak discharge	=	308.54 cfs
Storm frequency	=	2 yrs	Time to peak	=	12.17 hrs
Time interval	=	1 min	Hyd. volume	=	1,700,425 cuft
Inflow hyds.	=	6, 7	Contrib. drain. area	=	87.500 ac



Hydrograph Summary Report

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

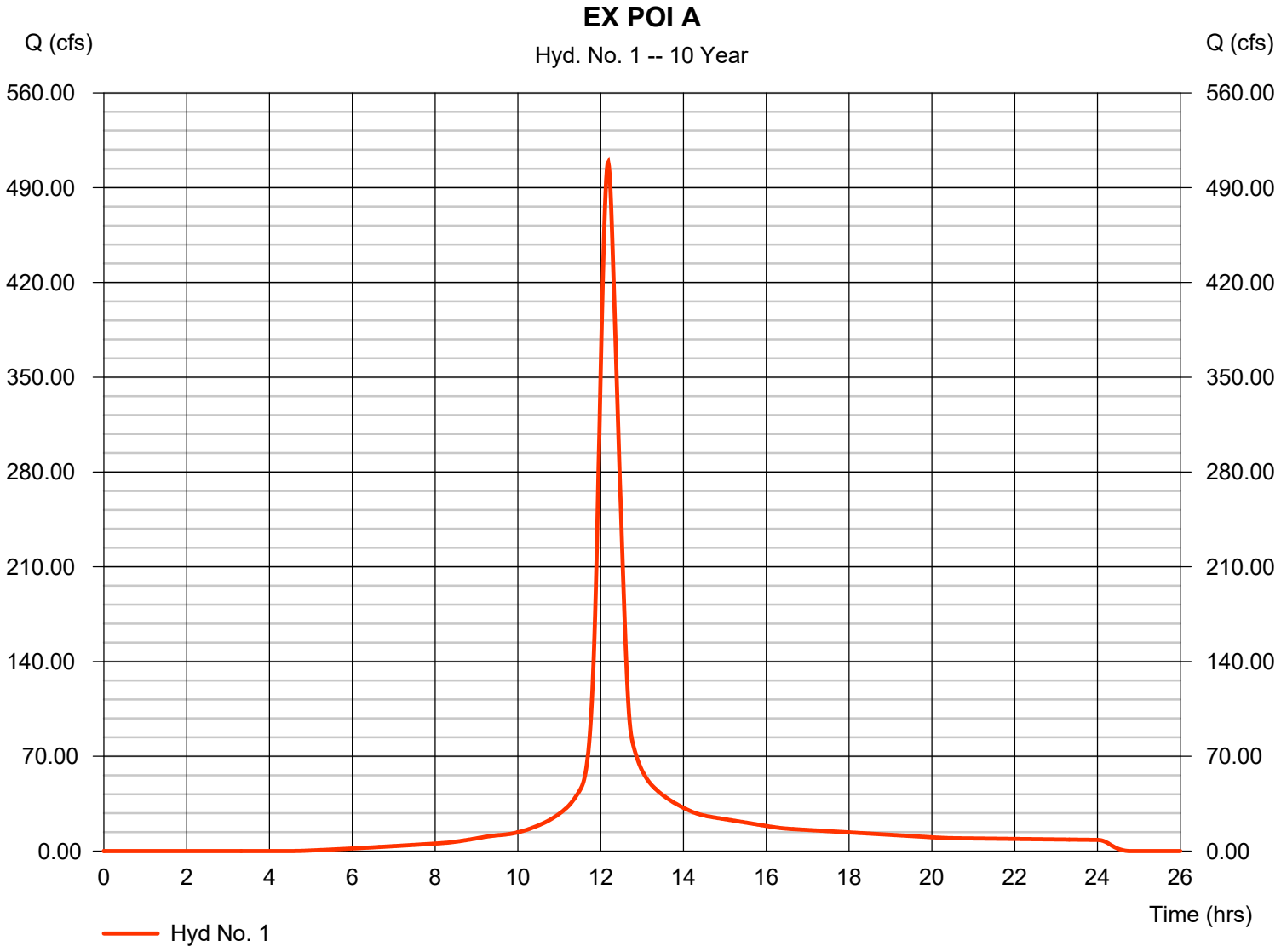
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	508.68	1	731	2,065,624	------	------	------	EX POI A
2	SCS Runoff	443.03	1	731	1,799,034	------	------	------	PROP POI A1
3	SCS Runoff	79.44	1	723	227,792	------	------	------	PROP SUBAREA A
4	Combine	498.80	1	729	2,026,826	2, 3	------	------	COMBINED (A1+A)
5	Reservoir	275.71	1	745	1,744,782	2	1000.19	537,400	DETAINED SUBAREA A1
6	Combine	288.47	1	745	1,972,574	3, 5	------	------	PROP POI A
7	SCS Runoff	317.20	1	726	1,044,953	------	------	------	SUBAREA B
8	SCS Runoff	548.30	1	743	3,116,573	------	------	------	EX POI B - FIS CALIBRATION
9	Combine	804.35	1	728	3,110,575	1, 7,	------	------	EX POI B - NO DETENTION
10	Combine	576.93	1	727	3,017,530	6, 7,	------	------	PROP POI B - WITH DETENTION

Hydrograph Report

Hyd. No. 1

EX POI A

Hydrograph type	=	SCS Runoff	Peak discharge	=	508.68 cfs
Storm frequency	=	10 yrs	Time to peak	=	12.18 hrs
Time interval	=	1 min	Hyd. volume	=	2,065,624 cuft
Drainage area	=	147.450 ac	Curve number	=	88
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	28.80 min
Total precip.	=	5.20 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

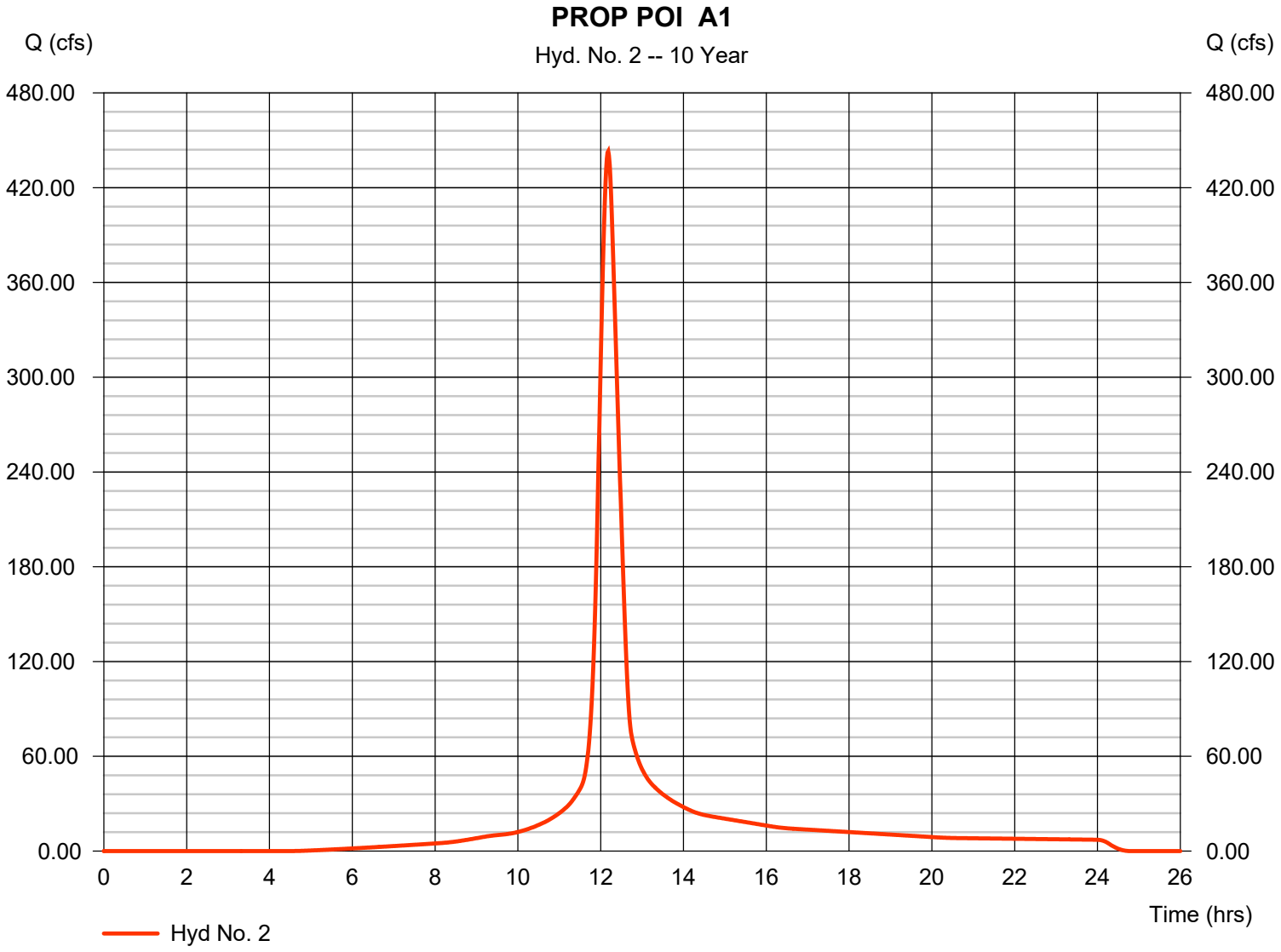


Hydrograph Report

Hyd. No. 2

PROP POI A1

Hydrograph type	= SCS Runoff	Peak discharge	= 443.03 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.18 hrs
Time interval	= 1 min	Hyd. volume	= 1,799,034 cuft
Drainage area	= 128.420 ac	Curve number	= 88
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 28.80 min
Total precip.	= 5.20 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

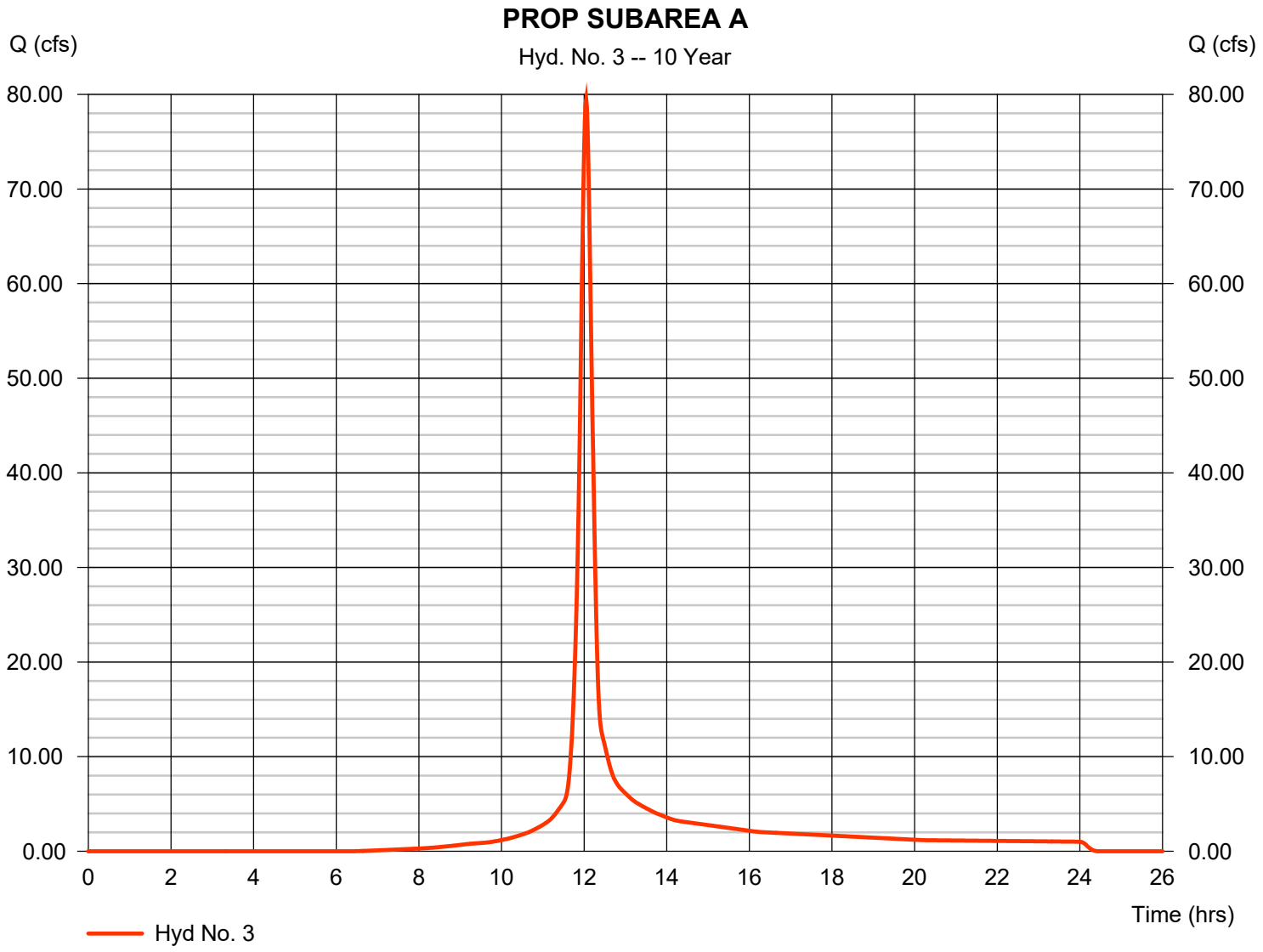


Hydrograph Report

Hyd. No. 3

PROP SUBAREA A

Hydrograph type	= SCS Runoff	Peak discharge	= 79.44 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.05 hrs
Time interval	= 1 min	Hyd. volume	= 227,792 cuft
Drainage area	= 19.020 ac	Curve number	= 82
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 15.70 min
Total precip.	= 5.20 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

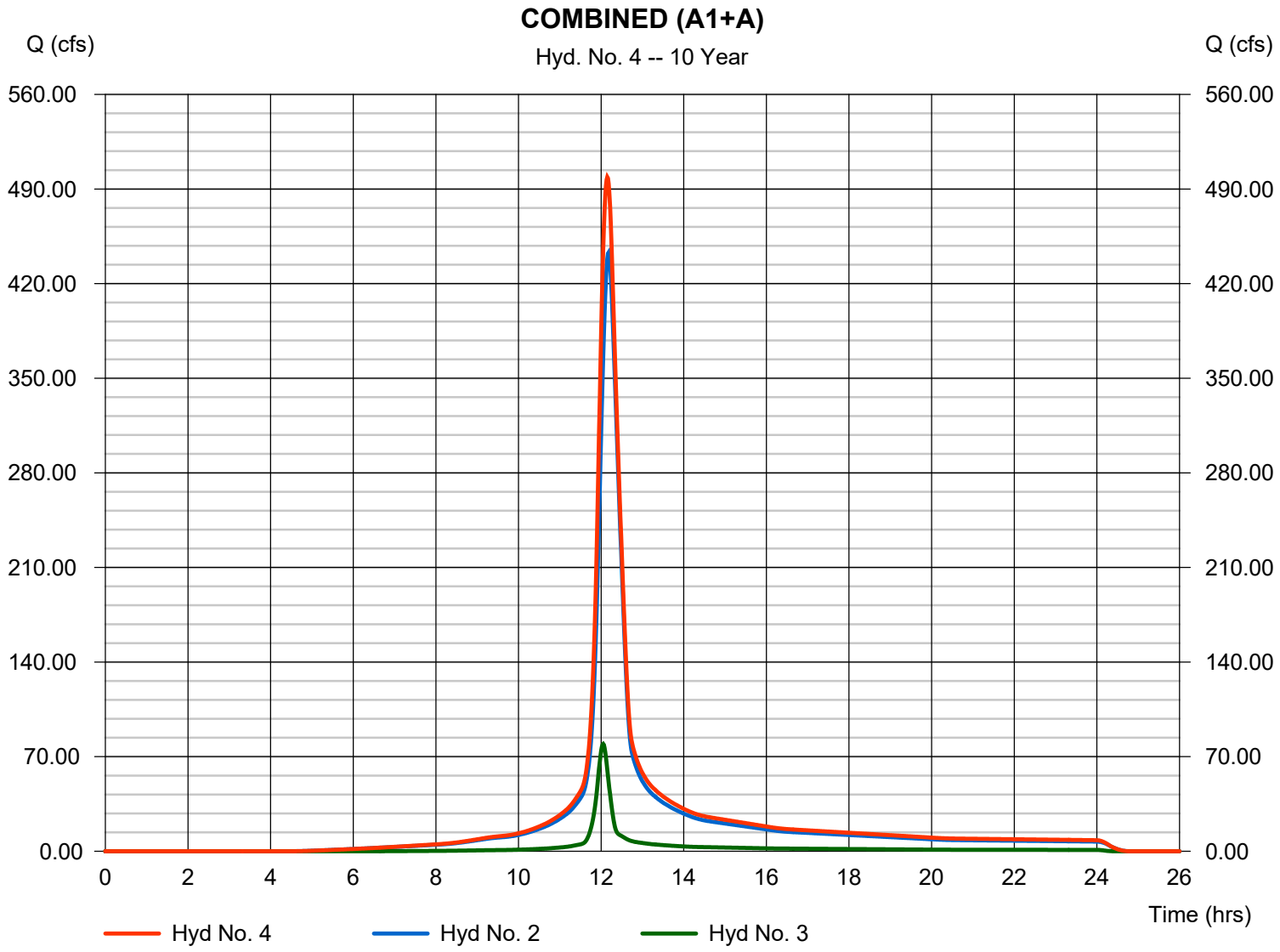


Hydrograph Report

Hyd. No. 4

COMBINED (A1+A)

Hydrograph type	=	Combine	Peak discharge	=	498.80 cfs
Storm frequency	=	10 yrs	Time to peak	=	12.15 hrs
Time interval	=	1 min	Hyd. volume	=	2,026,826 cuft
Inflow hyds.	=	2, 3	Contrib. drain. area	=	147.440 ac



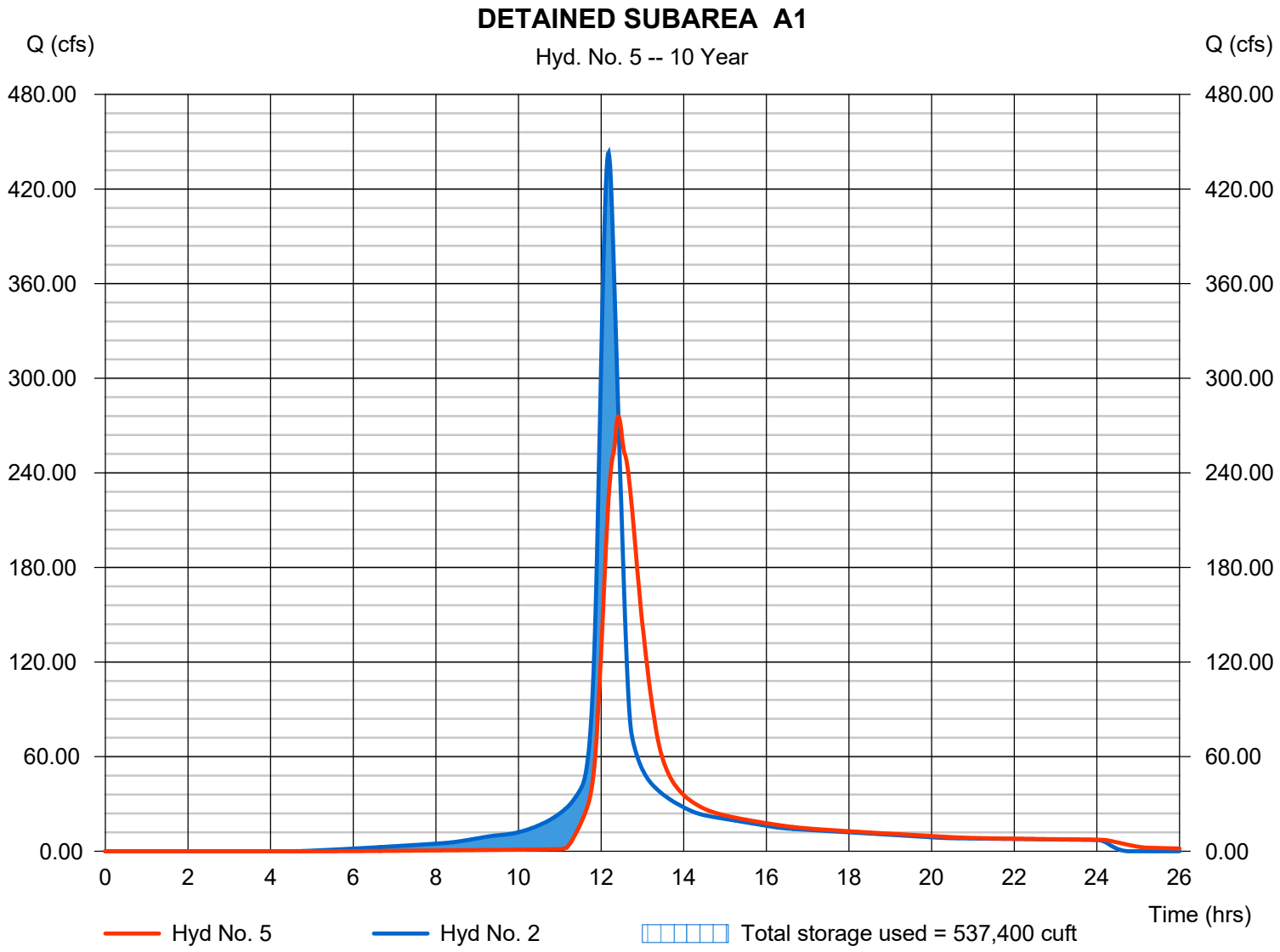
Hydrograph Report

Hyd. No. 5

DETAINED SUBAREA A1

Hydrograph type	=	Reservoir	Peak discharge	=	275.71 cfs
Storm frequency	=	10 yrs	Time to peak	=	12.42 hrs
Time interval	=	1 min	Hyd. volume	=	1,744,782 cuft
Inflow hyd. No.	=	2 - PROP POI A1	Max. Elevation	=	1000.19 ft
Reservoir name	=	Retention Basin A1	Max. Storage	=	537,400 cuft

Storage Indication method used.

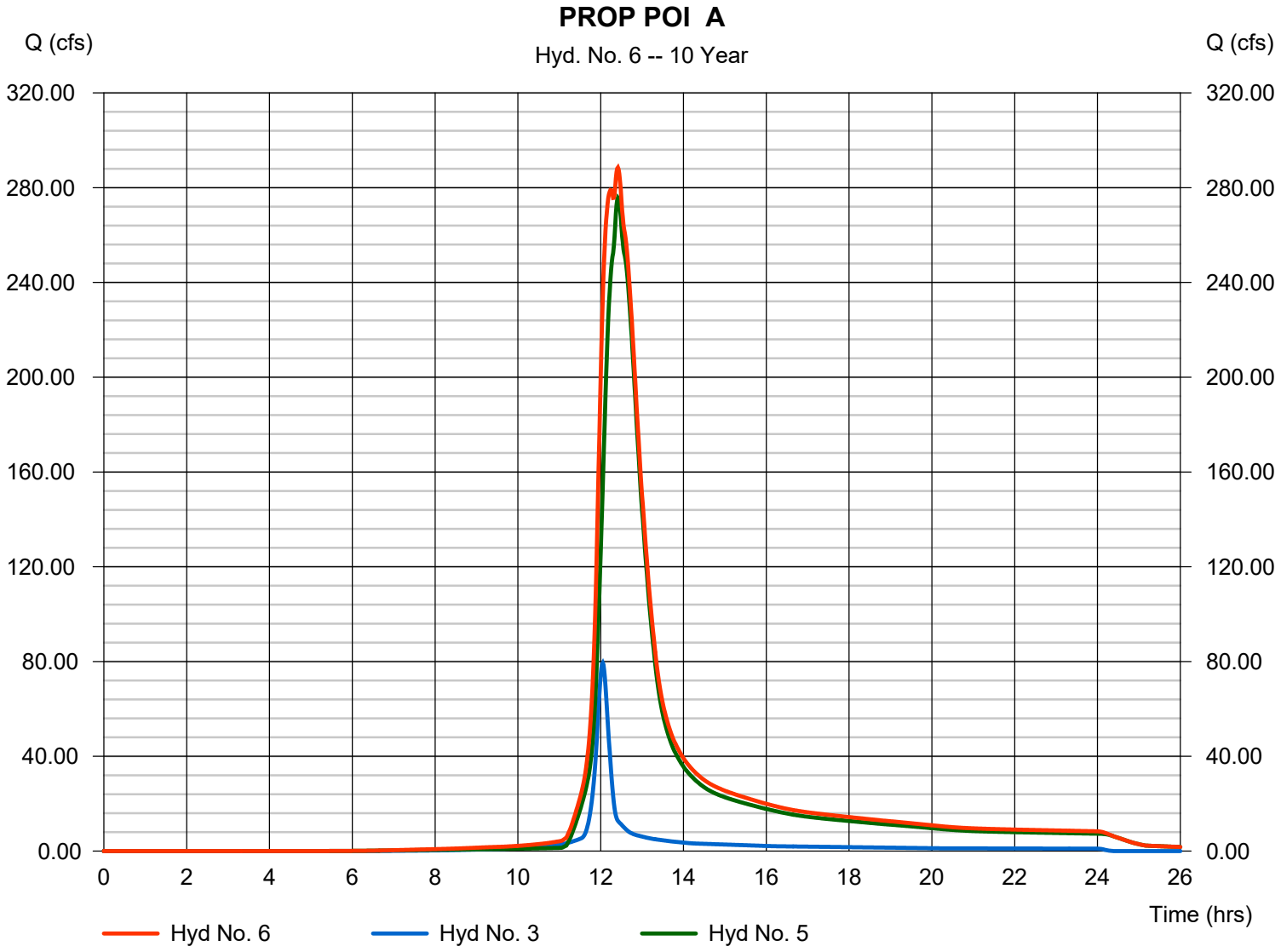


Hydrograph Report

Hyd. No. 6

PROP POI A

Hydrograph type	=	Combine	Peak discharge	=	288.47 cfs
Storm frequency	=	10 yrs	Time to peak	=	12.42 hrs
Time interval	=	1 min	Hyd. volume	=	1,972,574 cuft
Inflow hyds.	=	3, 5	Contrib. drain. area	=	19.020 ac

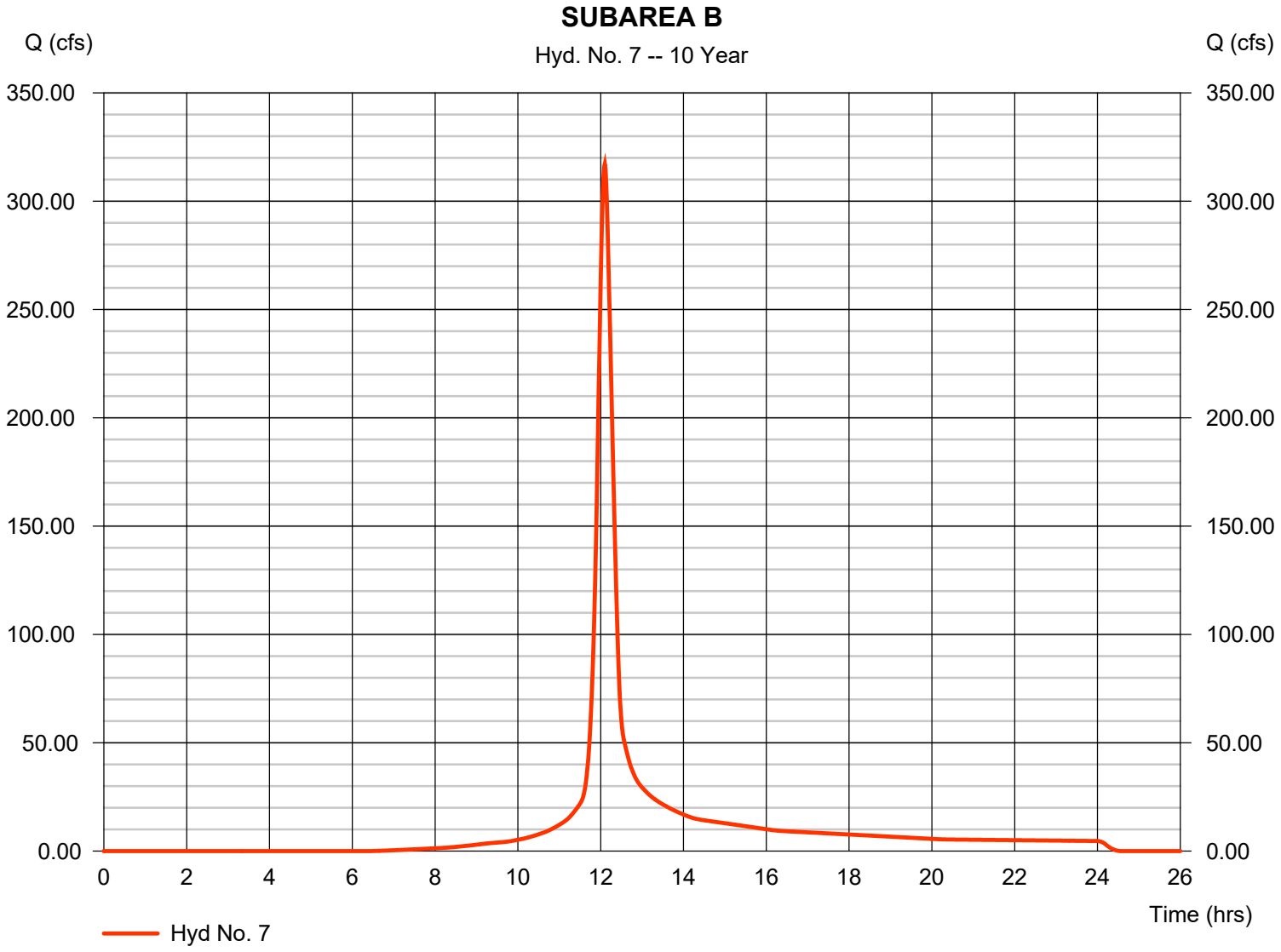


Hydrograph Report

Hyd. No. 7

SUBAREA B

Hydrograph type	=	SCS Runoff	Peak discharge	=	317.20 cfs
Storm frequency	=	10 yrs	Time to peak	=	12.10 hrs
Time interval	=	1 min	Hyd. volume	=	1,044,953 cuft
Drainage area	=	87.500 ac	Curve number	=	82
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	21.90 min
Total precip.	=	5.20 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

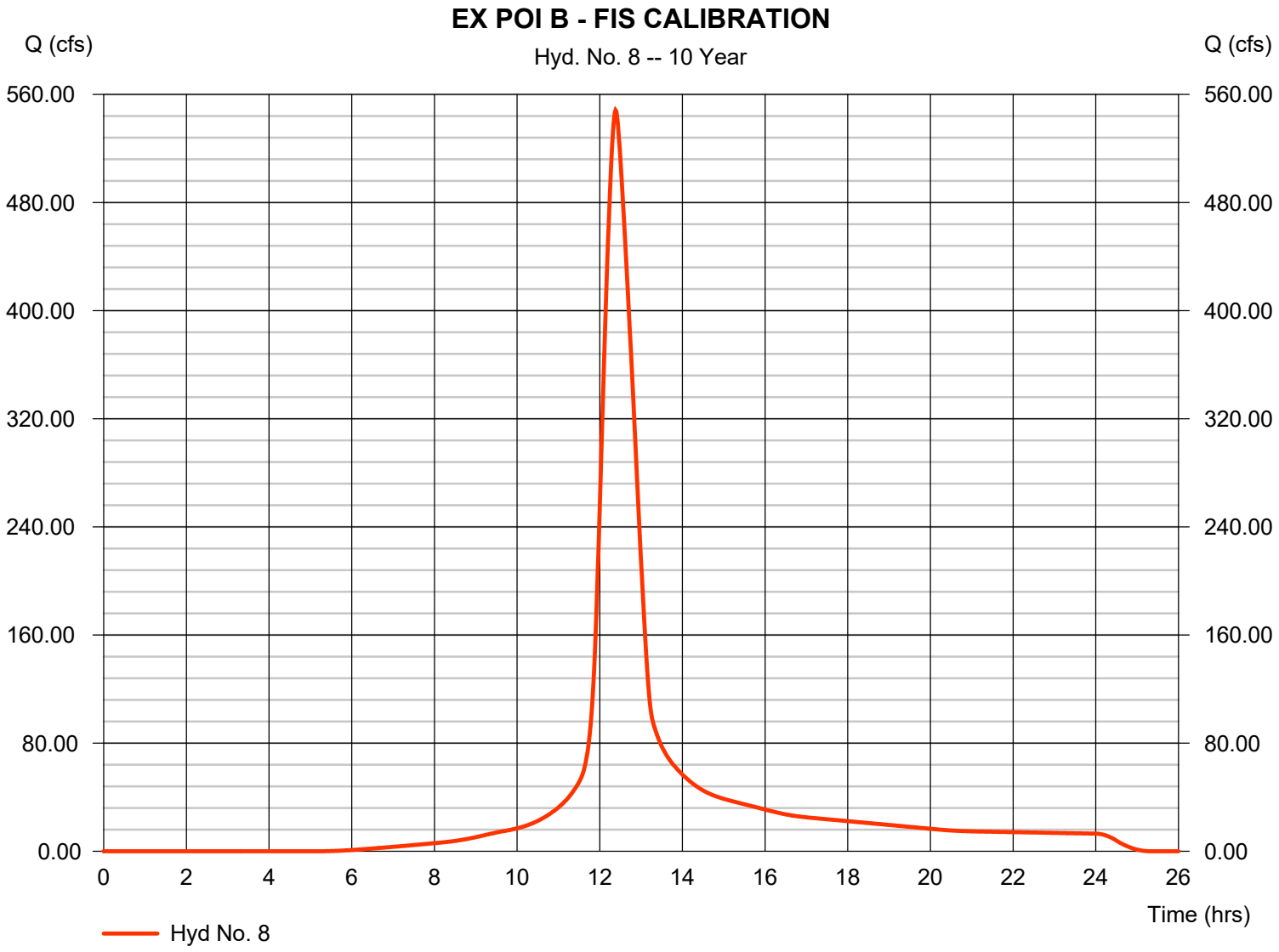


Hydrograph Report

Hyd. No. 8

EX POI B - FIS CALIBRATION

Hydrograph type	=	SCS Runoff	Peak discharge	=	548.30 cfs
Storm frequency	=	10 yrs	Time to peak	=	12.38 hrs
Time interval	=	1 min	Hyd. volume	=	3,116,573 cuft
Drainage area	=	234.960 ac	Curve number	=	86
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	49.40 min
Total precip.	=	5.20 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

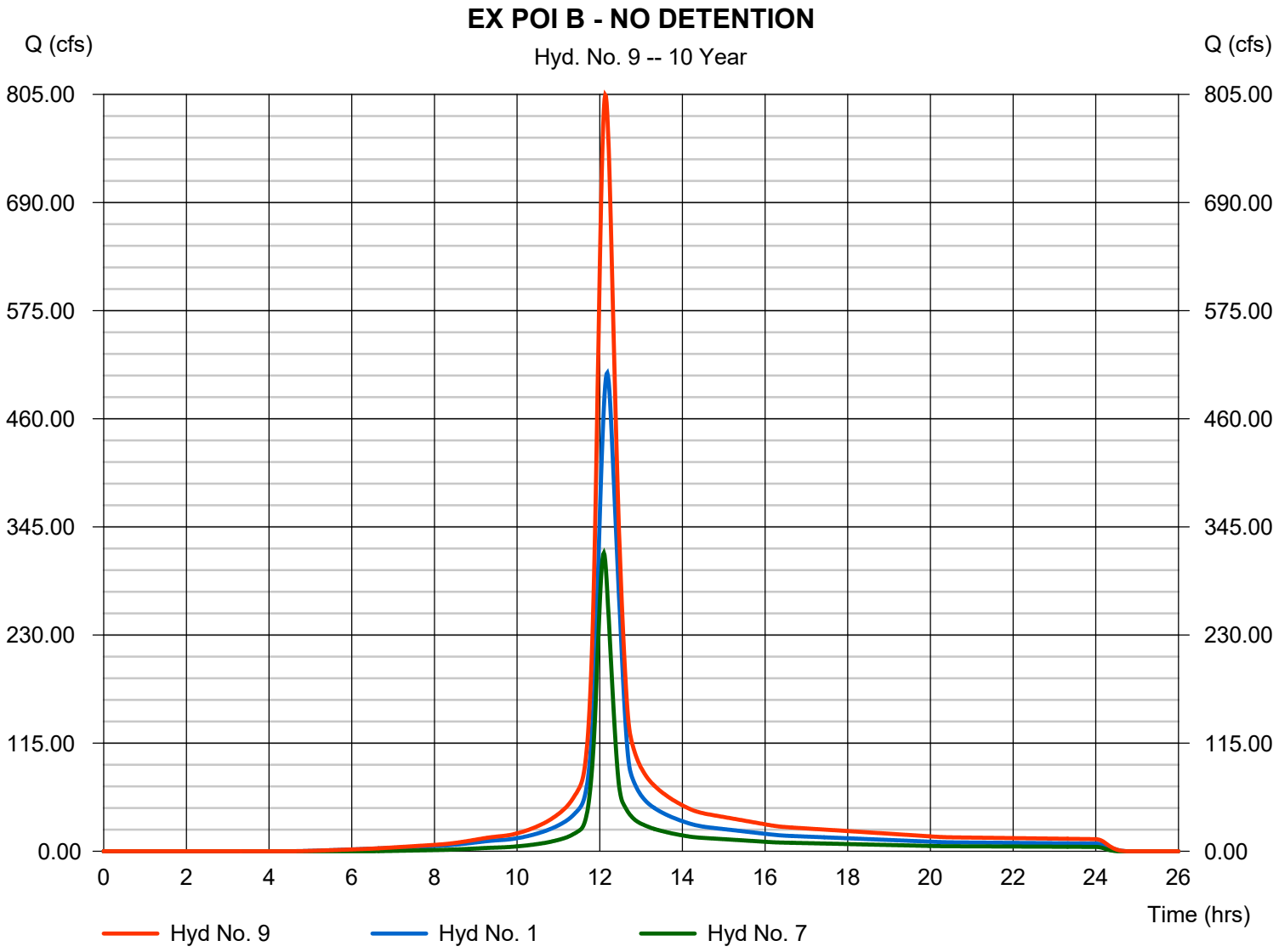


Hydrograph Report

Hyd. No. 9

EX POI B - NO DETENTION

Hydrograph type	=	Combine	Peak discharge	=	804.35 cfs
Storm frequency	=	10 yrs	Time to peak	=	12.13 hrs
Time interval	=	1 min	Hyd. volume	=	3,110,575 cuft
Inflow hyds.	=	1, 7	Contrib. drain. area	=	234.950 ac

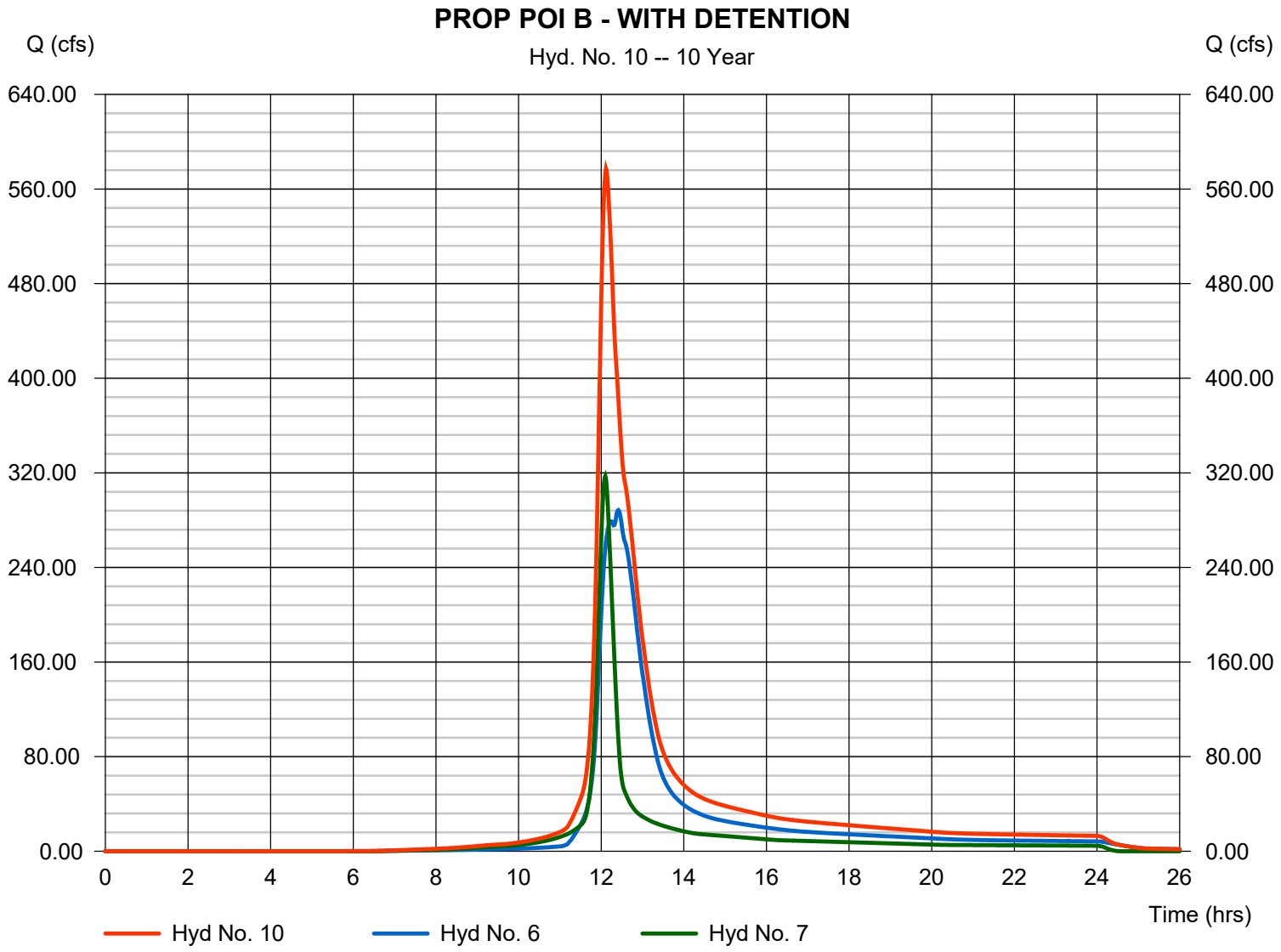


Hydrograph Report

Hyd. No. 10

PROP POI B - WITH DETENTION

Hydrograph type	=	Combine	Peak discharge	=	576.93 cfs
Storm frequency	=	10 yrs	Time to peak	=	12.12 hrs
Time interval	=	1 min	Hyd. volume	=	3,017,530 cuft
Inflow hyds.	=	6, 7	Contrib. drain. area	=	87.500 ac



Hydrograph Summary Report

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

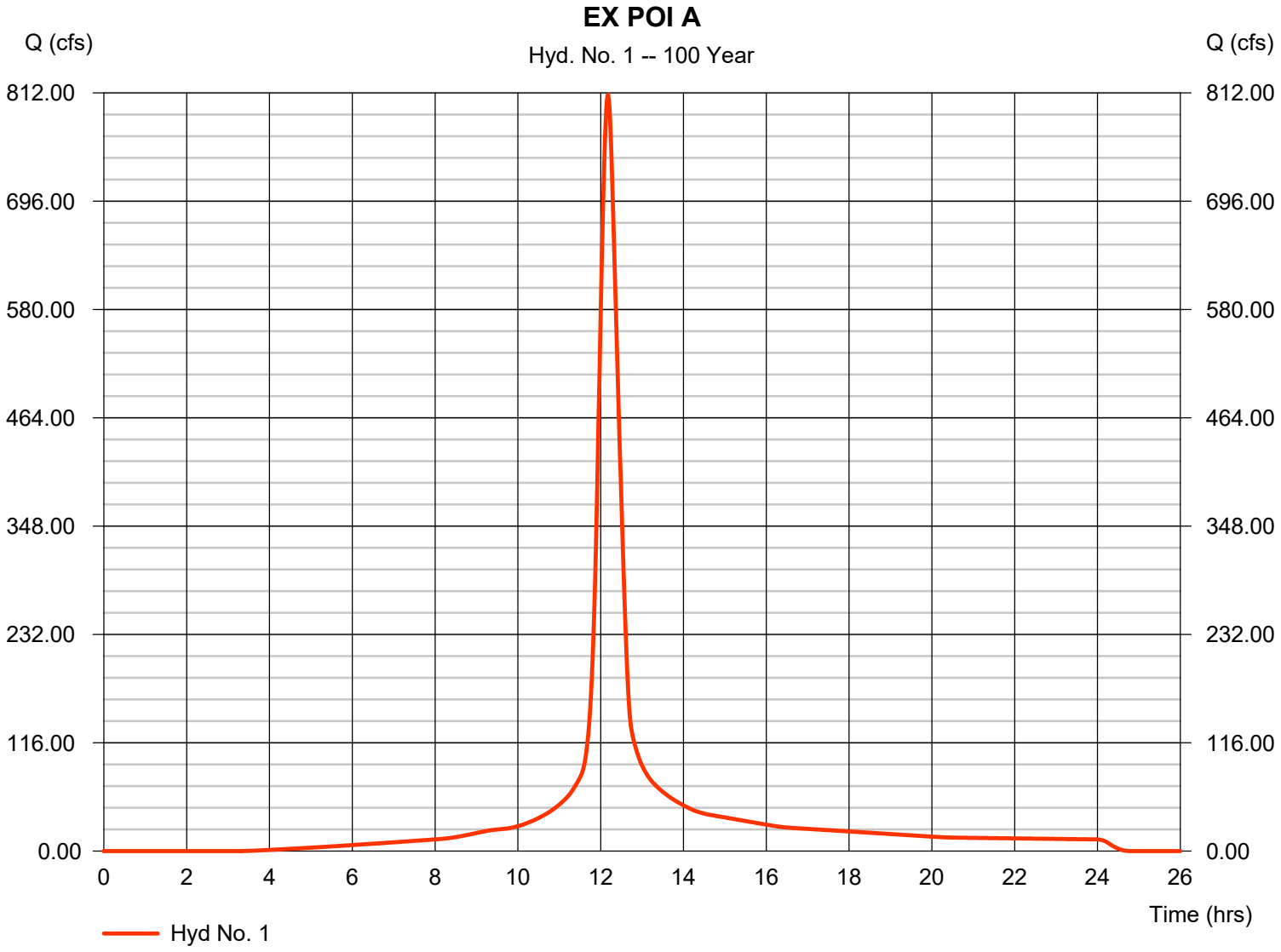
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	809.50	1	731	3,358,744	------	------	------	EX POI A
2	SCS Runoff	705.02	1	731	2,925,259	------	------	------	PROP POI A1
3	SCS Runoff	133.37	1	723	389,754	------	------	------	PROP SUBAREA A
4	Combine	799.42	1	729	3,315,014	2, 3	------	------	COMBINED (A1+A)
5	Reservoir	503.51	1	742	2,870,361	2	1001.73	727,643	DETAINED SUBAREA A1
6	Combine	529.69	1	740	3,260,120	3, 5	------	------	PROP POI A
7	SCS Runoff	534.31	1	726	1,787,923	------	------	------	SUBAREA B
8	SCS Runoff	892.27	1	743	5,152,304	------	------	------	EX POI B - FIS CALIBRATION
9	Combine	1309.46	1	728	5,146,663	1, 7,	------	------	EX POI B - NO DETENTION
10	Combine	943.76	1	729	5,048,042	6, 7,	------	------	PROP POI B - WITH DETENTION

Hydrograph Report

Hyd. No. 1

EX POI A

Hydrograph type	=	SCS Runoff	Peak discharge	=	809.50 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.18 hrs
Time interval	=	1 min	Hyd. volume	=	3,358,744 cuft
Drainage area	=	147.450 ac	Curve number	=	88
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	28.80 min
Total precip.	=	7.70 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

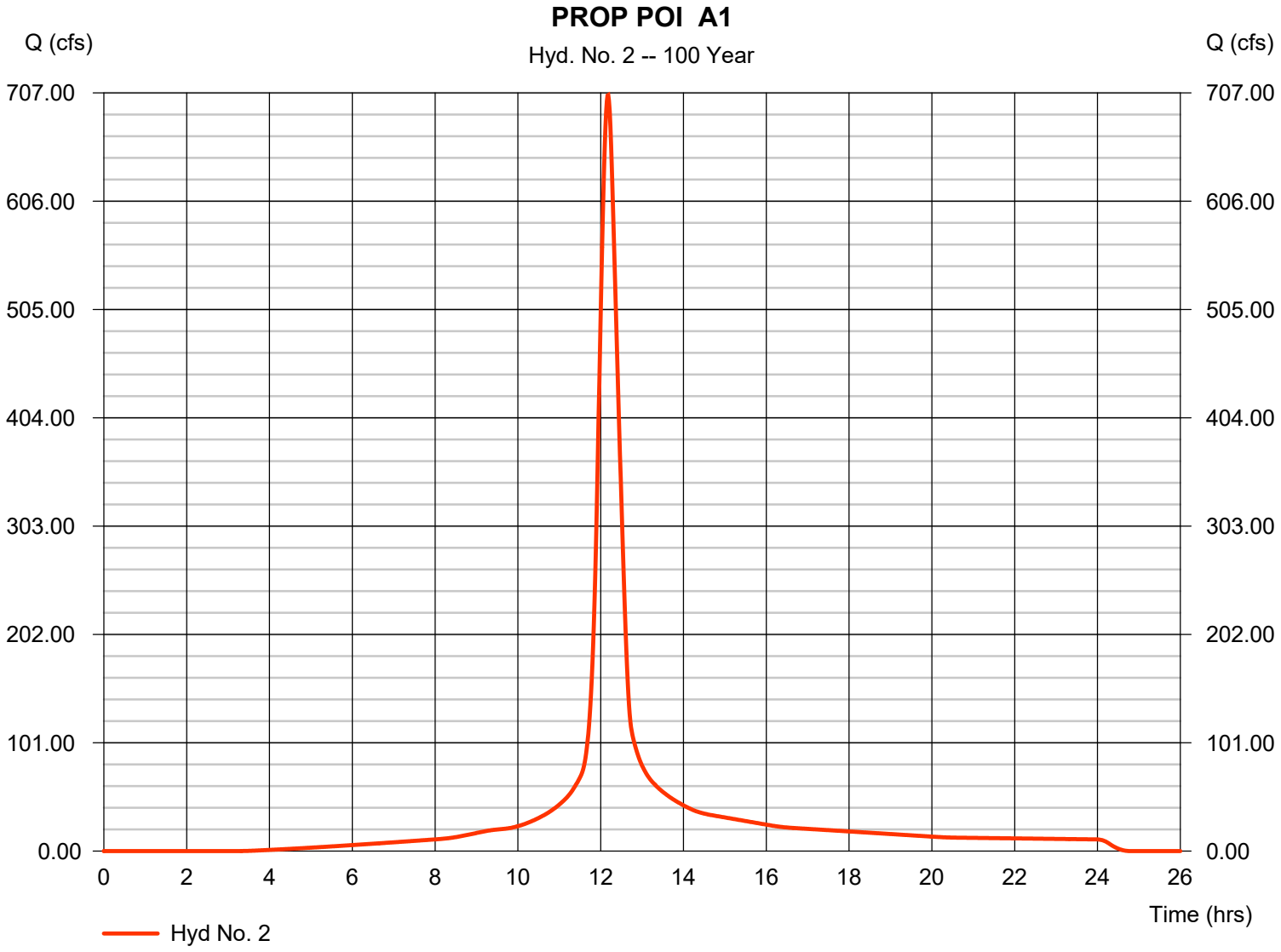


Hydrograph Report

Hyd. No. 2

PROP POI A1

Hydrograph type	= SCS Runoff	Peak discharge	= 705.02 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.18 hrs
Time interval	= 1 min	Hyd. volume	= 2,925,259 cuft
Drainage area	= 128.420 ac	Curve number	= 88
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 28.80 min
Total precip.	= 7.70 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

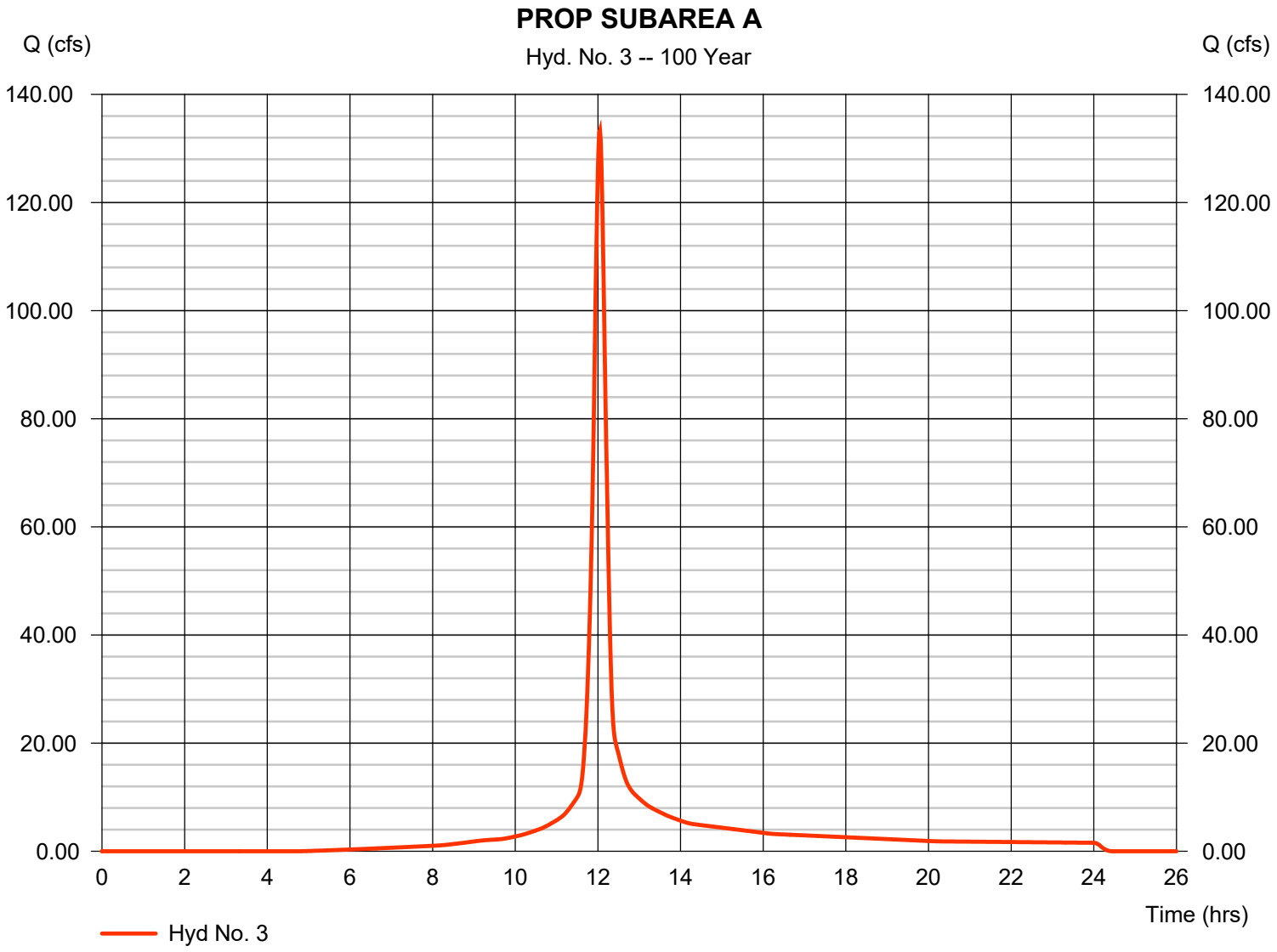


Hydrograph Report

Hyd. No. 3

PROP SUBAREA A

Hydrograph type	= SCS Runoff	Peak discharge	= 133.37 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.05 hrs
Time interval	= 1 min	Hyd. volume	= 389,754 cuft
Drainage area	= 19.020 ac	Curve number	= 82
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 15.70 min
Total precip.	= 7.70 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

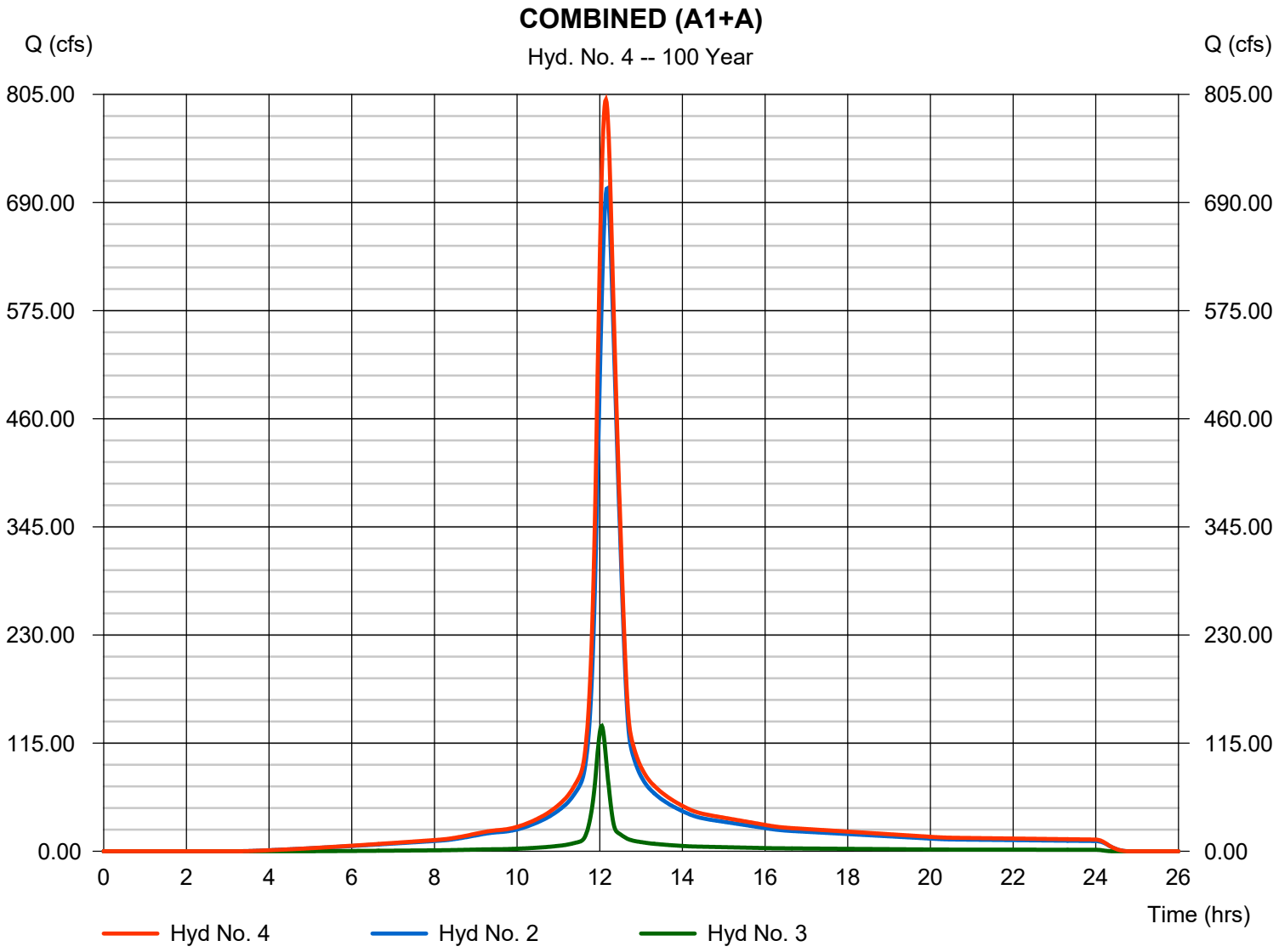


Hydrograph Report

Hyd. No. 4

COMBINED (A1+A)

Hydrograph type	=	Combine	Peak discharge	=	799.42 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.15 hrs
Time interval	=	1 min	Hyd. volume	=	3,315,014 cuft
Inflow hyds.	=	2, 3	Contrib. drain. area	=	147.440 ac



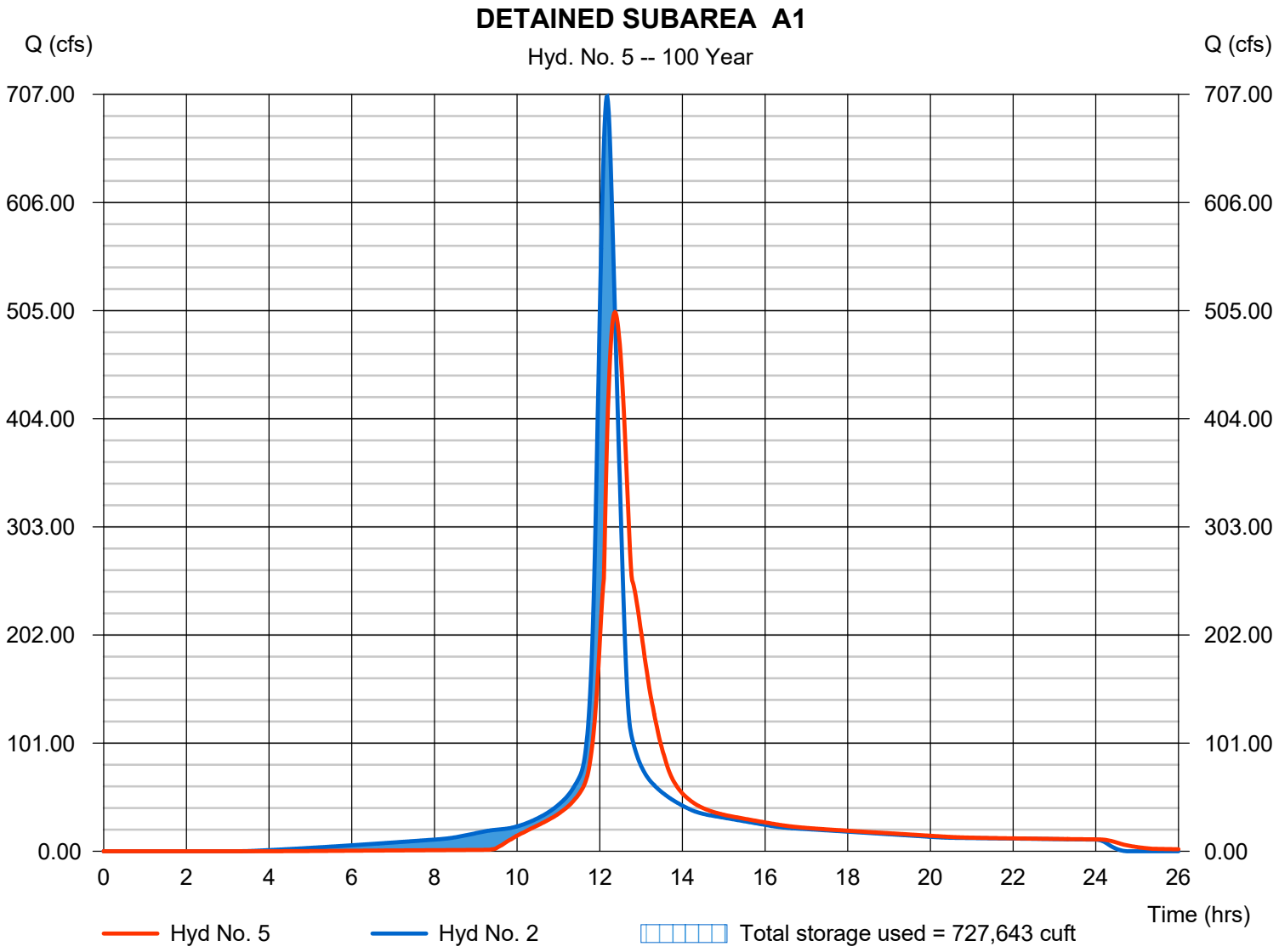
Hydrograph Report

Hyd. No. 5

DETAINED SUBAREA A1

Hydrograph type	=	Reservoir	Peak discharge	=	503.51 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.37 hrs
Time interval	=	1 min	Hyd. volume	=	2,870,361 cuft
Inflow hyd. No.	=	2 - PROP POI A1	Max. Elevation	=	1001.73 ft
Reservoir name	=	Retention Basin A1	Max. Storage	=	727,643 cuft

Storage Indication method used.

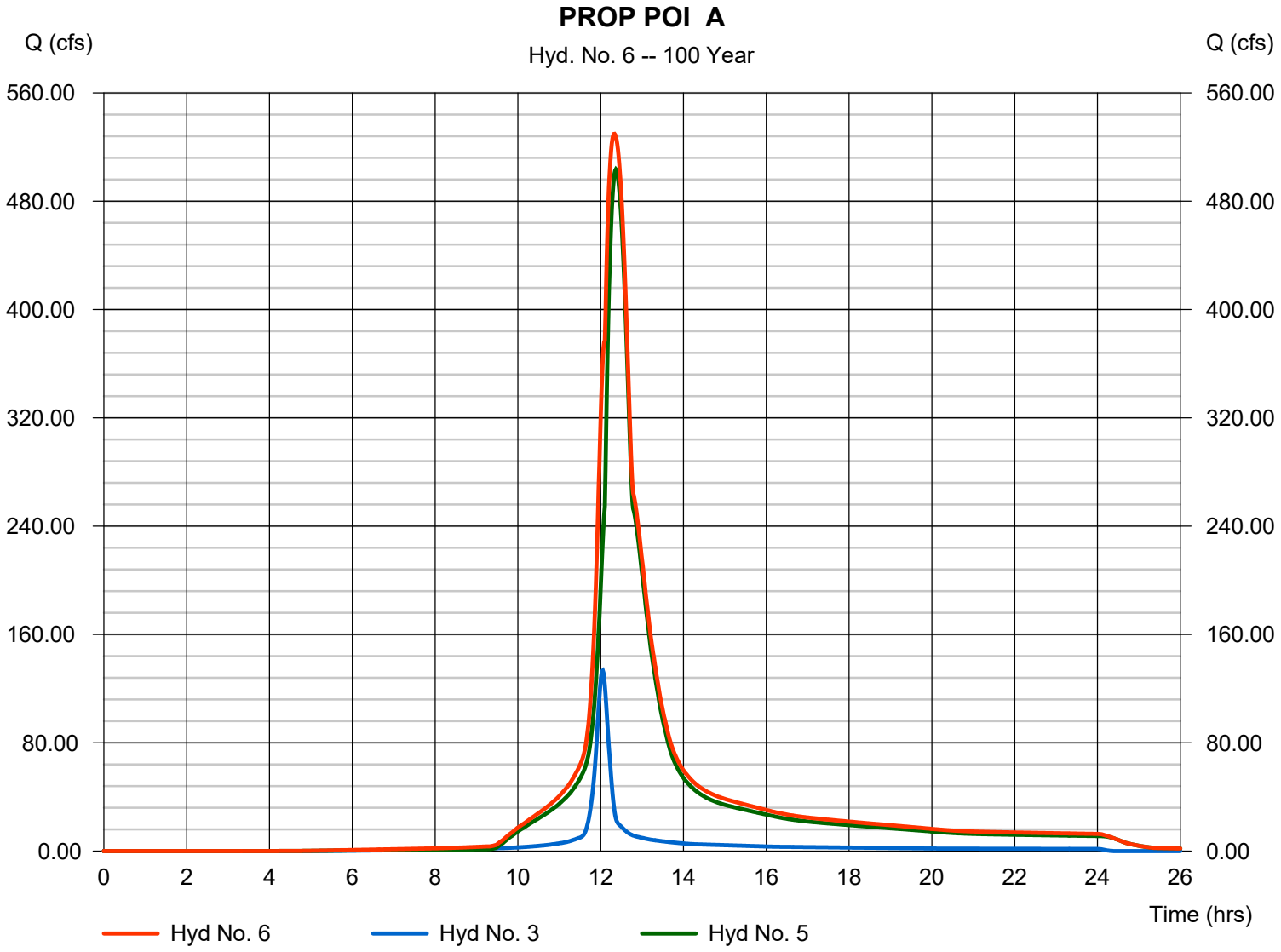


Hydrograph Report

Hyd. No. 6

PROP POI A

Hydrograph type	= Combine	Peak discharge	= 529.69 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.33 hrs
Time interval	= 1 min	Hyd. volume	= 3,260,120 cuft
Inflow hyds.	= 3, 5	Contrib. drain. area	= 19.020 ac

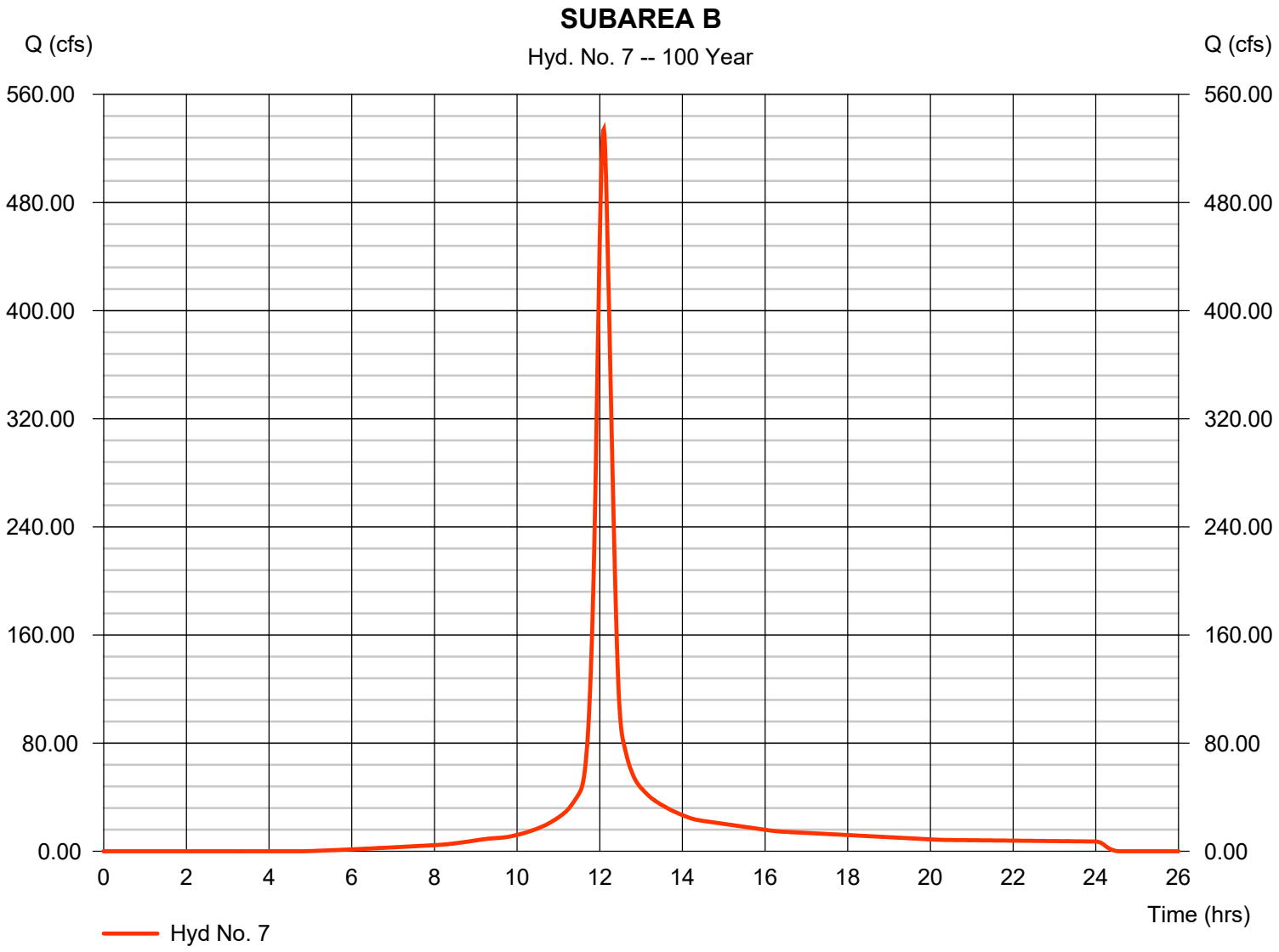


Hydrograph Report

Hyd. No. 7

SUBAREA B

Hydrograph type	=	SCS Runoff	Peak discharge	=	534.31 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.10 hrs
Time interval	=	1 min	Hyd. volume	=	1,787,923 cuft
Drainage area	=	87.500 ac	Curve number	=	82
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	21.90 min
Total precip.	=	7.70 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

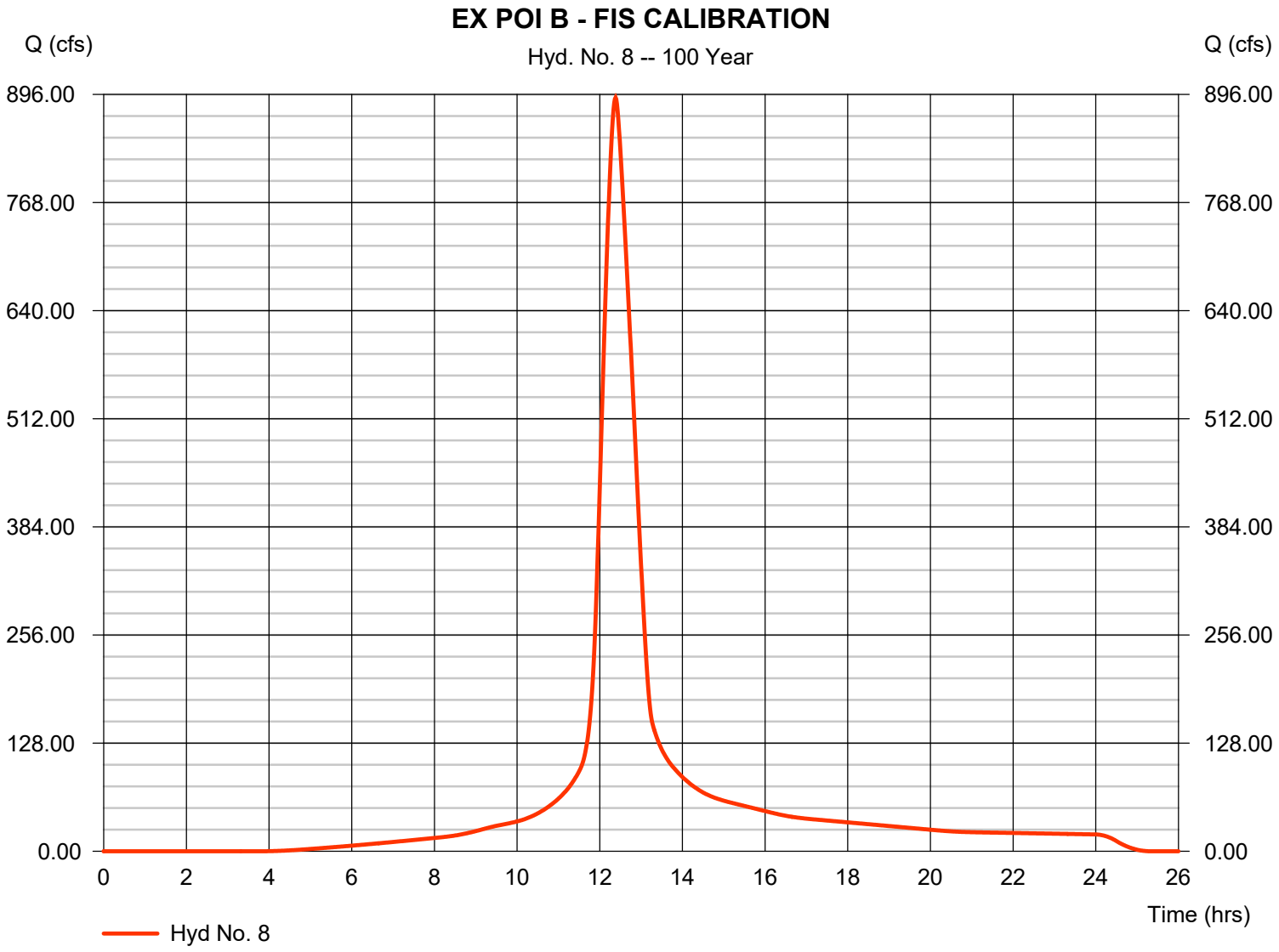


Hydrograph Report

Hyd. No. 8

EX POI B - FIS CALIBRATION

Hydrograph type	=	SCS Runoff	Peak discharge	=	892.27 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.38 hrs
Time interval	=	1 min	Hyd. volume	=	5,152,304 cuft
Drainage area	=	234.960 ac	Curve number	=	86
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	49.40 min
Total precip.	=	7.70 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

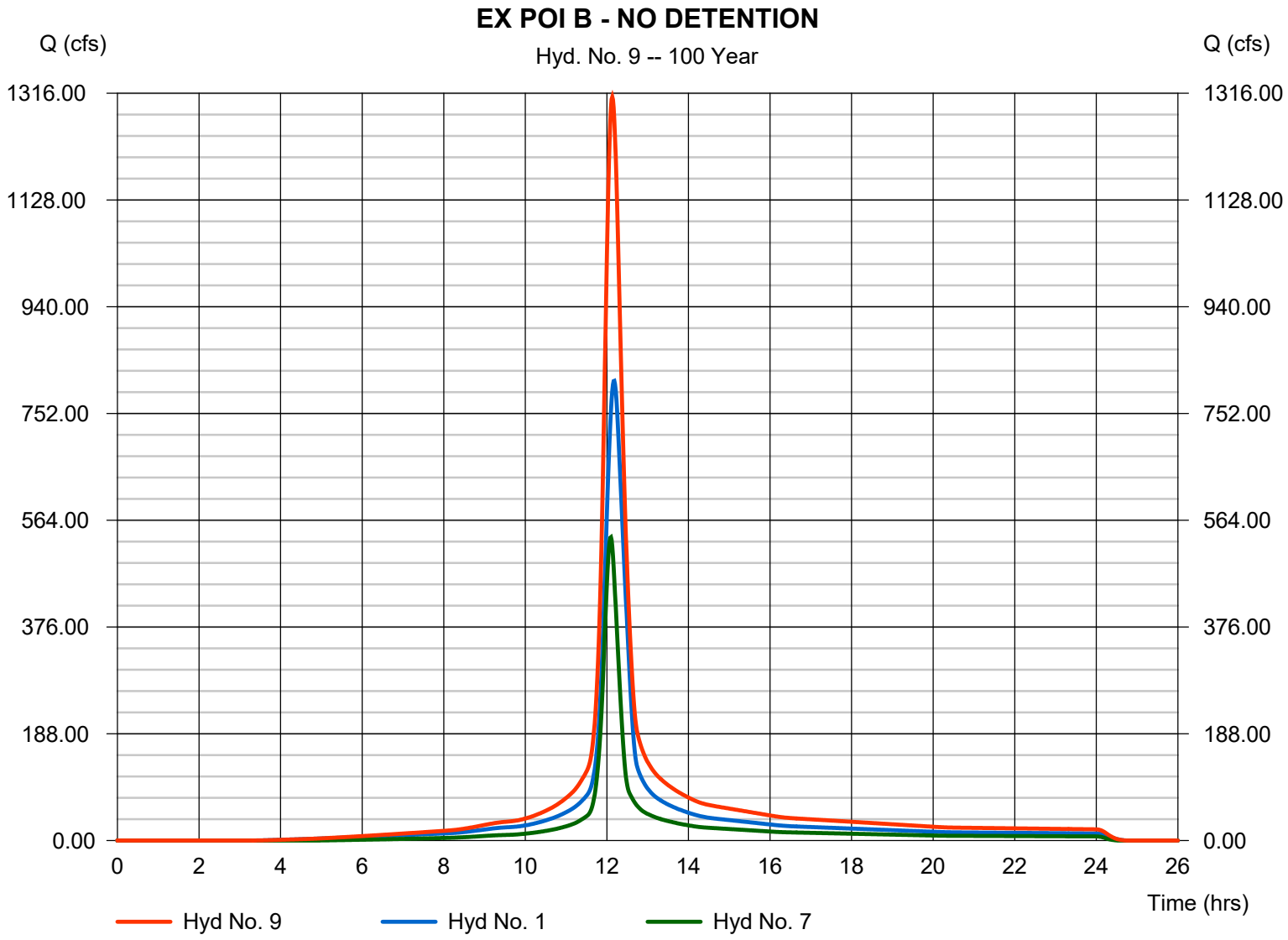


Hydrograph Report

Hyd. No. 9

EX POI B - NO DETENTION

Hydrograph type	=	Combine	Peak discharge	=	1309.46 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.13 hrs
Time interval	=	1 min	Hyd. volume	=	5,146,663 cuft
Inflow hyds.	=	1, 7	Contrib. drain. area	=	234.950 ac

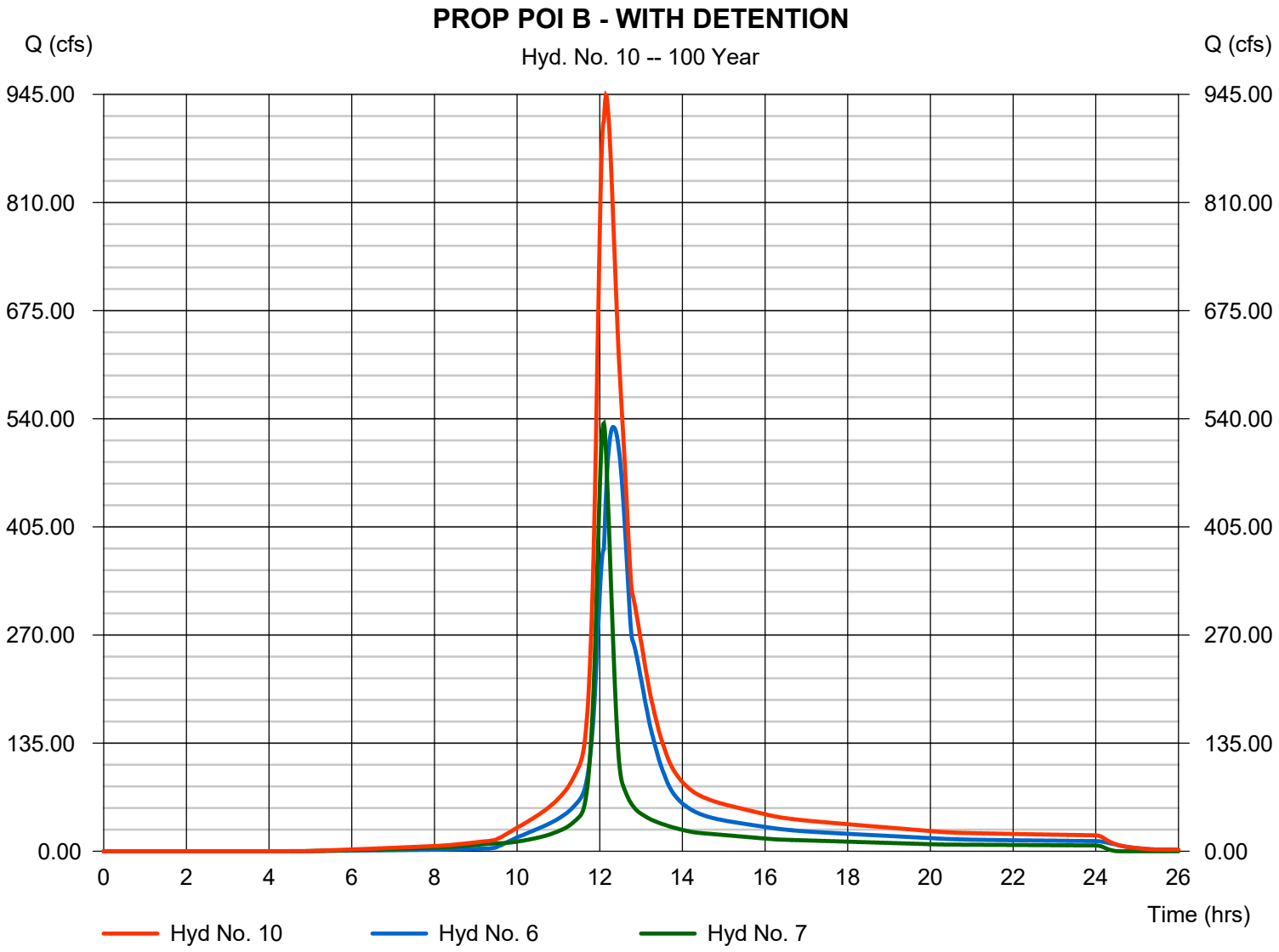


Hydrograph Report

Hyd. No. 10

PROP POI B - WITH DETENTION

Hydrograph type	=	Combine	Peak discharge	=	943.76 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.15 hrs
Time interval	=	1 min	Hyd. volume	=	5,048,042 cuft
Inflow hyds.	=	6, 7	Contrib. drain. area	=	87.500 ac



Hydraflow Rainfall Report

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

Intensity = B / (Tc + 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	1.37	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	2.49	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

Exhibit F

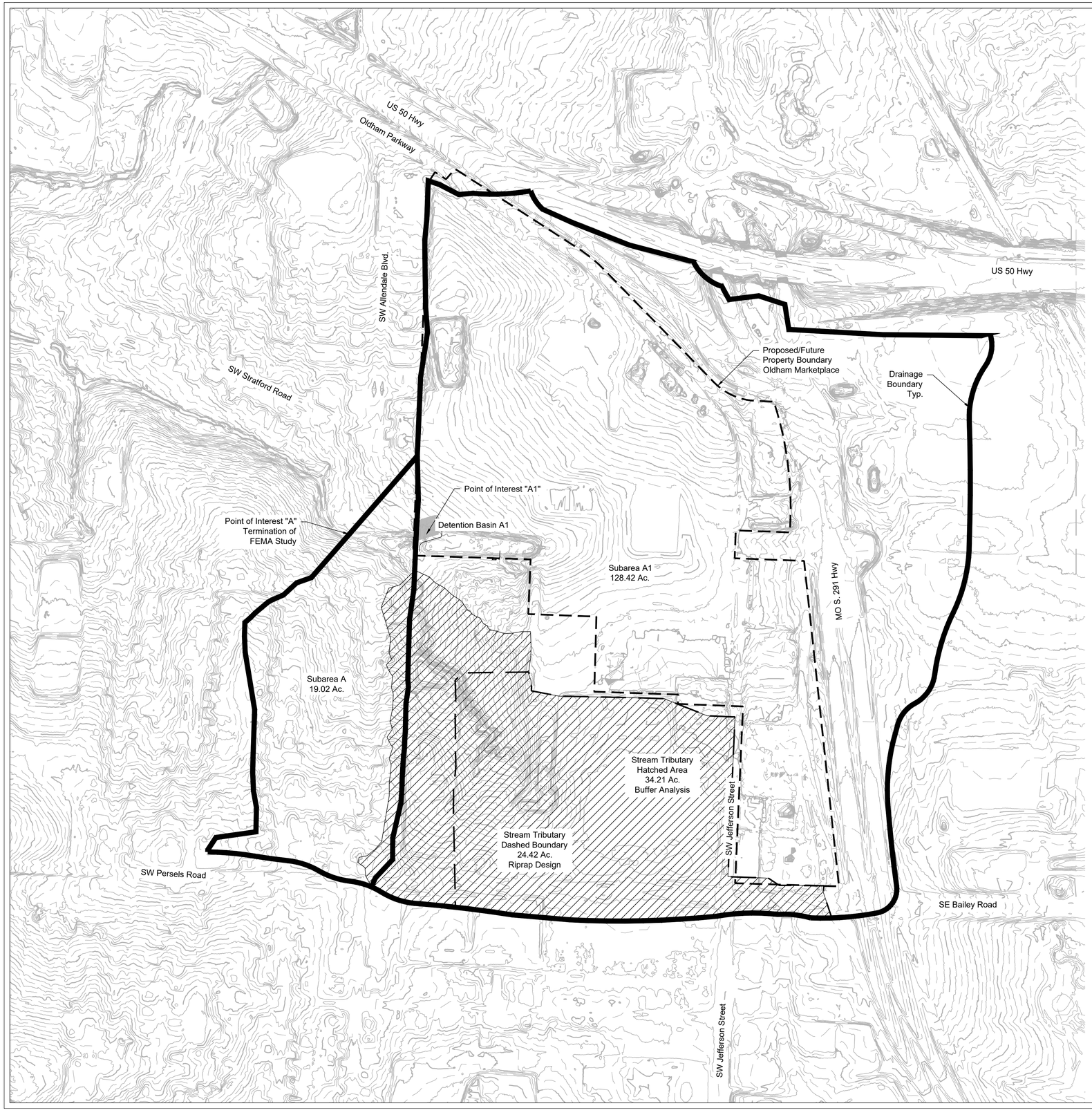
Proposed Drainage Area Map

North

0 100' 200' 400'

PROPOSED DRAINAGE MAP

SCALE: 1" = 200'



Oldham Marketplace
LEE'S SUMMIT, JACKSON COUNTY, MISSOURI

Project: Oldham Marketplace
Issue Date: October 20, 2022

PROPOSED DRAINAGE MAP
Conceptual Drainage Plan for:
Oldham Marketplace
Lee's Summit, Jackson County, Missouri

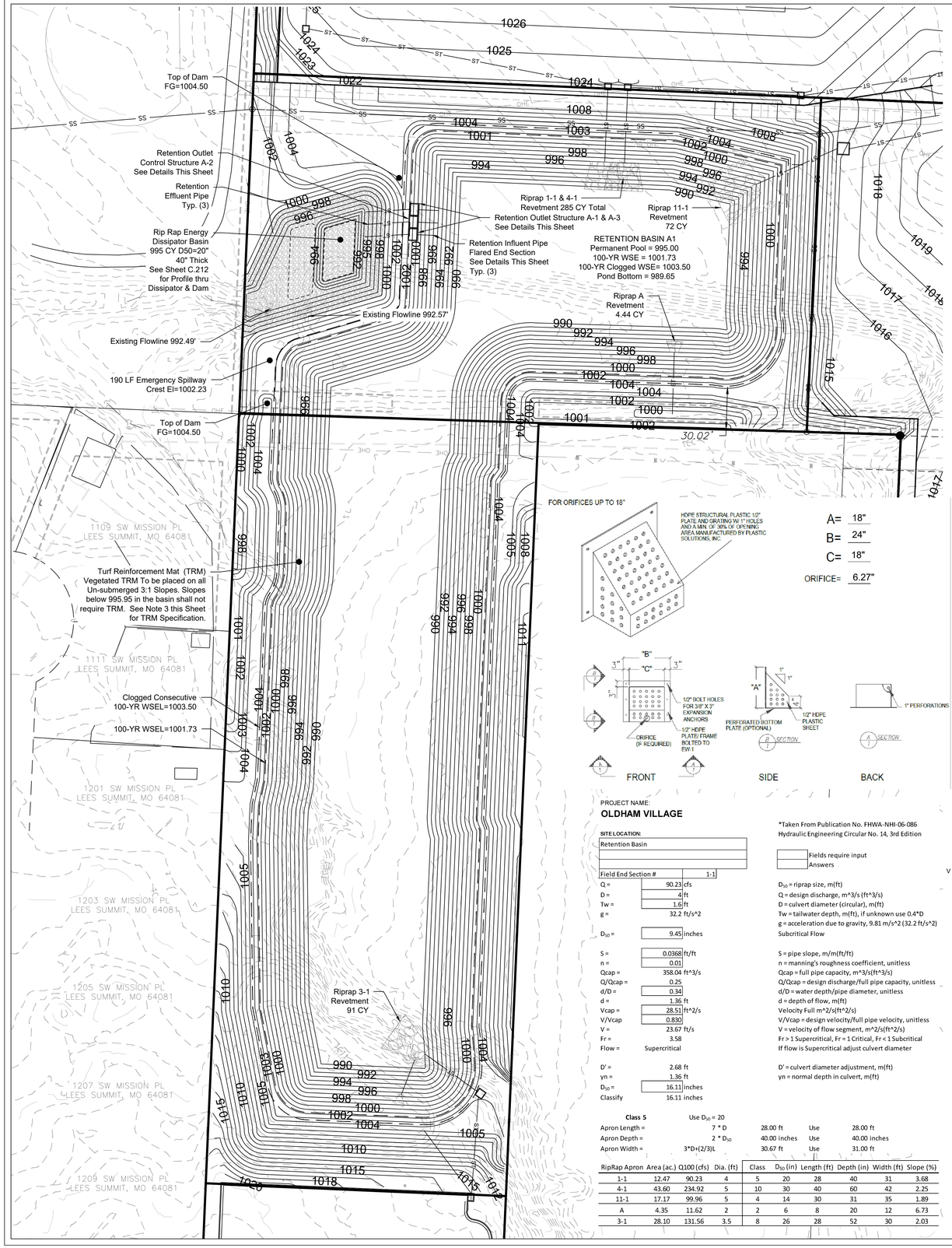
Matthew J. Schlicht
MO PE 2006019708
KS PE 19071
OK PE 25226
NE PE E-14335

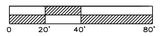
REVISIONS

C.201

Exhibit G

Retention Basin Plan





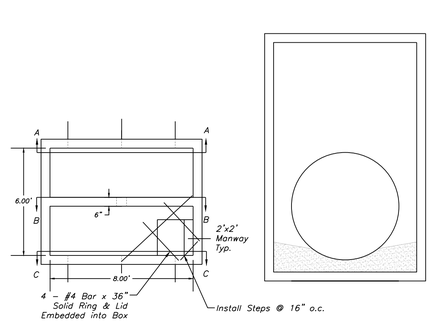
RETENTION BASIN PLAN

SCALE: 1" = 40'

NOTES:

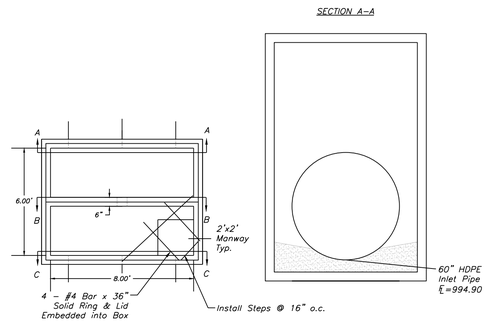
1. THE BASIN SHALL BE CONSTRUCTED WITH THE EROSION AND SEDIMENT CONTROL MEASURES.
2. AN AS-BUILT DETENTION BASIN PLAN SHALL BE SUBMITTED AND ACCEPTED PRIOR TO ISSUANCE OF A CERTIFICATE OF SUBSTANTIAL COMPLETION, WITH AS-BUILT VERSUS PROPOSED STORAGE.
3. TURF REINFORCEMENT MAT SHALL BE NORTH AMERICAN GREEN ERONET OR APPROVED EQUAL. TRM TO BE VEGETATED.
4. RIPRAP CALCULATIONS FOR PIPES ENTERING THE BASIN HAVE BEEN PROVIDED ON THIS SHEET. GEOTEXTILE SHALL BE GEI WORKS 8 OUNCE.

Outlet Structure Notes:
1. Locate ring and cover outlet on blank wall per detail
2. Use ¾" Chamfer on all exposed concrete corners
3. Floor of inlet grouted and shaped to match pipe invert to provide smooth flow
4. Steps required at 16" o.c.
5. Boxouts will not be allowed to project through the corners of the structure
6. The minimum reinforcing shall be 1 H-Bar over a cast-in-place pipe and 2 H-Bars over a precast boxout
7. 10" opening is required on retention basin side of all outlet structures
8. Precast lids shall be pinned, sealed with non-shrinkable grout and removable for future maintenance
9. For Ring and Cover see the stormwater approved product list



CONTROL STRUCTURE - BASIN A2 & A3

1/4" = 1'-0"



CONTROL STRUCTURE - BASIN A1

1/4" = 1'-0"

PROJECT NAME:

OLDHAM VILLAGE

SITE LOCATION:

Retention Basin	
Field End Section #	1-1
Q =	90.23 cfs
D =	4 ft
Tw =	1.6 ft
g =	32.2 ft/s^2
D_{50} =	9.45 inches
S =	0.0368 ft/ft
n =	0.01
Qcap =	358.04 ft^3/s
Q/Qcap =	0.25
d/D =	0.34
d =	1.36 ft
Vcap =	28.51 ft^2/s
V/Vcap	0.830
V =	23.67 ft/s
Fr =	3.58
Flow =	Supercritical
D' =	2.68 ft
yn =	1.36 ft
D_{50} =	16.11 inches
Classify	16.11 inches

*Taken From Publication No. FHWA-NHI-06-086 Hydraulic Engineering Circular No. 14, 3rd Edition

Fields require input
Answers

D_{50} = riprap size, m(ft)
Q = design discharge, m^3/s (ft^3/s)
D = culvert diameter (circular), m(ft)
Tw = tailwater depth, m(ft), if unknown use 0.4*D
g = acceleration due to gravity, 9.81 m/s^2 (32.2 ft/s^2)
Subcritical Flow

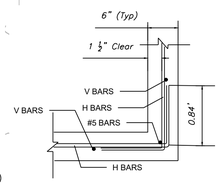
S = pipe slope, m/m(ft/ft)
n = manning's roughness coefficient, unitless
Qcap = full pipe capacity, m^3/s(ft^3/s)
Q/Qcap = design discharge/full pipe capacity, unitless
d/D = water depth/pipe diameter, unitless
d = depth of flow, m(ft)
Velocity Full m^2/s(ft^2/s)
V/Vcap = design velocity/full pipe velocity, unitless
V = velocity of flow segment, m^2/s(ft^2/s)
Fr > 1 Supercritical, Fr = 1 Critical, Fr < 1 Subcritical
If flow is Supercritical adjust culvert diameter

D' = culvert diameter adjustment, m(ft)
yn = normal depth in culvert, m(ft)

Class S — Use D_{50} = 20

Apron Length =	7 * D	28.00 ft	Use	28.00 ft	
Apron Depth =	2 * D_{50}	40.00 inches	Use	40.00 inches	
Apron Width =	3*D+(2/3)L	30.67 ft	Use	31.00 ft	

RipRap Apron	Area (ac.)	Q100 (cfs)	Dia. (ft)	Class	D_{50} (in)	Length (ft)	Depth (in)	Width (ft)	Slope (%)
1-1	12.47	90.23	4	5	20	28	40	31	3.68
4-1	43.60	234.92	5	10	30	40	60	42	2.25
11-1	17.17	99.96	5	4	14	30	31	35	1.89
A	4.35	11.62	2	2	6	8	20	12	6.73
3-1	28.10	131.56	3.5	8	26	28	52	30	2.03

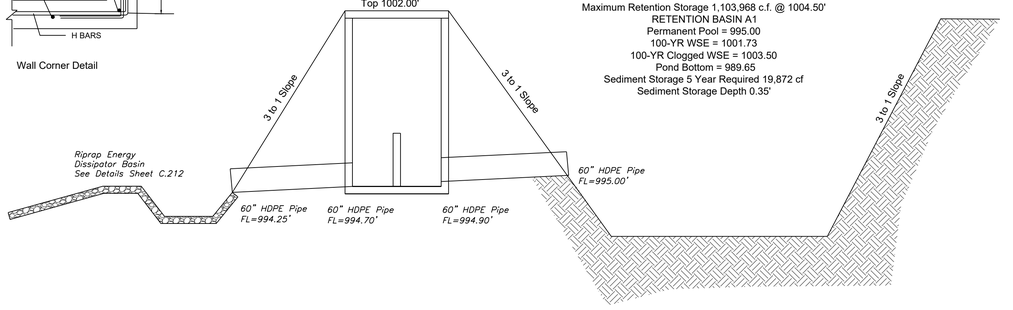


Wall Corner Detail

Control Structure Notes:
1. Control Structure depicted is an 8'x6' precast box.
2. The adjacent boxes shall not contain the 6.27" Rectangular Orifice.
3. Both adjacent structures shall have 10" diameter leveler pipes installed to center box upstream of the weir wall at FL elevation 994.90 to 994.80.
4. Install trash rack per manufacturer's recommendations.

Top Pond EL 1004.50'
Total Pond Storage 1,499,278 c.f. (Retention + Permanent)

Maximum Retention Storage 1,103,968 c.f. @ 1004.50'
RETENTION BASIN A1
Permanent Pool = 995.00
100-YR WSE = 1001.73
100-YR Clogged WSE = 1003.50
Pond Bottom = 989.65
Sediment Storage 5 Year Required 19,872 cf
Sediment Storage Depth 0.35'



SECTION VIEW - BASIN A1

N.T.S.

Detention Storage Area by Contour

Contour Elev	Total Storage
995.00	0
996.00	91,438
998.00	291,473
1000.00	514,780
1002.00	761,827
1004.00	1,033,089
1004.50	1,103,968

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Engineering E-1695
Surveying LS-218
Oklahoma
Engineering 6254
Nebraska
Engineering CA2821

Oldham Village
Lee's Summit, Jackson County, Missouri

Project: OLDHAM MARKETPLACE. LSMO
Issue Date: November 5, 2024

RETENTION BASIN PLAN
Construction Plans for:
Oldham Village
Lee's Summit, Jackson County, Missouri

STATE OF MISSOURI
MATTHEW J. SCHLICHT
NUMBER PE-2006019708
REGISTERED PROFESSIONAL ENGINEER

Matthew J. Schlicht
MO PE 2006019708
KS PE 19071
OK PE 25226
NE PE E-14335

REVISIONS

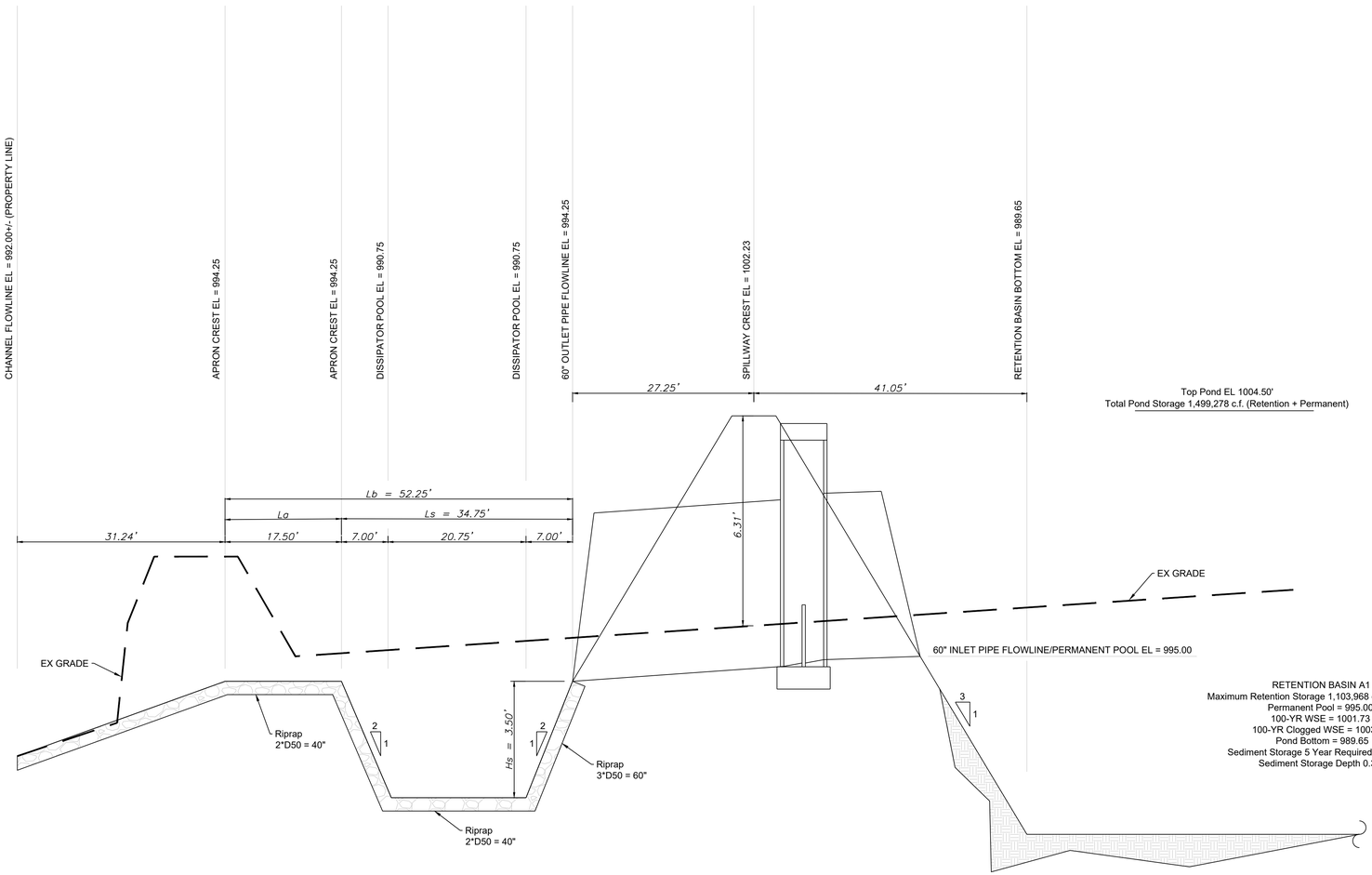
1 REV. 12/10/2024
2 REV. 1/2/2025
3 REV. 2/6/2025
REV. 3/5/2025

North

0 5' 10' 20'

ENERGY DISSIPATOR & RETENTION BASIN PROFILE VIEW

SCALE: 1" = 10'



Culvert Discharge

Q (cfs)	503.51	Q = Peak Dsicharge Rate (cfs)
D (ft)	6	D = culvert diameter (circular) (ft)
Tw (ft)	2.40	Tw = tailwater depth, (ft), if unknown use 0.4*D
S (ft/ft)	0.0141	S = pipe slope (ft/ft)
n	0.012	n = manning's roughness coefficient, unitless
Qcap (cfs)	545.26	Qcap = full pipe capacity (cfs)
Vo (Fr>1) (fps)	19.29	Supercritical use Manning's Velocity
Fr (Equivalent Brink Depth) =	1.79	Equivalent Depth (ye = (A/2)^0.5) where A = Brink Area
ye (ft)	3.61	ye = Equivalent Brink Depth (ft), ye = (A/2)^0.5
A (sf)	26.10	A = Brink Area (sf), A = Q/V
Select D50 Size		
D50 (ft)	1.67	D50 = Median Rock Size (ft)

Rip Rap Basin Envelope Design

hs/ye = 0.86 * (D50/ye)^-0.55 * (Vo/(g * ye)^0.5) - Co

Where:

hs (ft)	3.44	hs = Dissipator Pool Depth (ft)
ye (ft)	3.61	ye = Equivalent Brink (Outlet) Depth (ft)
D50 (ft)	1.67	D50 = Median Rock Size (ft)
Co	1.4	Co = Tailwater Parameter

Tailwater Parameter, Co

Tw (ft)	1.62	Tw = yc
ye (ft)	3.61	
Tw/ye	0.45	
Tw/ye < 0.75	Co = 1.4	
0.75 < Tw/ye < 1.0	Co = 4 * (Tw/ye) - 1.6	
1.0 < Tw/ye	Co = 2.4	

Checks

hs/D50	2.06	
hs/D50 >= 2.0	Good	
D50/ye	0.46	
D50/ye >= 0.1	Good	

Basin Dimensions

Ls (ft) = 10*hs	34.38	Length of Dissipating Pool (ft)
Ls > 3*Wo	18	Dissipating Pool Minimum Length (ft)
La (ft) = 5*hs	17.19	Length of Apron (ft)
La > Wo	6	Apron Minimum Length (ft)
Lb = Ls + La (ft)	51.57	Total Basin Length (ft)
Wb (ft)	40.38	Max Basin Width at Apron Termination (ft)

Critical Depth at Basin Exit, yc

Q^2/g = ((yc * (Wb + zyc))^3 / (Wb + 2zyc))

Q^2/g	7873	Left Side Eq
((yc * (Wb + zyc))^3 / (Wb + 2zyc))	7857	Right Side Eq
yc (ft)	1.620	Iterate yc Figure 10.1 -> yc = yb
Wb (ft)	40.38	
z	3	
Vc = Q/Ac (fps)	7.70	
Shear, τ (psf)	0.94	

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Surveying LS-218
Oklahoma
Engineering 6254
Nebraska
Engineering CA2821

Oldham Village
Lee's Summit, Jackson County, Missouri

Project: OLDHAM MARKETPLACE, LSMO
Issue Date: November 5, 2024

ENERGY DISSIPATOR & RETENTION BASIN PROFILE VIEW
Construction Plans for:
Oldham Village
Lee's Summit, Jackson County, Missouri

STATE OF MISSOURI
MATTHEW J. SCHLICHT
NUMBER PE-2009019708
PROFESSIONAL ENGINEER

Matthew J. Schlicht
MO PE 2006019708
KS PE 19071
OK PE 25226
NE PE E-14335

REVISIONS

1 REV. 12/10/2024
2 REV. 1/2/2025
3 REV. 2/6/2025
REV. 3/5/2025

Exhibit H

Emergency Spillway Calculations

Weir Report

Emergency Spillway - Broad Crested Earthen Weir

Rectangular Weir

Crest	= Broad
Bottom Length (ft)	= 190.00
Total Depth (ft)	= 2.27

Calculations

Weir Coeff. Cw	= 2.60
Compute by:	Known Q
Known Q (cfs)	= 705.02

Highlighted

Depth (ft)	= 1.27
Q (cfs)	= 705.02
Area (sqft)	= 240.87
Velocity (ft/s)	= 2.93
Top Width (ft)	= 190.00

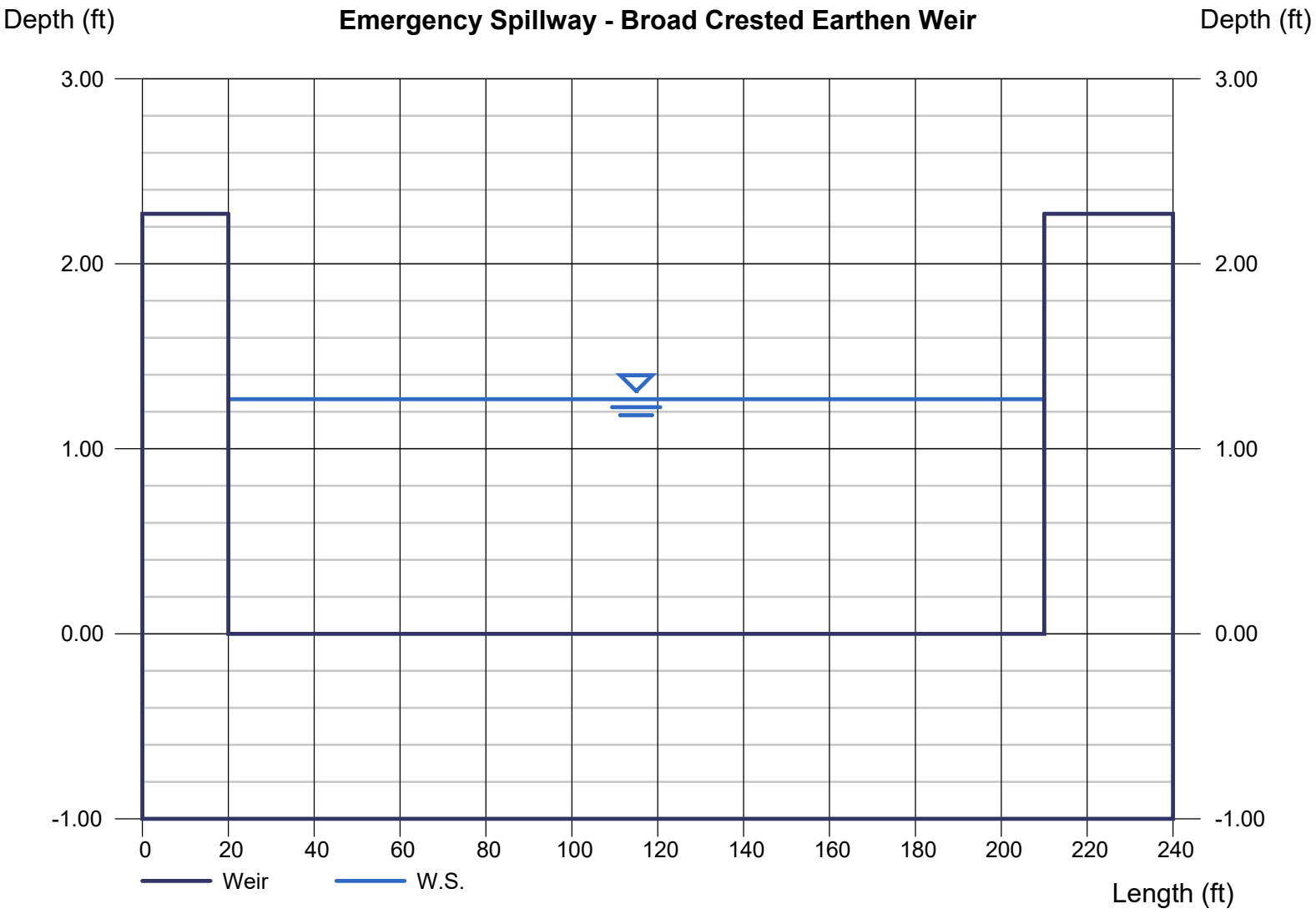


Exhibit I

40 Hour Extended Detention Calculations

Calculate Water Quality for Storm Study

Project: Oldham Village (Retention Basin A1) Date: 2-27-2025

To Calculate: WQv = P * Rv * A

P (in) =	1.37
P (ft) =	0.11
Impervious Area (sq. ft.) =	1,244,270.04
Total Area (sq. ft.) =	2,164,060.80
Impervious Area (ac) =	28.56
Total Area (acre) =	49.68
Rv = (0.05 * 0.009(I)) =	0.57
Percent Impervious (I) =	58.33
WQ_v (cu. ft.) =	142,054
WQ_v (ac. ft.) =	3.261

Enter data in these Fields

Unit Conversions
1 Acre = 43,560 Sq. Ft.

Pond Volume

Elevation	Area (Sq. Ft.)	Volume (Cu. Ft.)
995	88,607	0
996	94,268	91,438
998	105,792	291,498
1,000	117,544	514,834
1,002	129,533	761,911
1,004	141,758	1,033,202
1,005	141,758	1,104,081

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) =	49.68
Step 2) Calculate WQ_v using Sec. 6 (ac-ft) =	WQ_v (ac. ft.)=	3.261
Step 3) Add 20 Percent to Step 2.	V_{design} (ac-ft) =	3.913

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 = 1

Step 2) Proceed to Step IIb, IIc, or IId based on selection

IIb. Water Quality Outlet, Single Orifice

Step 1) Depth of water quality volume at outlet	Z_{WQ} (ft) =	1.51	See Below to Calc. Z_{WQ}
Step 2) Average Head of water volume over invert of Orifice	H_{WQ} (ft) =	0.75	
Step 3) Average Water quality outflow rate	Q_{WQ} (cfs) =	0.986	
Step 4) Set value of orifice discharge coefficient a) 0.66 when thickness of riser/weir plate ≤ orifice dia. b) 0.80 when thickness of riser/weir plate > orifice dia.	C0 (unitless) =	0.66	
Step 5) Water quality outlet orifice dia.	D_0 (in) =	6.27	6.27479103

(if orifice dia. < 4 inches, use outlet type 2 or 3)

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

Elevation 1 =	996.00	Storage 1 =	91,438.00
Elevation X =		Storage X =	142,054.16
Elevation 2 =	998.00	Storage 2 =	291,498.00
		Elevation X =	996.51
Lowest Elevation of Pond =	995.00		
Elevation X =	996.51	996.55	
Z_{WQ} (ft) =	1.51		

Recommended Method: Single Orifice

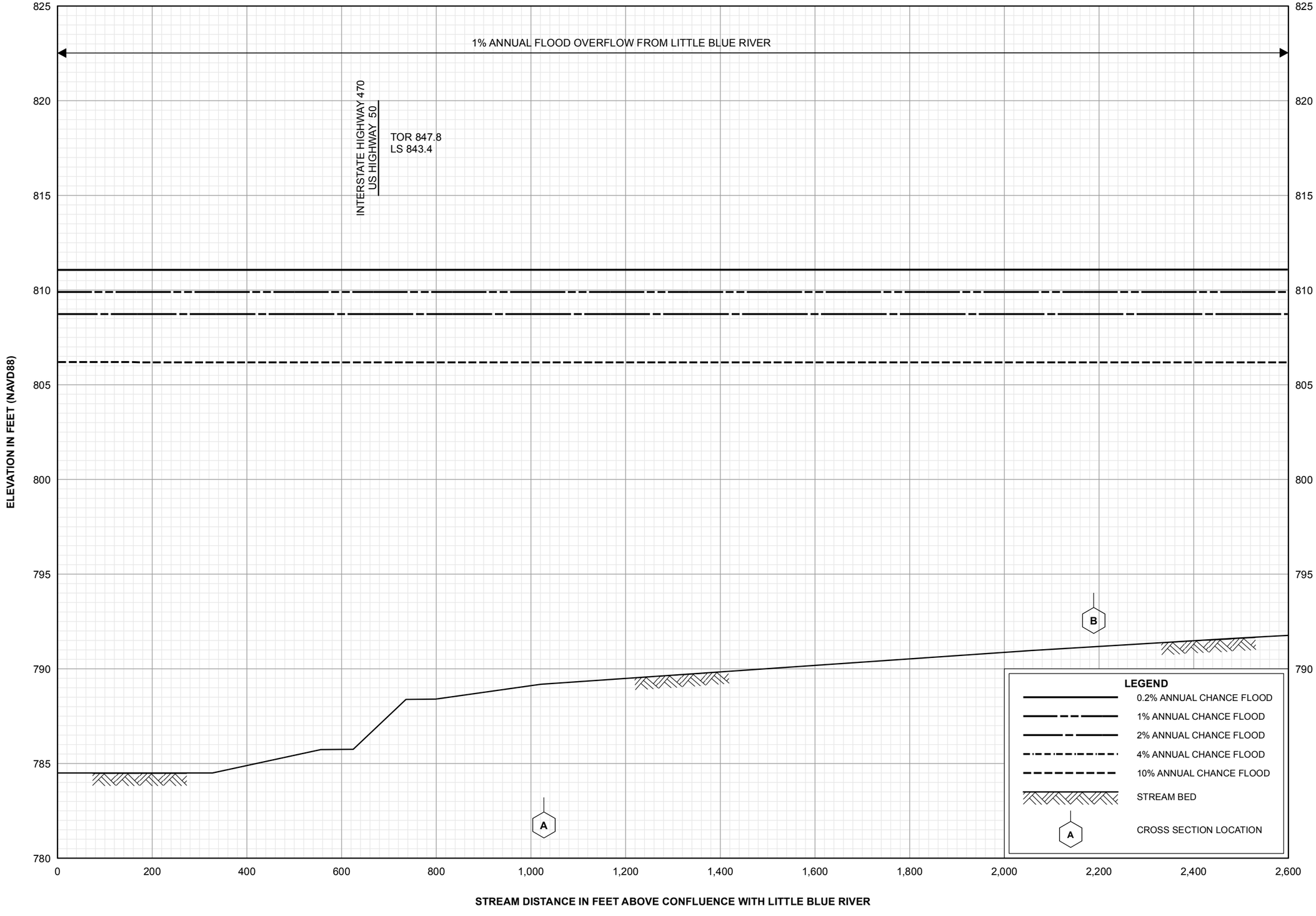
Exhibit J

FEMA FIS Data

Downstream Drainage Area Maps
With Parcels
Without Parcels

Composite Curve Number Calculations

Time of Concentration Calculations



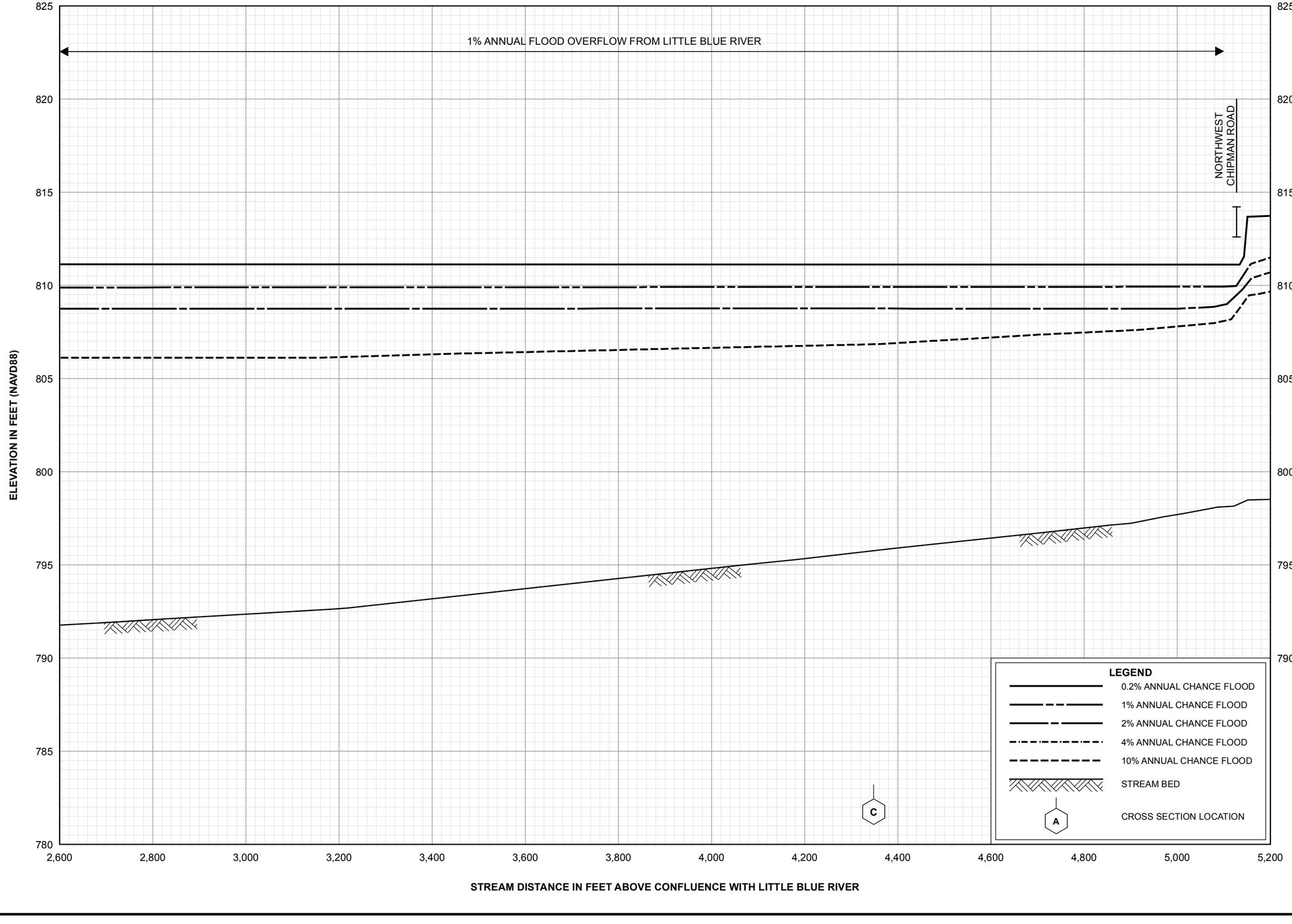
FLOOD PROFILES

CEDAR CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

JACKSON COUNTY, MO
AND INCORPORATED AREAS

087P



FLOOD PROFILES

CEDAR CREEK

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JACKSON COUNTY, MO

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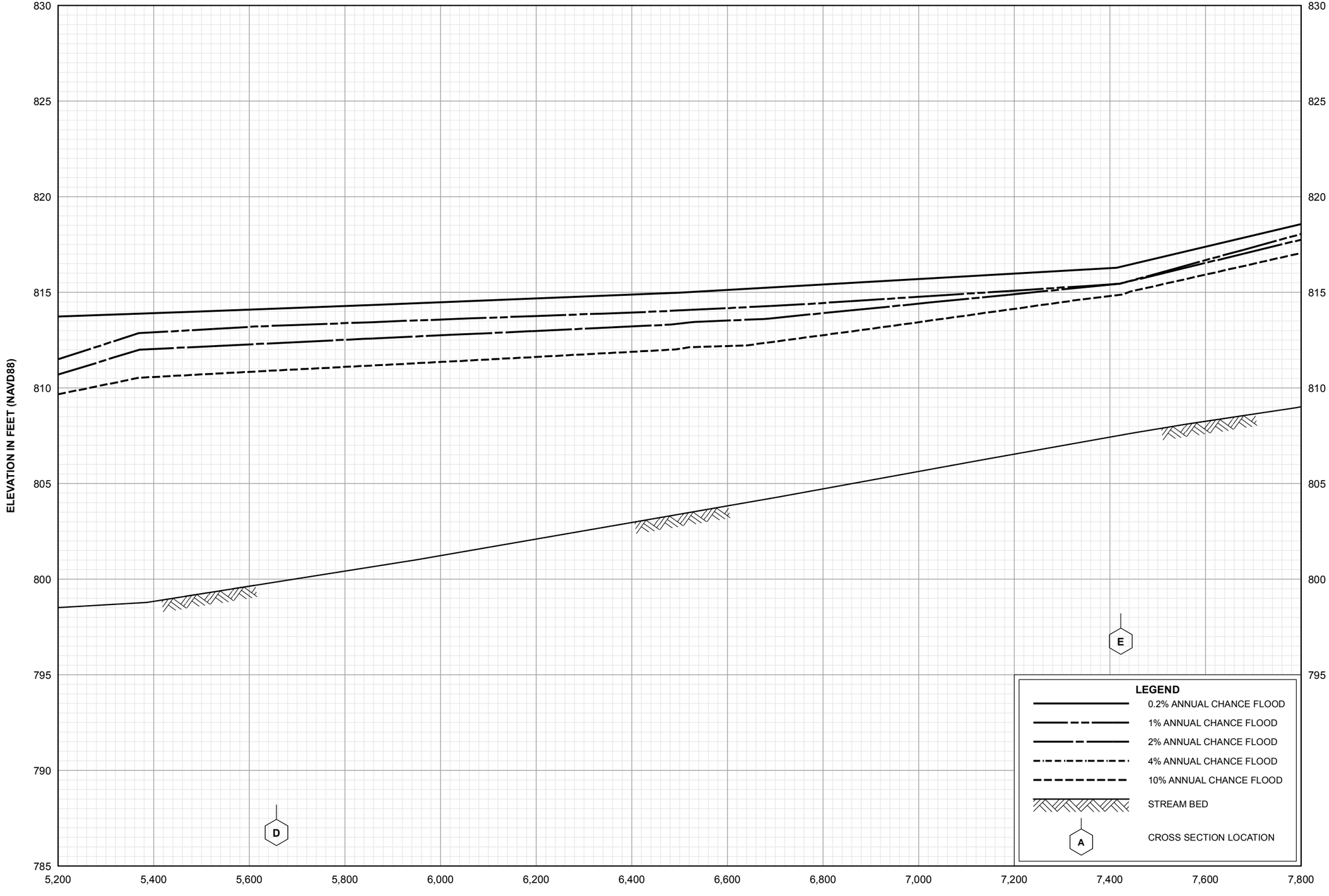

FLOOD PROFILES

CEDAR CREEK

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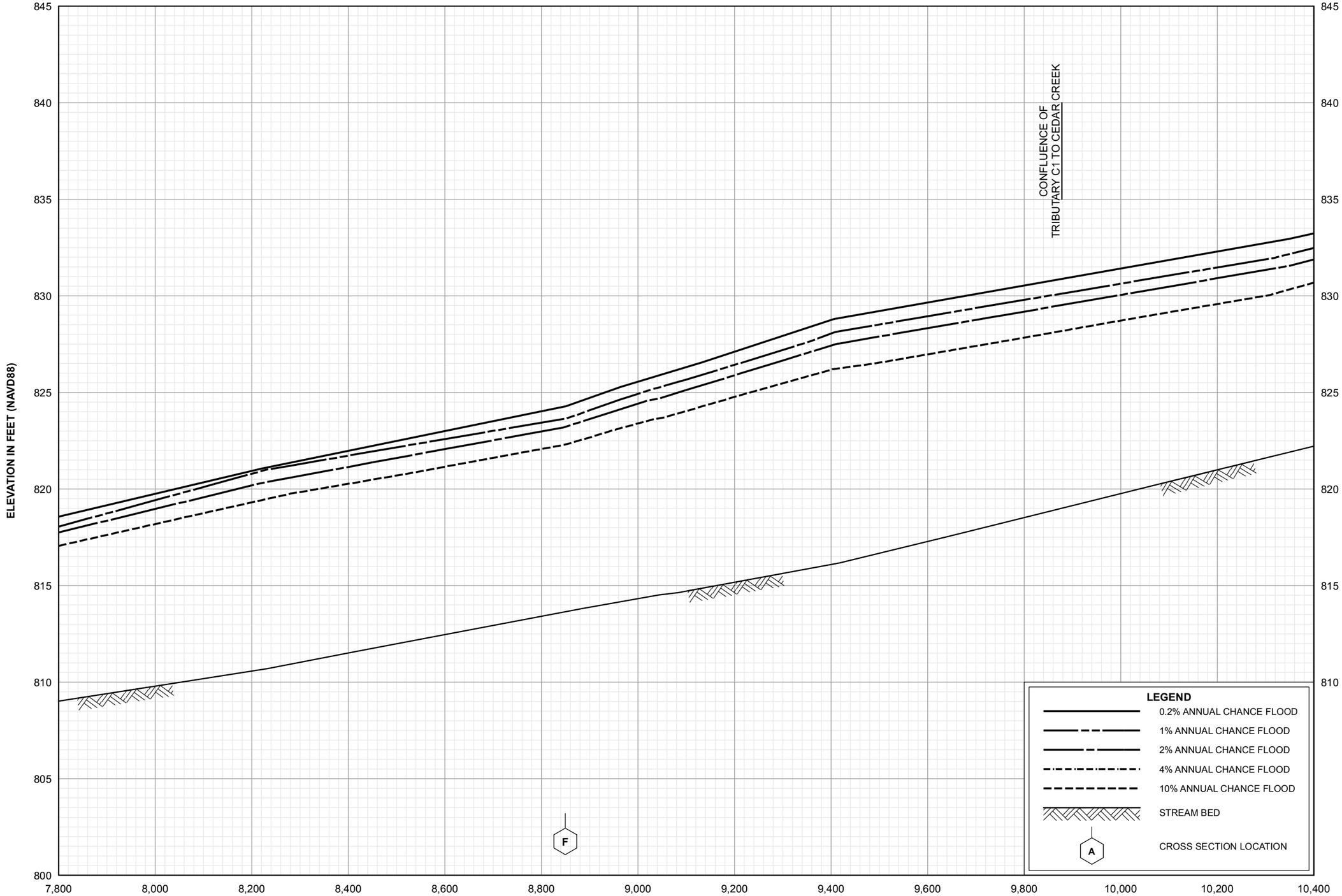

FLOOD PROFILES

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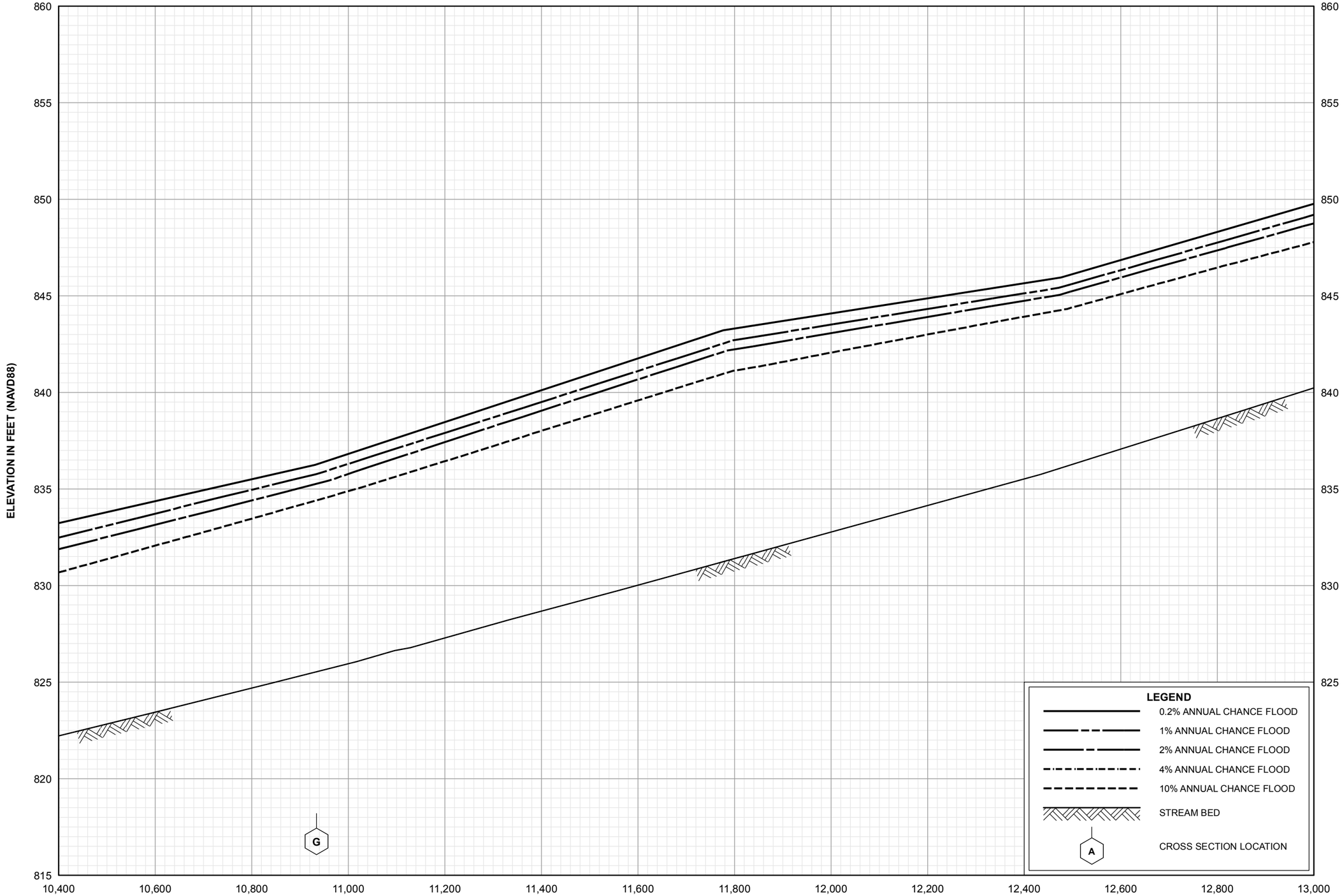

FLOOD PROFILES

CEDAR CREEK

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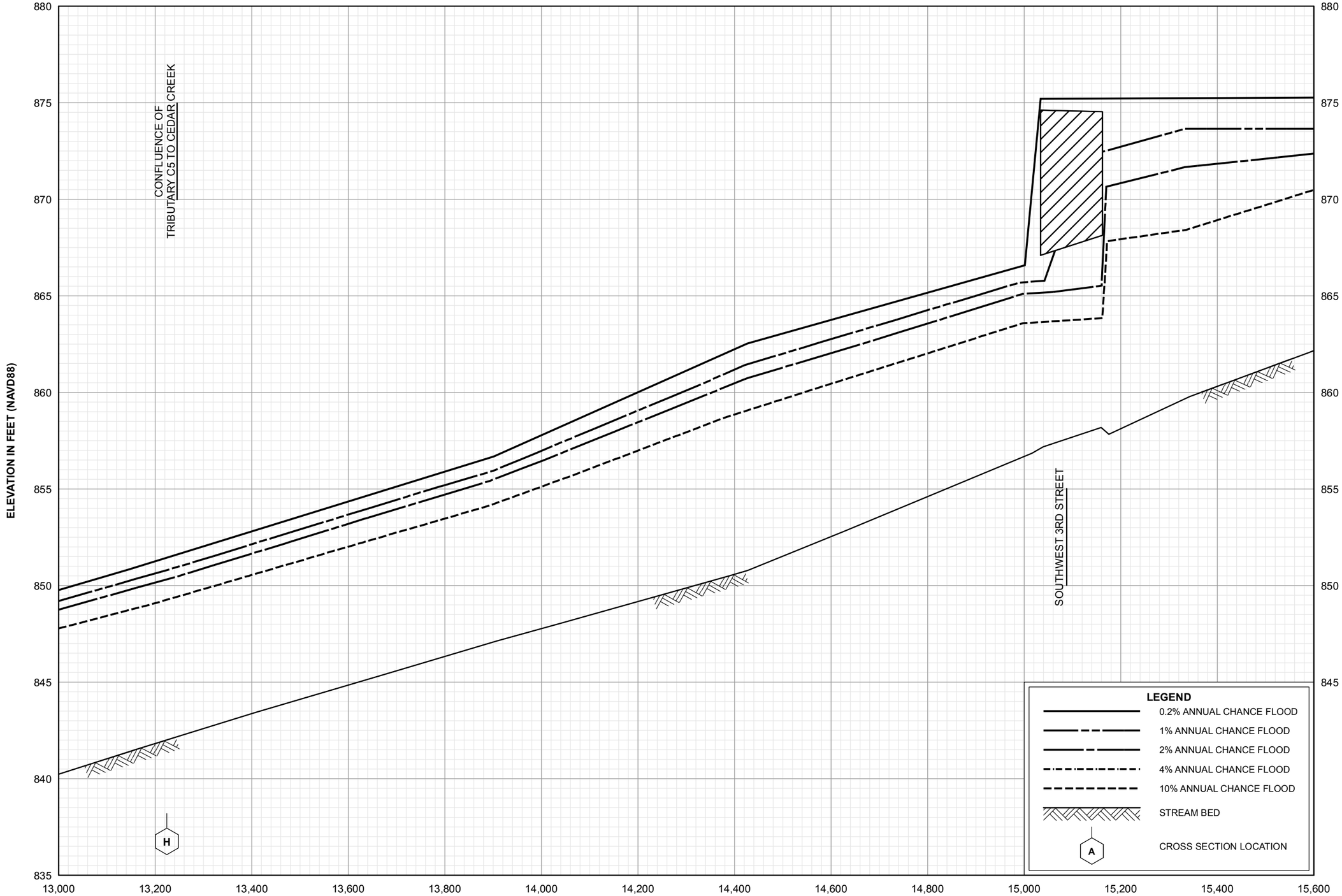

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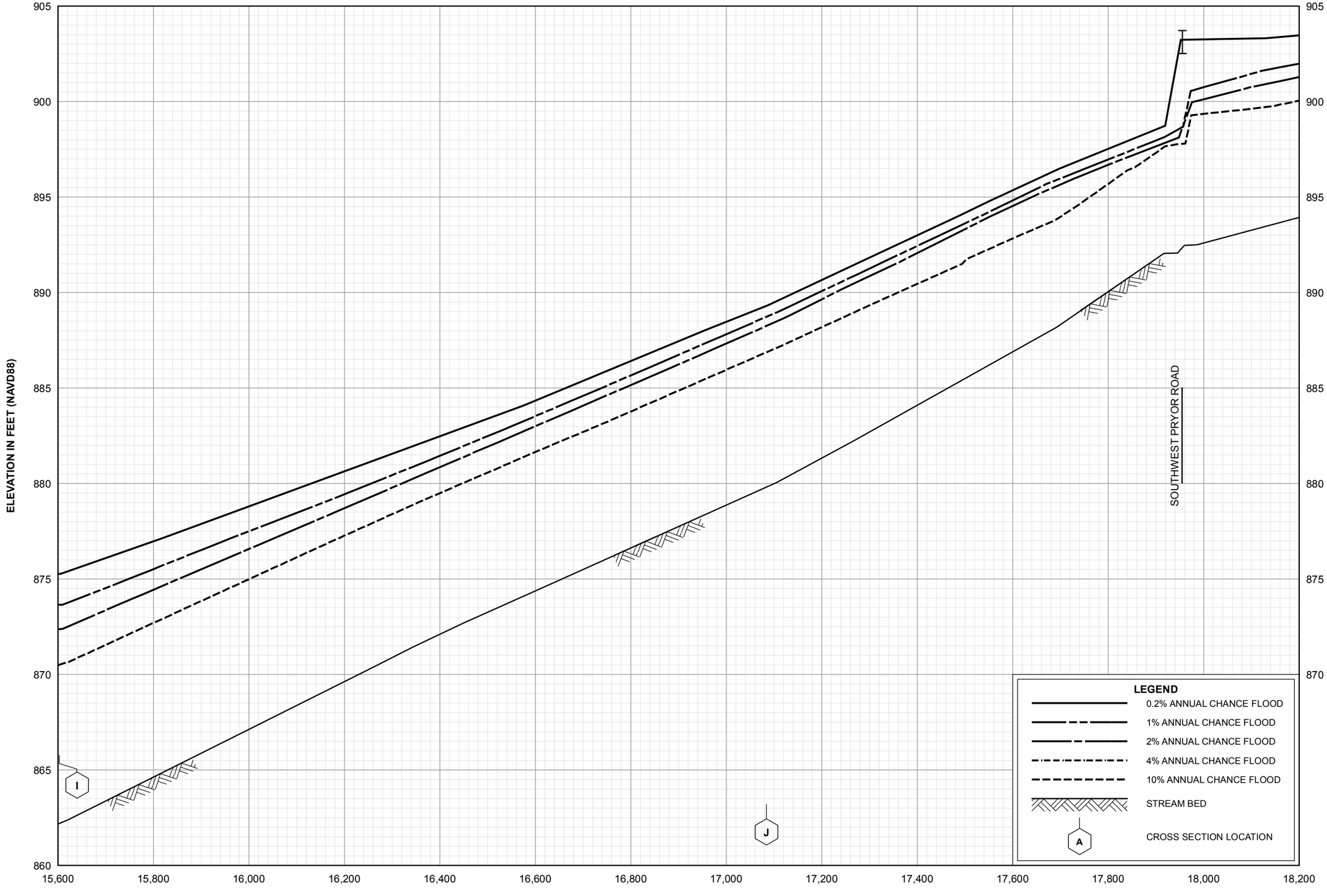

FLOOD PROFILES

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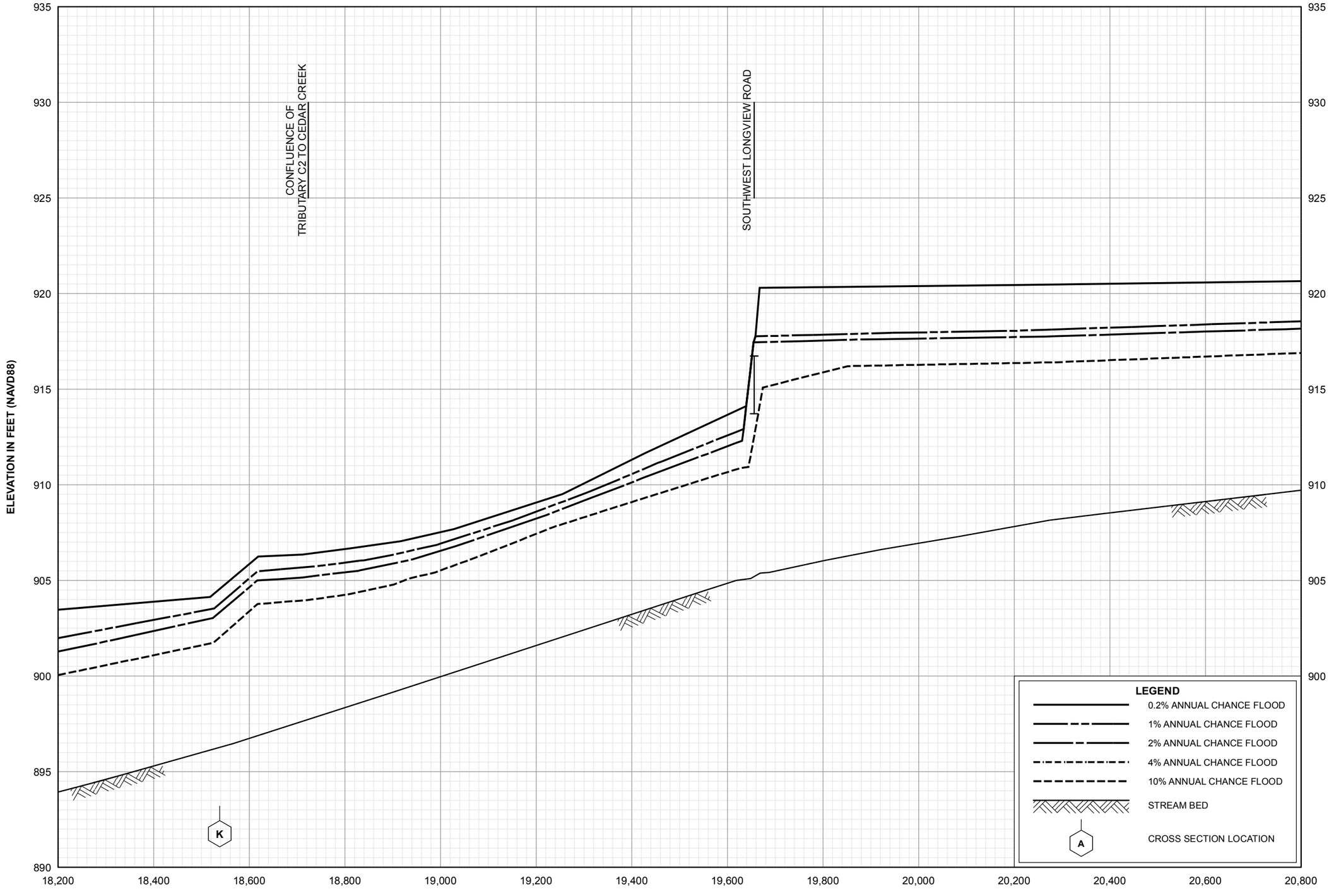

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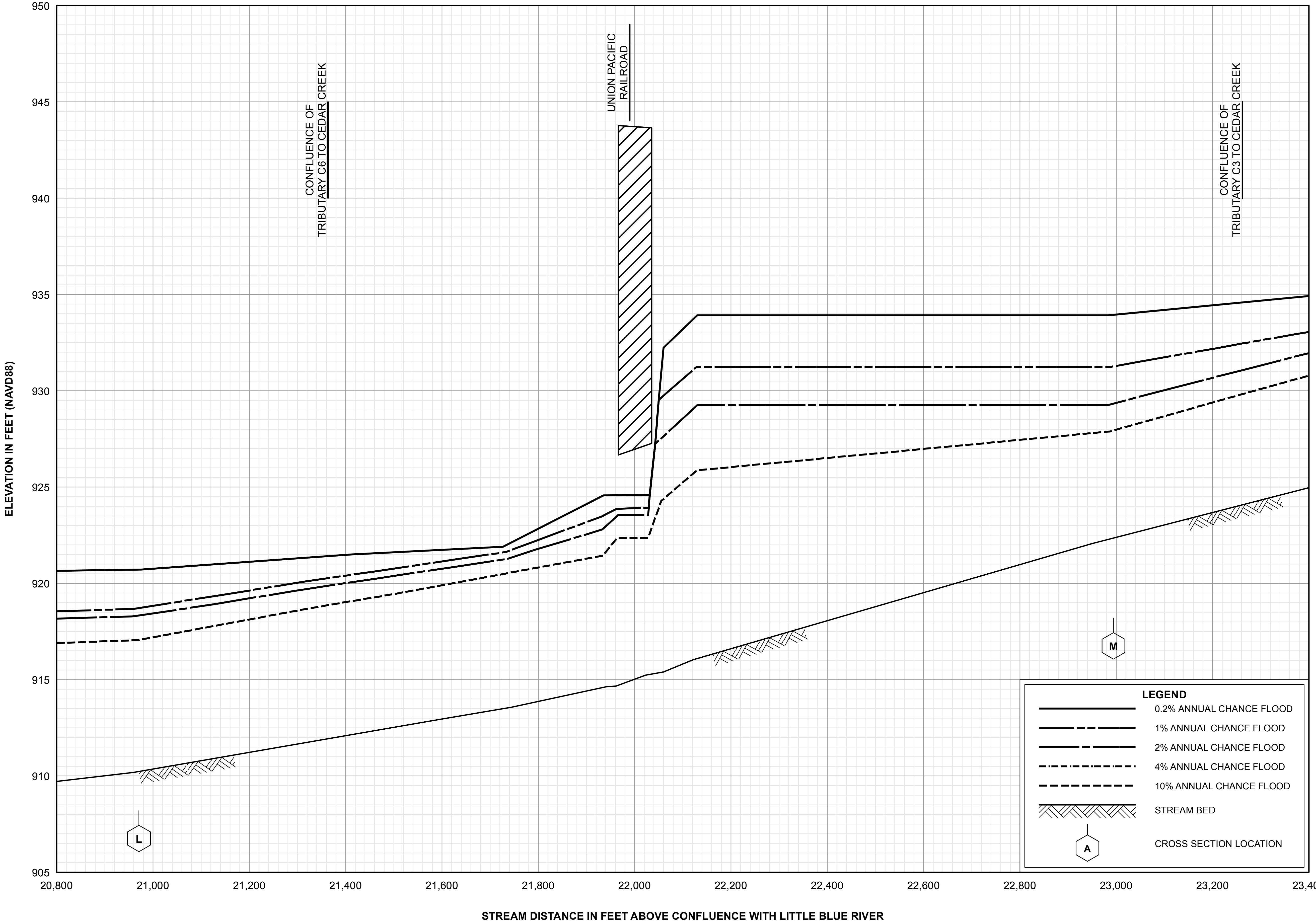

FLOOD PROFILES

CEDAR CREEK

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JACKSON COUNTY, MO

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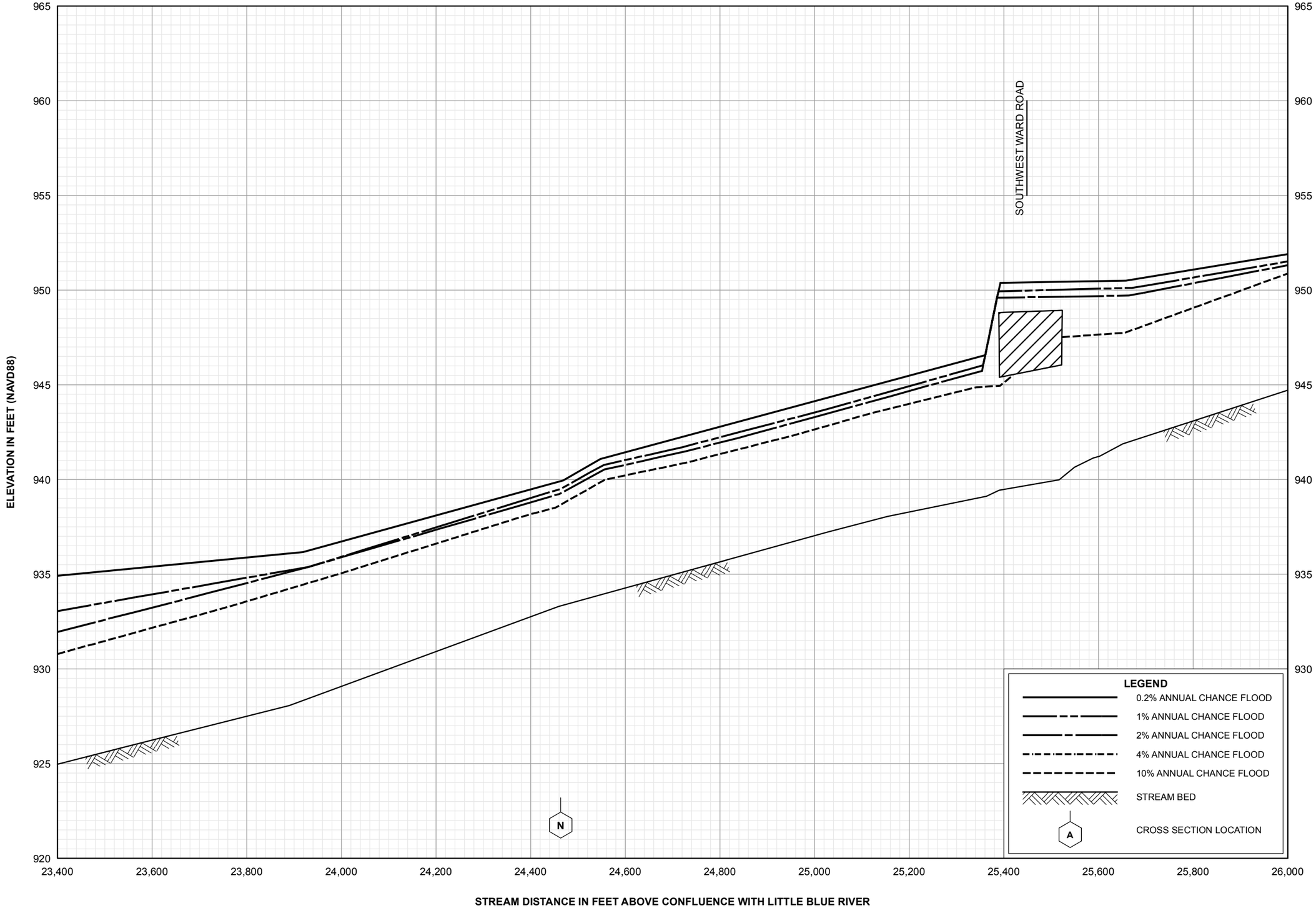

FLOOD PROFILES

CEDAR CREEK

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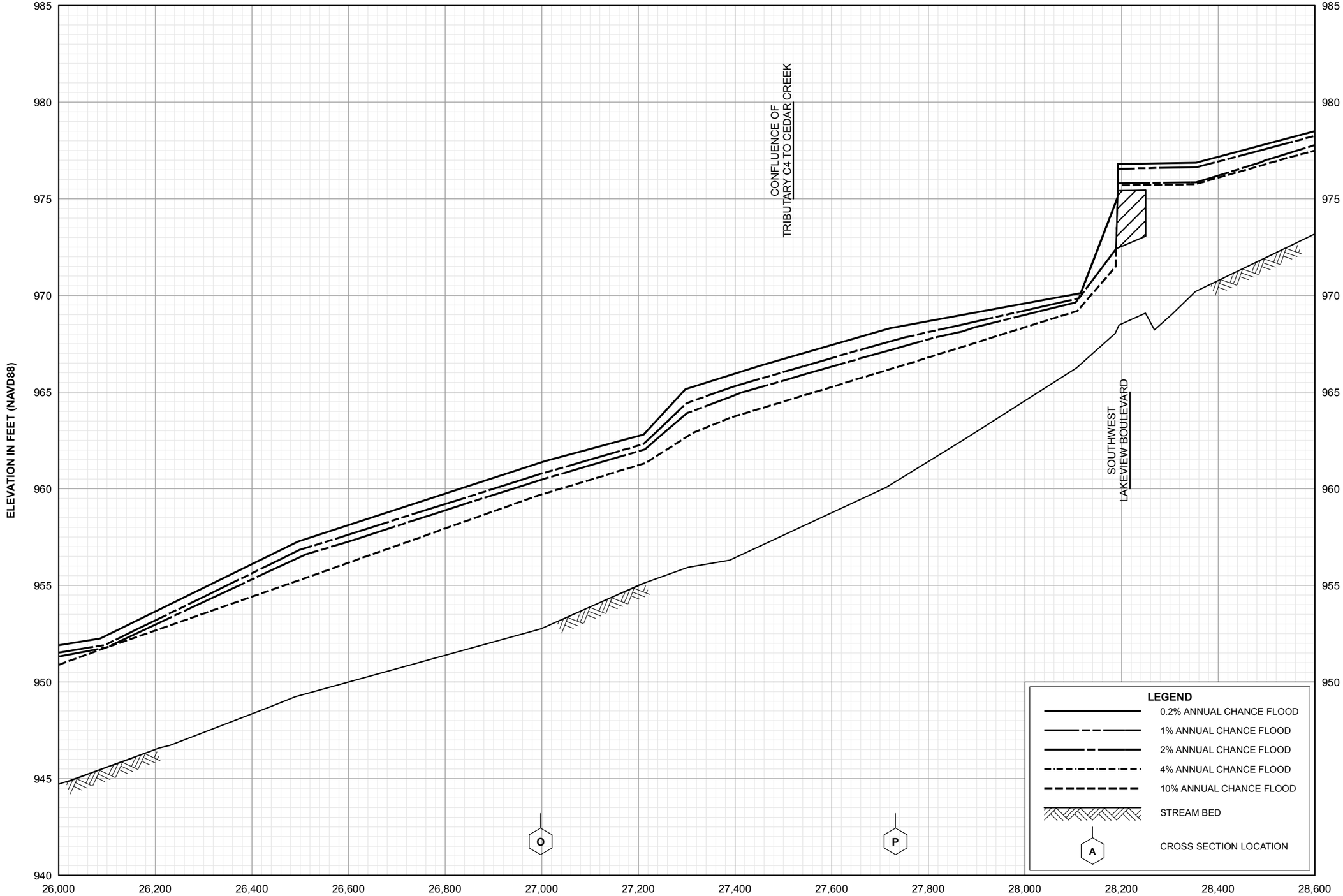

FLOOD PROFILES

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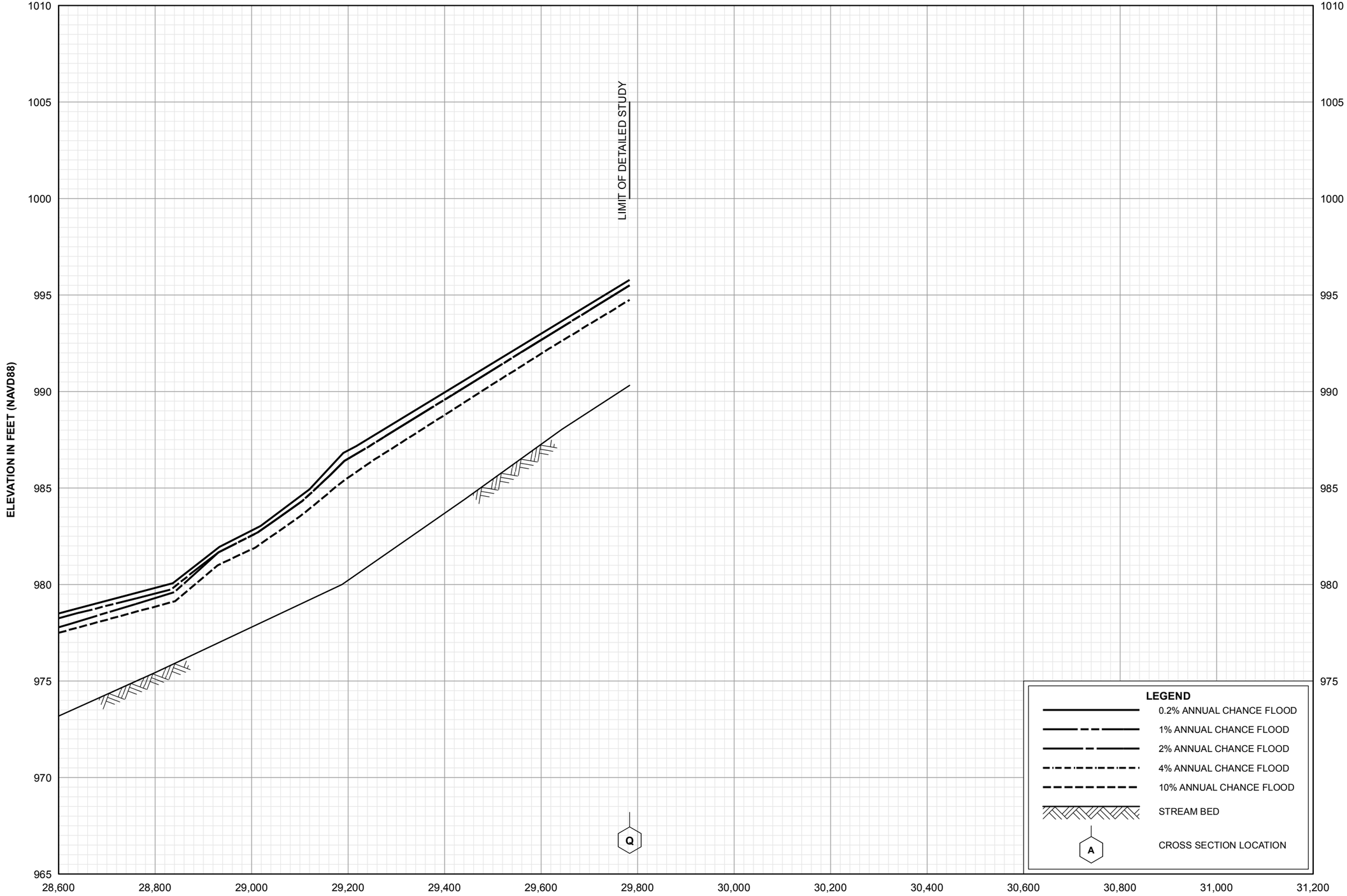

FLOOD PROFILES

CEDAR CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

JACKSON COUNTY, MO
AND INCORPORATED AREAS

098P

TABLE 3 – SUMMARY OF DISCHARGES (CONT'D)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK ANNUAL CHANCE DISCHARGES (CFS) 10-Percent Annual Chance	4-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent Annual-Chance
BURLINGTON CREEK (CONT'D)						
Just downstream of Tom Watson Parkway	0.4	955	N/A	1,288	1,535	1,943
BURLINGTON CREEK TRIBUTARY 1						
Just downstream of Northwest 62nd Terrace	0.4	955	N/A	1,289	1,535	1,943
BURLINGTON CREEK TRIBUTARY 2						
Approximately 1,000 feet upstream of the confluence with Burlington Creek	0.5	650	N/A	1,014	1,302	1,806
Approximately 1,500 feet upstream of the confluence with Burlington Creek	0.5	524	N/A	817	1,050	1,462
BURR OAK CREEK						
Approximately 1,500 feet downstream of Northwest Pink Hill Road	4.3	1,400	N/A	2,900	3,600	5,200
At Northwest Pink Hill road	1.7	800	N/A	1,700	2,100	3,000
BURR OAK CREEK TRIBUTARY						
Approximately 500 feet upstream of confluence with Burr Oak Creek	1.6	610	N/A	1,200	1,500	2,200
CEDAR CREEK						
At confluence with Little Blue River	*	3,900	N/A	5,780	6,750	8,240
At Northwest Chipman Road	*	3,840	N/A	5,710	6,680	8,180
Approximately 0.8 miles upstream of Northwest Chipman Road	*	3,470	N/A	5,130	5,990	7,310

*Data not available.

TABLE 3 – SUMMARY OF DISCHARGES (CONT'D)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK ANNUAL CHANCE DISCHARGES (CFS) 10-Percent Annual Chance	4-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent Annual-Chance
CEDAR CREEK (CONT'D)						
Approximately 1,870 feet downstream of Southwest 3rd Street	*	2,760	N/A	4,070	4,740	5,780
Approximately 580 feet upstream of Southwest Pryor Drive	*	1,710	N/A	2,520	2,900	3,540
Approximately 1,040 feet downstream of Union Pacific Railroad	*	1,480	N/A	2,140	2,470	2,990
Approximately 990 feet upstream of Union Pacific Railroad	*	1,040	N/A	1,500	1,720	2,090
Approximately 580 feet downstream of Southwest Lakeview Boulevard	*	536	N/A	766	869	1,050
CRACKERNECK CREEK						
At confluence with Little Blue River	6.7	4,610	N/A	7,580	9,180	15,370
DYKE BRANCH						
At confluence with Indian Creek	6.9	4,250	5,030	5,850	7,330	9,520
At Holmes Road	6.9	4,240	5,010	5,810	7,320	9,510
At Bannister Road	6.8	4,220	4,990	5,740	7,290	9,470
Approximately 800 ft upstream of Bannister Road	6.7	4,210	4,980	5,720	7,270	9,450
Approximately 2200 feet downstream of Wornall Road	6.5	4,160	4,920	5,660	7,190	9,340
Approximately 775 feet downstream of Wornall Road	6.4	4,140	4,900	5,650	7,200	9,350
Approximately 580 feet downstream of Wornall Road	5.9	4,010	4,750	5,470	6,950	9,000

*Data not available.

North

0 100' 200' 400'

SCALE: 1" = 200'

DOWNSTREAM DRAINAGE MAP

Point of Interest "B"
Approx. 580' downstream
of Southwest Lakeview Blvd
FEMA Peak Discharges
Q(10) = 536 cfs
Q(100) = 869 cfs

US 50 Hwy

Oldham Parkway

SW Allendale Blvd.

SW Lakeview Blvd

Cedar Creek

SW Stratford Road

Subarea B
87.50 Ac.

Point of Interest "A"
Termination of
FEMA Study

Subarea A
147.45 Ac.

Drainage
Boundary
Typ.

US 50 Hwy

MO S. 291 Hwy

SW Jefferson Street

SW Persels Road

SE Bailey Road

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OLDHAM MARKETPLACE
LEE'S SUMMIT, JACKSON COUNTY, MISSOURI

Project: Oldham Marketplace
Issue Date:

DOWNSTREAM DRAINAGE MAP
Conceptual Drainage Plan for:
Oldham Marketplace
Lee's Summit, Jackson County, Missouri

Matthew J. Schlicht
MO PE 2006019708
KS PE 19071
OK PE 25226
NE PE E-14335

REVISIONS

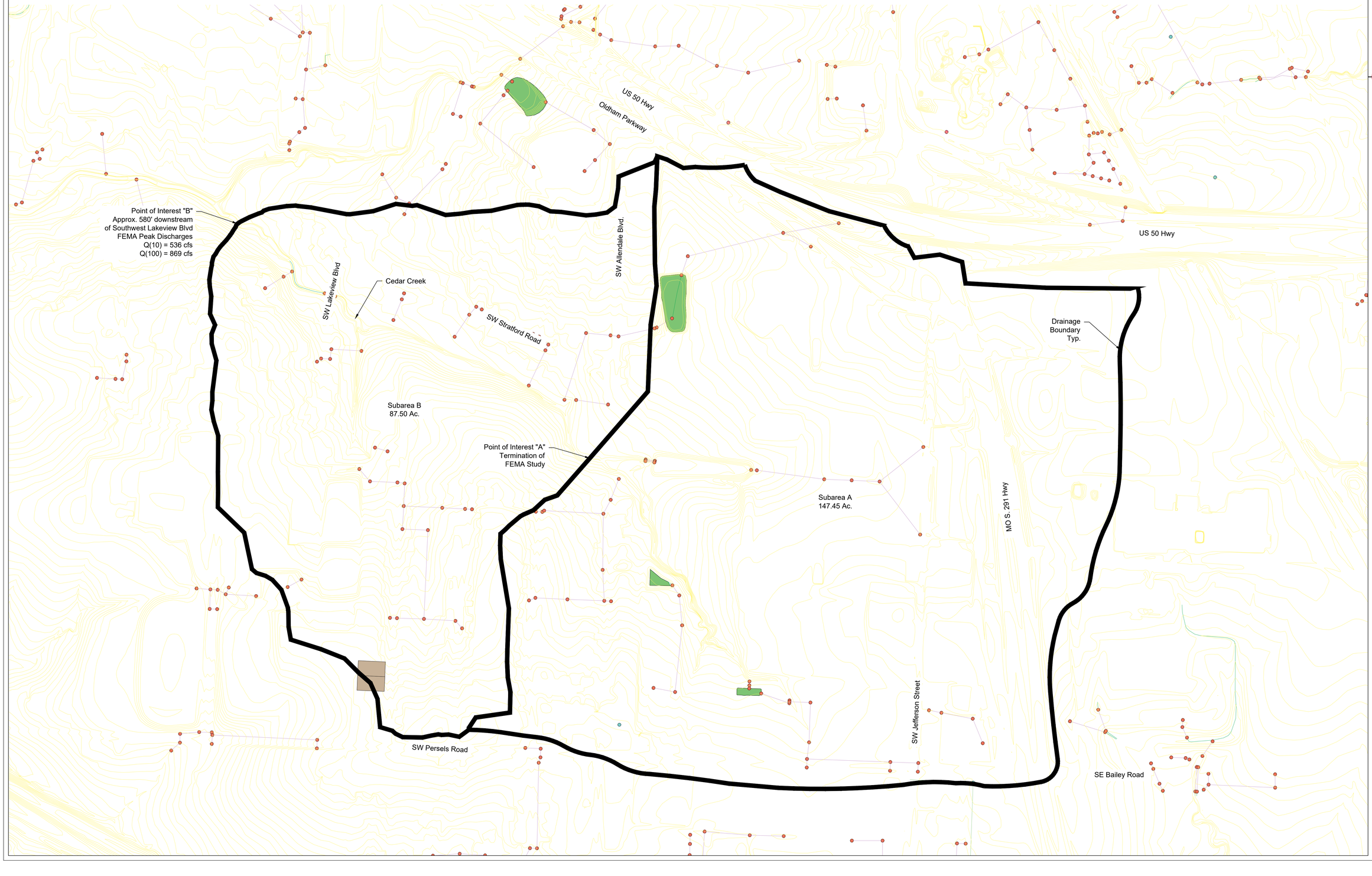
EXHIBIT

North

0 100' 200' 400'

SCALE: 1" = 200'

DOWNSTREAM DRAINAGE MAP



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OLDHAM MARKETPLACE
LEE'S SUMMIT, JACKSON COUNTY, MISSOURI

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Lee's Summit, Jackson County, Missouri

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NE PE E-14335

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APWA STORM DRAINAGE "TC" COMPUTATIONS FOR: OLDHAM MARKETPLACE

						Surface types:	Asph/Conc	Bus/Com	Dirt	Grass/Park	Lake	MultFam	SnglFam	Undev	Other											
		yellow areas are self computing				SURFACE CODES	A	B	D	G	L	M	S	U	Z											
		overwrite if necessary				"C" Values	0.90	0.87	0.60	0.30	0.90	0.66	0.51	0.3				TC COMPUTATION								
							Overwrite Length - DnElev or Slope				SURFACE	P=Paved		Overwrite Slope or Elevations												k
			TOTAL WATERSHED				if necessary				CODE	U=Unpaved		if necessary			Cal	Used	Cal	Cal					1.25
							OVERLAND FLOW - 100' MAX				P	CHANNEL FLOW - FIRST REACH					Overland	Min 5	Channel	Channel	Total				
AREA	TOTAL	TOTAL	WTRSHD	UP	DN	SURFACE	"C"	OVRLND	UP	DN	SLOPE	or	CHANNEL	UP	DN	SLOPE	VELOCITY	Flow	Max 15	One	Two		Intensity	Intensity	CFS	CFS	AREA
ID	SQ.FT.	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	10 I	100 I	10 Q	100 Q	ID
A1 EX	6422990	147.45	2875.0	1038.0	992.0	Z	0.68	100.0	1038.0	1036.0	2.0	U	2775.0	1036.0	992.0	1.59	2.0	6.0	6.0	22.8	0.0	28.8	3.9	5.6	386.86	705.96	A1 EX
A1 PROP	5594420	128.43	2875.0	1038.0	992.0	Z	0.68	100.0	1038.0	1036.0	2.0	U	2775.0	1036.0	992.0	1.59	2.0	6.0	6.0	22.8	0.0	28.8	3.9	5.6	336.95	614.89	A1 PROP
A	828570	19.02	1772.0	1054.0	992.0	Z	0.51	100.0	1054.0	1052.0	2.0	P	1672.0	1052.0	992.0	3.59	3.9	8.4	8.4	7.2	0.0	15.7	5.1	7.2	49.00	87.89	A
B	3811703	87.50	3243.0	1056.0	962.0	Z	0.51	100.0	1056.0	1052.0	4.0	P	3143.0	1052.0	962.0	2.86	3.4	6.7	6.7	15.2	0.0	21.9	4.4	6.4	196.43	355.65	B
A1 + B	10234693	234.96	5085.0	1038.0	962.0	Z	0.60	100.0	1038.0	1036.0	2.0	U	4985.0	1036.0	962.0	1.48	2.0	7.1	7.1	42.3	0.0	49.4	2.8	4.2	396.39	734.54	A1 + B
											REACH	U	2210.0	992.0	962.0	1.36	1.9	19.6									

Composite Curve Numbers
Oldham Marketplace Subbasin

Ex Land Usage POI A	Area (ac.)	CN	Area x CN
Right-of-Way	29.32	82	2404.24
Residential Multi-Family	18.47	88	1625.75
Residential Single-Family	19.30	82	1582.60
Undeveloped	9.87	74	730.38
Commercial	70.48	94	6625.12
Total Area	147.44		12968.09
Composite CN	88		

Prop Land Usage POI A1	Area (ac.)	CN	Area x CN
Right-of-Way	29.32	82	2404.24
Residential Multi-Family	18.47	88	1625.75
Residential Single-Family	0.28	82	22.96
Undeveloped	9.87	74	730.38
Commercial	70.48	94	6625.12
Total Area	128.42		11408.45
Composite CN	89		

Prop Land Usage Subarea A	Area (ac.)	CN	Area x CN
Right-of-Way	0.00	82	0.00
Residential Single-Family	19.02	82	1559.75
Undeveloped	0.00	74	0.00
Commercial	0.00	94	0.00
Total Area	19.02		1559.75
Composite CN	82		

Ex Land Usage Subarea B	Area (ac.)	CN	Area x CN
Park	14.92	75	1118.65
Residential Single-Family	61.95	82	5080.24
Undeveloped	0.00	74	0.00
School	10.64	92	978.44
Total Area	87.50		7177.33
Composite CN	82		

Land Usage Subarea A + A1 + B	Area (ac.)	CN	Area x CN
Right-of-Way	29.32	82	2404.24
Park	14.92	75	1118.65
Residential Single-Family	81.25	82	6662.50
Residential Multi-Family	18.47	88	1625.36
Undeveloped	9.87	74	730.38
Commercial	70.48	94	6625.12
School	10.64	92	978.44
Total Area	234.94		20144.69
Composite CN	86		

Exhibit K

Aerial Photo National Wetlands Inventory

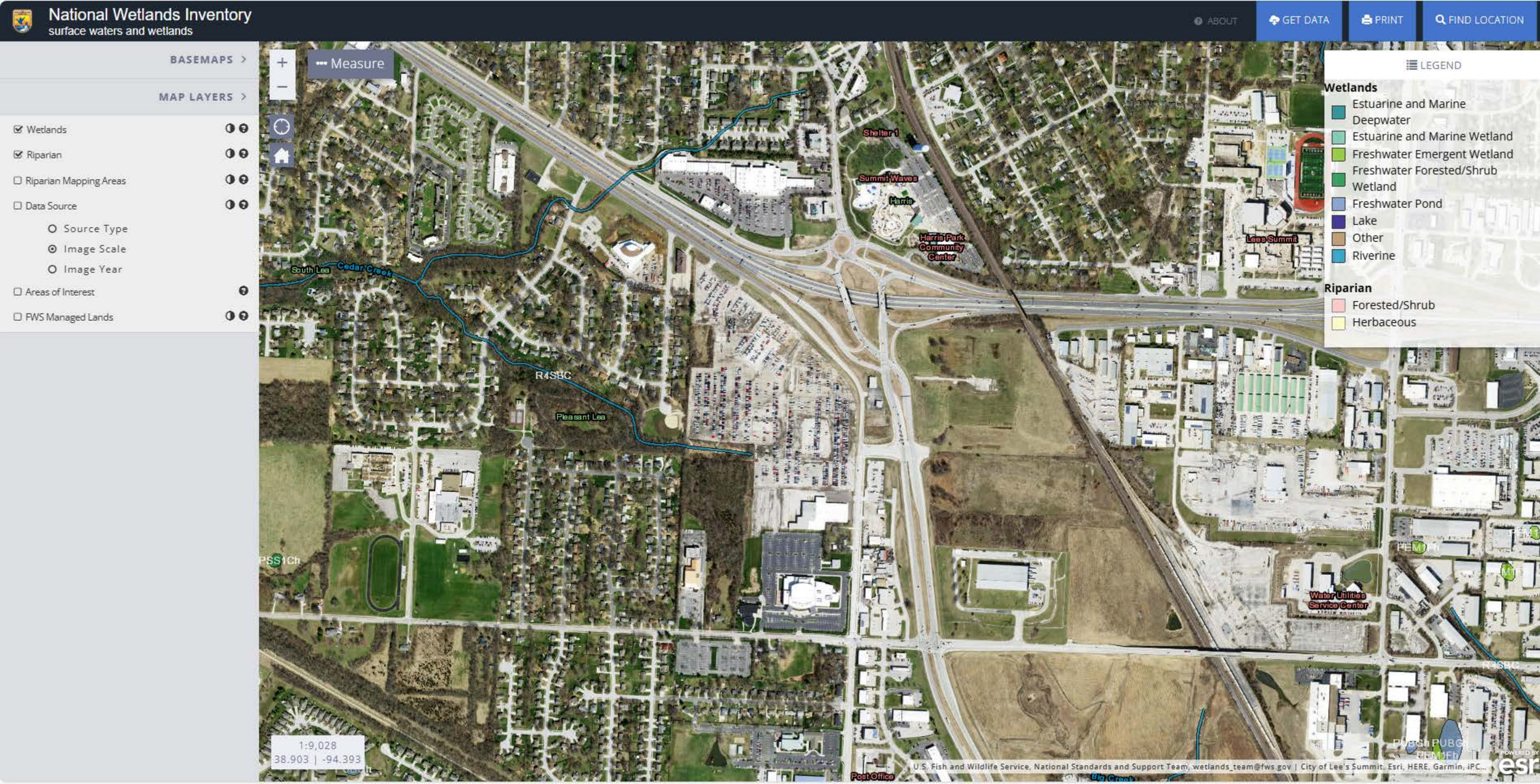

National Wetlands Inventory
surface waters and wetlands
ABOUT
GET DATA
PRINT
FIND LOCATION
BASEMAPS
MAP LAYERS
Wetlands
Riparian
Riparian Mapping Areas
Data Source
Source Type
Image Scale
Image Year
Areas of Interest
PWS Managed Lands
Measure
LEGEND
Wetlands
Estuarine and Marine Deepwater
Estuarine and Marine Wetland
Freshwater Emergent Wetland
Freshwater Forested/Shrub Wetland
Freshwater Pond
Lake
Other
Riverine
Riparian
Forested/Shrub
Herbaceous
Shelter 1
Summit Waves
Harris
Harris Park Community Center
Lees Summit
South Lea
Cedar Creek
R4SBC
Pleasant Lea
PSS1Ch
PEMF
Water Utilities Service Center
Post Office
1:9,028
38.903 | -94.393
U.S. Fish and Wildlife Service, National Standards and Support Team, wetlands_team@fws.gov | City of Lee's Summit, Esri, HERE, Garmin, iPC...

Exhibit L

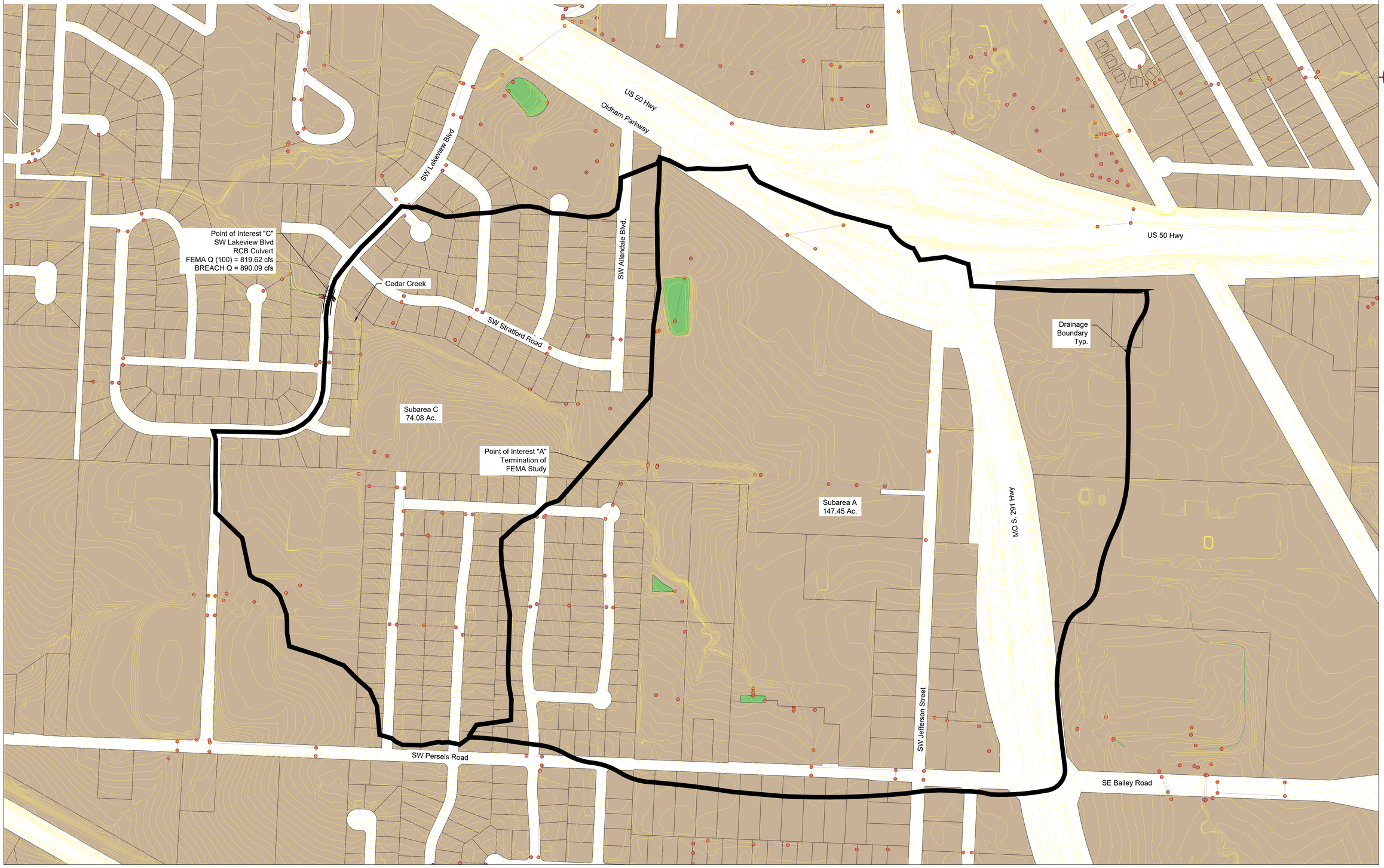
Downstream Breach Drainage Map

BREACH ANALYSIS DRAINAGE MAP

SCALE: 1" = 200'

0 100' 200' 400'

North



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Oklahoma
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Nebraska
Engineering CA2821

OLDHAM MARKETPLACE
LEE'S SUMMIT, JACKSON COUNTY, MISSOURI

Project: Oldham Marketplace
Issue Date:

BREACH ANALYSIS DRAINAGE MAP
Conceptual Drainage Plan for:
Oldham Marketplace
Lee's Summit, Jackson County, Missouri

Matthew J. Schlicht
MO PE 2006019708
KS PE 19071
OK PE 25226
NE PE E-14335

REVISIONS

EXHIBIT

Exhibit M

Peak Breach Discharge Calculations

Peak Breach Discharge Criteria - USDA TR 210-60

Evaluate Dam Failure at Peak Reservoir Stage resulting from the Probable Maximum Flood (PMF)

1. Depth of water at the dam at failure where Hw >= 103 ft

Qmax = 65 * Hw^1.85

Qmax (cfs)	2756.14	Where:
Hw (ft)	7.58	Qmax = Peak Breach Discharge (cfs)
Spillway HGL	1003.50	Hw = Depth of Water at time of dam failure not to exceed top of dam (ft)
Bottom Ex. Elev.	995.92	

2. Depth of water at the dam at failure where Hw < 103 ft

Qmax = 1100 * Br^1.35

Qmax (cfs)	545.62	Where:
Br (ac)	0.595	Br = Breach Factor, Br = Vs*Hw/A, (acres)
Vs (ac-ft)	20.17	Vs = Reservoir Storage at the time of Failure (ac-ft)
Hw (ft)	7.58	A = Cross-sectional Area of Embankment, normal to the Dam (sf)
Spillway HGL	1003.50	
Bottom Ex. Elev.	995.92	
A (sf)	257.00	

Not Less than Qmax = 3.2 * Hw^2.5

Qmax Not < than	506.20
	Good

Not More than Qmax = 65 * Hw^1.85

Qmax Not > than	2756.14
	Good

Exhibit N

SW Lakeview Boulevard – Culvert Analysis

North

0 10' 20' 40'

SW LAKEVIEW BLVD CULVERT ANALYSIS

SCALE: 1" = 20'

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OLDHAM MARKETPLACE
LEE'S SUMMIT, JACKSON COUNTY, MISSOURI

SW LAKEVIEW BLVD CULVERT ANALYSIS

Project: Oldham Marketplace

Issue Date:

Conceptual Drainage Plan for:
Oldham Marketplace
Lee's Summit, Jackson County, Missouri

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OK PE 25226
NE PE E-14335

REVISIONS

EXHIBIT

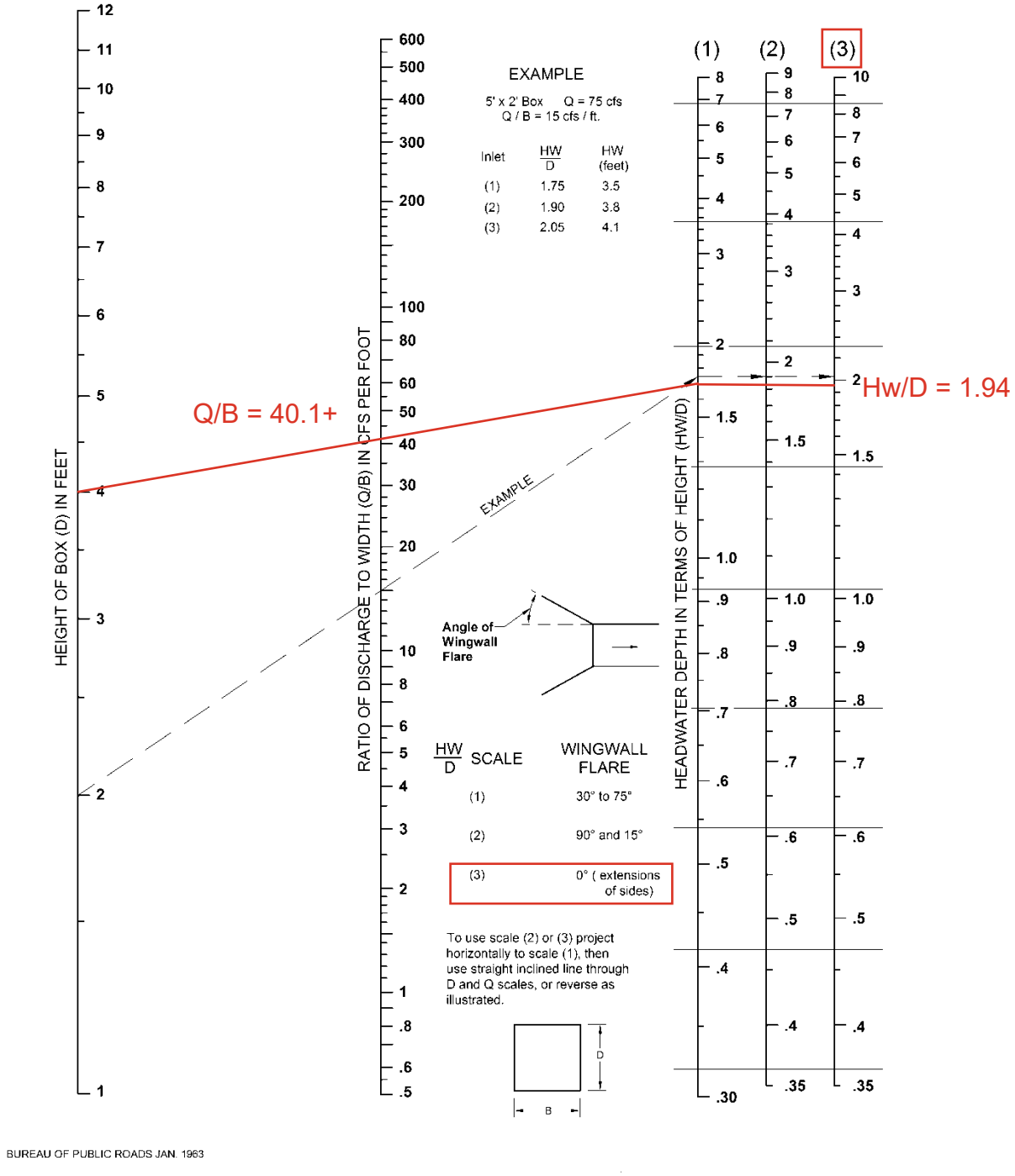

Figure 5603-1: Headwater Depth for Box Culverts with Inlet Control

ROADWAY OVERTOPPING (PEAK FLOW) Oldham Village Project - SW Lakeview Boulevard

Q = q(i) - q(n)

q = C * l * h^(2/3)

q (cfs)	8.330633	q = The flow for an increment of profile length (width of flow)
l (ft)	4	l = the incrmental width
C	3	C = a flow coefficient that shall not exceed 3.0
h (ft)	0.58	h = the average depth of flow at each increment

LEFT (South)

q (cfs)	l (ft)	El Dn	El Up	MAX WSE	h(ft)	C
36.96	9.93	**975.19**	975.25	976.60	1.38	3.00
39.03	10.72	975.25	975.28	976.60	1.34	3.00
42.42	12.55	975.28	975.53	976.60	1.20	3.00
44.62	16.08	975.53	975.89	976.60	0.89	3.00
26.96	16.07	975.89	976.47	976.60	0.42	3.00
	21.13	976.47	977.26	976.60	-0.26	3.00
189.99						

RIGHT (North)

q (cfs)	l (ft)	El Dn	El Up	MAX WSE	h(ft)	C
36.10	9.72	**975.19**	975.26	976.60	1.38	3.00
45.74	13.06	975.26	975.42	976.60	1.26	3.00
33.67	11.30	975.42	975.80	976.60	0.99	3.00
24.42	13.04	975.80	976.41	976.60	0.50	3.00
2.28	7.18	976.41	976.72	976.60	0.03	3.00
	4.27	976.72	976.91	976.60	-0.22	3.00
142.21						

Q (cfs) 332.20 Design Maximum Allowable Overtopping = 7" over Crown (High Point) in Street

14'x4' RCB at SW Lakeview Boulevard					w/o Overtop			Breach						Road Overtop
Condition	Q (cfs)	Width, B (ft)	Ratio (Q/B)	Req Hw/D	Allow Hw/D	Height, D (ft)	FL IN	WSE	Hw/D	Q/B	Q Culvert	Q Overtop	Q Total	Depth (ft)
Breach	890.09	14	63.58	3.7	1.59	4	968.85	976.60	1.94	40.1	561.4	332.20	893.60	1.41

* Roadway Overtopping Depth Calculated at the Crown