Stormwater Management Report

Hunt Addition – Phase 1
Milbank, South Dakota

Date: September 21st, 2023

ISG Project #: 23-29236

ISG
Architecture
Engineering
Environmental
Planning
ISGInc.com

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SIGNATURE SHEET

I HEREBY CERTIFY THAT THESE CALCULATIONS WERE PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF SOUTH DAKOTA.

_____

Eric B. Gjersvik, PE
Reg. No. 12288

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Hunt Addition – Phase 1
Milbank, South Dakota

Engineer's Project Number: 23-29236

Dated this 21st day of September 2023

TABLE OF CONTENTS

APPENDICES

INTRODUCTION

This stormwater management report was prepared in conjunction with site plans to facilitate new construction of a residential development in Milbank, South Dakota. The project site is located near the intersection of Track Avenue and Northridge Avenue. The total property is 34.10 acres, with the area of development (Phase 1) as 10.57 acres, and disturbed area for this phase of construction is approximately 12.01 acres.

The proposed project scope will include future building pad grading and construction of roads, connecting sidewalks, supporting underground utilities, and stormwater management for Phase 1.

In concurrence with the production of the site plans, hydrologic and hydraulic models were developed to generate the data presented within this report. Given that the project will disturb more than one acre of land and is part of a larger development plan, a NPDES Construction Stormwater Permit will be required. This project will also be submit for review to the City of Milbank.

EXISTING SITE DRAINAGE CONDITIONS

The existing site is currently a vacant lot and utilized for row crop farming. Soils onsite were determined by USG Web Soil Survey, and provided in **Appendix C**. The existing soils vary throughout the site; however, a primary pattern was identified. The soil is a mix of silt loams and clays.

This project is located within the city limits of Milbank, SD. Because Milbank has no stormwater performance standards, standard best management practices were used to design the stormwater system. The site will control stormwater to improve water quality standards and mimic existing conditions. The existing site drainage area includes the property area of Phase 1 and Phase 2, offsite drainage from the southwest, and some area to the north totaling 56.71 acres and consists of six (6) drainage areas. **Table 1** below summarizes the characteristics of the drainage area for the existing conditions as illustrated on the Existing Conditions Drainage Map in **Appendix A**. The site is relatively flat with an existing waterway that diverts flow to the northeast of the site, ultimately out letting to the South Fork Whetstone River. There is an ultimate low in the southeast which also discharges to South Fork Whetstone River. FEMA does identify a floodplain through the southeast corner of the site with an elevation of approximately 1123 feet.

Table 1. Existing Drainage Areas

Drainage Area	Total Area (AC)	Impervious Area (AC)	Pervious Area (AC)	Flows To
EX-1	1.74	0.00	1.74	Waterway
EX-2	20.19	0.42	19.77	Waterway
EX-3	0.24	0.00	0.24	North
EX-4	10.96	0.00	10.96	East
EX-5	6.25	0.00	6.25	South
EX-6	17.34	1.10	16.24	Culvert
TOTAL	**56.71**	**1.52**	**55.19**	

FEMA Floodplain

The southeast corner of the property is located within Zone AE, or regulated flooding area. The highest elevation of the floodplain within the relevant property area is 1123.00. The emergency overflow is set at 1124.00, allowing for a foot of freeboard. Additionally, there is no fill within the floodplain, ensuring an equal amount of storage post-construction. The FEMA FIRM map, FIS Study, and an engineer-verified exhibit showing the field verified base flood location are provided in **Appendix A**.

PROPOSED SITE DRAINAGE CONDITIONS

The proposed site will include the expansion of existing roadway networks, storm and sanitary sewer, watermain and services, 32 lots, and corresponding stormwater management. The proposed development stormwater will be conveyed through storm sewer to the proposed swale. The swale will act as a live detention basin, allowing proposed stormwater rate to be reduced when compared to existing. All stormwater within the development is anticipated to be collected via the proposed stormwater collection system and ultimately be routed to the swale in the southeast of the site.

The total proposed impervious is approximately 5.52 acres, which includes the street, sidewalk, and houses, as well as off-site existing development. The proposed drainage areas are split into five overall drainage areas. The proposed area of Phase 1 is designated as Drainage Area 1 or "DA-1", the northeast is Drainage Area 2 or "DA-2," the drainage area containing both the existing and proposed swale is "DA-3," the southeast drainage area is "DA-4," and the large region to the west is Drainage Area 5, or "DA-5". For visual reference, refer to **Appendix B** which contains the Proposed Conditions Drainage Map.

Phase 2 is a future phase with an unknown start date, therefore the proposed swale and outlet system is considered temporary and is only sized for Phase 1 construction. Although the swale takes into account runoff from the Phase 2 area (DA-3), only impervious area from DA-1 and offsite impervious is accounted for. Phase 1 is anticipated to be 38% impervious space. When Phase 2 is constructed, additional stormwater management may need to be provided on-site. Below, **Table 2** below summarizes the characteristics of each drainage area.

Table 2. Proposed Drainage Areas

Drainage Area	Total Area (AC)	Impervious Area (AC)	Pervious Area (AC)	Drains To
DA-1	10.04	3.92	6.13	Swale
DA-2	15.32	0.08	15.24	East
DA-3	8.47	0.42	8.06	Swale
DA-4	5.54	0.00	5.54	River
DA-5	17.34	1.10	16.24	South
TOTAL	**56.71**	**5.52**	**51.19**	

STORMWATER CALCULATIONS

Stormwater Requirements

The location of the project involves no agency with permanent stormwater requirements. However, the South Dakota Department of Agriculture and Natural Resources dictates that stormwater controls must withstand a 2-year 24-hour participation during earth moving activities. Using this, as well as other best management practices, the proposed stormwater management system reduces rate for the 2-year, 5-year, 10-year, and 100-year 24-hour precipitation events.

Stormwater Rate Control

The proposed project limits peak runoff flow rates from existing conditions for the 2-, 5-, 10-, and 100-year rainfall events. The majority of existing condition land use was modeled as row crop, with some impervious area factored in. Hydraulic calculations were performed for the proposed and existing stormwater utilities using the rainfall depths obtained from the NOAA Atlas 14 and following the SCS TR-20 rainfall distribution curve. Utilizing this information, the stormwater management system was modeled in HydroCAD to determine the runoff rates and stormwater basin elevations.

A swale constructed for both conducting flow and water detention is proposed south in the overall development. The outlet structure is located at the southeast corner of the swale and contains two pipes of differing sizes and elevations to control the rate. The outlet structure has a 24" pipe at 1116.48, the lowest elevation of the swale, and a 30" pipe at 1120.00. The overflow outlet for the events great than the 100-year discharges via a broad-crested weir at an elevation of 1124.00, which allows for over a foot of separation from the 100-year high water level (1122.12). The EOF of 1124.00 is also 1' above the FEMA floodplain (1123.00), allowing for more detention and rate control in higher storm events. A summary of the peak stormwater runoff rates is provided in **Table 3**. In addition, **Table 4** summarizes the HWLs for all events and the basin.

Table 3. HydroCAD Peak Runoff Calculations

Rainfall Event (100-Year Storm)	Conditions	
	Existing Peak Flow (CFS)	Proposed Peak Flow (CFS)
2-Year (2.55")	28.28	27.73
5-Year (3.16")	40.46	36.91
10-Year (3.70")	51.63	45.94
100-Year (5.77")	95.91	83.15

Table 4. Proposed HWL Summary + System Elevations

Site Profile	Storage (cf)	Outflow (cfs)	HWL Elevation (ft)
2-Year 24-hour storm	21,487	19.07	1119.33
5-Year 24-hour storm	34,332	24.45	1120.08
10-Year 24-hour storm	47,643	30.06	1120.68
100-Year 24-hour storm	97,162	53.78	1122.12

Bottom of Swale	-	-	1116.00
Normal Water Line	-	-	1116.00
Emergency Overflow	188,816	-	1124.00
Top of Swale	255,273	-	1125.00

As shown in **Table 3**, the peak stormwater runoff rate leaving the site is reduced for all storm events. The complete Existing and Proposed Conditions HydroCAD reports are provided in **Appendix D** and **E**, respectively. In addition to the hydrologic and hydraulic model, the rational method was used to calculate pipe sizes and the standard step method was used to determine hydraulic grade line (HGL) through Hydraflow. The pipe sizing calculations are provided in **Appendix F**. Riprap design calculations were also completed using the South Dakota DOT EM-1601 Equation; results and equation can be found in **Appendix G**.

CONCLUSION

The proposed project provides a stormwater management system that improves the stormwater flow rate for the 2, 5, 10, and 100-year precipitation events. The DANR Construction Stormwater Permit will be applied for prior to construction and available as soon as the permit is obtained. The proposed project as designed not only provides but exceeds minimum flow rate requirements.

Appendix A: Existing Drainage Areas Map + FEMA Map

EXISTING DRAINAGE AREAS

DRAINAGE AREA	TOTAL AREA [AC]	IMPERVIOUS AREA [AC]	PERVIOUS AREA [AC]
1	1.74	0.00	1.74
2	20.19	0.42	19.77
3	0.24	0.00	0.24
4	10.96	0.00	10.96
5	6.25	0.00	6.25
6	17.34	1.10	16.24
TOTAL	56.71	1.52	55.19

LEGEND

SYMBOL	DESCRIPTION
	EXISTING DRAINAGE ARROW
	PROPOSED DRAINAGE ARROW
101	EXISTING CONTOUR (MINOR INTERVAL)
100	EXISTING CONTOUR (MAJOR INTERVAL)
101	PROPOSED CONTOUR (MINOR INTERVAL)
100	PROPOSED CONTOUR (MAJOR INTERVAL)
1	DRAINAGE AREA DESIGNATION

NORTHRIDGE AVE

Approx. FEMA Zone AE Limits

WET

FP100

FP100

FBO

N

0 150 300

SCALE IN FEET

PLOT DATE: 9/19/2023 11:24 AM

ISG

PROJECT

HUNT SECOND ADDITION (PHASE 1)

MILBANK SOUTH DAKOTA

REVISION SCHEDULE

DATE	DESCRIPTION	BY

PROJECT NO.	23-29236
FILE NAME	29236 DRAINAGE AREAS
DRAWN BY	JRS / GBV
DESIGNED BY	JRS /GBV
REVIEWED BY	EBG / JRS
ORIGINAL ISSUE DATE	08/28/23
CLIENT PROJECT NO.	-

TITLE

Existing Drainage Areas (Overall)

SHEET

A-1.1

National Flood Hazard Layer FIRMette

FEMA

96°38'3"W 45°13'57"N

96°37'26"W 45°13'32"N

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

1:6,000

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
- 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 7/17/2023 at 11:22 AM 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.

NOTES TO USERS

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

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

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations tables in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations tables should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

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

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

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 14. The **horizontal datum** was NAD 83, GRS80 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

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

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

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

Base map transportation and Public Land Survey System information shown on this FIRM was provided in digital format by the First District Association of Local Governments, Watertown, South Dakota. Hydrography information was obtained from the USGS National Hydrography Dataset. Railroad information was obtained from TIGER 2000 data developed by the U.S. Bureau of the Census.

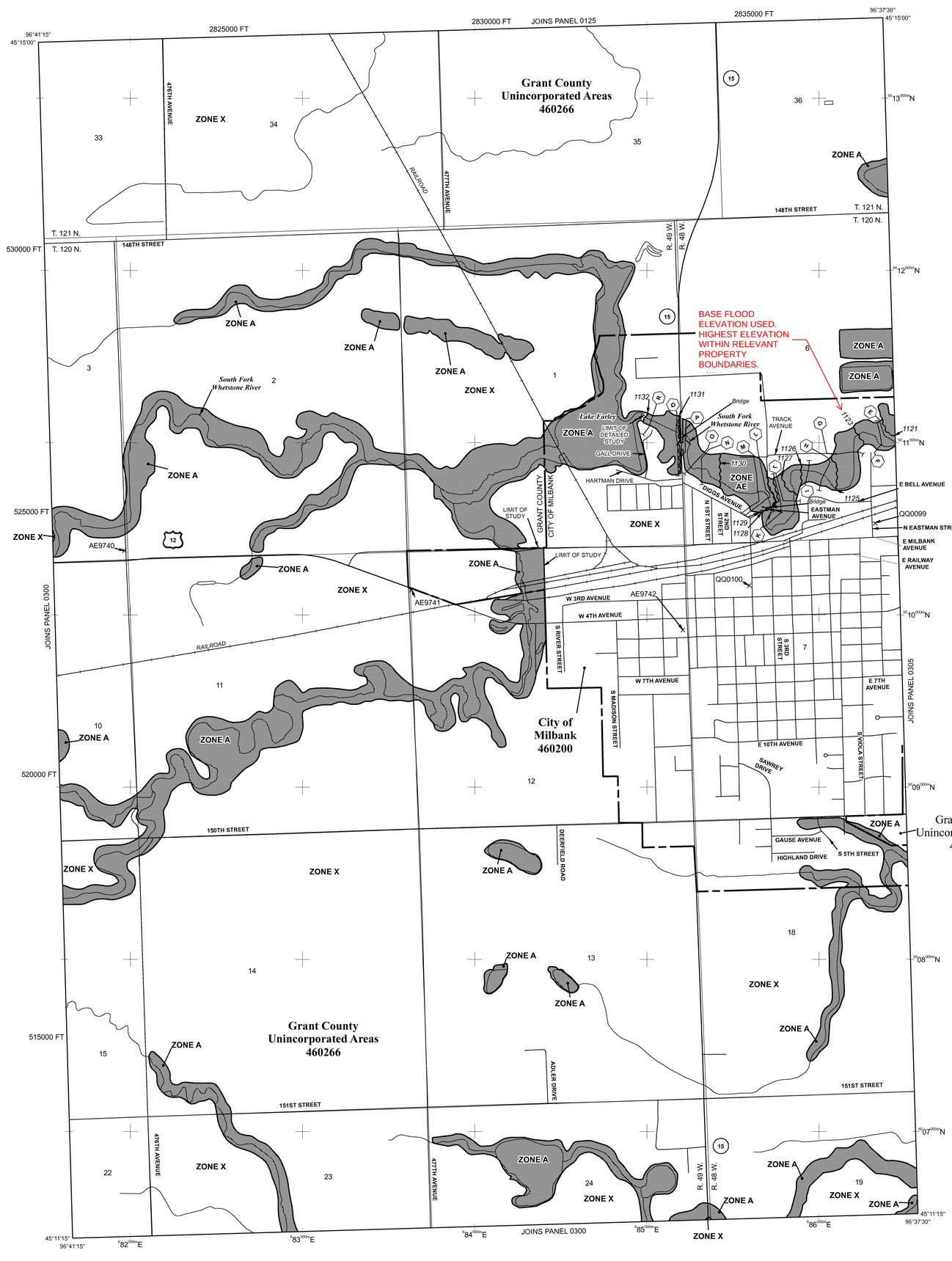
Based on updated topographic information, this map reflects more detailed and up-to-date **stream channel configurations and floodplain delineations** than those shown on the previous FIRM for this jurisdiction. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study Report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

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

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

Contact the **FEMA Map Service Center** at 1-800-358-9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study report, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1-800-358-9620 and its website at http://msc.fema.gov.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA MAP** (1-877-336-2627) or visit the FEMA website at www.fema.gov



LEGEND

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

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

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

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

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

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

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

- Floodplain boundary
- Floodway boundary
- Zone D boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Area zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
- 513 — Base Flood Elevation line and value; elevation in feet*
- (EL 987) — Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988

- Cross section Line
- Transect line
- 87°07'45", 32°22'30" — Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere
- 2476000mN — 1000-meter Universal Transverse Mercator grid values, zone NAD 1983 UTM Zone 14N
- 600000 FT — 5000-foot grid ticks: South Dakota State Plane coordinate system, North zone (FIPSZONE 4001), Lambert Conformal Conic projection
- DX5510 — Bench mark (see explanation in Notes to Users section of this FIRM panel)
- M1.5 — River Mile

MAP REPOSITORY
Refer to listing of Map Repositories on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
November 4, 2009

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

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

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

MAP SCALE 1" = 1000'

500 0 1000 2000 FEET

300 0 300 600 METERS

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0285C

FIRM

FLOOD INSURANCE RATE MAP

GRANT COUNTY, SOUTH DAKOTA AND INCORPORATED AREAS

PANEL 285 OF 600

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
GRANT COUNTY	460266	0285	C
MILBANK, CITY OF	460200	0285	C

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

MAP NUMBER
46051C0285C

EFFECTIVE DATE
NOVEMBER 4, 2009

Federal Emergency Management Agency

FUTURE PHASES

HADY AVENUE

SCRIVER AVENUE

ARCHER STREET

FIECHTNER STREET

TRACK AVENUE

WARD'S SECOND ADDITION

EFFECTIVE ESTIMATED FEMA FLOODPLAIN: REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988

ACTUAL 100 YR (BASE FLOOD) ELEVATION LIMITS: FIELD VERIFIED, REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988

Approx. FEMA Zone AE Limits

NO GRADING INSIDE FIELD VERIFIED 100 YR FLOODPLAIN (1123.00).

FP100 1123.00

N

0 50 100

SCALE IN FEET

PLOT DATE: 9/21/2023 3:51 PM

NOTE: THE APPROXIMATE FEMA ZONE AE LIMITS, ALSO KNOWN AS THE EFFECTIVE FLOODPLAIN IS AN ESTIMATE OF THE BASE FLOOD LOCATION OUTPUT BY FEMA, REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988.

THE ACTUAL BASE FLOOD ELEVATION WAS FIELD VERIFIED BY ISG SURVEY, AND IS DENOTED BY THE HIGHLIGHTED LINE BELOW.

PROJECT DATUM

HORIZONTAL COORDINATES HAVE BEEN REFERENCED TO THE NORTH AMERICAN DATUM OF 1983 (NAD83), 1996 ADJUSTMENT (NAD83(1996)) ON THE SOUTH DAKOTA STATE PLANES, NORTH ZONE, U.S. FOOT.

ELEVATIONS HAVE BEEN REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88). RTK GPS METHODS WERE USED TO ESTABLISH HORIZONTAL AND VERTICAL COORDINATES FOR THIS PROJECT.

ISG

REGISTERED PROFESSIONAL ENGINEER
REG. NO. 12288
ERIC B. GJERDVIK
SOUTH DAKOTA

PROJECT

HUNT SECOND ADDITION (PHASE 1)

MILBANK SOUTH DAKOTA

REVISION SCHEDULE

DATE	DESCRIPTION	BY

PROJECT NO.	23-29236
FILE NAME	29236 FEMA BASE FLOOD EXHIBIT
DRAWN BY	JRS / GBV
DESIGNED BY	JRS /GBV
REVIEWED BY	EBG / JRS
ORIGINAL ISSUE DATE	08/28/23
CLIENT PROJECT NO.	-

TITLE

FEMA BASE FLOOD EXHIBIT

SHEET

A-1.2

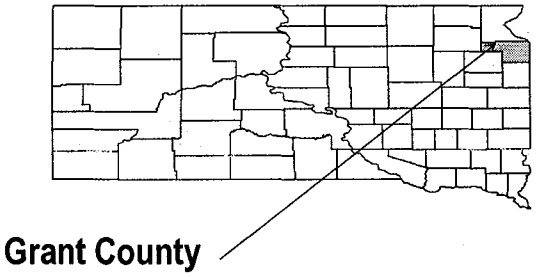
PRELIMINARY NOT FOR CONSTRUCTION

FLOOD INSURANCE STUDY

GRANT COUNTY, SOUTH DAKOTA
AND INCORPORATED AREAS

COMMUNITY NAME	COMMUNITY NUMBER
*ALBEE, TOWN OF	460056
BIG STONE CITY, CITY OF	460156
GRANT COUNTY (UNINCORPORATED AREAS)	460266
*LABOLT, TOWN OF	460204
*MARVIN, TOWN OF	465504
MILBANK, CITY OF	460200
REVILLO, TOWN OF	460031
*STOCKHOLM, TOWN OF	460203
*STRANDBURG, TOWN OF	460029
*TWIN BROOKS, TOWN OF	461208

*Non-Floodprone Community



NOVEMBER 4, 2009

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
46051CV000A

NOTICE TO
FLOOD INSURANCE STUDY USERS

Communities participating in the National Flood Insurance Program have established repositories of flood hazard data for floodplain management and flood insurance purposes. This Flood Insurance Study (FIS) may not contain all data available within the Community Map Repository. Please contact the Community Map Repository for any additional data.

The Federal Emergency Management Agency (FEMA) may revise and republish part or all of this FIS report at any time. In addition, FEMA may revise part of this FIS report by the Letter of Map Revision process, which does not involve republication or redistribution of the FIS report. Therefore, users should consult with community officials and check the Community Map Repository to obtain the most current FIS components.

Selected Flood Insurance Rate Map panels for this community contain information that was previously shown separately on the corresponding Flood Boundary and Floodway Map panels (e.g., floodways and cross sections). In addition, former flood hazard zone designations have been changed as follows.

Old Zone(s)	New Zone
A1 through A30	AE
V1 through V30	VE
B	X
C	X

Initial Countywide FIS Effective Date: November 4, 2009

TABLE OF CONTENTS

TABLE OF CONTENTS – continued

FLOOD INSURANCE STUDY
GRANT COUNTY, SOUTH DAKOTA AND INCORPORATED AREAS

1.0 INTRODUCTION

1.1 Purpose of Study

This countywide Flood Insurance Study (FIS) investigates the existence and severity of flood hazards in, or revises and updates previous FISs/Flood Insurance Rate Maps (FIRMs) for the geographic area of Grant County, South Dakota, including the Cities of Big Stone City and Milbank, the Town of Revillo, and the unincorporated areas of Grant County (hereinafter referred to collectively as Grant County).

This FIS aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This FIS has developed flood risk data for various areas of the county that will be used to establish actuarial flood insurance rates. This information will also be used by Grant County to update existing floodplain regulations as part of the Regular Phase of the National Flood Insurance Program (NFIP), and will also be used by local and regional planners to further promote sound land use and floodplain development. Minimum floodplain management requirements for participation in the NFIP are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

In some States or communities, floodplain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence and the State (or other jurisdictional agency) will be able to explain them.

No special flood hazard areas were identified in the Towns of Albee, Labolt, Marvin, Stockholm, Strandburg, or Twin Brooks.

1.2 Authority and Acknowledgments

The sources of authority for this FIS are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The authority and acknowledgments for Grant County and incorporated communities prior to this countywide FIS are not available because no FIS reports were ever published for those communities.

The hydrologic and hydraulic analyses for this countywide FIS were performed by Houston Engineering, Inc (HEI), for the South Dakota Office of Emergency Management (OEM) and the Federal Emergency Management Agency (FEMA), under Contract No. EMD-2007-GR-0771. This work was completed in January 2008.

Transportation and Public Land Survey System information was provided by the First District Association of Local Governments, Watertown, South Dakota, June 2007. Additional information may have been derived from other sources.

The coordinate system used for the production of this FIRM is Universal Transverse Mercator (UTM) zone 14. The horizontal datum used is North American Datum of 1983 (NAD 83), GRS 80 spheroid. Corner coordinates shown on the FIRM are in latitude and longitude referenced to the UTM projection, NAD 83. Differences in the datum and spheroid used in the production of FIRMs for adjacent counties may result in slight positional differences in map features at the county boundaries. These differences do not affect the accuracy of information shown on the FIRM.

1.3 Coordination

The coordination information for Grant County and incorporated communities prior to this countywide FIS are not available because no FIS reports were ever published for those communities.

A DFIRM scoping meeting for this countywide FIS was held on September 5, 2006. The meeting was attended by representatives of Grant County, Big Stone City, the City of Milbank, the Town of Revillo, and the South Dakota Office of Emergency Management (OEM). Meeting notes documenting these mapping needs and other project information were distributed.The State of South Dakota presented information to attending National Flood Insurance Program (NFIP) participating communities about the expected Digital Flood Insurance Rate Map (DFIRM) project. At this meeting, local community representatives identified desired flood hazard study areas. A Pre-Scoping Report was prepared on behalf of FEMA by Michael Baker Jr., Inc. in October 2006. As part of the pre-scoping process, communities were contacted by letter with some follow up phone contacts.

The results of this study were reviewed at the final CCO meeting held on August 25, 2008. The meeting was attended by representatives from FEMA, OEM, HEI, Michael Baker Jr, Inc., High Star Consulting, East Dakota Water Development District, Grant County, Big Stone City, City of Milbank, and the Towns of LaBolt, Marvin, Revillo, Stockholm, Strandburg, and Twin Brooks. All issues raised at that meeting have been addressed in this study.

2.0 AREA STUDIED

2.1 Scope of Study

This FIS covers the geographic area of Grant County, South Dakota. The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development and proposed construction.

No flooding sources were studied by detailed methods in Grant County prior to this countywide FIS. More than 550 miles of approximate Zone A were previously mapped for the unincorporated areas of Grant County, City of Big Stone City, and Town of Revillo and incorporated into this countywide FIS.

The only stream studied by detailed methods includes approximately 2 miles of detail study along the South Fork Whetstone River near and within the City of Milbank. Approximately 33 miles of approximate study along the Big Sioux and Indian Rivers within the former Sisseton Wahpeton Oyate (Lake Traverse Indian Reservation) boundary have been included.

2.2 Community Description

Grant County is located in northeastern South Dakota, approximately 100 miles north of Sioux Falls. Grant County is bordered on the north by Roberts County; on the east by Big Stone and Luc Qui Parle Counties, Minnesota; on the south by Deuel County; on the southwest by Codington County; and on the west by Day County. The total land area within Grant County in square miles is approximately 682, and the total population of Grant County was estimated at 7,278 in 2006 (U.S. Census Bureau Website, 2008). The county seat for Grant County is the City of Milbank.

Grant County has an interior continental climate with hot summers and cold winters. Typically, July is the warmest month, with average temperatures at about 84 degrees Fahrenheit (°F), and January is the coldest month, with average temperatures at about 22°F. June tends to be the wettest month, averaging about 3.5 inches of precipitation. The average precipitation for the entire year is approximately 22 inches (The Weather Channel Website, 2008).

Grant County varies in its elevation, from several hundred feet in the northeast corner of the county to a few thousand feet in the western portion of the county. The southern and western portion of Grant County is situated on a glaciated highland called the Coteau des Prairies. The topography varies from gentle to steep slopes. In general, the lush soil in this region is silty and loamy.

2.3 Principal Flood Problems

Most major flooding within Grant County, including the Big Sioux, Indian, Whetstone, North Fork Yellow Bank and South Fork Yellow Bank Rivers and their tributaries is the result of spring snowmelt and/or rainfall events. Flooding that occurs in the middle and late summer months is associated with high-intensity rainstorms.

Flooding problems also result from high lake levels on Big Stone Lake and several smaller lakes along the Coteau des Prairies. Some problems include inundation of shoreline homes and erosion of lakefront lands. Additional damage to homes and erosion of shoreline properties occur because of wave action associated with high lake levels and winds.

2.4 Flood Protection Measures

No significant flood protection measures have been constructed in the communities or unincorporated areas of Grant County.

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the county, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this FIS. Flood events of a magnitude which are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10-, 2-, 1-, and 0.2-percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (1-percent chance of annual exceedence) in any 50-year period is approximately 40 percent (4 in 10), and, for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the county at the time of completion of this FIS. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish peak discharge-frequency relationships for the flooding sources studied in detail affecting the county.

The 1-percent chance peak discharge for the reach of the South Fork Whetstone River being studied by detail methods was determined using USGS regression equations. Due to a discrepancy between high-water marks and the water-surface profile generated using the regression equation based discharge, one standard error of prediction was added to the regression flows resulting in the recommended discharge. A review of stream gage data from USGS Gage No. 05291000 on the Whetstone River near the City of Big Stone City and USGS Gage No. 06479215 on the Big Sioux River near Florence, along with a previous study prepared by the South Dakota Department of Water and Natural Resources relative to Lake Farley, supported the use of the recommended discharge.

Discharges for the approximate studies on the Big Sioux River, Indian River, and Indian River Tributary being done as part of the current study were generated using USGS regression equations. Peak discharge-drainage area relationships for South Fork Whetstone River are shown in Table 1, "Summary of Discharges."

TABLE 1 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-PERCENT ANNUAL CHANCE	2-PERCENT ANNUAL CHANCE	1-PERCENT ANNUAL CHANCE	0.2-PERCENT ANNUAL CHANCE
SOUTH FORK WHETSTONE RIVER					
At the City of Milbank	79.9	*	*	4,991	*

*Data not available

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals. Users should be aware that flood elevations shown on the FIRM represent rounded whole-foot elevations and may not exactly reflect the elevations shown on the Flood Profiles or in the Floodway Data tables in the FIS report. For construction and/or floodplain management purposes, users are encouraged to use the flood elevation data presented in this FIS in conjunction with the data shown on the FIRM.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1).

The hydraulic analyses for this FIS were based on unobstructed flow. The flood elevations shown on the Flood Profiles (Exhibit 1) are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

For the detail study along the South Fork Whetstone River, water-surface elevations corresponding to a 1-percent annual chance flood event were developed using HEC-RAS. Topography for the HEC-RAS model came from a combination of field surveyed cross sections and structures and the USGS 10-meter DEM for the area. Manning's 'n' values were estimated based on field reconnaissance and engineering judgment and varied from 0.035 to 0.045 in the channel and 0.06 to 0.12 in the over bank area. Starting water-surface elevations were established using normal depth.

For the approximate study along the Big Sioux and Indian Rivers and Indian River Tributary performed as part of the current study, water surface elevations corresponding to a 1-percent annual chance flood event were developed using HEC-RAS with cross sections cut from the USGS 10-meter DEM using HEC-GeoRAS.

Qualifying bench marks within a given jurisdiction that are cataloged by the National Geodetic Survey (NGS) and entered into the National Spatial Reference System (NSRS) as First or Second Order Vertical and have a vertical stability classification of A, B, or C are shown and labeled on the FIRM with their 6-character NSRS Permanent Identifier.

Bench marks cataloged by the NGS and entered into the NSRS vary widely in vertical stability classification. NSRS vertical stability classifications are as follows:

- Stability A: Monuments of the most reliable nature, expected to hold position/elevation well (e.g., mounted in bedrock)
- Stability B: Monuments which generally hold their position/elevation well (e.g., concrete bridge abutment)
- Stability C: Monuments which may be affected by surface ground movements (e.g., concrete monument below frost line)
- Stability D: Mark of questionable or unknown vertical stability (e.g., concrete monument above frost line, or steel witness post)

In addition to NSRS bench marks, the FIRM may also show vertical control monuments established by a local jurisdiction; these monuments will be shown on the FIRM with the appropriate designations. Local monuments will only be placed on the FIRM if the community has requested that they be included, and if the monuments meet the aforementioned NSRS inclusion criteria.

To obtain current elevation, description, and/or location information for bench marks shown on the FIRM for this jurisdiction, please contact the Information Services Branch of the NGS at (301) 713-3191, or visit their Web site at www.ngs.noaa.gov.

It is important to note that temporary vertical monuments are often established during the preparation of a flood hazard analysis for the purpose of establishing local vertical control. Although these monuments are not shown on the FIRM, they may be found in the Technical Support Data Notebook associated with this FIS and FIRM. Interested individuals may contact FEMA to access this data.

3.3 Vertical Datum

All FIS reports and FIRMs are referenced to a specific vertical datum. The vertical datum provides a starting point against which flood, ground, and structure elevations can be referenced and compared. Until recently, the standard vertical datum used for newly created or revised FIS reports and FIRMs was the National Geodetic Vertical Datum of 1929 (NGVD 29). With the completion of the North American Vertical Datum of 1988 (NAVD 88), many FIS reports and FIRMs, including this one, are now prepared using NAVD 88 as the referenced vertical datum.

All flood elevations shown in this FIS report and on the FIRM are referenced to NAVD 88. Structure and ground elevations in the community must, therefore, be referenced to NAVD 88. It is important to note that adjacent communities may be referenced to NGVD 29. This may result in a difference in the Base Flood Elevations (BFEs) across the corporate limits between counties.

For more information on NAVD 88, see Converting the National Flood Insurance Program to the North American Vertical Datum of 1988, FEMA Publication FIA-20/June 1992, or contact the Spatial Reference System Division, National Geodetic Survey, NOAA, Silver Spring Metro Center, 1315 East-West Highway, Silver Spring, Maryland 20910 (Internet address http://www.ngs.noaa.gov).

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The NFIP encourages State and local governments to adopt sound floodplain management programs. To assist in this endeavor, each FIS provides 1-percent-annual-chance floodplain data, which may include a combination of the following: 10-, 2-, 1-, and 0.2-percent-annual-chance flood elevations; delineations of the 1- and 0.2-percent-annual-chance floodplains; and 1-percent-annual-chance floodway. This information is presented on the FIRM and in many components of the FIS, including Flood Profiles, Floodway Data tables, and Summary of Stillwater Elevation tables. Users should reference the data presented in the FIS as well as additional information that may be available at the local community map repository before making flood elevation and/or floodplain boundary determinations.

4.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1-percent annual chance flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent annual chance flood is employed to indicate additional areas of flood risk in the county. For the streams studied in detail, the 1- and 0.2-percent annual chance floodplain boundaries have been delineated using the flood elevations determined at each cross section. For South Fork Whetstone River, the floodplain boundaries for the 1-percent annual chance flood were delineated using surveyed cross section data. Between the cross sections, the boundaries were delineated using the USGS 10-meter DEM. For the current approximate study along the Big Sioux and Indian Rivers, the 1-percent annual chance floodplain boundaries were delineated using the USGS 10-meter DEM.

The 1- and 0.2-percent annual chance floodplain boundaries are shown on the FIRM (Exhibit 2). On this map, the 1-percent annual chance floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A and AE), and the 0.2-percent annual chance floodplain boundary corresponds to the boundary of areas of moderate flood hazards. In cases where the 1- and 0.2-percent annual chance floodplain boundaries are close together, only the 1-percent annual chance floodplain boundary has been shown. Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

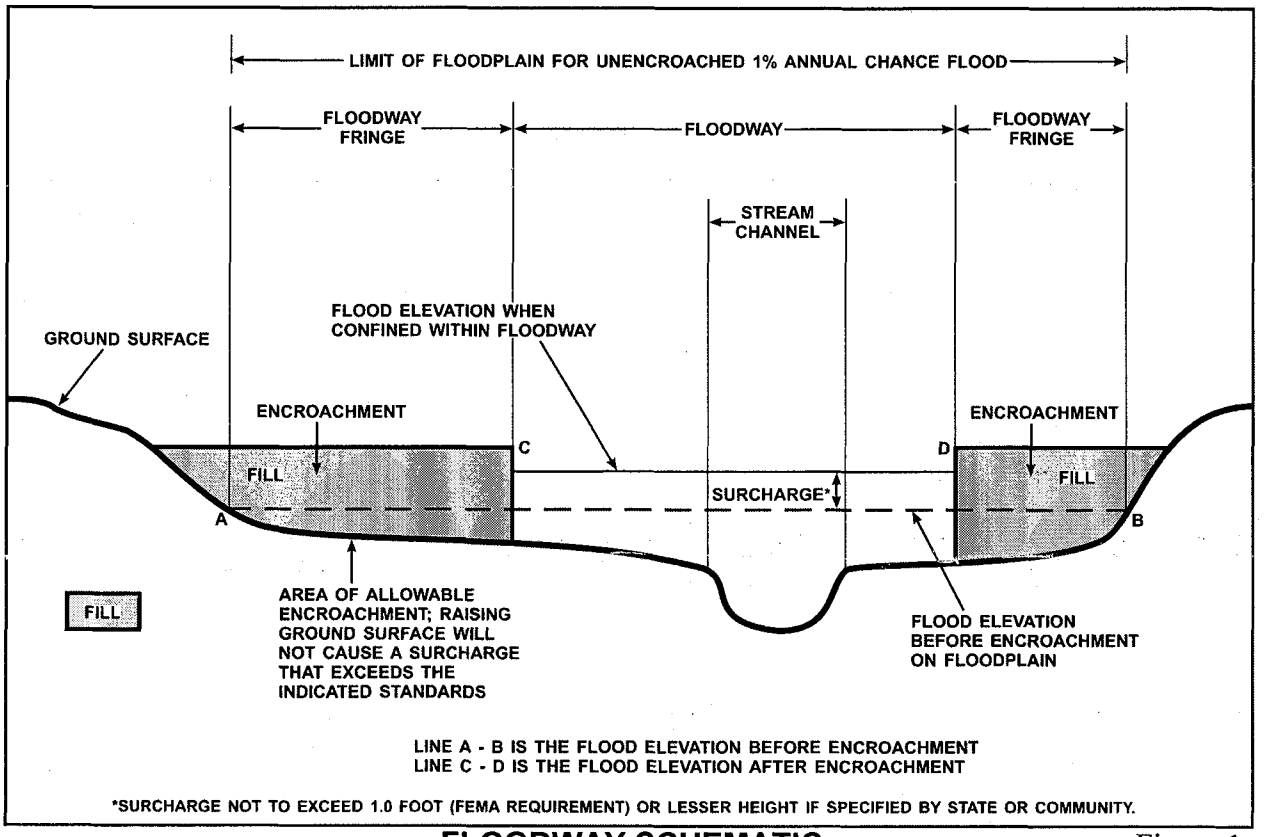
For the streams studied by approximate methods, only the 1-percent-annual-chance floodplain boundary is shown on the FIRM (Exhibit 2).

4.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard. For purposes of the NFIP, a floodway is used as a tool to assist local communities in this aspect of floodplain management. Under this concept, the area of the 1-percent annual chance floodplain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment so that the 1-percent annual chance flood can be carried without substantial increases in flood heights. Minimum federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this FIS are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies.

No floodway data was computed for Grant County.

The area between the floodway and 1-percent annual chance floodplain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing the water-surface elevation of the 1-percent annual chance flood by more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 1.



FLOODWAY SCHEMATIC Figure 1

5.0 INSURANCE APPLICATIONS

For flood insurance rating purposes, flood insurance zone designations are assigned to a community based on the results of the engineering analyses. The zones are as follows:

Zone A

Zone A is the flood insurance rate zone that corresponds to the 1-percent-annual-chance floodplains that are determined in the FIS by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no base flood elevations or depths are shown within this zone.

Zone AE

Zone AE is the flood insurance rate zone that corresponds to the 1-percent-annual-chance floodplains that are determined in the FIS by detailed methods. In most instances, whole-foot base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone AH

Zone AH is the flood insurance rate zone that corresponds to the areas of 1-percent-annual-chance shallow flooding (usually areas of ponding) where average depths are between 1 and 3 feet. Whole-foot base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone AO

Zone AO is the flood insurance rate zone that corresponds to the areas of 1-percent-annual-chance shallow flooding (usually sheet flow on sloping terrain) where average depths are between 1 and 3 feet. Average whole-foot depths derived from the detailed hydraulic analyses are shown within this zone.

Zone AR

Area of special flood hazard formerly protected from the 1-percent-annual-chance flood event by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1-percent-annual-chance or greater flood event.

Zone A99

Zone A99 is the flood insurance rate zone that corresponds to areas of the 1-percent-annual-chance floodplain that will be protected by a Federal flood protection system where construction has reached specified statutory milestones. No base flood elevations or depths are shown within this zone.

Zone V

Zone V is the flood insurance rate zone that corresponds to the 1-percent-annual-chance coastal floodplains that have additional hazards associated with storm waves. Because approximate hydraulic analyses are performed for such areas, no base flood elevations are shown within this zone.

Zone VE

Zone VE is the flood insurance rate zone that corresponds to the 1-percent-annual-chance coastal floodplains that have additional hazards associated with storm waves. Whole-foot base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone X

Zone X is the flood insurance rate zone that corresponds to areas outside the 0.2-percent-annual-chance floodplain, areas within the 0.2-percent-annual-chance floodplain, and to areas of 1-percent-annual-chance flooding where average depths are less than 1 foot, areas of 1-percent-annual-chance flooding where the contributing drainage area is less than 1 square mile, and areas protected from the 1-

percent-annual-chance flood by levees. No base flood elevations or depths are shown within this zone.

Zone D

Zone D is the flood insurance rate zone that corresponds to unstudied areas where flood hazards are undetermined, but possible.

6.0 FLOOD INSURANCE RATE MAP

The FIRM is designed for flood insurance and floodplain management applications.

For flood insurance applications, the map designates flood insurance rate zones as described in Section 5.0 and, in the 1-percent annual chance floodplains that were studied by detailed methods, shows selected whole-foot base flood elevations or average depths. Insurance agents use the zones and base flood elevations in conjunction with information on structures and their contents to assign premium rates for flood insurance policies.

For floodplain management applications, the map shows by tints, screens, and symbols, the 1- and 0.2-percent annual chance floodplains. Floodways and the locations of selected cross sections used in the hydraulic analyses and floodway computations are shown where applicable.

The current FIRM presents flooding information for the entire geographic area of Grant County. Previously, separate Flood Hazard Boundary Maps and/or FIRMs were prepared for each identified flood-prone incorporated community and the unincorporated areas of the county. This countywide FIRM also includes flood hazard information that was presented separately on Flood Boundary and Floodway Maps (FBFMs), where applicable. Historical data relating to the maps prepared for each community, up to and including the November 4, 2009, countywide FIS, are presented in Table 2, "Community Map History."

7.0 OTHER STUDIES

This FIS was prepared by compiling existing hydrologic and hydraulic technical and scientific data prepared by other organizations originally for purposes other than the NFIP. The data were identified as the best available at the time of compilation of this FIS and should depict the general conditions of the flooding sources with relative accuracy.

Information pertaining to revised and unrevised flood hazards for each jurisdiction within Grant County has been compiled into this FIS. Therefore, this FIS supersedes all previously printed FIS Reports, FHBMs, FBFMs, and FIRMs for all of the incorporated and unincorporated jurisdictions within Grant County.

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISIONS DATE	FIRM EFFECTIVE DATE	FIRM REVISIONS DATE
Albee[1], Town of	November 4, 2009	None	November 4, 2009	
Big Stone City, City of	November 12, 1976	None	July 1, 1998	November 4, 2009
Grant County (Unincorporated Areas)	December 20, 1977	None	February 1, 1987	November 4, 2009
Labolt[1], Town of	November 4, 2009	None	November 4, 2009	
Marvin[1], Town of	November 4, 2009	None	November 4, 2009	
Milbank, City of	November 4, 2009	None	November 4, 2009	
Revillo, Town of	September 19, 1975	None	October 1, 1986	November 4, 2009
Stockholm[1], Town of	November 4, 2009	None	November 4, 2009	
Strandburg[1], Town of	November 4, 2009	None	November 4, 2009	
Twin Brooks[1], Town of	November 4, 2009	None	November 4, 2009	

[1]Non-floodprone community

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

GRANT COUNTY, SD AND INCORPORATED AREAS

COMMUNITY MAP HISTORY

8.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this FIS can be obtained by contacting FEMA, Mitigation Division, Denver Federal Center, Building 710, Box 25267, Denver, Colorado 80225-0267.

9.0 BIBLIOGRAPHY AND REFERENCES

U.S. Army Corps of Engineers. HEC-Geo-RAS 4.1.1 Hydraulic Analysis Extension of ArcView Software. January 2006.

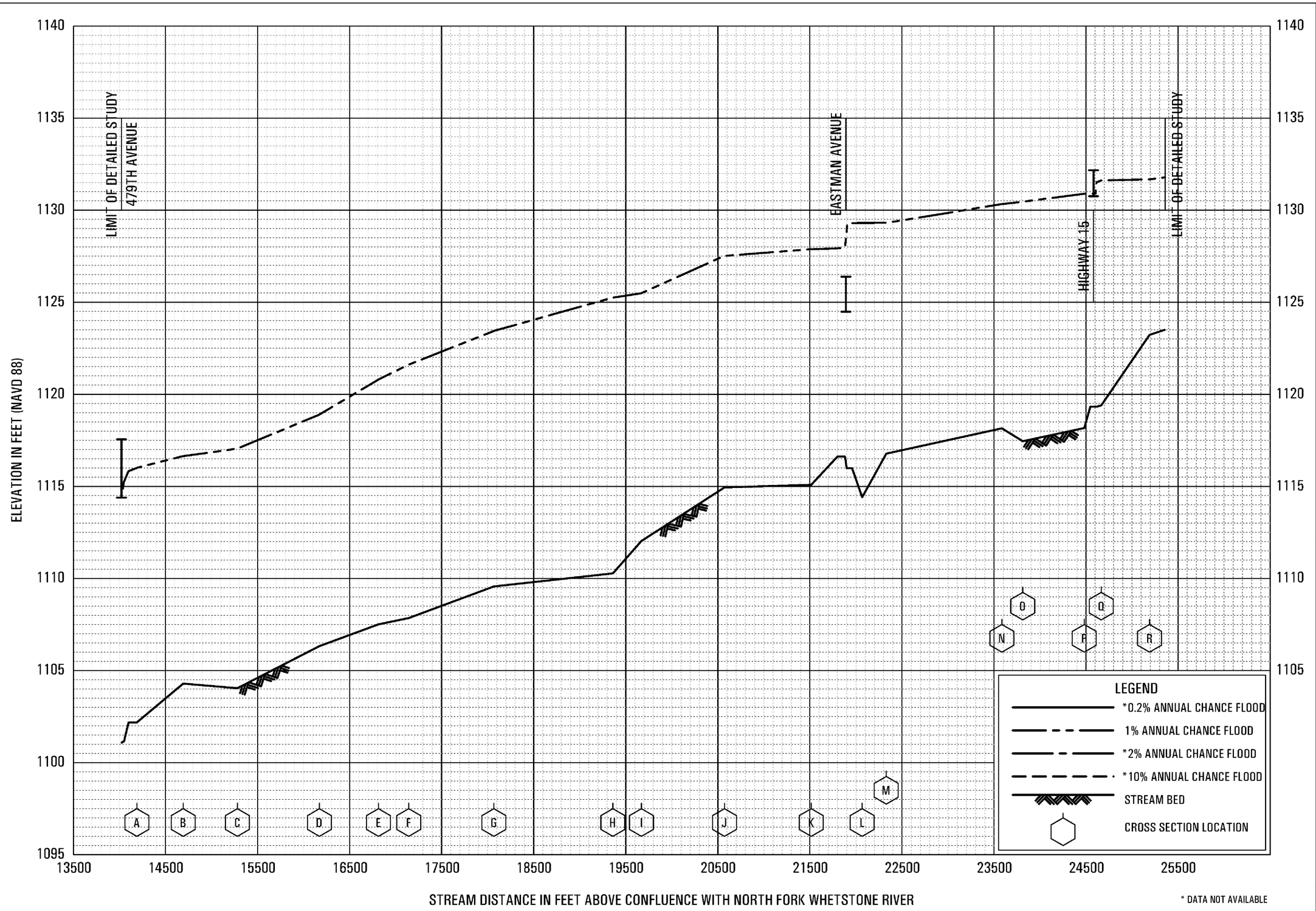
U.S. Army Corps of Engineers. HEC-RAS 3.1.3 Computerized Modeling Software. May 2005.

U.S. Census Bureau Website (Last accessed January 2008) (http://quickfacts.census.gov/qfd/states/46/46051.html)

U.S.D.A. Natural Resource Conservation Service. Hydrology Manual for North Dakota. Revised April, 1980.

U.S. Geological Survey. Techniques for Estimating Peak-Flow Magnitude and Frequency Relations for South Dakota Streams, Water Resources Investigation Report 98-4020, 1998.

The Weather Channel Website (Last accessed January 2008). "Milbank, SD." (http://www.weather.com/weather/wxclimatology/monthly/graph/USSD0219?from=36hr_bottomnav_undeclared)



FLOOD PROFILES

SOUTH FORK WHETSTONE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

GRANT COUNTY, SD

AND INCORPORATED AREAS

01P

Appendix B: Proposed Drainage Areas Map

PROPOSED DRAINAGE AREAS

DRAINAGE AREA	TOTAL AREA [AC]	IMPERVIOUS AREA [AC]	PERVIOUS AREA [AC]
1	10.04	3.92	6.13
2	15.32	0.08	15.24
3	8.47	0.42	8.06
4	5.54	0.00	5.54
5	17.34	1.10	16.24
TOTAL	56.71	5.52	51.19

LEGEND

SYMBOL	DESCRIPTION
	EXISTING DRAINAGE ARROW
	PROPOSED DRAINAGE ARROW
101	EXISTING CONTOUR (MINOR INTERVAL)
100	EXISTING CONTOUR (MAJOR INTERVAL)
101	PROPOSED CONTOUR (MINOR INTERVAL)
100	PROPOSED CONTOUR (MAJOR INTERVAL)
1	DRAINAGE AREA DESIGNATION

NORTHRIDGE AVE

N

0 150 300

SCALE IN FEET

PRELIMINARY NOT FOR CONSTRUCTION

PROJECT

HUNT SECOND ADDITION (PHASE 1)

MILBANK SOUTH DAKOTA

REVISION SCHEDULE

DATE	DESCRIPTION	BY

PROJECT NO.	23-29236
FILE NAME	29236 DRAINAGE AREAS
DRAWN BY	JRS / GBV
DESIGNED BY	JRS /GBV
REVIEWED BY	EBG / JRS
ORIGINAL ISSUE DATE	08/28/23
CLIENT PROJECT NO.	-

TITLE

Proposed Drainage Areas

SHEET

A-2

PLOT DATE: 9/19/2023 11:30 AM

Appendix C: USGS Web Soil Survey Map

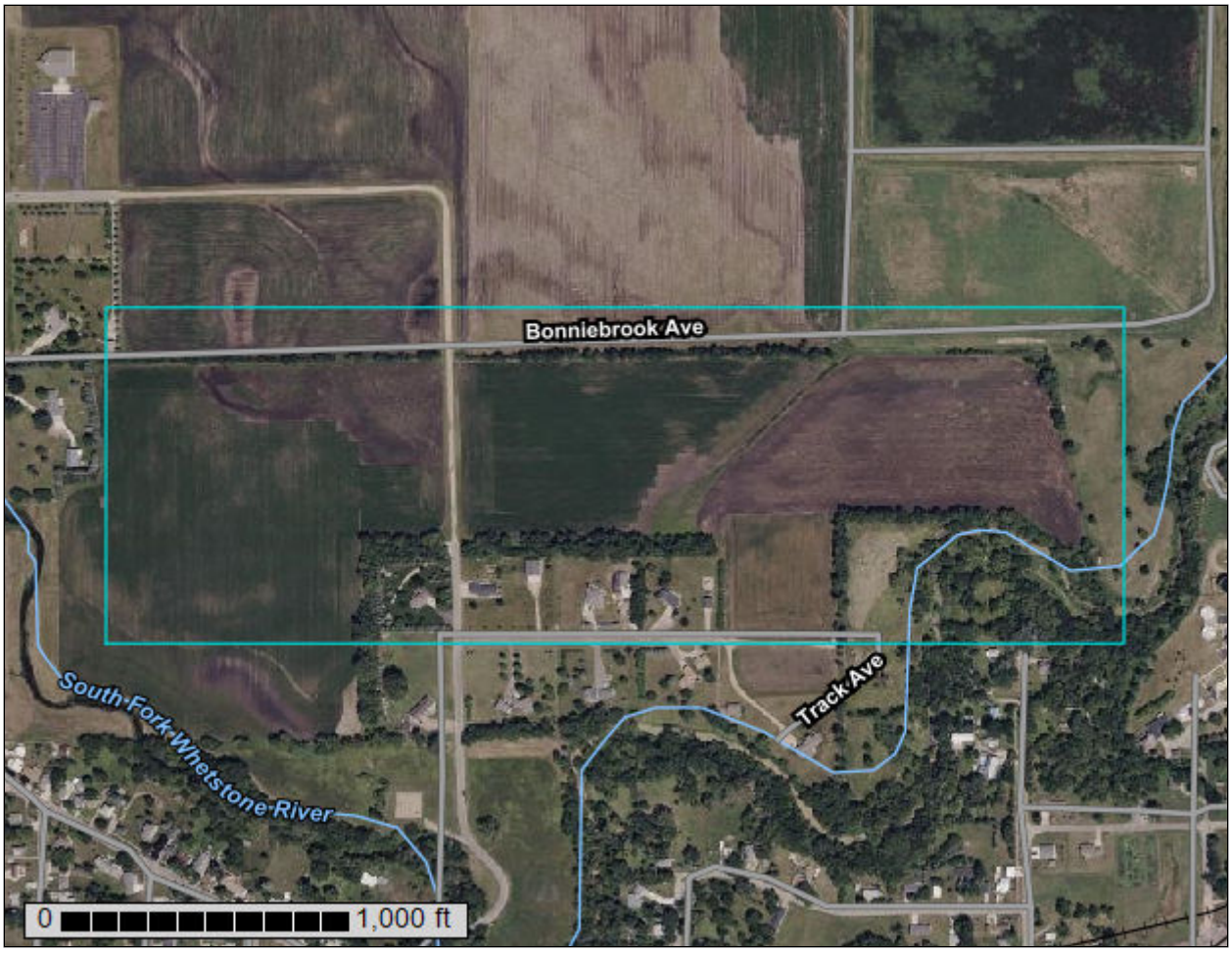
United States Department of Agriculture

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 Grant County, South Dakota



September 21, 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.

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

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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.

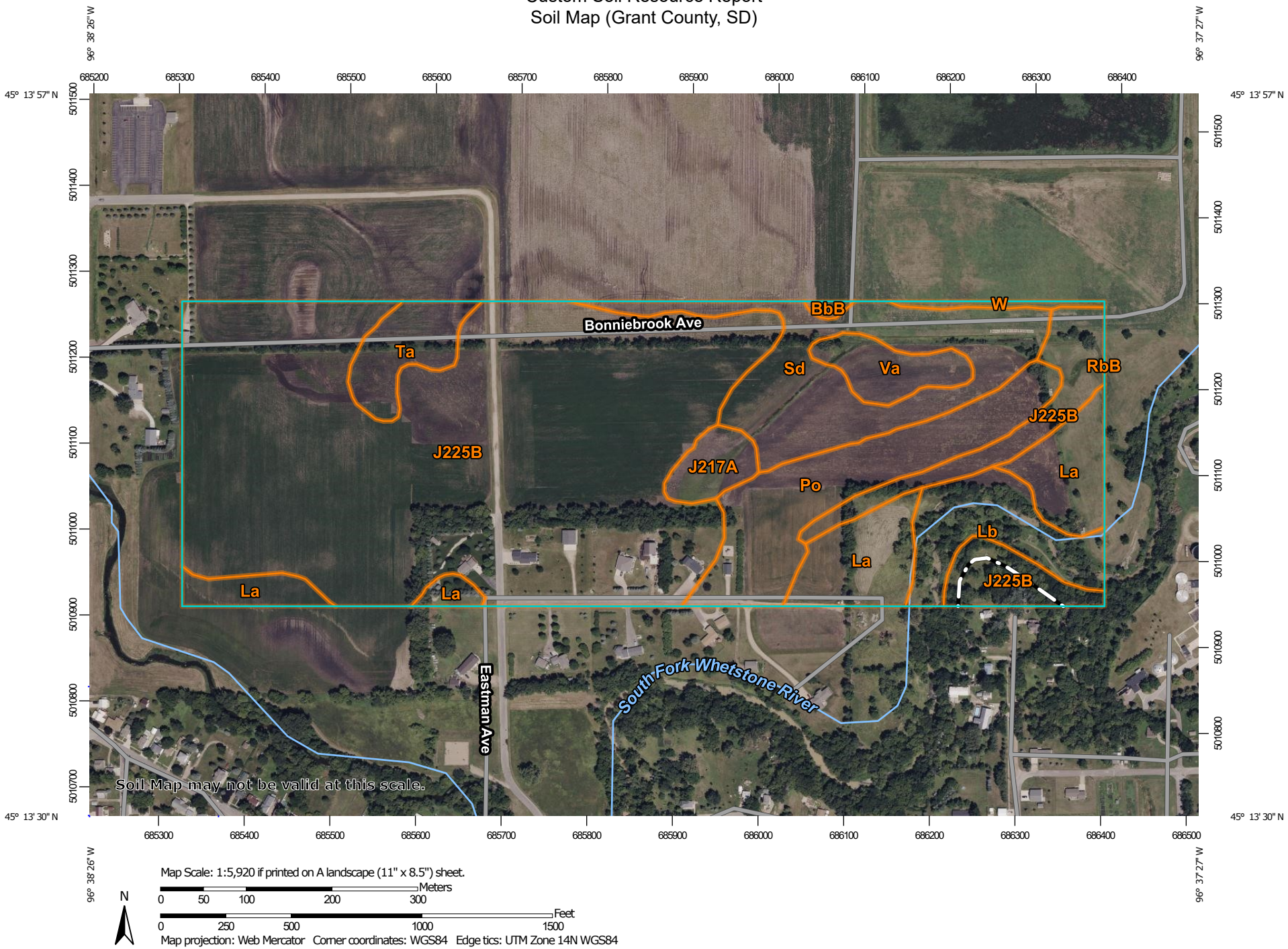
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree 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.


96° 38' 26" W
96° 37' 27" W
45° 13' 57" N
45° 13' 30" N
685200
685300
685400
685500
685600
685700
685800
685900
686000
686100
686200
686300
686400
686500
5011500
5011400
5011300
5011200
5011100
5011000
5010900
5010800
5010700
Bonniebrook Ave
Eastman Ave
South Fork Whetstone River
BbB
W
Ta
Sd
Va
RbB
J225B
J217A
Po
La
Lb
Soil Map may not be valid at this scale.
Map Scale: 1:5,920 if printed on A landscape (11" x 8.5") sheet.
Meters
0 50 100 200 300
Feet
0 250 500 1000 1500
N
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 14N 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 1:20,000.

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: Grant County, South Dakota
Survey Area Data: Version 24, Sep 12, 2022

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

Date(s) aerial images were photographed: Jun 17, 2022—Jul 21, 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 (Grant County, SD)

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
BbB	Hokans-Svea complex, 1 to 4 percent slopes	0.2	0.2%
J217A	Parnell silty clay loam, occasionally ponded, 0 to 1 percent slopes	1.6	1.7%
J225B	Forman-Aastad complex, 1 to 4 percent slopes	56.0	59.0%
La	LaDelle silt loam	8.4	8.8%
Lb	LaDelle silt loam, channeled	4.7	4.9%
Po	Poinsett-Waubay silty clay loams, 0 to 2 percent slopes	8.4	8.8%
RbB	Renshaw loam, 1 to 6 percent slopes	0.0	0.0%
Sd	Svea loam, 1 to 3 percent slopes	10.1	10.7%
Ta	Tonka silty clay loam, 0 to 1 percent slopes	2.8	2.9%
Va	Vallers clay loam, 0 to 2 percent slopes	2.3	2.4%
W	Water	0.4	0.5%
Totals for Area of Interest		**94.8**	**100.0%**

Map Unit Descriptions (Grant County, SD)

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.

Grant County, South Dakota

BbB—Hokans-Svea complex, 1 to 4 percent slopes

Map Unit Setting

National map unit symbol: 2w8dp
Elevation: 920 to 2,130 feet
Mean annual precipitation: 22 to 31 inches
Mean annual air temperature: 37 to 46 degrees F
Frost-free period: 120 to 160 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Hokans and similar soils: 60 percent
Svea and similar soils: 20 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hokans

Setting

Landform: Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Fine-loamy till

Typical profile

Ap - 0 to 15 inches: loam
Bw - 15 to 22 inches: loam
Bk - 22 to 40 inches: loam
C - 40 to 79 inches: loam

Properties and qualities

Slope: 1 to 4 percent
Surface area covered with cobbles, stones or boulders: 0.0 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 2.00 in/hr)
Depth to water table: About 47 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: High (about 10.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B
Ecological site: R102AY010SD - Loamy
Forage suitability group: Loam (G102AY100SD)
Other vegetative classification: Loam (G102AY100SD)
Hydric soil rating: No

Description of Svea

Setting

Landform: Moraines
Landform position (three-dimensional): Talf
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Fine-loamy till

Typical profile

Ap - 0 to 13 inches: loam
Bw - 13 to 17 inches: loam
Bk - 17 to 27 inches: clay loam
C - 27 to 79 inches: loam

Properties and qualities

Slope: 1 to 3 percent
Surface area covered with cobbles, stones or boulders: 0.0 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 2.00 in/hr)
Depth to water table: About 20 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: High (about 10.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C/D
Ecological site: R102AY020SD - Loamy Overflow
Forage suitability group: Loam (G102AY100SD)
Other vegetative classification: Loam (G102AY100SD)
Hydric soil rating: No

Minor Components

Lakepark

Percent of map unit: 10 percent
Landform: Moraines
Landform position (three-dimensional): Talf
Down-slope shape: Concave
Across-slope shape: Linear
Ecological site: R102AY002SD - Linear Meadow
Other vegetative classification: Wet (G102AY900SD)
Hydric soil rating: Yes

Buse

Percent of map unit: 5 percent
Landform: Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Convex
Across-slope shape: Convex

Ecological site: R102AY012SD - Thin Upland
Other vegetative classification: Loam (G102AY100SD)
Hydric soil rating: No

Parnell, occasionally ponded

Percent of map unit: 3 percent
Landform: Moraines
Landform position (three-dimensional): Dip
Down-slope shape: Concave
Across-slope shape: Concave
Ecological site: R102AY001SD - Shallow Marsh
Other vegetative classification: Not suited (G102AY000SD)
Hydric soil rating: Yes

Fordville

Percent of map unit: 2 percent
Landform: Moraines
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R102AY010SD - Loamy
Other vegetative classification: Droughty Loam (G102AY120SD)
Hydric soil rating: No

J217A—Parnell silty clay loam, occasionally ponded, 0 to 1 percent slopes

Map Unit Setting

National map unit symbol: 2vv63
Elevation: 920 to 2,130 feet
Mean annual precipitation: 22 to 31 inches
Mean annual air temperature: 37 to 46 degrees F
Frost-free period: 120 to 160 days
Farmland classification: Not prime farmland

Map Unit Composition

Parnell, occasionally ponded, and similar soils: 65 percent
Minor components: 35 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Parnell, Occasionally Ponded

Setting

Landform: Depressions on moraines
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Local alluvium over till

Typical profile

Ap - 0 to 8 inches: silty clay loam
A - 8 to 20 inches: silty clay loam
Btg1 - 20 to 37 inches: silty clay
Btg2 - 37 to 71 inches: silty clay
2Cg - 71 to 79 inches: clay loam

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
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 inches
Frequency of flooding: None
Frequency of ponding: Occasional
Calcium carbonate, maximum content: 15 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: High (about 9.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: C/D
Ecological site: R102AY001SD - Shallow Marsh
Forage suitability group: Not suited (G102AY000SD)
Other vegetative classification: Not suited (G102AY000SD)
Hydric soil rating: Yes

Minor Components

Parnell, frequently ponded

Percent of map unit: 10 percent
Landform: Depressions on moraines
Down-slope shape: Concave
Across-slope shape: Concave
Ecological site: R102AY001SD - Shallow Marsh
Other vegetative classification: Not suited (G102AY000SD)
Hydric soil rating: Yes

Vallers

Percent of map unit: 10 percent
Landform: Swales on moraines
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R102AY002SD - Linear Meadow
Other vegetative classification: Wet (G102AY900SD)
Hydric soil rating: Yes

Hamerly

Percent of map unit: 10 percent
Landform: Moraines
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Rise
Down-slope shape: Convex
Across-slope shape: Linear

Ecological site: R102AY006SD - Limy Subirrigated
Other vegetative classification: Subirrigated (G102AY700SD)
Hydric soil rating: No

Lakepark

Percent of map unit: 5 percent
Landform: Swales on moraines
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R102AY002SD - Linear Meadow
Other vegetative classification: Wet (G102AY900SD)
Hydric soil rating: Yes

J225B—Forman-Aastad complex, 1 to 4 percent slopes

Map Unit Setting

National map unit symbol: 2w8dv
Elevation: 920 to 2,130 feet
Mean annual precipitation: 22 to 31 inches
Mean annual air temperature: 37 to 46 degrees F
Frost-free period: 120 to 160 days

Map Unit Composition

Forman and similar soils: 55 percent
Aastad and similar soils: 20 percent
Minor components: 25 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Forman

Setting

Landform: Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Fine-loamy till

Typical profile

Ap - 0 to 9 inches: clay loam
Bt - 9 to 25 inches: clay loam
Bk - 25 to 79 inches: clay loam

Properties and qualities

Slope: 1 to 4 percent
Surface area covered with cobbles, stones or boulders: 0.0 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.60 in/hr)
Depth to water table: About 47 inches
Frequency of flooding: None

Frequency of ponding: None
Calcium carbonate, maximum content: 20 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: High (about 10.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Ecological site: R102AY010SD - Loamy
Forage suitability group: Loam (G102AY100SD)
Other vegetative classification: Loam (G102AY100SD)
Hydric soil rating: No

Description of Aastad

Setting

Landform: Moraines
Landform position (three-dimensional): Talf
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Fine-loamy till

Typical profile

Ap - 0 to 9 inches: clay loam
A - 9 to 23 inches: clay loam
Bt - 23 to 38 inches: clay loam
Bk - 38 to 64 inches: clay loam
BC - 64 to 79 inches: clay loam

Properties and qualities

Slope: 1 to 3 percent
Surface area covered with cobbles, stones or boulders: 0.0 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well 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 20 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Gypsum, maximum content: 1 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: High (about 10.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2c
Hydrologic Soil Group: C/D
Ecological site: R102AY020SD - Loamy Overflow
Forage suitability group: Overflow (G102AY500SD)
Other vegetative classification: Overflow (G102AY500SD)
Hydric soil rating: No

Minor Components

Mehurin

Percent of map unit: 12 percent
Landform: Moraines
Landform position (three-dimensional): Talf
Down-slope shape: Concave
Across-slope shape: Linear
Ecological site: R102AY011SD - Clayey
Other vegetative classification: Clayey Subsoil (G102AY210SD)
Hydric soil rating: No

Tonka, occasionally ponded

Percent of map unit: 8 percent
Landform: Moraines
Landform position (three-dimensional): Dip
Down-slope shape: Concave
Across-slope shape: Concave
Ecological site: R102AY004SD - Wet Meadow
Other vegetative classification: Wet (G102AY900SD)
Hydric soil rating: Yes

Parnell, frequently ponded

Percent of map unit: 3 percent
Landform: Moraines
Landform position (three-dimensional): Dip
Down-slope shape: Concave
Across-slope shape: Concave
Ecological site: R102AY001SD - Shallow Marsh
Other vegetative classification: Not suited (G102AY000SD)
Hydric soil rating: Yes

Vallers

Percent of map unit: 2 percent
Landform: Moraines
Landform position (three-dimensional): Talf
Down-slope shape: Concave
Across-slope shape: Linear
Ecological site: R102AY002SD - Linear Meadow
Other vegetative classification: Wet (G102AY900SD)
Hydric soil rating: Yes

La—LaDelle silt loam

Map Unit Setting

National map unit symbol: g144
Elevation: 1,000 to 2,000 feet
Mean annual precipitation: 19 to 29 inches
Mean annual air temperature: 39 to 45 degrees F

Frost-free period: 120 to 160 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Ladelle and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Ladelle

Setting

Landform: Flood plains
Landform position (two-dimensional): Footslope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Silty alluvium

Typical profile

H1 - 0 to 18 inches: silt loam
H2 - 18 to 36 inches: silty clay loam
H3 - 36 to 60 inches: stratified silt loam to clay loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 1.98 in/hr)
Depth to water table: About 42 to 60 inches
Frequency of flooding: OccasionalNone
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent
Gypsum, maximum content: 2 percent
Maximum salinity: Nonsaline to slightly saline (0.0 to 4.0 mmhos/cm)
Sodium adsorption ratio, maximum: 1.0
Available water supply, 0 to 60 inches: High (about 11.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 1
Hydrologic Soil Group: B
Ecological site: R102AY040SD - Loamy Floodplain
Forage suitability group: Overflow (G102AY500SD)
Other vegetative classification: Overflow (G102AY500SD)
Hydric soil rating: No

Minor Components

Castlewood, undrained

Percent of map unit: 5 percent
Landform: Flood plains
Landform position (two-dimensional): Toeslope
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R102AY020SD - Loamy Overflow
Other vegetative classification: Wet (G102AY900SD)
Hydric soil rating: Yes

Playmoor

Percent of map unit: 5 percent
Landform: Flood plains
Landform position (two-dimensional): Toeslope
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R102AY007SD - Saline Lowland
Other vegetative classification: Saline (G102AY895SD)
Hydric soil rating: Yes

Lb—LaDelle silt loam, channeled

Map Unit Setting

National map unit symbol: g145
Elevation: 1,000 to 2,000 feet
Mean annual precipitation: 19 to 29 inches
Mean annual air temperature: 39 to 45 degrees F
Frost-free period: 120 to 160 days
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Ladelle, Channeled

Setting

Landform: Flood plains
Landform position (two-dimensional): Footslope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Silty alluvium

Typical profile

H1 - 0 to 18 inches: silt loam
H2 - 18 to 36 inches: silty clay loam
H3 - 36 to 60 inches: stratified silt loam to clay loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 1.98 in/hr)
Depth to water table: About 42 to 60 inches
Frequency of flooding: OccasionalNone
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent
Gypsum, maximum content: 2 percent

Maximum salinity: Nonsaline to slightly saline (0.0 to 4.0 mmhos/cm)
Sodium adsorption ratio, maximum: 1.0
Available water supply, 0 to 60 inches: High (about 11.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6w
Hydrologic Soil Group: B
Ecological site: R102AY040SD - Loamy Floodplain
Forage suitability group: Overflow (G102AY500SD)
Other vegetative classification: Overflow (G102AY500SD)
Hydric soil rating: No

Minor Components

Marysland, undrained

Percent of map unit: 3 percent
Landform: Flood plains on outwash plains
Landform position (two-dimensional): Toeslope
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R102AY002SD - Linear Meadow
Other vegetative classification: Wet (G102AY900SD)
Hydric soil rating: Yes

Svea

Percent of map unit: 3 percent
Landform: Swales
Landform position (two-dimensional): Footslope
Down-slope shape: Linear
Across-slope shape: Concave
Ecological site: R102AY020SD - Loamy Overflow
Other vegetative classification: Overflow (G102AY500SD)
Hydric soil rating: No

Aastad

Percent of map unit: 3 percent
Landform: Swales
Landform position (two-dimensional): Footslope
Down-slope shape: Linear
Across-slope shape: Concave
Ecological site: R102AY020SD - Loamy Overflow
Other vegetative classification: Overflow (G102AY500SD)
Hydric soil rating: No

Rauville

Percent of map unit: 2 percent
Landform: Flood plains on outwash plains
Landform position (two-dimensional): Toeslope
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R102AY002SD - Linear Meadow
Other vegetative classification: Not suited (G102AY000SD)
Hydric soil rating: Yes

Forman

Percent of map unit: 2 percent

Landform: Plains
Landform position (two-dimensional): Backslope
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R102AY010SD - Loamy
Other vegetative classification: Loam (G102AY100SD)
Hydric soil rating: No

Playmoor

Percent of map unit: 2 percent
Landform: Flood plains
Landform position (two-dimensional): Toeslope
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R102AY007SD - Saline Lowland
Other vegetative classification: Saline (G102AY895SD)
Hydric soil rating: Yes

Po—Poinsett-Waubay silty clay loams, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 2t5qv
Elevation: 920 to 2,130 feet
Mean annual precipitation: 22 to 31 inches
Mean annual air temperature: 37 to 46 degrees F
Frost-free period: 120 to 160 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Poinsett and similar soils: 60 percent
Waubay and similar soils: 30 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Poinsett

Setting

Landform: Plains
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Periglacial loess over loamy till

Typical profile

Ap - 0 to 8 inches: silty clay loam
Bw - 8 to 24 inches: silty clay loam
Bk - 24 to 62 inches: silty clay loam
2C - 62 to 79 inches: clay loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well 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 49 to 61 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: High (about 11.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 1
Hydrologic Soil Group: C
Ecological site: R102AY010SD - Loamy
Forage suitability group: Loam (G102AY100SD)
Other vegetative classification: Loam (G102AY100SD)
Hydric soil rating: No

Description of Waubay

Setting

Landform: Swales
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Periglacial loess

Typical profile

Ap - 0 to 8 inches: silty clay loam
A - 8 to 15 inches: silty clay loam
Bw - 15 to 31 inches: silty clay loam
Bk - 31 to 50 inches: silt loam
C - 50 to 79 inches: silt loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well 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 30 to 41 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Very high (about 12.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 1
Hydrologic Soil Group: C

Ecological site: R102AY020SD - Loamy Overflow
Forage suitability group: Overflow (G102AY500SD)
Other vegetative classification: Overflow (G102AY500SD)
Hydric soil rating: No

Minor Components

Tonka, undrained
Percent of map unit: 4 percent
Landform: Potholes
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Dip
Down-slope shape: Concave
Across-slope shape: Concave
Ecological site: R102AY004SD - Wet Meadow
Other vegetative classification: Wet (G102AY900SD)
Hydric soil rating: Yes

Cubden
Percent of map unit: 4 percent
Landform: Rims on swales
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Convex
Ecological site: R102AY006SD - Limy Subirrigated
Other vegetative classification: Subirrigated (G102AY700SD)
Hydric soil rating: No

Rusklyn
Percent of map unit: 2 percent
Landform: Plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Rise
Down-slope shape: Convex
Across-slope shape: Convex
Ecological site: R102AY012SD - Thin Upland
Other vegetative classification: Limy Upland (G102AY400SD)
Hydric soil rating: No

RbB—Renshaw loam, 1 to 6 percent slopes

Map Unit Setting
National map unit symbol: 2w8f9
Elevation: 920 to 2,130 feet
Mean annual precipitation: 22 to 31 inches
Mean annual air temperature: 37 to 46 degrees F
Frost-free period: 120 to 160 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

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

Description of Renshaw

Setting

Landform: Hillslopes
Landform position (two-dimensional): Summit, backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Loamy glaciofluvial deposits over sandy and gravelly outwash

Typical profile

Ap - 0 to 7 inches: loam
Bw - 7 to 15 inches: loam
2Bk1 - 15 to 20 inches: gravelly loamy sand
2Bk2 - 20 to 79 inches: very gravelly loamy sand

Properties and qualities

Slope: 1 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 4.3 inches)

Interpretive groups

Land capability classification (irrigated): 4s
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: B
Ecological site: R102AY014SD - Shallow Gravel
Forage suitability group: Very Droughty Loam (G102AY130SD)
Other vegetative classification: Very Droughty Loam (G102AY130SD)
Hydric soil rating: No

Minor Components

Sioux

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Ecological site: R102AY016SD - Very Shallow
Other vegetative classification: Shallow (G102AY003SD)
Hydric soil rating: No

Fordville

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Linear
Ecological site: R102AY010SD - Loamy
Other vegetative classification: Droughty Loam (G102AY120SD)
Hydric soil rating: No

Spottswood

Percent of map unit: 3 percent
Landform: Hillslopes
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Concave
Ecological site: R102AY003SD - Subirrigated
Other vegetative classification: Subirrigated (G102AY700SD)
Hydric soil rating: No

Arvilla

Percent of map unit: 2 percent
Landform: Hillslopes
Landform position (two-dimensional): Summit, backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R102AY014SD - Shallow Gravel
Other vegetative classification: Very Droughty Loam (G102AY130SD)
Hydric soil rating: No

Sd—Svea loam, 1 to 3 percent slopes

Map Unit Setting

National map unit symbol: 2w0mt
Elevation: 920 to 2,130 feet
Mean annual precipitation: 22 to 31 inches
Mean annual air temperature: 37 to 46 degrees F
Frost-free period: 120 to 160 days
Farmland classification: All areas are prime farmland

Map Unit Composition

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

Description of Svea

Setting

Landform: Moraines
Landform position (three-dimensional): Talf
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Fine-loamy till

Typical profile

Ap - 0 to 13 inches: loam
Bw - 13 to 17 inches: loam
Bk - 17 to 27 inches: clay loam
C - 27 to 79 inches: loam

Properties and qualities

Slope: 1 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 2.00 in/hr)
Depth to water table: About 20 to 35 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: High (about 10.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Ecological site: R102AY010SD - Loamy
Forage suitability group: Loam (G102AY100SD)
Other vegetative classification: Loam (G102AY100SD)
Hydric soil rating: No

Minor Components

Hokans

Percent of map unit: 5 percent
Landform: Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Convex
Across-slope shape: Linear
Ecological site: R102AY010SD - Loamy
Other vegetative classification: Loam (G102AY100SD)
Hydric soil rating: No

Hamerly

Percent of map unit: 5 percent
Landform: Moraines
Landform position (three-dimensional): Talf
Down-slope shape: Concave
Across-slope shape: Linear
Ecological site: R102AY010SD - Loamy

Other vegetative classification: Subirrigated (G102AY700SD)
Hydric soil rating: No

Lakepark

Percent of map unit: 3 percent
Landform: Moraines
Landform position (three-dimensional): Talf
Down-slope shape: Concave
Across-slope shape: Linear
Ecological site: R102AY002SD - Linear Meadow
Other vegetative classification: Wet (G102AY900SD)
Hydric soil rating: Yes

Parnell, occasionally ponded

Percent of map unit: 2 percent
Landform: Moraines
Landform position (three-dimensional): Dip
Down-slope shape: Concave
Across-slope shape: Concave
Ecological site: R102AY001SD - Shallow Marsh
Other vegetative classification: Not suited (G102AY000SD)
Hydric soil rating: Yes

Ta—Tonka silty clay loam, 0 to 1 percent slopes

Map Unit Setting

National map unit symbol: 2tlc4
Elevation: 920 to 2,130 feet
Mean annual precipitation: 22 to 31 inches
Mean annual air temperature: 37 to 46 degrees F
Frost-free period: 120 to 160 days
Farmland classification: Prime farmland if drained

Map Unit Composition

Tonka and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Tonka

Setting

Landform: Depressions
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Local alluvium over loamy till

Typical profile

Ap - 0 to 8 inches: silty clay loam
A - 8 to 14 inches: silty clay loam
E - 14 to 24 inches: silt loam
Bt - 24 to 40 inches: silty clay

Cg1 - 40 to 54 inches: silty clay loam
2Cg2 - 54 to 79 inches: clay loam

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.60 in/hr)
Depth to water table: About 0 to 18 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Calcium carbonate, maximum content: 20 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: High (about 10.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4w
Hydrologic Soil Group: C/D
Ecological site: R102AY004SD - Wet Meadow
Forage suitability group: Wet (G102AY900SD)
Other vegetative classification: Wet (G102AY900SD)
Hydric soil rating: Yes

Minor Components

Cubden

Percent of map unit: 5 percent
Landform: Rims on depressions
Down-slope shape: Linear
Across-slope shape: Convex
Ecological site: R102AY006SD - Limy Subirrigated
Other vegetative classification: Subirrigated (G102AY700SD)
Hydric soil rating: No

Hamerly

Percent of map unit: 2 percent
Landform: Rims on depressions
Down-slope shape: Linear
Across-slope shape: Convex
Ecological site: R102AY006SD - Limy Subirrigated
Other vegetative classification: Subirrigated (G102AY700SD)
Hydric soil rating: No

Vallers

Percent of map unit: 2 percent
Landform: Rims on depressions
Down-slope shape: Concave
Across-slope shape: Linear
Ecological site: R102AY002SD - Linear Meadow
Other vegetative classification: Wet (G102AY900SD)
Hydric soil rating: Yes

Parnell

Percent of map unit: 1 percent
Landform: Depressions

Down-slope shape: Concave
Across-slope shape: Concave
Ecological site: R102AY001SD - Shallow Marsh
Other vegetative classification: Not suited (G102AY000SD)
Hydric soil rating: Yes

Va—Vallers clay loam, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 2vv6q
Elevation: 920 to 2,130 feet
Mean annual precipitation: 22 to 31 inches
Mean annual air temperature: 37 to 46 degrees F
Frost-free period: 120 to 160 days
Farmland classification: Prime farmland if drained

Map Unit Composition

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

Description of Vallers

Setting

Landform: Moraines
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Fine-loamy till

Typical profile

Ap - 0 to 10 inches: clay loam
A - 10 to 16 inches: clay loam
Bkg - 16 to 38 inches: clay loam
Cg - 38 to 79 inches: clay loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 2.00 in/hr)
Depth to water table: About 6 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Gypsum, maximum content: 2 percent
Maximum salinity: Nonsaline to slightly saline (0.0 to 4.0 mmhos/cm)
Sodium adsorption ratio, maximum: 2.0
Available water supply, 0 to 60 inches: High (about 10.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: C/D
Ecological site: R102AY002SD - Linear Meadow
Forage suitability group: Wet (G102AY900SD)
Other vegetative classification: Wet (G102AY900SD)
Hydric soil rating: Yes

Minor Components

Hamerly

Percent of map unit: 10 percent
Landform: Moraines
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R102AY006SD - Limy Subirrigated
Other vegetative classification: Subirrigated (G102AY700SD)
Hydric soil rating: No

Lakepark

Percent of map unit: 3 percent
Landform: Moraines
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R102AY002SD - Linear Meadow
Other vegetative classification: Wet (G102AY900SD)
Hydric soil rating: Yes

Quam, occasionally ponded

Percent of map unit: 2 percent
Landform: Moraines
Landform position (three-dimensional): Dip
Down-slope shape: Concave
Across-slope shape: Concave
Ecological site: R102AY001SD - Shallow Marsh
Other vegetative classification: Wet (G102AY900SD)
Hydric soil rating: Yes

W—Water

Map Unit Setting

National map unit symbol: 2wx3y
Elevation: 970 to 3,940 feet
Mean annual precipitation: 13 to 31 inches
Mean annual air temperature: 39 to 50 degrees F
Farmland classification: Not prime farmland

Map Unit Composition

Water: 100 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Water

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 8

Hydric soil rating: Unranked

References

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

National Research Council. 1995. Wetlands: Characteristics and boundaries.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577

Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580

Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.

United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374

United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084

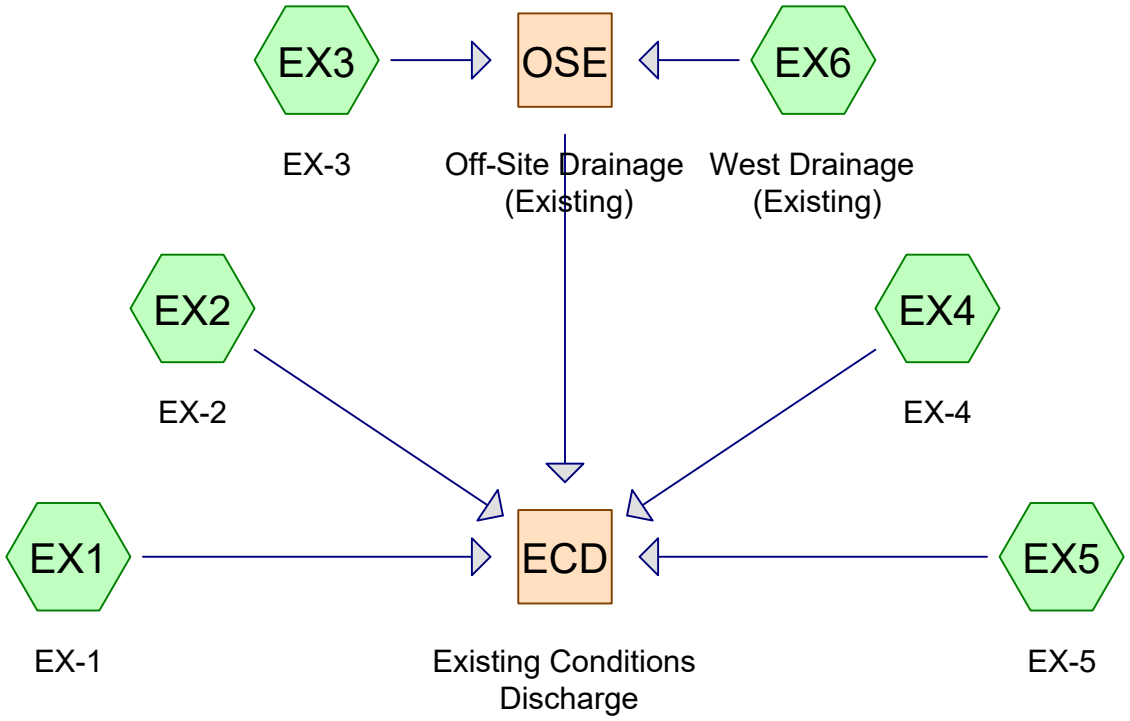
United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

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

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

Appendix D: Existing HydroCAD Report

Existing Conditions



Subcat Reach Pond Link

Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2 yr 24 hr	Type II 24-hr		Default	24.00	1	2.55	2
2	5 yr 24 hr	Type II 24-hr		Default	24.00	1	3.16	2
3	10 yr 24 hr	Type II 24-hr		Default	24.00	1	3.70	2
4	100 yr 24 hr	Type II 24-hr		Default	24.00	1	5.77	2

Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
1.523	98	Paved parking, HSG C (EX2, EX6)
6.247	78	Row crops, straight row, Good, HSG B (EX5)
48.941	85	Row crops, straight row, Good, HSG C (EX1, EX2, EX3, EX4, EX6)
56.711	**85**	**TOTAL AREA**

Soil Listing (selected nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
6.247	HSG B	EX5
50.464	HSG C	EX1, EX2, EX3, EX4, EX6
0.000	HSG D	
0.000	Other	
56.711		**TOTAL AREA**

Summary for Subcatchment EX1: EX-1

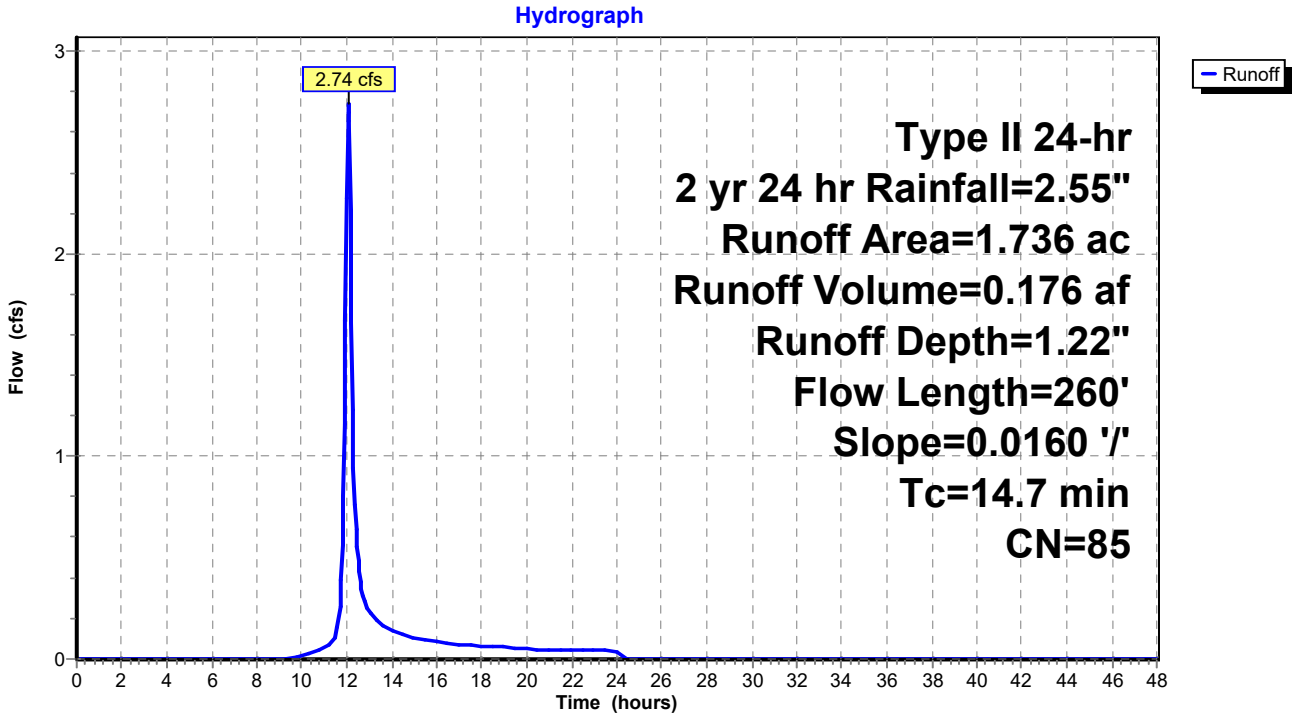
Runoff = 2.74 cfs @ 12.07 hrs, Volume= 0.176 af, Depth= 1.22"
Routed to Reach ECD : Existing Conditions Discharge

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 2 yr 24 hr Rainfall=2.55"

Area (ac)	CN	Description
1.736	85	Row crops, straight row, Good, HSG C
1.736		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.4	100	0.0160	0.13		**Sheet Flow,** Cultivated: Residue>20% n= 0.170 P2= 2.90"
2.3	160	0.0160	1.14		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
14.7	260	Total			

Subcatchment EX1: EX-1



Summary for Subcatchment EX2: EX-2

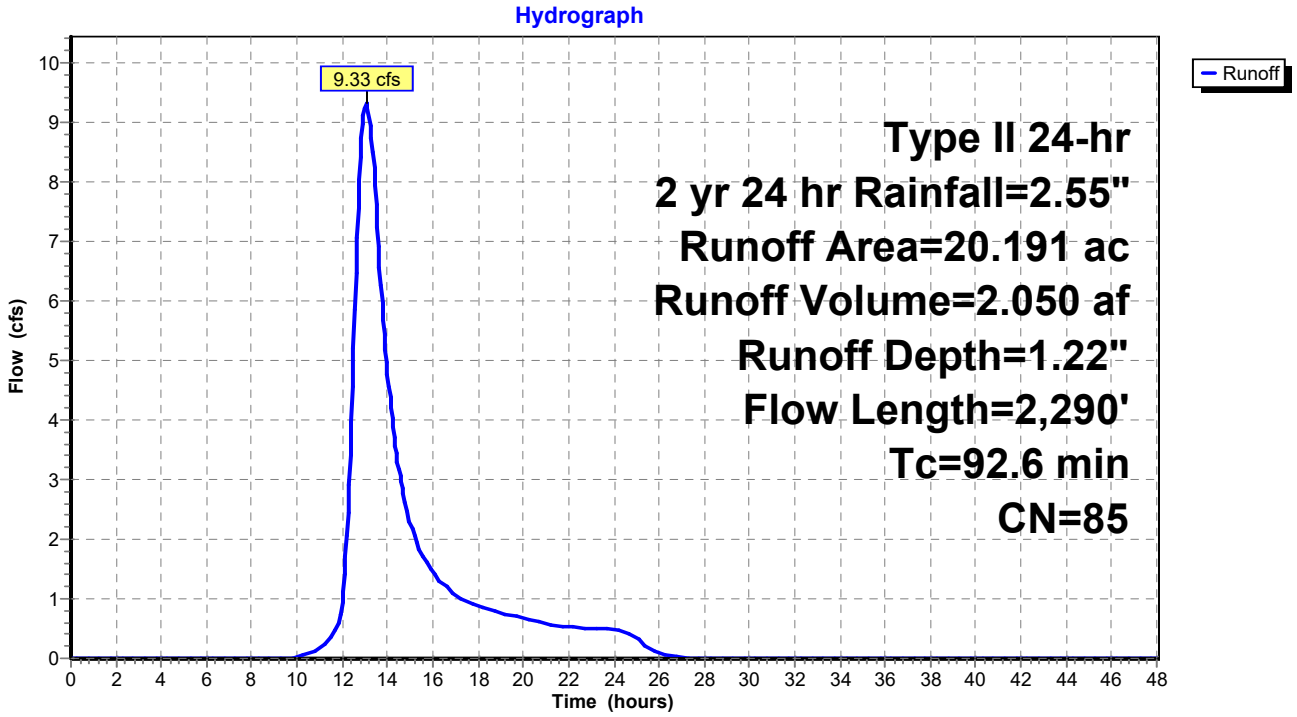
Runoff = 9.33 cfs @ 13.06 hrs, Volume= 2.050 af, Depth= 1.22"
Routed to Reach ECD : Existing Conditions Discharge

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 2 yr 24 hr Rainfall=2.55"

Area (ac)	CN	Description
19.773	85	Row crops, straight row, Good, HSG C
0.418	98	Paved parking, HSG C
20.191	85	Weighted Average
19.773		97.93% Pervious Area
0.418		2.07% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
34.1	100	0.0010	0.05		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.90"
7.9	452	0.0040	0.95		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
1.5	140	0.0110	1.57		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
32.0	910	0.0010	0.47		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
17.1	688	0.0020	0.67		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
92.6	2,290	Total			

Subcatchment EX2: EX-2



Summary for Subcatchment EX3: EX-3

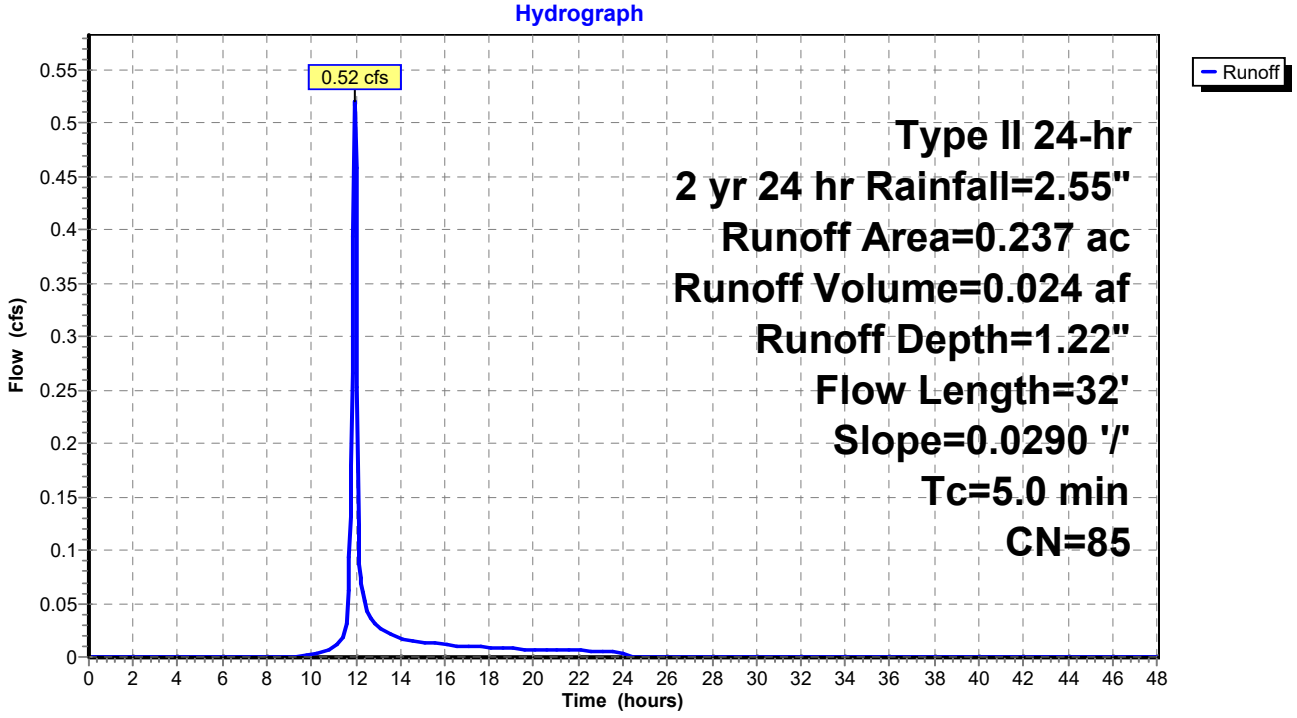
Runoff = 0.52 cfs @ 11.96 hrs, Volume= 0.024 af, Depth= 1.22"
Routed to Reach OSE : Off-Site Drainage (Existing)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 2 yr 24 hr Rainfall=2.55"

Area (ac)	CN	Description
0.237	85	Row crops, straight row, Good, HSG C
0.237		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.9	32	0.0290	0.14		**Sheet Flow,** Cultivated: Residue>20% n= 0.170 P2= 2.90"
3.9	32	Total, Increased to minimum Tc = 5.0 min			

Subcatchment EX3: EX-3



Summary for Subcatchment EX4: EX-4

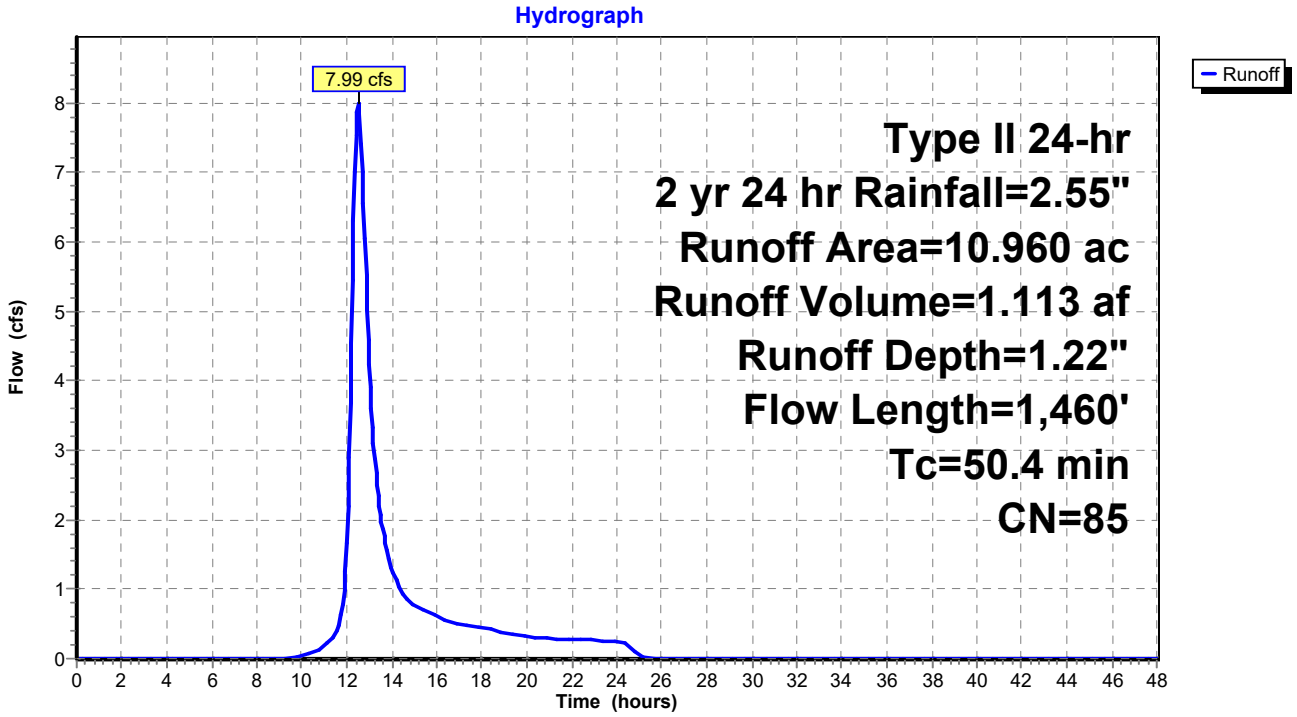
Runoff = 7.99 cfs @ 12.51 hrs, Volume= 1.113 af, Depth= 1.22"
Routed to Reach ECD : Existing Conditions Discharge

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 2 yr 24 hr Rainfall=2.55"

Area (ac)	CN	Description
10.960	85	Row crops, straight row, Good, HSG C
10.960		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
18.4	100	0.0060	0.09		**Sheet Flow,** Cultivated: Residue>20% n= 0.170 P2= 2.90"
19.7	752	0.0050	0.64		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
12.3	608	0.0030	0.82		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
50.4	1,460	Total			

Subcatchment EX4: EX-4



Summary for Subcatchment EX5: EX-5

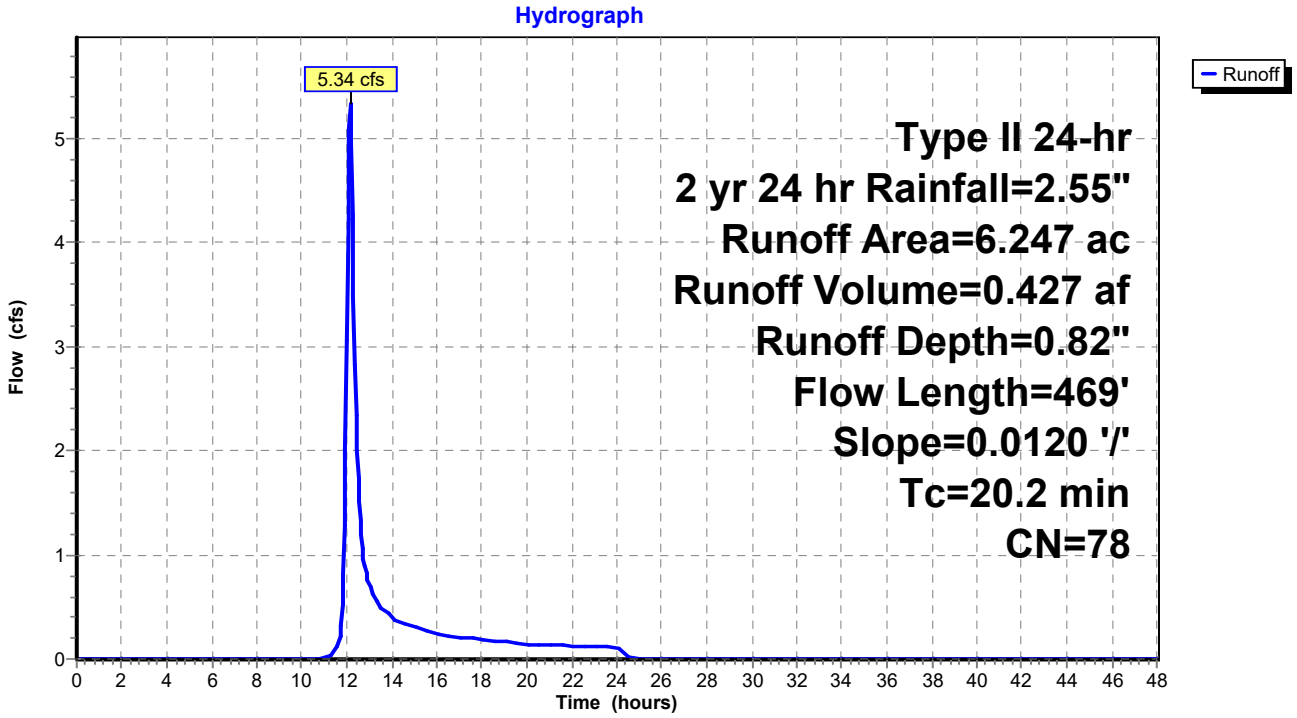
Runoff = 5.34 cfs @ 12.15 hrs, Volume= 0.427 af, Depth= 0.82"
Routed to Reach ECD : Existing Conditions Discharge

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 2 yr 24 hr Rainfall=2.55"

Area (ac)	CN	Description
6.247	78	Row crops, straight row, Good, HSG B
6.247		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.0	100	0.0120	0.12		**Sheet Flow,** Cultivated: Residue>20% n= 0.170 P2= 2.90"
6.2	369	0.0120	0.99		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
20.2	469	Total			

Subcatchment EX5: EX-5



Summary for Subcatchment EX6: West Drainage (Existing)

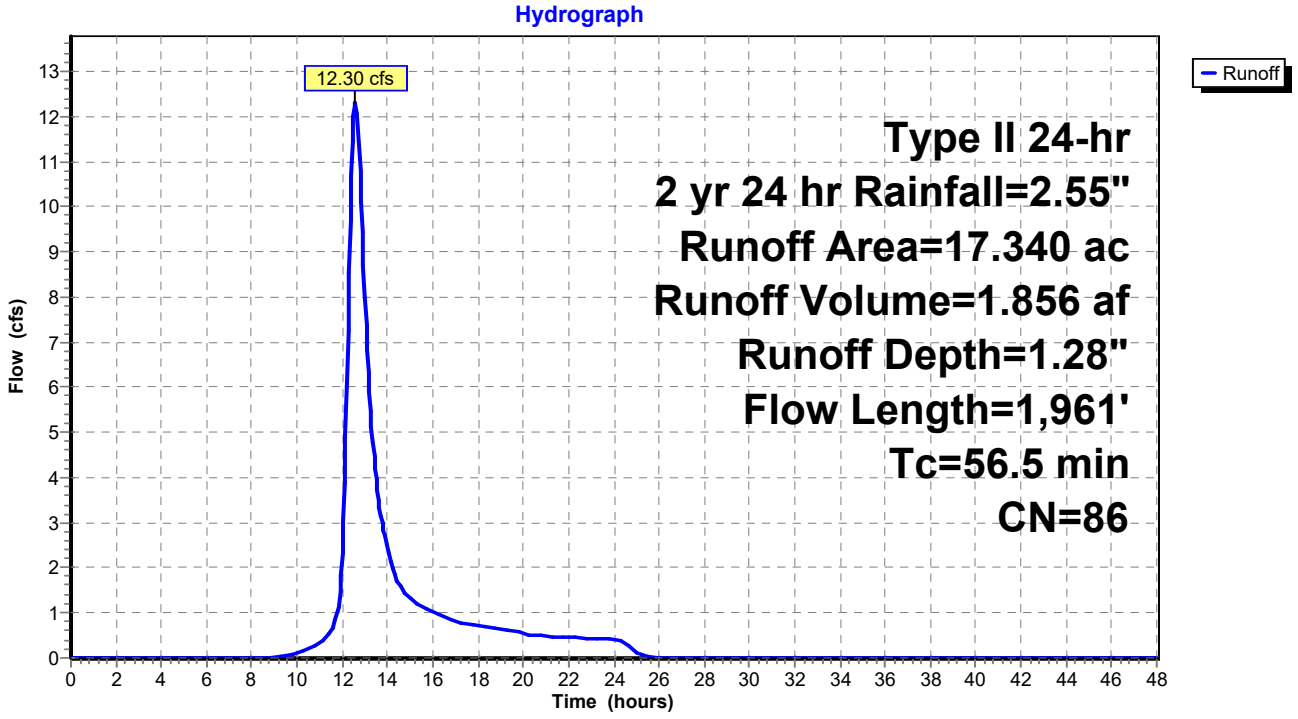
Runoff = 12.30 cfs @ 12.59 hrs, Volume= 1.856 af, Depth= 1.28"
Routed to Reach OSE : Off-Site Drainage (Existing)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 2 yr 24 hr Rainfall=2.55"

Area (ac)	CN	Description
16.235	85	Row crops, straight row, Good, HSG C
1.105	98	Paved parking, HSG C
17.340	86	Weighted Average
16.235		93.63% Pervious Area
1.105		6.37% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.4	100	0.0250	0.16		**Sheet Flow,** Cultivated: Residue>20% n= 0.170 P2= 2.90"
27.9	1,167	0.0060	0.70		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
18.2	694	0.0050	0.64		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
56.5	1,961	Total			

Subcatchment EX6: West Drainage (Existing)

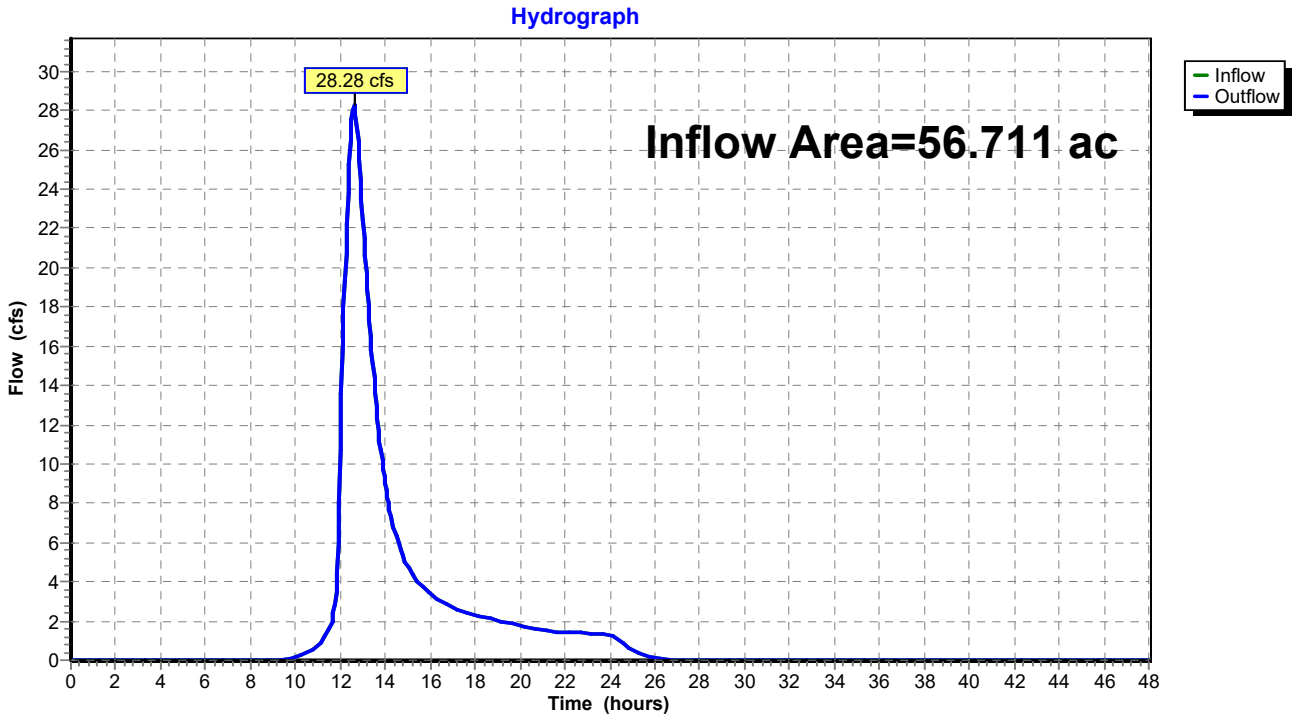


Summary for Reach ECD: Existing Conditions Discharge

Inflow Area = 56.711 ac, 2.69% Impervious, Inflow Depth = 1.19" for 2 yr 24 hr event
Inflow = 28.28 cfs @ 12.61 hrs, Volume= 5.646 af
Outflow = 28.28 cfs @ 12.61 hrs, Volume= 5.646 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach ECD: Existing Conditions Discharge

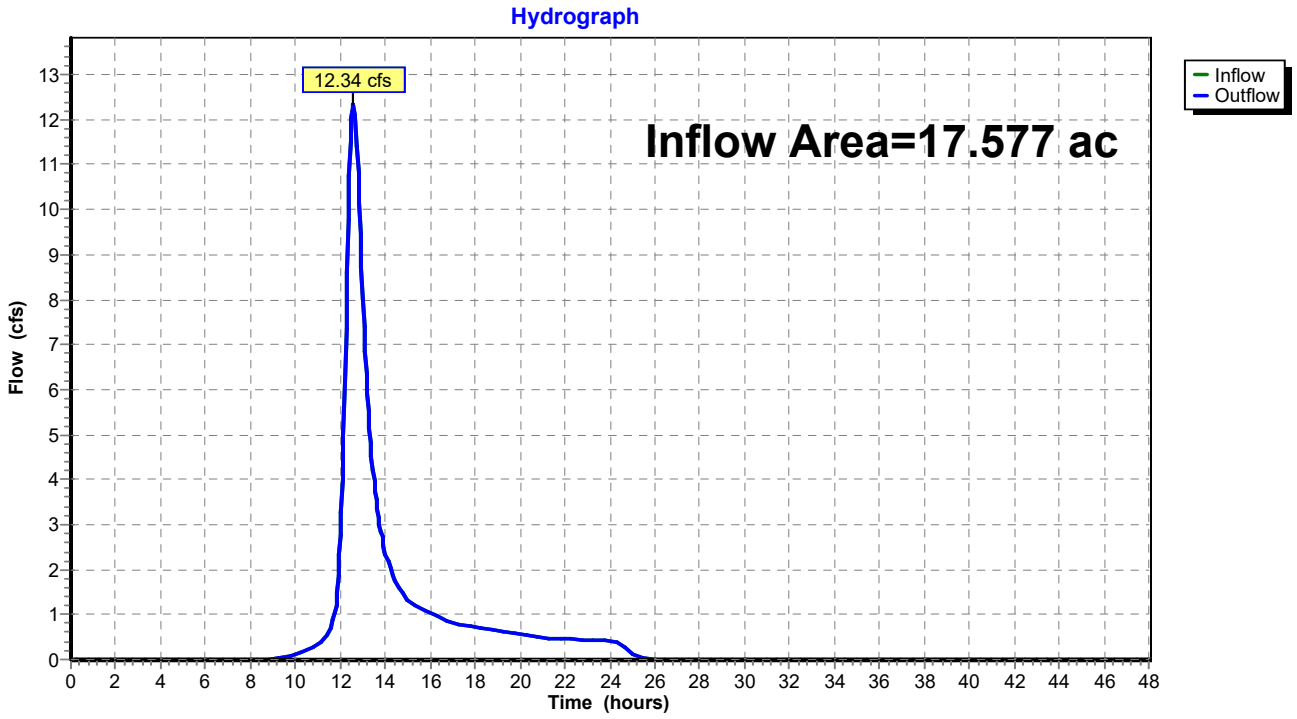


Summary for Reach OSE: Off-Site Drainage (Existing)

Inflow Area = 17.577 ac, 6.29% Impervious, Inflow Depth = 1.28" for 2 yr 24 hr event
Inflow = 12.34 cfs @ 12.59 hrs, Volume= 1.880 af
Outflow = 12.34 cfs @ 12.59 hrs, Volume= 1.880 af, Atten= 0%, Lag= 0.0 min
Routed to Reach ECD : Existing Conditions Discharge

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach OSE: Off-Site Drainage (Existing)



Summary for Subcatchment EX1: EX-1

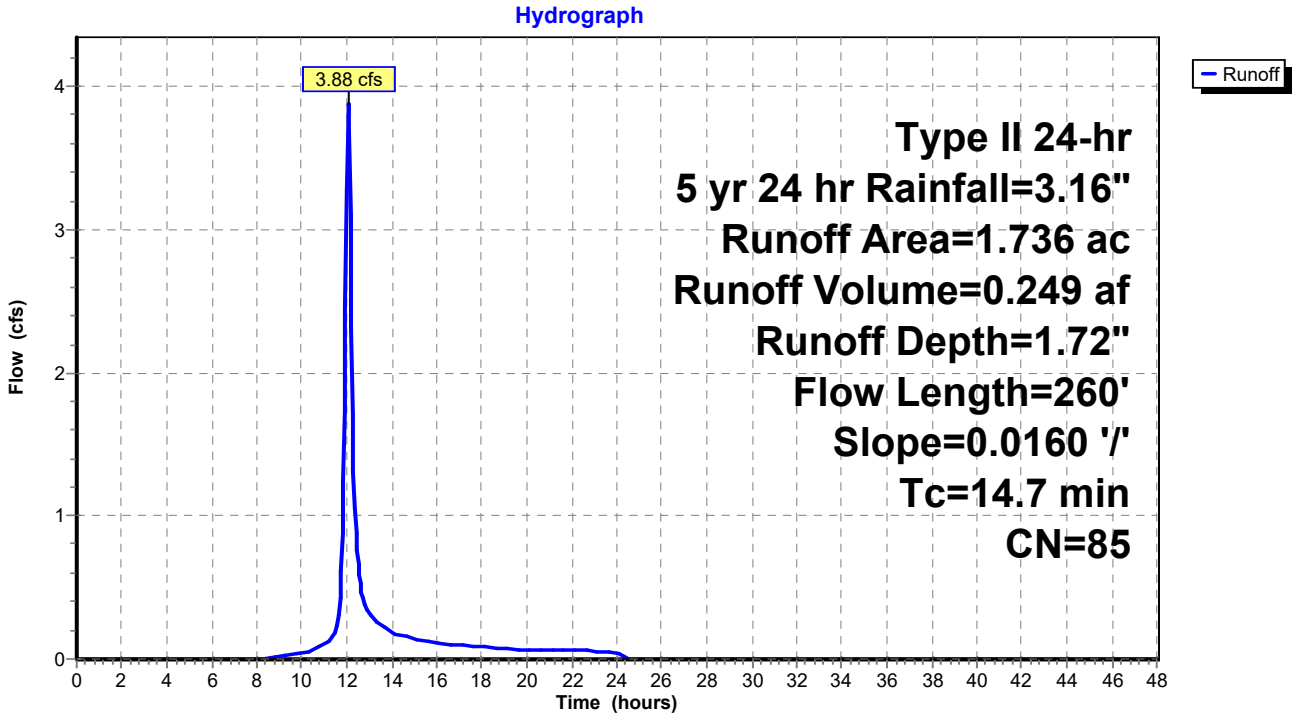
Runoff = 3.88 cfs @ 12.07 hrs, Volume= 0.249 af, Depth= 1.72"
Routed to Reach ECD : Existing Conditions Discharge

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 5 yr 24 hr Rainfall=3.16"

Area (ac)	CN	Description
1.736	85	Row crops, straight row, Good, HSG C
1.736		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.4	100	0.0160	0.13		**Sheet Flow,** Cultivated: Residue>20% n= 0.170 P2= 2.90"
2.3	160	0.0160	1.14		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
14.7	260	Total			

Subcatchment EX1: EX-1



Summary for Subcatchment EX2: EX-2

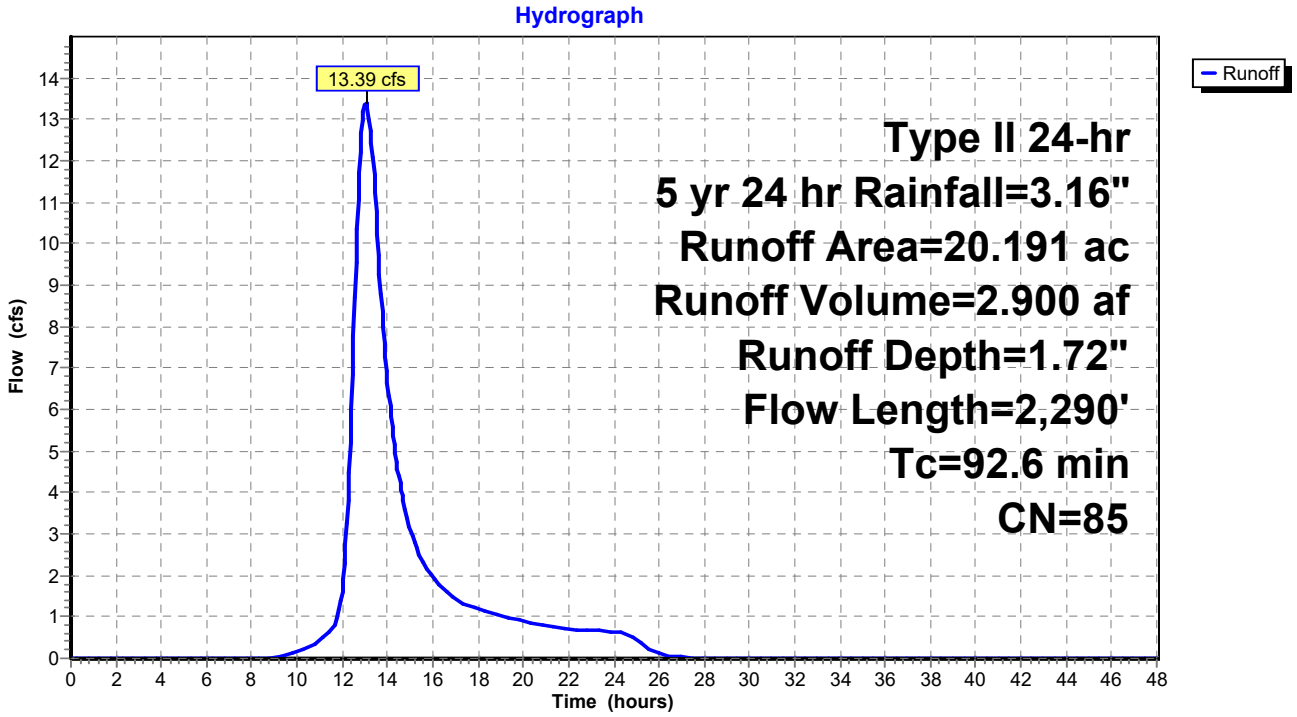
Runoff = 13.39 cfs @ 13.05 hrs, Volume= 2.900 af, Depth= 1.72"
Routed to Reach ECD : Existing Conditions Discharge

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 5 yr 24 hr Rainfall=3.16"

Area (ac)	CN	Description
19.773	85	Row crops, straight row, Good, HSG C
0.418	98	Paved parking, HSG C
20.191	85	Weighted Average
19.773		97.93% Pervious Area
0.418		2.07% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
34.1	100	0.0010	0.05		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.90"
7.9	452	0.0040	0.95		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
1.5	140	0.0110	1.57		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
32.0	910	0.0010	0.47		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
17.1	688	0.0020	0.67		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
92.6	2,290	Total			

Subcatchment EX2: EX-2



Summary for Subcatchment EX3: EX-3

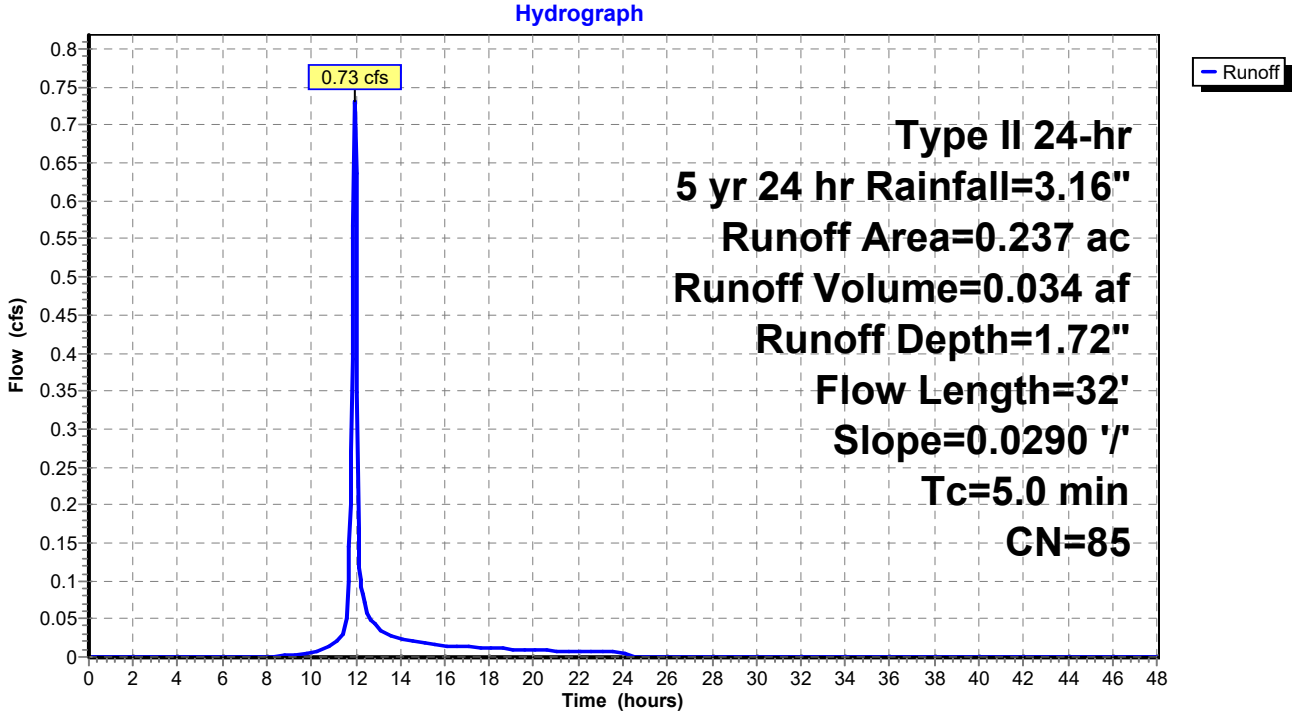
Runoff = 0.73 cfs @ 11.96 hrs, Volume= 0.034 af, Depth= 1.72"
Routed to Reach OSE : Off-Site Drainage (Existing)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 5 yr 24 hr Rainfall=3.16"

Area (ac)	CN	Description
0.237	85	Row crops, straight row, Good, HSG C
0.237		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.9	32	0.0290	0.14		**Sheet Flow,** Cultivated: Residue>20% n= 0.170 P2= 2.90"
3.9	32	Total, Increased to minimum Tc = 5.0 min			

Subcatchment EX3: EX-3



Summary for Subcatchment EX4: EX-4

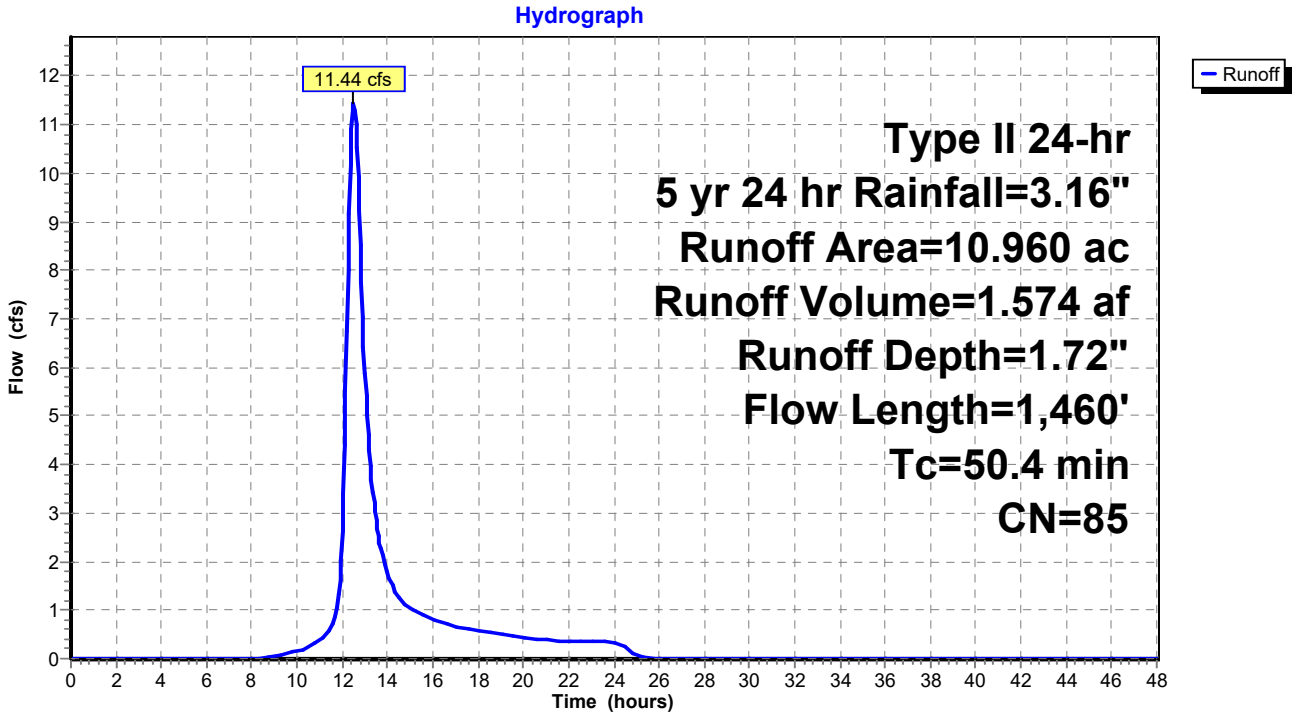
Runoff = 11.44 cfs @ 12.50 hrs, Volume= 1.574 af, Depth= 1.72"
Routed to Reach ECD : Existing Conditions Discharge

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 5 yr 24 hr Rainfall=3.16"

Area (ac)	CN	Description
10.960	85	Row crops, straight row, Good, HSG C
10.960		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
18.4	100	0.0060	0.09		**Sheet Flow,** Cultivated: Residue>20% n= 0.170 P2= 2.90"
19.7	752	0.0050	0.64		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
12.3	608	0.0030	0.82		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
50.4	1,460	Total			

Subcatchment EX4: EX-4



Summary for Subcatchment EX5: EX-5

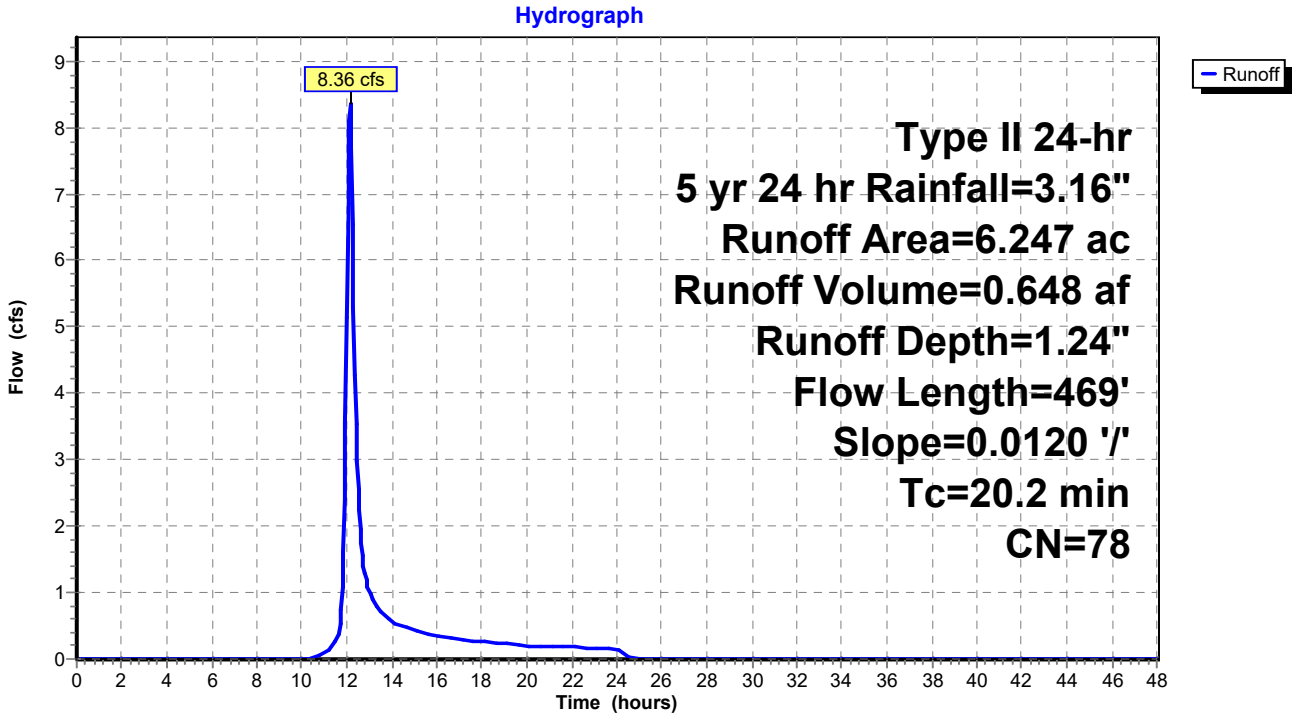
Runoff = 8.36 cfs @ 12.14 hrs, Volume= 0.648 af, Depth= 1.24"
Routed to Reach ECD : Existing Conditions Discharge

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 5 yr 24 hr Rainfall=3.16"

Area (ac)	CN	Description
6.247	78	Row crops, straight row, Good, HSG B
6.247		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.0	100	0.0120	0.12		**Sheet Flow,** Cultivated: Residue>20% n= 0.170 P2= 2.90"
6.2	369	0.0120	0.99		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
20.2	469	Total			

Subcatchment EX5: EX-5



Summary for Subcatchment EX6: West Drainage (Existing)

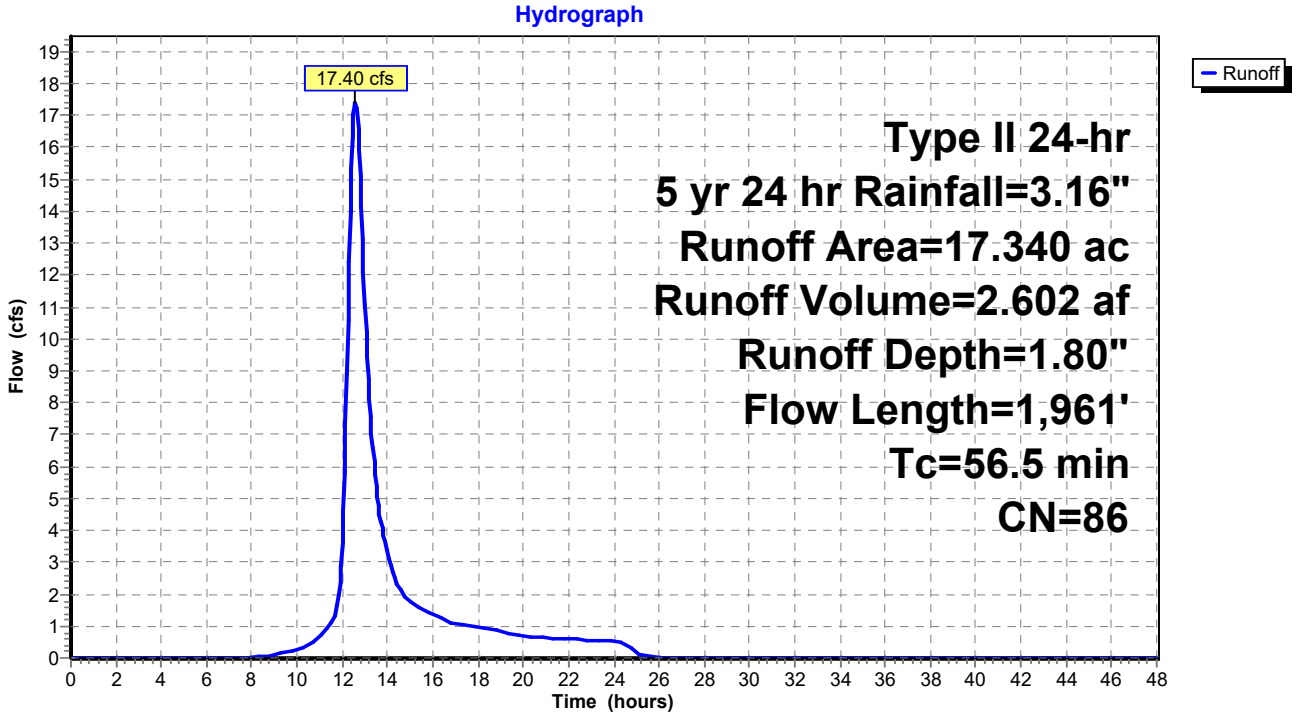
Runoff = 17.40 cfs @ 12.58 hrs, Volume= 2.602 af, Depth= 1.80"
Routed to Reach OSE : Off-Site Drainage (Existing)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 5 yr 24 hr Rainfall=3.16"

Area (ac)	CN	Description
16.235	85	Row crops, straight row, Good, HSG C
1.105	98	Paved parking, HSG C
17.340	86	Weighted Average
16.235		93.63% Pervious Area
1.105		6.37% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.4	100	0.0250	0.16		**Sheet Flow,** Cultivated: Residue>20% n= 0.170 P2= 2.90"
27.9	1,167	0.0060	0.70		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
18.2	694	0.0050	0.64		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
56.5	1,961	Total			

Subcatchment EX6: West Drainage (Existing)

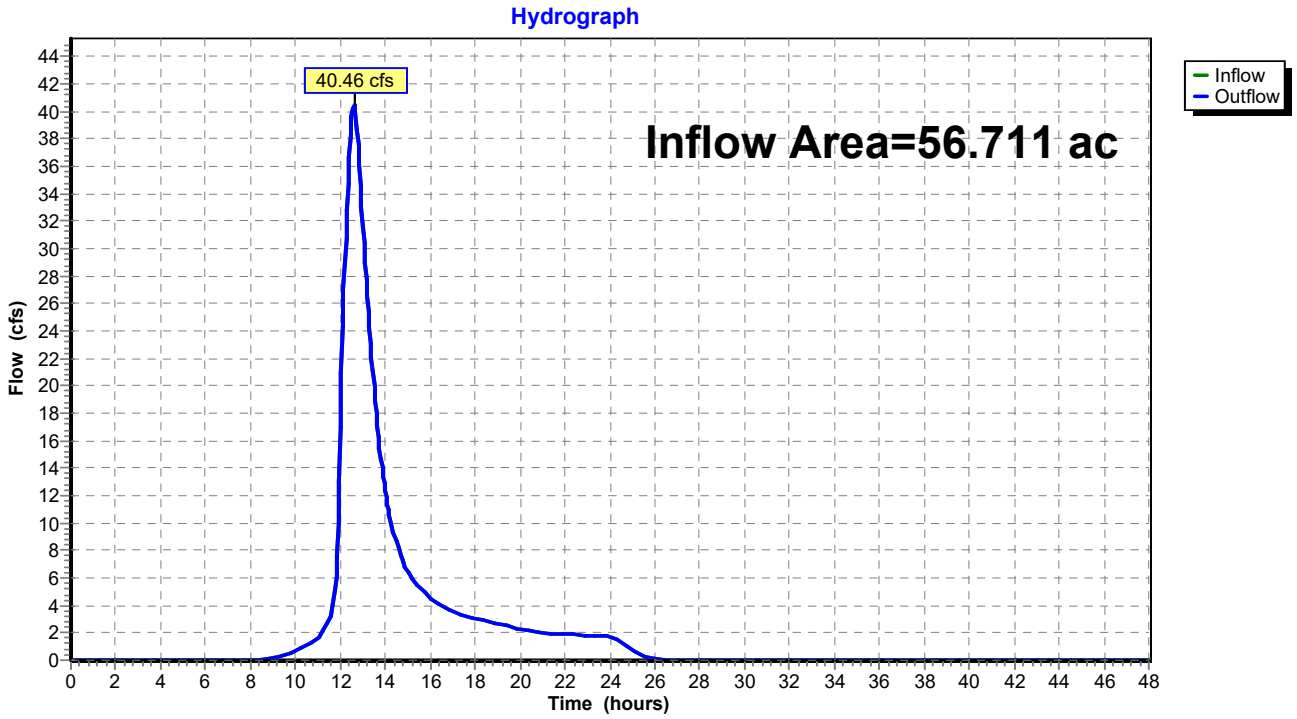


Summary for Reach ECD: Existing Conditions Discharge

Inflow Area = 56.711 ac, 2.69% Impervious, Inflow Depth = 1.69" for 5 yr 24 hr event
Inflow = 40.46 cfs @ 12.60 hrs, Volume= 8.007 af
Outflow = 40.46 cfs @ 12.60 hrs, Volume= 8.007 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach ECD: Existing Conditions Discharge

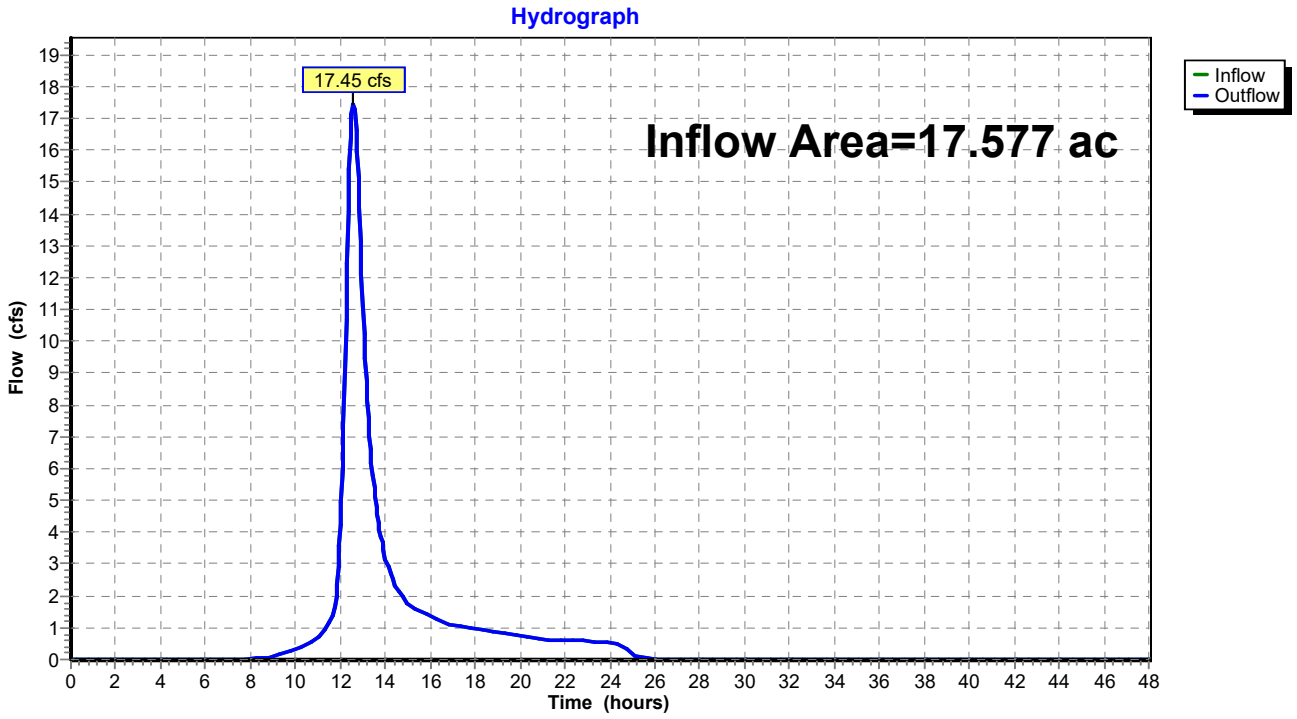


Summary for Reach OSE: Off-Site Drainage (Existing)

Inflow Area = 17.577 ac, 6.29% Impervious, Inflow Depth = 1.80" for 5 yr 24 hr event
Inflow = 17.45 cfs @ 12.58 hrs, Volume= 2.636 af
Outflow = 17.45 cfs @ 12.58 hrs, Volume= 2.636 af, Atten= 0%, Lag= 0.0 min
Routed to Reach ECD : Existing Conditions Discharge

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach OSE: Off-Site Drainage (Existing)



Summary for Subcatchment EX1: EX-1

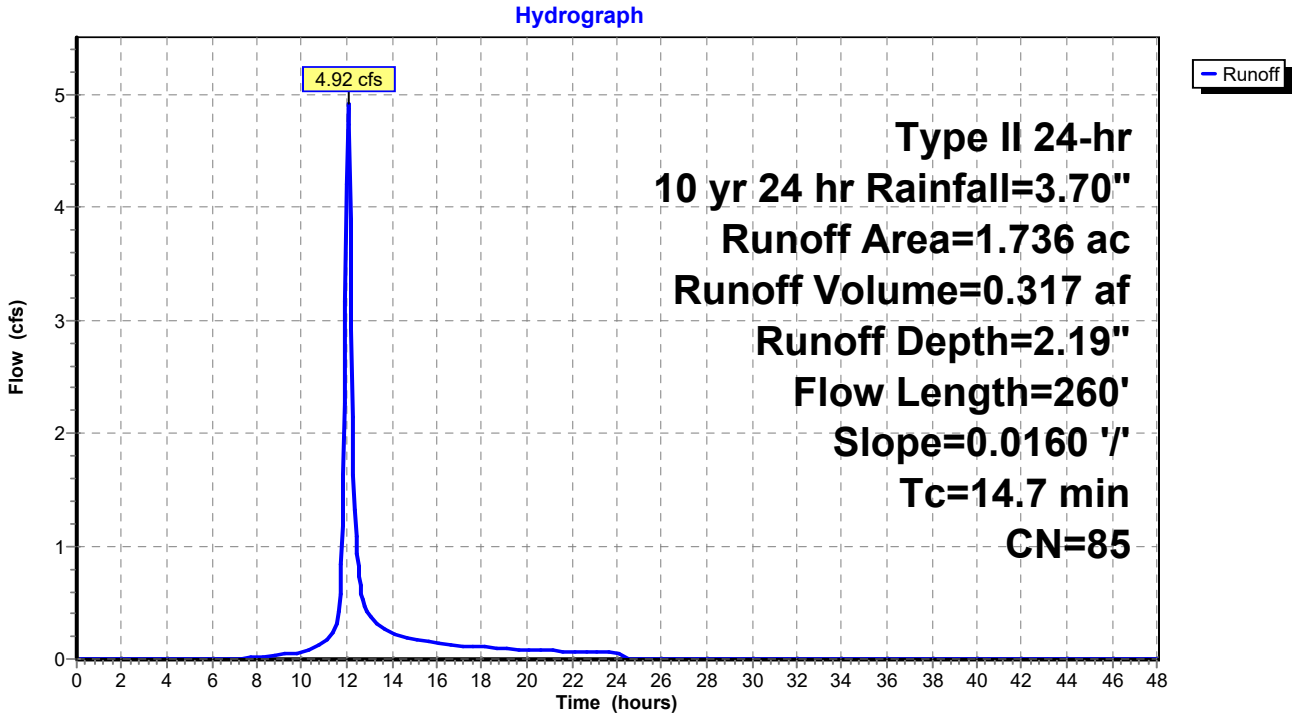
Runoff = 4.92 cfs @ 12.07 hrs, Volume= 0.317 af, Depth= 2.19"
Routed to Reach ECD : Existing Conditions Discharge

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 10 yr 24 hr Rainfall=3.70"

Area (ac)	CN	Description
1.736	85	Row crops, straight row, Good, HSG C
1.736		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.4	100	0.0160	0.13		**Sheet Flow,** Cultivated: Residue>20% n= 0.170 P2= 2.90"
2.3	160	0.0160	1.14		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
14.7	260	Total			

Subcatchment EX1: EX-1



Summary for Subcatchment EX2: EX-2

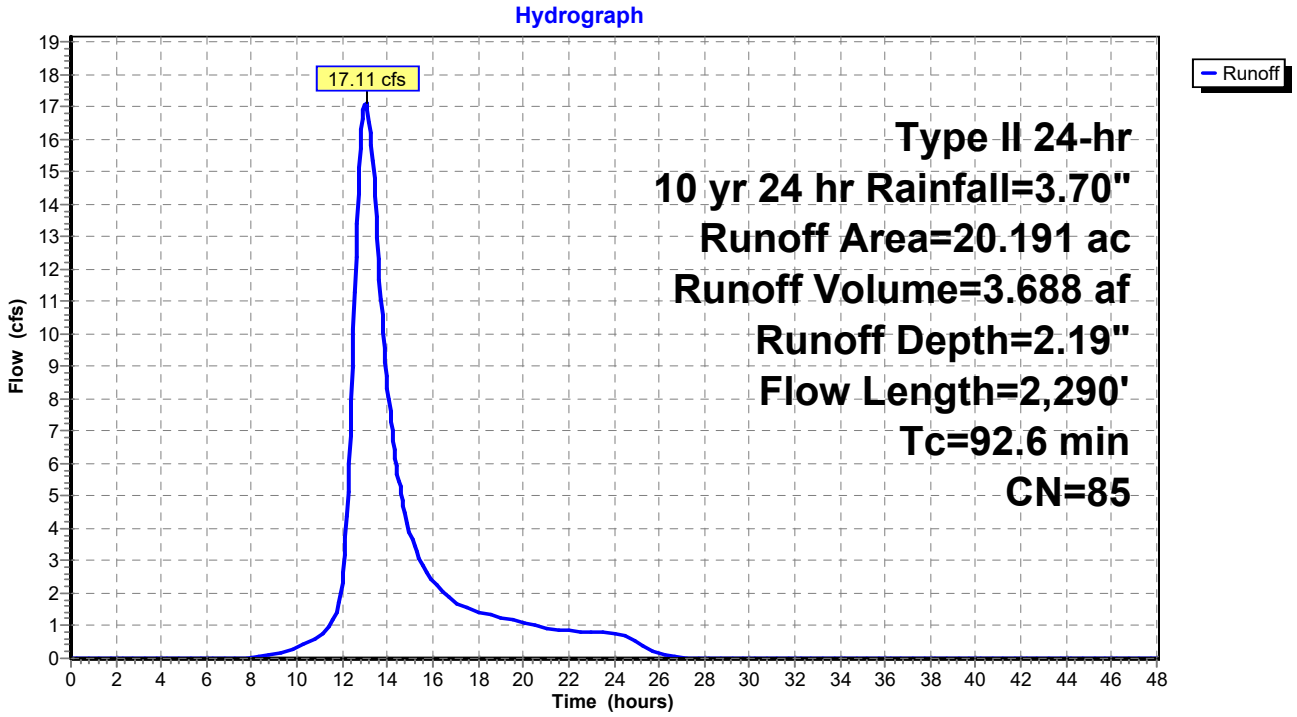
Runoff = 17.11 cfs @ 13.05 hrs, Volume= 3.688 af, Depth= 2.19"
Routed to Reach ECD : Existing Conditions Discharge

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 10 yr 24 hr Rainfall=3.70"

Area (ac)	CN	Description
19.773	85	Row crops, straight row, Good, HSG C
0.418	98	Paved parking, HSG C
20.191	85	Weighted Average
19.773		97.93% Pervious Area
0.418		2.07% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
34.1	100	0.0010	0.05		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.90"
7.9	452	0.0040	0.95		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
1.5	140	0.0110	1.57		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
32.0	910	0.0010	0.47		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
17.1	688	0.0020	0.67		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
92.6	2,290	Total			

Subcatchment EX2: EX-2



Summary for Subcatchment EX3: EX-3

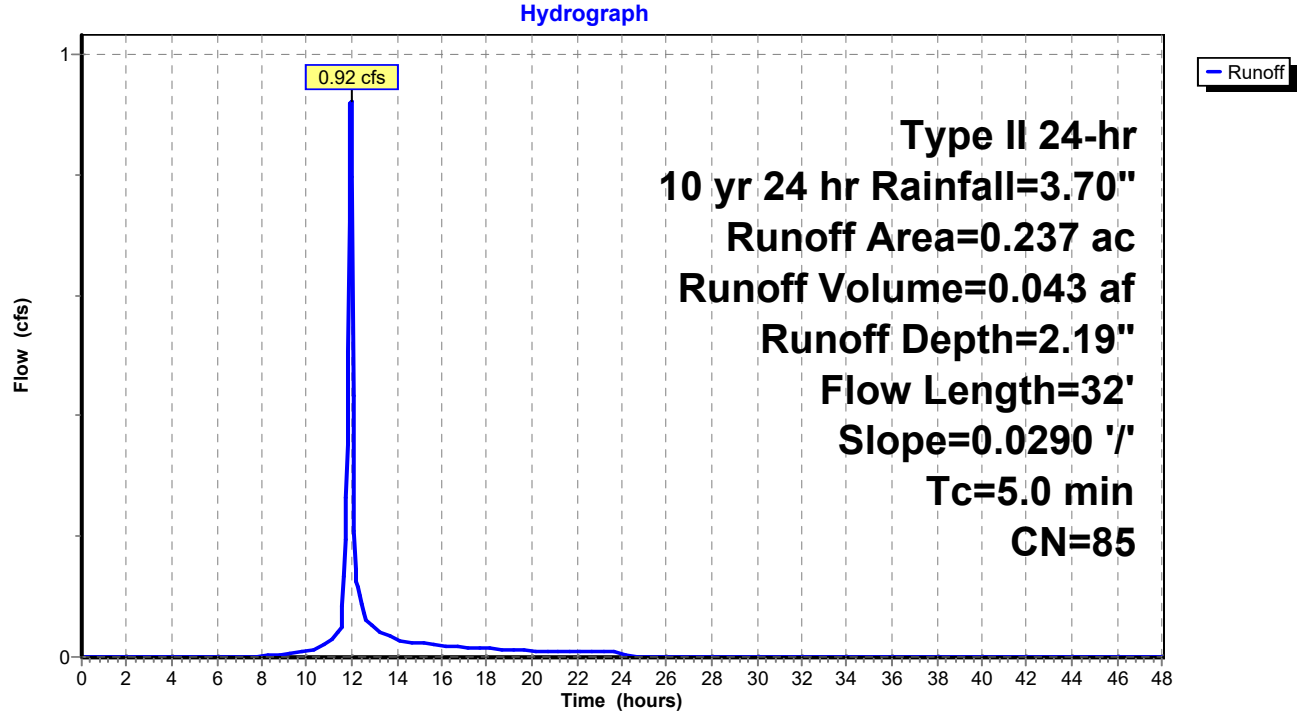
Runoff = 0.92 cfs @ 11.96 hrs, Volume= 0.043 af, Depth= 2.19"
Routed to Reach OSE : Off-Site Drainage (Existing)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 10 yr 24 hr Rainfall=3.70"

Area (ac)	CN	Description
0.237	85	Row crops, straight row, Good, HSG C
0.237		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.9	32	0.0290	0.14		**Sheet Flow,** Cultivated: Residue>20% n= 0.170 P2= 2.90"
3.9	32	Total, Increased to minimum Tc = 5.0 min			

Subcatchment EX3: EX-3



Summary for Subcatchment EX4: EX-4

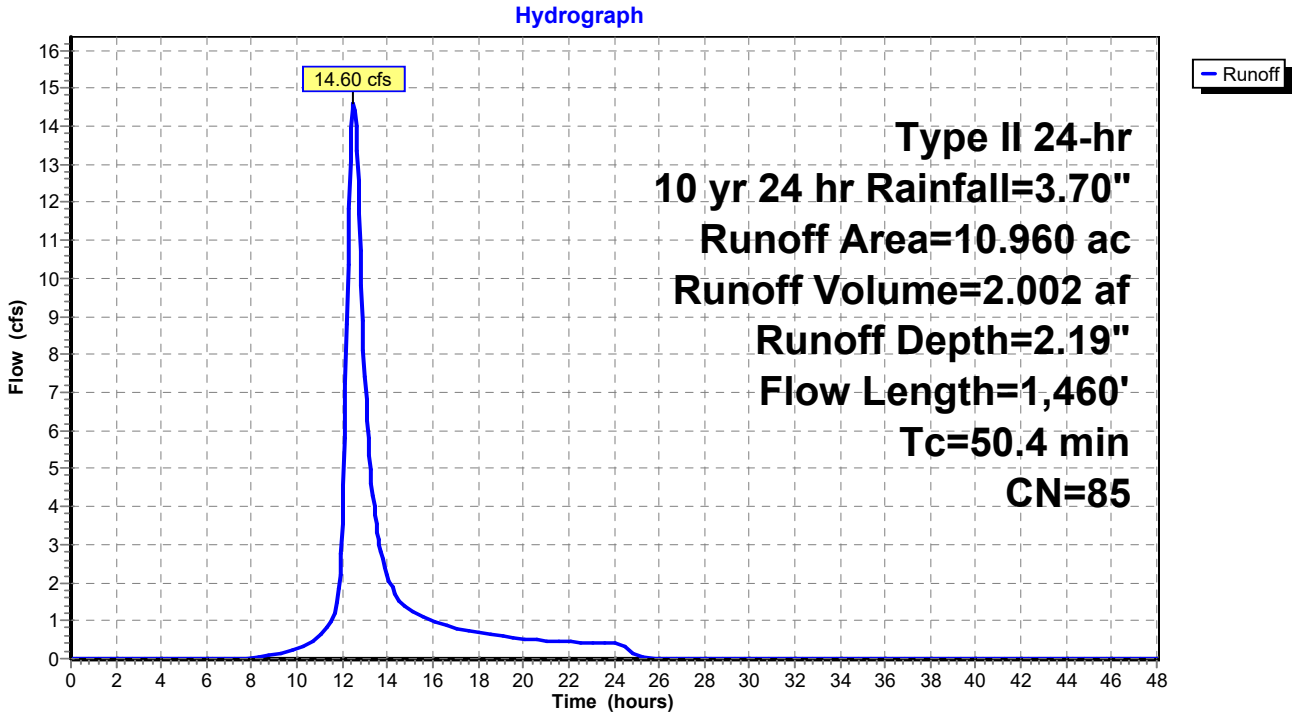
Runoff = 14.60 cfs @ 12.50 hrs, Volume= 2.002 af, Depth= 2.19"
Routed to Reach ECD : Existing Conditions Discharge

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 10 yr 24 hr Rainfall=3.70"

Area (ac)	CN	Description
10.960	85	Row crops, straight row, Good, HSG C
10.960		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
18.4	100	0.0060	0.09		**Sheet Flow,** Cultivated: Residue>20% n= 0.170 P2= 2.90"
19.7	752	0.0050	0.64		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
12.3	608	0.0030	0.82		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
50.4	1,460	Total			

Subcatchment EX4: EX-4



Summary for Subcatchment EX5: EX-5

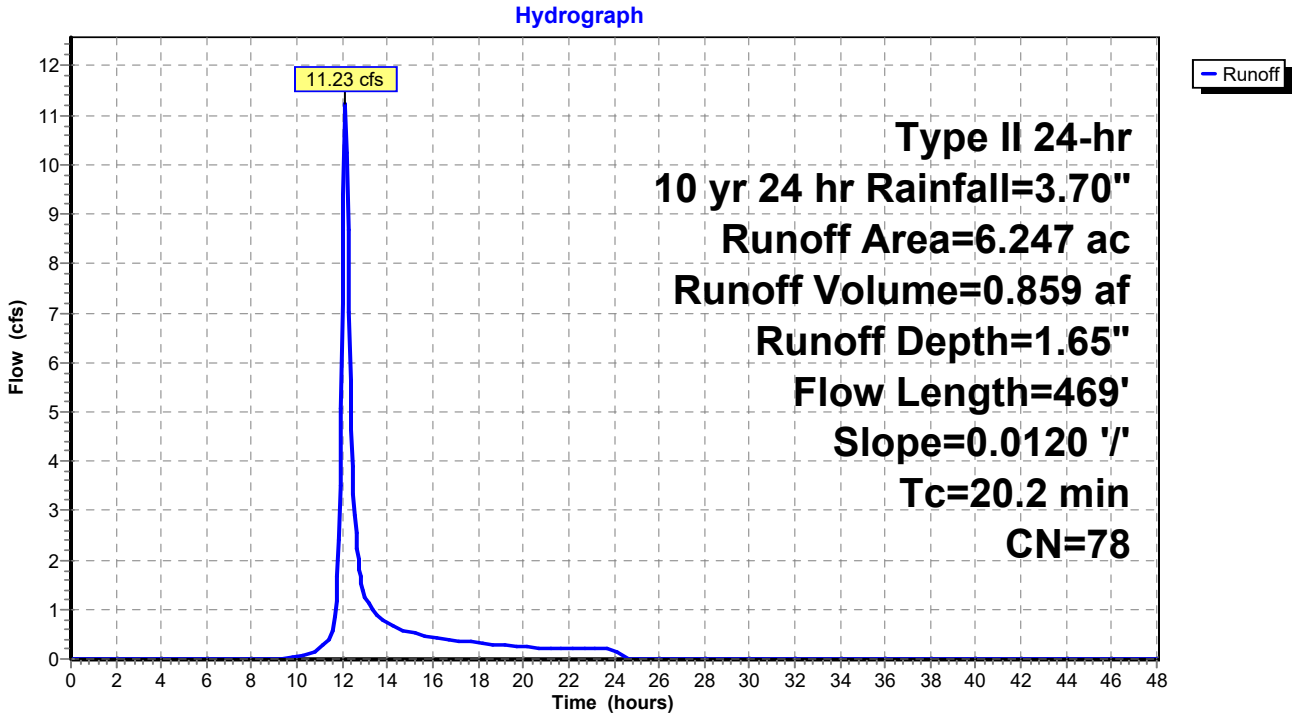
Runoff = 11.23 cfs @ 12.14 hrs, Volume= 0.859 af, Depth= 1.65"
Routed to Reach ECD : Existing Conditions Discharge

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 10 yr 24 hr Rainfall=3.70"

Area (ac)	CN	Description
6.247	78	Row crops, straight row, Good, HSG B
6.247		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.0	100	0.0120	0.12		**Sheet Flow,** Cultivated: Residue>20% n= 0.170 P2= 2.90"
6.2	369	0.0120	0.99		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
20.2	469	Total			

Subcatchment EX5: EX-5



Summary for Subcatchment EX6: West Drainage (Existing)

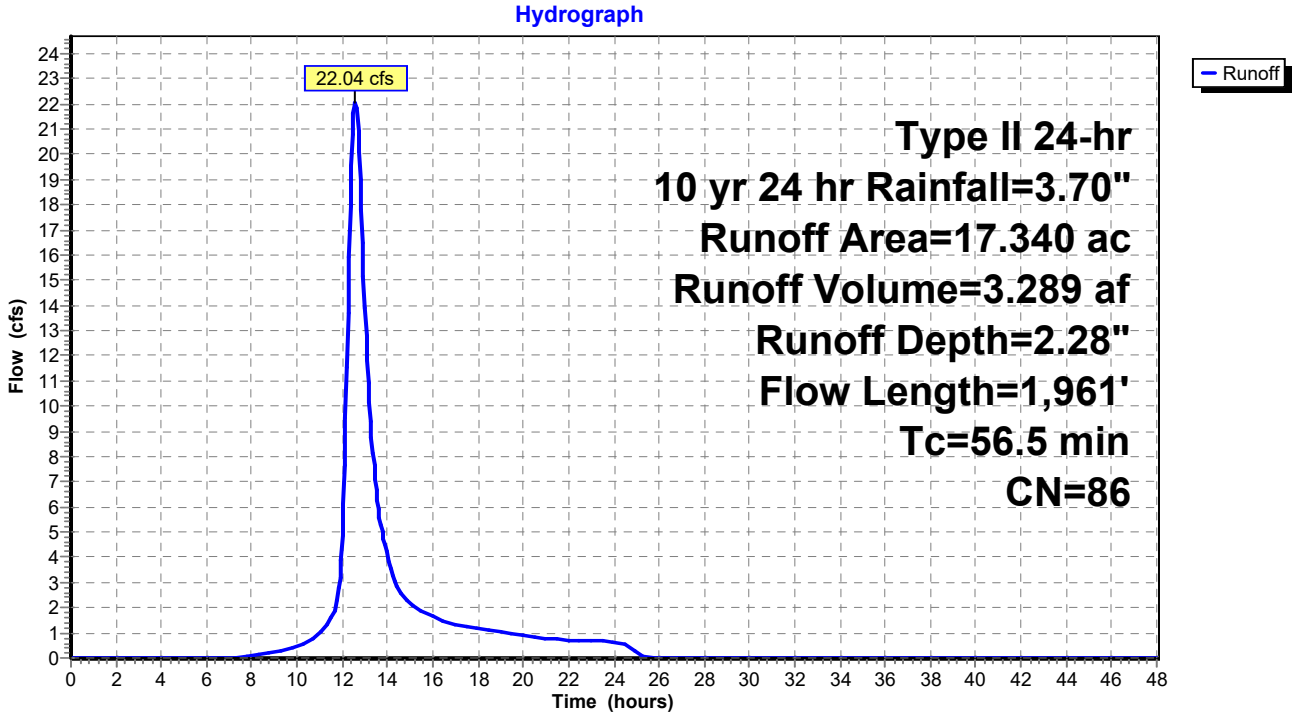
Runoff = 22.04 cfs @ 12.58 hrs, Volume= 3.289 af, Depth= 2.28"
Routed to Reach OSE : Off-Site Drainage (Existing)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 10 yr 24 hr Rainfall=3.70"

Area (ac)	CN	Description
16.235	85	Row crops, straight row, Good, HSG C
1.105	98	Paved parking, HSG C
17.340	86	Weighted Average
16.235		93.63% Pervious Area
1.105		6.37% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.4	100	0.0250	0.16		**Sheet Flow,** Cultivated: Residue>20% n= 0.170 P2= 2.90"
27.9	1,167	0.0060	0.70		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
18.2	694	0.0050	0.64		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
56.5	1,961	Total			

Subcatchment EX6: West Drainage (Existing)

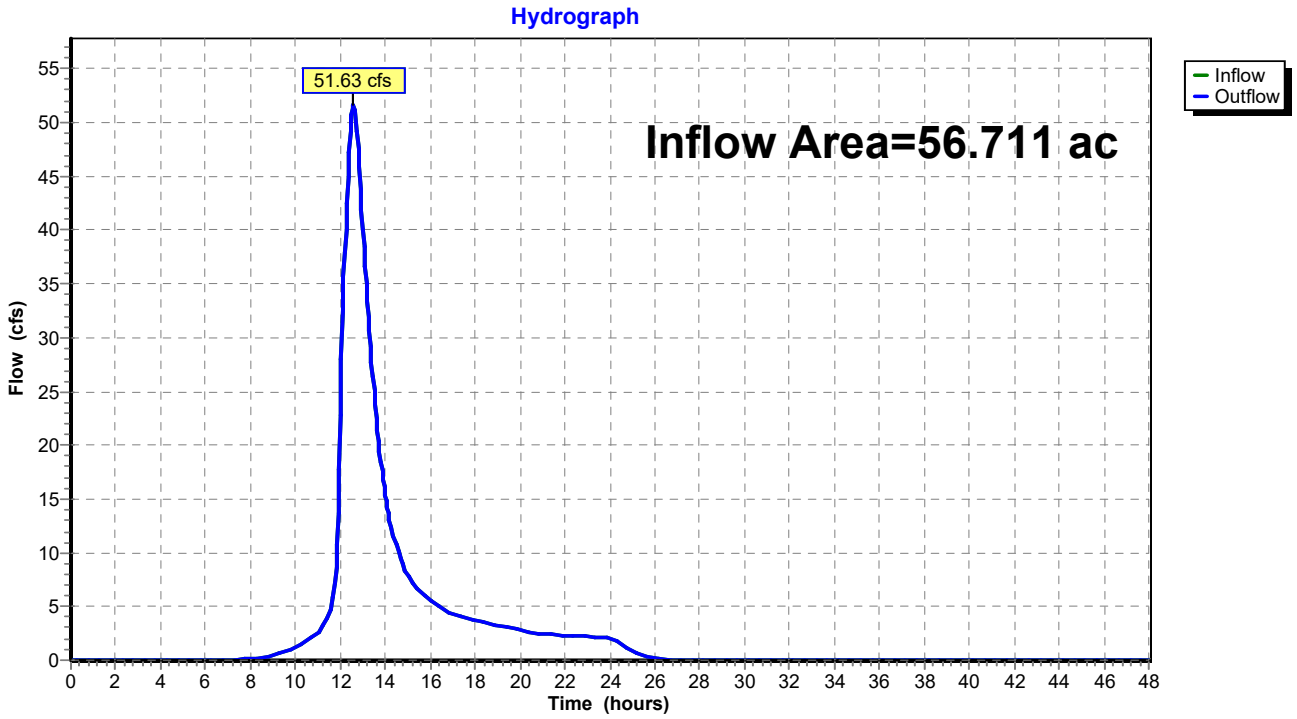


Summary for Reach ECD: Existing Conditions Discharge

Inflow Area = 56.711 ac, 2.69% Impervious, Inflow Depth = 2.16" for 10 yr 24 hr event
Inflow = 51.63 cfs @ 12.60 hrs, Volume= 10.198 af
Outflow = 51.63 cfs @ 12.60 hrs, Volume= 10.198 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach ECD: Existing Conditions Discharge

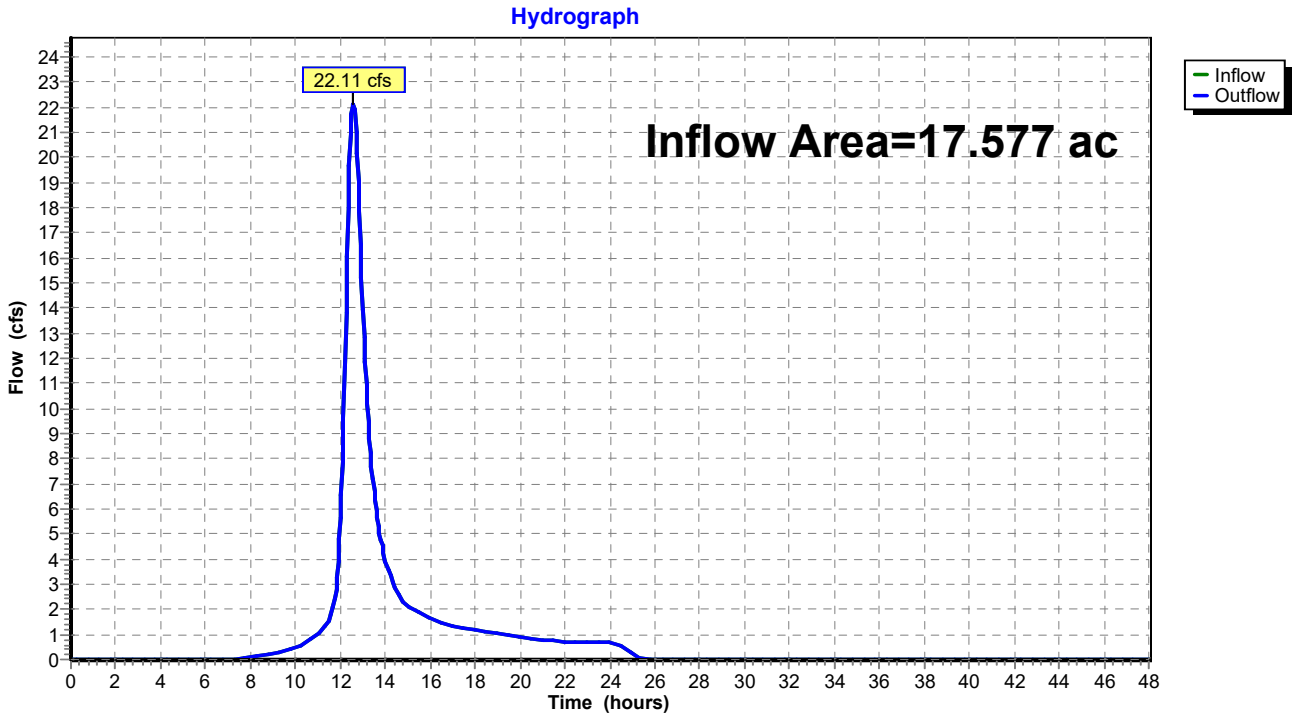


Summary for Reach OSE: Off-Site Drainage (Existing)

Inflow Area = 17.577 ac, 6.29% Impervious, Inflow Depth = 2.28" for 10 yr 24 hr event
Inflow = 22.11 cfs @ 12.58 hrs, Volume= 3.333 af
Outflow = 22.11 cfs @ 12.58 hrs, Volume= 3.333 af, Atten= 0%, Lag= 0.0 min
Routed to Reach ECD : Existing Conditions Discharge

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach OSE: Off-Site Drainage (Existing)



Summary for Subcatchment EX1: EX-1

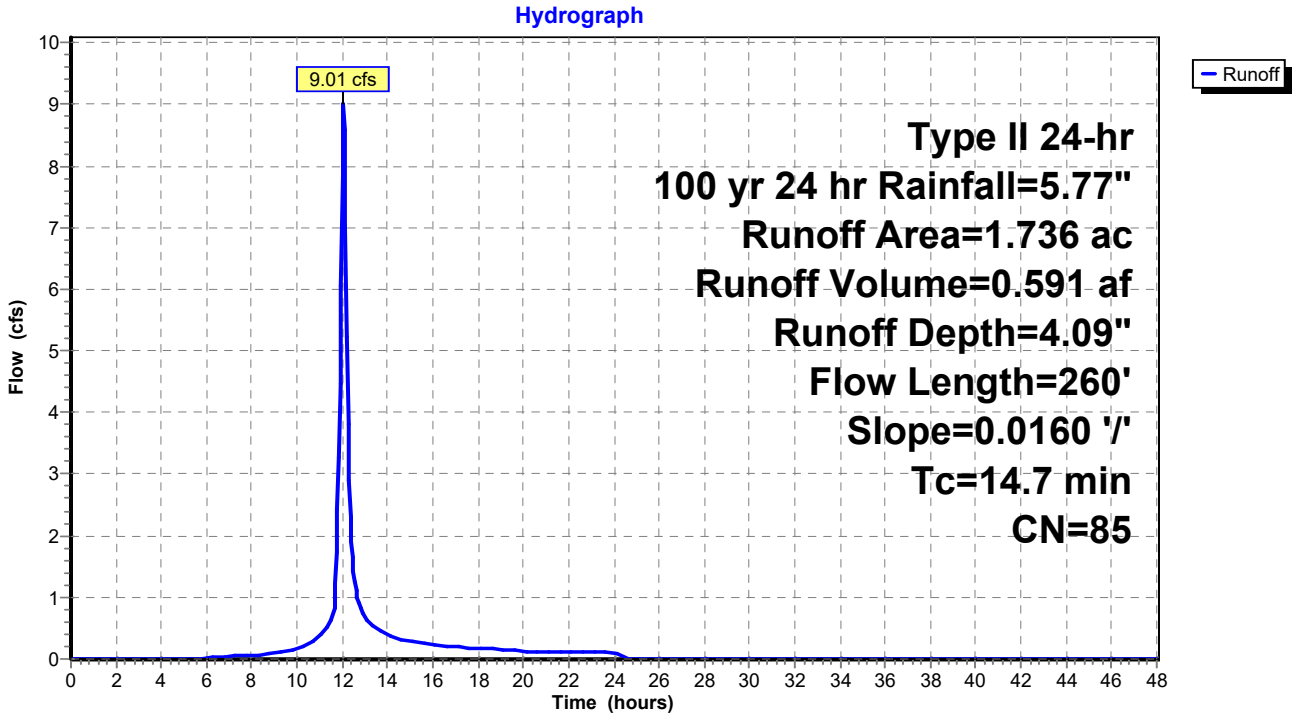
Runoff = 9.01 cfs @ 12.06 hrs, Volume= 0.591 af, Depth= 4.09"
Routed to Reach ECD : Existing Conditions Discharge

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 100 yr 24 hr Rainfall=5.77"

Area (ac)	CN	Description
1.736	85	Row crops, straight row, Good, HSG C
1.736		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.4	100	0.0160	0.13		**Sheet Flow,** Cultivated: Residue>20% n= 0.170 P2= 2.90"
2.3	160	0.0160	1.14		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
14.7	260	Total			

Subcatchment EX1: EX-1



Summary for Subcatchment EX2: EX-2

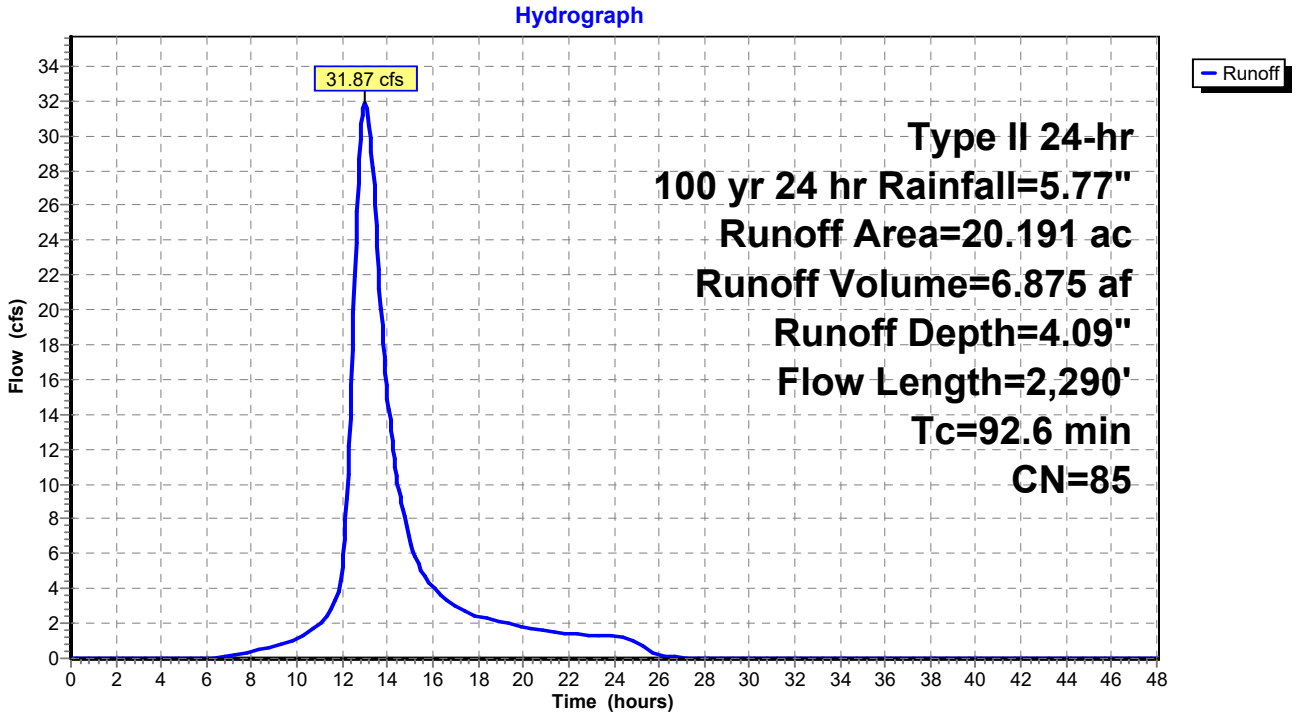
Runoff = 31.87 cfs @ 13.04 hrs, Volume= 6.875 af, Depth= 4.09"
Routed to Reach ECD : Existing Conditions Discharge

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 100 yr 24 hr Rainfall=5.77"

Area (ac)	CN	Description
19.773	85	Row crops, straight row, Good, HSG C
0.418	98	Paved parking, HSG C
20.191	85	Weighted Average
19.773		97.93% Pervious Area
0.418		2.07% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
34.1	100	0.0010	0.05		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.90"
7.9	452	0.0040	0.95		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
1.5	140	0.0110	1.57		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
32.0	910	0.0010	0.47		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
17.1	688	0.0020	0.67		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
92.6	2,290	Total			

Subcatchment EX2: EX-2



Summary for Subcatchment EX3: EX-3

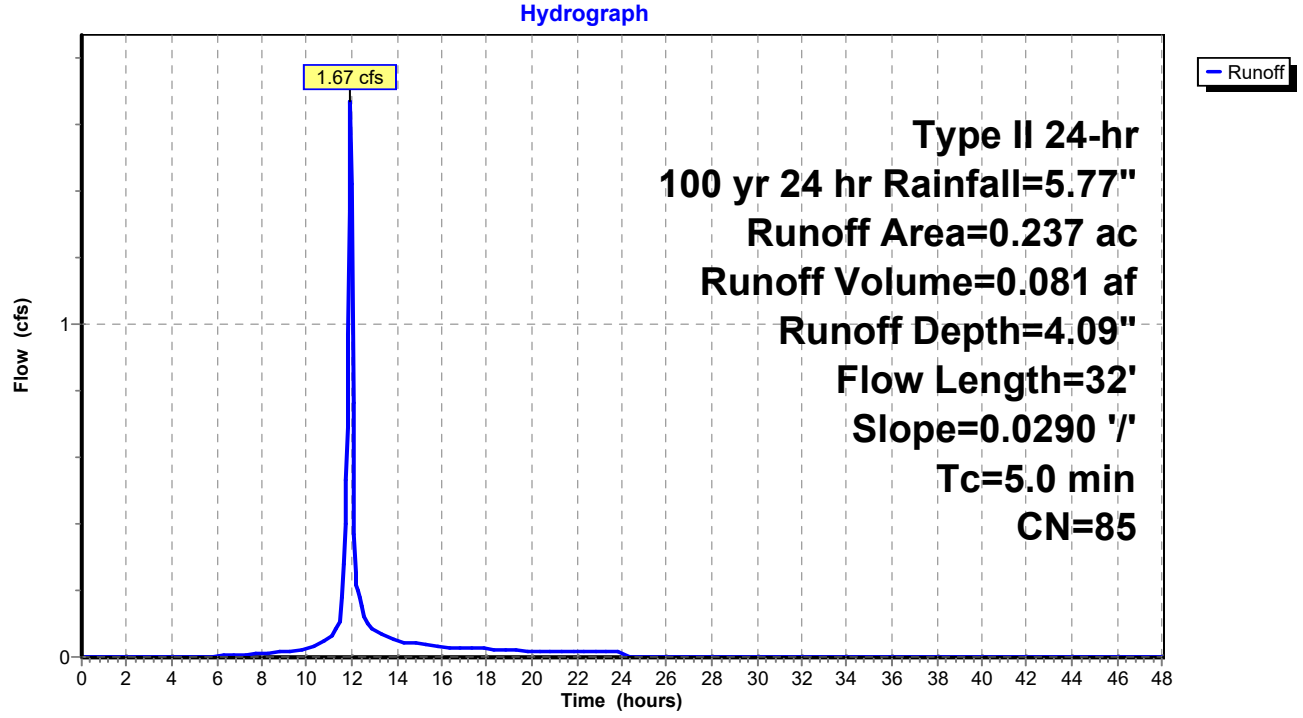
Runoff = 1.67 cfs @ 11.95 hrs, Volume= 0.081 af, Depth= 4.09"
Routed to Reach OSE : Off-Site Drainage (Existing)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 100 yr 24 hr Rainfall=5.77"

Area (ac)	CN	Description
0.237	85	Row crops, straight row, Good, HSG C
0.237		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.9	32	0.0290	0.14		**Sheet Flow,** Cultivated: Residue>20% n= 0.170 P2= 2.90"
3.9	32	Total, Increased to minimum Tc = 5.0 min			

Subcatchment EX3: EX-3



Summary for Subcatchment EX4: EX-4

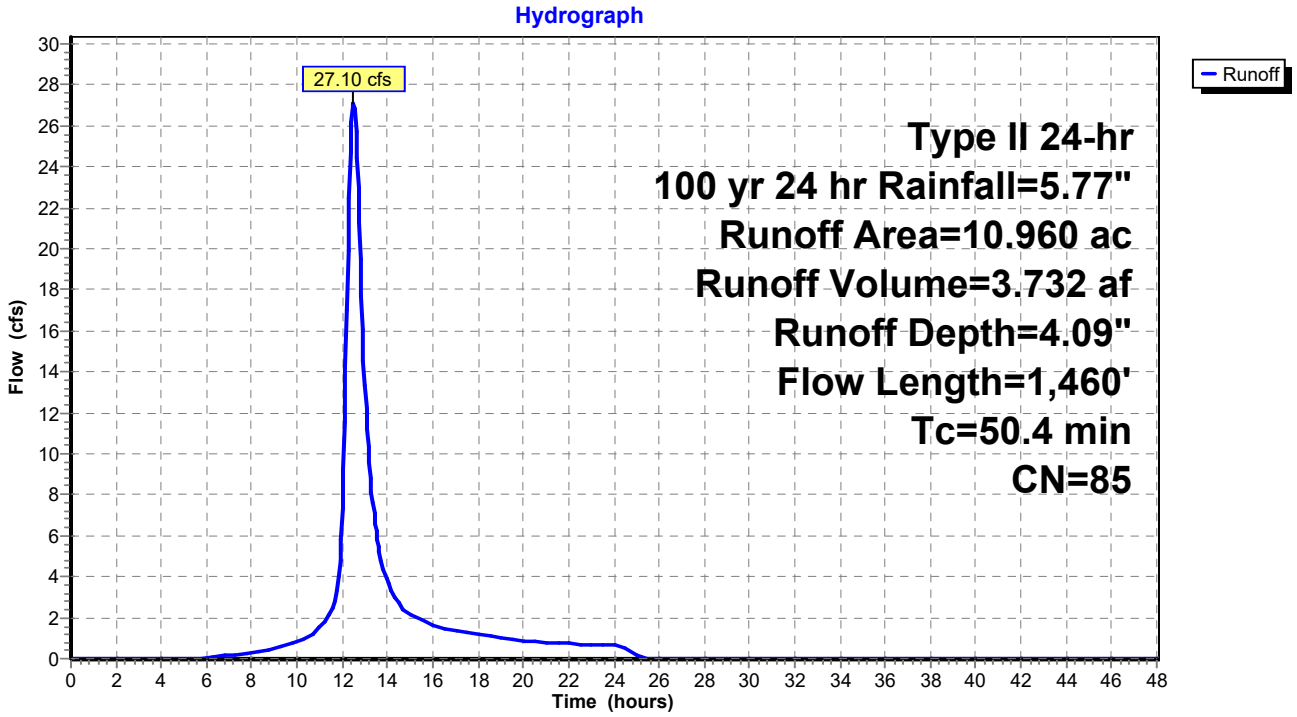
Runoff = 27.10 cfs @ 12.49 hrs, Volume= 3.732 af, Depth= 4.09"
Routed to Reach ECD : Existing Conditions Discharge

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 100 yr 24 hr Rainfall=5.77"

Area (ac)	CN	Description
10.960	85	Row crops, straight row, Good, HSG C
10.960		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
18.4	100	0.0060	0.09		**Sheet Flow,** Cultivated: Residue>20% n= 0.170 P2= 2.90"
19.7	752	0.0050	0.64		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
12.3	608	0.0030	0.82		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
50.4	1,460	Total			

Subcatchment EX4: EX-4



Summary for Subcatchment EX5: EX-5

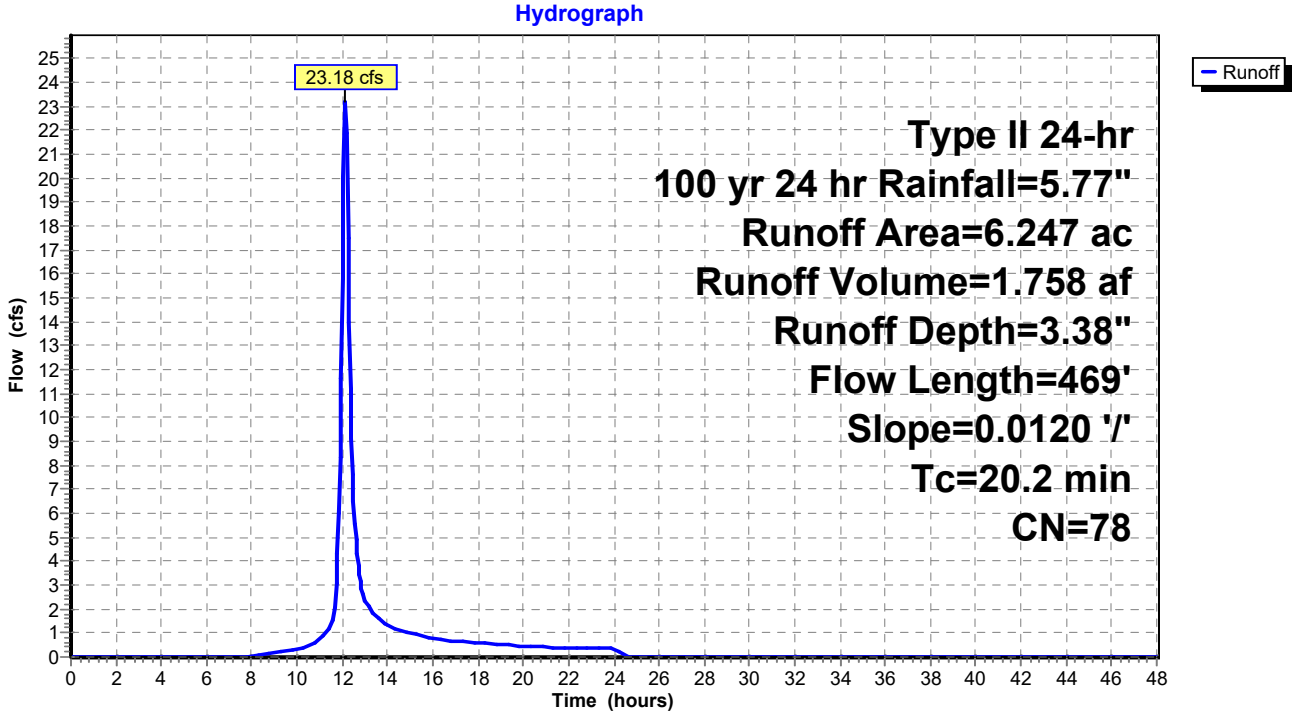
Runoff = 23.18 cfs @ 12.13 hrs, Volume= 1.758 af, Depth= 3.38"
Routed to Reach ECD : Existing Conditions Discharge

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 100 yr 24 hr Rainfall=5.77"

Area (ac)	CN	Description
6.247	78	Row crops, straight row, Good, HSG B
6.247		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.0	100	0.0120	0.12		**Sheet Flow,** Cultivated: Residue>20% n= 0.170 P2= 2.90"
6.2	369	0.0120	0.99		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
20.2	469	Total			

Subcatchment EX5: EX-5



Summary for Subcatchment EX6: West Drainage (Existing)

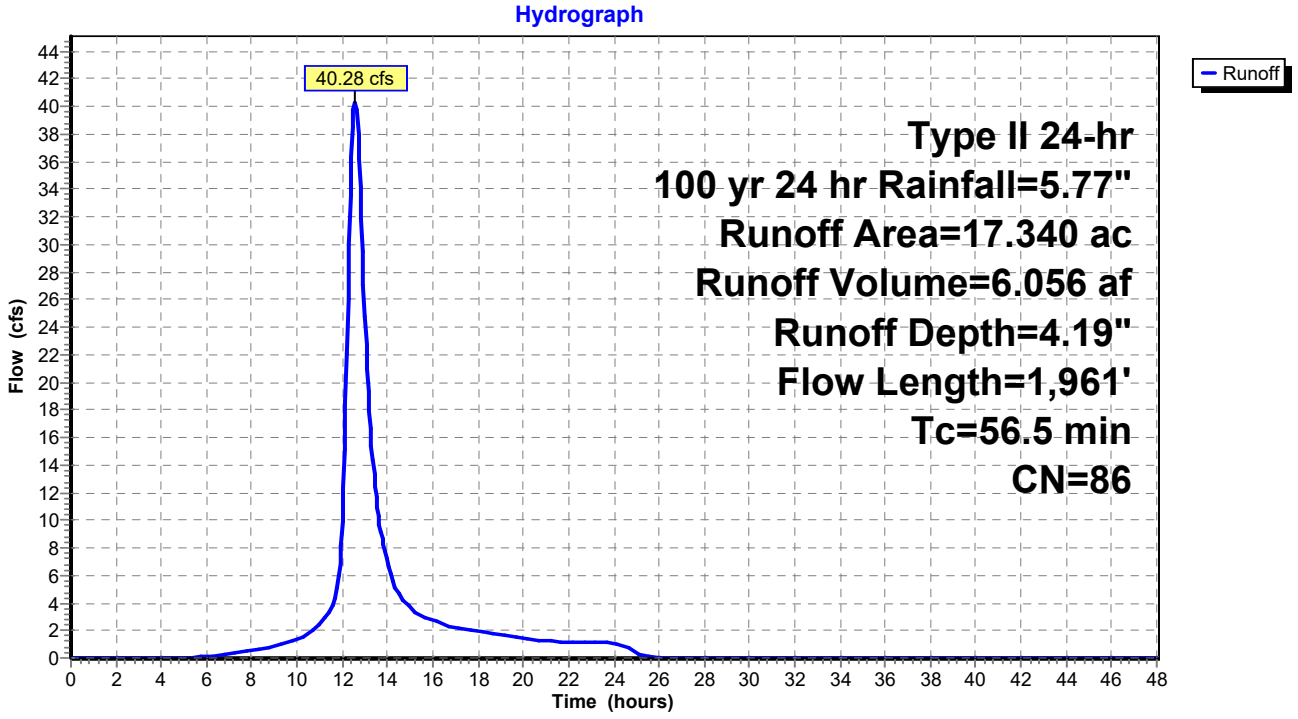
Runoff = 40.28 cfs @ 12.57 hrs, Volume= 6.056 af, Depth= 4.19"
Routed to Reach OSE : Off-Site Drainage (Existing)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 100 yr 24 hr Rainfall=5.77"

Area (ac)	CN	Description
16.235	85	Row crops, straight row, Good, HSG C
1.105	98	Paved parking, HSG C
17.340	86	Weighted Average
16.235		93.63% Pervious Area
1.105		6.37% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.4	100	0.0250	0.16		**Sheet Flow,** Cultivated: Residue>20% n= 0.170 P2= 2.90"
27.9	1,167	0.0060	0.70		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
18.2	694	0.0050	0.64		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
56.5	1,961	Total			

Subcatchment EX6: West Drainage (Existing)

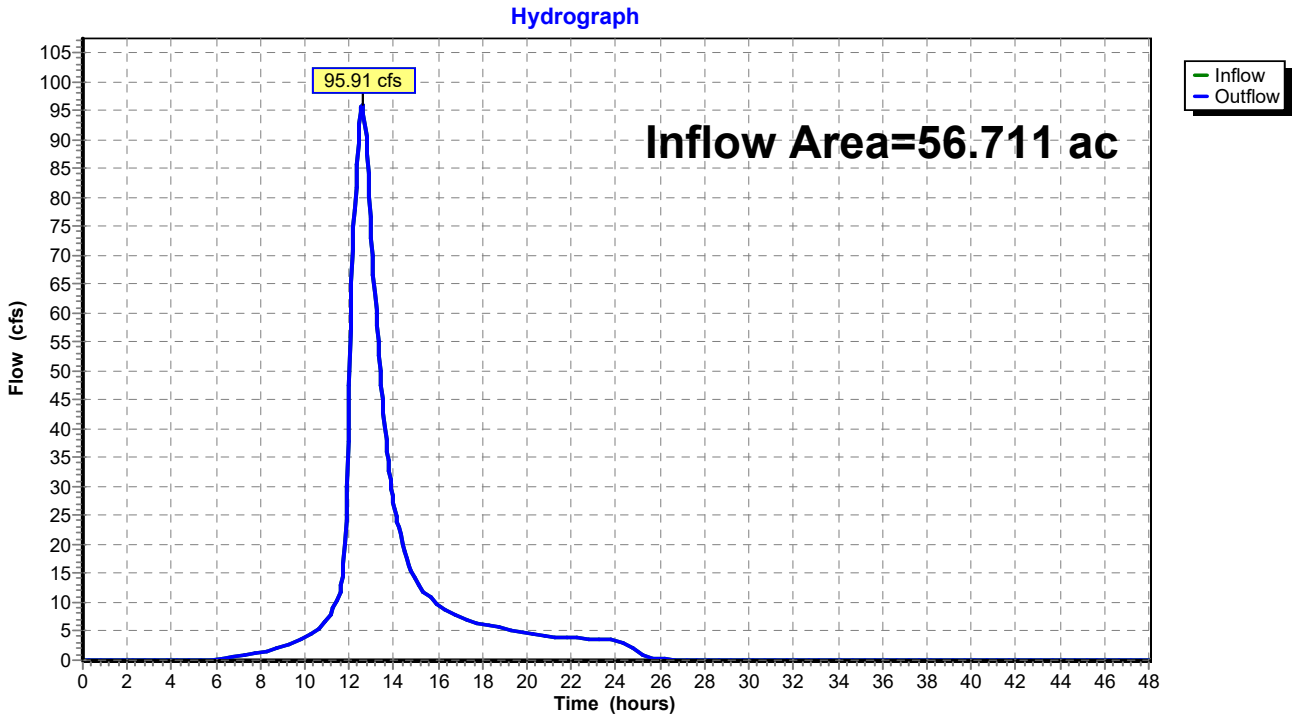


Summary for Reach ECD: Existing Conditions Discharge

Inflow Area = 56.711 ac, 2.69% Impervious, Inflow Depth = 4.04" for 100 yr 24 hr event
Inflow = 95.91 cfs @ 12.58 hrs, Volume= 19.093 af
Outflow = 95.91 cfs @ 12.58 hrs, Volume= 19.093 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach ECD: Existing Conditions Discharge

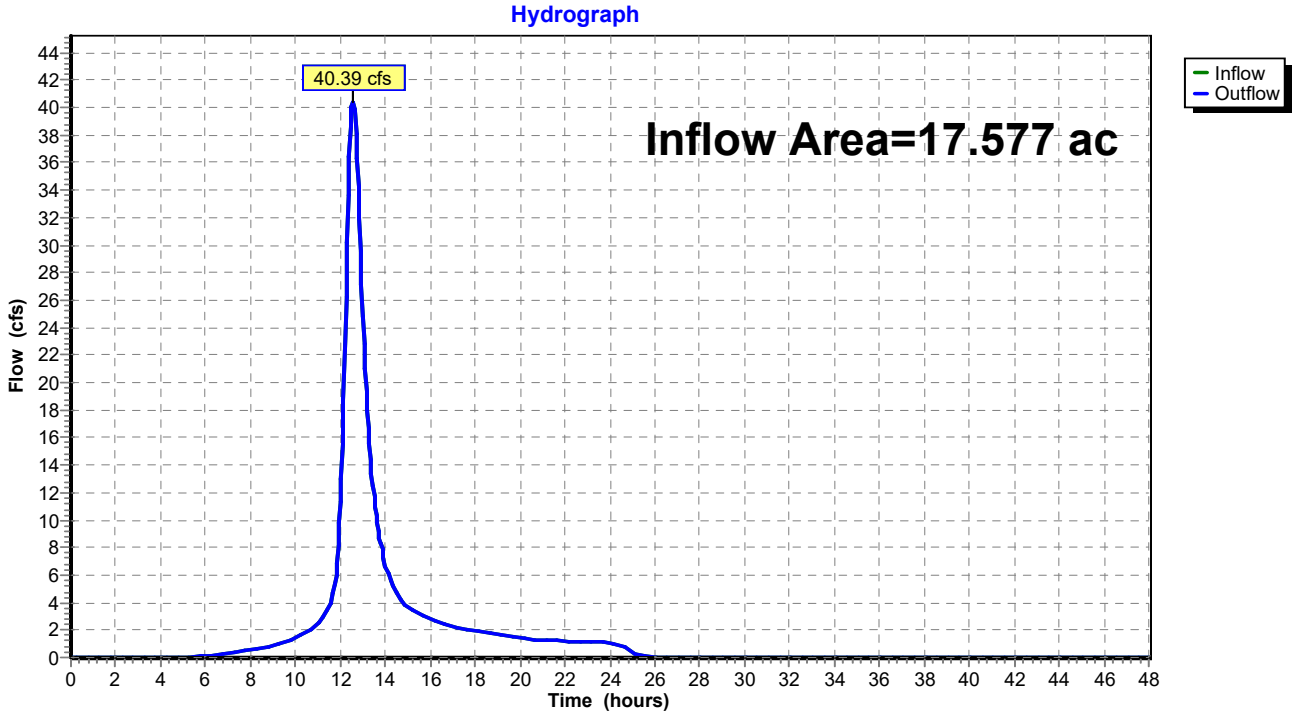


Summary for Reach OSE: Off-Site Drainage (Existing)

Inflow Area = 17.577 ac, 6.29% Impervious, Inflow Depth = 4.19" for 100 yr 24 hr event
Inflow = 40.39 cfs @ 12.57 hrs, Volume= 6.137 af
Outflow = 40.39 cfs @ 12.57 hrs, Volume= 6.137 af, Atten= 0%, Lag= 0.0 min
Routed to Reach ECD : Existing Conditions Discharge

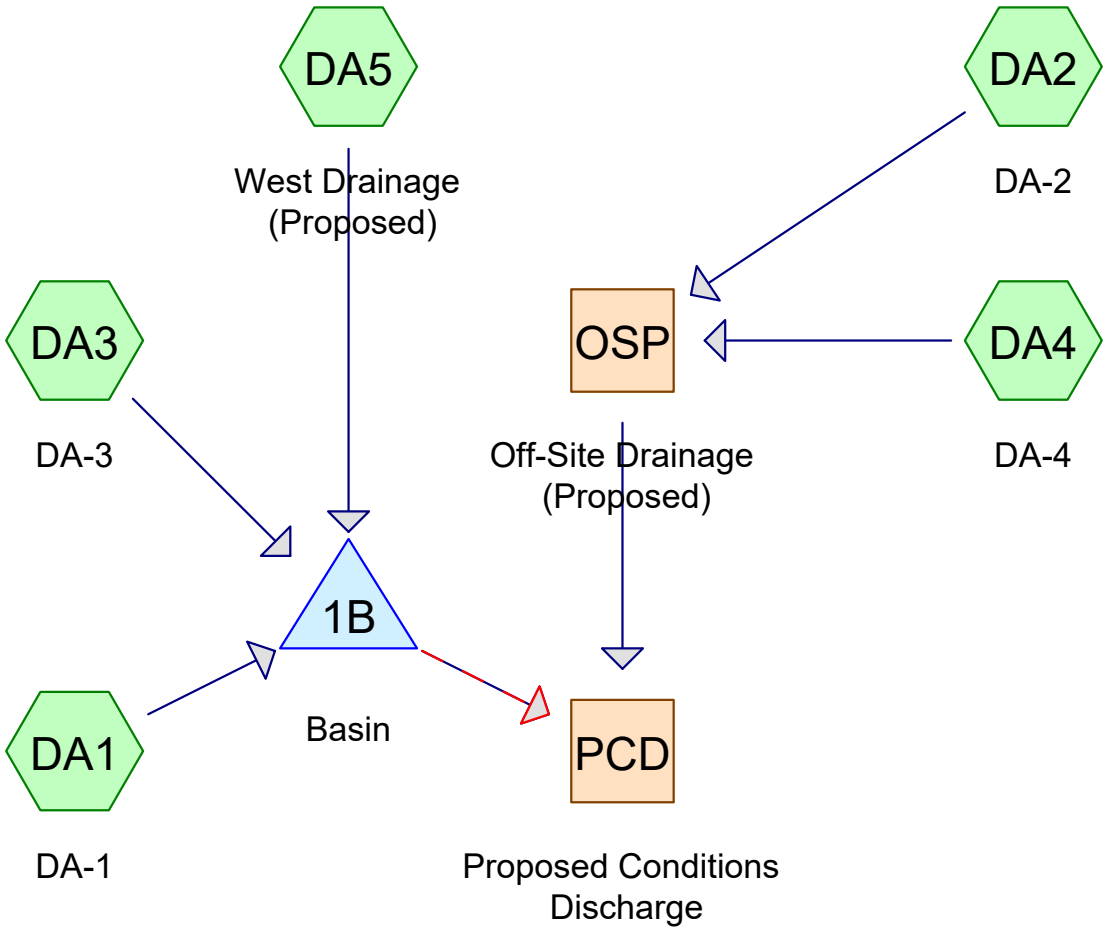
Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach OSE: Off-Site Drainage (Existing)



Appendix E: Proposed HydroCAD Report

Proposed Conditions



Subcat Reach Pond Link

Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2 yr 24 hr	Type II 24-hr		Default	24.00	1	2.55	2
2	5 yr 24 hr	Type II 24-hr		Default	24.00	1	3.16	2
3	10 yr 24 hr	Type II 24-hr		Default	24.00	1	3.70	2
4	100 yr 24 hr	Type II 24-hr		Default	24.00	1	5.77	2

Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
5.520	98	Paved parking, HSG C (DA1, DA2, DA3, DA5)
51.191	85	Row crops, straight row, Good, HSG C (DA1, DA2, DA3, DA4, DA5)
56.711	**86**	**TOTAL AREA**

Soil Listing (selected nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
56.711	HSG C	DA1, DA2, DA3, DA4, DA5
0.000	HSG D	
0.000	Other	
56.711		**TOTAL AREA**

Summary for Subcatchment DA1: DA-1

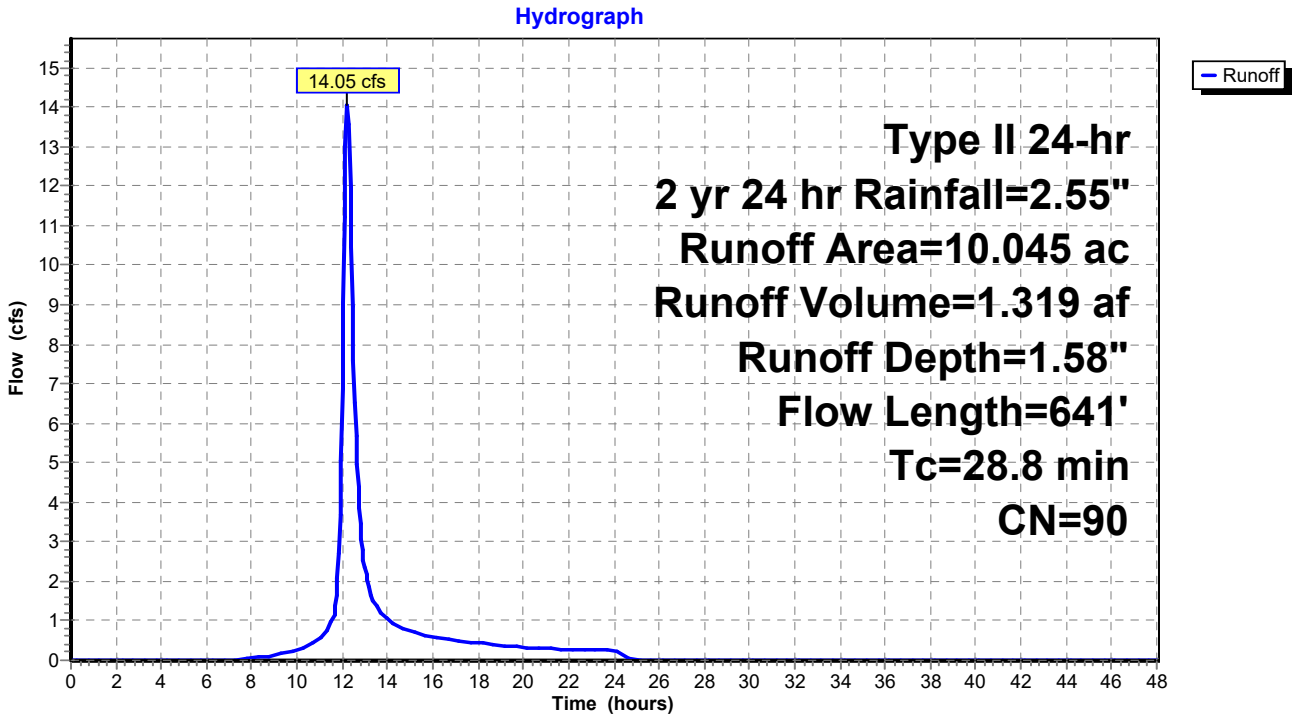
Runoff = 14.05 cfs @ 12.23 hrs, Volume= 1.319 af, Depth= 1.58"
Routed to Pond 1B : Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 2 yr 24 hr Rainfall=2.55"

Area (ac)	CN	Description
3.918	98	Paved parking, HSG C
6.127	85	Row crops, straight row, Good, HSG C
10.045	90	Weighted Average
6.127		61.00% Pervious Area
3.918		39.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
22.8	100	0.0070	0.07		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.90"
6.0	541	0.0100	1.50		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
28.8	641	Total			

Subcatchment DA1: DA-1



Summary for Subcatchment DA2: DA-2

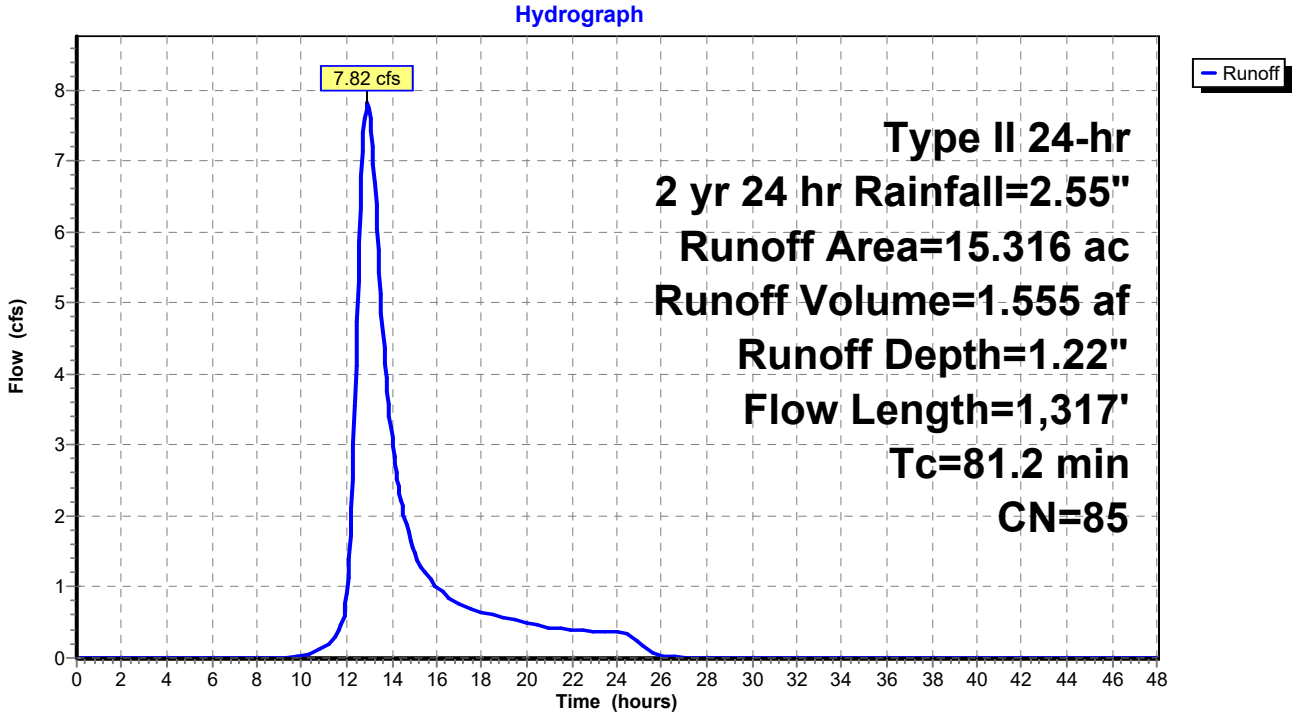
Runoff = 7.82 cfs @ 12.91 hrs, Volume= 1.555 af, Depth= 1.22"
Routed to Reach OSP : Off-Site Drainage (Proposed)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 2 yr 24 hr Rainfall=2.55"

Area (ac)	CN	Description
15.237	85	Row crops, straight row, Good, HSG C
0.079	98	Paved parking, HSG C
15.316	85	Weighted Average
15.237		99.48% Pervious Area
0.079		0.52% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
34.1	100	0.0010	0.05		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.90"
18.6	529	0.0010	0.47		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
28.5	688	0.0020	0.40		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
81.2	1,317	Total			

Subcatchment DA2: DA-2



Summary for Subcatchment DA3: DA-3

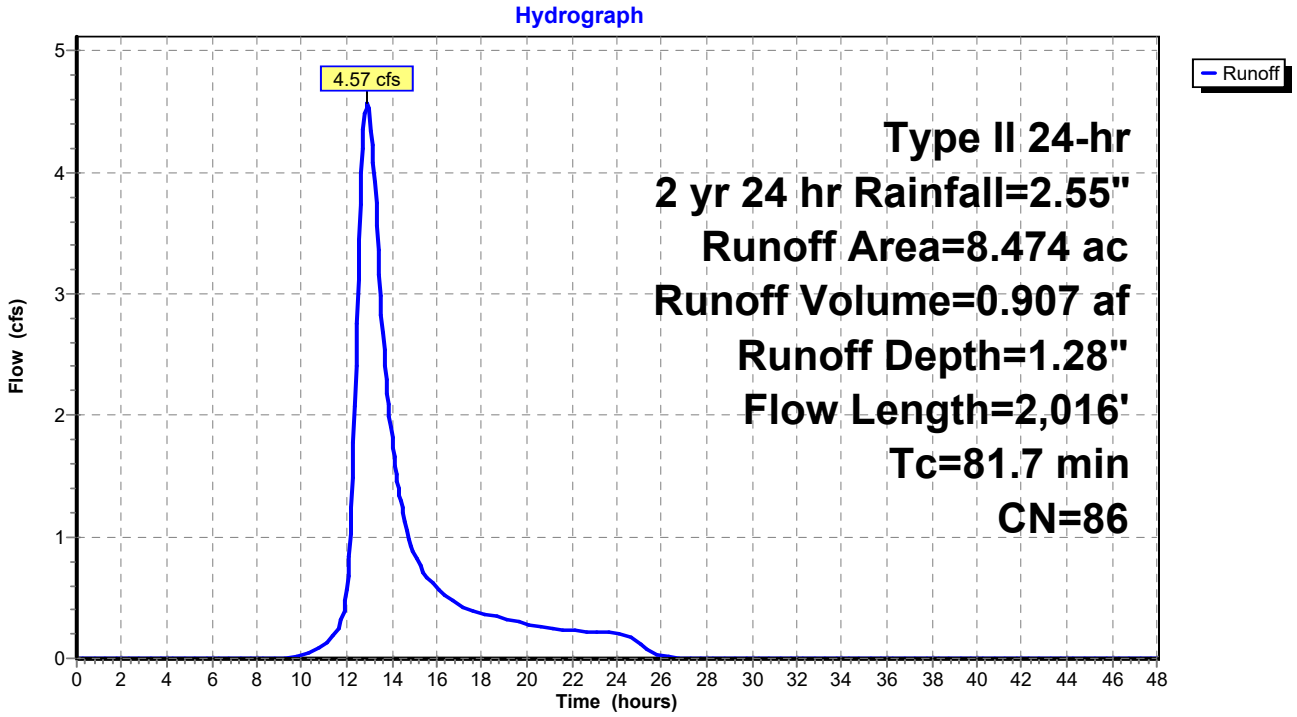
Runoff = 4.57 cfs @ 12.93 hrs, Volume= 0.907 af, Depth= 1.28"
Routed to Pond 1B : Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 2 yr 24 hr Rainfall=2.55"

Area (ac)	CN	Description
8.056	85	Row crops, straight row, Good, HSG C
0.418	98	Paved parking, HSG C
8.474	86	Weighted Average
8.056		95.07% Pervious Area
0.418		4.93% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
34.1	100	0.0010	0.05		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.90"
7.9	452	0.0040	0.95		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
3.2	140	0.0110	0.73		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
17.2	228	0.0010	0.22		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
19.3	1,096	0.0040	0.95		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
81.7	2,016	Total			

Subcatchment DA3: DA-3



Summary for Subcatchment DA4: DA-4

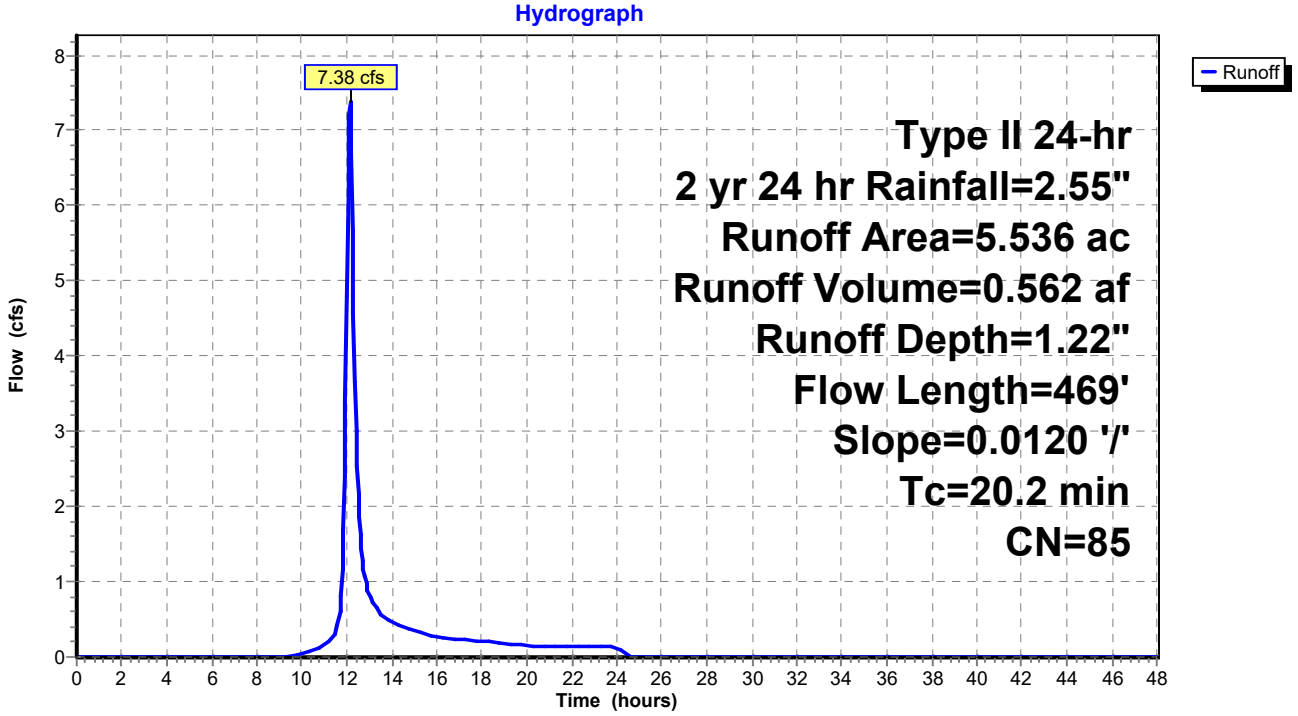
Runoff = 7.38 cfs @ 12.13 hrs, Volume= 0.562 af, Depth= 1.22"
Routed to Reach OSP : Off-Site Drainage (Proposed)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 2 yr 24 hr Rainfall=2.55"

Area (ac)	CN	Description
5.536	85	Row crops, straight row, Good, HSG C
5.536		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.0	100	0.0120	0.12		**Sheet Flow,** Cultivated: Residue>20% n= 0.170 P2= 2.90"
6.2	369	0.0120	0.99		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
20.2	469	Total			

Subcatchment DA4: DA-4



Summary for Subcatchment DA5: West Drainage (Proposed)

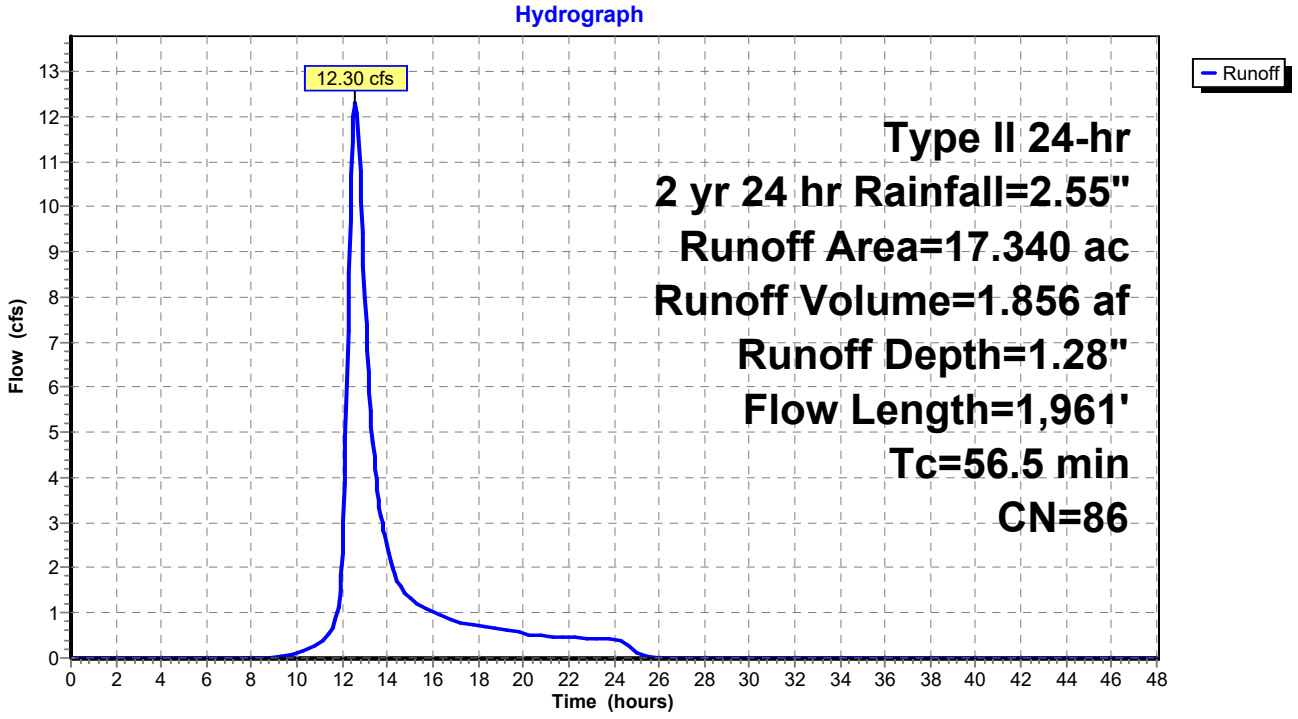
Runoff = 12.30 cfs @ 12.59 hrs, Volume= 1.856 af, Depth= 1.28"
Routed to Pond 1B : Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 2 yr 24 hr Rainfall=2.55"

Area (ac)	CN	Description
16.235	85	Row crops, straight row, Good, HSG C
1.105	98	Paved parking, HSG C
17.340	86	Weighted Average
16.235		93.63% Pervious Area
1.105		6.37% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.4	100	0.0250	0.16		**Sheet Flow,** Cultivated: Residue>20% n= 0.170 P2= 2.90"
27.9	1,167	0.0060	0.70		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
18.2	694	0.0050	0.64		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
56.5	1,961	Total			

Subcatchment DA5: West Drainage (Proposed)

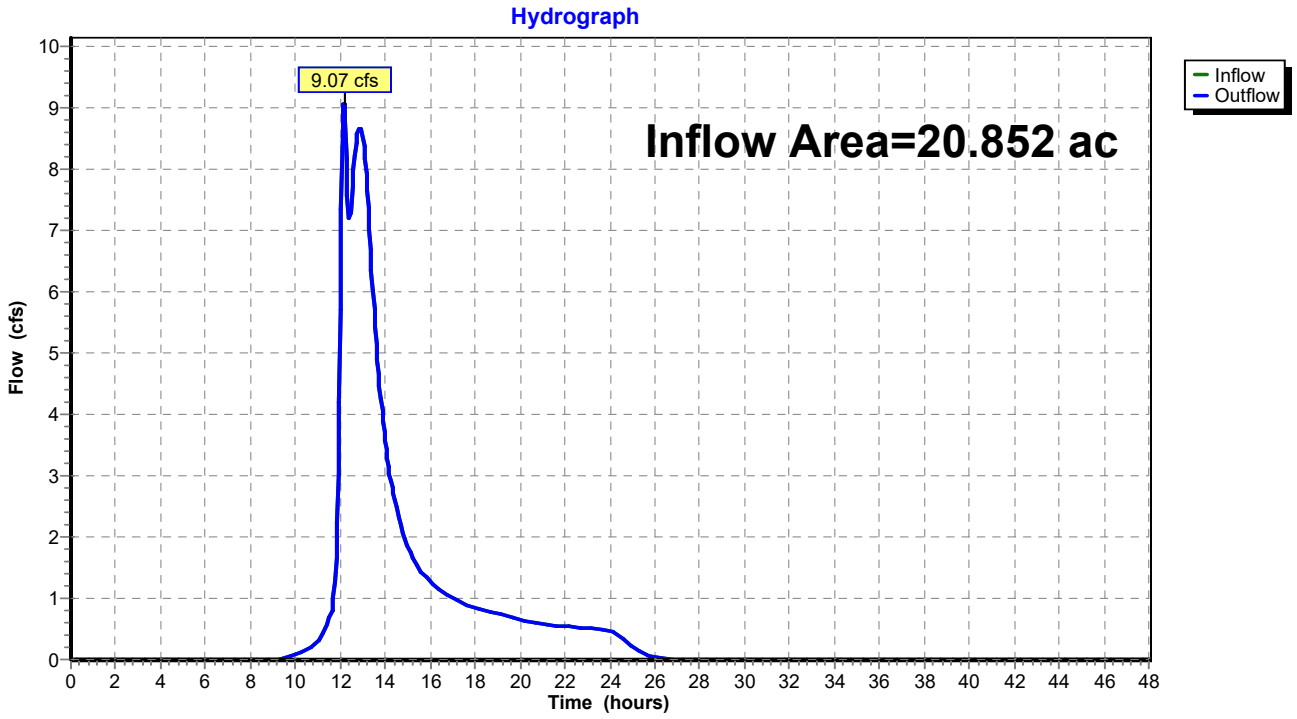


Summary for Reach OSP: Off-Site Drainage (Proposed)

Inflow Area = 20.852 ac, 0.38% Impervious, Inflow Depth = 1.22" for 2 yr 24 hr event
Inflow = 9.07 cfs @ 12.16 hrs, Volume= 2.117 af
Outflow = 9.07 cfs @ 12.16 hrs, Volume= 2.117 af, Atten= 0%, Lag= 0.0 min
Routed to Reach PCD : Proposed Conditions Discharge

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach OSP: Off-Site Drainage (Proposed)

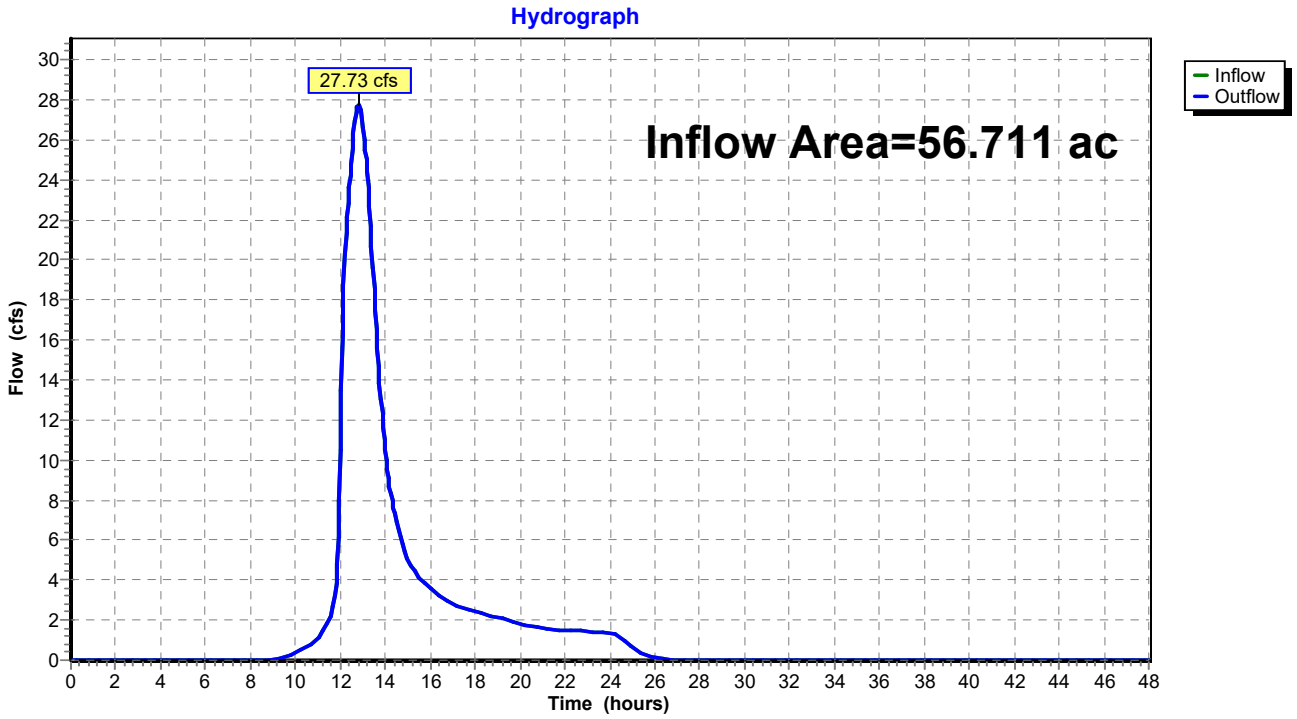


Summary for Reach PCD: Proposed Conditions Discharge

Inflow Area = 56.711 ac, 9.73% Impervious, Inflow Depth = 1.31" for 2 yr 24 hr event
Inflow = 27.73 cfs @ 12.81 hrs, Volume= 6.189 af
Outflow = 27.73 cfs @ 12.81 hrs, Volume= 6.189 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach PCD: Proposed Conditions Discharge



Summary for Pond 1B: Basin

Inflow Area = 35.859 ac, 15.17% Impervious, Inflow Depth = 1.37" for 2 yr 24 hr event
Inflow = 23.75 cfs @ 12.35 hrs, Volume= 4.082 af
Outflow = 19.07 cfs @ 12.78 hrs, Volume= 4.072 af, Atten= 20%, Lag= 25.7 min
Primary = 19.07 cfs @ 12.78 hrs, Volume= 4.072 af
Routed to Reach PCD : Proposed Conditions Discharge
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Reach PCD : Proposed Conditions Discharge

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 1,119.33' @ 12.78 hrs Surf.Area= 14,463 sf Storage= 21,487 cf

Plug-Flow detention time= 20.3 min calculated for 4.072 af (100% of inflow)
Center-of-Mass det. time= 18.2 min (886.1 - 867.9)

Volume	Invert	Avail.Storage	Storage Description
#1	1,116.00'	255,273 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

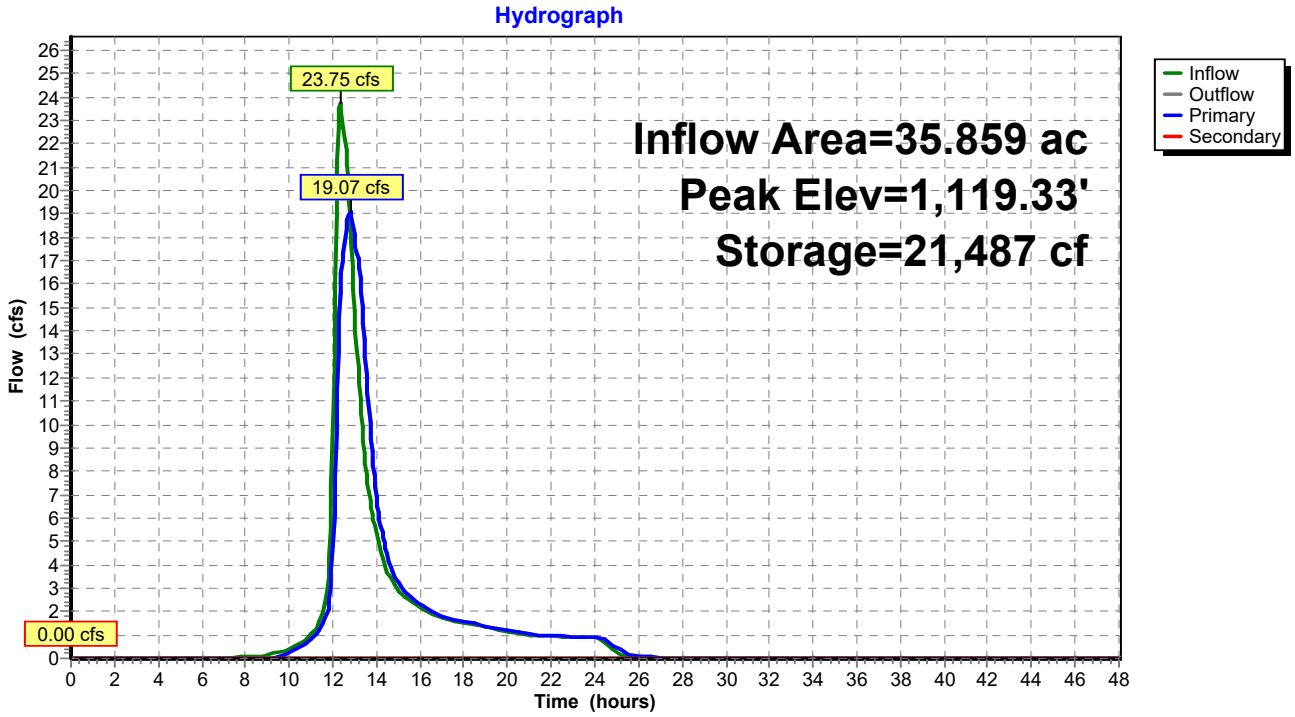
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,116.00	1	0	0
1,117.00	3,751	1,876	1,876
1,118.00	7,233	5,492	7,368
1,119.00	12,253	9,743	17,111
1,120.00	19,000	15,627	32,738
1,121.00	27,843	23,422	56,159
1,122.00	38,650	33,247	89,406
1,123.00	49,663	44,157	133,562
1,124.00	60,845	55,254	188,816
1,125.00	72,068	66,457	255,273

Device	Routing	Invert	Outlet Devices
#1	Primary	1,116.48'	**24.0" Round Culvert** L= 33.0' Ke= 0.500 Inlet / Outlet Invert= 1,116.48' / 1,116.33' S= 0.0045 '/' Cc= 0.900 n= 0.010 PVC, smooth interior, Flow Area= 3.14 sf
#2	Primary	1,120.00'	**30.0" Round Culvert** L= 16.0' Ke= 0.500 Inlet / Outlet Invert= 1,120.00' / 1,119.52' S= 0.0300 '/' Cc= 0.900 n= 0.010 PVC, smooth interior, Flow Area= 4.91 sf
#3	Secondary	1,124.00'	**4.0' long + 4.0 '/' SideZ x 16.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=19.06 cfs @ 12.78 hrs HW=1,119.33' TW=0.00' (Dynamic Tailwater)
1=Culvert (Barrel Controls 19.06 cfs @ 6.07 fps)
2=Culvert (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=1,116.00' TW=0.00' (Dynamic Tailwater)
3=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Pond 1B: Basin



Summary for Subcatchment DA1: DA-1

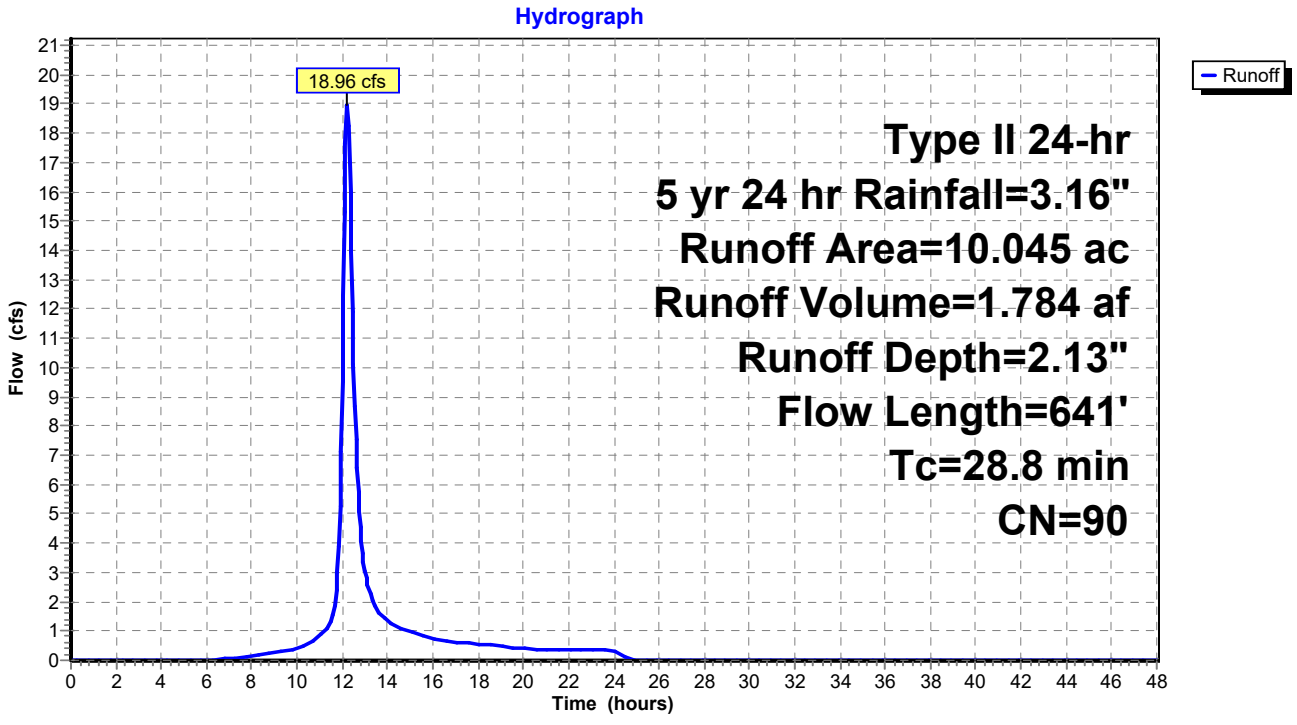
Runoff = 18.96 cfs @ 12.22 hrs, Volume= 1.784 af, Depth= 2.13"
Routed to Pond 1B : Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 5 yr 24 hr Rainfall=3.16"

Area (ac)	CN	Description
3.918	98	Paved parking, HSG C
6.127	85	Row crops, straight row, Good, HSG C
10.045	90	Weighted Average
6.127		61.00% Pervious Area
3.918		39.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
22.8	100	0.0070	0.07		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.90"
6.0	541	0.0100	1.50		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
28.8	641	Total			

Subcatchment DA1: DA-1



Summary for Subcatchment DA2: DA-2

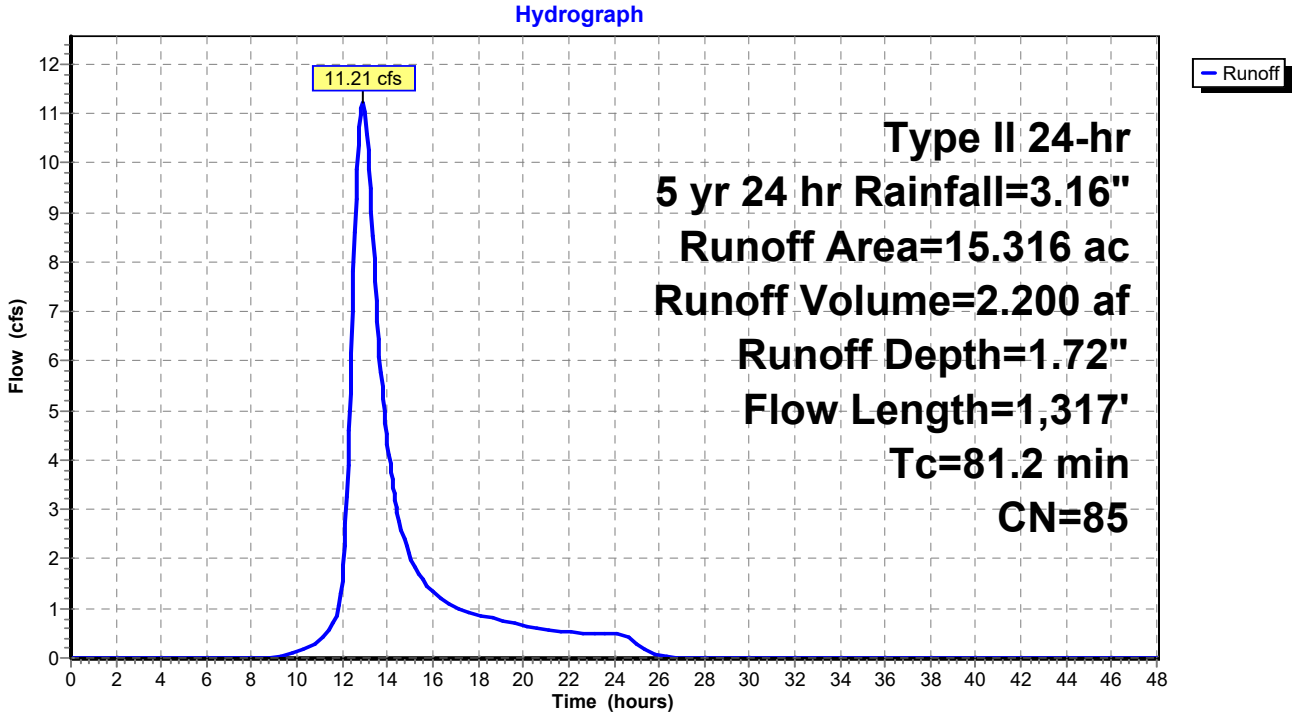
Runoff = 11.21 cfs @ 12.90 hrs, Volume= 2.200 af, Depth= 1.72"
Routed to Reach OSP : Off-Site Drainage (Proposed)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 5 yr 24 hr Rainfall=3.16"

Area (ac)	CN	Description
15.237	85	Row crops, straight row, Good, HSG C
0.079	98	Paved parking, HSG C
15.316	85	Weighted Average
15.237		99.48% Pervious Area
0.079		0.52% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
34.1	100	0.0010	0.05		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.90"
18.6	529	0.0010	0.47		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
28.5	688	0.0020	0.40		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
81.2	1,317	Total			

Subcatchment DA2: DA-2



Summary for Subcatchment DA3: DA-3

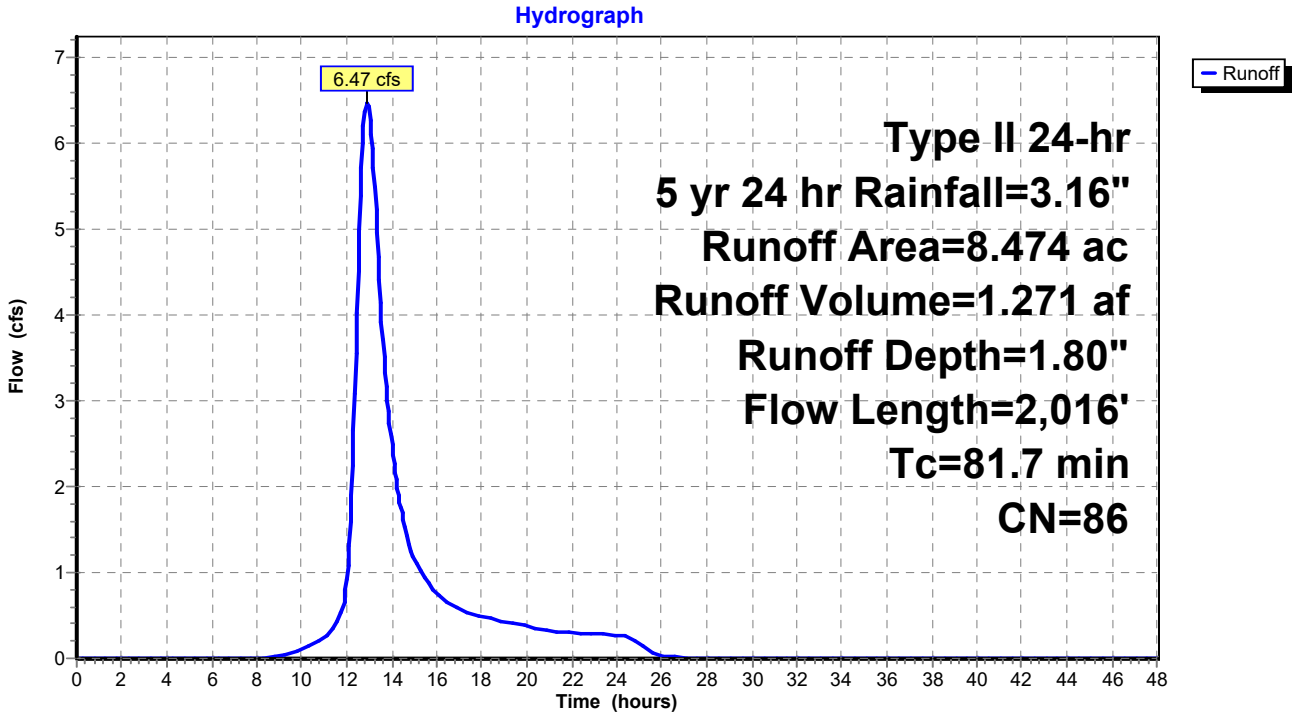
Runoff = 6.47 cfs @ 12.91 hrs, Volume= 1.271 af, Depth= 1.80"
Routed to Pond 1B : Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 5 yr 24 hr Rainfall=3.16"

Area (ac)	CN	Description
8.056	85	Row crops, straight row, Good, HSG C
0.418	98	Paved parking, HSG C
8.474	86	Weighted Average
8.056		95.07% Pervious Area
0.418		4.93% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
34.1	100	0.0010	0.05		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.90"
7.9	452	0.0040	0.95		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
3.2	140	0.0110	0.73		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
17.2	228	0.0010	0.22		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
19.3	1,096	0.0040	0.95		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
81.7	2,016	Total			

Subcatchment DA3: DA-3



Summary for Subcatchment DA4: DA-4

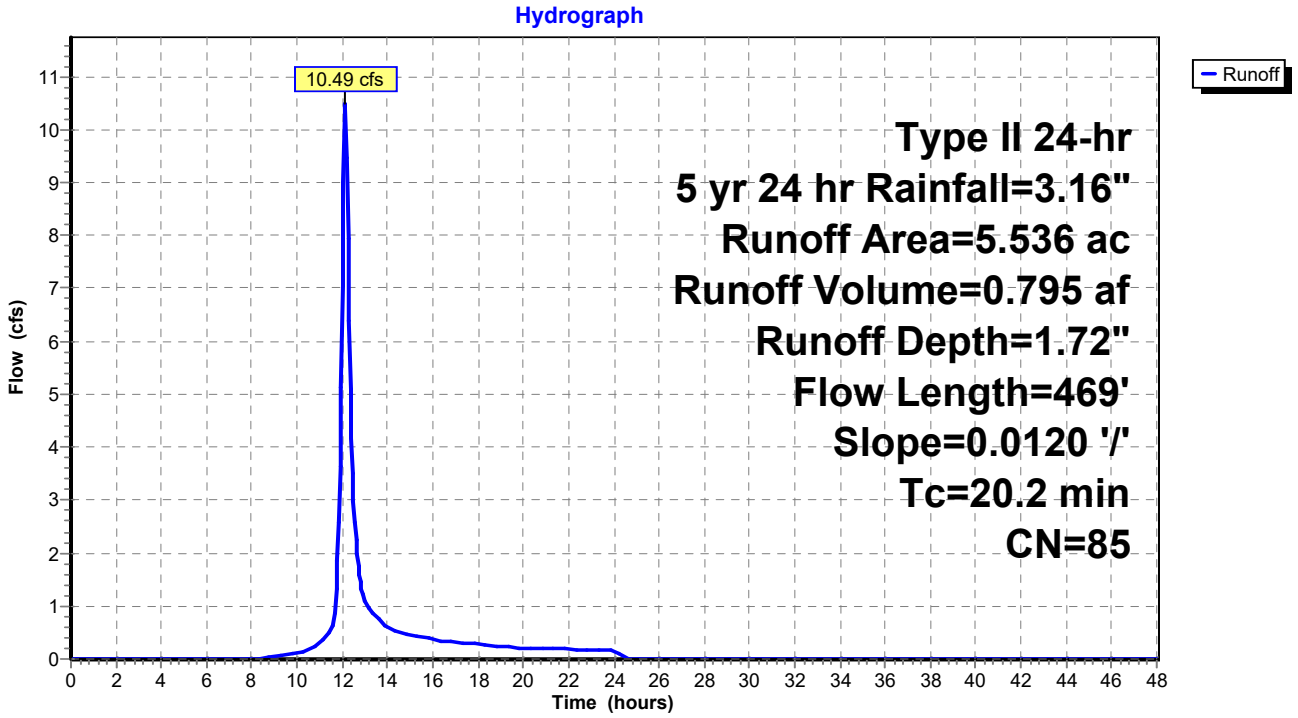
Runoff = 10.49 cfs @ 12.13 hrs, Volume= 0.795 af, Depth= 1.72"
Routed to Reach OSP : Off-Site Drainage (Proposed)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 5 yr 24 hr Rainfall=3.16"

Area (ac)	CN	Description
5.536	85	Row crops, straight row, Good, HSG C
5.536		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.0	100	0.0120	0.12		**Sheet Flow,** Cultivated: Residue>20% n= 0.170 P2= 2.90"
6.2	369	0.0120	0.99		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
20.2	469	Total			

Subcatchment DA4: DA-4



Summary for Subcatchment DA5: West Drainage (Proposed)

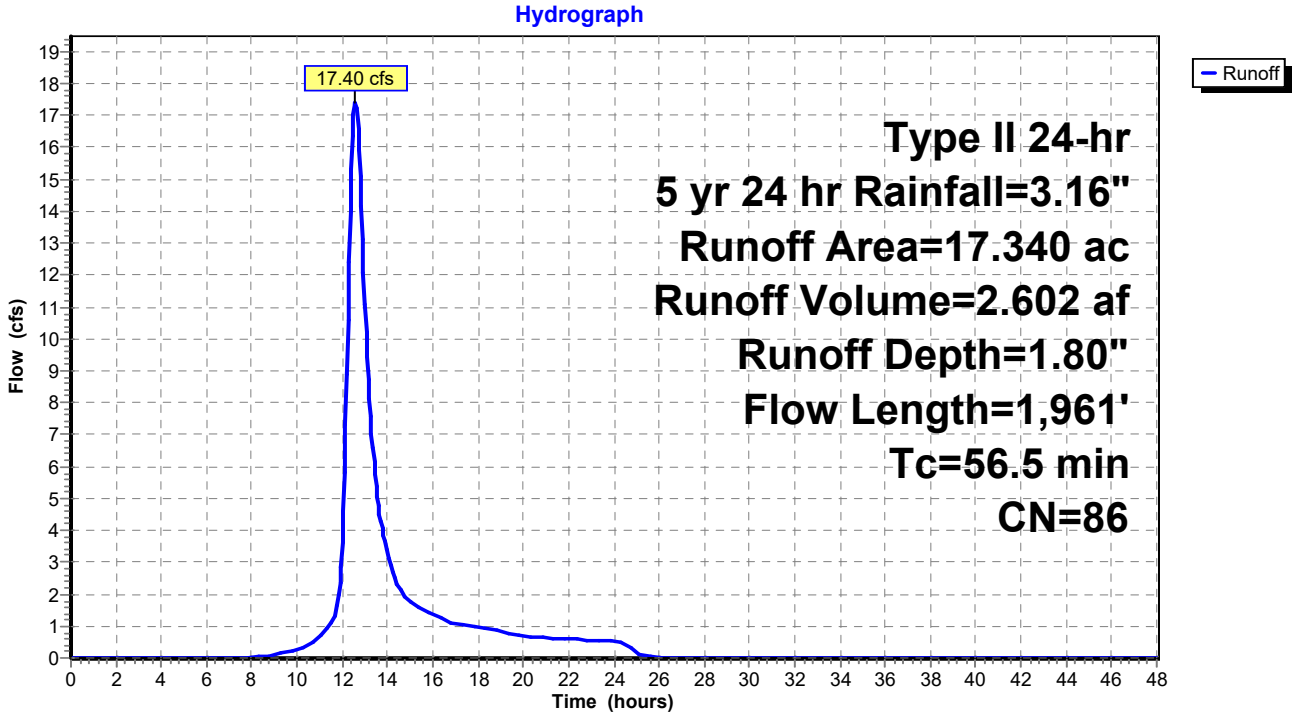
Runoff = 17.40 cfs @ 12.58 hrs, Volume= 2.602 af, Depth= 1.80"
Routed to Pond 1B : Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 5 yr 24 hr Rainfall=3.16"

Area (ac)	CN	Description
16.235	85	Row crops, straight row, Good, HSG C
1.105	98	Paved parking, HSG C
17.340	86	Weighted Average
16.235		93.63% Pervious Area
1.105		6.37% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.4	100	0.0250	0.16		**Sheet Flow,** Cultivated: Residue>20% n= 0.170 P2= 2.90"
27.9	1,167	0.0060	0.70		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
18.2	694	0.0050	0.64		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
56.5	1,961	Total			

Subcatchment DA5: West Drainage (Proposed)

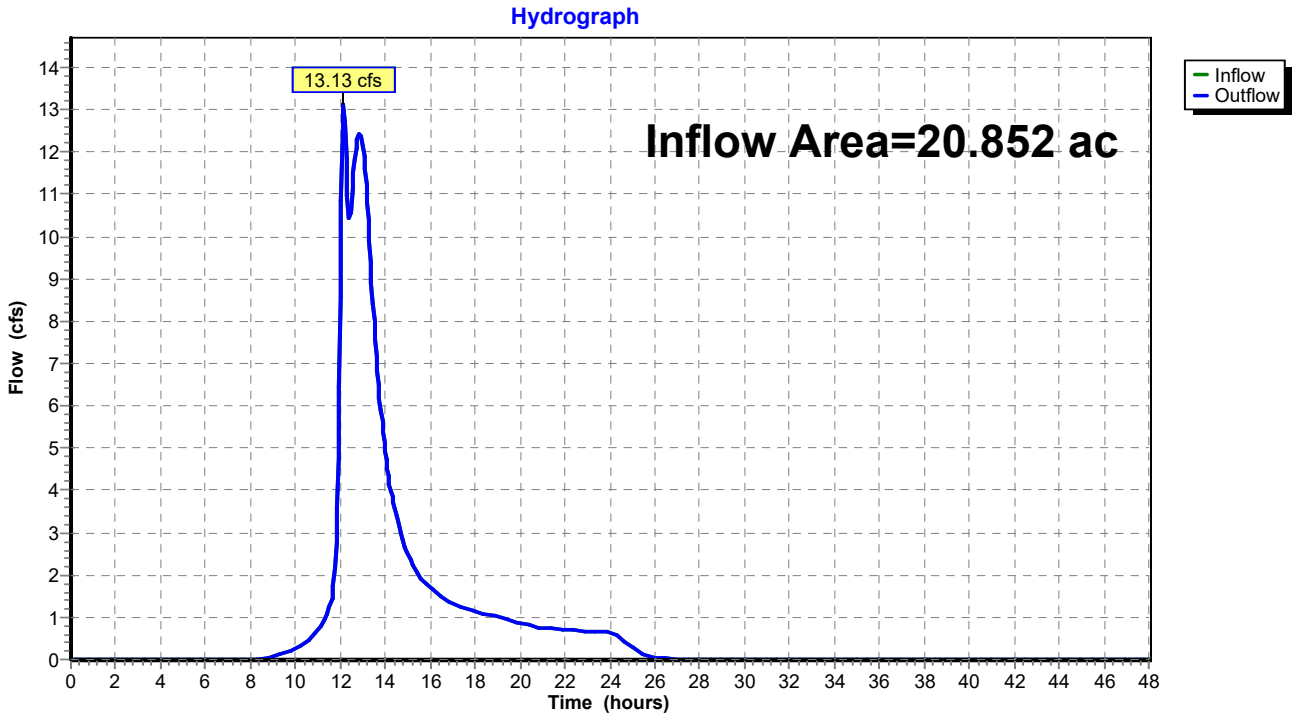


Summary for Reach OSP: Off-Site Drainage (Proposed)

Inflow Area = 20.852 ac, 0.38% Impervious, Inflow Depth = 1.72" for 5 yr 24 hr event
Inflow = 13.13 cfs @ 12.15 hrs, Volume= 2.995 af
Outflow = 13.13 cfs @ 12.15 hrs, Volume= 2.995 af, Atten= 0%, Lag= 0.0 min
Routed to Reach PCD : Proposed Conditions Discharge

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach OSP: Off-Site Drainage (Proposed)

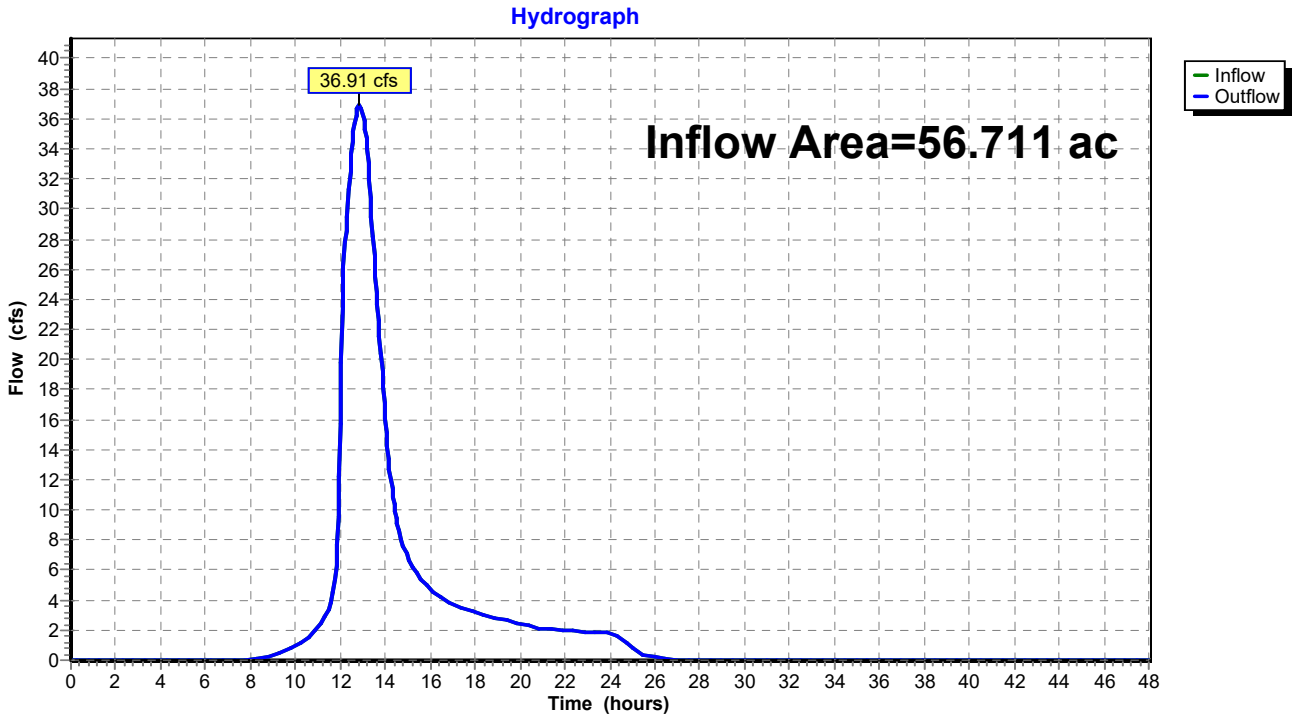


Summary for Reach PCD: Proposed Conditions Discharge

Inflow Area = 56.711 ac, 9.73% Impervious, Inflow Depth = 1.83" for 5 yr 24 hr event
Inflow = 36.91 cfs @ 12.87 hrs, Volume= 8.642 af
Outflow = 36.91 cfs @ 12.87 hrs, Volume= 8.642 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach PCD: Proposed Conditions Discharge



Summary for Pond 1B: Basin

Inflow Area = 35.859 ac, 15.17% Impervious, Inflow Depth = 1.89" for 5 yr 24 hr event
Inflow = 33.05 cfs @ 12.35 hrs, Volume= 5.657 af
Outflow = 24.45 cfs @ 12.86 hrs, Volume= 5.647 af, Atten= 26%, Lag= 30.2 min
Primary = 24.45 cfs @ 12.86 hrs, Volume= 5.647 af
Routed to Reach PCD : Proposed Conditions Discharge
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Reach PCD : Proposed Conditions Discharge

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 1,120.08' @ 12.86 hrs Surf.Area= 19,728 sf Storage= 34,332 cf

Plug-Flow detention time= 20.3 min calculated for 5.641 af (100% of inflow)
Center-of-Mass det. time= 19.3 min (878.3 - 859.0)

Volume	Invert	Avail.Storage	Storage Description
#1	1,116.00'	255,273 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

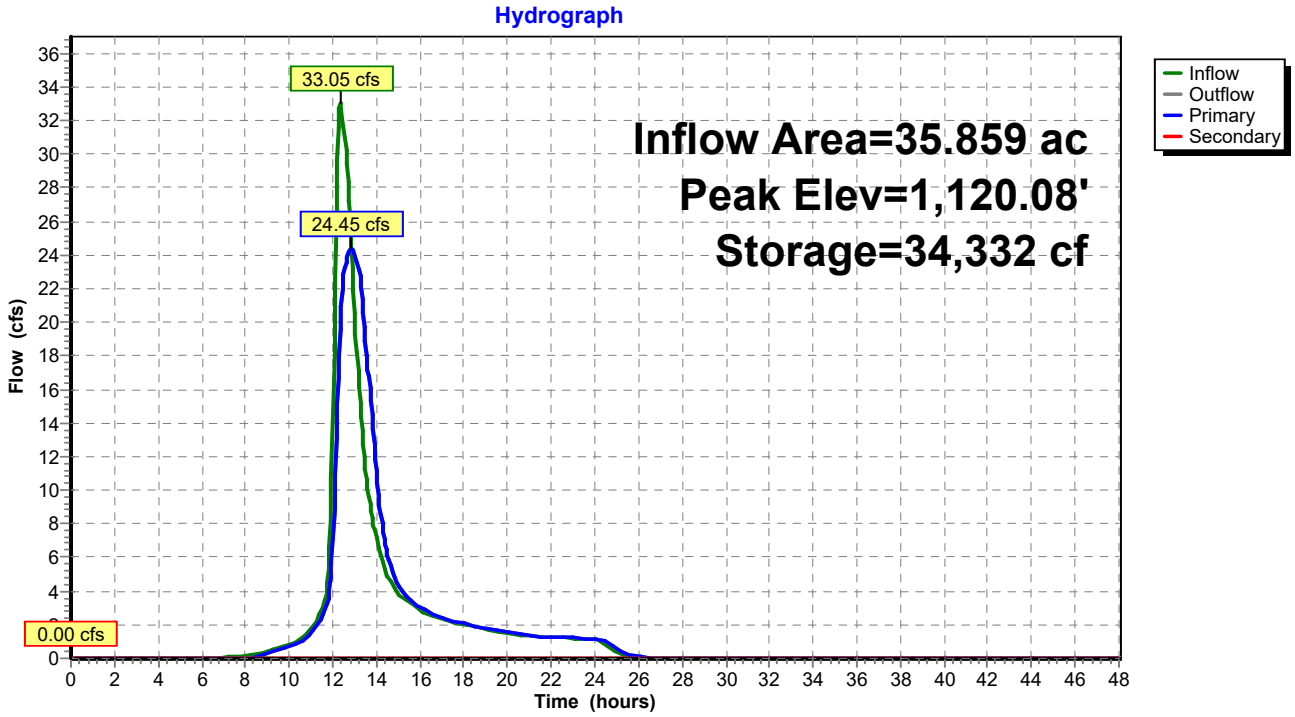
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,116.00	1	0	0
1,117.00	3,751	1,876	1,876
1,118.00	7,233	5,492	7,368
1,119.00	12,253	9,743	17,111
1,120.00	19,000	15,627	32,738
1,121.00	27,843	23,422	56,159
1,122.00	38,650	33,247	89,406
1,123.00	49,663	44,157	133,562
1,124.00	60,845	55,254	188,816
1,125.00	72,068	66,457	255,273

Device	Routing	Invert	Outlet Devices
#1	Primary	1,116.48'	**24.0" Round Culvert** L= 33.0' Ke= 0.500 Inlet / Outlet Invert= 1,116.48' / 1,116.33' S= 0.0045 '/' Cc= 0.900 n= 0.010 PVC, smooth interior, Flow Area= 3.14 sf
#2	Primary	1,120.00'	**30.0" Round Culvert** L= 16.0' Ke= 0.500 Inlet / Outlet Invert= 1,120.00' / 1,119.52' S= 0.0300 '/' Cc= 0.900 n= 0.010 PVC, smooth interior, Flow Area= 4.91 sf
#3	Secondary	1,124.00'	**4.0' long + 4.0 '/' SideZ x 16.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=24.45 cfs @ 12.86 hrs HW=1,120.08' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 24.40 cfs @ 7.77 fps)
└─**2=Culvert** (Inlet Controls 0.05 cfs @ 0.97 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=1,116.00' TW=0.00' (Dynamic Tailwater)
└─**3=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 1B: Basin



Summary for Subcatchment DA1: DA-1

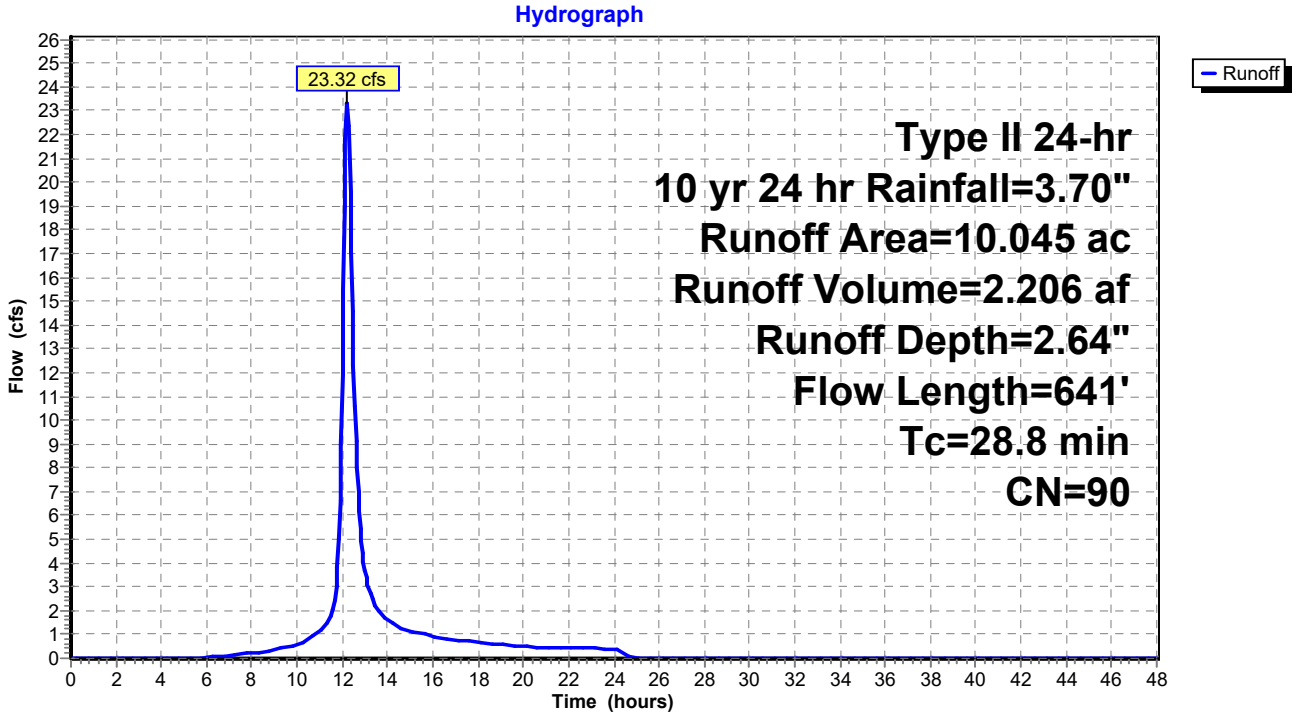
Runoff = 23.32 cfs @ 12.22 hrs, Volume= 2.206 af, Depth= 2.64"
Routed to Pond 1B : Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 10 yr 24 hr Rainfall=3.70"

Area (ac)	CN	Description
3.918	98	Paved parking, HSG C
6.127	85	Row crops, straight row, Good, HSG C
10.045	90	Weighted Average
6.127		61.00% Pervious Area
3.918		39.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
22.8	100	0.0070	0.07		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.90"
6.0	541	0.0100	1.50		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
28.8	641	Total			

Subcatchment DA1: DA-1



Summary for Subcatchment DA2: DA-2

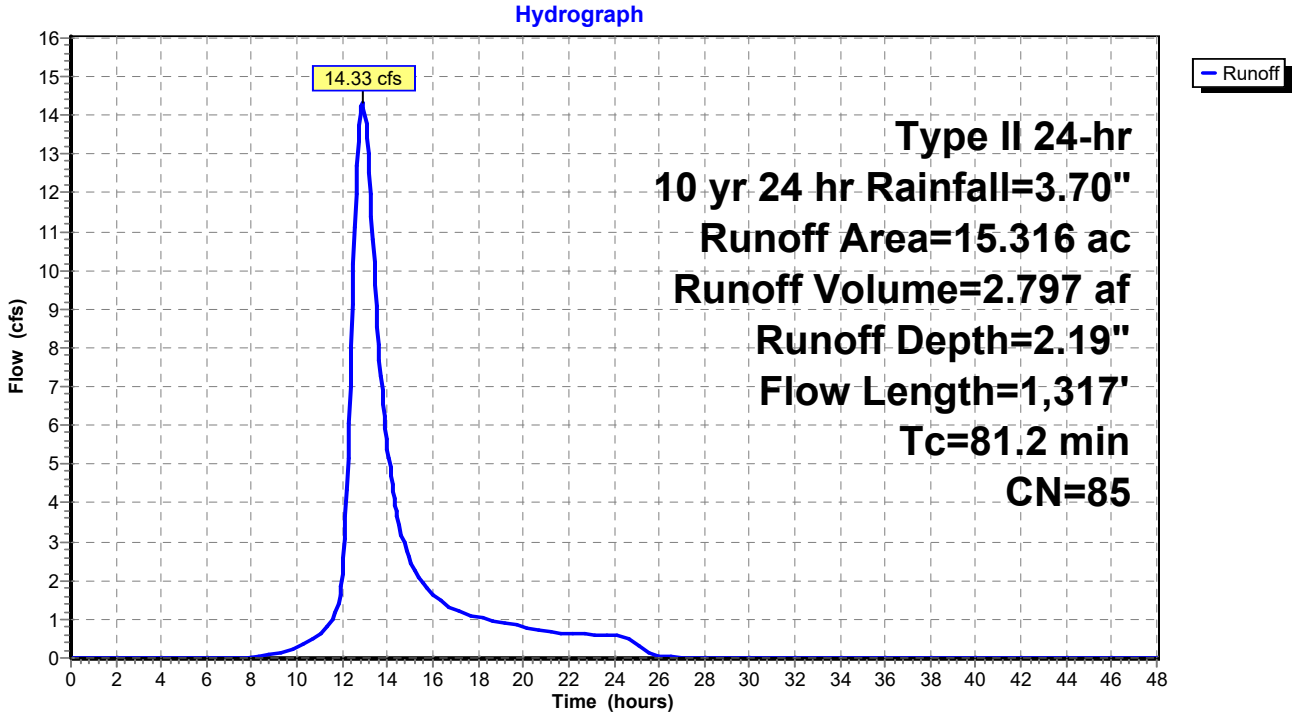
Runoff = 14.33 cfs @ 12.90 hrs, Volume= 2.797 af, Depth= 2.19"
Routed to Reach OSP : Off-Site Drainage (Proposed)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 10 yr 24 hr Rainfall=3.70"

Area (ac)	CN	Description
15.237	85	Row crops, straight row, Good, HSG C
0.079	98	Paved parking, HSG C
15.316	85	Weighted Average
15.237		99.48% Pervious Area
0.079		0.52% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
34.1	100	0.0010	0.05		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.90"
18.6	529	0.0010	0.47		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
28.5	688	0.0020	0.40		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
81.2	1,317	Total			

Subcatchment DA2: DA-2



Summary for Subcatchment DA3: DA-3

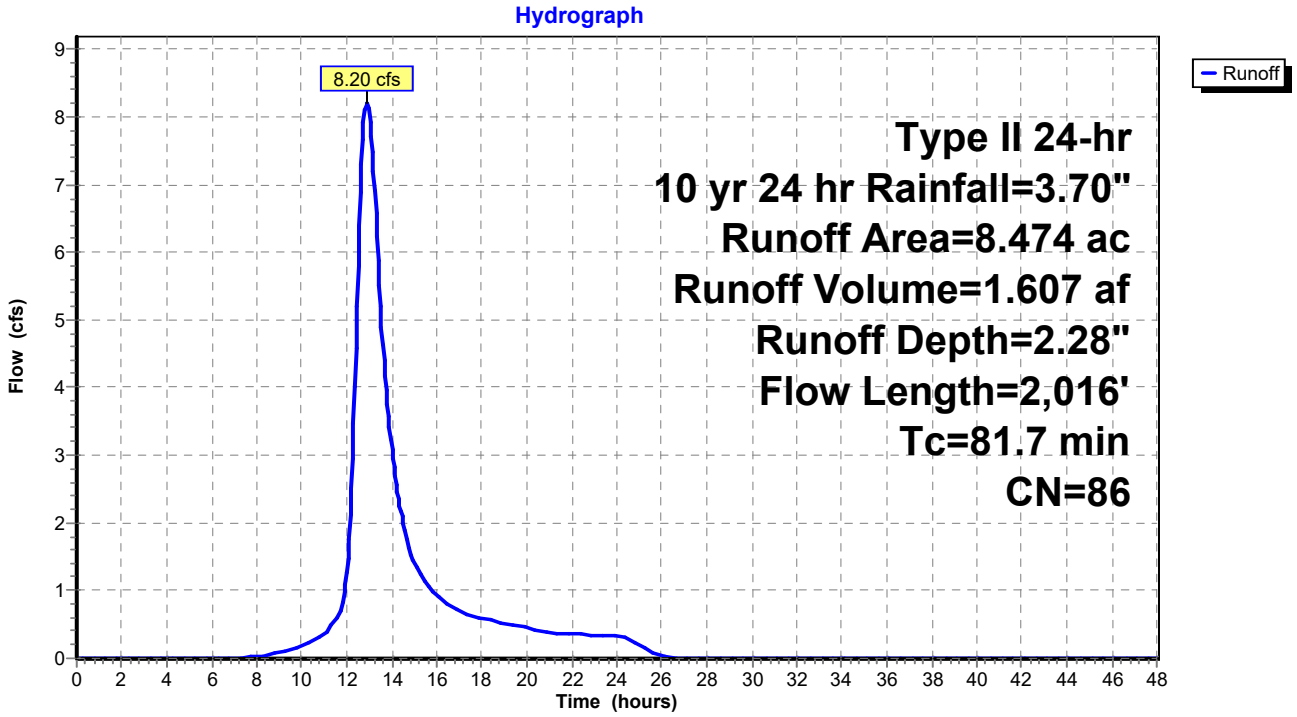
Runoff = 8.20 cfs @ 12.90 hrs, Volume= 1.607 af, Depth= 2.28"
Routed to Pond 1B : Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 10 yr 24 hr Rainfall=3.70"

Area (ac)	CN	Description
8.056	85	Row crops, straight row, Good, HSG C
0.418	98	Paved parking, HSG C
8.474	86	Weighted Average
8.056		95.07% Pervious Area
0.418		4.93% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
34.1	100	0.0010	0.05		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.90"
7.9	452	0.0040	0.95		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
3.2	140	0.0110	0.73		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
17.2	228	0.0010	0.22		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
19.3	1,096	0.0040	0.95		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
81.7	2,016	Total			

Subcatchment DA3: DA-3



Summary for Subcatchment DA4: DA-4

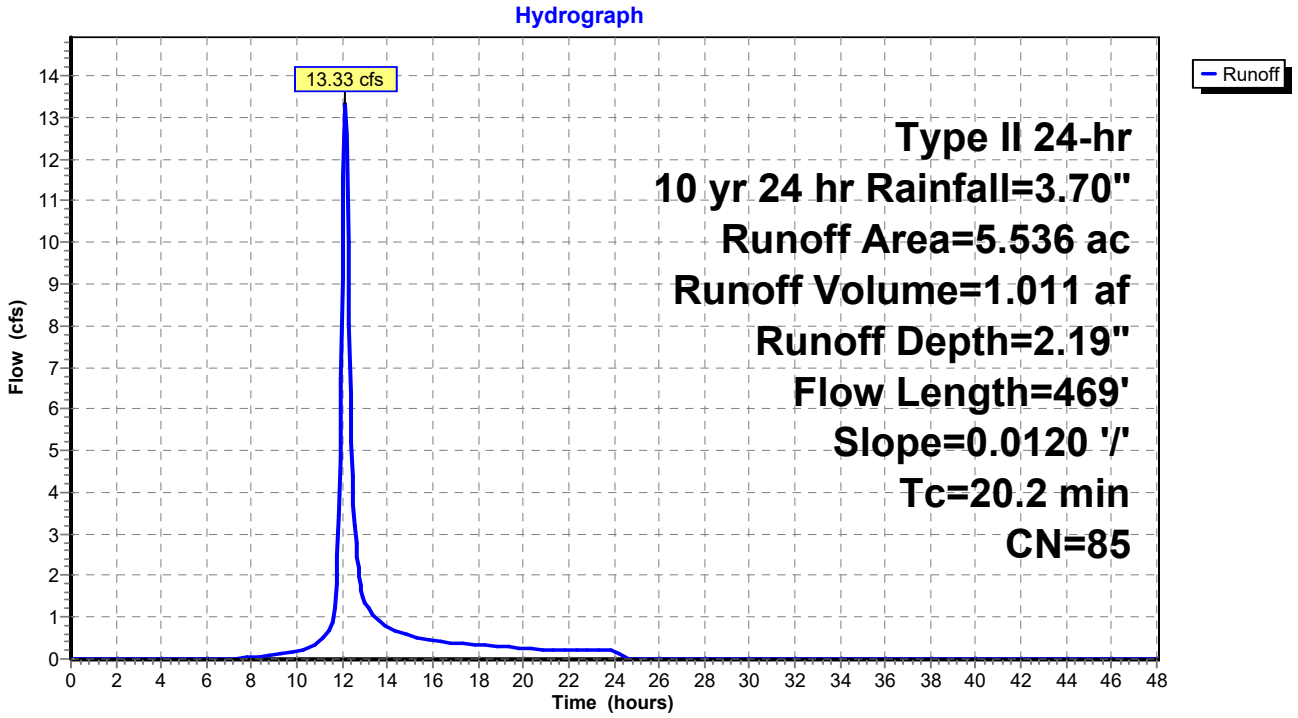
Runoff = 13.33 cfs @ 12.13 hrs, Volume= 1.011 af, Depth= 2.19"
Routed to Reach OSP : Off-Site Drainage (Proposed)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 10 yr 24 hr Rainfall=3.70"

Area (ac)	CN	Description
5.536	85	Row crops, straight row, Good, HSG C
5.536		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.0	100	0.0120	0.12		**Sheet Flow,** Cultivated: Residue>20% n= 0.170 P2= 2.90"
6.2	369	0.0120	0.99		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
20.2	469	Total			

Subcatchment DA4: DA-4



Summary for Subcatchment DA5: West Drainage (Proposed)

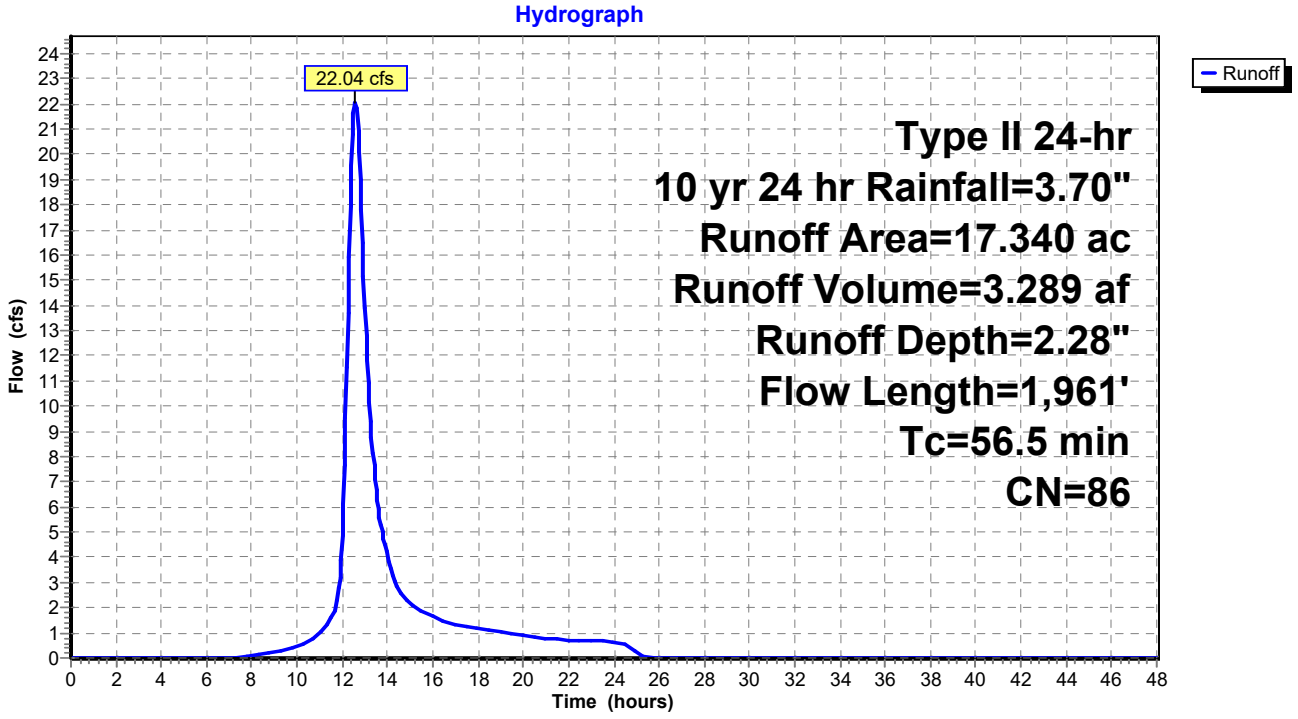
Runoff = 22.04 cfs @ 12.58 hrs, Volume= 3.289 af, Depth= 2.28"
Routed to Pond 1B : Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 10 yr 24 hr Rainfall=3.70"

Area (ac)	CN	Description
16.235	85	Row crops, straight row, Good, HSG C
1.105	98	Paved parking, HSG C
17.340	86	Weighted Average
16.235		93.63% Pervious Area
1.105		6.37% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.4	100	0.0250	0.16		**Sheet Flow,** Cultivated: Residue>20% n= 0.170 P2= 2.90"
27.9	1,167	0.0060	0.70		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
18.2	694	0.0050	0.64		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
56.5	1,961	Total			

Subcatchment DA5: West Drainage (Proposed)

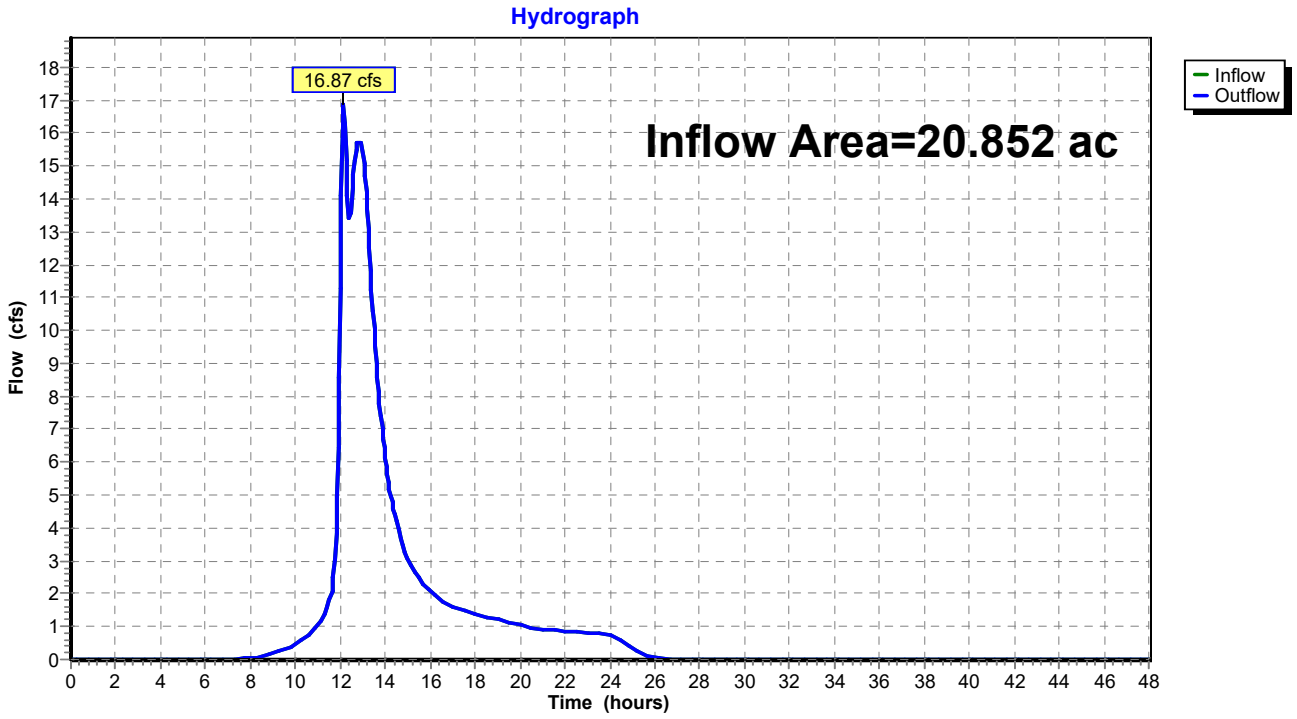


Summary for Reach OSP: Off-Site Drainage (Proposed)

Inflow Area = 20.852 ac, 0.38% Impervious, Inflow Depth = 2.19" for 10 yr 24 hr event
Inflow = 16.87 cfs @ 12.15 hrs, Volume= 3.808 af
Outflow = 16.87 cfs @ 12.15 hrs, Volume= 3.808 af, Atten= 0%, Lag= 0.0 min
Routed to Reach PCD : Proposed Conditions Discharge

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach OSP: Off-Site Drainage (Proposed)

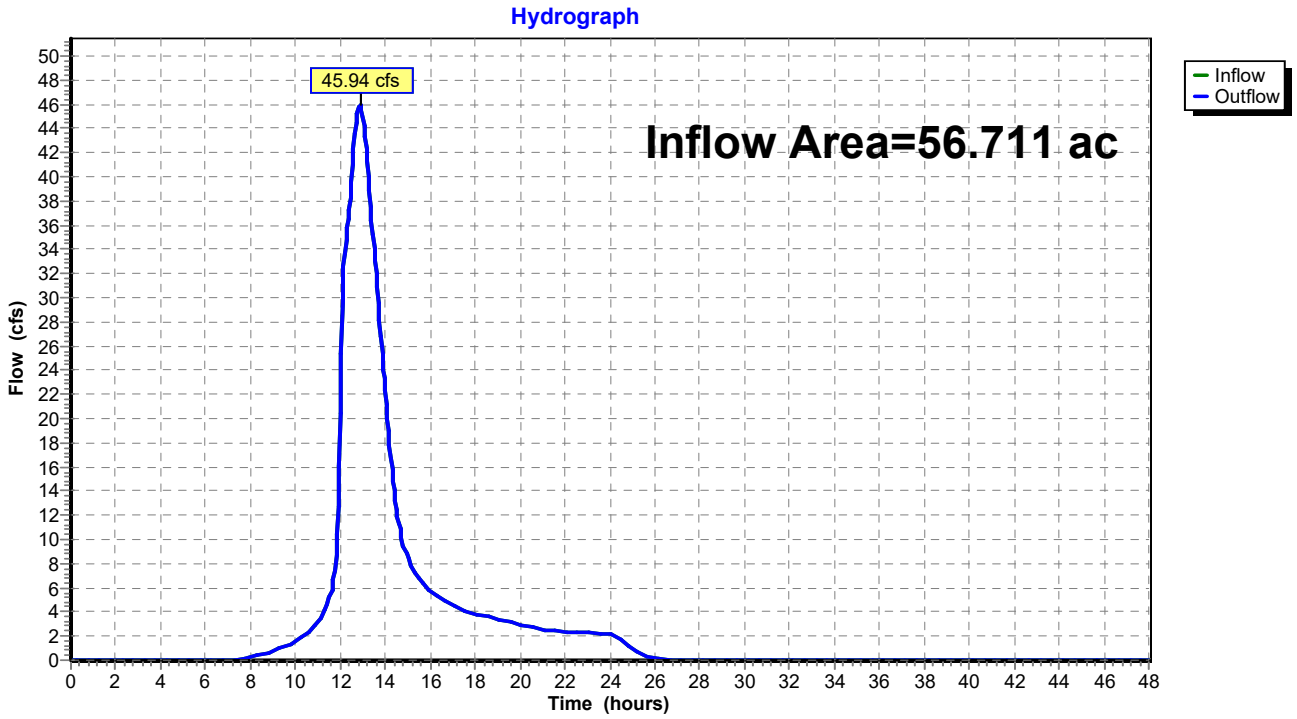


Summary for Reach PCD: Proposed Conditions Discharge

Inflow Area = 56.711 ac, 9.73% Impervious, Inflow Depth = 2.31" for 10 yr 24 hr event
Inflow = 45.94 cfs @ 12.87 hrs, Volume= 10.901 af
Outflow = 45.94 cfs @ 12.87 hrs, Volume= 10.901 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach PCD: Proposed Conditions Discharge



Summary for Pond 1B: Basin

Inflow Area = 35.859 ac, 15.17% Impervious, Inflow Depth = 2.38" for 10 yr 24 hr event
Inflow = 41.49 cfs @ 12.35 hrs, Volume= 7.103 af
Outflow = 30.06 cfs @ 12.87 hrs, Volume= 7.093 af, Atten= 28%, Lag= 31.1 min
Primary = 30.06 cfs @ 12.87 hrs, Volume= 7.093 af
Routed to Reach PCD : Proposed Conditions Discharge
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Reach PCD : Proposed Conditions Discharge

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 1,120.68' @ 12.87 hrs Surf.Area= 24,993 sf Storage= 47,643 cf

Plug-Flow detention time= 21.6 min calculated for 7.085 af (100% of inflow)
Center-of-Mass det. time= 20.8 min (873.5 - 852.8)

Volume	Invert	Avail.Storage	Storage Description
#1	1,116.00'	255,273 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

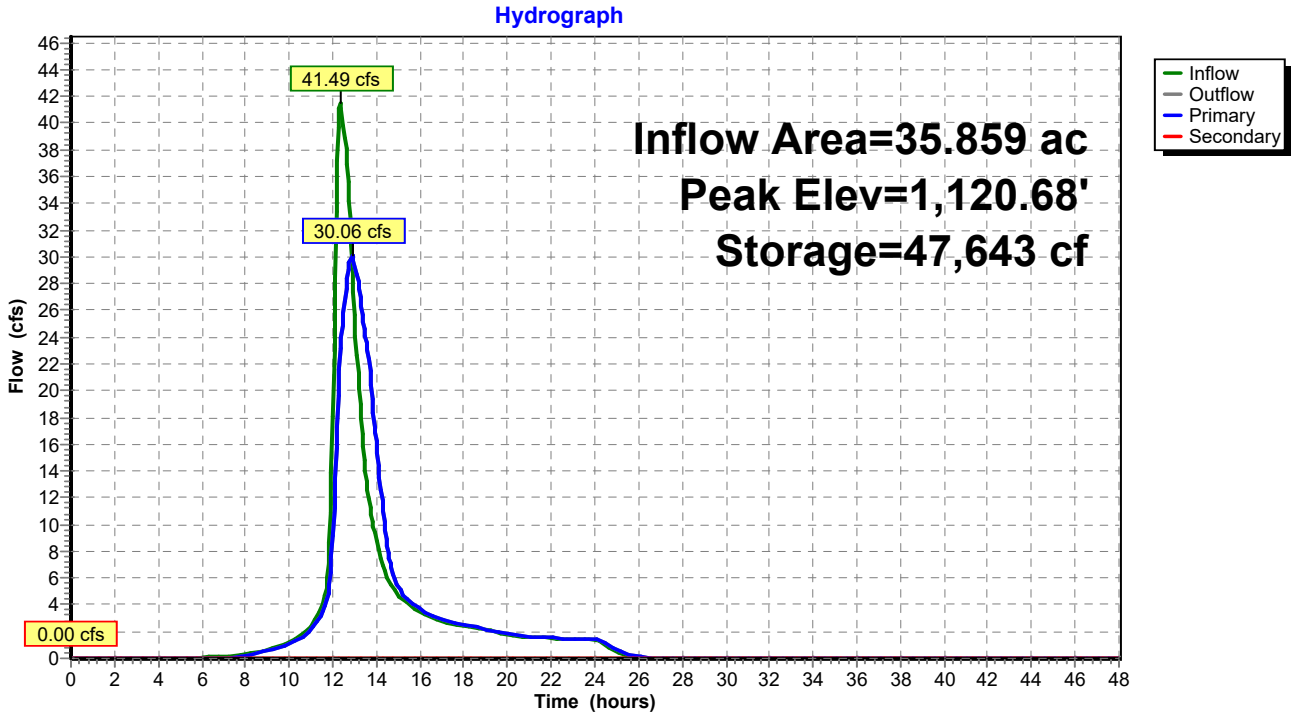
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,116.00	1	0	0
1,117.00	3,751	1,876	1,876
1,118.00	7,233	5,492	7,368
1,119.00	12,253	9,743	17,111
1,120.00	19,000	15,627	32,738
1,121.00	27,843	23,422	56,159
1,122.00	38,650	33,247	89,406
1,123.00	49,663	44,157	133,562
1,124.00	60,845	55,254	188,816
1,125.00	72,068	66,457	255,273

Device	Routing	Invert	Outlet Devices
#1	Primary	1,116.48'	**24.0" Round Culvert** L= 33.0' Ke= 0.500 Inlet / Outlet Invert= 1,116.48' / 1,116.33' S= 0.0045 '/' Cc= 0.900 n= 0.010 PVC, smooth interior, Flow Area= 3.14 sf
#2	Primary	1,120.00'	**30.0" Round Culvert** L= 16.0' Ke= 0.500 Inlet / Outlet Invert= 1,120.00' / 1,119.52' S= 0.0300 '/' Cc= 0.900 n= 0.010 PVC, smooth interior, Flow Area= 4.91 sf
#3	Secondary	1,124.00'	**4.0' long + 4.0 '/' SideZ x 16.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=30.04 cfs @ 12.87 hrs HW=1,120.68' TW=0.00' (Dynamic Tailwater)
1=Culvert (Inlet Controls 27.04 cfs @ 8.61 fps)
2=Culvert (Inlet Controls 3.00 cfs @ 2.80 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=1,116.00' TW=0.00' (Dynamic Tailwater)
3=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Pond 1B: Basin



Summary for Subcatchment DA1: DA-1

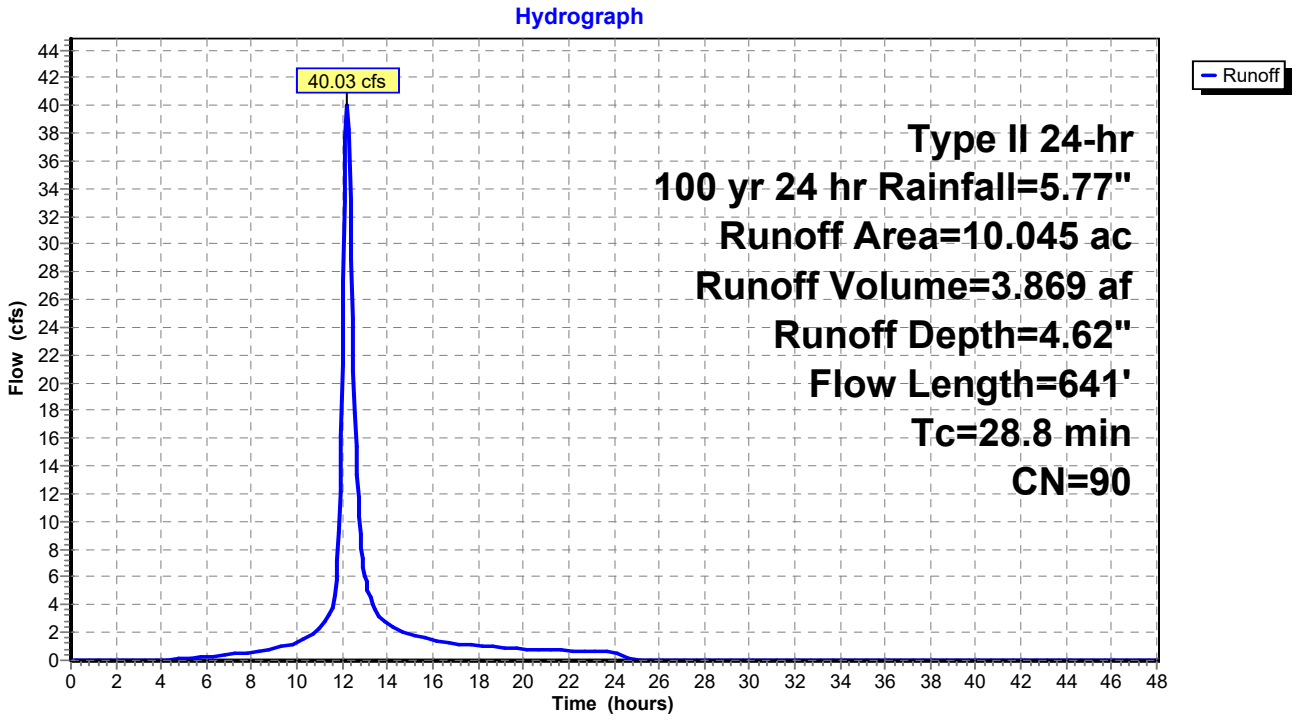
Runoff = 40.03 cfs @ 12.22 hrs, Volume= 3.869 af, Depth= 4.62"
Routed to Pond 1B : Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 100 yr 24 hr Rainfall=5.77"

Area (ac)	CN	Description
3.918	98	Paved parking, HSG C
6.127	85	Row crops, straight row, Good, HSG C
10.045	90	Weighted Average
6.127		61.00% Pervious Area
3.918		39.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
22.8	100	0.0070	0.07		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.90"
6.0	541	0.0100	1.50		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
28.8	641	Total			

Subcatchment DA1: DA-1



Summary for Subcatchment DA2: DA-2

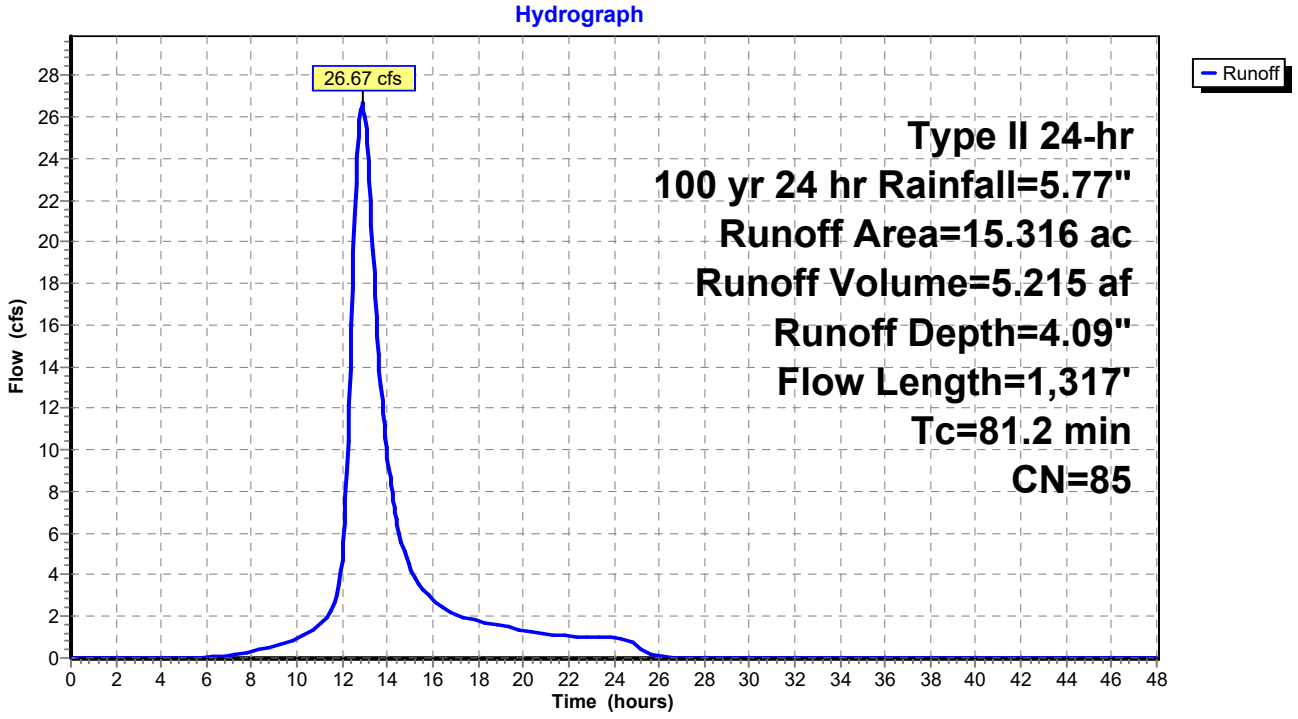
Runoff = 26.67 cfs @ 12.89 hrs, Volume= 5.215 af, Depth= 4.09"
Routed to Reach OSP : Off-Site Drainage (Proposed)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 100 yr 24 hr Rainfall=5.77"

Area (ac)	CN	Description
15.237	85	Row crops, straight row, Good, HSG C
0.079	98	Paved parking, HSG C
15.316	85	Weighted Average
15.237		99.48% Pervious Area
0.079		0.52% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
34.1	100	0.0010	0.05		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.90"
18.6	529	0.0010	0.47		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
28.5	688	0.0020	0.40		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
81.2	1,317	Total			

Subcatchment DA2: DA-2



Summary for Subcatchment DA3: DA-3

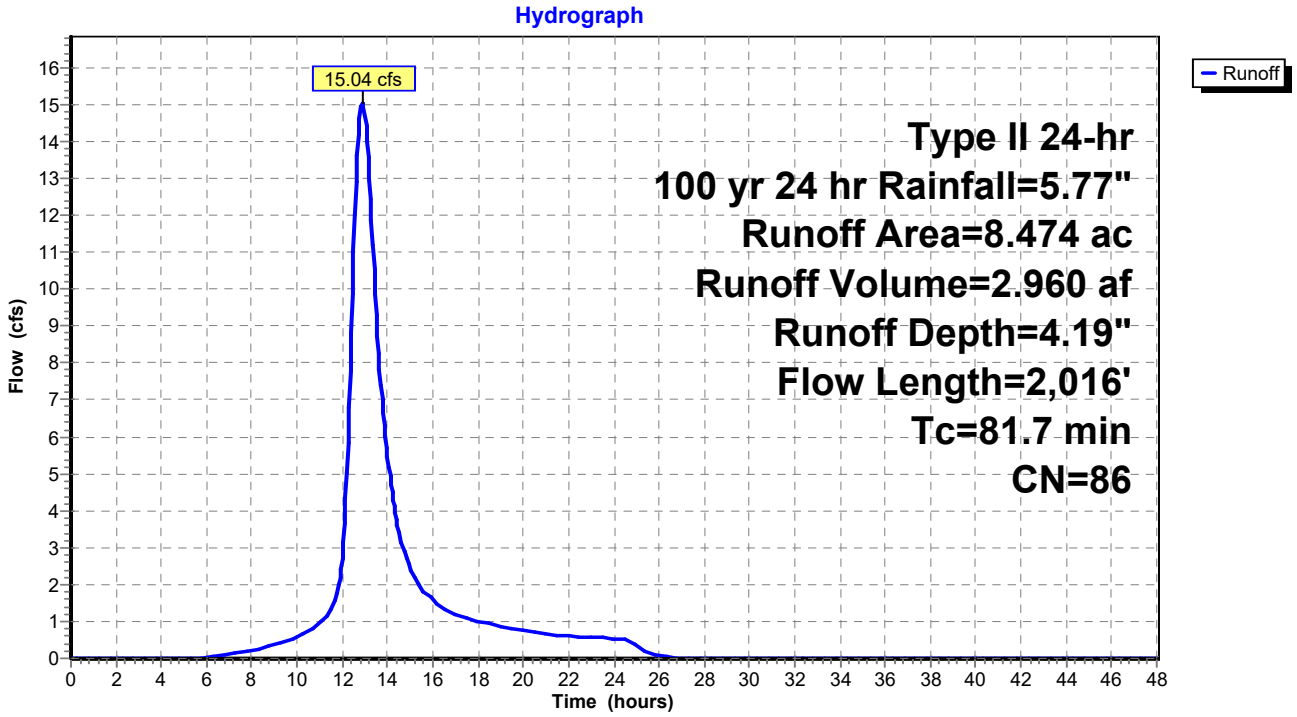
Runoff = 15.04 cfs @ 12.88 hrs, Volume= 2.960 af, Depth= 4.19"
Routed to Pond 1B : Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 100 yr 24 hr Rainfall=5.77"

Area (ac)	CN	Description
8.056	85	Row crops, straight row, Good, HSG C
0.418	98	Paved parking, HSG C
8.474	86	Weighted Average
8.056		95.07% Pervious Area
0.418		4.93% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
34.1	100	0.0010	0.05		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.90"
7.9	452	0.0040	0.95		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
3.2	140	0.0110	0.73		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
17.2	228	0.0010	0.22		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
19.3	1,096	0.0040	0.95		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
81.7	2,016	Total			

Subcatchment DA3: DA-3



Summary for Subcatchment DA4: DA-4

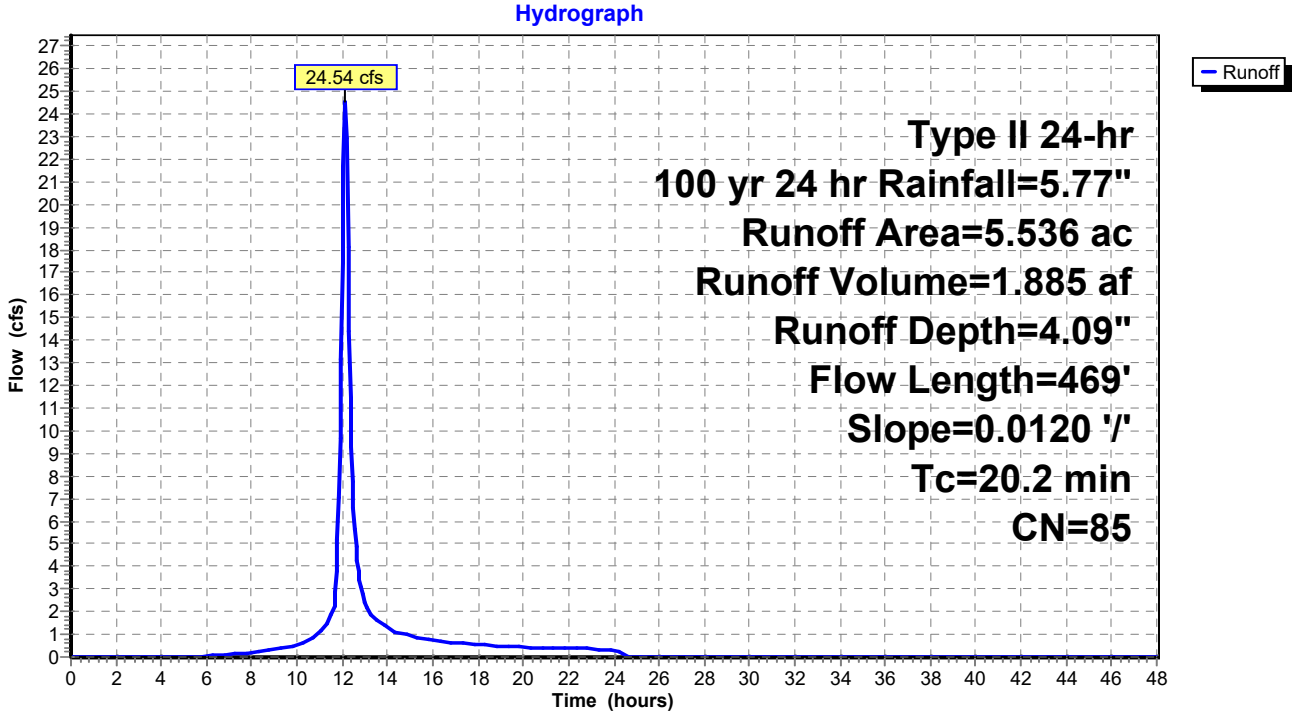
Runoff = 24.54 cfs @ 12.12 hrs, Volume= 1.885 af, Depth= 4.09"
Routed to Reach OSP : Off-Site Drainage (Proposed)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 100 yr 24 hr Rainfall=5.77"

Area (ac)	CN	Description
5.536	85	Row crops, straight row, Good, HSG C
5.536		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.0	100	0.0120	0.12		**Sheet Flow,** Cultivated: Residue>20% n= 0.170 P2= 2.90"
6.2	369	0.0120	0.99		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
20.2	469	Total			

Subcatchment DA4: DA-4



Summary for Subcatchment DA5: West Drainage (Proposed)

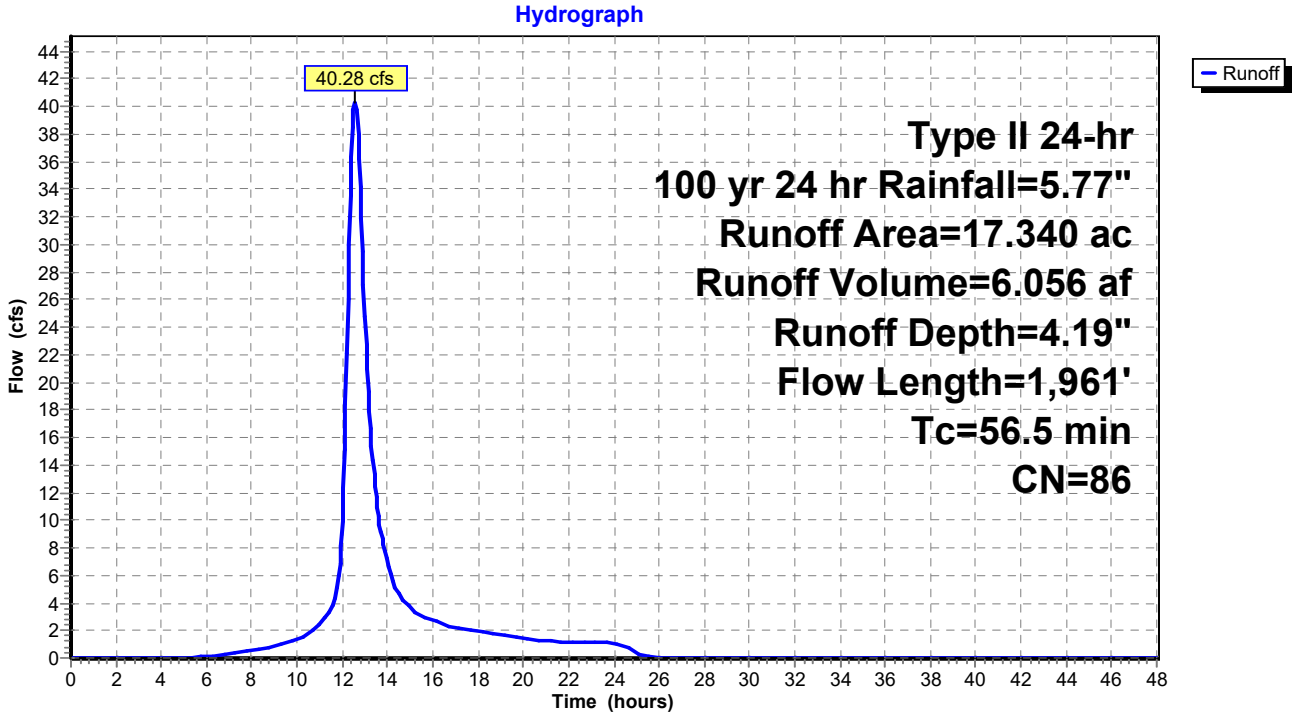
Runoff = 40.28 cfs @ 12.57 hrs, Volume= 6.056 af, Depth= 4.19"
Routed to Pond 1B : Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 100 yr 24 hr Rainfall=5.77"

Area (ac)	CN	Description
16.235	85	Row crops, straight row, Good, HSG C
1.105	98	Paved parking, HSG C
17.340	86	Weighted Average
16.235		93.63% Pervious Area
1.105		6.37% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.4	100	0.0250	0.16		**Sheet Flow,** Cultivated: Residue>20% n= 0.170 P2= 2.90"
27.9	1,167	0.0060	0.70		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
18.2	694	0.0050	0.64		**Shallow Concentrated Flow,** Cultivated Straight Rows Kv= 9.0 fps
56.5	1,961	Total			

Subcatchment DA5: West Drainage (Proposed)

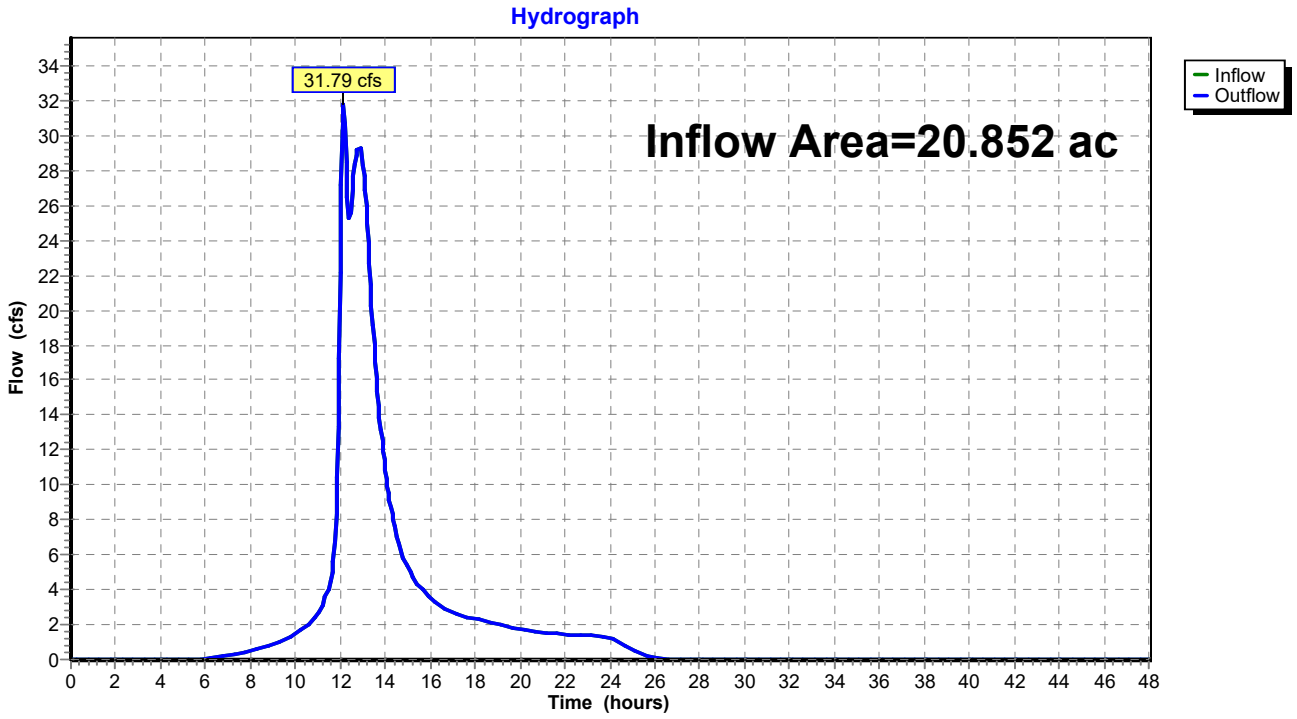


Summary for Reach OSP: Off-Site Drainage (Proposed)

Inflow Area = 20.852 ac, 0.38% Impervious, Inflow Depth = 4.09" for 100 yr 24 hr event
Inflow = 31.79 cfs @ 12.15 hrs, Volume= 7.100 af
Outflow = 31.79 cfs @ 12.15 hrs, Volume= 7.100 af, Atten= 0%, Lag= 0.0 min
Routed to Reach PCD : Proposed Conditions Discharge

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach OSP: Off-Site Drainage (Proposed)

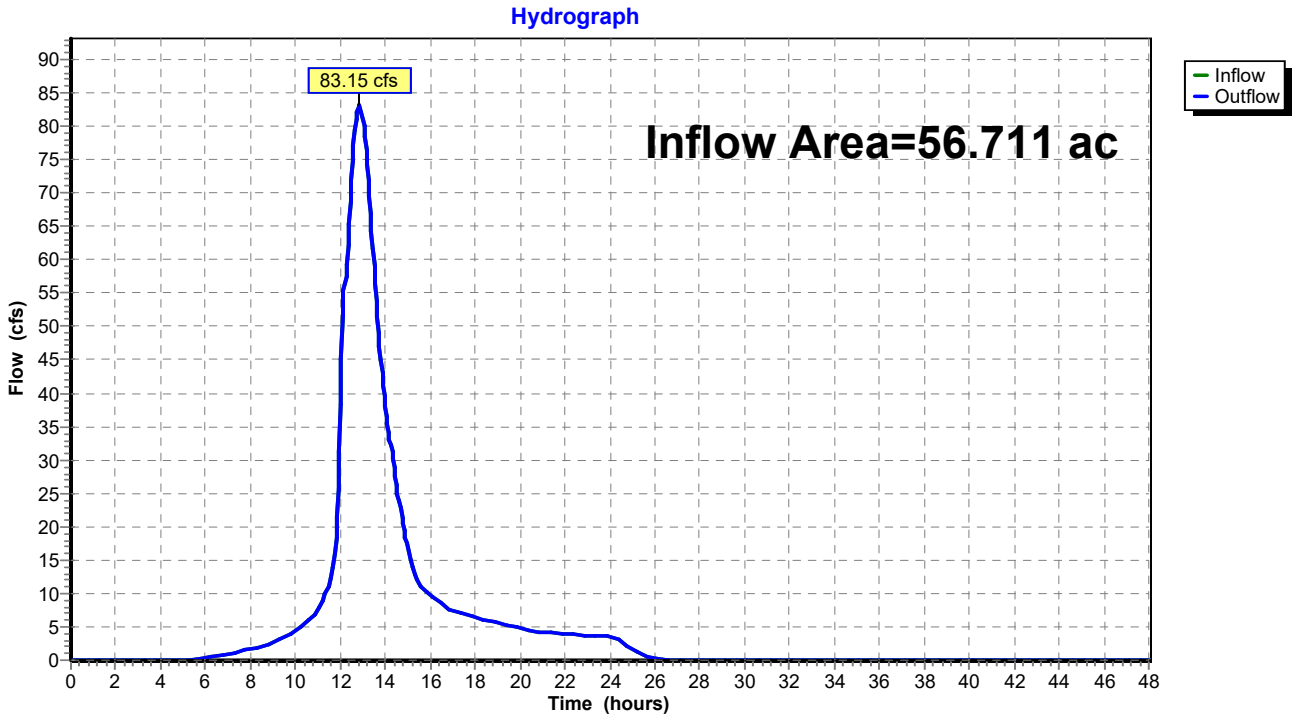


Summary for Reach PCD: Proposed Conditions Discharge

Inflow Area = 56.711 ac, 9.73% Impervious, Inflow Depth = 4.23" for 100 yr 24 hr event
Inflow = 83.15 cfs @ 12.86 hrs, Volume= 19.975 af
Outflow = 83.15 cfs @ 12.86 hrs, Volume= 19.975 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach PCD: Proposed Conditions Discharge



Summary for Pond 1B: Basin

Inflow Area = 35.859 ac, 15.17% Impervious, Inflow Depth = 4.31" for 100 yr 24 hr event
Inflow = 74.52 cfs @ 12.36 hrs, Volume= 12.885 af
Outflow = 53.78 cfs @ 12.87 hrs, Volume= 12.875 af, Atten= 28%, Lag= 30.9 min
Primary = 53.78 cfs @ 12.87 hrs, Volume= 12.875 af
Routed to Reach PCD : Proposed Conditions Discharge
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Reach PCD : Proposed Conditions Discharge

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 1,122.12' @ 12.87 hrs Surf.Area= 39,982 sf Storage= 94,162 cf

Plug-Flow detention time= 23.2 min calculated for 12.861 af (100% of inflow)
Center-of-Mass det. time= 22.8 min (859.2 - 836.4)

Volume	Invert	Avail.Storage	Storage Description
#1	1,116.00'	255,273 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

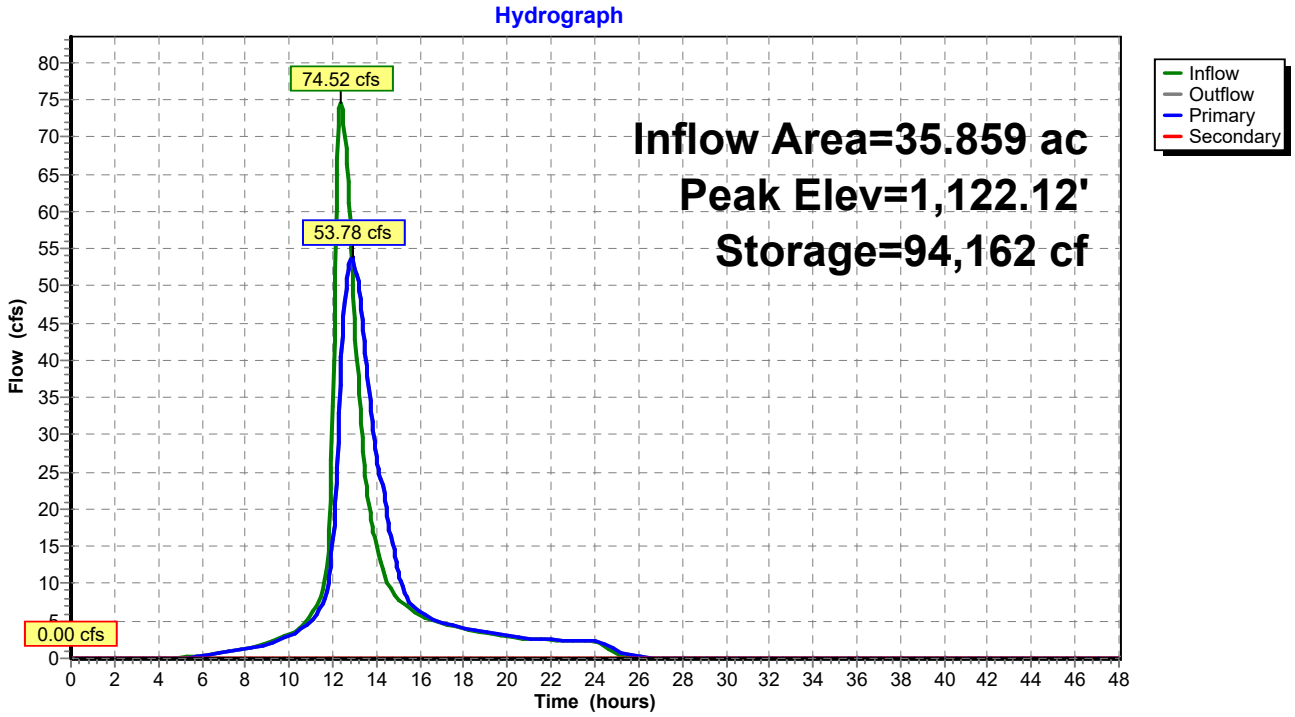
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,116.00	1	0	0
1,117.00	3,751	1,876	1,876
1,118.00	7,233	5,492	7,368
1,119.00	12,253	9,743	17,111
1,120.00	19,000	15,627	32,738
1,121.00	27,843	23,422	56,159
1,122.00	38,650	33,247	89,406
1,123.00	49,663	44,157	133,562
1,124.00	60,845	55,254	188,816
1,125.00	72,068	66,457	255,273

Device	Routing	Invert	Outlet Devices
#1	Primary	1,116.48'	**24.0" Round Culvert** L= 33.0' Ke= 0.500 Inlet / Outlet Invert= 1,116.48' / 1,116.33' S= 0.0045 '/' Cc= 0.900 n= 0.010 PVC, smooth interior, Flow Area= 3.14 sf
#2	Primary	1,120.00'	**30.0" Round Culvert** L= 16.0' Ke= 0.500 Inlet / Outlet Invert= 1,120.00' / 1,119.52' S= 0.0300 '/' Cc= 0.900 n= 0.010 PVC, smooth interior, Flow Area= 4.91 sf
#3	Secondary	1,124.00'	**4.0' long + 4.0 '/' SideZ x 16.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

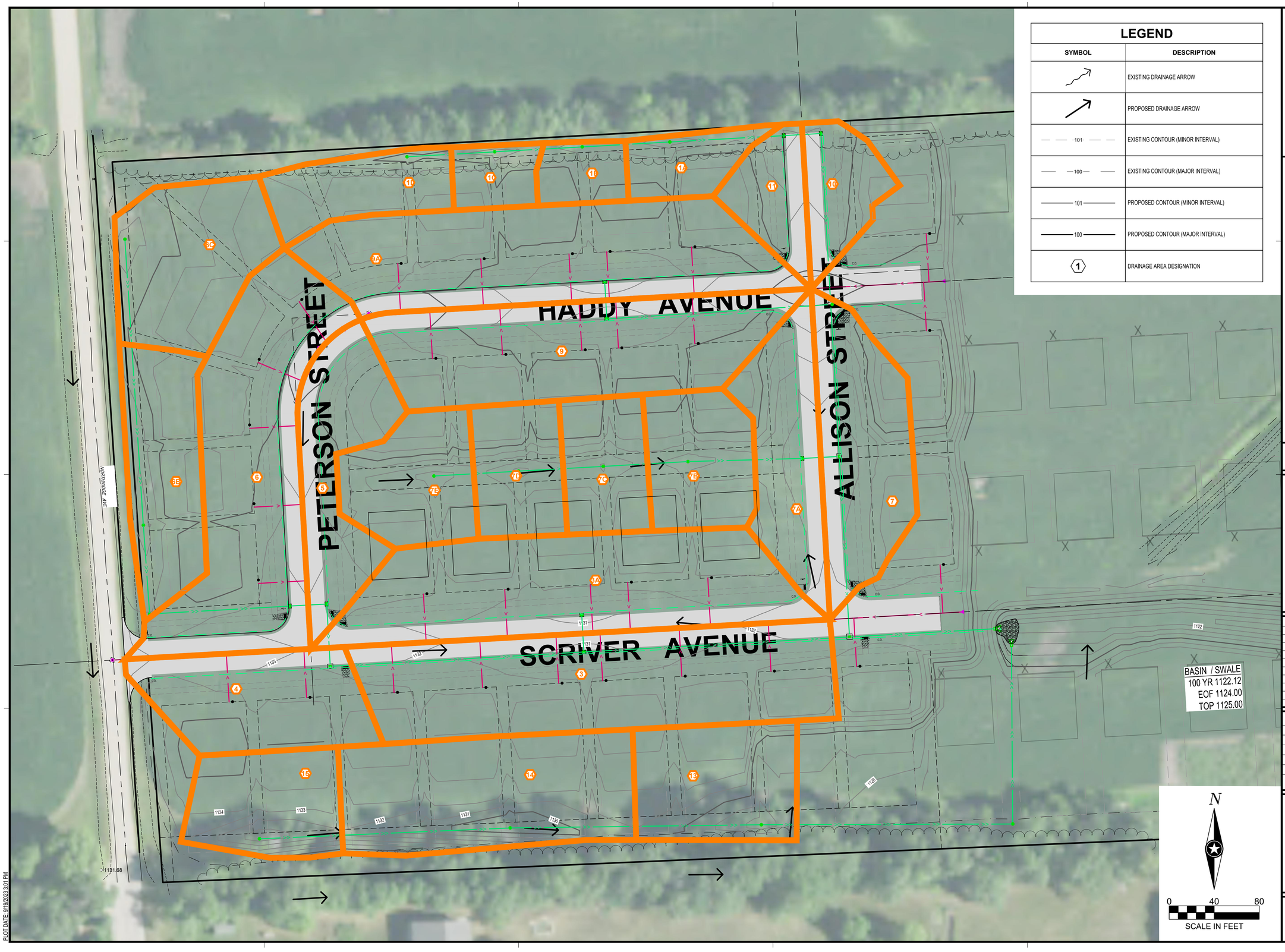
Primary OutFlow Max=53.75 cfs @ 12.87 hrs HW=1,122.12' TW=0.00' (Dynamic Tailwater)
1=Culvert (Inlet Controls 32.58 cfs @ 10.37 fps)
2=Culvert (Barrel Controls 21.17 cfs @ 6.43 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=1,116.00' TW=0.00' (Dynamic Tailwater)
3=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Pond 1B: Basin



Appendix F: Pipe Sizing – Hydraflow Calculations



LEGEND

SYMBOL	DESCRIPTION
	EXISTING DRAINAGE ARROW
	PROPOSED DRAINAGE ARROW
101	EXISTING CONTOUR (MINOR INTERVAL)
100	EXISTING CONTOUR (MAJOR INTERVAL)
101	PROPOSED CONTOUR (MINOR INTERVAL)
100	PROPOSED CONTOUR (MAJOR INTERVAL)
1	DRAINAGE AREA DESIGNATION

ISG

PROJECT

HUNT SECOND ADDITION (PHASE 1)

MILBANK SOUTH DAKOTA

REVISION SCHEDULE

DATE	DESCRIPTION	BY

PROJECT NO.	23-29236
FILE NAME	2023-09-19 29236 DRAINAGE AREAS
DRAWN BY	JRS / GBV
DESIGNED BY	JRS /GBV
REVIEWED BY	EBG / JRS
ORIGINAL ISSUE DATE	08/28/23
CLIENT PROJECT NO.	-

TITLE

Pipe Drainage Areas

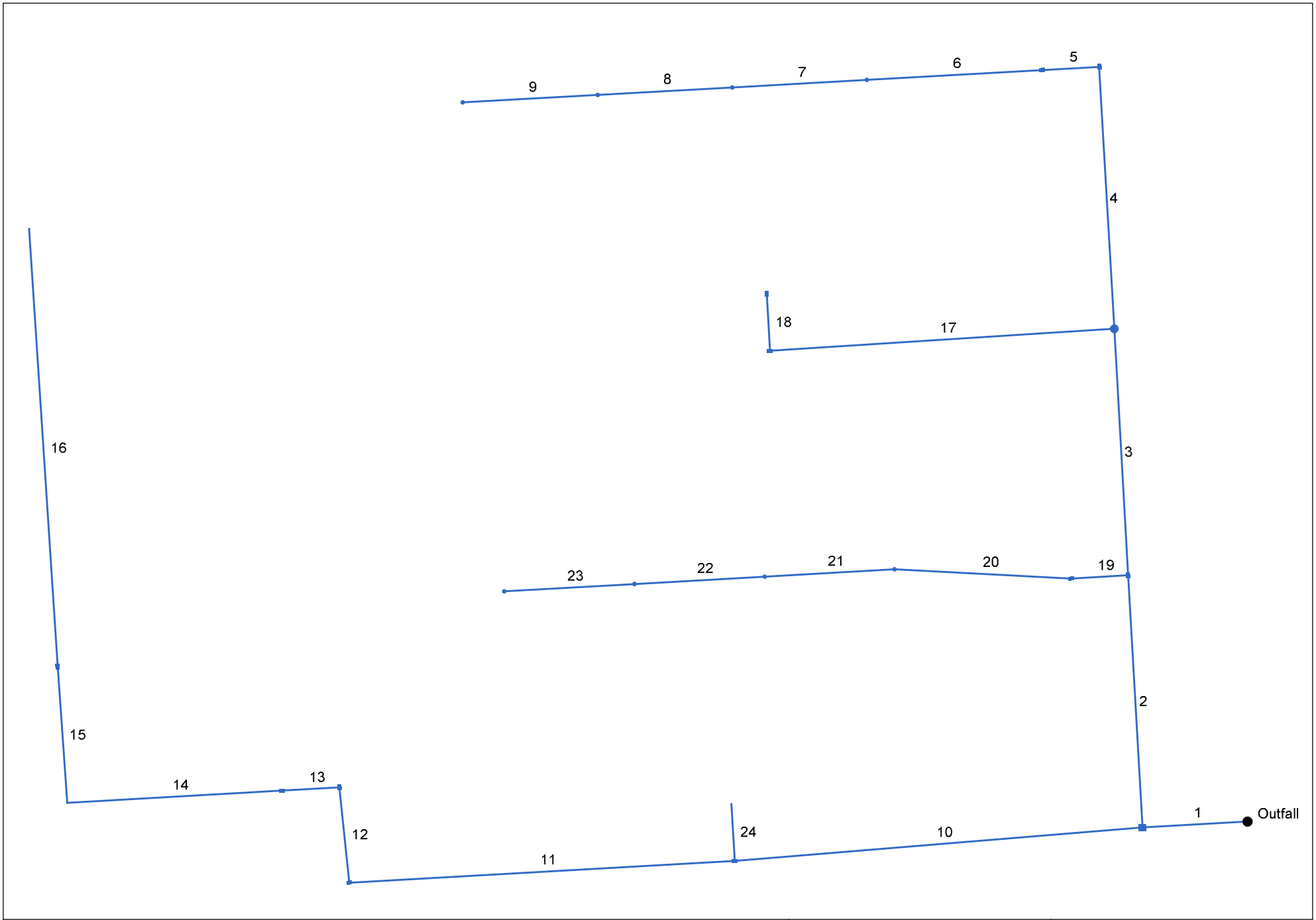
SHEET

A-3

PRELIMINARY NOT FOR CONSTRUCTION

PLOT DATE: 9/19/2023 3:01 PM

Hydraflow Storm Sewers Extension for Autodesk® Civil 3D® Plan



Project File: 29236 Storm (MDP).stm	Number of lines: 24	Date: 9/19/2023

Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
1	End	60.892	0.00	7.92	0.00	0.00	5.74	0.0	15.2	7.5	43.03	55.62	10.98	30	1.84	1122.85	1123.97	1124.50	1126.16	1132.41	1132.47	P-2
2	1	146.577	0.41	4.06	0.74	0.30	2.94	10.0	14.9	7.6	22.29	15.96	7.10	24	0.50	1124.67	1125.40	1126.76	1128.19	1132.47	1131.47	P-7
3	2	143.223	0.00	2.35	0.00	0.00	1.72	0.0	14.4	7.7	13.31	13.89	4.24	24	0.38	1125.99	1126.53	1129.86	1130.36	1131.47	1134.96	P-8
4	3	152.160	0.17	0.88	0.75	0.13	0.63	10.0	13.5	8.0	5.00	8.09	2.83	18	0.51	1126.80	1127.57	1130.79	1131.09	1134.96	1132.97	P-10
5	4	33.000	0.17	0.71	0.76	0.13	0.50	10.0	13.3	8.1	4.02	16.57	2.28	18	2.12	1127.77	1128.47	1131.32	1131.36	1132.97	1132.97	P-11
6	5	101.506	0.13	0.54	0.69	0.09	0.37	10.0	12.7	8.3	3.06	6.25	2.49	15	0.80	1128.67	1129.48	1131.40	1131.60	1132.97	1132.50	P-11A
7	6	77.941	0.10	0.41	0.70	0.07	0.28	10.0	12.0	8.5	2.38	4.41	1.94	15	0.40	1129.68	1129.99	1131.68	1131.77	1132.50	1133.56	P-11B
8	7	77.940	0.10	0.31	0.68	0.07	0.21	10.0	11.2	8.8	1.85	4.41	1.51	15	0.40	1130.19	1130.50	1131.82	1131.88	1133.56	1133.50	P-11C
9	8	77.940	0.21	0.21	0.68	0.14	0.14	10.0	10.0	9.3	1.32	6.63	2.19	15	0.90	1130.70	1131.40	1131.91	1131.85	1133.50	1134.40	P-11D
10	1	236.439	0.84	3.86	0.74	0.62	2.80	10.0	14.5	7.7	21.59	11.30	6.87	24	0.25	1124.67	1125.26	1126.81	1128.97	1132.47	1131.05	P-3
11	10	222.933	0.38	2.25	0.75	0.29	1.60	10.0	13.6	8.0	12.78	18.92	4.07	24	0.70	1125.93	1127.49	1130.54	1131.26	1131.05	1132.66	P-4
12	11	55.566	0.34	1.87	0.75	0.26	1.32	0.0	13.4	8.0	10.57	7.45	5.98	18	0.50	1127.69	1127.97	1131.64	1132.21	1132.66	1132.98	P-5
13	12	33.000	0.79	1.53	0.75	0.59	1.06	10.0	13.3	8.0	8.56	6.06	4.85	18	0.33	1128.17	1128.28	1133.23	1133.45	1132.98	1132.98	P-6
14	13	124.580	0.00	0.74	0.00	0.00	0.47	0.0	12.7	8.3	3.89	3.49	3.17	15	0.25	1128.48	1128.79	1133.84	1134.23	1132.98	1134.04	P-6A
15	14	79.074	0.34	0.74	0.67	0.23	0.47	10.0	12.3	8.4	3.96	4.16	3.22	15	0.35	1128.99	1129.27	1134.38	1134.64	1134.04	1132.46	P-6B
16	15	254.513	0.40	0.40	0.61	0.24	0.24	10.0	10.0	9.3	2.26	4.21	1.84	15	0.36	1129.47	1130.39	1134.83	1135.09	1132.46	1133.39	P-6C
17	3	199.310	0.68	1.47	0.75	0.51	1.09	10.0	10.2	9.2	10.07	20.58	3.21	24	0.83	1126.60	1128.25	1130.76	1131.15	1134.96	1132.99	P-9
18	17	33.000	0.79	0.79	0.74	0.58	0.58	10.0	10.0	9.3	5.42	14.74	3.07	18	1.97	1128.35	1129.00	1131.41	1131.49	1132.99	1132.99	P-9A
19	2	33.000	0.33	1.30	0.74	0.24	0.92	10.0	12.1	8.5	7.74	8.38	4.38	18	0.64	1126.01	1126.22	1129.85	1130.02	1131.47	1131.47	P-7A
20	19	102.102	0.26	0.97	0.71	0.18	0.67	10.0	11.7	8.6	5.76	4.09	4.69	15	0.40	1126.42	1126.83	1130.17	1130.99	1131.47	1131.49	P-7B
21	20	75.340	0.21	0.71	0.69	0.14	0.49	10.0	11.4	8.7	4.24	4.41	3.46	15	0.40	1127.03	1127.33	1131.32	1131.59	1131.49	1130.95	P-7C
22	21	75.330	0.22	0.50	0.70	0.15	0.34	10.0	10.9	8.9	3.04	4.41	2.48	15	0.40	1127.53	1127.83	1131.77	1131.92	1130.95	1130.83	P-7D

Project File: 29236 Storm (MDP).stm | Number of lines: 24 | Run Date: 9/19/2023

NOTES:Intensity = 76.26 / (Inlet time + 6.10) ^ 0.76; Return period =Yrs. 100 ; c = cir e = ellip b = box

Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
23	22	75.330	0.28	0.28	0.67	0.19	0.19	10.0	10.0	9.3	1.74	6.35	1.42	15	0.82	1128.03	1128.65	1132.03	1132.08	1130.83	1131.65	P-7E
24	10	33.000	0.77	0.77	0.75	0.58	0.58	10.0	10.0	9.3	5.36	6.56	4.37	15	1.03	1126.22	1126.56	1130.51	1130.73	1131.05	1131.05	P-3A

Project File: 29236 Storm (MDP).stm | Number of lines: 24 | Run Date: 9/19/2023

NOTES:Intensity = 76.26 / (Inlet time + 6.10) ^ 0.76; Return period =Yrs. 100 ; c = cir e = ellip b = box

Inlet Report

Line No	Inlet ID	Q = CIA (cfs)	Q carry (cfs)	Q capt (cfs)	Q Byp (cfs)	Junc Type	Curb Inlet		Grate Inlet			Gutter							Inlet			Byp Line No
							Ht (in)	L (ft)	Area (sqft)	L (ft)	W (ft)	So (ft/ft)	W (ft)	Sw (ft/ft)	Sx (ft/ft)	n	Depth (ft)	Spread (ft)	Depth (ft)	Spread (ft)	Depr (in)	
1	ST-2	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	Off
2	ST-7	2.81	0.00	2.81	0.00	Comb	5.0	3.00	2.70	3.00	1.50	Sag	2.00	0.050	0.020	0.000	0.30	11.93	0.38	11.93	1.0	Off
3	ST-8	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	Off
4	ST-10	1.18	0.00	1.18	0.00	Comb	5.0	3.00	2.40	3.00	1.50	Sag	1.50	0.050	0.020	0.000	0.16	5.69	0.24	5.69	1.0	Off
5	ST-11	1.20	0.00	1.20	0.00	Comb	5.0	3.00	2.40	3.00	1.50	Sag	2.00	0.050	0.020	0.000	0.17	5.63	0.26	5.63	1.0	Off
6	ST-11A	0.83	0.00	0.83	0.00	DrGrt	0.0	0.00	1.22	2.00	2.00	Sag	2.00	0.020	0.020	0.000	0.11	12.62	0.11	12.62	0.0	Off
7	ST-11B	0.65	0.00	0.65	0.00	DrGrt	0.0	0.00	1.22	2.00	2.00	Sag	2.00	0.020	0.020	0.000	0.09	11.00	0.09	11.00	0.0	Off
8	ST-11C	0.63	0.00	0.63	0.00	DrGrt	0.0	0.00	1.22	2.00	2.00	Sag	2.00	0.020	0.020	0.000	0.09	10.83	0.09	10.83	0.0	Off
9	ST-11D	1.32	0.00	1.32	0.00	DrGrt	0.0	0.00	1.22	2.00	2.00	Sag	2.00	0.020	0.020	0.000	0.14	16.48	0.14	16.48	0.0	Off
10	ST-3	5.77	1.22	6.98	0.00	Comb	5.0	3.00	2.70	3.00	1.50	Sag	1.50	0.050	0.020	0.000	0.53	24.14	0.61	24.14	1.0	Off
11	ST-4	2.64	0.00	1.43	1.22	Comb	5.0	3.00	0.00	3.00	1.50	0.007	1.50	0.050	0.020	0.013	0.24	9.99	0.27	7.30	1.0	10
12	ST-5	0.00	0.00	0.00	0.00	Comb	5.0	3.00	2.70	3.00	1.50	Sag	1.50	0.050	0.020	0.000	-0.08	0.00	0.00	0.00	1.0	Off
13	ST-6	5.50	0.00	5.50	0.00	Comb	5.0	3.00	2.70	3.00	1.50	Sag	1.50	0.050	0.020	0.000	0.45	20.22	0.53	20.22	1.0	Off
14	ST-6A	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	Off
15	ST-6B	2.11	0.00	2.11	0.00	DrGrt	0.0	0.00	1.22	2.00	2.00	Sag	2.00	0.020	0.020	0.000	0.20	21.78	0.20	21.78	0.0	Off
16	ST-6C	2.26	0.00	2.26	0.00	DrGrt	0.0	0.00	1.22	2.00	2.00	Sag	2.00	0.020	0.020	0.000	0.21	22.70	0.21	22.70	0.0	Off
17	ST-9	4.73	0.00	4.73	0.00	Comb	5.0	3.00	2.70	3.00	1.50	Sag	1.50	0.050	0.020	0.000	0.41	18.06	0.49	18.06	1.0	Off
18	ST-9A	5.42	0.00	5.42	0.00	Comb	5.0	3.00	2.70	3.00	1.50	Sag	1.50	0.050	0.020	0.000	0.45	20.02	0.53	20.02	1.0	Off
19	ST-7A	2.27	0.00	2.27	0.00	Comb	5.0	3.00	2.70	3.00	1.50	Sag	1.50	0.050	0.020	0.000	0.25	10.10	0.33	10.10	1.0	Off
20	ST-7B	1.71	0.00	1.71	0.00	DrGrt	0.0	0.00	1.22	2.00	2.00	Sag	2.00	0.020	0.020	0.000	0.17	19.19	0.17	19.19	0.0	Off
21	ST-7C	1.34	0.00	1.34	0.00	DrGrt	0.0	0.00	1.22	2.00	2.00	Sag	2.00	0.020	0.020	0.000	0.15	16.62	0.15	16.62	0.0	Off
22	ST-7D	1.43	0.00	1.43	0.00	DrGrt	0.0	0.00	1.22	2.00	2.00	Sag	2.00	0.020	0.020	0.000	0.15	17.23	0.15	17.23	0.0	Off
23	ST-7E	1.74	0.00	1.74	0.00	DrGrt	0.0	0.00	1.22	2.00	2.00	Sag	2.00	0.020	0.020	0.000	0.17	19.37	0.17	19.37	0.0	Off

Project File: 29236 Storm (MDP).stm | Number of lines: 24 | Run Date: 9/19/2023

NOTES: Inlet N-Values = 0.016; Intensity = 76.26 / (Inlet time + 6.10) ^ 0.76; Return period = 100 Yrs. ; * Indicates Known Q added. All curb inlets are Horiz throat.

Inlet Report

Line No	Inlet ID	Q = CIA (cfs)	Q carry (cfs)	Q capt (cfs)	Q Byp (cfs)	Junc Type	Curb Inlet		Grate Inlet			Gutter							Inlet			Byp Line No
							Ht (in)	L (ft)	Area (sqft)	L (ft)	W (ft)	So (ft/ft)	W (ft)	Sw (ft/ft)	Sx (ft/ft)	n	Depth (ft)	Spread (ft)	Depth (ft)	Spread (ft)	Depr (in)	
24	ST-3A	5.36	0.00	5.36	0.00	Comb	5.0	3.00	2.70	3.00	1.50	Sag	1.50	0.050	0.020	0.000	0.44	19.84	0.53	19.84	1.0	Off

Project File: 29236 Storm (MDP).stm | Number of lines: 24 | Run Date: 9/19/2023

NOTES: Inlet N-Values = 0.016; Intensity = 76.26 / (Inlet time + 6.10) ^ 0.76; Return period = 100 Yrs. ; * Indicates Known Q added. All curb inlets are Horiz throat.

Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
1	P-2	43.03	30	Cir	60.892	1122.85	1123.97	1.839	1124.50	1126.16	2.56	1126.16	End	Combination
2	P-7	22.29	24	Cir	146.577	1124.67	1125.40	0.498	1126.76*	1128.19*	1.17	1129.36	1	Combination
3	P-8	13.31	24	Cir	143.223	1125.99	1126.53	0.377	1129.86*	1130.36*	0.28	1130.64	2	Manhole
4	P-10	5.00	18	Cir	152.160	1126.80	1127.57	0.506	1130.79*	1131.09*	0.19	1131.28	3	Combination
5	P-11	4.02	18	Cir	33.000	1127.77	1128.47	2.121	1131.32*	1131.36*	0.04	1131.40	4	Combination
6	P-11A	3.06	15	Cir	101.506	1128.67	1129.48	0.798	1131.40*	1131.60*	0.05	1131.64	5	DropGrate
7	P-11B	2.38	15	Cir	77.941	1129.68	1129.99	0.398	1131.68*	1131.77*	0.03	1131.80	6	DropGrate
8	P-11C	1.85	15	Cir	77.940	1130.19	1130.50	0.398	1131.82*	1131.88*	0.02	1131.90	7	DropGrate
9	P-11D	1.32	15	Cir	77.940	1130.70	1131.40	0.898	1131.91	1131.85	0.17	1131.85	8	DropGrate
10	P-3	21.59	24	Cir	236.439	1124.67	1125.26	0.250	1126.81*	1128.97*	1.10	1130.07	1	Combination
11	P-4	12.78	24	Cir	222.933	1125.93	1127.49	0.700	1130.54*	1131.26*	0.39	1131.64	10	Combination
12	P-5	10.57	18	Cir	55.566	1127.69	1127.97	0.504	1131.64*	1132.21*	0.83	1133.04	11	Combination
13	P-6	8.56	18	Cir	33.000	1128.17	1128.28	0.333	1133.23*	1133.45*	0.18	1133.63	12	Combination
14	P-6A	3.89	15	Cir	124.580	1128.48	1128.79	0.249	1133.84*	1134.23*	0.16	1134.38	13	Manhole
15	P-6B	3.96	15	Cir	79.074	1128.99	1129.27	0.354	1134.38*	1134.64*	0.08	1134.72	14	DropGrate
16	P-6C	2.26	15	Cir	254.513	1129.47	1130.39	0.361	1134.83*	1135.09*	0.05	1135.15	15	DropGrate
17	P-9	10.07	24	Cir	199.310	1126.60	1128.25	0.828	1130.76*	1131.15*	0.24	1131.39	3	Combination
18	P-9A	5.42	18	Cir	33.000	1128.35	1129.00	1.970	1131.41*	1131.49*	0.15	1131.64	17	Combination
19	P-7A	7.74	18	Cir	33.000	1126.01	1126.22	0.636	1129.85*	1130.02*	0.15	1130.17	2	Combination
20	P-7B	5.76	15	Cir	102.102	1126.42	1126.83	0.401	1130.17*	1130.99*	0.17	1131.16	19	DropGrate
21	P-7C	4.24	15	Cir	75.340	1127.03	1127.33	0.398	1131.32*	1131.59*	0.09	1131.68	20	DropGrate
22	P-7D	3.04	15	Cir	75.330	1127.53	1127.83	0.398	1131.77*	1131.92*	0.05	1131.97	21	DropGrate
23	P-7E	1.74	15	Cir	75.330	1128.03	1128.65	0.823	1132.03*	1132.08*	0.03	1132.11	22	DropGrate
24	P-3A	5.36	15	Cir	33.000	1126.22	1126.56	1.031	1130.51*	1130.73*	0.30	1131.03	10	Combination

Project File: 29236 Storm (MDP).stm | Number of lines: 24 | Run Date: 9/19/2023

NOTES: Return period = 100 Yrs. ; *Surcharged (HGL above crown).

Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
1	End	60.892	0.00	7.92	0.00	0.00	5.74	0.0	20.7	3.1	17.75	55.62	5.65	30	1.84	1122.85	1123.97	1124.50	1125.40	1132.41	1132.47	P-2
2	1	146.577	0.41	4.06	0.74	0.30	2.94	10.0	20.0	3.2	9.26	15.96	5.07	24	0.50	1124.67	1125.40	1125.85	1126.49	1132.47	1131.47	P-7
3	2	143.223	0.00	2.35	0.00	0.00	1.72	0.0	18.9	3.3	5.60	13.89	4.17	24	0.38	1125.99	1126.53	1126.88	1127.41	1131.47	1134.96	P-8
4	3	152.160	0.17	0.88	0.75	0.13	0.63	10.0	17.2	3.4	2.15	8.09	2.57	18	0.51	1126.80	1127.57	1127.93	1128.12	1134.96	1132.97	P-10
5	4	33.000	0.17	0.71	0.76	0.13	0.50	10.0	16.8	3.5	1.74	16.57	3.21	18	2.12	1127.77	1128.47	1128.31	1128.97	1132.97	1132.97	P-11
6	5	101.506	0.13	0.54	0.69	0.09	0.37	10.0	15.5	3.6	1.35	6.25	3.31	15	0.80	1128.67	1129.48	1129.13	1129.94	1132.97	1132.50	P-11A
7	6	77.941	0.10	0.41	0.70	0.07	0.28	10.0	14.2	3.8	1.07	4.41	2.97	15	0.40	1129.68	1129.99	1130.10	1130.41	1132.50	1133.56	P-11B
8	7	77.940	0.10	0.31	0.68	0.07	0.21	10.0	12.5	4.1	0.86	4.41	2.63	15	0.40	1130.19	1130.50	1130.61	1130.87	1133.56	1133.50	P-11C
9	8	77.940	0.21	0.21	0.68	0.14	0.14	10.0	10.0	4.5	0.65	6.63	2.48	15	0.90	1130.70	1131.40	1131.05	1131.72	1133.50	1134.40	P-11D
10	1	236.439	0.84	3.86	0.74	0.62	2.80	10.0	19.1	3.2	9.07	11.30	4.00	24	0.25	1124.67	1125.26	1126.03	1126.62	1132.47	1131.05	P-3
11	10	222.933	0.38	2.25	0.75	0.29	1.60	10.0	17.3	3.4	5.49	18.92	3.56	24	0.70	1125.93	1127.49	1127.19	1128.32	1131.05	1132.66	P-4
12	11	55.566	0.34	1.87	0.75	0.26	1.32	0.0	17.0	3.5	4.56	7.45	4.42	18	0.50	1127.69	1127.97	1128.54	1128.82	1132.66	1132.98	P-5
13	12	33.000	0.79	1.53	0.75	0.59	1.06	10.0	16.8	3.5	3.71	6.06	2.33	18	0.33	1128.17	1128.28	1129.48	1129.51	1132.98	1132.98	P-6
14	13	124.580	0.00	0.74	0.00	0.00	0.47	0.0	15.5	3.6	1.72	3.49	1.74	15	0.25	1128.48	1128.79	1129.56	1129.63	1132.98	1134.04	P-6A
15	14	79.074	0.34	0.74	0.67	0.23	0.47	10.0	14.7	3.7	1.77	4.16	2.81	15	0.35	1128.99	1129.27	1129.72	1129.84	1134.04	1132.46	P-6B
16	15	254.513	0.40	0.40	0.61	0.24	0.24	10.0	10.0	4.5	1.11	4.21	2.51	15	0.36	1129.47	1130.39	1130.07	1130.80	1132.46	1133.39	P-6C
17	3	199.310	0.68	1.47	0.75	0.51	1.09	10.0	10.4	4.5	4.89	20.58	3.28	24	0.83	1126.60	1128.25	1127.92	1129.03	1134.96	1132.99	P-9
18	17	33.000	0.79	0.79	0.74	0.58	0.58	10.0	10.0	4.5	2.66	14.74	3.09	18	1.97	1128.35	1129.00	1129.28	1129.62	1132.99	1132.99	P-9A
19	2	33.000	0.33	1.30	0.74	0.24	0.92	10.0	14.3	3.8	3.48	8.38	3.78	18	0.64	1126.01	1126.22	1126.87	1126.93	1131.47	1131.47	P-7A
20	19	102.102	0.26	0.97	0.71	0.18	0.67	10.0	13.5	3.9	2.62	4.09	3.54	15	0.40	1126.42	1126.83	1127.15	1127.56	1131.47	1131.49	P-7B
21	20	75.340	0.21	0.71	0.69	0.14	0.49	10.0	12.8	4.0	1.96	4.41	2.93	15	0.40	1127.03	1127.33	1127.81	1127.92	1131.49	1130.95	P-7C
22	21	75.330	0.22	0.50	0.70	0.15	0.34	10.0	11.8	4.2	1.43	4.41	2.79	15	0.40	1127.53	1127.83	1128.17	1128.31	1130.95	1130.83	P-7D

Project File: 29236 Storm (MDP).stm

Number of lines: 24

Run Date: 9/19/2023

NOTES:Intensity = 35.17 / (Inlet time + 5.70) ^ 0.74; Return period =Yrs. 5 ; c = cir e = ellip b = box

Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
23	22	75.330	0.28	0.28	0.67	0.19	0.19	10.0	10.0	4.5	0.85	6.35	2.31	15	0.82	1128.03	1128.65	1128.56	1129.01	1130.83	1131.65	P-7E
24	10	33.000	0.77	0.77	0.75	0.58	0.58	10.0	10.0	4.5	2.63	6.56	3.36	15	1.03	1126.22	1126.56	1127.17	1127.21	1131.05	1131.05	P-3A

Project File: 29236 Storm (MDP).stm

Number of lines: 24

Run Date: 9/19/2023

NOTES:Intensity = 35.17 / (Inlet time + 5.70) ^ 0.74; Return period =Yrs. 5 ; c = cir e = ellip b = box

Inlet Report

Line No	Inlet ID	Q = CIA (cfs)	Q carry (cfs)	Q capt (cfs)	Q Byp (cfs)	Junc Type	Curb Inlet		Grate Inlet			Gutter							Inlet			Byp Line No
							Ht (in)	L (ft)	Area (sqft)	L (ft)	W (ft)	So (ft/ft)	W (ft)	Sw (ft/ft)	Sx (ft/ft)	n	Depth (ft)	Spread (ft)	Depth (ft)	Spread (ft)	Depr (in)	
1	ST-2	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	Off
2	ST-7	1.38	0.00	1.38	0.00	Comb	5.0	3.00	2.70	3.00	1.50	Sag	2.00	0.050	0.020	0.000	0.19	6.44	0.27	6.44	1.0	Off
3	ST-8	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	Off
4	ST-10	0.58	0.00	0.58	0.00	Comb	5.0	3.00	2.40	3.00	1.50	Sag	1.50	0.050	0.020	0.000	0.10	2.61	0.18	2.61	1.0	Off
5	ST-11	0.59	0.00	0.59	0.00	Comb	5.0	3.00	2.40	3.00	1.50	Sag	2.00	0.050	0.020	0.000	0.11	2.53	0.19	2.53	1.0	Off
6	ST-11A	0.41	0.00	0.41	0.00	DrGrt	0.0	0.00	1.22	2.00	2.00	Sag	2.00	0.020	0.020	0.000	0.07	8.60	0.07	8.60	0.0	Off
7	ST-11B	0.32	0.00	0.32	0.00	DrGrt	0.0	0.00	1.22	2.00	2.00	Sag	2.00	0.020	0.020	0.000	0.06	7.59	0.06	7.59	0.0	Off
8	ST-11C	0.31	0.00	0.31	0.00	DrGrt	0.0	0.00	1.22	2.00	2.00	Sag	2.00	0.020	0.020	0.000	0.05	7.49	0.05	7.49	0.0	Off
9	ST-11D	0.65	0.00	0.65	0.00	DrGrt	0.0	0.00	1.22	2.00	2.00	Sag	2.00	0.020	0.020	0.000	0.09	11.00	0.09	11.00	0.0	Off
10	ST-3	2.83	0.45	3.27	0.00	Comb	5.0	3.00	2.70	3.00	1.50	Sag	1.50	0.050	0.020	0.000	0.32	13.59	0.40	13.59	1.0	Off
11	ST-4	1.30	0.00	0.85	0.45	Comb	5.0	3.00	0.00	3.00	1.50	0.007	1.50	0.050	0.020	0.013	0.19	7.49	0.22	4.71	1.0	10
12	ST-5	0.00	0.00	0.00	0.00	Comb	5.0	3.00	2.70	3.00	1.50	Sag	1.50	0.050	0.020	0.000	-0.08	0.00	0.00	0.00	1.0	Off
13	ST-6	2.69	0.00	2.69	0.00	Comb	5.0	3.00	2.70	3.00	1.50	Sag	1.50	0.050	0.020	0.000	0.28	11.64	0.36	11.64	1.0	Off
14	ST-6A	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	Off
15	ST-6B	1.04	0.00	1.04	0.00	DrGrt	0.0	0.00	1.22	2.00	2.00	Sag	2.00	0.020	0.020	0.000	0.12	14.29	0.12	14.29	0.0	Off
16	ST-6C	1.11	0.00	1.11	0.00	DrGrt	0.0	0.00	1.22	2.00	2.00	Sag	2.00	0.020	0.020	0.000	0.13	14.87	0.13	14.87	0.0	Off
17	ST-9	2.32	0.00	2.32	0.00	Comb	5.0	3.00	2.70	3.00	1.50	Sag	1.50	0.050	0.020	0.000	0.25	10.30	0.33	10.30	1.0	Off
18	ST-9A	2.66	0.00	2.66	0.00	Comb	5.0	3.00	2.70	3.00	1.50	Sag	1.50	0.050	0.020	0.000	0.28	11.51	0.36	11.51	1.0	Off
19	ST-7A	1.11	0.00	1.11	0.00	Comb	5.0	3.00	2.70	3.00	1.50	Sag	1.50	0.050	0.020	0.000	0.15	5.35	0.24	5.35	1.0	Off
20	ST-7B	0.84	0.00	0.84	0.00	DrGrt	0.0	0.00	1.22	2.00	2.00	Sag	2.00	0.020	0.020	0.000	0.11	12.68	0.11	12.68	0.0	Off
21	ST-7C	0.66	0.00	0.66	0.00	DrGrt	0.0	0.00	1.22	2.00	2.00	Sag	2.00	0.020	0.020	0.000	0.09	11.09	0.09	11.09	0.0	Off
22	ST-7D	0.70	0.00	0.70	0.00	DrGrt	0.0	0.00	1.22	2.00	2.00	Sag	2.00	0.020	0.020	0.000	0.09	11.47	0.09	11.47	0.0	Off
23	ST-7E	0.85	0.00	0.85	0.00	DrGrt	0.0	0.00	1.22	2.00	2.00	Sag	2.00	0.020	0.020	0.000	0.11	12.80	0.11	12.80	0.0	Off

Project File: 29236 Storm (MDP).stm | Number of lines: 24 | Run Date: 9/19/2023

NOTES: Inlet N-Values = 0.016; Intensity = 35.17 / (Inlet time + 5.70) ^ 0.74; Return period = 5 Yrs. ; * Indicates Known Q added. All curb inlets are Horiz throat.

Inlet Report

Line No	Inlet ID	Q = CIA (cfs)	Q carry (cfs)	Q capt (cfs)	Q Byp (cfs)	Junc Type	Curb Inlet		Grate Inlet			Gutter							Inlet			Byp Line No
							Ht (in)	L (ft)	Area (sqft)	L (ft)	W (ft)	So (ft/ft)	W (ft)	Sw (ft/ft)	Sx (ft/ft)	n	Depth (ft)	Spread (ft)	Depth (ft)	Spread (ft)	Depr (in)	
24	ST-3A	2.63	0.00	2.63	0.00	Comb	5.0	3.00	2.70	3.00	1.50	Sag	1.50	0.050	0.020	0.000	0.27	11.40	0.36	11.40	1.0	Off

Project File: 29236 Storm (MDP).stm | Number of lines: 24 | Run Date: 9/19/2023

NOTES: Inlet N-Values = 0.016; Intensity = 35.17 / (Inlet time + 5.70) ^ 0.74; Return period = 5 Yrs. ; * Indicates Known Q added. All curb inlets are Horiz throat.

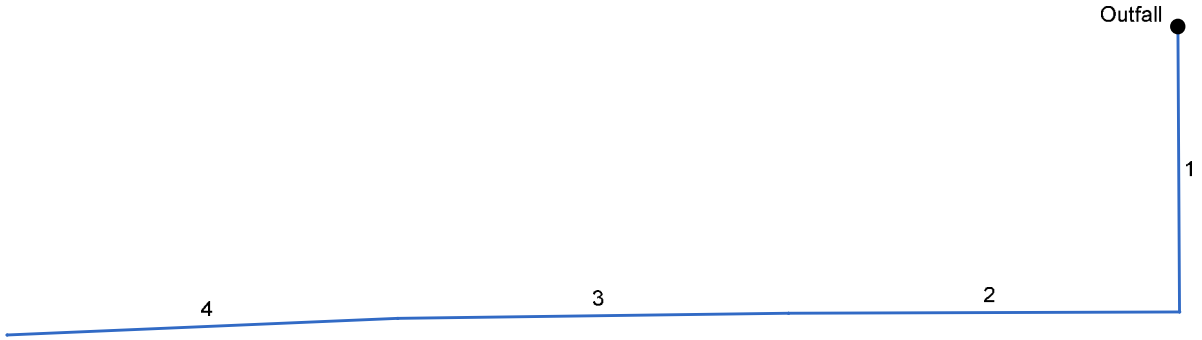
Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
1	P-2	17.75	30	Cir	60.892	1122.85	1123.97	1.839	1124.50	1125.40	n/a	1125.40 j	End	Combination
2	P-7	9.26	24	Cir	146.577	1124.67	1125.40	0.498	1125.85	1126.49	n/a	1126.49	1	Combination
3	P-8	5.60	24	Cir	143.223	1125.99	1126.53	0.377	1126.88	1127.41	0.27	1127.69	2	Manhole
4	P-10	2.15	18	Cir	152.160	1126.80	1127.57	0.506	1127.93	1128.12	n/a	1128.12 j	3	Combination
5	P-11	1.74	18	Cir	33.000	1127.77	1128.47	2.121	1128.31	1128.97	n/a	1128.97 j	4	Combination
6	P-11A	1.35	15	Cir	101.506	1128.67	1129.48	0.798	1129.13	1129.94	0.09	1129.94	5	DropGrate
7	P-11B	1.07	15	Cir	77.941	1129.68	1129.99	0.398	1130.10	1130.41	0.07	1130.48	6	DropGrate
8	P-11C	0.86	15	Cir	77.940	1130.19	1130.50	0.398	1130.61	1130.87	n/a	1130.93 j	7	DropGrate
9	P-11D	0.65	15	Cir	77.940	1130.70	1131.40	0.898	1131.05	1131.72	n/a	1131.72 j	8	DropGrate
10	P-3	9.07	24	Cir	236.439	1124.67	1125.26	0.250	1126.03	1126.62	0.37	1126.99	1	Combination
11	P-4	5.49	24	Cir	222.933	1125.93	1127.49	0.700	1127.19	1128.32	n/a	1128.32 j	10	Combination
12	P-5	4.56	18	Cir	55.566	1127.69	1127.97	0.504	1128.54	1128.82	0.46	1129.28	11	Combination
13	P-6	3.71	18	Cir	33.000	1128.17	1128.28	0.333	1129.48	1129.51	0.04	1129.55	12	Combination
14	P-6A	1.72	15	Cir	124.580	1128.48	1128.79	0.249	1129.56	1129.63	0.06	1129.69	13	Manhole
15	P-6B	1.77	15	Cir	79.074	1128.99	1129.27	0.354	1129.72	1129.84	0.08	1129.92	14	DropGrate
16	P-6C	1.11	15	Cir	254.513	1129.47	1130.39	0.361	1130.07	1130.80	n/a	1130.80	15	DropGrate
17	P-9	4.89	24	Cir	199.310	1126.60	1128.25	0.828	1127.92	1129.03	n/a	1129.03 j	3	Combination
18	P-9A	2.66	18	Cir	33.000	1128.35	1129.00	1.970	1129.28	1129.62	n/a	1129.62 j	17	Combination
19	P-7A	3.48	18	Cir	33.000	1126.01	1126.22	0.636	1126.87	1126.93	0.14	1126.93	2	Combination
20	P-7B	2.62	15	Cir	102.102	1126.42	1126.83	0.401	1127.15	1127.56	0.10	1127.65	19	DropGrate
21	P-7C	1.96	15	Cir	75.340	1127.03	1127.33	0.398	1127.81	1127.92	0.09	1128.01	20	DropGrate
22	P-7D	1.43	15	Cir	75.330	1127.53	1127.83	0.398	1128.17	1128.31	n/a	1128.39 j	21	DropGrate
23	P-7E	0.85	15	Cir	75.330	1128.03	1128.65	0.823	1128.56	1129.01	n/a	1129.01 j	22	DropGrate
24	P-3A	2.63	15	Cir	33.000	1126.22	1126.56	1.031	1127.17	1127.21	n/a	1127.21 j	10	Combination

Project File: 29236 Storm (MDP).stm | Number of lines: 24 | Run Date: 9/19/2023

NOTES: Return period = 5 Yrs. ; j - Line contains hyd. jump.

Hydraflow Storm Sewers Extension for Autodesk® Civil 3D® Plan



Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
1	End	163.670	0.00	1.21	0.00	0.00	0.77	0.0	14.8	7.3	5.61	3.83	5.06	15	0.30	1122.61	1123.10	1123.57	1124.85	1124.86	1126.90	P-12
2	1	223.309	0.34	1.21	0.63	0.21	0.77	10.0	14.1	7.5	5.72	5.23	4.66	15	0.56	1123.30	1124.55	1125.17	1126.67	1126.90	1127.55	P-13
3	2	223.125	0.59	0.87	0.63	0.37	0.55	10.0	13.0	7.7	4.23	5.07	3.45	15	0.52	1124.75	1125.92	1126.84	1127.65	1127.55	1128.92	P-14
4	3	222.899	0.28	0.28	0.64	0.18	0.18	10.0	10.0	8.4	1.50	5.44	2.07	15	0.61	1126.12	1127.47	1127.74	1128.02	1128.92	1130.47	P-15

Project File: 29236 South Backysrds Storm.stm | Number of lines: 4 | Run Date: 9/19/2023

NOTES:Intensity = 127.16 / (Inlet time + 17.80) ^ 0.82; Return period =Yrs. 100 ; c = cir e = ellip b = box

Inlet Report

Line No	Inlet ID	Q = CIA (cfs)	Q carry (cfs)	Q capt (cfs)	Q Byp (cfs)	Junc Type	Curb Inlet		Grate Inlet			Gutter							Inlet			Byp Line No
							Ht (in)	L (ft)	Area (sqft)	L (ft)	W (ft)	So (ft/ft)	W (ft)	Sw (ft/ft)	Sx (ft/ft)	n	Depth (ft)	Spread (ft)	Depth (ft)	Spread (ft)	Depr (in)	
1	ST-12	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	Off
2	ST-13	1.79	0.00	1.79	0.00	DrGrt	0.0	0.00	0.85	2.53	2.00	Sag	2.00	0.020	0.020	0.000	0.16	18.30	0.16	18.30	0.0	Off
3	ST-14	3.11	0.00	3.11	0.00	DrGrt	0.0	0.00	0.85	2.53	2.00	Sag	2.00	0.020	0.020	0.000	0.46	48.28	0.46	48.28	0.0	Off
4	ST-15	1.50	0.00	1.50	0.00	DrGrt	0.0	0.00	0.85	2.53	2.00	Sag	2.00	0.020	0.020	0.000	0.14	16.47	0.14	16.47	0.0	Off

Project File: 29236 South Backysrds Storm.stm | Number of lines: 4 | Run Date: 9/19/2023

NOTES: Inlet N-Values = 0.016; Intensity = 127.16 / (Inlet time + 17.80) ^ 0.82; Return period = 100 Yrs. ; * Indicates Known Q added. All curb inlets are throat.

Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
1	P-12	5.61	15	Cir	163.670	1122.61	1123.10	0.299	1123.57*	1124.85*	0.32	1125.17	End	Manhole
2	P-13	5.72	15	Cir	223.309	1123.30	1124.55	0.560	1125.17*	1126.67*	0.17	1126.84	1	DropGrate
3	P-14	4.23	15	Cir	223.125	1124.75	1125.92	0.524	1126.84*	1127.65*	0.09	1127.74	2	DropGrate
4	P-15	1.50	15	Cir	222.899	1126.12	1127.47	0.606	1127.74	1128.02	0.13	1128.15	3	DropGrate

Project File: 29236 South Backysrds Storm.stm | Number of lines: 4 | Run Date: 9/19/2023

NOTES: Return period = 100 Yrs. ; *Surcharged (HGL above crown).

Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
1	End	163.670	0.00	1.21	0.00	0.00	0.77	0.0	17.5	4.4	3.33	3.83	3.40	15	0.30	1122.61	1123.10	1123.57	1124.00	1124.86	1126.90	P-12
2	1	223.309	0.34	1.21	0.63	0.21	0.77	10.0	16.3	4.5	3.44	5.23	4.07	15	0.56	1123.30	1124.55	1124.19	1125.30	1126.90	1127.55	P-13
3	2	223.125	0.59	0.87	0.63	0.37	0.55	10.0	14.7	4.7	2.59	5.07	4.10	15	0.52	1124.75	1125.92	1125.38	1126.56	1127.55	1128.92	P-14
4	3	222.899	0.28	0.28	0.64	0.18	0.18	10.0	10.0	5.4	0.97	5.44	2.75	15	0.61	1126.12	1127.47	1126.56	1127.86	1128.92	1130.47	P-15

Project File: 29236 South Backysrds Storm.stm | Number of lines: 4 | Run Date: 9/19/2023

NOTES:Intensity = 79.26 / (Inlet time + 14.60) ^ 0.84; Return period =Yrs. 5 ; c = cir e = ellip b = box

Inlet Report

Line No	Inlet ID	Q = CIA (cfs)	Q carry (cfs)	Q capt (cfs)	Q Byp (cfs)	Junc Type	Curb Inlet		Grate Inlet			Gutter							Inlet			Byp Line No
							Ht (in)	L (ft)	Area (sqft)	L (ft)	W (ft)	So (ft/ft)	W (ft)	Sw (ft/ft)	Sx (ft/ft)	n	Depth (ft)	Spread (ft)	Depth (ft)	Spread (ft)	Depr (in)	
1	ST-12	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	Off
2	ST-13	1.16	0.00	1.16	0.00	DrGrt	0.0	0.00	0.85	2.53	2.00	Sag	2.00	0.020	0.020	0.000	0.12	14.22	0.12	14.22	0.0	Off
3	ST-14	2.02	0.00	2.02	0.00	DrGrt	0.0	0.00	0.85	2.53	2.00	Sag	2.00	0.020	0.020	0.000	0.20	21.54	0.20	21.54	0.0	Off
4	ST-15	0.97	0.00	0.97	0.00	DrGrt	0.0	0.00	0.85	2.53	2.00	Sag	2.00	0.020	0.020	0.000	0.11	12.85	0.11	12.85	0.0	Off

Project File: 29236 South Backysrds Storm.stm

Number of lines: 4

Run Date: 9/19/2023

NOTES: Inlet N-Values = 0.016; Intensity = 79.26 / (Inlet time + 14.60) ^ 0.84; Return period = 5 Yrs. ; * Indicates Known Q added. All curb inlets are throat.

Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
1	P-12	3.33	15	Cir	163.670	1122.61	1123.10	0.299	1123.57	1124.00	0.19	1124.19	End	Manhole
2	P-13	3.44	15	Cir	223.309	1123.30	1124.55	0.560	1124.19	1125.30	n/a	1125.30 j	1	DropGrate
3	P-14	2.59	15	Cir	223.125	1124.75	1125.92	0.524	1125.38	1126.56	n/a	1126.56	2	DropGrate
4	P-15	0.97	15	Cir	222.899	1126.12	1127.47	0.606	1126.56	1127.86	n/a	1127.86 j	3	DropGrate

Project File: 29236 South Backysrds Storm.stm | Number of lines: 4 | Run Date: 9/19/2023

NOTES: Return period = 5 Yrs. ; j - Line contains hyd. jump.

Combination Inlets in Sags

Combination inlets use a grate and a curb opening inlet. An equal length combination inlet has a curb opening that is the same length as the grate. When the curb opening is longer than the grate length, the inlet is called a sweeper inlet.

The procedures for combination inlets in sag start with a trial inlet depth measured at the face of the curb at the inlet. The trial depth is used to calculate a resulting trial flow. The trial is repeated with a larger depth until the resulting trial flow is equal to or greater than the design flow at the inlet.

Equal length inlets

The interception capacity of equal length combination inlets in sags is equal to that of the grate alone in weir flow. As the depth over the grate increases, it changes from weir flow to orifice flow. In orifice flow, the capacity of the equal length combination inlet is equal to the capacity of the grate plus the capacity of the curb opening (ref. HEC-22).

Computing the flow through the grate of an equal length inlet

The trial depth at the inlet is used to find the flow at the grate by using the smaller flow from the weir and orifice equations. The depth of water over the grate used in these equations is the average depth found at the center of the grate. Therefore, based on the inlet and depression dimensions, the trial depth is altered to use the corresponding depth over the center of the grate.

The equation for the weir flow at the grate is:

$$Q = CwPd^{1.5}$$

Where:

Cw = 3.0 (1.66)

P = Perimeter of the grate in ft (m) disregarding the side against the curb

d = Depth of water over the center of the grate, in ft (m). The trial inlet depth is adjusted to use the depth over the center of the grate.

The equation for orifice flow at the grate is:

$$Q = CoAg\sqrt{2gd}$$

Where:

Co = 0.67

Ag = Clear opening area in sqft (sqm)

g = 32.16 (9.8) gravity

d = Depth of water over the center of the grate in ft (m). The trial inlet depth is adjusted to use the depth over the center of the grate.

If the resulting trial flow is from the weir equation, it alone is compared to the design flow.

If the resulting trial flow is from the orifice equation, it will be increased by the flow through the curb opening. The same trial depth is used to find the flow through the curb opening using the methods described in the procedure for curb inlets. The total trial flow (from combining the grate and curb opening) is compared to the design flow.

Computing the flow through the curb opening of an equal length inlet

Curb inlets operate as weirs to depths equal to the curb opening height, and as orifices at depths greater than 1.4 times the total curb opening height (equal to the sum of the throat height, local depression, and gutter depression). At depths in between, flow is in transition stage.

In transition flow, Hydraflow Storm Sewers Extension solves both the weir and the orifice equations using the trial depth, and uses the smaller flow rate.

The equation that is used depends on whether the curb opening is a depressed or non-depressed inlet.

Depressed curb opening

The equation used for the interception capacity of the inlet operating as a weir is:

$$Q = Cw(L + 1.8W)d^{1.5}$$

Where:

Cw = 2.3 (1.25)

L = Length of curb opening in ft (m)

W = Gutter width in ft (m)

d = Depth at the face of the curb, measured from the cross slope, Sx, in ft (m). The trial depth at the face of the curb is adjusted to use the depth above the cross slope, Sx.

NOTE:

- If L > 12 ft., the equation for non-depressed inlets is used, as specified in HEC-22.
- The equation for depressed curb opening is used when there is either local depression, gutter depression only, or both local and gutter depression. HEC-22 indicates that this

equation will yield conservative estimates of the interception capacity for curb-opening inlets with a continuously depressed gutter.

Non-depressed curb inlets

The following equation is used to determine the interception capacity of inlets without any depression when operating as a weir:

$$Q = CwLd^{1.5}$$

Where:

Cw = 3.0 (1.60)

L = Length of curb opening in ft (m)

d = Depth at the face of the curb, measured from the cross slope, Sx, in ft (m)

Operating as an orifice

The equation used for the interception capacity of the curb inlet (depressed and non-depressed) operating as an orifice is:

$$Q = CohL\left(\sqrt{2gd_o}\right)$$

Where:

Co = 0.67

H = Total height of the curb opening orifice in ft, which is the sum of the throat height, gutter depression, and local depression.

L = Length of the curb opening orifice in ft

g = 32.2 (9.8) gravity

do = Depth measured to the center of the inlet opening in ft (m). The trial depth is adjusted to use the center of the inlet opening.

Trial depth iterations

The resulting flow from the curb opening is added to the resulting flow from the grate to create the trial flow.

NOTE: Both weir and orifice equations are used independently for the grate and curb inlet analysis, so the curb opening could be in weir flow, while the grate is in orifice flow.

The resulting trial flow is compared to the design flow to the inlet. The trial is repeated with a

larger depth until the resulting trial flow is equal to or greater than the design flow at the inlet.

Sweeper inlets

When the curb opening length of a combination inlet is larger than the grate length, the inlet is a sweeper inlet, and the extra length of the opening always contributes to the capacity of the combination inlet in sag. If the grate is in weir flow conditions, only the extra length of the curb opening contributes to the capacity. If the grate is in orifice flow conditions, the entire length of the curb opening contributes to the capacity.

The following procedure for sweeper inlets is the same as for equal length inlets, except that the extra length of the curb opening is combined with the grate flow.

Computing the flow through the grate of a sweeper inlet

The trial depth at the inlet is used to find the flow at the grate by using the smaller flow from the weir and orifice equations. The depth of water over the grate used in these equations is the average depth found at the center of the grate. Therefore, the trial depth is altered to use the corresponding depth over the center of the grate, based on the inlet and depression dimensions.

The equation for weir flow at the grate is:

$$Q = CwP\,d^{1.5}$$

Where:

Cw = 3.0 (1.66)

P = Perimeter of the grate in ft (m), disregarding the side against the curb

d = Depth of water over the center of the grate, in ft (m). The trial inlet depth is adjusted to use the depth over the center of the grate.

The equation for orifice flow at the grate is:

$$Q = CoAg\sqrt{2gd}$$

Where:

Co = 0.67

Ag = Clear opening in sqft (sqm)

g = 32.16 (9.8) gravity

d = Depth of water over the center of the grate, in ft (m). The trial inlet depth is adjusted to use the depth over the center of the grate.

Computing the flow through the curb opening of a sweeper inlet

Curb inlets operate as weirs to depths equal to the curb opening height, and as orifices at depths greater than 1.4 times the total curb opening height (equal to the sum of the throat height, local depression, and gutter depression). At depths in between, flow is in a transition stage.

In transition flow, Hydraflow Storm Sewers Extension solves both the weir and orifice equations using the trial depth, and uses the smaller flow rate.

The equation that is used depends on whether the curb opening is a depressed or non-depressed inlet.

The length in the equations is initially the additional length beyond the grate length. This is combined with the weir flow through the grate to determine the total resulting trial flow. When the grate becomes orifice flow, the length equal to the grate length is also used to compute the flow through that section of the curb opening. The two sections of the curb opening are computed separately and added together with the grate flow to determine the total resulting trial flow.

Depressed curb opening

The equation used for the interception capacity of the inlet operating as a weir is:

$$Q = Cw(L + 1.8W)d^{1.5}$$

Where:

Cw = 2.3 (1.25)

L = Length of curb opening in ft (m) (either length of grate or length beyond the grate)

W = Gutter width in ft (m)

d = Depth at the face of the curb, measured from the cross slope, Sx, in ft (m). The trial depth at the face of the curb is adjusted to use the depth above the cross slope, Sx.

NOTE:

- If L > 12 ft., the equation for non-depressed inlets is used, as specified in HEC-22.
- The equation for a depressed curb opening is used when there is local depression, gutter depression only, or both local and gutter depression. HEC-22 indicates that this equation will yield conservative estimates of the interception capacity for curb-opening inlets with a continuously depressed gutter.

Non-depressed curb inlets

The following equation is used to determine the interception capacity of inlets without any depression when operating as a weir:

$$Q = CwLd^{1.5}$$

Where:

Cw = 3.0 (1.60)

L = Length of curb opening in ft (m) (either length of grate or length beyond the grate)

d = Depth at the face of the curb, measured from the cross slope, Sx, in ft (m)

Operating as an orifice

The equation used for the interception capacity of the curb inlet (depressed and non-depressed) operating as an orifice is:

$$Q = CohL\left(\sqrt{2gd_o}\right)$$

Where:

Co = 0.67

H = Total height of the curb opening orifice in ft, which is the sum of the throat height, gutter depression, and local depression.

L = Length of curb opening orifice in ft (m)

g = 32.2 (9.8) gravity

do = Depth measured to the center of the inlet opening in ft (m). The trial depth is adjusted to the center of the inlet opening.

Trial depth iterations

When the trial depth results in a weir flow through the grate that is less than the orifice flow result, the weir flow result is combined with the flow through the extra length of curb opening for the total resulting trial flow. The resulting trial flow is compared to the design flow to the inlet. The trial is repeated with a larger depth until the resulting trial flow is equal to or greater than the design flow at the inlet.

When the grate flow becomes orifice flow, the length of the curb opening equal to the grate length is also added for the total resulting trial flow.

NOTE: Both weir and orifice equations are used independently for the grate and each section of the curb inlet analysis, so the results may produce different sections in weir or orifice flow.

Combination inlet design

Setting the grate dimensions to 0 (zero) will assign default values. If the curb opening inlet length is set to zero or the grate width is set to zero, the default value from the Design Codes will be used. If the grate length is set to zero, Hydraflow Storm Sewers Extension will calculate a length value. This length value will vary as the width value varies, but it is not computed using the flow value so it does not represent a computed design length. The open area will be computed as the product of the length and the width values.

Appendix G: Riprap Design Calculations

RIPRAP SIZING: MILBANK, SD

OUTLET	Y (ft)	Sf	Cs	Cv	Ct	V (fps)	K1	Sg	D50 (SIZE)	CLASS
FES-1	2.21	1.2	0.3	1	1	10.98	0.994	2.48	1.139	A
FES-12	1.39	1.2	0.3	1	1	5.06	0.994	2.48	0.184	A
FES-16	0.65	1.2	0.3	1	1	3.14	0.168	2.48	0.623	B

15.7.1 Riprap Size

The EM-1601 Equation can be used with uniform or gradually varying flow. Coefficients are included to account for the desired safety factor for design, specific gravity of the riprap stone, bank slope and bendway character. The EM-1601 Equation is:

$$D_{30} = y(S_f C_S C_V C_T)\left[\frac{(V_{des})}{\sqrt{K_1 (S_g - 1)gy}}\right]^{2.5} \qquad \text{(Equation 15.4)}$$

where:

D_{30} = particle size for which 30% is finer by weight, ft

y = local depth of flow above particle, ft

S_f = safety factor (should be > 1.0)

C_s = stability coefficient (for blanket thickness = D_{100} or $1.5D_{50}$, whichever is greater, and uniformity ratio D_{85}/D_{15} = 1.7 to 5.2)

= 0.30 for angular rock

= 0.375 for rounded rock

C_v = velocity distribution coefficient

= 1.0 for straight channels or the inside of bends

= $1.283 - 0.2 \log(R_c/W)$ for the outside of bends (1.0 for $R_c/W > 26$)

= 1.25 downstream from concrete channels

= 1.25 at the end of dikes

C_T = blanket thickness coefficient given as a function of the uniformity ratio D_{85}/D_{15}. C_T = 1.0 is recommended because it is based on very limited data.

V_{des} = characteristic velocity for design, defined as the depth-averaged velocity at a point 20% upslope from the toe of the revetment, fps:

For natural channels: $V_{des} = V_{avg}(1.74 - 0.52\log(R_c/W))$
$V_{des} = 0.90V_{avg}$ for $R_c/W > 42$

For trapezoidal channels: $V_{des} = V_{avg}(1.71 - 0.78 \log (R_c/W))$
$V_{des} = 0.82V_{avg}$ for $R_c/W > 14$

V_{avg} = channel cross-sectional average velocity, fps

K_1 = side slope correction factor

$$= \sqrt{1 - \left(\frac{\sin(\theta - 14°)}{\sin(32°)}\right)^{1.6}}$$

where θ is the bank angle in degrees

R_c = centerline radius of curvature of channel bend, ft

W = width of water surface at upstream end of channel bend, ft

S_g = specific gravity of riprap (usually taken as 2.48 by SDDOT)

g = acceleration due to gravity, 32.2 ft/sec^2

The values of the coefficients used in the EM-1601 Equation are provided in the variable definitions as given above. They can also be determined graphically from charts provided in Appendix B of EM-1601. Using the recommended riprap gradations from HEC 23 (Reference (1)), the D_{30} size of the riprap determined by Equation 15.4 is related to the recommended median (D_{50}) size by:

$$D_{50} = 1.20D_{30} \qquad \text{(Equation 15.5)}$$