Preliminary Storm Drainage Report

Sherwood Oldtown Apartments

Sherwood, Oregon

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VALID THROUGH 12–31–22

Date: October 22, 2021
Revised: December 27, 2021
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PDG Job No. 112-026

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1.0 INTRODUCTION

This report represents the **preliminary** storm drainage and stormwater analysis for the Sherwood Oldtown Apartments development project. The basis of this report is to comply with the City of Sherwood, Clean Water Services (CWS), and the State of Oregon's regulations and engineering standards as well as the latest edition of the Oregon Plumbing Specialty Code (OSPC). Compiled in this report are the design criteria for the site, the hydrologic methodology, and the **preliminary** drainage analysis.

2.0 SITE DESCRIPTION AND LOCATION

The proposed project is a 3-parcle partition for the development of a 24-unit apartment building with associated parking and utilities. There will also be two single-family detached homes on separate parcels. The property is identified as tax lot 400 of Tax Map 2S132BD and is approximately 1.18 acres. The site is currently addressed as 15665 SW Willamette Street and is located east of SW Pine Street and south of SW Columbia Street. The property lies within the Old Town Overlay District (Old Cannery Area) and is zoned High Density Residential (HDR) by the City of Sherwood's land use ordinance.

3.0 EXISTING CONDITIONS

The site is currently vacant and well vegetated with trees, shrubs, and grasses. A wetland has been identified on the property. Based on available jurisdictional maps, the site does not contain a 100-year floodplain or regionally significant habitat.

The site has frontage along three public streets including SW Pine Street to the west, SW Willamette Street to the south and SW Columbia Street to the north. Existing City storm, sanitary and water systems surround the property and are available for use to serve the development.

3.1 Site Topography

The property is relatively flat, sloping from the northeast to the southwest. The high point of the site is along the north boundary line an elevation of approximately 196 feet with a relative low point due to the wetlands in the southwest corner of the property at an approximate elevation of 189 feet.

The properties abutting the site are all zoned High Density Residential. Parcels across SW Columbia Street, north of the site, are zoned Retail Commercial (RC) while the properties south of the subject site are zoned Medium Density Residential Low (MDRL).

3.2 Soil Type

The predominant soil found on site is a mix of Aloha silt loam and Huberly silt loam with the corresponding hydrologic soil group (HSG) designation 'C/D', as shown on the attached Natural Resources Conservation Service (NRCS) soil survey for Washington County.

Table 3-2: Hydrologic Soil Group Ratings		
NRCS Map Unit Symbol	**NRCS Map Unit Name**	**Hydrologic Soil Group Rating**
1	Aloha silt loam	C/D
2225A	Huberly silt loam, 0 to 3 percent slopes	C/D

3.3 Runoff Curve Numbers

Predeveloped pervious areas will use a composite Runoff Curve Number (RCN) of 73.5 corresponding to "Woods" cover type (HSG designations 'C' and 'D') in good condition. Developed pervious areas will use a composite Runoff Curve Number (RCN) of 77 corresponding to "Open Space" cover type (HSG designations 'C' and 'D') in good condition. A runoff curve number of 98 will be used for all predeveloped and developed impervious areas (refer to the *SCS Runoff Curve Numbers* Exhibit).

Table 3.3 – Runoff Curve Numbers		
Land Description	**Existing RCN**	**Proposed RCN**
Woods, Good Condition	73.5	N/A
Open Space, Good Condition	N/A	77
Impervious	98	98

4.0 PROPOSED IMPROVEMENTS

We will be constructing impervious surfaces as a result of the public street improvements and private driveway along with the eventual townhomes and sidewalks. Private utilities will be extended into the site for the use of the mixed-use development.

The project will treat its collected runoff through a combination of LIDA planters, rain gardens, and proprietary single-cartridge stormfilter catch basins. Underground Stormtech detention chambers will provide detention for the site. The proposed storm drainage system will convey runoff into an existing public main located in SW Pine Street.

4.1 Hydrology/Hydraulic Methodology

Using the Santa Barbara Urban Hydrograph (SBUH) method based on a Type 1A rainfall distribution, the site has been analyzed to determine the proposed peak runoff rates for the 2, 5, 10, and 25-year 24-hour storm event. The SBUH method uses runoff curve numbers in conjunction with the property's hydrologic soil group to model the site's permeability.

A predeveloped time of concentration of 97.7 minutes and a developed time of concentration of 6.5 minutes were calculated using the methodology outlined in the TR-55 technical manual *(refer to the Time of Concentration Calculations and Exhibits)*.

Rainfall depths for all storm events used in the calculations and design of the proposed storm drainage system are found in latest edition of Clean Water Services (CWS) Design and Construction Standards and as shown below.

Table 4.1 – 24-Hour Rainfall Depth (CWS)

Recurrence Interval, Years	2	5	10	25
24-Hour Depths, Inches	2.50	3.10	3.45	3.90

4.2 Water Quality

As required by Clean Water Services, we will treat runoff from any new impervious surface created as a result of the proposed development and for any existing impervious areas to remain. The water quality facilities will be designed to treat storm water generated by 0.36 inches of precipitation falling in 4 hours with an average storm return period of 96 hours. The water quality facilities, in conjunction with the sumped catch basins, will remove a minimum of 65% of the Total Phosphorous (TP) from the storm water runoff.

Owners of new development and other activities which create or modify 1,000 square feet or greater of impervious surfaces, or increase the amount of stormwater runoff or pollution leaving the site, are required to implement or fund permanent water quality approaches to reduce contaminants entering the storm and surface water system.

Runoff from the majority of the site (Lot 1) will be treated in two rain gardens located on the southwest end of the site and two LIDA planters located next to the drive aisle. In areas of the parking lot where runoff cannot be directed into these facilities, treatment will be provided by proprietary single-cartridge stormfilter catch basins *(refer to Appendix 'E' – Stormfilter Catch Basin Detail)*. These facilities will provide treatment for all contributing onsite impervious surfaces in accordance with the Clean Water Services' *"Design and Construction Standard's for Sanitary and Storm Water Management"* (R&O 19-22) Section 4.04.

Parcels 2 and 3 will be partitioned into individual lots. Due to site constraints, it is impractical and inefficient to provide water quality treatment for runoff from the two single-family lots at the south end of the property. Instead, we are requesting a water quality fee-in-lieu payment for these lots. The total impervious area requiring fee-in-lieu is 5,280 SF.

The new impervious area within public right-of-way created by widening SE Willamette Street and installing new sidewalks, as well as impervious areas modified by installing driveway approaches, are not collected and will not be treated with this project. An existing downstream regional public water quality facility located on SW Columbia Street adjacent to the railroad treats surface water from the downtown area *(see Appendix 'G' – Stormwater Report for the Columbia Street Regional Water Quality Facility)*.

Table 4.2 – Site Cover Type (Existing)		
Cover Type	**Area (sq. ft.)**	**Area (acres)**
Impervious Area	0	0.00
Pervious Area	50,555	1.16
Total	50,555	1.16

Table 4.2.1 – Site Cover Type (Proposed)		
Cover Type	**Area (sq. ft.)**	**Area (acres)**
Impervious Area	33,839	0.78
Pervious Area	16,716	0.38
Total	50,555	1.16

Except for the two single-family lots, all on-site impervious areas will be treated per CWS requirements by the aforementioned LIDA planters, rain gardens, and filter catch basins.

4.3 Detention & Hydromodification

Water quantity control (detention) is being provided with this development in underground detention chambers as per the requirements of a Category 2 Hydromodification assessment. To satisfy the hydromodification criteria, the project proposes to use Peak-Flow Matching Detention in accordance with Clean Water Services' Design and Construction Standard's for Sanitary and Storm Water Management Section 4.08.6.

Due to topographic constraints, it is not feasible to provide detention for runoff from the two single-family lots. In exchange, the detention facility for the apartment site will over-detain its stormwater to include the runoff not being managed by the two residential properties.

Underground detention will be provided by StormTech ADS SC-310 detention chambers. Runoff from the site will flow into seven rows of 26 chambers located underneath the parking lot. 12" of drainage rock will be placed below the chambers, and 6" of rock will be placed above them. The bottom of the drainage rock will be at an elevation of 187.69, approximately 5 feet below the top of pavement.

In the 25-year storm, the water level in the underground detention facility will rise to an elevation of 102.81, near the top of the 6" of drainage rock on top of the chambers.

A flow control manhole with two orifices will attenuate the post-developed peak runoff for the 2, 5, 10-year storm events to the respective 50%-2 year, 5-year, and 10-year predeveloped peak flows for the facility. Orifice "A" will be sized to attenuate the 2-year storm, while Orifice "B" will be set above the 2-year storm elevation to attenuate larger storms. The top of the baffle wall will be set at an elevation of 102.78 to provide emergency overflow for the 25-year and 100-year storms. The underground detention facility will have a final total storage volume of 5,816 cubic feet (refer to *Appendix B*).

Table 4.3 – Underground Detention

Storm Event (yr)	Pre-Developed (cfs)	Developed (cfs)	Released Outflow (cfs)
2	0.04	0.49	0.02
5	0.08	0.64	0.08
10	0.11	0.73	0.11

4.4 Conveyance

The conveyance system for the site consists of an underground pipe system, underground detention facility, roof drains, and filtered catch basins. Stormwater from the site will be conveyed to an existing 27" storm system located in SW Pine Street. As per the requirements of CWS, the drainage system will be designed to convey the 25-year storm event and comply with the requirements of the Uniform Plumbing Code.

The pipes leading from the underground detention facility to the existing storm main will be 12" PVC at a slope of 0.005 ft/ft. Using a Manning's 'n' value of 0.013, a 12" pipe at a slope of 0.005 ft./ft. has capacity to convey the 25-year storm event for the entire

site. All storm pipes draining to the underground detention facility will be 6" PVC, with a minimum slope of 0.010 ft/ft. Using a Manning's 'n' value of 0.013, a 6" pipe at a slope of 0.010 ft./ft. has enough capacity to convey the 25-year storm event for half of the site (refer to the *Stormwater Conveyance Calculations*).

5.0 DOWNSTREAM ANALYSIS

Per CWS Section 2.04.2.m.3.A, any development constructing new impervious surface of greater than 5,280 square feet, or collecting and discharging greater than 5,280 square feet of impervious area shall perform a capacity and condition analysis of existing downstream storm facilities and conveyance elements receiving flow from the proposed development. The analysis shall extend downstream shall continue for one-quarter (1/4) of a mile; or until the additional flow constitutes less than 5 percent of the total tributary drainage flow.

Runoff from the development is discharged into an existing 27-inch storm main in SW Pine Street. The existing main conveys stormwater downstream to the southwest where it connects to a 30" pipe in SW Odge Gribble Lane before upsizing into a 36" and 42" pipe and ultimately discharging into the Columbia Street Regional Water Quality Facility.

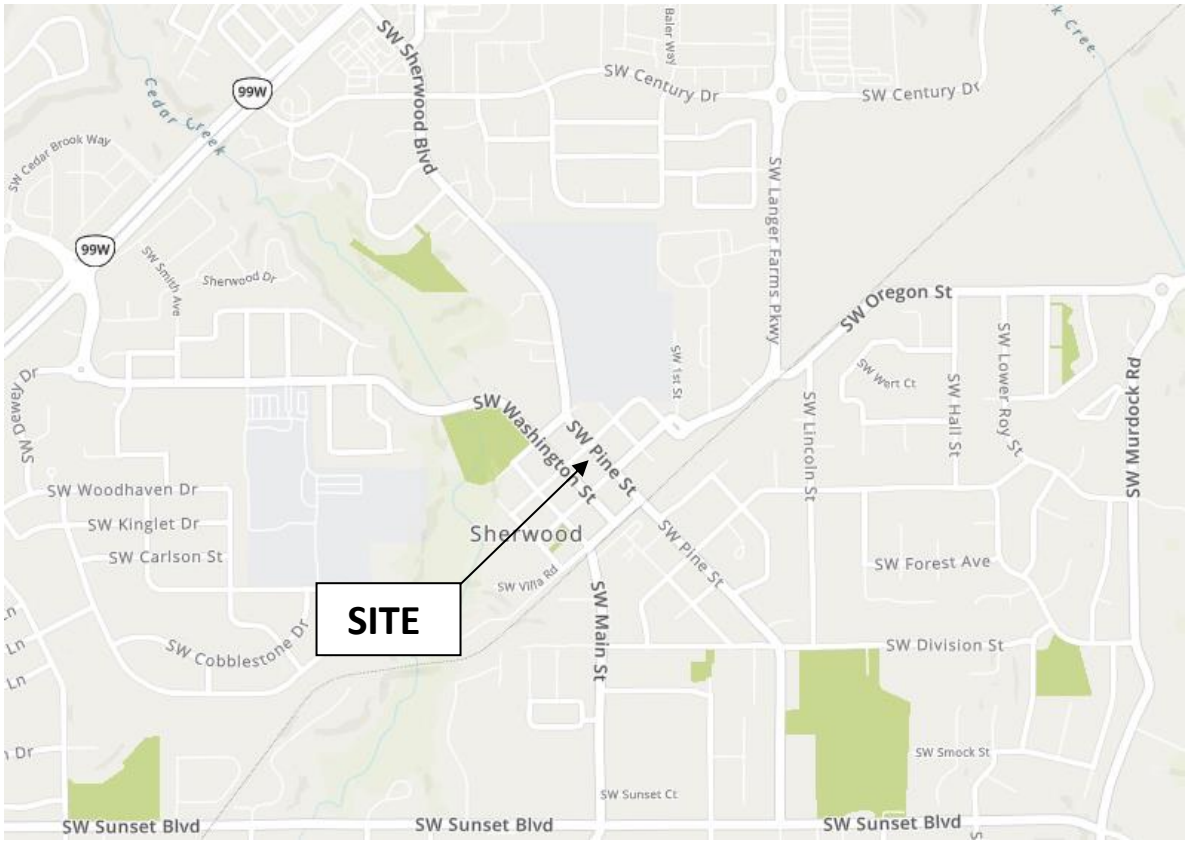
As shown in *Appendix 'G' – Stormwater Management Report for the Columbia Street Water Quality Facility*, a downstream analysis of existing and future stormwater improvements for this storm network was conducted determining the system had capacity to convey runoff from the proposed development.

Furthermore, detention is provided on site and the development will not increase peak runoff nor exacerbate any potential downstream restrictions.

6.0 CONCLUSION

Based on the supporting stormwater calculations and attached analysis, it is the opinion of Pioneer Design Group that the development of the Sherwood Oldtown Apartments project will not adversely affect the existing downstream drainage system or adjacent property owners. Therefore, all the requirements associated with the City of Sherwood and Clean Water Services' design and construction standards have been met for this project.

7.0 VICINITY MAP



ENGINEERING CALCULATIONS & SPREADSHEETS

Map Scale: 1:692 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 10 20 40 60

Feet: 0 30 60 120 180

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features

- Streams and Canals

Transportation

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

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

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: Washington County, Oregon
Survey Area Data: Version 20, Aug 26, 2021

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

Date(s) aerial images were photographed: Sep 19, 2018—Oct 20, 2018

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
1	Aloha silt loam	C/D	0.6	48.9%
2225A	Huberly silt loam, 0 to 3 percent slopes	C/D	0.6	51.1%
Totals for Area of Interest			**1.2**	**100.0%**

Description

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

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

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

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

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

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

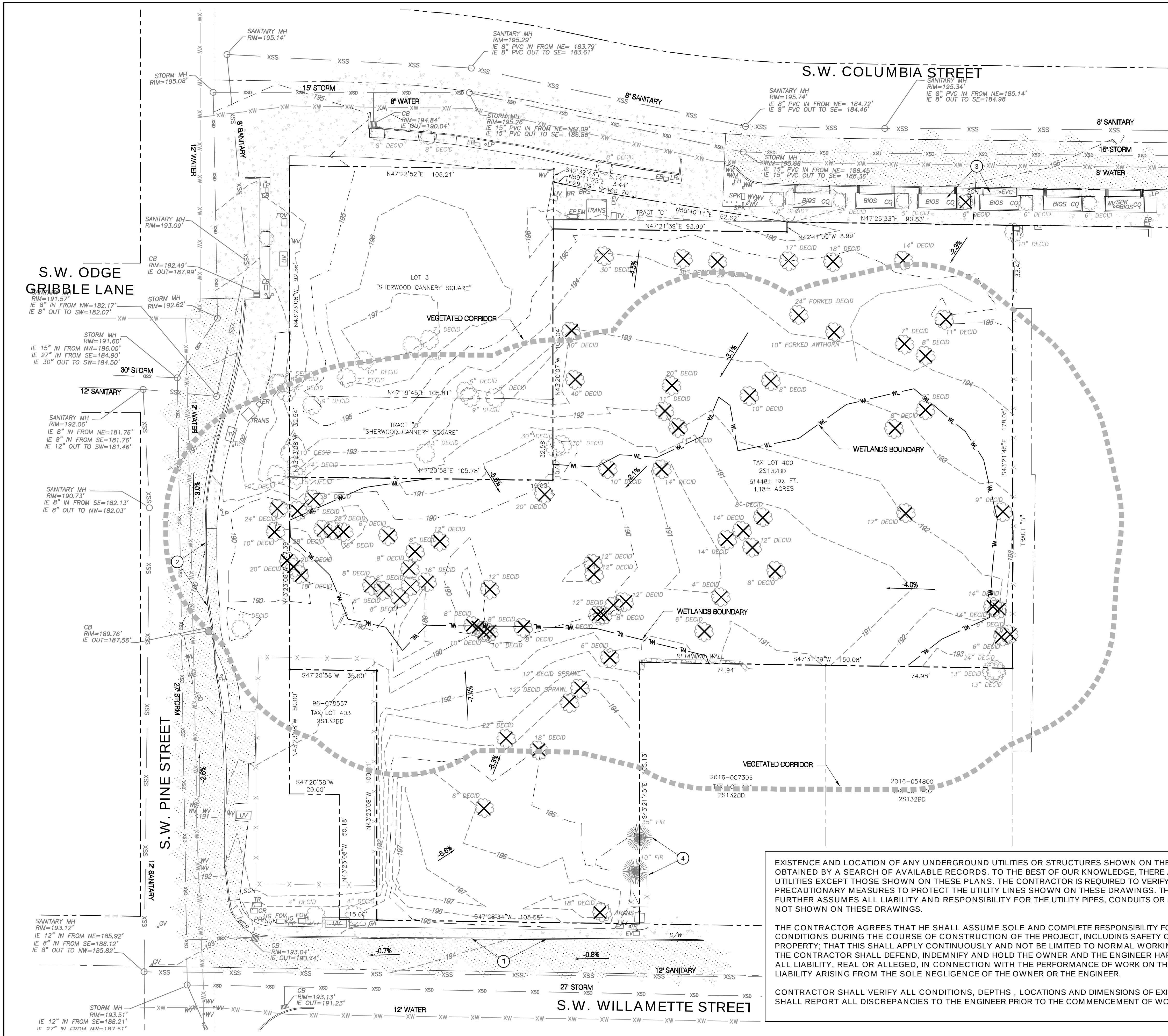
If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher



LEGEND

- RIGHT-OF-WAY LINE
- BOUNDARY LINE
- EXISTING LOT LINE
- CENTER LINE
- STORM DRAINAGE LINE
- SANITARY SEWER LINE
- WATER LINE
- EXISTING FENCE
- EXISTING 1' CONTOUR
- EXISTING 5' CONTOUR
- CONIFEROUS TREE (DBH)
- DECIDUOUS TREE (DBH)
- CATCH BASIN/DRAIN INLET
- STORM MANHOLE
- STORM CLEANOUT
- SANITARY MANHOLE
- WATER VALVE
- FIRE HYDRANT ASSEMBLY
- WATER METER
- GAS VALVE
- STREET SIGN
- ELECTRICAL TRANSFORMER
- POWER POLE
- BIKE RACK
- LIGHT POLE
- FOUND SURVEY MONUMENT
- EXISTING CONCRETE
- EXISTING ASPHALT PAVEMENT
- CONIFEROUS TREE TO BE REMOVED
- DECIDUOUS TREE TO BE REMOVED

DEMOLITION NOTES

1. EXISTING CURB AND SIDEWALK TO BE REMOVED FRONTING THE SITE ON SW WILLAMETTE STREET.
2. A PORTION OF THE EXISTING CURB AND ASPHALT SIDEWALK TO BE REMOVED ALONG SW PINE STREET.
3. A PORTION OF THE EXISTING CURB, SIDEWALK, AND LIDA FACILITIES TO BE REMOVED ALONG SW COLUMBIA STREET.
4. EXISTING TREES TO BE PROTECTED DURING CONSTRUCTION.

GENERAL NOTES

1. TOPOGRAPHIC SURVEY PROVIDED BY CASWELL/HERTEL SURVEYORS INC., DATED APRIL 12, 2021.

TREE TABLE

TREE DIAMETER	QUANTITY
DECIDUOUS, 7-12" DBH	29
DECIDUOUS, 12-18" DBH	18
DECIDUOUS, 18-24" DBH	9
DECIDUOUS, >24" DBH	12
EVERGREEN, 10" DBH	1
EVERGREEN, 35" DBH	1

EXISTENCE AND LOCATION OF ANY UNDERGROUND UTILITIES OR STRUCTURES SHOWN ON THESE PLANS ARE OBTAINED BY A SEARCH OF AVAILABLE RECORDS. TO THE BEST OF OUR KNOWLEDGE, THERE ARE NO EXISTING UTILITIES EXCEPT THOSE SHOWN ON THESE PLANS. THE CONTRACTOR IS REQUIRED TO VERIFY AND TAKE DUE PRECAUTIONARY MEASURES TO PROTECT THE UTILITY LINES SHOWN ON THESE DRAWINGS. THE CONTRACTOR FURTHER ASSUMES ALL LIABILITY AND RESPONSIBILITY FOR THE UTILITY PIPES, CONDUITS OR STRUCTURES SHOWN OR NOT SHOWN ON THESE DRAWINGS.

THE CONTRACTOR AGREES THAT HE SHALL ASSUME SOLE AND COMPLETE RESPONSIBILITY FOR THE JOB SITE CONDITIONS DURING THE COURSE OF CONSTRUCTION OF THE PROJECT, INCLUDING SAFETY OF ALL PERSONS AND PROPERTY; THAT THIS SHALL APPLY CONTINUOUSLY AND NOT BE LIMITED TO NORMAL WORKING HOURS; AND THAT THE CONTRACTOR SHALL DEFEND, INDEMNIFY AND HOLD THE OWNER AND THE ENGINEER HARMLESS FROM ANY AND ALL LIABILITY, REAL OR ALLEGED, IN CONNECTION WITH THE PERFORMANCE OF WORK ON THIS PROJECT, EXCEPT FOR LIABILITY ARISING FROM THE SOLE NEGLIGENCE OF THE OWNER OR THE ENGINEER.

CONTRACTOR SHALL VERIFY ALL CONDITIONS, DEPTHS, LOCATIONS AND DIMENSIONS OF EXISTING UTILITIES AND SHALL REPORT ALL DISCREPANCIES TO THE ENGINEER PRIOR TO THE COMMENCEMENT OF WORK.

SCALE
20 0 10 20
1 INCH = 20 FEET

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EXISTING CONDITIONS AND DEMOLITION PLAN

SHERWOOD OLDTOWN APARTMENTS
15665 SW WILLAMETTE ST., SHERWOOD, OREGON 97140

Designed by MLS Date 09/27/2021
Drawn by TCC Date 09/27/2021
Reviewed by MLS Date 09/27/2021
Project No. 112-026 REF.
Horiz. Scale: N/A
Vert. Scale: N/A

No.	Date	Revision	By

Project
SHERWOOD OLDTOWN APARTMENTS
No.
112-026
Type
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Sheet
P1.0

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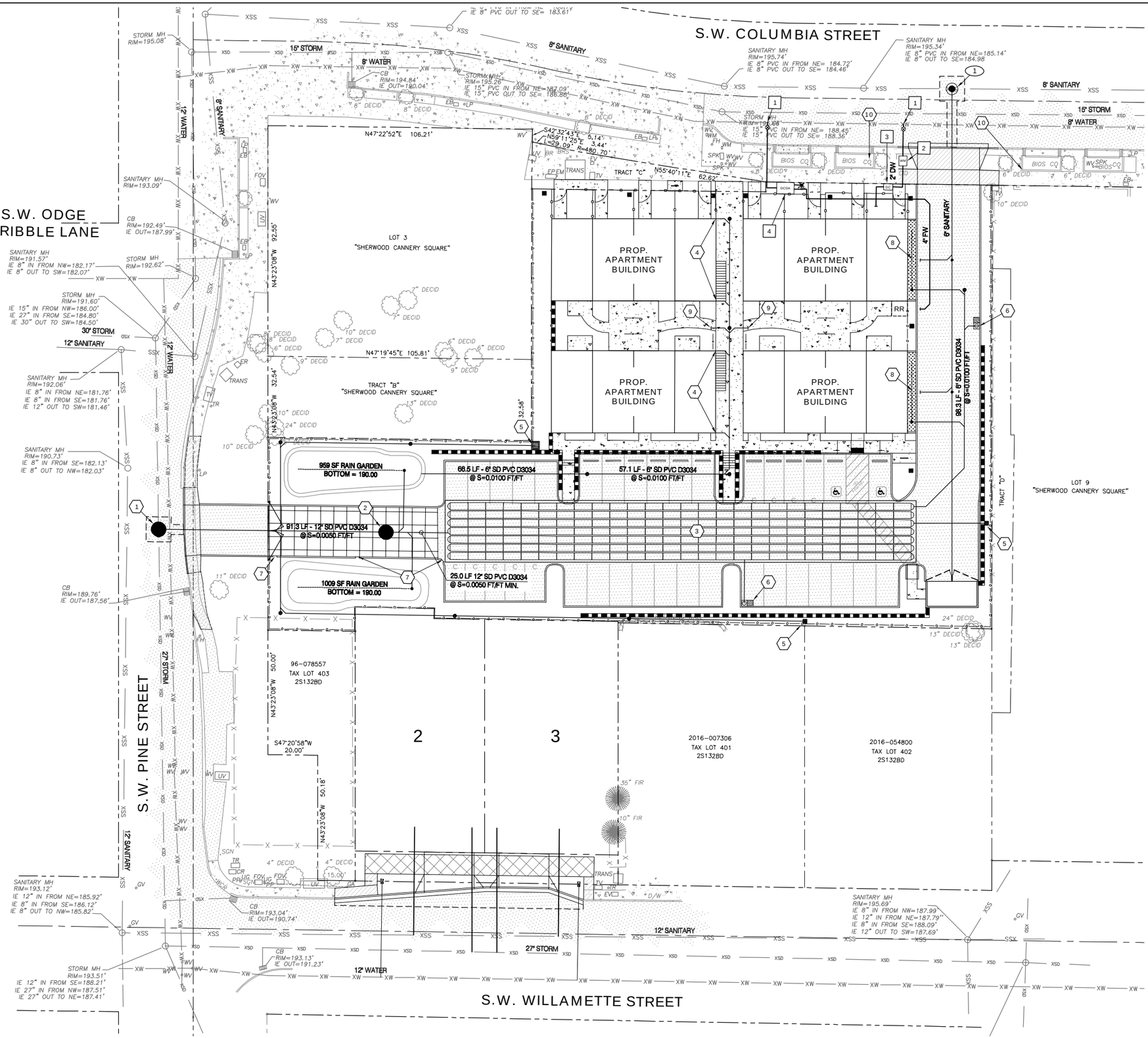

LEGEND

DW	PROPOSED DOMESTIC WATER LINE
FW	PROPOSED FIRE SERVICE LINE
DCDA	PROPOSED DOUBLE CHECK DETECTOR ASSEMBLY
	PROPOSED CLEANOUT
	PROPOSED CATCH BASIN
	PROPOSED FILTER CATCH BASIN
SS	PROPOSED SANITARY SEWER LINE
SD	PROPOSED STORM DRAIN LINE
	PROPOSED FIRE DEPARTMENT CONNECTION (FDC)
WM	PROPOSED WATER METER
DC	PROPOSED DC

GENERAL UTILITY NOTES

1. INSTALL CLEANOUTS EVERY 100' AND AT ALL BENDS 45° OR GREATER.
2. ALL ONSITE SANITARY AND STORM SEWER SYSTEMS SHALL BE PRIVATE.
3. THE CONTRACTOR SHALL FIELD VERIFY THE LOCATION OF EXISTING UTILITIES PRIOR TO BEGINNING CONSTRUCTION.
4. PRIVATE WATERLINES 3" AND SMALLER SHALL BE TYPE 'K' COPPER TUBING OR AS NOTED OTHERWISE.
5. STUB DOMESTIC WATER CONNECTION AND FIRE LINE 5.0 FEET FROM BUILDING. REFER TO PLUMBING PLANS FOR CONTINUATION.
6. RESTRAINT JOINTS SHALL MEET OREGON STATE PLUMBING CODE AND NFPA SECTION 10.8
7. COORDINATE WATER AND SEWER UTILITY LOCATIONS AT BUILDING WITH PLUMBING PLANS.

STORM SEWER NOTES

1. INSTALL 60" MANHOLE OVER EXISTING 27" STORM SEWER LINE.
   RIM = 190.19
   12" IE IN (NE) = 186.90
   27" IE IN (SE) = 185.65
   27" IE OUT (NW) = 185.65
2. INSTALL 60" FLOW CONTROL MANHOLE.
   RIM = 192.36
   12" IE IN (NE) = 187.56
   12" IE OUT (SW) = 187.36
3. 7 ROWS OF 26 DETENTION CHAMBERS (STORMTECH ADS SC-310)
   12" ROCK BASE, 6" ROCK COVER
   ROCK BOTTOM ELEV = 187.69
   CHAMBER BOTTOM ELEV = 188.69
4. CONNECT PROPOSED BUILDING DOWNSPOUTS TO 6" SD ROOF DRAIN LEADER.
5. CONSTRUCT 12" SQ. TRAPPED CATCH BASIN TO COLLECT RUNOFF FROM ADJACENT LOTS.
6. PROPOSED STORMFILTER CARTRIDGE CATCHBASIN TO TREAT RUNOFF FROM PARKING LOT.
7. CONSTRUCT CURB CUTS TO DIRECT RUNOFF INTO RAIN GARDEN.
8. PROPOSED LIDA PLANTERS
9. CONSTRUCT STORM SEWER STUB FOR PATIO DRAINAGE.
10. RECONECT EXISTING PLANTERS ON EAST AND WEST SIDE OF PROPOSED DRIVEWAY WITH 4" PVC SD. NEW IRRIGATION PIPING TO BE SLEEVED THROUGH DRIVEWAY.

WATER NOTES

1. CONNECT TO EXISTING 8" WATERLINE.
2. INSTALL 2" WATER METER IN PLANTER STRIP.
3. INSTALL DOUBLE CHECK BACKFLOW PREVENTER FOR DOMESTIC SERVICE.
4. INSTALL 4" FIRE DOUBLE CHECK DETECTOR IN 577-WA VAULT WITH J-5ALH20 BILCO DOOR. MONITORING DEVICES TO BE PROVIDED FOR ELECTRICAL INTERCONNECTION TO THE FIRE CONTROL PANEL. COORDINATE ALARM SETTINGS WITH ELECTRICAL PLANS AND FIRE SPRINKLER CONTRACTOR.

SANITARY SEWER NOTES

1. INSTALL SANITARY SEWER MANHOLE OVER EXISTING 8" SEWER LINE.

SCALE
20 0 10 20
1 INCH = 20 FEET

215
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PRELIMINARY COMPOSITE UTILITY PLAN

SHERWOOD OLDTOWN APARTMENTS
15665 SW WILLAMETTE ST., SHERWOOD, OREGON 97140

Designed by MLS Date 01/2022
Drawn by TCC Date 01/2022
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Project
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No.
112-026
Type
PLANNING
Sheet
P3.1

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SOIL FEATURES FOR WASHINGTON COUNTY

Soil name and map symbol	Hydro-logic group	Flooding		
		Frequency	Duration	Months
Aloha:				
1	C	NONE	NONE	NONE
Amity:				
2	C	NONE	NONE	NONE
Astoria:				
3E, 3F	B	NONE	NONE	NONE
Briedwell:				
4B, 5B, 5C, 5D	B	NONE	NONE	NONE
Carlton:				
6B, 6C	B	NONE	NONE	NONE
Cascade:				
7B, 7C, 7D, 7E, 7F	C	NONE	NONE	NONE
Chehalem:				
8C	C	NONE	NONE	NONE
Chehalis:				
9, 10	B	COMMON	BRIEF	NOV-MAR
Cornelius:				
11B, 11C, 11D, 11E, 11F:				
Cornelius part	C	NONE	NONE	NONE
Kinton part	C	NONE	NONE	NONE
Cornelius Varient:				
12A, 12B, 12C	C	NONE	NONE	NONE
Cove:				
13, 14	D	COMMON	BRIEF	DEC-APR
Dayton:				
15	D	NONE	NONE	NONE
Delena:				
16C	D	NONE	NONE	NONE
Goble:				
17B, 17C, 17D, 17E, 18E, 18F	C	NONE	NONE	NONE
Helvetia:				
19B, 19C, 19D, 19E	C	NONE	NONE	NONE
Hembre:				
20E, 20F, 20G	B	NONE	NONE	NONE
Hillsboro:				
21A, 21B, 21C, 21D	B	NONE	NONE	NONE
Hubberly:				
22	D	NONE	NONE	NONE
Jory:				
23B, 23C, 23D, 23E, 23F	C	NONE	NONE	NONE
Kilchis:				
24G				
Kilchis part	C	NONE	NONE	NONE
Klickitat part	B	NONE	NONE	NONE

RUNOFF CURVE NUMBERS (TR55)

Table 2-2a: Runoff curve numbers for urban areas [1]

Cover description		CN for hydrologic soil group			
Cover type and hydrologic condition	Average percent impervious area[2]	A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3]:					
Poor condition (grass cover <50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover >75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5]	77	86	91	94	
Idle lands (CNs are determined using cover types similar to those in table 2-2c)					

1: Average runoff condition, and $I_a = 0.2S$.

2: The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas hava a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.

3: CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.

4: Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.

5: Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

RUNOFF CURVE NUMBERS (TR55)

Table 2-2c: Runoff curve numbers for other agricultural lands [1]

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range -- continuous forage for grazing					
<50% ground cover or heavily grazed with no mulch.	Poor	68	79	86	89
50% to 75% ground cover and not heavily grazed.	Fair	49	69	79	84
>75% ground cover and lightly or only occasionally grazed.	Good	39	61	74	80
Meadow -- continuous grass, protected from grazing and generally mowed for hay	--	30	58	71	78
Brush – weed-grass mixture with brush as the major element					
<50% ground cover	Poor	48	67	77	83
50% to 75% ground cover	Fair	35	56	70	77
>75% ground cover	Good	30 [2]	48	65	73
Woods – grass combination (orchard or tree farm) [3]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods					
Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.	Poor	45	66	77	83
Woods are grazed but not burned, and some forest litter covers the soil.	Fair	36	60	73	79
Woods are protected from grazing, and litter and brush adequately cover the soil.	Good	30 [2]	55	70	77
Farmsteads -- buildings, lanes, driveways, and surrounding lots	--	59	74	82	86

1: Average runoff condition, and $I_a = 0.2S$.

2: Actual curve number is less than 30; use CN = 30 for runoff computations.

3: CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

MANNING'S "n" VALUES

SHEET FLOW EQUATION MANNING'S VALUES	n_s
Smooth Surfaces (concrete, asphault, gravel, or bare hand packed soil)	0.011
Fallow Fields or loose soil surface (no residue)	0.05
Cultivated soil with residue cover (≤ 20%)	0.06
Cultivated soil with residue cover (> 20%)	0.17
Short prairie grass and lawns	0.15
Dense grasses	0.24
Bermuda grasses	0.41
Range (natural)	0.13
Woods or forest with light underbrush	0.40
Woods or forest with dense underbrush	0.80

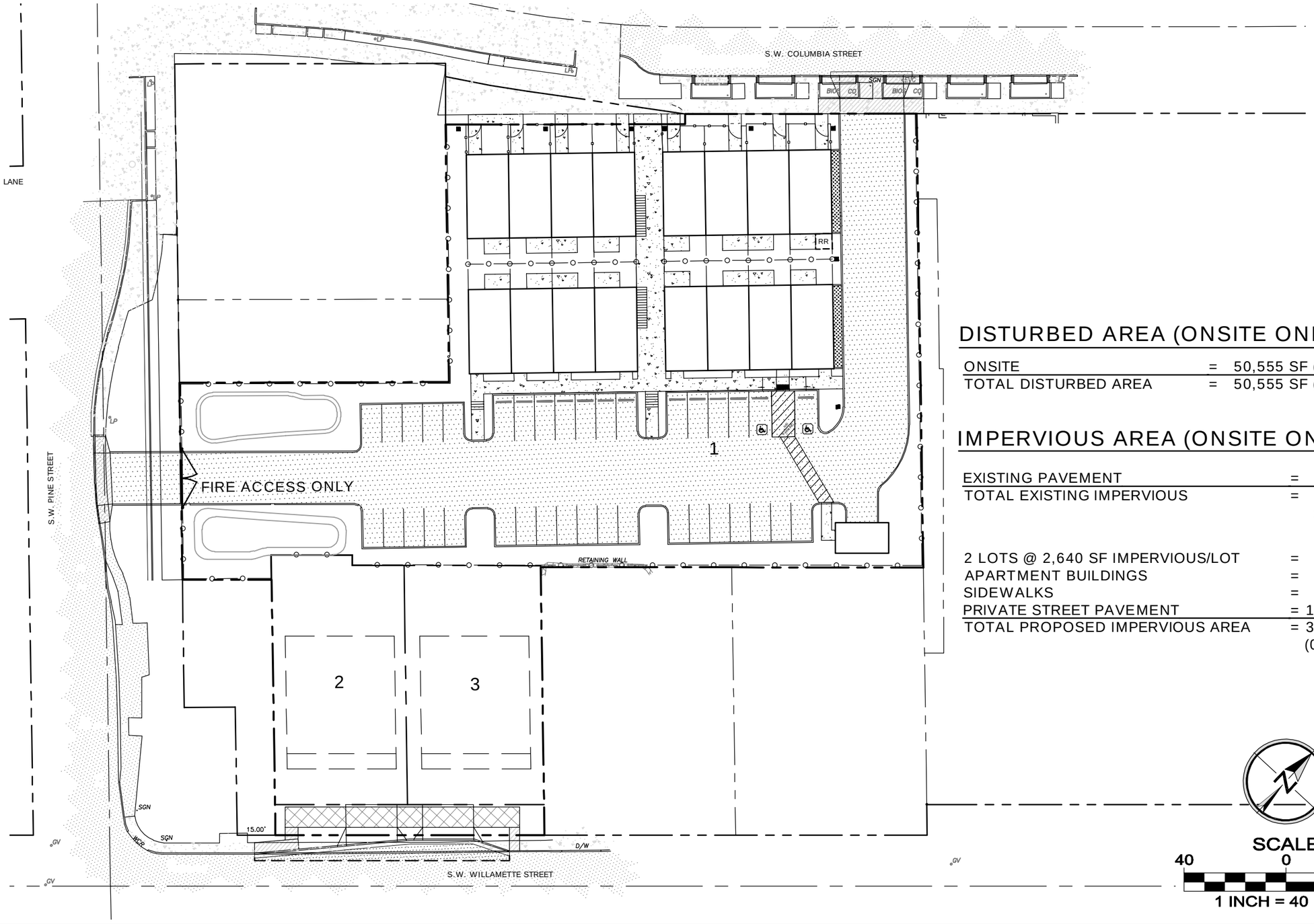
SHALLOW CONCENTRATED FLOW (after initial 300 ft of sheet flow, R = 0.1)	k_s
Forest with heavy ground litter and meadows (n = 0.010)	3
Brushy ground with some trees (n = 0.060)	5
Fallow or minimum tillage cultivation (n = 0.040)	8
High grass (n = 0.035)	9
Short grass, pasture and lawns (n = 0.030)	11
Nearly bare ground (n = 0.25)	13
Paved and gravel areas (n = 0.012)	27

CHANNEL FLOW (Intermittent) (At the beginning of all visible channels, R = 0.2)	k_c
Forested swale with heavy ground cover (n = 0.10)	5
Forested drainage course/ravine with defined channel bed (n = 0.050)	10
Rock-lined waterway (n = 0.035)	15
Grassed waterway (n = 0.030)	17
Earth-lined waterway (n = 0.025)	20
CMP pipe (n = 0.024)	21
Concrete pipe (n = 0.012)	42
Other waterways and pipe 0.508/n	

CHANNEL FLOW (continuous stream, R = 0.4)	k_c
Meandering stream (n = 0.040)	20
Rock-lined stream (n = 0.035)	23
Grass-lined stream (n = 0.030)	27
Other streams, man-made channels and pipe (n = 0.807/n)	

IMPERVIOUS AREA EXHIBIT

SHERWOOD OLDTOWN APARTMENTS



DISTURBED AREA (ONSITE ONLY)

ONSITE	=	50,555 SF (1.16 AC)
TOTAL DISTURBED AREA	=	50,555 SF (1.16 AC)

IMPERVIOUS AREA (ONSITE ONLY)

EXISTING PAVEMENT	=	0 SF
TOTAL EXISTING IMPERVIOUS	=	0 SF (0.00 AC)
2 LOTS @ 2,640 SF IMPERVIOUS/LOT	=	5,280 SF
APARTMENT BUILDINGS	=	9,003 SF
SIDEWALKS	=	3,836 SF
PRIVATE STREET PAVEMENT	=	15,720 SF
TOTAL PROPOSED IMPERVIOUS AREA	=	33,839 SF (0.78 AC)

SCALE

40 0 20 40

1 INCH = 40 FEET

PIONEER DESIGN GROUP
CIVIL ENGINEERING • LAND USE PLANNING • LAND SURVEYING • LANDSCAPE ARCHITECTURE
PORTLAND, OREGON | HONOLULU, HAWAII
PH: 503.643.8286 PH: 808.753.2376
WWW.PD-GRP.COM

Designed by JPB Date 10/2021
Drawn by JPB Date 10/2021
Reviewed by JPB Date 10/2021
Project No. 112-026 REF.
Horiz. Scale:
Vert. Scale:

112-026 IMPERVIOUS AREAS.DWG

Project
SHERWOOD OLDTOWN APARTMENTS

No.
112-026

Type
PLANNING

Sheet
1 of 1

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PIONEER DESIGN GROUP

IMPERVIOUS AREA CALCULATIONS

JOB NUMBER: 112-026
PROJECT: Sherwood Oldtown Apartments
FILE: 11226_Prelim Hydro.xls

NEW IMPERVIOUS AREA

2 LOTS AT 2,640-SF IMPERVIOUS AREA / LOT	5,280.00 ft^2	
APARTMENT BUILDINGS	9,003.00 ft^2	
SIDEWALKS	3,836.00 ft^2	
PRIVATE STREET PAVEMENT	15,720.00 ft^2	
	33,839.00 ft^2	**0.78 ac**

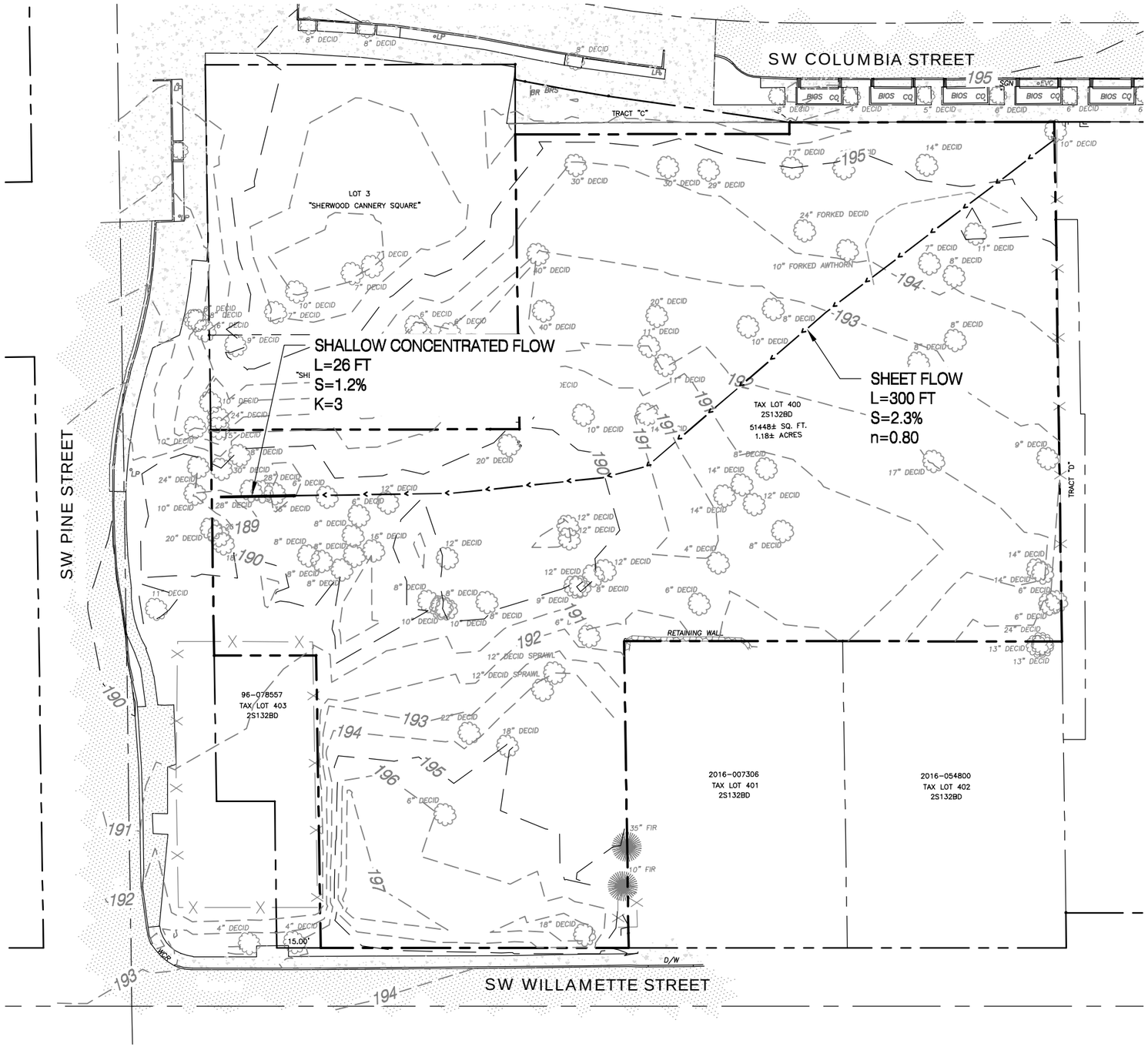
EXISTING IMPERVIOUS AREA

EXISTING PAVEMENT	0.00 ft^2	
	0.00 ft^2	**0.00 ac**

Total Shed Area	**50,555.00 ft^2**	**1.16 ac**
Existing Impervious Area	**0.00 ft^2**	**0.00 ac**
% Impervious		**0.0 %**
Proposed Impervious Area	**33,839.00 ft^2**	**0.78 ac**
% Impervious		**66.9 %**

PREDEVELOPED TIME OF CONCENTRATION

SHERWOOD OLDTOWN APARTMENTS



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Designed by	JPB	Date	10/2021
Drawn by	JPB	Date	10/2021
Reviewed by	JPB	Date	10/2021
Project No.	112-026	REF.	
Horiz. Scale:			
Vert. Scale:			

112-026_PREDEVELOPED TC.DWG

Project
SHERWOOD OLDTOWN APARTMENTS

No.
112-026

Type
PLANNING

Sheet
1 of 1

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PIONEER DESIGN GROUP

PREDEVELOPED TIME OF CONCENTRATION

JOB NUMBER: 112-026
PROJECT: Sherwood Oldtown Apartments
FILE: 11226_Prelim Hydro.xls

				Accum. Tc
LAG ONE: SHEET FLOW (FIRST 300 FEET)				
Tt = Travel time				
Manning's "n " =	0.80			
Flow Length, L =	300	ft	(300 ft. max.)	
P = 2-year, 24hr storm =	2.5	in		
Slope, S_0 =	0.023	ft/ft		
$T_T = \frac{(0.42)(n*L)^{0.8}}{(P)^{0.5}(S_0)^{0.4}}$	96.33	min.		96.33 min.
LAG TWO: SHALLOW CONCENTRATED FLOW (NEXT 26 FEET)				
Tc Velocity factor, k=	3			
Slope, S_0 =	0.012	ft/ft		
$V = k\sqrt{S_0}$	0.33	ft/s		
Flow Length, L =	26	ft		
$T = \frac{L}{(60)(V)}$	1.32	min.		97.65 min.

TOTAL PREDEVELOPED TIME OF CONCENTRATION (Tc) = 97.65 min.

PIONEER DESIGN GROUP

DEVELOPED TIME OF CONCENTRATION

JOB NUMBER: 112-026
PROJECT: Sherwood Oldtown Apartments
FILE: 11226_Prelim Hydro.xls

Catchment Time	5	min.
Longest Run of Pipe	264	ft
Velocity of Flow	3	ft/s
Time in Pipe = (264 ft)/(3.00 ft/s) =	88	s
TOTAL DEVELOPED Tc =	**6.47**	**min.**

PIONEER DESIGN GROUP

NORTH RAIN GARDEN CALCULATIONS

JOB NUMBER: 112-026
PROJECT: Sherwood Oldtown Apartments
FILE: 11226_Prelim Hydro.xls

REFERENCES:
1. Clean Water Services R&O 19-05.
2. Discussions with Clean Water Services.

DESIGN STORM

Precipitation:	0.36	inches
Storm Duration:	4	hours
Storm Return Period:	96	hours
Storm Window:	2	weeks

IMPERVIOUS AREA:

Roof Areas:	0.10	acres
Paved Areas:	0.06	acres
Impervious Area:	0.16	acres

Design Inflow = (0.16 ac)*(43560 ft^2/ac)*(0.36 in / 4.0 hrs) = **0.01 cfs**

VOLUME CALCULATION:

WATER QUALITY VOLUME = (0.16 acres)(43560 sqft/acre)(0.36 inch)/(12 in/ft) = **209 ft^3**

RAIN GARDEN PARAMETERS:

Bottom Area =	760	ft^2
Side Slopes =	3	:1
Treatment Depth =	6	in
Treatment Area =	959	ft^2
Storage Volume =	**430**	**ft^3**

Assumed Infiltration Rate =	0.2	in/hr (Per CWS R&O 19-05, Table 4-5)
Factor of Safety =	2	
Design Infiltration Rate =	0.1	in/hr
Infiltration Flow Rate =	7.99	ft^3/hr
Time to Infiltrate WQ Volume =	**26.2 hours**	(Maximum 36 hours)

PIONEER DESIGN GROUP

SOUTH RAIN GARDEN CALCULATIONS

JOB NUMBER: 112-026
PROJECT: Sherwood Oldtown Apartments
FILE: 11226_Prelim Hydro.xls

REFERENCES:
1. Clean Water Services R&O 19-05.
2. Discussions with Clean Water Services.

DESIGN STORM

Precipitation:	0.36	inches
Storm Duration:	4	hours
Storm Return Period:	96	hours
Storm Window:	2	weeks

IMPERVIOUS AREA:

Roof Areas:	0.00	acres
Paved Areas:	0.20	acres
Impervious Area:	0.20	acres

Design Inflow = (0.2 ac)*(43560 ft^2/ac)*(0.36 in / 4.0 hrs) = **0.02 cfs**

VOLUME CALCULATION:

WATER QUALITY VOLUME = (0.2 acres)(43560 sqft/acre)(0.36 inch)/(12 in/ft) = **261 ft^3**

RAIN GARDEN PARAMETERS:

Bottom Area =	585	ft^2
Side Slopes =	3	:1
Treatment Depth =	6	in
Treatment Area =	1009	ft^2
Storage Volume =	**399**	**ft^3**

Assumed Infiltration Rate =	0.2	in/hr (Per CWS R&O 19-05, Table 4-5)
Factor of Safety =	2	
Design Infiltration Rate =	0.1	in/hr
Infiltration Flow Rate =	8.41	ft^3/hr
Time to Infiltrate WQ Volume =	**31.0 hours**	(Maximum 36 hours)

PIONEER DESIGN GROUP

LIDA SIZING CALCULATIONS

JOB NUMBER:	112-026
PROJECT:	Sherwood Oldtown Apartments
FILE:	11226_Prelim Hydro.xls

REFERENCES:
1. Clean Water Services R&O 19-05.
2. Discussions with Clean Water Services.

Roof Area (each building):	2178	SF
Total Impervious Area:	2178	SF
Sizing factor:	0.06	
Treatment area:	131	SF
Reduced treatment area w/ 30" growing medium:	98	SF
Treatment area provided:	108	SF

PIONEER DESIGN GROUP

SANTA BARBARA URBAN HYDROGRAPHS

JOB NUMBER: 112-026
PROJECT: Sherwood Oldtown Apartments
FILE: 11226_Prelim Hydro.xls

DESCRIPTION	DESIGN STORM (YR)	DURATION (HR)	PRECIP (IN)	AREA TOTAL (AC)	% IMP	AREA PERV. (AC)	CN PER.	AREA IMP. (AC)	CN IMP.	TIME (MIN)	Q (CFS)
PREDEVELOPED 2-YEAR PEAK DISCHARGE	2	24	2.5	1.16	0.00	1.16	73.5	0.00	98	97.65	0.05
DEVELOPED 2-YEAR PEAK DISCHARGE	2	24	2.5	1.16	66.94	0.38	77	0.78	98	6.47	0.52
PREDEVELOPED 5-YEAR PEAK DISCHARGE	5	24	3.1	1.16	0.00	1.16	73.5	0.00	98	97.65	0.07
DEVELOPED 5-YEAR PEAK DISCHARGE	5	24	3.1	1.16	66.94	0.38	77	0.78	98	6.47	0.68
PREDEVELOPED 10-YEAR PEAK DISCHARGE	10	24	3.45	1.16	0.00	1.16	73.5	0.00	98	97.65	0.10
DEVELOPED 10-YEAR PEAK DISCHARGE	10	24	3.45	1.16	66.94	0.38	77	0.78	98	6.47	0.77
PREDEVELOPED 25-YEAR PEAK DISCHARGE	25	24	3.9	1.16	0.00	1.16	73.5	0.00	98	97.65	0.13
DEVELOPED 25-YEAR PEAK DISCHARGE	25	24	3.9	1.16	66.94	0.38	77	0.78	98	6.47	0.90
PREDEVELOPED 100-YEAR PEAK DISCHARGE	100	24	4.5	1.16	0.00	1.16	73.5	0.00	98	97.65	0.19
DEVELOPED 100-YEAR PEAK DISCHARGE	100	24	4.5	1.16	66.94	0.38	77	0.78	98	6.47	1.07

PIONEER DESIGN GROUP

STORMWATER CONVEYANCE CALCULATIONS

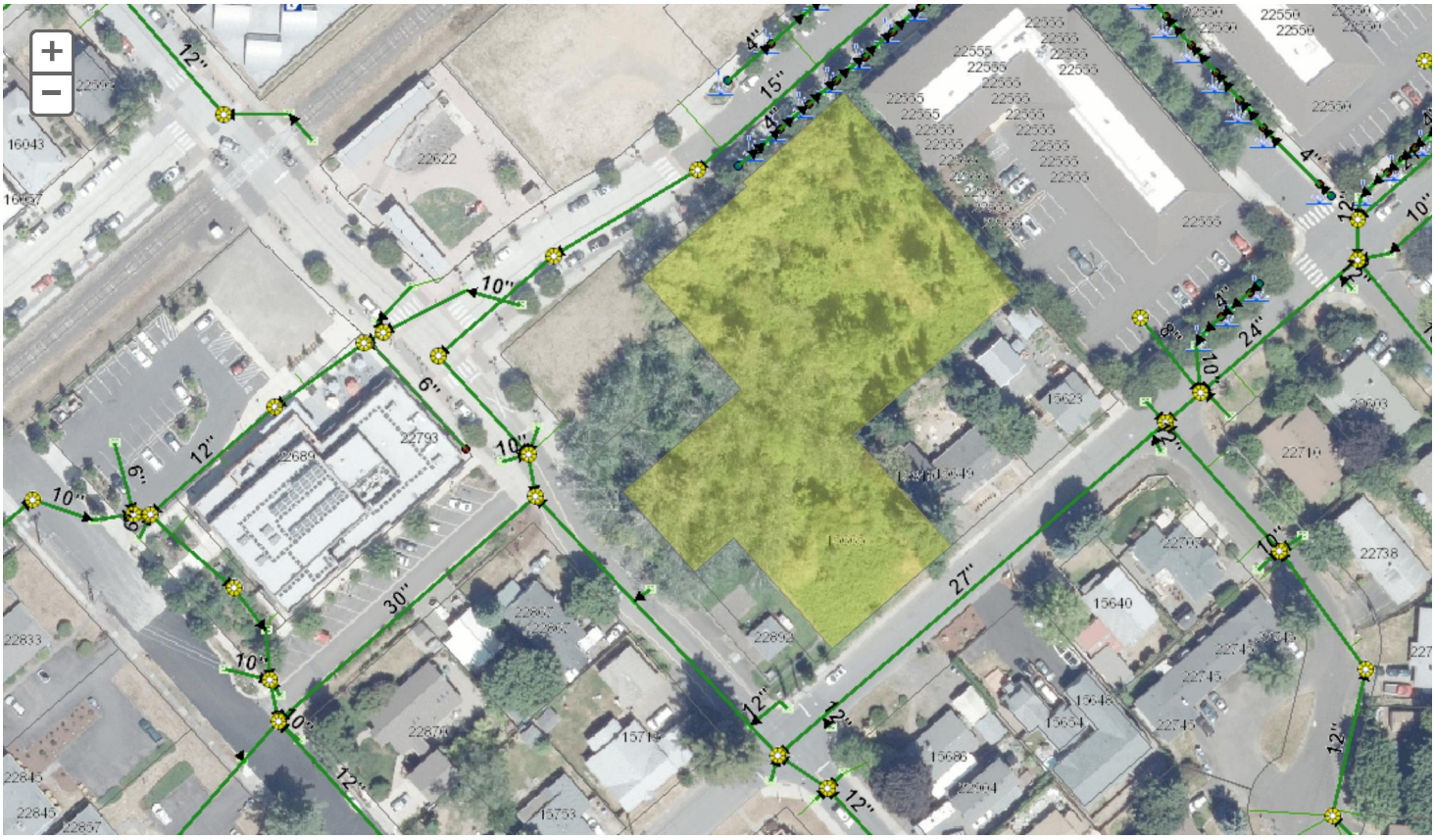
JOB NUMBER: 112-026
PROJECT: Sherwood Oldtown Apartments

FILE: 11226_Prelim Hydro.xls
Design Storm: 25 YR
Storm Duration: 24 HRS
Precipitation: 3.9 IN
Manning's "n" 0.013

LINE	INC. AREA (AC)	AREA TOTAL (AC)	% IMP.	AREA PERV. (AC)	CN PER.	AREA IMP. (AC)	CN IMP.	TIME (MIN)	Q (CFS)	PIPE SIZE (IN)	SLOPE (FT/FT)	Qf (CFS)	Q/Qf (%)	Vf (FPS)	V/Vf (%)	ACTUAL V (FPS)
ENTIRE SHED	1.16	1.16	66.94	0.38	77	0.78	98	6.47	0.90	12	0.0050	2.53	0.36	3.22	0.90	2.89
												(ENTIRE SHED AREA CAN BE CONVEYED IN A 12" PIPE AT 0.5% SLOPE)				
1/2 OF SITE	0.58	0.58	66.94	0.19	77	0.39	98	6.47	0.45	6	0.0100	0.56	0.80	2.87	1.14	3.26
												(1/2 OF SHED AREA CAN BE CONVEYED IN A 6" PIPE AT 1.0% SLOPE)				

APPENDIX 'A' – CITY OF SHERWOOD UTILITY MAPS & HYDROMODIFICATION MAP

15665 SW WILLAMETTE ST



15665 SW WILLAMETTE ST

Property Information

TLID: 2S132BD00400
SITEADDR: 15665 SW WILLAM
SITECITY: Sherwood
SITEZIP: 97140
LANDUSE: VAC
JURIS_CITY: SHERWOOD
Elementary School Boundaries
School_Name: Archer Glen E
Middle School Boundaries:
School_Name: Sherwood MS
Leaf Boundary:
Name: Leaf Pick-up Area 2
Time: Nov. 2nd Thru Nov. 9th
AdditionalText: Nov. 30th Thr
Notes:

County Reports
Parcel Summary

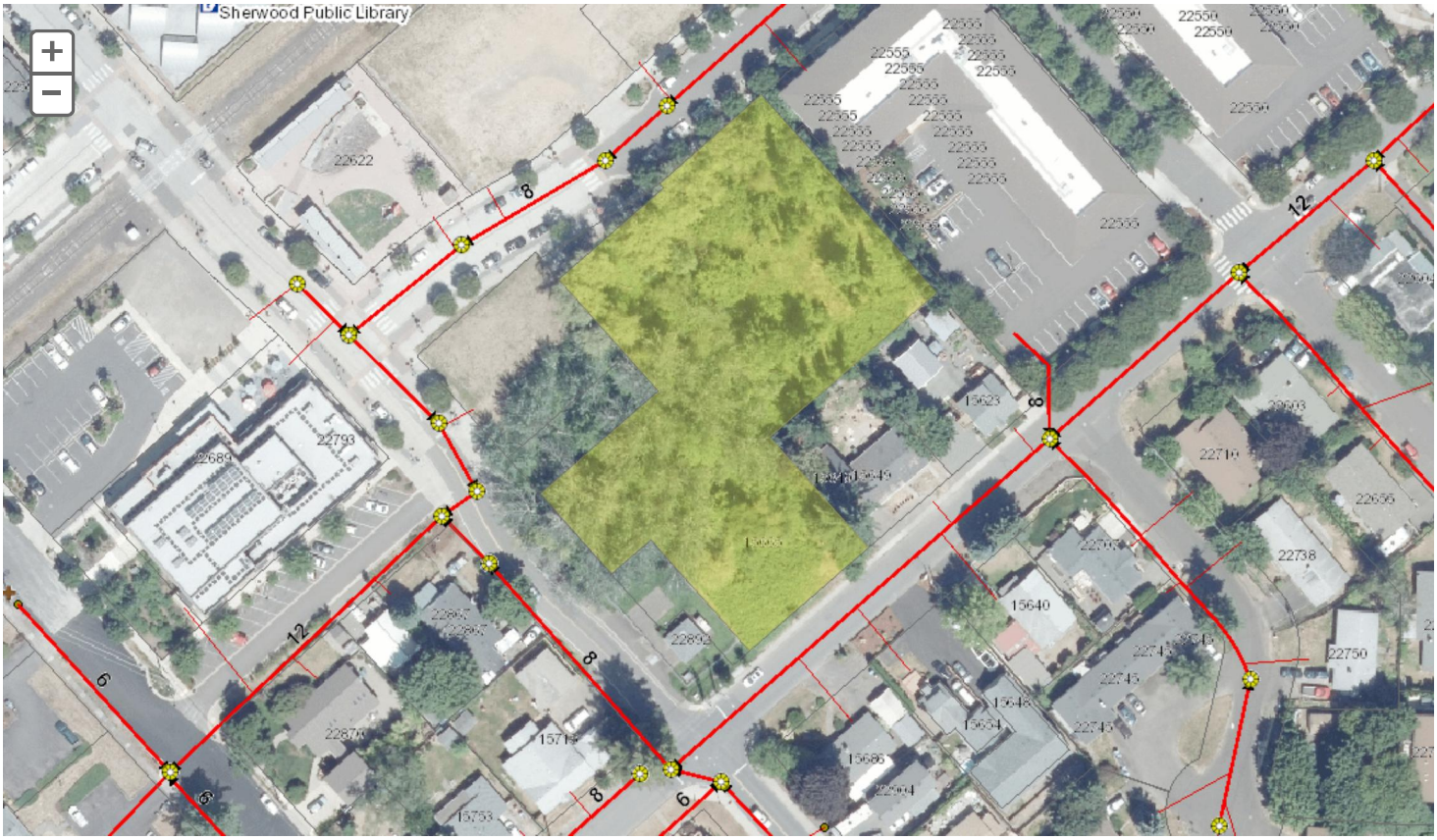
Map Themes

- [ ] Contours
- [ ] FEMA Flood Plain
- [x] Utilities
  - [ ] Sanitary
  - [x] Storm
  - [ ]
- [ ] Wetlands
- [ ] Zoning (Zoning Codes)

For questions contact City o
Planning at (503) 925-2308

New Searc

15665 SW WILLAMETTE ST



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Property Information

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SITECITY: Sherwood
SITEZIP: 97140
LANDUSE: VAC
JURIS_CITY: SHERWOOD
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School_Name: Archer Glen E
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Name: Leaf Pick-up Area 2
Time: Nov. 2nd Thru Nov. 9th
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County Reports
Parcel Summary

Map Themes

- [ ] Contours
- [ ] FEMA Flood Plain
- [x] Utilities
  - [ ] Sanitary
  - [ ] Storm
  - [x]
- [ ] Wetlands
- [ ] Zoning (Zoning Codes)

For questions contact City o
Planning at (503) 925-2308

New Searc

The City of Sherwood's infrastructure records, drawings, and other documents have been gathered over many years, using many different formats and standards. While the data provided is generally believed to be accurate, occasionally it proves to be incorrect; thus its accuracy making any property purchases or other investments based in full or in part upon the material provided, it is specifically advised that you independently field verify the information contained within our records.

Public Sanitary and Storm Sewers

Clean Water Services www.cleanwaterservices.org

Legend

Partner Storm

Storm Cleanouts

Storm Fittings

Storm Pond Outlets

Storm Inlets

Storm Manholes

Storm Vaults

Storm Ponds

Storm Open Conveyances

Storm Closed Conveyances

Storm Virtual Flows

Storm Pond Outlines

Taxlots

Taxlots

Taxlot Boundary

Hydromod Risk Levels

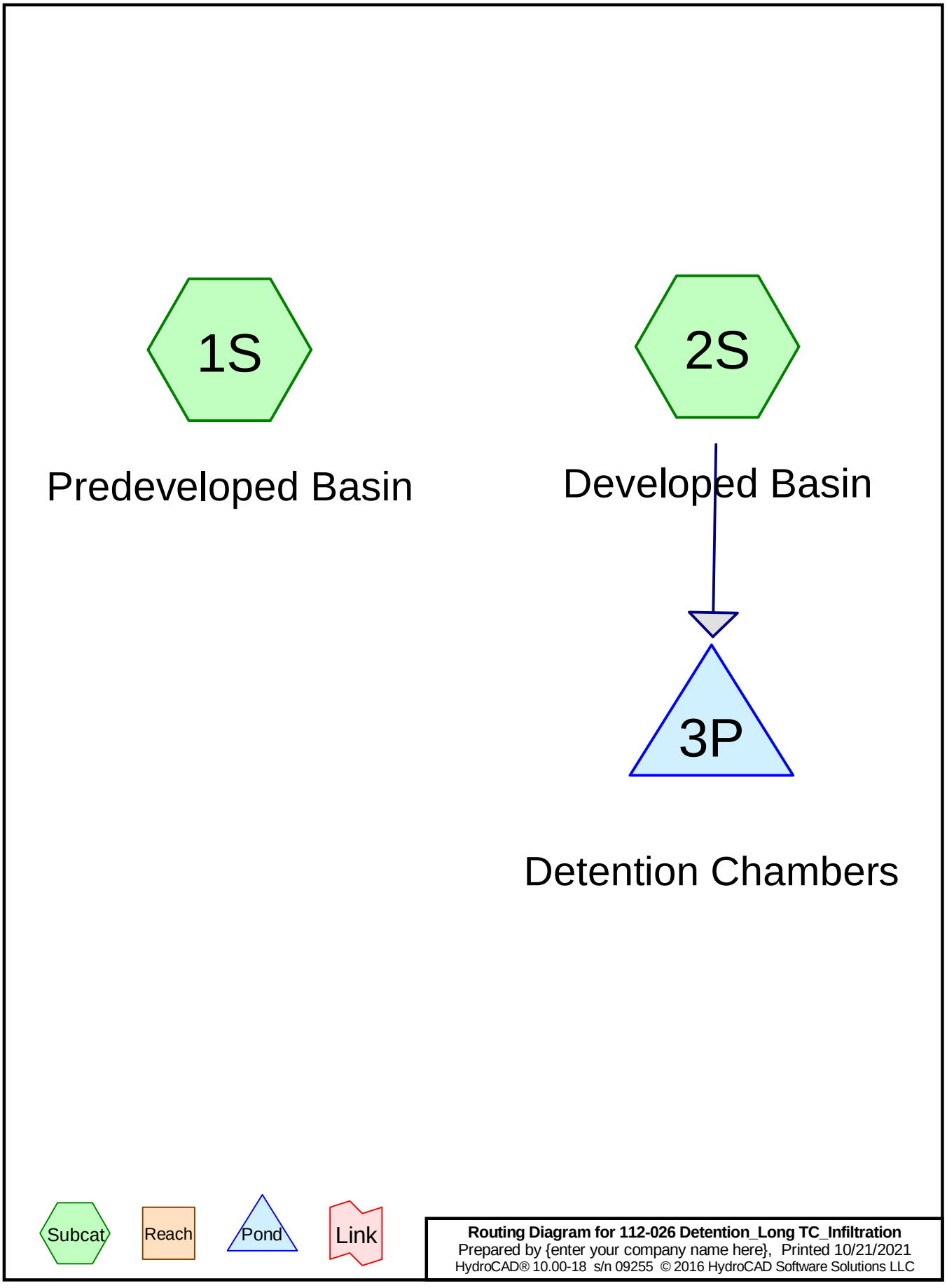
Hydromod Risk Levels

Low

Moderate

High

APPENDIX 'B' – HYDROCAD REPORT



Routing Diagram for 112-026 Detention_Long TC_Infiltration
Prepared by {enter your company name here}, Printed 10/21/2021

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.780	98	Impervious Areas (2S)
0.380	77	Open space, good condition, C/D soils (2S)
1.160	74	Woods, good condition, C/D soils (1S)
2.320	**83**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
2.320	Other	1S, 2S
2.320		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	0.000	0.780	0.780	Impervious Areas	2S
0.000	0.000	0.000	0.000	0.380	0.380	Open space, good condition, C/D soils	2S
0.000	0.000	0.000	0.000	1.160	1.160	Woods, good condition, C/D soils	1S
0.000	**0.000**	**0.000**	**0.000**	**2.320**	**2.320**	**TOTAL AREA**	

Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	3P	100.00	99.00	100.0	0.0100	0.013	12.0	0.0	0.0

Time span=0.00-100.00 hrs, dt=0.05 hrs, 2001 points
Runoff by SBUH method, Split Pervious/Imperv.
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Predeveloped Basin Runoff Area=1.160 ac 0.00% Impervious Runoff Depth=0.61"
Tc=97.7 min CN=74/0 Runoff=0.04 cfs 0.059 af

Subcatchment 2S: Developed Basin Runoff Area=1.160 ac 67.24% Impervious Runoff Depth=1.77"
Tc=6.5 min CN=77/98 Runoff=0.49 cfs 0.171 af

Pond 3P: Detention Chambers Peak Elev=102.49' Storage=5,374 cf Inflow=0.49 cfs 0.171 af
Discarded=0.01 cfs 0.075 af Primary=0.02 cfs 0.096 af Outflow=0.03 cfs 0.171 af

Total Runoff Area = 2.320 ac Runoff Volume = 0.230 af Average Runoff Depth = 1.19"
66.38% Pervious = 1.540 ac 33.62% Impervious = 0.780 ac

Summary for Subcatchment 1S: Predeveloped Basin

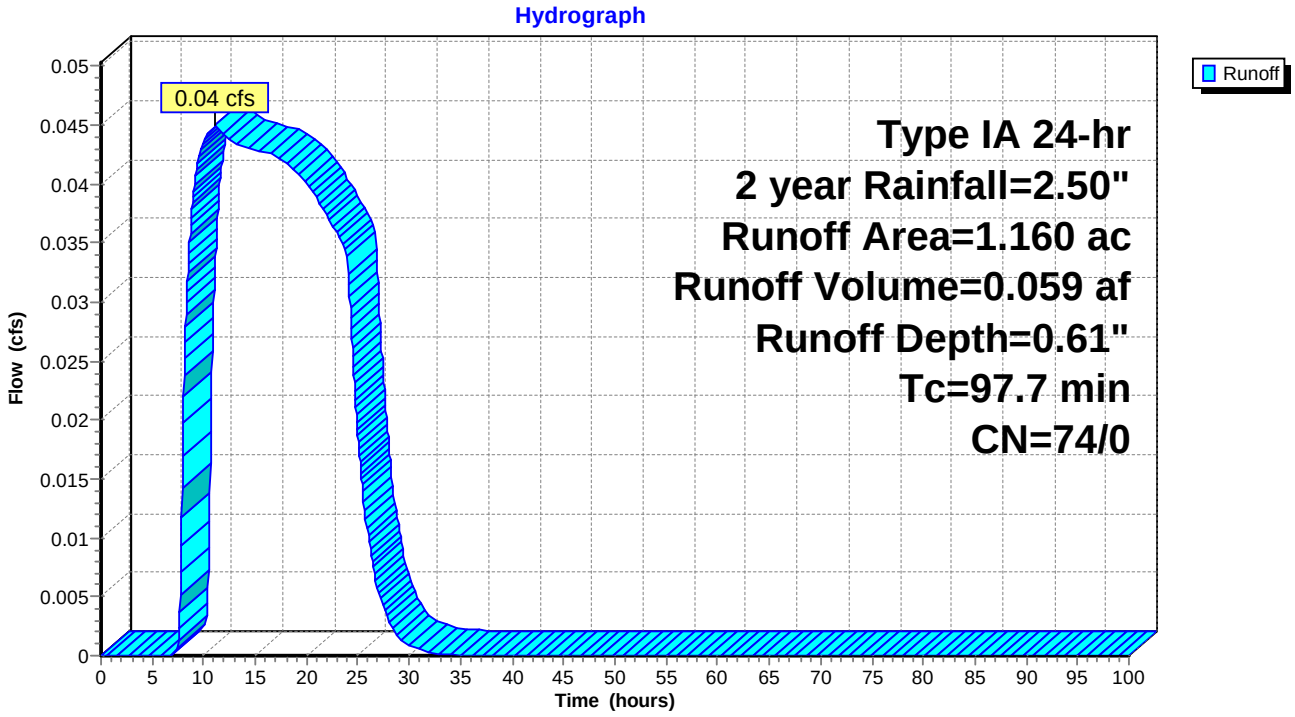
Runoff = 0.04 cfs @ 11.16 hrs, Volume= 0.059 af, Depth= 0.61"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
Type IA 24-hr 2 year Rainfall=2.50"

	Area (ac)	CN	Description
*	1.160	74	Woods, good condition, C/D soils
	1.160	74	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
97.7					**Direct Entry,**

Subcatchment 1S: Predeveloped Basin



Summary for Subcatchment 2S: Developed Basin

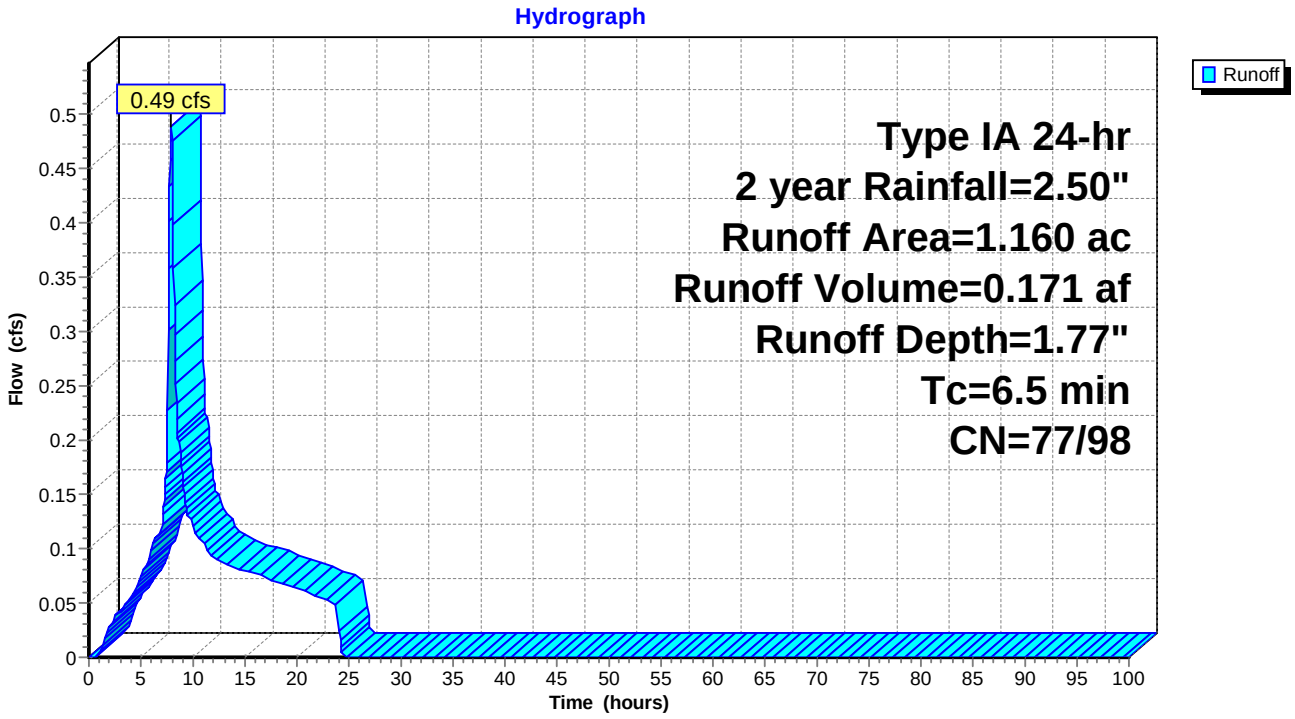
Runoff = 0.49 cfs @ 7.95 hrs, Volume= 0.171 af, Depth= 1.77"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
Type IA 24-hr 2 year Rainfall=2.50"

	Area (ac)	CN	Description
*	0.380	77	Open space, good condition, C/D soils
*	0.780	98	Impervious Areas
	1.160	91	Weighted Average
	0.380	77	32.76% Pervious Area
	0.780	98	67.24% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.5					**Direct Entry,**

Subcatchment 2S: Developed Basin



Summary for Pond 3P: Detention Chambers

Inflow Area = 1.160 ac, 67.24% Impervious, Inflow Depth = 1.77" for 2 year event
Inflow = 0.49 cfs @ 7.95 hrs, Volume= 0.171 af
Outflow = 0.03 cfs @ 24.08 hrs, Volume= 0.171 af, Atten= 94%, Lag= 967.7 min
Discarded = 0.01 cfs @ 2.05 hrs, Volume= 0.075 af
Primary = 0.02 cfs @ 24.08 hrs, Volume= 0.096 af

Routing by Stor-Ind method, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
Peak Elev= 102.49' @ 24.08 hrs Surf.Area= 4,677 sf Storage= 5,374 cf

Plug-Flow detention time= 1,773.5 min calculated for 0.171 af (100% of inflow)
Center-of-Mass det. time= 1,774.5 min (2,477.6 - 703.1)

Volume	Invert	Avail.Storage	Storage Description
#1A	100.00'	3,170 cf	**24.83'W x 188.32'L x 2.83'H Field A** 13,250 cf Overall - 2,683 cf Embedded = 10,567 cf x 30.0% Voids
#2A	101.00'	2,683 cf	**ADS_StormTech SC-310 +Cap** x 182 Inside #1 Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap 7 Rows of 26 Chambers
		5,853 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	100.00'	**12.0" Round Culvert** L= 100.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 100.00' / 99.00' S= 0.0100 '/' Cc= 0.900 n= 0.013, Flow Area= 0.79 sf
#2	Device 1	98.00'	**0.7" Vert. Orifice/Grate** C= 0.600
#3	Device 1	102.49'	**2.8" Vert. Orifice/Grate** C= 0.600
#4	Device 1	102.78'	**5.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32
#5	Discarded	100.00'	**0.100 in/hr Exfiltration over Horizontal area**

Discarded OutFlow Max=0.01 cfs @ 2.05 hrs HW=100.03' (Free Discharge)
└**5=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=0.02 cfs @ 24.08 hrs HW=102.49' (Free Discharge)
└**1=Culvert** (Passes 0.02 cfs of 4.21 cfs potential flow)
  ├**2=Orifice/Grate** (Orifice Controls 0.02 cfs @ 7.60 fps)
  ├**3=Orifice/Grate** (Orifice Controls 0.00 cfs @ 0.12 fps)
  └**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 3P: Detention Chambers - Chamber Wizard Field A

Chamber Model = ADS_StormTech SC-310 +Cap (ADS StormTech® SC-310 with cap length)
Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf
Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap

34.0" Wide + 6.0" Spacing = 40.0" C-C Row Spacing

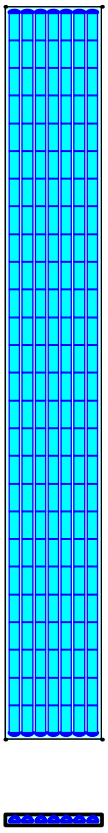
26 Chambers/Row x 7.12' Long +0.60' Cap Length x 2 = 186.32' Row Length +12.0" End Stone x 2 = 188.32' Base Length
7 Rows x 34.0" Wide + 6.0" Spacing x 6 + 12.0" Side Stone x 2 = 24.83' Base Width
12.0" Base + 16.0" Chamber Height + 6.0" Cover = 2.83' Field Height

182 Chambers x 14.7 cf = 2,683.0 cf Chamber Storage

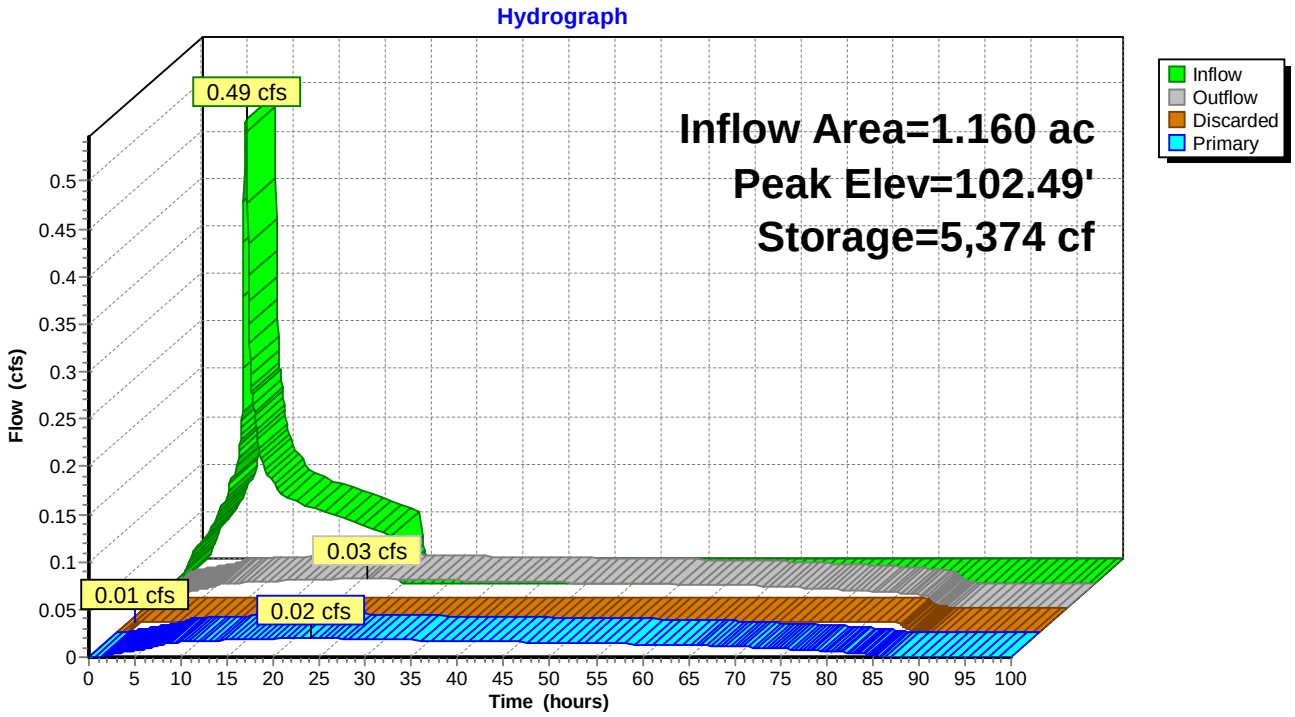
13,250.4 cf Field - 2,683.0 cf Chambers = 10,567.4 cf Stone x 30.0% Voids = 3,170.2 cf Stone Storage

Chamber Storage + Stone Storage = 5,853.2 cf = 0.134 af
Overall Storage Efficiency = 44.2%
Overall System Size = 188.32' x 24.83' x 2.83'

182 Chambers
490.8 cy Field
391.4 cy Stone



Pond 3P: Detention Chambers



Time span=0.00-100.00 hrs, dt=0.05 hrs, 2001 points
Runoff by SBUH method, Split Pervious/Imperv.
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Predeveloped Basin Runoff Area=1.160 ac 0.00% Impervious Runoff Depth=0.97"
Tc=97.7 min CN=74/0 Runoff=0.08 cfs 0.094 af

Subcatchment 2S: Developed Basin Runoff Area=1.160 ac 67.24% Impervious Runoff Depth=2.30"
Tc=6.5 min CN=77/98 Runoff=0.64 cfs 0.223 af

Pond 3P: Detention Chambers Peak Elev=102.70' Storage=5,670 cf Inflow=0.64 cfs 0.223 af
Discarded=0.01 cfs 0.077 af Primary=0.08 cfs 0.146 af Outflow=0.10 cfs 0.223 af

Total Runoff Area = 2.320 ac Runoff Volume = 0.317 af Average Runoff Depth = 1.64"
66.38% Pervious = 1.540 ac 33.62% Impervious = 0.780 ac

Summary for Subcatchment 1S: Predeveloped Basin

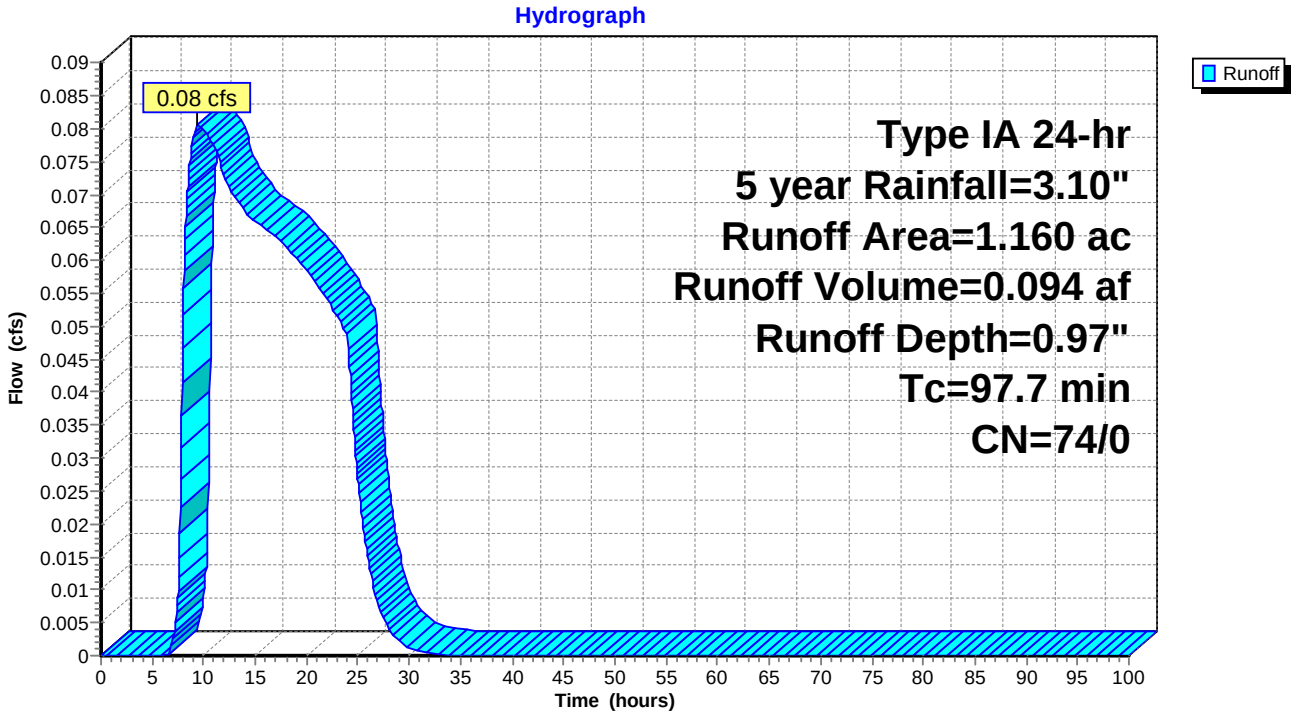
Runoff = 0.08 cfs @ 9.37 hrs, Volume= 0.094 af, Depth= 0.97"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
Type IA 24-hr 5 year Rainfall=3.10"

	Area (ac)	CN	Description
*	1.160	74	Woods, good condition, C/D soils
	1.160	74	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
97.7					**Direct Entry,**

Subcatchment 1S: Predeveloped Basin



Summary for Subcatchment 2S: Developed Basin

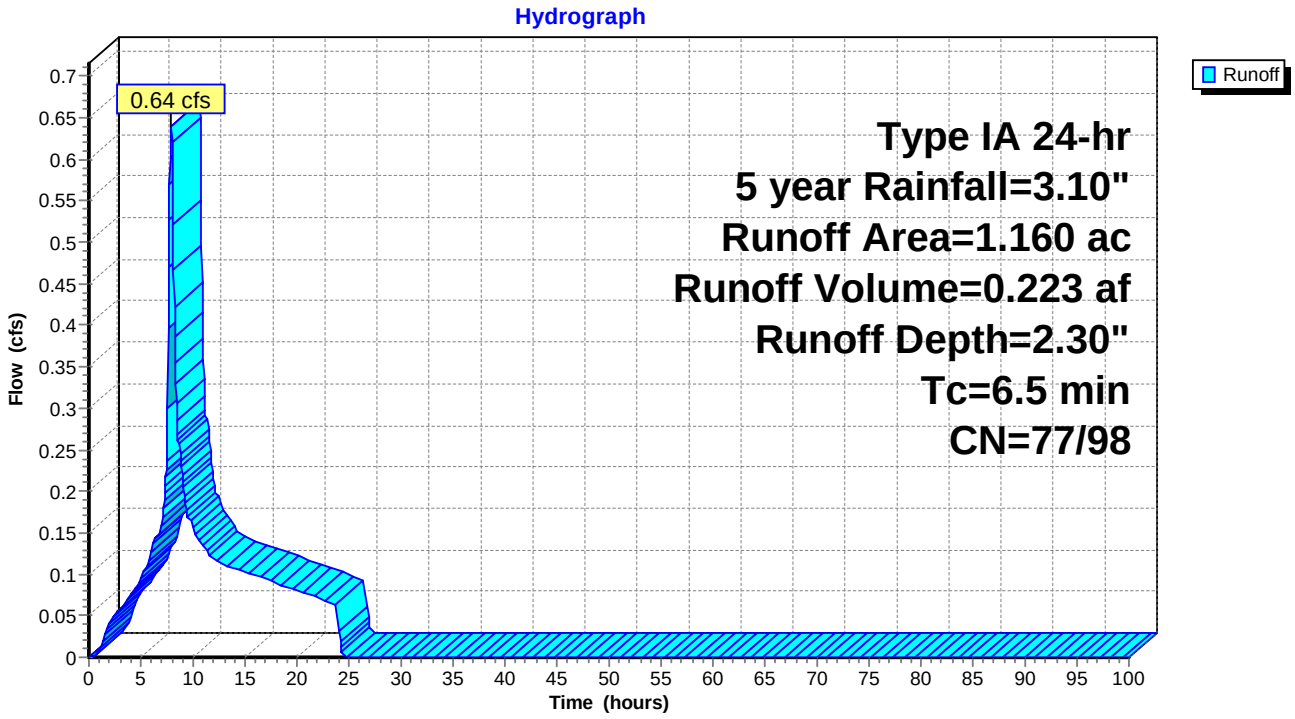
Runoff = 0.64 cfs @ 7.95 hrs, Volume= 0.223 af, Depth= 2.30"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
Type IA 24-hr 5 year Rainfall=3.10"

	Area (ac)	CN	Description
*	0.380	77	Open space, good condition, C/D soils
*	0.780	98	Impervious Areas
	1.160	91	Weighted Average
	0.380	77	32.76% Pervious Area
	0.780	98	67.24% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.5					**Direct Entry,**

Subcatchment 2S: Developed Basin



Summary for Pond 3P: Detention Chambers

Inflow Area = 1.160 ac, 67.24% Impervious, Inflow Depth = 2.30" for 5 year event
Inflow = 0.64 cfs @ 7.95 hrs, Volume= 0.223 af
Outflow = 0.10 cfs @ 16.66 hrs, Volume= 0.223 af, Atten= 85%, Lag= 522.7 min
Discarded = 0.01 cfs @ 1.70 hrs, Volume= 0.077 af
Primary = 0.08 cfs @ 16.66 hrs, Volume= 0.146 af

Routing by Stor-Ind method, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
Peak Elev= 102.70' @ 16.66 hrs Surf.Area= 4,677 sf Storage= 5,670 cf

Plug-Flow detention time= 1,508.9 min calculated for 0.223 af (100% of inflow)
Center-of-Mass det. time= 1,508.8 min (2,206.8 - 698.0)

Volume	Invert	Avail.Storage	Storage Description
#1A	100.00'	3,170 cf	**24.83'W x 188.32'L x 2.83'H Field A** 13,250 cf Overall - 2,683 cf Embedded = 10,567 cf x 30.0% Voids
#2A	101.00'	2,683 cf	**ADS_StormTech SC-310 +Cap** x 182 Inside #1 Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap 7 Rows of 26 Chambers
		5,853 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	100.00'	**12.0" Round Culvert** L= 100.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 100.00' / 99.00' S= 0.0100 '/' Cc= 0.900 n= 0.013, Flow Area= 0.79 sf
#2	Device 1	98.00'	**0.7" Vert. Orifice/Grate** C= 0.600
#3	Device 1	102.49'	**2.8" Vert. Orifice/Grate** C= 0.600
#4	Device 1	102.78'	**5.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32
#5	Discarded	100.00'	**0.100 in/hr Exfiltration over Horizontal area**

Discarded OutFlow Max=0.01 cfs @ 1.70 hrs HW=100.03' (Free Discharge)
└**5=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=0.09 cfs @ 16.66 hrs HW=102.70' (Free Discharge)
└**1=Culvert** (Passes 0.09 cfs of 4.43 cfs potential flow)
  ├**2=Orifice/Grate** (Orifice Controls 0.02 cfs @ 7.92 fps)
  ├**3=Orifice/Grate** (Orifice Controls 0.06 cfs @ 1.57 fps)
  └**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 3P: Detention Chambers - Chamber Wizard Field A

Chamber Model = ADS_StormTech SC-310 +Cap (ADS StormTech® SC-310 with cap length)
Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf
Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap

34.0" Wide + 6.0" Spacing = 40.0" C-C Row Spacing

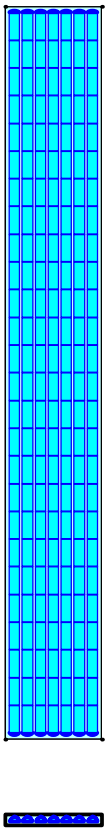
26 Chambers/Row x 7.12' Long +0.60' Cap Length x 2 = 186.32' Row Length +12.0" End Stone x 2 = 188.32' Base Length
7 Rows x 34.0" Wide + 6.0" Spacing x 6 + 12.0" Side Stone x 2 = 24.83' Base Width
12.0" Base + 16.0" Chamber Height + 6.0" Cover = 2.83' Field Height

182 Chambers x 14.7 cf = 2,683.0 cf Chamber Storage

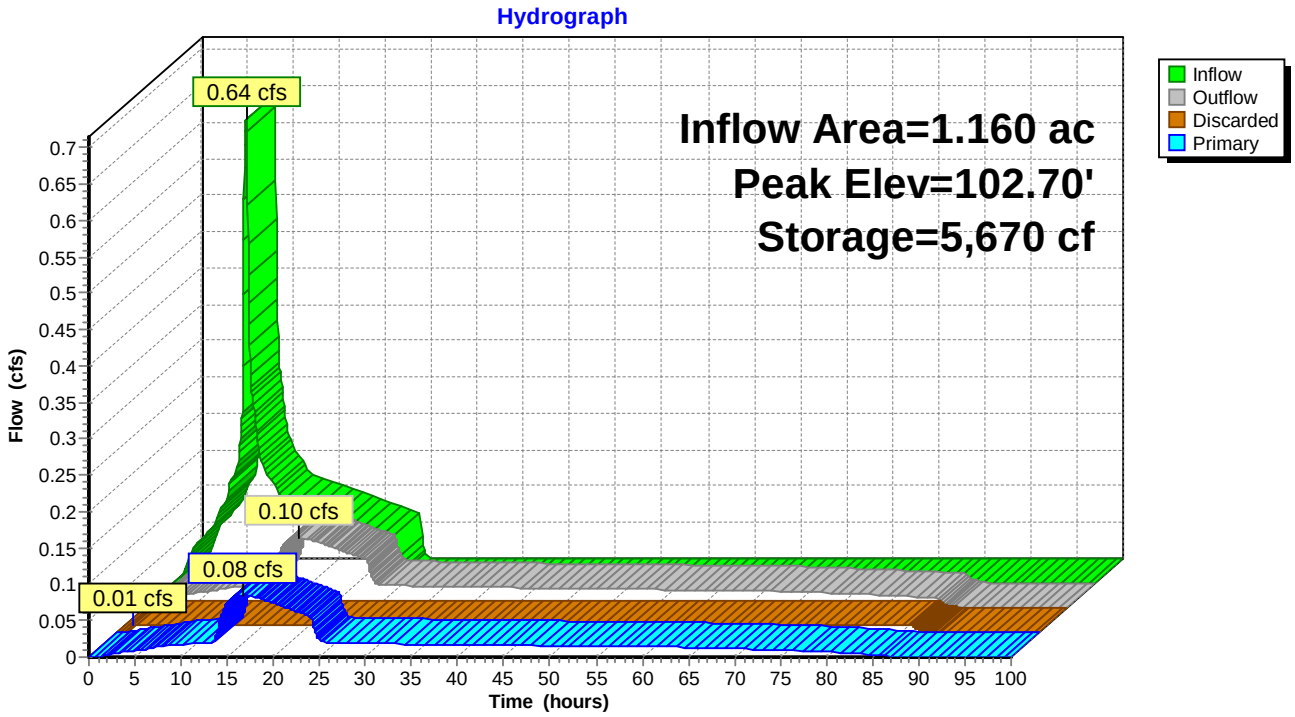
13,250.4 cf Field - 2,683.0 cf Chambers = 10,567.4 cf Stone x 30.0% Voids = 3,170.2 cf Stone Storage

Chamber Storage + Stone Storage = 5,853.2 cf = 0.134 af
Overall Storage Efficiency = 44.2%
Overall System Size = 188.32' x 24.83' x 2.83'

182 Chambers
490.8 cy Field
391.4 cy Stone



Pond 3P: Detention Chambers



Time span=0.00-100.00 hrs, dt=0.05 hrs, 2001 points
Runoff by SBUH method, Split Pervious/Imperv.
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Predeveloped Basin Runoff Area=1.160 ac 0.00% Impervious Runoff Depth=1.21"
Tc=97.7 min CN=74/0 Runoff=0.11 cfs 0.117 af

Subcatchment 2S: Developed Basin Runoff Area=1.160 ac 67.24% Impervious Runoff Depth=2.62"
Tc=6.5 min CN=77/98 Runoff=0.73 cfs 0.253 af

Pond 3P: Detention Chambers Peak Elev=102.78' Storage=5,777 cf Inflow=0.73 cfs 0.253 af
Discarded=0.01 cfs 0.077 af Primary=0.11 cfs 0.176 af Outflow=0.12 cfs 0.253 af

Total Runoff Area = 2.320 ac Runoff Volume = 0.370 af Average Runoff Depth = 1.91"
66.38% Pervious = 1.540 ac 33.62% Impervious = 0.780 ac

Summary for Subcatchment 1S: Predeveloped Basin

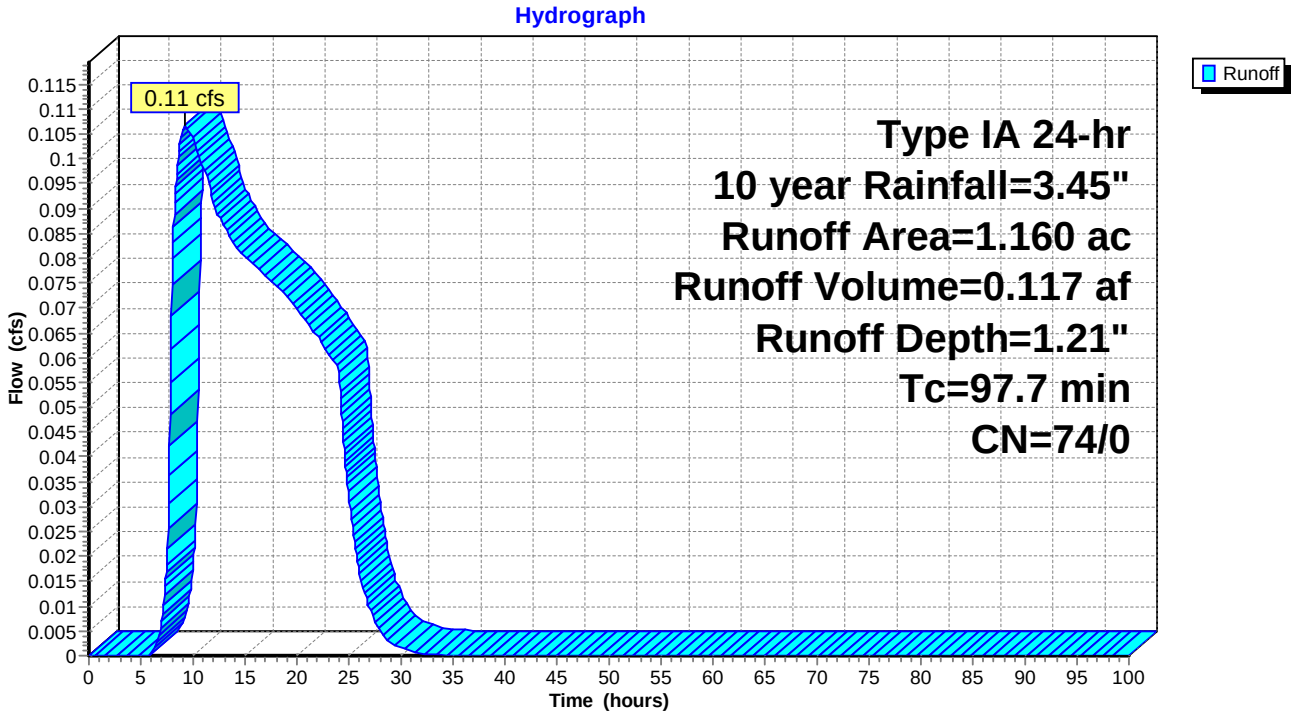
Runoff = 0.11 cfs @ 9.19 hrs, Volume= 0.117 af, Depth= 1.21"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
Type IA 24-hr 10 year Rainfall=3.45"

	Area (ac)	CN	Description
*	1.160	74	Woods, good condition, C/D soils
	1.160	74	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
97.7					**Direct Entry,**

Subcatchment 1S: Predeveloped Basin



Summary for Subcatchment 2S: Developed Basin

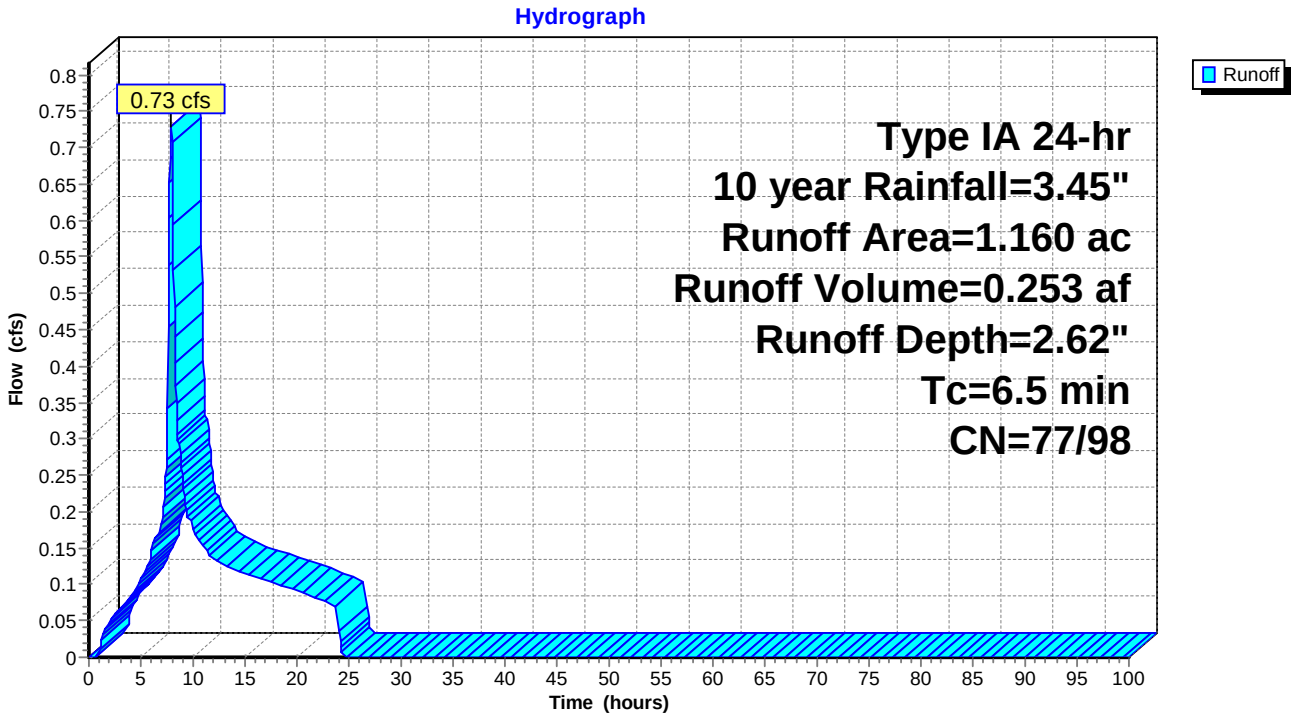
Runoff = 0.73 cfs @ 7.95 hrs, Volume= 0.253 af, Depth= 2.62"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
Type IA 24-hr 10 year Rainfall=3.45"

	Area (ac)	CN	Description
*	0.380	77	Open space, good condition, C/D soils
*	0.780	98	Impervious Areas
	1.160	91	Weighted Average
	0.380	77	32.76% Pervious Area
	0.780	98	67.24% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.5					**Direct Entry,**

Subcatchment 2S: Developed Basin



Summary for Pond 3P: Detention Chambers

Inflow Area = 1.160 ac, 67.24% Impervious, Inflow Depth = 2.62" for 10 year event
Inflow = 0.73 cfs @ 7.95 hrs, Volume= 0.253 af
Outflow = 0.12 cfs @ 14.67 hrs, Volume= 0.253 af, Atten= 84%, Lag= 403.2 min
Discarded = 0.01 cfs @ 1.60 hrs, Volume= 0.077 af
Primary = 0.11 cfs @ 14.67 hrs, Volume= 0.176 af

Routing by Stor-Ind method, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
Peak Elev= 102.78' @ 14.67 hrs Surf.Area= 4,677 sf Storage= 5,777 cf

Plug-Flow detention time= 1,356.4 min calculated for 0.253 af (100% of inflow)
Center-of-Mass det. time= 1,357.6 min (2,053.1 - 695.4)

Volume	Invert	Avail.Storage	Storage Description
#1A	100.00'	3,170 cf	**24.83'W x 188.32'L x 2.83'H Field A** 13,250 cf Overall - 2,683 cf Embedded = 10,567 cf x 30.0% Voids
#2A	101.00'	2,683 cf	**ADS_StormTech SC-310 +Cap** x 182 Inside #1 Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap 7 Rows of 26 Chambers
		5,853 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	100.00'	**12.0" Round Culvert** L= 100.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 100.00' / 99.00' S= 0.0100 '/' Cc= 0.900 n= 0.013, Flow Area= 0.79 sf
#2	Device 1	98.00'	**0.7" Vert. Orifice/Grate** C= 0.600
#3	Device 1	102.49'	**2.8" Vert. Orifice/Grate** C= 0.600
#4	Device 1	102.78'	**5.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32
#5	Discarded	100.00'	**0.100 in/hr Exfiltration over Horizontal area**

Discarded OutFlow Max=0.01 cfs @ 1.60 hrs HW=100.03' (Free Discharge)
└**5=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=0.11 cfs @ 14.67 hrs HW=102.78' (Free Discharge)
└**1=Culvert** (Passes 0.11 cfs of 4.51 cfs potential flow)
  ├**2=Orifice/Grate** (Orifice Controls 0.02 cfs @ 8.03 fps)
  ├**3=Orifice/Grate** (Orifice Controls 0.09 cfs @ 2.00 fps)
  └**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 3P: Detention Chambers - Chamber Wizard Field A

Chamber Model = ADS_StormTech SC-310 +Cap (ADS StormTech® SC-310 with cap length)
Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf
Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap

34.0" Wide + 6.0" Spacing = 40.0" C-C Row Spacing

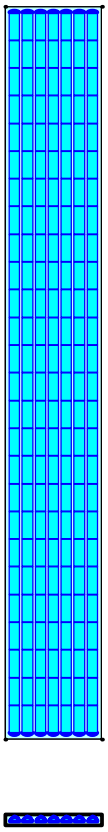
26 Chambers/Row x 7.12' Long +0.60' Cap Length x 2 = 186.32' Row Length +12.0" End Stone x 2 = 188.32' Base Length
7 Rows x 34.0" Wide + 6.0" Spacing x 6 + 12.0" Side Stone x 2 = 24.83' Base Width
12.0" Base + 16.0" Chamber Height + 6.0" Cover = 2.83' Field Height

182 Chambers x 14.7 cf = 2,683.0 cf Chamber Storage

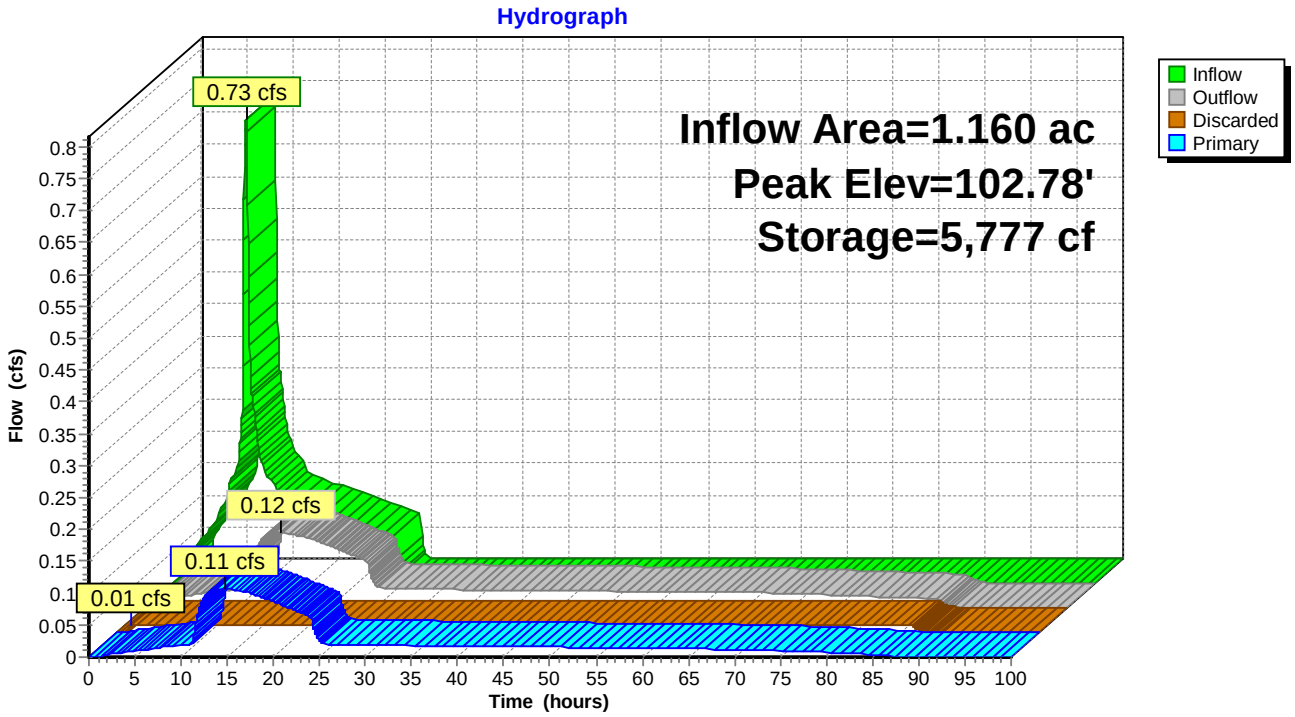
13,250.4 cf Field - 2,683.0 cf Chambers = 10,567.4 cf Stone x 30.0% Voids = 3,170.2 cf Stone Storage

Chamber Storage + Stone Storage = 5,853.2 cf = 0.134 af
Overall Storage Efficiency = 44.2%
Overall System Size = 188.32' x 24.83' x 2.83'

182 Chambers
490.8 cy Field
391.4 cy Stone



Pond 3P: Detention Chambers



Time span=0.00-100.00 hrs, dt=0.05 hrs, 2001 points
Runoff by SBUH method, Split Pervious/Imperv.
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Predeveloped Basin Runoff Area=1.160 ac 0.00% Impervious Runoff Depth=1.52"
Tc=97.7 min CN=74/0 Runoff=0.14 cfs 0.147 af

Subcatchment 2S: Developed Basin Runoff Area=1.160 ac 67.24% Impervious Runoff Depth=3.03"
Tc=6.5 min CN=77/98 Runoff=0.85 cfs 0.293 af

Pond 3P: Detention Chambers Peak Elev=102.81' Storage=5,816 cf Inflow=0.85 cfs 0.293 af
Discarded=0.01 cfs 0.077 af Primary=0.17 cfs 0.216 af Outflow=0.18 cfs 0.293 af

Total Runoff Area = 2.320 ac Runoff Volume = 0.440 af Average Runoff Depth = 2.28"
66.38% Pervious = 1.540 ac 33.62% Impervious = 0.780 ac

Summary for Subcatchment 1S: Predeveloped Basin

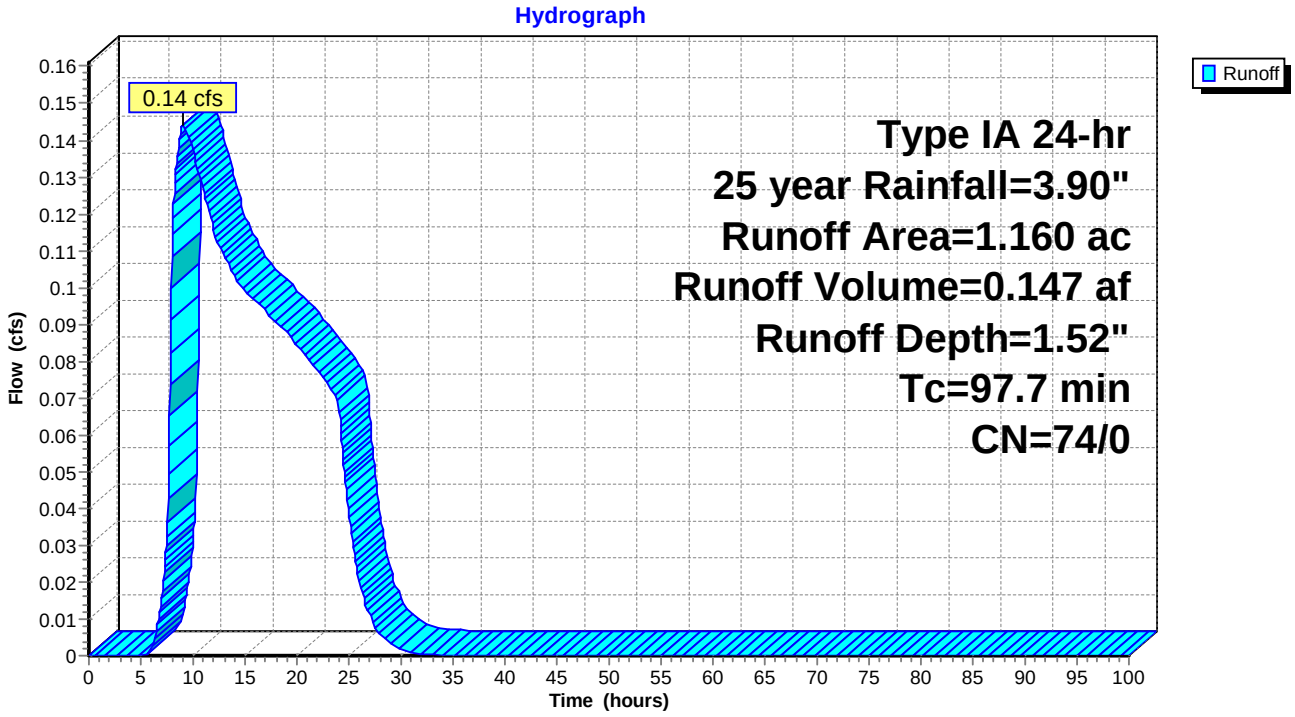
Runoff = 0.14 cfs @ 9.06 hrs, Volume= 0.147 af, Depth= 1.52"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
Type IA 24-hr 25 year Rainfall=3.90"

	Area (ac)	CN	Description
*	1.160	74	Woods, good condition, C/D soils
	1.160	74	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
97.7					**Direct Entry,**

Subcatchment 1S: Predeveloped Basin



Summary for Subcatchment 2S: Developed Basin

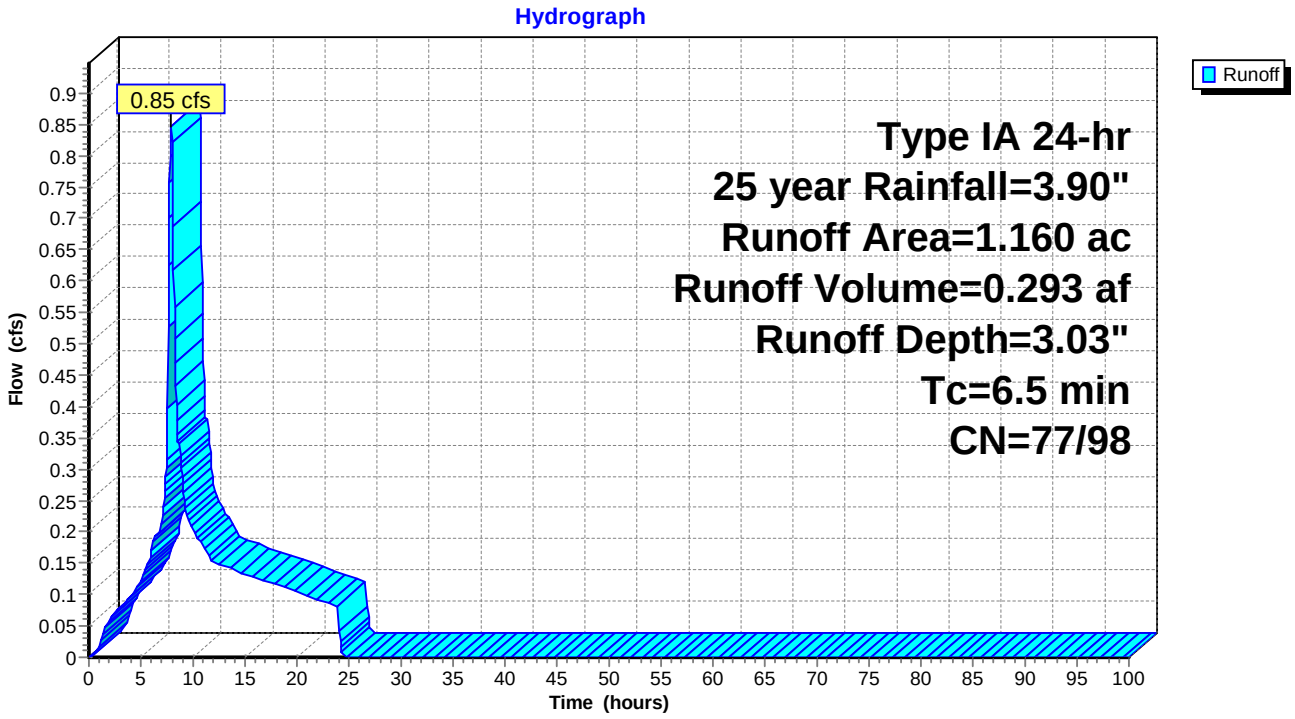
Runoff = 0.85 cfs @ 7.95 hrs, Volume= 0.293 af, Depth= 3.03"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
Type IA 24-hr 25 year Rainfall=3.90"

	Area (ac)	CN	Description
*	0.380	77	Open space, good condition, C/D soils
*	0.780	98	Impervious Areas
	1.160	91	Weighted Average
	0.380	77	32.76% Pervious Area
	0.780	98	67.24% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.5					**Direct Entry,**

Subcatchment 2S: Developed Basin



Summary for Pond 3P: Detention Chambers

Inflow Area = 1.160 ac, 67.24% Impervious, Inflow Depth = 3.03" for 25 year event
Inflow = 0.85 cfs @ 7.95 hrs, Volume= 0.293 af
Outflow = 0.18 cfs @ 10.82 hrs, Volume= 0.293 af, Atten= 78%, Lag= 172.4 min
Discarded = 0.01 cfs @ 1.45 hrs, Volume= 0.077 af
Primary = 0.17 cfs @ 10.82 hrs, Volume= 0.216 af

Routing by Stor-Ind method, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
Peak Elev= 102.81' @ 10.82 hrs Surf.Area= 4,677 sf Storage= 5,816 cf

Plug-Flow detention time= 1,194.7 min calculated for 0.293 af (100% of inflow)
Center-of-Mass det. time= 1,196.1 min (1,888.6 - 692.5)

Volume	Invert	Avail.Storage	Storage Description
#1A	100.00'	3,170 cf	**24.83'W x 188.32'L x 2.83'H Field A** 13,250 cf Overall - 2,683 cf Embedded = 10,567 cf x 30.0% Voids
#2A	101.00'	2,683 cf	**ADS_StormTech SC-310 +Cap** x 182 Inside #1 Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap 7 Rows of 26 Chambers
		5,853 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	100.00'	**12.0" Round Culvert** L= 100.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 100.00' / 99.00' S= 0.0100 '/' Cc= 0.900 n= 0.013, Flow Area= 0.79 sf
#2	Device 1	98.00'	**0.7" Vert. Orifice/Grate** C= 0.600
#3	Device 1	102.49'	**2.8" Vert. Orifice/Grate** C= 0.600
#4	Device 1	102.78'	**5.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32
#5	Discarded	100.00'	**0.100 in/hr Exfiltration over Horizontal area**

Discarded OutFlow Max=0.01 cfs @ 1.45 hrs HW=100.03' (Free Discharge)
└**5=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=0.17 cfs @ 10.82 hrs HW=102.81' (Free Discharge)
└**1=Culvert** (Passes 0.17 cfs of 4.53 cfs potential flow)
  ├**2=Orifice/Grate** (Orifice Controls 0.02 cfs @ 8.07 fps)
  ├**3=Orifice/Grate** (Orifice Controls 0.09 cfs @ 2.15 fps)
  └**4=Broad-Crested Rectangular Weir** (Weir Controls 0.06 cfs @ 0.44 fps)

Pond 3P: Detention Chambers - Chamber Wizard Field A

Chamber Model = ADS_StormTech SC-310 +Cap (ADS StormTech® SC-310 with cap length)
Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf
Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap

34.0" Wide + 6.0" Spacing = 40.0" C-C Row Spacing

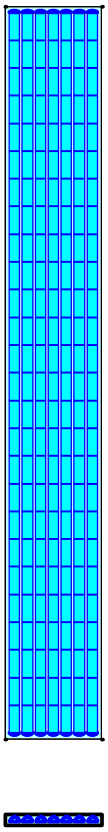
26 Chambers/Row x 7.12' Long +0.60' Cap Length x 2 = 186.32' Row Length +12.0" End Stone x 2 = 188.32' Base Length
7 Rows x 34.0" Wide + 6.0" Spacing x 6 + 12.0" Side Stone x 2 = 24.83' Base Width
12.0" Base + 16.0" Chamber Height + 6.0" Cover = 2.83' Field Height

182 Chambers x 14.7 cf = 2,683.0 cf Chamber Storage

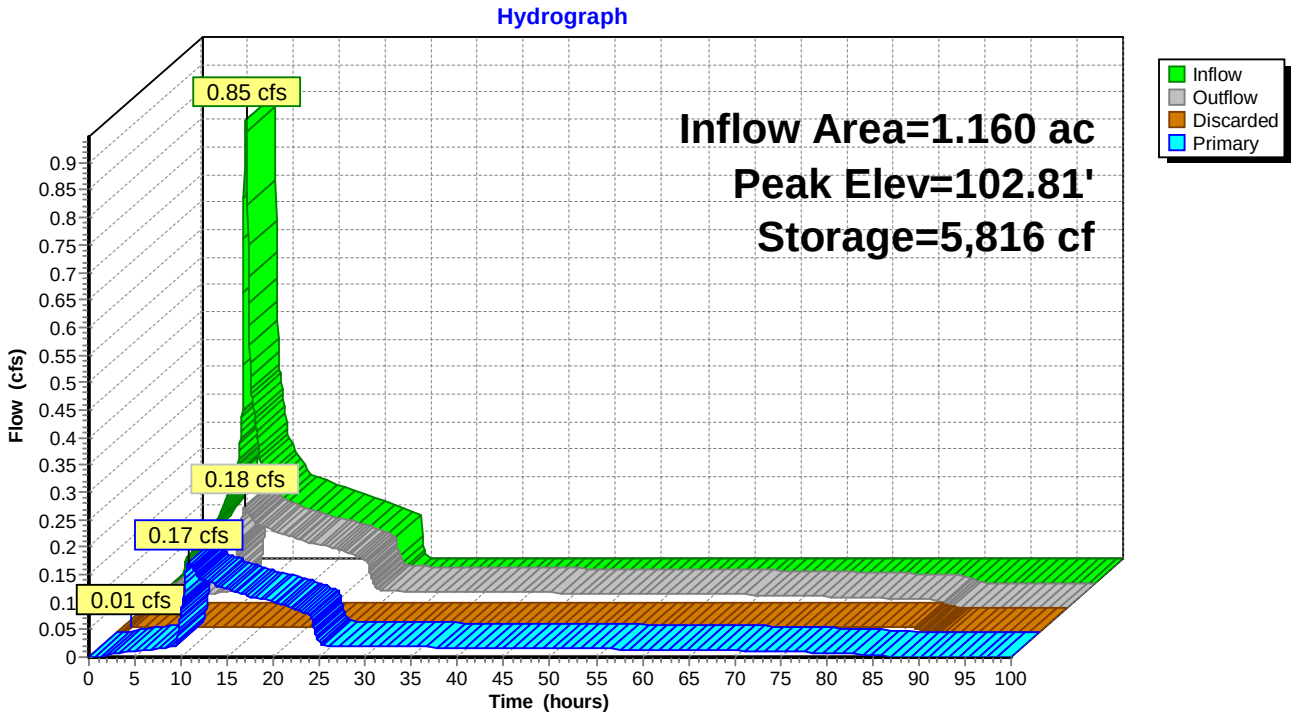
13,250.4 cf Field - 2,683.0 cf Chambers = 10,567.4 cf Stone x 30.0% Voids = 3,170.2 cf Stone Storage

Chamber Storage + Stone Storage = 5,853.2 cf = 0.134 af
Overall Storage Efficiency = 44.2%
Overall System Size = 188.32' x 24.83' x 2.83'

182 Chambers
490.8 cy Field
391.4 cy Stone



Pond 3P: Detention Chambers



Time span=0.00-100.00 hrs, dt=0.05 hrs, 2001 points
Runoff by SBUH method, Split Pervious/Imperv.
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Predeveloped Basin Runoff Area=1.160 ac 0.00% Impervious Runoff Depth=1.97"
Tc=97.7 min CN=74/0 Runoff=0.20 cfs 0.191 af

Subcatchment 2S: Developed Basin Runoff Area=1.160 ac 67.24% Impervious Runoff Depth=3.59"
Tc=6.5 min CN=77/98 Runoff=1.00 cfs 0.347 af

Pond 3P: Detention Chambers Peak Elev=102.84' Storage=5,853 cf Inflow=1.00 cfs 0.347 af
Discarded=0.01 cfs 0.077 af Primary=0.34 cfs 0.270 af Outflow=0.35 cfs 0.347 af

Total Runoff Area = 2.320 ac Runoff Volume = 0.538 af Average Runoff Depth = 2.78"
66.38% Pervious = 1.540 ac 33.62% Impervious = 0.780 ac

Summary for Subcatchment 1S: Predeveloped Basin

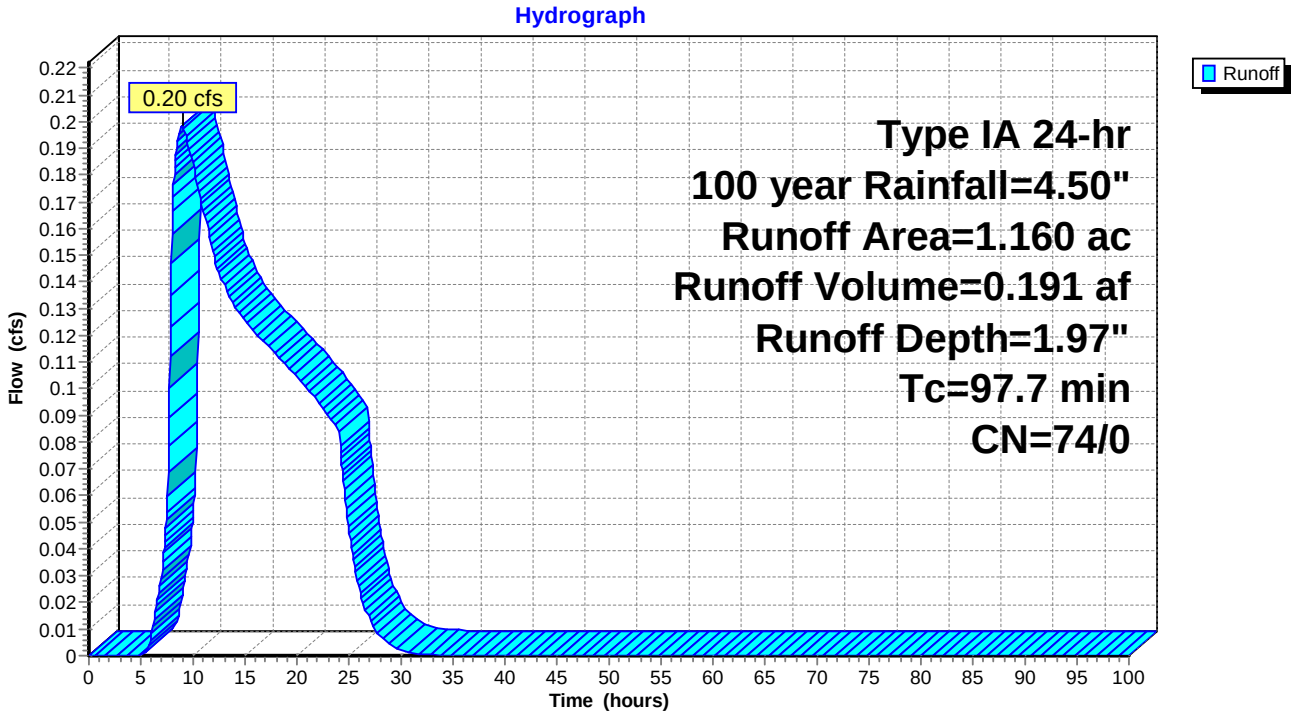
Runoff = 0.20 cfs @ 8.96 hrs, Volume= 0.191 af, Depth= 1.97"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100 year Rainfall=4.50"

	Area (ac)	CN	Description
*	1.160	74	Woods, good condition, C/D soils
	1.160	74	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
97.7					**Direct Entry,**

Subcatchment 1S: Predeveloped Basin



Summary for Subcatchment 2S: Developed Basin

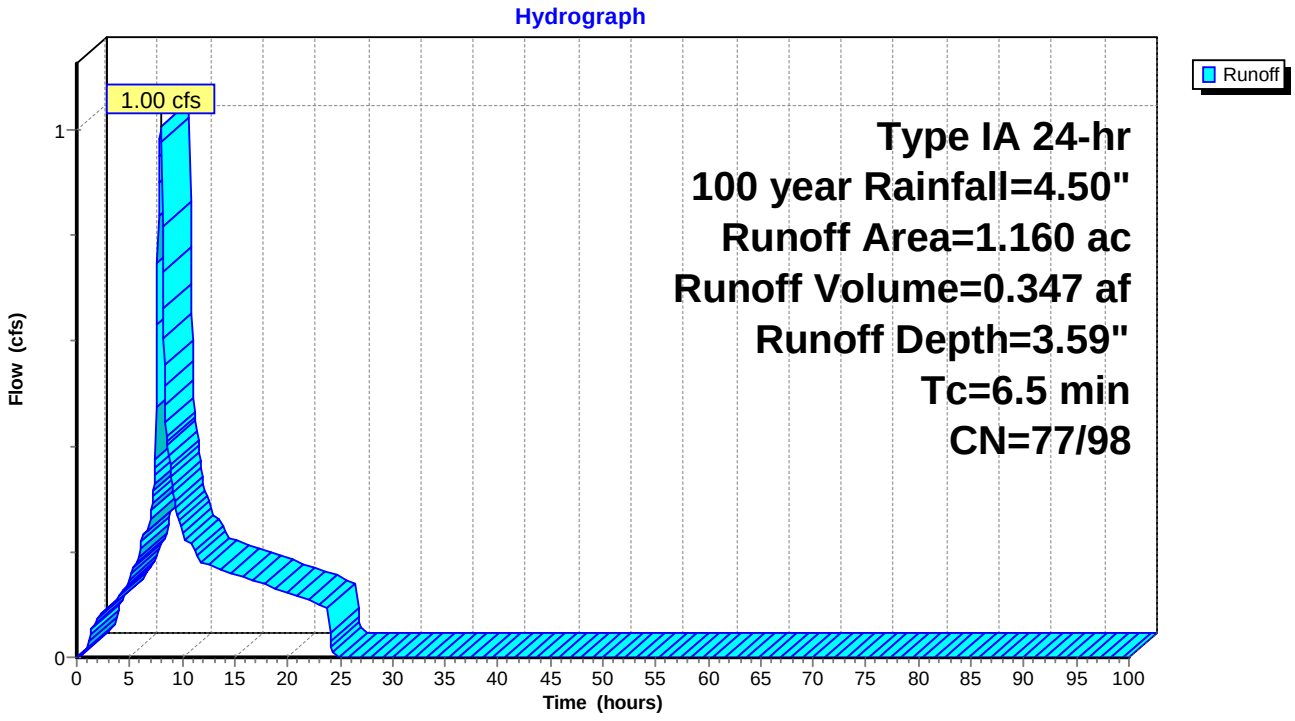
Runoff = 1.00 cfs @ 7.94 hrs, Volume= 0.347 af, Depth= 3.59"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100 year Rainfall=4.50"

	Area (ac)	CN	Description
*	0.380	77	Open space, good condition, C/D soils
*	0.780	98	Impervious Areas
	1.160	91	Weighted Average
	0.380	77	32.76% Pervious Area
	0.780	98	67.24% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.5					**Direct Entry,**

Subcatchment 2S: Developed Basin



Summary for Pond 3P: Detention Chambers

[93] Warning: Storage range exceeded by 0.01'

Inflow Area = 1.160 ac, 67.24% Impervious, Inflow Depth = 3.59" for 100 year event
Inflow = 1.00 cfs @ 7.94 hrs, Volume= 0.347 af
Outflow = 0.35 cfs @ 8.99 hrs, Volume= 0.347 af, Atten= 65%, Lag= 62.8 min
Discarded = 0.01 cfs @ 1.30 hrs, Volume= 0.077 af
Primary = 0.34 cfs @ 8.99 hrs, Volume= 0.270 af

Routing by Stor-Ind method, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
Peak Elev= 102.84' @ 8.99 hrs Surf.Area= 4,677 sf Storage= 5,853 cf

Plug-Flow detention time= 1,028.2 min calculated for 0.347 af (100% of inflow)
Center-of-Mass det. time= 1,028.0 min (1,717.2 - 689.1)

Volume	Invert	Avail.Storage	Storage Description
#1A	100.00'	3,170 cf	**24.83'W x 188.32'L x 2.83'H Field A** 13,250 cf Overall - 2,683 cf Embedded = 10,567 cf x 30.0% Voids
#2A	101.00'	2,683 cf	**ADS_StormTech SC-310 +Cap** x 182 Inside #1 Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap 7 Rows of 26 Chambers
		5,853 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
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#2	Device 1	98.00'	**0.7" Vert. Orifice/Grate** C= 0.600
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#4	Device 1	102.78'	**5.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32
#5	Discarded	100.00'	**0.100 in/hr Exfiltration over Horizontal area**

Discarded OutFlow Max=0.01 cfs @ 1.30 hrs HW=100.03' (Free Discharge)
└**5=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=0.33 cfs @ 8.99 hrs HW=102.84' (Free Discharge)
└**1=Culvert** (Passes 0.33 cfs of 4.57 cfs potential flow)
  ├**2=Orifice/Grate** (Orifice Controls 0.02 cfs @ 8.12 fps)
  ├**3=Orifice/Grate** (Orifice Controls 0.10 cfs @ 2.34 fps)
  └**4=Broad-Crested Rectangular Weir** (Weir Controls 0.21 cfs @ 0.67 fps)

Pond 3P: Detention Chambers - Chamber Wizard Field A

Chamber Model = ADS_StormTech SC-310 +Cap (ADS StormTech® SC-310 with cap length)
Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf
Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap

34.0" Wide + 6.0" Spacing = 40.0" C-C Row Spacing

26 Chambers/Row x 7.12' Long +0.60' Cap Length x 2 = 186.32' Row Length +12.0" End Stone x 2 = 188.32' Base Length
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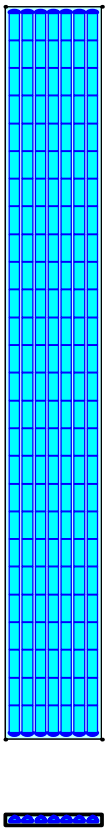
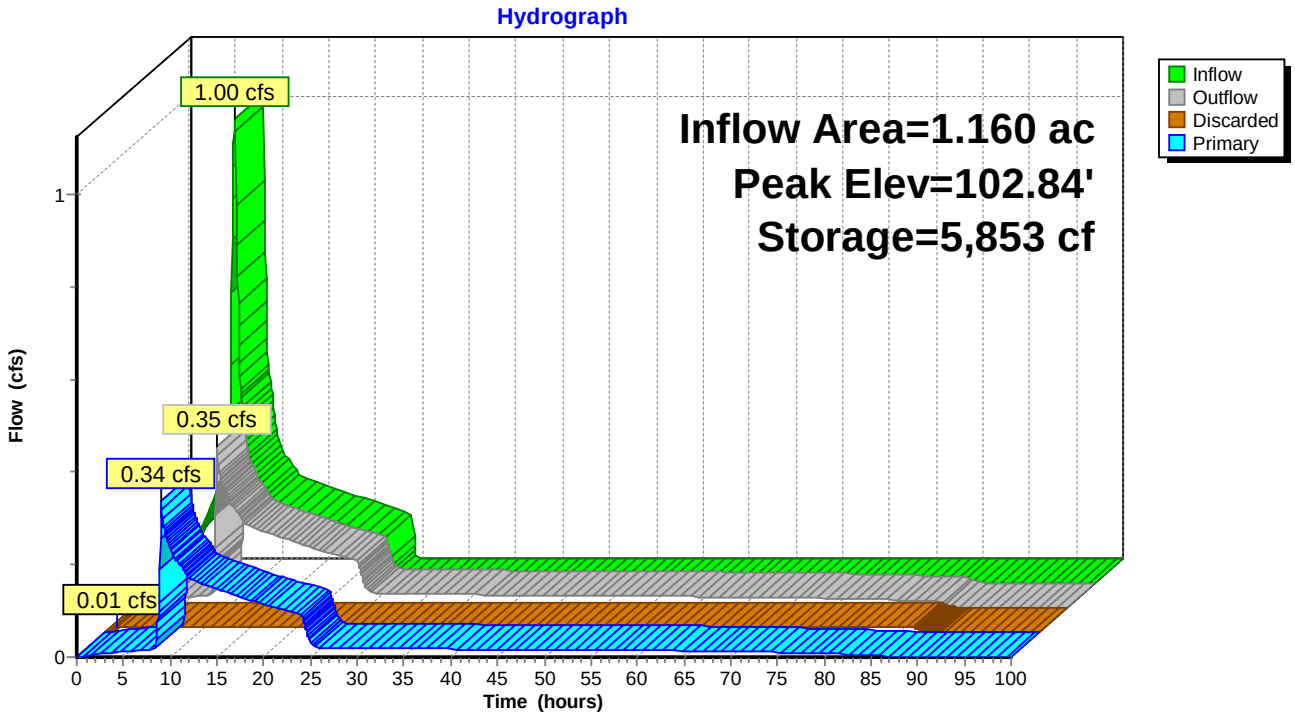
Chamber Storage + Stone Storage = 5,853.2 cf = 0.134 af
Overall Storage Efficiency = 44.2%
Overall System Size = 188.32' x 24.83' x 2.83'

182 Chambers
490.8 cy Field
391.4 cy Stone



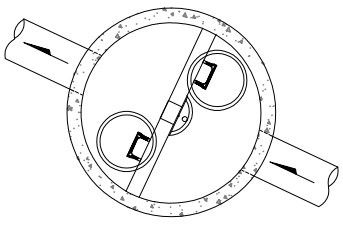
Pond 3P: Detention Chambers



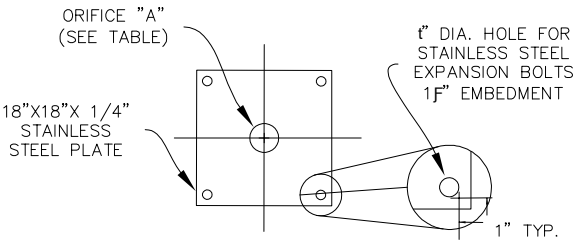
APPENDIX 'C' – FLOW CONTROL MANHOLE DETAIL

NOTES:

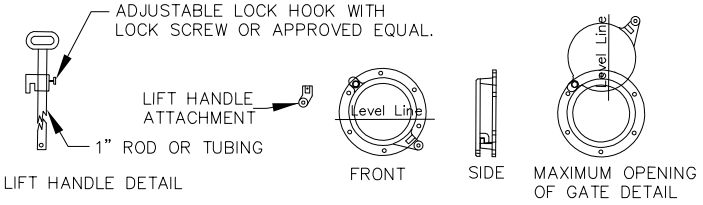
1. BAFFLE WALL SHALL HAVE #4 BAR AT 12" SPACING EACH WAY.
2. PRECAST BAFFLE SHALL BE KEYED AND GROUTED IN PLACE. JOINT BETWEEN CONCRETE BAFFLE AND MANHOLE WALL SHALL BE WATERTIGHT.
3. UPPER FLOW ORIFICE SHALL BE ALUMINUM, ALUMINIZED STEEL OR TREATMENT 1 GALVANIZED STEEL.
4. FRAME AND LADDER OR STEPS ARE TO BE OFFSET SO THAT SHEAR GATE IS VISIBLE FROM THE TOP; CLIMB-DOWN SPACE IS CLEAR OF RISER AND GATE; FRAME IS CLEAR OF CURB.
5. RESTRICTOR PLATE WITH ORIFICE AS SPECIFIED IN THE CONTRACT. OPENING IS TO BE CUT ROUND AND SMOOTH. NEOPRENE GASKET SHALL BE INSTALLED BETWEEN THE ORIFICE PLATE AND CONCRETE BAFFLE TO PROVIDE A WATERTIGHT SEAL.
6. SHEAR GATE SHALL BE MADE OF ALUMINUM ALLOY IN ACCORDANCE WITH ASTM B 26M AND ASTM B 275,
7. DESIGNATION Zg32A OR CAST IRON IN ACCORDANCE WITH ASTM A 48, CLASS 30B. LIFT HANDLE MAY BE SOLID ROD OR HOLLOW TUBING WITH ADJUSTABLE HOOK AS REQUIRED. NEOPRENE RUBBER GASKET REQUIRED BETWEEN RISER MOUNTING FLANGE AND GATE FLANGE. MATING SURFACES OF LID AND BODY SHALL BE MACHINED FOR PROPER FIT. FLANGE MOUNTING BOLTS SHALL BE 3/8" X 16 X 3" LG SS REDHEADS.
8. SHEAR GATE MAXIMUM OPENING SHALL BE CONTROLLED BY LIMITED HINGE MOVEMENT, STOP TAB OR SOME OTHER DEVISE.
9. ALTERNATE SHEAR GATES DESIGNS ARE ACCEPTABLE, IF MATERIAL SPECIFICATIONS ARE MET AND FLANGE BOLT PATTERN MATCHES.
10. ALL MANHOLE FLAT TOPS SHALL CONFORM TO ASTM C-478 AND ARE DESIGNED TO MEET H-20 TRAFFIC LOADING..



PLAN



RESTRICTOR PLATE, ORIFICE



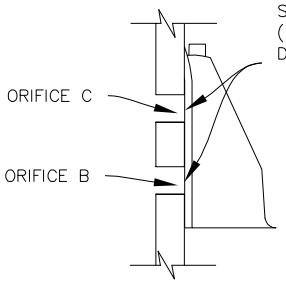
SHEAR GATE
MANUFACTURED BY KENNEDY VALVE OR EQUAL

INSTALLATION NOTE:

POSITION HOOD SUCH THAT BOTTOM FLANGE IS MIN 2" BELOW THE ORIFICE B INVERT.

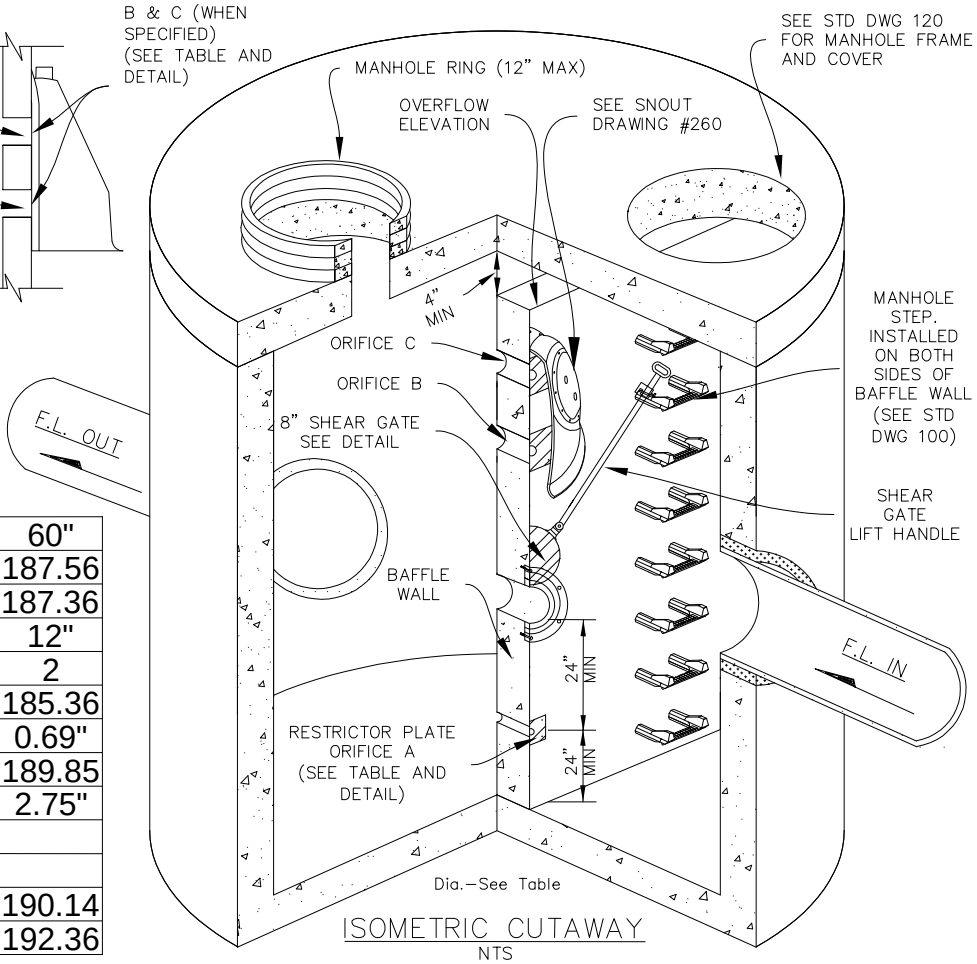
ONE SNOUT MAY BE USED FOR BOTH ORIFICE C AND B.

IT MAY BE NECESSARY TO USE TWO SNOUTS ON OFFSET ORIFICES TO MEET PLAN ELEVATION.



SNOUT DETAIL

RESTRICTOR PLATE ORIFICE WITH ORIFICE B & C (WHEN SPECIFIED) (SEE TABLE AND DETAIL)



ISOMETRIC CUTAWAY
NTS

FLOW CONTROL STRUCTURE TABLE

Diameter Of Manhole (In.) 60" MIN	60"
F.L. (In)	187.56
F.L. (Out)	187.36
Outlet Pipe Diameter (In.)	12"
Number Of Orifice	2
Orifice A Elevation	185.36
Diameter Of Orifice A (In.)	0.69"
Orifice B Elevation	189.85
Diameter Of Orifice B (In.)	2.75"
Orifice C Elevation	
Diameter Of Orifice C (In)	
Overflow Elevation	190.14
Rim Elevation	192.36

FLOW CONTROL STRUCTURE DETAIL

DRAWING NO. 270

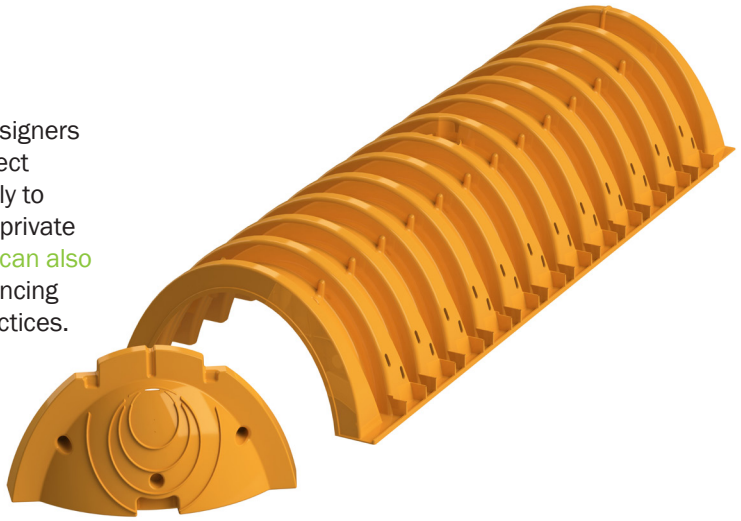
REVISED 10-31-19

Clean Water Services

APPENDIX 'D' – DETENTION CHAMBER SPECIFICATIONS

SC-310 CHAMBER

Designed to meet the most stringent industry performance standards for superior structural integrity while providing designers with a cost-effective method to save valuable land and protect water resources. The StormTech system is designed primarily to be used under parking lots, thus maximizing land usage for private (commercial) and public applications. StormTech chambers can also be used in conjunction with Green Infrastructure, thus enhancing the performance and extending the service life of these practices.



STORMTECH SC-310 CHAMBER
(not to scale)

Nominal Chamber Specifications

Size (L x W x H)
85.4" x 34.0" x 16.0"
2,170 mm x 864 mm x 406 mm

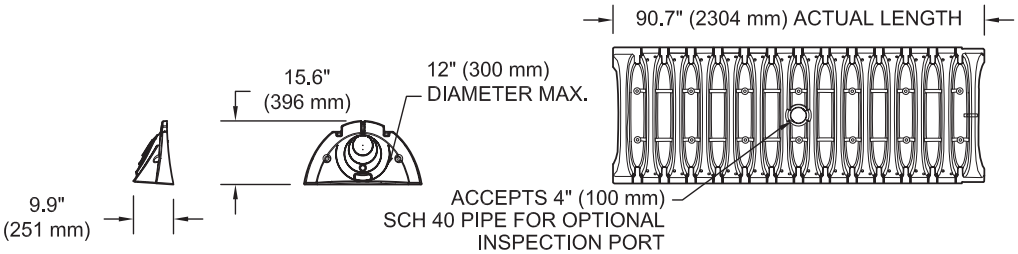
Chamber Storage
14.7 ft³ (0.42 m³)

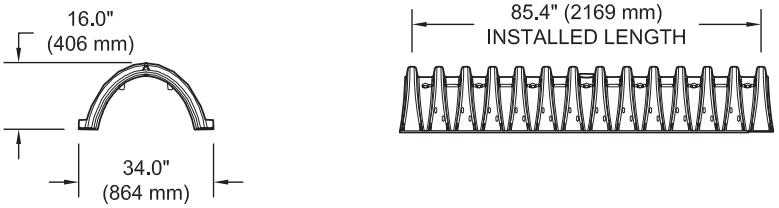
Min. Installed Storage*
31.0 ft³ (0.88 m³)

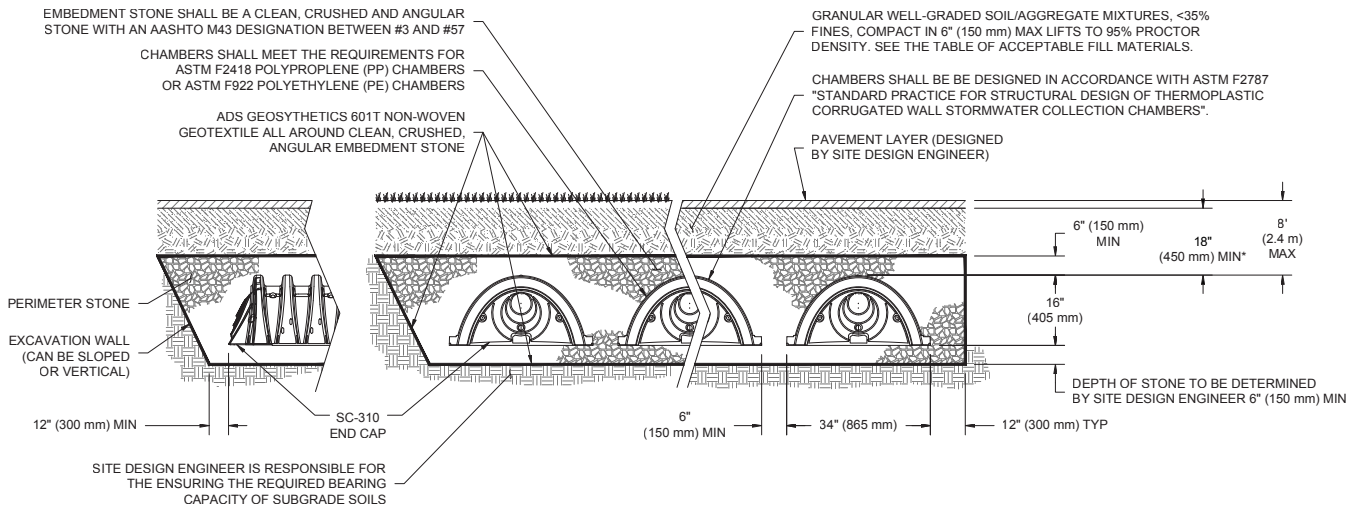
Weight
37.0 lbs (16.8 kg)

Shipping
41 chambers/pallet
108 end caps/pallet
18 pallets/truck

*Assumes 6" (150 mm) stone above and below chambers and 40% stone porosity.







*MINIMUM COVER TO BOTTOM OF FLEXIBLE PAVEMENT. FOR UNPAVED INSTALLATIONS WHERE RUTTING FROM VEHICLES MAY OCCUR, INCREASE COVER TO 24" (600 mm).

SC-310 CUMULATIVE STORAGE VOLUMES PER CHAMBER

Assumes 40% Stone Porosity. Calculations are Based Upon a 6" (150 mm) Stone Base Under Chambers.

Depth of Water in System Inches (mm)		Cumulative Chamber Storage ft³ (m³)	Total System Cumulative Storage ft³ (m³)
28 (711)		14.70 (0.416)	31.00 (0.878)
27 (686)		14.70 (0.416)	30.21 (0.855)
26 (680)	Stone	14.70 (0.416)	29.42 (0.833)
25 (610)	Cover	14.70 (0.416)	28.63 (0.811)
24 (609)		14.70 (0.416)	27.84 (0.788)
23 (584)		14.70 (0.416)	27.05 (0.766)
22 (559)		14.70 (0.416)	26.26 (0.748)
21 (533)		14.64 (0.415)	25.43 (0.720)
20 (508)		14.49 (0.410)	24.54 (0.695)
19 (483)		14.22 (0.403)	23.58 (0.668)
18 (457)		13.68 (0.387)	22.47 (0.636)
17 (432)		12.99 (0.368)	21.25 (0.602)
16 (406)		12.17 (0.345)	19.97 (0.566)
15 (381)		11.25 (0.319)	18.62 (0.528)
14 (356)		10.23 (0.290)	17.22 (0.488)
13 (330)		9.15 (0.260)	15.78 (0.447)
12 (305)		7.99 (0.227)	14.29 (0.425)
11 (279)		6.78 (0.192)	12.77 (0.362)
10 (254)		5.51 (0.156)	11.22 (0.318)
9 (229)		4.19 (0.119)	9.64 (0.278)
8 (203)		2.83 (0.081)	8.03 (0.227)
7 (178)		1.43 (0.041)	6.40 (0.181)
6 (152)		0	4.74 (0.134)
5 (127)		0	3.95 (0.112)
4(102)	Stone Foundation	0	3.16 (0.090)
3 (76)		0	2.37 (0.067)
2 (51)		0	1.58 (0.046)
1 (25)		0	0.79 (0.022)

Note: Add 0.79 ft³ (0.022 m³) of storage for each additional inch. (25 mm) of stone foundation.

STORAGE VOLUME PER CHAMBER FT³ (M³)

	Bare Chamber Storage ft³ (m³)	Chamber and Stone Foundation Depth in. (mm)		
		6 (150)	12 (300)	18 (450)
StormTech SC-310	14.7 (0.4)	31.0 (0.9)	35.7 (1.0)	40.4 (1.1)

Note: Assumes 6" (150 mm) of stone above chambers, 6" (150 mm) row spacing and 40% stone porosity.

AMOUNT OF STONE PER CHAMBER

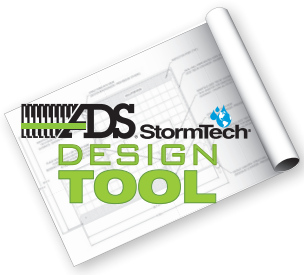
ENGLISH TONS (yds³)	Stone Foundation Depth		
	6"	12"	18"
StormTech SC-310	2.1 (1.5 yd³)	2.7 (1.9 yd³)	3.4 (2.4 yd³)
METRIC KILOGRAMS (m³)	**150 mm**	**300 mm**	**450 mm**
StormTech SC-310	1830 (1.1 m³)	2490 (1.5 m³)	2990 (1.8 m³)

Note: Assumes 6" (150 mm) of stone above, and between chambers.

VOLUME EXCAVATION PER CHAMBER YD³ (M³)

	Stone Foundation Depth		
	6" (150 mm)	12" (300 mm)	18" (450 mm)
StormTech SC-310	2.9 (2.2)	3.4 (2.6)	3.8 (2.9)

Note: Assumes 6" (150 mm) of row separation and 18" (450 mm) of cover. The volume of excavation will vary as the depth of the cover increases.



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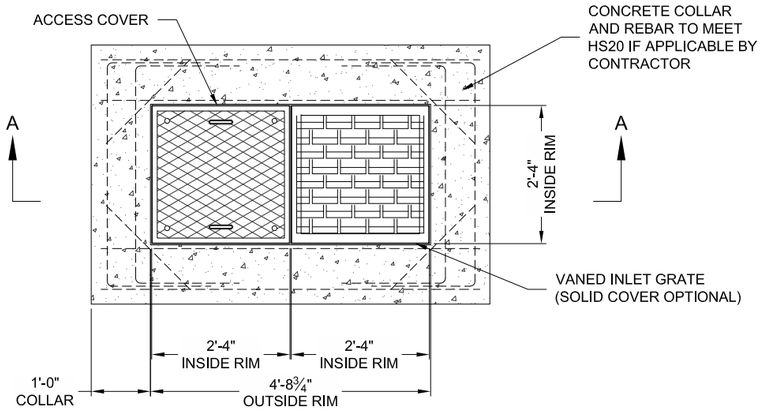
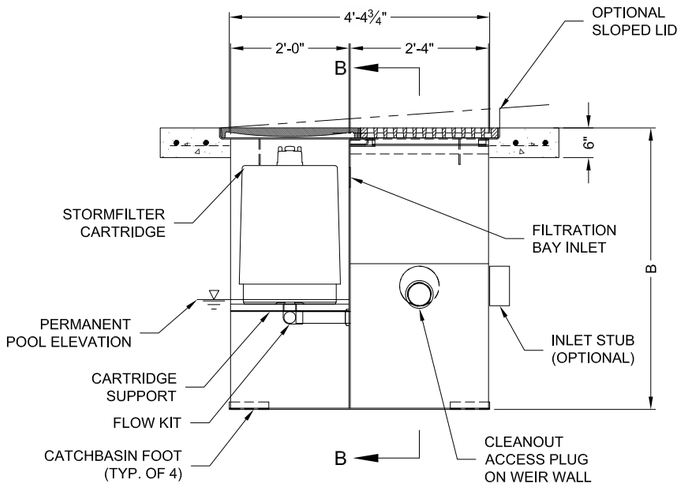
Advanced Drainage Systems, Inc.
4640 Trueman Blvd., Hilliard, OH 43026
1-800-821-6710 www.ads-pipe.com

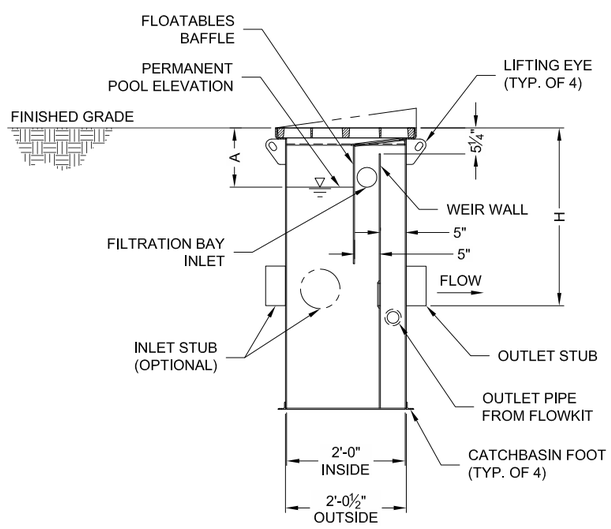
APPENDIX 'E' – FILTER CATCH BASIN DETAIL



PLAN VIEW



SECTION A-A



SECTION B-B

STORMFILTER STEEL CATCHBASIN DESIGN NOTES

STORMFILTER TREATMENT CAPACITY IS A FUNCTION OF THE CARTRIDGE SELECTION AND THE NUMBER OF CARTRIDGES. 1 CARTRIDGE CATCHBASIN HAS A MAXIMUM OF ONE CARTRIDGE. SYSTEM IS SHOWN WITH A 27" CARTRIDGE, AND IS ALSO AVAILABLE WITH AN 18" CARTRIDGE. STORMFILTER CATCHBASIN CONFIGURATIONS ARE AVAILABLE WITH A DRY INLET BAY FOR VECTOR CONTROL.
PEAK HYDRAULIC CAPACITY PER TABLE BELOW. IF THE SITE CONDITIONS EXCEED PEAK HYDRAULIC CAPACITY, AN UPSTREAM BYPASS STRUCTURE IS REQUIRED.

CARTRIDGE SELECTION

CARTRIDGE HEIGHT	27"			18"			18" DEEP		
RECOMMENDED HYDRAULIC DROP (H)	3.05'			2.3'			3.3'		
SPECIFIC FLOW RATE (gpm/sf)	2 gpm/sf	1.67* gpm/sf	1 gpm/sf	2 gpm/sf	1.67* gpm/sf	1 gpm/sf	2 gpm/sf	1.67* gpm/sf	1 gpm/sf
CARTRIDGE FLOW RATE (gpm)	22.5	18.79	11.25	15	12.53	7.5	15	12.53	7.5
PEAK HYDRAULIC CAPACITY	1.0			1.0			1.8		
INLET PERMANENT POOL LEVEL (A)	1'-0"			1'-0"			2'-0"		
OVERALL STRUCTURE HEIGHT (B)	4'-9"			3'-9"			4'-9"		

* 1.67 gpm/sf SPECIFIC FLOW RATE IS APPROVED WITH PHOSPHOSORB® (PSORB) MEDIA ONLY

GENERAL NOTES
1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. FOR SITE SPECIFIC DRAWINGS WITH DETAILED STORMFILTER CATCHBASIN STRUCTURE DIMENSIONS AND WEIGHTS, PLEASE CONTACT YOUR CONTECH ENGINEERED SOLUTIONS LLC REPRESENTATIVE. www.contechES.com
3. STORMFILTER CATCHBASIN WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING.
4. INLET SHOULD NOT BE LOWER THAN OUTLET. INLET (IF APPLICABLE) AND OUTLET PIPING TO BE SPECIFIED BY ENGINEER AND PROVIDED BY CONTRACTOR.
5. MANUFACTURER TO APPLY A SURFACE BEAD WELD IN THE SHAPE OF THE LETTER "O" ABOVE THE OUTLET PIPE STUB ON THE EXTERIOR SURFACE OF THE STEEL SFCB.
6. STORMFILTER CATCHBASIN EQUIPPED WITH 4 INCH (APPROXIMATE) LONG STUBS FOR INLET (IF APPLICABLE) AND OUTLET PIPING. STANDARD OUTLET STUB IS 8 INCHES IN DIAMETER. MAXIMUM OUTLET STUB IS 15 INCHES IN DIAMETER. CONNECTION TO COLLECTION PIPING CAN BE MADE USING FLEXIBLE COUPLING BY CONTRACTOR.
7. STEEL STRUCTURE TO BE MANUFACTURED OF 1/4 INCH STEEL PLATE. CASTINGS SHALL MEET AASHTO M306 LOAD RATING. TO MEET HS20 LOAD RATING ON STRUCTURE, A CONCRETE COLLAR IS REQUIRED. WHEN REQUIRED, CONCRETE COLLAR WITH #4 REINFORCING BARS TO BE PROVIDED BY CONTRACTOR.
8. FILTER CARTRIDGES SHALL BE MEDIA-FILLED, PASSIVE, SIPHON ACTUATED, RADIAL FLOW, AND SELF CLEANING. RADIAL MEDIA DEPTH SHALL BE 7-INCHES. FILTER MEDIA CONTACT TIME SHALL BE AT LEAST 38 SECONDS.
9. SPECIFIC FLOW RATE IS EQUAL TO THE FILTER TREATMENT CAPACITY (gpm) DIVIDED BY THE FILTER CONTACT SURFACE AREA (sq ft).

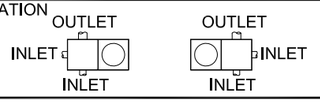
INSTALLATION NOTES
A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE CATCHBASIN (LIFTING CLUTCHES PROVIDED).
C. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO PROTECT CARTRIDGES FROM CONSTRUCTION-RELATED EROSION RUNOFF.

1-CARTRIDGE CATCHBASIN STORMFILTER DATA

STRUCTURE ID	XXX
WATER QUALITY FLOW RATE (cfs)	X.XX
PEAK FLOW RATE (<1 cfs)	X.XX
RETURN PERIOD OF PEAK FLOW (yrs)	XXX
CARTRIDGE HEIGHT (27", 18", 18" DEEP)	XX
CARTRIDGE FLOW RATE (gpm)	XX
MEDIA TYPE (PERLITE, ZPG, PSORB)	XXXXX
RIM ELEVATION	XXX.XX'

PIPE DATA:	I.E.	DIAMETER
INLET STUB	XXX.XX'	XX"
OUTLET STUB	XXX.XX'	XX"

CONFIGURATION



SLOPED LID	YES\NO
SOLID COVER	YES\NO

NOTES/SPECIAL REQUIREMENTS:

The Stormwater Management StormFilter®

CONTECH® ENGINEERED SOLUTIONS LLC
www.contechES.com
9025 Centre Pointe Dr., Suite 400, West Chester, OH 45069
800-526-3999 513-645-7000 513-645-7993 FAX

1 CARTRIDGE CATCHBASIN STORMFILTER STANDARD DETAIL

APPENDIX 'F' – OPERATIONS & MAINTENANCE PLAN

Infiltration Planter / Rain Garden Operation and Maintenance Plan

Annual inspections are required. It is recommended that the facility is inspected on a monthly basis to ensure proper function. The plan below describes inspection and maintenance activities, and may be used as an inspection log. Contact the design engineer, Clean Water Services or City representative for more information.

Identified Problem	Condition to Check for	Maintenance Activity	Maintenance Timing	✔ Task Complete Comments
Invasive Vegetation as outlined in Appendix A	Invasive vegetation found in facility. Examples include: Himalayan Blackberry; Reed Canary Grass; Teasel; English Ivy; Nightshade; Clematis; Cattail; Thistle; Scotch Broom	Remove excessive weeds and all invasive plants. Attempt to control even if complete eradication is not feasible. Refer to Clean Water Services Integrated Pest Management Plan for appropriate control methods, including proper use of chemical treatment.		
Obstructed Inlet/Outlet	Material such as vegetation, trash, sediment is blocking more than 10% of the inlet pipe or basin opening	Remove blockages from facility	 Inspect after major storm (1-inch in 24 hours)	
Excessive Vegetation	Vegetation grows so tall it competes with or shades approved emergent wetland grass/shrubs; interferes with access or becomes a fire danger	Cut tall grass 4″ to 6″ and remove clippings. Prune emergent wetland grass/shrubs that have become overgrown.	 Ideal time to prune emergent wetland grass is spring. Cut grass during dry months	
Tree/Shrub Growth	Tree/shrub growth shades out wetland/emergent grass in treatment area. Interferes with access for maintenance/inspection	Prune trees and shrubs that block sun from reaching treatment area. Remove trees that block access points. Do not remove trees that are not interfering with access or maintenance without first contacting Clean Water Services or local City.	 Ideal timing for pruning trees is winter	

Infiltration Planter / Rain Garden Operation and Maintenance Plan (continued)

Annual inspections are required. It is recommended that the facility is inspected on a monthly basis to ensure proper function. The plan below describes inspection and maintenance activities, and may be used as an inspection log. Contact the design engineer, Clean Water Services or City representative for more information.

Identified Problem	Condition to Check for	Maintenance Activity	Maintenance Timing	✔ Task Complete Comments
Hazard Trees	Observe dead, dying or diseased trees	Remove hazard trees. A certified arborist may need to determine health of tree or removal requirements	As Needed	
Poor Vegetation Coverage	80% survival of approved vegetation and no bare areas large enough to affect function of facility.	Determine cause of poor growth and correct the condition. Replant per the approved planting plan and applicable standards at the time of construction. Remove excessive weeds and all invasive plants.	 Ideal time to plant is spring and fall seasons	
Trash and Debris	Visual evidence of trash, debris or dumping	Remove trash and debris from facility. Dispose of properly		
Contaminants and Pollution	Evidence of oil, gasoline, contaminants or other pollutants. Look for sheens, odor or signs of contamination.	If contaminants or pollutants are present, coordinate removal/cleanup with local jurisdiction		
Erosion	Erosion or channelization that impacts or effects the function of the facility or creates a safety concern	Repair eroded areas and stabilize using proper erosion control measures. Establish appropriate vegetation as needed.		
Flow Not Distributed Evenly	Flows unevenly distributed through planter width due to uneven or clogged flow spreader	Level the spreader and clean so that flows spread evenly over entire planter width		

Infiltration Planter / Rain Garden Operation and Maintenance Plan (continued)

Annual inspections are required. It is recommended that the facility is inspected on a monthly basis to ensure proper function. The plan below describes inspection and maintenance activities, and may be used as an inspection log. Contact the design engineer, Clean Water Services or City representative for more information.

Identified Problem	Condition to Check for	Maintenance Activity	Maintenance Timing	✔ Task Complete Comments
Vector Control	Evidence of rodents or water piping through facility via rodent holes. Insects such as wasps and hornets interfere with maintenance/inspection activities	Repair facility if damaged. Remove harmful insects, use professional if needed. Refer to Clean Water Services Integrated Pest Management Plan for management options	As Needed	
Sediment Accumulation in Treatment Area	Sediment depth in treatment area exceeds 3 inches	Remove sediment from treatment area. Ensure planter is level from side to side and drains freely toward outlet; no standing water within 24 hours after any major storm (1-inch in 24 hours)	 Ideally in the dry season	
Standing Water	Standing water in the planter between storms that does not drain freely. Water should drain after 24 hours of dry weather	Remove sediment or trash blockages; improve end to end grade so there is no standing water 24 hours after any major storm (1-inch in 24 hours)	 Inspect after major storm (1-inch in 24 hours)	
Grate Damaged, Missing or Not in Place	Grate is missing or only partially in place may have missing or broken grate members	Grate must be in place and meets design standards. Replace or repair any open structure	As Needed	

Flow-Through Planter Operation and Maintenance Plan

Annual inspections are required. It is recommended that the facility is inspected on a monthly basis to ensure proper function. The plan below describes inspection and maintenance activities, and may be used as an inspection log. Contact the design engineer, Clean Water Services or City representative for more information.

Identified Problem	Condition to Check for	Maintenance Activity	Maintenance Timing	✔ Task Complete Comments
Sediment Accumulation in Treatment Area	Sediment depth exceeds 3 inches	Remove sediment from treatment area. Ensure planter is level from side to side and drains freely toward outlet; no standing water within 24 hours after any major storm (1-inch in 24 hours)	 Ideally in dry season	
Erosion	Erosion or channelization that impacts or effects the function of the facility or creates a safety concern	Repair eroded areas and stabilized using proper erosion control measures Establish appropriate vegetation as needed	 Inspect after major storm (1-inch in 24 hours)	
Standing Water	Standing water in the planter between storms that does not drain freely. Water should drain after 24 hours of dry weather.	Remove sediment or trash blockages. Grade out areas of mounding and improve end to end grade so there is no standing water.		
Flow Not Distributed Evenly	Flow unevenly distributed through planter width due to uneven or clogged flow spreader	Level the spreader and clean so that flows spread evenly over entire planter width		
Obstructed Inlet/Outlet	Material such as vegetation, sediment, trash is blocking more than 10% of the inlet/outlet pipe	Remove blockages from facility	 Inspect after major storm (1-inch in 24 hours)	

Flow-Through Planter Operation and Maintenance Plan (continued)

Annual inspections are required. It is recommended that the facility is inspected on a monthly basis to ensure proper function. The plan below describes inspection and maintenance activities, and may be used as an inspection log. Contact the design engineer, Clean Water Services or City representative for more information.

Identified Problem	Condition to Check for	Maintenance Activity	Maintenance Timing	✔ Task Complete Comments
Poor Vegetation Coverage	80% survival of approved vegetation and no bare areas large enough to affect function of facility.	Determine cause of poor growth and correct the condition; replant with plugs or containerized plants per approved plans and applicable standards at time of construction. Remove excessive weeds and all invasive plants.	 Ideal time to plant is spring and fall seasons	
Invasive Vegetation as outlined in Appendix A	Invasive vegetation found in facility. Examples include: Himalayan Blackberry; Reed Canary Grass; Teasel, English Ivy, Nightshade, Clematis, Cattail, Thistle	Remove excessive weeds and all invasive plants. Attempt to control even if complete eradication is not feasible. Refer to Clean Water Services Integrated Pest Management Plan for appropriate control methods, including proper use of chemical treatment.		
Excessive Vegetation	Vegetation grows so tall it competes with or shades approved emergent wetland grass/shrubs; interferes with access or becomes a fire danger	Prune over-hanging limbs, if possible; remove brushy vegetation as needed. Prune emergent wetland grass/shrubs that have become overgrown.	 Ideal time to prune emergent wetland grass is spring	
Vector Control	Evidence of rodents or water flowing through facility via rodent holes. Harmful insects such as wasps or hornets present	Repair damage to facility. Remove harmful insects, call professional if needed. Refer to Clean Water Services Integrated Pest Management Plan for management options.	As Needed	

Flow-Through Planter Operation and Maintenance Plan (continued)

Annual inspections are required. It is recommended that the facility is inspected on a monthly basis to ensure proper function. The plan below describes inspection and maintenance activities, and may be used as an inspection log. Contact the design engineer, Clean Water Services or City representative for more information.

Identified Problem	Condition to Check for	Maintenance Activity	Maintenance Timing	✔ Task Complete Comments
Trash and Debris	Visual evidence of trash, debris or dumping.	Remove and dispose of trash and debris from facility. Dispose of properly		
Contamination and Pollution	Evidence of oil, gasoline, contaminants, or other pollutants. Look for sheens, odor or signs of contamination.	If contaminants or pollutants present, coordinate removal/cleanup with local jurisdiction.		
Outlet Structure Damaged	Grate or overflow structure is missing or only partially in place and may have missing or broken grate members.	Repair or replace outlet structure.	As Needed	

After Recording Return to:
Clean Water Services
2550 SW Hillsboro Hwy.
Hillsboro, OR 97123

PRIVATE STORMWATER FACILITIES AGREEMENT

This Agreement is made and entered into this _____ day of _____ 20___, by and between Clean Water Services (District) and _____ (Owner) whose address is _____.

RECITALS

A. Owner has developed or will develop the Facilities listed below. (List the type of private stormwater facilities on site and the quantity of each type).

Facility type (list each) _____ Quantity_____

B. The Facilities enable development of property while mitigating the impacts of additional surface water and pollutants associated with stormwater runoff prior to discharge from the property to the public stormwater system. The consideration for this Agreement is connection to the public stormwater system.

C. The property benefited by the Facilities and subject to the obligation of this Agreement is described below or in Exhibit A (Property) attached hereto and incorporated by reference.

D. The Facilities are designed by a registered professional engineer to accommodate the anticipated volume of runoff and to detain and treat runoff in accordance with District's Design and Construction Standards.

E. Failure to inspect and maintain the Facilities can result in an unacceptable impact to the public stormwater system.

NOW, THEREFORE, it is agreed by and between the parties as follows:

1. OWNER INSPECTIONS District shall provide Owner an Operations and Maintenance Plan (O&M Plan) for each Facility. Owner agrees to operate, inspect and maintain each Facility in accordance with the current O&M Plan and any subsequent modifications to the Plan. Owner shall maintain a log of inspection activities. The log shall be available to District upon request or during District inspections.

2. DEFICIENCIES All aspects in which the Facilities fail to satisfy the O&M Plan shall be noted as "Deficiencies".

3. OWNER CORRECTIONS All Deficiencies shall be corrected at Owner's expense within thirty (30) days after completion of the inspection. If more than 30 days is reasonably needed to correct a Deficiency, Owner shall have a reasonable period to correct the Deficiency so long as the correction is commenced within the 30-day period and is diligently prosecuted to completion.

4. DISTRICT INSPECTIONS Owner grants District the right to inspect the Facilities. District will endeavor to give ten (10) days prior written notice to Owner, except that no notice shall be required in case of an emergency. District shall determine whether Deficiencies need to be corrected. Owner (at the address provided in this Agreement, or such other address as Owner may designate in writing to District) will be notified in writing through the US Mail of the Deficiencies and shall make corrections within 30 days of the date of the notice.

5. DISTRICT CORRECTIONS If correction of all Owner or District identified Deficiencies is not completed within thirty (30) days after Owner's inspection or District notice, District shall have the right to have any Deficiencies corrected. District (i) shall have access to the Facilities for the purpose of correcting such Deficiencies and (ii) shall bill Owner for all costs reasonably incurred by District for work performed to correct the Deficiencies (District Correction Costs) following Owner's failure to correct any Deficiencies in the Facilities. Owner shall pay District the District Correction Costs within thirty (30) days of the date of the invoice. Owner understands and agrees that upon non-payment, District Correction Costs shall be secured by a lien on the Property for the District Correction Cost amount plus interest and penalties.

6. EMERGENCY MEASURES If at any time District reasonably determines that the Facilities create any imminent threat to public health, safety or welfare, District may immediately and without prior notice to Owner take measures reasonably designed to remedy the threat. District shall provide notice of the threat and the measures taken to Owner as soon as reasonably practicable, and charge Owner for the cost of these corrective measures.

7. FORCE AND EFFECT This Agreement has the same force and effect as any deed covenant running with the land and shall benefit and bind all owners of the Property present and future, and their heirs, successors and assigns.

8. AMENDMENTS The terms of this Agreement may be amended only by mutual agreement of the parties. Any amendments shall be in writing, shall refer specifically to this Agreement, and shall be valid only when executed by the owners of the Property, District and recorded in the Official Records of the county where the Property is located.

9. PREVAILING PARTY In any action brought by either party to enforce the terms of this Agreement, the prevailing party shall be entitled to recover all costs, including reasonable attorney's fees as may be determined by the court having jurisdiction, including any appeal.

10. SEVERABILITY The invalidity of any section, clause, sentence, or provision of this Agreement shall not affect the validity of any other part of this Agreement, which can be given effect without such invalid part or parts.

IN WITNESS WHEREOF, Owner and District have signed this Agreement.

NOTARIZE DOCUMENT BELOW

INDIVIDUAL OWNERS SIGN BELOW

_____
Owner (Individual)

_____
Owner (Individual)

CORPORATE, LLC, PARTNERSHIP, TRUST OR OTHER LEGAL ENTITY SIGN BELOW

_____
(Entity name)

By: _____
(Sign here for entity)

Title: _____

CLEAN WATER SERVICES

By: _____
General Manager or Designee

APPROVED AS TO FORM

_____
District Counsel

[Use this notary block if OWNER is an individual.]

STATE OF _____)
)
County of _____)

This instrument was acknowledged before me this _____day of _____, 20____,
by _____.

_____
Notary Public

[Use this notary block if OWNER is an entity.]

STATE OF _____)
)
County of _____)

This instrument was acknowledged before me on _____(date)
by_____(name of person) as
_____ (title) of _____(name of entity).

_____
Notary Public

APPENDIX 'G' – STORMWATER REPORT FOR THE COLUMBIA STREET REGIONAL WATER QUALITY FACILITY

COLUMBIA STREET REGIONAL WATER QUALITY FACILITY

STORMWATER REPORT

DATE: May 9, 2014

CLIENT: City of Sherwood
Contact: Craig Christensen, PE
22560 SW Pine Street
Sherwood, OR 97140

ENGINEERING CONTACT: Alex Hurley, PE, PLS, Principal
Alex@aks-eng.com

ENGINEERING FIRM: AKS Engineering & Forestry, LLC.

AKS ENGINEERING & FORESTRY
12965 SW Herman Road, Suite 100
Tualatin, OR 97062
P: (503) 563-6151
www.aks-eng.com

AKS ENGINEERING & FORESTRY, LLC
ENGINEERING / SURVEYING / PLANNING / FORESTRY
LANDSCAPE ARCHITECTURE / ARBORICULTURE

TABLE OF CONTENTS

AKS ENGINEERING & FORESTRY, LLC
ENGINEERING / SURVEYING / PLANNING / FORESTRY
LANDSCAPE ARCHITECTURE / ARBORICULTURE

COLUMBIA STREET REGIONAL WATER QUALITY FACILITY SHERWOOD, OREGON

1.0 PURPOSE OF REPORT

The purpose of this report is to document the criteria for which the new regional stormwater facility for this site is designed to meet, the sources of information on which the analysis is based, the design methodology, and the results of the analysis.

2.0 PROJECT LOCATION/DESCRIPTION

The site is located on a parcel of land in Section 32, Township 2 South, Range 1 West, Willamette Meridian, Washington County, Oregon (Tax Lot 6801, Tax Map 2S-1-32BC). The project site (3.70 acres) is bounded by SW Main Street to the east, residential lots to the north, railroad to the west, and SW Division Street to the south. See Appendix A for the Vicinity Map which contains additional information regarding the project site location.

The City of Sherwood proposes to construct a regional stormwater quality facility and address a known culvert capacity issue beneath the Southern Pacific Railroad right-of-way. The existing culvert crossing beneath the railroad and Wildlife Haven Drive will be improved by providing additional flow capacity with a parallel and secondary 24-inch culvert to run westerly under the railroad tracks.

3.0 REGULATORY DESIGN CRITERIA

3.1 STORMWATER QUANTITY

Per *Clean Water Services (CWS) Design and Construction Standards Manual for Sanitary Sewer and Surface Water Management (R&O 07-20), Section 4.03 Water Quantity Control Requirements*, on-site detention is required when any of the following conditions exist:

1. *There is an identified downstream deficiency and the District or City determines that detention rather than conveyance system enlargement is the more effective solution.*

2. *There is an identified regional detention site within the boundary of the development.*

3. *Water quantity facilities are required by District-adopted watershed management plans or adopted subbasin master plans.*

The purpose of this project is to construct a regional stormwater quality facility to treat runoff from an approximate 99.5 acre drainage basin and construct an additional culvert to alleviate existing capacity issues.

The existing culvert under the railroad tracks is currently undersized to convey the upstream runoff from a 25-year storm event by gravity flow. Section 6.5 of this report documents the condition and capacity of the existing downstream 21-inch diameter CMP culvert that crosses westerly under the Southern Pacific Railroad tracks. Calculations estimate the anticipated surface water elevations due to the backwater effect during the 25-year storm.

3.2 STORMWATER QUALITY

Stormwater quality management will be provided with a vegetated swale designed to meet the requirements of *Clean Water Services Design and Construction Standards for Sanitary Sewer and Surface Water Management (R&O 07-20).* The stormwater swale is designed to treat runoff from the estimated impervious area contained within the regional basin. See Appendix A for the Regional Basin and Soil Map and the Regional Drainage Basin Delineation exhibit.

The vegetated swale design meets the CWS design criteria (per Section 4.06.02 of CWS R&O 07-20).

4.0 DESIGN METHODOLOGY

The vegetated swale was designed and analyzed by using Manning's equation based on the water quality flow. A high-flow bypass is proposed as part of the storm system improvements to limit the amount of stormwater passing through the water quality swale. The bypass structure will route stormwater beyond the water quality flow rate back to the existing channel as shown in the proposed plans. This will minimize degradation and erosion of the water quality swale.

A secondary culvert is proposed to reduce the backwater elevations caused by the existing undersized culvert under the existing Southern Pacific Railroad right of way and SW Wildlife Haven Drive. HydroCAD was utilized to evaluate the existing and proposed culvert and the reduction in the backwater elevation due to the new culvert.

5.0 DESIGN STORM

The Santa Barbara Urban Hydrograph (SBUH) Method was used to analyze stormwater runoff from the site. This method utilizes the SCS Type 1A 24-hour design storm. HydroCAD computer software (version 8.5) aided in the analysis. Representative curve numbers (CN) are obtained from the USDA *Technical Release 55* and are included in the Appendices. Water quality flow volumes that require treatment were calculated per *CWS R&O 07-20 Section 4.05.6.*

The proposed water quality swale design is based on the water quality flow mentioned in Section 3.2 above. The existing culvert is analyzed based on a 25-year storm event (24-hour Type IA rainfall of 3.90 inches).

5.1 SITE TOPOGRAPHY AND LAND USE

5.1.1 SITE TOPOGRAPHY

The overall drainage basin varies from relatively level in the lower portion of the basin to fairly steep in the upper reaches of the basin.

The majority of the proposed stormwater facility site (tax lots 6100 and 6801) contains slopes between 10 and 30 percent and has elevations varying from 186 to 160 feet. The proposed water quality swale and maintenance access road are located within the flattest portions of the site.

5.1.2 LAND USE

Based on the 2011 Sherwood Plan and Zone Map, the contributory drainage basin has a mixture of land uses, including the following:

- Low Density Residential (LDR)
- Medium Density Residential Low (MDRL)
- Medium Density Residential High (MDRH)
- High Density Residential (HDR)
- PUD-High Density Residential (PUD-HDR)
- Retail Commercial (RC)
- PUD-Retail Commercial (PUD-RC)
- Institutional and Public (IP)

The proposed stormwater facility site (tax lot 6801) is currently zoned as MDRH. However, the City of Sherwood purchased the property and the property is identified as the desired location for this regional stormwater facility on the City's Stormwater Master Plan (June 2007).

5.2 DESCRIPTION OF OFF-SITE CONTRIBUTORY BASINS

Based on visual observations of aerial photography across the City of Sherwood, the majority of the regional drainage basin is nearly built-out and can be considered fully developed with some small areas of infill development.

The stormwater analysis assumes that larger existing tax lots within the drainage basin will be further divided. This results in an additional 27 residential infill lots which are assumed to build-out the basin. It is assumed that the Archer Glen school site is currently built out and no additional impervious area will be created. The Cannery Row site is not fully constructed at this time, however; the hydraulic analysis is based on a full build out of the site at 85% impervious area coverage.

5.3 SOIL TYPE

The soils for the drainage basin are classified as the following by the USDA Soil Survey for Washington County. Appendix A contains a Basin and Soil Map which shows and delineates the various NRCS soil types across the regional stormwater drainage basin.

Map Unit Symbol	Map Unit Name	Hydrologic Group
1	Aloha Silt Loam	C/D
11B	Cornelius and Kinton Silt Loam, 2 to 7 percent slopes	C
11C	Cornelius and Kinton Silt Loam, 7 to 12 percent slopes	C
11D	Cornelius and Kinton Silt Loam, 12 to 20 percent slopes	C
21B	Hillsboro Loam, 3 to 7 percent slopes	B
22	Huberly Silt Loam	C/D
28B	Laurelwood Silt Loam, 3 to 7 percent slopes	B
37A	Quatama Loam, 0 to 3 percent slopes	C
37B	Quatama Loam, 3 to 7 percent slopes	C
44C	Willamette Silt Loam, 7 to 12 percent slopes	B
46F	Xerochrepts and Haploxerolls, very steep	B

Information on these soil types are included in the NRCS Soil Resource Report which is attached as an appendix at the end of this report.

6.0 CALCULATION METHODOLOGY

6.1 PROPOSED STORMWATER CONDUIT SIZING

The new storm drainage system proposes to redirect runoff from four (4) existing storm drainage outfalls which currently discharge into the Cedar Creek tributary. The new storm drainage system will route the existing systems to the new regional water quality facility. The stormwater pipes and inlets have been designed to convey flows from the 25-year storm event. See Appendix D for additional information and stormwater calculations with respect to the proposed storm drain system.

An existing stormwater facility is located along the north boundary of tax lot 6801 and will be abandoned/removed as part of the project. The primary desire for abandoning the existing stormwater facility and connecting the outfall pipe to the new regional stormwater quality facility is to eliminate the need for ongoing maintenance of multiple facilities.

6.2 PROPOSED STORMWATER QUALITY CONTROL FACILITY DESIGN

The stormwater runoff from the existing impervious areas within the regional basin will be routed to the new vegetated swale for treatment. As mentioned above, additional storm drainage improvements will allow collection and treatment of the existing outfalls which currently discharge untreated water into the unnamed tributary of Cedar Creek. The regional water quality swale is sized to meet Clean Water Services (CWS) requirements.

See Appendix B for water quality calculations associated with the design of the regional water quality swale.

6.3 PROPOSED STORMWATER QUANTITY CONTROL FACILTY DESIGN

As mentioned above in Section 3.1, this project is intended to construct a regional water quality facility and provide conveyance improvements with respect to the existing 21 inch culvert that

runs westerly under the railroad tracks. Since the project does not involve the construction of a significant amount of impervious area and the project includes downstream conveyance system upgrades, additional stormwater detention is not required or proposed as part of this project.

6.4 SECONDARY CULVERT (BACKWATER REDUCTION) ANALYSIS

This analysis reviewed the condition and capacity of the existing 21 inch diameter CMP culvert which conveys stormwater westerly under the Southern Pacific Railroad tracks.

Based on the development conditions and the soil types within the basin, curve numbers were assigned to all areas of the drainage basin. With all existing condition parameters input into the HydroCAD software, the estimated 25-year runoff for the drainage basin is 56.44 cfs. See Appendix C for detailed calculations.

The capacity of the culvert was analyzed considering the drainage area's stage/storage/discharge capacities. Under this condition, the culvert acts as an orifice restricting flow with storage volume available by virtue of the railroad embankment. As such, the incremental volume of the available storage was determined by the surface area of each upstream contour based on the topographic survey. The area of each 1 foot contour was input into the HydroCAD software along with the 21-inch culvert as the outflow orifice restrictor.

Based on the inflow hydrograph and the stage/storage/discharge characteristics of the drainage way, a backwater surface water elevation of 169.38 feet (invert of 21 inch culvert is 160.07 feet) is anticipated to occur during the 25-year storm event. The backwater elevation does not extend into the railroad right of way, but does encroach on the adjacent property to the south (tax lot 6400) where the drainage channel leaves tax lot 6801.

To increase the stormwater conveyance capacity, an additional parallel culvert is proposed. The proposed secondary culvert is planned to be 24 inches in diameter with the invert at 161.25 feet. This will lower the backwater surface elevation to 165.55 feet (3.83-foot reduction), and will lower the flood elevation such that flood backwater stays within the limits of city property (tax lot 6801). The secondary culvert provides additional conveyance capacity and reduces the backwater elevation to within the project limits.

The existing 21-inch CMP culvert currently requires continual monitoring and maintenance to ensure the inlet does not plug up during larger storm events. Steel "t" posts have been installed on the opposite bank of the culvert inlet in an attempt to "trap" downed tree limbs. The construction of the culvert maintenance access road and the secondary 24-inch culvert will provide City of Sherwood personnel with easier access to periodically clean the culvert inlet area and prevent clogging of the culvert inlets.

6.5 DOWNSTREAM ANALYSIS

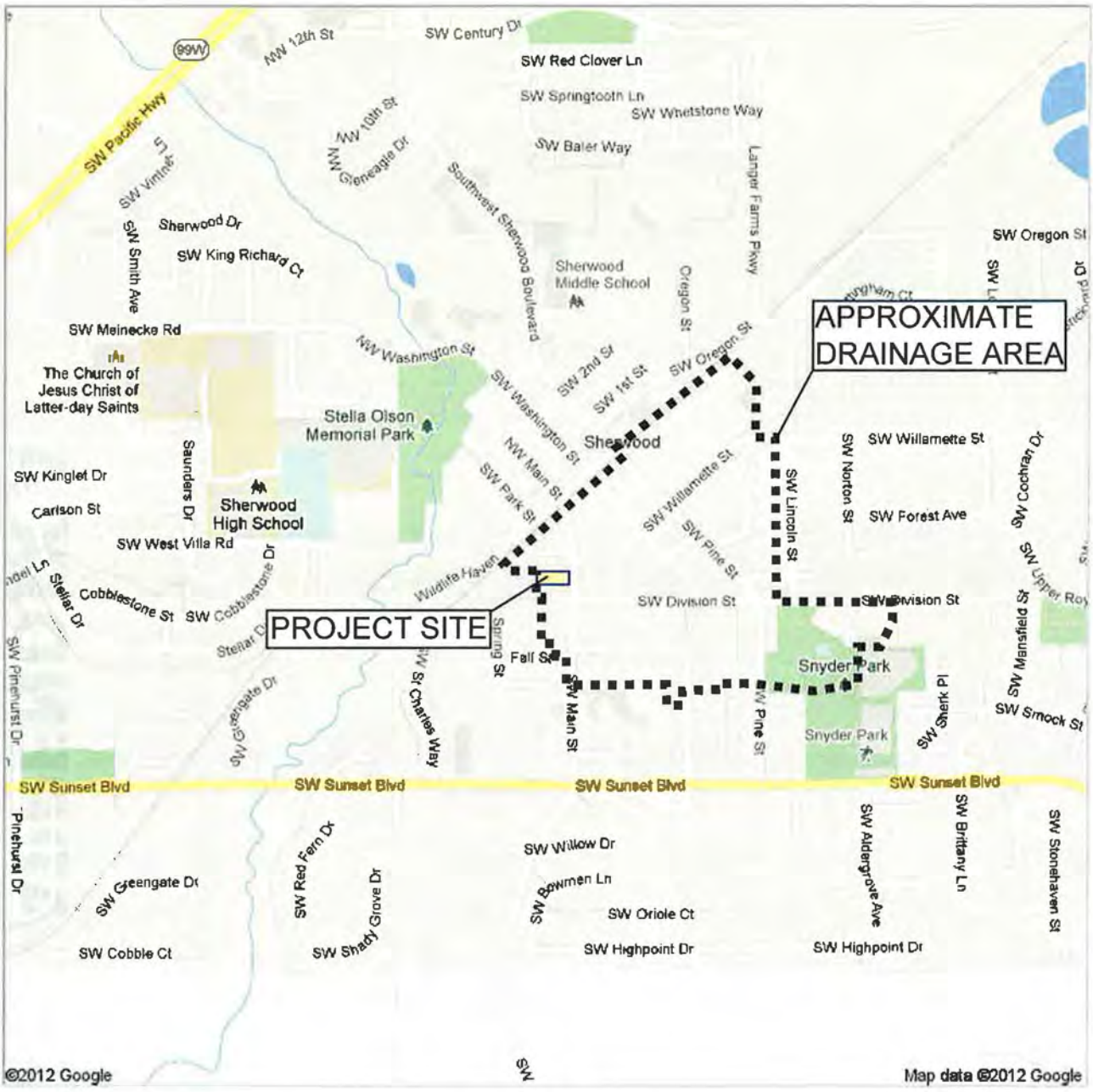
The purpose of this project is to construct a regional stormwater quality facility to treat runoff from several existing drainage basins within the City of Sherwood. Currently, the majority of the stormwater runoff from the developed drainage basins discharge as untreated runoff into the existing unnamed tributary to Cedar Creek. No new development or home/duplex construction is proposed as part of the project. The only new impervious area constructed as part of the regional

stormwater facility project is due to the construction of new access roads needed to provide the City of Sherwood access to facilities for future maintenance.

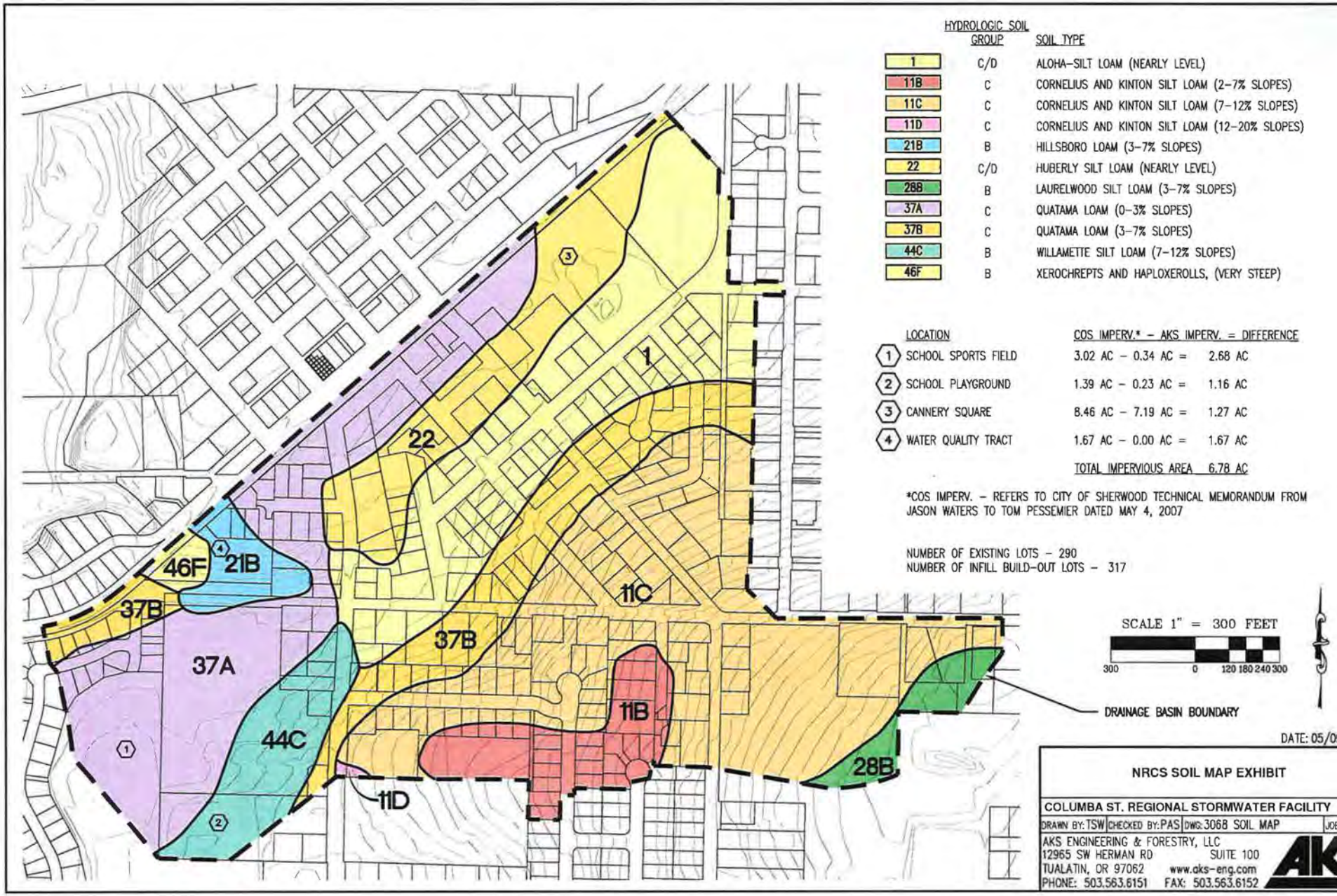
The new impervious access roads proposed as part of the project occupy 5,031 square feet of area. Per *CWS R&O 07-20 Section 2.04.1*, 5,280 square-feet of new impervious area is required to "trigger" the requirement evaluate the downstream system. Since the water quality project does not exceed this criteria, a downstream analysis is not necessary below the existing outlet culverts beneath the Southern Pacific Railroad embankment.

Earlier sections of this report address the capacity improvements which are proposed for the existing and proposed culverts beneath the Southern Pacific Railroad embankment.

APPENDIX A
FIGURES



VICINITY MAP



HYDROLOGIC SOIL GROUP		SOIL TYPE
1	C/D	ALOHA-SILT LOAM (NEARLY LEVEL)
11B	C	CORNELIUS AND KINTON SILT LOAM (2-7% SLOPES)
11C	C	CORNELIUS AND KINTON SILT LOAM (7-12% SLOPES)
11D	C	CORNELIUS AND KINTON SILT LOAM (12-20% SLOPES)
21B	B	HILLSBORO LOAM (3-7% SLOPES)
22	C/D	HUBERLY SILT LOAM (NEARLY LEVEL)
28B	B	LAURELWOOD SILT LOAM (3-7% SLOPES)
37A	C	QUATAMA LOAM (0-3% SLOPES)
37B	C	QUATAMA LOAM (3-7% SLOPES)
44C	B	WILLAMETTE SILT LOAM (7-12% SLOPES)
46F	B	XEROCHREPTS AND HAPLOXEROLLS, (VERY STEEP)

LOCATION	COS IMPERV.* - AKS IMPERV. = DIFFERENCE
(1) SCHOOL SPORTS FIELD	3.02 AC - 0.34 AC = 2.68 AC
(2) SCHOOL PLAYGROUND	1.39 AC - 0.23 AC = 1.16 AC
(3) CANNERY SQUARE	8.46 AC - 7.19 AC = 1.27 AC
(4) WATER QUALITY TRACT	1.67 AC - 0.00 AC = 1.67 AC
	TOTAL IMPERVIOUS AREA 6.78 AC

*COS IMPERV. - REFERS TO CITY OF SHERWOOD TECHNICAL MEMORANDUM FROM JASON WATERS TO TOM PESSEMIER DATED MAY 4, 2007

NUMBER OF EXISTING LOTS - 290
NUMBER OF INFILL BUILD-OUT LOTS - 317

SCALE 1" = 300 FEET

300 0 120 180 240 300

DRAINAGE BASIN BOUNDARY

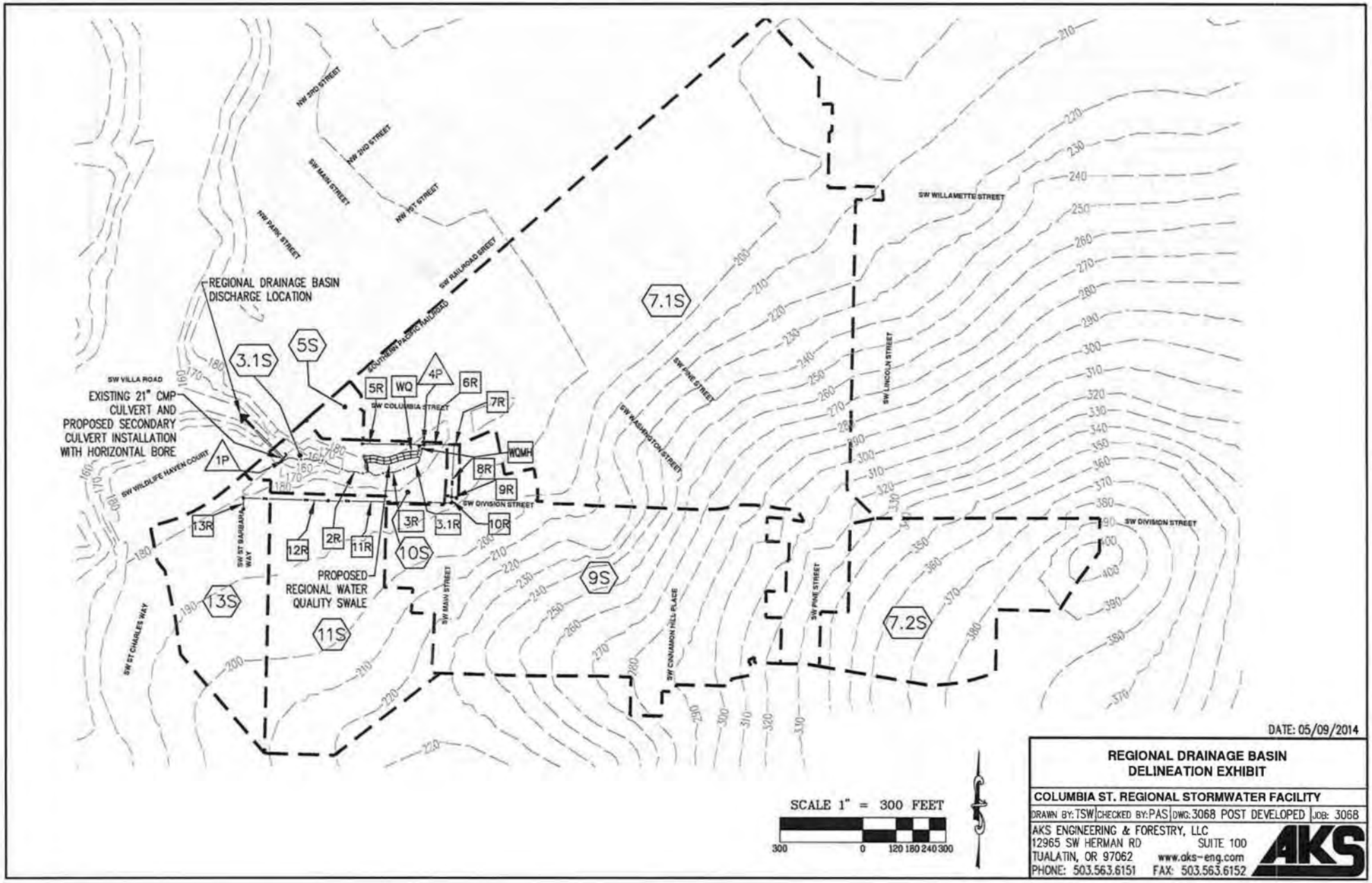
DATE: 05/09/2014

NRCS SOIL MAP EXHIBIT

COLUMBA ST. REGIONAL STORMWATER FACILITY

DRAWN BY: TSW | CHECKED BY: PAS | DWG: 3068 SOIL MAP | JOB: 3068

AKS ENGINEERING & FORESTRY, LLC
12965 SW HERMAN RD SUITE 100
TUALATIN, OR 97062 www.aks-eng.com
PHONE: 503.563.6151 FAX: 503.563.6152



SCALE 1" = 300 FEET

300 0 120 180 240 300

DATE: 05/09/2014

REGIONAL DRAINAGE BASIN DELINEATION EXHIBIT

COLUMBIA ST. REGIONAL STORMWATER FACILITY

DRAWN BY: TSW | CHECKED BY: PAS | DWG: 3068 POST DEVELOPED | JOB: 3068

AKS ENGINEERING & FORESTRY, LLC
12965 SW HERMAN RD SUITE 100
TUALATIN, OR 97062 www.aks-eng.com
PHONE: 503.563.6151 FAX: 503.563.6152

APPENDIX B
WATER QUALITY AND VEGETATED SWALE CALCULATIONS

STORMWATER QUALITY CALCULATIONS

Client: City of Sherwood
Project: Columbia St. Water Quality Facililty
AKS Job No.: 3068
Date: May 9, 2014
Done By: TSW/DS
Checked By: PAS

IMPERVIOUS AREA

Total Site Area:	99.49	acres
Total Site Area:	4,333,974	square feet (sf)
Number of Lots:	317	
Impervious Area Per Lot:	2,640	sf
Total Impervious Lot Area:	836,880	sf
Total Impervious Commercial Area:	474,189	sf
Total Impervious Right-of-Way Area:	671,988	sf
Total Impervious Area:	1,983,057	sf

'ATER QUALITY VOLUME (WQV)

(Per CWS 4.05.6b - R&O 07-20)

$$WQV = \frac{0.36" \text{ X Area (ft)}}{12" \text{ per ft}} = \textbf{59,492 cubic feet}$$

WATER QUALITY FLOW (WQF)

(Per CWS 4.05.6b - R&O 07-20)

$$WQF = \frac{WQV \text{ (sf)}}{14{,}400 \text{ seconds}} = \textbf{4.13 cfs}$$

'Y MANHOLE SUMP VOLUME CALCULATIONS

(Per CWS 4.06.1b - R&O 07-20)

CWS Criteria: Sump Volume = 20 cubic feet per 1.0 cfs of flow

Calculated 25-year Flow through WQ Manhole =	**7.72**	**cfs**	
Calculated Manhole Sump Volume =	**154.4**	**cubic feet**	
Calculated Manhole Sump Depth (84" Dia. Manhole) =	**4.0**	**ft**	< 5 feet maximum

VEGETATED SWALE, WATER QUALITY FLOW DESIGN & CALCULATIONS

Hydraulic Design Criteria (Per CWS 4.06.2 - R&O 07-20)

Design Flow: Water Quality Flow
Minimum Hydraulic Residence Time: 9 minutes
Maximum Water Design Depth: 0.5-ft
Minimum Freeboard: 1.0 foot (for facilities not protected from high flows)
Manning's "n" Value: 0.24
Maximum Velocity: 2.0 fps based on the 25-YR flow

Swale Sizing Assumptions:

Slope	Bottom Width	Manning's #	Side Slope	Depth of Swale	Length
(ft/ft)	(ft)	"n"	H:V	(ft)	(ft)
0.01	24.5	0.24	4	2.5	190

Water Quality Flow Hydraulic Calculations (See FlowsMaster Printouts):

Q	Flow Depth	Flow Area	Wp	R	Velocity
(cfs)	(ft)	(sf)	(ft)	(ft)	(fps)
4.13	0.45	11.88	28.22	0.42	0.35

25-Year Flow Hydraulic Calculations (See HydroCAD Printouts):

Q	Flow Depth	Velocity
(cfs)	(ft)	(fps)
7.72	0.65	0.44

Check Against Design Criteria:

	Calculated			CWS Criteria		Meet CWS Criteria?
Minimum Hydraulic Residence Time:	**9.0**	**minutes**	>	9	minutes	Yes
Maximum Water Design Depth:	**0.45**	**feet**	<	0.5	feet	Yes
Minimum Freeboard at 25-YR:	**1.85**	**feet**	>	1	feet	Yes
Maximum Velocity at 25-YR:	**0.44**	**fps**	<	2	fps	Yes
Minimum Length:	**190**	**feet**	≥	100	feet	Yes

Swale Water Quality Flow

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.01000	ft/ft
Discharge	4.13	ft³/s

Section Definitions

Station (ft)	Elevation (ft)
-0+21	2.500
-0+16	1.000
-0+12	0.000
0+12	0.000
0+16	1.000
0+21	2.500

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(-0+21, 2.500)	(-0+16, 1.000)	0.240
(-0+16, 1.000)	(-0+12, 0.000)	0.240
(-0+12, 0.000)	(0+12, 0.000)	0.240
(0+12, 0.000)	(0+16, 1.000)	0.240
(0+16, 1.000)	(0+21, 2.500)	0.240

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	0.45	ft
Elevation Range	0.00 to 2.50 ft	
Flow Area	11.88	ft²

Swale Water Quality Flow

Results

Wetted Perimeter		28.22	ft
Hydraulic Radius		0.42	ft
Top Width		28.11	ft
Normal Depth		0.45	ft
Critical Depth		0.10	ft
Critical Slope		1.84916	ft/ft
Velocity		0.348	ft/s
Velocity Head		0.00	ft
Specific Energy		0.45	ft
Froude Number		0.09	
Flow Type	Subcritical		

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.45	ft
Critical Depth	0.10	ft
Channel Slope	0.01000	ft/ft
Critical Slope	1.84916	ft/ft

Swale Water Quality Flow Section

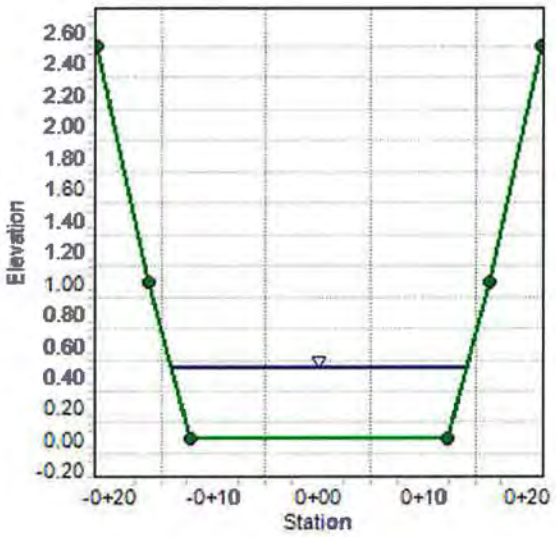
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

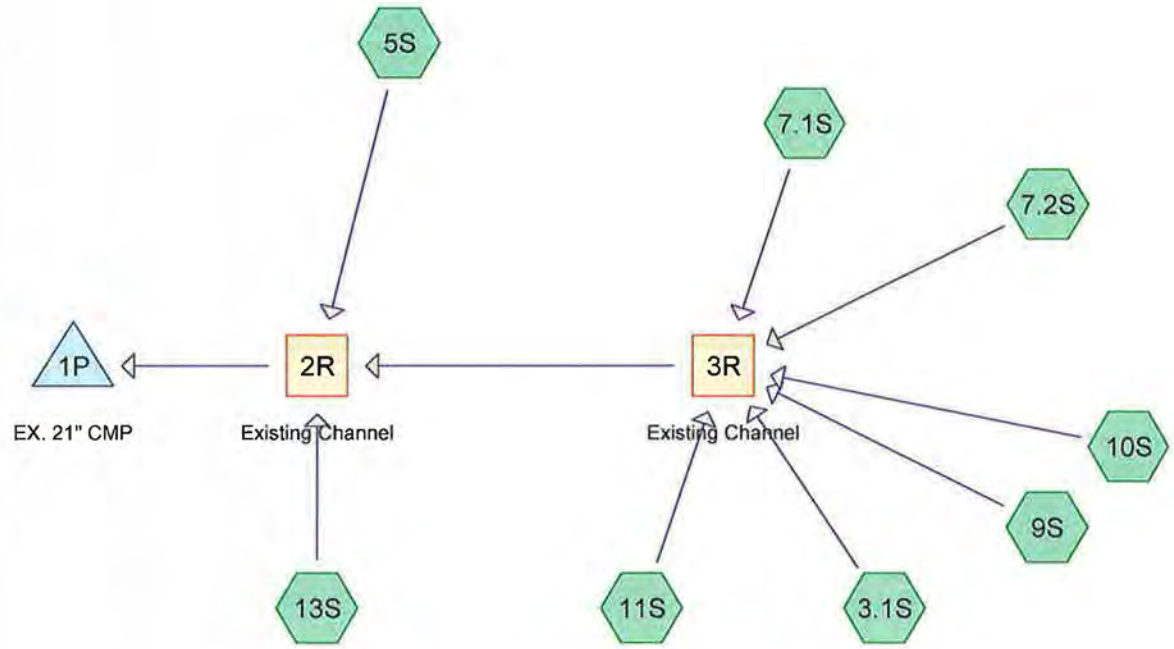
Input Data

Channel Slope	0.01000	ft/ft
Normal Depth	0.45	ft
Discharge	4.13	ft^3/s

Cross Section Image



APPENDIX C
PRE-CONSTRUCTION HYDRAULIC ANALYSIS, 25-YEAR STORM EVENT (3.90″)



Subcat | Reach | Pond | Link

Drainage Diagram for 3068 PRE-DEVELOPED
Prepared by AKS Engineering & Forestry, LLC., Printed 5/9/2014

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
5.560	61	>75% Grass cover, Good, HSG B (5S,7.1S,7.2S,9S,10S,11S,13S)
1.956	66	Woods, Poor, HSG B (3.1S)
36.278	74	>75% Grass cover, Good, HSG C (5S,7.1S,7.2S,9S,10S,11S,13S)
10.176	80	>75% Grass cover, Good, HSG D (7.1S,9S)
0.848	98	Impervious Area on Lots (14 Lots x 2640sf) (13S)
8.485	98	Impervious Area on Lots (140 Lots x 2640sf) (7.1S)
0.182	98	Impervious Area on Lots (3 Lots x 2640sf) (10S)
0.242	98	Impervious Area on Lots (4 Lots x 2640sf) (5S)
0.303	98	Impervious Area on Lots (5 Lots x 2640sf) (7.2S)
3.576	98	Impervious Area on Lots (59 Lots x 2640sf) (11S)
5.576	98	Impervious Area on Lots (92 Lots x 2640sf) (9S)
10.886	98	Impervious Commercial (7.1S,9S,11S,13S)
15.427	98	Impervious Street ROW (7.1S,7.2S,9S,10S,11S,13S)
99.494		**TOTAL AREA**

Summary for Subcatchment 3.1S:

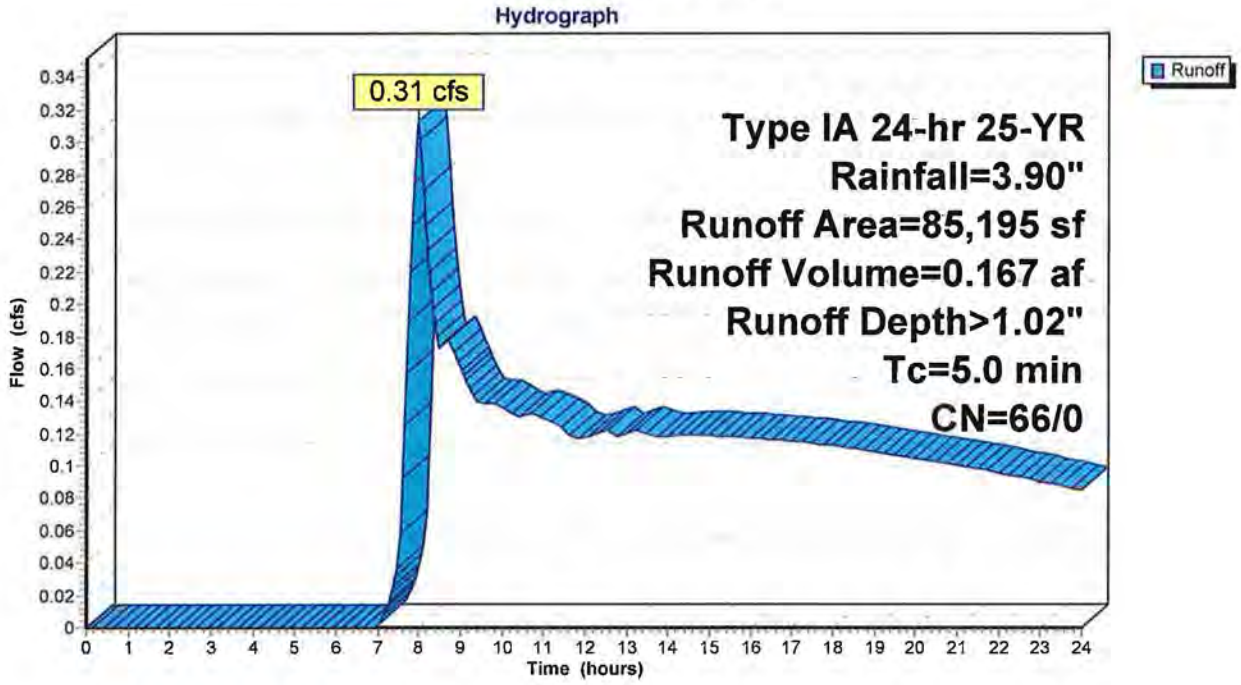
Runoff = 0.31 cfs @ 8.00 hrs, Volume= 0.167 af, Depth> 1.02"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 25-YR Rainfall=3.90"

Area (sf)	CN	Description
85,195	66	Woods, Poor, HSG B
85,195	66	Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, Stormwater runoff onsite. Minimum 5 minutes sele**

Subcatchment 3.1S:



Summary for Subcatchment 5S:

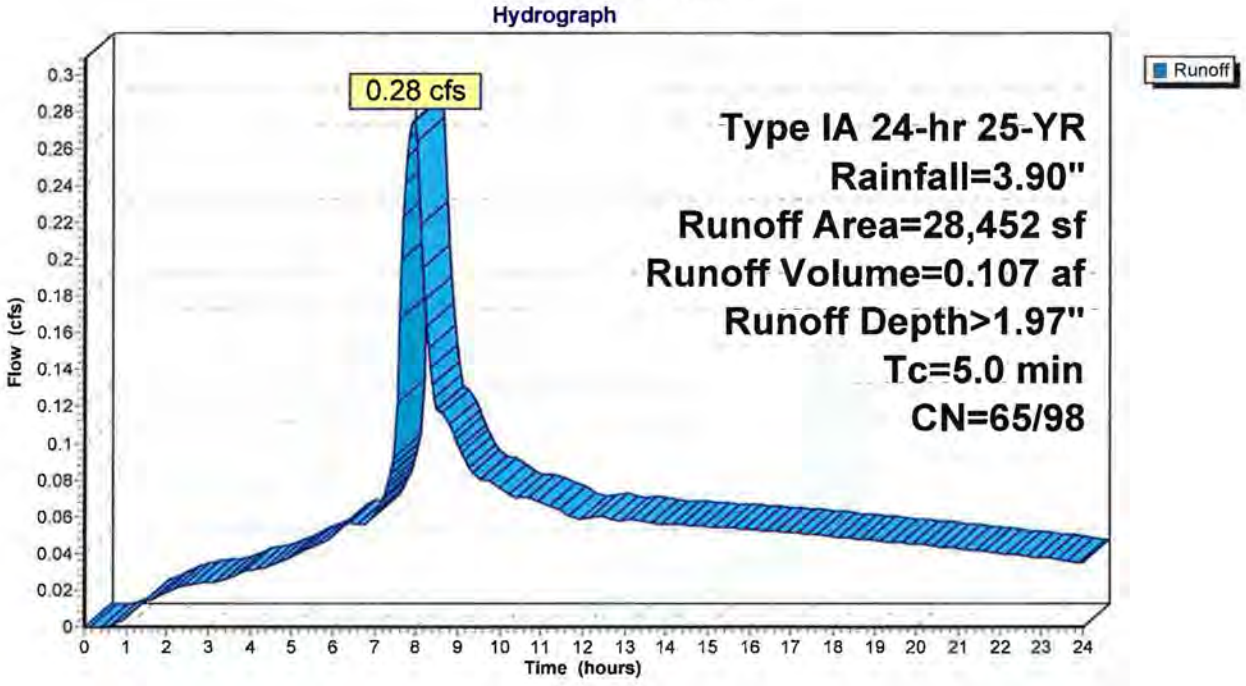
Runoff = 0.28 cfs @ 7.97 hrs, Volume= 0.107 af, Depth> 1.97"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 25-YR Rainfall=3.90"

	Area (sf)	CN	Description
*	10,560	98	Impervious Area on Lots (4 Lots x 2640sf)
	12,399	61	>75% Grass cover, Good, HSG B
	5,493	74	>75% Grass cover, Good, HSG C
	28,452	77	Weighted Average
	17,892	65	Pervious Area
	10,560	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, Minor sheet flow with all stormwater runoff conve**

Subcatchment 5S:



Summary for Subcatchment 7.1S:

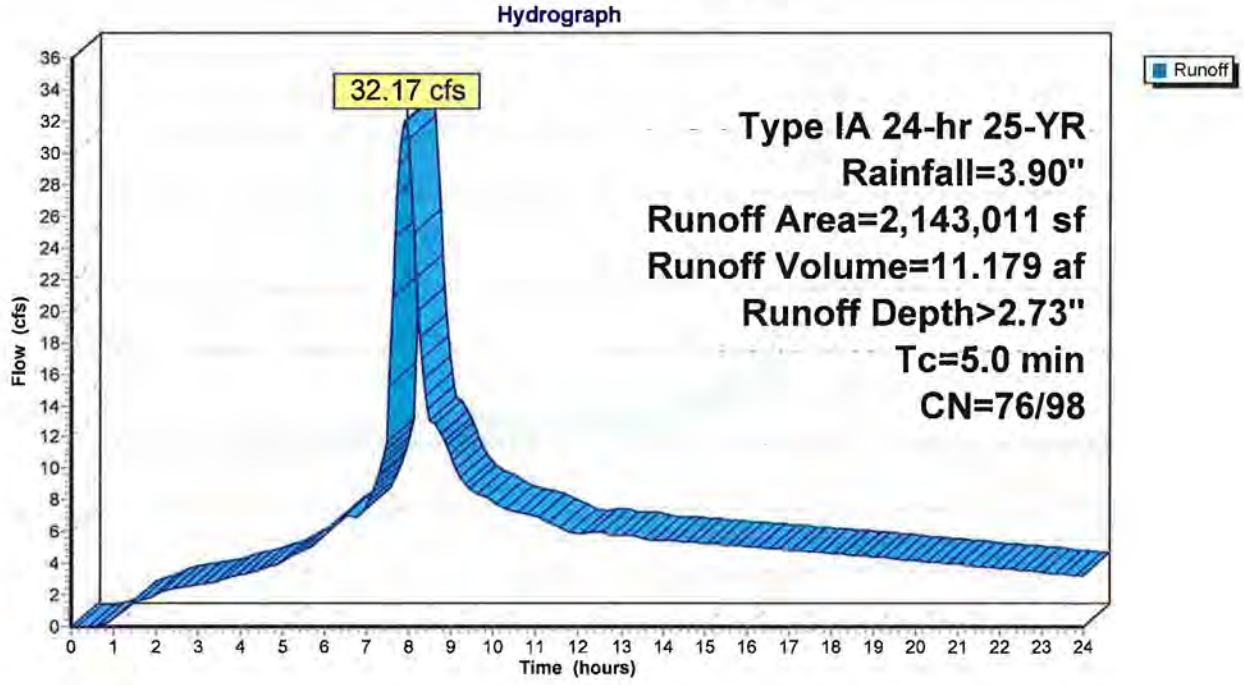
Runoff = 32.17 cfs @ 7.93 hrs, Volume= 11.179 af, Depth> 2.73"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 25-YR Rainfall=3.90"

	Area (sf)	CN	Description
*	369,600	98	Impervious Area on Lots (140 Lots x 2640sf)
*	344,936	98	Impervious Street ROW
*	430,182	98	Impervious Commercial
	12,115	61	>75% Grass cover, Good, HSG B
	593,407	74	>75% Grass cover, Good, HSG C
	392,771	80	>75% Grass cover, Good, HSG D
	2,143,011	88	Weighted Average
	998,293	76	Pervious Area
	1,144,718	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, Minor sheet flow with all stormwater runoff conve**

Subcatchment 7.1S:



Summary for Subcatchment 7.2S:

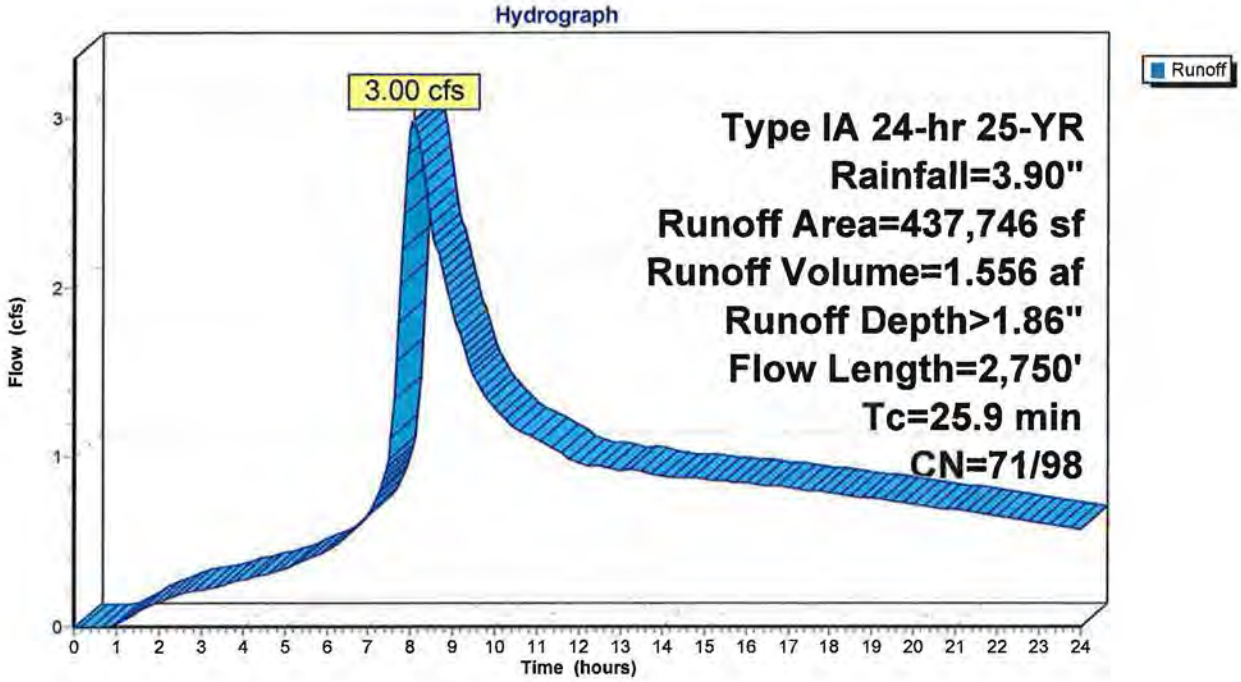
Runoff = 3.00 cfs @ 8.06 hrs, Volume= 1.556 af, Depth> 1.86"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 25-YR Rainfall=3.90"

	Area (sf)	CN	Description
*	91,020	98	Impervious Street ROW
*	13,200	98	Impervious Area on Lots (5 Lots x 2640sf)
	85,932	61	>75% Grass cover, Good, HSG B
	247,594	74	>75% Grass cover, Good, HSG C
	437,746	77	Weighted Average
	333,526	71	Pervious Area
	104,220	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
18.5	300	0.0500	0.27		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
1.2	250	0.0500	3.35		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
2.1	450	0.0300	3.52		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
4.1	1,750	0.0100	7.20	22.62	**Circular Channel (pipe),** Diam= 24.0" Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013
25.9	2,750	Total			

Subcatchment 7.2S:



Summary for Subcatchment 9S:

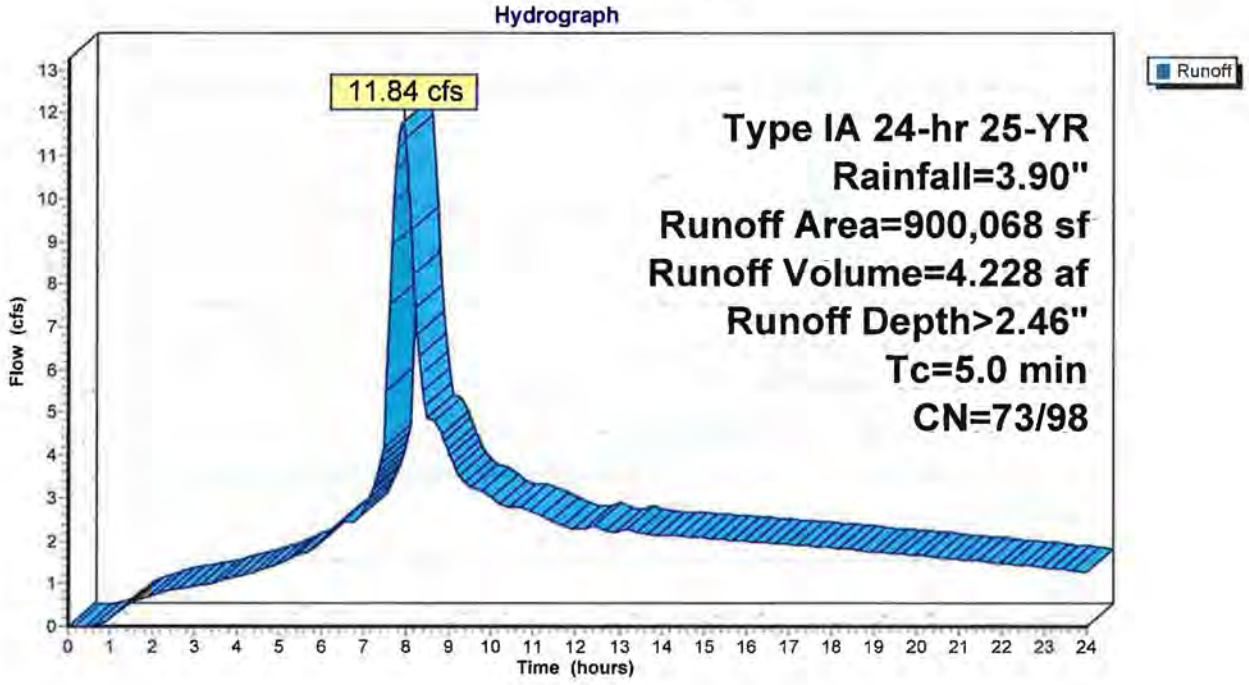
Runoff = 11.84 cfs @ 7.94 hrs, Volume= 4.228 af, Depth> 2.46"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 25-YR Rainfall=3.90"

	Area (sf)	CN	Description
*	242,880	98	Impervious Area on Lots (92 Lots x 2640sf)
*	14,366	98	Impervious Commercial
*	152,113	98	Impervious Street ROW
	52,566	61	>75% Grass cover, Good, HSG B
	387,655	74	>75% Grass cover, Good, HSG C
	50,488	80	>75% Grass cover, Good, HSG D
	900,068	84	Weighted Average
	490,709	73	Pervious Area
	409,359	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, Minor sheet flow with all stormwater runoff conve**

Subcatchment 9S:



Summary for Subcatchment 10S:

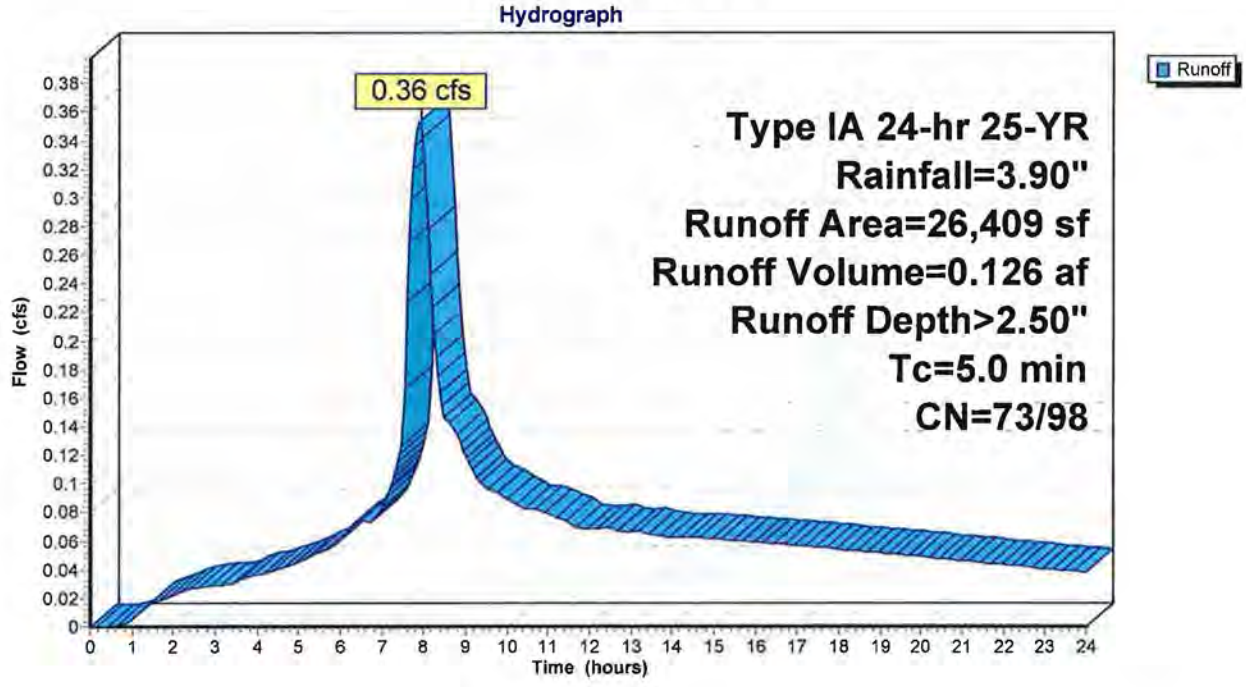
Runoff = 0.36 cfs @ 7.94 hrs, Volume= 0.126 af, Depth> 2.50"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 25-YR Rainfall=3.90"

	Area (sf)	CN	Description
*	4,635	98	Impervious Street ROW
*	7,920	98	Impervious Area on Lots (3 Lots x 2640sf)
	1,318	61	>75% Grass cover, Good, HSG B
	12,536	74	>75% Grass cover, Good, HSG C
	26,409	85	Weighted Average
	13,854	73	Pervious Area
	12,555	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, Minor sheet flow with all stormwater runoff conve**

Subcatchment 10S:



Summary for Subcatchment 11S:

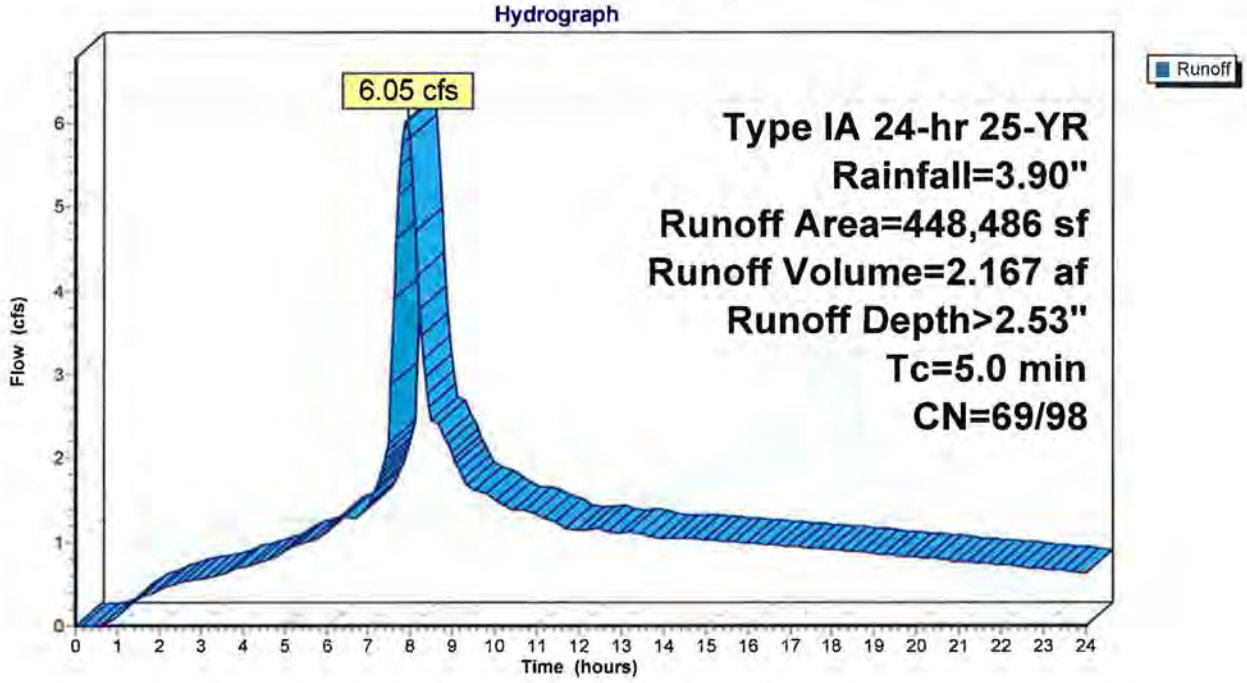
Runoff = 6.05 cfs @ 7.93 hrs, Volume= 2.167 af, Depth> 2.53"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 25-YR Rainfall=3.90"

	Area (sf)	CN	Description
*	27,403	98	Impervious Commercial
*	58,808	98	Impervious Street ROW
*	155,760	98	Impervious Area on Lots (59 Lots x 2640sf)
	77,385	61	>75% Grass cover, Good, HSG B
	129,130	74	>75% Grass cover, Good, HSG C
	448,486	85	Weighted Average
	206,515	69	Pervious Area
	241,971	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, Minor sheet flow with all stormwater runoff conve**

Subcatchment 11S:



Summary for Subcatchment 13S:

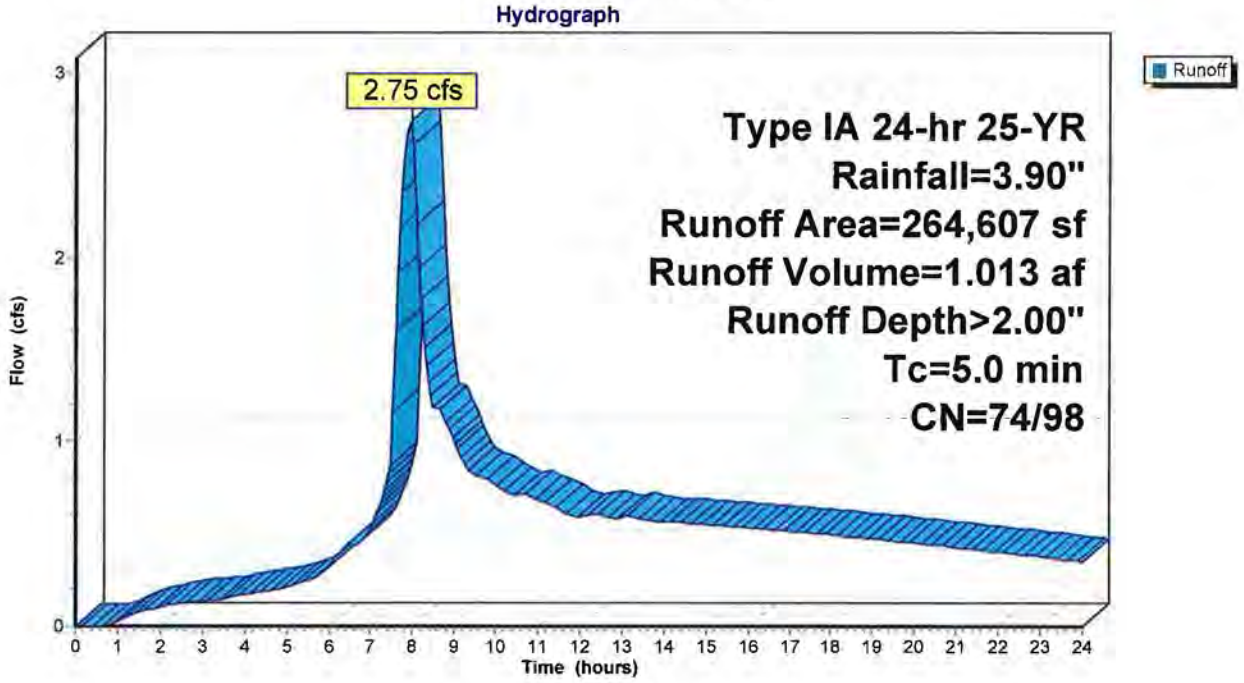
Runoff = 2.75 cfs @ 7.98 hrs, Volume= 1.013 af, Depth> 2.00"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 25-YR Rainfall=3.90"

	Area (sf)	CN	Description
*	2,238	98	Impervious Commercial
*	20,476	98	Impervious Street ROW
*	36,960	98	Impervious Area on Lots (14 Lots x 2640sf)
	462	61	>75% Grass cover, Good, HSG B
	204,471	74	>75% Grass cover, Good, HSG C
	264,607	79	Weighted Average
	204,933	74	Pervious Area
	59,674	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, Minor sheet flow with all stormwater runoff conve**

Subcatchment 13S:



Summary for Reach 2R: Existing Channel

Inflow Area = 99.494 ac, 45.76% Impervious, Inflow Depth > 2.48" for 25-YR event
Inflow = 56.48 cfs @ 7.96 hrs, Volume= 20.539 af
Outflow = 56.44 cfs @ 7.97 hrs, Volume= 20.525 af, Atten= 0%, Lag= 0.8 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.49 fps, Min. Travel Time= 1.0 min
Avg. Velocity = 3.62 fps, Avg. Travel Time= 1.5 min

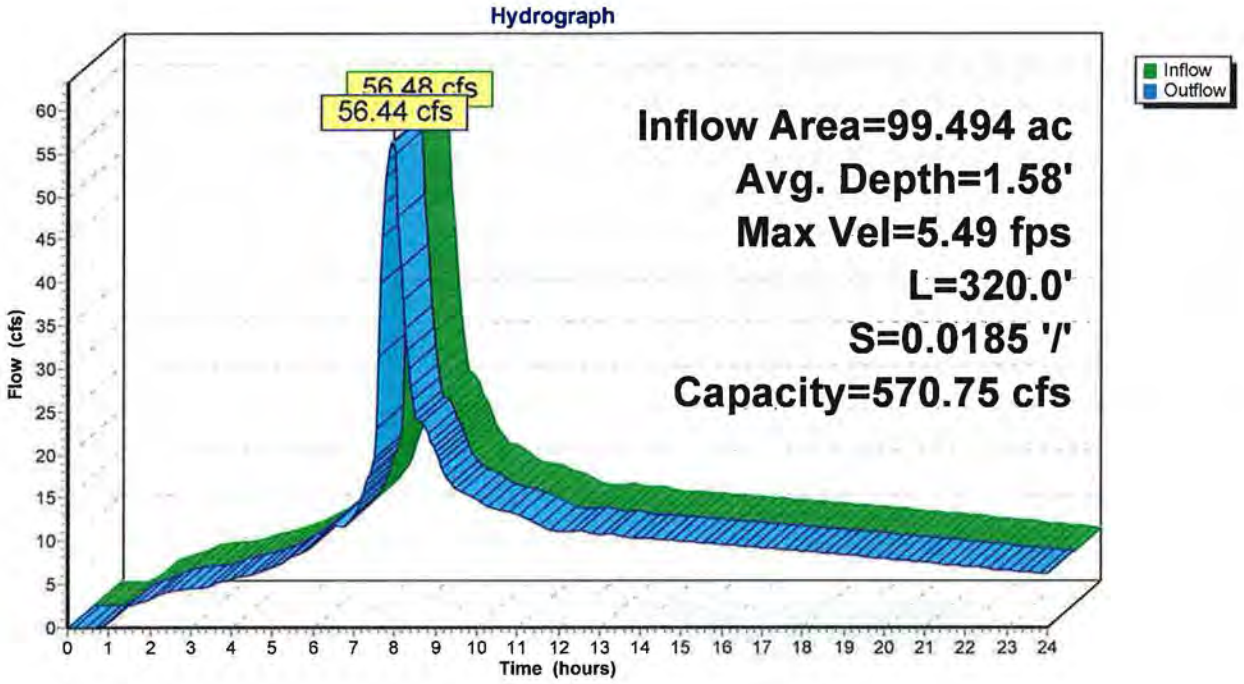
Peak Storage= 3,291 cf @ 7.97 hrs, Average Depth at Peak Storage= 1.58'
Bank-Full Depth= 5.00', Capacity at Bank-Full= 570.75 cfs

Custom cross-section, Length= 320.0' Slope= 0.0185 '/'
Flow calculated by Manning's Subdivision method
Inlet Invert= 166.00', Outlet Invert= 160.07'

Offset (feet)	Elevation (feet)	Chan.Depth (feet)	n	Description
-12.50	5.00	0.00		
-1.50	0.00	5.00	0.070	
1.50	0.00	5.00	0.030	
12.50	5.00	0.00	0.070	

Depth (feet)	End Area (sq-ft)	Perim. (feet)	Storage (cubic-feet)	Discharge (cfs)
0.00	0.0	3.0	0	0.00
5.00	70.0	27.2	22,400	570.75

Reach 2R: Existing Channel



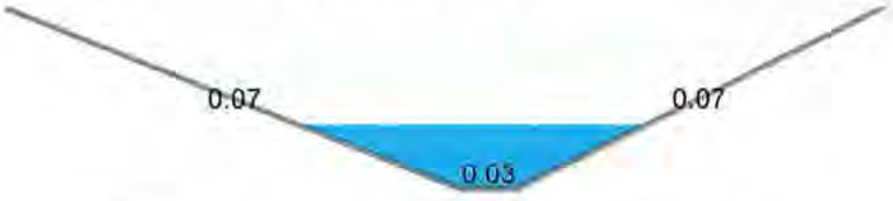
Summary for Reach 3R: Existing Channel

Inflow Area = 92.767 ac, 47.34% Impervious, Inflow Depth > 2.51" for 25-YR event
Inflow = 53.48 cfs @ 7.95 hrs, Volume= 19.424 af
Outflow = 53.48 cfs @ 7.95 hrs, Volume= 19.419 af, Atten= 0%, Lag= 0.4 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.29 fps, Min. Travel Time= 0.5 min
Avg. Velocity = 3.81 fps, Avg. Travel Time= 0.7 min

Peak Storage= 1,529 cf @ 7.95 hrs, Average Depth at Peak Storage= 1.81'
Bank-Full Depth= 5.00', Capacity at Bank-Full= 498.97 cfs

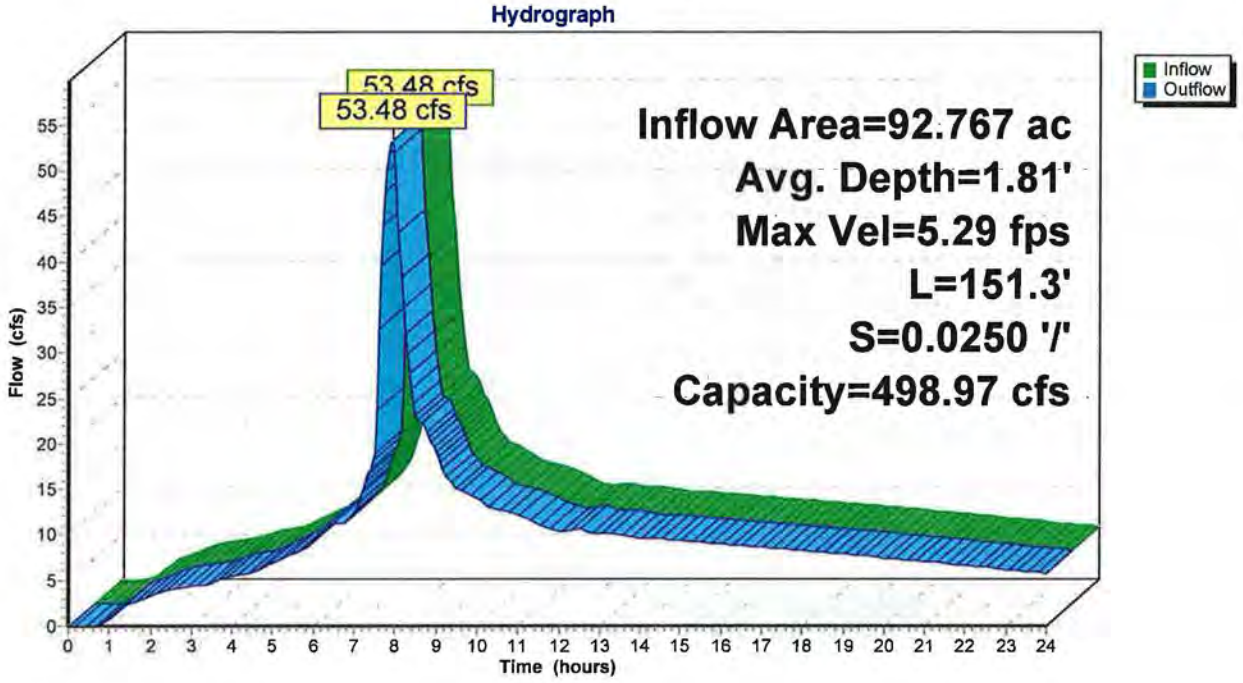
Custom cross-section, Length= 151.3' Slope= 0.0250 '/'
Flow calculated by Manning's Subdivision method
Inlet Invert= 169.78', Outlet Invert= 166.00'



Offset (feet)	Elevation (feet)	Chan.Depth (feet)	n	Description
-13.25	5.00	0.00		
-0.75	0.00	5.00	0.070	
0.75	0.00	5.00	0.030	
10.75	5.00	0.00	0.070	

Depth (feet)	End Area (sq-ft)	Perim. (feet)	Storage (cubic-feet)	Discharge (cfs)
0.00	0.0	1.5	0	0.00
5.00	63.8	26.1	9,645	498.97

Reach 3R: Existing Channel



Summary for Pond 1P: EX. 21" CMP

Inflow Area = 99.494 ac, 45.76% Impervious, Inflow Depth > 2.48" for 25-YR event
Inflow = 56.44 cfs @ 7.97 hrs, Volume= 20.525 af
Outflow = 34.77 cfs @ 8.26 hrs, Volume= 20.525 af, Atten= 38%, Lag= 17.1 min
Primary = 34.77 cfs @ 8.26 hrs, Volume= 20.525 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 169.38' @ 8.26 hrs Surf.Area= 14,825 sf Storage= 41,659 cf

Plug-Flow detention time= 3.1 min calculated for 20.525 af (100% of inflow)
Center-of-Mass det. time= 3.1 min (723.4 - 720.3)

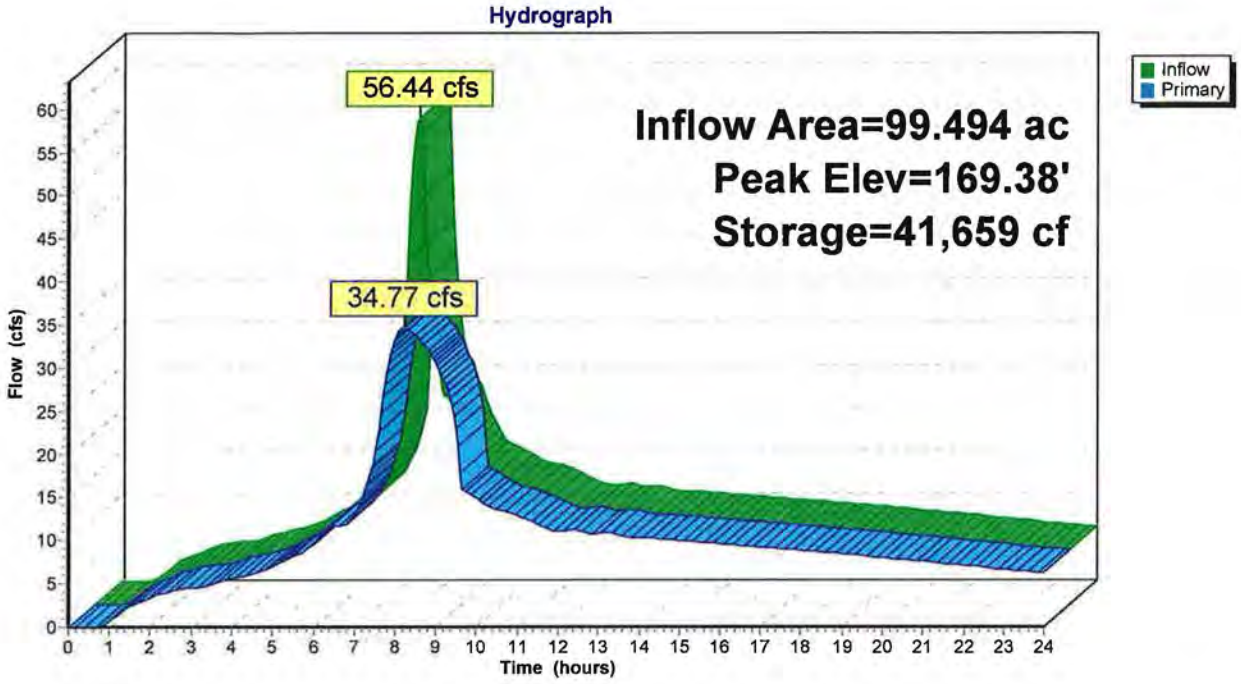
Volume	Invert	Avail.Storage	Storage Description
#1	160.00'	90,422 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
160.00	0	0	0
161.00	19	10	10
162.00	109	64	74
163.00	415	262	336
164.00	948	682	1,017
165.00	2,992	1,970	2,987
166.00	5,541	4,267	7,254
167.00	8,174	6,858	14,111
168.00	11,058	9,616	23,727
169.00	13,793	12,426	36,153
170.00	16,474	15,134	51,286
171.00	19,548	18,011	69,297
172.00	22,701	21,125	90,422

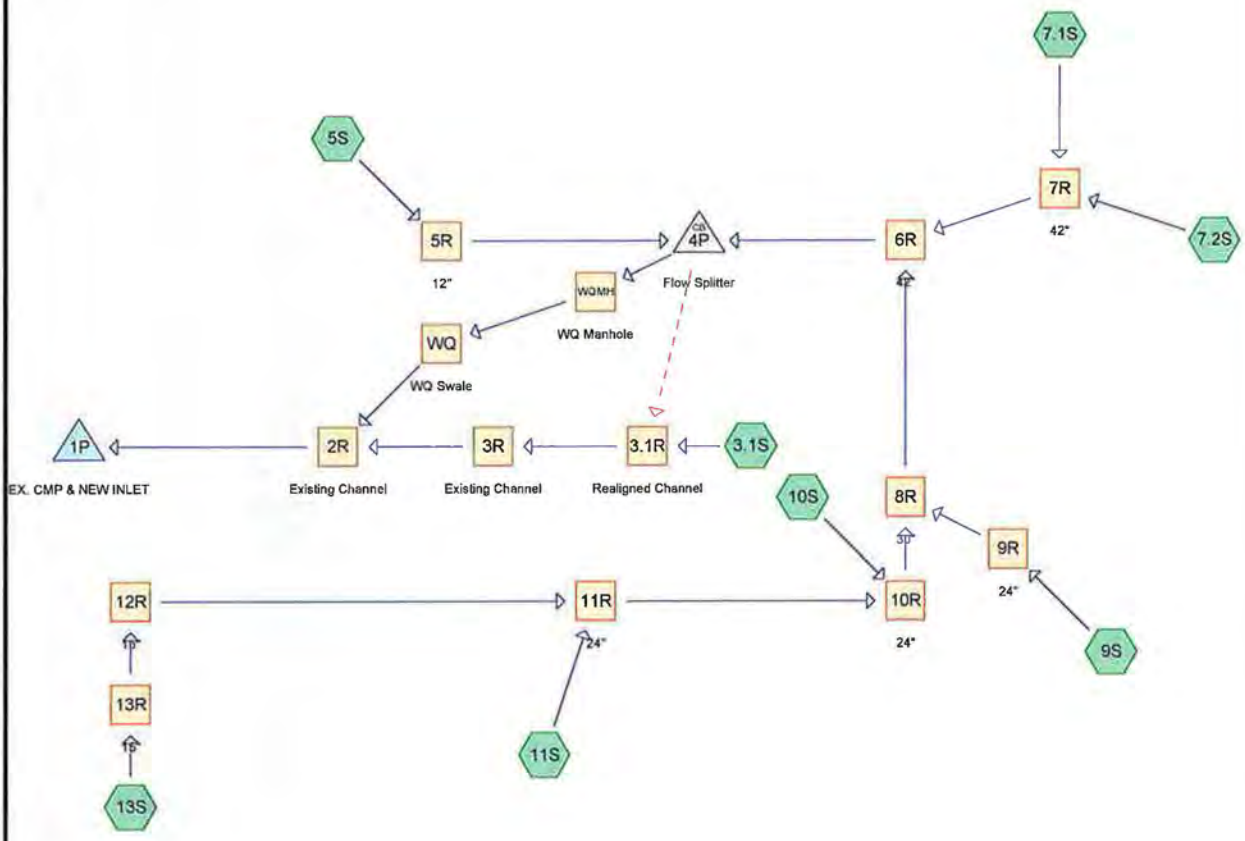
Device	Routing	Invert	Outlet Devices
#1	Primary	160.07'	**21.0" Vert. EX. 21" CMP, Orifice Inlet** C= 0.620

Primary OutFlow Max=34.76 cfs @ 8.26 hrs HW=169.38' (Free Discharge)
↑**1=EX. 21" CMP, Orifice Inlet** (Orifice Controls 34.76 cfs @ 14.45 fps)

Pond 1P: EX. 21" CMP



APPENDIX D
POST-CONSTRUCTION HYDRAULIC ANALYSIS, 25-YEAR STORM EVENT (3.90″)



Subcat | Reach | Pond | Link

Drainage Diagram for 3068 POST-DEVELOPED
Prepared by AKS Engineering & Forestry, LLC., Printed 5/9/2014

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
5.560	61	>75% Grass cover, Good, HSG B (5S,7.1S,7.2S,9S,10S,11S,13S)
1.840	66	Woods, Poor, HSG B (3.1S)
36.278	74	>75% Grass cover, Good, HSG C (5S,7.1S,7.2S,9S,10S,11S,13S)
10.176	80	>75% Grass cover, Good, HSG D (7.1S,9S)
0.115	98	Access Rd Pavements (3.1S)
0.848	98	Impervious Area on Lots (14 Lots x 2640sf) (13S)
8.485	98	Impervious Area on Lots (140 Lots x 2640sf) (7.1S)
0.182	98	Impervious Area on Lots (3 Lots x 2640sf) (10S)
0.242	98	Impervious Area on Lots (4 Lots x 2640sf) (5S)
0.303	98	Impervious Area on Lots (5 Lots x 2640sf) (7.2S)
3.576	98	Impervious Area on Lots (59 Lots x 2640sf) (11S)
5.576	98	Impervious Area on Lots (92 Lots x 2640sf) (9S)
10.886	98	Impervious Commercial (7.1S,9S,11S,13S)
15.427	98	Impervious Street ROW (7.1S,7.2S,9S,10S,11S,13S)
99.494		**TOTAL AREA**

Summary for Subcatchment 3.1S:

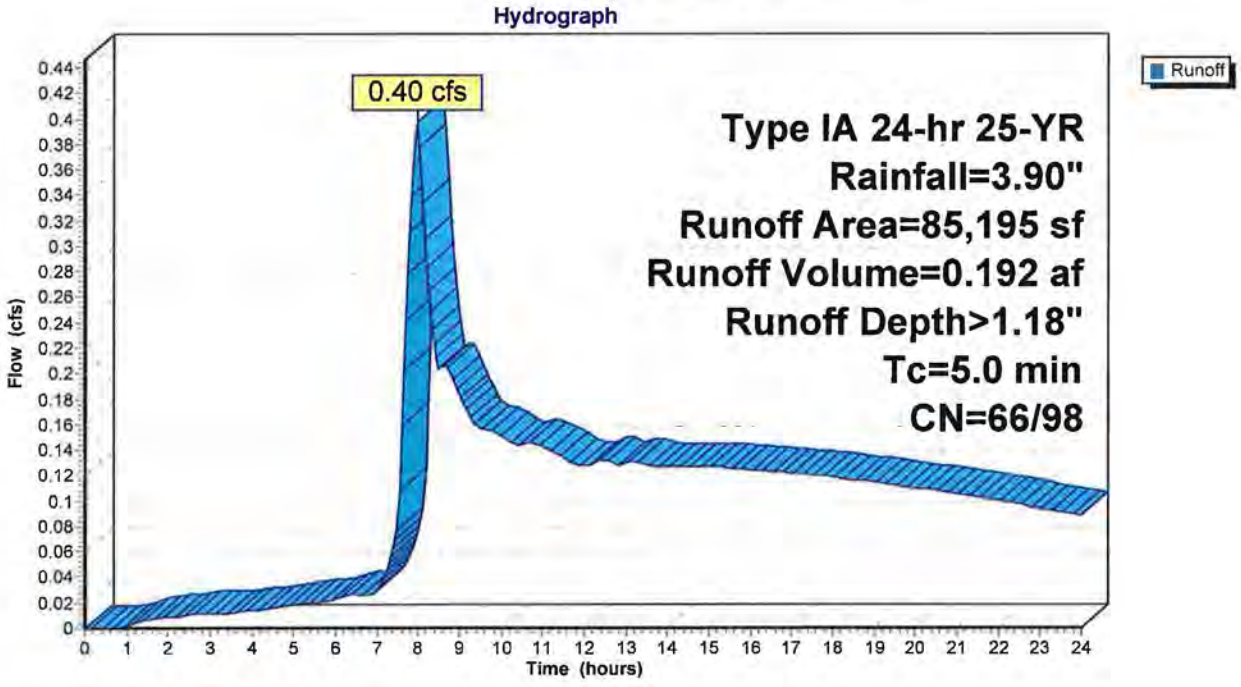
Runoff = 0.40 cfs @ 8.00 hrs, Volume= 0.192 af, Depth> 1.18"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 25-YR Rainfall=3.90"

	Area (sf)	CN	Description
	80,164	66	Woods, Poor, HSG B
*	5,031	98	Access Rd Pavements
	85,195	68	Weighted Average
	80,164	66	Pervious Area
	5,031	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, Stormwater runoff onsite. Minimum 5 minutes sele**

Subcatchment 3.1S:



Summary for Subcatchment 5S:

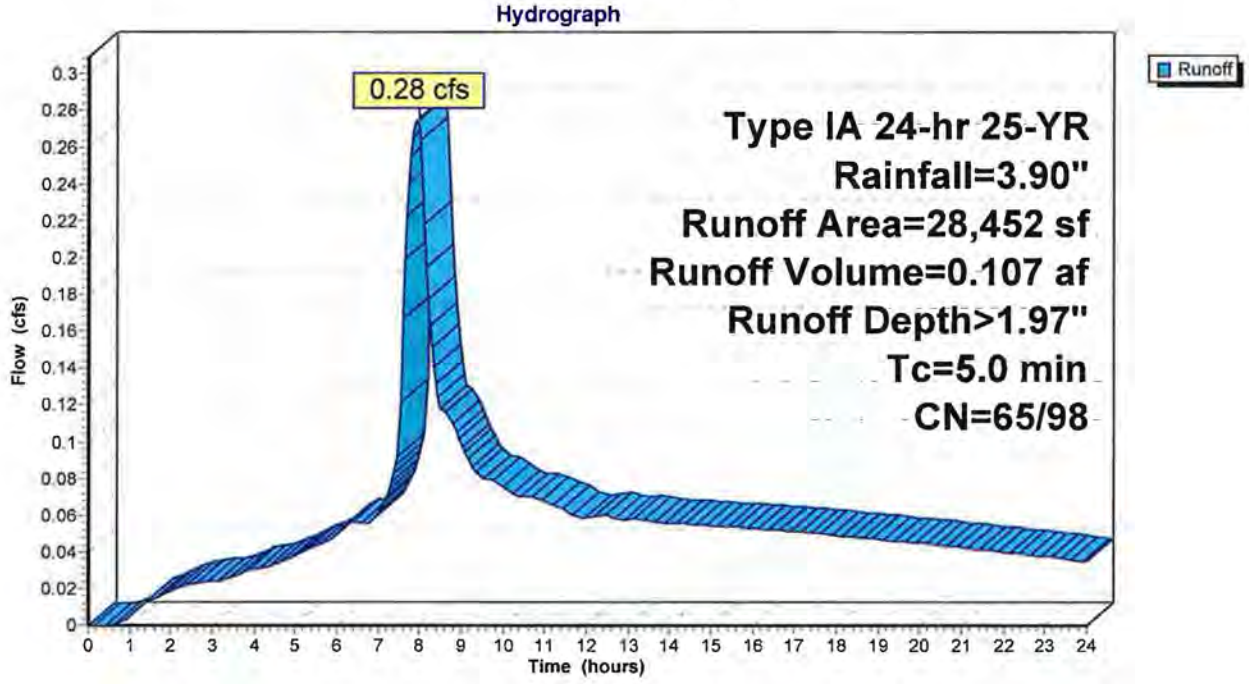
Runoff = 0.28 cfs @ 7.97 hrs, Volume= 0.107 af, Depth> 1.97"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 25-YR Rainfall=3.90"

	Area (sf)	CN	Description
*	10,560	98	Impervious Area on Lots (4 Lots x 2640sf)
	12,399	61	>75% Grass cover, Good, HSG B
	5,493	74	>75% Grass cover, Good, HSG C
	28,452	77	Weighted Average
	17,892	65	Pervious Area
	10,560	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, Minor sheet flow with all stormwater runoff conve**

Subcatchment 5S:



Summary for Subcatchment 7.1S:

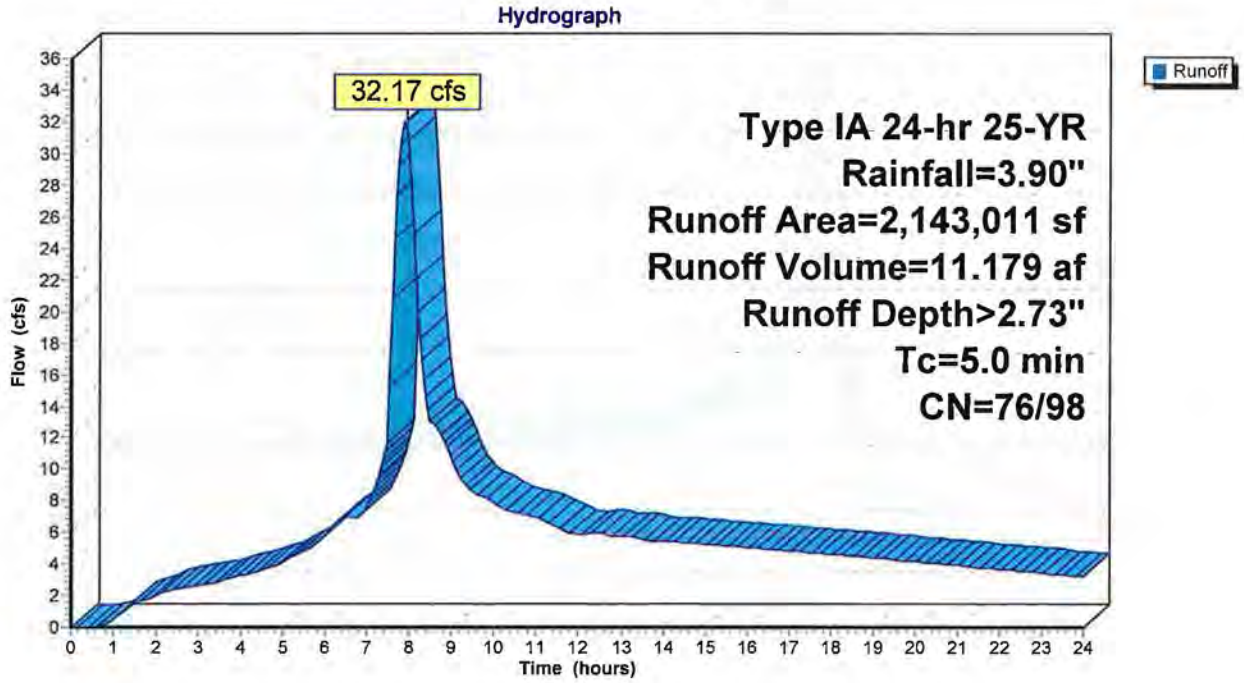
Runoff = 32.17 cfs @ 7.93 hrs, Volume= 11.179 af, Depth> 2.73"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 25-YR Rainfall=3.90"

	Area (sf)	CN	Description
*	369,600	98	Impervious Area on Lots (140 Lots x 2640sf)
*	344,936	98	Impervious Street ROW
*	430,182	98	Impervious Commercial
	12,115	61	>75% Grass cover, Good, HSG B
	593,407	74	>75% Grass cover, Good, HSG C
	392,771	80	>75% Grass cover, Good, HSG D
	2,143,011	88	Weighted Average
	998,293	76	Pervious Area
	1,144,718	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, Minor sheet flow with all stormwater runoff conve**

Subcatchment 7.1S:



Summary for Subcatchment 7.2S:

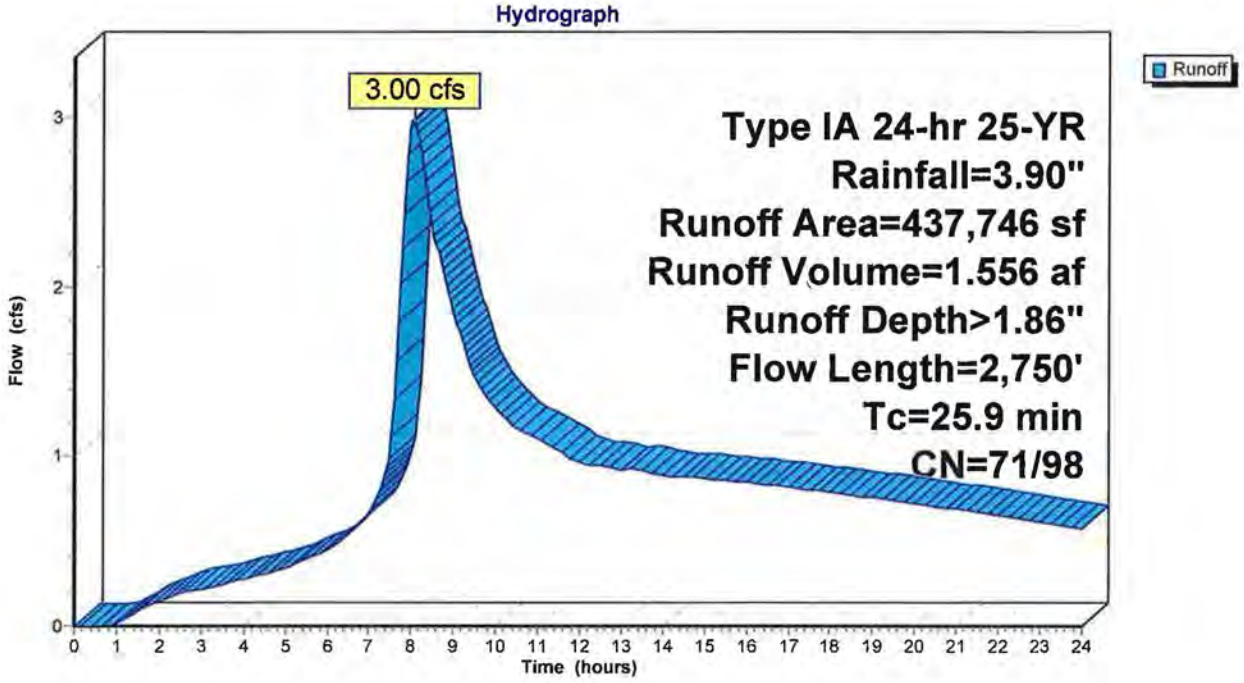
Runoff = 3.00 cfs @ 8.06 hrs, Volume= 1.556 af, Depth> 1.86"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 25-YR Rainfall=3.90"

	Area (sf)	CN	Description
*	91,020	98	Impervious Street ROW
*	13,200	98	Impervious Area on Lots (5 Lots x 2640sf)
	85,932	61	>75% Grass cover, Good, HSG B
	247,594	74	>75% Grass cover, Good, HSG C
	437,746	77	Weighted Average
	333,526	71	Pervious Area
	104,220	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
18.5	300	0.0500	0.27		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
1.2	250	0.0500	3.35		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
2.1	450	0.0300	3.52		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
4.1	1,750	0.0100	7.20	22.62	**Circular Channel (pipe),** Diam= 24.0" Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013
25.9	2,750	Total			

Subcatchment 7.2S:



Summary for Subcatchment 9S:

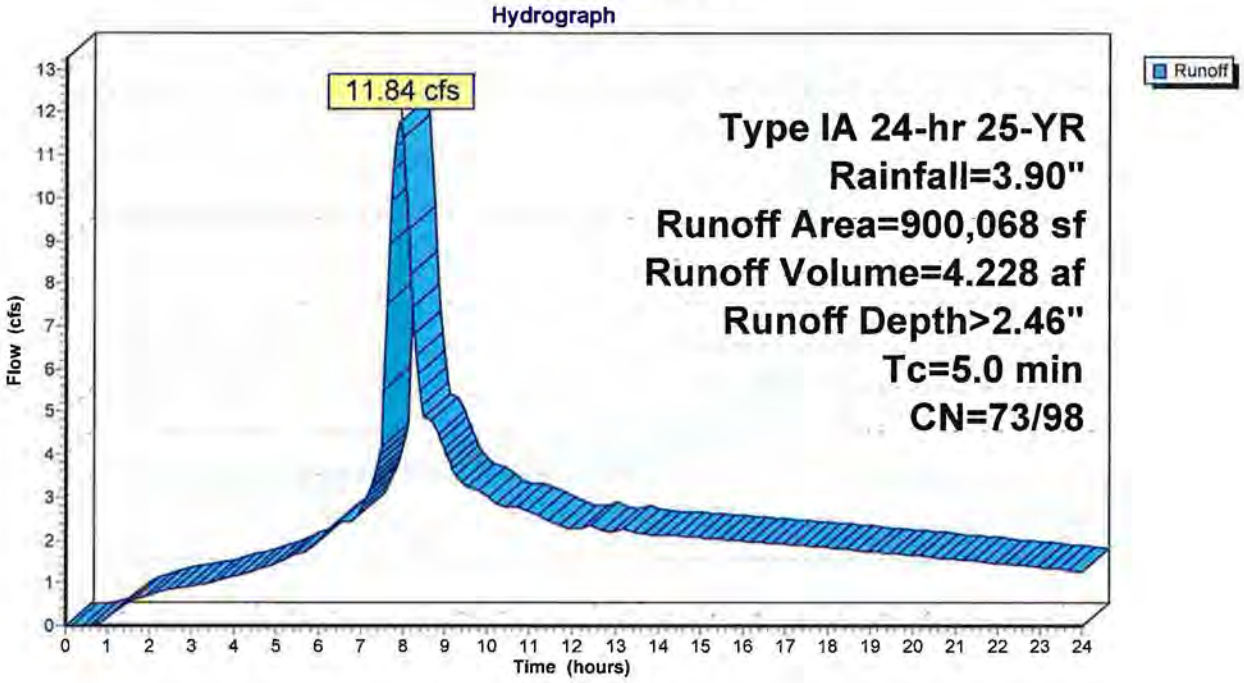
Runoff = 11.84 cfs @ 7.94 hrs, Volume= 4.228 af, Depth> 2.46"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 25-YR Rainfall=3.90"

	Area (sf)	CN	Description
*	242,880	98	Impervious Area on Lots (92 Lots x 2640sf)
*	14,366	98	Impervious Commercial
*	152,113	98	Impervious Street ROW
	52,566	61	>75% Grass cover, Good, HSG B
	387,655	74	>75% Grass cover, Good, HSG C
	50,488	80	>75% Grass cover, Good, HSG D
	900,068	84	Weighted Average
	490,709	73	Pervious Area
	409,359	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, Minor sheet flow with all stormwater runoff conve**

Subcatchment 9S:



Summary for Subcatchment 10S:

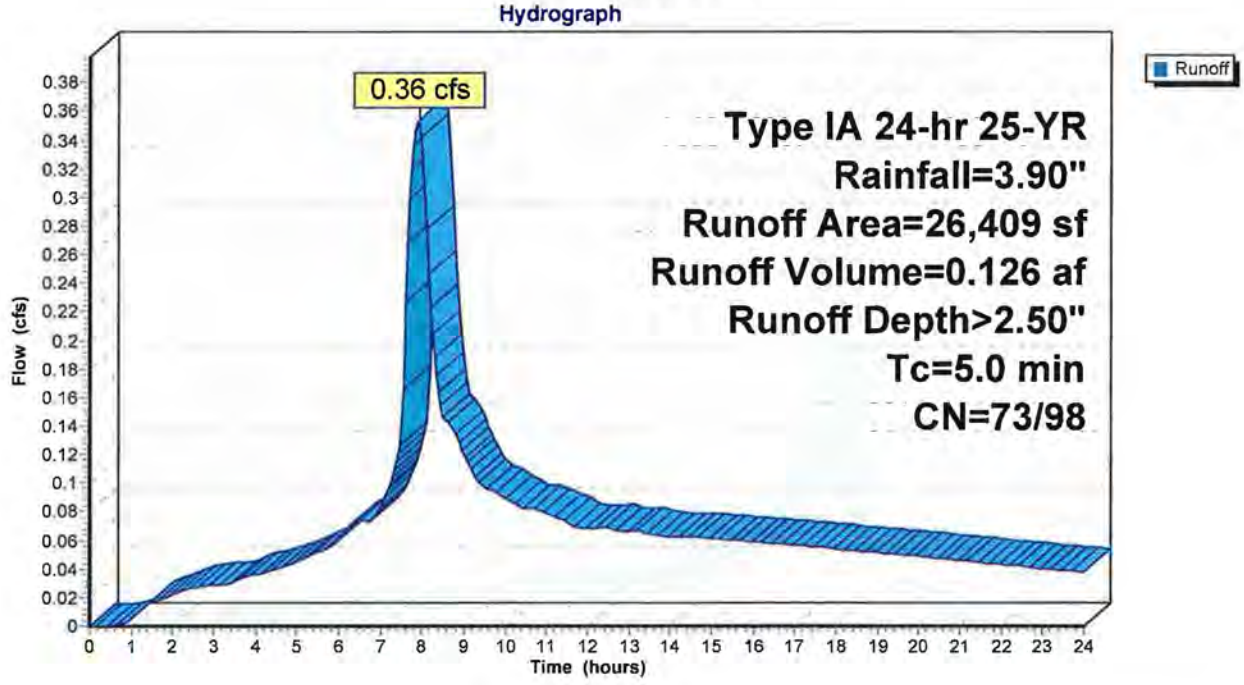
Runoff = 0.36 cfs @ 7.94 hrs, Volume= 0.126 af, Depth> 2.50"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 25-YR Rainfall=3.90"

	Area (sf)	CN	Description
*	4,635	98	Impervious Street ROW
*	7,920	98	Impervious Area on Lots (3 Lots x 2640sf)
	1,318	61	>75% Grass cover, Good, HSG B
	12,536	74	>75% Grass cover, Good, HSG C
	26,409	85	Weighted Average
	13,854	73	Pervious Area
	12,555	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, Minor sheet flow with all stormwater runoff convey**

Subcatchment 10S:



Summary for Subcatchment 11S:

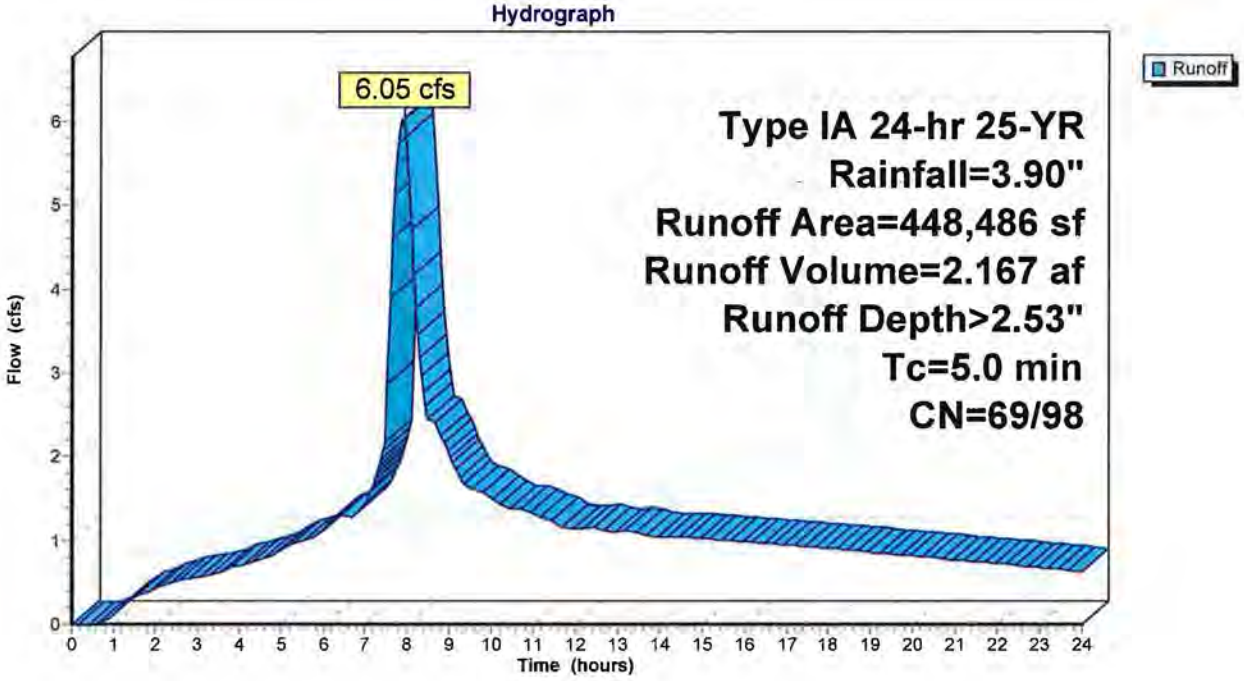
Runoff = 6.05 cfs @ 7.93 hrs, Volume= 2.167 af, Depth> 2.53"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 25-YR Rainfall=3.90"

	Area (sf)	CN	Description
*	27,403	98	Impervious Commercial
*	58,808	98	Impervious Street ROW
*	155,760	98	Impervious Area on Lots (59 Lots x 2640sf)
	77,385	61	>75% Grass cover, Good, HSG B
	129,130	74	>75% Grass cover, Good, HSG C
	448,486	85	Weighted Average
	206,515	69	Pervious Area
	241,971	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, Minor sheet flow with all stormwater runoff conve**

Subcatchment 11S:



Summary for Subcatchment 13S:

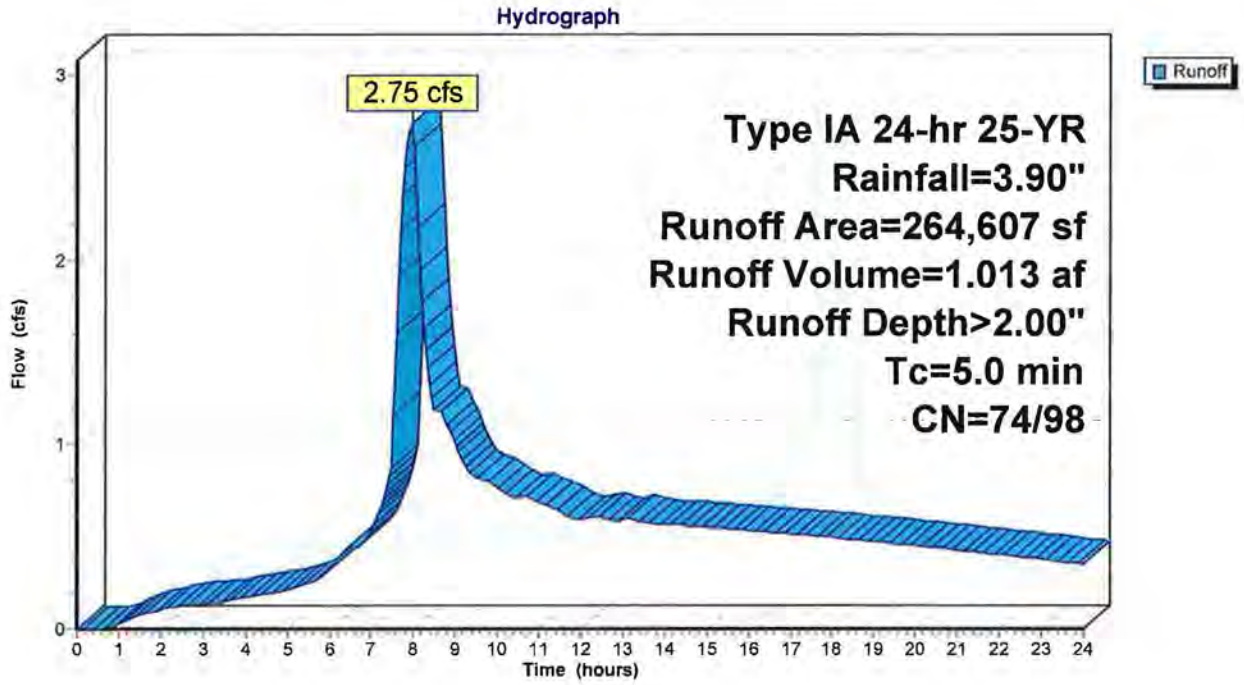
Runoff = 2.75 cfs @ 7.98 hrs, Volume= 1.013 af, Depth> 2.00"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 25-YR Rainfall=3.90"

	Area (sf)	CN	Description
*	2,238	98	Impervious Commercial
*	20,476	98	Impervious Street ROW
*	36,960	98	Impervious Area on Lots (14 Lots x 2640sf)
	462	61	>75% Grass cover, Good, HSG B
	204,471	74	>75% Grass cover, Good, HSG C
	264,607	79	Weighted Average
	204,933	74	Pervious Area
	59,674	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, Minor sheet flow with all stormwater runoff convey**

Subcatchment 13S:



Summary for Reach 2R: Existing Channel

Inflow Area = 99.494 ac, 45.87% Impervious, Inflow Depth > 2.47" for 25-YR event
Inflow = 56.62 cfs @ 7.98 hrs, Volume= 20.508 af
Outflow = 56.50 cfs @ 7.98 hrs, Volume= 20.494 af, Atten= 0%, Lag= 0.3 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.49 fps, Min. Travel Time= 1.0 min
Avg. Velocity = 3.61 fps, Avg. Travel Time= 1.5 min

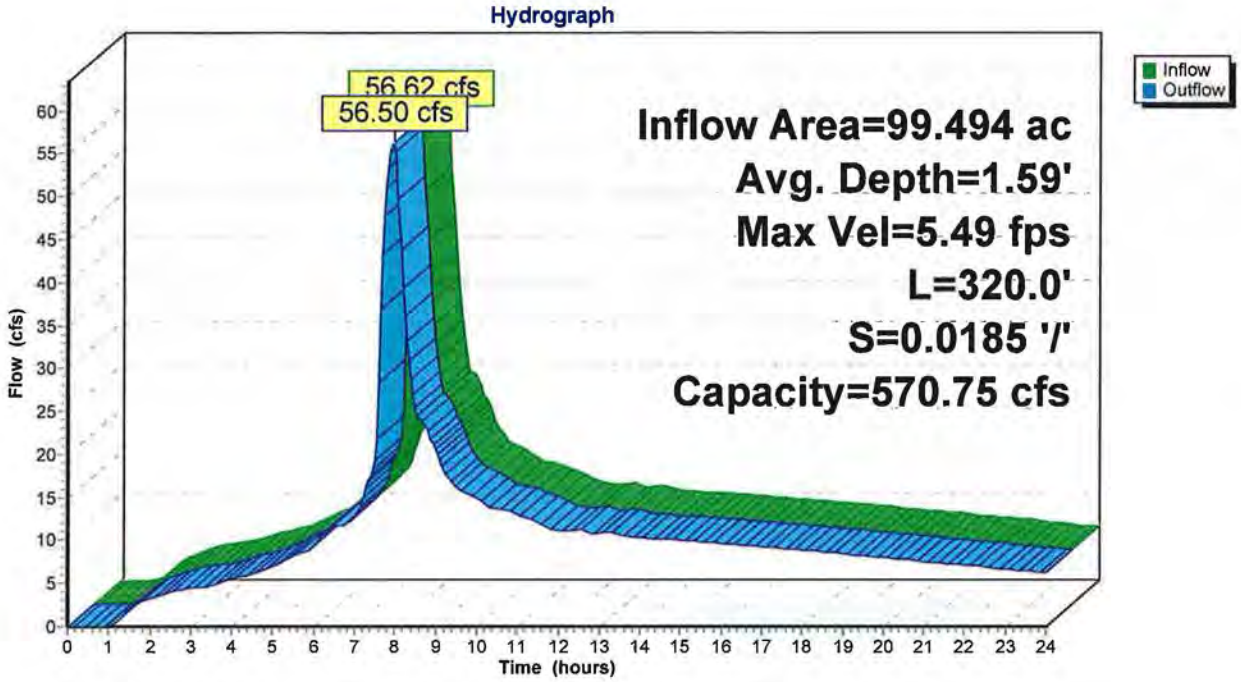
Peak Storage= 3,293 cf @ 7.98 hrs, Average Depth at Peak Storage= 1.59'
Bank-Full Depth= 5.00', Capacity at Bank-Full= 570.75 cfs

Custom cross-section, Length= 320.0' Slope= 0.0185 '/'
Flow calculated by Manning's Subdivision method
Inlet Invert= 166.00', Outlet Invert= 160.07'

Offset (feet)	Elevation (feet)	Chan.Depth (feet)	n	Description
-12.50	5.00	0.00		
-1.50	0.00	5.00	0.070	
1.50	0.00	5.00	0.030	
12.50	5.00	0.00	0.070	

Depth (feet)	End Area (sq-ft)	Perim. (feet)	Storage (cubic-feet)	Discharge (cfs)
0.00	0.0	3.0	0	0.00
5.00	70.0	27.2	22,400	570.75

Reach 2R: Existing Channel



Summary for Reach 3.1R: Realigned Channel

Inflow Area = 1.956 ac, 5.91% Impervious, Inflow Depth > 81.09" for 25-YR event
Inflow = 48.80 cfs @ 7.96 hrs, Volume= 13.217 af
Outflow = 48.80 cfs @ 7.96 hrs, Volume= 13.216 af, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 9.16 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 4.97 fps, Avg. Travel Time= 0.2 min

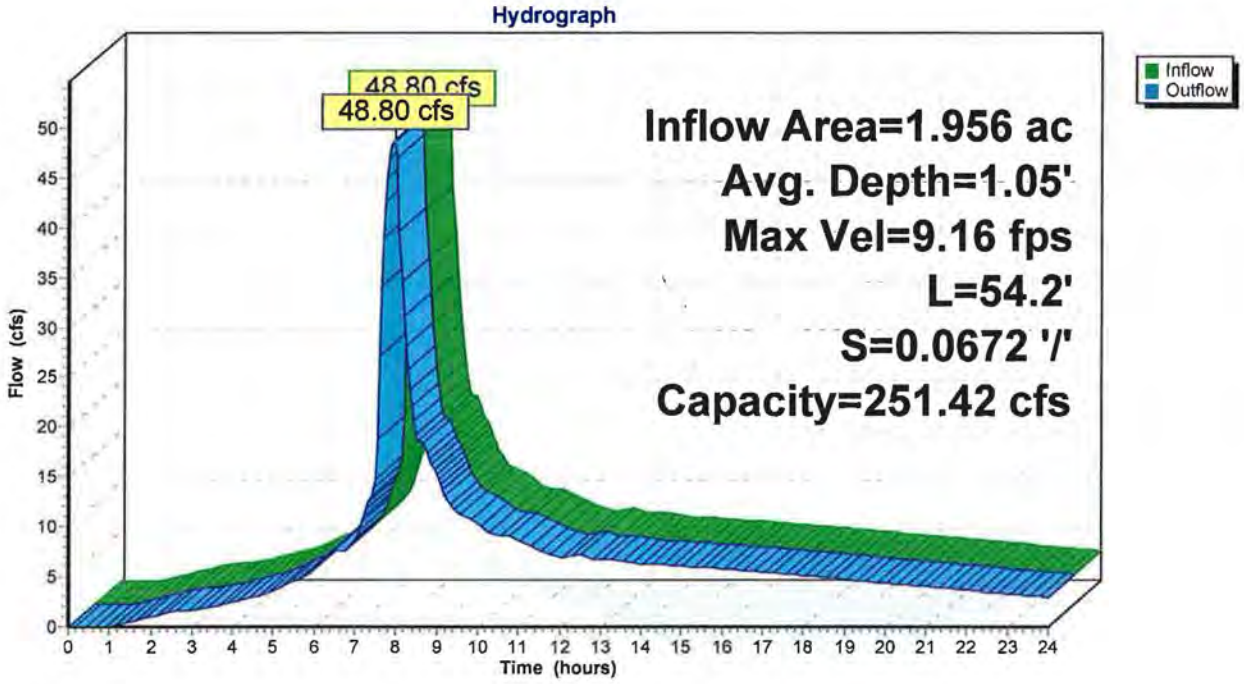
Peak Storage= 289 cf @ 7.96 hrs, Average Depth at Peak Storage= 1.05'
Bank-Full Depth= 2.50', Capacity at Bank-Full= 251.42 cfs

Custom cross-section, Length= 54.2' Slope= 0.0672 '/'
Flow calculated by Manning's Subdivision method
Inlet Invert= 173.42', Outlet Invert= 169.78'

Offset (feet)	Elevation (feet)	Chan.Depth (feet)	n	Description
-6.50	2.50	0.00		
-1.50	0.00	2.50	0.070	
1.50	0.00	2.50	0.030	
6.50	2.50	0.00	0.070	

Depth (feet)	End Area (sq-ft)	Perim. (feet)	Storage (cubic-feet)	Discharge (cfs)
0.00	0.0	3.0	0	0.00
2.50	20.0	14.2	1,084	251.42

Reach 3.1R: Realigned Channel



Summary for Reach 3R: Existing Channel

Inflow Area = 1.956 ac, 5.91% Impervious, Inflow Depth > 81.09" for 25-YR event
Inflow = 48.80 cfs @ 7.96 hrs, Volume= 13.216 af
Outflow = 48.78 cfs @ 7.97 hrs, Volume= 13.213 af, Atten= 0%, Lag= 0.5 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.21 fps, Min. Travel Time= 0.5 min
Avg. Velocity = 3.43 fps, Avg. Travel Time= 0.7 min

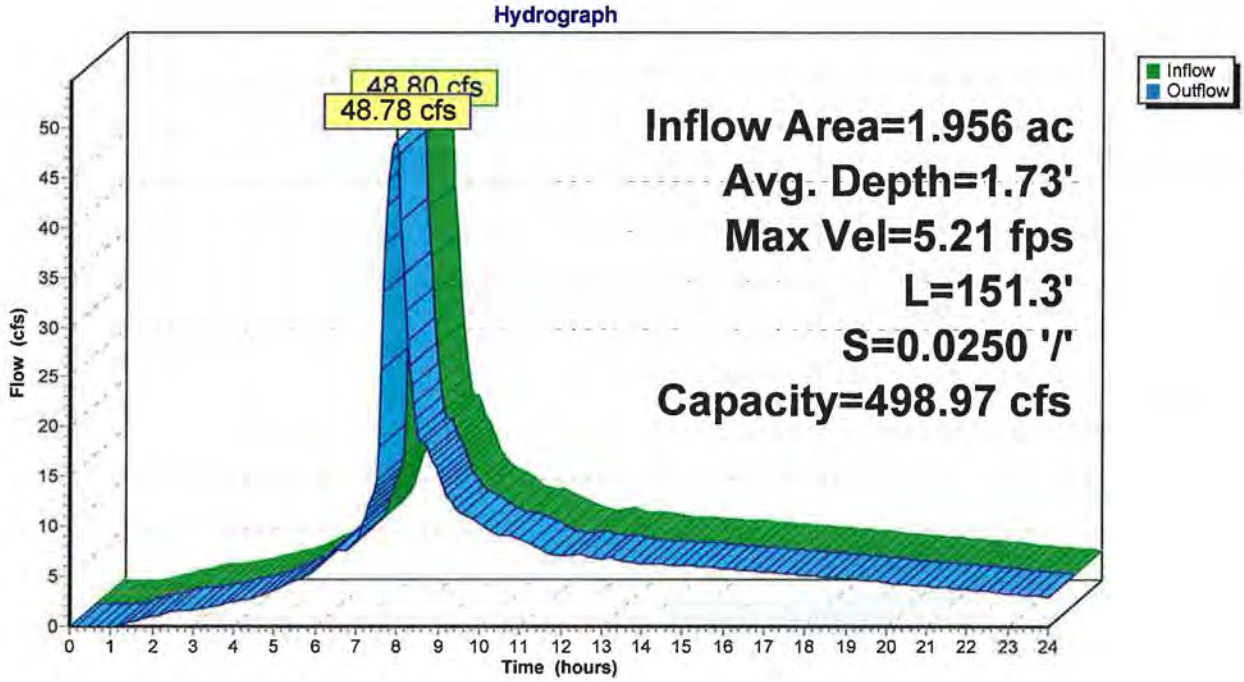
Peak Storage= 1,416 cf @ 7.97 hrs, Average Depth at Peak Storage= 1.73'
Bank-Full Depth= 5.00', Capacity at Bank-Full= 498.97 cfs

Custom cross-section, Length= 151.3' Slope= 0.0250 '/'
Flow calculated by Manning's Subdivision method
Inlet Invert= 169.78', Outlet Invert= 166.00'

Offset (feet)	Elevation (feet)	Chan.Depth (feet)	n	Description
-13.25	5.00	0.00		
-0.75	0.00	5.00	0.070	
0.75	0.00	5.00	0.030	
10.75	5.00	0.00	0.070	

Depth (feet)	End Area (sq-ft)	Perim. (feet)	Storage (cubic-feet)	Discharge (cfs)
0.00	0.0	1.5	0	0.00
5.00	63.8	26.1	9,645	498.97

Reach 3R: Existing Channel



Summary for Reach 5R: 12"

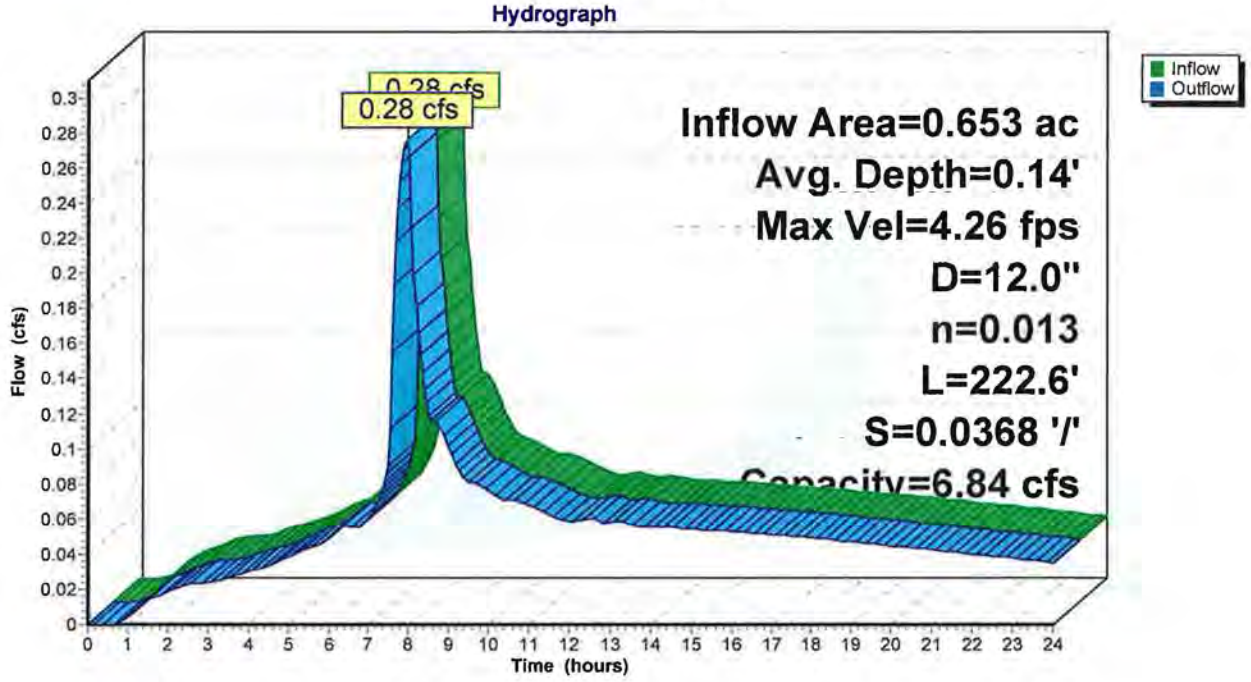
Inflow Area = 0.653 ac, 37.12% Impervious, Inflow Depth > 1.97" for 25-YR event
Inflow = 0.28 cfs @ 7.97 hrs, Volume= 0.107 af
Outflow = 0.28 cfs @ 7.98 hrs, Volume= 0.107 af, Atten= 0%, Lag= 0.6 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.26 fps, Min. Travel Time= 0.9 min
Avg. Velocity = 2.53 fps, Avg. Travel Time= 1.5 min

Peak Storage= 14 cf @ 7.98 hrs, Average Depth at Peak Storage= 0.14'
Defined Flood Depth= 188.13', Capacity at Flood Depth= -5,362.63 cfs
Bank-Full Depth= 1.00', Capacity at Bank-Full= 6.84 cfs

12.0" Diameter Pipe, n= 0.013
Length= 222.6' Slope= 0.0368 '/'
Inlet Invert= 183.50', Outlet Invert= 175.30'

Reach 5R: 12"



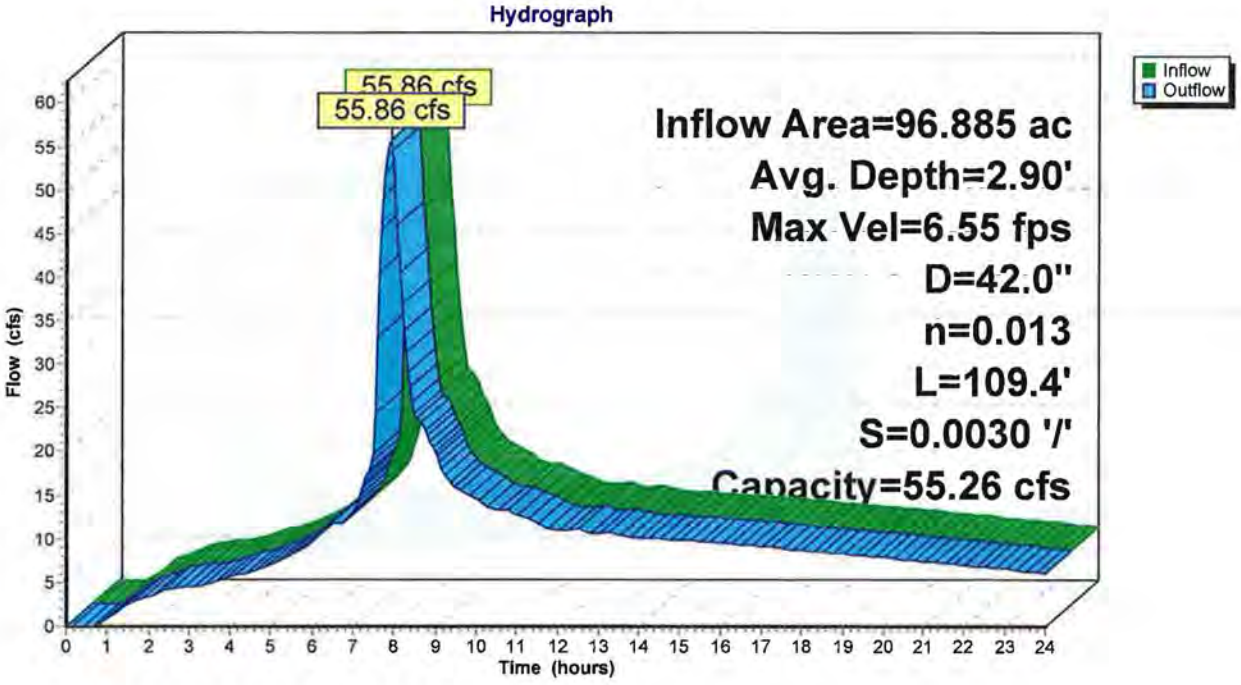
Summary for Reach 6R: 42"

Inflow Area = 96.885 ac, 46.74% Impervious, Inflow Depth > 2.51" for 25-YR event
Inflow = 55.86 cfs @ 7.96 hrs, Volume= 20.262 af
Outflow = 55.86 cfs @ 7.96 hrs, Volume= 20.258 af, Atten= 0%, Lag= 0.3 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 6.55 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 4.21 fps, Avg. Travel Time= 0.4 min

Peak Storage= 934 cf @ 7.96 hrs, Average Depth at Peak Storage= 2.90'
Defined Flood Depth= 185.88', Capacity at Flood Depth= -12,027.04 cfs
Bank-Full Depth= 3.50', Capacity at Bank-Full= 55.26 cfs

42.0" Diameter Pipe, n= 0.013
Length= 109.4' Slope= 0.0030 '/'
Inlet Invert= 173.69', Outlet Invert= 173.36'



Summary for Reach 7R: 42"

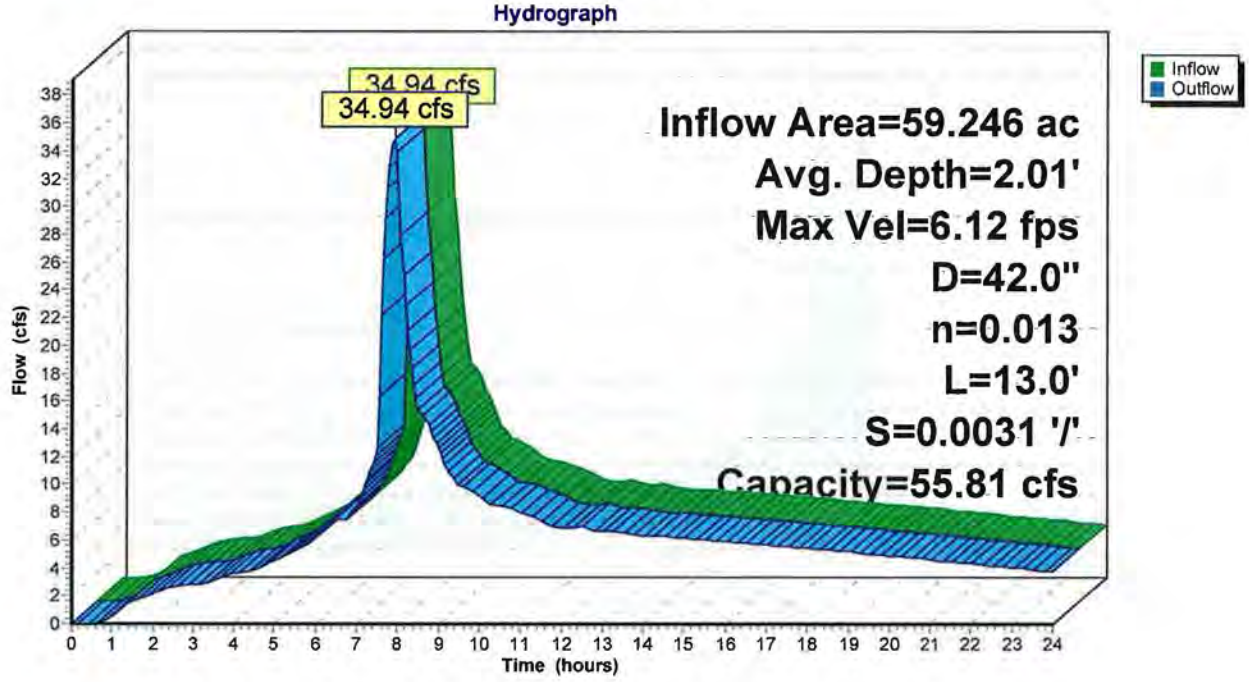
Inflow Area = 59.246 ac, 48.39% Impervious, Inflow Depth > 2.58" for 25-YR event
Inflow = 34.94 cfs @ 7.95 hrs, Volume= 12.736 af
Outflow = 34.94 cfs @ 7.95 hrs, Volume= 12.735 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 6.12 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 3.72 fps, Avg. Travel Time= 0.1 min

Peak Storage= 74 cf @ 7.95 hrs, Average Depth at Peak Storage= 2.01'
Defined Flood Depth= 183.83', Capacity at Flood Depth= -12,009.83 cfs
Bank-Full Depth= 3.50', Capacity at Bank-Full= 55.81 cfs

42.0" Diameter Pipe, n= 0.013
Length= 13.0' Slope= 0.0031 '/'
Inlet Invert= 173.73', Outlet Invert= 173.69'

Reach 7R: 42"



Summary for Reach 8R: 30"

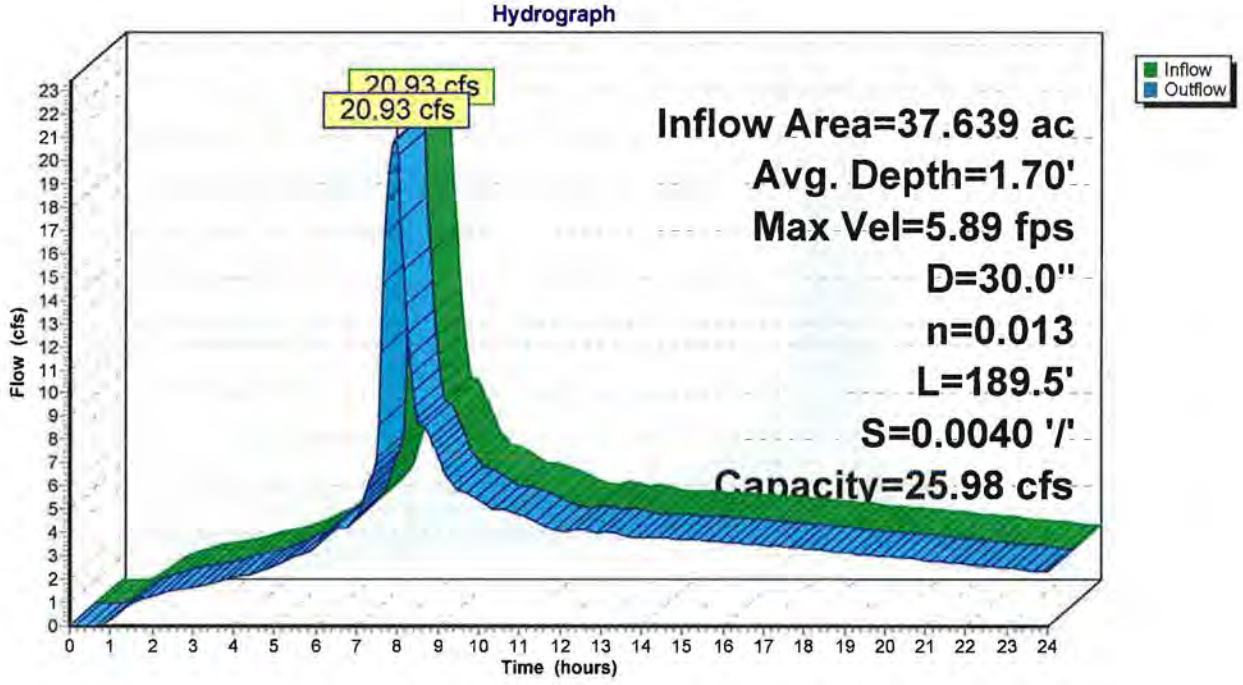
Inflow Area = 37.639 ac, 44.13% Impervious, Inflow Depth > 2.40" for 25-YR event
Inflow = 20.93 cfs @ 7.96 hrs, Volume= 7.530 af
Outflow = 20.93 cfs @ 7.96 hrs, Volume= 7.527 af, Atten= 0%, Lag= 0.4 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.89 fps, Min. Travel Time= 0.5 min
Avg. Velocity = 3.63 fps, Avg. Travel Time= 0.9 min

Peak Storage= 674 cf @ 7.96 hrs, Average Depth at Peak Storage= 1.70'
Defined Flood Depth= 188.59', Capacity at Flood Depth= -8,087.42 cfs
Bank-Full Depth= 2.50', Capacity at Bank-Full= 25.98 cfs

30.0" Diameter Pipe, n= 0.013
Length= 189.5' Slope= 0.0040 '/'
Inlet Invert= 175.45', Outlet Invert= 174.69'

Reach 8R: 30"



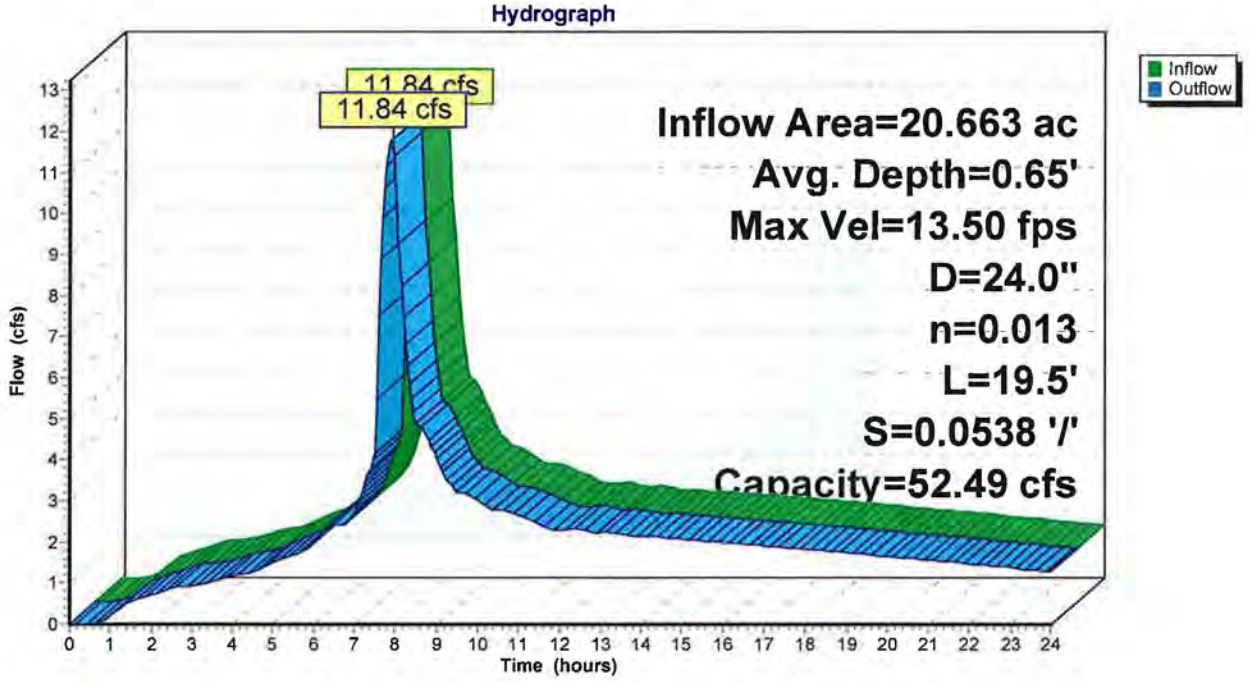
Summary for Reach 9R: 24"

Inflow Area = 20.663 ac, 45.48% Impervious, Inflow Depth > 2.46" for 25-YR event
Inflow = 11.84 cfs @ 7.94 hrs, Volume= 4.228 af
Outflow = 11.84 cfs @ 7.94 hrs, Volume= 4.228 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 13.50 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 7.89 fps, Avg. Travel Time= 0.0 min

Peak Storage= 17 cf @ 7.94 hrs, Average Depth at Peak Storage= 0.65'
Defined Flood Depth= 188.34', Capacity at Flood Depth= -20,470.65 cfs
Bank-Full Depth= 2.00', Capacity at Bank-Full= 52.49 cfs

24.0" Diameter Pipe, n= 0.013
Length= 19.5' Slope= 0.0538 '/'
Inlet Invert= 180.50', Outlet Invert= 179.45'



Summary for Reach 10R: 24"

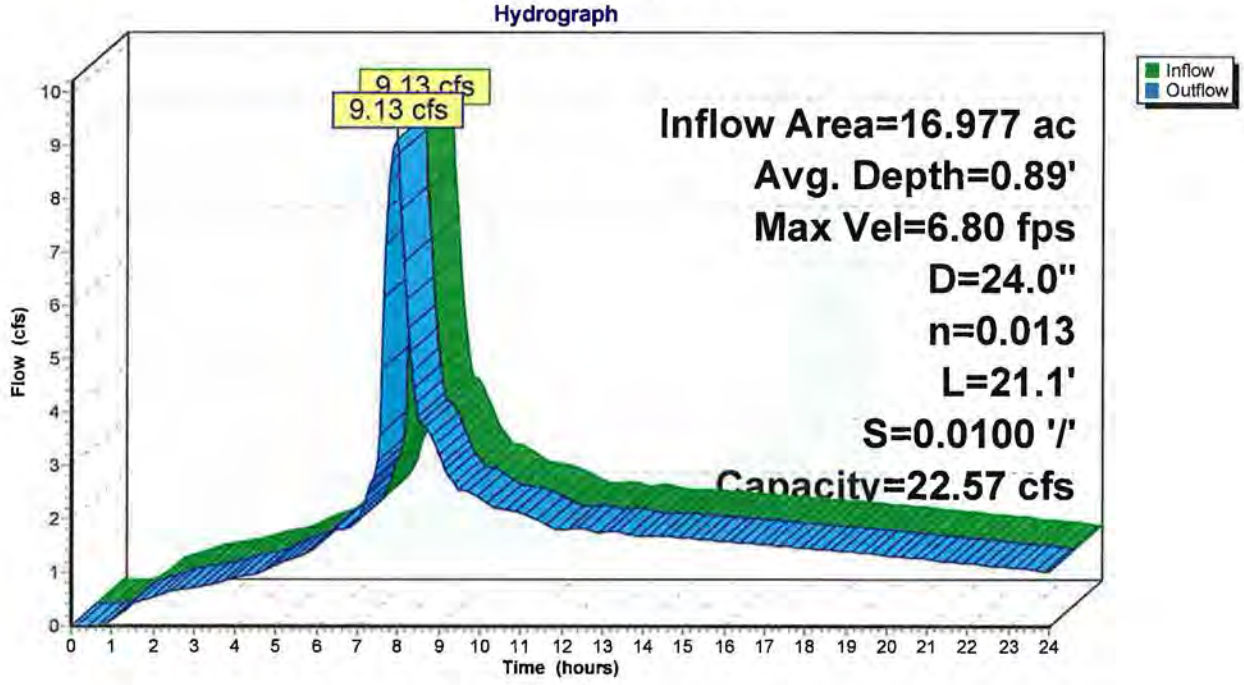
Inflow Area = 16.977 ac, 42.49% Impervious, Inflow Depth > 2.33" for 25-YR event
Inflow = 9.13 cfs @ 7.98 hrs, Volume= 3.301 af
Outflow = 9.13 cfs @ 7.98 hrs, Volume= 3.301 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 6.80 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 4.05 fps, Avg. Travel Time= 0.1 min

Peak Storage= 28 cf @ 7.98 hrs, Average Depth at Peak Storage= 0.89'
Defined Flood Depth= 188.59', Capacity at Flood Depth= -8,812.65 cfs
Bank-Full Depth= 2.00', Capacity at Bank-Full= 22.57 cfs

24.0" Diameter Pipe, n= 0.013
Length= 21.1' Slope= 0.0100 '/'
Inlet Invert= 176.16', Outlet Invert= 175.95'

Reach 10R: 24"



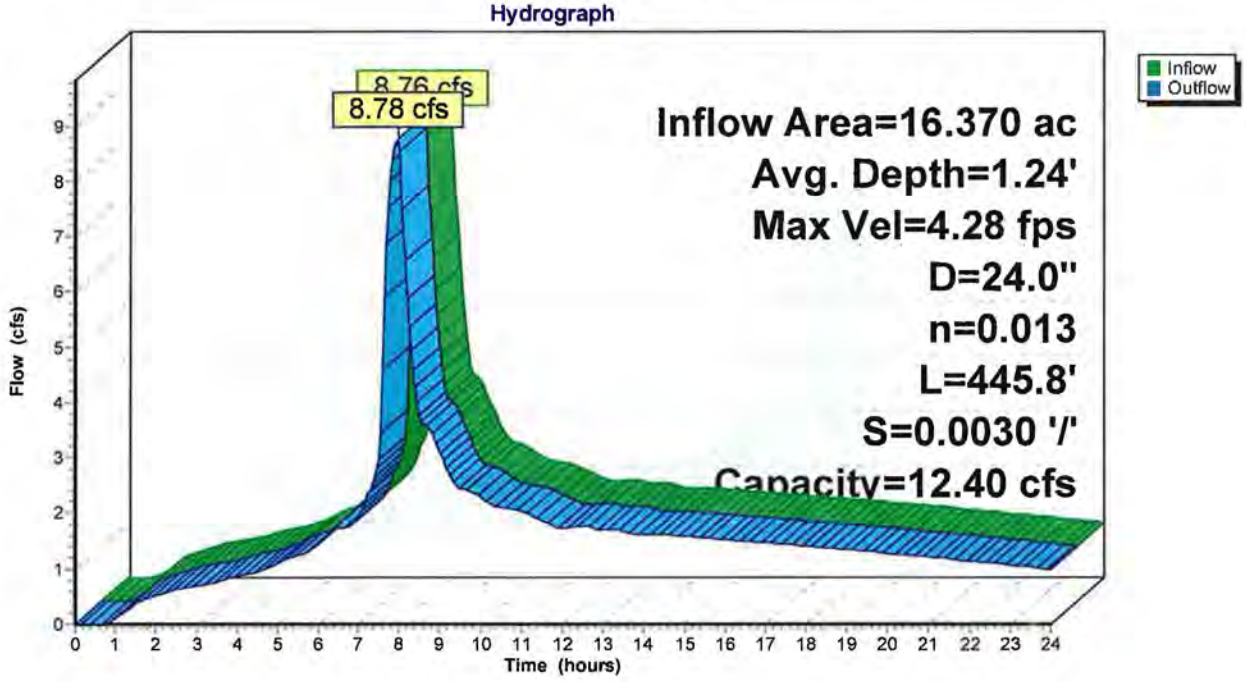
Summary for Reach 11R: 24"

Inflow Area = 16.370 ac, 42.30% Impervious, Inflow Depth > 2.33" for 25-YR event
Inflow = 8.76 cfs @ 7.95 hrs, Volume= 3.179 af
Outflow = 8.78 cfs @ 7.98 hrs, Volume= 3.175 af, Atten= 0%, Lag= 1.3 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.28 fps, Min. Travel Time= 1.7 min
Avg. Velocity = 2.62 fps, Avg. Travel Time= 2.8 min

Peak Storage= 914 cf @ 7.98 hrs, Average Depth at Peak Storage= 1.24'
Defined Flood Depth= 185.29', Capacity at Flood Depth= -4,757.19 cfs
Bank-Full Depth= 2.00', Capacity at Bank-Full= 12.40 cfs

24.0" Diameter Pipe, n= 0.013
Length= 445.8' Slope= 0.0030 '/'
Inlet Invert= 177.70', Outlet Invert= 176.36'



Summary for Reach 12R: 15"

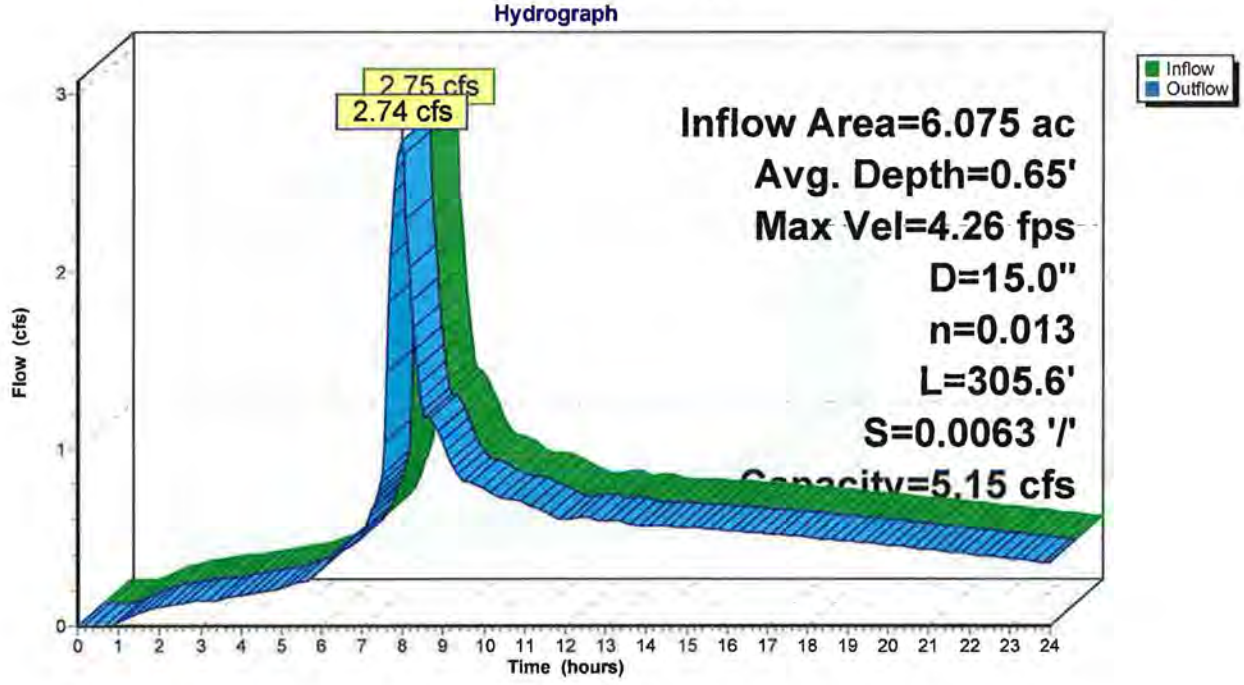
Inflow Area = 6.075 ac, 22.55% Impervious, Inflow Depth > 2.00" for 25-YR event
Inflow = 2.75 cfs @ 7.98 hrs, Volume= 1.013 af
Outflow = 2.74 cfs @ 7.98 hrs, Volume= 1.012 af, Atten= 0%, Lag= 0.3 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.26 fps, Min. Travel Time= 1.2 min
Avg. Velocity = 2.55 fps, Avg. Travel Time= 2.0 min

Peak Storage= 197 cf @ 7.98 hrs, Average Depth at Peak Storage= 0.65'
Defined Flood Depth= 186.10', Capacity at Flood Depth= -3,188.63 cfs
Bank-Full Depth= 1.25', Capacity at Bank-Full= 5.15 cfs

15.0" Diameter Pipe, n= 0.013
Length= 305.6' Slope= 0.0063 '/'
Inlet Invert= 180.39', Outlet Invert= 178.45'

Reach 12R: 15"



Summary for Reach 13R: 15"

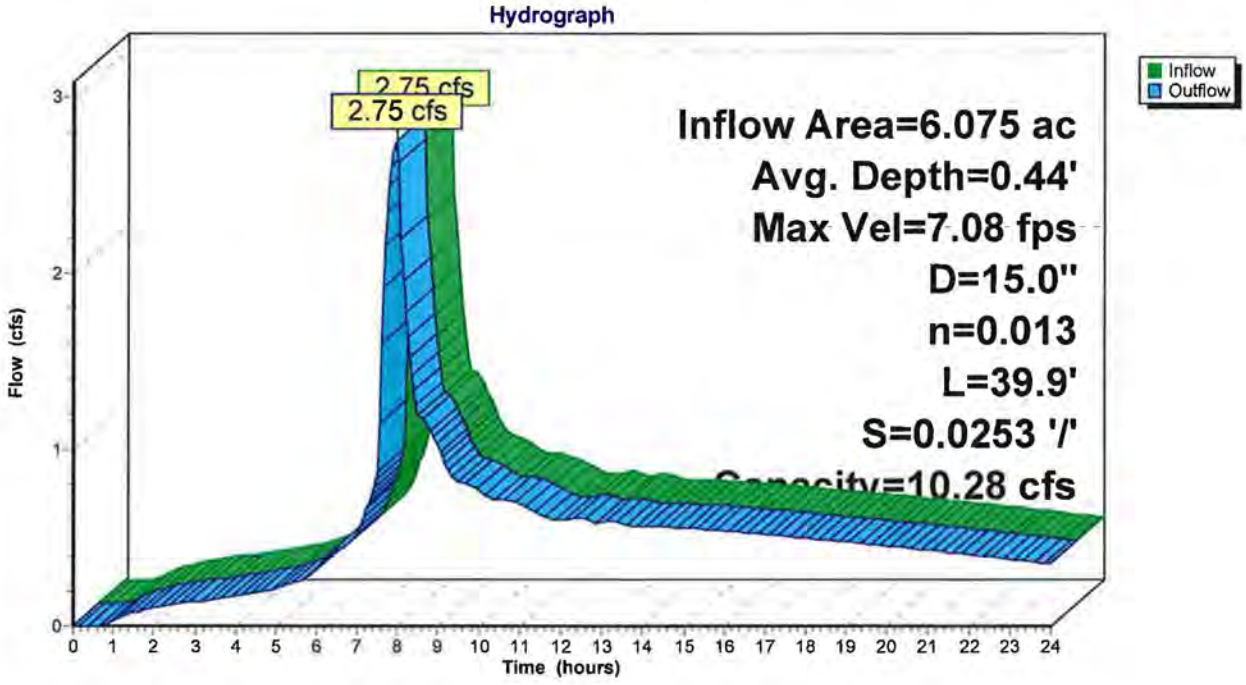
Inflow Area = 6.075 ac, 22.55% Impervious, Inflow Depth > 2.00" for 25-YR event
Inflow = 2.75 cfs @ 7.98 hrs, Volume= 1.013 af
Outflow = 2.75 cfs @ 7.98 hrs, Volume= 1.013 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 7.08 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 4.16 fps, Avg. Travel Time= 0.2 min

Peak Storage= 15 cf @ 7.98 hrs, Average Depth at Peak Storage= 0.44'
Bank-Full Depth= 1.25', Capacity at Bank-Full= 10.28 cfs

15.0" Diameter Pipe, n= 0.013
Length= 39.9' Slope= 0.0253 '/'
Inlet Invert= 181.60', Outlet Invert= 180.59'

Reach 13R: 15"



Summary for Reach WQ: WQ Swale

Inflow Area = 97.539 ac, 46.67% Impervious, Inflow Depth > 0.90" for 25-YR event
Inflow = 7.72 cfs @ 7.96 hrs, Volume= 7.340 af
Outflow = 7.65 cfs @ 8.02 hrs, Volume= 7.295 af, Atten= 1%, Lag= 3.6 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 0.44 fps, Min. Travel Time= 7.3 min
Avg. Velocity = 0.33 fps, Avg. Travel Time= 9.6 min

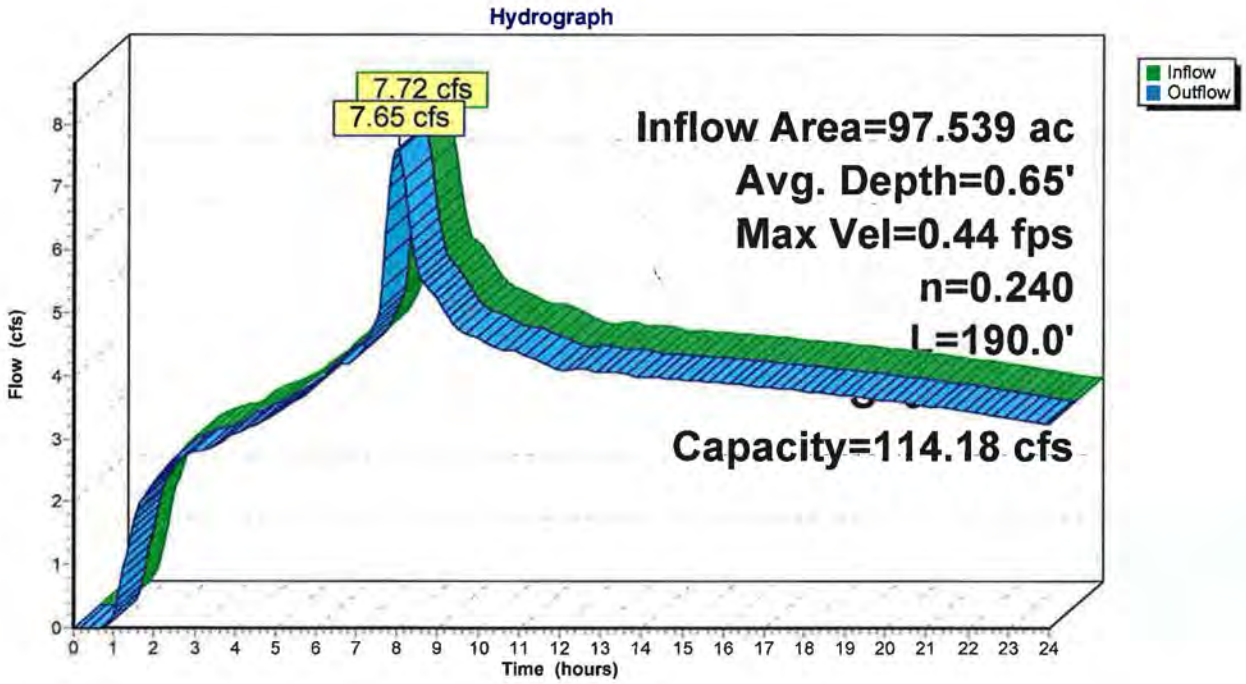
Peak Storage= 3,341 cf @ 8.02 hrs, Average Depth at Peak Storage= 0.65'
Bank-Full Depth= 3.00', Capacity at Bank-Full= 114.18 cfs

Custom cross-section, Length= 190.0' Slope= 0.0100 '/' (101 Elevation Intervals)
Constant n= 0.240
Inlet Invert= 172.16', Outlet Invert= 170.26'

Offset (feet)	Elevation (feet)	Chan.Depth (feet)
-21.25	3.00	0.00
-16.25	1.00	2.00
-12.25	0.00	3.00
12.25	0.00	3.00
16.25	1.00	2.00
21.25	3.00	0.00

Depth (feet)	End Area (sq-ft)	Perim. (feet)	Storage (cubic-feet)	Discharge (cfs)
0.00	0.0	24.5	0	0.00
1.00	28.5	32.7	5,415	16.09
3.00	103.5	43.5	19,665	114.18

Reach WQ: WQ Swale



Summary for Reach WQMH: WQ Manhole

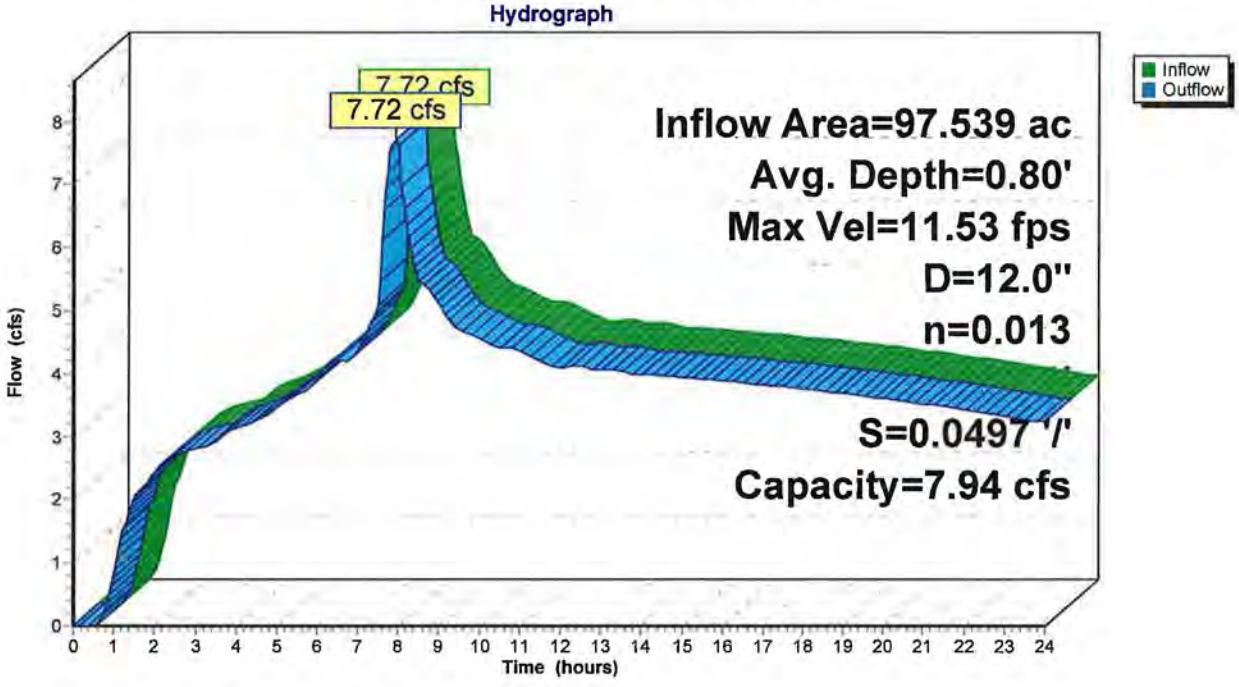
Inflow Area = 97.539 ac, 46.67% Impervious, Inflow Depth > 0.90" for 25-YR event
Inflow = 7.72 cfs @ 7.96 hrs, Volume= 7.340 af
Outflow = 7.72 cfs @ 7.96 hrs, Volume= 7.340 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 11.53 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 9.84 fps, Avg. Travel Time= 0.0 min

Peak Storage= 12 cf @ 7.96 hrs, Average Depth at Peak Storage= 0.80'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 7.94 cfs

12.0" Diameter Pipe, n= 0.013
Length= 18.1' Slope= 0.0497 '/'
Inlet Invert= 172.65', Outlet Invert= 171.75'

Reach WQMH: WQ Manhole



Summary for Pond 1P: EX. CMP & NEW INLET

Inflow Area = 99.494 ac, 45.87% Impervious, Inflow Depth > 2.47" for 25-YR event
Inflow = 56.50 cfs @ 7.98 hrs, Volume= 20.494 af
Outflow = 54.15 cfs @ 8.05 hrs, Volume= 20.493 af, Atten= 4%, Lag= 4.2 min
Primary = 25.76 cfs @ 8.05 hrs, Volume= 17.288 af
Secondary = 28.39 cfs @ 8.05 hrs, Volume= 3.206 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 165.55' @ 8.05 hrs Surf.Area= 4,391 sf Storage= 5,014 cf

Plug-Flow detention time= 0.2 min calculated for 20.493 af (100% of inflow)
Center-of-Mass det. time= 0.2 min (722.8 - 722.6)

Volume	Invert	Avail.Storage	Storage Description
#1	160.00'	90,422 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

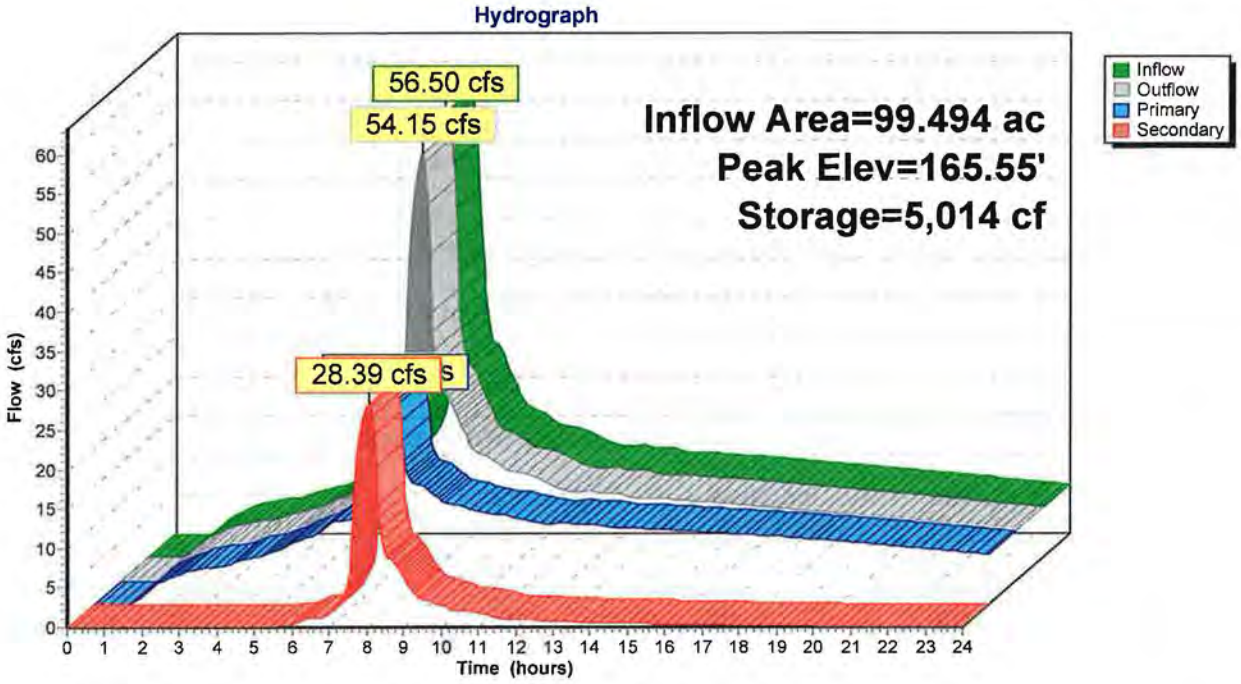
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
160.00	0	0	0
161.00	19	10	10
162.00	109	64	74
163.00	415	262	336
164.00	948	682	1,017
165.00	2,992	1,970	2,987
166.00	5,541	4,267	7,254
167.00	8,174	6,858	14,111
168.00	11,058	9,616	23,727
169.00	13,793	12,426	36,153
170.00	16,474	15,134	51,286
171.00	19,548	18,011	69,297
172.00	22,701	21,125	90,422

Device	Routing	Invert	Outlet Devices
#1	Primary	160.04'	**21.0" Vert. EX. 21" CMP, Orifice Inlet** C= 0.620
#2	Secondary	161.25'	**24.0" Vert. 24" CPP, Orifice Inlet** C= 0.620
#3	Device 1	160.04'	**4.00' x 4.00' Horiz. 4'x4' Grate** Limited to weir flow C= 0.620
#4	Device 2	161.25'	**4.00' W x 4.00' H Vert. 4'x4' Grate** C= 0.620

Primary OutFlow Max=25.76 cfs @ 8.05 hrs HW=165.55' (Free Discharge)
↑—**1=EX. 21" CMP, Orifice Inlet** (Orifice Controls 25.76 cfs @ 10.71 fps)
↑—**3=4'x4' Grate** (Passes 25.76 cfs of 186.84 cfs potential flow)

Secondary OutFlow Max=28.39 cfs @ 8.05 hrs HW=165.55' (Free Discharge)
↑—**2=24" CPP, Orifice Inlet** (Orifice Controls 28.39 cfs @ 9.04 fps)
↑—**4=4'x4' Grate** (Passes 28.39 cfs of 116.08 cfs potential flow)

Pond 1P: EX. CMP & NEW INLET



Summary for Pond 4P: Flow Splitter

Inflow Area = 97.539 ac, 46.67% Impervious, Inflow Depth > 2.51" for 25-YR event
Inflow = 56.14 cfs @ 7.96 hrs, Volume= 20.365 af
Outflow = 56.14 cfs @ 7.96 hrs, Volume= 20.365 af, Atten= 0%, Lag= 0.0 min
Primary = 7.72 cfs @ 7.96 hrs, Volume= 7.340 af
Secondary = 48.41 cfs @ 7.96 hrs, Volume= 13.025 af

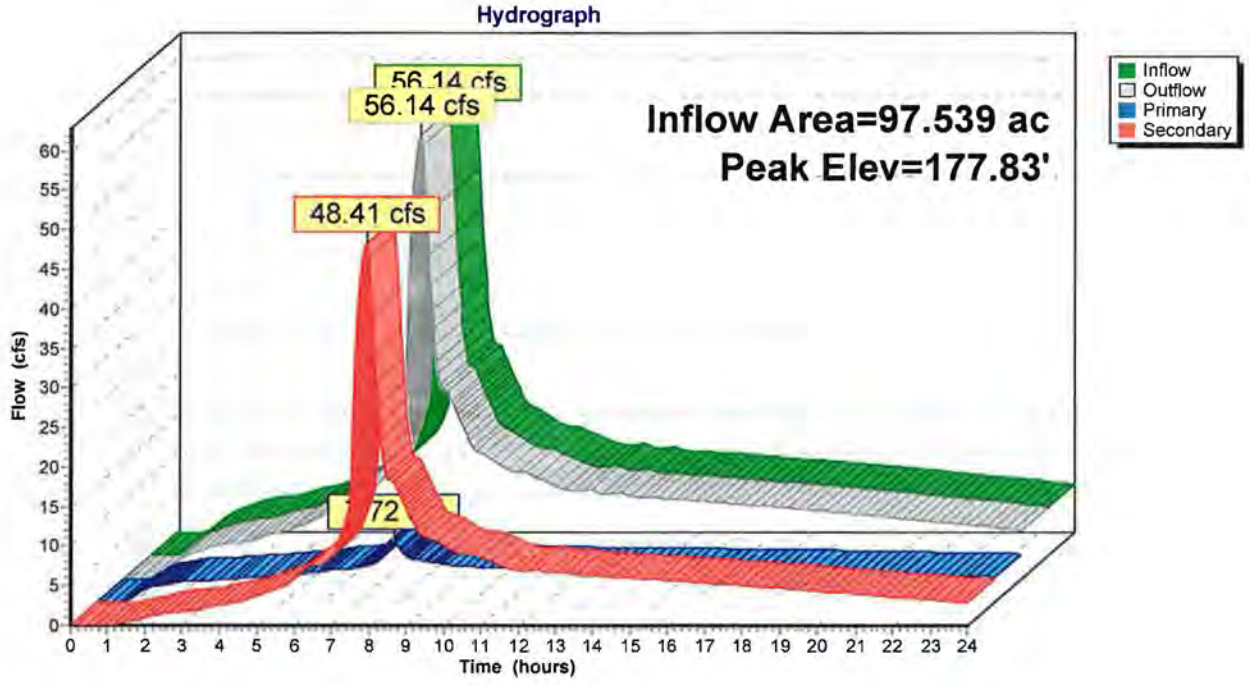
Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 177.83' @ 7.96 hrs
Flood Elev= 179.40'

Device	Routing	Invert	Outlet Devices
#1	Secondary	173.61'	**36.0" x 56.3' long Culvert** RCP, square edge headwall, Ke= 0.500 Outlet Invert= 173.44' S= 0.0030 '/' Cc= 0.900 n= 0.013
#2	Primary	173.16'	**12.0" x 18.0' long Culvert** CPP, square edge headwall, Ke= 0.500 Outlet Invert= 172.85' S= 0.0172 '/' Cc= 0.900 n= 0.013

Primary OutFlow Max=7.72 cfs @ 7.96 hrs HW=177.83' TW=173.45' (Dynamic Tailwater)
↑—**2=Culvert** (Inlet Controls 7.72 cfs @ 9.83 fps)

Secondary OutFlow Max=48.35 cfs @ 7.96 hrs HW=177.83' TW=174.47' (Dynamic Tailwater)
↑—**1=Culvert** (Barrel Controls 48.35 cfs @ 6.84 fps)

Pond 4P: Flow Splitter



APPENDIX E
CURVE NUMBERS FROM TECHNICAL RELEASE 55 URBAN HYDROLOGY FOR SMALL WATERSHED

Table 2-2a Runoff curve numbers for urban areas [1]

Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	Average percent impervious area [2]	A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

[1] Average runoff condition, and $I_a = 0.2S$.

[2] The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.

[3] CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.

[4] Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.

[5] Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

Table 2-2b Runoff curve numbers for cultivated agricultural lands [1]

Cover description			Curve numbers for hydrologic soil group			
Cover type	Treatment [2]	Hydrologic condition [3]	A	B	C	D
Fallow	Bare soil	—	77	86	91	94
	Crop residue cover (CR)	Poor	76	85	90	93
		Good	74	83	88	90
Row crops	Straight row (SR)	Poor	72	81	88	91
		Good	67	78	85	89
	SR + CR	Poor	71	80	87	90
		Good	64	75	82	85
	Contoured (C)	Poor	70	79	84	88
		Good	65	75	82	86
	C + CR	Poor	69	78	83	87
		Good	64	74	81	85
	Contoured & terraced (C&T)	Poor	66	74	80	82
		Good	62	71	78	81
	C&T+ CR	Poor	65	73	79	81
		Good	61	70	77	80
Small grain	SR	Poor	65	76	84	88
		Good	63	75	83	87
	SR + CR	Poor	64	75	83	86
		Good	60	72	80	84
	C	Poor	63	74	82	85
		Good	61	73	81	84
	C + CR	Poor	62	73	81	84
		Good	60	72	80	83
	C&T	Poor	61	72	79	82
		Good	59	70	78	81
	C&T+ CR	Poor	60	71	78	81
		Good	58	69	77	80
Close-seeded or broadcast legumes or rotation meadow	SR	Poor	66	77	85	89
		Good	58	72	81	85
	C	Poor	64	75	83	85
		Good	55	69	78	83
	C&T	Poor	63	73	80	83
		Good	51	67	76	80

[1] Average runoff condition, and I_a=0.2S

[2] Crop residue cover applies only if residue is on at least 5% of the surface throughout the year.

[3] Hydraulic condition is based on combination factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or close-seeded legumes, (d) percent of residue cover on the land surface (good ≥ 20%), and (e) degree of surface roughness.

Poor: Factors impair infiltration and tend to increase runoff.

Good: Factors encourage average and better than average infiltration and tend to decrease runoff.

Table 2-2c Runoff curve numbers for other agricultural lands [1]

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range—continuous forage for grazing. [2]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay.	—	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element. [3]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30 [4]	48	65	73
Woods—grass combination (orchard or tree farm). [5]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods. [6]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30 [4]	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	—	59	74	82	86

1 Average runoff condition, and $I_a = 0.2S$.

2 *Poor:* <50%) ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: > 75% ground cover and lightly or only occasionally grazed.

3 *Poor:* <50% ground cover.
Fair: 50 to 75% ground cover.
Good: >75% ground cover.

4 Actual curve number is less than 30; use CN = 30 for runoff computations.

5 CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

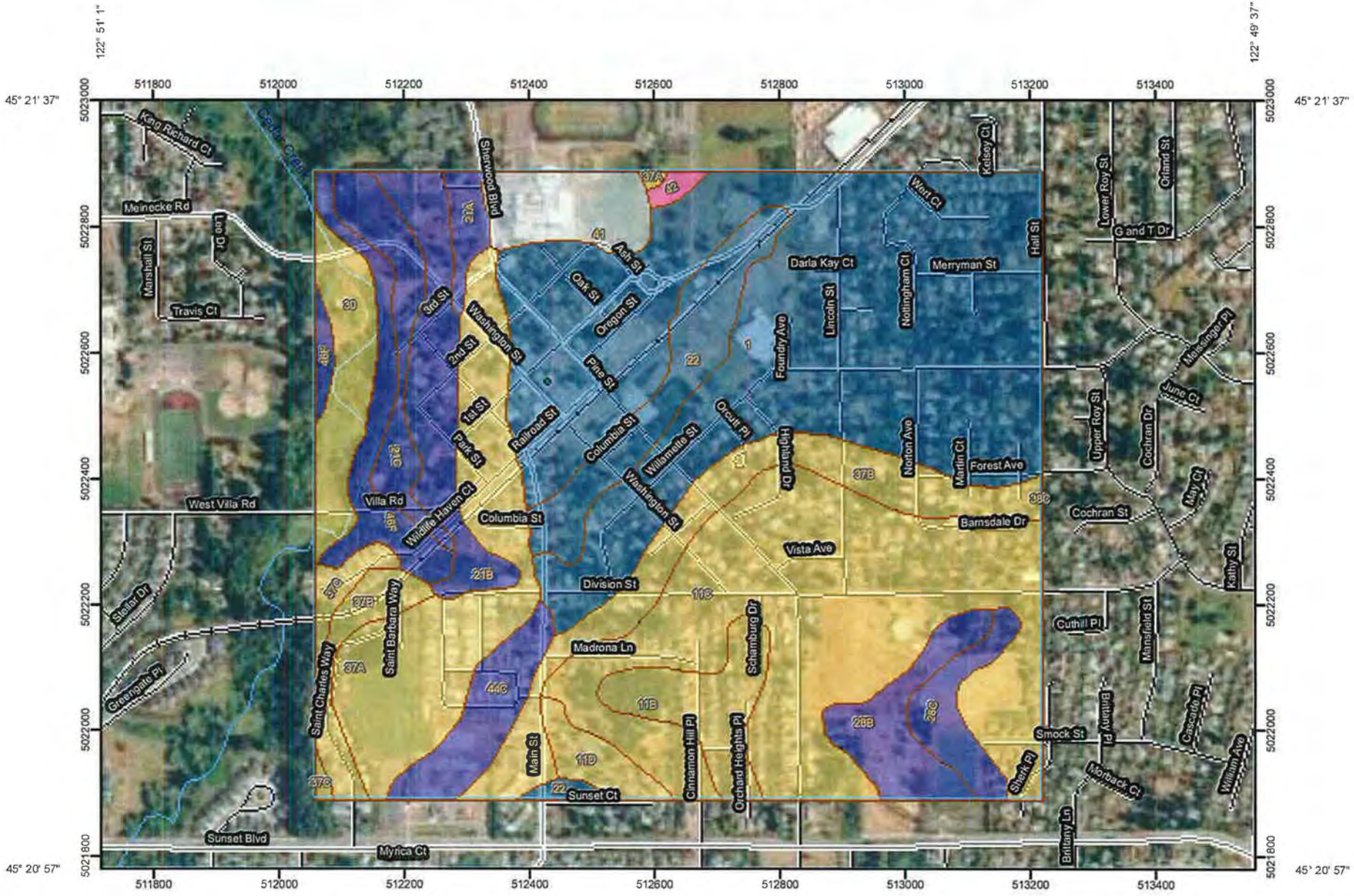
6 *Poor:* Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

Table 2-2d Runoff curve numbers for arid and semiarid rangelands [1]

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition [2]	A [3]	B	C	D
Herbaceous—mixture of grass, weeds, and low-growing brush, with brush the minor element.	Poor		80	87	93
	Fair		71	81	89
	Good		62	74	85
Oak-aspen—mountain brush mixture of oak brush, aspen, mountain mahogany, bitter brush, maple, and other brush.	Poor		66	74	79
	Fair		48	57	63
	Good		30	41	48
Pinyon-juniper—pinyon, juniper, or both; grass understory.	Poor		75	85	89
	Fair		58	73	80
	Good		41	61	71
Sagebrush with grass understory.	Poor		67	80	85
	Fair		51	63	70
	Good		35	47	55
Desert shrub—major plants include saltbush, greasewood, creosotebush, blackbrush, bursage, palo verde, mesquite, and cactus.	Poor	63	77	85	88
	Fair	55	72	81	86
	Good	49	68	79	84

1 Average runoff condition, and I_a = 0.2S. For range in humid regions, use table 2-2c.
2 Poor: <30% ground cover (litter, grass, and brush overstory).
Fair: 30 to 70% ground cover.
Good: > 70% ground cover.
3 Curve numbers for group A have been developed only for desert shrub.

APPENDIX F
USDA SOIL SURVEY OF WASHINGTON COUNTY



Map Scale: 1:8,740 if printed on A size (8.5" x 11") sheet.

N

Meters
0 100 200 400 600

Feet
0 450 900 1,800 2,700

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Units

Soil Ratings

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Political Features

- Cities

Water Features

- Streams and Canals

Transportation

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

MAP INFORMATION

Map Scale: 1:8,740 if printed on A size (8.5" × 11") sheet.

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 accurate map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 10N NAD83

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

Soil Survey Area: Washington County, Oregon
Survey Area Data: Version 10, Aug 20, 2012

Date(s) aerial images were photographed: 8/4/2005

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

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Washington County, Oregon (OR067)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
1	Aloha silt loam	C/D	89.8	31.3%
11B	Cornelius and Kinton silt loams, 2 to 7 percent slopes	C	8.4	2.9%
11C	Cornelius and Kinton silt loams, 7 to 12 percent slopes	C	56.4	19.7%
11D	Cornelius and Kinton silt loams, 12 to 20 percent slopes	C	3.5	1.2%
21A	Hillsboro loam, 0 to 3 percent slopes	B	2.5	0.9%
21B	Hillsboro loam, 3 to 7 percent slopes	B	11.8	4.1%
21C	Hillsboro loam, 7 to 12 percent slopes	B	7.4	2.6%
22	Huberly silt loam	C/D	12.2	4.3%
28B	Laurelwood silt loam, 3 to 7 percent slopes	B	7.7	2.7%
28C	Laurelwood silt loam, 7 to 12 percent slopes	B	5.2	1.8%
30	McBee silty clay loam	C	8.5	3.0%
37A	Quatama loam, 0 to 3 percent slopes	C	24.9	8.7%
37B	Quatama loam, 3 to 7 percent slopes	C	21.7	7.6%
37C	Quatama loam, 7 to 12 percent slopes	C	2.5	0.9%
38C	Saum silt loam, 7 to 12 percent slopes	C	0.1	0.0%
41	Urban land		7.6	2.7%
42	Verboort silty clay loam	D	0.8	0.3%
44C	Willamette silt loam, 7 to 12 percent slopes	B	7.2	2.5%
46F	Xerochrepts and Haploxerolls, very steep	B	8.8	3.1%
Totals for Area of Interest			**286.9**	**100.0%**

Description

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

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

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

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

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

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

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

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: *None Specified*

Tie-break Rule: Higher