ENGINEERING REPORT

BUFFALO SEWER AUTHORITY

WILLERT PARK GREEN INFRASTRUCTURE

FEBRUARY 2017

Prepared For:

BUFFALO SEWER AUTHORITY

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Prepared By:

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1. EXECUTIVE SUMMARY

This engineering report describes the design of the Willert Park Green Infrastructure (GI) project. This design includes construction of green infrastructure practices at three sites in the Willert Park neighborhood to control runoff to Sewer Patrol Point (SPP) 281. A combination of bioretention, infiltration, porous pavement and impervious area reduction have been proposed to meet the Buffalo Sewer Authority (BSA) goal to control 20% of the impervious area that contributes to SPP 281. By meeting this goal of the Long Term Control Plan (LTCP), BSA will limit the frequency, duration and volume of combined sewer overflows which will then improve water quality in the City of Buffalo.

Wendel has developed a detailed design of GI practices to control runoff from 26.1 acres in the SPP 2812 sewer shed. The proposed projects at three sites in the Willert Park neighborhood will have a dramatic impact on water quality in the City of Buffalo. Using HydroCAD modeling, Wendel can confirm that the GI practices used will control 100% of the volume from the 90th percentile storm (0.95" of rain) while also providing close to 40,000 ft3 of water quality volume.

Construction of this project will occur this summer and it is anticipated that final work will be complete by spring of 2018. The total cost of this project has been estimated at $3,585,000.

2. PROJECT OBJECTIVES

The Willert Park Green Infrastructure Improvement Project was developed in accordance with the BSA's Long Term Control Plan (LTCP). Under the recommended alternative of the Long Term Control Plan (LTCP), the Buffalo Sewer Authority (BSA) has agreed to a green infrastructure target of 20% impervious surface control in the drainage area that contributes to Sewer Patrol Point (SPP) 281. An SPP is a control structure that diverts flow to combined sewer overflows under high flow conditions. The drainage area upstream of a SPP 281 is shown in Figure 2.1 and this area roughly represents the Willert Park neighborhood in the City of Buffalo. Based on modeling completed as part of the LTCP, providing this level of control would limit frequency, duration, and volume of combined sewer overflows to a level recommended in the LTCP. The project plans and specifications provided also include sewer separation work on Miami and Louisiana Streets in South Buffalo. This work is not part of the EFC submittal, but will be included in this construction project.

Figure 2.1: SPP 281 Drainage Area in the City of Buffalo

3. EXISTING CONDITIONS

Three different sites make up the Willert Park Green Infrastructure project in the City of Buffalo. These sites include:

1) The Pratt Willert Community Center at 422 Pratt Street near the intersection of Pratt Street and Genesee Street.
2) The JFK Community Center at the Intersection of Clinton Avenue and Hickory Street.
3) William Street between Michigan Avenue and Jefferson Avenue in the City of Buffalo

Figure 3.1 shows the general location of each of the three sites in the City of Buffalo.

Land use for each of the three sites is fairly straight forward. At the two community centers, the properties owned by the City of Buffalo include the community center, parking lots, and some grassed areas. William Street is a public road maintained by the City of Buffalo Department of Public Works. Utility concerns at the community centers are minimal, but some utility avoidance/relocation was included in the design of green infrastructure on William Street.

Soil borings, pavement cores, and infiltration tests were done at each of the project sites. A copy of this geotechnical report with this data is included as Appendix A of this report. No bedrock or water table elevations at locations that would hinder GI were found. Appendix A also includes USDA soil classification reports for these sites. The report shows that “Urban Land” soils were found throughout with designation of Class D soils. Infiltration tests completed confirm low levels of infiltration as one might expect from Class D urban soils.

No floodplains or wetlands are located at these sites. There are no identified hot spots, contamination or brownfields and testing will be completed on soils removed from the site to confirm that exported soils are clean. No threatened or endangered species are present at the three sites and the State Historic Program Office (SHPO) provided correspondence (Appendix B) that confirmed that while these sites were in a archaeologically sensitive area, no historic or culturally significant areas will be impacted by this project.

The BSA has completed SEQR for this project and this was submitted to EFC under a separate cover.

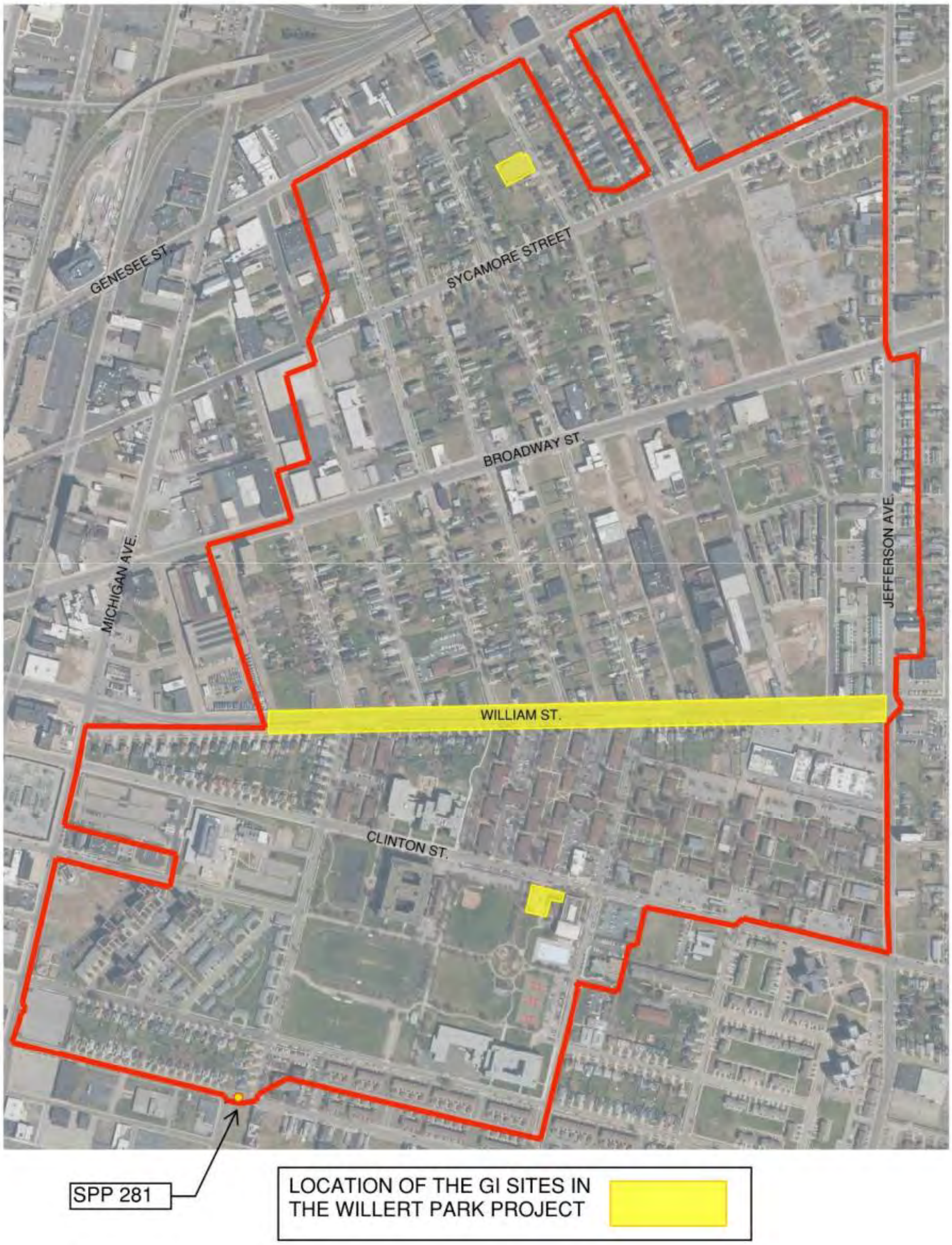


Figure 3.1: General Location of Each of the Three Sites in the Willert Park GI Project

4. PROJECT DESCRIPTION

At the three sites chosen for GI in the Willert Park neighborhood, a combination of bioretention, impervious area reduction, infiltration/storage galleries, and porous pavement will be used to provide stormwater volume reduction and water quality treatment. The use of these techniques will meet BSA's goal of controlling 20% of the impervious area in SPP 281 and allow this sewer shed to meet the goal provided in the approved LTCP. Providing GI in this sewer shed will reduce or eliminate the need for traditional grey infrastructure improvements in this area.

JFK Community Center

At the JFK Community Center, the runoff from the parking lot drains into three catch basins at the north edge of the parking lot. These catch basins then discharge directly to the combined sewer in Clinton Street. Figure 4.1 shows a plan view of this site with a delineation of the drainage area. In the proposed project, the three catch basins are removed and runoff from the parking lot flows into two bioretention areas constructed in a grassed area between the parking lot and street. The existing condition of this parking lot and the proposed design are shown on Sheet JF-C401 of the design plans.

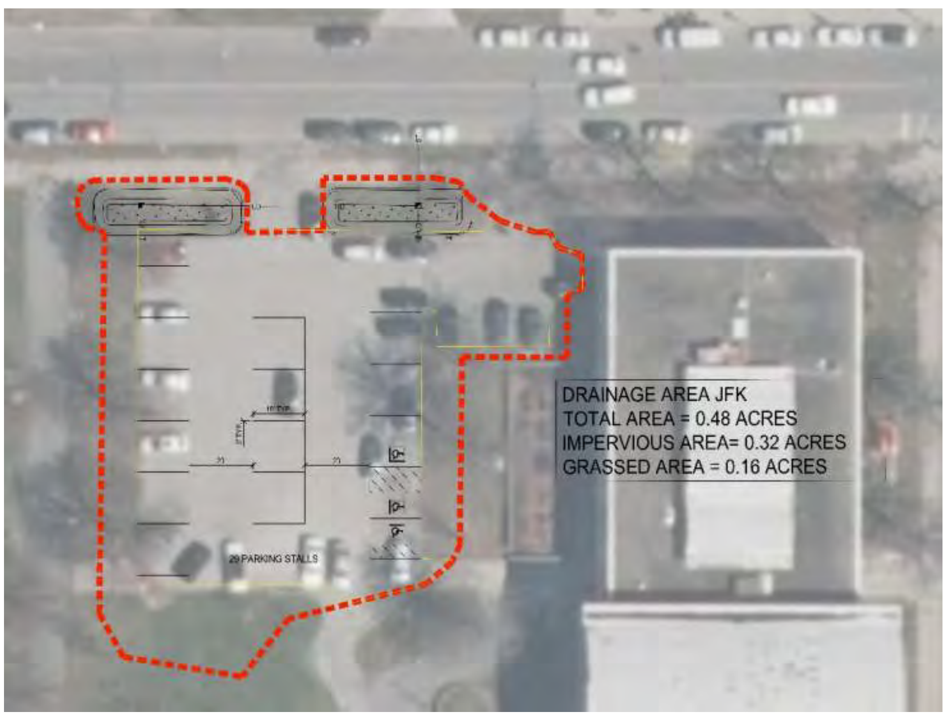


Figure 4.1: Plan View of the JFK Community Center and Drainage Area

The NYSDEC Runoff Reduction Worksheets were used to compare the design provided to the water quality volume (WQv) target for this site. Based on the drainage areas provided in Figure 4.1, a target WQv of 1,076 ft3 is calcuated. The bioretention areas shown in the plan provide 1,080 ft3 of WQv. Therefore, this design provides 100% control of the WQv target. The runoff reduction worksheets and a HydroCAD model of the bioretention area is provided in Appendix C. Renderings of the existing JFK Community Center and how it will look after proposed improvements are provided as Figures 4.2 and 4.3.

Figure 4.2: Existing Conditions at the JFK Community Center

Figure 4.3: Proposed GI Improvements at the JFK Community Center

Pratt Willert Community Center

At the Pratt Willert Community Center, the runoff for the parking lot flows into a single catch basin at the southeast edge of the parking lot. This catch basin then discharges directly into the combined sewer in Pratt Street. Figure 4.4 shows a plan view of this site with a delineation of the drainage area. In the proposed project, the catch basin is removed and runoff from the parking lot flows into a bioretention area constructed in the corner of the existing parking lot. The existing condition of this parking lot and the proposed design are shown on Sheet PW-C401 of the design plans.

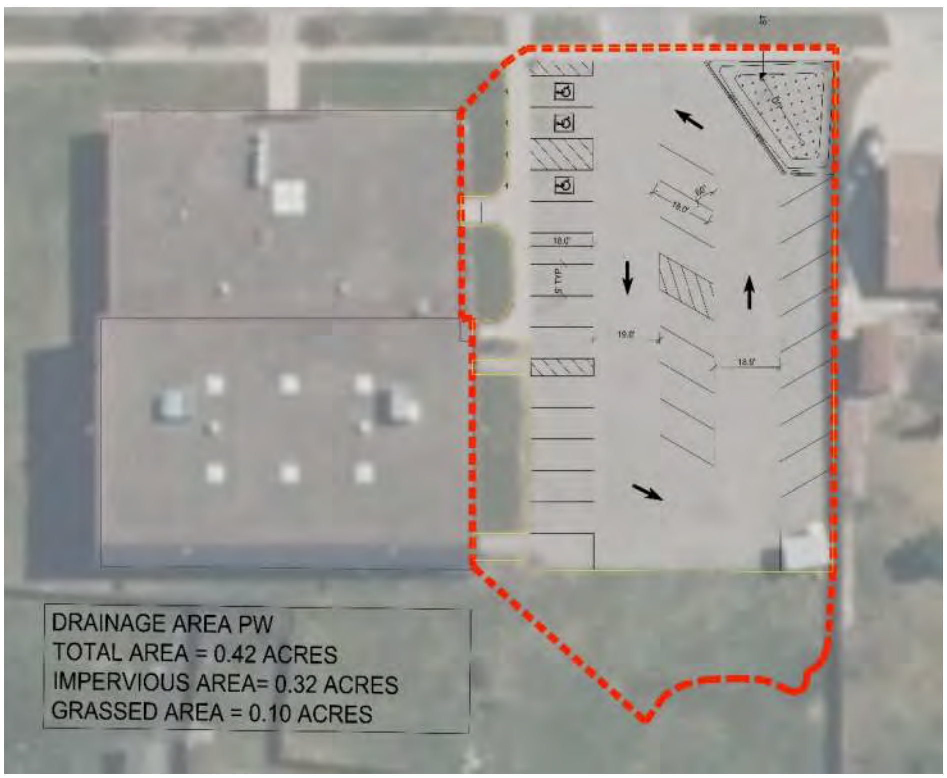


Figure 4.4: Plan View of the Pratt Willert Community Center and Drainage Area

The NYSDEC Runoff Reduction Worksheets were used to compare the design provided to the water quality volume (WQv) target for this site. Based on the drainage areas provided in Figure 4.4, a target WQv of 1,066 ft3 is calculated. The bioretention area shown on the plan provides 800 ft3 of WQv. Therefore, this design provides 75% control of the WQv target using traditional GI methods. The other 25% of the WQv target is treated in a stone infiltration gallery under the bioretention media (see Sheet G943). Even with almost no infiltration (0.2 in/hour), this stone infiltration gallery will be drained in under 48 hours. The runoff reduction worksheets and a HydroCAD model of the bioretention area and stone infiltration gallery is provided in Appendix C.

A design that met 100% of the WQv target in just the bioretention area could have been developed, but it would have further reduced parking at the community center. Therefore, the design with bioretention and infiltration was chosen to balance these competing requirements at the Pratt Willert Community Center. Renderings of the existing Pratt Willert Community Center and how is will look after proposed improvements are provided as Figures 4.5 and 4.6.

Figure 4.5: Existing Conditions at the Pratt Willert Community Center

Figure 4.6: Proposed GI Improvements at the Pratt Willert Community Center

William Street

Existing drainage conditions on William Street provide a unique opportunity to control over 25 acres in SPP 281 as shown in Figures 4.11 and 4.12 which are provided at the end of this section. Four different GI practices were used to control and treat runoff along William Street between Michigan and Jefferson Avenues in the City of Buffalo including impervious area reduction, porous pavement, bioretention, and infiltration.

The first GI practice used is impervious area reduction. Current traffic counts on William Street do not warrant more than a single lane of travel in each direction. Therefore, the median of William Street will be expanded from 15’ to approximately 38’ along this corridor. Expanding this median also allows us to expand a small pocket park (Jesse Clipper Park) at the west end of this project area. Together, expanding the median and park leads to a 1.53 acre reduction in impervious area along William Street. This impervious area reduction is shown in Figure 4.13 and can also been seen on Sheets WL-C401 to WL-C408 of the design plans. 5,012 ft3 of WQv is provided from this impervious area reduction as shown in Table 1.

Table 1: WQv provided from a reduction of impervious area (areas in acres)

Scenario	Calculating WQv		
	Total Area	Impervious Area	WQv (ft3)
Existing Conditions	25.20	13.47	46,151
Proposed Conditions	23.67	11.94	41,139
Total WQv Provided			5,012

As shown in the drainage delineation figures (Figure 4.11 and 4.12), large drainage areas from streets that connect on the north flow into the combined sewer on William Street. To control stormwater from these areas and the north edge of William Street, porous pavement will be used in the north parking lane of William Street. A HydroCAD model of these drainage areas and the porous pavement storage areas was created and can be found in Appendix C. The HydroCAD model shows that the entire WQv target is stored in the stone infiltration gallery below the underdrain, but due to some differences in the model techniques and equations used, the NYSDEC Runoff Reduction Sheets show a slightly lower capture rate and WQv treated. We believe that this is acceptable as we still treat over 75% of the WQv target even using the NYSDEC worksheet calculations. Table 2 shows the WQv provided for each drainage subbasin using porous pavement along William Street.

Table 2: WQv (ft3) treated using porous pavement along William Street

Drainage Areas Treated	Model Nodes		WQv Target (ft3)		WQv Provided (ft3)		% of Target WQv	
	Hydro CAD	DEC	Hydro CAD	DEC	Hydro CAD	DEC	Hydro CAD	DEC
1, 2	4P	1	1725	2097	1774	1774	100.0%	84.6%
3, 4, 5	5P	2	2061	2743	2251	2251	100.0%	82.1%
6, 7, 8	6P	3	2521	3733	2473	2473	98.1%*	66.2%
9, 10, 11	7P	4	2840	4012	3091	3091	100.0%	77.0%
12, 13, 14	8P	5	2158	3080	2434	2434	100.0%	79.0%
15, 16, 17	9P	6	1366	1812	1413	1413	100.0%	78.0%
18, 19	10P	7	898	1243	940	940	100.0%	75.6%
20, 21, 22, 23	11P	8	2807	3826	2844	2844	100.0%	74.3%
24, 25, 26	12P	9	1764	2462	1899	1899	100.0%	77.1%
27, 28	13P	10	1667	2338	1704	1704	100.0%	72.9%
29, 30	14P	11	1286	1859	1439	1439	100.0%	77.4%
TOTAL			**21,093**	**29,205**	**22,262**	**22,262**	**100.0%**	**76.2%**

The design plans for this porous pavement on William Street are provided on Sheets WL-C401 to WL-C408. Additional details for the porous pavement are provided on Sheet G910. Even with almost no infiltration (0.2 in/hour), the stone infiltration gallery under the porous asphalt will be drained in under 48 hours keeping this volume open for future storms. Flow from larger storms will be routed to the underdrain and swale in the porous pavement and flow back into the existing combined sewer.

To control stormwater from the middle and south portions of William Street, bioretention and infiltration galleries will be placed in the new median. Curb cuts in the median will allow stormwater from the road to flow into the bioretention area in the median. A HydroCAD model of the drainage areas associated with the median was created and can be found in Appendix C. The HydroCAD model shows that the entire WQv target is stored in the bioretention media and the underlying stone infiltration gallery. For simplicity, we completed the NYSDEC Runoff Reduction Sheets for the bioretention areas and not the infiltration galleries below the bioretention area as this shows that the practices treat 88% of the WQv target even without accounting for infiltration. Table 3 shows the WQv provided for each drainage subbasin using bioretention in the William Street median.

Table 3: WQv(ft3) treated using bioretention practices in the median of William Street

Drainage Areas Treated	Model Nodes		DEC Worksheet Values		
	HydroCAD	DEC	WQv Target (ft3)	WQv Provided (ft3)	% of Target WQv
31, 32, 39	1SP	1	2342	2342	100.0%
33, 34, 40	2SP	2	2779	2627	94.5%
35, 36, 40A	3SP	3	2476	2476	100.0%
37, 38, 41	4SP	4	4600	3294	71.6%
TOTAL			**12,197**	**10,739**	**88.0%**

The design plans for the bioretention and infiltration in the William Street Median are provided on Sheets WL-C401 to WL-C408. Additional details for the porous pavement are provided on Sheet G943. Even with almost no infiltration (0.2 in/hour), the stone infiltration gallery under the bioretention will be drained in under 48 hours keeping this volume open for future storms. Flow from larger storms will be routed to the underdrain and swale in the median and flow back into the existing combined sewer.

Renderings of the William Street under existing conditions and how is will look after proposed improvements are provided as Figures 4.7 through 4.10.

Figure 4.7: William Street near Hickory Street under Existing Conditions

Figure 4.8: Proposed GI Improvements at William Street near Hickory Street

Figure 4.9: William Street near Jesse Clipper Park under Existing Conditions

Figure 4.10: Proposed GI Improvements at William Street near Jesse Clipper Park

Summary

The proposed projects at the three sites in the Willert Park neighborhood will have a dramatic impact on water quality in the City of Buffalo. Runoff from 26.1 acres that contribute to SPP 281 will be controlled and significant water quality treatment will be provided. Using HydroCAD modeling, we can confirm that the GI practices used will control 100% of the volume from the 90^{th} percentile storm (0.95" of rain) while also providing over 91% of the water quality volume using the NYSDEC Worksheets (Appendix C). Table 4 summarizes the acreage controlled and the level of treatment provided.

Site/Practice	Area Controlled (ac)			WQv (ft3)		
	Impervious	Pervious	Total	DEC Target	Provided	% of Target
JFK Community Ctr	0.32	0.16	0.48	1,076	1,076	100.0%
Pratt Willert Community Ctr	0.32	0.10	0.42	1,066	800	75.0%
William Street – Porous Pavement	8.41	9.59	18.00	29.205	22,262	76.2%
William Street – Bioretention	3.53	3.67	7.20	12,197	10,739	88.0%
William St – Impervious Area Reduction					5,012	
TOTAL	**12.58**	**13.52**	**26.10**	**43,544**	**39,889**	**91.6%**

Note: The impervious area shown here represents proposed conditions after 1.53 acres of impervious area has been removed along William Street.

By controlling 26.1 acres of area (14.11 ac impervious), these proposed projects also meet the intent of the BSA target of 20% impervious surface control in the drainage area that contributes to Sewer Patrol Point (SPP) 281. Estimated from GIS, SPP 281 has 78.62 acres of impervious area. Therefore, control of 15.72 acres of impervious area would explicitly meet this target. This project does not meet this target based on only impervious area, but when adding the large area of pervious surfaces also controlled in this project allows the project to provide more peak flow control than required.

This can be confirmed with the following equations:

Peak Flow (Qp in cfs) = C * I * A
where: C = curve number
I = storm intensity (in/hr)
A = area (acres)

The peak Flow from 15.72 acres of impervious area is calculated as follows:

Qp = 0.9 * 2.44 * 15.72 = 34.52 cfs

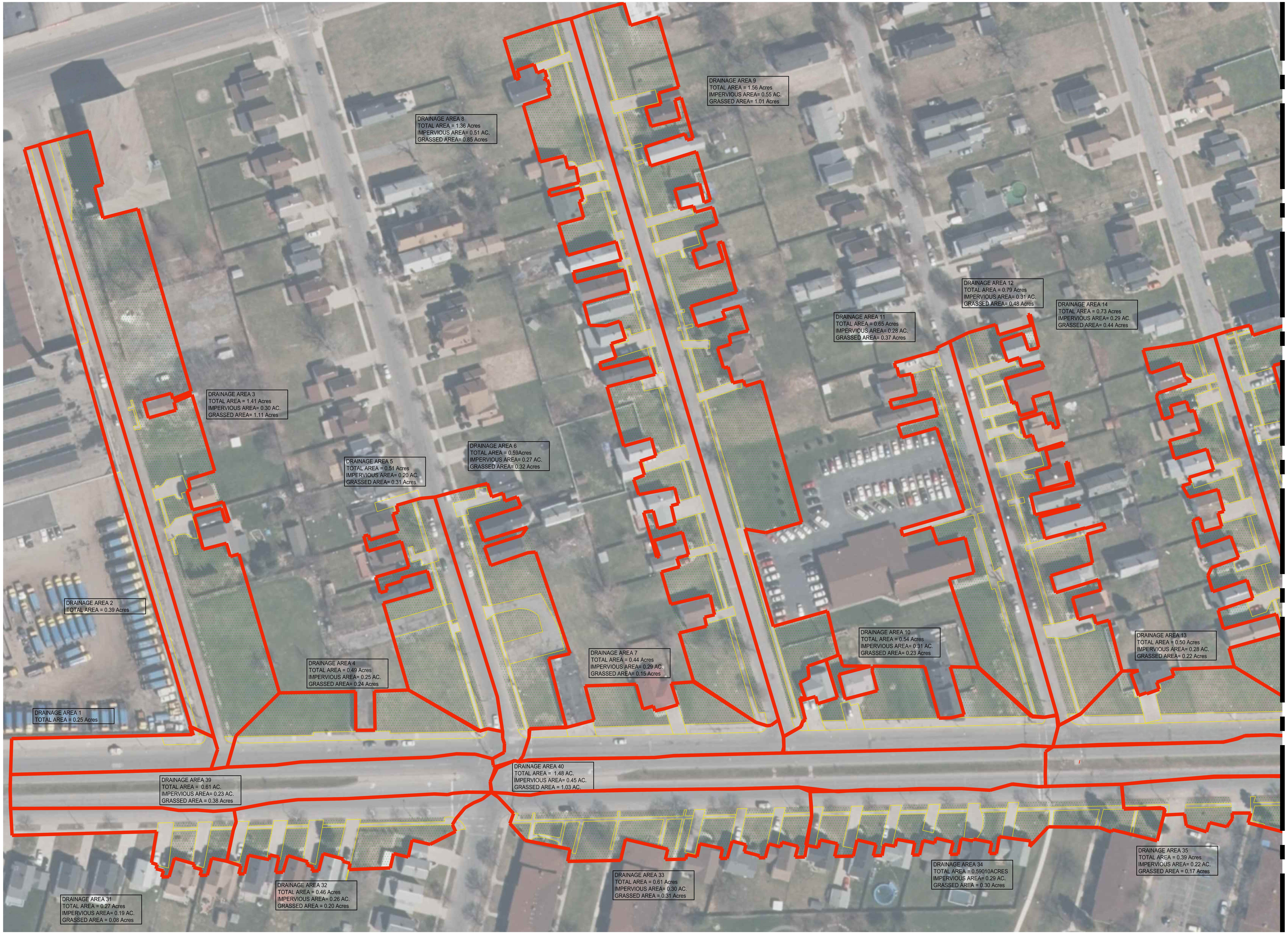
The peak flow from 26.1 acres (14.11 ac impervious) is equal to:

Qp = 0.62 * 2.44 * 26.1 = 39.76 cfs

The peak flow from controlled by the proposed project (39.76 cfs) is larger than the peak flow controlled from 15.72 acres of impervious area (34.52 cfs). Therefore, this project exceeds the goal of the LTCP for SPP 281.

Other alternatives for GI control were investigated but this combination of bioretention, impervious area reduction, infiltration, and porous pavement make the most sense at this location. Tree planting along the north side of William Street was investigated, but there was concern about future maintenance and utility conflicts. Rooftop disconnection and rain barrel use are being encouraged in this sewer shed, but the reliance on private owner participation limits the use of these practices on a large scale.

No impervious area will be added for this project. This project will impact more than 1 acre of impervious area, so a Stormwater Pollution Prevention Plan (SWPPP) has been developed and submitted to the BSA.



Buffalo Sewer Authority

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WILLERT PARK GREEN INFRASTRUCTURE & MIAMI STREET AND LOUISIANA STREET SEWER IMPROVEMENTS

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02-08-2017
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NO.	REVISIONS	DATE

DWG. TITLE

WILLIAM STREET DRAINAGE AREAS

GENERIC SCALE BAR
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DATE	01-30-2017		
SCALE	NTS		
DWN.	TED	CHK.	SMR
PROJ. No.	434925		
DWG. No.	C100		
Sheet No.			

Figure 4.11: Drainage Areas for the Western Portion of the William Street Project Site

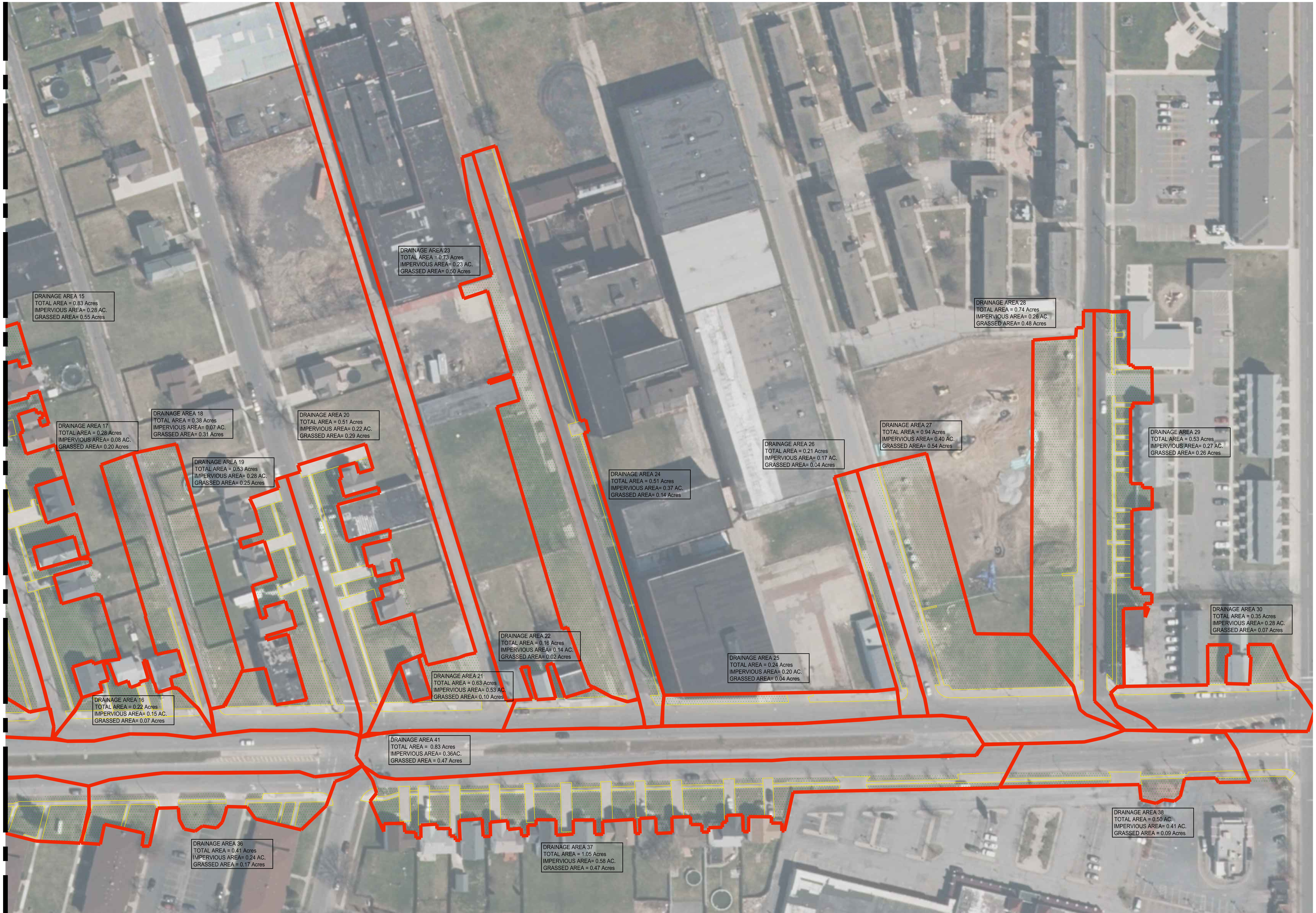

Figure 4.12: Drainage Areas for the Western Portion of the William Street Project Site

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DWG. TITLE

WILLIAM STREET DRAINAGE AREAS

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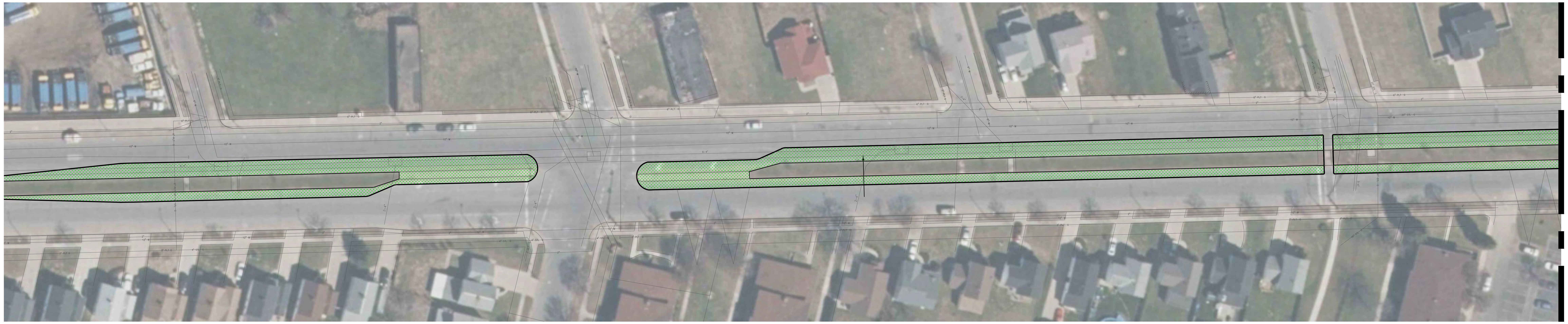
PROJ. No. 434925
DWG. No.

C101

Sheet No.

FILENAME: P:\434925 BSA PHATT WILLERT GREEN STREETS\06 REPORTS CALCS\SWPPP\DRAIN AREAS MAP.DWG LAYOUT: C101 DATE: 2/8/2017 9:03:29 AM



1 WILLIAM STREET WEST
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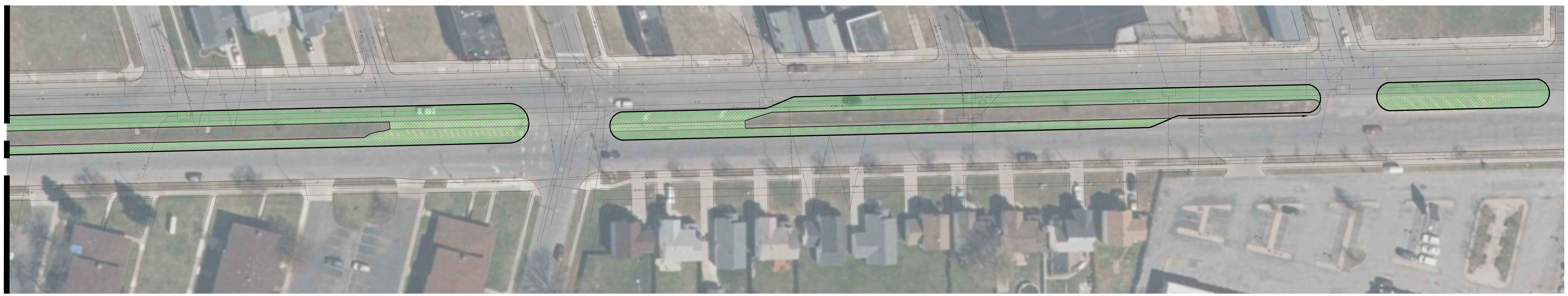

2 WILLIAM STREET EAST
SCALE: NTS

3 PRATT WILLERT COMMUNITY CENTER
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IMPERVIOUS REDUCTION: =

PRATT WILLERT IMPERVIOUS REDUCTION: = 0.02 ACRES

WILLIAM STREET IMPERVIOUS REDUCTION: = 1.28 ACRES

JESSE CLIPPER MEMORIAL PARK IMPERVIOUS REDUCTION: = 0.25 ACRES

TOTAL IMPERVIOUS REDUCTION: = 1.55 ACRES

3 JESSE CLIPPER MEMORIAL PARK
SCALE: NTS

Figure 4.13: Impervious Area Reduction along William Street

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WILLIAM STREET IMPERVIOUS AREA REDUCTION

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5. OPERATIONS AND MAINTENANCE PLAN

The GI practices provided as part of the Willet Park design must be managed if they are to perform well. This operation and maintenance plan (O&M Plan) has been developed to ensure that the GI components continue to provide adequate treatment well into the future. The O&M Plan includes a schedule for routine cleaning, inspection, and other monitoring.

This plan should be used as a starting point and can be updated in the future to reflect specific system characteristics learned during operation. The BSA will be responsible for implementation of this plan.

Bioretention Areas

During the first two years, significant effort will be needed to achieve successful establishment of the bioretention areas. The bioretention areas at the Pratt Willert and JFK Community Centers along with the bioretention areas in the median of William Street should be inspected after every large storm (greater than 0.5" of rainfall) and any bare spots or eroding areas must be immediately stabilized with mulch or other plantings as appropriate. For the first growing season, trees and other plantings in the bioretention areas should be watered at least once a week. Some plantings will not survive the first two growing seasons in the bioretention area and reinforcement plantings will be required to selectively replant portions where the bioretention area fails to fill in or survive.

Ongoing maintenance will be driven by periodic inspection of the bioretention area. A checklist for these periodic inspections has been created using the checklists from the NYS SWDM as a template. This checklist is given as Appendix D of this report. These periodic inspections should occur yearly at a minimum and will include the following:

- Examine the bioretention areas for debris, yard wastes, and litter.
- Monitor the growth and survival of plantings in the bioretention area. Confirm that plantings are taller than the cleanout and that the plant composition is similar to the approved plans.
- Check for growth of inappropriate plants (invasive plantings, for example).
- Monitor the bioretention areas to confirm that maximum water depths do not exceed six inches.
- Examine the bioretention area for erosion. Particular emphasis should be placed on inspection of the turf areas just downstream of the curb inlets.

Based on the inspection results, specific maintenance tasks will occur. For example, if debris is seen at the inlet or outlet, this debris shall be removed. Cleanups should also be scheduled on a yearly basis to remove any trash and debris in the bioretention area.

Inspections shall also be completed when abnormal water levels are seen in the bioretention area. If any of the following conditions occur, an inspection must be completed immediately and corrective maintenance shall be completed as soon as reasonably possible:

- If 48 hours after a storm, the water ponds above the bottom any of the bioretention cells.

Some non-routine maintenance will also be required with a bioretention area. Sediment accumulation should be removed when inspections indicate that the cobble dissipater pads downstream of the curb inlets are filled with sediment. If water ponding occurs, the top few inches of bioretention material shall be removed and replaced with fresh material. Areas devoid of mulch shall be re-mulched on an annual basis.

Permeable Pavement

Maintenance of the permeable paving shall be driven by periodic inspection of the permeable pavement. These periodic inspections should occur yearly at a minimum and will include the following:

- Inspection of the upstream (uphill) drainage areas. These areas send runoff to the permeable pavement area. Bare soils and eroded areas can send large amounts of sediment to the permeable pavement clogging the surface. Piles of mulch and grass and open containers of oils, greases, or paints should be noted.
- Inspection of the pavement surface. Check for dirt and grit accumulating on the surface and any slumping, cracking, or breaking of the pavement surface.

Based on the inspection results, specific maintenance tasks will occur. For example, if bare soils are found, seed and straw these areas to establish vegetation. Any material piles or open containers of oils, grease, or paints should be removed or contained. Dirt and grit should be removed using a vacuum sweeper. Any slumping, cracking, or breaking will need to be fixed by digging up the problem area to ensure that the subbase has not been compromised. Vacuuming should also be scheduled on a yearly basis to remove any accumulated sediment in the permeable pavement.

Inspections shall also be completed when water stands on the permeable pavement surface for more than one hour after a storm. If this occurs, an inspection must be completed immediately and corrective maintenance shall be completed as soon as reasonably possible:

For all Maintenance Practices

There is no reason to believe that the sediments excavated or vacuumed from this project will be hazardous or toxic. Therefore, these sediments can be safely disposed of by the Buffalo Sewer Authority. Other non-routine maintenance would include removal of undesirable invasive species and thinning and harvesting of woody growth. These two tasks should be done as needed, but no thinning should be completed for at least five years after the bioretention is constructed.

6. PROPOSED PROJECT SCHEDULE

The anticipated schedule is as follows:

- February 23, 2017 – Invitation to Bid
- March 16, 2017 – Open Bids from Contractors
- March 21, 2017 – Issue Recommendation of Award
- June 5, 2017 - Notice to Proceed to Contractor
- June 19, 2017 – Begin Construction
- November 2017 – Finish Major Elements of Construction
- Spring 2018 – Final Plantings in Median
- Summer 2018 – Project Completion

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7. PROJECT COST ESTIMATE

It is anticipated that this project will cost $3,585,000. This is calculated in current year dollars and includes the cost of construction and contingency. A full breakdown of these costs is given in Appendix E of this report.

APPENDIX A

Soil Report

wendel

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

Erie County, New York

January 6, 2017

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Soil Map

Map Scale: 1:2,170 if printed on A landscape (11" x 8.5") sheet.

Meters: 0 30 60 120 180

Feet: 0 100 200 400 600

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 17N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
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- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features

- Streams and Canals

Transportation

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

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

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

Soil Survey Area: Erie County, New York
Survey Area Data: Version 15, Sep 23, 2016

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

Date(s) aerial images were photographed: Data not available.

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

Map Unit Legend

Erie County, New York (NY029)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
Ud	Urban land	4.0	97.8%
Uo	Urban land-Cosad complex	0.1	2.2%
Totals for Area of Interest		**4.1**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however,

Soil Map

Map Scale: 1:5,130 if printed on A landscape (11" x 8.5") sheet.

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 17N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

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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)

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

Soil Survey Area: Erie County, New York
Survey Area Data: Version 15, Sep 23, 2016

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

Date(s) aerial images were photographed: Data not available.

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Map Unit Legend

Erie County, New York (NY029)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
Ud	Urban land	0.3	3.4%
Uu	Urban land-Schoharie complex	9.2	96.6%
Totals for Area of Interest		**9.5**	**100.0%**

Map Unit Descriptions

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Soil Map

Map Scale: 1:578 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 5, 10, 20, 30

Feet: 0, 25, 50, 100, 150

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 17N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features

- Streams and Canals

Transportation

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

Background

- Aerial Photography

MAP INFORMATION

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Warning: Soil Map may not be valid at this scale.

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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)

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Survey Area Data: Version 15, Sep 23, 2016

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

Date(s) aerial images were photographed: Data not available.

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.

Soil Map


78° 51' 39" W
78° 51' 33" W
42° 52' 58" N
42° 52' 55" N
674690
674700
674710
674720
674730
674740
674750
674760
674770
674780
674790
674800
674810
674820
4750040
4750030
4750020
4750010
4750000
4749990
4749980
4749970
4749960
354
Clinton St
Uu
Soil Map may not be valid at this scale.
N
Map Scale: 1:660 if printed on A landscape (11" x 8.5") sheet.
Meters
0 5 10 20 30
Feet
0 30 60 120 180
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 17N WGS84

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Map Unit Legend

Erie County, New York (NY029)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
Uu	Urban land-Schoharie complex	1.1	100.0%
Totals for Area of Interest		**1.1**	**100.0%**

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Map Unit Legend

Erie County, New York (NY029)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
UmA	Urban land-Collamer complex, 1 to 6 percent slopes	0.8	100.0%
Totals for Area of Interest		**0.8**	**100.0%**

Map Unit Descriptions

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onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Erie County, New York

Ud—Urban land

Map Unit Setting

National map unit symbol: 9rq4
Mean annual precipitation: 36 to 48 inches
Mean annual air temperature: 45 to 50 degrees F
Frost-free period: 115 to 195 days
Farmland classification: Not prime farmland

Map Unit Composition

Urban land: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Minor Components

Getzville

Percent of map unit: 5 percent
Landform: Depressions
Hydric soil rating: Yes

Mardin

Percent of map unit: 5 percent
Hydric soil rating: No

Odessa

Percent of map unit: 5 percent
Hydric soil rating: No

Udorthents

Percent of map unit: 5 percent
Hydric soil rating: No

Uo—Urban land-Cosad complex

Map Unit Setting

National map unit symbol: 9rqd
Elevation: 200 to 800 feet
Mean annual precipitation: 36 to 48 inches
Mean annual air temperature: 45 to 50 degrees F
Frost-free period: 115 to 195 days
Farmland classification: Not prime farmland

Map Unit Composition

Urban land: 60 percent
Cosad and similar soils: 25 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Urban Land

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8s
Hydric soil rating: Unranked

Description of Cosad

Setting

Landform: Lake plains
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Tread
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Sandy glaciofluvial or deltaic deposits over clayey glaciolacustrine deposits

Typical profile

H1 - 0 to 9 inches: loamy fine sand
H2 - 9 to 21 inches: loamy fine sand
H3 - 21 to 24 inches: fine sandy loam
H4 - 24 to 60 inches: silty clay

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 6 to 18 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Available water storage in profile: Moderate (about 7.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: C/D
Hydric soil rating: No

Minor Components

Rhinebeck

Percent of map unit: 5 percent
Hydric soil rating: No

Red hook

Percent of map unit: 5 percent
Hydric soil rating: No

Udorthents

Percent of map unit: 3 percent
Hydric soil rating: No

Cheektowaga

Percent of map unit: 2 percent

Landform: Depressions
Hydric soil rating: Yes

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February 6, 2017
Project No. BE-16-278

Wendel
Centerpointe Corporate Park
375 Essjay Road, Suite 200
Williamsville, New York
14221

Attn. Mr. Scott M. Rybarczyk, PE, LEED AP
Associate Principal – Senior Stormwater Engineer

Re: Geotechnical Evaluation Report for
Proposed Buffalo Sewer Authority - Pratt Willert Green Streets Project
Buffalo, New York

Dear Mr. Rybarczyk:

Empire Geo-Services, Inc. is pleased to submit two copies of the enclosed Geotechnical Evaluation Report to Wendel, for the above referenced project. We have also e-mailed an electronic copy (pdf file format) of this report to you, for your use and for distribution.

Please contact me should you have any questions or wish to discuss this report. Thank you for considering Empire for this work and we look forward to working with you on this project, through its completion.

Sincerely,

EMPIRE GEO-SERVICES, INC.

Thomas R. Seider, P.E.
Senior Geotechnical Engineer

Enc.: Geotechnical Engineering Report (2 copies)

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Geotechnical Evaluation Report for Proposed Buffalo Sewer Authority Pratt Willert Green Streets Project Buffalo, New York

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STATE OF NEW YORK
THOMAS R. SEIDER
079104
LICENSED PROFESSIONAL ENGINEER

2/6/2017

Project No. BE-16-278
February 2017

TABLE OF CONTENTS

1.00 INTRODUCTION

1.10 GENERAL

This report presents the results of a subsurface exploration program and geotechnical evaluation, completed by Empire Geo-Services, Inc. (Empire) for the proposed Buffalo Sewer Authority (BSA) Pratt Willert Green Streets project. Wendel retained Empire to complete this work, which was done in general accordance with our December 21st, 2017 proposal, and the Amendment to our Term Agreement for Professional Services with Wendel.

SJB Services, Inc. (SJB), our affiliated drilling company, completed the subsurface exploration program which consisted of five pavement cores with subbbase and subgrade sampling, and nine conventional test borings with infiltration test pipes installed within adjacent test borings. SJB also completed the field infiltration testing. On this basis, Empire prepared this report, which summarizes the surface and subsurface conditions encountered, and presents the field infiltration testing results.

1.20 SITE AND PROJECT DESCRIPTION

The project is expected to include improvements to existing roadways, parking areas, and green space, that will allow for infiltration of surface water runoff. Four project areas within the City of Buffalo were investigated, including the following:

- Parking area for the Pratt Willert Community Center, located at 422 Pratt Street;
- Green space adjacent to the parking area for the JFK Community Center, located at 114 Hickory Street;
- Louisiana and Miami Streets; and
- William Street, from just west of Pine Street to just east of Pratt Street.

The approximate location of the four project sites, and the pavement core / test boring locations are shown on the figures included in Appendix A, which were developed by Wendel.

2.00 SUBSURFACE EXPLORATIONS

2.10 EXPLORATION LOCATIONS

The subsurface exploration program consisted of: five pavement cores with subbbase and subgrade sampling, designated as C-1 through C-5; and nine conventional test borings, designated as I-1 through I-9. Following the completion of test borings I-1 through I-9, the driller moved over approximately 3 to 4 feet and drilled an infiltration test hole to a depth of about five feet and installed an infiltration test pipe. Following the first round of infiltration testing, SJB returned to the site and installed additional infiltration test pipes I-1A, I-2A, and I-9A. Additional details about the supplemental testing are included in Section 5.30.

The pavement core and infiltration test boring locations were initially established on site plans provided by Wendel. SJB then established the test boring locations in the field by referencing the locations to the site features shown on the site plans. The approximate test boring locations are shown on the four site plans included in Appendix A.

2.20 PAVEMENT CORES / TEST BORINGS

At the pavement core / test boring locations C-1 through C-5, a portable coring machine was initially used to obtain an approximate 6 inch diameter core sample of the asphalt concrete layer. SJB then hand excavated and sampled the underlying subbase material, and measured both the pavement and subbase thicknesses. The asphalt pavement conditions encountered are summarized on the Pavement Core Summary Sheets included in Appendix B.

Following completion of the pavement coring and subbase sampling, SJB used a Central Mine Equipment (CME) model 75, truck mounted drill rig, to obtain consecutive split spoon samples of the subgrade soils. The split spoons were advanced to a depth of about five feet, in general accordance with *ASTM D1586 – "Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils"*.

A geologist prepared the test boring logs based on visual observations of the recovered soil samples, along with a review of the driller's field notes. The soil samples were described based on a visual/manual estimation of the grain size distribution, along with characteristics such as color, relative density, consistency, moisture, etc. The test boring logs are presented in Appendix C, along with general information and a key of terms and symbols used to prepare the logs

2.30 INFILTRATION TEST BORINGS

Test borings I-1 through I-9 were completed using a CME model 75, truck mounted drill rig. Four of the nine infiltration test borings were located within a pavement parking lot or roadway. At these locations, the driller used the augers to grind through the pavement section. SJB then hand excavated and sampled the underlying subbase material, and measured both the pavement and subbase thicknesses.

The test borings were typically advanced to a depth of 9 feet using hollow stem auger and split spoon sampling methods. Exceptions include test boring B-1 where sample spoon refusal conditions were encountered at a depth of 8.6 feet. Split spoon samples and Standard Penetration Tests (SPTs) were taken continuously throughout the full depth of the test borings. As was done for the pavement core / test borings, a geologist prepared the test boring logs, which are presented in Appendix C.

3.00 ASPHALT PAVEMENT AND SUBBASE CONDITIONS

Asphalt pavement was encountered at the surface of pavement core / test borings C-1 through C-5, and test borings I-1, I-3, I-5, and I-8. Topsoil was encountered at the surface of the remaining test borings.

The total pavement thickness and the thickness of the individual pavement layers were measured in the laboratory for pavement cores C-1 through C-5. These measurements are summarized on the Pavement Core Summary Sheets included in Appendix B. The pavement sections typically consisted of asphalt pavement. However, at pavement core C-5, an asphalt pavement top course was encountered, followed by a Portland cement concrete course.

The total asphalt pavement thickness measured in the field by the Driller, are summarized on the test boring logs in Appendix C. These include pavement core / test borings C-1 through C-5, I-1, I-3, I-5, and I-8. The measurements made in the field are within about one inch of the measurements made in the laboratory.

When present, the Driller hand excavated through the pavement subbase and measured its approximate thickness. Photographs of the recovered subbase material at pavement core / test borings C-1 through C-5 are included on the Pavement Core Summary Sheets included in Appendix B. The subbase thickness measurements are included on the test boring logs in Appendix C.

4.00 SUBSURFACE CONDITIONS

4.10 GENERAL

Beneath the topsoil or pavement subbase, fill soils were typically encountered, which extended to depths of about 2 feet to more than 5 feet. Beneath the fill soils, the indigenous soils consisted of silty clays. Bedrock was not encountered at the depths and locations explored. The soil stratigraphy encountered and the groundwater conditions observed are described in more detail in the following sections and on the test boring logs in Appendix C.

4.20 FILL SOILS

Fill soils were typically encountered directly beneath the topsoil or the pavement subbase layer. Exceptions include test boring I-5, where fill soils were not apparent. The fill layer typically extended to a depth of about 2 to 4 feet, except at pavement core / test borings C-2 and C-3, where the fill soils were not fully penetrated within the five feet deep test borings. It should be expected that the thickness of the fill soils will vary between and away from the test boring locations, and will be dependent upon the original site topography prior to development.

The nature of the fill soils varied between test borings, but can generally be described as a mixture of silty clays, sands, and gravels. Concrete fragments, slag, brick fragments, wood, and organics were also observed within several samples of the fill. The Standard Penetration Test (SPT) "N" values obtained within the fill soils ranged from 3 to 11, indicating the fill soils generally have a "loose" relative density or a "medium" to "stiff" consistency.

4.30 INDIGENOUS SOILS

Where the fill soils were fully penetrated, the underlying indigenous soils consisted of silty clays with trace amounts of sand. Several samples of the silty clay soils contained silt partings (i.e. a soil layer less than about 1/8 inch thick), or trace amounts of gravel. The silty clay soils are classified as a CL group soil using the Unified Soil Classification System (USCS). The SPT "N" values obtained within the indigenous soils ranged from 5 to 47, typically increasing with depth, indicating the soils have a "medium" to "hard" consistency.

4.40 GROUNDWATER CONDITIONS

Water level measurements were made within the test borings at the completion of overburden drilling and sampling. In all cases, no free standing water was observed. However, it is possible that the groundwater did not have sufficient time to accumulate in the test holes within the time that had elapsed from the completion of drilling operations and the time of the measurements.

The collected soil samples from the William Street test borings (C-1 through C-3 and I-3 through I-9) were mostly described only as "moist", not "moist to wet" or "wet", suggesting the lack of a groundwater condition. Exceptions include pavement core / test boring C-3, where "moist to wet" or "wet" soils were encountered from about 1.5 feet to 5 feet. These soils were noted to consist of relatively granular fill soils. Accordingly, the wet conditions could be the result of perched or trapped groundwater, which had accumulated within the more granular soils, above the less permeable silty clay indigenous soils. Perched groundwater can be more prevalent following heavy or extended periods of precipitation and during seasonally wet periods.

At the remaining areas, "moist to wet" fill soils were encountered within pavement cores / test borings C-4 and C-5. In addition, "moist to wet" indigenous soils were encountered within test borings I-1 and I-2, and pavement cores / test borings C-4 and C-5. These conditions are an indication of a possible groundwater condition. Installation of groundwater observation wells would be necessary to define the actual presence or absence of a groundwater condition, and its depth. It should be expected that both perched and permanent groundwater conditions could vary with location and with changes in soil conditions, precipitation and seasonal conditions.

5.00 INFILTRATION TESTING

5.10 Infiltration Test Pipe Installation

Following the completion of test borings I-1 through I-9, the driller moved over approximately 3 to 4 feet and drilled an infiltration test hole to a depth of about five feet. A 4 inch diameter, PVC casing/riser pipe, was placed at the bottom of the test holes, and the annulus space between the casing pipes and the holes was backfilled with soil cuttings to the ground surface. SJB added about 24 inches of water to the casing pipes on January 18th, 2017 to pre-soak the holes.

5.20 Initial Infiltration Testing

SJB returned to the sites on January 19th, 2017 to complete the infiltration tests at six locations. The remaining three locations were tested on January 20th, 2017. The infiltration testing was completed in general conformance with the infiltration test procedure presented in the *NYSDEC Publication "Stormwater Management Design Manual – January 2015" – Appendix D: Infiltration Testing Requirements.*

Upon arrival to complete the testing, no pre-soak water remained within test pipe I-1. However, some amounts of pre-soak water remained within the remaining eight test pipes. The infiltration test at location I-1, included adding water into the test pipe to about 2 feet above the bottom of the pipe. At locations I-2 through I-9, about 2 feet of water was added above the remaining pre-soak water. The water level drop was measured in 60 minute intervals, for four consecutive test runs. The casing pipe was re-filled with water to the initial test depth, at the start of each test run.

The infiltration test data are presented on the Infiltration Test Data Summary Reports included in Appendix D. This data was used to develop an approximate infiltration rate at each location. The infiltration rate often decreased between successive test runs. Accordingly, the infiltration rates included in the following summary table are generally the lowest value of the four test runs.

Infiltration Testing Results Summary
January 19 and January 20, 2017

Test No.	Bottom of Infiltration Test Pipes		Testing Data / Results		
	Approx. Depth (feet)	Approximate Depth into Indigenous Silty Clay Soils (based on test boring) (feet)	Approximate Water Depth: Pre-Soak Remaining above Bottom (feet)	Approximate Water Depth: Above Bottom at Start (feet)	Approx. Infiltration Rate (in./hour)
I-1	4.6	1.6	None	2.0	21
I-2	4.9	1.9	1.3	3.3	14
I-3	5.2	1.2	0.9	2.9	3.6
I-4	4.4	0.4	0.2	2.2	12
I-5	5.2	3.4	0.5	2.5	0.0
I-6	4.9	2.9	0.8	2.8	0.0
I-7	5.0	3.0	0.6	2.6	0.1
I-8	4.9	2.9	1.3	3.3	9
I-9	4.9	2.9	0.9	2.9	5.5

Note: in. /hour = inches per hour.

Based on the findings from the adjacent test borings, and as summarized in the above table, the bottom of the test pipes should have been situated within the silty clay indigenous soils. The silty clay soils would be expected to have a limited infiltration rate, such as those observed at infiltration test pipes I-5, I-6, and I-7. In addition, the amount of pre-soak water that remained within the test pipes does not support the measured faster infiltration rates. For example, at infiltration test pipes I-2 and I-8, about 1.3 feet of pre-soak water remained within the test pipes. The measured infiltration rates were 14 and 9 inches per hour, respectively. If the silty clay soils actually had infiltration rates of 14 and 9 inches per hour, there should have been no pre-soak water remaining.

The faster infiltration rates observed at several locations was not expected. Possible reasons for the faster than expected infiltration rates are summarized below, and were confirmed by supplemental testing, as described in Section 5.30.

1. It is possible that the more granular fill soils extended deeper at the infiltration test pipe locations than what was observed at the adjacent test borings. Where the bottom of the test pipes were actually set within the looser and more granular fill soils, a faster infiltration rate would be expected. This appears to be the case at test pipe I-1, as described in the following section. It is also possible that this occurred at test pipe I-4, where the bottom of the test pipe was estimated to be only about 0.4 feet into the clay soils.

2. If a good seal between the bottom of the test pipe and indigenous silty clay soils was not achieved during installation, water from the test pipes could have seeped into the surrounding backfilled annulus space, and into the more granular fill soil layer. This appears to be the case at several locations, and was confirmed by the additional testing completed at locations I-2 and I-9, as described in the following section.

3. The possibility that the bottom of the test pipes were set within the fill soils and the remaining pre-soak water was actually perched or trapped groundwater within the fill soils. As more water was added, the water flowed into the unsaturated portion of the fill soils.

4. The last factor that could have impacted the test results includes the amount of water above the bottom of the test pipes. The NYSDEC guidelines require 2 feet of water above the bottom of the test pipe be used for the infiltration testing. However, because there was some pre-soak water remaining at most locations, 2 feet of water was added above the remaining

pre-soak water. However, the additional water is not expected to have a major impact on the observed infiltration rates.

5.30 Supplemental Infiltration Testing

Due to the faster than expected infiltration rates observed at several locations, SJB installed three additional infiltration test pipes near the original test pipes I-1, I-2, and I-9. These supplemental infiltration test pipes (I-1A, I-2A, and I-9A) were installed and pre-soaked on February 2nd, 2017, using similar methods as the original test pipes.

After the supplemental holes were drilled, the soils at the bottom of the holes were observed by a Geologist. At test pipe location I-1A, the soils consisted of a granular fill soil. The pre-soak water at this location drained within about 30 minutes. Accordingly, it appears the bottom of test pipe I-1 was actually installed within the granular fill soils, which extended to a deeper depth than that observed at the adjacent test boring location.

The observed soils at the bottom of test pipes I-2A and I-9A consisted of the silty clay indigenous soils. Pre-soak water was added to the test pipes on February 2nd, 2017. Observations made about an hour later indicated no pre-soak water had infiltrated into the clay soils at I-9A, with a minor amount of infiltration observed at I-2A. SJB returned to the site on February 3rd, 2017 to complete the infiltration testing. The results are included on the Infiltration Test Data Summary Reports included in Appendix D. The observed infiltration rates are included in the following summary table.

Supplemental Infiltration Testing Results Summary February 3, 2017					
Test No.	Bottom of Infiltration Test Pipes		Testing Data / Results		
	Approx. Depth (feet)	Approximate Depth into Indigenous Silty Clay Soils (based on test boring) (feet)	Approximate Water Depth		Approximate Infiltration Rate (in./hour)
			Pre-Soak Remaining above Bottom (feet)	Above Bottom at Start (feet)	
I-1A	5.1	none	none	2.0	22
I-2A	4.7	1.7	1.5	3.5	0.0
I-9A	5.0	3.0	2.0	4.0	0.0

Based on the initial and supplemental testing, the infiltration rates for the silty clay indigenous soils should be taken as 0.0 inches per hour. The infiltration rates obtained at I-1, I-2, I-3, I-4, I-8, and I-9, as summarized in section 5.20, appear to be representative of the looser and more granular fill soils. This is likely the result of the bottom of the test pipes being installed within the fill soils, or water seepage from beneath the pipes and into the fill soils.

6.00 CONCLUDING REMARKS

This report was prepared to assist in planning the design and construction of the proposed Buffalo Sewer Authority - Pratt Willert Green Streets project. The report has been prepared for the exclusive use of Wendel, Buffalo Sewer Authority, and other members of the design team, for specific application to this site and this project only.

The recommendations were prepared based on Empire Geo-Services, Inc.'s understanding of the proposed project, as described herein, and through the application of generally accepted soil engineering practices. No warranties, expressed or implied are made by the conclusions, opinions, recommendations or services provided. Important information regarding the use and interpretation of this report is presented in Appendix E.

Respectfully Submitted:

EMPIRE GEO-SERVICES, INC.

Thomas R. Seider, P.E.
Senior Geotechnical Engineer

APPENDIX A

EXPLORATION LOCATION PLANS – PREPARED BY WENDEL

KEY

PROPOSED INFILTRATION TEST

PROPOSED ROADWAY CORE

1 PRATT WILLERT COMMUNITY CENTER EXISTING
SCALE: 1"=20'

BUFFALO SEWER AUTHORITY

BUFFALO SEWER AUTHORITY
1038 CITY HALL
65 NIAGARA SQUARE
BUFFALO NY 14202-3378

WILLERT PARK
GREEN STREETS

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Wendel WD Architecture, Engineering, Surveying and Landscape Architecture, P.C.

PROGRESS PRINT
NOT FOR CONSTRUCTION

NO.	REVISIONS	DATE

PRATT WILLERT
COMMUNITY CENTER
INFILTRATION TESTING

GENERIC SCALE BAR
0 1" 2"
SCALE BAR SHOWN IS TWO INCHES ON THE ORIGINAL DRAWING. IF NOT TWO INCHES ON THIS SHEET, ADJUST ACCORDINGLY

DATE	11-03-2016
SCALE	AS NOTED
DWN.	TED — CHK. SMR/ TJZ
PROJ. No.	434925

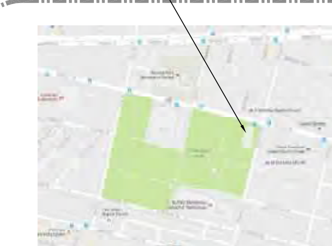
DWG. No.

PW - C100

KEY	
PROPOSED INFILTRATION TEST	(red symbol)
PROPOSED ROADWAY CORE	(green symbol)

1 JFK COMMUNITY CENTER PLAN
SCALE: 1"=20'

PROJECT LOCATION



KEY PLAN

BUFFALO SEWER AUTHORITY

1038 CITY HALL
65 NIAGARA SQUARE
BUFFALO NY 14202-3378

WILLERT PARK GREEN STREETS

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WendelWD Architecture, Engineering, Surveying and Landscape Architecture, P.C.

PROGRESS PRINT
12-05-2016
NOT FOR CONSTRUCTION

NO.	REVISIONS	DATE

DWG. TITLE

JFK COMMUNITY CENTER INFILTRATION TESTING

GENERIC SCALE BAR
0 1" 2"
SCALE BAR SHOWN IS TWO INCHES ON THE ORIGINAL DRAWING. IF NOT TWO INCHES ON THIS SHEET, ADJUST ACCORDINGLY

DATE	11-03-2016
SCALE	AS NOTED
DWN.	TED
CHK.	SMR/ TJZ
PROJ. No.	434925

DWG. No.

JFK - C102

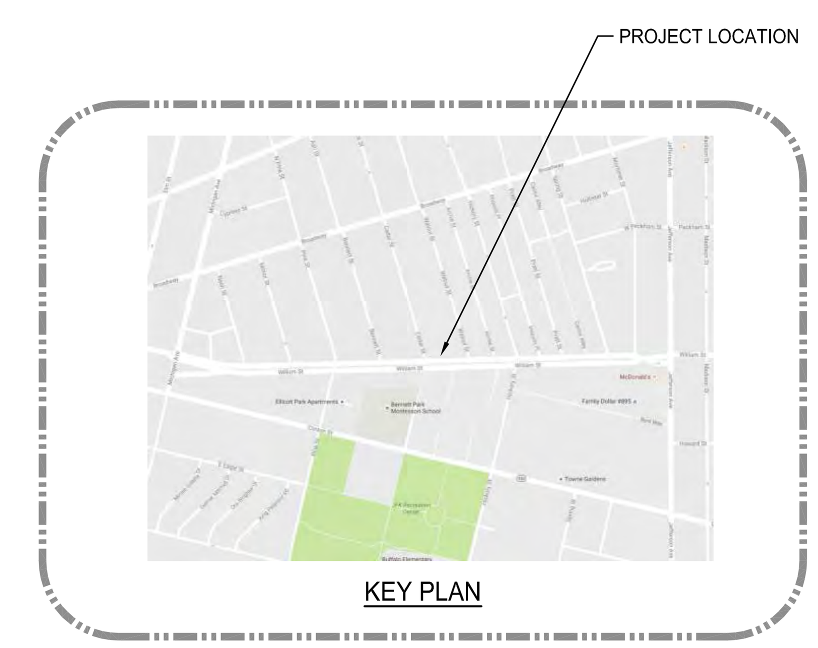
FILENAME: P:\434925 BSA PRINT WILLERT GREEN STREETS\16. CAD\DWG\CIVIL\COMPOSITE\BSA - JFK-PW COM. CTR. SCHEMATIC.DWG DATE: 12/5/2016 11:46:08 AM

1 WILLIAMS STREET INFILTRATION TESTING
SCALE: 1"=40'

KEY

PROPOSED INFILTRATION TEST

PROPOSED ROADWAY CORE



KEY PLAN

BUFFALO SEWER AUTHORITY

BUFFALO SEWER AUTHORITY
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65 NIAGARA SQUARE
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12-20-2016
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NO.	REVISIONS	DATE

DWG. TITLE

WILLIAM STREET INFILTRATION TESTING

0 1" 2"
GENERIC SCALE BAR
SCALE BAR SHOWN IS TWO INCHES ON THE ORIGINAL DRAWING.
IF NOT TWO INCHES ON THIS SHEET, ADJUST ACCORDINGLY

DATE	11-03-2016		
SCALE	AS NOTED		
DWN.	TED	CHK.	SMR/ TJZ
PROJ. No.	434925		

DWG. No.

WL - C100

1 LOUISIANA & MIAMI STREET PAVEMENT CORES
SCALE: 1"=40'

KEY

PROPOSED INFILTRATION TEST

PROPOSED ROADWAY CORE

BUFFALO SEWER AUTHORITY

BUFFALO SEWER AUTHORITY

1038 CITY HALL
65 NIAGARA SQUARE
BUFFALO NY 14202-3378

WILLERT PARK GREEN STREETS

wendel

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375 Essjay Road, Suite 200
Williamsville, NY 14221
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Wendel WD Architecture, Engineering, Surveying and Landscape Architecture, P.C.

PROGRESS PRINT
12-20-2016
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NO.	REVISIONS	DATE

DWG. TITLE

LOUISIANA & MIAMI PAVEMENT CORES

0 1" 2"
GENERIC SCALE BAR
SCALE BAR SHOWN IS TWO INCHES ON THE ORIGINAL DRAWING. IF NOT TWO INCHES ON THIS SHEET, ADJUST ACCORDINGLY

DATE	11-03-2016		
SCALE	AS NOTED		
DWN.	TED	CHK.	SMR/ TJZ
PROJ. No.	434925		

DWG. No.

LM - C100

APPENDIX B

PAVEMENT CORE SUMMARY SHEETS

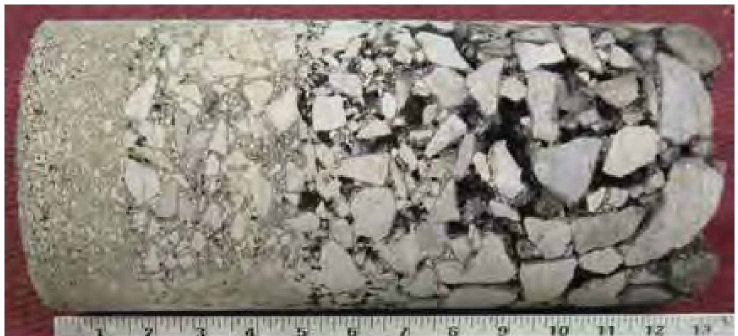
SJB SERVICES, INC.
BUFFALO SEWER AUTHORITY
PRATT WILLERT PROJECT
BE-16-278
CORE SUMMARY


BSA Pratt Willert Project Core C-1


BSA Pratt Willert Project Subbase C-1

CORE NUMBER	**DESCRIPTION**
C-1	TOTAL CORE LENGTH = 16.04” TOTAL ASPHALT = 16.04” - 1st Top Layer = 1.47” - Aggregate = 0.16” stone - 1st Binder Layer = 3.36” - Aggregate = 0.61” stone - 1st Base Layer = 7.63” - Aggregate = 1.46” stone - 2nd Binder Layer = 3.58” - Aggregate = 0.95” stone SUBBASE DEPTH = 12” - Crushed stone material

SJB SERVICES, INC.
BUFFALO SEWER AUTHORITY
PRATT WILLERT PROJECT
BE-16-278
CORE SUMMARY



BSA Pratt Willert Project Core C-2

BSA Pratt Willert Project Subbase C-2

CORE NUMBER	DESCRIPTION

C-2	TOTAL CORE LENGTH = 12.84”
	
	TOTAL ASPHALT = 12.84”
	- 1st Top Layer = 1.91”
	    - Aggregate = 0.16” stone
	- 1st Binder Layer = 2.98”
	    - Aggregate = 0.72” stone
	- 2nd Binder Layer = 3.00”
	    - Aggregate = 0.91” stone
	- 1st Base Layer = 4.95”
	    - Aggregate = 1.36” stone
	
	SUBBASE DEPTH =13”
	- Crushed stone material

SJB SERVICES, INC.
BUFFALO SEWER AUTHORITY
PRATT WILLERT PROJECT
BE-16-278
CORE SUMMARY

BSA Pratt Willert Project Core C-3

BSA Pratt Willert Project Subbase C-3

CORE NUMBER	DESCRIPTION

C-3	TOTAL CORE LENGTH = 6.4”
	
	TOTAL ASPHALT = 6.4”
	- 1st Top Layer = 2.10”
	  - Aggregate = 0.10” stone
	- 2nd Top Layer = 2.35”
	  - Aggregate = 0.13” stone
	- 1st Binder Layer = 1.95”
	  - Aggregate = 0.88” stone
	
	SUBBASE DEPTH = 10”
	- Crushed stone material

SJB SERVICES, INC.
BUFFALO SEWER AUTHORITY
PRATT WILLERT PROJECT
BE-16-278
CORE SUMMARY

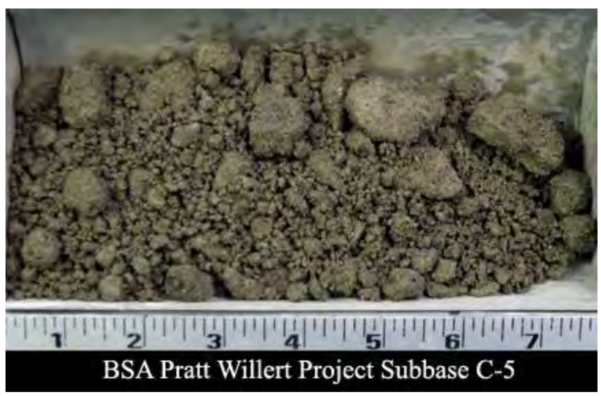

BSA Pratt Willert Project Core C-4


BSA Pratt Willert Project Subbase C-4

CORE NUMBER	DESCRIPTION
C-4	TOTAL CORE LENGTH = 3.77” TOTAL ASPHALT = 3.77” - 1st Top Layer = 1.41” - Aggregate = 0.43” stone - 2nd Top Layer = 0.94” - Aggregate = 0.47” stone - 1st Binder Layer = 1.42” - Aggregate = 0.36” stone SUBBASE DEPTH = 3” - Crushed stone material

SJB SERVICES, INC.
BUFFALO SEWER AUTHORITY
PRATT WILLERT PROJECT
BE-16-278
CORE SUMMARY


BSA Pratt Willert Project Core C-5


BSA Pratt Willert Project Subbase C-5

CORE NUMBER	DESCRIPTION
C-5	TOTAL CORE LENGTH = 8.01” TOTAL ASPHALT = 2.59” - 1st Top Layer = 2.59” - Aggregate = 0.17” gravel TOTAL CONCRETE = 5.42” - Aggregate = 0.86” slag - No Rebar encountered in core SUBBASE DEPTH = 4” - Crushed stone material

APPENDIX C

SUBSURFACE EXPLORATION LOGS

GENERAL INFORMATION & KEY TO SUBSURFACE LOGS

The Subsurface Logs attached to this report present the observations and mechanical data collected by the driller at the site, supplemented by classification of the material removed from the borings as determined through visual identification by technicians in the laboratory. It is cautioned that the materials removed from the borings represent only a fraction of the total volume of the deposits at the site and may not necessarily be representative of the subsurface condition between adjacent borings or between the sampled intervals. The data presented of the Subsurface Logs together with the recovered samples provide a basis for evaluating the character of the subsurface conditions relative to the project. The evaluation must consider all the recorded details and their procedures to more accurately evaluate the subsurface conditions. Any evaluation of the contents of this report and recovered samples must be performed by qualified professionals. The following information defines some of the procedures and terms used of the Subsurface Logs to describe the conditions encountered, consistent with the numbered identifiers shown on the Key opposite this page.

1. **The figures in the Depth column define the scale of the Subsurface Log.**

2. **The Samples column shows, graphically, the depth range from which a sample was recovered. See Table I for descriptions of the symbols used to represent the various types of samples.**

3. **The Sample No. is used for identification on sample containers and/or Laboratory Test Reports.**

4. **Blows on Sampler – shows the results of the "Penetration Test", recording the number of blows required to drive a split spoon sampler into the soil. The number of blows required for each six inches is recorded. The first 6 inches of penetration is considered a seating drive. The number of blows required for the second and third 6 inches of penetration is termed the penetration resistance, N.**

5. **Blows on Casing – Shows the number of blows required to advance the casing a distance of 12 inches. The casing size, hammer weight, and length of drop are noted at the bottom of the Subsurface Log. If the casing is advanced by means other than driving, the method of advancement will be indicated in the Notes column or under the Method of Investigation at the bottom of the Subsurface Log. Alternatively, sample recovery may be shown in this column or other data consistent with the column heading.**

6. **All recovered soil samples are reviewed in the laboratory by an engineering technician, geologist, or geotechnical engineer, unless noted otherwise. Visual descriptions are made on the basis of a combination of the driller's field descriptions and noted observations together with the sample as received in the laboratory. The method of visual classification is based primarily on the Unified Soil Classification System (ASTM D 2487) with regard to the particle size and plasticity (See Table No. II), and the Unified Soil Classification System group symbols for the soil types are sometimes included with the soil classification. Additionally, the relative portion, by weight, of two or more soil types is described for granular soils in accordance with "Suggested Methods of Test for Identification of Soils" by D.M. Burmister, ASTM Special Technical Publication 479, June 1970. (See Table No. III). Description of the relative soil density or consistency is based upon the penetration records as defined in Table No. IV. The description of the soil moisture is based upon the relative wetness of the soil as recovered and is described as dry, moist, wet, and saturated. Water introduced into the boring either naturally or during drilling may have affected the moisture condition of the recovered sample. Special terms are used as required to describe soil deposition in greater detail; several such terms are listed in Table V. When sampling gravelly soils with a standard two inch diameter split spoon, the true percentage of gravel is often not recovered due to the relatively small sampler diameter. The presence of boulders and large gravel is sometimes, but not necessarily, detected by an evaluation of the casing and sampler blows or through the "action" of the drill rig as reported by the driller.**

7. **Rock description is based on review of the recovered rock core and the driller's notes. Frequently used rock classification terms are included in Table VI.**

8. **The stratification lines represent the approximate boundary between soil types and the transition may be gradual. Solid stratification lines delineate apparent changes in soil type, based upon review of recovered soil samples and the driller's notes. Dashed lines convey a lesser degree of certainty with respect to either a change in soil type or where such change may occur.**

9. **Miscellaneous observations and procedures noted by the driller are shown in this column, including water level observations. It is important to realize the reliability of the water level observations depends upon the soil type (water does not readily stabilize in a hole through fine grained soils), and that any drill water used to advance the boring may have influenced the observations. The ground water level will fluctuate seasonally, typically. One or more perched or trapped water levels may exist in the ground seasonally. All the available readings should be evaluated. If definite conclusions cannot be made, it is often prudent to examine the conditions more thoroughly through test pit excavations or groundwater observation wells.**

10. **The length of core run is defined as the length of penetration of the core barrel. Core recovery is the length of core recovered divided by the core run. The RQD (Rock Quality Designation) is the total length of pieces of NX core exceeding 4 inches divided by the core run. The size core barrel used is also noted in the Method of Investigation at the bottom of the Subsurface Log.**

DATE STARTED ______ FINISHED ______ SHEET ____ OF ____	**SJB SERVICES, INC.** **SUBSURFACE LOG**	PROJ. No. ______ HOLE No. ______ SURF. ELEV. ______ G.W. DEPTH ______

PROJECT ______________________ LOCATION ______________________

DEPTH (ft)	SAMPLES	SAMPLE No.	BLOWS ON SAMPLER 0/6	6/12	12/18	18/24	N	BLOWS ON CASING C	SOIL OR ROCK CLASSIFICATION	NOTES
0		1	3	3	4	8	7	10	3" TOPSOIL	Groundwater at 10' upon completion, and 5' 24 hrs. after completion
								15	Brown SILT, some Sand, trace clay, ML (Moist-Loose)	
								50/.5		
5									Gray SHALE, medium hard, weathered, thin bedded, some fractures	Run#1, 2.5'-5.0' 95% Recovery 50% RQD
(1)	(2)	(3)	(4)	(4)	(4)	(4)		(5)	(6) (7) (8)	(9) (10)

(numbered features explained on reverse)

TABLE I

- Split Spoon Sample
- Shelby Tube Sample
- Geoprobe Macro-Core
- Auger or Test Pit Sample
- Rock Core

TABLE II

Identification of soil type is made on basis of an estimate of particle sizes, and in the case of fine grained soils also on basis of plasticity.

Soil Type	Soil Particle Size	
Boulder	>12"	Coarse Grained (Granular)
Cobble	3" - 12"	
Gravel - Coarse	3" - 3/4"	
- Fine	3/4" - #4	
Sand - Coarse	#4 - #10	
- Medium	#10 - #40	
- Fine	#40 - #200	
Silt - Non Plastic (Granular) Clay - Plastic (Cohesive)	<#200	Fine Grained

TABLE III

The following terms are used in classifying soils consisting of mixtures of two or more soil types. The estimate is based on weight of total sample.

Term	Percent of Total Sample
"and"	35 - 50
"some"	20 - 35
"little"	10 - 20
"trace"	less than 10

(When sampling gravelly soils with a standard split spoon, the true percentage of gravel is often not recovered due to the relatively small sampler diameter.)

TABLE IV

The relative compactness or consistency is described in accordance with the following terms:

Granular Soils		Cohesive Soils	
Term	**Blows per Foot, N**	**Term**	**Blows per Foot, N**
Loose	0 - 4	Very Soft	0 - 2
Loose	4 - 10	Soft	2 - 4
Firm	10 - 30	Medium	4 - 8
Compact	30 - 50	Stiff	8 - 15
Very Compact	>50	Very Stiff	15 - 30
		Hard	>30

(Large particles in the soils will often significantly influence the blows per foot recorded during the penetration test)

TABLE V

Varved	Horizontal uniform layers or seams of soil(s).
Layer	Soil deposit more than 6" thick.
Seam	Soil deposit less than 6" thick.
Parting	Soil deposit less than 1/8" thick.
Laminated	Irregular, horizontal and angled seams and partings of soil(s).

TABLE VI

Rock Classification Term		Meaning
Hardness	- Soft	Scratched by fingemail
	- Medium Hard	Scratched easily by penknife
	- Hard	Scratched with difficulty by penknife
	- Very Hard	Cannot be scratched by penknife
Weathering	- Very Weathered - Weathered - Sound	Judged from the relative amounts of disintegration, iron staining, core recovery, clay seams, etc.

Rock Classification Term		Meaning	
Bedding	- Laminated	(<1")	Natural breaks in Rock Layers
	- Thin Bedded	(1" - 4")	
	- Bedded	(4" - 12")	
	- Thick Bedded	(12" - 36")	
	- Massive	(>36")	

(Fracturing refers to natural breaks in the rock oriented at some angle to the rock layers)

DATE		
START	1/16/2017	
FINISH	1/16/2017	
SHEET	1 OF 1	

SJB SERVICES, INC.
SUBSURFACE LOG

HOLE NO. C-1
SURF. ELEV G.S.
G.W. DEPTH See Notes

PROJECT: PRATT-WILLERT GREEN STREETS PROJECT LOCATION: WILLIAM STREET
PROJ. NO.: BE-16-278 BUFFALO, NY

DEPTH FT.	SMPL NO.	BLOWS ON SAMPLER 0/6	6/12	12/18	N	SOIL OR ROCK CLASSIFICATION	NOTES
						ASPHALT SUBBASE	Driller noted approx. 17" Asphalt and 12" Subbase at the ground surface
	1	–	2			Dark Brown Silty CLAY, little f-c Sand, tr.gravel, tr.organics (moist, FILL)	
		4	6		10		
5	2	6	7			Brown Silty CLAY, tr.sand (moist, CL)	
						Boring Complete at 5.0'	No Free Standing Water encountered at Boring Completion
10							
15							
20							

N = NO. BLOWS TO DRIVE 2-INCH SPOON 12-INCHES WITH A 140 LB. PIN WT. FALLING 30-INCHES PER BLOW CLASSIFIED BY: Geologist

DRILLER: J. FRIDMAN DRILL RIG TYPE : CME-75

METHOD OF INVESTIGATION ASTM D-1586 USING HOLLOW STEM AUGERS

SJB SERVICES, INC.
SUBSURFACE LOG

DATE
START: 1/16/2017
FINISH: 1/16/2017
SHEET 1 OF 1

HOLE NO.: C-2
SURF. ELEV: G.S.
G.W. DEPTH: See Notes

PROJECT: PRATT-WILLERT GREEN STREETS PROJECT
LOCATION: WILLIAM STREET, BUFFALO, NY
PROJ. NO.: BE-16-278

DEPTH FT.	SMPL NO.	BLOWS ON SAMPLER 0/6	6/12	12/18	N	SOIL OR ROCK CLASSIFICATION	NOTES
						ASPHALT SUBBASE	Driller noted approx. 13" Asphalt and 13" Subbase at the ground surface
	1	2	5			Brown and Gray Silty CLAY, some f-c Sand, little f-c Gravel, little Wood, tr.brick (moist, FILL)	
		5	12		10		
5	2	5	7			Becomes Dark Brown Contains no wood	
						Boring Complete at 5.0'	No Free Standing Water encountered at Boring Completion
10							
15							
20							

N = NO. BLOWS TO DRIVE 2-INCH SPOON 12-INCHES WITH A 140 LB. PIN WT. FALLING 30-INCHES PER BLOW

CLASSIFIED BY: Geologist

DRILLER: J. FRIDMAN

DRILL RIG TYPE : CME-75

METHOD OF INVESTIGATION: ASTM D-1586 USING HOLLOW STEM AUGERS

SJB SERVICES, INC.
SUBSURFACE LOG

DATE START	1/17/2017
FINISH	1/17/2017
SHEET	1 OF 1
HOLE NO.	C-3
SURF. ELEV	G.S.
G.W. DEPTH	See Notes

PROJECT: PRATT-WILLERT GREEN STREETS PROJECT LOCATION: WILLIAM STREET
PROJ. NO.: BE-16-278 BUFFALO, NY

DEPTH FT.	SMPL NO.	BLOWS ON SAMPLER 0/6	6/12	12/18	N	SOIL OR ROCK CLASSIFICATION	NOTES
						ASPHALT SUBBASE	Driller noted approx. 6" Asphalt and 10" Subbase at the ground surface
	1	–	17			Gray SLAG and f-c Sand, little Silty Clay (moist-wet, FILL)	
	2	5	6			Contains little Brick, tr.silty clay	
		5	6		11		
5	3	8	9			Brown f-c GRAVEL and f-c Sand, tr.concrete, tr.silty clay (wet, FILL)	
						Boring Complete at 5.0'	No Free Standing Water encountered at Boring Completion
10							
15							
20							

N = NO. BLOWS TO DRIVE 2-INCH SPOON 12-INCHES WITH A 140 LB. PIN WT. FALLING 30-INCHES PER BLOW CLASSIFIED BY: Geologist

DRILLER: J. FRIDMAN DRILL RIG TYPE : CME-75

METHOD OF INVESTIGATION ASTM D-1586 USING HOLLOW STEM AUGERS

DATE
START 1/18/2017
FINISH 1/18/2017
SHEET 1 OF 1

SJB SERVICES, INC.
SUBSURFACE LOG

HOLE NO. C-4
SURF. ELEV G.S.
G.W. DEPTH See Notes

PROJECT: PRATT-WILLERT GREEN STREETS PROJECT LOCATION: LOUISIANA STREET
PROJ. NO.: BE-16-278 BUFFALO, NY

DEPTH FT.	SMPL NO.	BLOWS ON SAMPLER 0/6	6/12	12/18	N	SOIL OR ROCK CLASSIFICATION	NOTES
						ASPHALT SUBBASE	Driller noted approx. 4" Asphalt and 3" Subbase at the ground surface
	1	9	8			Dark Brown f-c GRAVEL and f-c Sand, little Silty Clay (moist, FILL)	
	2	5	6			Brown f-c SAND, little Silty Clay, tr.gravel (moist-wet, FILL)	
		5	7		11		
5	3	5	4			Brown-Gray Silty CLAY, tr.sand, tr.organics (moist-wet, CL)	
						Boring Complete at 5.0'	No Free Standing Water encountered at Boring Completion
10							
15							
20							

N = NO. BLOWS TO DRIVE 2-INCH SPOON 12-INCHES WITH A 140 LB. PIN WT. FALLING 30-INCHES PER BLOW CLASSIFIED BY: Geologist

DRILLER: J. FRIDMAN DRILL RIG TYPE : CME-75

METHOD OF INVESTIGATION ASTM D-1586 USING HOLLOW STEM AUGERS

DATE START 1/18/2017 FINISH 1/18/2017 SHEET 1 OF 1	**SJB SERVICES, INC.** **SUBSURFACE LOG**	HOLE NO. C-5 SURF. ELEV G.S. G.W. DEPTH See Notes

PROJECT: PRATT-WILLERT GREEN STREETS PROJECT LOCATION: MIAMI STREET
PROJ. NO.: BE-16-278 BUFFALO, NY

DEPTH FT.	SMPL NO.	BLOWS ON SAMPLER 0/6	6/12	12/18	N	SOIL OR ROCK CLASSIFICATION	NOTES
						ASPHALT / CONCRETE SUBBASE	Driller noted approx. 4" Asphalt, 5" Concrete, and 10" Subbase at the ground surface
	1	–	2			Brown f-c SAND, little Silty Clay, tr.gravel (moist-wet, FILL)	
	2	2	2			Gray-Brown Silty CLAY, tr.sand (moist-wet, medium, CL)	
		3	4		5	Contains Silt partings	
5	3	3	3				
						Boring Complete at 5.0'	No Free Standing Water encountered at Boring Completion
10							
15							
20							

N = NO. BLOWS TO DRIVE 2-INCH SPOON 12-INCHES WITH A 140 LB. PIN WT. FALLING 30-INCHES PER BLOW CLASSIFIED BY: Geologist

DRILLER: J. FRIDMAN DRILL RIG TYPE : CME-75

METHOD OF INVESTIGATION ASTM D-1586 USING HOLLOW STEM AUGERS

DATE			
START	1/18/2017	**SJB SERVICES, INC.**	HOLE NO. I-1
FINISH	1/18/2017	**SUBSURFACE LOG**	SURF. ELEV G.S.
SHEET	1 OF 1		G.W. DEPTH See Notes

PROJECT: PRATT-WILLERT GREEN STREETS PROJECT LOCATION: 422 PRATT STREET
PROJ. NO.: BE-16-278 BUFFALO, NY

DEPTH FT.	SMPL NO.	BLOWS ON SAMPLER 0/6	6/12	12/18	N	SOIL OR ROCK CLASSIFICATION	NOTES
						ASPHALT SUBBASE	Driller noted approx. 3.5" Asphalt and 12" Subbase at the ground surface
	1	–	50/0.2		REF	Gray CONCRETE fragments (moist, FILL)	REF = Sample Spoon Refusal
	2	9	7				
		7	6		14	Brown Silty CLAY, tr.sand (moist-wet, stiff, CL)	
5	3	8	7			Contains Silt partings	
		3	5		10		
	4	6	5			Contains little f-c Gravel	
		5	7		10		
	5	10	50/0.1		REF	Contains little f-c Sand	
10						Boring Complete with Sample Spoon Refusal at 8.6'	No Free Standing Water encountered at Boring Completion 4" PVC groundwater infiltration test pipe installed within an adjacent test boring. Refer to test data sheet for additional information.
15							
20							

N = NO. BLOWS TO DRIVE 2-INCH SPOON 12-INCHES WITH A 140 LB. PIN WT. FALLING 30-INCHES PER BLOW CLASSIFIED BY: Geologist

DRILLER: J. FRIDMAN DRILL RIG TYPE : CME-75

METHOD OF INVESTIGATION ASTM D-1586 USING HOLLOW STEM AUGERS

DATE	
START	1/18/2017
FINISH	1/18/2017
SHEET	1 OF 1

SJB SERVICES, INC.
SUBSURFACE LOG

HOLE NO. I-2
SURF. ELEV G.S.
G.W. DEPTH See Notes

PROJECT: PRATT-WILLERT GREEN STREETS PROJECT LOCATION: 114 HICKORY STREET
PROJ. NO.: BE-16-278 BUFFALO, NY

DEPTH FT.	SMPL NO.	BLOWS ON SAMPLER 0/6	6/12	12/18	N	SOIL OR ROCK CLASSIFICATION	NOTES
	1	1	2			TOPSOIL Dark Brown Silty CLAY, little f-c Sand, tr.gravel, tr.organics (moist, FILL)	Driller noted Topsoil at the ground surface
		3	5		5		
	2	6	7			Gray SLAG and f-c Sand, little Silty Clay (moist, FILL)	
		3	5		10	Brown Silty CLAY, tr.sand (moist, stiff, CL)	
5	3	4	6			Contains tr.gravel (v.stiff)	
		14	16		20		
	4	17	23			(hard)	
		24	25		47		
	5	15	7			Contains Silt partings (moist-wet)	
10						Boring Complete at 9.0'	No Free Standing Water encountered at Boring Completion 4" PVC groundwater infiltration test pipe installed within an adjacent test boring. Refer to test data sheet for additional information.
15							
20							

N = NO. BLOWS TO DRIVE 2-INCH SPOON 12-INCHES WITH A 140 LB. PIN WT. FALLING 30-INCHES PER BLOW CLASSIFIED BY: Geologist

DRILLER: J. FRIDMAN DRILL RIG TYPE : CME-75

METHOD OF INVESTIGATION ASTM D-1586 USING HOLLOW STEM AUGERS

DATE	**SJB SERVICES, INC.**	HOLE NO. I-3
START 1/17/2017	**SUBSURFACE LOG**	SURF. ELEV G.S.
FINISH 1/17/2017		G.W. DEPTH See Notes
SHEET 1 OF 1		

PROJECT: PRATT-WILLERT GREEN STREETS PROJECT LOCATION: WILLIAM STREET
PROJ. NO.: BE-16-278 BUFFALO, NY

DEPTH FT.	SMPL NO.	BLOWS ON SAMPLER 0/6	6/12	12/18	N	SOIL OR ROCK CLASSIFICATION	NOTES
						ASPHALT SUBBASE	Driller noted approx. 5" Asphalt and 3' Subbase at the ground surface
	1	4	5			Gray f-c SAND, little Silty Clay (moist, FILL)	
5	2	7	5			Brown Silty CLAY, tr.sand (moist, stiff, CL)	
		9	12		14		
	3	16	19			Contains Silt partings (hard)	
		25	28		44		
	4	15	20				
10						Boring Complete at 9.0'	No Free Standing Water encountered at Boring Completion 4" PVC groundwater infiltration test pipe installed within an adjacent test boring. Refer to test data sheet for additional information.
15							
20							

N = NO. BLOWS TO DRIVE 2-INCH SPOON 12-INCHES WITH A 140 LB. PIN WT. FALLING 30-INCHES PER BLOW CLASSIFIED BY: Geologist

DRILLER: J. FRIDMAN DRILL RIG TYPE : CME-75

METHOD OF INVESTIGATION ASTM D-1586 USING HOLLOW STEM AUGERS

SJB SERVICES, INC.
SUBSURFACE LOG

DATE	
START	1/17/2017
FINISH	1/17/2017
SHEET	1 OF 1
HOLE NO.	I-4
SURF. ELEV	G.S.
G.W. DEPTH	See Notes

PROJECT: PRATT-WILLERT GREEN STREETS PROJECT LOCATION: WILLIAM STREET
PROJ. NO.: BE-16-278 BUFFALO, NY

DEPTH FT.	SMPL NO.	BLOWS ON SAMPLER 0/6	6/12	12/18	N	SOIL OR ROCK CLASSIFICATION	NOTES
						TOPSOIL	Driller noted Topsoil at
	1	2	2			Brown Silty CLAY, little f-c Gravel, little f-c Sand	the ground surface
						(moist, FILL)	
		3	5		5		
	2	5	4			Contains some f-c Gravel	
		3	4		7		
						Brown Silty CLAY, tr.sand (moist, hard, CL)	
5	3	10	15				
		17	18		32		
	4	9	19				
		20	22		39		
						Contains Silt partings	
	5	10	21				
10						Boring Complete at 9.0'	No Free Standing Water encountered at Boring Completion 4" PVC groundwater infiltration test pipe installed within an adjacent test boring. Refer to test data sheet for additional information.
15							
20							

N = NO. BLOWS TO DRIVE 2-INCH SPOON 12-INCHES WITH A 140 LB. PIN WT. FALLING 30-INCHES PER BLOW CLASSIFIED BY: Geologist

DRILLER: J. FRIDMAN DRILL RIG TYPE : CME-75

METHOD OF INVESTIGATION ASTM D-1586 USING HOLLOW STEM AUGERS

DATE		**SJB SERVICES, INC.**	HOLE NO. I-5
START	1/16/2017	**SUBSURFACE LOG**	SURF. ELEV G.S.
FINISH	1/16/2017		G.W. DEPTH See Notes
SHEET	1 OF 1		

PROJECT: PRATT-WILLERT GREEN STREETS PROJECT LOCATION: WILLIAM STREET
PROJ. NO.: BE-16-278 BUFFALO, NY

DEPTH FT.	SMPL NO.	BLOWS ON SAMPLER 0/6	6/12	12/18	N	SOIL OR ROCK CLASSIFICATION	NOTES
						ASPHALT SUBBASE	Driller noted approx. 10" Asphalt and 12" Subbase at the ground surface
						Brown Silty CLAY, tr.sand (moist, stiff, CL)	
	1	3	4				
		5	8		9		
5	2	6	7			Contains Silt partings (v.stiff)	
		11	13		18		
	3	19	21			(hard)	
		26	27		47		
	4	25	27				
10						Boring Complete at 9.0'	No Free Standing Water encountered at Boring Completion 4" PVC groundwater infiltration test pipe installed within an adjacent test boring. Refer to test data sheet for additional information.
15							
20							

N = NO. BLOWS TO DRIVE 2-INCH SPOON 12-INCHES WITH A 140 LB. PIN WT. FALLING 30-INCHES PER BLOW CLASSIFIED BY: Geologist

DRILLER: J. FRIDMAN DRILL RIG TYPE : CME-75

METHOD OF INVESTIGATION ASTM D-1586 USING HOLLOW STEM AUGERS

DATE		**SJB SERVICES, INC.**	HOLE NO. I-6
START	1/17/2017	**SUBSURFACE LOG**	SURF. ELEV G.S.
FINISH	1/17/2017		G.W. DEPTH See Notes
SHEET	1 OF 1		

PROJECT: PRATT-WILLERT GREEN STREETS PROJECT LOCATION: WILLIAM STREET

PROJ. NO.: BE-16-278 BUFFALO, NY

DEPTH FT.	SMPL NO.	BLOWS ON SAMPLER 0/6	6/12	12/18	N	SOIL OR ROCK CLASSIFICATION	NOTES
						TOPSOIL	Driller noted Topsoil at
	1	1	1			Brown Silty CLAY, little f-c Sand, tr.gravel	the ground surface
						(moist-wet, FILL)	
		2	3		3		
						Brown Silty CLAY, tr.sand (moist, stiff, CL)	
	2	4	5				
		6	7		11		
						Contains Silt partings (v.stiff)	
5	3	3	6				
		9	13		15		
						Contains tr.gravel	
	4	8	12				
		14	22		26		
	5	15	19				
10						Boring Complete at 9.0'	No Free Standing Water encountered at Boring Completion
							4" PVC groundwater infiltration test pipe installed within an adjacent test boring. Refer to test data sheet for additional information.
15							
20							

N = NO. BLOWS TO DRIVE 2-INCH SPOON 12-INCHES WITH A 140 LB. PIN WT. FALLING 30-INCHES PER BLOW CLASSIFIED BY: Geologist

DRILLER: J. FRIDMAN DRILL RIG TYPE : CME-75

METHOD OF INVESTIGATION ASTM D-1586 USING HOLLOW STEM AUGERS

DATE			
START	1/17/2017	**SJB SERVICES, INC.**	HOLE NO. I-7
FINISH	1/17/2017	**SUBSURFACE LOG**	SURF. ELEV G.S.
SHEET	1 OF 1		G.W. DEPTH See Notes

PROJECT: PRATT-WILLERT GREEN STREETS PROJECT LOCATION: WILLIAM STREET
PROJ. NO.: BE-16-278 BUFFALO, NY

DEPTH FT.	SMPL NO.	BLOWS ON SAMPLER 0/6	6/12	12/18	N	SOIL OR ROCK CLASSIFICATION	NOTES
	1	2	2			TOPSOIL Brown f-c SAND and silty Clay, little Concrete, tr.organics (moist, FILL)	Driller noted Topsoil at the ground surface
		2	3		4		
	2	4	6			Brown Silty CLAY, tr.sand (moist, stiff, CL)	
		7	8		13		
5	3	8	8			Contains Silt partings (v.stiff)	
		12	14		20		
	4	11	15			(hard)	
		18	20		33		
	5	13	17				
10						Boring Complete at 9.0'	No Free Standing Water encountered at Boring Completion 4" PVC groundwater infiltration test pipe installed within an adjacent test boring. Refer to test data sheet for additional information.
15							
20							

N = NO. BLOWS TO DRIVE 2-INCH SPOON 12-INCHES WITH A 140 LB. PIN WT. FALLING 30-INCHES PER BLOW CLASSIFIED BY: Geologist

DRILLER: J. FRIDMAN DRILL RIG TYPE : CME-75

METHOD OF INVESTIGATION ASTM D-1586 USING HOLLOW STEM AUGERS

DATE START: 1/17/2017 FINISH: 1/17/2017 SHEET 1 OF 1	**SJB SERVICES, INC.** **SUBSURFACE LOG**	HOLE NO. I-8 SURF. ELEV G.S. G.W. DEPTH See Notes

PROJECT: PRATT-WILLERT GREEN STREETS PROJECT LOCATION: WILLIAM STREET, BUFFALO, NY

PROJ. NO.: BE-16-278

DEPTH FT.	SMPL NO.	BLOWS ON SAMPLER 0/6	6/12	12/18	N	SOIL OR ROCK CLASSIFICATION	NOTES
						ASPHALT SUBBASE	Driller noted approx. 13.5" Asphalt and 10" Subbase at the ground surface
	1	8	6			Brown Silty CLAY, tr.sand (moist, stiff, CL)	
		7	7		13	Contains Silt partings	
5	2	7	8				
		7	8		15	(v.stiff)	
	3	8	9				
		10	12		19		
	4	10	14			Contains tr.gravel	
10						Boring Complete at 9.0'	No Free Standing Water encountered at Boring Completion 4" PVC groundwater infiltration test pipe installed within an adjacent test boring. Refer to test data sheet for additional information.
15							
20							

N = NO. BLOWS TO DRIVE 2-INCH SPOON 12-INCHES WITH A 140 LB. PIN WT. FALLING 30-INCHES PER BLOW CLASSIFIED BY: Geologist

DRILLER: J. FRIDMAN DRILL RIG TYPE : CME-75

METHOD OF INVESTIGATION ASTM D-1586 USING HOLLOW STEM AUGERS

DATE		
START	1/17/2017	
FINISH	1/17/2017	
SHEET	1 OF 1	

SJB SERVICES, INC.
SUBSURFACE LOG

HOLE NO. I-9
SURF. ELEV G.S.
G.W. DEPTH See Notes

PROJECT: PRATT-WILLERT GREEN STREETS PROJECT LOCATION: WILLIAM STREET
PROJ. NO.: BE-16-278 BUFFALO, NY

DEPTH FT.	SMPL NO.	BLOWS ON SAMPLER 0/6	6/12	12/18	N	SOIL OR ROCK CLASSIFICATION	NOTES
						TOPSOIL	Driller noted Topsoil at
	1	1	2			Brown Silty CLAY, little f-c Sand, tr.gravel	the ground surface
						(moist, FILL)	
		3	4		5		
						Brown Silty CLAY, tr.sand (moist, v.stiff, CL)	
	2	4	7				
						Contains Silt partings	
		8	7		15		
							No Recovery Sample #3
5	3	4	4			(stiff)	
		4	16		8		
						Contains "and" f-c Gravel, little f-c Sand (v.stiff)	
	4	10	15				
		13	20		28		
	5	16	21				
10						Boring Complete at 9.0'	No Free Standing Water encountered at Boring Completion 4" PVC groundwater infiltration test pipe installed within an adjacent test boring. Refer to test data sheet for additional information.
15							
20							

N = NO. BLOWS TO DRIVE 2-INCH SPOON 12-INCHES WITH A 140 LB. PIN WT. FALLING 30-INCHES PER BLOW CLASSIFIED BY: Geologist

DRILLER: J. FRIDMAN DRILL RIG TYPE : CME-75

METHOD OF INVESTIGATION ASTM D-1586 USING HOLLOW STEM AUGERS

APPENDIX D

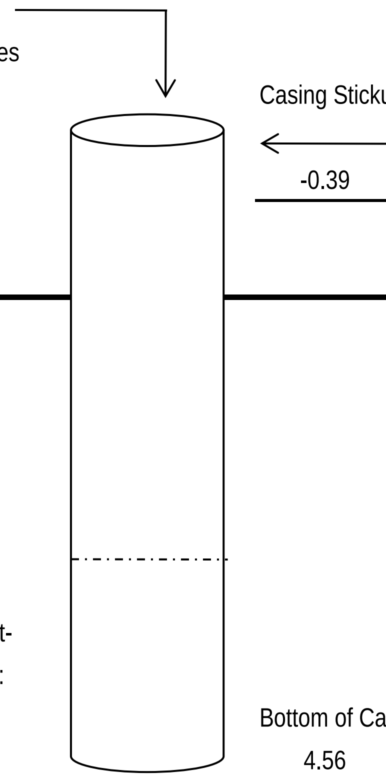
INFILTRATION TEST DATA SUMMARIES

INFILTRATION TEST DATA SUMMARY

PROJECT: BSA - PRATT WILLERT
LOCATION: BUFFALO, NY
PROJECT NO.: BE-16-278

INFILTRATION TEST POINT: I-1
PRESOAK DATE: 1/18/2017
PRESOAK TIME: 14:00

Diameter of Casing: 4 inches



Casing Stickup: -0.39 feet

Existing Grade

Total depth of infiltration test point- from top of casing: 4.17 feet

Bottom of Casing: 4.56 feet below ground surface

TEST DATA

TEST DATE: 1/20/2017
START OF TEST TIME: 11:35

IS THERE PRESOAK WATER IN TEST CASING?
YES (NO) — NO circled

IF YES, WHAT DEPTH:
NA FEET FROM TOP OF CASING.

RUN NUMBER	START TIME (HOURS)	END TIME (HOURS)	ELAPSED TIME (MIN)	DROP IN WATER LEVEL DURING TEST RUN (FEET)	REFILLED WITH WATER, LEVEL FROM TOP OF CASING (FEET)
START					2.17
RUN #1	11:35	12:35	60	1.89	2.17
RUN #2	12:38	13:38	60	1.72	2.17
RUN #3	13:40	14:40	60	1.72	2.17
RUN #4	14:43	15:43	60	1.77	

AVERAGE INFILTRATION RATE 1.77 FEET PER HOUR
AVERAGE INFILTRATION RATE 21 INCHES PER HOUR

TESTED BY: S. BOCHENEK

SJB SERVICES, INC.

INFILTRATION TEST DATA SUMMARY

PROJECT: BSA - PRATT WILLERT

LOCATION: BUFFALO, NY

PROJECT NO.: BE-16-278

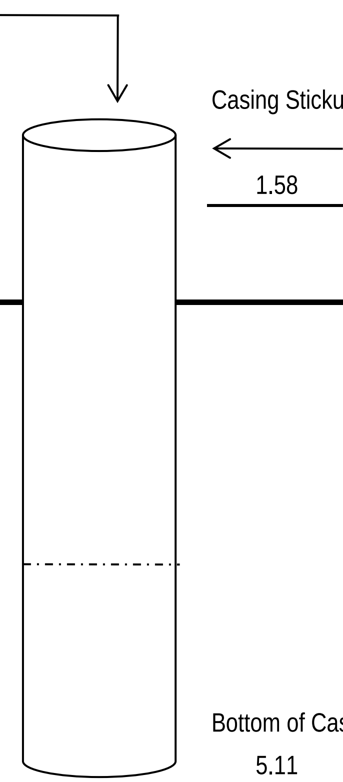
INFILTRATION TEST POINT: I-1A

PRESOAK DATE: 2/2/2017

PRESOAK TIME: 9:00

Diameter of Casing: 4 inches

Casing Stickup: 1.58 feet



Existing Grade

Total depth of infiltration test point- from top of casing: 6.69 feet

Bottom of Casing 5.11 feet below ground surface

TEST DATA

TEST DATE: 2/3/2017

START OF TEST TIME: 10:57

IS THERE PRESOAK WATER IN TEST CASING?

YES (NO) — NO circled

IF YES, WHAT DEPTH:

NA FEET FROM TOP OF CASING.

RUN NUMBER	START TIME (HOURS)	END TIME (HOURS)	ELAPSED TIME (MIN)	DROP IN WATER LEVEL DURING TEST RUN (FEET)	REFILLED WITH WATER, LEVEL FROM TOP OF CASING (FEET)
START					4.67
RUN #1	10:57	11:25	28	2.00	4.67
RUN #2	11:25	11:57	32	1.92	4.67
RUN #3	11:57	12:30	33	1.75	4.67
RUN #4	12:30	13:30	60	1.83	

APPROXIMATE INFILTRATION RATE 1.83 FEET PER HOUR

APPROXIMATE INFILTRATION RATE 22 INCHES PER HOUR

TESTED BY: A. MORSE

INFILTRATION TEST DATA SUMMARY

PROJECT: BSA - PRATT WILLERT

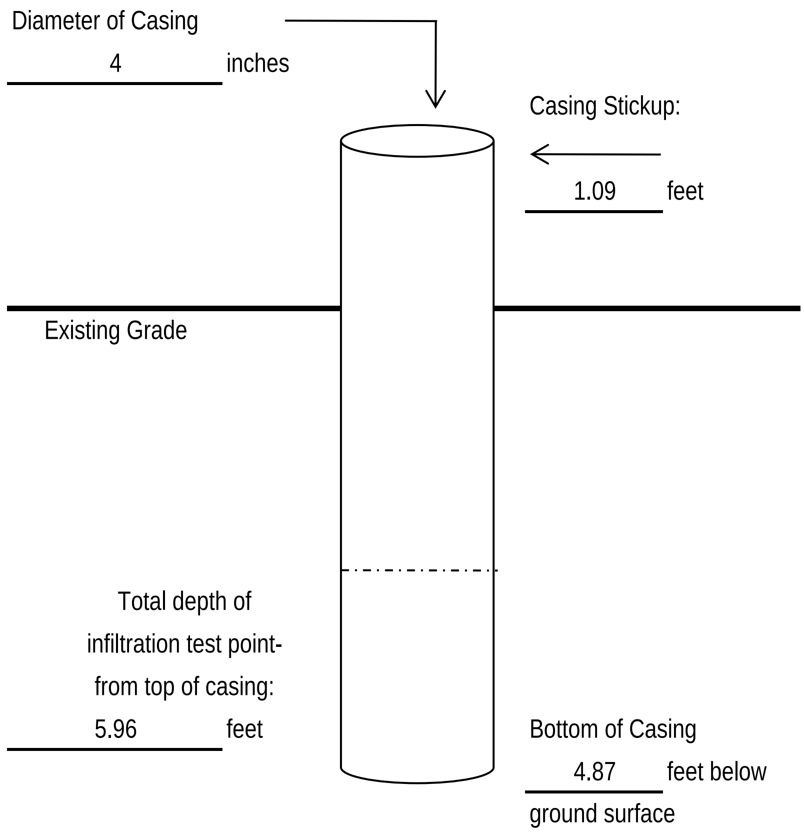
LOCATION: BUFFALO, NY

PROJECT NO.: BE-16-278

INFILTRATION
TEST POINT: I-2

PRESOAK DATE: 1/18/2017

PRESOAK TIME: 14:05



TEST DATA

TEST DATE: 1/20/2017

START OF TEST TIME: 11:28

IS THERE PRESOAK WATER IN TEST CASING?

(YES) NO

IF YES, WHAT DEPTH:

4.70 FEET FROM TOP OF CASING.

RUN NUMBER	START TIME (HOURS)	END TIME (HOURS)	ELAPSED TIME (MIN)	DROP IN WATER LEVEL DURING TEST RUN (FEET)	REFILLED WITH WATER, LEVEL FROM TOP OF CASING (FEET)
START					2.70
RUN #1	11:28	12:28	60	1.46	2.70
RUN #2	12:30	13:30	60	1.22	2.70
RUN #3	13:32	14:32	60	1.21	2.70
RUN #4	14:34	15:34	60	1.19	

Two feet of water added above remaining presoak water, resulting in about 3.3' of water above bottom.

APPROXIMATE INFILTRATION RATE 1.2 FEET PER HOUR

APPROXIMATE INFILTRATION RATE 14 INCHES PER HOUR

TESTED BY: S. BOCHENEK

INFILTRATION TEST DATA SUMMARY

PROJECT: BSA - PRATT WILLERT

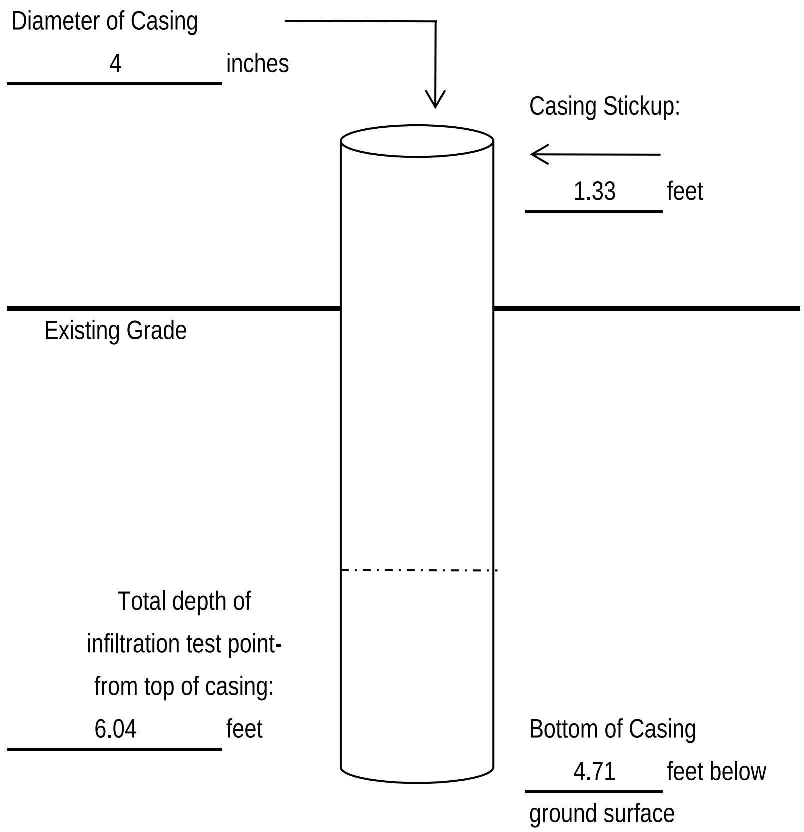
LOCATION: BUFFALO, NY

PROJECT NO.: BE-16-278

INFILTRATION
TEST POINT: I-2A

PRESOAK DATE: 2/2/2017

PRESOAK TIME: 9:05



TEST DATA

TEST DATE: 2/3/2017

START OF TEST TIME: 10:34

IS THERE PRESOAK WATER IN TEST CASING?

(YES) NO

IF YES, WHAT DEPTH:

4.58 FEET FROM TOP OF CASING.

RUN NUMBER	START TIME (HOURS)	END TIME (HOURS)	ELAPSED TIME (MIN)	DROP IN WATER LEVEL DURING TEST RUN (FEET)	REFILLED WITH WATER, LEVEL FROM TOP OF CASING (FEET)
START					2.58
RUN #1	10:34	11:34	60	0.08	2.58
RUN #2	11:34	12:34	60	0.0	2.58
RUN #3	12:34	13:34	60	0.0	2.58
RUN #4	13:34	14:30	60	0.0	

Two feet of water added above remaining presoak water, resulting in about 3.5' of water above bottom.

APPROXIMATE INFILTRATION RATE 0.0 FEET PER HOUR

APPROXIMATE INFILTRATION RATE 0.0 INCHES PER HOUR

TESTED BY: A. MORSE

SJB SERVICES, INC.

INFILTRATION TEST DATA SUMMARY

PROJECT: BSA - PRATT WILLERT

LOCATION: BUFFALO, NY

PROJECT NO.: BE-16-278

INFILTRATION
TEST POINT: I-3

PRESOAK DATE: 1/18/2017

PRESOAK TIME: 14:15

TEST DATA

TEST DATE: 1/20/2017

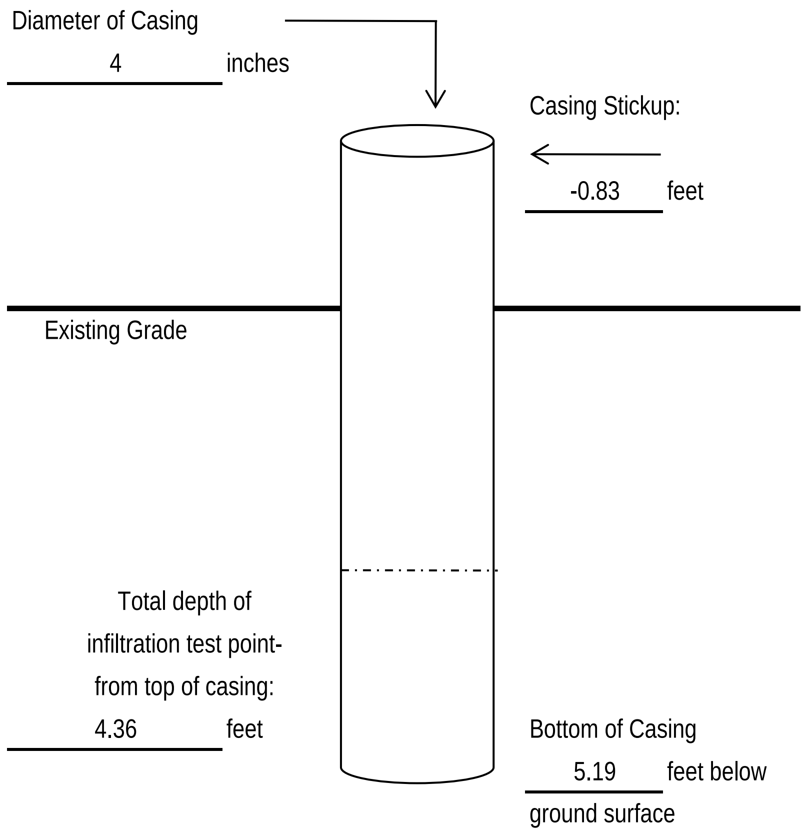
START OF TEST TIME: 9:15

IS THERE PRESOAK WATER IN TEST CASING?

(YES) NO

IF YES, WHAT DEPTH:

3.45 FEET FROM TOP OF CASING.



RUN NUMBER	START TIME (HOURS)	END TIME (HOURS)	ELAPSED TIME (MIN)	DROP IN WATER LEVEL DURING TEST RUN (FEET)	REFILLED WITH WATER, LEVEL FROM TOP OF CASING (FEET)
START					1.45
RUN #1	9:15	10:15	60	0.30	1.45
RUN #2	10:20	11:20	60	0.28	1.45
RUN #3	11:22	12:22	60	0.30	1.45
RUN #4	12:24	13:24	60	0.32	

Two feet of water added above remaining presoak water, resulting in about 2.9' of water above bottom.

APPROXIMATE INFILTRATION RATE 0.30 FEET PER HOUR

APPROXIMATE INFILTRATION RATE 3.6 INCHES PER HOUR

TESTED BY: S. BOCHENEK

INFILTRATION TEST DATA SUMMARY

SJB SERVICES, INC.

PROJECT: BSA - PRATT WILLERT

LOCATION: BUFFALO, NY

PROJECT NO.: BE-16-278

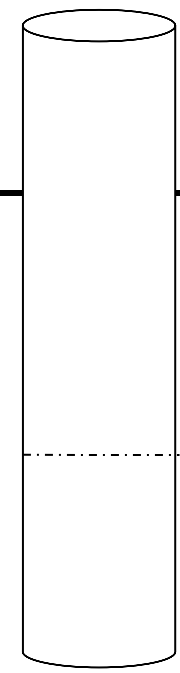
INFILTRATION TEST POINT: I-4

PRESOAK DATE: 1/18/2017

PRESOAK TIME: 14:20

Diameter of Casing: 4 inches

Casing Stickup: 0.75 feet



Existing Grade

TEST DATA

TEST DATE: 1/19/2017

START OF TEST TIME: 11:40

IS THERE PRESOAK WATER IN TEST CASING?

(YES) NO

IF YES, WHAT DEPTH:

4.93 FEET FROM TOP OF CASING.

Total depth of infiltration test point- from top of casing: 5.15 feet

Bottom of Casing 4.40 feet below ground surface

RUN NUMBER	START TIME (HOURS)	END TIME (HOURS)	ELAPSED TIME (MIN)	DROP IN WATER LEVEL DURING TEST RUN (FEET)	REFILLED WITH WATER, LEVEL FROM TOP OF CASING (FEET)
START					2.93
RUN #1	11:40	12:40	60	1.39	2.93
RUN #2	12:42	13:42	60	1.04	2.93
RUN #3	13:44	14:44	60	1.09	2.93
RUN #4	14:46	15:46	60	0.96	

Two feet of water added above remaining presoak water, resulting in about 2.2' of water above bottom.

APPROXIMATE INFILTRATION RATE 1.0 FEET PER HOUR

APPROXIMATE INFILTRATION RATE 12.0 INCHES PER HOUR

TESTED BY: S. BOCHENEK

INFILTRATION TEST DATA SUMMARY

PROJECT: BSA - PRATT WILLERT

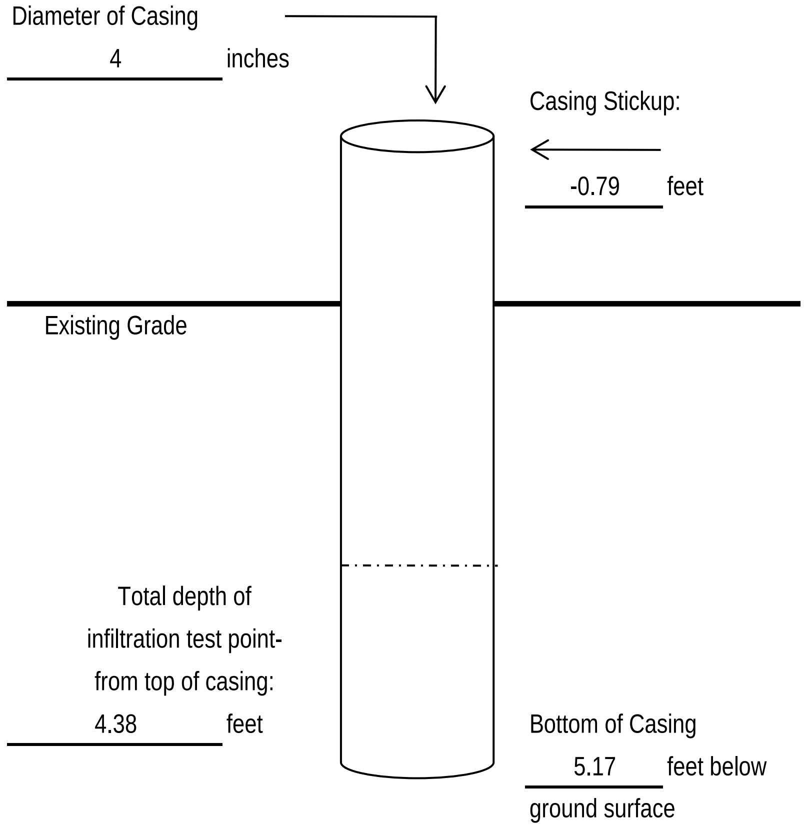
LOCATION: BUFFALO, NY

PROJECT NO.: BE-16-278

INFILTRATION TEST POINT: I-5

PRESOAK DATE: 1/18/2017

PRESOAK TIME: 14:25



TEST DATA

TEST DATE: 1/19/2017

START OF TEST TIME: 9:40

IS THERE PRESOAK WATER IN TEST CASING?

(YES) NO

IF YES, WHAT DEPTH:

3.85 FEET FROM TOP OF CASING.

RUN NUMBER	START TIME (HOURS)	END TIME (HOURS)	ELAPSED TIME (MIN)	DROP IN WATER LEVEL DURING TEST RUN (FEET)	REFILLED WITH WATER, LEVEL FROM TOP OF CASING (FEET)
START					1.85
RUN #1	9:40	10:40	60	0.45	1.85
RUN #2	10:42	11:42	60	0.05	1.85
RUN #3	11:44	12:44	60	0.0	1.85
RUN #4	12:45	13:45	60	0.0	

Two feet of water added above remaining presoak water, resulting in about 2.5' of water above bottom.

APPROXIMATE INFILTRATION RATE 0.0 FEET PER HOUR

APPROXIMATE INFILTRATION RATE 0.0 INCHES PER HOUR

TESTED BY: S. BOCHENEK

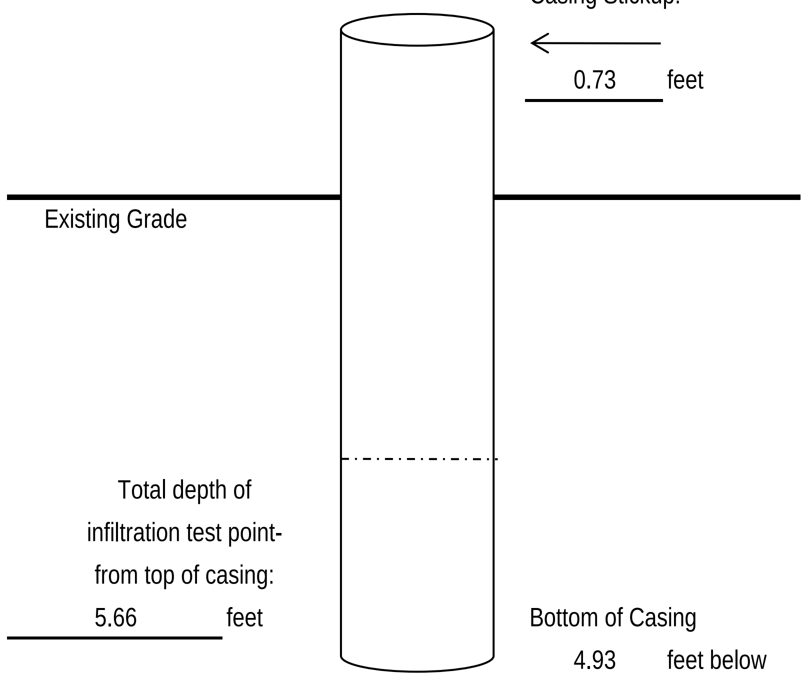
INFILTRATION TEST DATA SUMMARY

PROJECT: BSA - PRATT WILLERT
LOCATION: BUFFALO, NY
PROJECT NO.: BE-16-278

INFILTRATION
TEST POINT: I-6
PRESOAK DATE: 1/18/2017
PRESOAK TIME: 14:30

Diameter of Casing
4 inches

Casing Stickup:
0.73 feet



Existing Grade

Total depth of infiltration test point- from top of casing:
5.66 feet

Bottom of Casing
4.93 feet below ground surface

TEST DATA

TEST DATE: 1/19/2017
START OF TEST TIME: 9:45

IS THERE PRESOAK WATER IN TEST CASING?
(YES) NO
IF YES, WHAT DEPTH:
4.88 FEET FROM TOP OF CASING.

RUN NUMBER	START TIME (HOURS)	END TIME (HOURS)	ELAPSED TIME (MIN)	DROP IN WATER LEVEL DURING TEST RUN (FEET)	REFILLED WITH WATER, LEVEL FROM TOP OF CASING (FEET)
START					2.88
RUN #1	9:45	10:45	60	0.22	2.88
RUN #2	10:46	11:46	60	0.0	2.88
RUN #3	11:47	12:47	60	0.0	2.88
RUN #4	12:48	13:48	60	0.0	

Two feet of water added above remaining presoak water, resulting in about 2.8' of water above bottom.

APPROXIMATE INFILTRATION RATE 0.0 FEET PER HOUR
APPROXIMATE INFILTRATION RATE 0.0 INCHES PER HOUR

TESTED BY: S. BOCHENEK

INFILTRATION TEST DATA SUMMARY

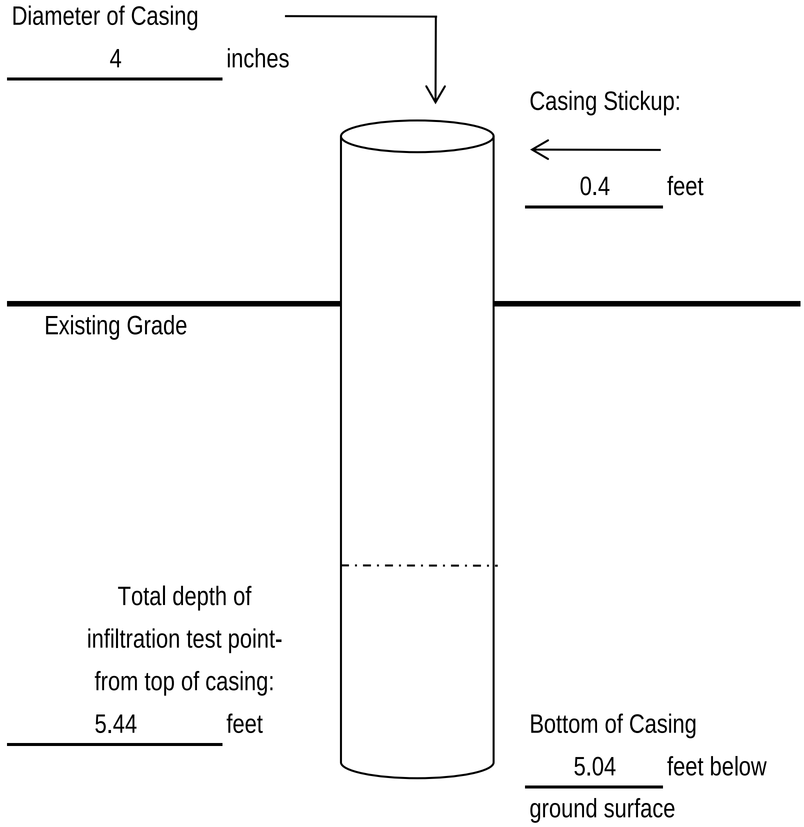
PROJECT: BSA - PRATT WILLERT
LOCATION: BUFFALO, NY
PROJECT NO.: BE-16-278

INFILTRATION
TEST POINT: I-7
PRESOAK DATE: 1/18/2017
PRESOAK TIME: 14:35

TEST DATA

TEST DATE: 1/19/2017
START OF TEST TIME: 9:30

IS THERE PRESOAK WATER IN TEST CASING?
(YES) NO
IF YES, WHAT DEPTH:
4.83 FEET FROM TOP OF CASING.



RUN NUMBER	START TIME (HOURS)	END TIME (HOURS)	ELAPSED TIME (MIN)	DROP IN WATER LEVEL DURING TEST RUN (FEET)	REFILLED WITH WATER, LEVEL FROM TOP OF CASING (FEET)
START					2.83
RUN #1	9:30	10:30	60	0.81	2.83
RUN #2	10:32	11:32	60	0.53	2.83
RUN #3	11:35	12:35	60	0.22	2.83
RUN #4	12:37	13:47	60	0.01	

Two feet of water added above remaining presoak water, resulting in about 2.6' of water above bottom.

APPROXIMATE INFILTRATION RATE 0.01 FEET PER HOUR
APPROXIMATE INFILTRATION RATE 0.10 INCHES PER HOUR

TESTED BY: S. BOCHENEK

SJB SERVICES, INC.

INFILTRATION TEST DATA SUMMARY

PROJECT: BSA - PRATT WILLERT

LOCATION: BUFFALO, NY

PROJECT NO.: BE-16-278

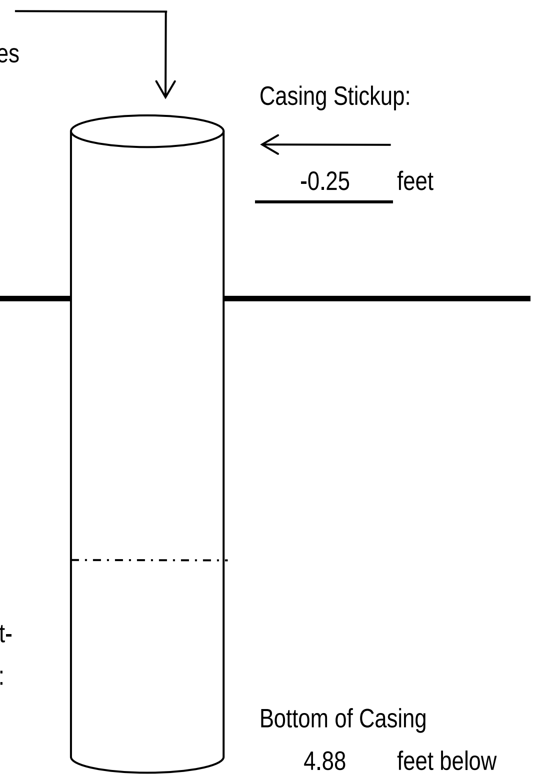
INFILTRATION TEST POINT: I-8

PRESOAK DATE: 1/18/2017

PRESOAK TIME: 14:40

Diameter of Casing 4 inches

Casing Stickup: -0.25 feet



Existing Grade

Total depth of infiltration test point- from top of casing: 4.63 feet

Bottom of Casing 4.88 feet below ground surface

TEST DATA

TEST DATE: 1/19/2017

START OF TEST TIME: 9:20

IS THERE PRESOAK WATER IN TEST CASING?

(YES) NO

IF YES, WHAT DEPTH:

3.36 FEET FROM TOP OF CASING.

RUN NUMBER	START TIME (HOURS)	END TIME (HOURS)	ELAPSED TIME (MIN)	DROP IN WATER LEVEL DURING TEST RUN (FEET)	REFILLED WITH WATER, LEVEL FROM TOP OF CASING (FEET)
START					1.36
RUN #1	9:20	10:20	60	0.93	1.36
RUN #2	10:21	11:21	60	0.78	1.36
RUN #3	11:23	12:23	60	0.74	1.36
RUN #4	12:25	13:25	60	1.05	

Two feet of water added above remaining presoak water, resulting in about 3.3' of water above bottom.

APPROXIMATE INFILTRATION RATE 0.75 FEET PER HOUR

APPROXIMATE INFILTRATION RATE 9.0 INCHES PER HOUR

TESTED BY: S. BOCHENEK

INFILTRATION TEST DATA SUMMARY

PROJECT: BSA - PRATT WILLERT

LOCATION: BUFFALO, NY

PROJECT NO.: BE-16-278

INFILTRATION
TEST POINT: I-9

PRESOAK DATE: 1/18/2017

PRESOAK TIME: 14:45

TEST DATA

TEST DATE: 1/19/2017

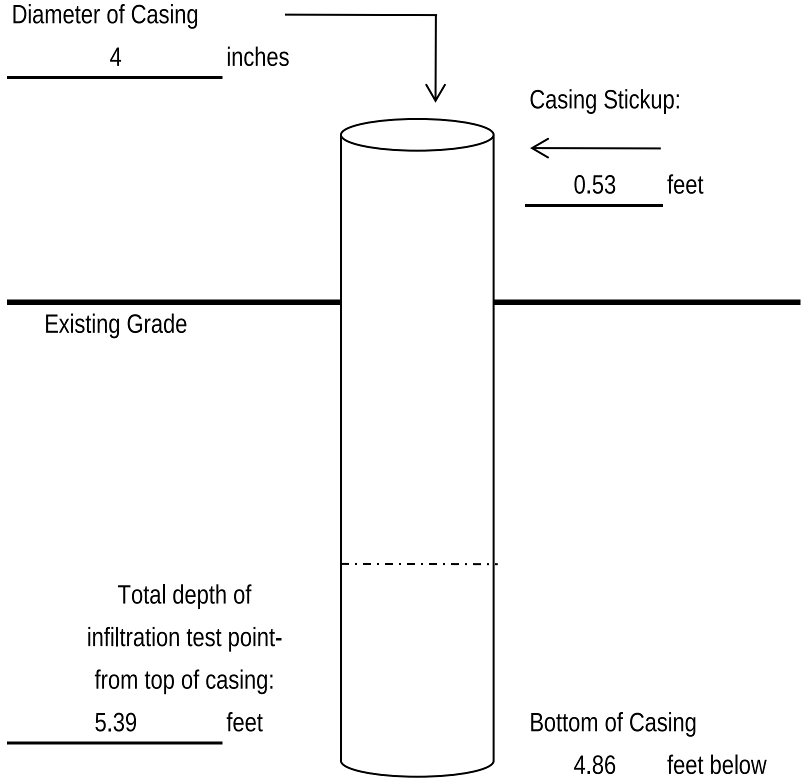
START OF TEST TIME: 9:00

IS THERE PRESOAK WATER IN TEST CASING?

(YES) NO

IF YES, WHAT DEPTH:

4.49 FEET FROM TOP OF CASING.



RUN NUMBER	START TIME (HOURS)	END TIME (HOURS)	ELAPSED TIME (MIN)	DROP IN WATER LEVEL DURING TEST RUN (FEET)	REFILLED WITH WATER, LEVEL FROM TOP OF CASING (FEET)
START					2.49
RUN #1	9:00	10:00	60	1.20	2.49
RUN #2	10:01	11:01	60	1.13	2.49
RUN #3	11:02	12:02	60	0.78	2.49
RUN #4	12:03	13:03	60	0.46	

Two feet of water added above remaining presoak water, resulting in about 2.9' of water above bottom.

APPROXIMATE INFILTRATION RATE 0.46 FEET PER HOUR

APPROXIMATE INFILTRATION RATE 5.5 INCHES PER HOUR

TESTED BY: S. BOCHENEK

SJB SERVICES, INC.

INFILTRATION TEST DATA SUMMARY

PROJECT: BSA - PRATT WILLERT

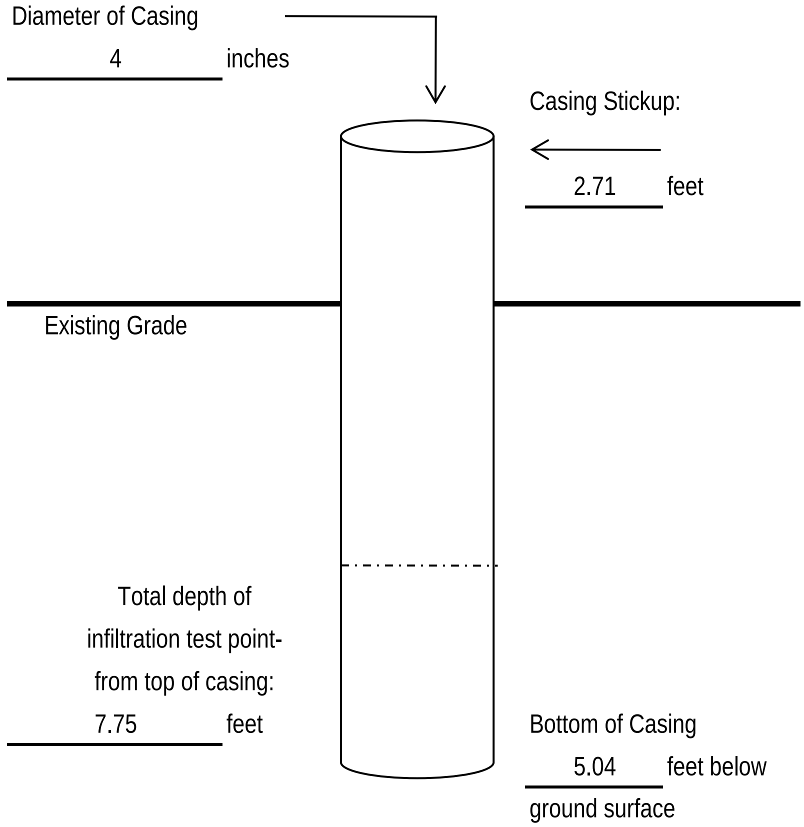
LOCATION: BUFFALO, NY

PROJECT NO.: BE-16-278

INFILTRATION
TEST POINT: I-9A

PRESOAK DATE: 2/2/2017

PRESOAK TIME: 9:45



TEST DATA

TEST DATE: 2/3/2017

START OF TEST TIME: 10:45

IS THERE PRESOAK WATER IN TEST CASING?

(YES) NO

IF YES, WHAT DEPTH:

5.75 FEET FROM TOP OF CASING.

RUN NUMBER	START TIME (HOURS)	END TIME (HOURS)	ELAPSED TIME (MIN)	DROP IN WATER LEVEL DURING TEST RUN (FEET)	REFILLED WITH WATER, LEVEL FROM TOP OF CASING (FEET)
START					3.67
RUN #1	10:45	11:45	60	0.0	3.67
RUN #2	11:45	12:45	60	0.0	3.67
RUN #3	12:45	13:45	60	0.0	3.67
RUN #4	13:45	14:45	60	0.0	

Two feet of water added above remaining presoak water, resulting in about 4.1' of water above bottom.

APPROXIMATE INFILTRATION RATE 0.0 FEET PER HOUR

APPROXIMATE INFILTRATION RATE 0.0 INCHES PER HOUR

TESTED BY: A. MORSE

APPENDIX E

GEOTECHNICAL REPORT LIMITATIONS

GEOTECHNICAL REPORT LIMITATIONS

Empire Geo-Services, Inc. (Empire) has endeavored to meet the generally accepted standard of care for the services completed, and in doing so is obliged to advise the geotechnical report user of our report limitations. Empire believes that providing information about the report preparation and limitations is essential to help the user reduce geotechnical-related delays, cost over-runs, and other problems that can develop during the design and construction process. Empire would be pleased to answer any questions regarding the following limitations and use of our report to assist the user in assessing risks and planning for site development and construction.

PROJECT SPECIFIC FACTORS: The conclusions and recommendations provided in our geotechnical report were prepared based on project specific factors described in the report, such as size, loading, and intended use of structures; general configuration of structures, roadways, and parking lots; existing and proposed site grading; and any other pertinent project information. Changes to the project details may alter the factors considered in development of the report conclusions and recommendations. *Accordingly, Empire cannot accept responsibility for problems which may develop if we are not consulted regarding any changes to the project specific factors that were assumed during the report preparation.*

SUBSURFACE CONDITIONS: The site exploration investigated subsurface conditions only at discrete test locations. Empire has used judgement to infer subsurface conditions between the discrete test locations, and on this basis the conclusions and recommendations in our geotechnical report were developed. It should be understood that the overall subsurface conditions inferred by Empire may vary from those revealed during construction, and these variations may impact on the assumptions made in developing the report conclusions and recommendations. *For this reason, Empire should be retained during construction to confirm that conditions are as expected, and to refine our conclusions and recommendations in the event that conditions are encountered that were not disclosed during the site exploration program.*

USE OF GEOTECHNICAL REPORT: Unless indicated otherwise, our geotechnical report has been prepared for the use of our client for specific application to the site and project conditions described in the report. *Without consulting with Empire, our geotechnical report should not be applied by any party to other sites or for any uses other than those originally intended.*

CHANGES IN SITE CONDITIONS: Surface and subsurface conditions are subject to change at a project site subsequent to preparation of the geotechnical report. Changes may include, but are not limited to, floods, earthquakes, groundwater fluctuations, and construction activities at the site and/or adjoining properties. *Empire should be informed of any such changes to determine if additional investigative and/or evaluation work is warranted.*

MISINTERPRETATION OF REPORT: The conclusions and recommendations contained in our geotechnical report are subject to misinterpretation. *To limit this possibility, Empire should review project plans and specifications relative to geotechnical issues to confirm that the recommendations contained in our report have been properly interpreted and applied.*

Subsurface exploration logs and other report data are also subject to misinterpretation by others if they are separated from the geotechnical report. This often occurs when copies of logs are given to contractors during the bid preparation process. *To minimize the potential for misinterpretation, the subsurface logs should not be separated from our geotechnical report and the use of excerpted or incomplete portions of the report should be avoided.*

OTHER LIMITATIONS: Geotechnical engineering is less exact than other design disciplines, as it is based partly on judgement and opinion. For this reason, our geotechnical report may include clauses that identify the limits of Empire's responsibility, or that may describe other limitations specific to a project. These clauses are intended to help all parties recognize their responsibilities and to assist them in assessing risks and decision making. Empire would be pleased to discuss these clauses and to answer any questions that may arise.

APPENDIX B

Correspondence

December 01, 2016

Ms. Catherine Knab
Principal Sanitary Engineer
Buffalo Sewer Authority
Room 1038 City Hall
65 Niagara Square
Buffalo, NY 14202

Re: NYSEFC
Willert Park Green Streets
City of Buffalo, Erie County, NY
16PR08124

Dear Ms. Knab:

Thank you for requesting the comments of the State Historic Preservation Office (SHPO). We have reviewed the project in accordance with Section 106 of the National Historic Preservation Act of 1966. These comments are those of the SHPO and relate only to Historic/Cultural resources. They do not include potential environmental impacts to New York State Parkland that may be involved in or near your project. Such impacts must be considered as part of the environmental review of the project pursuant to the National Environmental Policy Act and/or the State Environmental Quality Review Act (New York Environmental Conservation Law Article 8).

Based upon this review, the New York SHPO has determined that no historic properties will be affected by this undertaking.

If further correspondence is required regarding this project, please be sure to refer to the OPRHP Project Review (PR) number noted above.

Sincerely,

Ruth L. Pierpont

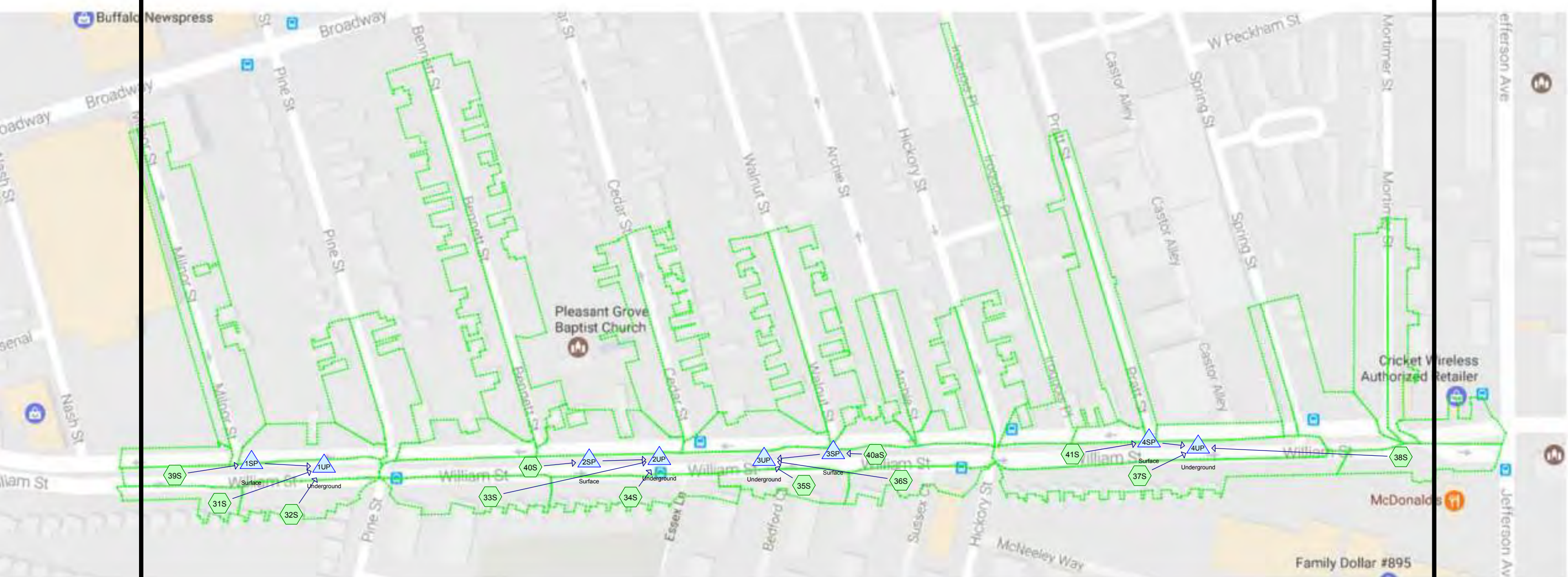
Ruth L. Pierpont
Deputy Commissioner for Historic Preservation

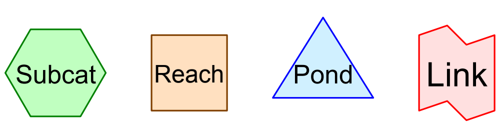
APPENDIX C1

HydroCAD Calculations

wendel

HydroCAD Output for the WQv Storm: Bioretention Areas along William Street





Routing Diagram for William Street Median Bio(1-17-17)
Prepared by Wendel, Printed 2/15/2017
HydroCAD® 10.00-13 s/n 00557 © 2014 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
3.670	84	50-75% Grass cover, Fair, HSG D (31S, 32S, 33S, 34S, 35S, 36S, 37S, 38S, 39S, 40aS, 40S, 41S)
3.531	98	Paved parking, HSG D (31S, 32S, 33S, 34S, 35S, 36S, 37S, 38S, 39S, 40aS, 40S, 41S)
7.201	**91**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
7.201	HSG D	31S, 32S, 33S, 34S, 35S, 36S, 37S, 38S, 39S, 40aS, 40S, 41S
0.000	Other	
7.201		**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	3.670	0.000	3.670	50-75% Grass cover, Fair	31S, 32S, 33S, 34S, 35S, 36S, 37S, 38S, 39S, 40aS, 40S, 41S
0.000	0.000	0.000	3.531	0.000	3.531	Paved parking	31S, 32S, 33S, 34S, 35S, 36S, 37S, 38S, 39S, 40aS, 40S, 41S
0.000	**0.000**	**0.000**	**7.201**	**0.000**	**7.201**	**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	1UP	22.73	22.43	15.0	0.0200	0.012	15.0	0.0	0.0
2	2UP	20.74	20.28	23.0	0.0200	0.012	15.0	0.0	0.0
3	3UP	19.21	18.81	20.0	0.0200	0.012	15.0	0.0	0.0
4	4UP	18.09	17.63	23.0	0.0200	0.012	18.0	0.0	0.0

Time span=0.00-60.00 hrs, dt=0.01 hrs, 6001 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment31S: Runoff Area=0.270 ac 70.37% Impervious Runoff Depth=0.46"
Tc=5.0 min CN=94 Runoff=0.23 cfs 0.010 af

Subcatchment32S: Runoff Area=0.460 ac 56.52% Impervious Runoff Depth=0.37"
Tc=5.0 min CN=92 Runoff=0.31 cfs 0.014 af

Subcatchment33S: Runoff Area=0.610 ac 49.18% Impervious Runoff Depth=0.32"
Tc=5.0 min CN=91 Runoff=0.37 cfs 0.017 af

Subcatchment34S: Runoff Area=0.590 ac 49.15% Impervious Runoff Depth=0.32"
Tc=5.0 min CN=91 Runoff=0.36 cfs 0.016 af

Subcatchment35S: Runoff Area=0.390 ac 56.41% Impervious Runoff Depth=0.37"
Tc=5.0 min CN=92 Runoff=0.27 cfs 0.012 af

Subcatchment36S: Runoff Area=0.410 ac 58.54% Impervious Runoff Depth=0.37"
Tc=5.0 min CN=92 Runoff=0.28 cfs 0.013 af

Subcatchment37S: Runoff Area=1.050 ac 55.24% Impervious Runoff Depth=0.37"
Tc=5.0 min CN=92 Runoff=0.72 cfs 0.032 af

Subcatchment38S: Runoff Area=0.500 ac 82.00% Impervious Runoff Depth=0.52"
Tc=5.0 min CN=95 Runoff=0.48 cfs 0.022 af

Subcatchment39S: Runoff Area=0.610 ac 37.70% Impervious Runoff Depth=0.25"
Tc=5.0 min CN=89 Runoff=0.28 cfs 0.013 af

Subcatchment40aS: Runoff Area=0.781 ac 32.14% Impervious Runoff Depth=0.22"
Tc=5.0 min CN=88 Runoff=0.31 cfs 0.015 af

Subcatchment40S: Runoff Area=0.700 ac 28.57% Impervious Runoff Depth=0.22"
Tc=5.0 min CN=88 Runoff=0.28 cfs 0.013 af

Subcatchment41S: Runoff Area=0.830 ac 43.37% Impervious Runoff Depth=0.29"
Tc=5.0 min CN=90 Runoff=0.44 cfs 0.020 af

Pond 1SP: Surface Peak Elev=25.95' Storage=564 cf Inflow=0.28 cfs 0.013 af
Outflow=0.00 cfs 0.000 af

Pond 1UP: Underground Peak Elev=22.64' Storage=1,065 cf Inflow=0.55 cfs 0.024 af
15.0" Round Culvert n=0.012 L=15.0' S=0.0200 '/' Outflow=0.00 cfs 0.000 af

Pond 2SP: Surface Peak Elev=24.15' Storage=571 cf Inflow=0.28 cfs 0.013 af
Outflow=0.00 cfs 0.000 af

Pond 2UP: Underground Peak Elev=20.70' Storage=1,415 cf Inflow=0.72 cfs 0.032 af
15.0" Round Culvert n=0.012 L=23.0' S=0.0200 '/' Outflow=0.00 cfs 0.000 af

Pond 3SP: Surface Peak Elev=22.38' Storage=637 cf Inflow=0.31 cfs 0.015 af
Outflow=0.00 cfs 0.000 af

Pond 3UP: Underground Peak Elev=19.18' Storage=1,063 cf Inflow=0.55 cfs 0.024 af
15.0" Round Culvert n=0.012 L=20.0' S=0.0200 '/' Outflow=0.00 cfs 0.000 af

Pond 4SP: Surface Peak Elev=21.49' Storage=868 cf Inflow=0.44 cfs 0.020 af
Outflow=0.00 cfs 0.000 af

Pond 4UP: Underground Peak Elev=18.05' Storage=2,340 cf Inflow=1.19 cfs 0.054 af
18.0" Round Culvert n=0.012 L=23.0' S=0.0200 '/' Outflow=0.00 cfs 0.000 af

Total Runoff Area = 7.201 ac Runoff Volume = 0.196 af Average Runoff Depth = 0.33"
50.97% Pervious = 3.670 ac 49.03% Impervious = 3.531 ac

Summary for Subcatchment 31S:

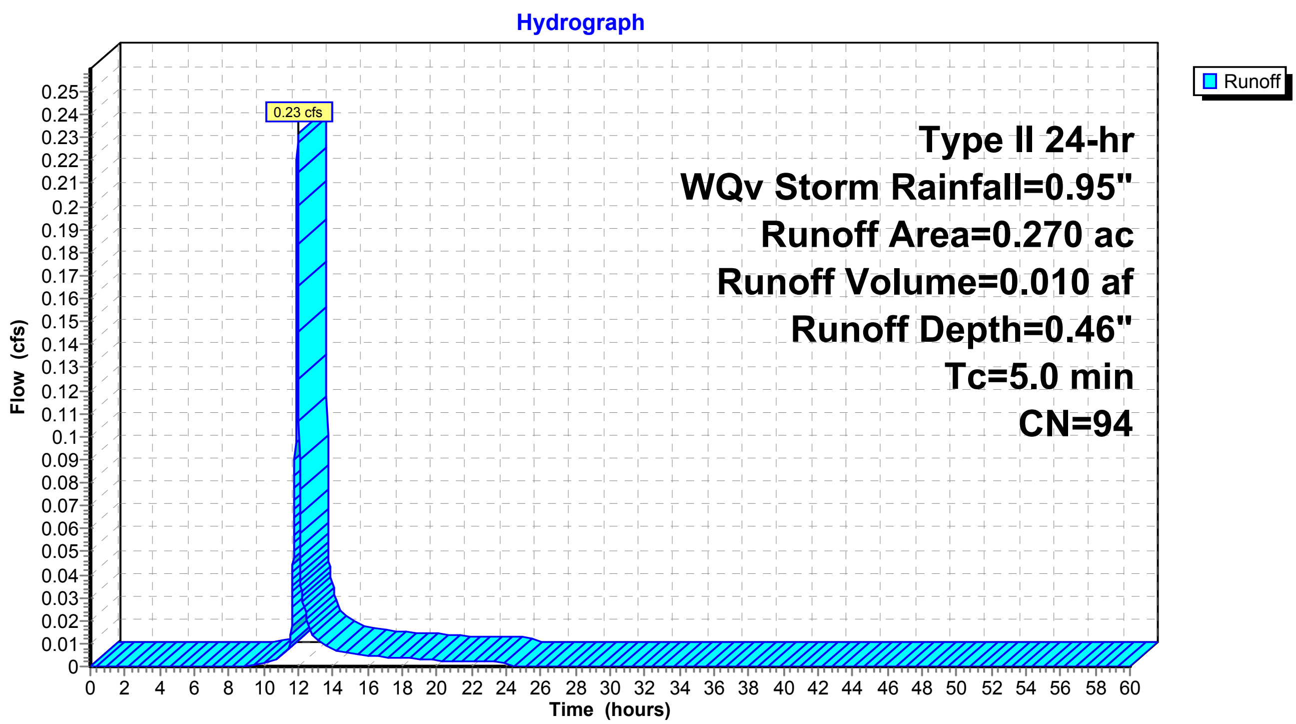
Runoff = 0.23 cfs @ 11.96 hrs, Volume= 0.010 af, Depth= 0.46"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type II 24-hr WQv Storm Rainfall=0.95"

Area (ac)	CN	Description
0.080	84	50-75% Grass cover, Fair, HSG D
0.190	98	Paved parking, HSG D
0.270	94	Weighted Average
0.080		29.63% Pervious Area
0.190		70.37% Impervious Area

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

Subcatchment 31S:



Summary for Subcatchment 32S:

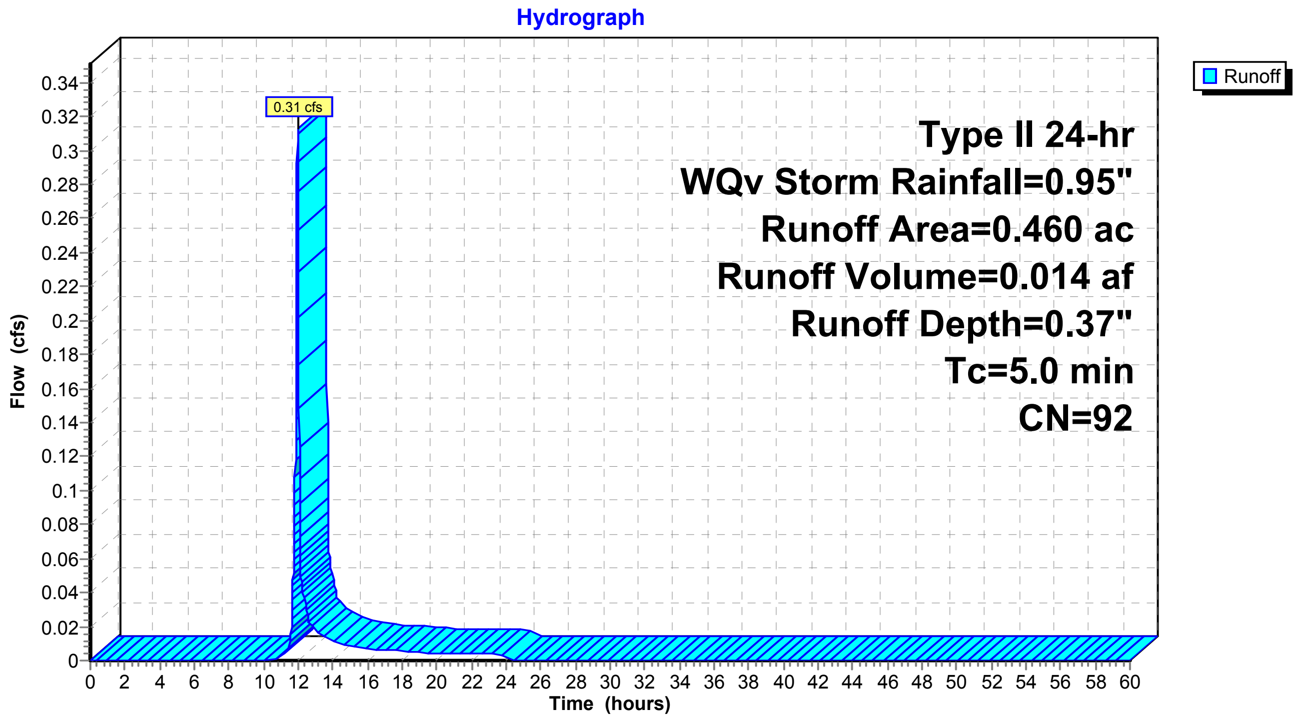
Runoff = 0.31 cfs @ 11.97 hrs, Volume= 0.014 af, Depth= 0.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type II 24-hr WQv Storm Rainfall=0.95"

Area (ac)	CN	Description
0.200	84	50-75% Grass cover, Fair, HSG D
0.260	98	Paved parking, HSG D
0.460	92	Weighted Average
0.200		43.48% Pervious Area
0.260		56.52% Impervious Area

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

Subcatchment 32S:



Summary for Subcatchment 33S:

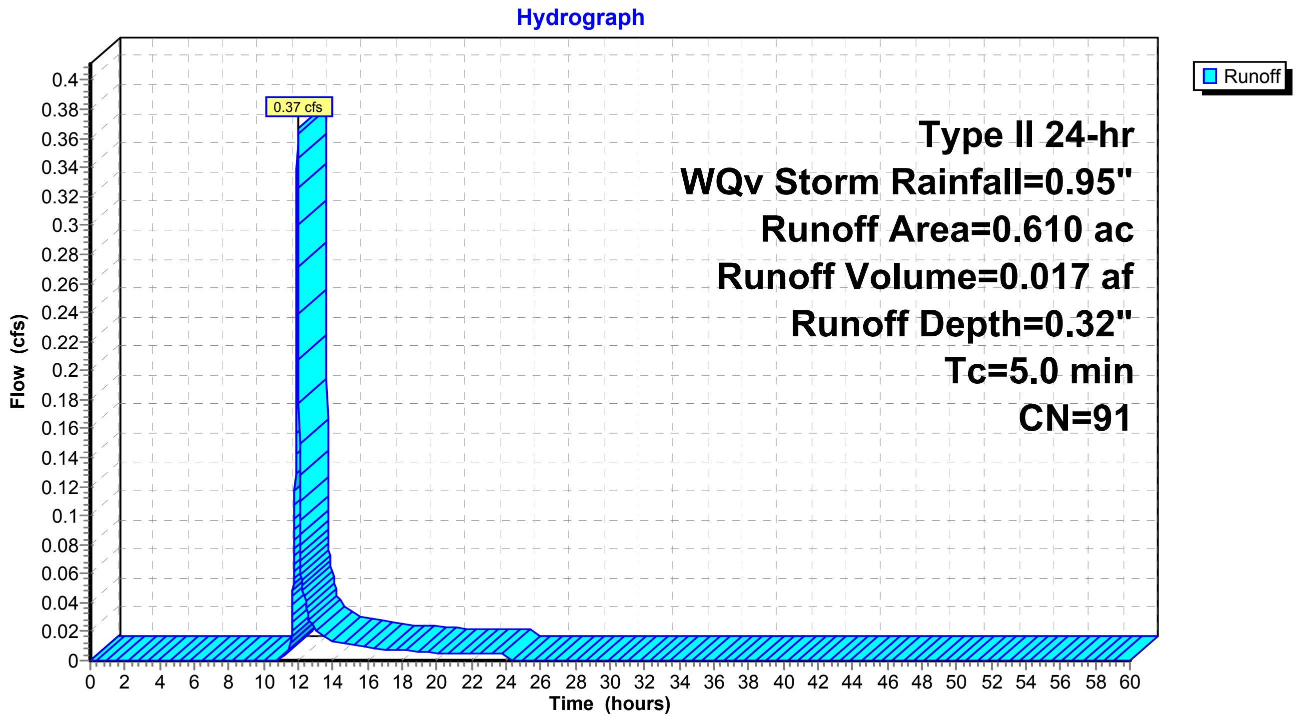
Runoff = 0.37 cfs @ 11.97 hrs, Volume= 0.017 af, Depth= 0.32"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type II 24-hr WQv Storm Rainfall=0.95"

Area (ac)	CN	Description
0.310	84	50-75% Grass cover, Fair, HSG D
0.300	98	Paved parking, HSG D
0.610	91	Weighted Average
0.310		50.82% Pervious Area
0.300		49.18% Impervious Area

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

Subcatchment 33S:



Summary for Subcatchment 34S:

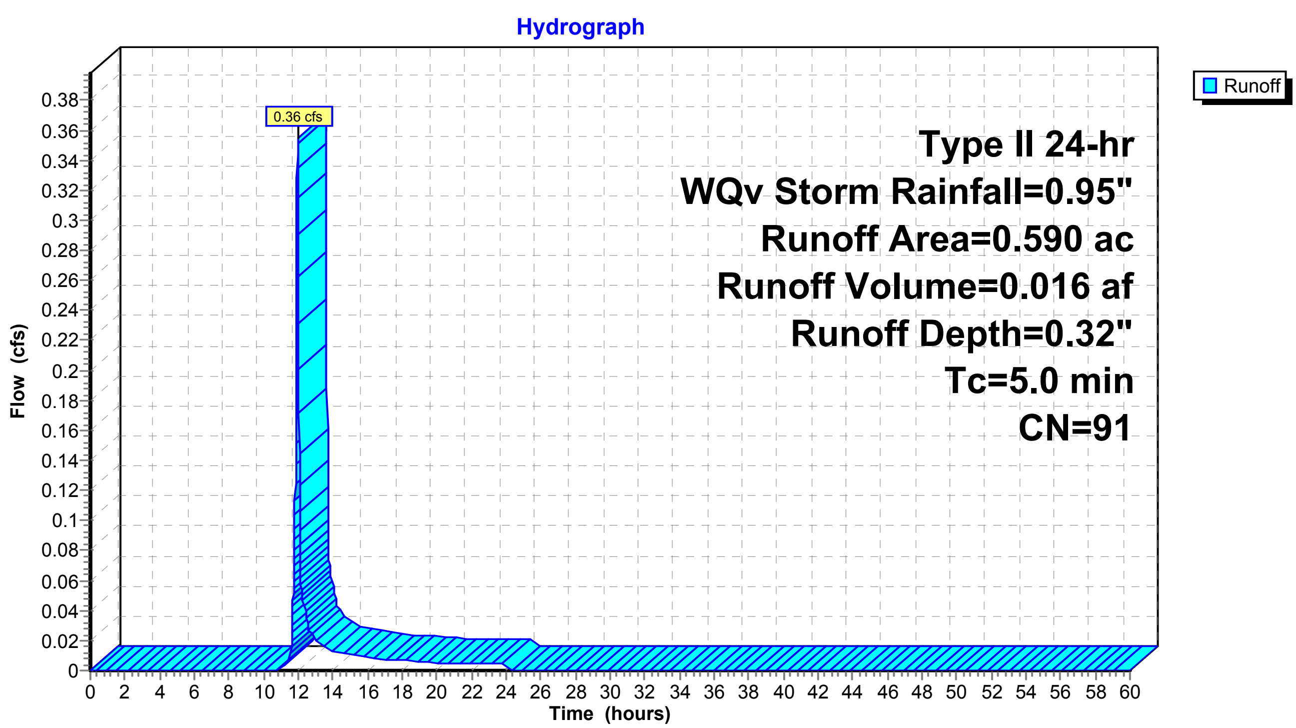
Runoff = 0.36 cfs @ 11.97 hrs, Volume= 0.016 af, Depth= 0.32"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type II 24-hr WQv Storm Rainfall=0.95"

Area (ac)	CN	Description
0.300	84	50-75% Grass cover, Fair, HSG D
0.290	98	Paved parking, HSG D
0.590	91	Weighted Average
0.300		50.85% Pervious Area
0.290		49.15% Impervious Area

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

Subcatchment 34S:



Summary for Subcatchment 35S:

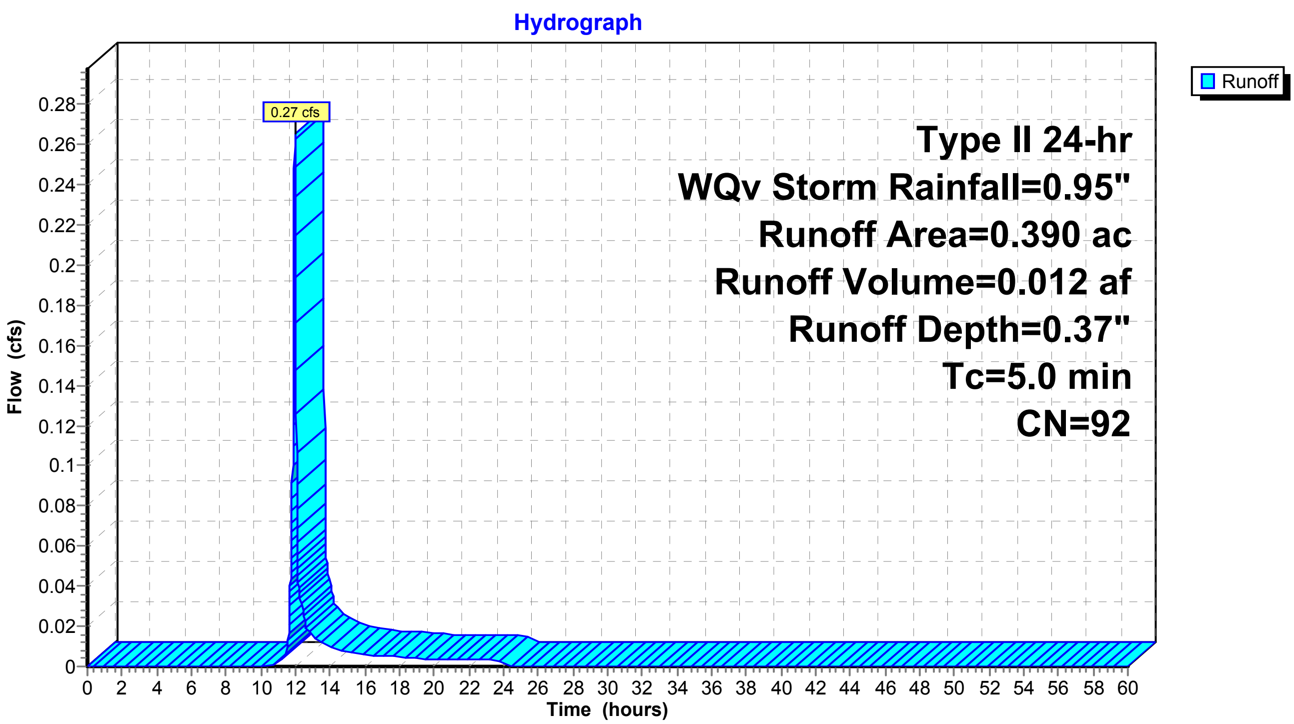
Runoff = 0.27 cfs @ 11.97 hrs, Volume= 0.012 af, Depth= 0.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type II 24-hr WQv Storm Rainfall=0.95"

Area (ac)	CN	Description
0.170	84	50-75% Grass cover, Fair, HSG D
0.220	98	Paved parking, HSG D
0.390	92	Weighted Average
0.170		43.59% Pervious Area
0.220		56.41% Impervious Area

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

Subcatchment 35S:



Summary for Subcatchment 36S:

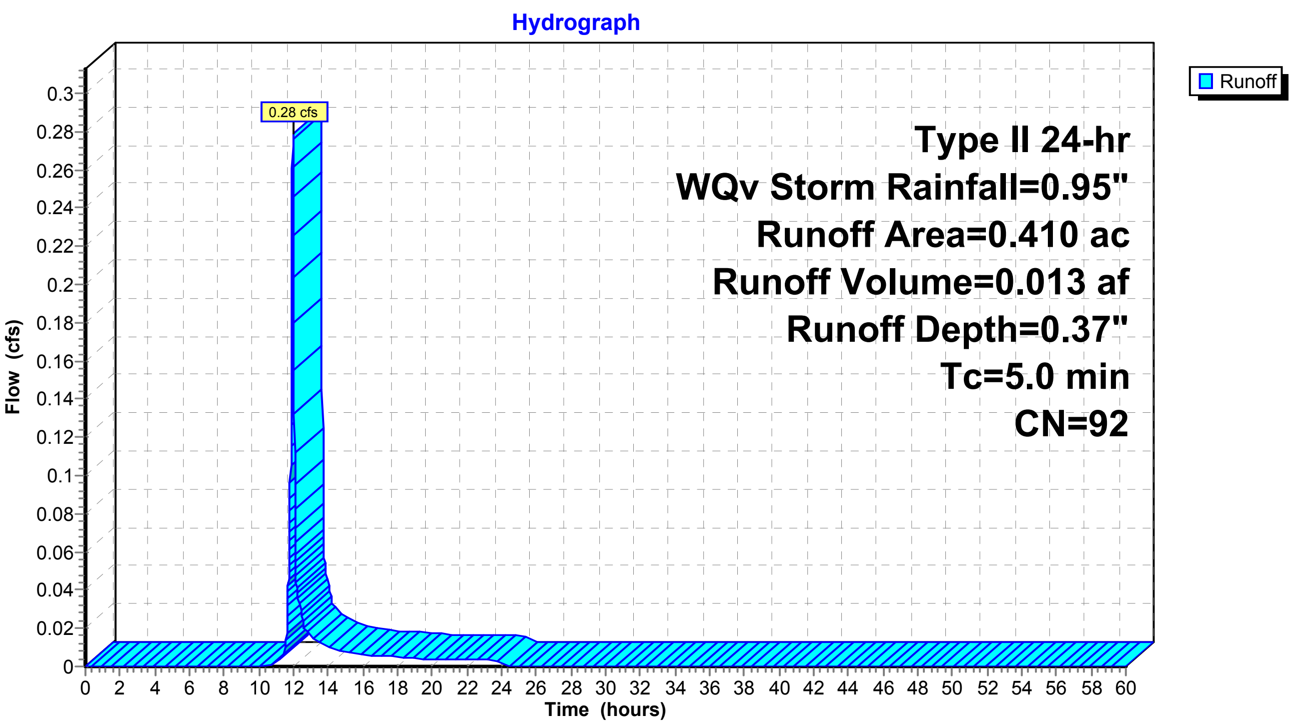
Runoff = 0.28 cfs @ 11.97 hrs, Volume= 0.013 af, Depth= 0.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type II 24-hr WQv Storm Rainfall=0.95"

Area (ac)	CN	Description
0.170	84	50-75% Grass cover, Fair, HSG D
0.240	98	Paved parking, HSG D
0.410	92	Weighted Average
0.170		41.46% Pervious Area
0.240		58.54% Impervious Area

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

Subcatchment 36S:



Summary for Subcatchment 37S:

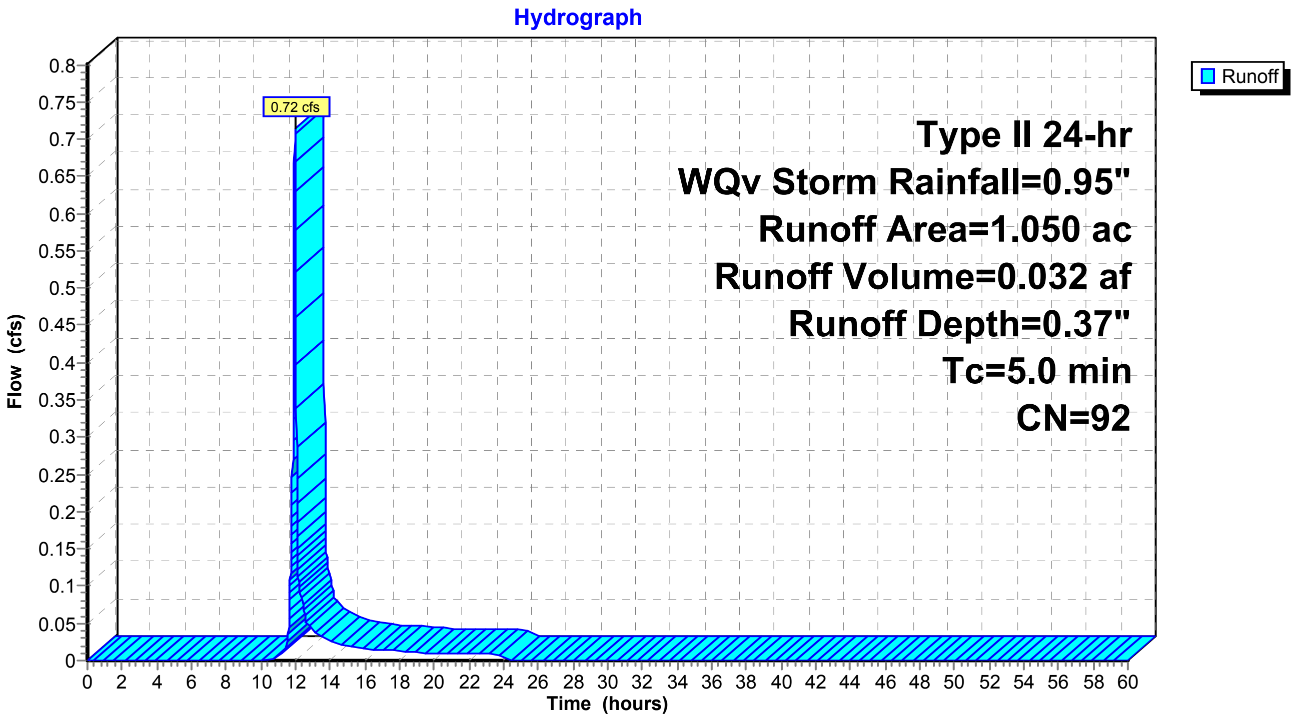
Runoff = 0.72 cfs @ 11.97 hrs, Volume= 0.032 af, Depth= 0.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type II 24-hr WQv Storm Rainfall=0.95"

Area (ac)	CN	Description
0.470	84	50-75% Grass cover, Fair, HSG D
0.580	98	Paved parking, HSG D
1.050	92	Weighted Average
0.470		44.76% Pervious Area
0.580		55.24% Impervious Area

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

Subcatchment 37S:



Summary for Subcatchment 38S:

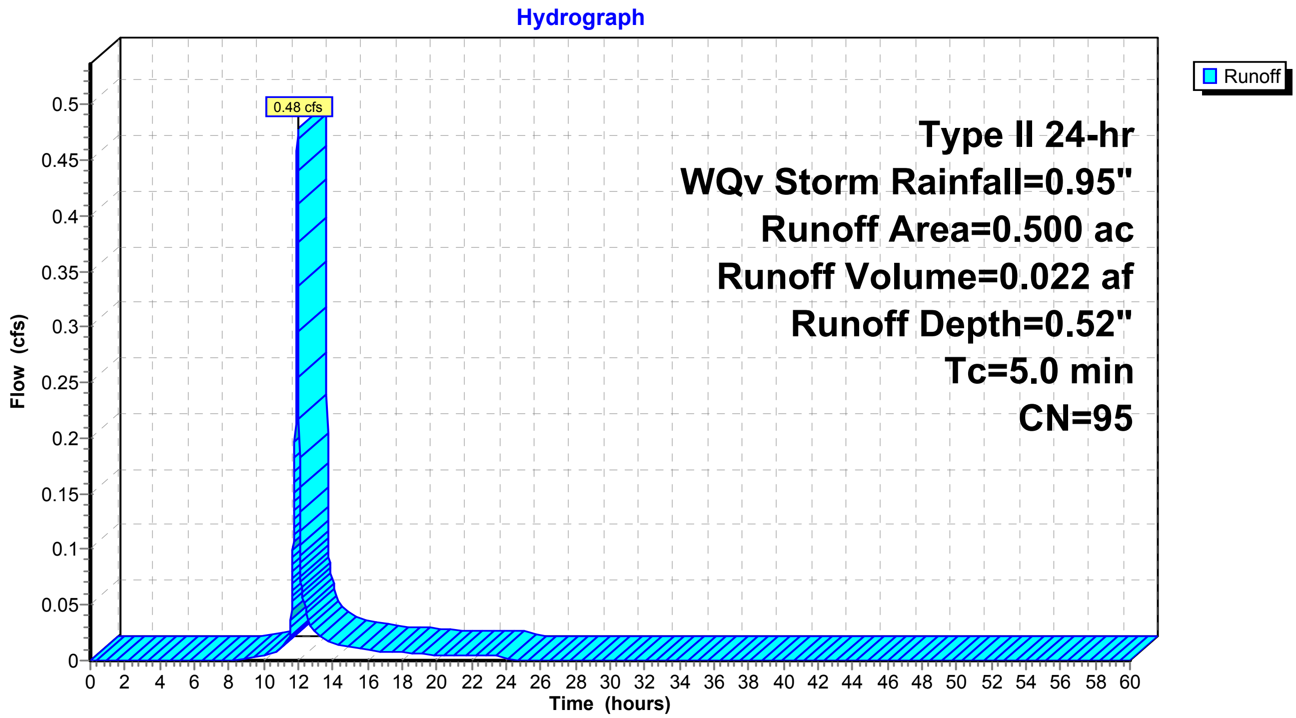
Runoff = 0.48 cfs @ 11.96 hrs, Volume= 0.022 af, Depth= 0.52"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type II 24-hr WQv Storm Rainfall=0.95"

Area (ac)	CN	Description
0.090	84	50-75% Grass cover, Fair, HSG D
0.410	98	Paved parking, HSG D
0.500	95	Weighted Average
0.090		18.00% Pervious Area
0.410		82.00% Impervious Area

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

Subcatchment 38S:



Summary for Subcatchment 39S:

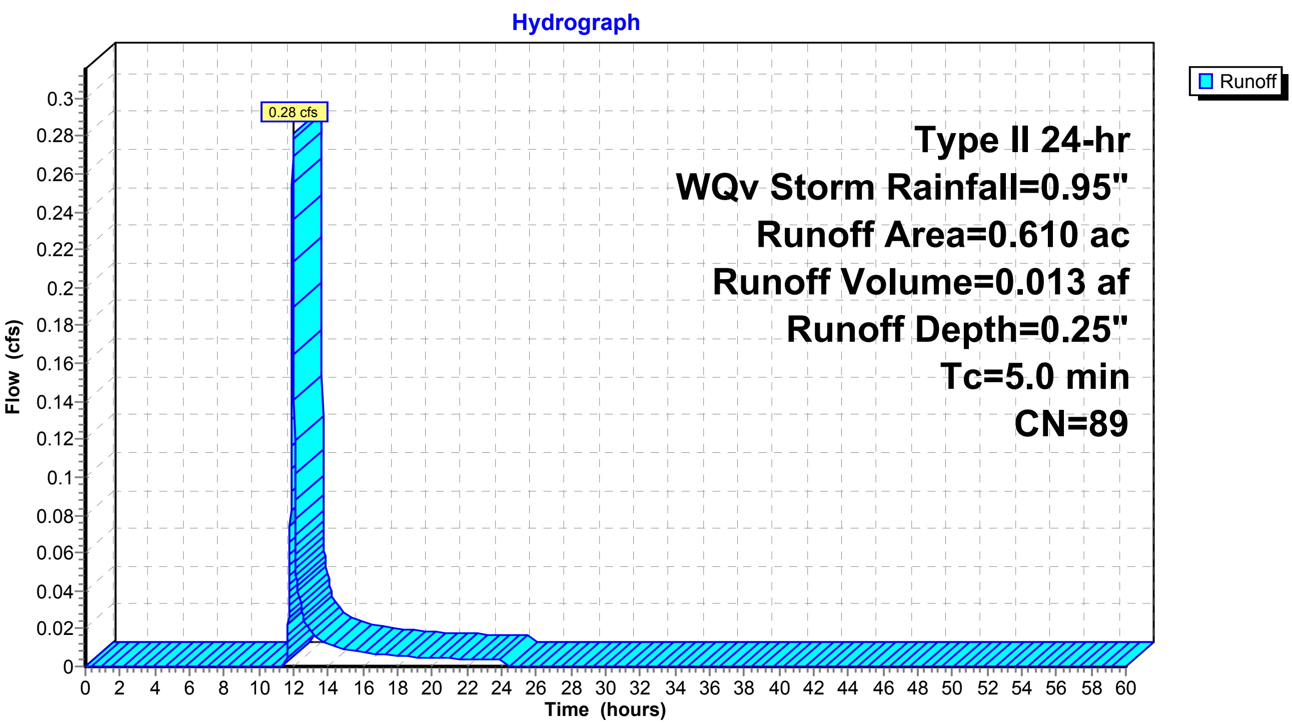
Runoff = 0.28 cfs @ 11.97 hrs, Volume= 0.013 af, Depth= 0.25"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type II 24-hr WQv Storm Rainfall=0.95"

Area (ac)	CN	Description
0.230	98	Paved parking, HSG D
0.380	84	50-75% Grass cover, Fair, HSG D
0.610	89	Weighted Average
0.380		62.30% Pervious Area
0.230		37.70% Impervious Area

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

Subcatchment 39S:



Summary for Subcatchment 40aS:

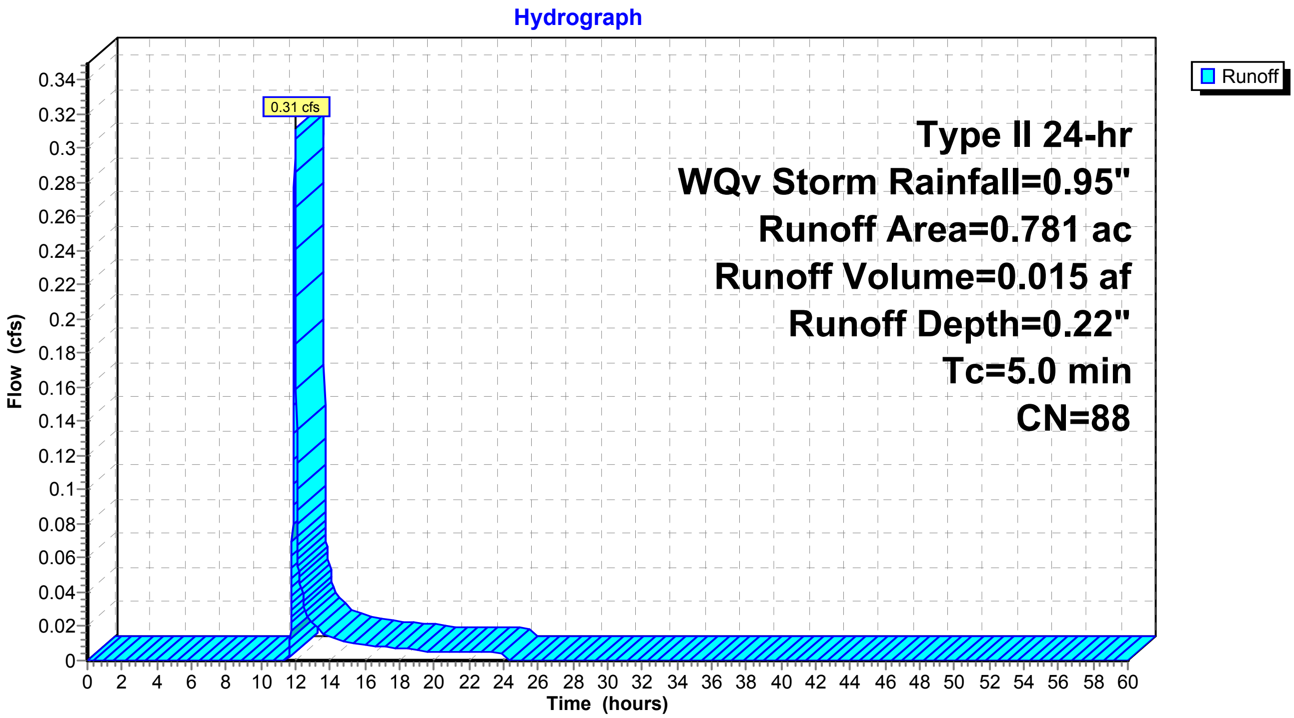
Runoff = 0.31 cfs @ 11.97 hrs, Volume= 0.015 af, Depth= 0.22"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type II 24-hr WQv Storm Rainfall=0.95"

Area (ac)	CN	Description
0.530	84	50-75% Grass cover, Fair, HSG D
0.251	98	Paved parking, HSG D
0.781	88	Weighted Average
0.530		67.86% Pervious Area
0.251		32.14% Impervious Area

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

Subcatchment 40aS:



Summary for Subcatchment 40S:

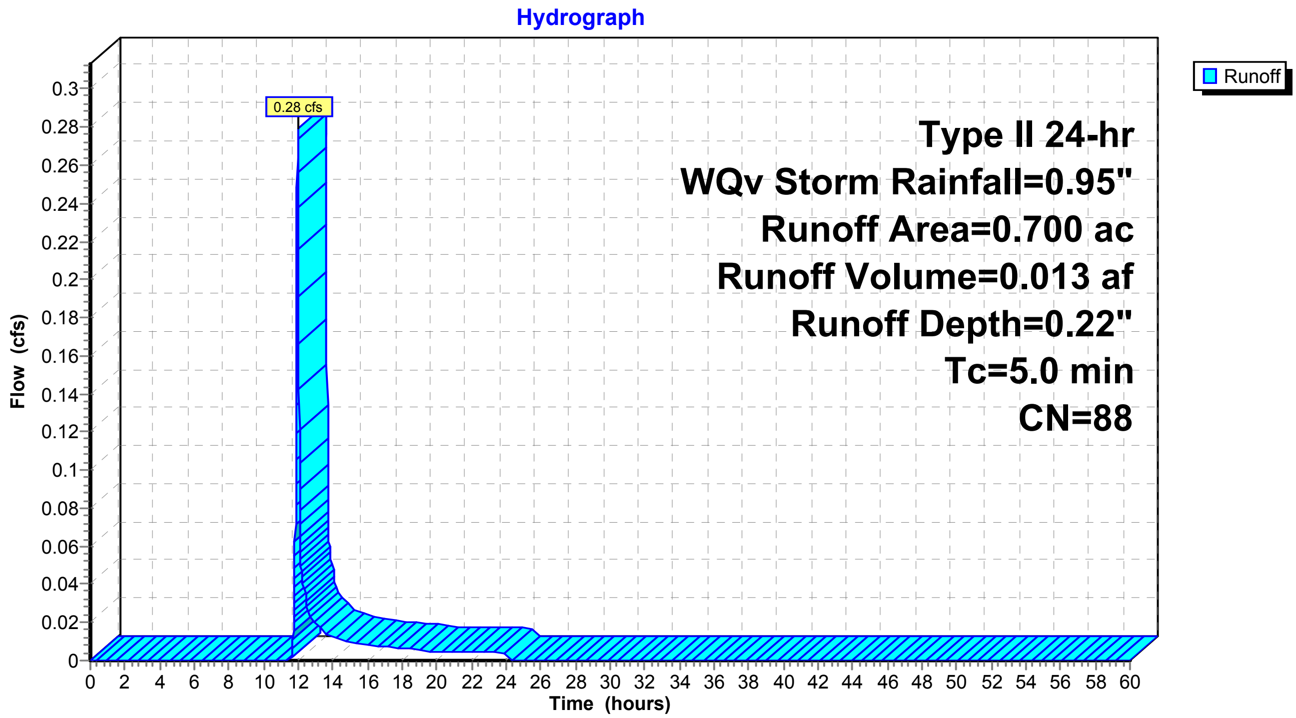
Runoff = 0.28 cfs @ 11.97 hrs, Volume= 0.013 af, Depth= 0.22"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type II 24-hr WQv Storm Rainfall=0.95"

Area (ac)	CN	Description
0.500	84	50-75% Grass cover, Fair, HSG D
0.200	98	Paved parking, HSG D
0.700	88	Weighted Average
0.500		71.43% Pervious Area
0.200		28.57% Impervious Area

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

Subcatchment 40S:



Summary for Subcatchment 41S:

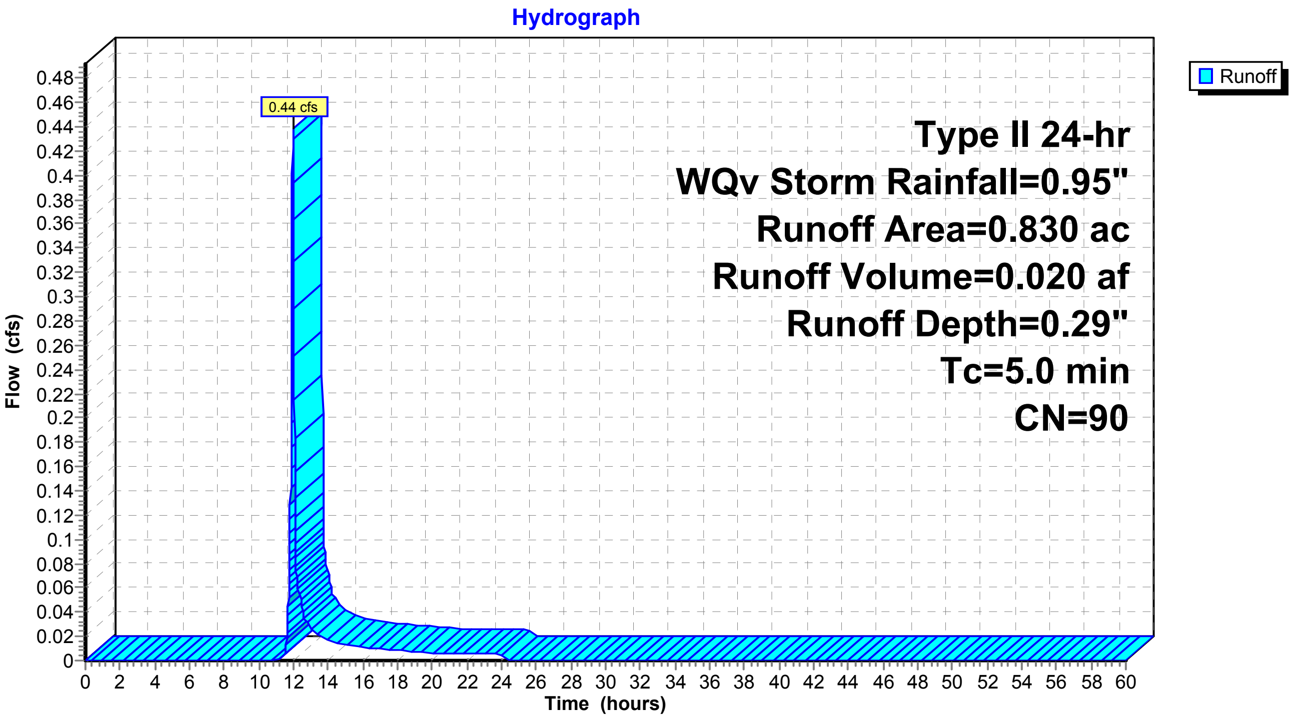
Runoff = 0.44 cfs @ 11.97 hrs, Volume= 0.020 af, Depth= 0.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type II 24-hr WQv Storm Rainfall=0.95"

Area (ac)	CN	Description
0.470	84	50-75% Grass cover, Fair, HSG D
0.360	98	Paved parking, HSG D
0.830	90	Weighted Average
0.470		56.63% Pervious Area
0.360		43.37% Impervious Area

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

Subcatchment 41S:



Summary for Pond 1SP: Surface

Inflow Area = 0.610 ac, 37.70% Impervious, Inflow Depth = 0.25" for WQv Storm event
Inflow = 0.28 cfs @ 11.97 hrs, Volume= 0.013 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Peak Elev= 25.95' @ 24.29 hrs Surf.Area= 2,818 sf Storage= 564 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

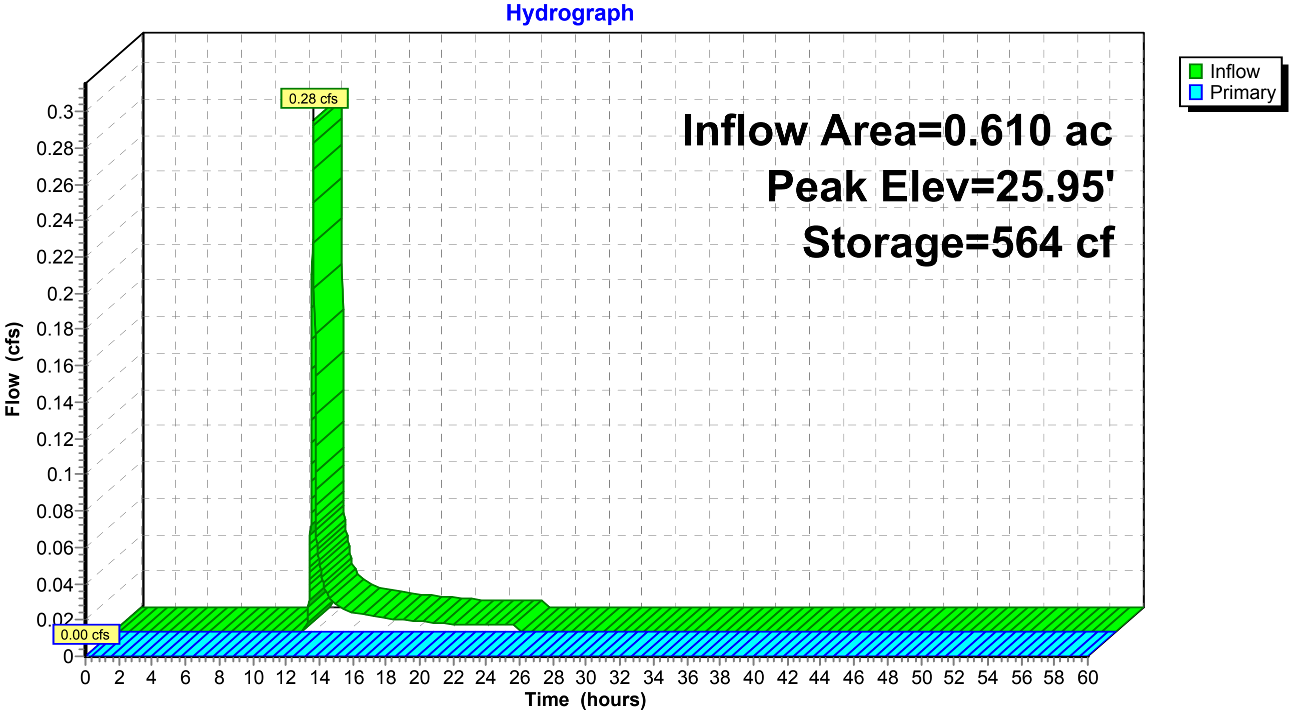
Volume	Invert	Avail.Storage	Storage Description
#1	25.73'	3,515 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
25.73	2,287	413.0	0	0	2,287
26.23	3,564	438.0	1,451	1,451	3,993
26.74	4,551	444.0	2,064	3,515	4,471

Device	Routing	Invert	Outlet Devices
#1	Primary	26.23'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=25.73' TW=21.48' (Dynamic Tailwater)
└─**1=Orifice/Grate** (Controls 0.00 cfs)

Pond 1SP: Surface



Summary for Pond 1UP: Underground

Inflow Area = 1.340 ac, 50.75% Impervious, Inflow Depth = 0.22" for WQv Storm event
Inflow = 0.55 cfs @ 11.96 hrs, Volume= 0.024 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Peak Elev= 22.64' @ 24.29 hrs Surf.Area= 2,291 sf Storage= 1,065 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

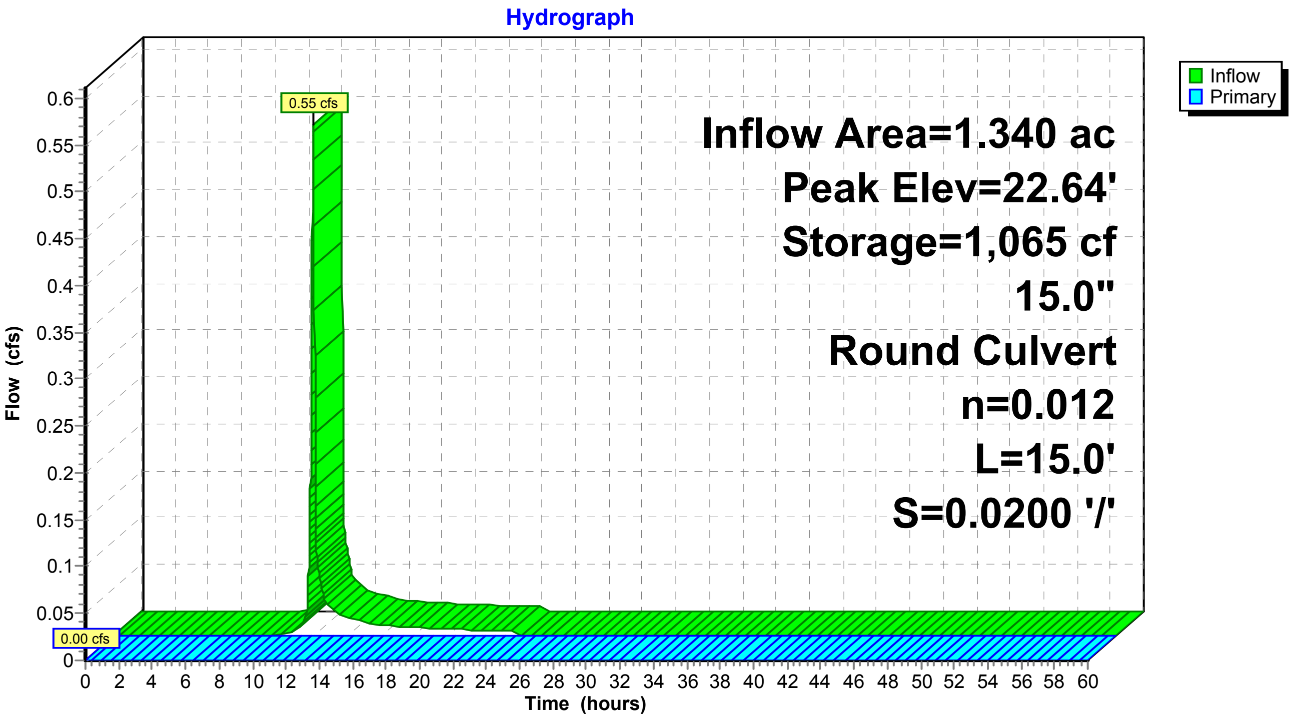
Volume	Invert	Avail.Storage	Storage Description
#1	21.48'	2,516 cf	**Custom Stage Data (Irregular)** Listed below (Recalc) 6,289 cf Overall x 40.0% Voids
#2	21.50'	19 cf	**2.00'W x 2.00'L x 4.73'H Prismatoid**
		2,535 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
21.48	2,287	412.5	0	0	2,287
24.23	2,287	412.5	6,289	6,289	3,421

Device	Routing	Invert	Outlet Devices
#1	Primary	22.73'	**15.0" Round Culvert** L= 15.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 22.73' / 22.43' S= 0.0200 '/' Cc= 0.900 n= 0.012, Flow Area= 1.23 sf

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=21.48' (Free Discharge)
└─**1=Culvert** (Controls 0.00 cfs)

Pond 1UP: Underground



Summary for Pond 2SP: Surface

Inflow Area = 0.700 ac, 28.57% Impervious, Inflow Depth = 0.22" for WQv Storm event
Inflow = 0.28 cfs @ 11.97 hrs, Volume= 0.013 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Peak Elev= 24.15' @ 24.29 hrs Surf.Area= 1,780 sf Storage= 571 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

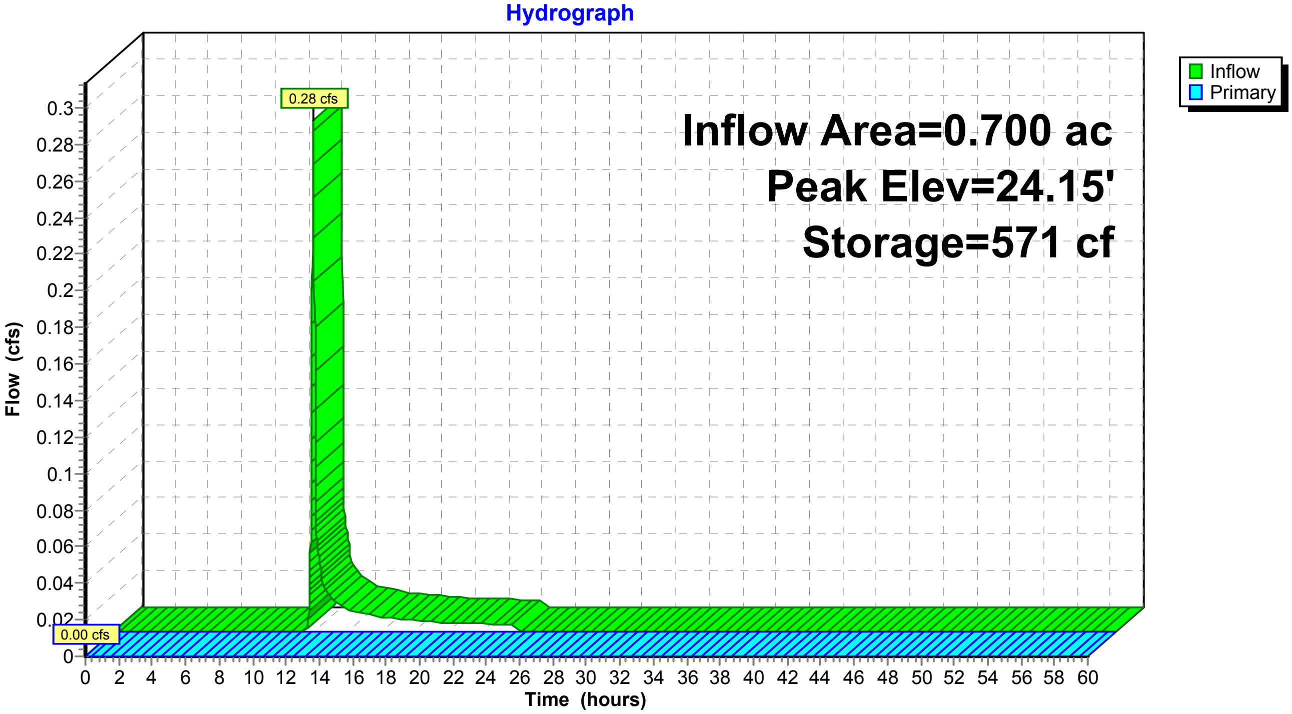
Volume	Invert	Avail.Storage	Storage Description
#1	23.74'	4,530 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
23.74	1,013	258.0	0	0	1,013
24.24	1,966	286.0	732	732	2,233
25.79	2,970	305.0	3,799	4,530	3,237

Device	Routing	Invert	Outlet Devices
#1	Primary	24.24'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=23.74' TW=17.24' (Dynamic Tailwater)
└─**1=Orifice/Grate** (Controls 0.00 cfs)

Pond 2SP: Surface



Summary for Pond 2UP: Underground

Inflow Area = 1.900 ac, 41.58% Impervious, Inflow Depth = 0.21" for WQv Storm event
Inflow = 0.72 cfs @ 11.97 hrs, Volume= 0.032 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Peak Elev= 20.70' @ 24.29 hrs Surf.Area= 1,017 sf Storage= 1,415 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

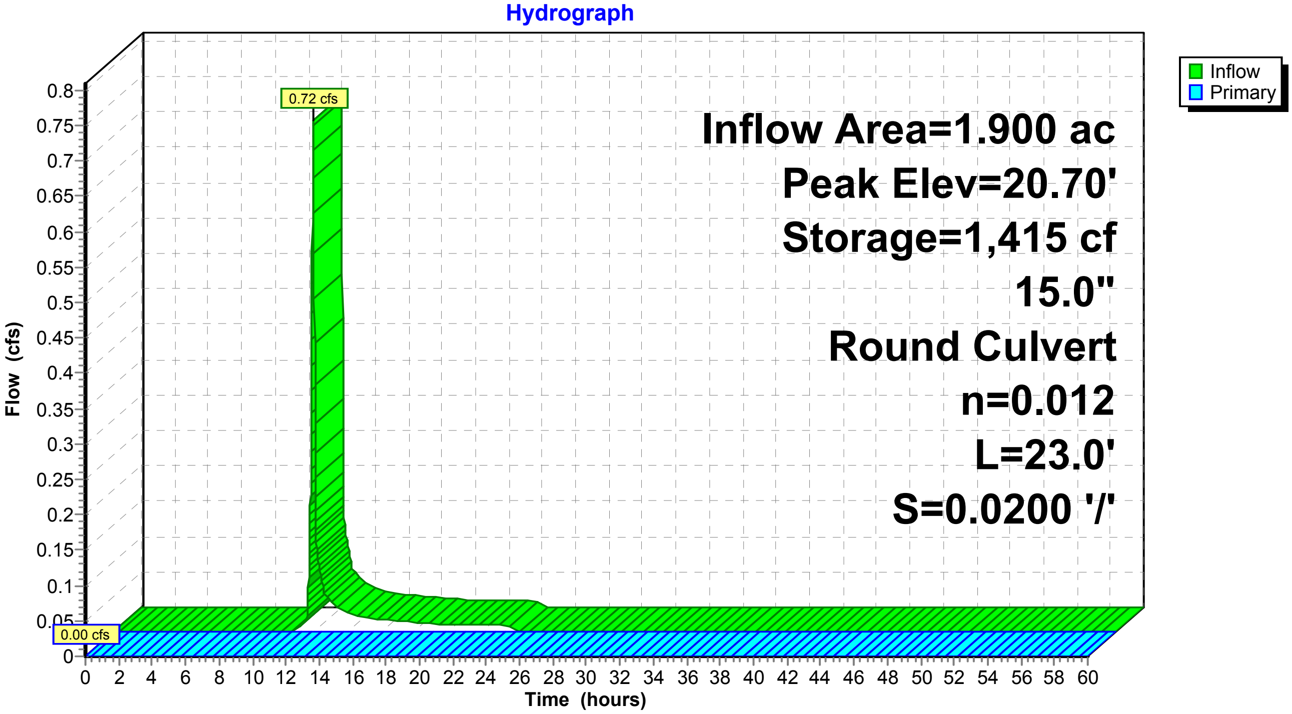
Volume	Invert	Avail.Storage	Storage Description
#1	17.24'	2,026 cf	**Custom Stage Data (Irregular)** Listed below (Recalc) 5,065 cf Overall x 40.0% Voids
#2	17.24'	28 cf	**2.00'W x 2.00'L x 7.00'H Prismatoid**
		2,054 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
17.24	1,013	258.0	0	0	1,013
22.24	1,013	258.0	5,065	5,065	2,303

Device	Routing	Invert	Outlet Devices
#1	Primary	20.74'	**15.0" Round Culvert** L= 23.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 20.74' / 20.28' S= 0.0200 '/' Cc= 0.900 n= 0.012, Flow Area= 1.23 sf

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=17.24' (Free Discharge)
└─**1=Culvert** (Controls 0.00 cfs)

Pond 2UP: Underground



Summary for Pond 3SP: Surface

Inflow Area = 0.781 ac, 32.14% Impervious, Inflow Depth = 0.22" for WQv Storm event
Inflow = 0.31 cfs @ 11.97 hrs, Volume= 0.015 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Peak Elev= 22.38' @ 24.29 hrs Surf.Area= 3,888 sf Storage= 637 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

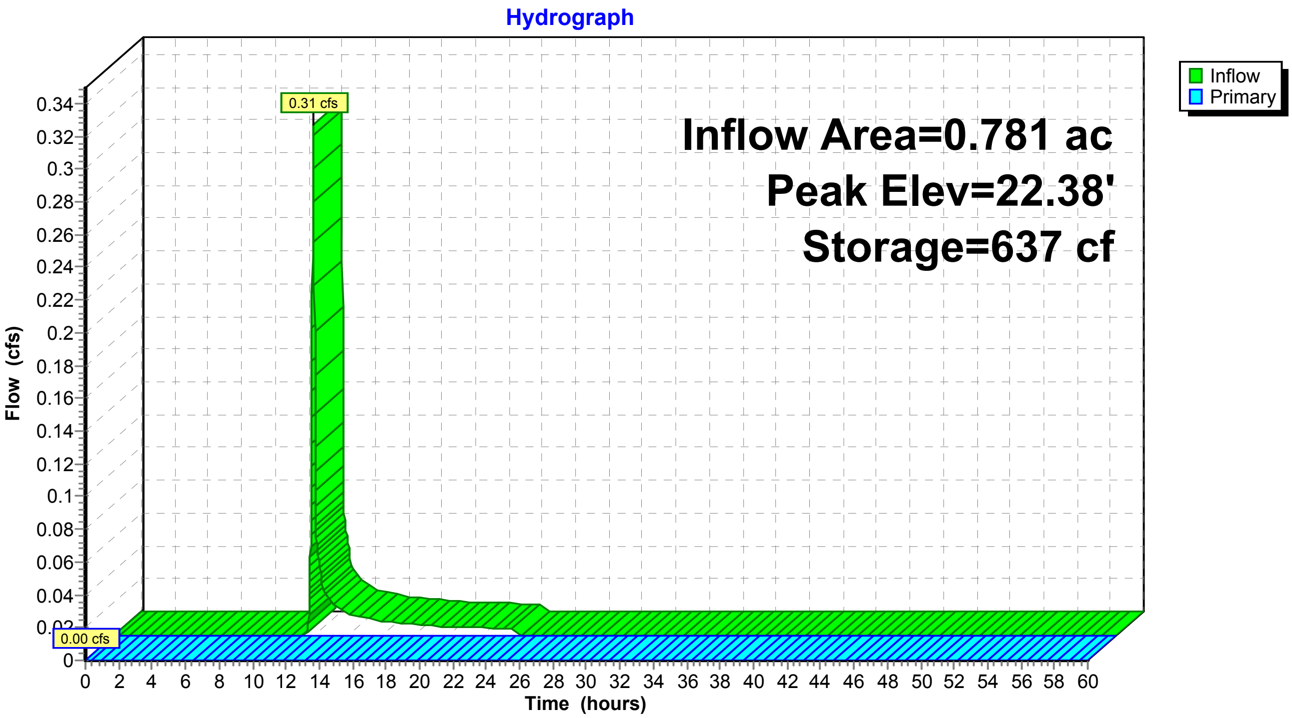
Volume	Invert	Avail.Storage	Storage Description
#1	22.21'	8,104 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
22.21	3,673	433.0	0	0	3,673
22.71	4,330	443.0	1,998	1,998	4,404
23.87	6,255	470.0	6,105	8,104	6,436

Device	Routing	Invert	Outlet Devices
#1	Primary	22.71'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=22.21' TW=18.46' (Dynamic Tailwater)
└─**1=Orifice/Grate** (Controls 0.00 cfs)

Pond 3SP: Surface



Summary for Pond 3UP: Underground

Inflow Area = 1.581 ac, 44.97% Impervious, Inflow Depth = 0.19" for WQv Storm event
Inflow = 0.55 cfs @ 11.97 hrs, Volume= 0.024 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Peak Elev= 19.18' @ 24.29 hrs Surf.Area= 3,673 sf Storage= 1,063 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

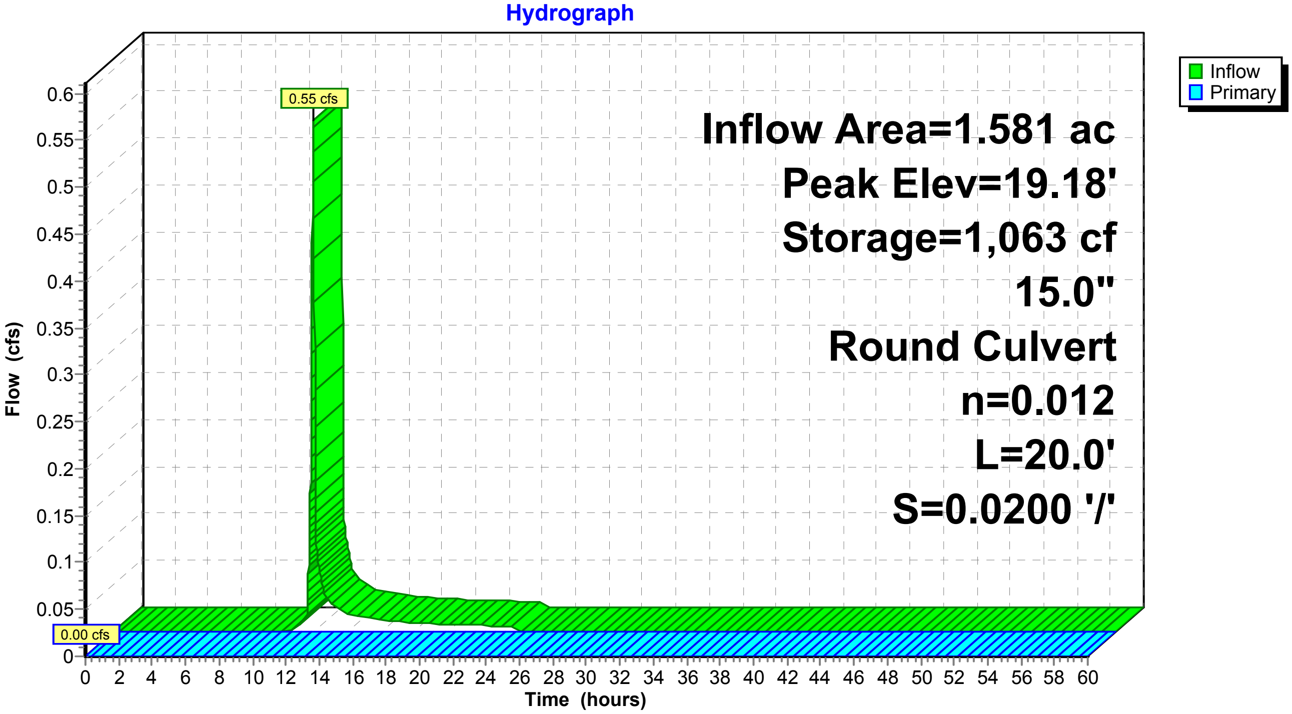
Volume	Invert	Avail.Storage	Storage Description
#1	18.46'	3,306 cf	**Custom Stage Data (Irregular)** Listed below (Recalc) 8,264 cf Overall x 40.0% Voids
#2	19.45'	13 cf	**2.00'W x 2.00'L x 3.26'H Prismatoid**
		3,319 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
18.46	3,673	433.0	0	0	3,673
20.71	3,673	433.0	8,264	8,264	4,647

Device	Routing	Invert	Outlet Devices
#1	Primary	19.21'	**15.0" Round Culvert** L= 20.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 19.21' / 18.81' S= 0.0200 '/' Cc= 0.900 n= 0.012, Flow Area= 1.23 sf

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=18.46' (Free Discharge)
└**1=Culvert** (Controls 0.00 cfs)

Pond 3UP: Underground



Summary for Pond 4SP: Surface

Inflow Area = 0.830 ac, 43.37% Impervious, Inflow Depth = 0.29" for WQv Storm event
Inflow = 0.44 cfs @ 11.97 hrs, Volume= 0.020 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Peak Elev= 21.49' @ 24.29 hrs Surf.Area= 2,550 sf Storage= 868 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

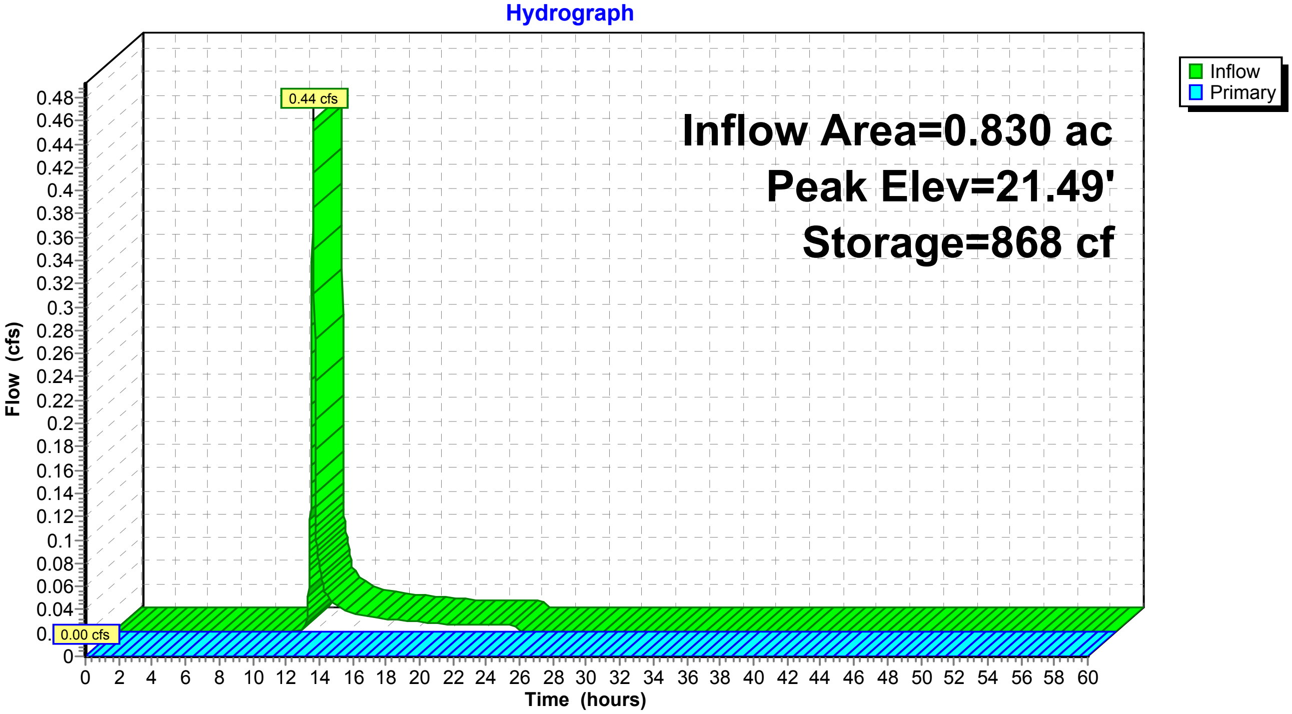
Volume	Invert	Avail.Storage	Storage Description
#1	21.09'	2,793 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
21.09	1,811	303.0	0	0	1,811
21.59	2,754	326.0	1,133	1,133	2,973
22.09	3,918	349.0	1,659	2,793	4,220

Device	Routing	Invert	Outlet Devices
#1	Primary	21.59'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=21.09' TW=14.80' (Dynamic Tailwater)
└─**1=Orifice/Grate** (Controls 0.00 cfs)

Pond 4SP: Surface



Summary for Pond 4UP: Underground

Inflow Area = 2.380 ac, 56.72% Impervious, Inflow Depth = 0.27" for WQv Storm event
Inflow = 1.19 cfs @ 11.96 hrs, Volume= 0.054 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Peak Elev= 18.05' @ 24.29 hrs Surf.Area= 1,815 sf Storage= 2,340 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

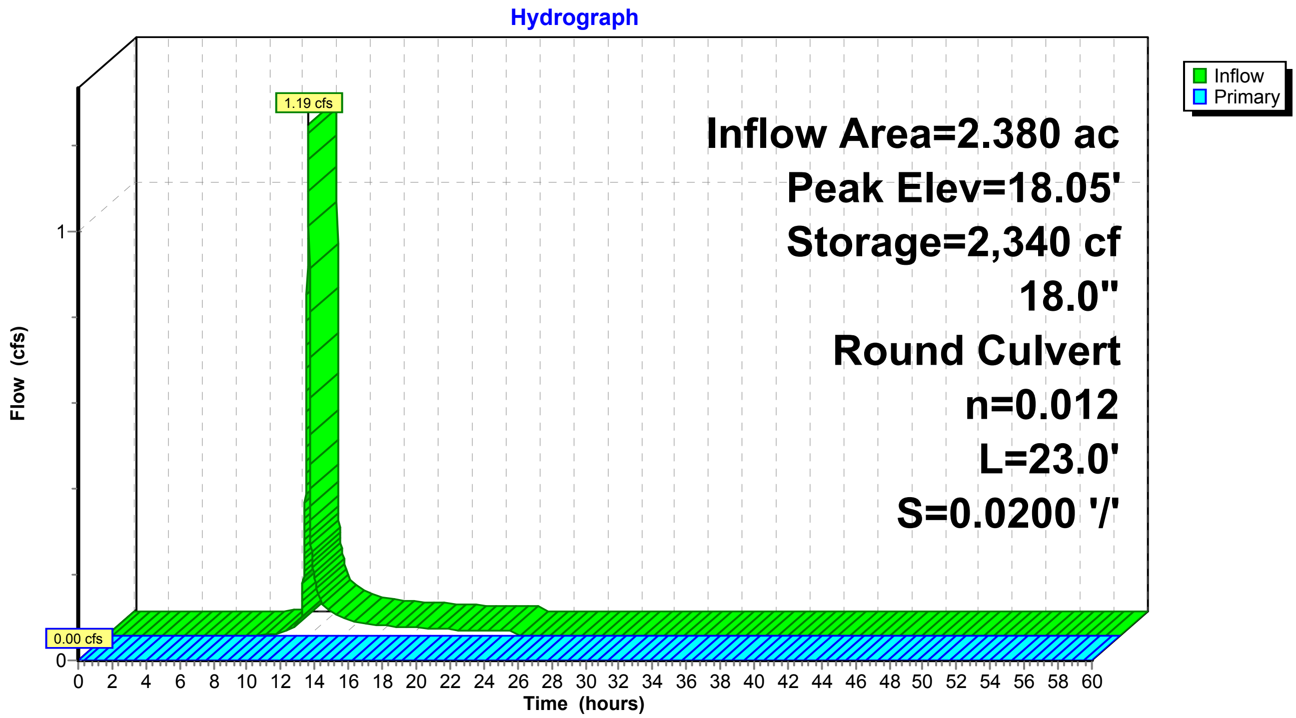
Volume	Invert	Avail.Storage	Storage Description
#1	14.84'	3,441 cf	**Custom Stage Data (Irregular)** Listed below (Recalc) 8,602 cf Overall x 40.0% Voids
#2	14.80'	27 cf	**2.00'W x 2.00'L x 6.79'H Prismatoid**
		3,468 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
14.84	1,811	303.0	0	0	1,811
19.59	1,811	303.0	8,602	8,602	3,250

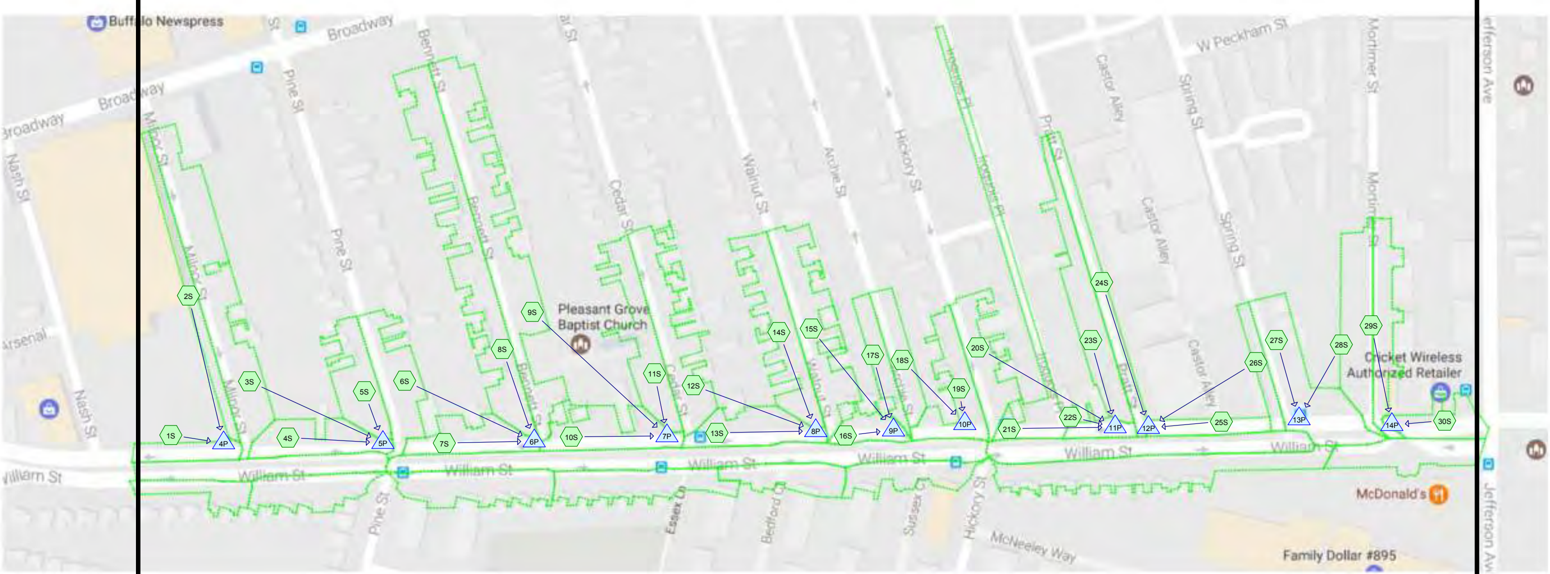
Device	Routing	Invert	Outlet Devices
#1	Primary	18.09'	**18.0" Round Culvert** L= 23.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 18.09' / 17.63' S= 0.0200 '/' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf

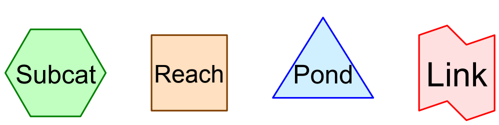
Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=14.80' (Free Discharge)
└─**1=Culvert** (Controls 0.00 cfs)

Pond 4UP: Underground



HydroCAD Output for the WQv Storm: Porous Pavement along William Street





Routing Diagram for William Street North Porous Pave (1-27-17)
Prepared by Wendel, Printed 2/15/2017
HydroCAD® 10.00-13 s/n 00557 © 2014 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
9.590	84	50-75% Grass cover, Fair, HSG D (3S, 4S, 5S, 6S, 7S, 8S, 9S, 10S, 11S, 12S, 13S, 14S, 15S, 16S, 17S, 18S, 19S, 20S, 21S, 22S, 23S, 24S, 25S, 26S, 27S, 28S, 29S, 30S)
8.240	98	Paved parking, HSG D (1S, 2S, 3S, 4S, 5S, 6S, 7S, 8S, 9S, 10S, 11S, 12S, 13S, 14S, 15S, 16S, 17S, 18S, 19S, 20S, 21S, 22S, 23S, 24S, 25S, 27S, 28S, 29S, 30S)
0.170	98	Water Surface, HSG D (26S)
18.000	**91**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
18.000	HSG D	1S, 2S, 3S, 4S, 5S, 6S, 7S, 8S, 9S, 10S, 11S, 12S, 13S, 14S, 15S, 16S, 17S, 18S, 19S, 20S, 21S, 22S, 23S, 24S, 25S, 26S, 27S, 28S, 29S, 30S
0.000	Other	
18.000		**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	9.590	0.000	9.590	50-75% Grass cover, Fair	3S, 4S, 5S, 6S, 7S, 8S, 9S, 10S, 11S, 12S, 13S, 14S, 15S, 16S, 17S, 18S, 19S, 20S, 21S, 22S, 23S, 24S, 25S, 26S, 27S, 28S, 29S, 30S
0.000	0.000	0.000	8.240	0.000	8.240	Paved parking	1S, 2S, 3S, 4S, 5S, 6S, 7S, 8S, 9S, 10S, 11S, 12S, 13S, 14S, 15S, 16S, 17S, 18S, 19S, 20S, 21S, 22S, 23S, 24S, 25S,

Ground Covers (all nodes) (continued)

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	0.170	0.000	0.170	Water Surface	26S
0.000	**0.000**	**0.000**	**18.000**	**0.000**	**18.000**	**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	4P	24.39	24.12	13.5	0.0200	0.012	12.0	0.0	0.0
2	5P	23.49	23.16	16.5	0.0200	0.012	12.0	0.0	0.0
3	6P	22.23	21.93	15.0	0.0200	0.012	12.0	0.0	0.0
4	7P	21.49	21.19	15.0	0.0200	0.012	12.0	0.0	0.0
5	8P	20.63	20.28	17.5	0.0200	0.012	12.0	0.0	0.0
6	9P	20.61	20.45	8.0	0.0200	0.012	12.0	0.0	0.0
7	10P	20.16	19.77	19.5	0.0200	0.012	12.0	0.0	0.0
8	11P	19.06	18.77	14.5	0.0200	0.012	12.0	0.0	0.0
9	12P	19.24	18.96	14.0	0.0200	0.012	12.0	0.0	0.0
10	13P	19.94	19.46	24.0	0.0200	0.012	12.0	0.0	0.0
11	14P	20.72	20.40	16.0	0.0200	0.012	12.0	0.0	0.0

Time span=0.00-60.00 hrs, dt=0.03 hrs, 2001 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment1S: Runoff Area=0.250 ac 100.00% Impervious Runoff Depth=0.74"
Tc=5.0 min CN=98 Runoff=0.32 cfs 0.015 af

Subcatchment2S: Runoff Area=0.390 ac 100.00% Impervious Runoff Depth=0.74"
Tc=5.0 min CN=98 Runoff=0.49 cfs 0.024 af

Subcatchment3S: Runoff Area=1.410 ac 21.28% Impervious Runoff Depth=0.20"
Tc=5.0 min CN=87 Runoff=0.48 cfs 0.023 af

Subcatchment4S: Runoff Area=0.490 ac 51.02% Impervious Runoff Depth=0.32"
Tc=5.0 min CN=91 Runoff=0.29 cfs 0.013 af

Subcatchment5S: Runoff Area=0.510 ac 39.22% Impervious Runoff Depth=0.25"
Tc=5.0 min CN=89 Runoff=0.23 cfs 0.011 af

Subcatchment6S: Runoff Area=0.590 ac 45.76% Impervious Runoff Depth=0.29"
Tc=5.0 min CN=90 Runoff=0.31 cfs 0.014 af

Subcatchment7S: Runoff Area=0.440 ac 65.91% Impervious Runoff Depth=0.41"
Tc=5.0 min CN=93 Runoff=0.33 cfs 0.015 af

Subcatchment8S: Runoff Area=1.360 ac 37.50% Impervious Runoff Depth=0.25"
Tc=5.0 min CN=89 Runoff=0.62 cfs 0.029 af

Subcatchment9S: Runoff Area=1.560 ac 35.26% Impervious Runoff Depth=0.25"
Tc=5.0 min CN=89 Runoff=0.71 cfs 0.033 af

Subcatchment10S: Runoff Area=0.540 ac 57.41% Impervious Runoff Depth=0.37"
Tc=5.0 min CN=92 Runoff=0.37 cfs 0.016 af

Subcatchment11S: Runoff Area=0.650 ac 43.08% Impervious Runoff Depth=0.29"
Tc=5.0 min CN=90 Runoff=0.34 cfs 0.016 af

Subcatchment12S: Runoff Area=0.790 ac 39.24% Impervious Runoff Depth=0.25"
Tc=5.0 min CN=89 Runoff=0.36 cfs 0.017 af

Subcatchment13S: Runoff Area=0.500 ac 56.00% Impervious Runoff Depth=0.37"
Tc=5.0 min CN=92 Runoff=0.34 cfs 0.015 af

Subcatchment14S: Runoff Area=0.730 ac 39.73% Impervious Runoff Depth=0.29"
Tc=5.0 min CN=90 Runoff=0.38 cfs 0.018 af

Subcatchment15S: Runoff Area=0.830 ac 33.73% Impervious Runoff Depth=0.25"
Tc=5.0 min CN=89 Runoff=0.38 cfs 0.018 af

Subcatchment16S: Runoff Area=0.220 ac 68.18% Impervious Runoff Depth=0.46"
Tc=5.0 min CN=94 Runoff=0.19 cfs 0.008 af

Subcatchment17S: Runoff Area=0.280 ac 28.57% Impervious Runoff Depth=0.22"
Tc=5.0 min CN=88 Runoff=0.11 cfs 0.005 af

Subcatchment18S: Runoff Area=0.380 ac 18.42% Impervious Runoff Depth=0.20"
Tc=5.0 min CN=87 Runoff=0.13 cfs 0.006 af

Subcatchment19S: Runoff Area=0.530 ac 52.83% Impervious Runoff Depth=0.32"
Tc=5.0 min CN=91 Runoff=0.32 cfs 0.014 af

Subcatchment20S: Runoff Area=0.510 ac 43.14% Impervious Runoff Depth=0.29"
Tc=5.0 min CN=90 Runoff=0.27 cfs 0.012 af

Subcatchment21S: Runoff Area=0.630 ac 84.13% Impervious Runoff Depth=0.59"
Tc=5.0 min CN=96 Runoff=0.66 cfs 0.031 af

Subcatchment22S: Runoff Area=0.160 ac 87.50% Impervious Runoff Depth=0.59"
Tc=5.0 min CN=96 Runoff=0.17 cfs 0.008 af

Subcatchment23S: Runoff Area=0.730 ac 31.51% Impervious Runoff Depth=0.22"
Tc=5.0 min CN=88 Runoff=0.29 cfs 0.014 af

Subcatchment24S: Runoff Area=0.510 ac 72.55% Impervious Runoff Depth=0.46"
Tc=5.0 min CN=94 Runoff=0.44 cfs 0.020 af

Subcatchment25S: Runoff Area=0.240 ac 83.33% Impervious Runoff Depth=0.59"
Tc=5.0 min CN=96 Runoff=0.25 cfs 0.012 af

Subcatchment26S: Runoff Area=0.210 ac 80.95% Impervious Runoff Depth=0.52"
Tc=5.0 min CN=95 Runoff=0.20 cfs 0.009 af

Subcatchment27S: Runoff Area=0.940 ac 42.55% Impervious Runoff Depth=0.29"
Tc=5.0 min CN=90 Runoff=0.49 cfs 0.023 af

Subcatchment28S: Runoff Area=0.740 ac 35.14% Impervious Runoff Depth=0.25"
Tc=5.0 min CN=89 Runoff=0.34 cfs 0.016 af

Subcatchment29S: Runoff Area=0.530 ac 50.94% Impervious Runoff Depth=0.32"
Tc=5.0 min CN=91 Runoff=0.32 cfs 0.014 af

Subcatchment30S: Runoff Area=0.350 ac 80.00% Impervious Runoff Depth=0.52"
Tc=5.0 min CN=95 Runoff=0.33 cfs 0.015 af

Pond 4P: Peak Elev=24.33' Storage=1,725 cf Inflow=0.81 cfs 0.040 af
12.0" Round Culvert n=0.012 L=13.5' S=0.0200 '/' Outflow=0.00 cfs 0.000 af

Pond 5P: Peak Elev=23.34' Storage=2,061 cf Inflow=1.00 cfs 0.047 af
12.0" Round Culvert n=0.012 L=16.5' S=0.0200 '/' Outflow=0.00 cfs 0.000 af

Pond 6P: Peak Elev=22.27' Storage=2,521 cf Inflow=1.27 cfs 0.058 af
12.0" Round Culvert n=0.012 L=15.0' S=0.0200 '/' Outflow=0.01 cfs 0.001 af

Pond 7P: Peak Elev=21.29' Storage=2,840 cf Inflow=1.42 cfs 0.065 af
12.0" Round Culvert n=0.012 L=15.0' S=0.0200 '/' Outflow=0.00 cfs 0.000 af

Pond 8P: Peak Elev=20.40' Storage=2,158 cf Inflow=1.08 cfs 0.050 af
12.0" Round Culvert n=0.012 L=17.5' S=0.0200 '/' Outflow=0.00 cfs 0.000 af

Pond 9P: Peak Elev=20.55' Storage=1,366 cf Inflow=0.68 cfs 0.031 af
12.0" Round Culvert n=0.012 L=8.0' S=0.0200 '/' Outflow=0.00 cfs 0.000 af

Pond 10P: Peak Elev=20.10' Storage=898 cf Inflow=0.45 cfs 0.021 af
12.0" Round Culvert n=0.012 L=19.5' S=0.0200 '/' Outflow=0.00 cfs 0.000 af

Pond 11P: Peak Elev=17.70' Storage=2,807 cf Inflow=1.39 cfs 0.064 af
12.0" Round Culvert n=0.012 L=14.5' S=0.0200 '/' Outflow=0.00 cfs 0.000 af

Pond 12P: Peak Elev=19.13' Storage=1,764 cf Inflow=0.89 cfs 0.040 af
12.0" Round Culvert n=0.012 L=14.0' S=0.0200 '/' Outflow=0.00 cfs 0.000 af

Pond 13P: Peak Elev=19.90' Storage=1,667 cf Inflow=0.83 cfs 0.038 af
12.0" Round Culvert n=0.012 L=24.0' S=0.0200 '/' Outflow=0.00 cfs 0.000 af

Pond 14P: Peak Elev=20.53' Storage=1,286 cf Inflow=0.65 cfs 0.030 af
12.0" Round Culvert n=0.012 L=16.0' S=0.0200 '/' Outflow=0.00 cfs 0.000 af

Total Runoff Area = 18.000 ac Runoff Volume = 0.484 af Average Runoff Depth = 0.32"
53.28% Pervious = 9.590 ac 46.72% Impervious = 8.410 ac

Summary for Subcatchment 1S:

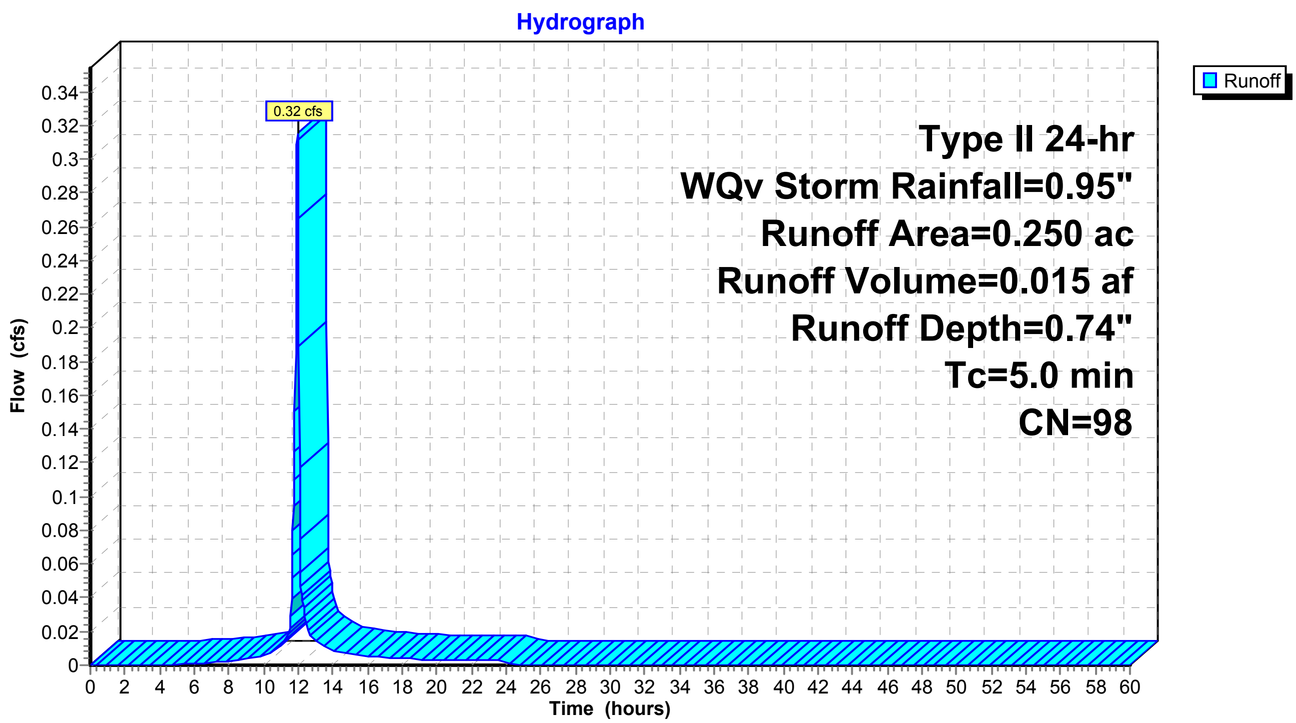
Runoff = 0.32 cfs @ 11.96 hrs, Volume= 0.015 af, Depth= 0.74"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type II 24-hr WQv Storm Rainfall=0.95"

Area (ac)	CN	Description
0.250	98	Paved parking, HSG D
0.250		100.00% Impervious Area

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

Subcatchment 1S:



Summary for Subcatchment 2S:

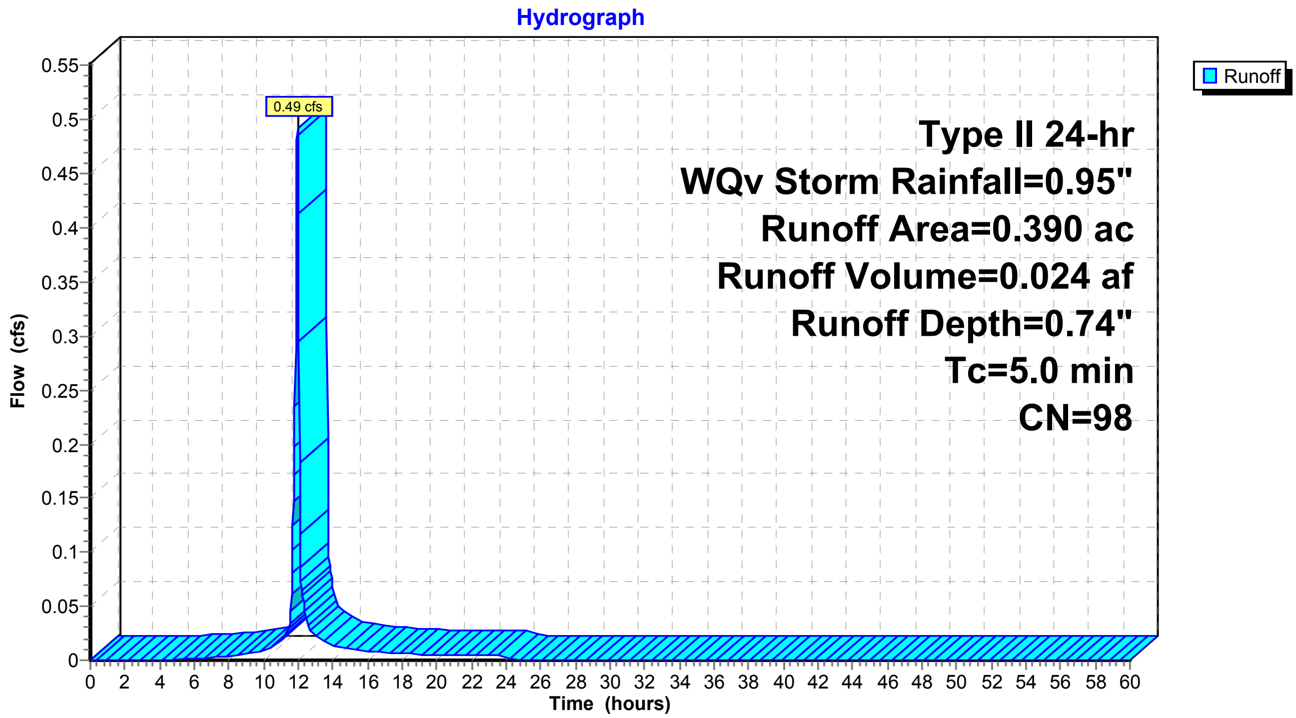
Runoff = 0.49 cfs @ 11.96 hrs, Volume= 0.024 af, Depth= 0.74"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type II 24-hr WQv Storm Rainfall=0.95"

Area (ac)	CN	Description
0.390	98	Paved parking, HSG D
0.390		100.00% Impervious Area

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

Subcatchment 2S:



Summary for Subcatchment 3S:

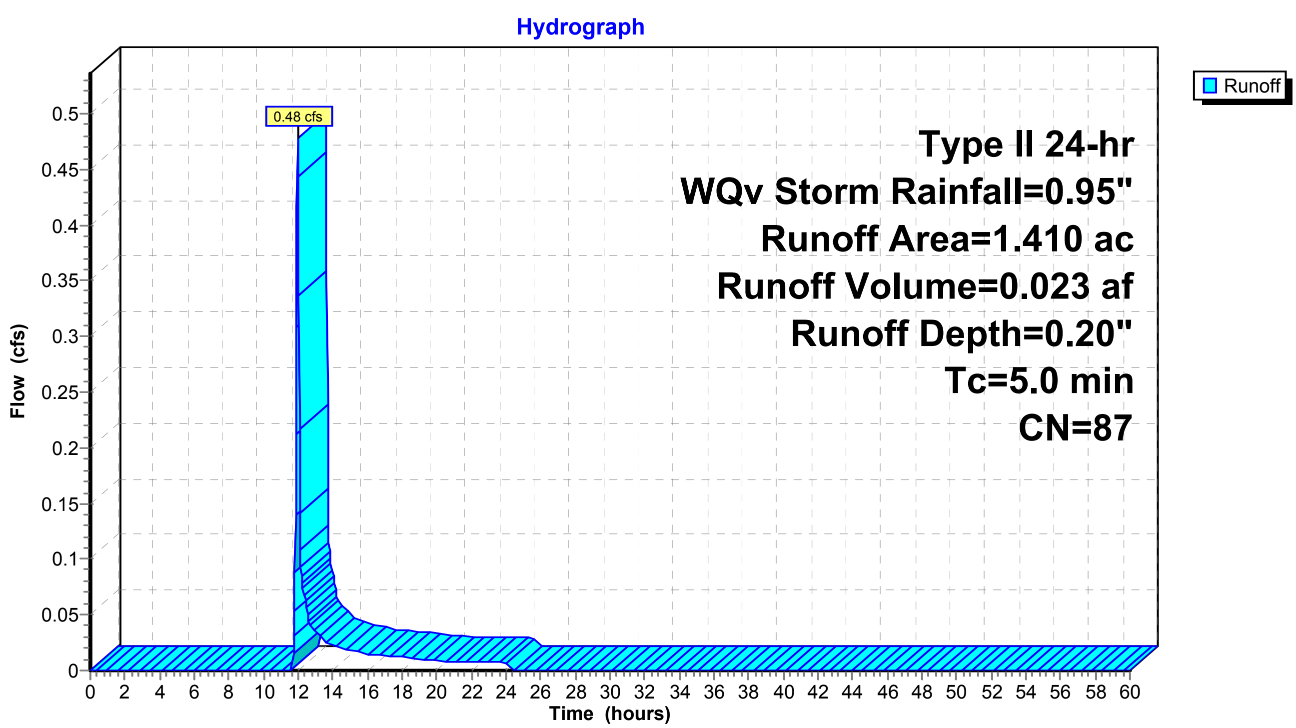
Runoff = 0.48 cfs @ 11.97 hrs, Volume= 0.023 af, Depth= 0.20"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type II 24-hr WQv Storm Rainfall=0.95"

Area (ac)	CN	Description
0.300	98	Paved parking, HSG D
1.110	84	50-75% Grass cover, Fair, HSG D
1.410	87	Weighted Average
1.110		78.72% Pervious Area
0.300		21.28% Impervious Area

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

Subcatchment 3S:



Summary for Subcatchment 4S:

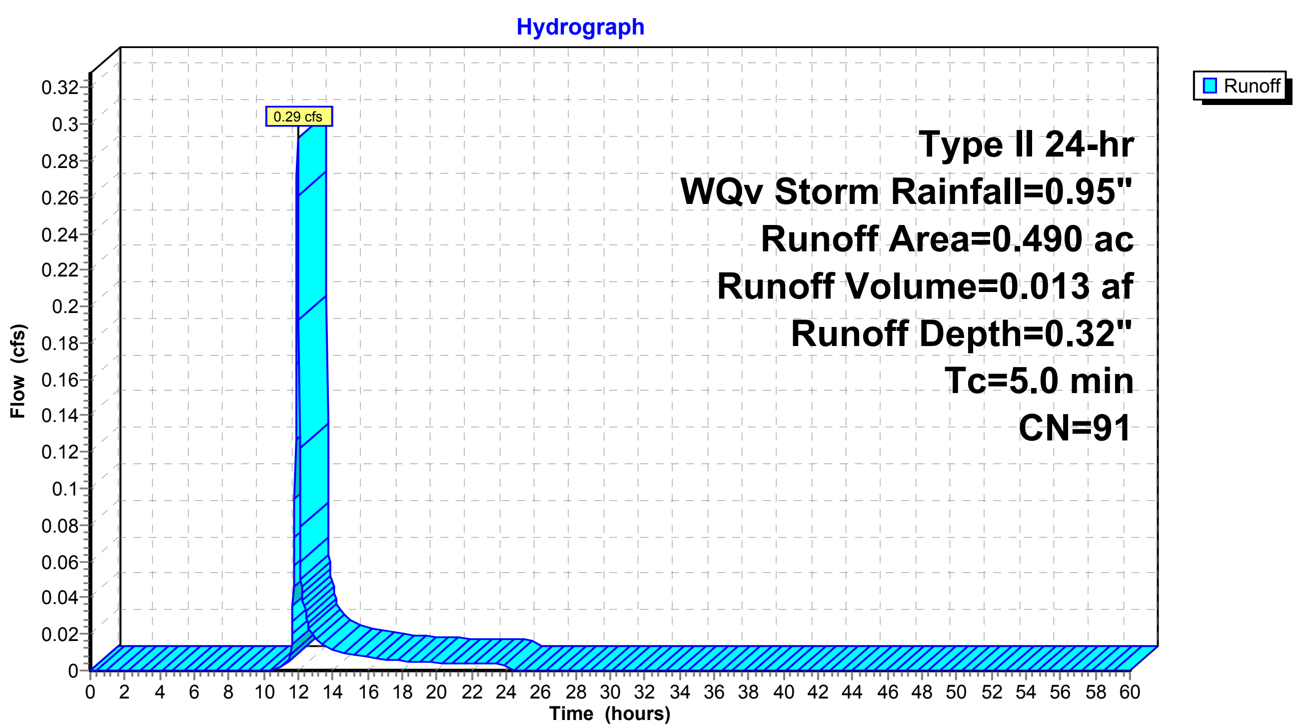
Runoff = 0.29 cfs @ 11.97 hrs, Volume= 0.013 af, Depth= 0.32"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type II 24-hr WQv Storm Rainfall=0.95"

Area (ac)	CN	Description
0.250	98	Paved parking, HSG D
0.240	84	50-75% Grass cover, Fair, HSG D
0.490	91	Weighted Average
0.240		48.98% Pervious Area
0.250		51.02% Impervious Area

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

Subcatchment 4S:



Summary for Subcatchment 5S:

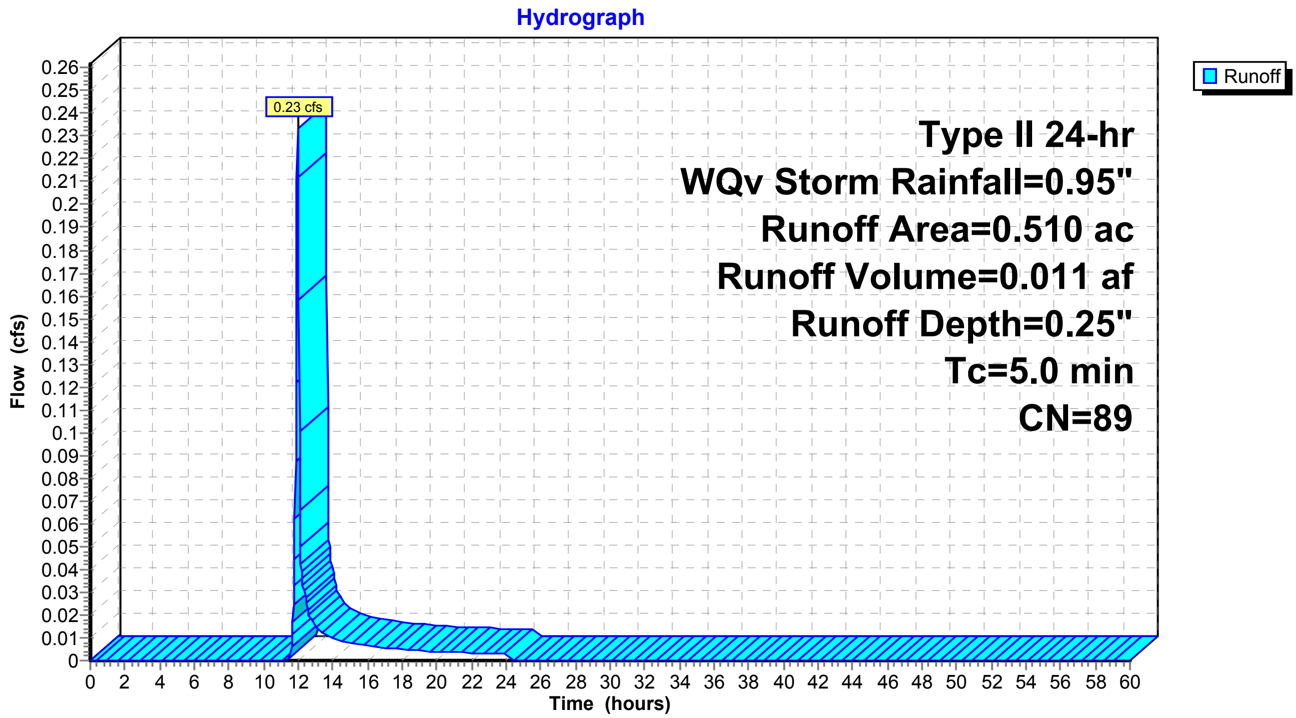
Runoff = 0.23 cfs @ 11.97 hrs, Volume= 0.011 af, Depth= 0.25"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type II 24-hr WQv Storm Rainfall=0.95"

Area (ac)	CN	Description
0.200	98	Paved parking, HSG D
0.310	84	50-75% Grass cover, Fair, HSG D
0.510	89	Weighted Average
0.310		60.78% Pervious Area
0.200		39.22% Impervious Area

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

Subcatchment 5S:



Summary for Subcatchment 6S:

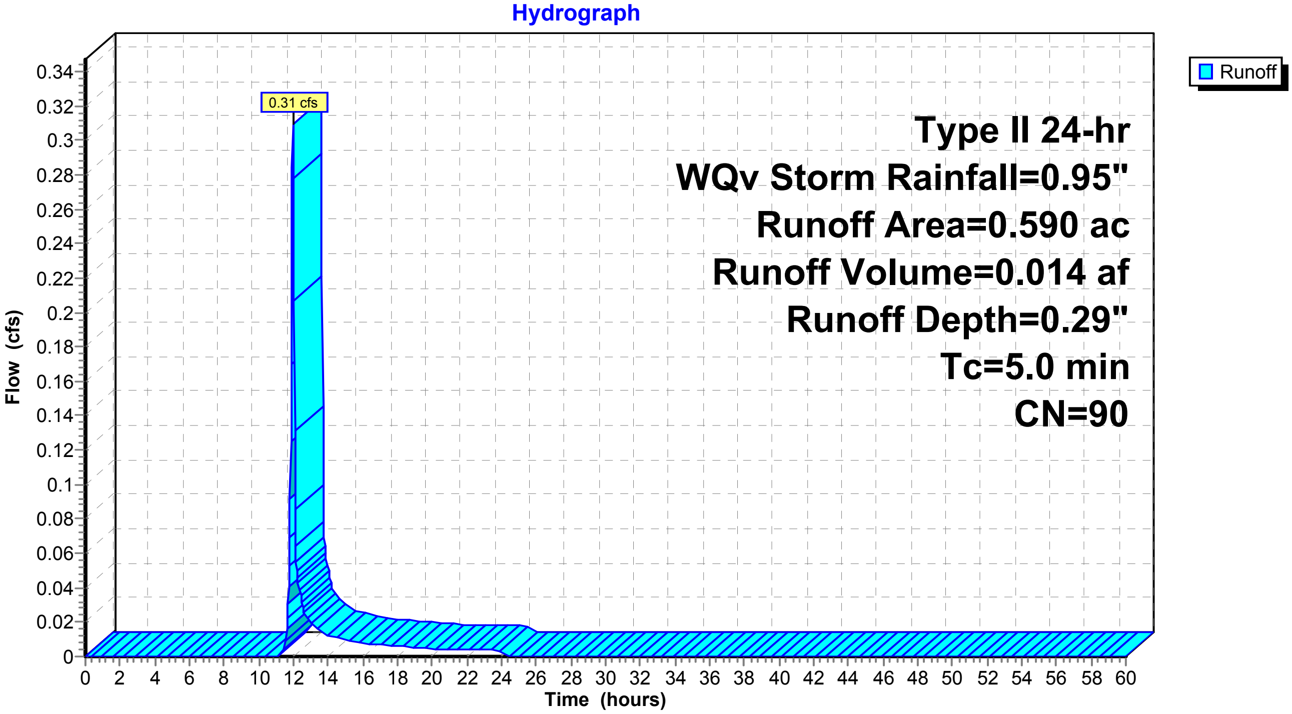
Runoff = 0.31 cfs @ 11.97 hrs, Volume= 0.014 af, Depth= 0.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type II 24-hr WQv Storm Rainfall=0.95"

Area (ac)	CN	Description
0.270	98	Paved parking, HSG D
0.320	84	50-75% Grass cover, Fair, HSG D
0.590	90	Weighted Average
0.320		54.24% Pervious Area
0.270		45.76% Impervious Area

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

Subcatchment 6S:



Summary for Subcatchment 7S:

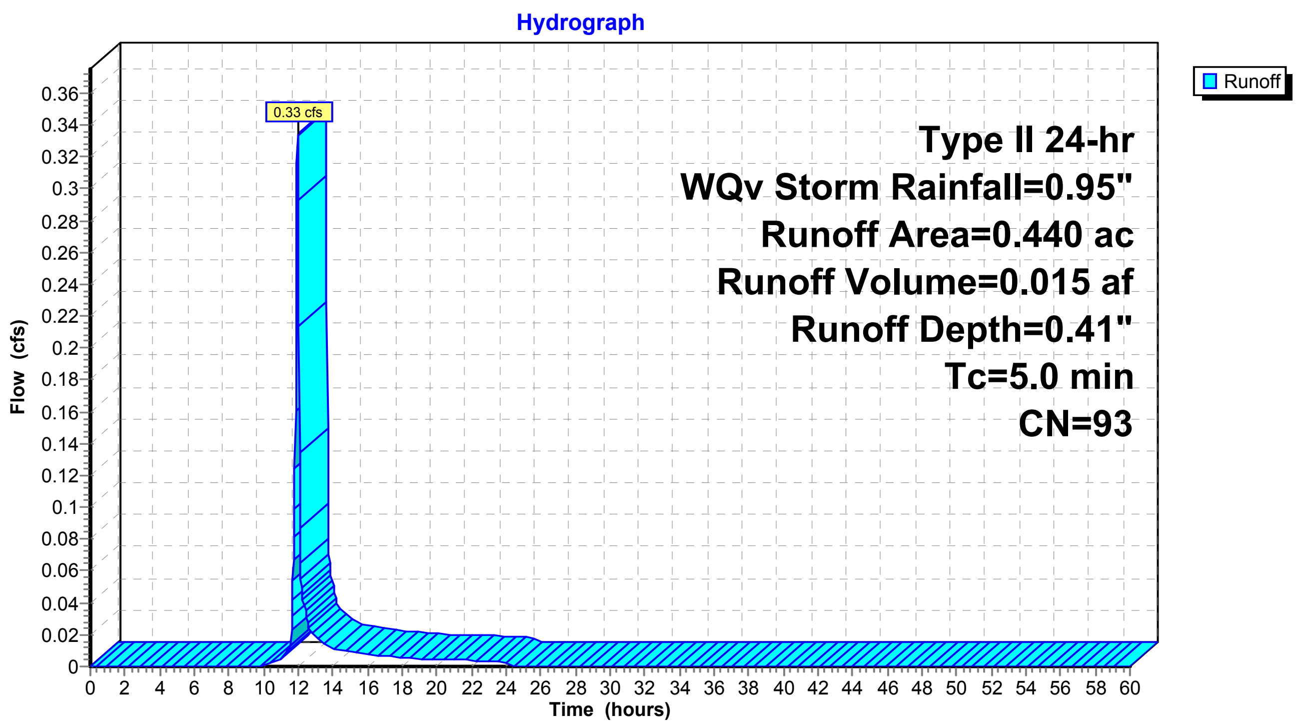
Runoff = 0.33 cfs @ 11.96 hrs, Volume= 0.015 af, Depth= 0.41"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type II 24-hr WQv Storm Rainfall=0.95"

Area (ac)	CN	Description
0.290	98	Paved parking, HSG D
0.150	84	50-75% Grass cover, Fair, HSG D
0.440	93	Weighted Average
0.150		34.09% Pervious Area
0.290		65.91% Impervious Area

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

Subcatchment 7S:



Summary for Subcatchment 8S:

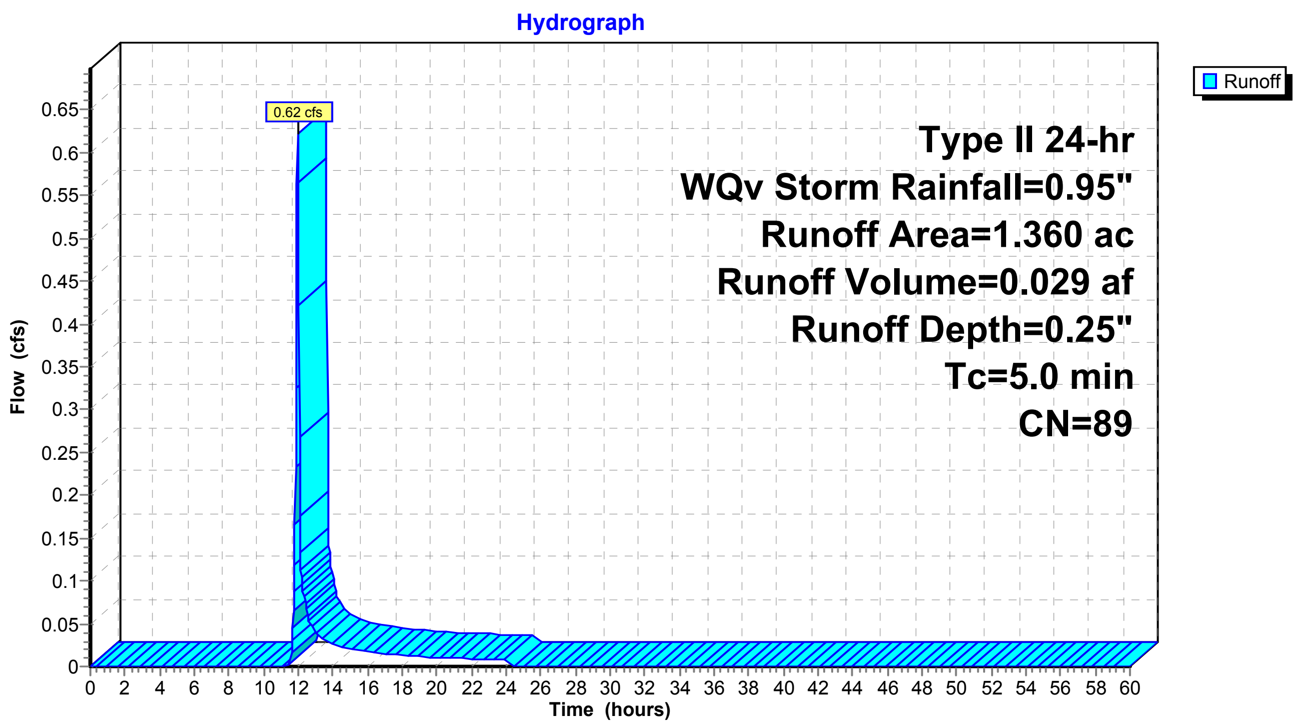
Runoff = 0.62 cfs @ 11.97 hrs, Volume= 0.029 af, Depth= 0.25"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type II 24-hr WQv Storm Rainfall=0.95"

Area (ac)	CN	Description
0.510	98	Paved parking, HSG D
0.850	84	50-75% Grass cover, Fair, HSG D
1.360	89	Weighted Average
0.850		62.50% Pervious Area
0.510		37.50% Impervious Area

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

Subcatchment 8S:



Summary for Subcatchment 9S:

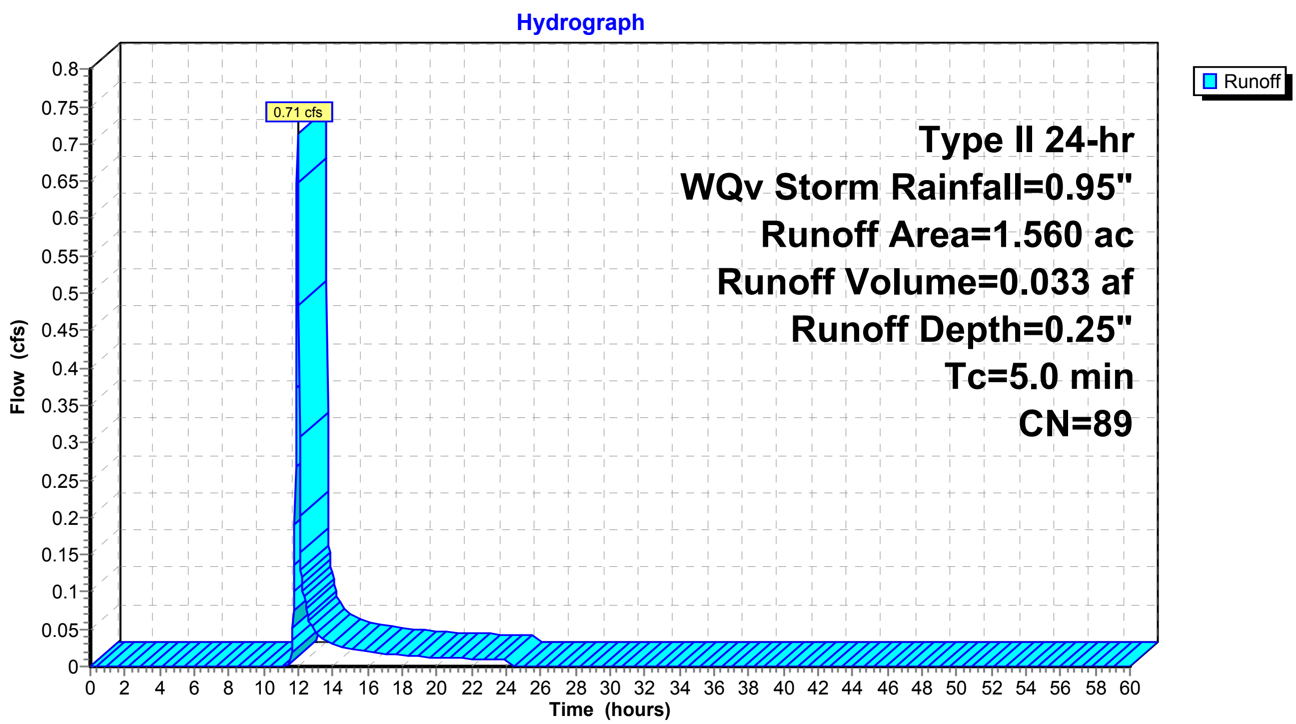
Runoff = 0.71 cfs @ 11.97 hrs, Volume= 0.033 af, Depth= 0.25"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type II 24-hr WQv Storm Rainfall=0.95"

Area (ac)	CN	Description
0.550	98	Paved parking, HSG D
1.010	84	50-75% Grass cover, Fair, HSG D
1.560	89	Weighted Average
1.010		64.74% Pervious Area
0.550		35.26% Impervious Area

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

Subcatchment 9S:



Summary for Subcatchment 10S:

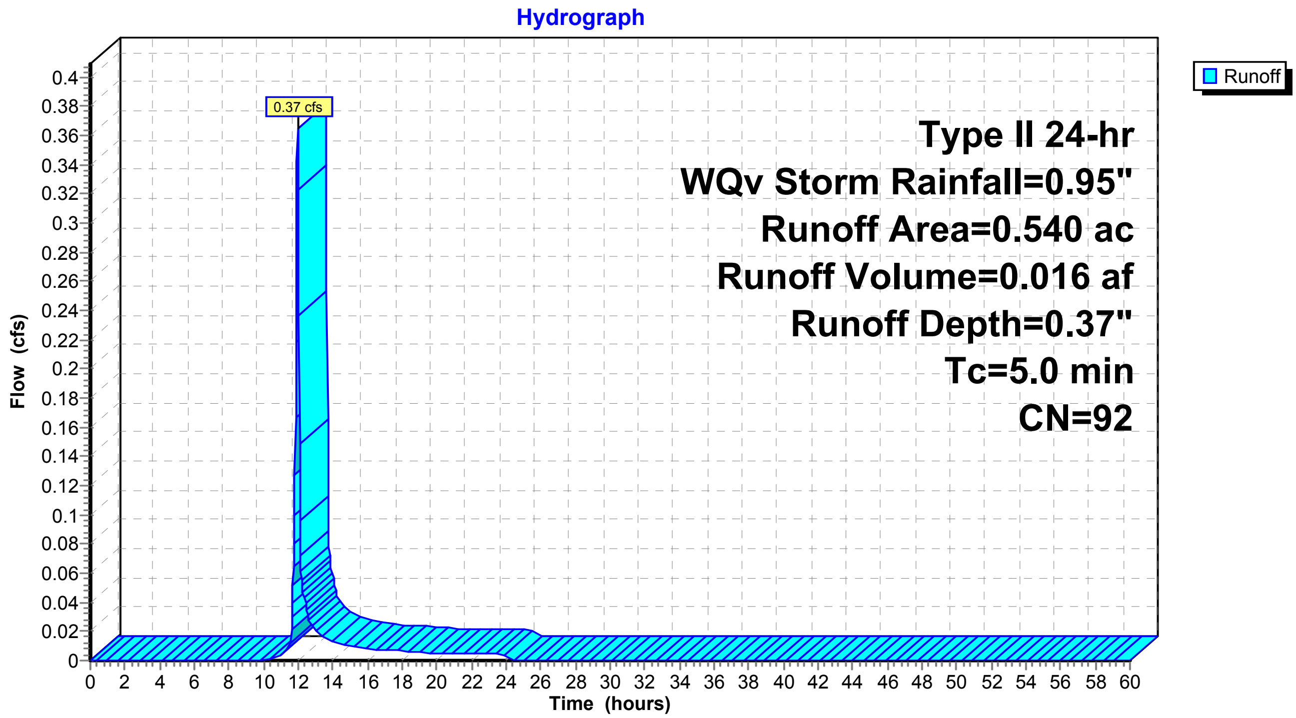
Runoff = 0.37 cfs @ 11.97 hrs, Volume= 0.016 af, Depth= 0.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type II 24-hr WQv Storm Rainfall=0.95"

Area (ac)	CN	Description
0.310	98	Paved parking, HSG D
0.230	84	50-75% Grass cover, Fair, HSG D
0.540	92	Weighted Average
0.230		42.59% Pervious Area
0.310		57.41% Impervious Area

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

Subcatchment 10S:



Summary for Subcatchment 11S:

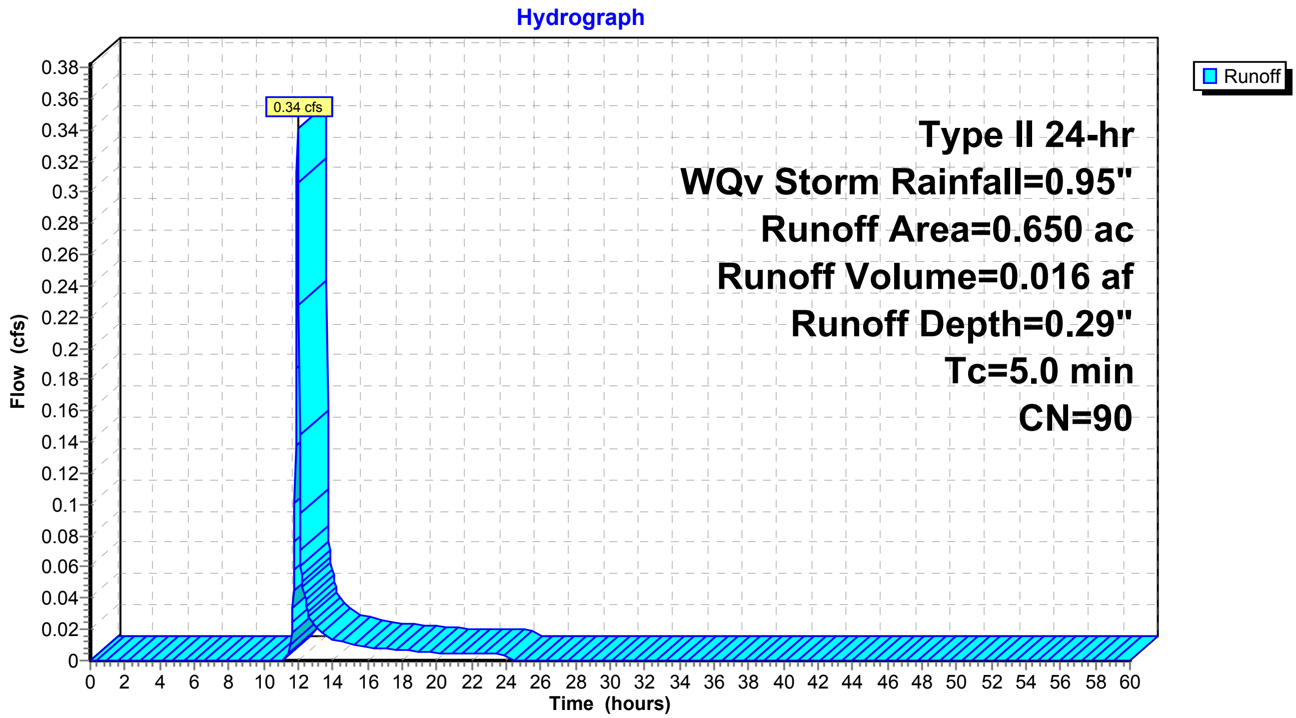
Runoff = 0.34 cfs @ 11.97 hrs, Volume= 0.016 af, Depth= 0.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type II 24-hr WQv Storm Rainfall=0.95"

Area (ac)	CN	Description
0.280	98	Paved parking, HSG D
0.370	84	50-75% Grass cover, Fair, HSG D
0.650	90	Weighted Average
0.370		56.92% Pervious Area
0.280		43.08% Impervious Area

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

Subcatchment 11S:



Summary for Subcatchment 12S:

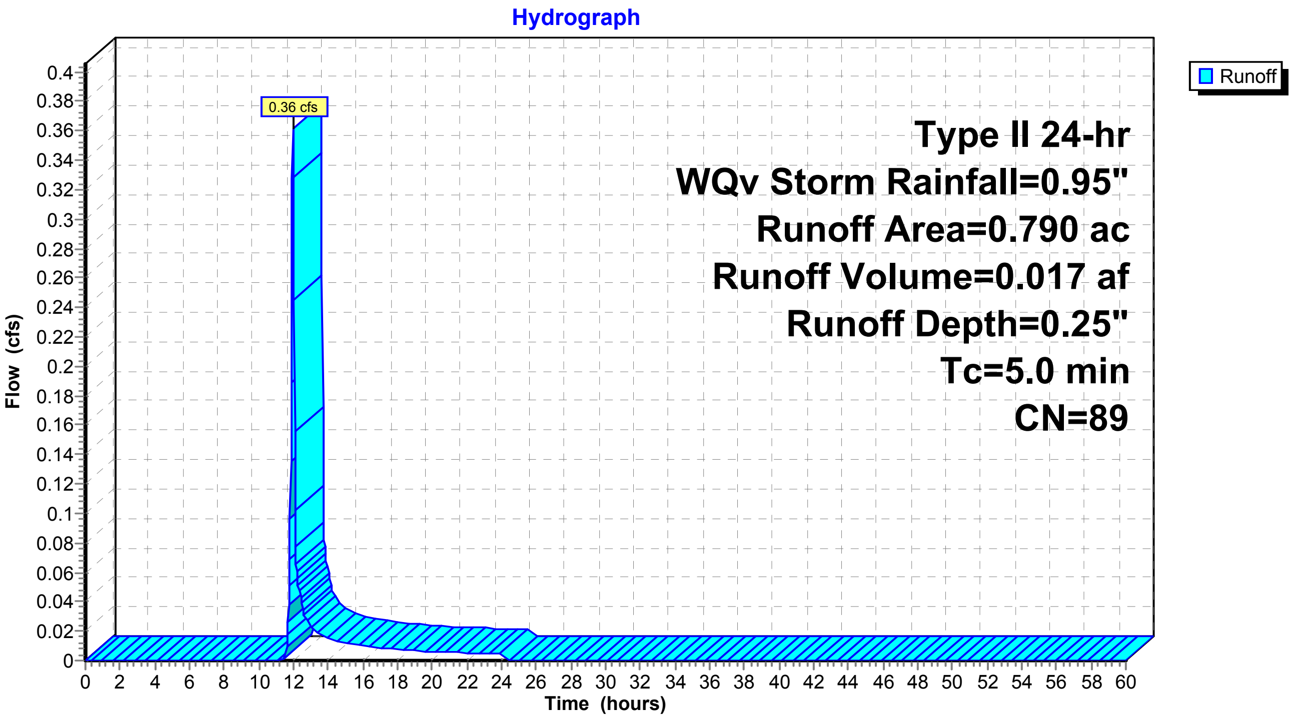
Runoff = 0.36 cfs @ 11.97 hrs, Volume= 0.017 af, Depth= 0.25"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type II 24-hr WQv Storm Rainfall=0.95"

Area (ac)	CN	Description
0.310	98	Paved parking, HSG D
0.480	84	50-75% Grass cover, Fair, HSG D
0.790	89	Weighted Average
0.480		60.76% Pervious Area
0.310		39.24% Impervious Area

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

Subcatchment 12S:



Summary for Subcatchment 13S:

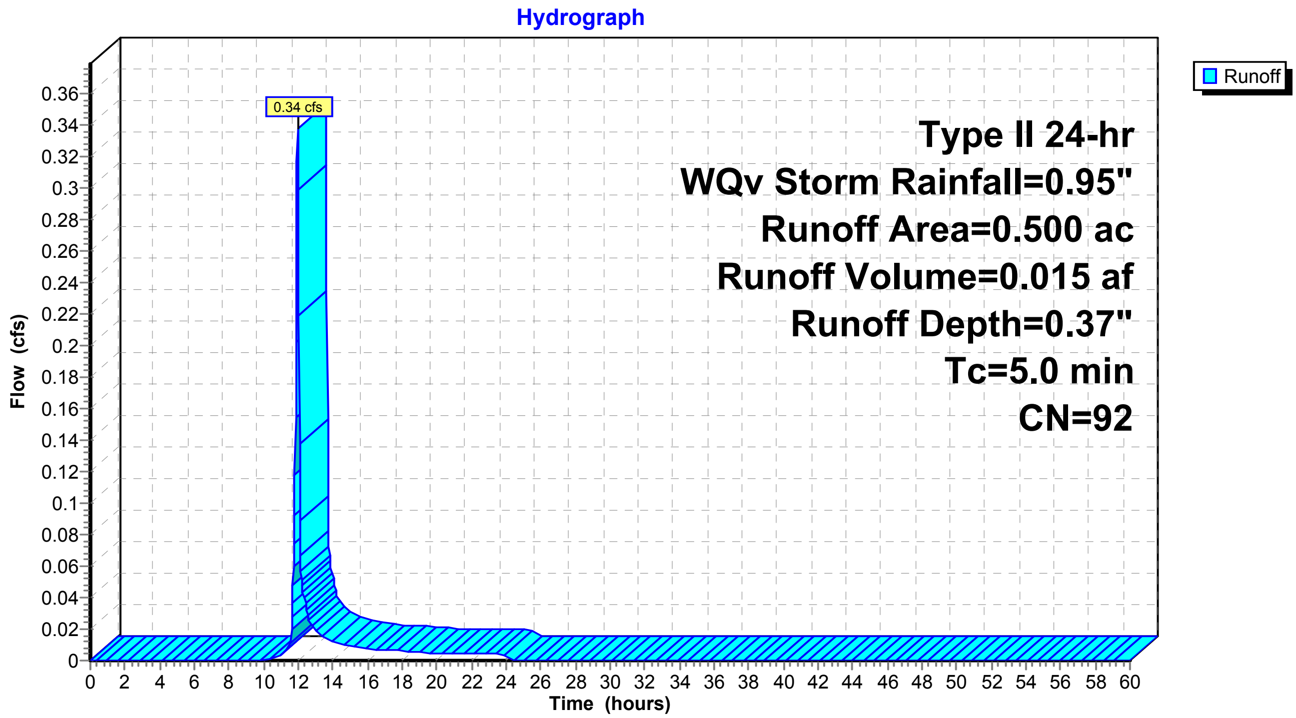
Runoff = 0.34 cfs @ 11.97 hrs, Volume= 0.015 af, Depth= 0.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type II 24-hr WQv Storm Rainfall=0.95"

Area (ac)	CN	Description
0.280	98	Paved parking, HSG D
0.220	84	50-75% Grass cover, Fair, HSG D
0.500	92	Weighted Average
0.220		44.00% Pervious Area
0.280		56.00% Impervious Area

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

Subcatchment 13S:



Summary for Subcatchment 14S:

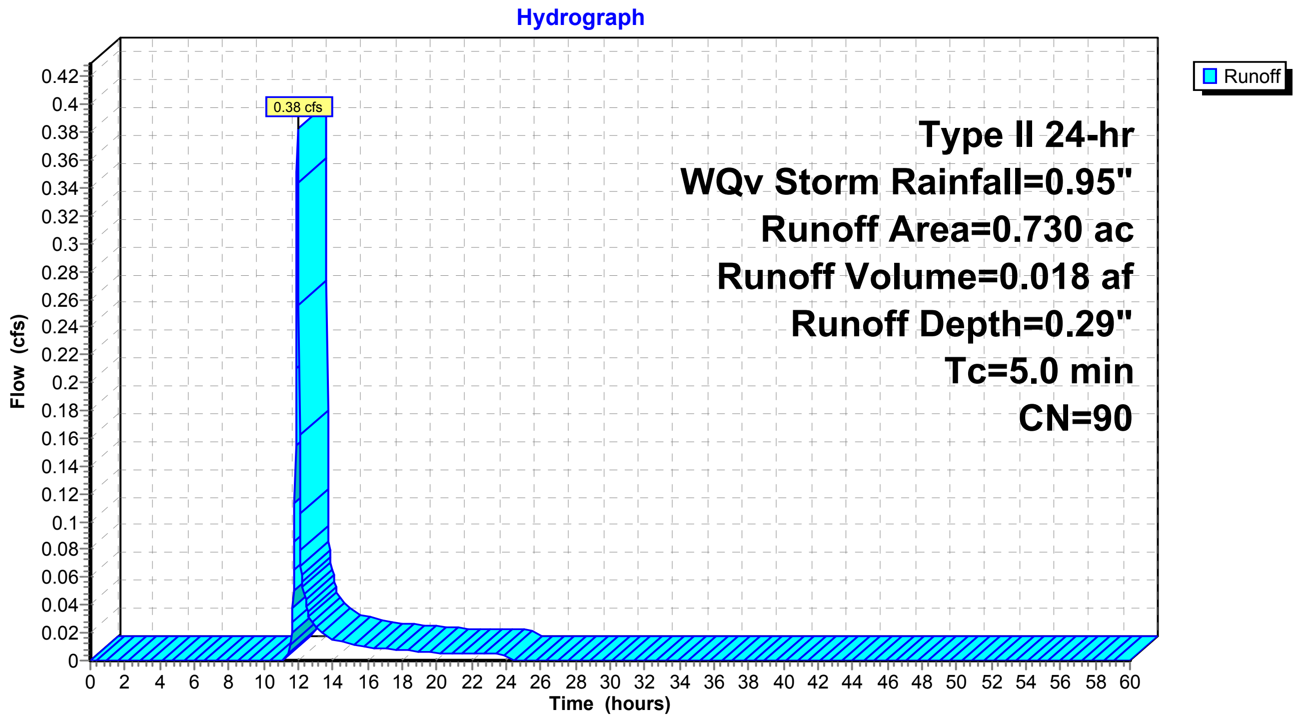
Runoff = 0.38 cfs @ 11.97 hrs, Volume= 0.018 af, Depth= 0.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type II 24-hr WQv Storm Rainfall=0.95"

Area (ac)	CN	Description
0.290	98	Paved parking, HSG D
0.440	84	50-75% Grass cover, Fair, HSG D
0.730	90	Weighted Average
0.440		60.27% Pervious Area
0.290		39.73% Impervious Area

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

Subcatchment 14S:



Summary for Subcatchment 15S:

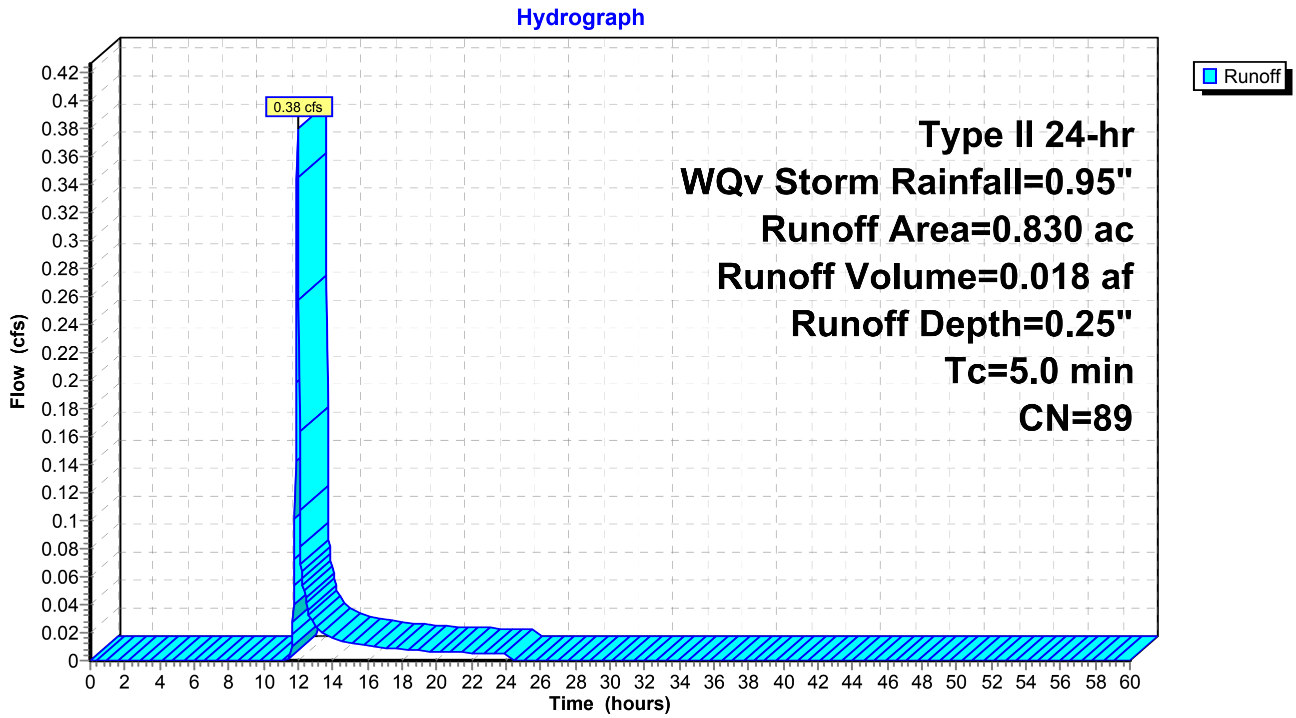
Runoff = 0.38 cfs @ 11.97 hrs, Volume= 0.018 af, Depth= 0.25"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type II 24-hr WQv Storm Rainfall=0.95"

Area (ac)	CN	Description
0.280	98	Paved parking, HSG D
0.550	84	50-75% Grass cover, Fair, HSG D
0.830	89	Weighted Average
0.550		66.27% Pervious Area
0.280		33.73% Impervious Area

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

Subcatchment 15S:



Summary for Subcatchment 16S:

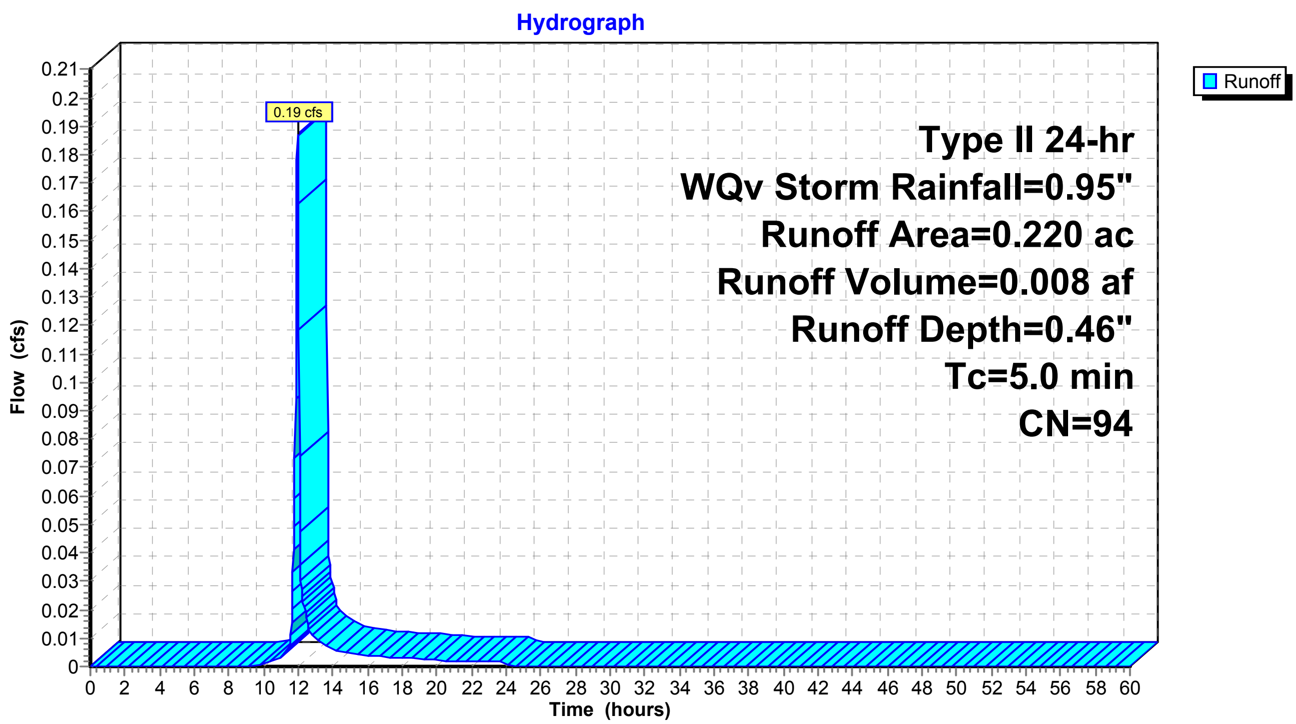
Runoff = 0.19 cfs @ 11.96 hrs, Volume= 0.008 af, Depth= 0.46"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type II 24-hr WQv Storm Rainfall=0.95"

Area (ac)	CN	Description
0.150	98	Paved parking, HSG D
0.070	84	50-75% Grass cover, Fair, HSG D
0.220	94	Weighted Average
0.070		31.82% Pervious Area
0.150		68.18% Impervious Area

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

Subcatchment 16S:



Summary for Subcatchment 17S:

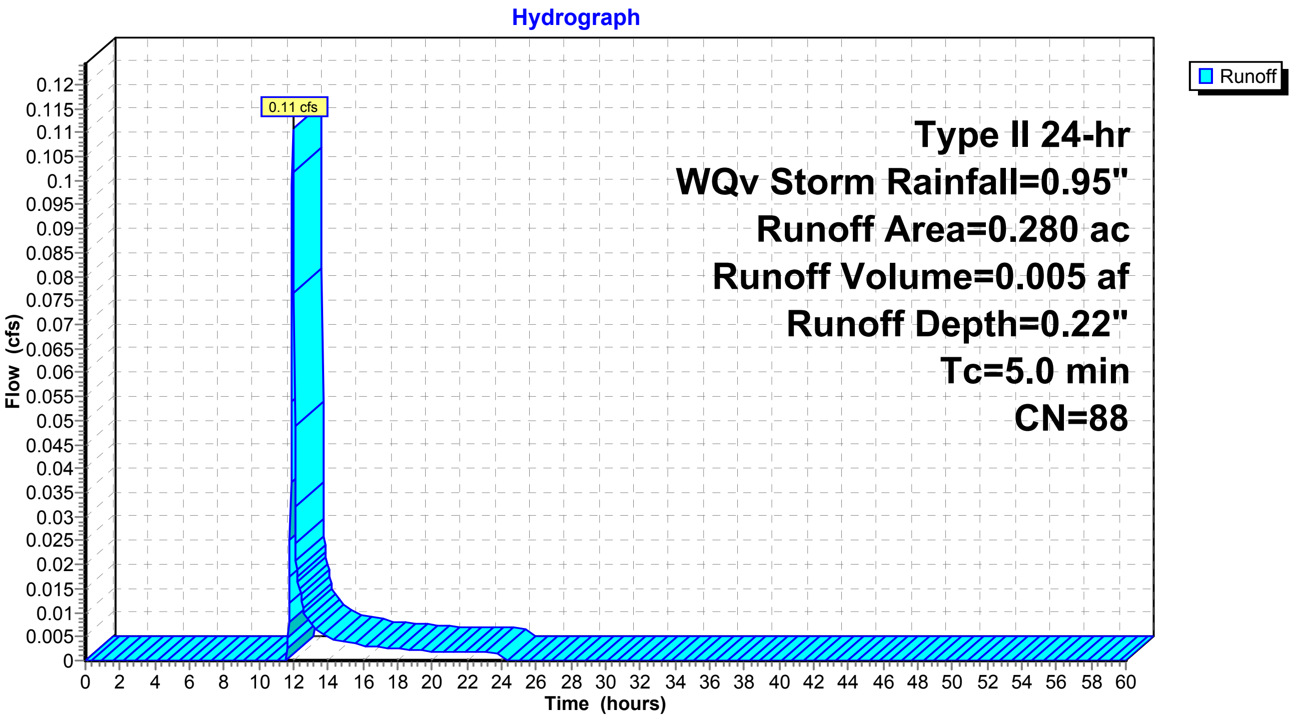
Runoff = 0.11 cfs @ 11.97 hrs, Volume= 0.005 af, Depth= 0.22"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type II 24-hr WQv Storm Rainfall=0.95"

Area (ac)	CN	Description
0.080	98	Paved parking, HSG D
0.200	84	50-75% Grass cover, Fair, HSG D
0.280	88	Weighted Average
0.200		71.43% Pervious Area
0.080		28.57% Impervious Area

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

Subcatchment 17S:



Summary for Subcatchment 18S:

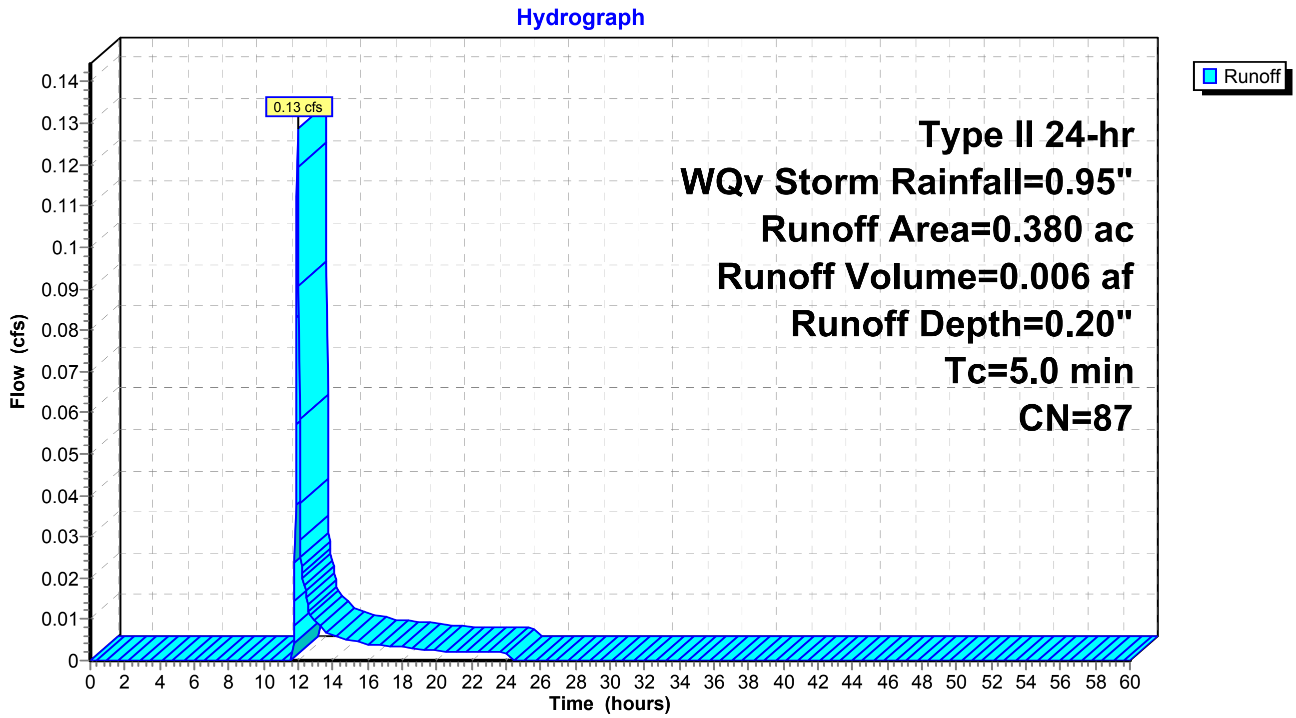
Runoff = 0.13 cfs @ 11.97 hrs, Volume= 0.006 af, Depth= 0.20"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type II 24-hr WQv Storm Rainfall=0.95"

Area (ac)	CN	Description
0.070	98	Paved parking, HSG D
0.310	84	50-75% Grass cover, Fair, HSG D
0.380	87	Weighted Average
0.310		81.58% Pervious Area
0.070		18.42% Impervious Area

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

Subcatchment 18S:



Summary for Subcatchment 19S:

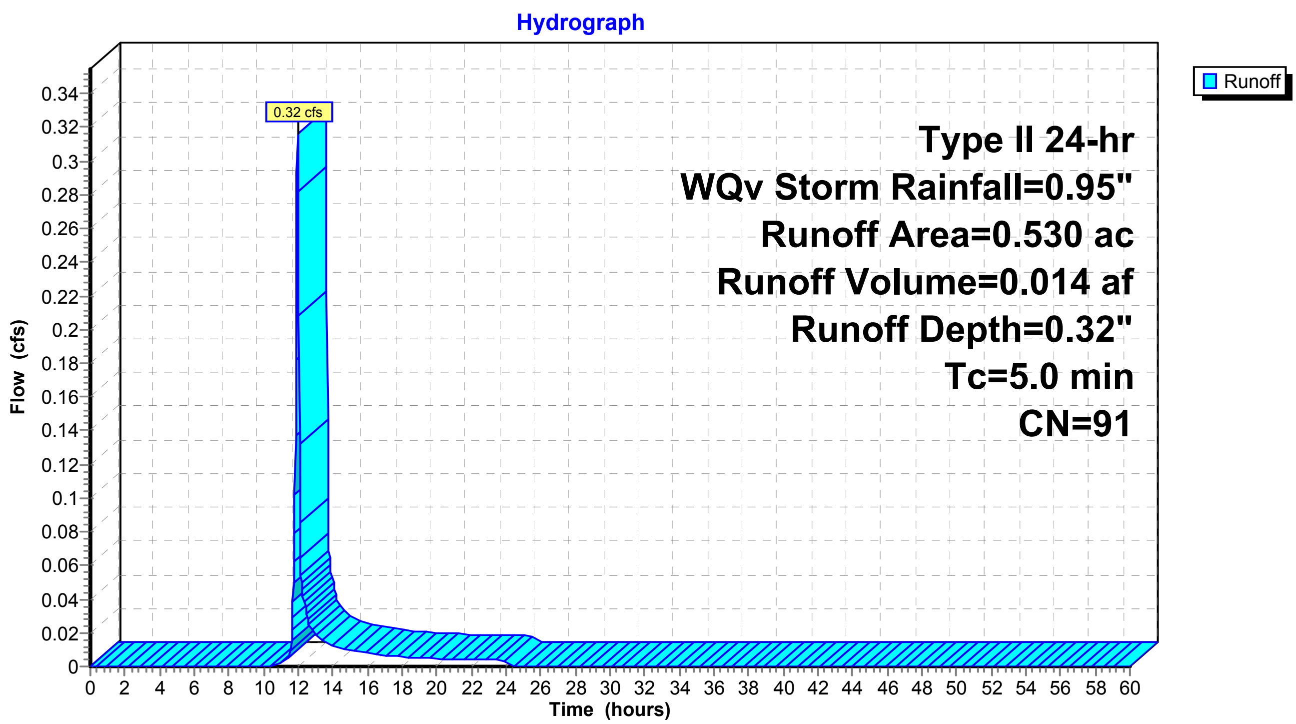
Runoff = 0.32 cfs @ 11.97 hrs, Volume= 0.014 af, Depth= 0.32"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type II 24-hr WQv Storm Rainfall=0.95"

Area (ac)	CN	Description
0.280	98	Paved parking, HSG D
0.250	84	50-75% Grass cover, Fair, HSG D
0.530	91	Weighted Average
0.250		47.17% Pervious Area
0.280		52.83% Impervious Area

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

Subcatchment 19S:



Summary for Subcatchment 20S:

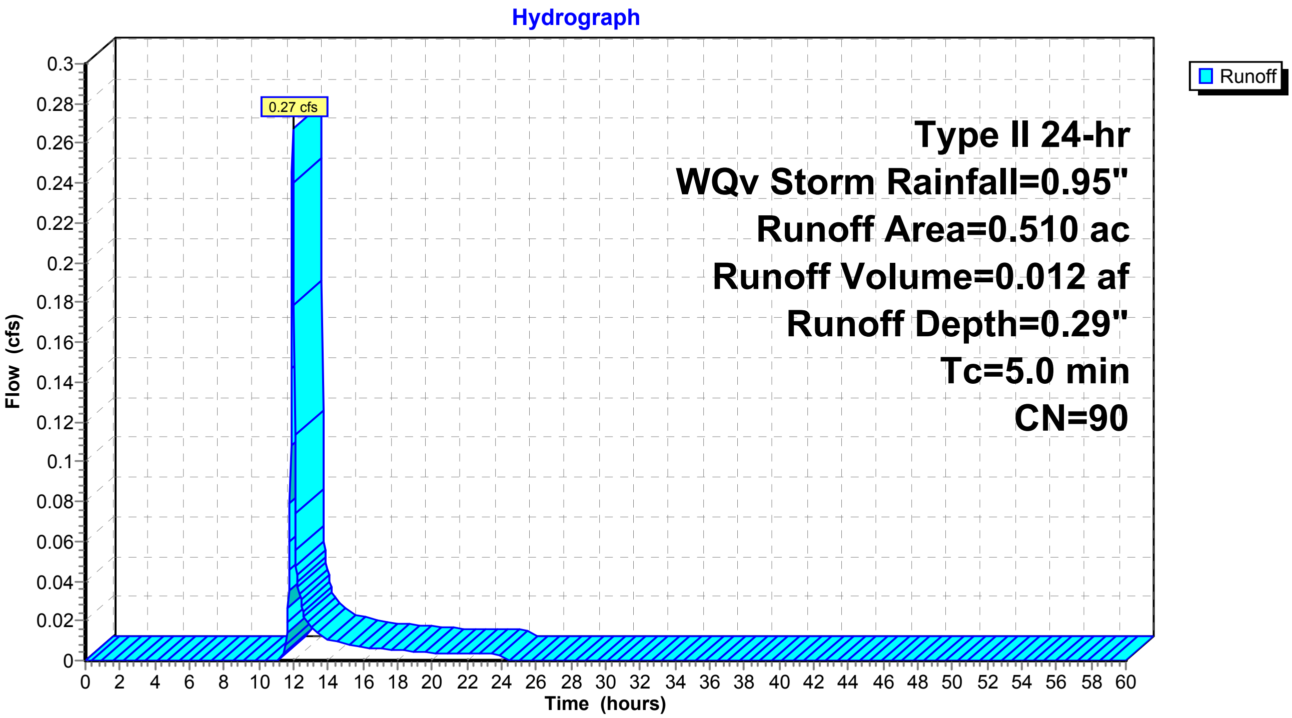
Runoff = 0.27 cfs @ 11.97 hrs, Volume= 0.012 af, Depth= 0.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type II 24-hr WQv Storm Rainfall=0.95"

Area (ac)	CN	Description
0.220	98	Paved parking, HSG D
0.290	84	50-75% Grass cover, Fair, HSG D
0.510	90	Weighted Average
0.290		56.86% Pervious Area
0.220		43.14% Impervious Area

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

Subcatchment 20S:



Summary for Subcatchment 21S:

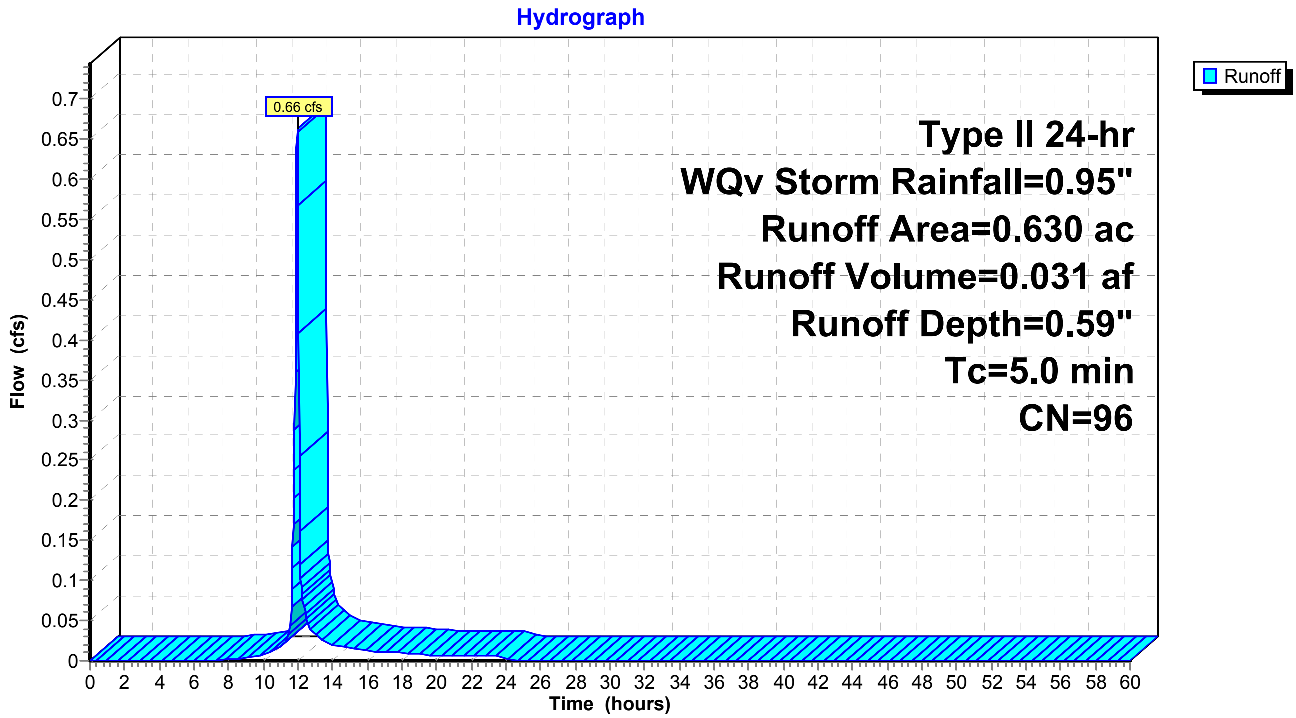
Runoff = 0.66 cfs @ 11.96 hrs, Volume= 0.031 af, Depth= 0.59"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type II 24-hr WQv Storm Rainfall=0.95"

Area (ac)	CN	Description
0.530	98	Paved parking, HSG D
0.100	84	50-75% Grass cover, Fair, HSG D
0.630	96	Weighted Average
0.100		15.87% Pervious Area
0.530		84.13% Impervious Area

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

Subcatchment 21S:



Summary for Subcatchment 22S:

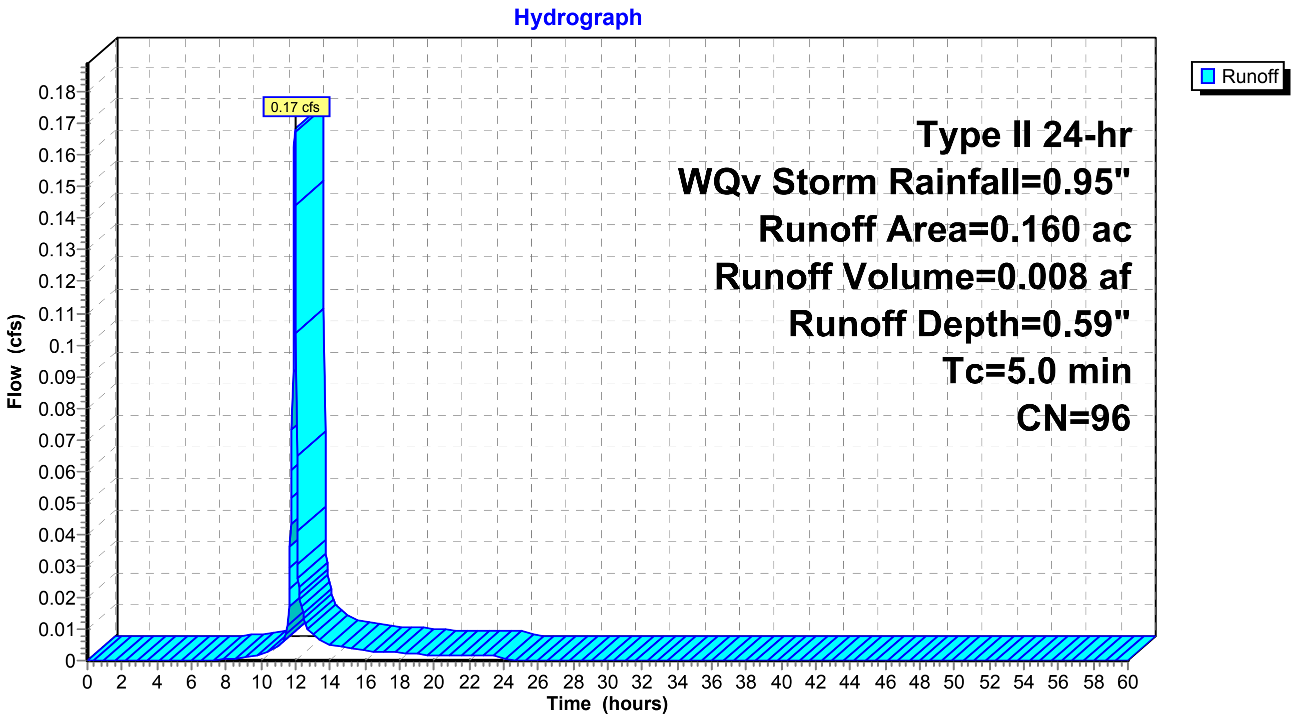
Runoff = 0.17 cfs @ 11.96 hrs, Volume= 0.008 af, Depth= 0.59"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type II 24-hr WQv Storm Rainfall=0.95"

Area (ac)	CN	Description
0.140	98	Paved parking, HSG D
0.020	84	50-75% Grass cover, Fair, HSG D
0.160	96	Weighted Average
0.020		12.50% Pervious Area
0.140		87.50% Impervious Area

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

Subcatchment 22S:



Summary for Subcatchment 23S:

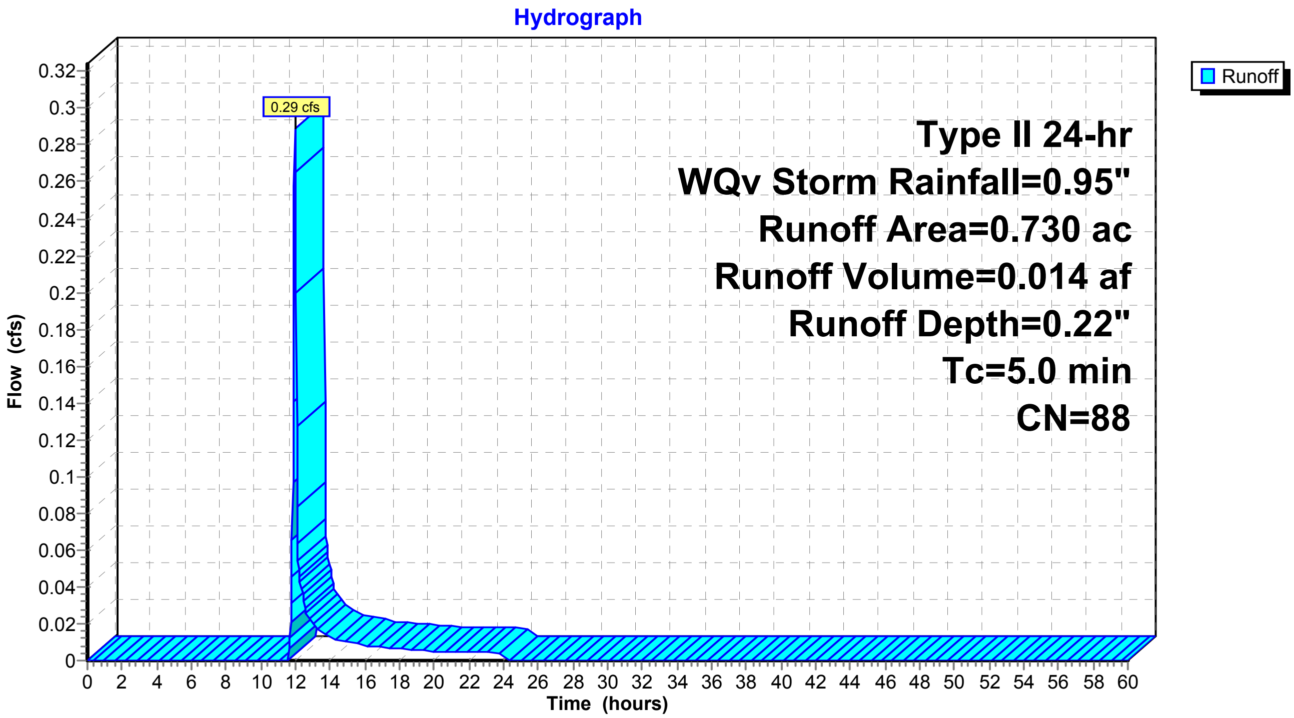
Runoff = 0.29 cfs @ 11.97 hrs, Volume= 0.014 af, Depth= 0.22"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type II 24-hr WQv Storm Rainfall=0.95"

Area (ac)	CN	Description
0.230	98	Paved parking, HSG D
0.500	84	50-75% Grass cover, Fair, HSG D
0.730	88	Weighted Average
0.500		68.49% Pervious Area
0.230		31.51% Impervious Area

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

Subcatchment 23S:



Summary for Subcatchment 24S:

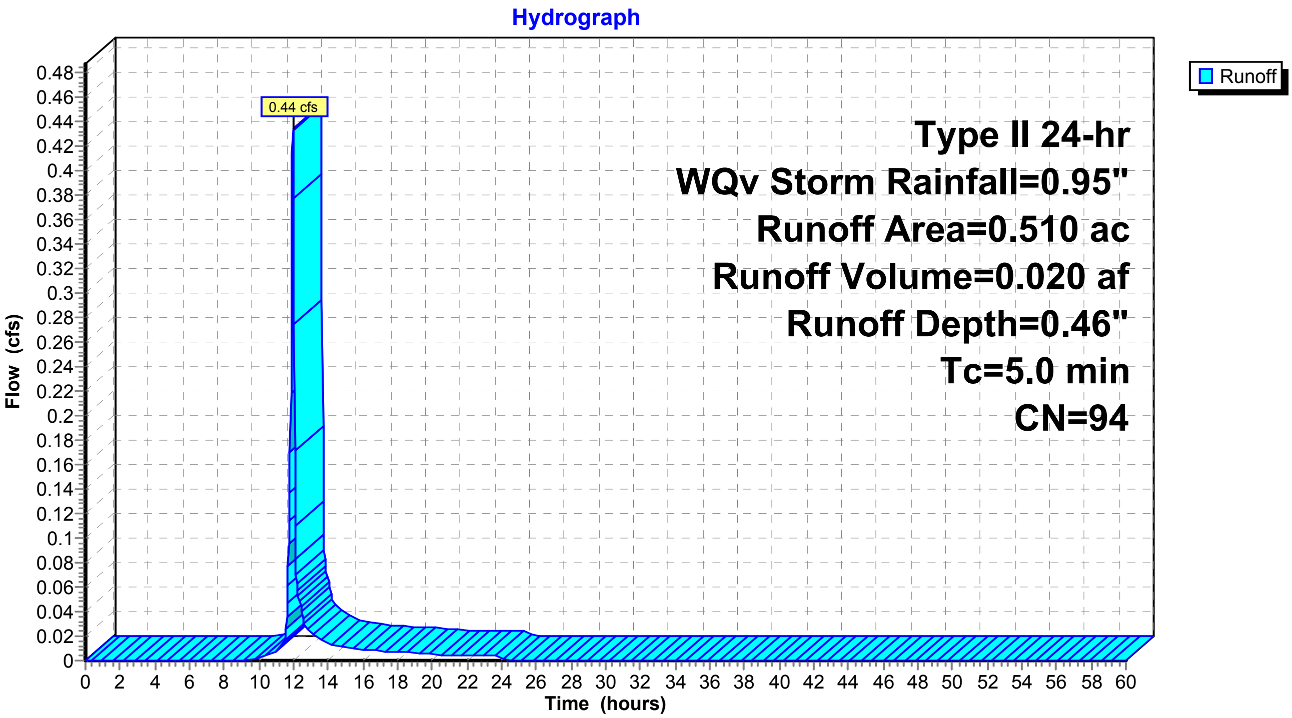
Runoff = 0.44 cfs @ 11.96 hrs, Volume= 0.020 af, Depth= 0.46"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type II 24-hr WQv Storm Rainfall=0.95"

Area (ac)	CN	Description
0.370	98	Paved parking, HSG D
0.140	84	50-75% Grass cover, Fair, HSG D
0.510	94	Weighted Average
0.140		27.45% Pervious Area
0.370		72.55% Impervious Area

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

Subcatchment 24S:



Summary for Subcatchment 25S:

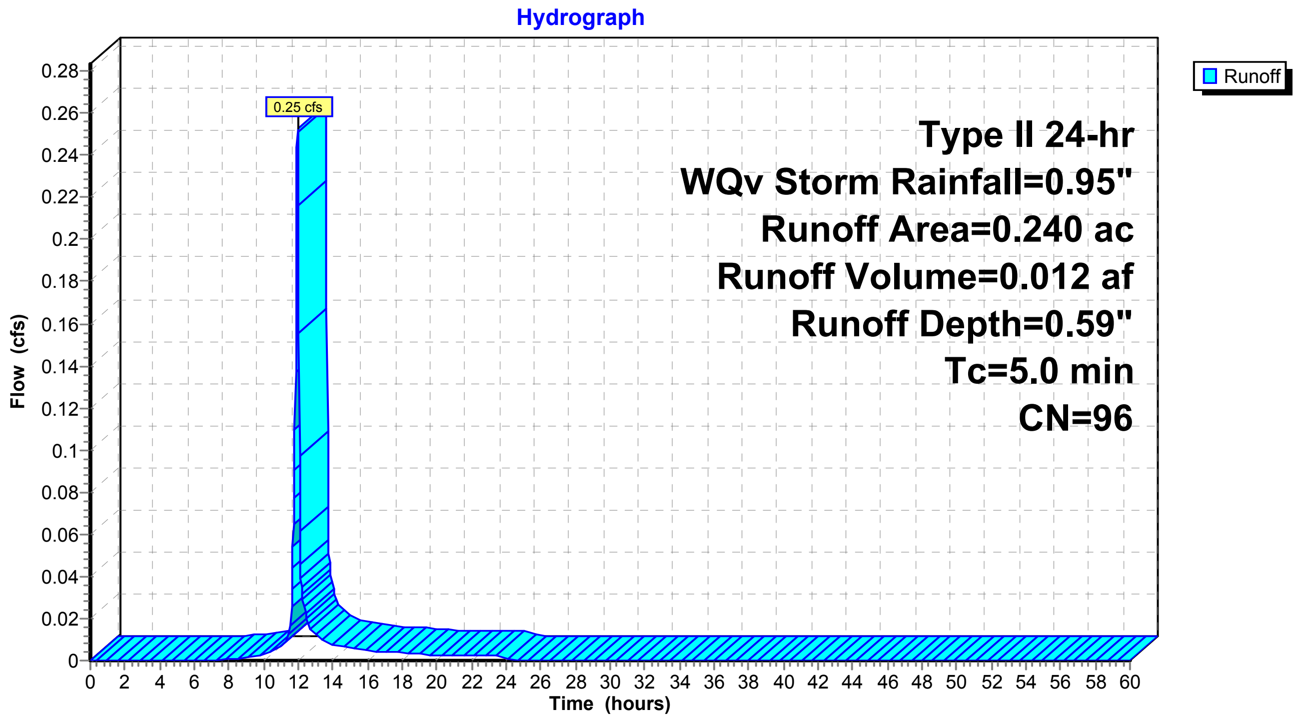
Runoff = 0.25 cfs @ 11.96 hrs, Volume= 0.012 af, Depth= 0.59"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type II 24-hr WQv Storm Rainfall=0.95"

Area (ac)	CN	Description
0.200	98	Paved parking, HSG D
0.040	84	50-75% Grass cover, Fair, HSG D
0.240	96	Weighted Average
0.040		16.67% Pervious Area
0.200		83.33% Impervious Area

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

Subcatchment 25S:



Summary for Subcatchment 26S:

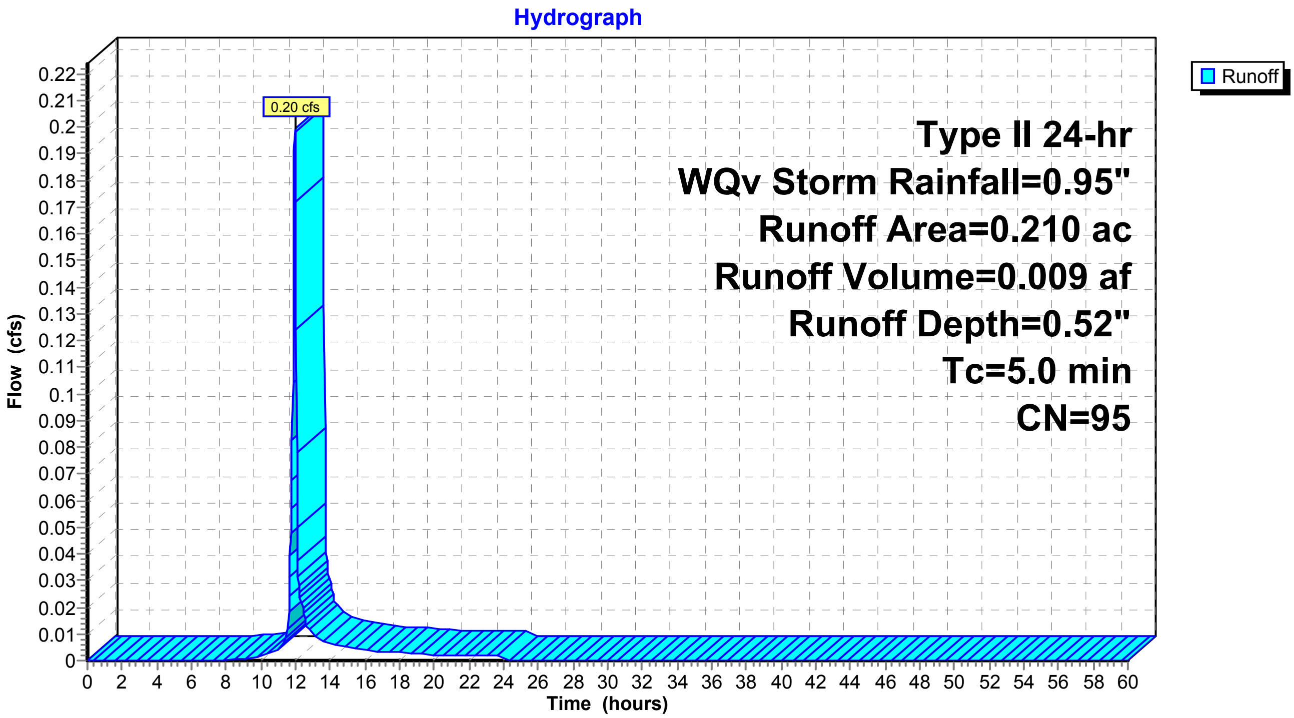
Runoff = 0.20 cfs @ 11.96 hrs, Volume= 0.009 af, Depth= 0.52"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type II 24-hr WQv Storm Rainfall=0.95"

Area (ac)	CN	Description
0.170	98	Water Surface, HSG D
0.040	84	50-75% Grass cover, Fair, HSG D
0.210	95	Weighted Average
0.040		19.05% Pervious Area
0.170		80.95% Impervious Area

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

Subcatchment 26S:



Summary for Subcatchment 27S:

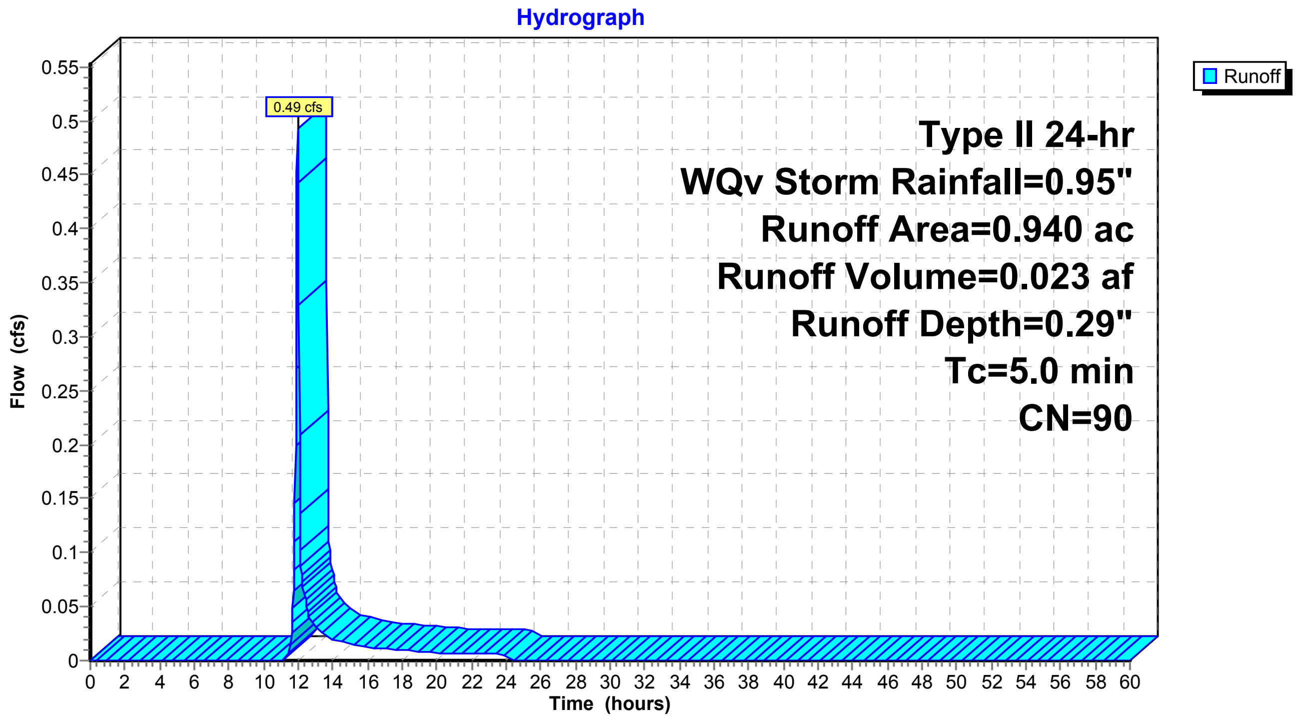
Runoff = 0.49 cfs @ 11.97 hrs, Volume= 0.023 af, Depth= 0.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type II 24-hr WQv Storm Rainfall=0.95"

Area (ac)	CN	Description
0.400	98	Paved parking, HSG D
0.540	84	50-75% Grass cover, Fair, HSG D
0.940	90	Weighted Average
0.540		57.45% Pervious Area
0.400		42.55% Impervious Area

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

Subcatchment 27S:



Summary for Subcatchment 28S:

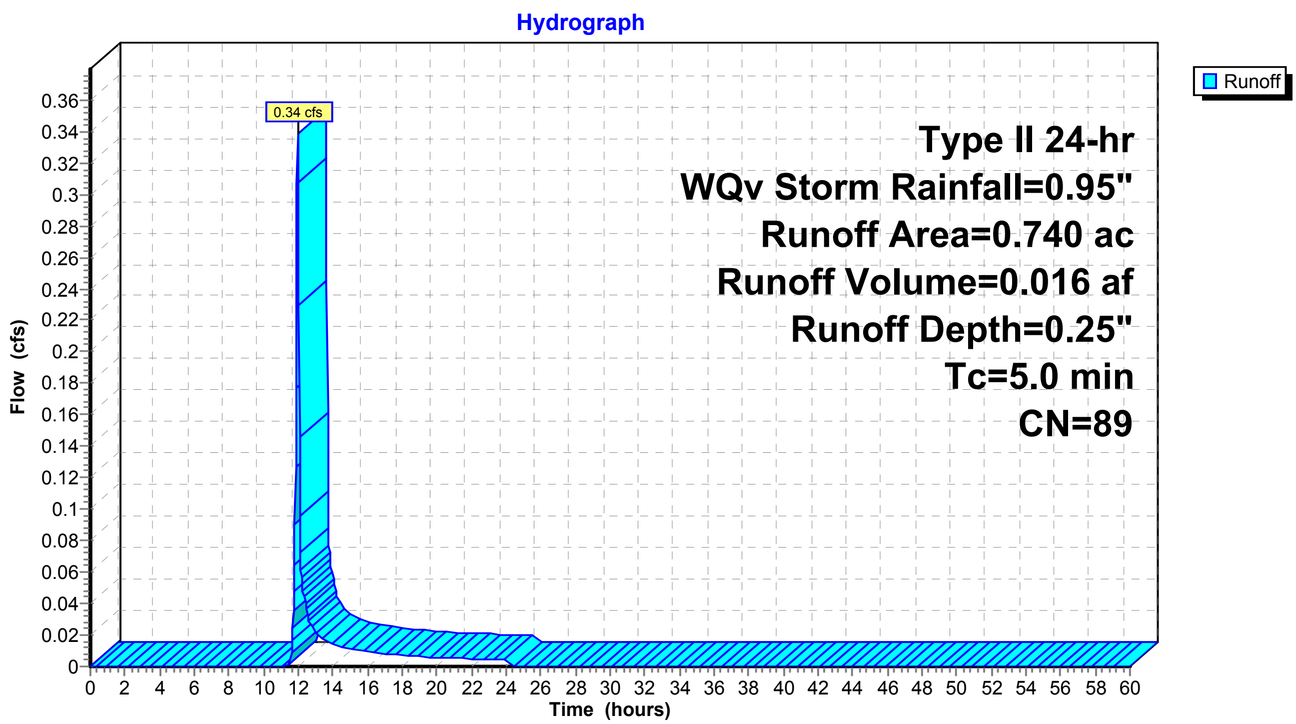
Runoff = 0.34 cfs @ 11.97 hrs, Volume= 0.016 af, Depth= 0.25"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type II 24-hr WQv Storm Rainfall=0.95"

Area (ac)	CN	Description
0.260	98	Paved parking, HSG D
0.480	84	50-75% Grass cover, Fair, HSG D
0.740	89	Weighted Average
0.480		64.86% Pervious Area
0.260		35.14% Impervious Area

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

Subcatchment 28S:



Summary for Subcatchment 29S:

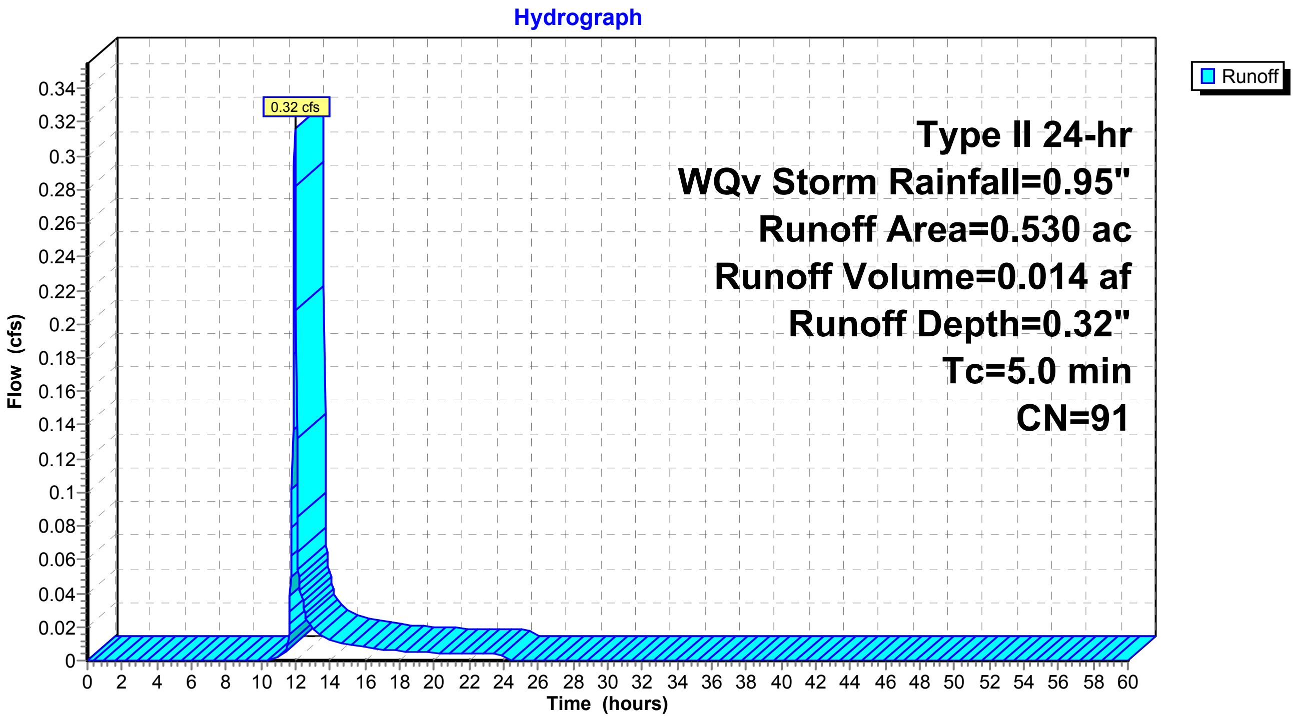
Runoff = 0.32 cfs @ 11.97 hrs, Volume= 0.014 af, Depth= 0.32"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type II 24-hr WQv Storm Rainfall=0.95"

Area (ac)	CN	Description
0.270	98	Paved parking, HSG D
0.260	84	50-75% Grass cover, Fair, HSG D
0.530	91	Weighted Average
0.260		49.06% Pervious Area
0.270		50.94% Impervious Area

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

Subcatchment 29S:



Summary for Subcatchment 30S:

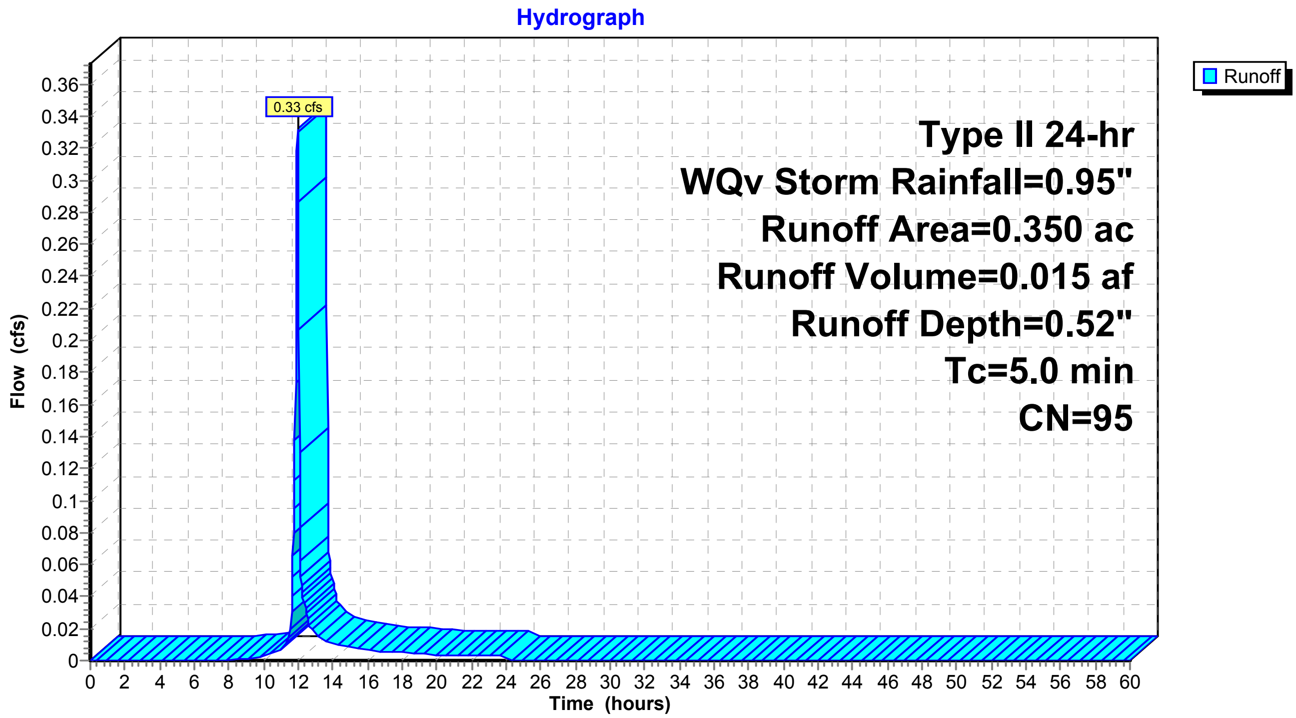
Runoff = 0.33 cfs @ 11.96 hrs, Volume= 0.015 af, Depth= 0.52"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Type II 24-hr WQv Storm Rainfall=0.95"

Area (ac)	CN	Description
0.280	98	Paved parking, HSG D
0.070	84	50-75% Grass cover, Fair, HSG D
0.350	95	Weighted Average
0.070		20.00% Pervious Area
0.280		80.00% Impervious Area

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

Subcatchment 30S:



Summary for Pond 4P:

Inflow Area = 0.640 ac,100.00% Impervious, Inflow Depth = 0.74" for WQv Storm event
Inflow = 0.81 cfs @ 11.96 hrs, Volume= 0.040 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Peak Elev= 24.33' @ 24.30 hrs Surf.Area= 2,218 sf Storage= 1,725 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

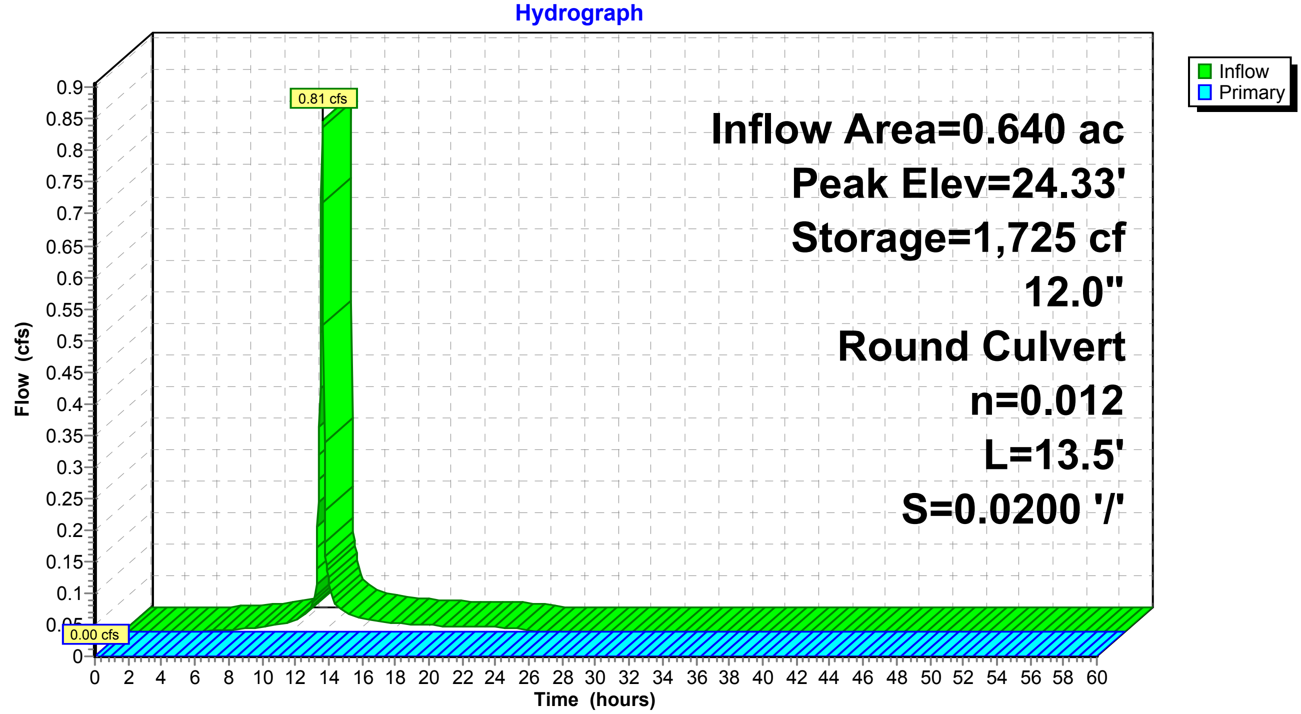
Volume	Invert	Avail.Storage	Storage Description
#1	22.39'	4,436 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) 11,090 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
22.39	2,218	0	0
27.39	2,218	11,090	11,090

Device	Routing	Invert	Outlet Devices
#1	Primary	24.39'	**12.0" Round Culvert** L= 13.5' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 24.39' / 24.12' S= 0.0200 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=22.39' (Free Discharge)
↑—**1=Culvert** (Controls 0.00 cfs)

Pond 4P:


Hydrograph
Inflow
Primary
0.81 cfs
0.00 cfs
Inflow Area=0.640 ac
Peak Elev=24.33'
Storage=1,725 cf
12.0"
Round Culvert
n=0.012
L=13.5'
S=0.0200 '/'
Flow (cfs)
Time (hours)
0.9
0.85
0.8
0.75
0.7
0.65
0.6
0.55
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60

Summary for Pond 5P:

Inflow Area = 2.410 ac, 31.12% Impervious, Inflow Depth = 0.24" for WQv Storm event
Inflow = 1.00 cfs @ 11.97 hrs, Volume= 0.047 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Peak Elev= 23.34' @ 24.30 hrs Surf.Area= 3,216 sf Storage= 2,061 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

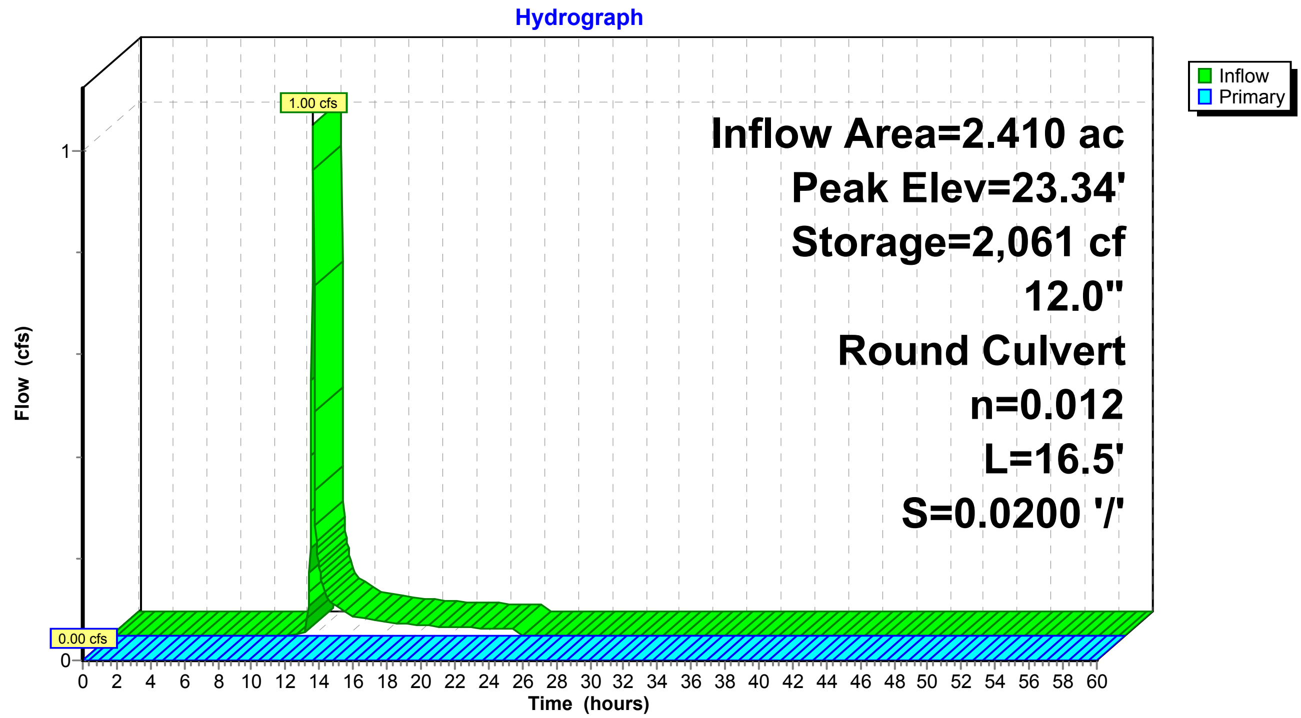
Volume	Invert	Avail.Storage	Storage Description
#1	21.74'	6,110 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) 15,276 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
21.74	3,216	0	0
26.49	3,216	15,276	15,276

Device	Routing	Invert	Outlet Devices
#1	Primary	23.49'	**12.0" Round Culvert** L= 16.5' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 23.49' / 23.16' S= 0.0200 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=21.74' (Free Discharge)
└─**1=Culvert** (Controls 0.00 cfs)

Pond 5P:


Hydrograph
1.00 cfs
0.00 cfs
Inflow
Primary
Inflow Area=2.410 ac
Peak Elev=23.34'
Storage=2,061 cf
12.0"
Round Culvert
n=0.012
L=16.5'
S=0.0200 '/'
Flow (cfs)
Time (hours)
0
1
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60

Summary for Pond 6P:

Inflow Area = 2.390 ac, 44.77% Impervious, Inflow Depth = 0.29" for WQv Storm event
Inflow = 1.27 cfs @ 11.97 hrs, Volume= 0.058 af
Outflow = 0.01 cfs @ 24.08 hrs, Volume= 0.001 af, Atten= 99%, Lag= 726.7 min
Primary = 0.01 cfs @ 24.08 hrs, Volume= 0.001 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Peak Elev= 22.27' @ 24.08 hrs Surf.Area= 3,091 sf Storage= 2,521 cf

Plug-Flow detention time= 962.2 min calculated for 0.001 af (2% of inflow)
Center-of-Mass det. time= 785.4 min (1,645.2 - 859.8)

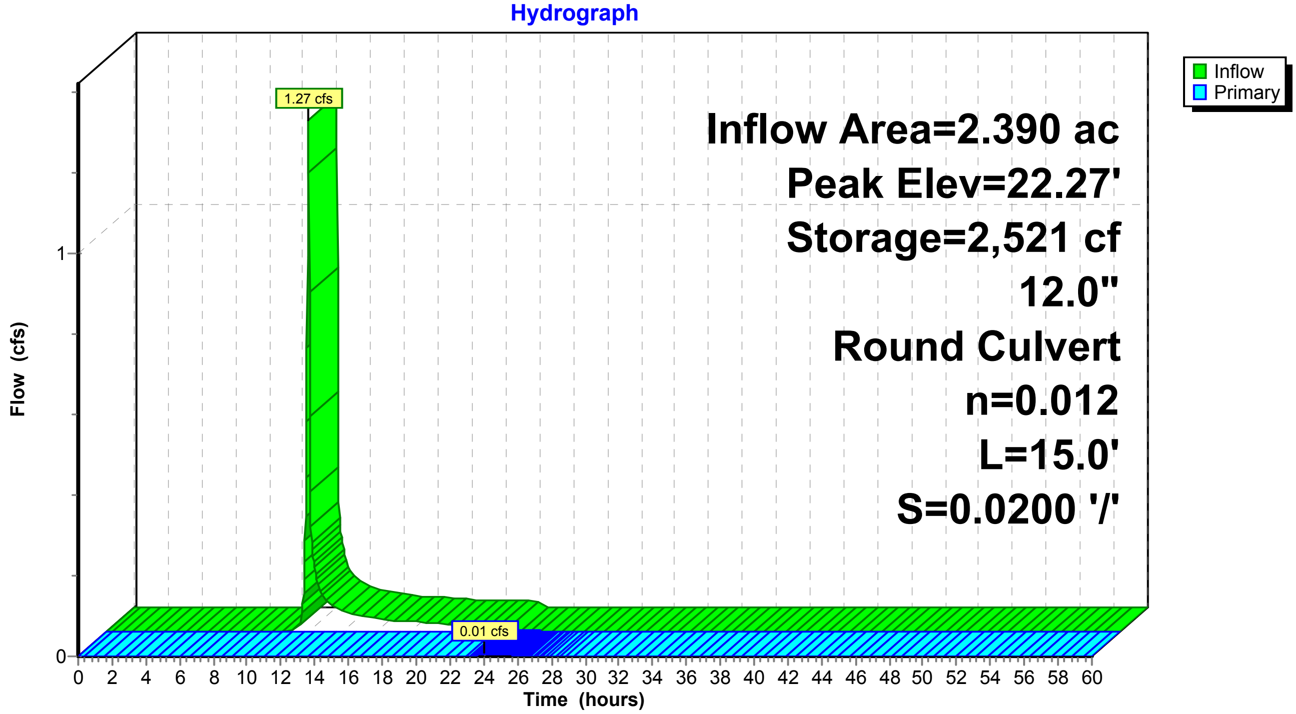
Volume	Invert	Avail.Storage	Storage Description
#1	20.23'	6,182 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) 15,455 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
20.23	3,091	0	0
25.23	3,091	15,455	15,455

Device	Routing	Invert	Outlet Devices
#1	Primary	22.23'	**12.0" Round Culvert** L= 15.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 22.23' / 21.93' S= 0.0200 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf

Primary OutFlow Max=0.01 cfs @ 24.08 hrs HW=22.27' (Free Discharge)
↑—**1=Culvert** (Inlet Controls 0.01 cfs @ 0.67 fps)

Pond 6P:


Hydrograph
1.27 cfs
0.01 cfs
Inflow Area=2.390 ac
Peak Elev=22.27'
Storage=2,521 cf
12.0"
Round Culvert
n=0.012
L=15.0'
S=0.0200 '/'
Inflow
Primary
Flow (cfs)
Time (hours)
0
1
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60

Summary for Pond 7P:

Inflow Area = 2.750 ac, 41.45% Impervious, Inflow Depth = 0.28" for WQv Storm event
Inflow = 1.42 cfs @ 11.97 hrs, Volume= 0.065 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Peak Elev= 21.29' @ 24.30 hrs Surf.Area= 3,091 sf Storage= 2,840 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

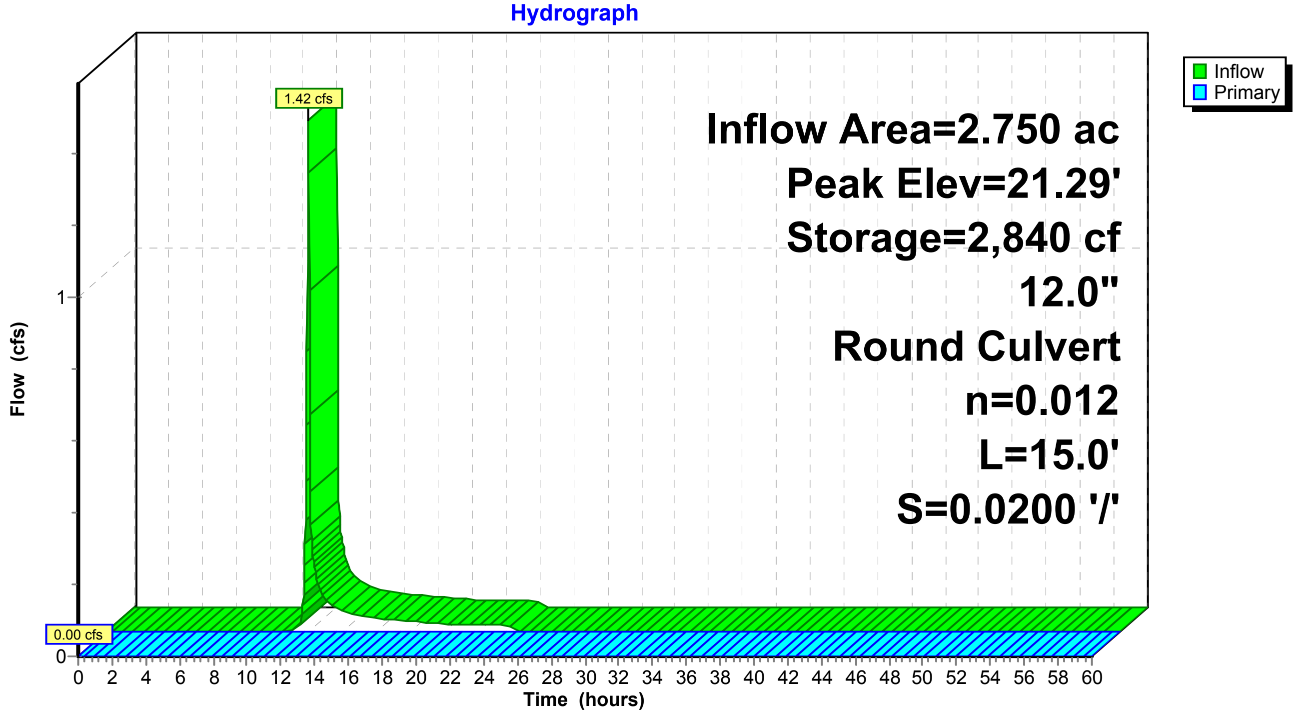
Volume	Invert	Avail.Storage	Storage Description
#1	18.99'	6,800 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) 17,001 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
18.99	3,091	0	0
24.49	3,091	17,001	17,001

Device	Routing	Invert	Outlet Devices
#1	Primary	21.49'	**12.0" Round Culvert** L= 15.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 21.49' / 21.19' S= 0.0200 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=18.99' (Free Discharge)
└─**1=Culvert** (Controls 0.00 cfs)

Pond 7P:


Hydrograph
1.42 cfs
0.00 cfs
Inflow
Primary
Inflow Area=2.750 ac
Peak Elev=21.29'
Storage=2,840 cf
12.0"
Round Culvert
n=0.012
L=15.0'
S=0.0200 '/'
Flow (cfs)
1
0
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60
Time (hours)

Summary for Pond 8P:

Inflow Area = 2.020 ac, 43.56% Impervious, Inflow Depth = 0.29" for WQv Storm event
Inflow = 1.08 cfs @ 11.97 hrs, Volume= 0.050 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Peak Elev= 20.40' @ 24.30 hrs Surf.Area= 3,043 sf Storage= 2,158 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

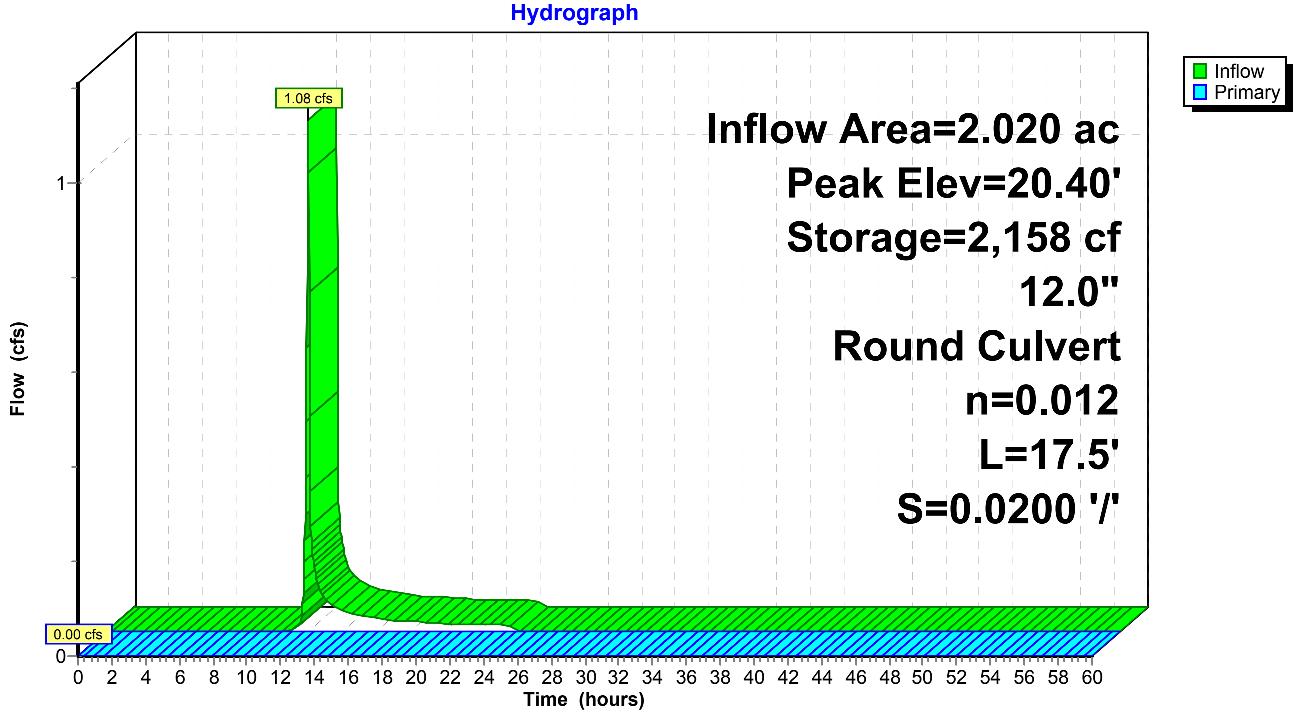
Volume	Invert	Avail.Storage	Storage Description
#1	18.63'	6,086 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) 15,215 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
18.63	3,043	0	0
23.63	3,043	15,215	15,215

Device	Routing	Invert	Outlet Devices
#1	Primary	20.63'	**12.0" Round Culvert** L= 17.5' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 20.63' / 20.28' S= 0.0200 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=18.63' (Free Discharge)
└─**1=Culvert** (Controls 0.00 cfs)

Pond 8P:


Hydrograph
1.08 cfs
0.00 cfs
Inflow
Primary
Inflow Area=2.020 ac
Peak Elev=20.40'
Storage=2,158 cf
12.0"
Round Culvert
n=0.012
L=17.5'
S=0.0200 '/'
Flow (cfs)
1
0
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60
Time (hours)

Summary for Pond 9P:

Inflow Area = 1.330 ac, 38.35% Impervious, Inflow Depth = 0.28" for WQv Storm event
Inflow = 0.68 cfs @ 11.97 hrs, Volume= 0.031 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Peak Elev= 20.55' @ 24.30 hrs Surf.Area= 2,018 sf Storage= 1,366 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

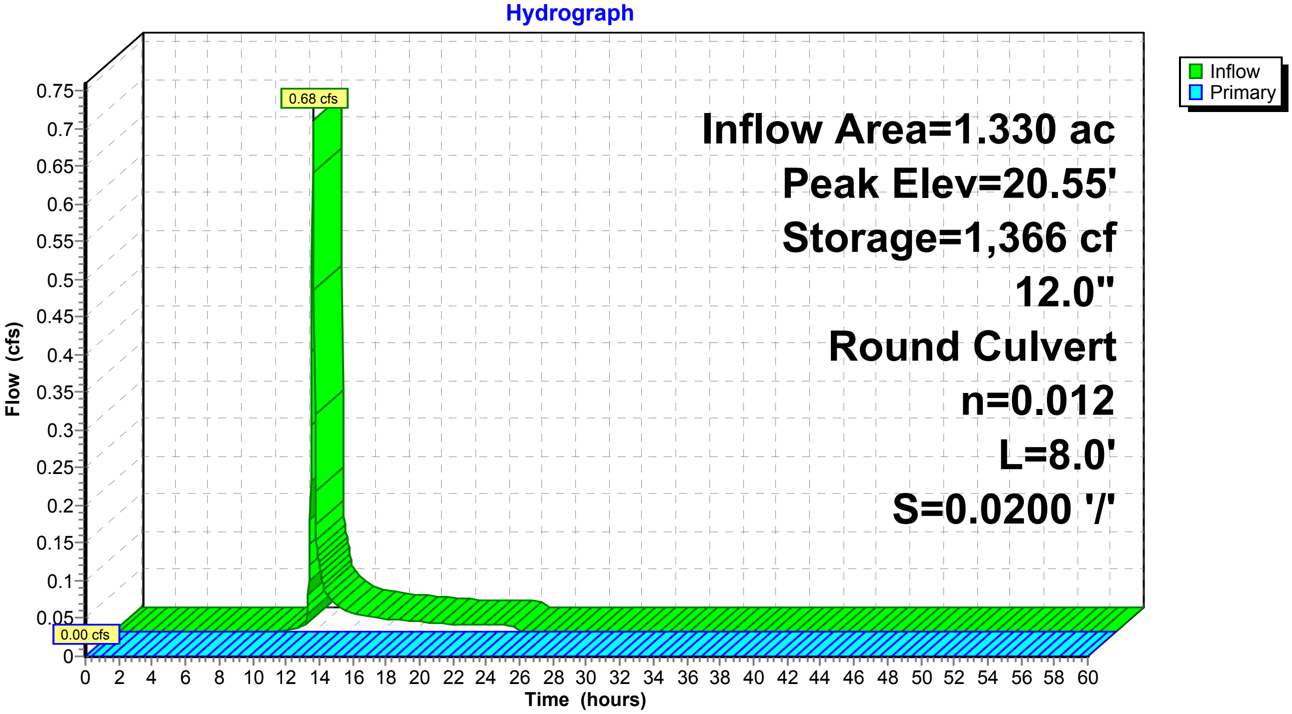
Volume	Invert	Avail.Storage	Storage Description
#1	18.86'	3,834 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) 9,586 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
18.86	2,018	0	0
23.61	2,018	9,586	9,586

Device	Routing	Invert	Outlet Devices
#1	Primary	20.61'	**12.0" Round Culvert** L= 8.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 20.61' / 20.45' S= 0.0200 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=18.86' (Free Discharge)
└─**1=Culvert** (Controls 0.00 cfs)

Pond 9P:


Hydrograph
Inflow
Primary
0.68 cfs
0.00 cfs
Inflow Area=1.330 ac
Peak Elev=20.55'
Storage=1,366 cf
12.0"
Round Culvert
n=0.012
L=8.0'
S=0.0200 '/'
Flow (cfs)
Time (hours)
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6
0.65
0.7
0.75
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60

Summary for Pond 10P:

Inflow Area = 0.910 ac, 38.46% Impervious, Inflow Depth = 0.27" for WQv Storm event
Inflow = 0.45 cfs @ 11.97 hrs, Volume= 0.021 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Peak Elev= 20.10' @ 24.30 hrs Surf.Area= 1,880 sf Storage= 898 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

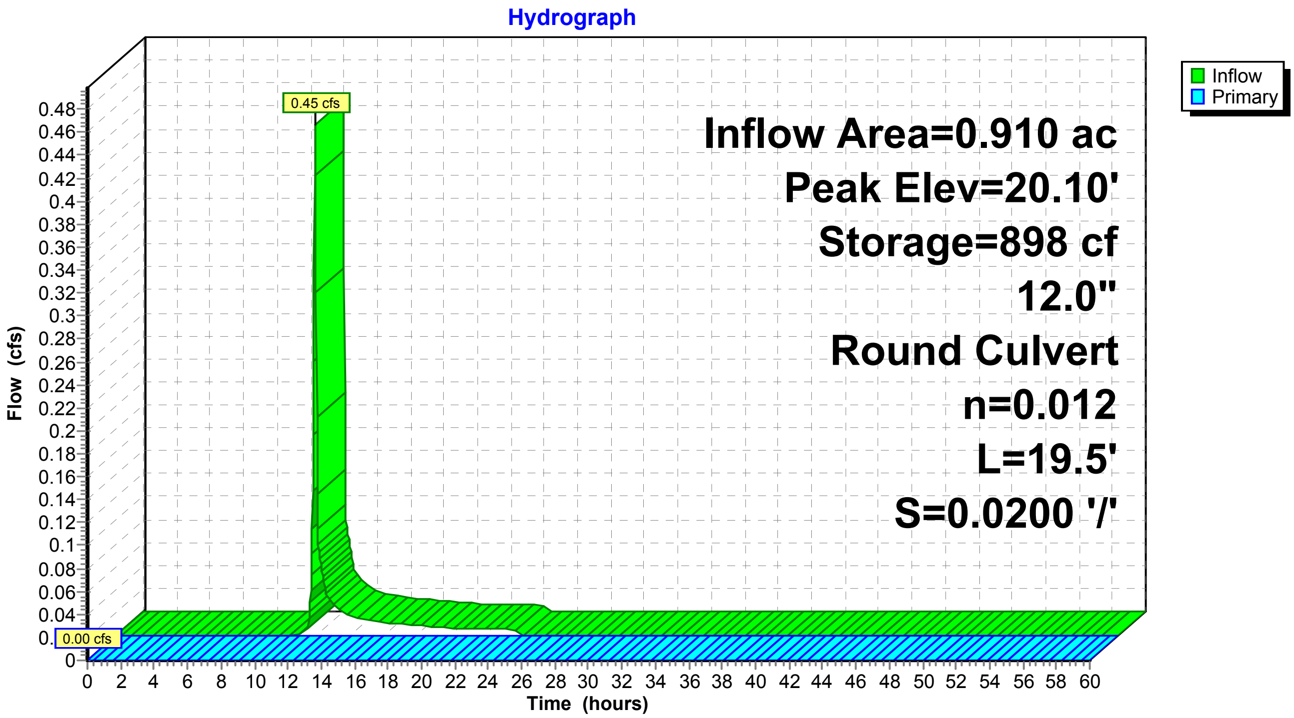
Volume	Invert	Avail.Storage	Storage Description
#1	18.91'	3,196 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) 7,990 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
18.91	1,880	0	0
23.16	1,880	7,990	7,990

Device	Routing	Invert	Outlet Devices
#1	Primary	20.16'	**12.0" Round Culvert** L= 19.5' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 20.16' / 19.77' S= 0.0200 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=18.91' (Free Discharge)
↑—**1=Culvert** (Controls 0.00 cfs)

Pond 10P:


Hydrograph
0.45 cfs
0.00 cfs
Inflow
Primary
Inflow Area=0.910 ac
Peak Elev=20.10'
Storage=898 cf
12.0"
Round Culvert
n=0.012
L=19.5'
S=0.0200 '/'
Flow (cfs)
Time (hours)

Summary for Pond 11P:

Inflow Area = 2.030 ac, 55.17% Impervious, Inflow Depth = 0.38" for WQv Storm event
Inflow = 1.39 cfs @ 11.96 hrs, Volume= 0.064 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Peak Elev= 17.70' @ 24.30 hrs Surf.Area= 3,160 sf Storage= 2,807 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

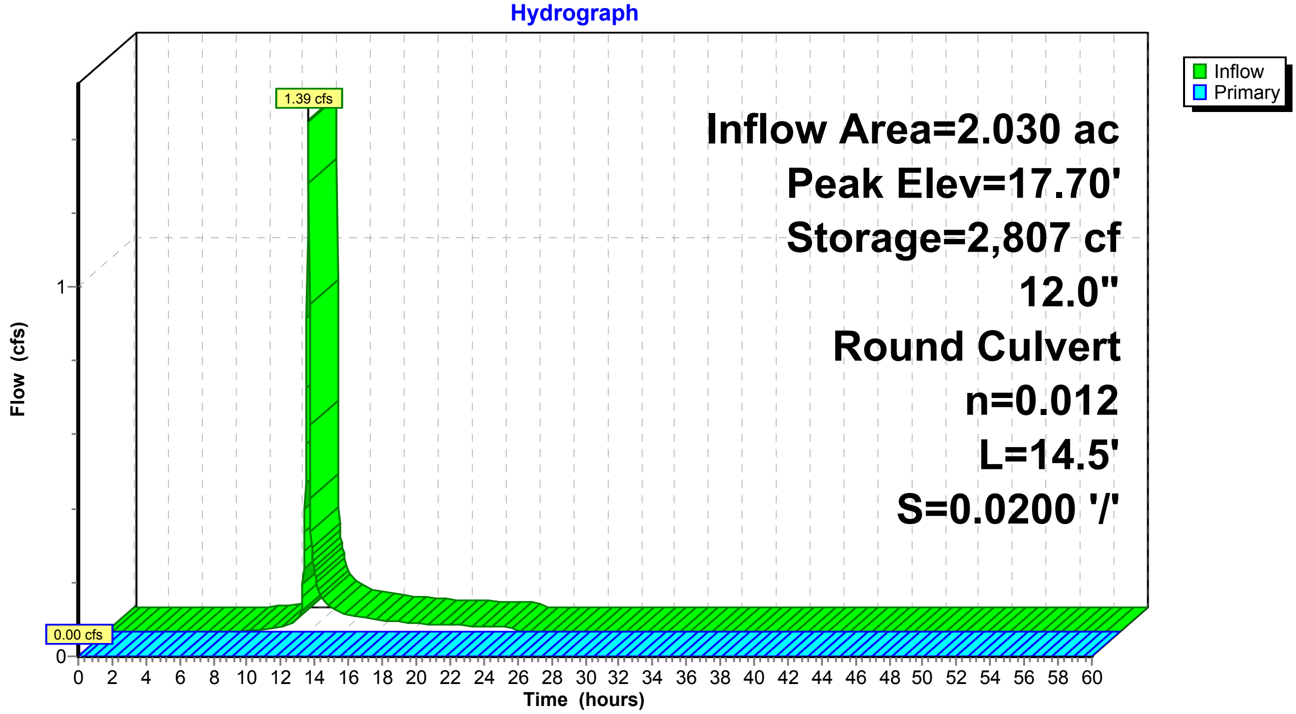
Volume	Invert	Avail.Storage	Storage Description
#1	16.81'	16,590 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
16.81	3,160	0	0
22.06	3,160	16,590	16,590

Device	Routing	Invert	Outlet Devices
#1	Primary	19.06'	**12.0" Round Culvert** L= 14.5' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 19.06' / 18.77' S= 0.0200 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=16.81' (Free Discharge)
└─**1=Culvert** (Controls 0.00 cfs)

Pond 11P:


Hydrograph
1.39 cfs
0.00 cfs
Inflow
Primary
Inflow Area=2.030 ac
Peak Elev=17.70'
Storage=2,807 cf
12.0"
Round Culvert
n=0.012
L=14.5'
S=0.0200 '/'
Flow (cfs)
1
0
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60
Time (hours)

Summary for Pond 12P:

Inflow Area = 0.960 ac, 77.08% Impervious, Inflow Depth = 0.51" for WQv Storm event
Inflow = 0.89 cfs @ 11.96 hrs, Volume= 0.040 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Peak Elev= 19.13' @ 24.30 hrs Surf.Area= 3,165 sf Storage= 1,764 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

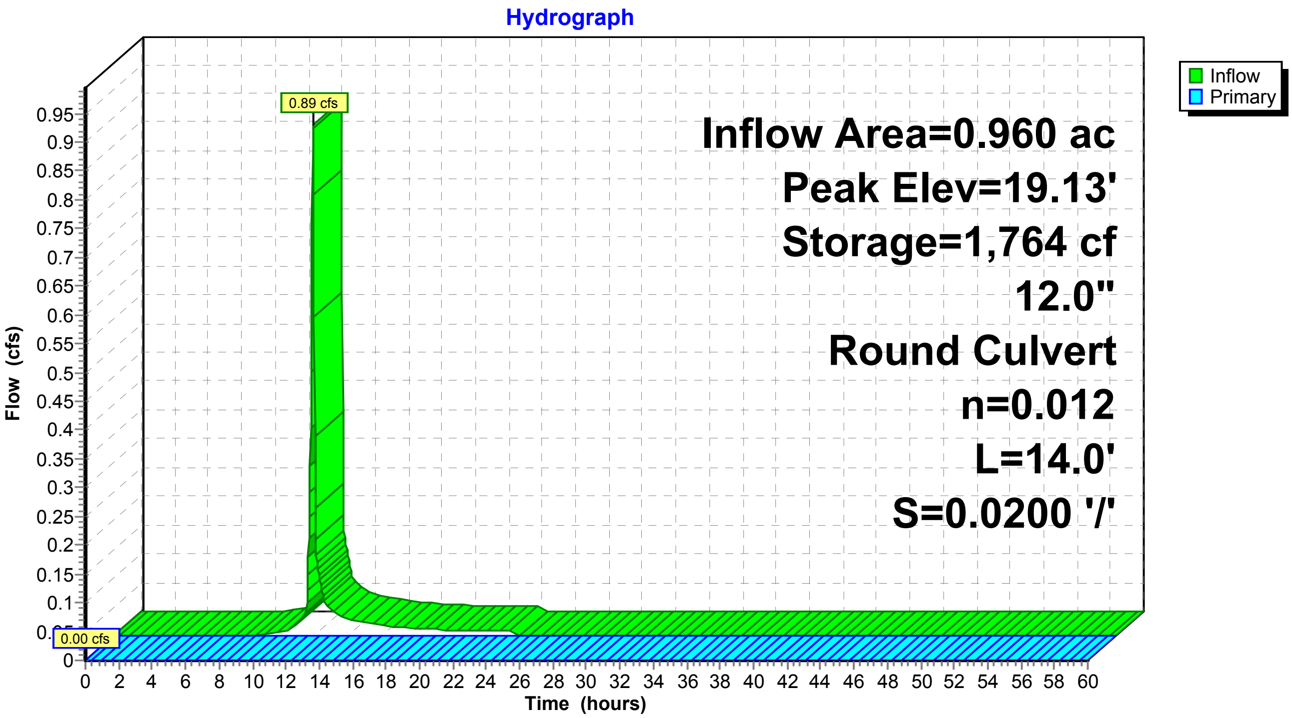
Volume	Invert	Avail.Storage	Storage Description
#1	17.74'	5,697 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) 14,243 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
17.74	3,165	0	0
22.24	3,165	14,243	14,243

Device	Routing	Invert	Outlet Devices
#1	Primary	19.24'	**12.0" Round Culvert** L= 14.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 19.24' / 18.96' S= 0.0200 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=17.74' (Free Discharge)
└─**1=Culvert** (Controls 0.00 cfs)

Pond 12P:


Hydrograph
0.89 cfs
0.00 cfs
Inflow Area=0.960 ac
Peak Elev=19.13'
Storage=1,764 cf
12.0"
Round Culvert
n=0.012
L=14.0'
S=0.0200 '/'
Inflow
Primary
Flow (cfs)
Time (hours)

Summary for Pond 13P:

Inflow Area = 1.680 ac, 39.29% Impervious, Inflow Depth = 0.27" for WQv Storm event
Inflow = 0.83 cfs @ 11.97 hrs, Volume= 0.038 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Peak Elev= 19.90' @ 24.30 hrs Surf.Area= 2,130 sf Storage= 1,667 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

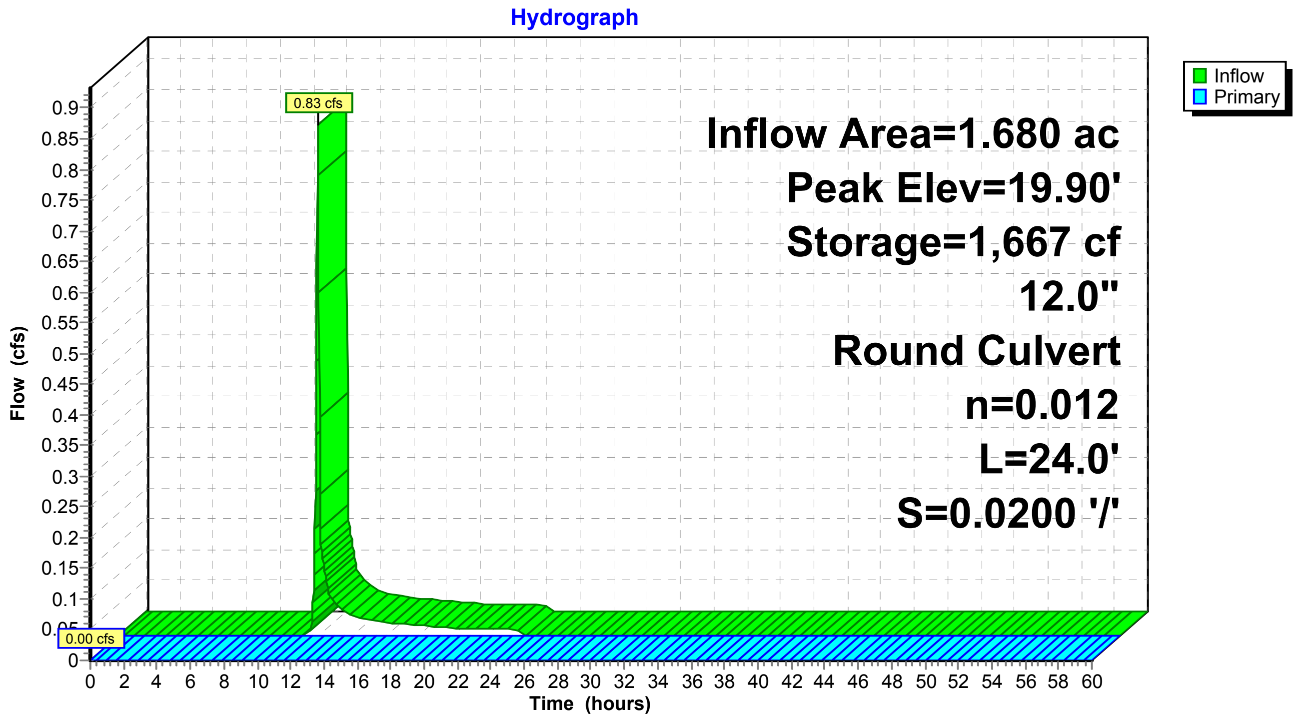
Volume	Invert	Avail.Storage	Storage Description
#1	17.94'	4,260 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) 10,650 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
17.94	2,130	0	0
22.94	2,130	10,650	10,650

Device	Routing	Invert	Outlet Devices
#1	Primary	19.94'	**12.0" Round Culvert** L= 24.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 19.94' / 19.46' S= 0.0200 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=17.94' (Free Discharge)
└─**1=Culvert** (Controls 0.00 cfs)

Pond 13P:


Hydrograph
Inflow
Primary
0.83 cfs
0.00 cfs
Inflow Area=1.680 ac
Peak Elev=19.90'
Storage=1,667 cf
12.0"
Round Culvert
n=0.012
L=24.0'
S=0.0200 '/'
Flow (cfs)
Time (hours)

Summary for Pond 14P:

Inflow Area = 0.880 ac, 62.50% Impervious, Inflow Depth = 0.40" for WQv Storm event
Inflow = 0.65 cfs @ 11.96 hrs, Volume= 0.030 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.03 hrs
Peak Elev= 20.53' @ 24.30 hrs Surf.Area= 2,055 sf Storage= 1,286 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

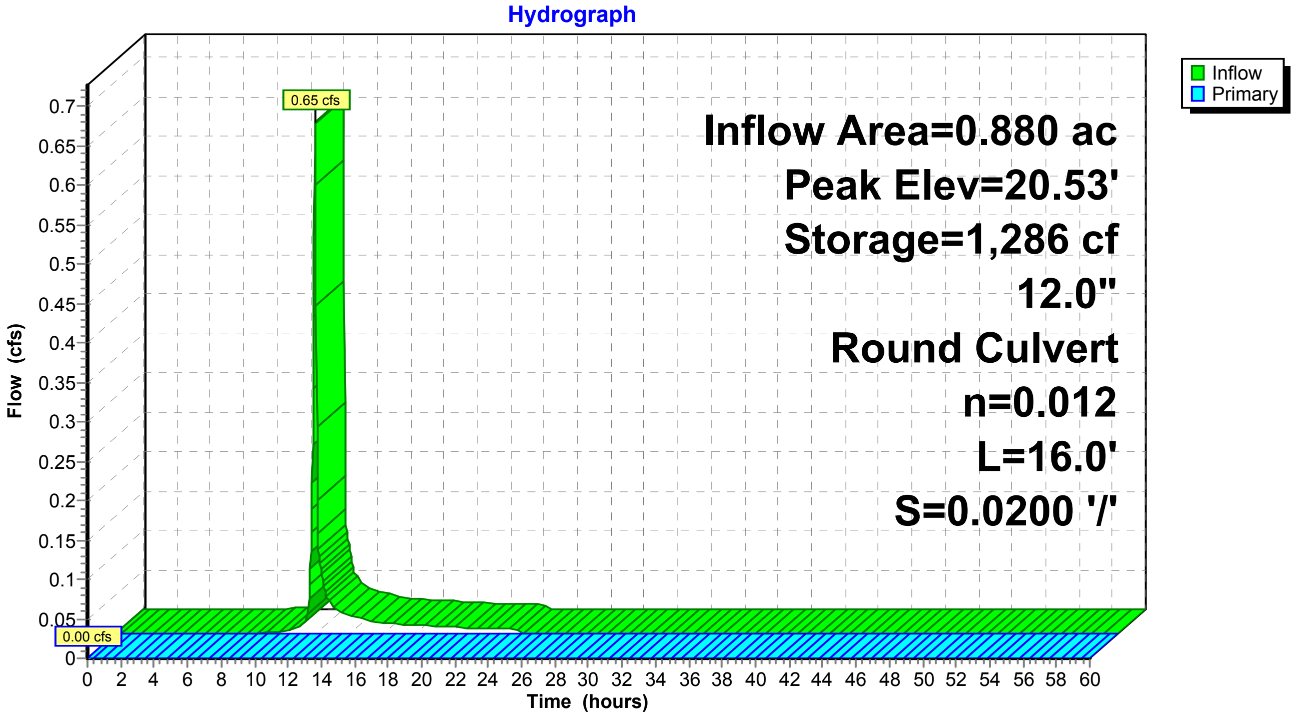
Volume	Invert	Avail.Storage	Storage Description
#1	18.97'	3,905 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) 9,761 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
18.97	2,055	0	0
23.72	2,055	9,761	9,761

Device	Routing	Invert	Outlet Devices
#1	Primary	20.72'	**12.0" Round Culvert** L= 16.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 20.72' / 20.40' S= 0.0200 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=18.97' (Free Discharge)
└─**1=Culvert** (Controls 0.00 cfs)

Pond 14P:


Hydrograph
Inflow
Primary
0.65 cfs
0.00 cfs
Inflow Area=0.880 ac
Peak Elev=20.53'
Storage=1,286 cf
12.0"
Round Culvert
n=0.012
L=16.0'
S=0.0200 '/'
Flow (cfs)
Time (hours)
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6
0.65
0.7
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60

APPENDIX C2

NYSDEC Worksheets

NYSDEC Worksheet for JFK Community Center

Version 1.7 — Total Water Quality Volume Calculation

Last Updated: 10/02/2015 — WQv(acre-feet) = [(P)(Rv)(A)] /12

Is this project subject to Chapter 10 of the NYS Design Manual (i.e. WQv is equal to post-development 1 year runoff volume)?...	No

Design Point:	1	
P=	0.95	*inch*

Manually enter P, Total Area and Impervious Cover.

Breakdown of Subcatchments						
Catchment Number	**Total Area** *(Acres)*	**Impervious Area** *(Acres)*	**Percent Impervious** *%*	**Rv**	**WQv** *(ft ^{3})*	**Description**
1	0.48	0.32	67%	0.65	1,076	Bioretention
2						
3						
4						
5						
6						
7						
8						
9						
10						
Subtotal (1-30)	0.48	0.32	67%	0.65	**1,076**	**Subtotal 1**
Total	0.48	0.32	67%	0.65	**1,076**	**Initial WQv**

Identify Runoff Reduction Techniques By Area			
Technique	**Total Contributing Area** *(Acre)*	**Contributing Impervious Area** *(Acre)*	**Notes**
Conservation of Natural Areas	0.00	0.00	*minimum 10,000 sf*
Riparian Buffers	0.00	0.00	*maximum contributing length 75 feet to 150 feet*
Filter Strips	0.00	0.00	
Tree Planting	0.00	0.00	*Up to 100 sf directly connected impervious area may be subtracted per tree*
Total	**0.00**	**0.00**	

Recalculate WQv after application of Area Reduction Techniques					
	Total Area *(Acres)*	**Impervious Area** *(Acres)*	**Percent Impervious** *%*	**Runoff Coefficient Rv**	**WQv** *(ft ^{3})*
"<<Initial WQv"	0.48	0.32	67%	0.65	1,076
Subtract Area	0.00	0.00			
WQv adjusted after Area Reductions	**0.48**	**0.32**	67%	0.65	1,076
Disconnection of Rooftops		0.00			
Adjusted WQv after Area Reduction and Rooftop Disconnect	0.48	0.32	67%	0.65	**1,076**
WQv reduced by Area Reduction techniques					0

Bioretention Worksheet

(For use on HSG C or D Soils with underdrains)

Af=WQv*(df)/[k*(hf+df)(tf)]

Af	Required Surface Area (ft2)
WQv	Water Quality Volume (ft3)
df	Depth of the Soil Medium (feet)
hf	Average height of water above the planter bed
tf	Volume Through the Filter Media (days)

k — The hydraulic conductivity [ft/day], can be varied depending on the properties of the soil media. Some reported conductivity values are: ***Sand*** - 3.5 ft/day (City of Austin 1988); ***Peat*** - 2.0 ft/day (Galli 1990); ***Leaf Compost*** - 8.7 ft/day (Claytor and Schueler, 1996); ***Bioretention Soil*** (0.5 ft/day (Claytor &

Design Point:	**1**						
Enter Site Data For Drainage Area to be Treated by Practice							
Catchment Number	**Total Area** *(Acres)*	**Impervious Area** *(Acres)*	**Percent Impervious** *%*	**Rv**	**WQv** *(ft^3)*	**Precipitation** *(in)*	**Description**
1	0.48	0.32	0.67	0.65	1075.93	0.95	Bioretention
Enter Impervious Area Reduced by Disconnection of Rooftops			67%	0.65	1,076	<<WQv after adjusting for Disconnected Rooftops	
Enter the portion of the WQv that is not reduced for all practices routed to this practice.						*ft^3*	
Soil Information							
Soil Group		D					
Soil Infiltration Rate		0.20	*in/hour*	*Okay*			
Using Underdrains?		Yes	*Okay*				
Calculate the Minimum Filter Area							
				Value		Units	Notes
WQv				1,076		*ft^3*	
Enter Depth of Soil Media			*df*	1.5		*ft*	*2.5-4 ft*
Enter Hydraulic Conductivity			*k*	0.5		*ft/day*	
Enter Average Height of Ponding			*hf*	0.5		*ft*	*6 inches max.*
Enter Filter Time			*tf*	2		*days*	
Required Filter Area			***Af***	**807**		***ft^2***	
Determine Actual Bio-Retention Area							
Filter Width		9	*ft*				
Filter Length		90	*ft*				
Filter Area		810	*ft^2*				
Actual Volume Provided		1080	*ft^3*				
Determine Runoff Reduction							
Is the Bioretention contributing flow to another practice?			No	Select Practice			
RRv		432					
RRv applied		**432**	***ft^3***	***This is 40% of the storage provided or WQv whichever is less.***			
Volume Treated		644	*ft^3*	*This is the portion of the WQv that is not reduced in the practice.*			
Volume Directed		0	*ft^3*	This volume is directed another practice			
Sizing √		OK		*Check to be sure Area provided ≥ Af*			

NYSDEC Worksheet for Pratt Willert Community Center

Version 1.7 | Total Water Quality Volume Calculation
Last Updated: 10/02/2015 | WQv(acre-feet) = [(P)(Rv)(A)] /12

Is this project subject to Chapter 10 of the NYS Design Manual (i.e. WQv is equal to post-development 1 year runoff volume)?...	No

Design Point:	1	
P=	0.95	*inch*

Manually enter P, Total Area and Impervious Cover.

Breakdown of Subcatchments

Catchment Number	Total Area *(Acres)*	Impervious Area *(Acres)*	Percent Impervious *%*	Rv	WQv *(ft³)*	Description
1	0.42	0.32	76%	0.74	1,066	Bioretention
2						
3						
4						
5						
6						
7						
8						
9						
10						
Subtotal (1-30)	0.42	0.32	76%	0.74	**1,066**	**Subtotal 1**
Total	0.42	0.32	76%	0.74	**1,066**	**Initial WQv**

Identify Runoff Reduction Techniques By Area

Technique	Total Contributing Area *(Acre)*	Contributing Impervious Area *(Acre)*	Notes
Conservation of Natural Areas	0.00	0.00	*minimum 10,000 sf*
Riparian Buffers	0.00	0.00	*maximum contributing length 75 feet to 150 feet*
Filter Strips	0.00	0.00	
Tree Planting	0.00	0.00	*Up to 100 sf directly connected impervious area may be subtracted per tree*
Total	**0.00**	**0.00**	

Recalculate WQv after application of Area Reduction Techniques

	Total Area *(Acres)*	Impervious Area *(Acres)*	Percent Impervious *%*	Runoff Coefficient Rv	WQv *(ft³)*
"<<Initial WQv"	0.42	0.32	76%	0.74	1,066
Subtract Area	0.00	0.00			
WQv adjusted after Area Reductions	**0.42**	**0.32**	76%	0.74	1,066
Disconnection of Rooftops		0.00			
Adjusted WQv after Area Reduction and Rooftop Disconnect	0.42	0.32	76%	0.74	**1,066**
WQv reduced by Area Reduction techniques					0

Bioretention Worksheet

(For use on HSG C or D Soils with underdrains)

Af=WQv*(df)/[k*(hf+df)(tf)]

Af	Required Surface Area (ft2)
WQv	Water Quality Volume (ft3)
df	Depth of the Soil Medium (feet)
hf	Average height of water above the planter bed
tf	Volume Through the Filter Media (days)

k The hydraulic conductivity [ft/day], can be varied depending on the properties of the soil media. Some reported conductivity values are: ***Sand*** - 3.5 ft/day (City of Austin 1988); ***Peat*** - 2.0 ft/day (Galli 1990); ***Leaf Compost*** - 8.7 ft/day (Claytor and Schueler, 1996); ***Bioretention Soil*** (0.5 ft/day (Claytor &

Design Point:	**1**

Enter Site Data For Drainage Area to be Treated by Practice							
Catchment Number	**Total Area** *(Acres)*	**Impervious Area** *(Acres)*	**Percent Impervious** *%*	**Rv**	**WQv** *(ft³)*	**Precipitation** *(in)*	**Description**
1	0.42	0.32	0.76	0.74	1065.59	0.95	Bioretention
Enter Impervious Area Reduced by Disconnection of Rooftops			76%	0.74	1,066	<<WQv after adjusting for Disconnected Rooftops	
Enter the portion of the WQv that is not reduced for all practices routed to this practice.					-266	*ft³*	
Soil Information							
Soil Group		D					
Soil Infiltration Rate		0.20	*in/hour*	*Okay*			
Using Underdrains?		Yes	*Okay*				
Calculate the Minimum Filter Area							
				Value		Units	Notes
WQv				800		*ft³*	
Enter Depth of Soil Media			*df*	1.5		*ft*	*2.5-4 ft*
Enter Hydraulic Conductivity			*k*	0.5		*ft/day*	
Enter Average Height of Ponding			*hf*	0.5		*ft*	*6 inches max.*
Enter Filter Time			*tf*	2		*days*	
Required Filter Area			***Af***	**600**		***ft²***	
Determine Actual Bio-Retention Area							
Filter Width		10	*ft*				
Filter Length		60	*ft*				
Filter Area		600	*ft²*				
Actual Volume Provided		800	*ft³*				
Determine Runoff Reduction							
Is the Bioretention contributing flow to another practice?			No	Select Practice			
RRv		320					
RRv applied		**320**	***ft³***	***This is 40% of the storage provided or WQv whichever is less.***			
Volume Treated		480	*ft³*	*This is the portion of the WQv that is not reduced in the practice.*			
Volume Directed		0	*ft³*	This volume is directed another practice			
Sizing √		OK		*Check to be sure Area provided ≥ Af*			

NYSDEC Worksheets for Porous Pavement on William Street

Version 1.7 — Total Water Quality Volume Calculation

Last Updated: 10/02/2015 — WQv(acre-feet) = [(P)(Rv)(A)] /12

Is this project subject to Chapter 10 of the NYS Design Manual (i.e. WQv is equal to post-development 1 year runoff volume)?...	No

Design Point:	1	
P=	0.95	*inch*

Manually enter P, Total Area and Impervious Cover.

Breakdown of Subcatchments

Catchment Number	Total Area *(Acres)*	Impervious Area *(Acres)*	Percent Impervious *%*	Rv	WQv *(ft^3)*	Description
1	0.64	0.64	100%	0.95	2,097	Porous Pavement
2	2.41	0.75	31%	0.33	2,743	Porous Pavement
3	2.39	1.07	45%	0.45	3,733	Porous Pavement
4	2.75	1.14	41%	0.42	4,012	Porous Pavement
5	2.02	0.88	44%	0.44	3,080	Porous Pavement
6	1.33	0.51	38%	0.40	1,812	Porous Pavement
7	0.91	0.35	38%	0.40	1,243	Porous Pavement
8	2.03	1.12	55%	0.55	3,826	Porous Pavement
9	0.96	0.74	77%	0.74	2,462	Porous Pavement
10	1.68	0.66	39%	0.40	2,338	Porous Pavement
Subtotal (1-30)	18.00	8.41	47%	0.47	**29,205**	**Subtotal 1**
Total	18.00	8.41	47%	0.47	**29,205**	**Initial WQv**

Identify Runoff Reduction Techniques By Area

Technique	Total Contributing Area *(Acre)*	Contributing Impervious Area *(Acre)*	Notes
Conservation of Natural Areas	0.00	0.00	*minimum 10,000 sf*
Riparian Buffers	0.00	0.00	*maximum contributing length 75 feet to 150 feet*
Filter Strips	0.00	0.00	
Tree Planting	0.00	0.00	*Up to 100 sf directly connected impervious area may be subtracted per tree*
Total	**0.00**	**0.00**	

Recalculate WQv after application of Area Reduction Techniques

	Total Area *(Acres)*	Impervious Area *(Acres)*	Percent Impervious *%*	Runoff Coefficient Rv	WQv *(ft^3)*
"<<Initial WQv"	18.00	8.41	47%	0.47	29,205
Subtract Area	0.00	0.00			
WQv adjusted after Area Reductions	**18.00**	**8.41**	47%	0.47	29,205
Disconnection of Rooftops		0.00			
Adjusted WQv after Area Reduction and Rooftop Disconnect	18.00	8.41	47%	0.47	**29,205**
WQv reduced by Area Reduction techniques					0

Total Water Quality Volume Calculation

WQv(acre-feet) = [(P)(Rv)(A)] /12

Additional Subcatchments						
Catchment Number	**Total Area** *(Acres)*	**Impervious Area** *(Acres)*	**Percent Impervious** *%*	**Rv**	**WQv** *(ft^3)*	**Description**
11	0.88	0.55	63%	0.61	1,859	Porous Pavement
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						
Subtotal	0.88	0.55	63%	0.61	**1,859**	**Subtotal**

Porous Pavement Worksheet

Ap = Vw / (n x dt)

Ap	Required porous pavement surface area	*ft2*	
Vw	Design Volume	*ft3*	
n	porosity of gravel bed/resevoir		*Assume .4 for gravel*
dt	depth of gravel bed/resevoir		

Design Point:	**1**						
Enter Site Data For Drainage Area to be Treated by Practice							
Catchment Number	**Total Area** *(Acres)*	**Impervious Area** *(Acres)*	**Percent Impervious** *%*	**Rv**	**WQv** *(ft^3)*	**Precipitation** *(in)*	**Description**
1	0.64	0.64	1.00	0.95	2096.69	0.95	Porous Pavement
Enter Soil Infiltration Rate							
Soil Inflitration Rate		0.20	*in/hour*	*Infiltration rate should be a minimum of 0.5 in/hr.*			
Calculate Required Surface Area							
Design Volume		Vw	2,097	*ft^3*			
Are underdrains being used?			Yes	-	Only Gravel Bed Depth below underdrain can be considered.		
Porosity of Gravel Bed		*n*	0.40	-			
Gravel Bed Depth		dt	2.00	*ft*	Must be the depth below the underdrain.		
Required Surface Area		Ap	2,621	*sf*			
Surface Area Provided			2,218	*sf*	*Dimensions of pavement can be provided here*		
Storage Volume Provided			1,774	*ft^3*	*Practice too small*		
Determine the Runoff Reduction							
RRv	**Error**	*ft^3*					

Porous Pavement Worksheet

$$Ap = Vw / (n \times dt)$$

Ap	Required porous pavement surface area	*ft2*	
Vw	Design Volume	*ft3*	
n	porosity of gravel bed/resevoir		*Assume .4 for gravel*
dt	depth of gravel bed/resevoir		

Design Point:	1						
Enter Site Data For Drainage Area to be Treated by Practice							
Catchment Number	**Total Area** *(Acres)*	**Impervious Area** *(Acres)*	**Percent Impervious** *%*	**Rv**	**WQv** *(ft^3)*	**Precipitation** *(in)*	**Description**
2	2.41	0.75	0.31	0.33	2743.28	0.95	Porous Pavement
Enter Soil Infiltration Rate							
Soil Inflitration Rate	0.20	*in/hour*	*Infiltration rate should be a minimum of 0.5 in/hr.*				
Calculate Required Surface Area							
Design Volume	Vw	2,743	*ft^3*				
Are underdrains being used?		Yes	-	Only Gravel Bed Depth below underdrain can be considered.			
Porosity of Gravel Bed	*n*	0.40	-				
Gravel Bed Depth	dt	1.75	*ft*	Must be the depth below the underdrain.			
Required Surface Area	Ap	3,919	*sf*				
Surface Area Provided		3,216	*sf*	*Dimensions of pavement can be provided here*			
Storage Volume Provided		2,251	*ft^3*	*Practice too small*			
Determine the Runoff Reduction							
RRv	**Error**	*ft^3*					

Porous Pavement Worksheet

$$Ap = Vw / (n \times dt)$$

Ap	Required porous pavement surface area	*ft2*	
Vw	Design Volume	*ft3*	
n	porosity of gravel bed/resevoir		*Assume .4 for gravel*
dt	depth of gravel bed/resevoir		

Design Point:	1						
Enter Site Data For Drainage Area to be Treated by Practice							
Catchment Number	**Total Area** *(Acres)*	**Impervious Area** *(Acres)*	**Percent Impervious** *%*	**Rv**	**WQv** *(ft^3)*	**Precipitation** *(in)*	**Description**
3	2.39	1.07	0.45	0.45	3733.00	0.95	Porous Pavement
Enter Soil Infiltration Rate							
Soil Inflitration Rate	0.50	*in/hour*					
Calculate Required Surface Area							
Design Volume	Vw	3,733	*ft^3*				
Are underdrains being used?		Yes	-	Only Gravel Bed Depth below underdrain can be considered.			
Porosity of Gravel Bed	*n*	0.40	-				
Gravel Bed Depth	dt	2.00	*ft*	Must be the depth below the underdrain.			
Required Surface Area	Ap	4,666	*sf*				
Surface Area Provided		3,091	*sf*	*Dimensions of pavement can be provided here*			
Storage Volume Provided		2,473	*ft^3*	*Practice too small*			
Determine the Runoff Reduction							
RRv	**Error**	*ft^3*					

Porous Pavement Worksheet

$$Ap = Vw / (n \times dt)$$

Ap	Required porous pavement surface area	*ft2*	
Vw	Design Volume	*ft3*	
n	porosity of gravel bed/resevoir		*Assume .4 for gravel*
dt	depth of gravel bed/resevoir		

Design Point:	**1**						
Enter Site Data For Drainage Area to be Treated by Practice							
Catchment Number	**Total Area** *(Acres)*	**Impervious Area** *(Acres)*	**Percent Impervious** *%*	**Rv**	**WQv** *(ft^3)*	**Precipitation** *(in)*	**Description**
4	2.75	1.14	0.41	0.42	4012.33	0.95	Porous Pavement
Enter Soil Infiltration Rate							
Soil Inflitration Rate	0.20	*in/hour*	*Infiltration rate should be a minimum of 0.5 in/hr.*				
Calculate Required Surface Area							
Design Volume	Vw	4,012	*ft^3*				
Are underdrains being used?		Yes	-	Only Gravel Bed Depth below underdrain can be considered.			
Porosity of Gravel Bed	*n*	0.40	-				
Gravel Bed Depth	dt	2.50	*ft*	Must be the depth below the underdrain.			
Required Surface Area	Ap	4,012	*sf*				
Surface Area Provided		3,091	*sf*	*Dimensions of pavement can be provided here*			
Storage Volume Provided		3,091	*ft^3*	*Practice too small*			
Determine the Runoff Reduction							
RRv	**Error**	***ft^3***					

Porous Pavement Worksheet

Ap = Vw / (n x dt)

Ap	Required porous pavement surface area	*ft2*	
Vw	Design Volume	*ft3*	
n	porosity of gravel bed/resevoir		*Assume .4 for gravel*
dt	depth of gravel bed/resevoir		

Design Point:	**1**						
Enter Site Data For Drainage Area to be Treated by Practice							
Catchment Number	**Total Area** *(Acres)*	**Impervious Area** *(Acres)*	**Percent Impervious** *%*	**Rv**	**WQv** *(ft^3)*	**Precipitation** *(in)*	**Description**
5	2.02	0.88	0.44	0.44	3079.51	0.95	Porous Pavement
Enter Soil Infiltration Rate							
Soil Inflitration Rate		0.20	*in/hour*	*Infiltration rate should be a minimum of 0.5 in/hr.*			
Calculate Required Surface Area							
Design Volume		Vw	3,080	*ft^3*			
Are underdrains being used?			Yes	-	Only Gravel Bed Depth below underdrain can be considered.		
Porosity of Gravel Bed		*n*	0.40	-			
Gravel Bed Depth		dt	2.00	*ft*	Must be the depth below the underdrain.		
Required Surface Area		Ap	3,849	*sf*			
Surface Area Provided			3,043	*sf*	*Dimensions of pavement can be provided here*		
Storage Volume Provided			2,434	*ft^3*	*Practice too small*		
Determine the Runoff Reduction							
RRv	**Error**	*ft^3*					

Porous Pavement Worksheet

Ap = Vw / (n x dt)

Ap	Required porous pavement surface area	*ft2*	
Vw	Design Volume	*ft3*	
n	porosity of gravel bed/resevoir		*Assume .4 for gravel*
dt	depth of gravel bed/resevoir		

Design Point:	**1**						
Enter Site Data For Drainage Area to be Treated by Practice							
Catchment Number	**Total Area** *(Acres)*	**Impervious Area** *(Acres)*	**Percent Impervious** *%*	**Rv**	**WQv** *(ft^3)*	**Precipitation** *(in)*	**Description**
6	1.33	0.51	0.38	0.40	1812.19	0.95	Porous Pavement
Enter Soil Infiltration Rate							
Soil Inflitration Rate	0.20	*in/hour*	*Infiltration rate should be a minimum of 0.5 in/hr.*				
Calculate Required Surface Area							
Design Volume	Vw	1,812	*ft^3*				
Are underdrains being used?		Yes	-	Only Gravel Bed Depth below underdrain can be considered.			
Porosity of Gravel Bed	*n*	0.40	-				
Gravel Bed Depth	dt	1.75	*ft*	Must be the depth below the underdrain.			
Required Surface Area	Ap	2,589	*sf*				
Surface Area Provided		2,018	*sf*	*Dimensions of pavement can be provided here*			
Storage Volume Provided		1,413	*ft^3*	*Practice too small*			
Determine the Runoff Reduction							
RRv	**Error**	*ft^3*					

Porous Pavement Worksheet

Ap = Vw / (n x dt)

Ap	Required porous pavement surface area	*ft2*	
Vw	Design Volume	*ft3*	
n	porosity of gravel bed/resevoir		*Assume .4 for gravel*
dt	depth of gravel bed/resevoir		

Design Point:	**1**						
Enter Site Data For Drainage Area to be Treated by Practice							
Catchment Number	**Total Area** *(Acres)*	**Impervious Area** *(Acres)*	**Percent Impervious** *%*	**Rv**	**WQv** *(ft^3)*	**Precipitation** *(in)*	**Description**
7	0.91	0.35	0.38	0.40	1243.18	0.95	Porous Pavement
Enter Soil Infiltration Rate							
Soil Inflitration Rate	0.20	*in/hour*	*Infiltration rate should be a minimum of 0.5 in/hr.*				
Calculate Required Surface Area							
Design Volume	Vw	1,243	*ft^3*				
Are underdrains being used?		Yes	-	Only Gravel Bed Depth below underdrain can be considered.			
Porosity of Gravel Bed	*n*	0.40	-				
Gravel Bed Depth	dt	1.25	*ft*	Must be the depth below the underdrain.			
Required Surface Area	Ap	2,486	*sf*				
Surface Area Provided		1,880	*sf*	*Dimensions of pavement can be provided here*			
Storage Volume Provided		940	*ft^3*	*Practice too small*			
Determine the Runoff Reduction							
RRv	**Error**	*ft^3*					

Porous Pavement Worksheet

Ap = Vw / (n x dt)

Ap	Required porous pavement surface area	*ft2*	
Vw	Design Volume	*ft3*	
n	porosity of gravel bed/resevoir		*Assume .4 for gravel*
dt	depth of gravel bed/resevoir		

Design Point:	**1**						
Enter Site Data For Drainage Area to be Treated by Practice							
Catchment Number	**Total Area** *(Acres)*	**Impervious Area** *(Acres)*	**Percent Impervious** *%*	**Rv**	**WQv** *(ft^3)*	**Precipitation** *(in)*	**Description**
8	2.03	1.12	0.55	0.55	3826.11	0.95	Porous Pavement
Enter Soil Infiltration Rate							
Soil Inflitration Rate	0.20	*in/hour*	*Infiltration rate should be a minimum of 0.5 in/hr.*				
Calculate Required Surface Area							
Design Volume	Vw	3,826	*ft^3*				
Are underdrains being used?		Yes	-	Only Gravel Bed Depth below underdrain can be considered.			
Porosity of Gravel Bed	*n*	0.40	-				
Gravel Bed Depth	dt	2.25	*ft*	Must be the depth below the underdrain.			
Required Surface Area	Ap	4,251	*sf*				
Surface Area Provided		3,160	*sf*	*Dimensions of pavement can be provided here*			
Storage Volume Provided		2,844	*ft^3*	*Practice too small*			
Determine the Runoff Reduction							
RRv	**Error**	*ft^3*					

Porous Pavement Worksheet

$$Ap = Vw / (n \times dt)$$

Ap	Required porous pavement surface area	*ft2*	
Vw	Design Volume	*ft3*	
n	porosity of gravel bed/resevoir		*Assume .4 for gravel*
dt	depth of gravel bed/resevoir		

Design Point:	**1**

Enter Site Data For Drainage Area to be Treated by Practice

Catchment Number	**Total Area** *(Acres)*	**Impervious Area** *(Acres)*	**Percent Impervious** *%*	**Rv**	**WQv** *(ft^3)*	**Precipitation** *(in)*	**Description**
9	0.96	0.74	0.77	0.74	2462.23	0.95	Porous Pavement

Enter Soil Infiltration Rate

Soil Inflitration Rate	0.20	*in/hour*	*Infiltration rate should be a minimum of 0.5 in/hr.*

Calculate Required Surface Area

Design Volume	Vw	2,462	*ft^3*	
Are underdrains being used?		Yes	-	Only Gravel Bed Depth below underdrain can be considered.
Porosity of Gravel Bed	*n*	0.40	-	
Gravel Bed Depth	dt	1.50	*ft*	Must be the depth below the underdrain.
Required Surface Area	Ap	4,104	*sf*	
Surface Area Provided		3,165	*sf*	*Dimensions of pavement can be provided here*
Storage Volume Provided		1,899	*ft^3*	*Practice too small*

Determine the Runoff Reduction

RRv	**Error**	*ft^3*	

Porous Pavement Worksheet

$$Ap = Vw / (n \times dt)$$

Ap	Required porous pavement surface area	*ft2*	
Vw	Design Volume	*ft3*	
n	porosity of gravel bed/resevoir		*Assume .4 for gravel*
dt	depth of gravel bed/resevoir		

Design Point:	**1**						
Enter Site Data For Drainage Area to be Treated by Practice							
Catchment Number	**Total Area** *(Acres)*	**Impervious Area** *(Acres)*	**Percent Impervious** *%*	**Rv**	**WQv** *(ft^3)*	**Precipitation** *(in)*	**Description**
10	1.68	0.66	0.39	0.40	2338.08	0.95	Porous Pavement
Enter Soil Infiltration Rate							
Soil Inflitration Rate	0.20	*in/hour*	*Infiltration rate should be a minimum of 0.5 in/hr.*				
Calculate Required Surface Area							
Design Volume	Vw	2,338	*ft^3*				
Are underdrains being used?		Yes	-	Only Gravel Bed Depth below underdrain can be considered.			
Porosity of Gravel Bed	*n*	0.40	-				
Gravel Bed Depth	dt	2.00	*ft*	Must be the depth below the underdrain.			
Required Surface Area	Ap	2,923	*sf*				
Surface Area Provided		2,130	*sf*	*Dimensions of pavement can be provided here*			
Storage Volume Provided		1,704	*ft^3*	*Practice too small*			
Determine the Runoff Reduction							
RRv	**Error**	***ft^3***					

Porous Pavement Worksheet

Ap = Vw / (n x dt)

Ap	Required porous pavement surface area	*ft2*	
Vw	Design Volume	*ft3*	
n	porosity of gravel bed/resevoir		*Assume .4 for gravel*
dt	depth of gravel bed/resevoir		

Design Point:	**1**						
Enter Site Data For Drainage Area to be Treated by Practice							
Catchment Number	**Total Area** *(Acres)*	**Impervious Area** *(Acres)*	**Percent Impervious** *%*	**Rv**	**WQv** *(ft^3)*	**Precipitation** *(in)*	**Description**
11	0.88	0.55	0.63	0.61	1858.74	0.95	Porous Pavement
Enter Soil Infiltration Rate							
Soil Inflitration Rate		0.20	*in/hour*	*Infiltration rate should be a minimum of 0.5 in/hr.*			
Calculate Required Surface Area							
Design Volume		Vw	1,859	*ft^3*			
Are underdrains being used?			Yes	-	Only Gravel Bed Depth below underdrain can be considered.		
Porosity of Gravel Bed		*n*	0.40	-			
Gravel Bed Depth		dt	1.75	*ft*	Must be the depth below the underdrain.		
Required Surface Area		Ap	2,655	*sf*			
Surface Area Provided			2,055	*sf*	*Dimensions of pavement can be provided here*		
Storage Volume Provided			1,439	*ft^3*	*Practice too small*		
Determine the Runoff Reduction							
RRv	**Error**	*ft^3*					

NYSDEC Worksheets for Bioretention Areas on William Street

Version 1.7 — Total Water Quality Volume Calculation

Last Updated: 10/02/2015 — WQv(acre-feet) = [(P)(Rv)(A)] /12

Is this project subject to Chapter 10 of the NYS Design Manual (i.e. WQv is equal to post-development 1 year runoff volume)?...	No

Design Point:	1	
P=	0.95	*inch*

Manually enter P, Total Area and Impervious Cover.

Breakdown of Subcatchments						
Catchment Number	**Total Area** *(Acres)*	**Impervious Area** *(Acres)*	**Percent Impervious** *%*	**Rv**	**WQv** *(ft³)*	**Description**
1	1.34	0.68	51%	0.51	2,342	Bioretention
2	1.90	0.79	42%	0.42	2,779	Bioretention
3	1.58	0.71	45%	0.45	2,476	Bioretention
4	2.38	1.35	57%	0.56	4,600	Bioretention
5						
6						
7						
8						
9						
10						
Subtotal (1-30)	7.20	3.53	49%	0.49	**12,197**	**Subtotal 1**
Total	7.20	3.53	49%	0.49	**12,197**	**Initial WQv**

Identify Runoff Reduction Techniques By Area			
Technique	**Total Contributing Area** *(Acre)*	**Contributing Impervious Area** *(Acre)*	**Notes**
Conservation of Natural Areas	0.00	0.00	*minimum 10,000 sf*
Riparian Buffers	0.00	0.00	*maximum contributing length 75 feet to 150 feet*
Filter Strips	0.00	0.00	
Tree Planting	0.00	0.00	*Up to 100 sf directly connected impervious area may be subtracted per tree*
Total	**0.00**	**0.00**	

Recalculate WQv after application of Area Reduction Techniques					
	Total Area *(Acres)*	**Impervious Area** *(Acres)*	**Percent Impervious** *%*	**Runoff Coefficient Rv**	**WQv** *(ft³)*
"<<Initial WQv"	7.20	3.53	49%	0.49	12,197
Subtract Area	0.00	0.00			
WQv adjusted after Area Reductions	**7.20**	**3.53**	49%	0.49	12,197
Disconnection of Rooftops		0.00			
Adjusted WQv after Area Reduction and Rooftop Disconnect	7.20	3.53	49%	0.49	**12,197**
WQv reduced by Area Reduction techniques					0

Bioretention Worksheet

(For use on HSG C or D Soils with underdrains)

Af=WQv*(df)/[k*(hf+df)(tf)]

Af	Required Surface Area (ft2)
WQv	Water Quality Volume (ft3)
df	Depth of the Soil Medium (feet)
hf	Average height of water above the planter bed
tf	Volume Through the Filter Media (days)

k The hydraulic conductivity [ft/day], can be varied depending on the properties of the soil media. Some reported conductivity values are: ***Sand*** - 3.5 ft/day (City of Austin 1988); ***Peat*** - 2.0 ft/day (Galli 1990); ***Leaf Compost*** - 8.7 ft/day (Claytor and Schueler, 1996); ***Bioretention Soil*** (0.5 ft/day (Claytor &

Design Point:	**1**

Enter Site Data For Drainage Area to be Treated by Practice							
Catchment Number	**Total Area** *(Acres)*	**Impervious Area** *(Acres)*	**Percent Impervious** *%*	**Rv**	**WQv** *(ft^3)*	**Precipitation** *(in)*	**Description**
1	1.34	0.68	0.51	0.51	2341.53	0.95	Bioretention
Enter Impervious Area Reduced by Disconnection of Rooftops			51%	0.51	2,342	<<WQv after adjusting for Disconnected Rooftops	
Enter the portion of the WQv that is not reduced for all practices routed to this practice.						*ft^3*	
Soil Information							
Soil Group		D					
Soil Infiltration Rate		0.20	*in/hour*	*Okay*			
Using Underdrains?		Yes	*Okay*				
Calculate the Minimum Filter Area							
				Value	Units	Notes	
WQv				2,342	*ft^3*		
Enter Depth of Soil Media			*df*	1.5	*ft*	*2.5-4 ft*	
Enter Hydraulic Conductivity			*k*	0.5	*ft/day*		
Enter Average Height of Ponding			*hf*	0.5	*ft*	*6 inches max.*	
Enter Filter Time			*tf*	2	*days*		
Required Filter Area			***Af***	**1756**	***ft^2***		
Determine Actual Bio-Retention Area							
Filter Width		20	*ft*				
Filter Length		178	*ft*				
Filter Area		3560	*ft^2*				
Actual Volume Provided		4747	*ft^3*				
Determine Runoff Reduction							
Is the Bioretention contributing flow to another practice?			No	Select Practice			
RRv		1,899					
RRv applied		**1,899**	***ft^3***	***This is 40% of the storage provided or WQv whichever is less.***			
Volume Treated		443	*ft^3*	*This is the portion of the WQv that is not reduced in the practice.*			
Volume Directed		0	*ft^3*	This volume is directed another practice			

Bioretention Worksheet

Sizing √	OK		*Check to be sure Area provided ≥ Af*

(For use on HSG C or D Soils with underdrains)

Af=WQv*(df)/[k*(hf+df)(tf)]

Af	Required Surface Area (ft2)
WQv	Water Quality Volume (ft3)
df	Depth of the Soil Medium (feet)
hf	Average height of water above the planter bed
tf	Volume Through the Filter Media (days)

k The hydraulic conductivity [ft/day], can be varied depending on the properties of the soil media. Some reported conductivity values are: ***Sand*** - 3.5 ft/day (City of Austin 1988); ***Peat*** - 2.0 ft/day (Galli 1990); ***Leaf Compost*** - 8.7 ft/day (Claytor and Schueler, 1996); ***Bioretention Soil*** (0.5 ft/day (Claytor & Schueler, 1996)

Design Point:	**1**

Enter Site Data For Drainage Area to be Treated by Practice

Catchment Number	**Total Area** *(Acres)*	**Impervious Area** *(Acres)*	**Percent Impervious** *%*	**Rv**	**WQv** *(ft^3)*	**Precipitation** *(in)*	**Description**
2	1.90	0.79	0.42	0.42	2779.49	0.95	Bioretention
Enter Impervious Area Reduced by Disconnection of Rooftops			42%	0.42	2,779	<<WQv after adjusting for Disconnected Rooftops	
Enter the portion of the WQv that is not reduced for all practices routed to this practice.						*ft^3*	

Soil Information

Soil Group	d		
Soil Infiltration Rate	0.20	*in/hour*	*Okay*
Using Underdrains?	Yes	*Okay*	

Calculate the Minimum Filter Area

		Value	Units	Notes
WQv		2,779	*ft^3*	
Enter Depth of Soil Media	*df*	1.5	*ft*	*2.5-4 ft*
Enter Hydraulic Conductivity	*k*	0.5	*ft/day*	
Enter Average Height of Ponding	*hf*	0.5	*ft*	*6 inches max.*
Enter Filter Time	*tf*	2	*days*	
Required Filter Area	***Af***	**2085**	***ft^2***	

Determine Actual Bio-Retention Area

Filter Width	10	*ft*	
Filter Length	197	*ft*	
Filter Area	1970	*ft^2*	
Actual Volume Provided	2627	*ft^3*	

Determine Runoff Reduction

Is the Bioretention contributing flow to another practice?		No	Select Practice	
RRv	1,051			
RRv applied	**1,051**	***ft^3***	***This is 40% of the storage provided or WQv whichever is less.***	
Volume Treated	1,729	*ft^3*	*This is the portion of the WQv that is not reduced in the practice.*	
Volume Directed	0	*ft^3*	This volume is directed another practice	

Bioretention Worksheet

Sizing √	Error		*Check to be sure Area provided ≥ Af*

(For use on HSG C or D Soils with underdrains)

Af=WQv*(df)/[k*(hf+df)(tf)]

Af	Required Surface Area (ft2)
WQv	Water Quality Volume (ft3)
df	Depth of the Soil Medium (feet)
hf	Average height of water above the planter bed
tf	Volume Through the Filter Media (days)

k The hydraulic conductivity [ft/day], can be varied depending on the properties of the soil media. Some reported conductivity values are: ***Sand*** - 3.5 ft/day (City of Austin 1988); ***Peat*** - 2.0 ft/day (Galli 1990); ***Leaf Compost*** - 8.7 ft/day (Claytor and Schueler, 1996); ***Bioretention Soil*** (0.5 ft/day (Claytor &

Design Point:	**1**

Enter Site Data For Drainage Area to be Treated by Practice							
Catchment Number	**Total Area** *(Acres)*	**Impervious Area** *(Acres)*	**Percent Impervious** *%*	**Rv**	**WQv** *(ft^3)*	**Precipitation** *(in)*	**Description**
3	1.58	0.71	0.45	0.45	2476.02	0.95	Bioretention
Enter Impervious Area Reduced by Disconnection of Rooftops			45%	0.45	2,476	<<WQv after adjusting for Disconnected Rooftops	
Enter the portion of the WQv that is not reduced for all practices routed to this practice.						*ft^3*	

Soil Information			
Soil Group	D		
Soil Infiltration Rate	0.20	*in/hour*	*Okay*
Using Underdrains?	Yes	*Okay*	

Calculate the Minimum Filter Area				
		Value	Units	Notes
WQv		2,476	*ft^3*	
Enter Depth of Soil Media	*df*	1.5	*ft*	*2.5-4 ft*
Enter Hydraulic Conductivity	*k*	0.5	*ft/day*	
Enter Average Height of Ponding	*hf*	0.5	*ft*	*6 inches max.*
Enter Filter Time	*tf*	2	*days*	
Required Filter Area	***Af***	**1857**	***ft^2***	

Determine Actual Bio-Retention Area			
Filter Width	15	*ft*	
Filter Length	290	*ft*	
Filter Area	4350	*ft^2*	
Actual Volume Provided	5800	*ft^3*	

Determine Runoff Reduction			
Is the Bioretention contributing flow to another practice?		Select Practice	
RRv	2,320		
RRv applied	**2,320**	***ft^3***	***This is 40% of the storage provided or WQv whichever is less.***
Volume Treated	156	*ft^3*	*This is the portion of the WQv that is not reduced in the practice.*

Bioretention Worksheet

Volume Directed	0	ft^3	This volume is directed another practice
Sizing √	OK		*Check to be sure Area provided ≥ Af*

(For use on HSG C or D Soils with underdrains)

Af=WQv*(df)/[k*(hf+df)(tf)]

Af	Required Surface Area (ft2)
WQv	Water Quality Volume (ft3)
df	Depth of the Soil Medium (feet)
hf	Average height of water above the planter bed
tf	Volume Through the Filter Media (days)

k The hydraulic conductivity [ft/day], can be varied depending on the properties of the soil media. Some reported conductivity values are: ***Sand*** - 3.5 ft/day (City of Austin 1988); ***Peat*** - 2.0 ft/day (Galli 1990); ***Leaf Compost*** - 8.7 ft/day (Claytor and Schueler, 1996); ***Bioretention Soil*** (0.5 ft/day (Claytor &

Design Point:	**1**

Enter Site Data For Drainage Area to be Treated by Practice							
Catchment Number	**Total Area** *(Acres)*	**Impervious Area** *(Acres)*	**Percent Impervious** *%*	**Rv**	**WQv** *(ft^3)*	**Precipitation** *(in)*	**Description**
4	2.38	1.35	0.57	0.56	4600.30	0.95	Bioretention
Enter Impervious Area Reduced by Disconnection of Rooftops			57%	0.56	4,600	<<WQv after adjusting for Disconnected Rooftops	
Enter the portion of the WQv that is not reduced for all practices routed to this practice.						ft^3	

Soil Information			
Soil Group	D		
Soil Infiltration Rate	0.20	*in/hour*	*Okay*
Using Underdrains?	Yes	*Okay*	

Calculate the Minimum Filter Area				
		Value	Units	Notes
WQv		4,600	ft^3	
Enter Depth of Soil Media	*df*	2.5	*ft*	*2.5-4 ft*
Enter Hydraulic Conductivity	*k*	0.5	*ft/day*	
Enter Average Height of Ponding	*hf*	0.5	*ft*	*6 inches max.*
Enter Filter Time	*tf*	2	*days*	
Required Filter Area	***Af***	**3834**	ft^2	

Determine Actual Bio-Retention Area		
Filter Width	15	*ft*
Filter Length	183	*ft*
Filter Area	2745	ft^2
Actual Volume Provided	3294	ft^3

Determine Runoff Reduction			
Is the Bioretention contributing flow to another practice?		Select Practice	
RRv	1,318		
RRv applied	**1,318**	ft^3	***This is 40% of the storage provided or WQv whichever is less.***
Volume Treated	3,283	ft^3	*This is the portion of the WQv that is not reduced in the practice.*

APPENDIX D

Maintenance Plan

Bioretention Area Operation, Maintenance, and Management Inspection Checklist

Project: Willert Park Green Infrastructure Improvement Project
Location: ____________________
Site Status: ____________________

Date: ____________________
Time: ____________________
Inspector: ____________________

Maintenance Item	Satisfactory/ Unsatisfactory	Comments
1. Debris Cleanout (Monthly and After Major Storms)		
a. Bioretention and Contributing Areas Clean of Debris		
b. No yard wastes present		
c. Litter Removal		
d. Other (specify)		
2. Vegetation and Water Level (Monthly and After Major Storms)		
a. Plant Height in Bioretention Area > 6"		
b. Plant Composition Matches Plan		
c. Unauthorized Plantings		
d. Grass Height Less Than 6"		
e. Water Level Less Than 6"		
f. Any Erosion		
g. Other (specify)		
3. Bioretention Forebay & Manhole (Annually and After Major Storms)		
a. Sedimentation Noted		
b. Sediment Cleanout when depth < 50% design depth		
c. Check Cleanouts for Debris or Material Damage		
d. Other (specify)		

Maintenance Item	Satisfactory/ Unsatisfactory	Comments
4. Outlet Catch Basin (Annually and After Major Storms)		
a. Debris on Grate of Catch Basin		
b. Corrosion in Frame and Grate of Catch Basin		
c. Grate Operational and Excercised		
d. Sediment Accumulation in Catch Basin		
e. Other (specify)		
5. Other (as needed)		
a. Encroachment on Bioretention Area		
b. Complaints from Neighbors		
c. Any Public Hazards		

Actions to be Taken: ____

____

Cost Estimate

WILLERT PARK 60% ENGINEERS ESTIMATE - WILLIAM STREET ONLY

wendel

DATE: January 26, 2017

DESCRIPTION: Wilert Park Green Streets Infrastructure Improvements

BY: CML

PROJECT NO.: 434925

CHKD BY: SMR

ITEM	DESCRIPTION	UNIT	UNIT COST	QTY.	ROUNDED QTY.	TOTAL
201.06	CLEARING AND GRUBBING	LS	$ 2,000.00	1.0	1.0	$ 2,000.00
203.02	UNCLASSIFIED EXCAVATION AND DISPOSAL	CY	$ 17.00	11,249.1	11,250.0	$ 191,250.00
203.03	EMBANKMENT IN PLACE	CY	$ 33.00	412.3	420.0	$ 13,860.00
206.0201	TRENCH AND CULVERT EXCAVATION	CY	$ 21.00	3,974.2	3,980.0	$ 83,580.00
207.22	GEOTEXTILE DRAINAGE FILTER FABRIC	SY	$ 3.00	6,650.9	6,660.0	$ 19,980.00
208.01030022	BIORETENTION AND DRY SWALE SOIL	CY	$ 80.00	320.4	330.0	$ 26,400.00
304.01000010	SUBBASE COURSE FOR THE CONSTRUCTION OF PERVIOUS/POROUS PAVEMENT SYSTEMS	CY	$ 65.00	4,768.0	4,770.0	$ 310,050.00
304.12	SUBBASE COURSE, TYPE 2	CY	$ 55.00	559.0	560.0	$ 30,800.00
402.096203	9.5 F2 TOP COURSE HMA, 60 SERIES COMPACTION (1.5")	TON	$ 80.00	2,151.9	2,160.0	$ 172,800.00
402.196903	19 F9 BINDER COURSE HMA, 60 SERIES COMPACTION (2.5")	TON	$ 80.00	3,581.5	3,590.0	$ 287,200.00
402.376903	37.5 F9 BASE COURSE HMA, 60 SERIES COMPACTION (6.5")	TON	$ 80.00	598.2	600.0	$ 48,000.00
407.0102	DILUTED TACK COAT	GAL	$ 6.00	3,122.4	3,130.0	$ 18,780.00
420.01190201	BINDER COURSE POROUS ASPHALT PAVEMENT F9 (6")	TON	$ 140.00	1,119.9	1,120.0	$ 156,800.00
420.10190201	TOP COURSE POROUS ASPHALT PAVEMENT WITH MINERAL FIBER F9 (3")	TON	$ 100.00	571.9	580.0	$ 58,000.00
490.10	PRODUCTION COLD MILLING OF BITUMINOUS CONCRETE	SY	$ 3.00	26,020.3	26,030.0	$ 78,090.00
605.0901	UNDERDRAIN FILTER TYPE 1	CY	$ 59.00	236.7	240.0	$ 14,160.00
605.1501	PERFORATED CORRUGATED POLYETHYLENE UNDERDRAIN TUBING, 4 INCH DIAMETER	LF	$ 3.00	5,873.0	5,880.0	$ 17,640.00
605.1603	PERFORATED POLYVINYL CHLORIDE UNDERDRAIN PIPE, 8 INCH DIAMETER	LF	$ 6.00	3,576.0	3,580.0	$ 21,480.00
605.1605	PERFORATED POLYVINYL CHLORIDE UNDERDRAIN PIPE, 12 INCH DIAMETER	LF	$ 8.36	1,016.3	1,020.0	$ 8,527.20
608.0101	CONCRETE DRIVEWAYS AND SIDEWALKS	CY	$ 400.00	299.6	300.0	$ 120,000.00
609.0203	STONE CURB, GRANITE (TYPE C)	LF	$ 50.00	9,604.0	9,610.0	$ 480,500.00
610.1101	MULCH FOR PLANTING TYPE A, B & D - WOOD CHIPS AND SHREDDED BARK	CY	$ 75.00	32.0	40.0	$ 3,000.00
610.1403	TOPSOIL - LAWNS	CY	$60.00	1,676.4	1,680.0	$ 100,800.00
610.1602	TURF ESTABLISHMENT - LAWNS	SY	$3.19	10,933.2	10,940.0	$ 34,898.60
614.060104	TREE REMOVAL OVER 4 INCHES TO 6 INCHES DIAMETER BREAST HEIGHT - STUMPS GRUBBED	EA	$100.00	41.0	41.0	$ 4,100.00
619.01	BASIC WORK ZONE TRAFFIC CONTROL	LS	$35,000.00	1.0	1.0	$ 35,000.00
623.12	CRUSHED STONE (IN-PLACE MEASURE)	CY	$65.00	1,974.4	1,980.0	$ 128,700.00
627.50140008	CUTTING PAVEMENT	LF	$3.50	11,736.0	11,740.0	$ 41,090.00
663.011001ER	DUCTILE IRON WATER MAIN PIPE	LF	$100.00	50.0	50.0	$ 5,000.00
663.201000ER	WATER MAIN PIPE SPECIALS	LB	$10.00	1,720.0	1,720.0	$ 17,200.00
664.011001ER	PVC SEWER PIPE, 10 INCH	LF	$110.00	339.0	340.0	$ 37,400.00
664.011201ER	PVC SEWER PIPE, 12 INCH	LF	$125.00	727.0	730.0	$ 91,250.00
664.505220ER	2'x2' CATCH BASIN	EA	$2,500.00	43.0	43.0	$ 107,500.00
664.506400ER	MANHOLE ADJUSTMENT (BSA)	EA	$420.00	28.0	28.0	$ 11,760.00
685.11	WHITE EPOXY REFLECTORIZED PAVEMENT STRIPES - 20 MILS	LF	$1.43	14,916.0	14,920.0	$ 21,335.60
685.12	YELLOW EPOXY REFLECTORIZED PAVEMENT STRIPES - 20 MILS	LF	$1.43	7,458.0	7,460.0	$ 10,667.80
688.04	WHITE PREFORMED REFLECTORIZED PAVEMENT SYMBOLS	EA	$207.03	38.0	40.0	$ 8,281.20
					SUBTOTAL:	$ 2,815,880.40
697.03	OTHER ITEMS (SIGNAGE, SIGNALS, LANDSCAPING - 5%)	DC	$140,794.02	1.0	1.0	$ 140,794.02
699.040001	MOBILIZATION (4%)	LS	$112,635.22	1.0	1.0	$ 112,635.22
				CONTINGENCY (15%)		$ 422,382.06
					TOTAL CONSTRUCTION COST:	**$ 3,491,692**
					SAY =	**$3,500,000**

WILLERT PARK 60% ENGINEERS ESTIMATE - JFK COMMUNITY CENTER

DATE: January 26, 2017

DESCRIPTION: Wilert Park Green Streets Infrastructure Improvements

BY: CML

PROJECT NO.: 434925

CHKD BY: SMR

ITEM	DESCRIPTION	UNIT	UNIT COST	QTY.	ROUNDED QTY.	TOTAL
203.02	UNCLASSIFIED EXCAVATION AND DISPOSAL	CY	$ 17.00	292.7	300.0	$ 5,100.00
207.22	GEOTEXTILE DRAINAGE FILTER FABRIC	SY	$ 3.00	503.6	510.0	$ 1,530.00
208.01030022	BIORETENTION AND DRY SWALE SOIL	CY	$ 80.00	92.4	100.0	$ 8,000.00
402.378903	37.5 F9 BASE COURSE HMA, 80 SERIES COMPACTION (6.5")	TON	$ 80.00	8.5	10.0	$ 800.00
520.51000006	SAWCUTTING EXISTING CONCRETE GRANITE AND ASPHALT CURBS	LF	$ 5.00	12.7	20.0	$ 100.00
605.0901	UNDERDRAIN FILTER TYPE 1	CY	$ 59.00	0.2	10.0	$ 590.00
605.1603	PERFORATED POLYVINYL CHLORIDE UNDERDRAIN PIPE, 8 INCH DIAMETER	LF	$ 6.00	20.0	20.0	$ 120.00
605.1605	PERFORATED POLYVINYL CHLORIDE UNDERDRAIN PIPE, 12 INCH DIAMETER	LF	$ 8.36	95.0	100.0	$ 836.00
610.1101	MULCH FOR PLANTING TYPE A, B & D - WOOD CHIPS AND SHREDDED BARK	CY	$ 75.00	15.4	20.0	$ 1,500.00
614.060104	TREE REMOVAL OVER 4 INCHES TO 6 INCHES DIAMETER BREAST HEIGHT - STUMPS GRUBBED	EA	$100.00	1.0	1.0	$ 100.00
614.060404	TREE REMOVAL OVER 18 INCHES TO 24 INCHES DIAMETER BREAST HEIGHT - STUMPS GRUBBED	EA	$400.00	1.0	1.0	$ 400.00
614.0701	PRE-EXISTING STUMP REMOVAL UP TO 24 INCH DIAMETER AT 6 INCHES ABOVE GRADE	EA	$200.00	1.0	1.0	$ 200.00
623.12	CRUSHED STONE (IN-PLACE MEASURE)	CY	$65.00	138.7	140.0	$ 9,100.00
645.81	TYPE A SIGN POSTS	EA	$141.80	2.0	2.0	$ 283.60
647.31	RELOCATE SIGN PANEL, SIGN PANEL ASSEMBLY SIZE I (UNDER 30 SQUARE FEET)	EA	$50.00	2.0	2.0	$ 100.00
664.011201ER	PVC SEWER PIPE, 12 INCH	LF	$125.00	43.0	50.0	$ 6,250.00
664.505220ER	2'x2' CATCH BASIN	EA	$2,500.00	2.0	2.0	$ 5,000.00
					SUBTOTAL:	$ 40,009.60
697.03	OTHER (REPLACEMENT OF PAVING, SIDEWALK - 5%)	DC	$2,000.48	1.0	1.0	$ 2,000.48
699.040001	MOBILIZATION (4%)	LS	$ 1,600.38	1.0	1.0	$ 1,600.38
					CONTINGENCY (15%)	$ 6,001.44
					TOTAL CONSTRUCTION COST:	**$ 49,612**
					SAY =	**$50,000**

WILLERT PARK 60% ENGINEERS ESTIMATE - PRATT WILLERT COMMUNITY CENTER

DATE: January 26, 2017

DESCRIPTION: Wilert Park Green Streets Infrastructure Improvements **BY:** CML

PROJECT NO.: 434925 **CHKD BY:** SMR

ITEM	DESCRIPTION	UNIT	UNIT COST	QTY.	ROUNDED QTY.	TOTAL
203.02	UNCLASSIFIED EXCAVATION AND DISPOSAL	CY	$ 17.00	184.7	190.0	$ 3,230.00
207.22	GEOTEXTILE DRAINAGE FILTER FABRIC	SY	$ 3.00	311.5	320.0	$ 960.00
208.01030022	BIORETENTION AND DRY SWALE SOIL	CY	$ 80.00	48.6	50.0	$ 4,000.00
402.378903	37.5 F9 BASE COURSE HMA, 80 SERIES COMPACTION (6.5")	TON	$ 80.00	5.9	10.0	$ 800.00
605.0901	UNDERDRAIN FILTER TYPE 1	CY	$ 59.00	0.2	10.0	$ 590.00
609.0401	CAST IN PLACE CONCRETE CURB TYPE VF150	LF	$ 30.00	51.0	60.0	$ 1,800.00
610.1101	MULCH FOR PLANTING TYPE A, B & D - WOOD CHIPS AND SHREDDED BARK	CY	$ 75.00	8.1	10.0	$ 750.00
623.12	CRUSHED STONE (IN-PLACE MEASURE)	CY	$65.00	103.7	110.0	$ 7,150.00
664.010801ER	PVC SEWER PIPE, 8 INCH	LF	$100.00	32.0	40.0	$ 4,000.00
664.505220ER	2'x2' CATCH BASIN	EA	$2,500.00	1.0	1.0	$ 2,500.00
685.12	YELLOW EPOXY REFLECTORIZED PAVEMENT STRIPES - 20 MILS	LF	$1.43	1,200.0	1,200.0	$ 1,716.00
					SUBTOTAL:	$ 27,496.00
697.03	OTHER (SIGNAGE - 5%)	DC	$1,374.80	1.0	1.0	$ 1,374.80
699.040001	MOBILIZATION (4%)	LS	$ 1,099.84	1.0	1.0	$ 1,099.84
					CONTINGENCY (15%)	$ 4,124.40
					TOTAL CONSTRUCTION COST:	**$ 34,095**
					SAY =	**$35,000**