Arlington Conservation Commission

Date: Thursday, October 24, 2024
Time: 7:00 PM
Location: Conducted by Remote Participation.

Please register in advance for this meeting: https://town-arlington-ma-us.zoom.us/meeting/register/tZEqcuyvqjgpHdd98ZwruZj_z3SR6m7Yu6vi Reference materials, instructions, and access information for this specific meeting will be available 48 hours prior to the meeting on the Commission's agenda and minutes page. This meeting will be conducted in a remote format consistent with Chapter 2 of the Acts of 2023, which further extends certain COVID-19 measures regarding remote participation in public meetings until March 31, 2025. Please note: Not all items listed may in fact be discussed and other items not listed may be brought up for discussion to the extent permitted by law. This agenda includes those matters which can be reasonably anticipated to be discussed at the meeting.

Agenda

1. Administrative
    a. Correspondence Received.
2. Hearings

DEP #091-0356: Notice of Intent: Thorndike Place (Continued from 09/05/2024).

DEP #091-0356: Notice of Intent: Thorndike Place (Continued from 09/05/2024).
The Conservation Commission will hold a public hearing under the Wetlands Protection Act to consider a Notice of Intent for the construction of Thorndike Place, a multifamily development on Dorothy Road in Arlington. Areas proposed to be altered include Buffer Zone to Bordering Vegetated Wetland and Bordering Land Subject to Flooding associated with Alewife Brook.

Correspondence Received.

Summary:
Correspondence Received.

ATTACHMENTS:

	Type	File Name	Description
🗋	Reference Material	Thorndike_Place_-_MMA_Response_to_GZA_Letter_082324.pdf	Correspondence Received - Thorndike Place - MMA Response to GZA Letter 082324.pdf

August 23, 2024

Town of Arlington, Massachusetts Conservation Commission
C/O Mr. Charles Tirone, Chair
730 Mass Ave. Annex
Arlington, MA 02476

VIA EMAIL

RE: Thorndike Place, Dorothy Road, Arlington, Massachusetts – Response to GZA Peer Review of Stormwater Mound Evaluation and Design Groundwater Elevation

Dear Chairman Tirone and Commission Members,

We have reviewed GZA GeoEnvironmental, Inc.'s (GZA's) August 1, 2024 peer review summary letter and are providing the following comments:

Groundwater/Stormwater Mounding Analysis:

GZA's review, like our own recent reviews, finds that BSC's groundwater mounding analysis improperly considers an infiltration volume much smaller than the actual volume that is proposed. They refer to this quantity as the "*required recharge volume*", which is the minimum amount of stormwater that they are required to infiltrate. However, due to the expansive size of the project and related impervious surfaces, the proposed stormwater system would attempt to infiltrate much larger volumes during storm events. As a result, BSC's groundwater mounding analysis is not useful. It does not demonstrate that the systems will operate as intended during storm events, nor does it provide any support for claimed compliance with Stormwater Standard 2 and the 72-hour drainage time requirement noted in the Massachusetts Stormwater Handbook (MSH).

In identifying this problem and assessing its implications, GZA correctly concludes the proposed infiltration systems must be redesigned. We fully support this overarching conclusion; however, we respectfully request clarification from GZA relative to the following statement: "*In GZA's opinion both the large main stormwater infiltration system and the smaller driveway infiltrations* (sic) *systems would need to be redesigned to account for the impacts of groundwater mounding during large storm events and to meet the MassDEP Stormwater Manual's maximum allowable drainage standard of 72-hours*". On Page 4 of their letter, GZA notes the following, which we interpret as a reference to Stormwater Standard 2, which addresses peak rate control: "*...redesign should also address peak flow rates that discharge to the stormwater outfall control system*". Thus, we feel it is important for GZA's conclusion(s) to be extended to specifically state that any new/updated design must comply with the Stormwater Standards—Standard 2, in particular—in addition to the 72-hour drainage time requirement defined within the MSH.

Seasonal High Groundwater Condition:

Relative to GZA's comments on the seasonal high groundwater condition proposed by BSC, we respectfully seek clarification on their approach and conclusion. GZA presents the MSH definition of seasonal high groundwater as "*the highest groundwater elevation*", yet their conclusion refers to BSC's proposed elevation of 4.0-feet as being "*above normal*" and thus finds it to be, in their opinion, "*suitable to be used for stormwater design for this project*". Is the 4.0-foot groundwater elevation viewed by GZA

as simply being "*above normal*", or is it the maximum/highest condition, which would be consistent with the MSH definition?

If the answer is "*above normal*", the pertinent follow up question would be: why is GZA's basis for "*suitable"* seemingly different from MassDEP's, as represented by the MSH? Conversely, if GZA does view the 4.0-foot elevation as "*the highest groundwater elevation*" at the site, how do they explain the results of correctly applying the so-called "Frimpter" adjustment method that specifically attempts to estimate a maximum site-specific groundwater elevation based on a historical record of measurements associated with a U.S. Geological Survey (USGS) index well? GZA should note that, to date, we have only used Frimpter method results to highlight BSC's methodological errors (i.e., in implementing their own Frimpter and generally illustrate the point that groundwater levels do exceed the proposed ESHGW elevation of 4.0-feet. Therefore, GZA's comments pertaining to the representativeness of certain USGS index wells are not germane, as any nearby index well would produce the same outcome (i.e., an adjusted seasonal high groundwater elevation exceeding 4.0-feet).

Furthermore, as reported in multiple prior comment letters, water level data have been collected at a nearby monitoring well that we installed on the adjacent town-owed parcel on Dorothy Road (approximately 100-feet from proposed primary stormwater infiltration system INF-1). The data collected from this well reflect a peak groundwater elevation during the March 19 – April 20 period of 4.4-feet occurring during March 29, 2024. BSC's groundwater level measurements were taken on April 1, 17, and 24 when water levels had receded relative to the peak condition.

To reach a resolution on this issue at the site, we believe one key question must be reasonably answered: how far above 4.0-feet does the highest groundwater elevation extend? Our position on this matter is simple—more information is needed to reliably identify "*the highest groundwater elevation*" in a manner consistent with the guidance presented in the MSH.

Sincerely,

Scott W. Horsley
Water Resources Consultant

Michael Mobile, Ph.D., CGWP
President – McDonald Morrissey Associates, LLC

Town of Arlington, Massachusetts

DEP #091-0356: Notice of Intent: Thorndike Place (Continued from 09/05/2024).

Summary:
DEP #091-0356: Notice of Intent: Thorndike Place (Continued from 09/05/2024).
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ATTACHMENTS:

	Type	File Name	Description
🗋	Reference Material	Thorndike_Place_-_GZA_Peer_Review_08012024.pdf	Thorndike Place - GZA Peer Review 08012024.pdf
🗋	Reference Material	Thorndike_Place_-_BSC_Revised_Stormwater_Calculations_09092024.pdf	Thorndike Place - BSC Revised Stormwater Calculations 09092024.pdf
🗋	Reference Material	Thorndike_Place_-_GZA_Peer_Review_10222024.pdf	Thorndike Place - GZA Peer Review 10222024.pdf
🗋	Reference Material	Thorndike_Place_-_BSC_Response_to_GZA_Peer_Review_Comments_10042024.pdf	Thorndike Place - BSC Response to GZA Peer Review Comments 10042024.pdf

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August 1, 2024
File No. 03.0035410.00

David Morgan
Environmental Planner and Conservation Agent
Arlington Town Hall
730 Massachusetts Avenue
Arlington, Massachusetts 02467

Re: Peer Review of Stormwater Mound Evaluation and Design Groundwater Elevation
Proposed Thorndike Place Residential Development
Arlington, Massachusetts

Dear Mr. Morgan:

In accordance with your request, GZA GeoEnvironmental, Inc. (GZA) performed a peer review of groundwater monitoring and stormwater mounding analysis performed by the BSC Group (BSC) associated with the proposed Thorndike Place residential development in Arlington, Massachusetts (the "Site"). BSC performed their work on behalf of the Applicant (Arlington Land Realty, LLC). This letter report is subject to the Limitations provided in Appendix A.

BACKGROUND

Thorndike Place (the "Project") is a proposed multifamily development in Arlington located south of Dorothy Road. The Arlington Conservation Commission is reviewing a Wetlands Notice of Intent application (NOI) for the Project and is seeking a peer review of associated materials for compliance with Massachusetts Stormwater Standards No. 2 and No. 3, specifically regarding the stormwater groundwater mound analysis.

The proposed development includes 78,629 square feet (1.8 acres) of impervious paved and rooftop area within the 17.7-acre parcel of land. Most of the stormwater runoff will be directed to a large central stormwater infiltration system. That stormwater infiltration system is planned to be 196 feet long, 41.5 feet wide, with the bottom of the infiltration system located 2 feet above the seasonal high groundwater table.

The reported seasonal high "design" groundwater table is elevation 4.0 feet and the bottom of the stormwater infiltration system at elevation 6.0 feet. When the water level in the stormwater infiltration basin rises 1.5 feet (to elevation 7.5 feet) during large storm events it will begin to overflow through a stormwater outlet structure.

In addition, there are five smaller (driveway) stormwater infiltration areas (each with dimensions about 21 feet long and 14 feet wide) located just south of Dorothy Road.

The most recent BSC Site Plans and updated Stormwater Report are dated September 6, 2023. On behalf of the Conservation Commission, Hatch Associates Consultants Inc. (Hatch) peer reviewed those plans and report and provided comments. BSC responded with additional information in letters dated January 24, 2024, February 13, 2024, February 28, 2024, March 13, 2024, April 24, 2024, and June 10, 2024. BSC's June 10, 2024 letter provided additional information on soil testing and estimated seasonal high groundwater levels and an updated groundwater mound analysis.

On behalf of others, Scott Horsley from Water Resource Consultant (Horsley) provided a letter dated May 16, 2024 to the Conservation Commission expressing concerns regarding the seasonal high groundwater elevation and the stormwater groundwater mound analysis. Similarly, Michael Mobile from McDonald Morrissy Associates, LLC (MMA) provided letters dated April 26, 2024, and May 16, 2024, and a draft presentation dated May 2, 2024 expressing the same concerns.

A Hatch letter report dated May 28, 2024 agreed with the BSC design groundwater elevation of 4.0 feet, but expressed additional concern regarding the groundwater mound analysis and the required drawdown time for the smaller (driveway) infiltration systems.

SUBSURFACE CONDITIONS

A total of 13 test pits (TP-1 to TP-13) were performed on behalf of BSC to depths ranging from 6 to 11 feet below grade at the Site. The soil was generally comprised of a sandy loam fill to a depth of about 8 feet underlain by fine sandy loam. For design purposes Hydrologic Soil Group C (silt loam) was used.

DESIGN SEASONAL HIGH-WATER TABLE

The Massachusetts Stormwater Handbook states:

> *Seasonal high groundwater represents the highest groundwater elevation. Depth to seasonal high groundwater may be identified based on redox features in the soil. When redox features are not available, installation of temporary push point wells or piezometers should be considered. Ideally, such wells should be monitored in the spring when the groundwater is highest and the results compared to nearby groundwater wells monitored by the USGS to estimate whether regional groundwater is below normal, normal or above normal.*

Redox features were observed in test pit TP-3 at elevation 3.6 feet and TP-5 at elevation 4.0 feet. These two test pits are located along Dorothy Road in the area where the five smaller (driveway) stormwater infiltration areas are planned. There were no redox features observed in the fill strata in the area planned for the large central stormwater infiltration system. As a result, water levels were measured by BSC in observation wells installed in this area at test pit TP-7 on April 1, 17, and 24, 2024 and test pit TP-9 on April 17 and 24, 2024. The groundwater levels peaked in both wells on April 17, 2024 at elevation 3.5 feet at TP-7 and elevation 4.0 feet at TP-9. Our review of the USGS historical groundwater elevation data at four Middlesex County wells (Wayland MA-WKW-2R, Concord MA-CTW-167R, Acton MA-ACW-158, and Wilmington MA-XMW-78) revealed that the April 2024 groundwater levels were the highest seasonal water levels observed over the past 10 years. Therefore, we conclude that the seasonal high water table elevation of 4.0 feet used by BSC is for “above normal” groundwater conditions and is suitable to be used for stormwater design for this project. As noted above, GZA’s opinion on design groundwater elevation findings are consistent with the opinion expressed by Hatch and BSC.

Note that we did not use USGS well Lexington MA-LTW-104 (which was used by MMA and Horsley) in our analysis because that well is in a sand and gravel aquifer with a very shallow water table. Those conditions are not present at the Site. In addition, that USGS well is more effected by individual rainfall events than by seasonal variations of the groundwater table, which is not typical of other USGS wells in the area.

GROUNDWATER MOUND EVALUATION

The Massachusetts Stormwater Handbook states:

Mounding analysis is required when the vertical separation from the bottom of an exfiltration system to seasonal high groundwater is less than four (4) feet and the recharge system is proposed to attenuate the peak discharge from a 10-year or higher 24-hour storm (e.g., 10-year, 25 year, or 100-year 24- hour storm). In such cases, the mounding analysis must demonstrate that the Required Recharge Volume (e.g., infiltration basin storage) is fully dewatered with 72 hours (so the next storm can be stored for exfiltration).

The proposed bottom of the exfiltration system is 2 feet from the seasonal high groundwater table and the system is designed to attenuate the peak discharge from the 10, 25, and 100 year 24- hour storms, therefore a groundwater mounding analysis is required.

The groundwater mound that will develop beneath the stormwater infiltration system is dependent on the horizontal hydraulic conductivity of the aquifer (Kh), the thickness of the aquifer (H), the specific yield of the aquifer (S), the length and width of the infiltration area, the applied recharge rate to the infiltration area, and the duration of discharge.

BSC's latest groundwater mound evaluations are provided in their June 10, 2024 letter report. They used a Kh of 5.4 feet per day, which was based on a Rawls vertical hydraulic conductivity (Kv) of 0.54 feet per day (i.e., 0.27-inches per hour) for silt loam and assuming an anisotropic ratio of 10 to 1 (i.e., Kh to Kv). They also assumed that the initial saturated thickness of the aquifer was 5 feet. The transmissivity (T) of the aquifer is Kh times the saturated thickness, which would be 27 feet squared per day. It is GZA's opinion that the assumed transmissivity (T) of 27 feet squared per day used by BSC is a reasonable value to be used in the groundwater mound evaluation for the soil conditions at this Site. BSC assumed a specific yield (S) of 0.08, which again GZA believes is reasonable for the soil conditions encountered at the Site.

The large main stormwater infiltration system is planned to be about 196 feet long and 41.5 feet wide. Per BSC's Stormwater Report the Required Recharge Volume for the Hydrologic Soil Group C is 1,638 cubic feet. The bottom area of the large stormwater infiltration system is 8,134 square feet. Dividing the required recharge volume of 1,638 by the bottom area of 8,134 results in a static water height of 0.2014 feet (or 2.42-inches).

If the stormwater infiltration system was instantaneously filled with the required recharge volume of 1,638 cubic feet and then discharged out of the system at the Kv design rate of 0.27-inches per hour (0.54 feet per day), it would take 8.96 hours to drain (i.e., 0.374 days). GZA's initial groundwater mound analysis using the Hantush method and the values listed above (Large Infiltration System V-1) is provided in Appendix B and indicates that maximum groundwater mound would be 2.27 feet.

However, it is more likely that the required recharge volume would flow out of the infiltration basin over the duration of one day. GZA's second groundwater mound analysis (Large Infiltration System V-2) assumed the same conditions as the Large Infiltration System V-1 except the duration was one day and the applied recharge was 0.2014 feet per day. The resulting maximum groundwater mound would be 1.85 feet (see Appendix B).

It is GZA's opinion that the Required Recharge Volume of 1,638 cubic feet can be infiltrated into the ground, without causing excessive groundwater mounding. However, for stormwater volumes larger than 1,638 cubic feet the rate of groundwater infiltration will decrease significantly, and the groundwater mound will extend into the bottom of the infiltration system.

When the groundwater mound is below the bottom of the infiltration system the water flows out at a vertical hydraulic gradient of 1.0 feet per foot, which allows flow out at the Rawls Kv rate of 0.54 feet per day (0.27-inches per hour). With the bottom area of 8,134 square feet, the flow out of the infiltration system would be 3.05 cubic feet per minute. However, once the groundwater mound extends into the bottom of the infiltration bed (i.e., after about 1,638 cubic

feet of discharge), the hydraulic gradient forcing flow vertically out of the infiltration system will decrease by about an order of magnitude (10 to1 ratio), resulting in flow out of the infiltration system of about 0.3 cubic feet per minute. At that point the flow rate will be similar to flow out of a large diameter well. An example calculation of the decrease in flow rate is provided in Appendix B, assuming a Kh of 5.4 feet per day, initial saturated thickness of 5 feet, a 2-foot separation from the bottom of the infiltration system to the seasonal high groundwater table and a radius of influence of 120 feet.

The BSC Stormwater report indicates that for storms with a 2-year frequency, or larger, the stormwater infiltration system will store up to 10,497 cubic feet of water within the basin (between the stormwater outfall invert elevation of 7.5 feet and the bottom of the infiltration basin at 6.0 feet). Due to the decrease in exfiltration flow rate associated with stormwater mounding (described above), the stormwater infiltration chamber will not empty within the required 72-hour period. Assuming the flow rate decreases to about 0.3 cubic feet per minute, only about 1,300 cubic feet of additional water would drain in the 72-hour period. Also, many of the smaller stormwater events would not exfiltrate within the 72-hour period.

The Massachusetts Stormwater Handbook has a footnote 21 in Volume 3, Chapter 1, page 25 with respect to the "Drawdown within 72 hours" requirement that states:

> *In some cases, the infiltration structure may be designed to treat the Required Water Quality Volume and/or to attenuate peak discharges in addition to infiltrating the Required Recharge Volume. In that event, the storage volume of the structure must be used in the formula for determining drawdown time in place of the Required Recharge Volume.*

As noted above, the Required Recharge Volume is 1,638 cubic feet, but the main stormwater infiltration system has a storage volume of 10,497 cubic feet. It is GZA's opinion that the large main stormwater infiltration system would need to be redesigned to allow drainage of the system within 72-hours to meet the requirements of the MassDEP Stormwater Handbook, and to account for the impacts of groundwater mounding during storm events which result in greater than 1638 cubic feet of stormwater runoff. The redesign should also address peak flow rates that discharge to the stormwater outfall control system.

The five smaller (driveway) stormwater infiltration areas are planned to be 21 feet long and 14 feet wide. Per BSC's Stormwater Report the recharge volume during the 100-year storm event for these systems is up to 883 cubic feet. Dividing that recharge volume by the bottom area of 294 feet results in a water height of 3.0 feet (or 36-inches). Using the Kv design rate of 0.27-inches per hour, it would take 133.3 hours (i.e., 5.55 days) to drain the recharge basin. This exceeds the MassDEP Stormwater Handbook requirement of draining within 72 hours. These smaller infiltration systems would need to be redesigned and then a groundwater mound analysis should be performed to redesign these stormwater management systems.

CONCLUSIONS

GZA agrees with BSC and Hatch that the design seasonal high groundwater elevation for the stormwater infiltrations systems should be 4.0 feet.

Although GZA believes the Required Recharge Volume of 1,638 cubic feet can be infiltrated into the ground without causing excessive groundwater mounding, larger volumes of storm water runoff will not drain within the required 72-hour period. It is GZA's opinion that for stormwater volumes larger than the Required Recharge Volume, the rate of groundwater infiltration will decrease significantly, and the groundwater mound will extend into the bottom of the large main infiltration system. In GZA's opinion both the large main stormwater infiltration system and the smaller

driveway stormwater infiltrations systems would need to be redesigned to account for the impacts of groundwater mounding during large storm events and to meet the MassDEP Stormwater Manual's maximum allowable drainage standard of 72-hours.

We trust this information satisfies your current needs. If you have any questions or comments, please feel free to contact the undersigned at (401) 374-2317 or via email at anthony.urbano@gza.com.

Very truly yours,

GZA GEOENVIRONMENTAL, INC.

Anthony B. Urbano, P.E.
Senior Project Manager

Steven T. D'Ambrosio, P.E.
Consultant/Reviewer

Todd Greene, P.E. (RI)
Principal

Attachments: Attachment A – Limitations
Attachment B – Calculations

Jobs/env/35410.ABU/reports/35410-letter-report.docx

ATTACHMENT A

LIMITATIONS

USE OF REPORT

1. GZA GeoEnvironmental, Inc. (GZA) prepared this report on behalf of, and for the exclusive use of our Client for the stated purpose(s) and location(s) identified in the Proposal for Services and/or Report. Use of this report, in whole or in part, at other locations, or for other purposes, may lead to inappropriate conclusions; and we do not accept any responsibility for the consequences of such use(s). Further, reliance by any party not expressly identified in the agreement, for any use, without our prior written permission, shall be at that party's sole risk, and without any liability to GZA.

STANDARD OF CARE

2. GZA's findings and conclusions are based on the work conducted as part of the Scope of Services set forth in the Proposal for Services and/or Report and reflect our professional judgment. These findings and conclusions must be considered not as scientific or engineering certainties, but rather as our professional opinions concerning the limited data gathered during the course of our work. Conditions other than described in this report may be found at the subject location(s).

3. GZA's services were performed using the degree of skill and care ordinarily exercised by qualified professionals performing the same type of services, at the same time, under similar conditions, at the same or a similar property. No warranty, expressed or implied, is made. Specifically, GZA does not and cannot represent that the Site contains no hazardous material, oil, or other latent condition beyond that observed by GZA during its study. Additionally, GZA makes no warranty that any response action or recommended action will achieve all of its objectives or that the findings of this study will be upheld by a local, state or federal agency.

4. In conducting our work, GZA relied upon certain information made available by public agencies, Client and/or others. GZA did not attempt to independently verify the accuracy or completeness of that information. Inconsistencies in this information which we have noted, if any, are discussed in the Report.

SUBSURFACE CONDITIONS

5. The generalized soil profile(s) provided in our Report are based on widely-spaced subsurface explorations and are intended only to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized, and were based on our assessment of subsurface conditions. The composition of strata, and the transitions between strata, may be more variable and more complex than indicated. For more specific information on soil conditions at a specific location refer to the exploration logs. The nature and extent of variations between these explorations may not become evident until further exploration or construction. If variations or other latent conditions then become evident, it will be necessary to reevaluate the conclusions and recommendations of this report.

6. Water level readings have been made, as described in this Report, in and monitoring wells at the specified times and under the stated conditions. These data have been reviewed and interpretations have been made in this report. Fluctuations in the level of the groundwater however occur due to temporal or spatial variations in areal recharge rates, tidal fluctuations, soil heterogeneities, the presence of subsurface utilities, and/or natural or artificially induced perturbations. The observed water table may be other than indicated in the Report.

COMPLIANCE WITH CODES AND REGULATIONS

7. We used reasonable care in identifying and interpreting applicable codes and regulations necessary to execute our scope of work. These codes and regulations are subject to various, and possibly contradictory, interpretations. Interpretations and compliance with codes and regulations by other parties is beyond our control.

SCREENING AND ANALYTICAL TESTING

8. GZA collected environmental samples at the locations identified in the Report. These samples were analyzed for the specific parameters identified in the report. Additional constituents, for which analyses were not conducted, may be present in soil, groundwater, surface water, sediment and/or air. Future Site activities and uses may result in a requirement for additional testing.

9. Our interpretation of field screening and laboratory data is presented in the Report. Unless otherwise noted, we relied upon the laboratory's QA/QC program to validate these data.

10. Variations in the types and concentrations of contaminants observed at a given location or time may occur due to release mechanisms, disposal practices, changes in flow paths, and/or the influence of various physical, chemical, biological or radiological processes. Subsequently observed concentrations may be other than indicated in the Report.

INTERPRETATION OF DATA

11. Our opinions are based on available information as described in the Report, and on our professional judgment. Additional observations made over time, and/or space, may not support the opinions provided in the Report.

ADDITIONAL INFORMATION

12. In the event that the Client or others authorized to use this report obtain additional information on environmental or hazardous waste issues at the Site not contained in this report, such information shall be brought to GZA's attention forthwith. GZA will evaluate such information and, on the basis of this evaluation, may modify the conclusions stated in this report.

ADDITIONAL SERVICES

13. GZA recommends that we be retained to provide services during any future investigations, design, implementation activities, construction, and/or property development/ redevelopment at the Site. This will allow us the opportunity to: i) observe conditions and compliance with our design concepts and opinions; ii) allow for changes in the event that conditions are other than anticipated; iii) provide modifications to our design; and iv) assess the consequences of changes in technologies and/or regulations.

ATTACHMENT B

CALCULATIONS

Large Infiltration System V-1

This spreadsheet will calculate the height of a groundwater mound beneath a stormwater infiltration basin. More information can be found in the U.S. Geological Survey Scientific Investigations Report 2010-5102 "Simulation of groundwater mounding beneath hypothetical stormwater infiltration basins".

The user must specify infiltration rate (R), specific yield (Sy), horizontal hydraulic conductivity (Kh), basin dimensions (x, y), duration of infiltration period (t), and the initial thickness of the saturated zone (hi(0), height of the water table if the bottom of the aquifer is the datum). For a square basin the half width equals the half length (x = y). For a rectangular basin, if the user wants the water-table changes perpendicular to the long side, specify x as the short dimension and y as the long dimension. Conversely, if the user wants the values perpendicular to the short side, specify y as the short dimension, x as the long dimension. All distances are from the center of the basin. Users can change the distances from the center of the basin at which water-table aquifer thickness are calculated.
Cells highlighted in yellow are values that can be changed by the user. Cells highlighted in red are output values based on user-specified inputs. The user MUST click the blue "Re-Calculate Now" button each time ANY of the user-specified inputs are changed otherwise necessary iterations to converge on the correct solution will not be done and values shown will be incorrect. Use consistent units for all input values (for example, feet and days)

use consistent units (e.g. feet & days **or** inches & hours)

Input Values		
0.5400	***R***	**Recharge (infiltration) rate (feet/day)**
0.080	**Sy**	**Specific yield, Sy (dimensionless, between 0 and 1)**
5.40	**K**	**Horizontal hydraulic conductivity, Kh (feet/day)***
98.000	**x**	**1/2 length of basin (x direction, in feet)**
20.750	**y**	**1/2 width of basin (y direction, in feet)**
0.374	**t**	**duration of infiltration period (days)**
5.000	**hi(0)**	**initial thickness of saturated zone (feet)**

Conversion Table

inch/hour	feet/day
0.67	1.33
2.00	4.00

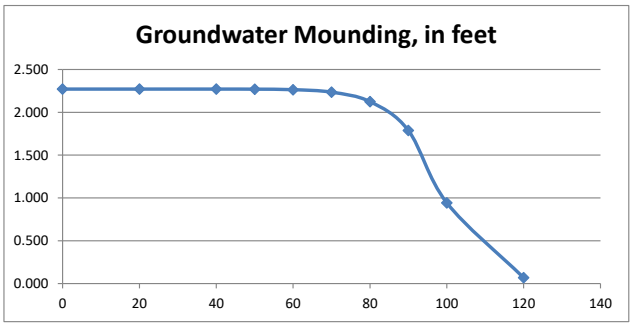
hours	days
36	1.50

In the report accompanying this spreadsheet (USGS SIR 2010-5102), vertical soil permeability (ft/d) is assumed to be one-tenth horizontal hydraulic conductivity (ft/d).

7.271	**h(max)**	**maximum thickness of saturated zone (beneath center of basin at end of infiltration period)**
2.271	**Δh(max)**	**maximum groundwater mounding (beneath center of basin at end of infiltration period)**

Ground-water Mounding, in feet	Distance from center of basin in x direction, in feet
2.271	0
2.271	20
2.271	40
2.270	50
2.264	60
2.235	70
2.125	80
1.788	90
0.943	100
0.069	120

Re-Calculate Now



Disclaimer

This spreadsheet solving the Hantush (1967) equation for ground-water mounding beneath an infiltration basin is made available to the general public as a convenience for those wishing to replicate values documented in the USGS Scientific Investigations Report 2010-5102 "Groundwater mounding beneath hypothetical stormwater infiltration basins" or to calculate values based on user-specified site conditions. Any changes made to the spreadsheet (other than values identified as user-specified) after transmission from the USGS could have unintended, undesirable consequences. These consequences could include, but may not be limited to: erroneous output, numerical instabilities, and violations of underlying assumptions that are inherent in results presented in the accompanying USGS published report. The USGS assumes no responsibility for the consequences of any changes made to the spreadsheet. If changes are made to the spreadsheet, the user is responsible for documenting the changes and justifying the results and conclusions.

Large Infiltration System V-2

This spreadsheet will calculate the height of a groundwater mound beneath a stormwater infiltration basin. More information can be found in the U.S. Geological Survey Scientific Investigations Report 2010-5102 "Simulation of groundwater mounding beneath hypothetical stormwater infiltration basins".

The user must specify infiltration rate (R), specific yield (Sy), horizontal hydraulic conductivity (Kh), basin dimensions (x, y), duration of infiltration period (t), and the initial thickness of the saturated zone (hi(0), height of the water table if the bottom of the aquifer is the datum). For a square basin the half width equals the half length (x = y). For a rectangular basin, if the user wants the water-table changes perpendicular to the long side, specify x as the short dimension and y as the long dimension. Conversely, if the user wants the values perpendicular to the short side, specify y as the short dimension, x as the long dimension. All distances are from the center of the basin. Users can change the distances from the center of the basin at which water-table aquifer thickness are calculated.
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use consistent units (e.g. feet & days **or** inches & hours)

Input Values		
0.2014	***R***	**Recharge (infiltration) rate (feet/day)**
0.080	**Sy**	**Specific yield, Sy (dimensionless, between 0 and 1)**
5.40	**K**	**Horizontal hydraulic conductivity, Kh (feet/day)***
98.000	**x**	**1/2 length of basin (x direction, in feet)**
20.750	**y**	**1/2 width of basin (y direction, in feet)**
1.000	**t**	**duration of infiltration period (days)**
5.000	**hi(0)**	**initial thickness of saturated zone (feet)**

Conversion Table

inch/hour	feet/day
0.67	1.33
2.00	4.00

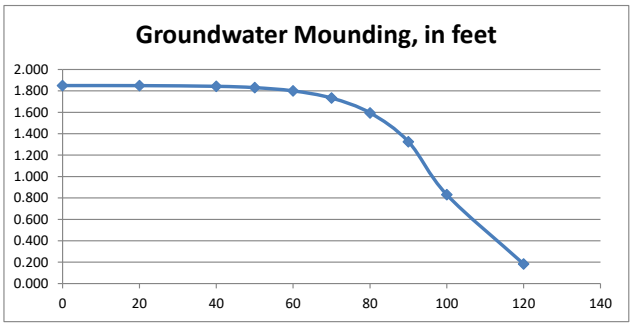
hours	days
36	1.50

In the report accompanying this spreadsheet (USGS SIR 2010-5102), vertical soil permeability (ft/d) is assumed to be one-tenth horizontal hydraulic conductivity (ft/d).

6.850	**h(max)**	**maximum thickness of saturated zone (beneath center of basin at end of infiltration period)**
1.850	**Δh(max)**	**maximum groundwater mounding (beneath center of basin at end of infiltration period)**

Ground-water Mounding, in feet	Distance from center of basin in x direction, in feet
1.850	0
1.849	20
1.843	40
1.830	50
1.800	60
1.733	70
1.595	80
1.325	90
0.830	100
0.183	120

Re-Calculate Now



Disclaimer

This spreadsheet solving the Hantush (1967) equation for ground-water mounding beneath an infiltration basin is made available to the general public as a convenience for those wishing to replicate values documented in the USGS Scientific Investigations Report 2010-5102 "Groundwater mounding beneath hypothetical stormwater infiltration basins" or to calculate values based on user-specified site conditions. Any changes made to the spreadsheet (other than values identified as user-specified) after transmission from the USGS could have unintended, undesirable consequences. These consequences could include, but may not be limited to: erroneous output, numerical instabilities, and violations of underlying assumptions that are inherent in results presented in the accompanying USGS published report. The USGS assumes no responsibility for the consequences of any changes made to the spreadsheet. If changes are made to the spreadsheet, the user is responsible for documenting the changes and justifying the results and conclusions.

GZA GeoEnvironmental Inc.

188 Valley St, Providence
Rhode Island 02909

Project Thorndike Place
Arlington, MA

Date: 7/24/2024
Sheet 1 of 1
By: ABU

File No. 35410.00

Estimate steady state flow to a well extracting ground water from a water table aquifer,

$H := 7$ Static head from bottom of aquifer (Ft)

$hw := 5$ Depth of water in a fully penetrating extraction well (Ft)

$k := 5.4$ Hydraulic Conductivity (Ft/Day)

$R := 120$ Radius, or cone of influance (Ft/Day)

$Rw := 51$ Radius of extraction well (Ft)

Qw Ground water extraction rate (Cubic Ft/Day)

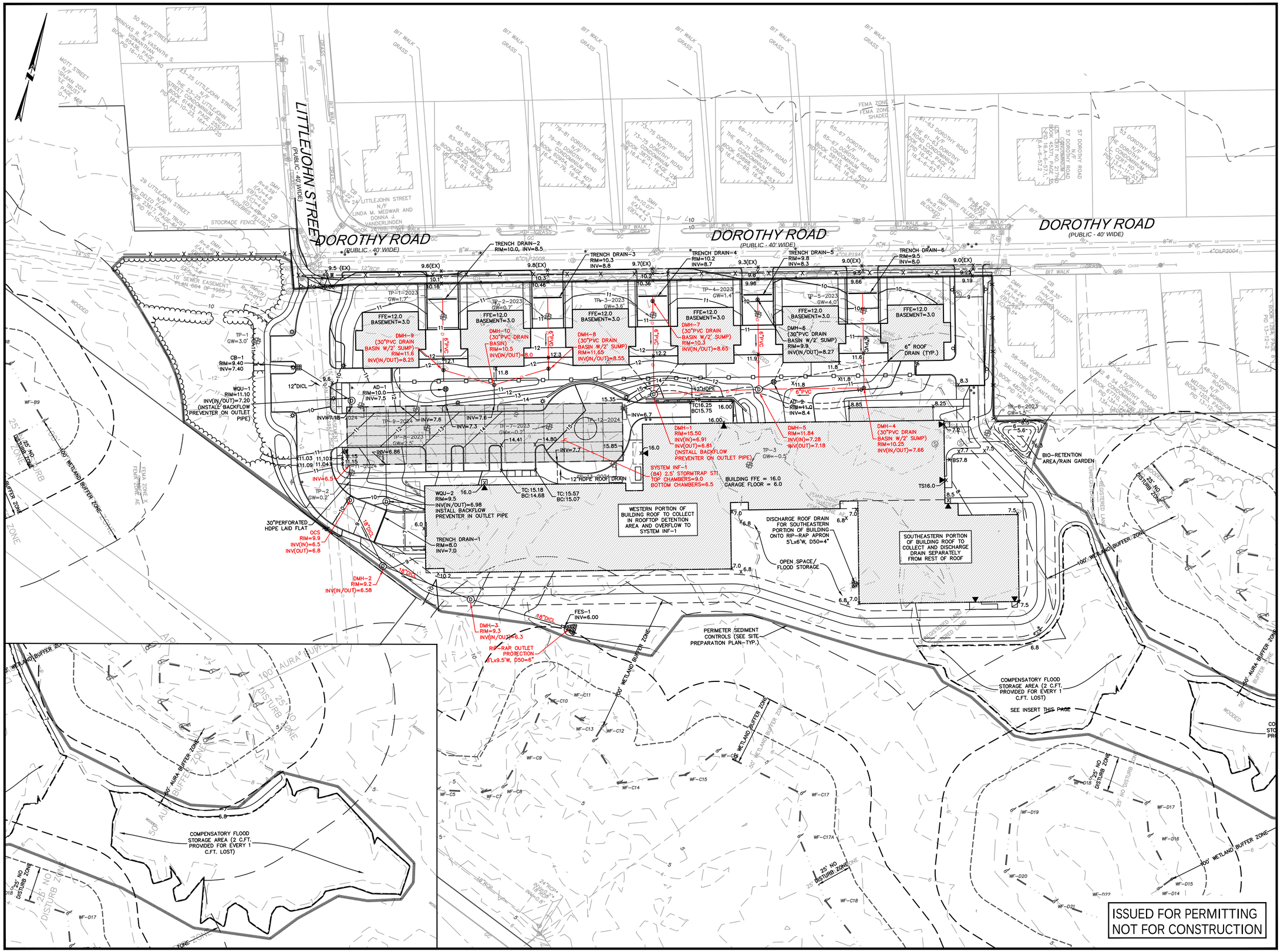
$$Qw := \frac{\pi \cdot k \cdot \left(H^2 - hw^2\right)}{\ln\left(\frac{R}{Rw}\right)}$$ Theim-Dupuit Equation [1]

$Qw = 475.829$ Cubic Ft/Day $Qgpm := Qw \cdot \frac{7.5}{1440}$ $Qgpm = 2.48$ GPM

$r := Rw, 13.. R$

$$s(r) := -(H - hw) + \frac{Qw \cdot \ln\left(\frac{r}{Rw}\right)}{\pi \cdot k \cdot (H + hw)}$$

1. Ground Water Manual, U.S. Department of the Interior, Revised edition 1981, P.30



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09/09/2024 7:45:50 AM

PROFESSIONAL ENGINEER

THORNDIKE PLACE
NOTICE OF INTENT

DOROTHY ROAD
IN
ARLINGTON
MASSACHUSETTS
(MIDDLESEX COUNTY)

GRADING & DRAINAGE PLAN

SEPTEMBER 6, 2023

REVISIONS:

NO.	DATE	DESC.

PREPARED FOR:
ARLINGTON LAND REALTY, LLC
84 SHERMAN STREET, 2ND FLOOR
CAMBRIDGE, MA

BSC GROUP
803 Summer Street
Boston, Massachusetts
02127
617 896 4300

SCALE: 1" = 30'
0 15 30 60 FEET

FILE: 2340702\C\D\2340702-GR
DWG.:
JOB. NO: 23407.02
SHEET C-104

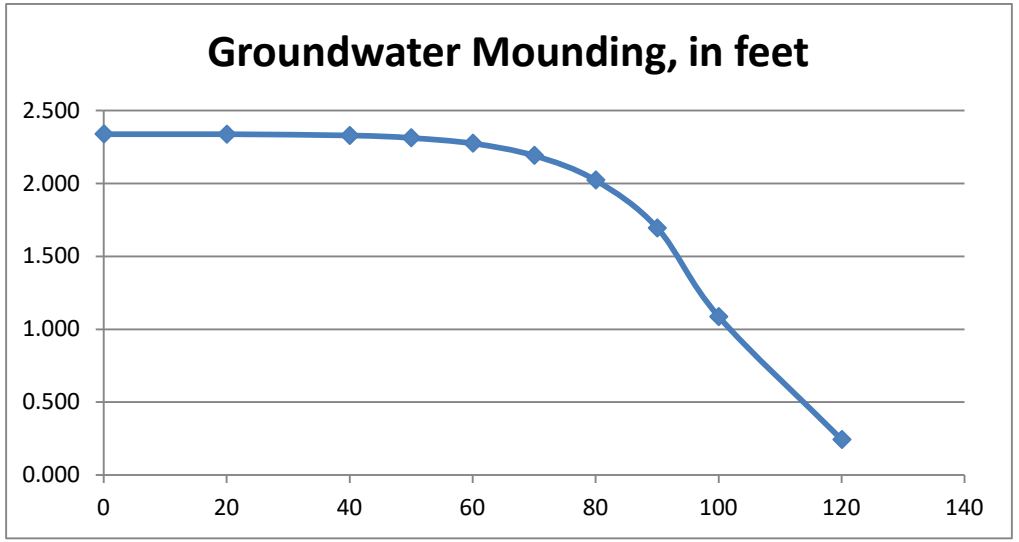
Input Values

			inch/hour	feet/day	
0.2580	*R*	Recharge (infiltration) rate (feet/day)	0.67	1.33	
0.080	Sy	Specific yield, Sy (dimensionless, between 0 and 1)			
5.40	K	Horizontal hydraulic conductivity, Kh (feet/day)*	2.00	4.00	In the repor
98.420	x	1/2 length of basin (x direction, in feet)			(USGS SIR 2(
20.670	y	1/2 width of basin (y direction, in feet)	hours	days	(ft/d) is assu
1.000	t	duration of infiltration period (days)	36	1.50	hydraulic co
5.000	hi(0)	initial thickness of saturated zone (feet)			

7.339	h(max)	maximum thickness of saturated zone (beneath center of basin at end of infiltration period)
2.339	Δh(max)	maximum groundwater mounding (beneath center of basin at end of infiltration period)

Ground-water Mounding, in feet	Distance from center of basin in x direction, in feet
2.339	0
2.338	20
2.329	40
2.313	50
2.275	60
2.192	70
2.022	80
1.695	90
1.086	100
0.243	120

Re-Calculate Now



Disclaimer

This spreadsheet solving the Hantush (1967) equation for ground-water mounding beneath an infiltration basin is made available to the general public as a convenience for those wishing to replicate values documented in the USGS Scientific Investigations Report 2010-5102 "Groundwater mounding beneath hypothetical stormwater infiltration basins" or to calculate values based on user-specified site conditions. Any changes made to the spreadsheet (other than values identified as user-specified) after transmission from the USGS could have unintended, undesirable consequences. These consequences could include, but may not be limited to: erroneous output, numerical instabilities, and violations of underlying assumptions that are inherent in results presented in the accompanying USGS published report. The USGS assumes no responsibility for the consequences of any changes made to the spreadsheet. If changes are made to the spreadsheet, the user is responsible for documenting the changes and justifying the results and conclusions.

Recharge/Infiltration Rate (ft/day) = [Required Recharge Volume (cft)/Bottom Recharge System (sft)]/Duration (day)

Required Recharge Volume	2,099	cft
Bottom Recharge System	8,137	sft
Duration	1	day
Recharge/Infiltration Rate	**0.2580**	**ft/day**

Horizontal Hydraulic Conductivity (ft/day) = [Rawls Rate (in/hr) * (1ft/12in) * (24hr/1day)] * 10

Rawls Rate (silt loam)	0.27	in/hr
Horizontal Hydraulic Conductivity	**5.40**	**ft/day**

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
6.5	8,137	0
6.55	8,137	350
6.6	8,137	700
6.65	8,137	1,050
6.7	8,137	1,400
6.75	8,137	1,750
6.8	8,137	2,099
6.85	8,137	2,449
6.9	8,137	2,799
6.95	8,137	3,149
7	8,137	3,499
7.05	8,137	3,849
7.1	8,137	4,199
7.15	8,137	4,549
7.2	8,137	4,899
7.25	8,137	5,249
7.3	8,137	5,599
7.35	8,137	5,948
7.4	8,137	6,298
7.45	8,137	6,648
7.5	8,137	6,998
7.55	8,137	7,348
7.6	8,137	7,698
7.65	8,137	8,048
7.7	8,137	8,398
7.75	8,137	8,748
7.8	8,137	9,098
7.85	8,137	9,447
7.9	8,137	9,797
7.95	8,137	10,147
8	8,137	10,497
8.05	8,137	10,847
8.1	8,137	11,197
8.15	8,137	11,547
8.2	8,137	11,897
8.25	8,137	12,247
8.3	8,137	12,597
8.35	8,137	12,947
8.4	8,137	13,296
8.45	8,137	13,646
8.5	8,137	13,996
8.55	8,137	14,346
8.6	8,137	14,696
8.65	8,137	15,046
8.7	8,137	15,396
8.75	8,137	15,746
8.8	8,137	16,096
8.85	8,137	16,446
8.9	8,137	16,796
8.95	8,137	17,145
9	8,137	17,495

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October 22, 2024
File No. 03.0035410.00

Mr. David Morgan
Environmental Planner and Conservation Agent
Arlington Town Hall
730 Massachusetts Avenue
Arlington, MA 02467

Re: Response to Redesign
Peer Review of Stormwater Mound Evaluation and Design Groundwater Elevation
Proposed Thorndike Place Residential Development
Arlington, Massachusetts

Dear Mr. Morgan:

In accordance with your request, GZA GeoEnvironmental, Inc. (GZA) prepared this letter to address the BSC Group (BSC)'s revised stormwater infiltration design and groundwater mounding analysis associated with the proposed Thorndike Place residential development in Arlington, Massachusetts (the "Site"). BSC performed their work on behalf of the Applicant (Arlington Land Realty, LLC). We also provide our response to the most recent Scott Horsley comment letter. This letter report is subject to the Limitations provided in Appendix A.

BACKGROUND

BSC's June 10, 2024 letter report provided a stormwater mound evaluation and a recommended design groundwater elevation for the Site. GZA's August 1, 2024 peer review of that report recommended that the stormwater infiltration system be redesigned to account for the impacts of groundwater mounding during large storm events and to meet the MassDEP Stormwater Manual's maximum allowable drainage standard of 72-hours. In addition, the redesign was to address peak flow rates that discharge to the stormwater outfall control system (i.e., MassDEP Stormwater Standard 2- Peak Rate attenuation).

BSC RESPONSE AND REDESIGN

BSC subsequently prepared a response letter dated October 4, 2024 that provided a revised stormwater design and associated mounding analysis, with a smaller volume of stormwater infiltration that would be drained in less than 72 hours. The elevation of the bottom of the infiltration system was raised 0.5 feet to elevation 6.5 feet and the outlet control pipe for the infiltration system was lowered to elevation 6.8 feet. In addition, the smaller driveway stormwater infiltration systems were removed.

BSC's revised peak storm water flow calculations provided in their October 4, 2024 letter indicated that post development flows remain less than predevelopment flows, which satisfies MassDEP's Stormwater Standard 2.

GZA RESPONSE

The revised underground infiltration volume is now 2,099 cubic feet, which is estimated to drain in 11.5 hours (not the 6 hours referenced in the revised BSC report)[1]. The revised groundwater mound estimate for the 100 year design storm is approximately 2.34 feet (using the same aquifer parameter values that GZA used in our previous peer review letter). This revised groundwater mound elevation is approximately 6.34 feet and does not reach the bottom of the infiltration basin (Elevation 6.5 feet).

We note that the bottom of the stormwater infiltration system is now higher than the proposed garage floor level of the new building that is planned to be located 15 feet from the stormwater infiltration system. The proposed garage floor level is elevation 6.0 feet. It is GZA's opinion, that a groundwater underdrain should be designed and constructed beneath the garage floor level in this area to address potential water infiltration issues.

REVIEW OF August 23, 2024 SCOTT HORSLEY LETTER

On behalf of others, Scott Horsley from Water Resource Consultant (Horsley) provided a letter dated August 23, 2024 to the Conservation Commission with additional comments regarding GZA's August 1, 2024 peer review report. One of their comments noted that the stormwater redesign should address MassDEP Stormwater Standard 2 (regarding peak rate control). As noted above the BSC redesign appears to address this comment. The other comment requested clarification on the design seasonal high groundwater elevation.

As previously noted, the Massachusetts Stormwater Handbook states:

> *Seasonal high groundwater represents the highest groundwater elevation. Depth to seasonal high groundwater may be identified based on redox features in the soil. When redox features are not available, installation of temporary push point wells or piezometers should be considered. Ideally, such wells should be monitored in the spring when the groundwater is highest, and the results compared to nearby groundwater wells monitored by the USGS to estimate whether regional groundwater is below normal, normal or above normal.*

It is GZA's opinion that BSC's design groundwater elevation findings are consistent with this definition (in its entirety). Redox features were not present; therefore, wells were installed, water levels were measured in the spring (when the groundwater was highest), and the water levels were compared to historic USGS groundwater levels for a relative comparison of the type of spring conditions present at the time that the measurements were recorded at the Site. As previously reported by GZA, the USGS water levels were well above normal at the time of the Site recorded groundwater elevation measurements (i.e., the highest seasonal water table observed over the past 10 year).

CONCLUSIONS

It is GZA's opinion that the revised stormwater mound evaluation provided in BSC's October 4, 2024 report adequately addresses the impacts of groundwater mounding during large storm events and addresses the 72 hour drainage requirement for the infiltration system. The revised predicted groundwater mound beneath the stormwater infiltration system is not expected to adversely impact the ability of the infiltration system to empty in less than 72 hours. In addition, we believe the storm water redesign adequately addresses the MassDEP Stormwater Standard 2- Peak Rate attenuation requirements.

[1] The design Rawl's rate is 0.27"/hour (0.0225 feet per hour) not 0.043 feet per hour.

We also conclude that the seasonal high water table elevation of 4.0 feet used by BSC is for "above normal" groundwater conditions and is the seasonal high-water table for stormwater management system design for this project.

We trust this information satisfies your current needs. If you have any questions or comments, please feel free to contact the undersigned at (401) 374-2317 or via email at anthony.urbano@gza.com.

Very truly yours,

GZA GEOENVIRONMENTAL, INC.

Anthony B. Urbano, P.E.
Senior Project Manager

Todd Greene, P.E. (RI)
Principal

Attachment: Attachment A – Limitations

Jobs/env/35410.ABU/correspondence/35410-response to redesign.docx

ATTACHMENT A

Geohydrologic Limitations

USE OF REPORT

1. GZA GeoEnvironmental, Inc. (GZA) prepared this report on behalf of, and for the exclusive use of our Client for the stated purpose(s) and location(s) identified in the Proposal for Services and/or Report. Use of this report, in whole or in part, at other locations, or for other purposes, may lead to inappropriate conclusions; and we do not accept any responsibility for the consequences of such use(s). Further, reliance by any party not expressly identified in the agreement, for any use, without our prior written permission, shall be at that party's sole risk, and without any liability to GZA.

STANDARD OF CARE

2. GZA's findings and conclusions are based on the work conducted as part of the Scope of Services set forth in the Proposal for Services and/or Report and reflect our professional judgment. These findings and conclusions must be considered not as scientific or engineering certainties, but rather as our professional opinions concerning the limited data gathered during the course of our work. Conditions other than described in this report may be found at the subject location(s).

3. GZA's services were performed using the degree of skill and care ordinarily exercised by qualified professionals performing the same type of services, at the same time, under similar conditions, at the same or a similar property. No warranty, expressed or implied, is made. Specifically, GZA does not and cannot represent that the Site contains no hazardous material, oil, or other latent condition beyond that observed by GZA during its study. Additionally, GZA makes no warranty that any response action or recommended action will achieve all of its objectives or that the findings of this study will be upheld by a local, state or federal agency.

4. In conducting our work, GZA relied upon certain information made available by public agencies, Client and/or others. GZA did not attempt to independently verify the accuracy or completeness of that information. Inconsistencies in this information which we have noted, if any, are discussed in the Report.

SUBSURFACE CONDITIONS

5. The generalized soil profile(s) provided in our Report are based on widely-spaced subsurface explorations and are intended only to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized, and were based on our assessment of subsurface conditions. The composition of strata, and the transitions between strata, may be more variable and more complex than indicated. For more specific information on soil conditions at a specific location refer to the exploration logs. The nature and extent of variations between these explorations may not become evident until further exploration or construction. If variations or other latent conditions then become evident, it will be necessary to reevaluate the conclusions and recommendations of this report.

6. Water level readings have been made, as described in this Report, in and monitoring wells at the specified times and under the stated conditions. These data have been reviewed and interpretations have been made in this report. Fluctuations in the level of the groundwater however occur due to temporal or spatial variations in areal recharge rates, tidal fluctuations, soil heterogeneities, the presence of subsurface utilities, and/or natural or artificially induced perturbations. The observed water table may be other than indicated in the Report.

COMPLIANCE WITH CODES AND REGULATIONS

7. We used reasonable care in identifying and interpreting applicable codes and regulations necessary to execute our scope of work. These codes and regulations are subject to various, and possibly contradictory, interpretations. Interpretations and compliance with codes and regulations by other parties is beyond our control.

SCREENING AND ANALYTICAL TESTING

8. GZA collected environmental samples at the locations identified in the Report. These samples were analyzed for the specific parameters identified in the report. Additional constituents, for which analyses were not conducted, may be present in soil, groundwater, surface water, sediment and/or air. Future Site activities and uses may result in a requirement for additional testing.

9. Our interpretation of field screening and laboratory data is presented in the Report. Unless otherwise noted, we relied upon the laboratory's QA/QC program to validate these data.

10. Variations in the types and concentrations of contaminants observed at a given location or time may occur due to release mechanisms, disposal practices, changes in flow paths, and/or the influence of various physical, chemical, biological or radiological processes. Subsequently observed concentrations may be other than indicated in the Report.

INTERPRETATION OF DATA

11. Our opinions are based on available information as described in the Report, and on our professional judgment. Additional observations made over time, and/or space, may not support the opinions provided in the Report.

ADDITIONAL INFORMATION

12. In the event that the Client or others authorized to use this report obtain additional information on environmental or hazardous waste issues at the Site not contained in this report, such information shall be brought to GZA's attention forthwith. GZA will evaluate such information and, on the basis of this evaluation, may modify the conclusions stated in this report.

ADDITIONAL SERVICES

13. GZA recommends that we be retained to provide services during any future investigations, design, implementation activities, construction, and/or property development/ redevelopment at the Site. This will allow us the opportunity to: i) observe conditions and compliance with our design concepts and opinions; ii) allow for changes in the event that conditions are other than anticipated; iii) provide modifications to our design; and iv) assess the consequences of changes in technologies and/or regulations.

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OCTOBER 4, 2024

Town of Arlington Conservation Commission
c/o Mr. David Morgan, Environmental Planner + Conservation Agent
Robbins Memorial Town Hall
730 Massachusetts Avenue
Arlington, Massachusetts 02476

RE: Response to GZA Peer Review Comments
Thorndike Place Residential Development

Dear Members of the Arlington Conservation Commission,

On behalf of the Applicant, Arlington Land Realty, LLC, BSC Group, Inc. (BSC) is pleased to submit this response to peer review comments provided by GZA GeoEnvironmental, Inc. (GZA) relative to the Thorndike Place residential development (the Project) to be located off of Dorothy Road in the Town of Arlington. GZA's peer review on behalf of the Arlington Conservation Commission was issued in a letter dated August 1, 2024. For clarity, our responses are organized in accordance with GZA's letter. Each of GZA's conclusions is followed by a response or acknowledgement by BSC as appropriate.

Design Seasonal High-Water Table

In their August 1, 2024, letter, GZA wrote:

> *Therefore, we conclude that the seasonal high water table elevation of 4.0 feet used by BSC is for "above normal" groundwater conditions and is suitable to be used for stormwater design for this project. As noted above, GZA's opinion on design groundwater elevation findings are consistent with the opinion expressed by Hatch and BSC.*
>
> *Note that we did not use USGS well Lexington MA-LTW-104 (which was used by MMA and Horsley) in our analysis because that well is in a sand and gravel aquifer with a very shallow water table. Those conditions are not present at the Site. In addition, that USGS well is more effected by individual rainfall events than by seasonal variations of the groundwater table, which is not typical of other USGS wells in the area.*

BSC agrees with GZA's conclusions, and no response is required.

Groundwater Mound Evaluation

In their August 1, 2024, letter, GZA wrote:

> *As noted above, the Required Recharge Volume is 1,638 cubic feet, but the main stormwater infiltration system has a storage volume of 10,497 cubic feet. It is GZA's opinion that the large main stormwater infiltration system would need to be redesigned to allow drainage of the system within 72-hours to meet the requirements of the MassDEP Stormwater Handbook, and to account for the impacts of groundwater mounding during storm events which result in greater than 1638 cubic feet of stormwater runoff. The redesign should also address peak flow rates that discharge to the stormwater outfall control system.*
>
> *The five smaller (driveway) stormwater infiltration areas are planned to be 21 feet long and 14 feet wide. Per BSC's Stormwater Report the recharge volume during the 100-year storm event for these systems is up to 883 cubic feet. Dividing that recharge volume by the bottom area of 294 feet results*

803 Summer Street, Third Floor / Boston, MA 02127 / 617-896-4300

> *in a water height of 3.0 feet (or 36-inches). Using the Kv design rate of 0.27-inches per hour, it would take 133.3 hours (i.e., 5.55 days) to drain the recharge basin. This exceeds the MassDEP Stormwater Handbook requirement of draining within 72 hours. These smaller infiltration systems would need to be redesigned and then a groundwater mound analysis should be performed to redesign these stormwater management systems.*

After discussing this portion of the review with GZA, we have performed revisions to address their concerns regarding groundwater mounding for storm events that result in greater than 1,638 cubic feet of stormwater runoff. The result of these revisions is that a smaller volume of runoff is forced to infiltrate, and the entire infiltration volume can be drained in 72 hours. Specifically, the following revisions have been made:

- The R-Tank underground chamber systems from the townhouse driveways have been removed from the design. The trench drains that capture runoff from these driveways have been redirected to the large infiltration system (Infiltration System 1).
- The roof top detention system has been adjusted so that a somewhat larger area of the roof is detained and discharged at a controlled rate to Infiltration System 1 and a smaller portion of the roof runoff is being discharged via the rip rap apron at the southeast portion of the building.
- Infiltration System 1 has been revised to a 2.5-foot StormTrap system form the previous system height of 3-feet. The elevation of the bottom of the system has bene raised 0.5 feet higher to elevation 6.5, and the outlet control for this system has been revised. These revisions allow for infiltration of the required recharge and water quality volumes but minimizes the amount of recharged stormwater during larger storm events.
- Various pipe sizes and slope have been revised to accommodate the changes detailed above.

Calculations for outlet protection sizing, post-development peak runoff rates, groundwater recharge, groundwater mounding, and total suspended solids (TSS) removal have been performed and are attached along with the revised Grading and Drainage Plan for the Project.

Conclusions

In their August 1, 2024, letter, GZA wrote:

> *GZA agrees with BSC and Hatch that the design seasonal high groundwater elevation for the stormwater infiltrations systems should be 4.0 feet.*

BSC agrees with GZA's conclusions, and no response is required.

In their August 1, 2024, letter, GZA wrote:

> *Although GZA believes the Required Recharge Volume of 1,638 cubic feet can be infiltrated into the ground without causing excessive groundwater mounding, larger volumes of storm water runoff will not drain within the required 72-hour period. It is GZA's opinion that for stormwater volumes larger than the Required Recharge Volume, the rate of groundwater infiltration will decrease significantly, and the groundwater mound will extend into the bottom of the large main infiltration system. In GZA's opinion both the large main stormwater infiltration system and the smaller driveway stormwater infiltrations systems would need to be redesigned to account for the impacts of groundwater mounding during large storm events and to meet the MassDEP Stormwater Manual's maximum allowable drainage standard of 72-hours.*

As described above, we have revised the stormwater management system to respond to GZA's concern. Applicable plans and calculations are attached.

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We believe that these responses fully respond to all comments from the GZA peer review. We look forward to discussing this project with you further at the upcoming public hearing on the project. Please feel free to contact me at (617) 896-4386 or drinaldi@bscgroup.com should you have any questions on the information in this letter.

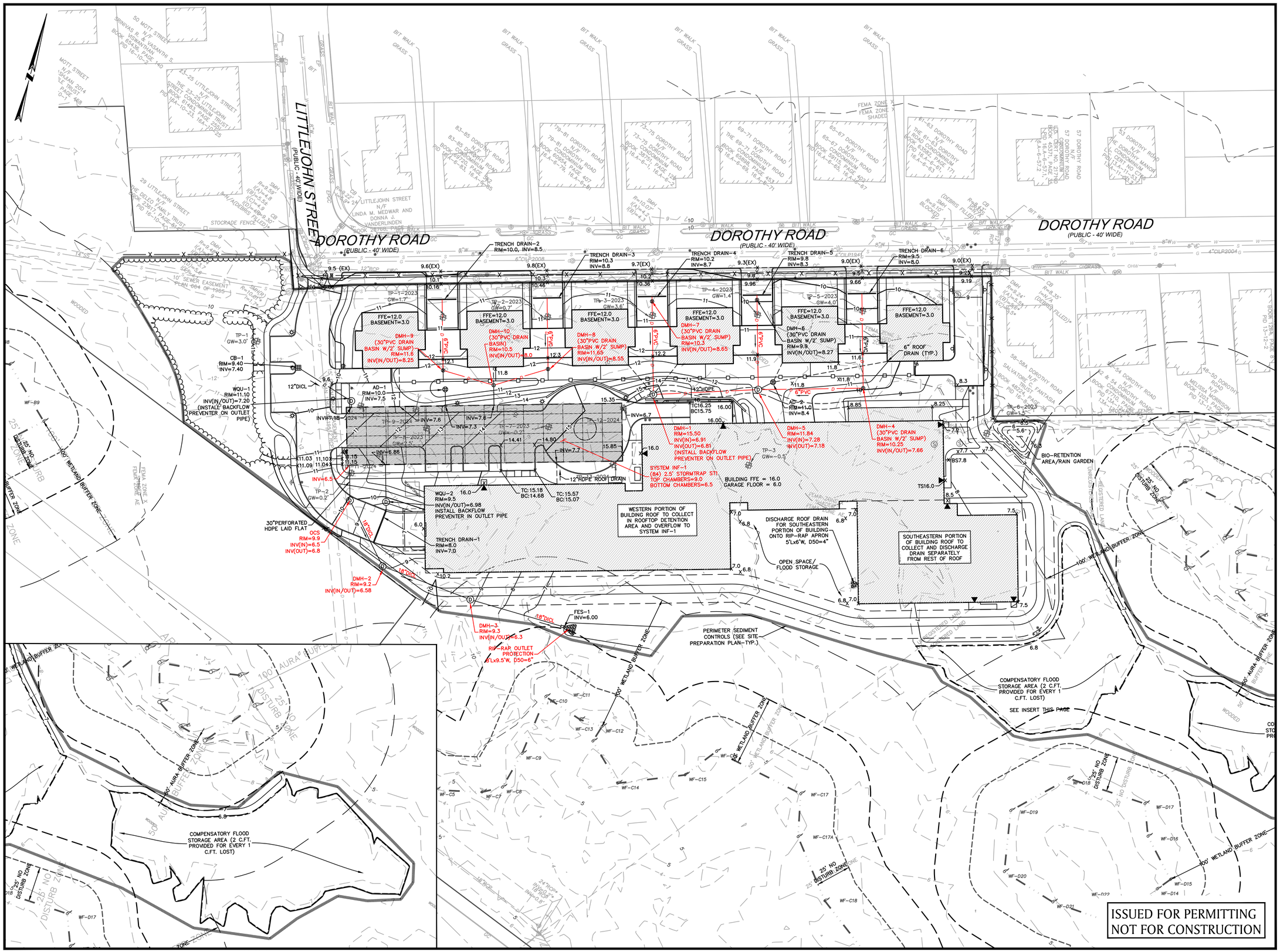
Sincerely,
BSC Group, Inc.

Dominic Rinaldi, PE
Senior Associate

803 Summer Street, Third Floor / Boston, MA 02127 / 617-896-4300

ATTACHMENT A
THORNDIKE PLACE NOTICE OF INTENT
GRADING & DRAINAGE PLAN, SHEET C-104
REVISION 1 DATED 9/12/24

803 Summer Street, Third Floor / Boston, MA 02127 / 617-896-4300



PROFESSIONAL ENGINEER

THORNDIKE PLACE
NOTICE OF INTENT

DOROTHY ROAD

IN

ARLINGTON
MASSACHUSETTS
(MIDDLESEX COUNTY)

GRADING & DRAINAGE PLAN

SEPTEMBER 6, 2023

REVISIONS:

NO.	DATE	DESC.
1	9/12/24	INFILTRATION SYSTEM

PREPARED FOR:
ARLINGTON LAND REALTY, LLC
84 SHERMAN STREET, 2ND FLOOR
CAMBRIDGE, MA

BSC GROUP
803 Summer Street
Boston, Massachusetts
02127
617 896 4300

SCALE: 1" = 30'
0 15 30 60 FEET

FILE: 2340702\C\D\2340702-GR
DWG.:
JOB. NO: 23407.02
SHEET C-104

ATTACHMENT B
OUTLET PROTECTION SIZING CALCULATIONS

803 Summer Street, Third Floor / Boston, MA 02127 / 617-896-4300

OUTLET PROTECTION SIZING

BSC GROUP

Project No.	23407.02	**Calc By**	EAD
Subject	Outlet Protection Sizing Calcs	**Date**	9/5/2024
Location	Arlington, MA	**Checked by**	DRR
		Date	9/5/2024

FES-1

Q=Design Discharge, (ft^3/s)	=	7.1	cfs
D=Culvert Diameter, (ft)	=	1.50	ft
TW=Tailwater Depth, (ft)	=	0.6	ft, (0.4xD for unknow tailwater, or enter known tailwater)
			(Tailwater depth is to be limited to between 0.4D and 1.0D)

Riprap Rock Sizing

$$D_{50} = 0.2D\left[\frac{Q}{\sqrt{gD^{2.5}}}\right]^{4/3}\left[\frac{D}{TW}\right]$$

g=32.2 fps

D_{50} = median rock size, ft

$$D_{50} = 0.28\,\frac{7.10}{15.64}^{(4/3)}\,\frac{1.50}{0.60} = 0.24 \text{ ft}$$

= 2.93 inches

Table 1 : Riprap Classes and Apron Dimensions

Class	D_{50} (in)	Apron Length	Apron Depth	
1	5	4D	$3.5D_{50}$	
2	**6**	**4D**	**$3.5D_{50}$**	**Use Class 2**
3	10	5D	$3.3D_{50}$	
4	14	6D	$2.2D_{50}$	
5	20	7D	$2.0D_{50}$	
6	22	8D	$2.0D_{50}$	

Apron Dimensions

Length, L=5D	=	**8 ft**	
Depth=$3.3D_{50}$	=	**19.80 Inches**	
Width=3D+(2/3)L	=	**9.50 ft**	(at apron end)

Riprap Rock Sizing Gradation

Given Size	Size of Stone, inches		
100	**9**	to	**12**
85	**8**	to	**11**
50	**6**	to	**9**
15	**3**	to	**8**

Reference Note: Sizing based in accordance with HEC #14 as required by MassHighway Design Manual

OUTLET PROTECTION SIZING

BSC GROUP

Project No.	23407.02	**Calc By**	EAD
Subject	Outlet Protection Sizing Calcs	**Date**	9/5/2024
Location	Arlington, MA	**Checked by**	DRR
		Date	9/5/2024

Roof Drain

Q=Design Discharge, (ft^3/s)	=	2	cfs
D=Culvert Diameter, (ft)	=	1.00	ft
TW=Tailwater Depth, (ft)	=	0.4	ft, (0.4xD for unknow tailwater, or enter known tailwater)
			(Tailwater depth is to be limited to between 0.4D and 1.0D)

Riprap Rock Sizing

$$D_{50} = 0.2D\left[\frac{Q}{\sqrt{gD^{2.5}}}\right]^{4/3}\left[\frac{D}{TW}\right]$$

g=32.2 fps

D_{50} = median rock size, ft

$$D_{50} = 0.28\,\frac{2.00}{5.67}\,(4/3)\,\frac{1.00}{0.40} = 0.17 \text{ ft}$$

= 2.09 inches

Table 1 : Riprap Classes and Apron Dimensions

Class	D_{50} (in)	Apron Length	Apron Depth	
1	5	4D	$3.5D_{50}$	
2	**6**	**4D**	**$3.5D_{50}$**	**Use Class 2**
3	10	5D	$3.3D_{50}$	
4	14	6D	$2.2D_{50}$	
5	20	7D	$2.0D_{50}$	
6	22	8D	$2.0D_{50}$	

Apron Dimensions

Length, L=5D	=	**5 ft**	
Depth=$3.3D_{50}$	=	**19.80 Inches**	
Width=3D+(2/3)L	=	**6.33 ft**	(at apron end)

Riprap Rock Sizing Gradation

Given Size	Size of Stone, inches		
100	**9**	to	**12**
85	**8**	to	**11**
50	**6**	to	**9**
15	**3**	to	**8**

Reference Note: Sizing based in accordance with HEC #14 as required by MassHighway Design Manual

ATTACHMENT C
POST-DEVELOPMENT HYDROCAD CALCULATIONS

803 Summer Street, Third Floor / Boston, MA 02127 / 617-896-4300

Post-development watershed modeling was updated based upon the revisions to the stormwater management system detailed in our October 4, 2024, letter. The following tables demonstrate that there will be no increase to peak runoff rates from the Project site for the 2, 10, 25, 50, and 100-year, 24-hour storm events:

Node 1L – Flow to Wetlands

Storm Event	Pre-Development Peak Discharge Rate (cfs)[1]	Post-Development Peak Discharge Rate (cfs)	Change in Peak Discharge Rate (cfs)
2-Year	3.7	3.5	-0.2
10-Year	9.0	8.2	-0.8
25-Year	13.7	11.4	-2.3
50-Year	17.2	13.7	-3.5
100-Year	22.0	18.5	-3.5

Node 2L – Flow Towards Street

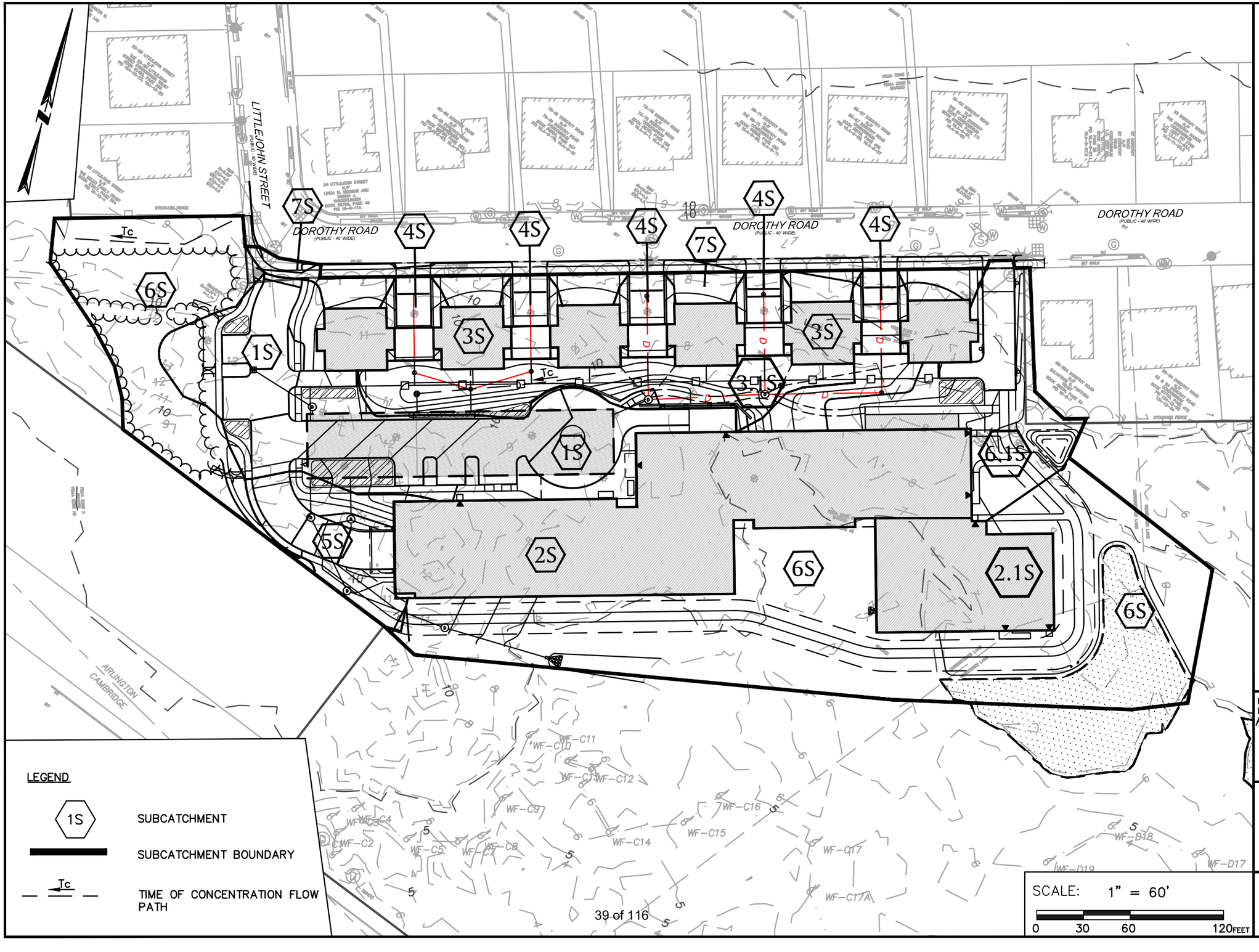
Storm Event	Pre-Development Peak Discharge Rate (cfs)[1]	Post-Development Peak Discharge Rate (cfs)	Change in Peak Discharge Rate (cfs)
2-Year	0.3	0.3	0.0
10-Year	0.7	0.6	-0.1
25-Year	1.0	0.9	-0.1
50-Year	1.2	1.1	-0.1
100-Year	1.5	1.3	-0.2

Node 100L – Total Flows

Storm Event	Pre-Development Peak Discharge Rate (cfs)[1]	Post-Development Peak Discharge Rate (cfs)	Change in Peak Discharge Rate (cfs)
2-Year	3.8	3.7	-0.1
10-Year	9.4	8.7	-0.7
25-Year	14.2	12.1	-2.1
50-Year	17.9	14.4	-3.5
100-Year	22.7	19.3	-3.4

[1] Pre-development peak discharge rates taken from Stormwater Report, Thorndike Place, Dorothy Road, Arlington, MA, prepared by BSC Group, dated November 2020, last revised September 2023. These rates have not changed.

803 Summer Street, Third Floor / Boston, MA 02127 / 617-896-4300



THORNDIKE PLACE

DOROTHY ROAD

ARLINGTON
MASSACHUSETTS
(MIDDLESEX COUNTY)

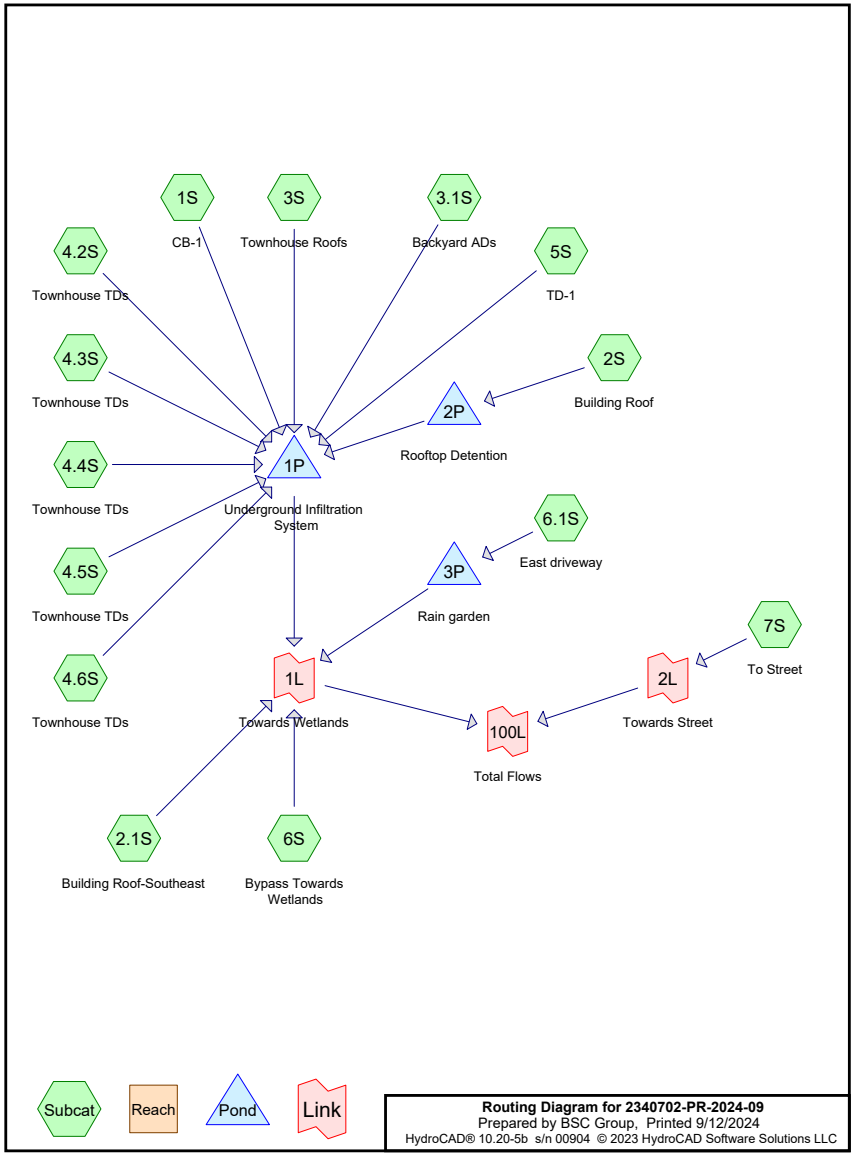
PROPOSED WATERSHED PLAN

NOVEMBER 3, 2020

PREPARED FOR:
ARLINGTON LAND REALTY
84 SHERMAN STREET
CAMBRIDGE, MA

BSC GROUP
803 Summer Street
Boston, Massachusetts
02127
617 896 4300

Job No.: 23407.02 Date: 11/3/2020
Scale: 1" = 60' Revised: 9/13/2024
Dwg No: PRW
File: C\DRAINAGE DESIGN\2340700-PRW



Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2-Year	Type III 24-hr		Default	24.00	1	4.02	2
2	10-Year	Type III 24-hr		Default	24.00	1	6.40	2
3	25-Year	Type III 24-hr		Default	24.00	1	8.30	2
4	50-Year	Type III 24-hr		Default	24.00	1	9.67	2
5	100-Year	Type III 24-hr		Default	24.00	1	11.50	2

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
74,444	74	>75% Grass cover, Good, HSG C (1S, 3.1S, 4.2S, 4.3S, 4.4S, 4.5S, 4.6S, 5S, 6.1S, 6S, 7S)
220	89	Gravel roads, HSG C (6.1S)
411	89	Gravel sidewalk, HSG C (3.1S)
25,811	98	Paved parking, HSG C (1S, 4.2S, 4.3S, 4.4S, 4.5S, 4.6S, 5S, 7S)
6,444	98	Paved roads w/curbs & sewers, HSG C (6.1S)
46,099	98	Roofs, HSG C (2.1S, 2S, 3S, 6S)
272	98	Unconnected pavement, HSG C (3.1S)
4,985	70	Woods, Good, HSG C (6S)
158,686	**86**	**TOTAL AREA**

Soil Listing (all nodes)

Area (sq-ft)	Soil Group	Subcatchment Numbers
0	HSG A	
0	HSG B	
158,686	HSG C	1S, 2.1S, 2S, 3.1S, 3S, 4.2S, 4.3S, 4.4S, 4.5S, 4.6S, 5S, 6.1S, 6S, 7S
0	HSG D	
0	Other	
158,686		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (sq-ft)	HSG-B (sq-ft)	HSG-C (sq-ft)	HSG-D (sq-ft)	Other (sq-ft)	Total (sq-ft)	Ground Cover
0	0	74,444	0	0	74,444	>75% Grass cover, Good
0	0	220	0	0	220	Gravel roads
0	0	411	0	0	411	Gravel sidewalk
0	0	25,811	0	0	25,811	Paved parking
0	0	6,444	0	0	6,444	Paved roads w/curbs & sewers
0	0	46,099	0	0	46,099	Roofs
0	0	272	0	0	272	Unconnected pavement
0	0	4,985	0	0	4,985	Woods, Good
0	**0**	**158,686**	**0**	**0**	**158,686**	**TOTAL AREA**

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: CB-1 Runoff Area=22,742 sf 72.16% Impervious Runoff Depth=3.04"
Tc=6.0 min CN=91 Runoff=1.8 cfs 5,755 cf

Subcatchment2.1S: Building Runoff Area=7,811 sf 100.00% Impervious Runoff Depth=3.79"
Tc=6.0 min CN=98 Runoff=0.7 cfs 2,464 cf

Subcatchment2S: Building Roof Runoff Area=25,114 sf 100.00% Impervious Runoff Depth=3.79"
Tc=6.0 min CN=98 Runoff=2.3 cfs 7,921 cf

Subcatchment3.1S: Backyard ADs Runoff Area=8,985 sf 3.03% Impervious Runoff Depth=1.68"
Flow Length=147' Tc=10.3 min CN=75 Runoff=0.3 cfs 1,259 cf

Subcatchment3S: Townhouse Roofs Runoff Area=13,067 sf 100.00% Impervious Runoff Depth=3.79"
Tc=6.0 min CN=98 Runoff=1.2 cfs 4,122 cf

Subcatchment4.2S: Townhouse TDs Runoff Area=1,112 sf 95.68% Impervious Runoff Depth=3.67"
Tc=6.0 min CN=97 Runoff=0.1 cfs 340 cf

Subcatchment4.3S: Townhouse TDs Runoff Area=1,105 sf 97.29% Impervious Runoff Depth=3.67"
Tc=6.0 min CN=97 Runoff=0.1 cfs 338 cf

Subcatchment4.4S: Townhouse TDs Runoff Area=1,104 sf 97.46% Impervious Runoff Depth=3.67"
Tc=6.0 min CN=97 Runoff=0.1 cfs 338 cf

Subcatchment4.5S: Townhouse TDs Runoff Area=1,082 sf 98.06% Impervious Runoff Depth=3.79"
Tc=6.0 min CN=98 Runoff=0.1 cfs 341 cf

Subcatchment4.6S: Townhouse TDs Runoff Area=1,056 sf 99.24% Impervious Runoff Depth=3.79"
Tc=6.0 min CN=98 Runoff=0.1 cfs 333 cf

Subcatchment5S: TD-1 Runoff Area=5,851 sf 51.63% Impervious Runoff Depth=2.56"
Tc=6.0 min CN=86 Runoff=0.4 cfs 1,250 cf

Subcatchment6.1S: East driveway Runoff Area=12,275 sf 52.50% Impervious Runoff Depth=2.66"
Tc=6.0 min CN=87 Runoff=0.9 cfs 2,716 cf

Subcatchment6S: Bypass Towards Runoff Area=51,539 sf 0.21% Impervious Runoff Depth=1.61"
Flow Length=125' Tc=14.0 min CN=74 Runoff=1.7 cfs 6,919 cf

Subcatchment7S: To Street Runoff Area=5,843 sf 18.07% Impervious Runoff Depth=1.90"
Tc=6.0 min CN=78 Runoff=0.3 cfs 927 cf

Pond 1P: Underground Infiltration System Peak Elev=7.38' Storage=6,133 cf Inflow=4.3 cfs 21,954 cf
Discarded=0.1 cfs 9,980 cf Primary=1.2 cfs 11,973 cf Outflow=1.3 cfs 21,953 cf

Pond 2P: Rooftop Detention Peak Elev=57.22' Storage=4,423 cf Inflow=2.3 cfs 7,921 cf
Outflow=0.2 cfs 7,878 cf

Pond 3P: Rain garden Peak Elev=6.37' Storage=196 cf Inflow=0.9 cfs 2,716 cf
Discarded=0.0 cfs 411 cf Primary=0.9 cfs 2,305 cf Outflow=0.9 cfs 2,716 cf

Link 1L: Towards Wetlands Inflow=3.5 cfs 23,660 cf
Primary=3.5 cfs 23,660 cf

Link 2L: Towards Street Inflow=0.3 cfs 927 cf
Primary=0.3 cfs 927 cf

Link 100L: Total Flows Inflow=3.7 cfs 24,587 cf
Primary=3.7 cfs 24,587 cf

Total Runoff Area = 158,686 sf Runoff Volume = 35,023 cf Average Runoff Depth = 2.65"
50.45% Pervious = 80,060 sf 49.55% Impervious = 78,626 sf

Summary for Subcatchment 1S: CB-1

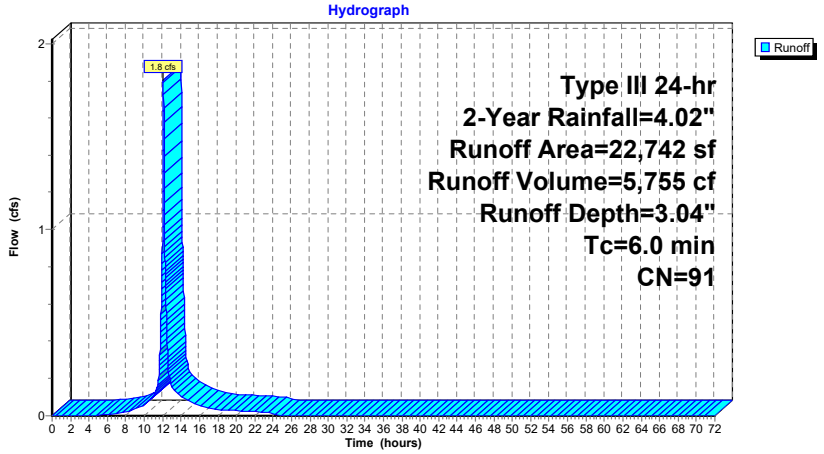
Runoff = 1.8 cfs @ 12.09 hrs, Volume= 5,755 cf, Depth= 3.04"
Routed to Pond 1P : Underground Infiltration System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=4.02"

Area (sf)	CN	Description
16,410	98	Paved parking, HSG C
6,332	74	>75% Grass cover, Good, HSG C
22,742	91	Weighted Average
6,332		27.84% Pervious Area
16,410		72.16% Impervious Area

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

Subcatchment 1S: CB-1



Summary for Subcatchment 2.1S: Building Roof-Southeast

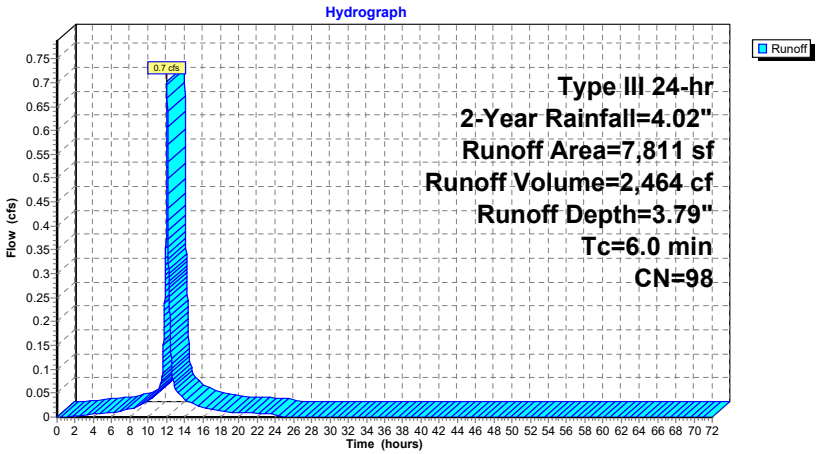
Runoff = 0.7 cfs @ 12.08 hrs, Volume= 2,464 cf, Depth= 3.79"
Routed to Link 1L : Towards Wetlands

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=4.02"

Area (sf)	CN	Description
7,811	98	Roofs, HSG C
7,811		100.00% Impervious Area

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

Subcatchment 2.1S: Building Roof-Southeast



Summary for Subcatchment 2S: Building Roof

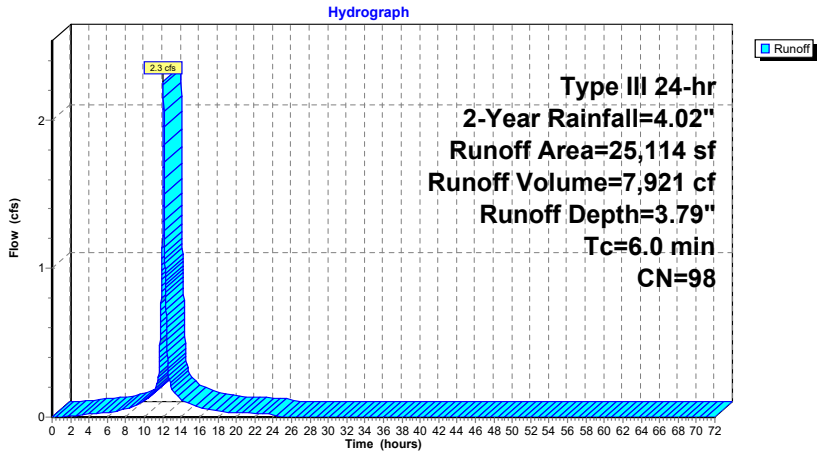
Runoff = 2.3 cfs @ 12.08 hrs, Volume= 7,921 cf, Depth= 3.79"
Routed to Pond 2P : Rooftop Detention

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=4.02"

Area (sf)	CN	Description
25,114	98	Roofs, HSG C
25,114		100.00% Impervious Area

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

Subcatchment 2S: Building Roof



Summary for Subcatchment 3.1S: Backyard ADs

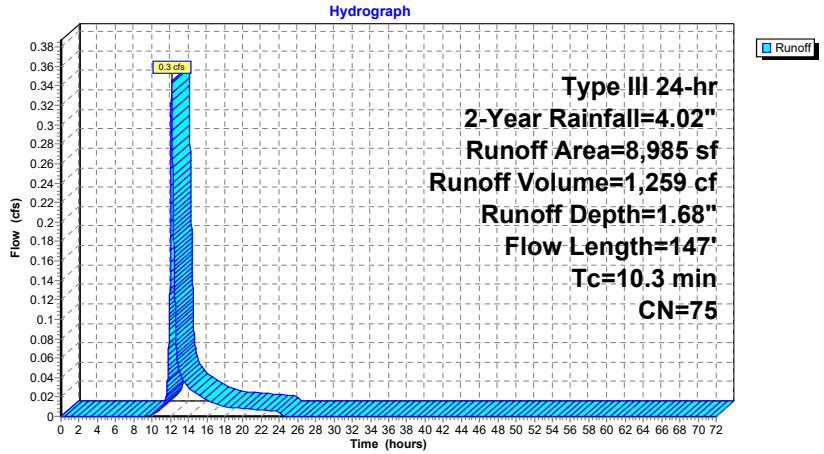
Runoff = 0.3 cfs @ 12.15 hrs, Volume= 1,259 cf, Depth= 1.68"
Routed to Pond 1P : Underground Infiltration System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=4.02"

	Area (sf)	CN	Description
	272	98	Unconnected pavement, HSG C
	8,302	74	>75% Grass cover, Good, HSG C
*	411	89	Gravel sidewalk, HSG C
	8,985	75	Weighted Average
	8,713		96.97% Pervious Area
	272		3.03% Impervious Area
	272		100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.4	50	0.0142	0.09		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.23"
0.9	97	0.0154	1.86		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
10.3	147	Total			

Subcatchment 3.1S: Backyard ADs



Summary for Subcatchment 3S: Townhouse Roofs

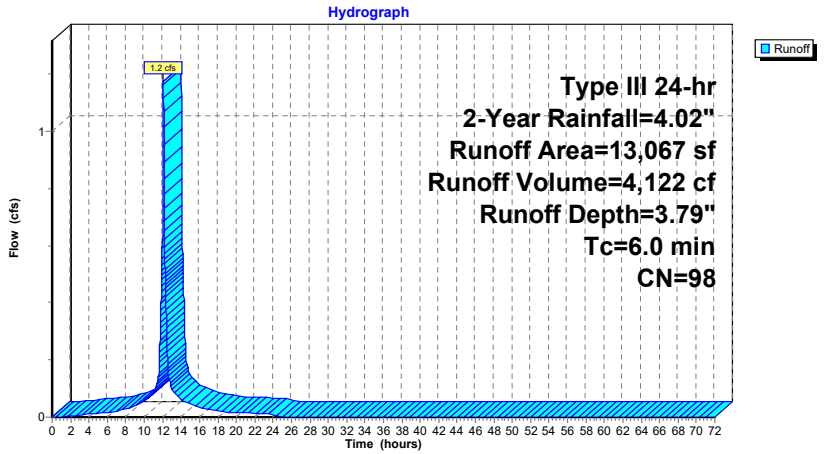
Runoff = 1.2 cfs @ 12.08 hrs, Volume= 4,122 cf, Depth= 3.79"
Routed to Pond 1P : Underground Infiltration System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=4.02"

Area (sf)	CN	Description
13,067	98	Roofs, HSG C
13,067		100.00% Impervious Area

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

Subcatchment 3S: Townhouse Roofs



Summary for Subcatchment 4.2S: Townhouse TDs

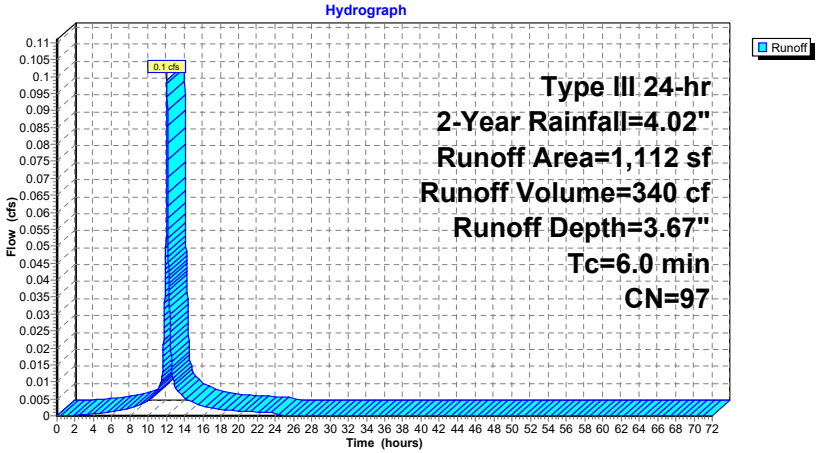
Runoff = 0.1 cfs @ 12.08 hrs, Volume= 340 cf, Depth= 3.67"
Routed to Pond 1P : Underground Infiltration System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=4.02"

Area (sf)	CN	Description
1,064	98	Paved parking, HSG C
48	74	>75% Grass cover, Good, HSG C
1,112	97	Weighted Average
48		4.32% Pervious Area
1,064		95.68% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min. Tc

Subcatchment 4.2S: Townhouse TDs



Summary for Subcatchment 4.3S: Townhouse TDs

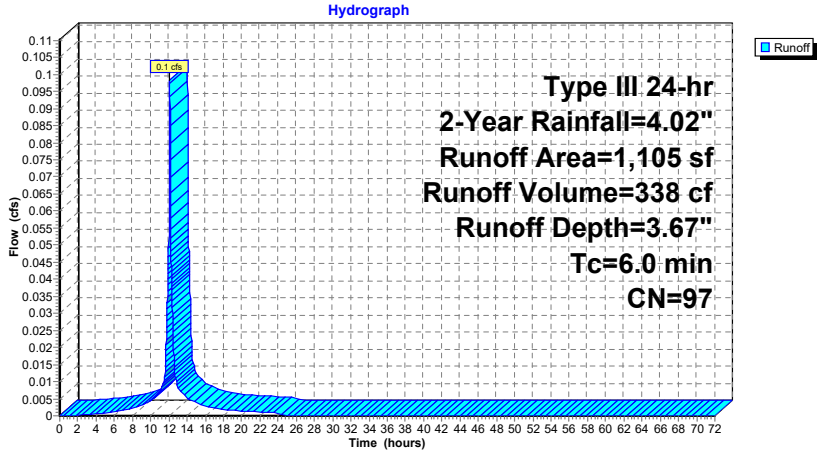
Runoff = 0.1 cfs @ 12.08 hrs, Volume= 338 cf, Depth= 3.67"
Routed to Pond 1P : Underground Infiltration System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=4.02"

Area (sf)	CN	Description
1,075	98	Paved parking, HSG C
30	74	>75% Grass cover, Good, HSG C
1,105	97	Weighted Average
30		2.71% Pervious Area
1,075		97.29% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min. Tc

Subcatchment 4.3S: Townhouse TDs



Summary for Subcatchment 4.4S: Townhouse TDs

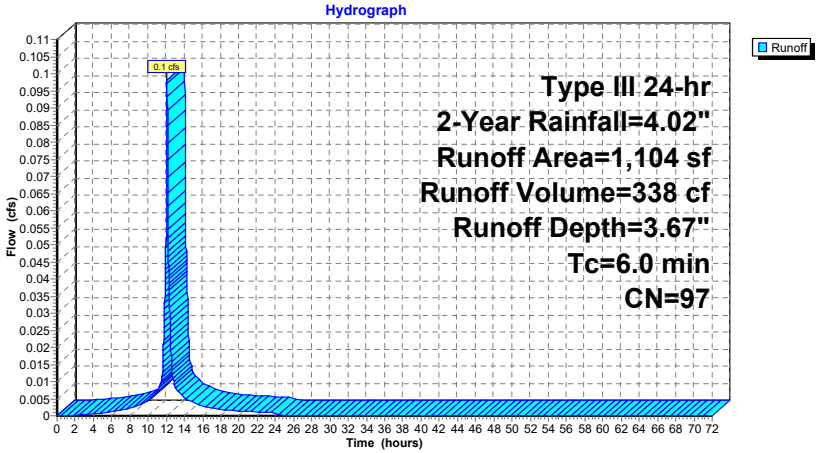
Runoff = 0.1 cfs @ 12.08 hrs, Volume= 338 cf, Depth= 3.67"
Routed to Pond 1P : Underground Infiltration System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=4.02"

Area (sf)	CN	Description
1,076	98	Paved parking, HSG C
28	74	>75% Grass cover, Good, HSG C
1,104	97	Weighted Average
28		2.54% Pervious Area
1,076		97.46% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min. Tc

Subcatchment 4.4S: Townhouse TDs



Summary for Subcatchment 4.5S: Townhouse TDs

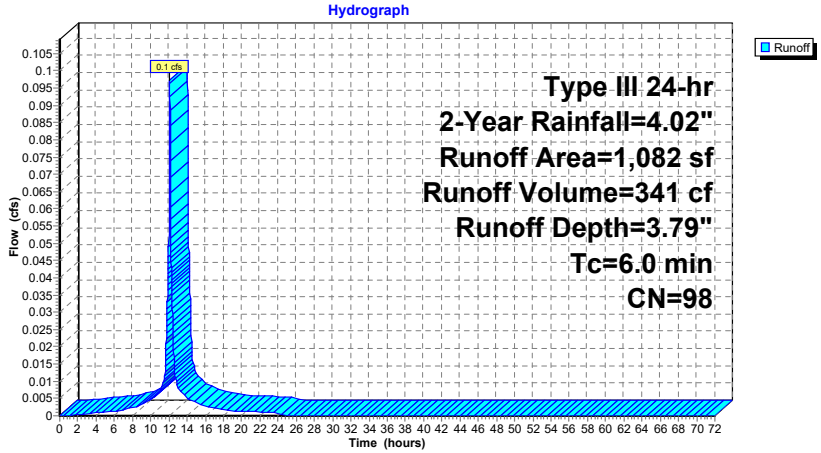
Runoff = 0.1 cfs @ 12.08 hrs, Volume= 341 cf, Depth= 3.79"
Routed to Pond 1P : Underground Infiltration System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=4.02"

Area (sf)	CN	Description
1,061	98	Paved parking, HSG C
21	74	>75% Grass cover, Good, HSG C
1,082	98	Weighted Average
21		1.94% Pervious Area
1,061		98.06% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min. Tc

Subcatchment 4.5S: Townhouse TDs



Summary for Subcatchment 4.6S: Townhouse TDs

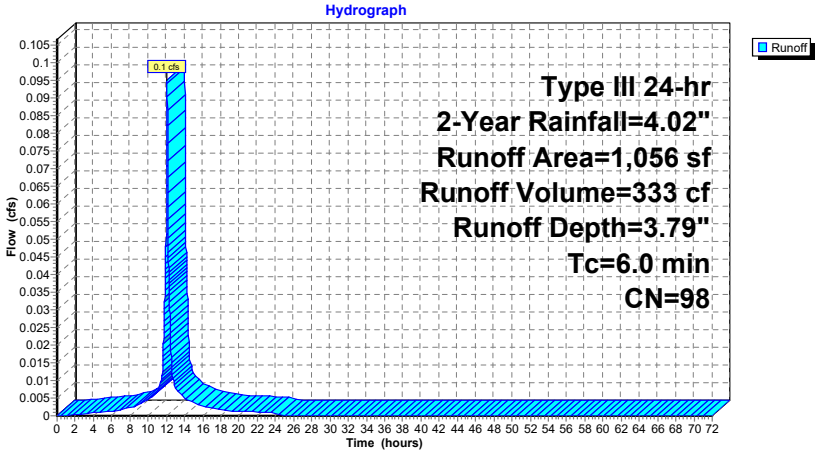
Runoff = 0.1 cfs @ 12.08 hrs, Volume= 333 cf, Depth= 3.79"
Routed to Pond 1P : Underground Infiltration System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=4.02"

Area (sf)	CN	Description
1,048	98	Paved parking, HSG C
8	74	>75% Grass cover, Good, HSG C
1,056	98	Weighted Average
8		0.76% Pervious Area
1,048		99.24% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min. Tc

Subcatchment 4.6S: Townhouse TDs



Summary for Subcatchment 5S: TD-1

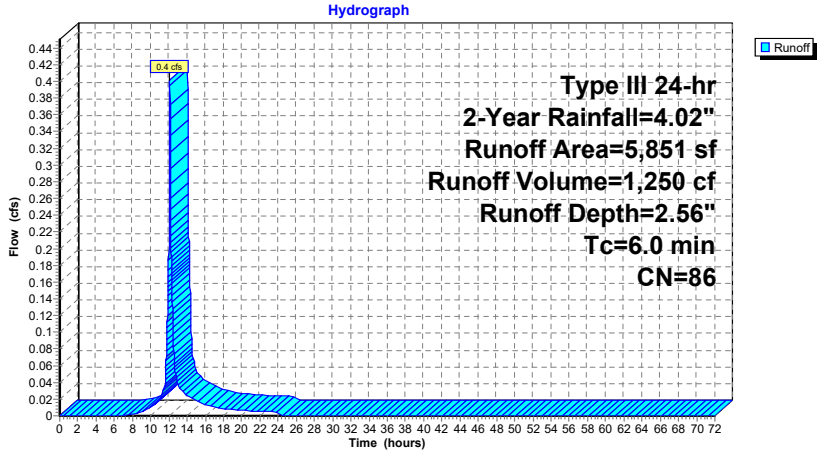
Runoff = 0.4 cfs @ 12.09 hrs, Volume= 1,250 cf, Depth= 2.56"
Routed to Pond 1P : Underground Infiltration System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=4.02"

Area (sf)	CN	Description
3,021	98	Paved parking, HSG C
2,830	74	>75% Grass cover, Good, HSG C
5,851	86	Weighted Average
2,830		48.37% Pervious Area
3,021		51.63% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min. Tc

Subcatchment 5S: TD-1



Summary for Subcatchment 6.1S: East driveway

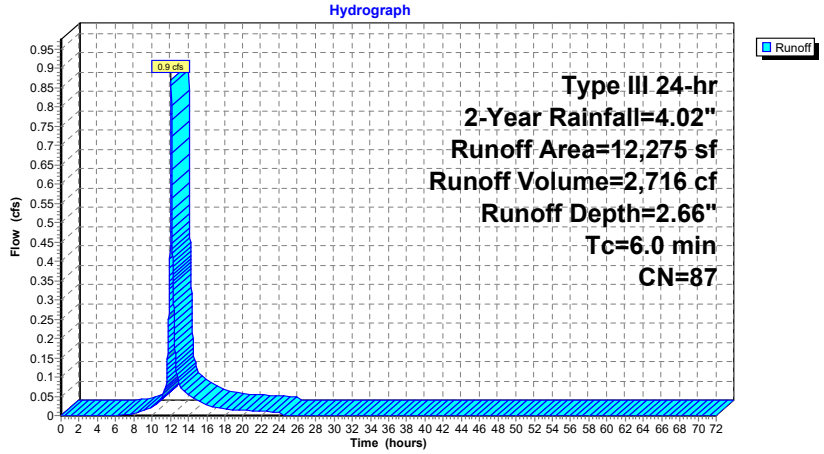
Runoff = 0.9 cfs @ 12.09 hrs, Volume= 2,716 cf, Depth= 2.66"
Routed to Pond 3P : Rain garden

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=4.02"

Area (sf)	CN	Description
5,611	74	>75% Grass cover, Good, HSG C
6,444	98	Paved roads w/curbs & sewers, HSG C
220	89	Gravel roads, HSG C
12,275	87	Weighted Average
5,831		47.50% Pervious Area
6,444		52.50% Impervious Area

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

Subcatchment 6.1S: East driveway



Summary for Subcatchment 6S: Bypass Towards Wetlands

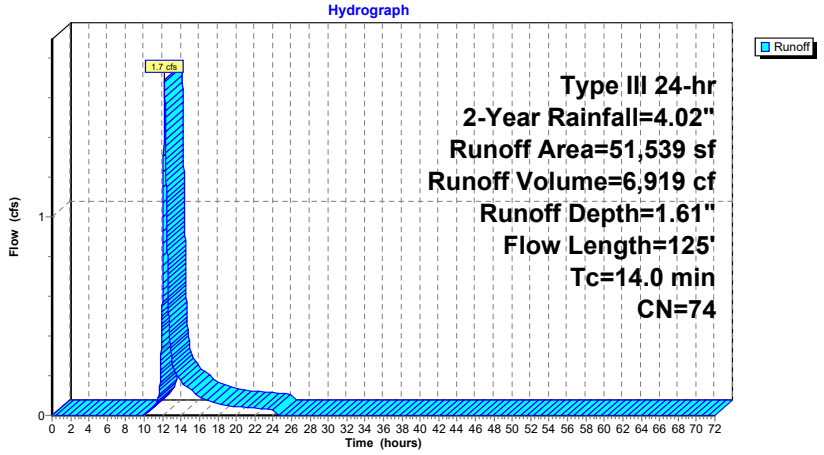
Runoff = 1.7 cfs @ 12.20 hrs, Volume= 6,919 cf, Depth= 1.61"
Routed to Link 1L : Towards Wetlands

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=4.02"

Area (sf)	CN	Description
4,985	70	Woods, Good, HSG C
46,447	74	>75% Grass cover, Good, HSG C
107	98	Roofs, HSG C
51,539	74	Weighted Average
51,432		99.79% Pervious Area
107		0.21% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.8	50	0.0220	0.07		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.23"
2.2	75	0.0133	0.58		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
14.0	125	Total			

Subcatchment 6S: Bypass Towards Wetlands



Summary for Subcatchment 7S: To Street

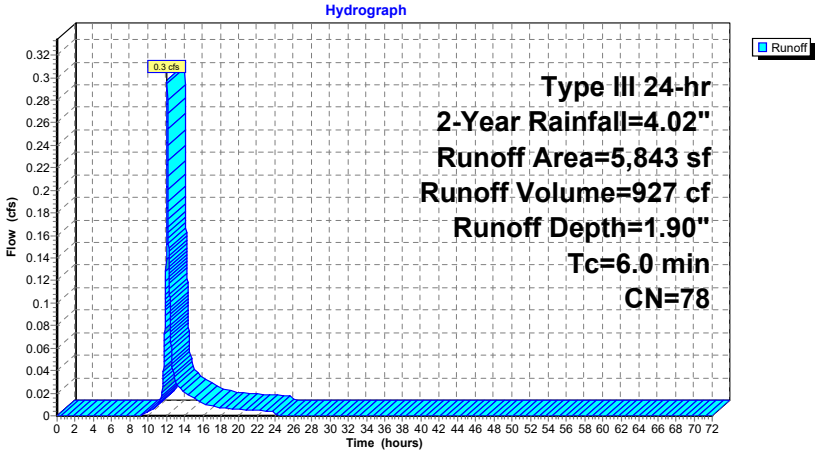
Runoff = 0.3 cfs @ 12.09 hrs, Volume= 927 cf, Depth= 1.90"
Routed to Link 2L : Towards Street

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=4.02"

Area (sf)	CN	Description
1,056	98	Paved parking, HSG C
4,787	74	>75% Grass cover, Good, HSG C
5,843	78	Weighted Average
4,787		81.93% Pervious Area
1,056		18.07% Impervious Area

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

Subcatchment 7S: To Street



Summary for Pond 1P: Underground Infiltration System

Inflow Area = 81,218 sf, 77.83% Impervious, Inflow Depth > 3.24" for 2-Year event
Inflow = 4.3 cfs @ 12.09 hrs, Volume= 21,954 cf
Outflow = 1.3 cfs @ 12.46 hrs, Volume= 21,953 cf, Atten= 70%, Lag= 22.6 min
Discarded = 0.1 cfs @ 9.04 hrs, Volume= 9,980 cf
Primary = 1.2 cfs @ 12.46 hrs, Volume= 11,973 cf
Routed to Link 1L : Towards Wetlands

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 7.38' @ 12.46 hrs Surf.Area= 8,137 sf Storage= 6,133 cf

Plug-Flow detention time= 175.6 min calculated for 21,953 cf (100% of inflow)
Center-of-Mass det. time= 175.4 min (1,080.9 - 905.5)

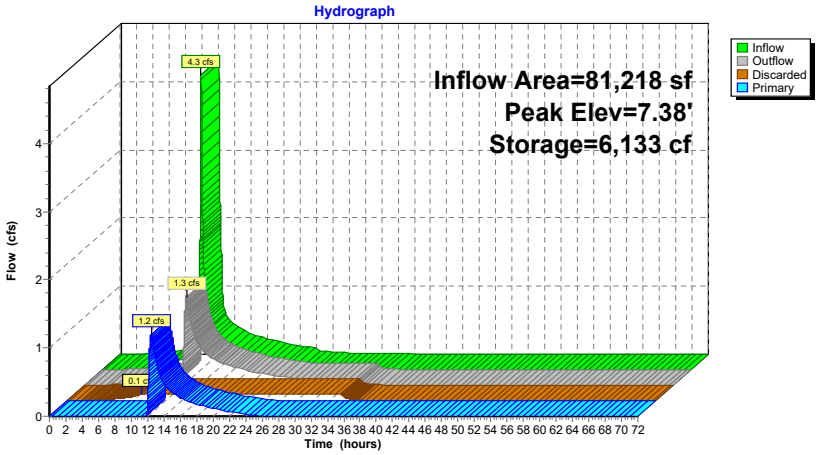
Volume	Invert	Avail.Storage	Storage Description
#1	6.50'	17,495 cf	**6.89'W x 14.06'L x 2.50'H StormTrap ST-1 Units (Irregular Shape)** x 84 20,343 cf Overall x 86.0% Voids

Device	Routing	Invert	Outlet Devices
#1	Discarded	6.50'	**0.520 in/hr Exfiltration over Surface area**
#2	Primary	6.80'	**18.0" Round Culvert** L= 190.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 6.80' / 6.00' S= 0.0042 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf
#3	Device 2	6.80'	**12.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Device 2	8.25'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Discarded OutFlow Max=0.1 cfs @ 9.04 hrs HW=6.53' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.1 cfs)

Primary OutFlow Max=1.2 cfs @ 12.46 hrs HW=7.38' (Free Discharge)
└**2=Culvert** (Barrel Controls 1.2 cfs @ 2.84 fps)
  └**3=Orifice/Grate** (Passes 1.2 cfs of 1.2 cfs potential flow)
  └**4=Sharp-Crested Rectangular Weir** (Controls 0.0 cfs)

Pond 1P: Underground Infiltration System



Summary for Pond 2P: Rooftop Detention

Inflow Area = 25,114 sf,100.00% Impervious, Inflow Depth = 3.79" for 2-Year event
Inflow = 2.3 cfs @ 12.08 hrs, Volume= 7,921 cf
Outflow = 0.2 cfs @ 12.96 hrs, Volume= 7,878 cf, Atten= 91%, Lag= 52.8 min
Primary = 0.2 cfs @ 12.96 hrs, Volume= 7,878 cf
Routed to Pond 1P : Underground Infiltration System

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 57.22' @ 12.96 hrs Surf.Area= 20,000 sf Storage= 4,423 cf

Plug-Flow detention time= 374.6 min calculated for 7,878 cf (99% of inflow)
Center-of-Mass det. time= 370.8 min (1,122.7 - 751.9)

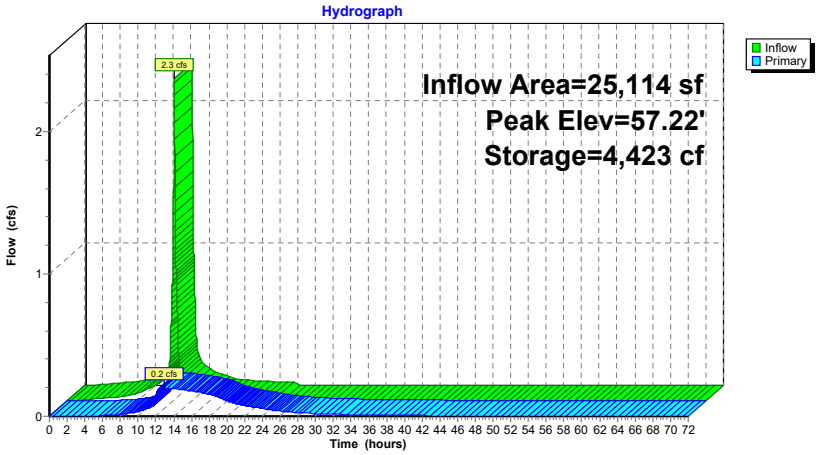
Volume	Invert	Avail.Storage	Storage Description
#1	57.00'	14,000 cf	**Rooftop Detention (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
57.00	20,000	0	0
57.70	20,000	14,000	14,000

Device	Routing	Invert	Outlet Devices
#1	Primary	8.02'	**12.0" Round Roof Drain** L= 16.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 8.02' / 7.70' S= 0.0200 '/' Cc= 0.900 n= 0.013, Flow Area= 0.79 sf
#2	Device 1	57.00'	**4.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.2 cfs @ 12.96 hrs HW=57.22' (Free Discharge)
└**1=Roof Drain** (Passes 0.2 cfs of 23.3 cfs potential flow)
└**2=Orifice/Grate** (Orifice Controls 0.2 cfs @ 2.26 fps)

Pond 2P: Rooftop Detention



Summary for Pond 3P: Rain garden

Inflow Area = 12,275 sf, 52.50% Impervious, Inflow Depth = 2.66" for 2-Year event
Inflow = 0.9 cfs @ 12.09 hrs, Volume= 2,716 cf
Outflow = 0.9 cfs @ 12.09 hrs, Volume= 2,716 cf, Atten= 0%, Lag= 0.3 min
Discarded = 0.0 cfs @ 12.09 hrs, Volume= 411 cf
Primary = 0.9 cfs @ 12.09 hrs, Volume= 2,305 cf
Routed to Link 1L : Towards Wetlands

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 6.37' @ 12.09 hrs Surf.Area= 384 sf Storage= 196 cf

Plug-Flow detention time= 80.6 min calculated for 2,715 cf (100% of inflow)
Center-of-Mass det. time= 80.8 min (890.3 - 809.6)

Volume	Invert	Avail.Storage	Storage Description
#1	5.60'	253 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

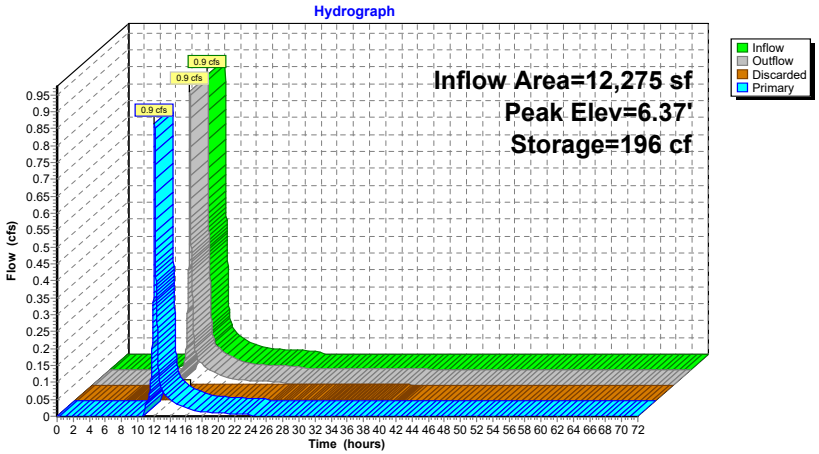
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
5.60	125	46.0	0	0	125
6.00	276	66.0	78	78	305
6.30	350	73.0	94	172	385
6.50	460	87.0	81	253	564

Device	Routing	Invert	Outlet Devices
#1	Discarded	5.60'	**0.520 in/hr Exfiltration over Surface area**
#2	Primary	6.30'	**22.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Discarded OutFlow Max=0.0 cfs @ 12.09 hrs HW=6.37' (Free Discharge)
↑**1=Exfiltration** (Exfiltration Controls 0.0 cfs)

Primary OutFlow Max=0.9 cfs @ 12.09 hrs HW=6.37' (Free Discharge)
↑**2=Broad-Crested Rectangular Weir** (Weir Controls 0.9 cfs @ 0.60 fps)

Pond 3P: Rain garden

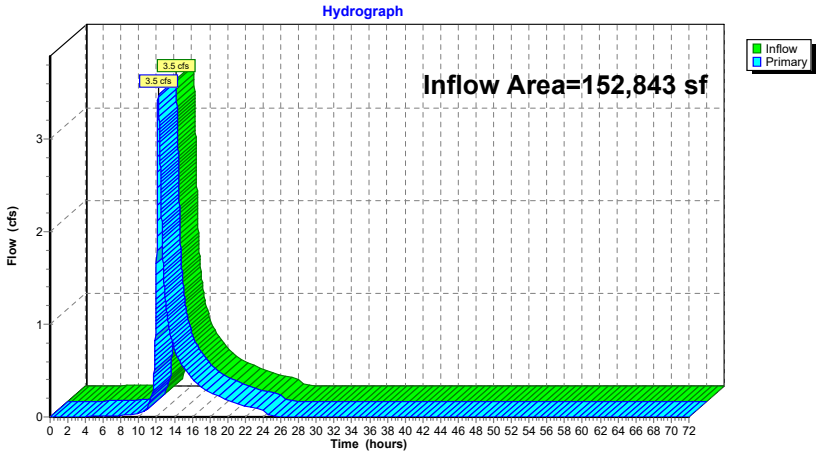


Summary for Link 1L: Towards Wetlands

Inflow Area = 152,843 sf, 50.75% Impervious, Inflow Depth = 1.86" for 2-Year event
Inflow = 3.5 cfs @ 12.17 hrs, Volume= 23,660 cf
Primary = 3.5 cfs @ 12.17 hrs, Volume= 23,660 cf, Atten= 0%, Lag= 0.0 min
Routed to Link 100L : Total Flows

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link 1L: Towards Wetlands

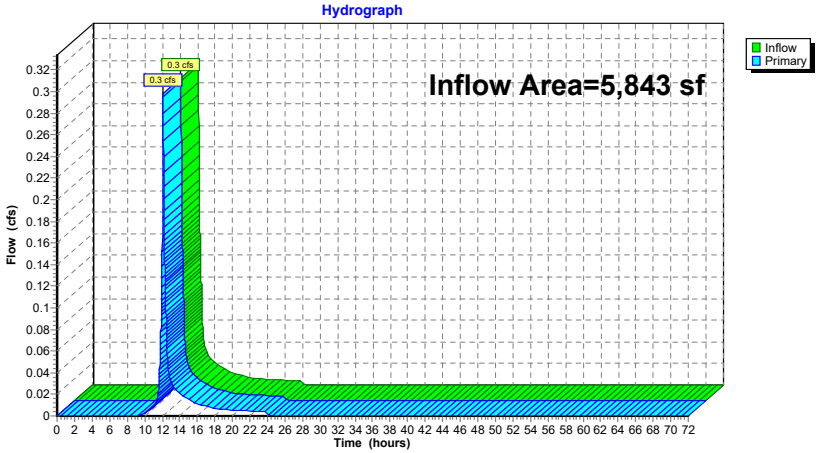


Summary for Link 2L: Towards Street

Inflow Area = 5,843 sf, 18.07% Impervious, Inflow Depth = 1.90" for 2-Year event
Inflow = 0.3 cfs @ 12.09 hrs, Volume= 927 cf
Primary = 0.3 cfs @ 12.09 hrs, Volume= 927 cf, Atten= 0%, Lag= 0.0 min
Routed to Link 100L : Total Flows

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link 2L: Towards Street

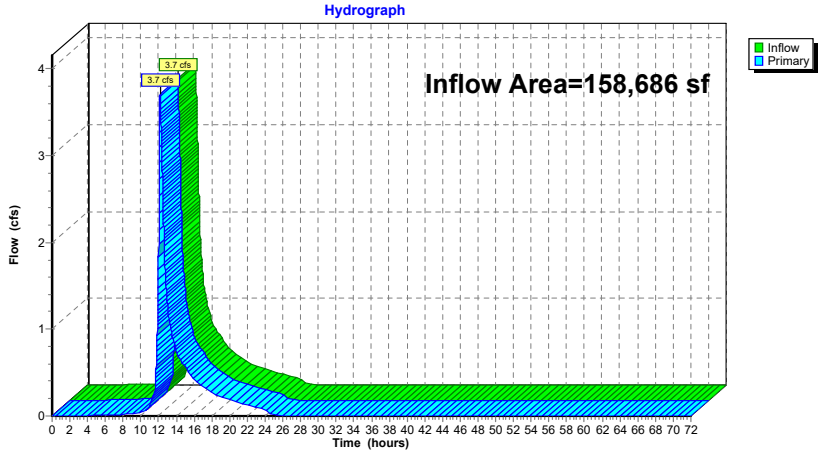


Summary for Link 100L: Total Flows

Inflow Area = 158,686 sf, 49.55% Impervious, Inflow Depth = 1.86" for 2-Year event
Inflow = 3.7 cfs @ 12.15 hrs, Volume= 24,587 cf
Primary = 3.7 cfs @ 12.15 hrs, Volume= 24,587 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link 100L: Total Flows



Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: CB-1 Runoff Area=22,742 sf 72.16% Impervious Runoff Depth=5.35"
Tc=6.0 min CN=91 Runoff=3.1 cfs 10,138 cf

Subcatchment2.1S: Building Runoff Area=7,811 sf 100.00% Impervious Runoff Depth=6.16"
Tc=6.0 min CN=98 Runoff=1.1 cfs 4,011 cf

Subcatchment2S: Building Roof Runoff Area=25,114 sf 100.00% Impervious Runoff Depth=6.16"
Tc=6.0 min CN=98 Runoff=3.6 cfs 12,895 cf

Subcatchment3.1S: Backyard ADs Runoff Area=8,985 sf 3.03% Impervious Runoff Depth=3.63"
Flow Length=147' Tc=10.3 min CN=75 Runoff=0.8 cfs 2,715 cf

Subcatchment3S: Townhouse Roofs Runoff Area=13,067 sf 100.00% Impervious Runoff Depth=6.16"
Tc=6.0 min CN=98 Runoff=1.9 cfs 6,709 cf

Subcatchment4.2S: Townhouse TDs Runoff Area=1,112 sf 95.68% Impervious Runoff Depth=6.04"
Tc=6.0 min CN=97 Runoff=0.2 cfs 560 cf

Subcatchment4.3S: Townhouse TDs Runoff Area=1,105 sf 97.29% Impervious Runoff Depth=6.04"
Tc=6.0 min CN=97 Runoff=0.2 cfs 556 cf

Subcatchment4.4S: Townhouse TDs Runoff Area=1,104 sf 97.46% Impervious Runoff Depth=6.04"
Tc=6.0 min CN=97 Runoff=0.2 cfs 556 cf

Subcatchment4.5S: Townhouse TDs Runoff Area=1,082 sf 98.06% Impervious Runoff Depth=6.16"
Tc=6.0 min CN=98 Runoff=0.2 cfs 556 cf

Subcatchment4.6S: Townhouse TDs Runoff Area=1,056 sf 99.24% Impervious Runoff Depth=6.16"
Tc=6.0 min CN=98 Runoff=0.2 cfs 542 cf

Subcatchment5S: TD-1 Runoff Area=5,851 sf 51.63% Impervious Runoff Depth=4.79"
Tc=6.0 min CN=86 Runoff=0.7 cfs 2,336 cf

Subcatchment6.1S: East driveway Runoff Area=12,275 sf 52.50% Impervious Runoff Depth=4.90"
Tc=6.0 min CN=87 Runoff=1.6 cfs 5,013 cf

Subcatchment6S: Bypass Towards Runoff Area=51,539 sf 0.21% Impervious Runoff Depth=3.52"
Flow Length=125' Tc=14.0 min CN=74 Runoff=3.8 cfs 15,135 cf

Subcatchment7S: To Street Runoff Area=5,843 sf 18.07% Impervious Runoff Depth=3.93"
Tc=6.0 min CN=78 Runoff=0.6 cfs 1,916 cf

Pond 1P: Underground Infiltration System Peak Elev=7.85' Storage=9,468 cf Inflow=7.3 cfs 37,510 cf
Discarded=0.1 cfs 11,761 cf Primary=2.8 cfs 25,748 cf Outflow=2.9 cfs 37,508 cf

Pond 2P: Rooftop Detention Peak Elev=57.36' Storage=7,258 cf Inflow=3.6 cfs 12,895 cf
Outflow=0.3 cfs 12,842 cf

Pond 3P: Rain garden Peak Elev=6.40' Storage=208 cf Inflow=1.6 cfs 5,013 cf
Discarded=0.0 cfs 442 cf Primary=1.6 cfs 4,571 cf Outflow=1.6 cfs 5,013 cf

Link 1L: Towards Wetlands Inflow=8.2 cfs 49,465 cf
Primary=8.2 cfs 49,465 cf

Link 2L: Towards Street Inflow=0.6 cfs 1,916 cf
Primary=0.6 cfs 1,916 cf

Link 100L: Total Flows Inflow=8.7 cfs 51,381 cf
Primary=8.7 cfs 51,381 cf

Total Runoff Area = 158,686 sf Runoff Volume = 63,637 cf Average Runoff Depth = 4.81"
50.45% Pervious = 80,060 sf 49.55% Impervious = 78,626 sf

Summary for Subcatchment 1S: CB-1

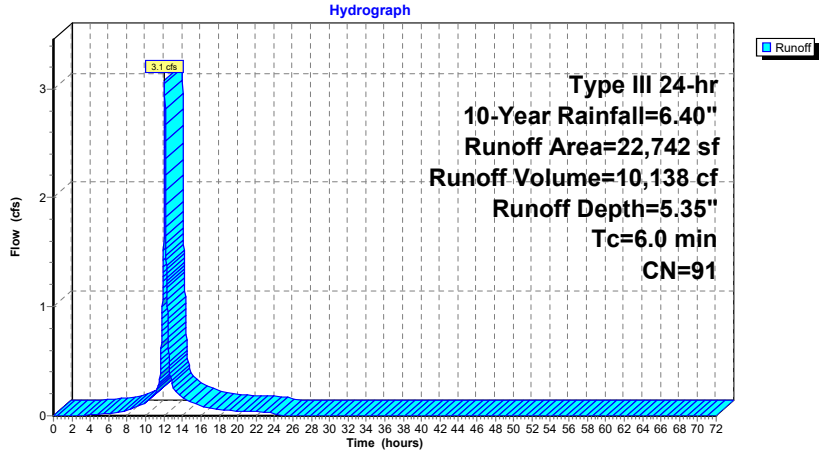
Runoff = 3.1 cfs @ 12.08 hrs, Volume= 10,138 cf, Depth= 5.35"
Routed to Pond 1P : Underground Infiltration System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=6.40"

Area (sf)	CN	Description
16,410	98	Paved parking, HSG C
6,332	74	>75% Grass cover, Good, HSG C
22,742	91	Weighted Average
6,332		27.84% Pervious Area
16,410		72.16% Impervious Area

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

Subcatchment 1S: CB-1



Summary for Subcatchment 2.1S: Building Roof-Southeast

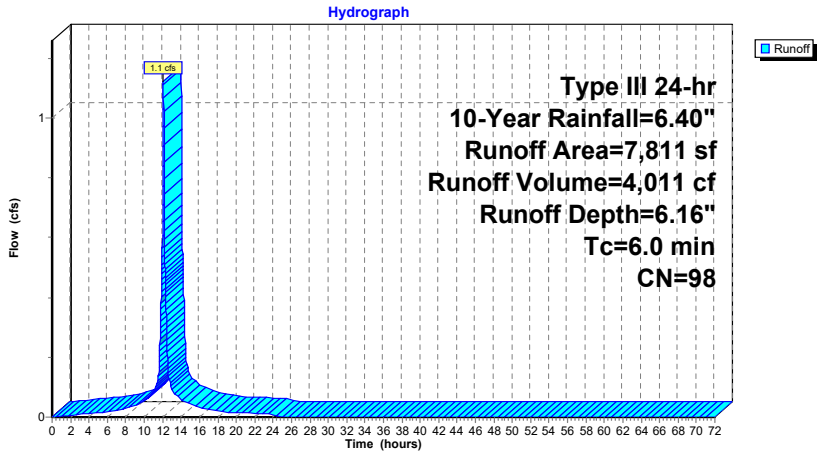
Runoff = 1.1 cfs @ 12.08 hrs, Volume= 4,011 cf, Depth= 6.16"
Routed to Link 1L : Towards Wetlands

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=6.40"

Area (sf)	CN	Description
7,811	98	Roofs, HSG C
7,811		100.00% Impervious Area

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

Subcatchment 2.1S: Building Roof-Southeast



Summary for Subcatchment 2S: Building Roof

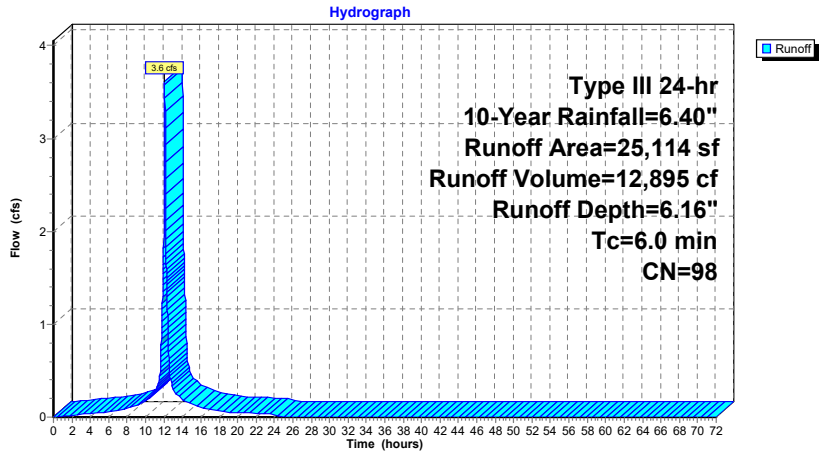
Runoff = 3.6 cfs @ 12.08 hrs, Volume= 12,895 cf, Depth= 6.16"
Routed to Pond 2P : Rooftop Detention

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=6.40"

Area (sf)	CN	Description
25,114	98	Roofs, HSG C
25,114		100.00% Impervious Area

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

Subcatchment 2S: Building Roof



Summary for Subcatchment 3.1S: Backyard ADs

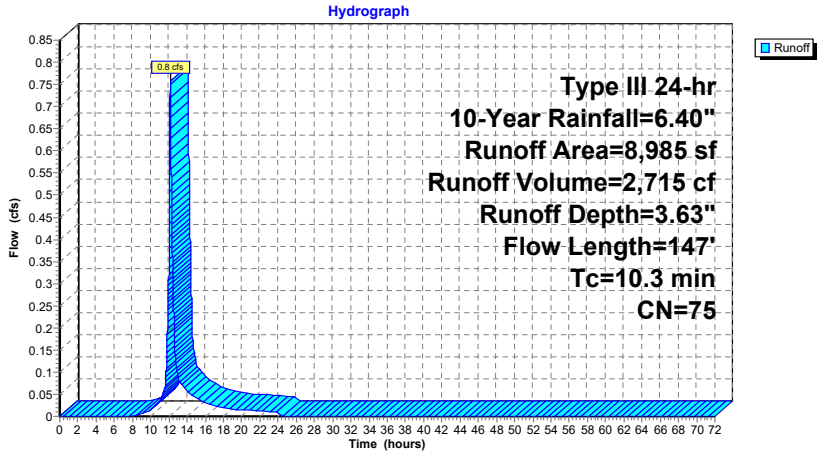
Runoff = 0.8 cfs @ 12.14 hrs, Volume= 2,715 cf, Depth= 3.63"
Routed to Pond 1P : Underground Infiltration System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=6.40"

	Area (sf)	CN	Description
	272	98	Unconnected pavement, HSG C
	8,302	74	>75% Grass cover, Good, HSG C
*	411	89	Gravel sidewalk, HSG C
	8,985	75	Weighted Average
	8,713		96.97% Pervious Area
	272		3.03% Impervious Area
	272		100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.4	50	0.0142	0.09		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.23"
0.9	97	0.0154	1.86		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
10.3	147	Total			

Subcatchment 3.1S: Backyard ADs



Summary for Subcatchment 3S: Townhouse Roofs

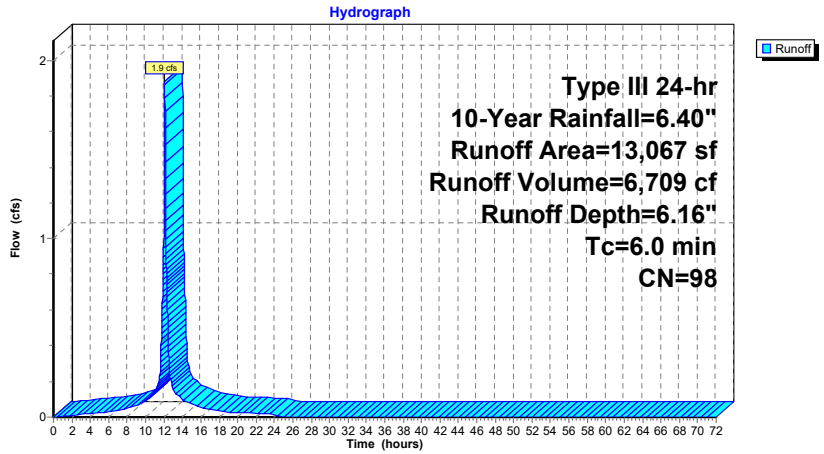
Runoff = 1.9 cfs @ 12.08 hrs, Volume= 6,709 cf, Depth= 6.16"
Routed to Pond 1P : Underground Infiltration System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=6.40"

Area (sf)	CN	Description
13,067	98	Roofs, HSG C
13,067		100.00% Impervious Area

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

Subcatchment 3S: Townhouse Roofs



Summary for Subcatchment 4.2S: Townhouse TDs

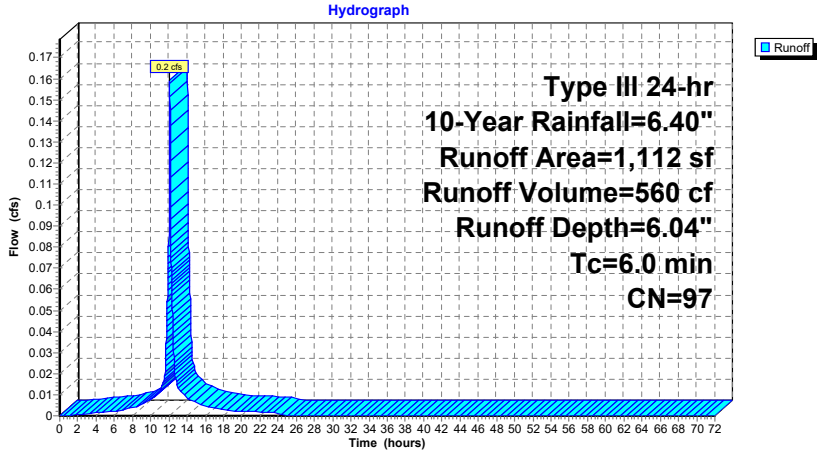
Runoff = 0.2 cfs @ 12.08 hrs, Volume= 560 cf, Depth= 6.04"
Routed to Pond 1P : Underground Infiltration System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=6.40"

Area (sf)	CN	Description
1,064	98	Paved parking, HSG C
48	74	>75% Grass cover, Good, HSG C
1,112	97	Weighted Average
48		4.32% Pervious Area
1,064		95.68% Impervious Area

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

Subcatchment 4.2S: Townhouse TDs



Summary for Subcatchment 4.3S: Townhouse TDs

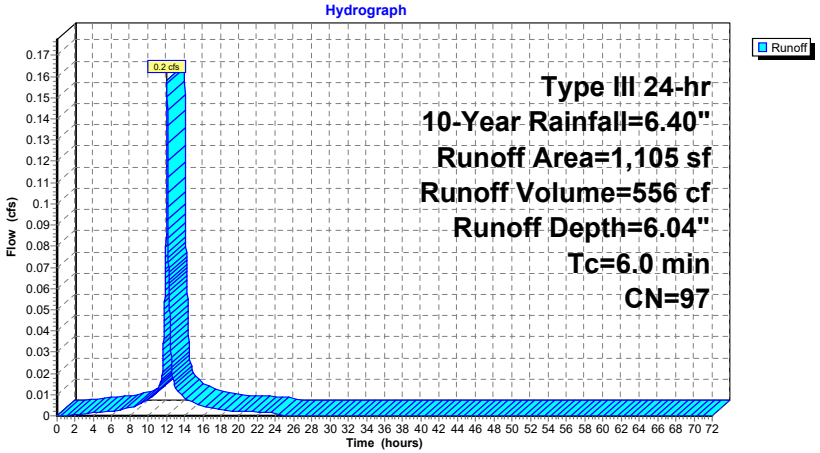
Runoff = 0.2 cfs @ 12.08 hrs, Volume= 556 cf, Depth= 6.04"
Routed to Pond 1P : Underground Infiltration System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=6.40"

Area (sf)	CN	Description
1,075	98	Paved parking, HSG C
30	74	>75% Grass cover, Good, HSG C
1,105	97	Weighted Average
30		2.71% Pervious Area
1,075		97.29% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min. Tc

Subcatchment 4.3S: Townhouse TDs



Summary for Subcatchment 4.4S: Townhouse TDs

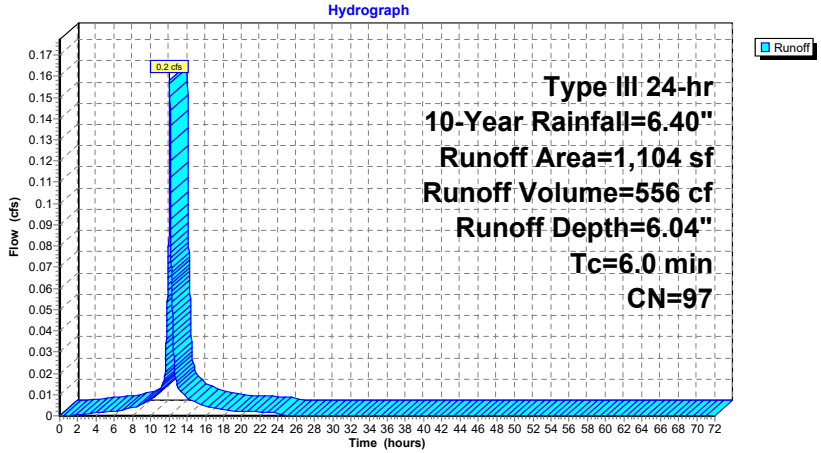
Runoff = 0.2 cfs @ 12.08 hrs, Volume= 556 cf, Depth= 6.04"
Routed to Pond 1P : Underground Infiltration System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=6.40"

Area (sf)	CN	Description
1,076	98	Paved parking, HSG C
28	74	>75% Grass cover, Good, HSG C
1,104	97	Weighted Average
28		2.54% Pervious Area
1,076		97.46% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min. Tc

Subcatchment 4.4S: Townhouse TDs



Summary for Subcatchment 4.5S: Townhouse TDs

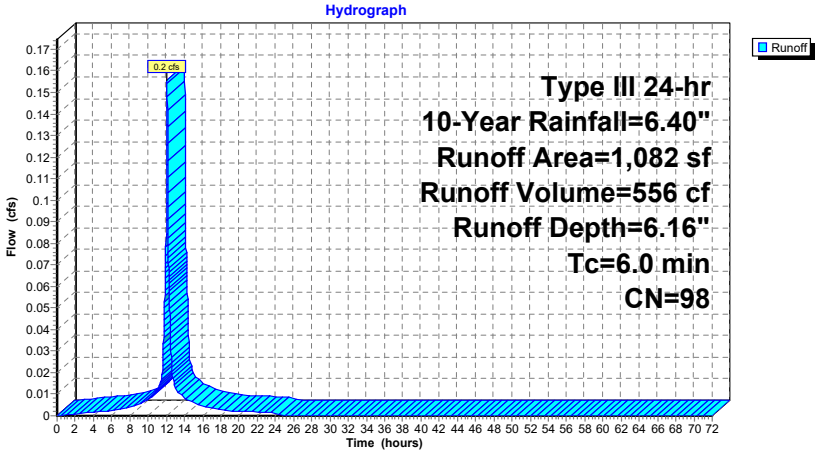
Runoff = 0.2 cfs @ 12.08 hrs, Volume= 556 cf, Depth= 6.16"
Routed to Pond 1P : Underground Infiltration System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=6.40"

Area (sf)	CN	Description
1,061	98	Paved parking, HSG C
21	74	>75% Grass cover, Good, HSG C
1,082	98	Weighted Average
21		1.94% Pervious Area
1,061		98.06% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min. Tc

Subcatchment 4.5S: Townhouse TDs



Summary for Subcatchment 4.6S: Townhouse TDs

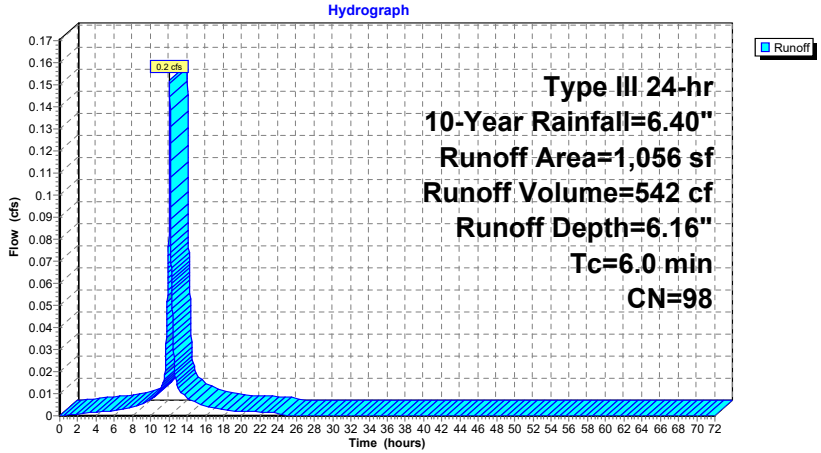
Runoff = 0.2 cfs @ 12.08 hrs, Volume= 542 cf, Depth= 6.16"
Routed to Pond 1P : Underground Infiltration System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=6.40"

Area (sf)	CN	Description
1,048	98	Paved parking, HSG C
8	74	>75% Grass cover, Good, HSG C
1,056	98	Weighted Average
8		0.76% Pervious Area
1,048		99.24% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min. Tc

Subcatchment 4.6S: Townhouse TDs



Summary for Subcatchment 5S: TD-1

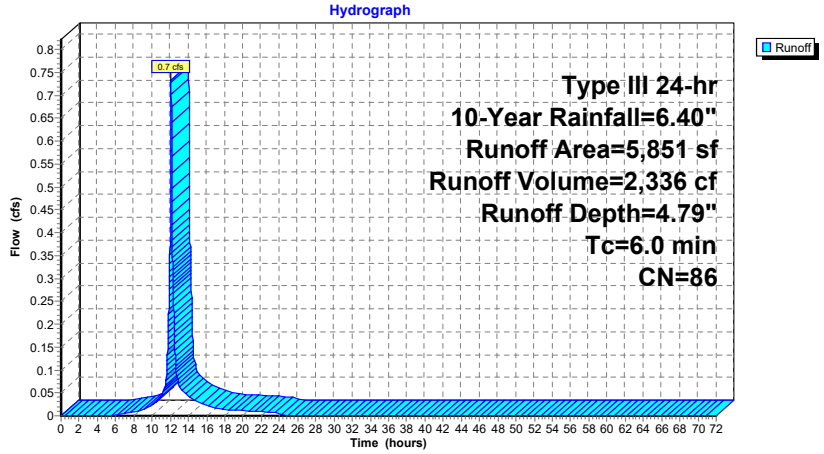
Runoff = 0.7 cfs @ 12.09 hrs, Volume= 2,336 cf, Depth= 4.79"
Routed to Pond 1P : Underground Infiltration System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=6.40"

Area (sf)	CN	Description
3,021	98	Paved parking, HSG C
2,830	74	>75% Grass cover, Good, HSG C
5,851	86	Weighted Average
2,830		48.37% Pervious Area
3,021		51.63% Impervious Area

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

Subcatchment 5S: TD-1



Summary for Subcatchment 6.1S: East driveway

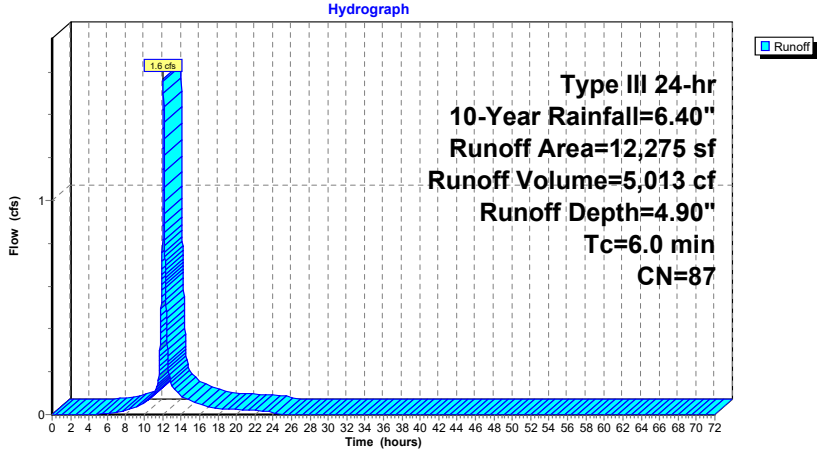
Runoff = 1.6 cfs @ 12.09 hrs, Volume= 5,013 cf, Depth= 4.90"
Routed to Pond 3P : Rain garden

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=6.40"

Area (sf)	CN	Description
5,611	74	>75% Grass cover, Good, HSG C
6,444	98	Paved roads w/curbs & sewers, HSG C
220	89	Gravel roads, HSG C
12,275	87	Weighted Average
5,831		47.50% Pervious Area
6,444		52.50% Impervious Area

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

Subcatchment 6.1S: East driveway



Summary for Subcatchment 6S: Bypass Towards Wetlands

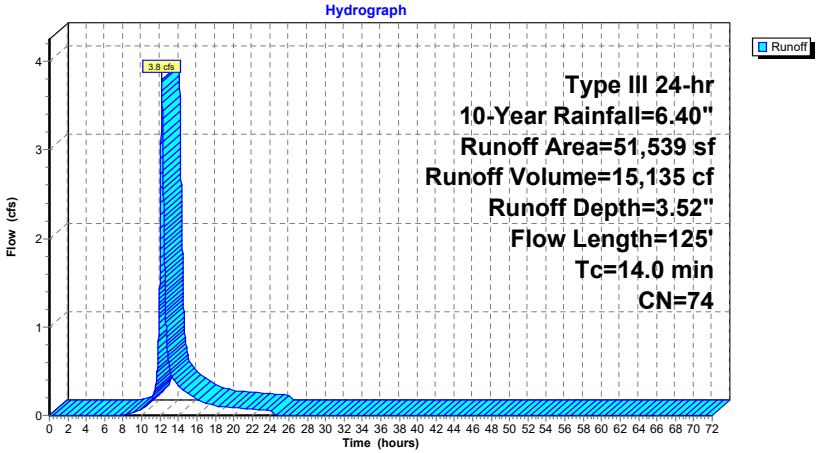
Runoff = 3.8 cfs @ 12.19 hrs, Volume= 15,135 cf, Depth= 3.52"
Routed to Link 1L : Towards Wetlands

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=6.40"

Area (sf)	CN	Description
4,985	70	Woods, Good, HSG C
46,447	74	>75% Grass cover, Good, HSG C
107	98	Roofs, HSG C
51,539	74	Weighted Average
51,432		99.79% Pervious Area
107		0.21% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.8	50	0.0220	0.07		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.23"
2.2	75	0.0133	0.58		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
14.0	125	Total			

Subcatchment 6S: Bypass Towards Wetlands



Summary for Subcatchment 7S: To Street

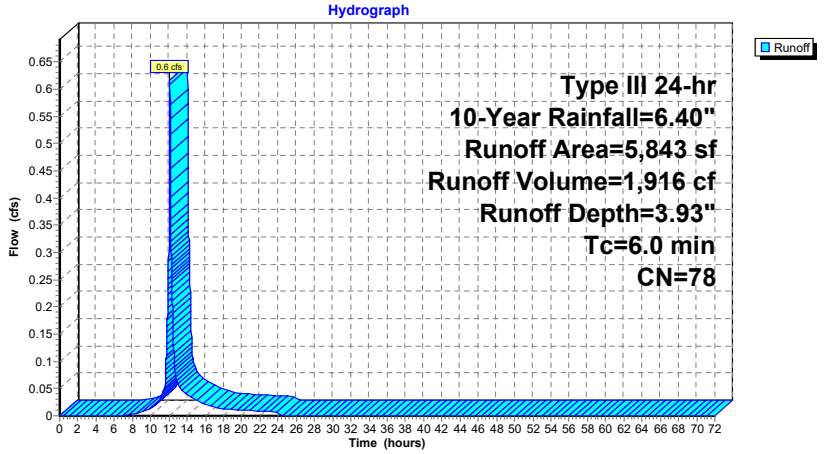
Runoff = 0.6 cfs @ 12.09 hrs, Volume= 1,916 cf, Depth= 3.93"
Routed to Link 2L : Towards Street

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=6.40"

Area (sf)	CN	Description
1,056	98	Paved parking, HSG C
4,787	74	>75% Grass cover, Good, HSG C
5,843	78	Weighted Average
4,787		81.93% Pervious Area
1,056		18.07% Impervious Area

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

Subcatchment 7S: To Street



Summary for Pond 1P: Underground Infiltration System

Inflow Area = 81,218 sf, 77.83% Impervious, Inflow Depth > 5.54" for 10-Year event
Inflow = 7.3 cfs @ 12.09 hrs, Volume= 37,510 cf
Outflow = 2.9 cfs @ 12.35 hrs, Volume= 37,508 cf, Atten= 60%, Lag= 15.7 min
Discarded = 0.1 cfs @ 7.20 hrs, Volume= 11,761 cf
Primary = 2.8 cfs @ 12.35 hrs, Volume= 25,748 cf
Routed to Link 1L : Towards Wetlands

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 7.85' @ 12.35 hrs Surf.Area= 8,137 sf Storage= 9,468 cf

Plug-Flow detention time= 140.1 min calculated for 37,508 cf (100% of inflow)
Center-of-Mass det. time= 139.9 min (1,041.4 - 901.5)

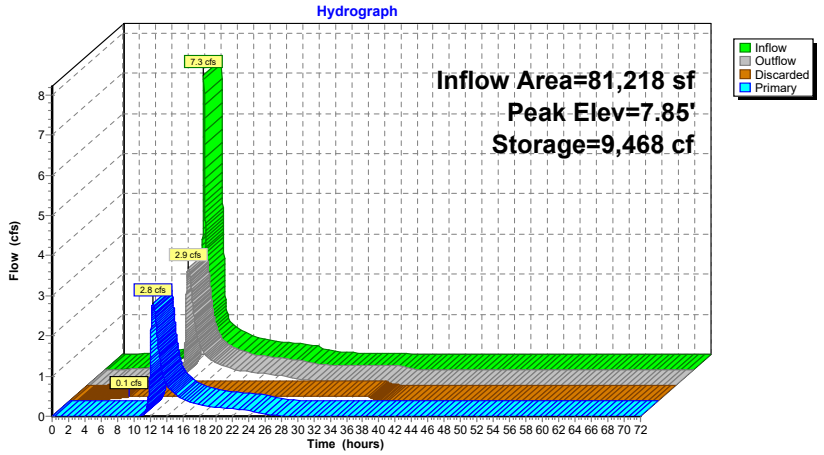
Volume	Invert	Avail.Storage	Storage Description
#1	6.50'	17,495 cf	**6.89'W x 14.06'L x 2.50'H StormTrap ST-1 Units (Irregular Shape)** x 84 20,343 cf Overall x 86.0% Voids

Device	Routing	Invert	Outlet Devices
#1	Discarded	6.50'	**0.520 in/hr Exfiltration over Surface area**
#2	Primary	6.80'	**18.0" Round Culvert** L= 190.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 6.80' / 6.00' S= 0.0042 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf
#3	Device 2	6.80'	**12.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Device 2	8.25'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Discarded OutFlow Max=0.1 cfs @ 7.20 hrs HW=6.53' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.1 cfs)

Primary OutFlow Max=2.8 cfs @ 12.35 hrs HW=7.85' (Free Discharge)
└**2=Culvert** (Passes 2.8 cfs of 3.6 cfs potential flow)
  └**3=Orifice/Grate** (Orifice Controls 2.8 cfs @ 3.58 fps)
  └**4=Sharp-Crested Rectangular Weir** (Controls 0.0 cfs)

Pond 1P: Underground Infiltration System



Summary for Pond 2P: Rooftop Detention

Inflow Area = 25,114 sf,100.00% Impervious, Inflow Depth = 6.16" for 10-Year event
Inflow = 3.6 cfs @ 12.08 hrs, Volume= 12,895 cf
Outflow = 0.3 cfs @ 13.30 hrs, Volume= 12,842 cf, Atten= 93%, Lag= 72.7 min
Primary = 0.3 cfs @ 13.30 hrs, Volume= 12,842 cf
Routed to Pond 1P : Underground Infiltration System

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 57.36' @ 13.30 hrs Surf.Area= 20,000 sf Storage= 7,258 cf

Plug-Flow detention time= 406.8 min calculated for 12,842 cf (100% of inflow)
Center-of-Mass det. time= 404.0 min (1,148.2 - 744.2)

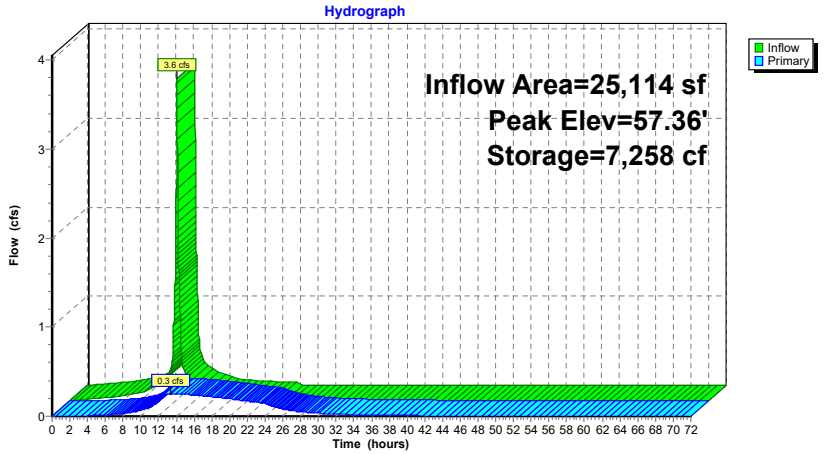
Volume	Invert	Avail.Storage	Storage Description
#1	57.00'	14,000 cf	**Rooftop Detention (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
57.00	20,000	0	0
57.70	20,000	14,000	14,000

Device	Routing	Invert	Outlet Devices
#1	Primary	8.02'	**12.0" Round Roof Drain** L= 16.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 8.02' / 7.70' S= 0.0200 '/' Cc= 0.900 n= 0.013, Flow Area= 0.79 sf
#2	Device 1	57.00'	**4.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.3 cfs @ 13.30 hrs HW=57.36' (Free Discharge)
└**1=Roof Drain** (Passes 0.3 cfs of 23.3 cfs potential flow)
└**2=Orifice/Grate** (Orifice Controls 0.3 cfs @ 2.90 fps)

Pond 2P: Rooftop Detention



Summary for Pond 3P: Rain garden

Inflow Area = 12,275 sf, 52.50% Impervious, Inflow Depth = 4.90" for 10-Year event
Inflow = 1.6 cfs @ 12.09 hrs, Volume= 5,013 cf
Outflow = 1.6 cfs @ 12.09 hrs, Volume= 5,013 cf, Atten= 0%, Lag= 0.3 min
Discarded = 0.0 cfs @ 12.09 hrs, Volume= 442 cf
Primary = 1.6 cfs @ 12.09 hrs, Volume= 4,571 cf
Routed to Link 1L : Towards Wetlands

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 6.40' @ 12.09 hrs Surf.Area= 402 sf Storage= 208 cf

Plug-Flow detention time= 47.7 min calculated for 5,012 cf (100% of inflow)
Center-of-Mass det. time= 47.9 min (840.3 - 792.4)

Volume	Invert	Avail.Storage	Storage Description
#1	5.60'	253 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

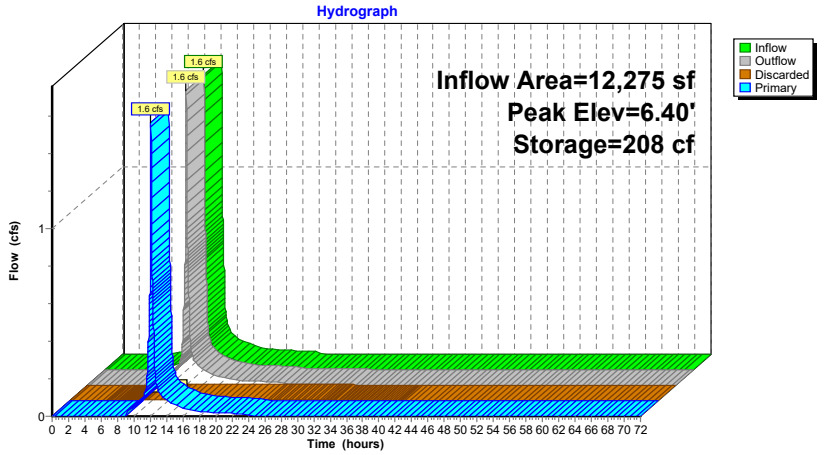
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
5.60	125	46.0	0	0	125
6.00	276	66.0	78	78	305
6.30	350	73.0	94	172	385
6.50	460	87.0	81	253	564

Device	Routing	Invert	Outlet Devices
#1	Discarded	5.60'	**0.520 in/hr Exfiltration over Surface area**
#2	Primary	6.30'	**22.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Discarded OutFlow Max=0.0 cfs @ 12.09 hrs HW=6.40' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.0 cfs)

Primary OutFlow Max=1.6 cfs @ 12.09 hrs HW=6.40' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** (Weir Controls 1.6 cfs @ 0.73 fps)

Pond 3P: Rain garden

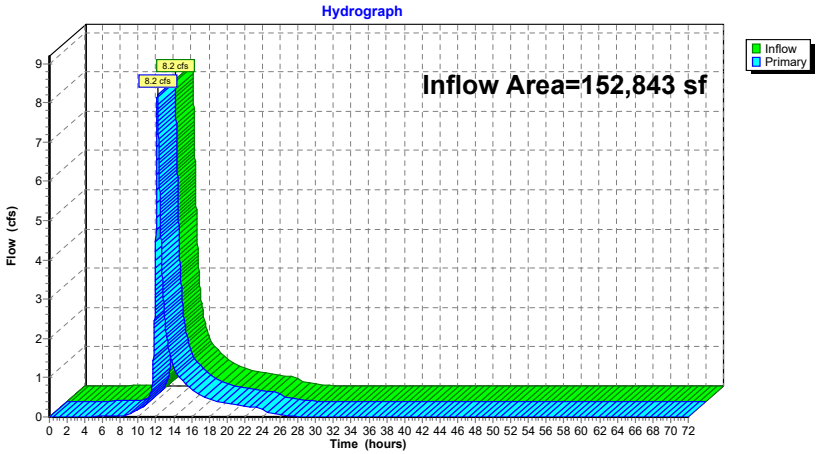


Summary for Link 1L: Towards Wetlands

Inflow Area = 152,843 sf, 50.75% Impervious, Inflow Depth = 3.88" for 10-Year event
Inflow = 8.2 cfs @ 12.15 hrs, Volume= 49,465 cf
Primary = 8.2 cfs @ 12.15 hrs, Volume= 49,465 cf, Atten= 0%, Lag= 0.0 min
Routed to Link 100L : Total Flows

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link 1L: Towards Wetlands

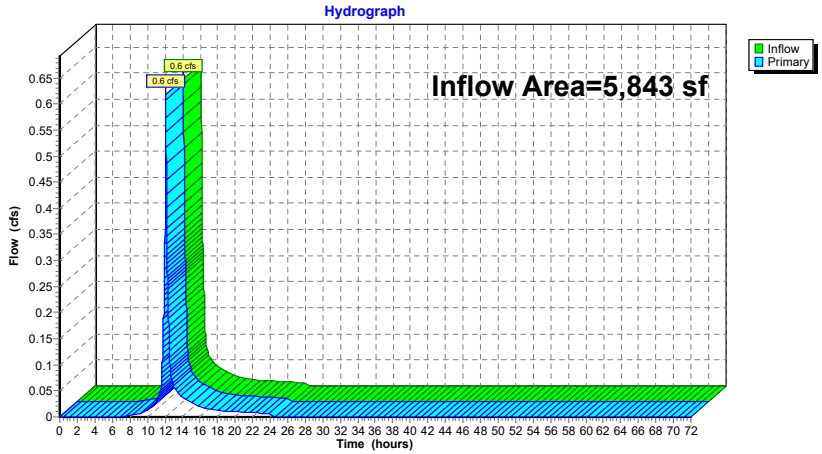


Summary for Link 2L: Towards Street

Inflow Area = 5,843 sf, 18.07% Impervious, Inflow Depth = 3.93" for 10-Year event
Inflow = 0.6 cfs @ 12.09 hrs, Volume= 1,916 cf
Primary = 0.6 cfs @ 12.09 hrs, Volume= 1,916 cf, Atten= 0%, Lag= 0.0 min
Routed to Link 100L : Total Flows

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link 2L: Towards Street

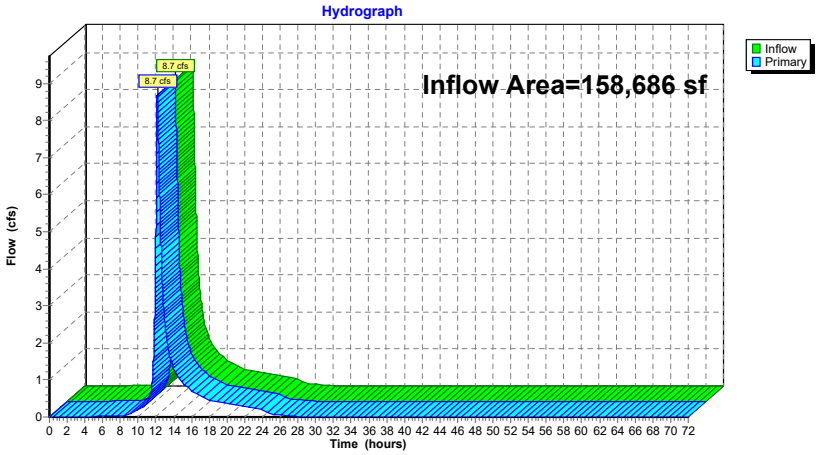


Summary for Link 100L: Total Flows

Inflow Area = 158,686 sf, 49.55% Impervious, Inflow Depth = 3.89" for 10-Year event
Inflow = 8.7 cfs @ 12.14 hrs, Volume= 51,381 cf
Primary = 8.7 cfs @ 12.14 hrs, Volume= 51,381 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link 100L: Total Flows



Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: CB-1 Runoff Area=22,742 sf 72.16% Impervious Runoff Depth=7.22"
Tc=6.0 min CN=91 Runoff=4.1 cfs 13,685 cf

Subcatchment2.1S: Building Runoff Area=7,811 sf 100.00% Impervious Runoff Depth=8.06"
Tc=6.0 min CN=98 Runoff=1.5 cfs 5,246 cf

Subcatchment2S: Building Roof Runoff Area=25,114 sf 100.00% Impervious Runoff Depth=8.06"
Tc=6.0 min CN=98 Runoff=4.7 cfs 16,868 cf

Subcatchment3.1S: Backyard ADs Runoff Area=8,985 sf 3.03% Impervious Runoff Depth=5.31"
Flow Length=147' Tc=10.3 min CN=75 Runoff=1.1 cfs 3,978 cf

Subcatchment3S: Townhouse Roofs Runoff Area=13,067 sf 100.00% Impervious Runoff Depth=8.06"
Tc=6.0 min CN=98 Runoff=2.4 cfs 8,777 cf

Subcatchment4.2S: Townhouse TDs Runoff Area=1,112 sf 95.68% Impervious Runoff Depth=7.94"
Tc=6.0 min CN=97 Runoff=0.2 cfs 736 cf

Subcatchment4.3S: Townhouse TDs Runoff Area=1,105 sf 97.29% Impervious Runoff Depth=7.94"
Tc=6.0 min CN=97 Runoff=0.2 cfs 731 cf

Subcatchment4.4S: Townhouse TDs Runoff Area=1,104 sf 97.46% Impervious Runoff Depth=7.94"
Tc=6.0 min CN=97 Runoff=0.2 cfs 730 cf

Subcatchment4.5S: Townhouse TDs Runoff Area=1,082 sf 98.06% Impervious Runoff Depth=8.06"
Tc=6.0 min CN=98 Runoff=0.2 cfs 727 cf

Subcatchment4.6S: Townhouse TDs Runoff Area=1,056 sf 99.24% Impervious Runoff Depth=8.06"
Tc=6.0 min CN=98 Runoff=0.2 cfs 709 cf

Subcatchment5S: TD-1 Runoff Area=5,851 sf 51.63% Impervious Runoff Depth=6.62"
Tc=6.0 min CN=86 Runoff=1.0 cfs 3,229 cf

Subcatchment6.1S: East driveway Runoff Area=12,275 sf 52.50% Impervious Runoff Depth=6.74"
Tc=6.0 min CN=87 Runoff=2.1 cfs 6,897 cf

Subcatchment6S: Bypass Towards Runoff Area=51,539 sf 0.21% Impervious Runoff Depth=5.19"
Flow Length=125' Tc=14.0 min CN=74 Runoff=5.6 cfs 22,311 cf

Subcatchment7S: To Street Runoff Area=5,843 sf 18.07% Impervious Runoff Depth=5.67"
Tc=6.0 min CN=78 Runoff=0.9 cfs 2,760 cf

Pond 1P: Underground Infiltration System Peak Elev=8.22' Storage=12,020 cf Inflow=9.7 cfs 50,110 cf
Discarded=0.1 cfs 13,046 cf Primary=3.6 cfs 37,062 cf Outflow=3.7 cfs 50,108 cf

Pond 2P: Rooftop Detention Peak Elev=57.48' Storage=9,608 cf Inflow=4.7 cfs 16,868 cf
Outflow=0.3 cfs 16,808 cf

Pond 3P: Rain garden Peak Elev=6.42' Storage=217 cf Inflow=2.1 cfs 6,897 cf
Discarded=0.0 cfs 459 cf Primary=2.1 cfs 6,438 cf Outflow=2.1 cfs 6,897 cf

Link 1L: Towards Wetlands Inflow=11.4 cfs 71,057 cf
Primary=11.4 cfs 71,057 cf

Link 2L: Towards Street Inflow=0.9 cfs 2,760 cf
Primary=0.9 cfs 2,760 cf

Link 100L: Total Flows Inflow=12.1 cfs 73,817 cf
Primary=12.1 cfs 73,817 cf

Total Runoff Area = 158,686 sf Runoff Volume = 87,385 cf Average Runoff Depth = 6.61"
50.45% Pervious = 80,060 sf 49.55% Impervious = 78,626 sf

Summary for Subcatchment 1S: CB-1

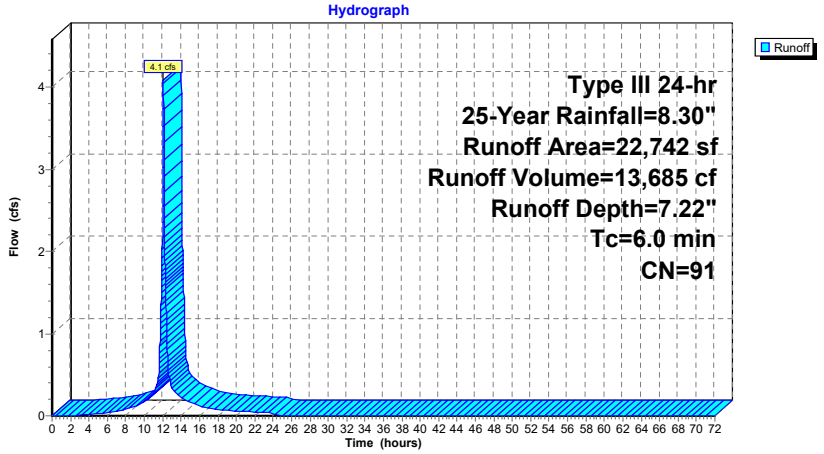
Runoff = 4.1 cfs @ 12.08 hrs, Volume= 13,685 cf, Depth= 7.22"
Routed to Pond 1P : Underground Infiltration System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.30"

Area (sf)	CN	Description
16,410	98	Paved parking, HSG C
6,332	74	>75% Grass cover, Good, HSG C
22,742	91	Weighted Average
6,332		27.84% Pervious Area
16,410		72.16% Impervious Area

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

Subcatchment 1S: CB-1



Summary for Subcatchment 2.1S: Building Roof-Southeast

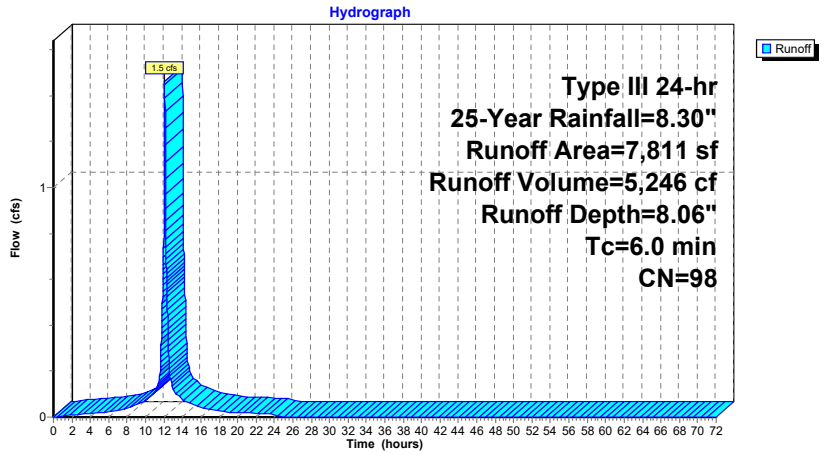
Runoff = 1.5 cfs @ 12.08 hrs, Volume= 5,246 cf, Depth= 8.06"
Routed to Link 1L : Towards Wetlands

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.30"

Area (sf)	CN	Description
7,811	98	Roofs, HSG C
7,811		100.00% Impervious Area

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

Subcatchment 2.1S: Building Roof-Southeast



Summary for Subcatchment 2S: Building Roof

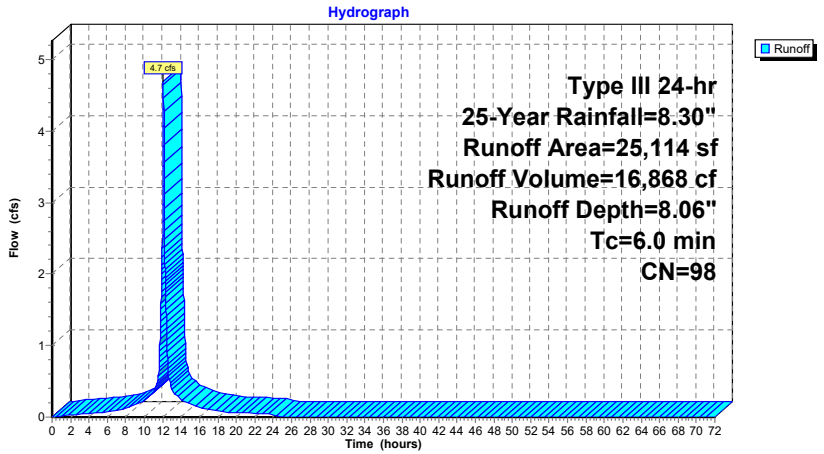
Runoff = 4.7 cfs @ 12.08 hrs, Volume= 16,868 cf, Depth= 8.06"
Routed to Pond 2P : Rooftop Detention

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.30"

Area (sf)	CN	Description
25,114	98	Roofs, HSG C
25,114		100.00% Impervious Area

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

Subcatchment 2S: Building Roof



Summary for Subcatchment 3.1S: Backyard ADs

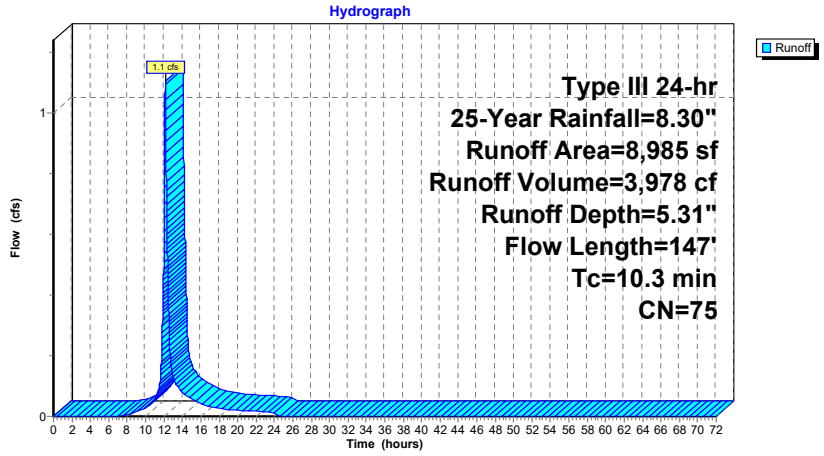
Runoff = 1.1 cfs @ 12.14 hrs, Volume= 3,978 cf, Depth= 5.31"
Routed to Pond 1P : Underground Infiltration System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.30"

	Area (sf)	CN	Description
	272	98	Unconnected pavement, HSG C
	8,302	74	>75% Grass cover, Good, HSG C
*	411	89	Gravel sidewalk, HSG C
	8,985	75	Weighted Average
	8,713		96.97% Pervious Area
	272		3.03% Impervious Area
	272		100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.4	50	0.0142	0.09		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.23"
0.9	97	0.0154	1.86		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
10.3	147	Total			

Subcatchment 3.1S: Backyard ADs



Summary for Subcatchment 3S: Townhouse Roofs

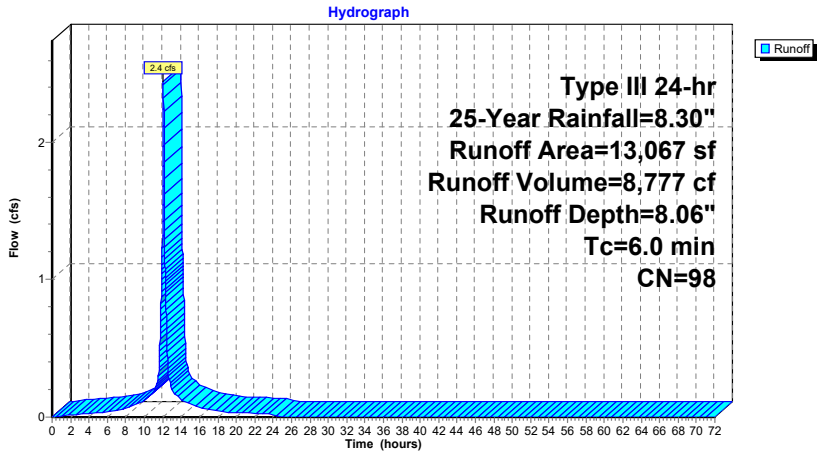
Runoff = 2.4 cfs @ 12.08 hrs, Volume= 8,777 cf, Depth= 8.06"
Routed to Pond 1P : Underground Infiltration System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.30"

Area (sf)	CN	Description
13,067	98	Roofs, HSG C
13,067		100.00% Impervious Area

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

Subcatchment 3S: Townhouse Roofs



Summary for Subcatchment 4.2S: Townhouse TDs

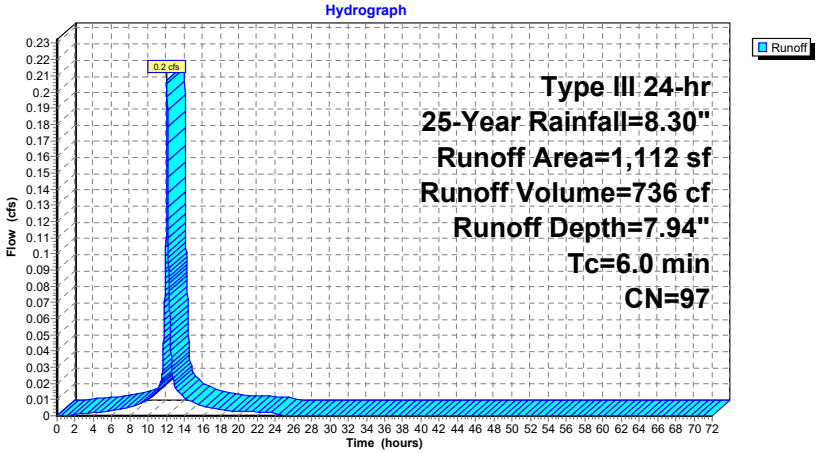
Runoff = 0.2 cfs @ 12.08 hrs, Volume= 736 cf, Depth= 7.94"
Routed to Pond 1P : Underground Infiltration System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.30"

Area (sf)	CN	Description
1,064	98	Paved parking, HSG C
48	74	>75% Grass cover, Good, HSG C
1,112	97	Weighted Average
48		4.32% Pervious Area
1,064		95.68% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min. Tc

Subcatchment 4.2S: Townhouse TDs



Summary for Subcatchment 4.3S: Townhouse TDs

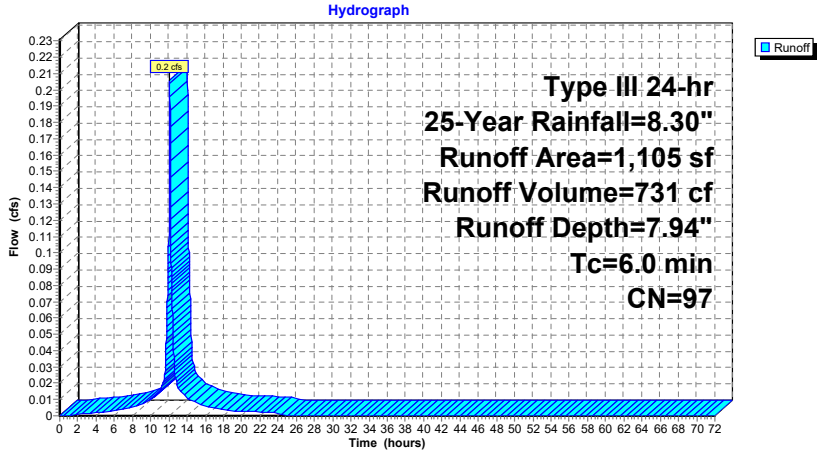
Runoff = 0.2 cfs @ 12.08 hrs, Volume= 731 cf, Depth= 7.94"
Routed to Pond 1P : Underground Infiltration System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.30"

Area (sf)	CN	Description
1,075	98	Paved parking, HSG C
30	74	>75% Grass cover, Good, HSG C
1,105	97	Weighted Average
30		2.71% Pervious Area
1,075		97.29% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min. Tc

Subcatchment 4.3S: Townhouse TDs



Summary for Subcatchment 4.4S: Townhouse TDs

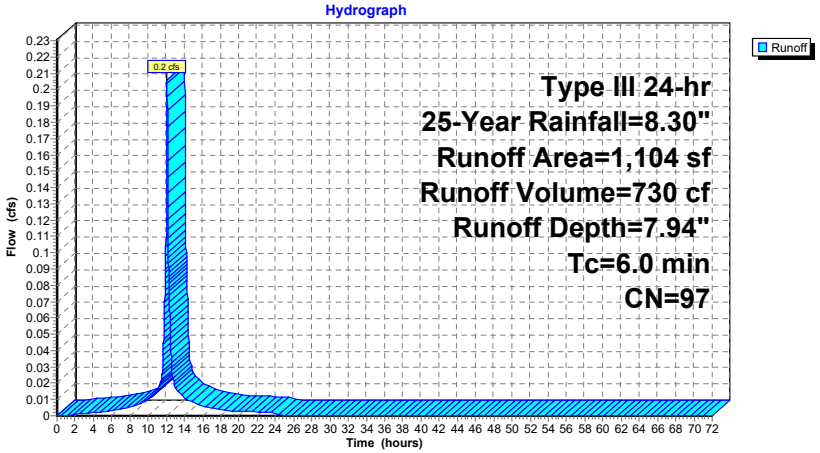
Runoff = 0.2 cfs @ 12.08 hrs, Volume= 730 cf, Depth= 7.94"
Routed to Pond 1P : Underground Infiltration System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.30"

Area (sf)	CN	Description
1,076	98	Paved parking, HSG C
28	74	>75% Grass cover, Good, HSG C
1,104	97	Weighted Average
28		2.54% Pervious Area
1,076		97.46% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min. Tc

Subcatchment 4.4S: Townhouse TDs



Summary for Subcatchment 4.5S: Townhouse TDs

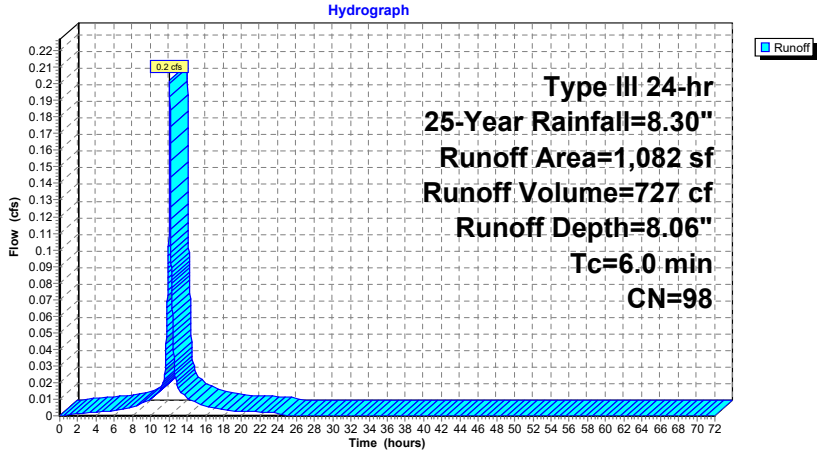
Runoff = 0.2 cfs @ 12.08 hrs, Volume= 727 cf, Depth= 8.06"
Routed to Pond 1P : Underground Infiltration System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.30"

Area (sf)	CN	Description
1,061	98	Paved parking, HSG C
21	74	>75% Grass cover, Good, HSG C
1,082	98	Weighted Average
21		1.94% Pervious Area
1,061		98.06% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min. Tc

Subcatchment 4.5S: Townhouse TDs



Summary for Subcatchment 4.6S: Townhouse TDs

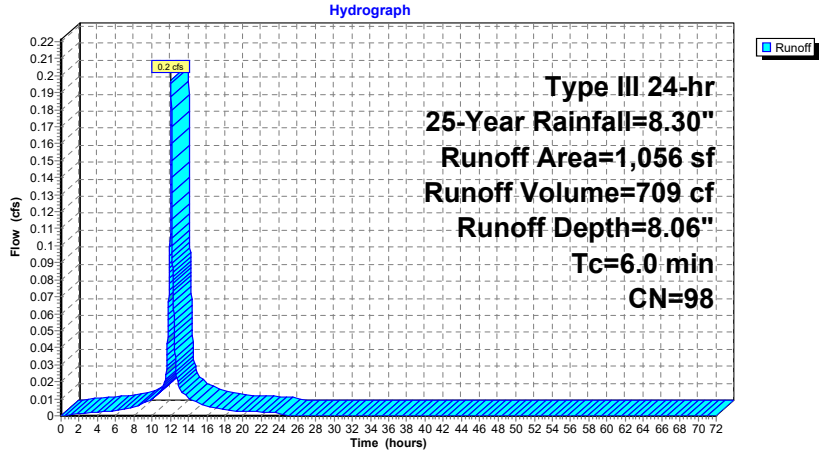
Runoff = 0.2 cfs @ 12.08 hrs, Volume= 709 cf, Depth= 8.06"
Routed to Pond 1P : Underground Infiltration System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.30"

Area (sf)	CN	Description
1,048	98	Paved parking, HSG C
8	74	>75% Grass cover, Good, HSG C
1,056	98	Weighted Average
8		0.76% Pervious Area
1,048		99.24% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min. Tc

Subcatchment 4.6S: Townhouse TDs



Summary for Subcatchment 5S: TD-1

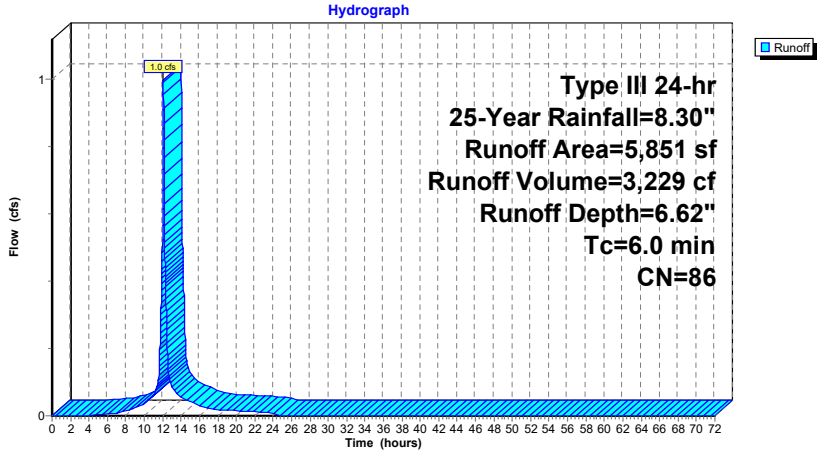
Runoff = 1.0 cfs @ 12.08 hrs, Volume= 3,229 cf, Depth= 6.62"
Routed to Pond 1P : Underground Infiltration System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.30"

Area (sf)	CN	Description
3,021	98	Paved parking, HSG C
2,830	74	>75% Grass cover, Good, HSG C
5,851	86	Weighted Average
2,830		48.37% Pervious Area
3,021		51.63% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min. Tc

Subcatchment 5S: TD-1



Summary for Subcatchment 6.1S: East driveway

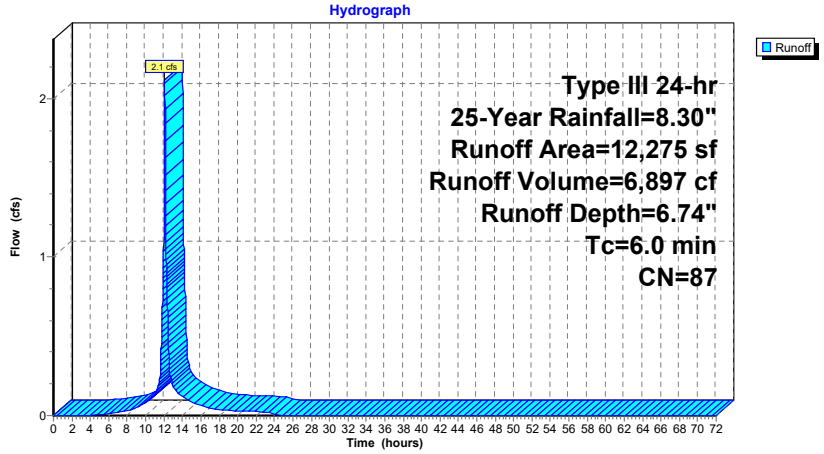
Runoff = 2.1 cfs @ 12.08 hrs, Volume= 6,897 cf, Depth= 6.74"
Routed to Pond 3P : Rain garden

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.30"

Area (sf)	CN	Description
5,611	74	>75% Grass cover, Good, HSG C
6,444	98	Paved roads w/curbs & sewers, HSG C
220	89	Gravel roads, HSG C
12,275	87	Weighted Average
5,831		47.50% Pervious Area
6,444		52.50% Impervious Area

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

Subcatchment 6.1S: East driveway



Summary for Subcatchment 6S: Bypass Towards Wetlands

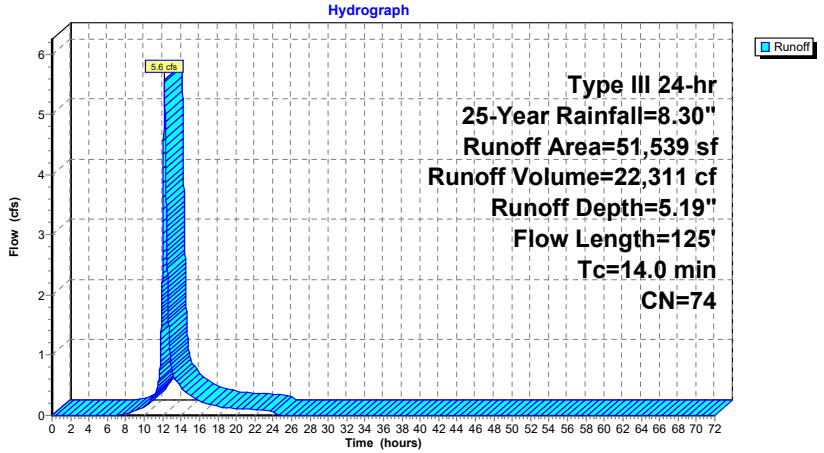
Runoff = 5.6 cfs @ 12.19 hrs, Volume= 22,311 cf, Depth= 5.19"
Routed to Link 1L : Towards Wetlands

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.30"

Area (sf)	CN	Description
4,985	70	Woods, Good, HSG C
46,447	74	>75% Grass cover, Good, HSG C
107	98	Roofs, HSG C
51,539	74	Weighted Average
51,432		99.79% Pervious Area
107		0.21% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.8	50	0.0220	0.07		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.23"
2.2	75	0.0133	0.58		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
14.0	125	Total			

Subcatchment 6S: Bypass Towards Wetlands



Summary for Subcatchment 7S: To Street

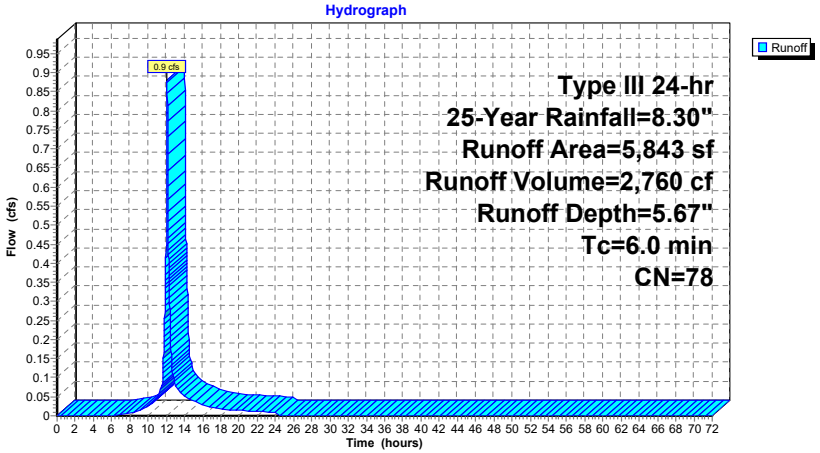
Runoff = 0.9 cfs @ 12.09 hrs, Volume= 2,760 cf, Depth= 5.67"
Routed to Link 2L : Towards Street

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.30"

Area (sf)	CN	Description
1,056	98	Paved parking, HSG C
4,787	74	>75% Grass cover, Good, HSG C
5,843	78	Weighted Average
4,787		81.93% Pervious Area
1,056		18.07% Impervious Area

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

Subcatchment 7S: To Street



Summary for Pond 1P: Underground Infiltration System

Inflow Area = 81,218 sf, 77.83% Impervious, Inflow Depth = 7.40" for 25-Year event
Inflow = 9.7 cfs @ 12.09 hrs, Volume= 50,110 cf
Outflow = 3.7 cfs @ 12.36 hrs, Volume= 50,108 cf, Atten= 62%, Lag= 16.4 min
Discarded = 0.1 cfs @ 5.98 hrs, Volume= 13,046 cf
Primary = 3.6 cfs @ 12.36 hrs, Volume= 37,062 cf
Routed to Link 1L : Towards Wetlands

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 8.22' @ 12.36 hrs Surf.Area= 8,137 sf Storage= 12,020 cf

Plug-Flow detention time= 127.6 min calculated for 50,101 cf (100% of inflow)
Center-of-Mass det. time= 127.5 min (1,033.4 - 905.9)

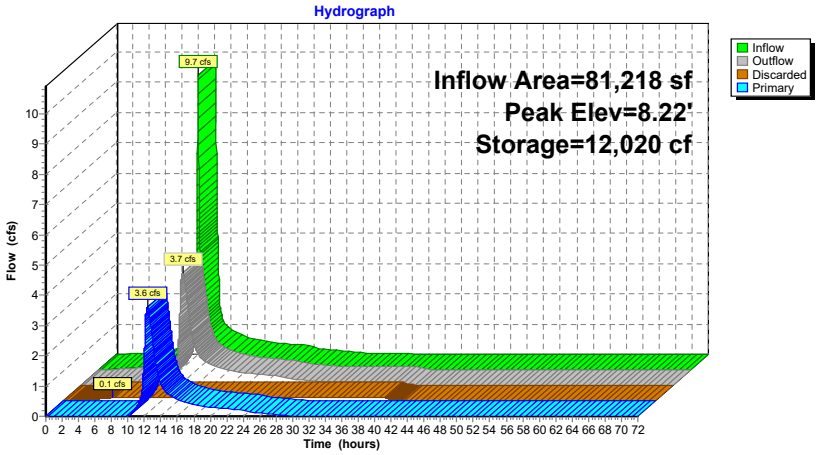
Volume	Invert	Avail.Storage	Storage Description
#1	6.50'	17,495 cf	**6.89'W x 14.06'L x 2.50'H StormTrap ST-1 Units (Irregular Shape)** x 84 20,343 cf Overall x 86.0% Voids

Device	Routing	Invert	Outlet Devices
#1	Discarded	6.50'	**0.520 in/hr Exfiltration over Surface area**
#2	Primary	6.80'	**18.0" Round Culvert** L= 190.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 6.80' / 6.00' S= 0.0042 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf
#3	Device 2	6.80'	**12.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Device 2	8.25'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Discarded OutFlow Max=0.1 cfs @ 5.98 hrs HW=6.53' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.1 cfs)

Primary OutFlow Max=3.6 cfs @ 12.36 hrs HW=8.22' (Free Discharge)
└**2=Culvert** (Passes 3.6 cfs of 5.6 cfs potential flow)
  └**3=Orifice/Grate** (Orifice Controls 3.6 cfs @ 4.61 fps)
  └**4=Sharp-Crested Rectangular Weir** (Controls 0.0 cfs)

Pond 1P: Underground Infiltration System



Summary for Pond 2P: Rooftop Detention

Inflow Area = 25,114 sf,100.00% Impervious, Inflow Depth = 8.06" for 25-Year event
Inflow = 4.7 cfs @ 12.08 hrs, Volume= 16,868 cf
Outflow = 0.3 cfs @ 13.62 hrs, Volume= 16,808 cf, Atten= 94%, Lag= 92.1 min
Primary = 0.3 cfs @ 13.62 hrs, Volume= 16,808 cf
Routed to Pond 1P : Underground Infiltration System

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 57.48' @ 13.62 hrs Surf.Area= 20,000 sf Storage= 9,608 cf

Plug-Flow detention time= 442.0 min calculated for 16,805 cf (100% of inflow)
Center-of-Mass det. time= 439.8 min (1,180.6 - 740.8)

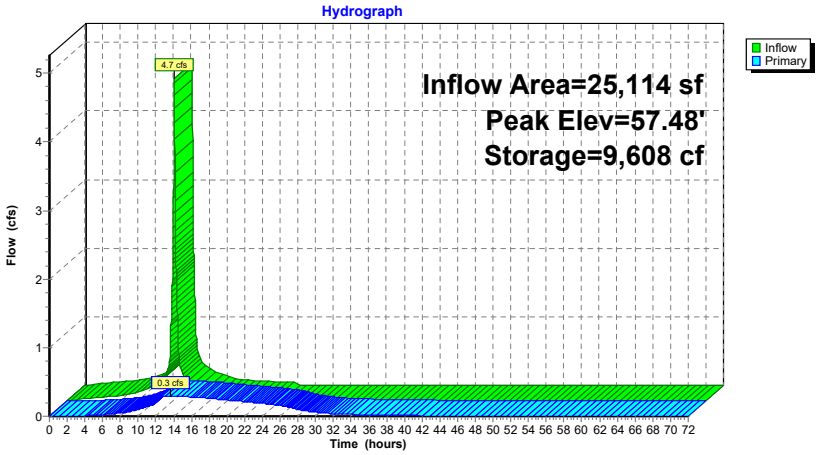
Volume	Invert	Avail.Storage	Storage Description
#1	57.00'	14,000 cf	**Rooftop Detention (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
57.00	20,000	0	0
57.70	20,000	14,000	14,000

Device	Routing	Invert	Outlet Devices
#1	Primary	8.02'	**12.0" Round Roof Drain** L= 16.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 8.02' / 7.70' S= 0.0200 '/' Cc= 0.900 n= 0.013, Flow Area= 0.79 sf
#2	Device 1	57.00'	**4.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.3 cfs @ 13.62 hrs HW=57.48' (Free Discharge)
└**1=Roof Drain** (Passes 0.3 cfs of 23.3 cfs potential flow)
└**2=Orifice/Grate** (Orifice Controls 0.3 cfs @ 3.34 fps)

Pond 2P: Rooftop Detention



Summary for Pond 3P: Rain garden

Inflow Area = 12,275 sf, 52.50% Impervious, Inflow Depth = 6.74" for 25-Year event
Inflow = 2.1 cfs @ 12.08 hrs, Volume= 6,897 cf
Outflow = 2.1 cfs @ 12.09 hrs, Volume= 6,897 cf, Atten= 0%, Lag= 0.3 min
Discarded = 0.0 cfs @ 12.09 hrs, Volume= 459 cf
Primary = 2.1 cfs @ 12.09 hrs, Volume= 6,438 cf
Routed to Link 1L : Towards Wetlands

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 6.42' @ 12.09 hrs Surf.Area= 414 sf Storage= 217 cf

Plug-Flow detention time= 36.5 min calculated for 6,896 cf (100% of inflow)
Center-of-Mass det. time= 36.7 min (820.5 - 783.8)

Volume	Invert	Avail.Storage	Storage Description
#1	5.60'	253 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

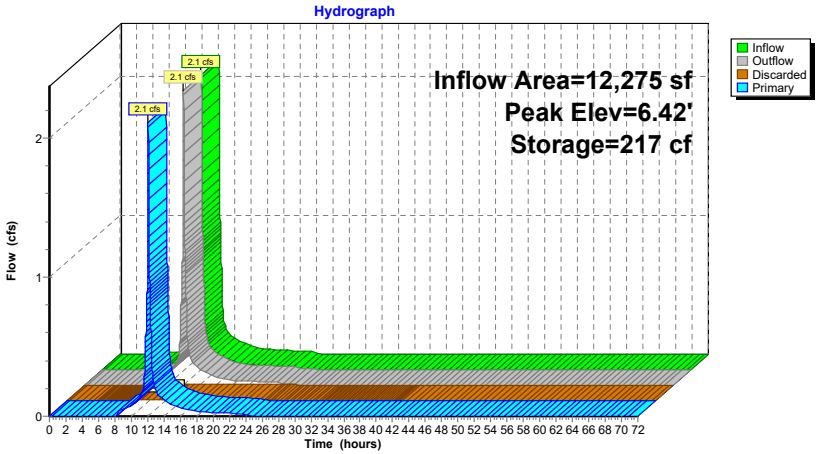
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
5.60	125	46.0	0	0	125
6.00	276	66.0	78	78	305
6.30	350	73.0	94	172	385
6.50	460	87.0	81	253	564

Device	Routing	Invert	Outlet Devices
#1	Discarded	5.60'	**0.520 in/hr Exfiltration over Surface area**
#2	Primary	6.30'	**22.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Discarded OutFlow Max=0.0 cfs @ 12.09 hrs HW=6.42' (Free Discharge)
↑**1=Exfiltration** (Exfiltration Controls 0.0 cfs)

Primary OutFlow Max=2.1 cfs @ 12.09 hrs HW=6.42' (Free Discharge)
↑**2=Broad-Crested Rectangular Weir** (Weir Controls 2.1 cfs @ 0.81 fps)

Pond 3P: Rain garden

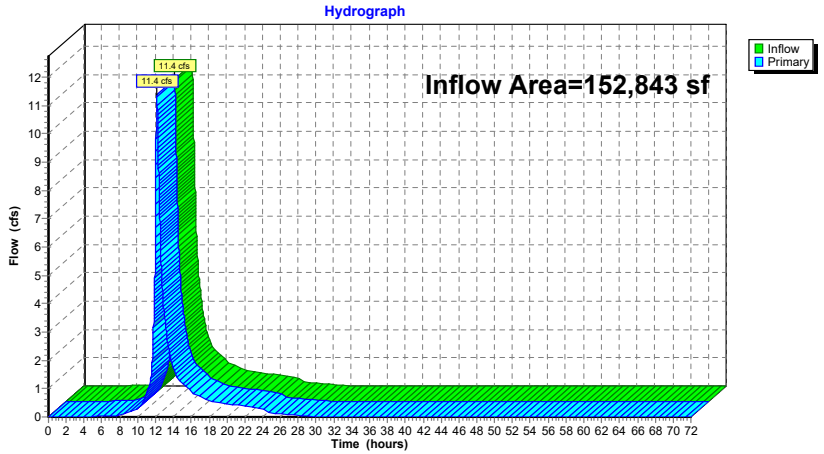


Summary for Link 1L: Towards Wetlands

Inflow Area = 152,843 sf, 50.75% Impervious, Inflow Depth = 5.58" for 25-Year event
Inflow = 11.4 cfs @ 12.15 hrs, Volume= 71,057 cf
Primary = 11.4 cfs @ 12.15 hrs, Volume= 71,057 cf, Atten= 0%, Lag= 0.0 min
Routed to Link 100L : Total Flows

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link 1L: Towards Wetlands

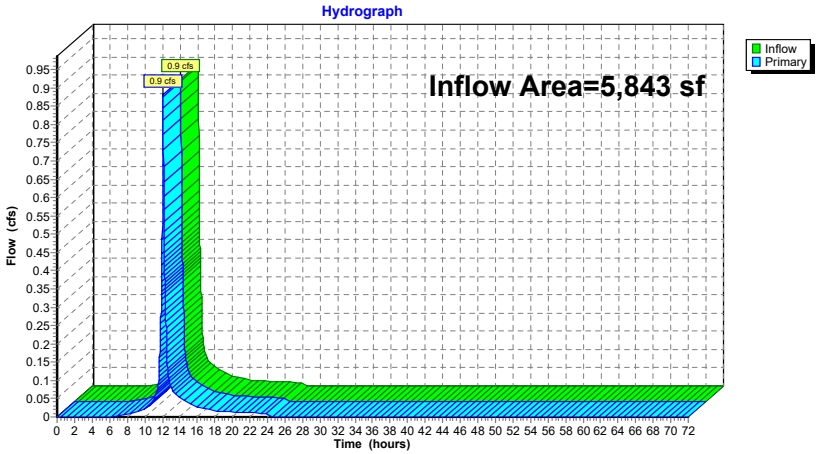


Summary for Link 2L: Towards Street

Inflow Area = 5,843 sf, 18.07% Impervious, Inflow Depth = 5.67" for 25-Year event
Inflow = 0.9 cfs @ 12.09 hrs, Volume= 2,760 cf
Primary = 0.9 cfs @ 12.09 hrs, Volume= 2,760 cf, Atten= 0%, Lag= 0.0 min
Routed to Link 100L : Total Flows

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link 2L: Towards Street

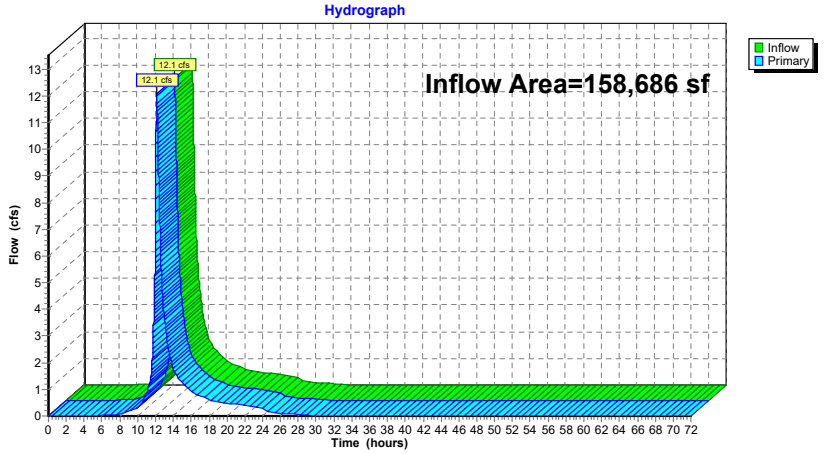


Summary for Link 100L: Total Flows

Inflow Area = 158,686 sf, 49.55% Impervious, Inflow Depth = 5.58" for 25-Year event
Inflow = 12.1 cfs @ 12.14 hrs, Volume= 73,817 cf
Primary = 12.1 cfs @ 12.14 hrs, Volume= 73,817 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link 100L: Total Flows



Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: CB-1 Runoff Area=22,742 sf 72.16% Impervious Runoff Depth=8.58"
Tc=6.0 min CN=91 Runoff=4.8 cfs 16,254 cf

Subcatchment2.1S: Building Runoff Area=7,811 sf 100.00% Impervious Runoff Depth=9.43"
Tc=6.0 min CN=98 Runoff=1.7 cfs 6,138 cf

Subcatchment2S: Building Roof Runoff Area=25,114 sf 100.00% Impervious Runoff Depth=9.43"
Tc=6.0 min CN=98 Runoff=5.5 cfs 19,734 cf

Subcatchment3.1S: Backyard ADs Runoff Area=8,985 sf 3.03% Impervious Runoff Depth=6.57"
Flow Length=147' Tc=10.3 min CN=75 Runoff=1.4 cfs 4,920 cf

Subcatchment3S: Townhouse Roofs Runoff Area=13,067 sf 100.00% Impervious Runoff Depth=9.43"
Tc=6.0 min CN=98 Runoff=2.9 cfs 10,268 cf

Subcatchment4.2S: Townhouse TDs Runoff Area=1,112 sf 95.68% Impervious Runoff Depth=9.31"
Tc=6.0 min CN=97 Runoff=0.2 cfs 863 cf

Subcatchment4.3S: Townhouse TDs Runoff Area=1,105 sf 97.29% Impervious Runoff Depth=9.31"
Tc=6.0 min CN=97 Runoff=0.2 cfs 857 cf

Subcatchment4.4S: Townhouse TDs Runoff Area=1,104 sf 97.46% Impervious Runoff Depth=9.31"
Tc=6.0 min CN=97 Runoff=0.2 cfs 856 cf

Subcatchment4.5S: Townhouse TDs Runoff Area=1,082 sf 98.06% Impervious Runoff Depth=9.43"
Tc=6.0 min CN=98 Runoff=0.2 cfs 850 cf

Subcatchment4.6S: Townhouse TDs Runoff Area=1,056 sf 99.24% Impervious Runoff Depth=9.43"
Tc=6.0 min CN=98 Runoff=0.2 cfs 830 cf

Subcatchment5S: TD-1 Runoff Area=5,851 sf 51.63% Impervious Runoff Depth=7.96"
Tc=6.0 min CN=86 Runoff=1.2 cfs 3,880 cf

Subcatchment6.1S: East driveway Runoff Area=12,275 sf 52.50% Impervious Runoff Depth=8.08"
Tc=6.0 min CN=87 Runoff=2.5 cfs 8,268 cf

Subcatchment6S: Bypass Towards Runoff Area=51,539 sf 0.21% Impervious Runoff Depth=6.44"
Flow Length=125' Tc=14.0 min CN=74 Runoff=6.9 cfs 27,672 cf

Subcatchment7S: To Street Runoff Area=5,843 sf 18.07% Impervious Runoff Depth=6.95"
Tc=6.0 min CN=78 Runoff=1.1 cfs 3,385 cf

Pond 1P: Underground Infiltration System Peak Elev=8.42' Storage=13,421 cf Inflow=11.5 cfs 59,246 cf
Discarded=0.1 cfs 13,870 cf Primary=4.9 cfs 45,374 cf Outflow=5.0 cfs 59,244 cf

Pond 2P: Rooftop Detention Peak Elev=57.57' Storage=11,360 cf Inflow=5.5 cfs 19,734 cf
Outflow=0.3 cfs 19,668 cf

Pond 3P: Rain garden Peak Elev=6.43' Storage=223 cf Inflow=2.5 cfs 8,268 cf
Discarded=0.0 cfs 469 cf Primary=2.5 cfs 7,799 cf Outflow=2.5 cfs 8,268 cf

Link 1L: Towards Wetlands Inflow=13.7 cfs 86,982 cf
Primary=13.7 cfs 86,982 cf

Link 2L: Towards Street Inflow=1.1 cfs 3,385 cf
Primary=1.1 cfs 3,385 cf

Link 100L: Total Flows Inflow=14.4 cfs 90,367 cf
Primary=14.4 cfs 90,367 cf

Total Runoff Area = 158,686 sf Runoff Volume = 104,774 cf Average Runoff Depth = 7.92"
50.45% Pervious = 80,060 sf 49.55% Impervious = 78,626 sf

Summary for Subcatchment 1S: CB-1

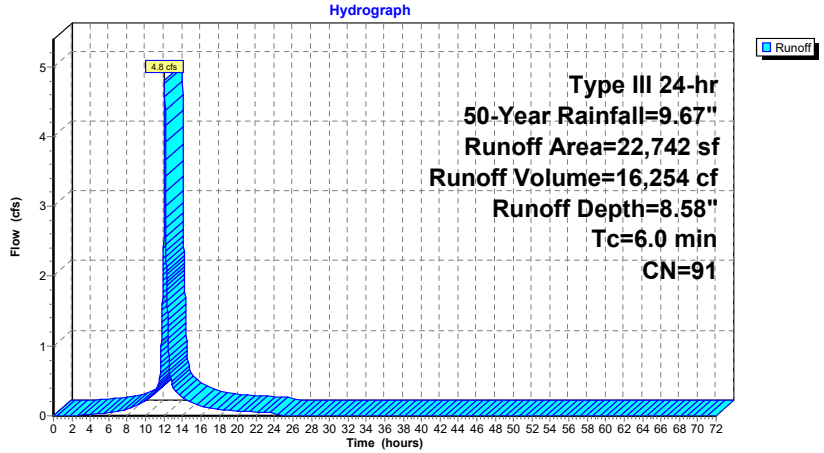
Runoff = 4.8 cfs @ 12.08 hrs, Volume= 16,254 cf, Depth= 8.58"
Routed to Pond 1P : Underground Infiltration System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 50-Year Rainfall=9.67"

Area (sf)	CN	Description
16,410	98	Paved parking, HSG C
6,332	74	>75% Grass cover, Good, HSG C
22,742	91	Weighted Average
6,332		27.84% Pervious Area
16,410		72.16% Impervious Area

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

Subcatchment 1S: CB-1



Summary for Subcatchment 2.1S: Building Roof-Southeast

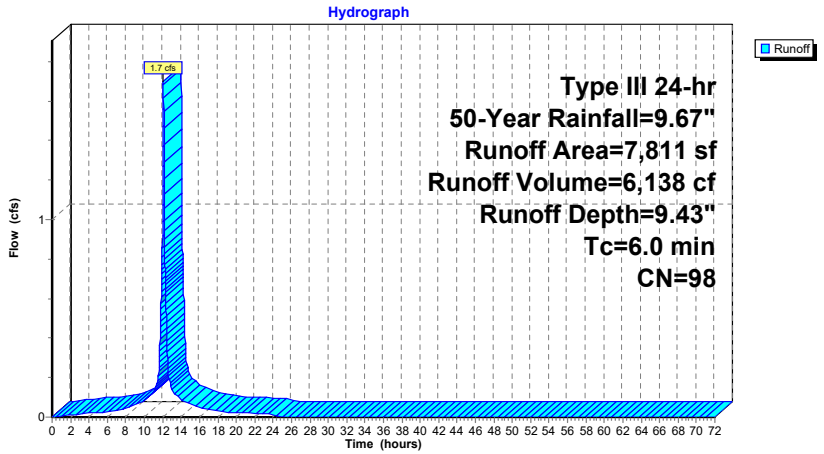
Runoff = 1.7 cfs @ 12.08 hrs, Volume= 6,138 cf, Depth= 9.43"
Routed to Link 1L : Towards Wetlands

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 50-Year Rainfall=9.67"

Area (sf)	CN	Description
7,811	98	Roofs, HSG C
7,811		100.00% Impervious Area

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

Subcatchment 2.1S: Building Roof-Southeast



Summary for Subcatchment 2S: Building Roof

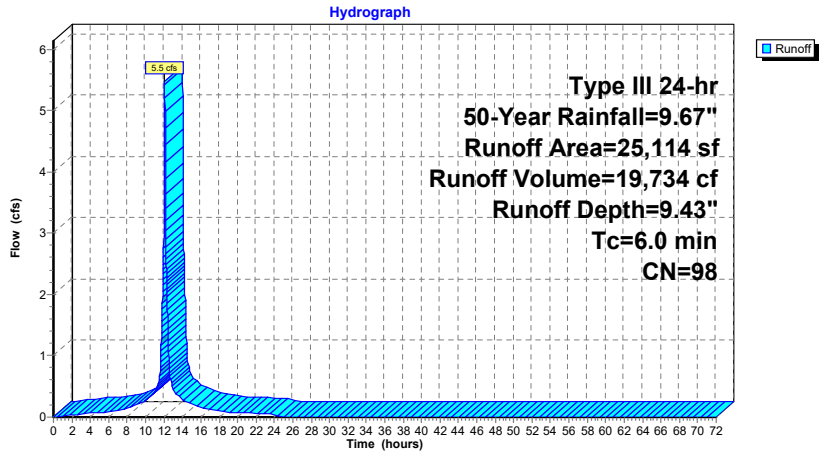
Runoff = 5.5 cfs @ 12.08 hrs, Volume= 19,734 cf, Depth= 9.43"
Routed to Pond 2P : Rooftop Detention

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 50-Year Rainfall=9.67"

Area (sf)	CN	Description
25,114	98	Roofs, HSG C
25,114		100.00% Impervious Area

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

Subcatchment 2S: Building Roof



Summary for Subcatchment 3.1S: Backyard ADs

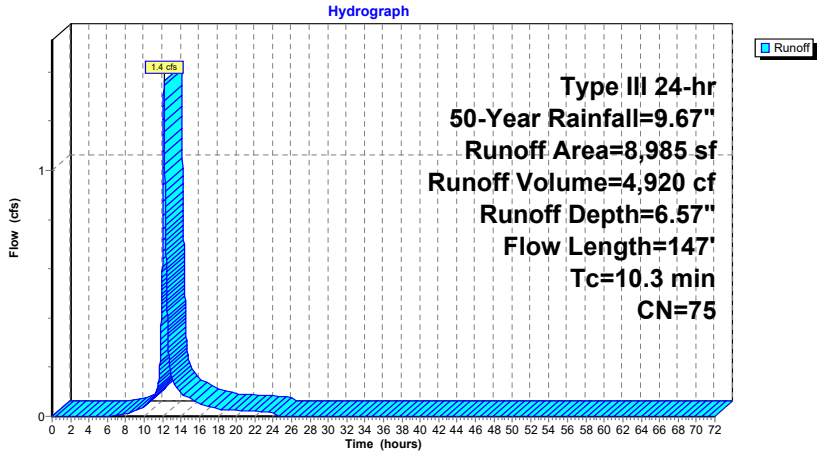
Runoff = 1.4 cfs @ 12.14 hrs, Volume= 4,920 cf, Depth= 6.57"
Routed to Pond 1P : Underground Infiltration System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 50-Year Rainfall=9.67"

	Area (sf)	CN	Description
	272	98	Unconnected pavement, HSG C
	8,302	74	>75% Grass cover, Good, HSG C
*	411	89	Gravel sidewalk, HSG C
	8,985	75	Weighted Average
	8,713		96.97% Pervious Area
	272		3.03% Impervious Area
	272		100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.4	50	0.0142	0.09		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.23"
0.9	97	0.0154	1.86		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
10.3	147	Total			

Subcatchment 3.1S: Backyard ADs



Summary for Subcatchment 3S: Townhouse Roofs

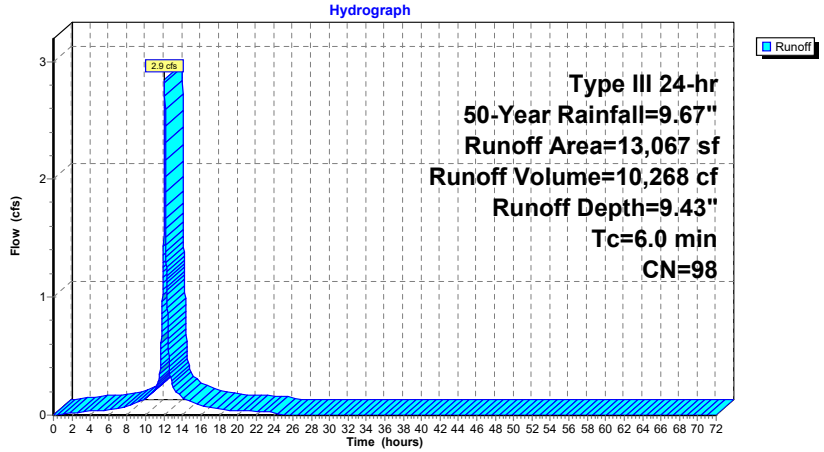
Runoff = 2.9 cfs @ 12.08 hrs, Volume= 10,268 cf, Depth= 9.43"
Routed to Pond 1P : Underground Infiltration System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 50-Year Rainfall=9.67"

Area (sf)	CN	Description
13,067	98	Roofs, HSG C
13,067		100.00% Impervious Area

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

Subcatchment 3S: Townhouse Roofs



Summary for Subcatchment 4.2S: Townhouse TDs

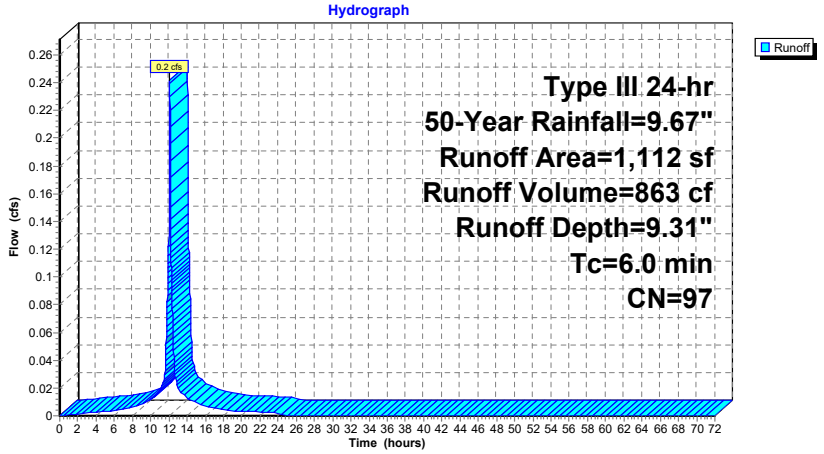
Runoff = 0.2 cfs @ 12.08 hrs, Volume= 863 cf, Depth= 9.31"
Routed to Pond 1P : Underground Infiltration System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 50-Year Rainfall=9.67"

Area (sf)	CN	Description
1,064	98	Paved parking, HSG C
48	74	>75% Grass cover, Good, HSG C
1,112	97	Weighted Average
48		4.32% Pervious Area
1,064		95.68% Impervious Area

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

Subcatchment 4.2S: Townhouse TDs



Summary for Subcatchment 4.3S: Townhouse TDs

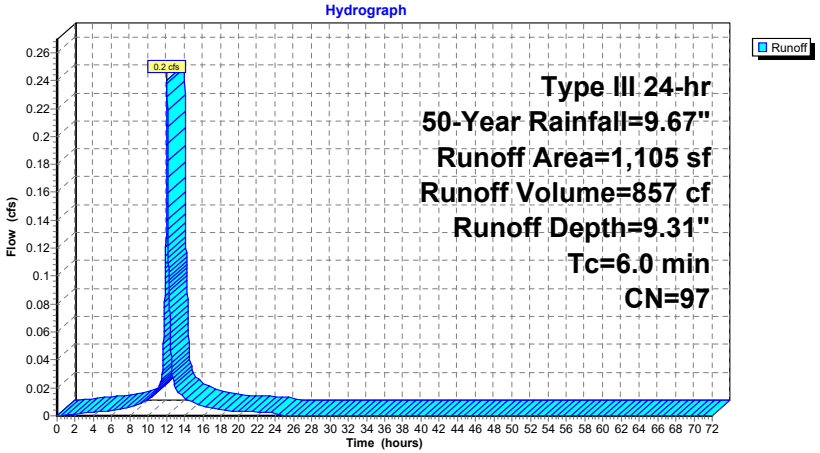
Runoff = 0.2 cfs @ 12.08 hrs, Volume= 857 cf, Depth= 9.31"
Routed to Pond 1P : Underground Infiltration System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 50-Year Rainfall=9.67"

Area (sf)	CN	Description
1,075	98	Paved parking, HSG C
30	74	>75% Grass cover, Good, HSG C
1,105	97	Weighted Average
30		2.71% Pervious Area
1,075		97.29% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min. Tc

Subcatchment 4.3S: Townhouse TDs



Summary for Subcatchment 4.4S: Townhouse TDs

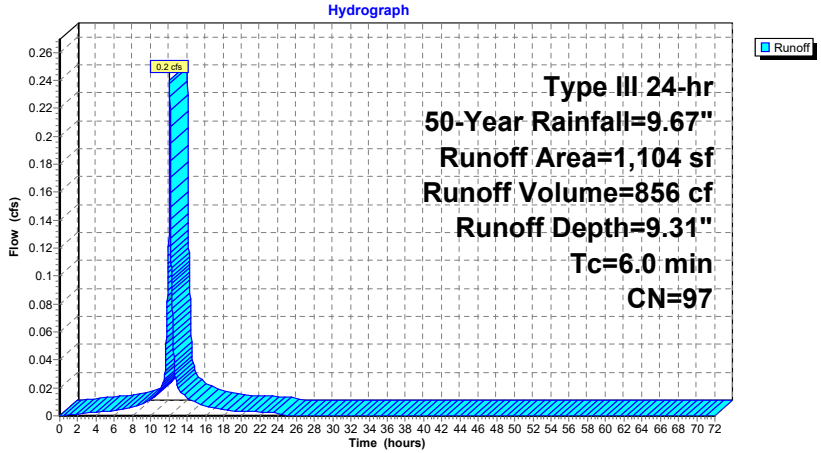
Runoff = 0.2 cfs @ 12.08 hrs, Volume= 856 cf, Depth= 9.31"
Routed to Pond 1P : Underground Infiltration System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 50-Year Rainfall=9.67"

Area (sf)	CN	Description
1,076	98	Paved parking, HSG C
28	74	>75% Grass cover, Good, HSG C
1,104	97	Weighted Average
28		2.54% Pervious Area
1,076		97.46% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min. Tc

Subcatchment 4.4S: Townhouse TDs



Summary for Subcatchment 4.5S: Townhouse TDs

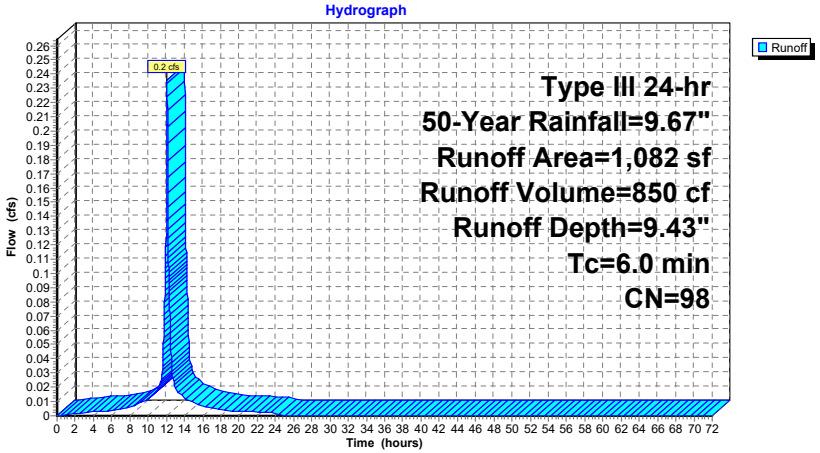
Runoff = 0.2 cfs @ 12.08 hrs, Volume= 850 cf, Depth= 9.43"
Routed to Pond 1P : Underground Infiltration System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 50-Year Rainfall=9.67"

Area (sf)	CN	Description
1,061	98	Paved parking, HSG C
21	74	>75% Grass cover, Good, HSG C
1,082	98	Weighted Average
21		1.94% Pervious Area
1,061		98.06% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min. Tc

Subcatchment 4.5S: Townhouse TDs



Summary for Subcatchment 4.6S: Townhouse TDs

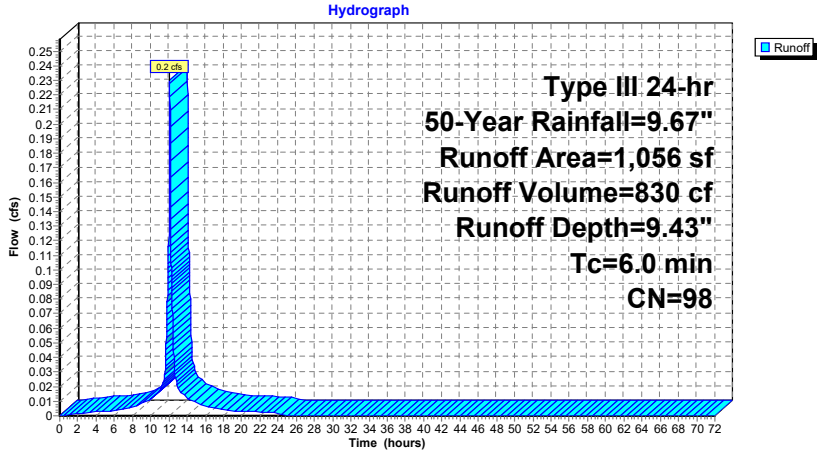
Runoff = 0.2 cfs @ 12.08 hrs, Volume= 830 cf, Depth= 9.43"
Routed to Pond 1P : Underground Infiltration System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 50-Year Rainfall=9.67"

Area (sf)	CN	Description
1,048	98	Paved parking, HSG C
8	74	>75% Grass cover, Good, HSG C
1,056	98	Weighted Average
8		0.76% Pervious Area
1,048		99.24% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min. Tc

Subcatchment 4.6S: Townhouse TDs



Summary for Subcatchment 5S: TD-1

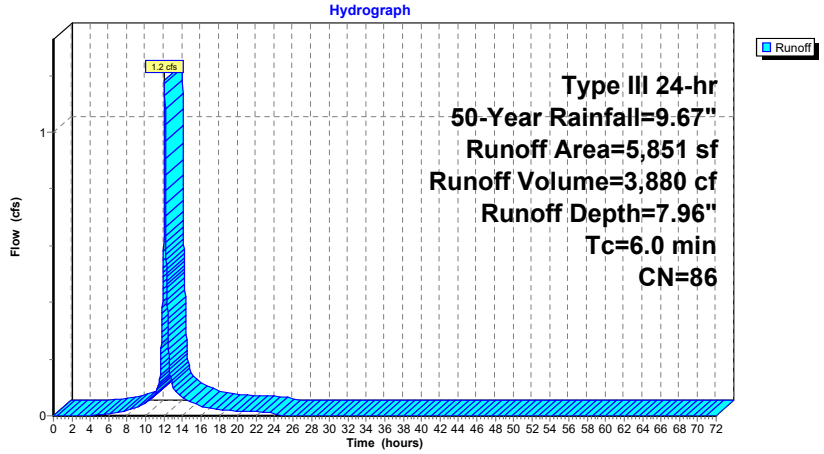
Runoff = 1.2 cfs @ 12.08 hrs, Volume= 3,880 cf, Depth= 7.96"
Routed to Pond 1P : Underground Infiltration System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 50-Year Rainfall=9.67"

Area (sf)	CN	Description
3,021	98	Paved parking, HSG C
2,830	74	>75% Grass cover, Good, HSG C
5,851	86	Weighted Average
2,830		48.37% Pervious Area
3,021		51.63% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min. Tc

Subcatchment 5S: TD-1



Summary for Subcatchment 6.1S: East driveway

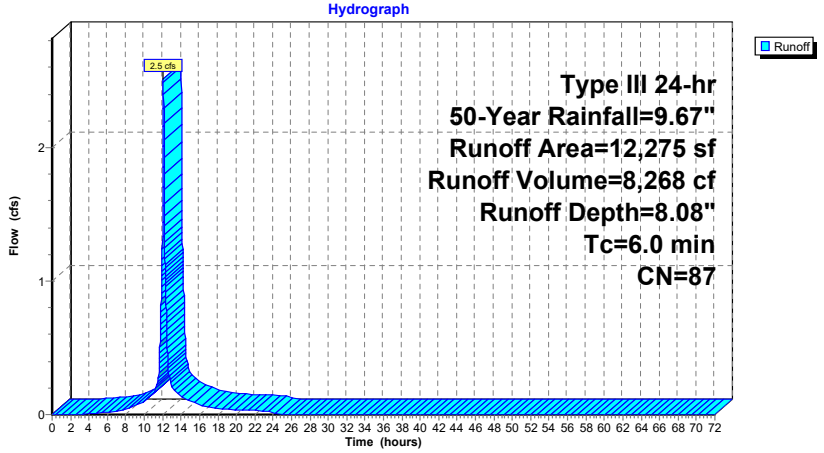
Runoff = 2.5 cfs @ 12.08 hrs, Volume= 8,268 cf, Depth= 8.08"
Routed to Pond 3P : Rain garden

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 50-Year Rainfall=9.67"

Area (sf)	CN	Description
5,611	74	>75% Grass cover, Good, HSG C
6,444	98	Paved roads w/curbs & sewers, HSG C
220	89	Gravel roads, HSG C
12,275	87	Weighted Average
5,831		47.50% Pervious Area
6,444		52.50% Impervious Area

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

Subcatchment 6.1S: East driveway



Summary for Subcatchment 6S: Bypass Towards Wetlands

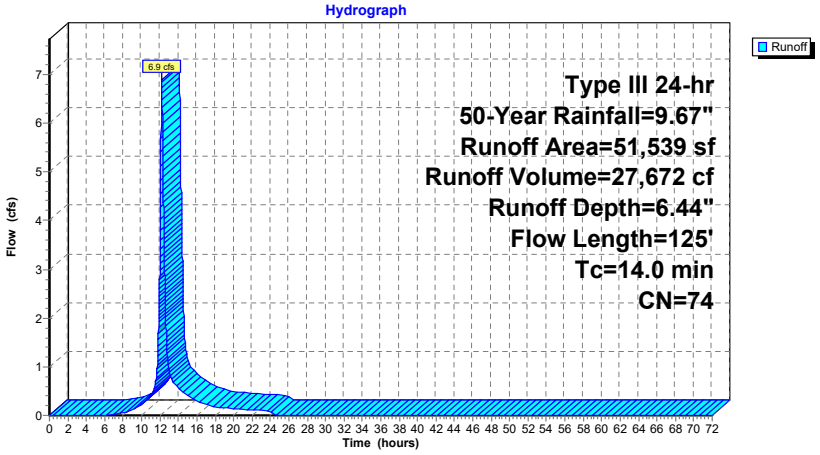
Runoff = 6.9 cfs @ 12.19 hrs, Volume= 27,672 cf, Depth= 6.44"
Routed to Link 1L : Towards Wetlands

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 50-Year Rainfall=9.67"

Area (sf)	CN	Description
4,985	70	Woods, Good, HSG C
46,447	74	>75% Grass cover, Good, HSG C
107	98	Roofs, HSG C
51,539	74	Weighted Average
51,432		99.79% Pervious Area
107		0.21% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.8	50	0.0220	0.07		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.23"
2.2	75	0.0133	0.58		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
14.0	125	Total			

Subcatchment 6S: Bypass Towards Wetlands



Summary for Subcatchment 7S: To Street

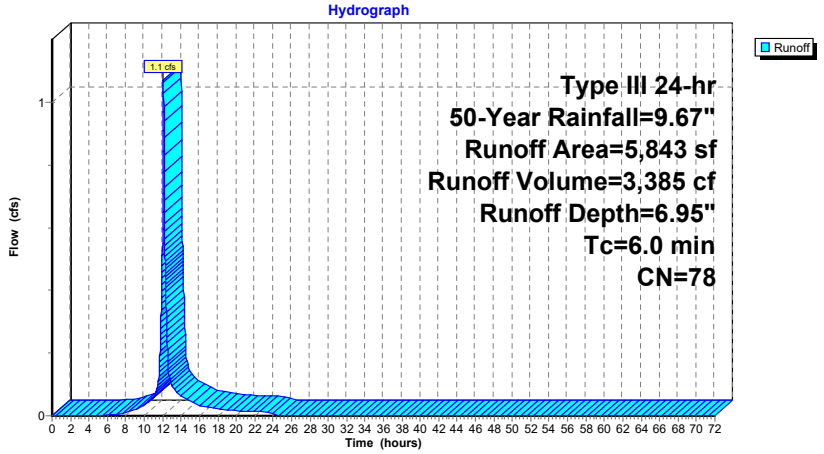
Runoff = 1.1 cfs @ 12.09 hrs, Volume= 3,385 cf, Depth= 6.95"
Routed to Link 2L : Towards Street

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 50-Year Rainfall=9.67"

Area (sf)	CN	Description
1,056	98	Paved parking, HSG C
4,787	74	>75% Grass cover, Good, HSG C
5,843	78	Weighted Average
4,787		81.93% Pervious Area
1,056		18.07% Impervious Area

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

Subcatchment 7S: To Street



Summary for Pond 1P: Underground Infiltration System

Inflow Area = 81,218 sf, 77.83% Impervious, Inflow Depth = 8.75" for 50-Year event
Inflow = 11.5 cfs @ 12.09 hrs, Volume= 59,246 cf
Outflow = 5.0 cfs @ 12.31 hrs, Volume= 59,244 cf, Atten= 56%, Lag= 13.2 min
Discarded = 0.1 cfs @ 5.12 hrs, Volume= 13,870 cf
Primary = 4.9 cfs @ 12.31 hrs, Volume= 45,374 cf
Routed to Link 1L : Towards Wetlands

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 8.42' @ 12.31 hrs Surf.Area= 8,137 sf Storage= 13,421 cf

Plug-Flow detention time= 121.1 min calculated for 59,236 cf (100% of inflow)
Center-of-Mass det. time= 121.0 min (1,031.5 - 910.5)

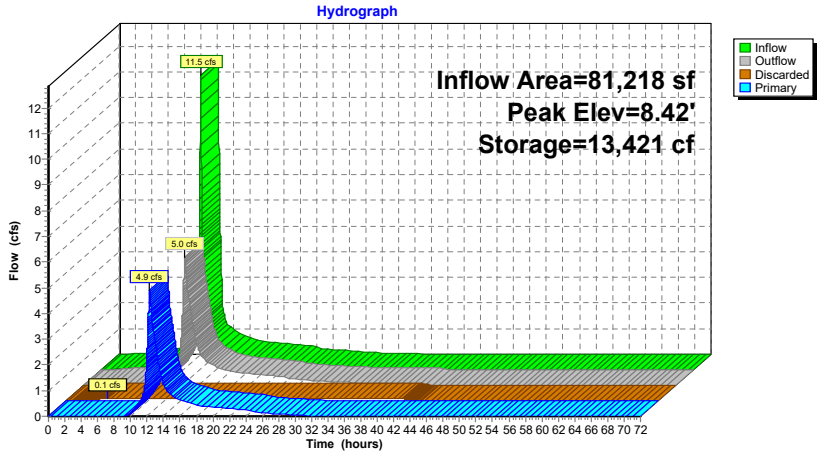
Volume	Invert	Avail.Storage	Storage Description
#1	6.50'	17,495 cf	**6.89'W x 14.06'L x 2.50'H StormTrap ST-1 Units (Irregular Shape)** x 84 20,343 cf Overall x 86.0% Voids

Device	Routing	Invert	Outlet Devices
#1	Discarded	6.50'	**0.520 in/hr Exfiltration over Surface area**
#2	Primary	6.80'	**18.0" Round Culvert** L= 190.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 6.80' / 6.00' S= 0.0042 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf
#3	Device 2	6.80'	**12.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Device 2	8.25'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Discarded OutFlow Max=0.1 cfs @ 5.12 hrs HW=6.53' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.1 cfs)

Primary OutFlow Max=4.9 cfs @ 12.31 hrs HW=8.42' (Free Discharge)
└**2=Culvert** (Passes 4.9 cfs of 6.6 cfs potential flow)
  └**3=Orifice/Grate** (Orifice Controls 4.0 cfs @ 5.09 fps)
  └**4=Sharp-Crested Rectangular Weir** (Weir Controls 0.9 cfs @ 1.34 fps)

Pond 1P: Underground Infiltration System



Summary for Pond 2P: Rooftop Detention

Inflow Area = 25,114 sf,100.00% Impervious, Inflow Depth = 9.43" for 50-Year event
Inflow = 5.5 cfs @ 12.08 hrs, Volume= 19,734 cf
Outflow = 0.3 cfs @ 13.79 hrs, Volume= 19,668 cf, Atten= 94%, Lag= 102.2 min
Primary = 0.3 cfs @ 13.79 hrs, Volume= 19,668 cf
Routed to Pond 1P : Underground Infiltration System

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 57.57' @ 13.79 hrs Surf.Area= 20,000 sf Storage= 11,360 cf

Plug-Flow detention time= 468.2 min calculated for 19,665 cf (100% of inflow)
Center-of-Mass det. time= 466.2 min (1,205.2 - 739.0)

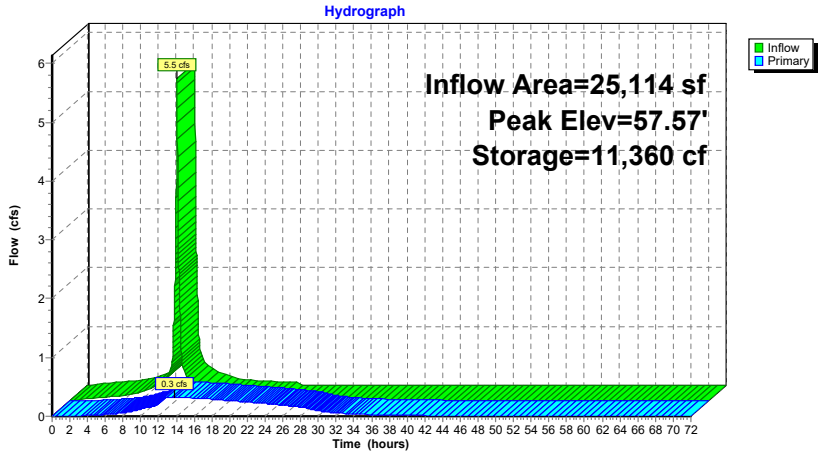
Volume	Invert	Avail.Storage	Storage Description
#1	57.00'	14,000 cf	**Rooftop Detention (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
57.00	20,000	0	0
57.70	20,000	14,000	14,000

Device	Routing	Invert	Outlet Devices
#1	Primary	8.02'	**12.0" Round Roof Drain** L= 16.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 8.02' / 7.70' S= 0.0200 '/' Cc= 0.900 n= 0.013, Flow Area= 0.79 sf
#2	Device 1	57.00'	**4.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.3 cfs @ 13.79 hrs HW=57.57' (Free Discharge)
└**1=Roof Drain** (Passes 0.3 cfs of 23.4 cfs potential flow)
└**2=Orifice/Grate** (Orifice Controls 0.3 cfs @ 3.63 fps)

Pond 2P: Rooftop Detention



Summary for Pond 3P: Rain garden

Inflow Area = 12,275 sf, 52.50% Impervious, Inflow Depth = 8.08" for 50-Year event
Inflow = 2.5 cfs @ 12.08 hrs, Volume= 8,268 cf
Outflow = 2.5 cfs @ 12.09 hrs, Volume= 8,268 cf, Atten= 0%, Lag= 0.2 min
Discarded = 0.0 cfs @ 12.09 hrs, Volume= 469 cf
Primary = 2.5 cfs @ 12.09 hrs, Volume= 7,799 cf
Routed to Link 1L : Towards Wetlands

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 6.43' @ 12.09 hrs Surf.Area= 422 sf Storage= 223 cf

Plug-Flow detention time= 31.4 min calculated for 8,266 cf (100% of inflow)
Center-of-Mass det. time= 31.5 min (810.6 - 779.1)

Volume	Invert	Avail.Storage	Storage Description
#1	5.60'	253 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

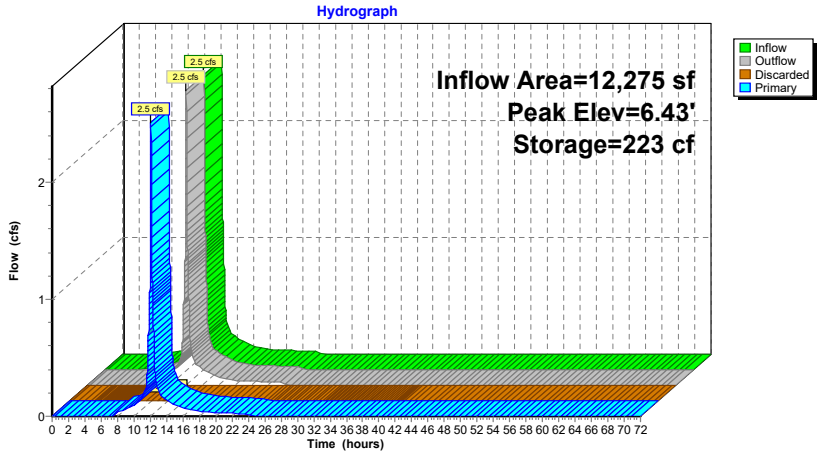
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
5.60	125	46.0	0	0	125
6.00	276	66.0	78	78	305
6.30	350	73.0	94	172	385
6.50	460	87.0	81	253	564

Device	Routing	Invert	Outlet Devices
#1	Discarded	5.60'	**0.520 in/hr Exfiltration over Surface area**
#2	Primary	6.30'	**22.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Discarded OutFlow Max=0.0 cfs @ 12.09 hrs HW=6.43' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.0 cfs)

Primary OutFlow Max=2.5 cfs @ 12.09 hrs HW=6.43' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** (Weir Controls 2.5 cfs @ 0.85 fps)

Pond 3P: Rain garden

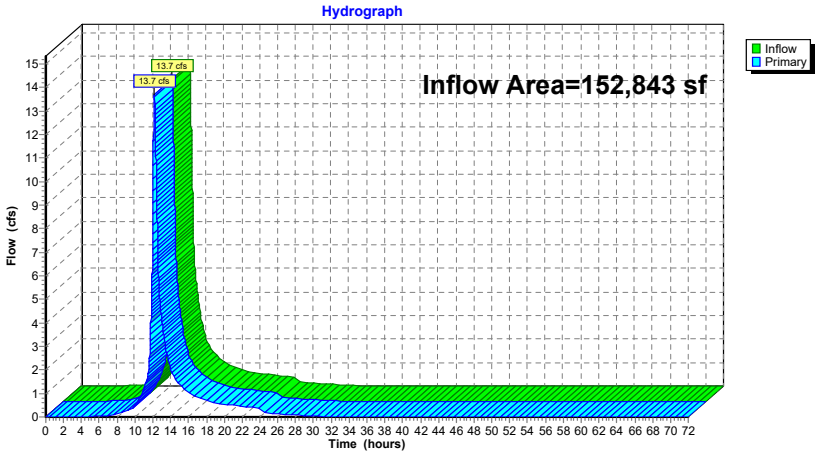


Summary for Link 1L: Towards Wetlands

Inflow Area = 152,843 sf, 50.75% Impervious, Inflow Depth = 6.83" for 50-Year event
Inflow = 13.7 cfs @ 12.18 hrs, Volume= 86,982 cf
Primary = 13.7 cfs @ 12.18 hrs, Volume= 86,982 cf, Atten= 0%, Lag= 0.0 min
Routed to Link 100L : Total Flows

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link 1L: Towards Wetlands

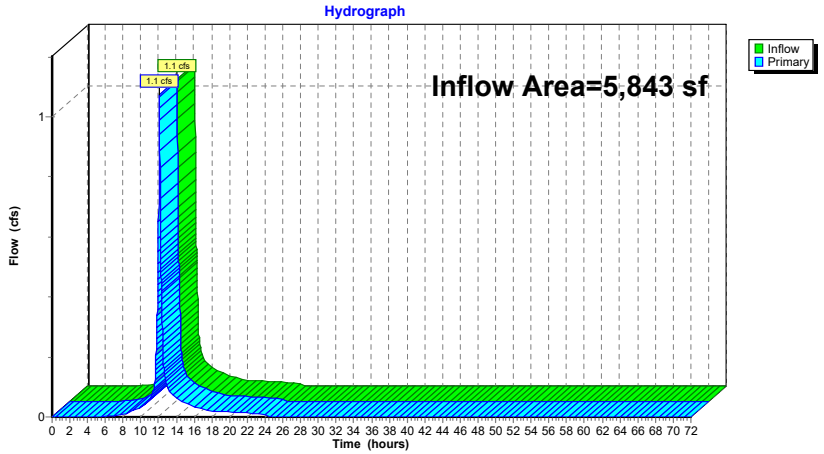


Summary for Link 2L: Towards Street

Inflow Area = 5,843 sf, 18.07% Impervious, Inflow Depth = 6.95" for 50-Year event
Inflow = 1.1 cfs @ 12.09 hrs, Volume= 3,385 cf
Primary = 1.1 cfs @ 12.09 hrs, Volume= 3,385 cf, Atten= 0%, Lag= 0.0 min
Routed to Link 100L : Total Flows

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link 2L: Towards Street

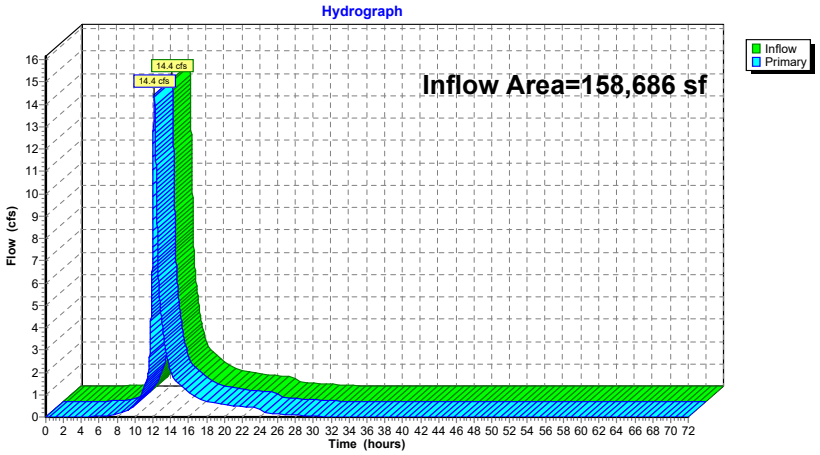


Summary for Link 100L: Total Flows

Inflow Area = 158,686 sf, 49.55% Impervious, Inflow Depth = 6.83" for 50-Year event
Inflow = 14.4 cfs @ 12.14 hrs, Volume= 90,367 cf
Primary = 14.4 cfs @ 12.14 hrs, Volume= 90,367 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link 100L: Total Flows



Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: CB-1 Runoff Area=22,742 sf 72.16% Impervious Runoff Depth=10.39"
Tc=6.0 min CN=91 Runoff=5.8 cfs 19,696 cf

Subcatchment2.1S: Building Runoff Area=7,811 sf 100.00% Impervious Runoff Depth=11.26"
Tc=6.0 min CN=98 Runoff=2.0 cfs 7,328 cf

Subcatchment2S: Building Roof Runoff Area=25,114 sf 100.00% Impervious Runoff Depth=11.26"
Tc=6.0 min CN=98 Runoff=6.5 cfs 23,563 cf

Subcatchment3.1S: Backyard ADs Runoff Area=8,985 sf 3.03% Impervious Runoff Depth=8.28"
Flow Length=147' Tc=10.3 min CN=75 Runoff=1.7 cfs 6,203 cf

Subcatchment3S: Townhouse Roofs Runoff Area=13,067 sf 100.00% Impervious Runoff Depth=11.26"
Tc=6.0 min CN=98 Runoff=3.4 cfs 12,260 cf

Subcatchment4.2S: Townhouse TDs Runoff Area=1,112 sf 95.68% Impervious Runoff Depth=11.14"
Tc=6.0 min CN=97 Runoff=0.3 cfs 1,032 cf

Subcatchment4.3S: Townhouse TDs Runoff Area=1,105 sf 97.29% Impervious Runoff Depth=11.14"
Tc=6.0 min CN=97 Runoff=0.3 cfs 1,026 cf

Subcatchment4.4S: Townhouse TDs Runoff Area=1,104 sf 97.46% Impervious Runoff Depth=11.14"
Tc=6.0 min CN=97 Runoff=0.3 cfs 1,025 cf

Subcatchment4.5S: Townhouse TDs Runoff Area=1,082 sf 98.06% Impervious Runoff Depth=11.26"
Tc=6.0 min CN=98 Runoff=0.3 cfs 1,015 cf

Subcatchment4.6S: Townhouse TDs Runoff Area=1,056 sf 99.24% Impervious Runoff Depth=11.26"
Tc=6.0 min CN=98 Runoff=0.3 cfs 991 cf

Subcatchment5S: TD-1 Runoff Area=5,851 sf 51.63% Impervious Runoff Depth=9.75"
Tc=6.0 min CN=86 Runoff=1.4 cfs 4,756 cf

Subcatchment6.1S: East driveway Runoff Area=12,275 sf 52.50% Impervious Runoff Depth=9.88"
Tc=6.0 min CN=87 Runoff=3.0 cfs 10,109 cf

Subcatchment6S: Bypass Towards Runoff Area=51,539 sf 0.21% Impervious Runoff Depth=8.15"
Flow Length=125' Tc=14.0 min CN=74 Runoff=8.7 cfs 34,988 cf

Subcatchment7S: To Street Runoff Area=5,843 sf 18.07% Impervious Runoff Depth=8.69"
Tc=6.0 min CN=78 Runoff=1.3 cfs 4,233 cf

Pond 1P: Underground Infiltration System Peak Elev=8.61' Storage=14,744 cf Inflow=13.8 cfs 71,490 cf
Discarded=0.1 cfs 14,852 cf Primary=7.1 cfs 56,636 cf Outflow=7.2 cfs 71,488 cf

Pond 2P: Rooftop Detention Peak Elev=57.69' Storage=13,762 cf Inflow=6.5 cfs 23,563 cf
Outflow=0.3 cfs 23,488 cf

Pond 3P: Rain garden Peak Elev=6.45' Storage=231 cf Inflow=3.0 cfs 10,109 cf
Discarded=0.0 cfs 480 cf Primary=3.0 cfs 9,630 cf Outflow=3.0 cfs 10,109 cf

Link 1L: Towards Wetlands Inflow=18.5 cfs 108,582 cf
Primary=18.5 cfs 108,582 cf

Link 2L: Towards Street Inflow=1.3 cfs 4,233 cf
Primary=1.3 cfs 4,233 cf

Link 100L: Total Flows Inflow=19.3 cfs 112,815 cf
Primary=19.3 cfs 112,815 cf

Total Runoff Area = 158,686 sf Runoff Volume = 128,224 cf Average Runoff Depth = 9.70"
50.45% Pervious = 80,060 sf 49.55% Impervious = 78,626 sf

Summary for Subcatchment 1S: CB-1

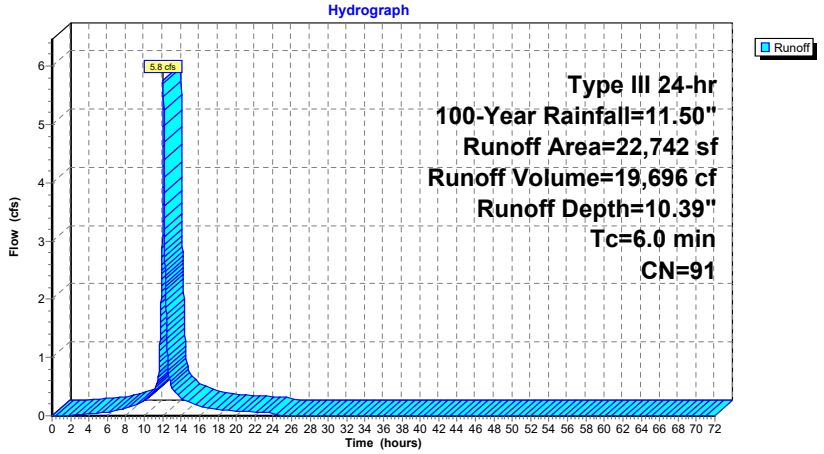
Runoff = 5.8 cfs @ 12.08 hrs, Volume= 19,696 cf, Depth=10.39"
Routed to Pond 1P : Underground Infiltration System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (sf)	CN	Description
16,410	98	Paved parking, HSG C
6,332	74	>75% Grass cover, Good, HSG C
22,742	91	Weighted Average
6,332		27.84% Pervious Area
16,410		72.16% Impervious Area

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

Subcatchment 1S: CB-1



Summary for Subcatchment 2.1S: Building Roof-Southeast

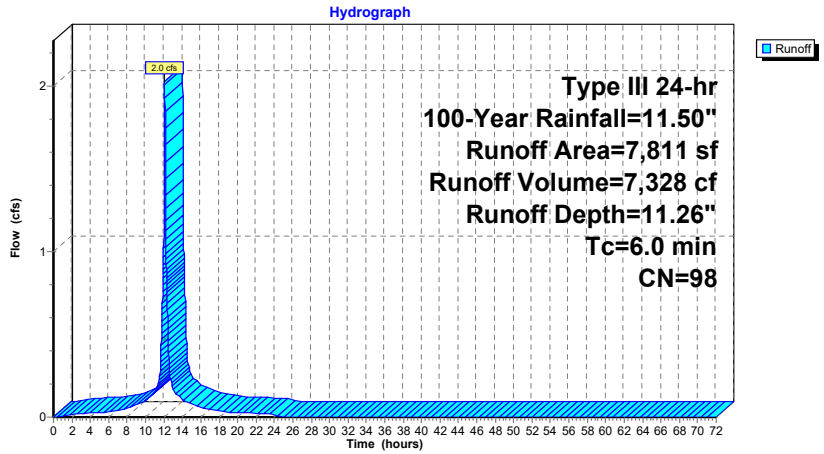
Runoff = 2.0 cfs @ 12.08 hrs, Volume= 7,328 cf, Depth=11.26"
Routed to Link 1L : Towards Wetlands

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (sf)	CN	Description
7,811	98	Roofs, HSG C
7,811		100.00% Impervious Area

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

Subcatchment 2.1S: Building Roof-Southeast



Summary for Subcatchment 2S: Building Roof

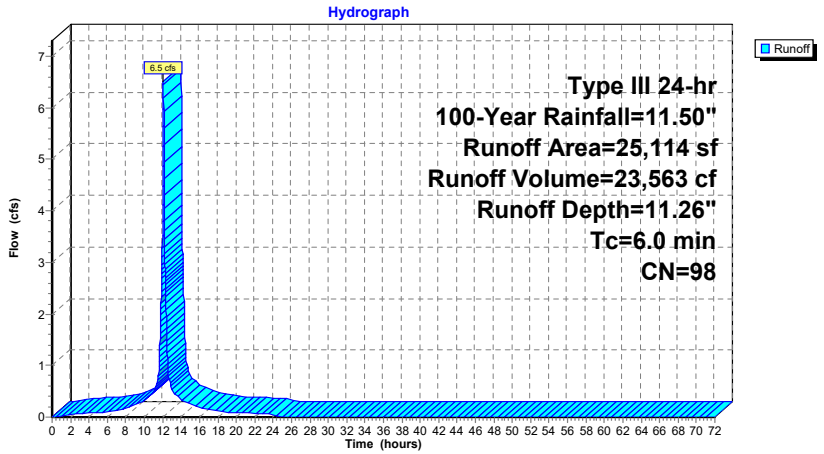
Runoff = 6.5 cfs @ 12.08 hrs, Volume= 23,563 cf, Depth=11.26"
Routed to Pond 2P : Rooftop Detention

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (sf)	CN	Description
25,114	98	Roofs, HSG C
25,114		100.00% Impervious Area

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

Subcatchment 2S: Building Roof



Summary for Subcatchment 3.1S: Backyard ADs

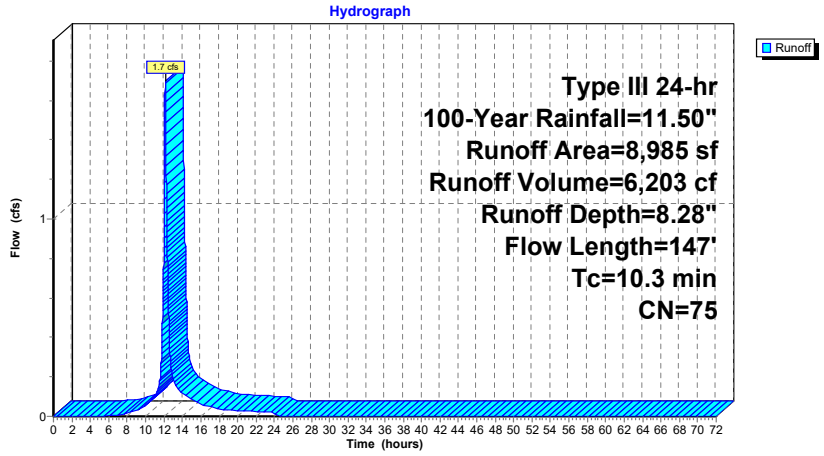
Runoff = 1.7 cfs @ 12.14 hrs, Volume= 6,203 cf, Depth= 8.28"
Routed to Pond 1P : Underground Infiltration System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

	Area (sf)	CN	Description
	272	98	Unconnected pavement, HSG C
	8,302	74	>75% Grass cover, Good, HSG C
*	411	89	Gravel sidewalk, HSG C
	8,985	75	Weighted Average
	8,713		96.97% Pervious Area
	272		3.03% Impervious Area
	272		100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.4	50	0.0142	0.09		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.23"
0.9	97	0.0154	1.86		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
10.3	147	Total			

Subcatchment 3.1S: Backyard ADs



Summary for Subcatchment 3S: Townhouse Roofs

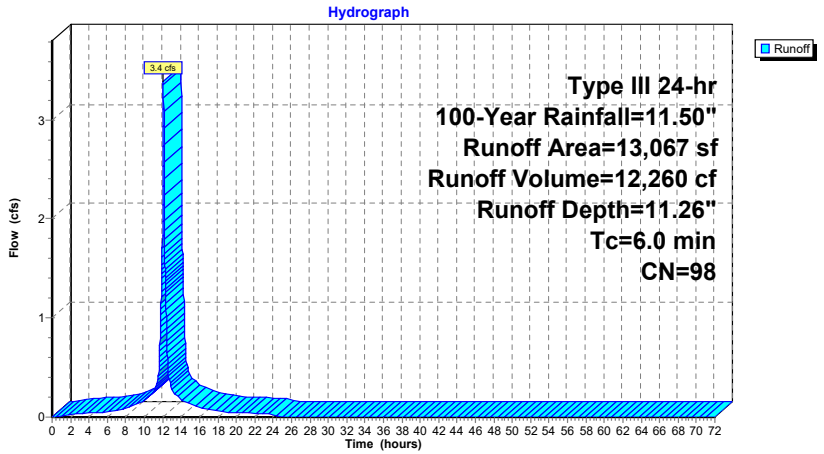
Runoff = 3.4 cfs @ 12.08 hrs, Volume= 12,260 cf, Depth=11.26"
Routed to Pond 1P : Underground Infiltration System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (sf)	CN	Description
13,067	98	Roofs, HSG C
13,067		100.00% Impervious Area

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

Subcatchment 3S: Townhouse Roofs



Summary for Subcatchment 4.2S: Townhouse TDs

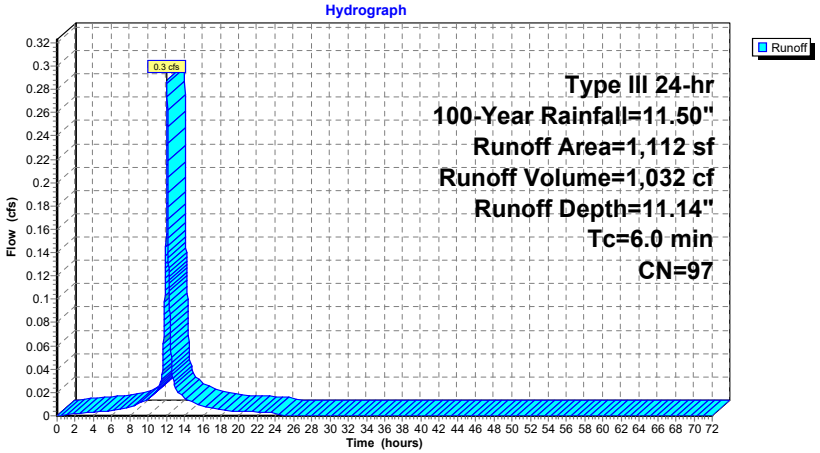
Runoff = 0.3 cfs @ 12.08 hrs, Volume= 1,032 cf, Depth=11.14"
Routed to Pond 1P : Underground Infiltration System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (sf)	CN	Description
1,064	98	Paved parking, HSG C
48	74	>75% Grass cover, Good, HSG C
1,112	97	Weighted Average
48		4.32% Pervious Area
1,064		95.68% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min. Tc

Subcatchment 4.2S: Townhouse TDs



Summary for Subcatchment 4.3S: Townhouse TDs

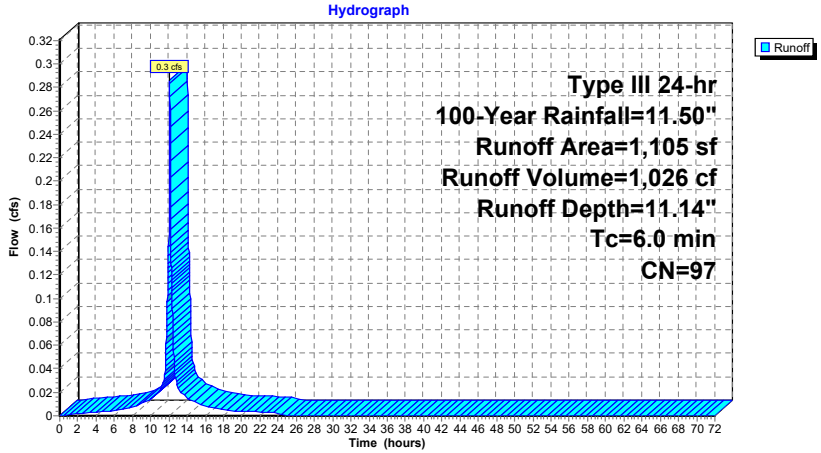
Runoff = 0.3 cfs @ 12.08 hrs, Volume= 1,026 cf, Depth=11.14"
Routed to Pond 1P : Underground Infiltration System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (sf)	CN	Description
1,075	98	Paved parking, HSG C
30	74	>75% Grass cover, Good, HSG C
1,105	97	Weighted Average
30		2.71% Pervious Area
1,075		97.29% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min. Tc

Subcatchment 4.3S: Townhouse TDs



Summary for Subcatchment 4.4S: Townhouse TDs

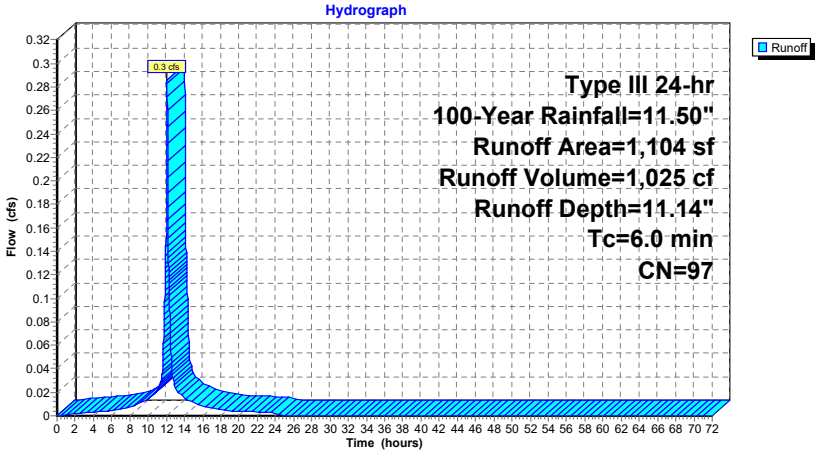
Runoff = 0.3 cfs @ 12.08 hrs, Volume= 1,025 cf, Depth=11.14"
Routed to Pond 1P : Underground Infiltration System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (sf)	CN	Description
1,076	98	Paved parking, HSG C
28	74	>75% Grass cover, Good, HSG C
1,104	97	Weighted Average
28		2.54% Pervious Area
1,076		97.46% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min. Tc

Subcatchment 4.4S: Townhouse TDs



Summary for Subcatchment 4.5S: Townhouse TDs

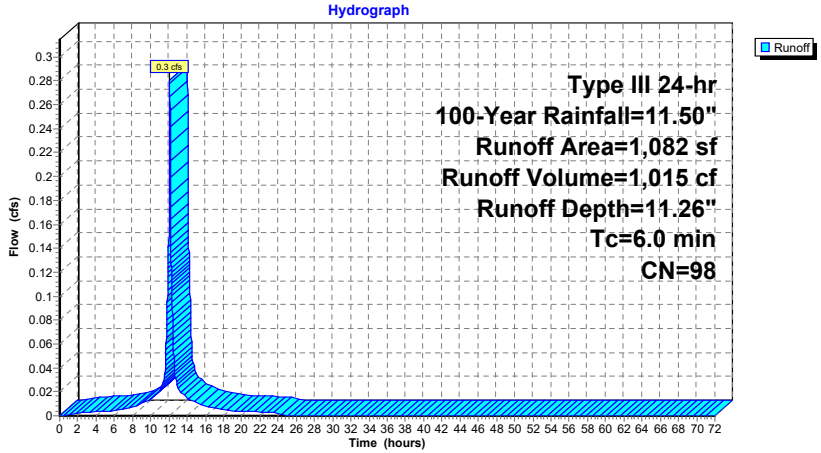
Runoff = 0.3 cfs @ 12.08 hrs, Volume= 1,015 cf, Depth=11.26"
Routed to Pond 1P : Underground Infiltration System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (sf)	CN	Description
1,061	98	Paved parking, HSG C
21	74	>75% Grass cover, Good, HSG C
1,082	98	Weighted Average
21		1.94% Pervious Area
1,061		98.06% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min. Tc

Subcatchment 4.5S: Townhouse TDs



Summary for Subcatchment 4.6S: Townhouse TDs

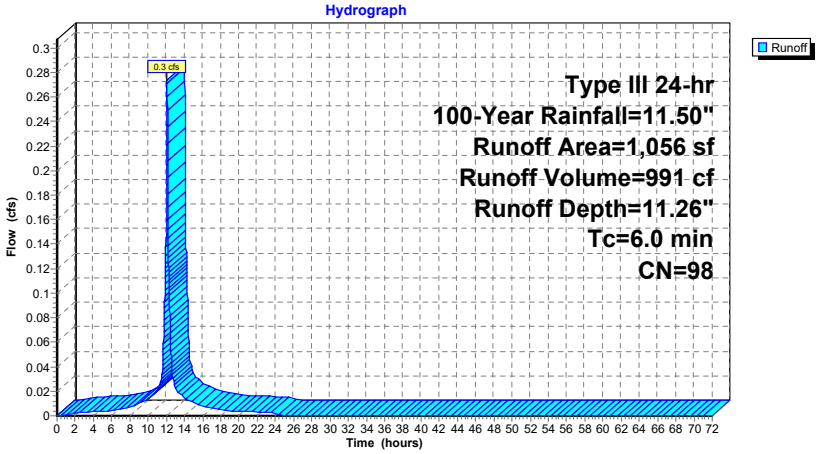
Runoff = 0.3 cfs @ 12.08 hrs, Volume= 991 cf, Depth=11.26"
Routed to Pond 1P : Underground Infiltration System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (sf)	CN	Description
1,048	98	Paved parking, HSG C
8	74	>75% Grass cover, Good, HSG C
1,056	98	Weighted Average
8		0.76% Pervious Area
1,048		99.24% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min. Tc

Subcatchment 4.6S: Townhouse TDs



Summary for Subcatchment 5S: TD-1

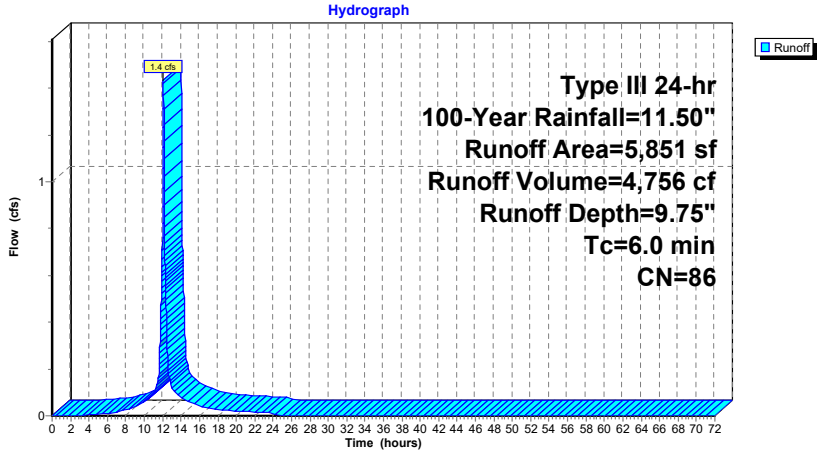
Runoff = 1.4 cfs @ 12.08 hrs, Volume= 4,756 cf, Depth= 9.75"
Routed to Pond 1P : Underground Infiltration System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (sf)	CN	Description
3,021	98	Paved parking, HSG C
2,830	74	>75% Grass cover, Good, HSG C
5,851	86	Weighted Average
2,830		48.37% Pervious Area
3,021		51.63% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry, Min. Tc

Subcatchment 5S: TD-1



Summary for Subcatchment 6.1S: East driveway

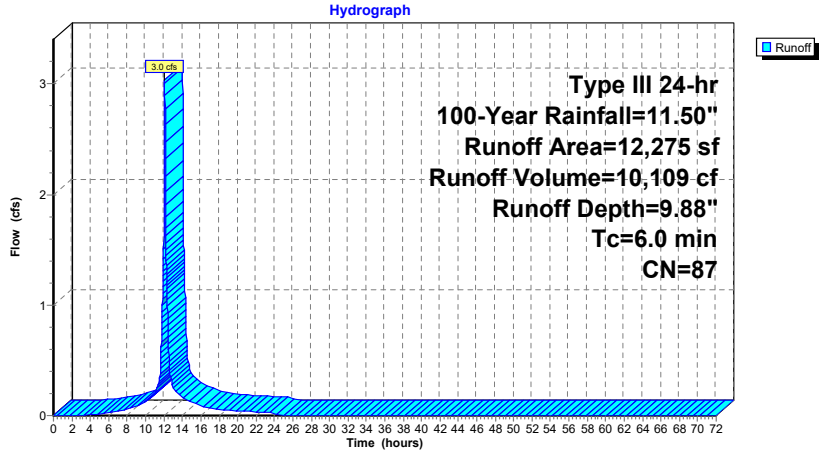
Runoff = 3.0 cfs @ 12.08 hrs, Volume= 10,109 cf, Depth= 9.88"
Routed to Pond 3P : Rain garden

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (sf)	CN	Description
5,611	74	>75% Grass cover, Good, HSG C
6,444	98	Paved roads w/curbs & sewers, HSG C
220	89	Gravel roads, HSG C
12,275	87	Weighted Average
5,831		47.50% Pervious Area
6,444		52.50% Impervious Area

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

Subcatchment 6.1S: East driveway



Summary for Subcatchment 6S: Bypass Towards Wetlands

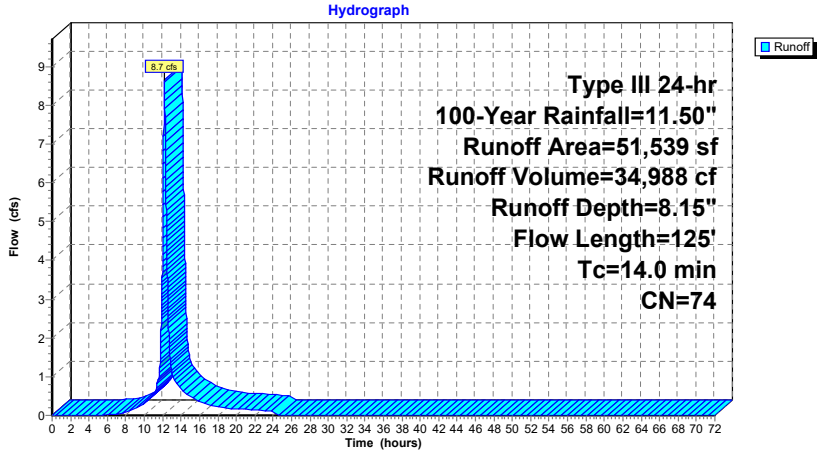
Runoff = 8.7 cfs @ 12.18 hrs, Volume= 34,988 cf, Depth= 8.15"
Routed to Link 1L : Towards Wetlands

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (sf)	CN	Description
4,985	70	Woods, Good, HSG C
46,447	74	>75% Grass cover, Good, HSG C
107	98	Roofs, HSG C
51,539	74	Weighted Average
51,432		99.79% Pervious Area
107		0.21% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.8	50	0.0220	0.07		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.23"
2.2	75	0.0133	0.58		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
14.0	125	Total			

Subcatchment 6S: Bypass Towards Wetlands



Summary for Subcatchment 7S: To Street

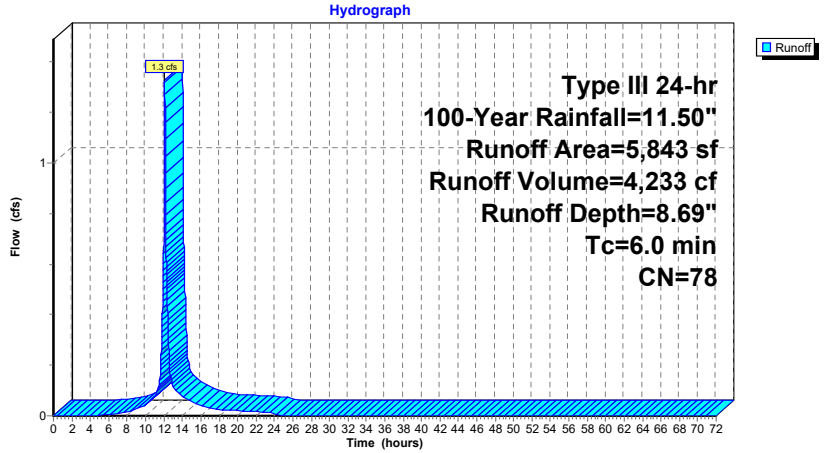
Runoff = 1.3 cfs @ 12.09 hrs, Volume= 4,233 cf, Depth= 8.69"
Routed to Link 2L : Towards Street

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (sf)	CN	Description
1,056	98	Paved parking, HSG C
4,787	74	>75% Grass cover, Good, HSG C
5,843	78	Weighted Average
4,787		81.93% Pervious Area
1,056		18.07% Impervious Area

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

Subcatchment 7S: To Street



Summary for Pond 1P: Underground Infiltration System

Inflow Area = 81,218 sf, 77.83% Impervious, Inflow Depth = 10.56" for 100-Year event
Inflow = 13.8 cfs @ 12.09 hrs, Volume= 71,490 cf
Outflow = 7.2 cfs @ 12.24 hrs, Volume= 71,488 cf, Atten= 48%, Lag= 9.4 min
Discarded = 0.1 cfs @ 4.26 hrs, Volume= 14,852 cf
Primary = 7.1 cfs @ 12.24 hrs, Volume= 56,636 cf
Routed to Link 1L : Towards Wetlands

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 8.61' @ 12.24 hrs Surf.Area= 8,137 sf Storage= 14,744 cf

Plug-Flow detention time= 113.7 min calculated for 71,478 cf (100% of inflow)
Center-of-Mass det. time= 113.6 min (1,031.2 - 917.6)

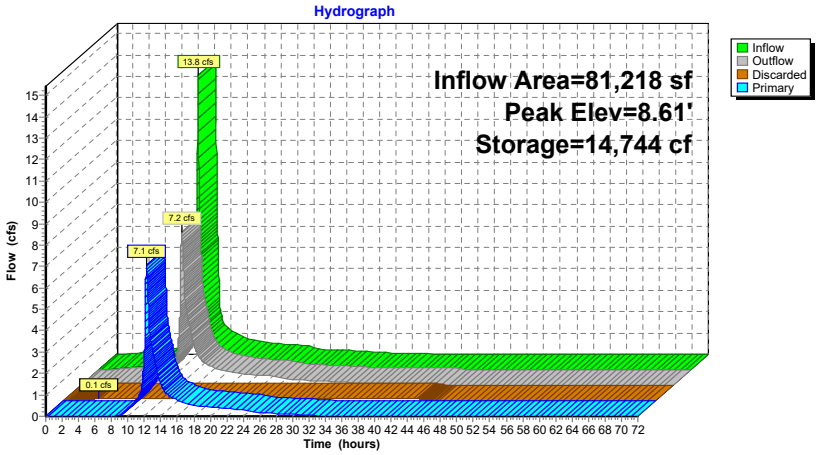
Volume	Invert	Avail.Storage	Storage Description
#1	6.50'	17,495 cf	**6.89'W x 14.06'L x 2.50'H StormTrap ST-1 Units (Irregular Shape)** x 84 20,343 cf Overall x 86.0% Voids

Device	Routing	Invert	Outlet Devices
#1	Discarded	6.50'	**0.520 in/hr Exfiltration over Surface area**
#2	Primary	6.80'	**18.0" Round Culvert** L= 190.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 6.80' / 6.00' S= 0.0042 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf
#3	Device 2	6.80'	**12.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Device 2	8.25'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Discarded OutFlow Max=0.1 cfs @ 4.26 hrs HW=6.53' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.1 cfs)

Primary OutFlow Max=7.1 cfs @ 12.24 hrs HW=8.61' (Free Discharge)
└**2=Culvert** (Passes 7.1 cfs of 7.3 cfs potential flow)
  └**3=Orifice/Grate** (Orifice Controls 4.3 cfs @ 5.50 fps)
  └**4=Sharp-Crested Rectangular Weir** (Weir Controls 2.7 cfs @ 1.95 fps)

Pond 1P: Underground Infiltration System



Summary for Pond 2P: Rooftop Detention

Inflow Area = 25,114 sf,100.00% Impervious, Inflow Depth = 11.26" for 100-Year event
Inflow = 6.5 cfs @ 12.08 hrs, Volume= 23,563 cf
Outflow = 0.3 cfs @ 13.96 hrs, Volume= 23,488 cf, Atten= 95%, Lag= 112.7 min
Primary = 0.3 cfs @ 13.96 hrs, Volume= 23,488 cf
Routed to Pond 1P : Underground Infiltration System

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 57.69' @ 13.96 hrs Surf.Area= 20,000 sf Storage= 13,762 cf

Plug-Flow detention time= 503.0 min calculated for 23,485 cf (100% of inflow)
Center-of-Mass det. time= 501.1 min (1,238.3 - 737.2)

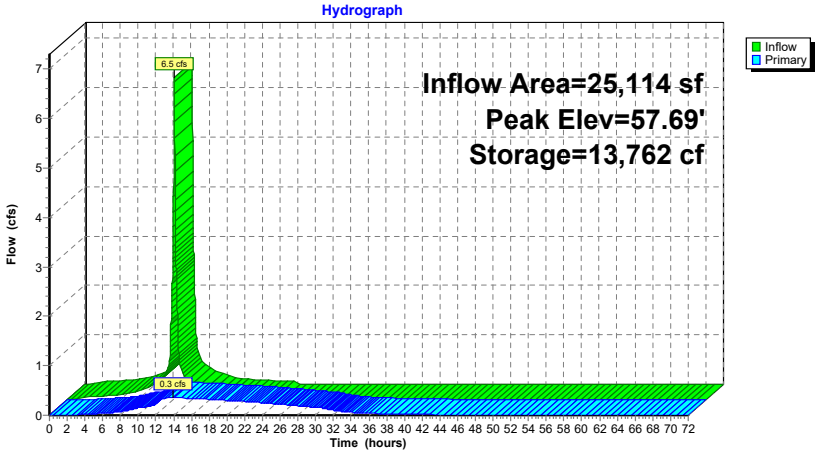
Volume	Invert	Avail.Storage	Storage Description
#1	57.00'	14,000 cf	**Rooftop Detention (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
57.00	20,000	0	0
57.70	20,000	14,000	14,000

Device	Routing	Invert	Outlet Devices
#1	Primary	8.02'	**12.0" Round Roof Drain** L= 16.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 8.02' / 7.70' S= 0.0200 '/' Cc= 0.900 n= 0.013, Flow Area= 0.79 sf
#2	Device 1	57.00'	**4.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.3 cfs @ 13.96 hrs HW=57.69' (Free Discharge)
└**1=Roof Drain** (Passes 0.3 cfs of 23.4 cfs potential flow)
└**2=Orifice/Grate** (Orifice Controls 0.3 cfs @ 3.99 fps)

Pond 2P: Rooftop Detention



Summary for Pond 3P: Rain garden

Inflow Area = 12,275 sf, 52.50% Impervious, Inflow Depth = 9.88" for 100-Year event
Inflow = 3.0 cfs @ 12.08 hrs, Volume= 10,109 cf
Outflow = 3.0 cfs @ 12.09 hrs, Volume= 10,109 cf, Atten= 0%, Lag= 0.2 min
Discarded = 0.0 cfs @ 12.09 hrs, Volume= 480 cf
Primary = 3.0 cfs @ 12.09 hrs, Volume= 9,630 cf
Routed to Link 1L : Towards Wetlands

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 6.45' @ 12.09 hrs Surf.Area= 432 sf Storage= 231 cf

Plug-Flow detention time= 26.5 min calculated for 10,108 cf (100% of inflow)
Center-of-Mass det. time= 26.6 min (800.6 - 774.0)

Volume	Invert	Avail.Storage	Storage Description
#1	5.60'	253 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

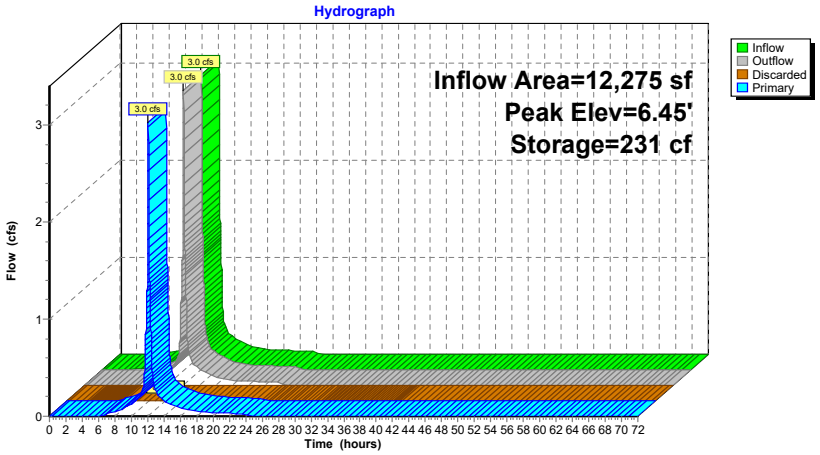
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
5.60	125	46.0	0	0	125
6.00	276	66.0	78	78	305
6.30	350	73.0	94	172	385
6.50	460	87.0	81	253	564

Device	Routing	Invert	Outlet Devices
#1	Discarded	5.60'	**0.520 in/hr Exfiltration over Surface area**
#2	Primary	6.30'	**22.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Discarded OutFlow Max=0.0 cfs @ 12.09 hrs HW=6.45' (Free Discharge)
↑**1=Exfiltration** (Exfiltration Controls 0.0 cfs)

Primary OutFlow Max=3.0 cfs @ 12.09 hrs HW=6.45' (Free Discharge)
↑**2=Broad-Crested Rectangular Weir** (Weir Controls 3.0 cfs @ 0.91 fps)

Pond 3P: Rain garden

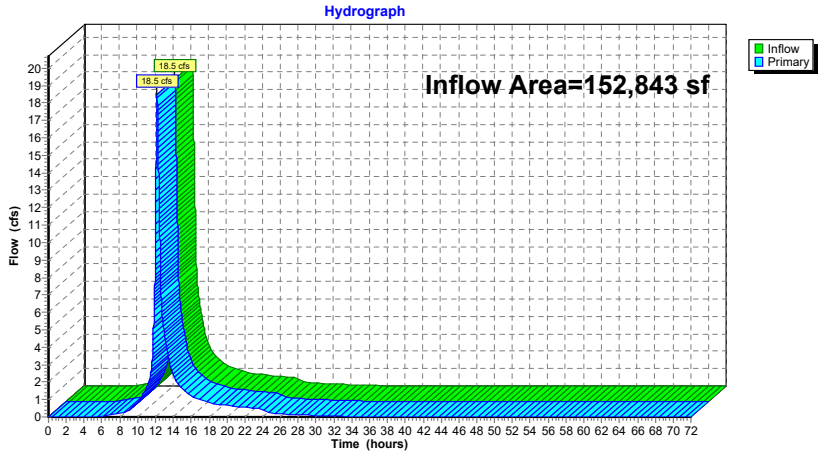


Summary for Link 1L: Towards Wetlands

Inflow Area = 152,843 sf, 50.75% Impervious, Inflow Depth = 8.53" for 100-Year event
Inflow = 18.5 cfs @ 12.18 hrs, Volume= 108,582 cf
Primary = 18.5 cfs @ 12.18 hrs, Volume= 108,582 cf, Atten= 0%, Lag= 0.0 min
Routed to Link 100L : Total Flows

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link 1L: Towards Wetlands

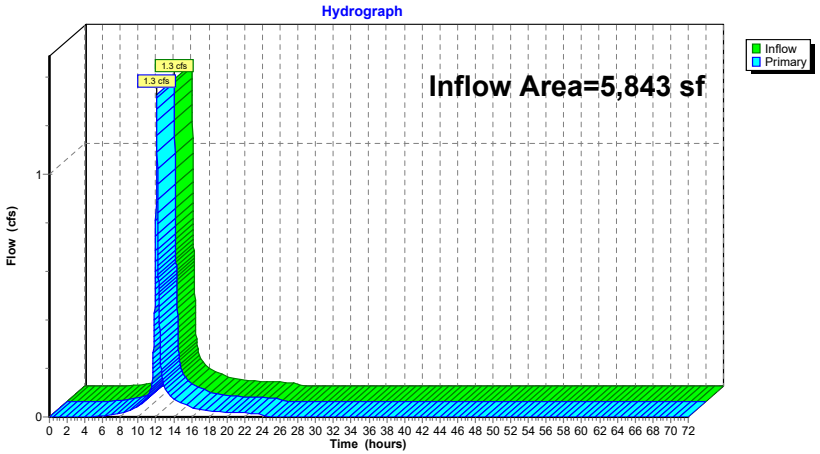


Summary for Link 2L: Towards Street

Inflow Area = 5,843 sf, 18.07% Impervious, Inflow Depth = 8.69" for 100-Year event
Inflow = 1.3 cfs @ 12.09 hrs, Volume= 4,233 cf
Primary = 1.3 cfs @ 12.09 hrs, Volume= 4,233 cf, Atten= 0%, Lag= 0.0 min
Routed to Link 100L : Total Flows

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link 2L: Towards Street

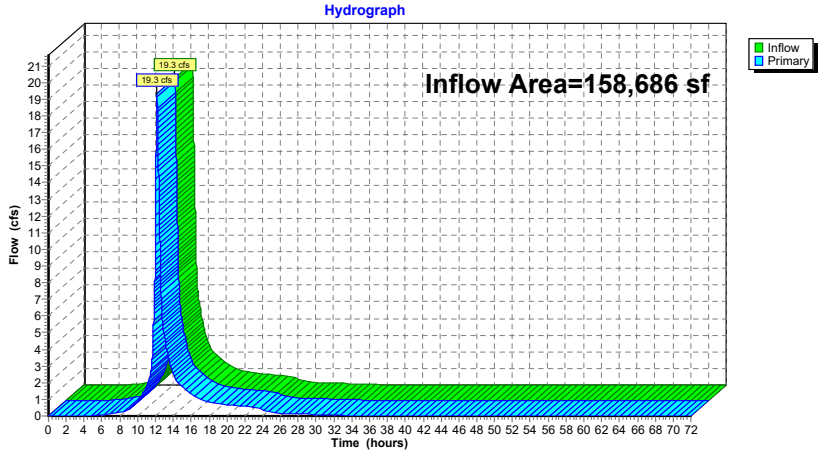


Summary for Link 100L: Total Flows

Inflow Area = 158,686 sf, 49.55% Impervious, Inflow Depth = 8.53" for 100-Year event
Inflow = 19.3 cfs @ 12.18 hrs, Volume= 112,815 cf
Primary = 19.3 cfs @ 12.18 hrs, Volume= 112,815 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link 100L: Total Flows



ATTACHMENT D
GROUNDWATER RECHARGE CALCULATIONS

803 Summer Street, Third Floor / Boston, MA 02127 / 617-896-4300

Required Recharge Volume

Rv = F x Impervious Area

Where:

Rv = Recharge Volume

F=Target Depth Factor associated with each Hydrologic Soil Group

(F=0.25-inch for Soil Type C)

Impervious Area = Proposed Pavement and Rooftop area on-site

$$Rv = \left(\frac{0.25in}{12}\right)(78{,}626sft) =$$

Rv = 1,638 cf (required recharge volume)

As not all impervious surfaces are directed to an infiltration BMP, an adjusted Required Volume must be provided. The adjusted Required Volume (Rva) is calculated as:

$$Rva = \frac{Total\ Imp.Area}{Imp.Area\ to\ BMP}\ (\text{Rv}) =$$

$$Rva = \left(\frac{78{,}626sft}{69{,}652sft}\right)(1{,}638cf) =$$

$$Rva = 1{,}849\ cf$$

Storage Provided

- Underground Infiltration System = 2,099 cubic feet provided.
  Rain garden not required to meet volume, but provides additional infiltration above and beyond that required.
  Refer to the HydroCAD storage table provided for more information.

Drawdown Within 72-Hours

Pond 1P

Rv = Recharge Volume, cu.ft. (see above)

K = Saturated Hydraulic Conductivity, in/hr (from Rawls Table)

Bottom Area = Area of Infiltration System Bottom, sq.ft.

$$Time = \frac{Rv}{(K)(Bottom\ Area)}$$

$$Time = \left(\frac{2{,}099\ cu.ft.}{(0.043\ ft/hr)(8{,}137 sq.ft.)}\right) =$$

$$Time = 6.0\ hours$$

- 6 hours < 72 hours

Pond 3P (Rain Garden)

Rv = Recharge Volume, 172 cu.ft. (see HydroCAD)

K = Saturated Hydraulic Conductivity, in/hr (from Rawls Table)

Bottom Area = Area of Infiltration System Bottom, sq.ft.

$$Time = \frac{Rv}{(K)(Bottom\ Area)}$$

$$Time = \left(\frac{172\ cu.ft.}{(0.043\ ft/hr)(125 sq.ft.)}\right) =$$

$$Time = 32\ hours$$

- 32 hours < 72 hours

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
6.5	8,137	0
6.55	8,137	350
6.6	8,137	700
6.65	8,137	1,050
6.7	8,137	1,400
6.75	8,137	1,750
6.8	8,137	2,099
6.85	8,137	2,449
6.9	8,137	2,799
6.95	8,137	3,149
7	8,137	3,499
7.05	8,137	3,849
7.1	8,137	4,199
7.15	8,137	4,549
7.2	8,137	4,899
7.25	8,137	5,249
7.3	8,137	5,599
7.35	8,137	5,948
7.4	8,137	6,298
7.45	8,137	6,648
7.5	8,137	6,998
7.55	8,137	7,348
7.6	8,137	7,698
7.65	8,137	8,048
7.7	8,137	8,398
7.75	8,137	8,748
7.8	8,137	9,098
7.85	8,137	9,447
7.9	8,137	9,797
7.95	8,137	10,147
8	8,137	10,497
8.05	8,137	10,847
8.1	8,137	11,197
8.15	8,137	11,547
8.2	8,137	11,897
8.25	8,137	12,247
8.3	8,137	12,597
8.35	8,137	12,947
8.4	8,137	13,296
8.45	8,137	13,646
8.5	8,137	13,996
8.55	8,137	14,346
8.6	8,137	14,696
8.65	8,137	15,046
8.7	8,137	15,396
8.75	8,137	15,746
8.8	8,137	16,096
8.85	8,137	16,446
8.9	8,137	16,796
8.95	8,137	17,145
9	8,137	17,495

ATTACHMENT E
GROUNDWATER MOUNDING CALCULATION

803 Summer Street, Third Floor / Boston, MA 02127 / 617-896-4300

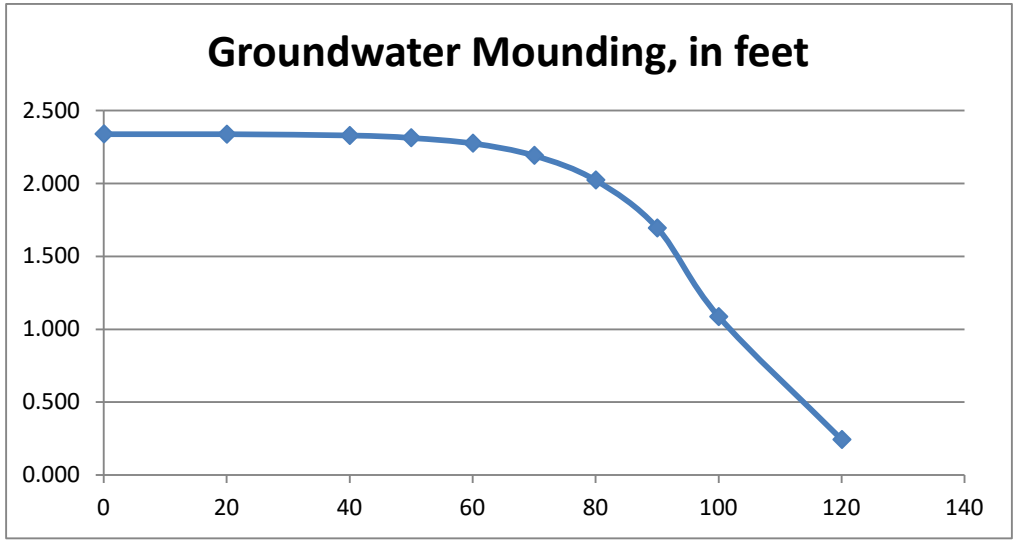
Input Values

			inch/hour	feet/day	
0.2580	*R*	Recharge (infiltration) rate (feet/day)	0.67	1.33	
0.080	Sy	Specific yield, Sy (dimensionless, between 0 and 1)			
5.40	K	Horizontal hydraulic conductivity, Kh (feet/day)*	2.00	4.00	In the repor
98.420	x	1/2 length of basin (x direction, in feet)			(USGS SIR 2(
20.670	y	1/2 width of basin (y direction, in feet)	hours	days	(ft/d) is assu
1.000	t	duration of infiltration period (days)	36	1.50	hydraulic co
5.000	hi(0)	initial thickness of saturated zone (feet)			

7.339	h(max)	maximum thickness of saturated zone (beneath center of basin at end of infiltration period)
2.339	Δh(max)	maximum groundwater mounding (beneath center of basin at end of infiltration period)

Ground-water Mounding, in feet	Distance from center of basin in x direction, in feet
2.339	0
2.338	20
2.329	40
2.313	50
2.275	60
2.192	70
2.022	80
1.695	90
1.086	100
0.243	120

Re-Calculate Now



Disclaimer

This spreadsheet solving the Hantush (1967) equation for ground-water mounding beneath an infiltration basin is made available to the general public as a convenience for those wishing to replicate values documented in the USGS Scientific Investigations Report 2010-5102 "Groundwater mounding beneath hypothetical stormwater infiltration basins" or to calculate values based on user-specified site conditions. Any changes made to the spreadsheet (other than values identified as user-specified) after transmission from the USGS could have unintended, undesirable consequences. These consequences could include, but may not be limited to: erroneous output, numerical instabilities, and violations of underlying assumptions that are inherent in results presented in the accompanying USGS published report. The USGS assumes no responsibility for the consequences of any changes made to the spreadsheet. If changes are made to the spreadsheet, the user is responsible for documenting the changes and justifying the results and conclusions.

Recharge/Infiltration Rate (ft/day) = [Required Recharge Volume (cft)/Bottom Recharge System (sft)]/Duration (day)

Required Recharge Volume	2,099	cft
Bottom Recharge System	8,137	sft
Duration	1	day
Recharge/Infiltration Rate	**0.2580**	**ft/day**

Horizontal Hydraulic Conductivity (ft/day) = [Rawls Rate (in/hr) * (1ft/12in) * (24hr/1day)] * 10

Rawls Rate (silt loam)	0.27	in/hr
Horizontal Hydraulic Conductivity	**5.40**	**ft/day**

ATTACHMENT F
WATER QUALITY CALCULATIONS

803 Summer Street, Third Floor / Boston, MA 02127 / 617-896-4300

Water Quality Volume Calculation

V_{WQ} = (D_{WQ}/12 inches/foot) * (A_{IMP} square feet)

V_{WQ} = Required Water Quality Volume (in cubic feet)
D_{WQ} = Water Quality Depth: **0.5-inch**
A_{IMP} = Total Impervious Area (in acres) used for driveways, parking, etc.

Underground Infiltration Systems and Bio-Retention Areas

A_{IMP} = 32,527 sq.ft.

V_{WQ} = (0.5 inches/12 inches/foot) * (32,527 sq.ft.)

V_{WQ} = 1,355 cubic feet (required volume), provided volume = 2,099 cubic feet in Underground Infiltration System (refer to the HydroCAD storage tables provided in groundwater recharge section). Additional water quality volume provided in rain garden above and beyond the water quality volume required.

TSS Removal Calculation Worksheet

Location: Thorndike Place, Arlington, MA

Project: 23407.02

Prepared By: E. Derrig

Date: 9/12/2024

AREA 1 - CB-1

Total Impervious Area, Acres= 0.377

A	B	C	D	E
BMP	TSS Removal Rate	Starting TSS Load*	Amount Removed (BxC)	Remaining Load (C-D)
Deep Sump and Hooded Catchbasins	0.25	1.00	0.25	0.75
Hydrodynamic Separator	0.7	0.75	0.53	0.23
Infiltration Basin	0.8	0.23	0.18	0.05

TSS Removal = 0.96

AREA 2 - TD-1

Total Impervious Area, Acres= 0.069

A	B	C	D	E
BMP	TSS Removal Rate	Starting TSS Load*	Amount Removed (BxC)	Remaining Load (C-D)
Hydrodynamic Separator	0.7	1.00	0.70	0.30
Infiltration Basin	0.8	0.30	0.24	0.06

TSS Removal = 0.94

AREA 3 - TD-2-6

Total Impervious Area, Acres= 0.122

A	B	C	D	E
BMP	TSS Removal Rate	Starting TSS Load*	Amount Removed (BxC)	Remaining Load (C-D)
Infiltration Basin	0.8	1.00	0.80	0.20

TSS Removal = 0.80

AREA 4 - Bypass to Street

Total Impervious Area, Acres= 0.024

A	B	C	D	E
BMP	TSS Removal Rate	Starting TSS Load*	Amount Removed (BxC)	Remaining Load (C-D)
		1.00		

TSS Removal =

AREA 5 - East Driveway

Total Impervious Area, Acres= 0.148

A	B	C	D	E
BMP	TSS Removal Rate	Starting TSS Load*	Amount Removed (BxC)	Remaining Load (C-D)
Rain Garden	0.8	1.00	0.80	0.20

TSS Removal = 0.80

Weighted Annual Average TSS Removal Rate

[TSS Removal-1 (Area-1) + TSS Revoval-2 (Area-2)+ ….] / [Area-1 + Area-2 + ...] = 0.87

Project Site TSS Removal = 0.87