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MEMORANDUM

TO: William A. Jones, P.E., Linden Engineering

FROM: Jessica Wala, Nitsch Engineering

DATE: March 31, 2022

RE: New Swampscott Elementary School
Peer Review
Response to Comments

Nitsch Engineering is pleased to submit the revised plans, reports and supporting documentation for the New Swampscott Elementary School Project located in Swampscott, MA.

The following responses and supporting documentation are in response to peer review comments received on March 28, 2022 from Linden Engineering Partners, LLC, in response to the Notice of Intent submission dated February 23, 2022.

Please find enclosed:

- A_KP Law Letter dated March 31, 2022, to the MassDEP;
- B_LEC Environmental Consultants Letter dated March 30, 2022;
- C_NRCS Hydrologic Soil Group Classification
- D_ Existing HydroCAD Report Revised
- E_ Proposed HydroCAD Report Revised
- F_ SSA_220401
- G_ Revised Stormwater Report (P. 6)
- H_ Revised Long Term Pollution Prevention Plans (P. 5)
- I_ Jellyfish Water Quality Treatment Testing
- J_ Isolator Row UNH Stormwater Center Testing Data

1. The Notice of Intent Form as filed with the SCC at the beginning of the month was improperly completed. The box under Section A2 of the form indicating there were multiple property owners was not checked and it should have been. In addition, ownership information for the adjacent UU Church property was not shown in the form was not signed by the UU Church as an owner. We understand that after the filing of the NOI, the Town of Swampscott made an eminent domain taking against the UU Church property. We have been provided a copy of a letter from Town Counsel to the SCC asserting that the eminent domain taking qualifies the town of Swampscott as a "Owner" under the wetlands protection act. While the issue of land ownership and rights to file the NOI are legal issues and need to be resolved by an attorney or the courts, we believe that the NOI Form should be revised to indicate multiple property owners, indicate the eminent domain taking, add the book and page of the eminent domain taking to the recording information on the form and an explanation as to the town's ability to file the NOI should be attached to the form. This amended form should be filed with both the SCC and the MADEP as part of the official record for this filing.

Nitsch Response: *KP Law, Town Counsel to the Town of Swampscott, has reviewed the NOI and has determined that a formal amendment to the application is not necessary. Please see the attached letter*

from A. Alexander Weisheit of KP Law dated March 31, 2022, to the MassDEP Northeast Regional Office regarding the matter.

2. We understand that LEC feels that these areas are not jurisdictional and that they have reached out to MADEP. They have reported that MADEP agrees that these areas are not jurisdictional. In our opinion the Applicant should provide a written letter or email to the SCC from MADEP stating that they have reviewed these areas and in their opinion they are not jurisdictional under the MAWPA. Otherwise, these areas should be delineated, shown on the plans and the proposed path should be moved out of these areas.

   Nitsch Response: *The project's environmental consultant, LEC Environmental Consultants, Inc., has reviewed the matter with the MassDEP Northeast Regional Office. MassDEP confirm LEC's determination that the area in question is not subject to protection under the Massachusetts Wetlands Protection Act. Please see the attached memorandum from LEC dated March 30, 2022, detailing their findings including confirmation of their opinion by Pam Merrill, Environmental Analyst of the MassDEP Wetlands Program.*

3. The Table of Contents for the Stormwater Report is missing all the items before Stormwater Standard 7, It appears there is a page missing.

   Nitsch Response: *This may have been due to a printing error, the electronic version of the Stormwater Report includes the full Table of Contents.*

4. The Soils data attached to the Stormwater Report is all labeled, "draft". This data should be finalized and the Stormwater Report should be updated with the final data. Were any of the test pits observed and logged by a Massachusetts Licensed Soil Evaluator?

   Nitsch Response: *The draft geotechnical report will be finalized mid-April. Note that the test pit documentation and depth to bedrock information will not change from Draft to Final. The remaining work to finalize the geotechnical report is only related to the final details of the proposed building foundation system.*

5. The soil type used for many of the existing and proposed watersheds is predominantly HSG D with some HSG C and a small portion of HSG B in the existing watersheds. Many of the soils on the site are mapped as Udorthents or Urban Land. The adjacent soils are HSG B soils. The Engineer needs to explain his use of HSG D soils for the modelling rather than HSG B or even HSG C soils.

   Nitsch Response: *Per the Web Soil Survey, the tree covered area covering the western portion of the Stanley School and a portion of the UU Site is identified as HSG B Soil, while the remainder of the soils are characterized as Urban Land or Udorthents, which does not have an associated HSG.*

   The existing forested area within the Stanley School parcel (within Subcatchment EX-1) is categorized as HSG B, and the remainder of the soils are updated to reflect HSG D Soil conditions. HSG D soils were selected based on known characteristics of the subsurface conditions and per guidance from the Natural Resources Conservation Service (NRCS), Part 630 Hydrology National Engineering Handbook (attached for refence).

   Per the NRCS guidance, Table 7–1 Criteria for Assignment Of Hydrologic Soil Groups When A Water Impermeable Layer Exists At A Depth Between 20 And 40 Inches: if the saturated hydraulic conductivity

of the least transmissive layer is less than 0.14 inches/hour (i.e. bedrock), the soil shall be categorized as HSG D. The bedrock elevations vary throughout the site, however majority of the site shows bedrock at one location within 40-inches of the surface elevation (see test pits data), therefore the uncategorized land area was classified as HSG D.

Please see enclosed the revised HydroCAD (existing and proposed), as well as the revised P. 6 of the Stormwater Report which summarizes the peak runoff volumes to the two wetlands (DP-1 and DP-4) and the revised peak runoff rates to all four (4) design points, which reflect these HSGs.

6. Many of the times of concentration for the modelling were directly entered as 6 minutes, which is the minimum for the methodology. The times for each subcatchment should be entered as the longest flow path and a minimum time of 6 minutes should be entered under Advanced Options. The software will then calculate the time of concentration from the flow path and either use that time or 6 minutes, whichever is longer.

   Nitsch Response: *The HydroCAD has been updated so that each subcatchment includes the calculated Time of Concentration. Majority of the paved sites have a Tc of less than 6-minutes, so Nitsch Engineering directly input the differential between the Tc and 6- minutes to ensure a minimum Tc of 6-minutes for each subcatchment.*

7. The calculations in the model do not include the outlet pipes from the underground detention basins and they need to. This is a concern as it appears that the existing 18" pipe that the runoff flows to does not have sufficient capacity to carry the flow in larger storms (an older 18" concrete pipe at a slope of 0.857% has a capacity of about 8.6 c.f.s. while the 25 year storm flow out of the two detention systems and bypassed drainage is 10.44 c.f.s. and the 100 year storm flow is 22.34 c.f.s.). Therefore, the model's assumption of a free discharge out of the control structures may be incorrect and the underground storage systems may not function as expected in larger storms. The model should be updated to include these discharge pipes in the calculations. Also, the actual elevations of the 18" pipe at the connection point were not obtained as the manholes were not found. Has there been a correlation between the elevations on the old plan of the 18" pipe and the datum of the present survey? Using that correlation, what is the elevation of the 18" pipe at the connection point?.

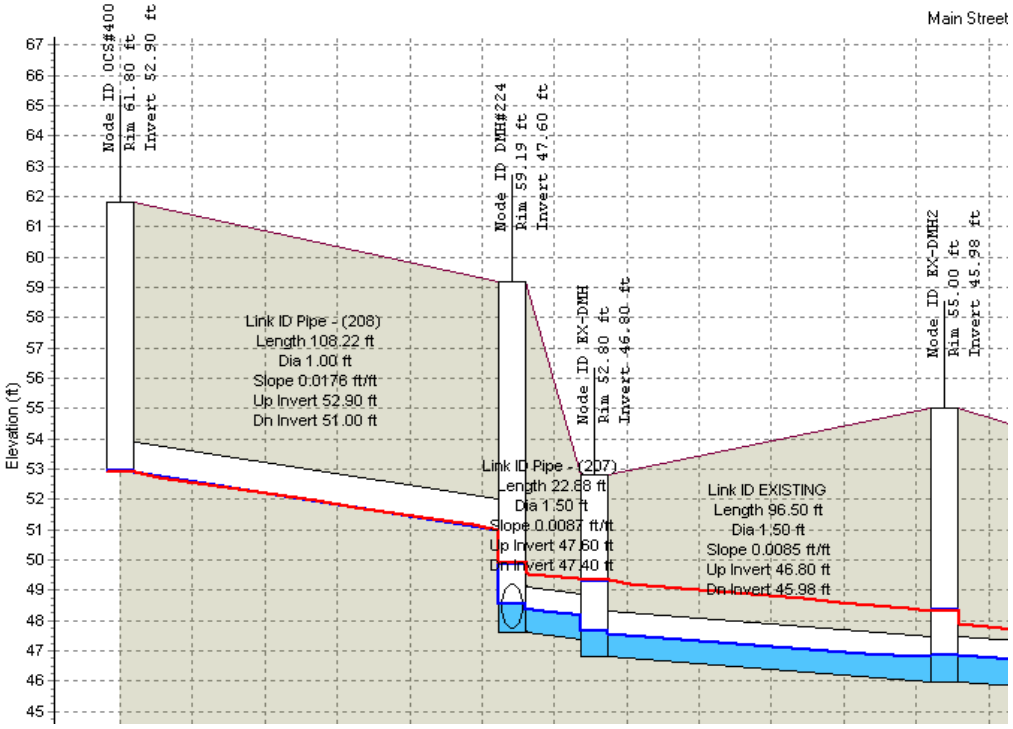
   Nitsch Response: *The HydroCAD and the SSA Analysis have been updated to model the existing 18-inch, based on record slopes, inverts and pipe sizes. Per record plans, converted to the project datum, the 18-inch pipe has the following inverts:*
   Inv(upstream)=46.80; Inv(downstream)=45.98
   96.5 linear feet of pipe @ 0.008571 slope.

   As shown in the SSA model, the limited capacity of this existing 18-inch pipe does not significantly increase the surcharged conditions of the proposed upstream pipes and will not cause flooding at grade at structures. The Project will continue to reduce the peak runoff rates to the existing 18-inch drain pipe. See below for revisions made to Detention System #2 to ensure that the system and pipes are not surcharging during peak conditions.

   See Revised HydroCAD report and SSA Analysis for the updated analysis.

   <u>Detention System #1:</u> The bottom of the subsurface detention system is above the maximum hydraulic grade line (HGL) elevation.

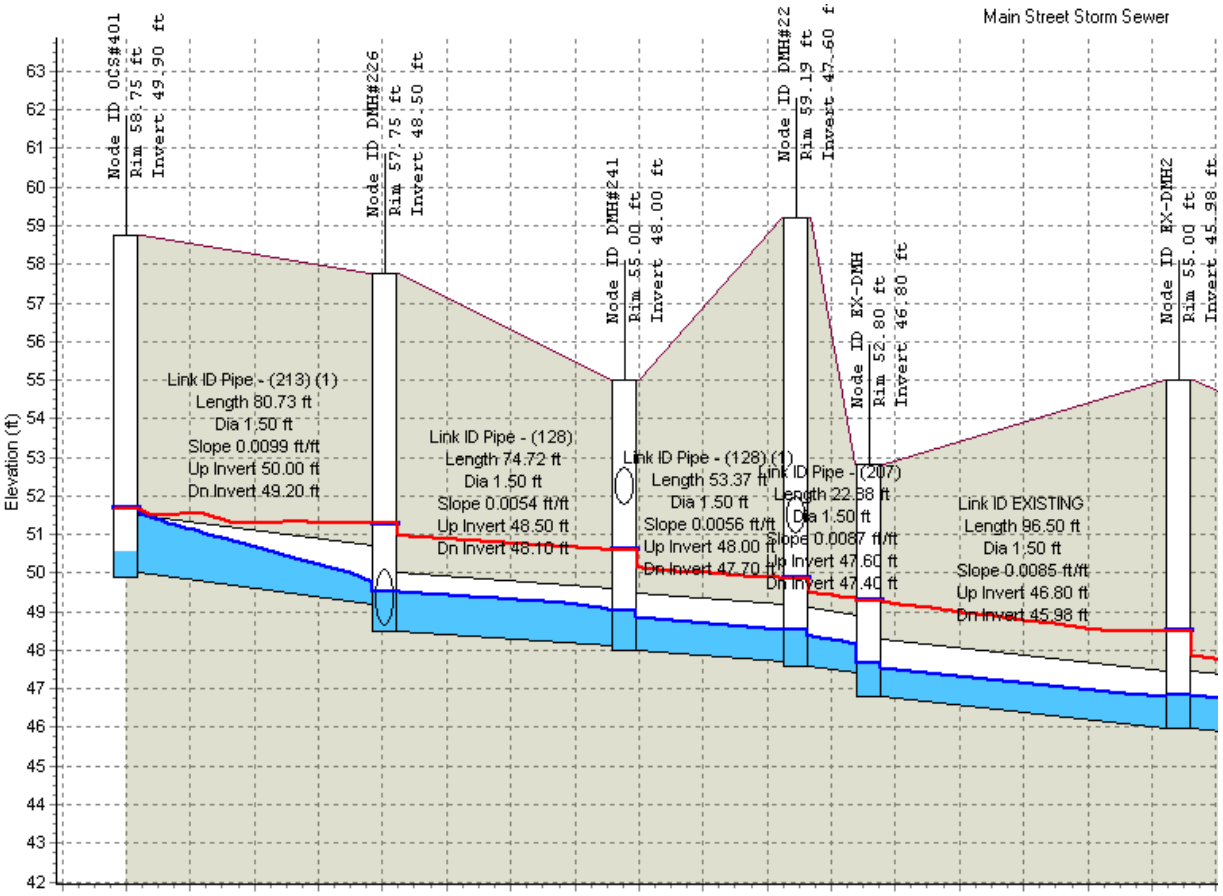
See the below profile plot of the pipe run from Detention System #1 (OCS #400), which indicates that though the existing 18-inch pipe is surcharged, the hydraulic grade line does pass above the bottom of the detention system structure/outlet structure, therefore is not surcharging/flooding the system and the detention system will be able to freely drain. Maximum HGL is shown in red.



Profile Plot: Detention System #1 to 18-inch Ex. Pipe

<u>Detention System #2:</u> Nitsch Engineering revised the elevations of Detention System #2 and upstream pipe elevations to raise the detention system above the maximum hydraulic grade line, based on the SSA analysis incorporating the existing 18-inch pipe.

See below profile plot of the pipe run from Detention System #2 (OCS #401), which indicates that the maximum HGL elevation is 51.7. As a result of this updated SSA Analysis (incorporating the existing 18-inch drain pipe), Nitsch Engineering raised the elevation of Subsurface Detention System #2 so that the bottom of the stone elevation is 51.50, top of stone elevation is 55.00. Nitsch revised the upstream pipes to accommodate the higher detention system elevation and ran the SSA analysis to confirm that the upstream drainage network will not be surcharged. As a result, even during conditions when the downstream pipes are surcharged during peak flow events due to the limited capacity of the existing 18-inch pipe, the subsurface detention system will not be surcharged and there will be no flooding at the detention system/upstream structures.



Profile Plot: Detention System #2 to 18-inch Ex. Pipe

8. Why is the drainage from the southeast corner of the site not connected to the isolator row and subsurface detention system #2? It seems that a lot of drainage pipe is being installed when this flow could be connected to the storage system. This would decrease the load on the proposed jellyfish treatment system.

   Nitsch Response: *These catch basins would require driving down the elevation of Detention System #2, due to the RIM elevations at the structures, which would result in too low of a system. The stormwater network was designed so that only catch basins in areas that are too low to discharge to the detention system bypass the detention systems and go to the Jellyfish water quality structure.*

9. There are a number of manhole locations where the angle between the upstream drain pipes and the discharge pipe is less that 90 degrees. It appears that most of these can be eliminated by adjusting the manhole locations. We recommend that these be changed where possible so that the pipes are at least 90 degrees apart (not less than 90 degrees).

   Nitsch Response: *The plans are updated to remove any acute changes (less than 90-degrees) in pipe flows. DMH203 and DMH208 have been updated.*

10. The proposed underground storage facilities are located below the likely Estimated Seasonal High Groundwater Table (ESHGWT) and not 2 feet above the ESHGWT as MADEP requires for all such facilities. While we understand the difficulties this site presents this is contrary to MADEP requirements. The facilities have been encapsulated in an impermeable barrier which is good engineering practice. If these systems are to remain as designed, the Engineer should include a plan to monitor the systems for groundwater intrusion, a corrective action plan should this occur and flotation calculations for the dry systems. Also, details should be included for sealing the system barrier at all penetrations (such as at pipes). We suggest that the LTPPP inspection interval for these systems be increased to every 2 months from twice/year.

    Nitsch Response: *The operations and maintenance plan has been modified to indicated inspections every two months as requested. A requirement for the submission of buoyancy calculations to be provided by the contractor is included in the specifications for the system.*

11. What precautions are being taken in the blasting specifications for the project to ensure that none of the blasting work will create any unforeseen changes in the adjacent wetlands (such as opening up cracks in the underlying rock which could cause the wetland to dry up)?

    Nitsch Response: *To help ensure that peak particle velocity stay below state limits the project will require additional seismic monitoring along the property lines at points closest to the resource areas. Due to state requirements that limit off-site peak particle velocity off-site fracturing of bedrock would not reasonably be expected. In addition, the plastic nature of hydric soils within the resource areas would not be expected to crack in any event.*

12. The project is proposing the use of proprietary BMPs to treat the stormwater from the project (isolator rows and jellyfisg filter). Given that this is a publicly bid project we understand that in general alternates may be proposed by the Contractor. The OOC to be issued for the project will state that any alternates that the part from the proposed storm water treatment system must be submitted to and approved by the SCC prior to the contractor ordering this alternative system.

    Nitsch Response: *The proprietary Jellyfish BMP will be included on the Project's list of proprietary items not subject to substitution.*

    The 33 40 00-Storm Drainage Utilities Specification was updated to note:

    The stormwater quality filter treatment structure indicated on the Contract Drawings is a Jellyfish® Filter as manufactured by the Contech Engineered Solutions, West Chester, OH. Other acceptable equivalent manufactured devices may be used if following requirements are met [requirements noted in Specification 33 40 00]. Prior to acceptance, the contractor shall receive written approval for use of said substitution from the Town of Swampscott Conservation Commission and DPW and/or their authorized representatives.

13. All references in the Stormwater Report to the 2017 CGP should be updated to reference the 2022 CGP and the 2017 CGP in the DRAFT SWPPP needs to be replaced with the 2022 CGP.

    Nitsch Response: *All references to the 2017 CGP have been replaced with references to the 2022 CGP.*

14. The SWPPP provided is a DRAFT SWPPP which is appropriate at this point. The OOC for the project should require that a final SWPPP be prepared, submitted to the SCC for review and be approved by the SCC prior to any site work occurring on the project.

    Nitsch Response: *The project team takes no issue with the Final SWPPP being submitted to the SCC prior to the start of work..*

15. We are attaching to this report questions that the acting chair of the SCC forwarded to us has regarding the LTPPP, CPPPP and other aspects of the project. Rather than repeating these questions herein, the Applicant and his Engineers should also address the questions that are attached hereto.

    SEE END OF MEMO FOR RESPONSES TO SCC COMMENTS.

DESIGN AND PLAN REVIEW AND COMMENTS:

GENERAL

16. The plans filed with the NOI all say, "DD SUBMISSION and DRAFT PERMIT – NOT FOR CONSTRUCTION". While they are signed and sealed by a Massachusetts Registered Professional Engineer, the Applicant needs to understand that once these plans are accepted and the project is approved by the SCC, ANY changes to the plans will have to come back to the SCC for a determination as to whether the changes are significant, require an Amended OOC or the filing of a New NOI. The labels "DD SUBMISSION" and "DRAFT PERMIT – NOT FOR CONSTRUCTION" should be removed from the final revised plans before acceptance by the SCC.

    Nitsch Response: *The plans have revised to address the comment.*

17. The plans do not show any underdrains around the building or in any other locations. Will there be any underdrains installed for the project? If so, they should be shown on the plans.

    Nitsch Response: *Underdrains for the building or foundation are not proposed.*

18. The LIMIT OF WORK and EROSION CONTROL lines should be shown on the Site Layout, Utility, Drainage and Grading Plans.

    Nitsch Response: *The LOW has been added to all plans. For clarity erosion control is not shown on all plans but the limits of the erosion control has been coordinated with the work.*

19. We understand that the Town has made an eminent domain taking of an easement or other property rights in the adjacent UU Church property. The location of this easement should be added to all of the plans for the project.

    Nitsch Response: *The easement plan has been included for reference. For clarity the easement plans are not shown on the Construction Documents, but the work has been coordinated easement.*

20. Landscaping plans showing the treatment of all non-paved areas should be submitted to the SCC. These plans should be reviewed by the SCC to ensure that there are no non-native species and invasive species proposed for the project.

Nitsch Response: *The Planting Plan has been included in the revised plan set. No non-native species are being proposed within any buffer area. One small area of the site has proposed non-native species. The only single remaining non-native species that is currently being utilized is Viburnum plicatum tomentosum 'Mariesii' (Doublefile Viburnum). The Doublefile Viburnum shrubs are providing screening in the shady southwest corner of the outdoor classroom and in a limited use in the southeast corner of the outdoor play area. The attractiveness of the viburnums spring bloom, unique layered leaf pattern, rich fall color, and clean winter branching will provide an appealing visual screen to the adjacent properties and roadways in all seasons.*

Sheets C-100 & 101

21. Include a note defining what the terms "R&D" and "R&S" mean.

    Nitsch Response: *Notes & Abbreviations are shown on Sheet C-000, including R&D and R&S.*

22. There is some R&D Pavement outside of the erosion control line as well as water line work.. The erosion control line should be adjusted to include these areas.

    Nitsch Response: *The plans have been revised to address the comment.*

23. An access gate should be added to the west side of the work to gain access from the Church Property.

    Nitsch Response: *The plans have been revised to address the comment.*

24. It appears that the location of the construction fence on the south side of the property needs to be adjusted in a southerly direction to accommodate all of the work.

    Nitsch Response: *The plans have been revised to address the comment.*

25. A limit of work line needs to be shown on this plan (and all of the plans).

    Nitsch Response: *The plans have been revised to address the comment.*

26. Is there no R&D or R&S work proposed on the UU Church property (none is shown)?

    Nitsch Response: *The plans have been revised to address the comment.*

Sheets C-200 & 201

27. Dimensions should be shown on all driveways walks, etc.

    Nitsch Response: *The plans are draw for scale and for clarity not all dimensions are shown at this time. Prior to issuance of final construction documents a layout plan will be prepared.*

28. The plan shows the work extending north away from the main school site however the details of this work are not shown.

    Nitsch Response: *The work is not part of the school building project and has been removed from our plans. Those improvements will be completed by the town under a separate contract.*

29. The crosswalk at the outlet to Whitman Road should be perpendicular across the roadway.

Nitsch Response: *The intersection was raised to increase the safety of those crossing in response to a comment from the Planning Board.*

30. Which ADA parking spaces are van spaces? What pavement type is in front of the school building between the ADA access?

Nitsch Response: *The plans have been revised to indicate the van spaces and bituminous asphalt would be the paving type used.*

31. How tall is the chain-link fence around the basketball court?

Nitsch Response: *The fence in that location is 10'. No sports netting in proposed.*

32. Which parking spaces are EV spaces? Are there signs designating the EV spaces? Are there any compact parking spaces?

Nitsch Response: *Final locations of EV spaces (which will be provided) will be determined in conjunction with the school administration.*

33. What is the large stippled circular area between the parking lot in the roadway? DC

Nitsch Response: *A sitting area with benches*

34. What are the paved surface types at the front of the new building?

Nitsch Response: *Cast-in-place concrete, and concrete unit pavers.*

35. What is the construction of the pathway in the UU church property?

Nitsch Response: *Cast-in-place concrete.*

36. There are no details of the crosswalk ramps, etc. at Laurel Road and Forest Avenue.

Nitsch Response: *The work is not part of the school building project and has been removed from our plans. Those improvements will be completed by the town under a separate contract.*

37. The paint striping appears to end at the western end of Forest Avenue, why?

Nitsch Response: *The work is not part of the school building project and has been removed from our plans. Those improvements will be completed by the town under a separate contract.*

38. The southerly end of the driveway and walkway (near the 20.00 dimension) does not meet existing conditions, why?

Nitsch Response: *The driveway in this location was narrowed as a traffic calming measure.*

39. The vehicle gates in the driveway's appear to be single leaf 28 foot wide gates. These are very heavy and we suggest you consider changing them to double leaf 14 foot gates.

Nitsch Response: *The plans have been revised to address the comment.*

Sheets C-300 & 301

40. The new water connection to the 10 inch main south of the school is located off the school property and outside of the erosion control and limit of work lines. Will a street opening permit of Forest Avenue be required for this work? As previously stated limit of work and erosion control lines need to be adjusted to include this work.

Nitsch Response: *The LOW line has been adjusted to include this work.*

41. The hydrant connections are shown on this plan as 4". Standard practice is for these connections to be 6" and the detail on the plans shows these connections as 6". The discrepancy should be reconciled.

Nitsch Response: *Hydrant connections have been updated from 4" to 6".*

42. We suggest consideration being given to adding a divisional valve on the long section of new 8 inch water line.

Nitsch Response: *A valve has been added to this section.*

43. The inverts for the proposed 5000 gallon grease trap should be shown and slopes should be shown on all proposed sewer lines. The sewers entering SMHs 302 and 304 should be adjusted to be 90° or greater.

Nitsch Response: *The plans have been revised to add address the comment.*

44. There should be a gate valve on the water line connecting to the fire hydrant near subsurface detention system #1

Nitsch Response: *The plans have been revised to address the comment.*

45. The curbing is located directly over the frame and cover of EX. SMH#308. The curbing configuration should be adjusted.

Nitsch Response: *The plans have been revised to address the comment.*

46. A note should be added to the lights along the new walkway on the UU Church property to indicate that these are lights.

Nitsch Response: *The plans have been revised to address the comment.*

Sheets C-400 & 401

47. The manhole covers on the jellyfish treatment unit should be shown on the plan as the curbing is located across the unit. If necessary either the location of the unit or the curbing configuration should be adjusted.

    Nitsch Response: *The plans have been revised to address the comment.*

48. How deep is the foundation of the new school building adjacent to the subsurface isolator row proposed for roof drain #4?

    Nitsch Response: *4 feet.*

49. All of the drain pipes on the drainage plans need to have pipe slopes shown on them.

    Nitsch Response: *The plans have been revised to address the comment.*

50. What is the circle located in the northwest corner of subsurface detention system #1? The plan should also show the locations of the access/cleanout manholes for both of the subsurface detention systems.

    Nitsch Response: *The circle has been removed (it was a CAD block not meant to be shown) and the access basins are shown on the plan.*

51. A note should be added to the plans denoting that, "CPP" is corrugated plastic pipe.

    Nitsch Response: *Please see Sheet C-000 for a list of all plan symbols and abbreviations.*

52. What is the invert elevation out of DMH #207?

    Nitsch Response: *The plans have been revised to add the invert.*

<u>Sheets C-500 & 501</u>

53. Spot elevations should be added to the plan where the contours are spaced further apart. The rim elevations of catch basins should be shown on the plan.

    Nitsch Response: *Additional spot grades will be added to the plan prior to the issuance of final construction documents.*

54. The Engineer should review the slope of the parking lot northwest corner (appears to be steep),

    Nitsch Response: *The grading in that area has been discussed and agreed to with the project team (including the Owner). Previous plan iterations indicted a wall in that area but it was removed to meet budget goals.*

55. The sidewalk along the west side of the parking area does not show a railing as required by ADA. Details need to be added to the detail sheets in the parking lot may require a retaining wall along the west side due to walkway slope and level landings. The Engineer should review this.

Nitsch Response: *Final coordination of this area including railings, materials and final details, will be done prior to the issuance of final construction documents.*

56. The plan should show the surface features around the school that are shown on the previous plans. These features should be identified and the planters and other structures at the front of the school should also be identified.

Nitsch Response*: Please see the Landscape Architect's Materials and Planting Plan for this information.* DC

57. The limit of work and erosion control should be expanded at the southeast and corner of the site where the driveway connects to the existing pavement in Forest Avenue. Grades should also be shown at the pathway to the woods at the south side of the new school building.

Nitsch Response: *The plans have been revised to address the comment.*

58. The grassed area between the new driveway on the east side of the site and the property line appears to grade into the neighbors' yards (it does not presently do this). What is the impact of this work on the neighboring properties?

Nitsch Response: *The grading is intended to match the existing condition as much as possible. Though the grade (slope) is increased in certain areas, the area contributing to DP-3 is reduced. This is evident in the reduction of the peak rate for every storm event.*

59. What is the limit of the full depth pavement reconstruction on the UU Church property?

Nitsch Response: *The plans have been revised to address the comment.*

<u>Sheet C-600</u>

60. The tracking pad is shown as *12 x 50. We believe that this should be wider (even for one way traffic) and it should be clarified as to whether the optional wash rack is included/required or not. The detail should correlate with plans.

Nitsch Response: *The plans have been revised to address the comment.*

<u>Sheets C-601 & 602</u>

No Comments.

<u>Sheet C-603</u>

61. The typical trench drain detail references to XX.XXX should be changed to actual numbers.

Nitsch Response: *The Detail has been revised to reference Sheet C-601.*

62. In the SC 740 chamber detail, what material is to be used under, over and immediately inside the impermeable liner material for the subsurface storage systems? Is there a stone size limit or material

spec for the fill material over these systems? We assume that the 18" cover is under paved areas only and that deeper cover is required under non-paved areas but this should be clarified.

Nitsch Response: *The Detail has been revised to clarify the stone material (1 1/2" DOUBLE WASHED CRUSHED STONE).*

63. In the Isolator Row Detail, what is the sump depth?

Nitsch Response: *The Detail has been revised to show a 4-ft sump.*

64. We suggest that an additional manhole cover be included in the OCS Detail so that access can be gained to each side of the weir plate for cleanout.

Nitsch Response: *This is our standard detail and we found that the single manhole provides more than enough clearance for inspection and cleaning the structure.*

COMMENTS PROVIDED BY THE COMMISSION

Long Term Pollution Prevention Plan and Stormwater Operation & Maintenance Plan

O&M plan includes routine maintenance, insp. and repair of stormwater system, street sweeping, etc., and specifically references ConCom. If an OOC is issued, elements of both plans should be included as ongoing conditions that continue in perpetuity.

Nitsch Response: *Understood.*

Who will be responsible for the ongoing maintenance? DPW? School Dept? If it's the school, does it have staff to perform or does it need to contract out? If the latter, does this need to be included in the school budget?

And how to ensure the maintenance is done? Who will be filling out the insp. forms that are supposed to be submitted? Is the submission of such insp. rpts. sufficient?

Nitsch Response: *Maintenance of school facilities is shared by the Town of Swampscott School Department and Town of Swampscott Department of Public Works. The Town is aware of the maintenance and inspection requirements being proposed. Inspection, maintenance and if required, any repair of the stormwater systems will be done be a combination of DPW, School and contracted personnel. Inspection forms, if required, will be kept by School Facilities personnel.*

Stormwater Rpt. dated 2-23-22

-my very general understanding is that, although there will be an increase in impervious surface, the proposed water quality treatment will both reduce peak runoff from the site and remove solids and phosphorus from the discharge. I assume the reduction in flow is due mainly to the retention

basins. I understand how proposed water quality systems will also reduce solids (via settling), but how do they also result in a reduction of phosphorus?

Nitsch Response: *Per Contech, the manufacturer of Jelly Fish: The membrane filters provide a very large surface area to effectively remove fine sand and silt-sized particles, and a high percentage of particulate-bound pollutants such as nitrogen, phosphorus, metals, and hydrocarbons while ensuring long-lasting treatment.*

Jellyfish Filter Performance Testing Results

Pollutant of Concern	% Removal
Total Trash	99%
Total Suspended Solids (TSS)	89%
Total Phosphorus (TP)	59%
Total Nitrogen (TN)	51%
Total Copper (TCu)	>50%
Total Zinc (TZn)	>50%
Turbidity (NTU)	< 15

Sources
TARP II Field Study – 2012 JF 4-2-1 Configuration
MRDC Floatables Testing – 2008 JF6-6-1 Configuration

Per testing data available from Stormtech, the Isolator Row system removes an average of 50% Phosphorous removal. Per the University of New Hampshire Stormwater Center: Runoff slowly passes from the chambers through a woven geotextile fabric and into the crushed stone reservoir below the system. The runoff passes through the fabric, leaving behind sediments and associated contaminants through the physical unit operations of filtration and sedimentation. As an organic filter cake develops over the fabric, phosphorus is also removed via the chemical process or sorption. See attached. Find attached documentation from UNH.

The report references the O&M plan requirements (mentioned above) but also the need for proper snow management. Is there a snow disposal plan? And is it in accordance with Mass. Policy? Some specific questions: where will the snow be stored? And what snow/ice treatments are proposed?

Nitsch Response: *Snow will be managed/disposed in accordance with MassDEP policy. No snow storage will be indicated in any buffer zone and if required the Town will truck snow off site for proper storage/disposal.*

-if an OOC is issued, the proposed treatment (deep sump and hooded catch basins, subsurface detention systems with isolator row, etc.) should likely be included as conditions in perpetuity, which again raises issues of responsibility for maintenance of those systems.

Nitsch Response: *The Town of Swampscott is committed to maintain the stormwater systems and understands the continued inspection and maintenance will be a requirement of any Order of Conditions.*

1-as raised at the Mar 17 meeting, the Commission would like to have further discussion on possible protective barriers between the school and Ewing Woods.

Nitsch Response: *During construction additional erosion control barriers, in addition to the construction fence have been indicated along the property line adjacent to Ewing Woods. In the finished condition the school was designed to provide both visual and physical connections to Ewing Woods for the students. If*

additional screening of the service area is desired the project is will to incorporate a fence into the wall detail for that area.

Draft SWPPP (for construction period)

I noticed that draft says it's in compliance with 2017 Construction Gen. Permit; note that there is now a newly effective 2022 CGP that town will have to file under.

Nitsch Response: *See response to Comment #13.*

What federally listed threatened or endangered species or their habitat is in the site area? I was under the assumption there were none in Swamp't.

Nitsch Response: *The Massachusetts Natural Heritage and Endangered Species Program (NHESP) does not indicate any endangered or threatened species within this site.*

The SWPPP talks about pesticides, herbicides, fertilizers, etc. and the need for them to be safely contained. The Commission believes there needs to be discussion on restricting use of such materials.

Nitsch Response: *Pesticides, herbicides and fertilizers will not be stored on the school site after construction. Regarding the use of such materials, Town of Swampscott and their landscape contractor's practice Integrated Pest Management (IPM). IPM is an ecosystem-based strategy that focuses on long-term prevention of pests or their damage through a combination of techniques such as biological control, habitat manipulation, modification of cultural practices, and use of resistant varieties. Pesticides are used only after monitoring indicates they are needed according to established guidelines, and treatments are made with the goal of removing only the target organism. Pest control materials are selected and applied in a manner that minimizes risks to human health, beneficial and nontarget organisms, and the environment. Please not that in IPM the use of the term "pest" includes weeds and other organisms that causes disease, or may harm water quality, animal life, or other parts of the ecosystem.*

I note that "personnel responsible for inspections" is not named (section 6.1). Also not named is personnel responsible for corrective action or delegations of authority (section 6.2 and 6.3).

Copies of SWPPP insp. rpts. should also go to ConCom.

Nitsch Response: *Once a contractor is selected, they will be responsible for filling out the applicable sections of the SWPPP including the sections noted. In addition, copies of the completed SWPPP and proof of filing under the NPDES 2022 CGP will be provided to the Conservation Commission. The SWPPP requires that all inspection report be kept and maintained on site and that they are available for review. Copies of inspection reports can be sent to the Conservation Commission if desired.*

Misc. Q.

Is the Forest River paper road part of the Ewing Woods easement? Is there a deed showing boundaries?

Nitsch Response: *The limits of the Forest Avenue right-of-way are shown on the plans.*

I understand that the select board voted to take by eminent domain the UU Church easement, has this been recorded? Is this sufficient to give town “ownership” for purposes of submitting the NOI with church signature? Is there a confirmation from town counsel on this?

Nitsch Response: *Please see response to Comment #1.*

KP | LAW
The Leader in Public Sector Law

101 Arch Street, Boston, MA 02110
Tel: 617.556.0007 | Fax: 617.654.1735
www.k-plaw.com

March 31, 2022

A. Alexander Weisheit
aweisheit@k-plaw.com

CERTIFIED MAIL - RETURN RECEIPT REQUESTED

MassDEP Northeast Regional Office
205B Lowell Street
Wilmington, MA 01887

Re: Town of Swampscott – NOI File No. 071-0349 – New Swampscott Elementary School Project at 10 Whitman Street

Dear Sir/Madam:

KP Law serves as Town Counsel to the Town of Swampscott (the "Town"). This letter is intended to serve to notify MassDEP of the Town's position regarding an issue identified by the Town's Conservation Commission's (the "Commission") peer reviewer, William A. Jones, Sr. ("Mr. Jones"), in a report submitted to the Commission on March 28, 2022 regarding the above-referenced NOI. Mr. Jones has suggested that the Town amend its NOI application form to include reference to the record owner of an abutting property where a limited amount of work is proposed under the Town's NOI. The abutting property is owned by the UU Church. For the reasons that follow, it is the Town's position that a formal amendment to the application form is not necessary as the Town has cured the issue identified by Mr. Jones. However, as requested by Mr. Jones, the following will serve as an explanation of the situation and the reasons for which the Town has the lawful authority to pursue the NOI as a "landowner" as that term is defined in 310 CMR 10.04.

The Town recorded an Order of Taking at the Registry of Deeds for the relevant portion of the UU Church property on or about March 17, 2022. The Order of Taking is recorded at the Essex County Registry of Deeds in Book 40797, Page 375. Accordingly, in my opinion, the Town acquired a legal interest as an easement holder in the UU Church property prior to the opening of the public hearing by the Commission on the Town's NOI. In my opinion, at the time the Town recorded its Order of Taking, the Town became a "landowner" as that term is defined in 310 CMR 10.04. See, In re: Sloan, Docket No. 2006-864 (DALA 137-0874), Ruling on Motion for Summary Decision (March 7, 2007), Recommended Final Decision (June 13, 2007), adopted by Final Decision (October 16, 2007), holding that an easement holder is also a "landowner" and can file a NOI without the signature of the owner of the fee. The Massachusetts Appeals Court has also addressed this issue in Tindley v. Department of Environmental Quality Engineering, 10 Mass. App. Ct. 623 (1980) which provides that the owner of a dominant estate does not need the authority of the servient owner to file a NOI. Accordingly, while the signature of a landowner normally must be obtained prior to the filing of a NOI if the applicant is not a landowner (See 310 CMR 10.05 (4)(a)), here, in my opinion, the arguable procedural defect with the Town filing its NOI without the signature of the UU Church was cured when the Town became a landowner prior to the opening of the public hearing. Moreover, the UU Church was provided copies of the Town's draft NOI before it was filed.

Accordingly, in my opinion, the Commission may proceed with a substantive review of the Town's NOI and issue an appropriate OOC.

Please let me know if the Department has any questions or if there is any other way I can be of assistance. Thank you for your attention to this matter.

Very truly yours,

A. Alexander Weisheit

AAW/smm
cc: Town Administrator
Conservation Commission

806765/SWAM/0239

LEC WETLANDS WILDLIFE WATERWAYS

MEMORANDUM

DATE: March 30, 2022

TO: David Conway, Nitsch Engineering

FROM: Andrea Kendall

RE: DEP File No. 071-0349
Town of Swampscott
Swampscott Public Schools
10 Whitman Road
Swampscott, Massachusetts

PROJECT #: NEI\20-400.04

LEC has prepared this Memorandum to discuss the jurisdictional status of a wetland area within a landscape island on the Unitarian Universalist Church (UU Church) property (Parcel ID: 23-E) located on Forest Avenue. This area was reviewed by Seekamp Environmental Consulting, Inc., (SEC) as part of a peer review of a Notice of Intent Application filed by Nitsch Engineering, Inc., for the proposed redevelopment of the Swampscott Elementary School. A portion of the UU Church Property is included in the project area. SEC offered the following comments as part of their March 17, 2022 Peer Review Memo related to a topographically depressed area within a parking lot landscape island on the site:

> *Upon review, SEC has found what we believe to be a **separate small wetland area** on the UU Church Site which has not been identified. This is a small remnant pocket wetland, located at the very bottom of the long, narrow island on the UU Church parking lot, which is immediately adjacent to several wet sumps connected by concrete pipes which had saturated soils and a small amount of standing water in them at the time of our review. The pocket wetland appears to have a predominance of wetland species in the tree, sapling and shrub canopies, with the herbaceous stratum inconclusive due to the winter seasonal conditions. Soil conditions were saturated but inconclusive due to refusal at 10 inches or so below the ground surface due to the dense rock substrate here.*
>
> *In keeping with LEC's definition of such pocket wetlands connected by pipes (intermittent stream) while being "hydrologically isolated and topographically confined", our understanding is that these meet that definition the same as other wetlands identified as BVW on the Ewing Woods and UU parcel. It is our understanding that currently, future work is proposed in this area which involves a walking path through this wetland. Further, our understanding is these areas were constructed prior to 2008, and while they may have been done under a valid Order of Conditions, they have no Operation and Maintenance Plan associated with them. As such, these wet areas*

> *should delineated and shown on the Plans with their Buffer Zone and any work in these areas should be avoided if possible.*

LEC agrees that the area in question includes a predominant wetland plant community comprised of shrubs and trees and a wetland soil profile, but asserts that the area is not subject to jurisdiction under the *Massachusetts Wetlands Protection Act* (*Act*, M.G.L. c. 131, s. 40) and its implementing Regulations (*Act Regulations*, 310 CMR 10.00), in accordance with 310 CMR 10.02(5), which states (underline added):

> *(5) For purposes of 310 CMR 10.02(2)(c) and (4), the applicant has the burden of proving that the proposed project involves a stormwater management system designed, constructed, installed, operated, maintained and/or improved as defined at 310 CMR 10.04 in accordance with the Stormwater Management Standards as provided in the Stormwater Management Policy (1996) or 310 CMR 10.05(6)(k) through (q) and that the system was designed, constructed, installed and/or improved on or after November 18, 1996. The applicant also has the burden of establishing whether said stormwater management system was installed in an Area Subject to Protection under M.G.L. c. 131, § 40 or associated Buffer Zone, and, if so, that the system was constructed in accordance with all applicable provisions of 310 CMR 10.00. An applicant shall use the best evidence available to meet the burden of proof required. For purposes of 310 CMR 10.02(2)(c) and (4), the best evidence is the Order of Conditions, Order of Resource Area Delineation or Determination of Applicability for the project served by the stormwater management system together with the plans referenced in and accompanying such Order or Determination, and, if applicable, the Certificate of Compliance. If the best evidence is available, the date the system was designed shall be the date the Notice of Intent, Request for Determination or Notice of Resource Area Delineation was filed. If the best evidence is not available, the applicant shall rely on other credible evidence to meet the required burden of proof such as local approval of the stormwater management system along with the plans referenced in and accompanying said approval and any wetland conservancy maps and wetland change maps for the relevant time period published by the Department on MassGIS.* [Emphasis Added]

On October 23, 1979, a Notice of Intent (NOI) Application was filed on behalf of the UU Church for construction of the existing facility. On December 19, 1979, the Swampscott Conservation Commission issued an Order of Conditions (DEP File. No. 71-43), and following completion of construction, a Certificate of Compliance was issued on January 12, 1982 (re-issued on November 17, 1982) (Attachment A). Note the NOI was filed and Order of Conditions and Certificate of Compliance issued prior to the April 1, 1983 promulgation of the *Regulations*. According to the Drainage Plan (Attachment B) submitted with the NOI, the area in question was not identified as an Area Subject to Protection under the *Act*. The only Area Subject to Protection depicted on the Drainage Plan includes the northerly wetland system (i.e., currently identified as the A-Series wetland) and associated 100-foot Buffer Zone.

The Drainage Plan depicts a series of roadway catch basins and area drains that collect and then convey stormwater runoff through a series of drainage pipes and two constructed low-lying depressions located within the upland landscape islands. In addition, based on proposed grading and lack of curbing, a

portion of runoff from the adjacent parking lots/roadway was designed to sheet flow onto the landscaped islands. The area in question (i.e., low-lying depression) has a piped inlet and outlet and was constructed in a parking lot landscape island to manage stormwater from the facility infrastructure. It is also important to note that since the *Act* did not require the submission of an Operations and Maintenance Plan, there were and are no requirements to follow a maintenance plan for the stormwater system.

It is not the intent of the *Act* or *Act Regulations* to regulate stormwater management structures that were created or constructed in uplands as jurisdictional wetlands.

On March 23, 2022, LEC spoke with Pamela Merrill, Environmental Analyst, from MassDEP Wetlands Program, to confirm that 310 CMR 10.02(5) is the regulatory citation for assessing the jurisdictional status of the area in question. Ms. Merrill reviewed the Drainage Plan, acknowledged the area was constructed in an upland for the apparent purpose of managing stormwater, and noted that with the permitting record (i.e., OOC and CoC), she would concur with LEC's findings.

alk:20-400.04 NEI Memo

Attachment A

Order of Conditions, DEP File No. 71-43,
issued by the Swampscott Conservation Commission
on December 19, 1979

Certificate of Compliance, DEP File No. 71-43,
issued by the Swampscott Conservation Commission
on January 12, 1982 (and re-issued November 17, 1982)

BK6668 PG309

ORDER
WETLAND PROTECTION ACT
G.L. C. 131 s. 40

Lw
B.6910
P.500R

FILE NUMBER: 71-43
TO: Unitarian Universalist Church
63 Burrill St
Swampscott
NOTICE OF INTENT AND PLANS
DATED: 10/23/79
DATE OF PUBLIC HEARING: 11/27/79

PROJECT LOCATION: SWAMPSCOTT
STREET AND #: Forest Ave, near Laurel
PLATE AND LOT #: Pl 22 lot E,
Pl 23 lot 42
CERT. MAIL #:
DATE OF RECEIPT BY
CONSERVATION COMMISSION: 11/7/79

Pursuant to the authority of G.L. C. 131 s. 40, the SWAMPSCOTT CONSERVATION COMMISSION has considered your Notice of IDtent and plans submitted therewith, and has determined that the area on which the proposed work is to be done is significant to one or more of the interests described in the said act. The SWAMPSCOTT CONSERVATION COMMISSION hereby orders that the following conditions are necessary and all work must be performed in strict accordance with said conditions and with the Notice of Intent and Plans, unless modified by said conditions:

CONDITIONS:

1. Failure to comply with all conditions stated herein, and with all related statutes and other regulatory measures, shall be deemed cause to revoke or modify this order.

2. This order does not grant any property rights or any exclusive privileges; it does not authorize any injury to private property or invasion of private rights.

3. This order does not relieve the permittee or any other person of the necessity of complying with all other applicable federal, state, or local statutes, ordinances, by-laws and/or regulations.

4. The work authorized hereunder shall be completed within one (1) year from the date of this order unless otherwise stated below pursuant to Regulation 6.7. The order may be extended by the issuing authority for one or more additional one-year periods upon application to the said issuing authority at least thirty days prior to the expiration date of the order or its extension.

5. Any fill used in connection with this project shall be clean fill, containing no trash, refuse, rubbish, or debris, including, without limiting the generality of the foregoing, lumber, bricks, plaster, wire, lath, paper, cardboard, pipe, tires, ashes, refrigerators, motor vehicles or parts of any of the foregoing.

6. No work may be commenced until all appeal periods have elapsed from the order of the Conservation Commission or from a final order by the Department of Environmental Quality Engineering.

7. No work shall be undertaken until the final Order, with respect to the proposed project, has been recorded in the Registry of Deeds for the district in which the land is located within the chain of title of the affected property. Copy to be furnished to issuer of this order showing book and page prior to commencement of work.

8. Upon completion of the work described herein, the applicant shall forthwith request, in writing, that a Certificate of compliance be issued stating that the work has been satisfactorily completed. Where a project has been completed in accordance with plans stamped by a Registered Professional Engineer, Architect, Landscape Architect, or Land Surveyor, a written statement by the aforesaid professional person certifying compliance with the plans shall accompany said request.

9. A sign shall be displayed at the site not less than two square feet or more than three square feet bearing the words, "Massachusetts Department of Environmental Quality Engineering. Number 71-43 ".

10. Where the Department of Environmental Quality Engineering is requested to make a determination and to issue a superseding order, the Conservation Commission shall be a party to all agency proceedings and hearings before the Department.

11. The work shall conform to the following described plans and additional conditions:

Notice of Intent dated 10/23/79 and the plans made a part thereof, labeled "Drainage Plan October 1979, Job # 2007" and revisions thereto dated 12/14/79 ; subject to approval by the Dept of Public Works.

12. For any change made or intended to be made in the plans or in the work, the applicant shall file a new Notice of Intent or inquire in writing of the Conservation Commission whether the change is substantial enough to require a new Notice of Intent.

13. The Swampscott Conservation Commission or its duly authorized agents will have access to the location of any work described in your letter of intent or plan, for the purpose of inspecting such location for compliance with the provisions of this Order.

14. The issuance of Conditions does not in any way certify or imply that the site for which the application is made will not be subject to flooding or any other form of storm or water damage.

15. This Order also contemplates and permits the removal of dead or dangerous trees on the property..

CONDITIONS CONTINUED PAGE 3 FILE NO. 71-43

The applicant, any person aggrieved by this order, any owner of land abutting the land upon which the proposed work is to be done, or any ten residents of the city or town in which such land is located, are hereby notified of their right to appeal this order to the Dept. of Environmental Quality Engineering provided the request is made in writing and by certified mail to the Department within ten(10) days from the issuance of this order.

ISSUED BY: SWAMPSCOTT CONSERVATION COMMISSION

12/19/79
Date of Issuance

On this 19th day of December 1979, before me personally appeared Esther Ewing to me known to be the person described in and who executed the foregoing instrument and acknowledged that he executed the same as his free act and deed.

My Commission expires Oct 1 '82

ESSEX SS. RECORDED Jan. 4 1980 26M. PAST 11 AM. INST. #101

COMMONWEALTH OF MASSACHUSETTS

WETLAND PROTECTION ACT

G.L. C.131 s.40

CERTIFICATE OF COMPLIANCE

PROJECT LOCATION Forest Ave, SWAMPSCOTT DATE Jan 12, 1982

FILE NO. 71-43, Unitarian-Universalist Church

It is hereby certified that the work regulated by an Order of Conditions dated 12/19/79, ext 5/19/81 by the Department of Natural Resources / / Conservation Commission /x/ has been satisfactorily completed.

This Certificate shall be recorded in the Registry of Deeds for the district in which the land is located. The Order was originally recorded on Jan 4, 1980 (date) in 6686 (book) 309 (page)

Esther S. Ewing
Harold Riggs
John A. DelSimone
Muriel P. Ingalls

SWAMPSCOTT CONSERVATION COMMISSION
Signature of Issuing Authority

On this 2nd day of February 1982 before me personally appeared Esther S. Ewing to me known to be the person described in and who executed the foregoing instrument and acknowledged that he executed the same as his free act and deed.

Genevieve H. Carmier — Notary Public

Oct. 1 '82 — My commission expires

"F"

-34-

ESSEX SS. RECORDED Feb 23, 1982 50 M. PAST 11 A.M. INST #85

BK7023 PG250

COMMONWEALTH OF MASSACHUSETTS

WETLAND PROTECTION ACT

G.L. C.131 s.40

CERTIFICATE OF COMPLIANCE

PROJECT LOCATION Forest Ave, SWAMPSCOTT DATE Nov 16, 1982

FILE NO. 71-43, Unitarian-Universalist Church

It is hereby certified that the work regulated by an Order of Conditions dated 12/19/79, ext 5/19/81 by the Department of Natural Resources / / Conservation Commission /X/ has been satisfactorily completed.

This Certificate shall be recorded in the Registry of Deeds for the district in which the land is located. The Order was originally recorded on Jan 4, 1980 (date) in 6686 (book) 309 (page)

Sarah P. Dingwall — Esther S Ewing

Stephen J Deeds — Nancy L Driggs

Charles W. Burson

SWAMPSCOTT CONSERVATION COMMISSION

Signature of Issuing Authority

On this 12th day of Nov. 1982, before me personally appeared Esther Ewing to me known to be the person described in and who executed the foregoing instrument and acknowledged that he executed the same as his free act and deed.

Notary Public — My commission expires Sept 22, 1989

"F"

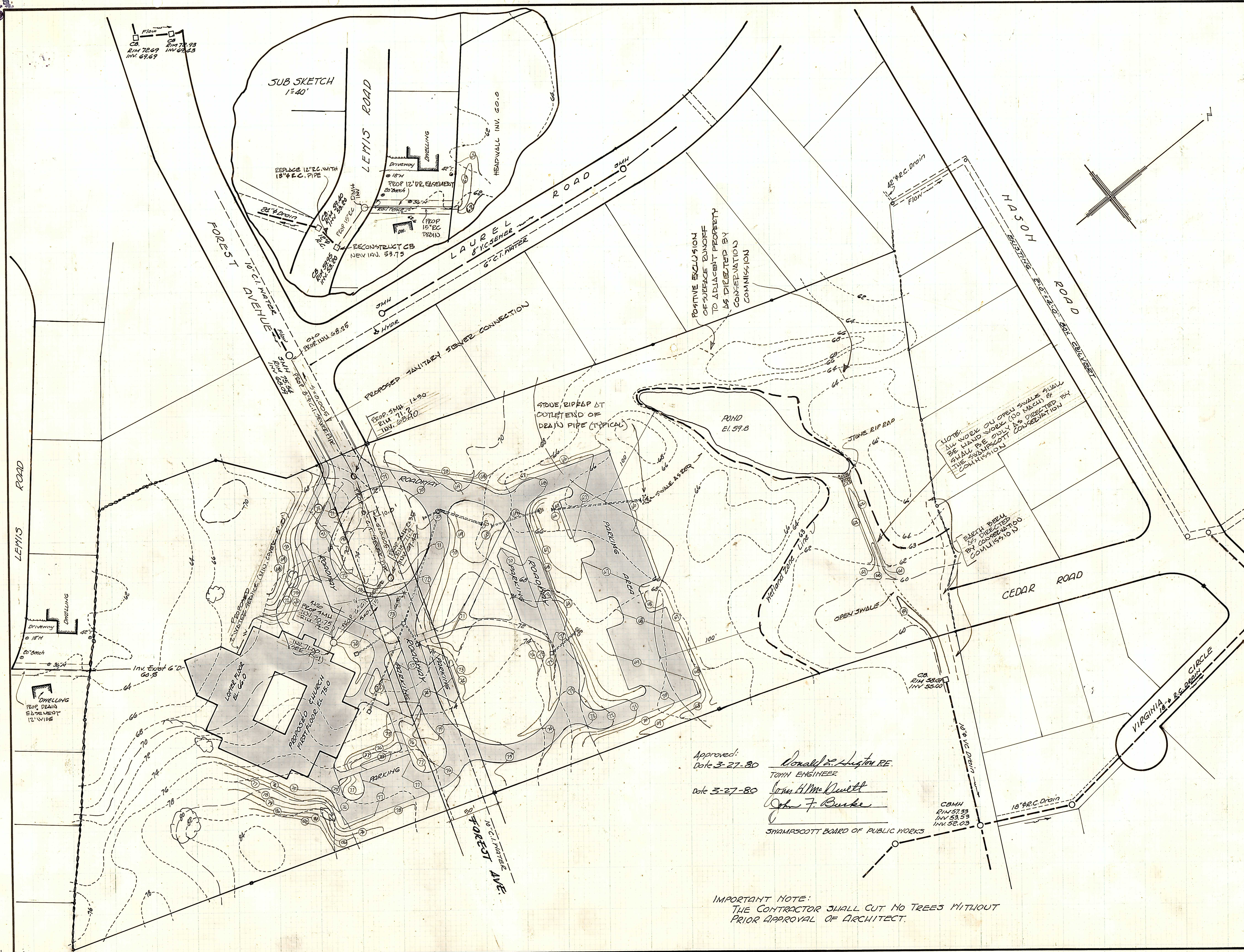
-34-

Note: Origianally issued Jan 12, 1982. Re-issued at request of applicant because of loss of original certificate.

ESSEX SS. RECORDED Dec. 29, 1982 48 M. PAST 2 P. M. INST # 258

Attachment B

Unitarian Universalist Church, Drainage Plan,
prepared by Essex Survey Service, Inc., dated October 1979



GENERAL NOTES

1. ---62--- INDICATES EXISTING CONTOURS
2. —(62)— INDICATES FINISH CONTOURS.
3. EXISTING CONTOURS FROM TOPOGRAPHIC PLAN OF LAND BY LANDMARK ENGINEERING & SURVEYING - LYNN, MA. DATED OCTOBER 1978.
4. FINISH CONTOURS FROM PRELIMINARY SITE PLAN BY THE GLUCK WALKER WILLIAM PARTNERSHIP - MC EASTON, MA.

2. JAN 28, 1980 SEWER & WATER CONN.
1. DEC. 14, 1979

REVISIONS

SHEPLEY BULFINCH RICHARDSON & ABBOTT
ONE COURT ST., BOSTON, MA. 02108
ARCHITECTS

ESSEX SURVEY SERVICE, INC.
47 FEDERAL ST., SALEM, MA. 01970
ENGINEERS

UNITARIAN UNIVERSALIST CHURCH
63 BURRILL ST., SWAMPSCOTT, MA. 01907
OWNER

UNITARIAN UNIVERSALIST CHURCH
PROJECT

DRAINAGE PLAN
DRAWING TITLE

JOB NO. 2007
DATE OCT, 1979
DWN. E.T. CKD.
SCALE 1" = 40'-0"

D1
DRAWING NO.

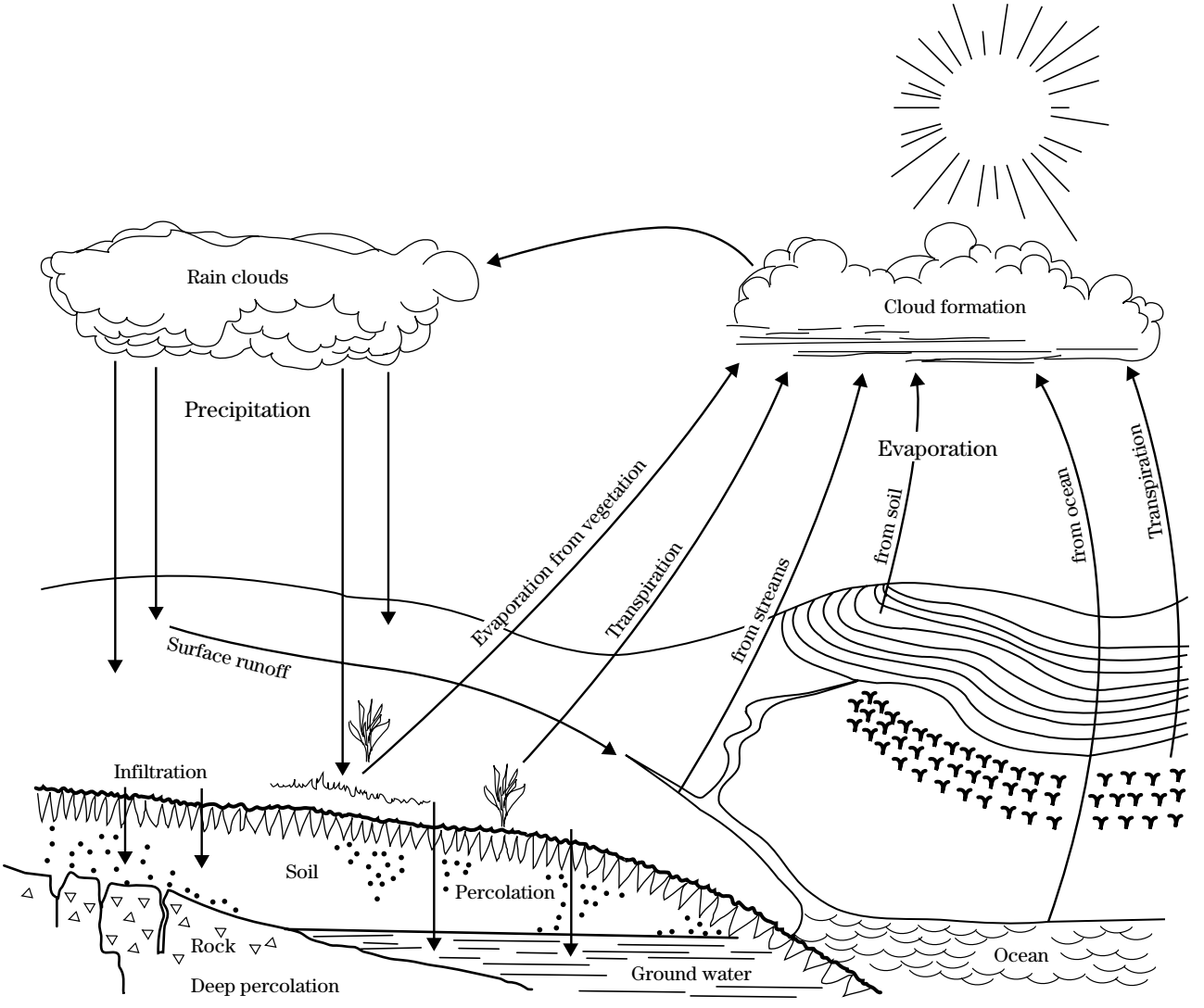
8-455

United States
Department of
Agriculture

**Natural
Resources
Conservation
Service**

Part 630 Hydrology
National Engineering Handbook

Chapter 7 Hydrologic Soil Groups



Issued May 2007

Acknowledgments

Chapter 7 was originally prepared by **Victor Mockus** (retired) and reprinted with minor revisions in 1972. This version was prepared by the U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS) under guidance of **Jon Werner** (retired), NRCS; with assistance from **Donald E. Woodward** (retired), NRCS; **Robert Nielsen** (retired), NRCS; **Robert Dobos**, soil scientist, NRCS; and **Allen Hjelmfelt** (retired), Agricultural Research Service. It was finalized under the guidance of **Claudia C. Hoeft**, national hydraulic engineer.

Preface

This chapter of the National Engineering Handbook (NEH) Part 630, Hydrology, represents a multi-year collaboration between soil scientists at the National Soil Survey Center (NSSC) and engineers in the Conservation Engineering Division (CED) at National Headquarters to develop an agreed upon model for classifying hydrologic soil groups.

This chapter contains the official definitions of the various hydrologic soil groups. The National Soil Survey Handbook (NSSH) references and refers users to NEH630.07 as the official hydrologic soil group (HSG) reference. Updating the hydrologic soil groups was originally planned and developed based on this perspective.

Listing HSGs by soil map unit component and not by soil series is a new concept for the engineers. Past engineering references contained lists of HSGs by soil series. Soil series are continually being defined and re-defined, and the list of soil series names changes so frequently as to make the task of maintaining a single national list virtually impossible. Therefore, no such lists will be maintained. All such references are obsolete and their use should be discontinued.

Instructions for obtaining HSG information can be found in the introduction of this chapter.

Chapter 7 Hydrologic Soil Groups

Contents:

Tables

Chapter 7 Hydrologic Soil Groups

630.0700 Introduction

This chapter defines four hydrologic soil groups, or HSGs, that, along with land use, management practices, and hydrologic conditions, determine a soil's associated runoff curve number (NEH630.09). Runoff curve numbers are used to estimate direct runoff from rainfall (NEH630.10).

A map unit is a collection of areas defined and named the same in terms of their soil components or miscellaneous areas or both (NSSH 627.03). Soil scientists assign map unit components to hydrologic soil groups. Map unit components assigned to a specific hydrologic soil group have similar physical and runoff characteristics. Soils in the United States, its territories, and Puerto Rico have been assigned to hydrologic soil groups. The assigned groups can be found by consulting the Natural Resources Conservation Service's (NRCS) Field Office Technical Guide; published soil survey data bases; the NRCS Soil Data Mart Web site (*http://soildatamart.nrcs.usda.gov/*); and/or the Web Soil Survey Web site (*http://websoilsurvey.nrcs.usda.gov/*).

The state soil scientist should be contacted if a soil survey does not exist for a given area or where the soils within a watershed have not been assigned to hydrologic groups.

630.0701 Hydrologic soil groups

Soils were originally assigned to hydrologic soil groups based on measured rainfall, runoff, and infiltrometer data (Musgrave 1955). Since the initial work was done to establish these groupings, assignment of soils to hydrologic soil groups has been based on the judgment of soil scientists. Assignments are made based on comparison of the characteristics of unclassified soil profiles with profiles of soils already placed into hydrologic soil groups. Most of the groupings are based on the premise that soils found within a climatic region that are similar in depth to a restrictive layer or water table, transmission rate of water, texture, structure, and degree of swelling when saturated, will have similar runoff responses. The classes are based on the following factors:

- intake and transmission of water under the conditions of maximum yearly wetness (thoroughly wet)
- soil not frozen
- bare soil surface
- maximum swelling of expansive clays

The slope of the soil surface is not considered when assigning hydrologic soil groups.

In its simplest form, hydrologic soil group is determined by the water transmitting soil layer with the lowest saturated hydraulic conductivity and depth to any layer that is more or less water impermeable (such as a fragipan or duripan) or depth to a water table (if present). The least transmissive layer can be any soil horizon that transmits water at a slower rate relative to those horizons above or below it. For example, a layer having a saturated hydraulic conductivity of 9.0 micrometers per second (1.3 inches per hour) is the least transmissive layer in a soil if the layers above and below it have a saturated hydraulic conductivity of 23 micrometers per second (3.3 inches per hour).

Water impermeable soil layers are among those types of layers recorded in the component restriction table of the National Soil Information System (NASIS) database. The saturated hydraulic conductivity of an impermeable or nearly impermeable layer may range

from essentially 0 micrometers per second (0 inches per hour) to 0.9 micrometers per second (0.1 inches per hour). For simplicity, either case is considered impermeable for hydrologic soil group purposes. In some cases, saturated hydraulic conductivity (a quantitatively measured characteristic) data are not always readily available or obtainable. In these situations, other soil properties such as texture, compaction (bulk density), strength of soil structure, clay mineralogy, and organic matter are used to estimate water movement. Tables 7–1 and 7–2 relate saturated hydraulic conductivity to hydrologic soil group.

The four hydrologic soil groups (HSGs) are described as:

Group A—Soils in this group have low runoff potential when thoroughly wet. Water is transmitted freely through the soil. Group A soils typically have less than 10 percent clay and more than 90 percent sand or gravel and have gravel or sand textures. Some soils having loamy sand, sandy loam, loam or silt loam textures may be placed in this group if they are well aggregated, of low bulk density, or contain greater than 35 percent rock fragments.

The limits on the diagnostic physical characteristics of group A are as follows. The saturated hydraulic conductivity of all soil layers exceeds 40.0 micrometers per second (5.67 inches per hour). The depth to any water impermeable layer is greater than 50 centimeters [20 inches]. The depth to the water table is greater than 60 centimeters [24 inches]. Soils that are deeper than 100 centimeters [40 inches] to a water impermeable layer are in group A if the saturated hydraulic conductivity of all soil layers within 100 centimeters [40 inches] of the surface exceeds 10 micrometers per second (1.42 inches per hour).

Group B—Soils in this group have moderately low runoff potential when thoroughly wet. Water transmission through the soil is unimpeded. Group B soils typically have between 10 percent and 20 percent clay and 50 percent to 90 percent sand and have loamy sand or sandy loam textures. Some soils having loam, silt loam, silt, or sandy clay loam textures may be placed in this group if they are well aggregated, of low bulk density, or contain greater than 35 percent rock fragments.

The limits on the diagnostic physical characteristics of group B are as follows. The saturated hydraulic conductivity in the least transmissive layer between the surface and 50 centimeters [20 inches] ranges from 10.0 micrometers per second (1.42 inches per hour) to 40.0 micrometers per second (5.67 inches per hour). The depth to any water impermeable layer is greater than 50 centimeters [20 inches]. The depth to the water table is greater than 60 centimeters [24 inches]. Soils that are deeper than 100 centimeters [40 inches] to a water impermeable layer or water table are in group B if the saturated hydraulic conductivity of all soil layers within 100 centimeters [40 inches] of the surface exceeds 4.0 micrometers per second (0.57 inches per hour) but is less than 10.0 micrometers per second (1.42 inches per hour).

Group C—Soils in this group have moderately high runoff potential when thoroughly wet. Water transmission through the soil is somewhat restricted. Group C soils typically have between 20 percent and 40 percent clay and less than 50 percent sand and have loam, silt loam, sandy clay loam, clay loam, and silty clay loam textures. Some soils having clay, silty clay, or sandy clay textures may be placed in this group if they are well aggregated, of low bulk density, or contain greater than 35 percent rock fragments.

The limits on the diagnostic physical characteristics of group C are as follows. The saturated hydraulic conductivity in the least transmissive layer between the surface and 50 centimeters [20 inches] is between 1.0 micrometers per second (0.14 inches per hour) and 10.0 micrometers per second (1.42 inches per hour). The depth to any water impermeable layer is greater than 50 centimeters [20 inches]. The depth to the water table is greater than 60 centimeters [24 inches]. Soils that are deeper than 100 centimeters [40 inches] to a restriction or water table are in group C if the saturated hydraulic conductivity of all soil layers within 100 centimeters [40 inches] of the surface exceeds 0.40 micrometers per second (0.06 inches per hour) but is less than 4.0 micrometers per second (0.57 inches per hour).

Group D—Soils in this group have high runoff potential when thoroughly wet. Water movement through the soil is restricted or very restricted. Group D soils typically have greater than 40 percent clay, less than 50 percent sand, and have clayey textures. In some areas, they also have high shrink-swell potential. All soils with a depth to a water impermeable layer less than 50 centimeters [20 inches] and all soils with a water table

within 60 centimeters [24 inches] of the surface are in this group, although some may have a dual classification, as described in the next section, if they can be adequately drained.

The limits on the physical diagnostic characteristics of group D are as follows. For soils with a water impermeable layer at a depth between 50 centimeters and 100 centimeters [20 and 40 inches], the saturated hydraulic conductivity in the least transmissive soil layer is less than or equal to 1.0 micrometers per second (0.14 inches per hour). For soils that are deeper than 100 centimeters [40 inches] to a restriction or water table, the saturated hydraulic conductivity of all soil layers within 100 centimeters [40 inches] of the surface is less than or equal to 0.40 micrometers per second (0.06 inches per hour).

Dual hydrologic soil groups—Certain wet soils are placed in group D based solely on the presence of a water table within 60 centimeters [24 inches] of the surface even though the saturated hydraulic conductivity may be favorable for water transmission. If these soils can be adequately drained, then they are assigned to dual hydrologic soil groups (A/D, B/D, and C/D) based on their saturated hydraulic conductivity and the water table depth when drained. The first letter applies to the drained condition and the second to the undrained condition. For the purpose of hydrologic soil group, adequately drained means that the seasonal high water table is kept at least 60 centimeters [24 inches] below the surface in a soil where it would be higher in a natural state.

Matrix of hydrologic soil group assignment criteria—The decision matrix in tables 7–1 and 7–2 can be used to determine a soil's hydrologic soil group. Check both tables before making a final decision. If saturated hydraulic conductivity data are available and deemed to be reliable, then these data, along with water table depth information, should be used to place the soil into the appropriate hydrologic soil group. If these data are not available, the hydrologic soil group is determined by observing the properties of the soil in the field. Factors such as texture, compaction (bulk density), strength of soil structure, clay mineralogy, and organic matter are considered in estimating the hydraulic conductivity of each layer in the soil profile. The depth and hydraulic conductivity of any water impermeable layer and the depth to any high water table are used to determine correct hydrologic soil group for the soil. The property that is most limiting to water movement generally determines the soil's hydrologic group. In anomalous situations, when adjustments to hydrologic soil group become necessary, they shall be made by the NRCS state soil scientist in consultation with the state conservation engineer.

Table 7–1 Criteria for assignment of hydrologic soil groups when a water impermeable layer exists at a depth between 50 and 100 centimeters [20 and 40 inches]

Soil property	Hydrologic soil group A	Hydrologic soil group B	Hydrologic soil group C	Hydrologic soil group D
Saturated hydraulic conductivity of the least transmissive layer	>40.0 µm/s (>5.67 in/h)	≤40.0 to >10.0 µm/s (≤5.67 to >1.42 in/h)	≤10.0 to >1.0 µm/s (≤1.42 to >0.14 in/h)	≤1.0 µm/s (≤0.14 in/h)
	and	and	and	and/or
Depth to water impermeable layer	50 to 100 cm [20 to 40 in]	50 to 100 cm [20 to 40 in]	50 to 100 cm [20 to 40 in]	<50 cm [<20 in]
	and	and	and	and/or
Depth to high water table	60 to 100 cm [24 to 40 in]	60 to 100 cm [24 to 40 in]	60 to 100 cm [24 to 40 in]	<60 cm [<24 in]

Table 7–2 Criteria for assignment of hydrologic soil groups when any water impermeable layer exists at a depth greater than 100 centimeters [40 inches]

Soil property	Hydrologic soil group A	Hydrologic soil group B	Hydrologic soil group C	Hydrologic soil group D
Saturated hydraulic conductivity of the least transmissive layer	>10 µm/s (>1.42 in/h)	≤10.0 to >4.0 µm/s (≤1.42 to >57 in/h)	≤4.0 to >0.40 µm/s (≤0.57 to >0.06 in/h)	≤0.40 µm/s (≤0.06 in/h)
	and	and	and	and/or
Depth to water impermeable layer	>100 cm [>40 in]	>100 cm [>40 in]	>100 cm [>40 in]	>100 cm [>40 in]
	and	and	and	and/or
Depth to high water table	>100 cm [>40 in]	>100 cm [>40 in]	>100 cm [>40 in]	>100 cm [>40 in]

630.0702 Disturbed soils

As a result of construction and other disturbances, the soil profile can be altered from its natural state and the listed group assignments generally no longer apply, nor can any supposition based on the natural soil be made that will accurately describe the hydrologic properties of the disturbed soil. In these circumstances, an onsite investigation should be made to determine the hydrologic soil group. A general set of guidelines for estimating saturated hydraulic conductivity from field observable characteristics is presented in the Soil Survey Manual (Soil Survey Staff 1993).

630.0703 References

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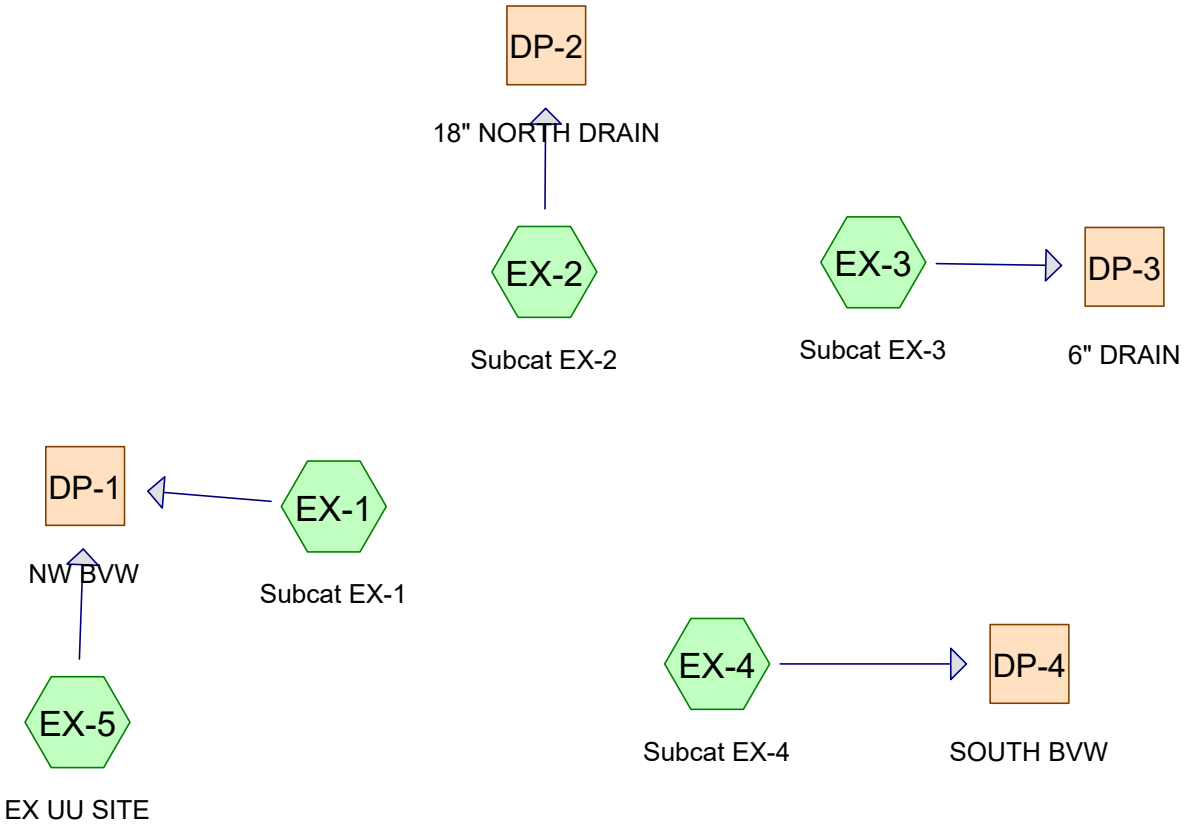


EXISTING CONDITIONS
HYDROCAD
4/1/2022

Subcat Reach Pond Link

Routing Diagram for 13858 - EX Conditions
Prepared by {enter your company name here}, Printed 4/1/2022

Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	1year 24-hr	NOAA 24-hr	D	Default	24.00	1	2.56	2
2	2year 24-hr	NOAA 24-hr	D	Default	24.00	1	3.17	2
3	10year 24-hr	NOAA 24-hr	D	Default	24.00	1	5.01	2
4	25year 24-hr	NOAA 24-hr	D	Default	24.00	1	6.16	2
5	100year 24-hr	NOAA 24-hr	D	Default	24.00	1	7.93	2

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
3,746	61	>75% Grass cover, Good, HSG B (EX-1, EX-2)
135,283	80	>75% Grass cover, Good, HSG D (EX-1, EX-2, EX-3, EX-4, EX-5)
1,081	89	Dirt roads, HSG D (EX-4)
12,441	89	Dirt, HSG D (EX-2, EX-3)
1,515	98	Impervious, HSG B (EX-1)
49,766	98	Impervious, HSG D (EX-2, EX-3)
39,052	98	Paved parking, HSG D (EX-1, EX-3, EX-4, EX-5)
19,670	98	Roofs, HSG D (EX-2)
21,184	55	Woods, Good, HSG B (EX-1, EX-2)
39,376	77	Woods, Good, HSG D (EX-1, EX-4, EX-5)
323,114	**84**	**TOTAL AREA**

Soil Listing (all nodes)

Area (sq-ft)	Soil Group	Subcatchment Numbers
0	HSG A	
26,445	HSG B	EX-1, EX-2
0	HSG C	
296,669	HSG D	EX-1, EX-2, EX-3, EX-4, EX-5
0	Other	
323,114		**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	Su Nu
0	3,746	0	135,283	0	139,029	>75% Grass cover, Good	
0	0	0	12,441	0	12,441	Dirt	
0	0	0	1,081	0	1,081	Dirt roads	
0	1,515	0	49,766	0	51,281	Impervious	
0	0	0	39,052	0	39,052	Paved parking	
0	0	0	19,670	0	19,670	Roofs	
0	21,184	0	39,376	0	60,560	Woods, Good	
0	**26,445**	**0**	**296,669**	**0**	**323,114**	**TOTAL AREA**	

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EX-1: Subcat EX-1 Runoff Area=36,178 sf 4.63% Impervious Runoff Depth>0.38"
Flow Length=202' Tc=6.0 min CN=67 Runoff=0.27 cfs 1,148 cf

Subcatchment EX-2: Subcat EX-2 Runoff Area=161,850 sf 32.62% Impervious Runoff Depth>1.29"
Flow Length=760' Tc=10.9 min CN=86 Runoff=4.62 cfs 17,390 cf

Subcatchment EX-3: Subcat EX-3 Runoff Area=43,439 sf 41.34% Impervious Runoff Depth>1.43"
Flow Length=246' Tc=7.8 min CN=88 Runoff=1.54 cfs 5,179 cf

Subcatchment EX-4: Subcat EX-4 Runoff Area=19,462 sf 33.84% Impervious Runoff Depth>1.29"
Flow Length=83' Tc=6.0 min CN=86 Runoff=0.66 cfs 2,094 cf

Subcatchment EX-5: EX UU SITE Runoff Area=62,185 sf 49.82% Impervious Runoff Depth>1.43"
Flow Length=362' Slope=0.0100 '/' Tc=6.2 min CN=88 Runoff=2.31 cfs 7,417 cf

Reach DP-1: NW BVW Inflow=2.58 cfs 8,565 cf
Outflow=2.58 cfs 8,565 cf

Reach DP-2: 18" NORTH DRAIN Inflow=4.62 cfs 17,390 cf
Outflow=4.62 cfs 17,390 cf

Reach DP-3: 6" DRAIN Inflow=1.54 cfs 5,179 cf
Outflow=1.54 cfs 5,179 cf

Reach DP-4: SOUTH BVW Inflow=0.66 cfs 2,094 cf
Outflow=0.66 cfs 2,094 cf

Total Runoff Area = 323,114 sf Runoff Volume = 33,227 cf Average Runoff Depth = 1.23"
65.96% Pervious = 213,111 sf 34.04% Impervious = 110,003 sf

Summary for Subcatchment EX-1: Subcat EX-1

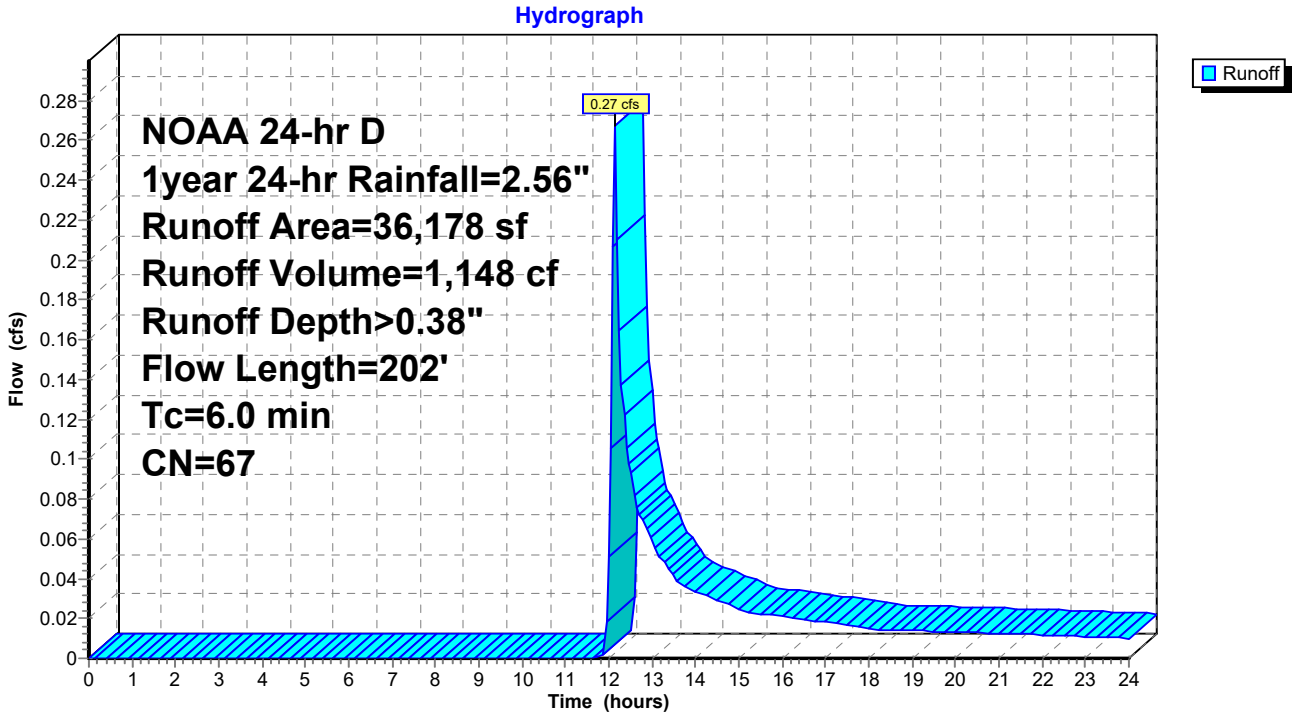
Runoff = 0.27 cfs @ 12.15 hrs, Volume= 1,148 cf, Depth> 0.38"
Routed to Reach DP-1 : NW BVW

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 1year 24-hr Rainfall=2.56"

	Area (sf)	CN	Description
	1,840	61	>75% Grass cover, Good, HSG B
	7,992	80	>75% Grass cover, Good, HSG D
*	1,515	98	Impervious, HSG B
	159	98	Paved parking, HSG D
	17,152	55	Woods, Good, HSG B
	7,520	77	Woods, Good, HSG D
	36,178	67	Weighted Average
	34,504		95.37% Pervious Area
	1,674		4.63% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.0	50	0.0480	0.21		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.17"
1.5	152	0.0579	1.68		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.5					**Direct Entry,**
6.0	202	Total			

Subcatchment EX-1: Subcat EX-1



Summary for Subcatchment EX-2: Subcat EX-2

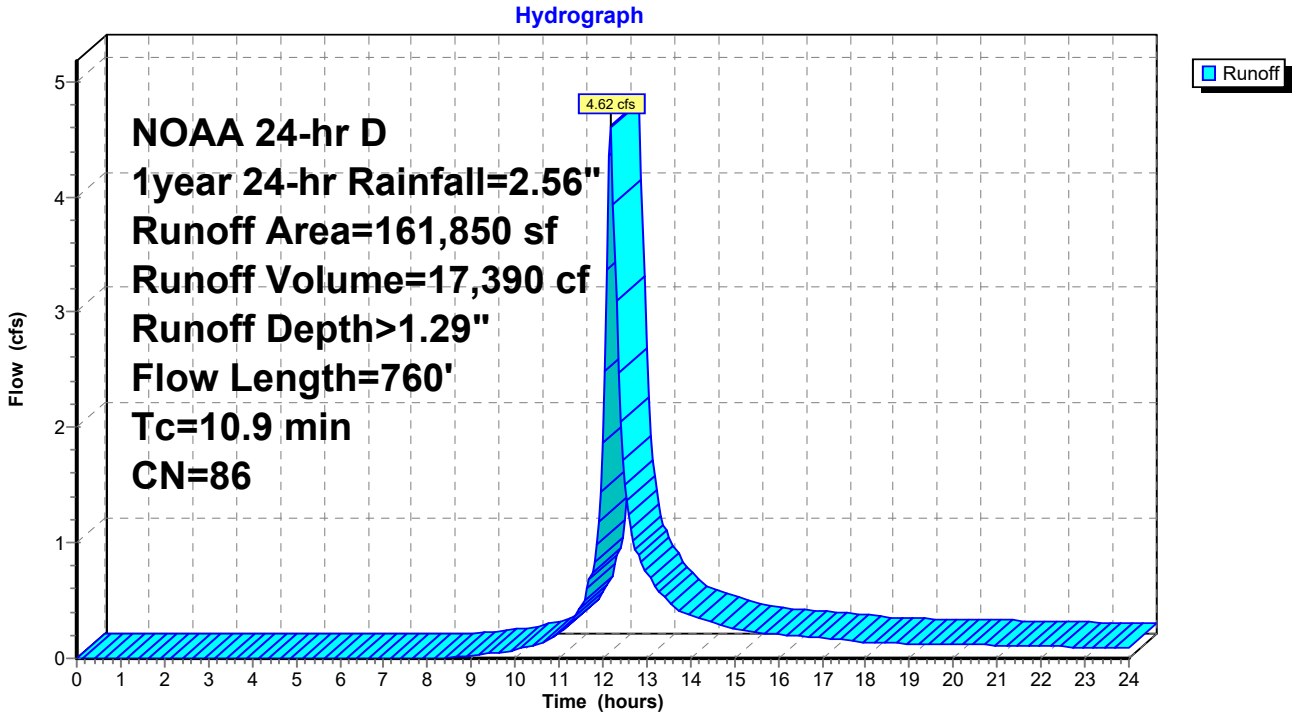
Runoff = 4.62 cfs @ 12.19 hrs, Volume= 17,390 cf, Depth> 1.29"
Routed to Reach DP-2 : 18" NORTH DRAIN

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 1year 24-hr Rainfall=2.56"

	Area (sf)	CN	Description
	1,906	61	>75% Grass cover, Good, HSG B
	91,166	80	>75% Grass cover, Good, HSG D
*	11,943	89	Dirt, HSG D
	33,133	98	Impervious, HSG D
	19,670	98	Roofs, HSG D
	4,032	55	Woods, Good, HSG B
	161,850	86	Weighted Average
	109,047		67.38% Pervious Area
	52,803		32.62% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.9	50	0.0180	0.14		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.17"
4.1	335	0.0380	1.36		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.9	375	0.0100	7.03	12.41	**Pipe Channel, RCP_Round 18"** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.011 Concrete pipe, straight & clean
10.9	760	Total			

Subcatchment EX-2: Subcat EX-2



Summary for Subcatchment EX-3: Subcat EX-3

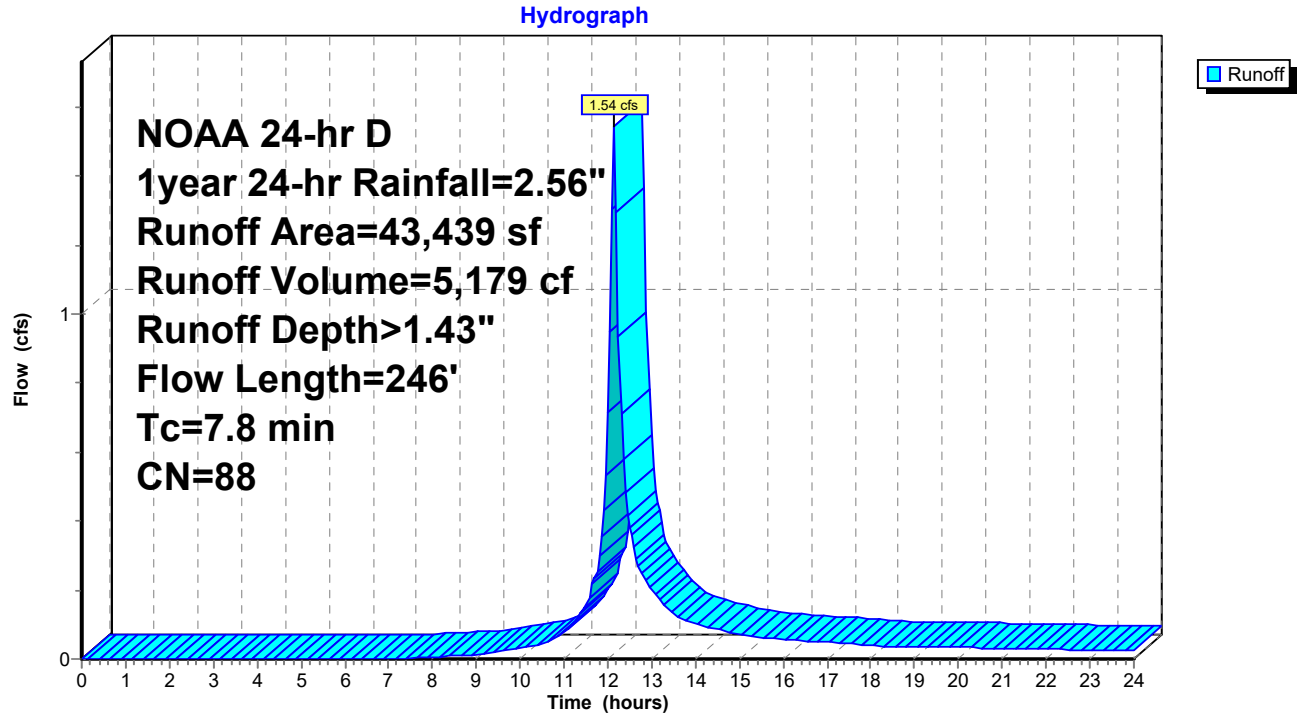
Runoff = 1.54 cfs @ 12.15 hrs, Volume= 5,179 cf, Depth> 1.43"
Routed to Reach DP-3 : 6" DRAIN

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 1year 24-hr Rainfall=2.56"

	Area (sf)	CN	Description
	8,239	80	>75% Grass cover, Good, HSG D
	16,195	80	>75% Grass cover, Good, HSG D
	549	80	>75% Grass cover, Good, HSG D
*	498	89	Dirt, HSG D
	1,325	98	Paved parking, HSG D
	16,633	98	Impervious, HSG D
	43,439	88	Weighted Average
	25,481		58.66% Pervious Area
	17,958		41.34% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.3	50	0.0150	0.13		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.17"
1.5	196	0.0200	2.12		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
7.8	246	Total			

Subcatchment EX-3: Subcat EX-3



Summary for Subcatchment EX-4: Subcat EX-4

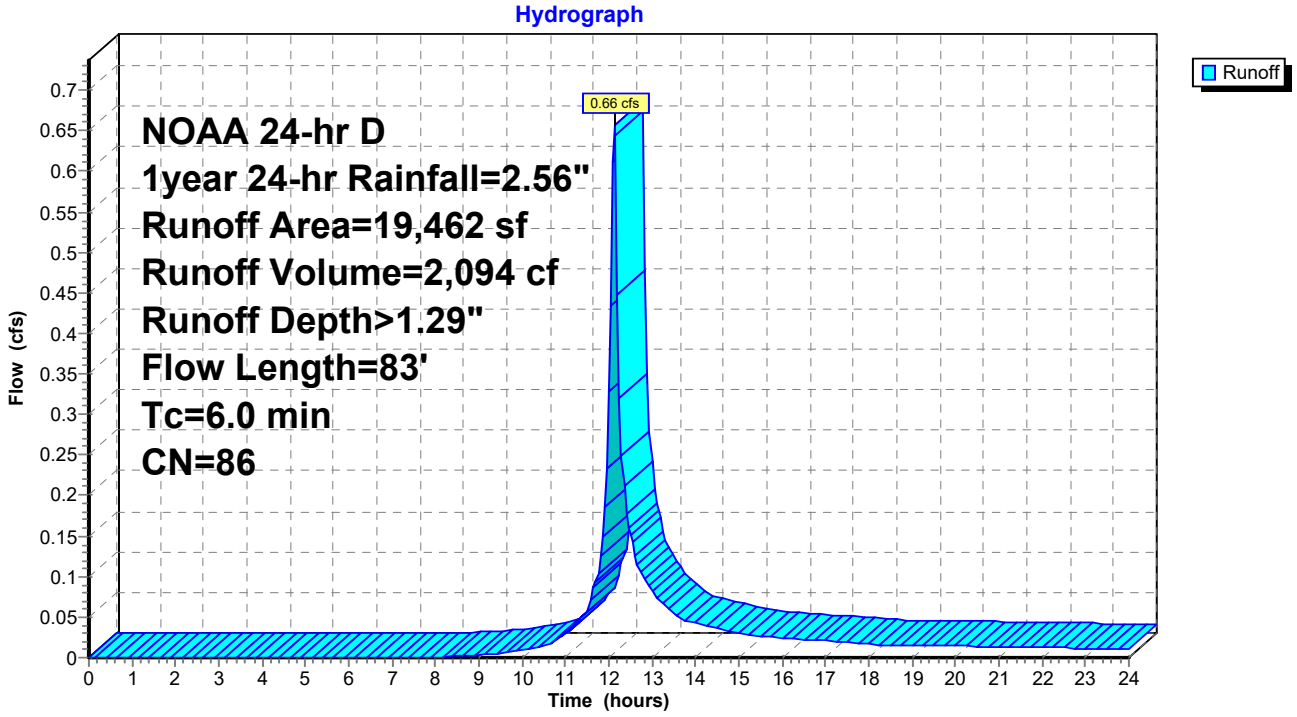
Runoff = 0.66 cfs @ 12.13 hrs, Volume= 2,094 cf, Depth> 1.29"
Routed to Reach DP-4 : SOUTH BVW

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 1year 24-hr Rainfall=2.56"

Area (sf)	CN	Description
9,604	80	>75% Grass cover, Good, HSG D
1,081	89	Dirt roads, HSG D
6,586	98	Paved parking, HSG D
2,191	77	Woods, Good, HSG D
19,462	86	Weighted Average
12,876		66.16% Pervious Area
6,586		33.84% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.9	50	0.0500	0.21		**Sheet Flow, Grass-Sheet** Grass: Short n= 0.150 P2= 3.17"
0.2	33	0.1400	2.62		**Shallow Concentrated Flow, Con Flow** Short Grass Pasture Kv= 7.0 fps
1.9					**Direct Entry, Minimum Tc of 6 Min**
6.0	83	Total			

Subcatchment EX-4: Subcat EX-4



Summary for Subcatchment EX-5: EX UU SITE

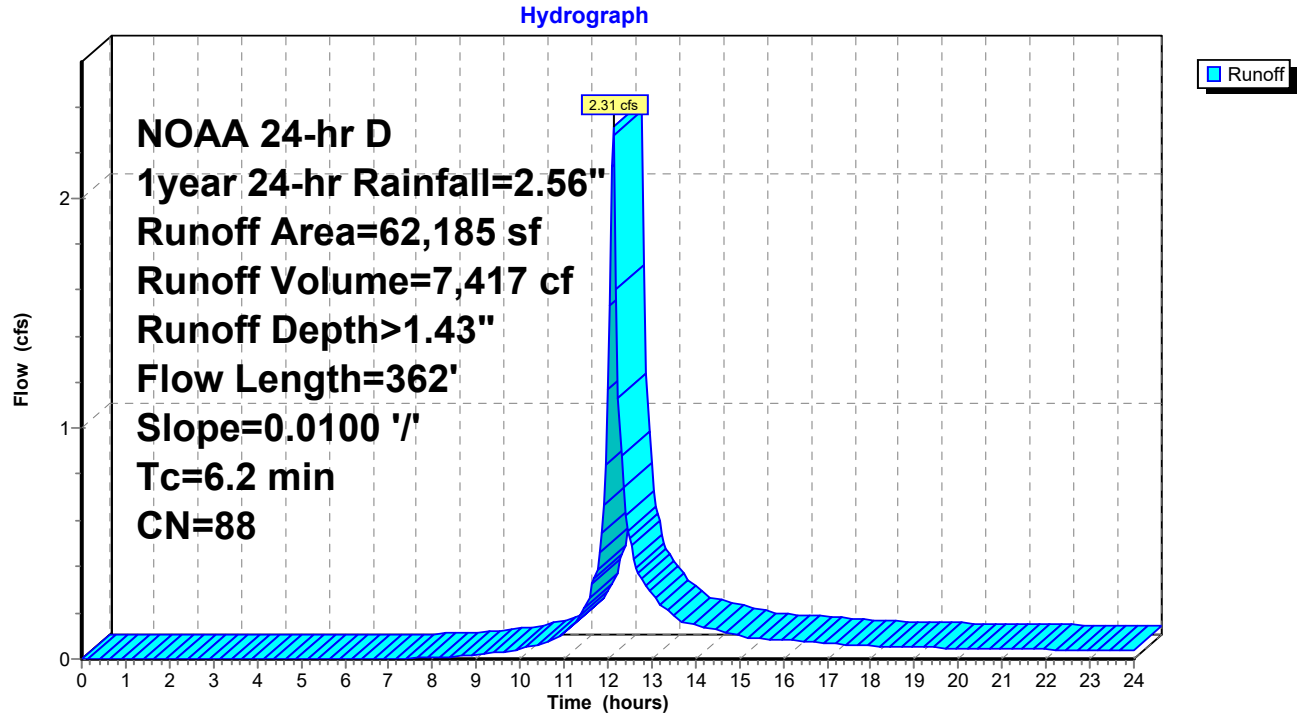
Runoff = 2.31 cfs @ 12.13 hrs, Volume= 7,417 cf, Depth> 1.43"
Routed to Reach DP-1 : NW BVW

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 1year 24-hr Rainfall=2.56"

Area (sf)	CN	Description
30,982	98	Paved parking, HSG D
29,665	77	Woods, Good, HSG D
1,538	80	>75% Grass cover, Good, HSG D
62,185	88	Weighted Average
31,203		50.18% Pervious Area
30,982		49.82% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.90		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.17"
5.0	212	0.0100	0.70		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.3	100	0.0100	6.22	7.63	**Pipe Channel,** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.011 Concrete pipe, straight & clean
6.2	362	Total			

Subcatchment EX-5: EX UU SITE



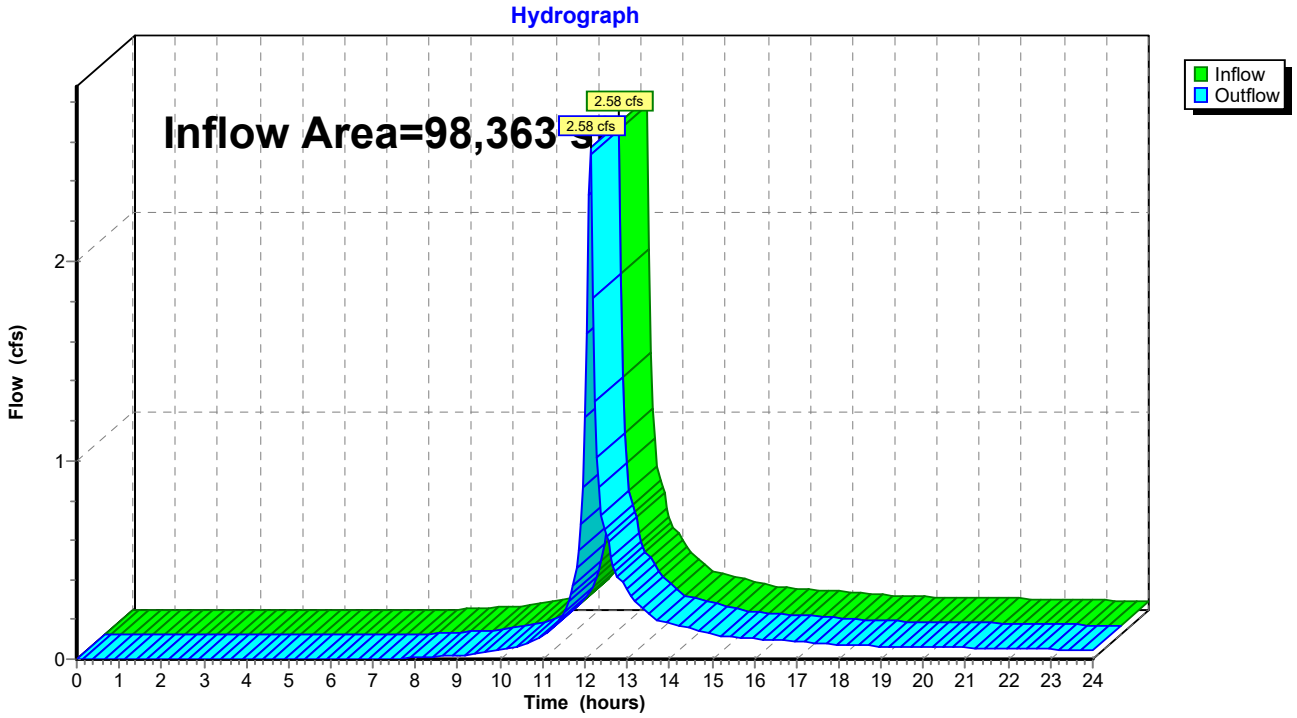
Summary for Reach DP-1: NW BVW

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 98,363 sf, 33.20% Impervious, Inflow Depth > 1.04" for 1year 24-hr event
Inflow = 2.58 cfs @ 12.14 hrs, Volume= 8,565 cf
Outflow = 2.58 cfs @ 12.14 hrs, Volume= 8,565 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-1: NW BVW



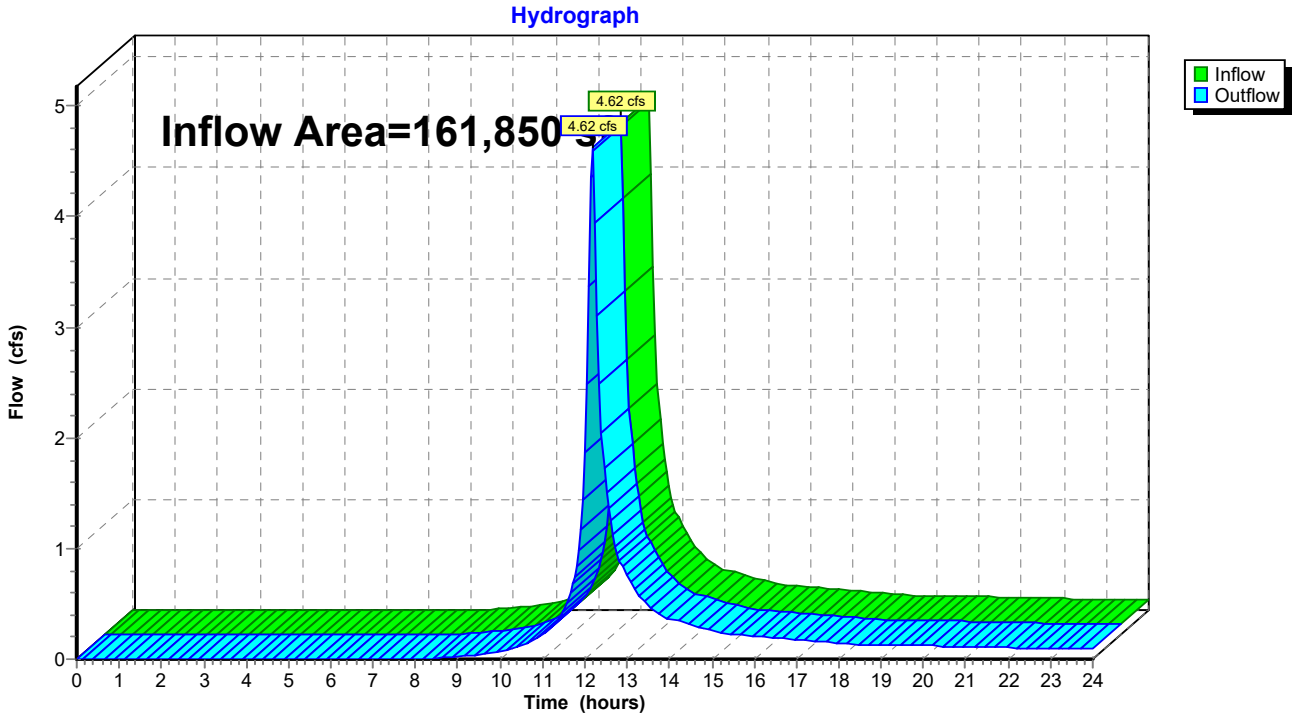
Summary for Reach DP-2: 18" NORTH DRAIN

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 161,850 sf, 32.62% Impervious, Inflow Depth > 1.29" for 1year 24-hr event
Inflow = 4.62 cfs @ 12.19 hrs, Volume= 17,390 cf
Outflow = 4.62 cfs @ 12.19 hrs, Volume= 17,390 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-2: 18" NORTH DRAIN



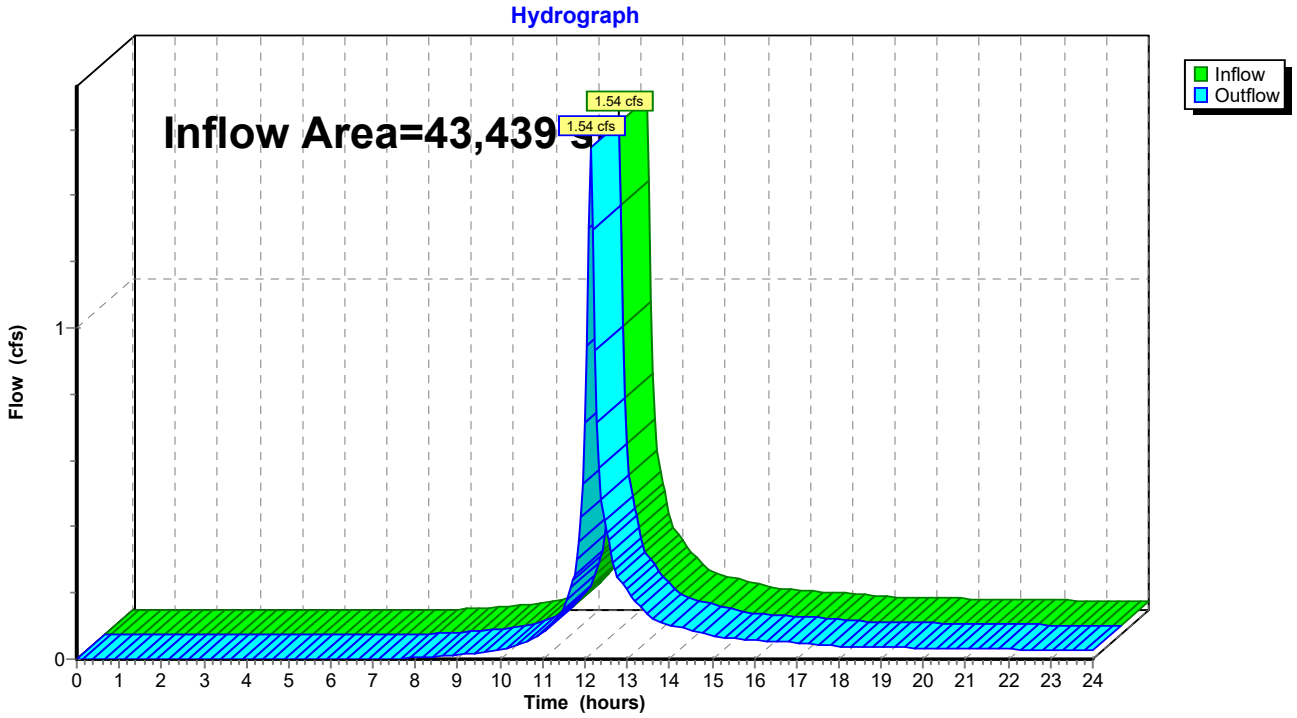
Summary for Reach DP-3: 6" DRAIN

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 43,439 sf, 41.34% Impervious, Inflow Depth > 1.43" for 1year 24-hr event
Inflow = 1.54 cfs @ 12.15 hrs, Volume= 5,179 cf
Outflow = 1.54 cfs @ 12.15 hrs, Volume= 5,179 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-3: 6" DRAIN



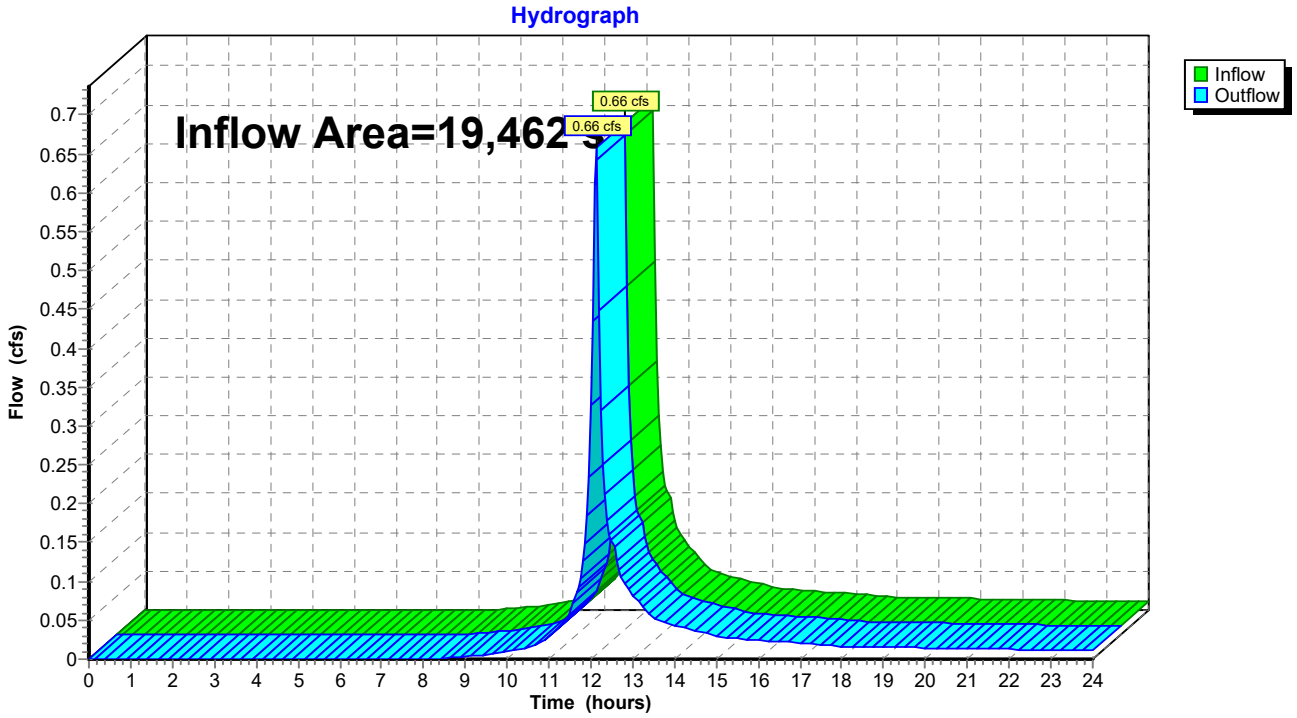
Summary for Reach DP-4: SOUTH BVW

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 19,462 sf, 33.84% Impervious, Inflow Depth > 1.29" for 1year 24-hr event
Inflow = 0.66 cfs @ 12.13 hrs, Volume= 2,094 cf
Outflow = 0.66 cfs @ 12.13 hrs, Volume= 2,094 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-4: SOUTH BVW



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EX-1: Subcat EX-1 Runoff Area=36,178 sf 4.63% Impervious Runoff Depth>0.67"
Flow Length=202' Tc=6.0 min CN=67 Runoff=0.56 cfs 2,020 cf

Subcatchment EX-2: Subcat EX-2 Runoff Area=161,850 sf 32.62% Impervious Runoff Depth>1.80"
Flow Length=760' Tc=10.9 min CN=86 Runoff=6.46 cfs 24,341 cf

Subcatchment EX-3: Subcat EX-3 Runoff Area=43,439 sf 41.34% Impervious Runoff Depth>1.97"
Flow Length=246' Tc=7.8 min CN=88 Runoff=2.10 cfs 7,121 cf

Subcatchment EX-4: Subcat EX-4 Runoff Area=19,462 sf 33.84% Impervious Runoff Depth>1.81"
Flow Length=83' Tc=6.0 min CN=86 Runoff=0.92 cfs 2,931 cf

Subcatchment EX-5: EX UU SITE Runoff Area=62,185 sf 49.82% Impervious Runoff Depth>1.97"
Flow Length=362' Slope=0.0100 '/' Tc=6.2 min CN=88 Runoff=3.15 cfs 10,197 cf

Reach DP-1: NW BVW Inflow=3.71 cfs 12,218 cf
Outflow=3.71 cfs 12,218 cf

Reach DP-2: 18" NORTH DRAIN Inflow=6.46 cfs 24,341 cf
Outflow=6.46 cfs 24,341 cf

Reach DP-3: 6" DRAIN Inflow=2.10 cfs 7,121 cf
Outflow=2.10 cfs 7,121 cf

Reach DP-4: SOUTH BVW Inflow=0.92 cfs 2,931 cf
Outflow=0.92 cfs 2,931 cf

Total Runoff Area = 323,114 sf Runoff Volume = 46,610 cf Average Runoff Depth = 1.73"
65.96% Pervious = 213,111 sf 34.04% Impervious = 110,003 sf

Summary for Subcatchment EX-1: Subcat EX-1

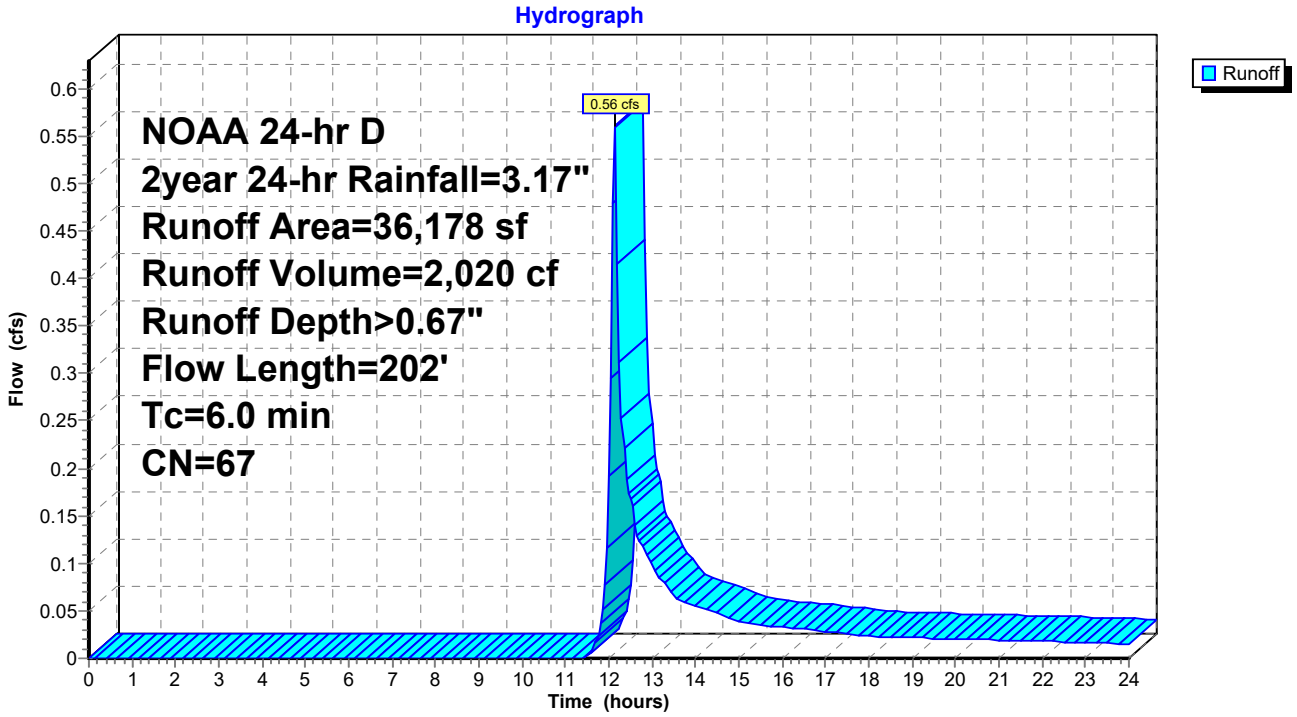
Runoff = 0.56 cfs @ 12.14 hrs, Volume= 2,020 cf, Depth> 0.67"
Routed to Reach DP-1 : NW BVW

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 2year 24-hr Rainfall=3.17"

	Area (sf)	CN	Description
	1,840	61	>75% Grass cover, Good, HSG B
	7,992	80	>75% Grass cover, Good, HSG D
*	1,515	98	Impervious, HSG B
	159	98	Paved parking, HSG D
	17,152	55	Woods, Good, HSG B
	7,520	77	Woods, Good, HSG D
	36,178	67	Weighted Average
	34,504		95.37% Pervious Area
	1,674		4.63% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.0	50	0.0480	0.21		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.17"
1.5	152	0.0579	1.68		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.5					**Direct Entry,**
6.0	202	Total			

Subcatchment EX-1: Subcat EX-1



Summary for Subcatchment EX-2: Subcat EX-2

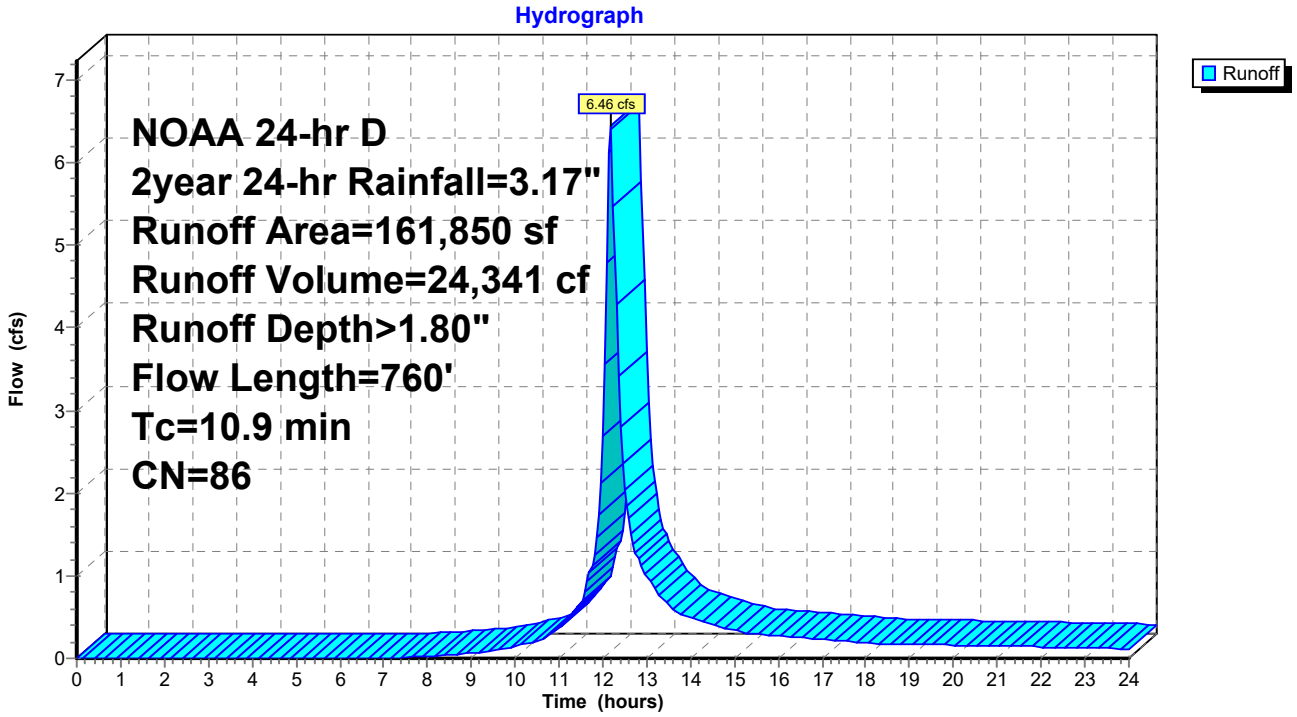
Runoff = 6.46 cfs @ 12.19 hrs, Volume= 24,341 cf, Depth> 1.80"
Routed to Reach DP-2 : 18" NORTH DRAIN

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 2year 24-hr Rainfall=3.17"

	Area (sf)	CN	Description
	1,906	61	>75% Grass cover, Good, HSG B
	91,166	80	>75% Grass cover, Good, HSG D
*	11,943	89	Dirt, HSG D
	33,133	98	Impervious, HSG D
	19,670	98	Roofs, HSG D
	4,032	55	Woods, Good, HSG B
	161,850	86	Weighted Average
	109,047		67.38% Pervious Area
	52,803		32.62% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.9	50	0.0180	0.14		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.17"
4.1	335	0.0380	1.36		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.9	375	0.0100	7.03	12.41	**Pipe Channel, RCP_Round 18"** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.011 Concrete pipe, straight & clean
10.9	760	Total			

Subcatchment EX-2: Subcat EX-2



Summary for Subcatchment EX-3: Subcat EX-3

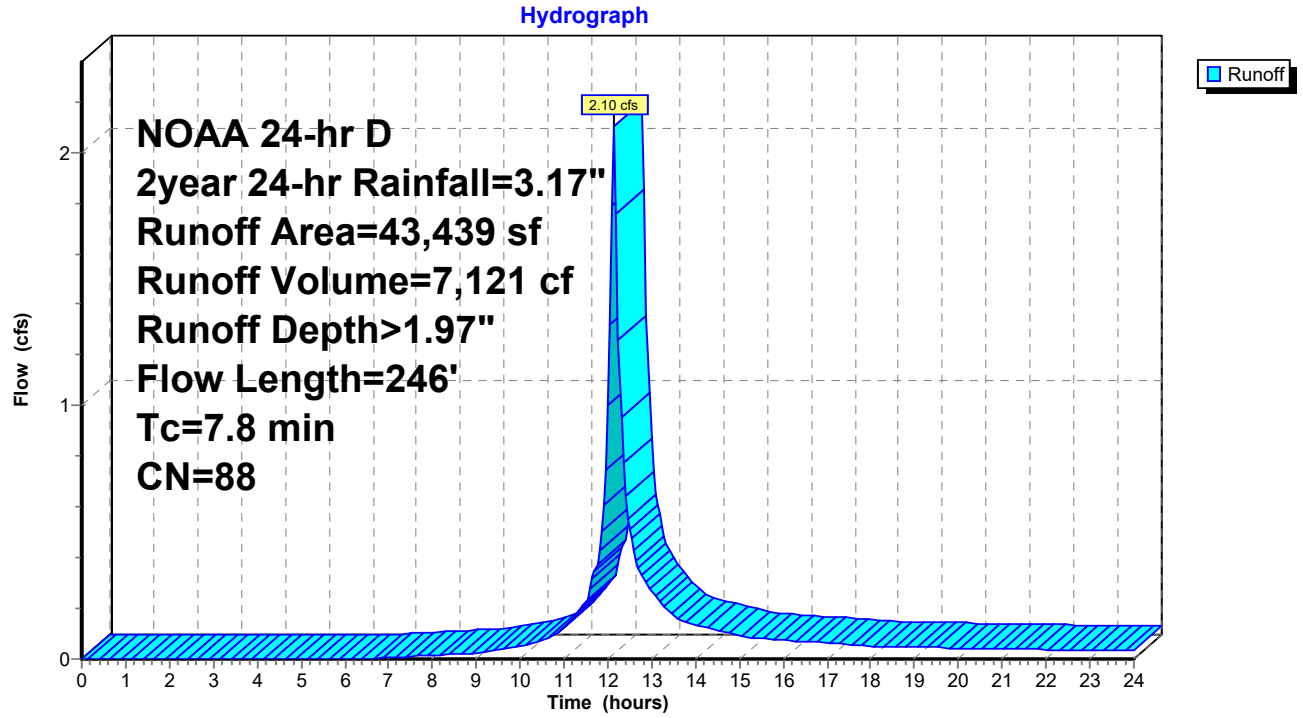
Runoff = 2.10 cfs @ 12.15 hrs, Volume= 7,121 cf, Depth> 1.97"
Routed to Reach DP-3 : 6" DRAIN

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 2year 24-hr Rainfall=3.17"

	Area (sf)	CN	Description
	8,239	80	>75% Grass cover, Good, HSG D
	16,195	80	>75% Grass cover, Good, HSG D
	549	80	>75% Grass cover, Good, HSG D
*	498	89	Dirt, HSG D
	1,325	98	Paved parking, HSG D
	16,633	98	Impervious, HSG D
	43,439	88	Weighted Average
	25,481		58.66% Pervious Area
	17,958		41.34% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.3	50	0.0150	0.13		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.17"
1.5	196	0.0200	2.12		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
7.8	246	Total			

Subcatchment EX-3: Subcat EX-3



Summary for Subcatchment EX-4: Subcat EX-4

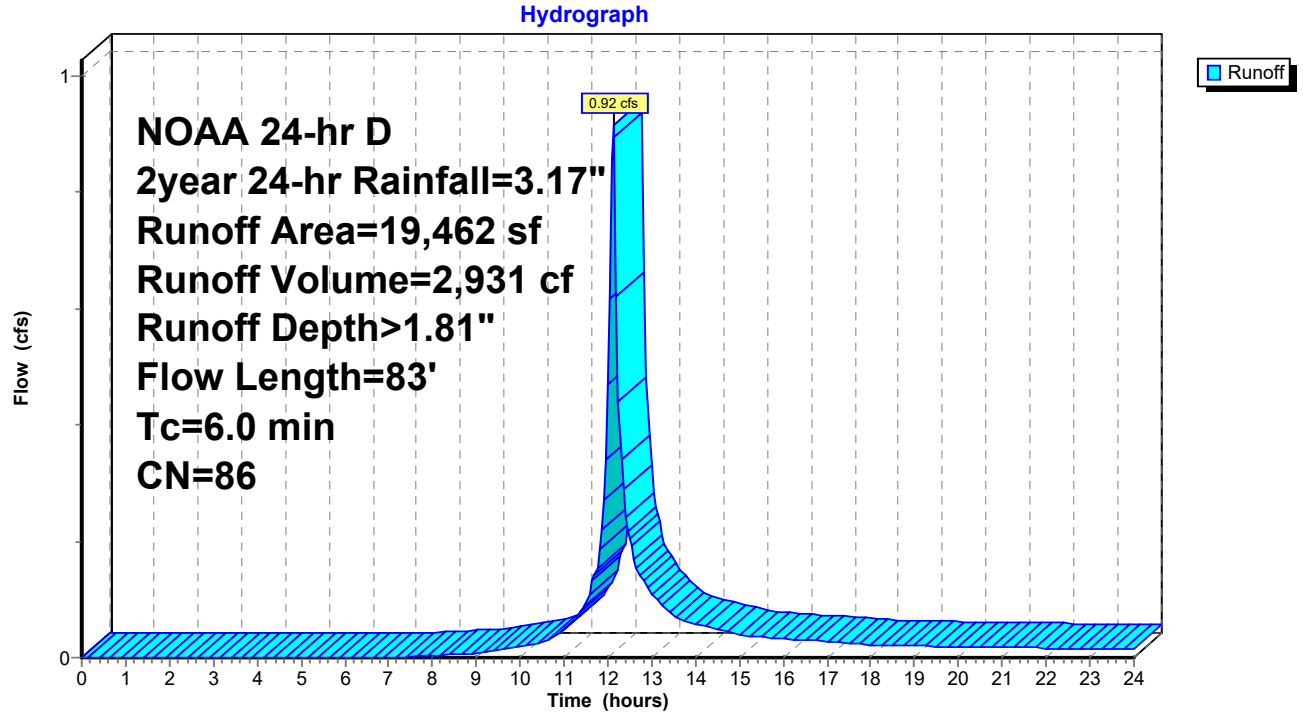
Runoff = 0.92 cfs @ 12.13 hrs, Volume= 2,931 cf, Depth> 1.81"
Routed to Reach DP-4 : SOUTH BVW

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 2year 24-hr Rainfall=3.17"

Area (sf)	CN	Description
9,604	80	>75% Grass cover, Good, HSG D
1,081	89	Dirt roads, HSG D
6,586	98	Paved parking, HSG D
2,191	77	Woods, Good, HSG D
19,462	86	Weighted Average
12,876		66.16% Pervious Area
6,586		33.84% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.9	50	0.0500	0.21		**Sheet Flow, Grass-Sheet** Grass: Short n= 0.150 P2= 3.17"
0.2	33	0.1400	2.62		**Shallow Concentrated Flow, Con Flow** Short Grass Pasture Kv= 7.0 fps
1.9					**Direct Entry, Minimum Tc of 6 Min**
6.0	83	Total			

Subcatchment EX-4: Subcat EX-4



Summary for Subcatchment EX-5: EX UU SITE

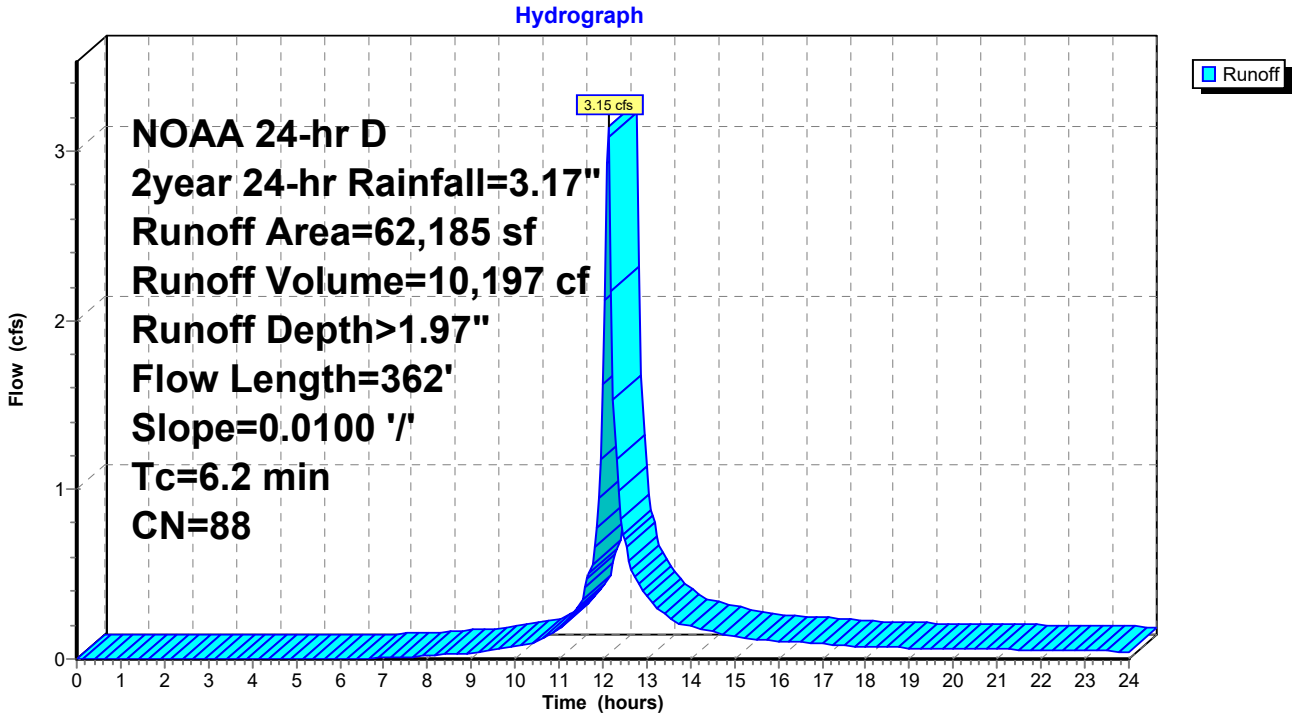
Runoff = 3.15 cfs @ 12.13 hrs, Volume= 10,197 cf, Depth> 1.97"
Routed to Reach DP-1 : NW BVW

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 2year 24-hr Rainfall=3.17"

Area (sf)	CN	Description
30,982	98	Paved parking, HSG D
29,665	77	Woods, Good, HSG D
1,538	80	>75% Grass cover, Good, HSG D
62,185	88	Weighted Average
31,203		50.18% Pervious Area
30,982		49.82% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.90		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.17"
5.0	212	0.0100	0.70		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.3	100	0.0100	6.22	7.63	**Pipe Channel,** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.011 Concrete pipe, straight & clean
6.2	362	Total			

Subcatchment EX-5: EX UU SITE



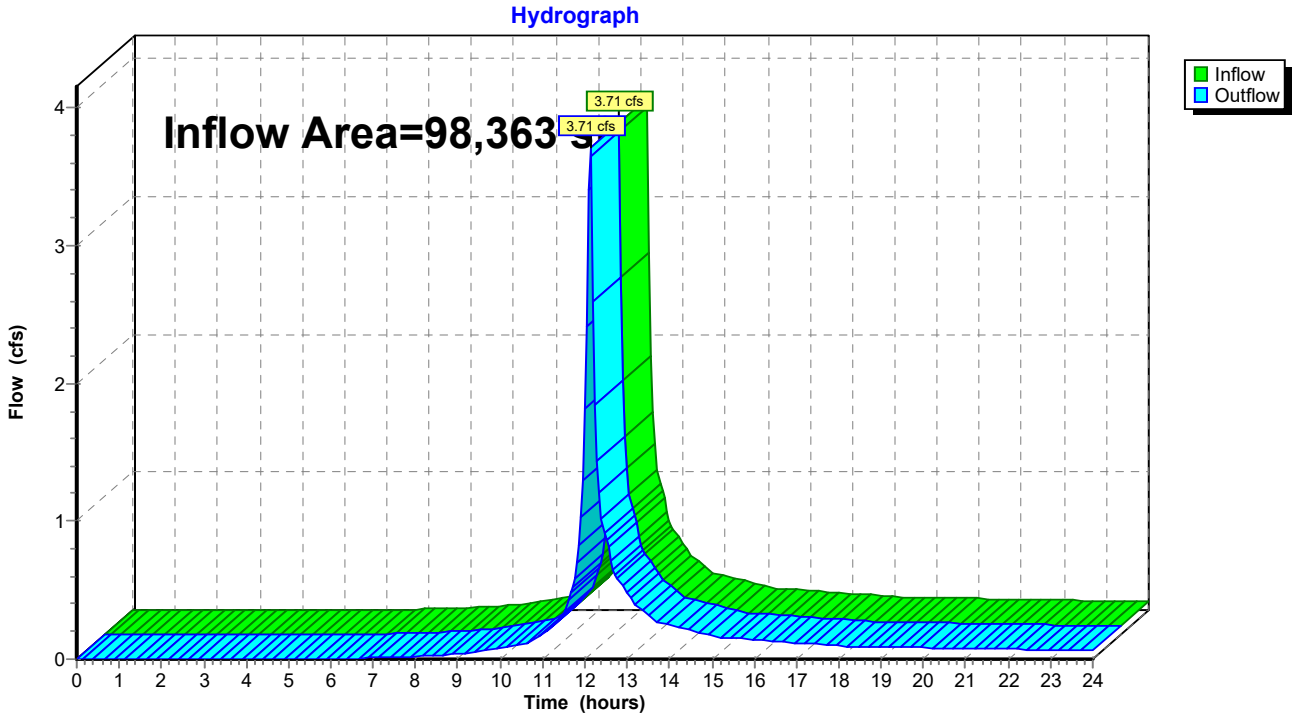
Summary for Reach DP-1: NW BVW

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 98,363 sf, 33.20% Impervious, Inflow Depth > 1.49" for 2year 24-hr event
Inflow = 3.71 cfs @ 12.13 hrs, Volume= 12,218 cf
Outflow = 3.71 cfs @ 12.13 hrs, Volume= 12,218 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-1: NW BVW



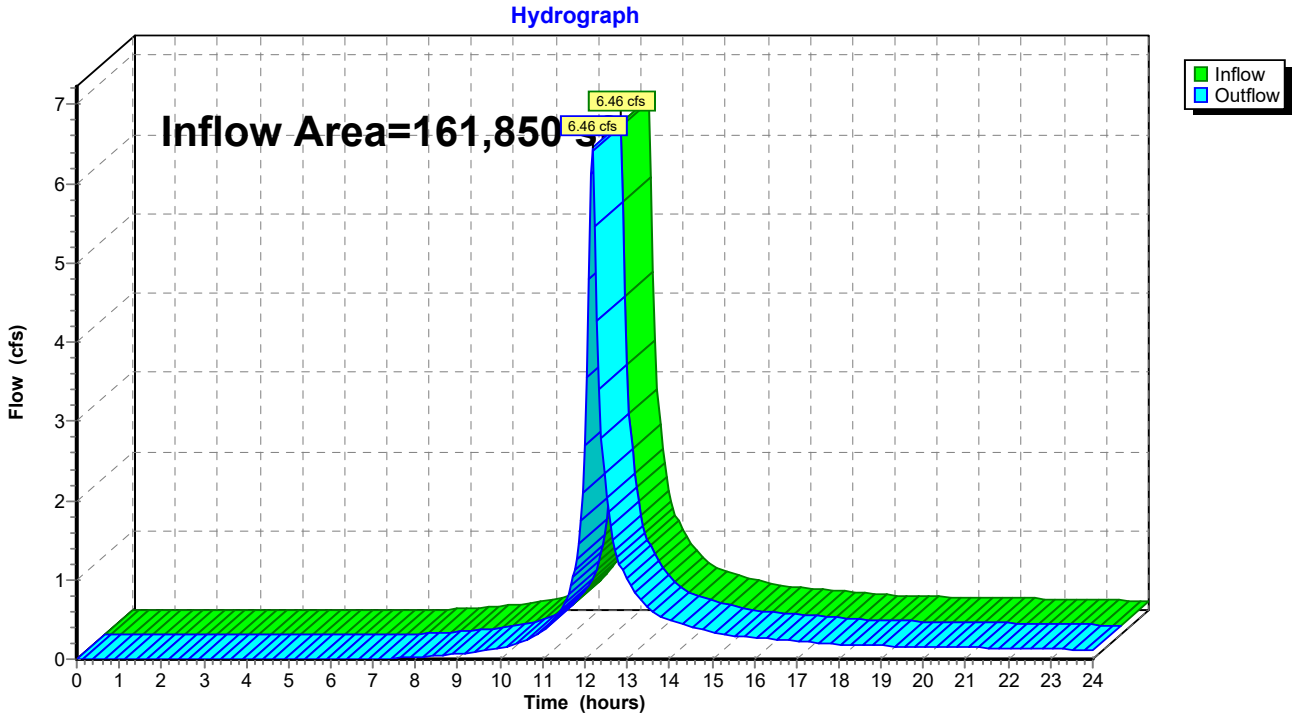
Summary for Reach DP-2: 18" NORTH DRAIN

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 161,850 sf, 32.62% Impervious, Inflow Depth > 1.80" for 2year 24-hr event
Inflow = 6.46 cfs @ 12.19 hrs, Volume= 24,341 cf
Outflow = 6.46 cfs @ 12.19 hrs, Volume= 24,341 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-2: 18" NORTH DRAIN



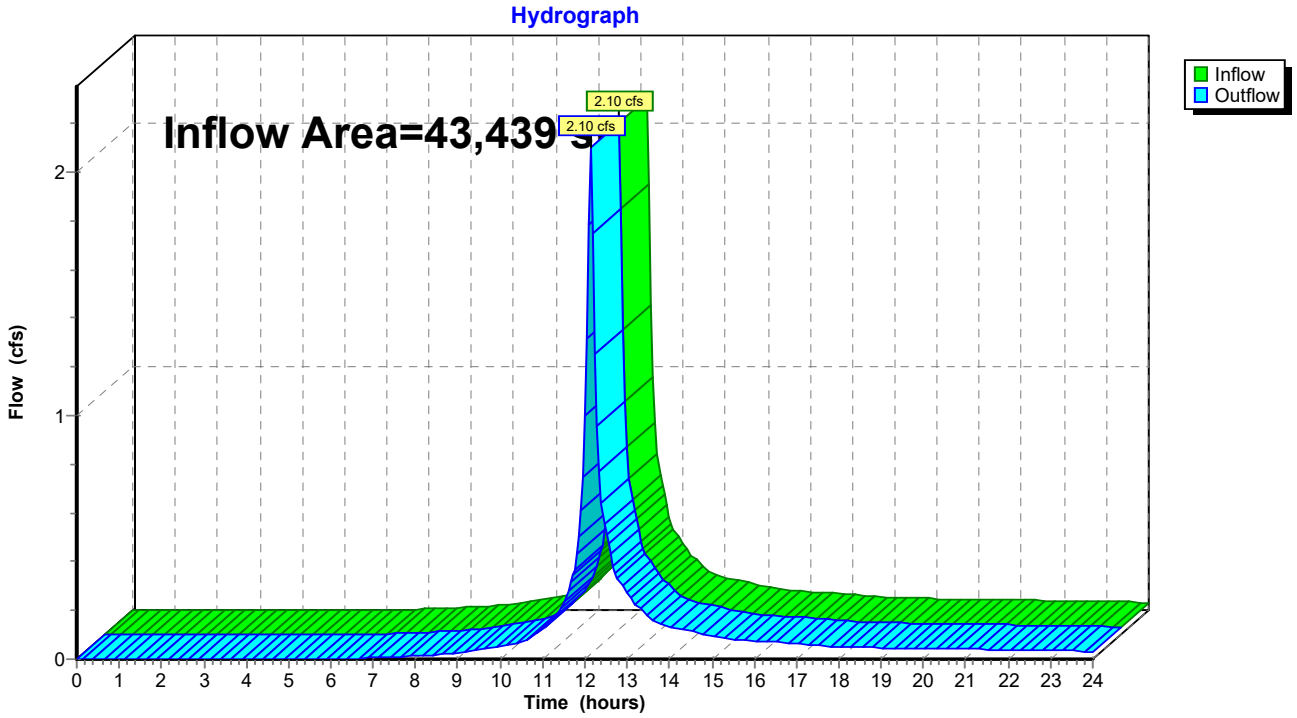
Summary for Reach DP-3: 6" DRAIN

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 43,439 sf, 41.34% Impervious, Inflow Depth > 1.97" for 2year 24-hr event
Inflow = 2.10 cfs @ 12.15 hrs, Volume= 7,121 cf
Outflow = 2.10 cfs @ 12.15 hrs, Volume= 7,121 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-3: 6" DRAIN



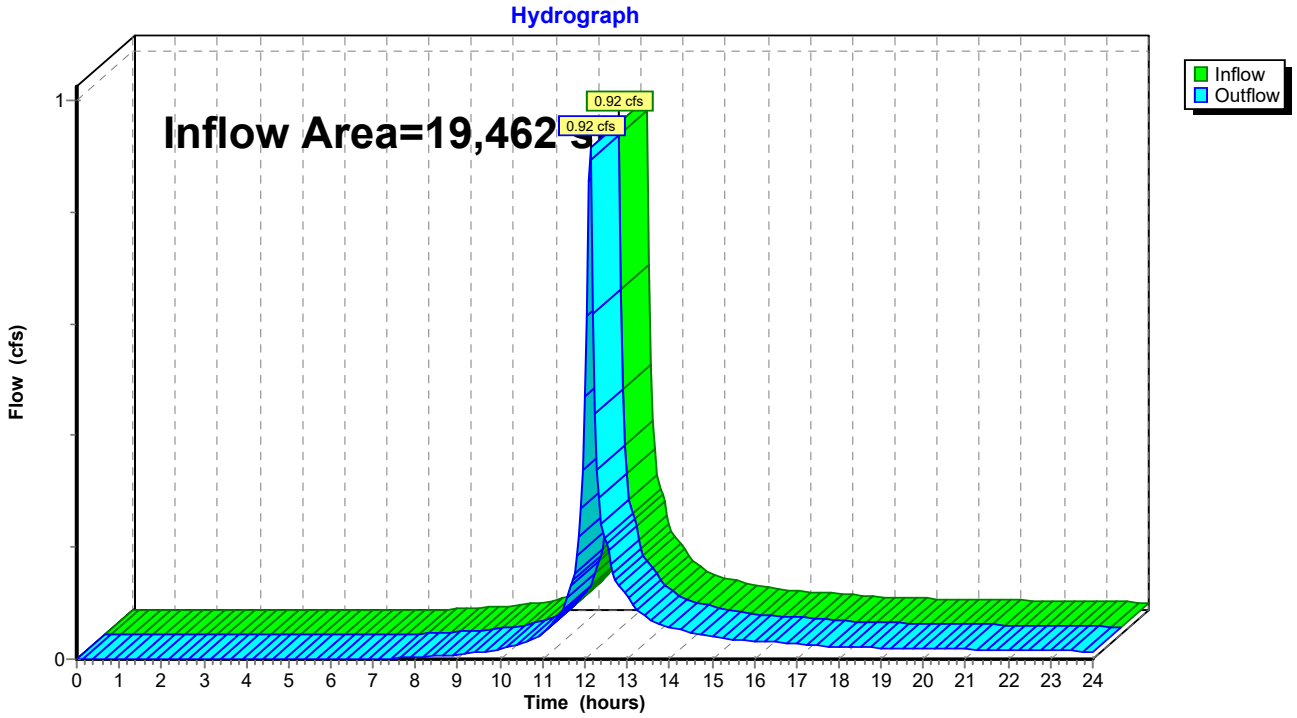
Summary for Reach DP-4: SOUTH BVW

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 19,462 sf, 33.84% Impervious, Inflow Depth > 1.81" for 2year 24-hr event
Inflow = 0.92 cfs @ 12.13 hrs, Volume= 2,931 cf
Outflow = 0.92 cfs @ 12.13 hrs, Volume= 2,931 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-4: SOUTH BVW



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EX-1: Subcat EX-1 Runoff Area=36,178 sf 4.63% Impervious Runoff Depth>1.81"
Flow Length=202' Tc=6.0 min CN=67 Runoff=1.69 cfs 5,449 cf

Subcatchment EX-2: Subcat EX-2 Runoff Area=161,850 sf 32.62% Impervious Runoff Depth>3.47"
Flow Length=760' Tc=10.9 min CN=86 Runoff=12.17 cfs 46,787 cf

Subcatchment EX-3: Subcat EX-3 Runoff Area=43,439 sf 41.34% Impervious Runoff Depth>3.67"
Flow Length=246' Tc=7.8 min CN=88 Runoff=3.82 cfs 13,297 cf

Subcatchment EX-4: Subcat EX-4 Runoff Area=19,462 sf 33.84% Impervious Runoff Depth>3.47"
Flow Length=83' Tc=6.0 min CN=86 Runoff=1.72 cfs 5,632 cf

Subcatchment EX-5: EX UU SITE Runoff Area=62,185 sf 49.82% Impervious Runoff Depth>3.67"
Flow Length=362' Slope=0.0100 '/' Tc=6.2 min CN=88 Runoff=5.72 cfs 19,043 cf

Reach DP-1: NW BVW Inflow=7.41 cfs 24,492 cf
Outflow=7.41 cfs 24,492 cf

Reach DP-2: 18" NORTH DRAIN Inflow=12.17 cfs 46,787 cf
Outflow=12.17 cfs 46,787 cf

Reach DP-3: 6" DRAIN Inflow=3.82 cfs 13,297 cf
Outflow=3.82 cfs 13,297 cf

Reach DP-4: SOUTH BVW Inflow=1.72 cfs 5,632 cf
Outflow=1.72 cfs 5,632 cf

Total Runoff Area = 323,114 sf Runoff Volume = 90,209 cf Average Runoff Depth = 3.35"
65.96% Pervious = 213,111 sf 34.04% Impervious = 110,003 sf

Summary for Subcatchment EX-1: Subcat EX-1

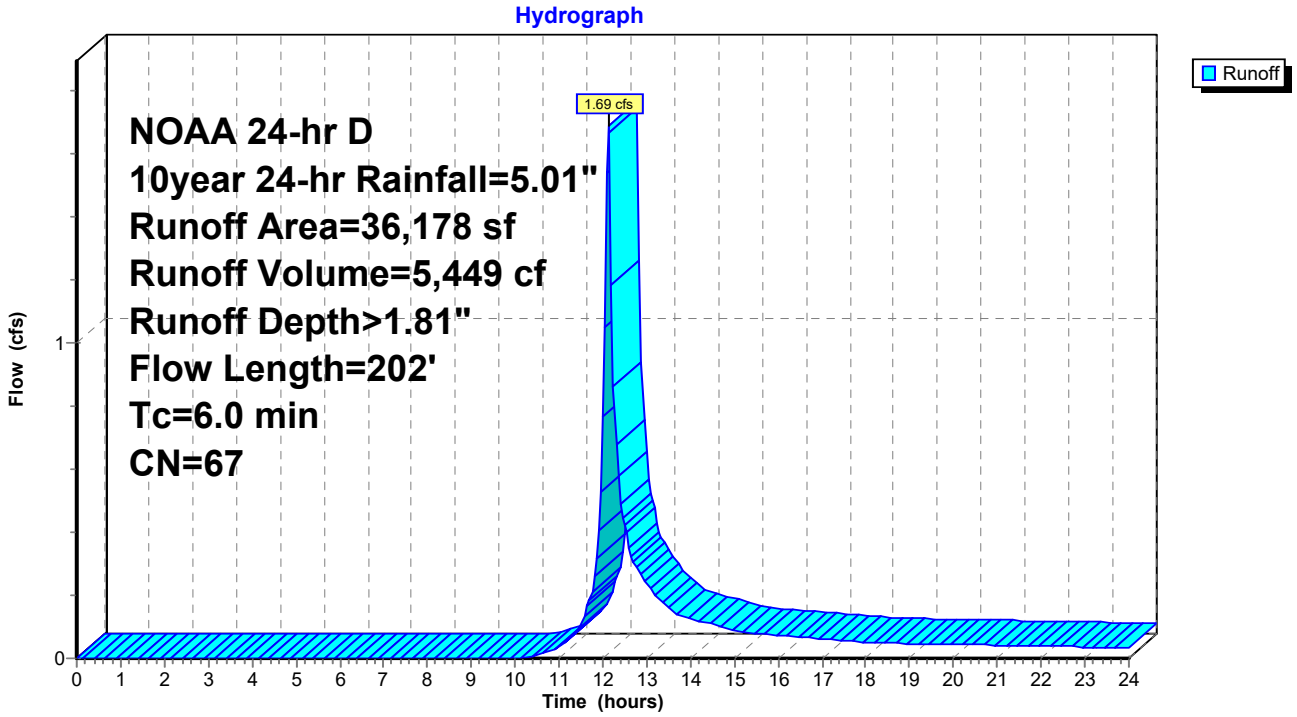
Runoff = 1.69 cfs @ 12.14 hrs, Volume= 5,449 cf, Depth> 1.81"
Routed to Reach DP-1 : NW BVW

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 10year 24-hr Rainfall=5.01"

	Area (sf)	CN	Description
	1,840	61	>75% Grass cover, Good, HSG B
	7,992	80	>75% Grass cover, Good, HSG D
*	1,515	98	Impervious, HSG B
	159	98	Paved parking, HSG D
	17,152	55	Woods, Good, HSG B
	7,520	77	Woods, Good, HSG D
	36,178	67	Weighted Average
	34,504		95.37% Pervious Area
	1,674		4.63% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.0	50	0.0480	0.21		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.17"
1.5	152	0.0579	1.68		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.5					**Direct Entry,**
6.0	202	Total			

Subcatchment EX-1: Subcat EX-1



Summary for Subcatchment EX-2: Subcat EX-2

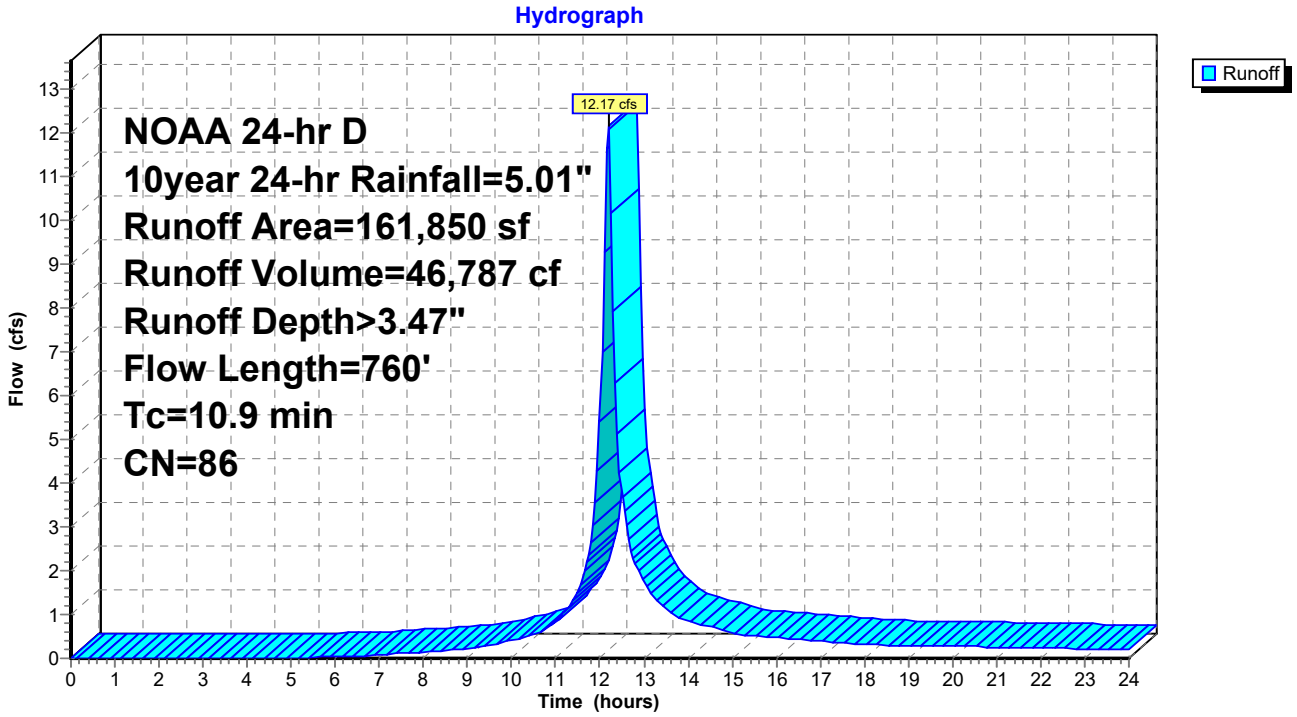
Runoff = 12.17 cfs @ 12.18 hrs, Volume= 46,787 cf, Depth> 3.47"
Routed to Reach DP-2 : 18" NORTH DRAIN

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 10year 24-hr Rainfall=5.01"

	Area (sf)	CN	Description
	1,906	61	>75% Grass cover, Good, HSG B
	91,166	80	>75% Grass cover, Good, HSG D
*	11,943	89	Dirt, HSG D
	33,133	98	Impervious, HSG D
	19,670	98	Roofs, HSG D
	4,032	55	Woods, Good, HSG B
	161,850	86	Weighted Average
	109,047		67.38% Pervious Area
	52,803		32.62% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.9	50	0.0180	0.14		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.17"
4.1	335	0.0380	1.36		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.9	375	0.0100	7.03	12.41	**Pipe Channel, RCP_Round 18"** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.011 Concrete pipe, straight & clean
10.9	760	Total			

Subcatchment EX-2: Subcat EX-2



Summary for Subcatchment EX-3: Subcat EX-3

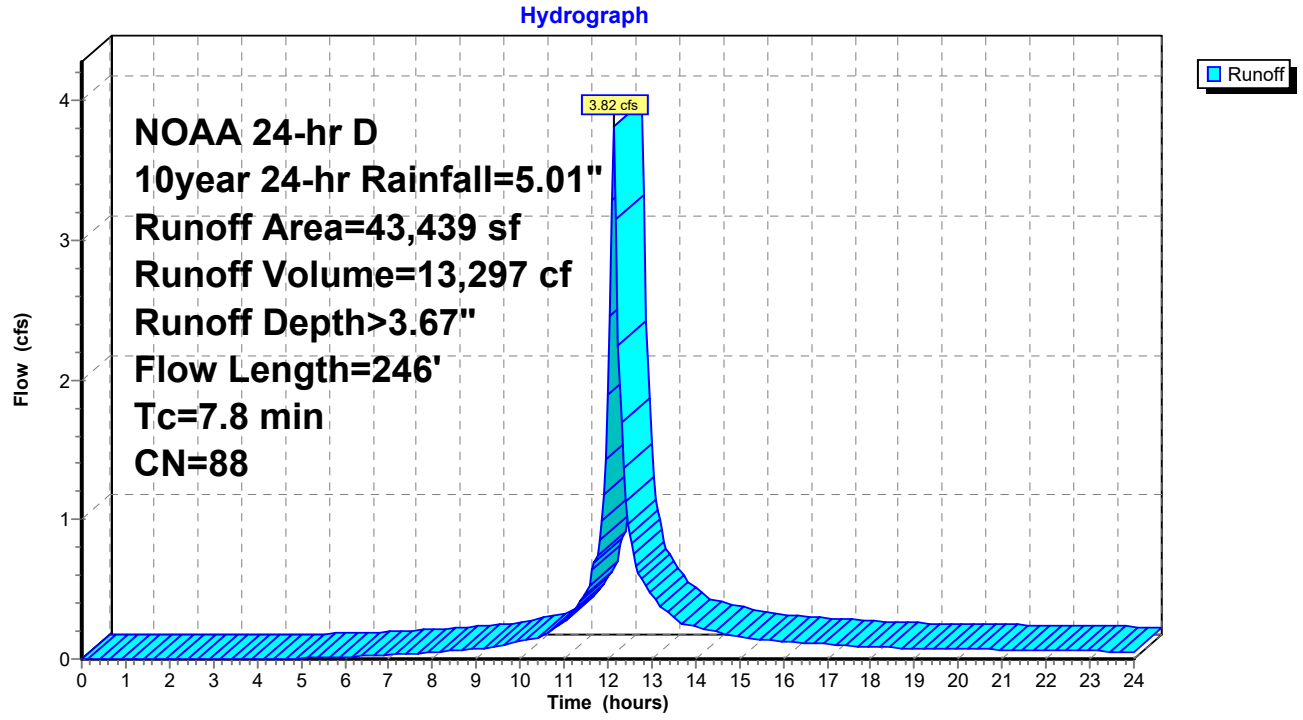
Runoff = 3.82 cfs @ 12.15 hrs, Volume= 13,297 cf, Depth> 3.67"
Routed to Reach DP-3 : 6" DRAIN

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 10year 24-hr Rainfall=5.01"

	Area (sf)	CN	Description
	8,239	80	>75% Grass cover, Good, HSG D
	16,195	80	>75% Grass cover, Good, HSG D
	549	80	>75% Grass cover, Good, HSG D
*	498	89	Dirt, HSG D
	1,325	98	Paved parking, HSG D
	16,633	98	Impervious, HSG D
	43,439	88	Weighted Average
	25,481		58.66% Pervious Area
	17,958		41.34% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.3	50	0.0150	0.13		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.17"
1.5	196	0.0200	2.12		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
7.8	246	Total			

Subcatchment EX-3: Subcat EX-3



Summary for Subcatchment EX-4: Subcat EX-4

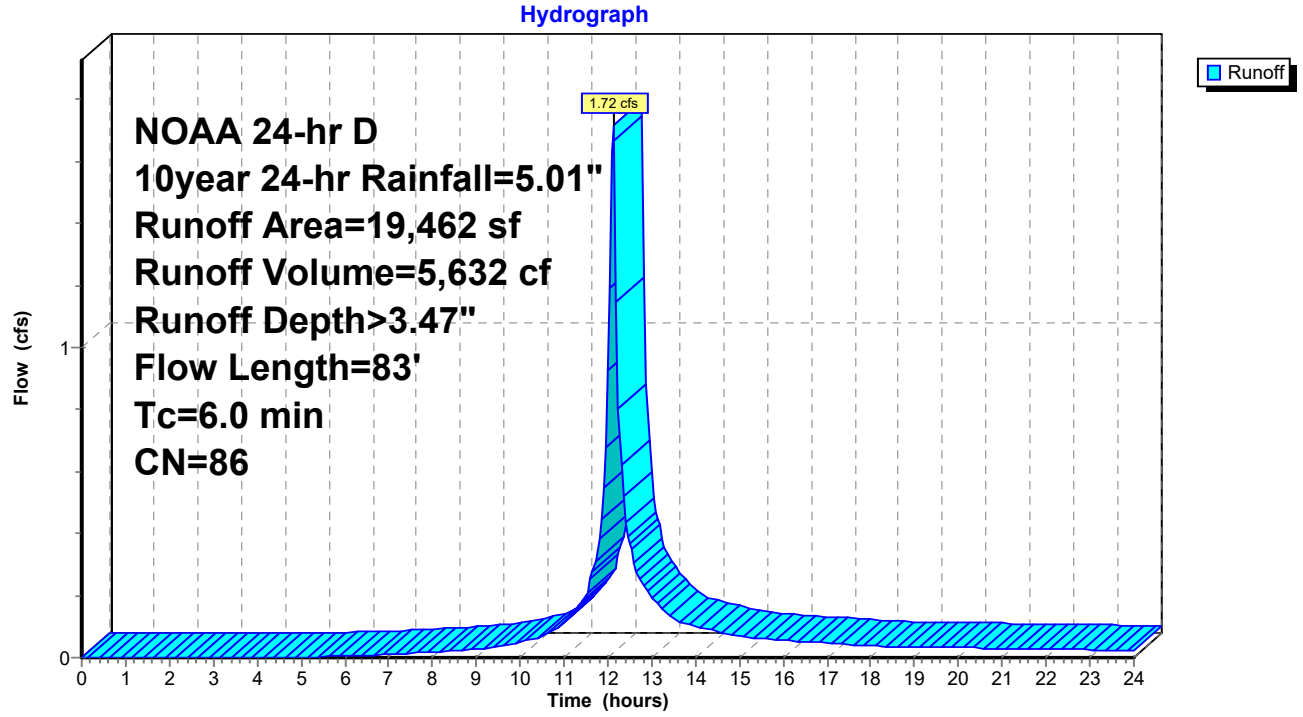
Runoff = 1.72 cfs @ 12.13 hrs, Volume= 5,632 cf, Depth> 3.47"
Routed to Reach DP-4 : SOUTH BVW

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 10year 24-hr Rainfall=5.01"

Area (sf)	CN	Description
9,604	80	>75% Grass cover, Good, HSG D
1,081	89	Dirt roads, HSG D
6,586	98	Paved parking, HSG D
2,191	77	Woods, Good, HSG D
19,462	86	Weighted Average
12,876		66.16% Pervious Area
6,586		33.84% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.9	50	0.0500	0.21		**Sheet Flow, Grass-Sheet** Grass: Short n= 0.150 P2= 3.17"
0.2	33	0.1400	2.62		**Shallow Concentrated Flow, Con Flow** Short Grass Pasture Kv= 7.0 fps
1.9					**Direct Entry, Minimum Tc of 6 Min**
6.0	83	Total			

Subcatchment EX-4: Subcat EX-4



Summary for Subcatchment EX-5: EX UU SITE

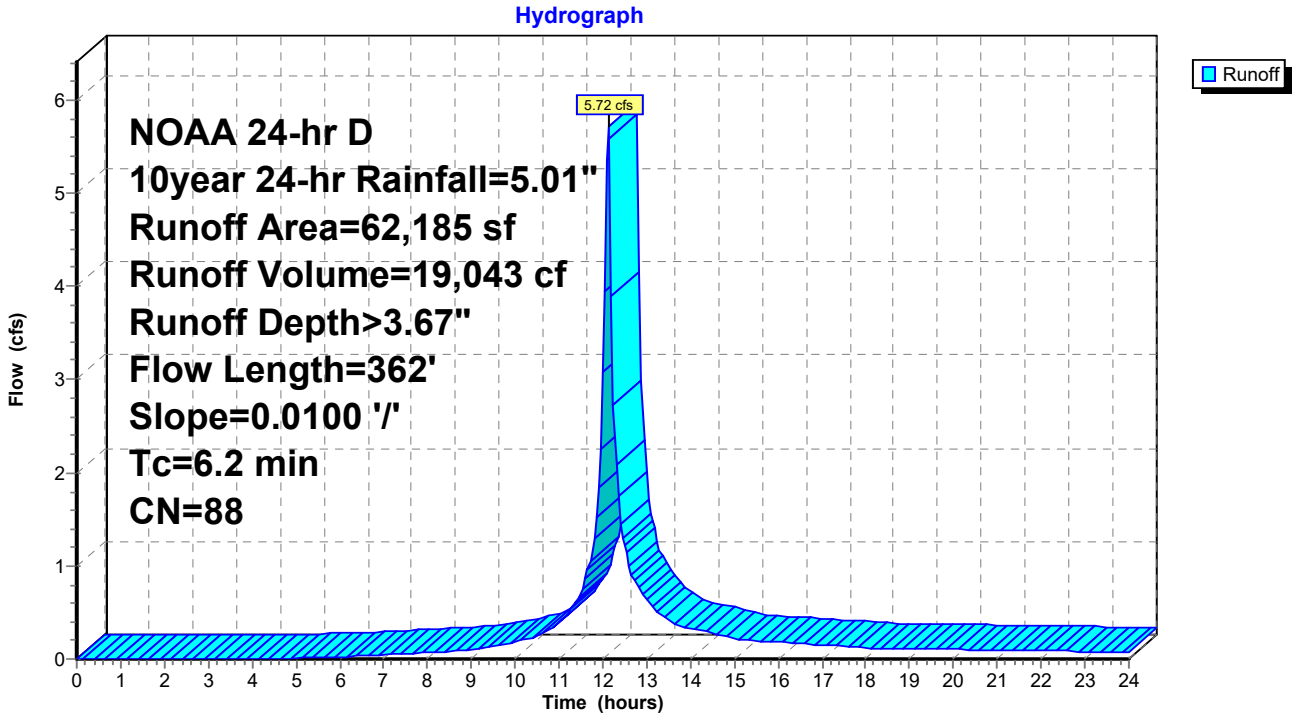
Runoff = 5.72 cfs @ 12.13 hrs, Volume= 19,043 cf, Depth> 3.67"
Routed to Reach DP-1 : NW BVW

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 10year 24-hr Rainfall=5.01"

Area (sf)	CN	Description
30,982	98	Paved parking, HSG D
29,665	77	Woods, Good, HSG D
1,538	80	>75% Grass cover, Good, HSG D
62,185	88	Weighted Average
31,203		50.18% Pervious Area
30,982		49.82% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.90		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.17"
5.0	212	0.0100	0.70		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.3	100	0.0100	6.22	7.63	**Pipe Channel,** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.011 Concrete pipe, straight & clean
6.2	362	Total			

Subcatchment EX-5: EX UU SITE



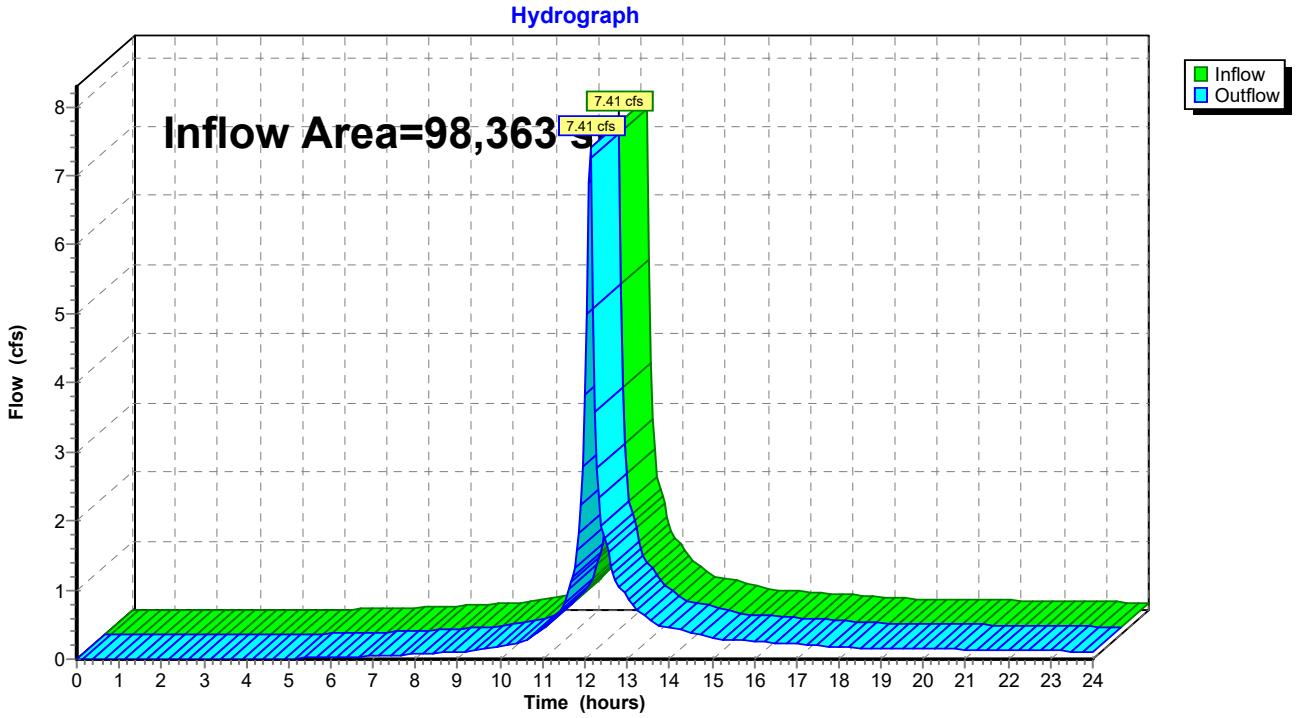
Summary for Reach DP-1: NW BVW

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 98,363 sf, 33.20% Impervious, Inflow Depth > 2.99" for 10year 24-hr event
Inflow = 7.41 cfs @ 12.13 hrs, Volume= 24,492 cf
Outflow = 7.41 cfs @ 12.13 hrs, Volume= 24,492 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-1: NW BVW



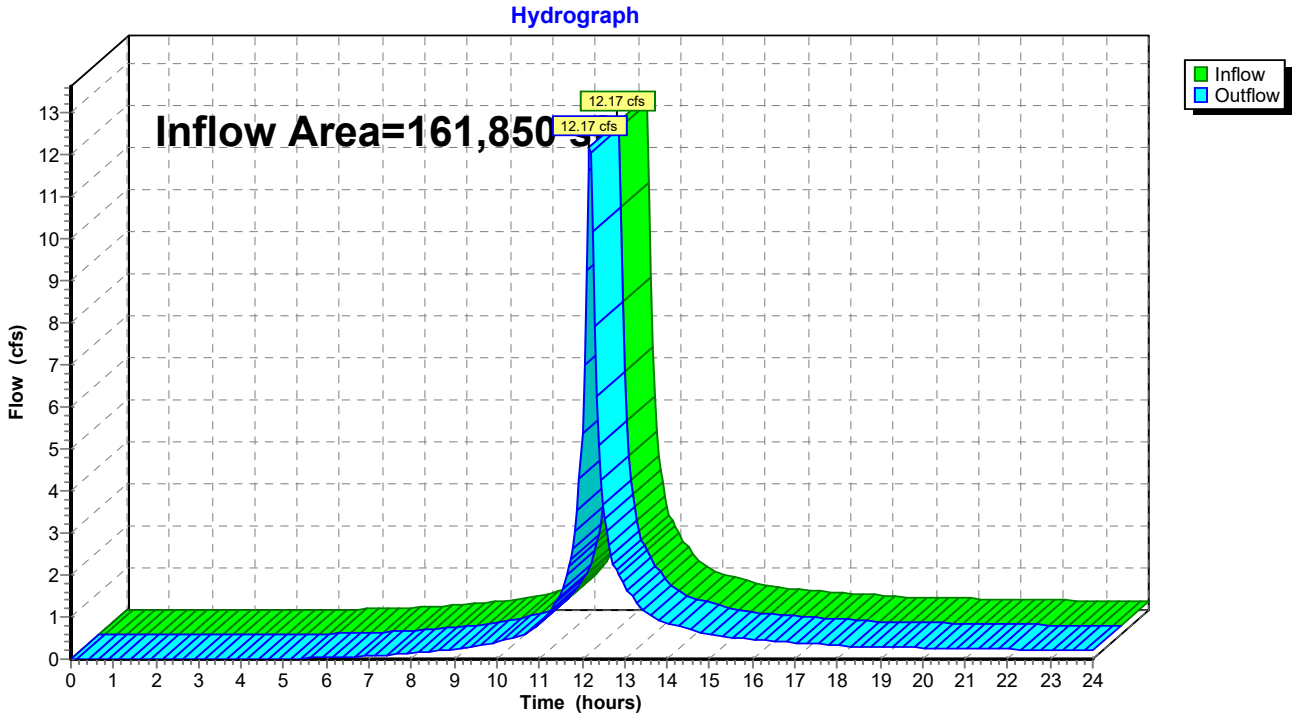
Summary for Reach DP-2: 18" NORTH DRAIN

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 161,850 sf, 32.62% Impervious, Inflow Depth > 3.47" for 10year 24-hr event
Inflow = 12.17 cfs @ 12.18 hrs, Volume= 46,787 cf
Outflow = 12.17 cfs @ 12.18 hrs, Volume= 46,787 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-2: 18" NORTH DRAIN



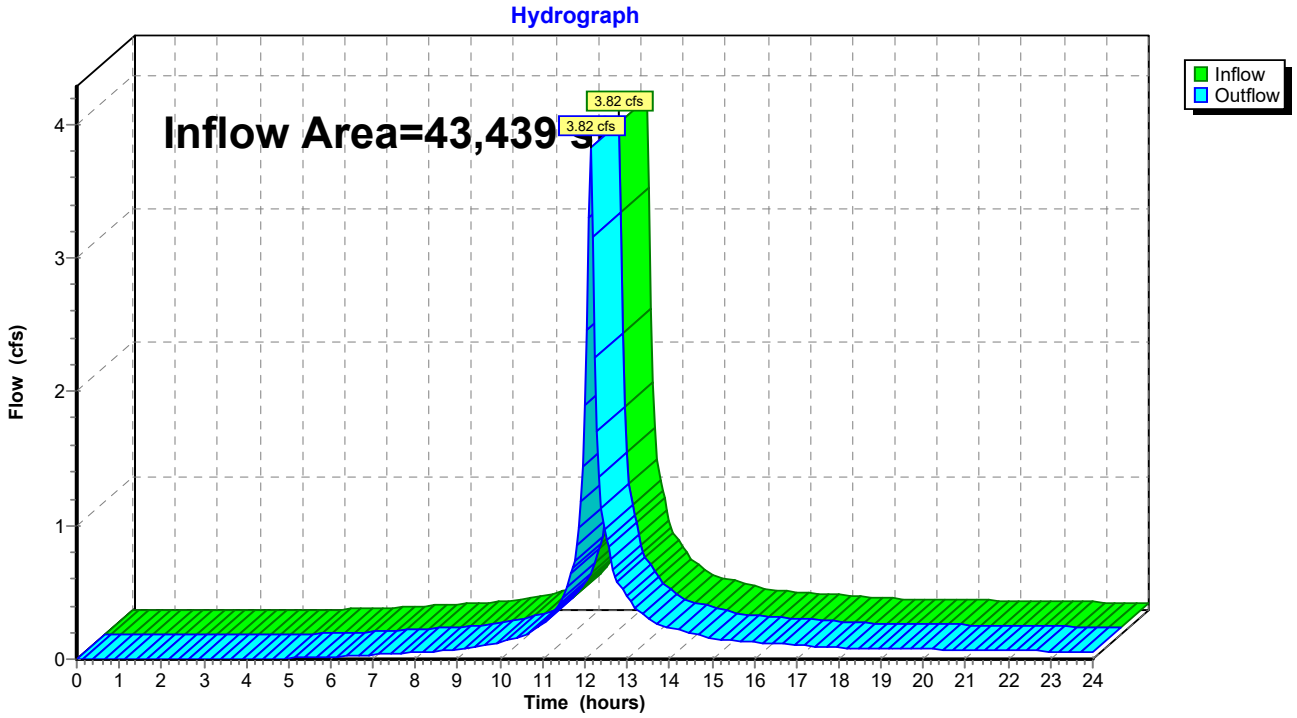
Summary for Reach DP-3: 6" DRAIN

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 43,439 sf, 41.34% Impervious, Inflow Depth > 3.67" for 10year 24-hr event
Inflow = 3.82 cfs @ 12.15 hrs, Volume= 13,297 cf
Outflow = 3.82 cfs @ 12.15 hrs, Volume= 13,297 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-3: 6" DRAIN



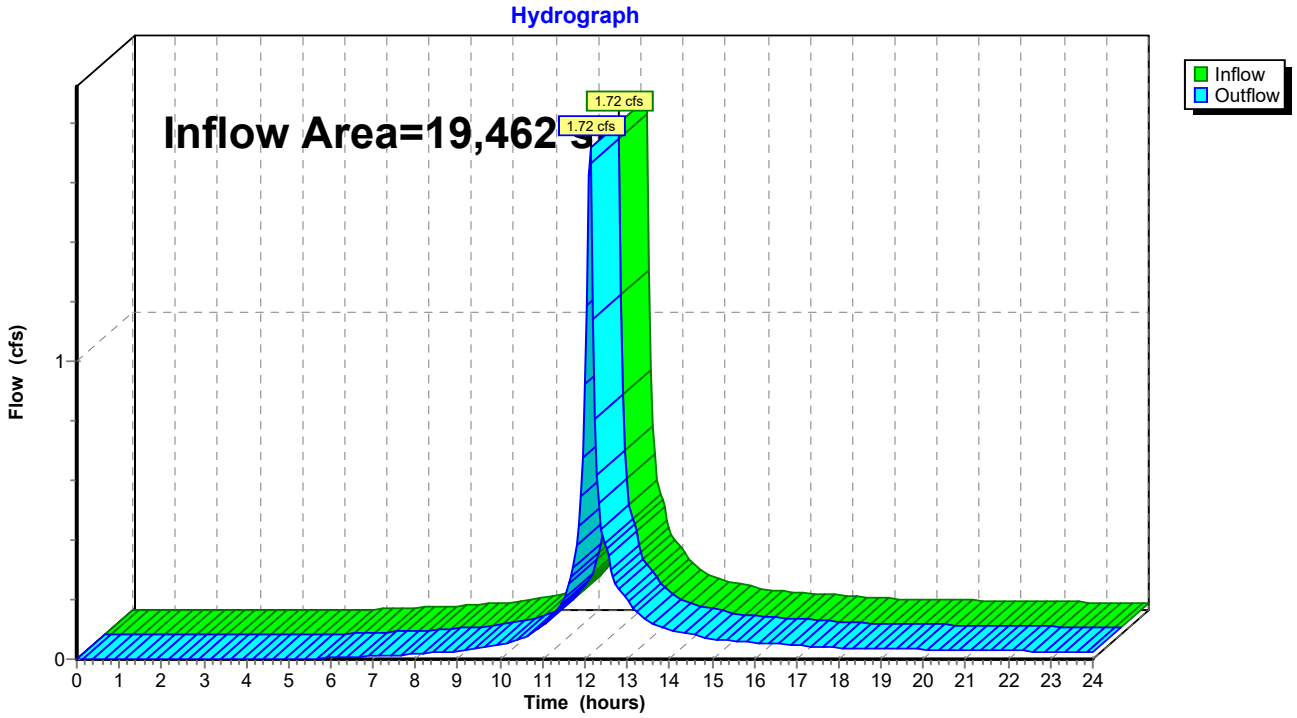
Summary for Reach DP-4: SOUTH BVW

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 19,462 sf, 33.84% Impervious, Inflow Depth > 3.47" for 10year 24-hr event
Inflow = 1.72 cfs @ 12.13 hrs, Volume= 5,632 cf
Outflow = 1.72 cfs @ 12.13 hrs, Volume= 5,632 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-4: SOUTH BVW



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EX-1: Subcat EX-1 Runoff Area=36,178 sf 4.63% Impervious Runoff Depth>2.65"
Flow Length=202' Tc=6.0 min CN=67 Runoff=2.50 cfs 7,983 cf

Subcatchment EX-2: Subcat EX-2 Runoff Area=161,850 sf 32.62% Impervious Runoff Depth>4.55"
Flow Length=760' Tc=10.9 min CN=86 Runoff=15.76 cfs 61,400 cf

Subcatchment EX-3: Subcat EX-3 Runoff Area=43,439 sf 41.34% Impervious Runoff Depth>4.77"
Flow Length=246' Tc=7.8 min CN=88 Runoff=4.90 cfs 17,281 cf

Subcatchment EX-4: Subcat EX-4 Runoff Area=19,462 sf 33.84% Impervious Runoff Depth>4.56"
Flow Length=83' Tc=6.0 min CN=86 Runoff=2.22 cfs 7,391 cf

Subcatchment EX-5: EX UU SITE Runoff Area=62,185 sf 49.82% Impervious Runoff Depth>4.78"
Flow Length=362' Slope=0.0100 '/' Tc=6.2 min CN=88 Runoff=7.32 cfs 24,747 cf

Reach DP-1: NW BVW Inflow=9.82 cfs 32,730 cf
Outflow=9.82 cfs 32,730 cf

Reach DP-2: 18" NORTH DRAIN Inflow=15.76 cfs 61,400 cf
Outflow=15.76 cfs 61,400 cf

Reach DP-3: 6" DRAIN Inflow=4.90 cfs 17,281 cf
Outflow=4.90 cfs 17,281 cf

Reach DP-4: SOUTH BVW Inflow=2.22 cfs 7,391 cf
Outflow=2.22 cfs 7,391 cf

Total Runoff Area = 323,114 sf Runoff Volume = 118,801 cf Average Runoff Depth = 4.41"
65.96% Pervious = 213,111 sf 34.04% Impervious = 110,003 sf

Summary for Subcatchment EX-1: Subcat EX-1

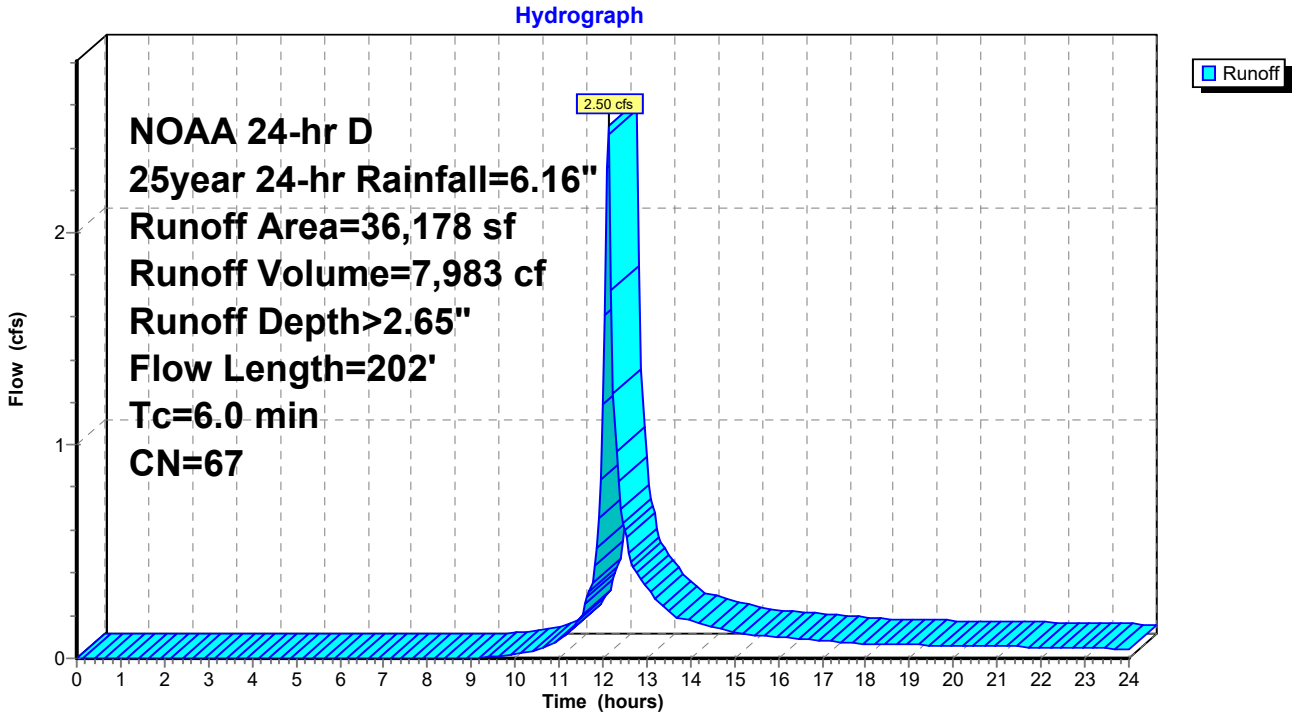
Runoff = 2.50 cfs @ 12.13 hrs, Volume= 7,983 cf, Depth> 2.65"
Routed to Reach DP-1 : NW BVW

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 25year 24-hr Rainfall=6.16"

	Area (sf)	CN	Description
	1,840	61	>75% Grass cover, Good, HSG B
	7,992	80	>75% Grass cover, Good, HSG D
*	1,515	98	Impervious, HSG B
	159	98	Paved parking, HSG D
	17,152	55	Woods, Good, HSG B
	7,520	77	Woods, Good, HSG D
	36,178	67	Weighted Average
	34,504		95.37% Pervious Area
	1,674		4.63% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.0	50	0.0480	0.21		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.17"
1.5	152	0.0579	1.68		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.5					**Direct Entry,**
6.0	202	Total			

Subcatchment EX-1: Subcat EX-1



Summary for Subcatchment EX-2: Subcat EX-2

[47] Hint: Peak is 127% of capacity of segment #3

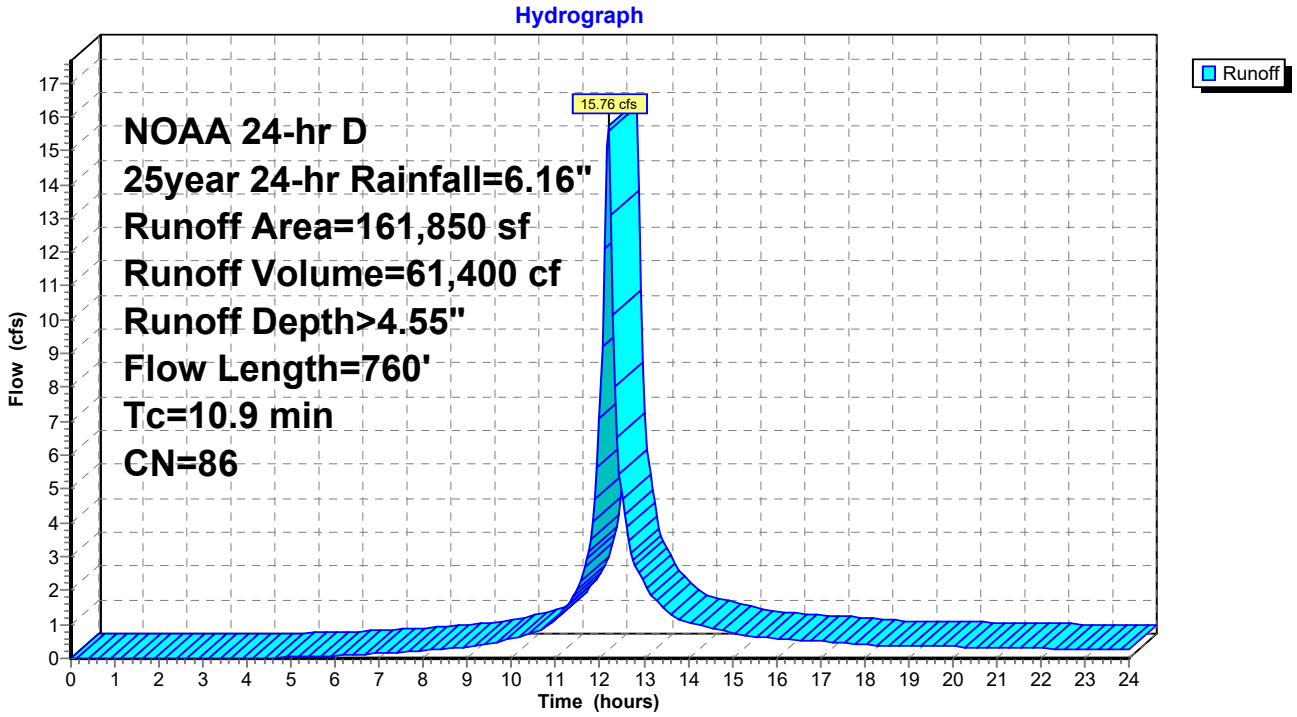
Runoff = 15.76 cfs @ 12.18 hrs, Volume= 61,400 cf, Depth> 4.55"
Routed to Reach DP-2 : 18" NORTH DRAIN

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 25year 24-hr Rainfall=6.16"

	Area (sf)	CN	Description
	1,906	61	>75% Grass cover, Good, HSG B
	91,166	80	>75% Grass cover, Good, HSG D
*	11,943	89	Dirt, HSG D
	33,133	98	Impervious, HSG D
	19,670	98	Roofs, HSG D
	4,032	55	Woods, Good, HSG B
	161,850	86	Weighted Average
	109,047		67.38% Pervious Area
	52,803		32.62% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.9	50	0.0180	0.14		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.17"
4.1	335	0.0380	1.36		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.9	375	0.0100	7.03	12.41	**Pipe Channel, RCP_Round 18"** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.011 Concrete pipe, straight & clean
10.9	760	Total			

Subcatchment EX-2: Subcat EX-2



Summary for Subcatchment EX-3: Subcat EX-3

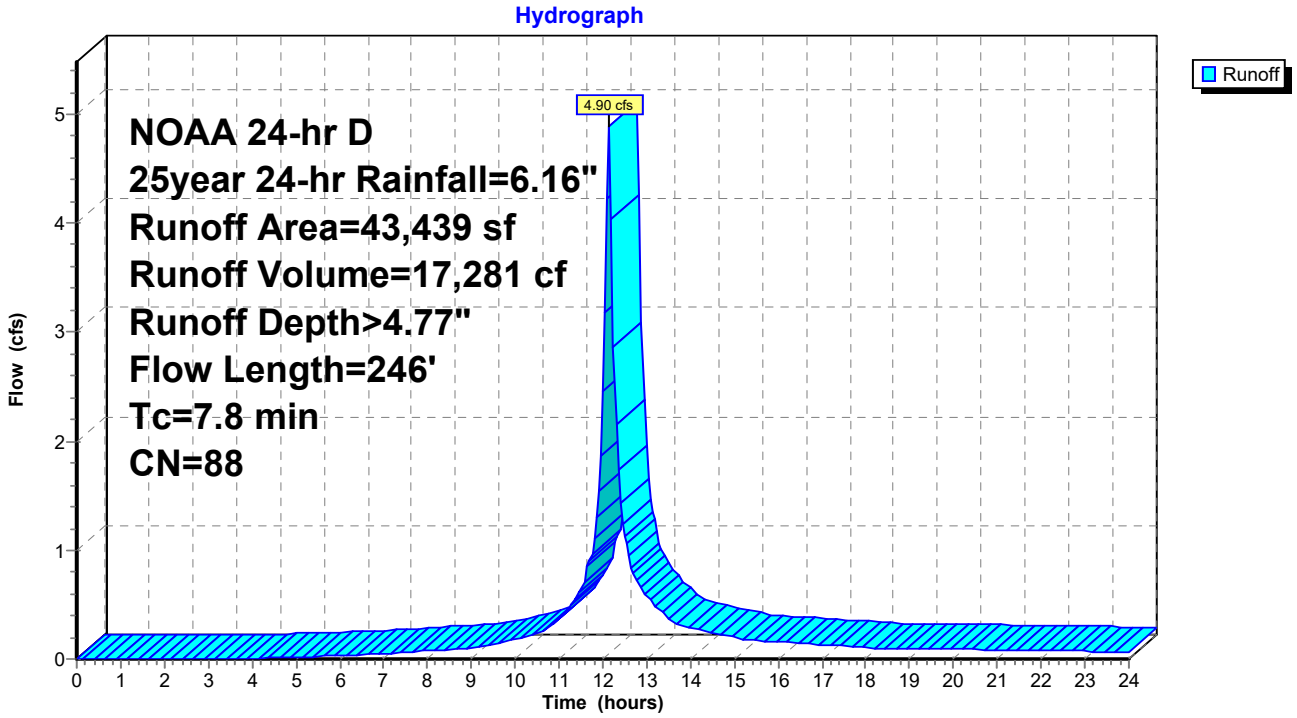
Runoff = 4.90 cfs @ 12.15 hrs, Volume= 17,281 cf, Depth> 4.77"
Routed to Reach DP-3 : 6" DRAIN

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 25year 24-hr Rainfall=6.16"

	Area (sf)	CN	Description
	8,239	80	>75% Grass cover, Good, HSG D
	16,195	80	>75% Grass cover, Good, HSG D
	549	80	>75% Grass cover, Good, HSG D
*	498	89	Dirt, HSG D
	1,325	98	Paved parking, HSG D
	16,633	98	Impervious, HSG D
	43,439	88	Weighted Average
	25,481		58.66% Pervious Area
	17,958		41.34% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.3	50	0.0150	0.13		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.17"
1.5	196	0.0200	2.12		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
7.8	246	Total			

Subcatchment EX-3: Subcat EX-3



Summary for Subcatchment EX-4: Subcat EX-4

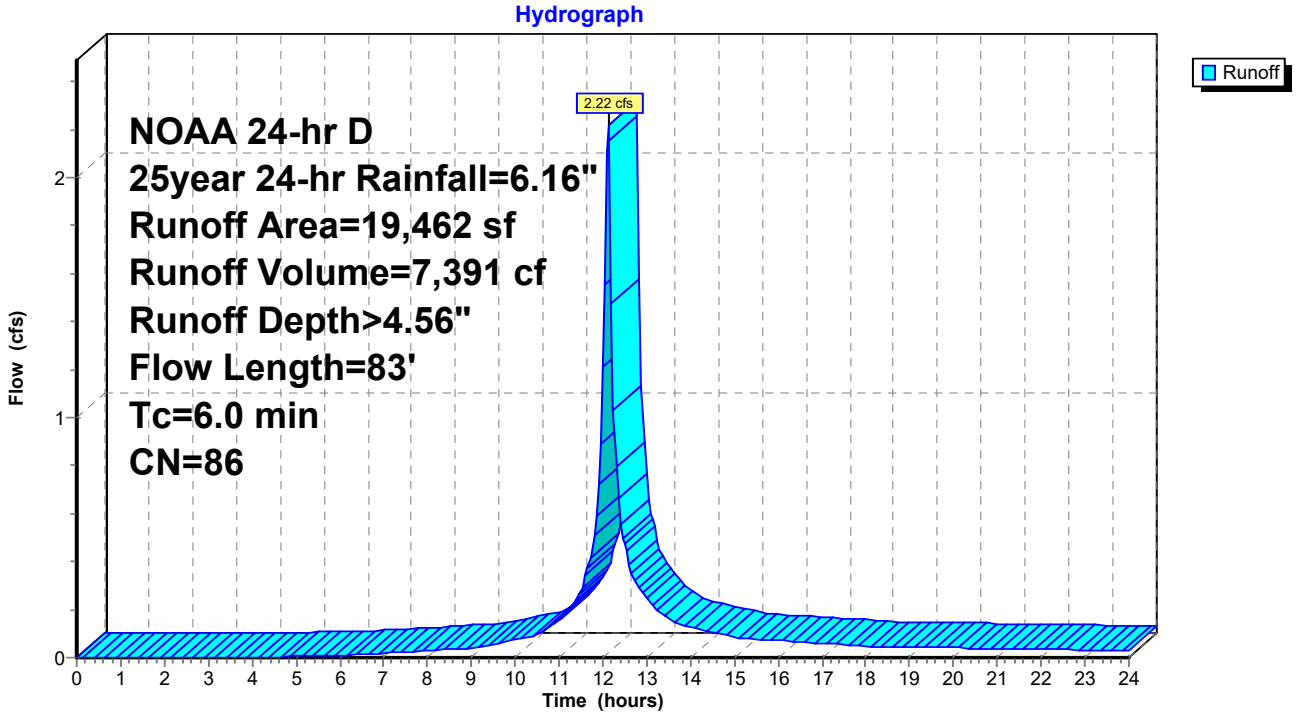
Runoff = 2.22 cfs @ 12.13 hrs, Volume= 7,391 cf, Depth> 4.56"
Routed to Reach DP-4 : SOUTH BVW

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 25year 24-hr Rainfall=6.16"

Area (sf)	CN	Description
9,604	80	>75% Grass cover, Good, HSG D
1,081	89	Dirt roads, HSG D
6,586	98	Paved parking, HSG D
2,191	77	Woods, Good, HSG D
19,462	86	Weighted Average
12,876		66.16% Pervious Area
6,586		33.84% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.9	50	0.0500	0.21		**Sheet Flow, Grass-Sheet** Grass: Short n= 0.150 P2= 3.17"
0.2	33	0.1400	2.62		**Shallow Concentrated Flow, Con Flow** Short Grass Pasture Kv= 7.0 fps
1.9					**Direct Entry, Minimum Tc of 6 Min**
6.0	83	Total			

Subcatchment EX-4: Subcat EX-4



Summary for Subcatchment EX-5: EX UU SITE

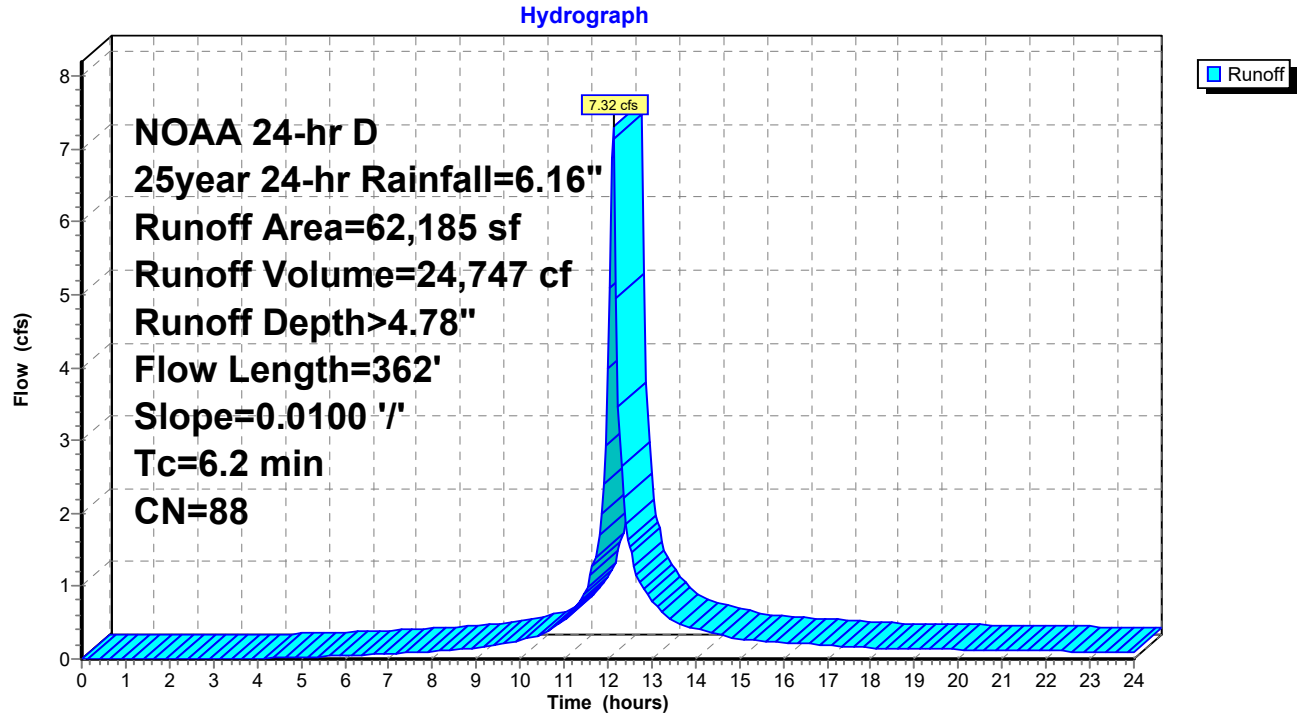
Runoff = 7.32 cfs @ 12.13 hrs, Volume= 24,747 cf, Depth> 4.78"
Routed to Reach DP-1 : NW BVW

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 25year 24-hr Rainfall=6.16"

Area (sf)	CN	Description
30,982	98	Paved parking, HSG D
29,665	77	Woods, Good, HSG D
1,538	80	>75% Grass cover, Good, HSG D
62,185	88	Weighted Average
31,203		50.18% Pervious Area
30,982		49.82% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.90		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.17"
5.0	212	0.0100	0.70		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.3	100	0.0100	6.22	7.63	**Pipe Channel,** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.011 Concrete pipe, straight & clean
6.2	362	Total			

Subcatchment EX-5: EX UU SITE



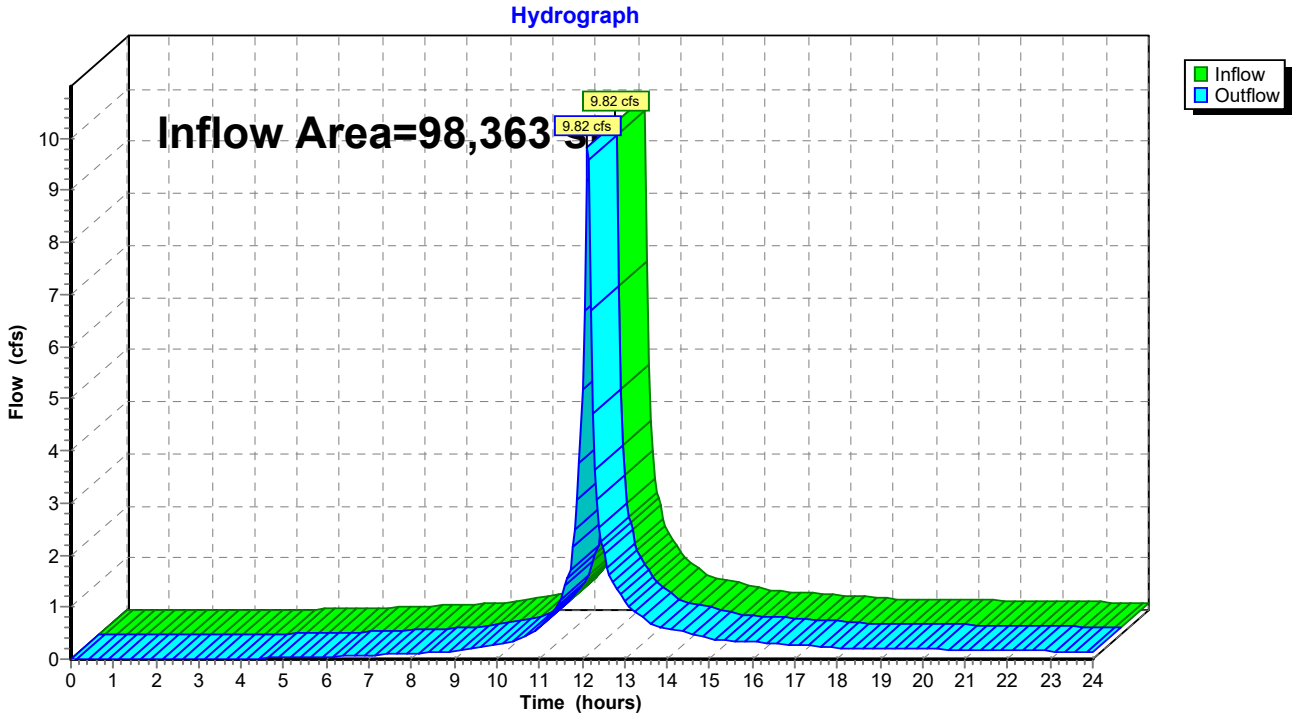
Summary for Reach DP-1: NW BVW

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 98,363 sf, 33.20% Impervious, Inflow Depth > 3.99" for 25year 24-hr event
Inflow = 9.82 cfs @ 12.13 hrs, Volume= 32,730 cf
Outflow = 9.82 cfs @ 12.13 hrs, Volume= 32,730 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-1: NW BVW



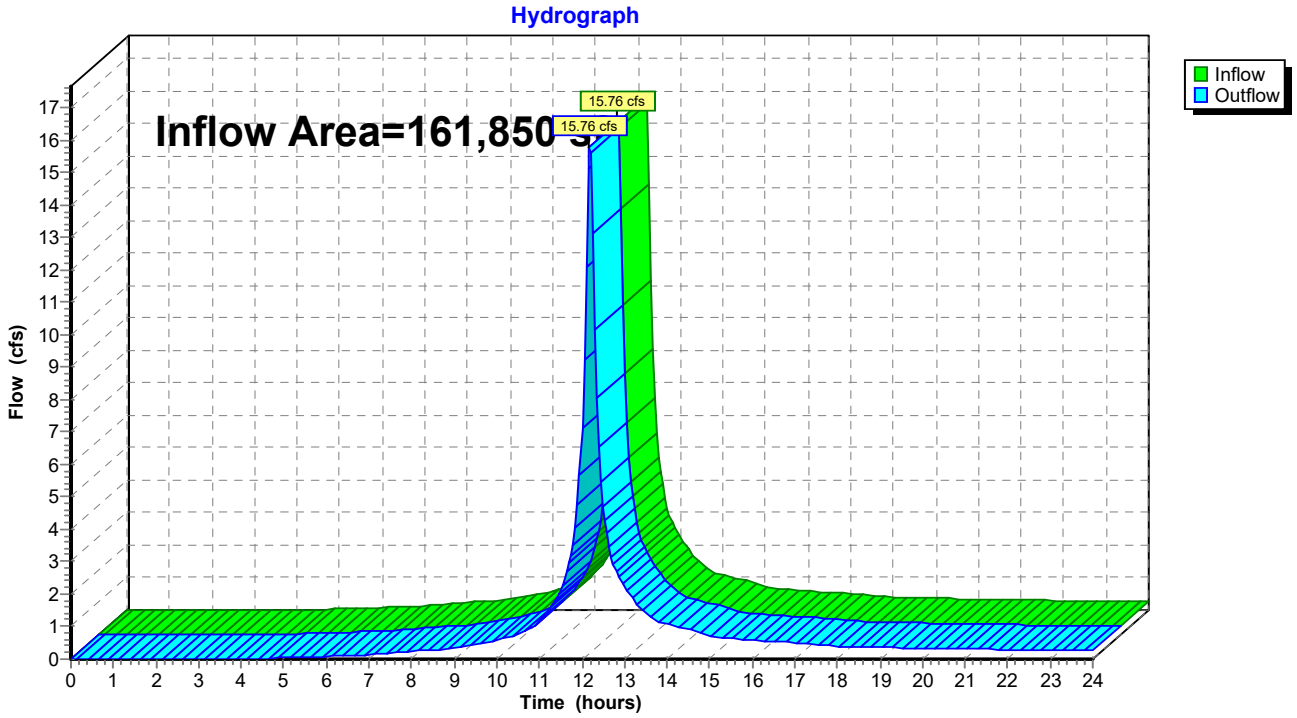
Summary for Reach DP-2: 18" NORTH DRAIN

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 161,850 sf, 32.62% Impervious, Inflow Depth > 4.55" for 25year 24-hr event
Inflow = 15.76 cfs @ 12.18 hrs, Volume= 61,400 cf
Outflow = 15.76 cfs @ 12.18 hrs, Volume= 61,400 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-2: 18" NORTH DRAIN



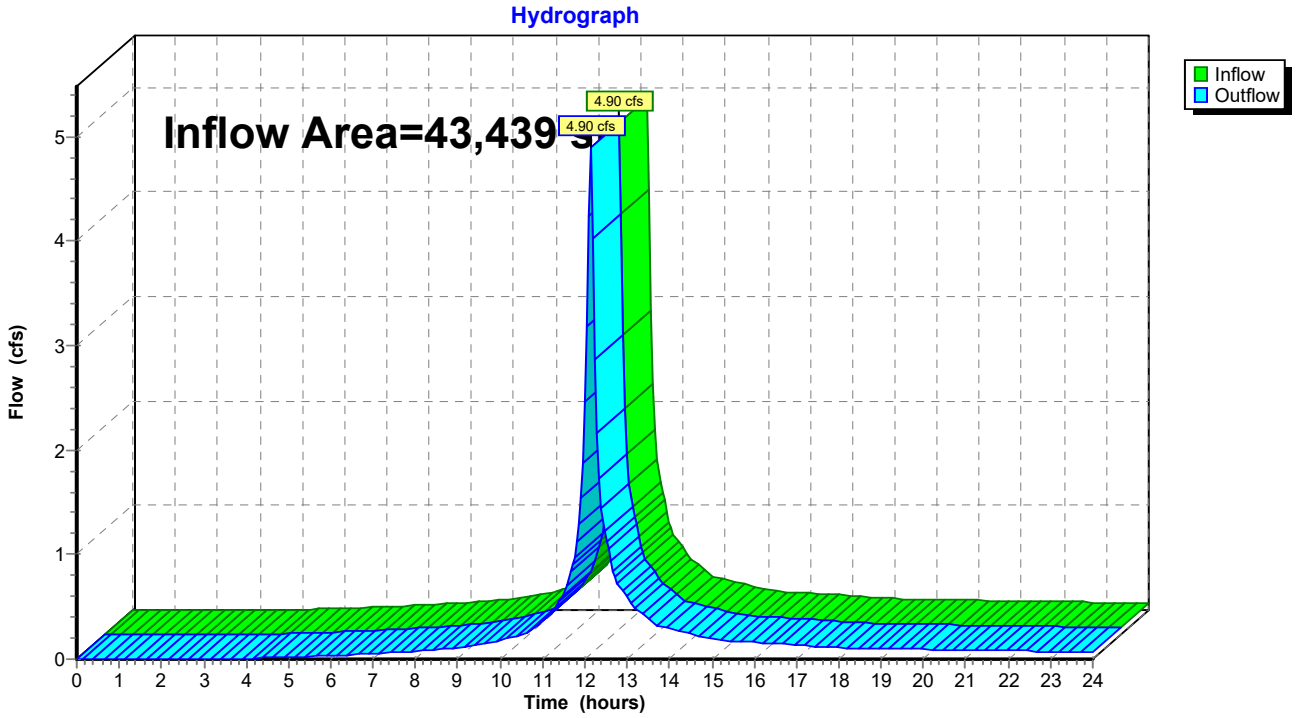
Summary for Reach DP-3: 6" DRAIN

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 43,439 sf, 41.34% Impervious, Inflow Depth > 4.77" for 25year 24-hr event
Inflow = 4.90 cfs @ 12.15 hrs, Volume= 17,281 cf
Outflow = 4.90 cfs @ 12.15 hrs, Volume= 17,281 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-3: 6" DRAIN



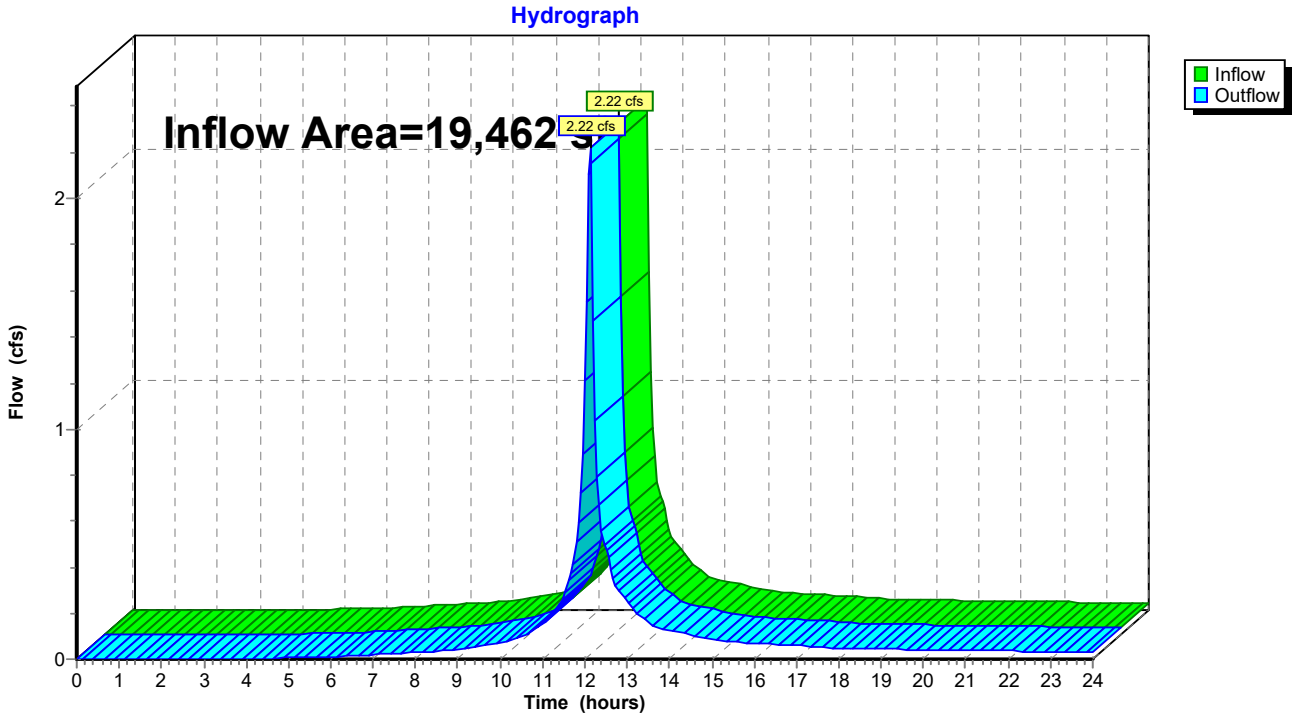
Summary for Reach DP-4: SOUTH BVW

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 19,462 sf, 33.84% Impervious, Inflow Depth > 4.56" for 25year 24-hr event
Inflow = 2.22 cfs @ 12.13 hrs, Volume= 7,391 cf
Outflow = 2.22 cfs @ 12.13 hrs, Volume= 7,391 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-4: SOUTH BVW



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EX-1: Subcat EX-1 Runoff Area=36,178 sf 4.63% Impervious Runoff Depth>4.06"
Flow Length=202' Tc=6.0 min CN=67 Runoff=3.84 cfs 12,235 cf

Subcatchment EX-2: Subcat EX-2 Runoff Area=161,850 sf 32.62% Impervious Runoff Depth>6.25"
Flow Length=760' Tc=10.9 min CN=86 Runoff=21.26 cfs 84,316 cf

Subcatchment EX-3: Subcat EX-3 Runoff Area=43,439 sf 41.34% Impervious Runoff Depth>6.49"
Flow Length=246' Tc=7.8 min CN=88 Runoff=6.53 cfs 23,499 cf

Subcatchment EX-4: Subcat EX-4 Runoff Area=19,462 sf 33.84% Impervious Runoff Depth>6.26"
Flow Length=83' Tc=6.0 min CN=86 Runoff=2.99 cfs 10,149 cf

Subcatchment EX-5: EX UU SITE Runoff Area=62,185 sf 49.82% Impervious Runoff Depth>6.49"
Flow Length=362' Slope=0.0100 '/' Tc=6.2 min CN=88 Runoff=9.76 cfs 33,651 cf

Reach DP-1: NW BVW Inflow=13.60 cfs 45,886 cf
Outflow=13.60 cfs 45,886 cf

Reach DP-2: 18" NORTH DRAIN Inflow=21.26 cfs 84,316 cf
Outflow=21.26 cfs 84,316 cf

Reach DP-3: 6" DRAIN Inflow=6.53 cfs 23,499 cf
Outflow=6.53 cfs 23,499 cf

Reach DP-4: SOUTH BVW Inflow=2.99 cfs 10,149 cf
Outflow=2.99 cfs 10,149 cf

Total Runoff Area = 323,114 sf Runoff Volume = 163,850 cf Average Runoff Depth = 6.09"
65.96% Pervious = 213,111 sf 34.04% Impervious = 110,003 sf

Summary for Subcatchment EX-1: Subcat EX-1

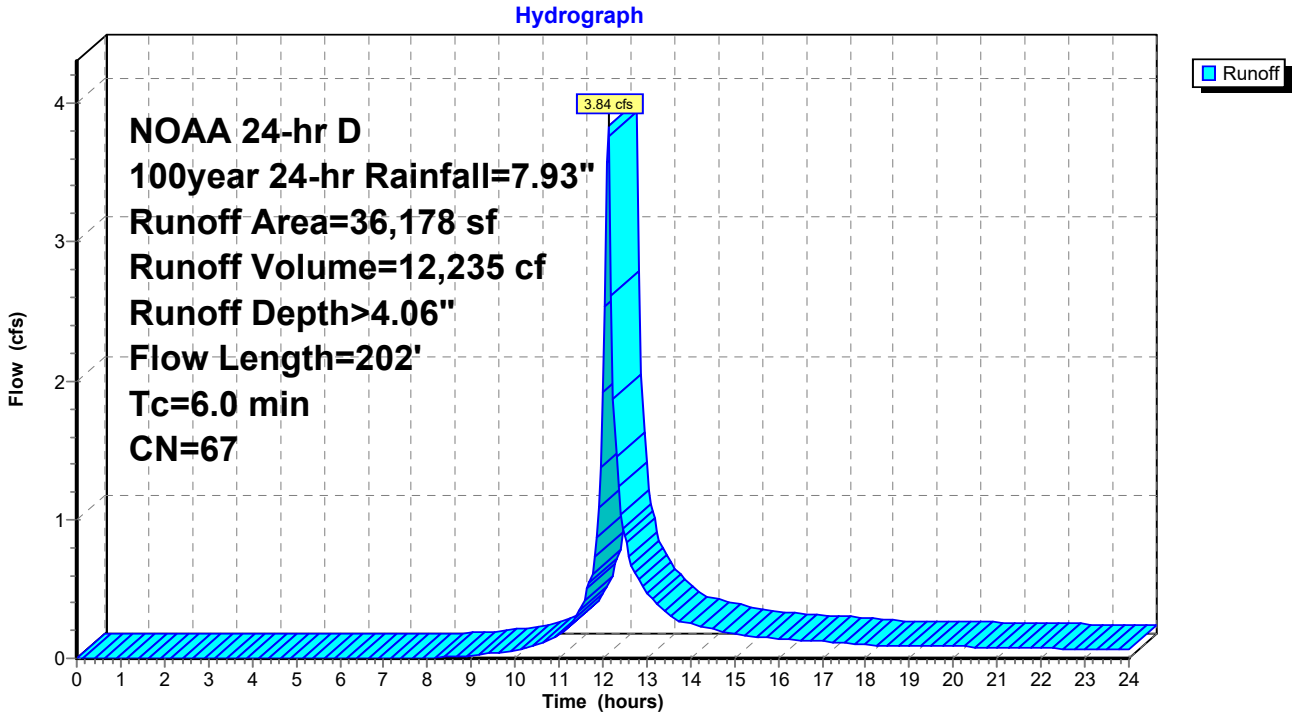
Runoff = 3.84 cfs @ 12.13 hrs, Volume= 12,235 cf, Depth> 4.06"
Routed to Reach DP-1 : NW BVW

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 100year 24-hr Rainfall=7.93"

	Area (sf)	CN	Description
	1,840	61	>75% Grass cover, Good, HSG B
	7,992	80	>75% Grass cover, Good, HSG D
*	1,515	98	Impervious, HSG B
	159	98	Paved parking, HSG D
	17,152	55	Woods, Good, HSG B
	7,520	77	Woods, Good, HSG D
	36,178	67	Weighted Average
	34,504		95.37% Pervious Area
	1,674		4.63% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.0	50	0.0480	0.21		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.17"
1.5	152	0.0579	1.68		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.5					**Direct Entry,**
6.0	202	Total			

Subcatchment EX-1: Subcat EX-1



Summary for Subcatchment EX-2: Subcat EX-2

[47] Hint: Peak is 171% of capacity of segment #3

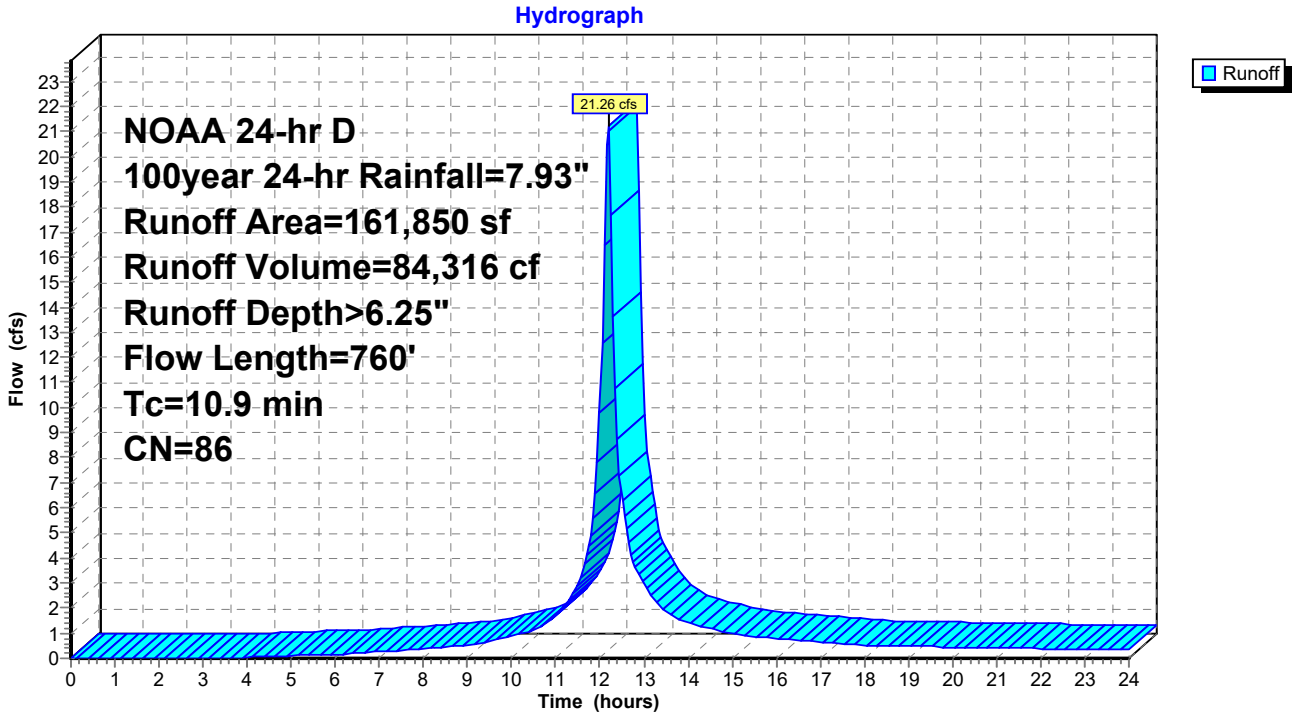
Runoff = 21.26 cfs @ 12.18 hrs, Volume= 84,316 cf, Depth> 6.25"
Routed to Reach DP-2 : 18" NORTH DRAIN

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 100year 24-hr Rainfall=7.93"

	Area (sf)	CN	Description
	1,906	61	>75% Grass cover, Good, HSG B
	91,166	80	>75% Grass cover, Good, HSG D
*	11,943	89	Dirt, HSG D
	33,133	98	Impervious, HSG D
	19,670	98	Roofs, HSG D
	4,032	55	Woods, Good, HSG B
	161,850	86	Weighted Average
	109,047		67.38% Pervious Area
	52,803		32.62% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.9	50	0.0180	0.14		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.17"
4.1	335	0.0380	1.36		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.9	375	0.0100	7.03	12.41	**Pipe Channel, RCP_Round 18"** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.011 Concrete pipe, straight & clean
10.9	760	Total			

Subcatchment EX-2: Subcat EX-2



Summary for Subcatchment EX-3: Subcat EX-3

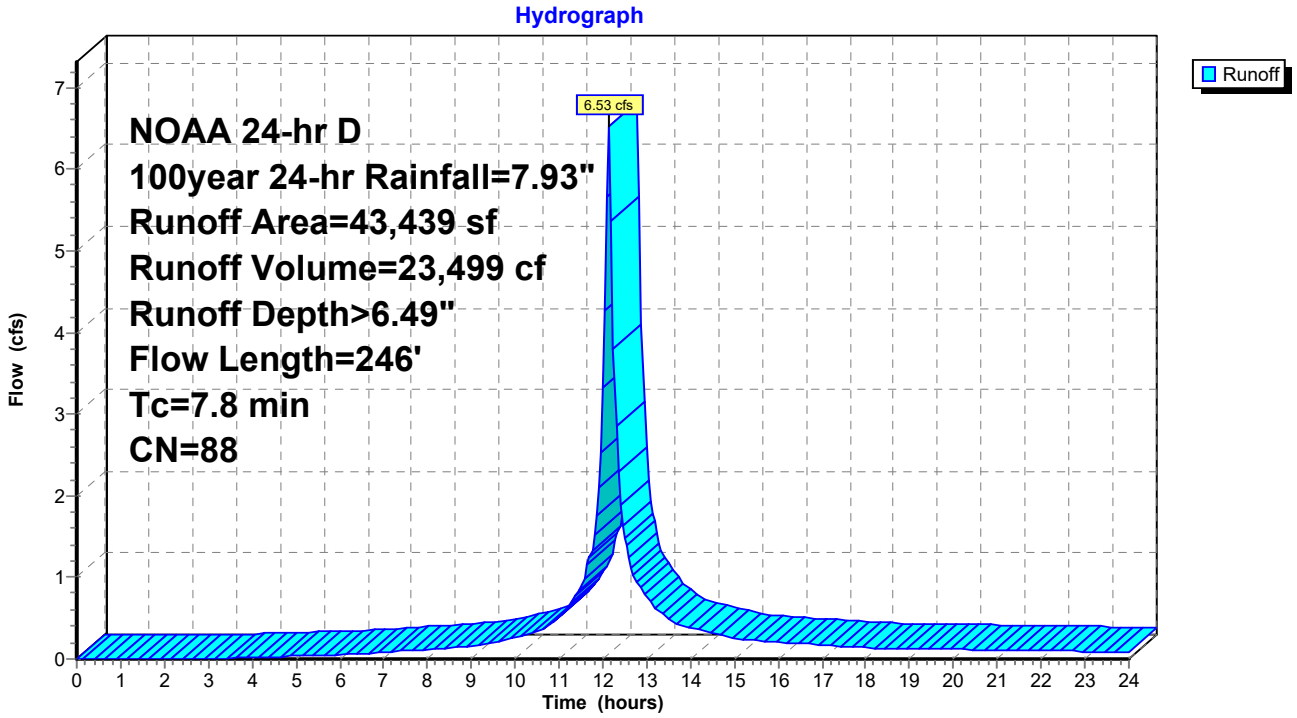
Runoff = 6.53 cfs @ 12.15 hrs, Volume= 23,499 cf, Depth> 6.49"
Routed to Reach DP-3 : 6" DRAIN

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 100year 24-hr Rainfall=7.93"

	Area (sf)	CN	Description
	8,239	80	>75% Grass cover, Good, HSG D
	16,195	80	>75% Grass cover, Good, HSG D
	549	80	>75% Grass cover, Good, HSG D
*	498	89	Dirt, HSG D
	1,325	98	Paved parking, HSG D
	16,633	98	Impervious, HSG D
	43,439	88	Weighted Average
	25,481		58.66% Pervious Area
	17,958		41.34% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.3	50	0.0150	0.13		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.17"
1.5	196	0.0200	2.12		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
7.8	246	Total			

Subcatchment EX-3: Subcat EX-3



Summary for Subcatchment EX-4: Subcat EX-4

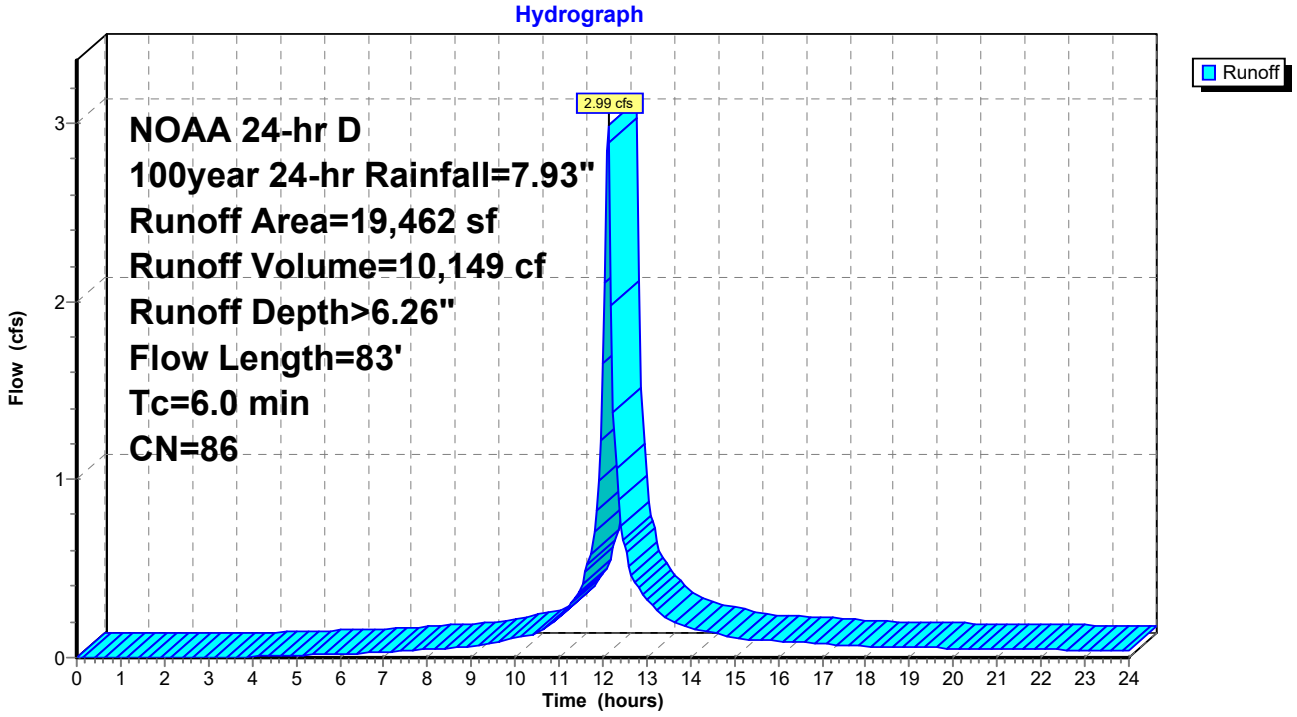
Runoff = 2.99 cfs @ 12.13 hrs, Volume= 10,149 cf, Depth> 6.26"
Routed to Reach DP-4 : SOUTH BVW

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 100year 24-hr Rainfall=7.93"

Area (sf)	CN	Description
9,604	80	>75% Grass cover, Good, HSG D
1,081	89	Dirt roads, HSG D
6,586	98	Paved parking, HSG D
2,191	77	Woods, Good, HSG D
19,462	86	Weighted Average
12,876		66.16% Pervious Area
6,586		33.84% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.9	50	0.0500	0.21		**Sheet Flow, Grass-Sheet** Grass: Short n= 0.150 P2= 3.17"
0.2	33	0.1400	2.62		**Shallow Concentrated Flow, Con Flow** Short Grass Pasture Kv= 7.0 fps
1.9					**Direct Entry, Minimum Tc of 6 Min**
6.0	83	Total			

Subcatchment EX-4: Subcat EX-4



Summary for Subcatchment EX-5: EX UU SITE

[47] Hint: Peak is 128% of capacity of segment #3

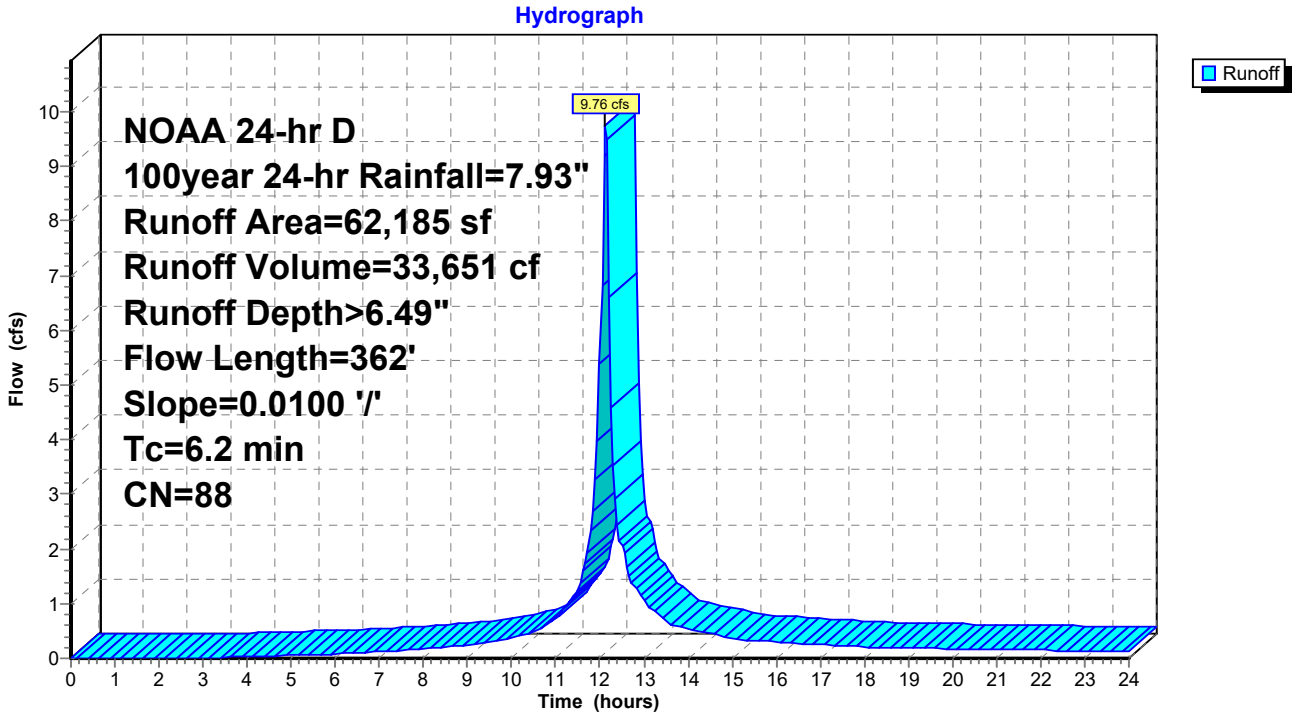
Runoff = 9.76 cfs @ 12.13 hrs, Volume= 33,651 cf, Depth> 6.49"
Routed to Reach DP-1 : NW BVW

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 100year 24-hr Rainfall=7.93"

Area (sf)	CN	Description
30,982	98	Paved parking, HSG D
29,665	77	Woods, Good, HSG D
1,538	80	>75% Grass cover, Good, HSG D
62,185	88	Weighted Average
31,203		50.18% Pervious Area
30,982		49.82% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.90		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.17"
5.0	212	0.0100	0.70		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.3	100	0.0100	6.22	7.63	**Pipe Channel,** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.011 Concrete pipe, straight & clean
6.2	362	Total			

Subcatchment EX-5: EX UU SITE



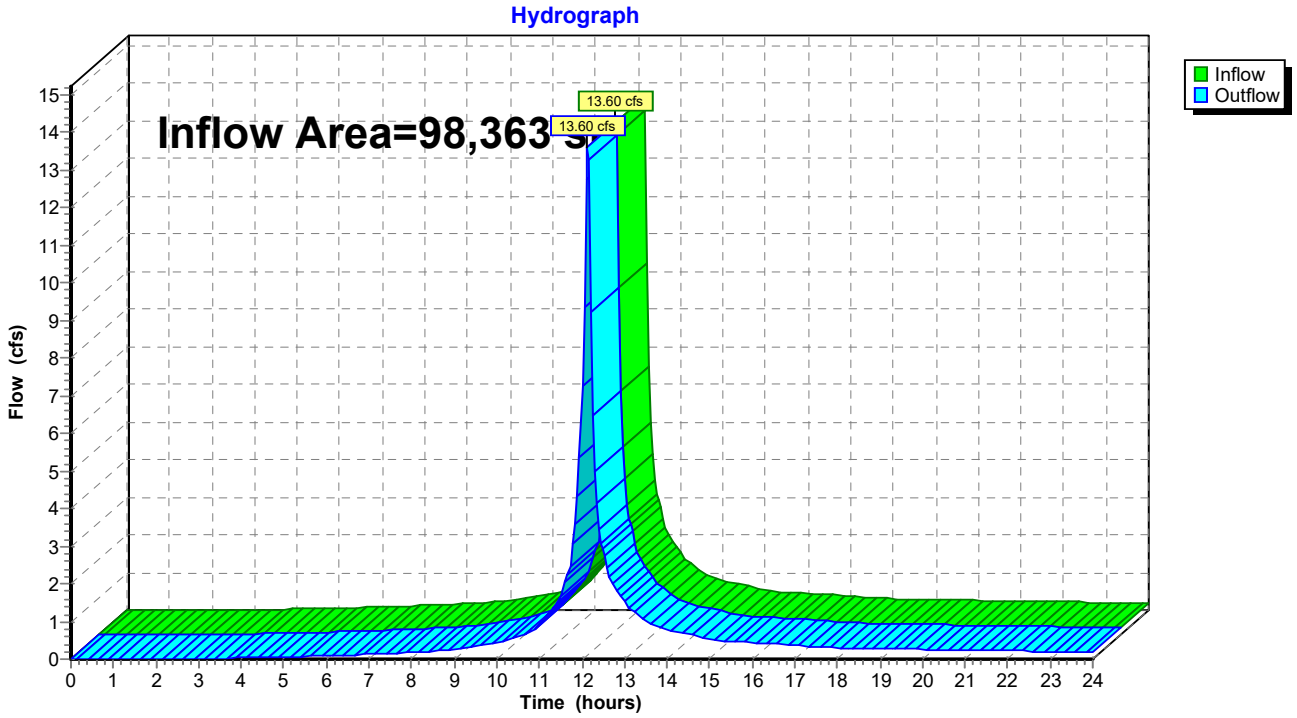
Summary for Reach DP-1: NW BVW

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 98,363 sf, 33.20% Impervious, Inflow Depth > 5.60" for 100year 24-hr event
Inflow = 13.60 cfs @ 12.13 hrs, Volume= 45,886 cf
Outflow = 13.60 cfs @ 12.13 hrs, Volume= 45,886 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-1: NW BVW



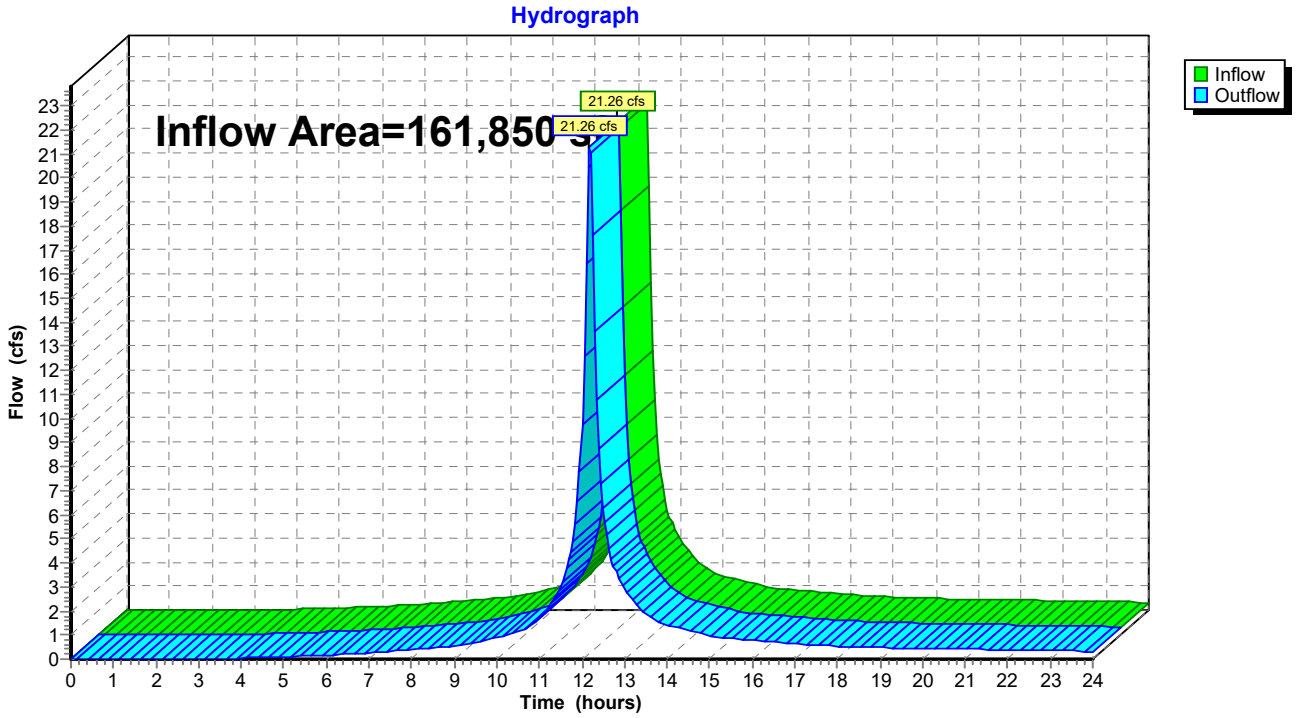
Summary for Reach DP-2: 18" NORTH DRAIN

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 161,850 sf, 32.62% Impervious, Inflow Depth > 6.25" for 100year 24-hr event
Inflow = 21.26 cfs @ 12.18 hrs, Volume= 84,316 cf
Outflow = 21.26 cfs @ 12.18 hrs, Volume= 84,316 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-2: 18" NORTH DRAIN



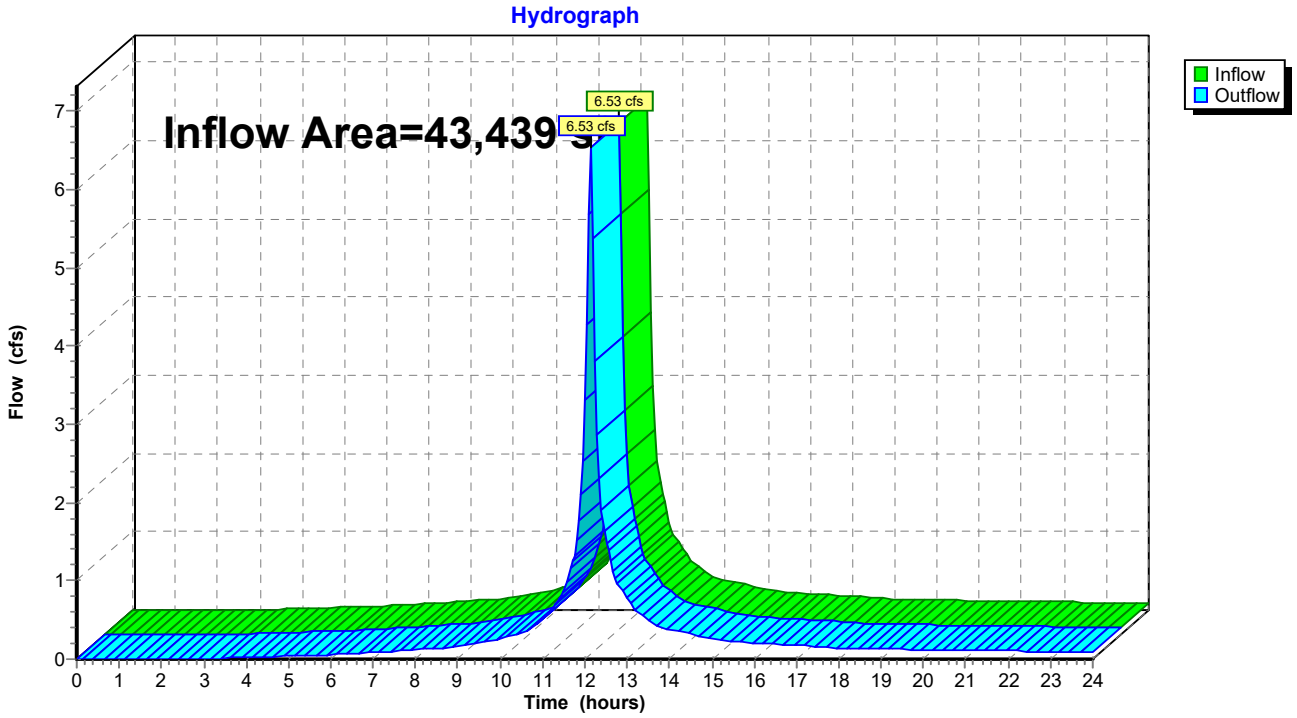
Summary for Reach DP-3: 6" DRAIN

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 43,439 sf, 41.34% Impervious, Inflow Depth > 6.49" for 100year 24-hr event
Inflow = 6.53 cfs @ 12.15 hrs, Volume= 23,499 cf
Outflow = 6.53 cfs @ 12.15 hrs, Volume= 23,499 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-3: 6" DRAIN



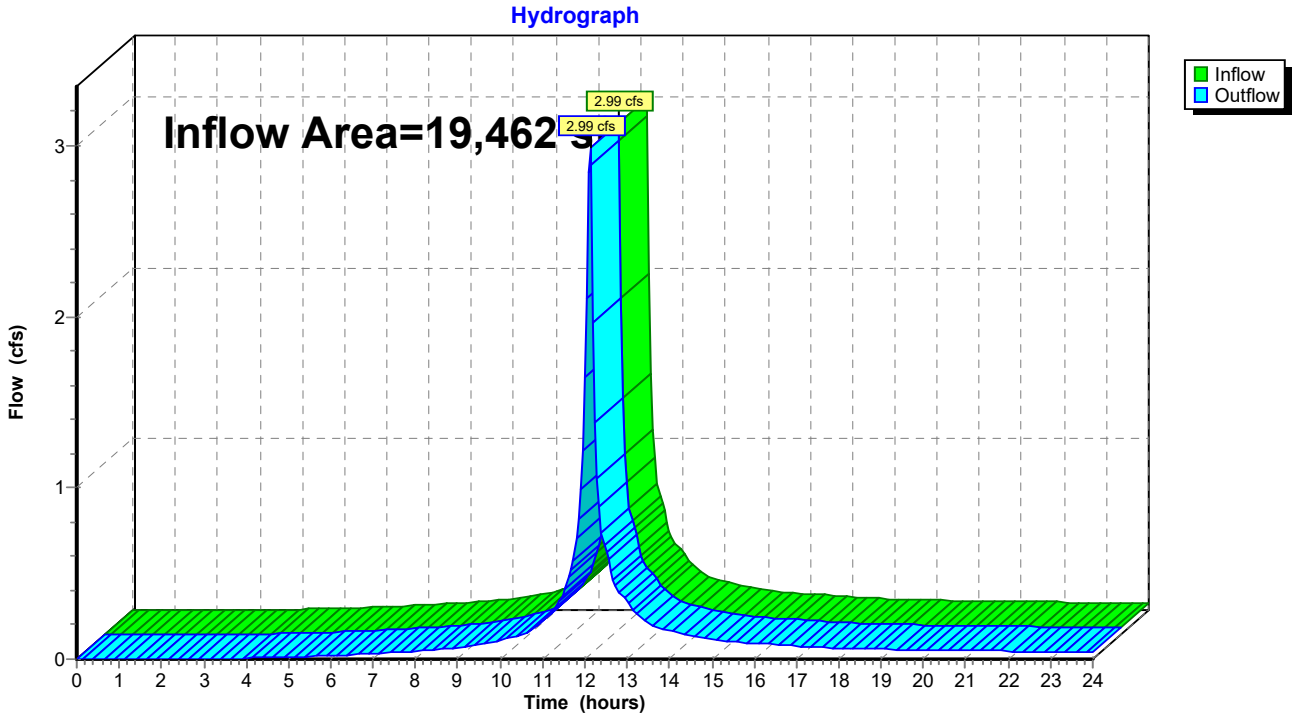
Summary for Reach DP-4: SOUTH BVW

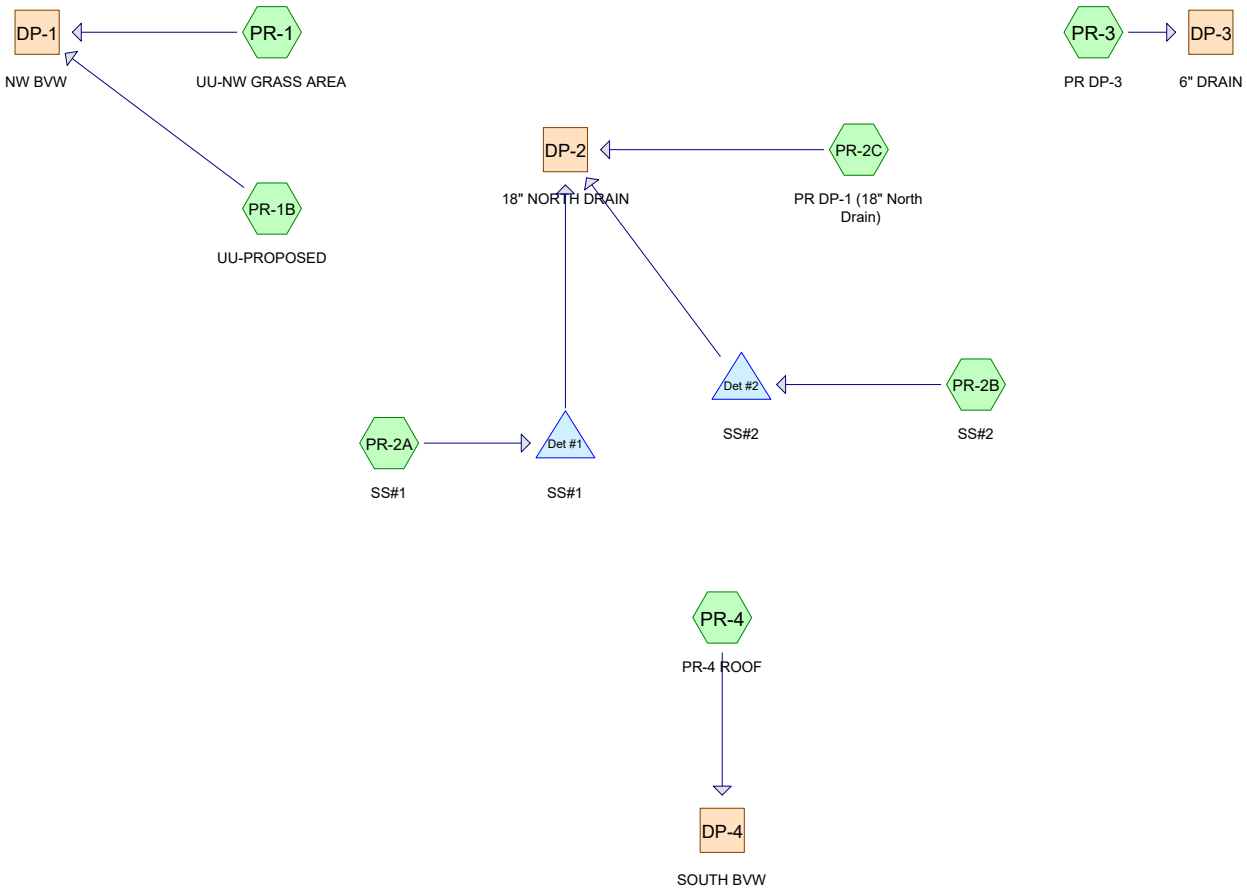
[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 19,462 sf, 33.84% Impervious, Inflow Depth > 6.26" for 100year 24-hr event
Inflow = 2.99 cfs @ 12.13 hrs, Volume= 10,149 cf
Outflow = 2.99 cfs @ 12.13 hrs, Volume= 10,149 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-4: SOUTH BVW





PROPOSED CONDITIONS
HYDROCAD
4/1/2022

Subcat Reach Pond Link

Routing Diagram for 13858 - PR Conditions
Prepared by {enter your company name here}, Printed 4/1/2022

Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	1year 24-hr	NOAA 24-hr	D	Default	24.00	1	2.56	2
2	2year 24-hr	NOAA 24-hr	D	Default	24.00	1	3.17	2
3	10year 24-hr	NOAA 24-hr	D	Default	24.00	1	5.01	2
4	25year 24-hr	NOAA 24-hr	D	Default	24.00	1	6.16	2
5	100year 24-hr	NOAA 24-hr	D	Default	24.00	1	7.93	2

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
84,532	80	>75% Grass cover, Good, HSG D (PR-1, PR-1B, PR-2A, PR-2B, PR-2C, PR-3)
163,215	98	Paved parking, HSG D (PR-1B, PR-2A, PR-2B, PR-2C, PR-3)
59,522	98	Roofs, HSG D (PR-2A, PR-2B, PR-4)
20,000	77	Woods, Good, HSG D (PR-1B)
327,269	**92**	**TOTAL AREA**

Soil Listing (all nodes)

Area (sq-ft)	Soil Group	Subcatchment Numbers
0	HSG A	
0	HSG B	
0	HSG C	
327,269	HSG D	PR-1, PR-1B, PR-2A, PR-2B, PR-2C, PR-3, PR-4
0	Other	
327,269		**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	Su Nu
0	0	0	84,532	0	84,532	>75% Grass cover, Good	
0	0	0	163,215	0	163,215	Paved parking	
0	0	0	59,522	0	59,522	Roofs	
0	0	0	20,000	0	20,000	Woods, Good	
0	**0**	**0**	**327,269**	**0**	**327,269**	**TOTAL AREA**	

Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Width (inches)	Diam/Height (inches)	Inside-Fill (inches)
1	PR-1B	0.00	0.00	116.0	0.0100	0.011	0.0	15.0	0.0
2	PR-2A	0.00	0.00	500.0	0.0100	0.009	0.0	12.0	0.0
3	PR-2B	0.00	0.00	159.0	0.0100	0.009	0.0	12.0	0.0
4	PR-2C	0.00	0.00	775.0	0.0100	0.010	0.0	15.0	0.0
5	PR-4	0.00	0.00	127.0	0.0100	0.009	0.0	12.0	0.0
6	Det #1	46.80	45.98	96.5	0.0085	0.012	0.0	18.0	0.0
7	Det #2	48.30	47.48	96.5	0.0085	0.012	0.0	18.0	0.0

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment PR-1: UU-NW GRASS AREA Runoff Area=5,726 sf 0.00% Impervious Runoff Depth>0.93"
Flow Length=66' Tc=6.0 min CN=80 Runoff=0.14 cfs 443 cf

Subcatchment PR-1B: UU-PROPOSED Runoff Area=56,996 sf 52.08% Impervious Runoff Depth>1.43"
Flow Length=288' Tc=6.0 min CN=88 Runoff=2.13 cfs 6,798 cf

Subcatchment PR-2A: SS#1 Runoff Area=133,345 sf 72.76% Impervious Runoff Depth>1.83"
Flow Length=550' Tc=6.0 min CN=93 Runoff=6.17 cfs 20,381 cf

Subcatchment PR-2B: SS#2 Runoff Area=73,858 sf 92.54% Impervious Runoff Depth>2.22"
Flow Length=209' Tc=6.0 min CN=97 Runoff=3.87 cfs 13,670 cf

Subcatchment PR-2C: PR DP-1 (18" North Runoff Area=40,442 sf 54.88% Impervious Runoff Depth>1.58"
Flow Length=933' Tc=6.0 min CN=90 Runoff=1.66 cfs 5,335 cf

Subcatchment PR-3: PR DP-3 Runoff Area=11,702 sf 2.39% Impervious Runoff Depth>0.93"
Flow Length=93' Tc=6.0 min CN=80 Runoff=0.28 cfs 906 cf

Subcatchment PR-4: PR-4 ROOF Runoff Area=5,200 sf 100.00% Impervious Runoff Depth>2.33"
Flow Length=177' Slope=0.0100 '/' Tc=6.0 min CN=98 Runoff=0.28 cfs 1,009 cf

Reach DP-1: NW BVW Inflow=2.27 cfs 7,242 cf
Outflow=2.27 cfs 7,242 cf

Reach DP-2: 18" NORTH DRAIN Inflow=4.02 cfs 38,881 cf
Outflow=4.02 cfs 38,881 cf

Reach DP-3: 6" DRAIN Inflow=0.28 cfs 906 cf
Outflow=0.28 cfs 906 cf

Reach DP-4: SOUTH BVW Inflow=0.28 cfs 1,009 cf
Outflow=0.28 cfs 1,009 cf

Pond Det #1: SS#1 Peak Elev=55.20' Storage=5,359 cf Inflow=6.17 cfs 20,381 cf
Outflow=1.73 cfs 20,058 cf

Pond Det #2: SS#2 Peak Elev=52.48' Storage=3,622 cf Inflow=3.87 cfs 13,670 cf
Outflow=0.96 cfs 13,488 cf

Total Runoff Area = 327,269 sf Runoff Volume = 48,543 cf Average Runoff Depth = 1.78"
31.94% Pervious = 104,532 sf 68.06% Impervious = 222,737 sf

Summary for Subcatchment PR-1: UU-NW GRASS AREA

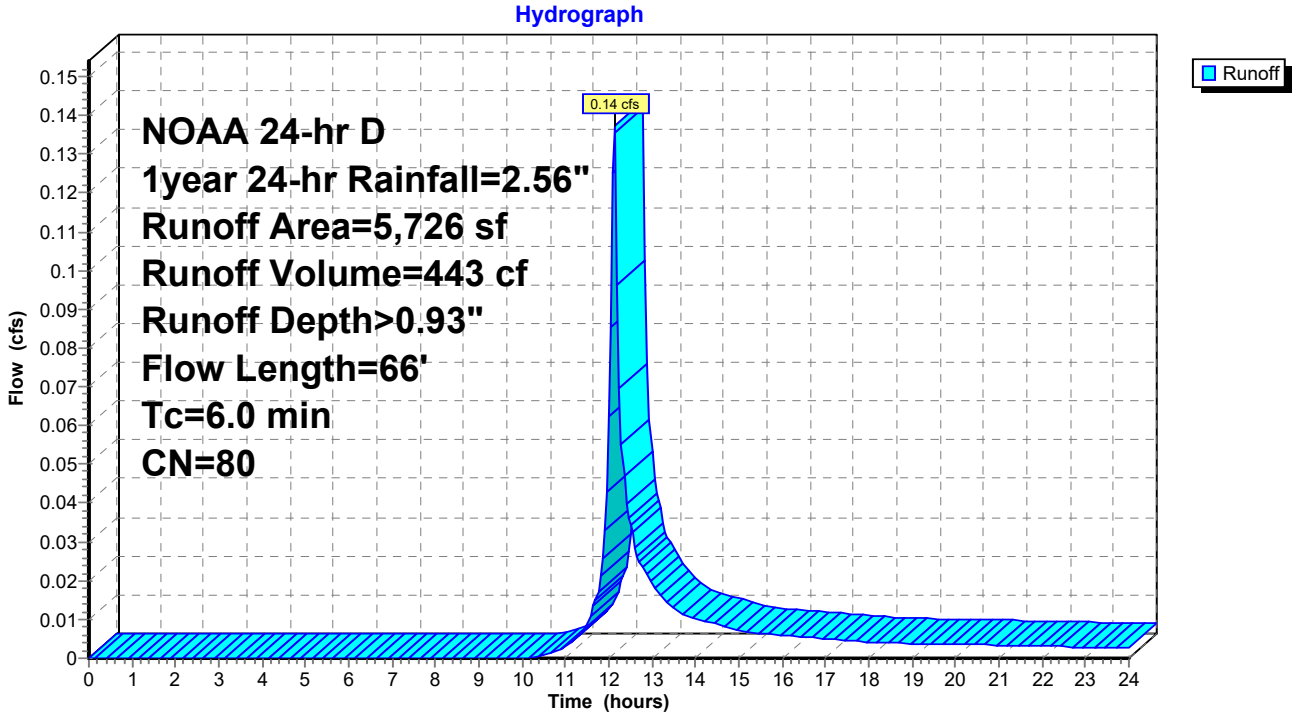
Runoff = 0.14 cfs @ 12.14 hrs, Volume= 443 cf, Depth> 0.93"
Routed to Reach DP-1 : NW BVW

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 1year 24-hr Rainfall=2.56"

Area (sf)	CN	Description
5,726	80	>75% Grass cover, Good, HSG D
5,726		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	50	0.0600	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.17"
0.3	16	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
2.1					**Direct Entry, Minimum Tc of 6 Min**
6.0	66	Total			

Subcatchment PR-1: UU-NW GRASS AREA



Summary for Subcatchment PR-1B: UU-PROPOSED

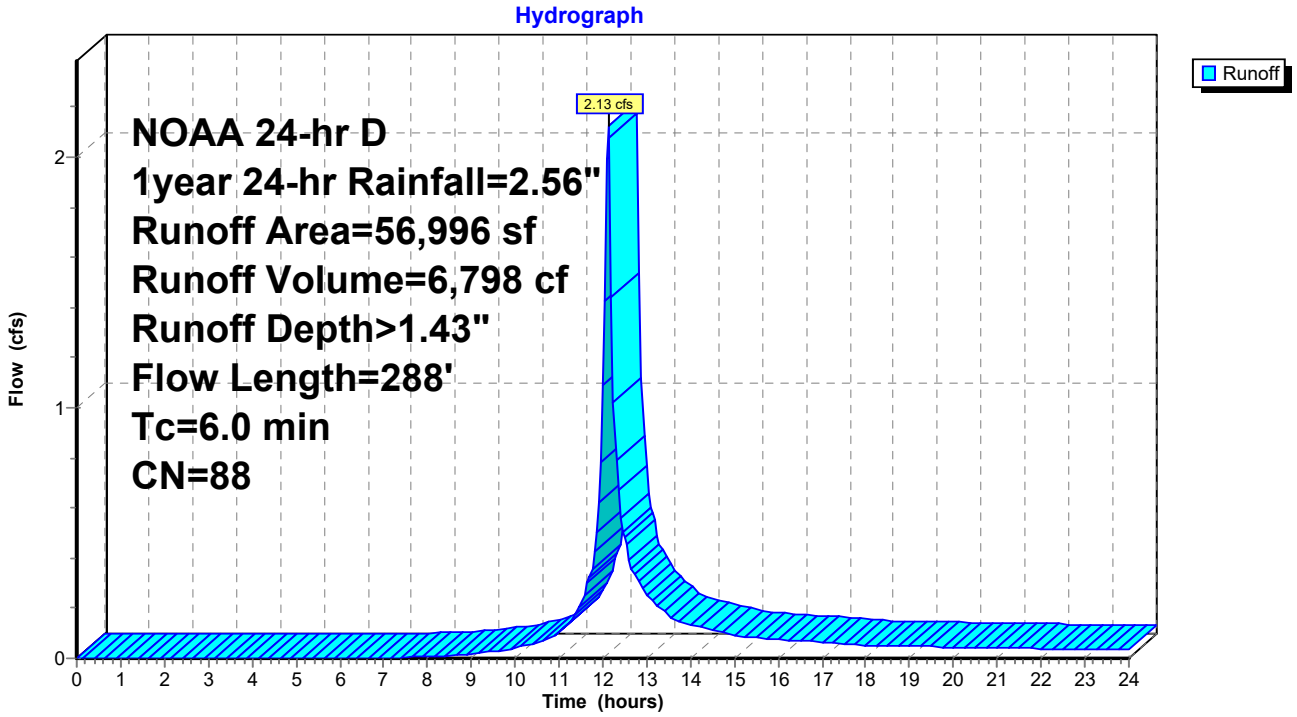
Runoff = 2.13 cfs @ 12.13 hrs, Volume= 6,798 cf, Depth> 1.43"
Routed to Reach DP-1 : NW BVW

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 1year 24-hr Rainfall=2.56"

Area (sf)	CN	Description
7,313	80	>75% Grass cover, Good, HSG D
20,000	77	Woods, Good, HSG D
29,683	98	Paved parking, HSG D
56,996	88	Weighted Average
27,313		47.92% Pervious Area
29,683		52.08% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.90		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.17"
4.3	122	0.0010	0.47		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
0.3	116	0.0100	6.22	7.63	**Pipe Channel, RCP_Round 15"** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.011 Concrete pipe, straight & clean
0.5					**Direct Entry, Minimum Tc of 6 Min**
6.0	288	Total			

Subcatchment PR-1B: UU-PROPOSED



Summary for Subcatchment PR-2A: SS#1

[47] Hint: Peak is 120% of capacity of segment #2

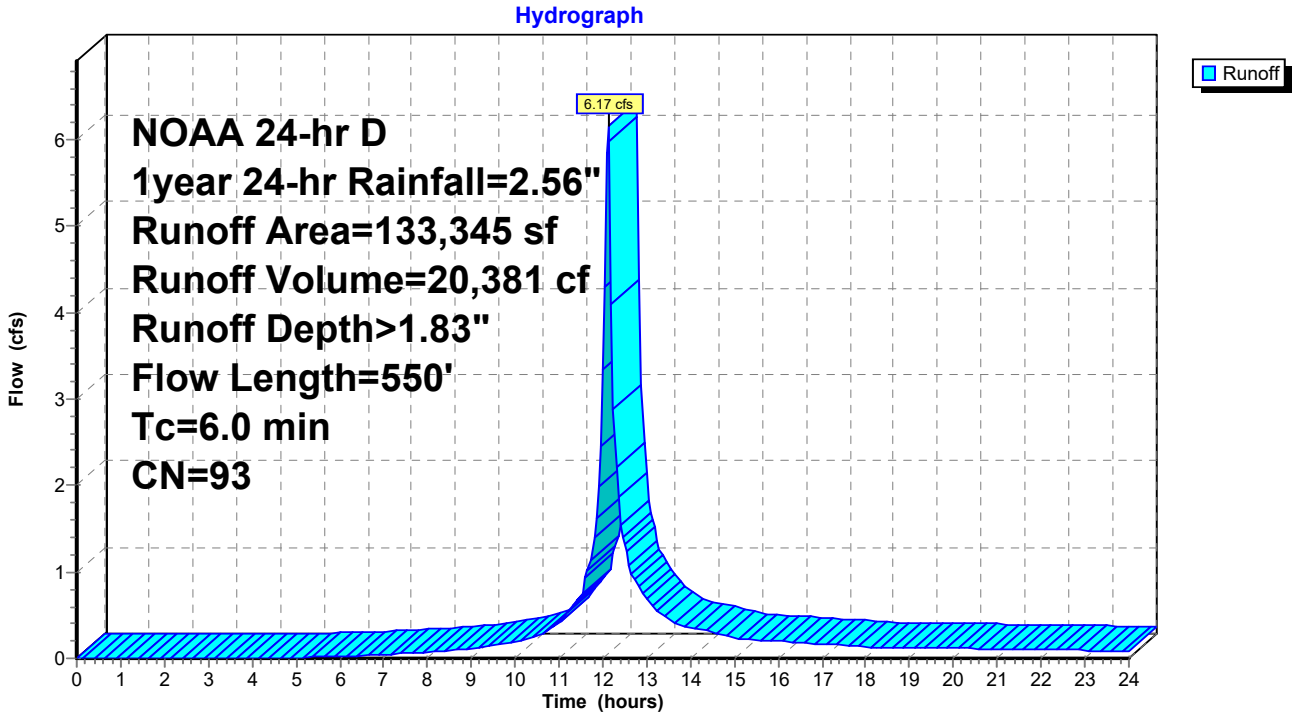
Runoff = 6.17 cfs @ 12.13 hrs, Volume= 20,381 cf, Depth> 1.83"
Routed to Pond Det #1 : SS#1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 1year 24-hr Rainfall=2.56"

Area (sf)	CN	Description
36,318	80	>75% Grass cover, Good, HSG D
66,336	98	Paved parking, HSG D
30,691	98	Roofs, HSG D
133,345	93	Weighted Average
36,318		27.24% Pervious Area
97,027		72.76% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	50	0.0300	1.40		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.17"
1.3	500	0.0100	6.55	5.15	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.009
4.1					**Direct Entry, Minimum Tc of 6 Min**
6.0	550	Total			

Subcatchment PR-2A: SS#1



Summary for Subcatchment PR-2B: SS#2

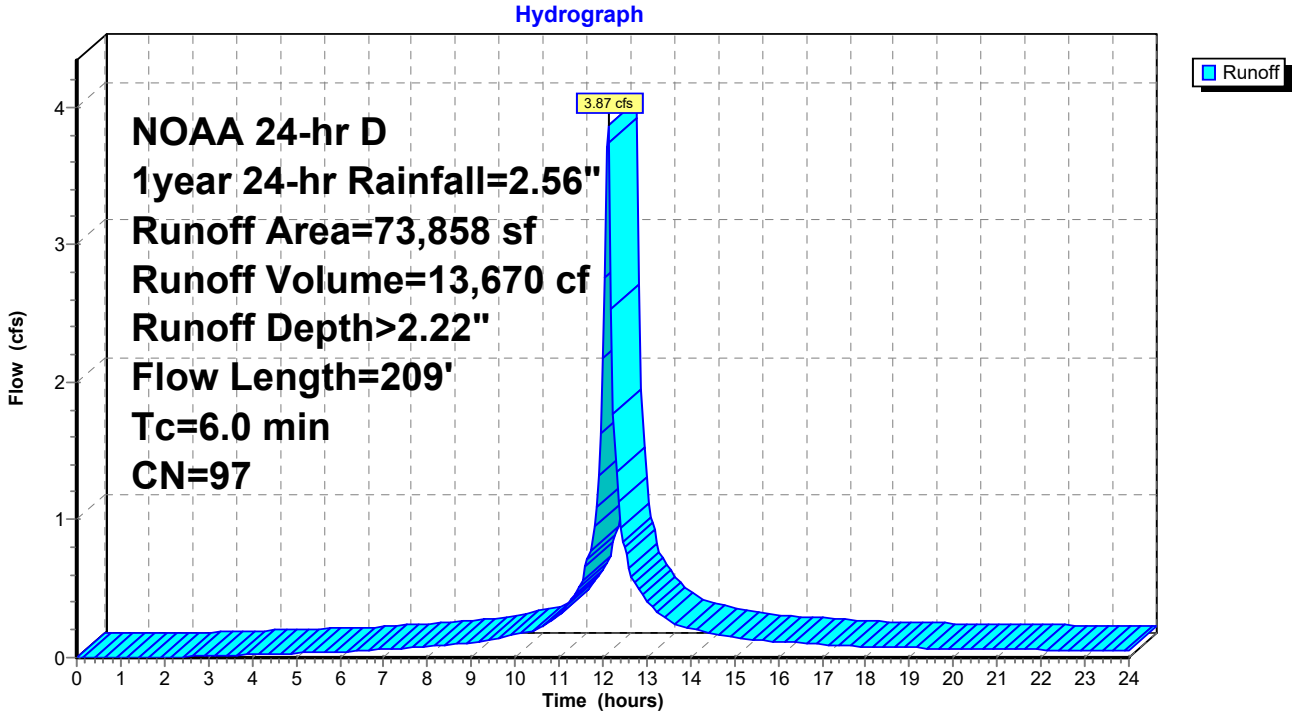
Runoff = 3.87 cfs @ 12.13 hrs, Volume= 13,670 cf, Depth> 2.22"
Routed to Pond Det #2 : SS#2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 1year 24-hr Rainfall=2.56"

Area (sf)	CN	Description
5,507	80	>75% Grass cover, Good, HSG D
44,720	98	Paved parking, HSG D
23,631	98	Roofs, HSG D
73,858	97	Weighted Average
5,507		7.46% Pervious Area
68,351		92.54% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	50	0.0200	1.19		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.17"
0.4	159	0.0100	6.55	5.15	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.009
4.9					**Direct Entry, Minimum Tc of 6 Min**
6.0	209	Total			

Subcatchment PR-2B: SS#2



Summary for Subcatchment PR-2C: PR DP-1 (18" North Drain)

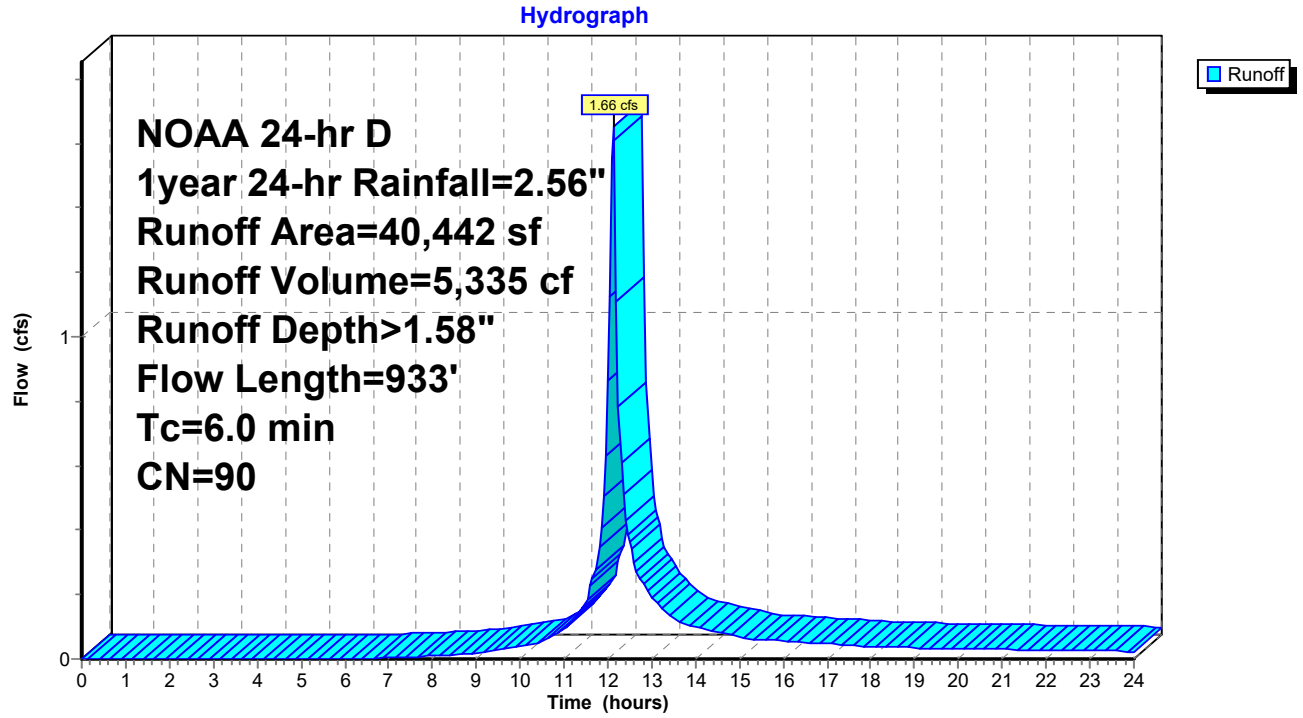
Runoff = 1.66 cfs @ 12.13 hrs, Volume= 5,335 cf, Depth> 1.58"
Routed to Reach DP-2 : 18" NORTH DRAIN

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 1year 24-hr Rainfall=2.56"

Area (sf)	CN	Description
18,246	80	>75% Grass cover, Good, HSG D
22,196	98	Paved parking, HSG D
40,442	90	Weighted Average
18,246		45.12% Pervious Area
22,196		54.88% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.90		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.17"
0.6	108	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.9	775	0.0100	6.84	8.40	**Pipe Channel,** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.010 PVC, smooth interior
2.6					**Direct Entry, Minimum Tc of 6 Min**
6.0	933	Total			

Subcatchment PR-2C: PR DP-1 (18" North Drain)



Summary for Subcatchment PR-3: PR DP-3

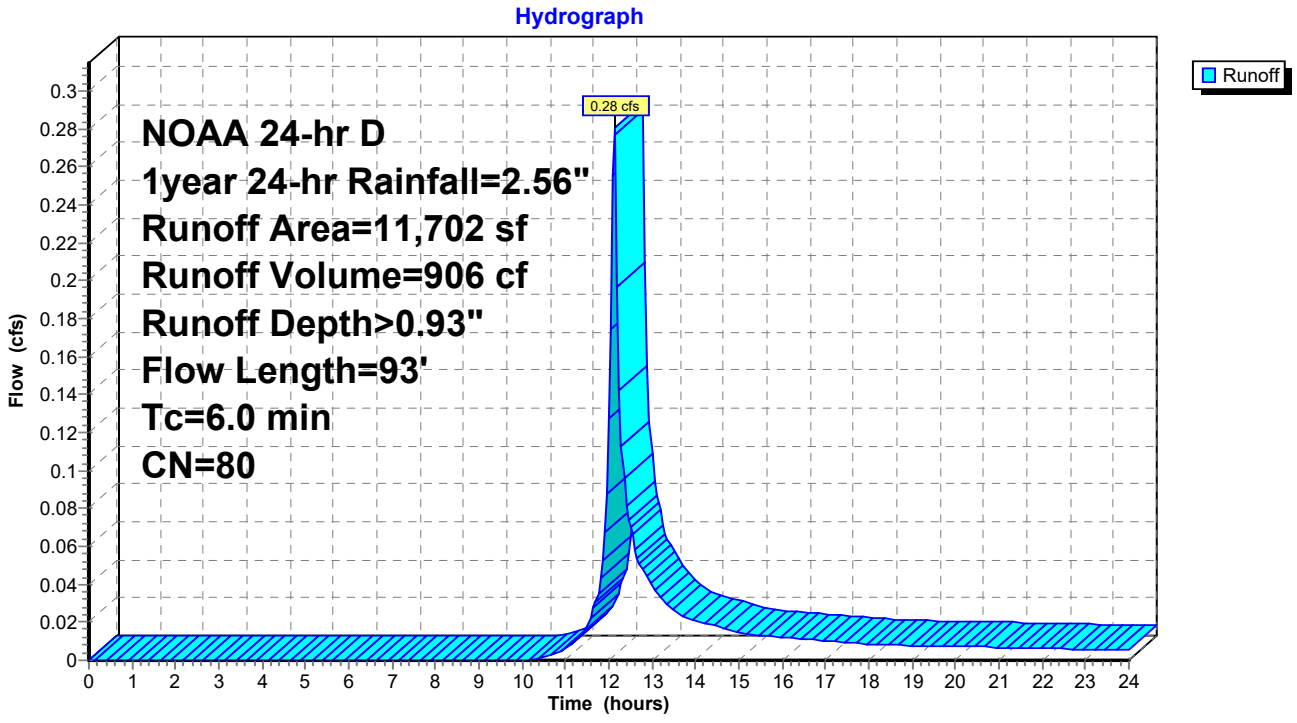
Runoff = 0.28 cfs @ 12.14 hrs, Volume= 906 cf, Depth> 0.93"
Routed to Reach DP-3 : 6" DRAIN

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 1year 24-hr Rainfall=2.56"

Area (sf)	CN	Description
11,422	80	>75% Grass cover, Good, HSG D
280	98	Paved parking, HSG D
11,702	80	Weighted Average
11,422		97.61% Pervious Area
280		2.39% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.7	50	0.0200	0.15		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.17"
0.3	43	0.1000	2.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
6.0	93	Total			

Subcatchment PR-3: PR DP-3



Summary for Subcatchment PR-4: PR-4 ROOF

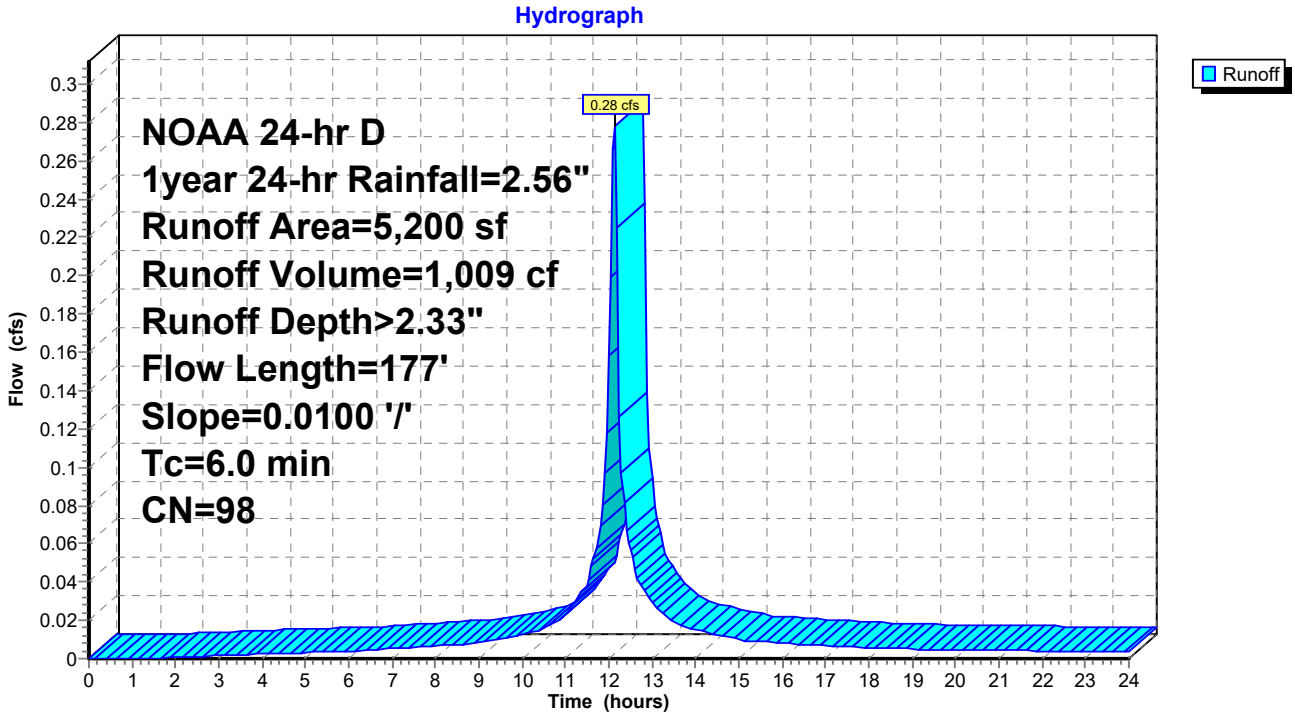
Runoff = 0.28 cfs @ 12.13 hrs, Volume= 1,009 cf, Depth> 2.33"
Routed to Reach DP-4 : SOUTH BVW

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 1year 24-hr Rainfall=2.56"

Area (sf)	CN	Description
5,200	98	Roofs, HSG D
5,200		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.90		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.17"
0.3	127	0.0100	6.55	5.15	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.009
4.8					**Direct Entry, Minimum Tc of 6 Min**
6.0	177	Total			

Subcatchment PR-4: PR-4 ROOF



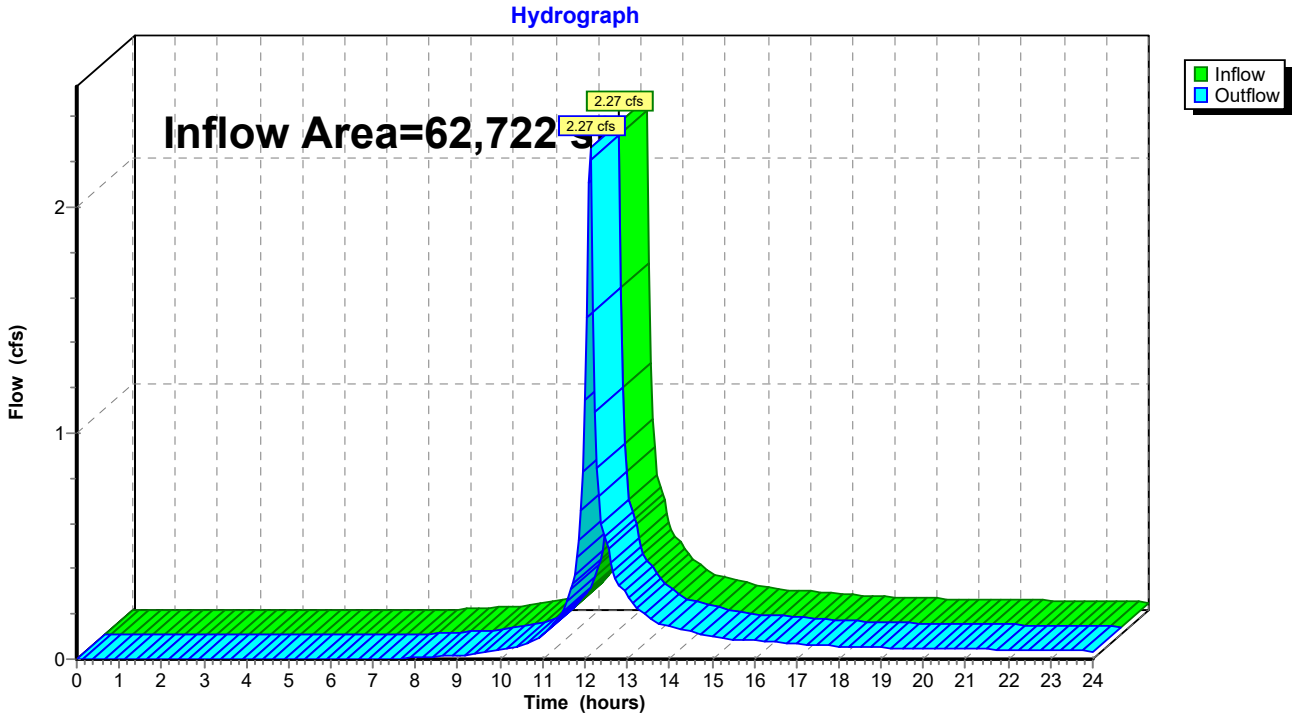
Summary for Reach DP-1: NW BVW

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 62,722 sf, 47.32% Impervious, Inflow Depth > 1.39" for 1year 24-hr event
Inflow = 2.27 cfs @ 12.13 hrs, Volume= 7,242 cf
Outflow = 2.27 cfs @ 12.13 hrs, Volume= 7,242 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-1: NW BVW



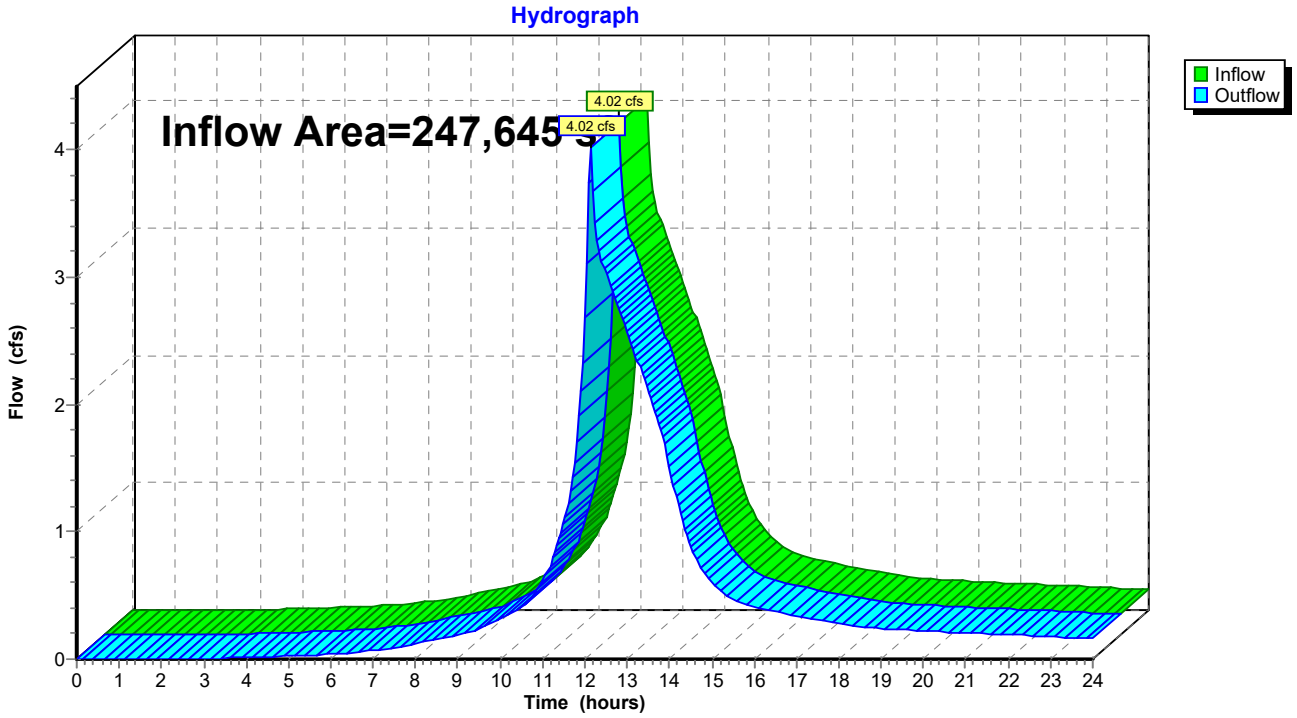
Summary for Reach DP-2: 18" NORTH DRAIN

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 247,645 sf, 75.74% Impervious, Inflow Depth > 1.88" for 1year 24-hr event
Inflow = 4.02 cfs @ 12.15 hrs, Volume= 38,881 cf
Outflow = 4.02 cfs @ 12.15 hrs, Volume= 38,881 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 3

Reach DP-2: 18" NORTH DRAIN



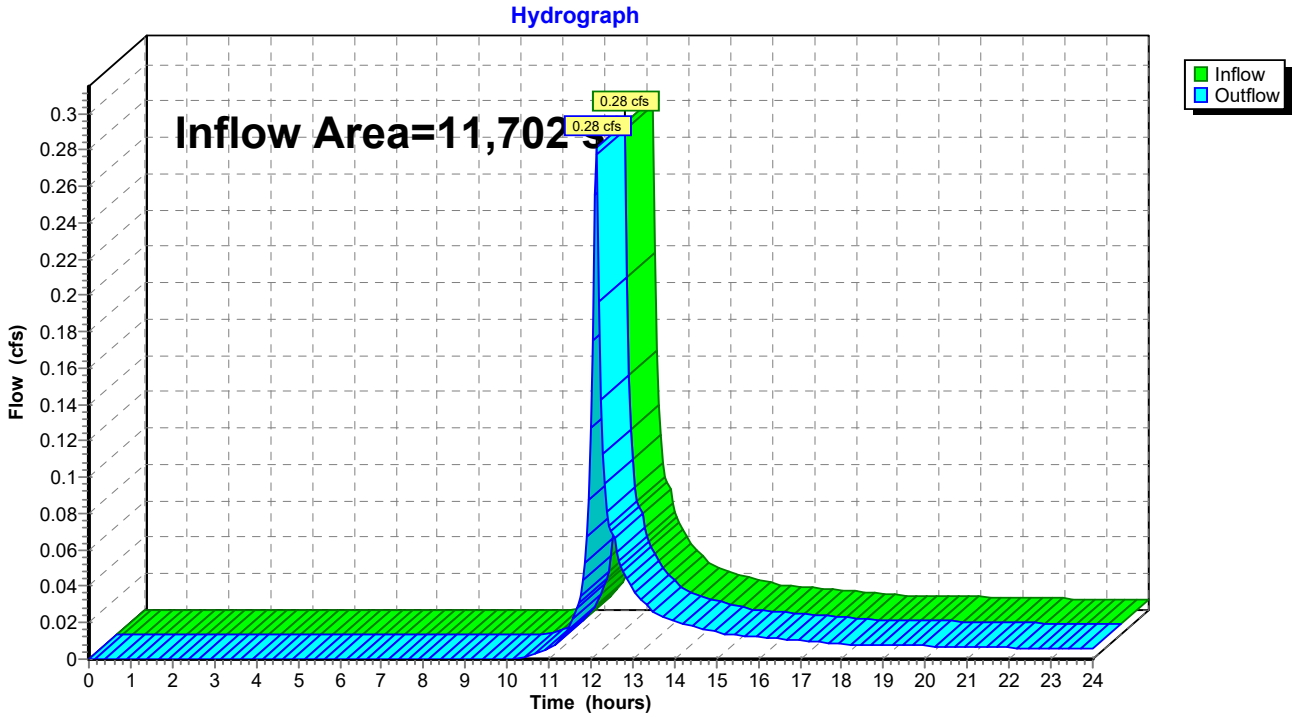
Summary for Reach DP-3: 6" DRAIN

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 11,702 sf, 2.39% Impervious, Inflow Depth > 0.93" for 1year 24-hr event
Inflow = 0.28 cfs @ 12.14 hrs, Volume= 906 cf
Outflow = 0.28 cfs @ 12.14 hrs, Volume= 906 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-3: 6" DRAIN



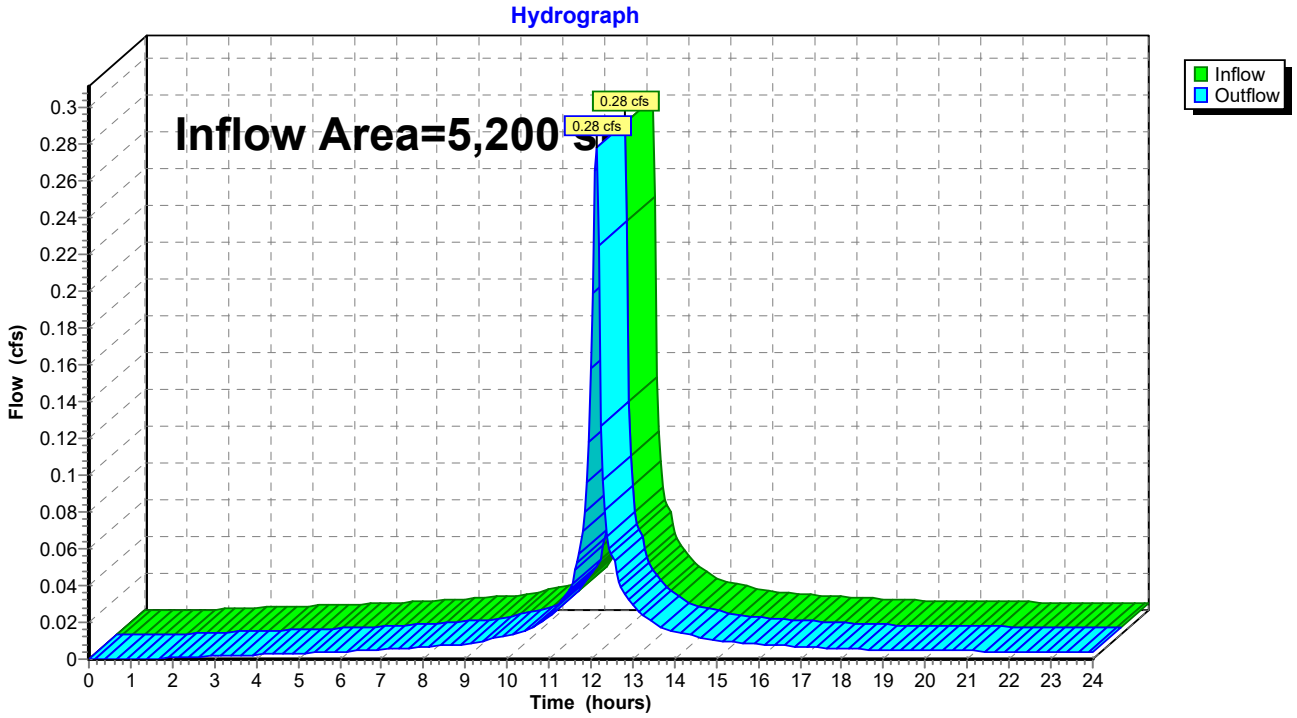
Summary for Reach DP-4: SOUTH BVW

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 5,200 sf,100.00% Impervious, Inflow Depth > 2.33" for 1year 24-hr event
Inflow = 0.28 cfs @ 12.13 hrs, Volume= 1,009 cf
Outflow = 0.28 cfs @ 12.13 hrs, Volume= 1,009 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-4: SOUTH BVW



Summary for Pond Det #1: SS#1

Inflow Area = 133,345 sf, 72.76% Impervious, Inflow Depth > 1.83" for 1year 24-hr event
Inflow = 6.17 cfs @ 12.13 hrs, Volume= 20,381 cf
Outflow = 1.73 cfs @ 12.37 hrs, Volume= 20,058 cf, Atten= 72%, Lag= 14.5 min
Primary = 1.73 cfs @ 12.37 hrs, Volume= 20,058 cf
Routed to Reach DP-2 : 18" NORTH DRAIN

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 55.20' @ 12.37 hrs Surf.Area= 9,069 sf Storage= 5,359 cf

Plug-Flow detention time= 43.7 min calculated for 20,016 cf (98% of inflow)
Center-of-Mass det. time= 34.1 min (840.7 - 806.7)

Volume	Invert	Avail.Storage	Storage Description
#1A	54.20'	7,009 cf	**72.75'W x 124.66'L x 3.50'H Field A** 31,741 cf Overall - 11,715 cf Embedded = 20,026 cf x 35.0% Voids
#2A	54.70'	11,715 cf	**ADS_StormTech SC-740 +Cap** x 255 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 255 Chambers in 15 Rows
		18,724 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Device 4	54.20'	**10.0" W x 6.0" H Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Device 4	55.30'	**12.0" W x 8.0" H Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 4	57.20'	**5.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#4	Primary	46.80'	**18.0" Round Culvert** L= 96.5' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 46.80' / 45.98' S= 0.0085 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 1.77 sf

Primary OutFlow Max=1.73 cfs @ 12.37 hrs HW=55.20' (Free Discharge)
└**4=Culvert** (Passes 1.73 cfs of 22.74 cfs potential flow)
  ├**1=Orifice/Grate** (Orifice Controls 1.73 cfs @ 4.16 fps)
  ├**2=Orifice/Grate** (Controls 0.00 cfs)
  └**3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond Det #1: SS#1 - Chamber Wizard Field A

Chamber Model = ADS_StormTechSC-740 +Cap (ADS StormTech®SC-740 with cap length)
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

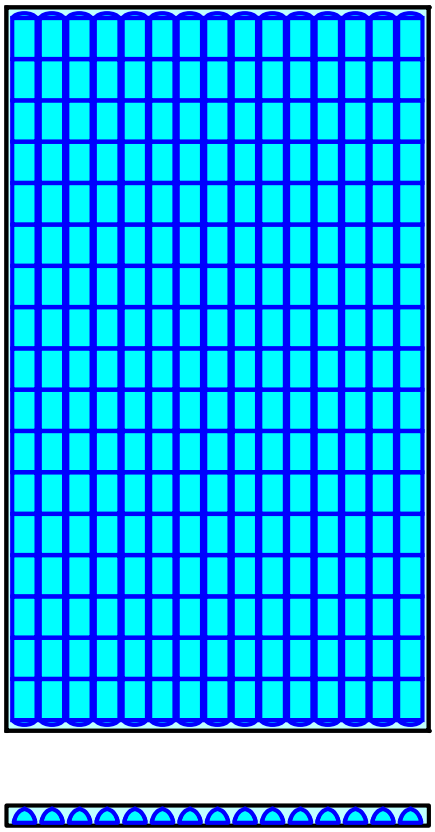
17 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 122.66' Row Length +12.0" End Stone x 2 = 124.66' Base Length
15 Rows x 51.0" Wide + 6.0" Spacing x 14 + 12.0" Side Stone x 2 = 72.75' Base Width
6.0" Stone Base + 30.0" Chamber Height + 6.0" Stone Cover = 3.50' Field Height

255 Chambers x 45.9 cf = 11,714.7 cf Chamber Storage

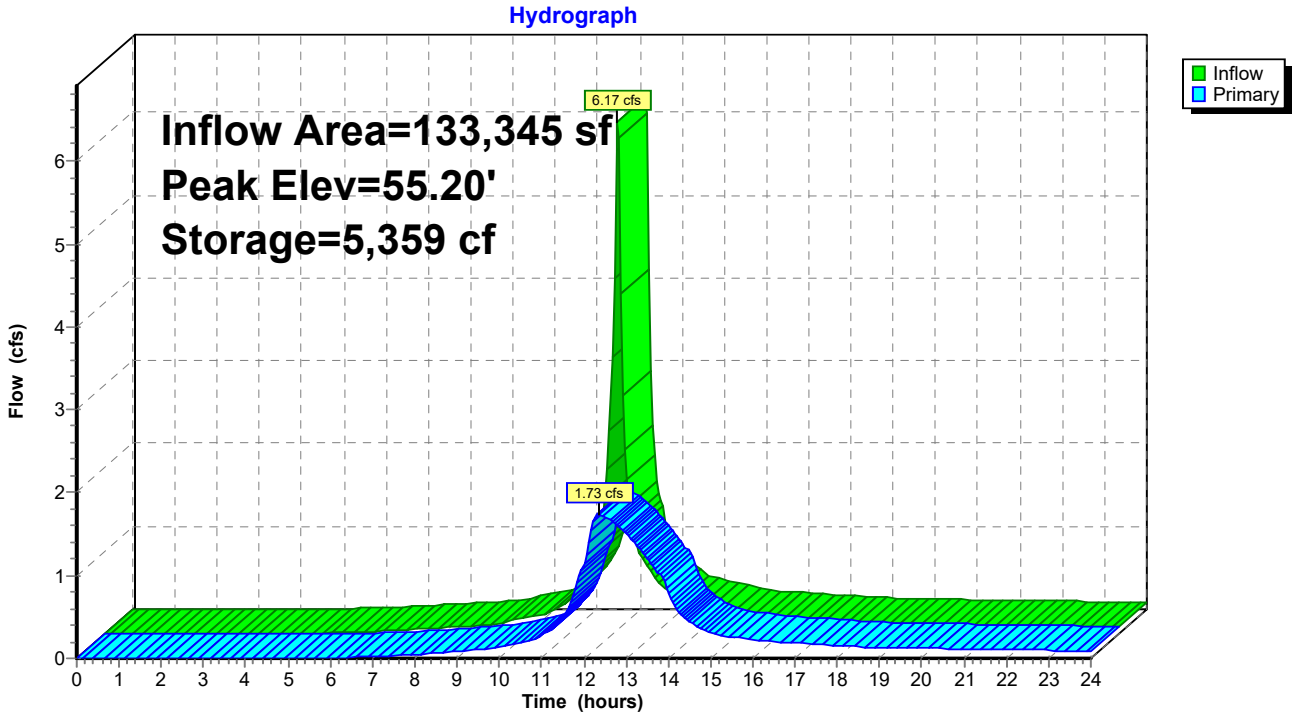
31,740.7 cf Field - 11,714.7 cf Chambers = 20,026.0 cf Stone x 35.0% Voids = 7,009.1 cf Stone Storage

Chamber Storage + Stone Storage = 18,723.8 cf = 0.430 af
Overall Storage Efficiency = 59.0%
Overall System Size = 124.66' x 72.75' x 3.50'

255 Chambers
1,175.6 cy Field
741.7 cy Stone



Pond Det #1: SS#1



Summary for Pond Det #2: SS#2

Inflow Area = 73,858 sf, 92.54% Impervious, Inflow Depth > 2.22" for 1year 24-hr event
Inflow = 3.87 cfs @ 12.13 hrs, Volume= 13,670 cf
Outflow = 0.96 cfs @ 12.40 hrs, Volume= 13,488 cf, Atten= 75%, Lag= 16.4 min
Primary = 0.96 cfs @ 12.40 hrs, Volume= 13,488 cf
Routed to Reach DP-2 : 18" NORTH DRAIN

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 52.48' @ 12.40 hrs Surf.Area= 6,337 sf Storage= 3,622 cf

Plug-Flow detention time= 46.3 min calculated for 13,460 cf (98% of inflow)
Center-of-Mass det. time= 37.8 min (812.6 - 774.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	51.50'	4,909 cf	**53.75'W x 117.54'L x 3.50'H Field A** 22,112 cf Overall - 8,085 cf Embedded = 14,026 cf x 35.0% Voids
#2A	52.00'	8,085 cf	**ADS_StormTech SC-740 +Cap** x 176 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 176 Chambers in 11 Rows
#3	51.50'	157 cf	**5.00'D x 8.00'H Vertical Cone/Cylinder**
		13,152 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Device 4	51.50'	**8.0" W x 4.0" H Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Device 4	52.50'	**8.0" W x 7.0" H Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 4	54.40'	**5.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#4	Primary	48.30'	**18.0" Round Culvert** L= 96.5' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 48.30' / 47.48' S= 0.0085 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 1.77 sf

Primary OutFlow Max=0.96 cfs @ 12.40 hrs HW=52.48' (Free Discharge)
└**4=Culvert** (Passes 0.96 cfs of 15.31 cfs potential flow)
  ├**1=Orifice/Grate** (Orifice Controls 0.96 cfs @ 4.34 fps)
  ├**2=Orifice/Grate** (Controls 0.00 cfs)
  └**3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond Det #2: SS#2 - Chamber Wizard Field A

Chamber Model = ADS_StormTechSC-740 +Cap (ADS StormTech®SC-740 with cap length)
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

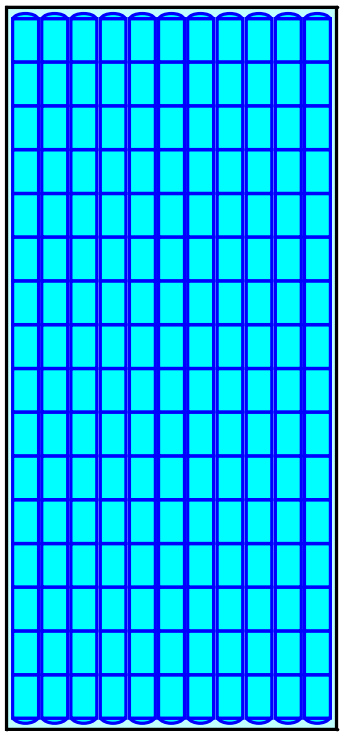
16 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 115.54' Row Length +12.0" End Stone x 2 = 117.54' Base Length
11 Rows x 51.0" Wide + 6.0" Spacing x 10 + 12.0" Side Stone x 2 = 53.75' Base Width
6.0" Stone Base + 30.0" Chamber Height + 6.0" Stone Cover = 3.50' Field Height

176 Chambers x 45.9 cf = 8,085.4 cf Chamber Storage

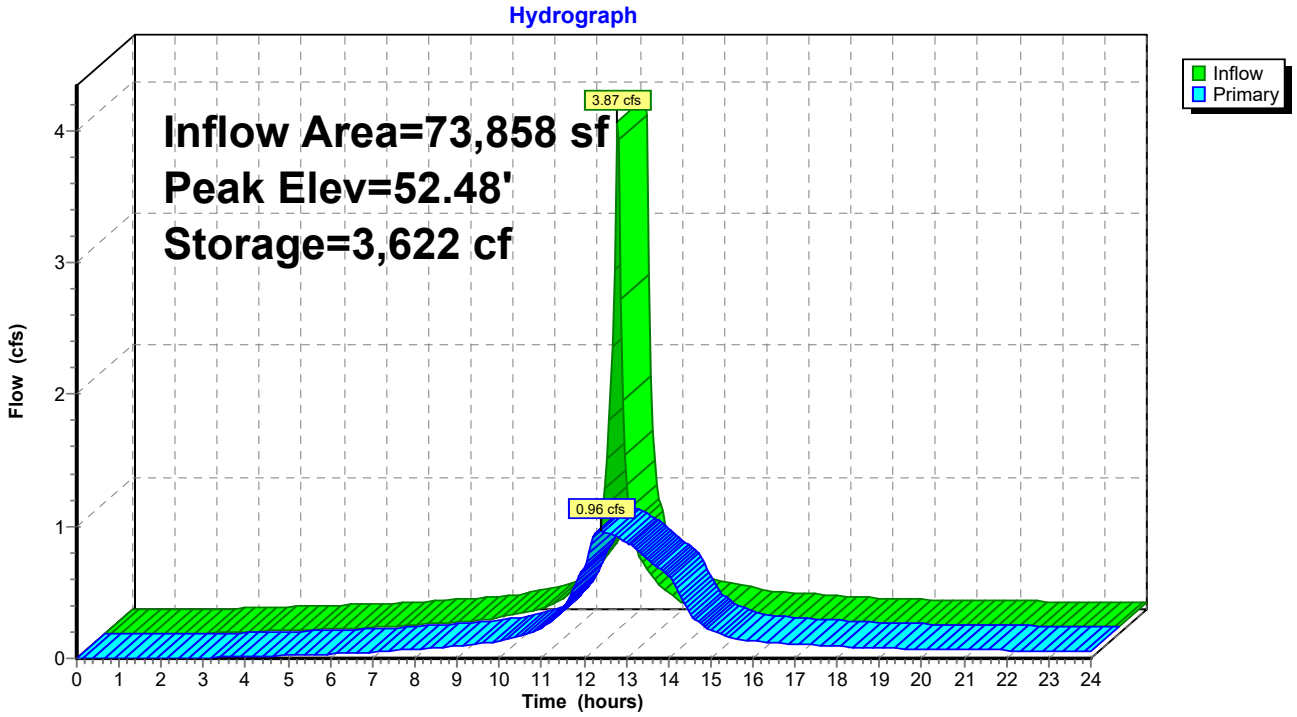
22,111.6 cf Field - 8,085.4 cf Chambers = 14,026.1 cf Stone x 35.0% Voids = 4,909.1 cf Stone Storage

Chamber Storage + Stone Storage = 12,994.6 cf = 0.298 af
Overall Storage Efficiency = 58.8%
Overall System Size = 117.54' x 53.75' x 3.50'

176 Chambers
818.9 cy Field
519.5 cy Stone



Pond Det #2: SS#2



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment PR-1: UU-NW GRASS AREA Runoff Area=5,726 sf 0.00% Impervious Runoff Depth>1.38"
Flow Length=66' Tc=6.0 min CN=80 Runoff=0.21 cfs 657 cf

Subcatchment PR-1B: UU-PROPOSED Runoff Area=56,996 sf 52.08% Impervious Runoff Depth>1.97"
Flow Length=288' Tc=6.0 min CN=88 Runoff=2.90 cfs 9,347 cf

Subcatchment PR-2A: SS#1 Runoff Area=133,345 sf 72.76% Impervious Runoff Depth>2.41"
Flow Length=550' Tc=6.0 min CN=93 Runoff=8.00 cfs 26,832 cf

Subcatchment PR-2B: SS#2 Runoff Area=73,858 sf 92.54% Impervious Runoff Depth>2.82"
Flow Length=209' Tc=6.0 min CN=97 Runoff=4.86 cfs 17,384 cf

Subcatchment PR-2C: PR DP-1 (18" North Runoff Area=40,442 sf 54.88% Impervious Runoff Depth>2.14"
Flow Length=933' Tc=6.0 min CN=90 Runoff=2.21 cfs 7,208 cf

Subcatchment PR-3: PR DP-3 Runoff Area=11,702 sf 2.39% Impervious Runoff Depth>1.38"
Flow Length=93' Tc=6.0 min CN=80 Runoff=0.42 cfs 1,343 cf

Subcatchment PR-4: PR-4 ROOF Runoff Area=5,200 sf 100.00% Impervious Runoff Depth>2.94"
Flow Length=177' Slope=0.0100 '/' Tc=6.0 min CN=98 Runoff=0.35 cfs 1,272 cf

Reach DP-1: NW BVW Inflow=3.11 cfs 10,004 cf
Outflow=3.11 cfs 10,004 cf

Reach DP-2: 18" NORTH DRAIN Inflow=4.90 cfs 50,843 cf
Outflow=4.90 cfs 50,843 cf

Reach DP-3: 6" DRAIN Inflow=0.42 cfs 1,343 cf
Outflow=0.42 cfs 1,343 cf

Reach DP-4: SOUTH BVW Inflow=0.35 cfs 1,272 cf
Outflow=0.35 cfs 1,272 cf

Pond Det #1: SS#1 Peak Elev=55.46' Storage=7,220 cf Inflow=8.00 cfs 26,832 cf
Outflow=2.22 cfs 26,457 cf

Pond Det #2: SS#2 Peak Elev=52.69' Storage=4,673 cf Inflow=4.86 cfs 17,384 cf
Outflow=1.26 cfs 17,178 cf

Total Runoff Area = 327,269 sf Runoff Volume = 64,043 cf Average Runoff Depth = 2.35"
31.94% Pervious = 104,532 sf 68.06% Impervious = 222,737 sf

Summary for Subcatchment PR-1: UU-NW GRASS AREA

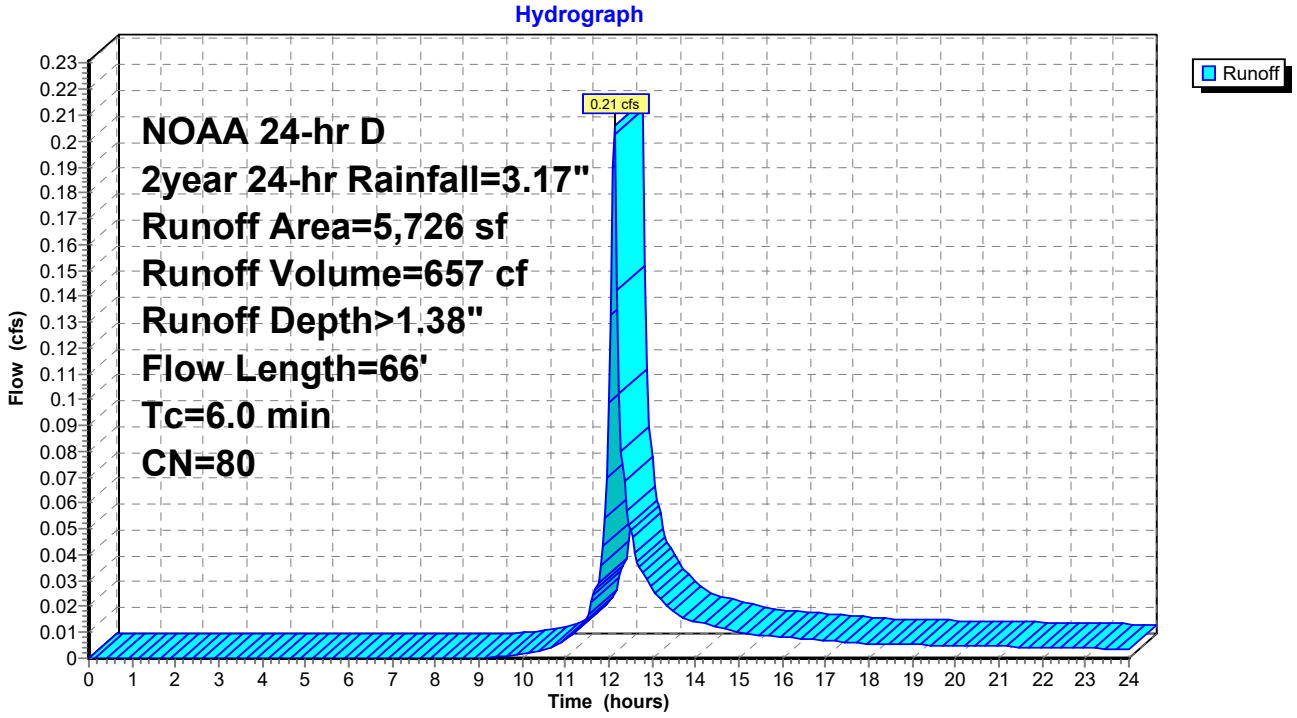
Runoff = 0.21 cfs @ 12.13 hrs, Volume= 657 cf, Depth> 1.38"
Routed to Reach DP-1 : NW BVW

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 2year 24-hr Rainfall=3.17"

Area (sf)	CN	Description
5,726	80	>75% Grass cover, Good, HSG D
5,726		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	50	0.0600	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.17"
0.3	16	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
2.1					**Direct Entry, Minimum Tc of 6 Min**
6.0	66	Total			

Subcatchment PR-1: UU-NW GRASS AREA



Summary for Subcatchment PR-1B: UU-PROPOSED

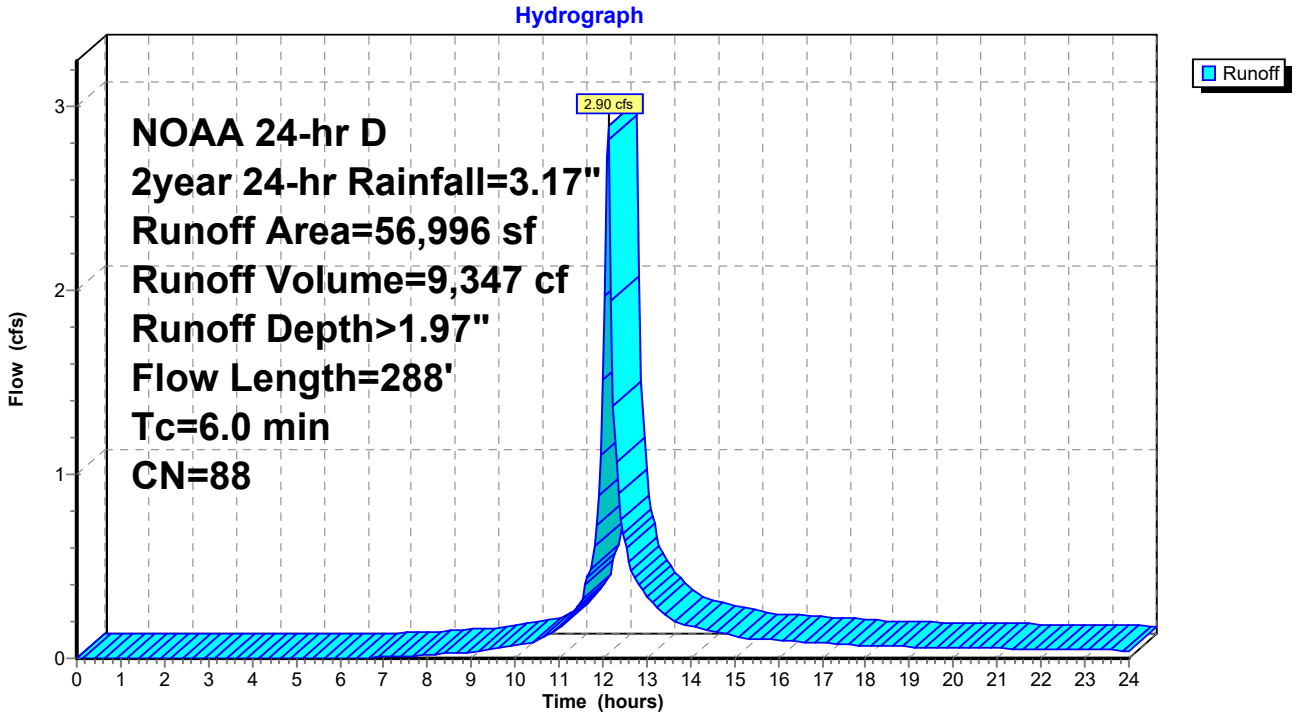
Runoff = 2.90 cfs @ 12.13 hrs, Volume= 9,347 cf, Depth> 1.97"
Routed to Reach DP-1 : NW BVW

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 2year 24-hr Rainfall=3.17"

Area (sf)	CN	Description
7,313	80	>75% Grass cover, Good, HSG D
20,000	77	Woods, Good, HSG D
29,683	98	Paved parking, HSG D
56,996	88	Weighted Average
27,313		47.92% Pervious Area
29,683		52.08% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.90		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.17"
4.3	122	0.0010	0.47		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
0.3	116	0.0100	6.22	7.63	**Pipe Channel, RCP_Round 15"** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.011 Concrete pipe, straight & clean
0.5					**Direct Entry, Minimum Tc of 6 Min**
6.0	288	Total			

Subcatchment PR-1B: UU-PROPOSED



Summary for Subcatchment PR-2A: SS#1

[47] Hint: Peak is 155% of capacity of segment #2

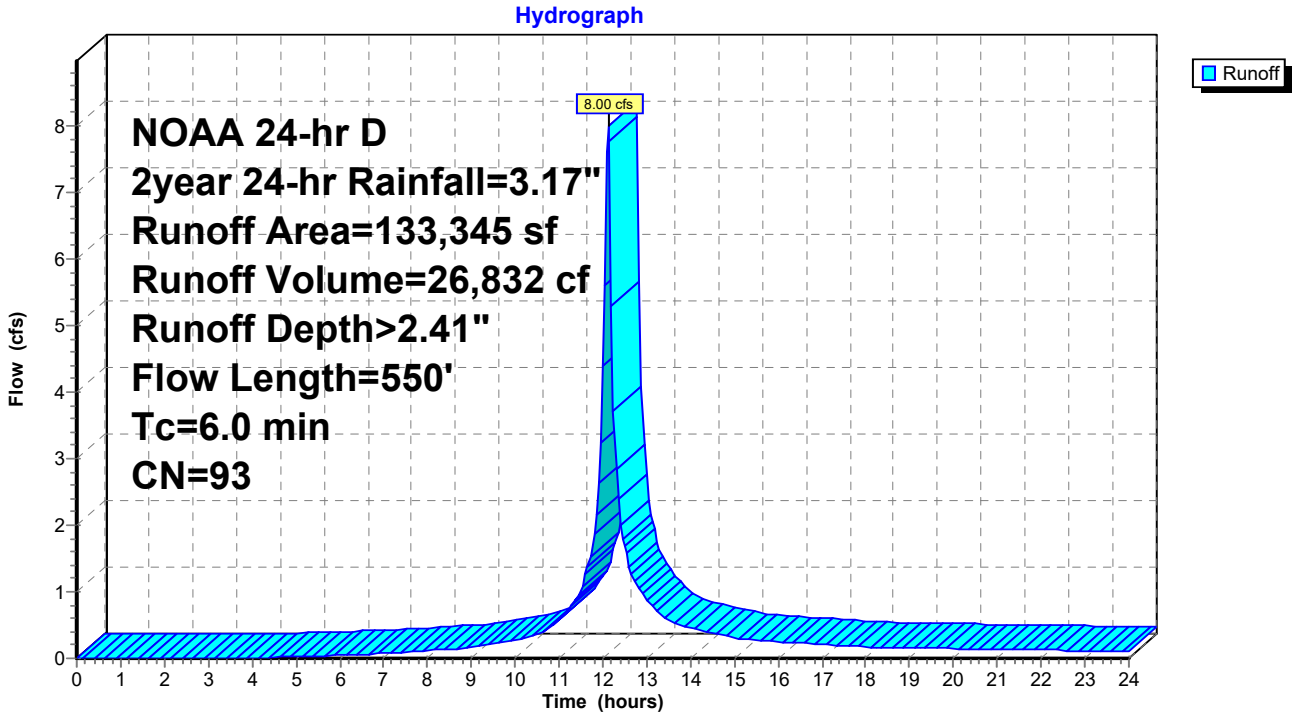
Runoff = 8.00 cfs @ 12.13 hrs, Volume= 26,832 cf, Depth> 2.41"
Routed to Pond Det #1 : SS#1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 2year 24-hr Rainfall=3.17"

Area (sf)	CN	Description
36,318	80	>75% Grass cover, Good, HSG D
66,336	98	Paved parking, HSG D
30,691	98	Roofs, HSG D
133,345	93	Weighted Average
36,318		27.24% Pervious Area
97,027		72.76% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	50	0.0300	1.40		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.17"
1.3	500	0.0100	6.55	5.15	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.009
4.1					**Direct Entry, Minimum Tc of 6 Min**
6.0	550	Total			

Subcatchment PR-2A: SS#1



Summary for Subcatchment PR-2B: SS#2

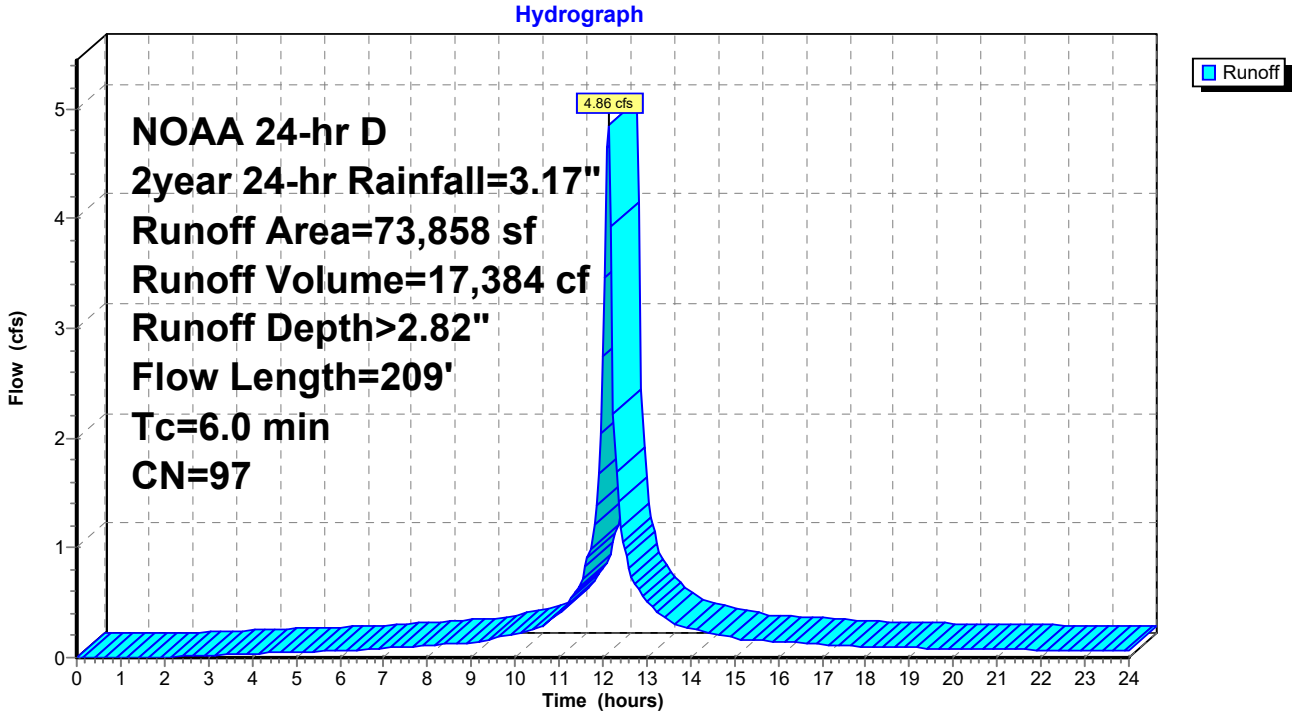
Runoff = 4.86 cfs @ 12.13 hrs, Volume= 17,384 cf, Depth> 2.82"
Routed to Pond Det #2 : SS#2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 2year 24-hr Rainfall=3.17"

Area (sf)	CN	Description
5,507	80	>75% Grass cover, Good, HSG D
44,720	98	Paved parking, HSG D
23,631	98	Roofs, HSG D
73,858	97	Weighted Average
5,507		7.46% Pervious Area
68,351		92.54% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	50	0.0200	1.19		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.17"
0.4	159	0.0100	6.55	5.15	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.009
4.9					**Direct Entry, Minimum Tc of 6 Min**
6.0	209	Total			

Subcatchment PR-2B: SS#2



Summary for Subcatchment PR-2C: PR DP-1 (18" North Drain)

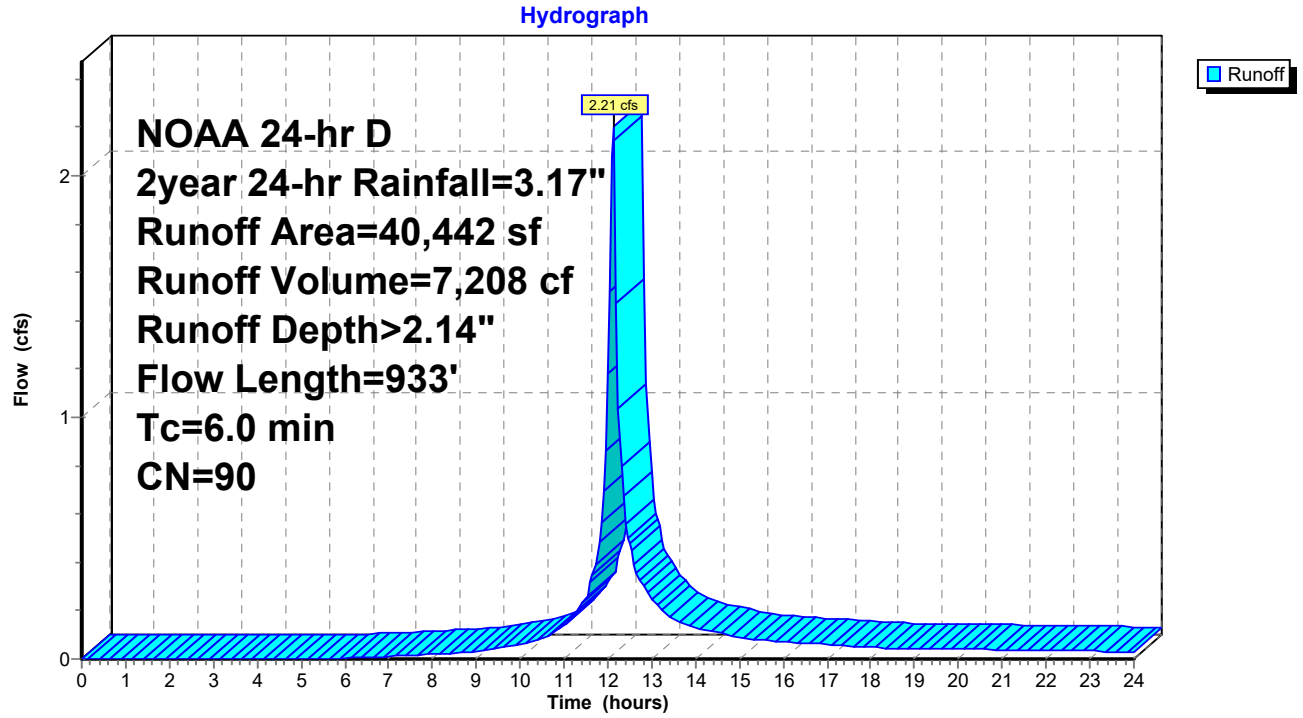
Runoff = 2.21 cfs @ 12.13 hrs, Volume= 7,208 cf, Depth> 2.14"
Routed to Reach DP-2 : 18" NORTH DRAIN

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 2year 24-hr Rainfall=3.17"

Area (sf)	CN	Description
18,246	80	>75% Grass cover, Good, HSG D
22,196	98	Paved parking, HSG D
40,442	90	Weighted Average
18,246		45.12% Pervious Area
22,196		54.88% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.90		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.17"
0.6	108	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.9	775	0.0100	6.84	8.40	**Pipe Channel,** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.010 PVC, smooth interior
2.6					**Direct Entry, Minimum Tc of 6 Min**
6.0	933	Total			

Subcatchment PR-2C: PR DP-1 (18" North Drain)



Summary for Subcatchment PR-3: PR DP-3

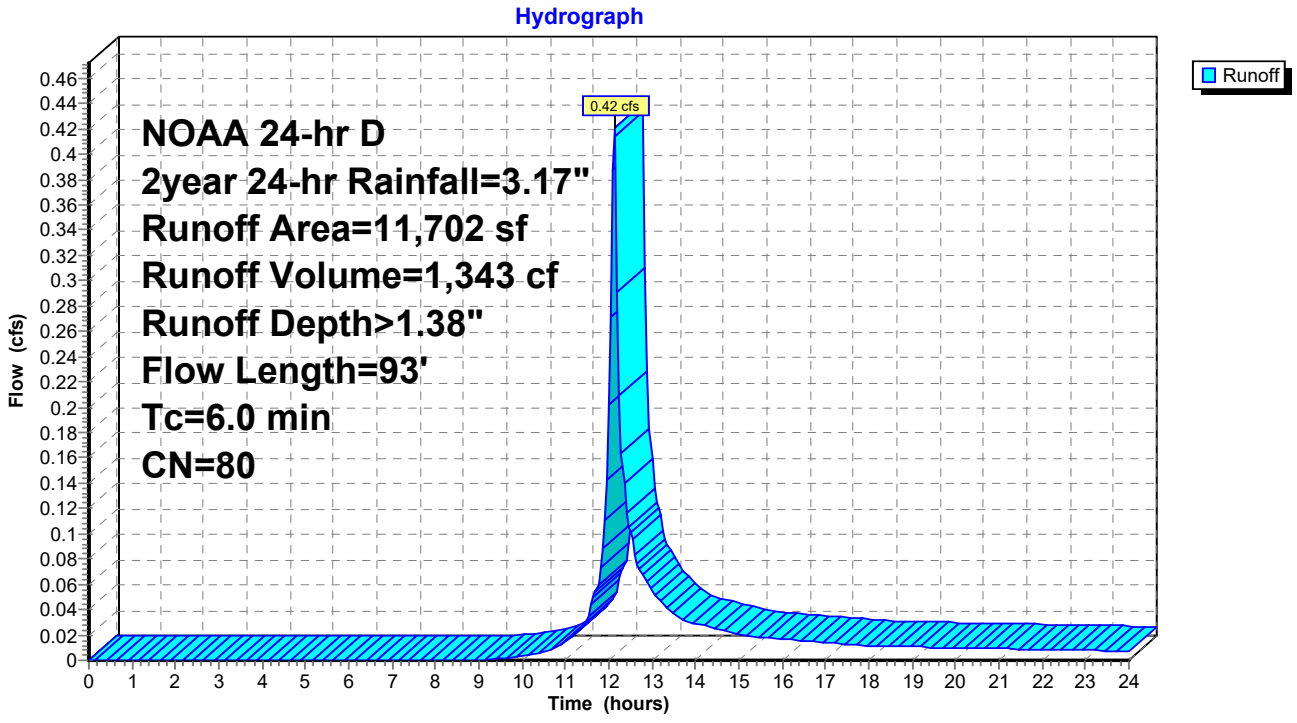
Runoff = 0.42 cfs @ 12.13 hrs, Volume= 1,343 cf, Depth> 1.38"
Routed to Reach DP-3 : 6" DRAIN

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 2year 24-hr Rainfall=3.17"

Area (sf)	CN	Description
11,422	80	>75% Grass cover, Good, HSG D
280	98	Paved parking, HSG D
11,702	80	Weighted Average
11,422		97.61% Pervious Area
280		2.39% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.7	50	0.0200	0.15		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.17"
0.3	43	0.1000	2.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
6.0	93	Total			

Subcatchment PR-3: PR DP-3



Summary for Subcatchment PR-4: PR-4 ROOF

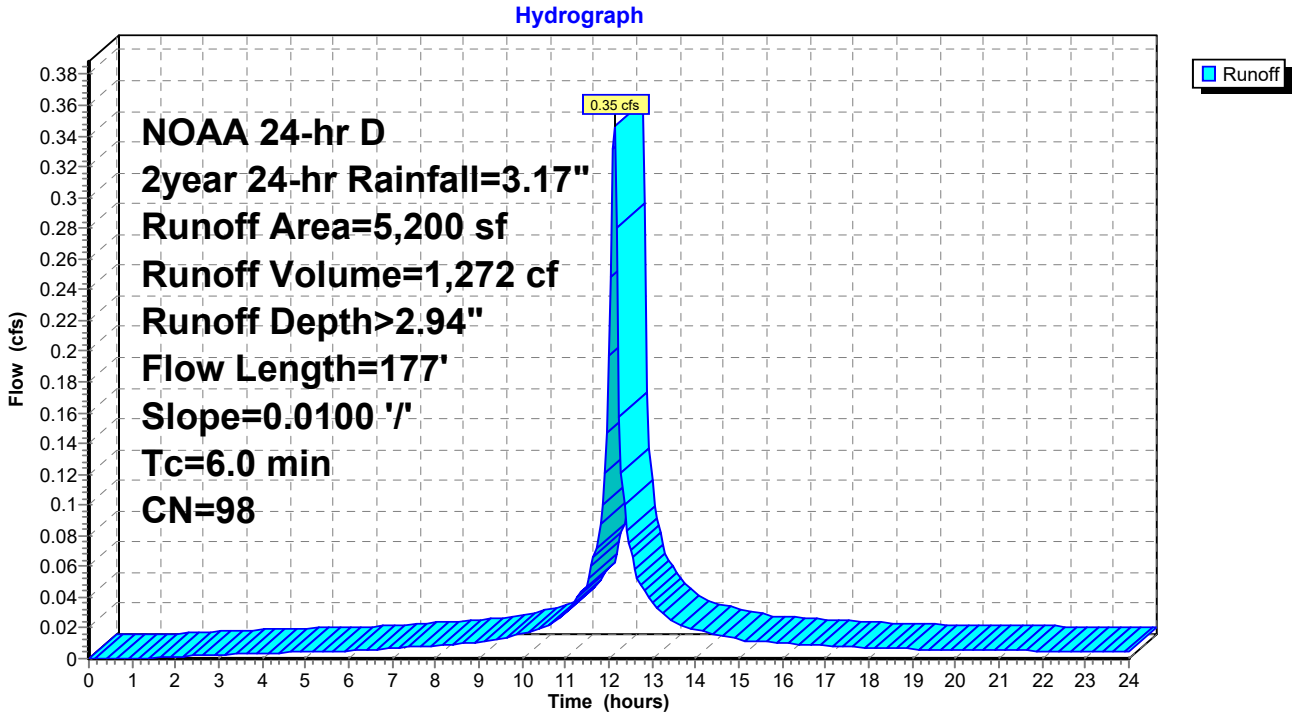
Runoff = 0.35 cfs @ 12.13 hrs, Volume= 1,272 cf, Depth> 2.94"
Routed to Reach DP-4 : SOUTH BVW

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 2year 24-hr Rainfall=3.17"

Area (sf)	CN	Description
5,200	98	Roofs, HSG D
5,200		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.90		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.17"
0.3	127	0.0100	6.55	5.15	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.009
4.8					**Direct Entry, Minimum Tc of 6 Min**
6.0	177	Total			

Subcatchment PR-4: PR-4 ROOF



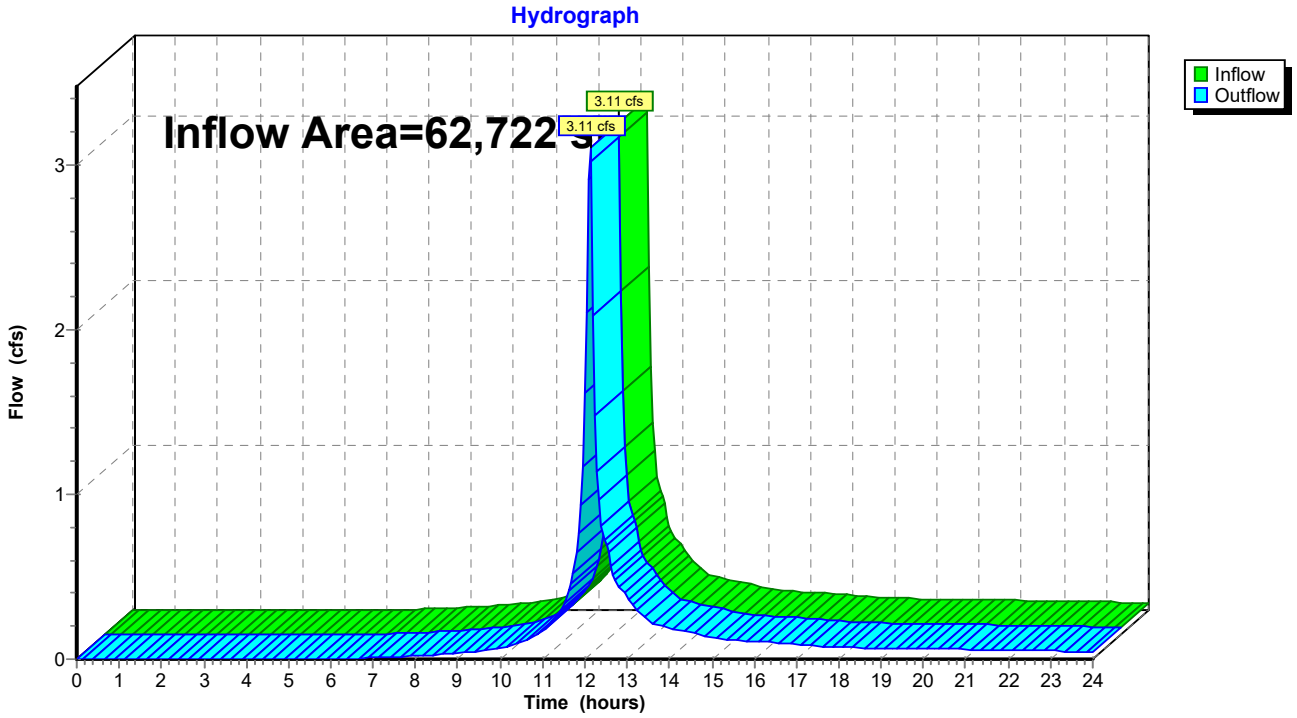
Summary for Reach DP-1: NW BVW

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 62,722 sf, 47.32% Impervious, Inflow Depth > 1.91" for 2year 24-hr event
Inflow = 3.11 cfs @ 12.13 hrs, Volume= 10,004 cf
Outflow = 3.11 cfs @ 12.13 hrs, Volume= 10,004 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-1: NW BVW



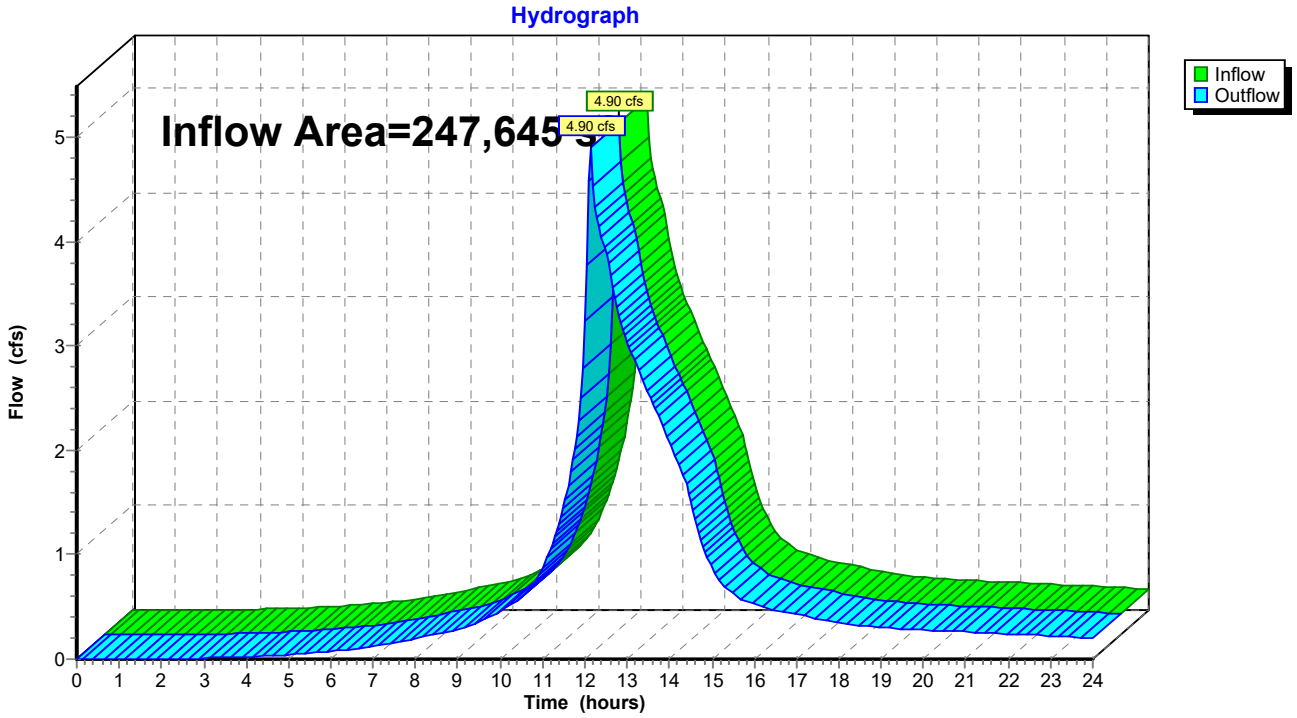
Summary for Reach DP-2: 18" NORTH DRAIN

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 247,645 sf, 75.74% Impervious, Inflow Depth > 2.46" for 2year 24-hr event
Inflow = 4.90 cfs @ 12.15 hrs, Volume= 50,843 cf
Outflow = 4.90 cfs @ 12.15 hrs, Volume= 50,843 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 3

Reach DP-2: 18" NORTH DRAIN



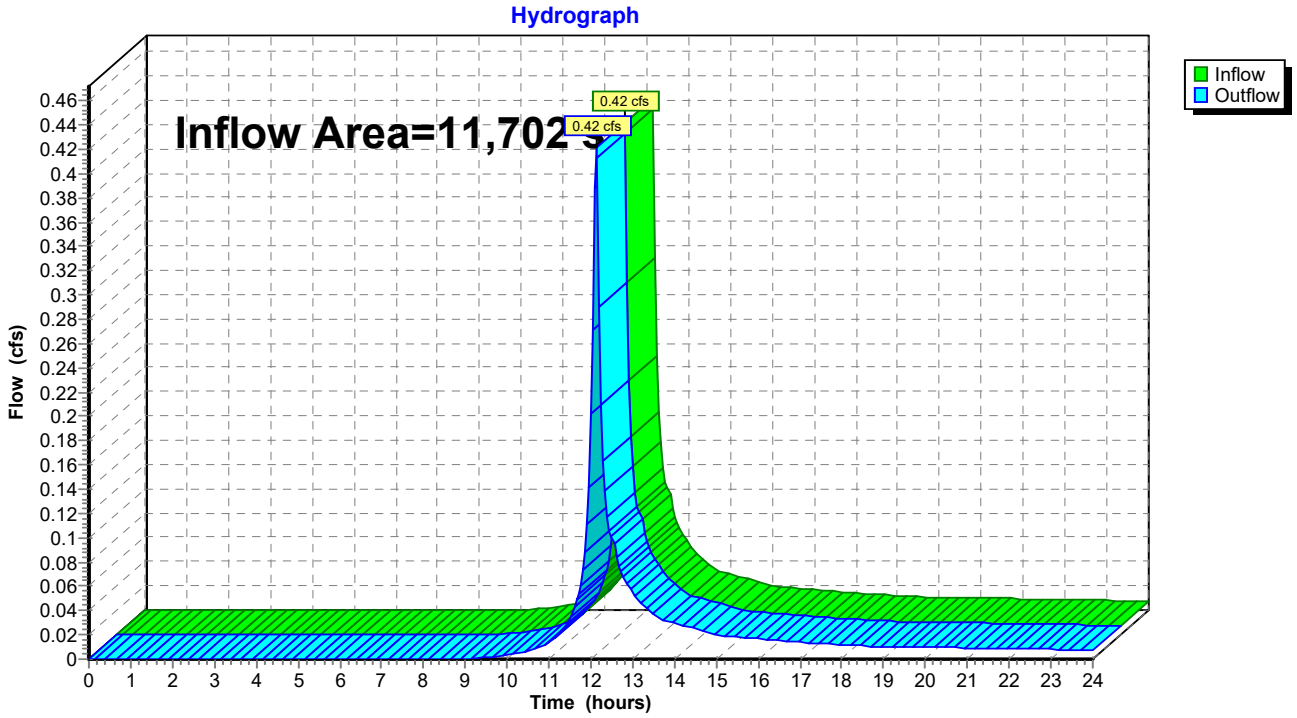
Summary for Reach DP-3: 6" DRAIN

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 11,702 sf, 2.39% Impervious, Inflow Depth > 1.38" for 2year 24-hr event
Inflow = 0.42 cfs @ 12.13 hrs, Volume= 1,343 cf
Outflow = 0.42 cfs @ 12.13 hrs, Volume= 1,343 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-3: 6" DRAIN



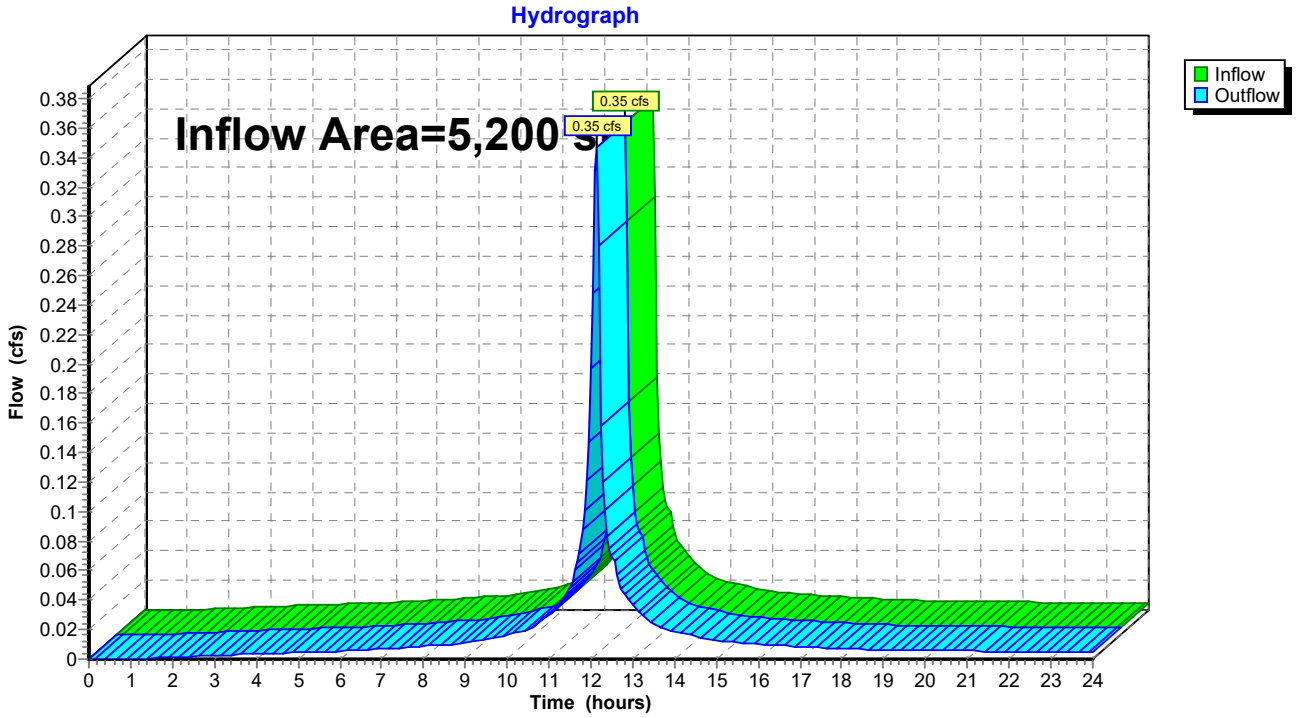
Summary for Reach DP-4: SOUTH BVW

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 5,200 sf,100.00% Impervious, Inflow Depth > 2.94" for 2year 24-hr event
Inflow = 0.35 cfs @ 12.13 hrs, Volume= 1,272 cf
Outflow = 0.35 cfs @ 12.13 hrs, Volume= 1,272 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-4: SOUTH BVW



Summary for Pond Det #1: SS#1

Inflow Area = 133,345 sf, 72.76% Impervious, Inflow Depth > 2.41" for 2year 24-hr event
Inflow = 8.00 cfs @ 12.13 hrs, Volume= 26,832 cf
Outflow = 2.22 cfs @ 12.37 hrs, Volume= 26,457 cf, Atten= 72%, Lag= 14.6 min
Primary = 2.22 cfs @ 12.37 hrs, Volume= 26,457 cf
Routed to Reach DP-2 : 18" NORTH DRAIN

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 55.46' @ 12.37 hrs Surf.Area= 9,069 sf Storage= 7,220 cf

Plug-Flow detention time= 45.1 min calculated for 26,402 cf (98% of inflow)
Center-of-Mass det. time= 36.5 min (834.7 - 798.2)

Volume	Invert	Avail.Storage	Storage Description
#1A	54.20'	7,009 cf	**72.75'W x 124.66'L x 3.50'H Field A** 31,741 cf Overall - 11,715 cf Embedded = 20,026 cf x 35.0% Voids
#2A	54.70'	11,715 cf	**ADS_StormTech SC-740 +Cap** x 255 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 255 Chambers in 15 Rows
		18,724 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Device 4	54.20'	**10.0" W x 6.0" H Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Device 4	55.30'	**12.0" W x 8.0" H Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 4	57.20'	**5.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#4	Primary	46.80'	**18.0" Round Culvert** L= 96.5' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 46.80' / 45.98' S= 0.0085 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 1.77 sf

Primary OutFlow Max=2.22 cfs @ 12.37 hrs HW=55.46' (Free Discharge)
└**4=Culvert** (Passes 2.22 cfs of 23.12 cfs potential flow)
  ├**1=Orifice/Grate** (Orifice Controls 2.01 cfs @ 4.83 fps)
  ├**2=Orifice/Grate** (Orifice Controls 0.21 cfs @ 1.29 fps)
  └**3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond Det #1: SS#1 - Chamber Wizard Field A

Chamber Model = ADS_StormTechSC-740 +Cap (ADS StormTech®SC-740 with cap length)
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

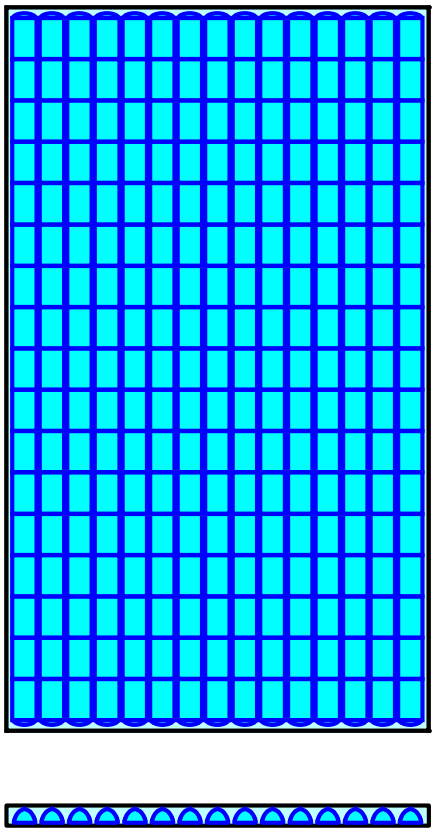
17 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 122.66' Row Length +12.0" End Stone x 2 = 124.66' Base Length
15 Rows x 51.0" Wide + 6.0" Spacing x 14 + 12.0" Side Stone x 2 = 72.75' Base Width
6.0" Stone Base + 30.0" Chamber Height + 6.0" Stone Cover = 3.50' Field Height

255 Chambers x 45.9 cf = 11,714.7 cf Chamber Storage

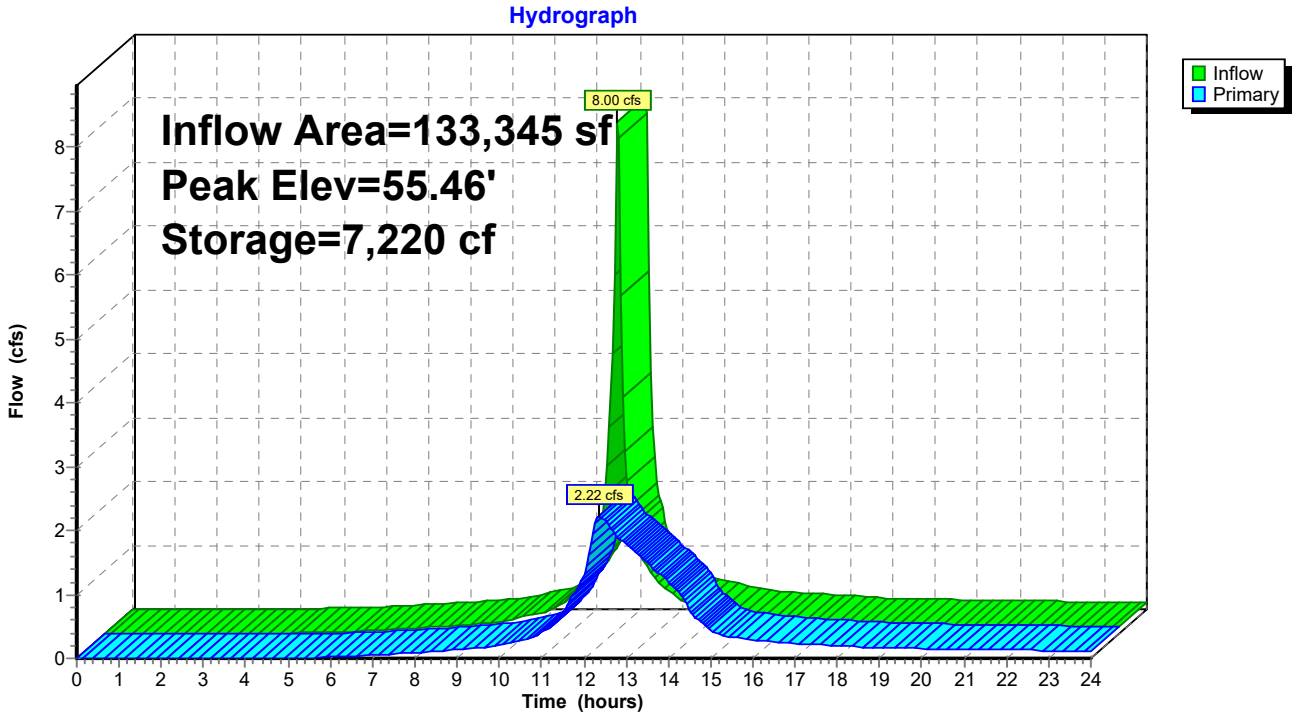
31,740.7 cf Field - 11,714.7 cf Chambers = 20,026.0 cf Stone x 35.0% Voids = 7,009.1 cf Stone Storage

Chamber Storage + Stone Storage = 18,723.8 cf = 0.430 af
Overall Storage Efficiency = 59.0%
Overall System Size = 124.66' x 72.75' x 3.50'

255 Chambers
1,175.6 cy Field
741.7 cy Stone



Pond Det #1: SS#1



Summary for Pond Det #2: SS#2

Inflow Area = 73,858 sf, 92.54% Impervious, Inflow Depth > 2.82" for 2year 24-hr event
Inflow = 4.86 cfs @ 12.13 hrs, Volume= 17,384 cf
Outflow = 1.26 cfs @ 12.39 hrs, Volume= 17,178 cf, Atten= 74%, Lag= 15.6 min
Primary = 1.26 cfs @ 12.39 hrs, Volume= 17,178 cf
Routed to Reach DP-2 : 18" NORTH DRAIN

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 52.69' @ 12.39 hrs Surf.Area= 6,337 sf Storage= 4,673 cf

Plug-Flow detention time= 48.0 min calculated for 17,178 cf (99% of inflow)
Center-of-Mass det. time= 40.2 min (808.8 - 768.6)

Volume	Invert	Avail.Storage	Storage Description
#1A	51.50'	4,909 cf	**53.75'W x 117.54'L x 3.50'H Field A** 22,112 cf Overall - 8,085 cf Embedded = 14,026 cf x 35.0% Voids
#2A	52.00'	8,085 cf	**ADS_StormTech SC-740 +Cap** x 176 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 176 Chambers in 11 Rows
#3	51.50'	157 cf	**5.00'D x 8.00'H Vertical Cone/Cylinder**
		13,152 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Device 4	51.50'	**8.0" W x 4.0" H Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Device 4	52.50'	**8.0" W x 7.0" H Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 4	54.40'	**5.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#4	Primary	48.30'	**18.0" Round Culvert** L= 96.5' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 48.30' / 47.48' S= 0.0085 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 1.77 sf

Primary OutFlow Max=1.26 cfs @ 12.39 hrs HW=52.69' (Free Discharge)
└**4=Culvert** (Passes 1.26 cfs of 15.76 cfs potential flow)
  ├**1=Orifice/Grate** (Orifice Controls 1.08 cfs @ 4.86 fps)
  ├**2=Orifice/Grate** (Orifice Controls 0.18 cfs @ 1.40 fps)
  └**3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond Det #2: SS#2 - Chamber Wizard Field A

Chamber Model = ADS_StormTechSC-740 +Cap (ADS StormTech®SC-740 with cap length)
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

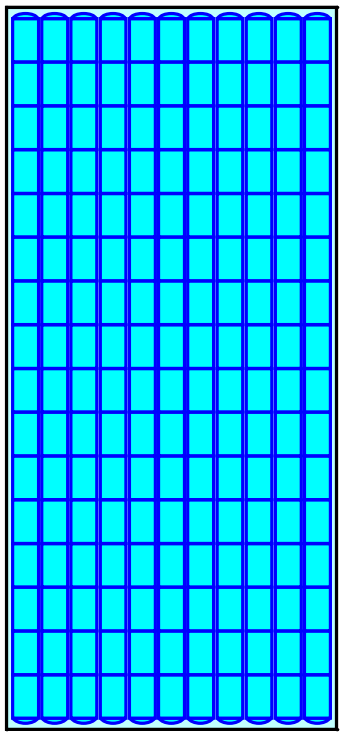
16 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 115.54' Row Length +12.0" End Stone x 2 = 117.54' Base Length
11 Rows x 51.0" Wide + 6.0" Spacing x 10 + 12.0" Side Stone x 2 = 53.75' Base Width
6.0" Stone Base + 30.0" Chamber Height + 6.0" Stone Cover = 3.50' Field Height

176 Chambers x 45.9 cf = 8,085.4 cf Chamber Storage

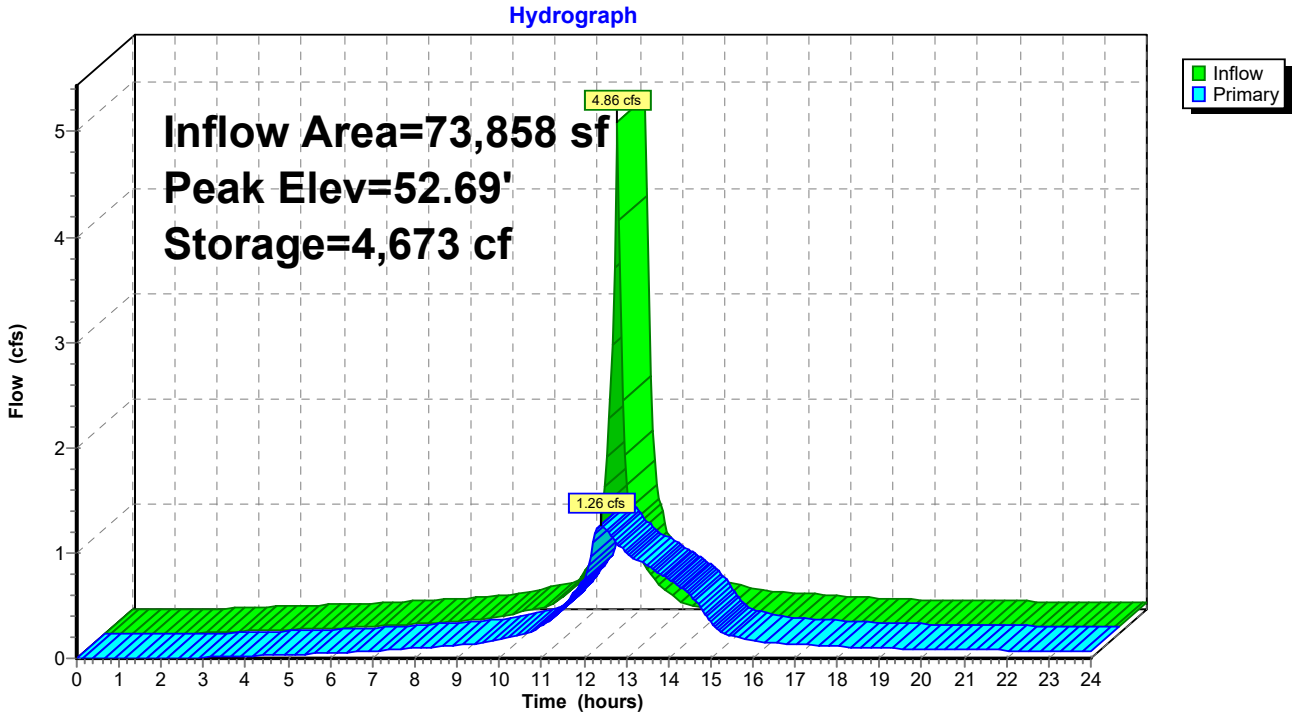
22,111.6 cf Field - 8,085.4 cf Chambers = 14,026.1 cf Stone x 35.0% Voids = 4,909.1 cf Stone Storage

Chamber Storage + Stone Storage = 12,994.6 cf = 0.298 af
Overall Storage Efficiency = 58.8%
Overall System Size = 117.54' x 53.75' x 3.50'

176 Chambers
818.9 cy Field
519.5 cy Stone



Pond Det #2: SS#2



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment PR-1: UU-NW GRASS AREA Runoff Area=5,726 sf 0.00% Impervious Runoff Depth>2.90"
Flow Length=66' Tc=6.0 min CN=80 Runoff=0.43 cfs 1,383 cf

Subcatchment PR-1B: UU-PROPOSED Runoff Area=56,996 sf 52.08% Impervious Runoff Depth>3.67"
Flow Length=288' Tc=6.0 min CN=88 Runoff=5.26 cfs 17,454 cf

Subcatchment PR-2A: SS#1 Runoff Area=133,345 sf 72.76% Impervious Runoff Depth>4.20"
Flow Length=550' Tc=6.0 min CN=93 Runoff=13.45 cfs 46,716 cf

Subcatchment PR-2B: SS#2 Runoff Area=73,858 sf 92.54% Impervious Runoff Depth>4.65"
Flow Length=209' Tc=6.0 min CN=97 Runoff=7.79 cfs 28,640 cf

Subcatchment PR-2C: PR DP-1 (18" North Runoff Area=40,442 sf 54.88% Impervious Runoff Depth>3.88"
Flow Length=933' Tc=6.0 min CN=90 Runoff=3.88 cfs 13,084 cf

Subcatchment PR-3: PR DP-3 Runoff Area=11,702 sf 2.39% Impervious Runoff Depth>2.90"
Flow Length=93' Tc=6.0 min CN=80 Runoff=0.88 cfs 2,826 cf

Subcatchment PR-4: PR-4 ROOF Runoff Area=5,200 sf 100.00% Impervious Runoff Depth>4.77"
Flow Length=177' Slope=0.0100 '/' Tc=6.0 min CN=98 Runoff=0.55 cfs 2,067 cf

Reach DP-1: NW BVW Inflow=5.69 cfs 18,837 cf
Outflow=5.69 cfs 18,837 cf

Reach DP-2: 18" NORTH DRAIN Inflow=9.91 cfs 87,645 cf
Outflow=9.91 cfs 87,645 cf

Reach DP-3: 6" DRAIN Inflow=0.88 cfs 2,826 cf
Outflow=0.88 cfs 2,826 cf

Reach DP-4: SOUTH BVW Inflow=0.55 cfs 2,067 cf
Outflow=0.55 cfs 2,067 cf

Pond Det #1: SS#1 Peak Elev=56.17' Storage=12,024 cf Inflow=13.45 cfs 46,716 cf
Outflow=4.95 cfs 46,200 cf

Pond Det #2: SS#2 Peak Elev=53.27' Storage=7,466 cf Inflow=7.79 cfs 28,640 cf
Outflow=2.63 cfs 28,360 cf

Total Runoff Area = 327,269 sf Runoff Volume = 112,171 cf Average Runoff Depth = 4.11"
31.94% Pervious = 104,532 sf 68.06% Impervious = 222,737 sf

Summary for Subcatchment PR-1: UU-NW GRASS AREA

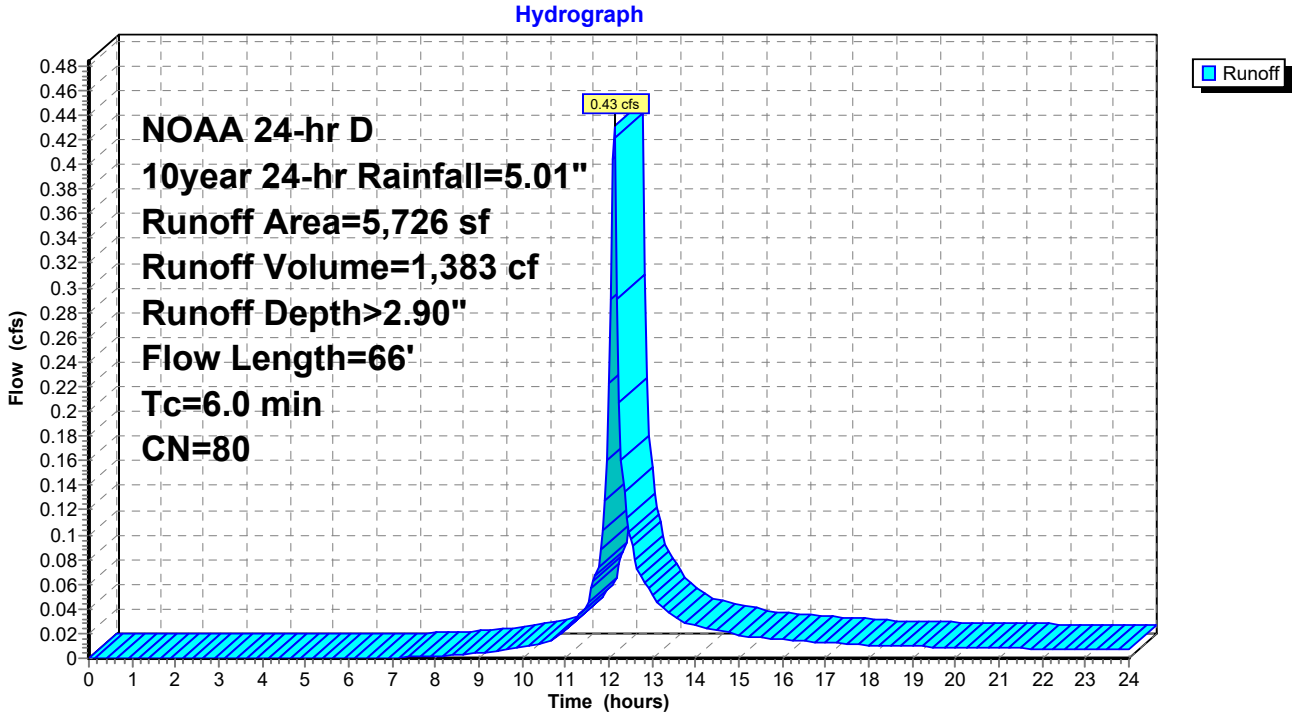
Runoff = 0.43 cfs @ 12.13 hrs, Volume= 1,383 cf, Depth> 2.90"
Routed to Reach DP-1 : NW BVW

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 10year 24-hr Rainfall=5.01"

Area (sf)	CN	Description
5,726	80	>75% Grass cover, Good, HSG D
5,726		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	50	0.0600	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.17"
0.3	16	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
2.1					**Direct Entry, Minimum Tc of 6 Min**
6.0	66	Total			

Subcatchment PR-1: UU-NW GRASS AREA



Summary for Subcatchment PR-1B: UU-PROPOSED

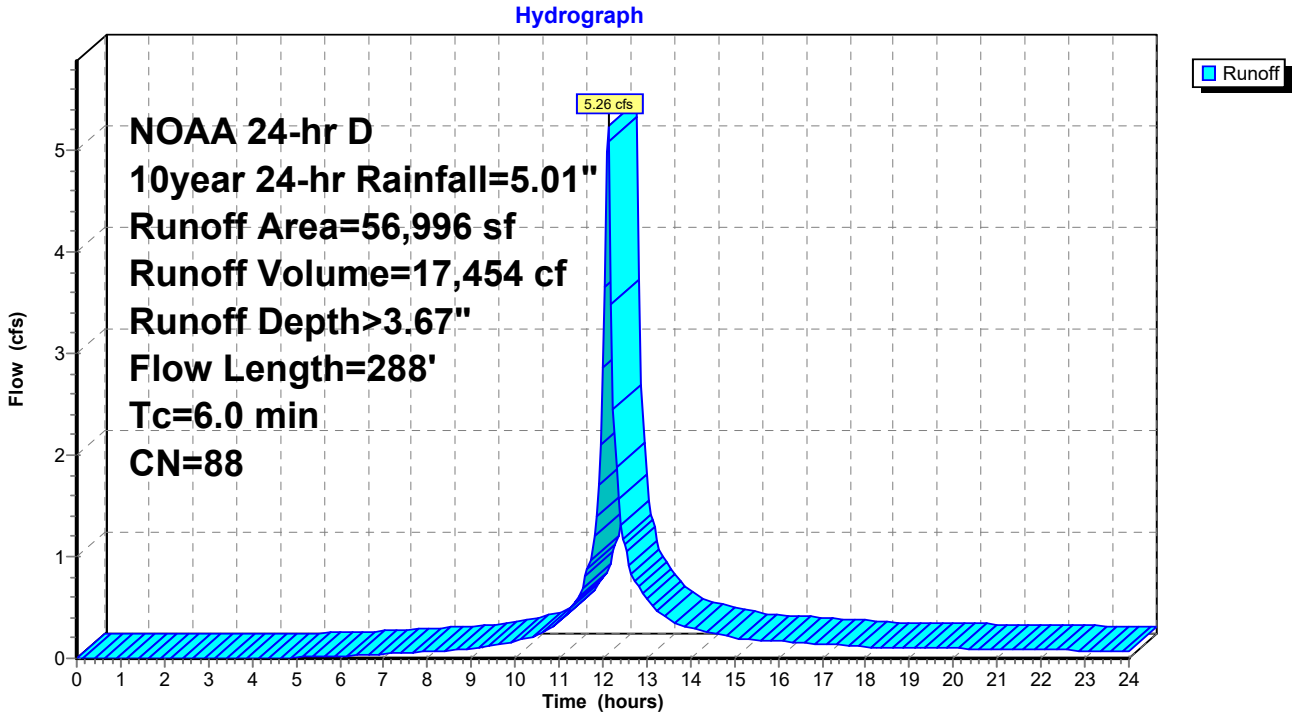
Runoff = 5.26 cfs @ 12.13 hrs, Volume= 17,454 cf, Depth> 3.67"
Routed to Reach DP-1 : NW BVW

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 10year 24-hr Rainfall=5.01"

Area (sf)	CN	Description
7,313	80	>75% Grass cover, Good, HSG D
20,000	77	Woods, Good, HSG D
29,683	98	Paved parking, HSG D
56,996	88	Weighted Average
27,313		47.92% Pervious Area
29,683		52.08% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.90		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.17"
4.3	122	0.0010	0.47		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
0.3	116	0.0100	6.22	7.63	**Pipe Channel, RCP_Round 15"** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.011 Concrete pipe, straight & clean
0.5					**Direct Entry, Minimum Tc of 6 Min**
6.0	288	Total			

Subcatchment PR-1B: UU-PROPOSED



Summary for Subcatchment PR-2A: SS#1

[47] Hint: Peak is 261% of capacity of segment #2

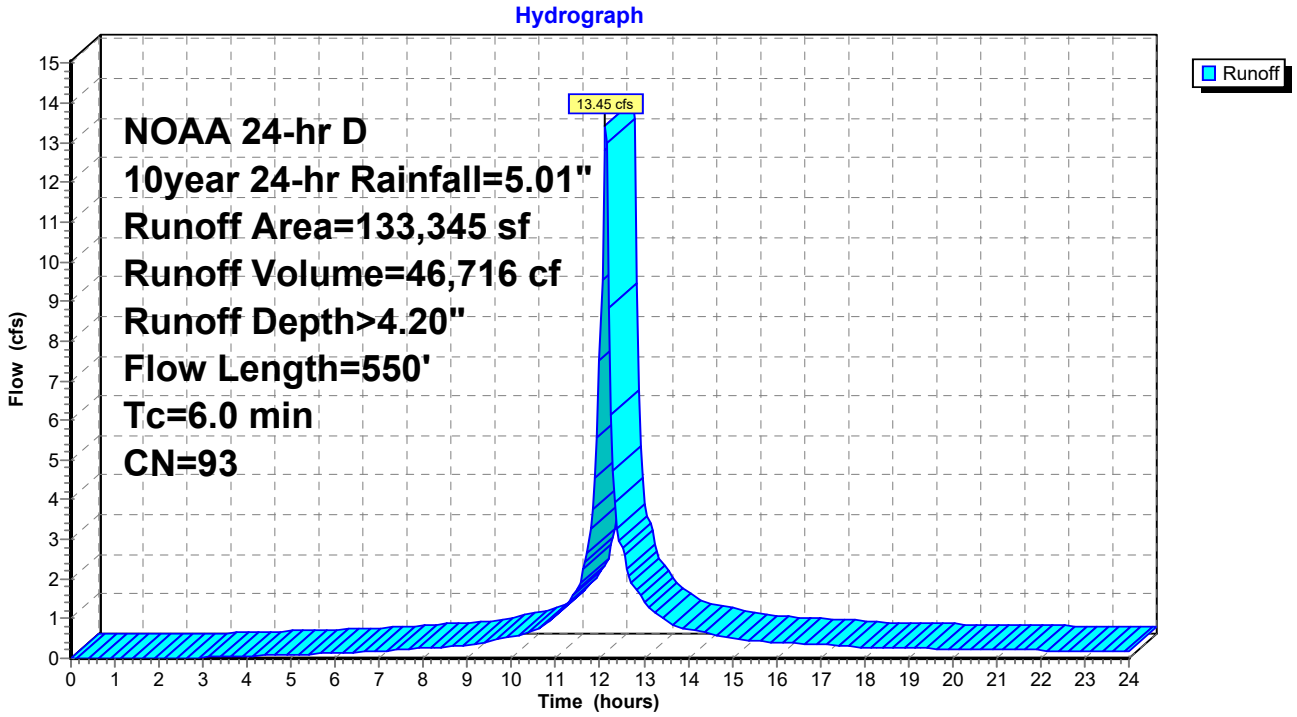
Runoff = 13.45 cfs @ 12.13 hrs, Volume= 46,716 cf, Depth> 4.20"
Routed to Pond Det #1 : SS#1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 10year 24-hr Rainfall=5.01"

Area (sf)	CN	Description
36,318	80	>75% Grass cover, Good, HSG D
66,336	98	Paved parking, HSG D
30,691	98	Roofs, HSG D
133,345	93	Weighted Average
36,318		27.24% Pervious Area
97,027		72.76% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	50	0.0300	1.40		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.17"
1.3	500	0.0100	6.55	5.15	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.009
4.1					**Direct Entry, Minimum Tc of 6 Min**
6.0	550	Total			

Subcatchment PR-2A: SS#1



Summary for Subcatchment PR-2B: SS#2

[47] Hint: Peak is 151% of capacity of segment #2

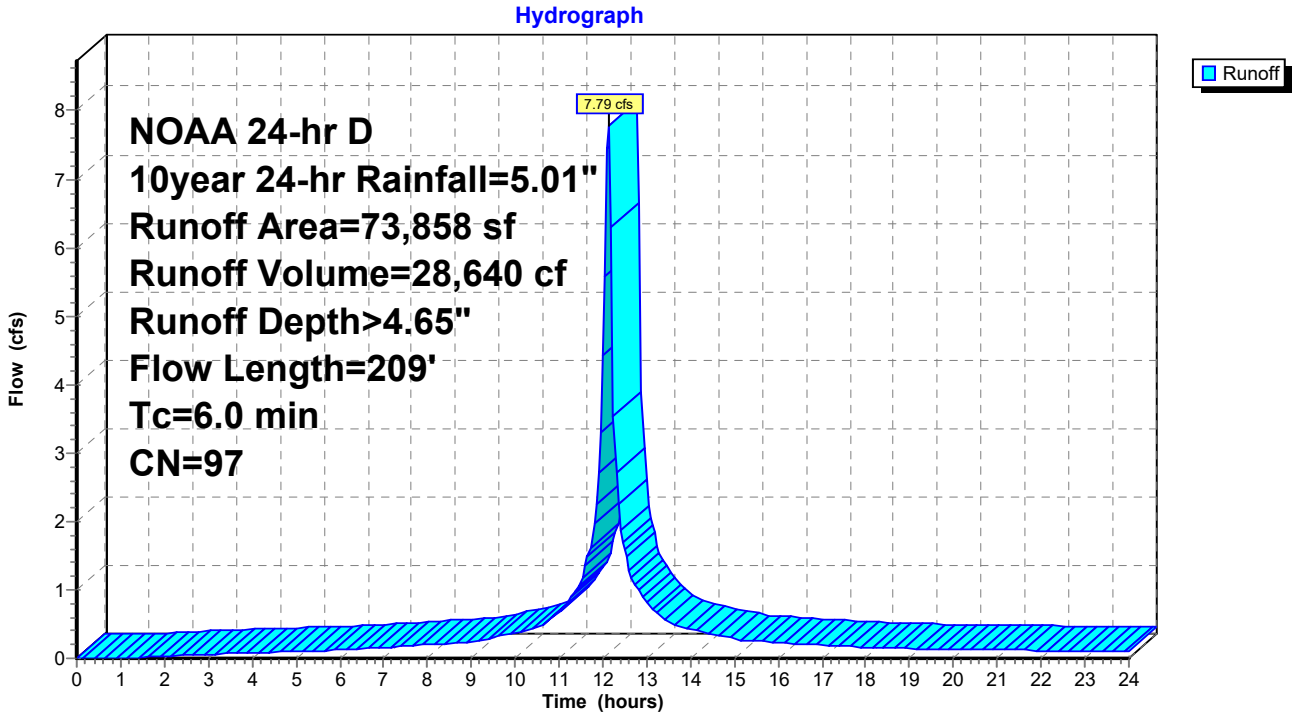
Runoff = 7.79 cfs @ 12.13 hrs, Volume= 28,640 cf, Depth> 4.65"
Routed to Pond Det #2 : SS#2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 10year 24-hr Rainfall=5.01"

Area (sf)	CN	Description
5,507	80	>75% Grass cover, Good, HSG D
44,720	98	Paved parking, HSG D
23,631	98	Roofs, HSG D
73,858	97	Weighted Average
5,507		7.46% Pervious Area
68,351		92.54% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	50	0.0200	1.19		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.17"
0.4	159	0.0100	6.55	5.15	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.009
4.9					**Direct Entry, Minimum Tc of 6 Min**
6.0	209	Total			

Subcatchment PR-2B: SS#2



Summary for Subcatchment PR-2C: PR DP-1 (18" North Drain)

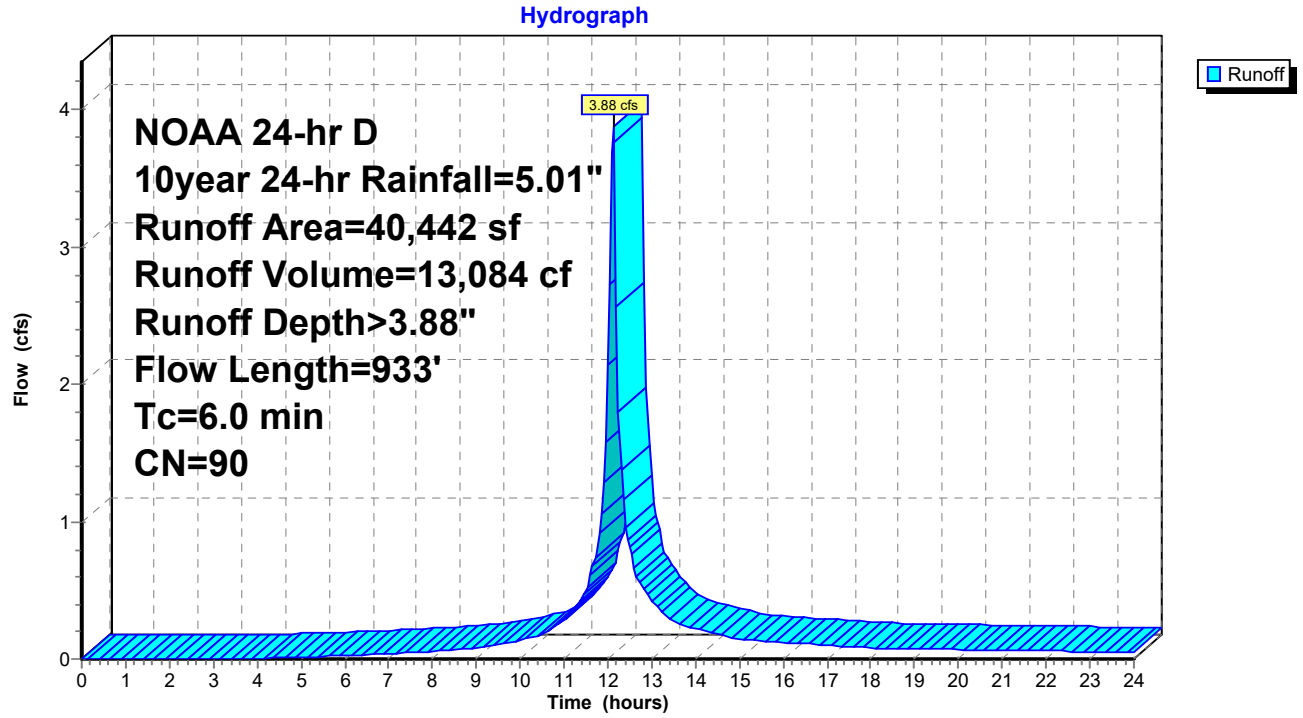
Runoff = 3.88 cfs @ 12.13 hrs, Volume= 13,084 cf, Depth> 3.88"
Routed to Reach DP-2 : 18" NORTH DRAIN

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 10year 24-hr Rainfall=5.01"

Area (sf)	CN	Description
18,246	80	>75% Grass cover, Good, HSG D
22,196	98	Paved parking, HSG D
40,442	90	Weighted Average
18,246		45.12% Pervious Area
22,196		54.88% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.90		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.17"
0.6	108	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.9	775	0.0100	6.84	8.40	**Pipe Channel,** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.010 PVC, smooth interior
2.6					**Direct Entry, Minimum Tc of 6 Min**
6.0	933	Total			

Subcatchment PR-2C: PR DP-1 (18" North Drain)



Summary for Subcatchment PR-3: PR DP-3

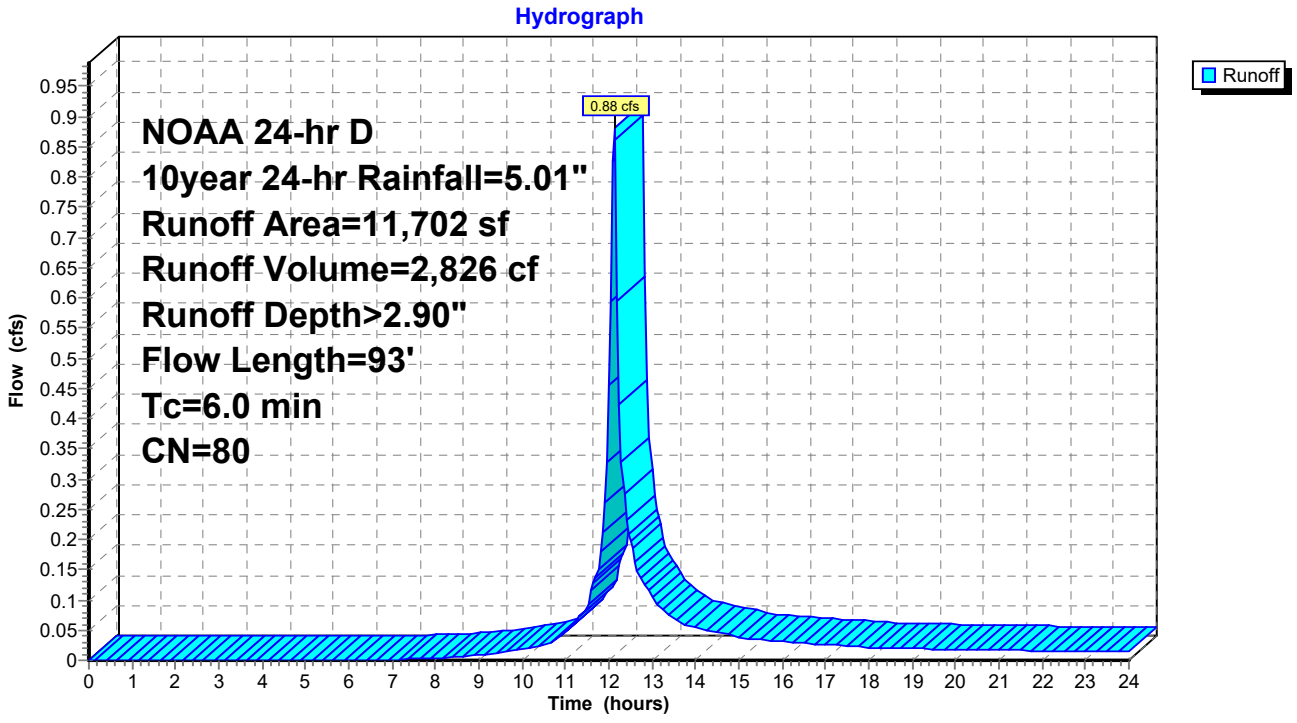
Runoff = 0.88 cfs @ 12.13 hrs, Volume= 2,826 cf, Depth> 2.90"
Routed to Reach DP-3 : 6" DRAIN

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 10year 24-hr Rainfall=5.01"

Area (sf)	CN	Description
11,422	80	>75% Grass cover, Good, HSG D
280	98	Paved parking, HSG D
11,702	80	Weighted Average
11,422		97.61% Pervious Area
280		2.39% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.7	50	0.0200	0.15		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.17"
0.3	43	0.1000	2.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
6.0	93	Total			

Subcatchment PR-3: PR DP-3



Summary for Subcatchment PR-4: PR-4 ROOF

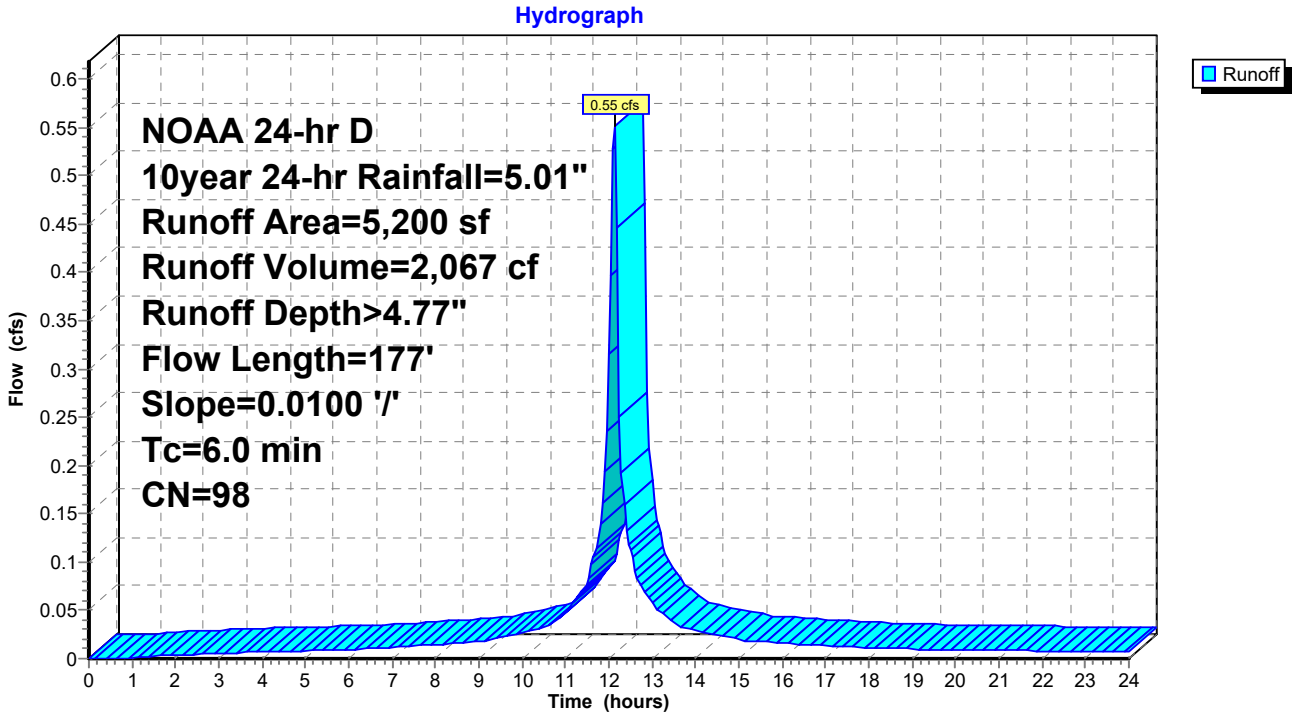
Runoff = 0.55 cfs @ 12.13 hrs, Volume= 2,067 cf, Depth> 4.77"
Routed to Reach DP-4 : SOUTH BVW

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 10year 24-hr Rainfall=5.01"

Area (sf)	CN	Description
5,200	98	Roofs, HSG D
5,200		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.90		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.17"
0.3	127	0.0100	6.55	5.15	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.009
4.8					**Direct Entry, Minimum Tc of 6 Min**
6.0	177	Total			

Subcatchment PR-4: PR-4 ROOF



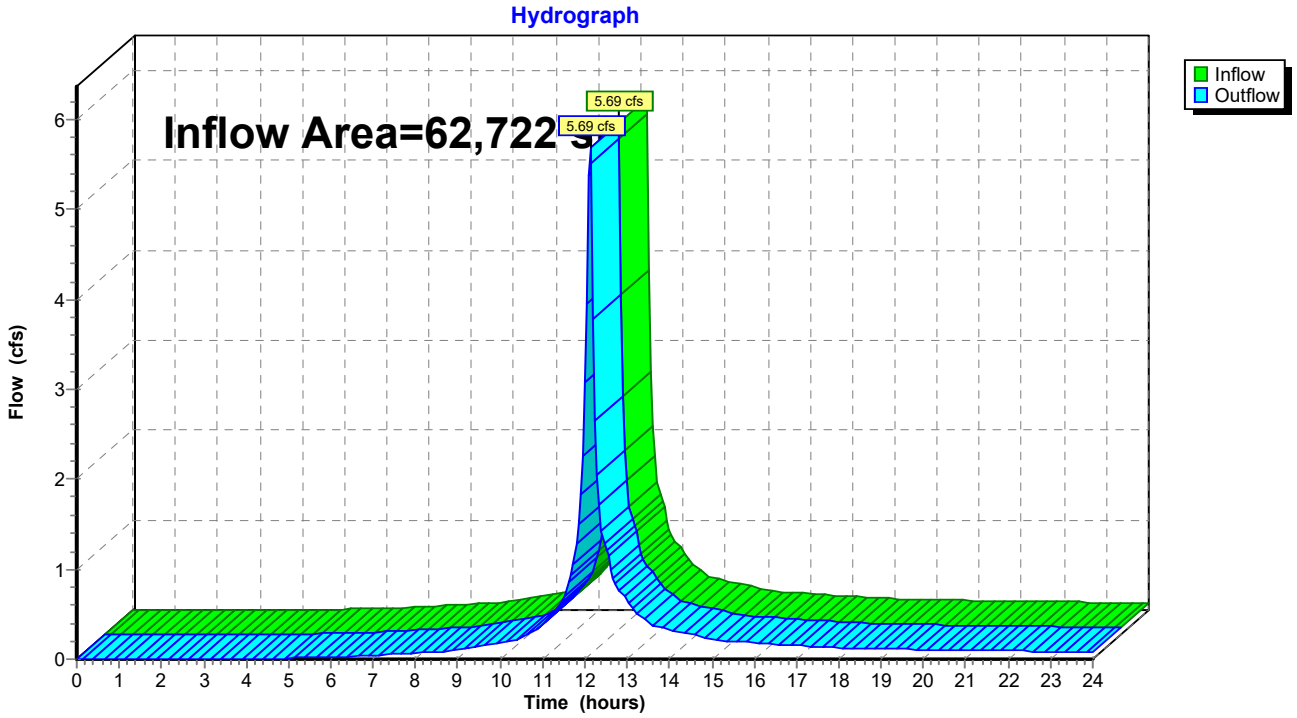
Summary for Reach DP-1: NW BVW

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 62,722 sf, 47.32% Impervious, Inflow Depth > 3.60" for 10year 24-hr event
Inflow = 5.69 cfs @ 12.13 hrs, Volume= 18,837 cf
Outflow = 5.69 cfs @ 12.13 hrs, Volume= 18,837 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-1: NW BVW



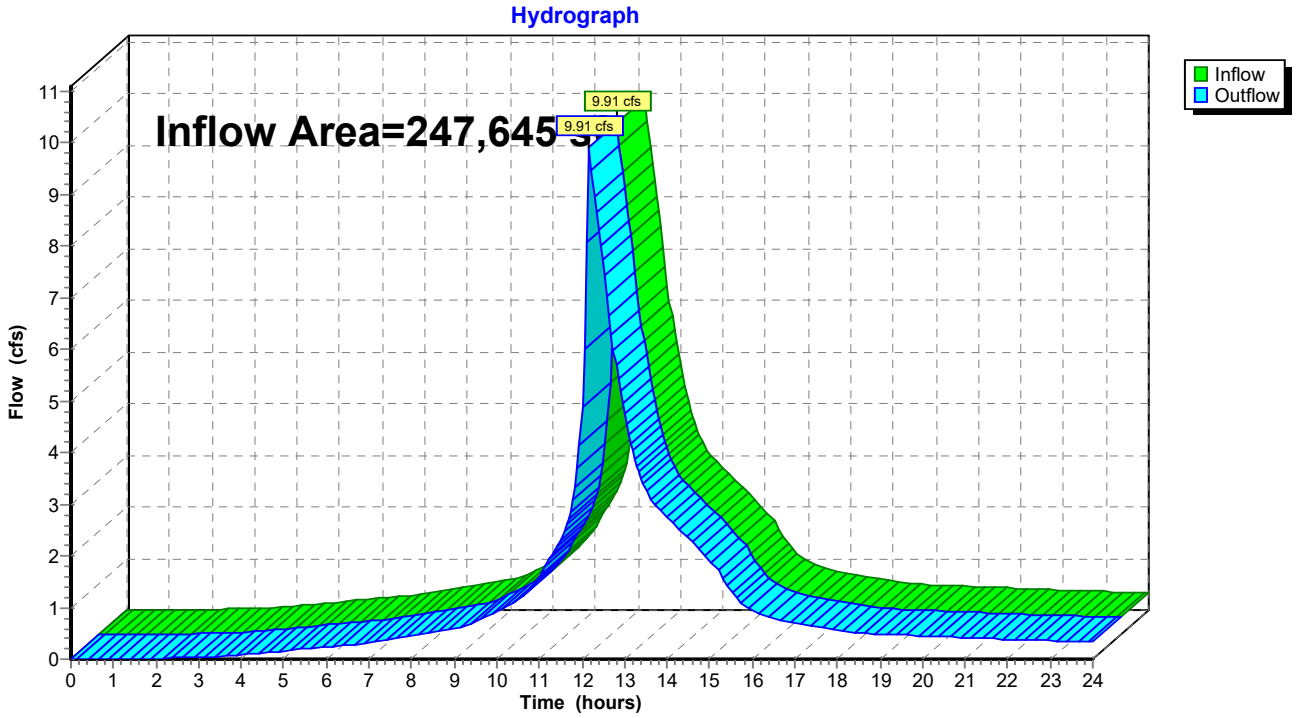
Summary for Reach DP-2: 18" NORTH DRAIN

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 247,645 sf, 75.74% Impervious, Inflow Depth > 4.25" for 10year 24-hr event
Inflow = 9.91 cfs @ 12.17 hrs, Volume= 87,645 cf
Outflow = 9.91 cfs @ 12.17 hrs, Volume= 87,645 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 3

Reach DP-2: 18" NORTH DRAIN



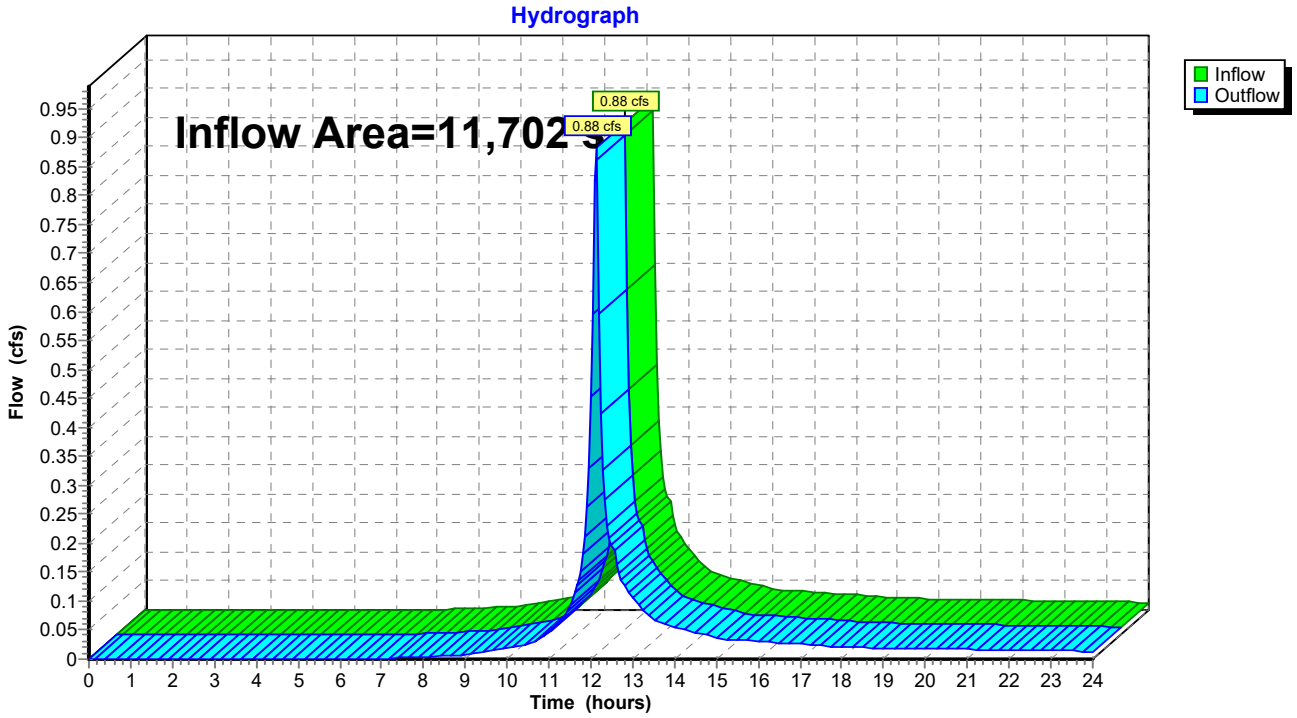
Summary for Reach DP-3: 6" DRAIN

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 11,702 sf, 2.39% Impervious, Inflow Depth > 2.90" for 10year 24-hr event
Inflow = 0.88 cfs @ 12.13 hrs, Volume= 2,826 cf
Outflow = 0.88 cfs @ 12.13 hrs, Volume= 2,826 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-3: 6" DRAIN



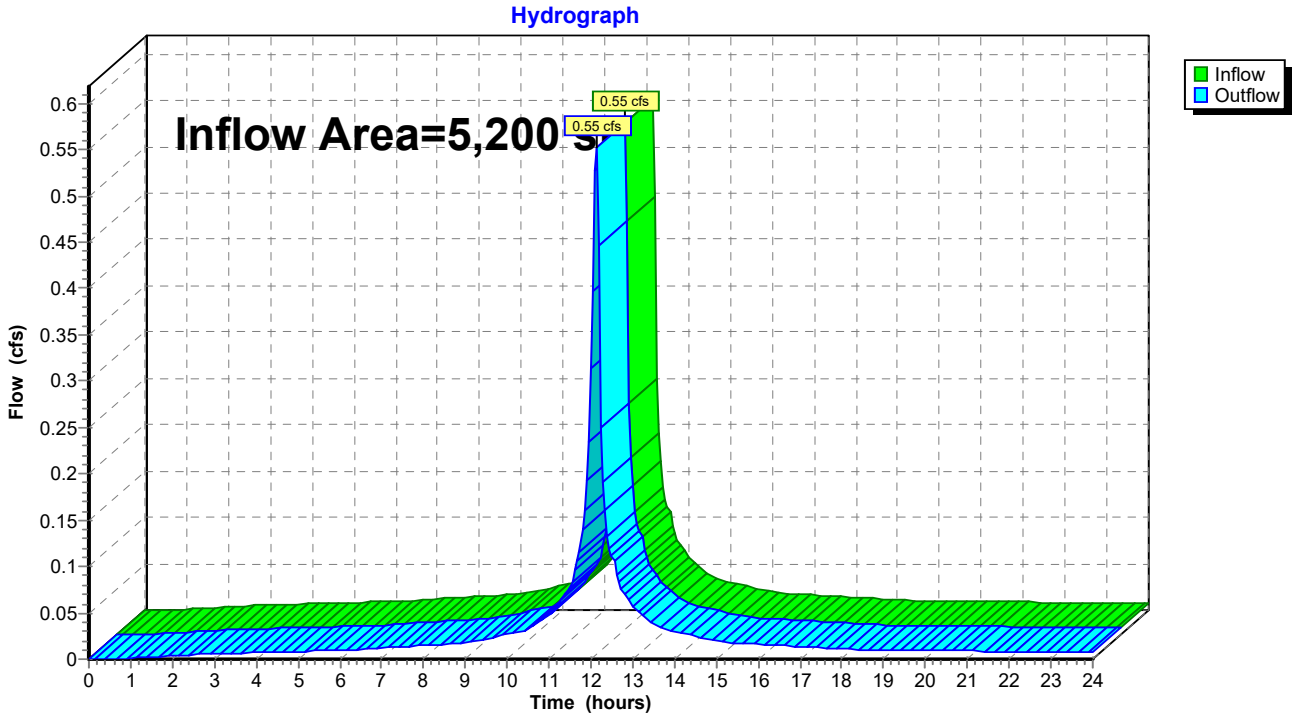
Summary for Reach DP-4: SOUTH BVW

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 5,200 sf,100.00% Impervious, Inflow Depth > 4.77" for 10year 24-hr event
Inflow = 0.55 cfs @ 12.13 hrs, Volume= 2,067 cf
Outflow = 0.55 cfs @ 12.13 hrs, Volume= 2,067 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-4: SOUTH BVW



Summary for Pond Det #1: SS#1

Inflow Area = 133,345 sf, 72.76% Impervious, Inflow Depth > 4.20" for 10year 24-hr event
Inflow = 13.45 cfs @ 12.13 hrs, Volume= 46,716 cf
Outflow = 4.95 cfs @ 12.30 hrs, Volume= 46,200 cf, Atten= 63%, Lag= 10.3 min
Primary = 4.95 cfs @ 12.30 hrs, Volume= 46,200 cf
Routed to Reach DP-2 : 18" NORTH DRAIN

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 56.17' @ 12.30 hrs Surf.Area= 9,069 sf Storage= 12,024 cf

Plug-Flow detention time= 42.7 min calculated for 46,200 cf (99% of inflow)
Center-of-Mass det. time= 35.6 min (817.4 - 781.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	54.20'	7,009 cf	**72.75'W x 124.66'L x 3.50'H Field A** 31,741 cf Overall - 11,715 cf Embedded = 20,026 cf x 35.0% Voids
#2A	54.70'	11,715 cf	**ADS_StormTech SC-740 +Cap** x 255 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 255 Chambers in 15 Rows
		18,724 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Device 4	54.20'	**10.0" W x 6.0" H Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Device 4	55.30'	**12.0" W x 8.0" H Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 4	57.20'	**5.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#4	Primary	46.80'	**18.0" Round Culvert** L= 96.5' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 46.80' / 45.98' S= 0.0085 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 1.77 sf

Primary OutFlow Max=4.95 cfs @ 12.30 hrs HW=56.17' (Free Discharge)
└**4=Culvert** (Passes 4.95 cfs of 24.13 cfs potential flow)
  ├**1=Orifice/Grate** (Orifice Controls 2.63 cfs @ 6.32 fps)
  ├**2=Orifice/Grate** (Orifice Controls 2.32 cfs @ 3.48 fps)
  └**3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond Det #1: SS#1 - Chamber Wizard Field A

Chamber Model = ADS_StormTechSC-740 +Cap (ADS StormTech®SC-740 with cap length)
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

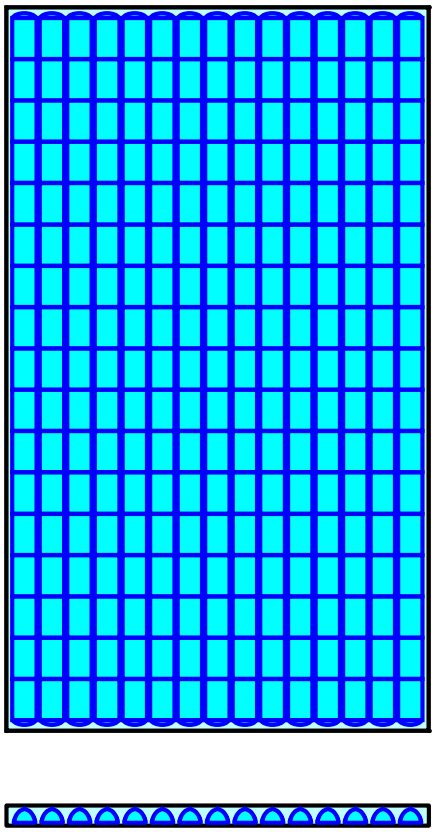
17 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 122.66' Row Length +12.0" End Stone x 2 = 124.66' Base Length
15 Rows x 51.0" Wide + 6.0" Spacing x 14 + 12.0" Side Stone x 2 = 72.75' Base Width
6.0" Stone Base + 30.0" Chamber Height + 6.0" Stone Cover = 3.50' Field Height

255 Chambers x 45.9 cf = 11,714.7 cf Chamber Storage

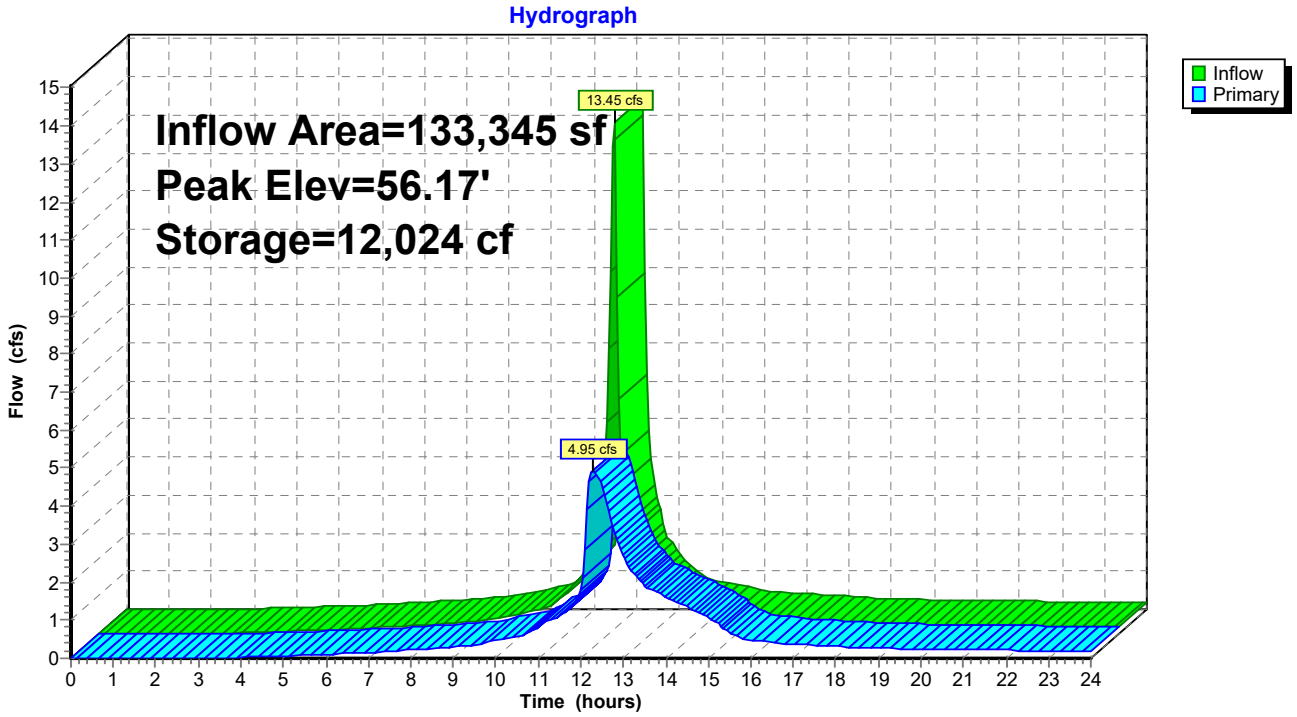
31,740.7 cf Field - 11,714.7 cf Chambers = 20,026.0 cf Stone x 35.0% Voids = 7,009.1 cf Stone Storage

Chamber Storage + Stone Storage = 18,723.8 cf = 0.430 af
Overall Storage Efficiency = 59.0%
Overall System Size = 124.66' x 72.75' x 3.50'

255 Chambers
1,175.6 cy Field
741.7 cy Stone



Pond Det #1: SS#1



Summary for Pond Det #2: SS#2

Inflow Area = 73,858 sf, 92.54% Impervious, Inflow Depth > 4.65" for 10year 24-hr event
Inflow = 7.79 cfs @ 12.13 hrs, Volume= 28,640 cf
Outflow = 2.63 cfs @ 12.31 hrs, Volume= 28,360 cf, Atten= 66%, Lag= 11.3 min
Primary = 2.63 cfs @ 12.31 hrs, Volume= 28,360 cf
Routed to Reach DP-2 : 18" NORTH DRAIN

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 53.27' @ 12.31 hrs Surf.Area= 6,337 sf Storage= 7,466 cf

Plug-Flow detention time= 46.2 min calculated for 28,360 cf (99% of inflow)
Center-of-Mass det. time= 39.7 min (796.8 - 757.1)

Volume	Invert	Avail.Storage	Storage Description
#1A	51.50'	4,909 cf	**53.75'W x 117.54'L x 3.50'H Field A** 22,112 cf Overall - 8,085 cf Embedded = 14,026 cf x 35.0% Voids
#2A	52.00'	8,085 cf	**ADS_StormTech SC-740 +Cap** x 176 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 176 Chambers in 11 Rows
#3	51.50'	157 cf	**5.00'D x 8.00'H Vertical Cone/Cylinder**
		13,152 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Device 4	51.50'	**8.0" W x 4.0" H Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Device 4	52.50'	**8.0" W x 7.0" H Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 4	54.40'	**5.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#4	Primary	48.30'	**18.0" Round Culvert** L= 96.5' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 48.30' / 47.48' S= 0.0085 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 1.77 sf

Primary OutFlow Max=2.62 cfs @ 12.31 hrs HW=53.27' (Free Discharge)
└**4=Culvert** (Passes 2.62 cfs of 16.94 cfs potential flow)
  ├**1=Orifice/Grate** (Orifice Controls 1.35 cfs @ 6.09 fps)
  ├**2=Orifice/Grate** (Orifice Controls 1.27 cfs @ 3.27 fps)
  └**3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond Det #2: SS#2 - Chamber Wizard Field A

Chamber Model = ADS_StormTechSC-740 +Cap (ADS StormTech®SC-740 with cap length)
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

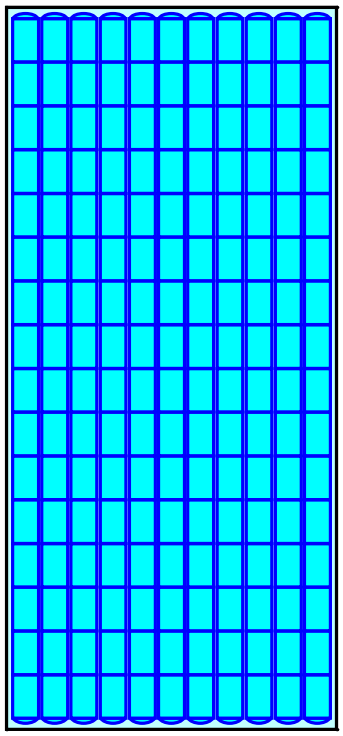
16 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 115.54' Row Length +12.0" End Stone x 2 = 117.54' Base Length
11 Rows x 51.0" Wide + 6.0" Spacing x 10 + 12.0" Side Stone x 2 = 53.75' Base Width
6.0" Stone Base + 30.0" Chamber Height + 6.0" Stone Cover = 3.50' Field Height

176 Chambers x 45.9 cf = 8,085.4 cf Chamber Storage

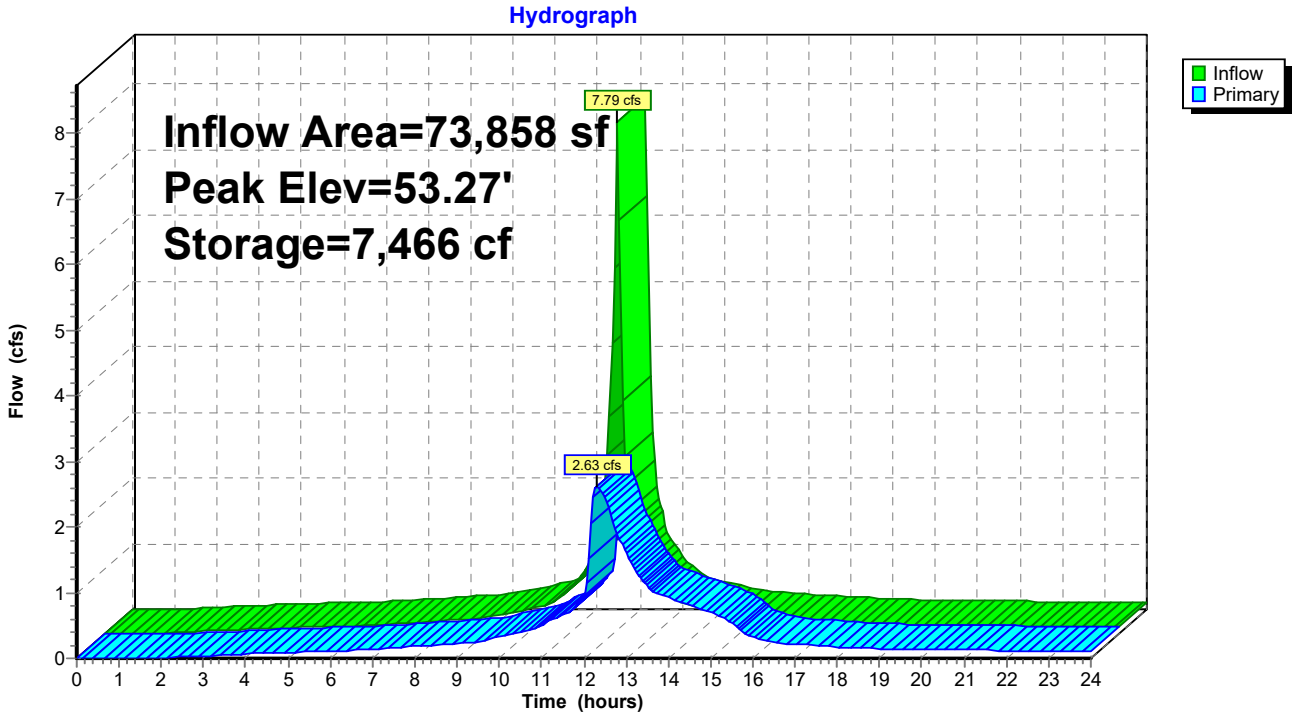
22,111.6 cf Field - 8,085.4 cf Chambers = 14,026.1 cf Stone x 35.0% Voids = 4,909.1 cf Stone Storage

Chamber Storage + Stone Storage = 12,994.6 cf = 0.298 af
Overall Storage Efficiency = 58.8%
Overall System Size = 117.54' x 53.75' x 3.50'

176 Chambers
818.9 cy Field
519.5 cy Stone



Pond Det #2: SS#2



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment PR-1: UU-NW GRASS AREA Runoff Area=5,726 sf 0.00% Impervious Runoff Depth>3.92"
Flow Length=66' Tc=6.0 min CN=80 Runoff=0.58 cfs 1,871 cf

Subcatchment PR-1B: UU-PROPOSED Runoff Area=56,996 sf 52.08% Impervious Runoff Depth>4.78"
Flow Length=288' Tc=6.0 min CN=88 Runoff=6.73 cfs 22,683 cf

Subcatchment PR-2A: SS#1 Runoff Area=133,345 sf 72.76% Impervious Runoff Depth>5.34"
Flow Length=550' Tc=6.0 min CN=93 Runoff=16.82 cfs 59,294 cf

Subcatchment PR-2B: SS#2 Runoff Area=73,858 sf 92.54% Impervious Runoff Depth>5.80"
Flow Length=209' Tc=6.0 min CN=97 Runoff=9.62 cfs 35,693 cf

Subcatchment PR-2C: PR DP-1 (18" North Runoff Area=40,442 sf 54.88% Impervious Runoff Depth>5.00"
Flow Length=933' Tc=6.0 min CN=90 Runoff=4.92 cfs 16,842 cf

Subcatchment PR-3: PR DP-3 Runoff Area=11,702 sf 2.39% Impervious Runoff Depth>3.92"
Flow Length=93' Tc=6.0 min CN=80 Runoff=1.18 cfs 3,824 cf

Subcatchment PR-4: PR-4 ROOF Runoff Area=5,200 sf 100.00% Impervious Runoff Depth>5.92"
Flow Length=177' Slope=0.0100 '/' Tc=6.0 min CN=98 Runoff=0.68 cfs 2,564 cf

Reach DP-1: NW BVW Inflow=7.31 cfs 24,554 cf
Outflow=7.31 cfs 24,554 cf

Reach DP-2: 18" NORTH DRAIN Inflow=13.02 cfs 110,911 cf
Outflow=13.02 cfs 110,911 cf

Reach DP-3: 6" DRAIN Inflow=1.18 cfs 3,824 cf
Outflow=1.18 cfs 3,824 cf

Reach DP-4: SOUTH BVW Inflow=0.68 cfs 2,564 cf
Outflow=0.68 cfs 2,564 cf

Pond Det #1: SS#1 Peak Elev=56.70' Storage=15,085 cf Inflow=16.82 cfs 59,294 cf
Outflow=6.31 cfs 58,702 cf

Pond Det #2: SS#2 Peak Elev=53.68' Storage=9,278 cf Inflow=9.62 cfs 35,693 cf
Outflow=3.28 cfs 35,367 cf

Total Runoff Area = 327,269 sf Runoff Volume = 142,772 cf Average Runoff Depth = 5.24"
31.94% Pervious = 104,532 sf 68.06% Impervious = 222,737 sf

Summary for Subcatchment PR-1: UU-NW GRASS AREA

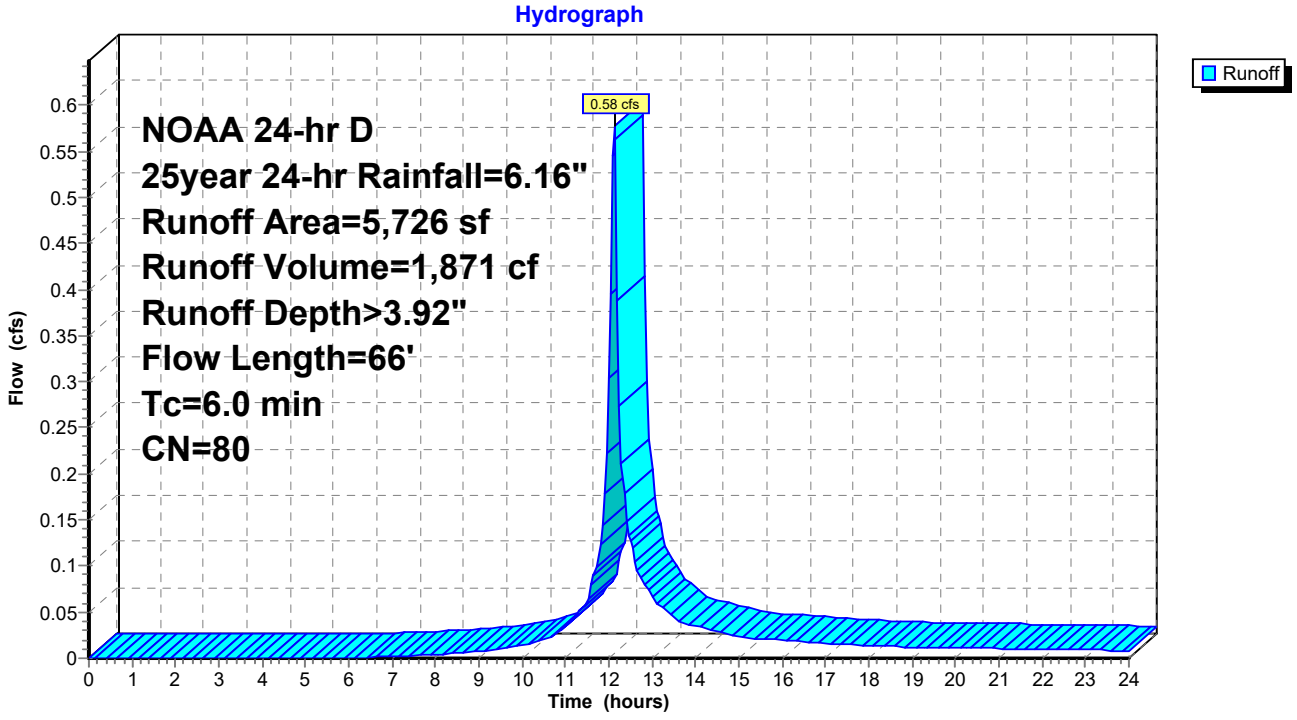
Runoff = 0.58 cfs @ 12.13 hrs, Volume= 1,871 cf, Depth> 3.92"
Routed to Reach DP-1 : NW BVW

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 25year 24-hr Rainfall=6.16"

Area (sf)	CN	Description
5,726	80	>75% Grass cover, Good, HSG D
5,726		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	50	0.0600	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.17"
0.3	16	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
2.1					**Direct Entry, Minimum Tc of 6 Min**
6.0	66	Total			

Subcatchment PR-1: UU-NW GRASS AREA



Summary for Subcatchment PR-1B: UU-PROPOSED

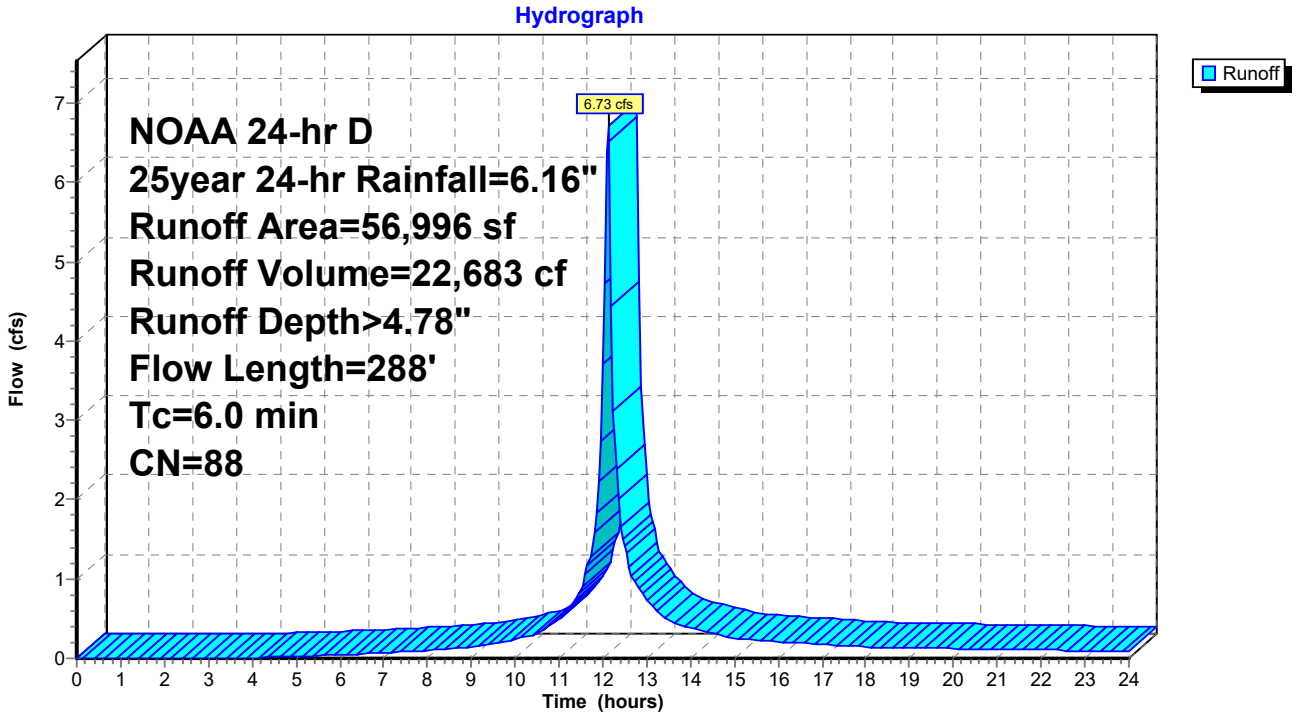
Runoff = 6.73 cfs @ 12.13 hrs, Volume= 22,683 cf, Depth> 4.78"
Routed to Reach DP-1 : NW BVW

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 25year 24-hr Rainfall=6.16"

Area (sf)	CN	Description
7,313	80	>75% Grass cover, Good, HSG D
20,000	77	Woods, Good, HSG D
29,683	98	Paved parking, HSG D
56,996	88	Weighted Average
27,313		47.92% Pervious Area
29,683		52.08% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.90		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.17"
4.3	122	0.0010	0.47		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
0.3	116	0.0100	6.22	7.63	**Pipe Channel, RCP_Round 15"** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.011 Concrete pipe, straight & clean
0.5					**Direct Entry, Minimum Tc of 6 Min**
6.0	288	Total			

Subcatchment PR-1B: UU-PROPOSED



Summary for Subcatchment PR-2A: SS#1

[47] Hint: Peak is 327% of capacity of segment #2

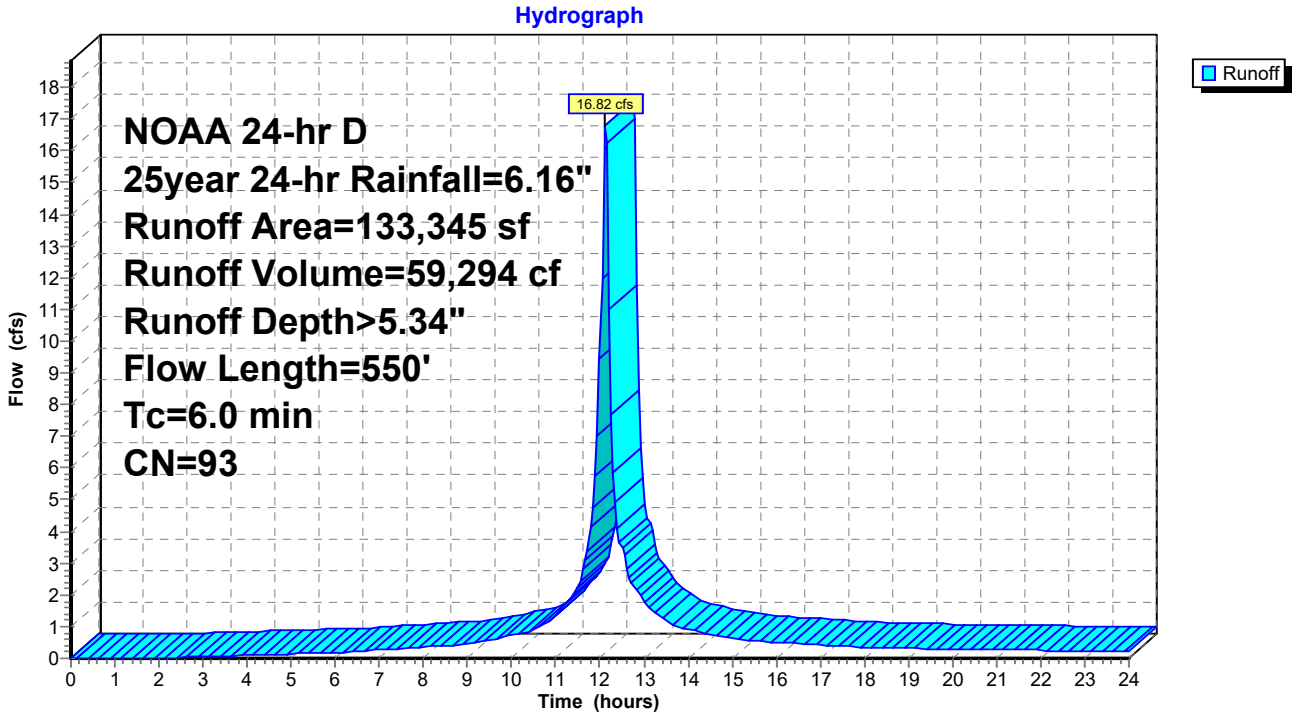
Runoff = 16.82 cfs @ 12.13 hrs, Volume= 59,294 cf, Depth> 5.34"
Routed to Pond Det #1 : SS#1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 25year 24-hr Rainfall=6.16"

Area (sf)	CN	Description
36,318	80	>75% Grass cover, Good, HSG D
66,336	98	Paved parking, HSG D
30,691	98	Roofs, HSG D
133,345	93	Weighted Average
36,318		27.24% Pervious Area
97,027		72.76% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	50	0.0300	1.40		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.17"
1.3	500	0.0100	6.55	5.15	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.009
4.1					**Direct Entry, Minimum Tc of 6 Min**
6.0	550	Total			

Subcatchment PR-2A: SS#1



Summary for Subcatchment PR-2B: SS#2

[47] Hint: Peak is 187% of capacity of segment #2

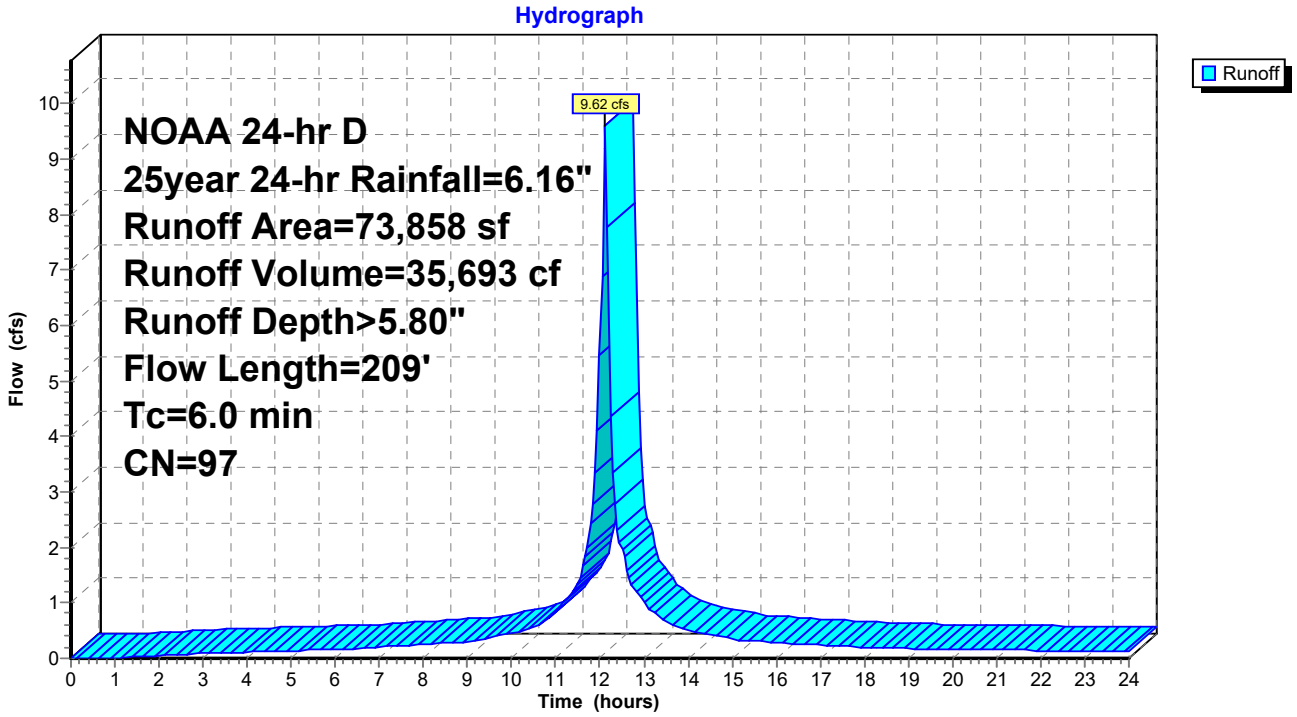
Runoff = 9.62 cfs @ 12.13 hrs, Volume= 35,693 cf, Depth> 5.80"
Routed to Pond Det #2 : SS#2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 25year 24-hr Rainfall=6.16"

Area (sf)	CN	Description
5,507	80	>75% Grass cover, Good, HSG D
44,720	98	Paved parking, HSG D
23,631	98	Roofs, HSG D
73,858	97	Weighted Average
5,507		7.46% Pervious Area
68,351		92.54% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	50	0.0200	1.19		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.17"
0.4	159	0.0100	6.55	5.15	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.009
4.9					**Direct Entry, Minimum Tc of 6 Min**
6.0	209	Total			

Subcatchment PR-2B: SS#2



Summary for Subcatchment PR-2C: PR DP-1 (18" North Drain)

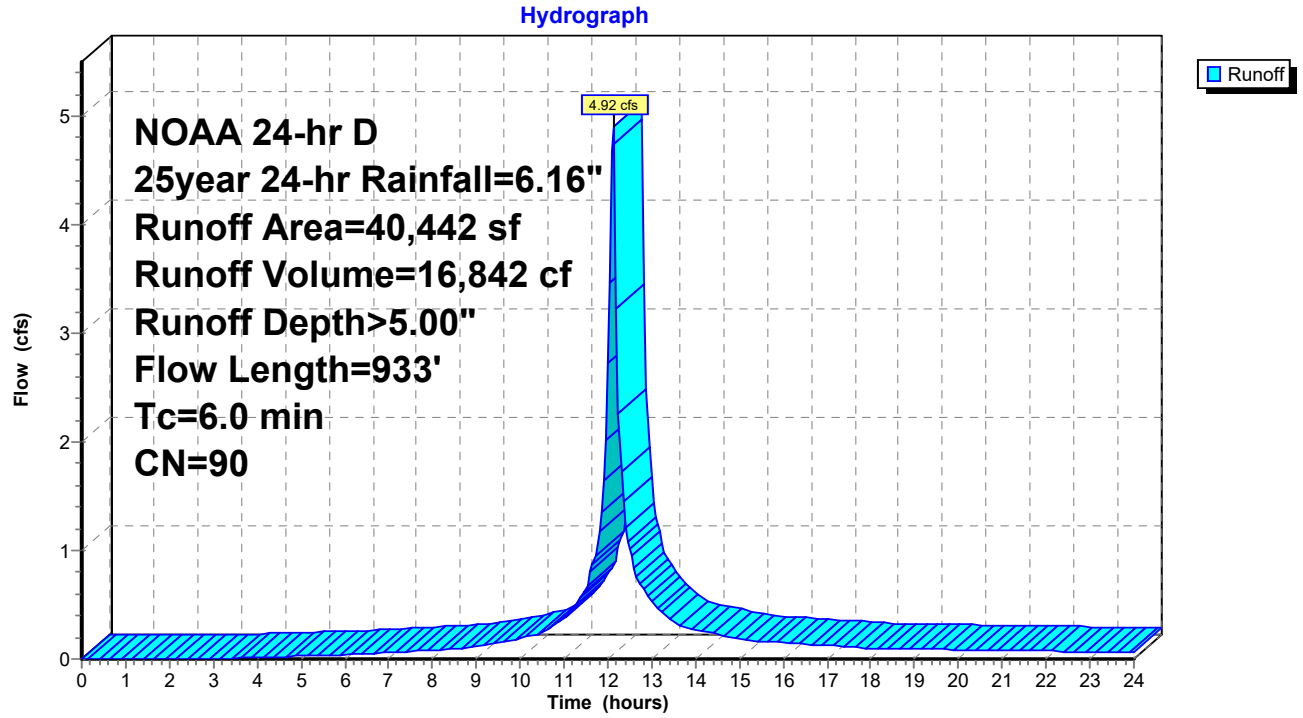
Runoff = 4.92 cfs @ 12.13 hrs, Volume= 16,842 cf, Depth> 5.00"
Routed to Reach DP-2 : 18" NORTH DRAIN

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 25year 24-hr Rainfall=6.16"

Area (sf)	CN	Description
18,246	80	>75% Grass cover, Good, HSG D
22,196	98	Paved parking, HSG D
40,442	90	Weighted Average
18,246		45.12% Pervious Area
22,196		54.88% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.90		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.17"
0.6	108	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.9	775	0.0100	6.84	8.40	**Pipe Channel,** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.010 PVC, smooth interior
2.6					**Direct Entry, Minimum Tc of 6 Min**
6.0	933	Total			

Subcatchment PR-2C: PR DP-1 (18" North Drain)



Summary for Subcatchment PR-3: PR DP-3

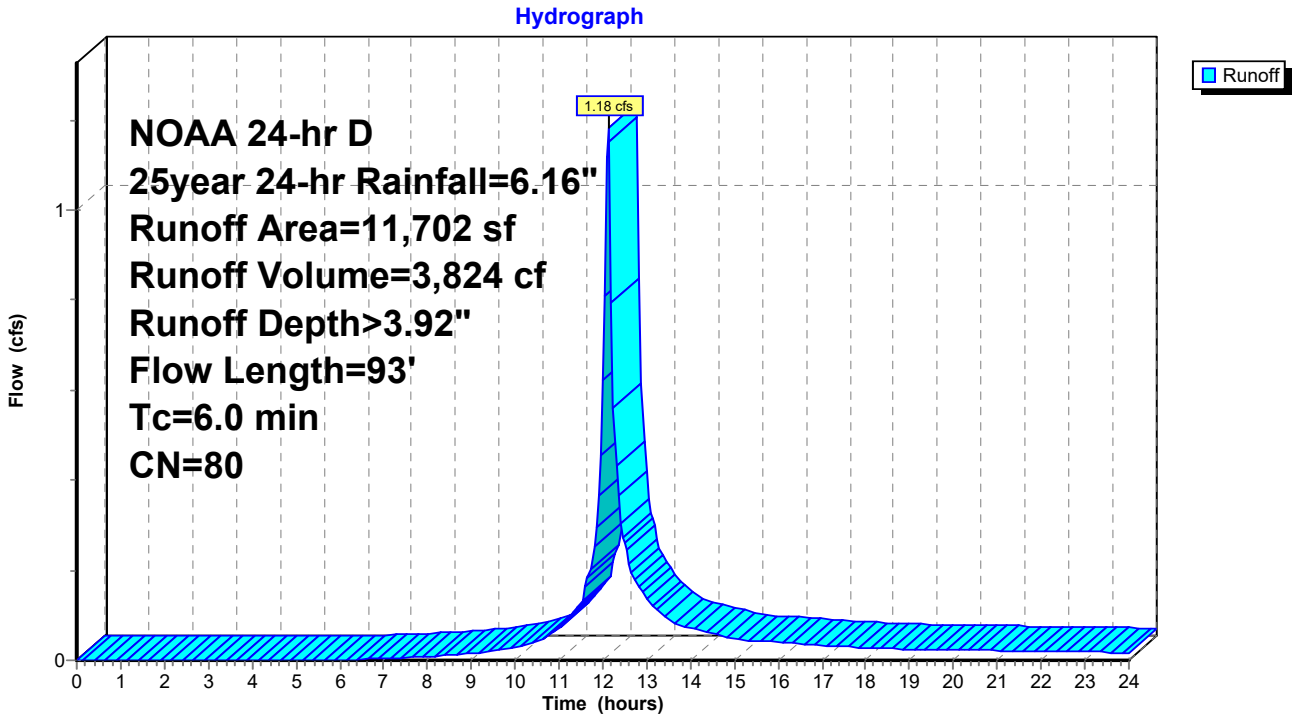
Runoff = 1.18 cfs @ 12.13 hrs, Volume= 3,824 cf, Depth> 3.92"
Routed to Reach DP-3 : 6" DRAIN

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 25year 24-hr Rainfall=6.16"

Area (sf)	CN	Description
11,422	80	>75% Grass cover, Good, HSG D
280	98	Paved parking, HSG D
11,702	80	Weighted Average
11,422		97.61% Pervious Area
280		2.39% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.7	50	0.0200	0.15		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.17"
0.3	43	0.1000	2.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
6.0	93	Total			

Subcatchment PR-3: PR DP-3



Summary for Subcatchment PR-4: PR-4 ROOF

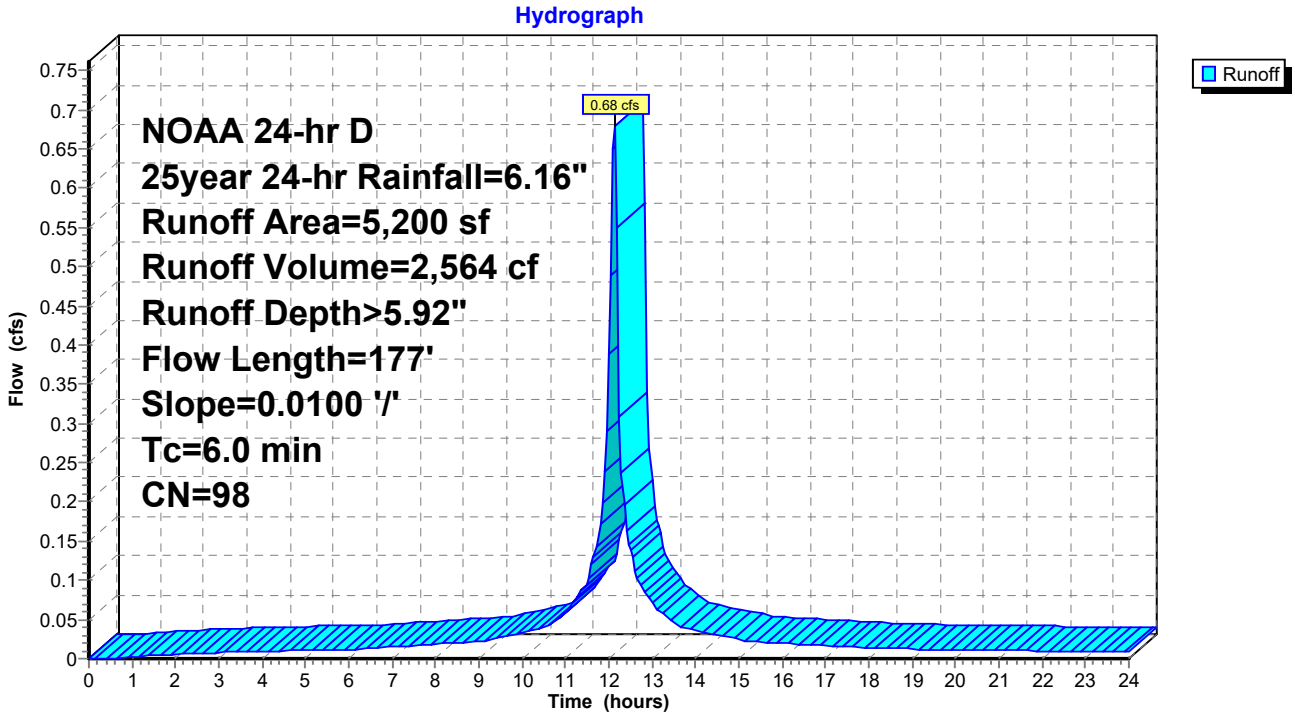
Runoff = 0.68 cfs @ 12.13 hrs, Volume= 2,564 cf, Depth> 5.92"
Routed to Reach DP-4 : SOUTH BVW

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 25year 24-hr Rainfall=6.16"

Area (sf)	CN	Description
5,200	98	Roofs, HSG D
5,200		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.90		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.17"
0.3	127	0.0100	6.55	5.15	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.009
4.8					**Direct Entry, Minimum Tc of 6 Min**
6.0	177	Total			

Subcatchment PR-4: PR-4 ROOF



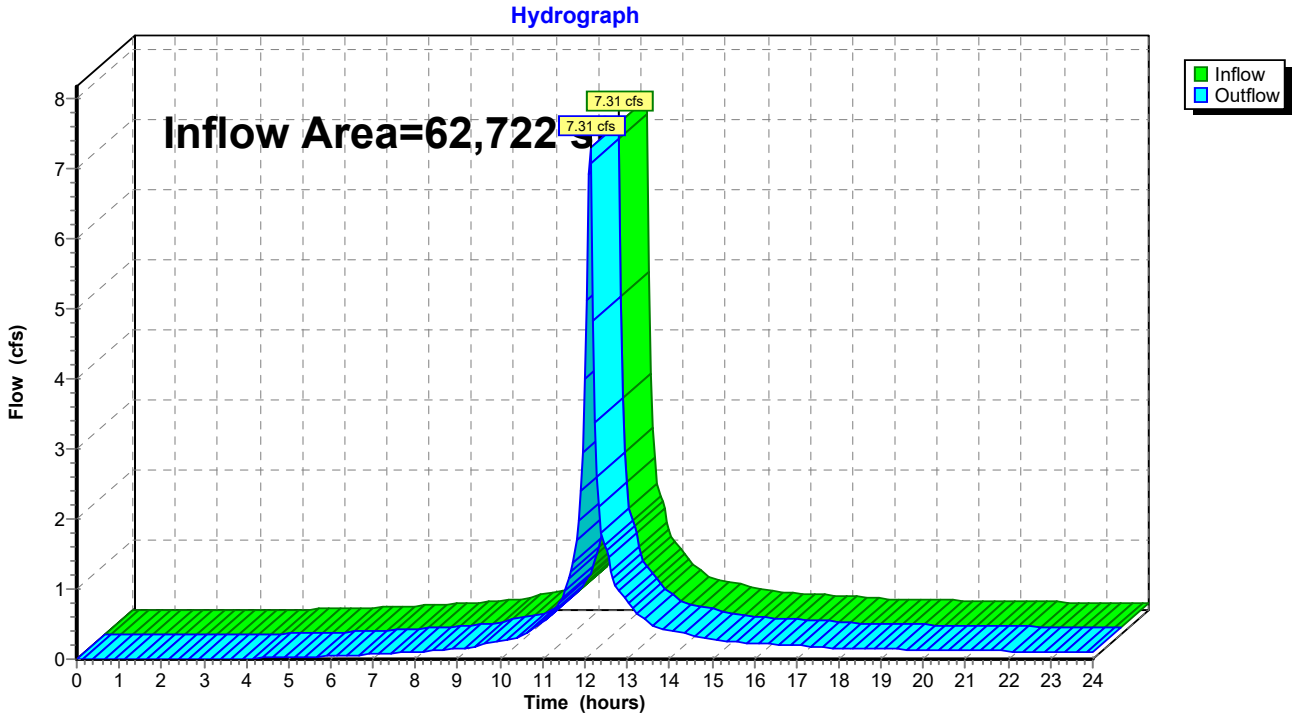
Summary for Reach DP-1: NW BVW

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 62,722 sf, 47.32% Impervious, Inflow Depth > 4.70" for 25year 24-hr event
Inflow = 7.31 cfs @ 12.13 hrs, Volume= 24,554 cf
Outflow = 7.31 cfs @ 12.13 hrs, Volume= 24,554 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-1: NW BVW



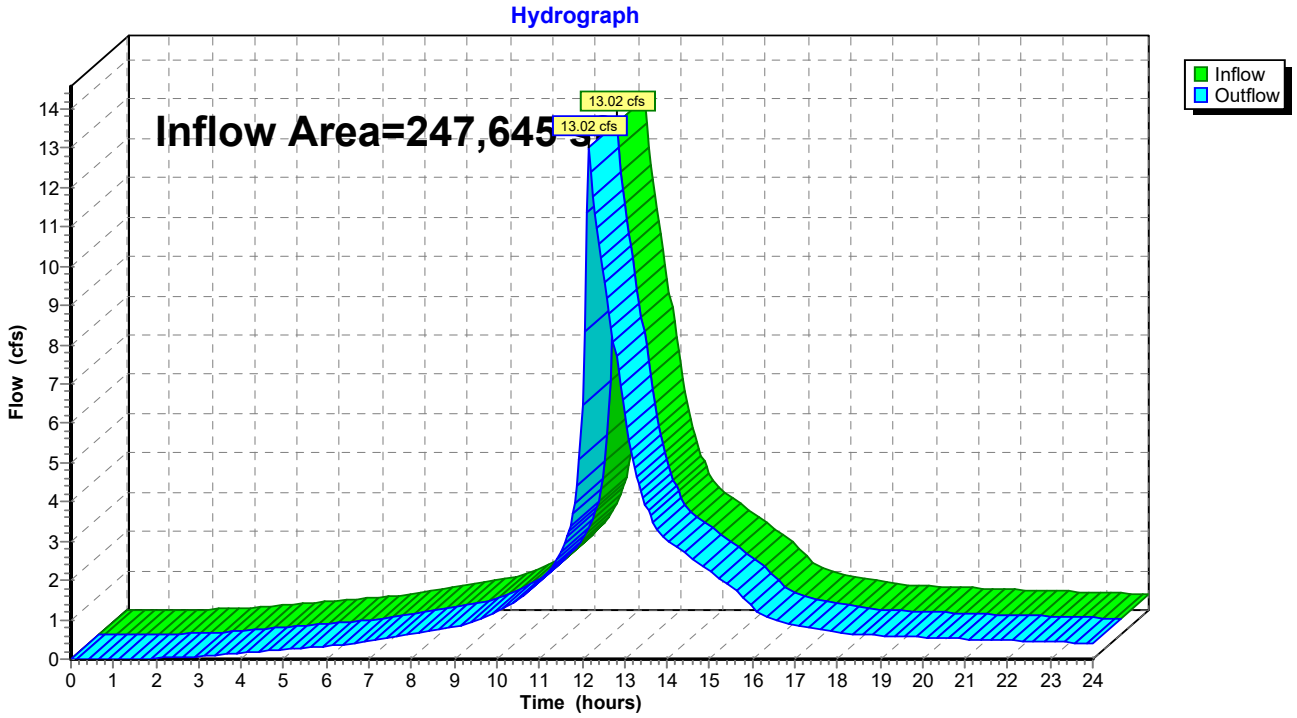
Summary for Reach DP-2: 18" NORTH DRAIN

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 247,645 sf, 75.74% Impervious, Inflow Depth > 5.37" for 25year 24-hr event
Inflow = 13.02 cfs @ 12.16 hrs, Volume= 110,911 cf
Outflow = 13.02 cfs @ 12.16 hrs, Volume= 110,911 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 3

Reach DP-2: 18" NORTH DRAIN



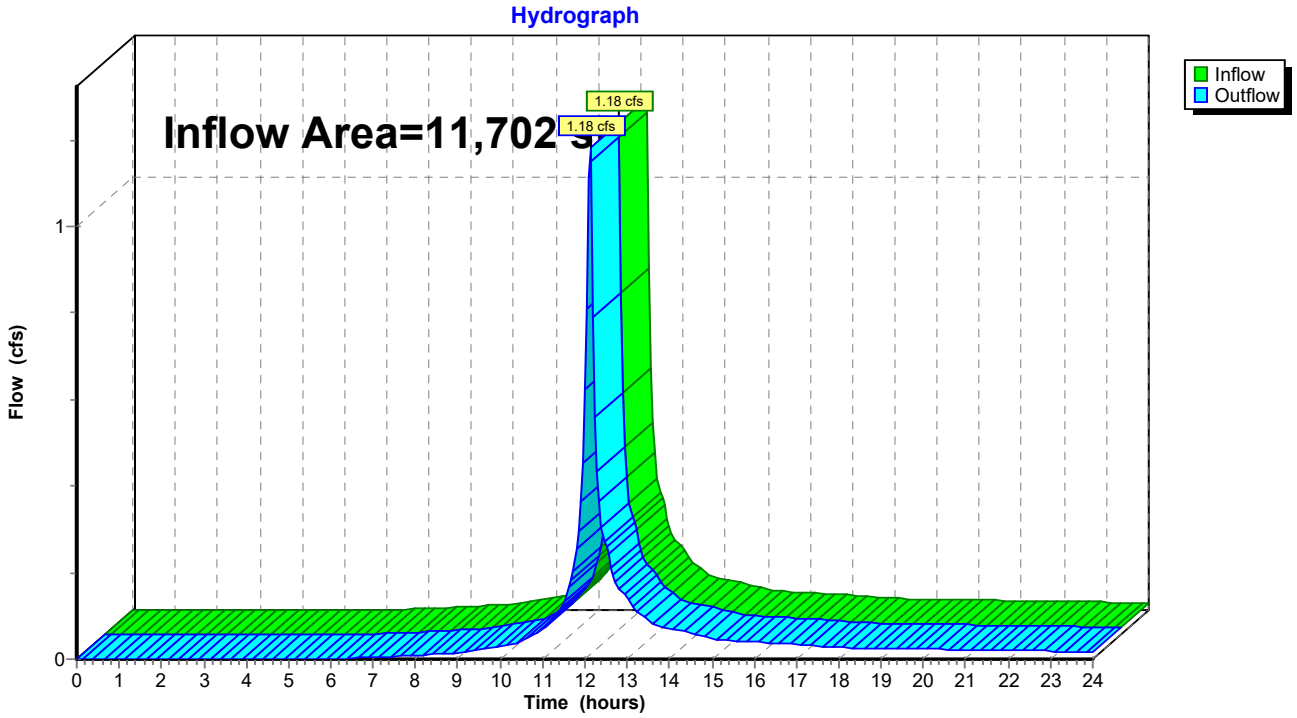
Summary for Reach DP-3: 6" DRAIN

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 11,702 sf, 2.39% Impervious, Inflow Depth > 3.92" for 25year 24-hr event
Inflow = 1.18 cfs @ 12.13 hrs, Volume= 3,824 cf
Outflow = 1.18 cfs @ 12.13 hrs, Volume= 3,824 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-3: 6" DRAIN



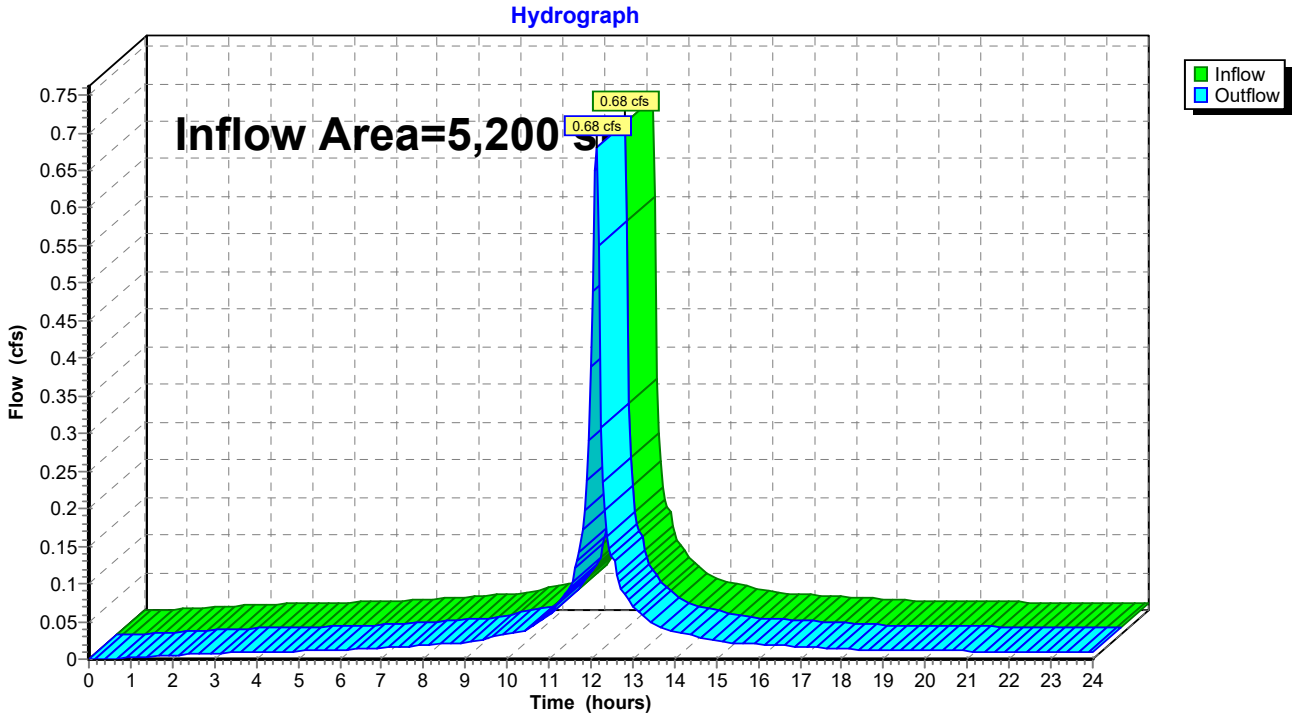
Summary for Reach DP-4: SOUTH BVW

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 5,200 sf,100.00% Impervious, Inflow Depth > 5.92" for 25year 24-hr event
Inflow = 0.68 cfs @ 12.13 hrs, Volume= 2,564 cf
Outflow = 0.68 cfs @ 12.13 hrs, Volume= 2,564 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-4: SOUTH BVW



Summary for Pond Det #1: SS#1

Inflow Area = 133,345 sf, 72.76% Impervious, Inflow Depth > 5.34" for 25year 24-hr event
Inflow = 16.82 cfs @ 12.13 hrs, Volume= 59,294 cf
Outflow = 6.31 cfs @ 12.29 hrs, Volume= 58,702 cf, Atten= 62%, Lag= 10.0 min
Primary = 6.31 cfs @ 12.29 hrs, Volume= 58,702 cf
Routed to Reach DP-2 : 18" NORTH DRAIN

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 56.70' @ 12.29 hrs Surf.Area= 9,069 sf Storage= 15,085 cf

Plug-Flow detention time= 41.5 min calculated for 58,580 cf (99% of inflow)
Center-of-Mass det. time= 35.1 min (810.3 - 775.2)

Volume	Invert	Avail.Storage	Storage Description
#1A	54.20'	7,009 cf	**72.75'W x 124.66'L x 3.50'H Field A** 31,741 cf Overall - 11,715 cf Embedded = 20,026 cf x 35.0% Voids
#2A	54.70'	11,715 cf	**ADS_StormTech SC-740 +Cap** x 255 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 255 Chambers in 15 Rows
		18,724 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Device 4	54.20'	**10.0" W x 6.0" H Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Device 4	55.30'	**12.0" W x 8.0" H Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 4	57.20'	**5.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#4	Primary	46.80'	**18.0" Round Culvert** L= 96.5' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 46.80' / 45.98' S= 0.0085 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 1.77 sf

Primary OutFlow Max=6.31 cfs @ 12.29 hrs HW=56.70' (Free Discharge)
└**4=Culvert** (Passes 6.31 cfs of 24.84 cfs potential flow)
  ├**1=Orifice/Grate** (Orifice Controls 3.01 cfs @ 7.22 fps)
  ├**2=Orifice/Grate** (Orifice Controls 3.30 cfs @ 4.95 fps)
  └**3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond Det #1: SS#1 - Chamber Wizard Field A

Chamber Model = ADS_StormTechSC-740 +Cap (ADS StormTech®SC-740 with cap length)
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

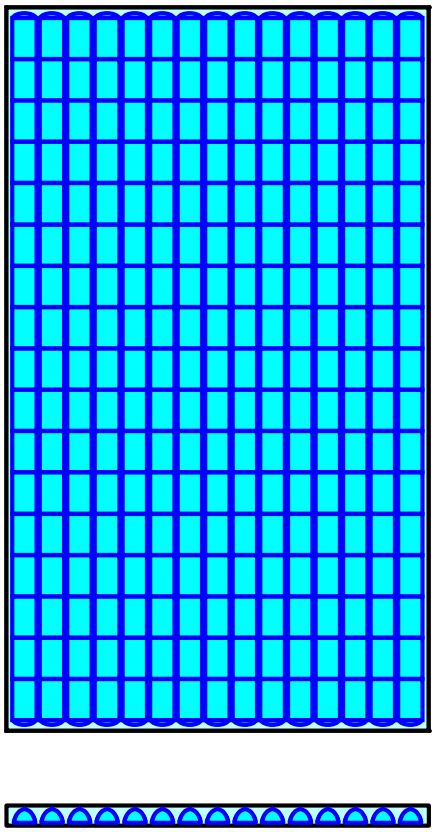
17 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 122.66' Row Length +12.0" End Stone x 2 = 124.66' Base Length
15 Rows x 51.0" Wide + 6.0" Spacing x 14 + 12.0" Side Stone x 2 = 72.75' Base Width
6.0" Stone Base + 30.0" Chamber Height + 6.0" Stone Cover = 3.50' Field Height

255 Chambers x 45.9 cf = 11,714.7 cf Chamber Storage

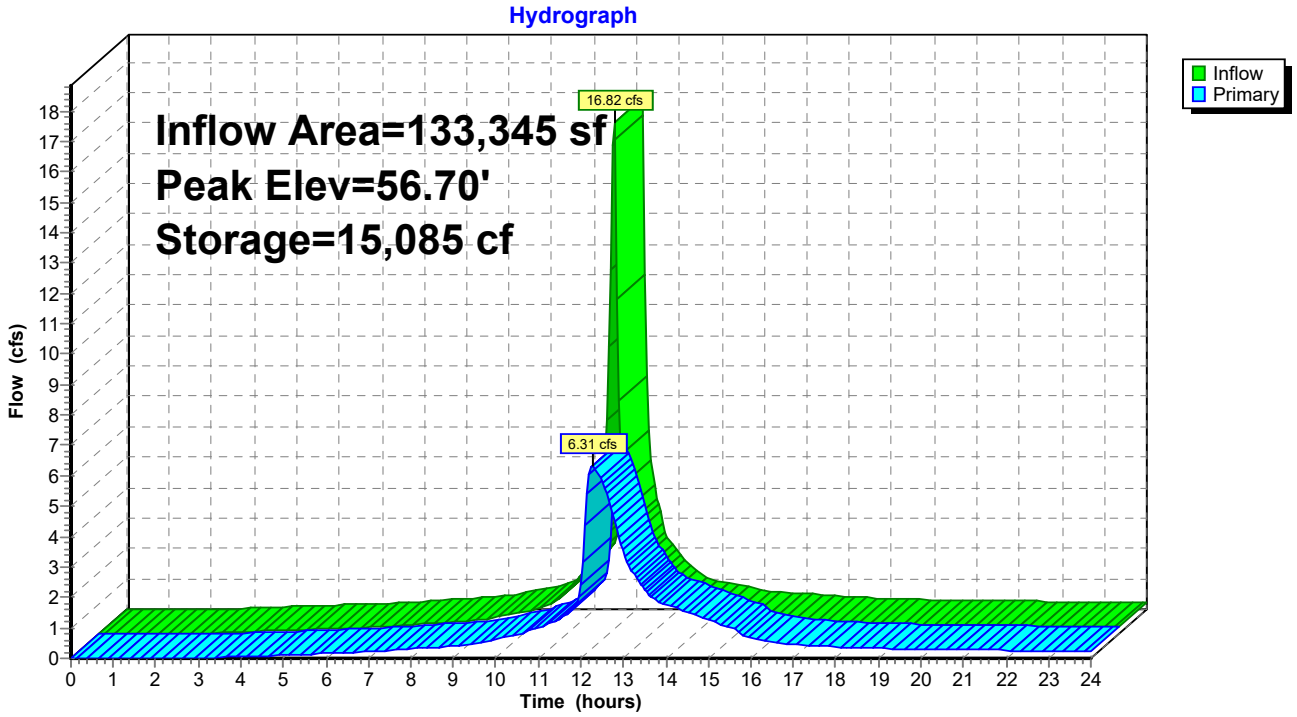
31,740.7 cf Field - 11,714.7 cf Chambers = 20,026.0 cf Stone x 35.0% Voids = 7,009.1 cf Stone Storage

Chamber Storage + Stone Storage = 18,723.8 cf = 0.430 af
Overall Storage Efficiency = 59.0%
Overall System Size = 124.66' x 72.75' x 3.50'

255 Chambers
1,175.6 cy Field
741.7 cy Stone



Pond Det #1: SS#1



Summary for Pond Det #2: SS#2

Inflow Area = 73,858 sf, 92.54% Impervious, Inflow Depth > 5.80" for 25year 24-hr event
Inflow = 9.62 cfs @ 12.13 hrs, Volume= 35,693 cf
Outflow = 3.28 cfs @ 12.31 hrs, Volume= 35,367 cf, Atten= 66%, Lag= 11.1 min
Primary = 3.28 cfs @ 12.31 hrs, Volume= 35,367 cf
Routed to Reach DP-2 : 18" NORTH DRAIN

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 53.68' @ 12.31 hrs Surf.Area= 6,337 sf Storage= 9,278 cf

Plug-Flow detention time= 45.5 min calculated for 35,367 cf (99% of inflow)
Center-of-Mass det. time= 39.4 min (792.0 - 752.7)

Volume	Invert	Avail.Storage	Storage Description
#1A	51.50'	4,909 cf	**53.75'W x 117.54'L x 3.50'H Field A** 22,112 cf Overall - 8,085 cf Embedded = 14,026 cf x 35.0% Voids
#2A	52.00'	8,085 cf	**ADS_StormTech SC-740 +Cap** x 176 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 176 Chambers in 11 Rows
#3	51.50'	157 cf	**5.00'D x 8.00'H Vertical Cone/Cylinder**
		13,152 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Device 4	51.50'	**8.0" W x 4.0" H Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Device 4	52.50'	**8.0" W x 7.0" H Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 4	54.40'	**5.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#4	Primary	48.30'	**18.0" Round Culvert** L= 96.5' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 48.30' / 47.48' S= 0.0085 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 1.77 sf

Primary OutFlow Max=3.28 cfs @ 12.31 hrs HW=53.68' (Free Discharge)
└**4=Culvert** (Passes 3.28 cfs of 17.74 cfs potential flow)
  ├**1=Orifice/Grate** (Orifice Controls 1.52 cfs @ 6.83 fps)
  ├**2=Orifice/Grate** (Orifice Controls 1.76 cfs @ 4.52 fps)
  └**3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond Det #2: SS#2 - Chamber Wizard Field A

Chamber Model = ADS_StormTechSC-740 +Cap (ADS StormTech®SC-740 with cap length)
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

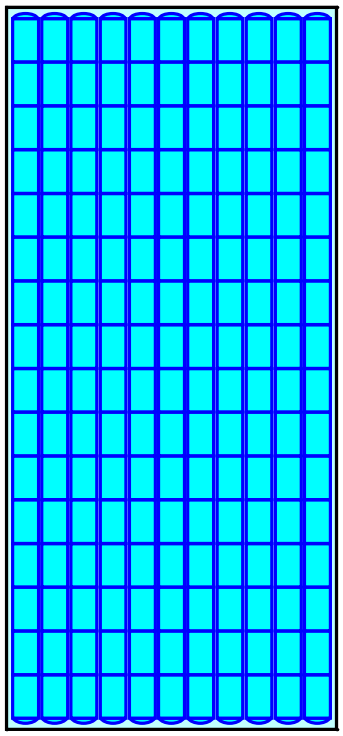
16 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 115.54' Row Length +12.0" End Stone x 2 = 117.54' Base Length
11 Rows x 51.0" Wide + 6.0" Spacing x 10 + 12.0" Side Stone x 2 = 53.75' Base Width
6.0" Stone Base + 30.0" Chamber Height + 6.0" Stone Cover = 3.50' Field Height

176 Chambers x 45.9 cf = 8,085.4 cf Chamber Storage

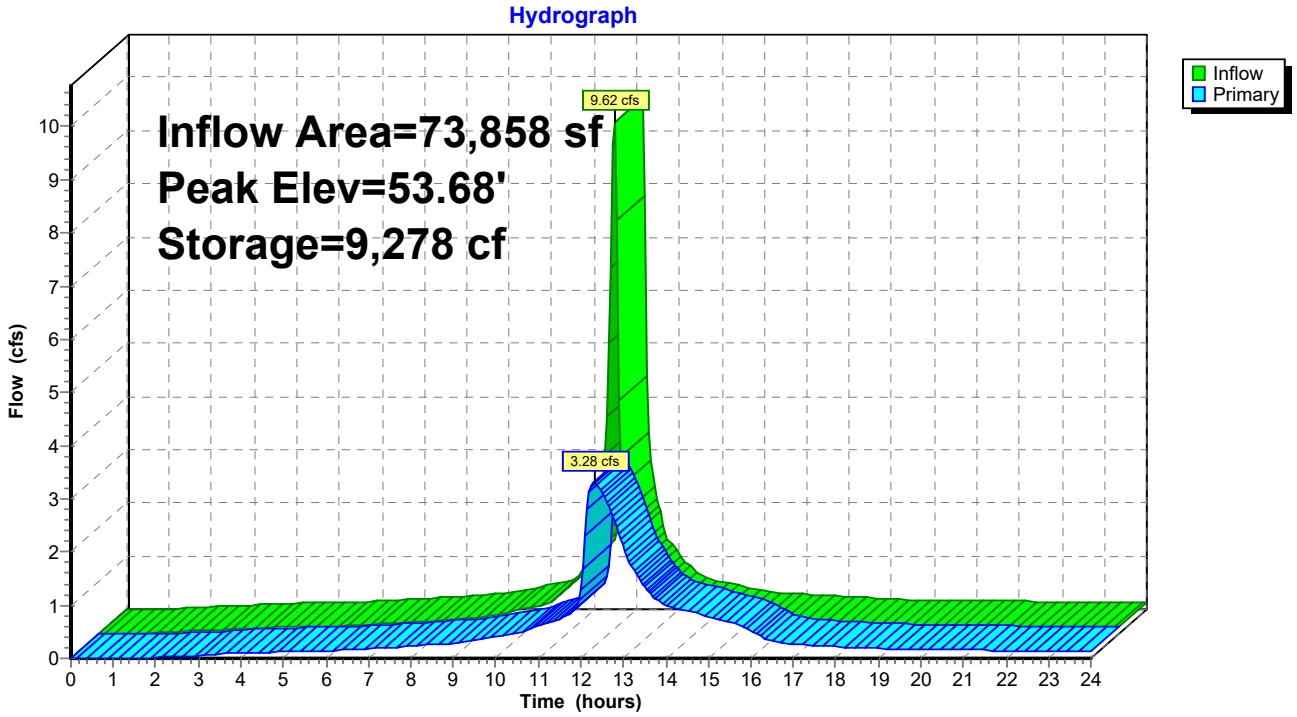
22,111.6 cf Field - 8,085.4 cf Chambers = 14,026.1 cf Stone x 35.0% Voids = 4,909.1 cf Stone Storage

Chamber Storage + Stone Storage = 12,994.6 cf = 0.298 af
Overall Storage Efficiency = 58.8%
Overall System Size = 117.54' x 53.75' x 3.50'

176 Chambers
818.9 cy Field
519.5 cy Stone



Pond Det #2: SS#2



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment PR-1: UU-NW GRASS AREA Runoff Area=5,726 sf 0.00% Impervious Runoff Depth>5.55"
Flow Length=66' Tc=6.0 min CN=80 Runoff=0.81 cfs 2,650 cf

Subcatchment PR-1B: UU-PROPOSED Runoff Area=56,996 sf 52.08% Impervious Runoff Depth>6.49"
Flow Length=288' Tc=6.0 min CN=88 Runoff=8.97 cfs 30,844 cf

Subcatchment PR-2A: SS#1 Runoff Area=133,345 sf 72.76% Impervious Runoff Depth>7.09"
Flow Length=550' Tc=6.0 min CN=93 Runoff=21.96 cfs 78,755 cf

Subcatchment PR-2B: SS#2 Runoff Area=73,858 sf 92.54% Impervious Runoff Depth>7.56"
Flow Length=209' Tc=6.0 min CN=97 Runoff=12.42 cfs 46,559 cf

Subcatchment PR-2C: PR DP-1 (18" North Runoff Area=40,442 sf 54.88% Impervious Runoff Depth>6.73"
Flow Length=933' Tc=6.0 min CN=90 Runoff=6.50 cfs 22,684 cf

Subcatchment PR-3: PR DP-3 Runoff Area=11,702 sf 2.39% Impervious Runoff Depth>5.55"
Flow Length=93' Tc=6.0 min CN=80 Runoff=1.65 cfs 5,416 cf

Subcatchment PR-4: PR-4 ROOF Runoff Area=5,200 sf 100.00% Impervious Runoff Depth>7.68"
Flow Length=177' Slope=0.0100 '/' Tc=6.0 min CN=98 Runoff=0.88 cfs 3,330 cf

Reach DP-1: NW BVW Inflow=9.78 cfs 33,494 cf
Outflow=9.78 cfs 33,494 cf

Reach DP-2: 18" NORTH DRAIN Inflow=21.21 cfs 146,911 cf
Outflow=21.21 cfs 146,911 cf

Reach DP-3: 6" DRAIN Inflow=1.65 cfs 5,416 cf
Outflow=1.65 cfs 5,416 cf

Reach DP-4: SOUTH BVW Inflow=0.88 cfs 3,330 cf
Outflow=0.88 cfs 3,330 cf

Pond Det #1: SS#1 Peak Elev=57.68' Storage=18,668 cf Inflow=21.96 cfs 78,755 cf
Outflow=13.27 cfs 78,053 cf

Pond Det #2: SS#2 Peak Elev=54.51' Storage=11,964 cf Inflow=12.42 cfs 46,559 cf
Outflow=4.82 cfs 46,174 cf

Total Runoff Area = 327,269 sf Runoff Volume = 190,238 cf Average Runoff Depth = 6.98"
31.94% Pervious = 104,532 sf 68.06% Impervious = 222,737 sf

Summary for Subcatchment PR-1: UU-NW GRASS AREA

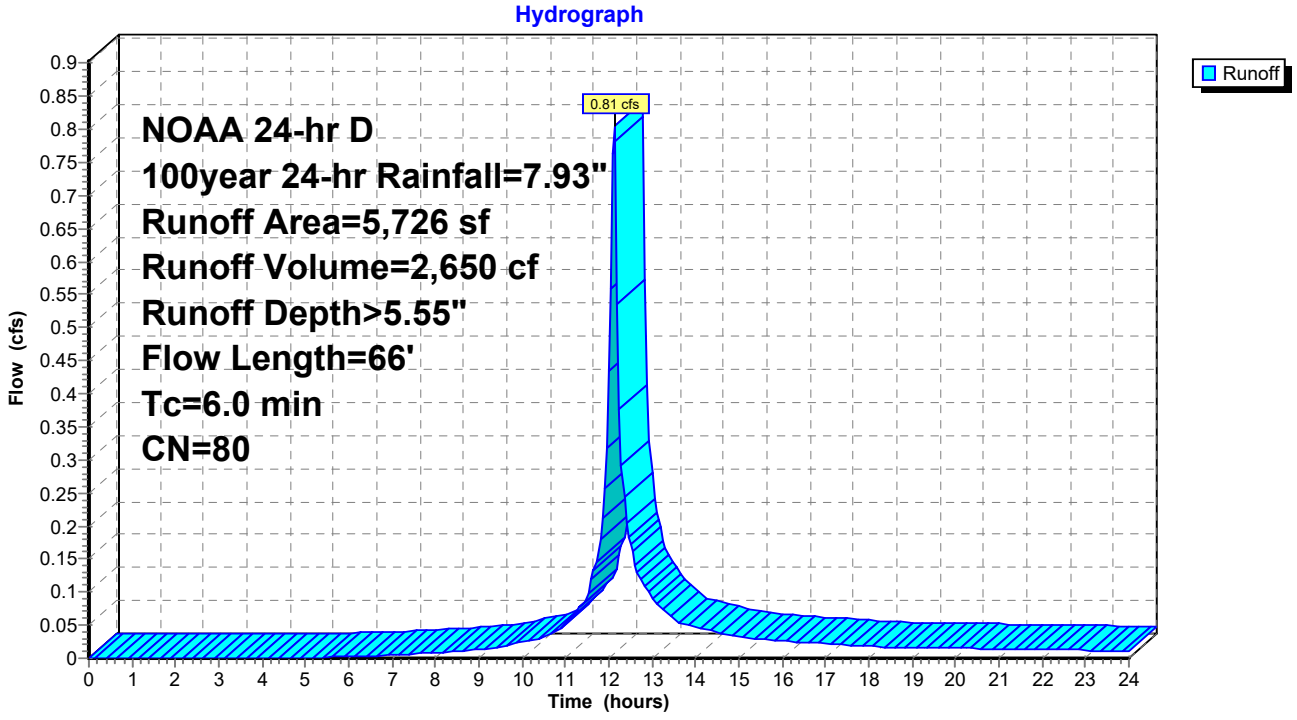
Runoff = 0.81 cfs @ 12.13 hrs, Volume= 2,650 cf, Depth> 5.55"
Routed to Reach DP-1 : NW BVW

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 100year 24-hr Rainfall=7.93"

Area (sf)	CN	Description
5,726	80	>75% Grass cover, Good, HSG D
5,726		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	50	0.0600	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.17"
0.3	16	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
2.1					**Direct Entry, Minimum Tc of 6 Min**
6.0	66	Total			

Subcatchment PR-1: UU-NW GRASS AREA



Summary for Subcatchment PR-1B: UU-PROPOSED

[47] Hint: Peak is 118% of capacity of segment #3

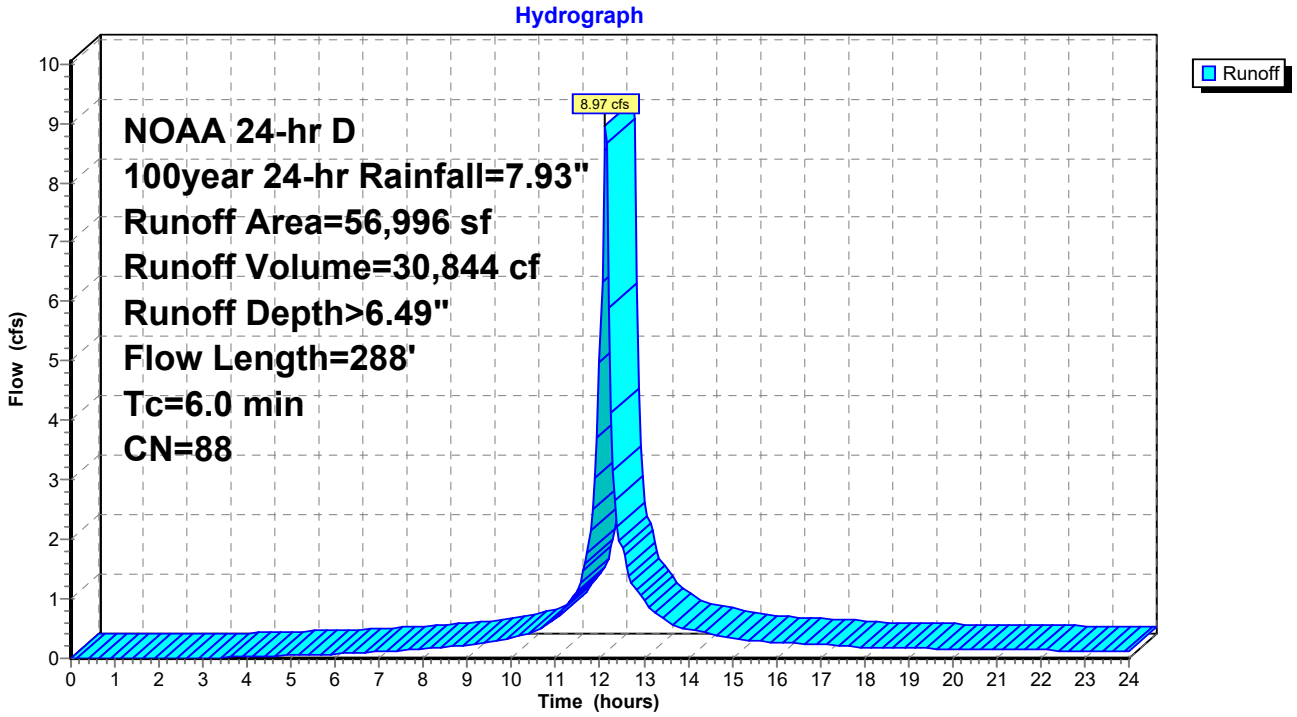
Runoff = 8.97 cfs @ 12.13 hrs, Volume= 30,844 cf, Depth> 6.49"
Routed to Reach DP-1 : NW BVW

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 100year 24-hr Rainfall=7.93"

Area (sf)	CN	Description
7,313	80	>75% Grass cover, Good, HSG D
20,000	77	Woods, Good, HSG D
29,683	98	Paved parking, HSG D
56,996	88	Weighted Average
27,313		47.92% Pervious Area
29,683		52.08% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.90		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.17"
4.3	122	0.0010	0.47		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
0.3	116	0.0100	6.22	7.63	**Pipe Channel, RCP_Round 15"** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.011 Concrete pipe, straight & clean
0.5					**Direct Entry, Minimum Tc of 6 Min**
6.0	288	Total			

Subcatchment PR-1B: UU-PROPOSED



Summary for Subcatchment PR-2A: SS#1

[47] Hint: Peak is 427% of capacity of segment #2

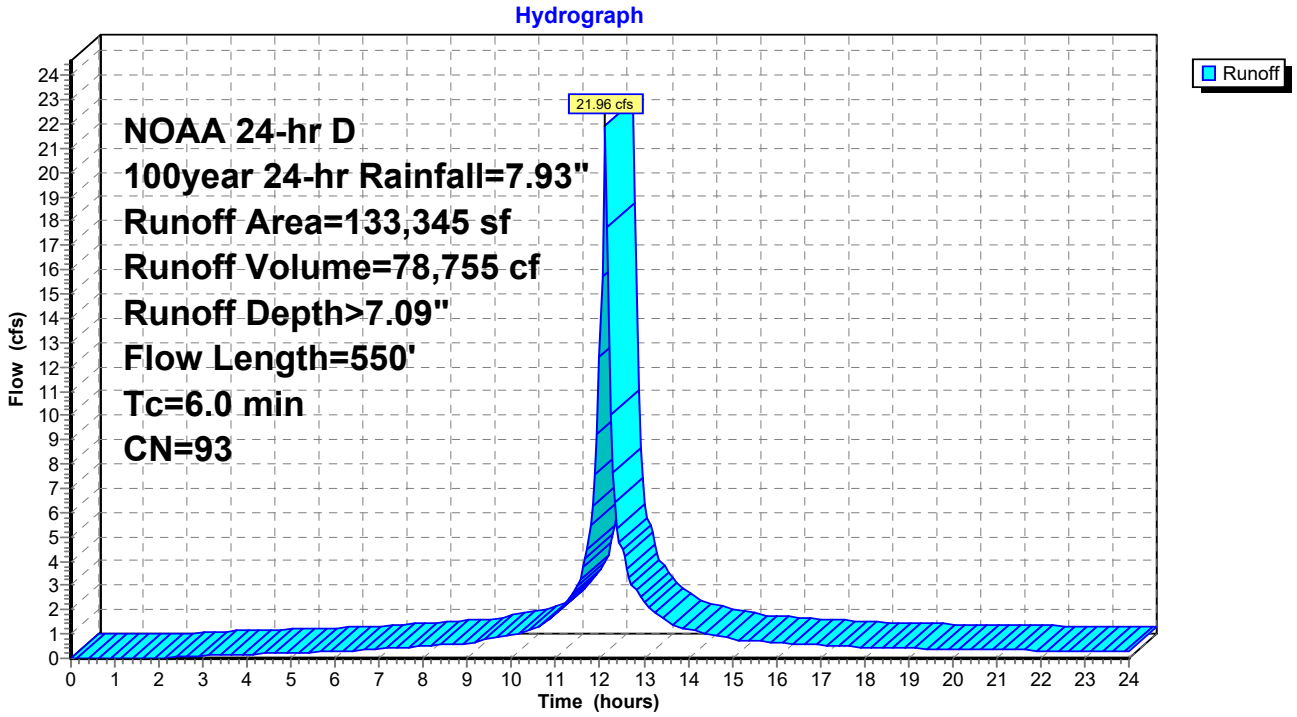
Runoff = 21.96 cfs @ 12.13 hrs, Volume= 78,755 cf, Depth> 7.09"
Routed to Pond Det #1 : SS#1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 100year 24-hr Rainfall=7.93"

Area (sf)	CN	Description
36,318	80	>75% Grass cover, Good, HSG D
66,336	98	Paved parking, HSG D
30,691	98	Roofs, HSG D
133,345	93	Weighted Average
36,318		27.24% Pervious Area
97,027		72.76% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	50	0.0300	1.40		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.17"
1.3	500	0.0100	6.55	5.15	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.009
4.1					**Direct Entry, Minimum Tc of 6 Min**
6.0	550	Total			

Subcatchment PR-2A: SS#1



Summary for Subcatchment PR-2B: SS#2

[47] Hint: Peak is 241% of capacity of segment #2

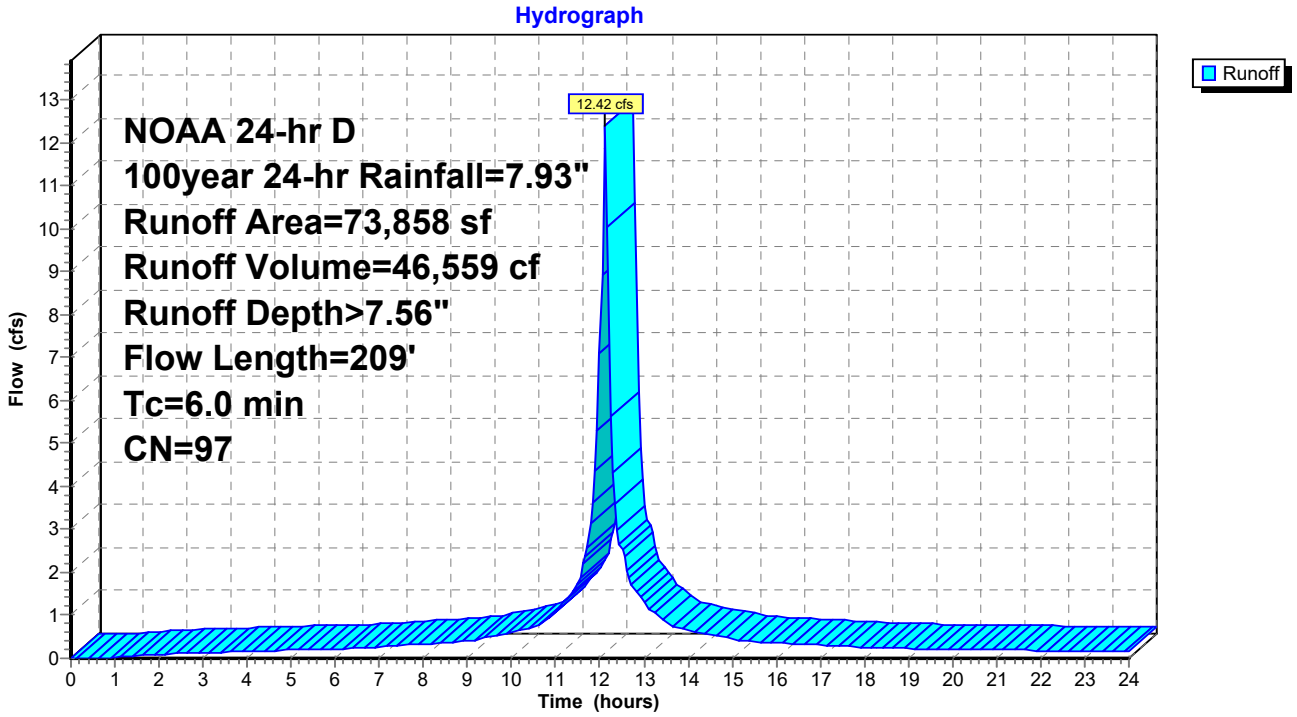
Runoff = 12.42 cfs @ 12.13 hrs, Volume= 46,559 cf, Depth> 7.56"
Routed to Pond Det #2 : SS#2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 100year 24-hr Rainfall=7.93"

Area (sf)	CN	Description
5,507	80	>75% Grass cover, Good, HSG D
44,720	98	Paved parking, HSG D
23,631	98	Roofs, HSG D
73,858	97	Weighted Average
5,507		7.46% Pervious Area
68,351		92.54% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	50	0.0200	1.19		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.17"
0.4	159	0.0100	6.55	5.15	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.009
4.9					**Direct Entry, Minimum Tc of 6 Min**
6.0	209	Total			

Subcatchment PR-2B: SS#2



Summary for Subcatchment PR-2C: PR DP-1 (18" North Drain)

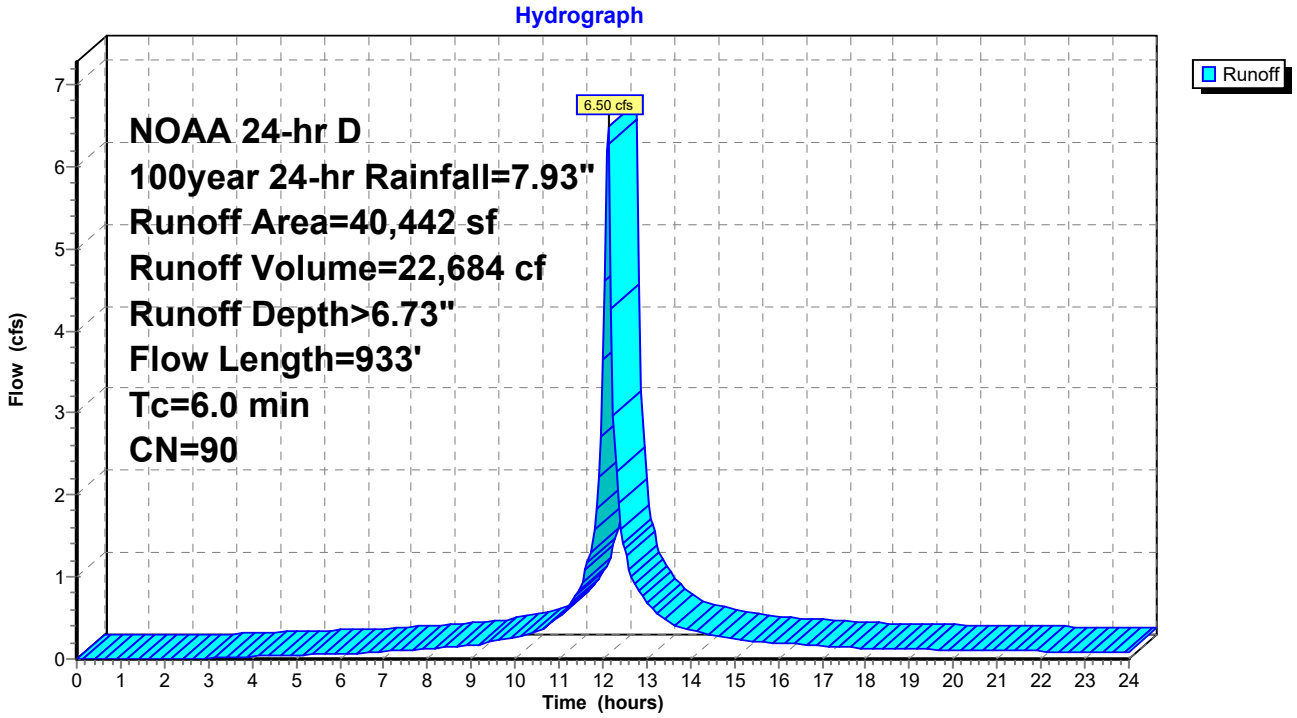
Runoff = 6.50 cfs @ 12.13 hrs, Volume= 22,684 cf, Depth> 6.73"
Routed to Reach DP-2 : 18" NORTH DRAIN

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 100year 24-hr Rainfall=7.93"

Area (sf)	CN	Description
18,246	80	>75% Grass cover, Good, HSG D
22,196	98	Paved parking, HSG D
40,442	90	Weighted Average
18,246		45.12% Pervious Area
22,196		54.88% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.90		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.17"
0.6	108	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.9	775	0.0100	6.84	8.40	**Pipe Channel,** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.010 PVC, smooth interior
2.6					**Direct Entry, Minimum Tc of 6 Min**
6.0	933	Total			

Subcatchment PR-2C: PR DP-1 (18" North Drain)



Summary for Subcatchment PR-3: PR DP-3

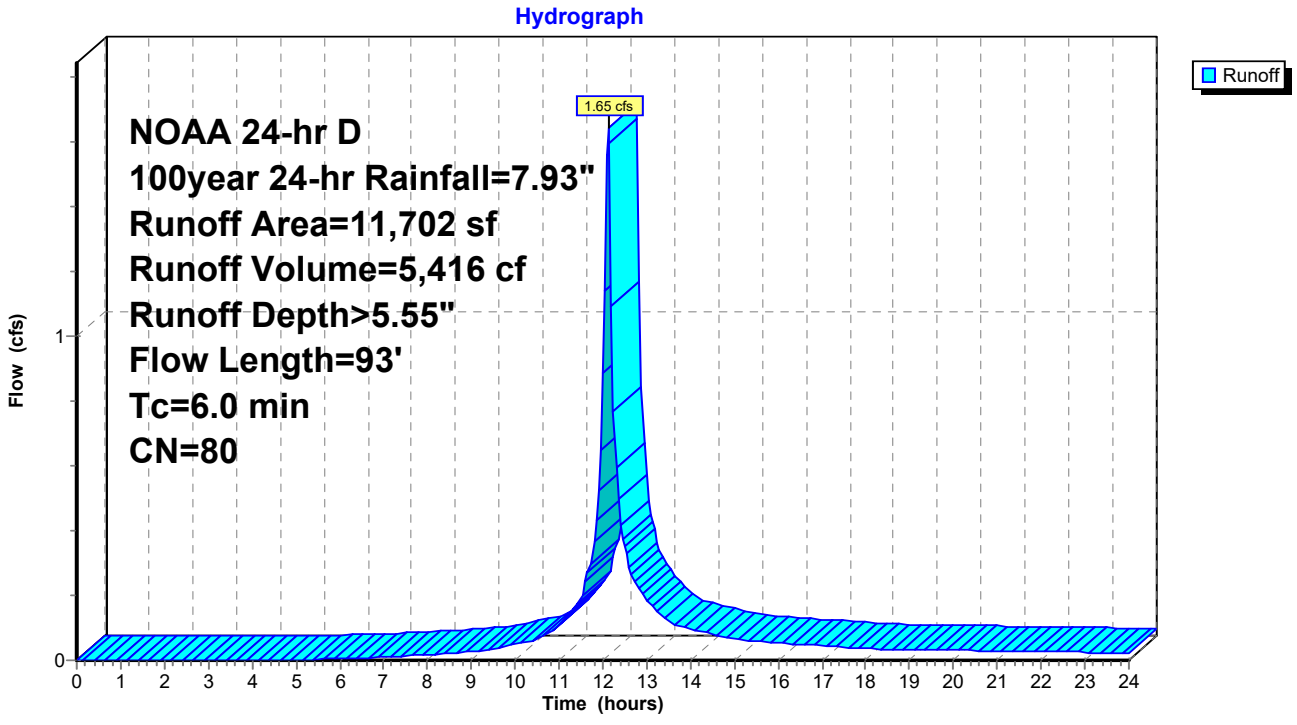
Runoff = 1.65 cfs @ 12.13 hrs, Volume= 5,416 cf, Depth> 5.55"
Routed to Reach DP-3 : 6" DRAIN

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 100year 24-hr Rainfall=7.93"

Area (sf)	CN	Description
11,422	80	>75% Grass cover, Good, HSG D
280	98	Paved parking, HSG D
11,702	80	Weighted Average
11,422		97.61% Pervious Area
280		2.39% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.7	50	0.0200	0.15		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.17"
0.3	43	0.1000	2.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
6.0	93	Total			

Subcatchment PR-3: PR DP-3



Summary for Subcatchment PR-4: PR-4 ROOF

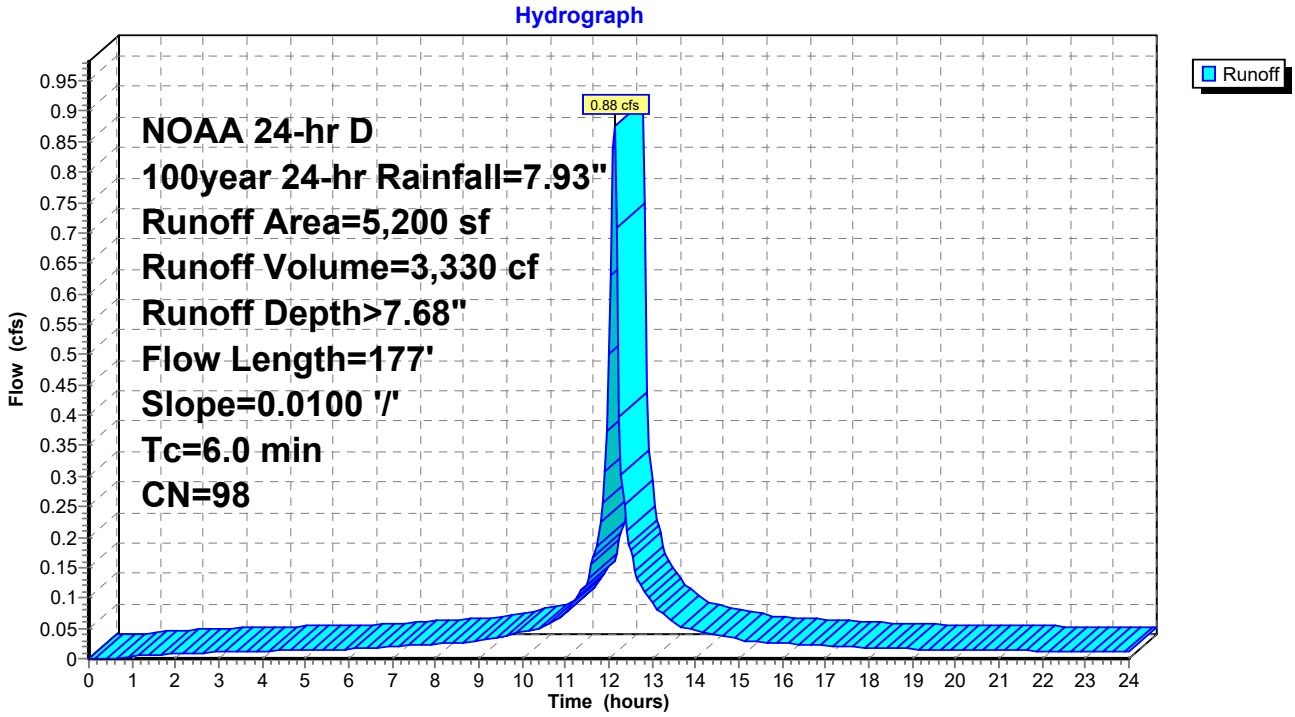
Runoff = 0.88 cfs @ 12.13 hrs, Volume= 3,330 cf, Depth> 7.68"
Routed to Reach DP-4 : SOUTH BVW

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NOAA 24-hr D 100year 24-hr Rainfall=7.93"

Area (sf)	CN	Description
5,200	98	Roofs, HSG D
5,200		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.90		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.17"
0.3	127	0.0100	6.55	5.15	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.009
4.8					**Direct Entry, Minimum Tc of 6 Min**
6.0	177	Total			

Subcatchment PR-4: PR-4 ROOF



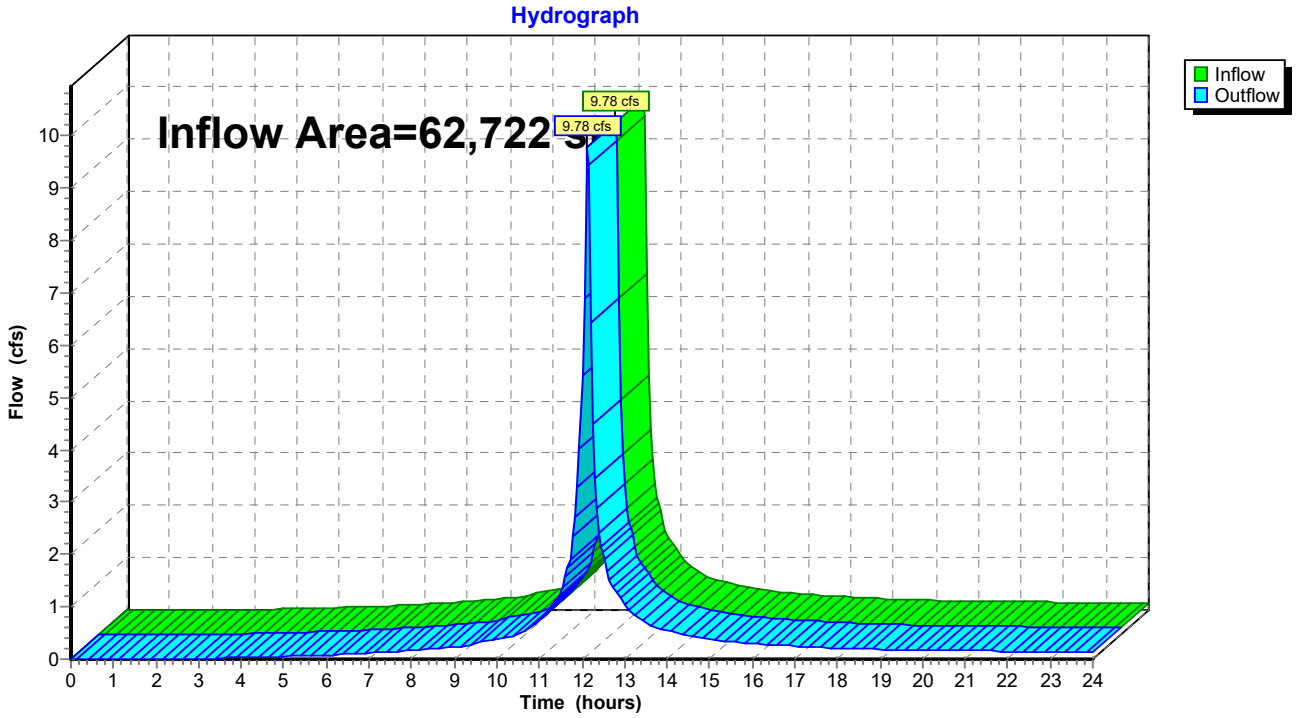
Summary for Reach DP-1: NW BVW

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 62,722 sf, 47.32% Impervious, Inflow Depth > 6.41" for 100year 24-hr event
Inflow = 9.78 cfs @ 12.13 hrs, Volume= 33,494 cf
Outflow = 9.78 cfs @ 12.13 hrs, Volume= 33,494 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-1: NW BVW



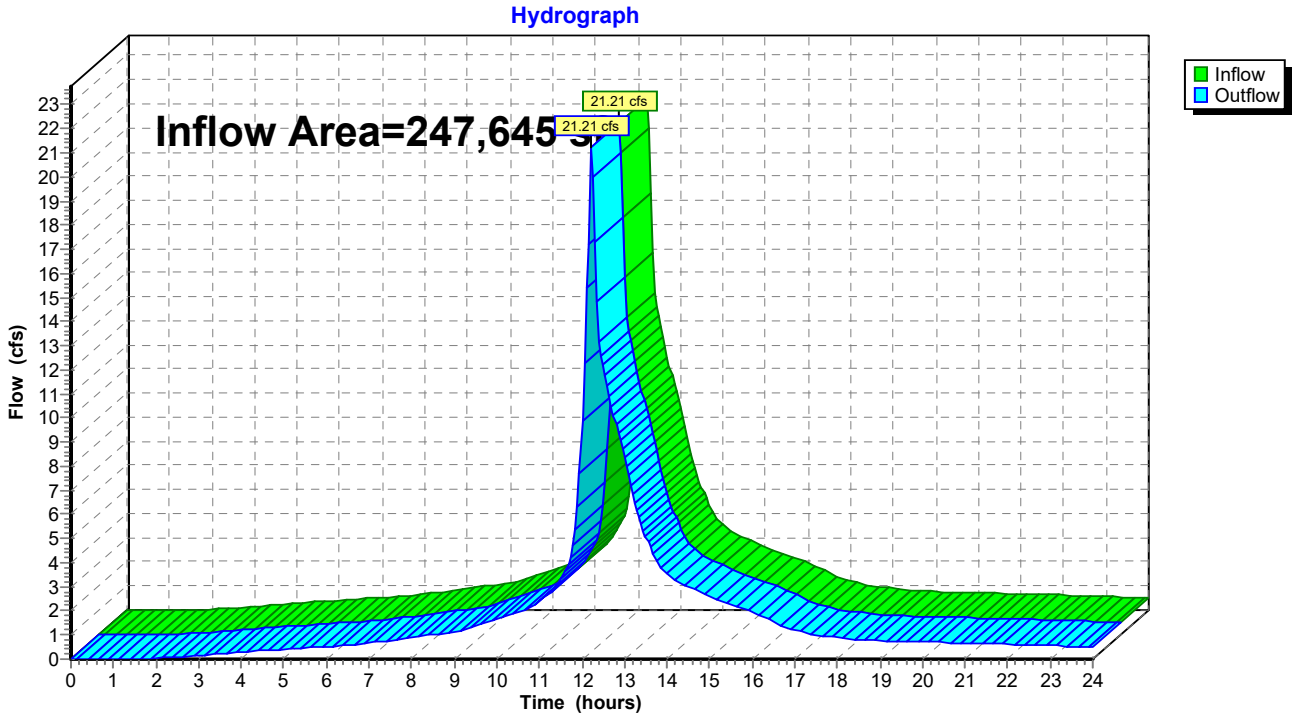
Summary for Reach DP-2: 18" NORTH DRAIN

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 247,645 sf, 75.74% Impervious, Inflow Depth > 7.12" for 100year 24-hr event
Inflow = 21.21 cfs @ 12.21 hrs, Volume= 146,911 cf
Outflow = 21.21 cfs @ 12.21 hrs, Volume= 146,911 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 3

Reach DP-2: 18" NORTH DRAIN



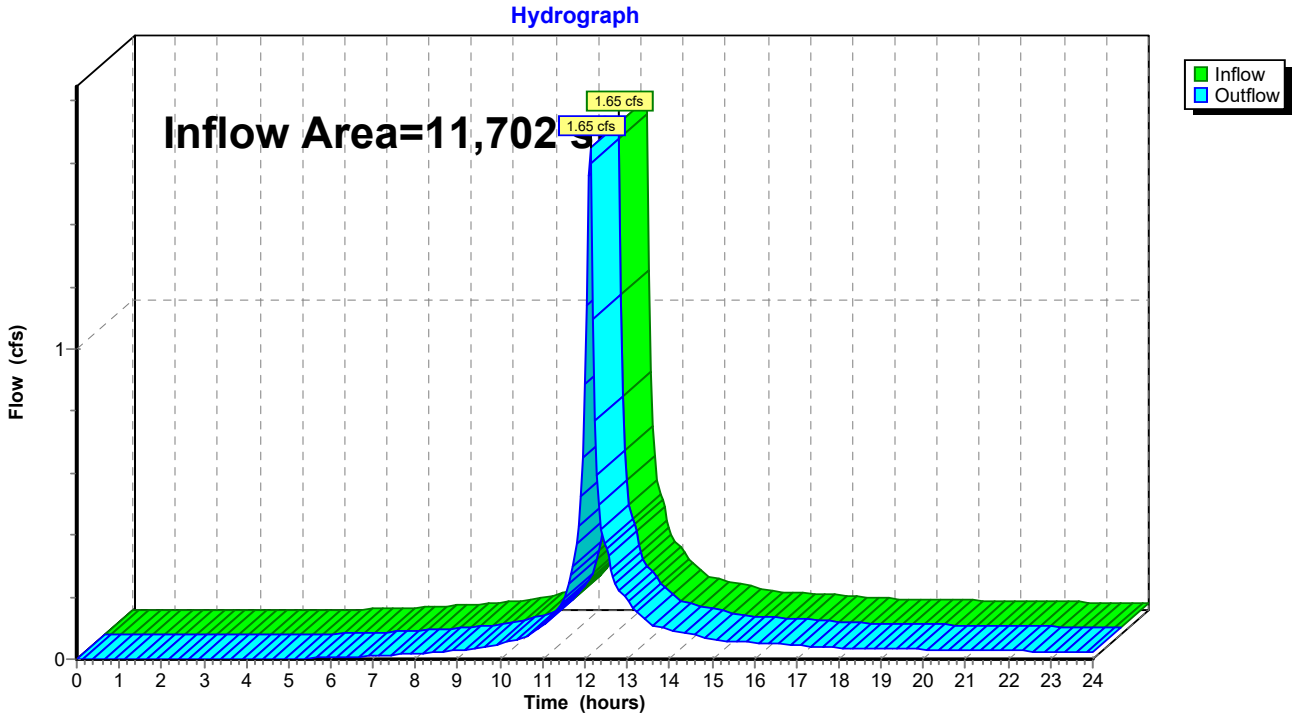
Summary for Reach DP-3: 6" DRAIN

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 11,702 sf, 2.39% Impervious, Inflow Depth > 5.55" for 100year 24-hr event
Inflow = 1.65 cfs @ 12.13 hrs, Volume= 5,416 cf
Outflow = 1.65 cfs @ 12.13 hrs, Volume= 5,416 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-3: 6" DRAIN



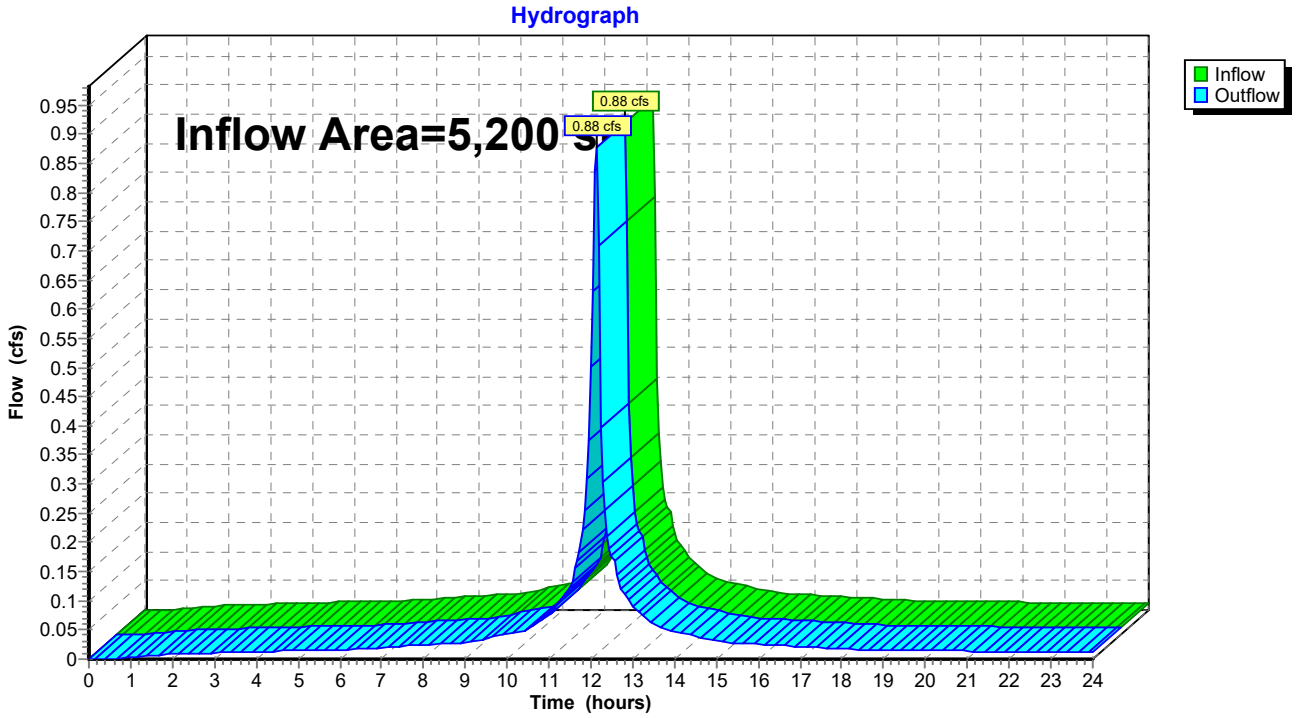
Summary for Reach DP-4: SOUTH BVW

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 5,200 sf,100.00% Impervious, Inflow Depth > 7.68" for 100year 24-hr event
Inflow = 0.88 cfs @ 12.13 hrs, Volume= 3,330 cf
Outflow = 0.88 cfs @ 12.13 hrs, Volume= 3,330 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach DP-4: SOUTH BVW



Summary for Pond Det #1: SS#1

Inflow Area = 133,345 sf, 72.76% Impervious, Inflow Depth > 7.09" for 100year 24-hr event
Inflow = 21.96 cfs @ 12.13 hrs, Volume= 78,755 cf
Outflow = 13.27 cfs @ 12.22 hrs, Volume= 78,053 cf, Atten= 40%, Lag= 5.7 min
Primary = 13.27 cfs @ 12.22 hrs, Volume= 78,053 cf
Routed to Reach DP-2 : 18" NORTH DRAIN

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 57.68' @ 12.22 hrs Surf.Area= 9,069 sf Storage= 18,668 cf

Plug-Flow detention time= 39.5 min calculated for 78,053 cf (99% of inflow)
Center-of-Mass det. time= 33.7 min (801.5 - 767.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	54.20'	7,009 cf	**72.75'W x 124.66'L x 3.50'H Field A** 31,741 cf Overall - 11,715 cf Embedded = 20,026 cf x 35.0% Voids
#2A	54.70'	11,715 cf	**ADS_StormTech SC-740 +Cap** x 255 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 255 Chambers in 15 Rows
		18,724 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Device 4	54.20'	**10.0" W x 6.0" H Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Device 4	55.30'	**12.0" W x 8.0" H Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 4	57.20'	**5.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#4	Primary	46.80'	**18.0" Round Culvert** L= 96.5' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 46.80' / 45.98' S= 0.0085 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 1.77 sf

Primary OutFlow Max=12.56 cfs @ 12.22 hrs HW=57.63' (Free Discharge)
└**4=Culvert** (Passes 12.56 cfs of 26.06 cfs potential flow)
  ├**1=Orifice/Grate** (Orifice Controls 3.57 cfs @ 8.58 fps)
  ├**2=Orifice/Grate** (Orifice Controls 4.53 cfs @ 6.79 fps)
  └**3=Sharp-Crested Rectangular Weir** (Weir Controls 4.46 cfs @ 2.13 fps)

Pond Det #1: SS#1 - Chamber Wizard Field A

Chamber Model = ADS_StormTechSC-740 +Cap (ADS StormTech®SC-740 with cap length)
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

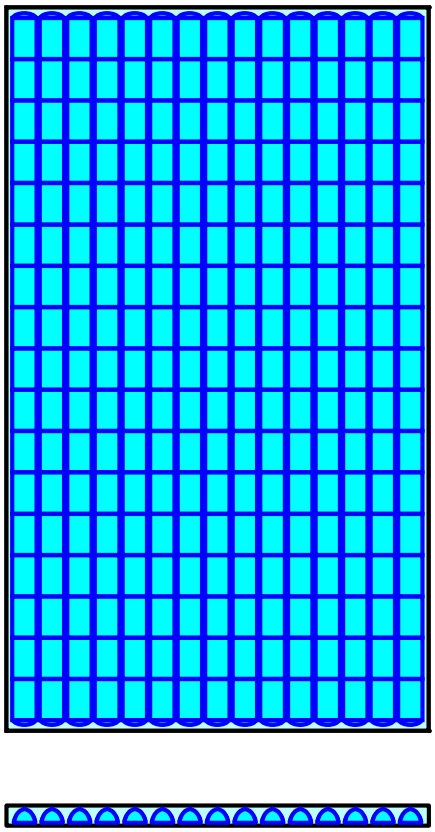
17 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 122.66' Row Length +12.0" End Stone x 2 = 124.66' Base Length
15 Rows x 51.0" Wide + 6.0" Spacing x 14 + 12.0" Side Stone x 2 = 72.75' Base Width
6.0" Stone Base + 30.0" Chamber Height + 6.0" Stone Cover = 3.50' Field Height

255 Chambers x 45.9 cf = 11,714.7 cf Chamber Storage

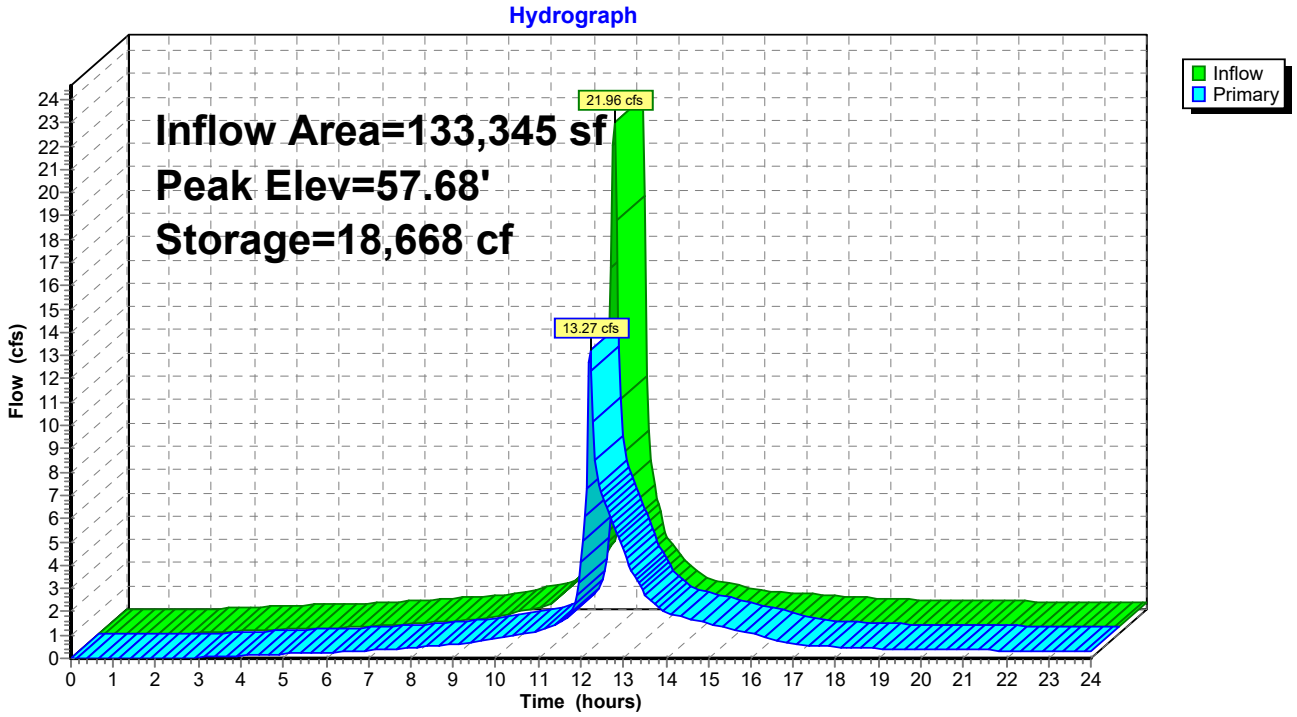
31,740.7 cf Field - 11,714.7 cf Chambers = 20,026.0 cf Stone x 35.0% Voids = 7,009.1 cf Stone Storage

Chamber Storage + Stone Storage = 18,723.8 cf = 0.430 af
Overall Storage Efficiency = 59.0%
Overall System Size = 124.66' x 72.75' x 3.50'

255 Chambers
1,175.6 cy Field
741.7 cy Stone



Pond Det #1: SS#1



Summary for Pond Det #2: SS#2

Inflow Area = 73,858 sf, 92.54% Impervious, Inflow Depth > 7.56" for 100year 24-hr event
Inflow = 12.42 cfs @ 12.13 hrs, Volume= 46,559 cf
Outflow = 4.82 cfs @ 12.29 hrs, Volume= 46,174 cf, Atten= 61%, Lag= 9.8 min
Primary = 4.82 cfs @ 12.29 hrs, Volume= 46,174 cf
Routed to Reach DP-2 : 18" NORTH DRAIN

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 54.51' @ 12.29 hrs Surf.Area= 6,337 sf Storage= 11,964 cf

Plug-Flow detention time= 44.9 min calculated for 46,078 cf (99% of inflow)
Center-of-Mass det. time= 39.3 min (787.3 - 747.9)

Volume	Invert	Avail.Storage	Storage Description
#1A	51.50'	4,909 cf	**53.75'W x 117.54'L x 3.50'H Field A** 22,112 cf Overall - 8,085 cf Embedded = 14,026 cf x 35.0% Voids
#2A	52.00'	8,085 cf	**ADS_StormTech SC-740 +Cap** x 176 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 176 Chambers in 11 Rows
#3	51.50'	157 cf	**5.00'D x 8.00'H Vertical Cone/Cylinder**
		13,152 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Device 4	51.50'	**8.0" W x 4.0" H Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Device 4	52.50'	**8.0" W x 7.0" H Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 4	54.40'	**5.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#4	Primary	48.30'	**18.0" Round Culvert** L= 96.5' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 48.30' / 47.48' S= 0.0085 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 1.77 sf

Primary OutFlow Max=4.77 cfs @ 12.29 hrs HW=54.50' (Free Discharge)
└**4=Culvert** (Passes 4.77 cfs of 19.23 cfs potential flow)
  ├**1=Orifice/Grate** (Orifice Controls 1.80 cfs @ 8.11 fps)
  ├**2=Orifice/Grate** (Orifice Controls 2.45 cfs @ 6.29 fps)
  └**3=Sharp-Crested Rectangular Weir** (Weir Controls 0.52 cfs @ 1.04 fps)

Pond Det #2: SS#2 - Chamber Wizard Field A

Chamber Model = ADS_StormTechSC-740 +Cap (ADS StormTech®SC-740 with cap length)
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

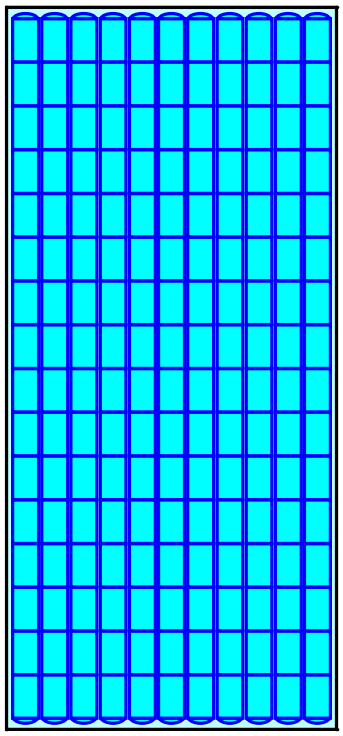
16 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 115.54' Row Length +12.0" End Stone x 2 = 117.54' Base Length
11 Rows x 51.0" Wide + 6.0" Spacing x 10 + 12.0" Side Stone x 2 = 53.75' Base Width
6.0" Stone Base + 30.0" Chamber Height + 6.0" Stone Cover = 3.50' Field Height

176 Chambers x 45.9 cf = 8,085.4 cf Chamber Storage

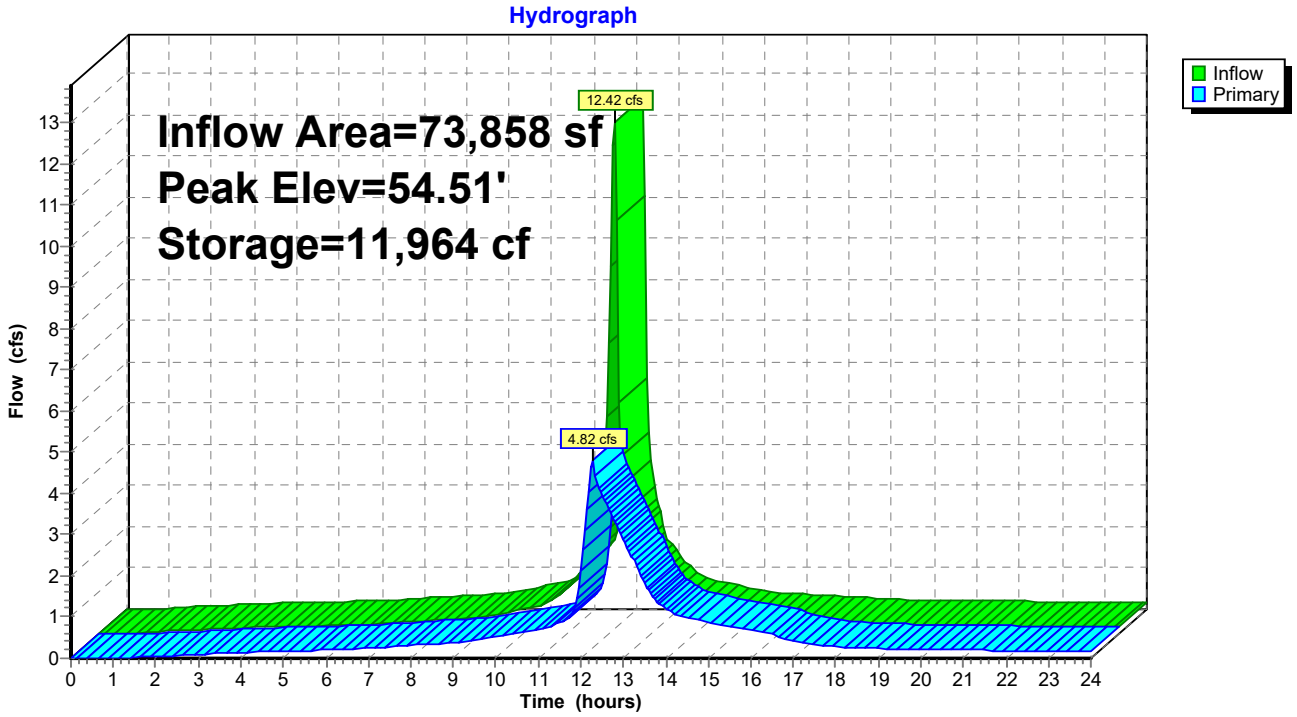
22,111.6 cf Field - 8,085.4 cf Chambers = 14,026.1 cf Stone x 35.0% Voids = 4,909.1 cf Stone Storage

Chamber Storage + Stone Storage = 12,994.6 cf = 0.298 af
Overall Storage Efficiency = 58.8%
Overall System Size = 117.54' x 53.75' x 3.50'

176 Chambers
818.9 cy Field
519.5 cy Stone



Pond Det #2: SS#2



Rainfall Details

Return Period..... 25 year(s)

Subbasin Summary

Subbasin Name	Area (ac)	Weighted Runoff Coefficient	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
AD-100	0.10	0.90	0.70	0 00:06:00
AD-101	0.07	0.90	0.51	0 00:06:00
AD-102	0.17	0.64	0.83	0 00:06:00
AD-103	0.16	0.79	1.00	0 00:06:00
AD-104	0.05	0.60	0.22	0 00:06:00
AD-105	0.05	0.67	0.26	0 00:06:00
AD-106	0.06	0.90	0.44	0 00:06:00
AD-107	0.12	0.75	0.72	0 00:06:00
AD-108	0.06	0.71	0.31	0 00:06:00
AD-109	0.12	0.90	0.85	0 00:06:00
CB-100	0.17	0.90	1.18	0 00:06:00
CB-101	0.11	0.60	0.52	0 00:06:00
CB-102	0.04	0.90	0.28	0 00:06:00
CB-103	0.07	0.63	0.36	0 00:06:00
CB-104	0.05	0.90	0.33	0 00:05:00
CB-105	0.03	0.90	0.20	0 00:06:00
CB-106	0.06	0.57	0.26	0 00:06:00
CB-107	0.11	0.84	0.74	0 00:06:00
CB-108	0.16	0.79	1.01	0 00:06:00
CB-109	0.12	0.90	0.85	0 00:06:00
CB-110	0.04	0.90	0.31	0 00:06:00
CB-111	0.08	0.90	0.53	0 00:06:00
CB-112	0.12	0.90	0.84	0 00:06:00
CB-113	0.03	0.90	0.18	0 00:06:00
CB-114	0.10	0.90	0.68	0 00:06:00
CB-115	0.08	0.71	0.45	0 00:06:00
CB-116	0.05	0.90	0.37	0 00:06:00
CB-117	0.09	0.73	0.51	0 00:06:00
CB-118	0.11	0.86	0.72	0 00:06:00
CB-119	0.12	0.85	0.81	0 00:06:00
CB-121	0.08	0.90	0.58	0 00:06:00
CB-122	0.07	0.90	0.46	0 00:06:00
CB-123	0.18	0.46	0.64	0 00:06:00
CB-135	0.33	0.52	1.34	0 00:06:00
CB-136	0.10	0.90	0.67	0 00:06:00
CB-137	0.09	0.90	0.63	0 00:06:00
CB-138	0.02	0.67	0.12	0 00:06:00
RD-1	0.38	0.90	2.64	0 00:06:00
RD-2	0.31	0.90	2.18	0 00:06:00
RD-3	0.39	0.90	2.78	0 00:06:00
RD-4	0.29	0.90	2.01	0 00:06:00
SS-1	0.88	0.43	2.97	0 00:06:00
TD-1	0.09	0.90	0.65	0 00:06:00

Link Summary

Pipe Name	From (Inlet) Node	Inlet Invert Elevation	To (Outlet) Node	Outlet Invert Elevation	Pipe Length	Pipe Slope	Pipe Diameter	Manning's Roughness	Peak Flow Q	Peak Flow Velocity	Pipe Design Capacity Qf	Q/Qf Ratio
		(ft)		(ft)	(ft)	(%)	(in)		(cfs)	(ft/sec)	(cfs)	
EXISTING	EX-DMH	46.80	EX-DMH2	45.98	97	0.85	18	0.0120	9.11	6.44	10.49	0.87
Link-02	EX-DMH2	45.98	Out-02	43.62	279	0.85	18	0.0150	8.99	5.16	8.38	1.07
Pipe - (100)	TD#1	61.00	DMH#200	60.65	37	0.94	12	0.0120	0.64	2.99	3.75	0.17
Pipe - (102)	DMH#214	52.10	DMH#213	51.80	34	0.87	15	0.0120	2.25	3.70	6.53	0.34
Pipe - (104)	DMH#215	57.50	DMH#217	57.00	46	1.10	12	0.0120	1.08	3.96	4.04	0.27
Pipe - (108)	DMH#219	55.65	DMH#222	55.25	73	0.55	12	0.0120	1.62	3.02	2.86	0.57
Pipe - (109)	CB#103	53.40	DMH#214	53.10	32	0.95	12	0.0120	0.35	2.77	3.76	0.09
Pipe - (110)	CB#101	52.50	DMH#214	52.20	39	0.77	12	0.0120	0.50	1.82	3.39	0.15
Pipe - (111)	CB#104	54.75	DMH#240	54.50	17	1.45	12	0.0120	0.33	3.05	4.65	0.07
Pipe - (112)	CB#106	58.00	DMH#215	57.60	37	1.09	12	0.0120	0.26	1.90	4.04	0.06
Pipe - (114)	CB#108	56.50	DMH#231	55.30	76	1.58	12	0.0120	1.00	3.42	4.65	0.21
Pipe - (114) (1)	DMH#217	56.40	DMH#231	55.75	63	1.03	15	0.0120	3.97	5.26	7.10	0.56
Pipe - (115)	CB#107	56.00	DMH-206	55.20	24	3.39	12	0.0120	0.73	5.17	7.11	0.10
Pipe - (116)	CB#110	58.00	DMH#215	57.80	19	1.08	12	0.0120	0.84	3.48	4.01	0.21
Pipe - (118)	CB#111	56.00	DMH#219	55.75	27	0.92	12	0.0120	0.83	2.53	3.70	0.22
Pipe - (119)	CB#114	58.70	DMH#221	58.50	38	0.52	12	0.0120	0.66	2.66	2.79	0.24
Pipe - (120)	DMH#221	57.90	DMH#222	57.80	7	1.41	12	0.0120	0.83	3.52	4.58	0.18
Pipe - (121)	CB#113	58.50	DMH#221	58.00	47	1.06	12	0.0120	0.17	1.59	3.98	0.04
Pipe - (122)	CB#112	56.00	DMH#219	55.85	15	0.99	12	0.0120	0.83	2.94	3.84	0.22
Pipe - (123)	DMH#212	55.75	Out-1Pipe - (123)	55.75	9	0.00	18	0.0120	10.88	6.97	5.09	2.14
Pipe - (124)	CB#115	54.50	DMH#230	54.20	7	4.26	12	0.0120	0.45	4.32	7.96	0.06
Pipe - (128)	DMH#226	48.50	DMH#241	48.10	75	0.54	18	0.0120	8.12	4.60	8.33	0.98
Pipe - (128) (1)	DMH#241	48.00	DMH#224	47.70	53	0.56	18	0.0120	9.49	5.37	8.53	1.11
Pipe - (130)	CB#116	54.50	DMH#230	54.20	35	0.86	12	0.0120	0.36	2.71	3.57	0.10
Pipe - (131)	CB#117	54.00	DMH#230	53.90	34	0.29	12	0.0120	0.46	2.05	2.08	0.22
Pipe - (131) (1)	DMH#230	53.80	DMH-206	53.20	52	1.15	12	0.0120	1.22	1.88	4.15	0.29
Pipe - (131) (1) (1)	DMH-206	53.10	DMH#207	53.00	10	1.01	18	0.0120	7.37	5.46	11.42	0.65
Pipe - (133)	DMH#204	59.55	DMH#205	58.75	72	1.11	12	0.0120	2.49	4.94	4.07	0.61
Pipe - (134) (1)	DMH#208	59.00	AB#200	57.30	116	1.46	12	0.0120	1.98	3.14	4.67	0.42
Pipe - (136)	AB#200	57.20	DMH#210	56.40	105	0.76	12	0.0120	2.20	2.80	3.37	0.65
Pipe - (137)	DMH#211	57.25	DMH#210	56.40	89	0.96	18	0.0120	5.26	2.98	11.15	0.47
Pipe - (138)	AD#107	59.00	DMH#210	58.75	32	0.78	12	0.0120	0.71	3.11	3.41	0.21
Pipe - (139)	AD#106	60.25	AB#200	60.25	23	0.00	12	0.0120	0.43	1.86	1.73	0.25
Pipe - (140)	RD#2	60.00	DMH#208	59.50	21	2.41	12	0.0120	2.16	3.79	5.99	0.36
Pipe - (141)	RD#1	60.00	DMH#204	60.00	8	0.00	12	0.0120	2.49	3.54	1.73	1.44
Pipe - (142)	AD#104	58.00	DMH#205	57.75	19	1.32	12	0.0120	0.21	2.67	4.44	0.05
Pipe - (143)	CB#118	56.00	DMH-206	54.50	111	1.35	12	0.0120	0.69	4.00	4.48	0.15
Pipe - (144)	CB#119	53.00	DMH#232	52.50	51	0.98	12	0.0120	0.81	1.42	3.82	0.21
Pipe - (145)	CB#123	51.25	DMH#239	51.15	6	1.55	12	0.0120	0.64	3.37	4.80	0.13
Pipe - (146)	CB#121	50.00	DMH#239	49.80	24	0.84	12	0.0120	0.49	2.72	3.54	0.14
Pipe - (148)	CB#122	50.50	DMH#237	50.30	10	2.03	12	0.0120	0.45	3.47	5.51	0.08
Pipe - (150)	AD#105	58.00	DMH#205	57.00	102	0.98	12	0.0120	0.25	1.14	3.82	0.06
Pipe - (151)	DMH#222	55.15	Out-1Pipe - (151)	55.10	3	1.45	12	0.0120	2.43	4.57	4.64	0.52
Pipe - (198)	CB#102	55.25	DMH#213	55.00	22	1.15	12	0.0120	1.27	3.97	4.15	0.31
Pipe - (199)	AD#108	59.00	DMH#211	58.67	32	1.03	12	0.0120	0.31	2.73	3.92	0.08
Pipe - (200)	DMH#213	51.70	DMH#238	50.25	275	0.53	15	0.0120	3.39	4.10	5.08	0.67
Pipe - (203)	DMH#231	54.90	DMH-206	54.60	11	2.86	15	0.0120	4.89	8.61	19.32	0.25
Pipe - (205)	DMH#205	56.90	DMH#217	56.50	33	1.21	12	0.0120	2.91	4.51	4.25	0.68
Pipe - (207)	DMH#224	47.60	EX-DMH	47.40	23	0.87	18	0.0120	9.41	5.78	10.64	0.88
Pipe - (208)	OCS#400	52.90	DMH#224	51.00	108	1.76	12	0.0120	0.00	0.00	5.11	0.00
Pipe - (209)	DMH#238	50.15	DMH#239	49.00	203	0.57	15	0.0120	2.34	2.41	5.26	0.44
Pipe - (210)	DMH#239	48.90	DMH#237	48.80	18	0.55	18	0.0120	2.94	2.16	8.43	0.35
Pipe - (211)	RD#4	61.00	DMH#236	60.95	5	0.97	12	0.0120	2.00	3.34	3.80	0.53
Pipe - (211) (1)	DMH#236	60.95	DMH#235	60.80	6	2.48	12	0.0120	1.42	4.62	6.07	0.23
Pipe - (213) (1)	OCS#401	50.00	DMH#226	49.20	81	0.99	18	0.0120	5.19	5.57	11.33	0.46
Pipe - (215)	DMH#235	59.30	Null_1	58.40	104	0.87	12	0.0120	1.39	3.05	3.60	0.39

Link Summary

Pipe Name	From (Inlet) Node	Inlet Invert Elevation	To (Outlet) Node	Outlet Invert Elevation	Pipe Length	Pipe Slope	Pipe Diameter	Manning's Roughness	Peak Flow Q	Peak Flow Velocity	Pipe Design Capacity Qf	Q/Qf Ratio
		(ft)		(ft)	(ft)	(%)	(in)		(cfs)	(ft/sec)	(cfs)	
Pipe - (216)	Null_1	58.40	Outlet_216	58.30	13	0.80	12	0.0120	1.34	2.89	3.45	0.39
Pipe - (217)	CB#100	54.00	DMH#240	53.50	50	1.01	12	0.0120	1.17	3.87	3.88	0.30
Pipe - (218)	DMH#240	53.40	DMH#214	53.10	21	1.46	12	0.0120	1.43	4.38	4.66	0.31
Pipe - (219)	CB#136	58.50	DMH#245	57.85	63	1.03	12	0.0120	0.61	2.91	3.93	0.16
Pipe - (220)	CB#137	58.20	DMH#211	57.75	39	1.16	12	0.0120	0.58	2.81	4.15	0.14
Pipe - (221)	CB#138	58.75	DMH#245	58.50	23	1.11	12	0.0120	0.15	1.99	4.06	0.04
Pipe - (222)	DMH#245	57.75	DMH#211	57.45	28	1.06	12	0.0120	0.78	1.84	3.98	0.20
Pipe - (226)	DMH#237	48.70	DMH#226	48.60	17	0.59	18	0.0120	3.15	2.15	8.71	0.36
Pipe - (227)	AD#109	52.00	DMH#241	51.75	5	4.83	12	0.0120	2.18	5.94	8.48	0.26
Pipe - (229)	DMH#236	60.85	Outlet_229	60.83	5	0.34	6	0.0120	0.58	3.15	0.35	1.64
Pipe - (232)	DMH#232	52.40	Out-1Pipe - (232)	52.30	9	1.08	12	0.0120	2.93	4.24	4.00	0.73
Pipe - (91)	AD#100	60.75	DMH#200	60.65	17	0.59	12	0.0120	0.70	2.68	2.96	0.24
Pipe - (92)	DMH#200	60.55	DMH#201	59.75	80	1.00	12	0.0120	1.47	3.59	3.86	0.38
Pipe - (93)	AD#101	60.00	DMH#201	59.75	10	2.57	12	0.0120	0.72	2.86	6.19	0.12
Pipe - (94)	DMH#201	59.65	DMH#202	59.30	38	0.93	12	0.0120	1.58	3.91	3.73	0.42
Pipe - (95)	DMH#202	59.20	DMH#203	58.70	57	0.87	12	0.0120	1.69	2.41	3.60	0.47
Pipe - (96)	DMH#203	58.65	DMH#211	57.35	124	1.05	12	0.0120	4.28	5.46	3.95	1.09
Pipe - (97)	DMH#210	56.30	DMH#212	55.75	61	0.90	18	0.0120	7.88	4.46	10.79	0.73
Pipe - (98)	AD#102	59.10	DMH#203	58.80	32	0.94	12	0.0120	0.88	2.41	3.75	0.23
Pipe - (99)	RD#3	60.00	DMH#203	59.75	24	1.06	12	0.0120	2.74	4.87	16.39	0.17

Junction Input

Juntion Name	Invert Elevation (ft)	Rim Elevation (ft)
AB#200	57.00	63.00
AD#100	60.75	63.10
AD#101	60.00	63.60
AD#102	59.10	63.10
AD#104	58.00	62.00
AD#105	58.00	62.50
AD#106	60.25	64.20
AD#107	59.00	63.50
AD#108	59.00	62.50
AD#109	52.00	55.00
CB#100	54.00	59.00
CB#101	52.50	56.50
CB#102	55.25	59.25
CB#103	53.40	57.40
CB#104	54.75	58.75
CB#105	58.50	62.25
CB#106	58.00	62.19
CB#107	56.00	60.00
CB#108	56.50	60.50
CB#110	58.00	62.19
CB#111	56.00	60.00
CB#112	56.00	60.00
CB#113	58.50	63.30
CB#114	58.70	62.89
CB#115	54.50	58.50
CB#116	54.00	58.00
CB#117	54.00	58.00
CB#118	56.00	60.00
CB#119	53.00	56.00
CB#121	50.00	54.00
CB#122	50.50	54.50
CB#123	51.25	55.25
CB#136	58.50	62.25
CB#137	58.20	62.50
CB#138	58.75	63.75
DMH#200	60.55	63.40
DMH#201	59.65	63.70
DMH#202	59.20	65.20
DMH#203	58.65	63.50
DMH#204	59.55	63.69
DMH#205	56.90	63.00
DMH#208	56.30	62.30
DMH#210	56.30	64.10
DMH#211	57.25	63.40
DMH#212	55.75	62.80
DMH#213	51.70	59.60
DMH#214	52.10	58.10
DMH#215	57.50	62.35
DMH#217	56.40	63.50
DMH#219	55.65	60.75
DMH#221	57.90	62.87
DMH#222	55.15	62.00
DMH#224	47.60	59.19
DMH#226	48.50	57.75
DMH#230	53.70	58.00
DMH#231	55.40	60.20
DMH#232	52.00	57.69
DMH#235	59.30	65.29
DMH#236	60.85	64.64
DMH#237	48.70	55.00
DMH#238	50.15	59.10
DMH#239	48.90	56.00
DMH#240	53.40	58.19
DMH#241	48.00	55.00
DMH#245	57.75	62.75
DMH-206	53.00	61.20
EX-DMH	46.80	52.80
EX-DMH2	45.98	55.00
Null_1	58.40	62.58
OCS#400	52.90	61.80
OCS#401	49.90	58.75
RD#1	60.00	61.08
RD#2	60.00	64.00
RD#3	64.00	60.08
RD#4	61.00	62.08
TD#1	61.00	63.15

Table 3a – Peak Rates of Runoff in Cubic Feet per Second (cfs)

	Storm Event	2-year	10-year	25-year	100-year
DP-1 (NW Wetland)	Existing	3.71	7.41	9.82	13.60
	Proposed	3.11	5.69	7.31	9.78
DP-2 (18" Drain)	Existing	6.46	12.17	15.71	21.26
	Proposed	4.90	9.91	13.02	21.21
DP-3 (6" Drain)	Existing	2.10	3.82	4.90	6.53
	Proposed	0.42	0.88	1.18	1.65
DP-4 (South Wetland)	Existing	0.92	1.72	2.22	2.99
	Proposed	0.35	0.55	0.68	0.88

In addition to the peak runoff rate analysis, Nitsch performed a volumetric analysis to estimate the reduction in volume to the two wetland systems as a result of the Project (DP-1 and DP-4). The intent is to confirm that the Project does not excessively reduce the peak runoff volumes in the 1-year, 2-year and 10-year storm events, so that the wetlands continue to receive sufficient water flow for their function.

See Table 3b for a summary of the existing and proposed peak runoff volumes to the northwestern wetland (DP-1) and the southern wetland (DP-4).

Table 3b – Peak Volumes of Runoff in Cubic Feet to Wetlands (cfs)

	Storm Event	1-year	2-year	10-year
DP-1 (NW Wetland)	Existing	8,565	12,218	24,492
	Proposed	7,242	10,004	18,837
DP-4 (South Wetland)	Existing	2,094	2,931	5,632
	Proposed	1,009	1,272	2,067

5.0 Town Stormwater Regulations

Per the Town Regulations, Section 8.0, the stormwater management system shall meet the US EPA Total Phosphorus (TP) and Total Suspended Solids (TSS) design requirements for new development and redevelopment per the Federal NPDES Permit.

Per the NDPES definition, the site is considered a redevelopment:

> **New development** is defined as any construction activities or land alteration resulting in total earth disturbances equal to or greater than 1 acre (or activities that are part of a larger

- Transport and disposal of accumulated sediment off-site shall be in accordance with applicable local, state and federal guidelines and regulations.

Area Drains

Inspect area drains at least once per month and remove debris from the grate. Clean out accumulated sediments at least once per year and more frequently as necessary.

Water Quality Units (Proprietary Separators)

Maintain water quality units according the recommendations set forth by the manufacturer. General inspection and maintenance procedures for proprietary devices are provided below:

- Inspect units following completion of construction, prior to being put into service.
- Inspect units at least twice per year following installation and no less than once per year thereafter.
- Inspect units immediately after any oil, fuel or chemical spill.
- All inspections shall include checking the oil level and sediment depth in the unit. Removal of sediments/oils shall occur per manufacturer recommendations.
- A licensed waste management company shall remove captured petroleum waste products from any oil, chemical or fuel spills and dispose.
- OSHA confined space entry protocols shall be followed if entry into the unit is required.

Level Spreaders

Inspect level spreaders regularly, especially after major storm events (rainfall totals greater than 2.5 inches in 24 hours). Repair any erosion or low spots in the level spreader.

Subsurface Detention/Infiltration Structures

- Inspect subsurface detention/infiltration structures **every two (2) months**. Inspect the inlets and observation ports to determine if there is accumulated sediment within the system. Remove all debris and accumulated sediment that may clog the system.

Stormwater Outfalls

Inspect flared end sections and associated riprap spillways at least once per year and after major storm events (rainfall totals greater than 2.5 inches in 24 hours) to ensure that the stability of the outlet area is maintained. Keep the outfall area clear of debris such as trash, branches, and sediment. Make repairs immediately if riprap displacement or downstream channel scour is observed.

3.3 Street Sweeping

Perform street sweeping at least twice per year, whenever there is significant debris present on roads and parking lots. Street sweeping shall occur in the spring and fall. Sweepings must be handled and disposed of properly according to the Swampscott Conservation Commission.

3.4 Repair of the Stormwater Management System

The stormwater management system shall be maintained. The repair of any component of the system shall be made as soon as possible to prevent any potential pollutants including silt from entering the resource areas or the existing closed drainage system.

CONTECH®
ENGINEERED SOLUTIONS

Jellyfish® Filter
Stormwater Treatment

The experts you need to solve your stormwater challenges

Contech is the leader in stormwater solutions, helping engineers, contractors and owners with infrastructure and land development projects throughout North America.

With our responsive team of stormwater experts, local regulatory expertise and flexible solutions, Contech is the trusted partner you can count on for stormwater management solutions.

Your Contech Team

STORMWATER CONSULTANT

It's my job to recommend the best solution to meet permitting requirements.

STORMWATER DESIGN ENGINEER

I work with consultants to design the best approved solution to meet your project's needs.

REGULATORY MANAGER

I understand the local stormwater regulations and what solutions will be approved.

SALES ENGINEER

I make sure our solutions meet the needs of the contractor during construction.

Contech is your partner in stormwater management solutions

Setting new standards in Stormwater Treatment – Jellyfish® Filter

The Jellyfish Filter has been tested in the field and laboratory, and has received approval from numerous stormwater regulatory agencies.

The Jellyfish Filter is a stormwater quality treatment technology featuring high flow pretreatment and membrane filtration in a compact stand-alone system. Jellyfish removes floatables, trash, oil, debris, TSS, fine silt-sized particles, and a high percentage of particulate-bound pollutants; including phosphorus, nitrogen, metals and hydrocarbons. The high surface area membrane cartridges, combined with up-flow hydraulics, frequent, passive backwashing, and rinseable/ reusable cartridges ensure long-lasting performance.

Jellyfish® Filter

How the Jellyfish® Filter Treats Stormwater

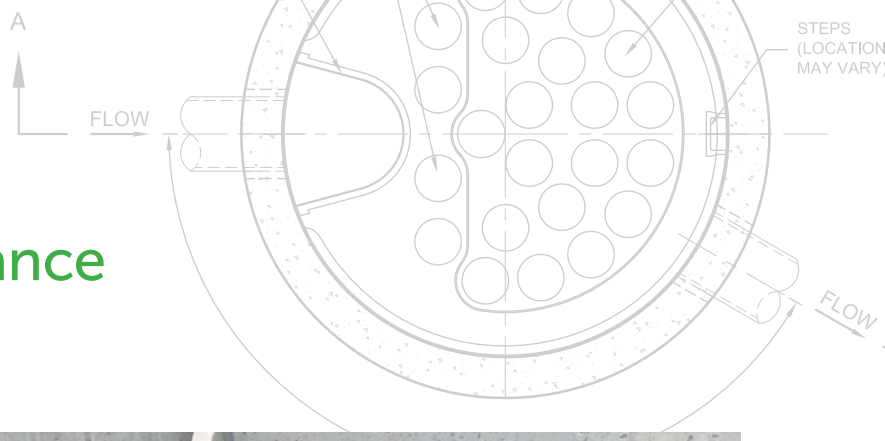
Tested in the field and laboratory ...

- Stormwater enters the Jellyfish through the inlet pipe and traps floating pollutants behind the maintenance access wall and below the cartridge deck.
- Water is conveyed below the cartridge deck where a separation skirt around the cartridges isolates oil, trash and debris outside the filtration zone.
- Water is directed to the filtration zone and up through the top of the cartridge where it exits via the outlet pipe.
- The membrane filters provide a very large surface area to effectively remove fine sand and silt-sized particles, and a high percentage of particulate-bound pollutants such as nitrogen, phosphorus, metals, and hydrocarbons while ensuring long-lasting treatment.
- As influent flow subsides, the water in the backwash pool flows back into the lower chamber. This passive backwash extends cartridge life.
- The draindown cartridge(s) located outside the backwash pool enables water levels to balance.

Jellyfish® Filter Standard Configuration

Learn More:
www.ContechES.com/jellyfish

Pretreat bioretention or infiltration with Jellyfish to extend service life.



Jellyfish® Filter Performance Testing Results

APPLICATION TIPS

- The Peak Diversion Jellyfish provides treatment and high-flow bypass in one structure, eliminating the need for a separate bypass structure.
- LID and GI are complemented by filtration solutions, as they help keep sites free from fine sediments that can impede performance, remove unsightly trash, and provide a single point of maintenance.
- Selecting a filter with a long maintenance cycle and low maintenance cost will result in healthy waterways and happy property owners.

The pleated tentacles of the Jellyfish® Filter provide a large surface area for pollutant removal.

POLLUTANT OF CONCERN	% REMOVAL
Total Trash	99%
Total Suspended Solids (TSS)	89%
Total Phosphorus (TP)	59%
Total Nitrogen (TN)	51%
Total Copper (TCu)	> 50%
Total Zinc (TZn)	> 50%

Sources:
TARP II Field Study – 2012 JF 4-2-1 Configuration
MRDC Floatables Testing – 2008 JF6-6-1 Configuration

Jellyfish® Filter Features and Benefits

FEATURE	BENEFITS
High surface area membrane filtration	Low flux rate promotes cake filtration and slows membrane occlusion
High design treatment flow rate per cartridge (up to 80 gpm (5 L/s))	Compact system with a small footprint, lower construction cost
Low driving head (typically 18 inches or less (457 mm))	Design flexibility, lower construction cost
Lightweight cartridges with passive backwash	Easy maintenance and low life-cycle cost

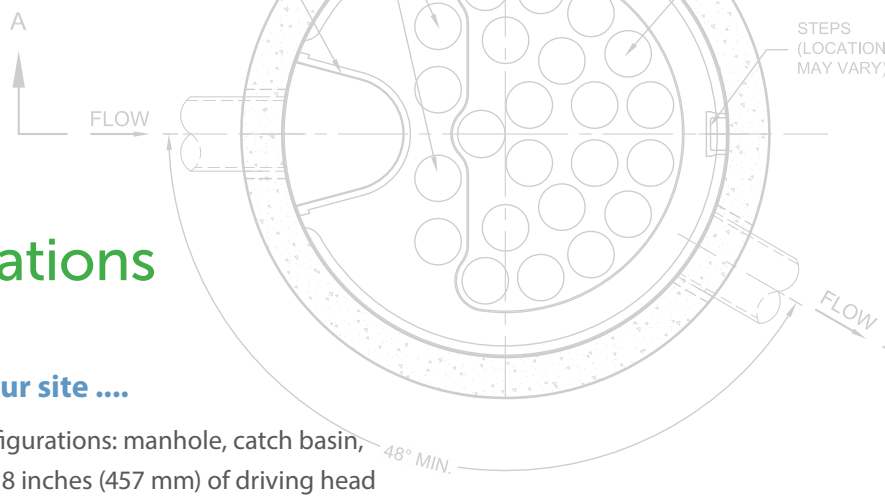
The Jellyfish Filter can be configured in a manhole, catch basin, or vault.

Select Jellyfish® Filter Certifications and Verifications

The Jellyfish Filter has been reviewed by numerous state and federal programs, including:

- Washington State Department of Ecology (TAPE) GULD – BASIC, Phosphorus
- Virginia Department of Environmental Quality (VA DEQ)
- Texas Commission of Environmental Quality (TCEQ)
- Canada ISO 14034 Environmental Management – Environmental Technology Verification (ETV)
- Philadelphia Water District (PWD)
- Maryland Department of the Environment (MD DOE)

Field tested and performance verified

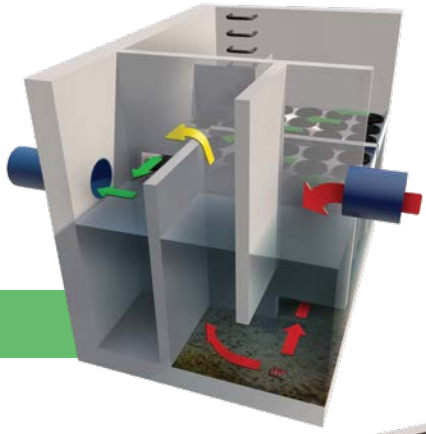


Jellyfish® Filter Configurations

Multiple system configurations to optimize your site ....

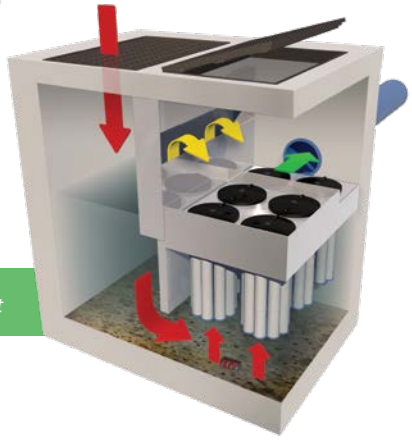
The Jellyfish Filter can be manufactured in a variety of configurations: manhole, catch basin, vault, fiberglass tank, or custom configurations. Typically, 18 inches (457 mm) of driving head is designed into the system. For low drop sites, the designed driving head can be less.

Manhole



Vault

Curb Inlet



Grated Inlet

Jellyfish® Filter Maintenance

- Jellyfish Filter cartridges are light weight and reusable
- Maintenance of the filter cartridges is performed by removing, rinsing and reusing the cartridge tentacles.
- Vacuum extraction of captured pollutants in the sump is recommended at the same time.
- Full cartridge replacement intervals differ by site due to varying pollutant loading and type, and maintenance frequency. Replacement is anticipated every 2-5 years.
- Contech® has created a network of Certified Maintenance Providers to provide maintenance on stormwater BMP's.

The Jellyfish® Filter tentacle is light and easy to clean.

A partner you can rely on

STORMWATER SOLUTIONS

PIPE SOLUTIONS

STRUCTURES SOLUTIONS

Few companies offer the wide range of high-quality stormwater resources you can find with us — state-of-the-art products, decades of expertise, and all the maintenance support you need to operate your system cost-effectively.

THE CONTECH WAY

Contech® Engineered Solutions provides innovative, cost-effective site solutions to engineers, contractors, and developers on projects across North America. Our portfolio includes bridges, drainage, erosion control, retaining wall, sanitary sewer and stormwater management products.

TAKE THE NEXT STEP

For more information: www.ContechES.com

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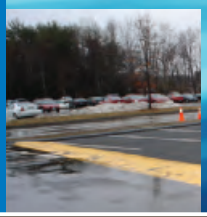
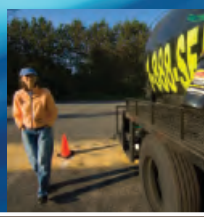
University of New Hampshire Stormwater Center





2009 BIANNUAL REPORT

NOAA

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University of New Hampshire

CICEET

Contents

Workshop at
UNHSC field site

About the Center

The University of New Hampshire Stormwater Center (UNHSC) is dedicated to the protection of water resources through effective stormwater management.

Center researchers evaluate and enhance the ability of stormwater treatment systems to treat the pollution in stormwater runoff and reduce the flooding that it can cause. The Center provides information on performance, cost, design, and maintenance to people who select, review, permit, design, install, and maintain stormwater management systems. The research is integrated with an evolving outreach program that supports a wide range of stormwater managers and professionals who seek to build programs that protect water quality, preserve environmental values, and reduce the impact of stormwater runoff.

The Center receives its primary funding and program support from the Cooperative Institute for Coastal and Estuarine Environmental Technology (CICEET), a partnership of UNH and the National Oceanic and Atmospheric Administration (NOAA). It is housed within the University's Environmental Research Group, a division of the College of Engineering and Physical Sciences.

Resources for Stormwater Managers

The Center's research has served as the foundation for a range of outreach products—from best management practice (BMP) workshops geared to support municipal decision makers and stormwater engineers to peer-reviewed publications that explore the frontiers of stormwater science. Learn more about these resources at www.unh.edu/erg/cstev.


Storm Water Low-Impact Development, Conventional Structural, and Manufactured Treatment Strategies for Parking Lot Runoff
Performance Evaluations Under Varied Mass Loading Conditions

- BMP Fact Sheets
- Data Reports
- Design Drawings
- Design Specs
- Journal Articles
- Web Resources

Directors' Message

UNH Stormwater Center
field site

These economic times challenge all of us to make difficult choices about what we can and cannot afford. For state and local governments facing budget shortfalls, the University of New Hampshire Stormwater Center has some welcome news: when it comes to effective stormwater management, you do not have to choose between affordability and healthy waters.

People often tell us that they think they do have to choose, that even if Low Impact Development (LID) stormwater techniques do a better job of protecting water quality, they are too costly to install and maintain. Yet our research is demonstrating that this is not the case. Since 2004 we have monitored the ability of 23 stormwater systems to treat pollution and reduce the volume of runoff. We have worked with hundreds of municipal officials, regulators, engineers, contractors, and educators on dozens of stormwater demonstration and education projects.

In the process, we have found that projects that use LID approaches to managing stormwater runoff can be both more effective in treating pollution and in some instances less expensive to install than those that rely on curbs, pipes, and ponds. LID systems do require maintenance to function properly, but so do all of the commonly used systems that are believed to require little or no attention. In particular, our research has demonstrated that when retention ponds are not adequately maintained, they not only fail to remove pollutants from runoff; they can magnify the negative impact of polluted stormwater on receiving waters.

Using LID approaches for stormwater management involves decentralizing runoff and maximizing infiltration, which ultimately reduces the stress on urban stormwater infrastructure. Metropolitan areas like Portland, OR., are already seeing the economic benefits of using LID to reduce the runoff flowing through their combined sewers. These savings extend to residential and commercial development and redevelopment projects. Homeowners that use techniques like rain barrels, drought resistant rain gardens, and porous pavements can save on water utility bills and help prevent flooded basements.

By allowing for these less familiar but more effective techniques in stormwater ordinances, municipalities can help insure these benefits at every level. In so doing, they anticipate the inevitable. Federal laws requiring LID-style approaches to stormwater are already in place as part of Phase II of the Clean Water Act. It is only a matter of time before all municipalities will have to comply with mandates to clean up impaired waters, and our research is showing that in many case an LID approach to stormwater management is essential in meeting that goal.

A proactive response to federal regulations has the added benefit of preparing us for the impacts of climate change. Whether climate change has brought severe storms or drought to a community, LID stormwater techniques can help mitigate the flooding associated with impervious surfaces, can allow rainfall to replenish aquifers, and can be powerful tools for adaptive management.

This report is one of many tools we use to communicate our work in a way that we hope stormwater managers from many backgrounds will find useful. We welcome your comments and questions, about this report and all of the work we do.

Sincerely,

Robert Roseen
Director

Thomas Ballestero
Senior Scientist

Jamie Houle
Program Manager
and Outreach Coordinator

StormTech Isolator Row

The StormTech Isolator Row is an effective filtration/infiltration system best suited to locations where space is at a premium and the system's relatively expensive installation cost can be offset by increasing available space for development.

About the StormTech Isolator Row

The StormTech Isolator Row is a manufactured system designed to provide subsurface water quality treatment and easy access for maintenance. It is typically used to remove pollution from runoff before it flows into unlined infiltration chambers designed for detention and water quantity control. The Isolator Row consists of a series of StormTech chambers installed over a layer of woven geotextile, which sits on a crushed stone infiltration bed surrounded with filter fabric. The bed is directly connected to an upstream manhole for maintenance access and large storm bypass. At UNHSC, the Isolator Row has met a TSS median annual removal standard of 80 percent, and exhibited an enhanced capacity to remove phosphorus. The Isolator Row is well suited for urban environments where space is at a premium.

Implementation

The StormTech Isolator Row is part of a class of manufactured, subsurface filtration/infiltration systems that are being used more and more throughout the United States. In general, these systems are best suited to locations where above ground space is at a premium. They are often used in urban areas, where they are located beneath parking lots and other infrastructure. As with any infiltration system, care must be taken when locating these systems near pollution hotspots, or where seasonal high groundwater levels may lead to groundwater contamination. In such cases, if installed, the systems should be lined to prevent infiltration into groundwater, and outfitted with subdrains that discharge to the surface. Designs for the StormTech Isolator Row are available from the manufacturer.

System Performance

Cost & Maintenance

While subsurface HDPE systems such as the Isolator Row tend to be more expensive than conventional stormwater treatments like retention ponds, the costs are ameliorated by the increase in available space for development. The cost to install a StormTech Isolator Row system large enough to treat runoff from one acre of impervious surface was $34,000 in 2006.

In more than two years of operation, the system is at less than 50 percent of its recommended maintenance trigger point. Maintenance should be conducted when the sediment in the chambers reaches approximately three inches in depth according to recommendations from the manufacturer. Sediment accumulation can be monitored through inspection ports. When maintenance is needed, the entire row can be

Fast Facts

CATEGORY / BMP TYPE
Filtration, Infiltration, Manufactured Treatment Device

UNIT OPERATIONS & PROCESSES
Hydrologic (Flow Alteration)

Water Quality: Physical (Sedimentation, Filtration) & Chemical (Sorption)

DESIGN SOURCE
StormTech, LLC

BASIC DIMENSIONS
Chamber: 51" wide X 30" high X 85.4" long

SPECIFICATIONS
Catchment Area: 1 acre

Water Quality Flow: 1 cfs

Water Quality Volume: 3,300 cf

INSTALLATION COST
$34,000 per acre treated

MAINTENANCE
Maintenance Sensitivity: Low

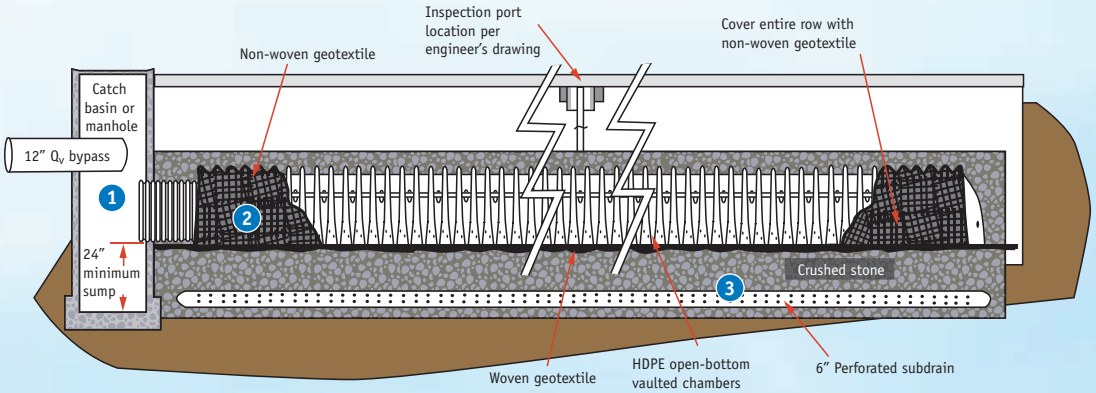
Inspections: High

Sediment Removal: Moderate

How the System Works

WATER QUALITY TREATMENT PROCESS ▼

1. Runoff flows into the Isolator Row chambers from a catchbasin or pipe.
2. Runoff slowly passes from the chambers through a woven geotextile fabric and into the crushed stone reservoir below the system. The runoff passes through the fabric, leaving behind sediments and associated contaminants through the physical unit operations of filtration and sedimentation. As an organic filter cake develops over the fabric, phosphorus is also removed via the chemical process of sorption.
3. Filtered runoff collects in a perforated subdrain and returns to a storm drain system, infiltrates into the subgrade, or is discharged to the surface.



washed clean through an access manhole and by a hydro-jet with sediment removed by vactoring (vacuuming). Entry into the system is considered a confined space entry and requires trained personnel and equipment.

During two years of evaluation at UNHSC, the Isolator Row has accumulated, at most, one and one half inches of sediment in its chambers. As a result, researchers have not performed maintenance on the system. The Isolator Row presents an interesting opportunity to study the relationship between maintenance and performance. Researchers have observed enhanced phosphorus removal as the system develops an organic filter cake between the chambers and the woven geotextile fabric that lies beneath them. This enhancement is tempered by the likelihood that, as the filter cake continues to grow, hydraulic efficiency will decline and more runoff will bypass the system untreated until maintenance is performed. Analyses are underway to develop maintenance recommendations that balance and optimize the water quality and water quantity management abilities of this system.

Cold Climate

This system's water quality treatment and volume control capacity remained strong in all seasons, reinforcing the conclusion that filtration and infiltration systems perform well, even in cold climates.

Water Quality Treatment

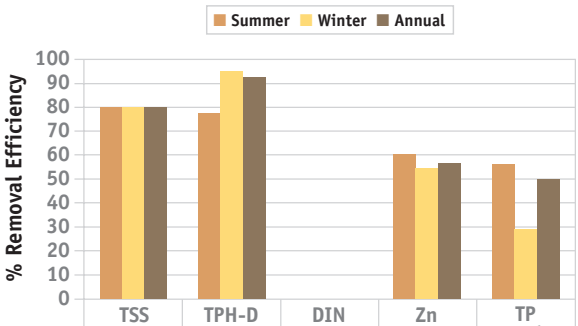
The StormTech Isolator Row system does a good job of reducing the concentration of common pollutants associated with stormwater performance assessment with the exception of nitrogen. It generally meets EPA's recommended level of removal for total suspended solids, and meets regional ambient water quality criteria for heavy metals and petroleum hydrocarbons. The system has a capacity to achieve modest levels of total phosphorus removal, which may be enhanced over time. (See Cost & Maintenance Section.) The lack of nitrogen treatment is typical for non-vegetated aerobic systems. Nutrient load reduction would be further increased through volume reduction by infiltration. Like all other systems monitored at UNHSC, it does not provide chloride removal.

The chart at top right reflects the system's performance in removing total suspended solids, total petroleum hydrocarbons, dissolved inorganic nitrogen, total phosphorus, and zinc. Values represent results recorded over a two-year monitoring period, with the data further divided into summer and winter components.

Water Quantity Control

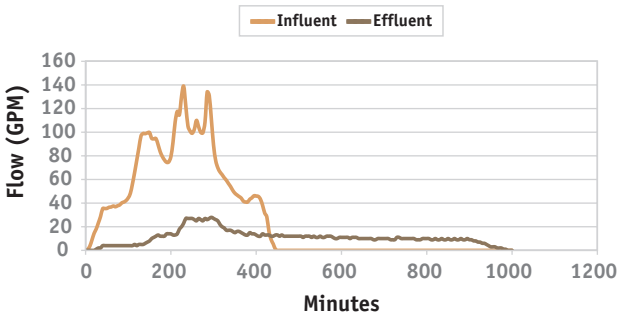
Like other infiltration and filtration systems, the StormTech Isolator Row system exhibits the capacity to reduce peak flows and could be used to reduce runoff volume in appropriate soils, such as those belonging to groups "A" or "B." The figure at bottom right provides information on peak flow reduction and lag times for the system.

POLLUTANT REMOVAL: 2006–2008



Median Annual Influent Event Mean Concentrations (EMC) in mg/L				
48	860 ug/L	.2	.04	.08

HYDRAULIC PERFORMANCE



	Winter	Summer	Annual Average
Average Peak Flow Reduction	71%	81%	76%
Average Lag Time (minutes)	358	190	274

SYSTEM DESIGN ▼

The StormTech Isolator Row is designed to provide subsurface water quality treatment for small storms. The manufacturer adapts the system's design in accordance with local watershed conditions and target treatment objectives.

Chamber units are made of high-density polyethylene (HDPE) pipe and are designed to bear loads consistent with those experienced by parking lots. The UNHSC chamber dimensions are 51 x 30 x 85.4 inches and can be linked together to form linear rows up to 200 feet long. The chambers are laid over woven geotextile, which rests on an infiltration base composed of one foot of three quarter inch crushed stone. The entire excavation is then wrapped in nonwoven geotextile to protect the system from the migration of fine particles from the surrounding soil.

A three- to five-foot separation from seasonal high groundwater table (as designated by regulations) is necessary to minimize the potential for groundwater contamination. Stormwater flows of up to one cubic foot per second (cfs) enter the system through an upstream manhole or other flow diverter. This is representative of flow-based sizing of a BMP common for devices that have limited detention or storage. Such devices are often better described by a maximum treatable flow rate as opposed to a treatment volume.

A bypass is incorporated in the StormTech system where flows exceeding the design rate are bypassed around the device and flow directly into adjacent chambers that can be sized to treat the CP_v and Q_p. Because of the bypass design, maintenance requirements are extremely important. A poorly maintained device would bypass prematurely into the unlined chamber systems and eventually clog subsurface soils resulting in system failure.