



December 13, 2023

Breeka Li Goodlander, Agent
Town of Franklin Conservation Commission
355 East Central Street
Franklin, MA 02038

RE: *Response to BETA Notice of Intent Peer Review Comments, November 30, 2023*
Upper Union Solar Project – Franklin, MA
ADE Job #3328.00
DEP File #CE 159-1281

Dear Ms. Goodlander:

This response letter addresses the comments made in the BETA Notice of Intent Peer Review Comments Letter dated November 30, 2023, for above-referenced project. Please note the peer review comments are italicized, and our responses follow in bold text:

ADMINISTRATIVE AND PLAN COMMENTS

PLAN AND GENERAL COMMENTS

A1. As of August 18, 2023, MassDEP has not issued a file number.

ADE: The DEP file number is CE 159-1281.

BETA2: A MassDEP file number has been issued with comments. Comments from MassDEP are provided below in plain text and ADE's responses are provided in italics.

a. The applicant should confirm that the detention basin will drain within 72 hours of precipitation events. The Cultec infiltration system should be clearly labelled on the Site Plans, and the applicant should verify that there is adequate separation (>4' or >2' with mounding calculations) between the bottom of the system and mean annual high groundwater.

ADE: Basin drawdown calculations are included in the Miscellaneous Calculations section of the Drainage Addendum. The Cultec chambers are labelled and clarified on the revised Site Plans, Sheet 6. The soil evaluated test pits confirmed adequate separation to groundwater.

b. A seed mix comprised of a diversity of native herbaceous species, sufficient topsoil, and infrequent mowing are recommended beneath the array.

ADE: The revised Site Plans indicate all areas disturbed due to solar construction to be planted with seed mix designed in accordance with the Town of Franklin Best Development Practices Guidebook along with a minimum of 6" of topsoil. Mowing is anticipated to be limited to twice a year.

- c. Many solar arrays in Massachusetts experience erosion problems during construction. Phasing of the project, extra erosion control measures, and frequent monitoring are recommended to prevent erosion problems, particularly in areas with steep slopes, stony soils, or where panel configurations can cause gullies to form at the driplines.

ADE: Additional intermediate rows of erosion control measures are provided on the revised Site Plans and erosion control notes have been added to instruct the contractor to limit the time of exposed soil prior to stabilization.

BETA2: Comment A.1.a. will be addressed through BETA's ongoing stormwater peer review with the Planning Board. The Applicant's responses to Comments A.1.b. and c. appear appropriate; however, it is recommended that a proposed seed mixture with species names and ratios be provided to the Conservation Commission prior to construction, and that mowing be limited to once per year between October 15th and November 30th. These could be included as conditions of approval.

ADE2: Atlantic has indicated the proposed seed mixture with species names and ratios will be provided to the Conservation Commission prior to construction as a condition of approval. Please refer to Sheet 7 of the revised site plans dated 12/13/2023.

- A2. *Provide a Construction Schedule and Sequence in the plan notes as required under Section 7.18.1.14. of the Bylaw.*

ADE: Refer to the Construction Sequence and Schedule by Atlantic Design Engineers, Inc. dated 11/10/2023.

BETA2: Comment addressed. A Construction Sequence and Schedule has been provided and is included on the Project plans. BETA recommends that plantings within the Wetland Replication Area be installed as soon as possible following Replication Area construction.

ADE2: Plantings within the Wetland Replication Area shall be installed as soon as possible following Replication Area construction. Please refer to Sheet 10 of the revised site plans dated 12/13/2023.

- A3. *The Existing Conditions Plans must be stamped by a Professional Land Surveyor registered in the state of Massachusetts.*

ADE: The revised existing conditions plan sheets are stamped by a PLS.

BETA2: Comment addressed. The revised existing conditions plan sheets have been stamped by Edwin H. Gless, MA PLS No. 39045.

- A4. *The NOI narrative references a total of 31,676 sf of alteration proposed within the Buffer Zones to local and state jurisdictional Resource Areas; however, the Resource Area Impact Summary Form references a total of 33,923 sf of Buffer Zone alteration. The Applicant should clarify the correct square footage of proposed impact to Buffer Zone.*

ADE: The square footage of impact to Buffer Zone was revised due to

additional wetlands found and site design changes. It is provided on the revised site plans.

BETA2: Comment not addressed. Revised impact numbers for Buffer Zone alteration were not observed on the Site Plans. A revised Resource Area Impact Summary Form should also be provided.

ADE2: A revised Resource Area Impact Summary Form was provided to the Commission on 11/30/2023. Additionally, revised impact numbers for Buffer Zone alteration have been added to Sheet 7 of the revised site plans dated 12/13/2023.

A5. *Provide a note stating who performed the wetland delineation and when it occurred.*

ADE: This note is provided on Sheet 2 of the revised site plans.

BETA2: Comment addressed.

WETLAND RESOURCE AREAS AND REGULATORY REVIEW

BETA conducted an onsite review and completed a regulatory review of the submitted documents and plans, focusing on compliance with Resource Area definitions and Performance Standards set forth in the Act and the Bylaw. The Project Narrative states that proposed work will only occur within Buffer Zone; however, it appears that impacts to IVW will be required to construct the Project as designed (Comment W6). The Project is subject to the MassDEP Stormwater Standards and a review of compliance with these Standards is being completed by BETA as part of the Planning Board review process.

The NOI application includes narrative information describing the Project and the proposed impacts within the Buffer Zone. However, impacts to the IVW that BETA observed in the field will require quantification by the Applicant, as well as demonstration of the Avoid/Minimize/Mitigate sequencing. Mitigation measures presently include use of erosion controls, installation of Stormwater Best Management Practices (BMP's), and Buffer Zone restoration. It is recommended that the Applicant review the Resource Area boundary comments presented in this letter to determine if any modifications to the Bylaw Variance request or the proposed Buffer Zone mitigation plan are required. In addition, any revised materials should include all materials required under the Bylaw including a construction sequencing plan and a functions and characteristics statement.

Additional information is required to describe the effects of the work on the interests of the Act and the Bylaw, including demonstration of compliance with the Massachusetts Stormwater Management Standards, demonstration of compliance with the Bylaw, and reassessment of Resource Area boundaries.

ADE: Refer to Goddard Associates Response to Peer Review Comments.

BETA2: The Applicant has provided the Conservation Commission with revised plans and documents that address BETA's comments regarding erosion controls, compliance

with the provisions of the Bylaw, and measures to promote the successful establishment of the Buffer Zone Mitigation Area. In addition, the revised plans and documents accurately reflect the observations and discussions from the September 28, 2023 Site visit between BETA, GC, and the Franklin Conservation Agent. As a result of this Site visit, the Applicant has revised Resource Area boundaries, accurately documented the extent of impacts to the 25-foot No Disturb Zone, and quantified the fill of an onsite IVW. As mitigation for the fill of IVW, the Applicant now proposes at least a 2:1 replication of lost IVW along an existing BVW.

As of this writing, the Applicant will be required to provide a revised Resource Area Impact Summary Form and confirm compliance with the Massachusetts Stormwater Management Regulations.

ADE2: In Atlantic’s opinion, the project conforms to Massachusetts Stormwater Management Regulation, subject to BETA Group’s review. A revised Resource Area Impact Summary Form was provided to the Commission on 11/30/2023. Additionally, revised impact numbers for Buffer Zone alteration have been added to Sheet 7 of the revised site plans dated 12/13/2023.

RESOURCE AREA AND BOUNDARY COMMENTS

BETA conducted a Site visit on August 9, 2023 to assess existing conditions and to review Resource Area delineations, focusing on the definitions and methodologies referenced under the Act and the Bylaw. Review of Resource Area delineations was limited to locations where the delineated boundary was within, or may be within, 100 feet of the Limit of Work (LOW) and located within the subject Site.

W1. BETA concurs with the identification of the B-Series as an IVW Subject to Protection under the Bylaw.

ADE: No response necessary

W2. To verify the conclusions made in the Vernal Pool Evaluation, BETA reviewed the B-Series IVW for Vernal Pool indicators. During the Site visit, little to no standing water was observed within the B- Series IVW. Although the time BETA’s assessment is not seasonally appropriate for an evaluation of the presence of Vernal Pool species, BETA does concur that there was insufficient evidence to support ponding at a depth sufficient to support Vernal Pool species common to this region. No other areas at the Site were observed to meet the criteria for a Vernal Pool.

ADE: No response necessary

W3. Hydric soil meeting the criteria for Hydric Soil Indicator F6 Redox Dark Surface and hydrophytic vegetation including spotted joe-pye weed, smooth arrowwood (*Viburnum dentatum*) and sensitive fern were observed approximately 5-10 feet upgradient of flag B-26.

ADE: The wetland boundary and flagging were revised in the field and are shown on the revised site plans. Refer to Goddard Associates Response to Peer Review Comments.

GC: Goddard Consulting, Breka Li Goodlander, and Jonathan Niro of BETA Group visited the site together on September 28, 2023, to review the existing wetland delineation per the attached comment. On the site walk, Goddard agreed with the BETA comment that both soils meeting the criteria for a hydric soil as well as a predominance of wetland vegetation were located upgradient of flag GC B26. Two new flags, GC B26-1 and GC B26-2 were hung upgradient of the existing delineation. These flags were agreed upon in the field, surveyed, and added to the new site plan.

BETA2: Comment addressed.

*W4. Hydric soil meeting the criteria for Hydric Soil Indicator F6 Redox Dark Surface¹ and hydrophytic vegetation including royal fern (*Osmunda regalis*), sensitive fern (*Onoclea sensibilis*), spotted joe-pye weed (*Eutrochium maculatum*), and purple loosestrife (*Lythrum salicaria*) were observed approximately 5-10 feet upgradient of flags A36-A38.*

ADE: The wetland boundary and flagging were revised in the field and are shown on the revised site plans. Refer to Goddard Associates Response to Peer Review Comments.

GC: Goddard Consulting, Breka Li Goodlander, and Jonathan Niro of BETA Group visited the site together on September 28, 2023, to review the existing wetland delineation per the attached comment. On the site walk, Goddard and BETA reached an agreement that the soils upgradient of the existing delineation did not meet the criteria to be considered a wetland soil. The delineation was agreed upon to remain in place.

BETA2: Comment addressed.

*W5. Hydric soil meeting the criteria for Hydric Soil Indicator F6 Redox Dark Surface and hydrophytic vegetation including royal fern, sensitive fern, and cinnamon fern (*Osmundastrum cinnamomeum*) were observed 5-10 feet upgradient of flags A46 to A49.*

ADE: The wetland boundary and flagging were revised in the field and are shown on the revised site plans. Refer to Goddard Associates Response to Peer Review Comments.

GC: Goddard Consulting, Breka Li Goodlander, and Jonathan Niro of BETA Group visited the site together on September 28, 2023, review the existing wetland delineation per the attached comment. On the site walk, Goddard agreed with the BETA comment that both soils meeting the criteria for a hydric soil as well as a predominance of wetland vegetation were located upgradient of the existing delineation above A46 to A49. Flags GC A46 to A48 were removed in the field. New wetland flags GC A46R, GC A47R, GC A47-1,

GC A48R, and GC A48-1 were hung in the field upgradient of the old flags. These flags were agreed upon in the field, surveyed, and added to the new site plan.

- W6. Hydric soil indicators consisting of a depleted matrix under a thick, dark A horizon within 12” of the surface and hydrophytic vegetation including highbush blueberry (*Vaccinium corymbosum*), royal fern, cinnamon fern, and silky dogwood (*Cornus amomum*) were observed north of an existing stone wall and east of the existing stockpile. Based on BETA’s observations, the Applicant should re-evaluate this area and flag the boundaries of additional Areas Subject to Protection under the Act and/or Bylaw.

ADE: The wetland boundary and flagging were revised in the field and are shown on the revised site plans. Refer to Goddard Associates Response to Peer Review Comments.

GC: Goddard Consulting, Breka Li Goodlander, and Jonathan Niro of BETA Group visited the site together on September 28, 2023, to review the existing wetland delineation per the attached comment. On the site walk, Goddard and BETA located the area in question. The area was identified as an isolated vegetated wetland jurisdictional under the local bylaw. As such, the area was flagged with series GC I1 to GC I15. These flags were agreed upon in the field, surveyed, and added to the new site plan.

BETA2: Comment addressed.

- W7. Channelized flow along a hydraulic gradient was observed interior of the A Series wetland. This channel is not depicted on the Project plans but is described within the Wetland Border Report and depicted on Figure 1 of the Report. Based on BETA’s observations, the channelized flow meets the definition of a stream with protected Bank and Land Under Water (LUW). This stream is not mapped on the most recent USGS maps; however, the Applicant should provide proof of the stream’s status as intermittent using the StreamStats method identified in 310 CMR 10.58 (2)(a)1.c.i.

ADE: Refer to Goddard Associates Response to Peer Review Comments.

GC: Goddard agrees that there is an intermittent stream with channelized flow internal of the A- Series wetland. As the area is not proposed to be impacted, no delineation of the area was deemed necessary. However, to document the area as intermittent, Goddard has attached a StreamStats documentation of the area. The viable sampling point was significantly downstream of the site, however still yields an intermittent stream documentation, with a 99% flow duration of .00174, and a drainage area of .17 square miles.

BETA2: Comment addressed. BETA recommends that the Commission include a finding in the Order of Conditions stating that this internal stream is intermittent, and its associated Bank was not delineated or approved as part of the project.

ADE2: The Applicant is amenable to including this as an order of condition.

CONSTRUCTION COMMENTS

W8. *Material storage and laydown areas should be depicted on the Project plans and located outside of jurisdictional areas.*

ADE: Material storage and laydown areas are shown outside of jurisdictional areas on the revised site plans.

BETA2: Comment addressed.

W9. *A swale with haybale check dams is proposed along the Site access roadway. The Applicant should clarify if this is intended to be a construction-period stormwater control, and BETA recommends that the haybales be replaced with straw to avoid the spread of non-native plant species.*

ADE: The haybale check dams have been replaced with stone check dams in the revised site plans.

BETA2: Comment addressed.

W10. *The NOI narrative indicates that compost filter tubes and/or silt fence will be used as an erosion control measure. Silt fence is not a permitted erosion control measure in the Town of Franklin (Pg. 13 of Town of Franklin Best Development Practices Guidebook). BETA defers to the Commission regarding the use of silt fence.*

ADE: The silt fence is proposed only in conjunction with the compost filter tubes as a double erosion control measure. This has been clarified on the plans.

BETA2: Comment remains. BETA defers to the Commission regarding the use of silt fence. The Applicant could consider using an additional row of compost filter tubes in lieu of silt fence.

ADE2: Details for the proposed solar project, shown on Sheets 8-10 of the revised site plans dated 12/13/2023, has removed reference to silt fence. The detail for double erosion control has replaced use of a silt fence with an additional row of compost filter tubes.

W11. *The project as currently depicted will disturb more than (1) one acre of land which will require preparation of a Stormwater Pollution Prevention Plan (SWPPP) and filing of a Notice of Intent with the EPA.*

ADE: Acknowledged

BETA2: No comment.

MITIGATION COMMENTS

The Applicant proposed an approximately 617 sf mitigation area to offset approximately 308 sf of impact within the locally protected 25-foot No Disturb Buffer Zone associated with installation of a portion of the gravel access road and associated grading.

W12. The proposed mitigation is located within an existing unvegetated cart path. The path is well-defined, and the lack of vegetation may indicate soil compaction that could make establishment of the proposed plantings difficult. The Applicant should include a protocol within the Buffer Zone Mitigation Plan for use if the existing soil is compacted. Spreading a layer of loam of an undetermined thickness may not be a suitable planting medium if the underlying soil is compacted and/or unsuitable for planting. This protocol should also include a range of depths of loam that will be used dependent on soil conditions.

ADE: Refer to Goddard Associates Response to Peer Review Comments.

GC: Goddard Consulting has revised the original restoration plan with a date of 11/13/2023 to address the attached comment. In this revised plan, Goddard added a section discussing the potential for compacted soils, and how to ensure proper planting substrate if encountered.

BETA2: Comment addressed.

W13. Organic material (i.e. leaf litter) removed during preparation of the mitigation area for planting should be saved if feasible and spread within the mitigation area to increase organic content of the soil.

ADE: Refer to Goddard Associates Response to Peer Review Comments.

GC: Goddard agrees with the attached comment. Materials such as leaf litter, logs, and rocks will be saved and placed over the final restoration area. This will assist in the organic content of the soil, while also creating microhabitats along the previously barren path.

BETA2: Comment addressed.

W14. BETA defers to the Commission to determine if the proposed mitigation is sufficient to offset the proposed impact to the Buffer Zone Resource Area pursuant to Section 7.11 of the Bylaw.

ADE: Acknowledged

BETA2: Comment remains. As noted in Comment W16, the impact area has increased which has resulted in the proposed mitigation to impact ratio now being less than 2:1.

ADE2: Acknowledged

WPA PERFORMANCE STANDARDS COMMENTS

The Project does not propose any work within Resource Areas Subject to Protection under the Act; however, the Project does propose work within Buffer Zone and local Buffer Zone Resource Areas.

BYLAW REGULATORY COMMENTS

W15. The following materials must be submitted per the submission requirements of the Bylaw Regulations:

- a. A Construction Sequence and Schedule (Section 7.15); and*

ADE: Refer to the Construction Sequence and Schedule by Atlantic Design Engineers, Inc. dated 11/10/2023.

BETA2: Comment addressed.

- b. A complete Functions and Characteristics Statement (Section 7.10.1).*

ADE: Refer to Goddard Associates Response to Peer Review Comments.

GC: In accordance with the local bylaw, Goddard has submitted a Functions and Characteristics Statement dated 11/13/2023 as part of this supplemental submittal.

BETA2: Comment addressed.

W16. The Applicant has requested a Variance per Section 5 of the Bylaw Regulations for work within the 0-25 No Disturb Buffer Zone. BETA defers to the Commission for approval of the requested Variance.

ADE: Acknowledged

BETA2: Comment remains. Per the Buffer Zone Mitigation Plan, revised flagging has resulted in an increase in impacts to the 0-25' No Disturb Zone from 308 sf to 773 sf. The Applicant has provided an updated Variance Request to include the change in impact area. BETA defers to the Commission for approval of the requested Variance.

ADE2: Acknowledge

W17. Portions of the proposed gravel access road and Site fencing are proposed within the 25-50 Buffer Zone. BETA defers to the Commission regarding classification of the access road as a structure per Section 4.3.1 of the Bylaw Regulations and the requirement of an associated Variance request.

ADE: Acknowledged

BETA2: Comment remains.

ADE2: Acknowledge

W18. BETA2: An IVW was identified and delineated at the Site within the Project work limits. A Variance per Section 5 of the Bylaw Regulations has been requested to fill the locally protected 1,647-sf IVW. The Applicant has also submitted a Wetland Replication Plan for the construction of a 3,294-sf Wetland Replication Area in compliance with the Bylaw Regulation 2:1 ratio of replication to lost area. BETA defers to the Commission for approval of the proposed Wetland Replication Area under the Bylaw. This area will establish as BVW as opposed to IVW; however, it is BETA's opinion that constructing wetland mitigation off of an existing wetland boundary with an existing hydrologic regime will increase the likelihood of successful establishment. BETA also concurs with the procedures set forth within the wetland replication plan including the establishment of grades to support hydrology, reuse of hydric soils from the impacted IVW, transplanting of native hydrophytic vegetation from the impacted IVW, and monitoring protocols. It is recommended that the wetland mitigation plan include a provision requiring stockpiled hydric soils to be kept moist and covered until reuse; however, the Commission could consider requiring this revision as a condition of approval.

ADE2: The Applicant is amenable to including this as an order of condition.

STORMWATER MANAGEMENT

Stormwater management features proposed include the construction of a stormwater detention basin along the northerly edge of the access driveway at the western edge of the easement, a second detention basin at the far easterly edge of the parcel, and an infiltration trench and deep sump catch basin at the entrance. The two detention basins will capture stormwater runoff from the arrays and the gravel roadway. A catch basin is proposed at the Site entrance which will discharge to a subsurface infiltration trench beneath the driveway. Outfalls from this basin are proposed to convey captured stormwater runoff to the east. The remainder of the Site will generally follow pre-development flow patterns with no stormwater BMPs proposed.

A review of the Project's compliance with the Massachusetts Stormwater Management Standards and the applicable local Regulations was issued to the Planning Board on August 4, 2023. Currently, the Project does not fully comply with the Massachusetts Stormwater Standards, and revisions to the design are required to comply with the Standards.

ADE: Acknowledged

BETA2: The Project is undergoing a separate review through the Planning Board for compliance with the Stormwater Management Standards.

ADE2: Acknowledged

REVIEW SUMMARY

Based on our review of the revised NOI submittal and Project plans, the Applicant has not provided sufficient information to describe the Site, the work, and the effect of the work on



*Breka Li Goodlander, Agent
Town of Franklin Conservation Commission
Response to BETA Notice of Intent Peer Review Comments, November 30, 2023
Upper Union Solar Project – Franklin, MA (ADE Project #3328.00)
December 13, 2023 – Page 11*

the interests identified in the Act and the Bylaw. Specifically, documentation of compliance with the MA Stormwater Standards under the Act (to be completed through the Planning Board review process) and a revised Resource Area Impact Summary Form should be provided.

Please call us at (508) 888-9282 if you should have any questions.

Sincerely,

ATLANTIC DESIGN ENGINEERS, INC.

A handwritten signature in blue ink, appearing to read 'Richard J. Tabaczynski', is written over a light gray diagonal line that extends from the bottom left towards the top right of the page.

Richard J. Tabaczynski, P.E.
Vice President



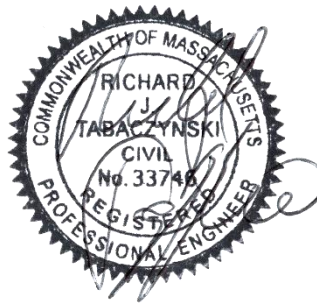
**STORMWATER
ADDENDUM #2
For
Upper Union Solar Project
0 Upper Union Street
Franklin, Massachusetts**

Prepared for:

**VS Union Solar Smart, LLC
24941 Dana Point Harbor
Dana Point, California 92629**

Prepared by:

**Atlantic Design Engineers, Inc.
P.O. Box 1051
Sandwich, Massachusetts 02563**



December 13, 2023
ADE Project No. 3328.00

TABLE OF CONTENTS

- 1.0 Summary
- 2.0 Pre and Post-development Runoff Rates and Volume Comparison Table for Subcatchment 1S

APPENDICES

- A. Revised HydroCAD Calculations for Pre-Development Subcatchment 1S and Volume Calculation for Cul-tec 100-HD Subsurface Infiltration System
- B. Miscellaneous Calculations
- C. Groundwater Mounding Analysis

1.0 SUMMARY

This Addendum #2 to the original stormwater report dated 6/19/23 addresses the stormwater/drainage-related comments from the BETA Group, Inc review letters dated 11/29/23 and 11/30/23.

The following is a summary of the revisions incorporated into this Stormwater Report Addendum #2:

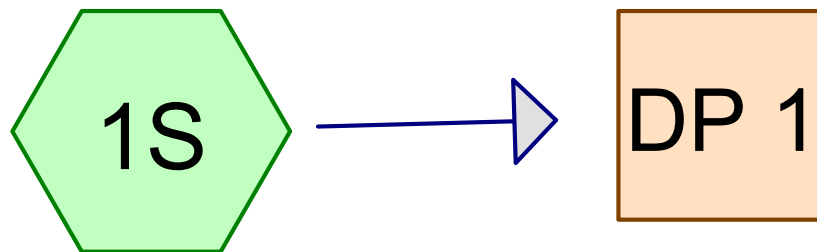
- Pre-development Time of Concentration (Tc) for Subcatchment 1S was increased to 12.2 minutes to match Post-development conditions per comments from BETA Group. Accordingly, Atlantic has provided a revised Pre and Post-development volume and runoff rate comparison table for Subcatchment 1S.
- Revised Water Quality, Recharge and TSS Removal calculations.
- Provide Groundwater Mounding Analysis

**2.0 PRE & POST-DEVELOPMENT RUNOFF RATE AND VOLUME COMPARISON
 TABLE FOR SUBCATCHMENT 1S**

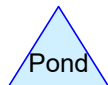
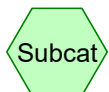
<i>Design Point #DP 1 – Offsite West</i>				
<i>Storm Event</i>	<i>Pre-Development</i>		<i>Post-Development</i>	
	<i>Runoff Rate</i>	<i>Volume</i>	<i>Runoff Rate</i>	<i>Volume</i>
2-year	0.95 cfs	3,622 cf	0.97 cfs	3,603 cf
10-year	2.16 cfs	7,899 cf	2.02 cfs	7,365 cf
25-year	3.21 cfs	11,691 cf	2.91 cfs	10,609 cf
100-year	5.48 cfs	20,101 cf	4.77 cfs	17,670 cf

APPENDIX A

**Revised HydroCAD Calculations for Pre-Development Subcatchment 1S and
Volume Calculation for Cul-tec 100-HD Subsurface Infiltration System**



Towards Offsite West



3328.00-PRE REV2-SUB 1S

Prepared by {enter your company name here}

HydroCAD® 10.00-25 s/n 00480 © 2019 HydroCAD Software Solutions LLC

Printed 12/13/2023

Page 2

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
23,498	74	>75% Grass cover, Good, HSG C (1S)
1,932	98	Roofs, HSG C (1S)
18,229	70	Woods, Good, HSG C (1S)
43,659	73	TOTAL AREA

3328.00-PRE REV2-SUB 1S

Prepared by {enter your company name here}

HydroCAD® 10.00-25 s/n 00480 © 2019 HydroCAD Software Solutions LLC

Printed 12/13/2023

Page 3

Soil Listing (all nodes)

Area (sq-ft)	Soil Group	Subcatchment Numbers
0	HSG A	
0	HSG B	
43,659	HSG C	1S
0	HSG D	
0	Other	
43,659		TOTAL AREA

3328.00-PRE REV2-SUB 1S

Prepared by {enter your company name here}

Printed 12/13/2023

HydroCAD® 10.00-25 s/n 00480 © 2019 HydroCAD Software Solutions LLC

Page 4

Ground Covers (all nodes)

HSG-A (sq-ft)	HSG-B (sq-ft)	HSG-C (sq-ft)	HSG-D (sq-ft)	Other (sq-ft)	Total (sq-ft)	Ground Cover
0	0	23,498	0	0	23,498	>75% Grass cover, Good
0	0	1,932	0	0	1,932	Roofs
0	0	18,229	0	0	18,229	Woods, Good
0	0	43,659	0	0	43,659	TOTAL AREA

3328.00-PRE REV2-SUB 1S

NRCC 24-hr C 2-Year Rainfall=3.22"

Prepared by {enter your company name here}

Printed 12/13/2023

HydroCAD® 10.00-25 s/n 00480 © 2019 HydroCAD Software Solutions LLC

Page 5

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

Subcatchment 1S:

Runoff Area=43,659 sf 4.43% Impervious Runoff Depth=1.00"
Tc=12.2 min CN=73 Runoff=0.95 cfs 3,622 cf

Reach DP 1: Towards Offsite West

Inflow=0.95 cfs 3,622 cf
Outflow=0.95 cfs 3,622 cf

Total Runoff Area = 43,659 sf Runoff Volume = 3,622 cf Average Runoff Depth = 1.00"
95.57% Pervious = 41,727 sf 4.43% Impervious = 1,932 sf

Summary for Subcatchment 1S:

Runoff = 0.95 cfs @ 12.21 hrs, Volume= 3,622 cf, Depth= 1.00"

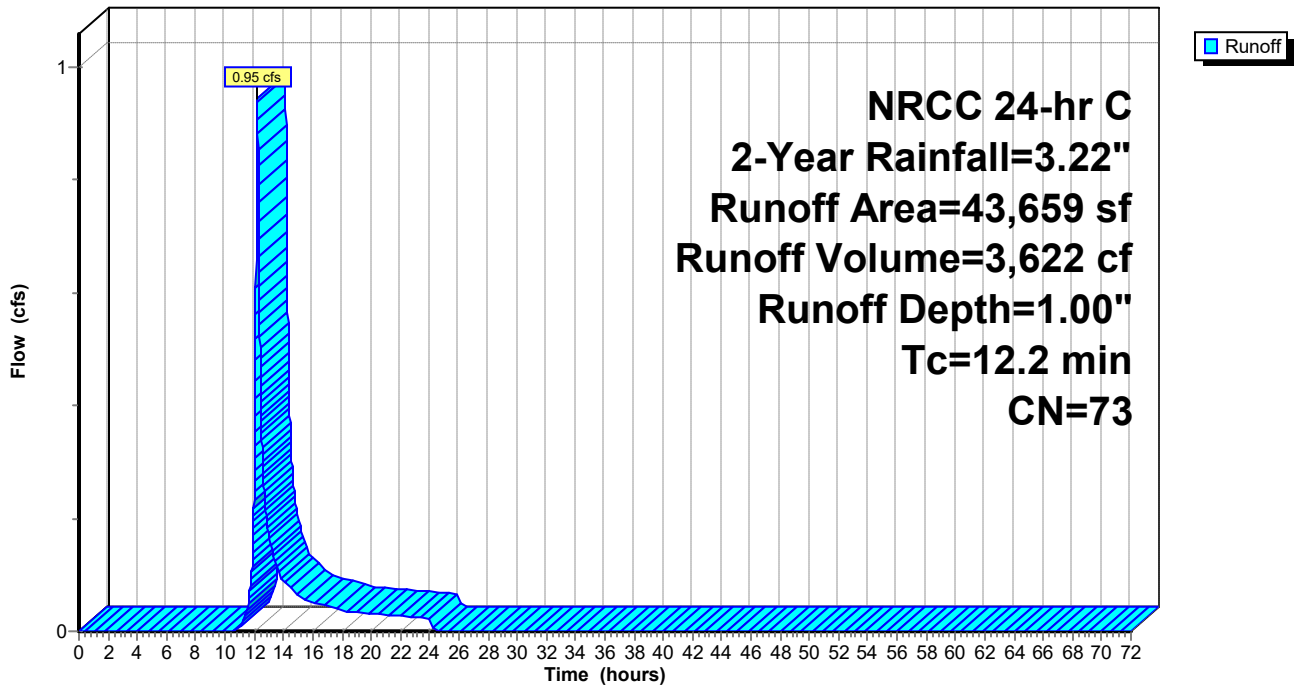
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
 NRCC 24-hr C 2-Year Rainfall=3.22"

Area (sf)	CN	Description
18,229	70	Woods, Good, HSG C
1,932	98	Roofs, HSG C
23,498	74	>75% Grass cover, Good, HSG C
43,659	73	Weighted Average
41,727		95.57% Pervious Area
1,932		4.43% Impervious Area

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

Subcatchment 1S:

Hydrograph



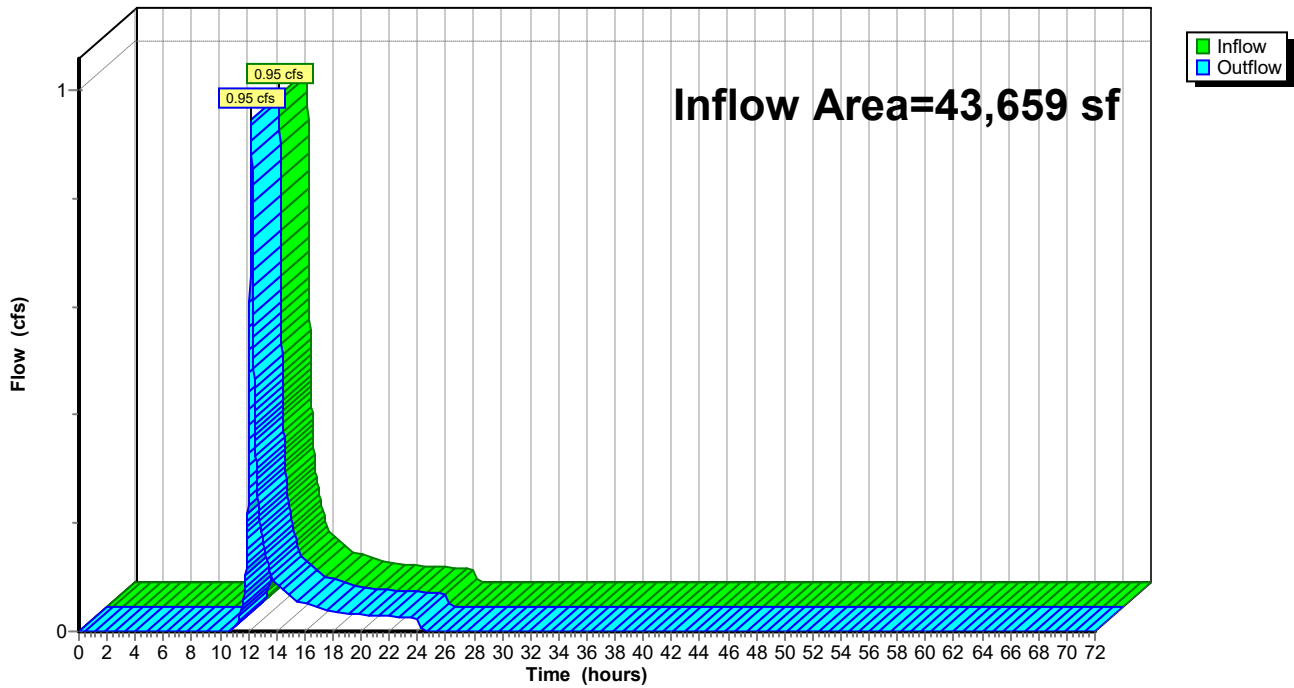
Summary for Reach DP 1: Towards Offsite West

Inflow Area = 43,659 sf, 4.43% Impervious, Inflow Depth = 1.00" for 2-Year event
Inflow = 0.95 cfs @ 12.21 hrs, Volume= 3,622 cf
Outflow = 0.95 cfs @ 12.21 hrs, Volume= 3,622 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Reach DP 1: Towards Offsite West

Hydrograph



3328.00-PRE REV2-SUB 1S

NRCC 24-hr C 10-Year Rainfall=4.86"

Prepared by {enter your company name here}

Printed 12/13/2023

HydroCAD® 10.00-25 s/n 00480 © 2019 HydroCAD Software Solutions LLC

Page 8

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

Subcatchment 1S:

Runoff Area=43,659 sf 4.43% Impervious Runoff Depth=2.17"
Tc=12.2 min CN=73 Runoff=2.16 cfs 7,899 cf

Reach DP 1: Towards Offsite West

Inflow=2.16 cfs 7,899 cf
Outflow=2.16 cfs 7,899 cf

Total Runoff Area = 43,659 sf Runoff Volume = 7,899 cf Average Runoff Depth = 2.17"
95.57% Pervious = 41,727 sf 4.43% Impervious = 1,932 sf

Summary for Subcatchment 1S:

Runoff = 2.16 cfs @ 12.20 hrs, Volume= 7,899 cf, Depth= 2.17"

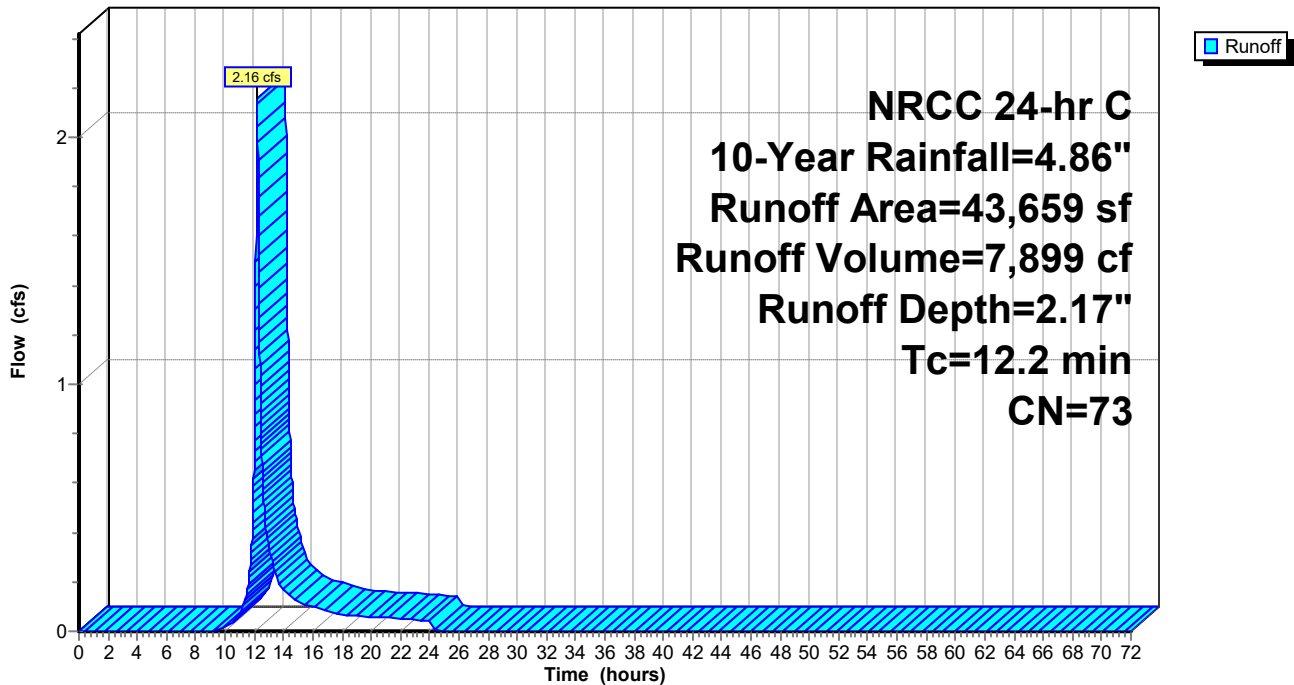
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
 NRCC 24-hr C 10-Year Rainfall=4.86"

Area (sf)	CN	Description
18,229	70	Woods, Good, HSG C
1,932	98	Roofs, HSG C
23,498	74	>75% Grass cover, Good, HSG C
43,659	73	Weighted Average
41,727		95.57% Pervious Area
1,932		4.43% Impervious Area

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

Subcatchment 1S:

Hydrograph



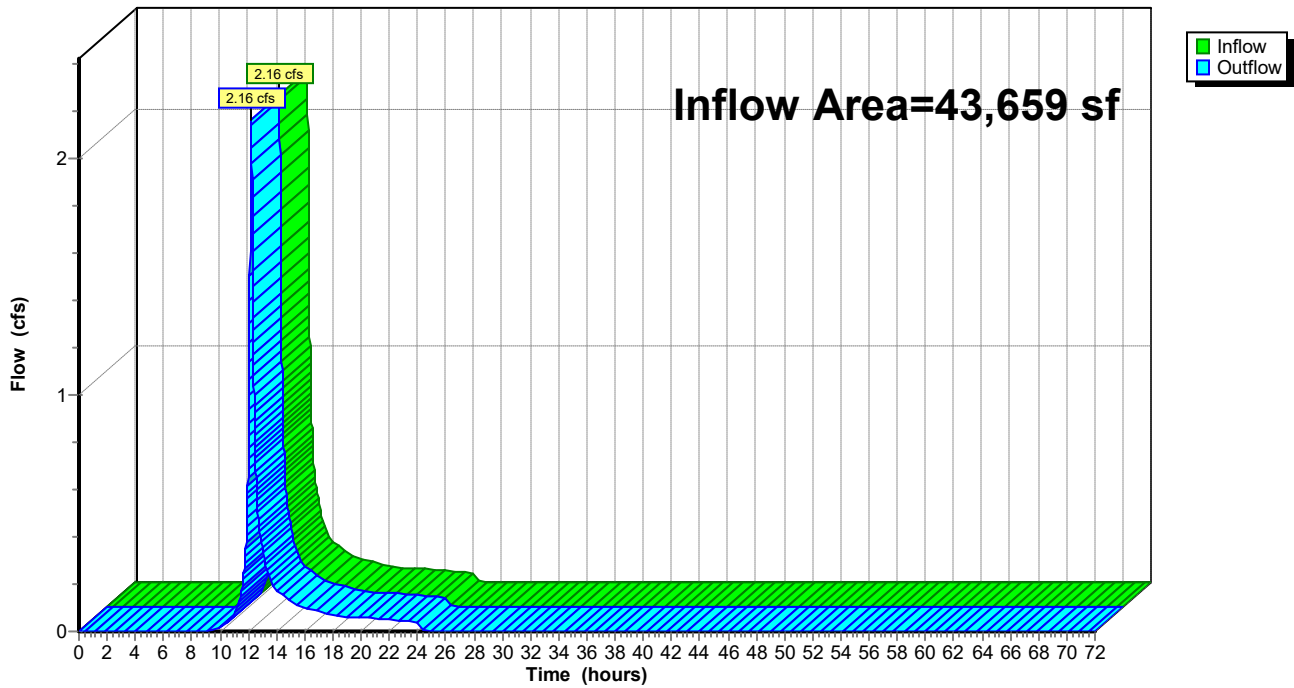
Summary for Reach DP 1: Towards Offsite West

Inflow Area = 43,659 sf, 4.43% Impervious, Inflow Depth = 2.17" for 10-Year event
Inflow = 2.16 cfs @ 12.20 hrs, Volume= 7,899 cf
Outflow = 2.16 cfs @ 12.20 hrs, Volume= 7,899 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Reach DP 1: Towards Offsite West

Hydrograph



3328.00-PRE REV2-SUB 1S

NRCC 24-hr C 25-Year Rainfall=6.15"

Prepared by {enter your company name here}

Printed 12/13/2023

HydroCAD® 10.00-25 s/n 00480 © 2019 HydroCAD Software Solutions LLC

Page 11

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

Subcatchment 1S:

Runoff Area=43,659 sf 4.43% Impervious Runoff Depth=3.21"
Tc=12.2 min CN=73 Runoff=3.21 cfs 11,691 cf

Reach DP 1: Towards Offsite West

Inflow=3.21 cfs 11,691 cf
Outflow=3.21 cfs 11,691 cf

Total Runoff Area = 43,659 sf Runoff Volume = 11,691 cf Average Runoff Depth = 3.21"
95.57% Pervious = 41,727 sf 4.43% Impervious = 1,932 sf

Summary for Subcatchment 1S:

Runoff = 3.21 cfs @ 12.20 hrs, Volume= 11,691 cf, Depth= 3.21"

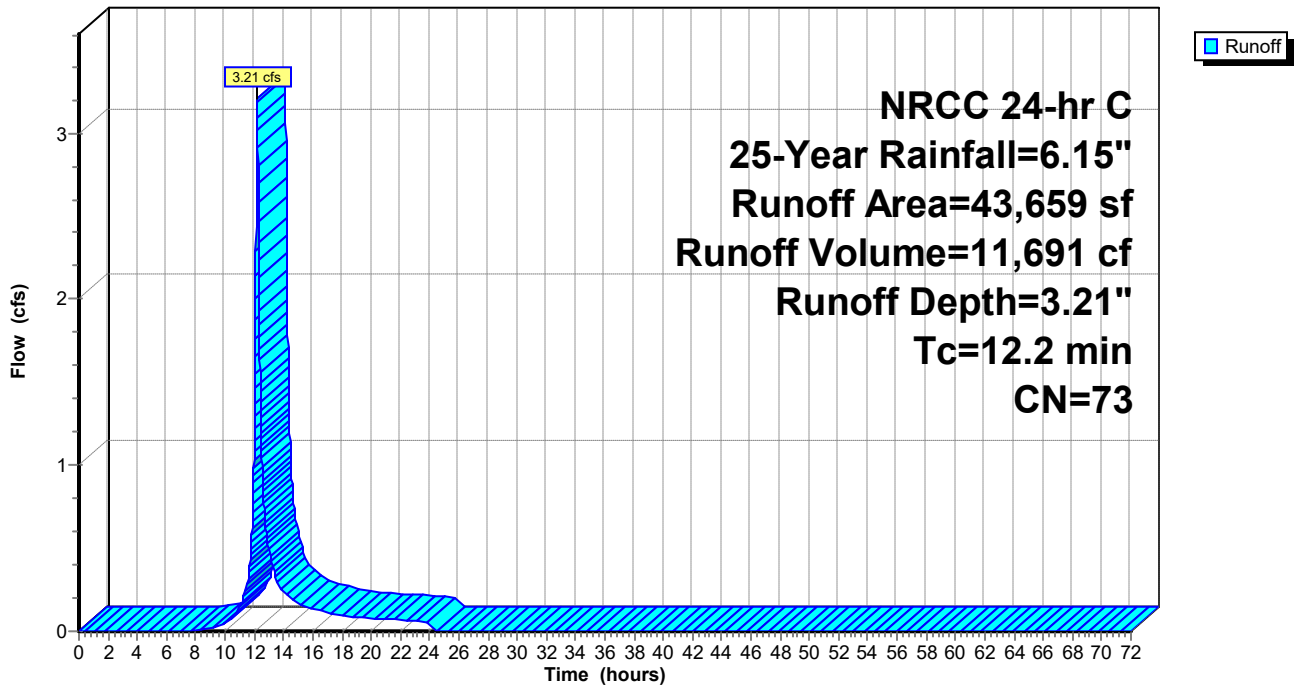
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
NRCC 24-hr C 25-Year Rainfall=6.15"

Area (sf)	CN	Description
18,229	70	Woods, Good, HSG C
1,932	98	Roofs, HSG C
23,498	74	>75% Grass cover, Good, HSG C
43,659	73	Weighted Average
41,727		95.57% Pervious Area
1,932		4.43% Impervious Area

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

Subcatchment 1S:

Hydrograph



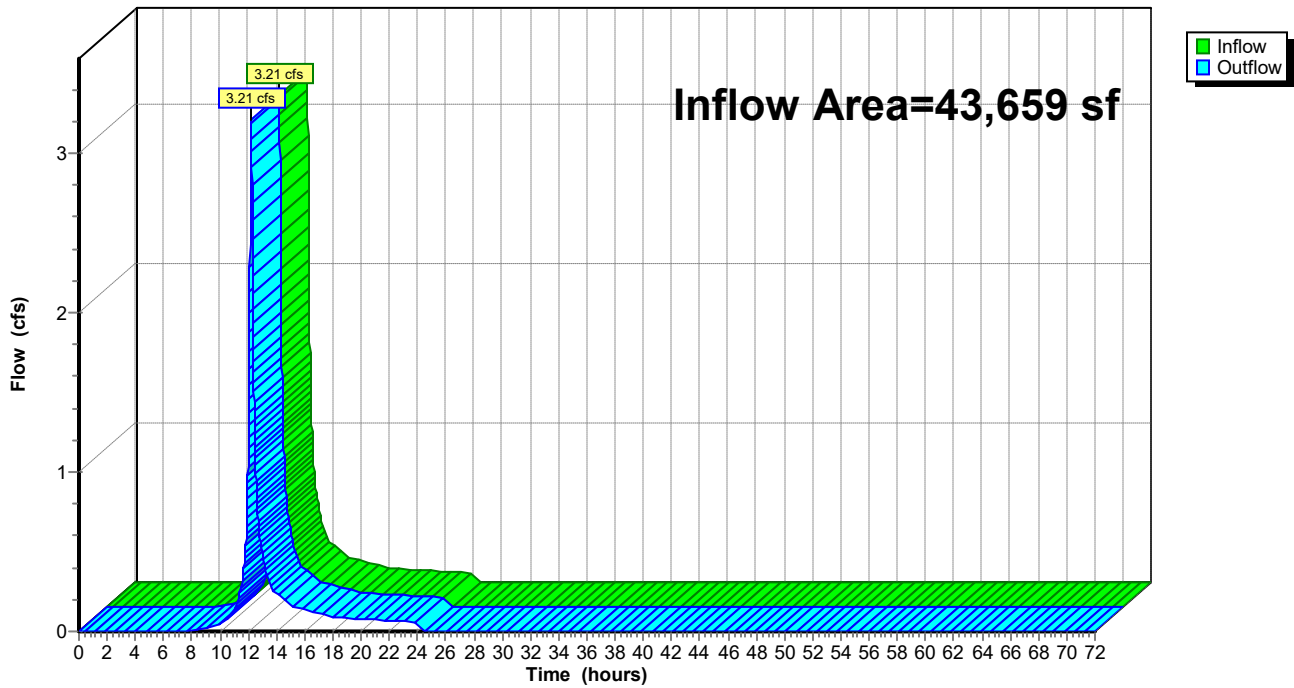
Summary for Reach DP 1: Towards Offsite West

Inflow Area = 43,659 sf, 4.43% Impervious, Inflow Depth = 3.21" for 25-Year event
Inflow = 3.21 cfs @ 12.20 hrs, Volume= 11,691 cf
Outflow = 3.21 cfs @ 12.20 hrs, Volume= 11,691 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Reach DP 1: Towards Offsite West

Hydrograph



3328.00-PRE REV2-SUB 1S

NRCC 24-hr C 100-Year Rainfall=8.80"

Prepared by {enter your company name here}

Printed 12/13/2023

HydroCAD® 10.00-25 s/n 00480 © 2019 HydroCAD Software Solutions LLC

Page 14

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

Subcatchment 1S:

Runoff Area=43,659 sf 4.43% Impervious Runoff Depth=5.53"
Tc=12.2 min CN=73 Runoff=5.48 cfs 20,101 cf

Reach DP 1: Towards Offsite West

Inflow=5.48 cfs 20,101 cf
Outflow=5.48 cfs 20,101 cf

Total Runoff Area = 43,659 sf Runoff Volume = 20,101 cf Average Runoff Depth = 5.53"
95.57% Pervious = 41,727 sf 4.43% Impervious = 1,932 sf

Summary for Subcatchment 1S:

Runoff = 5.48 cfs @ 12.20 hrs, Volume= 20,101 cf, Depth= 5.53"

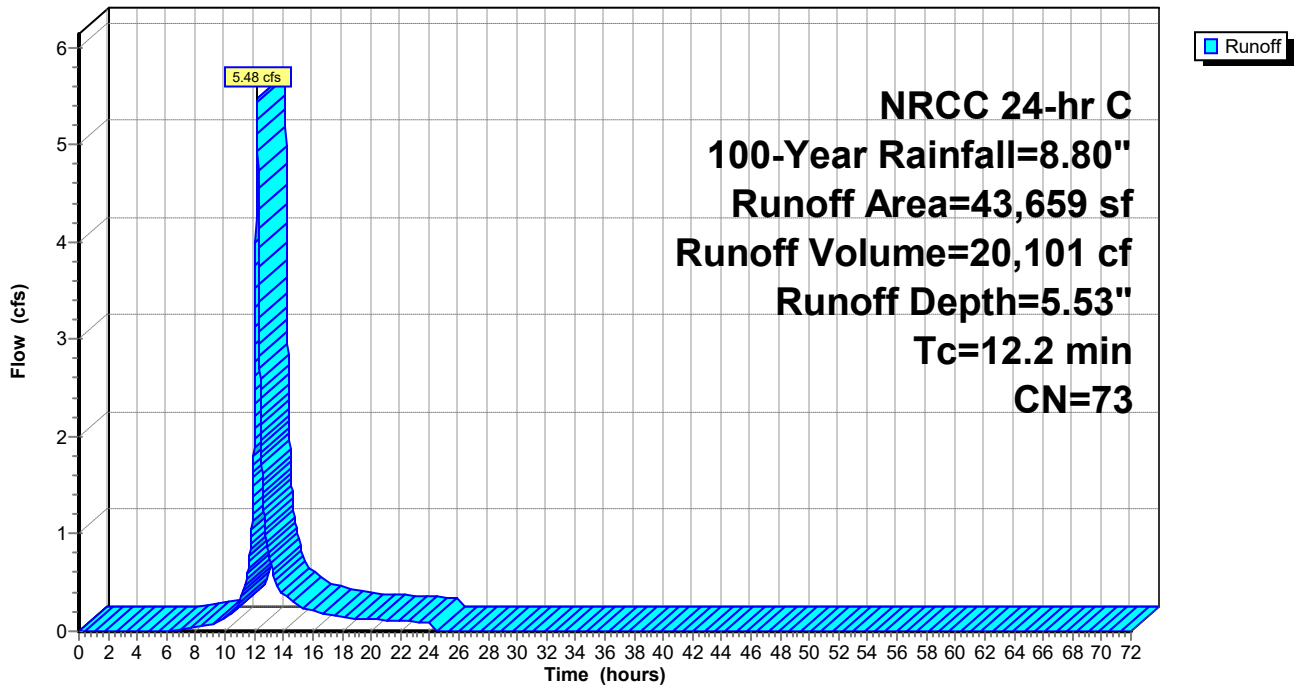
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
NRCC 24-hr C 100-Year Rainfall=8.80"

Area (sf)	CN	Description
18,229	70	Woods, Good, HSG C
1,932	98	Roofs, HSG C
23,498	74	>75% Grass cover, Good, HSG C
43,659	73	Weighted Average
41,727		95.57% Pervious Area
1,932		4.43% Impervious Area

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

Subcatchment 1S:

Hydrograph



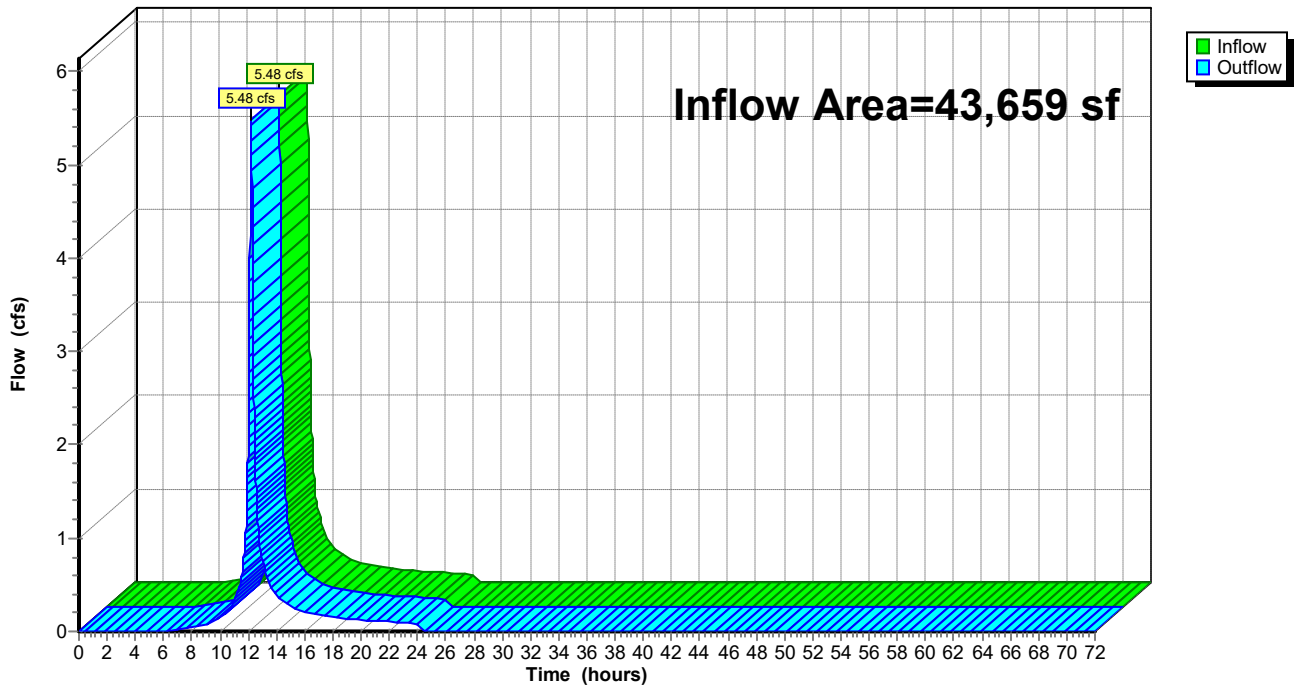
Summary for Reach DP 1: Towards Offsite West

Inflow Area = 43,659 sf, 4.43% Impervious, Inflow Depth = 5.53" for 100-Year event
Inflow = 5.48 cfs @ 12.20 hrs, Volume= 20,101 cf
Outflow = 5.48 cfs @ 12.20 hrs, Volume= 20,101 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Reach DP 1: Towards Offsite West

Hydrograph



APPENDIX B
Miscellaneous Calculations

Required Recharge Volume

Design Engineer:	Atlantic Design Engineers, Inc	Job No.:	3328.00
Project Name:	Upper Union Solar Project	Calc'd By:	BJR
Location:	0 Upper Union Street, Franklin, MA	Original Date:	6/19/2023
		Revised Date:	11/10/2023
		Revised Date:	12/13/2023

The groundwater recharge volume is required for the proposed asphalt **impervious area**.

$R_v = (F) (A_{imp})$
 R_v = Required Recharge Volume
 A_{imp} = Impervious Area on site
 F = Target Depth Factor: 0.25 inch for C soils

Required Recharge

Existing Impervious Are (Rooftops)=	2,138 sf		
New Impervious Area (Paved Apron) =	1,137 sf		
Required Recharge Volume (Rv)=	3,275	*0.25** (1/12)=	68 cf
Recharge Volume Provided			
Cultec C-100HD Subsurface System	Cultec C-100HD Chambers w/ Stone (See HydroCAD Calcs)		279 cf
Proposed Volume Provided in Sub-Surface Systems=			279 cf
Total Required Recharge Volume on Site=			
			68 cf
Proposed Recharge Volume Provided in Subsurface System=			
			279 cf
			279 > 68
			Standard is Met

Required Recharge Volume

Design Engineer:	Atlantic Design Engineers, Inc	Job No.:	3328.00
Project Name:	Upper Union Solar Project	Calc'd By:	BJR
Location:	0 Upper Union Street, Franklin, MA	Original Date:	6/19/2023
		Revision Date:	11/10/2023
		Revision Date:	12/13/2023

The groundwater recharge volume is required for the proposed equipment pad **impervious area**.

$R_v = (F) (A_{imp})$
 R_v = Required Recharge Volume
 A_{imp} = Impervious Area on site
 F = Target Depth Factor: 0.6 inch for A soils

Infiltration Basin 6P

Total New Impervious Area (Equipment Pad) =	640 sf	
Required Recharge Volume (Rv)=	640 *0.6** (1/12)=	32 cf

Recharge Volume Provided

	Infiltration Basin	Basin 6P - Northeast (See HydroCAD Calcs)	18,479 cf
--	--------------------	--	------------------

Proposed Volume Provided in Infiltration Basin 6P=	18,479 cf
---	------------------

Total Required Recharge Volume on Site=	32 cf
--	--------------

Proposed Recharge Volume Provided in Infiltration Trench=	18479 cf
--	-----------------

18479 > 32

Standard is Met

TSS REMOVAL CALCULATION SHEET

Design Engineer: Atlantic Design Engineers, Inc Job No.: 3328.00
Project Name: Upper Union Solar Project Calc'd By: BR
Location: 0 Upper Union Street, Franklin, MA Date: 12/13/2023

Paved Driveway Section (44% Pre-Treatment Requirement)

BMP	Removal Rate	Starting TSS Load	TSS Removed	Remaining Load
Deep Sump Catch Basins w/ Grate	25%	100.0%	25%	75.0%
Deep Sump Catch Basins w/ Manhole Cover	25%	75.0%	19%	56.3%
Total Removed			44%	

TSS REMOVAL CALCULATION SHEET

Design Engineer: Atlantic Design Engineers, Inc Job No.: 3328.00
Project Name: Upper Union Solar Project Calc'd By: BR
Location: 0 Upper Union Street, Franklin, MA Original Date: 11/10/2023
Revised Date: 12/13/2023

Paved Apron (80% Treatment Requirement)

BMP	Removal Rate	Starting TSS Load	TSS Removed	Remaining Load
Deep Sump Catch Basins w/ Grate	0%	100.0%	0%	100.0%
Deep Sump Catch Basins w/ Manhole Cover	0%	100.0%	0%	100.0%
Subsurface Infiltration (Cultec HD-100)	80%	100.0%	80%	20.0%
Total Removed			80%	

TSS REMOVAL CALCULATION SHEET

Design Engineer: Atlantic Design Engineers, Inc Job No.: 3328.00
Project Name: Upper Union Solar Project Calc'd By: BR
Location: 0 Upper Union Street, Franklin, MA Original Date: 12/13/2023

Equipment Pad Section (80% Treatment Requirement)

BMP	Removal Rate	Starting TSS Load	TSS Removed	Remaining Load
Vegetative Filter Strip (50' Wide)	0%	100.0%	0%	100.0%
Infiltration Basin	80%	100.0%	80%	20.0%
Total Removed			80%	

Water Quality Calculation Sheet*

Design Engineer: Atlantic Design Engineers, Inc
 Project Name: Upper Union Solar Project
 Location: 0 Upper Union Street, Franklin, MA

Job No.: 3328.00
 Calc'd By: BJR
 Original Date: 6/19/2023
 Revision Date: 11/10/2023
 Revision Date: 12/13/2023

The required water quality treatment volume is calculated as follows:

$$Vwq = (Dwq) * (Aimp)$$

Vwq = Required Water Quality Volume
 Dwq = Water Quality Depth * 1"
 Aimp = Area of Impervious

Subcatchment Area: 1S

Existing Impervious Area (Rooftops)= 2,138 sf
 New Impervious Area (Paved Apron)= 1,137 sf
 Total Impervious Area for the Subcatchment= 3,275 sf

Water Quality Volume Required (Vwq)= 3,275 * 1" * (1/12)= 273 cf

Volume Provided via Cultec 100HD= Cultec C-100HD Chambers w/ Stone (See HydroCAD Calcs) 279 cf

Volume Required= 272.9 < 279 **Water Quality Volume is met**

Subcatchment Area: 6A

Total Impervious Area for the Subcatchment= 640 sf

Water Quality Volume Required (Vwq)= 640 * 1" * (1/12)= 53 cf

Volume Provided via Infiltration Basin= Basin 6P - Northeast (See HydroCAD Calcs) 18479 cf

Volume Required= 53.3 < 18,479 **Water Quality Volume is met**

Total Impervious Area on the Site= 1,777 sf
Total Volume Quality Required= 326 cf
Total Volume Provided= 18,758 cf

* The purpose of these calculations is to show compliance with the Town of Franklin Stormwater Management Bylaw Chapter 153, specifically Section 153-16.B.(1).(a)

APPENDIX C
Groundwater Mounding Analysis



1.0 INTRODUCTION

The Upper Union Solar Project located at 0 Upper Union Street in Franklin, MA, is located on the boundary of the Upper Charles River Basin and Blackstone River Basin; however, the Site is primarily located within the Burnt Swamp Brook Aquifer located within the eastern portion of the Blackstone River Basin. The U.S. Geological Survey, in cooperation with the Massachusetts Department of Environmental Management, Office of Water Resources, completed a study of water resources in the Blackstone River Basin in 2000 under Water-Resource Investigation Report 93-4167.

2.0 GROUNDWATER MOUNDING ANALYSIS USING HANTUSH EQUATION

Infiltration Basin 2P Inputs:

Recharge (Infiltration) Rate, $R = 2.41$ in/hr = 4.82 ft/day

Specific Yield, $S_y = 0.20$

- Test Pit Data from TP-2 & TP-3 indicated C Soil Layer was Loamy Sand. Specific Yield was estimated using Figure 1 on Page D8 of the following document: Johnson, A.I. "Specific Yield: Compilation of Specific Yields for Various Materials." *Water Supply Paper*, 1 Jan. 1994, pubs.usgs.gov/publication/wsp1662D.

Horizontal Hydraulic Conductivity, $K = 87.5$ ft/day

- Hydraulic Conductivity was estimated assuming medium sand and using Table 2 on Page 11 of following document: Izbicki, John A. *Water Resources of the Blackstone River Basin, Massachusetts*, <https://www.usgs.gov/publications/water-resources-blackstone-river-basin-massachusetts-0>.

$\frac{1}{2}$ Length of Basin, $x = 51/2 = 25.5$ ft

$\frac{1}{2}$ Width of Basin, $y = 127/2 = 63.5$ ft

Duration of Infiltration, $t = 1.5$ days

- Duration of Infiltration was estimated based on HydroCAD calculations.

Initial Saturated Thickness, $h_i(0) = 34.5$ ft (ESHGW to weathered bedrock)

- Saturated Thickness was estimated using Test Pit Data from TP-2 & TP-3 and the following document: Izbicki, John A. *Water Resources of the Blackstone River Basin, Massachusetts*, <https://www.usgs.gov/publications/water-resources-blackstone-river-basin-massachusetts-0>.

Projected Mound @ t=1.5 day = ±3.2 ft

Input Values		use consistent units (e.g. feet & days OR inches & hours)		Conversion Table	
4.8200	R	Recharge (infiltration) rate (feet/day)		inch/hour	feet/day
0.200	Sy	Specific yield, Sy (dimensionless, between 0 and 1)		0.67	1.33
87.50	K	Horizontal hydraulic conductivity, Kh (feet/day)*		2.00	4.00
25.500	x	1/2 length of basin (x direction, in feet)			
63.500	y	1/2 width of basin (y direction, in feet)		hours	days
1.500	t	duration of infiltration period (days)		36	1.50
34.500	hi(0)	initial thickness of saturated zone (feet)			
37.662	h(max)	maximum thickness of saturated zone (beneath center of basin at end of infiltration period)			
3.162	Δh(max)	maximum groundwater mounding (beneath center of basin at end of infiltration period)			
Ground-water Mounding, in feet	Distance from center of basin in x direction, in feet				
3.162	0				
2.939	20				
2.426	40				
2.195	50				
1.988	60				
1.803	70				
1.637	80				
1.488	90				
1.353	100				
1.121	120				

Distance from center of basin (x), in feet	Groundwater Mounding (h), in feet
0	3.162
20	2.939
40	2.426
50	2.195
60	1.988
70	1.803
80	1.637
90	1.488
100	1.353
120	1.121

Disclaimer

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

Figure 1: Spreadsheet solving the Hantush (1967) equation for ground-water mounding beneath an infiltration basin was obtained from <https://pubs.usgs.gov/sir/2010/5102/>

Infiltration Basin 6P Inputs:

Recharge (Infiltration) Rate, $R = 2.41$ in/hr = 4.82 ft/day

Specific Yield, $S_y = 0.25$

- Test Pit Date from TP-4 & TP-5 indicated C Soil Layer was Loamy Sand. Specific Yield was estimated using Figure 1 on Page D8 of the following document: Johnson, A.I. “Specific Yield: Compilation of Specific Yields for Various Materials.” *Water Supply Paper*, 1 Jan. 1994, pubs.usgs.gov/publication/wsp1662D.

Horizontal Hydraulic Conductivity, $K = 87.5$ ft/day

- Hydraulic Conductivity was estimated assuming medium sand and using Table 2 on Page 11 of following document: Izbicki, John A. *Water Resources of the Blackstone River Basin, Massachusetts*, <https://www.usgs.gov/publications/water-resources-blackstone-river-basin-massachusetts-0>.

$\frac{1}{2}$ Length of Basin, $x = 39/2 = 19.5$ ft

$\frac{1}{2}$ Width of Basin, $y = 73/2 = 36.5$ ft

Duration of Infiltration, $t = 1.92$ days

- Duration of Infiltration was estimated based on HydroCAD calculations.

Initial Saturated Thickness, $hi(0) = 36.25$ ft (ESHGW to weathered bedrock)

- Saturated Thickness was estimated using Test Pit Date from TP-4 & TP-5 and the following document: Izbicki, John A. *Water Resources of the Blackstone River Basin, Massachusetts*, <https://www.usgs.gov/publications/water-resources-blackstone-river-basin-massachusetts-0>.

Projected Mound @ $t=1.92$ day = ± 1.7 ft

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

Input Values			Conversion Table	
			inch/hour	feet/day
4.8200	R	Recharge (infiltration) rate (feet/day)	0.67	1.33
0.250	Sy	Specific yield, Sy (dimensionless, between 0 and 1)		
87.50	K	Horizontal hydraulic conductivity, Kh (feet/day)*	2.00	4.00
19.500	x	1/2 length of basin (x direction, in feet)		
36.500	y	1/2 width of basin (y direction, in feet)		
1.920	t	duration of infiltration period (days)	hours	days
36.250	hi(0)	initial thickness of saturated zone (feet)	36	1.50
37.933	h(max)	maximum thickness of saturated zone (beneath center of basin at end of infiltration period)		
1.681	Δh(max)	maximum groundwater mounding (beneath center of basin at end of infiltration period)		
Ground-water Mounding, in feet	Distance from center of basin in x direction, in feet			
1.681	0			
1.486	20			
1.160	40			
1.034	50			
0.927	60			
0.834	70			
0.754	80			
0.683	90			
0.620	100			
0.514	120			

Groundwater Mounding, in feet

Disclaimer

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

Figure 2: Spreadsheet solving the Hantush (1967) equation for ground-water mounding beneath an infiltration basin was obtained from <https://pubs.usgs.gov/sir/2010/5102/>