**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

APPENDICES

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

Atlantic

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

	Design Point #DP 1 – Offsite West			
Storm Event	**Pre-Development**		**Post-Development**	
	Runoff Rate	*Volume*	*Runoff Rate*	*Volume*
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

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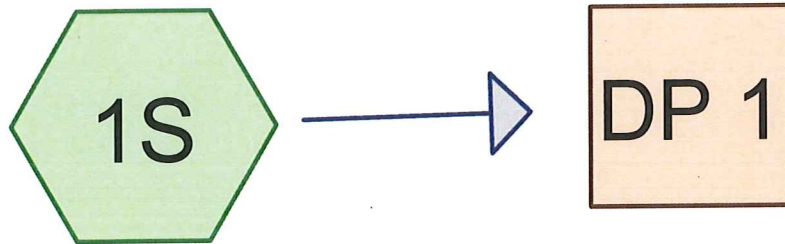
1S

DP 1

Towards Offsite West

Subcat Reach Pond Link

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**

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**

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	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
Prepared by {enter your company name here}
HydroCAD® 10.00-25 s/n 00480 © 2019 HydroCAD Software Solutions LLC

NRCC 24-hr C 2-Year Rainfall=3.22"
Printed 12/13/2023
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

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

NRCC 24-hr C 2-Year Rainfall=3.22"
Printed 12/13/2023
Page 6

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

NRCC 24-hr C
2-Year Rainfall=3.22"
Runoff Area=43,659 sf
Runoff Volume=3,622 cf
Runoff Depth=1.00"
Tc=12.2 min
CN=73

0.95 cfs

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

NRCC 24-hr C 2-Year Rainfall=3.22"
Printed 12/13/2023
Page 7

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

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

NRCC 24-hr C 10-Year Rainfall=4.86"
Printed 12/13/2023
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

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

NRCC 24-hr C 10-Year Rainfall=4.86"
Printed 12/13/2023
Page 9

Summary for Subcatchment 1S:

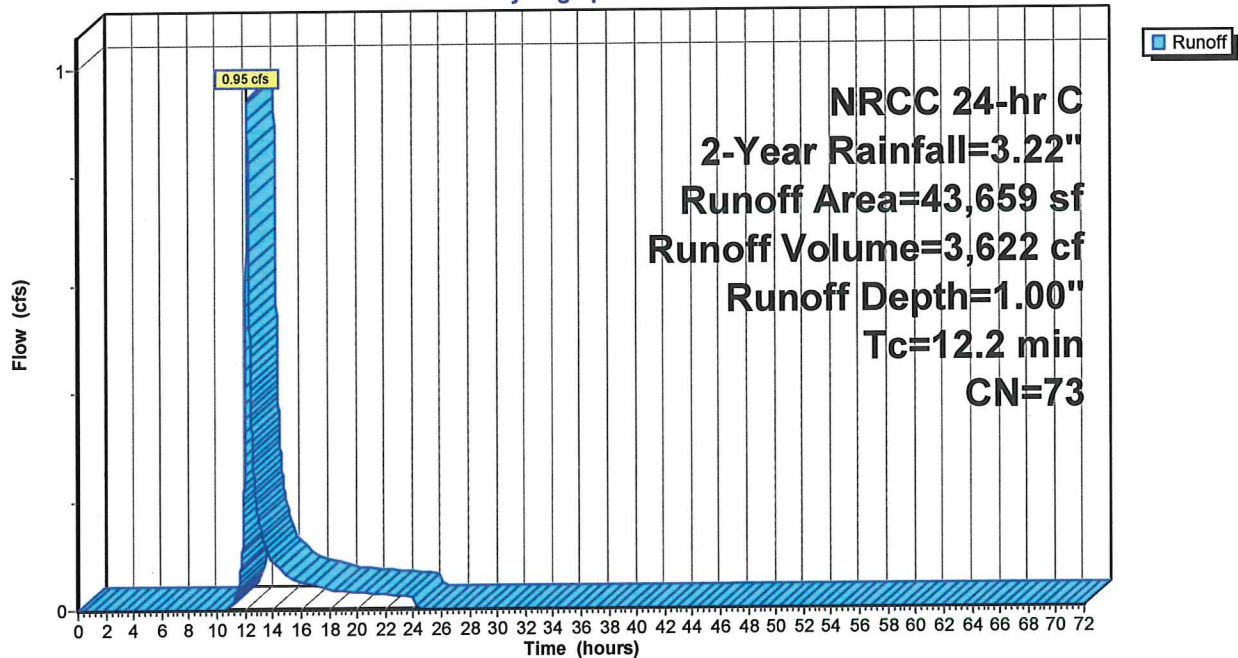Runoff   =   2.16 cfs @ 12.20 hrs, Volume=   7,899 cf, Depth= 2.17"

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

NRCC 24-hr C
10-Year Rainfall=4.86"
Runoff Area=43,659 sf
Runoff Volume=7,899 cf
Runoff Depth=2.17"
Tc=12.2 min
CN=73

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

NRCC 24-hr C 10-Year Rainfall=4.86"
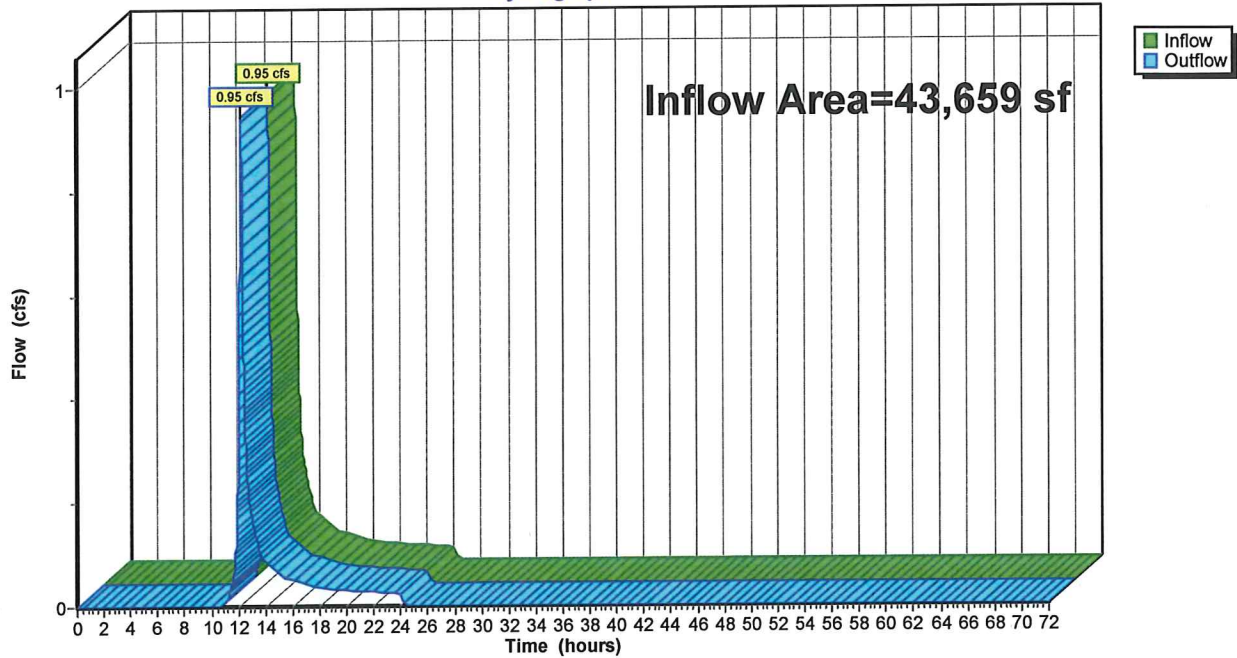Printed 12/13/2023
Page 10

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
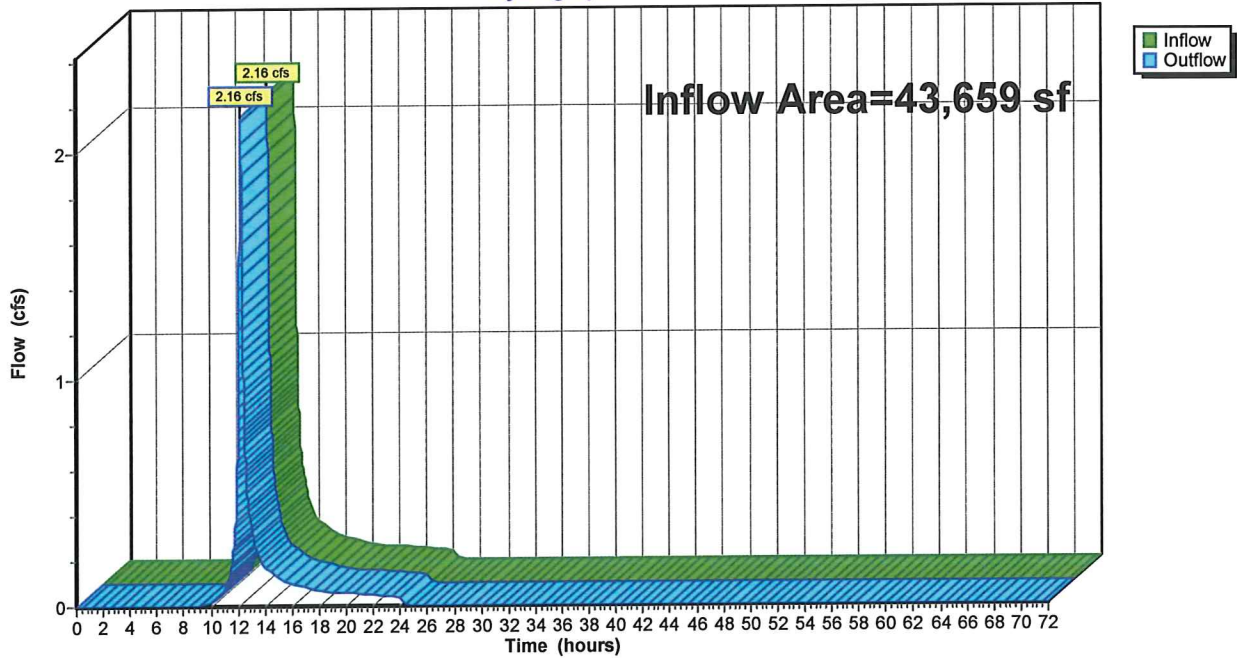
3328.00-PRE REV2-SUB 1S
Prepared by {enter your company name here}
HydroCAD® 10.00-25 s/n 00480 © 2019 HydroCAD Software Solutions LLC

NRCC 24-hr C 25-Year Rainfall=6.15"
Printed 12/13/2023
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

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

NRCC 24-hr C 25-Year Rainfall=6.15"
Printed 12/13/2023
Page 12

Summary for Subcatchment 1S:

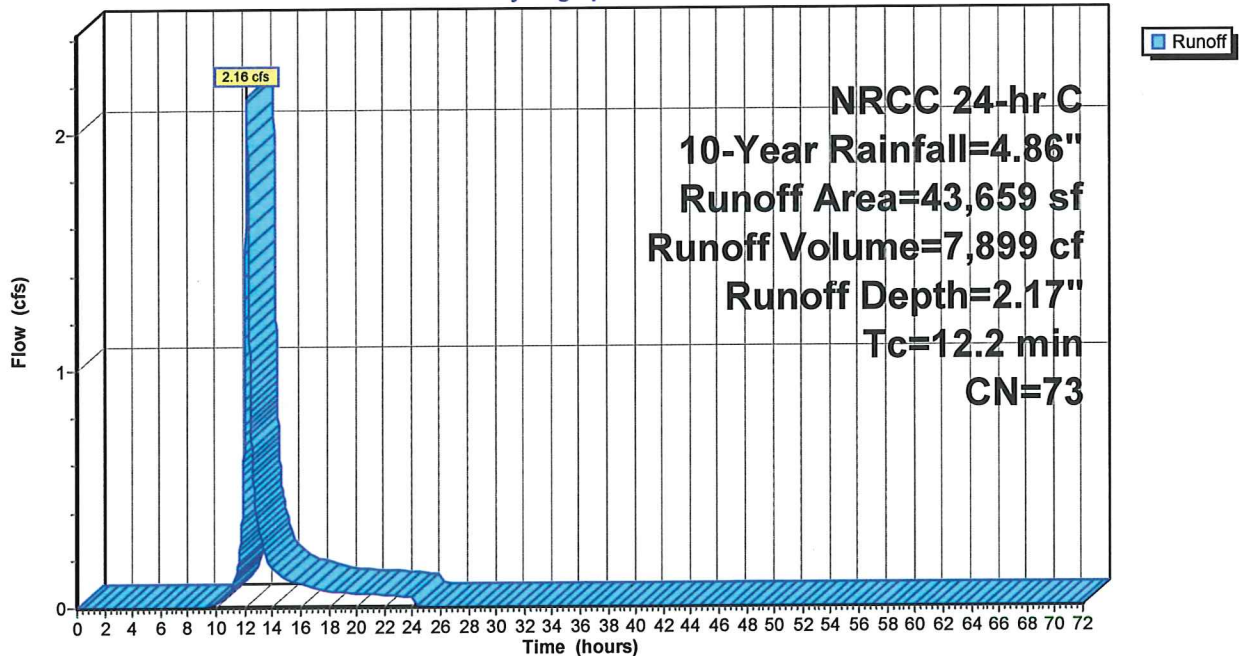Runoff   =   3.21 cfs @ 12.20 hrs, Volume=   11,691 cf, Depth= 3.21"

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

NRCC 24-hr C
25-Year Rainfall=6.15"
Runoff Area=43,659 sf
Runoff Volume=11,691 cf
Runoff Depth=3.21"
Tc=12.2 min
CN=73

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

NRCC 24-hr C 25-Year Rainfall=6.15"
Printed 12/13/2023
Page 13

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

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

NRCC 24-hr C 100-Year Rainfall=8.80"
Printed 12/13/2023
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

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

NRCC 24-hr C 100-Year Rainfall=8.80"
Printed 12/13/2023
Page 15

Summary for Subcatchment 1S:

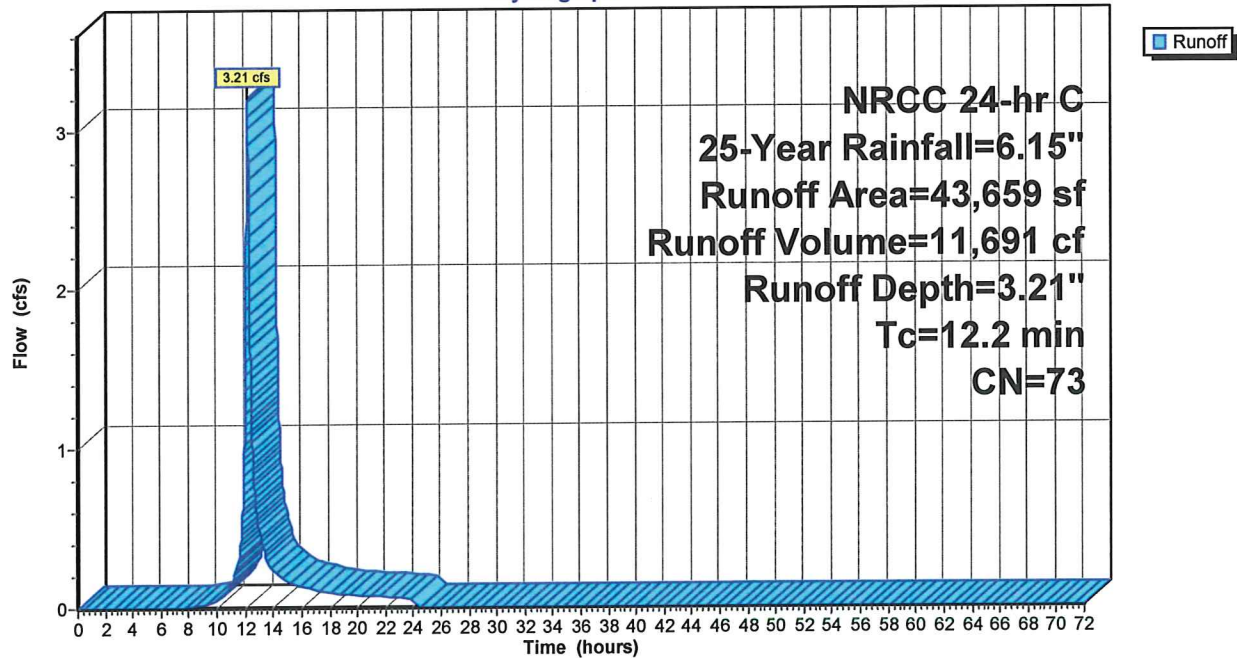Runoff   =   5.48 cfs @ 12.20 hrs, Volume=   20,101 cf, Depth= 5.53"

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

NRCC 24-hr C
100-Year Rainfall=8.80"
Runoff Area=43,659 sf
Runoff Volume=20,101 cf
Runoff Depth=5.53"
Tc=12.2 min
CN=73

5.48 cfs

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

NRCC 24-hr C 100-Year Rainfall=8.80"
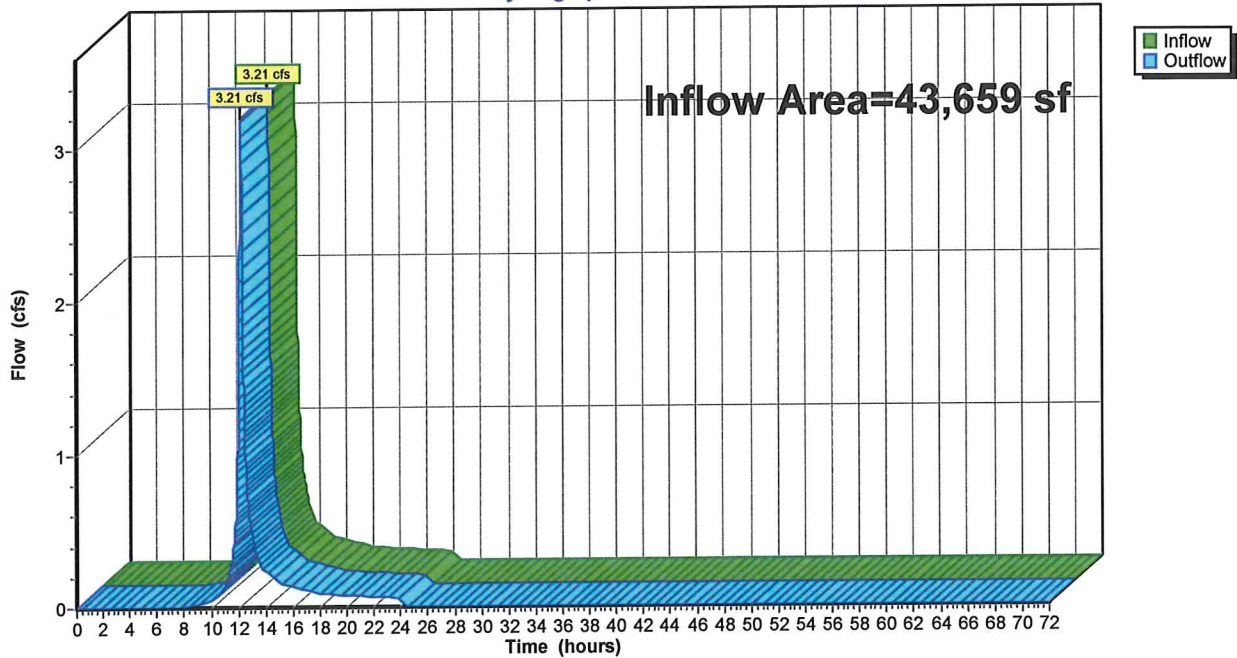Printed 12/13/2023
Page 16

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

Required Recharge Volume

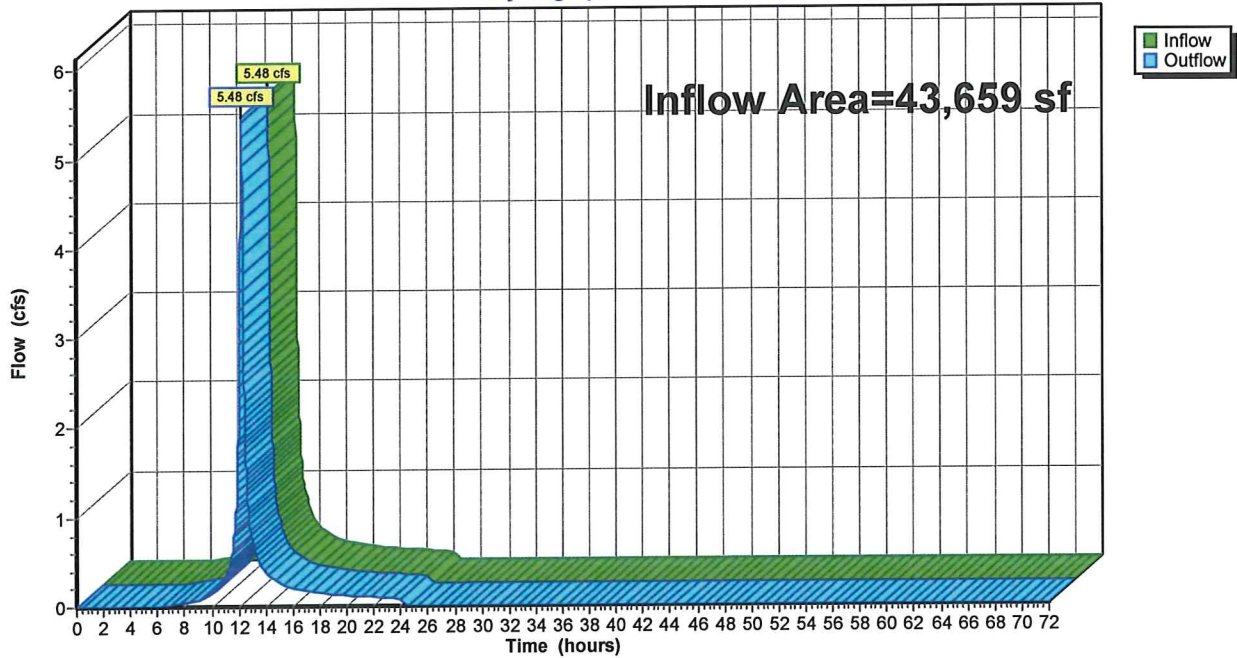|			
Design Engineer:	Atlantic Design Engineers, Inc	Job No.:	3328.00
Project Name:	Upper Union Solar Project	Calc'd By:	BJR
Location:	0 Upper Union Street, Franklin, MA	Original Date:	6/19/2023
		Revised Date:	11/10/2023
		Revised Date:	12/13/2023

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

$$Rv = (F)(Aimp)$$

Rv = Required Recharge Volume

Aimp = 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.**

$$Rv = (F)(Aimp)$$
Rv = Required Recharge Volume
Aimp = Impervious Area on site
F = Target Depth Factor: 0.6 inch for A soils

Infiltration Basin 6P

Total New Impervious Area (Eqipment 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 Calulation Sheet*

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 required water quality treatment volume is calculated as follows:

$$V_{wq} = (D_{wq}) * (A_{imp})$$

V_{wq} = Required Water Quality Volume
D_{wq} = Water Quality Depth * 1"
A_{imp} = 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 Section153-16.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, Sy = 0.20

> Test Pit Date 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.

½ Length of Basin, x = 51/2 = 25.5 ft

½ 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 Date 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.
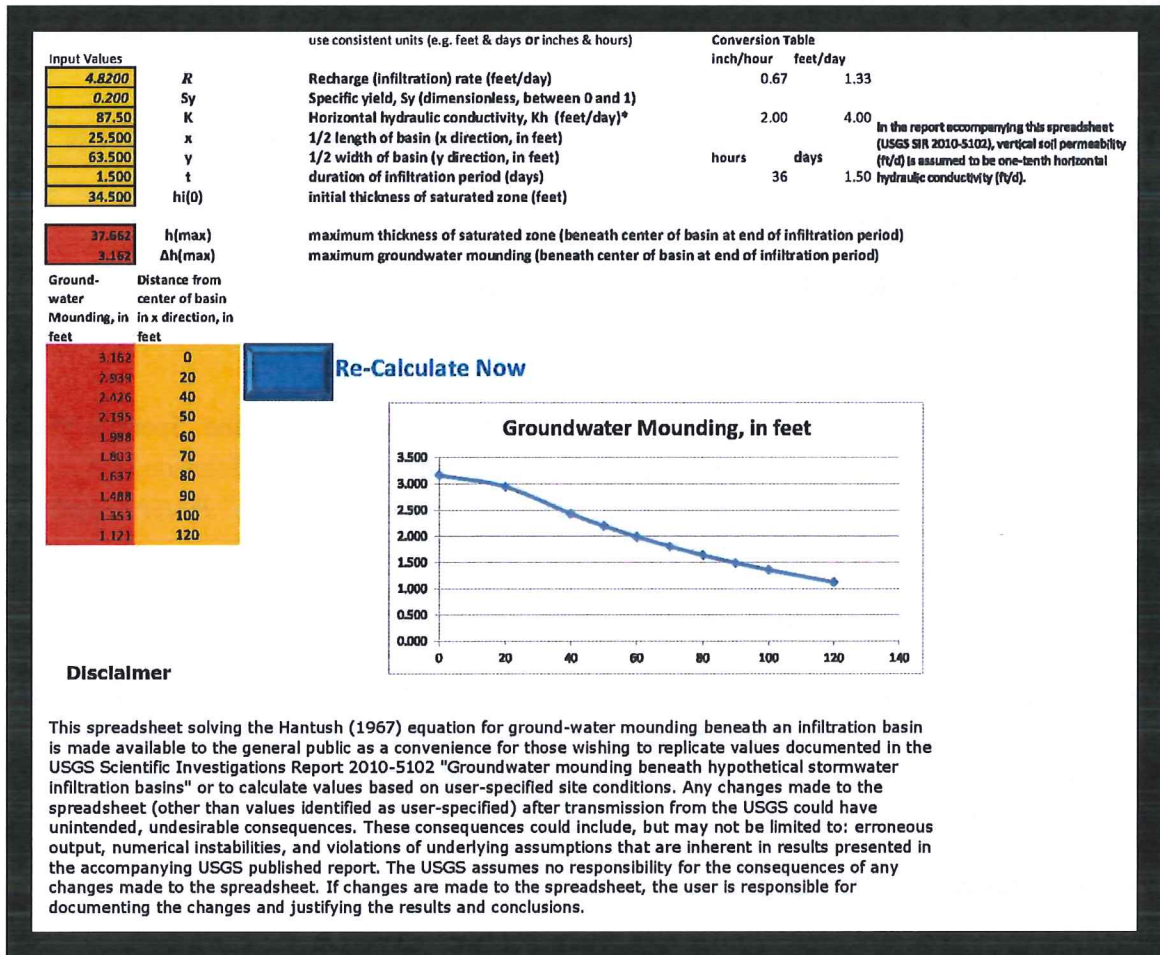
Projected Mound @ t=1.5 day = ±3.2 ft

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
0.200	Sy	Specific yield, Sy (dimensionless, between 0 and 1)			
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)			

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

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)

Groundwater 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

Re-Calculate Now

Disclaimer

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

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, Sy = 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.

½ Length of Basin, x = 39/2 = 19.5 ft

½ 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)

Conversion Table

Input Values				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)		hours	days
1.920	t	duration of infiltration period (days)		36	1.50
36.250	hi(0)	initial thickness of saturated zone (feet)			

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

37.931	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)

Groundwater 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

Re-Calculate Now

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/