STORMWATER REPORT

For Proposed work at:
1320 South Street
Andover, MA 02743

Prepared By:
Borrego Solar Systems, Inc.
55 Technology Drive, Suite 102
Lowell, MA 01851

Submitted to:
Town of Andover
Planning Board
36 Bartlet Street
Andover, MA 01810

April 12, 2022

1. Introduction

The proposed project is to construct a 12MW AC stand alone storage facility on a +/-9.88 acre parcel off of Moonlight Drive in Andover, Massachusetts. The proposed project area of disturbance is approximately 1.5 acres and consists of the lithium-ion battery storage system, gravel access road, necessary grading and tree clearing areas.

The project is subject to Massachusetts Department of Environmental Protection (MADEP) stormwater standards. The project has been designed to comply with these stormwater standards; calculations and supporting evidence has been presented in section 4 of this document. This document also presents existing conditions and proposed construction as well as hydrologic conditions pre- and post-development.

2. Existing Conditions

The proposed project is located to the east of Moonlight Drive in Andover, Massachusetts. Natural resources have been professionally delineated within and around the project site, resulting in the flagging of a wetland complex just north of the parcel, and one vernal pool located to the northwest. A few hundred feet north of the parcel also lies the Shawsheen River.

The area of hydrologic study is approximately 6.9 acres; however, the total project limit of disturbance area will be kept to an area of approximately 1.5 acres. The area of study is mostly wooded land cover with some grassed areas, brush within a utility easement and wetlands. The existing topography of the project area is sloping towards the northern wetland complex, which then drains to the Shawsheen River, which is all offsite. The elevations of the project site range from +/-102 feet in the southwest corner of the parcel to +/-67 feet in the northeast corner.

3. Proposed Construction

The proposed project will consist of the construction of the standalone storage equipment pads, and gravel access road. The project is located outside all wetland buffers, riverfront

buffers, vernal pool buffers and FEMA Zone AE areas. The layout of the proposed project can be found in the project plan set on sheet C-3.0 Layout and Materials Plan.

Energy Storage Facility Characteristics

Parcel Area:	9.88± acres
Batteries:	92 – 4 hour duration lithium ion batteries
Number of Inverters:	4 inverters
Height of Fence:	7-foot
Proposed Impervious area:	6,739 sf (concrete pads)
Proposed gravel roads/pad:	27,585 ± sf
Total area of disturbance:	1.5 acres
Fenced area:	0.52 acres

Where batteries or roads are installed, wooded areas will need to be cleared and the stumps removed. Due to the more significant impact this represents, no activity will be done in any buffer zones or protected areas.

4. Stormwater

The Massachusetts Department of Environmental Protection (MA DEP) issued stormwater standards in 2008. The following section describes how each of these standards will be achieved by incorporating Best Management Practices into the design.

Standard No. 1 – No new stormwater conveyances may discharge untreated directly to or cause erosion in wetlands or waters of the Commonwealth.

There are only negligible (6,739 square feet) new impervious surfaces (concrete pads) associated with this project. Stormwater runoff from this site discharges to wetlands north and northwest of the project area; this will be unchanged post-construction. Two infiltration swales are proposed to capture runoff from the road and battery system areas and direct stormwater northwest and northeast of the project site. Check dams located along the length of these swales will slow the flow of water to prevent scouring or transportation of sediment off of the site. Additionally, runoff from the entire fenced portion of the project will be captured by an infiltration basin and remaining water will be discharged to the northwest at a rate designed to mimic existing discharge rates. These

discharges are located a minimum of 100 feet away from the wetland boundary. There is no need for treatment and therefore Standard 1 is satisfied.

Standard No. 2 – Stormwater management systems shall be designed so that post-development peak discharge rates do not exceed pre-development peak discharge rates.

The following section outlines the procedure for determining the peak rates for the existing condition as well as the methods for attenuating the peak flows in the proposed condition.

Methodology and Design Criteria

The drainage analysis was performed using the Soil Conservation Service (SCS) TR-55 and TR-20 methodologies and the computer program HydroCAD by HydroCAD Software Solutions, LLC.

Time of concentration (Tc) values were calculated using Average Velocities for Overland Flow, found in SCS TR-55 Urban Hydrology for Small Watersheds.

Curve numbers were developed for each of the different use categories and hydrologic soil group types within each sub-area. The curve numbers were based on the SCS TR-55 methodology and are included in the HydroCAD input and output found in the attachments of this report.

Rainfall depths are based on a 24 event using the “Atlas of Precipitation Extremes for the Northeastern United States and Southeastern Canada”. The following rainfall depths were used in the calculations:

Storm Event	Rainfall Depth		
1-Year	2.63 inches	25-Year	6.16 inches
2-Year	3.15 inches	50-Year	7.42 inches
10-Year	4.83 inches	100-Year	8.94 inches

Soil Conditions

The NRCS soil maps for the proposed project area find soils with a low runoff potential, classified as Hydrologic Soil Group A. Approximately 0.5 acres of the site is classified as Hydrologic Soil Group D. The soils found within the area of analysis are:

- Water
- Freetown muck, 0 to 1 percent slopes
- Windsor loamy sand, 3 to 8 percent slopes

The NRCS soil report can be found in the attachments section of this report.

Existing Conditions

The area of analysis is approximately 6.9 acres. Under the existing condition stormwater runoff from the proposed project site flows to one main point of analyses. A pre-development watershed map can be found in the attachments.

Point of Analysis 1

Point of Analysis 1 (POA-1) discharges on the north and northwestern end of the site. Runoff from this area travels overland across the proposed project site where it exits the parcel and travels towards the wetland system. The existing condition POA-1 consists of one subcatchment area (1) which is approximately 6.9 acres and consists of mostly woods with some areas of grass, brush and roofs.

Each existing cover type was assigned a curve number. Those can be found broken down in the HydroCAD Report attached. The weighted drainage area characteristics for the existing conditions can be found in Table 1.

Table 1 - Existing Conditions Drainage Area Characteristics

Subcatchment	Area Acres (AC)	Curve Number*	Tc (mins**)
1	6.87	35	39.9

*Reference HydroCAD Data for Pre-Development Conditions, CN of each drainage area.

**Reference HydroCAD Data for Pre-Development Conditions, TC of each drainage area.

Proposed Conditions

The proposed conditions continue to consider the one Point of Analysis (POA-1) as described above. A post development watershed map can be found in the attachments.

Point of Analysis 1

The location of Point of Analysis 1 (POA-1) is unchanged from existing conditions; it is located at the north/northwestern end of the site. Post-development, this area consists of batteries and a gravel access drive with existing woodlands and grassed wetland areas that will remain undisturbed. Under the proposed conditions, four subcatchment areas flow to POA-1, 10, 11, 12 and 13.

Subcatchment 13 consists of a small area (0.07 acres) of the gravel access road which will flow towards an infiltration swale and then into an infiltration ditch. This ditch will be dug out and lined with fabric and then filled with crushed stone to allow for proper infiltration. This is modeled in HydroCAD as 14P. The water that does not infiltrate will be discharged to the northwest of the site towards POA-1. The infiltration rate used to model this was gathered from the NRCS data base. The area where the BMP is proposed is rated 100 micrometers/hr. In inches/hr this translates to 14.2 in/hr. To be extremely conservative until soil testing is performed, the infiltration rate chosen for the model was 7 in/hr, which is the NRCS data base number cut in half. The depth to groundwater was also considered and that value from the NRCS data base was >200 cm. In feet this is around 6.6 ft. To be conservative a value of 3 ft was used for the model until soil testing is performed. Both soil maps are attached for reference.

Subcatchment 12 encompasses the entire gravel and concrete equipment pad. The pad was graded with a slight decline in elevation, allowing water to travel northwest into an infiltration basin. The water that doesn't infiltrate will exit the basin through a rip-rap lined level spreader at elevation 81'. This remaining water will then travel through the woods into the wetlands where it will link up at POA-1. The infiltration rate used to model this was gathered from the NRCS data base. The area where the BMP is proposed is rated 100 micrometers/hr. In inches/hr this translates to 14.2 in/hr. To be extremely conservative until soil testing is performed, the infiltration rate chosen for the model was 7 in/hr, which is the NRCS data base number cut in half. The depth to groundwater was also considered and that value from the NRCS data base was >200 cm. In feet this is around 6.6 ft. To be conservative a value of 3 ft was used for the model until soil testing is performed. Both soil maps are attached for reference.

Subcatchment 11 consists of water that initially flowing from a highpoint near the neighbors house. The water will enter an infiltration swale designed so the water doesn't

flow over the road or create a low spot next to the road. The remaining water that doesn't get infiltrated will get taken east where it will discharge away from the system and towards the original POA-1. The infiltration rate used to model this was gathered from the NRCS data base. The area where the BMP is proposed is rated 100 micrometers/hr. In inches/hr this translates to 14.2 in/hr. To be extremely conservative until soil testing is performed, the infiltration rate chosen for the model was 7 in/hr, which is the NRCS data base number cut in half. The depth to groundwater was also considered and that value from the NRCS data base was >200 cm. In feet this is around 6.6 ft. To be conservative a value of 3 ft was used for the model until soil testing is performed. Both soil maps are attached for reference.

Subcatchment 10 consists of all remaining areas that will flow overland to POA-1 and is approximately 4.4 acres.

Table 2 - Proposed Conditions Drainage Area Characteristics

Subcatchment	Area Acres (AC)	Curve Number*	Tc (mins**)
10	4.41	37	35.2
11	1.67	40	16.0
12	0.71	67	0.8
13	0.08	68	0.5

*Reference HydroCAD Data for Post-Development Conditions, CN of each drainage area.

**Reference HydroCAD Data for Post-Development Conditions, TC of each drainage area.

Peak Discharge Runoff Rates

The peak flows were calculated for the 2-, 10-, and 100-year storm events under the existing and proposed conditions to compare with the existing runoff rates. These rates are shown in

Table 3.

Table 3 Existing and Proposed Peak Rates of Runoff

	2-YR			10-YR			100-YR		
Discharge Point	Pre (cfs)	Post (cfs)	Δ (cfs)	Pre (cfs)	Post (cfs)	Δ (cfs)	Pre (cfs)	Post (cfs)	Δ (cfs)
POA-1	0.0	0.0	(0.0)	0.1	0.1	(0.0)	3.0	2.7	(0.3)

As shown, all the proposed peak rates of runoff will be lower than the existing rates.

Standard No. 3 – Loss of annual recharge to groundwater shall be eliminated or minimized through the use of infiltration measures including environmentally sensitive site design, low impact development techniques, stormwater best management practices, and good operations and maintenance. At a minimum, the annual recharge from pre-development site shall approximate the annual recharge from pre-development conditions based on soil type. This standard is met when the stormwater management system is designed to infiltrate the required recharge volume as determined in accordance with the Massachusetts Stormwater Handbook.

There is only a minor increase (6,739 square feet) of impervious cover proposed as part of this project. Annual recharge to groundwater will continue to occur. Any precipitation that falls on the project site will shed directly onto the ground not affecting annual groundwater recharge. The small amount of impervious cover are due to the battery equipment. Any water that lands in that area will be guided to an infiltration basin to allow precipitation to drip through.

Recharge Calculations:

The required recharge volume equals a depth of runoff corresponding to the soil type times the impervious areas covering that soil type at the post-development site. See Table 4 for the target depth of runoff to be infiltrated for each soil group.

Table 4 Target Recharge Depth Based on Hydrologic Soil Group

HSG	Soil Texture	Target Depth (inches)
A	Sand	0.60
B	Loam	0.35
C	Silty Loam	0.25
D	Clay	0.10

Recharge Volumes Required

Based on impervious surfaces (concrete pads = 6,739 sf), and the soil type where they are located (HSG A):

$$Recharge\ Volume\ Required = (Area)(Target\ Depth)\left(\frac{in}{ft}\right) = \frac{6{,}739sf\,(0.60in)}{12} = \mathbf{337\ cubic\ feet}$$

Recharge Volumes Required

The concrete equipment pads (at energy storage areas) include a 12-inch thick crushed stone area between and all around the pads. The total crushed stone at the electrical equipment areas is approximately 22,643 square feet. Excluding the concrete pad areas of 6,739 square feet total, the recharge area is 15,904 square feet. At a 12" depth, this equates to a crushed stone volume of 15,904 CF. A typical crushed stone void ratio of 30% provides a recharge storage of 4,771 cubic ft, providing greater than the ~337 cubic feet of recharge volume, and therefore meeting Standard No. 3.

Standard No. 4 – Stormwater Management systems shall be designed to remove 80% of the average annual post-construction load of Total Suspended Solids (TSS).

The minimal amount of impervious surface proposed as part of this project is not for vehicular access. Therefore, there are no generators (impervious surfaces) of TSS as part of the proposed project. Furthermore, all such areas are surrounded by gravel surfaces which will capture and infiltration runoff from these small areas of impervious coverage. Any access to the project will be via gravel drives and stormwater runoff will be allowed to directly recharge into the ground. Such areas will also be surrounded by grassed pervious surfaces, which will encourage further infiltration. Standard 4 has been met.

Standard No. 5 – For land uses with higher pollutant loads, source control and pollution prevention shall be implemented in accordance with the Massachusetts Stormwater Handbook to eliminate or reduce the discharge of stormwater runoff from such land uses to the maximum extent practicable.

The proposed project is not classified as a "Land Use with Higher Pollutant Loads". This standard does not apply to the project. Standard 5 has been met.

Standard No. 6 – Stormwater discharges with the Zone II or Interim Wellhead Protection Area of a public water supply, and stormwater discharges near or to any other critical area, require the use of the specific source control and pollution prevention measures and the specific structural stormwater best management practices determined by the Department to be suitable for managing discharges to such areas, as provided in the Massachusetts Stormwater Handbook.

We have reviewed the Massachusetts Geographical Information System (GIS) and the site is not located within Zone II, Interim Wellhead Protection Areas, or Outstanding Resource Watersheds and therefore this standard has been met.

Standard No. 7 – A redevelopment project is required to meet the following Stormwater Management Standards only to the maximum extent practicable: Standard 2, Standard 3, and the pretreatment and structural best management practice requirements of Standards 4, 5 and 6. Existing stormwater discharges shall comply with Standard 1 only to the maximum extent practicable. A redevelopment project shall also comply with all other requirements of the Stormwater Management Standards and improve existing conditions.

The project is not a redevelopment project.

Standard No. 8 - A plan to control construction-related impacts including erosion, sedimentation and other pollutant sources during construction and land disturbance activities (construction period pollution prevention plan) shall be developed and implemented.

A Stormwater Pollution Prevention Plan (SWPPP) will be implemented to control erosion and sedimentation associated with the construction/installation of the project. Erosion and sedimentation controls will be in place prior to construction-related land disturbance on the site. A NPDES (National Pollutant Discharge Elimination System) Notice of Intent (NOI) will be filed with the US EPA a minimum of 14 days prior to the commencement of construction.

Standard No. 9 - A long-term Operation and Maintenance Plan shall be developed and implemented to ensure that stormwater management systems function as designed.

An Operations and Maintenance Plan (O & M) has been developed. The O & M Plan will be implemented to ensure that any site stormwater management systems function as designed. The owner of the system will be responsible for contracting with a energy storage facility operations and maintenance company to implement the attached O & M Plan. The Site Inspection Protocol and Long-Term Pollution Prevention Plans is provided in the attachments to this report.

Standard No. 10 - All illicit discharges to the stormwater management system are prohibited.

An Illicit Discharge Compliance Statement confirming that no illicit discharges exist on site will be provided prior to the discharge of any stormwater to post-construction BMPs.

Standard No. 11 – Volume Control

The stormwater BMPs provided in the project design will infiltrate the small increase in runoff this development will create. Due to the underlying soils and hydrologic conditions of the existing site, and the minimal impervious area created with this type of development, the increase in stormwater runoff needed to be infiltrated is minimal. This is largely due to the fact that although 1.5 acres of tree clearing will take place, the majority of the water that will be landing on the proposed project will be rerouted to infiltration basins and swales. This will slow runoff from the site and reduce stormwater discharges considerably when compared with a more traditional development (residential, commercial office space, etc.) which include much higher percentages of impervious area.

As demonstrated by the above sections and the attached supporting material, the proposed project at 1320 South Street in Andover, Massachusetts has been designed to meet the stormwater standards set forth by the Massachusetts Department of Environmental Protection and the Regulations for Stormwater Quality and Quantity Control in Andover, Massachusetts.

If any questions arise during review of the contents above and attachments, please do not hesitate to contact me.

Thank you,

Borrego Solar Systems

Carli Shroyer

Civil Engineer

cshroyer@borregosolar.com

860-558-4869

Attachments:

Pre-Development Watershed Plan

Post-Development Watershed Plan

Pre-Development HydroCAD Analysis

Post-Development HydroCAD Analysis

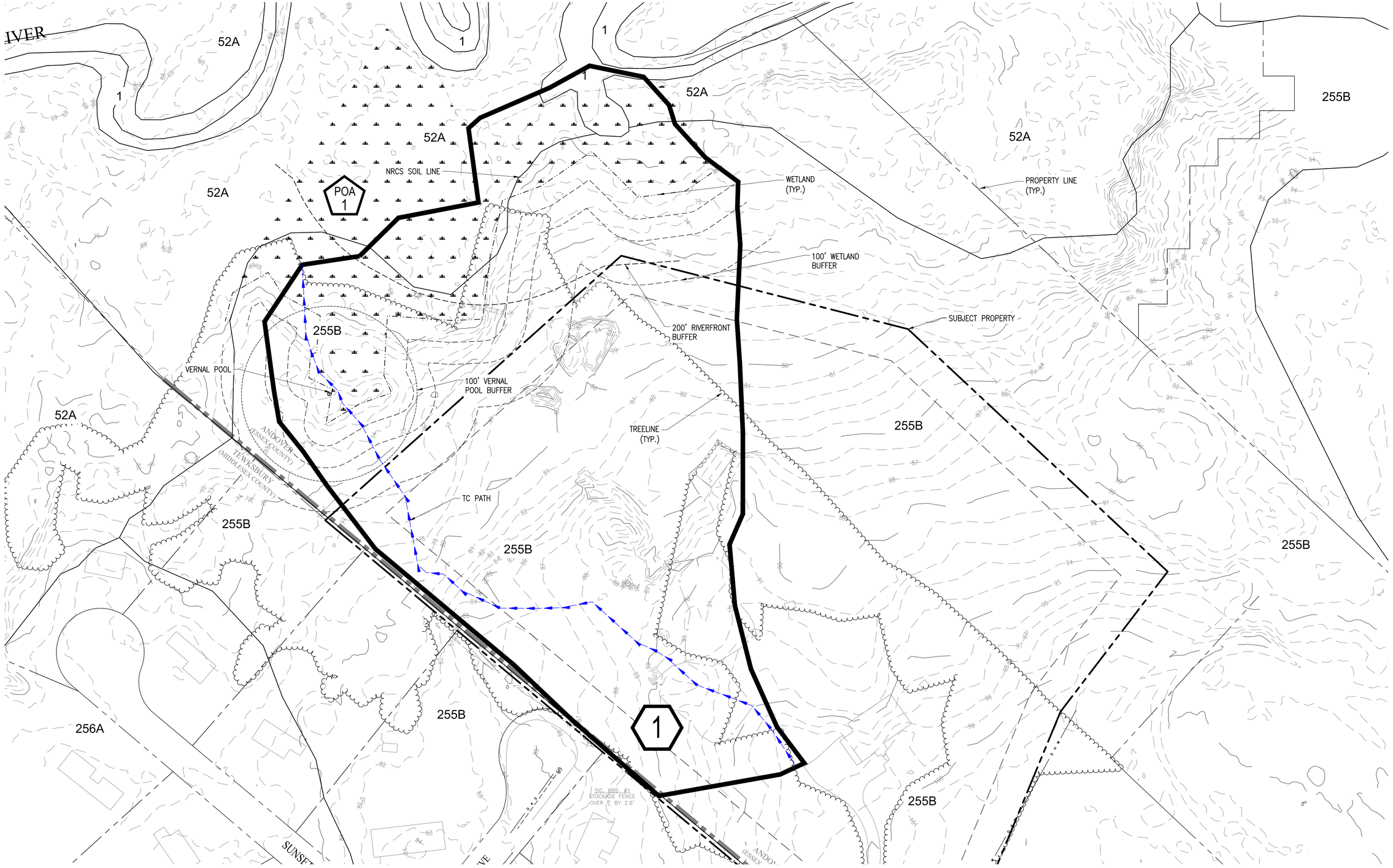
NRCS Hydrologic Soil Group Report

NRCS Depth to Water Table Report

NRCS Saturated Hydraulic Conductivity (ksat) Report

O&M Plan

PRE-DEVELOPMENT WATERSHED PLAN



PRE-DEVELOPMENT WATERSHED PLAN

SCALE: 1" = 50'

0 50' 100'

BORREGO
55 TECHNOLOGY DRIVE, SUITE 102
LOWELL, MA 01851
PHONE: (888) 898-6273
FAX: (888) 843-6778
WWW.BORREGOSOLAR.COM

NOT FOR CONSTRUCTION

SITE USE PLAN SET
1320 S STREET
ANDOVER, MA 01810

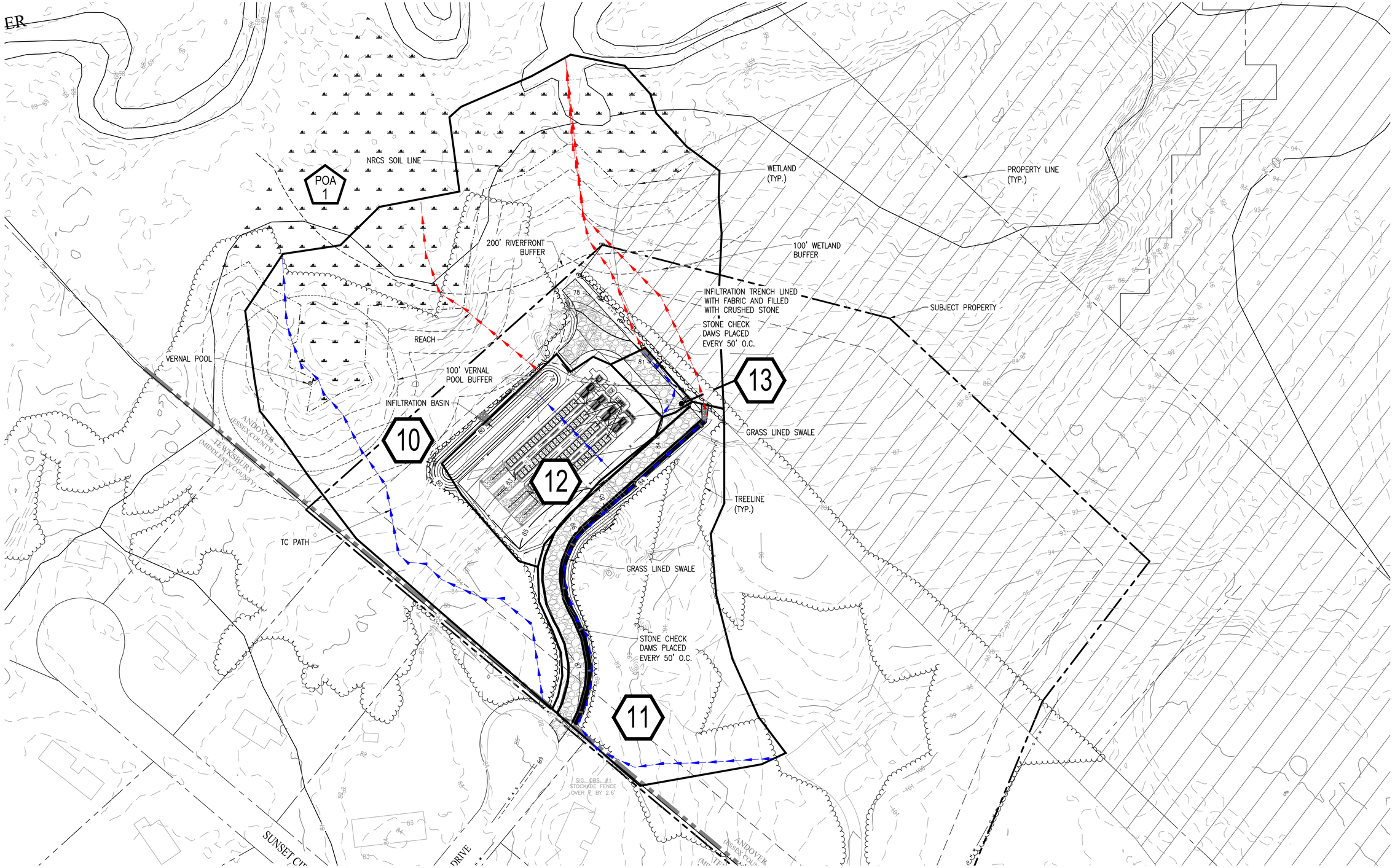
PROJECT NUMBER: 120-0345

REV	DATE	DRAWN	CHECKED	RELEASE LEVEL
1	4/12/21	CS	BS	SITE USE PERMIT SET

SCALES STATED ON DRAWINGS ARE VALID ONLY WHEN PLOTTED ARCH D 24" X 36"

W-1.0
PRE-DEVELOPMENT WATERSHED PLAN

POST-DEVELOPMENT WATERSHED PLAN



POST DEVELOPMENT WATERSHED PLAN

SCALE: 1" = 50'

0 50' 100'

BORREGO
55 TECHNOLOGY DRIVE, SUITE 102
LOWELL, MA 01851
PHONE: (888) 898-6273
FAX: (888) 843-6778
WWW.BORREGOSOLAR.COM

NOT FOR CONSTRUCTION

SITE USE PLAN SET
1320 S STREET
ANDOVER, MA 01810

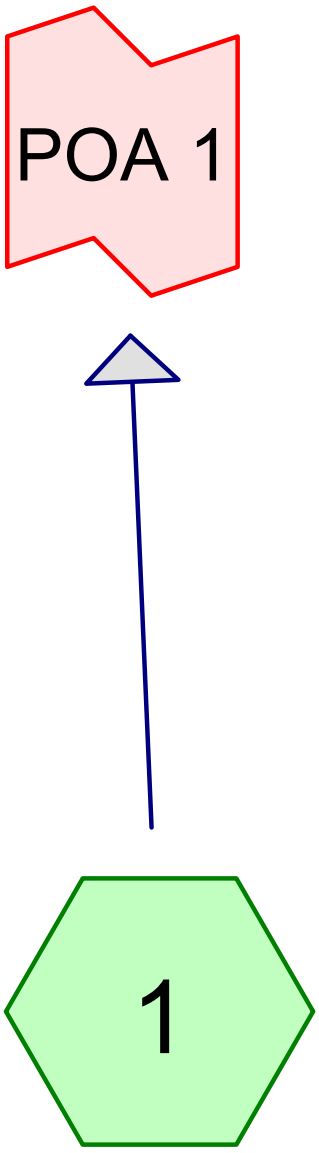
PROJECT NUMBER: 120-0345

REV	DATE	DRAWN	CHECKED	RELEASE LEVEL
1	4/12/21	CS	BS	SITE USE PERMIT SET

SCALES STATED ON DRAWINGS ARE VALID ONLY WHEN PLOTTED ARCH D 24" X 36"

W-2.0
POST DEVELOPMENT WATERSHED PLAN

PRE-DEVELOPMENT HYDROCAD ANALYSIS



Subcat 1

Subcat Reach Pond Link

Routing Diagram for 1320 South St MA_Pre_033022_D
Prepared by {enter your company name here}, Printed 4/10/2022

Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2-Year	Type III 24-hr		Default	24.00	1	3.15	2
2	10-Year	Type III 24-hr		Default	24.00	1	4.83	2
3	100-Year	Type III 24-hr		Default	24.00	1	8.94	2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.42	39	>75% Grass cover, Good, HSG A (1)
1.29	30	Brush, Good, HSG A (1)
0.58	73	Brush, Good, HSG D (1)
0.03	98	Roofs, HSG A (1)
4.52	30	Woods, Good, HSG A (1)
0.04	77	Woods, Good, HSG D (1)
6.87	**35**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
6.25	HSG A	1
0.00	HSG B	
0.00	HSG C	
0.63	HSG D	1
0.00	Other	
6.87		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.42	0.00	0.00	0.00	0.00	0.42	>75% Grass cover, Good	1
1.29	0.00	0.00	0.58	0.00	1.87	Brush, Good	1
0.03	0.00	0.00	0.00	0.00	0.03	Roofs	1
4.52	0.00	0.00	0.04	0.00	4.56	Woods, Good	1
6.25	**0.00**	**0.00**	**0.63**	**0.00**	**6.87**	**TOTAL AREA**	

Time span=5.00-30.00 hrs, dt=0.05 hrs, 501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1: Subcat 1 Runoff Area=6.87 ac 0.40% Impervious Runoff Depth=0.00"
Flow Length=847' Tc=39.9 min CN=35 Runoff=0.0 cfs 0.000 af

Link POA 1: Inflow=0.0 cfs 0.000 af
Primary=0.0 cfs 0.000 af

Total Runoff Area = 6.87 ac Runoff Volume = 0.000 af Average Runoff Depth = 0.00"
99.60% Pervious = 6.85 ac 0.40% Impervious = 0.03 ac

Summary for Subcatchment 1: Subcat 1

Runoff = 0.0 cfs @ 5.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.15"

Area (ac)	CN	Description
0.42	39	>75% Grass cover, Good, HSG A
1.29	30	Brush, Good, HSG A
0.58	73	Brush, Good, HSG D
0.03	98	Roofs, HSG A
4.52	30	Woods, Good, HSG A
0.04	77	Woods, Good, HSG D
6.87	35	Weighted Average
6.85		99.60% Pervious Area
0.03		0.40% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
25.9	50	0.0032	0.03		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.15"
0.6	53	0.0520	1.60		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
13.4	744	0.0341	0.92		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
39.9	847	Total			

Summary for Link POA 1:

Inflow Area = 6.87 ac, 0.40% Impervious, Inflow Depth = 0.00" for 2-Year event
Inflow = 0.0 cfs @ 5.00 hrs, Volume= 0.000 af
Primary = 0.0 cfs @ 5.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs

Time span=5.00-30.00 hrs, dt=0.05 hrs, 501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1: Subcat 1 Runoff Area=6.87 ac 0.40% Impervious Runoff Depth=0.06"
Flow Length=847' Tc=39.9 min CN=35 Runoff=0.1 cfs 0.036 af

Link POA 1: Inflow=0.1 cfs 0.036 af
Primary=0.1 cfs 0.036 af

Total Runoff Area = 6.87 ac Runoff Volume = 0.036 af Average Runoff Depth = 0.06"
99.60% Pervious = 6.85 ac 0.40% Impervious = 0.03 ac

Summary for Subcatchment 1: Subcat 1

Runoff = 0.1 cfs @ 15.90 hrs, Volume= 0.036 af, Depth= 0.06"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.83"

Area (ac)	CN	Description
0.42	39	>75% Grass cover, Good, HSG A
1.29	30	Brush, Good, HSG A
0.58	73	Brush, Good, HSG D
0.03	98	Roofs, HSG A
4.52	30	Woods, Good, HSG A
0.04	77	Woods, Good, HSG D
6.87	35	Weighted Average
6.85		99.60% Pervious Area
0.03		0.40% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
25.9	50	0.0032	0.03		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.15"
0.6	53	0.0520	1.60		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
13.4	744	0.0341	0.92		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
39.9	847	Total			

Summary for Link POA 1:

Inflow Area = 6.87 ac, 0.40% Impervious, Inflow Depth = 0.06" for 10-Year event
Inflow = 0.1 cfs @ 15.90 hrs, Volume= 0.036 af
Primary = 0.1 cfs @ 15.90 hrs, Volume= 0.036 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs

Time span=5.00-30.00 hrs, dt=0.05 hrs, 501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1: Subcat 1 Runoff Area=6.87 ac 0.40% Impervious Runoff Depth=1.15"
Flow Length=847' Tc=39.9 min CN=35 Runoff=3.0 cfs 0.657 af

Link POA 1: Inflow=3.0 cfs 0.657 af
Primary=3.0 cfs 0.657 af

Total Runoff Area = 6.87 ac Runoff Volume = 0.657 af Average Runoff Depth = 1.15"
99.60% Pervious = 6.85 ac 0.40% Impervious = 0.03 ac

Summary for Subcatchment 1: Subcat 1

Runoff = 3.0 cfs @ 12.72 hrs, Volume= 0.657 af, Depth= 1.15"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.94"

Area (ac)	CN	Description
0.42	39	>75% Grass cover, Good, HSG A
1.29	30	Brush, Good, HSG A
0.58	73	Brush, Good, HSG D
0.03	98	Roofs, HSG A
4.52	30	Woods, Good, HSG A
0.04	77	Woods, Good, HSG D
6.87	35	Weighted Average
6.85		99.60% Pervious Area
0.03		0.40% Impervious Area

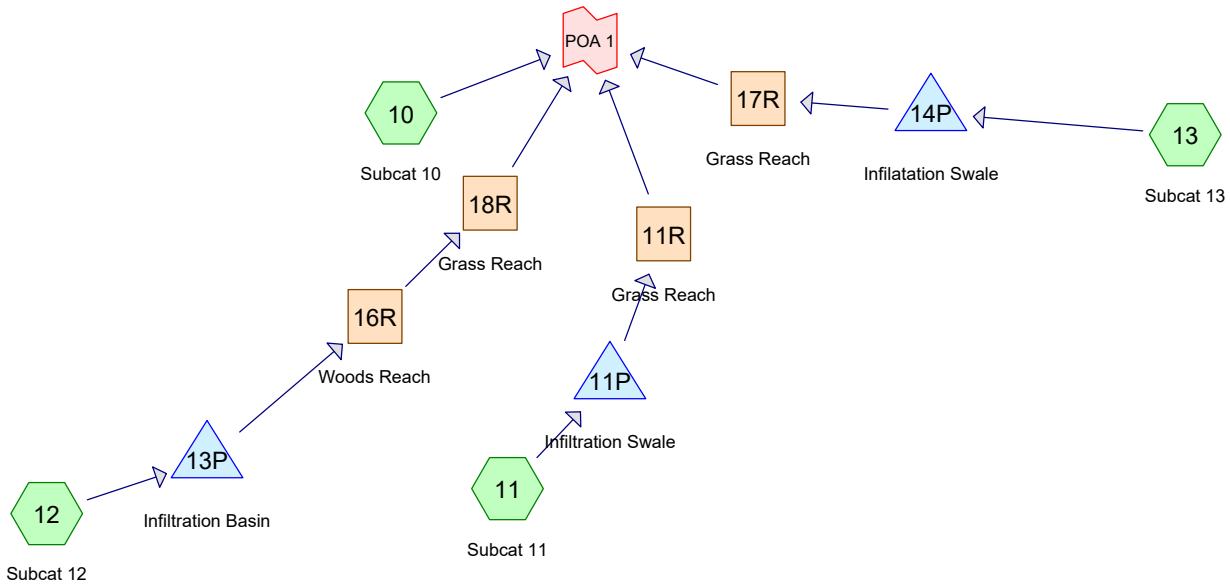
Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
25.9	50	0.0032	0.03		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.15"
0.6	53	0.0520	1.60		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
13.4	744	0.0341	0.92		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
39.9	847	Total			

Summary for Link POA 1:

Inflow Area = 6.87 ac, 0.40% Impervious, Inflow Depth = 1.15" for 100-Year event
Inflow = 3.0 cfs @ 12.72 hrs, Volume= 0.657 af
Primary = 3.0 cfs @ 12.72 hrs, Volume= 0.657 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-30.00 hrs, dt= 0.05 hrs

POST-DEVELOPMENT HYDROCAD ANALYSIS



Subcat Reach Pond Link

Routing Diagram for 1320 South St MA_Post_033022_D
Prepared by {enter your company name here}, Printed 4/12/2022

Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2-Year	Type III 24-hr		Default	24.00	1	3.15	2
2	10-Year	Type III 24-hr		Default	24.00	1	4.83	2
3	100-Year	Type III 24-hr		Default	24.00	1	8.94	2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.44	39	>75% Grass cover, Good, HSG A (11)
1.99	30	Brush, Good, HSG A (10, 11, 12, 13)
0.58	73	Brush, Good, HSG D (10)
0.57	96	Gravel surface, HSG A (10, 11, 12, 13)
0.15	98	Paved parking, HSG A (12)
3.10	30	Woods, Good, HSG A (10, 11)
0.04	77	Woods, Good, HSG D (10)
6.89	**41**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
6.26	HSG A	10, 11, 12, 13
0.00	HSG B	
0.00	HSG C	
0.63	HSG D	10
0.00	Other	
6.89		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.44	0.00	0.00	0.00	0.00	0.44	>75% Grass cover, Good	11
1.99	0.00	0.00	0.58	0.00	2.57	Brush, Good	10, 11, 12, 13
0.57	0.00	0.00	0.00	0.00	0.57	Gravel surface	10, 11, 12, 13
0.15	0.00	0.00	0.00	0.00	0.15	Paved parking	12
3.10	0.00	0.00	0.04	0.00	3.15	Woods, Good	10, 11
6.26	**0.00**	**0.00**	**0.63**	**0.00**	**6.89**	**TOTAL AREA**	

Time span=1.00-30.00 hrs, dt=0.05 hrs, 581 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment10: Subcat 10 Runoff Area=4.42 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=644' Tc=35.2 min CN=37 Runoff=0.0 cfs 0.000 af

Subcatchment11: Subcat 11 Runoff Area=1.68 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=673' Tc=16.0 min CN=40 Runoff=0.0 cfs 0.000 af

Subcatchment12: Subcat 12 Runoff Area=0.72 ac 21.54% Impervious Runoff Depth=0.66"
Flow Length=120' Tc=0.8 min CN=67 Runoff=0.5 cfs 0.040 af

Subcatchment13: Subcat 13 Runoff Area=0.08 ac 0.00% Impervious Runoff Depth=0.62"
Flow Length=89' Tc=0.5 min CN=66 Runoff=0.0 cfs 0.004 af

Reach 11R: Grass Reach Avg. Flow Depth=0.00' Max Vel=0.00 fps
n=0.080 L=398.0' S=0.0366 '/' Capacity=53.9 cfs Outflow=0.0 cfs 0.000 af

Reach 16R: Woods Reach Avg. Flow Depth=0.00' Max Vel=0.00 fps
n=0.100 L=140.0' S=0.0599 '/' Capacity=55.2 cfs Outflow=0.0 cfs 0.000 af

Reach 17R: Grass Reach Avg. Flow Depth=0.00' Max Vel=0.00 fps
n=0.080 L=289.0' S=0.0417 '/' Capacity=57.6 cfs Outflow=0.0 cfs 0.000 af

Reach 18R: Grass Reach Avg. Flow Depth=0.00' Max Vel=0.00 fps Inflow=0.0 cfs 0.000 af
n=0.030 L=112.0' S=0.0060 '/' Capacity=58.1 cfs Outflow=0.0 cfs 0.000 af

Pond 11P: Infiltration Swale Peak Elev=83.00' Storage=0 cf Inflow=0.0 cfs 0.000 af
Outflow=0.0 cfs 0.000 af

Pond 13P: Infiltration Basin Peak Elev=78.14' Storage=180 cf Inflow=0.5 cfs 0.040 af
Outflow=0.2 cfs 0.040 af

Pond 14P: Infilatation Swale Peak Elev=78.30' Storage=15 cf Inflow=0.0 cfs 0.004 af
Outflow=0.0 cfs 0.004 af

Link POA 1: Inflow=0.0 cfs 0.000 af
Primary=0.0 cfs 0.000 af

Total Runoff Area = 6.89 ac Runoff Volume = 0.044 af Average Runoff Depth = 0.08"
97.75% Pervious = 6.73 ac 2.25% Impervious = 0.15 ac

Summary for Subcatchment 10: Subcat 10

Runoff = 0.0 cfs @ 1.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.15"

Area (ac)	CN	Description
1.45	30	Brush, Good, HSG A
0.58	73	Brush, Good, HSG D
0.08	96	Gravel surface, HSG A
2.26	30	Woods, Good, HSG A
0.04	77	Woods, Good, HSG D
4.42	37	Weighted Average
4.42		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.7	50	0.0040	0.04		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.15"
11.5	594	0.0298	0.86		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
35.2	644	Total			

Summary for Subcatchment 11: Subcat 11

Runoff = 0.0 cfs @ 24.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.15"

Area (ac)	CN	Description
0.44	39	>75% Grass cover, Good, HSG A
0.18	30	Brush, Good, HSG A
0.20	96	Gravel surface, HSG A
0.85	30	Woods, Good, HSG A
1.68	40	Weighted Average
1.68		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.9	50	0.0280	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.15"
3.1	198	0.0453	1.06		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
2.0	425	0.0100	3.53	17.63	**Trap/Vee/Rect Channel Flow,** Bot.W=2.00' D=1.00' Z= 3.0 '/' Top.W=8.00' n= 0.030 Earth, grassed & winding
16.0	673	Total			

Summary for Subcatchment 12: Subcat 12

Runoff = 0.5 cfs @ 12.03 hrs, Volume= 0.040 af, Depth= 0.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.15"

Area (ac)	CN	Description
0.32	30	Brush, Good, HSG A
0.24	96	Gravel surface, HSG A
0.15	98	Paved parking, HSG A
0.72	67	Weighted Average
0.56		78.46% Pervious Area
0.15		21.54% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	50	0.0314	1.42		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.15"
0.2	70	0.0791	5.71		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.8	120	Total			

Summary for Subcatchment 13: Subcat 13

Runoff = 0.0 cfs @ 12.03 hrs, Volume= 0.004 af, Depth= 0.62"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.15"

Area (ac)	CN	Description
0.03	30	Brush, Good, HSG A
0.04	96	Gravel surface, HSG A
0.08	66	Weighted Average
0.08		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.3	37	0.1012	2.14		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.15"
0.2	52	0.0221	4.92	19.68	**Trap/Vee/Rect Channel Flow,** Bot.W=1.00' D=1.00' Z= 3.0 '/' Top.W=7.00' n= 0.030 Earth, grassed & winding
0.5	89	Total			

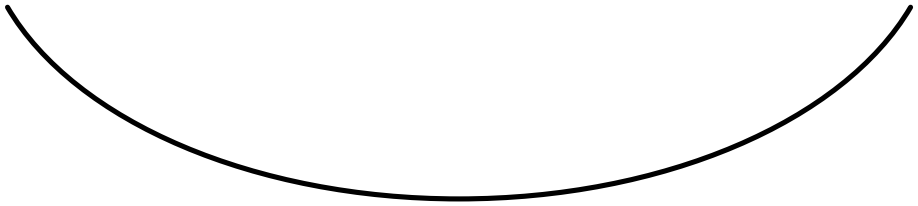
Summary for Reach 11R: Grass Reach

Inflow Area = 1.68 ac, 0.00% Impervious, Inflow Depth = 0.00" for 2-Year event
Outflow = 0.0 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Stor-Ind+Trans method, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 0.00 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 0.00 fps, Avg. Travel Time= 0.0 min

Peak Storage= 0 cf @ 0.00 hrs
Average Depth at Peak Storage= 0.00'
Bank-Full Depth= 2.00' Flow Area= 13.3 sf, Capacity= 53.9 cfs

10.00' x 2.00' deep Parabolic Channel, n= 0.080 Earth, long dense weeds
Length= 398.0' Slope= 0.0366 '/'
Inlet Invert= 82.52', Outlet Invert= 67.96'



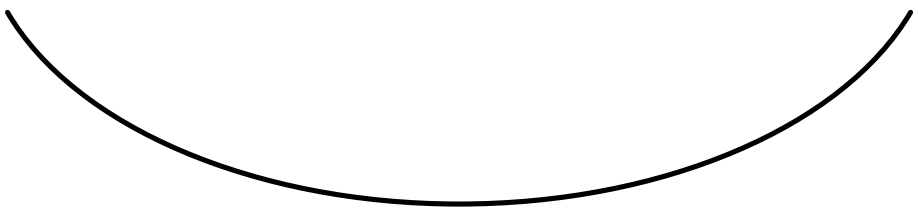
Summary for Reach 16R: Woods Reach

Inflow Area = 0.72 ac, 21.54% Impervious, Inflow Depth = 0.00" for 2-Year event
Outflow = 0.0 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Stor-Ind+Trans method, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 0.00 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 0.00 fps, Avg. Travel Time= 0.0 min

Peak Storage= 0 cf @ 0.00 hrs
Average Depth at Peak Storage= 0.00'
Bank-Full Depth= 2.00' Flow Area= 13.3 sf, Capacity= 55.2 cfs

10.00' x 2.00' deep Parabolic Channel, n= 0.100 Heavy timber, flow below branches
Length= 140.0' Slope= 0.0599 '/'
Inlet Invert= 77.43', Outlet Invert= 69.05'



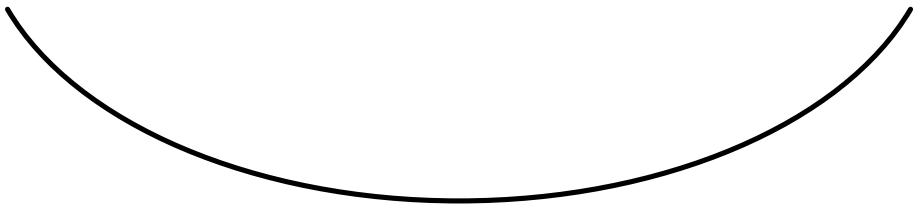
Summary for Reach 17R: Grass Reach

Inflow Area = 0.08 ac, 0.00% Impervious, Inflow Depth = 0.00" for 2-Year event
Outflow = 0.0 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Stor-Ind+Trans method, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 0.00 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 0.00 fps, Avg. Travel Time= 0.0 min

Peak Storage= 0 cf @ 0.00 hrs
Average Depth at Peak Storage= 0.00'
Bank-Full Depth= 2.00' Flow Area= 13.3 sf, Capacity= 57.6 cfs

10.00' x 2.00' deep Parabolic Channel, n= 0.080 Earth, long dense weeds
Length= 289.0' Slope= 0.0417 '/'
Inlet Invert= 80.02', Outlet Invert= 67.96'



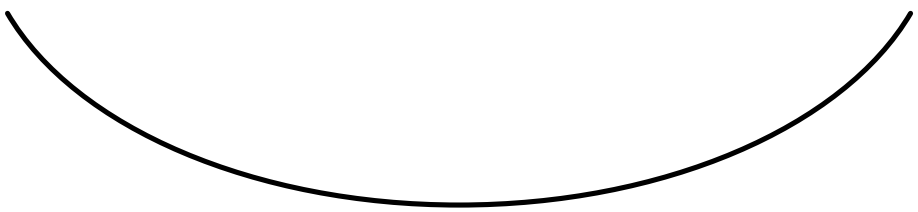
Summary for Reach 18R: Grass Reach

Inflow Area = 0.72 ac, 21.54% Impervious, Inflow Depth = 0.00" for 2-Year event
Inflow = 0.0 cfs @ 1.00 hrs, Volume= 0.000 af
Outflow = 0.0 cfs @ 1.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 0.00 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 0.00 fps, Avg. Travel Time= 0.0 min

Peak Storage= 0 cf @ 1.00 hrs
Average Depth at Peak Storage= 0.00'
Bank-Full Depth= 2.00' Flow Area= 13.3 sf, Capacity= 58.1 cfs

10.00' x 2.00' deep Parabolic Channel, n= 0.030 Short grass
Length= 112.0' Slope= 0.0060 '/'
Inlet Invert= 69.05', Outlet Invert= 68.38'



Summary for Pond 11P: Infiltration Swale

Inflow Area = 1.68 ac, 0.00% Impervious, Inflow Depth = 0.00" for 2-Year event
Inflow = 0.0 cfs @ 24.00 hrs, Volume= 0.000 af
Outflow = 0.0 cfs @ 24.03 hrs, Volume= 0.000 af, Atten= 0%, Lag= 1.7 min
Discarded = 0.0 cfs @ 24.03 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 83.00' @ 24.03 hrs Surf.Area= 536 sf Storage= 0 cf

Plug-Flow detention time= 4.0 min calculated for 0.000 af (100% of inflow)
Center-of-Mass det. time= 4.0 min (1,361.4 - 1,357.5)

Volume	Invert	Avail.Storage	Storage Description
#1	83.00'	9,176 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
83.00	536	0	0
84.00	1,277	907	907
85.00	2,115	1,696	2,603
86.00	3,016	2,566	5,168
87.00	5,000	4,008	9,176

Device	Routing	Invert	Outlet Devices
#1	Discarded	83.00'	**7.000 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 80.00'

Discarded OutFlow Max=0.1 cfs @ 24.03 hrs HW=83.00' (Free Discharge)
↑**1=Exfiltration** (Controls 0.1 cfs)

Summary for Pond 13P: Infiltration Basin

Inflow Area = 0.72 ac, 21.54% Impervious, Inflow Depth = 0.66" for 2-Year event
Inflow = 0.5 cfs @ 12.03 hrs, Volume= 0.040 af
Outflow = 0.2 cfs @ 12.29 hrs, Volume= 0.040 af, Atten= 54%, Lag= 15.2 min
Discarded = 0.2 cfs @ 12.29 hrs, Volume= 0.040 af

Routing by Stor-Ind method, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 78.14' @ 12.29 hrs Surf.Area= 1,392 sf Storage= 180 cf

Plug-Flow detention time= 6.0 min calculated for 0.039 af (100% of inflow)
Center-of-Mass det. time= 6.0 min (889.7 - 883.6)

Volume	Invert	Avail.Storage	Storage Description
#1	78.00'	13,892 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
78.00	1,249	0	0
79.00	2,298	1,774	1,774
80.00	3,403	2,851	4,624
81.00	4,566	3,985	8,609
82.00	6,000	5,283	13,892

Device	Routing	Invert	Outlet Devices
#1	Discarded	78.00'	**7.000 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 75.00'

Discarded OutFlow Max=0.2 cfs @ 12.29 hrs HW=78.14' (Free Discharge)
1=Exfiltration (Controls 0.2 cfs)

Summary for Pond 14P: Infilatation Swale

Inflow Area = 0.08 ac, 0.00% Impervious, Inflow Depth = 0.62" for 2-Year event
Inflow = 0.0 cfs @ 12.03 hrs, Volume= 0.004 af
Outflow = 0.0 cfs @ 12.29 hrs, Volume= 0.004 af, Atten= 53%, Lag= 15.8 min
Discarded = 0.0 cfs @ 12.29 hrs, Volume= 0.004 af

Routing by Stor-Ind method, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 78.30' @ 12.29 hrs Surf.Area= 127 sf Storage= 15 cf

Plug-Flow detention time= 3.9 min calculated for 0.004 af (100% of inflow)
Center-of-Mass det. time= 4.2 min (891.6 - 887.5)

Volume	Invert	Avail.Storage	Storage Description
#1	78.00'	1,611 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
78.00	127	0.0	0	0
79.00	127	40.0	51	51
80.00	127	100.0	127	178
81.00	332	100.0	230	407
82.00	538	100.0	435	842
83.00	1,000	100.0	769	1,611

Device	Routing	Invert	Outlet Devices
#1	Discarded	78.00'	**7.000 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 75.00'

Discarded OutFlow Max=0.0 cfs @ 12.29 hrs HW=78.30' (Free Discharge)
1=Exfiltration (Controls 0.0 cfs)

Summary for Link POA 1:

Inflow Area = 6.89 ac, 2.25% Impervious, Inflow Depth = 0.00" for 2-Year event
Inflow = 0.0 cfs @ 1.00 hrs, Volume= 0.000 af
Primary = 0.0 cfs @ 1.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs

Time span=1.00-30.00 hrs, dt=0.05 hrs, 581 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment10: Subcat 10 Runoff Area=4.42 ac 0.00% Impervious Runoff Depth=0.11"
Flow Length=644' Tc=35.2 min CN=37 Runoff=0.1 cfs 0.040 af

Subcatchment11: Subcat 11 Runoff Area=1.68 ac 0.00% Impervious Runoff Depth=0.20"
Flow Length=673' Tc=16.0 min CN=40 Runoff=0.1 cfs 0.028 af

Subcatchment12: Subcat 12 Runoff Area=0.72 ac 21.54% Impervious Runoff Depth=1.69"
Flow Length=120' Tc=0.8 min CN=67 Runoff=1.5 cfs 0.101 af

Subcatchment13: Subcat 13 Runoff Area=0.08 ac 0.00% Impervious Runoff Depth=1.61"
Flow Length=89' Tc=0.5 min CN=66 Runoff=0.2 cfs 0.010 af

Reach 11R: Grass Reach Avg. Flow Depth=0.00' Max Vel=0.00 fps
n=0.080 L=398.0' S=0.0366 '/' Capacity=53.9 cfs Outflow=0.0 cfs 0.000 af

Reach 16R: Woods Reach Avg. Flow Depth=0.00' Max Vel=0.00 fps
n=0.100 L=140.0' S=0.0599 '/' Capacity=55.2 cfs Outflow=0.0 cfs 0.000 af

Reach 17R: Grass Reach Avg. Flow Depth=0.00' Max Vel=0.00 fps
n=0.080 L=289.0' S=0.0417 '/' Capacity=57.6 cfs Outflow=0.0 cfs 0.000 af

Reach 18R: Grass Reach Avg. Flow Depth=0.00' Max Vel=0.00 fps Inflow=0.0 cfs 0.000 af
n=0.030 L=112.0' S=0.0060 '/' Capacity=58.1 cfs Outflow=0.0 cfs 0.000 af

Pond 11P: Infiltration Swale Peak Elev=83.02' Storage=12 cf Inflow=0.1 cfs 0.028 af
Outflow=0.1 cfs 0.028 af

Pond 13P: Infiltration Basin Peak Elev=78.66' Storage=1,046 cf Inflow=1.5 cfs 0.101 af
Outflow=0.4 cfs 0.101 af

Pond 14P: Infilatation Swale Peak Elev=79.47' Storage=111 cf Inflow=0.2 cfs 0.010 af
Outflow=0.0 cfs 0.010 af

Link POA 1: Inflow=0.1 cfs 0.040 af
Primary=0.1 cfs 0.040 af

Total Runoff Area = 6.89 ac Runoff Volume = 0.179 af Average Runoff Depth = 0.31"
97.75% Pervious = 6.73 ac 2.25% Impervious = 0.15 ac

Summary for Subcatchment 10: Subcat 10

Runoff = 0.1 cfs @ 15.20 hrs, Volume= 0.040 af, Depth= 0.11"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.83"

Area (ac)	CN	Description
1.45	30	Brush, Good, HSG A
0.58	73	Brush, Good, HSG D
0.08	96	Gravel surface, HSG A
2.26	30	Woods, Good, HSG A
0.04	77	Woods, Good, HSG D
4.42	37	Weighted Average
4.42		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.7	50	0.0040	0.04		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.15"
11.5	594	0.0298	0.86		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
35.2	644	Total			

Summary for Subcatchment 11: Subcat 11

Runoff = 0.1 cfs @ 12.65 hrs, Volume= 0.028 af, Depth= 0.20"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.83"

Area (ac)	CN	Description
0.44	39	>75% Grass cover, Good, HSG A
0.18	30	Brush, Good, HSG A
0.20	96	Gravel surface, HSG A
0.85	30	Woods, Good, HSG A
1.68	40	Weighted Average
1.68		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.9	50	0.0280	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.15"
3.1	198	0.0453	1.06		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
2.0	425	0.0100	3.53	17.63	**Trap/Vee/Rect Channel Flow,** Bot.W=2.00' D=1.00' Z= 3.0 '/' Top.W=8.00' n= 0.030 Earth, grassed & winding
16.0	673	Total			

Summary for Subcatchment 12: Subcat 12

Runoff = 1.5 cfs @ 12.02 hrs, Volume= 0.101 af, Depth= 1.69"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.83"

Area (ac)	CN	Description
0.32	30	Brush, Good, HSG A
0.24	96	Gravel surface, HSG A
0.15	98	Paved parking, HSG A
0.72	67	Weighted Average
0.56		78.46% Pervious Area
0.15		21.54% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	50	0.0314	1.42		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.15"
0.2	70	0.0791	5.71		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.8	120	Total			

Summary for Subcatchment 13: Subcat 13

Runoff = 0.2 cfs @ 12.02 hrs, Volume= 0.010 af, Depth= 1.61"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.83"

Area (ac)	CN	Description
0.03	30	Brush, Good, HSG A
0.04	96	Gravel surface, HSG A
0.08	66	Weighted Average
0.08		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.3	37	0.1012	2.14		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.15"
0.2	52	0.0221	4.92	19.68	**Trap/Vee/Rect Channel Flow,** Bot.W=1.00' D=1.00' Z= 3.0 '/' Top.W=7.00' n= 0.030 Earth, grassed & winding
0.5	89	Total			

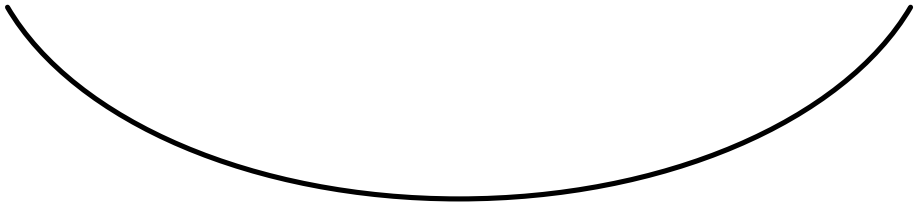
Summary for Reach 11R: Grass Reach

Inflow Area = 1.68 ac, 0.00% Impervious, Inflow Depth = 0.00" for 10-Year event
Outflow = 0.0 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Stor-Ind+Trans method, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 0.00 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 0.00 fps, Avg. Travel Time= 0.0 min

Peak Storage= 0 cf @ 0.00 hrs
Average Depth at Peak Storage= 0.00'
Bank-Full Depth= 2.00' Flow Area= 13.3 sf, Capacity= 53.9 cfs

10.00' x 2.00' deep Parabolic Channel, n= 0.080 Earth, long dense weeds
Length= 398.0' Slope= 0.0366 '/'
Inlet Invert= 82.52', Outlet Invert= 67.96'



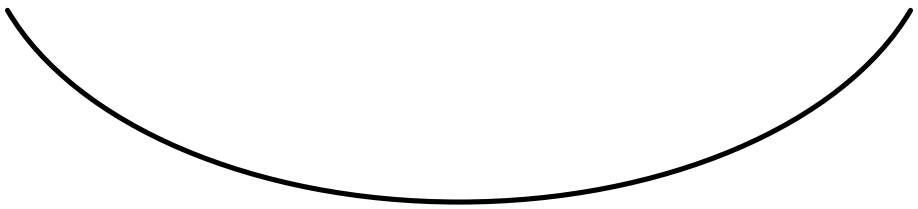
Summary for Reach 16R: Woods Reach

Inflow Area = 0.72 ac, 21.54% Impervious, Inflow Depth = 0.00" for 10-Year event
Outflow = 0.0 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Stor-Ind+Trans method, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 0.00 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 0.00 fps, Avg. Travel Time= 0.0 min

Peak Storage= 0 cf @ 0.00 hrs
Average Depth at Peak Storage= 0.00'
Bank-Full Depth= 2.00' Flow Area= 13.3 sf, Capacity= 55.2 cfs

10.00' x 2.00' deep Parabolic Channel, n= 0.100 Heavy timber, flow below branches
Length= 140.0' Slope= 0.0599 '/'
Inlet Invert= 77.43', Outlet Invert= 69.05'



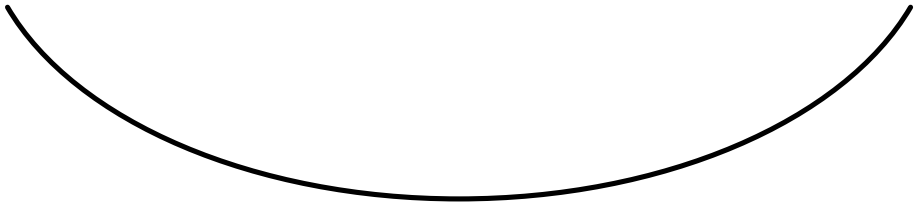
Summary for Reach 17R: Grass Reach

Inflow Area = 0.08 ac, 0.00% Impervious, Inflow Depth = 0.00" for 10-Year event
Outflow = 0.0 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Stor-Ind+Trans method, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 0.00 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 0.00 fps, Avg. Travel Time= 0.0 min

Peak Storage= 0 cf @ 0.00 hrs
Average Depth at Peak Storage= 0.00'
Bank-Full Depth= 2.00' Flow Area= 13.3 sf, Capacity= 57.6 cfs

10.00' x 2.00' deep Parabolic Channel, n= 0.080 Earth, long dense weeds
Length= 289.0' Slope= 0.0417 '/'
Inlet Invert= 80.02', Outlet Invert= 67.96'



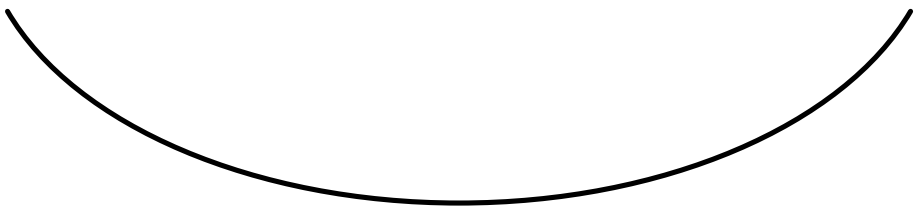
Summary for Reach 18R: Grass Reach

Inflow Area = 0.72 ac, 21.54% Impervious, Inflow Depth = 0.00" for 10-Year event
Inflow = 0.0 cfs @ 1.00 hrs, Volume= 0.000 af
Outflow = 0.0 cfs @ 1.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 0.00 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 0.00 fps, Avg. Travel Time= 0.0 min

Peak Storage= 0 cf @ 1.00 hrs
Average Depth at Peak Storage= 0.00'
Bank-Full Depth= 2.00' Flow Area= 13.3 sf, Capacity= 58.1 cfs

10.00' x 2.00' deep Parabolic Channel, n= 0.030 Short grass
Length= 112.0' Slope= 0.0060 '/'
Inlet Invert= 69.05', Outlet Invert= 68.38'



Summary for Pond 11P: Infiltration Swale

Inflow Area = 1.68 ac, 0.00% Impervious, Inflow Depth = 0.20" for 10-Year event
Inflow = 0.1 cfs @ 12.65 hrs, Volume= 0.028 af
Outflow = 0.1 cfs @ 12.76 hrs, Volume= 0.028 af, Atten= 3%, Lag= 6.8 min
Discarded = 0.1 cfs @ 12.76 hrs, Volume= 0.028 af

Routing by Stor-Ind method, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 83.02' @ 12.76 hrs Surf.Area= 553 sf Storage= 12 cf

Plug-Flow detention time= 4.0 min calculated for 0.028 af (100% of inflow)
Center-of-Mass det. time= 4.0 min (1,021.0 - 1,017.1)

Volume	Invert	Avail.Storage	Storage Description
#1	83.00'	9,176 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
83.00	536	0	0
84.00	1,277	907	907
85.00	2,115	1,696	2,603
86.00	3,016	2,566	5,168
87.00	5,000	4,008	9,176

Device	Routing	Invert	Outlet Devices
#1	Discarded	83.00'	**7.000 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 80.00'

Discarded OutFlow Max=0.1 cfs @ 12.76 hrs HW=83.02' (Free Discharge)
↑**1=Exfiltration** (Controls 0.1 cfs)

Summary for Pond 13P: Infiltration Basin

Inflow Area = 0.72 ac, 21.54% Impervious, Inflow Depth = 1.69" for 10-Year event
Inflow = 1.5 cfs @ 12.02 hrs, Volume= 0.101 af
Outflow = 0.4 cfs @ 12.43 hrs, Volume= 0.101 af, Atten= 76%, Lag= 24.4 min
Discarded = 0.4 cfs @ 12.43 hrs, Volume= 0.101 af

Routing by Stor-Ind method, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 78.66' @ 12.43 hrs Surf.Area= 1,938 sf Storage= 1,046 cf

Plug-Flow detention time= 21.0 min calculated for 0.101 af (100% of inflow)
Center-of-Mass det. time= 21.0 min (873.7 - 852.7)

Volume	Invert	Avail.Storage	Storage Description
#1	78.00'	13,892 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
78.00	1,249	0	0
79.00	2,298	1,774	1,774
80.00	3,403	2,851	4,624
81.00	4,566	3,985	8,609
82.00	6,000	5,283	13,892

Device	Routing	Invert	Outlet Devices
#1	Discarded	78.00'	**7.000 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 75.00'

Discarded OutFlow Max=0.4 cfs @ 12.43 hrs HW=78.66' (Free Discharge)
└**1=Exfiltration** (Controls 0.4 cfs)

Summary for Pond 14P: Infilatation Swale

Inflow Area = 0.08 ac, 0.00% Impervious, Inflow Depth = 1.61" for 10-Year event
Inflow = 0.2 cfs @ 12.02 hrs, Volume= 0.010 af
Outflow = 0.0 cfs @ 12.46 hrs, Volume= 0.010 af, Atten= 80%, Lag= 26.9 min
Discarded = 0.0 cfs @ 12.46 hrs, Volume= 0.010 af

Routing by Stor-Ind method, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 79.47' @ 12.46 hrs Surf.Area= 127 sf Storage= 111 cf

Plug-Flow detention time= 24.9 min calculated for 0.010 af (100% of inflow)
Center-of-Mass det. time= 24.8 min (880.0 - 855.2)

Volume	Invert	Avail.Storage	Storage Description
#1	78.00'	1,611 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
78.00	127	0.0	0	0
79.00	127	40.0	51	51
80.00	127	100.0	127	178
81.00	332	100.0	230	407
82.00	538	100.0	435	842
83.00	1,000	100.0	769	1,611

Device	Routing	Invert	Outlet Devices
#1	Discarded	78.00'	**7.000 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 75.00'

Discarded OutFlow Max=0.0 cfs @ 12.46 hrs HW=79.47' (Free Discharge)
└**1=Exfiltration** (Controls 0.0 cfs)

Summary for Link POA 1:

Inflow Area = 6.89 ac, 2.25% Impervious, Inflow Depth = 0.07" for 10-Year event
Inflow = 0.1 cfs @ 15.20 hrs, Volume= 0.040 af
Primary = 0.1 cfs @ 15.20 hrs, Volume= 0.040 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs

Time span=1.00-30.00 hrs, dt=0.05 hrs, 581 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment10: Subcat 10 Runoff Area=4.42 ac 0.00% Impervious Runoff Depth=1.36"
Flow Length=644' Tc=35.2 min CN=37 Runoff=2.7 cfs 0.500 af

Subcatchment11: Subcat 11 Runoff Area=1.68 ac 0.00% Impervious Runoff Depth=1.68"
Flow Length=673' Tc=16.0 min CN=40 Runoff=1.9 cfs 0.236 af

Subcatchment12: Subcat 12 Runoff Area=0.72 ac 21.54% Impervious Runoff Depth=4.91"
Flow Length=120' Tc=0.8 min CN=67 Runoff=4.6 cfs 0.294 af

Subcatchment13: Subcat 13 Runoff Area=0.08 ac 0.00% Impervious Runoff Depth=4.79"
Flow Length=89' Tc=0.5 min CN=66 Runoff=0.5 cfs 0.030 af

Reach 11R: Grass Reach Avg. Flow Depth=0.00' Max Vel=0.00 fps
n=0.080 L=398.0' S=0.0366 '/' Capacity=53.9 cfs Outflow=0.0 cfs 0.000 af

Reach 16R: Woods Reach Avg. Flow Depth=0.00' Max Vel=0.00 fps
n=0.100 L=140.0' S=0.0599 '/' Capacity=55.2 cfs Outflow=0.0 cfs 0.000 af

Reach 17R: Grass Reach Avg. Flow Depth=0.00' Max Vel=0.00 fps
n=0.080 L=289.0' S=0.0417 '/' Capacity=57.6 cfs Outflow=0.0 cfs 0.000 af

Reach 18R: Grass Reach Avg. Flow Depth=0.00' Max Vel=0.00 fps Inflow=0.0 cfs 0.000 af
n=0.030 L=112.0' S=0.0060 '/' Capacity=58.1 cfs Outflow=0.0 cfs 0.000 af

Pond 11P: Infiltration Swale Peak Elev=85.07' Storage=2,756 cf Inflow=1.9 cfs 0.236 af
Outflow=0.5 cfs 0.236 af

Pond 13P: Infiltration Basin Peak Elev=79.92' Storage=4,341 cf Inflow=4.6 cfs 0.294 af
Outflow=0.8 cfs 0.294 af

Pond 14P: Infilatation Swale Peak Elev=81.11' Storage=444 cf Inflow=0.5 cfs 0.030 af
Outflow=0.1 cfs 0.030 af

Link POA 1: Inflow=2.7 cfs 0.500 af
Primary=2.7 cfs 0.500 af

Total Runoff Area = 6.89 ac Runoff Volume = 1.059 af Average Runoff Depth = 1.85"
97.75% Pervious = 6.73 ac 2.25% Impervious = 0.15 ac

Summary for Subcatchment 10: Subcat 10

Runoff = 2.7 cfs @ 12.63 hrs, Volume= 0.500 af, Depth= 1.36"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.94"

Area (ac)	CN	Description
1.45	30	Brush, Good, HSG A
0.58	73	Brush, Good, HSG D
0.08	96	Gravel surface, HSG A
2.26	30	Woods, Good, HSG A
0.04	77	Woods, Good, HSG D
4.42	37	Weighted Average
4.42		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.7	50	0.0040	0.04		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.15"
11.5	594	0.0298	0.86		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
35.2	644	Total			

Summary for Subcatchment 11: Subcat 11

Runoff = 1.9 cfs @ 12.27 hrs, Volume= 0.236 af, Depth= 1.68"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.94"

Area (ac)	CN	Description
0.44	39	>75% Grass cover, Good, HSG A
0.18	30	Brush, Good, HSG A
0.20	96	Gravel surface, HSG A
0.85	30	Woods, Good, HSG A
1.68	40	Weighted Average
1.68		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.9	50	0.0280	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.15"
3.1	198	0.0453	1.06		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
2.0	425	0.0100	3.53	17.63	**Trap/Vee/Rect Channel Flow,** Bot.W=2.00' D=1.00' Z= 3.0 '/' Top.W=8.00' n= 0.030 Earth, grassed & winding
16.0	673	Total			

Summary for Subcatchment 12: Subcat 12

Runoff = 4.6 cfs @ 12.01 hrs, Volume= 0.294 af, Depth= 4.91"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.94"

Area (ac)	CN	Description
0.32	30	Brush, Good, HSG A
0.24	96	Gravel surface, HSG A
0.15	98	Paved parking, HSG A
0.72	67	Weighted Average
0.56		78.46% Pervious Area
0.15		21.54% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	50	0.0314	1.42		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.15"
0.2	70	0.0791	5.71		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.8	120	Total			

Summary for Subcatchment 13: Subcat 13

Runoff = 0.5 cfs @ 12.01 hrs, Volume= 0.030 af, Depth= 4.79"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.94"

Area (ac)	CN	Description
0.03	30	Brush, Good, HSG A
0.04	96	Gravel surface, HSG A
0.08	66	Weighted Average
0.08		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.3	37	0.1012	2.14		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.15"
0.2	52	0.0221	4.92	19.68	**Trap/Vee/Rect Channel Flow,** Bot.W=1.00' D=1.00' Z= 3.0 '/' Top.W=7.00' n= 0.030 Earth, grassed & winding
0.5	89	Total			

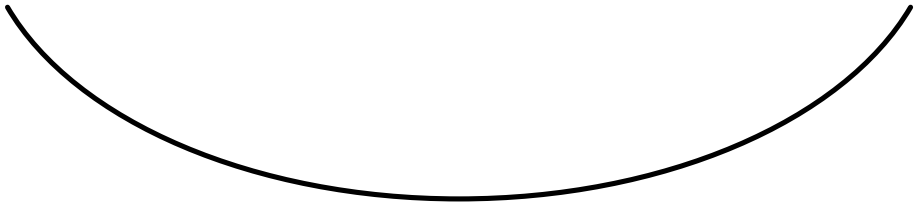
Summary for Reach 11R: Grass Reach

Inflow Area = 1.68 ac, 0.00% Impervious, Inflow Depth = 0.00" for 100-Year event
Outflow = 0.0 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Stor-Ind+Trans method, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 0.00 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 0.00 fps, Avg. Travel Time= 0.0 min

Peak Storage= 0 cf @ 0.00 hrs
Average Depth at Peak Storage= 0.00'
Bank-Full Depth= 2.00' Flow Area= 13.3 sf, Capacity= 53.9 cfs

10.00' x 2.00' deep Parabolic Channel, n= 0.080 Earth, long dense weeds
Length= 398.0' Slope= 0.0366 '/'
Inlet Invert= 82.52', Outlet Invert= 67.96'



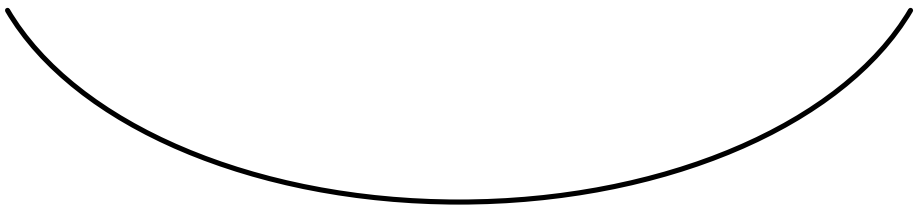
Summary for Reach 16R: Woods Reach

Inflow Area = 0.72 ac, 21.54% Impervious, Inflow Depth = 0.00" for 100-Year event
Outflow = 0.0 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Stor-Ind+Trans method, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 0.00 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 0.00 fps, Avg. Travel Time= 0.0 min

Peak Storage= 0 cf @ 0.00 hrs
Average Depth at Peak Storage= 0.00'
Bank-Full Depth= 2.00' Flow Area= 13.3 sf, Capacity= 55.2 cfs

10.00' x 2.00' deep Parabolic Channel, n= 0.100 Heavy timber, flow below branches
Length= 140.0' Slope= 0.0599 '/'
Inlet Invert= 77.43', Outlet Invert= 69.05'



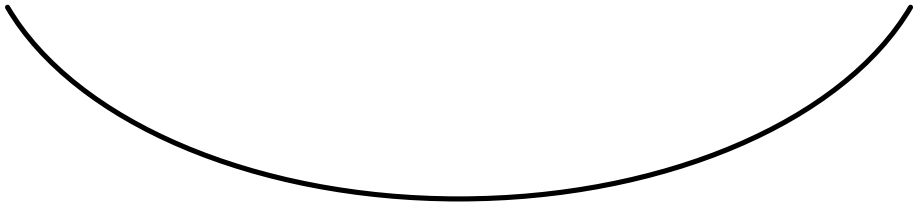
Summary for Reach 17R: Grass Reach

Inflow Area = 0.08 ac, 0.00% Impervious, Inflow Depth = 0.00" for 100-Year event
Outflow = 0.0 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Stor-Ind+Trans method, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 0.00 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 0.00 fps, Avg. Travel Time= 0.0 min

Peak Storage= 0 cf @ 0.00 hrs
Average Depth at Peak Storage= 0.00'
Bank-Full Depth= 2.00' Flow Area= 13.3 sf, Capacity= 57.6 cfs

10.00' x 2.00' deep Parabolic Channel, n= 0.080 Earth, long dense weeds
Length= 289.0' Slope= 0.0417 '/'
Inlet Invert= 80.02', Outlet Invert= 67.96'



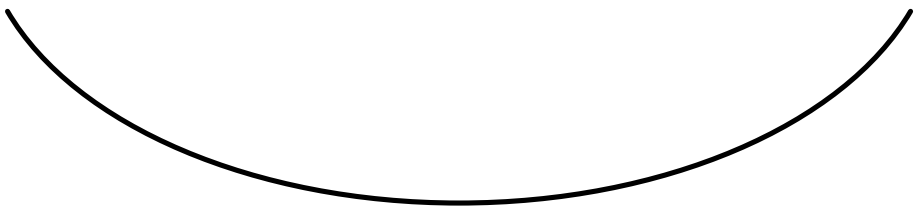
Summary for Reach 18R: Grass Reach

Inflow Area = 0.72 ac, 21.54% Impervious, Inflow Depth = 0.00" for 100-Year event
Inflow = 0.0 cfs @ 1.00 hrs, Volume= 0.000 af
Outflow = 0.0 cfs @ 1.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 0.00 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 0.00 fps, Avg. Travel Time= 0.0 min

Peak Storage= 0 cf @ 1.00 hrs
Average Depth at Peak Storage= 0.00'
Bank-Full Depth= 2.00' Flow Area= 13.3 sf, Capacity= 58.1 cfs

10.00' x 2.00' deep Parabolic Channel, n= 0.030 Short grass
Length= 112.0' Slope= 0.0060 '/'
Inlet Invert= 69.05', Outlet Invert= 68.38'



Summary for Pond 11P: Infiltration Swale

Inflow Area = 1.68 ac, 0.00% Impervious, Inflow Depth = 1.68" for 100-Year event
Inflow = 1.9 cfs @ 12.27 hrs, Volume= 0.236 af
Outflow = 0.5 cfs @ 13.05 hrs, Volume= 0.236 af, Atten= 74%, Lag= 46.7 min
Discarded = 0.5 cfs @ 13.05 hrs, Volume= 0.236 af

Routing by Stor-Ind method, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 85.07' @ 13.05 hrs Surf.Area= 2,179 sf Storage= 2,756 cf

Plug-Flow detention time= 65.2 min calculated for 0.235 af (100% of inflow)
Center-of-Mass det. time= 65.1 min (969.4 - 904.4)

Volume	Invert	Avail.Storage	Storage Description
#1	83.00'	9,176 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
83.00	536	0	0
84.00	1,277	907	907
85.00	2,115	1,696	2,603
86.00	3,016	2,566	5,168
87.00	5,000	4,008	9,176

Device	Routing	Invert	Outlet Devices
#1	Discarded	83.00'	**7.000 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 80.00'

Discarded OutFlow Max=0.5 cfs @ 13.05 hrs HW=85.07' (Free Discharge)
↑**1=Exfiltration** (Controls 0.5 cfs)

Summary for Pond 13P: Infiltration Basin

Inflow Area = 0.72 ac, 21.54% Impervious, Inflow Depth = 4.91" for 100-Year event
Inflow = 4.6 cfs @ 12.01 hrs, Volume= 0.294 af
Outflow = 0.8 cfs @ 12.48 hrs, Volume= 0.294 af, Atten= 84%, Lag= 27.8 min
Discarded = 0.8 cfs @ 12.48 hrs, Volume= 0.294 af

Routing by Stor-Ind method, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 79.92' @ 12.48 hrs Surf.Area= 3,310 sf Storage= 4,341 cf

Plug-Flow detention time= 55.6 min calculated for 0.294 af (100% of inflow)
Center-of-Mass det. time= 55.5 min (876.7 - 821.2)

Volume	Invert	Avail.Storage	Storage Description
#1	78.00'	13,892 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
78.00	1,249	0	0
79.00	2,298	1,774	1,774
80.00	3,403	2,851	4,624
81.00	4,566	3,985	8,609
82.00	6,000	5,283	13,892

Device	Routing	Invert	Outlet Devices
#1	Discarded	78.00'	**7.000 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 75.00'

Discarded OutFlow Max=0.8 cfs @ 12.48 hrs HW=79.91' (Free Discharge)
1=Exfiltration (Controls 0.8 cfs)

Summary for Pond 14P: Infilatation Swale

Inflow Area = 0.08 ac, 0.00% Impervious, Inflow Depth = 4.79" for 100-Year event
Inflow = 0.5 cfs @ 12.01 hrs, Volume= 0.030 af
Outflow = 0.1 cfs @ 12.46 hrs, Volume= 0.030 af, Atten= 83%, Lag= 27.1 min
Discarded = 0.1 cfs @ 12.46 hrs, Volume= 0.030 af

Routing by Stor-Ind method, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 81.11' @ 12.46 hrs Surf.Area= 354 sf Storage= 444 cf

Plug-Flow detention time= 59.9 min calculated for 0.030 af (100% of inflow)
Center-of-Mass det. time= 59.9 min (882.9 - 823.0)

Volume	Invert	Avail.Storage	Storage Description
#1	78.00'	1,611 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
78.00	127	0.0	0	0
79.00	127	40.0	51	51
80.00	127	100.0	127	178
81.00	332	100.0	230	407
82.00	538	100.0	435	842
83.00	1,000	100.0	769	1,611

Device	Routing	Invert	Outlet Devices
#1	Discarded	78.00'	**7.000 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 75.00'

Discarded OutFlow Max=0.1 cfs @ 12.46 hrs HW=81.11' (Free Discharge)
1=Exfiltration (Controls 0.1 cfs)

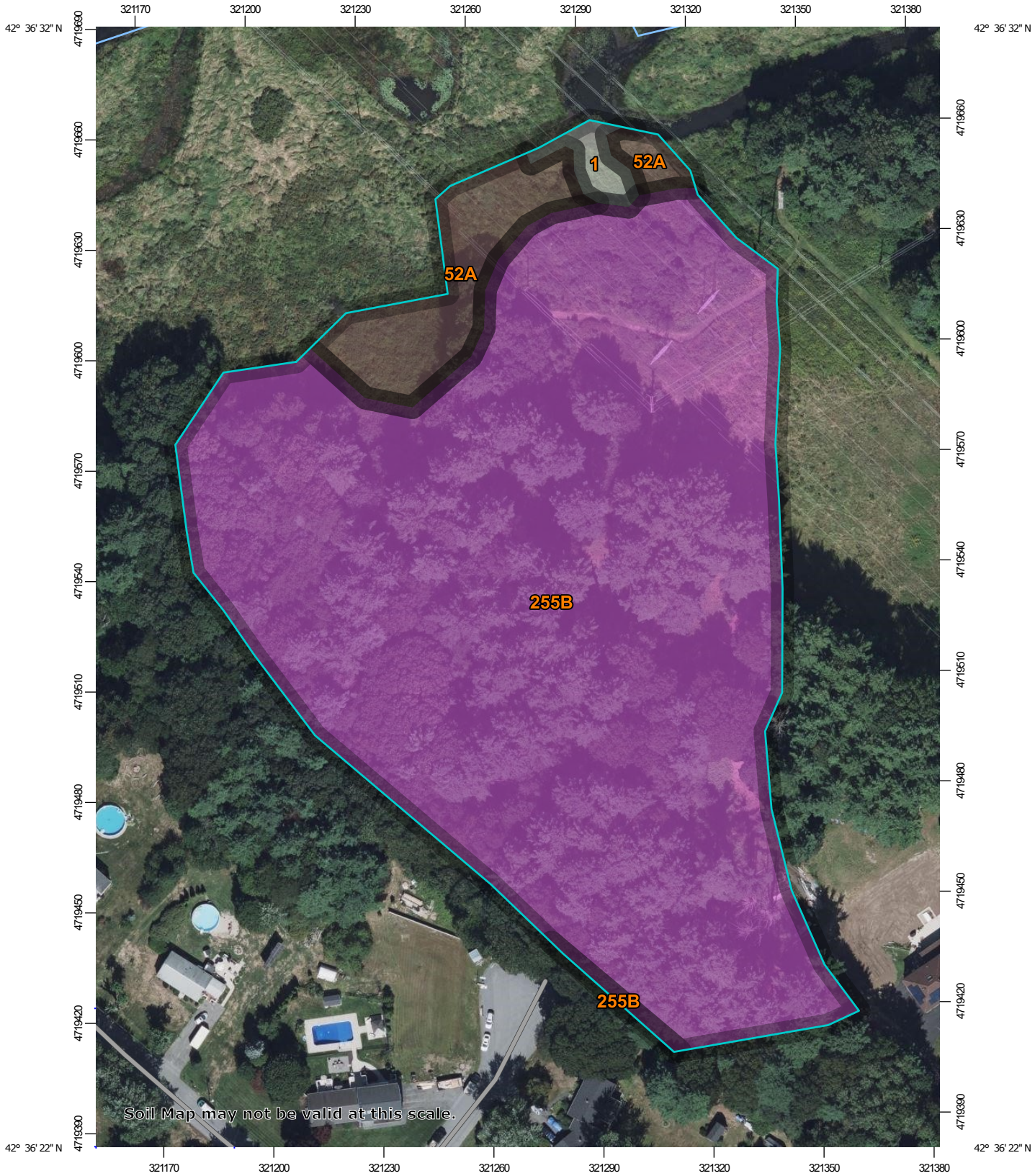
Summary for Link POA 1:

Inflow Area = 6.89 ac, 2.25% Impervious, Inflow Depth = 0.87" for 100-Year event
Inflow = 2.7 cfs @ 12.63 hrs, Volume= 0.500 af
Primary = 2.7 cfs @ 12.63 hrs, Volume= 0.500 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs

NRCS HYDROLOGIC SOIL GROUP REPORT

Hydrologic Soil Group—Essex County, Massachusetts, Northern Part; and Middlesex County, Massachusetts
(1320 South Street - Andover, MA)



Map Scale: 1:1,480 if printed on A portrait (8.5" x 11") sheet.

N

Meters
0 20 40 80 120

Feet
0 50 100 200 300

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features

- Streams and Canals

Transportation

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

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at scales ranging from 1:15,800 to 1:25,000.

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

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

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

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

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

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

Soil Survey Area: Essex County, Massachusetts, Northern Part
Survey Area Data: Version 17, Sep 2, 2021

Soil Survey Area: Middlesex County, Massachusetts
Survey Area Data: Version 21, Sep 2, 2021

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

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

Date(s) aerial images were photographed: Aug 13, 2020—Sep 15, 2020

MAP LEGEND

MAP INFORMATION

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
1	Water		0.1	1.2%
52A	Freetown muck, 0 to 1 percent slopes	B/D	0.5	7.6%
255B	Windsor loamy sand, 3 to 8 percent slopes	A	6.3	91.1%
Subtotals for Soil Survey Area			**6.9**	**99.9%**
Totals for Area of Interest			**6.9**	**100.0%**

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
255B	Windsor loamy sand, 3 to 8 percent slopes	A	0.0	0.1%
Subtotals for Soil Survey Area			**0.0**	**0.1%**
Totals for Area of Interest			**6.9**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

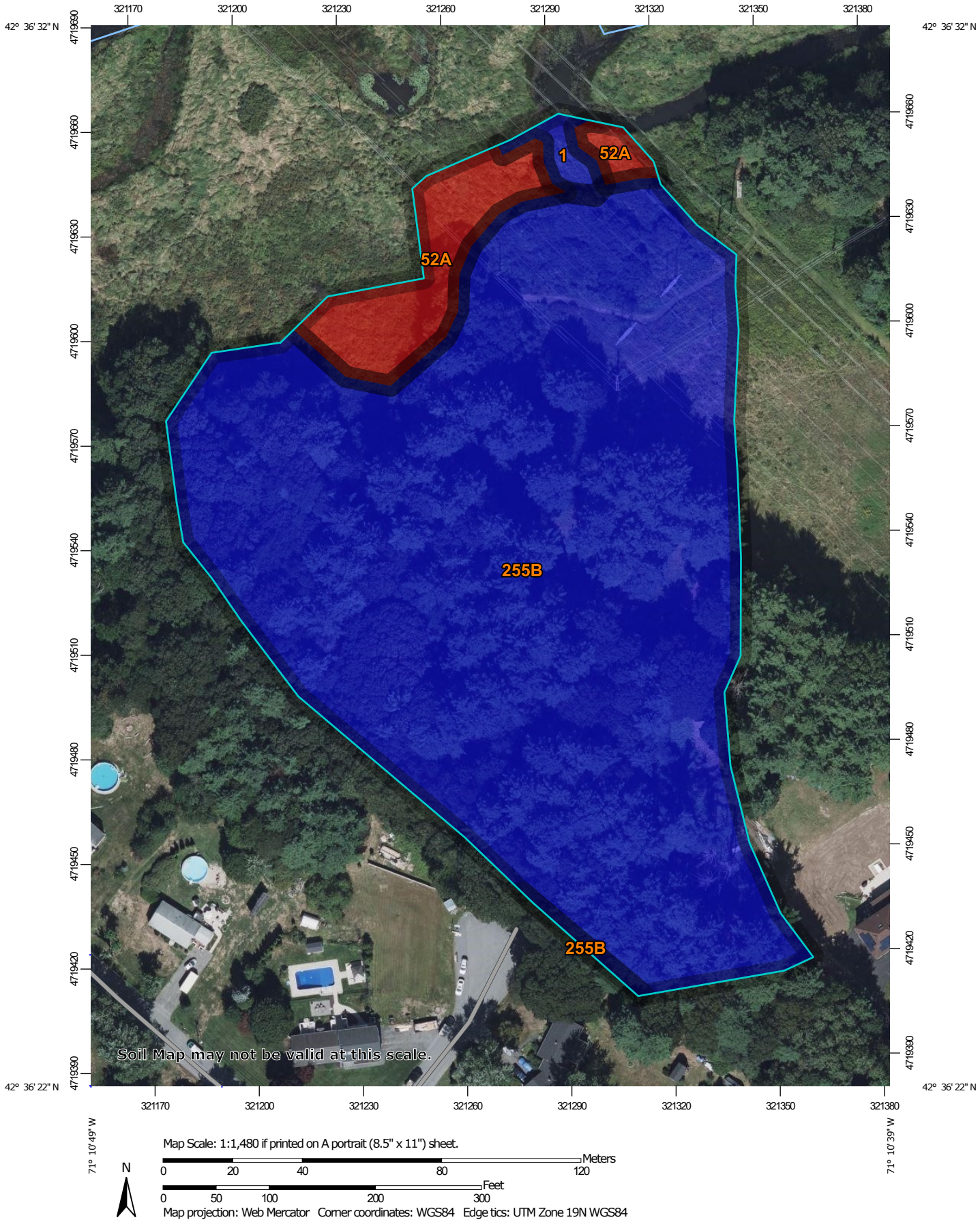
Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

NRCS DEPTH TO WATER TABLE REPORT

Depth to Water Table—Essex County, Massachusetts, Northern Part; and Middlesex County, Massachusetts
(1320 South Street - Andover, MA)



Map Scale: 1:1,480 if printed on A portrait (8.5" x 11") sheet.

N

Meters
0 20 40 80 120

Feet
0 50 100 200 300

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

MAP LEGEND

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

Soils

Soil Rating Polygons
- 0 - 25
- 25 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- > 200
- Not rated or not available

Soil Rating Lines
- 0 - 25
- 25 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- > 200
- Not rated or not available

Soil Rating Points
- 0 - 25
- 25 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- > 200
- Not rated or not available

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at scales ranging from 1:15,800 to 1:25,000.

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

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

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

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

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

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

Soil Survey Area: Essex County, Massachusetts, Northern Part
Survey Area Data: Version 17, Sep 2, 2021

Soil Survey Area: Middlesex County, Massachusetts
Survey Area Data: Version 21, Sep 2, 2021

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

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

Date(s) aerial images were photographed: Aug 13, 2020—Sep 15, 2020

MAP LEGEND

MAP INFORMATION

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

Depth to Water Table

Map unit symbol	Map unit name	Rating (centimeters)	Acres in AOI	Percent of AOI
1	Water	>200	0.1	1.2%
52A	Freetown muck, 0 to 1 percent slopes	0	0.5	7.6%
255B	Windsor loamy sand, 3 to 8 percent slopes	>200	6.3	91.1%
Subtotals for Soil Survey Area			**6.9**	**99.9%**
Totals for Area of Interest			**6.9**	**100.0%**

Map unit symbol	Map unit name	Rating (centimeters)	Acres in AOI	Percent of AOI
255B	Windsor loamy sand, 3 to 8 percent slopes	>200	0.0	0.1%
Subtotals for Soil Survey Area			**0.0**	**0.1%**
Totals for Area of Interest			**6.9**	**100.0%**

Description

"Water table" refers to a saturated zone in the soil. It occurs during specified months. Estimates of the upper limit are based mainly on observations of the water table at selected sites and on evidence of a saturated zone, namely grayish colors (redoximorphic features) in the soil. A saturated zone that lasts for less than a month is not considered a water table.

This attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

Rating Options

Units of Measure: centimeters

Aggregation Method: Dominant Component

Component Percent Cutoff: None Specified

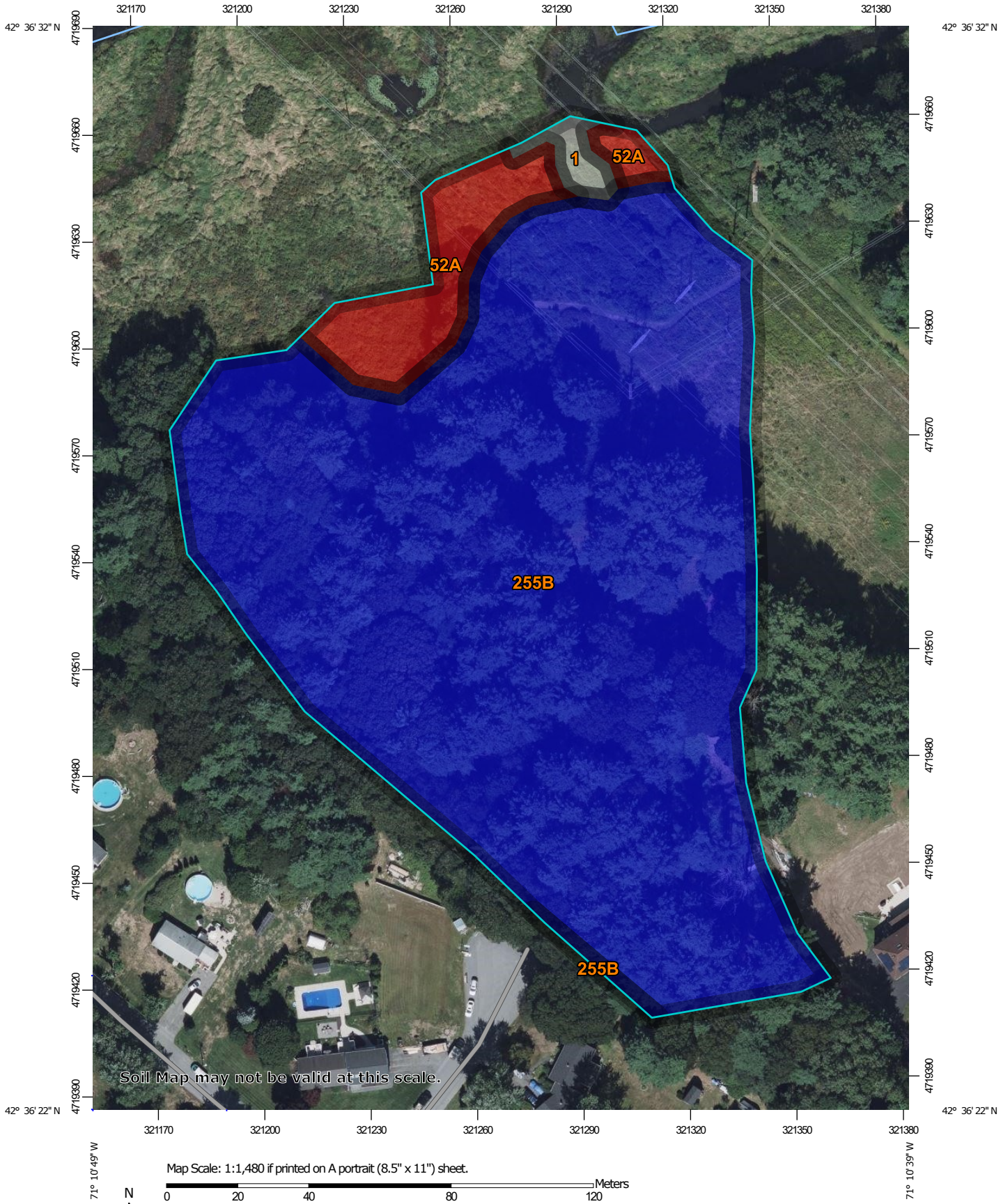
Tie-break Rule: Lower

Interpret Nulls as Zero: No

Beginning Month: January

Ending Month: December

NRCS SATURATED HYDRAULIC CONDUCITIVITY (KSAT) REPORT



Map Scale: 1:1,480 if printed on A portrait (8.5" x 11") sheet.

N

Meters
0 20 40 80 120

Feet
0 50 100 200 300

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

- <= 10.0000
- > 10.0000 and <= 100.0000
- Not rated or not available

Soil Rating Lines

- <= 10.0000
- > 10.0000 and <= 100.0000
- Not rated or not available

Soil Rating Points

- <= 10.0000
- > 10.0000 and <= 100.0000
- Not rated or not available

Water Features

- Streams and Canals

Transportation

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

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at scales ranging from 1:15,800 to 1:25,000.

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

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

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

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

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

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

Soil Survey Area: Essex County, Massachusetts, Northern Part
Survey Area Data: Version 17, Sep 2, 2021

Soil Survey Area: Middlesex County, Massachusetts
Survey Area Data: Version 21, Sep 2, 2021

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

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

Date(s) aerial images were photographed: Aug 13, 2020—Sep 15, 2020

MAP LEGEND

MAP INFORMATION

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

Saturated Hydraulic Conductivity (Ksat)

Map unit symbol	Map unit name	Rating (micrometers per second)	Acres in AOI	Percent of AOI
1	Water		0.1	1.2%
52A	Freetown muck, 0 to 1 percent slopes	10.0000	0.5	7.6%
255B	Windsor loamy sand, 3 to 8 percent slopes	100.0000	6.3	91.1%
Subtotals for Soil Survey Area			**6.9**	**99.9%**
Totals for Area of Interest			**6.9**	**100.0%**

Map unit symbol	Map unit name	Rating (micrometers per second)	Acres in AOI	Percent of AOI
255B	Windsor loamy sand, 3 to 8 percent slopes	100.0000	0.0	0.1%
Subtotals for Soil Survey Area			**0.0**	**0.1%**
Totals for Area of Interest			**6.9**	**100.0%**

Description

Saturated hydraulic conductivity (Ksat) refers to the ease with which pores in a saturated soil transmit water. The estimates are expressed in terms of micrometers per second. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Saturated hydraulic conductivity is considered in the design of soil drainage systems and septic tank absorption fields.

For each soil layer, this attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

The numeric Ksat values have been grouped according to standard Ksat class limits.

Rating Options

Units of Measure: micrometers per second

Aggregation Method: Dominant Component

Component Percent Cutoff: None Specified

Tie-break Rule: Fastest

Interpret Nulls as Zero: No

Layer Options (Horizon Aggregation Method): Surface Layer (Not applicable)

O&M Plan

OPERATIONS & MAINTENANCE PLAN

For Proposed work at:

1320 South Street

Andover, MA 01810

Prepared By:

Borrego Solar Systems, Inc.

55 Technology Drive, Suite 102

Lowell, MA 01851

Submitted to:

Town of Andover

Planning Board

36 Bartlet

Andover, MA 01810

April 12, 2022

Services

During the Term, Contractor shall perform the following services on each System:

Energy Storage System will be maintained per the manufacture specific operations and maintenance plan.

Description of Work	Frequency of Inspection
Vegetation Management	Minimum of once per year
Gravel Access Road	Minimum of once per year
Stormwater System Inspection	Two times per year

Scope of Work

1. Vegetation Management

The site shall be inspected for evidence of erosion and rilling in any slopes. If slopes are degraded, they can reduce water quality and/or divert water to unintended areas. Revegetation of slopes helps to stabilize and ensure that storm water runoff behaves as intended. Any such conditions shall be noted in the annual report for re-vegetating.

Growth of trees or other vegetation that is having a shade impact on the arrays should be noted in the annual report. Vegetation growth (saplings, bush, large weeds, etc.) within any array fences or inverter enclosures shall be removed. The site shall be mowed a minimum of twice per year. Outside of the energy storage facility, vegetation is allowed to grow for longer periods. Maintenance is required when:

- Erosion or rilling is found
- Standing water remains longer than 72 hours after a rain event
- Vegetation die-off has occurred resulting in unstable slopes

2. Gravel Access Roads

Roads should be stable enough that very little sediment is released during weather events. Preventative maintenance is required to avoid erosion to the roadway or roadbed. Inspections of the roadway will check for rill erosion in the road or along the shoulders, and areas of poor drainage resulting from subgrade settlement or poor

compaction. These conditions shall be noted and supported with photographs and locations as part of the annual report.

Maintenance:
Inspect roadways a minimum of once per year. Maintenance is required when:

- Erosion of the roadway or shoulders is identified
- Clean out roadside ditches when they become clogged with sediments or debris, to prevent ponding, bank overflows, and road washouts
- Fill in areas of erosion or settlement with clean washed stone. If erosion is along shoulder, ensure shoulder is properly revegetated

3. Stormwater Management Maintenance

Diversion Swale

Swale maintenance effects how efficiently water will be transported to the detention basin. Swales should resist erosion, be self-cleaning, and discharge onto nearly level vegetated or stabilized areas, thus maximizing the length of time between regrading or cleaning, reducing maintenance costs. Typically, little maintenance is required.

Maintenance:
Check the diversion swale after major storm events (greater than 2.5" in 24 hours) and in spring and fall for:

- Obstructions, erosion, or bank collapse
- Sediment or debris clogging or impeding the flow of water. Clean swale to prevent ponding, bank overflows, and road washouts.
- Re-grade swale only when necessary and line with vegetation or stone as necessary. Re-grading of swale should be limited to late spring or summer, after spring rains have diminished and drier weather has set in, and when vegetation can be re-established. Other times may be suitable depending on weather patterns, work to be performed, and urgency of work to be done.

Detention Basin

Basins only attenuate peak flows when they operate as designed, so regular maintenance is essential. Inspections shall take place every six months.

Maintenance is required when:
- Too much sediment accumulates and interferes with volume capacity,
- Trees or other shrub vegetation grow on the embankment,
- The embankment becomes denuded or otherwise presents an erosion problem,
- Animal burrows are present on the embankment, or
- Standing water remains longer than 72 hours after a rain event.
  Remediation measures to be taken include:
- Remove sediments
- Repair any rilling or gullying

- After removal of sediment, replace any vegetation damaged during the clean-out by reseeding or re-sodding. When reseeding, incorporate practices such as hydroseeding with a tackifier, blanket, or similar practice to ensure that no scour occurs while the seed germinate and develop roots.

Culverts

Culverts are designed to transfer stormwater, generally to allow the flow of water beneath roadways to retain the pre-construction drainage characteristics of a site. Typically, no grate is required for energy storage facility installations, and large debris is absent from the site, so little maintenance is required.

Maintenance is required when:

- Too much sediment or debris accumulates and interferes with volume capacity,
- Erosion is observed either at the culvert inlet or outlet.

Notes

1. Name of stormwater management system owners: TBD
2. Party responsible for operation and maintenance and the person(s) responsible for financing maintenance and emergency repairs: TBD
3. Estimated operation and maintenance budget: TBD