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June 6, 2023

Planning Board  
900 Main Street  
Town Offices  
Millis, MA 02054

Ref: Acorn Place  
Stormwater Basin Modifications

Dear Members of the Board:

This letter is an updated version of our January 3, 2023 letter. At that time BETA suggested that we treat the existing stormwater basins as Sand Filters as outline in the DEP Stormwater Management Handbook and update the redesign as needed. This letter repeats the prior correspondence but has been updated to reflect this change.

I am writing on behalf of the applicant to request a modification to the stormwater basin designs at Acorn Place. As has been documented, Basin 1 does not drain down within 72 hours during wet seasons (periods of time with repeated, frequent rainfall events). During these same wet seasons, Basin 2 holds more shallow depths of water for longer than 72 hours. it is well known that the glacial till soils on the site are restrictive<sup>1</sup>, which is why there are wetlands on the site in low lying valley areas (areas where stormwater cannot readily runoff). These wetlands exhibit similar patterns to the stormwater basins, holding surface water during wet seasons but being dry during other times of the year.

Due to shallow perched groundwater conditions typically associated with these types of glacial till soils, the design called for unsuitable soils to be removed and the floor of the basin to be filled with clean sand or loamy sand to raise the grade to design elevations. We took samples of the topsoil and underlying fill materials for each basin and had them tested for classification (See Attachment A for results). For Basin 1, a processed gravel material was used as the fill material. Both the loam and processed fill material samples were classified as loamy sand. For Basin 2, Title V septic sand was used as the fill material. Both the loam and

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<sup>1</sup> The NRCS soil survey classifies them as Woodbridge, Class C/D (depending on groundwater depth).



processed fill material samples were classified as sand. We therefore conclude that the fill materials imported into the basins are not restricting infiltration.

We note the following provisions from the MassDEP Stormwater Handbook relative to stormwater infiltration basins:

- As Volume 1, Chapter 1, page 6-7 notes, “MassDEP recognized that it may be difficult to infiltrate the required recharge volume on certain sites because of soils conditions. For sites comprised solely of C and D soils...proponents are required to infiltrate the required recharge volume only to the maximum extent practicable.” It is noted that the site is comprised of Class C and D soils (woodbridge soils per NRCS).
- The minimum permitted design infiltration rate for an infiltration facility is 0.17 inches per hour. Soils with slower permeability rates are typically not deemed to be suitable for infiltration. This is very close to the design infiltration rate for Basin 1 (design rate of 0.4 inches per hour), which supports a conclusion that the natural soils on the site are simply not suited to the infiltration of large volumes of runoff, which is anecdotally supporting by surficial hydrology conditions during certain times of the year.

Given the fact that the site is comprised of C/D soils, during periods of persistent rainfall and perched high groundwater conditions, it is our conclusion that the underlying glacial till is simply unable to accommodate the infiltration of significant volumes of runoff, as the natural till soil matrix is likely already highly saturated by perched groundwater conditions throughout the site during these periods. The performance of Basin 2 supports this conclusion. It is a shallow basin with a holding depth of only 0.3 feet, and it has difficulty draining down within 72 hours during periods of persistent saturation.

The installation of a subdrain into both basins provides a potential solution. It will allow for the basin and the sand layer below it to drain out slowly, thus preventing excessive periods of standing water. In order to demonstrate compliance with 80% TSS removal, as has been suggested by BETA, given that both basins have a substantial layer of imported sand under the loam and above the native soil, the water trapped below the lowest outlet in each basin will have to infiltrate through the loam and sand before it can be captured by the new subdrain and discharged. This operates in the same manner as a sand filter as described in the DEP Stormwater Handbook. A sand filter achieves 80% TSS removal with one pretreatment BMP. Each basin is preceded by either deep sump catch basins, a sediment forebay, or both, thus meeting the 80%TSS requirement. Based on commentary from BETA, the attached details have been revised accordingly. For Basin 2, given the existing ground



elevations at the outfall, the subdrain can be placed below 18" of sand. For Basin 2, given the existing ground elevations at the outfall, the subdrain can be placed below 9" of sand. That in combination with the loam layer provides 15" of soil above the top of the subdrain. We note, however, that this would only impact the area immediately above the subdrain, as all other flows to the subdrain must pass through the loam and then laterally through the sand layers to reach the subdrain. We view this as reasonable given the site constraints.

As a conservative measure, although water will still infiltrate into the underlying permeable fill materials, we have re-run the Hydrocad models with no infiltration accounted for to ensure that there will be no increase in peak rates of runoff. Given the low permeability of the natural glacial till soils, infiltration did not play a significant role in peak rate mitigation. However, due to the specific configuration of the discharge headwalls in the basins, existing outlet configurations in the headwalls would need to be modified to maintain peak rates below pre-development conditions with no infiltration accounted for in the Hydrocad model. In order to model the subdrain while meeting predevelopment peak rates of runoff, we have introduced a 2" diameter outlet at the bottom of each basin in the Hydrocad calculations. The revised stormwater basin outlet details restrict the discharge from the subdrains to 2" with a capped outlet. See below for further discussion:

#### **DESIGN POINT #1: Flow to Shadowfax Farm**

For Basin 1, the elimination of infiltration in the Hydrocad model only resulting in an increased peak rate of runoff in the 100-year storm. Thus, additional low-flow outlets are proposed to change the stage-discharge model to allow all peak rates to be lowered. In order to maintain the Water Quality Volume storage within the basin (4,332 c.f.), three additional 4" diameter cores are proposed to be added to the headwall at elevation 210.80, which results in a raw standing volume of 4,981 c.f. within the basin. These three new outlets will be 0.2 feet lower than the existing low-flow outlet, reducing the depth of standing water in the basin to 0.3 feet. This modification yields the following as indicated in the attached Hydrocad model:

Design Storm (Year)	Peak Runoff Rate (cfs)	
	Existing	Proposed
1	1.80	1.75
2	3.78	3.27
10	9.08	6.92
50	14.74	10.66
100	17.30	14.83



**DESIGN POINT #2: Flow to Southern Abutters**

For Basin 2, the elimination of infiltration in the Hydrocad resulting in small peak rate increases in all storm events. Thus, to accommodate the revised stage-storage relationship with no infiltration included, the outlet notch is proposed to be modified per the detail in attachment C. This modification yields the following as indicated in the attached Hydrocad model:

Design Storm (Year)	Peak Runoff Rate (cfs)	
	Existing	Proposed
1	3.20	3.20
2	6.64	6.40
10	15.82	15.24
50	25.64	25.07
100	30.09	29.45

Also attached is a revised O&M plan reflecting the change of the status of the stormwater basins to sand filters, although they also provide stormwater detention. Do not hesitate to contact me should you have any questions or comments.

Yours Truly,

LEGACY ENGINEERING LLC

Daniel J. Merrikin, P.E.  
President

cc: File

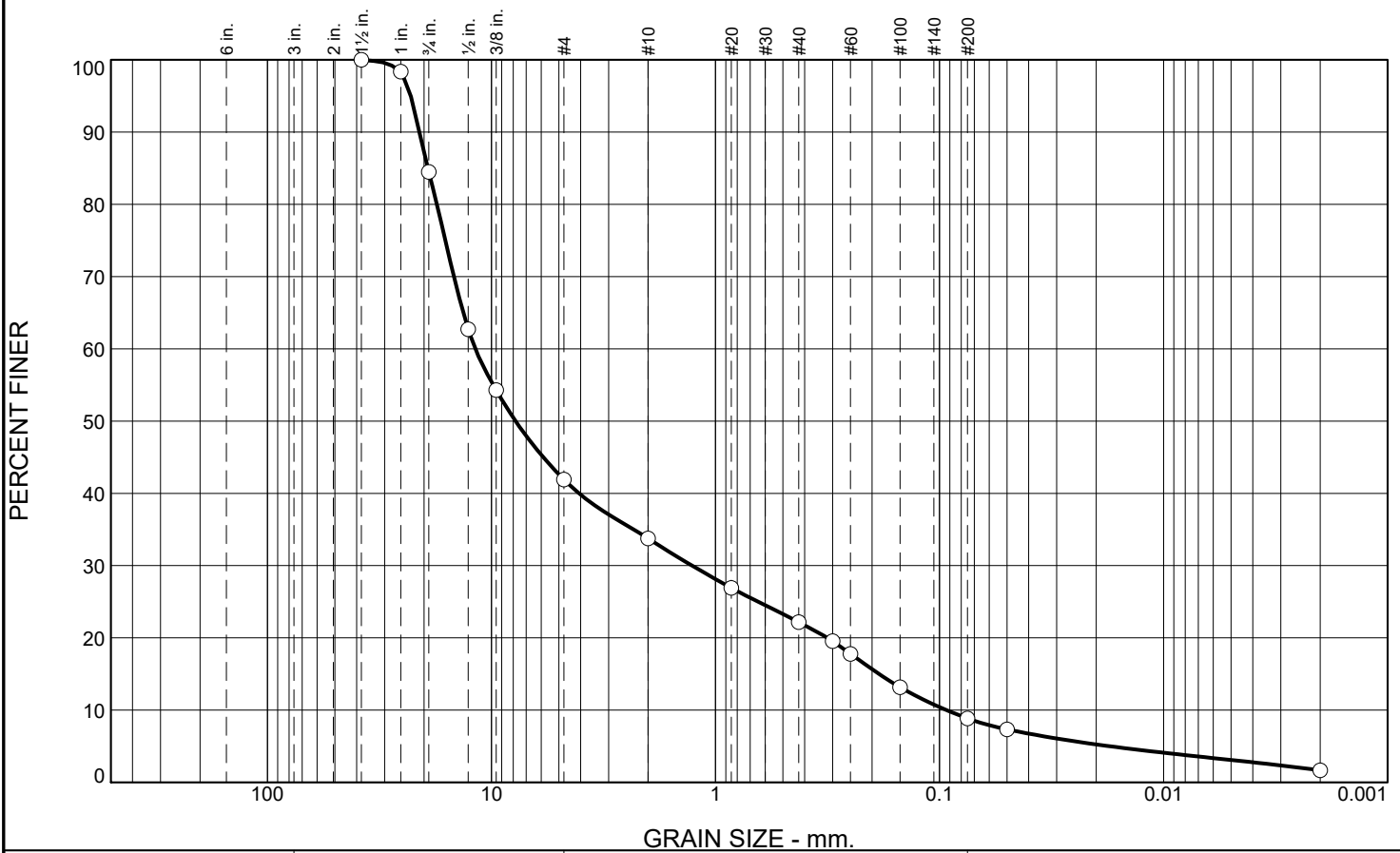


## ATTACHMENT A

### STORMWATER BASIN SOILS SAMPLING TEST RESULTS



# Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	15.5	42.6	8.1	11.6	13.3	7.2	1.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5	100.0		
1	98.3		
.75	84.5		
.5	62.7		
.375	54.3		
#4	41.9		
#10	33.8		
#20	26.9		
#40	22.2		
#50	19.5		
#60	17.8		
#100	13.2		
#200	8.9		
0.05mm	7.3		
0.002mm	1.7		

\* (no specification provided)

## Material Description

Brown 1.5" max gravel some f/m sand trace silt  
USDA Textural Classification = Loamy Sand

## Atterberg Limits

PL= NP

LL= NV

PI= NP

## Coefficients

D<sub>85</sub>= 19.2385

D<sub>60</sub>= 11.8080

D<sub>50</sub>= 7.8065

D<sub>30</sub>= 1.2719

D<sub>15</sub>= 0.1863

D<sub>10</sub>= 0.0930

C<sub>u</sub>= 126.95

C<sub>c</sub>= 1.47

## Classification

USCS= GW-GM

AASHTO= A-1-a

## Remarks

Sample submitted by client on 06/16/22  
No soil specs provided

Sample No.: L-31524  
Location: Basin Fill #1

Source of Sample: Unknown Site

Date: 6/22/22  
Elev./Depth: submitted

**YANKEE ENGINEERING  
& TESTING, INC.**

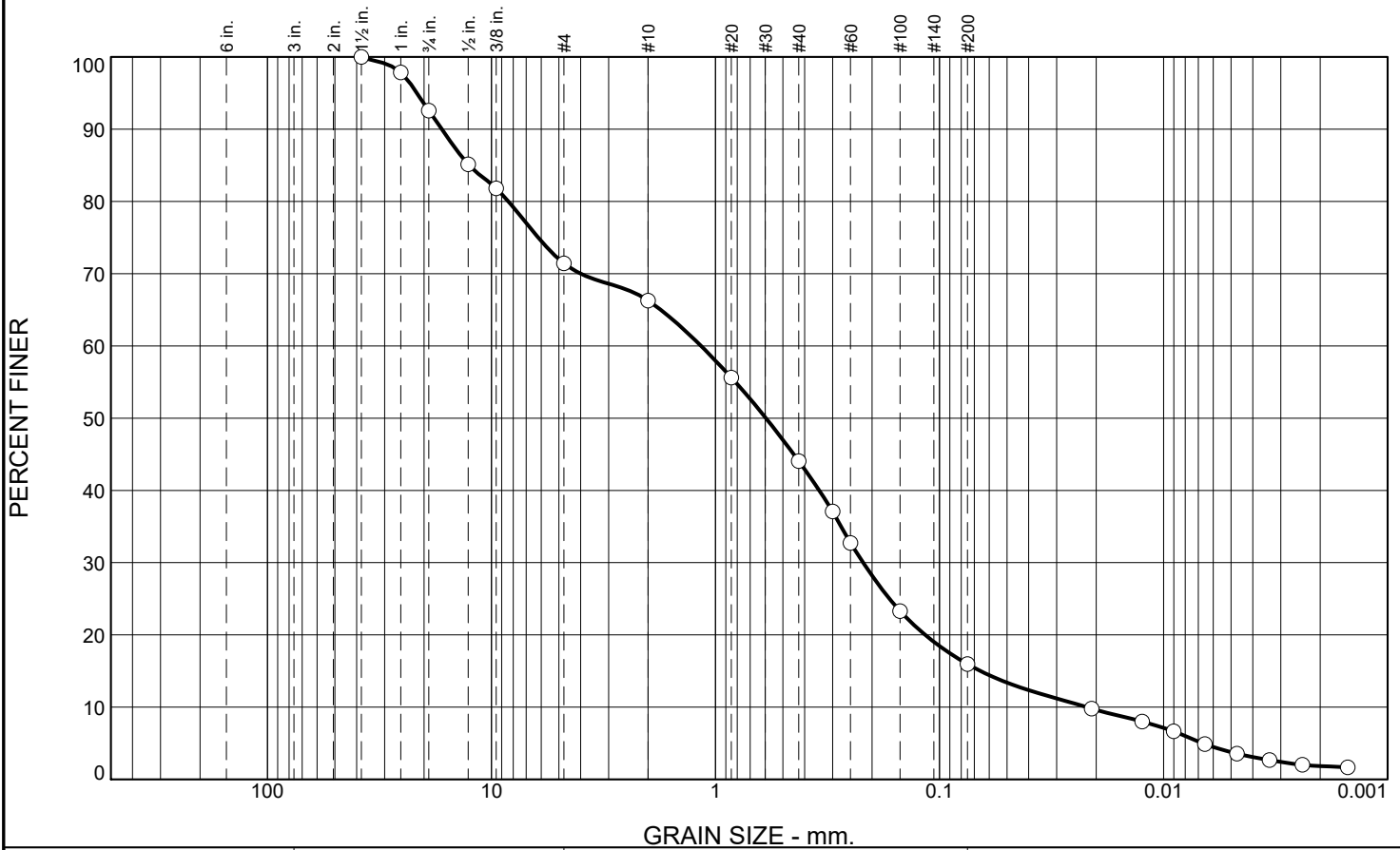
Client: Legacy Engineering  
Project: Legacy Engineering  
Various Projects/Sites  
Project No: 2022.44

BASIN 1 - IMPORTED FILL

Tested By: AK

Checked By: SMM

# Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	7.4	21.2	5.1	22.3	28.0	14.2	1.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5	100.0		
1	97.8		
.75	92.6		
.5	85.1		
.375	81.8		
#4	71.4		
#10	66.3		
#20	55.6		
#40	44.0		
#50	37.1		
#60	32.7		
#100	23.3		
#200	16.0		

\* (no specification provided)

## Material Description

Brown 1.5" max silty sand some gravel  
USDA Textural Classification = Loamy Sand

## Atterberg Limits

PL= NP      LL= NV      PI= NP

## Coefficients

D<sub>85</sub>= 12.5906      D<sub>60</sub>= 1.1609      D<sub>50</sub>= 0.5955  
D<sub>30</sub>= 0.2193      D<sub>15</sub>= 0.0656      D<sub>10</sub>= 0.0220  
C<sub>u</sub>= 52.78      C<sub>c</sub>= 1.88

## Classification

USCS= SM      AASHTO= A-1-b

## Remarks

Sample submitted by client on 06/16/22  
No soil specs provided  
Silty soils = moisture susceptible

Sample No.: L-31525  
Location: Topsoil #1

Source of Sample: Unknown Site

Date: 6/22/22  
Elev./Depth: submitted

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& TESTING, INC.**

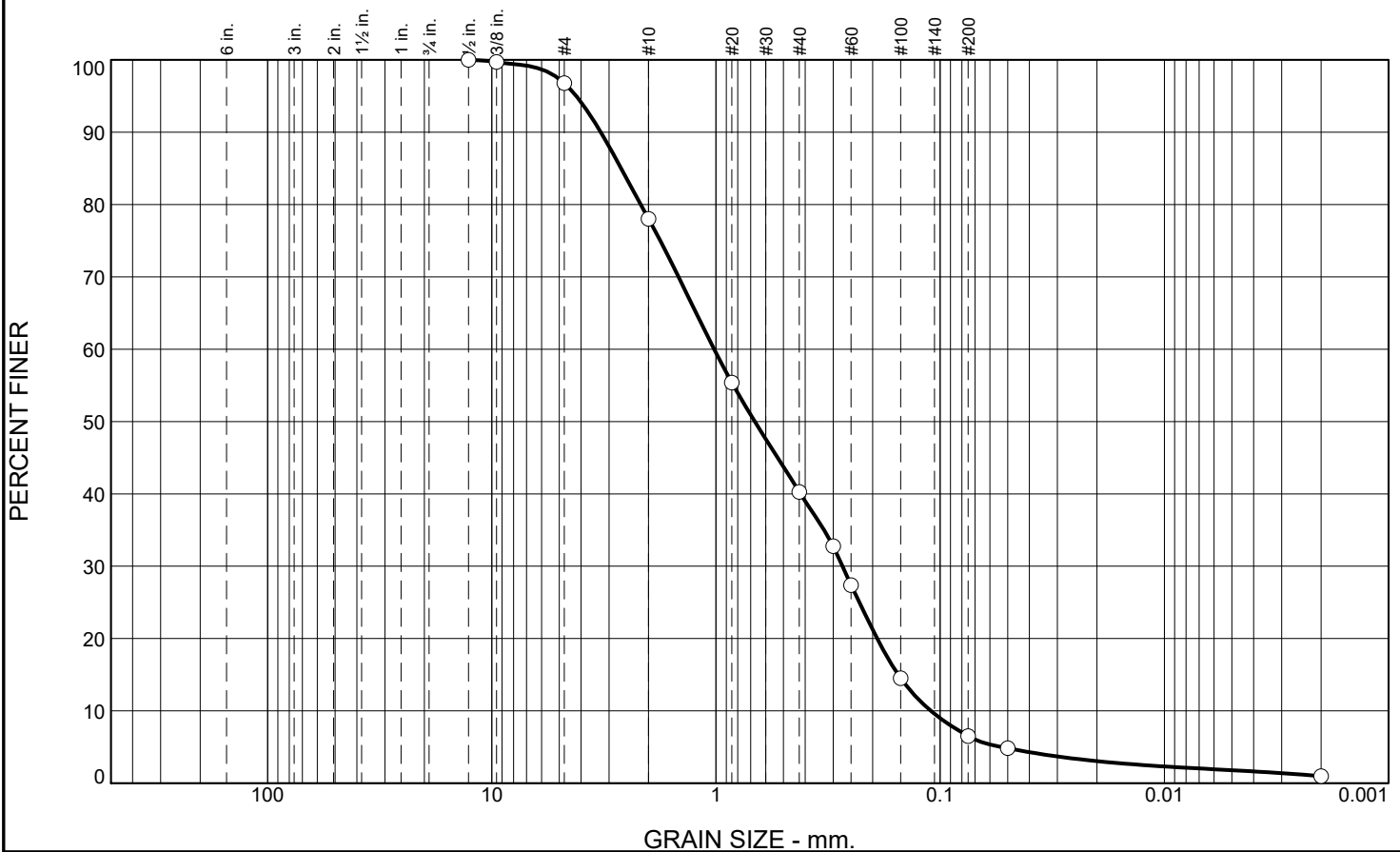
Client: Legacy Engineering  
Project: Legacy Engineering  
Various Projects/Sites  
Project No: 2022.44

BASIN 1 - TOPSOIL

Tested By: AK / AH

Checked By: SMM

# Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	3.2	18.8	37.7	33.8	5.5	1.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.5	100.0		
.375	99.7		
#4	96.8		
#10	78.0		
#20	55.4		
#40	40.3		
#50	32.8		
#60	27.4		
#100	14.5		
#200	6.5		
0.05mm	4.8		
0.002mm	1.0		

\* (no specification provided)

<b>Material Description</b> Brown m/f sand trace silt trace gravel USDA Textural Classification = Sand		
PL= NP  D <sub>85</sub> = 2.6487 D <sub>30</sub> = 0.2728 C <sub>u</sub> = 9.26	<b>Atterberg Limits</b> LL= NV  <b>Coefficients</b> D <sub>60</sub> = 1.0190 D <sub>15</sub> = 0.1540 C <sub>c</sub> = 0.66	PI= NP  D <sub>50</sub> = 0.6714 D <sub>10</sub> = 0.1101
<b>Classification</b> USCS= SP-SM      AASHTO= A-1-b		
<b>Remarks</b> Sample submitted by client on 06/16/22 No soil specs provided		

Sample No.: L-31526  
Location: Basin Fill #2

Source of Sample: Unknown Site

Date: 6/22/22  
Elev./Depth: submitted

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& TESTING, INC.**

Client: Legacy Engineering  
Project: Legacy Engineering  
Various Projects/Sites  
Project No: 2022.44

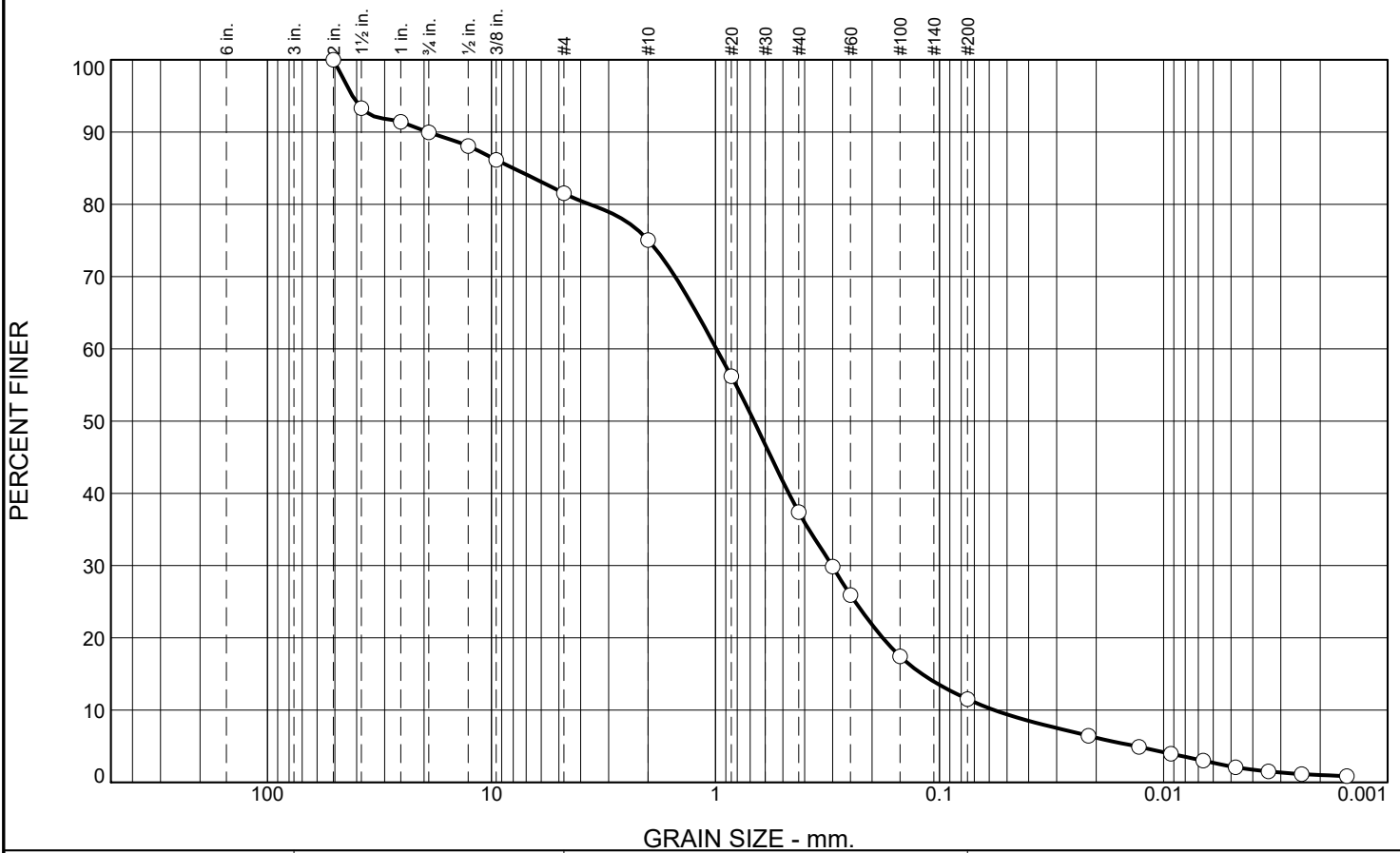
BASIN 2 - IMPORTED FILL

Tested By: AK / AH

Checked By: SMM



# Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	10.0	8.5	6.4	37.7	25.9	10.5	1.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
2	100.0		
1.5	93.3		
1	91.4		
.75	90.0		
.5	88.1		
.375	86.1		
#4	81.5		
#10	75.1		
#20	56.2		
#40	37.4		
#50	29.9		
#60	25.9		
#100	17.4		
#200	11.5		

\* (no specification provided)

<b><u>Material Description</u></b>		
Brown 1.5" max silty m/f sand little gravel USDA Textural Classification = Sand		
<b><u>Atterberg Limits</u></b>		
PL= NP	LL= NV	PI= NP
<b><u>Coefficients</u></b>		
D <sub>85</sub> = 7.9974	D <sub>60</sub> = 0.9909	D <sub>50</sub> = 0.6734
D <sub>30</sub> = 0.3020	D <sub>15</sub> = 0.1198	D <sub>10</sub> = 0.0569
C <sub>u</sub> = 17.41	C <sub>c</sub> = 1.62	
<b><u>Classification</u></b>		
USCS= SW-SM	AASHTO= A-1-b	
<b><u>Remarks</u></b>		
Sample submitted by client on 06/16/22 No soil specs provided		

Sample No.: L-31527  
Location: Topsoil #2

Source of Sample: Unknown Site

Date: 6/22/22  
Elev./Depth: submitted

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& TESTING, INC.**

Client: Legacy Engineering  
Project: Legacy Engineering  
Various Projects/Sites  
Project No: 2022.44

BASIN 2 - TOPSOIL

Tested By: AK / AH

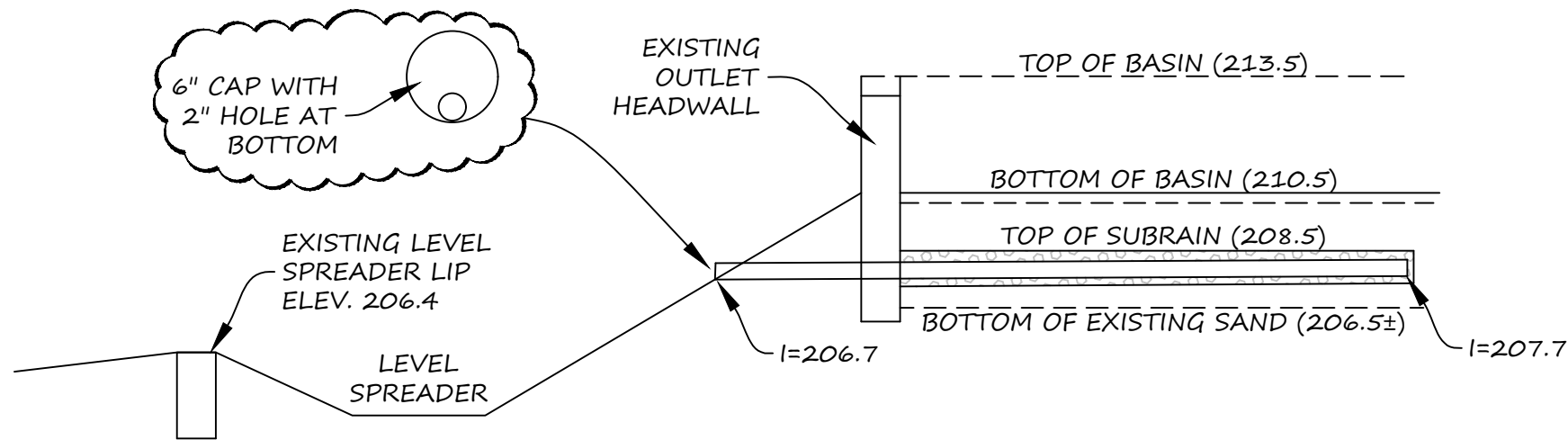
Checked By: SMM



## ATTACHMENT B

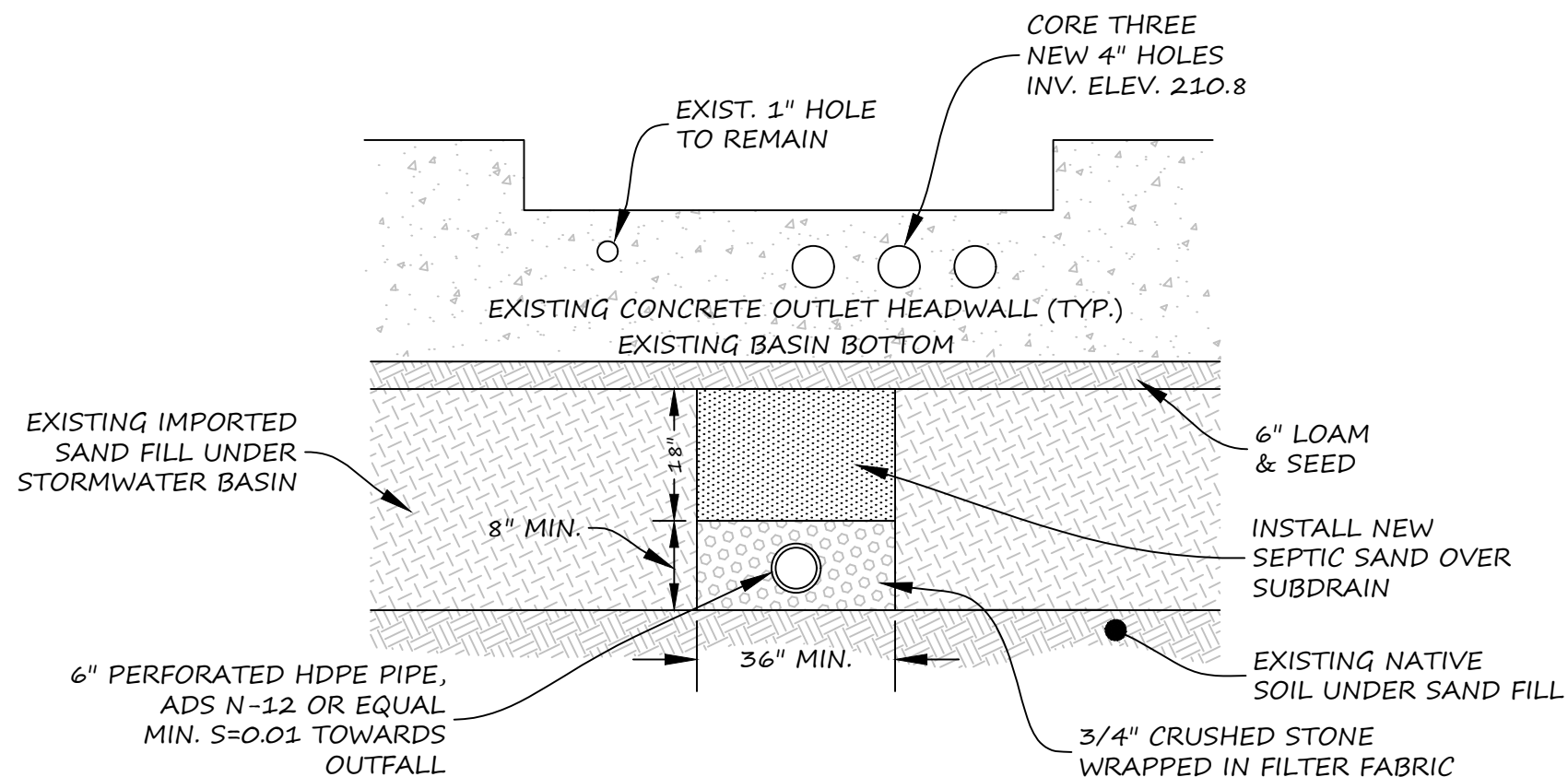
### STORMWATER BASIN #1 DETAILS





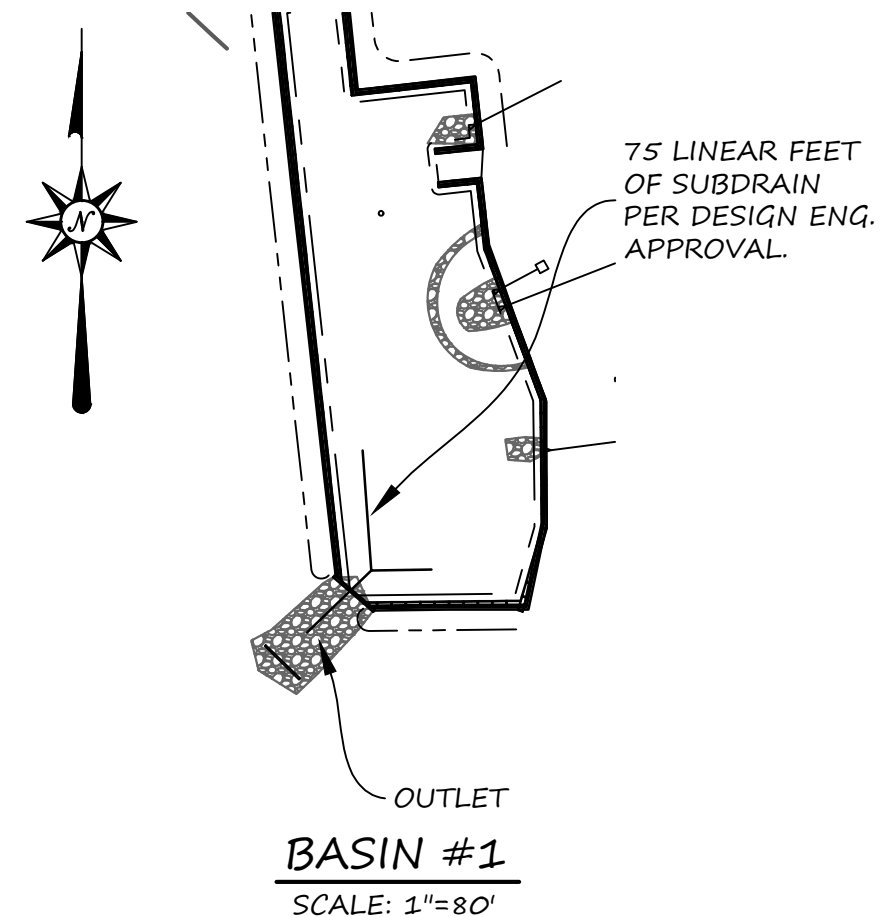
## CROSS-SECTIONAL VIEW

NOT TO SCALE



## BASIN #1 MODIFICATION DETAIL

NOT TO SCALE



PLAN SCALE: AS NOTED



PLAN DATE: JUNE 6, 2023

REVISION	DATE	BY

ACORN PLACE  
STORMWATER BASIN 1  
MODIFICATION  
PLAN OF LAND IN  
MILLIS, MA

730 MAIN STREET  
SUITE 2C  
MILLIS, MA 02054  
508-376-8883(o)

SHEET 1 OF 2



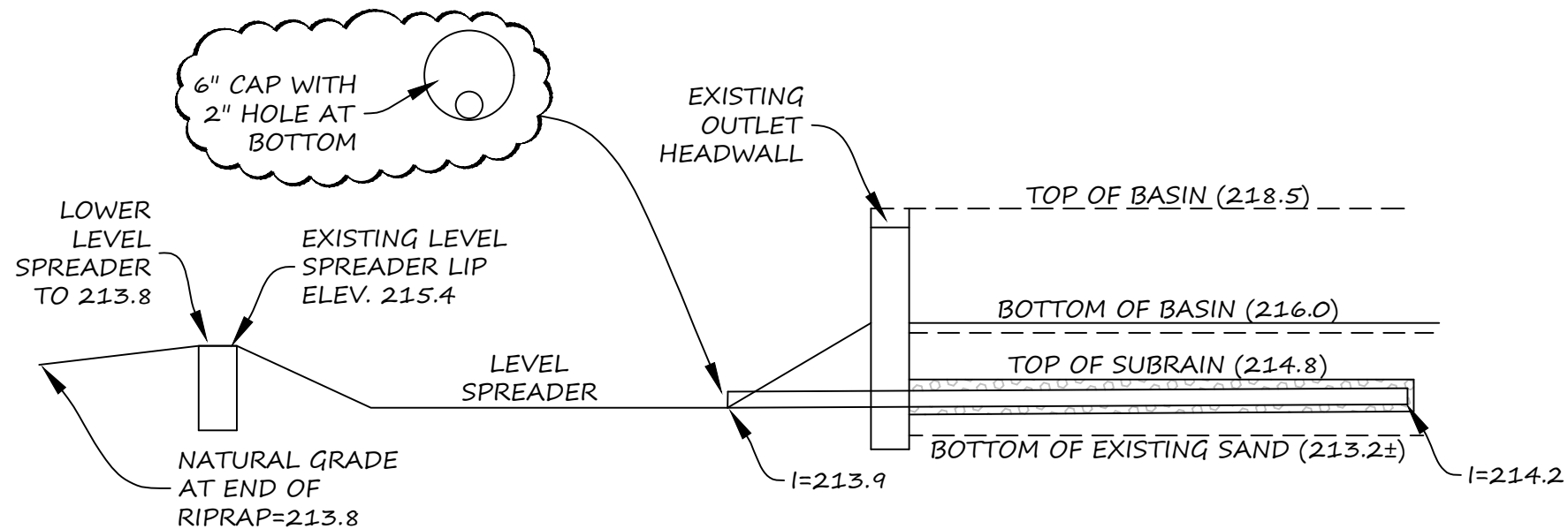
**LEGACY**  
ENGINEERING



## ATTACHMENT C

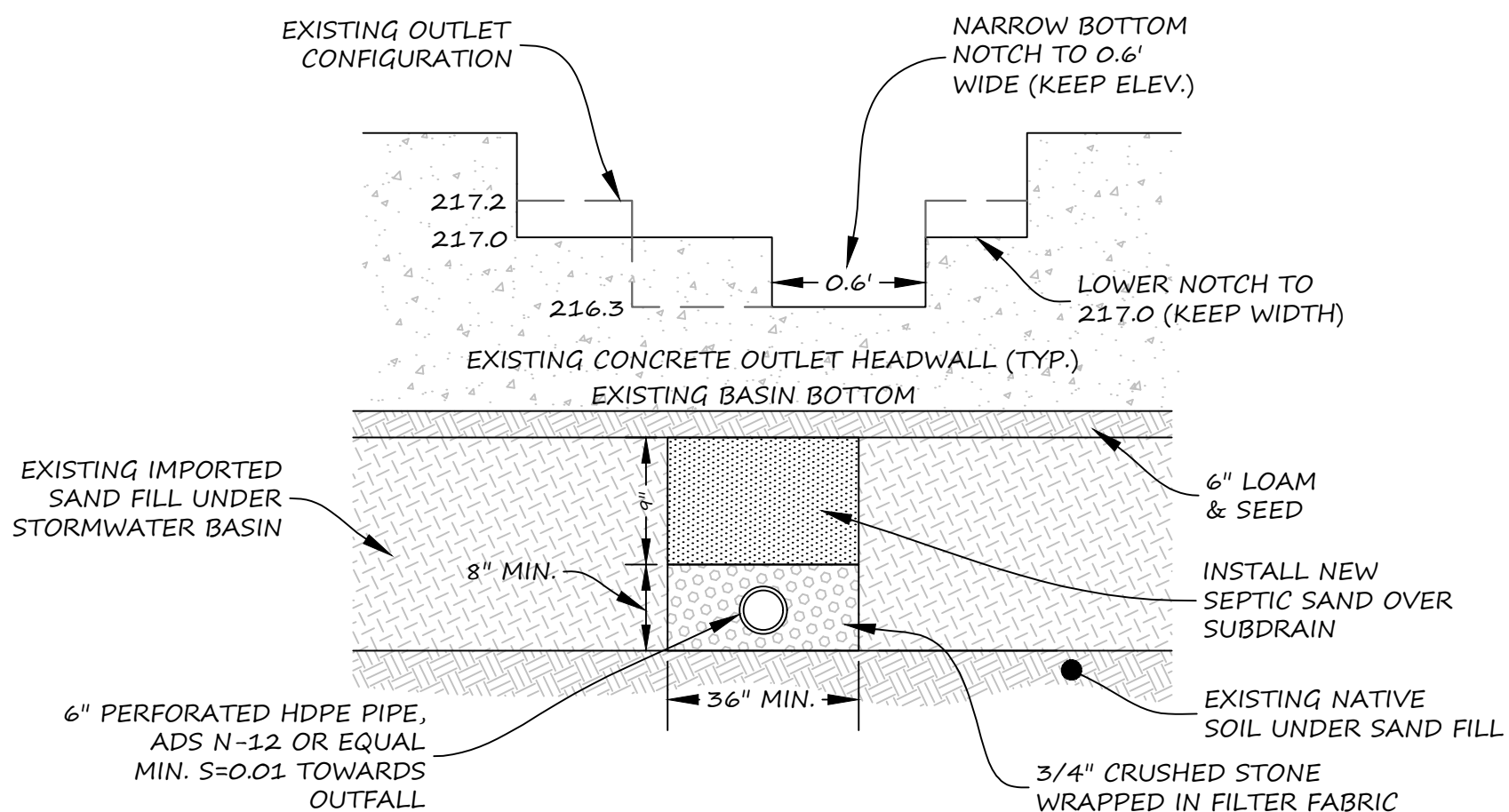
### STORMWATER BASIN #2 DETAILS





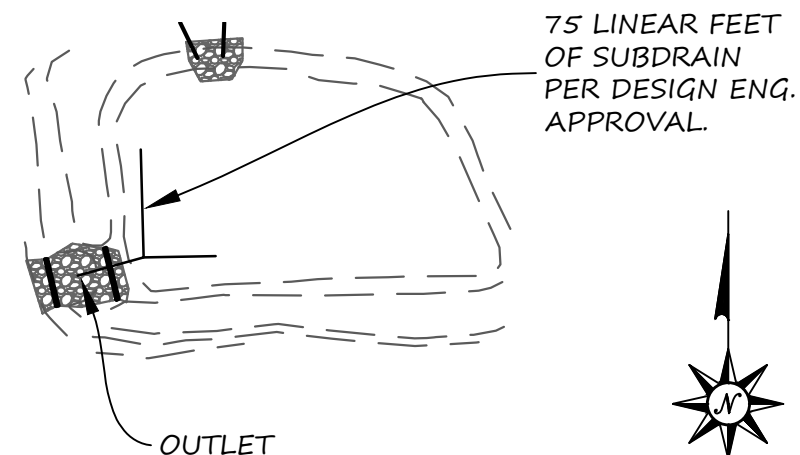
## CROSS-SECTIONAL VIEW

NOT TO SCALE



## BASIN #2 MODIFICATION DETAIL

NOT TO SCALE



## BASIN #2

SCALE: 1"=80'



PLAN SCALE: AS NOTED



PLAN DATE: JUNE 6, 2023

REVISION	DATE	BY

ACORN PLACE  
STORMWATER BASIN 2  
MODIFICATION  
PLAN OF LAND IN  
MILLIS, MA

730 MAIN STREET  
SUITE 2C  
MILLIS, MA 02054  
508-376-8883(o)

SHEET 2 OF 2



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## ATTACHMENT D

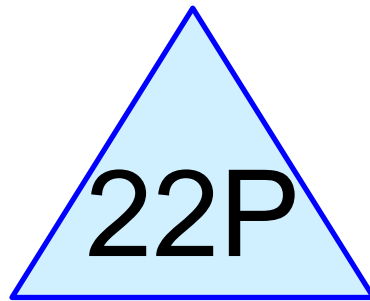
### HYDROCAD RESULTS – NO BASIN INFILTRATION



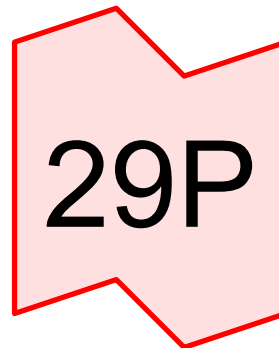
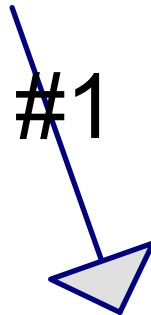


## DESIGN POINT #1 – BASIN 1

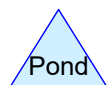
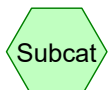




Basin #1



Design Point #1: Flow to  
Shadowfax Farm





## 2023-06-05 Basin Reconfiguration

Type III 24-hr 1-YR Rainfall=2.50"

Prepared by Legacy Engineering LLC

Printed 6/5/2023

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Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 points  
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN  
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

### Pond 22P: Basin #1

Peak Elev=211.25' Storage=13,006 cf Inflow=6.17 cfs 0.536 af  
Outflow=0.77 cfs 0.420 af

### Link 29P: Design Point #1: Flow to Shadowfax Farm

Inflow=1.75 cfs 0.563 af  
Primary=1.75 cfs 0.563 af

**2023-06-05 Basin Reconfiguration**

Type III 24-hr 1-YR Rainfall=2.50"

Prepared by Legacy Engineering LLC

Printed 6/5/2023

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**Summary for Pond 22P: Basin #1**

Inflow Area = 3.658 ac, 77.31% Impervious, Inflow Depth = 1.76" for 1-YR event  
 Inflow = 6.17 cfs @ 12.12 hrs, Volume= 0.536 af  
 Outflow = 0.77 cfs @ 12.92 hrs, Volume= 0.420 af, Atten= 88%, Lag= 47.9 min  
 Primary = 0.77 cfs @ 12.92 hrs, Volume= 0.420 af  
 Routed to Link 29P : Design Point #1: Flow to Shadowfax Farm

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs  
 Peak Elev= 211.25' @ 12.92 hrs Surf.Area= 18,041 sf Storage= 13,006 cf

Plug-Flow detention time= 299.7 min calculated for 0.420 af (78% of inflow)  
 Center-of-Mass det. time= 219.2 min ( 1,018.2 - 799.0 )

Volume	Invert	Avail.Storage	Storage Description		
#1	210.50'	53,991 cf	<b>Custom Stage Data (Irregular)</b> Listed below (Recalc)		
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
210.50	16,003	665.0	0	0	16,003
211.00	18,041	690.0	8,506	8,506	18,720
213.00	18,041	690.0	36,082	44,588	20,100
213.50	19,580	704.0	9,403	53,991	21,692

Device	Routing	Invert	Outlet Devices
#1	Primary	212.32'	<b>Custom Weir/Orifice, Cv= 2.62 (C= 3.28)</b> Elev. (feet) 212.32 213.00 Width (feet) 15.00 15.00
#2	Primary	211.00'	<b>1.0" Vert. Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads
#3	Primary	210.80'	<b>4.0" Vert. Orifice/Grate X 3.00</b> C= 0.600 Limited to weir flow at low heads
#4	Primary	210.50'	<b>2.0" Vert. Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads

**Primary OutFlow** Max=0.77 cfs @ 12.92 hrs HW=211.25' (Free Discharge)

- 1=Custom Weir/Orifice ( Controls 0.00 cfs)
- 2=Orifice/Grate (Orifice Controls 0.01 cfs @ 2.19 fps)
- 3=Orifice/Grate (Orifice Controls 0.67 cfs @ 2.56 fps)
- 4=Orifice/Grate (Orifice Controls 0.09 cfs @ 3.93 fps)

## 2023-06-05 Basin Reconfiguration

Prepared by Legacy Engineering LLC

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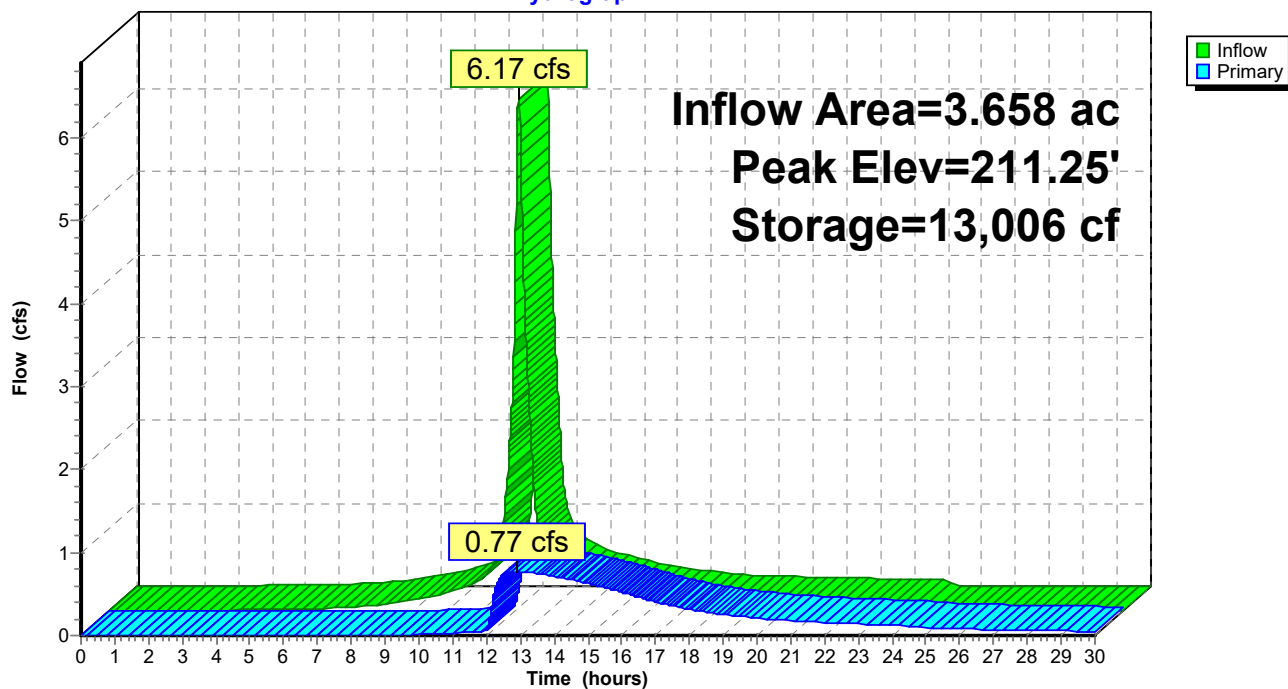
Type III 24-hr 1-YR Rainfall=2.50"

Printed 6/5/2023

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### Pond 22P: Basin #1

Hydrograph

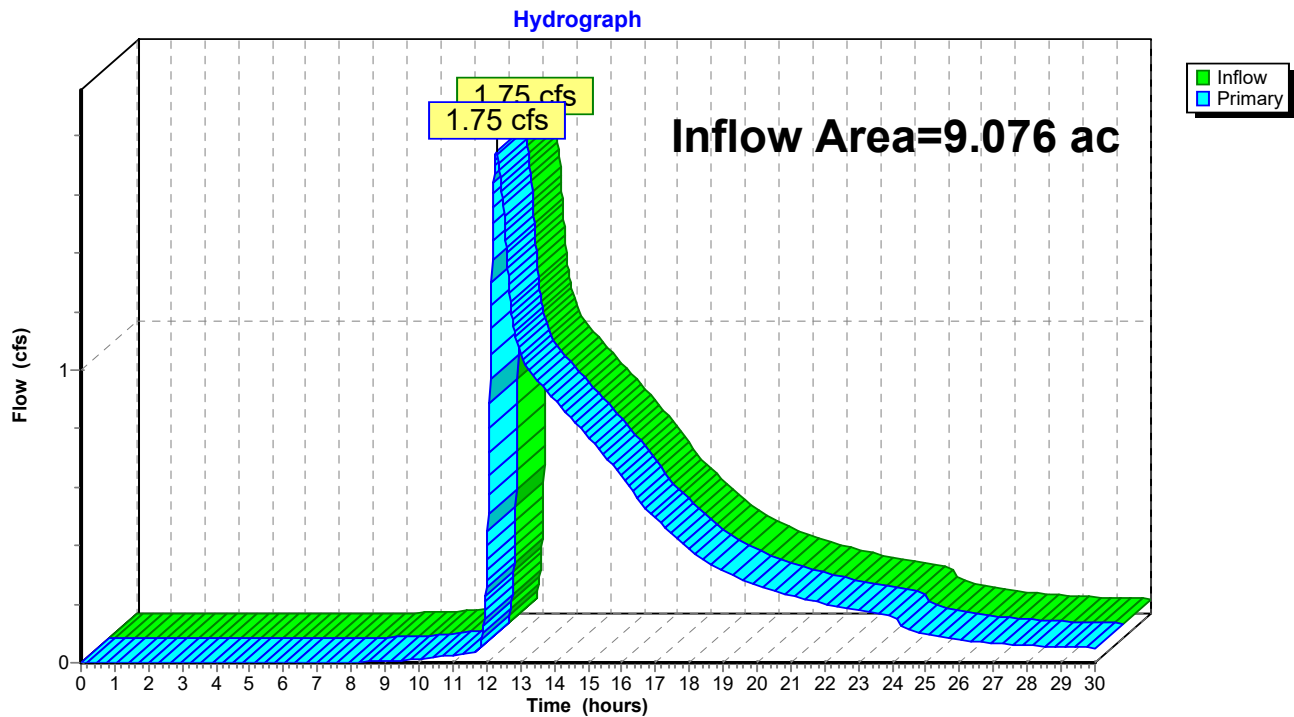


### Summary for Link 29P: Design Point #1: Flow to Shadowfax Farm

Inflow Area = 9.076 ac, 41.50% Impervious, Inflow Depth > 0.74" for 1-YR event  
Inflow = 1.75 cfs @ 12.28 hrs, Volume= 0.563 af  
Primary = 1.75 cfs @ 12.28 hrs, Volume= 0.563 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

### Link 29P: Design Point #1: Flow to Shadowfax Farm



## 2023-06-05 Basin Reconfiguration

Type III 24-hr 2-YR Rainfall=3.20"

Prepared by Legacy Engineering LLC

Printed 6/5/2023

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Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 points  
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN  
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

### Pond 22P: Basin #1

Peak Elev=211.52' Storage=17,857 cf Inflow=8.40 cfs 0.736 af  
Outflow=1.06 cfs 0.616 af

### Link 29P: Design Point #1: Flow to Shadowfax Farm

Inflow=3.27 cfs 0.872 af  
Primary=3.27 cfs 0.872 af

**2023-06-05 Basin Reconfiguration**

Type III 24-hr 2-YR Rainfall=3.20"

Prepared by Legacy Engineering LLC

Printed 6/5/2023

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**Summary for Pond 22P: Basin #1**

Inflow Area = 3.658 ac, 77.31% Impervious, Inflow Depth = 2.42" for 2-YR event  
 Inflow = 8.40 cfs @ 12.12 hrs, Volume= 0.736 af  
 Outflow = 1.06 cfs @ 12.89 hrs, Volume= 0.616 af, Atten= 87%, Lag= 46.0 min  
 Primary = 1.06 cfs @ 12.89 hrs, Volume= 0.616 af  
 Routed to Link 29P : Design Point #1: Flow to Shadowfax Farm

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs  
 Peak Elev= 211.52' @ 12.89 hrs Surf.Area= 18,041 sf Storage= 17,857 cf

Plug-Flow detention time= 283.3 min calculated for 0.616 af (84% of inflow)  
 Center-of-Mass det. time= 215.4 min ( 1,007.0 - 791.6 )

Volume	Invert	Avail.Storage	Storage Description
#1	210.50'	53,991 cf	<b>Custom Stage Data (Irregular)</b> Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
210.50	16,003	665.0	0	0	16,003
211.00	18,041	690.0	8,506	8,506	18,720
213.00	18,041	690.0	36,082	44,588	20,100
213.50	19,580	704.0	9,403	53,991	21,692

Device	Routing	Invert	Outlet Devices
#1	Primary	212.32'	<b>Custom Weir/Orifice, Cv= 2.62 (C= 3.28)</b> Elev. (feet) 212.32 213.00 Width (feet) 15.00 15.00
#2	Primary	211.00'	<b>1.0" Vert. Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads
#3	Primary	210.80'	<b>4.0" Vert. Orifice/Grate X 3.00</b> C= 0.600 Limited to weir flow at low heads
#4	Primary	210.50'	<b>2.0" Vert. Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads

**Primary OutFlow** Max=1.06 cfs @ 12.89 hrs HW=211.52' (Free Discharge)

↑  
 1=Custom Weir/Orifice ( Controls 0.00 cfs)  
 2=Orifice/Grate (Orifice Controls 0.02 cfs @ 3.32 fps)  
 3=Orifice/Grate (Orifice Controls 0.94 cfs @ 3.58 fps)  
 4=Orifice/Grate (Orifice Controls 0.10 cfs @ 4.66 fps)

## 2023-06-05 Basin Reconfiguration

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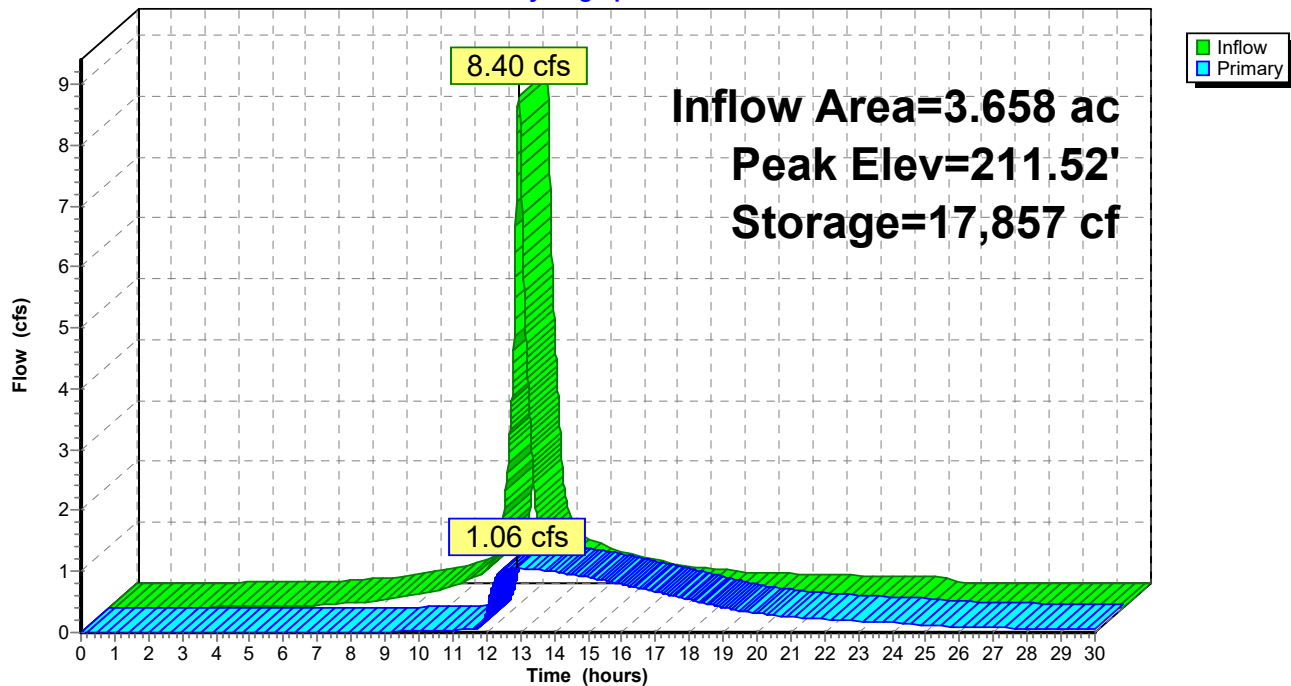
Type III 24-hr 2-YR Rainfall=3.20"

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### Pond 22P: Basin #1

Hydrograph

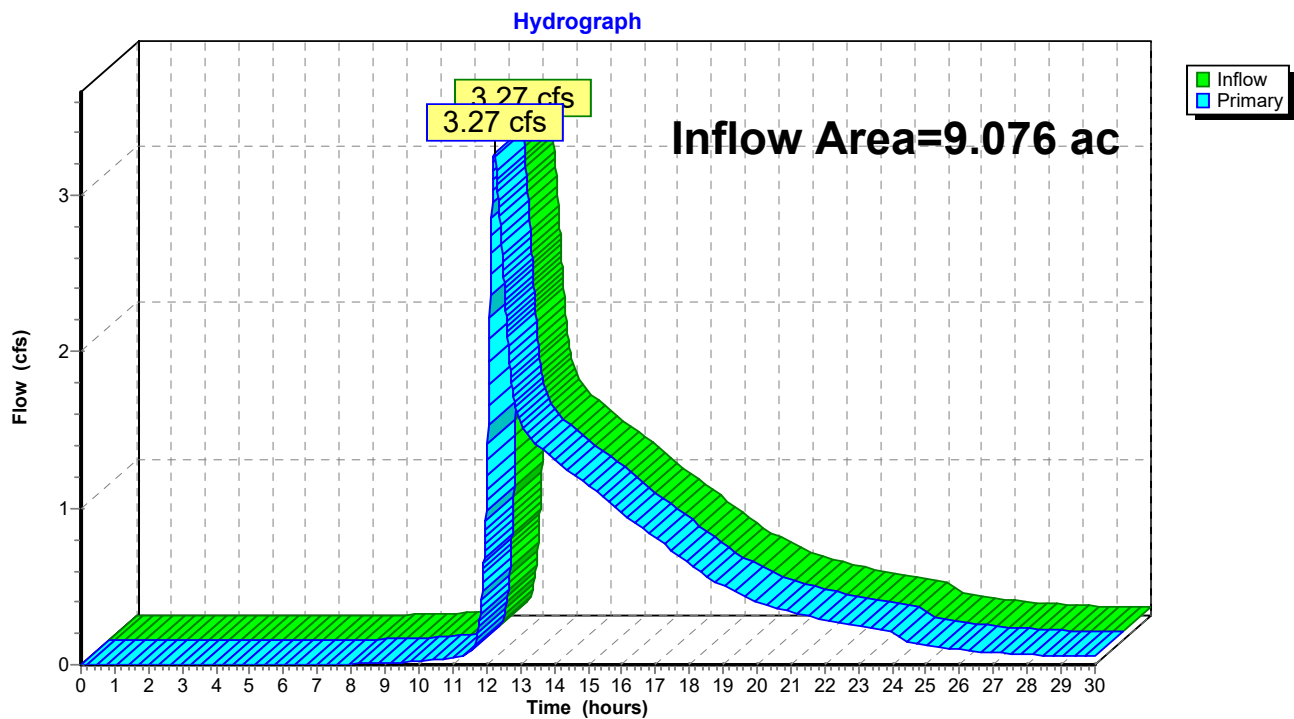


### Summary for Link 29P: Design Point #1: Flow to Shadowfax Farm

Inflow Area = 9.076 ac, 41.50% Impervious, Inflow Depth > 1.15" for 2-YR event  
 Inflow = 3.27 cfs @ 12.23 hrs, Volume= 0.872 af  
 Primary = 3.27 cfs @ 12.23 hrs, Volume= 0.872 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

### Link 29P: Design Point #1: Flow to Shadowfax Farm





## 2023-06-05 Basin Reconfiguration

Type III 24-hr 10-YR Rainfall=4.70"

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Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 points  
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN  
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

### Pond 22P: Basin #1

Peak Elev=212.11' Storage=28,614 cf Inflow=13.20 cfs 1.176 af  
Outflow=1.51 cfs 1.049 af

### Link 29P: Design Point #1: Flow to Shadowfax Farm

Inflow=6.92 cfs 1.601 af  
Primary=6.92 cfs 1.601 af

**2023-06-05 Basin Reconfiguration**

Type III 24-hr 10-YR Rainfall=4.70"

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**Summary for Pond 22P: Basin #1**

Inflow Area = 3.658 ac, 77.31% Impervious, Inflow Depth = 3.86" for 10-YR event  
 Inflow = 13.20 cfs @ 12.12 hrs, Volume= 1.176 af  
 Outflow = 1.51 cfs @ 12.95 hrs, Volume= 1.049 af, Atten= 89%, Lag= 49.9 min  
 Primary = 1.51 cfs @ 12.95 hrs, Volume= 1.049 af  
 Routed to Link 29P : Design Point #1: Flow to Shadowfax Farm

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs  
 Peak Elev= 212.11' @ 12.95 hrs Surf.Area= 18,041 sf Storage= 28,614 cf

Plug-Flow detention time= 286.0 min calculated for 1.049 af (89% of inflow)  
 Center-of-Mass det. time= 234.1 min ( 1,015.0 - 780.9 )

Volume	Invert	Avail.Storage	Storage Description		
#1	210.50'	53,991 cf	<b>Custom Stage Data (Irregular)</b> Listed below (Recalc)		
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
210.50	16,003	665.0	0	0	16,003
211.00	18,041	690.0	8,506	8,506	18,720
213.00	18,041	690.0	36,082	44,588	20,100
213.50	19,580	704.0	9,403	53,991	21,692

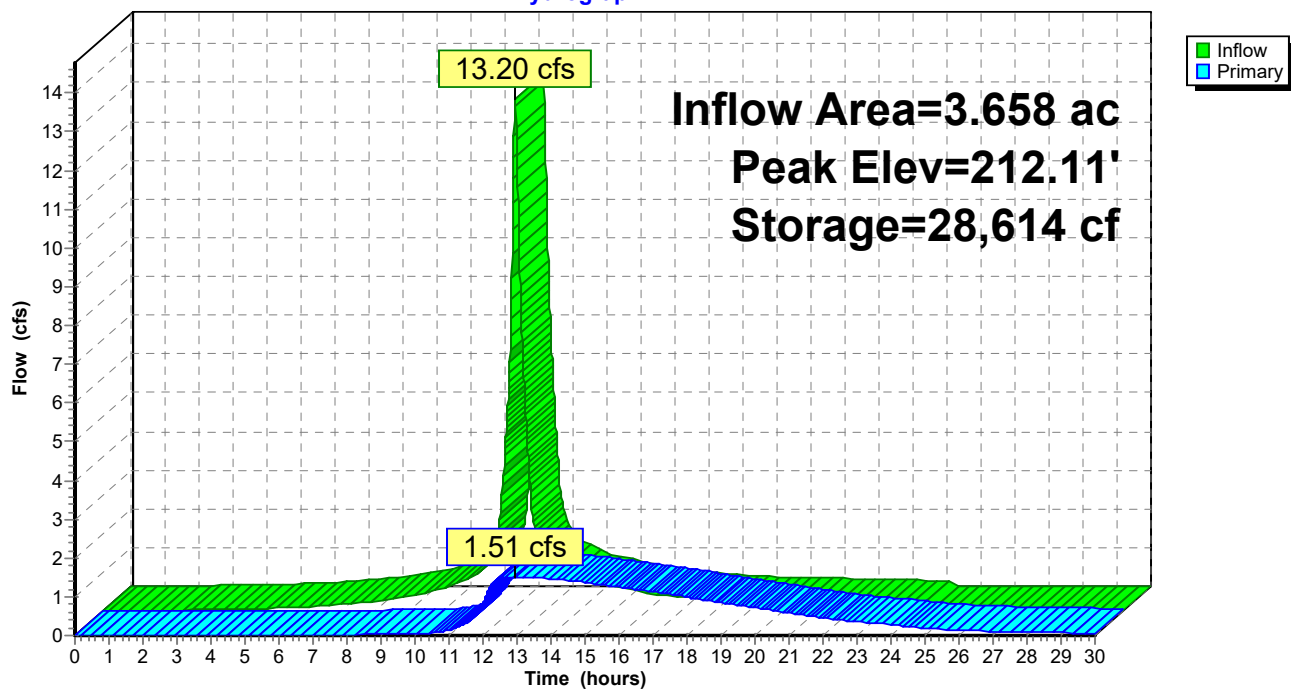
Device	Routing	Invert	Outlet Devices
#1	Primary	212.32'	<b>Custom Weir/Orifice, Cv= 2.62 (C= 3.28)</b> Elev. (feet) 212.32 213.00 Width (feet) 15.00 15.00
#2	Primary	211.00'	<b>1.0" Vert. Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads
#3	Primary	210.80'	<b>4.0" Vert. Orifice/Grate X 3.00</b> C= 0.600 Limited to weir flow at low heads
#4	Primary	210.50'	<b>2.0" Vert. Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads

**Primary OutFlow** Max=1.51 cfs @ 12.95 hrs HW=212.11' (Free Discharge)

- 1=Custom Weir/Orifice ( Controls 0.00 cfs)
- 2=Orifice/Grate (Orifice Controls 0.03 cfs @ 4.99 fps)
- 3=Orifice/Grate (Orifice Controls 1.35 cfs @ 5.16 fps)
- 4=Orifice/Grate (Orifice Controls 0.13 cfs @ 5.96 fps)

Pond 22P: Basin #1

Hydrograph



## 2023-06-05 Basin Reconfiguration

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Type III 24-hr 10-YR Rainfall=4.70"

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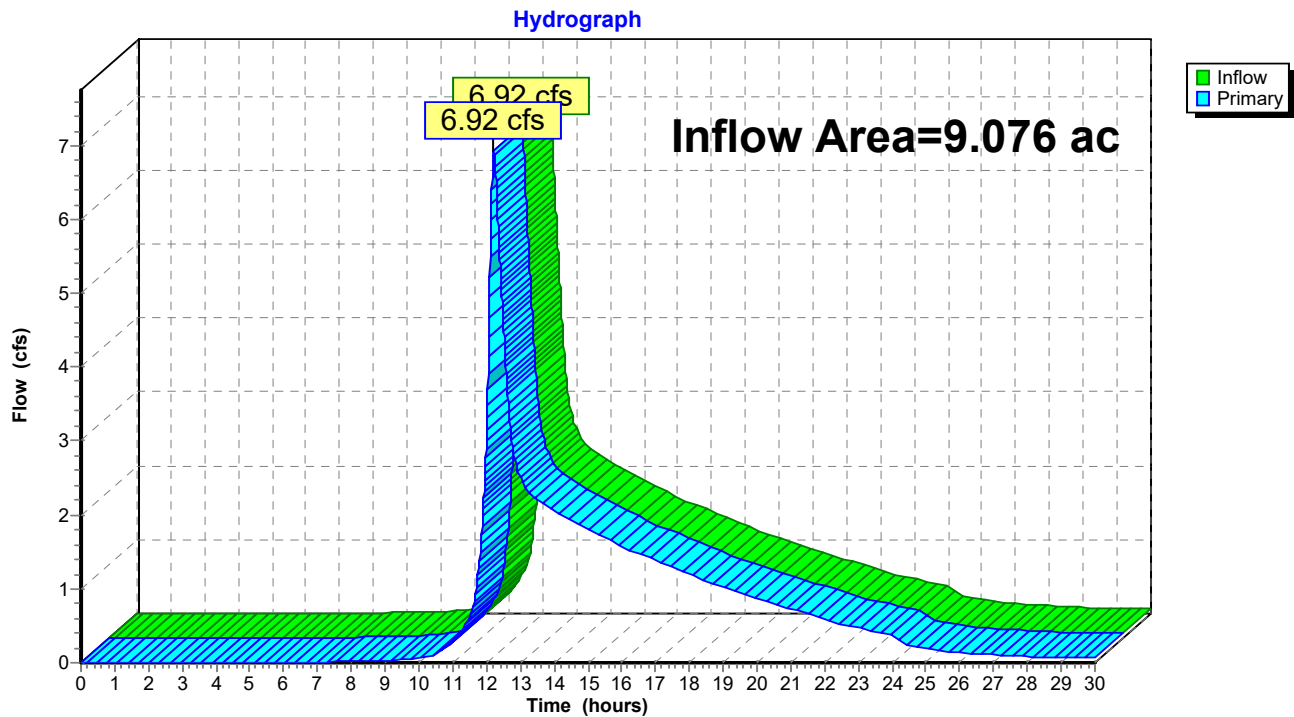
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### Summary for Link 29P: Design Point #1: Flow to Shadowfax Farm

Inflow Area = 9.076 ac, 41.50% Impervious, Inflow Depth > 2.12" for 10-YR event  
Inflow = 6.92 cfs @ 12.21 hrs, Volume= 1.601 af  
Primary = 6.92 cfs @ 12.21 hrs, Volume= 1.601 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

### Link 29P: Design Point #1: Flow to Shadowfax Farm



## 2023-06-05 Basin Reconfiguration

Type III 24-hr 50-YR Rainfall=6.10"

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Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 points  
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN  
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

### Pond 22P: Basin #1

Peak Elev=212.49' Storage=35,314 cf Inflow=17.65 cfs 1.594 af  
Outflow=5.06 cfs 1.462 af

### Link 29P: Design Point #1: Flow to Shadowfax Farm

Inflow=10.66 cfs 2.364 af  
Primary=10.66 cfs 2.364 af

**2023-06-05 Basin Reconfiguration**

Type III 24-hr 50-YR Rainfall=6.10"

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**Summary for Pond 22P: Basin #1**

Inflow Area = 3.658 ac, 77.31% Impervious, Inflow Depth = 5.23" for 50-YR event  
 Inflow = 17.65 cfs @ 12.12 hrs, Volume= 1.594 af  
 Outflow = 5.06 cfs @ 12.52 hrs, Volume= 1.462 af, Atten= 71%, Lag= 24.0 min  
 Primary = 5.06 cfs @ 12.52 hrs, Volume= 1.462 af  
 Routed to Link 29P : Design Point #1: Flow to Shadowfax Farm

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs  
 Peak Elev= 212.49' @ 12.52 hrs Surf.Area= 18,041 sf Storage= 35,314 cf

Plug-Flow detention time= 264.5 min calculated for 1.461 af (92% of inflow)  
 Center-of-Mass det. time= 221.8 min ( 995.9 - 774.2 )

Volume	Invert	Avail.Storage	Storage Description		
#1	210.50'	53,991 cf	<b>Custom Stage Data (Irregular)</b> Listed below (Recalc)		
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
210.50	16,003	665.0	0	0	16,003
211.00	18,041	690.0	8,506	8,506	18,720
213.00	18,041	690.0	36,082	44,588	20,100
213.50	19,580	704.0	9,403	53,991	21,692

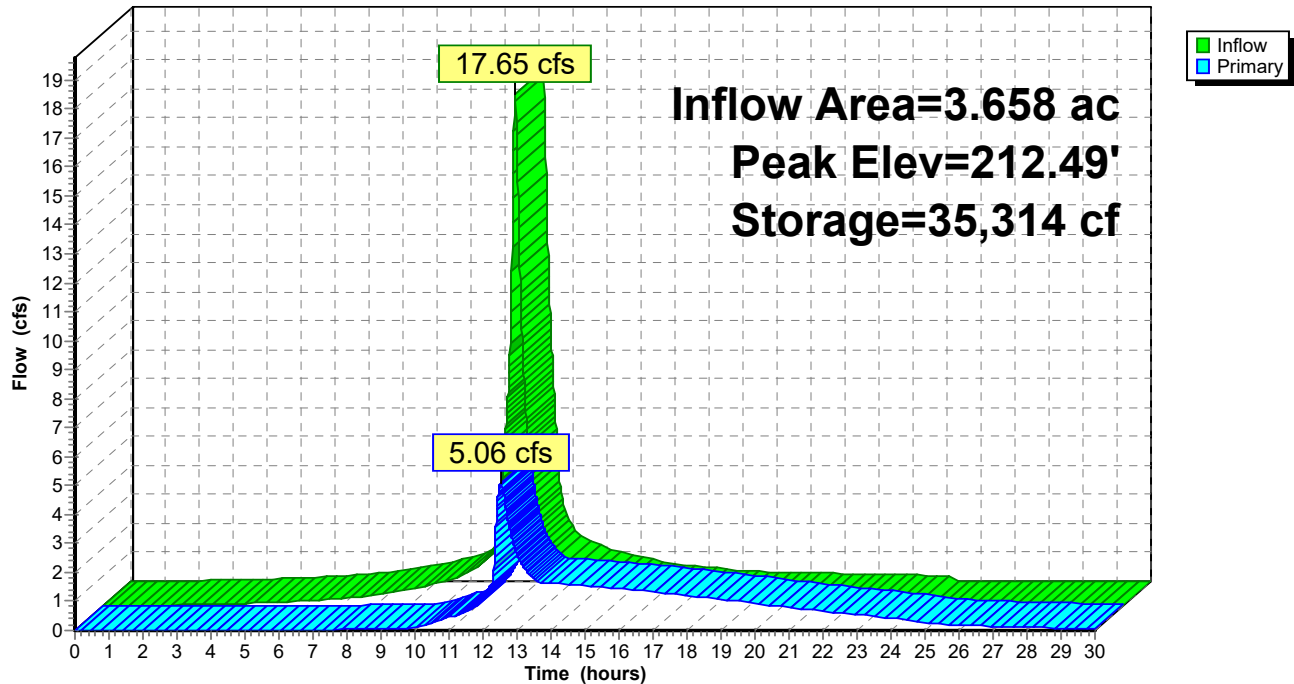
Device	Routing	Invert	Outlet Devices
#1	Primary	212.32'	<b>Custom Weir/Orifice, Cv= 2.62 (C= 3.28)</b> Elev. (feet) 212.32 213.00 Width (feet) 15.00 15.00
#2	Primary	211.00'	<b>1.0" Vert. Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads
#3	Primary	210.80'	<b>4.0" Vert. Orifice/Grate X 3.00</b> C= 0.600 Limited to weir flow at low heads
#4	Primary	210.50'	<b>2.0" Vert. Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads

**Primary OutFlow** Max=5.05 cfs @ 12.52 hrs HW=212.49' (Free Discharge)

- 1=Custom Weir/Orifice (Weir Controls 3.32 cfs @ 1.33 fps)
- 2=Orifice/Grate (Orifice Controls 0.03 cfs @ 5.79 fps)
- 3=Orifice/Grate (Orifice Controls 1.55 cfs @ 5.93 fps)
- 4=Orifice/Grate (Orifice Controls 0.14 cfs @ 6.64 fps)

Pond 22P: Basin #1

Hydrograph



## 2023-06-05 Basin Reconfiguration

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Type III 24-hr 50-YR Rainfall=6.10"

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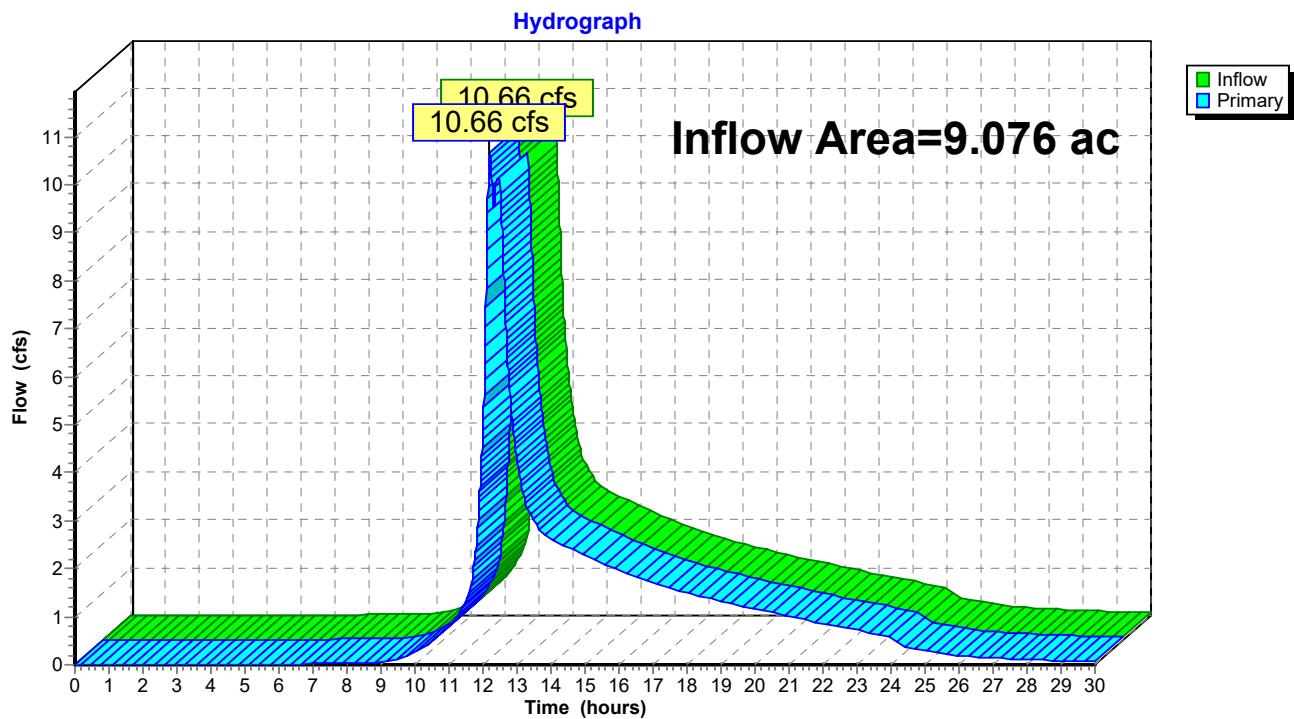
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### Summary for Link 29P: Design Point #1: Flow to Shadowfax Farm

Inflow Area = 9.076 ac, 41.50% Impervious, Inflow Depth > 3.13" for 50-YR event  
Inflow = 10.66 cfs @ 12.20 hrs, Volume= 2.364 af  
Primary = 10.66 cfs @ 12.20 hrs, Volume= 2.364 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

### Link 29P: Design Point #1: Flow to Shadowfax Farm





## 2023-06-05 Basin Reconfiguration

Type III 24-hr 100-YR Rainfall=6.70"

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Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 points  
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN  
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

### Pond 22P: Basin #1

Peak Elev=212.56' Storage=36,629 cf Inflow=19.55 cfs 1.774 af  
Outflow=7.51 cfs 1.640 af

### Link 29P: Design Point #1: Flow to Shadowfax Farm

Inflow=14.83 cfs 2.719 af  
Primary=14.83 cfs 2.719 af

**2023-06-05 Basin Reconfiguration**

Type III 24-hr 100-YR Rainfall=6.70"

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**Summary for Pond 22P: Basin #1**

Inflow Area = 3.658 ac, 77.31% Impervious, Inflow Depth = 5.82" for 100-YR event  
 Inflow = 19.55 cfs @ 12.12 hrs, Volume= 1.774 af  
 Outflow = 7.51 cfs @ 12.44 hrs, Volume= 1.640 af, Atten= 62%, Lag= 18.8 min  
 Primary = 7.51 cfs @ 12.44 hrs, Volume= 1.640 af  
 Routed to Link 29P : Design Point #1: Flow to Shadowfax Farm

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs  
 Peak Elev= 212.56' @ 12.44 hrs Surf.Area= 18,041 sf Storage= 36,629 cf

Plug-Flow detention time= 248.7 min calculated for 1.640 af (92% of inflow)  
 Center-of-Mass det. time= 208.9 min ( 980.8 - 771.9 )

Volume	Invert	Avail.Storage	Storage Description		
#1	210.50'	53,991 cf	<b>Custom Stage Data (Irregular)</b> Listed below (Recalc)		
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
210.50	16,003	665.0	0	0	16,003
211.00	18,041	690.0	8,506	8,506	18,720
213.00	18,041	690.0	36,082	44,588	20,100
213.50	19,580	704.0	9,403	53,991	21,692

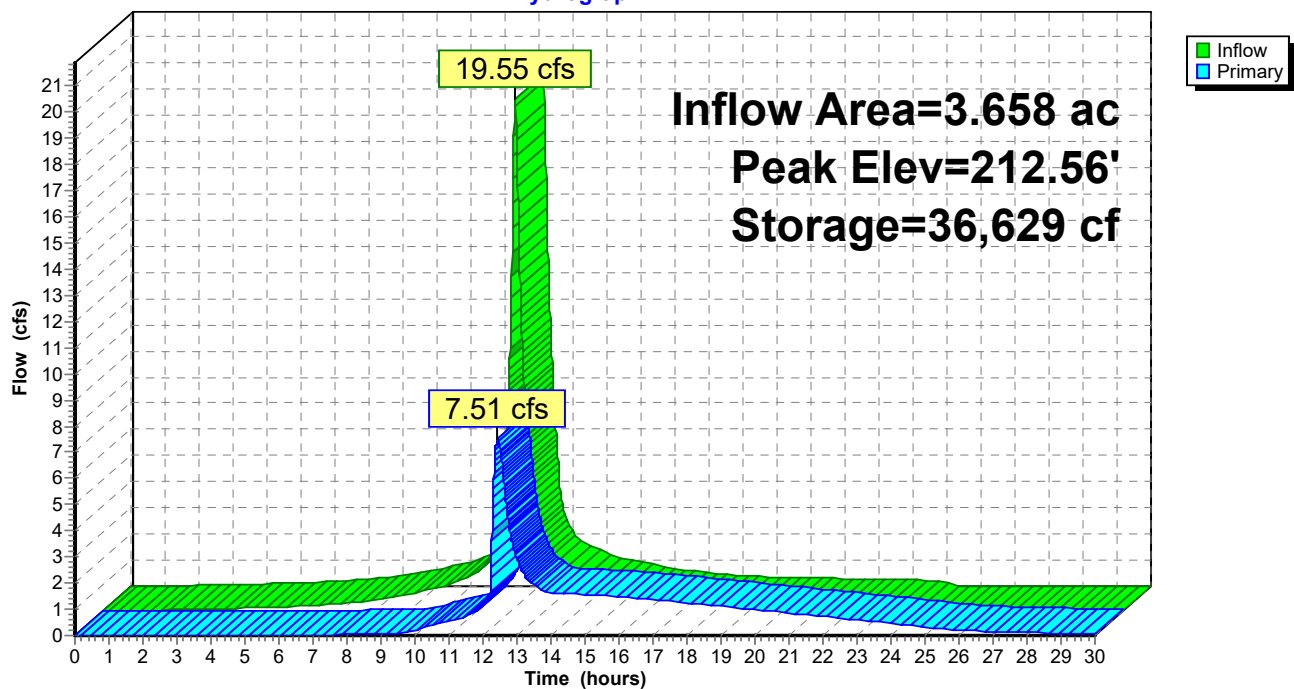
Device	Routing	Invert	Outlet Devices
#1	Primary	212.32'	<b>Custom Weir/Orifice, Cv= 2.62 (C= 3.28)</b> Elev. (feet) 212.32 213.00 Width (feet) 15.00 15.00
#2	Primary	211.00'	<b>1.0" Vert. Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads
#3	Primary	210.80'	<b>4.0" Vert. Orifice/Grate X 3.00</b> C= 0.600 Limited to weir flow at low heads
#4	Primary	210.50'	<b>2.0" Vert. Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads

**Primary OutFlow** Max=7.50 cfs @ 12.44 hrs HW=212.56' (Free Discharge)

- 1=Custom Weir/Orifice (Weir Controls 5.73 cfs @ 1.60 fps)
- 2=Orifice/Grate (Orifice Controls 0.03 cfs @ 5.93 fps)
- 3=Orifice/Grate (Orifice Controls 1.59 cfs @ 6.08 fps)
- 4=Orifice/Grate (Orifice Controls 0.15 cfs @ 6.77 fps)

Pond 22P: Basin #1

Hydrograph



## 2023-06-05 Basin Reconfiguration

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Type III 24-hr 100-YR Rainfall=6.70"

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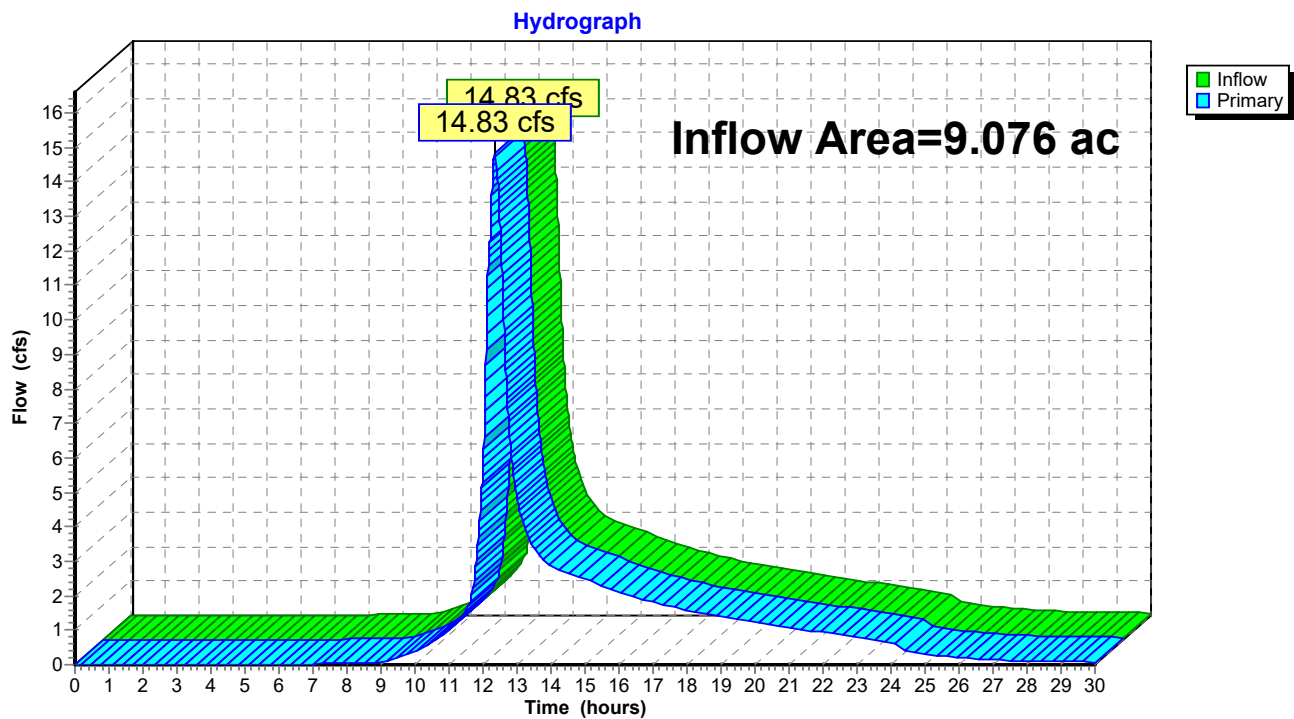
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### Summary for Link 29P: Design Point #1: Flow to Shadowfax Farm

Inflow Area = 9.076 ac, 41.50% Impervious, Inflow Depth > 3.59" for 100-YR event  
Inflow = 14.83 cfs @ 12.36 hrs, Volume= 2.719 af  
Primary = 14.83 cfs @ 12.36 hrs, Volume= 2.719 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

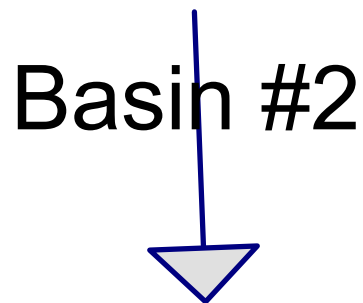
### Link 29P: Design Point #1: Flow to Shadowfax Farm



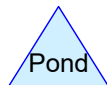
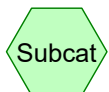


## DESIGN POINT #2 – BASIN 2





Design Point #2: Flow to  
Southern Abutters



## 2023-06-05 Basin Reconfiguration

Type III 24-hr 1-YR Rainfall=2.50"

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Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 points  
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN  
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

### Pond 43P: Basin #2

Peak Elev=216.66' Storage=8,517 cf Inflow=3.40 cfs 0.356 af  
Outflow=0.51 cfs 0.278 af

### Link 44P: Design Point #2: Flow to Southern Abutters

Inflow=3.20 cfs 0.706 af  
Primary=3.20 cfs 0.706 af

**2023-06-05 Basin Reconfiguration**

Type III 24-hr 1-YR Rainfall=2.50"

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**Summary for Pond 43P: Basin #2**

Inflow Area = 2.747 ac, 65.33% Impervious, Inflow Depth = 1.56" for 1-YR event  
 Inflow = 3.40 cfs @ 12.16 hrs, Volume= 0.356 af  
 Outflow = 0.51 cfs @ 13.00 hrs, Volume= 0.278 af, Atten= 85%, Lag= 50.4 min  
 Primary = 0.51 cfs @ 13.00 hrs, Volume= 0.278 af  
 Routed to Link 44P : Design Point #2: Flow to Southern Abutters

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs  
 Peak Elev= 216.66' @ 13.00 hrs Surf.Area= 13,509 sf Storage= 8,517 cf

Plug-Flow detention time= 318.1 min calculated for 0.278 af (78% of inflow)  
 Center-of-Mass det. time= 235.6 min ( 1,042.3 - 806.7 )

Volume	Invert	Avail.Storage	Storage Description
#1	216.00'	36,749 cf	<b>Custom Stage Data (Irregular)</b> Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
216.00	12,268	457.0	0	0	12,268
218.50	17,274	522.0	36,749	36,749	17,478

Device	Routing	Invert	Outlet Devices
#1	Primary	216.30'	<b>Custom Weir/Orifice, Cv= 2.62 (C= 3.28)</b> Elev. (feet) 216.30 217.00 217.00 218.00 Width (feet) 0.60 0.60 2.00 2.00
#2	Primary	216.00'	<b>2.0" Vert. Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads

**Primary OutFlow** Max=0.51 cfs @ 13.00 hrs HW=216.66' (Free Discharge)

↑ **1=Custom Weir/Orifice** (Weir Controls 0.43 cfs @ 1.97 fps)  
 ↓ **2=Orifice/Grate** (Orifice Controls 0.08 cfs @ 3.66 fps)



## 2023-06-05 Basin Reconfiguration

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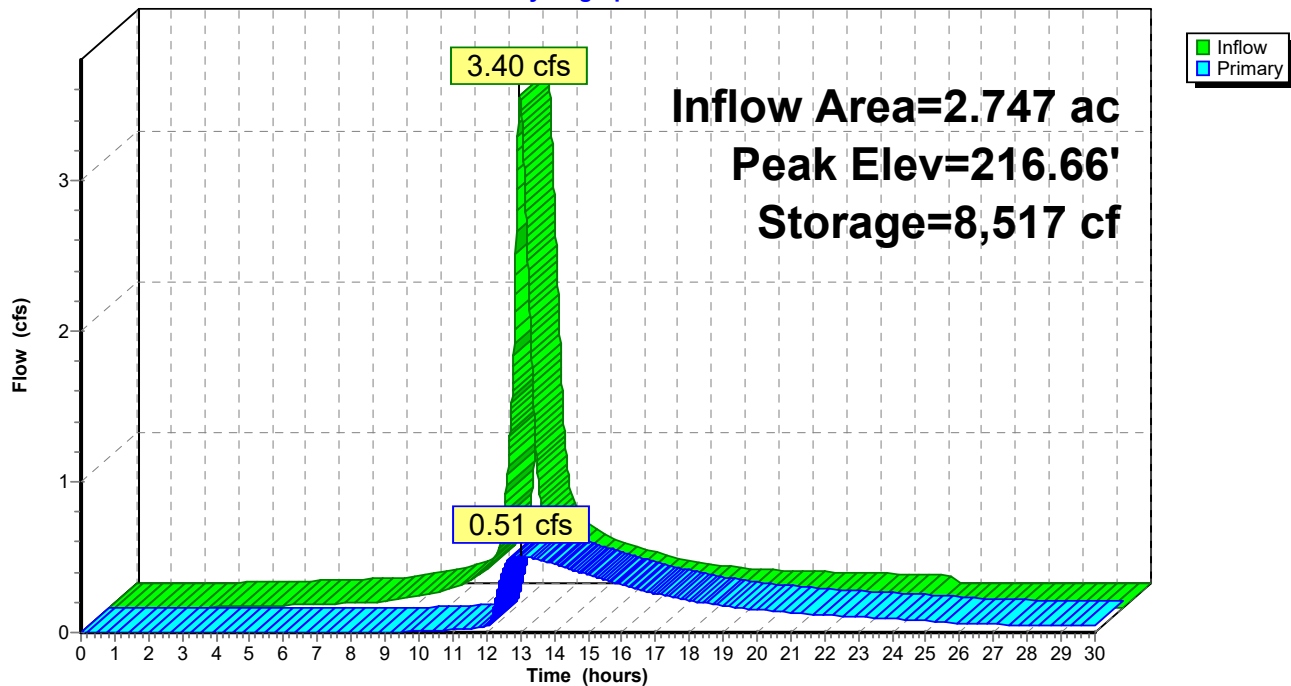
Type III 24-hr 1-YR Rainfall=2.50"

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### Pond 43P: Basin #2

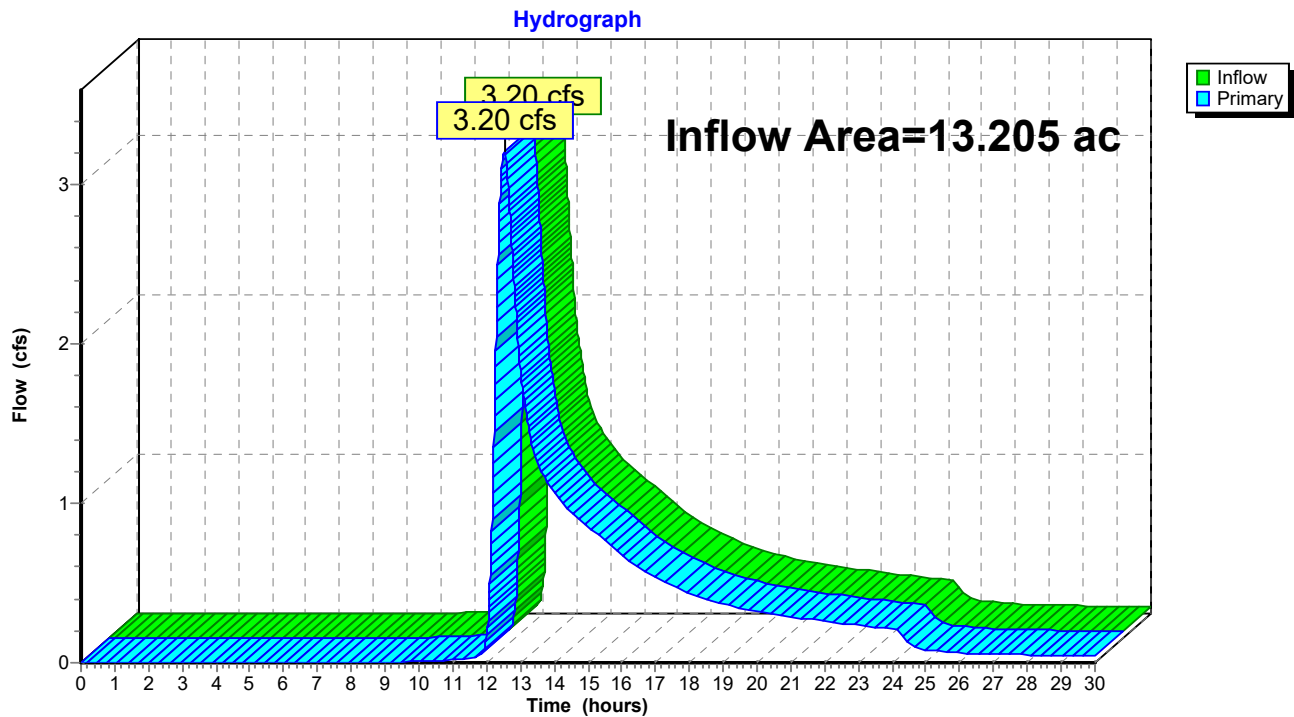
Hydrograph



**Summary for Link 44P: Design Point #2: Flow to Southern Abutters**

Inflow Area = 13.205 ac, 13.59% Impervious, Inflow Depth > 0.64" for 1-YR event  
Inflow = 3.20 cfs @ 12.53 hrs, Volume= 0.706 af  
Primary = 3.20 cfs @ 12.53 hrs, Volume= 0.706 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

**Link 44P: Design Point #2: Flow to Southern Abutters**

## 2023-06-05 Basin Reconfiguration

Type III 24-hr 2-YR Rainfall=3.20"

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Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 points  
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN  
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

### Pond 43P: Basin #2

Peak Elev=216.88' Storage=11,457 cf Inflow=4.74 cfs 0.499 af  
Outflow=0.95 cfs 0.417 af

### Link 44P: Design Point #2: Flow to Southern Abutters

Inflow=6.40 cfs 1.182 af  
Primary=6.40 cfs 1.182 af

**2023-06-05 Basin Reconfiguration**

Type III 24-hr 2-YR Rainfall=3.20"

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**Summary for Pond 43P: Basin #2**

Inflow Area = 2.747 ac, 65.33% Impervious, Inflow Depth = 2.18" for 2-YR event  
 Inflow = 4.74 cfs @ 12.16 hrs, Volume= 0.499 af  
 Outflow = 0.95 cfs @ 12.78 hrs, Volume= 0.417 af, Atten= 80%, Lag= 37.5 min  
 Primary = 0.95 cfs @ 12.78 hrs, Volume= 0.417 af  
 Routed to Link 44P : Design Point #2: Flow to Southern Abutters

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs  
 Peak Elev= 216.88' @ 12.78 hrs Surf.Area= 13,924 sf Storage= 11,457 cf

Plug-Flow detention time= 271.4 min calculated for 0.417 af (84% of inflow)  
 Center-of-Mass det. time= 202.7 min ( 1,003.0 - 800.3 )

Volume	Invert	Avail.Storage	Storage Description
#1	216.00'	36,749 cf	<b>Custom Stage Data (Irregular)</b> Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
216.00	12,268	457.0	0	0	12,268
218.50	17,274	522.0	36,749	36,749	17,478

Device	Routing	Invert	Outlet Devices
#1	Primary	216.30'	<b>Custom Weir/Orifice, Cv= 2.62 (C= 3.28)</b> Elev. (feet) 216.30 217.00 217.00 218.00 Width (feet) 0.60 0.60 2.00 2.00
#2	Primary	216.00'	<b>2.0" Vert. Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads

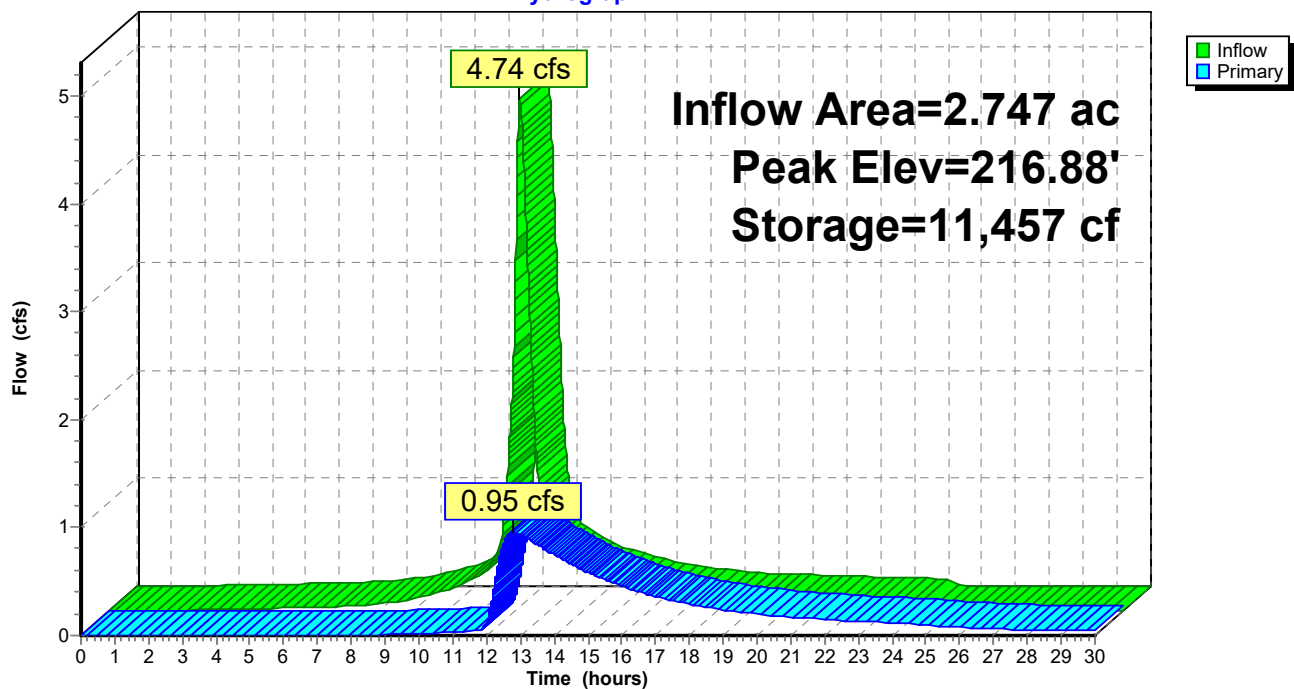
**Primary OutFlow** Max=0.95 cfs @ 12.78 hrs HW=216.88' (Free Discharge)

1=Custom Weir/Orifice (Weir Controls 0.86 cfs @ 2.48 fps)

2=Orifice/Grate (Orifice Controls 0.09 cfs @ 4.29 fps)

Pond 43P: Basin #2

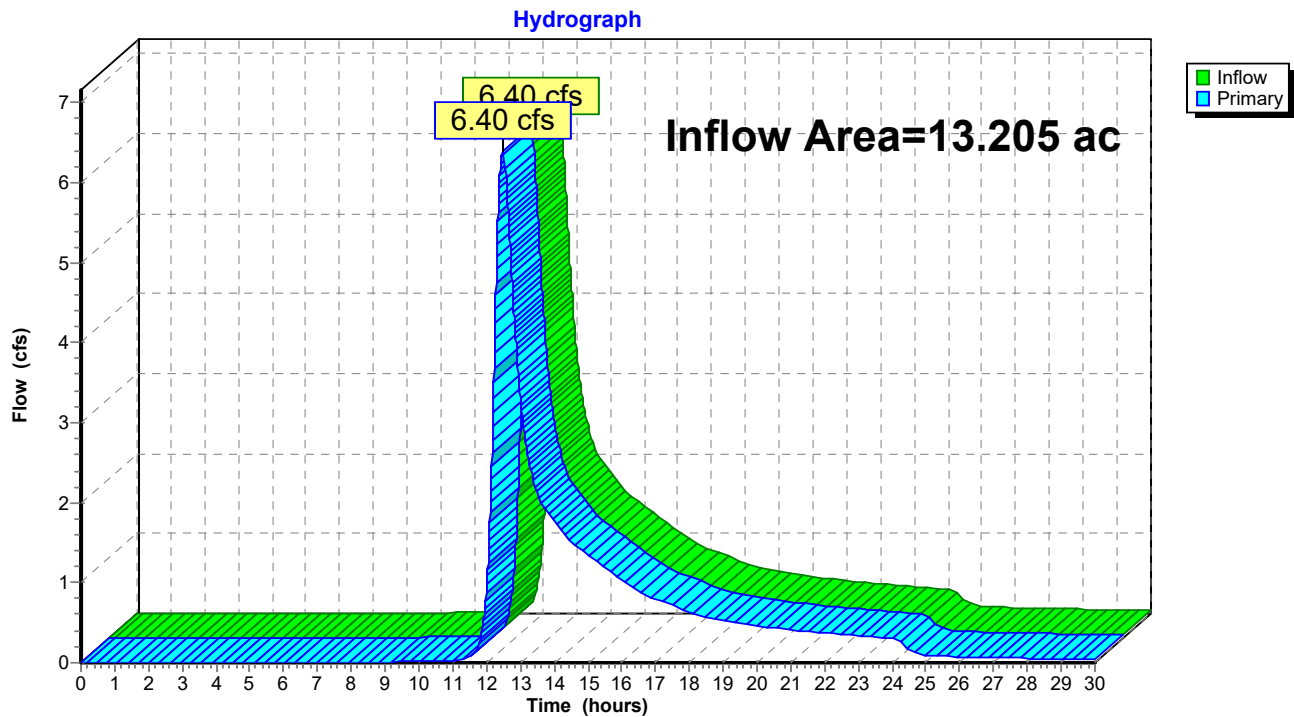
Hydrograph



**Summary for Link 44P: Design Point #2: Flow to Southern Abutters**

Inflow Area = 13.205 ac, 13.59% Impervious, Inflow Depth > 1.07" for 2-YR event  
Inflow = 6.40 cfs @ 12.47 hrs, Volume= 1.182 af  
Primary = 6.40 cfs @ 12.47 hrs, Volume= 1.182 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

**Link 44P: Design Point #2: Flow to Southern Abutters**

## 2023-06-05 Basin Reconfiguration

Type III 24-hr 10-YR Rainfall=4.70"

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Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 points  
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN  
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

### Pond 43P: Basin #2

Peak Elev=217.27' Storage=17,035 cf Inflow=7.63 cfs 0.818 af  
Outflow=2.61 cfs 0.732 af

### Link 44P: Design Point #2: Flow to Southern Abutters

Inflow=15.24 cfs 2.381 af  
Primary=15.24 cfs 2.381 af

**2023-06-05 Basin Reconfiguration**

Type III 24-hr 10-YR Rainfall=4.70"

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**Summary for Pond 43P: Basin #2**

Inflow Area = 2.747 ac, 65.33% Impervious, Inflow Depth = 3.57" for 10-YR event  
 Inflow = 7.63 cfs @ 12.16 hrs, Volume= 0.818 af  
 Outflow = 2.61 cfs @ 12.62 hrs, Volume= 0.732 af, Atten= 66%, Lag= 27.5 min  
 Primary = 2.61 cfs @ 12.62 hrs, Volume= 0.732 af  
 Routed to Link 44P : Design Point #2: Flow to Southern Abutters

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs  
 Peak Elev= 217.27' @ 12.62 hrs Surf.Area= 14,695 sf Storage= 17,035 cf

Plug-Flow detention time= 214.6 min calculated for 0.732 af (89% of inflow)  
 Center-of-Mass det. time= 163.5 min ( 954.0 - 790.4 )

Volume	Invert	Avail.Storage	Storage Description
#1	216.00'	36,749 cf	<b>Custom Stage Data (Irregular)</b> Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
216.00	12,268	457.0	0	0	12,268
218.50	17,274	522.0	36,749	36,749	17,478

Device	Routing	Invert	Outlet Devices
#1	Primary	216.30'	<b>Custom Weir/Orifice, Cv= 2.62 (C= 3.28)</b> Elev. (feet) 216.30 217.00 217.00 218.00 Width (feet) 0.60 0.60 2.00 2.00
#2	Primary	216.00'	<b>2.0" Vert. Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads

**Primary OutFlow** Max=2.60 cfs @ 12.62 hrs HW=217.27' (Free Discharge)

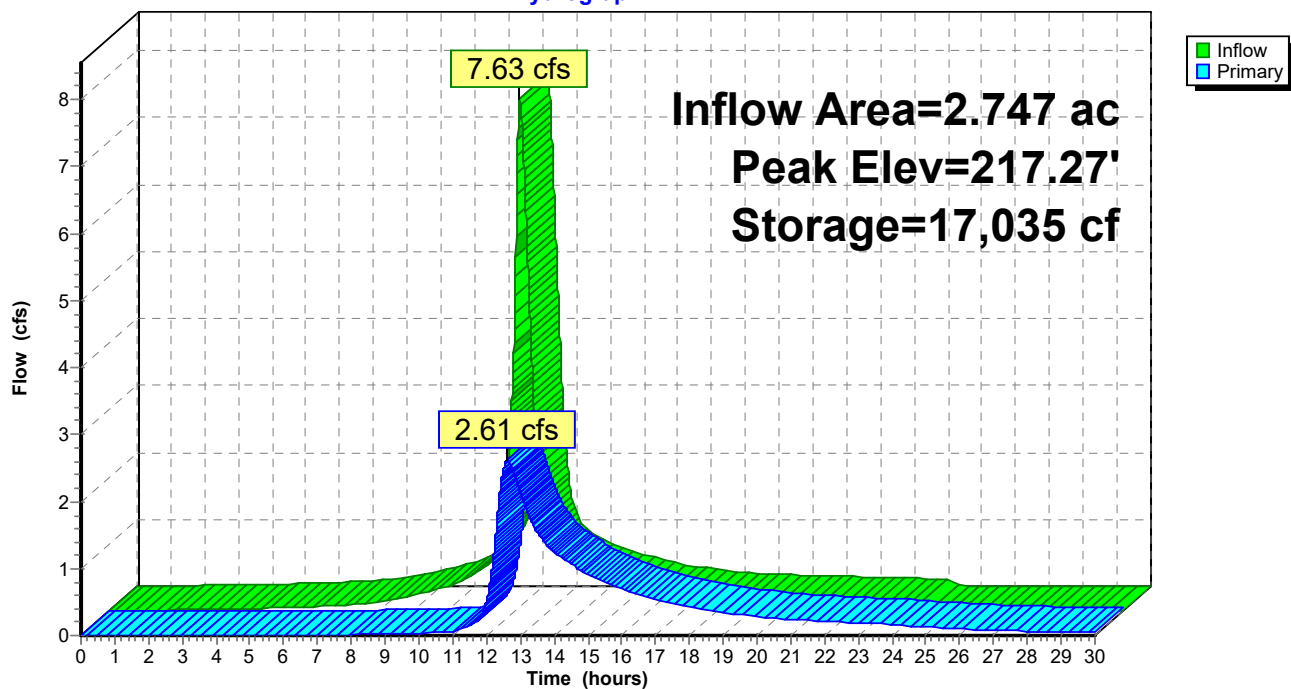
1=Custom Weir/Orifice (Weir Controls 2.49 cfs @ 2.62 fps)

2=Orifice/Grate (Orifice Controls 0.11 cfs @ 5.23 fps)



Pond 43P: Basin #2

Hydrograph

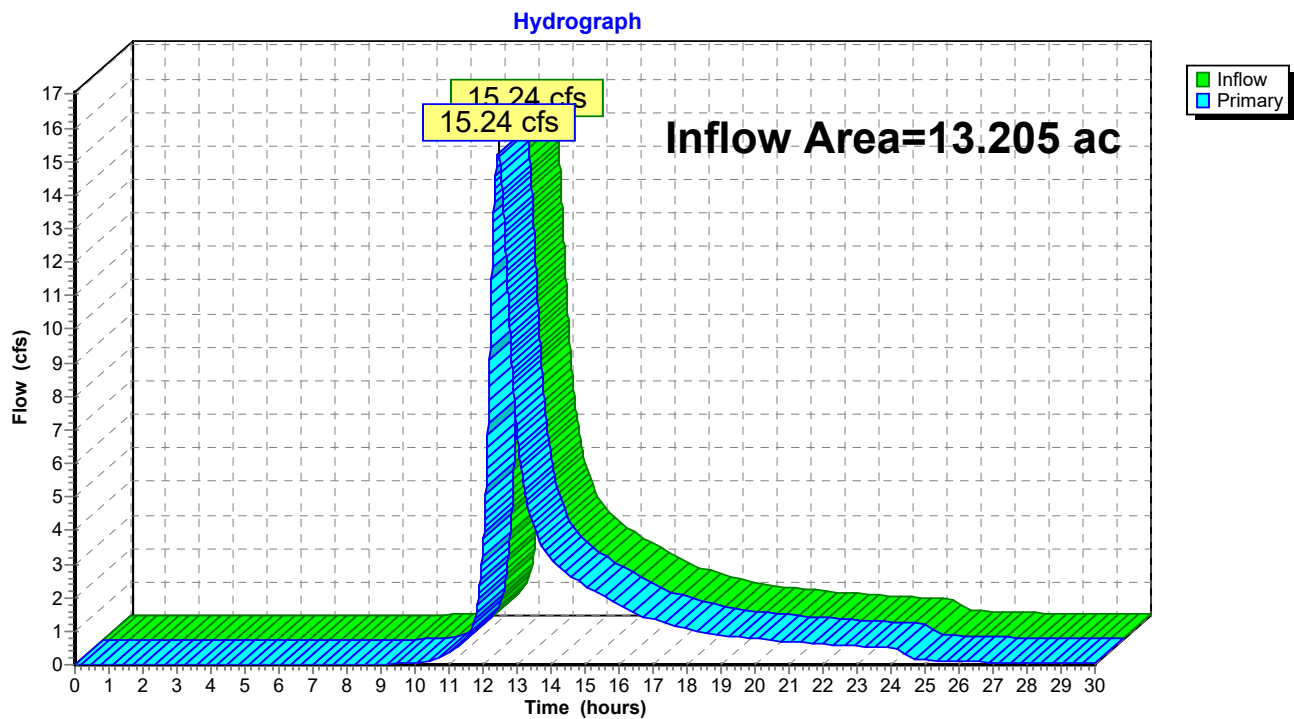


### Summary for Link 44P: Design Point #2: Flow to Southern Abutters

Inflow Area = 13.205 ac, 13.59% Impervious, Inflow Depth > 2.16" for 10-YR event  
 Inflow = 15.24 cfs @ 12.46 hrs, Volume= 2.381 af  
 Primary = 15.24 cfs @ 12.46 hrs, Volume= 2.381 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

### Link 44P: Design Point #2: Flow to Southern Abutters



## 2023-06-05 Basin Reconfiguration

Type III 24-hr 50-YR Rainfall=6.10"

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Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 points  
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN  
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

### Pond 43P: Basin #2

Peak Elev=217.53' Storage=21,066 cf Inflow=10.27 cfs 1.124 af  
Outflow=4.62 cfs 1.035 af

### Link 44P: Design Point #2: Flow to Southern Abutters

Inflow=25.07 cfs 3.632 af  
Primary=25.07 cfs 3.632 af

**2023-06-05 Basin Reconfiguration**

Type III 24-hr 50-YR Rainfall=6.10"

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**Summary for Pond 43P: Basin #2**

Inflow Area = 2.747 ac, 65.33% Impervious, Inflow Depth = 4.91" for 50-YR event  
 Inflow = 10.27 cfs @ 12.16 hrs, Volume= 1.124 af  
 Outflow = 4.62 cfs @ 12.54 hrs, Volume= 1.035 af, Atten= 55%, Lag= 23.2 min  
 Primary = 4.62 cfs @ 12.54 hrs, Volume= 1.035 af  
 Routed to Link 44P : Design Point #2: Flow to Southern Abutters

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs  
 Peak Elev= 217.53' @ 12.54 hrs Surf.Area= 15,240 sf Storage= 21,066 cf

Plug-Flow detention time= 182.0 min calculated for 1.035 af (92% of inflow)  
 Center-of-Mass det. time= 140.6 min ( 924.6 - 784.0 )

Volume	Invert	Avail.Storage	Storage Description
#1	216.00'	36,749 cf	<b>Custom Stage Data (Irregular)</b> Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
216.00	12,268	457.0	0	0	12,268
218.50	17,274	522.0	36,749	36,749	17,478

Device	Routing	Invert	Outlet Devices
#1	Primary	216.30'	<b>Custom Weir/Orifice, Cv= 2.62 (C= 3.28)</b> Elev. (feet) 216.30 217.00 217.00 218.00 Width (feet) 0.60 0.60 2.00 2.00
#2	Primary	216.00'	<b>2.0" Vert. Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads

**Primary OutFlow** Max=4.61 cfs @ 12.54 hrs HW=217.53' (Free Discharge)

1=Custom Weir/Orifice (Weir Controls 4.49 cfs @ 3.01 fps)

2=Orifice/Grate (Orifice Controls 0.13 cfs @ 5.80 fps)

## 2023-06-05 Basin Reconfiguration

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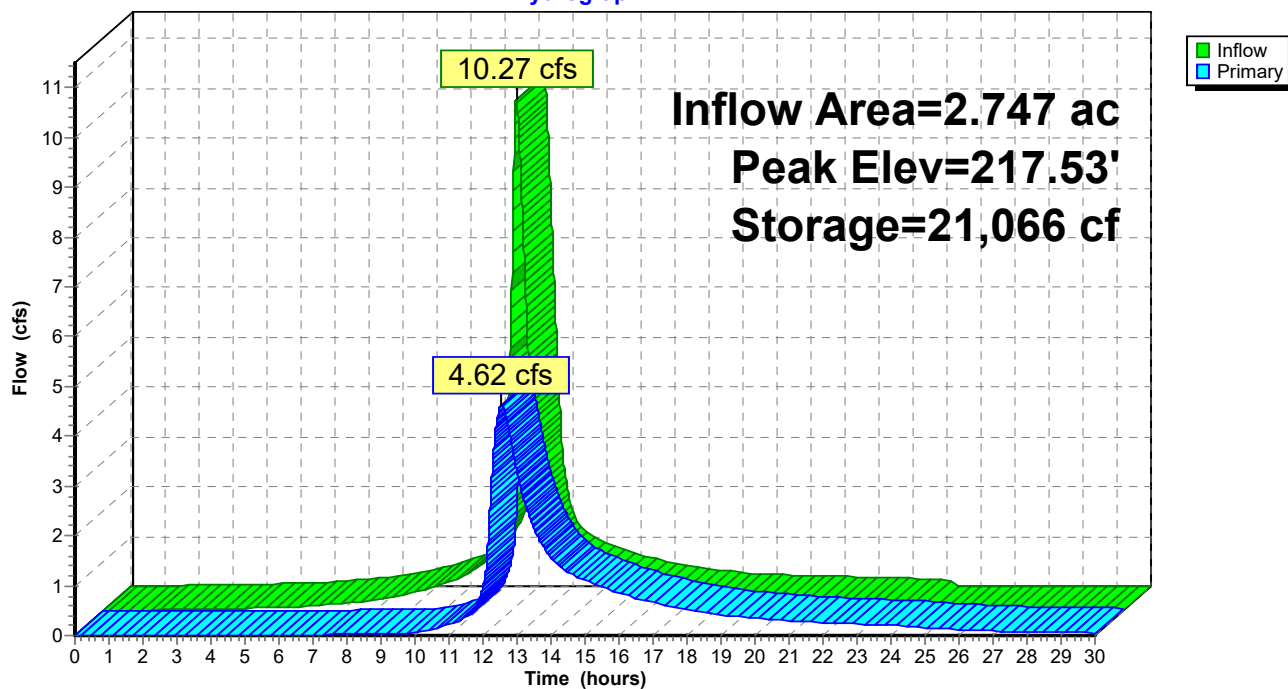
Type III 24-hr 50-YR Rainfall=6.10"

Printed 6/5/2023

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### Pond 43P: Basin #2

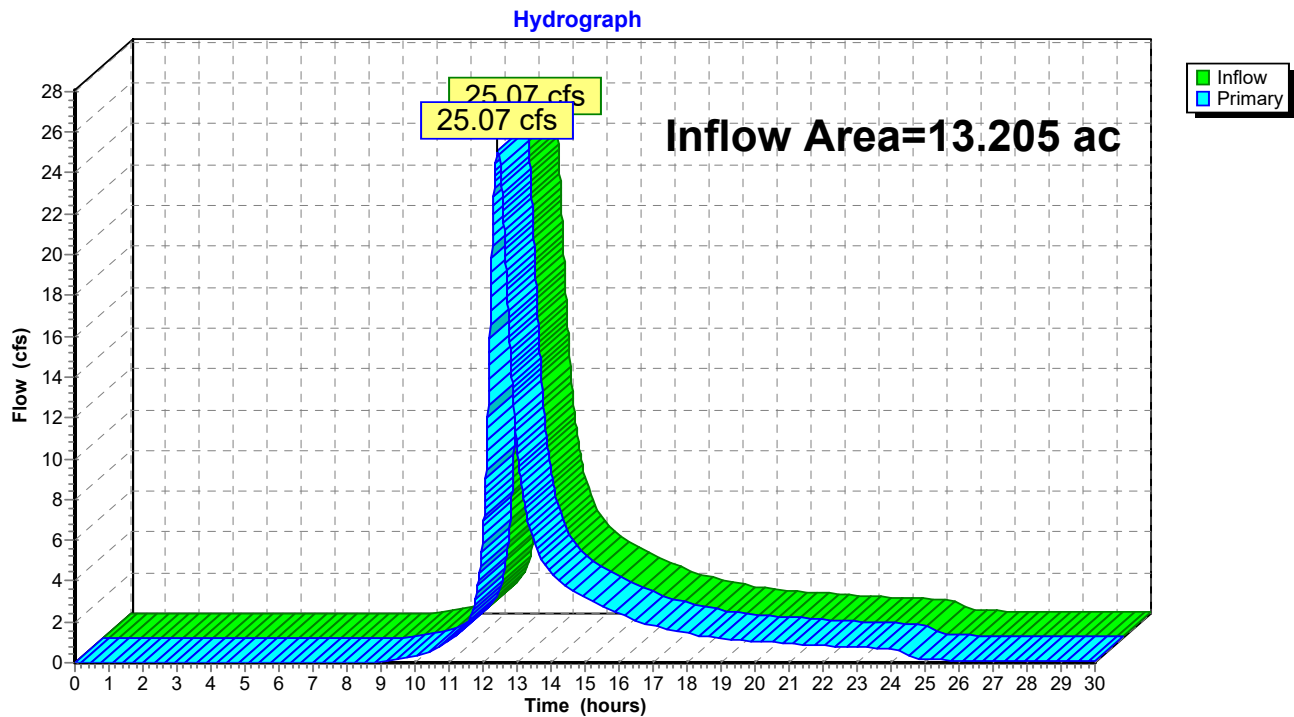
Hydrograph



**Summary for Link 44P: Design Point #2: Flow to Southern Abutters**

Inflow Area = 13.205 ac, 13.59% Impervious, Inflow Depth > 3.30" for 50-YR event  
Inflow = 25.07 cfs @ 12.43 hrs, Volume= 3.632 af  
Primary = 25.07 cfs @ 12.43 hrs, Volume= 3.632 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

**Link 44P: Design Point #2: Flow to Southern Abutters**

## 2023-06-05 Basin Reconfiguration

Type III 24-hr 100-YR Rainfall=6.70"

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Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 points  
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN  
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

### Pond 43P: Basin #2

Peak Elev=217.64' Storage=22,613 cf Inflow=11.36 cfs 1.257 af  
Outflow=5.49 cfs 1.167 af

### Link 44P: Design Point #2: Flow to Southern Abutters

Inflow=29.45 cfs 4.194 af  
Primary=29.45 cfs 4.194 af

**2023-06-05 Basin Reconfiguration**

Type III 24-hr 100-YR Rainfall=6.70"

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**Summary for Pond 43P: Basin #2**

Inflow Area = 2.747 ac, 65.33% Impervious, Inflow Depth = 5.49" for 100-YR event  
 Inflow = 11.36 cfs @ 12.16 hrs, Volume= 1.257 af  
 Outflow = 5.49 cfs @ 12.53 hrs, Volume= 1.167 af, Atten= 52%, Lag= 22.2 min  
 Primary = 5.49 cfs @ 12.53 hrs, Volume= 1.167 af  
 Routed to Link 44P : Design Point #2: Flow to Southern Abutters

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs  
 Peak Elev= 217.64' @ 12.53 hrs Surf.Area= 15,446 sf Storage= 22,613 cf

Plug-Flow detention time= 171.7 min calculated for 1.167 af (93% of inflow)  
 Center-of-Mass det. time= 133.6 min ( 915.4 - 781.8 )

Volume	Invert	Avail.Storage	Storage Description
#1	216.00'	36,749 cf	<b>Custom Stage Data (Irregular)</b> Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
216.00	12,268	457.0	0	0	12,268
218.50	17,274	522.0	36,749	36,749	17,478

Device	Routing	Invert	Outlet Devices
#1	Primary	216.30'	<b>Custom Weir/Orifice, Cv= 2.62 (C= 3.28)</b> Elev. (feet) 216.30 217.00 217.00 218.00 Width (feet) 0.60 0.60 2.00 2.00
#2	Primary	216.00'	<b>2.0" Vert. Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads

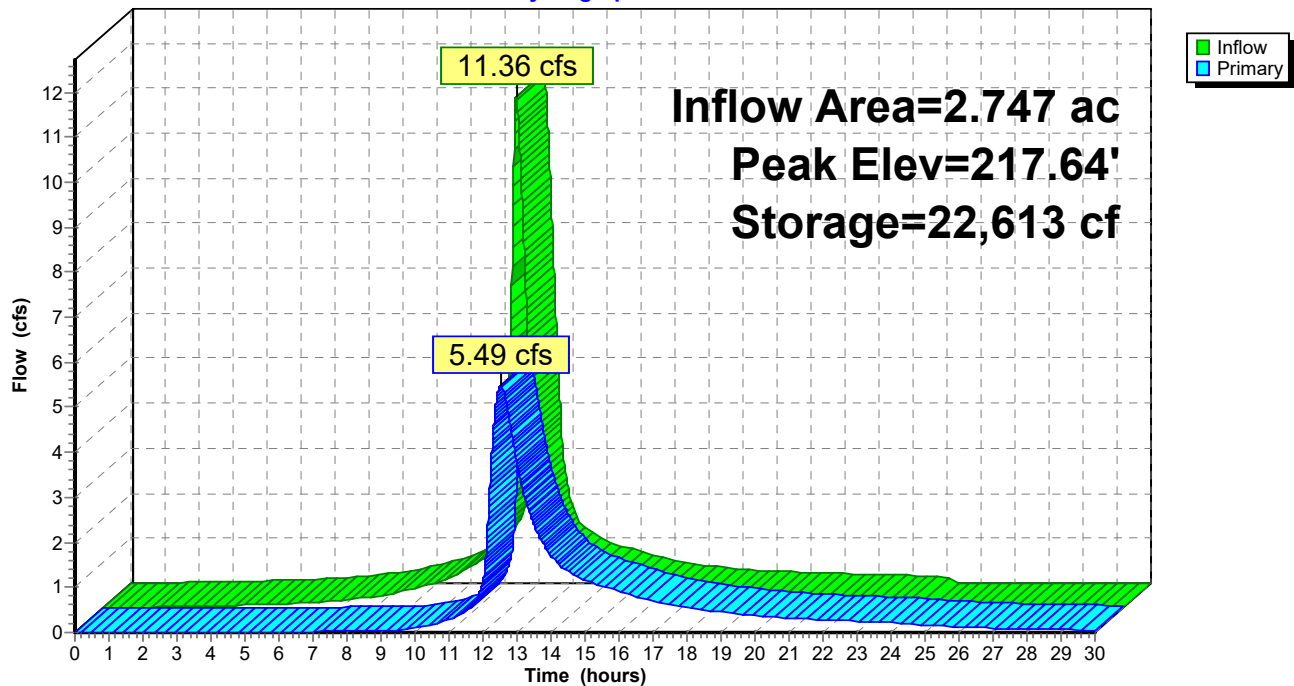
**Primary OutFlow** Max=5.49 cfs @ 12.53 hrs HW=217.64' (Free Discharge)

1=Custom Weir/Orifice (Weir Controls 5.35 cfs @ 3.17 fps)  
 2=Orifice/Grate (Orifice Controls 0.13 cfs @ 6.00 fps)



Pond 43P: Basin #2

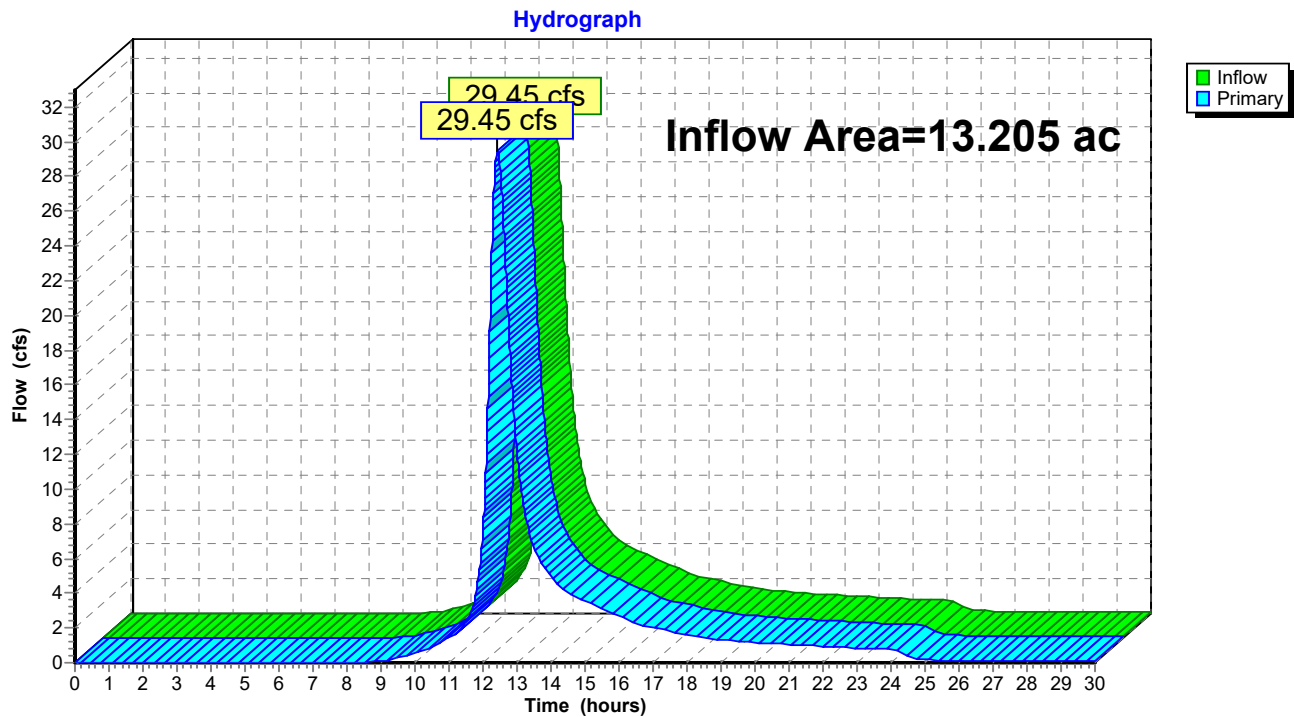
Hydrograph



**Summary for Link 44P: Design Point #2: Flow to Southern Abutters**

Inflow Area = 13.205 ac, 13.59% Impervious, Inflow Depth > 3.81" for 100-YR event  
Inflow = 29.45 cfs @ 12.43 hrs, Volume= 4.194 af  
Primary = 29.45 cfs @ 12.43 hrs, Volume= 4.194 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

**Link 44P: Design Point #2: Flow to Southern Abutters**



[dan@legacy-ce.com](mailto:dan@legacy-ce.com)  
508-376-8883(o)  
508-868-8353(c)  
730 Main Street  
Suite 2C  
Millis, MA 02054

## ATTACHMENT E

### REVISED O&M PLAN

# OPERATIONS & MAINTENANCE PLAN

FOR

## *ACORN PLACE*

ACORN STREET  
MILLIS MA, 02054

### *PROPOSED SENIOR RESIDENTIAL COMMUNITY*

JULY 12, 2018  
REVISED SEPTEMBER 27, 2018  
REVISED OCTOBER 12, 2018  
REVISED DECEMBER 14, 2021  
REVISED JUNE 6, 2023 (BY LEGACY ENGINEERING)

PREPARED BY:  
MERRIKIN ENGINEERING, LLP  
CONSULTING ENGINEERS  
730 MAIN STREET, SUITE 2C  
MILLIS, MA 02054

PREPARED FOR:  
ACORN MILLIS RESIDENTIAL, LLC  
38 BENJAMINS GATE  
PLYMOUTH, MA 02360

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# INTRODUCTION

This Operations and Maintenance Plan (hereinafter referred to “O&M Plan”) is provided to ensure the long-term monitoring and maintenance of various components of the Acorn Place infrastructure. This O&M Plan includes the following provisions:

1. Stormwater System Operations and Maintenance
2. Miscellaneous Provisions
3. Accidental Spill and Emergency Response Plan

The “Development” and the various components which are referenced in this O&M Plan are described on the site plan referenced below.

## **Project Name**

Acorn Place

## **Project Location**

Acorn Street  
Millis MA, 02054

## **Operator Name and Address**

Acorn Millis Residential, LLC  
38 Benjamins Gate  
Plymouth, MA 02360

## **References**

This O&M Plan references other documents as follows:

Site Plan - Plans entitled “Acorn Place Site Plan of Land in Millis, Massachusetts” with an original date of July 12, 2018 (as may be amended), and prepared by Merrikin Engineering, LLP, hereinafter referred to as the “Site Plan”.

Stormwater Report – Report entitled “Stormwater Report for Acorn Place, Acorn Street Millis, MA 02054 prepared by Merrikin Engineering, LLP with an original date of July 12, 2018 (as may be amended).

## **Site Description**

The 24.26 acre site consists of 22 two unit dwellings and 4 single unit dwellings along with associated driveways, landscape areas, utility systems, and stormwater management systems. Those land areas are collectively referred to herein as the “Development.”

## **Site Usage and Activities**

A senior residential community and associated appurtenances.

# **PART 1: STORMWATER SYSTEM OPERATIONS AND MAINTENANCE**

In order to maximize the continued effectiveness of the Stormwater Management BMP's for Acorn Place, the following Operation and Maintenance requirements apply to all stormwater facilities within the extents of the Development. The stormwater facilities are depicted on the Site Plan and are hereinafter referred to as the "Stormwater Facilities."

## **Operations and Maintenance Responsibilities**

The Operator or its designee shall be responsible for implementing all Operations and Maintenance (O&M) responsibilities.

## **Easement Areas**

No easements are proposed for the site.

## **Commencement of Operations and Maintenance Responsibilities**

Operations and Maintenance tasks shall be commenced once each respective Stormwater Facility is fully constructed and is receiving runoff from the Development.

## **Operations and Maintenance Tasks**

### *Deep Sump Catch Basins:*

1. Deep sump catch basins shall be inspected daily during construction activities and all sediments and debris shall be removed four times per year unless the owner can determine through recorded observations that sediment accumulation does not warrant such frequent cleanings. If deep sump catch basin cleaning occurs less than four times per year, cleaning shall occur when two feet of sediments have accumulated in the sump and at least once per year.
2. Silt sacks shall be installed on all catch basins throughout the time of construction.
3. All sediments and hydrocarbons shall be disposed of off-site in accordance with all applicable local, state, and federal regulations.

### *Sediment Forebays:*

1. Sediment forebays shall be inspected at least four times per year to insure proper operation (during a storm event).
2. Sediment forebays should be mowed and all clippings and debris removed at least twice per year. Debris shall be removed at more frequent intervals if warranted by extreme weather events.
3. Sediment should be removed when 3-inches of sediment accumulates anywhere in the forebay.
4. Remove woody vegetation, leaves, and other materials that would affect the life of the system or its operations.

#### Stormwater Basin/Sand Filter:

1. Stormwater basins shall be inspected at least twice per year to insure proper operation (during a storm event).
2. Inspections shall include ensuring that inlet, outlet, and splash pad rip-rap aprons are in good condition and that that interior wall systems are in good condition. Deficiencies shall be remedied immediately.
3. Inspections shall include an observation of the accumulation of sediment in the basin. Pretreatment BMPs are intended to capture and contain coarse sediments. Should indication of significant accumulation of sediments in the infiltration basin be observed, increased frequency of cleaning of the preceding sediment forebay and catch basins shall be implemented.
4. Inspections shall include ensuring that outlet structures and the sub-drain outfalls are unobstructed and free-flowing per the Site Plan design specifications. Should the sub-drain not discharge accumulated water from under the basin, it may need to be replaced in-kind.
5. Inspections shall include ensuring that all berms are fully stabilized, structurally sound and not eroded. Deficiencies shall be remedied immediately.
6. Stormwater basins should be mowed and all clippings and debris removed at least twice per year. Debris shall be removed at more frequent intervals if warranted by extreme weather events. If wetland vegetation grows at the bottom of the stormwater basin, it shall only be mowed once per year at the beginning of the winter season.
7. Sediment should be removed at least once every 5 years or when 2-inches of sediment accumulates anywhere in the basin and disposed of off-site in accordance with all applicable local, state, and federal regulations. Two sedimentation markers shall be installed in the basin by a Registered Land Surveyors with a clear marking of the 2-inch accumulation line. It is recommended that stone bounds be installed with chiseled marks indicating the limit of accumulation, although other similarly permanent marking methods may be utilized.

#### Stormwater Pipes, Inlets and Outfalls:

1. All stormwater inlets and outfalls shall be inspected twice per year.
2. Trash, leaves, debris and sediment shall be removed from inlets and outfalls as needed to keep them free flowing.
3. If inspections indicate that stormwater pipelines have become partially obstructed with trash, leaves, debris or sediment, the pipelines shall be cleaned by water jet truck and the obstructions removed and disposed of.

The various operations and maintenance schedule requirements listed above may be reduced in frequency by approval from the Town. Should such permission be desired, the Operator shall provide documentation of actual on-site maintenance observations by a qualified source (engineer or other qualified person meeting the approval of the Town) demonstrating that the particular Stormwater BMP in question does not warrant the specified frequency of inspection or maintenance activities.



## Reporting Requirements

The following documentation shall be submitted no later than December 31<sup>st</sup> of each calendar year to the Town:

1. A statement, signed by an authorized representative of the Operator indicating that the requirements of this O&M Plan were performed during the previous calendar year. Where requirements were not met, a schedule for their completion shall be provided and a follow-up statement submitted when complete.
2. A list of the maintenance activities performed along with the approximate date of the work.
3. A list of the inspections performed along with a statement by each inspector summarizing the results of the inspections performed in accordance with this O&M plan.
4. Copies of appurtenant documentation supporting the completion of the O&M responsibilities such as copies of contracts and/or receipts with parties engaged to perform maintenance and inspection services.
5. A notation regarding whether there has been any change in the name and or contact information for the Operator.

## Public Safety Features

The stormwater system has been designed to safely collect surface runoff from developed areas (as described on the Site Plan and Stormwater Report) by providing collections systems at regular intervals to prevent surface flooding and to treat that runoff in accordance with the provisions of the Massachusetts Stormwater Management Standards and Handbook.

# PART 2: MISCELLANEOUS PROVISIONS

## Good Housekeeping Controls

The following good housekeeping measures will be implemented in the day-to-day operation of the Development:

1. The site will be maintained in a neat and orderly manner.
2. Fertilizers and pesticide application on the lots shall be in accordance with this plan.
3. All waste materials from the development will be collected in dumpsters and removed from the site by properly licensed disposal companies.

## Management of Deicing Chemicals and Snow

Management of on-site snow will be as follows:

1. The site shall be plowed as needed to maintain safe driving conditions. Snow will be stored in windrows along pavement edges and shall be piled in landscape strips as needed.
2. Snow will not be plowed into piles which block or obstruct stormwater management facilities.
3. Snow will not be plowed into piles at roadway intersections such that it would obstruct visibility for entering or exiting vehicles.

4. Deicing chemicals application will be as little as possible while provide a safe environment for vehicular operation and function.

### **Fire Lane Maintenance**

The Operator is responsible for ensuring that the gravel fire lane from the site driveway to Acorn Street is clear and passable at all times. During winter months, the surface shall be plowed. During warm weather months, debris shall be removed as needed and the surface shall be re-graded and re-compacted if it ponding, erosion or soft spots develop. Existing trees and shrubs along the shoulders shall be maintained as long as healthy, but shall be trimmed to be clear of the traversable fire lane surface.

### **Operator Training**

The Operator is responsible for providing training for the staff that will be responsible for the implementation of this O&M Plan. Such training shall occur at least once annually.

### **Illicit Discharges**

The Operator shall not allow non-stormwater discharges into the development's stormwater system. Any discovered non-stormwater discharges into the development's stormwater system shall be immediately disconnected.

### **Estimated Operations and Maintenance Budget**

It is estimated that the regular annual maintenance tasks described herein will cost the following amounts year (2023 value):

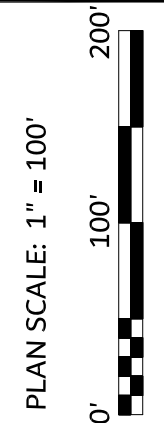
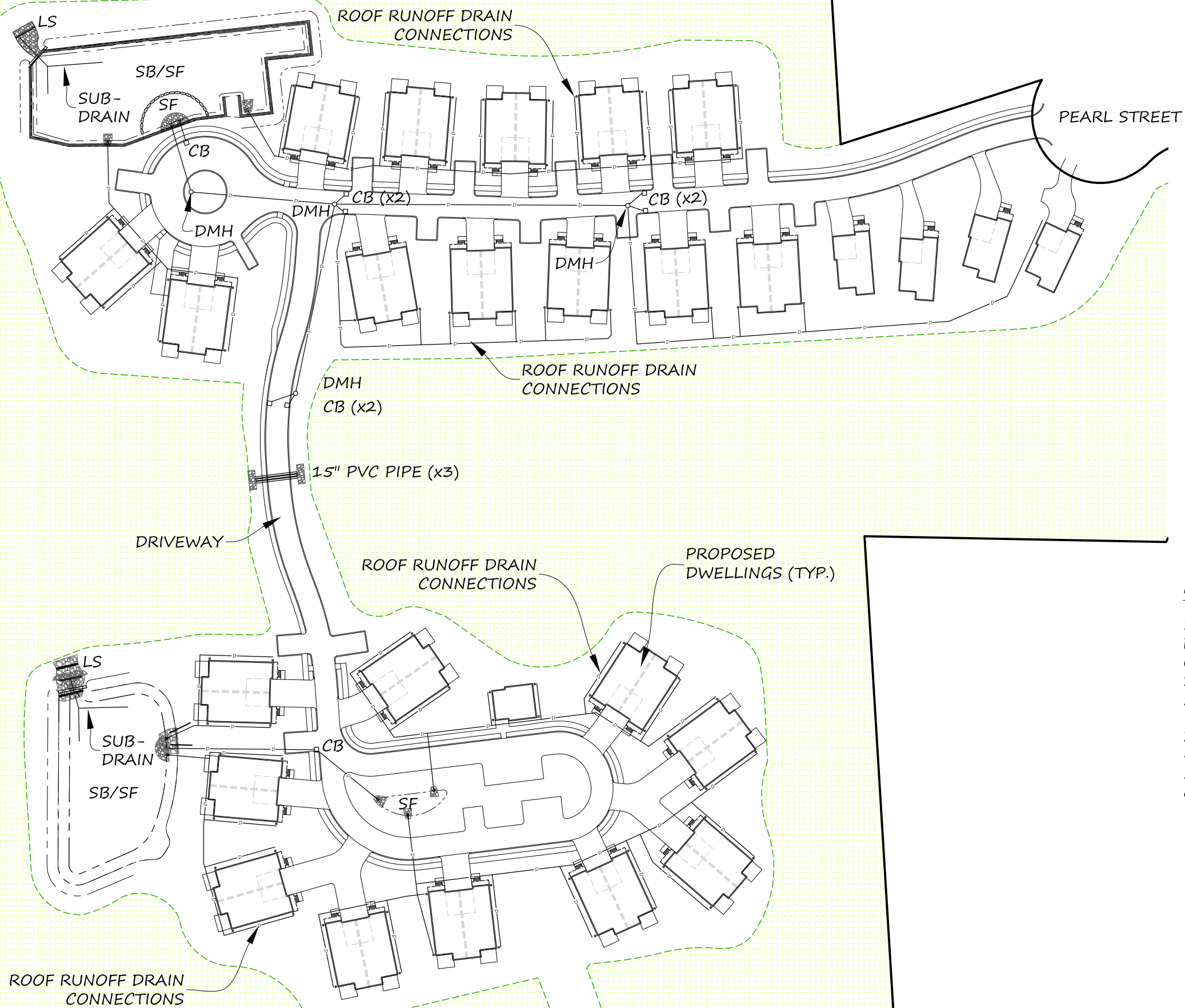
- Catch basin cleaning - \$65 per catch basin
- Basin/Forebay mowing - \$600 per mowing
- Inspections - \$500 per inspection
- Snow plowing - TBD

## **PART 3: ACCIDENTAL SPILL AND EMERGENCY RESPONSE PLAN**

In the event of an accident within the boundaries of the Site, where significant gasoline or other petroleum products or other hazardous materials are released, the following procedure shall be followed in the order noted.

1. As quickly as possible, attempt to block the nearest stormwater catch basins if on a roadway, or if in proximity to wetlands, create a berm of soil downslope of the spill.
2. Immediately, and while the containment measures are implemented as described above, notify the following governmental entities and inform them of the type of spill that occurred:
  - Millis Fire Department at 508-376-2361,
  - Millis Board of Health at 508-376-7042,
  - Millis Conservation Commission at 508-376-7045,
  - Mass. Department of Environmental Protection (DEP) Central Region at (508) 792-7650 (address is 8 New Bond Street Worcester, MA 01606), and
  - National Response Center (NRC) at (800) 424-8802 (for spills that require such notification pursuant to 40 CFR Part 110, 40 CFR Part 117, and 40 CR Part 302).
3. Once the various emergency response teams have arrived at the site and if the spill occurs on a lot, the owner shall follow the instructions of the various governmental entities, which may include the following:
  - A clean up firm may need to be immediately contacted.
  - If the hazardous materials have entered the stormwater system, portions of it may need to be cleaned and restored per the DEP. All such activities shall be as specified by the DEP.

# **EXHIBIT 1 STORMWATER FACILITIES SITE PLAN**



PLAN DATE: JULY 12, 2018

REVISION	DATE	BY
REV'S PER TOWN COMMENTS	9/27/18	DJM
REV'S PER TOWN COMMENTS	10/12/18	DJM
BASIN REV (LEGACY ENG.)	6/6/23	DJM

ACORN PLACE  
OPERATION &  
MAINTENANCE  
PLAN OF LAND IN  
MILLIS, MA

NOTES:

1. REFER TO APPROVED SITE PLAN FOR COMPLETE DETAILS OF EXISTING AND PROPOSED SITE FEATURES.
2. SB/SF=STORMWATER BASIN SAND FILTER
3. SF=SEDIMENT FOREBAY
4. CB=CATCH BASIN
5. DMH= DRAIN MANHOLE
6. LS= LEVEL SPREADER



730 MAIN STREET, SUITE 2C  
MILLIS, MA 02054  
ph. 508-376-8883 fax 508-376-8823

D69-01

SHEET 1 OF 1

# **EXHIBIT 2** STORMWATER SYSTEM OPERATIONS AND MAINTENANCE LOG FORM

# Stormwater System Operations and Maintenance Log

Year \_\_\_\_\_

General Information	
Project Name	Acorn Place
Site Location	Acorn Street Millis, MA 02054
Inspector's Name	
Inspector's Title	
Inspector's Phone	
Signature of Operator at end of Year, Certifying that Work was Completed as Noted. Date:	

## O&M Task Checklist

	O&M Activity	Date Completed	Notes/Comments
Deep Sump Catch Basins			
	1 <sup>st</sup> Quarter Cleanout		
	2 <sup>nd</sup> Quarter Cleanout		
	3 <sup>rd</sup> Quarter Cleanout		
	4 <sup>th</sup> Quarter Cleanout		
Sediment Forebay			
	1 <sup>st</sup> Annual Inspection		
	2 <sup>nd</sup> Annual Inspection		
	3 <sup>rd</sup> Annual Inspection		
	4 <sup>th</sup> Annual Inspection		
	1 <sup>st</sup> Annual Mowing		
	2 <sup>nd</sup> Annual Mowing		
	Sediment Rem. Req'd?		

Stormwater Basin/Sand Filter			
	1 <sup>st</sup> Annual Inspection		
	2 <sup>nd</sup> Annual Inspection		
	1 <sup>st</sup> Annual Mowing		
	2 <sup>nd</sup> Annual Mowing		
	Sediment Rem. Req'd?		
Stormwater Pipes, Inlets and Outlets			
	1 <sup>st</sup> Annual Inspection		
	2 <sup>nd</sup> Annual inspection		