STORMWATER DRAINAGE SUMMARY REPORT

FOR

PROPOSED

110 Grill

MODERN • FRESH • INNOVATIVE

1165 &1175 Main Street
Map 638, Block 8, Lot 1&2
City of Haverhill, Massachusetts
Essex County

Prepared by:

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BEPC #W161155

BOHLER
ENGINEERING

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I. INTRODUCTION

The following report provides an analysis of the stormwater drainage conditions that will result from the re-development of an existing site that formerly contained an auto dealership and restaurant. The site is located along the easterly side of Main Street (a.k.a. Route 125) and is comprised of two parcels of land identified by the Haverhill Assessor's Office as Map 638, Block 8, Lots 1 and 2 which contains approximately 75,925 square feet of land (or 1.74± acres).

The property is bound to the west by Main street (a two-way, three-lane right of way under local jurisdiction), to the east by wetlands and residential properties, to the north by Woodman Avenue (a two-way, two-lane right of way under local jurisdiction) and to the south by a restaurant. The property is located outside all flood hazard zones per FEMA mapping.

This report includes an analysis of the existing and proposed drainage characteristics of the site including building, parking and landscaped areas and provides a detailed analysis of the proposed stormwater facilities and best management practices (BMPs) that will control stormwater outflow associated with the post-redeveloped site which will help serve to reduce the rate of leaving the site.

This report addresses a comparative analysis of the pre- and post-development site stormwater runoff conditions with the following primary design constraints being:

1. The Massachusetts Department of Environmental Protection Agency's Stormwater Management Standards,
2. Meeting the City of Haverhill Requirements for Stormwater Drainage.

II. DRAINAGE – EXISTING SITE CONDITIONS

The area of the proposed improvements is currently developed consisting of paved parking and minimal landscaped areas and contains (4) four drainage areas (E-1,E-2, E-3 and E-4) which are conveyed to different design points as described below.

Drainage Area E1 is further divided into two subwatersheds (E1A & E1B).

Drainage Area E1A consists of ±28,295 sf of paved areas and ±1,789 sf of landscaped areas in poor condition totaling ±30,084 sf of land. Stormwater from Drainage Area E1A sheet flows to one of two existing catch basins where it is conveyed via a piped connection to the Main Street Drainage System (Design Point 1- DPE1).

Drainage Area E1B consists of ±14,750 sf of paved areas and ±52 sf of landscaped areas in poor condition totaling ±14,802 sf of land. Stormwater from Drainage Area E1A sheet flows uncontrolled to the Main Street Drainage System (Design Point 1- DPE1).

Drainage Area E2 consists of ±15,226 sf of paved areas, ±1,091 sf of landscaped areas in poor condition and ±3,850 sf of wooded area totaling ±20,167 sf of land. Stormwater from Drainage Area E2 sheet flows uncontrolled towards the wetlands on the easterly side of the site (Design Point 2- DPE2).

Drainage Area E3 consists of ±25 sf of paved areas and ±377 sf of landscaped areas in poor condition totaling ±402 sf of land. Stormwater from Drainage Area E3 sheet flows uncontrolled onto the southerly abutting land (Design Point 3- DPE3).

Drainage Area E4 consists of ±2,111 sf of paved areas and ±30 sf of landscaped areas in poor condition totaling ±2,141 sf of land. Stormwater from Drainage Area E4 sheet flows uncontrolled towards Woodman Avenue (Design Point 4- DPE4).

These drainage areas above are shown on the "Existing Drainage Tributary Map" included within the Appendix 3 of this report.

Based on our review of the Natural Resources Conservation Service (NRCS) WSS online soil databases as well as the Geotechnical Boring Logs, the underground soils at the subject site are mostly classified as "Woodbridge Fine Sandy Loam" with a small portion of "Agawam Fine Sandy Loam" toward the south Property line and "Wareham Loamy Sands" toward the wetland area. As such, we have conservatively utilized Hydrologic Group C soils associated with the "Woodbridge Fine Sandy Loam" at this site based on same. We have also utilized the corresponding exfiltration rate of 0.27in/hr based on the Rawls Table within the Mass DEP Stormwater Management Standards.

III. DRAINAGE- PROPOSED SITE CONDITIONS

The post-redevelopment conditions include a 5,870 sf restaurant, new paved parking areas and various site improvements as illustrated on the Site Development Plans prepared by Bohler Engineering. Post-redevelopment conditions will result in a significant decrease in impervious areas by approximately 7,900sf, which will subsequently result in a decrease in peak runoff rates for all storm events as well as improvements to groundwater recharge and water quality when compared to existing conditions.

The goals of the stormwater management system design were to maintain existing site drainage patterns, mitigate peak post development flows, and protect water quality of the receiving waters.

Stormwater quality improvements proposed for the re-developed site include street sweeping, deep-sump hooded catch basins, bioretantion areas with sediment forebays and a stormwater quality unit which will improve total suspended solids (TSS) removal when compared to existing conditions.

The post-development conditions are divided into (4) four drainage areas, similar to existing conditions.

Drainage Area P1 is further divided into three subwatersheds (P1A, P1B & P1C).

Drainage Area P1A consists of ±19,506 sf of paved area and ±5,856 sf of landscaped area totaling ±25,362 sf of land. Stormwater from Drainage Area P1A is collected via a deep-sump catch basin with water quality hood and routed to an offline stormwater quality unit that conveys runoff to the Main Street Drainage System (Design Point 1-DPP1), but at a lesser rate than existing conditions.

Drainage Area P1B consists of ±5,870 sf of roofed area. Stormwater from Drainage Area P1B is collected via roof drains and routed to an underground infiltration basin which has been sized to infiltrate at least 1" of roof runoff before overflowing towards Main Street (Design Point 1-DPP1) via a piped overflow connection, but at a lesser rate than existing conditions.

Drainage Area P1C consists of ±12,650 sf of paved area and ±447 sf of landscaped area totaling ±13,097 sf of land. Stormwater from Drainage Area P1C is collected via a deep-sump catch basin with water quality hood and routed to an offline stormwater quality unit that conveys runoff to the Main Street Drainage System (Design Point 1-DPP1), but at a lesser rate than existing conditions.

Drainage Area P2 is further divided into three subwatersheds (P2, P2A & P2B).

Drainage Area P2 consists of ±1,087 sf of grassed area and ±3,544 sf of wooded area totaling ±4,631 sf of land. Stormwater from Drainage Area P2 drains toward the wetlands, similar to existing conditions (Design Point 1-DPP2), but at a lesser rate.

Drainage Area P2A consists of ±4,940 sf of paved area and ±1,833 sf of grassed area totaling ±6,773 sf of land. Stormwater from Drainage Area P2A utilizes country drainage and flows to a curb break and into a stone forebay before ultimately flowing into a bioretention area which will improve water quality and provide recharge of stormwater before overflowing towards the wetland (Design Point 2-DPP2) via a stone spillway, but at a lesser rate than existing conditions.

Drainage Area P2B consists of ±5,349 sf of paved area and ±1,621 sf of grassed area totaling ±6,970 sf of land. Stormwater from Drainage Area P2B utilizes country drainage and flows to a curb break and into a stone forebay before ultimately flowing into a bioretention area which will improve water quality and provide recharge of stormwater before overflowing towards the wetland (Design Point 2-DPP2) via a stone spillway, but at a lesser rate than existing conditions.

Drainage Area P3 consists of ±550 sf of grassed areas. Stormwater from Drainage Area P3 flows toward the southerly abutting land (Design Point 3- DPP3) as it does under existing conditions, but at a lesser rate.

Drainage Area P4 consists of ±643 sf of paved areas and ±3,429 sf of landscaped areas totaling ±4,072 sf of land. Stormwater from Drainage Area P4 flows into a small shallow depression where groundwater recharge is provided before ultimately discharging towards Woodman Avenue (Design Point 4- DPP4).

Please refer to the "Proposed Drainage Tributary Map" included within the Appendix 3 of this report for a graphical representation of the proposed drainage areas.

IV. DRAINAGE ANALYSIS METHODOLGY

The methodology utilized to design the subject stormwater management system to demonstrate compliance with the City of Haverhill, and State requirements / guidelines is based on the SCS TR 55 Urban Hydrology for small watersheds method. In addition, times of concentration were generated from the SCS TR 55 Urban Hydrology for small watersheds method. Runoff coefficients for the existing and proposed development conditions were developed using widely accepted runoff coefficients.

Compliance with the Massachusetts Department of Environmental Protection's Stormwater Management Standards and the City of Haverhill Requirements for Stormwater Drainage are the primary goals of the drainage system design. The rainfall rates used were based on the SCS TR 55 Urban Hydrology rates.

V. DRAINAGE ANALYSIS RESULTS

The tables below demonstrates that the post-redevelopment runoff rates associated with all storm events including the 2-year, 10-year, 25-year and 100-year storms will be decreased as a result of the proposed stormwater management system. This is the result of the significant decrease in impervious areas and the implementation of the proposed stormwater

management system which includes bioretention areas, deep sump hooded catch basins, an underground infiltration system and a water quality unit.

Table 1 - Stormwater Runoff Rate
Summary to Design Point 1 (Main Street)

Storm Frequency	Existing Flow (CFS)	Proposed Flow (CFS)	Change (CFS)
2 year	3.07	2.72	-0.35
10 year	4.50	4.12	-0.38
25 year	5.43	5.01	-0.42
100 year	6.55	6.07	-0.48

Table 2 - Stormwater Runoff Rate
Summary to Design Point 2 (Wetlands)

Storm Frequency	Existing Flow (CFS)	Proposed Flow (CFS)	Change (CFS)
2 year	1.20	0.50	-0.70
10 year	1.87	0.86	-1.01
25 year	2.30	1.48	-0.82
100 year	2.82	2.28	-0.54

Table 3 - Stormwater Runoff Rate
Summary to Design Point 3 (South Abutter)

Storm Frequency	Existing Flow (CFS)	Proposed Flow (CFS)	Change (CFS)
2 year	0.02	0.01	-0.01
10 year	0.03	0.03	0.0
25 year	0.04	0.04	0.0
100 year	0.05	0.05	0.0

Table 4 - Stormwater Runoff Rate
Summary to Design Point 4 (Woodsman Avenue)

Storm Frequency	Existing Flow (CFS)	Proposed Flow (CFS)	Change (CFS)
2 year	0.15	0.00	-0.15
10 year	0.22	0.02	-0.20
25 year	0.28	0.12	-0.16
100 year	0.31	0.31	0.0

The results show that the proposed redevelopment reduces the peak runoff rates to all design points. It should also be noted that the above reductions in runoff rates will have a negligible impact based on the overall tributary area to the receiving waters.

VI. CONCLUSIONS

In conclusion, the proposed stormwater management system illustrated on the enclosed drawings prepared by Bohler Engineering results in a decrease in post-redevelopment stormwater runoff rates and in an increase in the amount of annual groundwater recharge associated with the proposed re-development condition. In addition, the stormwater quality measures and Low Impact Development practices proposed will achieve the required 80% TSS removal prior to stormwater runoff being discharged to their respective design point downstream. As a result, the project complies with the requirements of the Massachusetts Department of Environmental Protection Stormwater Standards and the City of Haverhill's Requirements for Stormwater Drainage and represents a significant improvement over the existing conditions.

VII. STORMWATER MANAGEMENT STANDARDS

As outlined below, the proposed drainage system was designed in accordance with the Massachusetts Stormwater Management Policy to the maximum extent practicable.

Standard #1: **No new stormwater conveyances (e.g. outfalls) may discharge untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth.**

There are no new outfalls located on the site.

Standard #2: **Stormwater management systems shall be designed so that post-development peak discharge rates do not exceed pre-development peak discharge rates.**

Runoff rates for the post-redevelopment conditions were calculated for the 2-year, 10-year, 25-year and 100-year 24-hour storm events. As summarized in this report, there is no increase in peak stormwater runoff rates for the any of the storm events analyzed due to the implementation of a stormwater management system under post-redevelopment conditions.

Standard #3: **Loss of annual recharge to ground water 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 operation and maintenance.**

Best management practices have been implemented into the proposed stormwater management system including street sweeping, deep sump hooded catch basins, bioretention areas and a stormwater quality unit. The proposed re-development provides additional groundwater recharge due to the net reduction of impervious areas and infiltration via the underground infiltration basin and the bioretention areas. As a result, the post-development recharge is greater than the recharge from pre-development conditions and therefore, the project complies with this standard to the extent practicable.

Standard #4: **Stormwater management systems shall be designed to remove 80% of the average annual post-construction load of Total Suspended Solids (TSS)**

Water quality has been improved to the maximum extent practicable through the addition of treatment trains, which will provide the required 80% TSS removal when compared to existing conditions.

Standard #5: **For land uses with higher potential 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 stormwater quality best management practices were sized to handle the first one inch of stormwater.

Standard #6: **Stormwater discharges within 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.**

This standard does not apply to this project.

Standard #7: **A redevelopment project is required to meet the following Stormwater Management Standards only to the maximum extent practicable.**

The site qualifies as a re-development and meets all standards to the extent practicable.

Standard #8: **A plan to control construction-related impacts including erosion, sedimentation and other pollutant sources during construction and land disturbance activities (construction period erosion, sedimentation, and pollution prevention plan) shall be developed and implemented.**

An Erosion and Sediment control plan has been prepared as part of the enclosed Site Development Plans prepared by Bohler Engineering.

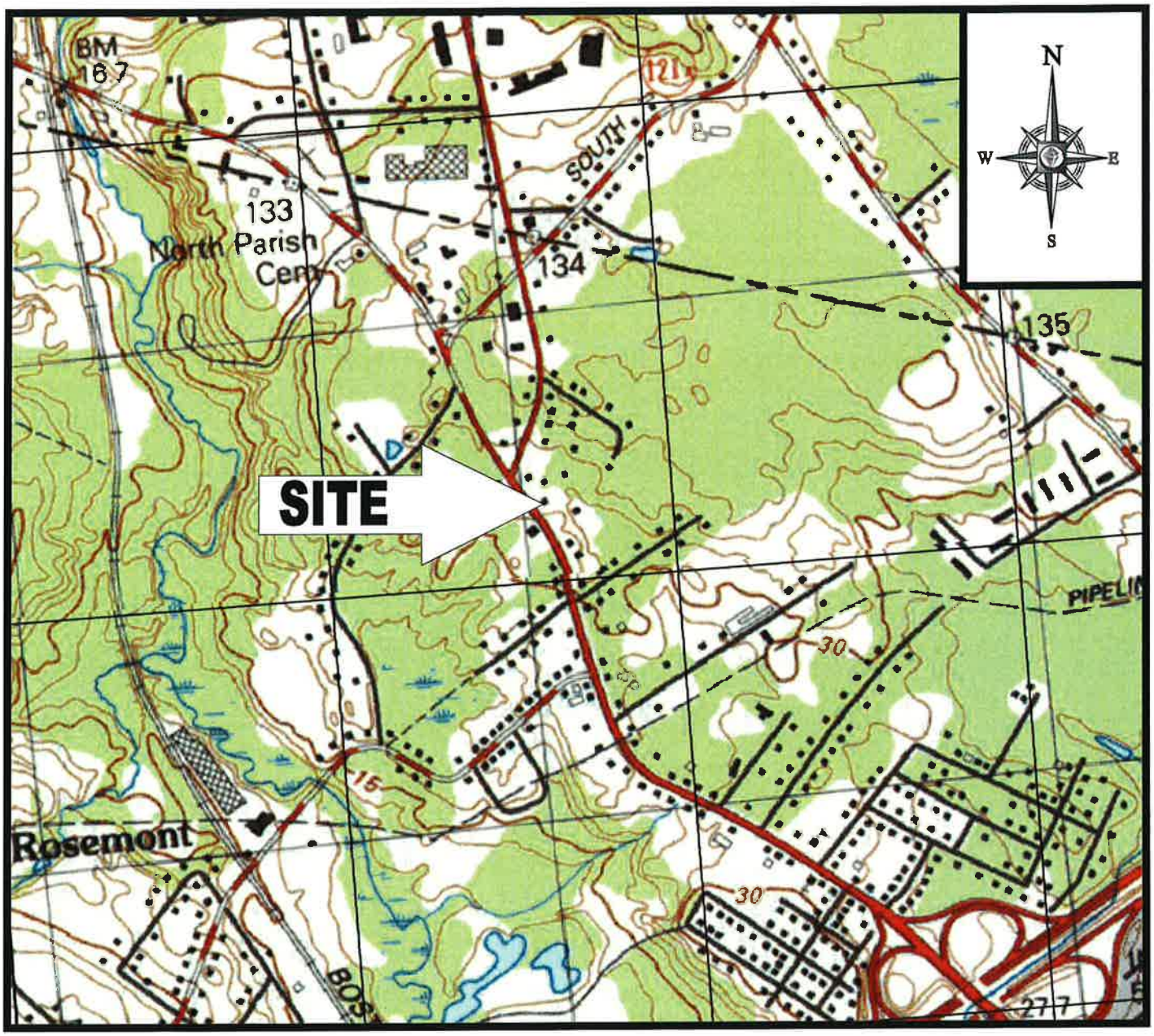
Standard #9: **A long-term operation and maintenance plan shall be developed and implemented to ensure that stormwater management systems function as designed.**

A Long Term Operation and Maintenance Plan for the proposed BMP's has been developed for this project and is included within this report.

Standard #10: **All illicit discharges to the stormwater management system are prohibited**

No illicit discharges will be created as part of the site construction in the area in question.

Appendix 1



LOCATION MAP

SCALE: 1"=1000'
PLAN REFERENCE: USGS HAVERHILL MASSACHUSETTS QUADRANGLE

Appendix 2

MAP SCALE 1" = 500'

250 0 500 1000

FEET

METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0086F

FIRM

FLOOD INSURANCE RATE MAP

ESSEX COUNTY, MASSACHUSETTS (ALL JURISDICTIONS)

PANEL 86 OF 600

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
HAVERHILL, CITY OF	250085	0086	F

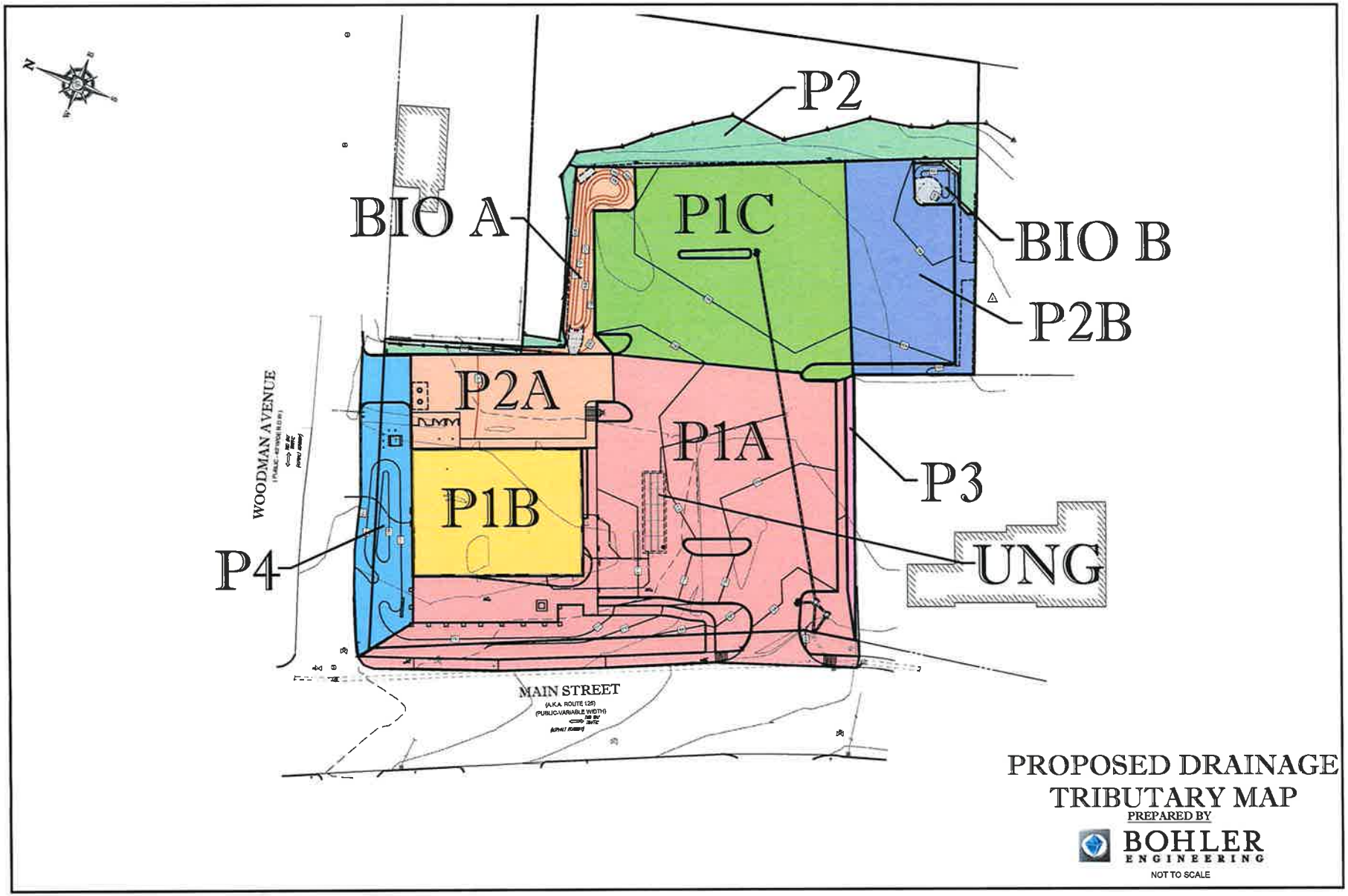
Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
25009C0086F

EFFECTIVE DATE
JULY 3, 2012

Federal Emergency Management Agency

Appendix 3



PROPOSED DRAINAGE TRIBUTARY MAP

PREPARED BY

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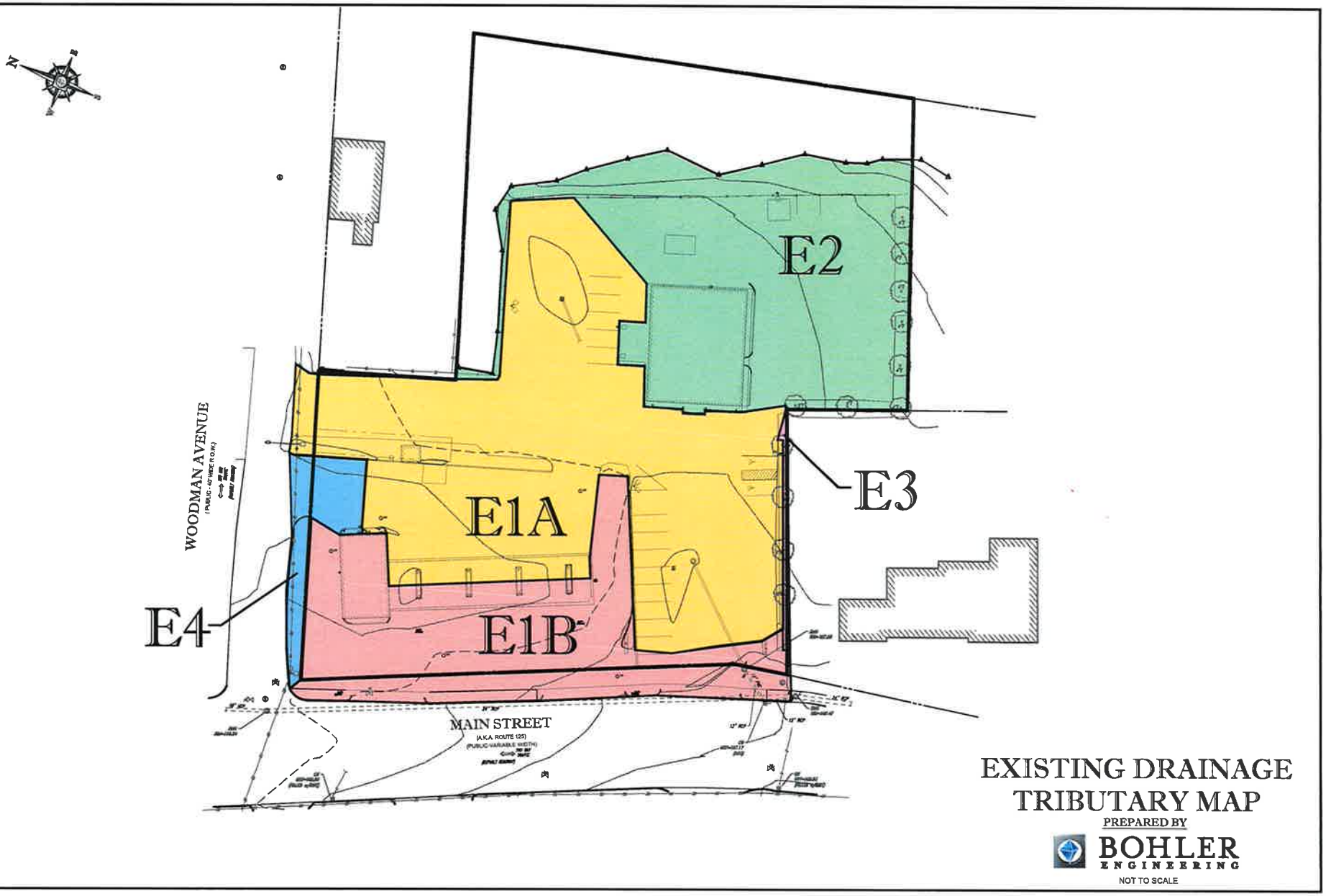
NOT TO SCALE



EXISTING DRAINAGE TRIBUTARY MAP

PREPARED BY

BOHLER ENGINEERING

NOT TO SCALE

Appendix 4

Rainfall Frequencies for Massachusetts Counties

	1	2	5	10	25	50	100
"BARNSTABLE"	2.5	3.6	4.5	4.8	5.7	6.4	7.1
"BERKSHIRE"	2.5	2.9	3.8	4.4	5.1	5.9	6.4
"BRISTOL"	2.5	3.4	4.3	4.8	5.6	6.3	7.0
"DUKES"	2.5	3.6	4.6	4.9	5.8	6.5	7.2
"ESSEX"	2.5	3.1	3.9	4.5	5.4	5.9	6.5
"FRANKLIN"	2.5	2.9	3.8	4.3	5.1	5.8	6.2
"HAMPDEN"	2.5	3.0	4.0	4.6	5.3	6.0	6.5
"HAMPSHIRE"	2.5	3.0	3.9	4.5	5.2	5.9	6.4
"MIDDLESEX"	2.5	3.1	4.0	4.5	5.3	5.9	6.5
"NANTUCKET"	2.5	3.6	4.6	4.9	5.8	6.5	7.2
"NORFOLK"	2.5	3.2	4.1	4.7	5.5	6.1	6.7
"PLYMOUTH"	2.5	3.4	4.3	4.7	5.6	6.2	7.0
"SUFFOLK"	2.5	3.2	4.0	4.6	5.5	6.0	6.6
"WORCESTER"	2.5	3.0	4.0	4.5	5.3	5.9	6.5

Summary for Subcatchment E1A: Developed area to inlets

Runoff = 2.04 cfs @ 12.08 hrs, Volume= 0.159 af, Depth= 2.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 2YR Rainfall=3.10"

Area (sf)	CN	Description
28,295	98	Paved parking, HSG C
1,789	86	<50% Grass cover, Poor, HSG C
30,084	97	Weighted Average
1,789		5.95% Pervious Area
28,295		94.05% Impervious Area

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

Summary for Subcatchment E1B: Developed area sheet flow to Main Street

Runoff = 1.02 cfs @ 12.08 hrs, Volume= 0.081 af, Depth= 2.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 2YR Rainfall=3.10"

Area (sf)	CN	Description
14,750	98	Paved parking, HSG C
52	86	<50% Grass cover, Poor, HSG C
14,802	98	Weighted Average
52		0.35% Pervious Area
14,750		99.65% Impervious Area

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

Summary for Subcatchment E2: To wetlands

Runoff = 1.20 cfs @ 12.09 hrs, Volume= 0.087 af, Depth= 2.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 2YR Rainfall=3.10"

Area (sf)	CN	Description
15,226	98	Paved parking, HSG C
1,091	86	<50% Grass cover, Poor, HSG C
3,850	70	Woods, Good, HSG C
20,167	92	Weighted Average
4,941		24.50% Pervious Area
15,226		75.50% Impervious Area

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

Summary for Subcatchment E3: To abutting property-South

Runoff = 0.02 cfs @ 12.09 hrs, Volume= 0.001 af, Depth= 1.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 2YR Rainfall=3.10"

Area (sf)	CN	Description
25	98	Paved parking, HSG C
377	86	<50% Grass cover, Poor, HSG C
402	87	Weighted Average
377		93.78% Pervious Area
25		6.22% Impervious Area

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

Summary for Subcatchment E4: Sheet flow to Woodsman Ave

Runoff = 0.15 cfs @ 12.08 hrs, Volume= 0.012 af, Depth= 2.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 2YR Rainfall=3.10"

Area (sf)	CN	Description
2,111	98	Paved parking, HSG C
30	86	<50% Grass cover, Poor, HSG C
2,141	98	Weighted Average
30		1.40% Pervious Area
2,111		98.60% Impervious Area

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

Summary for Subcatchment P1A: Developed area to inlets

Runoff = 1.51 cfs @ 12.09 hrs, Volume= 0.109 af, Depth= 2.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 2YR Rainfall=3.10"

Area (sf)	CN	Description
19,506	98	Paved parking, HSG C
5,856	74	>75% Grass cover, Good, HSG C
25,362	92	Weighted Average
5,856		23.09% Pervious Area
19,506		76.91% Impervious Area

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

Summary for Subcatchment P1B: Bldg

Runoff = 0.41 cfs @ 12.08 hrs, Volume= 0.032 af, Depth= 2.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 2YR Rainfall=3.10"

Area (sf)	CN	Description
5,870	98	Roofs, HSG C
5,870		100.00% Impervious Area

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

Summary for Subcatchment P1C: Developed area to inlets

Runoff = 0.89 cfs @ 12.08 hrs, Volume= 0.069 af, Depth= 2.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 2YR Rainfall=3.10"

Area (sf)	CN	Description
12,650	98	Paved parking, HSG C
447	74	>75% Grass cover, Good, HSG C
13,097	97	Weighted Average
447		3.41% Pervious Area
12,650		96.59% Impervious Area

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

Summary for Subcatchment P2: To wetlands sheet flow

Runoff = 0.09 cfs @ 12.10 hrs, Volume= 0.007 af, Depth= 0.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 2YR Rainfall=3.10"

Area (sf)	CN	Description
1,087	74	>75% Grass cover, Good, HSG C
3,544	70	Woods, Good, HSG C
4,631	71	Weighted Average
4,631		100.00% Pervious Area

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

Summary for Subcatchment P2A: To Bio A

Runoff = 0.40 cfs @ 12.09 hrs, Volume= 0.029 af, Depth= 2.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 2YR Rainfall=3.10"

Area (sf)	CN	Description
1,833	74	>75% Grass cover, Good, HSG C
4,940	98	Paved parking, HSG C
6,773	92	Weighted Average
1,833		27.06% Pervious Area
4,940		72.94% Impervious Area

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

Summary for Subcatchment P2B: To Bio B

Runoff = 0.41 cfs @ 12.09 hrs, Volume= 0.030 af, Depth= 2.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 2YR Rainfall=3.10"

Area (sf)	CN	Description
1,621	74	>75% Grass cover, Good, HSG C
5,349	98	Paved parking, HSG C
6,970	92	Weighted Average
1,621		23.26% Pervious Area
5,349		76.74% Impervious Area

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

Summary for Subcatchment P3: To abutting property-South

Runoff = 0.01 cfs @ 12.10 hrs, Volume= 0.001 af, Depth= 0.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 2YR Rainfall=3.10"

Area (sf)	CN	Description
550	74	>75% Grass cover, Good, HSG C
550		100.00% Pervious Area

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

Summary for Subcatchment P4: Sheet flow to Woodsman Ave

Runoff = 0.13 cfs @ 12.09 hrs, Volume= 0.009 af, Depth= 1.20"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 2YR Rainfall=3.10"

Area (sf)	CN	Description
643	98	Paved parking, HSG C
3,429	74	>75% Grass cover, Good, HSG C
4,072	78	Weighted Average
3,429		84.21% Pervious Area
643		15.79% Impervious Area

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

Summary for Reach DPE1: Design Point #1 - Main Street

Inflow Area = 1.030 ac, 95.90% Impervious, Inflow Depth = 2.79" for 2YR event
Inflow = 3.07 cfs @ 12.08 hrs, Volume= 0.240 af
Outflow = 3.07 cfs @ 12.08 hrs, Volume= 0.240 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs

Summary for Reach DPE2: Design Point #2 - Wetlands

Inflow Area = 0.463 ac, 75.50% Impervious, Inflow Depth = 2.26" for 2YR event
Inflow = 1.20 cfs @ 12.09 hrs, Volume= 0.087 af
Outflow = 1.20 cfs @ 12.09 hrs, Volume= 0.087 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs

Summary for Reach DPE3: Design Point #5 - South Abutter

Inflow Area = 0.009 ac, 6.22% Impervious, Inflow Depth = 1.83" for 2YR event
Inflow = 0.02 cfs @ 12.09 hrs, Volume= 0.001 af
Outflow = 0.02 cfs @ 12.09 hrs, Volume= 0.001 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs

Summary for Reach DPE4: Design Point #4 - Woodsman Ave

Inflow Area = 0.049 ac, 98.60% Impervious, Inflow Depth = 2.87" for 2YR event
Inflow = 0.15 cfs @ 12.08 hrs, Volume= 0.012 af
Outflow = 0.15 cfs @ 12.08 hrs, Volume= 0.012 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs

Summary for Reach DPP1: Design Point #1 - Main Street

Inflow Area = 1.018 ac, 85.78% Impervious, Inflow Depth = 2.37" for 2YR event
Inflow = 2.72 cfs @ 12.09 hrs, Volume= 0.201 af
Outflow = 2.72 cfs @ 12.09 hrs, Volume= 0.201 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs

Summary for Reach DPP2: Design Point #2 - Wetlands

Inflow Area = 0.422 ac, 56.00% Impervious, Inflow Depth = 0.94" for 2YR event
Inflow = 0.50 cfs @ 12.09 hrs, Volume= 0.033 af
Outflow = 0.50 cfs @ 12.09 hrs, Volume= 0.033 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs

Summary for Reach DPP3: Design Point #5 - South Abutter

Inflow Area = 0.013 ac, 0.00% Impervious, Inflow Depth = 0.97" for 2YR event
Inflow = 0.01 cfs @ 12.10 hrs, Volume= 0.001 af
Outflow = 0.01 cfs @ 12.10 hrs, Volume= 0.001 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs

Summary for Reach DPP4: Design Point #4 - Woodsman Ave

Inflow Area = 0.093 ac, 15.79% Impervious, Inflow Depth = 0.00" for 2YR event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs

Summary for Pond BIOA: Bioretention "A"

Inflow Area = 0.155 ac, 72.94% Impervious, Inflow Depth = 2.26" for 2YR event
Inflow = 0.40 cfs @ 12.09 hrs, Volume= 0.029 af
Outflow = 0.01 cfs @ 18.57 hrs, Volume= 0.009 af, Atten= 98%, Lag= 388.9 min
Discarded = 0.01 cfs @ 18.57 hrs, Volume= 0.008 af
Primary = 0.00 cfs @ 18.57 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Peak Elev= 108.50' @ 18.57 hrs Surf.Area= 904 sf Storage= 988 cf

Plug-Flow detention time= 463.9 min calculated for 0.009 af (29% of inflow)
Center-of-Mass det. time= 322.6 min (1,121.5 - 798.9)

Volume	Invert	Avail.Storage	Storage Description
#1	107.00'	1,174 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
107.00	382	0	0
108.00	761	572	572
108.70	961	603	1,174

Device	Routing	Invert	Outlet Devices
#1	Discarded	107.00'	**0.270 in/hr Exfiltration over Surface area**
#2	Primary	108.50'	**10.0' long (Profile 1) Broad-Crested Rectangular Weir**
			Head (feet) 0.49 0.98 1.48
			Coef. (English) 2.92 3.37 3.59

Discarded OutFlow Max=0.01 cfs @ 18.57 hrs HW=108.50' (Free Discharge)
↑**1=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=0.00 cfs @ 18.57 hrs HW=108.50' (Free Discharge)
↑**2=Broad-Crested Rectangular Weir** (Weir Controls 0.00 cfs @ 0.06 fps)

Summary for Pond BIOB: Bioretention "B"

Inflow Area = 0.160 ac, 76.74% Impervious, Inflow Depth = 2.26" for 2YR event
Inflow = 0.41 cfs @ 12.09 hrs, Volume= 0.030 af
Outflow = 0.41 cfs @ 12.09 hrs, Volume= 0.028 af, Atten= 0%, Lag= 0.4 min
Discarded = 0.00 cfs @ 12.09 hrs, Volume= 0.002 af
Primary = 0.41 cfs @ 12.09 hrs, Volume= 0.026 af

Routing by Stor-Ind method, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Peak Elev= 107.76' @ 12.09 hrs Surf.Area= 249 sf Storage= 126 cf

Plug-Flow detention time= 71.1 min calculated for 0.028 af (93% of inflow)
Center-of-Mass det. time= 33.8 min (832.7 - 798.9)

Volume	Invert	Avail.Storage	Storage Description
#1	107.00'	164 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
107.00	92	0	0
107.50	188	70	70
107.90	282	94	164

Device	Routing	Invert	Outlet Devices
#1	Discarded	107.00'	**0.270 in/hr Exfiltration over Surface area**
#2	Primary	107.70'	**10.0' long (Profile 1) Broad-Crested Rectangular Weir**
			Head (feet) 0.49 0.98 1.48
			Coef. (English) 2.92 3.37 3.59

Discarded OutFlow Max=0.00 cfs @ 12.09 hrs HW=107.76' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.00 cfs)

Primary OutFlow Max=0.41 cfs @ 12.09 hrs HW=107.76' (Free Discharge)
↑—**2=Broad-Crested Rectangular Weir** (Weir Controls 0.41 cfs @ 0.70 fps)

Summary for Pond DP: grassed depression

Inflow Area = 0.093 ac, 15.79% Impervious, Inflow Depth = 1.20" for 2YR event
Inflow = 0.13 cfs @ 12.09 hrs, Volume= 0.009 af
Outflow = 0.00 cfs @ 16.90 hrs, Volume= 0.006 af, Atten= 97%, Lag= 288.5 min
Discarded = 0.00 cfs @ 16.90 hrs, Volume= 0.006 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Peak Elev= 110.55' @ 16.90 hrs Surf.Area= 708 sf Storage= 256 cf

Plug-Flow detention time= 444.0 min calculated for 0.006 af (60% of inflow)
Center-of-Mass det. time= 328.0 min (1,179.0 - 850.9)

Volume	Invert	Avail.Storage	Storage Description
#1	110.00'	1,406 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
110.00	224	0	0
111.00	1,104	664	664
111.50	1,863	742	1,406

Device	Routing	Invert	Outlet Devices
#1	Discarded	110.00'	**0.270 in/hr Exfiltration over Surface area**
#2	Primary	110.75'	**10.0' long (Profile 1) Broad-Crested Rectangular Weir**
			Head (feet) 0.49 0.98 1.48
			Coef. (English) 2.92 3.37 3.59

Discarded OutFlow Max=0.00 cfs @ 16.90 hrs HW=110.55' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.00 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=110.00' (Free Discharge)
↑—**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond RD: CULTEC 100 HD

Inflow Area = 0.135 ac,100.00% Impervious, Inflow Depth = 2.87" for 2YR event
Inflow = 0.41 cfs @ 12.08 hrs, Volume= 0.032 af
Outflow = 0.36 cfs @ 12.13 hrs, Volume= 0.028 af, Atten= 12%, Lag= 2.6 min
Discarded = 0.00 cfs @ 4.05 hrs, Volume= 0.005 af
Primary = 0.35 cfs @ 12.13 hrs, Volume= 0.023 af

Routing by Stor-Ind method, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs / 9
Peak Elev= 108.45' @ 12.13 hrs Surf.Area= 390 sf Storage= 336 cf

Plug-Flow detention time= 130.3 min calculated for 0.028 af (86% of inflow)
Center-of-Mass det. time= 69.3 min (826.4 - 757.1)

Volume	Invert	Avail.Storage	Storage Description
#1A	107.00'	263 cf	**12.00'W x 32.50'L x 2.04'H Field A**
			796 cf Overall - 170 cf Embedded = 626 cf x 42.0% Voids
#2A	107.50'	170 cf	**Cultec C-100HD** x 12 Inside #1
			Effective Size= 32.1"W x 12.0"H => 1.86 sf x 7.50'L = 14.0 cf
			Overall Size= 36.0"W x 12.5"H x 8.00'L with 0.50' Overlap
			Row Length Adjustment= +0.50' x 1.86 sf x 3 rows
		433 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	107.00'	**0.270 in/hr Exfiltration over Surface area**
#2	Primary	107.98'	**6.0" Round Culvert**
			L= 80.0' CMP, projecting, no headwall, Ke= 0.900
			Inlet / Outlet Invert= 107.98' / 104.95' S= 0.0379 '/' Cc= 0.900
			n= 0.013, Flow Area= 0.20 sf

Discarded OutFlow Max=0.00 cfs @ 4.05 hrs HW=107.02' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.00 cfs)

Primary OutFlow Max=0.35 cfs @ 12.13 hrs HW=108.45' (Free Discharge)
↑—**2=Culvert** (Inlet Controls 0.35 cfs @ 1.84 fps)

Summary for Subcatchment E1A: Developed area to inlets

Runoff = 3.01 cfs @ 12.08 hrs, Volume= 0.239 af, Depth= 4.15"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 10YR Rainfall=4.50"

Area (sf)	CN	Description
28,295	98	Paved parking, HSG C
1,789	86	<50% Grass cover, Poor, HSG C
30,084	97	Weighted Average
1,789		5.95% Pervious Area
28,295		94.05% Impervious Area

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

Summary for Subcatchment E1B: Developed area sheet flow to Main Street

Runoff = 1.49 cfs @ 12.08 hrs, Volume= 0.121 af, Depth= 4.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 10YR Rainfall=4.50"

Area (sf)	CN	Description
14,750	98	Paved parking, HSG C
52	86	<50% Grass cover, Poor, HSG C
14,802	98	Weighted Average
52		0.35% Pervious Area
14,750		99.65% Impervious Area

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

Summary for Subcatchment E2: To wetlands

Runoff = 1.87 cfs @ 12.08 hrs, Volume= 0.139 af, Depth= 3.60"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 10YR Rainfall=4.50"

Area (sf)	CN	Description
15,226	98	Paved parking, HSG C
1,091	86	<50% Grass cover, Poor, HSG C
3,850	70	Woods, Good, HSG C
20,167	92	Weighted Average
4,941		24.50% Pervious Area
15,226		75.50% Impervious Area

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

Summary for Subcatchment E3: To abutting property-South

Runoff = 0.03 cfs @ 12.09 hrs, Volume= 0.002 af, Depth= 3.10"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 10YR Rainfall=4.50"

Area (sf)	CN	Description
25	98	Paved parking, HSG C
377	86	<50% Grass cover, Poor, HSG C
402	87	Weighted Average
377		93.78% Pervious Area
25		6.22% Impervious Area

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

Summary for Subcatchment E4: Sheet flow to Woodsman Ave

Runoff = 0.22 cfs @ 12.08 hrs, Volume= 0.017 af, Depth= 4.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 10YR Rainfall=4.50"

Area (sf)	CN	Description
2,111	98	Paved parking, HSG C
30	86	<50% Grass cover, Poor, HSG C
2,141	98	Weighted Average
30		1.40% Pervious Area
2,111		98.60% Impervious Area

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

Summary for Subcatchment P1A: Developed area to inlets

Runoff = 2.35 cfs @ 12.08 hrs, Volume= 0.175 af, Depth= 3.60"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 10YR Rainfall=4.50"

Area (sf)	CN	Description
19,506	98	Paved parking, HSG C
5,856	74	>75% Grass cover, Good, HSG C
25,362	92	Weighted Average
5,856		23.09% Pervious Area
19,506		76.91% Impervious Area

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

Summary for Subcatchment P1B: Bldg

Runoff = 0.59 cfs @ 12.08 hrs, Volume= 0.048 af, Depth= 4.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 10YR Rainfall=4.50"

Area (sf)	CN	Description
5,870	98	Roofs, HSG C
5,870		100.00% Impervious Area

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

Summary for Subcatchment P1C: Developed area to inlets

Runoff = 1.31 cfs @ 12.08 hrs, Volume= 0.104 af, Depth= 4.15"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 10YR Rainfall=4.50"

Area (sf)	CN	Description
12,650	98	Paved parking, HSG C
447	74	>75% Grass cover, Good, HSG C
13,097	97	Weighted Average
447		3.41% Pervious Area
12,650		96.59% Impervious Area

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

Summary for Subcatchment P2: To wetlands sheet flow

Runoff = 0.21 cfs @ 12.09 hrs, Volume= 0.015 af, Depth= 1.75"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 10YR Rainfall=4.50"

Area (sf)	CN	Description
1,087	74	>75% Grass cover, Good, HSG C
3,544	70	Woods, Good, HSG C
4,631	71	Weighted Average
4,631		100.00% Pervious Area

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

Summary for Subcatchment P2A: To Bio A

Runoff = 0.63 cfs @ 12.08 hrs, Volume= 0.047 af, Depth= 3.60"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 10YR Rainfall=4.50"

Area (sf)	CN	Description
1,833	74	>75% Grass cover, Good, HSG C
4,940	98	Paved parking, HSG C
6,773	92	Weighted Average
1,833		27.06% Pervious Area
4,940		72.94% Impervious Area

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

Summary for Subcatchment P2B: To Bio B

Runoff = 0.65 cfs @ 12.08 hrs, Volume= 0.048 af, Depth= 3.60"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 10YR Rainfall=4.50"

Area (sf)	CN	Description
1,621	74	>75% Grass cover, Good, HSG C
5,349	98	Paved parking, HSG C
6,970	92	Weighted Average
1,621		23.26% Pervious Area
5,349		76.74% Impervious Area

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

Summary for Subcatchment P3: To abutting property-South

Runoff = 0.03 cfs @ 12.09 hrs, Volume= 0.002 af, Depth= 1.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 10YR Rainfall=4.50"

Area (sf)	CN	Description
550	74	>75% Grass cover, Good, HSG C
550		100.00% Pervious Area

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

Summary for Subcatchment P4: Sheet flow to Woodsman Ave

Runoff = 0.25 cfs @ 12.09 hrs, Volume= 0.018 af, Depth= 2.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 10YR Rainfall=4.50"

Area (sf)	CN	Description
643	98	Paved parking, HSG C
3,429	74	>75% Grass cover, Good, HSG C
4,072	78	Weighted Average
3,429		84.21% Pervious Area
643		15.79% Impervious Area

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

Summary for Reach DPE1: Design Point #1 - Main Street

Inflow Area = 1.030 ac, 95.90% Impervious, Inflow Depth = 4.19" for 10YR event
Inflow = 4.50 cfs @ 12.08 hrs, Volume= 0.360 af
Outflow = 4.50 cfs @ 12.08 hrs, Volume= 0.360 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs

Summary for Reach DPE2: Design Point #2 - Wetlands

Inflow Area = 0.463 ac, 75.50% Impervious, Inflow Depth = 3.60" for 10YR event
Inflow = 1.87 cfs @ 12.08 hrs, Volume= 0.139 af
Outflow = 1.87 cfs @ 12.08 hrs, Volume= 0.139 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs

Summary for Reach DPE3: Design Point #5 - South Abutter

Inflow Area = 0.009 ac, 6.22% Impervious, Inflow Depth = 3.10" for 10YR event
Inflow = 0.03 cfs @ 12.09 hrs, Volume= 0.002 af
Outflow = 0.03 cfs @ 12.09 hrs, Volume= 0.002 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs

Summary for Reach DPE4: Design Point #4 - Woodsman Ave

Inflow Area = 0.049 ac, 98.60% Impervious, Inflow Depth = 4.26" for 10YR event
Inflow = 0.22 cfs @ 12.08 hrs, Volume= 0.017 af
Outflow = 0.22 cfs @ 12.08 hrs, Volume= 0.017 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs

Summary for Reach DPP1: Design Point #1 - Main Street

Inflow Area = 1.018 ac, 85.78% Impervious, Inflow Depth = 3.74" for 10YR event
Inflow = 4.12 cfs @ 12.09 hrs, Volume= 0.317 af
Outflow = 4.12 cfs @ 12.09 hrs, Volume= 0.317 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs

Summary for Reach DPP2: Design Point #2 - Wetlands

Inflow Area = 0.422 ac, 56.00% Impervious, Inflow Depth = 2.15" for 10YR event
Inflow = 0.86 cfs @ 12.09 hrs, Volume= 0.076 af
Outflow = 0.86 cfs @ 12.09 hrs, Volume= 0.076 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs

Summary for Reach DPP3: Design Point #5 - South Abutter

Inflow Area = 0.013 ac, 0.00% Impervious, Inflow Depth = 1.97" for 10YR event
Inflow = 0.03 cfs @ 12.09 hrs, Volume= 0.002 af
Outflow = 0.03 cfs @ 12.09 hrs, Volume= 0.002 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs

Summary for Reach DPP4: Design Point #4 - Woodsman Ave

Inflow Area = 0.093 ac, 15.79% Impervious, Inflow Depth = 0.40" for 10YR event
Inflow = 0.02 cfs @ 12.98 hrs, Volume= 0.003 af
Outflow = 0.02 cfs @ 12.98 hrs, Volume= 0.003 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs

Summary for Pond BIOA: Bioretention "A"

Inflow Area = 0.155 ac, 72.94% Impervious, Inflow Depth = 3.60" for 10YR event
Inflow = 0.63 cfs @ 12.08 hrs, Volume= 0.047 af
Outflow = 0.24 cfs @ 12.33 hrs, Volume= 0.026 af, Atten= 62%, Lag= 14.6 min
Discarded = 0.01 cfs @ 12.33 hrs, Volume= 0.009 af
Primary = 0.23 cfs @ 12.33 hrs, Volume= 0.017 af

Routing by Stor-Ind method, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Peak Elev= 108.54' @ 12.33 hrs Surf.Area= 915 sf Storage= 1,023 cf

Plug-Flow detention time= 254.6 min calculated for 0.026 af (55% of inflow)
Center-of-Mass det. time= 146.6 min (932.7 - 786.1)

Volume	Invert	Avail.Storage	Storage Description
#1	107.00'	1,174 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
107.00	382	0	0
108.00	761	572	572
108.70	961	603	1,174

Device	Routing	Invert	Outlet Devices
#1	Discarded	107.00'	**0.270 in/hr Exfiltration over Surface area**
#2	Primary	108.50'	**10.0' long (Profile 1) Broad-Crested Rectangular Weir**
			Head (feet) 0.49 0.98 1.48
			Coef. (English) 2.92 3.37 3.59

Discarded OutFlow Max=0.01 cfs @ 12.33 hrs HW=108.54' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=0.23 cfs @ 12.33 hrs HW=108.54' (Free Discharge)
↑—**2=Broad-Crested Rectangular Weir** (Weir Controls 0.23 cfs @ 0.58 fps)

Summary for Pond BIOB: Bioretention "B"

Inflow Area = 0.160 ac, 76.74% Impervious, Inflow Depth = 3.60" for 10YR event
Inflow = 0.65 cfs @ 12.08 hrs, Volume= 0.048 af
Outflow = 0.64 cfs @ 12.09 hrs, Volume= 0.046 af, Atten= 0%, Lag= 0.3 min
Discarded = 0.00 cfs @ 12.09 hrs, Volume= 0.003 af
Primary = 0.64 cfs @ 12.09 hrs, Volume= 0.043 af

Routing by Stor-Ind method, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Peak Elev= 107.78' @ 12.09 hrs Surf.Area= 253 sf Storage= 131 cf

Plug-Flow detention time= 50.6 min calculated for 0.046 af (96% of inflow)
Center-of-Mass det. time= 25.3 min (811.4 - 786.1)

Volume	Invert	Avail.Storage	Storage Description
#1	107.00'	164 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
107.00	92	0	0
107.50	188	70	70
107.90	282	94	164

Device	Routing	Invert	Outlet Devices
#1	Discarded	107.00'	**0.270 in/hr Exfiltration over Surface area**
#2	Primary	107.70'	**10.0' long (Profile 1) Broad-Crested Rectangular Weir**
			Head (feet) 0.49 0.98 1.48
			Coef. (English) 2.92 3.37 3.59

Discarded OutFlow Max=0.00 cfs @ 12.09 hrs HW=107.78' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.00 cfs)

Primary OutFlow Max=0.64 cfs @ 12.09 hrs HW=107.78' (Free Discharge)
↑—**2=Broad-Crested Rectangular Weir** (Weir Controls 0.64 cfs @ 0.82 fps)

Summary for Pond DP: grassed depression

Inflow Area = 0.093 ac, 15.79% Impervious, Inflow Depth = 2.29" for 10YR event
Inflow = 0.25 cfs @ 12.09 hrs, Volume= 0.018 af
Outflow = 0.03 cfs @ 12.98 hrs, Volume= 0.011 af, Atten= 90%, Lag= 53.6 min
Discarded = 0.01 cfs @ 12.98 hrs, Volume= 0.008 af
Primary = 0.02 cfs @ 12.98 hrs, Volume= 0.003 af

Routing by Stor-Ind method, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Peak Elev= 110.76' @ 12.98 hrs Surf.Area= 889 sf Storage= 421 cf

Plug-Flow detention time= 353.7 min calculated for 0.011 af (59% of inflow)
Center-of-Mass det. time= 243.3 min (1,075.2 - 831.9)

Volume	Invert	Avail.Storage	Storage Description
#1	110.00'	1,406 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
110.00	224	0	0
111.00	1,104	664	664
111.50	1,863	742	1,406

Device	Routing	Invert	Outlet Devices
#1	Discarded	110.00'	**0.270 in/hr Exfiltration over Surface area**
#2	Primary	110.75'	**10.0' long (Profile 1) Broad-Crested Rectangular Weir**
			Head (feet) 0.49 0.98 1.48
			Coef. (English) 2.92 3.37 3.59

Discarded OutFlow Max=0.01 cfs @ 12.98 hrs HW=110.76' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=0.01 cfs @ 12.98 hrs HW=110.76' (Free Discharge)
↑—**2=Broad-Crested Rectangular Weir** (Weir Controls 0.01 cfs @ 0.22 fps)

Summary for Pond RD: CULTEC 100 HD

Inflow Area = 0.135 ac,100.00% Impervious, Inflow Depth = 4.26" for 10YR event
Inflow = 0.59 cfs @ 12.08 hrs, Volume= 0.048 af
Outflow = 0.50 cfs @ 12.13 hrs, Volume= 0.043 af, Atten= 15%, Lag= 2.9 min
Discarded = 0.00 cfs @ 2.65 hrs, Volume= 0.005 af
Primary = 0.50 cfs @ 12.13 hrs, Volume= 0.038 af

Routing by Stor-Ind method, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs / 9
Peak Elev= 108.68' @ 12.13 hrs Surf.Area= 390 sf Storage= 374 cf

Plug-Flow detention time= 105.3 min calculated for 0.043 af (91% of inflow)
Center-of-Mass det. time= 57.9 min (807.7 - 749.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	107.00'	263 cf	**12.00'W x 32.50'L x 2.04'H Field A**
			796 cf Overall - 170 cf Embedded = 626 cf x 42.0% Voids
#2A	107.50'	170 cf	**Cultec C-100HD** x 12 Inside #1
			Effective Size= 32.1"W x 12.0"H => 1.86 sf x 7.50'L = 14.0 cf
			Overall Size= 36.0"W x 12.5"H x 8.00'L with 0.50' Overlap
			Row Length Adjustment= +0.50' x 1.86 sf x 3 rows
		433 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	107.00'	**0.270 in/hr Exfiltration over Surface area**
#2	Primary	107.98'	**6.0" Round Culvert**
			L= 80.0' CMP, projecting, no headwall, Ke= 0.900
			Inlet / Outlet Invert= 107.98' / 104.95' S= 0.0379 '/' Cc= 0.900
			n= 0.013, Flow Area= 0.20 sf

Discarded OutFlow Max=0.00 cfs @ 2.65 hrs HW=107.02' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.00 cfs)

Primary OutFlow Max=0.50 cfs @ 12.13 hrs HW=108.68' (Free Discharge)
↑—**2=Culvert** (Inlet Controls 0.50 cfs @ 2.55 fps)

Summary for Subcatchment E1A: Developed area to inlets

Runoff = 3.63 cfs @ 12.08 hrs, Volume= 0.290 af, Depth= 5.05"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 25YR Rainfall=5.40"

Area (sf)	CN	Description
28,295	98	Paved parking, HSG C
1,789	86	<50% Grass cover, Poor, HSG C
30,084	97	Weighted Average
1,789		5.95% Pervious Area
28,295		94.05% Impervious Area

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

Summary for Subcatchment E1B: Developed area sheet flow to Main Street

Runoff = 1.80 cfs @ 12.08 hrs, Volume= 0.146 af, Depth= 5.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 25YR Rainfall=5.40"

Area (sf)	CN	Description
14,750	98	Paved parking, HSG C
52	86	<50% Grass cover, Poor, HSG C
14,802	98	Weighted Average
52		0.35% Pervious Area
14,750		99.65% Impervious Area

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

Summary for Subcatchment E2: To wetlands

Runoff = 2.30 cfs @ 12.08 hrs, Volume= 0.173 af, Depth= 4.48"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 25YR Rainfall=5.40"

Area (sf)	CN	Description
15,226	98	Paved parking, HSG C
1,091	86	<50% Grass cover, Poor, HSG C
3,850	70	Woods, Good, HSG C
20,167	92	Weighted Average
4,941		24.50% Pervious Area
15,226		75.50% Impervious Area

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

Summary for Subcatchment E3: To abutting property-South

Runoff = 0.04 cfs @ 12.09 hrs, Volume= 0.003 af, Depth= 3.95"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 25YR Rainfall=5.40"

Area (sf)	CN	Description
25	98	Paved parking, HSG C
377	86	<50% Grass cover, Poor, HSG C
402	87	Weighted Average
377		93.78% Pervious Area
25		6.22% Impervious Area

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

Summary for Subcatchment E4: Sheet flow to Woodsman Ave

Runoff = 0.26 cfs @ 12.08 hrs, Volume= 0.021 af, Depth= 5.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 25YR Rainfall=5.40"

Area (sf)	CN	Description
2,111	98	Paved parking, HSG C
30	86	<50% Grass cover, Poor, HSG C
2,141	98	Weighted Average
30		1.40% Pervious Area
2,111		98.60% Impervious Area

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

Summary for Subcatchment P1A: Developed area to inlets

Runoff = 2.89 cfs @ 12.08 hrs, Volume= 0.217 af, Depth= 4.48"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 25YR Rainfall=5.40"

Area (sf)	CN	Description
19,506	98	Paved parking, HSG C
5,856	74	>75% Grass cover, Good, HSG C
25,362	92	Weighted Average
5,856		23.09% Pervious Area
19,506		76.91% Impervious Area

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

Summary for Subcatchment P1B: Bldg

Runoff = 0.71 cfs @ 12.08 hrs, Volume= 0.058 af, Depth= 5.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 25YR Rainfall=5.40"

Area (sf)	CN	Description
5,870	98	Roofs, HSG C
5,870		100.00% Impervious Area

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

Summary for Subcatchment P1C: Developed area to inlets

Runoff = 1.58 cfs @ 12.08 hrs, Volume= 0.126 af, Depth= 5.05"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 25YR Rainfall=5.40"

Area (sf)	CN	Description
12,650	98	Paved parking, HSG C
447	74	>75% Grass cover, Good, HSG C
13,097	97	Weighted Average
447		3.41% Pervious Area
12,650		96.59% Impervious Area

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

Summary for Subcatchment P2: To wetlands sheet flow

Runoff = 0.30 cfs @ 12.09 hrs, Volume= 0.021 af, Depth= 2.42"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 25YR Rainfall=5.40"

Area (sf)	CN	Description
1,087	74	>75% Grass cover, Good, HSG C
3,544	70	Woods, Good, HSG C
4,631	71	Weighted Average
4,631		100.00% Pervious Area

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

Summary for Subcatchment P2A: To Bio A

Runoff = 0.77 cfs @ 12.08 hrs, Volume= 0.058 af, Depth= 4.48"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 25YR Rainfall=5.40"

Area (sf)	CN	Description
1,833	74	>75% Grass cover, Good, HSG C
4,940	98	Paved parking, HSG C
6,773	92	Weighted Average
1,833		27.06% Pervious Area
4,940		72.94% Impervious Area

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

Summary for Subcatchment P2B: To Bio B

Runoff = 0.79 cfs @ 12.08 hrs, Volume= 0.060 af, Depth= 4.48"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 25YR Rainfall=5.40"

Area (sf)	CN	Description
1,621	74	>75% Grass cover, Good, HSG C
5,349	98	Paved parking, HSG C
6,970	92	Weighted Average
1,621		23.26% Pervious Area
5,349		76.74% Impervious Area

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

Summary for Subcatchment P3: To abutting property-South

Runoff = 0.04 cfs @ 12.09 hrs, Volume= 0.003 af, Depth= 2.69"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 25YR Rainfall=5.40"

Area (sf)	CN	Description
550	74	>75% Grass cover, Good, HSG C
550		100.00% Pervious Area

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

Summary for Subcatchment P4: Sheet flow to Woodsman Ave

Runoff = 0.33 cfs @ 12.09 hrs, Volume= 0.024 af, Depth= 3.05"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 25YR Rainfall=5.40"

Area (sf)	CN	Description
643	98	Paved parking, HSG C
3,429	74	>75% Grass cover, Good, HSG C
4,072	78	Weighted Average
3,429		84.21% Pervious Area
643		15.79% Impervious Area

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

Summary for Reach DPE1: Design Point #1 - Main Street

Inflow Area = 1.030 ac, 95.90% Impervious, Inflow Depth = 5.08" for 25YR event
Inflow = 5.43 cfs @ 12.08 hrs, Volume= 0.437 af
Outflow = 5.43 cfs @ 12.08 hrs, Volume= 0.437 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs

Summary for Reach DPE2: Design Point #2 - Wetlands

Inflow Area = 0.463 ac, 75.50% Impervious, Inflow Depth = 4.48" for 25YR event
Inflow = 2.30 cfs @ 12.08 hrs, Volume= 0.173 af
Outflow = 2.30 cfs @ 12.08 hrs, Volume= 0.173 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs

Summary for Reach DPE3: Design Point #5 - South Abutter

Inflow Area = 0.009 ac, 6.22% Impervious, Inflow Depth = 3.95" for 25YR event
Inflow = 0.04 cfs @ 12.09 hrs, Volume= 0.003 af
Outflow = 0.04 cfs @ 12.09 hrs, Volume= 0.003 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs

Summary for Reach DPE4: Design Point #4 - Woodsman Ave

Inflow Area = 0.049 ac, 98.60% Impervious, Inflow Depth = 5.16" for 25YR event
Inflow = 0.26 cfs @ 12.08 hrs, Volume= 0.021 af
Outflow = 0.26 cfs @ 12.08 hrs, Volume= 0.021 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs

Summary for Reach DPP1: Design Point #1 - Main Street

Inflow Area = 1.018 ac, 85.78% Impervious, Inflow Depth = 4.62" for 25YR event
Inflow = 5.01 cfs @ 12.09 hrs, Volume= 0.392 af
Outflow = 5.01 cfs @ 12.09 hrs, Volume= 0.392 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs

Summary for Reach DPP2: Design Point #2 - Wetlands

Inflow Area = 0.422 ac, 56.00% Impervious, Inflow Depth = 2.97" for 25YR event
Inflow = 1.48 cfs @ 12.14 hrs, Volume= 0.104 af
Outflow = 1.48 cfs @ 12.14 hrs, Volume= 0.104 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs

Summary for Reach DPP3: Design Point #5 - South Abutter

Inflow Area = 0.013 ac, 0.00% Impervious, Inflow Depth = 2.69" for 25YR event
Inflow = 0.04 cfs @ 12.09 hrs, Volume= 0.003 af
Outflow = 0.04 cfs @ 12.09 hrs, Volume= 0.003 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs

Summary for Reach DPP4: Design Point #4 - Woodsman Ave

Inflow Area = 0.093 ac, 15.79% Impervious, Inflow Depth = 1.09" for 25YR event
Inflow = 0.12 cfs @ 12.35 hrs, Volume= 0.008 af
Outflow = 0.12 cfs @ 12.35 hrs, Volume= 0.008 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs

Summary for Pond BIOA: Bioretention "A"

Inflow Area = 0.155 ac, 72.94% Impervious, Inflow Depth = 4.48" for 25YR event
Inflow = 0.77 cfs @ 12.08 hrs, Volume= 0.058 af
Outflow = 0.58 cfs @ 12.15 hrs, Volume= 0.037 af, Atten= 25%, Lag= 4.2 min
Discarded = 0.01 cfs @ 12.15 hrs, Volume= 0.009 af
Primary = 0.57 cfs @ 12.15 hrs, Volume= 0.028 af

Routing by Stor-Ind method, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Peak Elev= 108.57' @ 12.15 hrs Surf.Area= 925 sf Storage= 1,054 cf

Plug-Flow detention time= 210.2 min calculated for 0.037 af (64% of inflow)
Center-of-Mass det. time= 111.3 min (891.6 - 780.3)

Volume	Invert	Avail.Storage	Storage Description
#1	107.00'	1,174 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
107.00	382	0	0
108.00	761	572	572
108.70	961	603	1,174

Device	Routing	Invert	Outlet Devices
#1	Discarded	107.00'	**0.270 in/hr Exfiltration over Surface area**
#2	Primary	108.50'	**10.0' long (Profile 1) Broad-Crested Rectangular Weir**
			Head (feet) 0.49 0.98 1.48
			Coef. (English) 2.92 3.37 3.59

Discarded OutFlow Max=0.01 cfs @ 12.15 hrs HW=108.57' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=0.57 cfs @ 12.15 hrs HW=108.57' (Free Discharge)
↑—**2=Broad-Crested Rectangular Weir** (Weir Controls 0.57 cfs @ 0.78 fps)

Summary for Pond BIOB: Bioretention "B"

Inflow Area = 0.160 ac, 76.74% Impervious, Inflow Depth = 4.48" for 25YR event
Inflow = 0.79 cfs @ 12.08 hrs, Volume= 0.060 af
Outflow = 0.79 cfs @ 12.09 hrs, Volume= 0.058 af, Atten= 0%, Lag= 0.3 min
Discarded = 0.00 cfs @ 12.09 hrs, Volume= 0.003 af
Primary = 0.79 cfs @ 12.09 hrs, Volume= 0.055 af

Routing by Stor-Ind method, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Peak Elev= 107.79' @ 12.09 hrs Surf.Area= 256 sf Storage= 134 cf

Plug-Flow detention time= 43.2 min calculated for 0.058 af (96% of inflow)
Center-of-Mass det. time= 22.2 min (802.5 - 780.3)

Volume	Invert	Avail.Storage	Storage Description
#1	107.00'	164 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
107.00	92	0	0
107.50	188	70	70
107.90	282	94	164

Device	Routing	Invert	Outlet Devices
#1	Discarded	107.00'	**0.270 in/hr Exfiltration over Surface area**
#2	Primary	107.70'	**10.0' long (Profile 1) Broad-Crested Rectangular Weir**
			Head (feet) 0.49 0.98 1.48
			Coef. (English) 2.92 3.37 3.59

Discarded OutFlow Max=0.00 cfs @ 12.09 hrs HW=107.79' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.00 cfs)

Primary OutFlow Max=0.79 cfs @ 12.09 hrs HW=107.79' (Free Discharge)
↑—**2=Broad-Crested Rectangular Weir** (Weir Controls 0.79 cfs @ 0.88 fps)

Summary for Pond DP: grassed depression

Inflow Area = 0.093 ac, 15.79% Impervious, Inflow Depth = 3.05" for 25YR event
Inflow = 0.33 cfs @ 12.09 hrs, Volume= 0.024 af
Outflow = 0.13 cfs @ 12.35 hrs, Volume= 0.016 af, Atten= 61%, Lag= 15.4 min
Discarded = 0.01 cfs @ 12.35 hrs, Volume= 0.008 af
Primary = 0.12 cfs @ 12.35 hrs, Volume= 0.008 af

Routing by Stor-Ind method, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Peak Elev= 110.78' @ 12.35 hrs Surf.Area= 907 sf Storage= 439 cf

Plug-Flow detention time= 255.0 min calculated for 0.016 af (68% of inflow)
Center-of-Mass det. time= 156.3 min (980.0 - 823.7)

Volume	Invert	Avail.Storage	Storage Description
#1	110.00'	1,406 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
110.00	224	0	0
111.00	1,104	664	664
111.50	1,863	742	1,406

Device	Routing	Invert	Outlet Devices
#1	Discarded	110.00'	**0.270 in/hr Exfiltration over Surface area**
#2	Primary	110.75'	**10.0' long (Profile 1) Broad-Crested Rectangular Weir**
			Head (feet) 0.49 0.98 1.48
			Coef. (English) 2.92 3.37 3.59

Discarded OutFlow Max=0.01 cfs @ 12.35 hrs HW=110.78' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=0.12 cfs @ 12.35 hrs HW=110.78' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** (Weir Controls 0.12 cfs @ 0.47 fps)

Summary for Pond RD: CULTEC 100 HD

Inflow Area = 0.135 ac,100.00% Impervious, Inflow Depth = 5.16" for 25YR event
Inflow = 0.71 cfs @ 12.08 hrs, Volume= 0.058 af
Outflow = 0.59 cfs @ 12.14 hrs, Volume= 0.053 af, Atten= 17%, Lag= 3.2 min
Discarded = 0.00 cfs @ 2.11 hrs, Volume= 0.005 af
Primary = 0.59 cfs @ 12.14 hrs, Volume= 0.048 af

Routing by Stor-Ind method, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs / 9
Peak Elev= 108.85' @ 12.14 hrs Surf.Area= 390 sf Storage= 402 cf

Plug-Flow detention time= 94.5 min calculated for 0.053 af (92% of inflow)
Center-of-Mass det. time= 52.9 min (799.7 - 746.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	107.00'	263 cf	**12.00'W x 32.50'L x 2.04'H Field A**
			796 cf Overall - 170 cf Embedded = 626 cf x 42.0% Voids
#2A	107.50'	170 cf	**Cultec C-100HD** x 12 Inside #1
			Effective Size= 32.1"W x 12.0"H => 1.86 sf x 7.50'L = 14.0 cf
			Overall Size= 36.0"W x 12.5"H x 8.00'L with 0.50' Overlap
			Row Length Adjustment= +0.50' x 1.86 sf x 3 rows
		433 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	107.00'	**0.270 in/hr Exfiltration over Surface area**
#2	Primary	107.98'	**6.0" Round Culvert**
			L= 80.0' CMP, projecting, no headwall, Ke= 0.900
			Inlet / Outlet Invert= 107.98' / 104.95' S= 0.0379 '/' Cc= 0.900
			n= 0.013, Flow Area= 0.20 sf

Discarded OutFlow Max=0.00 cfs @ 2.11 hrs HW=107.02' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.00 cfs)

Primary OutFlow Max=0.59 cfs @ 12.14 hrs HW=108.85' (Free Discharge)
└**2=Culvert** (Inlet Controls 0.59 cfs @ 3.00 fps)

Summary for Subcatchment E1A: Developed area to inlets

Runoff = 4.38 cfs @ 12.08 hrs, Volume= 0.354 af, Depth= 6.14"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 100YR Rainfall=6.50"

Area (sf)	CN	Description
28,295	98	Paved parking, HSG C
1,789	86	<50% Grass cover, Poor, HSG C
30,084	97	Weighted Average
1,789		5.95% Pervious Area
28,295		94.05% Impervious Area

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

Summary for Subcatchment E1B: Developed area sheet flow to Main Street

Runoff = 2.17 cfs @ 12.08 hrs, Volume= 0.177 af, Depth= 6.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 100YR Rainfall=6.50"

Area (sf)	CN	Description
14,750	98	Paved parking, HSG C
52	86	<50% Grass cover, Poor, HSG C
14,802	98	Weighted Average
52		0.35% Pervious Area
14,750		99.65% Impervious Area

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

Summary for Subcatchment E2: To wetlands

Runoff = 2.82 cfs @ 12.08 hrs, Volume= 0.215 af, Depth= 5.56"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 100YR Rainfall=6.50"

Area (sf)	CN	Description
15,226	98	Paved parking, HSG C
1,091	86	<50% Grass cover, Poor, HSG C
3,850	70	Woods, Good, HSG C
20,167	92	Weighted Average
4,941		24.50% Pervious Area
15,226		75.50% Impervious Area

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

Summary for Subcatchment E3: To abutting property-South

Runoff = 0.05 cfs @ 12.09 hrs, Volume= 0.004 af, Depth= 5.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 100YR Rainfall=6.50"

Area (sf)	CN	Description
25	98	Paved parking, HSG C
377	86	<50% Grass cover, Poor, HSG C
402	87	Weighted Average
377		93.78% Pervious Area
25		6.22% Impervious Area

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

Summary for Subcatchment E4: Sheet flow to Woodsman Ave

Runoff = 0.31 cfs @ 12.08 hrs, Volume= 0.026 af, Depth= 6.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 100YR Rainfall=6.50"

Area (sf)	CN	Description
2,111	98	Paved parking, HSG C
30	86	<50% Grass cover, Poor, HSG C
2,141	98	Weighted Average
30		1.40% Pervious Area
2,111		98.60% Impervious Area

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

Summary for Subcatchment P1A: Developed area to inlets

Runoff = 3.54 cfs @ 12.08 hrs, Volume= 0.270 af, Depth= 5.56"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 100YR Rainfall=6.50"

Area (sf)	CN	Description
19,506	98	Paved parking, HSG C
5,856	74	>75% Grass cover, Good, HSG C
25,362	92	Weighted Average
5,856		23.09% Pervious Area
19,506		76.91% Impervious Area

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

Summary for Subcatchment P1B: Bldg

Runoff = 0.86 cfs @ 12.08 hrs, Volume= 0.070 af, Depth= 6.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 100YR Rainfall=6.50"

Area (sf)	CN	Description
5,870	98	Roofs, HSG C
5,870		100.00% Impervious Area

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

Summary for Subcatchment P1C: Developed area to inlets

Runoff = 1.91 cfs @ 12.08 hrs, Volume= 0.154 af, Depth= 6.14"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 100YR Rainfall=6.50"

Area (sf)	CN	Description
12,650	98	Paved parking, HSG C
447	74	>75% Grass cover, Good, HSG C
13,097	97	Weighted Average
447		3.41% Pervious Area
12,650		96.59% Impervious Area

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

Summary for Subcatchment P2: To wetlands sheet flow

Runoff = 0.41 cfs @ 12.09 hrs, Volume= 0.029 af, Depth= 3.31"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 100YR Rainfall=6.50"

Area (sf)	CN	Description
1,087	74	>75% Grass cover, Good, HSG C
3,544	70	Woods, Good, HSG C
4,631	71	Weighted Average
4,631		100.00% Pervious Area

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

Summary for Subcatchment P2A: To Bio A

Runoff = 0.95 cfs @ 12.08 hrs, Volume= 0.072 af, Depth= 5.56"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 100YR Rainfall=6.50"

Area (sf)	CN	Description
1,833	74	>75% Grass cover, Good, HSG C
4,940	98	Paved parking, HSG C
6,773	92	Weighted Average
1,833		27.06% Pervious Area
4,940		72.94% Impervious Area

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

Summary for Subcatchment P2B: To Bio B

Runoff = 0.97 cfs @ 12.08 hrs, Volume= 0.074 af, Depth= 5.56"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 100YR Rainfall=6.50"

Area (sf)	CN	Description
1,621	74	>75% Grass cover, Good, HSG C
5,349	98	Paved parking, HSG C
6,970	92	Weighted Average
1,621		23.26% Pervious Area
5,349		76.74% Impervious Area

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

Summary for Subcatchment P3: To abutting property-South

Runoff = 0.05 cfs @ 12.09 hrs, Volume= 0.004 af, Depth= 3.61"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 100YR Rainfall=6.50"

Area (sf)	CN	Description
550	74	>75% Grass cover, Good, HSG C
550		100.00% Pervious Area

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

Summary for Subcatchment P4: Sheet flow to Woodsman Ave

Runoff = 0.44 cfs @ 12.09 hrs, Volume= 0.031 af, Depth= 4.02"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Type III 24-hr 100YR Rainfall=6.50"

Area (sf)	CN	Description
643	98	Paved parking, HSG C
3,429	74	>75% Grass cover, Good, HSG C
4,072	78	Weighted Average
3,429		84.21% Pervious Area
643		15.79% Impervious Area

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

Summary for Reach DPE1: Design Point #1 - Main Street

Inflow Area = 1.030 ac, 95.90% Impervious, Inflow Depth = 6.18" for 100YR event
Inflow = 6.55 cfs @ 12.08 hrs, Volume= 0.531 af
Outflow = 6.55 cfs @ 12.08 hrs, Volume= 0.531 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs

Summary for Reach DPE2: Design Point #2 - Wetlands

Inflow Area = 0.463 ac, 75.50% Impervious, Inflow Depth = 5.56" for 100YR event
Inflow = 2.82 cfs @ 12.08 hrs, Volume= 0.215 af
Outflow = 2.82 cfs @ 12.08 hrs, Volume= 0.215 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs

Summary for Reach DPE3: Design Point #5 - South Abutter

Inflow Area = 0.009 ac, 6.22% Impervious, Inflow Depth = 5.00" for 100YR event
Inflow = 0.05 cfs @ 12.09 hrs, Volume= 0.004 af
Outflow = 0.05 cfs @ 12.09 hrs, Volume= 0.004 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs

Summary for Reach DPE4: Design Point #4 - Woodsman Ave

Inflow Area = 0.049 ac, 98.60% Impervious, Inflow Depth = 6.26" for 100YR event
Inflow = 0.31 cfs @ 12.08 hrs, Volume= 0.026 af
Outflow = 0.31 cfs @ 12.08 hrs, Volume= 0.026 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs

Summary for Reach DPP1: Design Point #1 - Main Street

Inflow Area = 1.018 ac, 85.78% Impervious, Inflow Depth = 5.71" for 100YR event
Inflow = 6.07 cfs @ 12.09 hrs, Volume= 0.484 af
Outflow = 6.07 cfs @ 12.09 hrs, Volume= 0.484 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs

Summary for Reach DPP2: Design Point #2 - Wetlands

Inflow Area = 0.422 ac, 56.00% Impervious, Inflow Depth = 3.99" for 100YR event
Inflow = 2.28 cfs @ 12.10 hrs, Volume= 0.140 af
Outflow = 2.28 cfs @ 12.10 hrs, Volume= 0.140 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs

Summary for Reach DPP3: Design Point #5 - South Abutter

Inflow Area = 0.013 ac, 0.00% Impervious, Inflow Depth = 3.61" for 100YR event
Inflow = 0.05 cfs @ 12.09 hrs, Volume= 0.004 af
Outflow = 0.05 cfs @ 12.09 hrs, Volume= 0.004 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs

Summary for Reach DPP4: Design Point #4 - Woodsman Ave

Inflow Area = 0.093 ac, 15.79% Impervious, Inflow Depth = 2.00" for 100YR event
Inflow = 0.31 cfs @ 12.16 hrs, Volume= 0.016 af
Outflow = 0.31 cfs @ 12.16 hrs, Volume= 0.016 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs

Summary for Pond BIOA: Bioretention "A"

Inflow Area = 0.155 ac, 72.94% Impervious, Inflow Depth = 5.56" for 100YR event
Inflow = 0.95 cfs @ 12.08 hrs, Volume= 0.072 af
Outflow = 0.92 cfs @ 12.10 hrs, Volume= 0.051 af, Atten= 3%, Lag= 1.2 min
Discarded = 0.01 cfs @ 12.10 hrs, Volume= 0.010 af
Primary = 0.91 cfs @ 12.10 hrs, Volume= 0.042 af

Routing by Stor-Ind method, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Peak Elev= 108.60' @ 12.10 hrs Surf.Area= 932 sf Storage= 1,079 cf

Plug-Flow detention time= 181.3 min calculated for 0.051 af (71% of inflow)
Center-of-Mass det. time= 90.5 min (865.3 - 774.8)

Volume	Invert	Avail.Storage	Storage Description
#1	107.00'	1,174 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
107.00	382	0	0
108.00	761	572	572
108.70	961	603	1,174

Device	Routing	Invert	Outlet Devices
#1	Discarded	107.00'	**0.270 in/hr Exfiltration over Surface area**
#2	Primary	108.50'	**10.0' long (Profile 1) Broad-Crested Rectangular Weir**
			Head (feet) 0.49 0.98 1.48
			Coef. (English) 2.92 3.37 3.59

Discarded OutFlow Max=0.01 cfs @ 12.10 hrs HW=108.60' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=0.91 cfs @ 12.10 hrs HW=108.60' (Free Discharge)
↑—**2=Broad-Crested Rectangular Weir** (Weir Controls 0.91 cfs @ 0.92 fps)

Summary for Pond BIOB: Bioretention "B"

Inflow Area = 0.160 ac, 76.74% Impervious, Inflow Depth = 5.56" for 100YR event
Inflow = 0.97 cfs @ 12.08 hrs, Volume= 0.074 af
Outflow = 0.97 cfs @ 12.09 hrs, Volume= 0.072 af, Atten= 0%, Lag= 0.3 min
Discarded = 0.00 cfs @ 12.09 hrs, Volume= 0.003 af
Primary = 0.97 cfs @ 12.09 hrs, Volume= 0.069 af

Routing by Stor-Ind method, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Peak Elev= 107.80' @ 12.09 hrs Surf.Area= 259 sf Storage= 138 cf

Plug-Flow detention time= 37.0 min calculated for 0.072 af (97% of inflow)
Center-of-Mass det. time= 19.4 min (794.2 - 774.8)

Volume	Invert	Avail.Storage	Storage Description
#1	107.00'	164 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
107.00	92	0	0
107.50	188	70	70
107.90	282	94	164

Device	Routing	Invert	Outlet Devices
#1	Discarded	107.00'	**0.270 in/hr Exfiltration over Surface area**
#2	Primary	107.70'	**10.0' long (Profile 1) Broad-Crested Rectangular Weir**
			Head (feet) 0.49 0.98 1.48
			Coef. (English) 2.92 3.37 3.59

Discarded OutFlow Max=0.00 cfs @ 12.09 hrs HW=107.80' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.00 cfs)

Primary OutFlow Max=0.97 cfs @ 12.09 hrs HW=107.80' (Free Discharge)
↑—**2=Broad-Crested Rectangular Weir** (Weir Controls 0.97 cfs @ 0.94 fps)

Summary for Pond DP: grassed depression

Inflow Area = 0.093 ac, 15.79% Impervious, Inflow Depth = 4.02" for 100YR event
Inflow = 0.44 cfs @ 12.09 hrs, Volume= 0.031 af
Outflow = 0.32 cfs @ 12.16 hrs, Volume= 0.024 af, Atten= 27%, Lag= 4.5 min
Discarded = 0.01 cfs @ 12.16 hrs, Volume= 0.008 af
Primary = 0.31 cfs @ 12.16 hrs, Volume= 0.016 af

Routing by Stor-Ind method, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs
Peak Elev= 110.80' @ 12.16 hrs Surf.Area= 927 sf Storage= 460 cf

Plug-Flow detention time= 194.1 min calculated for 0.024 af (75% of inflow)
Center-of-Mass det. time= 107.6 min (923.4 - 815.8)

Volume	Invert	Avail.Storage	Storage Description
#1	110.00'	1,406 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
110.00	224	0	0
111.00	1,104	664	664
111.50	1,863	742	1,406

Device	Routing	Invert	Outlet Devices
#1	Discarded	110.00'	**0.270 in/hr Exfiltration over Surface area**
#2	Primary	110.75'	**10.0' long (Profile 1) Broad-Crested Rectangular Weir**
			Head (feet) 0.49 0.98 1.48
			Coef. (English) 2.92 3.37 3.59

Discarded OutFlow Max=0.01 cfs @ 12.16 hrs HW=110.80' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=0.31 cfs @ 12.16 hrs HW=110.80' (Free Discharge)
↑—**2=Broad-Crested Rectangular Weir** (Weir Controls 0.31 cfs @ 0.64 fps)

Summary for Pond RD: CULTEC 100 HD

Inflow Area = 0.135 ac,100.00% Impervious, Inflow Depth = 6.26" for 100YR event
Inflow = 0.86 cfs @ 12.08 hrs, Volume= 0.070 af
Outflow = 0.78 cfs @ 12.13 hrs, Volume= 0.066 af, Atten= 10%, Lag= 2.6 min
Discarded = 0.00 cfs @ 1.66 hrs, Volume= 0.005 af
Primary = 0.77 cfs @ 12.13 hrs, Volume= 0.060 af

Routing by Stor-Ind method, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs / 9
Peak Elev= 109.30' @ 12.13 hrs Surf.Area= 390 sf Storage= 433 cf

Plug-Flow detention time= 84.6 min calculated for 0.066 af (94% of inflow)
Center-of-Mass det. time= 48.3 min (792.2 - 744.0)

Volume	Invert	Avail.Storage	Storage Description
#1A	107.00'	263 cf	**12.00'W x 32.50'L x 2.04'H Field A**
			796 cf Overall - 170 cf Embedded = 626 cf x 42.0% Voids
#2A	107.50'	170 cf	**Cultec C-100HD** x 12 Inside #1
			Effective Size= 32.1"W x 12.0"H => 1.86 sf x 7.50'L = 14.0 cf
			Overall Size= 36.0"W x 12.5"H x 8.00'L with 0.50' Overlap
			Row Length Adjustment= +0.50' x 1.86 sf x 3 rows
		433 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	107.00'	**0.270 in/hr Exfiltration over Surface area**
#2	Primary	107.98'	**6.0" Round Culvert**
			L= 80.0' CMP, projecting, no headwall, Ke= 0.900
			Inlet / Outlet Invert= 107.98' / 104.95' S= 0.0379 '/' Cc= 0.900
			n= 0.013, Flow Area= 0.20 sf

Discarded OutFlow Max=0.00 cfs @ 1.66 hrs HW=107.02' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.00 cfs)

Primary OutFlow Max=0.76 cfs @ 12.13 hrs HW=109.27' (Free Discharge)
↑—**2=Culvert** (Inlet Controls 0.76 cfs @ 3.88 fps)

Summary for Pond RD: CULTEC 100 HD

Inflow Area = 0.135 ac,100.00% Impervious, Inflow Depth = 0.79" for 1" Storm event
Inflow = 0.12 cfs @ 12.08 hrs, Volume= 0.009 af
Outflow = 0.01 cfs @ 14.24 hrs, Volume= 0.005 af, Atten= 95%, Lag= 129.4 min
Discarded = 0.00 cfs @ 9.14 hrs, Volume= 0.004 af
Primary = 0.00 cfs @ 14.24 hrs, Volume= 0.001 af

Routing by Stor-Ind method, Time Span= 0.00-28.00 hrs, dt= 0.01 hrs / 9
Peak Elev= 108.02' @ 14.24 hrs Surf.Area= 390 sf Storage= 233 cf

Plug-Flow detention time= 356.2 min calculated for 0.005 af (56% of inflow)
Center-of-Mass det. time= 248.9 min (1,036.8 - 787.9)

Volume	Invert	Avail.Storage	Storage Description
#1A	107.00'	263 cf	**12.00'W x 32.50'L x 2.04'H Field A** 796 cf Overall - 170 cf Embedded = 626 cf x 42.0% Voids
#2A	107.50'	170 cf	**Cultec C-100HD** x 12 Inside #1 Effective Size= 32.1"W x 12.0"H => 1.86 sf x 7.50'L = 14.0 cf Overall Size= 36.0"W x 12.5"H x 8.00'L with 0.50' Overlap Row Length Adjustment= +0.50' x 1.86 sf x 3 rows
		433 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	107.00'	**0.270 in/hr Exfiltration over Surface area**
#2	Primary	107.98'	**6.0" Round Culvert** L= 80.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 107.98' / 104.95' S= 0.0379 '/' Cc= 0.900 n= 0.013, Flow Area= 0.20 sf

Discarded OutFlow Max=0.00 cfs @ 9.14 hrs HW=107.02' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.00 cfs)

Primary OutFlow Max=0.00 cfs @ 14.24 hrs HW=108.02' (Free Discharge)
↑—**2=Culvert** (Inlet Controls 0.00 cfs @ 0.52 fps)

Appendix 5

STORMWATER CONTROLS MAINTENANCE
&
LONG-TERM POLLUTION PREVENTION PLAN

Proposed 110 Grill
1165 & 1175 Main Street
Haverhill, Massachusetts
10/20/16

The Stormwater Management Standards

Standard 9: A Long –Term Operation and Maintenance (O&M) Plan shall be developed and implemented to ensure that stormwater management systems function as designed.

The Long-term Operation and Maintenance Plan shall at a minimum identify:

1. Stormwater management system(s) owners;
2. The party or parties responsible for operation and maintenance, including how future property owners will be notified of the presence of the stormwater management system and the requirement for proper operation and maintenance;
3. The routine and non-routine maintenance tasks to be undertaken after construction is complete and a schedule for implementing those tasks;
4. Plan that is drawn to scale and shows the location of all stormwater BMPs in each treatment train along with the discharge point;
5. Description and delineation of public safety features; and
6. Estimated operations and maintenance budget.

The Operation and Maintenance Plan shall identify best management practices for implementing maintenance activities in a manner that minimizes impacts to wetland resource areas.

The Proposal is for a private development.

Stormwater Management Systems – 1165 & 1175 Main Street

Future Owner: Ryan Development, LLC

General Contractor: TBD

The General Contractor shall have all logs and reports as stated within the Stormwater Pollution Prevention Plan readily available at all times for inspection by the City of Haverhill.

Method of recording for future Owners

☐ Deed
☐ Order of Conditions
☐ Other: _____

LONG-TERM POLLUTION PREVENTION PLAN

1. Good Housekeeping Practices

The Owner/Operator shall use good housekeeping practices by following the Operation and Maintenance plans as provided within this report.

2. Provisions for storing materials and waste products inside or under cover

Hazardous materials or wastes are not expected to be stored at the site. Any such materials or wastes will be stored and handled in accordance with all applicable local, state, and federal regulations. In the event of a significant spill of any hazardous material or waste, emergency contact numbers are listed below.

3. Vehicle washing controls

Vehicle washing is not anticipated to occur at this site.

4. Requirements for routine inspections and maintenance of stormwater BMPs

The Owner/Operator shall maintain the BMP's by following the Operation and Maintenance Plan.

4. Spill prevention and response plan

There is very limited risk of significant spills at this site. Any spill requiring action would most likely be associated with motor vehicles. In the event of a large spill contact the following:

Mass DEP 24 hour Spill Emergency Response Notification line: 888-304-1133.

Regulatory Contacts:

Contact information for reporting oil and hazardous materials releases to the EPA, DEP, and local agencies are provided below.

Agency	Telephone
Fire Department	911 / (978) 373-8460
Massachusetts Department of Environmental Protection	888-304-1133
United States Environmental Protection Agency	(617) 918-1279

5. Provisions for maintenance of lawns, gardens, and other landscaped areas

Only the use of phosphorous-free chemical fertilizers shall be allowed.

7. Requirements for storage and use of fertilizers, herbicides, and pesticides

Fertilizers, herbicides, and pesticides will not be stored outdoors at the site.

8. Requirements for the use of salt, sand, and heavy equipment for snow plowing operation.

Storage of Salt and sand stockpiles must be covered at all times. Heavy equipment can only be stored at the designated location.

9. Provisions for solid waste management

All solid waste management systems shall be inspected and maintained in accordance with all local, state and federal requirements.

SURFACE MAINTENANCE

The stormwater controls are to be operated and maintained in compliance with the following permanent procedures by the land owner. See attached sketch entitled Stormwater Controls Maintenance Plan for corresponding component location onsite.

COMPONENT: Water Quality Structure (CDS Separator Unit)

RESPONSIBILITY: Ryan Development, LLC

ACTION: Inspection / cleaning

FREQUENCY: Per Manufacturer's Maintenance Guidelines (attached). Inspections should be performed at a minimum twice per year (spring and fall), however more frequent inspections may be required depending on the rate of sediment accumulation due to equipment washdown, winter sanding operations, or in areas where excessive amounts of trash are expected.

DESCRIPTION: See attached Manufacturer's Maintenance Guidelines. All accumulated materials shall be disposed of in accordance with DEP regulations. A vaccum truck may be required to remove sediment and debris from the sump of the water quality structure. Remove sediment when the level has reached 75% of capacity in the isolated sump or when an appreciable level of hydrocarbons and trash has accumulated.

BUDGET: Inspection/cleaning- $500/yr based on inspections and cleanings of twice a year.

COMPONENT: Bio-retention areas

RESPONSIBILITY: Ryan Development, LLC

ACTION: Inspection / cleaning / maintenance

FREQUENCY:

1. Inspection to ensure proper functioning – After every major storm during the first 3 months of operation and twice a year thereafter.
2. Maintenance shall consist of the following: Mulch annually in the spring; Periodic weeding and removal of dead vegetation should occur annually during the spring or fall; Replace dead vegetation annually during the spring; Prune vegetation annually during the spring or fall.
3. Replace all media and vegetation as needed in the late spring or early summer.
4. Inspect and clean outlet control devices- After every major storm during the first 3 months of operation and twice a year thereafter.

DESCRIPTION: The bio-retention systems shall be inspected bi-yearly to ensure that it is operating as intended and that all components are stable and in working order. Inspections shall be by qualified personnel assigned by the owner. Sediment collecting in the basin bottom shall be inspected twice a year, and removal shall commence any time the sediment reaches a depth of six inches anywhere in the basin. Sediments removed shall be disposed of in accordance with the latest DEP guidelines for stormwater sediment disposal.

Inspections:

- Inlet and Outlet condition
- Sediment Accumulation
- Oil/Gas Sheen in water
- Condition of outlet pipe
- General Inspection of basin

BUDGET: Cleaning - $500/ yr based on annual cleanings
Inspection - $500/ yr based on bi-annual inspections

COMPONENT: Drive Aisles / Parking Areas

RESPONSIBILITY: Ryan Development, LLC

ACTION: Street Sweeping

FREQUENCY:

- Type: High Efficiency Vacuum Sweeper
  Frequency: Quarterly Average, with sweeping scheduled primarily in spring and fall.

- Type: Regenerative Air Sweeper– Frequency of Sweeping
  Frequency: Quarterly Average, with sweeping scheduled primarily in spring and fall.

- Type: Mechanical Sweeper (Rotary Broom)
  Frequency: Monthly Average, with sweeping scheduled primarily in spring and fall

DESCRIPTION: Drive aisles and parking areas shall be swept per the above table. Sweeping shall be performed to remove sediments prior to introduction into the stormwater collection system. Washing and water jetting shall be discouraged.

BUDGET: $2000 /year based on monthly sweepings post construction.

COMPONENT: Outlet Structures / Deep sump catch basins

RESPONSIBILITY: Ryan Development, LLC

ACTION: Cleaning (Sediment removal / sump cleaning) and Inspection

FREQUENCY:

1. Cleaning – Four times a year or whenever the depth of deposits is greater than or equal to one half the depth from the bottom invert of the lowest pipe in the basin.
2. Inspection – Four times per year

DESCRIPTION: Catch basins are to be cleaned four times per year. The Owner will monitor sumps post construction on an as needed basis. Precautions shall take place to maintain the integrity of the oil trapping hoods during cleaning. The hoods shall be inspected and repaired as necessary. Accumulated Hydrocarbon shall be collected separately from accumulated sediment. All material shall be disposed of in accordance with DEP regulations.
Inspections:

- Frame and Grate
- Inlet and Outlet condition
- Cracks and settlement & joint failure & leaking
- Sediment Accumulation
- Oil/Gas Sheen in water
- Condition of hood
- General Inspection of structure

BUDGET: $250/ per basin per year based on inspections and cleanings of four times a year.

COMPONENT: Subsurface Infiltration Basin

RESPONSIBILITY: Ryan Development, LLC

ACTION: Various inspection, maintenance, and cleaning activities

FREQUENCY:

1. Preventative Maintenance - Two times per year.
2. Inspection to ensure proper function – After every major storm during the first 3 months of operation and twice a year thereafter, and after a storm event of 1-inch or greater.
3. Inspect and clean pretreatment devices

DESCRIPTION: The isolator row is to be inspected a minimum of twice a year in March-April and October-November. Inspection ports are to be examined to determine if the underdrain system is working. There should not be any water in the system within 72 hours after the end of rainfall. If there is routinely water within the system within that time, contact a civil engineer for

further observation and potential repairs. The isolator row is to be cleaned when the average depth of sediment throughout the length of the isolator row exceeds three (3) inches.

COMPONENT: Sediment Forebay

RESPONSIBILITY: Ryan Development, LLC

ACTION: Various inspection, maintenance, and cleaning activities

FREQUENCY:

1. Cleaning – Four times per year and whenever the sediment depth is 6" deep.
2. Inspection – Four times per year
3. Mow the buffer area and side slopes. Remove all grass clippings and accumulated organic matter- Twice yearly during the growing season.

DESCRIPTION: The sediment forebay shall be inspected a minimum of four times per year to ensure that they are operating as intended and that all components are stable and in working order. Inspections shall be by qualified personnel assigned by the property owner. During the growing season, they shall be mowed at least twice, with additional cuttings performed as needed. All tree saplings of any species will be removed from embankments and the pond bottom. The inlet to the shall be inspected for erosion and sedimentation, and rip-rap shall be promptly repaired in the case of erosion. Sediment collecting in the pond bottom shall be inspected four times annually, and removal shall commence any time the sediment reaches a depth of six inches anywhere in the pond. Any sediments removed shall be disposed of in accordance with the latest DEP guidelines for stormwater sediment disposal.

Inspections:

- Inlet and Outlet condition
- Sediment Accumulation
- Oil/Gas Sheen in water
- General Inspection of forebay

BUDGET: $500/ yr based on quarterly cleanings & insepctions

OTHER SURFACE MAINTENANCE PROCEDURES:

- Snow plowing operations shall store snow at the locations shown on the approved site plans. In the event snow storage hinders the parking operations of the lot, the owner shall have the snow stockpiles removed from the site in accordance to all state, local and federal regulations. Stockpiling snow within the wetland areas is strictly forbidden.

Each spring the snow stockpile locations shall be swept (remove sediment per applicable codes) and replace vegetation as necessary.

Illicit Discharge Statement:

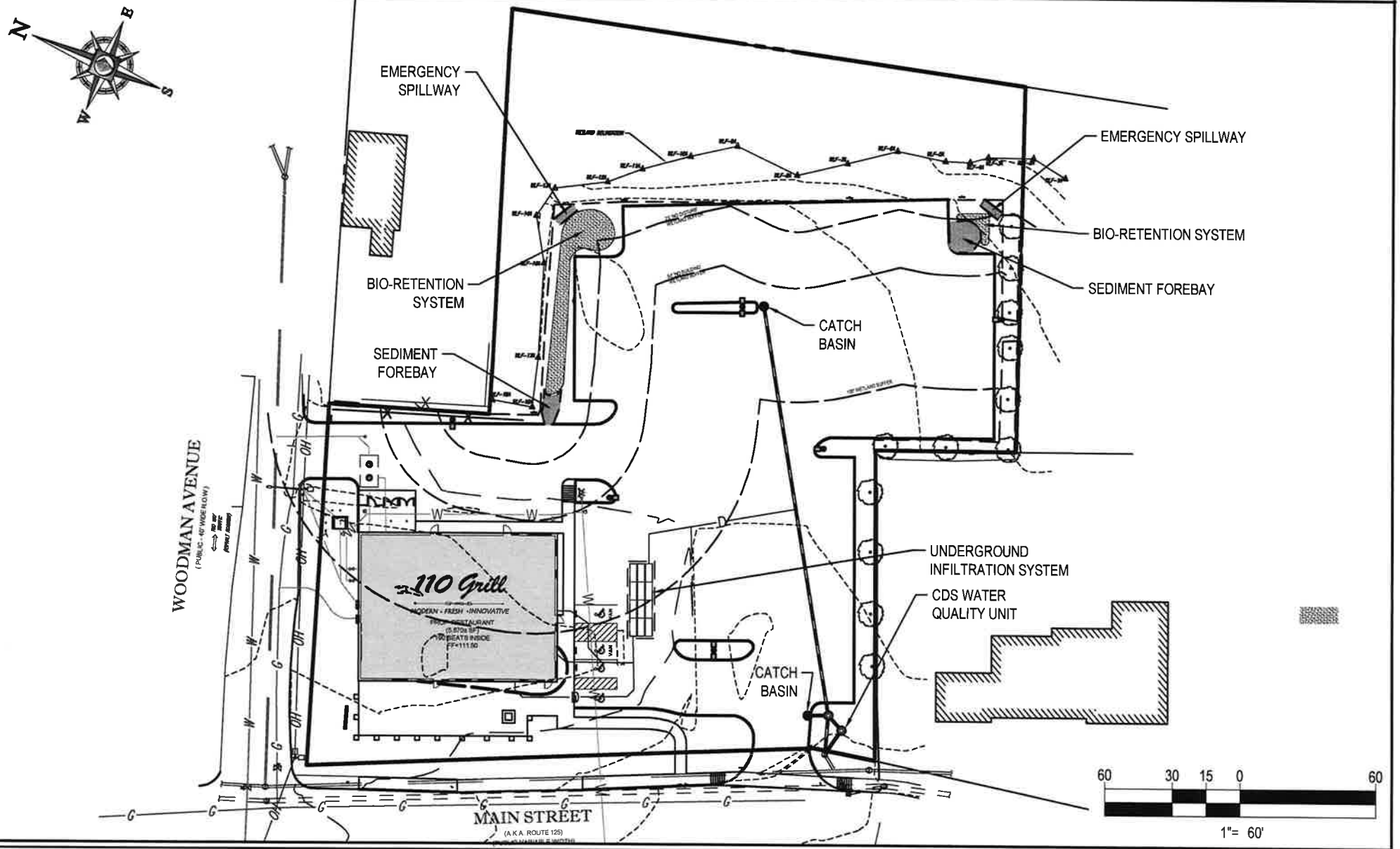
Certain types of non-stormwater discharges are allowed under the U.S. Environmental Protection Agency Construction General Permit. These types of discharges will be allowed under the conditions that no pollutants will be allowed to come in contact with the water prior to or after its discharge. The control measures which have been outlined previously in this LTPPP will be strictly followed to ensure that no contamination of these non-storm water discharges takes place. Any existing illicit discharges, if discovered during the course of the work, will be reported to MassDEP, as applicable, to be addressed in accordance with their respective policies. No illicit discharges will be allowed in conjunction with the proposed improvements.

POST CONSTRUCTION ACTIVITY FORM

NOTE: The contractor is responsible for maintaining an accurate and complete log of construction activities, including, but not limited to, commencement of stabilization, major grading activities, timeframes when construction ceases on a portion of site (temporary or permanent) until the Notice of Termination (NOT) is filed.

MAJOR STABILIZATION AND GRADING ACTIVITIES

Construction Activity	Contractor Name	Start Date	End Date	Location



PROJECT:

STORMWATER CONTROLS MAINTENANCE PLAN

FOR

110 Grill

MODERN • FRESH • INNOVATIVE

MAP 638, BLOCK 8, LOTS 1 & 2
1165 & 1175 MAIN STREET
CITY OF HAVERHILL, ESSEX COUNTY, MA

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SITE CIVIL AND CONSULTING ENGINEERING
LAND SURVEYING · PROGRAM MANAGEMENT · LANDSCAPE ARCHITECTURE
SUSTAINABLE DESIGN · PERMITTING SERVICES · TRANSPORTATION SERVICES

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- NEW ENGLAND
- BOSTON, MA
- NEW YORK METRO
- NEW YORK, NY
- NEW JERSEY
- PHILADELPHIA, PA
- LEHIGH VALLEY, PA
- SOUTHEASTERN, PA
- REHOBOTH BEACH, DE
- BALTIMORE, MD
- SOUTHERN MARYLAND
- NORTHERN VIRGINIA
- CENTRAL VIRGINIA
- RALEIGH, NC
- CHARLOTTE, NC
- ATLANTA, GEORGIA
- TAMPA, FL
- SOUTH FLORIDA

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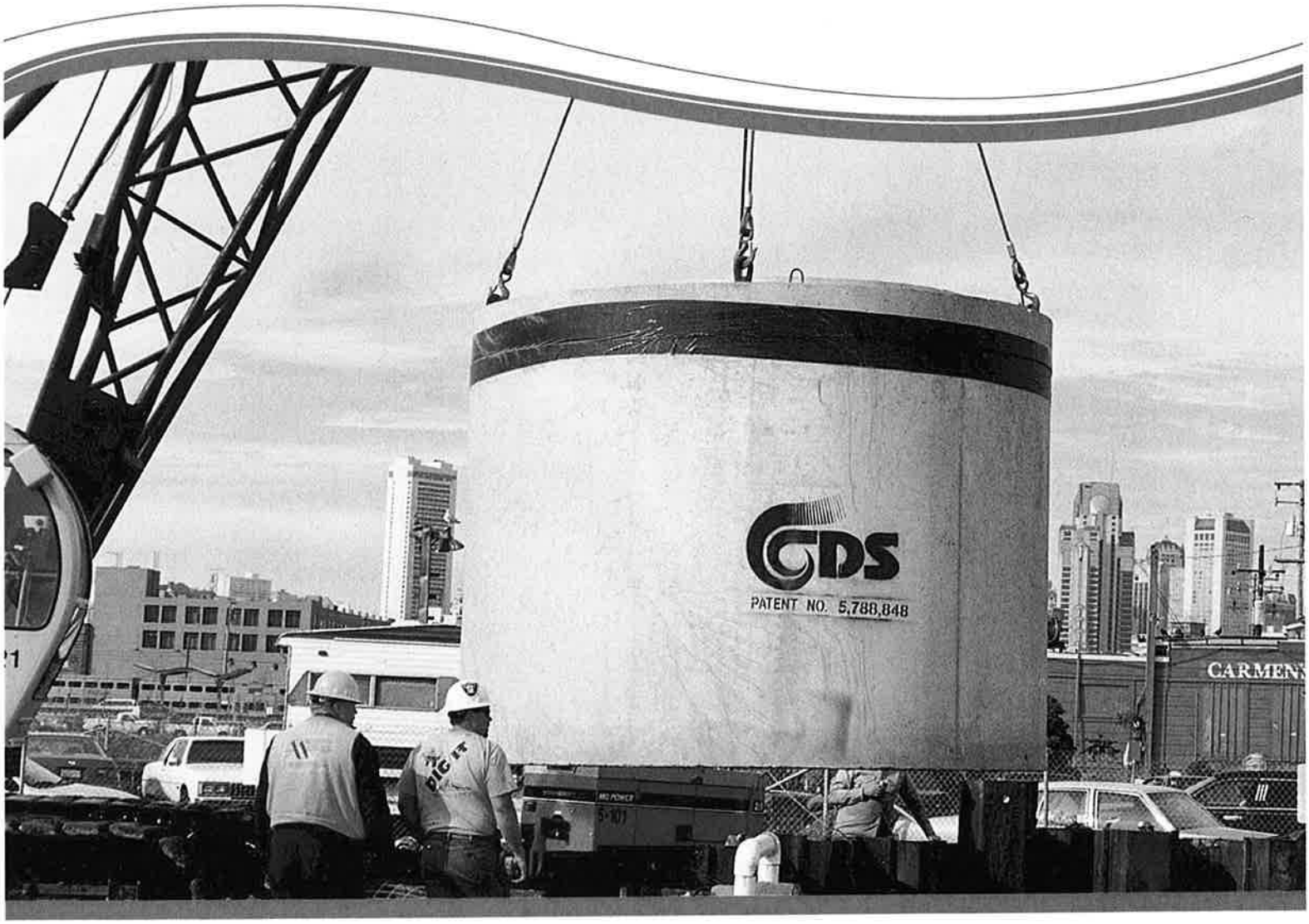
ENGINEERED SOLUTIONS

CDS Guide
Operation, Design, Performance and Maintenance



CDS®

Using patented continuous deflective separation technology, the CDS system screens, separates and traps debris, sediment, and oil and grease from stormwater runoff. The indirect screening capability of the system allows for 100% removal of floatables and neutrally buoyant material without blinding. Flow and screening controls physically separate captured solids, and minimize the re-suspension and release of previously trapped pollutants. Inline units can treat up to 6 cfs, and internally bypass flows in excess of 50 cfs (1416 L/s). Available precast or cast-in-place, offline units can treat flows from 1 to 300 cfs (28.3 to 8495 L/s). The pollutant removal capacity of the CDS system has been proven in lab and field testing.

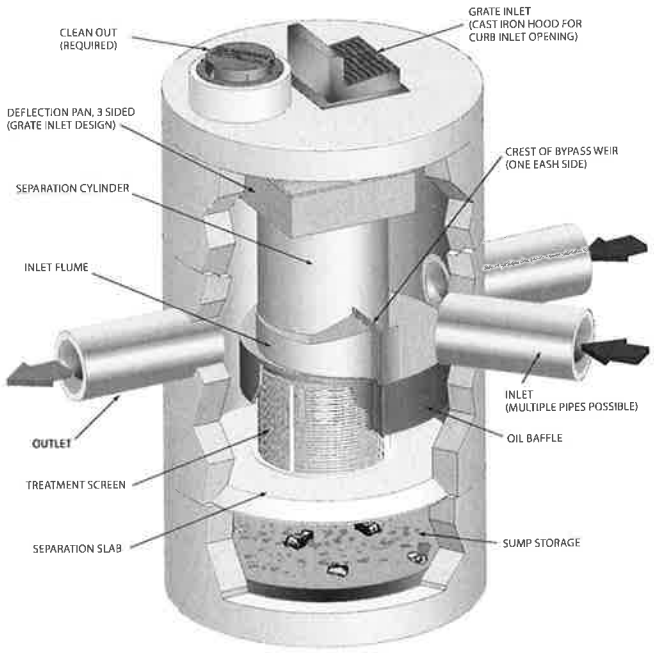
Operation Overview

Stormwater enters the diversion chamber where the diversion weir guides the flow into the unit's separation chamber and pollutants are removed from the flow. All flows up to the system's treatment design capacity enter the separation chamber and are treated.

Swirl concentration and screen deflection force floatables and solids to the center of the separation chamber where 100% of floatables and neutrally buoyant debris larger than the screen apertures are trapped.

Stormwater then moves through the separation screen, under the oil baffle and exits the system. The separation screen remains clog free due to continuous deflection.

During the flow events exceeding the treatment design capacity, the diversion weir bypasses excessive flows around the separation chamber, so captured pollutants are retained in the separation cylinder.



Design Basics

There are three primary methods of sizing a CDS system. The Water Quality Flow Rate Method determines which model size provides the desired removal efficiency at a given flow rate for a defined particle size. The Rational Rainfall Method™ or the and Probabilistic Method is used when a specific removal efficiency of the net annual sediment load is required.

Typically in the Unites States, CDS systems are designed to achieve an 80% annual solids load reduction based on lab generated performance curves for a gradation with an average particle size (d50) of 125 microns (μm). For some regulatory environments, CDS systems can also be designed to achieve an 80% annual solids load reduction based on an average particle size (d50) of 75 microns (μm) or 50 microns (μm).

Water Quality Flow Rate Method

In some cases, regulations require that a specific treatment rate, often referred to as the water quality design flow (WQQ), be treated. This WQQ represents the peak flow rate from either an event with a specific recurrence interval, e.g. the six-month storm, or a water quality depth, e.g. 1/2-inch (13 mm) of rainfall.

The CDS is designed to treat all flows up to the WQQ. At influent rates higher than the WQQ, the diversion weir will direct most flow exceeding the WQQ around the separation chamber. This allows removal efficiency to remain relatively constant in the separation chamber and eliminates the risk of washout during bypass flows regardless of influent flow rates.

Treatment flow rates are defined as the rate at which the CDS will remove a specific gradation of sediment at a specific removal efficiency. Therefore the treatment flow rate is variable, based on the gradation and removal efficiency specified by the design engineer.

Rational Rainfall Method™

Differences in local climate, topography and scale make every site hydraulically unique. It is important to take these factors into consideration when estimating the long-term performance of any stormwater treatment system. The Rational Rainfall Method combines site-specific information with laboratory generated performance data, and local historical precipitation records to estimate removal efficiencies as accurately as possible.

Short duration rain gauge records from across the United States and Canada were analyzed to determine the percent of the total annual rainfall that fell at a range of intensities. US stations' depths were totaled every 15 minutes, or hourly, and recorded in 0.01-inch increments. Depths were recorded hourly with 1-mm resolution at Canadian stations. One trend was consistent at all sites; the vast majority of precipitation fell at low intensities and high intensity storms contributed relatively little to the total annual depth.

These intensities, along with the total drainage area and runoff coefficient for each specific site, are translated into flow rates using the Rational Rainfall Method. Since most sites are relatively small and highly impervious, the Rational Rainfall Method is appropriate. Based on the runoff flow rates calculated for each intensity, operating rates within a proposed CDS system are

determined. Performance efficiency curve determined from full scale laboratory tests on defined sediment PSDs is applied to calculate solids removal efficiency. The relative removal efficiency at each operating rate is added to produce a net annual pollutant removal efficiency estimate.

Probabilistic Rational Method

The Probabilistic Rational Method is a sizing program Contech developed to estimate a net annual sediment load reduction for a particular CDS model based on site size, site runoff coefficient, regional rainfall intensity distribution, and anticipated pollutant characteristics.

The Probabilistic Method is an extension of the Rational Method used to estimate peak discharge rates generated by storm events of varying statistical return frequencies (e.g. 2-year storm event). Under the Rational Method, an adjustment factor is used to adjust the runoff coefficient estimated for the 10-year event, correlating a known hydrologic parameter with the target storm event. The rainfall intensities vary depending on the return frequency of the storm event under consideration. In general, these two frequency dependent parameters (rainfall intensity and runoff coefficient) increase as the return frequency increases while the drainage area remains constant.

These intensities, along with the total drainage area and runoff coefficient for each specific site, are translated into flow rates using the Rational Method. Since most sites are relatively small and highly impervious, the Rational Method is appropriate. Based on the runoff flow rates calculated for each intensity, operating rates within a proposed CDS are determined. Performance efficiency curve on defined sediment PSDs is applied to calculate solids removal efficiency. The relative removal efficiency at each operating rate is added to produce a net annual pollutant removal efficiency estimate.

Treatment Flow Rate

The inlet throat area is sized to ensure that the WQQ passes through the separation chamber at a water surface elevation equal to the crest of the diversion weir. The diversion weir bypasses excessive flows around the separation chamber, thus preventing re-suspension or re-entrainment of previously captured particles.

Hydraulic Capacity

The hydraulic capacity of a CDS system is determined by the length and height of the diversion weir and by the maximum allowable head in the system. Typical configurations allow hydraulic capacities of up to ten times the treatment flow rate. The crest of the diversion weir may be lowered and the inlet throat may be widened to increase the capacity of the system at a given water surface elevation. The unit is designed to meet project specific hydraulic requirements.

Performance

Full-Scale Laboratory Test Results

A full-scale CDS system (Model CDS2020-5B) was tested at the facility of University of Florida, Gainesville, FL. This CDS unit was evaluated under controlled laboratory conditions of influent flow rate and addition of sediment.

Two different gradations of silica sand material (UF Sediment & OK-110) were used in the CDS performance evaluation. The particle size distributions (PSDs) of the test materials were analyzed using standard method "Gradation ASTM D-422 "Standard Test Method for Particle-Size Analysis of Soils" by a certified laboratory.

UF Sediment is a mixture of three different products produced by the U.S. Silica Company: "Sil-Co-Sil 106", "#1 DRY" and "20/40 Oil Frac". Particle size distribution analysis shows that the UF Sediment has a very fine gradation (d50 = 20 to 30 μm) covering a wide size range (Coefficient of Uniformity, C averaged at 10.6). In comparison with the hypothetical TSS gradation specified in the NJDEP (New Jersey Department of Environmental Protection) and NJCAT (New Jersey Corporation for Advanced Technology) protocol for lab testing, the UF Sediment covers a similar range of particle size but with a finer d50 (d50 for NJDEP is approximately 50 μm) (NJDEP, 2003).

The OK-110 silica sand is a commercial product of U.S. Silica Sand. The particle size distribution analysis of this material, also included in Figure 1, shows that 99.9% of the OK-110 sand is finer than 250 microns, with a mean particle size (d50) of 106 microns. The PSDs for the test material are shown in Figure 1.

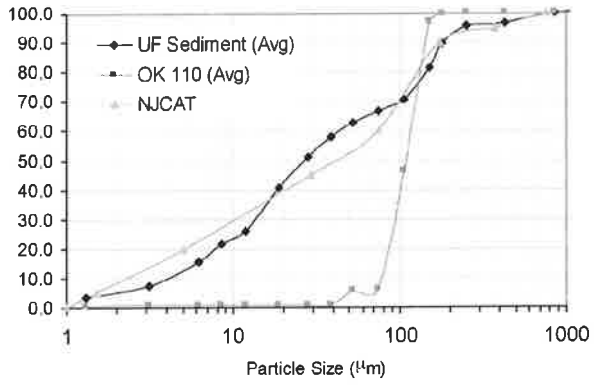


Figure 1. Particle size distributions

Tests were conducted to quantify the performance of a specific CDS unit (1.1 cfs (31.3-L/s) design capacity) at various flow rates, ranging from 1% up to 125% of the treatment design capacity of the unit, using the 2400 micron screen. All tests were conducted with controlled influent concentrations of approximately 200 mg/L. Effluent samples were taken at equal time intervals across the entire duration of each test run. These samples were then processed with a Dekaport Cone sample splitter to obtain representative sub-samples for Suspended Sediment Concentration (SSC) testing using ASTM D3977-97 "Standard Test Methods for Determining Sediment Concentration in Water Samples", and particle size distribution analysis.

Results and Modeling

Based on the data from the University of Florida, a performance model was developed for the CDS system. A regression analysis was used to develop a fitting curve representative of the scattered data points at various design flow rates. This model, which demonstrated good agreement with the laboratory data, can then be used to predict CDS system performance with respect

to SSC removal for any particle size gradation, assuming the particles are inorganic sandy-silt. Figure 2 shows CDS predictive performance for two typical particle size gradations (NJCAT gradation and OK-110 sand) as a function of operating rate.

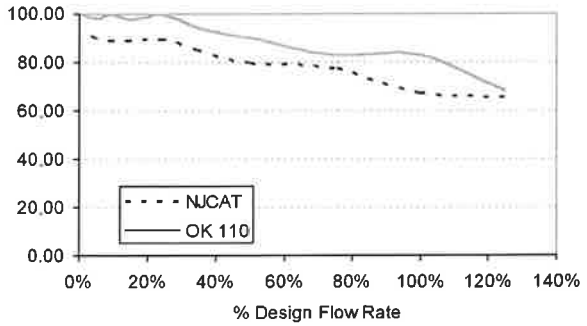


Figure 2. CDS stormwater treatment predictive performance for various particle gradations as a function of operating rate.

Many regulatory jurisdictions set a performance standard for hydrodynamic devices by stating that the devices shall be capable of achieving an 80% removal efficiency for particles having a mean particle size (d50) of 125 microns (e.g. Washington State Department of Ecology — WASDOE - 2008). The model can be used to calculate the expected performance of such a PSD (shown in Figure 3). The model indicates (Figure 4) that the CDS system with 2400 micron screen achieves approximately 80% removal at the design (100%) flow rate, for this particle size distribution (d50 = 125 μm).

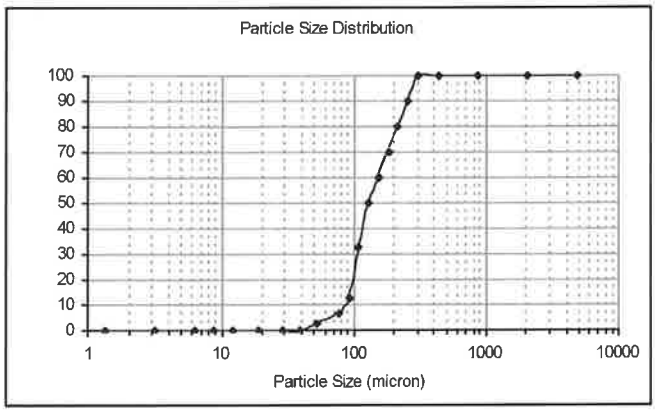


Figure 3. WASDOE PSD

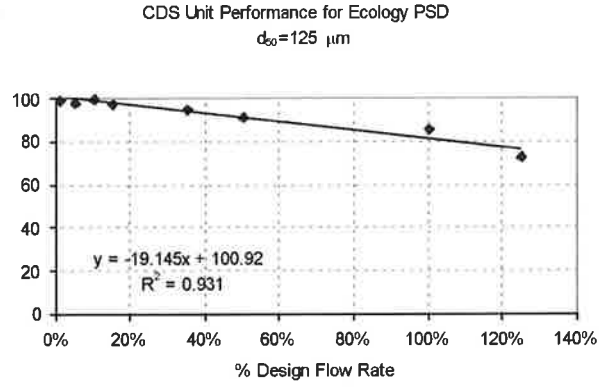


Figure 4. Modeled performance for WASDOE PSD.

Maintenance

The CDS system should be inspected at regular intervals and maintained when necessary to ensure optimum performance. The rate at which the system collects pollutants will depend more heavily on site activities than the size of the unit. For example, unstable soils or heavy winter sanding will cause the grit chamber to fill more quickly but regular sweeping of paved surfaces will slow accumulation.

Inspection

Inspection is the key to effective maintenance and is easily performed. Pollutant transport and deposition may vary from year to year and regular inspections will help ensure that the system is cleaned out at the appropriate time. At a minimum, inspections should be performed twice per year (e.g. spring and fall) however more frequent inspections may be necessary in climates where winter sanding operations may lead to rapid accumulations, or in equipment washdown areas. Installations should also be inspected more frequently where excessive amounts of trash are expected.

The visual inspection should ascertain that the system components are in working order and that there are no blockages or obstructions in the inlet and separation screen. The inspection should also quantify the accumulation of hydrocarbons, trash, and sediment in the system. Measuring pollutant accumulation can be done with a calibrated dipstick, tape measure or other measuring instrument. If absorbent material is used for enhanced removal of hydrocarbons, the level of discoloration of the sorbent material should also be identified

during inspection. It is useful and often required as part of an operating permit to keep a record of each inspection. A simple form for doing so is provided.

Access to the CDS unit is typically achieved through two manhole access covers. One opening allows for inspection and cleanout of the separation chamber (cylinder and screen) and isolated sump. The other allows for inspection and cleanout of sediment captured and retained outside the screen. For deep units, a single manhole access point would allows both sump cleanout and access outside the screen.

The CDS system should be cleaned when the level of sediment has reached 75% of capacity in the isolated sump or when an appreciable level of hydrocarbons and trash has accumulated. If absorbent material is used, it should be replaced when significant discoloration has occurred. Performance will not be impacted until 100% of the sump capacity is exceeded however it is recommended that the system be cleaned prior to that for easier removal of sediment. The level of sediment is easily determined by measuring from finished grade down to the top of the sediment pile. To avoid underestimating the level of sediment in the chamber, the measuring device must be lowered to the top of the sediment pile carefully. Particles at the top of the pile typically offer less resistance to the end of the rod than consolidated particles toward the bottom of the pile. Once this measurement is recorded, it should be compared to the as-built drawing for the unit to determine weather the height of the sediment pile off the bottom of the sump floor exceeds 75% of the total height of isolated sump.

Cleaning

Cleaning of a CDS systems should be done during dry weather conditions when no flow is entering the system. The use of a vacuum truck is generally the most effective and convenient method of removing pollutants from the system. Simply remove the manhole covers and insert the vacuum hose into the sump. The system should be completely drained down and the sump fully evacuated of sediment. The area outside the screen should also be cleaned out if pollutant build-up exists in this area.

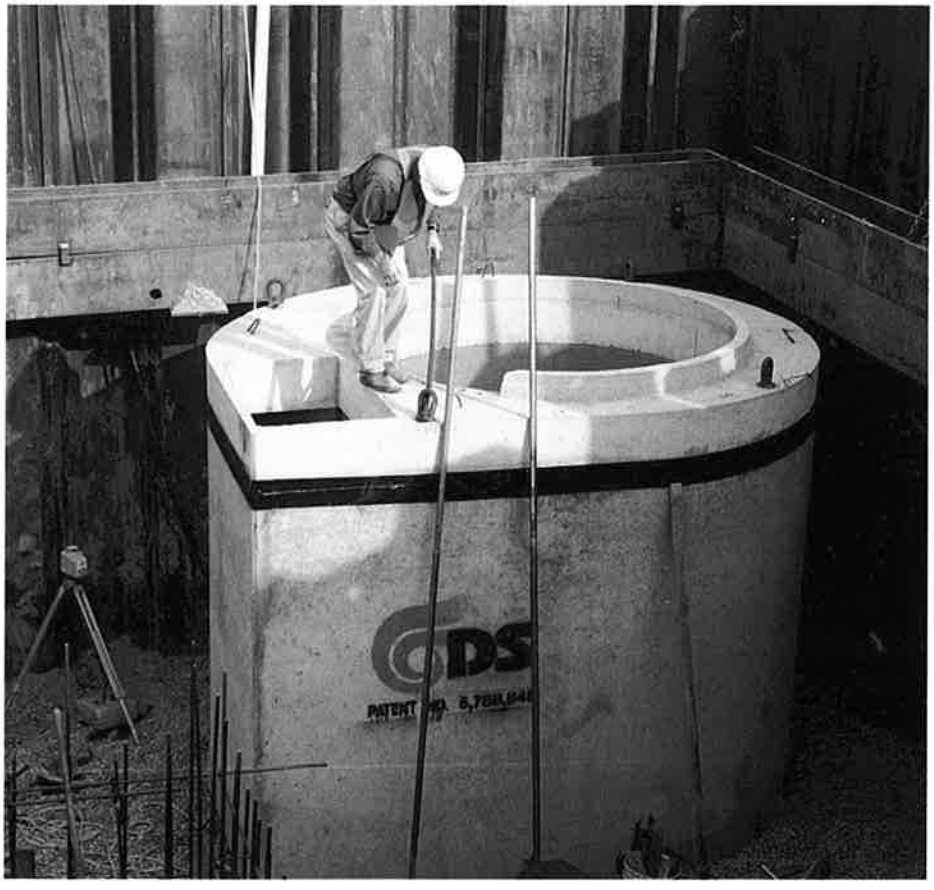
In installations where the risk of petroleum spills is small, liquid contaminants may not accumulate as quickly as sediment. However, the system should be cleaned out immediately in the event of an oil or gasoline spill. Motor oil and other hydrocarbons that accumulate on a more routine basis should be removed when an appreciable layer has been captured. To remove these pollutants, it may be preferable to use absorbent pads since they are usually less expensive to dispose than the oil/water emulsion that may be created by vacuuming the oily layer. Trash and debris can be netted out to separate it from the other pollutants. The screen should be cleaned to ensure it is free of trash and debris.

Manhole covers should be securely seated following cleaning activities to prevent leakage of runoff into the system from above and also to ensure that proper safety precautions have been followed. Confined space entry procedures need to be followed if physical access is required. Disposal of all material removed from the CDS system should be done in accordance with local regulations. In many jurisdictions, disposal of the sediments may be handled in the same manner as the disposal of sediments removed from catch basins or deep sump manholes. Check your local regulations for specific requirements on disposal.

CDS Model	Diameter		Distance from Water Surface to Top of Sediment Pile		Sediment Storage Capacity	
	ft	m	ft	m	yd3	m3
CDS2015-4	4	1.2	3.0	0.9	0.5	0.4
CDS2015	**5**	**1.5**	**3.0**	**0.9**	**1.3**	**1.0**
CDS2020	5	1.5	3.5	1.1	1.3	1.0
CDS2025	**5**	**1.5**	**4.0**	**1.2**	**1.3**	**1.0**
CDS3020	6	1.8	4.0	1.2	2.1	1.6
CDS3030	**6**	**1.8**	**4.6**	**1.4**	**2.1**	**1.6**
CDS3035	6	1.8	5.0	1.5	2.1	1.6
CDS4030	**8**	**2.4**	**4.6**	**1.4**	**5.6**	**4.3**
CDS4040	8	2.4	5.7	1.7	5.6	4.3
CDS4045	**8**	**2.4**	**6.2**	**1.9**	**5.6**	**4.3**

Table 1: CDS Maintenance Indicators and Sediment Storage Capacities

Note: To avoid underestimating the volume of sediment in the chamber, carefully lower the measuring device to the top of the sediment pile. Finer silty particles at the top of the pile may be more difficult to feel with a measuring stick. These finer particles typically offer less resistance to the end of the rod than larger particles toward the bottom of the pile.



CDS Inspection & Maintenance Log

CDS Model: _____ Location: _____

Date	Water depth to sediment[1]	Floatable Layer Thickness[2]	Describe Maintenance Performed	Maintenance Personnel	Comments

1. The water depth to sediment is determined by taking two measurements with a stadia rod: one measurement from the manhole opening to the top of the sediment pile and the other from the manhole opening to the water surface. If the difference between these measurements is less than the values listed in table 1 the system should be cleaned out. **Note: to avoid underestimating the volume of sediment in the chamber, the measuring device must be carefully lowered to the top of the sediment pile.**

2. For optimum performance, the system should be cleaned out when the floating hydrocarbon layer accumulates to an appreciable thickness. In the event of an oil spill, the system should be cleaned immediately.

Support

- Drawings and specifications are available at www.ContechES.com.
- Site-specific design support is available from our engineers.

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The product(s) described may be protected by one or more of the following US patents: 5,322,629; 5,624,576; 5,707,527; 5,759,415; 5,788,848; 5,985,157; 6,027,639; 6,350,374; 6,406,218; 6,641,720; 6,511,595; 6,649,048; 6,991,114; 6,998,038; 7,186,058; 7,296,692; 7,297,266; related foreign patents or other patents pending.

RECYCLED PAPER

cds_manual 7/14 PDF

Contech® Hydrodynamic Separation

Pretreatment for Green Stormwater Solutions

Before CDS®

A bank by a stormwater retention pond in Pinellas County, Florida was fouled with cigarettes and other debris.

After CDS®

Two and a half months later after a CDS was installed, the bank was clean.

HDS Benefits

- Cost-effective method of gross pollutant removal
- Pretreatment reduces size and increases longevity of land based BMPs
- Variety of sizes to meet range of applications and flows
- Easy, low-cost maintenance

HDS Applications

- Pre-treatment for rainwater harvesting/stormwater reuse
- Pre-treatment for infiltration and bioretention
- Urban retrofit/redevelopment
- Sediment and trash protection for ponds/lakes
- Pump protection

CDS Features

- Captures and retains 100% of floatables and neutrally buoyant debris 2.4 mm or larger
- Proven removal of solids, oil and grease
- Patented indirect screening capability keeps screen from clogging
- Retention of all captured pollutants, even at high flows
- Easy access to remove captured pollutants
- Performance verified by NJCAT and WA Ecology
- Flexible design
  - Allows for multiple inlet pipes
  - In-line, grate and curb inlet configurations
  - Easily installed in existing storm drain

CONTECH® ENGINEERED SOLUTIONS

Toll Free: 1-800-338-1122
www.ContechES.com

Appendix 6

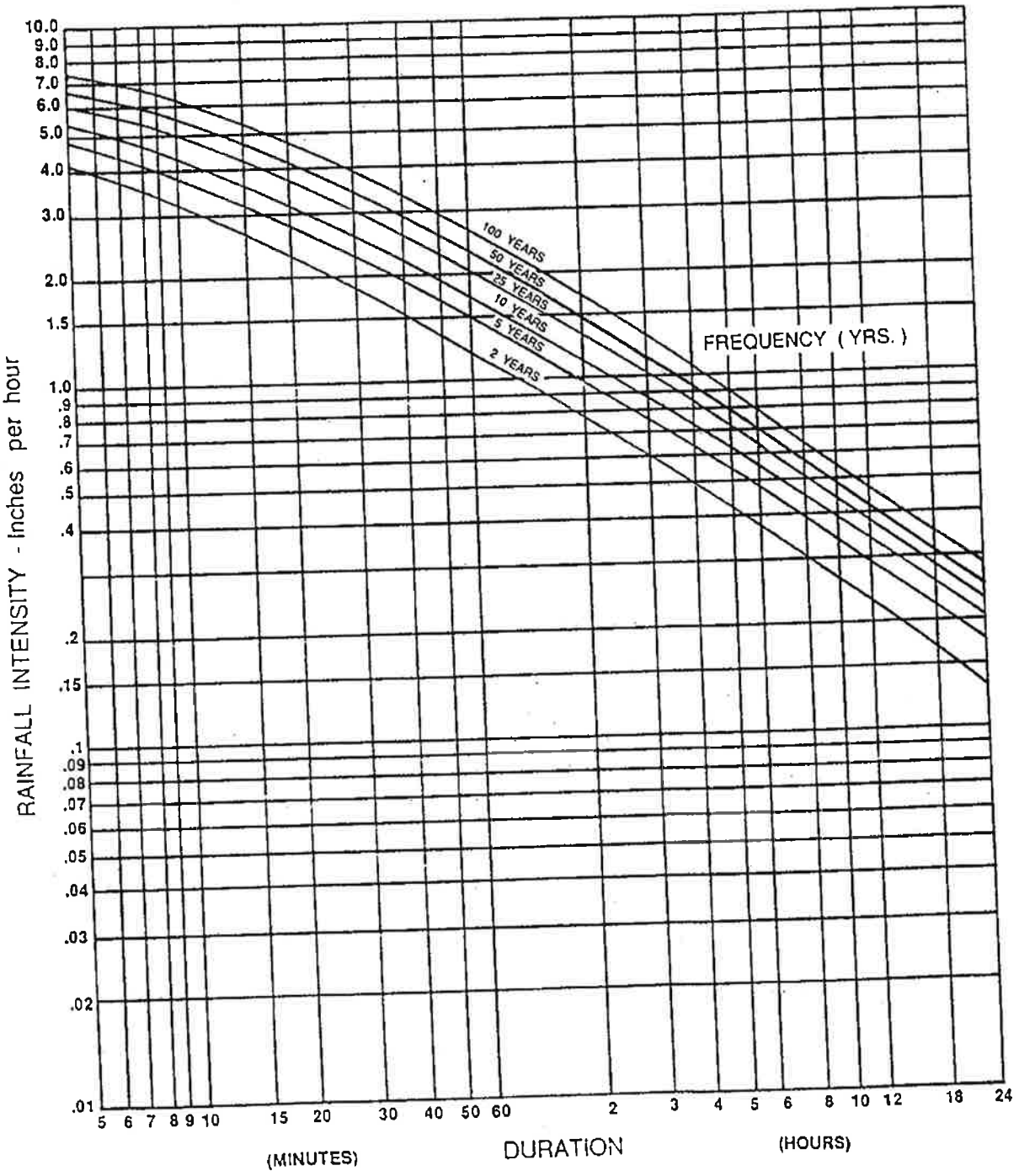


Figure 10-4. Intensity — Duration — Frequency Curve for Boston, MA

PROPOSED CATCH BASIN DRAINAGE TRIBUTARY MAP

PREPARED BY

BOHLER ENGINEERING

NOT TO SCALE

DRAINAGE COMPUTATIONS

COMP. BY: KBS

PROJECT: Main Street

JOB NO. W161155

DATE: 10/18/2016

Location: Haverhill, MA

RATIONAL METHOD PIPE CALCULATIONS **DESIGN PERIOD:** **25-YEAR STORM**

LOCATION			IMPERVIOUS			LANDSCAPE			AVG			Q		Min.		Q	V
FROM	TO	A (total)	A	C	CA	A	C	CA	C	Tc	I	CxIxA	D	S	n	full	full
		(Ac)	(Ac)			(Ac)				(Min)	in/hr	(cfs)	(in)	(ft/ft)		(cfs)	(fps)
CB1	DMH A	0.30	0.29	0.90	0.261	0.01	0.30	0.003	0.88	5	6.0	1.58					
RD	DMH A		25YR OUTFLOW FROM UNDERGROUND SYSTEM									0.59					
CB1/RD	DMH A	0.00										2.17	12	0.005	0.013	2.52	3.21
CB2	DMH A	0.36	0.35	0.90	0.315	0.01	0.30	0.003	0.88	5	6.0	1.91	12	0.005	0.013	2.52	3.21
DMH A	SWQ	0.36	0.35	0.90	0.315	0.01	0.30	0.003	0.88	5	6.0	4.08	15	0.005	0.013	4.57	3.72

Appendix 7

Water Quality Volume Calculator

JOB: 110 GRILL
LOCATION: HAVERHILL,MA
BY:KBS

AREA IN QUESTION:	BIO A	
IMPERVIOUS COVERAGE (AC)	0.11	ACRES
WQV FACTOR (.5 OR 1) (INCHES)*	1	INCHES
WQV=1"/ IMPERVIOUS ACRE	399.3	CF REQUIRED
* SEE THE STORMWATER MANAGEMENT REGULATIONS TO DETERMINE WHICH FACTOR TO USE.		

Summary

Total Volume Provided	See Below	cf
WQV Total Volume Required	399.3	cf

AREA IN QUESTION:	BIO B	
IMPERVIOUS COVERAGE (AC)	0.12	ACRES
WQV FACTOR (.5 OR 1) (INCHES)*	1	INCHES
WQV=1"/ IMPERVIOUS ACRE	435.6	CF REQUIRED
* SEE THE STORMWATER MANAGEMENT REGULATIONS TO DETERMINE WHICH FACTOR TO USE.		

Summary

Total Volume Provided	See Below	cf
WQV Total Volume Required	435.6	cf

Total WQV required	834.9	cf

Total WQV provided	1339	cf

Recharge Volume Calculator

JOB: 110 Grill
LOCATION: Westborough,MA
BY:KBS

AREA IN QUESTION: Site

IMPERVIOUS COVERAGE (AC)	1.12	ACRES
RECHARGE FACTOR**	0.25	INCHES
	1016.4	CF REQUIRED
**		

Hydrologic Group Volume to Recharge (x Total Impervious

Hydrologic Group	Volume to Recharge x Total Impervious Area
A	0.60 inches of runoff
B	0.35 inches of runoff
C	0.25 inches of runoff
D	0.10 inches of runoff

Summary

Total Recharge Vol. Provided	1771 cf
Total Recharge Vol. Required	1016 cf

Recharge Volume Provided:

Underground Infiltration System	433cf
Bio-Retention System A	1174cf
Bio-Retention System B	164cf
	Total = 1771cf

Drawdown Analysis

JOB: 110 Grill
LOCATION: Haverhill,MA
BY:KBS

AREA IN QUESTION:	BIO A	
RV	1174	cubic feet
K	3	see table
Bottom Area	382	square feet
$Time_{drawdown} = \frac{Rv}{(K)(Bottom\ \ Area)}$	12.34256397	Hours

RV=Storage Volume

K = Saturated Hydraulic Conductivity For "Static" and "Simple Dynamic" Methods, from field testing

Bottom Area= Bottom area of the Recharge Structure

AREA IN QUESTION:	BIO B	
RV	164	cubic feet
K	3	see table
Bottom Area	92	square feet
$Time_{drawdown} = \frac{Rv}{(K)(Bottom\ \ Area)}$	0.594202899	Hours

RV=Storage Volume

K = Saturated Hydraulic Conductivity For "Static" and "Simple Dynamic" Methods, from field testing

Bottom Area= Bottom area of the Recharge Structure

Location: Haverhill, MA

TSS Removal Calculation Worksheet

B BMP[1]	C TSS Removal Rate[2]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Bioretention w/ forebay	0.90	1.00	0.90	0.10
	0.00	0.10	0.00	0.10
	0.00	0.10	0.00	0.10
	0.00	0.10	0.00	0.10
	0.00	0.10	0.00	0.10

Total TSS Removal = 90%

Project: 110 Grille Haverhill

Prepared By: Kevin Sanders

Date: 10/20/16

*Equals remaining load from previous BMP (E) which enters the BMP

1. BMP From Table on Page 1-7 of MassDEP Stormwater Mgt. Policy Handbook, Volume 1
2. TSS Removal Rate from Table on page 1-7 of the MassDEP Stormwater Mgt. Policy, Volume 1

Automated 4-19-06

Location: Haverhill, MA

TSS Removal Calculation Worksheet

B BMP[1]	C TSS Removal Rate[2]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Deep Sump and Hooded Catch Basin	**0.25**	**1.00**	**0.25**	**0.75**
CDS Unit (offline)	**0.75**	**0.75**	**0.56**	**0.19**
	0.00	**0.19**	**0.00**	**0.19**
	0.00	**0.19**	**0.00**	**0.19**
	0.00	**0.19**	**0.00**	**0.19**

Total TSS Removal = **81%**

Project: **110 Grille Haverhill**

Prepared By: **Kevin Sanders**

Date: **10/20/16**

*Equals remaining load from previous BMP (E) which enters the BMP

1. BMP From Table on Page 1-7 of MassDEP Stormwater Mgt. Policy Handbook, Volume 1
2. TSS Removal Rate from Table on page 1-7 of the MassDEP Stormwater Mgt. Policy, Volume 1

Automated 4-19-06

Appendix 8

Stormwater Report

A Stormwater Report must be submitted with the permit application to document compliance with the Stormwater Management Standards. The Stormwater Report must be organized into sections that correspond to the categories listed in the Checklist (e.g., Project Type, LID Practices, Standard 1 etc.). As noted in the Checklist, the Stormwater Report must contain the engineering computations and supporting information set forth in Volume 3 of the Massachusetts Stormwater Handbook. The Stormwater Report must be prepared by a Registered Professional Engineer (RPE) licensed in the Commonwealth.

The Stormwater Report must include:

- Applicant/Project Name
- Project Address
- Name of Firm and Registered Professional Engineer that prepared the Report
- Long-Term Pollution Prevention Plan required by Standards 4-6
- Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan required by Standard 8[1]
- Operation and Maintenance Plan required by Standard 9
- The Stormwater Checklist completed and stamped by a Registered Professional Engineer (attached) that certifies that the Stormwater Report contains all required submittals.[2]

In addition to all plans and supporting information, the Stormwater Report must include a brief narrative describing stormwater management practices, including environmentally sensitive site design and LID techniques, along with a diagram depicting runoff through the proposed BMP treatment train. Plans are required to show existing and proposed conditions, identify all wetland resource areas, NRCS soil types, critical areas, Land Uses with Higher Potential Pollutant Loads (LUHPPL), and any areas on the site where infiltration rate is greater than 2.4 inches per hour. The Plans shall identify the drainage areas for both existing and proposed conditions at a scale that enables verification of supporting calculations.

As noted in the Checklist, the Stormwater Management Report shall document compliance with each of the Stormwater Management Standards as provided in the Massachusetts Stormwater Handbook. The soils evaluation and calculations shall be done using the methodologies set forth in Volume 3 of the Massachusetts Stormwater Handbook.

To ensure that the Stormwater Report is complete, applicants are required to fill in the Stormwater Report Checklist by checking the box to indicate that the specified information has been included in the Stormwater Report. If any of the information specified in the checklist has

---

[1] For some complex projects, it may not be possible to include the Construction Period Erosion and Sedimentation Control Plan in the Stormwater Report. In that event, the issuing authority has the discretion to issue an Order of Conditions that approves the project and includes a condition requiring the proponent to submit the Construction Period Erosion and Sedimentation Control Plan before commencing any land disturbance activity on the site.

[2] The Stormwater Report may also include the Illicit Discharge Compliance Statement required by Standard 10. If not included in the Stormwater Report, the Illicit Discharge Compliance Statement must be submitted prior to the discharge of stormwater runoff to the post-construction best management practices.

not been submitted, the applicant must provide an explanation. The completed Stormwater Report Checklist and Certification must be submitted with the Stormwater Report.

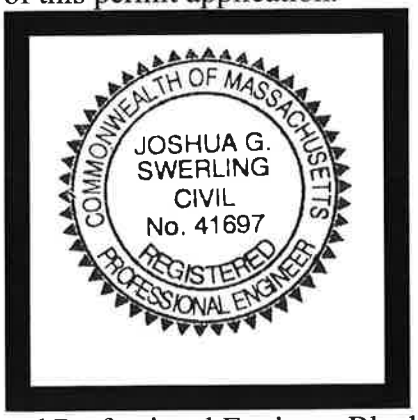
Stormwater Checklist and Certification

The following checklist is intended to serve as a guide for applicants as to the elements that ordinarily need to be addressed in a complete Stormwater Report. The checklist is also intended to provide conservation commissions and other reviewing authorities with a summary of the components necessary to comprise a comprehensive Stormwater Report that addresses the ten Stormwater Standards. *Note:* Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the item is not applicable (N.A.) and provide the reasons for that determination.

A complete checklist must include the Certification set forth below signed by the Registered Professional Engineer who prepared the Stormwater Report.

Registered Professional Engineer's Certification

I have reviewed the Stormwater Report, including the soil evaluation, computations, Long-term Pollution Prevention Plan, the Construction Period Erosion and Sedimentation Control Plan (if included), the Long-term Post-Construction Operation and Maintenance Plan, the Illicit Discharge Compliance Statement (if included) and the plans showing the stormwater management system, and have determined that they have been prepared in accordance with the requirements of the Stormwater Management Standards as further elaborated by the Massachusetts Stormwater Handbook. I have also determined that the information presented in the Stormwater Checklist is accurate and that the information presented in the Stormwater Report accurately reflects conditions at the site as of the date of this permit application.



Registered Professional Engineer Block and Signature

Joshua G Swerling 11/2/16

Signature, Date

Project Type: Is the application for new development, redevelopment, or a mix of new and redevelopment?

☐ New Development
☒ Redevelopment
☐ Mix of New Development and Redevelopment

LID Measures: Stormwater Standards require LID measures to be considered. Document what environmentally sensitive design and LID Techniques were considered during the planning and design of the project:

☐ No disturbance to any Wetland Resource Areas
☐ Site Design Practices (e.g. clustered development, reduced frontage setbacks)
☒ Reduced Impervious Area (Redevelopment Only)
☐ Minimizing disturbance to existing trees and shrubs
☐ LID Site Design Credit Requested:
  ☐ Credit 1
  ☐ Credit 2
  ☐ Credit 3
☒ Use of "country drainage" versus curb and gutter conveyance and pipe
☒ Bioretention Cells (includes Rain Gardens)
☐ Constructed Stormwater Wetlands (includes Gravel Wetlands designs)
☐ Treebox Filter
☐ Water Quality Swale
☐ Grass Channel
☐ Green Roof
☐ Other _____

Standard 1: No New Untreated Discharges

☒ No new untreated discharges
☐ Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth
☐ Supporting calculations specified in Volume 3 of the Massachusetts Stormwater Handbook included.

Standard 2: Peak Rate Attenuation

☐ Standard 2 waiver requested because the project is located in land subject to coastal storm flowage and stormwater discharge is to a wetland subject to coastal flooding.
☒ Evaluation provided to determine whether off-site flooding increases during the 100-year 24-hour storm
☒ Calculations provided to show that post-development peak discharge rates do not exceed pre-development rates for the 2-year and 10-year 24-hour storms. If evaluation shows that off-site flooding increases during the 100-year 24-hour storm, calculations are also provided to show that post-development peak discharge rates do not exceed pre-development rates for the 100-year 24-hour storm.

Standard 3: Recharge

☐ Soil Analysis provided.
☐ Required Recharge Volume calculation provided
☒ Required Recharge volume reduced through use of the LID site Design Credits.
☐ Sizing the infiltration, BMPs is based on the following method: Circle the method used.

(Static) Simple Dynamic Dynamic Field[3]

☐ Runoff from all impervious areas at the site discharging to the infiltration BMP.
☐ Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume.
☐ Recharge BMPs have been sized to infiltrate the Required Recharge Volume.
☒ Recharge BMPs have been sized to infiltrate the Required Recharge Volume *only* to the maximum extent practicable for the following reason:

- ☐ Site is comprised solely of C and D soils and/or bedrock at the land surface
- ☐ M.G.L. c. 21E sites pursuant to 310 CMR 40.0000
- ☐ Solid Waste Landfill pursuant to 310 CMR 19.000
- ☒ Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable.

☐ Calculations showing that the infiltration BMPs will drain in 72 hours are provided.
☐ Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.
☐ The infiltration BMP is used to attenuate peak flows during storms greater than or equal to the 10-year 24-hour storm and separation to seasonal high groundwater is less than 4 feet and a mounding analysis is provided.
☒ Documentation is provided showing that infiltration BMPs do not adversely impact nearby wetland resource areas.

Standard 4: Water Quality

The Long-Term Pollution Prevention Plan typically includes the following:

- Good housekeeping practices;
- Provisions for storing materials and waste products inside or under cover;
- Vehicle washing controls;
- Requirements for routine inspections and maintenance of stormwater BMPs;
- Spill prevention and response plans;
- Provisions for maintenance of lawns, gardens, and other landscaped areas;
- Requirements for storage and use of fertilizers, herbicides, and pesticides;
- Pet waste management provisions;
- Provisions for operation and management of septic systems;
- Provisions for solid waste management;

[3] 80% TSS removal is required prior to discharge to infiltration BMP if Dynamic Field method is used.

- Snow disposal and plowing plans relative to Wetland Resource Areas;
- Winter Road Salt and/or Sand Use and Storage restrictions;
- Street sweeping schedules;
- Provisions for prevention of illicit discharges to the stormwater management system;
- Documentation that Stormwater BMPs are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from LUHPPL;
- Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan;
- List of Emergency contacts for implementing Long-Term Pollution Prevention Plan.

☒ A Long-Term Pollution Prevention Plan is attached to Stormwater Report and is included as an attachment to the Wetlands Notice of Intent.

☐ Treatment BMPs subject to the 44% TSS removal pretreatment requirement and the one inch rule for calculating the water quality volume are included, and discharge:

- ☐ is within the Zone II or Interim Wellhead Protection Area
- ☐ is near or to other critical areas
- ☐ is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)
- ☐ involves runoff from land uses with higher potential pollutant loads.

☐ The Required Water Quality Volume is reduced through use of the LID site Design Credits.

☒ Calculations documenting that the treatment train meets the 80% TSS removal requirement and, if applicable, the 44% TSS removal pretreatment requirement, are provided.

☐ The BMP is sized (and calculations provided) based on:

- ☒ The ½" or 1" Water Quality Volume or
- ☐ The equivalent flow rate associated with the Water Quality Volume and documentation is provided showing that the BMP treats the required water quality volume.

☒ The applicant proposes to use proprietary BMPs, and documentation supporting use of proprietary BMP and proposed TSS removal rate is provided. This documentation may be in the form of the propriety BMP checklist found in Volume 2, Chapter 4 of the Massachusetts Stormwater Handbook and submitting copies of the TARP Report, STEP Report, and/or other third party studies verifying performance of the proprietary BMPs.

☐ A TMDL exists that indicates a need to reduce pollutants other than TSS and documentation showing that the BMPs selected are consistent with the TMDL is provided.

Standard 5: Land Uses With Higher Potential Pollutant Loads (LUHPPLs)

☐ The NPDES Multi-Sector General Permit covers the land use and the Stormwater Pollution Prevention Plan (SWPPP) has been included with the Stormwater Report.

☒ The NPDES Multi-Sector General Permit covers the land use and the SWPPP will be submitted ***prior to*** the discharge of stormwater to the post-construction stormwater BMPs.

☐ The NPDES Multi-Sector General Permit does ***not*** cover the land use.

☐ LUHPPLs are located at the site and industry specific source control and pollution prevention measures have been proposed to reduce or eliminate the exposure of LUHPPLs to rain, snow, snow melt and runoff, and been included in the long term Pollution Prevention Plan.

☒ All exposure has been eliminated
☐ All exposure has ***not*** been eliminated and all BMPs selected are on MassDEP LUHPPL list.
☐ The LUHPPL has the potential to generate runoff with moderate to higher concentrations of oil and grease (e.g. all parking lots with >1000 vehicle trips per day) and the treatment train includes an oil grit separator, a filtering bioretention area, a sand filter or equivalent.

Standard 6: Critical Areas

☐ The discharge is near or to a critical area and the treatment train includes only BMPs that MassDEP has approved for stormwater discharges to or near that particular class of critical area.
☒ Critical areas and BMPs are identified in the Stormwater Report.

Standard 7: Redevelopments and Other Projects Subject to the Standards only to the maximum extent practicable

☒ The project is subject to the Stormwater Management Standards only to the maximum Extent Practicable as a:

- ☐ Limited Project
- ☐ Small Residential Projects:
  5-9 single family houses or 5-9 units in a multi-family development provided there is no discharge that may potentially affect a critical area.
- ☐ 2-4 single family houses or 2-4 units in a multi-family development with a discharge to a critical area
- ☐ Marina and/or boatyard provided the hull painting, service and maintenance areas are protected from exposure to rain, snow, snow melt and runoff
- ☐ Bike Path and/or Foot Path
- ☒ Redevelopment Project
- ☐ Redevelopment portion of mix of new and redevelopment.

☐ Certain standards are not fully met (Standard No. 1, 8, 9, and 10 must always be fully met) and an explanation of why these standards are not met is contained in the Stormwater Report.
☒ The project involves redevelopment and a description of all measures that have been taken to improve existing conditions is provided in the Stormwater Report. The redevelopment checklist found in Volume 2 Chapter 3 of the Massachusetts Stormwater Handbook may be used to document that the proposed stormwater management system (a) complies with Standards 2, 3 and the pretreatment and structural BMP requirements of Standards 4-6 to the maximum extent practicable and (b) improves existing conditions.

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control

A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan must include the following information:

- Narrative;
- Construction Period Operation and Maintenance Plan;
- Names of Persons or Entity Responsible for Plan Compliance;
- Construction Period Pollution Prevention Measures;
- Erosion and Sedimentation Control Plan Drawings;
- Detail drawings and specifications for erosion control BMPs, including sizing calculations;
- Vegetation Planning;
- Site Development Plan;
- Construction Sequencing Plan;
- Sequencing of Erosion and Sedimentation Controls;
- Operation and Maintenance of Erosion and Sedimentation Controls;
- Inspection Schedule;
- Maintenance Schedule;
- Inspection and Maintenance Log Form.

☐ A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan containing the information set forth above has been included in the Stormwater Report.
☒ The project is highly complex and information is included in the Stormwater Report that explains why it is not possible to submit the Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan with the application. A Construction Period Pollution Prevention and Erosion and Sedimentation Control has ***not*** been included in the Stormwater Report but will be submitted ***before*** land disturbance begins.
☐ The project is ***not*** covered by a NPDES Construction General Permit.
☐ The project is covered by a NPDES Construction General Permit and a copy of the SWPPP is in the Stormwater Report.
☐ The project is covered by a NPDES Construction General Permit but no SWPPP been submitted. The SWPPP will be submitted BEFORE land disturbance begins.

Standard 9: Operation and Maintenance Plan

☒ The Post Construction Operation and Maintenance Plan is included in the Stormwater Report and includes the following information:

- ☒ Name of the stormwater management system owners;
- ☒ Party responsible for operation and maintenance;
- ☒ Schedule for implementation of routine and non-routine maintenance tasks;
- ☒ Plan showing the location of all stormwater BMPs maintenance access areas;
- ☒ Description and delineation of public safety features;
- ☒ Estimated operation and maintenance budget; and

☒ Operation and Maintenance Log Form (to be completed by contractor)

☐ The responsible party is ***not*** the owner of the parcel where the BMP is located and the Stormwater Report includes the following submissions:

☐ A copy of the legal instrument (deed, homeowner's association, utility trust or other legal entity) that establishes the terms of and legal responsibility for the operation and maintenance of the project site stormwater BMPs;

☐ A plan and easement deed that allows site access for the legal entity to operate and maintain BMP functions.

Standard 10: Prohibition of Illicit Discharges

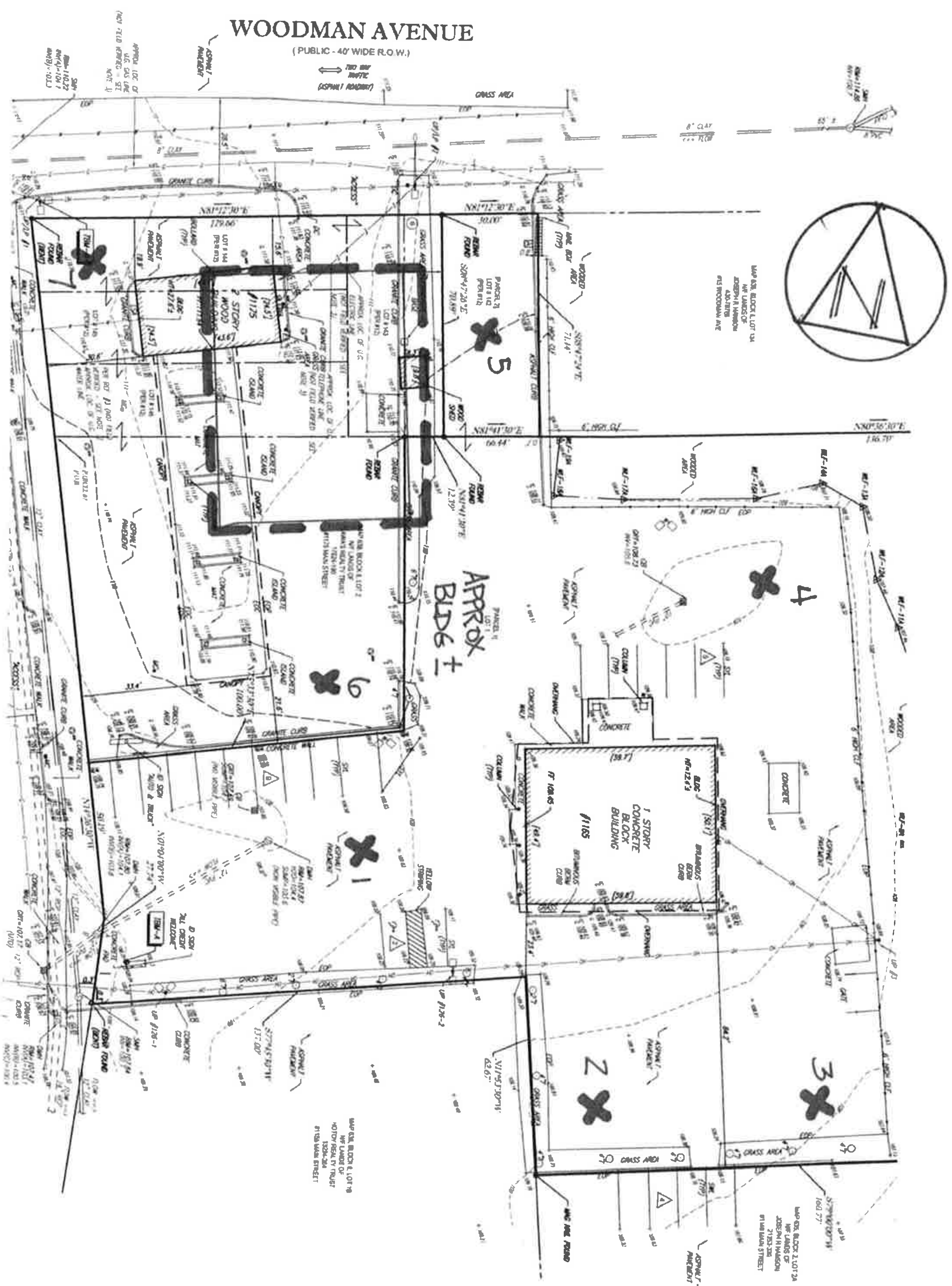
☒ The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;
☐ An Illicit Discharge Compliance Statement is attached;
☐ NO Illicit Discharge Compliance Statement is attached but will be submitted ***prior to*** the discharge of any stormwater to post-construction BMPs.

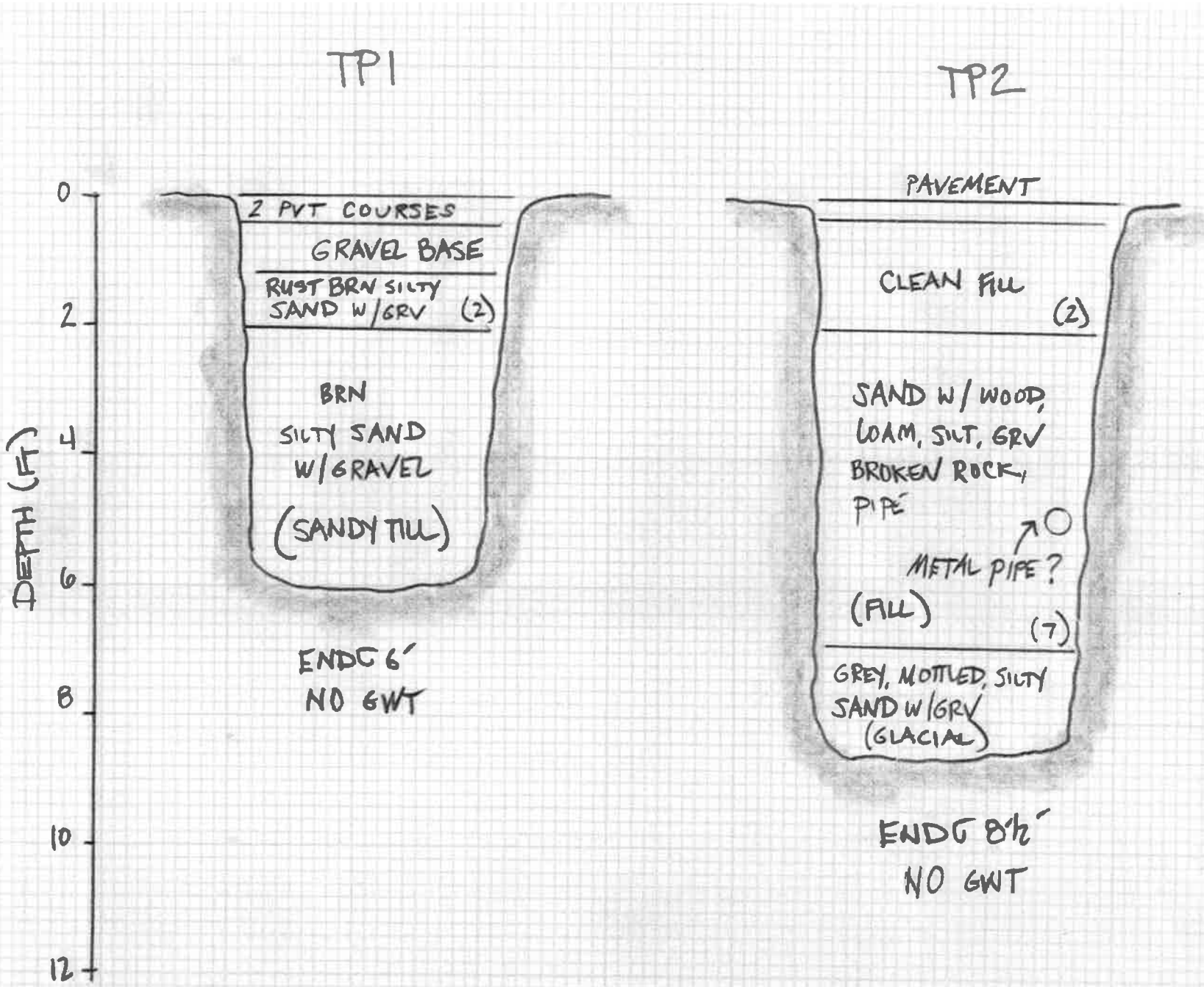
Appendix 9

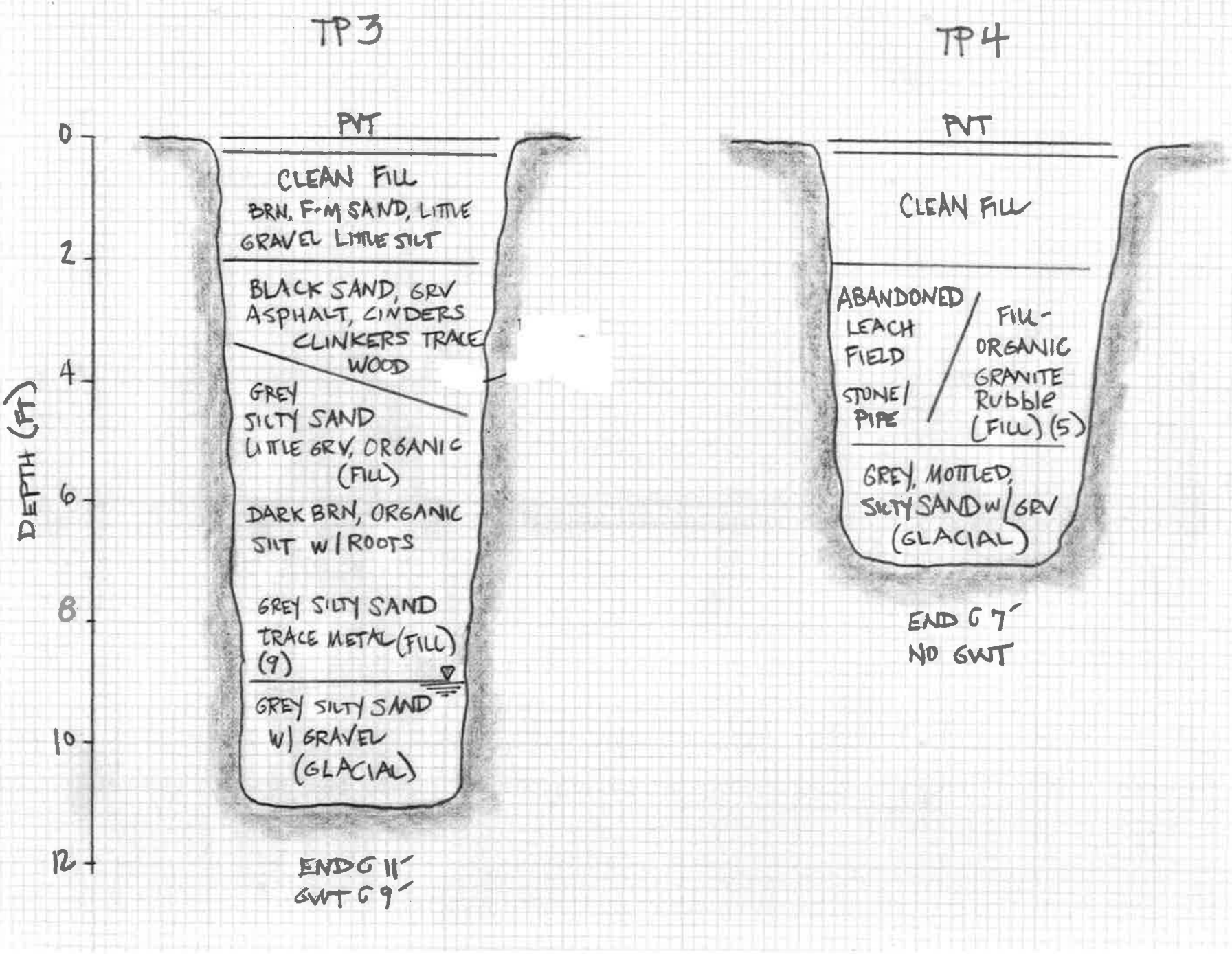

71° 6' 32" W
71° 5' 49" W
42° 48' 54" N
42° 48' 13" N
327600
327700
327800
327900
328000
328100
328200
328300
328400
328500
4742400
4742300
4742200
4742100
4742000
4741900
4741800
4741700
4741600
4741500
4741400
4741300
4741200
125
Cushing
Main
Ramp
Angie Ave
Merrill Ave
Woodrow Ave
Peppercorn Ln
255C
256A
301C
38A
311B
301B
715A
715B
421C
411B
32B
420C
410B
16A
275C
12A
40A
276B
276A
Map Scale: 1:6,210 if printed on A portrait (8.5" x 11") sheet.
N
Meters
0 50 100 200 300
Feet
0 300 600 1200 1800
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

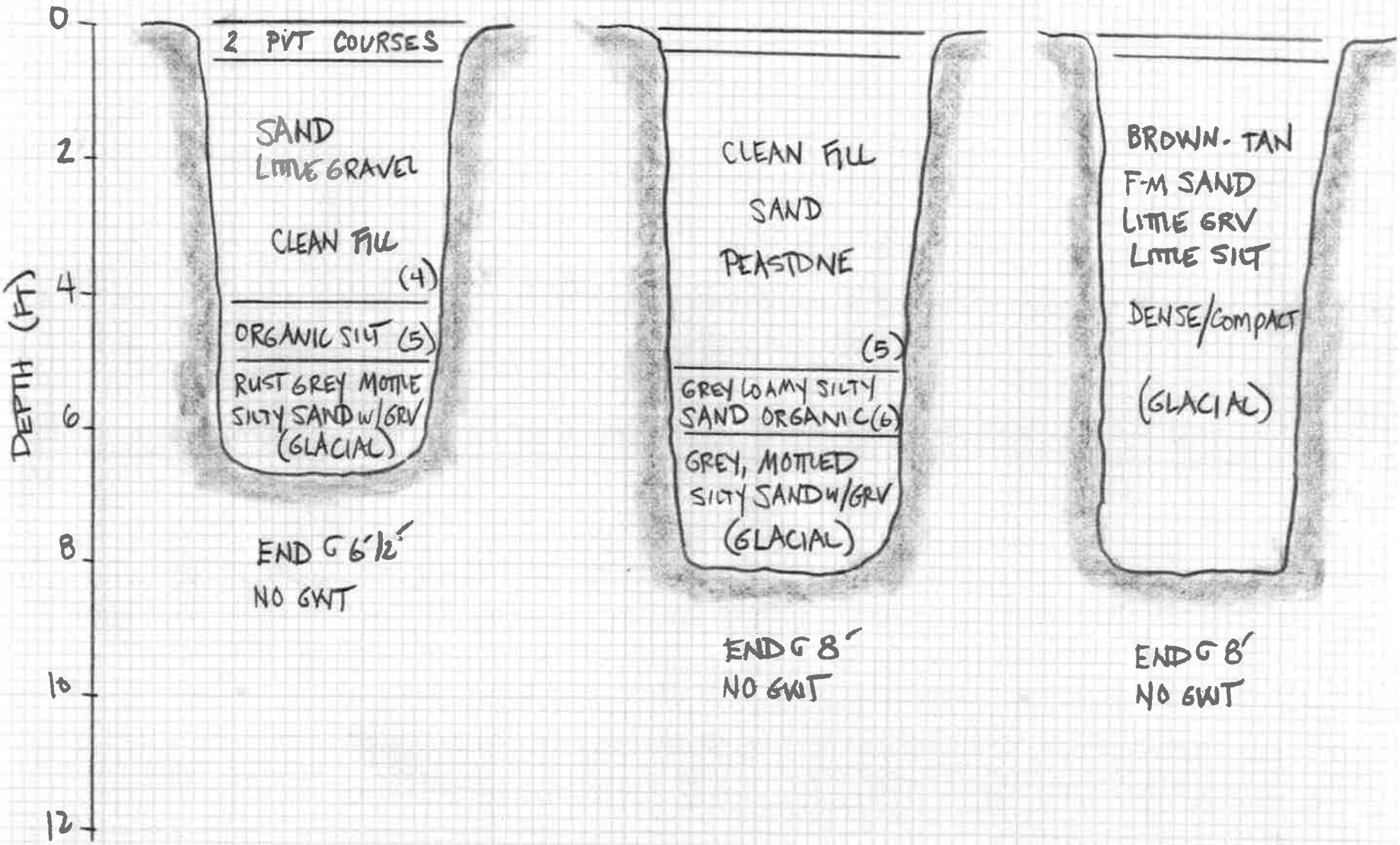
Map Unit Legend

Essex County, Massachusetts, Northern Part (MA605)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
12A	Maybid silt loam, 0 to 3 percent slopes	5.9	3.3%
16A	Scantic silt loam, 0 to 3 percent slopes	8.0	4.4%
32B	Wareham loamy sand, 3 to 8 percent slopes	7.3	4.0%
38A	Pipestone loamy sand, 0 to 3 percent slopes	3.7	2.0%
40A	Swanton fine sandy loam, 0 to 3 percent slopes	6.4	3.5%
255C	Windsor loamy sand, 8 to 15 percent slopes	1.4	0.8%
256A	Deerfield loamy fine sand, 0 to 3 percent slopes	0.8	0.4%
275C	Agawam fine sandy loam, 8 to 15 percent slopes	17.1	9.4%
276A	Ninigret fine sandy loam, 0 to 3 percent slopes	0.0	0.0%
276B	Ninigret fine sandy loam, 3 to 8 percent slopes	9.0	4.9%
301B	Montauk fine sandy loam, 0 to 8 percent slopes, very stony	14.3	7.9%
301C	Montauk fine sandy loam, 8 to 15 percent slopes, very stony	13.7	7.5%
311B	Woodbridge fine sandy loam, 0 to 8 percent slopes, very stony	70.6	38.8%
410B	Sutton fine sandy loam, 3 to 8 percent slopes	1.6	0.9%
411B	Sutton fine sandy loam, 3 to 8 percent slopes, very stony	3.4	1.9%
420C	Canton fine sandy loam, 8 to 15 percent slopes	4.1	2.3%
421C	Canton fine sandy loam, 8 to 15 percent slopes, very stony	6.3	3.5%
715A	Ridgebury and Leicester fine sandy loams, 0 to 3 percent slopes, extremely stony	0.6	0.3%
715B	Ridgebury and Leicester fine sandy loams, 3 to 8 percent slopes, extremely stony	7.5	4.1%
Totals for Area of Interest		**181.8**	**100.0%**


WOODMAN AVENUE
(PUBLIC - 40' WIDE R.O.W.)
APPROX BLDG ±
1 STORY CONCRETE BLOCK BUILDING
#1165
2 STORY WOOD BUILDING
#1175
1
2
3
4
5
6
7


TP1
TP2
DEPTH (FT)
0
2
4
6
8
10
12
2 PVT COURSES
GRAVEL BASE
RUST BRN SILTY SAND W/GRV (2)
BRN SILTY SAND W/GRAVEL (SANDY TILL)
ENDG 6'
NO GWT
PAVEMENT
CLEAN FILL (2)
SAND W/ WOOD, LOAM, SILT, GRV BROKEN ROCK, PIPE
METAL PIPE?
(FILL) (7)
GREY, MOTTLED, SILTY SAND W/GRV (GLACIAL)
ENDG 8½'
NO GWT


TP3
PVT
0
2
4
6
8
10
12
DEPTH (FT)
CLEAN FILL
BRN, F-M SAND, LITTLE GRAVEL LITTLE SILT
BLACK SAND, GRV ASPHALT, CINDERS CLINKERS TRACE WOOD
GREY SILTY SAND LITTLE GRV, ORGANIC (FILL)
DARK BRN, ORGANIC SILT W/ ROOTS
GREY SILTY SAND TRACE METAL (FILL) (9)
GREY SILTY SAND W/ GRAVEL (GLACIAL)
END @ 11'
GWT @ 9'
TP4
PVT
CLEAN FILL
ABANDONED LEACH FIELD STONE/ PIPE
FILL - ORGANIC GRANITE RUBBLE (FILL) (5)
GREY, MOTTLED, SILTY SAND W/ GRV (GLACIAL)
END @ 7'
NO GWT


TP5
TP6
TP7
DEPTH (FT)
0
2
4
6
8
10
12
2 PVT COURSES
SAND
LITTLE GRAVEL
CLEAN FILL
(4)
ORGANIC SILT (5)
RUST GREY MOTTLE
SILTY SAND w/GRV
(GLACIAL)
END @ 6'12"
NO GWT
CLEAN FILL
SAND
PEASTONE
(5)
GREY LOAMY SILTY
SAND ORGANIC (6)
GREY, MOTTLED
SILTY SAND w/GRV
(GLACIAL)
END @ 8'
NO GWT
BROWN-TAN
F-M SAND
LITTLE GRV
LITTLE SILT
DENSE/COMPACT
(GLACIAL)
END @ 8'
NO GWT