DRAINAGE ANALYSIS

FOR
Washington Street

LOCATED IN
FRANKLIN, MASSACHUSETTS

PREPARED FOR
Franklin Flex Space, LLC
13 Clovelly Road
Wellesley, MA

PREPARED BY
UNITED CONSULTANTS, INC.
850 FRANKLIN STREET, SUITE 11D
WRENTHAM, MA. 02093

DATE: June 28, 2021
Revised: November 22, 2021

COMMONWEALTH OF MASSACHUSETTS
CARLOS A. QUINTAL
CIVIL
No. 30812
REGISTERED PROFESSIONAL ENGINEER

12/3/21

Table of Contents

Appendix A	-	Narrative Description
Appendix B	-	Pre-Development vs. Post Development Rate and Volume of Runoff
Appendix C	-	Pre-development Drainage Analysis
Appendix D	-	Post-development Drainage Analysis
Appendix E	-	Manufacturers Stormceptor and CDS TSS Removal Rates and TSS Removal Worksheet
Appendix F	-	Permeability Calculations and SCS Soil Map and Information
Appendix G	-	Pond Drain Time – 100 year storm
Appendix H	-	Checklist for Designers
Appendix I	-	Storm-water Management Checklist
Appendix J	-	Operation and Maintenance Plan, Stormwater Facilities Plan and Yearly Inspection and Maintenance Log
Appendix K	-	Illicit Discharge Statement
Appendix L	-	Watershed Plans (Entire Site) Rear

APPENDIX A

I. DESCRIPTION

This report is offered in support of the stormwater management system designed for the "Site Plan – Washington Street" located in Franklin, Massachusetts. The primary goals of this system are to collect the stormwater runoff generated by the impervious building and parking area and treat it prior to discharge to the three on-site underground infiltration ponds. Additionally, there is a developed area located between Washington Street and the site which includes houses, driveways, lawn areas and wooded areas. This offsite area will be captured in the three proposed trench drains and will be piped to the underground infiltration ponds.

The three building roofs will not have any gutters or downspouts and will have roofs that slope to the rear of the buildings. Stormwater from the roofs will be directed to the trench drains.

The parking areas will be captured in catch basins and water quality units. The catch basins will be piped to water quality units and all the catchment structures will discharge to the three underground infiltration ponds.

Both the pre-development and post-development storm-water conditions flowing to the downgradient wetland are summarized in Appendix B. This design will allow for the reduction of the rate and volume of runoff at the downgradient wetland. The required volume of storm-water infiltration as required by the Massachusetts State Storm-water Standards has been provided. The stormwater system has also been designed to comply with the Town of Franklin Stormwater Regulations.

II. Purpose

The purpose of this report is to examine the hydrological and hydraulic aspects of the proposed "Washington Street" Site Plan. This report was developed for review by the Town of Franklin Planning Board, Conservation Commission and Zoning Board of Appeal to obtain the necessary permits to allow the project to proceed.

This report considers the overall hydrological impact of proposed, additional development upon the local watersheds with specific emphasis directed toward the adjacent and immediate downstream areas. The hydrology and criteria are consistent with the Town of Franklin Planning Board, Conservation Commission and the Massachusetts Department of Environmental Protection Storm Water Management Policies.

III. Pre-Development Conditions

The site consists of four parcels of land that were combined to create a parcel with 6.15 acres of land. One of the four parcels was formerly a railroad right of way. The site is currently vacant. There is also a right of way which will have a portion of the proposed driveway located within it. There is an existing easement for the overhead power transmission lines that cross the site.

The upland soils for the site were taken from the soil survey of Norfolk and Suffolk counties. The soils are classified as Hinckley Loamy Sand which has a hydrologic soil group A. Soil testing was conducted on the site to confirm the soil types and to determine permeability rates. See the soils information and permeability test results located in Appendix F. Seven permeability test were conducted on the site with two being located approximate to the three proposed underground infiltration ponds.

Utilizing a Hydrocad computer model the pre-development and post development conditions were calculated. The proposed development is located in an area with the Hinckley soils which led us to utilize a HSG of A (Hinckley) for the pre-development and post-development modeling. A comparison of the pre-development vs. post development rate and volume of runoff can be found in Appendix B.

IV. Post Development Conditions

The proposed development will consist of the construction of three buildings with vehicle parking areas. A storm-water systems has been proposed for the site. This storm-water system will have catch basin, water quality units and three trench drains to capture the stormwater. Additional water quality units will be included in line of the stormwater system to provide the required water quality treatment. Three underground infiltration ponds will also be constructed.
The underground infiltration pond 1 will provide storm-water infiltration for the entrance driveway, the parking area located to the south of building 1 and a portion of the larger parking area. CB 5 will be a Stormceptor WQU and DMH 3 will be a CDS WQU. Underground infiltration pond 2 will provide storm-water infiltration for buildings 1 and 2, and a portion of the larger parking area. CB 8 and CB9 will be a Stormceptor WQU's and DMH 7 will be a CDS WQU. Underground infiltration pond 3 will provide storm-water infiltration for building 3, and a portion of the larger parking area. CB 10 will be a Stormceptor WQU CB 14 will be a CDS WQU.
A municipal water connection and utility connections are proposed for the site. A septic system will be provided. The project will utilize a single driveway entrance from Washington Street. Utilizing the same computer model as the existing conditions we have modeled the changes in surfaces and ground cover and have calculated the post development conditions.

All calculations for the above have been included in this report. Pre-development calculations are located in Appendix C. Post-development calculations are located in Appendix D.

V. Conclusion

Storm-water from building and the proposed parking areas will be captured by catch basins, trench drains and water quality units then piped to the drain manholes and water quality units then through a manifold and into the underground infiltration ponds 1, 2 and 3. The comparison in Appendix B summarizes the rate and volumes of runoff leaving the site in both the pre-development and post-development conditions. This comparison indicates that there is not an increase in the rate or volume of runoff during the 2-year 10-year or 100-year storm events.

VI. Stormwater Management Standards

LID Measures

- Ground water infiltration is proposed to mimic pre-development conditions.

Standard 1: No New Untreated Discharges
No new untreated discharges are proposed.
Stormwater from the entrance driveway and parking areas will be captured in catch basins and grated water quality units. The catch basins will be directed to water quality units. This treatment in the water quality units will precede discharge into ponds 1, 2 or 3. See appendix E for TSS Removal Worksheets.

Standard 2: Peak Rate Attenuation
The drainage system has been designed to match or slightly reduce the rate of storm-water runoff from the site when comparing the pre-development conditions to the post development conditions. See Appendix B of this report for a summary of the design storms.

Standard 3: Recharge

- Soil testing has been completed. See Appendix F or this report.
- Ponds 1, 2 and 3 were designed based on the Static Method method.
- The required water recharge volume has been provided.

- Front site area Hinckley Soils – Use A soils
  A soils – 0.60 inches x 136,999 sq. ft. impervious = 6,850 cubic feet
  Total storage required 6,536 cubic feet
  Storage provided in Pond 1 = 4,513 cubic feet.
  Storage provided in Pond 2 = 13,057cubic feet
  Storage provided in Pond 3 = 5,077 cubic feet
  Total storage provided = 23,097
  The three Recharge systems have been designed to store and infiltrate the required recharge volume.
- See Appendix G for a summary of drain times for Ponds 1, 2 and 3. Ponds 1, 2 and 3 are drained down by hour 24.3 (Ponds 1 and 2) and 24.2 (Pond 3). This is less than the 72 hours as provided in the Stormwater management standards Chapter 5.
- The drainage system has been designed to infiltrate the required water recharge volume. The soil report provides the depths of test pits and the indication of ESHGW based on the elevation of the bottom of the permeability test pits or observed groundwater.

Standard 4: Water Quality

- The owner will include the necessary restrictions in the building lease agreements. The owner will be responsible for compliance with standard four requirements.
- Refer to sheet 6 for the Inspection and Maintenance Schedule and the Operation and Maintenance Schedule and refer to Appendix I for the O&M.
- See Appendix E for the Manufactures Stormceptor and CDS Unit TSS removal rates. IT should be noted that the flow rated to the WQU were revised and the rates are lower than originally proposed. The original Manufactures reports have been included. The site is located within a zone II. Ponds 1, 2 and 3 have rapid soil infiltration rates. This led to the Stormceptor units and the CDS units being modeled with a 1 inch WQV.
- The proposed project will include four Stormceptor Water Quality Unit and three CDS water quality units all of which will provide TSS removal. The summary of the Manufacturers Predicted Net Annual results as well as the TSS Removal Worksheet are included in Appendix E.

Standard 5: Land uses with higher potential pollutant loads

Not Applicable

Standard 6: Critical Areas

Zone II – Water Quality Volume – 1 inch.

Standard 7: Re-developments and Other Projects

Not Applicable

Standard 8: Construction Period Pollution Prevention and Erosion Sedimentation Control

- Refer to sheet 6 for the Inspection and Maintenance Schedule and the Operation and Maintenance Schedule.
- The project will be covered by a NPDES Construction General Permit.

Standard 9: Operation and Maintenance Plan

- Refer to sheet 6 for the Inspection and Maintenance Schedule and the Operation and Maintenance Schedule.
- The owner will be responsible for the storm-water management system, implementation of the operation and maintenance, the maintenance costs, and completion of the maintenance logs.

- Refer to sheet 6 for the Inspection and Maintenance Schedule and the Operation and Maintenance Schedule.

- Refer to Appendix J for the Operation and Maintenance Plan.

Standard 10: Prohibition of Illicit Discharges

- Owner to be responsible for compliance with avoiding illicit discharges. The owner or owner's representative will provide a signed illicit discharge statement with the application for a stormwater permit from the Town of Franklin DPW.
- The site will be connected to an onsite soil absorption system.

APPENDIX B

Pre-Development vs. Post Development Rate and Volume of Runoff

This analysis was prepared to show the summary of the pre-development and post development rate and volume of runoff as required by the Town of Franklin Storm-water Requirements.

The pre-development watershed areas were combined in Sub-catchment 1S and the post-development watersheds and ponds were combined in Link 1L. The below is a summary of the studied storm events:

2 year storm event (CFS)

Pre		Post
1S	vs	1L
0.00		0.00

2 year storm event (A.F.)

Pre		Post
1S	vs	1L
0.000		0.000

10 year storm event (CFS)

Pre		Post
1S	vs	1L
0.04		0.00

10 year storm event (A.F.)

Pre		Post
1S	vs	1L
0.031		0.002

100 year storm event (CFS)

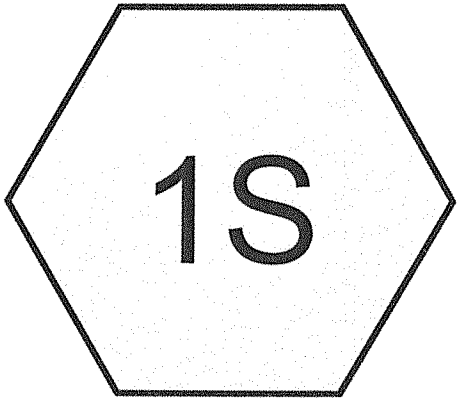
Pre		Post
1S	vs	1L
1.24		1.11

100 year storm event (A.F.)

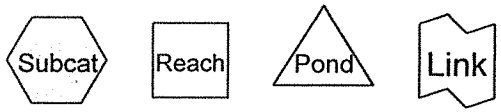
Pre		Post
1S	vs	1L
0.353		0.094

A reduction in the rate and volume of runoff has been realized with the proposed storm-water systems.

APPENDIX C



1 S



Drainage Diagram for UC1502-PRE
Prepared by {enter your company name here} 7/8/2021
HydroCAD® 8.00 s/n 001535 © 2006 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcats)
8.920	30	Woods, Good, HSG A (1S)
1.795	39	>75% Grass cover, Good, HSG A (1S)
0.394	98	Paved parking & roofs (1S)
11.110		

2 YR PRE-DEVELOPMENT

Subcatchment 1S: 1 S

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

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2YR Rainfall=3.25"

Area (sf)	CN	Description
17,166	98	Paved parking & roofs
78,207	39	>75% Grass cover, Good, HSG A
388,572	30	Woods, Good, HSG A
483,945	34	Weighted Average
466,779		Pervious Area
17,166		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.4	50	0.1540	0.15		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.25"
1.9	223	0.1540	1.96		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.7	45	0.0444	1.05		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.3	23	0.0869	1.47		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.6	66	0.1212	1.74		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.4	54	0.1851	2.15		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.2	36	0.2777	2.63		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.3	39	0.1500	1.94		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
9.8	536	Total			

10 YR PRE-DEVELOPMENT

Subcatchment 1S: 1 S

Runoff = 0.04 cfs @ 17.17 hrs, Volume= 0.031 af, Depth= 0.03"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10YR Rainfall=4.70"

Area (sf)	CN	Description
17,166	98	Paved parking & roofs
78,207	39	>75% Grass cover, Good, HSG A
388,572	30	Woods, Good, HSG A
483,945	34	Weighted Average
466,779		Pervious Area
17,166		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.4	50	0.1540	0.15		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.25"
1.9	223	0.1540	1.96		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.7	45	0.0444	1.05		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.3	23	0.0869	1.47		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.6	66	0.1212	1.74		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.4	54	0.1851	2.15		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.2	36	0.2777	2.63		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.3	39	0.1500	1.94		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
9.8	536	Total			

100 YR PRE-DEVELOPMENT

Subcatchment 1S: 1 S

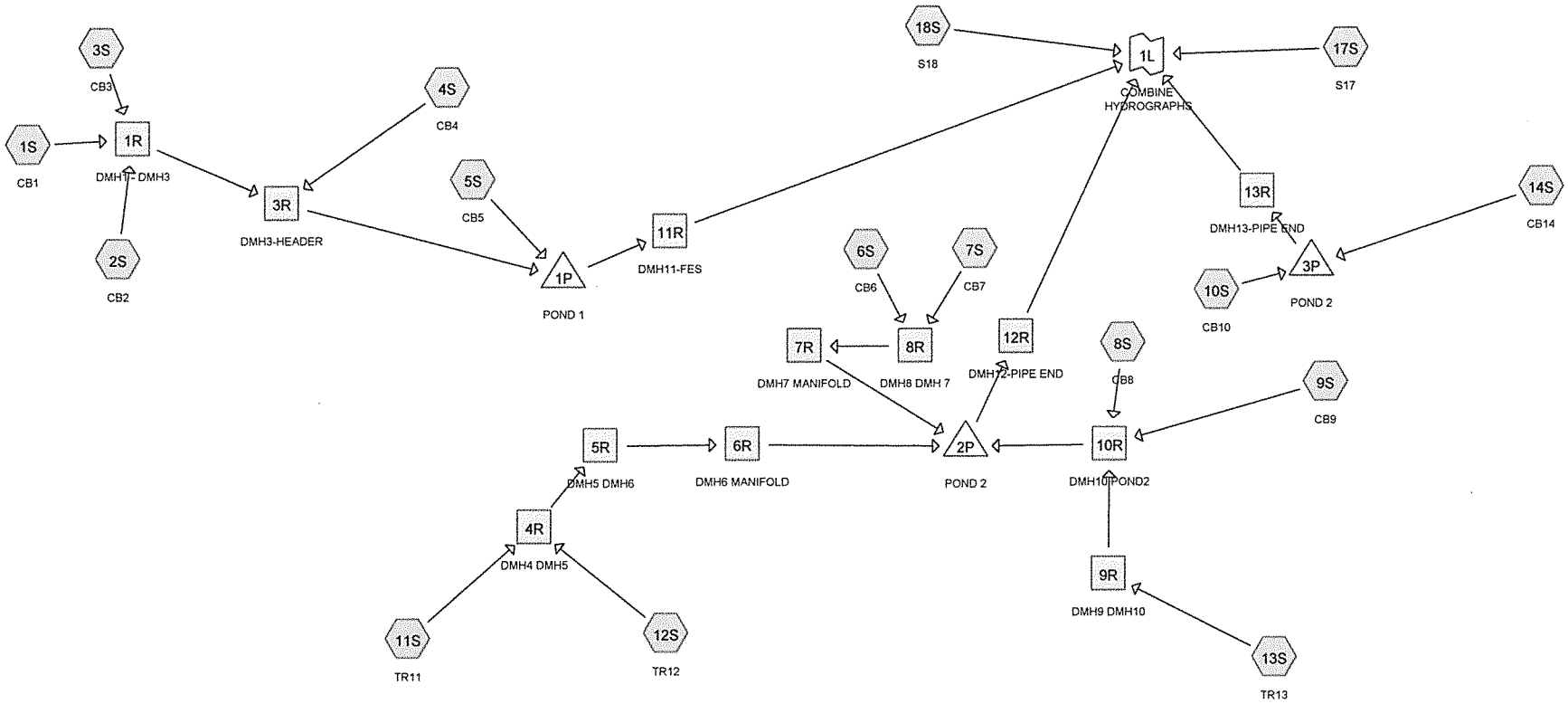
Runoff = 1.24 cfs @ 12.46 hrs, Volume= 0.353 af, Depth= 0.38"

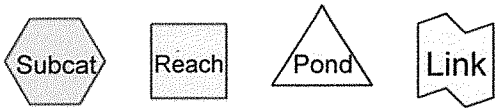
Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100YR Rainfall=6.80"

Area (sf)	CN	Description
17,166	98	Paved parking & roofs
78,207	39	>75% Grass cover, Good, HSG A
388,572	30	Woods, Good, HSG A
483,945	34	Weighted Average
466,779		Pervious Area
17,166		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.4	50	0.1540	0.15		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.25"
1.9	223	0.1540	1.96		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.7	45	0.0444	1.05		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.3	23	0.0869	1.47		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.6	66	0.1212	1.74		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.4	54	0.1851	2.15		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.2	36	0.2777	2.63		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.3	39	0.1500	1.94		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
9.8	536	Total			

APPENDIX D





Drainage Diagram for UC1502-POST-rev1

Prepared by {enter your company name here} 12/5/2021

HydroCAD® 8.00 s/n 001535 © 2006 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcats)
4.349	30	Woods, Good, HSG A (2S,5S,8S,10S,11S,12S,13S,17S,18S)
3.198	39	>75% Grass cover, Good, HSG A (1S,2S,3S,5S,8S,10S,11S,12S,13S,14S,17S,18S)
3.604	98	Paved parking & roofs (1S,2S,3S,4S,5S,6S,7S,8S,9S,10S,11S,12S,13S,14S)
11.151		

Post-Development Area is 0.041 larger than pre-Development Area Due to elimination of wall and grading at electric company property

2 YR POST-DEVELOPMENT

Subcatchment 1S: CB1

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.14 cfs @ 12.20 hrs, Volume= 0.020 af, Depth= 0.39"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 2YR Rainfall=3.25"

Area (sf)	CN	Description
9,043	98	Paved parking & roofs
18,146	39	>75% Grass cover, Good, HSG A
27,189	59	Weighted Average
18,146		Pervious Area
9,043		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Min TC**
0.3	79	0.0100	4.91	3.86	**Circular Channel (pipe),** Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
6.3	79	Total			

Subcatchment 2S: CB2

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.04 cfs @ 12.35 hrs, Volume= 0.008 af, Depth= 0.24"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 2YR Rainfall=3.25"

Area (sf)	CN	Description
4,842	98	Paved parking & roofs
7,887	39	>75% Grass cover, Good, HSG A
3,942	30	Woods, Good, HSG A
16,671	54	Weighted Average
11,829		Pervious Area
4,842		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.1	48	0.1670	0.16		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.25"
0.1	18	0.2220	2.36		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.2	22	0.0900	2.10		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	12	0.0420	1.43		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	70	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1					**Direct Entry, Min TC**
0.2	48	0.0100	4.91	3.86	**Circular Channel (pipe),** Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
6.2	218	Total			

Subcatchment 3S: CB3

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.38 cfs @ 12.10 hrs, Volume= 0.029 af, Depth= 1.44"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 2YR Rainfall=3.25"

Area (sf)	CN	Description
7,317	98	Paved parking & roofs
3,103	39	>75% Grass cover, Good, HSG A
10,420	80	Weighted Average
3,103		Pervious Area
7,317		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, MIN. TC**
0.0	8	0.0100	4.91	3.86	**Circular Channel (pipe),** Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
6.0	8	Total			

Subcatchment 4S: CB4

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.36 cfs @ 12.09 hrs, Volume= 0.029 af, Depth> 2.82"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 2YR Rainfall=3.25"

Area (sf)	CN	Description
5,376	98	Paved parking & roofs
5,376		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Min TC**
0.1	31	0.0100	4.91	3.86	**Circular Channel (pipe),** Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
6.1	31	Total			

Subcatchment 5S: CB5

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.17 cfs @ 12.14 hrs, Volume= 0.019 af, Depth= 0.54"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 2YR Rainfall=3.25"

Area (sf)	CN	Description
8,247	98	Paved parking & roofs
2,985	39	>75% Grass cover, Good, HSG A
6,808	30	Woods, Good, HSG A
18,040	63	Weighted Average
9,793		Pervious Area
8,247		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	50	0.1830	0.17		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.25"
0.7	92	0.1830	2.14		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.4	45	0.1360	1.84		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.0	10	1.0000	7.00		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	72	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.3	60	0.0320	3.63		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.3	101	0.0100	4.91	3.86	**Circular Channel (pipe),** Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
7.1	430	Total			

Subcatchment 6S: CB6

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.74 cfs @ 12.09 hrs, Volume= 0.060 af, Depth> 2.82"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 2YR Rainfall=3.25"

Area (sf)	CN	Description
11,020	98	Paved parking & roofs
11,020		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Min TC**
0.0	3	0.0200	6.95	5.46	**Circular Channel (pipe),** Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
6.0	3	Total			

Subcatchment 7S: CB7

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.50 cfs @ 12.10 hrs, Volume= 0.041 af, Depth> 2.82"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 2YR Rainfall=3.25"

Area (sf)	CN	Description
7,497	98	Paved parking & roofs
7,497		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Min TC**
0.4	120	0.0100	4.91	3.86	**Circular Channel (pipe),** Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
6.4	120	Total			

Subcatchment 8S: CB8

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.11 cfs @ 12.35 hrs, Volume= 0.020 af, Depth= 0.30"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 2YR Rainfall=3.25"

Area (sf)	CN	Description
12,116	98	Paved parking & roofs
8,994	39	>75% Grass cover, Good, HSG A
14,308	30	Woods, Good, HSG A
35,418	56	Weighted Average
23,302		Pervious Area
12,116		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.4	50	0.1540	0.15		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.25"
2.1	248	0.1540	1.96		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.0	10	1.0000	7.00		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.2	73	0.0210	1.01		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	77	0.0270	3.34		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1	31	0.0374	9.50	7.46	**Circular Channel (pipe),** Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
9.2	489	Total			

Subcatchment 9S: CB9

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.62 cfs @ 12.10 hrs, Volume= 0.050 af, Depth> 2.82"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 2YR Rainfall=3.25"

Area (sf)	CN	Description
9,254	98	Paved parking & roofs
9,254		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, M IN. TC**
0.3	116	0.0100	5.90	4.63	**Circular Channel (pipe),** Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.010 PVC, smooth interior
6.3	116	Total			

Subcatchment 10S: CB10

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.25 cfs @ 12.13 hrs, Volume= 0.025 af, Depth= 0.58"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 2YR Rainfall=3.25"

Area (sf)	CN	Description
10,776	98	Paved parking & roofs
1,709	39	>75% Grass cover, Good, HSG A
9,781	30	Woods, Good, HSG A
22,266	64	Weighted Average
11,490		Pervious Area
10,776		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, MIN. TC**
0.0	15	0.0400	9.83	7.72	**Circular Channel (pipe),** Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
6.0	15	Total			

Subcatchment 11S: TR11

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.22 cfs @ 12.24 hrs, Volume= 0.034 af, Depth= 0.36"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 2YR Rainfall=3.25"

Area (sf)	CN	Description
17,178	98	Paved parking & roofs
25,172	39	>75% Grass cover, Good, HSG A
7,847	30	Woods, Good, HSG A
50,197	58	Weighted Average
33,019		Pervious Area
17,178		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.9	50	0.2020	0.17		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.25"
0.2	31	0.2020	2.25		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.2	30	0.1610	2.81		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	16	0.1250	2.47		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	15	0.0590	3.64		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
0.3	19	0.0590	1.21		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.1	19	0.3160	2.81		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.2	10	0.0100	0.70		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.0	7	0.1420	2.64		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.0	246	0.0050	4.17	3.28	**Circular Channel (pipe), TRENCH DRAIN 11** Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.010 PVC, smooth interior
7.1	443	Total			

Subcatchment 12S: TR12

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.08 cfs @ 12.45 hrs, Volume= 0.025 af, Depth= 0.16"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 2YR Rainfall=3.25"

Area (sf)	CN	Description
20,701	98	Paved parking & roofs
27,521	39	>75% Grass cover, Good, HSG A
32,521	30	Woods, Good, HSG A
80,743	51	Weighted Average
60,042		Pervious Area
20,701		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, MIN. TC.**
1.1	274	0.0050	4.17	3.28	**Circular Channel (pipe),** Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.010 PVC, smooth interior
7.1	274	Total			

Subcatchment 13S: TR13

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.05 cfs @ 12.49 hrs, Volume= 0.018 af, Depth= 0.14"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 2YR Rainfall=3.25"

Area (sf)	CN	Description
18,951	98	Paved parking & roofs
14,429	39	>75% Grass cover, Good, HSG A
36,229	30	Woods, Good, HSG A
69,609	50	Weighted Average
50,658		Pervious Area
18,951		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.8	50	0.1170	0.30		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.25"
0.3	48	0.1170	2.39		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.8	185	0.1170	1.71		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.0	9	0.2220	3.30		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	18	0.1000	2.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.0					**Direct Entry, Min TC**
0.9	226	0.0050	4.17	3.28	**Circular Channel (pipe),** Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.010 PVC, smooth interior
6.9	536	Total			

Subcatchment 14S: CB14

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.87 cfs @ 12.10 hrs, Volume= 0.066 af, Depth> 1.88"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 2YR Rainfall=3.25"

Area (sf)	CN	Description
14,656	98	Paved parking & roofs
3,692	39	>75% Grass cover, Good, HSG A
18,348	86	Weighted Average
3,692		Pervious Area
14,656		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, MIN. TC**
0.1	25	0.0100	4.91	3.86	**Circular Channel (pipe),** Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
6.1	25	Total			

Subcatchment 17S: S17

[45] Hint: Runoff=Zero

Runoff = 0.00 cfs @ 8.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 2YR Rainfall=3.25"

Area (sf)	CN	Description
21,239	39	>75% Grass cover, Good, HSG A
67,689	30	Woods, Good, HSG A
88,928	32	Weighted Average
88,928		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.1	50	0.0254	0.07		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.25"
0.3	13	0.0254	0.80		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.5	74	0.2160	2.32		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.7	49	0.0510	1.13		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
12.6	186	Total			

Subcatchment 18S: S18

[49] Hint: Tc<2dt may require smaller dt
[45] Hint: Runoff=Zero

Runoff = 0.00 cfs @ 8.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 2YR Rainfall=3.25"

Area (sf)	CN	Description
4,448	39	>75% Grass cover, Good, HSG A
10,309	30	Woods, Good, HSG A
14,757	33	Weighted Average
14,757		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	13	0.3080	0.34		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.25"
1.2	17	0.1180	0.24		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.25"
0.4	4	0.5000	0.15		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.25"
0.5	16	0.7690	0.51		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.25"
0.1	57	0.8770	6.56		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.2					**Direct Entry, Min TC**
0.1	44	0.0250	7.77	6.10	**Circular Channel (pipe), XCB1-XDMH1** Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
6.1	151	Total			

Reach 1R: DMH1 - DMH3

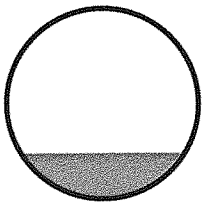
[52] Hint: Inlet conditions not evaluated

Inflow Area = 1.246 ac, Inflow Depth = 0.55" for 2YR event
Inflow = 0.52 cfs @ 12.12 hrs, Volume= 0.057 af
Outflow = 0.50 cfs @ 12.13 hrs, Volume= 0.057 af, Atten= 3%, Lag= 0.6 min

Routing by Stor-Ind+Trans method, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Max. Velocity= 3.49 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 1.52 fps, Avg. Travel Time= 0.7 min

Peak Storage= 10 cf @ 12.13 hrs, Average Depth at Peak Storage= 0.24'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 4.03 cfs

12.0" Diameter Pipe, n= 0.012 Concrete pipe, finished
Length= 67.0' Slope= 0.0109 '/'
Inlet Invert= 255.08', Outlet Invert= 254.35'



Reach 3R: DMH3-HEADER

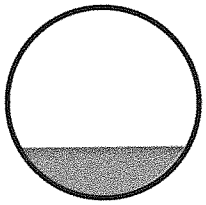
[52] Hint: Inlet conditions not evaluated
[82] Warning: Early inflow requires earlier time span
[85] Warning: Oscillations may require Finer Routing>1
[61] Hint: Submerged 23% of Reach 1R bottom

Inflow Area =	1.370 ac,	Inflow Depth >	0.75"	for	2YR event
Inflow =	0.85 cfs @	12.12 hrs,	Volume=	0.086 af	
Outflow =	0.85 cfs @	12.12 hrs,	Volume=	0.086 af,	Atten= 1%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Max. Velocity= 5.01 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.06 fps, Avg. Travel Time= 0.2 min

Peak Storage= 4 cf @ 12.12 hrs, Average Depth at Peak Storage= 0.27'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 5.41 cfs

12.0" Diameter Pipe, n= 0.010 PVC, smooth interior
Length= 22.0' Slope= 0.0136 '/'
Inlet Invert= 254.25', Outlet Invert= 253.95'



Reach 4R: DMH4 DMH5

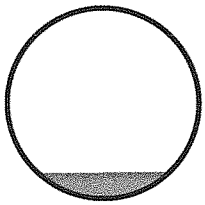
[52] Hint: Inlet conditions not evaluated
[88] Warning: Qout>Qin may require Finer Routing>1

Inflow Area =	3.006 ac,	Inflow Depth =	0.24"	for	2YR event
Inflow =	0.26 cfs @	12.36 hrs,	Volume=	0.059 af	
Outflow =	0.27 cfs @	12.38 hrs,	Volume=	0.059 af,	Atten= 0%, Lag= 0.9 min

Routing by Stor-Ind+Trans method, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Max. Velocity= 4.15 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 2.49 fps, Avg. Travel Time= 0.5 min

Peak Storage= 5 cf @ 12.38 hrs, Average Depth at Peak Storage= 0.14'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 6.69 cfs

12.0" Diameter Pipe, n= 0.012 Concrete pipe, finished
Length= 72.0' Slope= 0.0300 '/'
Inlet Invert= 256.46', Outlet Invert= 254.30'



Reach 5R: DMH5 DMH6

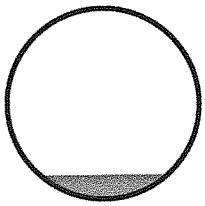
[52] Hint: Inlet conditions not evaluated
[61] Hint: Submerged 1% of Reach 4R bottom

Inflow Area =	3.006 ac,	Inflow Depth =	0.24"	for	2YR event
Inflow =	0.27 cfs @	12.38 hrs,	Volume=	0.059 af	
Outflow =	0.27 cfs @	12.38 hrs,	Volume=	0.059 af,	Atten= 0%, Lag= 0.4 min

Routing by Stor-Ind+Trans method, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Max. Velocity= 4.62 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 2.76 fps, Avg. Travel Time= 0.4 min

Peak Storage= 3 cf @ 12.38 hrs, Average Depth at Peak Storage= 0.13'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 7.78 cfs

12.0" Diameter Pipe, n= 0.012 Concrete pipe, finished
Length= 60.0' Slope= 0.0407 '/'
Inlet Invert= 254.20', Outlet Invert= 251.76'



Reach 6R: DMH6 MANIFOLD

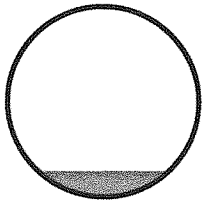
[52] Hint: Inlet conditions not evaluated
[61] Hint: Submerged 2% of Reach 5R bottom

Inflow Area =	3.006 ac,	Inflow Depth =	0.24"	for	2YR event
Inflow =	0.27 cfs @	12.38 hrs,	Volume=	0.059 af	
Outflow =	0.27 cfs @	12.39 hrs,	Volume=	0.059 af,	Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Max. Velocity= 4.10 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.45 fps, Avg. Travel Time= 0.1 min

Peak Storage= 1 cf @ 12.39 hrs, Average Depth at Peak Storage= 0.14'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 6.55 cfs

12.0" Diameter Pipe, n= 0.010 PVC, smooth interior
Length= 18.0' Slope= 0.0200 '/'
Inlet Invert= 251.66', Outlet Invert= 251.30'



Reach 7R: DMH7 MANIFOLD

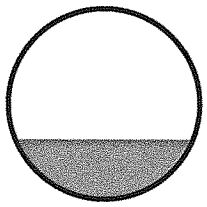
[52] Hint: Inlet conditions not evaluated
[85] Warning: Oscillations may require Finer Routing>1
[61] Hint: Submerged 36% of Reach 8R bottom

Inflow Area =	0.425 ac,	Inflow Depth >	2.82"	for	2YR event
Inflow =	1.24 cfs @	12.10 hrs,	Volume=	0.100 af	
Outflow =	1.23 cfs @	12.10 hrs,	Volume=	0.100 af,	Atten= 1%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Max. Velocity= 5.77 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.16 fps, Avg. Travel Time= 0.2 min

Peak Storage= 4 cf @ 12.10 hrs, Average Depth at Peak Storage= 0.32'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 5.67 cfs

12.0" Diameter Pipe, n= 0.010 PVC, smooth interior
Length= 20.0' Slope= 0.0150 '/'
Inlet Invert= 251.60', Outlet Invert= 251.30'



Reach 8R: DMH8 DMH 7

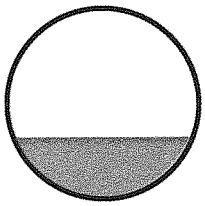
[52] Hint: Inlet conditions not evaluated
[82] Warning: Early inflow requires earlier time span
[85] Warning: Oscillations may require Finer Routing>1

Inflow Area =	0.425 ac,	Inflow Depth >	2.82"	for	2YR event
Inflow =	1.25 cfs @	12.10 hrs,	Volume=	0.100 af	
Outflow =	1.24 cfs @	12.10 hrs,	Volume=	0.100 af,	Atten= 1%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Max. Velocity= 5.63 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.10 fps, Avg. Travel Time= 0.2 min

Peak Storage= 7 cf @ 12.10 hrs, Average Depth at Peak Storage= 0.32'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 5.46 cfs

12.0" Diameter Pipe, n= 0.012 Concrete pipe, finished
Length= 30.0' Slope= 0.0200 '/'
Inlet Invert= 252.30', Outlet Invert= 251.70'



Reach 9R: DMH9 DMH10

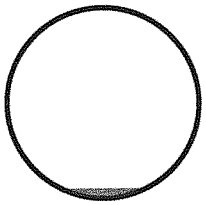
[52] Hint: Inlet conditions not evaluated

Inflow Area =	1.598 ac,	Inflow Depth =	0.14"	for	2YR event	
Inflow =	0.05 cfs @	12.49 hrs,	Volume=		0.018 af	
Outflow =	0.04 cfs @	12.51 hrs,	Volume=		0.018 af,	Atten= 1%, Lag= 1.1 min

Routing by Stor-Ind+Trans method, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Max. Velocity= 2.73 fps, Min. Travel Time= 0.6 min
Avg. Velocity = 2.02 fps, Avg. Travel Time= 0.8 min

Peak Storage= 2 cf @ 12.50 hrs, Average Depth at Peak Storage= 0.05'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 7.87 cfs

12.0" Diameter Pipe, n= 0.012 Concrete pipe, finished
Length= 99.0' Slope= 0.0416 '/'
Inlet Invert= 256.56', Outlet Invert= 252.44'



Reach 10R: DMH10 POND2

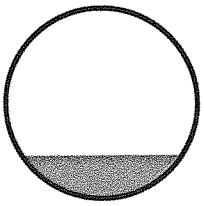
[52] Hint: Inlet conditions not evaluated
[82] Warning: Early inflow requires earlier time span
[85] Warning: Oscillations may require Finer Routing>1
[61] Hint: Submerged 3% of Reach 9R bottom

Inflow Area = 2.624 ac, Inflow Depth > 0.40" for 2YR event
Inflow = 0.65 cfs @ 12.11 hrs, Volume= 0.089 af
Outflow = 0.64 cfs @ 12.11 hrs, Volume= 0.088 af, Atten= 1%, Lag= 0.2 min

Routing by Stor-Ind+Trans method, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Max. Velocity= 4.85 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 2.24 fps, Avg. Travel Time= 0.3 min

Peak Storage= 6 cf @ 12.11 hrs, Average Depth at Peak Storage= 0.23'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 5.74 cfs

12.0" Diameter Pipe, n= 0.012 Concrete pipe, finished
Length= 47.0' Slope= 0.0221 '/'
Inlet Invert= 252.34', Outlet Invert= 251.30'



Reach 11R: DMH11-FES

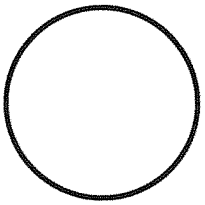
[52] Hint: Inlet conditions not evaluated

Inflow Area = 1.784 ac, Inflow Depth = 0.00" for 2YR event
Inflow = 0.00 cfs @ 8.00 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 8.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Max. Velocity= 0.00 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 0.00 fps, Avg. Travel Time= 0.0 min

Peak Storage= 0 cf @ 8.00 hrs, Average Depth at Peak Storage= 0.00'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 8.63 cfs

12.0" Diameter Pipe, n= 0.012 Concrete pipe, finished
Length= 28.0' Slope= 0.0500 '/'
Inlet Invert= 247.40', Outlet Invert= 246.00'



Reach 12R: DMH12-PIPE END

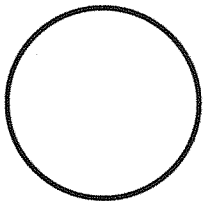
[52] Hint: Inlet conditions not evaluated

Inflow Area = 6.055 ac, Inflow Depth = 0.00" for 2YR event
Inflow = 0.00 cfs @ 8.00 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 8.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Max. Velocity= 0.00 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 0.00 fps, Avg. Travel Time= 0.0 min

Peak Storage= 0 cf @ 8.00 hrs, Average Depth at Peak Storage= 0.00'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 7.72 cfs

12.0" Diameter Pipe, n= 0.012 Concrete pipe, finished
Length= 20.0' Slope= 0.0400 '/'
Inlet Invert= 244.80', Outlet Invert= 244.00'



Reach 13R: DMH13-PIPE END

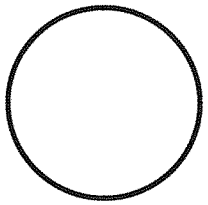
[52] Hint: Inlet conditions not evaluated

Inflow Area = 0.932 ac, Inflow Depth = 0.00" for 2YR event
Inflow = 0.00 cfs @ 8.00 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 8.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Max. Velocity= 0.00 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 0.00 fps, Avg. Travel Time= 0.0 min

Peak Storage= 0 cf @ 8.00 hrs, Average Depth at Peak Storage= 0.00'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 7.72 cfs

12.0" Diameter Pipe, n= 0.012 Concrete pipe, finished
Length= 17.0' Slope= 0.0400 '/'
Inlet Invert= 246.68', Outlet Invert= 246.00'



Pond 1P: POND 1

Inflow Area =	1.784 ac,	Inflow Depth >	0.70"	for 2YR event	
Inflow =	1.02 cfs @	12.12 hrs,	Volume=	0.104 af	
Outflow =	0.81 cfs @	12.10 hrs,	Volume=	0.104 af,	Atten= 20%, Lag= 0.0 min
Discarded =	0.81 cfs @	12.10 hrs,	Volume=	0.104 af	
Primary =	0.00 cfs @	8.00 hrs,	Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Peak Elev= 249.94' @ 12.20 hrs Surf.Area= 0.042 ac Storage= 0.002 af

Plug-Flow detention time= 1.0 min calculated for 0.104 af (100% of inflow)
Center-of-Mass det. time= 1.0 min (863.4 - 862.5)

Volume	Invert	Avail.Storage	Storage Description
#1	249.80'	0.063 af	**20.70'W x 89.00'L x 5.50'H Prismatoid**
			0.233 af Overall - 0.074 af Embedded = 0.158 af x 40.0% Voids
#2	251.05'	0.074 af	**48.0"D x 86.00'L Horizontal Cylinder** x 3 Inside #1
		0.138 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Discarded	249.70'	**19.110 in/hr Exfiltration over Surface area above invert**
			Excluded Surface area = 0.000 ac
#2	Primary	253.95'	**12.0" Vert. Orifice/Grate X 2.00** C= 0.600

Discarded OutFlow Max=0.81 cfs @ 12.10 hrs HW=249.89' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.81 cfs)

Primary OutFlow Max=0.00 cfs @ 8.00 hrs HW=249.80' (Free Discharge)
└**2=Orifice/Grate** (Controls 0.00 cfs)

Pond 2P: POND 2

Inflow Area =	6.055 ac,	Inflow Depth >	0.49"	for 2YR event	
Inflow =	2.00 cfs @	12.11 hrs,	Volume=	0.248 af	
Outflow =	1.91 cfs @	12.13 hrs,	Volume=	0.248 af,	Atten= 5%, Lag= 1.3 min
Discarded =	1.91 cfs @	12.13 hrs,	Volume=	0.248 af	
Primary =	0.00 cfs @	8.00 hrs,	Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Peak Elev= 247.20' @ 12.13 hrs Surf.Area= 5,460 sf Storage= 119 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 1.0 min (857.3 - 856.3)

Volume	Invert	Avail.Storage	Storage Description
#1	247.15'	8,051 cf	**27.30'W x 200.00'L x 5.50'H Prismatoid**
			30,030 cf Overall - 9,902 cf Embedded = 20,128 cf x 40.0% Voids
#2	248.40'	9,902 cf	**48.0"D x 197.00'L Horizontal Cylinder** x 4 Inside #1
		17,953 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Discarded	247.10'	**15.200 in/hr Exfiltration over Surface area above invert** Excluded Surface area = 0 sf
#2	Primary	251.30'	**12.0" Vert. Orifice/Grate X 3.00** C= 0.600

Discarded OutFlow Max=1.92 cfs @ 12.13 hrs HW=247.20' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 1.92 cfs)

Primary OutFlow Max=0.00 cfs @ 8.00 hrs HW=247.15' (Free Discharge)
└**2=Orifice/Grate** (Controls 0.00 cfs)

Pond 3P: POND 2

[82] Warning: Early inflow requires earlier time span

Inflow Area =	0.932 ac,	Inflow Depth >	1.17"	for 2YR event	
Inflow =	1.12 cfs @	12.11 hrs,	Volume=	0.091 af	
Outflow =	0.52 cfs @	12.00 hrs,	Volume=	0.091 af,	Atten= 54%, Lag= 0.0 min
Discarded =	0.52 cfs @	12.00 hrs,	Volume=	0.091 af	
Primary =	0.00 cfs @	8.00 hrs,	Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Peak Elev= 248.59' @ 12.35 hrs Surf.Area= 2,070 sf Storage= 406 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 4.2 min (847.1 - 842.9)

Volume	Invert	Avail.Storage	Storage Description
#1	248.10'	3,091 cf	**20.70'W x 100.00'L x 5.50'H Prismatoid** 11,385 cf Overall - 3,657 cf Embedded = 7,728 cf x 40.0% Voids
#2	249.35'	3,657 cf	**48.0"D x 97.00'L Horizontal Cylinder** x 3 Inside #1
		6,748 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Discarded	248.09'	**10.800 in/hr Exfiltration over Surface area above invert** Excluded Surface area = 0 sf
#2	Primary	252.25'	**12.0" Vert. Orifice/Grate** C= 0.600

Discarded OutFlow Max=0.52 cfs @ 12.00 hrs HW=248.17' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.52 cfs)

Primary OutFlow Max=0.00 cfs @ 8.00 hrs HW=248.10' (Free Discharge)
└**2=Orifice/Grate** (Controls 0.00 cfs)

Link 1L: COMBINE HYDROGRAPHS

Inflow Area =	11.151 ac,	Inflow Depth =	0.00"	for 2YR event	
Inflow =	0.00 cfs @	8.00 hrs,	Volume=	0.000 af	
Primary =	0.00 cfs @	8.00 hrs,	Volume=	0.000 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs

10 YR POST-DEVELOPMENT

Subcatchment 1S: CB1

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.63 cfs @ 12.12 hrs, Volume= 0.056 af, Depth= 1.07"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 10YR Rainfall=4.70"

Area (sf)	CN	Description
9,043	98	Paved parking & roofs
18,146	39	>75% Grass cover, Good, HSG A
27,189	59	Weighted Average
18,146		Pervious Area
9,043		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Min TC**
0.3	79	0.0100	4.91	3.86	**Circular Channel (pipe),** Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
6.3	79	Total			

Subcatchment 2S: CB2

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.24 cfs @ 12.13 hrs, Volume= 0.025 af, Depth= 0.78"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 10YR Rainfall=4.70"

Area (sf)	CN	Description
4,842	98	Paved parking & roofs
7,887	39	>75% Grass cover, Good, HSG A
3,942	30	Woods, Good, HSG A
16,671	54	Weighted Average
11,829		Pervious Area
4,842		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.1	48	0.1670	0.16		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.25"
0.1	18	0.2220	2.36		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.2	22	0.0900	2.10		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	12	0.0420	1.43		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	70	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1					**Direct Entry, Min TC**
0.2	48	0.0100	4.91	3.86	**Circular Channel (pipe),** Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
6.2	218	Total			

Subcatchment 3S: CB3

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.69 cfs @ 12.10 hrs, Volume= 0.052 af, Depth> 2.63"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 10YR Rainfall=4.70"

Area (sf)	CN	Description
7,317	98	Paved parking & roofs
3,103	39	>75% Grass cover, Good, HSG A
10,420	80	Weighted Average
3,103		Pervious Area
7,317		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, MIN. TC**
0.0	8	0.0100	4.91	3.86	**Circular Channel (pipe),** Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
6.0	8	Total			

Subcatchment 4S: CB4

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.53 cfs @ 12.09 hrs, Volume= 0.042 af, Depth> 4.13"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 10YR Rainfall=4.70"

Area (sf)	CN	Description
5,376	98	Paved parking & roofs
5,376		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Min TC**
0.1	31	0.0100	4.91	3.86	**Circular Channel (pipe),** Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
6.1	31	Total			

Subcatchment 5S: CB5

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.54 cfs @ 12.12 hrs, Volume= 0.046 af, Depth= 1.32"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 10YR Rainfall=4.70"

Area (sf)	CN	Description
8,247	98	Paved parking & roofs
2,985	39	>75% Grass cover, Good, HSG A
6,808	30	Woods, Good, HSG A
18,040	63	Weighted Average
9,793		Pervious Area
8,247		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	50	0.1830	0.17		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.25"
0.7	92	0.1830	2.14		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.4	45	0.1360	1.84		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.0	10	1.0000	7.00		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	72	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.3	60	0.0320	3.63		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.3	101	0.0100	4.91	3.86	**Circular Channel (pipe),** Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
7.1	430	Total			

Subcatchment 6S: CB6

[49] Hint: Tc<2dt may require smaller dt

Runoff = 1.08 cfs @ 12.09 hrs, Volume= 0.087 af, Depth> 4.13"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 10YR Rainfall=4.70"

Area (sf)	CN	Description
11,020	98	Paved parking & roofs
11,020		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Min TC**
0.0	3	0.0200	6.95	5.46	**Circular Channel (pipe),** Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
6.0	3	Total			

Subcatchment 7S: CB7

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.73 cfs @ 12.10 hrs, Volume= 0.059 af, Depth> 4.13"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 10YR Rainfall=4.70"

Area (sf)	CN	Description
7,497	98	Paved parking & roofs
7,497		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Min TC**
0.4	120	0.0100	4.91	3.86	**Circular Channel (pipe),** Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
6.4	120	Total			

Subcatchment 8S: CB8

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.55 cfs @ 12.19 hrs, Volume= 0.060 af, Depth= 0.89"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 10YR Rainfall=4.70"

Area (sf)	CN	Description
12,116	98	Paved parking & roofs
8,994	39	>75% Grass cover, Good, HSG A
14,308	30	Woods, Good, HSG A
35,418	56	Weighted Average
23,302		Pervious Area
12,116		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.4	50	0.1540	0.15		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.25"
2.1	248	0.1540	1.96		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.0	10	1.0000	7.00		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.2	73	0.0210	1.01		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	77	0.0270	3.34		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1	31	0.0374	9.50	7.46	**Circular Channel (pipe),** Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
9.2	489	Total			

Subcatchment 9S: CB9

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.91 cfs @ 12.10 hrs, Volume= 0.073 af, Depth> 4.13"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 10YR Rainfall=4.70"

Area (sf)	CN	Description
9,254	98	Paved parking & roofs
9,254		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, M IN. TC**
0.3	116	0.0100	5.90	4.63	**Circular Channel (pipe),** Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.010 PVC, smooth interior
6.3	116	Total			

Subcatchment 10S: CB10

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.73 cfs @ 12.11 hrs, Volume= 0.059 af, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 10YR Rainfall=4.70"

Area (sf)	CN	Description
10,776	98	Paved parking & roofs
1,709	39	>75% Grass cover, Good, HSG A
9,781	30	Woods, Good, HSG A
22,266	64	Weighted Average
11,490		Pervious Area
10,776		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, MIN. TC**
0.0	15	0.0400	9.83	7.72	**Circular Channel (pipe),** Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
6.0	15	Total			

Subcatchment 11S: TR11

[49] Hint: Tc<2dt may require smaller dt

Runoff = 1.03 cfs @ 12.13 hrs, Volume= 0.097 af, Depth= 1.01"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 10YR Rainfall=4.70"

Area (sf)	CN	Description
17,178	98	Paved parking & roofs
25,172	39	>75% Grass cover, Good, HSG A
7,847	30	Woods, Good, HSG A
50,197	58	Weighted Average
33,019		Pervious Area
17,178		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.9	50	0.2020	0.17		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.25"
0.2	31	0.2020	2.25		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.2	30	0.1610	2.81		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	16	0.1250	2.47		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	15	0.0590	3.64		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
0.3	19	0.0590	1.21		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.1	19	0.3160	2.81		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.2	10	0.0100	0.70		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.0	7	0.1420	2.64		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.0	246	0.0050	4.17	3.28	**Circular Channel (pipe), TRENCH DRAIN 11** Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.010 PVC, smooth interior
7.1	443	Total			

Subcatchment 12S: TR12

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.71 cfs @ 12.20 hrs, Volume= 0.096 af, Depth= 0.62"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 10YR Rainfall=4.70"

Area (sf)	CN	Description
20,701	98	Paved parking & roofs
27,521	39	>75% Grass cover, Good, HSG A
32,521	30	Woods, Good, HSG A
80,743	51	Weighted Average
60,042		Pervious Area
20,701		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, MIN. TC.**
1.1	274	0.0050	4.17	3.28	**Circular Channel (pipe),** Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.010 PVC, smooth interior
7.1	274	Total			

Subcatchment 13S: TR13

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.53 cfs @ 12.21 hrs, Volume= 0.076 af, Depth= 0.57"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 10YR Rainfall=4.70"

Area (sf)	CN	Description
18,951	98	Paved parking & roofs
14,429	39	>75% Grass cover, Good, HSG A
36,229	30	Woods, Good, HSG A
69,609	50	Weighted Average
50,658		Pervious Area
18,951		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.8	50	0.1170	0.30		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.25"
0.3	48	0.1170	2.39		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.8	185	0.1170	1.71		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.0	9	0.2220	3.30		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	18	0.1000	2.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.0					**Direct Entry, Min TC**
0.9	226	0.0050	4.17	3.28	**Circular Channel (pipe),** Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.010 PVC, smooth interior
6.9	536	Total			

Subcatchment 14S: CB14

[49] Hint: Tc<2dt may require smaller dt

Runoff = 1.45 cfs @ 12.10 hrs, Volume= 0.111 af, Depth> 3.17"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 10YR Rainfall=4.70"

Area (sf)	CN	Description
14,656	98	Paved parking & roofs
3,692	39	>75% Grass cover, Good, HSG A
18,348	86	Weighted Average
3,692		Pervious Area
14,656		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, MIN. TC**
0.1	25	0.0100	4.91	3.86	**Circular Channel (pipe),** Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
6.1	25	Total			

Subcatchment 17S: S17

Runoff = 0.00 cfs @ 22.95 hrs, Volume= 0.002 af, Depth= 0.01"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 10YR Rainfall=4.70"

Area (sf)	CN	Description
21,239	39	>75% Grass cover, Good, HSG A
67,689	30	Woods, Good, HSG A
88,928	32	Weighted Average
88,928		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.1	50	0.0254	0.07		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.25"
0.3	13	0.0254	0.80		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.5	74	0.2160	2.32		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.7	49	0.0510	1.13		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
12.6	186	Total			

Subcatchment 18S: S18

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.00 cfs @ 21.53 hrs, Volume= 0.001 af, Depth= 0.02"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 10YR Rainfall=4.70"

Area (sf)	CN	Description
4,448	39	>75% Grass cover, Good, HSG A
10,309	30	Woods, Good, HSG A
14,757	33	Weighted Average
14,757		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	13	0.3080	0.34		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.25"
1.2	17	0.1180	0.24		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.25"
0.4	4	0.5000	0.15		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.25"
0.5	16	0.7690	0.51		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.25"
0.1	57	0.8770	6.56		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.2					**Direct Entry, Min TC**
0.1	44	0.0250	7.77	6.10	**Circular Channel (pipe), XCB1-XDMH1** Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
6.1	151	Total			

Reach 1R: DMH1 - DMH3

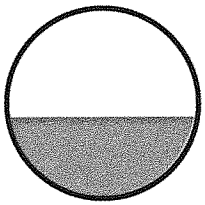
[52] Hint: Inlet conditions not evaluated

Inflow Area = 1.246 ac, Inflow Depth > 1.28" for 10YR event
Inflow = 1.55 cfs @ 12.11 hrs, Volume= 0.133 af
Outflow = 1.51 cfs @ 12.12 hrs, Volume= 0.133 af, Atten= 3%, Lag= 0.4 min

Routing by Stor-Ind+Trans method, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Max. Velocity= 4.77 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 1.83 fps, Avg. Travel Time= 0.6 min

Peak Storage= 22 cf @ 12.12 hrs, Average Depth at Peak Storage= 0.43'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 4.03 cfs

12.0" Diameter Pipe, n= 0.012 Concrete pipe, finished
Length= 67.0' Slope= 0.0109 '/'
Inlet Invert= 255.08', Outlet Invert= 254.35'



Reach 3R: DMH3-HEADER

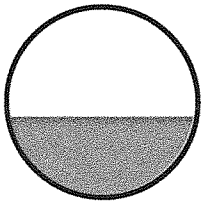
[52] Hint: Inlet conditions not evaluated
[82] Warning: Early inflow requires earlier time span
[85] Warning: Oscillations may require Finer Routing>1
[61] Hint: Submerged 44% of Reach 1R bottom

Inflow Area = 1.370 ac, Inflow Depth > 1.54" for 10YR event
Inflow = 2.03 cfs @ 12.11 hrs, Volume= 0.175 af
Outflow = 2.02 cfs @ 12.11 hrs, Volume= 0.175 af, Atten= 1%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Max. Velocity= 6.38 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.51 fps, Avg. Travel Time= 0.1 min

Peak Storage= 7 cf @ 12.11 hrs, Average Depth at Peak Storage= 0.42'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 5.41 cfs

12.0" Diameter Pipe, n= 0.010 PVC, smooth interior
Length= 22.0' Slope= 0.0136 '/'
Inlet Invert= 254.25', Outlet Invert= 253.95'



Reach 4R: DMH4 DMH5

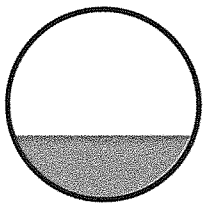
[52] Hint: Inlet conditions not evaluated

Inflow Area = 3.006 ac, Inflow Depth = 0.77" for 10YR event
Inflow = 1.75 cfs @ 12.14 hrs, Volume= 0.193 af
Outflow = 1.63 cfs @ 12.16 hrs, Volume= 0.193 af, Atten= 7%, Lag= 0.9 min

Routing by Stor-Ind+Trans method, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Max. Velocity= 7.00 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 3.32 fps, Avg. Travel Time= 0.4 min

Peak Storage= 17 cf @ 12.15 hrs, Average Depth at Peak Storage= 0.34'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 6.69 cfs

12.0" Diameter Pipe, n= 0.012 Concrete pipe, finished
Length= 72.0' Slope= 0.0300 '/'
Inlet Invert= 256.46', Outlet Invert= 254.30'



Reach 5R: DMH5 DMH6

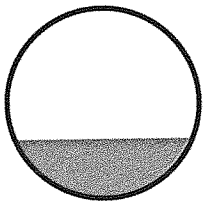
[52] Hint: Inlet conditions not evaluated
[88] Warning: Qout>Qin may require Finer Routing>1
[61] Hint: Submerged 10% of Reach 4R bottom

Inflow Area =	3.006 ac,	Inflow Depth =	0.77"	for	10YR event
Inflow =	1.63 cfs @	12.16 hrs,	Volume=	0.193 af	
Outflow =	1.64 cfs @	12.17 hrs,	Volume=	0.193 af,	Atten= 0%, Lag= 0.8 min

Routing by Stor-Ind+Trans method, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Max. Velocity= 7.83 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 3.70 fps, Avg. Travel Time= 0.3 min

Peak Storage= 13 cf @ 12.17 hrs, Average Depth at Peak Storage= 0.31'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 7.78 cfs

12.0" Diameter Pipe, n= 0.012 Concrete pipe, finished
Length= 60.0' Slope= 0.0407 '/'
Inlet Invert= 254.20', Outlet Invert= 251.76'



Reach 6R: DMH6 MANIFOLD

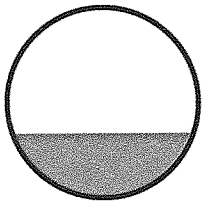
[52] Hint: Inlet conditions not evaluated
[88] Warning: Qout>Qin may require Finer Routing>1
[61] Hint: Submerged 10% of Reach 5R bottom

Inflow Area =	3.006 ac,	Inflow Depth =	0.77"	for	10YR event
Inflow =	1.64 cfs @	12.17 hrs,	Volume=	0.193 af	
Outflow =	1.64 cfs @	12.18 hrs,	Volume=	0.193 af,	Atten= 0%, Lag= 0.2 min

Routing by Stor-Ind+Trans method, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Max. Velocity= 6.93 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 3.28 fps, Avg. Travel Time= 0.1 min

Peak Storage= 4 cf @ 12.17 hrs, Average Depth at Peak Storage= 0.34'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 6.55 cfs

12.0" Diameter Pipe, n= 0.010 PVC, smooth interior
Length= 18.0' Slope= 0.0200 '/'
Inlet Invert= 251.66', Outlet Invert= 251.30'



Reach 7R: DMH7 MANIFOLD

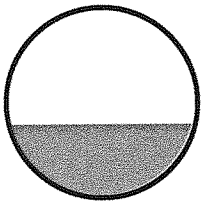
[52] Hint: Inlet conditions not evaluated
[85] Warning: Oscillations may require Finer Routing>1
[61] Hint: Submerged 48% of Reach 8R bottom

Inflow Area = 0.425 ac, Inflow Depth > 4.12" for 10YR event
Inflow = 1.81 cfs @ 12.10 hrs, Volume= 0.146 af
Outflow = 1.79 cfs @ 12.10 hrs, Volume= 0.146 af, Atten= 1%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Max. Velocity= 6.41 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.42 fps, Avg. Travel Time= 0.1 min

Peak Storage= 6 cf @ 12.10 hrs, Average Depth at Peak Storage= 0.39'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 5.67 cfs

12.0" Diameter Pipe, n= 0.010 PVC, smooth interior
Length= 20.0' Slope= 0.0150 '/'
Inlet Invert= 251.60', Outlet Invert= 251.30'



Reach 8R: DMH8 DMH 7

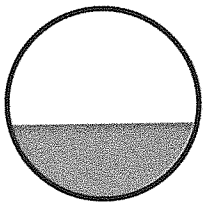
[52] Hint: Inlet conditions not evaluated
[82] Warning: Early inflow requires earlier time span
[85] Warning: Oscillations may require Finer Routing>1

Inflow Area = 0.425 ac, Inflow Depth > 4.13" for 10YR event
Inflow = 1.82 cfs @ 12.10 hrs, Volume= 0.146 af
Outflow = 1.81 cfs @ 12.10 hrs, Volume= 0.146 af, Atten= 1%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Max. Velocity= 6.25 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.35 fps, Avg. Travel Time= 0.2 min

Peak Storage= 9 cf @ 12.10 hrs, Average Depth at Peak Storage= 0.40'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 5.46 cfs

12.0" Diameter Pipe, n= 0.012 Concrete pipe, finished
Length= 30.0' Slope= 0.0200 '/'
Inlet Invert= 252.30', Outlet Invert= 251.70'



Reach 9R: DMH9 DMH10

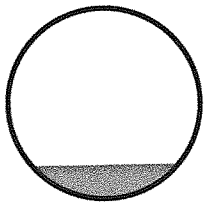
[52] Hint: Inlet conditions not evaluated
[88] Warning: Qout>Qin may require Finer Routing>1

Inflow Area =	1.598 ac,	Inflow Depth =	0.57"	for	10YR event
Inflow =	0.53 cfs @	12.21 hrs,	Volume=	0.076 af	
Outflow =	0.54 cfs @	12.22 hrs,	Volume=	0.076 af,	Atten= 0%, Lag= 0.3 min

Routing by Stor-Ind+Trans method, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Max. Velocity= 5.75 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 2.94 fps, Avg. Travel Time= 0.6 min

Peak Storage= 9 cf @ 12.21 hrs, Average Depth at Peak Storage= 0.18'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 7.87 cfs

12.0" Diameter Pipe, n= 0.012 Concrete pipe, finished
Length= 99.0' Slope= 0.0416 '/'
Inlet Invert= 256.56', Outlet Invert= 252.44'



Reach 10R: DMH10 POND2

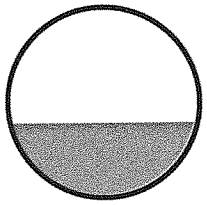
[52] Hint: Inlet conditions not evaluated
[82] Warning: Early inflow requires earlier time span
[85] Warning: Oscillations may require Finer Routing>1
[61] Hint: Submerged 7% of Reach 9R bottom

Inflow Area =	2.624 ac,	Inflow Depth >	0.96"	for	10YR event
Inflow =	1.87 cfs @	12.14 hrs,	Volume=	0.210 af	
Outflow =	1.85 cfs @	12.14 hrs,	Volume=	0.210 af,	Atten= 1%, Lag= 0.3 min

Routing by Stor-Ind+Trans method, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Max. Velocity= 6.44 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.82 fps, Avg. Travel Time= 0.3 min

Peak Storage= 13 cf @ 12.14 hrs, Average Depth at Peak Storage= 0.39'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 5.74 cfs

12.0" Diameter Pipe, n= 0.012 Concrete pipe, finished
Length= 47.0' Slope= 0.0221 '/'
Inlet Invert= 252.34', Outlet Invert= 251.30'



Reach 11R: DMH11-FES

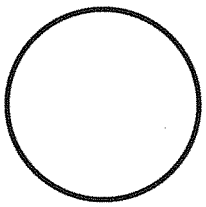
[52] Hint: Inlet conditions not evaluated

Inflow Area =	1.784 ac,	Inflow Depth =	0.00"	for	10YR event	
Inflow =	0.00 cfs @	8.00 hrs,	Volume=		0.000 af	
Outflow =	0.00 cfs @	8.00 hrs,	Volume=		0.000 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Max. Velocity= 0.00 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 0.00 fps, Avg. Travel Time= 0.0 min

Peak Storage= 0 cf @ 8.00 hrs, Average Depth at Peak Storage= 0.00'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 8.63 cfs

12.0" Diameter Pipe, n= 0.012 Concrete pipe, finished
Length= 28.0' Slope= 0.0500 '/'
Inlet Invert= 247.40', Outlet Invert= 246.00'



Reach 12R: DMH12-PIPE END

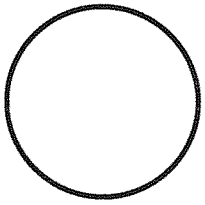
[52] Hint: Inlet conditions not evaluated

Inflow Area = 6.055 ac, Inflow Depth = 0.00" for 10YR event
Inflow = 0.00 cfs @ 8.00 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 8.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Max. Velocity= 0.00 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 0.00 fps, Avg. Travel Time= 0.0 min

Peak Storage= 0 cf @ 8.00 hrs, Average Depth at Peak Storage= 0.00'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 7.72 cfs

12.0" Diameter Pipe, n= 0.012 Concrete pipe, finished
Length= 20.0' Slope= 0.0400 '/'
Inlet Invert= 244.80', Outlet Invert= 244.00'



Reach 13R: DMH13-PIPE END

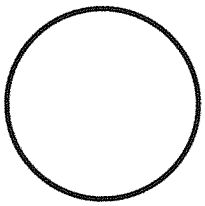
[52] Hint: Inlet conditions not evaluated

Inflow Area = 0.932 ac, Inflow Depth = 0.00" for 10YR event
Inflow = 0.00 cfs @ 8.00 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 8.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Max. Velocity= 0.00 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 0.00 fps, Avg. Travel Time= 0.0 min

Peak Storage= 0 cf @ 8.00 hrs, Average Depth at Peak Storage= 0.00'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 7.72 cfs

12.0" Diameter Pipe, n= 0.012 Concrete pipe, finished
Length= 17.0' Slope= 0.0400 '/'
Inlet Invert= 246.68', Outlet Invert= 246.00'



Pond 1P: POND 1

Inflow Area =	1.784 ac,	Inflow Depth >	1.49"	for	10YR event
Inflow =	2.56 cfs @	12.12 hrs,	Volume=	0.221 af	
Outflow =	0.81 cfs @	12.00 hrs,	Volume=	0.221 af,	Atten= 68%, Lag= 0.0 min
Discarded =	0.81 cfs @	12.00 hrs,	Volume=	0.221 af	
Primary =	0.00 cfs @	8.00 hrs,	Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Peak Elev= 251.71' @ 12.51 hrs Surf.Area= 0.042 ac Storage= 0.037 af

Plug-Flow detention time= 10.0 min calculated for 0.220 af (100% of inflow)
Center-of-Mass det. time= 10.0 min (860.6 - 850.6)

Volume	Invert	Avail.Storage	Storage Description
#1	249.80'	0.063 af	**20.70'W x 89.00'L x 5.50'H Prismatoid** 0.233 af Overall - 0.074 af Embedded = 0.158 af x 40.0% Voids
#2	251.05'	0.074 af	**48.0"D x 86.00'L Horizontal Cylinder** x 3 Inside #1
		0.138 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Discarded	249.70'	**19.110 in/hr Exfiltration over Surface area above invert** Excluded Surface area = 0.000 ac
#2	Primary	253.95'	**12.0" Vert. Orifice/Grate X 2.00** C= 0.600

Discarded OutFlow Max=0.81 cfs @ 12.00 hrs HW=250.00' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.81 cfs)

Primary OutFlow Max=0.00 cfs @ 8.00 hrs HW=249.80' (Free Discharge)
└─**2=Orifice/Grate** (Controls 0.00 cfs)

Pond 2P: POND 2

Inflow Area =	6.055 ac,	Inflow Depth >	1.09"	for	10YR event
Inflow =	5.21 cfs @	12.13 hrs,	Volume=	0.549 af	
Outflow =	1.92 cfs @	12.00 hrs,	Volume=	0.549 af,	Atten= 63%, Lag= 0.0 min
Discarded =	1.92 cfs @	12.00 hrs,	Volume=	0.549 af	
Primary =	0.00 cfs @	8.00 hrs,	Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Peak Elev= 248.60' @ 12.53 hrs Surf.Area= 5,460 sf Storage= 3,263 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 7.9 min (866.2 - 858.3)

Volume	Invert	Avail.Storage	Storage Description
#1	247.15'	8,051 cf	**27.30'W x 200.00'L x 5.50'H Prismatoid** 30,030 cf Overall - 9,902 cf Embedded = 20,128 cf x 40.0% Voids
#2	248.40'	9,902 cf	**48.0"D x 197.00'L Horizontal Cylinder** x 4 Inside #1
		17,953 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Discarded	247.10'	**15.200 in/hr Exfiltration over Surface area above invert** Excluded Surface area = 0 sf
#2	Primary	251.30'	**12.0" Vert. Orifice/Grate X 3.00** C= 0.600

Discarded OutFlow Max=1.92 cfs @ 12.00 hrs HW=247.24' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 1.92 cfs)

Primary OutFlow Max=0.00 cfs @ 8.00 hrs HW=247.15' (Free Discharge)
└─**2=Orifice/Grate** (Controls 0.00 cfs)

Pond 3P: POND 2

[82] Warning: Early inflow requires earlier time span
[85] Warning: Oscillations may require Finer Routing>1

Inflow Area =	0.932 ac,	Inflow Depth >	2.19"	for	10YR event
Inflow =	2.18 cfs @	12.10 hrs,	Volume=	0.170 af	
Outflow =	0.52 cfs @	11.90 hrs,	Volume=	0.170 af,	Atten= 76%, Lag= 0.0 min
Discarded =	0.52 cfs @	11.90 hrs,	Volume=	0.170 af	
Primary =	0.00 cfs @	8.00 hrs,	Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Peak Elev= 249.91' @ 12.53 hrs Surf.Area= 2,070 sf Storage= 1,691 cf

Plug-Flow detention time= 18.7 min calculated for 0.170 af (100% of inflow)
Center-of-Mass det. time= 18.6 min (848.2 - 829.6)

Volume	Invert	Avail.Storage	Storage Description
#1	248.10'	3,091 cf	**20.70'W x 100.00'L x 5.50'H Prismatoid** 11,385 cf Overall - 3,657 cf Embedded = 7,728 cf x 40.0% Voids
#2	249.35'	3,657 cf	**48.0"D x 97.00'L Horizontal Cylinder** x 3 Inside #1
		6,748 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Discarded	248.09'	**10.800 in/hr Exfiltration over Surface area above invert** Excluded Surface area = 0 sf
#2	Primary	252.25'	**12.0" Vert. Orifice/Grate** C= 0.600

Discarded OutFlow Max=0.52 cfs @ 11.90 hrs HW=248.21' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.52 cfs)

Primary OutFlow Max=0.00 cfs @ 8.00 hrs HW=248.10' (Free Discharge)
└─**2=Orifice/Grate** (Controls 0.00 cfs)

Link 1L: COMBINE HYDROGRAPHS

Inflow Area =	11.151 ac,	Inflow Depth =	0.00"	for	10YR event	
Inflow =	0.00 cfs @	22.75 hrs,	Volume=		0.002 af	
Primary =	0.00 cfs @	22.75 hrs,	Volume=		0.002 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs

100 YR POST-DEVELOPMENT

Subcatchment 1S: CB1

[49] Hint: Tc<2dt may require smaller dt

Runoff = 1.56 cfs @ 12.11 hrs, Volume= 0.123 af, Depth= 2.37"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 100YR Rainfall=6.80"

Area (sf)	CN	Description
9,043	98	Paved parking & roofs
18,146	39	>75% Grass cover, Good, HSG A
27,189	59	Weighted Average
18,146		Pervious Area
9,043		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Min TC**
0.3	79	0.0100	4.91	3.86	**Circular Channel (pipe),** Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
6.3	79	Total			

Subcatchment 2S: CB2

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.74 cfs @ 12.11 hrs, Volume= 0.061 af, Depth= 1.91"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 100YR Rainfall=6.80"

Area (sf)	CN	Description
4,842	98	Paved parking & roofs
7,887	39	>75% Grass cover, Good, HSG A
3,942	30	Woods, Good, HSG A
16,671	54	Weighted Average
11,829		Pervious Area
4,842		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.1	48	0.1670	0.16		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.25"
0.1	18	0.2220	2.36		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.2	22	0.0900	2.10		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	12	0.0420	1.43		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	70	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1					**Direct Entry, Min TC**
0.2	48	0.0100	4.91	3.86	**Circular Channel (pipe),** Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
6.2	218	Total			

Subcatchment 3S: CB3

[49] Hint: Tc<2dt may require smaller dt

Runoff = 1.17 cfs @ 12.10 hrs, Volume= 0.089 af, Depth> 4.49"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 100YR Rainfall=6.80"

Area (sf)	CN	Description
7,317	98	Paved parking & roofs
3,103	39	>75% Grass cover, Good, HSG A
10,420	80	Weighted Average
3,103		Pervious Area
7,317		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, MIN. TC**
0.0	8	0.0100	4.91	3.86	**Circular Channel (pipe),** Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
6.0	8	Total			

Subcatchment 4S: CB4

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.77 cfs @ 12.09 hrs, Volume= 0.062 af, Depth> 6.01"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 100YR Rainfall=6.80"

Area (sf)	CN	Description
5,376	98	Paved parking & roofs
5,376		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Min TC**
0.1	31	0.0100	4.91	3.86	**Circular Channel (pipe),** Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
6.1	31	Total			

Subcatchment 5S: CB5

[49] Hint: Tc<2dt may require smaller dt

Runoff = 1.20 cfs @ 12.12 hrs, Volume= 0.095 af, Depth= 2.75"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 100YR Rainfall=6.80"

Area (sf)	CN	Description
8,247	98	Paved parking & roofs
2,985	39	>75% Grass cover, Good, HSG A
6,808	30	Woods, Good, HSG A
18,040	63	Weighted Average
9,793		Pervious Area
8,247		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	50	0.1830	0.17		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.25"
0.7	92	0.1830	2.14		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.4	45	0.1360	1.84		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.0	10	1.0000	7.00		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	72	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.3	60	0.0320	3.63		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.3	101	0.0100	4.91	3.86	**Circular Channel (pipe),** Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
7.1	430	Total			

Subcatchment 6S: CB6

[49] Hint: Tc<2dt may require smaller dt

Runoff = 1.57 cfs @ 12.09 hrs, Volume= 0.127 af, Depth> 6.01"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 100YR Rainfall=6.80"

Area (sf)	CN	Description
11,020	98	Paved parking & roofs
11,020		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Min TC**
0.0	3	0.0200	6.95	5.46	**Circular Channel (pipe),** Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
6.0	3	Total			

Subcatchment 7S: CB7

[49] Hint: Tc<2dt may require smaller dt

Runoff = 1.06 cfs @ 12.10 hrs, Volume= 0.086 af, Depth> 6.01"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 100YR Rainfall=6.80"

Area (sf)	CN	Description
7,497	98	Paved parking & roofs
7,497		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Min TC**
0.4	120	0.0100	4.91	3.86	**Circular Channel (pipe),** Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
6.4	120	Total			

Subcatchment 8S: CB8

[49] Hint: Tc<2dt may require smaller dt

Runoff = 1.56 cfs @ 12.15 hrs, Volume= 0.142 af, Depth= 2.09"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 100YR Rainfall=6.80"

Area (sf)	CN	Description
12,116	98	Paved parking & roofs
8,994	39	>75% Grass cover, Good, HSG A
14,308	30	Woods, Good, HSG A
35,418	56	Weighted Average
23,302		Pervious Area
12,116		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.4	50	0.1540	0.15		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.25"
2.1	248	0.1540	1.96		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.0	10	1.0000	7.00		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.2	73	0.0210	1.01		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	77	0.0270	3.34		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1	31	0.0374	9.50	7.46	**Circular Channel (pipe),** Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
9.2	489	Total			

Subcatchment 9S: CB9

[49] Hint: Tc<2dt may require smaller dt

Runoff = 1.32 cfs @ 12.10 hrs, Volume= 0.106 af, Depth> 6.01"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 100YR Rainfall=6.80"

Area (sf)	CN	Description
9,254	98	Paved parking & roofs
9,254		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, M IN. TC**
0.3	116	0.0100	5.90	4.63	**Circular Channel (pipe),** Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.010 PVC, smooth interior
6.3	116	Total			

Subcatchment 10S: CB10

[49] Hint: Tc<2dt may require smaller dt

Runoff = 1.59 cfs @ 12.11 hrs, Volume= 0.121 af, Depth= 2.85"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 100YR Rainfall=6.80"

Area (sf)	CN	Description
10,776	98	Paved parking & roofs
1,709	39	>75% Grass cover, Good, HSG A
9,781	30	Woods, Good, HSG A
22,266	64	Weighted Average
11,490		Pervious Area
10,776		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, MIN. TC**
0.0	15	0.0400	9.83	7.72	**Circular Channel (pipe),** Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
6.0	15	Total			

Subcatchment 11S: TR11

[49] Hint: Tc<2dt may require smaller dt

Runoff = 2.68 cfs @ 12.12 hrs, Volume= 0.218 af, Depth= 2.27"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 100YR Rainfall=6.80"

Area (sf)	CN	Description
17,178	98	Paved parking & roofs
25,172	39	>75% Grass cover, Good, HSG A
7,847	30	Woods, Good, HSG A
50,197	58	Weighted Average
33,019		Pervious Area
17,178		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.9	50	0.2020	0.17		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.25"
0.2	31	0.2020	2.25		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.2	30	0.1610	2.81		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	16	0.1250	2.47		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	15	0.0590	3.64		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
0.3	19	0.0590	1.21		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.1	19	0.3160	2.81		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.2	10	0.0100	0.70		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.0	7	0.1420	2.64		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.0	246	0.0050	4.17	3.28	**Circular Channel (pipe), TRENCH DRAIN 11** Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.010 PVC, smooth interior
7.1	443	Total			

Subcatchment 12S: TR12

[49] Hint: Tc<2dt may require smaller dt

Runoff = 2.85 cfs @ 12.13 hrs, Volume= 0.254 af, Depth= 1.64"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 100YR Rainfall=6.80"

Area (sf)	CN	Description
20,701	98	Paved parking & roofs
27,521	39	>75% Grass cover, Good, HSG A
32,521	30	Woods, Good, HSG A
80,743	51	Weighted Average
60,042		Pervious Area
20,701		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, MIN. TC.**
1.1	274	0.0050	4.17	3.28	**Circular Channel (pipe),** Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.010 PVC, smooth interior
7.1	274	Total			

Subcatchment 13S: TR13

[49] Hint: Tc<2dt may require smaller dt

Runoff = 2.30 cfs @ 12.13 hrs, Volume= 0.207 af, Depth= 1.56"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 100YR Rainfall=6.80"

Area (sf)	CN	Description
18,951	98	Paved parking & roofs
14,429	39	>75% Grass cover, Good, HSG A
36,229	30	Woods, Good, HSG A
69,609	50	Weighted Average
50,658		Pervious Area
18,951		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.8	50	0.1170	0.30		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.25"
0.3	48	0.1170	2.39		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.8	185	0.1170	1.71		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.0	9	0.2220	3.30		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	18	0.1000	2.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.0					**Direct Entry, Min TC**
0.9	226	0.0050	4.17	3.28	**Circular Channel (pipe),** Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.010 PVC, smooth interior
6.9	536	Total			

Subcatchment 14S: CB14

[49] Hint: Tc<2dt may require smaller dt

Runoff = 2.31 cfs @ 12.10 hrs, Volume= 0.179 af, Depth> 5.09"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 100YR Rainfall=6.80"

Area (sf)	CN	Description
14,656	98	Paved parking & roofs
3,692	39	>75% Grass cover, Good, HSG A
18,348	86	Weighted Average
3,692		Pervious Area
14,656		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, MIN. TC**
0.1	25	0.0100	4.91	3.86	**Circular Channel (pipe),** Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
6.1	25	Total			

Subcatchment 17S: S17

Runoff = 0.09 cfs @ 12.62 hrs, Volume= 0.046 af, Depth= 0.27"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 100YR Rainfall=6.80"

Area (sf)	CN	Description
21,239	39	>75% Grass cover, Good, HSG A
67,689	30	Woods, Good, HSG A
88,928	32	Weighted Average
88,928		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.1	50	0.0254	0.07		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.25"
0.3	13	0.0254	0.80		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.5	74	0.2160	2.32		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.7	49	0.0510	1.13		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
12.6	186	Total			

Subcatchment 18S: S18

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.03 cfs @ 12.44 hrs, Volume= 0.009 af, Depth= 0.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 100YR Rainfall=6.80"

Area (sf)	CN	Description
4,448	39	>75% Grass cover, Good, HSG A
10,309	30	Woods, Good, HSG A
14,757	33	Weighted Average
14,757		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	13	0.3080	0.34		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.25"
1.2	17	0.1180	0.24		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.25"
0.4	4	0.5000	0.15		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.25"
0.5	16	0.7690	0.51		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.25"
0.1	57	0.8770	6.56		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.2					**Direct Entry, Min TC**
0.1	44	0.0250	7.77	6.10	**Circular Channel (pipe), XCB1-XDMH1** Diam= 12.0" Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
6.1	151	Total			

Reach 1R: DMH1 - DMH3

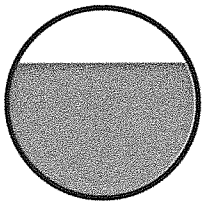
[52] Hint: Inlet conditions not evaluated
[82] Warning: Early inflow requires earlier time span
[85] Warning: Oscillations may require Finer Routing>1

Inflow Area = 1.246 ac, Inflow Depth > 2.63" for 100YR event
Inflow = 3.47 cfs @ 12.11 hrs, Volume= 0.273 af
Outflow = 3.40 cfs @ 12.11 hrs, Volume= 0.273 af, Atten= 2%, Lag= 0.3 min

Routing by Stor-Ind+Trans method, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Max. Velocity= 5.76 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 2.25 fps, Avg. Travel Time= 0.5 min

Peak Storage= 40 cf @ 12.11 hrs, Average Depth at Peak Storage= 0.71'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 4.03 cfs

12.0" Diameter Pipe, n= 0.012 Concrete pipe, finished
Length= 67.0' Slope= 0.0109 '/'
Inlet Invert= 255.08', Outlet Invert= 254.35'



Reach 3R: DMH3-HEADER

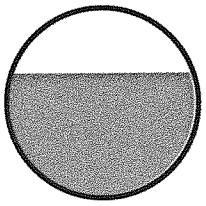
[52] Hint: Inlet conditions not evaluated
[82] Warning: Early inflow requires earlier time span
[85] Warning: Oscillations may require Finer Routing>1
[61] Hint: Submerged 76% of Reach 1R bottom

Inflow Area =	1.370 ac,	Inflow Depth > 2.94"	for 100YR event		
Inflow =	4.16 cfs @	12.11 hrs,	Volume=	0.335 af	
Outflow =	4.14 cfs @	12.11 hrs,	Volume=	0.335 af,	Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Max. Velocity= 7.59 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 2.99 fps, Avg. Travel Time= 0.1 min

Peak Storage= 12 cf @ 12.11 hrs, Average Depth at Peak Storage= 0.66'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 5.41 cfs

12.0" Diameter Pipe, n= 0.010 PVC, smooth interior
Length= 22.0' Slope= 0.0136 '/'
Inlet Invert= 254.25', Outlet Invert= 253.95'



Reach 4R: DMH4 DMH5

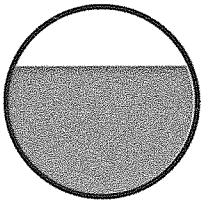
[52] Hint: Inlet conditions not evaluated
[85] Warning: Oscillations may require Finer Routing>1

Inflow Area =	3.006 ac,	Inflow Depth = 1.88"	for 100YR event		
Inflow =	5.52 cfs @	12.12 hrs,	Volume=	0.472 af	
Outflow =	5.44 cfs @	12.13 hrs,	Volume=	0.472 af,	Atten= 2%, Lag= 0.3 min

Routing by Stor-Ind+Trans method, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Max. Velocity= 9.46 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 4.05 fps, Avg. Travel Time= 0.3 min

Peak Storage= 42 cf @ 12.13 hrs, Average Depth at Peak Storage= 0.69'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 6.69 cfs

12.0" Diameter Pipe, n= 0.012 Concrete pipe, finished
Length= 72.0' Slope= 0.0300 '/'
Inlet Invert= 256.46', Outlet Invert= 254.30'



Reach 5R: DMH5 DMH6

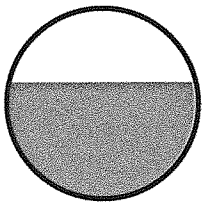
[52] Hint: Inlet conditions not evaluated
[61] Hint: Submerged 23% of Reach 4R bottom

Inflow Area =	3.006 ac,	Inflow Depth =	1.88"	for	100YR event
Inflow =	5.44 cfs @	12.13 hrs,	Volume=	0.472 af	
Outflow =	5.38 cfs @	12.13 hrs,	Volume=	0.472 af,	Atten= 1%, Lag= 0.2 min

Routing by Stor-Ind+Trans method, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Max. Velocity= 10.65 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 4.51 fps, Avg. Travel Time= 0.2 min

Peak Storage= 30 cf @ 12.13 hrs, Average Depth at Peak Storage= 0.61'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 7.78 cfs

12.0" Diameter Pipe, n= 0.012 Concrete pipe, finished
Length= 60.0' Slope= 0.0407 '/'
Inlet Invert= 254.20', Outlet Invert= 251.76'



Reach 6R: DMH6 MANIFOLD

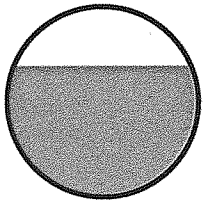
[52] Hint: Inlet conditions not evaluated
[61] Hint: Submerged 24% of Reach 5R bottom

Inflow Area =	3.006 ac,	Inflow Depth =	1.88"	for	100YR event
Inflow =	5.38 cfs @	12.13 hrs,	Volume=	0.472 af	
Outflow =	5.36 cfs @	12.13 hrs,	Volume=	0.472 af,	Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Max. Velocity= 9.26 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 3.99 fps, Avg. Travel Time= 0.1 min

Peak Storage= 10 cf @ 12.13 hrs, Average Depth at Peak Storage= 0.69'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 6.55 cfs

12.0" Diameter Pipe, n= 0.010 PVC, smooth interior
Length= 18.0' Slope= 0.0200 '/'
Inlet Invert= 251.66', Outlet Invert= 251.30'



Reach 7R: DMH7 MANIFOLD

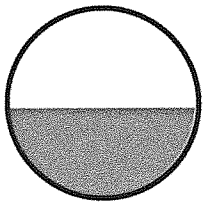
[52] Hint: Inlet conditions not evaluated
[85] Warning: Oscillations may require Finer Routing>1
[61] Hint: Submerged 63% of Reach 8R bottom

Inflow Area =	0.425 ac,	Inflow Depth >	6.00"	for	100YR event
Inflow =	2.62 cfs @	12.10 hrs,	Volume=	0.213 af	
Outflow =	2.60 cfs @	12.10 hrs,	Volume=	0.213 af,	Atten= 1%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Max. Velocity= 7.07 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 2.70 fps, Avg. Travel Time= 0.1 min

Peak Storage= 7 cf @ 12.10 hrs, Average Depth at Peak Storage= 0.48'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 5.67 cfs

12.0" Diameter Pipe, n= 0.010 PVC, smooth interior
Length= 20.0' Slope= 0.0150 '/'
Inlet Invert= 251.60', Outlet Invert= 251.30'



Reach 8R: DMH8 DMH 7

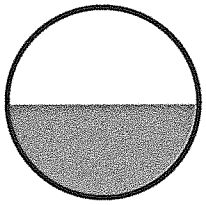
[52] Hint: Inlet conditions not evaluated
[82] Warning: Early inflow requires earlier time span
[85] Warning: Oscillations may require Finer Routing>1

Inflow Area =	0.425 ac,	Inflow Depth >	6.01"	for	100YR event
Inflow =	2.64 cfs @	12.10 hrs,	Volume=	0.213 af	
Outflow =	2.62 cfs @	12.10 hrs,	Volume=	0.213 af,	Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Max. Velocity= 6.89 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.63 fps, Avg. Travel Time= 0.2 min

Peak Storage= 11 cf @ 12.10 hrs, Average Depth at Peak Storage= 0.49'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 5.46 cfs

12.0" Diameter Pipe, n= 0.012 Concrete pipe, finished
Length= 30.0' Slope= 0.0200 '/'
Inlet Invert= 252.30', Outlet Invert= 251.70'



Reach 9R: DMH9 DMH10

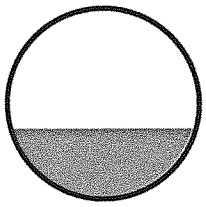
[52] Hint: Inlet conditions not evaluated

Inflow Area = 1.598 ac, Inflow Depth = 1.56" for 100YR event
Inflow = 2.30 cfs @ 12.13 hrs, Volume= 0.207 af
Outflow = 2.25 cfs @ 12.13 hrs, Volume= 0.207 af, Atten= 2%, Lag= 0.4 min

Routing by Stor-Ind+Trans method, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Max. Velocity= 8.60 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 3.73 fps, Avg. Travel Time= 0.4 min

Peak Storage= 26 cf @ 12.13 hrs, Average Depth at Peak Storage= 0.37'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 7.87 cfs

12.0" Diameter Pipe, n= 0.012 Concrete pipe, finished
Length= 99.0' Slope= 0.0416 '/'
Inlet Invert= 256.56', Outlet Invert= 252.44'



Reach 10R: DMH10 POND2

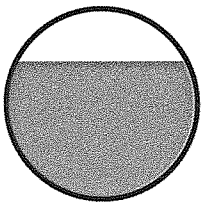
[52] Hint: Inlet conditions not evaluated
[82] Warning: Early inflow requires earlier time span
[85] Warning: Oscillations may require Finer Routing>1
[61] Hint: Submerged 15% of Reach 9R bottom

Inflow Area = 2.624 ac, Inflow Depth > 2.08" for 100YR event
Inflow = 5.06 cfs @ 12.13 hrs, Volume= 0.455 af
Outflow = 5.01 cfs @ 12.13 hrs, Volume= 0.455 af, Atten= 1%, Lag= 0.2 min

Routing by Stor-Ind+Trans method, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Max. Velocity= 8.21 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 3.43 fps, Avg. Travel Time= 0.2 min

Peak Storage= 29 cf @ 12.13 hrs, Average Depth at Peak Storage= 0.72'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 5.74 cfs

12.0" Diameter Pipe, n= 0.012 Concrete pipe, finished
Length= 47.0' Slope= 0.0221 '/'
Inlet Invert= 252.34', Outlet Invert= 251.30'



Reach 11R: DMH11-FES

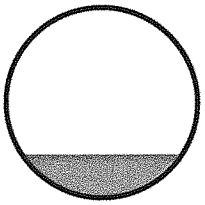
[52] Hint: Inlet conditions not evaluated
[88] Warning: Qout>Qin may require Finer Routing>1

Inflow Area = 1.784 ac, Inflow Depth = 0.15" for 100YR event
Inflow = 0.98 cfs @ 12.50 hrs, Volume= 0.022 af
Outflow = 0.99 cfs @ 12.50 hrs, Volume= 0.022 af, Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Max. Velocity= 7.32 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 4.37 fps, Avg. Travel Time= 0.1 min

Peak Storage= 4 cf @ 12.50 hrs, Average Depth at Peak Storage= 0.23'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 8.63 cfs

12.0" Diameter Pipe, n= 0.012 Concrete pipe, finished
Length= 28.0' Slope= 0.0500 '/'
Inlet Invert= 247.40', Outlet Invert= 246.00'



Reach 12R: DMH12-PIPE END

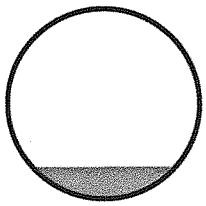
[52] Hint: Inlet conditions not evaluated
[88] Warning: Qout>Qin may require Finer Routing>1

Inflow Area = 6.055 ac, Inflow Depth = 0.03" for 100YR event
Inflow = 0.48 cfs @ 12.73 hrs, Volume= 0.016 af
Outflow = 0.48 cfs @ 12.73 hrs, Volume= 0.016 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Max. Velocity= 5.44 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 4.14 fps, Avg. Travel Time= 0.1 min

Peak Storage= 2 cf @ 12.73 hrs, Average Depth at Peak Storage= 0.17'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 7.72 cfs

12.0" Diameter Pipe, n= 0.012 Concrete pipe, finished
Length= 20.0' Slope= 0.0400 '/'
Inlet Invert= 244.80', Outlet Invert= 244.00'



Reach 13R: DMH13-PIPE END

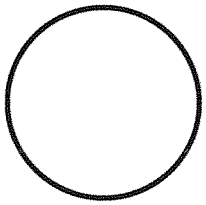
[52] Hint: Inlet conditions not evaluated

Inflow Area = 0.932 ac, Inflow Depth = 0.00" for 100YR event
Inflow = 0.00 cfs @ 8.00 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 8.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Max. Velocity= 0.00 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 0.00 fps, Avg. Travel Time= 0.0 min

Peak Storage= 0 cf @ 8.00 hrs, Average Depth at Peak Storage= 0.00'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 7.72 cfs

12.0" Diameter Pipe, n= 0.012 Concrete pipe, finished
Length= 17.0' Slope= 0.0400 '/'
Inlet Invert= 246.68', Outlet Invert= 246.00'



Pond 1P: POND 1

[62] Warning: Submerged 5% of Reach 3R inlet

Inflow Area =	1.784 ac,	Inflow Depth >	2.89"	for	100YR event
Inflow =	5.34 cfs @	12.11 hrs,	Volume=	0.430 af	
Outflow =	1.80 cfs @	12.50 hrs,	Volume=	0.430 af,	Atten= 66%, Lag= 23.1 min
Discarded =	0.81 cfs @	11.80 hrs,	Volume=	0.408 af	
Primary =	0.98 cfs @	12.50 hrs,	Volume=	0.022 af	

Routing by Stor-Ind method, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Peak Elev= 254.30' @ 12.50 hrs Surf.Area= 0.042 ac Storage= 0.115 af

Plug-Flow detention time= 39.1 min calculated for 0.429 af (100% of inflow)
Center-of-Mass det. time= 38.9 min (876.6 - 837.7)

Volume	Invert	Avail.Storage	Storage Description
#1	249.80'	0.063 af	**20.70'W x 89.00'L x 5.50'H Prismatoid**
			0.233 af Overall - 0.074 af Embedded = 0.158 af x 40.0% Voids
#2	251.05'	0.074 af	**48.0"D x 86.00'L Horizontal Cylinder** x 3 Inside #1
		0.138 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Discarded	249.70'	**19.110 in/hr Exfiltration over Surface area above invert**
			Excluded Surface area = 0.000 ac
#2	Primary	253.95'	**12.0" Vert. Orifice/Grate X 2.00** C= 0.600

Discarded OutFlow Max=0.81 cfs @ 11.80 hrs HW=249.95' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.81 cfs)

Primary OutFlow Max=0.96 cfs @ 12.50 hrs HW=254.30' (Free Discharge)
└─**2=Orifice/Grate** (Orifice Controls 0.96 cfs @ 2.00 fps)

Pond 2P: POND 2

[61] Hint: Submerged 53% of Reach 6R bottom
[61] Hint: Submerged 63% of Reach 7R bottom
[61] Hint: Submerged 18% of Reach 10R bottom

Inflow Area =	6.055 ac,	Inflow Depth >	2.26"	for	100YR event
Inflow =	12.90 cfs @	12.12 hrs,	Volume=	1.140 af	
Outflow =	2.40 cfs @	12.73 hrs,	Volume=	1.140 af,	Atten= 81%, Lag= 36.6 min
Discarded =	1.92 cfs @	11.80 hrs,	Volume=	1.124 af	
Primary =	0.48 cfs @	12.73 hrs,	Volume=	0.016 af	

Routing by Stor-Ind method, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Peak Elev= 251.49' @ 12.73 hrs Surf.Area= 5,460 sf Storage= 14,415 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 55.7 min (904.8 - 849.1)

Volume	Invert	Avail.Storage	Storage Description
#1	247.15'	8,051 cf	**27.30'W x 200.00'L x 5.50'H Prismatoid**
			30,030 cf Overall - 9,902 cf Embedded = 20,128 cf x 40.0% Voids
#2	248.40'	9,902 cf	**48.0"D x 197.00'L Horizontal Cylinder** x 4 Inside #1
		17,953 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Discarded	247.10'	**15.200 in/hr Exfiltration over Surface area above invert**
			Excluded Surface area = 0 sf
#2	Primary	251.30'	**12.0" Vert. Orifice/Grate X 3.00** C= 0.600

Discarded OutFlow Max=1.92 cfs @ 11.80 hrs HW=247.24' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 1.92 cfs)

Primary OutFlow Max=0.45 cfs @ 12.73 hrs HW=251.49' (Free Discharge)
└─**2=Orifice/Grate** (Orifice Controls 0.45 cfs @ 1.47 fps)

Pond 3P: POND 2

[82] Warning: Early inflow requires earlier time span
[85] Warning: Oscillations may require Finer Routing>1

Inflow Area =	0.932 ac,	Inflow Depth > 3.86"	for 100YR event		
Inflow =	3.89 cfs @	12.10 hrs,	Volume=	0.300 af	
Outflow =	0.52 cfs @	11.70 hrs,	Volume=	0.300 af,	Atten= 87%, Lag= 0.0 min
Discarded =	0.52 cfs @	11.70 hrs,	Volume=	0.300 af	
Primary =	0.00 cfs @	8.00 hrs,	Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs
Peak Elev= 251.67' @ 12.75 hrs Surf.Area= 2,070 sf Storage= 4,279 cf

Plug-Flow detention time= 60.7 min calculated for 0.300 af (100% of inflow)
Center-of-Mass det. time= 60.6 min (879.0 - 818.5)

Volume	Invert	Avail.Storage	Storage Description
#1	248.10'	3,091 cf	**20.70'W x 100.00'L x 5.50'H Prismatoid**
			11,385 cf Overall - 3,657 cf Embedded = 7,728 cf x 40.0% Voids
#2	249.35'	3,657 cf	**48.0"D x 97.00'L Horizontal Cylinder** x 3 Inside #1
		6,748 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Discarded	248.09'	**10.800 in/hr Exfiltration over Surface area above invert**
			Excluded Surface area = 0 sf
#2	Primary	252.25'	**12.0" Vert. Orifice/Grate** C= 0.600

Discarded OutFlow Max=0.52 cfs @ 11.70 hrs HW=248.19' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.52 cfs)

Primary OutFlow Max=0.00 cfs @ 8.00 hrs HW=248.10' (Free Discharge)
└─**2=Orifice/Grate** (Controls 0.00 cfs)

Link 1L: COMBINE HYDROGRAPHS

Inflow Area =	11.151 ac,	Inflow Depth =	0.10"	for	100YR event	
Inflow =	1.11 cfs @	12.53 hrs,	Volume=		0.094 af	
Primary =	1.11 cfs @	12.53 hrs,	Volume=		0.094 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 8.00-36.00 hrs, dt= 0.10 hrs

APPENDIX E

Project:	Washington St
Location:	Franklin, MA
Prepared For:	United Consultants / Rick Goodreau

CONTECH ENGINEERED SOLUTIONS

Purpose: To calculate the water quality flow rate (WQF) over a given site area. In this situation the WQF is derived from the first 1" of runoff from the contributing impervious surface.

Reference: Massachusetts Dept. of Environmental Protection Wetlands Program / United States Department of Agriculture Natural Resources Conservation Service TR-55 Manual

Procedure: Determine unit peak discharge using Figure 1 or 2. Figure 2 is in tabular form so is preferred. Using the tc, read the unit peak discharge (qu) from Figure 1 or Table in Figure 2. qu is expressed in the following units: cfs/mi^2/watershed inches (csm/in).

Compute Q Rate using the following equation:

$$Q = (qu)\ (A)\ (WQV)$$

where:

Q = flow rate associated with first 1" of runoff
qu = the unit peak discharge, in csm/in.
A = impervious surface drainage area (in square miles)
WQV = water quality volume in watershed inches (1" in this case)

Structure Name	Impv. (acres)	A (miles^2)	t_c (min)	t_c (hr)	WQV (in)	qu (csm/in.)	Q (cfs)
DMH 3	0.59	0.0009219	5.0	0.083	1.00	795.00	0.73
CB 5	0.19	0.0002953	5.0	0.083	1.00	795.00	0.23
DMH 7	0.45	0.0006984	5.0	0.083	1.00	795.00	0.56
CB 8	0.31	0.0004813	5.0	0.083	1.00	795.00	0.38
CB 9	0.19	0.0002891	5.0	0.083	1.00	795.00	0.23
CB 10	0.41	0.0006375	5.0	0.083	1.00	795.00	0.51

Stormceptor®

CONTECH ENGINEERED SOLUTIONS A COMPANY

Brief Stormceptor Sizing Report - CB #5

Project Information & Location			
Project Name	Washington St	Project Number	685246
City	Franklin	State/ Province	Massachusetts
Country	United States of America	Date	8/31/2021
Designer Information		EOR Information (optional)	
Name	Jim Lyons	Name	Rick Goodreau
Company	Contech ES	Company	United Consultants
Phone #	413-246-5151	Phone #	508-922-1063
Email	jlyons@conteches.com	Email	rick@uci850.com

Stormwater Treatment Recommendation

The recommended Stormceptor Model(s) which achieve or exceed the user defined water quality objective for each site within the project are listed in the below Sizing Summary table.

Site Name	CB #5
Target TSS Removal (%)	80
TSS Removal (%) Provided	94
Recommended Stormceptor Model	STC 450i

The recommended Stormceptor Model achieves the water quality objectives based on the selected inputs, historical rainfall records and selected particle size distribution.

Stormceptor Sizing Summary	
Stormceptor Model	**% TSS Removal Provided**
STC 450i	94
STC 900	97
STC 1200	97
STC 1800	97
STC 2400	98
STC 3600	98
STC 4800	99
STC 6000	99
STC 7200	99
STC 11000	99
STC 13000	99
STC 16000	100

Stormceptor®

CONTECH ENGINEERED SOLUTIONS A [redacted] COMPANY

Sizing Details			
Drainage Area		**Water Quality Objective**	
Total Area (acres)	0.19	TSS Removal (%)	80.0
Imperviousness %	100.0	Runoff Volume Capture (%)	
Rainfall		Oil Spill Capture Volume (Gal)	
Station Name	BLUE HILL	Peak Conveyed Flow Rate (CFS)	
State/Province	Massachusetts	Water Quality Flow Rate (CFS)	0.23
Station ID #	0736	**Up Stream Storage**	
Years of Records	58	Storage (ac-ft)	Discharge (cfs)
Latitude	42°12'44"N	0.000	0.000
Longitude	71°6'53"W	**Up Stream Flow Diversion**	
		Max. Flow to Stormceptor (cfs)	

Particle Size Distribution (PSD) The selected PSD defines TSS removal		
OK-110		
Particle Diameter (microns)	Distribution %	Specific Gravity
1.0	0.0	2.65
53.0	3.0	2.65
75.0	15.0	2.65
88.0	25.0	2.65
106.0	41.0	2.65
125.0	15.0	2.65
150.0	1.0	2.65
212.0	0.0	2.65

Notes

- Stormceptor performance estimates are based on simulations using PCSWMM for Stormceptor, which uses the EPA Rainfall and Runoff modules.
- Design estimates listed are only representative of specific project requirements based on total suspended solids (TSS) removal defined by the selected PSD, and based on stable site conditions only, after construction is completed.
- For submerged applications or sites specific to spill control, please contact your local Stormceptor representative for further design assistance.

For Stormceptor Specifications and Drawings Please Visit:
https://www.conteches.com/technical-guides/search?filter=1WBC0O5EYX

Stormceptor®

CONTECH ENGINEERED SOLUTIONS A [redacted] COMPANY

Brief Stormceptor Sizing Report - CB #8

Project Information & Location			
Project Name	Washington St	Project Number	685246
City	Franklin	State/ Province	Massachusetts
Country	United States of America	Date	8/31/2021
Designer Information		EOR Information (optional)	
Name	Jim Lyons	Name	Rick Goodreau
Company	Contech ES	Company	United Consultants
Phone #	413-246-5151	Phone #	508-922-1063
Email	jlyons@conteches.com	Email	rick@uci850.com

Stormwater Treatment Recommendation

The recommended Stormceptor Model(s) which achieve or exceed the user defined water quality objective for each site within the project are listed in the below Sizing Summary table.

Site Name	CB #8
Target TSS Removal (%)	80
TSS Removal (%) Provided	91
Recommended Stormceptor Model	STC 450i

The recommended Stormceptor Model achieves the water quality objectives based on the selected inputs, historical rainfall records and selected particle size distribution.

Stormceptor Sizing Summary	
Stormceptor Model	**% TSS Removal Provided**
STC 450i	91
STC 900	95
STC 1200	96
STC 1800	96
STC 2400	97
STC 3600	97
STC 4800	98
STC 6000	98
STC 7200	99
STC 11000	99
STC 13000	99
STC 16000	99

Stormceptor®

CONTECH ENGINEERED SOLUTIONS
A SCHNEIDER COMPANY

Sizing Details	
Drainage Area	
Total Area (acres)	0.31
Imperviousness %	100.0
Rainfall	
Station Name	BLUE HILL
State/Province	Massachusetts
Station ID #	0736
Years of Records	58
Latitude	42°12'44"N
Longitude	71°6'53"W

Water Quality Objective	
TSS Removal (%)	80.0
Runoff Volume Capture (%)	
Oil Spill Capture Volume (Gal)	
Peak Conveyed Flow Rate (CFS)	
Water Quality Flow Rate (CFS)	0.23

Up Stream Storage	
Storage (ac-ft)	Discharge (cfs)
0.000	0.000

Up Stream Flow Diversion	
Max. Flow to Stormceptor (cfs)	

Particle Size Distribution (PSD) The selected PSD defines TSS removal		
OK-110		
Particle Diameter (microns)	Distribution %	Specific Gravity
1.0	0.0	2.65
53.0	3.0	2.65
75.0	15.0	2.65
88.0	25.0	2.65
106.0	41.0	2.65
125.0	15.0	2.65
150.0	1.0	2.65
212.0	0.0	2.65

Notes

- Stormceptor performance estimates are based on simulations using PCSWMM for Stormceptor, which uses the EPA Rainfall and Runoff modules.
- Design estimates listed are only representative of specific project requirements based on total suspended solids (TSS) removal defined by the selected PSD, and based on stable site conditions only, after construction is completed.
- For submerged applications or sites specific to spill control, please contact your local Stormceptor representative for further design assistance.

For Stormceptor Specifications and Drawings Please Visit:
https://www.conteches.com/technical-guides/search?filter=1WBC0O5EYX

Stormceptor®

CONTECH ENGINEERED SOLUTIONS A [illegible] COMPANY

Brief Stormceptor Sizing Report - CB #9

Project Information & Location			
Project Name	Washington St	Project Number	685246
City	Franklin	State/ Province	Massachusetts
Country	United States of America	Date	8/31/2021
Designer Information		EOR Information (optional)	
Name	Jim Lyons	Name	Rick Goodreau
Company	Contech ES	Company	United Consultants
Phone #	413-246-5151	Phone #	508-922-1063
Email	jlyons@conteches.com	Email	rick@uci850.com

Stormwater Treatment Recommendation

The recommended Stormceptor Model(s) which achieve or exceed the user defined water quality objective for each site within the project are listed in the below Sizing Summary table.

Site Name	CB #9
Target TSS Removal (%)	80
TSS Removal (%) Provided	94
Recommended Stormceptor Model	STC 450i

The recommended Stormceptor Model achieves the water quality objectives based on the selected inputs, historical rainfall records and selected particle size distribution.

Stormceptor Sizing Summary	
Stormceptor Model	**% TSS Removal Provided**
STC 450i	94
STC 900	97
STC 1200	97
STC 1800	97
STC 2400	98
STC 3600	98
STC 4800	99
STC 6000	99
STC 7200	99
STC 11000	99
STC 13000	99
STC 16000	100

Stormceptor®

CONTECH ENGINEERED SOLUTIONS A [redacted] COMPANY

Sizing Details	
Drainage Area	
Total Area (acres)	0.19
Imperviousness %	100.0
Rainfall	
Station Name	BLUE HILL
State/Province	Massachusetts
Station ID #	0736
Years of Records	58
Latitude	42°12'44"N
Longitude	71°6'53"W

Water Quality Objective	
TSS Removal (%)	80.0
Runoff Volume Capture (%)	
Oil Spill Capture Volume (Gal)	
Peak Conveyed Flow Rate (CFS)	
Water Quality Flow Rate (CFS)	0.23

Up Stream Storage	
Storage (ac-ft)	Discharge (cfs)
0.000	0.000

Up Stream Flow Diversion	
Max. Flow to Stormceptor (cfs)	

Particle Size Distribution (PSD)
The selected PSD defines TSS removal

OK-110		
Particle Diameter (microns)	Distribution %	Specific Gravity
1.0	0.0	2.65
53.0	3.0	2.65
75.0	15.0	2.65
88.0	25.0	2.65
106.0	41.0	2.65
125.0	15.0	2.65
150.0	1.0	2.65
212.0	0.0	2.65

Notes

- Stormceptor performance estimates are based on simulations using PCSWMM for Stormceptor, which uses the EPA Rainfall and Runoff modules.
- Design estimates listed are only representative of specific project requirements based on total suspended solids (TSS) removal defined by the selected PSD, and based on stable site conditions only, after construction is completed.
- For submerged applications or sites specific to spill control, please contact your local Stormceptor representative for further design assistance.

For Stormceptor Specifications and Drawings Please Visit:
https://www.conteches.com/technical-guides/search?filter=1WBC0O5EYX

CONTECH® ENGINEERED SOLUTIONS

CDS TECHNOLOGIES

CDS ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION BASED ON THE RATIONAL RAINFALL METHOD

WASHINGTON ST
FRANKLIN, MA

Area	0.59 ac	Unit Site Designation	DMH 3
Weighted C	0.9	Rainfall Station #	68
t_c	5 min		
CDS Model	1515-3	CDS Treatment Capacity	1.0 cfs

Rainfall Intensity[1] (in/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (cfs)	Treated Flowrate (cfs)	Incremental Removal (%)
0.02	9.3%	9.3%	0.01	0.01	9.3
0.04	9.5%	18.8%	0.02	0.02	9.5
0.06	8.7%	27.5%	0.03	0.03	8.7
0.08	10.1%	37.6%	0.04	0.04	10.0
0.10	7.2%	44.8%	0.05	0.05	7.1
0.12	6.0%	50.8%	0.06	0.06	5.9
0.14	6.3%	57.1%	0.07	0.07	6.2
0.16	5.6%	62.7%	0.08	0.08	5.4
0.18	4.7%	67.4%	0.10	0.10	4.5
0.20	3.6%	71.0%	0.11	0.11	3.5
0.25	8.2%	79.1%	0.13	0.13	7.8
0.50	14.9%	94.0%	0.27	0.27	13.2
0.75	3.2%	97.3%	0.40	0.40	2.7
1.00	1.2%	98.5%	0.53	0.53	0.9
1.50	0.7%	99.2%	0.80	0.80	0.5
2.00	0.8%	100.0%	1.06	1.00	0.4
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
					95.6
				Removal Efficiency Adjustment[2] =	6.5%
				Predicted % Annual Rainfall Treated =	93.5%
				Predicted Net Annual Load Removal Efficiency =	**89.1%**

1 - Based on 10 years of rainfall data from NCDC station 736, Blue Hill, Norfolk County, MA
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.

CONTECH® ENGINEERED SOLUTIONS

CDS TECHNOLOGIES

CDS ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION BASED ON THE RATIONAL RAINFALL METHOD

WASHINGTON ST
FRANKLIN, MA

Area	0.45 ac	Unit Site Designation	DMH 7
Weighted C	0.9	Rainfall Station #	68
t_c	5 min		
CDS Model	1515-3	CDS Treatment Capacity	1.0 cfs

Rainfall Intensity[1] (in/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (cfs)	Treated Flowrate (cfs)	Incremental Removal (%)
0.02	9.3%	9.3%	0.01	0.01	9.3
0.04	9.5%	18.8%	0.02	0.02	9.5
0.06	8.7%	27.5%	0.02	0.02	8.7
0.08	10.1%	37.6%	0.03	0.03	10.1
0.10	7.2%	44.8%	0.04	0.04	7.1
0.12	6.0%	50.8%	0.05	0.05	6.0
0.14	6.3%	57.1%	0.06	0.06	6.2
0.16	5.6%	62.7%	0.06	0.06	5.5
0.18	4.7%	67.4%	0.07	0.07	4.6
0.20	3.6%	71.0%	0.08	0.08	3.5
0.25	8.2%	79.1%	0.10	0.10	7.9
0.50	14.9%	94.0%	0.20	0.20	13.7
0.75	3.2%	97.3%	0.30	0.30	2.8
1.00	1.2%	98.5%	0.40	0.40	1.0
1.50	0.7%	99.2%	0.60	0.60	0.5
2.00	0.8%	100.0%	0.80	0.80	0.5
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
					96.9
				Removal Efficiency Adjustment[2] =	6.5%
				Predicted % Annual Rainfall Treated =	93.5%
				Predicted Net Annual Load Removal Efficiency =	**90.5%**

1 - Based on 10 years of rainfall data from NCDC station 736, Blue Hill, Norfolk County, MA
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.

CONTECH® ENGINEERED SOLUTIONS

CDS TECHNOLOGIES

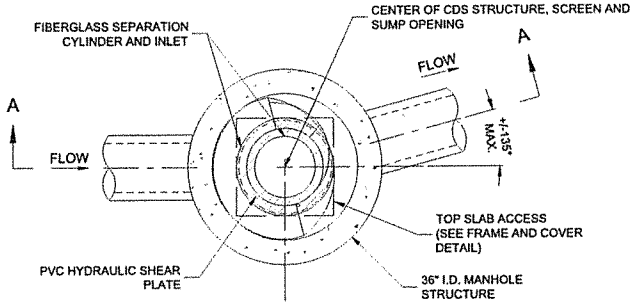
CDS ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION BASED ON THE RATIONAL RAINFALL METHOD

WASHINGTON ST
FRANKLIN, MA

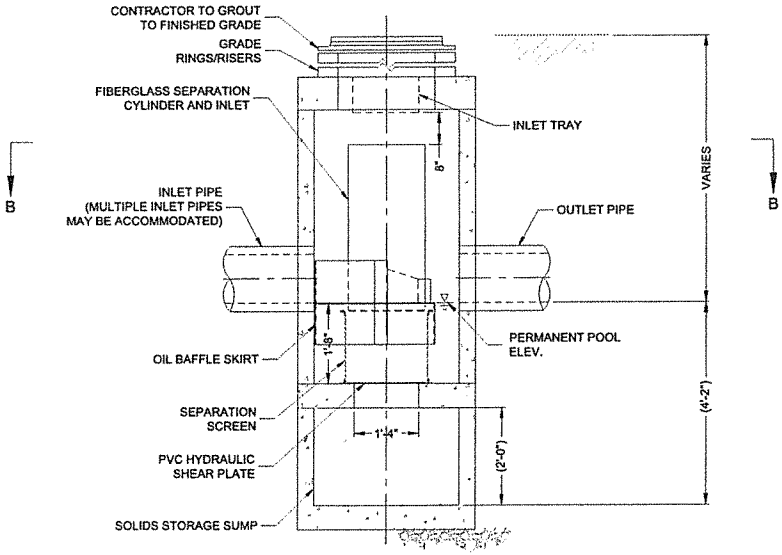
Area	0.41 ac	Unit Site Designation	CB 10
Weighted C	0.9	Rainfall Station #	68
t_c	5 min		
CDS Model	1515-3	CDS Treatment Capacity	1.0 cfs

Rainfall Intensity[1] (in/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (cfs)	Treated Flowrate (cfs)	Incremental Removal (%)
0.02	9.3%	9.3%	0.01	0.01	9.3
0.04	9.5%	18.8%	0.01	0.01	9.5
0.06	8.7%	27.5%	0.02	0.02	8.7
0.08	10.1%	37.6%	0.03	0.03	10.1
0.10	7.2%	44.8%	0.04	0.04	7.1
0.12	6.0%	50.8%	0.04	0.04	6.0
0.14	6.3%	57.1%	0.05	0.05	6.2
0.16	5.6%	62.7%	0.06	0.06	5.5
0.18	4.7%	67.4%	0.07	0.07	4.6
0.20	3.6%	71.0%	0.07	0.07	3.5
0.25	8.2%	79.1%	0.09	0.09	7.9
0.50	14.9%	94.0%	0.18	0.18	13.8
0.75	3.2%	97.3%	0.28	0.28	2.8
1.00	1.2%	98.5%	0.37	0.37	1.0
1.50	0.7%	99.2%	0.55	0.55	0.5
2.00	0.8%	100.0%	0.73	0.73	0.5
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
					97.3
				Removal Efficiency Adjustment[2] =	6.5%
				Predicted % Annual Rainfall Treated =	93.5%
				Predicted Net Annual Load Removal Efficiency =	**90.8%**

1 - Based on 10 years of rainfall data from NCDC station 736, Blue Hill, Norfolk County, MA
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.



PLAN VIEW B-B
N.T.S.



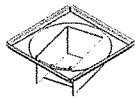
ELEVATION A-A
N.T.S.

CDS1515-3-C DESIGN NOTES

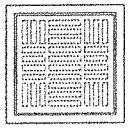
CDS1515-3-C RATED TREATMENT CAPACITY IS 1.0 CFS, OR PER LOCAL REGULATIONS.

THE STANDARD CDS1515-3-C WITH GRATED INLET CONFIGURATION IS SHOWN. ALTERNATE CONFIGURATIONS ARE AVAILABLE AND ARE LISTED BELOW. SOME CONFIGURATIONS MAY BE COMBINED TO SUIT SITE REQUIREMENTS.

CONFIGURATION DESCRIPTION
GRATED INLET ONLY (NO INLET PIPE)
GRATED INLET WITH INLET PIPE OR PIPES



INLET TRAY
NOT TO SCALE



24" X 24" FRAME AND GRATE
(MAY VARY)
NOT TO SCALE

SITE SPECIFIC DATA REQUIREMENTS

STRUCTURE ID	
WATER QUALITY FLOW RATE (CFS OR L/s)	*
PEAK FLOW RATE (CFS OR L/s)	*
RETURN PERIOD OF PEAK FLOW (YRS)	*
SCREEN APERTURE (2400 OR 4700)	*

PIPE DATA:	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	*	*	*
INLET PIPE 2	*	*	*
OUTLET PIPE	*	*	*

RIM ELEVATION	*

ANTI-FLOTATION BALLAST	WIDTH	HEIGHT
	*	*

NOTES/SPECIAL REQUIREMENTS:

* PER ENGINEER OF RECORD

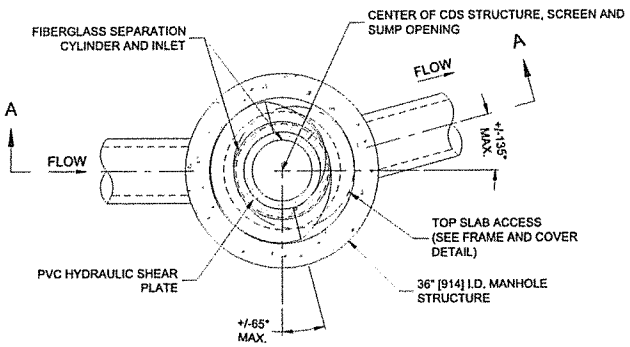
GENERAL NOTES
1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. FOR SITE SPECIFIC DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHT, PLEASE CONTACT YOUR CONTECH ENGINEERED SOLUTIONS LLC REPRESENTATIVE. www.ContechES.com
3. CDS WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING. CONTRACTOR TO CONFIRM STRUCTURE MEETS REQUIREMENTS OF PROJECT.
4. STRUCTURE SHALL MEET AASHTO HS20 LOAD RATING, ASSUMING EARTH COVER OF 0' - 2', AND GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION. CASTINGS SHALL MEET AASHTO M306 AND BE CAST WITH THE CONTECH LOGO..
5. IF REQUIRED, PVC HYDRAULIC SHEAR PLATE IS PLACED ON SHELF AT BOTTOM OF SCREEN CYLINDER. REMOVE AND REPLACE AS NECESSARY DURING MAINTENANCE CLEANING.
6. CDS STRUCTURE SHALL BE PRECAST CONCRETE CONFORMING TO ASTM C-478 AND AASHTO LOAD FACTOR DESIGN METHOD.

INSTALLATION NOTES
A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE CDS MANHOLE STRUCTURE.
C. CONTRACTOR TO INSTALL JOINT SEALANT BETWEEN ALL STRUCTURE SECTIONS AND ASSEMBLE STRUCTURE.
D. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT INLET AND OUTLET PIPE(S). MATCH PIPE INVERTS WITH ELEVATIONS SHOWN. ALL PIPE CENTERLINES TO MATCH PIPE OPENING CENTERLINES.
E. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO ASSURE UNIT IS WATER TIGHT, HOLDING WATER TO FLOWLINE INVERT MINIMUM. IT IS SUGGESTED THAT ALL JOINTS BELOW PIPE INVERTS ARE GROUTED.

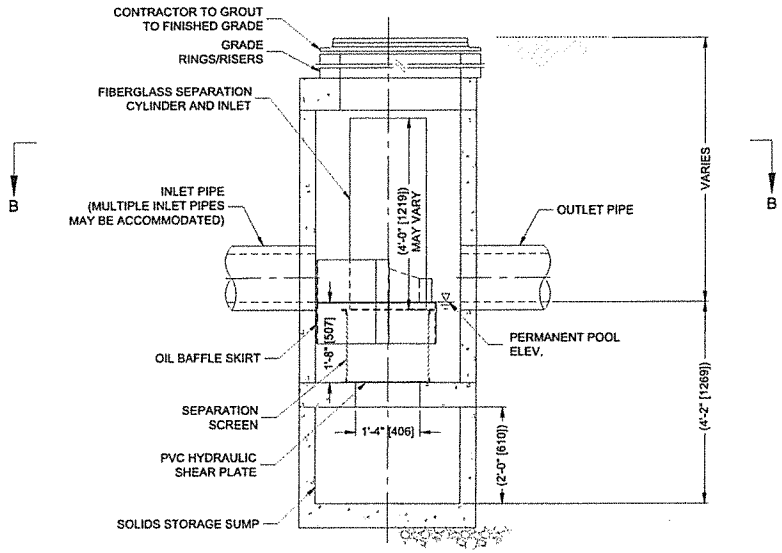
CONTECH ENGINEERED SOLUTIONS LLC
www.contechES.com
9025 Centre Pointe Dr., Suite 400, West Chester, OH 45069
800-338-1122 513-645-7000 513-645-7993 FAX

CDS1515-3-C
ONLINE CDS
STANDARD DETAIL

I:\STORM\WATER\JURISDICTION\SUSAMA_SDE DESIGN TOOLS_STANDARD DETAILS\CDS\CDS1515-3-C-DTL WITH GRATED INLET.DWG 7/15/2020 2:30 PM



PLAN VIEW B-B
N.T.S.

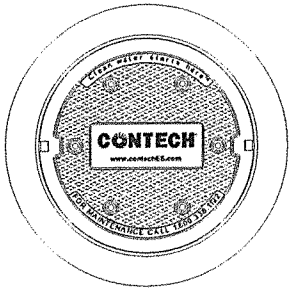


ELEVATION A-A
N.T.S.

CDS1515-3-C DESIGN NOTES

CDS1515-3-C RATED TREATMENT CAPACITY IS 1.0 CFS, OR PER LOCAL REGULATIONS.

THE STANDARD CDS1515-3-C CONFIGURATION IS SHOWN.



FRAME AND COVER
(DIAMETER VARIES)
N.T.S.

SITE SPECIFIC DATA REQUIREMENTS

STRUCTURE ID			
WATER QUALITY FLOW RATE (CFS OR L/s)			*
PEAK FLOW RATE (CFS OR L/s)			*
RETURN PERIOD OF PEAK FLOW (YRS)			*
SCREEN APERTURE (2400 OR 4700)			*
PIPE DATA:	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	*	*	*
INLET PIPE 2	*	*	*
OUTLET PIPE	*	*	*
RIM ELEVATION			*
ANTI-FLOTATION BALLAST		WIDTH	HEIGHT
		*	*

NOTES/SPECIAL REQUIREMENTS:

* PER ENGINEER OF RECORD

GENERAL NOTES
1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. FOR SITE SPECIFIC DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHT, PLEASE CONTACT YOUR CONTECH ENGINEERED SOLUTIONS LLC REPRESENTATIVE. www.ContechES.com
3. CDS WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING. CONTRACTOR TO CONFIRM STRUCTURE MEETS REQUIREMENTS OF PROJECT.
4. STRUCTURE SHALL MEET AASHTO HS20 LOAD RATING, ASSUMING EARTH COVER OF 0' - 2', AND GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION. CASTINGS SHALL MEET AASHTO M306 AND BE CAST WITH THE CONTECH LOGO..
5. IF REQUIRED, PVC HYDRAULIC SHEAR PLATE IS PLACED ON SHELF AT BOTTOM OF SCREEN CYLINDER. REMOVE AND REPLACE AS NECESSARY DURING MAINTENANCE CLEANING.
6. CDS STRUCTURE SHALL BE PRECAST CONCRETE CONFORMING TO ASTM C-478 AND AASHTO LOAD FACTOR DESIGN METHOD.

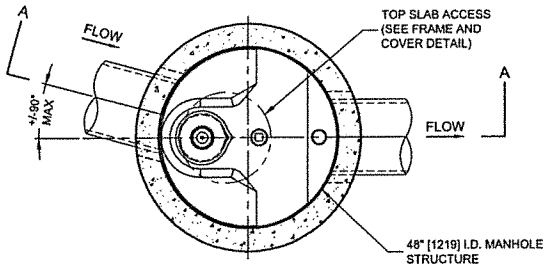
INSTALLATION NOTES
A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE CDS MANHOLE STRUCTURE.
C. CONTRACTOR TO INSTALL JOINT SEALANT BETWEEN ALL STRUCTURE SECTIONS AND ASSEMBLE STRUCTURE.
D. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT INLET AND OUTLET PIPE(S). MATCH PIPE INVERTS WITH ELEVATIONS SHOWN. ALL PIPE CENTERLINES TO MATCH PIPE OPENING CENTERLINES.
E. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO ASSURE UNIT IS WATER TIGHT, HOLDING WATER TO FLOWLINE INVERT MINIMUM. IT IS SUGGESTED THAT ALL JOINTS BELOW PIPE INVERTS ARE GROUTED.

CONTECH®
ENGINEERED SOLUTIONS LLC
www.contechES.com
9025 Centre Pointe Dr., Suite 400, West Chester, OH 45069
800-338-1122 513-645-7000 513-645-7993 FAX

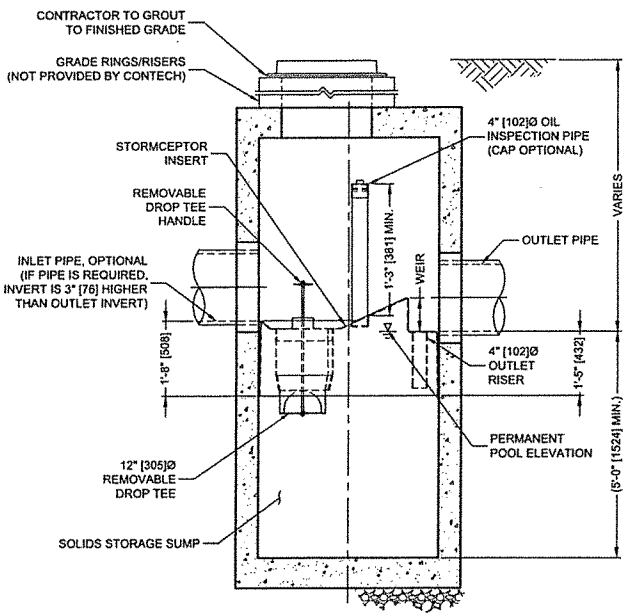
CDS1515-3-C
ONLINE CDS
STANDARD DETAIL

CDS
THIS PROJECT MAY BE PROTECTED BY ONE OR MORE OF THE FOLLOWING US PATENTS: 5,788,848; 6,641,739; 6,511,605; 6,967,193 AND/OR FOREIGN PATENTS, OR OTHER PATENTS PENDING.

\\AD.CONTECH-CPI.COM\ROOT\STORM\WATER-JURISDICTION\USA\MAL_SOE DESIGN TOOLS_STANDARD DETAILS\CDS1515-3-C-OTL.DWG 8/6/2018 4:16 PM



PLAN VIEW
TOP SLAB NOT SHOWN



SECTION A-A

Stormceptor®
FOR PATENT INFORMATION, GO TO www.ContechES.com/IP

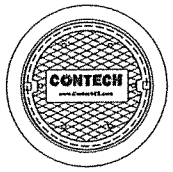
STORMCEPTOR DESIGN NOTES

THE STANDARD STC450i CONFIGURATION WITH ROUND, SOLID FRAME AND COVER, AND INLET PIPE IS SHOWN. ALTERNATE CONFIGURATIONS ARE AVAILABLE AND ARE LISTED BELOW. SOME CONFIGURATIONS MAY BE COMBINED TO SUIT SITE REQUIREMENTS.

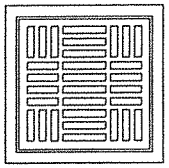
CONFIGURATION DESCRIPTION
GRATED INLET ONLY (NO INLET PIPE)
GRATED INLET WITH INLET PIPE OR PIPES
CURB INLET ONLY (NO INLET PIPE)
CURB INLET WITH INLET PIPE OR PIPES

SITE SPECIFIC DATA REQUIREMENTS

STRUCTURE ID			
WATER QUALITY FLOW RATE (cfs [L/s])			
PEAK FLOW RATE (cfs [L/s])			
RETURN PERIOD OF PEAK FLOW (yrs)			
RIM ELEVATION			
PIPE DATA:	INVERT	MATERIAL	DIAMETER
INLET PIPE 1			
INLET PIPE 2			
OUTLET PIPE			
NOTES / SPECIAL REQUIREMENTS:			



FRAME AND COVER
(MAY VARY)
NOT TO SCALE



FRAME AND GRATE
(MAY VARY)
NOT TO SCALE

GENERAL NOTES
1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. FOR SITE SPECIFIC DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHT, PLEASE CONTACT YOUR CONTECH ENGINEERED SOLUTIONS LLC REPRESENTATIVE. www.ContechES.com
3. STORMCEPTOR WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING. CONTRACTOR TO CONFIRM STRUCTURE MEETS REQUIREMENTS OF PROJECT.
4. STORMCEPTOR STRUCTURE SHALL MEET AASHTO HS20 LOAD RATING, ASSUMING EARTH COVER OF 0' - 2' [610], AND GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION. CASTINGS SHALL MEET AASHTO M306 AND BE CAST WITH THE CONTECH LOGO.
5. STORMCEPTOR STRUCTURE SHALL BE PRECAST CONCRETE CONFORMING TO ASTM C478 AND AASHTO LOAD FACTOR DESIGN METHOD.
6. ALTERNATE UNITS ARE SHOWN IN MILLIMETERS [mm].

INSTALLATION NOTES
A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE STORMCEPTOR MANHOLE STRUCTURE.
C. CONTRACTOR TO INSTALL JOINT SEALANT BETWEEN ALL STRUCTURE SECTIONS AND ASSEMBLE STRUCTURE.
D. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT INLET AND OUTLET PIPE(S). MATCH PIPE INVERTS WITH ELEVATIONS SHOWN. ALL PIPE CENTERLINES TO MATCH PIPE OPENING CENTERLINES.
E. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO ASSURE UNIT IS WATER TIGHT, HOLDING WATER TO FLOWLINE INVERT MINIMUM. IT IS SUGGESTED THAT ALL JOINTS BELOW PIPE INVERTS ARE GROUTED.

CONTECH®
ENGINEERED SOLUTIONS LLC
www.contechES.com
9025 Centre Pointe Dr., Suite 400, West Chester, OH 45069
800-338-1122 513-645-7000 513-645-7993 FAX

STC450i
STORMCEPTOR
STANDARD DETAIL

I:\COMMON\CAD\TREATMENT\23 STORMCEPTOR\40 STANDARD DRAWINGS\IN PROCESS\STC450I-DTL.DWG 2/1/2019 3:12 PM

Non-automated: Mar. 4, 2008

INSTRUCTIONS:

1. Sheet is nonautomated. Print sheet and complete using hand calculations. Column A and B: See MassDEP Structural BMP Table
2. The calculations must be completed using the Column Headings specified in Chart and Not the Excel Column Headings
3. To complete Chart Column D, multiple Column B value within Row x Column C value within Row
4. To complete Chart Column E value, subtract Column D value within Row from Column C within Row
5. Total TSS Removal = Sum All Values in Column D

Location: Washington Street

TSS Removal Calculation Worksheet

A BMP[1]	B TSS Removal Rate[1]	C Starting TSS Load*	D Amount Removed (B*C)	E Remaining Load (C-D)
Stormwater Co 5,8,9 & 10	65%	1.00	65%	35%
Stormwater Pole 1,2,3	80% with treatment train	1.00	80%	20%

Total TSS Removal = 80%

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: Washington St.
Prepared By: [illegible]
Date: 9/12/21

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

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed
1. From MassDEP Stormwater Handbook Vol. 1

Mass. Dept. of Environmental Protection

Non-automated: Mar. 4, 2008

INSTRUCTIONS:

1. Sheet is nonautomated. Print sheet and complete using hand calculations. Column A and B: See MassDEP Structural BMP Table
2. The calculations must be completed using the Column Headings specified in Chart and Not the Excel Column Headings
3. To complete Chart Column D, multiple Column B value within Row x Column C value within Row
4. To complete Chart Column E value, subtract Column D value within Row from Column C within Row
5. Total TSS Removal = Sum All Values in Column D

Location: Washington Street

TSS Removal Calculation Worksheet

A BMP[1]	B TSS Removal Rate[1]	C Starting TSS Load*	D Amount Removed (B*C)	E Remaining Load (C-D)
Roof Drain Hoods CB	25%	1.00	25%	75%
CDS Units CB14+DH4S+7	65%	[illegible]	48.75	26.25
Infiltration Beds 1,2+3	80%	20%	80%	20%

Pre Treat

Pre Treat

Total TSS Removal = 20%

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: [illegible]

Prepared By: [illegible]

Date: [illegible]

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

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed

1. From MassDEP Stormwater Handbook Vol. 1

Mass. Dept. of Environmental Protection

APPENDIX F

Guelph Permeameter Calculations

☐ Input

☐ Result

Support: at@soilmoisture.com

Head #1

Reservoir Type (enter "1" for Combined and "2" for Inner reservoir): 1

Enter water Head Height ("H" in cm): 5

Enter the Borehole Radius ("a" in cm): 3

Enter the soil texture-structure category (enter one of the below numbers): 4

1 Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.

2 Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.

3 Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.

4 Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macro-pores, etc.

Steady State Rate of Water Level Change ("R" in cm/min): 18.8000

α = 0.36 cm^{-1}

C_1 = 0.80315

Q_1 = 11.0356

K_{fs} = 3.32E-02 *cm/sec*
####### *cm/min*
3.32E-04 *m/sec*
7.84E-01 *inch/min*
1.31E-02 *inch/sec*

Φ_m = 9.22E-02 cm^2/sec

Head #2

Reservoir Type (enter "1" for Combined and "2" for Inner reservoir): 1

Enter water Head Height ("H" in cm): 10

Enter the Borehole Radius ("a" in cm): 3

Enter the soil texture-structure category (enter one of the below numbers): 4

1 Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.

2 Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.

3 Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.

4 Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macro-pores, etc.

Steady State Rate of Water Level Change ("R" in cm/min): 23.0000

α = 0.36 cm^{-1}

C_1 = 1.28754

Q_1 = 13.501

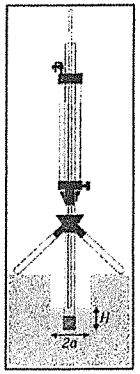
K_{fs} = 2.07E-02 *cm/sec*
####### *cm/min*
2.07E-04 *m/sec*
4.89E-01 *inch/min*
8.15E-03 *inch/sec*

Φ_m = 5.75E-02 cm^2/sec

Average

K_{fs} = 2.70E-02 *cm/sec*
1.62E+00 *cm/min*
2.70E-04 *m/s*
6.37E-01 *inch/min*
1.06E-02 *inch/sec*

Φ_m = 7.49E-02 cm^2/sec



Two Head Method

Reservoir Type (enter "1" for Combined and "2" for Inner reservoir): 1

Enter the first water Head Height ("H1" in cm): 5

Enter the second water Head Height ("H2" in cm): 10

Enter the Borehole Radius ("a" in cm): 3

Enter the soil texture-structure category (enter one of the below numbers): 4

1 Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.

2 Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.

3 Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.

4 Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macro-pores, etc.

α = 0.36 cm^{-1}

Steady State Rate of Water Level Change ("R1" in cm/min): 18.8000

Steady State Rate of Water Level Change ("R2" in cm/min): 23.0000

1.95

Q_1 = 0.6768

Q_2 = 0.828

C_1 = 0.80315

C_2 = 1.28754

G_1 = 0.00498

G_2 = 0.00397

G_3 = 0.05569

G_4 = 0.02415

K_{fs} = ####### *cm/sec*
####### *cm/min*
####### *m/sec*
####### *inch/min*
####### *inch/sec*

Φ_m = 1.77E-02 cm^2/sec

Calculation formulas related to shape factor C_1. Where H_1 is the first water head height (cm), H_2 is the second water head height (cm), a is borehole radius (cm) and α^{-1} is macroscopic capillary length factor which is decided according to the soil texture-structure category. For one head method, only C_1 needs to be calculated while for two head method, C_1 and C_2 are calculated (Zang et al., 1998).

Soil Texture-Structure Category	α^{-1} (cm^{-1})	Shape Factor
Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.	0.01	$C_1 = \left(\frac{H_1/a}{2.102 + 0.118(H_1/a)}\right)^{0.828}$ $C_2 = \left(\frac{H_2/a}{2.102 + 0.118(H_2/a)}\right)^{0.828}$
Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.	0.04	$C_1 = \left(\frac{H_1/a}{1.992 + 0.091(H_1/a)}\right)^{0.828}$ $C_2 = \left(\frac{H_2/a}{1.992 + 0.091(H_2/a)}\right)^{0.828}$
Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.	0.12	$C_1 = \left(\frac{H_1/a}{2.074 + 0.093(H_1/a)}\right)^{0.828}$ $C_2 = \left(\frac{H_2/a}{2.074 + 0.093(H_2/a)}\right)^{0.828}$
Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macro-pores, etc.	0.36	$C_1 = \left(\frac{H_1/a}{2.074 + 0.093(H_1/a)}\right)^{0.828}$ $C_2 = \left(\frac{H_2/a}{2.074 + 0.093(H_2/a)}\right)^{0.828}$

Calculation formulas related to one-head and two-head methods. Where R is steady-state rate of fall of water in reservoir (cm/s), K_{fs} is Soil saturated hydraulic conductivity (cm/s), Φ_m is Soil matric flux potential (cm^2/s), α^{-1} is Macroscopic capillary length parameter (from Table 2), a is Borehole radius (cm), H_1 is the first head of water established in borehole (cm), H_2 is the second head of water established in borehole (cm) and C_1 is Shape factor (from Table 2).

One Head, Combined Reservoir	$Q_1 = \bar{R}_1 \times 35.22$	$K_{fs} = \frac{C_1 \times Q_1}{2\pi H_1^2 + \pi a^2 C_1 + 2\pi\left(\frac{H_1}{\alpha^*}\right)}$
One Head, Inner Reservoir	$Q_2 = \bar{R}_1 \times 2.16$	$\Phi_m = \frac{C_1 \times Q_1}{(2\pi H_1^2 + \pi a^2 C_1)\alpha^* + 2\pi H_1}$
Two Head, Combined Reservoir	$Q_1 = \bar{R}_1 \times 35.22$ $Q_2 = \bar{R}_2 \times 35.22$	$G_1 = \frac{H_2 C_1}{\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$ $G_2 = \frac{H_1 C_2}{\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$ $K_{fs} = G_2Q_2 - G_1Q_1$ $G_3 = \frac{(2H_2^2 + a^2C_2)C_1}{2\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$
Two Head, Inner Reservoir	$Q_1 = \bar{R}_1 \times 2.16$ $Q_2 = \bar{R}_2 \times 2.16$	$G_4 = \frac{(2H_1^2 + a^2C_1)C_2}{2\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$ $\Phi_m = G_3Q_1 - G_4Q_2$

Guelph Permeameter Data Sheet

Investigator: [illegible] Date: [illegible]

Location: [illegible] Test Id: [illegible]

Depth of hole: 60" Radius: [illegible] (standard calcs assume 3 cm radius)

Reservoirs used during test (check one): Combined: [illegible] Inner only: _____

Reservoir constant used: [illegible]

Water level in well = 5 cm				
Time t (min)	Dt (min)	Water level in reservoir h (cm)	Dh (cm)	Rate of change Dh/ Dt
0		30		
[illegible]	[illegible]	25	5	[illegible]
[illegible]	[illegible]	30	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	1.4
[illegible]	[illegible]	[illegible]		[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	21.4
[illegible]	[illegible]			15.3
[illegible]	[illegible]	60	[illegible]	21.4
[illegible]	[illegible]	[illegible]	[illegible]	15.3
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]		33.1
Steady rate for 3 consecutive readings (R_1):				[illegible]

Water level in well = 10 cm				
Time t (min)	Dt (min)	Water level in reservoir h (cm)	Dh (cm)	Rate of change Dh/ Dt
0		[illegible]		
[illegible]	[illegible]	[illegible]	5	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	40		[illegible]
[illegible]	[illegible]	[illegible]	5	33.1
[illegible]	[illegible]	50	[illegible]	33.1
[illegible]	[illegible]	55	5	33.1
[illegible]	[illegible]	[illegible]	5	21.4
[illegible]	[illegible]	[illegible]	5	33.1
[illegible]	[illegible]	70	5	21.4
[illegible]	[illegible]	75	5	[illegible]
Steady rate for 3 consecutive readings (R_2):				[illegible]

Comments:

[illegible]

GP FIELD DATA SHEET

SECTION 1: SITE INFORMATION

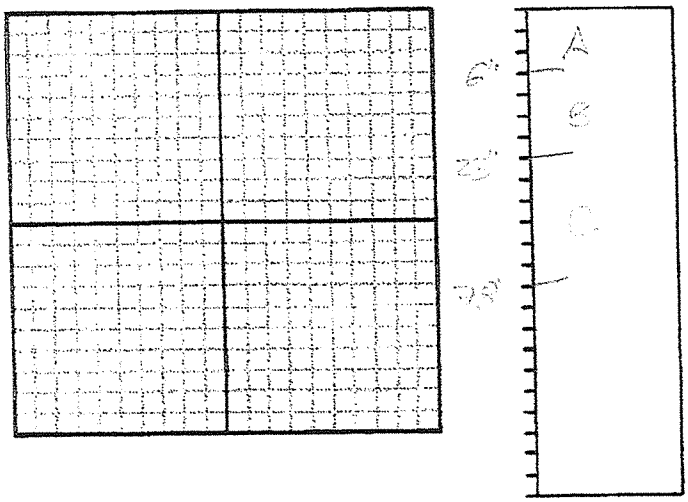
Date _____ Investigator _____

Site Location _____

Dominant Soil Type(s) _____

Site Map:

Soil Profile Description (horizon depth, texture, structure, color, etc.):



Depth	Description

Presence of special soil conditions (mottling, water table depth, hardpan, induration, compacted layers, etc.):

_____

_____

_____

_____

_____

Comments and Notes (topography, slope, vegetation, etc.):

_____

_____

_____

_____

SOILMOISTURE EQUIPMENT CORP.
P.O. Box 30025, Santa Barbara, CA 93130 USA
Phone: 805-964-3525 - Fax: (805) 683-2189 - Email: sales@soilmoisture.com
Website: http://www.soilmoisture.com

SOILMOISTURE®

Guelph Permeameter Calculations

☐ Input

☐ Result

Support: s3@soilmoisture.com

Head #1

Reservoir Type (enter "1" for Combined and "2" for inner reservoir): 1
Enter water Head Height ("H" in cm): 5
Enter the Borehole Radius ("a" in cm): 3

Enter the soil texture-structure category (enter one of the below numbers): 4

1 - Compacted, structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.

2 - Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.

3 - Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.

4 - Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macropores, etc.

Steady State Rate of Water Level Change ("R" in cm/min): 24.1000

H_1 = 0.36 (cm)

C_1 = 0.80315
Q_1 = 14.1467

K_{fs} = 4.26E-02 cm/sec
####### cm/min
4.26E-04 m/sec
####### inch/min
1.68E-02 inch/sec

Φ_m = 1.18E-01 (cm²/sec)

Head #2

Reservoir Type (enter "1" for Combined and "2" for inner reservoir): 1
Enter water Head Height ("H" in cm): 10
Enter the Borehole Radius ("a" in cm): 3

Enter the soil texture-structure category (enter one of the below numbers): 4

1 - Compacted, structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.

2 - Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.

3 - Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.

4 - Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macropores, etc.

Steady State Rate of Water Level Change ("R" in cm/min): 33.6000

H_1 = 0.36 (cm)

C_1 = 1.28754
Q_1 = 19.7232

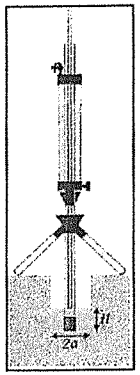
K_{fs} = 3.03E-02 cm/sec
####### cm/min
3.03E-04 m/ses
7.15E-01 inch/min
1.19E-02 inch/sec

Φ_m = 8.41E-02 (cm²/sec)

Average

K_{fs} = 3.64E-02 cm/sec
2.18E+00 cm/min
3.64E-04 m/s
8.60E-01 inch/min
1.43E-02 inch/sec

Φ_m = 1.01E-01 (cm²/sec)



Two Head Method

Reservoir Type (enter "1" for Combined and "2" for inner reservoir): 1

Enter the first water Head Height ("H1" in cm): 5
Enter the second water Head Height ("H2" in cm): 10

Enter the Borehole Radius ("a" in cm): 3

Enter the soil texture-structure category (enter one of the below numbers): 4

1 - Compacted, structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.

2 - Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.

3 - Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.

4 - Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macropores, etc.

H_1 = 0.36 (cm)

Steady State Rate of Water Level Change ("R1" in cm/min): 24.1000

Steady State Rate of Water Level Change ("R2" in cm/min): 33.6000

1.95

Q_2 = 0.6676

Q_1 = 1.2096

C_1 = 0.80315

C_2 = 1.28754

G_1 = 0.00496

G_2 = 0.00397

G_3 = 0.05569

G_4 = 0.02415

K_{fs} = 5.05E-04 cm/sec
3.03E-02 cm/min
5.05E-06 m/sec
1.19E-02 inch/min
1.99E-04 inch/sec

Φ_m = 1.91E-02 (cm²/sec)

Calculation formulas related to shape factor C. Where H_1 is the first water head height (cm), H_2 is the second water head height (cm), a is borehole radius (cm), and α^* is macroscopic capillary length parameter in a detailed according to the soil texture-structure category. For one head method only C_1 needs to be calculated while for two-head method C_1 and C_2 are calculated (Zang et al., 1998).

Soil Texture-Structure Category	α^* (cm^{-1})	Shape Factor
Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.	0.01	$C_1 = \left(\frac{H_1/a}{2.107 + 0.118(H_1/a)}\right)^{(1)}$ $C_2 = \left(\frac{H_2/a}{2.107 + 0.118(H_2/a)}\right)^{(2)}$
Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.	0.04	$C_1 = \left(\frac{H_1/a}{1.992 + 0.091(H_1/a)}\right)^{(1)}$ $C_2 = \left(\frac{H_2/a}{1.992 + 0.091(H_2/a)}\right)^{(2)}$
Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.	0.12	$C_1 = \left(\frac{H_1/a}{2.074 + 0.093(H_1/a)}\right)^{(1)}$ $C_2 = \left(\frac{H_2/a}{2.074 + 0.093(H_2/a)}\right)^{(2)}$
Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macro pores, etc.	0.36	$C_1 = \left(\frac{H_1/a}{2.074 + 0.093(H_1/a)}\right)^{(1)}$ $C_2 = \left(\frac{H_2/a}{2.074 + 0.093(H_2/a)}\right)^{(2)}$

Calculation formulas related to one-head and two-head methods. Where R is steady-state rate of fall of water in reservoir (cm/s), K_{fs} is Soil saturated hydraulic conductivity (cm/s), Φ_m is Soil matric flux potential (cm²/s), α^* is Macroscopic capillary length parameter (from Table 2), a is Borehole radius (cm), H_1 is the first head of water established in borehole (cm), H_2 is the second head of water established in borehole (cm) and C is Shape factor (from Table 2).

One Head, Combined Reservoir	$Q_1 = \bar{R}_1 \times 35.22$	$K_{fs} = \frac{C_1 \times Q_1}{2\pi H_1^2 + \pi a^2 C_1 + 2\pi\left(\frac{H_1}{\alpha^*}\right)}$ $\Phi_m = \frac{C_1 \times Q_1}{(2\pi H_1^2 + \pi a^2 C_1)\alpha^* + 2\pi H_1}$
One Head, Inner Reservoir	$Q_1 = \bar{R}_1 \times 2.16$	
Two Head, Combined Reservoir	$Q_1 = \bar{R}_1 \times 35.22$ $Q_2 = \bar{R}_2 \times 35.22$	$G_1 = \frac{H_2 C_1}{\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$ $G_2 = \frac{H_1 C_2}{\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$ $K_{fs} = G_2Q_2 - G_1Q_1$ $G_3 = \frac{(2H_2^2 + a^2C_2)C_1}{2\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$
Two Head, Inner Reservoir	$Q_1 = \bar{R}_1 \times 2.16$ $Q_2 = \bar{R}_2 \times 2.16$	$G_4 = \frac{(2H_1^2 + a^2C_1)C_2}{2\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$ $\Phi_m = G_3Q_1 - G_4Q_2$

Guelph Permeameter Data Sheet

Investigator: [illegible] Date: [illegible]

Location: [illegible] Test Id: [illegible]

Depth of hole: [illegible] Radius: [illegible] (standard calcs assume 3 cm radius)

Reservoirs used during test (check one): Combined: ✓ Inner only: _____

Reservoir constant used: [illegible]

Water level in well = 5 cm				
Time t (min)	Dt (min)	Water level in reservoir h (cm)	Dh (cm)	Rate of change Dh/ Dt
0		[illegible]		
[illegible]	0.13	[illegible]	5	[illegible]
[illegible]	0.13	30	5	[illegible]
[illegible]	[illegible]	[illegible]	5	[illegible]
[illegible]	[illegible]	40	5	[illegible]
[illegible]	[illegible]	[illegible]	5	[illegible]
[illegible]	[illegible]	[illegible]	5	[illegible]
[illegible]	[illegible]	[illegible]	5	[illegible]
[illegible]	[illegible]	[illegible]	5	[illegible]
[illegible]	[illegible]	[illegible]	5	[illegible]
[illegible]	[illegible]	[illegible]	5	[illegible]
[illegible]	[illegible]	[illegible]	5	[illegible]
[illegible]	[illegible]	[illegible]	5	[illegible]

Steady rate for 3 consecutive readings (R_1): [illegible]

Water level in well = 10 cm				
Time t (min)	Dt (min)	Water level in reservoir h (cm)	Dh (cm)	Rate of change Dh/ Dt
0		[illegible]		
[illegible]	0.13	[illegible]	10	60.0
[illegible]	0.33	40	10	37.5
[illegible]	0.13	45	5	38.5
[illegible]	0.15	50	5	33.3
[illegible]	0.13	55	5	37.5
100	0.15	[illegible]	5	33.3
[illegible]	0.13	[illegible]	5	38.0
[illegible]	0.13	[illegible]	5	37.5
[illegible]	[illegible]	[illegible]	5	[illegible]

Steady rate for 3 consecutive readings (R_2): [illegible]

Comments:

K = 0.86 [illegible] 3.16 [illegible]

GP FIELD DATA SHEET

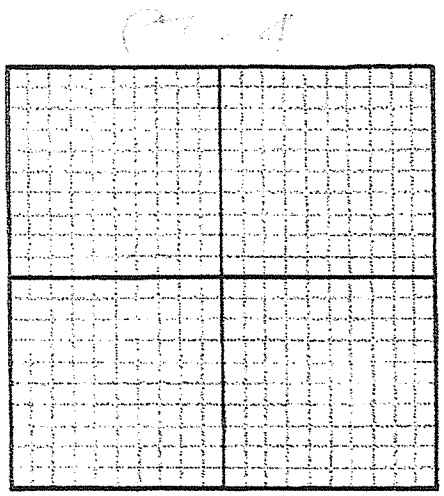
SECTION 1: SITE INFORMATION

Date _____ Investigator _____

Site Location _____

Dominant Soil Type(s) _____

Site Map:



Soil Profile Description (horizon depth, texture, structure, color, etc.):

Depth	Description
A	
B	
C	

Presence of special soil conditions (mottling, water table depth, hardpan, induration, compacted layers, etc.):

Comments and Notes (topography, slope, vegetation, etc.):

SOILMOISTURE EQUIPMENT CORP.
P.O. Box 30025, Santa Barbara, CA 93130 USA
Phone: 805-964-3525 - Fax: (805) 683-2189 - Email: sales@soilmoisture.com
Website: http://www.soilmoisture.com

SOILMOISTURE®

Guelph Permeameter Calculations

☐ Input

☐ Result

Support: al@soilmoisture.com

Head #1

Reservoir Type (enter "1" for Combined and "2" for Inner reservoir): 1

Enter water Head Height ("H" in cm): 5

Enter the Borehole Radius ("a" in cm): 3

Enter the soil texture-structure category (enter one of the below numbers): 4

1 - Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.

2 - Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.

3 - Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.

4 - Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macro pores, etc.

Steady State Rate of Water Level Change ("R" in cm/min): 27.3000

α = 0.36 cm^{-1}

C_1 = 0.80315

Q_1 = 16.0251

K_{fs} = 4.82E-02 *cm/sec*
####### *cm/min*
4.82E-04 *m/sec*
####### *inch/min*
1.90E-02 *inch/sec*

Φ_m = 1.34E-01 in^2/min

Head #2

Reservoir Type (enter "1" for Combined and "2" for Inner reservoir): 1

Enter water Head Height ("H" in cm): 10

Enter the Borehole Radius ("a" in cm): 3

Enter the soil texture-structure category (enter one of the below numbers): 4

1 - Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.

2 - Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.

3 - Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.

4 - Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macro pores, etc.

Steady State Rate of Water Level Change ("R" in cm/min): 30.0000

α = 0.36 cm^{-1}

C_1 = 1.28754

Q_1 = 17.61

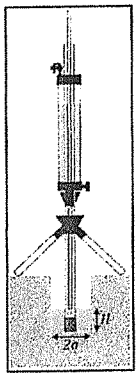
K_{fs} = 2.70E-02 *cm/sec*
####### *cm/min*
2.70E-04 *m/sec*
6.38E-01 *inch/min*
1.06E-02 *inch/sec*

Φ_m = 7.50E-02 in^2/min

Average

K_{fs} = 3.76E-02 *cm/sec*
2.26E+00 *cm/min*
3.76E-04 *m/s*
8.88E-01 *inch/min*
1.48E-02 *inch/sec*

Φ_m = 1.04E-01 in^2/min



Two Head Method

Reservoir Type (enter "1" for Combined and "2" for Inner reservoir): 1

Enter the first water Head Height ("H1" in cm): 5

Enter the second water Head Height ("H2" in cm): 10

Enter the Borehole Radius ("a" in cm): 3

Enter the soil texture-structure category (enter one of the below numbers): 4

1 - Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.

2 - Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.

3 - Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.

4 - Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macro pores, etc.

α = 0.36 cm^{-1}

Steady State Rate of Water Level Change ("R1" in cm/min): 27.3000

Steady State Rate of Water Level Change ("R2" in cm/min): 30.0000

1.95

Q_1 = 0.9828

Q_2 = 1.08

C_1 = 0.80315

C_2 = 1.28754

G_1 = 0.00496

G_2 = 0.00397

G_3 = 0.05569

G_4 = 0.02415

K_{fs} = ####### *cm/sec*
####### *cm/min*
####### *m/sec*
####### *inch/min*
####### *inch/sec*

Φ_m = 2.87E-02 in^2/min

Calculation formulas related to shape factor, G. Where H_1 is the first water head height (cm), H_2 is the second water head height (cm), a is borehole radius (cm), and α is macroscopic capillary length factor which is decided according to the soil texture-structure category. For one head method, only G_1 needs to be calculated while for two head method, G_1 and G_2 are calculated (Zhang et al., 1998).

Soil Texture-Structure Category	α^* (cm^{-1})	Shape Factor
Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.	0.01	$G_1 = \left(\frac{H_1/a}{2.102 + 0.118(H_1/a)}\right)^{0.655}$ $G_2 = \left(\frac{H_2/a}{2.102 + 0.118(H_2/a)}\right)^{0.655}$
Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.	0.04	$G_1 = \left(\frac{H_1/a}{1.992 + 0.091(H_1/a)}\right)^{0.669}$ $G_2 = \left(\frac{H_2/a}{1.992 + 0.091(H_2/a)}\right)^{0.669}$
Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.	0.12	$G_1 = \left(\frac{H_1/a}{2.074 + 0.093(H_1/a)}\right)^{0.676}$ $G_2 = \left(\frac{H_2/a}{2.074 + 0.093(H_2/a)}\right)^{0.676}$
Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macro pores, etc.	0.36	$G_1 = \left(\frac{H_1/a}{2.074 + 0.093(H_1/a)}\right)^{0.676}$ $G_2 = \left(\frac{H_2/a}{2.074 + 0.093(H_2/a)}\right)^{0.676}$

Calculation formulas related to one-head and two-head methods. Where R is steady-state rate of fall of water in reservoir (cm/s), K_{fs} is Soil saturated hydraulic conductivity (cm/s), Φ_m is Soil matric flux potential (cm^2/s), α^* is Macroscopic capillary length parameter (from Table 2), a is Borehole radius (cm), H_1 is the first head of water established in borehole (cm), H_2 is the second head of water established in borehole (cm) and G is Shape Factor (from Table 2).

One Head, Combined Reservoir	$Q_1 = R_1 \times 35.22$	$K_{fs} = \frac{C_1 \times Q_1}{2\pi H_1^2 + \pi a^2 C_1 + 2\pi\left(\frac{H_1}{\alpha^*}\right)}$ $\Phi_m = \frac{C_1 \times Q_1}{(2\pi H_1^2 + \pi a^2 C_1)\alpha^* + 2\pi H_1}$
One Head, Inner Reservoir	$Q_1 = \bar{R}_1 \times 2.16$	
Two Head, Combined Reservoir	$Q_1 = \bar{R}_1 \times 35.22$ $Q_2 = \bar{R}_2 \times 35.22$	$G_1 = \frac{H_2 C_1}{\alpha(2H_1H_2(H_2 - H_1) + \alpha^2(H_1C_2 - H_2C_1))}$ $G_2 = \frac{H_1 C_2}{\alpha(2H_1H_2(H_2 - H_1) + \alpha^2(H_1C_2 - H_2C_1))}$ $K_{fs} = G_2Q_2 - G_1Q_1$ $G_3 = \frac{(2H_2^2 + \alpha^2 C_2)C_1}{2\pi(2H_1H_2(H_2 - H_1) + \alpha^2(H_1C_2 - H_2C_1))}$ $G_4 = \frac{(2H_1^2 + \alpha^2 C_1)C_2}{2\pi(2H_1H_2(H_2 - H_1) + \alpha^2(H_1C_2 - H_2C_1))}$ $\Phi_m = G_3Q_1 - G_4Q_2$
Two Head, Inner Reservoir	$Q_1 = \bar{R}_1 \times 2.16$ $Q_2 = \bar{R}_2 \times 2.16$	

Guelph Permeameter Data Sheet

Investigator: GAR/RAC Date: 6/16/01

Location: Wash. St. - Traverse Test Id: PT - 5

Depth of hole: 4.5" Radius: 3 cm (standard calcs assume 3 cm radius)

Reservoirs used during test (check one): Combined: ✓ Inner only: _____

Reservoir constant used: 35.22

Water level in well = 5 cm				
Time t (min)	Dt (min)	Water level in reservoir h (cm)	Dh (cm)	Rate of change Dh/ Dt
0		30		
1:08	0.13	25	5	38.5
1:12	0.09	30	5	55.0
1:23	0.16	35	5	31.3
1:33	0.17	40	5	30.0
1:45	0.20	45	5	25.0
1:54	0.15	50	5	33.3
1:64	0.10	55	5	50.0
1:72	0.08	60	5	62.1
1:78	0.18	65	5	27.3
1:89	0.18	70	5	27.3
1:93	0.23	75	5	21.7
Steady rate for 3 consecutive readings (R_1):				33.3

Water level in well = 10 cm				
Time t (min)	Dt (min)	Water level in reservoir h (cm)	Dh (cm)	Rate of change Dh/ Dt
0		30		
1:05	0.08	35	5	62.0
1:11	0.1	30	5	50.0
1:20	0.15	35	5	33.3
1:30	0.17	40	5	30.0
1:40	0.17	45	5	[illegible]
1:50	0.17	50	5	30.0
1:60	0.17	55	5	[illegible]
1:70	0.17	60	5	30.0
1:80	0.17	65	5	[illegible]
1:90	0.17	70	5	[illegible]
1:40	0.17	75	5	30.0
Steady rate for 3 consecutive readings (R_2):				30.0

Comments:

Ks = 0.838 in/min = 53.3 in/hr

GP FIELD DATA SHEET

SECTION 1: SITE INFORMATION

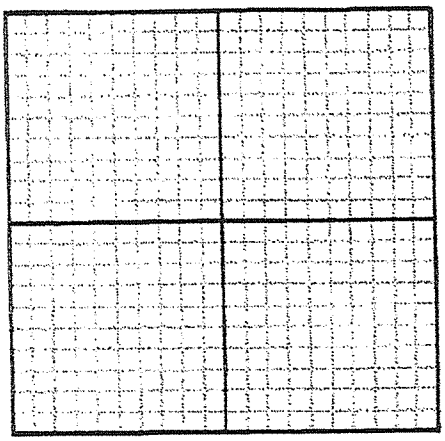
Date _____ Investigator _____

Site Location _____

Dominant Soil Type(s) _____

Site Map:

PT. 5



Soil Profile Description (horizon depth, texture, structure, color, etc.):

Depth	Description

Presence of special soil conditions (mottling, water table depth, hardpan, induration, compacted layers, etc.):

Comments and Notes (topography, slope, vegetation, etc.):

SOILMOISTURE EQUIPMENT CORP.
P.O. Box 30025, Santa Barbara, CA 93130 USA
Phone: 805-964-3525 - Fax: (805) 683-2189 - Email: sales@soilmoisture.com
Website: http://www.soilmoisture.com

SOILMOISTURE®

Guelph Permeameter Calculations

☐ Input

☐ Result

Support: a5@soilmoisture.com

Head #1

Reservoir Type (enter "1" for Combined and "2" for inner reservoir): 1
Enter water Head Height ("H" in cm): 5
Enter the Borehole Radius ("a" in cm): 3

Enter the soil texture-structure category (enter one of the below numbers): 4

1. Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.
2. Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands
3. Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.
4. Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macropores, etc

Steady State Rate of Water Level Change ("R" in cm/min): 4.4500

α^* = 0.36 cm^{-1}

C = 0.80315
Q = 2.61215

K_s = 7.86E-03 cm/sec
4.71E-01 cm/min
7.86E-05 m/ses
1.86E-01 inch/min
3.09E-03 inch/sec

Φ_m = 2.18E-02 cm^2/sec

Head #2

Reservoir Type (enter "1" for Combined and "2" for inner reservoir): 1
Enter water Head Height ("H" in cm): 10
Enter the Borehole Radius ("a" in cm): 3

Enter the soil texture-structure category (enter one of the below numbers): 4

1. Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.
2. Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands
3. Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils
4. Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macropores, etc

Steady State Rate of Water Level Change ("R" in cm/min): 5.3000

α^* = 0.36 cm^{-1}

C = 1.28754
Q = 3.1111

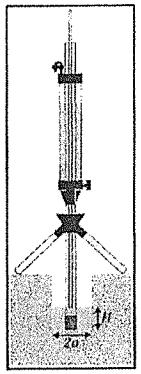
K_s = 4.77E-03 cm/sec
2.86E-01 cm/min
4.77E-05 m/ses
1.13E-01 inch/min
1.88E-03 inch/sec

Φ_m = 1.33E-02 cm^2/sec

Average

K_s = 6.31E-03 cm/sec
3.78E-01 cm/min
6.31E-05 m/s
1.49E-01 inch/min
2.49E-03 inch/sec

Φ_m = 1.75E-02 cm^2/sec



Two Head Method

Reservoir Type (enter "1" for Combined and "2" for inner reservoir): 1

Enter the first water Head Height ("H1" in cm): 5
Enter the second water Head Height ("H2" in cm): 10

Enter the Borehole Radius ("a" in cm): 3

Enter the soil texture-structure category (enter one of the below numbers): 4

1. Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.
2. Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands
3. Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.
4. Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macropores, etc

α^* = 0.36 cm^{-1}

Steady State Rate of Water Level Change ("R1" in cm/min): 4.4500

Steady State Rate of Water Level Change ("R2" in cm/min): 5.3000

1.95

Q_1 = 0.1602

Q_2 = 0.1908

C = 0.80315

C_1 = 1.28754

G_1 = 0.00496

G_2 = 0.00397

G_3 = 0.05569

G_4 = 0.02415

K_s = ####### cm/sec
####### cm/min
####### m/sec
####### inch/min
####### inch/sec

Φ_m = 4.31E-03 cm^2/sec

Calculation formulas related to shape factor (C). Where H_1 is the first water head height (cm), H_2 is the second water head height (cm), a is borehole radius (cm), and α^* is macroscopic capillary length factor which is decided according to the soil texture-structure category. For one head method, only C_1 needs to be calculated while for two head method, C_1 and C_2 are calculated (Zhang et al, 1995).

Soil Texture-Structure Category	α^* (cm^{-1})	Shape Factor
Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.	0.01	$C_1 = \left(\frac{H_1/a}{2.102 + 0.118(H_1/a)}\right)$ (cm) $C_2 = \left(\frac{H_2/a}{2.102 + 0.118(H_2/a)}\right)$ (cm)
Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.	0.04	$C_1 = \left(\frac{H_1/a}{1.992 + 0.091(H_1/a)}\right)$ (cm) $C_2 = \left(\frac{H_2/a}{1.992 + 0.091(H_2/a)}\right)$ (cm)
Most structured soils from clays through loams, also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils	0.12	$C_1 = \left(\frac{H_1/a}{2.074 + 0.093(H_1/a)}\right)$ (cm) $C_2 = \left(\frac{H_2/a}{2.074 + 0.093(H_2/a)}\right)$ (cm)
Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macro pores, etc.	0.36	$C_1 = \left(\frac{H_1/a}{2.074 + 0.093(H_1/a)}\right)$ (cm) $C_2 = \left(\frac{H_2/a}{2.074 + 0.093(H_2/a)}\right)$ (cm)

Calculation formulas related to one-head and two-head methods. Where R is steady-state rate of fall of water in reservoir (cm/s), K_{fs} is Soil saturated hydraulic conductivity (cm/s), Φ_m is Soil matric flux potential (cm^2/s), α^* is Macroscopic capillary length parameter (from Table 2), a is Borehole radius (cm), H_1 is the first head of water established in borehole (cm), H_2 is the second head of water established in borehole (cm) and C is Shape factor (from Table 2).

One Head, Combined Reservoir	$Q_1 = R_1 \times 35.22$	$K_{fs} = \frac{C_1 \times Q_1}{2\pi H_1^2 + \pi a^2 C_1 + 2\pi\left(\frac{H_1}{\alpha^*}\right)}$ $\Phi_m = \frac{C_1 \times Q_1}{(2\pi H_1^2 + \pi a^2 C_1)\alpha^* + 2\pi H_1}$
One Head, Inner Reservoir	$Q_1 = \bar{R}_1 \times 2.16$	
Two Head, Combined Reservoir	$Q_1 = \bar{R}_1 \times 35.22$ $Q_2 = \bar{R}_2 \times 35.22$	$G_1 = \frac{H_2 C_1}{2(H_1 H_2(H_2 - H_1) + \alpha^{*2} H_1 C_2 - H_2 C_1)}$ $G_2 = \frac{H_1 C_2}{2(H_1 H_2(H_2 - H_1) + \alpha^{*2} H_2 C_2 - H_1 C_1)}$ $K_{fs} = G_1 Q_2 - G_2 Q_1$ $G_3 = \frac{(2H_2^2 + \alpha^{*2} C_2) C_1}{2\pi(2H_1 H_2^2(H_2 - H_1) + \alpha^{*2} H_1 C_2 - H_2 C_1)}$ $G_4 = \frac{(2H_1^2 + \alpha^{*2} C_1) C_2}{2\pi(2H_1 H_2^2(H_2 - H_1) + \alpha^{*2} H_2 C_2 - H_1 C_1)}$ $\Phi_m = G_3 Q_2 - G_4 Q_1$
Two Head, Inner Reservoir	$Q_1 = \bar{R}_1 \times 2.16$ $Q_2 = \bar{R}_2 \times 2.16$	

Guelph Permeameter Data Sheet

Investigator: [illegible] Date: 6/16/21

Location: [illegible] Test Id: [illegible]

Depth of hole: 40" Radius: [illegible] (standard calcs assume 3 cm radius)

Reservoirs used during test (check one): Combined: ✓ Inner only: _____

Reservoir constant used: 35.22

Water level in well = 5 cm				
Time t (min)	Dt (min)	Water level in reservoir h (cm)	Dh (cm)	Rate of change Dh/ Dt
0		30		
1:37	0.65	25	5	7.7
1:45	0.93	30	5	5.1
2:21	[illegible]	[illegible]	5	5.1
3:40	1.10	[illegible]	5	4.5
[illegible]	1.03	[illegible]	5	4.8
[illegible]	1.10	50	5	4.5
7:00	1.20	55	5	4.2
8:00	1.13	60	5	4.4
9:15	1.13	65	5	4.3
10:14	[illegible]	70	5	3.9
[illegible]	[illegible]	[illegible]	[illegible]	4.1
Steady rate for 3 consecutive readings (R_1):				4.45

Water level in well = 10 cm				
Time t (min)	Dt (min)	Water level in reservoir h (cm)	Dh (cm)	Rate of change Dh/ Dt
0		17		
1:33	0.55	20	3	5.5
1:38	0.92	25	5	5.5
2:25	0.95	30	5	5.3
3:18	0.88	35	5	5.7
4:16	[illegible]	40	5	5.2
5:12	0.93	45	5	5.4
6:06	[illegible]	50	5	5.1
7:02	[illegible]	55	5	5.4
8:07	[illegible]	60	5	5.2
9:08	0.97	65	5	5.3
[illegible]	0.95	70	5	5.2
10:51	0.93	75	5	5.4
Steady rate for 3 consecutive readings (R_2):				5.3

Comments:

K_s = 0.149 in/min = 3.94 in/hr

GP FIELD DATA SHEET

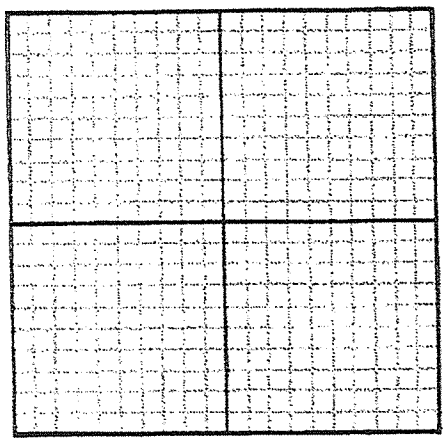
SECTION 1: SITE INFORMATION

Date _____ Investigator _____

Site Location _____

Dominant Soil Type(s) _____

Site Map:



Soil Profile Description (horizon depth, texture, structure, color, etc.):

Depth	Description
A	
B	
C	

Presence of special soil conditions (mottling, water table depth, hardpan, induration, compacted layers, etc.):

Comments and Notes (topography, slope, vegetation, etc.):

SOILMOISTURE EQUIPMENT CORP.
P.O. Box 30025, Santa Barbara, CA 93130 USA
Phone: 805-964-3525 - Fax: (805) 683-2189 - Email: sales@soilmoisture.com
Website: http://www.soilmoisture.com

SOILMOISTURE®

Guelph Permeameter Calculations

☐ Input

☐ Result

Suppert. a5@soilmoisture.com

Head #1

Reservoir Type (enter "1" for Combined and "2" for Inner reservoir): 1

Enter water Head Height ("H" in cm): 5

Enter the Borehole Radius ("a" in cm): 3

Enter the soil texture-structure category (enter one of the below numbers): 4

1 - Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.

2 - Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.

3 - Most structured soils from clays through loams; also includes unstructured medium and fine sands. This category most frequently applicable for agricultural soils.

4 - Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macropores, etc.

Steady State Rate of Water Level Change ("R" in cm/min): 15.8000

α^* = 0.36 cm^{-1}

C_1 = 0.80315

C_2 = 9.2746

K_{fs} = 2.79E-02 cm/sec
####### cm/min
2.79E-04 m/sec
6.69E-01 inch/min
1.10E-02 inch/sec

Φ_m = 7.75E-02 (cm^2/min)

Head #2

Reservoir Type (enter "1" for Combined and "2" for Inner reservoir): 1

Enter water Head Height ("H" in cm): 10

Enter the Borehole Radius ("a" in cm): 3

Enter the soil texture-structure category (enter one of the below numbers): 4

1 - Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.

2 - Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.

3 - Most structured soils from clays through loams; also includes unstructured medium and fine sands. This category most frequently applicable for agricultural soils.

4 - Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macropores, etc.

Steady State Rate of Water Level Change ("R" in cm/min): 16.7000

α^* = 0.36 cm^{-1}

C_1 = 1.28754

C_2 = 9.8029

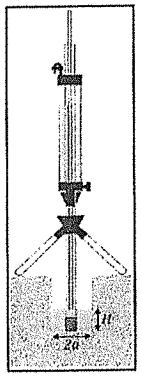
K_{fs} = 1.60E-02 cm/sec
9.02E-01 cm/min
1.60E-04 m/sec
3.56E-01 inch/min
5.92E-03 inch/sec

Φ_m = 4.16E-02 (cm^2/min)

Average

K_{fs} = 2.15E-02 cm/sec
1.29E+00 cm/min
2.15E-04 m/s
5.07E-01 inch/min
8.45E-03 inch/sec

Φ_m = 5.96E-02 (cm^2/min)



Two Head Method

Reservoir Type (enter "1" for Combined and "2" for Inner reservoir): 1

Enter the first water Head Height ("H1" in cm): 5

Enter the second water Head Height ("H2" in cm): 10

Enter the Borehole Radius ("a" in cm): 3

Enter the soil texture-structure category (enter one of the below numbers): 4

1 - Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.

2 - Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.

3 - Most structured soils from clays through loams; also includes unstructured medium and fine sands. This category most frequently applicable for agricultural soils.

4 - Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macropores, etc.

α^* = 0.36 cm^{-1}

Steady State Rate of Water Level Change ("R1" in cm/min): 16.8000

Steady State Rate of Water Level Change ("R2" in cm/min): 16.7000

1.95

Q_1 = 0.5688

Q_2 = 0.6012

C_1 = 0.80315

C_2 = 1.28754

G_1 = 0.00496

G_2 = 0.00397

G_3 = 0.05569

G_4 = 0.02415

K_{fs} = ####### cm/sec
####### cm/min
####### m/sec
####### inch/min
####### inch/sec

Φ_m = 1.72E-02 (cm^2/min)

Calculation formulas related to shape factor, C. Where H_1 is the first water head height (cm), H_2 is the second water head height (cm), a is borehole radius (cm), and α^* is macroscopic capillary length factor which is decided according to the soil texture-structure category. For one-head method, only C_1 needs to be calculated while for two-head method, C_1 and C_2 are calculated (Zang et al. 1994).

Soil Texture-Structure Category	α^* (cm^{-1})	Shape Factor
Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.	0.01	$C_1 = \left(\frac{H_1/a}{2.102 + 0.118(H_1/a)}\right)^{0.828}$ $C_2 = \left(\frac{H_2/a}{2.102 + 0.118(H_2/a)}\right)^{0.828}$
Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.	0.04	$C_1 = \left(\frac{H_1/a}{1.992 + 0.091(H_1/a)}\right)^{0.955}$ $C_2 = \left(\frac{H_2/a}{1.992 + 0.091(H_2/a)}\right)^{0.955}$
Most structured soils from clays through loams, also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.	0.12	$C_1 = \left(\frac{H_1/a}{2.074 + 0.093(H_1/a)}\right)^{0.934}$ $C_2 = \left(\frac{H_2/a}{2.074 + 0.093(H_2/a)}\right)^{0.934}$
Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macro pores, etc.	0.36	$C_1 = \left(\frac{H_1/a}{2.074 + 0.093(H_1/a)}\right)^{0.934}$ $C_2 = \left(\frac{H_2/a}{2.074 + 0.093(H_2/a)}\right)^{0.934}$

Calculation formulas related to one-head and two-head methods. Where R is steady-state rate of fall of water in reservoir (cm/s), K_{fs} is Soil saturated hydraulic conductivity (cm/s), Φ_m is Soil matric flux potential (cm²/s), α^* is Macroscopic capillary length parameter (from Table 2), a is Borehole radius (cm), H_1 is the first head of water established in borehole (cm), H_2 is the second head of water established in borehole (cm) and C is Shape factor (from Table 2).

One Head, Combined Reservoir	$Q_1 = \bar{R}_1 \times 35.22$	$K_{fs} = \frac{C_1 \times Q_1}{2\pi H_1^2 + \pi a^2 C_1 + 2\pi\left(\frac{H_1}{\alpha^*}\right)}$ $\Phi_m = \frac{C_1 \times Q_1}{(2\pi H_1^2 + \pi a^2 C_1)\alpha^* + 2\pi H_1}$
One Head, Inner Reservoir	$Q_1 = \bar{R}_1 \times 2.16$	
Two Head, Combined Reservoir	$Q_1 = \bar{R}_1 \times 35.22$ $Q_2 = \bar{R}_2 \times 35.22$	$G_1 = \frac{H_2 C_1}{\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$ $G_2 = \frac{H_1 C_2}{\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$ $K_{fs} = G_2Q_2 - G_1Q_1$ $G_3 = \frac{(2H_2^2 + a^2C_2)C_1}{2\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$ $G_4 = \frac{(2H_1^2 + a^2C_1)C_2}{2\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$ $\Phi_m = G_3Q_1 - G_4Q_2$
Two Head, Inner Reservoir	$Q_1 = \bar{R}_1 \times 2.16$ $Q_2 = \bar{R}_2 \times 2.16$	

Guelph Permeameter Data Sheet

Investigator: [illegible] Date: [illegible]

Location: [illegible] Test Id: [illegible]

Depth of hole: [illegible] Radius: [illegible] (standard calcs assume 3 cm radius)

Reservoirs used during test (check one): Combined: ✓ Inner only: _____

Reservoir constant used: [illegible]

Water level in well = 5 cm

Time t (min)	Dt (min)	Water level in reservoir h (cm)	Dh (cm)	Rate of change Dh/ Dt
0		[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1:12	0.3	40	5	16.7
[illegible]	[illegible]	45	5	16.7
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	55	5	15.3
[illegible]	[illegible]	60	5	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	17.6
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	15.3

Steady rate for 3 consecutive readings (R_1): 15.3

Water level in well = 10 cm

Time t (min)	Dt (min)	Water level in reservoir h (cm)	Dh (cm)	Rate of change Dh/ Dt
[illegible]		20		
[illegible]	0.15	[illegible]	5	[illegible]
[illegible]	[illegible]	[illegible]	5	[illegible]
1:17	0.3	[illegible]	5	16.7
1:02	0.32	40	5	15.6
[illegible]	[illegible]	45	[illegible]	16.3
[illegible]	[illegible]	50	5	16.0
1:5	0.28	55	5	[illegible]
[illegible]	[illegible]	60	5	15.0
[illegible]	[illegible]	[illegible]	5	[illegible]
[illegible]	[illegible]	[illegible]	5	15.3
2:10	[illegible]	[illegible]	5	[illegible]

Steady rate for 3 consecutive readings (R_2): 16.7

Comments:

[illegible]

GP FIELD DATA SHEET

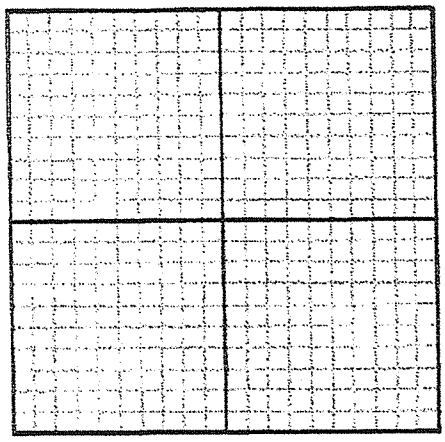
SECTION 1: SITE INFORMATION

Date _____ Investigator _____

Site Location _____

Dominant Soil Type(s) _____

Site Map:



Soil Profile Description (horizon depth, texture, structure, color, etc.):

Depth	Description
7"	A
	B
20"	
	C
72"	

Presence of special soil conditions (mottling, water table depth, hardpan, induration, compacted layers, etc.):

Comments and Notes (topography, slope, vegetation, etc.):

SOILMOISTURE EQUIPMENT CORP.
P.O. Box 30025, Santa Barbara, CA 93130 USA
Phone: 805-964-3525 - Fax: (805) 683-2189 - Email: sales@soilmoisture.com
Website: http://www.soilmoisture.com

SOILMOISTURE®

Guelph Permeameter Calculations

☐ Input

☐ Result

Support: sf@soilmoisture.com

Head #1

Reservoir Type (enter "1" for Combined and "2" for inner reservoir): 1
Enter water Head Height ("H" in cm): 5
Enter the Borehole Radius ("a" in cm): 3

Enter the soil texture-structure category (enter one of the below numbers): 4

1 Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.

2 Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.

3 Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.

4 Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macropores, etc.

Steady State Rate of Water Level Change ("R" in cm/min): 23.3000

α = 0.36 (cm^{-1})

C_1 = 0.80315
Q = 13.6771

K_{fs} = 4.11E-02 cm/sec
####### cm/min
4.11E-04 m/sec
9.72E-01 inch/min
1.62E-02 inch/sec

Φ_m = 1.14E-01 (cm^2/sec)

Head #2

Reservoir Type (enter "1" for Combined and "2" for inner reservoir): 1
Enter water Head Height ("H" in cm): 10
Enter the Borehole Radius ("a" in cm): 3

Enter the soil texture-structure category (enter one of the below numbers): 4

1 Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.

2 Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.

3 Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.

4 Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macropores, etc.

Steady State Rate of Water Level Change ("R" in cm/min): 28.7000

α = 0.36 (cm^{-1})

C_1 = 1.26754
Q = 18.8469

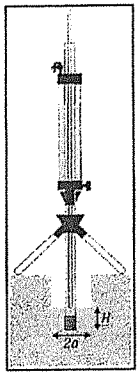
K_{fs} = 2.58E-02 cm/sec
####### cm/min
2.58E-04 m/sec
6.11E-01 inch/min
1.02E-02 inch/sec

Φ_m = 7.18E-02 (cm^2/sec)

Average

K_{fs} = 3.35E-02 cm/sec
2.01E+00 cm/min
3.35E-04 m/s
7.91E-01 inch/min
1.32E-02 inch/sec

Φ_m = 9.30E-02 (cm^2/sec)



Two Head Method

Reservoir Type (enter "1" for Combined and "2" for inner reservoir): 1

Enter the first water Head Height ("H1" in cm): 5
Enter the second water Head Height ("H2" in cm): 10

Enter the Borehole Radius ("a" in cm): 3

Enter the soil texture-structure category (enter one of the below numbers): 4

1 Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.

2 Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.

3 Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.

4 Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macropores, etc.

α = 0.36 (cm^{-1})

Steady State Rate of Water Level Change ("R1" in cm/min): 23.3000

Steady State Rate of Water Level Change ("R2" in cm/min): 28.7000

1.95

Q_1 = 0.8358

Q_2 = 1.0332

C_1 = 0.80315

C_2 = 1.26754

G_1 = 0.00490

G_2 = 0.00397

G_3 = 0.05569

H_1 = 0.02415

K_{fs} = ####### cm/sec
####### cm/min
####### m/sec
####### inch/min
####### inch/sec

Φ_m = 2.18E-02 (cm^2/sec)

Calculation formulas related to shape factor (C). Where H_1 is the first water head height (cm), H_2 is the second water head height (cm), a is borehole radius (cm), and α^* is a macroscopic capillary length factor which is decided according to the soil texture-structure category. For one head method, only C needs to be calculated while for two head method, C_1 and C_2 are calculated. (Zhang et al., 1996).

Soil Texture-Structure Category	α^* (cm^{-1})	Shape Factor
Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.	0.01	$C_1 = \left(\frac{H_1/a}{2.102 + 0.118(H_1/a)}\right)^{0.818}$ $C_2 = \left(\frac{H_2/a}{2.102 + 0.118(H_2/a)}\right)^{0.818}$
Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.	0.04	$C_1 = \left(\frac{H_1/a}{1.992 + 0.091(H_1/a)}\right)^{0.909}$ $C_2 = \left(\frac{H_2/a}{1.992 + 0.091(H_2/a)}\right)^{0.909}$
Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.	0.12	$C_1 = \left(\frac{H_1/a}{2.074 + 0.093(H_1/a)}\right)^{0.926}$ $C_2 = \left(\frac{H_2/a}{2.074 + 0.093(H_2/a)}\right)^{0.926}$
Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macro pores, etc.	0.36	$C_1 = \left(\frac{H_1/a}{2.074 + 0.093(H_1/a)}\right)^{0.926}$ $C_2 = \left(\frac{H_2/a}{2.074 + 0.093(H_2/a)}\right)^{0.926}$

Calculation formulas related to one-head and two-head methods. Where R is steady-state rate of fall of water in reservoir (cm/s), K_{fs} is Soil saturated hydraulic conductivity (cm/s), Φ_m is Soil matric flux potential (cm^2/s), α^* is Macroscopic capillary length parameter (from Table 2), a is Borehole radius (cm), H_1 is the first head of water established in borehole (cm), H_2 is the second head of water established in borehole (cm) and C is Shape factor (from Table 2).

One Head, Combined Reservoir	$Q_1 = \bar{R}_1 \times 35.22$	$K_{fs} = \frac{C_1 \times Q_1}{2\pi H_1^2 + \pi a^2 C_1 + 2\pi\left(\frac{H_1}{\alpha^*}\right)}$
One Head, Inner Reservoir	$Q_1 = \bar{R}_1 \times 2.16$	$\Phi_m = \frac{C_1 \times Q_1}{(2\pi H_1^2 + \pi a^2 C_1)\alpha^* + 2\pi H_1}$
Two Head, Combined Reservoir	$Q_1 = \bar{R}_1 \times 35.22$ $Q_2 = \bar{R}_2 \times 35.22$	$G_1 = \frac{H_1 C_1}{\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$ $G_2 = \frac{H_2 C_2}{\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$ $K_{fs} = G_2Q_2 - G_1Q_1$ $G_3 = \frac{(2H_1^2 + a^2C_1)C_2}{2\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$
Two Head, Inner Reservoir	$Q_1 = \bar{R}_1 \times 2.16$ $Q_2 = \bar{R}_2 \times 2.16$	$G_2 = \frac{(2H_2^2 + a^2C_2)C_1}{2\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$ $\Phi_m = G_1Q_1 - G_2Q_2$

GP FIELD DATA SHEET

SECTION 1: SITE INFORMATION

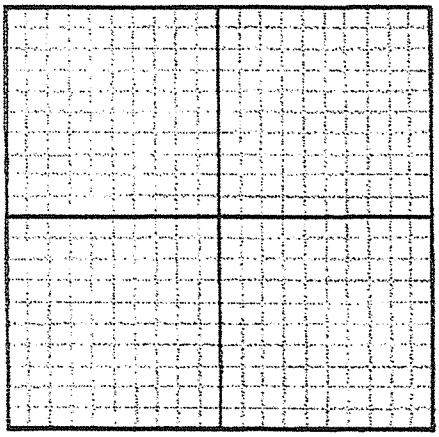
Date [illegible] Investigator [illegible]

Site Location [illegible] Francisco

Dominant Soil Type(s) [illegible]

Site Map:

P7-9



Soil Profile Description (horizon depth, texture, structure, color, etc.):

Depth	Description
6" A	SL-10YR [illegible]
E	SL-2.5YR 4/4
30"	
C	Sand & Gr-1 2.5Y 4/4
11'-11"	

Presence of special soil conditions (mottling, water table depth, hardpan, induration, compacted layers, etc.):

Comments and Notes (topography, slope, vegetation, etc.):

SOILMOISTURE EQUIPMENT CORP.
P.O. Box 30025, Santa Barbara, CA 93130 USA
Phone: 805-964-3525 - Fax: (805) 683-2189 - Email: sales@soilmoisture.com
Website: http://www.soilmoisture.com

SOILMOISTURE®

Guelph Permeameter Data Sheet

Investigator: [illegible] Date: [illegible]

Location: [illegible] Test Id: [illegible]

Depth of hole: [illegible] Radius: [illegible] (standard calcs assume 3 cm radius)

Reservoirs used during test (check one): Combined: ✓ Inner only: _____

Reservoir constant used: [illegible]

Water level in well = 5 cm

Time t (min)	Dt (min)	Water level in reservoir h (cm)	Dh (cm)	Rate of change Dh/ Dt
0		20		
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Steady rate for 3 consecutive readings (R_1): [illegible]

Water level in well = 10 cm

Time t (min)	Dt (min)	Water level in reservoir h (cm)	Dh (cm)	Rate of change Dh/ Dt
0		20		
[illegible]	0.08	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	5	[illegible]
[illegible]	[illegible]	[illegible]	5	33.5
[illegible]	[illegible]	[illegible]	5	[illegible]
[illegible]	[illegible]	[illegible]	5	[illegible]
[illegible]	[illegible]	[illegible]	5	[illegible]
[illegible]	0.18	[illegible]	5	[illegible]
[illegible]	[illegible]	[illegible]	5	[illegible]
[illegible]	[illegible]	[illegible]	5	[illegible]
[illegible]	[illegible]	[illegible]	5	[illegible]
[illegible]	[illegible]	[illegible]	5	[illegible]
[illegible]	[illegible]	[illegible]	5	[illegible]

Steady rate for 3 consecutive readings (R_2): 28.2

Comments:

[illegible]

Guelph Permeameter Calculations

Input

Result

Support: ali@soilmoisture.com

Head #1

Reservoir Type (enter "1" for Combined and "2" for Inner reservoir): 1
Enter water Head Height ("H" in cm): 5
Enter the Borehole Radius ("a" in cm): 3

Enter the soil texture-structure category (enter one of the below numbers): 4

1. Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.
2. Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.
3. Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.
4. Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macropors, etc

Steady State Rate of Water Level Change ("R" in cm/min): 7.6900

Reservoir Type: 35.22
H: 5
a: 3
R: 7.69
α^*: 0.36
C: 0.80315
Q: 4.51403
K_{fs}: ####### cm/sec
####### cm/min
####### m/sec
####### inch/min
####### inch/sec
Φ_m: ####### (cm^2/min)

Head #2

Reservoir Type (enter "1" for Combined and "2" for Inner reservoir): 1
Enter water Head Height ("H" in cm): 10
Enter the Borehole Radius ("a" in cm): 3

Enter the soil texture-structure category (enter one of the below numbers): 4

1. Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.
2. Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.
3. Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.
4. Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macropors, etc

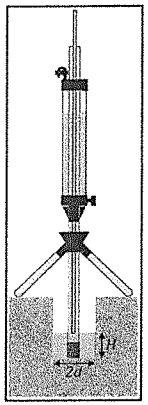
Steady State Rate of Water Level Change ("R" in cm/min): 18.7500

Reservoir Type: 35.22
H: 10
a: 3
R: 18.75
α^*: 0.36
C: 1.28754
Q: 11.0063
K_{fs}: ####### cm/sec
####### cm/min
####### m/ses
####### inch/min
####### inch/sec
Φ_m: ####### (cm^2/min)

Average

K_{fs} = 1.52E-02 cm/sec
9.14E-01 cm/min
1.52E-04 m/s
3.60E-01 inch/min
6.00E-03 inch/sec

Φ_m = 4.23E-02 (cm^2/min)



Two Head Method

Reservoir Type (enter "1" for Combined and "2" for Inner reservoir): 1

Enter the first water Head Height ("H1" in cm): 5
Enter the second water Head Height ("H2" in cm): 10

Enter the Borehole Radius ("a" in cm): 3

Enter the soil texture-structure category (enter one of the below numbers): 4

1. Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.
2. Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.
3. Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.
4. Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macropors, etc

α^* = 0.36 (cm^{-1})

Steady State Rate of Water Level Change ("R1" in cm/min): 7.6900

Steady State Rate of Water Level Change ("R2" in cm/min): 18.7500

Q_1 = 0.27684

Q_2 = 0.675

C_1 = 0.80315

C_2 = 1.28754

G_1 = 0.00496

G_2 = 0.00397

G_3 = 0.05569

G_4 = 0.02415

K_{fs} = ####### cm/sec
####### cm/min
####### m/sec
####### inch/min
####### inch/sec

Φ_m = ####### (cm^2/min)

Calculation formulas related to shape factor (C). Where H_1 is the first water head height (cm), H_2 is the second water head height (cm), a is borehole radius (cm) and α^* is microscopic capillary length factor which is decided according to the soil texture-structure category For one-head method, only C_1 needs to be calculated while for two-head method, C_1 and C_2 are calculated (Zang et al., 1998).

Soil Texture-Structure Category	α^* (cm^{-1})	Shape Factor
Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.	0.01	$C_1 = \left(\frac{H_1/a}{2.102 + 0.118(H_1/a)}\right)^{0.655}$ $C_2 = \left(\frac{H_2/a}{2.102 + 0.118(H_2/a)}\right)^{0.655}$
Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.	0.04	$C_1 = \left(\frac{H_1/a}{1.992 + 0.091(H_1/a)}\right)^{0.683}$ $C_2 = \left(\frac{H_2/a}{1.992 + 0.091(H_2/a)}\right)^{0.683}$
Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.	0.12	$C_1 = \left(\frac{H_1/a}{2.074 + 0.093(H_1/a)}\right)^{0.714}$ $C_2 = \left(\frac{H_2/a}{2.074 + 0.093(H_2/a)}\right)^{0.714}$
Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macro pores, etc.	0.36	$C_1 = \left(\frac{H_1/a}{2.074 + 0.093(H_1/a)}\right)^{0.714}$ $C_2 = \left(\frac{H_2/a}{2.074 + 0.093(H_2/a)}\right)^{0.714}$

Calculation formulas related to one-head and two-head methods. Where R is steady-state rate of fall of water in reservoir (cm/s), K_{fs} is Soil saturated hydraulic conductivity (cm/s), Φ_m is Soil matric flux potential (cm^2/s), α^* is Macroscopic capillary length parameter (from Table 2), a is Borehole radius (cm), H_1 is the first head of water established in borehole (cm), H_2 is the second head of water established in borehole (cm) and C is Shape factor (from Table 2).

One Head, Combined Reservoir	$Q_1 = \bar{R}_1 \times 35.22$	$K_{fs} = \frac{C_1 \times Q_1}{2\pi H_1^2 + \pi a^2 C_1 + 2\pi\left(\frac{H_1}{\alpha^*}\right)}$ $\Phi_m = \frac{C_1 \times Q_1}{(2\pi H_1^2 + \pi a^2 C_1)\alpha^* + 2\pi H_1}$
One Head, Inner Reservoir	$Q_1 = \bar{R}_1 \times 2.16$	
Two Head, Combined Reservoir	$Q_1 = \bar{R}_1 \times 35.22$ $Q_2 = \bar{R}_2 \times 35.22$	$G_1 = \frac{H_2 C_1}{\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$ $G_2 = \frac{H_1 C_2}{\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$ $K_{fs} = G_2Q_2 - G_1Q_1$ $G_3 = \frac{(2H_2^2 + a^2C_2)C_1}{2\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$ $G_4 = \frac{(2H_1^2 + a^2C_1)C_2}{2\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$ $\Phi_m = G_3Q_1 - G_4Q_2$
Two Head, Inner Reservoir	$Q_1 = \bar{R}_1 \times 2.16$ $Q_2 = \bar{R}_2 \times 2.16$	

Guelph Permeameter Data Sheet

Investigator: CAO & RG Date: 8/23/21

Location: WASHINGTON & FRANKLIN Test Id: TP 10

Depth of hole: 42" Radius: 3 cm (standard calcs assume 3 cm radius)

Reservoirs used during test (check one): Combined: ✓ Inner only: _____

Reservoir constant used: 35.22

Water level in well = 5 cm

Time t (min)	Dt (min)	Water level in reservoir h (cm)	Dh (cm)	Rate of change Dh/ Dt
0		21		
0:25	0.42	25	4	9.60
1:02	0.62	30	5	8.11
1:40	0.63	35	5	7.89
2:59	1.32	45	10	7.58
3:38	0.65	50	5	7.69
4:18	0.65	55	5	7.69
5:01	0.72	60	5	6.98
5:33	0.53	65	5	9.38
6:15	0.70	70	5	7.14
6:52	0.62	75	5	8.11

Steady rate for 3 consecutive readings (R_1): 7.69

Water level in well = 10 cm

Time t (min)	Dt (min)	Water level in reservoir h (cm)	Dh (cm)	Rate of change Dh/ Dt
0		30		
0:41	0.68	45	15	21.95
0:58	0.28	50	5	17.65
1:13	0.25	55	5	20.00
1:30	0.28	60	5	17.65
1:46	0.27	65	5	18.75
2:02	0.27	70	5	18.75
2:20	0.30	75	5	16.67

Steady rate for 3 consecutive readings (R_2): 18.75

Comments:

K_s = 0.36 in/min = 21.6 in/hr

GP FIELD DATA SHEET

SECTION 1: SITE INFORMATION

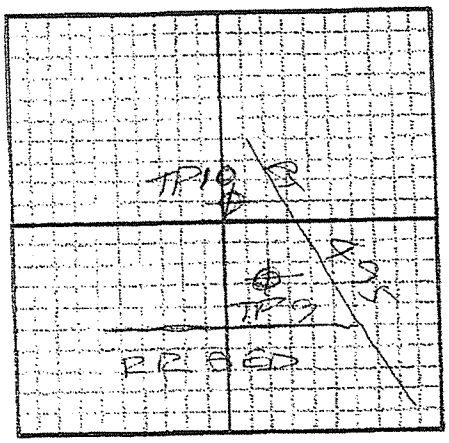
Date 11/23/21 Investigator CARLOS QUINTAL & RICK GOODREAU

Site Location 304 WASHINGTON ST. - FRANKLIN

Dominant Soil Type(s) HINKLEY LOAMY SAND

Site Map: TP-10

Soil Profile Description (horizon depth, texture, structure, color, etc.):



Depth	Description
A	TOP SOIL
6"	
B	SUBSOIL
40"	
C1	S & GRAVEL
82"	
C2	L. S & G
124"	
	water @ 124"

Presence of special soil conditions (mottling, water table depth, hardpan, induration, compacted layers, etc.):

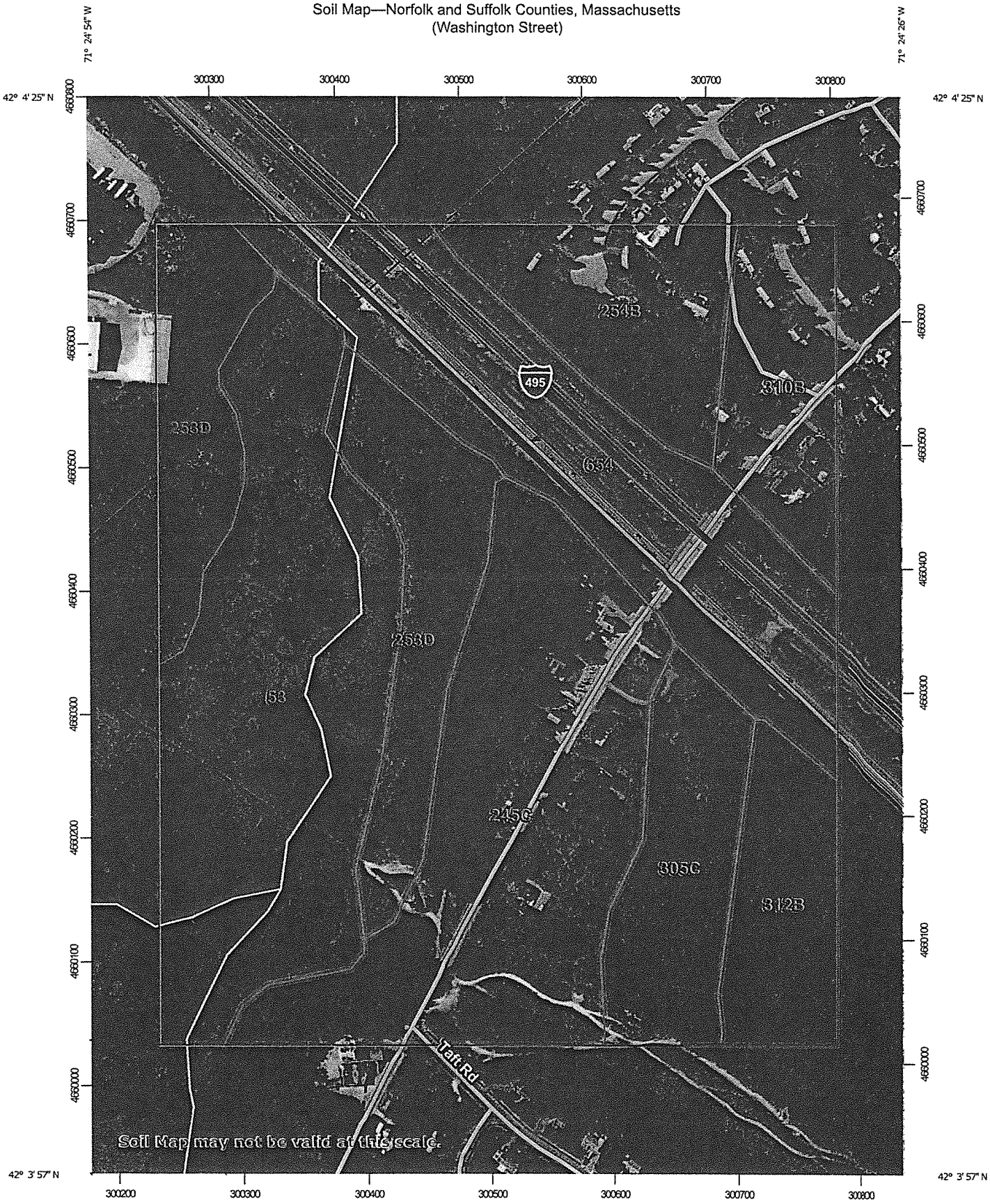
water standing @ 124"

Comments and Notes (topography, slope, vegetation, etc.):

SOILMOISTURE EQUIPMENT CORP.
P.O. Box 30025, Santa Barbara, CA 93130 USA
Phone: 805-964-3525 - Fax: (805) 683-2189 - Email: sales@soilmoisture.com
Website: http://www.soilmoisture.com

SOILMOISTURE

Soil Map—Norfolk and Suffolk Counties, Massachusetts
(Washington Street)



Map Scale: 1:4,250 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 50 100 200 300

Feet: 0 200 400 800 1200

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

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features

- Streams and Canals

Transportation

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

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:25,000.

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

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

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

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

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

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

Soil Survey Area: Norfolk and Suffolk Counties, Massachusetts
Survey Area Data: Version 16, Jun 11, 2020

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

Date(s) aerial images were photographed: Jul 5, 2019—Jul 8, 2019

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
53	Freetown muck, ponded, 0 to 1 percent slopes	20.1	22.2%
245C	Hinckley loamy sand, 8 to 15 percent slopes	19.0	21.0%
253D	Hinckley loamy sand, 15 to 35 percent slopes	12.1	13.4%
254B	Merrimac fine sandy loam, 3 to 8 percent slopes	6.8	7.5%
305C	Paxton fine sandy loam, 8 to 15 percent slopes	6.5	7.2%
310B	Woodbridge fine sandy loam, 3 to 8 percent slopes	5.7	6.3%
312B	Woodbridge fine sandy loam, 0 to 8 percent slopes, extremely stony	5.1	5.7%
654	Udorthents, loamy	15.1	16.7%
Totals for Area of Interest		**90.4**	**100.0%**

Norfolk and Suffolk Counties, Massachusetts

245C—Hinckley loamy sand, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2svm9
Elevation: 0 to 1,480 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Hinckley and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hinckley

Setting

Landform: Outwash deltas, kame terraces, outwash plains, kames, eskers, moraines, outwash terraces
Landform position (two-dimensional): Shoulder, toeslope, footslope, backslope
Landform position (three-dimensional): Nose slope, side slope, crest, head slope, riser
Down-slope shape: Convex, concave, linear
Across-slope shape: Concave, linear, convex
Parent material: Sandy and gravelly glaciofluvial deposits derived from gneiss and/or granite and/or schist

Typical profile

Oe - 0 to 1 inches: moderately decomposed plant material
A - 1 to 8 inches: loamy sand
Bw1 - 8 to 11 inches: gravelly loamy sand
Bw2 - 11 to 16 inches: gravelly loamy sand
BC - 16 to 19 inches: very gravelly loamy sand
C - 19 to 65 inches: very gravelly sand

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to very high (1.42 to 99.90 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water capacity: Low (about 3.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: A
Ecological site: F144AY022MA - Dry Outwash
Hydric soil rating: No

Minor Components

Merrimac

Percent of map unit: 5 percent
Landform: Eskers, moraines, outwash terraces, outwash plains, kames
Landform position (two-dimensional): Shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Side slope, head slope, nose slope, crest, riser
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Windsor

Percent of map unit: 5 percent
Landform: Moraines, kame terraces, outwash plains, outwash terraces, outwash deltas, kames, eskers
Landform position (two-dimensional): Shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Nose slope, side slope, crest, head slope, riser
Down-slope shape: Convex, linear, concave
Across-slope shape: Linear, convex, concave
Hydric soil rating: No

Sudbury

Percent of map unit: 5 percent
Landform: Outwash terraces, kame terraces, outwash plains, moraines, outwash deltas
Landform position (two-dimensional): Backslope, footslope
Landform position (three-dimensional): Base slope, tread
Down-slope shape: Concave, linear
Across-slope shape: Linear, concave
Hydric soil rating: No

Data Source Information

Soil Survey Area: Norfolk and Suffolk Counties, Massachusetts
Survey Area Data: Version 16, Jun 11, 2020

Norfolk and Suffolk Counties, Massachusetts

253D—Hinckley loamy sand, 15 to 35 percent slopes

Map Unit Setting

National map unit symbol: 2svmd
Elevation: 0 to 860 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Hinckley and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hinckley

Setting

Landform: Outwash plains, kames, eskers, moraines, outwash terraces, outwash deltas, kame terraces
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Crest, nose slope, side slope, head slope, riser
Down-slope shape: Concave, convex, linear
Across-slope shape: Linear, convex, concave
Parent material: Sandy and gravelly glaciofluvial deposits derived from gneiss and/or granite and/or schist

Typical profile

Oe - 0 to 1 inches: moderately decomposed plant material
A - 1 to 8 inches: loamy sand
Bw1 - 8 to 11 inches: gravelly loamy sand
Bw2 - 11 to 16 inches: gravelly loamy sand
BC - 16 to 19 inches: very gravelly loamy sand
C - 19 to 65 inches: very gravelly sand

Properties and qualities

Slope: 15 to 35 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to very high (1.42 to 99.90 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water capacity: Low (about 3.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: A
Ecological site: F144AY022MA - Dry Outwash
Hydric soil rating: No

Minor Components

Windsor

Percent of map unit: 10 percent
Landform: Moraines, kame terraces, outwash plains, outwash terraces, outwash deltas, kames, eskers
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Nose slope, crest, side slope, head slope, riser
Down-slope shape: Convex, linear, concave
Across-slope shape: Convex, linear, concave
Hydric soil rating: No

Merrimac

Percent of map unit: 3 percent
Landform: Kames, eskers, moraines, outwash terraces, outwash plains, kame terraces
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope, crest, head slope, nose slope, riser
Down-slope shape: Convex, concave, linear
Across-slope shape: Concave, convex, linear
Hydric soil rating: No

Sudbury

Percent of map unit: 2 percent
Landform: Moraines, outwash terraces, kame terraces, outwash plains, outwash deltas
Landform position (two-dimensional): Backslope, footslope, toeslope
Landform position (three-dimensional): Base slope, tread
Down-slope shape: Linear, concave
Across-slope shape: Concave, linear
Hydric soil rating: No

Data Source Information

Soil Survey Area: Norfolk and Suffolk Counties, Massachusetts
Survey Area Data: Version 16, Jun 11, 2020

APPENDIX G

Hydrograph for Pond 1P: POND 1 (continued)

Time (hours)	Inflow (cfs)	Storage (acre-feet)	Elevation (feet)	Outflow (cfs)	Discarded (cfs)	Primary (cfs)
23.60	0.08	0.000	249.81	0.08	0.08	0.00
23.70	0.08	0.000	249.81	0.08	0.08	0.00
23.80	0.08	0.000	249.81	0.08	0.08	0.00
23.90	0.08	0.000	249.81	0.08	0.08	0.00
24.00	0.08	0.000	249.81	0.08	0.08	0.00
24.10	0.04	0.000	249.80	0.05	0.05	0.00
24.20	0.01	0.000	249.80	0.01	0.01	0.00
24.30	0.00	0.000	249.80	0.00	0.00	0.00
24.40	0.00	0.000	249.80	0.00	0.00	0.00
24.50	0.00	0.000	249.80	0.00	0.00	0.00
24.60	0.00	0.000	249.80	0.00	0.00	0.00
24.70	0.00	0.000	249.80	0.00	0.00	0.00
24.80	0.00	0.000	249.80	0.00	0.00	0.00
24.90	0.00	0.000	249.80	0.00	0.00	0.00
25.00	0.00	0.000	249.80	0.00	0.00	0.00
25.10	0.00	0.000	249.80	0.00	0.00	0.00
25.20	0.00	0.000	249.80	0.00	0.00	0.00
25.30	0.00	0.000	249.80	0.00	0.00	0.00
25.40	0.00	0.000	249.80	0.00	0.00	0.00
25.50	0.00	0.000	249.80	0.00	0.00	0.00
25.60	0.00	0.000	249.80	0.00	0.00	0.00
25.70	0.00	0.000	249.80	0.00	0.00	0.00
25.80	0.00	0.000	249.80	0.00	0.00	0.00
25.90	0.00	0.000	249.80	0.00	0.00	0.00
26.00	0.00	0.000	249.80	0.00	0.00	0.00
26.10	0.00	0.000	249.80	0.00	0.00	0.00
26.20	0.00	0.000	249.80	0.00	0.00	0.00
26.30	0.00	0.000	249.80	0.00	0.00	0.00
26.40	0.00	0.000	249.80	0.00	0.00	0.00
26.50	0.00	0.000	249.80	0.00	0.00	0.00
26.60	0.00	0.000	249.80	0.00	0.00	0.00
26.70	0.00	0.000	249.80	0.00	0.00	0.00
26.80	0.00	0.000	249.80	0.00	0.00	0.00
26.90	0.00	0.000	249.80	0.00	0.00	0.00
27.00	0.00	0.000	249.80	0.00	0.00	0.00
27.10	0.00	0.000	249.80	0.00	0.00	0.00
27.20	0.00	0.000	249.80	0.00	0.00	0.00
27.30	0.00	0.000	249.80	0.00	0.00	0.00
27.40	0.00	0.000	249.80	0.00	0.00	0.00
27.50	0.00	0.000	249.80	0.00	0.00	0.00
27.60	0.00	0.000	249.80	0.00	0.00	0.00
27.70	0.00	0.000	249.80	0.00	0.00	0.00
27.80	0.00	0.000	249.80	0.00	0.00	0.00
27.90	0.00	0.000	249.80	0.00	0.00	0.00
28.00	0.00	0.000	249.80	0.00	0.00	0.00
28.10	0.00	0.000	249.80	0.00	0.00	0.00
28.20	0.00	0.000	249.80	0.00	0.00	0.00
28.30	0.00	0.000	249.80	0.00	0.00	0.00
28.40	0.00	0.000	249.80	0.00	0.00	0.00
28.50	0.00	0.000	249.80	0.00	0.00	0.00
28.60	0.00	0.000	249.80	0.00	0.00	0.00
28.70	0.00	0.000	249.80	0.00	0.00	0.00

Hydrograph for Pond 2P: POND 2 (continued)

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Outflow (cfs)	Discarded (cfs)	Primary (cfs)
23.60	0.24	15	247.16	0.24	0.24	0.00
23.70	0.24	15	247.16	0.24	0.24	0.00
23.80	0.23	15	247.16	0.23	0.23	0.00
23.90	0.23	14	247.16	0.23	0.23	0.00
24.00	0.23	14	247.16	0.23	0.23	0.00
24.10	0.14	10	247.15	0.16	0.16	0.00
24.20	0.03	3	247.15	0.05	0.05	0.00
24.30	0.00	0	247.15	0.00	0.00	0.00
24.40	0.00	0	247.15	0.00	0.00	0.00
24.50	0.00	0	247.15	0.00	0.00	0.00
24.60	0.00	0	247.15	0.00	0.00	0.00
24.70	0.00	0	247.15	0.00	0.00	0.00
24.80	0.00	0	247.15	0.00	0.00	0.00
24.90	0.00	0	247.15	0.00	0.00	0.00
25.00	0.00	0	247.15	0.00	0.00	0.00
25.10	0.00	0	247.15	0.00	0.00	0.00
25.20	0.00	0	247.15	0.00	0.00	0.00
25.30	0.00	0	247.15	0.00	0.00	0.00
25.40	0.00	0	247.15	0.00	0.00	0.00
25.50	0.00	0	247.15	0.00	0.00	0.00
25.60	0.00	0	247.15	0.00	0.00	0.00
25.70	0.00	0	247.15	0.00	0.00	0.00
25.80	0.00	0	247.15	0.00	0.00	0.00
25.90	0.00	0	247.15	0.00	0.00	0.00
26.00	0.00	0	247.15	0.00	0.00	0.00
26.10	0.00	0	247.15	0.00	0.00	0.00
26.20	0.00	0	247.15	0.00	0.00	0.00
26.30	0.00	0	247.15	0.00	0.00	0.00
26.40	0.00	0	247.15	0.00	0.00	0.00
26.50	0.00	0	247.15	0.00	0.00	0.00
26.60	0.00	0	247.15	0.00	0.00	0.00
26.70	0.00	0	247.15	0.00	0.00	0.00
26.80	0.00	0	247.15	0.00	0.00	0.00
26.90	0.00	0	247.15	0.00	0.00	0.00
27.00	0.00	0	247.15	0.00	0.00	0.00
27.10	0.00	0	247.15	0.00	0.00	0.00
27.20	0.00	0	247.15	0.00	0.00	0.00
27.30	0.00	0	247.15	0.00	0.00	0.00
27.40	0.00	0	247.15	0.00	0.00	0.00
27.50	0.00	0	247.15	0.00	0.00	0.00
27.60	0.00	0	247.15	0.00	0.00	0.00
27.70	0.00	0	247.15	0.00	0.00	0.00
27.80	0.00	0	247.15	0.00	0.00	0.00
27.90	0.00	0	247.15	0.00	0.00	0.00
28.00	0.00	0	247.15	0.00	0.00	0.00
28.10	0.00	0	247.15	0.00	0.00	0.00
28.20	0.00	0	247.15	0.00	0.00	0.00
28.30	0.00	0	247.15	0.00	0.00	0.00
28.40	0.00	0	247.15	0.00	0.00	0.00
28.50	0.00	0	247.15	0.00	0.00	0.00
28.60	0.00	0	247.15	0.00	0.00	0.00
28.70	0.00	0	247.15	0.00	0.00	0.00

Hydrograph for Pond 3P: POND 2 (continued)

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Outflow (cfs)	Discarded (cfs)	Primary (cfs)
23.60	0.05	4	248.11	0.05	0.05	0.00
23.70	0.05	4	248.11	0.05	0.05	0.00
23.80	0.05	4	248.11	0.05	0.05	0.00
23.90	0.05	4	248.11	0.05	0.05	0.00
24.00	0.05	4	248.10	0.05	0.05	0.00
24.10	0.02	2	248.10	0.03	0.03	0.00
24.20	0.00	0	248.10	0.00	0.00	0.00
24.30	0.00	0	248.10	0.00	0.00	0.00
24.40	0.00	0	248.10	0.00	0.00	0.00
24.50	0.00	0	248.10	0.00	0.00	0.00
24.60	0.00	0	248.10	0.00	0.00	0.00
24.70	0.00	0	248.10	0.00	0.00	0.00
24.80	0.00	0	248.10	0.00	0.00	0.00
24.90	0.00	0	248.10	0.00	0.00	0.00
25.00	0.00	0	248.10	0.00	0.00	0.00
25.10	0.00	0	248.10	0.00	0.00	0.00
25.20	0.00	0	248.10	0.00	0.00	0.00
25.30	0.00	0	248.10	0.00	0.00	0.00
25.40	0.00	0	248.10	0.00	0.00	0.00
25.50	0.00	0	248.10	0.00	0.00	0.00
25.60	0.00	0	248.10	0.00	0.00	0.00
25.70	0.00	0	248.10	0.00	0.00	0.00
25.80	0.00	0	248.10	0.00	0.00	0.00
25.90	0.00	0	248.10	0.00	0.00	0.00
26.00	0.00	0	248.10	0.00	0.00	0.00
26.10	0.00	0	248.10	0.00	0.00	0.00
26.20	0.00	0	248.10	0.00	0.00	0.00
26.30	0.00	0	248.10	0.00	0.00	0.00
26.40	0.00	0	248.10	0.00	0.00	0.00
26.50	0.00	0	248.10	0.00	0.00	0.00
26.60	0.00	0	248.10	0.00	0.00	0.00
26.70	0.00	0	248.10	0.00	0.00	0.00
26.80	0.00	0	248.10	0.00	0.00	0.00
26.90	0.00	0	248.10	0.00	0.00	0.00
27.00	0.00	0	248.10	0.00	0.00	0.00
27.10	0.00	0	248.10	0.00	0.00	0.00
27.20	0.00	0	248.10	0.00	0.00	0.00
27.30	0.00	0	248.10	0.00	0.00	0.00
27.40	0.00	0	248.10	0.00	0.00	0.00
27.50	0.00	0	248.10	0.00	0.00	0.00
27.60	0.00	0	248.10	0.00	0.00	0.00
27.70	0.00	0	248.10	0.00	0.00	0.00
27.80	0.00	0	248.10	0.00	0.00	0.00
27.90	0.00	0	248.10	0.00	0.00	0.00
28.00	0.00	0	248.10	0.00	0.00	0.00
28.10	0.00	0	248.10	0.00	0.00	0.00
28.20	0.00	0	248.10	0.00	0.00	0.00
28.30	0.00	0	248.10	0.00	0.00	0.00
28.40	0.00	0	248.10	0.00	0.00	0.00
28.50	0.00	0	248.10	0.00	0.00	0.00
28.60	0.00	0	248.10	0.00	0.00	0.00
28.70	0.00	0	248.10	0.00	0.00	0.00

APPENDIX H

CHECKLIST FOR DESIGNERS

Site Planning

Checklist for Designers

GOALS and NEEDS addressed:

1. Create a visually appealing community
2. Stabilize and increase property values
3. Encourage low impact development
4. Preserve the Town's historic and cultural heritage
5. Protect Franklin's natural environment, including habitat, water resources, and ecosystem services

FRANKLIN POLICY:
Subdivision plans and site plans for all forms of development shall adhere to the principles of environmental and aesthetic compatibility and energy-efficient design.

BEST DEVELOPMENT PRACTICES The site plan should be designed to address the following to the maximum extent practicable	Incorporated into Project?
Unique natural features have been preserved *(the development program should either avoid altering or showcase significant natural features)*	☐ n/a
Native vegetation planted in disturbed areas as needed to enhance or restore habitat	☑
Historic and cultural resources have been preserved *(the development program should either avoid altering or showcase significant historic and cultural features)*	☐ n/a
Clearing, grading, and building placement consider viewsheds	☑
Cut and fill have been minimized	☑
Buildings blend into the natural topography	☑
Buildings are oriented to the sun and wind for maximum energy efficiency *Vegetated protection from northwest (winter) winds is provided* *Deciduous species planted or retained close to the East, South and West building edges*	☑
Conforms to §185-31 of the Town of Franklin Zoning Code and/ or Chapter 300 of the Town of Franklin Subdivision Regulations	☑

w/ waiver requests

GOALS and NEEDS addressed:

1. Protect local and regional wetlands and water bodies
2. Maximize groundwater recharge to retain a viable local groundwater supply
3. Minimize pollutants in stormwater runoff

FRANKLIN POLICIES:

(A) All new development and redevelopment projects in Franklin shall meet the following stormwater management performance standards.

i. Post-development peak discharge rates and volumes from the site shall not exceed pre-development peak discharge rates and volumes from the site.

ii. The stormwater management system shall remove at least 80% of the average annual load of total suspended solids (TSS), at least 80% of the phosphorus loading, and at least 60% of nitrogen loading from the post-development stormwater created on site.

iii. All drainage facilities proposed shall utilize best management practices as outlined in the Massachusetts Stormwater Management Standards.

iv. All sites will have an Operation and Maintenance plan to insure future compliance.

(B) Non-structural stormwater management systems should be used wherever site conditions allow.

BEST DEVELOPMENT PRACTICES The site plan should be designed to address the following to the maximum extent practicable	Incorporated into Project?
Vegetated swales *(recommended to convey runoff from roadways & parking lots)*	☐
Vegetated filter strips *(recommended to filter and infiltrate runoff from roadways, parking lots, and driveways; use along roadsides and parking lots)*	☐
Constructed wetlands *(preferred method for stormwater retention & pollutant removal)*	☐
Bioretention cells *(rain gardens) (recommended on residential lots and parking lot islands)*	☐
Pervious paving surfaces *(recommended in overflow parking and low-traffic areas)*	☐
Sediment Forebays *(use in combination with other BDP)*	☐
Roof gardens *(encouraged on flat or gently sloped commercial and industrial rooftops)*	☐
Retention/Detention basins *(may be used in series with other practices to provide pre-treatment)*	☐
Recharge Systems *(suitable for all areas of development)*	☐
Drain pipe/catch basin systems *(as required to collect runoff when other systems are not practical)*	☐
If utilizing drain pipe and/or catch basin systems, have you documented that other systems are infeasible?	☐

Erosion and Sedimentation Control

Checklist for Designers

GOALS and NEEDS addressed:

1. Minimize clearing and regrading;
2. Prevent erosion and sedimentation.

FRANKLIN POLICIES:

(A) Any proposed project on a previously undeveloped site shall accommodate the development program in a way that minimizes clearing and re-grading, especially in areas of steep slopes, erosion-prone soils, or sensitive vegetation. For redevelopment projects, the site plan shall concentrate development in previously-disturbed areas to the extent possible.

(B) As a condition of approval, every proposed project shall submit and adhere to an erosion control plan that addresses soil stabilization, sediment retention, perimeter protection, construction scheduling, traffic area stabilization and dust control.

(C) If the proposed project is in an area under conservation jurisdiction, the project will require permitting deemed appropriate by the Conservation Commission.

BEST DEVELOPMENT PRACTICES The site plan should be designed to address the following to the maximum extent practicable.	Incorporated intoProject?
Clearing and re-grading have been minimized	☐ ✓
Plan identifies sensitive areas to be protected and areas that are suitable for development	☐ ✓
Conservation Permits have been obtained *(when applicable)*	☐ ✓
The erosion and sedimentation control plan addresses:	
• **Soil stabilization** *(cover or stabilize erodible surfaces not in immediate use)*	☐ ✓
• **Sediment retention** *(runoff interceptors and sediment traps/ponds)*	☐ ✓
• **Perimeter protection** *(vegetated buffers, compost socks or straw wattles at limit of work)*	☐ ✓
• **Construction scheduling** *(minimize disturbed area at any given time)*	☐ ✓
• **Traffic area stabilization** *(crushed rock or similar at construction vehicle entrance and parking areas)*	☐ ✓
• **Dust control** *(plan for stabilizing dry, dust-prone surfaces when necessary)*	☐ ✓
• **Vegetation** *(preserve existing vegetation and/or identify areas to be revegetated including proposed planting species, quantity and planting specifications)*	☐ ✓

Landscape Design

Checklist for Designers

GOALS and NEEDS addressed:

1. Stabilize water use at a sustainable level
2. Create landscapes that minimize habitat destruction and maximize habitat value
3. Encourage the development of landscapes that provide environmental quality and visual relief through the planting of native or naturalized species

FRANKLIN POLICIES:

(A) Site plans and landscape plans for all proposed projects shall take appropriate steps, as outlined in the Guidebook, to minimize water use for irrigation and to allow for natural recharge of groundwater. Landscape plans shall follow the guidelines in the Guidebook for selecting species that are most appropriate to the site conditions.

(B) Native and habitat-creating species shall be used in all landscape plans to the maximum extent possible while still meeting the site's landscaping needs. Invasive species may not be planted in Franklin under any condition. Refer to the Massachusetts Prohibited Plant list for more information.

(C) Actively promote the Town of Franklin's Water Conservation Measures.

BEST DEVELOPMENT PRACTICES The site plan must address all of the following principles.	Incorporated into Project?
Retain and Recharge water on site *(install bio-retention cells, vegetated filter strips and minimize lawn areas where feasible)*	☐ ✓
Preserve natural vegetation to the maximum extent practicable	☐ ✓
Irrigation system is water efficient *(if an in-ground irrigation system is proposed, it is a water efficient system with timers and automatic sensors to prevent overwatering)*	☐ N/A
Preserve soil permeability *(minimize disturbing existing landscapes. Prepare new planting beds in accordance to the Planting Bed Guidelines on p. 13, and install 1-2" of shredded pine bark mulch on new planting areas)*	☐ ✓
Minimize the use of turf grass *(when applicable, reduce the size of the lawn area; instead, plant a bio-retention cell, use alternative, drought tolerant groundcover)*	☐ ✓
Specify variety of native and naturalized species *(species from the plant list have been incorporated into the landscape design, and no invasive species are used. Refer to the Plant Species Section and the Massachusetts Prohibited Plant List)*	☐ ✓
Species are appropriate to the soil, site, and microclimate conditions *(select appropriate species from the plant list in this guidebook)*	☐ ✓

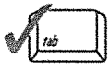
APPENDIX I

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

A. Introduction

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.



A Stormwater Report must be submitted with the Notice of Intent permit application to document compliance with the Stormwater Management Standards. The following checklist is NOT a substitute for the Stormwater Report (which should provide more substantive and detailed information) but is offered here as a tool to help the applicant organize their Stormwater Management documentation for their Report and for the reviewer to assess this information in a consistent format. 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 and certified by a Registered Professional Engineer (RPE) licensed in the Commonwealth.

The Stormwater Report must include:

- The Stormwater Checklist completed and stamped by a Registered Professional Engineer (see page 2) that certifies that the Stormwater Report contains all required submittals.[1] This Checklist is to be used as the cover for the completed Stormwater Report.
- 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[2]
- Operation and Maintenance Plan required by Standard 9

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

---

[1] 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.

[2] 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.

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

B. 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 for 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

COMMONWEALTH OF MASSACHUSETTS
CARLOS A. QUINTAL
CIVIL
No. 30812
REGISTERED PROFESSIONAL ENGINEER

12/3/21
Signature and Date

Checklist

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

Checklist (continued)

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 (describe): _____

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.

Checklist (continued)

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: Check the method used.

☒ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

☒ 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.

[1] 80% TSS removal is required prior to discharge to infiltration BMP if Dynamic Field method is used.

Checklist (continued)

Standard 3: Recharge (continued)

☐ 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;
- 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.

Checklist for Stormwater Report

Checklist (continued)

Standard 4: Water Quality (continued)

☒ 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.

Checklist (continued)

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.
- ☐ Small Residential Projects: 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.

Checklist (continued)

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control (continued)

☐ 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.

☐ 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 J

Operation and Maintenance Plan

Good House Keeping Measures

1. The parking area and driveway will receive the minimum amount of sand and salt. Snow will be stored at the locations shown on the site plan.
2. The site consists of mulch with trees, turf lawn, conservation and wildlife planting areas and existing wooded areas. These areas will be assessed by the owner's landscape professional to determine the minimum amounts of fertilizers, herbicides and pesticides necessary and shall only apply the minimums necessary.
3. The site will be stabilized with landscaped areas with mulch, conservation and wildlife areas and turf lawn. This will improve the existing site coverage.

Long Term Pollution Prevention Plan

The owner shall employ good housekeeping measures, which include removing trash and debris from the site, keeping trash in receptacles and complying with the long term operation and maintenance plan.
The owner does not plan to store materials or waste products on the site.
The owner will not allow vehicles to be washed on site.
The owner will have routine inspections and maintenance completed for the Storm-water BMP's. See sheet 6 for details and schedule.
The owner will hire a licensed company to deal with any spills that may occur on the site.
The owner will employ a landscape professional to determine and apply the minimum amounts of fertilizers, herbicides and pesticides.
The site is serviced by Town water.
An onsite septic system has been proposed which will be designed and installed in compliance with Title V.
Floor drains are proposed and will b connected to Industrial Waste Water Holding Tanks.
The owner will apply the minimum amount of sand and salt necessary. The parking area will be swept immediately following the last winter sanding.
Sand piles will not be stored on site.

Operation and Maintenance Plan

An operation and maintenance schedule for the construction period and the post-development period has been provided on sheet6.
During the construction period and after completion the Owner, shall be responsible for the operation and maintenance of the site and the drainage system.
Upon completion of the construction work the property owner shall be responsible for the maintenance of the drainage facilities.
The yearly estimated operation and maintenance budget is $4,500.00

Yearly Inspection and Maintenance Log

Page 1

Panther Way
Franklin, Massachusetts

Parking Lot Sweeping - Annually

Date: _____ Performed By: _____
Date: _____ Performed By: _____
Date: _____ Performed By: _____
Date: _____ Performed By: _____

Notes:

Catch Basin Sumps – Inspect 4 Times per year
Remove sediment when it reaches a depth of two feet.
Remove hydrocarbons and debris when discovered.

Date: _____ Performed By: _____
Date: _____ Performed By: _____
Date: _____ Performed By: _____
Date: _____ Performed By: _____

Notes:

CDS Units – Inspect 4 Times per year –
Remove sediment when it reaches 75% capacity in the isolation sump
Remove hydrocarbons and debris when discovered.

Date: _____ Performed By: _____
Date: _____ Performed By: _____
Date: _____ Performed By: _____
Date: _____ Performed By: _____

Date: _____ Performed By: _____
Date: _____ Performed By: _____
Date: _____ Performed By: _____
Date: _____ Performed By: _____

Notes:

Stormceptor – Inspect 4 Times per year
Remove sediment when it reaches a depth of eight inches.
Remove hydrocarbons and debris when discovered.

Date: _____ Performed By: _____
Date: _____ Performed By: _____
Date: _____ Performed By: _____
Date: _____ Performed By: _____

Notes:

Underground Pond 1 – 4 times per year
Maintenance

- Preventative Maintenance – twice a year
- Inspect to insure proper functioning – after major storm events for three months after completion of construction, twice per year thereafter and when there is a discharge through the high outlet.
- Inspect and clean pre-treatment devices – twice per year and after major storm events.

Date: _____ Performed By: _____
Date: _____ Performed By: _____
Date: _____ Performed By: _____
Date: _____ Performed By: _____

Notes:

Pond 2 – 4 times per year

- Maintenance Preventative Maintenance – twice a year
- Inspect to insure proper functioning – after major storm events for three months after completion of construction, twice per year thereafter and when there is a discharge through the high outlet.
- Mow the buffer area, side slopes, remove trash and debris, remove grass clippings and accumulated organic matter – twice per year
- Inspect and clean pre-treatment devices – twice per year and after major storm events.

Date: _____ Performed By: _____
Date: _____ Performed By: _____
Date: _____ Performed By: _____
Date: _____ Performed By: _____

Notes:

Pond 3 – 4 times per year

- Maintenance Preventative Maintenance – twice a year
- Inspect to insure proper functioning – after major storm events for three months after completion of construction, twice per year thereafter and when there is a discharge through the high outlet.
- Mow the buffer area, side slopes, remove trash and debris, remove grass clippings and accumulated organic matter – twice per year
- Inspect and clean pre-treatment devices – twice per year and after major storm events.

Date: _____ Performed By: _____
Date: _____ Performed By: _____
Date: _____ Performed By: _____
Date: _____ Performed By: _____

Notes:

Landscape Area Inspection – 4 times per year

Date: _____ Performed By: _____
Date: _____ Performed By: _____
Date: _____ Performed By: _____
Date: _____ Performed By: _____

Notes:

APPENDIX K

In Compliance with DEP Storm-water Management Standard 10

Washington Street – Franklin MA
Map 304 Parcel 64

No Illicit discharges to the storm-water management system, including wastewater discharges and discharges of storm-water contaminated by contact with process wastes, raw materials, toxic pollutants, hazardous substances, oil, or grease are proposed and shall not be allowed.

The site map located in Appendix I shall be part of this Illicit Discharge Compliance Statement.

Franklin Flex Space, LLC, owner, will be the responsible party.

Authorize Signatory
Franklin Flex Space, LLC,

In Compliance with DEP Storm-water Management Standard 10

Washington Street – Franklin MA
Map 304 Parcels 64 and 64-001

No Illicit discharges to the storm-water management system, including wastewater discharges and discharges of storm-water contaminated by contact with process wastes, raw materials, toxic pollutants, hazardous substances, oil, or grease are proposed and shall not be allowed.

The site map located in Appendix I shall be part of this Illicit Discharge Compliance Statement.

Franklin Flex Space, LLC, owner, will be the responsible party.

_____

Authorize Signatory
Franklin Flex Space, LLC,

APPENDIX L