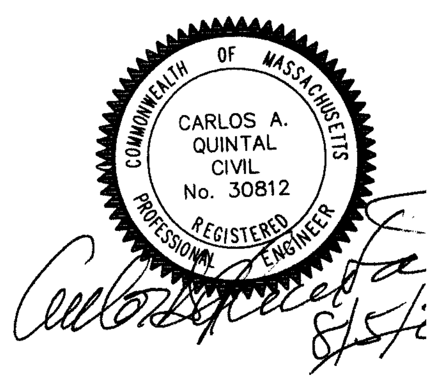
DRAINAGE ANALYSIS

FOR
Site Plan
Lot 2 Forge Parkway

LOCATED IN
FRANKLIN, MASSACHUSETTS

PREPARED FOR
Camford Property Group, LLC
138 East Central Street
Franklin, MA 02038



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DATE: July 7, 2025

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APPENDIX A

I. DESCRIPTION

This report is offered in support of the stormwater management system designed for the "Site Plan – Lot 2 Forge Parkway in Franklin, Massachusetts. The site currently consists of a 130,961 vacant lot located at the intersection of Forge Parkway and West Central Street. There is an active railroad line located to the south of the site. The Easterly boundary is bordered by a developed property with a building which is shown on the site plan. The site has a wetland system which has existing stormwater discharges from the Forge Park Development.
This project included the construction of a building with a footprint of 11,200 square feet building. Parking areas, utility connections and a stormwater system are proposed for the project.
The primary goals of the stormwater system are to collect the stormwater runoff generated from the proposed driveways, parking areas, and buildings. The stormwater will be directed to an infiltration pond. Infiltration Pond 1 is an underground infiltration area located north of the proposed building.
Both the pre-development and post-development conditions flowing offsite are summarized in Appendix B.

II. Purpose

The purpose of this report is to examine the hydrological and hydraulic aspects of the proposed Lot 2 Forge Parkway Site Plan. This report was developed for review by the Town of Franklin Planning Board and Conservation Commission 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, Franklin Conservation Commission and Mass DEP Storm Water Management Policies.

III. Pre-Development Conditions

The site currently consists of a 130,961 vacant lot located at the intersection of Forge Parkway and West Central Street. There is an active railroad line located to the south of the site. The Easterly boundary is bordered by a developed property with a building which is shown on the site plan. The site has a wetland system which has existing stormwater discharges from the Forge Park Development. The upland soils for the site were taken from the soil survey of Norfolk and Suffolk counties. The soils are mapped as Udorthents Loamy (HSG-A), Hollis Rock-Outcrop-Charlton Complex (Charlton - HSG-A) and Freetown Muck (HSG-B/D Note: HSG-B was used in the analysis) Refer to the site plan for the location and soil types. Soil testing was conducted on the site to determine soil types and permeability rates. See the soil logs and permeability test results located in Appendix F. Permeability test was completed on site and the results can be found in Appendix F.
Utilizing a Hydrocad computer model the pre-development and post development conditions were calculated. This included an analysis of the watershed utilizing a Hydrologic soil group A or B. 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 a commercial building and parking area. The proposed building will be accessed by private driveways and parking areas.
The driveways will be captured in catch basin style water quality units and then directed to the underground infiltration pond. The proposed infiltration system will promote groundwater re-charge as required by the Town of Franklin Stormwater Regulations. Municipal utility connections are also included in the project. The proposal is to service the buildings with town water and sewer. The project

design includes the construction of a single site entrance from Forge Parkway. A site driveway will provide access to the parking areas and the rear of the building will have overhead doors to provide access to the building.
TSS removal will be accomplished by a treatment train with catch basin type water quality units, and an infiltration pond. 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 in Appendix C. Post-development calculations are located in Appendix D.

V. Conclusion

Stormwater from the proposed parking areas and driveways will be captured by the catch basins type water quality units for TSS removal which will then be directed to the underground infiltration pond. Stormwater runoff from the existing undeveloped portion of the site which will not be altered, will flow to the existing wetland located on the site. The proposed roof will be captured and directed to an underground infiltration pond. The comparison in Appendix B summarizes the rate and volumes of runoff leaving the site in both the pre-development and post-development conditions.

VI. Stormwater Management Standards

Refer to Checklist for Stormwater Report in Appendix H

Town of Franklin Stormwater Management Bylaw – Chapter 153 – Bylaw Amendment 21-867

Impervious Coverage Entire Site site =

1" x 38,126 sq. ft. impervious = 3,177 cubic feet (Required)

Storage in Pond 1 below the outlet invert (206.63) = 12,841 cubic feet (Provided)

LID Measures

- No disturbance is proposed to any Wetland Resource Area.
- Existing Vegetation Removal within the buffer zone has been reduced to the extent practicable and mitigation plantings have been proposed.
-

Standard 1: No New Untreated Discharges
No new untreated discharges are proposed.
A stormwater system has been provided or is proposed which will provide the required TSS removal which includes the installation of water quality units and an infiltration basin.

Standard 2: Peak Rate Attenuation
The drainage system has been designed to match or 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 of this report for permeability test results and soil testing information. Additionally, soil testing results can be found on the plan sheets.

- Drawdown within 72 hours
  Pond 1 - Storage Volume below outlet = 12,841 cubic feet
  Time = (12,841) / (4.26"/hr x 1'/12" x 3,688 sf. = 9.81 hours < 72 hours
  See Stage Area-Storage table this appendix.

Standard 4: Water Quality

- The owner will be responsible for compliance with standard four requirements.
- Refer to the Operation and Maintenance Plan and the Storm-water Facilities Plan for the Inspection and Maintenance Schedule and the Operation and Maintenance Schedule.
- See Appendix E for the Manufactures TSS removal rate. The site is not located within a zone II. The Infiltration Pond has been designed with an infiltration rate of 4.26 inches per hour. This led to the Water Quality unit being modeled with a 1" WQV.
- The proposed project will include Water Quality Unit's which will provide TSS removal. The summary of the Manufacturers' Predicted Net Annual results as well as the TSS Removal Worksheet are included.

Water Quality Volumes for Pond 1 5

Pond 1
38,126 x 1/12 = 3,177 cubic feet (Required)
Storage Volume below outlet = 12,841 cubic feet provided

Standard 5: Land uses with higher potential pollutant loads
None proposed for Lot 2.

Standard 6: Critical Areas
N/A

Standard 7: Re-developments and Other Projects
N/A

Standard 8: Construction Period Pollution Prevention and Erosion Sedimentation Control

- Refer to Site Plans for the Inspection and Maintenance Schedule and the Operation and Maintenance Schedule.
- The project will be covered by an NPDES Construction General Permit.

Standard 9: Operation and Maintenance Plan

- Refer to Site Plans 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.

Standard 10: Prohibition of Illicit Discharges

- Owner to be responsible for compliance with avoiding illicit discharges.
- The site will be connected to the town sewer system.

Stage-Area-Storage for Pond POND 1: POND 1

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)	Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
201.23	**3,688**	0	202.27	3,688	1,541
201.25	3,688	30	202.29	3,688	1,575
201.27	3,688	59	202.31	3,688	1,611
201.29	3,688	89	202.33	3,688	1,648
201.31	3,688	118	202.35	3,688	1,685
201.33	3,688	148	202.37	3,688	1,723
201.35	3,688	177	202.39	3,688	1,762
201.37	3,688	207	202.41	3,688	1,801
201.39	3,688	236	202.43	3,688	1,840
201.41	3,688	266	202.45	3,688	1,881
201.43	3,688	295	202.47	3,688	1,921
201.45	3,688	325	202.49	3,688	1,962
201.47	3,688	354	202.51	3,688	2,004
201.49	3,688	384	202.53	3,688	2,046
201.51	3,688	413	202.55	3,688	2,088
201.53	3,688	443	202.57	3,688	2,131
201.55	3,688	472	202.59	3,688	2,174
201.57	3,688	502	202.61	3,688	2,217
201.59	3,688	531	202.63	3,688	2,261
201.61	3,688	561	202.65	3,688	2,305
201.63	3,688	590	202.67	3,688	2,350
201.65	3,688	620	202.69	3,688	2,395
201.67	3,688	649	202.71	3,688	2,440
201.69	3,688	679	202.73	3,688	2,485
201.71	3,688	708	202.75	3,688	2,531
201.73	3,688	738	202.77	3,688	2,577
201.75	3,688	767	202.79	3,688	2,623
201.77	3,688	797	202.81	3,688	2,669
201.79	3,688	826	202.83	3,688	2,716
201.81	3,688	856	202.85	3,688	2,763
201.83	3,688	885	202.87	3,688	2,810
201.85	3,688	915	202.89	3,688	2,857
201.87	3,688	944	202.91	3,688	2,905
201.89	3,688	974	202.93	3,688	2,953
201.91	3,688	1,003	202.95	3,688	3,001
201.93	3,688	1,033	202.97	3,688	3,049
201.95	3,688	1,062	202.99	3,688	3,098
201.97	3,688	1,092	203.01	3,688	3,147
201.99	3,688	1,121	203.03	3,688	3,196
202.01	3,688	1,151	203.05	3,688	3,245
202.03	3,688	1,180	203.07	3,688	3,294
202.05	3,688	1,210	203.09	3,688	3,343
202.07	3,688	1,239	203.11	3,688	3,393
202.09	3,688	1,269	203.13	3,688	3,443
202.11	3,688	1,298	203.15	3,688	3,493
202.13	3,688	1,328	203.17	3,688	3,543
202.15	3,688	1,357	203.19	3,688	3,594
202.17	3,688	1,387	203.21	3,688	3,644
202.19	3,688	1,416	203.23	3,688	3,695
202.21	3,688	1,446	203.25	3,688	3,746
202.23	3,688	1,475	203.27	3,688	3,797
202.25	3,688	1,507	203.29	3,688	3,848

Stage-Area-Storage for Pond POND 1: POND 1 (continued)

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
203.31	3,688	3,900
203.33	3,688	3,951
203.35	3,688	4,003
203.37	3,688	4,055
203.39	3,688	4,106
203.41	3,688	4,159
203.43	3,688	4,211
203.45	3,688	4,263
203.47	3,688	4,315
203.49	3,688	4,368
203.51	3,688	4,421
203.53	3,688	4,474
203.55	3,688	4,527
203.57	3,688	4,580
203.59	3,688	4,633
203.61	3,688	4,686
203.63	3,688	4,739
203.65	3,688	4,793
203.67	3,688	4,846
203.69	3,688	4,900
203.71	3,688	4,954
203.73	3,688	5,008
203.75	3,688	5,062
203.77	3,688	5,116
203.79	3,688	5,170
203.81	3,688	5,224
203.83	3,688	5,278
203.85	3,688	5,333
203.87	3,688	5,387
203.89	3,688	5,442
203.91	3,688	5,497
203.93	3,688	5,551
203.95	3,688	5,606
203.97	3,688	5,661
203.99	3,688	5,716
204.01	3,688	5,771
204.03	3,688	5,826
204.05	3,688	5,881
204.07	3,688	5,936
204.09	3,688	5,991
204.11	3,688	6,047
204.13	3,688	6,102
204.15	3,688	6,157
204.17	3,688	6,213
204.19	3,688	6,268
204.21	3,688	6,324
204.23	3,688	6,379
204.25	3,688	6,435
204.27	3,688	6,491
204.29	3,688	6,546
204.31	3,688	6,602
204.33	3,688	6,658

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
204.35	3,688	6,714
204.37	3,688	6,770
204.39	3,688	6,825
204.41	3,688	6,881
204.43	3,688	6,937
204.45	3,688	6,993
204.47	3,688	7,049
204.49	3,688	7,105
204.51	3,688	7,161
204.53	3,688	7,217
204.55	3,688	7,273
204.57	3,688	7,329
204.59	3,688	7,386
204.61	3,688	7,442
204.63	3,688	7,498
204.65	3,688	7,554
204.67	3,688	7,610
204.69	3,688	7,666
204.71	3,688	7,722
204.73	3,688	7,778
204.75	3,688	7,835
204.77	3,688	7,891
204.79	3,688	7,947
204.81	3,688	8,003
204.83	3,688	8,059
204.85	3,688	8,115
204.87	3,688	8,171
204.89	3,688	8,227
204.91	3,688	8,284
204.93	3,688	8,340
204.95	3,688	8,396
204.97	3,688	8,452
204.99	3,688	8,508
205.01	3,688	8,564
205.03	3,688	8,620
205.05	3,688	8,676
205.07	3,688	8,732
205.09	3,688	8,787
205.11	3,688	8,843
205.13	3,688	8,899
205.15	3,688	8,955
205.17	3,688	9,011
205.19	3,688	9,066
205.21	3,688	9,122
205.23	3,688	9,178
205.25	3,688	9,233
205.27	3,688	9,289
205.29	3,688	9,344
205.31	3,688	9,400
205.33	3,688	9,455
205.35	3,688	9,510
205.37	3,688	9,566

Stage-Area-Storage for Pond POND 1: POND 1 (continued)

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)	Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
205.39	3,688	9,621	206.43	3,688	12,361
205.41	3,688	9,676	206.45	3,688	12,410
205.43	3,688	9,731	206.47	3,688	12,459
205.45	3,688	9,786	206.49	3,688	12,508
205.47	3,688	9,841	206.51	3,688	12,556
205.49	3,688	9,896	206.53	3,688	12,604
205.51	3,688	9,951	206.55	3,688	12,652
205.53	3,688	10,006	206.57	3,688	12,700
205.55	3,688	10,060	206.59	3,688	12,747
205.57	3,688	10,115	206.61	3,688	12,794
205.59	3,688	10,170	206.63	3,688	12,841
205.61	3,688	10,224	206.65	3,688	12,888
205.63	3,688	10,279	206.67	3,688	12,934
205.65	3,688	10,333	206.69	3,688	12,980
205.67	3,688	10,387	206.71	3,688	13,026
205.69	3,688	10,441	206.73	3,688	13,072
205.71	3,688	10,495	206.75	3,688	13,117
205.73	3,688	10,549	206.77	3,688	13,162
205.75	3,688	10,603	206.79	3,688	13,207
205.77	3,688	10,657	206.81	3,688	13,252
205.79	3,688	10,711	206.83	3,688	13,296
205.81	3,688	10,764	206.85	3,688	13,339
205.83	3,688	10,818	206.87	3,688	13,383
205.85	3,688	10,871	206.89	3,688	13,426
205.87	3,688	10,924	206.91	3,688	13,469
205.89	3,688	10,977	206.93	3,688	13,511
205.91	3,688	11,030	206.95	3,688	13,553
205.93	3,688	11,083	206.97	3,688	13,595
205.95	3,688	11,136	206.99	3,688	13,636
205.97	3,688	11,189	207.01	3,688	13,676
205.99	3,688	11,241	207.03	3,688	13,717
206.01	3,688	11,294	207.05	3,688	13,756
206.03	3,688	11,346	207.07	3,688	13,795
206.05	3,688	11,398	207.09	3,688	13,834
206.07	3,688	11,450	207.11	3,688	13,872
206.09	3,688	11,502	207.13	3,688	13,909
206.11	3,688	11,554	207.15	3,688	13,946
206.13	3,688	11,606	207.17	3,688	13,982
206.15	3,688	11,657	207.19	3,688	14,016
206.17	3,688	11,709	207.21	3,688	14,050
206.19	3,688	11,760	207.23	3,688	14,082
206.21	3,688	11,811	207.25	3,688	14,111
206.23	3,688	11,862	207.27	3,688	14,141
206.25	3,688	11,913	207.29	3,688	14,170
206.27	3,688	11,963	207.31	3,688	14,200
206.29	3,688	12,014	207.33	3,688	14,229
206.31	3,688	12,064	207.35	3,688	14,259
206.33	3,688	12,114	207.37	3,688	14,288
206.35	3,688	12,164	207.39	3,688	14,318
206.37	3,688	12,213	207.41	3,688	14,347
206.39	3,688	12,263	207.43	3,688	14,377
206.41	3,688	12,312	207.45	3,688	14,406

Stage-Area-Storage for Pond POND 1: POND 1 (continued)

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
207.47	3,688	14,436
207.49	3,688	14,465
207.51	3,688	14,495
207.53	3,688	14,524
207.55	3,688	14,554
207.57	3,688	14,583
207.59	3,688	14,613
207.61	3,688	14,642
207.63	3,688	14,672
207.65	3,688	14,701
207.67	3,688	14,731
207.69	3,688	14,760
207.71	3,688	14,790
207.73	3,688	14,819
207.75	3,688	14,849
207.77	3,688	14,878
207.79	3,688	14,908
207.81	3,688	14,937
207.83	3,688	14,967
207.85	3,688	14,996
207.87	3,688	15,026
207.89	3,688	15,055
207.91	3,688	15,085
207.93	3,688	15,114
207.95	3,688	15,144
207.97	3,688	15,173
207.99	3,688	15,203
208.01	3,688	15,232
208.03	3,688	15,262
208.05	3,688	15,291
208.07	3,688	15,321
208.09	3,688	15,350
208.11	3,688	15,380
208.13	3,688	15,409
208.15	3,688	15,439
208.17	3,688	15,468
208.19	3,688	15,498
208.21	3,688	15,527
208.23	3,688	**15,557**

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 area W-1 has a discharge to the on-site wetland. Post-development Link 1L was provided to combine the outlet from Pond 2 and the piped outlet from Pond 1 with the undeveloped area which discharge to the on-site wetland. A comparison of the rate and volume for pre-development area W-1 and post-development Link 1L (To Wetlands) is provided below:

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
0.02		0.01

10 year storm event (A.F.)

Pre		Post
1S	vs	1L
0.011		0.007

100 year storm event (CFS)

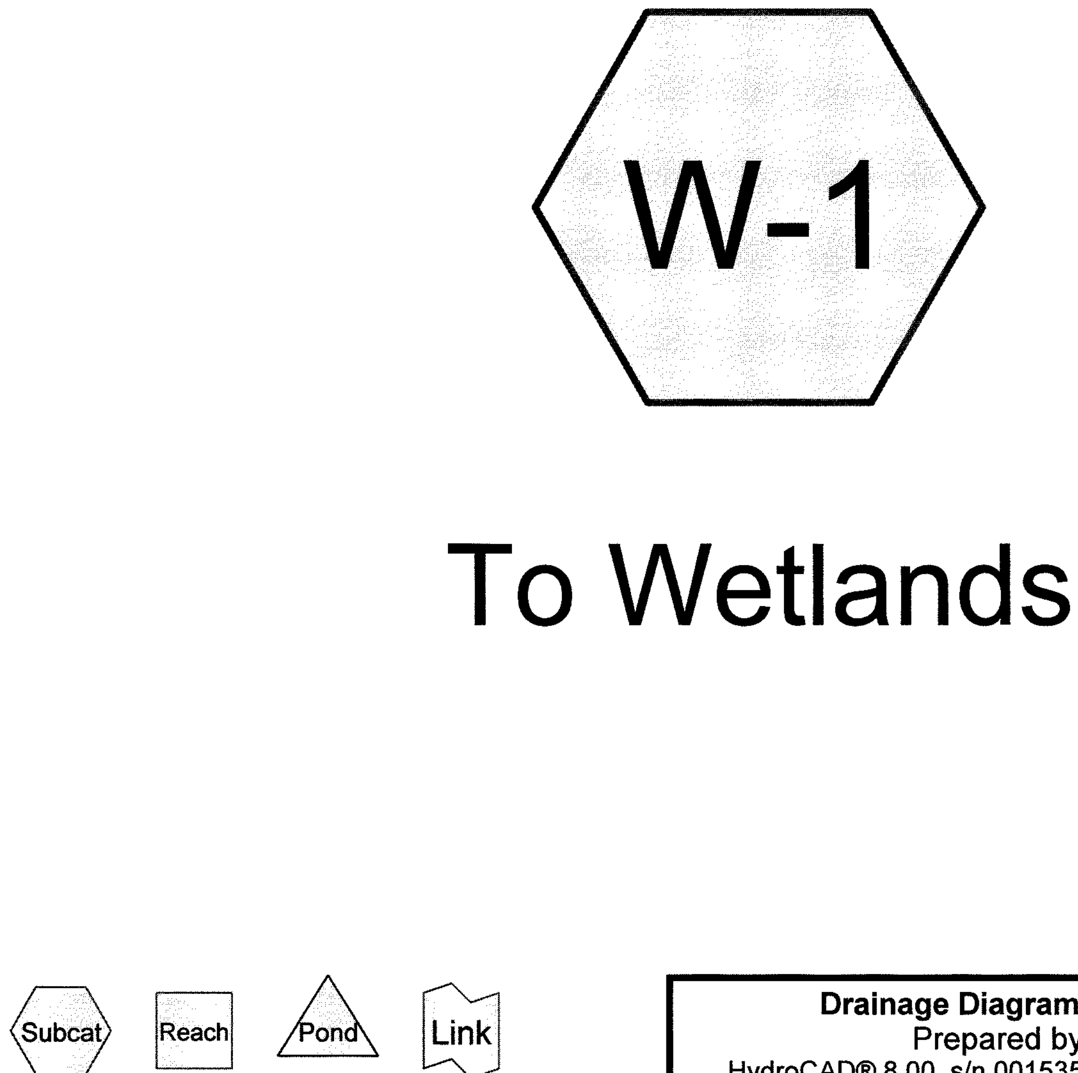
Pre		Post
1S	vs	1L
0.61		0.35

100 year storm event (A.F.)

Pre		Post
1S	vs	1L
0.119		0.067

A reduction in both the rate of runoff and volume of runoff for the 2 year, 10 year and 100 year storm events have been realized.

APPENDIX C



Drainage Diagram for UC1645-PRE-development
Prepared by United Consultants, Inc.
HydroCAD® 8.00 s/n 001535

Area Listing (all nodes)

Area (acres)	CN	Description (subcats)
1.687	30	Woods, Good, HSG A (W-1)
0.224	39	>75% Grass cover, Good, HSG A (W-1)
0.098	55	Woods, Good, HSG B (W-1)
0.050	72	Dirt roads, HSG A (W-1)
0.003	98	Paved parking & roofs (W-1)
2.063		

2 YR PRE-DEVELOPMENT

Subcatchment W-1: To Wetlands

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-NOAA Rainfall=3.36"

Area (sf)	CN	Description
141	98	Paved parking & roofs
73,500	30	Woods, Good, HSG A
4,276	55	Woods, Good, HSG B
9,762	39	>75% Grass cover, Good, HSG A
2,182	72	Dirt roads, HSG A
89,861	33	Weighted Average
89,720		Pervious Area
141		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.0	15	0.1667	0.13		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.36"
3.9	31	0.1290	0.13		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.36"
0.3	44	0.1818	2.13		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.5	52	0.1153	1.70		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.9	97	0.1240	1.76		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.6	42	0.0476	1.09		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.3	27	0.0714	1.34		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
8.5	308	Total			

10 YR PRE-DEVELOPMENT

Subcatchment W-1: To Wetlands

Runoff = 0.02 cfs @ 15.52 hrs, Volume= 0.011 af, Depth= 0.06"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10YR-noaa Rainfall=5.22"

Area (sf)	CN	Description
141	98	Paved parking & roofs
73,500	30	Woods, Good, HSG A
4,276	55	Woods, Good, HSG B
9,762	39	>75% Grass cover, Good, HSG A
2,182	72	Dirt roads, HSG A
89,861	33	Weighted Average
89,720		Pervious Area
141		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.0	15	0.1667	0.13		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.36"
3.9	31	0.1290	0.13		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.36"
0.3	44	0.1818	2.13		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.5	52	0.1153	1.70		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.9	97	0.1240	1.76		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.6	42	0.0476	1.09		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.3	27	0.0714	1.34		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
8.5	308	Total			

100 YR PRE-DEVELOPMENT

Subcatchment W-1: To Wetlands

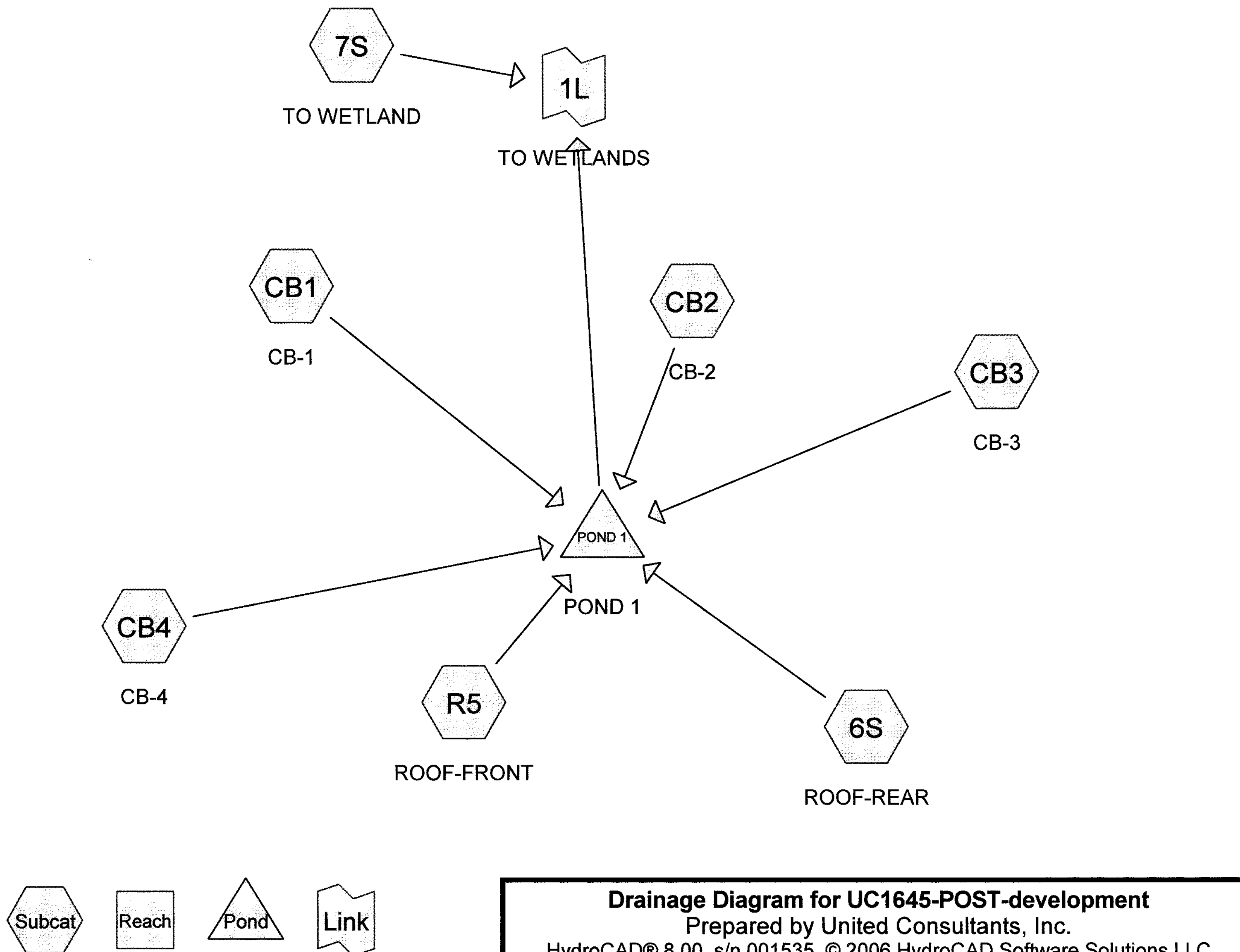
Runoff = 0.61 cfs @ 12.36 hrs, Volume= 0.119 af, Depth= 0.69"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100YR-noaa Rainfall=8.18"

Area (sf)	CN	Description
141	98	Paved parking & roofs
73,500	30	Woods, Good, HSG A
4,276	55	Woods, Good, HSG B
9,762	39	>75% Grass cover, Good, HSG A
2,182	72	Dirt roads, HSG A
89,861	33	Weighted Average
89,720		Pervious Area
141		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.0	15	0.1667	0.13		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.36"
3.9	31	0.1290	0.13		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.36"
0.3	44	0.1818	2.13		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.5	52	0.1153	1.70		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.9	97	0.1240	1.76		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.6	42	0.0476	1.09		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.3	27	0.0714	1.34		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
8.5	308	Total			

APPENDIX D



Drainage Diagram for UC1645-POST-development
Prepared by United Consultants, Inc.
HydroCAD® 8.00 s/n 001535 © 2006 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcats)
0.617	30	Woods, Good, HSG A (7S,CB1,CB2,CB3,CB4)
0.432	39	>75% Grass cover, Good, HSG A (7S,CB1,CB2,CB3,CB4)
0.075	55	Woods, Good, HSG B (7S)
0.014	61	>75% Grass cover, Good, HSG B (7S,CB3)
0.050	72	Dirt roads, HSG A (7S,CB2,CB3)
0.875	98	Paved parking & roofs (6S,CB1,CB2,CB3,CB4,R5)
2.063		

2 YR POST-DEVELOPMENT

Subcatchment 6S: ROOF-REAR

Runoff = 0.42 cfs @ 12.09 hrs, Volume= 0.033 af, Depth= 3.13"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2YR-NOAA Rainfall=3.36"

Area (sf)	CN	Description
5,600	98	Paved parking & roofs
5,600		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, MIN TC**
0.2	87	0.0300	7.79	2.72	**Circular Channel (pipe),** Diam= 8.0" Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.010 PVC, smooth interior
6.2	87	Total			

Subcatchment 7S: TO WETLAND

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-NOAA Rainfall=3.36"

Area (sf)	CN	Description
7,032	39	>75% Grass cover, Good, HSG A
202	61	>75% Grass cover, Good, HSG B
22,204	30	Woods, Good, HSG A
3,279	55	Woods, Good, HSG B
572	72	Dirt roads, HSG A
33,289	35	Weighted Average
33,289		Pervious Area

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

Subcatchment CB1: CB-1

Runoff = 0.33 cfs @ 12.10 hrs, Volume= 0.025 af, Depth= 0.98"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2YR-NOAA Rainfall=3.36"

Area (sf)	CN	Description
7,639	98	Paved parking & roofs
4,094	39	>75% Grass cover, Good, HSG A
1,796	30	Woods, Good, HSG A
13,529	71	Weighted Average
5,890		Pervious Area
7,639		Impervious Area

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

Subcatchment CB2: CB-2

Runoff = 0.64 cfs @ 12.09 hrs, Volume= 0.045 af, Depth= 1.67"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2YR-NOAA Rainfall=3.36"

Area (sf)	CN	Description
10,239	98	Paved parking & roofs
2,161	39	>75% Grass cover, Good, HSG A
1,273	30	Woods, Good, HSG A
512	72	Dirt roads, HSG A
14,185	82	Weighted Average
3,946		Pervious Area
10,239		Impervious Area

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

Subcatchment CB3: CB-3

Runoff = 0.38 cfs @ 12.09 hrs, Volume= 0.027 af, Depth= 1.46"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2YR-NOAA Rainfall=3.36"

Area (sf)	CN	Description
5,914	98	Paved parking & roofs
1,265	39	>75% Grass cover, Good, HSG A
395	61	>75% Grass cover, Good, HSG B
1,018	30	Woods, Good, HSG A
1,098	72	Dirt roads, HSG A
9,690	79	Weighted Average
3,776		Pervious Area
5,914		Impervious Area

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

Subcatchment CB4: CB-4

Runoff = 0.08 cfs @ 12.11 hrs, Volume= 0.008 af, Depth= 0.55"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2YR-NOAA Rainfall=3.36"

Area (sf)	CN	Description
3,134	98	Paved parking & roofs
4,270	39	>75% Grass cover, Good, HSG A
565	30	Woods, Good, HSG A
7,969	62	Weighted Average
4,835		Pervious Area
3,134		Impervious Area

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

Subcatchment R5: ROOF-FRONT

Runoff = 0.42 cfs @ 12.09 hrs, Volume= 0.033 af, Depth= 3.13"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2YR-NOAA Rainfall=3.36"

Area (sf)	CN	Description
5,600	98	Paved parking & roofs
5,600		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, MIN TC**
0.2	87	0.0300	7.79	2.72	**Circular Channel (pipe),** Diam= 8.0" Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.010 PVC, smooth interior
6.2	87	Total			

Pond POND 1: POND 1

Inflow Area = 1.299 ac, Inflow Depth = 1.60" for 2YR-NOAA event
Inflow = 2.25 cfs @ 12.09 hrs, Volume= 0.173 af
Outflow = 0.36 cfs @ 11.78 hrs, Volume= 0.173 af, Atten= 84%, Lag= 0.0 min
Discarded = 0.36 cfs @ 11.78 hrs, Volume= 0.173 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 202.56' @ 12.60 hrs Surf.Area= 3,688 sf Storage= 2,108 cf

Plug-Flow detention time= 38.8 min calculated for 0.173 af (100% of inflow)
Center-of-Mass det. time= 38.8 min (852.3 - 813.5)

Volume	Invert	Avail.Storage	Storage Description
#1	201.23'	6,839 cf	**31.40'W x 117.45'L x 7.00'H Prismatoid** 25,816 cf Overall - 8,718 cf Embedded = 17,098 cf x 40.0% Voids
#2	202.23'	8,718 cf	**60.0"D x 111.00'L Horizontal Cylinder** x 4 Inside #1
		15,557 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Discarded	201.20'	**4.260 in/hr Exfiltration over Surface area above invert** Excluded Surface area = 0 sf
#2	Primary	206.63'	**6.0" Vert. Orifice/Grate X 3.00** C= 0.600

Discarded OutFlow Max=0.36 cfs @ 11.78 hrs HW=201.30' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.36 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=201.23' (Free Discharge)
↑—**2=Orifice/Grate** (Controls 0.00 cfs)

Link 1L: TO WETLANDS

Inflow Area =	2.063 ac,	Inflow Depth = 0.00"	for 2YR-NOAA event	
Inflow =	0.00 cfs @	0.00 hrs, Volume=	0.000 af	
Primary =	0.00 cfs @	0.00 hrs, Volume=	0.000 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

10 YR POST-DEVELOPMENT

Subcatchment 6S: ROOF-REAR

Runoff = 0.65 cfs @ 12.09 hrs, Volume= 0.053 af, Depth= 4.98"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10YR-noaa Rainfall=5.22"

Area (sf)	CN	Description
5,600	98	Paved parking & roofs
5,600		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, MIN TC**
0.2	87	0.0300	7.79	2.72	**Circular Channel (pipe),** Diam= 8.0" Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.010 PVC, smooth interior
6.2	87	Total			

Subcatchment 7S: TO WETLAND

Runoff = 0.01 cfs @ 14.86 hrs, Volume= 0.007 af, Depth= 0.11"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10YR-noaa Rainfall=5.22"

Area (sf)	CN	Description
7,032	39	>75% Grass cover, Good, HSG A
202	61	>75% Grass cover, Good, HSG B
22,204	30	Woods, Good, HSG A
3,279	55	Woods, Good, HSG B
572	72	Dirt roads, HSG A
33,289	35	Weighted Average
33,289		Pervious Area

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

Subcatchment CB1: CB-1

Runoff = 0.82 cfs @ 12.09 hrs, Volume= 0.059 af, Depth= 2.28"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10YR-noaa Rainfall=5.22"

Area (sf)	CN	Description
7,639	98	Paved parking & roofs
4,094	39	>75% Grass cover, Good, HSG A
1,796	30	Woods, Good, HSG A
13,529	71	Weighted Average
5,890		Pervious Area
7,639		Impervious Area

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

Subcatchment CB2: CB-2

Runoff = 1.25 cfs @ 12.09 hrs, Volume= 0.089 af, Depth= 3.28"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10YR-noaa Rainfall=5.22"

Area (sf)	CN	Description
10,239	98	Paved parking & roofs
2,161	39	>75% Grass cover, Good, HSG A
1,273	30	Woods, Good, HSG A
512	72	Dirt roads, HSG A
14,185	82	Weighted Average
3,946		Pervious Area
10,239		Impervious Area

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

Subcatchment CB3: CB-3

Runoff = 0.78 cfs @ 12.09 hrs, Volume= 0.055 af, Depth= 2.99"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10YR-noaa Rainfall=5.22"

Area (sf)	CN	Description
5,914	98	Paved parking & roofs
1,265	39	>75% Grass cover, Good, HSG A
395	61	>75% Grass cover, Good, HSG B
1,018	30	Woods, Good, HSG A
1,098	72	Dirt roads, HSG A
9,690	79	Weighted Average
3,776		Pervious Area
5,914		Impervious Area

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

Subcatchment CB4: CB-4

Runoff = 0.32 cfs @ 12.10 hrs, Volume= 0.024 af, Depth= 1.58"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10YR-noaa Rainfall=5.22"

Area (sf)	CN	Description
3,134	98	Paved parking & roofs
4,270	39	>75% Grass cover, Good, HSG A
565	30	Woods, Good, HSG A
7,969	62	Weighted Average
4,835		Pervious Area
3,134		Impervious Area

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

Subcatchment R5: ROOF-FRONT

Runoff = 0.65 cfs @ 12.09 hrs, Volume= 0.053 af, Depth= 4.98"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10YR-noaa Rainfall=5.22"

Area (sf)	CN	Description
5,600	98	Paved parking & roofs
5,600		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, MIN TC**
0.2	87	0.0300	7.79	2.72	**Circular Channel (pipe),** Diam= 8.0" Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.010 PVC, smooth interior
6.2	87	Total			

Pond POND 1: POND 1

Inflow Area = 1.299 ac, Inflow Depth = 3.09" for 10YR-noaa event
Inflow = 4.47 cfs @ 12.09 hrs, Volume= 0.334 af
Outflow = 0.36 cfs @ 11.57 hrs, Volume= 0.334 af, Atten= 92%, Lag= 0.0 min
Discarded = 0.36 cfs @ 11.57 hrs, Volume= 0.334 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 203.96' @ 13.32 hrs Surf.Area= 3,688 sf Storage= 5,628 cf

Plug-Flow detention time= 130.3 min calculated for 0.334 af (100% of inflow)
Center-of-Mass det. time= 130.2 min (933.4 - 803.2)

Volume	Invert	Avail.Storage	Storage Description
#1	201.23'	6,839 cf	**31.40'W x 117.45'L x 7.00'H Prismatoid**
			25,816 cf Overall - 8,718 cf Embedded = 17,098 cf x 40.0% Voids
#2	202.23'	8,718 cf	**60.0"D x 111.00'L Horizontal Cylinder** x 4 Inside #1
		15,557 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Discarded	201.20'	**4.260 in/hr Exfiltration over Surface area above invert**
			Excluded Surface area = 0 sf
#2	Primary	206.63'	**6.0" Vert. Orifice/Grate X 3.00** C= 0.600

Discarded OutFlow Max=0.36 cfs @ 11.57 hrs HW=201.30' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.36 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=201.23' (Free Discharge)
↑—**2=Orifice/Grate** (Controls 0.00 cfs)

Link 1L: TO WETLANDS

Inflow Area = 2.063 ac, Inflow Depth = 0.04" for 10YR-noaa event
Inflow = 0.01 cfs @ 14.86 hrs, Volume= 0.007 af
Primary = 0.01 cfs @ 14.86 hrs, Volume= 0.007 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

100 YR POST-DEVELOPMENT

Subcatchment 6S: ROOF-REAR

Runoff = 1.03 cfs @ 12.09 hrs, Volume= 0.085 af, Depth= 7.94"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100YR-noaa Rainfall=8.18"

Area (sf)	CN	Description
5,600	98	Paved parking & roofs
5,600		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, MIN TC**
0.2	87	0.0300	7.79	2.72	**Circular Channel (pipe),** Diam= 8.0" Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.010 PVC, smooth interior
6.2	87	Total			

Subcatchment 7S: TO WETLAND

Runoff = 0.35 cfs @ 12.15 hrs, Volume= 0.055 af, Depth= 0.87"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100YR-noaa Rainfall=8.18"

Area (sf)	CN	Description
7,032	39	>75% Grass cover, Good, HSG A
202	61	>75% Grass cover, Good, HSG B
22,204	30	Woods, Good, HSG A
3,279	55	Woods, Good, HSG B
572	72	Dirt roads, HSG A
33,289	35	Weighted Average
33,289		Pervious Area

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

Subcatchment CB1: CB-1

Runoff = 1.72 cfs @ 12.09 hrs, Volume= 0.123 af, Depth= 4.74"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100YR-noaa Rainfall=8.18"

Area (sf)	CN	Description
7,639	98	Paved parking & roofs
4,094	39	>75% Grass cover, Good, HSG A
1,796	30	Woods, Good, HSG A
13,529	71	Weighted Average
5,890		Pervious Area
7,639		Impervious Area

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

Subcatchment CB2: CB-2

Runoff = 2.25 cfs @ 12.09 hrs, Volume= 0.164 af, Depth= 6.03"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100YR-noaa Rainfall=8.18"

Area (sf)	CN	Description
10,239	98	Paved parking & roofs
2,161	39	>75% Grass cover, Good, HSG A
1,273	30	Woods, Good, HSG A
512	72	Dirt roads, HSG A
14,185	82	Weighted Average
3,946		Pervious Area
10,239		Impervious Area

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

Subcatchment CB3: CB-3

Runoff = 1.46 cfs @ 12.09 hrs, Volume= 0.105 af, Depth= 5.68"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100YR-noaa Rainfall=8.18"

Area (sf)	CN	Description
5,914	98	Paved parking & roofs
1,265	39	>75% Grass cover, Good, HSG A
395	61	>75% Grass cover, Good, HSG B
1,018	30	Woods, Good, HSG A
1,098	72	Dirt roads, HSG A
9,690	79	Weighted Average
3,776		Pervious Area
5,914		Impervious Area

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

Subcatchment CB4: CB-4

Runoff = 0.79 cfs @ 12.09 hrs, Volume= 0.056 af, Depth= 3.70"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100YR-noaa Rainfall=8.18"

Area (sf)	CN	Description
3,134	98	Paved parking & roofs
4,270	39	>75% Grass cover, Good, HSG A
565	30	Woods, Good, HSG A
7,969	62	Weighted Average
4,835		Pervious Area
3,134		Impervious Area

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

Subcatchment R5: ROOF-FRONT

Runoff = 1.03 cfs @ 12.09 hrs, Volume= 0.085 af, Depth= 7.94"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100YR-noaa Rainfall=8.18"

Area (sf)	CN	Description
5,600	98	Paved parking & roofs
5,600		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, MIN TC**
0.2	87	0.0300	7.79	2.72	**Circular Channel (pipe),** Diam= 8.0" Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.010 PVC, smooth interior
6.2	87	Total			

Pond POND 1: POND 1

Inflow Area = 1.299 ac, Inflow Depth = 5.71" for 100YR-noaa event
Inflow = 8.27 cfs @ 12.09 hrs, Volume= 0.618 af
Outflow = 0.48 cfs @ 14.03 hrs, Volume= 0.618 af, Atten= 94%, Lag= 116.6 min
Discarded = 0.36 cfs @ 10.71 hrs, Volume= 0.606 af
Primary = 0.12 cfs @ 14.03 hrs, Volume= 0.012 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 206.74' @ 14.03 hrs Surf.Area= 3,688 sf Storage= 13,094 cf

Plug-Flow detention time= 322.6 min calculated for 0.618 af (100% of inflow)
Center-of-Mass det. time= 322.6 min (1,114.5 - 791.8)

Volume	Invert	Avail.Storage	Storage Description
#1	201.23'	6,839 cf	**31.40'W x 117.45'L x 7.00'H Prismatoid** 25,816 cf Overall - 8,718 cf Embedded = 17,098 cf x 40.0% Voids
#2	202.23'	8,718 cf	**60.0"D x 111.00'L Horizontal Cylinder** x 4 Inside #1
		15,557 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Discarded	201.20'	**4.260 in/hr Exfiltration over Surface area above invert** Excluded Surface area = 0 sf
#2	Primary	206.63'	**6.0" Vert. Orifice/Grate X 3.00** C= 0.600

Discarded OutFlow Max=0.36 cfs @ 10.71 hrs HW=201.30' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.36 cfs)

Primary OutFlow Max=0.11 cfs @ 14.03 hrs HW=206.74' (Free Discharge)
↑—**2=Orifice/Grate** (Orifice Controls 0.11 cfs @ 1.13 fps)

Link 1L: TO WETLANDS

Inflow Area =	2.063 ac,	Inflow Depth = 0.39"	for 100YR-noaa event	
Inflow =	0.35 cfs @	12.15 hrs, Volume=	0.067 af	
Primary =	0.35 cfs @	12.15 hrs, Volume=	0.067 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

APPENDIX E

INSTRUCTIONS:
1. In BMP Column, click on Blue Cell to Activate Drop Down Menu
2. Select BMP from Drop Down Menu
3. After BMP is selected, TSS Removal and other Columns are automatically completed.

Version 1, Automated: Mar. 4, 2008

TSS Removal Calculation Worksheet

Location: Lot 2 Forge Prkway Infiltration Basin 1 - Pretreatment

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Proprietary Treatment Practice	0.45	1.00	0.45	0.55
	0.00	1.00	0.00	1.00
	0.00	1.00	0.00	1.00
	0.00	1.00	0.00	1.00
	0.00	1.00	0.00	1.00

Total TSS Removal = 45%

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

Project: Lot 2 Forge Parkway
Prepared By: RRG
Date: 7/7/2025

*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

INSTRUCTIONS:
1. In BMP Column, click on Blue Cell to Activate Drop Down Menu
2. Select BMP from Drop Down Menu
3. After BMP is selected, TSS Removal and other Columns are automatically completed.

Version 1, Automated: Mar. 4, 2008

TSS Removal Calculation Worksheet

Location: Lot 2 Forge Parkway - Infiltration Basin 1

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Infiltration Basin	0.80	1.00	0.80	0.20
	0.00	0.20	0.00	0.20
	0.00	0.20	0.00	0.20
	0.00	0.20	0.00	0.20
	0.00	0.20	0.00	0.20

Total TSS Removal = 80%

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

Project: Lot 2 Forge Parkway
Prepared By: RRG
Date: 7/7/2025

*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

Project:	**2 Forge Parkway**
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)

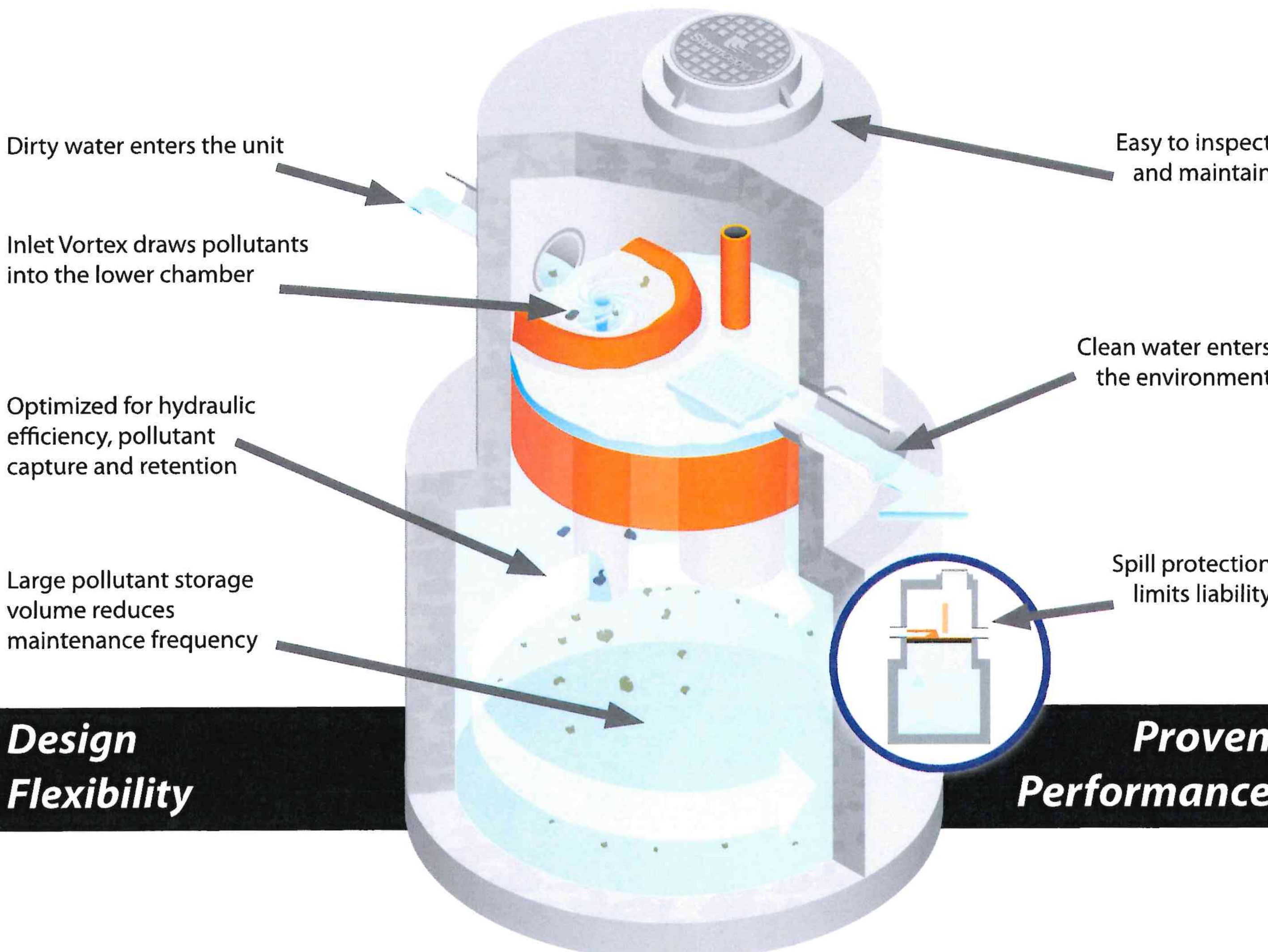
Structure Name	Impv. (acres)	A (miles^2)	t_c (min)	t_c (hr)	WQV (in)	qu (csm/in.)	Q (cfs)
CB 1	0.18	0.0002813	5.0	0.083	1.00	795.00	0.22
CB 2	0.24	0.0003750	5.0	0.083	1.00	795.00	0.30
CB 3	0.14	0.0002188	5.0	0.083	1.00	795.00	0.17
CB 4	0.07	0.0001094	5.0	0.083	1.00	795.00	0.09

The WQf sizing calculation selects the minimum size CDS/Cascade/StormCeptor model capable of operating at the computed WQf peak flowrate prior to bypassing. It assumes free discharge of the WQf through the unit and ignores the routing effect of any upstream storm drain piping. As with all hydrodynamic separators, there will be some impact to the Hydraulic Gradient of the corresponding drainage system, and evaluation of this impact should be considered in the design.

Stormceptor®

Stormwater Treatment Made Simple!

TSS & Oil Removal ■ *Scour Prevention* ■ *Small Footprint*



Environmentally Engineered Stormwater Solutions...
that exceed your client's needs!

A calm treatment environment

CONTECH® ENGINEERED SOLUTIONS

Stormceptor® STC

Stormceptor® is an underground stormwater quality treatment device that is unparalleled in its effectiveness for pollutant capture and retention. With thousands of systems operating worldwide, Stormceptor delivers protection every day in every storm.

With patented technology, optimal treatment occurs by allowing free oil to rise and sediment to settle. The Stormceptor design prohibits scour and release of previously captured pollutants, ensuring superior treatment and protection during even the most extreme storm events.

Stormceptor is very easy to design and provides flexibility under varying site constraints such as tight right-of-ways, zero lot lines and retrofit projects. Design flexibility allows for a cost-effective approach to stormwater treatment. Stormceptor has proven performance backed by the longest record of lab and field verification in the industry.

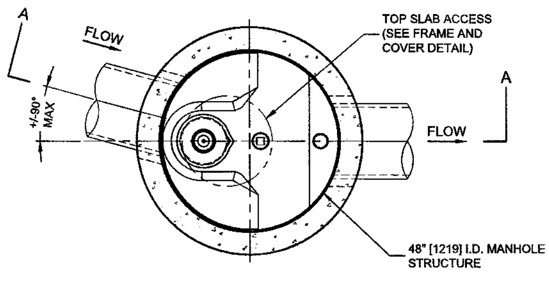
Tested Performance

- Fine particle capture
- Prevents scour or release
- 95%+ Oil removal

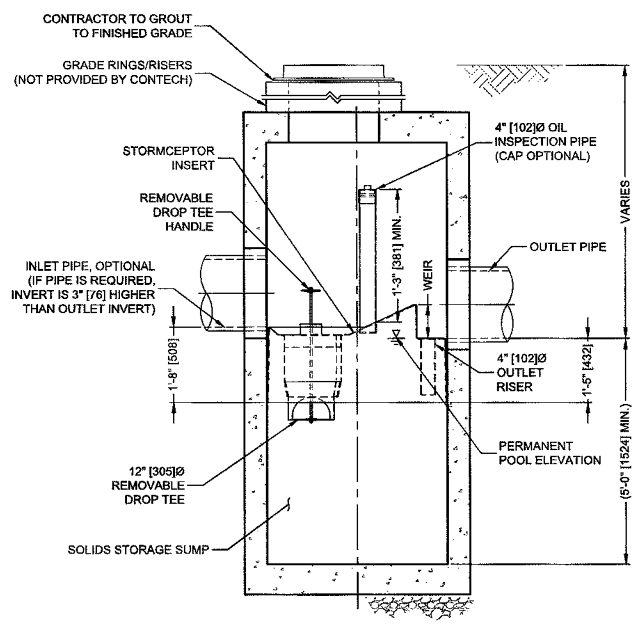
Massachusetts – Water Quality (Q) Flow Rate

Stormceptor STC Model	Inside Diameter (ft)	Typical Depth Below Inlet Pipe Invert [1] (in)	Water Quality Flow Rate Q [2] (cfs)	Peak Conveyance Flow Rate [3] (cfs)	Hydrocarbon Capacity [4] (Gallons)	Maximum Sediment Capacity [4] (ft^3)
STC 450i	4	68	0.40	5.5	86	46
STC 900	6	63	0.89	22	251	89
STC 2400	8	104	1.58	22	840	205
STC 4800	10	140	2.47	22	909	543
STC 7200	12	148	3.56	22	1,059	839
STC 11000	2 x 10	142	4.94	48	2,792	1,086
STC 16000	2 x 12	148	7.12	48	3,055	1,677

[1] Depth Below Pipe Inlet Invert to the Bottom of Base Slab, and Maximum Sediment Capacity can vary to accommodate specific site designs and pollutant loads. Depths can vary to accommodate special designs or site conditions. Contact your local representative for assistance.
[2] Water Quality Flow Rate (Q) is based on 80% annual average TSS removal of the OK110 particle size distribution.
[3] Peak Conveyance Flow Rate is based upon ideal velocity of 3 feet per second and outlet pipe diameters of 18-inch, 36-inch, and 54-inch diameters.
[4] Hydrocarbon & Sediment capacities can be modified to accommodate specific site design requirements, contact your local representative for assistance.



PLAN VIEW
TOP SLAB NOT SHOWN



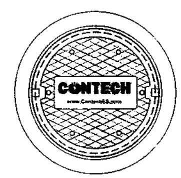
SECTION A-A

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

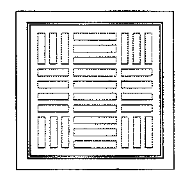
STORMCEPTOR DESIGN NOTES

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



FRAME AND COVER
(MAY VARY)
NOT TO SCALE



FRAME AND GRATE
(MAY VARY)
NOT TO SCALE

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:			

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

APPENDIX F

SOILMOISTURE 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): 2.9800

$\alpha^* =$ 0.36 (cm^{-1})

$C =$ 0.80316
$Q =$ 1.74926

$K_{fs} =$ 5.26E-03 cm/sec; 3.16E-01 cm/min; 5.26E-05 m/sec; 1.24E-01 inch/min; 2.07E-03 inch/sec

$\Phi_m =$ 1.46E-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. 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): 7.5100

$\alpha^* =$ 0.36 (cm^{-1})

$C =$ 1.28754
$Q =$ 4.40837

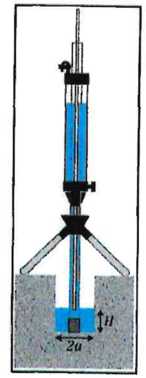
$K_{fs} =$ 6.76E-03 cm/sec; 4.06E-01 cm/min; 6.76E-05 m/ses; 1.60E-01 inch/min; 2.66E-03 inch/sec

$\Phi_m =$ 1.88E-02 (cm^2/min)

Average

$K_{fs} =$ 6.01E-03 cm/sec; 3.61E-01 cm/min; 6.01E-05 m/s; 1.42E-01 inch/min; 2.37E-03 inch/sec

$\Phi_m =$ 1.67E-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

$\alpha^* =$ 0.36 (cm^{-1})

Steady State Rate of Water Level Change ("R1" in cm/min): 2.9800

Steady State Rate of Water Level Change ("R2" in cm/min): 7.5100

1.95

$Q_1 =$ 0.10728

$Q_2 =$ 0.27036

$C_1 =$ 0.80316

$C_2 =$ 1.28754

$G_1 =$ 0.00496

$G_2 =$ 0.00397

$G_3 =$ 0.05569

$G_4 =$ 0.02416

$K_{fs} =$ 5.42E-04 cm/sec; 3.25E-02 cm/min; 5.42E-06 m/sec; 1.28E-02 inch/min; 2.14E-04 inch/sec

$\Phi_m =$ ####### (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	$\alpha^*(cm^{-1})$	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	$C_1 = \left(\frac{H_1/a}{2.074 + 0.093(H_1/a)}\right)^{0.754}$ $C_2 = \left(\frac{H_2/a}{2.074 + 0.093(H_2/a)}\right)^{0.754}$
Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macro pores, etc.	0.36	$C_1 = \left(\frac{H_1/a}{2.074 + 0.093(H_1/a)}\right)^{0.754}$ $C_2 = \left(\frac{H_2/a}{2.074 + 0.093(H_2/a)}\right)^{0.754}$

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: C. QUINTAL Date: 3/12/25

Location: Lot 2 Forge Park Test Id: 4

Depth of hole: 32" 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)	D*t* (min)	Water level in reservoir *h* (cm)	D*h* (cm)	Rate of change D*h*/D*t*
0		16		
1:13	1.22	20	4	3.29
2:54	1.68	25	5	2.97
4:36	1.70	30	5	2.94
6:20	1.73	35	5	2.89
8:01	1.68	40	5	2.97
9:45	1.73	45	5	2.89
11:22	1.62	50	5	3.09
13:05	1.72	55	5	2.91
14:45	1.67	60	5	3.00
16:29	1.73	65	5	2.88
18:12	1.72	70	5	2.91

Steady rate for 3 consecutive readings (R_1): 2.98

Water level in well = 10 cm				
Time *t* (min)	D*t* (min)	Water level in reservoir *h* (cm)	D*h* (cm)	Rate of change D*h*/D*t*
0		23		
0:14	0.23	25	2	8.57
0:50	0.60	30	5	8.33
1:30	0.67	35	5	7.50
2:10	0.67	40	5	7.50
2:53	0.72	45	5	6.98
3:33	0.67	50	5	7.50
4:14	0.68	55	5	7.32
4:57	0.72	60	5	6.98
5:38	0.68	65	5	7.32
6:20	0.70	70	5	7.14

Steady rate for 3 consecutive readings (R_2): 7.51

Comments:

K_{fs} = 0.142 in/min = 8.52 in/hr

GP FIELD DATA SHEET

SECTION 1: SITE INFORMATION

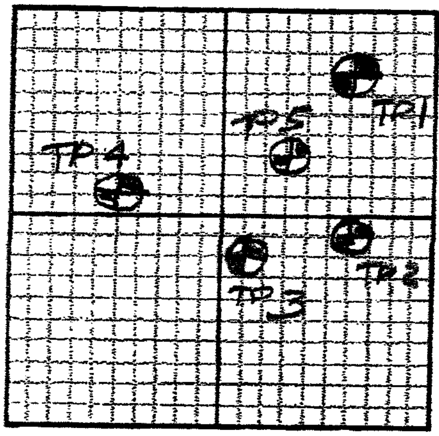
Date 3/12/25 Investigator G. QUINTAL - B. LANE

Site Location LOT 2 FORGE PARK

Dominant Soil Type(s) GRAVELLY FINE SANDY LOAM

Site Map:

TP. 4



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

Depth		Description
6"	A	SANDY LOAM 10YR 3/2
	B	SANDY LOAM 10YR 4/6
30"		
	C	SAND & GRAVEL 2.5Y 5/4
84"		

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

NO WATER

NO MOTTLES

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: 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): 3

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): 0.9600

$\alpha^* =$ 0.12 (cm^{-1})

$C =$ 0.80315
$Q =$ 0.56352

$K_{fs} =$ 1.02E-03 cm/sec
8.15E-02 cm/min
1.02E-05 m/sec
2.42E-02 inch/min
4.04E-04 inch/sec

$\Phi_m =$ 8.54E-03 (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): 3

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): 1.0400

$\alpha^* =$ 0.12 (cm^{-1})

$C =$ 1.28754
$Q =$ 0.61048

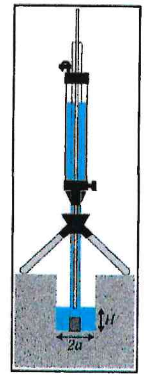
$K_{fs} =$ 6.61E-04 cm/sec
3.97E-02 cm/min
6.61E-06 m/sec
1.56E-02 inch/min
2.60E-04 inch/sec

$\Phi_m =$ 5.51E-03 (cm^2/min)

Average

$K_{fs} =$ 8.43E-04 cm/sec
5.06E-02 cm/min
8.43E-06 m/s
1.99E-02 inch/min
3.32E-04 inch/sec

$\Phi_m =$ 7.03E-03 (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): 3

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

$\alpha^* =$ 0.12 (cm^{-1})

Steady State Rate of Water Level Change ("R1" in cm/min): 0.9600

Steady State Rate of Water Level Change ("R2" in cm/min): 1.0400

1.95
$Q_1 =$ 0.03456

$Q_2 =$ 0.03744

$C_1 =$ 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

$\Phi_m =$ 1.02E-03 (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	$\alpha^*(cm^{-1})$	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	$C_1 = \left(\frac{H_1/a}{2.074 + 0.093(H_1/a)}\right)^{0.754}$ $C_2 = \left(\frac{H_2/a}{2.074 + 0.093(H_2/a)}\right)^{0.754}$
Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macro pores, etc.	0.36	$C_1 = \left(\frac{H_1/a}{2.074 + 0.093(H_1/a)}\right)^{0.754}$ $C_2 = \left(\frac{H_2/a}{2.074 + 0.093(H_2/a)}\right)^{0.754}$

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: C. QUINTAL Date: 3/12/25

Location: LOT 2 FORGE PARK Test Id: 3

Depth of hole: 36" Radius: 3cm (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)	D*t* (min)	Water level in reservoir *h* (cm)	D*h* (cm)	Rate of change D*h*/D*t*
0		17		
3:00	3.00	20	3	1.00
7:54	4.90	25	5	1.02
12:50	4.93	30	5	1.01
17:51	5.02	35	5	1.00
22:57	5.10	40	5	0.98
28:02	5.08	45	5	0.98
33:15	5.22	50	5	0.96
38:36	5.35	55	5	0.94
44:10	5.57	60	5	0.90
50:15	6.08	65	5	0.82

Steady rate for 3 consecutive readings (R_1): 0.96

Water level in well = 10 cm				
Time *t* (min)	D*t* (min)	Water level in reservoir *h* (cm)	D*h* (cm)	Rate of change D*h*/D*t*
0		15		
7:55	7.92	20	5	0.63
12:20	4.42	25	5	1.13
17:05	4.75	30	5	1.05
21:56	4.85	35	5	1.03
26:46	4.83	40	5	1.03
31:30	4.73	45	5	1.06
36:27	4.95	50	5	1.01
41:16	4.82	55	5	1.04
46:20	5.07	60	5	0.99
51:23	5.05	65	5	0.99

Steady rate for 3 consecutive readings (R_2): 1.04

Comments:

K_{fs} = 0.01994/min = 1.19 in/hr

GP FIELD DATA SHEET — **SECTION 1: SITE INFORMATION**

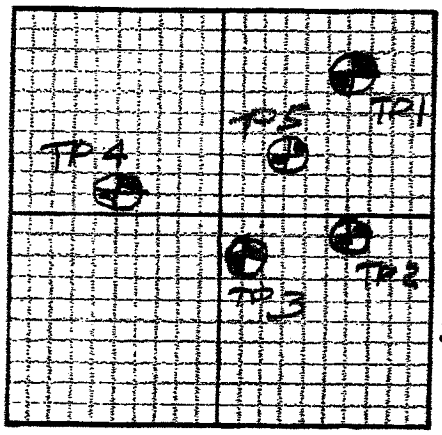
Date 3/12/25 Investigator C. QUINTAL - B. LANE

Site Location LOT 2 FORGE PARK

Dominant Soil Type(s) GRAVELLY FINE SANDY LOAM

Site Map:

TP-3



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

Depth		Description
6"	A	
12"	B	SANDY LOAM 10YR 4/6
72"	C	SAND & GRAVEL 2.5Y 5/3

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

MOTTLES AT 33"

WATER AT 45"

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

Guelph Permeameter Calculations

SOILMOISTURE®

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): 3

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): 1.2600

$\alpha^* =$ 0.12 (cm^{-1})

$C =$ 0.80316
$Q =$ 0.73962

$K_{fs} =$ 1.35E-03 cm/sec
8.07E-02 cm/min
1.35E-05 m/sec
3.18E-02 inch/min
5.30E-04 inch/sec

$\Phi_m =$ 1.12E-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): 3

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): 2.1000

$\alpha^* =$ 0.12 (cm^{-1})

$C =$ 1.28764
$Q =$ 1.2327

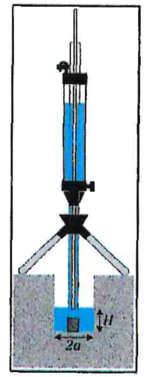
$K_{fs} =$ 1.34E-03 cm/sec
8.01E-02 cm/min
1.34E-05 m/ses
3.16E-02 inch/min
5.28E-04 inch/sec

$\Phi_m =$ 1.11E-02 (cm^2/min)

Average

$K_{fs} =$ 1.34E-03 cm/sec
8.04E-02 cm/min
1.34E-05 m/s
3.17E-02 inch/min
5.28E-04 inch/sec

$\Phi_m =$ 1.12E-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): 3

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

$\alpha^* =$ 0.12 (cm^{-1})

Steady State Rate of Water Level Change ("R1" in cm/min): 1.2600

Steady State Rate of Water Level Change ("R2" in cm/min): 2.1000

1.95

$Q_1 =$ 0.04536

$Q_2 =$ 0.0756

$C_1 =$ 0.80316

$C_2 =$ 1.28754

$G_1 =$ 0.00496

$G_2 =$ 0.00397

$G_3 =$ 0.05569

$G_4 =$ 0.02415

$K_{fs} =$ 7.56E-05 cm/sec
4.53E-03 cm/min
7.56E-07 m/sec
1.78E-03 inch/min
2.97E-05 inch/sec

$\Phi_m =$ 7.01E-04 (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	$\alpha^*(cm^{-1})$	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	$C_1 = \left(\frac{H_1/a}{2.074 + 0.093(H_1/a)}\right)^{0.754}$ $C_2 = \left(\frac{H_2/a}{2.074 + 0.093(H_2/a)}\right)^{0.754}$
Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macro pores, etc.	0.36	$C_1 = \left(\frac{H_1/a}{2.074 + 0.093(H_1/a)}\right)^{0.754}$ $C_2 = \left(\frac{H_2/a}{2.074 + 0.093(H_2/a)}\right)^{0.754}$

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: C. QUINTAL Date: 3/12/25

Location: LOT 2 FORGE PARK Test Id: 1

Depth of hole: 46" 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		22		
2:19	2.31	25	3	1.30
6:00	3.68	30	5	1.36
10:05	4.08	35	5	1.22
14:05	4.00	40	5	1.25
18:14	4.15	45	5	1.21
22:14	4.00	50	5	1.25
26:14	4.00	55	5	1.25
30:14	4.00	60	5	1.25
34:20	4.10	65	5	1.22

Steady rate for 3 consecutive readings (R_1): 1.26

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		14		
2:27	2.45	20	6	2.45
5:34	3.12	26	6	1.93
7:31	1.95	30	4	2.05
10:33	3.03	36	6	1.98
12:22	1.82	40	4	2.20
14:57	2.58	45	5	1.94
17:17	2.40	50	5	2.08
20:00	2.72	55	5	1.84
22:04	2.07	60	5	2.42
24:26	2.37	65	5	2.11

Steady rate for 3 consecutive readings (R_2): 2.10

Comments:

K_{fs} = 0.0317 in/min = 1.90 in/hr

GP FIELD DATA SHEET **SECTION 1: SITE INFORMATION**

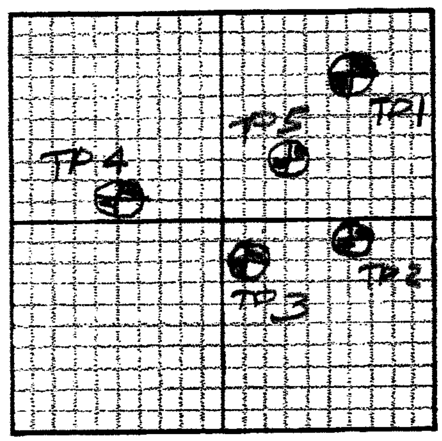
Date 3/12/25 Investigator C. QUINTAL - B. LANE

Site Location LOT 2 FORGE PARK

Dominant Soil Type(s) GRAVELY FINE SANDY LOAM

Site Map:

TP-1



TP 2 ABANDONED

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

Depth		Description
26"	A+	SANDY LOAM 10YR 5/2
44"	C1	LOAMY SAND 2.5Y 5/3
58"	C2	LOAMY SAND 10YR 5/4
108"	C3	SAND & GRAVEL 2.5Y 5/3

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

BOULDERS IN C3

NO WATER

NO MOTTLES

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

SOILMOISTURE

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): **4.1700**

$\alpha^* =$ 0.36 (cm^{-1})

$C =$ 0.80316
$Q =$ 2.44779

$K_{fs} =$ 7.36E-03 cm/sec
4.42E-01 cm/min
7.36E-05 m/sec
1.74E-01 inch/min
2.90E-03 inch/sec

$\Phi_m =$ 2.04E-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. 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): **7.0200**

$\alpha^* =$ 0.36 (cm^{-1})

$C =$ 1.28754
$Q =$ 4.12074

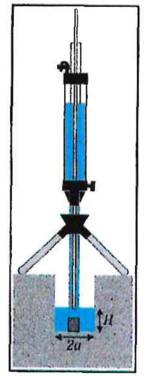
$K_{fs} =$ 6.32E-03 cm/sec
3.79E-01 cm/min
6.32E-05 m/ses
1.49E-01 inch/min
2.49E-03 inch/sec

$\Phi_m =$ 1.76E-02 (cm^2/min)

Average

$K_{fs} =$ 6.84E-03 cm/sec
4.11E-01 cm/min
6.84E-05 m/s
1.62E-01 inch/min
2.69E-03 inch/sec

$\Phi_m =$ 1.90E-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

$\alpha^* =$ 0.36 (cm^{-1})

Steady State Rate of Water Level Change ("R1" in cm/min): **4.1700**

Steady State Rate of Water Level Change ("R2" in cm/min): **7.0200**

1.95

$Q_1 =$ 0.15012

$Q_2 =$ 0.25272

$C_1 =$ 0.80315

$C_2 =$ 1.28754

$G_1 =$ 0.00496

$G_2 =$ 0.00397

$G_3 =$ 0.05569

$G_4 =$ 0.02415

$K_{fs} =$ 2.60E-04 cm/sec
1.56E-02 cm/min
2.60E-06 m/sec
6.14E-03 inch/min
1.02E-04 inch/sec

$\Phi_m =$ 2.26E-03 (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 a^* 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	$C_1 = \left(\frac{H_1/a}{2.074 + 0.093(H_1/a)}\right)^{0.754}$ $C_2 = \left(\frac{H_2/a}{2.074 + 0.093(H_2/a)}\right)^{0.754}$
Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macro pores, etc.	0.36	$C_1 = \left(\frac{H_1/a}{2.074 + 0.093(H_1/a)}\right)^{0.754}$ $C_2 = \left(\frac{H_2/a}{2.074 + 0.093(H_2/a)}\right)^{0.754}$

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: G. QUINTAL Date: 3/12/24

Location: LOT 2 FORGE PARK Test Id: 5

Depth of hole: 20" 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		17		
0:31	0.52	20	3	5.81
1:40	1.15	25	5	4.35
2:52	1.20	30	5	4.17
4:02	1.17	35	5	4.29
5:12	1.17	40	5	4.29
6:26	1.23	45	5	4.05
7:37	1.18	50	5	4.22
8:50	1.22	55	5	4.11
10:04	1.23	60	5	4.05
11:15	1.18	65	5	4.23
12:31	1.27	70	5	3.94

Steady rate for 3 consecutive readings (R_1): 4.17

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		22		
0:45	0.75	30	8	10.67
1:26	0.68	35	5	7.32
2:08	0.70	40	5	7.14
2:50	0.70	45	5	7.14
3:34	0.73	50	5	6.82
4:17	0.72	55	5	6.98
5:00	0.72	60	5	6.98
5:45	0.75	65	5	6.67
6:27	0.70	70	5	7.14

Steady rate for 3 consecutive readings (R_2): 7.02

Comments:

K_{fs} = 0.162 in/min = 9.72 in/hr

GP FIELD DATA SHEET **SECTION 1: SITE INFORMATION**

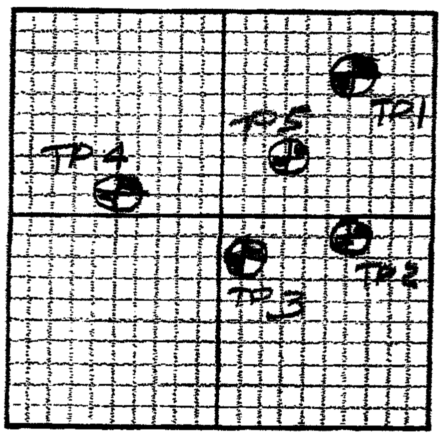
Date 3/12/25 Investigator G. QUINTAL - B. LANE

Site Location LOT 2 FORGE PARK

Dominant Soil Type(s) GRAVELLY SANDY LOAM (W/SHALE)

Site Map:

TP-5



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

Depth	Horizon	Description
0–20"	A+B	
20"–52"	C1	SAND & GRAVEL 2.5Y 5/3
52"–84"	C2	SAND & SHALE 2.5Y 5/2

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

WEATHERED SHALE - BREAKING EASILY

NO WATER

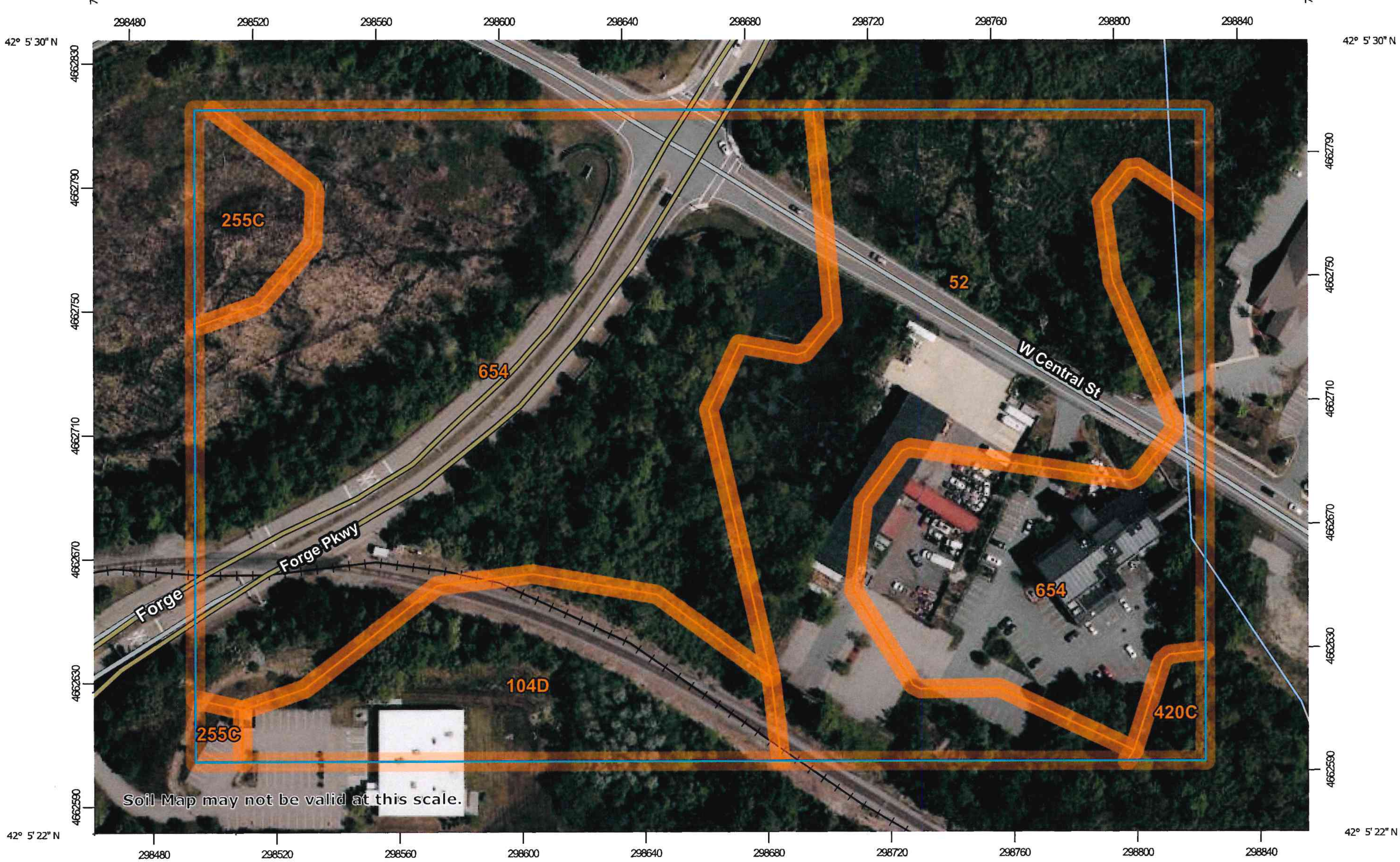
NO MOTTLES

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
(Lot 2 Forge Park)



Map Scale: 1:1,810 if printed on A landscape (11" x 8.5") sheet.

Meters: 0, 25, 50, 100, 150

Feet: 0, 50, 100, 200, 300

N

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 20, Aug 27, 2024

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

Date(s) aerial images were photographed: May 22, 2022—Jun 5, 2022

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
52	Freetown muck, 0 to 1 percent slopes	4.6	27.0%
104D	Hollis-Rock outcrop-Charlton complex, 15 to 35 percent slopes	1.9	11.3%
255C	Windsor loamy sand, 8 to 15 percent slopes	0.5	3.2%
420C	Canton fine sandy loam, 8 to 15 percent slopes	0.2	0.9%
654	Udorthents, loamy	9.9	57.6%
Totals for Area of Interest		**17.2**	**100.0%**

Norfolk and Suffolk Counties, Massachusetts

654—Udorthents, loamy

Map Unit Setting

National map unit symbol: vkyb
Elevation: 0 to 3,000 feet
Mean annual precipitation: 45 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 145 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Udorthents and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Udorthents

Setting

Landform position (two-dimensional): Shoulder, summit
Landform position (three-dimensional): Riser, tread
Down-slope shape: Convex, linear
Across-slope shape: Convex, linear
Parent material: Excavated and filled coarse-loamy human transported material

Typical profile

H1 - 0 to 6 inches: variable
H2 - 6 to 60 inches: variable

Properties and qualities

Slope: 0 to 25 percent
Depth to restrictive feature: More than 80 inches
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to very high (0.06 to 20.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: A
Hydric soil rating: Unranked

Minor Components

Udorthents,sandy

Percent of map unit: 8 percent
Hydric soil rating: Unranked

Udorthents,wet substr.

Percent of map unit: 8 percent
Hydric soil rating: Unranked

Urban land

Percent of map unit: 4 percent
Hydric soil rating: Unranked

Data Source Information

Soil Survey Area: Norfolk and Suffolk Counties, Massachusetts
Survey Area Data: Version 20, Aug 27, 2024

Norfolk and Suffolk Counties, Massachusetts

104D—Hollis-Rock outcrop-Charlton complex, 15 to 35 percent slopes

Map Unit Setting

National map unit symbol: vkvh
Elevation: 20 to 610 feet
Mean annual precipitation: 32 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 120 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Hollis and similar soils: 35 percent
Rock outcrop: 30 percent
Charlton and similar soils: 25 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hollis

Setting

Landform: Hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Shallow, friable loamy ablation till derived from igneous and metamorphic rock

Typical profile

H1 - 0 to 3 inches: fine sandy loam
H2 - 3 to 14 inches: gravelly fine sandy loam
H3 - 14 to 18 inches: unweathered bedrock

Properties and qualities

Slope: 15 to 35 percent
Surface area covered with cobbles, stones or boulders: 1.6 percent
Depth to restrictive feature: 10 to 20 inches to lithic bedrock
Drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.14 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Very low (about 1.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: D
Ecological site: F144AY033MA - Shallow Dry Till Uplands
Hydric soil rating: No

Description of Rock Outcrop

Setting

Parent material: Igneous and metamorphic rock

Properties and qualities

Slope: 15 to 35 percent
Depth to restrictive feature: 0 inches to lithic bedrock

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8s
Hydric soil rating: Unranked

Description of Charlton

Setting

Landform: Hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Friable coarse-loamy ablation till derived from granite

Typical profile

H1 - 0 to 6 inches: fine sandy loam
H2 - 6 to 36 inches: fine sandy loam
H3 - 36 to 60 inches: fine sandy loam

Properties and qualities

Slope: 15 to 35 percent
Surface area covered with cobbles, stones or boulders: 1.6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 7.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: A
Ecological site: F144AY034CT - Well Drained Till Uplands
Hydric soil rating: No

Minor Components

Chatfield

Percent of map unit: 5 percent
Hydric soil rating: No

Canton

Percent of map unit: 5 percent
Hydric soil rating: No

Data Source Information

Soil Survey Area: Norfolk and Suffolk Counties, Massachusetts
Survey Area Data: Version 20, Aug 27, 2024

Norfolk and Suffolk Counties, Massachusetts

52—Freetown muck, 0 to 1 percent slopes

Map Unit Setting

National map unit symbol: 2t2q9
Elevation: 0 to 1,110 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

Freetown and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Freetown

Setting

Landform: Depressions, depressions, swamps, kettles, marshes, bogs
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread, dip
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Highly decomposed organic material

Typical profile

Oe - 0 to 2 inches: mucky peat
Oa - 2 to 79 inches: muck

Properties and qualities

Slope: 0 to 1 percent
Surface area covered with cobbles, stones or boulders: 0.0 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.14 to 14.17 in/hr)
Depth to water table: About 0 to 6 inches
Frequency of flooding: Rare
Frequency of ponding: Frequent
Available water supply, 0 to 60 inches: Very high (about 19.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: B/D
Ecological site: F144AY043MA - Acidic Organic Wetlands

Hydric soil rating: Yes

Minor Components

Whitman

Percent of map unit: 5 percent
Landform: Drainageways, depressions
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Swansea

Percent of map unit: 5 percent
Landform: Bogs, swamps, marshes, depressions, depressions, kettles
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread, dip
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Scarboro

Percent of map unit: 5 percent
Landform: Drainageways, depressions
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope, tread, dip
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Data Source Information

Soil Survey Area: Norfolk and Suffolk Counties, Massachusetts
Survey Area Data: Version 20, Aug 27, 2024

Commonwealth of Massachusetts
City/Town of

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

A. Facility Information

Owner Name

Lot 2 Forge Park
Street Address

Map/Lot #

Franklin — City
MA — State
02038 — Zip Code

B. Site Information

1. (Check one) ☒ New Construction ☐ Upgrade
2. Soil Survey
   NRCS — Source
   Udorthents over Hollis Rock — Soil Map Unit
   104D — Soil Series
   hills — Landform
   Soil Limitations
   friable loamy ablation till — Soil Parent material
3. Surficial Geological Report
   MassMapper — Year Published/Source
   Map Unit
   Description of Geologic Map Unit:
4. Flood Rate Insurance Map — Within a regulatory floodway? ☐ Yes ☒ No
5. Within a velocity zone? ☐ Yes ☒ No
6. Within a Mapped Wetland Area? ☐ Yes ☒ No — If yes, MassGIS Wetland Data Layer: Wetland Type
7. Current Water Resource Conditions (USGS): 07/16/2025 (Month/Day/ Year) — Range: ☐ Above Normal ☒ Normal ☐ Below Normal
8. Other references reviewed:
   (Zone II, IWPA, Zone A, EEA Data Portal, etc.)

Commonwealth of Massachusetts
City/Town of

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

C. On-Site Review *(minimum of two holes required at every proposed primary and reserve disposal area)*

Deep Observation Hole Number: TP-6 (Hole #) | 7/16/25 (Date) | 9:30 (Time) | 90 (Weather) | ____ (Latitude) | ____ (Longitude)

1. Land Use: forested (e.g., woodland, agricultural field, vacant lot, etc.) | trees (Vegetation) | ____ Surface Stones (e.g., cobbles, stones, boulders, etc.) | 5-7% Slope (%)

Description of Location: vacant lot

2. Soil Parent Material: friable loamy ablation till | hills (Landform) | ____ Position on Landscape (SU, SH, BS, FS, TS, Plain)

3. Distances from: Open Water Body ____ feet | Drainage Way ____ feet | Wetlands >100 feet

Property Line ____ feet | Drinking Water Well ____ feet | Other ____ feet

4. Unsuitable Materials Present: ☐ Yes ☒ No | If Yes: ☐ Disturbed Soil/Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☐ Yes ☒ No | If yes: ____ Depth to Weeping in Hole ____ Depth to Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-9"	A	sandy loam	10YR3/2		Cnc : Dpl:				single gran	loose	
9-27"	B	sandy loam	10YR5/4		Cnc : Dpl:				single grain	loose	
27-57"	C1	loamy sand	2.5Y5/3		Cnc : Dpl:				single rain	dense	
57-122"	C2	med-fine sand	2.5Y6/3		Cnc : Dpl:				single grain	loose	
					Cnc : Dpl:						
no water	mo mottles				Cnc : Dpl:						

Additional Notes:

Commonwealth of Massachusetts
City/Town of

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

C. On-Site Review *(minimum of two holes required at every proposed primary and reserve disposal area)*

Deep Observation Hole Number: TP-7 (Hole #) 7/16/25 (Date) 10:00 (Time) 90 (Weather) ____ (Latitude) ____ (Longitude)

1. Land Use: forested (e.g., woodland, agricultural field, vacant lot, etc.) trees (Vegetation) ____ Surface Stones (e.g., cobbles, stones, boulders, etc.) ____ Slope (%)

   Description of Location: vacamt

2. Soil Parent Material: Udorthents over Hollis Rock hills (Landform) ____ Position on Landscape (SU, SH, BS, FS, TS, Plain)

3. Distances from: Open Water Body ____ feet Drainage Way ____ feet Wetlands >100 feet

   Property Line ____ feet Drinking Water Well ____ feet Other ____ feet

4. Unsuitable Materials Present: ☐ Yes ☒ No If Yes: ☐ Disturbed Soil/Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☐ Yes ☒ No If yes: ____ Depth to Weeping in Hole ____ Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA)	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-9"	A	sandy loam	10YR3/2		Cnc : Dpl:				single grain	loose	
9-27"	B	sandy loam	10YR5/4		Cnc : Dpl:				single grain	loose	
27-44"	C1	loamy sand	2.5Y5/3		Cnc : Dpl:				single grain	dense	
44-134"	C2	med-fine sand	2.5Y6/3		Cnc : Dpl:				single grain	loose	
					Cnc : Dpl:						
no water	no mottles				Cnc : Dpl:						

Additional Notes:

Commonwealth of Massachusetts
City/Town of

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

D. Determination of High Groundwater Elevation

1. Method Used (Choose one): Obs. Hole # _____ Obs. Hole # _____

☐ Depth to soil redoximorphic features _____ inches _____ inches

☐ Depth to observed standing water in observation hole _____ inches _____ inches

☐ Depth to adjusted seasonal high groundwater (S_h) (USGS methodology) _____ inches _____ inches

_____ Index Well Number _____ Reading Date

$S_h = S_c - [S_r \times (OW_c - OW_{max})/OW_r]$

Obs. Hole/Well# _____ S_c _____ S_r _____ OW_c _____ OW_{max} _____ OW_r _____ S_h _____

E. Depth of Pervious Material

1. Depth of Naturally Occurring Pervious Material

a. Does at least four feet of naturally occurring pervious material exist in all areas observed throughout the area proposed for the soil absorption system?

☐ Yes ☐ No

b. If yes, at what depth was it observed (exclude O, A, and E Horizons)? Upper boundary: _____ inches Lower boundary: _____ inches

c. If no, at what depth was impervious material observed? Upper boundary: _____ inches Lower boundary: _____ inches

Commonwealth of Massachusetts
City/Town of

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

F. Certification

I certify that I am currently approved by the Department of Environmental Protection pursuant to 310 CMR 15.017 to conduct soil evaluations and that the above analysis has been performed by me consistent with the required training, expertise and experience described in 310 CMR 15.017. I further certify that the results of my soil evaluation, as indicated in the attached Soil Evaluation Form, are accurate and in accordance with 310 CMR 15.100 through 15.107

Signature of Soil Evaluator	07/16/2025 Date
Carlos A. Quintal, SE1990 Typed or Printed Name of Soil Evaluator / License #	06/30/2028 Expiration Date of License
Name of Approving Authority Witness	Approving Authority

Note: In accordance with 310 CMR 15.018(2) this form must be submitted to the approving authority within 60 days of the date of field testing, and to the designer and the property owner with Percolation Test Form 12.

Field Diagrams: Use this area for field diagrams:

APPENDIX G

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)*	✓
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)*	✓
Clearing, grading, and building placement consider view sheds	✓
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	✓

GOALS and NEEDS addressed:

1. Protect local and regional wetlands and water bodies;
2. Maximize groundwater recharge to retain a viable local groundwater supply; and
3. Minimize pollutants in stormwater runoff.

FRANKLIN POLICY: In addition to MassDEP's Stormwatcr Management Standards, all new development projects in Franklin must meet the following performance measures. All redevelopment projects shall meet the standards and if they fail to meet the standards, shall retrofit or expand existing stormwatcr management systems to improve existing conditions.

1. Post-development peak discharge rates and volumes from the site shall not exceed pre-development peak discharge rates and volumes from the site.
2. All drainage facilities proposed shall utilize best management practices as outlined in the Massachusetts Stormwater Management Standards.
3. All sites will have an Operation and Maintenance plan to insure future compliance.

Additionally, new development projects must:

1. Retain the volume of runoff equivalent to, or greater than, one (1.0) inch multiplied by the total post-construction impervious surface area on the site AND/OR
2. Remove 90% of the average annual load of Total Suspended Solids (TSS) generated from the total post-construction impervious area on the site AND 60% of the average annual load of Total Phosphorus (TP) generated from the total post-construction impervious surface area on the site.

And redevelopment projects must:

1. Retain the volume of runoff equivalent to, or greater than, 0.80 inch multiplied by the total post-construction impervious surface area on the site AND/OR
2. Remove 80% of the average annual post-construction load of Total Suspended Solids (TSS) generated from the total post-construction impervious area on the site AND 50% of the average annual load of Total Phosphorus (TP) generated from the total post-construction impervious surface area on the site.

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?	Site Constraints Necessitate Use

Erosion & Sedimentation Control

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, and 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 into Project?
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)*	Filed For

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)*
	✓

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 H

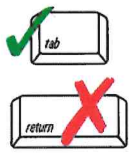
Massachusetts Department of Environmental Protection

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.

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[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.

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

8/4/15

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 for Stormwater Report

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 for Stormwater Report

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.

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[1] 80% TSS removal is required prior to discharge to infiltration BMP if Dynamic Field method is used.

Checklist for Stormwater Report

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 (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 I

Operation and Maintenance Plan

FOR
Site Plan Lot 2 Forge Parkway

LOCATED IN
FRANKLIN, MASSACHUSETTS

PREPARED FOR
Camford Property Group, LLC
138 East Central Street
Franklin, MA 02038

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

DATE: July 7, 2025

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 landscaping will consist of mulch with trees, shrubs, turf lawn 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 and native seed mixes. 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 outside of the building.
The owner will have routine inspections and maintenance completed for the Storm-water BMP's. See the Operation and Maintenance Plan Stormwater Facilities Plan for details and schedule.
No hazardous materials for the businesses are anticipated. If hazardous materials are proposed in the future they will be stored within the building.
The owner will employ a landscape professional to determine and apply the minimum amounts of fertilizers, herbicides and pesticides. No storage of landscape materials on site is proposed.
The site is serviced by Town water and an onsite septic systems.
A dumpster is proposed to provide refuse storage and will be emptied and disposed of offsite.
The owner will designate an emergency contact person prior to commencing construction.
Snow will be placed in the snow storage areas provided on the site plan. If necessary, excess parking spaces could be used to store snow.
The owner will apply the minimum amount of sand and salt necessary. The parking area will be swept four per year with one sweeping being immediately following the last winter sanding.
Sand piles will not be stored on site.

Operation and Maintenance Plan Reference

An operation and maintenance schedule for the construction period and the post-development period has been provided on the Operation and Maintenance Plan Stormwater Facilities Plan.
Refer to the O&M plan (Sheet 5) for the location of the proposed grading and drainage easement.

During the construction period and after completion the future Owner, Camford Property Group, Inc. 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 $2,500.

The owner will provide documentation which will be submitted to the Franklin DPW confirming when maintenance has been satisfactorily completed.

The maintenance in the maintenance agreement may be amended to achieve the purpose of the bylaws by mutual agreement of the Director of the DPW and the responsible parties.

The owner of the stormwater management system will notify the Director of changes in ownership or assignment of financial responsibility.

The owner will provide future property owners with a copy of the O&M plan and the Stormwater Facilities plan and inform them of the responsibilities of the stormwater system inspections and maintenance.

The owner shall contract with a company which provides emergency response, spill containment and remediation.
The owner will have a spill prevention kit on site for any spills containing oil or gas.
The owners shall employ a landscape professional who is qualified in fertilizer and pesticide applications.
Landscape professionals shall provide spill containment for all fertilizers and pesticides.

Industrial Wastewater Holding Tank (IWWHT)
The IWWHT shall be inspected weekly including the depth of liquid in the tank and possible leakage into the outer tank. The floats shall also be inspected to confirm they are functioning.
The IWWHT is equipped with alarms for the inner tank and the outer tank. If an alarm is triggered the owner shall immediately address the alarm by either emptying the tank or repairing a leak in the inner tank. If a leak is found in the inner tank the interstitial space shall be pumped out.
The contents of the tank shall be removed by a qualified company and shall be disposed of offsite an in compliance with all local state and federal regulations.

The owner will provide documentation which will be submitted to the Franklin DPW confirming when maintenance has been satisfactorily completed.

The owner of the stormwater management system will notify the Director of changes in ownership or assignment of financial responsibility.

The Future Owner, Camford Property Group, Inc. will be the party responsible.

____

Name Title

Note: This document shall be signed and submitted with SWPPP and the Town of Franklin Stormwater Permit.

Yearly Inspection and Maintenance Log

Page 1

Lot 2 Forge Parkway
Franklin, Massachusetts

Parking Lot Sweeping and Curb Inspection – Four Times Per Year
Date: __________ Performed By: ______________________________
Date: __________ Performed By: ______________________________
Date: __________ Performed By: ______________________________
Date: __________ Performed By: ______________________________
Parking Lot sweeping shall be completed by a mechanical or vacuum sweeper.

Notes:

Water Quality Units - 4 Times per year
Date: __________ Performed By: ______________________________
Date: __________ Performed By: ______________________________
Date: __________ Performed By: ______________________________
Date: __________ Performed By: ______________________________

Cleaning Performed – 4 Times per year
Date: __________ Performed By: ______________________________
Date: __________ Performed By: ______________________________
Date: __________ Performed By: ______________________________
Date: __________ Performed By: ______________________________
See attached Stormceptor manufactures recommended maintenance requirements.

Notes:

Underground Infiltration Pond – 4 times per year
Date: __________ Performed By: ______________________________
Date: __________ Performed By: ______________________________
Date: __________ Performed By: ______________________________
Date: __________ Performed By: ______________________________

Cleaning Performed:
Date: __________ Performed By: ______________________________
Date: __________ Performed By: ______________________________
Date: __________ Performed By: ______________________________
Date: __________ Performed By: ______________________________
Inspect and clean pretreatment BMP's every six months and after every major storm event (2 year return frequency). Check the inlet and outlet pipes to determine if they are clogged. Remove accumulated sediment, trash, debris, leaves, lawn clippings from mowing.
Inspect the infiltration area after the first several rainfall events, after all major storms, and on regularly scheduled dates every six months.
Inspect the infiltration area 24 hours to several days after a rain event, to look for ponded water at the surface of the trench. If water is present in may be that the infiltration area is clogged. If so then

rehabilitation of the bottom of the trench shall be completed including removing all accumulated sediment, scarifying and till the bottom area, remove and replace the stone media.

Notes:

<u>Landscape Area Inspection – 4 times per year</u>

Date: __________ Performed By:______________________________

Date: __________ Performed By:______________________________

Date: __________ Performed By:______________________________

Date: __________ Performed By:______________________________

Work Performed Repairs completed:

Date: __________ Performed By:______________________________

Date: __________ Performed By:______________________________

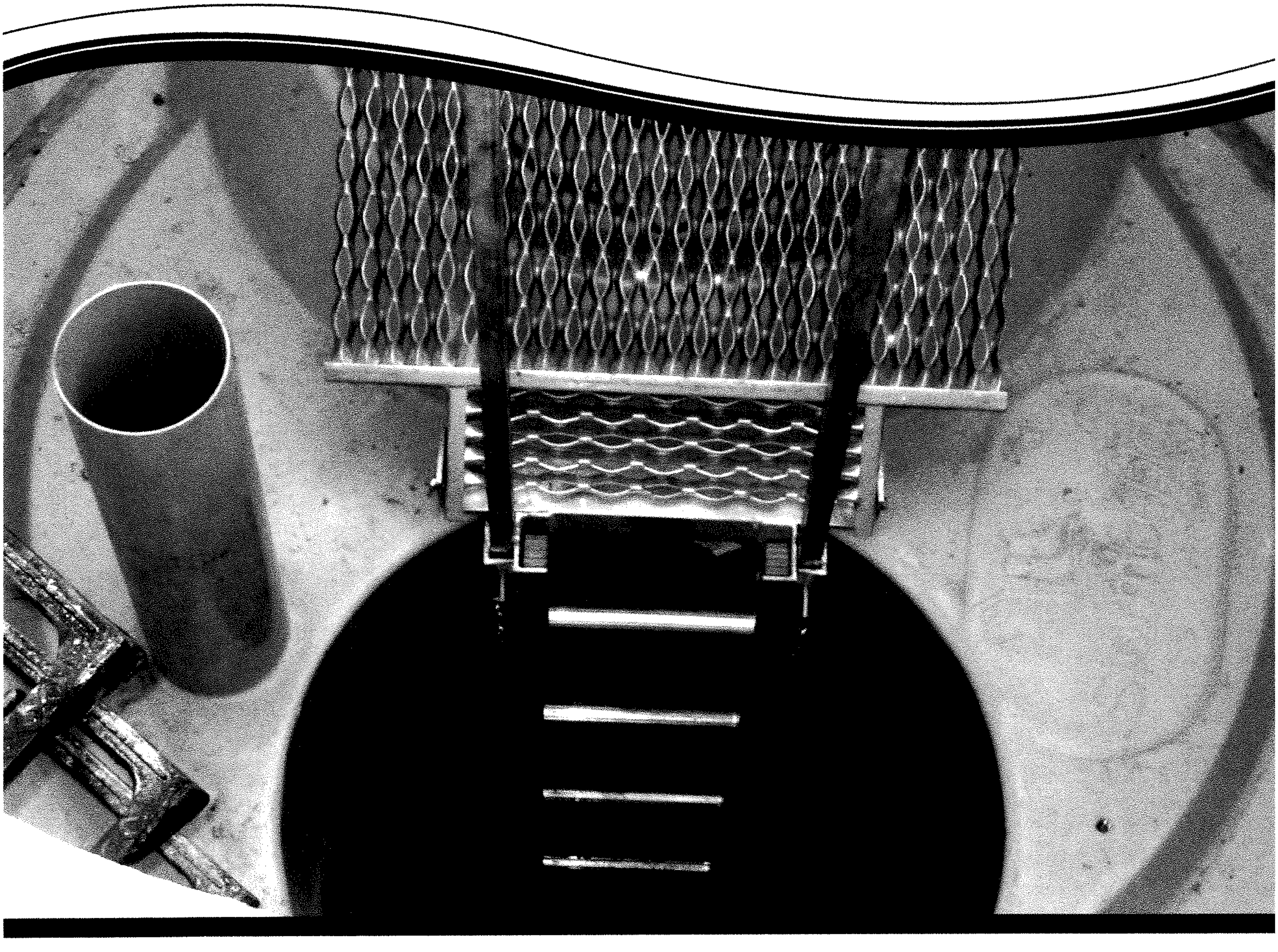
Date: __________ Performed By:______________________________

Date: __________ Performed By:______________________________

Inspect the area with grass for bare spots and erosion. Repair eroded areas with loam and seed to provide adequate coverage. Inspect landscaped areas for erosion and weeds. Fix erosion and apply additional mulch or landscape stone as necessary.

CONTECH®
ENGINEERED SOLUTIONS

Stormceptor® STC
Operation and Maintenance Guide



Stormceptor STC

Stormceptor Design Notes

- Only the STC 450i is adaptable to function with a catch basin inlet and/or inline pipes.
- Only the Stormceptor models STC 450i to STC 7200 may accommodate multiple inlet pipes.

Inlet and outlet invert elevation differences are as follows:

Inlet and Outlet Pipe Invert Elevations Differences			
Inlet Pipe Configuration	STC 450i	STC 900 to STC 7200	STC 11000 to STC 16000
Single inlet pipe	3 in. (75 mm)	1 in. (25 mm)	3 in. (75 mm)
Multiple inlet pipes	3 in. (75 mm)	3 in. (75 mm)	Only one inlet pipe.

Maximum inlet and outlet pipe diameters:

Inlet/Outlet Configuration	**Inlet Unit** STC 450i	**In-Line Unit** STC 900 to STC 7200	**Series*** STC 11000 to STC 16000
Straight Through	24 inch (600 mm)	42 inch (1050 mm)	60 inch (1500 mm)
Bend (90 degrees)	18 inch (450 mm)	33 inch (825 mm)	33 inch (825 mm)

- The inlet and in-line Stormceptor units can accommodate turns to a maximum of 90 degrees.
- Minimum distance from top of grade to crown is 2 feet (0.6 m)
- Submerged conditions. A unit is submerged when the standing water elevation at the proposed location of the Stormceptor unit is greater than the outlet invert elevation during zero flow conditions. In these cases, please contact your local Stormceptor representative and provide the following information:
- Top of grade elevation
- Stormceptor inlet and outlet pipe diameters and invert elevations
- Standing water elevation
- Stormceptor head loss, K = 1.3 (for submerged condition, K = 4)

Stormceptor

OPERATION AND MAINTENANCE GUIDE

Table of Content

1. About Stormceptor

The Stormceptor® STC (Standard Treatment Cell) was developed by Imbrium™ Systems to address the growing need to remove and isolate pollution from the storm drain system before it enters the environment. The Stormceptor STC targets hydrocarbons and total suspended solids (TSS) in stormwater runoff. It improves water quality by removing contaminants through the gravitational settling of fine sediments and floatation of hydrocarbons while preventing the re-suspension or scour of previously captured pollutants.

The development of the Stormceptor STC revolutionized stormwater treatment, and created an entirely new category of environmental technology. Protecting thousands of waterways around the world, the Stormceptor System has set the standard for effective stormwater treatment.

1.1. Patent Information

The Stormceptor technology is protected by the following patents:

- Australia Patent No. 693,164 • 693,164 • 707,133 • 729,096 • 779401
- Austrian Patent No. 289647
- Canadian Patent No 2,009,208 •2,137,942 • 2,175,277 • 2,180,305 • 2,180,383 • 2,206,338 • 2,327,768 (Pending)
- China Patent No 1168439
- Denmark DK 711879
- German DE 69534021
- Indonesian Patent No 16688
- Japan Patent No 9-11476 (Pending)
- Korea 10-2000-0026101 (Pending)
- Malaysia Patent No PI9701737 (Pending)
- New Zealand Patent No 314646
- United States Patent No 4,985,148 • 5,498,331 • 5,725,760 • 5,753,115 • 5,849,181 • 6,068,765 • 6,371,690
- Stormceptor OSR Patent Pending • Stormceptor LCS Patent Pending

2. Stormceptor Design Overview

2.1. Design Philosophy

The patented Stormceptor System has been designed to focus on the environmental objective of providing long-term pollution control. The unique and innovative Stormceptor design allows for continuous positive treatment of runoff during all rainfall events, while ensuring that all captured pollutants are retained within the system, even during intense storm events.

An integral part of the Stormceptor design is PCSWMM for Stormceptor - sizing software developed in conjunction with Computational Hydraulics Inc. (CHI) and internationally acclaimed expert, Dr. Bill James. Using local historical rainfall data and continuous simulation modeling, this software allows a Stormceptor unit to be designed for each individual site and the corresponding water quality objectives.

By using PCSWMM for Stormceptor, the Stormceptor System can be designed to remove a wide range of particles (typically from 20 to 2,000 microns), and can also be customized to remove a specific particle size distribution (PSD). The specified PSD should accurately reflect what is in the stormwater runoff to ensure the device is achieving the desired water quality objective. Since stormwater runoff contains small particles (less than 75 microns), it is important to design a treatment system to remove smaller particles in addition to coarse particles.

2.2. Benefits

The Stormceptor System removes free oil and suspended solids from stormwater, preventing spills and non-point source pollution from entering downstream lakes and rivers. The key benefits, capabilities and applications of the Stormceptor System are as follows:

- Provides continuous positive treatment during all rainfall events
- Can be designed to remove over 80% of the annual sediment load
- Removes a wide range of particles
- Can be designed to remove a specific particle size distribution (PSD)
- Captures free oil from stormwater
- Prevents scouring or re-suspension of trapped pollutants
- Pre-treatment to reduce maintenance costs for downstream treatment measures (ponds, swales, detention basins, filters)
- Groundwater recharge protection
- Spills capture and mitigation
- Simple to design and specify
- Designed to your local watershed conditions
- Small footprint to allow for easy retrofit installations
- Easy to maintain (vacuum truck)
- Multiple inlets can connect to a single unit
- Suitable as a bend structure
- Pre-engineered for traffic loading (minimum AASHTO HS-20)
- Minimal elevation drop between inlet and outlet pipes
- Small head loss
- Additional protection provided by an 18" (457 mm) fiberglass skirt below the top of the insert, for the containment of hydrocarbons in the event of a spill.

2.3. Environmental Benefit

Freshwater resources are vital to the health and welfare of their surrounding communities. There is increasing public awareness, government regulations and corporate commitment to reducing the pollution entering our waterways. A major source of this pollution originates from stormwater runoff from urban areas. Rainfall runoff carries oils, sediment and other contaminants from roads and parking lots discharging directly into our streams, lakes and coastal waterways.

The Stormceptor System is designed to isolate contaminants from getting into the natural environment. The Stormceptor technology provides protection for the environment from spills that occur at service stations and vehicle accident sites, while also removing contaminated sediment in runoff that washes from roads and parking lots.

3. Key Operation Features

3.1. Scour Prevention

A key feature of the Stormceptor System is its patented scour prevention technology. This innovation ensures pollutants are captured and retained during all rainfall events, even extreme storms. The Stormceptor System provides continuous positive treatment for all rainfall events, including intense storms. Stormceptor slows incoming runoff, controlling and reducing velocities in the lower chamber to create a non-turbulent environment that promotes free oils and floatable debris to rise and sediment to settle.

The patented scour prevention technology, the fiberglass insert, regulates flows into the lower chamber through a combination of a weir and orifice while diverting high energy flows away through the upper chamber to prevent scouring. Laboratory testing demonstrated no scouring when tested up to 125% of the unit's operating rate, with the unit loaded to 100% sediment capacity (NJDEP, 2005). Second, the depth of the lower chamber ensures the sediment storage zone is adequately separated from the path of flow in the lower chamber to prevent scouring.

3.2. Operational Hydraulic Loading Rate

Designers and regulators need to evaluate the treatment capacity and performance of manufactured stormwater treatment systems. A commonly used parameter is the "operational hydraulic loading rate" which originated as a design methodology for wastewater treatment devices.

Operational hydraulic loading rate may be calculated by dividing the flow rate into a device by its settling area. This represents the critical settling velocity that is the prime determinant to quantify the influent particle size and density captured by the device. PCSWMM for Stormceptor uses a similar parameter that is calculated by dividing the hydraulic detention time in the device by the fall distance of the sediment.

$$v_{sc} = \frac{H}{6_H} = \frac{Q}{A_s}$$

Where:

v_{sc} = critical settling velocity, ft/s (m/s)

H = tank depth, ft (m)

$Ø_H$ = hydraulic detention time, ft/s (m/s)

Q = volumetric flow rate, ft3/s (m3/s)

A_s = surface area, ft^2 (m^2)

(Tchobanoglous, G. and Schroeder, E.D. 1987. Water Quality. Addison Wesley.)

Unlike designing typical wastewater devices, stormwater systems are designed for highly variable flow rates including intense peak flows. PCSWMM for Stormceptor incorporates all of the flows into its calculations, ensuring that the operational hydraulic loading rate is considered not only for one flow rate, but for all flows including extreme events.

3.3. Double Wall Containment

The Stormceptor System was conceived as a pollution identifier to assist with identifying illicit discharges. The fiberglass insert has a continuous skirt that lines the concrete barrel wall for a depth of 18 inches (457 mm) that provides double wall containment for hydrocarbons storage. This protective barrier ensures that toxic floatables do not migrate through the concrete wall into the surrounding soils.

4. Stormceptor Product Line

4.1. Stormceptor Models

A summary of Stormceptor models and capacities are listed in Table 1.

Table 1. Stormceptor Models

Stormceptor Model	Total Storage Volume U.S. Gal (L)	Hydrocarbon Storage Capacity U.S. Gal (L)	Maximum Sediment Capacity ft^3 (L)
STC 450i	470 (1,780)	86 (330)	46 (1,302)
STC 900	952 (3,600)	251 (950)	89 (2,520)
STC 1200	1,234 (4,670)	251 (950)	127 (3,596)
STC 1800	1,833 (6,940)	251 (950)	207 (5,861)
STC 2400	2,462 (9,320)	840 (3,180)	205 (5,805)
STC 3600	3,715 (1,406)	840 (3,180)	373 (10,562)
STC 4800	5,059 (1,950)	909 (3,440)	543 (15,376)
STC 6000	6,136 (23,230)	909 (3,440)	687 (19,453)
STC 7200	7,420 (28,090)	1,059 (4,010)	839 (23,757)
STC 11000	11,194 (42,370)	2,797 (10, 590)	1,086 (30,752)
STC 13000	13,348 (50,530)	2,797 (10, 590)	1,374 (38,907)
STC 16000	15,918 (60,260)	3,055 (11, 560)	1,677 (47,487)

NOTE: Storage volumes may vary slightly from region to region. For detailed information, contact your local Stormceptor representative.

4.2. Inline Stormceptor

The Inline Stormceptor, Figure 1, is the standard design for most stormwater treatment applications. The patented Stormceptor design allows the Inline unit to maintain continuous positive treatment of total suspended solids (TSS) year-round, regardless of flow rate. The Inline Stormceptor is composed of a precast concrete tank with a fiberglass insert situated at the invert of the storm sewer pipe, creating an upper chamber above the insert and a lower chamber below the insert.

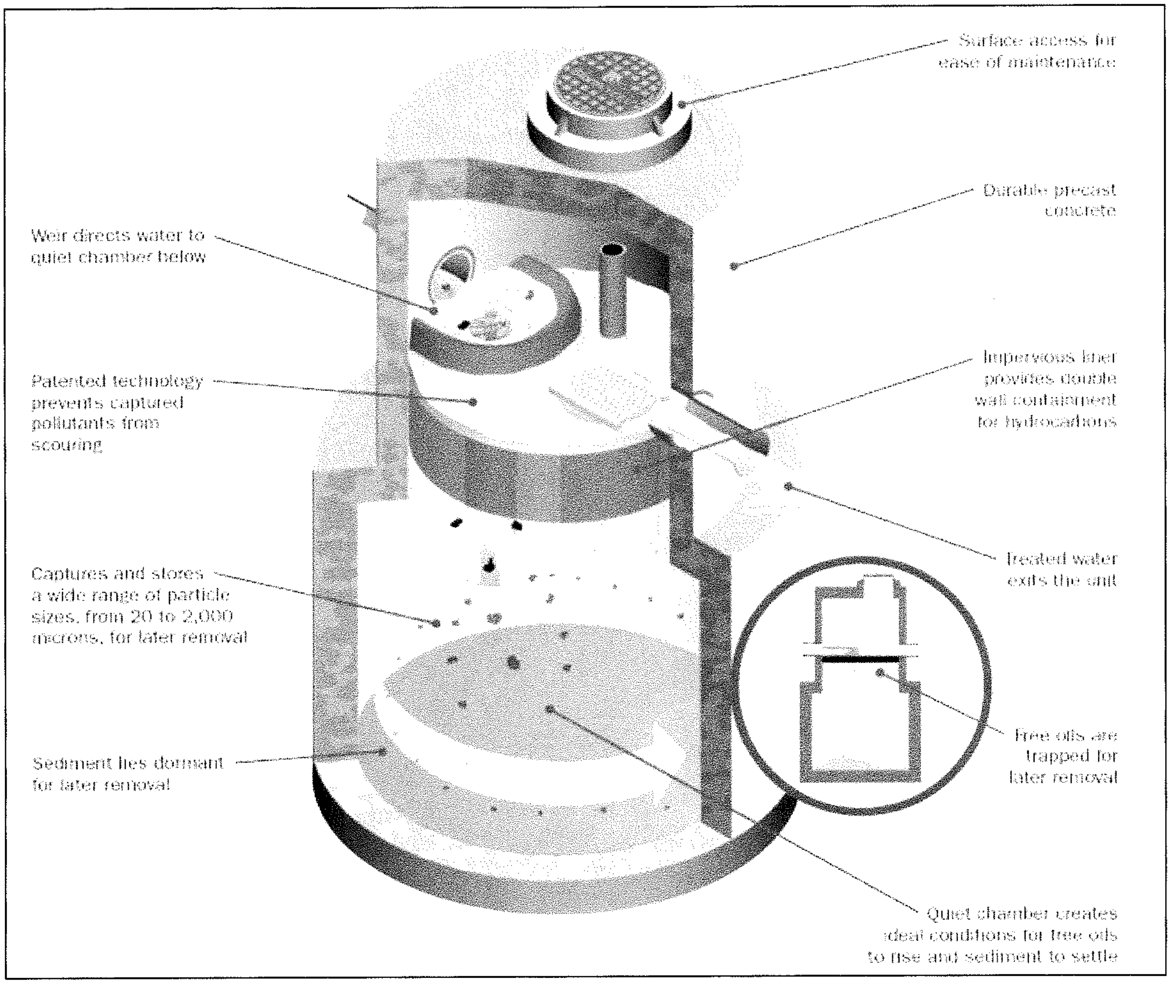


Figure 1. Inline Stormceptor

Operation

As water flows into the Stormceptor unit, it is slowed and directed to the lower chamber by a weir and drop tee. The stormwater enters the lower chamber, a non-turbulent environment, allowing free oils to rise and sediment to settle. The oil is captured underneath the fiberglass insert and shielded from exposure to the concrete walls by a fiberglass skirt. After the pollutants separate, treated water continues up a riser pipe, and exits the lower chamber on the downstream side of the weir before leaving the unit. During high flow events, the Stormceptor System's patented scour prevention technology ensures continuous pollutant removal and prevents re-suspension of previously captured pollutants.

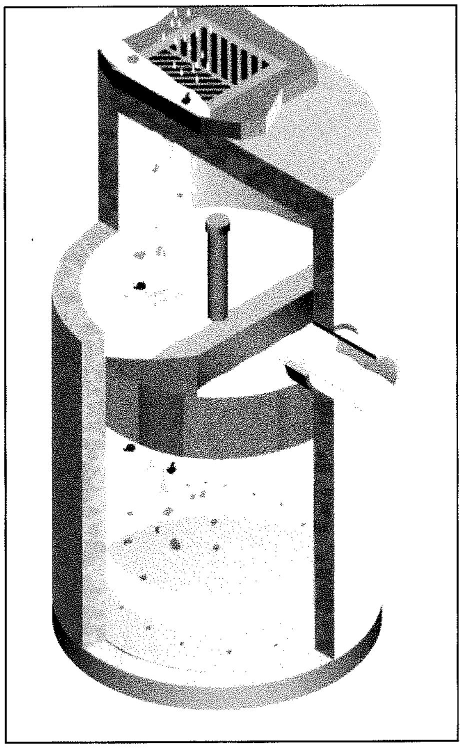


Figure 2. Inlet Stormceptor

4.3. Inlet Stormceptor

The Inlet Stormceptor System, Figure 2, was designed to provide protection for parking lots, loading bays, gas stations and other spill-prone areas. The Inlet Stormceptor is designed to remove sediment from stormwater introduced through a grated inlet, a storm sewer pipe, or both.

The Inlet Stormceptor design operates in the same manner as the Inline unit, providing continuous positive treatment, and ensuring that captured material is not re-suspended.

4.4. Series Stormceptor

Designed to treat larger drainage areas, the Series Stormceptor System, Figure 3, consists of two adjacent Stormceptor models that function in parallel. This design eliminates the need for additional structures and piping to reduce installation costs.

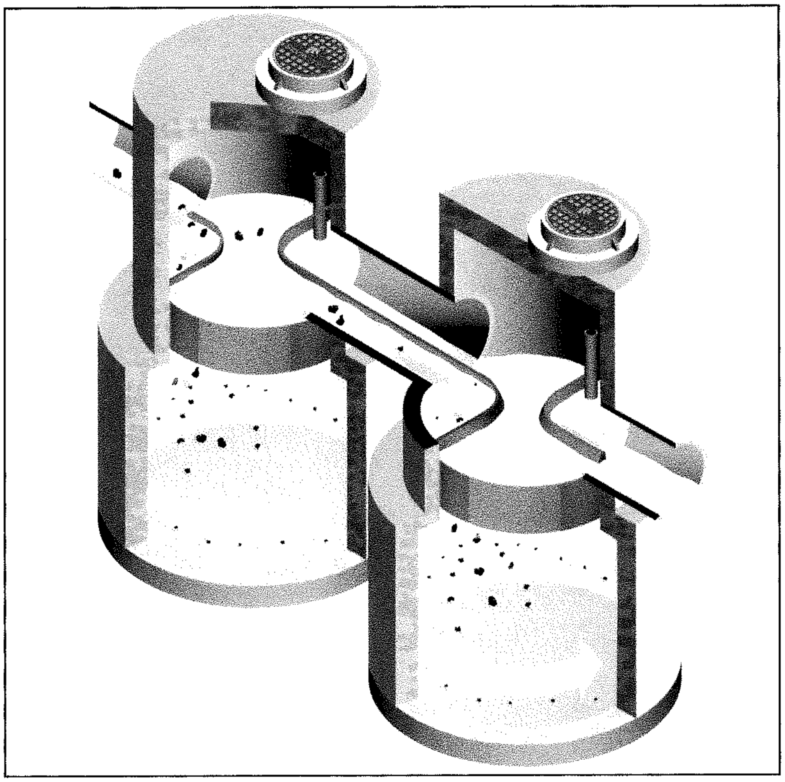


Figure 3. Series System

The Series Stormceptor design operates in the same manner as the Inline unit, providing continuous positive treatment, and ensuring that captured material is not re-suspended.

5. Sizing the Stormceptor System

The Stormceptor System is a versatile product that can be used for many different aspects of water quality improvement. While addressing these needs, there are conditions that the designer needs to be aware of in order to size the Stormceptor model to meet the demands of each individual site in an efficient and cost-effective manner.

PCSWMM for Stormceptor is the support tool used for identifying the appropriate Stormceptor model. In order to size a unit, it is recommended the user follow the seven design steps in the program. The steps are as follows:

STEP 1 – Project Details

The first step prior to sizing the Stormceptor System is to clearly identify the water quality objective for the development. It is recommended that a level of annual sediment (TSS) removal be identified and defined by a particle size distribution.

STEP 2 – Site Details

Identify the site development by the drainage area and the level of imperviousness. It is recommended that imperviousness be calculated based on the actual area of imperviousness based on paved surfaces, sidewalks and rooftops.

STEP 3 – Upstream Attenuation

The Stormceptor System is designed as a water quality device and is sometimes used in conjunction with onsite water quantity control devices such as ponds or underground detention systems. When possible, a greater benefit is typically achieved when installing a Stormceptor unit upstream of a detention facility. By placing the Stormceptor unit upstream of a detention structure, a benefit of less maintenance of the detention facility is realized.

STEP 4 – Particle Size Distribution

It is critical that the PSD be defined as part of the water quality objective. PSD is critical for the design of treatment system for a unit process of gravity settling and governs the size of a treatment system. A range of particle sizes has been provided and it is recommended that clays and silt-sized particles be considered in addition to sand and gravel-sized particles. Options and sample PSDs are provided in PCSWMM for Stormceptor. The default particle size distribution is the Fine Distribution, Table 2, option.

Table 2. Fine Distribution

Particle Size	Distribution	Specific Gravity
20	20%	1.3
60	20%	1.8
150	20%	2.2
400	20%	2.65
2000	20%	2.65

If the objective is the long-term removal of 80% of the total suspended solids on a given site, the PSD should be representative of the expected sediment on the site. For example, a system designed to remove 80% of coarse particles (greater than 75 microns) would provide relatively poor removal efficiency of finer particles that may be naturally prevalent in runoff from the site.

Since the small particle fraction contributes a disproportionately large amount of the total available particle surface area for pollutant adsorption, a system designed primarily for coarse particle capture will compromise water quality objectives.

STEP 5 – Rainfall Records

Local historical rainfall has been acquired from the U.S. National Oceanic and Atmospheric Administration, Environment Canada and regulatory agencies across North America. The rainfall data provided with PCSMM for Stormceptor provides an accurate estimation of small storm hydrology by modeling actual historical storm events including duration, intensities and peaks.

STEP 6 – Summary

At this point, the program may be executed to predict the level of TSS removal from the site. Once the simulation has completed, a table shall be generated identifying the TSS removal of each Stormceptor unit.

STEP 7 – Sizing Summary

Performance estimates of all Stormceptor units for the given site parameters will be displayed in a tabular format. The unit that meets the water quality objective, identified in Step 1, will be highlighted.

5.1. PCSWMM for Stormceptor

The Stormceptor System has been developed in conjunction with PCSWMM for Stormceptor as a technological solution to achieve water quality goals. Together, these two innovations model, simulate, predict and calculate the water quality objectives desired by a design engineer for TSS removal.

PCSWMM for Stormceptor is a proprietary sizing program which uses site specific inputs to a computer model to simulate sediment accumulation, hydrology and long-term total suspended solids removal. The model has been calibrated to field monitoring results from Stormceptor units that have been monitored in North America. The sizing methodology can be described by three processes:

1. Determination of real time hydrology
2. Buildup and wash off of TSS from impervious land areas
3. TSS transport through the Stormceptor (settling and discharge). The use of a calibrated model is the preferred method for sizing stormwater quality structures for the following reasons:
   - The hydrology of the local area is properly and accurately incorporated in the sizing (distribution of flows, flow rate ranges and peaks, back-to-back storms, inter-event times)
   - The distribution of TSS with the hydrology is properly and accurately considered in the sizing
   - Particle size distribution is properly considered in the sizing
   - The sizing can be optimized for TSS removal
   - The cost benefit of alternate TSS removal criteria can be easily assessed
   - The program assesses the performance of all Stormceptor models. Sizing may be selected based on a specific water quality outcome or based on the Maximum Extent Practicable

For more information regarding PCSWMM for Stormceptor, contact your local Stormceptor representative, or visit www.imbriumsystems.com to download a free copy of the program.

5.2. Sediment Loading Characteristics

The way in which sediment is transferred to stormwater can have a considerable effect on which type of system is implemented. On typical impervious surfaces (e.g. parking lots) sediment will build over time and wash off with the next rainfall. When rainfall patterns are examined, a short intense storm will have a higher concentration of sediment than a long slow drizzle. Together with rainfall data representing the site's typical rainfall patterns, sediment loading characteristics play a part in the correct sizing of a stormwater quality device.

Typical Sites

For standard site design of the Stormceptor System, PCSWMM for Stormceptor is utilized to accurately assess the unit's performance. As an integral part of the product's design, the program can be used to meet local requirements for total suspended solid removal. Typical installations of manufactured stormwater treatment devices would occur on areas such as paved parking lots or paved roads. These are considered "stable" surfaces which have non – erodible surfaces.

Unstable Sites

While standard sites consist of stable concrete or asphalt surfaces, sites such as gravel parking lots, or maintenance yards with stockpiles of sediment would be classified as "unstable". These types of sites do not exhibit first flush characteristics, are highly erodible and exhibit atypical sediment loading characteristics and must therefore be sized more carefully. Contact your local Stormceptor representative for assistance in selecting a proper unit sized for such unstable sites.

6. Spill Controls

When considering the removal of total petroleum hydrocarbons (TPH) from a storm sewer system there are two functions of the system: oil removal, and spill capture.

'Oil Removal' describes the capture of the minute volumes of free oil mobilized from impervious surfaces. In this instance relatively low concentrations, volumes and flow rates are considered. While the Stormceptor unit will still provide an appreciable oil removal function during higher flow events and/or with higher TPH concentrations, desired effluent limits may be exceeded under these conditions.

'Spill Capture' describes a manner of TPH removal more appropriate to recovery of a relatively high volume of a single phase deleterious liquid that is introduced to the storm sewer system over a relatively short duration. The two design criteria involved when considering this manner of introduction are overall volume and the specific gravity of the material. A standard Stormceptor unit will be able to capture and retain a maximum spill volume and a minimum specific gravity.

For spill characteristics that fall outside these limits, unit modifications are required. Contact your local Stormceptor Representative for more information.

One of the key features of the Stormceptor technology is its ability to capture and retain spills. While the standard Stormceptor System provides excellent protection for spill control, there are additional options to enhance spill protection if desired.

6.1. Oil Level Alarm

The oil level alarm is an electronic monitoring system designed to trigger a visual and audible alarm when a pre-set level of oil is reached within the lower chamber. As a standard, the oil

level alarm is designed to trigger at approximately 85% of the unit's available depth level for oil capture. The feature acts as a safeguard against spills caused by exceeding the oil storage capacity of the separator and eliminates the need for manual oil level inspection.

The oil level alarm installed on the Stormceptor insert is illustrated in Figure 4.

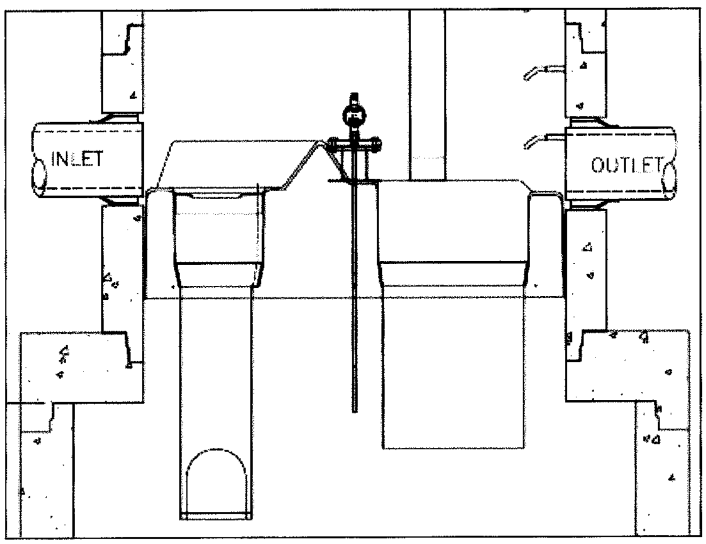


Figure 4. Oil level alarm

6.2. Increased Volume Storage Capacity

The Stormceptor unit may be modified to store a greater spill volume than is typically available. Under such a scenario, instead of installing a larger than required unit, modifications can be made to the recommended Stormceptor model to accommodate larger volumes. Contact your local Stormceptor representative for additional information and assistance for modifications.

7. Stormceptor Options

The Stormceptor System allows flexibility to incorporate to existing and new storm drainage infrastructure. The following section identifies considerations that should be reviewed when installing the system into a drainage network. For conditions that fall outside of the recommendations in this section, please contact your local Stormceptor representative for further guidance.

7.1. Installation Depth Minimum Cover

The minimum distance from the top of grade to the crown of the inlet pipe is 24 inches (600 mm). For situations that have a lower minimum distance, contact your local Stormceptor representative.

7.2. Maximum Inlet and Outlet Pipe Diameters

Maximum inlet and outlet pipe diameters are illustrated in Figure 5. Contact your local Stormceptor representative for larger pipe diameters

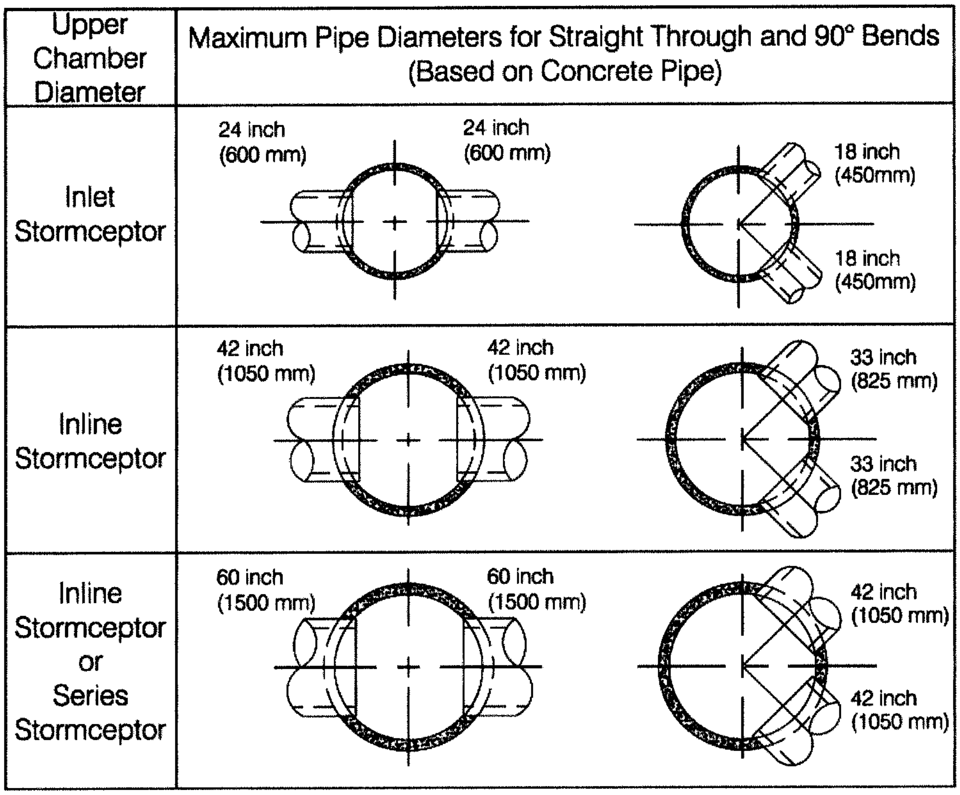


Figure 5. Maximum pipe diameters for straight through and bend applications

*The bend should only be incorporated into the second structure (downstream structure) of the Series Stormceptor System

7.3. Bends

The Stormceptor System can be used to change horizontal alignment in the storm drain network up to a maximum of 90 degrees. Figure 6 illustrates the typical bend situations of the Stormceptor System. Bends should only be applied to the second structure (downstream structure) of the Series Stormceptor System.

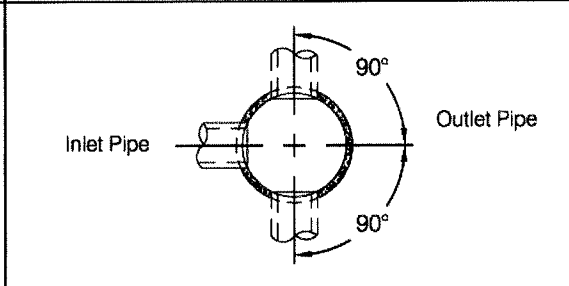
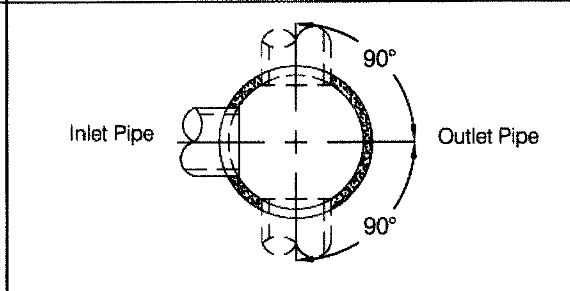
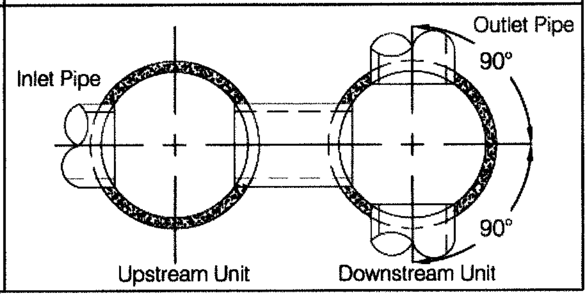
Stormceptor System	Maximum Bend Configurations
Inlet Stormceptor	
Inline Stormceptor	
Series Stormceptor	

Figure 6. Maximum bend angles

7.4. Multiple Inlet Pipes

The Inlet and Inline Stormceptor System can accommodate two or more inlet pipes. The maximum number of inlet pipes that can be accommodated into a Stormceptor unit is a function of the number, alignment and diameter of the pipes and its effects on the structural integrity of the precast concrete. When multiple inlet pipes are used for new developments, each inlet pipe shall have an invert elevation 3 inches (75 mm) higher than the outlet pipe invert elevation.

7.5. Inlet/Outlet Pipe Invert Elevations

Recommended inlet and outlet pipe invert differences are listed in Table 3.

Table 3. Recommended Drops Between Inlet and Outlet Pipe Inverts

Number of Inlet Pipes	Inlet System	In-Line System	Series System
1	3 inches (75 mm)	1 inch (25 mm)	3 inches (75 mm)
>1	3 inches (75 mm)	3 inches (75 mm)	Not Applicable

7.6. Shallow Stormceptor

In cases where there may be restrictions to the depth of burial of storm sewer systems. In this situation, for selected Stormceptor models, the lower chamber components may be increased in diameter to reduce the overall depth of excavation required.

7.7. Customized Live Load

The Stormceptor system is typically designed for local highway truck loading (AASHTO HS- 20). When the project requires live loads greater than HS-20, the Stormceptor System may be customized structurally for a pre-specified live load. Contact your local Stormceptor representative for customized loading conditions.

7.8. Pre-treatment

The Stormceptor System may be sized to remove sediment and for spills control in conjunction with other stormwater BMPs to meet the water quality objective. For pretreatment applications, the Stormceptor System should be the first unit in a treatment train. The benefits of pre-treatment include the extension of the operational life (extension of maintenance frequency) of large stormwater management facilities, prevention of spills and lower total life- cycle maintenance cost.

7.9. Head loss

The head loss through the Stormceptor System is similar to a 60 degree bend at a manhole. The K value for calculating minor losses is approximately 1.3 (minor loss = k*1.3v2/2g).

However, when a Submerged modification is applied to a Stormceptor unit, the corresponding K value is 4.

7.10. Submerged

The Submerged modification, Figure 7, allows the Stormceptor System to operate in submerged or partially submerged storm sewers. This configuration can be installed on all models of the Stormceptor System by modifying the fiberglass insert. A customized weir height and a secondary drop tee are added.

Submerged instances are defined as standing water in the storm drain system during zero flow conditions. In these instances, the following information is necessary for the proper design and application of submerged modifications:

- Stormceptor top of grade elevation
- Stormceptor outlet pipe invert elevation
- Standing water elevation

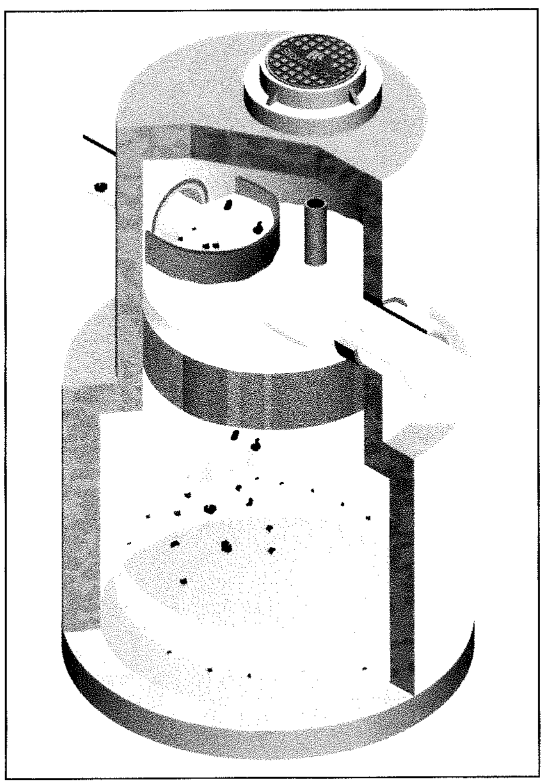


Figure 7. Submerged Stormceptor

8. Comparing Technologies

Designers have many choices available to achieve water quality goals in the treatment of stormwater runoff. Since many alternatives are available for use in stormwater quality treatment it is important to consider how to make an appropriate comparison between "approved alternatives". The following is a guide to assist with the accurate comparison of differing technologies and performance claims.

8.1. Particle Size Distribution (PSD)

The most sensitive parameter to the design of a stormwater quality device is the selection of the design particle size. While it is recommended that the actual particle size distribution (PSD) for sites be measured prior to sizing, alternative values for particle size should be selected to represent what is likely to occur naturally on the site. A reasonable estimate of a particle size distribution likely to be found on parking lots or other impervious surfaces should consist of a wide range of particles such as 20 microns to 2,000 microns (Ontario MOE, 1994).

There is no absolute right particle size distribution or specific gravity and the user is cautioned to review the site location, characteristics, material handling practices and regulatory requirements when selecting a particle size distribution. When comparing technologies, designs using different PSDs will result in incomparable TSS removal efficiencies. The PSD of the TSS removed needs to be standard between two products to allow for an accurate comparison.

8.2. Scour Prevention

In order to accurately predict the performance of a manufactured treatment device, there must be confidence that it will perform under all conditions. Since rainfall patterns cannot be predicted, stormwater quality devices placed in storm sewer systems must be able to withstand extreme events, and ensure that all pollutants previously captured are retained in the system.

In order to have confidence in a system's performance under extreme conditions, independent validation of scour prevention is essential when examining different technologies. Lack of independent verification of scour prevention should make a designer wary of accepting any product's performance claims.

8.3. Hydraulics

Full scale laboratory testing has been used to confirm the hydraulics of the Stormceptor System. Results of lab testing have been used to physically design the Stormceptor System and the sewer pipes entering and leaving the unit. Key benefits of Stormceptor are:

- Low head loss (typical k value of 1.3)
- Minimal inlet/outlet invert elevation drop across the structure
- Use as a bend structure
- Accommodates multiple inlets

The adaptability of the treatment device to the storm sewer design infrastructure can affect the overall performance and cost of the site.

8.4. Hydrology

Stormwater quality treatment technologies need to perform under varying climatic conditions. These can vary from long low intensity rainfall to short duration, high intensity storms. Since a treatment device is expected to perform under all these conditions, it makes sense that any system's design should accommodate those conditions as well.

Long-term continuous simulation evaluates the performance of a technology under the varying conditions expected in the climate of the subject site. Single, peak event design does not provide this information and is not equivalent to long-term simulation. Designers should request long-term simulation performance to ensure the technology can meet the long-term water quality objective.

9. Testing

The Stormceptor System has been the most widely monitored stormwater treatment technology in the world. Performance verification and monitoring programs are completed to the strictest standards and integrity. Since its introduction in 1990, numerous independent field tests and studies detailing the effectiveness of the Stormceptor System have been completed.

- Coventry University, UK – 97% removal of oil, 83% removal of sand and 73% removal of peat
- National Water Research Institute, Canada, - scaled testing for the development of the Stormceptor System identifying both TSS removal and scour prevention.
- New Jersey TARP Program – full scale testing of an STC 900 demonstrating 75% TSS removal of particles from 1 to 1000 microns. Scour testing completed demonstrated that the system does not scour. The New Jersey Department of Environmental Protection was followed.
- City of Indianapolis – full scale testing of an STC 900 demonstrating over 80% TSS removal of particles from 50 microns to 300 microns at 130% of the unit's operating rate. Scour testing completed demonstrated that the system does not scour.
- Westwood Massachusetts (1997), demonstrated >80% TSS removal
- Como Park (1997), demonstrated 76% TSS removal
- Ontario MOE SWAMP Program – 57% removal of 1 to 25 micron particles
- Laval Quebec – 50% removal of 1 to 25 micron particles

10. Installation

The installation of the concrete Stormceptor should conform in general to state highway, or local specifications for the installation of manholes. Selected sections of a general specification that are applicable are summarized in the following sections.

10.1. Excavation

Excavation for the installation of the Stormceptor should conform to state highway, or local specifications. Topsoil removed during the excavation for the Stormceptor should be stockpiled in designated areas and should not be mixed with subsoil or other materials.

Topsoil stockpiles and the general site preparation for the installation of the Stormceptor should conform to state highway or local specifications.

The Stormceptor should not be installed on frozen ground. Excavation should extend a minimum of 12 inches (300 mm) from the precast concrete surfaces plus an allowance for shoring and bracing where required. If the bottom of the excavation provides an unsuitable foundation additional excavation may be required.

In areas with a high water table, continuous dewatering may be required to ensure that the excavation is stable and free of water.

10.2. Backfilling

Backfill material should conform to state highway or local specifications. Backfill material should be placed in uniform layers not exceeding 12 inches (300mm) in depth and compacted to state highway or local specifications.

11. Stormceptor Construction Sequence

The concrete Stormceptor is installed in sections in the following sequence:

1. Aggregate base
2. Base slab
3. Lower chamber sections
4. Upper chamber section with fiberglass insert
5. Connect inlet and outlet pipes
6. Assembly of fiberglass insert components (drop tee, riser pipe, oil cleanout port and orifice plate
7. Remainder of upper chamber
8. Frame and access cover

The precast base should be placed level at the specified grade. The entire base should be in contact with the underlying compacted granular material. Subsequent sections, complete with joint seals, should be installed in accordance with the precast concrete manufacturer's recommendations.

Adjustment of the Stormceptor can be performed by lifting the upper sections free of the excavated area, re-leveling the base and re-installing the sections. Damaged sections and gaskets should be repaired or replaced as necessary. Once the Stormceptor has been constructed, any lift holes must be plugged with mortar.

12. Maintenance

12.1. Health and Safety

The Stormceptor System has been designed considering safety first. It is recommended that confined space entry protocols be followed if entry to the unit is required. In addition, the fiberglass insert has the following health and safety features:

- Designed to withstand the weight of personnel
- A safety grate is located over the 24 inch (600 mm) riser pipe opening
- Ladder rungs can be provided for entry into the unit, if required

12.2. Maintenance Procedures

Maintenance of the Stormceptor system is performed using vacuum trucks. No entry into the unit is required for maintenance (in most cases). The vacuum service industry is a well- established sector of the service industry that cleans underground tanks, sewers and catch basins. Costs to clean a Stormceptor will vary based on the size of unit and transportation distances.

The need for maintenance can be determined easily by inspecting the unit from the surface. The depth of oil in the unit can be determined by inserting a dipstick in the oil inspection/cleanout port.

Similarly, the depth of sediment can be measured from the surface without entry into the Stormceptor via a dipstick tube equipped with a ball valve. This tube would be inserted through the riser pipe. Maintenance should be performed once the sediment depth exceeds the guideline values provided in the Table 4.

Table 4. Sediment Depths Indicating Required Servicing*

Particle Size	Specific Gravity
Model	Sediment Depth inches (mm)
450i	8 (200)
900	8 (200)
1200	10 (250)
1800	15 (381)
2400	12 (300)
3600	17 (430)
4800	15 (380)
6000	18 (460)
7200	15 (381)
11000	17 (380)
13000	20 (500)
16000	17 (380)
* based on 15% of the Stormceptor unit's total storage	

Although annual servicing is recommended, the frequency of maintenance may need to be increased or reduced based on local conditions (i.e. if the unit is filling up with sediment more quickly than projected, maintenance may be required semi-annually; conversely once the site has stabilized maintenance may only be required every two or three years).

Oil is removed through the oil inspection/cleanout port and sediment is removed through the riser pipe. Alternatively oil could be removed from the 24 inches (600 mm) opening if water is removed from the lower chamber to lower the oil level below the drop pipes.

The following procedures should be taken when cleaning out Stormceptor:

1. Check for oil through the oil cleanout port
2. Remove any oil separately using a small portable pump
3. Decant the water from the unit to the sanitary sewer, if permitted by the local regulating authority, or into a separate containment tank
4. Remove the sludge from the bottom of the unit using the vacuum truck
5. Re-fill Stormceptor with water where required by the local jurisdiction

12.3. Submerged Stormceptor

Careful attention should be paid to maintenance of the Submerged Stormceptor System. In cases where the storm drain system is submerged, there is a requirement to plug both the inlet and outlet pipes to economically clean out the unit.

12.4. Hydrocarbon Spills

The Stormceptor is often installed in areas where the potential for spills is great. The Stormceptor System should be cleaned immediately after a spill occurs by a licensed liquid waste hauler.

12.5. Disposal

Requirements for the disposal of material from the Stormceptor System are similar to that of any other stormwater Best Management Practice (BMP) where permitted. Disposal options for the sediment may range from disposal in a sanitary trunk sewer upstream of a sewage treatment plant, to disposal in a sanitary landfill site. Petroleum waste products collected in the Stormceptor (free oil/chemical/fuel spills) should be removed by a licensed waste management company.

12.6. Oil Sheens

With a steady influx of water with high concentrations of oil, a sheen may be noticeable at the Stormceptor outlet. This may occur because a rainbow or sheen can be seen at very small oil concentrations (<10 mg/L). Stormceptor will remove over 98% of all free oil spills from storm sewer systems for dry weather or frequently occurring runoff events.

The appearance of a sheen at the outlet with high influent oil concentrations does not mean the unit is not working to this level of removal. In addition, if the influent oil is emulsified the Stormceptor will not be able to remove it. The Stormceptor is designed for free oil removal and not emulsified conditions.

SUPPORT

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

APPENDIX J

In Compliance with DEP Storm-water Management Standard 10

Lot 2 Forge Parkway

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 J shall be part of this Illicit Discharge Compliance Statement.

The future owner, Camford Property Group, Inc, will be the responsible party.

____

Name Title

Note: This document shall be signed and submitted with SWPPP and the Town of Franklin Stormwater Permit.

APPENDIX K

Last updated: July 29, 2024

Rip Rap Calculator

I want to find the...

- (selected) average rock diameter (D_{50})
- rip rap volume
- both D_{50} and rip rap volume

Rip rap specifications

Water velocity (V)

8.27 ft/s

Isbash constant (C)

- (selected) Highly turbulent (0.86)
- Low turbulence (1.2)

Gravitational acceleration (g)

32.17 ft/s²

Specific gravity (S)

2.75

Average rock diameter (D_{50})

9.855 in

Share result

Reload calculator

Clear all changes

Did we solve your problem today? Yes No

Check out 36 similar construction materials calculators

APPENDIX L