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Environmental Scientists and Engineers
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P.O. Box 584
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Effective, Affordable, and Sustainable Solutions for Land & Water Environment

July 26, 2018
Revised August 11, 2018

Conservation Commission
Town Hall
101 Main Street, 2nd Floor
Ashland, MA 01721

Re: **Stormwater Management Permit for 128 Main Street in Ashland, MA**

Dear Sir/Madam:

On behalf of Mr. Carlos Hanzi, we are pleased to submit this application of Stormwater Management Permit for proposed redevelopment at 128 Main Street in Ashland, MA. Enclosed, please find the following related materials:

1. Project Narrative, which includes:
    - Existing Condition
    - Proposed Condition
    - List of Required Permits and/or Approvals
    - Earth Removal/Fill Calculations
2. Stormwater Management Application Form
3. Sample Notice of Public Hearing
4. Abutters List
5. Copy of requisite fee check ($1,250)
6. Recorded Deed

7. Flood Control and Stormwater Management report July 26, 2018, which includes:
    - Operation and Maintenance Plan for Stormwater BMPs as Appendix E

8. Site plans by Creative Land & Water Engineering, LLC July 26, 2018

Please feel free to contact us if you have any questions.

Thank you.

Sincerely,
Creative Land & Water Engineering, LLC
by

Desheng Wang, Ph.D., P.E.
Civil & Hydraulic Engineer

cc: Mr. Carlos Hanzi, 21 Loring Dr., Ashland, MA 01721

6. Project Narrative

Existing Condition

The project site, known as 128 Main Street, a total of 0.357 acres of land, currently hosts one building with mixed of commercial and residential uses with paved driveway and dirt parking lot. There are no stormwater management systems currently located on the property. The total impervious area including roof and driveway is 0.28 acres (includes 0.099 acers of dirt parking area).

Proposed Condition

The proposed redevelopment is to demolish the existing building and erect a mixed use 3-story building containing 15 residential units (one on first floor, 7 each on 2nd and 3rd floors) and a commercial space on the first floor. The total impervious area will be 0.336 acres including roof, driveway, and parking space. Stormwater management system that meets 10 MA DEP stormwater management standards will be provided including runoff collection, pre-treatment and treatment and peak and volume control. The proposed condition will be an improvement to the existing condition. The building will be on slab and does not have a basement.

Required Permits

-ZBA special permit for height waiver
-Conservation Commission – SMP
-Building Department – building permit

Earth Removal/Fill Calculations

The proposed site will be kept with similar grading except for the excavation of the building footing and stormwater management infiltration trench:

Earth Removal/Fill Calculations

Item	Description	Quantity	Dimension	height, ft	Volume, cu ft	
1	Catch basins	2	4	8	200.96	
2	DMH	2	5	6, 9.45	303.21	
3	Infiltration Trench	1	11x42	4	1848.00	
4	Footing	1	300x2,300x0.83	1, 3	1347	
	Total				3699.17	cu. ft.
					137.01	Cu. Yard

A. Application for a Stormwater Management Permit **SMP#________**

Refer to the "Stormwater Management Regulations" available from the Conservation Commission for details on the information and fees required for this application. Contact the Commission at 508-881-0100 x656 with any questions concerning the Regulations. Incomplete applications may be denied.

Please type or print your application.

1. Location and Street Address of Site 128 Main Street
   Name of Proposed Development Comercial and resendential mixed

2. Applicant's Name: Carlos Hanz i
   Address: 21 Loring Dive, Ashland, MA 01721
   Telephone 781-726-2008

3. Record Owner's Name: Benito R & Bernice C. Alberini
   Address: 120 West Union Street, Ashland, MA 01721
   Telephone ______________

4. Zoning District(s) of Parcel(s) ADDC (031-Multiuse-com)
   Town Atlas Map(s)/ Parcel Number(s) 14-150

5 a) Total Area of Development 0.357 ac. b) Total Area of Land Disturbed 0.357 ac.
   c) Total area of land disturbed with slope of 15% of greater 0 d) Percent of impervious land 96% e) Total gross floor area of buildings proposed 18,258
   f) Method of sewage disposal public sewer

6. Deed Book & Page number(s) or Land Court Certificate number(s): --- bk 12510 p134

The undersigned hereby apply to the Conservation Commission for a public hearing and an SMP under the Bylaw.

The undersigned hereby certify that the information on this application and plans submitted herewith is correct, and that the application complies with all applicable provisions of Statutes, Regulations, and Bylaws to the best of his/her knowledge. The above is subscribed to and executed by the undersigned under the penalties of perjury in accordance with Section 1-A of Chapter 268, General Laws of the Commonwealth of Massachusetts.

[signature] 7/12/18

Signature of Petitioner(s) Signature of Petitioner(s) Date

RECORD OWNER'S KNOWLEDGE AND CONSENT

I hereby assert that I have knowledge of and give my consent to the application presented above.

[signature] 7.12.18

Signature of Record Owner(s) Signature of Record Owner(s) Date

B. Notice of Public Hearing

In accordance with the provisions of the Ashland Stormwater Management Bylaw, the Ashland Conservation Commission will hold a public hearing on August 27, 2018 at 7:30 P.M., in the Ashland Town Hall, 101 Main Street, Ashland, MA on the petition of Carlos Hanzi for approval of a Stormwater Management Permit for the parcel located at 128 Main Street and shown on Town Assessor Map 14, parcel 150.

C. STORMWATER MANAGEMENT PERMIT ELIGIBILITY WORKSHEET

Project Name: 128 Main Street - redevelopment Date:7/26/2018
Applicant Name: Carlos Hanzi
Street: 21 Loring Dr Town Ashland ,State: MA Zip: 01721
Phone: 781-726-2008 Fax:
Email:

1. Check all that might apply to your proposed project:	*Yes*	*No*	*Maybe*
a) Any activity subject to Site Plan Review (§ 282-6);	☐	☐	x☐
b) Any activity that will result in soil disturbance of 10,000 square feet or more or more than fifty percent (50%) of the parcel or lot, whichever is less;	x☐	☐	☐
c) Any residential development or redevelopment of five (5) or more acres of land proposed pursuant to "the Subdivision Control Law" G. L. c. 41 sec. 81K to 81GG inclusive, or proposed under a special permit process pursuant to G. L. c. 40A sec. 9;	☐	x☐	☐
d) Any activity that will increase the amount of impervious surfaces more than 50% of the area of a parcel or lot, and	x☐	☐	☐
e) Any activity that will disturb land with 15% or greater slope and where the land disturbance is greater than or equal to 5,000 square feet within the sloped area.	☐	x☐	☐

If you checked "No" for all of the above, **STOP**. The Ashland Stormwater Management Bylaw does not apply to your project. If you checked "**Yes**" or "**Maybe**" for any of the above, you **may** be required to meet the requirements of Ashland's Stormwater Management Bylaw. **Proceed to Question 2.**

2. *If you meet one of the following descriptions, you are exempt from Ashland's Stormwater Management Bylaw:*

a) Normal maintenance of Town owned public land, ways and appurtenances; ☐
b) Normal maintenance and improvement of land in agricultural use; ☐
c) Repair or replacement of septic systems when approved by the Board of Health for the protection of public health; ☐
d) Normal maintenance of existing landscaping, gardens or lawn areas associated with a single family dwelling provided such maintenance does not include the addition of more than 100 cubic yards of soil material, or alteration of drainage patterns; ☐
e) The construction of fencing that will not alter existing terrain or drainage patterns; ☐
f) Construction and associated grading of a way that has been approved by the Planning Board; ☐
g) The maintenance, reconstruction or resurfacing of any public way; and the installation of drainage structures or utilities within or associated with public ways that have been approved by the appropriate authorities provided that written notice be filed with the Conservation Commission fourteen days (14) prior to commencement of activity; ☐
h) The removal of earth products undertaken in connection with an agricultural use if the removal is necessary for or directly related to planting, cultivating or harvesting or the raising or care of animals, or ☐
i) Activity in accordance with the terms of an existing Order of Conditions or Determination of Applicability issued by the Commission pursuant to M.G.L. Ch. 131, Section 40, or the Ashland Wetlands Protection Bylaw, Chapter 280 of the Code of the Town of Ashland. ☐

If you checked any of the boxes in Question 2, STOP. You are exempt from Ashland's Stormwater Management Bylaw. If you do not meet any of these exemptions, you will need to apply for a Stormwater Management Permit.

July 17, 2018

To The Conservation Commission
128-132 Main Street
Benito R. and Bernice C. Alberini
Abutters To Map 14 Parcel 150

PARCEL ID	PARCEL ADDRESS	OWNER 1	OWNER 2	MAILING ADDRESS	CITY/TOWN	STATE	ZIP
14-083-00-000	119 MAIN ST	ASHLAND HOUSE ASSOCIATES		5A EAST POINT DR	BEDFORD	NH	03110
14-084-00-000	137 MAIN ST	TOWN OF ASHLAND	FIRE DEPT - STATION 1 / POLICE DEPT	101 MAIN ST	ASHLAND	MA	01721
14-131-00-000	24 CONCORD ST	TAYLOR RYAN	TRUSTEE 18-28 RT CONCORD RLTY TR	PO BOX 471	ASHLAND	MA	01721
14-144-00-000	20 FRONT ST	TALVY RUTH M		20 FRONT ST	ASHLAND	MA	01721
14-145-00-000	18 CONCORD ST REAR	TAYLOR RYAN	TRUSTEE 18-28 RT CONCORD REALTY TR	PO BOX 471	ASHLAND	MA	01721
14-146-00-000	0 MAIN ST REAR	TOWN OF ASHLAND (UNIONVILLE EVANGELICAL)	SOCIETY TO PARISH CHURCH	OLD VILLAGE CEMETERY	ASHLAND	MA	01721
14-147-00-000	0 FRONT ST	S-BNK ASHLAND LLC	C/O SOVEREIGN BANK/TRAMMELL CROW CO	P O BOX 14115	READING	PA	19612
14-148-00-000	12 FRONT ST	S-BNK ASHLAND LLC	C/O SOVEREIGN BANK/TRAMMELL CROW CO	P O BOX 14115	READING	PA	19612
14-149-00-000	4 FRONT ST	S-BNK ASHLAND LLC	C/O SOVEREIGN BANK/TRAMMELL CROW CO	P O BOX 14115	READING	PA	19612
14-151-00-000	118 MAIN ST	FEDERATED CHURCH OF ASHLAND INC		118 MAIN ST	ASHLAND	MA	01721

The above reflects the latest information available on our records.

Richard E. Ball, M.A.A.
Assistant Assessor

Date 7/17/18

CH LANDSCAPING AND CONSTRUCTION, INC.
21 LORING DRIVE
ASHLAND MA 01721-2243

2270

53-7181/2113

DATE 7/17/18

PAY TO THE ORDER OF Town OF AsHland $ 1250.00

one THousand two Hundred fifty only DOLLARS

MUTUALOne BANK

FOR Storm Water 128 Main st

⑈002270⑈ ⑆211371816⑆ 1047669346⑈

Southern Middlesex - 20/20 Perfect Vision i2 Document Detail Report

Current datetime: 7/26/2018 10:58:45 PM

Doc#	Document Type	Town	Book/Page	File Date	Consideration
1251078	DEED		12510/134	08/29/1973	35000.00

Property-Street Address and/or Description

MAIN ST

Grantors

CAMPION ROBERT C

Grantees

ALBERINI BENITO R, ALBERINI BERNICE C

References-Book/Pg Description Recorded Year

Registered Land Certificate(s)-Cert# Book/Pg

AUG29-73 AM 11:45 1788E**10.00

BK 12510 PG 134

pw 10 — 08

I, ROBERT C. CAMPION, of Framingham, Middlesex County, Commonwealth of Massachusetts,
[illegible]
[illegible] — COMMISSIONER

appointed by the Middlesex Probate Court, Docket No. 463313,
by power conferred by warrant issued May 1, 1973, by said Court,

and every other power,

for Thirty-Five Thousand and no/100 ($35,000.00)—————————— Dollars
paid, grant to BENITO R. ALBERINI and BERNICE C. ALBERINI, husband and wife, as tenants by the entirety, both of 120 West Union Street, Ashland, Middlesex County, Massachusetts,

the land in said Ashland, with the buildings thereon, bounded and described as follows:

Beginning at the northerly corner thereof; thence running

SOUTHEASTERLY	by the cemetery 80 feet more or less to land formerly of Patrick Manning, later of one Tierney; thence turning and running
SOUTHWESTERLY	by said last-mentioned land 210 feet more or less and land formerly of August A. Coburn, later of one Tierney, to Main Street; thence turning and running
NORTHWESTERLY	by Main Street 100 feet more or less to land of the First Parish; thence running
NORTHEASTERLY	by land of the First Parish 200 feet more or less to the bound first mentioned.

Meaning hereby to convey and hereby conveying the premises described in a deed from Fannie Seaver Knowlton and others to Albert W. Dunlap, et ux, dated February 18, 1928, recorded with Middlesex South District Registry of Deeds in Book 5205, Page 322.

CO[MM]ONWEALTH OF MASSACHUSETTS CANCELLED 73.30

Witness my hand and seal as Commissioner aforesaid this 27th day of August 1973.

Robert C. Campion
Robert C. Campion

The Commonwealth of Massachusetts

Middlesex, ss. August 27, 1973

Then personally appeared the above named ROBERT C. CAMPION, COMMISSIONER, and acknowledged the foregoing instrument to be his free act and deed, before me

James M. Sweeney
Notary Public — Justice of the Peace

My commission expires

JAMES M. SWEENEY
Notary Public
My Commission Expires October 18, 1974

JAMES M. SWEENEY 1974

Flood Impact Analysis and Stormwater Management
128 Main Street
Ashland, MA

August 10, 2018

Prepared for:

Carlos Hanzi
12 Loring Drive
Ashland, MA 01721

Prepared by:

Creative Land & Water Engineering, LLC
P.O. Box 584
Southborough, MA 01772

By

Desheng Wang, Ph.D., P.E.
Sr. Environmental/Hydraulic Engineer

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Appendix B: FLOOD ROUTING CALCULATIONS FOR STORAGE AREAS B-1
Appendix C: CALCULATIONS OF STORMWATER QUALITY CONTROL...............C-1
Appendix D: INFILTRATION CALCULATIONS D-1
Appendix E: OPERATION AND MAINTENANCE PLAN FOR STORMWATER BMPsE-1

1.0 Introduction

A mixed commercial and residential redevelopment is proposed at 128 Main Street in Ashland. The site is in Asland downtown district C (ADDC). Except for the frontage with Main Street, the site is bordered by commercial properties on two sides and a cemetery to the rear. See Figure 1 for site locus.

The property is shaped like a trapezoid. It is not located in floodplain or within the 100-foot buffer of a bordering vegetated wetland (BVW). It currently host a 2-story wood framed building of mixed use of residential and commercial and associated driveway, dirt parking, and fringe lawn. The proposed redevelopment is to replace the existing building with a new three story building and renovated the driveway, parking lot with up to date stormwater management system. No stormwater management system existed on site. The runoff mostly sheds to the south and collected by a catch basin on the southerly off site property. A small area drains to the Main street drainage system. Upon request of project proponent, Carlos Hanzi, Creative Land & Water Engineering, LLC (CLAWE) devised the flood control and stormwater management plan for the site to satisfy the requirements of the ten DEP stormwater management standards and Ashland bylaw and regulations. This report presents the results.

2.0 Flood Condition Analyses and Flood Control

Since there is no work proposed beyond the tree line marked by the edge of lawn and the chain link fence on the south side, the drainage study area is limited to the area encircled by the tree line and property lines at the north, west and east. In general, the site drains easterly to the rear toward the BVW. There are no flood control or storwatrer management structures under the existing conditions at the project site. bBased on the drainage pattern, the control point for flood control calculations is set at the eastern property line. The following is s a summary of the land uses within the study area.

Table 1. Land Use table

Site Condition	Watershed	Land use, ac					
		Roof	Pave	Gravel	Woods	Lawn	Total
Existing	E1	0.026				0.034	0.06
	E2	0.029	0.065	0.099	0	0.077	0.27
	Total	0.055	0.065	0.099	0	0.111	**0.33**
Proposed	P1		0.006				0.006
	P2	0.167	0.142			0.015	0.324
	Total	0.167	0.148	0	0	0.015	**0.33**

NRCS soil survey map (Figure 2) indicates the soils of the site are Udorthents urban complex soil. Our field soil testing showed the soil is gravely coarse medium sand, well drained Hydrologic Class A soils. A total three deep hole soil test pits were excavated on the site to collect groundwater and soil permeability data for the stormwater management system design. See site plan for locations. Based on field inspections, the high groundwater table is more than 11 ft below ground surface. See soil logs for details. Two constant head tests were conducted in the proposed infiltration trench area to determine the infiltration rate. Half of the tested infiltration rate of average rate was used for the design. Detailed soil log can be found in Appendix D.

For the proposed conditions, the flood control will be achieved by an infiltration trench at the rear parking lot. Pretreatment for the infiltration trench is proved by a distribution manhole and oil/grit

separator. The following is a diagram for the drainage model. The drainage divide and details of the infiltration trench, distribution manhole, oil/grit separator, and can be found in figures 3 to 9.
More details of the design features can be found on the engineering plan by Creative Land & Water Engineering, LLC dated July 26, 2018.

The flood conditions under both existing and proposed conditions are summarized in Table 2. Detailed data and calculations area presented in Appendix A.

Table 2 Summary of Peak Runoffs Leaving the Project Site

Sub-watershed		*Peak Runoffs (cfs)*				*Runoff Volume (ac-ft)*			
		2-year	*10-year*	*25-year*	*100-year*	*2-year*	*10-year*	*25-year*	*100-year*
Existing-	*E1*	0.026	0.072	0.103	0.154	0.003	0.007	0.009	0.013
	E2	0.284	0.575	0.756	1.037	0.024	0.046	0.061	0.083
	Total	0.310	0.647	0.859	1.191	0.027	0.053	0.070	0.096
Proposed-	*P1*	0.008	0.015	0.019	0.026	0.001	0.001	0.002	0.002
without control	*P2*	0.855	1.268	1.501	1.850	0.073	0.110	0.132	0.164
	Total	0.863	1.283	1.520	1.876	0.074	0.111	0.134	0.166
Proposed-	*P1*	0.008	0.015	0.019	0.026	0.001	0.001	0.002	0.002
with control	*P2*	0.000	0.000	0.000	0.432	0.000	0.000	0..0	0.003
	Total	0.008	0.015	0.019	0.458	0.001	0.001	0.002	0.005
	Reduction	-97%	-98%	-98%	-62%	-96%	-98%	-97%	-95%

As indicated in Table 2 and Table 3, the results of flood control are satisfactory.

3.0 Stormwater Management

This section demonstrates that the drainage design satisfies all ten DEP stormwater management standards.

Standard #1: Untreated Stormwater

No untreated stormwater from the proposed project area will be discharged to downgradient areas for the proposed conditions. Runoff from paved area will be adequately treated before overflowing to downgradient area. The treatment train includes deep sump catchbasins equipped with oil traps, modified manhole, oil/grit separator and infiltration trench. The following table is a summary of infiltration routing.

Table 3. Summary of Trench Routing

		2-yr	*10-yr*	*25-yr*	*100-yr*
Peak in (cfs)		0.86	1.27	1.50	1.85
Peak overflow (cfs)		0.00	0.00	0.00	0.43
Peak recharge (cfs)		0.55	0.674	0.768	1.33
Total inflow (ac-ft)		0.07	0.11	0.13	0.16
Total overflow (ac-ft)		0.000	0.00	0.00	0.00
Total recharge (ac-ft)		0.073	0.110	0.132	0.161
Peak storage (ac-ft)		0.006	0.013	0.017	0.022
Peak elevation (ft)		185.64	186.77	187.65	188.86

Standard #2: Post-Development Peak Discharge Rates

Stormwater controls have been designed for 2, 10, 25, and 100-year storms according to both state and town regulations. The post-development peak discharge rates and volumes with flood control do not exceed pre-development rates on the site at the downgradient discharge points. See Tables 2 for details.

Standard #3: Recharge to Groundwater

The soils on the site are hydrologic class A soils based on *in-situ* soil evaluations. The required infiltration will be 0.6 inches of runoff per storm from increased impervious areas. However, the system is designed to meet the recharge requirement as an new project. Given the total impervious area of 0.315 acre, the required recharge volume is calculated as 687 ft^3. The recharge trench as designed has a total capacity of 40272 ft^3, which is more than the required recharge volume and satisfies Standard 3. See Appendix C for details.

Standard # 4: Water Quality

(a) Water Quality Volume. The water quality treatment volume for runoff from paved area is provided by distribution manhole, oil/grit separator, and the infiltration trench. The storage volume in the system is more than 40272 ft^3, much larger than the required 1143 ft^3 based on 1-inch rule over total impervious area.

(b) TSS Removal. The BMPs used for the proposed project to enhance water quality include: deep sump catch basins with oil trap, oil/grit separator with modified distribution manhole, and an infiltration trench.
The TSS removal rate for the paved area will be 99%. The overall TSS removal rate including roof and lawn will be 95%. See the attached calculation sheets in Appendix C for details.

Standard # 5: Higher Potential Pollutant Loads

The proposed land use will not have higher potential pollutant loads. Given the large volume for stormwater treatment, the site should have a lower pollutant load compared with the existing conditions. See Appendix C for details. Oil traps will be added to all on-site catchbasins.

Standard #6: Protection of Critical Areas

The site does not contain or in the vicinity of any of the critical resource areas as listed below:

- Surface drinking water supplies, certified vernal pools, Areas of Critical Environmental Concern;
- Shellfish growing areas;
- Public swimming beaches;
- Cold water fisheries.

The proposed stormwater management facilities will promote groundwater recharge and reduce flood impacts.

Standard #7: Redevelopment Projects

The proposed project is a redevelopment. The proposed stormwater management will meet all ten DEP stormwater standards (2008). As proposed, the project will provide better water quality and mitigated flood impact to downgraident areas.

Standard #8: Erosion/Sediment Control

Staked wattles and silt fences will be installed at the downgradient limit of work before any excavation starts. Six-inch thick of 3”-4” crushed stones should be spread at the entrance from the existing roadway to the project site to prevent mud from escaping the site during construction. Any sediment tracked to Main Street should be swept promptly. The detailed in the plans.

Standard #9: Long-term Operation/Maintenance Plan

See Appendix E for details.

Standard #10: Illicit Discharges

There are no existing illicit discharges into stormwater system and there will be no illicit discharges under 310 CMR 10.04 will be allowed for proposed conditions. This is emphasized in the Operation and Maintenance Plan.

4.0 Summary

Flood control and stormwater management have been designed to meet the latest stormwater BMPs standards. The design satisfies all ten stormwater management standards as required in the MA DEP Stormwater Management Regulation and Ashland by-law. Here are some of the highlights:

- Proposed peak flows for 2-year to 100-year storm events will not exceed the existing conditions;
- The street flooding in downgradient will be significantly mitigated;
- Overall Total suspended solids (TSS) removal rate will be 95%;
- The capacity for water quality treatment and groundwater recharge exceeds DEP requirements.

Figures

Figure 1: Site Locus
Figure 2: NRCS Soil Map
Figure 3a: Drainage Divide- Existing Conditions
Figure 3a: Drainage Divide- Proposed Conditions
Figure 4: Flow Distribution Design
Figure 5: Detail of Infiltration Trench
Figure 6: Storage Indication Table _ Infiltration Trench
Figure 7: Stormwater Management schematic layout

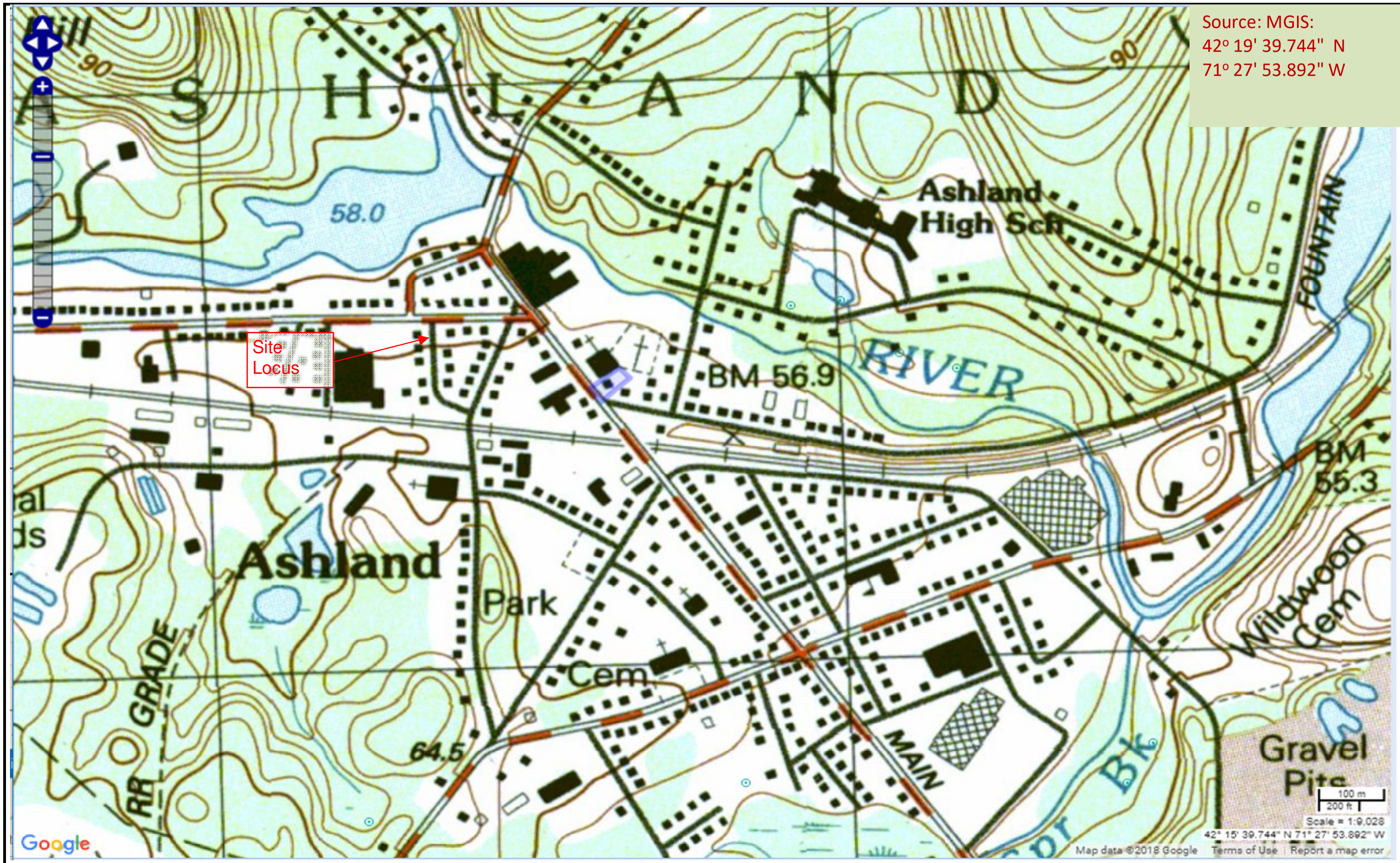
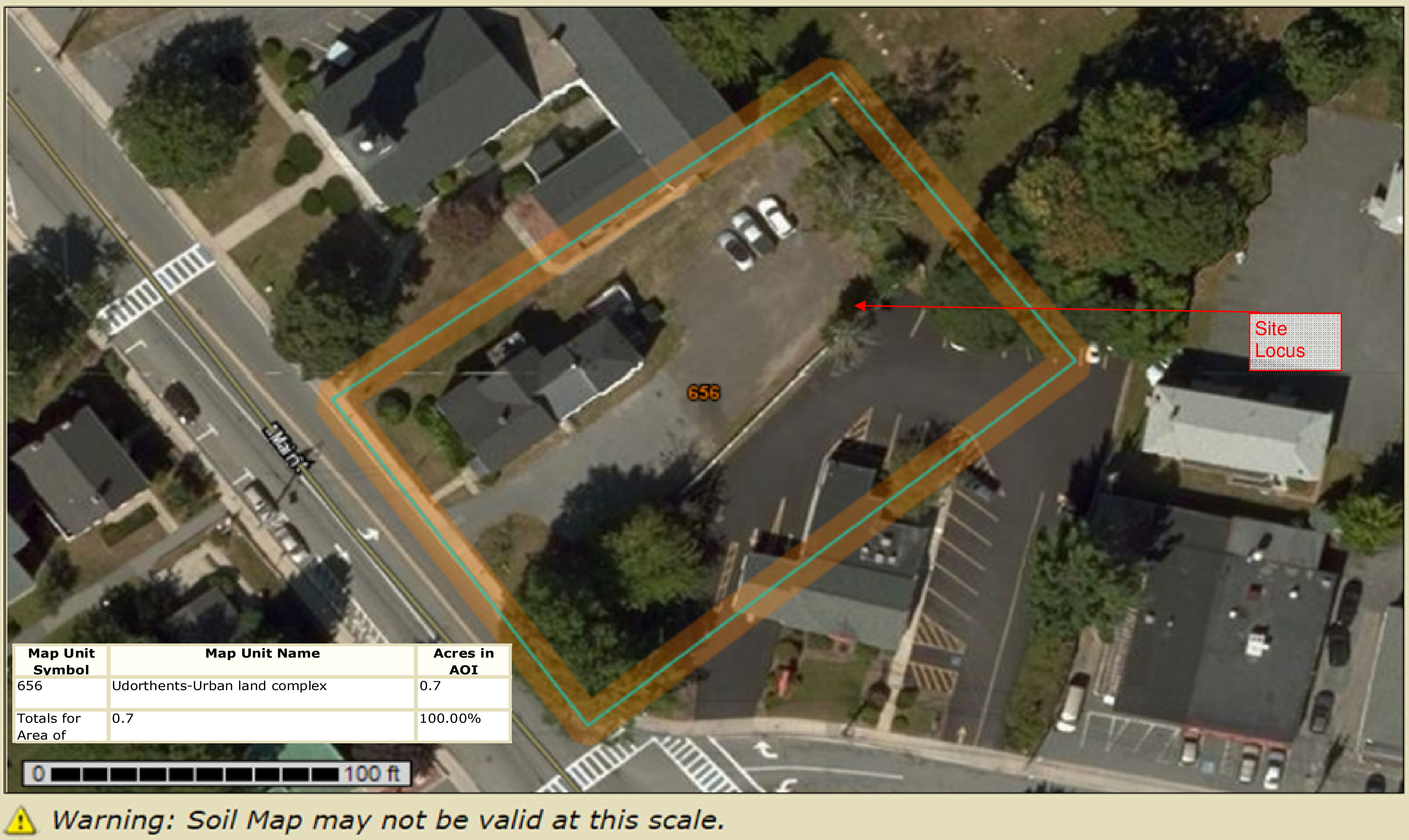


Figure 1.

USGS Site Locus & Resources Map
128 Main Street, Ashland, MA

By: Desheng Wang, Ph.D., P.E.
Creative Land & Water Engineering, LLC
P.O. Box 584
Southborough, MA 01772
508-281-1694



Map Unit Symbol	Map Unit Name	Acres in AOI
656	Udorthents-Urban land complex	0.7
Totals for Area of	0.7	100.00%

Figure 2. NRCS Soi Map
128 Main Street, Ashland, MA

By: Desheng Wang, Ph.D., P.E.
Creative Land & Water Engineering, LLC
P.O. Box 584
Southborough, MA 01772
508-281-1694

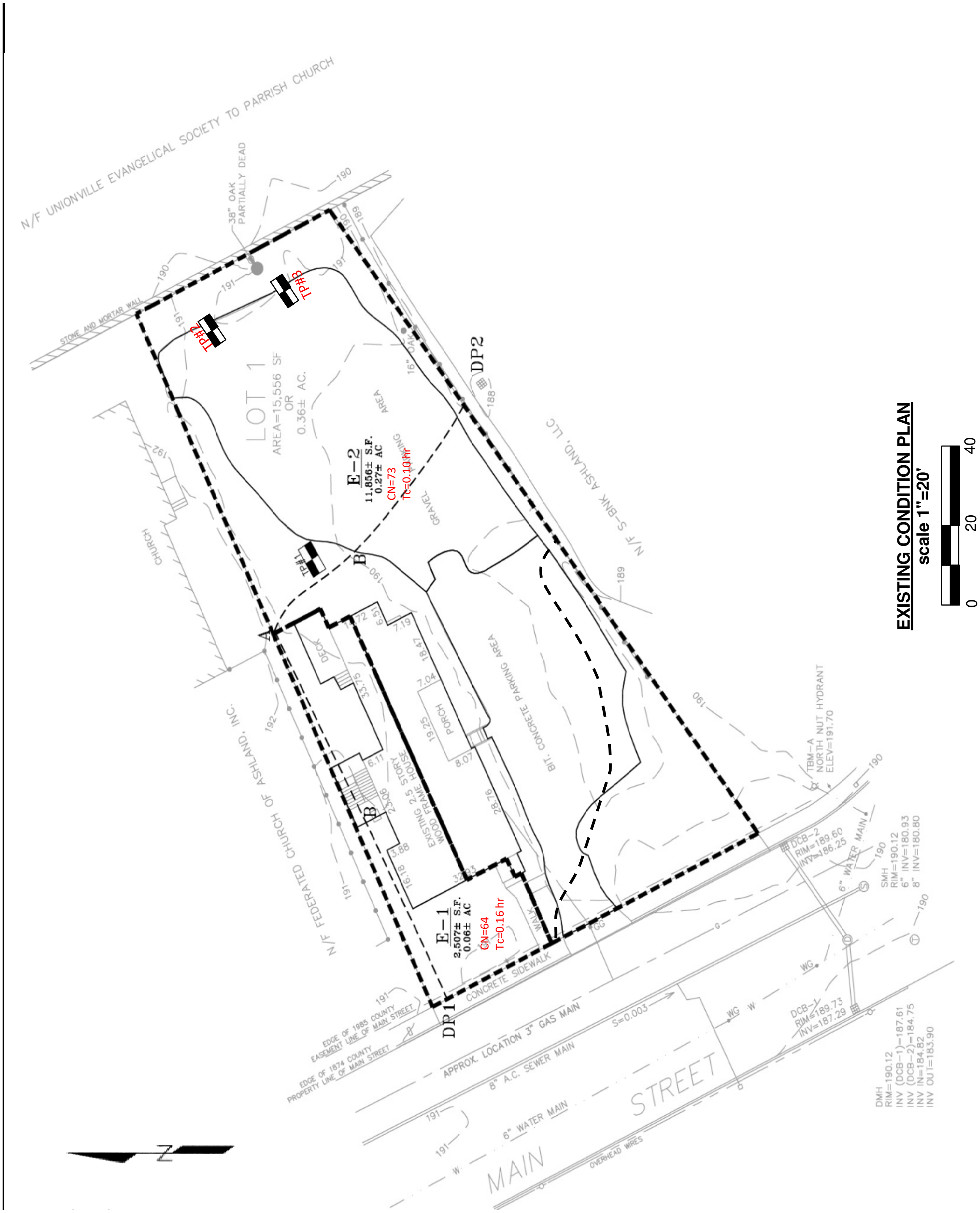


Figure 3a: Watershed divide: Existing Condition

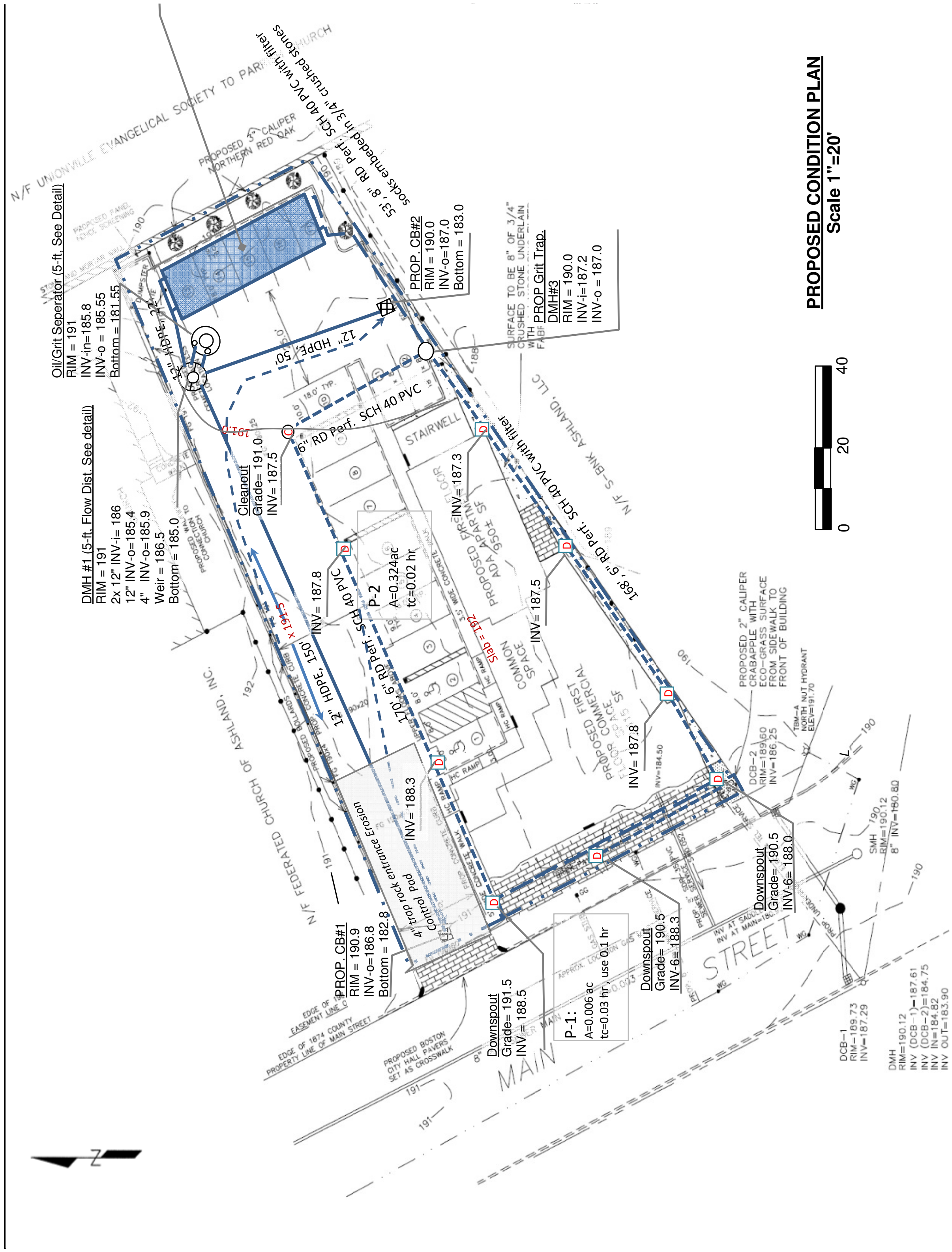


Figure 3b: Watershed divide: Proposed Condition

Flow Distribution Design in the Front Parking Lot

Project:	128 Main Street	**Date:**	7/12/2018
By:	Creative Land & Water Eng. LLC	**Cal. by:**	dsw
		Chk by:	

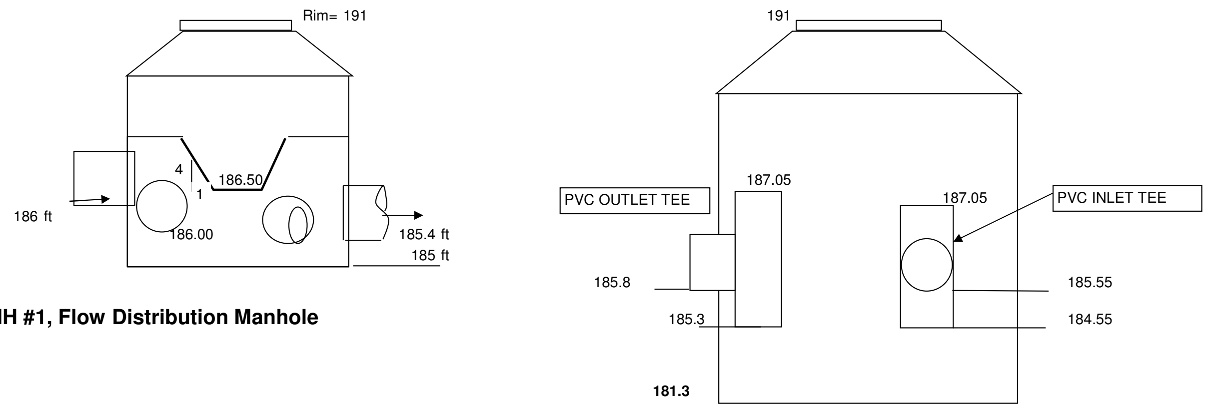
Bottom of manhole:	185 ft		
INV of Inflow pipes (12"):	186 ft		
INV of Orifice to O/G :	186 ft	Opening dia.:	4 in
INV of O.V.F. Weir:	186.50 ft	Weir bottom width (Cipoletti):	1 ft
INV of O.V.F Pipe:	185.4 ft	OVF pipe dia.:	1 ft
			12 in

Treatment Flow Design Storm (0.5" or 1"): 1"

Component	Designed flow (cfs)	Elev. (ft)	Head (ft)	Designed Treatment Capacity (cfs)	Treatment ratio
Treatment Device:		186.50	0.33	0.24	1
Overflow weir:	0.24	186.50	0		
Total				0.24	

Overflow Flow Design Storm: 100-year

Component	Design flow (cfs)	Elev. (ft)	Head (ft)	Cal. Flow (cfs)	Treatment ratio
Treatment Device:		186.88	0.71	0.35	0.31
Overflow weir:	1.15	186.88	0.38	0.79	
Total				1.14	
Overflow pipe sizing:		186.88	1.48	4.26	



DMH #1, Flow Distribution Manhole

Oil/Grit Separator

Elevation View (N.T.S)

Figure 4: Flow Distribution Design

Creative Land & Water Engineering, LLC

Environmental Science, Engineering, & Resource Management

303 Worcester Road
Framingham, MA 01701
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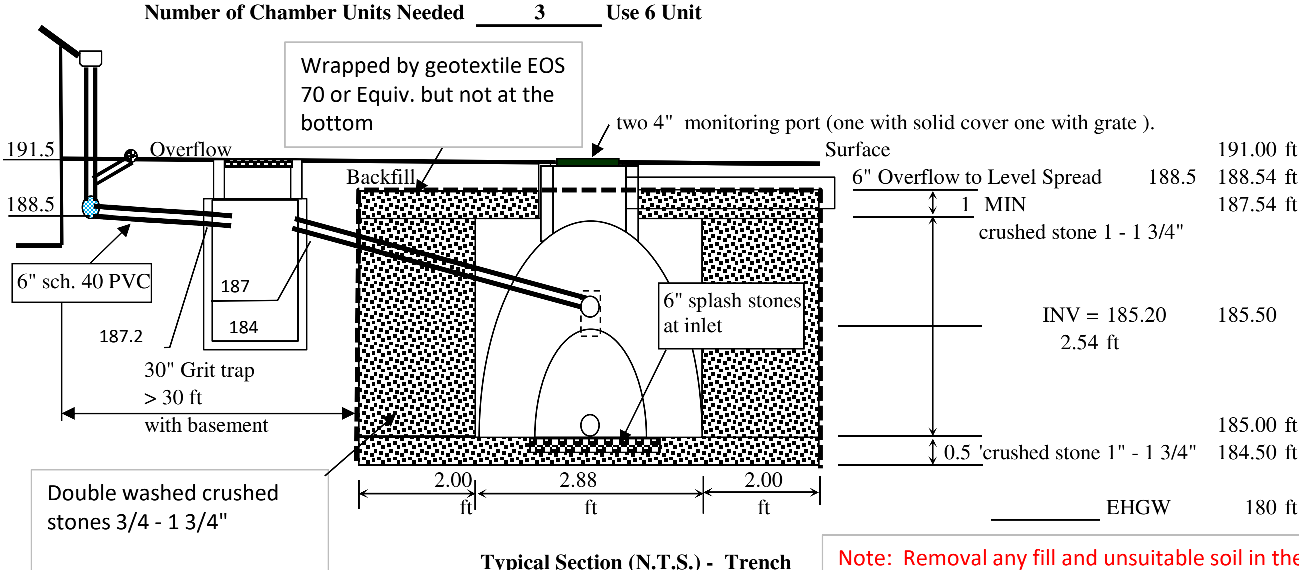
Calculations by:	Desheng Wang
Date:	7/19/2018 3/14/2018
Checked by:	Desheng Wang
Date:	
Job #:	J14-8
Page:	1 of 1

Project: 128 Main Street, Ashland, MA   Revision:

Worksheet for Recharge Design

Input:	Hydrological Class	Co.M. Sand		Infiltration surface:		side and bottom
	Estimated Permeability (ft/s)	1.05E-03		Safety Factor:		1.5
	Measured Permeability (ft/s)	1.05E-03	Impervious	Existing	Proposed	
	Design Frequency (years)	100	Roof	2395.8	7258	
	P - Rainfall (inches)	7.00	Drive	5009.4	6185	
	Soil Porosity (%)	40	Total	7405.2	13443	
	Curve Number	98		water quality volume (cu. ft)		
	Runoff Area (ft^2)	13443		1120.25		
	Infiltration time (hr)	12		Considered gravel existing gravel drive credit of 21780 sq. ft		
Design:	S - Potential max. retention after runoff begins (inches)	0.20				
	Q - Runoff (inches)	6.76				
	Vr - Runoff Volume (ft^3)	**7573.92**	56652.90	gallons		
	Cylinder drywell			Rectangular drywell		x
	H - Height of Dry Well (ft)	2.54				
	D - Diameter of Dry Well (ft)			Length (ft): 8.5		Width (ft): 2.88
	Width of Stone Around Well (ft)	2.00	Total	Model Cultec 300 HD		
	Vd - Volume of Dry Well (ft^3)	**147.68**	**443.03**	3313.89 gallons		
	Qi - Infiltration Rate (ft^3/s)	7.81E-02				Actual recharge area:
	Infiltration Capacity (ft^3)	**3,374.44**	**10123.31**	75722.38 gallons		25005.71 sq. ft
	Total Capacity (ft3)	3522.12	10566.35	79036.26		
	Number of Chamber Units Needed	**3**	**Use 6 Unit**			



Typical Section (N.T.S.) - Trench
Rectangular drywell
Cultec Chamber 330 XLHD or equal.

Note: Removal any fill and unsuitable soil in the bottom of the drywell during construction Should be inspected by the design engineer and the town stormwater engineer if required.

Figure 5: Detail of Infiltration Trench

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Tel: (508)281-1694 Email: deshengw@yahoo.com

Subject: Infiltration Trench_ Front Parking Lot
128 Main Street
Ashland, MA

revised:
By: dsw
Chkd: dsw
Job No.: J14-8

Date:
Date: 20-Jul-18
Date:
Sheet: 1 of 1

STORAGE INDICATION ANALYSIS _ INFILTRATION TRENCH

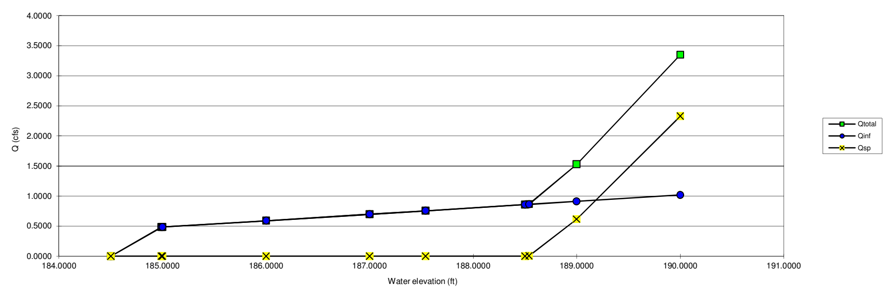
Storage-Indication Analysis

(1)Permeability (ft/sec):	0.00105	Water table (ft):	180		
Bottom elevation (ft):	184.5	Depth of aquifer (ft):	40+		
Trench width (ft):	10	Time step (sec):	60	Bottom factor:	1.00
Trench length (ft):	41	BC weir length/pipe diam (ft):	0.670	Weir width (ft):	0.5
Trench depth (ft):	4	Weir crest elevation/INV (ft):	188.500	Weir or Pipe (w or p):	p
				Discharge coefficient:	0.6

Location	Elevation	**Total Q**	H	**Qinfil**	**Qweir/pipe**	Voids Area	Trench Storage	Dewater time	storage
	ft	**cfs**	ft	**cfs**	**cfs**	ft^2	ft^3	hrs	ac-ft
Bottom of trench	184.5000	**0.0000**		**0.0000**	**0.0000**	164.00	0.00	0.00	0.00000
Bottom of riser/Chamber	184.9900	**0.4830**	0.4900	**0.4830**	**0.0000**	164.00	80.36	0.09	0.00184
	185.0000	**0.4841**	0.5000	**0.4841**	**0.0000**	303.40	82.70	0.09	0.00190
Middle of Chamber	186.0000	**0.5912**	1.5000	**0.5912**	**0.0000**	266.50	367.65	0.24	0.00844
	187.0000	**0.6983**	2.5000	**0.6983**	**0.0000**	246.00	623.90	0.35	0.01432
Top of Chamber	187.5400	**0.7561**	3.0400	**0.7561**	**0.0000**	164.00	734.60	0.39	0.01686
Overflow	188.5000	**0.8589**	4.0000	**0.8589**	**0.0000**	164.00	892.04	0.45	0.02048
Top of trench	188.54	**0.8661**	4.0400	**0.8632**	**0.0029**	164.00	898.60	0.45	0.02063
	189	**1.5289**	4.5	**0.9125**	**0.6165**	106.60	960.83	0.46	0.02206
Subbase	190	**3.3495**	5.5	**1.0196**	**2.3300**	106.60	1067.44	0.48	0.02450

(1) Half of average tested or lesser of the tested rate.

Storage-Indication Curve



References:

[1] Schueler, T. R. (1987) "Controlling Urban Runoff," Metropolitan Council of Governments, Washington D.C.
[2] Urbonas, B. and Stahre, P. (1993) "Stormwater Best Management Practices and Detention for Water Quality, Drainage, and CSO Management" PTR Prentice Hall, Englewood Cliffs, New Jersey 07632.
[3] U.S. D. I. (1974) "Earth Manual -A Water Resources Technical Publication", Washington D. C.
[4] David R. Maidment ed. (1992). Handbook of Hydrology, McGraw-Hill, Inc. New York.
[5] Wang, Desheng (1999). "A simple mathematical model for infiltration BMP design," Hydrological Science and Technology, Vol. 15, NO. 1-4, American Institute of Hydrology, 248-256.

Figure 6: Storage Indication Table _ Infiltration Trench

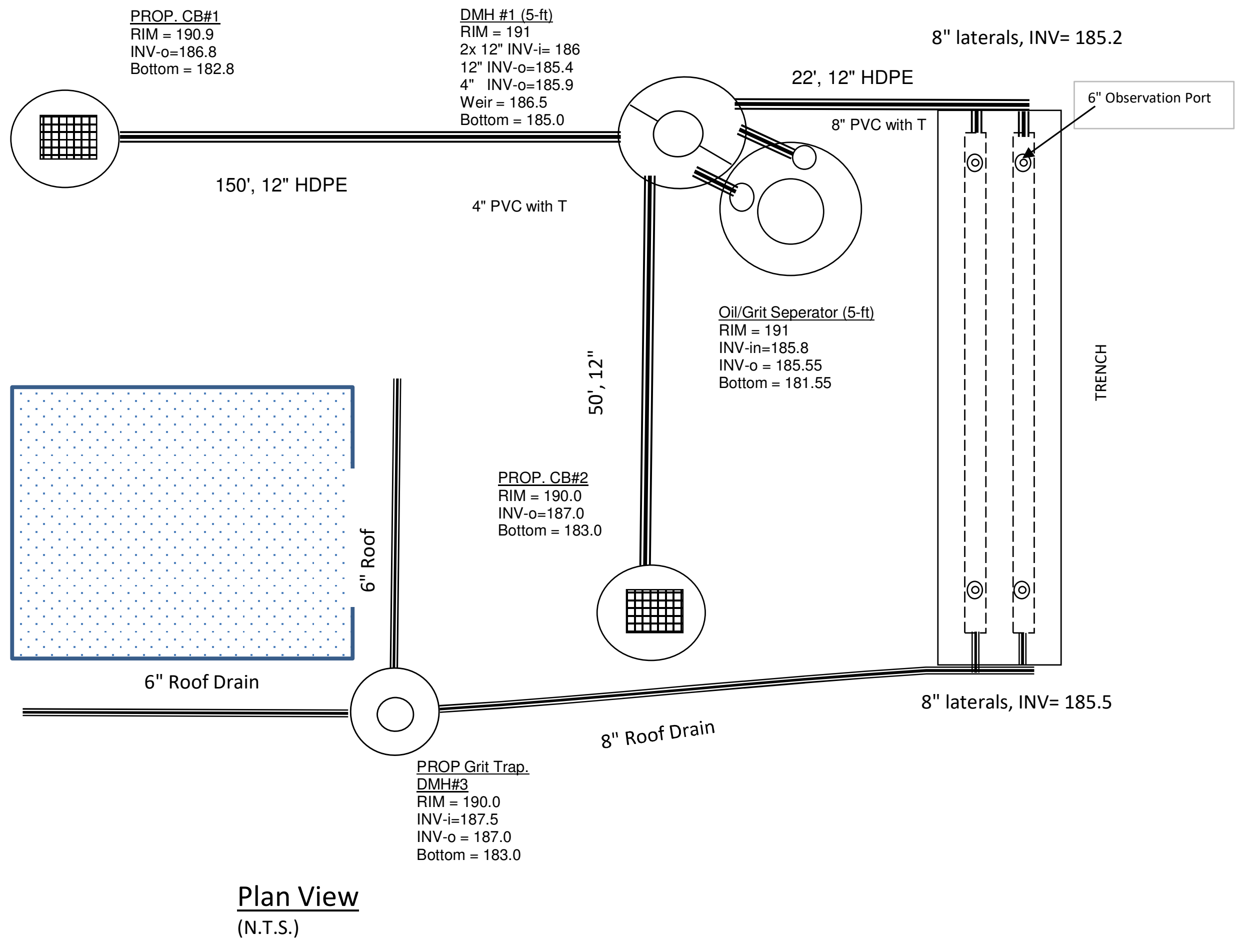


Figure 7: Stormwater Management schematic layout

Appendix A: PEAK FLOW AND PEAK HYDROGRAPH CALCULATIONS

Computer Model HEC-HMS was used for the calculations of peak flow, unit hydrograph. The input data are summarized in Table A-1.

Table A-1 Summary of Input Parameter

Watershed	Area(ac)	Area(mi2)	CN	I (in)[a]	TC(hr)	Lag (min) [b]
E-1	0.06	0.00009	64.567	1.098	0.16	5.76
E-2	0.27	0.00042	73.107	0.736	0.1	3.6
Total	0.33					
P-1	0.006	0.00001	76	0.632	0.1	3.6
P-2	0.324	0.00051	95.269	0.099	0.1	3.6
Total	0.33	0.00052				

Meteorological Model	Method: SCS hypothetical storm Storm selection: Type III 1" storm event: 1 in 2-yr 24-hr rainfall depth: 3.2 in 10-yr 24-hr rainfall depth: 4.6 in 25-yr 24-hr rainfall depth: 5.4 in 100-yr 24-hr rainfall depth: 6.6 in

a: I, initial abstraction = 0.2 x (1000CN-10) as specified in TR55

b: lag = 0.6 x TC

Detailed land use table, calculation sheets of CN and TC, and output report of HEC-HMS are on the following pages.

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Environmental Science and Engineering
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Subject: SCS MODIFIED SOIL COVER COMPLEX METHOD

Location: 128 Main Street, Ashland **Job No.:** J14-8

Project Name: 128 Main Street
Sub-basin: E-1
Condition: Existing

Analysis Date: 18-Jul-18
Analyst: dsw
Checked:

Storm Frequency:	2-year	10-year	25-year	100-year
24-hour rainfall (Rainfall:	**3.2**	**4.600**	**5.400**	**6.600**

Average Slope(ft/ft): Percent: 0.000 Length (ft):

Land Use	Soil Group	CN	Area (acres)	Area x CN
Impervious area:				
1 Roof	A	98.000	0.026	2.548
2 Driveway	A	98.000		0.000
3 Impvervious	A	98.000		0.000
4				0.000
5				0.000
6				0.000
Pervious area:				
1 woods	A	30.000	0.000	0.000
2 lawn (good)	A	39.000	0.034	1.326
3				0.000
4				0.000
5				0.000
6				0.000
		Total :	0.060	3.874
		Average CN:		64.567
		Imperviousness (%):		43.333

Project Name: 128 Main Street
Sub-basin: E-2
Condition: Proposed

Analysis Date: 18-Jul-18
Analyst: dsw
Checked:

Storm Frequency:	2-year	10-year	25-year	100-year
24-hour rainfall (Rainfall:	**3.2**	**4.600**	**5.400**	**6.600**

Average Slope(ft/ft): Percent: 0.000 Length (ft):

Land Use	Soil Group	CN	Area (acres)	Area x CN
Impervious area:				
1 Roof	A	98.000	0.029	2.842
2 Driveway	A	98.000	0.065	6.370
3 gravel	A	76.000	0.099	7.524
4				0.000
5				0.000
6				0.000
Pervious area:				
1 woods	A	30.000	0.000	0.000
2 lawn (good)	A	39.000	0.077	3.003
3				0.000
4				0.000
5				0.000
6				0.000
		Total :	0.270	19.739
		Average CN:		73.107
		Imperviousness (%):		71.481

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Subject: Time of Concentration (Tc) or Travel Timel (Tt)
Location: Ashland **Job No.:** J14-8

Project:	128 Main street	By dsw	Date 7/18/2018
Location:		Checked	Date
Condition:	Existing E-1		
Time (hrs):	0.16 through subarea	E-1	
	0.16 to be used		

Notes: Space for as many as two segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to Tc only)	Unit	Segment ID	Segment ID		Total
1. Surface description (table 3-1)................................		Grass	paved		
2. Manning's roughness coeff., n (table 3-1)..................		0.24			
3. Flow length, L (total L <= 300 ft)...	ft	50			
4. Two-yr 24-hr rainfall, P2..	in	3.2	3.2		
5. Land slope, s	ft/ft	0.014	0.0128		
6. Tt = 0.007 (nL)^0.8/P2^0.5 s^0.4 Compute Tt	hr	0.157549429	+ 0	=	0.1575494

Shallow concentrated flow-reach1	Unit	Segment ID	Segment ID		Total
7. Surface description (paved or unpaved)		Paved	Unpaved		
8. Flow length, L	ft		55		
9. Watercourse slope, s	ft/ft		0.019		
10. Average velocity, V (figure 3-1)	ft/s	0	2.218800785		
11. Tt = L/3600V Computer Tt	hr	0	+ 0.006885601	=	0.0068856

Shallow concentrated flow-reach2	Unit	Segment ID	Segment ID		Total
7. Surface description (paved or unpaved)		Unpaved	Unpaved		
8. Flow length, L	ft				
9. Watercourse slope, s	ft/ft		0.136363636		
10. Average velocity, V (figure 3-1)	ft/s	0	5.908391567		
11. Tt = L/3600V Computer Tt	hr	0	+ 0	=	0

Channel flow	Unit	Segment ID #1	#2		Total
12. Cross sectional flow area, a	ft^2				
13. Wetted perimeter, Pw	ft	4	0.375		
14. Hydraulic radius, r=a/Pw Computer r	ft	0	0		
15. Channel slope, s	ft/ft	0.060869565	0.05		
16. Manning's roughness coeff., n		0.03	0.015		
17. V = 1.49 r^(2/3) s^(1/2) / n Compute V	ft/s	0	0		
18. Flow length, L	ft	230	250		
19. Tt = L/3600V Computer Tt	hr	0	+ 0	=	0

Channel flow	Unit	Segment ID #3	#4		Total
12. Cross sectional flow area, a	ft^2				
13. Wetted perimeter, Pw	ft				
14. Hydraulic radius, r=a/Pw Computer r	ft	0	0		
15. Channel slope, s	ft/ft				
16. Manning's roughness coeff., n					
17. V = 1.49 r^(2/3) s^(1/2) / n Compute V	ft/s	0	0		
18. Flow length, L	ft	0			
19. Tt = L/3600V Computer Tt	hr	0	+ 0	=	0
20. Watershed or subarea Tc or Tt (add Tr in steps 6, 11, and 19)				hr	0.164435

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Subject: Time of Concentration (Tc) or Travel Timel (Tt)
Location: Ashland **Job No.:** J14-8

Project:	128 Main street	By dsw	Date 7/18/2018
Location:		Checked	Date
Condition:	Existing E-2		
Time (hrs):	0.02 through subarea	E-2	
	0.10 to be used		
Notes:	Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic, or description of flow segments.		

Sheet flow (Applicable to Tc only)	Unit	Segment ID	Segment ID		Total
1. Surface description (table 3-1)................................		Grass	paved		
2. Manning's roughness coeff., n (table 3-1)..................		0.24	0.011		
3. Flow length, L (total L <= 300 ft)..	ft	0	50		
4. Two-yr 24-hr rainfall, P2...	in	3.2	3.2		
5. Land slope, s	ft/ft	0.014	0.014		
6. Tt = 0.007 (nL)^0.8/P2^0.5 s^0.4 Compute Tt	hr	0	+ 0.0133771	=	0.0133771

Shallow concentrated flow-reach1	Unit	Segment ID	Segment ID		Total
7. Surface description (paved or unpaved)		Paved	Unpaved		
8. Flow length, L	ft		60		
9. Watercourse slope, s	ft/ft		0.019		
10. Average velocity, V (figure 3-1)	ft/s	0	2.218800785		
11. Tt = L/3600V Computer Tt	hr	0	+ 0.007511565	=	0.0075116

Shallow concentrated flow-reach2	Unit	Segment ID	Segment ID		Total
7. Surface description (paved or unpaved)		Unpaved	Unpaved		
8. Flow length, L	ft				
9. Watercourse slope, s	ft/ft		0.136363636		
10. Average velocity, V (figure 3-1)	ft/s	0	5.908391567		
11. Tt = L/3600V Computer Tt	hr	0	+ 0	=	0

Channel flow	Unit	Segment ID #1	#2		Total
12. Cross sectional flow area, a	ft^2				
13. Wetted perimeter, Pw	ft	4	0.375		
14. Hydraulic radius, r=a/Pw Computer r	ft	0	0		
15. Channel slope, s	ft/ft	0.060869565	0.05		
16. Manning's roughness coeff., n		0.03	0.015		
17. V = 1.49 r^(2/3) s^(1/2) / n Compute V	ft/s	0	0		
18. Flow length, L	ft	230	250		
19. Tt = L/3600V Computer Tt	hr	0	+ 0	=	0

Channel flow	Unit	Segment ID #3	#4		Total
12. Cross sectional flow area, a	ft^2				
13. Wetted perimeter, Pw	ft				
14. Hydraulic radius, r=a/Pw Computer r	ft	0	0		
15. Channel slope, s	ft/ft				
16. Manning's roughness coeff., n					
17. V = 1.49 r^(2/3) s^(1/2) / n Compute V	ft/s	0	0		
18. Flow length, L	ft	0			
19. Tt = L/3600V Computer Tt	hr	0	+ 0	=	0
20. Watershed or subarea Tc or Tt (add Tr in steps 6, 11, and 19)				hr	0.0208887

Creative Land & Water Engineering, LLC
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Subject: **SCS MODIFIED SOIL COVER COMPLEX METHOD**

Location: 128 Main Street, Ashland **Job No.:** J14-8

Project Name: 128 Main Street
Sub-basin: P-1
Condition: Proposed

Analysis Date: 18-Jul-18
Analyst: dsw
Checked:

Storm Frequency:	2-year	10-year	25-year	100-year
24-hour rainfall:	**3.2**	**4.600**	**5.400**	**6.600**

Average Slope(ft/ft): Percent: 0.000 Length (ft):

Land Use		Soil Group	CN	Area (acres)	Area x CN
Impervious area:					
1	Roof	A	98.000	0.000	0.000
2	Driveway - pavers	A	76.000	0.006	0.456
3	Impvervious	A	98.000		0.000
4					0.000
5					0.000
6					0.000
Pervious area:					
1	woods	A	30.000	0.000	0.000
2	lawn (good)	A	39.000	0.000	0.000
3					0.000
4					0.000
5					0.000
6					0.000
			Total :	0.006	0.456
			Average CN:		76.000
			Imperviousness (%):		100.000

Project Name: 128 Main Street
Sub-basin: P-2
Condition: Proposed

Analysis Date: 18-Jul-18
Analyst: dsw
Checked:

Storm Frequency:	2-year	10-year	25-year	100-year
24-hour rainfall:	**3.2**	**4.600**	**5.400**	**6.600**

Average Slope(ft/ft): Percent: 0.000 Length (ft):

Land Use		Soil Group	CN	Area (acres)	Area x CN
Impervious area:					
1	Roof	A	98.000	0.167	16.366
2	Driveway	A	98.000	0.142	13.916
3	gravel	A	83.000	0.000	0.000
4					0.000
5					0.000
6					0.000
Pervious area:					
1	woods	A	30.000	0.000	0.000
2	lawn (good)	A	39.000	0.015	0.585
3					0.000
4					0.000
5					0.000
6					0.000
			Total :	0.324	30.867
			Average CN:		95.269
			Imperviousness (%):		95.370

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Location: Ashland **Job No.:** J14-8

Project:	128 Main street	By	dsw	Date	7/18/2018
Location:		Checked		Date	
Condition:	Proposed P-1				
Time (hrs):	0.03 through subarea	P-1			
	0.10 to be used				

Notes: Space for as many as two segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to Tc only)	Unit	Segment ID		Segment ID		Total
1. Surface description (table 3-1)................................		Grass		paved		
2. Manning's roughness coeff., n (table 3-1)..................		0.24		0.011		
3. Flow length, L (total L <= 300 ft)..	ft	0		50		
4. Two-yr 24-hr rainfall, P2..	in	3.2		3.2		
5. Land slope, s	ft/ft	0.014		0.00625		
6. Tt = 0.007 (nL)^0.8/P2^0.5 s^0.4 Compute Tt	hr	0	+	0.018469758	=	0.0184698

Shallow concentrated flow-reach1	Unit	Segment ID		Segment ID		Total
7. Surface description (paved or unpaved)		Paved		Unpaved		
8. Flow length, L	ft	30		0		
9. Watercourse slope, s	ft/ft	0.00625		0.019		
10. Average velocity, V (figure 3-1)	ft/s	1.606437051		2.218800785		
11. Tt = L/3600V Computer Tt	hr	0.005187463	+	0	=	0.0051875

Shallow concentrated flow-reach2	Unit	Segment ID		Segment ID		Total
7. Surface description (paved or unpaved)		Unpaved		Unpaved		
8. Flow length, L	ft					
9. Watercourse slope, s	ft/ft			0.136363636		
10. Average velocity, V (figure 3-1)	ft/s	0		5.908391567		
11. Tt = L/3600V Computer Tt	hr	0	+	0	=	0

Channel flow	Unit	Segment ID		Segment ID		Total
		#1		#2		
12. Cross sectional flow area, a	ft^2	0.785				
13. Wetted perimeter, Pw	ft	3.14		0.375		
14. Hydraulic radius, r=a/Pw Computer r	ft	0.25		0		
15. Channel slope, s	ft/ft	0.005714286		0.05		
16. Manning's roughness coeff., n		0.011		0.015		
17. V = 1.49 r^(2/3) s^(1/2) / n Compute V	ft/s	4.06350905		0		
18. Flow length, L	ft	140		250		
19. Tt = L/3600V Computer Tt	hr	0.009570272	+	0	=	0.0095703

Channel flow	Unit	Segment ID		Segment ID		Total
		#3		#4		
12. Cross sectional flow area, a	ft^2					
13. Wetted perimeter, Pw	ft					
14. Hydraulic radius, r=a/Pw Computer r	ft	0		0		
15. Channel slope, s	ft/ft					
16. Manning's roughness coeff., n						
17. V = 1.49 r^(2/3) s^(1/2) / n Compute V	ft/s	0		0		
18. Flow length, L	ft	0				
19. Tt = L/3600V Computer Tt	hr	0	+	0	=	0
20. Watershed or subarea Tc or Tt (add Tr in steps 6, 11, and 19)					hr	0.0332275

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Subject: Time of Concentration (Tc) or Travel Timel (Tt)
Location: Ashland **Job No.:** J14-8

Project:	128 Main street	By dsw	Date 7/18/2018
Location:		Checked	Date
Condition:	Proposed P-2		
Time (hrs):	0.02 through subarea	P-2	
	0.10 to be used		

Notes: Space for as many as two segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to Tc only)	Unit	Segment ID		Segment ID		Total
1. Surface description (table 3-1)................................		Grass		paved		
2. Manning's roughness coeff., n (table 3-1)..................		0.24		0.011		
3. Flow length, L (total L <= 300 ft)..	ft	0		50		
4. Two-yr 24-hr rainfall, P2..	in	3.2		3.2		
5. Land slope, s	ft/ft	0.014		0.009090909		
6. Tt = 0.007 (nL)^0.8/P2^0.5 s^0.4 Compute Tt	hr	0	+	0.015899017	=	0.015899

Shallow concentrated flow-reach1	Unit	Segment ID		Segment ID		Total
7. Surface description (paved or unpaved)		Paved		Unpaved		
8. Flow length, L	ft	60		0		
9. Watercourse slope, s	ft/ft	0.016666667		0.019		
10. Average velocity, V (figure 3-1)	ft/s	2.62330072		2.218800785		
11. Tt = L/3600V Computer Tt	hr	0.006353319	+	0	=	0.0063533

Shallow concentrated flow-reach2	Unit	Segment ID		Segment ID		Total
7. Surface description (paved or unpaved)		Unpaved		Unpaved		
8. Flow length, L	ft					
9. Watercourse slope, s	ft/ft			0.136363636		
10. Average velocity, V (figure 3-1)	ft/s	0		5.908391567		
11. Tt = L/3600V Computer Tt	hr	0	+	0	=	0

Channel flow	Unit	Segment ID #1		#2		Total
12. Cross sectional flow area, a	ft^2	0.785				
13. Wetted perimeter, Pw	ft	3.14		0.375		
14. Hydraulic radius, r=a/Pw Computer r	ft	0.25		0		
15. Channel slope, s	ft/ft	0.016666667		0.05		
16. Manning's roughness coeff., n		0.011		0.015		
17. V = 1.49 r^(2/3) s^(1/2) / n Compute V	ft/s	6.939762863		0		
18. Flow length, L	ft	60		250		
19. Tt = L/3600V Computer Tt	hr	0.002401619	+	0	=	0.0024016

Channel flow	Unit	Segment ID #3		#4		Total
12. Cross sectional flow area, a	ft^2					
13. Wetted perimeter, Pw	ft					
14. Hydraulic radius, r=a/Pw Computer r	ft	0		0		
15. Channel slope, s	ft/ft					
16. Manning's roughness coeff., n						
17. V = 1.49 r^(2/3) s^(1/2) / n Compute V	ft/s	0		0		
18. Flow length, L	ft	0				
19. Tt = L/3600V Computer Tt	hr	0	+	0	=	0
20. Watershed or subarea Tc or Tt (add Tr in steps 6, 11, and 19)					hr	0.024654

Table 1: Street Drainage Calculations

SITE DRAINAGE ENGINEERING

Creative Land & Water Engineering, LLC
Environmental Science and Engineering
P.O. Box 584
Southborough, MA 01772
Tel: (508)281-1694 **Fax: (508)281-1694**

Project: 128 Main Street
Ashland, MA

S. D.D.A. No.:

Date: 16-Jul-18
By: dsw
Chkd. by:

Given:
Manning's coef., n= 0.0110 Region = 3
i = Rainfall intensity at 100 year storm Ref. storm= 25
Minimum pipe size= 12 inches

Kr= 230 br= 30 *K= 290 b= 31

Line		Length	Drainage	Total area	Run-	Time of Concentration, min.				Rainfall I **	Required Qd	Pipe Size	Invert Elevation		Slope, S	Flow at INV. Slope		Design Condition	
From	To	ft	area(ac)	ac	off, C	overland	gutter	channel	subdivision	in/hr	cfs	D, in	Upper, ft	Lower, ft	ft/ft	Qf, cfs	Vf, fps	d, in	vd, fps
CB#1	DMH1	140	0.0514	0.0514	0.95	5			5.000	8.056	0.416	12	186.80	186.00	0.006	3.184	4.055		
CB#2	DMH1	20	0.07	0.0906	0.95	5			5.000	8.056	0.734	12	187.00	186.00	0.050	9.420	11.993		
DMH1	DMH2	25	0	0.1420	0.95			0.028	5.028	8.049	1.149	12	185.90	185.40	0.020	5.958	7.585		
DMH#3	Infil MF	50	0.167	0.167	0.95	5		0.055	5.000	8.056	0.676	8	187.00	186.00	0.020	2.021	5.789		
total			0.2884233																

*Standard Handbook for Civil Engineers, Third Edition
alculate rainfall intensity to be conservative.

Appendix B: FLOOD ROUTING CALCULATIONS FOR STORAGE AREAS

On the following pages, are the results of flood routing calculations by Storage-Indication method. We prefer this classical technique to the short cut methods because the assumptions for the short cut methods are often violated in real drainage areas.

The computation is carried out by HEC-HMS.

Creative Land & Water Engineering, LLC
Environmental Science and Engineering
P.O. Box 584, Southborough, MA 01772
Tel: (508)281-1694 Email: deshengw@yahoo.com

Subject: Infiltration Trench_ Front Parking Lot
128 Main Street
Ashland, MA

revised:
By: dsw
Chkd: dsw
Job No.: J14-8

Date:
Date: 20-Jul-18
Date:
Sheet: 1 of 1

STORAGE INDICATION ANALYSIS _ INFILTRATION TRENCH

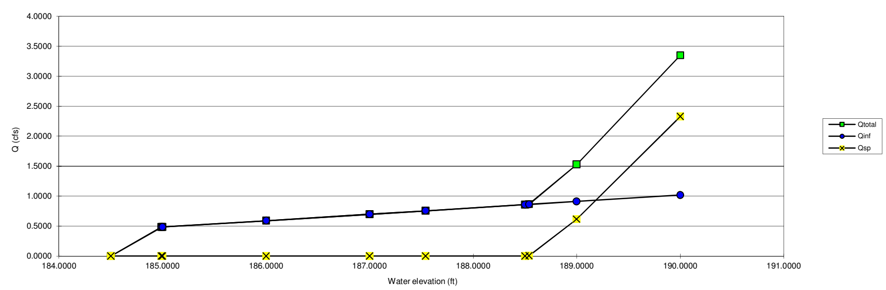
Storage-Indication Analysis

(1)Permeability (ft/sec):	0.00105	Water table (ft):	180		
Bottom elevation (ft):	184.5	Depth of aquifer (ft):	40+		
Trench width (ft):	10	Time step (sec):	60	Bottom factor:	1.00
Trench length (ft):	41	BC weir length/pipe diam (ft):	0.670	Weir width (ft):	0.5
Trench depth (ft):	4	Weir crest elevation/INV (ft):	188.500	Weir or Pipe (w or p):	p
				Discharge coefficient:	0.6

Location	Elevation	Total Q	H	Qinfil	Qweir/pipe	Voids Area	Trench Storage	Dewater time	storage
	ft	cfs	ft	cfs	cfs	ft^2	ft^3	hrs	ac-ft
Bottom of trench	184.5000	**0.0000**		**0.0000**	**0.0000**	164.00	0.00	0.00	0.00000
Bottom of riser/Chamber	184.9900	**0.4830**	0.4900	**0.4830**	**0.0000**	164.00	80.36	0.09	0.00184
	185.0000	**0.4841**	0.5000	**0.4841**	**0.0000**	303.40	82.70	0.09	0.00190
Middle of Chamber	186.0000	**0.5912**	1.5000	**0.5912**	**0.0000**	266.50	367.65	0.24	0.00844
	187.0000	**0.6983**	2.5000	**0.6983**	**0.0000**	246.00	623.90	0.35	0.01432
Top of Chamber	187.5400	**0.7561**	3.0400	**0.7561**	**0.0000**	164.00	734.60	0.39	0.01686
Overflow	188.5000	**0.8589**	4.0000	**0.8589**	**0.0000**	164.00	892.04	0.45	0.02048
Top of trench	188.54	**0.8661**	4.0400	**0.8632**	**0.0029**	164.00	898.60	0.45	0.02063
	189	**1.5289**	4.5	**0.9125**	**0.6165**	106.60	960.83	0.46	0.02206
Subbase	190	**3.3495**	5.5	**1.0196**	**2.3300**	106.60	1067.44	0.48	0.02450

(1) Half of average tested or lesser of the tested rate.

Storage-Indication Curve



References:

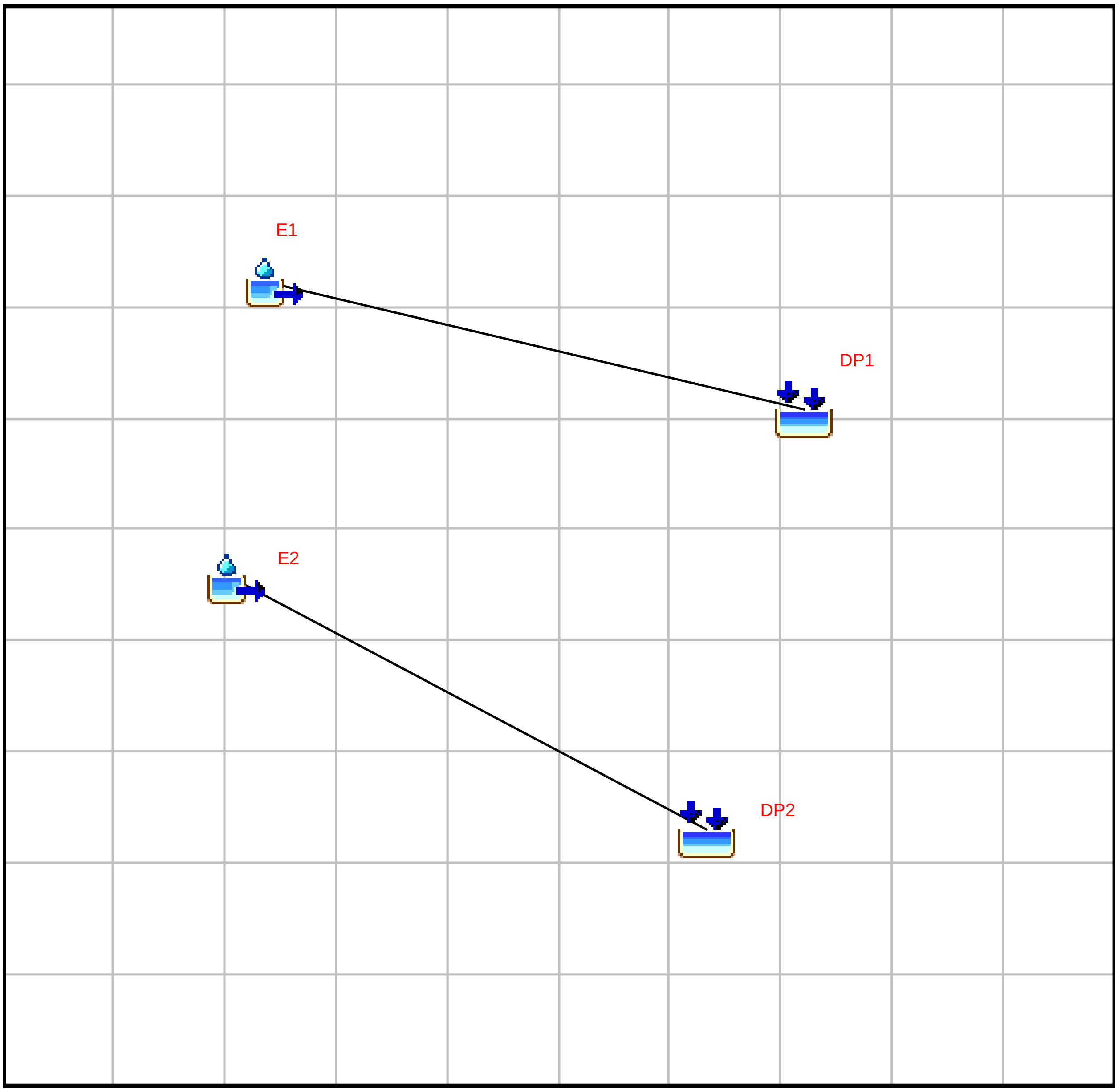
[1] Schueler, T. R. (1987) "Controlling Urban Runoff," Metropolitan Council of Governments, Washington D.C.
[2] Urbonas, B. and Stahre, P. (1993) "Stormwater Best Management Practices and Detention for Water Quality, Drainage, and CSO Management" PTR Prentice Hall, Englewood Cliffs, New Jersey 07632.
[3] U.S. D. I. (1974) "Earth Manual -A Water Resources Technical Publication", Washington D. C.
[4] David R. Maidment ed. (1992). Handbook of Hydrology, McGraw-Hill, Inc. New York.
[5] Wang, Desheng (1999). "A simple mathematical model for infiltration BMP design," Hydrological Science and Technology, Vol. 15, NO. 1-4, American Institute of Hydrology, 248-256.

HEC-HMS

Project : Project 1

Basin Model : Existing

Aug 09 14:44:39 EDT 2018



Project: Project 1 Simulation Run: ex2

Start of Run:	01Jan2015, 00:00	Basin Model:	Existing
End of Run:	07Jan2015, 00:00	Meteorologic Model:	2-yr
Compute Time:	09Aug2018, 15:00:15	Control Specifications:	2 min

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
E1	0.00009	0.026	01Jan2015, 12:10	0.003
DP1	0.00009	0.026	01Jan2015, 12:10	0.003
E2	0.00042	0.284	01Jan2015, 12:06	0.024
DP2	0.00042	0.284	01Jan2015, 12:06	0.024

Project: Project 1 Simulation Run: ex10

Start of Run:	01Jan2015, 00:00	Basin Model:	Existing
End of Run:	07Jan2015, 00:00	Meteorologic Model:	10-yr
Compute Time:	09Aug2018, 14:57:50	Control Specifications:	2 min

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
E1	0.00009	0.072	01Jan2015, 12:08	0.007
DP1	0.00009	0.072	01Jan2015, 12:08	0.007
E2	0.00042	0.575	01Jan2015, 12:06	0.046
DP2	0.00042	0.575	01Jan2015, 12:06	0.046

Project: Project 1 Simulation Run: ex25

Start of Run: 01Jan2015, 00:00 Basin Model: Existing
End of Run: 07Jan2015, 00:00 Meteorologic Model: 25-yr
Compute Time: 09Aug2018, 15:01:52 Control Specifications: 2 min

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
E1	0.00009	0.103	01Jan2015, 12:08	0.009
DP1	0.00009	0.103	01Jan2015, 12:08	0.009
E2	0.00042	0.756	01Jan2015, 12:06	0.061
DP2	0.00042	0.756	01Jan2015, 12:06	0.061

Project: Project 1 Simulation Run: ex100

Start of Run:	01Jan2015, 00:00	Basin Model:	Existing
End of Run:	07Jan2015, 00:00	Meteorologic Model:	100-year
Compute Time:	09Aug2018, 15:04:11	Control Specifications:	2 min

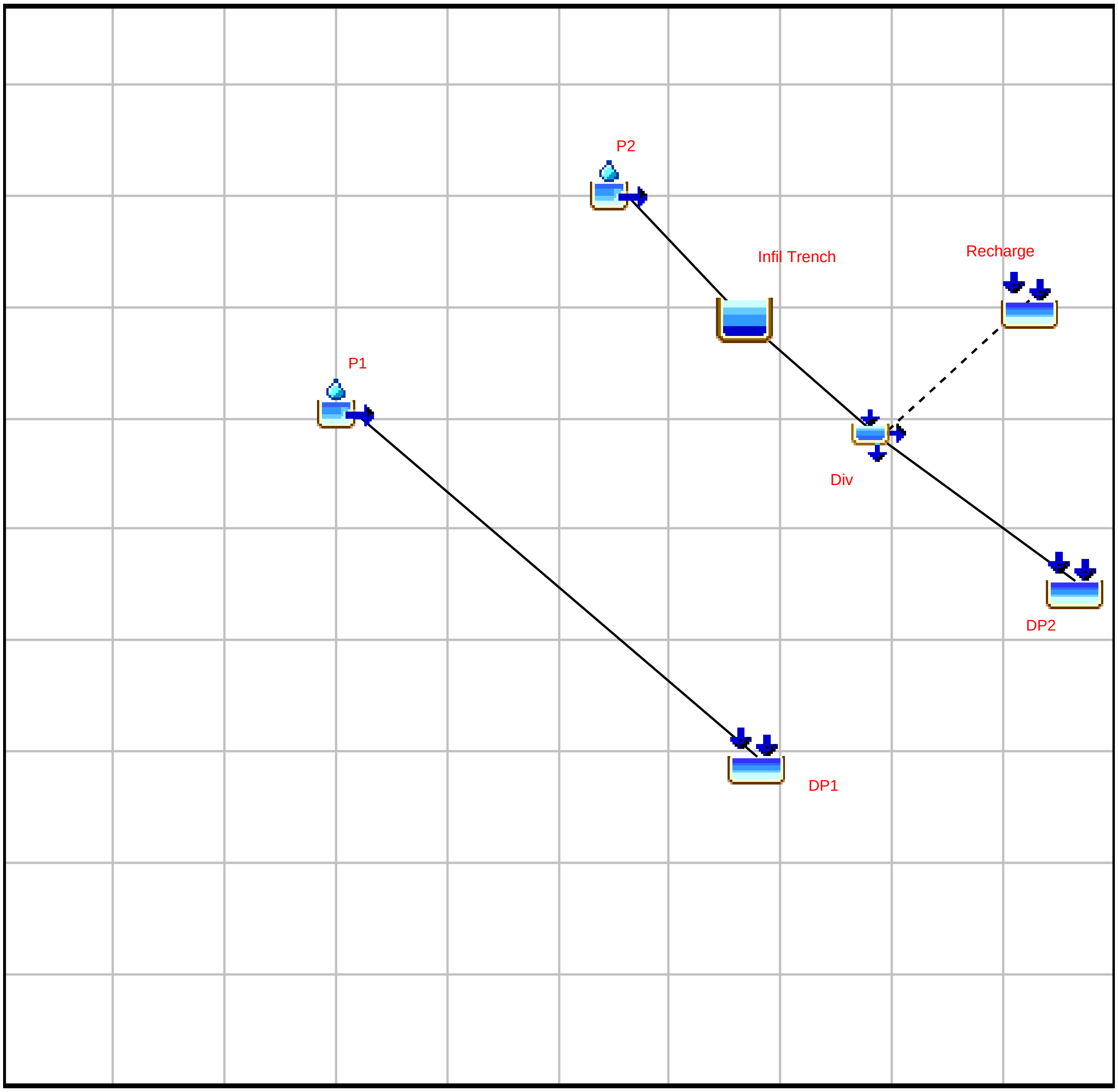
Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
E1	0.00009	0.154	01Jan2015, 12:08	0.013
DP1	0.00009	0.154	01Jan2015, 12:08	0.013
E2	0.00042	1.037	01Jan2015, 12:06	0.083
DP2	0.00042	1.037	01Jan2015, 12:06	0.083

HEC-HMS

Project : Project 1

Basin Model : Proposed

Aug 09 15:07:02 EDT 2018



Project: Project 1 Simulation Run: P 2

Start of Run:	01Jan2015, 00:00	Basin Model:	Proposed
End of Run:	07Jan2015, 00:00	Meteorologic Model:	2-yr
Compute Time:	09Aug2018, 15:10:18	Control Specifications:	2 min

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
P1	0.00001	0.008	01Jan2015, 12:06	0.001
DP1	0.00001	0.008	01Jan2015, 12:06	0.001
P2	0.00051	0.855	01Jan2015, 12:04	0.073
Infil	0.00051	0.552	01Jan2015, 12:12	0.073
Div 1	0.00051	0.000	01Jan2015, 00:00	0.000
DP2	0.00051	0.000	01Jan2015, 00:00	0.000
recharge	0.00000	0.552	01Jan2015, 12:12	0.073

Project: Project 1

Simulation Run: P 2 Reservoir: Infil

Start of Run:	01Jan2015, 00:00	Basin Model:	Proposed
End of Run:	07Jan2015, 00:00	Meteorologic Model:	2-yr
Compute Time:	09Aug2018, 15:10:18	Control Specifications:	2 min

Volume Units: AC-FT

Computed Results

Peak Inflow :	0.855 (CFS)	Date/Time of Peak Inflow :	01Jan2015, 12:04
Peak Outflow :	0.552 (CFS)	Date/Time of Peak Outflow :	01Jan2015, 12:12
Total Inflow :	0.073 (AC-FT)	Peak Storage :	0.006 (AC-FT)
Total Outflow :	0.073 (AC-FT)	Peak Elevation :	185.6372 (FT)

Project:	Project 1
Simulation Run:	P 2 Diversion: Div 1

Start of Run:	01Jan2015, 00:00	Basin Model:	Proposed
End of Run:	07Jan2015, 00:00	Meteorologic Model:	2-yr
Compute Time:	09Aug2018, 15:10:18	Control Specifications:	2 min

Volume Units: AC-FT

Computed Results

Peak Inflow :	0.552 (CFS)	Date/Time of Peak Inflow :	01Jan2015, 12:12
Peak Outflow :	0.000 (CFS)	Date/Time of Peak Outflow :	01Jan2015, 00:00
Peak Diversion :	0.552 (CFS)	Date/Time of Peak Diversion :	01Jan2015, 12:12
Total Inflow :	0.073 (AC-FT)		
Total Outflow :	0.000 (AC-FT)	Total Diversion :	0.073 (AC-FT)

Project: Project 1 Simulation Run: P 10

Start of Run: 01Jan2015, 00:00 Basin Model: Proposed
End of Run: 07Jan2015, 00:00 Meteorologic Model: 10-yr
Compute Time: 09Aug2018, 15:17:20 Control Specifications: 2 min

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
P1	0.00001	0.015	01Jan2015, 12:06	0.001
DP1	0.00001	0.015	01Jan2015, 12:06	0.001
P2	0.00051	1.268	01Jan2015, 12:04	0.110
Infil	0.00051	0.674	01Jan2015, 12:14	0.110
Div 1	0.00051	0.000	01Jan2015, 00:00	0.000
DP2	0.00051	0.000	01Jan2015, 00:00	0.000
recharge	0.00000	0.674	01Jan2015, 12:14	0.110

Project: Project 1

Simulation Run: P 10 Reservoir: Infil

Start of Run:	01Jan2015, 00:00	Basin Model:	Proposed
End of Run:	07Jan2015, 00:00	Meteorologic Model:	10-yr
Compute Time:	09Aug2018, 15:17:20	Control Specifications:	2 min

Volume Units: AC-FT

Computed Results

Peak Inflow :	1.268 (CFS)	Date/Time of Peak Inflow :	01Jan2015, 12:04
Peak Outflow :	0.674 (CFS)	Date/Time of Peak Outflow :	01Jan2015, 12:14
Total Inflow :	0.110 (AC-FT)	Peak Storage :	0.013 (AC-FT)
Total Outflow :	0.110 (AC-FT)	Peak Elevation :	186.7709 (FT)

Project: Project 1

Simulation Run: P 10 Diversion: Div 1

Start of Run:	01Jan2015, 00:00	Basin Model:	Proposed
End of Run:	07Jan2015, 00:00	Meteorologic Model:	10-yr
Compute Time:	09Aug2018, 15:17:20	Control Specifications:	2 min

Volume Units: AC-FT

Computed Results

Peak Inflow :	0.674 (CFS)	Date/Time of Peak Inflow :	01Jan2015, 12:14
Peak Outflow :	0.000 (CFS)	Date/Time of Peak Outflow :	01Jan2015, 00:00
Peak Diversion :	0.674 (CFS)	Date/Time of Peak Diversion :	01Jan2015, 12:14
Total Inflow :	0.110 (AC-FT)		
Total Outflow :	0.000 (AC-FT)	Total Diversion :	0.110 (AC-FT)

Project: Project 1 Simulation Run: P 25

Start of Run: 01Jan2015, 00:00 Basin Model: Proposed
End of Run: 07Jan2015, 00:00 Meteorologic Model: 25-yr
Compute Time: 09Aug2018, 15:49:16 Control Specifications: 2 min

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
P1	0.00001	0.019	01Jan2015, 12:06	0.002
DP1	0.00001	0.019	01Jan2015, 12:06	0.002
P2	0.00051	1.501	01Jan2015, 12:04	0.132
Infil	0.00051	0.768	01Jan2015, 12:14	0.132
Div 1	0.00051	0.000	01Jan2015, 00:00	0.000
DP2	0.00051	0.000	01Jan2015, 00:00	0.000
recharge	0.00000	0.768	01Jan2015, 12:14	0.132

Project: Project 1

Simulation Run: P 25 Reservoir: Infil

Start of Run:	01Jan2015, 00:00	Basin Model:	Proposed
End of Run:	07Jan2015, 00:00	Meteorologic Model:	25-yr
Compute Time:	09Aug2018, 15:49:16	Control Specifications:	2 min

Volume Units: AC-FT

Computed Results

Peak Inflow :	1.501 (CFS)	Date/Time of Peak Inflow :	01Jan2015, 12:04
Peak Outflow :	0.768 (CFS)	Date/Time of Peak Outflow :	01Jan2015, 12:14
Total Inflow :	0.132 (AC-FT)	Peak Storage :	0.017 (AC-FT)
Total Outflow :	0.132 (AC-FT)	Peak Elevation :	187.6488 (FT)

Project: Project 1

Simulation Run: P 25 Diversion: Div 1

Start of Run:	01Jan2015, 00:00	Basin Model:	Proposed
End of Run:	07Jan2015, 00:00	Meteorologic Model:	25-yr
Compute Time:	09Aug2018, 15:49:16	Control Specifications:	2 min

Volume Units: AC-FT

Computed Results

Peak Inflow :	0.768 (CFS)	Date/Time of Peak Inflow :	01Jan2015, 12:14
Peak Outflow :	0.000 (CFS)	Date/Time of Peak Outflow :	01Jan2015, 00:00
Peak Diversion :	0.768 (CFS)	Date/Time of Peak Diversion :	01Jan2015, 12:14
Total Inflow :	0.132 (AC-FT)		
Total Outflow :	0.000 (AC-FT)	Total Diversion :	0.132 (AC-FT)

Project: Project 1 Simulation Run: P 100

Start of Run: 01Jan2015, 00:00 Basin Model: Proposed
End of Run: 07Jan2015, 00:00 Meteorologic Model: 100-year
Compute Time: 09Aug2018, 15:52:43 Control Specifications: 2 min

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
P1	0.00001	0.026	01Jan2015, 12:06	0.002
DP1	0.00001	0.026	01Jan2015, 12:06	0.002
P2	0.00051	1.850	01Jan2015, 12:04	0.164
Infil	0.00051	1.330	01Jan2015, 12:10	0.164
Div 1	0.00051	0.432	01Jan2015, 12:10	0.003
DP2	0.00051	0.432	01Jan2015, 12:10	0.003
recharge	0.00000	0.898	01Jan2015, 12:10	0.161

Project:	Project 1		
Simulation Run:	P 100	Reservoir:	Infil
Start of Run:	01Jan2015, 00:00	Basin Model:	Proposed
End of Run:	07Jan2015, 00:00	Meteorologic Model:	100-year
Compute Time:	09Aug2018, 15:52:43	Control Specifications:	2 min
Volume Units:	AC-FT		

Computed Results

Peak Inflow :	1.850 (CFS)	Date/Time of Peak Inflow :	01Jan2015, 12:04
Peak Outflow :	1.330 (CFS)	Date/Time of Peak Outflow :	01Jan2015, 12:10
Total Inflow :	0.164 (AC-FT)	Peak Storage :	0.022 (AC-FT)
Total Outflow :	0.164 (AC-FT)	Peak Elevation :	188.8617 (FT)

Project: Project 1

Simulation Run: P 100 Diversion: Div 1

Start of Run:	01Jan2015, 00:00	Basin Model:	Proposed
End of Run:	07Jan2015, 00:00	Meteorologic Model:	100-year
Compute Time:	09Aug2018, 15:52:43	Control Specifications:	2 min

Volume Units: AC-FT

Computed Results

Peak Inflow :	1.330 (CFS)	Date/Time of Peak Inflow :	01Jan2015, 12:10
Peak Outflow :	0.432 (CFS)	Date/Time of Peak Outflow :	01Jan2015, 12:10
Peak Diversion :	0.898 (CFS)	Date/Time of Peak Diversion :	01Jan2015, 12:10
Total Inflow :	0.164 (AC-FT)		
Total Outflow :	0.003 (AC-FT)	Total Diversion :	0.161 (AC-FT)

Appendix C: CALCULATIONS OF STORMWATER QUALITY CONTROL[1]

1. Infiltration Pond

In current Best Management Practices, extended infiltration ponds are one of the most widely used methods. We have used the most recent studies (Schueler 1987, 1992, Urbonas and Stahre 1993) on stormwater quality control by extended infiltration ponds (EDP) to calculate nutrient load. The results are used as a basis for the designs of sediment forebays and water treatment pools. Information on pollutant concentration from runoff (EPA 1983) is used. Pollutant loads from predevelopment and postdevelopment are calculated and compared. Removal efficiency is calculated based on long-term average results from typical basins, U.S. EPA (1986), and adapted to reflect modifications of Walker (1986) and short term dynamic effect. A generalized formula is provided in the following (Wang and Carr 1996):

$$Pr = Prmax\left(1 - \frac{1}{1 + Vi^{np}}\right).\mathrm{fr} \qquad (1)$$

in which, Pr = pollutant removal rate (%);

Prmax = maximum pollutant removal rate (%);
Vi = ratio of designed water treatment volume to the runoff volume from mean storm (about 0.5 inches rainfall);
np = power coefficient, 1.4 is used in this study.
fr = residence time coefficient to reflect the dynamic effect.

$$fr = 1 - [1 + \frac{V_s t}{nh}]^{-n} \qquad (2)$$

where, n = turbulence or short circuiting constant (Fair and Geyer 1954), n = 1 for poor performance, n = 3 for good performance, n >5 for very good, and n = 4 for ideal performance;
Vs = effective settling velocity, ft/hr.
t = residence time, hr;
h = average depth of the pond, ft.

Some Prmax values for some pollutants are summarized here:

Pollutant	Prmax (%)
TSS	100
BOD, COD, Zn,Cu	45
TP	70
TN	50
Pb	95

These removal rates do not include the effect of swales or sediment sumps in catch basins. Removal rates of trace metals can be different due to the form of the metal. The particulate forms of metals are

[1] Water Quality Module of Stormwater Analysis Version 1.0 © 1996, by Desheng Wang, Ph.D., P.E.,

easy to remove. The soluble forms of metals are usually more difficult to remove. However, significant parts of soluble metals appear to adsorb to sediment particles and settle out of the water column. 60% removal rate was estimated in a case when 80% of zinc is in soluble form (Schueler 1987). The following table shows the removal rates of selected pollutants for a typical extended infiltration pond with a water treatment volume of 2.5 times the average runoff volume.

Table A.1: Fact Sheet of Standard Extended Infiltration Ponds (SEDP) (Schueler 1987, 1992)

Contaminant	Removal Efficiency (%)	Remarks
TSS	78	Total suspended solids
TN	41	Total nitrogen
TP	51	Total phosphorus
BOD	40	Biological oxygen demand
COD	40	Chemical oxygen demand
Pb	72	Lead
Zn	40	Zinc
Cu	40	Copper
HCs	60	Hydrocarbons*
Bact	70	Bacteria*

* Based on field studies by EPA (1981), Grizzard et al. (1986).

The SEDP requires that a pond volume equal the runoff volume of a rainfall event with exceedance frequency 90%.

The summary of calculations is presented below.

Standard Pond Volume (Treatment Volume, in acre-ft) (Schueler 1987, 1992):

$$Vp=[(P)(Pj)(Rv)/12]A \qquad (3)$$

Total Pollutant Load in lbs:

$$L=[(P)(Pj)(Rv)/12](A)\ (C)\ (2.72) \qquad (4)$$

where, P=Rainfall depth (inches); Pj=correction factor, equals the accumulative frequency of rainfall events; Rv=runoff coefficient, =0.05 + 0.009I; I= Imperviousness (%); A = watershed area (Acre); L= pollutant load (lbs); C = pollutant concentration (mg/l).

Sediment forebay is designed to hold 5 years accumulation of TSS. Once a year or once every two years cleanup of the forebay is recommended. In addition, 24 hrs or longer infiltration time is recommended to achieve predicted removal rate (Schueler 1987, Urbonas and Stahre 1993). Most coarse particles are supposed to be trapped by sediment forebay. For a given site condition, the area of the forebay can be determined by the following equation which was derived by the Washington State Department of Ecology from the Camp-Hazen equation (Washington State Department of Ecology, 1992 and Chen, 1975):

$$A_s = -(\frac{Q_o}{\omega}) * Ln(1 - E) \quad (5),$$

where:

A_s = sediment forebay or basin surface area (ft^2);

E = target removal efficiency of suspended solids;

ω = particle settling velocity; for target particle size (silt) use settling velocity = 0.0004 ft/sec for a site with imperviousness larger or equal to 75% and 0.0003 ft/sec for imperviousness < 75%;

Q_o = rate of outflow form the basin; which is equal to the water quality volume divided by the infiltration time (t_d).

Besides the above mentioned pollutants, it has been reported that an order of magnitude reduction in bacterial counts after 32 hours of infiltration occurs (Whipple and Hunter 1981). Also, about 60 - 70% removal of hydrocarbons was reported over the same interval.

In addition to the pond attenuation abilites, marshes are used to provide extra treatment and purification for the water passing through them. Tables A.2 and A.3 provide average removal rates for selected pollutants from typical marshes.

Table A.2 Uptake Potentials of Cattail (Typha latifolia) Marshes (Chan et al 1982)

Contaminant	Uptake (lbs/acre/yr)
TP	9.7 to 358.7
TN	456.3 to 2340.7
Cu	0.32
Zn	0.53
Mn	12.16

Table A.3 Uptake Potentials and Removal Rate of Free Water Surface Marshes (Reed 1990)

Contaminant	Uptake (lbs/acre/yr)	Removal Rate (%)

TSS	125 to 49,508	61 to 95
TP	19.2 to 400.6	31 to 80
TN	215 to 430.6	43 to 93
BOD	220 to 20,764	49 to 95

2. Catch Basins

Catch basins are to be equipped with sediment sumps and oil/grease traps. Regularly maintained and cleaned catch basins can remove significant amounts of pollutants. Table A.4 presents an average removal rate of selected pollutants from catch basin sumps (Aronson et al 1983).

Table A.4 Average Removal Rates of Catch Basins for Selected Contaminants

Contaminant	Average Removal Rate (%)
TSS	58
TN	17
P	4
TM	50

* P = Phosphates; TM = Total metals.

References:

[1] Aronson, G. L., et al. (1983). "*Evaluation of Catchbasin Performance for Urban Stormwater Pollution Control*," Municipal Environmental Research Laboratory, Office of Research and Development, U.S. EPA. EPA-600/2-83-043.

[2] Reed, S. C. (1990). "*Natural Systems for Wastewater Treatment - Manual of Practice FD-16,*" Water Pollution Control Federation.

[3] Shueler, T. (1987) *Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs,* Dept. of Environmental Programs, Metropolitan Washington Council of Governments, Washington D. C.

[4] Shueler, T. (1992) *Design of Stormwater Wetland Systems: Guidelines for Creating Diverse and Effective Stormwater Wetland Systems in the Mid-Atlantic Region*, Anacostia Restoration Team, Dept. of Environmental Programs, Metropolitan Washington Council of Governments, Washington D. C.

[5] Urbonas, Ben, and Stahre, Peter (1993) *Stormwater --Best Management Practices and Infiltration for Water Quality, Drainage, and CSO Management*, PTR Prentice Hall, Englewood Cliffs, New Jersey.

[6] Walker, W. (1986). "*Phosphorus Removal by Urban Runoff Infiltration Basins,*" Presented at Lake and Reservoir Management Conference: Influence on Nonpoint Source Pollutants. North American Lake Management Society, Portland, Oregon, November 5-8, 1986.

[7] Wang, D. S., and Carr, B. J. (1996). "Pollutant Removal Rates for Stormwater Infiltration Ponds," Proceedings of 1996 AIH Conference, Boston.

[8] Claytor, R. A., and Schueler, T. T. (1996) *Design of Stormwater Filtering Systems*, the Center for Watershed Protection, Silver Spring, MD 20910.

TSS Removal Calcualtion Worksheet

				Revised:			
Project:	128 Main St	Designed by:	dsw	Date:	11-Aug-18	Sheet:	1 of 1
Location:	Ashland	chkd by:		Date:		Job:	J14-8
	Roof	revision:		Date:			

A	B	C	D	E
BMP*	TSS Removal Rate	Starting TSS	Amount Removed (BxC)	Remaining Load (C - D)
Roof	0.8	1	0.8	0.2
IT	0.8	0.2	0.16	0.04

Total TSS Removal= 0.96

* WQS = water quality swale; WQI = water Qality inlet; EDB = extended detention basin.
DSCB = deep sump catch basin; SW = sweeping; DW=drywell; IT = infiltration trench.
FB = sediment Forebay; CW = constructed wetland, RB = retention basin, WB = wet basin
IB = Infiltration Basin
Reference: MADEP (2008) Stormwater Management, Volume I & II.
** Rate calculated based on actual design volume.

TSS Removal Calcualtion Worksheet

				Revised:			
Project:	128 Main St	Designed by:	dsw	Date:	10-Aug-18	Sheet:	1 of 1
Location:	Ashland	chkd by:		Date:		Job:	J14-8
		revision:		Date:			

A	B	C	D	E
BMP*	TSS Removal Rate	Starting TSS	Amount Removed (BxC)	Remaining Load (C - D)
DSCB	0.25	1	0.25	0.75
Oil/grit seperator	0.91	0.75	0.6825	0.0675
Infiltration Trench	0.8	0.0675	0.054	0.0135

Total TSS Removal= 0.99

* WQS = water quality swale; WQI = water Qality inlet; EDB = extended detention basin.
DSCB = deep sump catch basin; SW = sweeping; DW=drywell; IT = infiltration trench.
FB = sediment Forebay; CW = constructed wetland, RB = retention basin, WB = wet basin
IB = Infiltration Basin
Reference: MADEP (2008) Stormwater Management, Volume I & II.
** Rate calculated based on actual design volume.

CREATIVE LAND & WATER ENGINEERING, LLC

Environmental Science and Resource Management

P.O. Box 584, Southborough, MA 01772

Tel/Fax: (508)281-1694 Email: deshengw@yahoo.com

Subject:	Groundwater Recharge	revision by:	**Date:**
	Water Quality Calcs.	**By:** dsw	**Date:** 8/10/2018
	128 Main Street	**Chkd:**	**Date:**
Location:	Ashland	**Job No.:** J14-8	**Sheet:** 1

1. Land Use Break Down Land Uses (Acres)

	Subbasin	Existing	Proposed	Existing	Proposed	Increment
1	Roof	0.055	0.167	0.055	0.167	0.112
2	Pave	0.164	0.148	0.164	0.148	-0.016
3	Pervious	0.111	0.015			
	Total	0.33	0.33	0.219	0.315	0.096
	Imperviousness (%)			66.36	95.45	

2. Groundwater Recharge

Dry wells (2)

Infiltration time (hrs):	12							
Diameter (ft):	6	width (ft):		Depth (ft):	6	Pipe dia. (in):		
Storage volume (cu.ft):								
Infil. rate (cfs):								
Infiltration volume (cu.ft):	0							
Total volume (cu ft) :	0							
Impervious area (acres):	A soil	B Soil	C Soil	D Soil	Total			
					0 acres		Provided	
DEP required GW recharge volume:					**0** cu. ft	larger than	**0** cu. ft	OK!

Crushed Gravel

Infiltration time (hrs):	12		Basin PB				Total	
At elevation (ft):								
Storage volume (cu.ft):							**0**	
Infil. rate (cfs):								
Infiltration volume (cu.ft):				0	0		**0**	
Total volume (cu ft) :				0	0	0	**0**	
Impervious area (acres):	A soil	B Soil	C Soil	D Soil	Total			
					0 acres		Provided	
DEP required GW recharge volume:					**0** cu. ft	less than	**0** cu. ft	OK!

Infiltration trenches:

			Basin PA						
Infiltration time (hrs):	12		Trench 1	Trench 2	Trench 3	Trench 4	Trench 5	Trench 6	Total
Depth (ft):			4.5						
Storage volume (cu.ft):			960.00						**960**
Infil. rate (cfs):			0.91						
Infiltration volume (cu.ft):			39312	0	0	0	0	0	**39312**
Total volume (cu ft) :			40272	0	0	0	0	0	**40272**
Impervious area (acres):	A soil	B Soil	C Soil	D Soil	Total				
	0.315				0.315 acres		Provided		
DEP required GW recharge volume:	686.07				**686.07** cu. ft	less than	**40272** cu. ft	OK!	

An Average Storm Event Runoff:

Precipitation (in):	0.7	
Total Impervious area (acres):	0.315	
Runoff Volume (cu. ft):	**800.415**	This is a conservative average groundwater recharge volume for a average rain event.
Total infiltration capacity(cu.ft):	40272.00	larger than 800.415 cu. ft OK !

Conclusion 1: Therefore, the pratical average groundwater recharge compensation will be **800.415** cu.ft. larger than **686.07** cu.ft as DEP required.

3. Average Site TSS Removal Rate

	Subbasin	Area (acres)	TSS removal (%)	A x TSS
1	P-1	0.006	0.8	0.0048
2	P-2 Drive	0.157	99	15.543
3	P-2 Roof	0.167	96	16.032
	Total	0.33		31.5798
	Total average removal rate		95.70 %	

Conclusion 2: The average total suspended solid removal rate is 9569.64% better than existing conditions

4. Water Quality Volume

Water quality rule 1 inches

	Impervious area	WQV req.	WQV provided	
Site Conditions	acres	cu. ft	cu. ft	
existing	0.219	none	none	
Proposed	0.315	1143.45	40272	OK!

Conclusion 3: Therefore, the total stormwater quality volume for proposed condition will be **40272** cu.ft. larger than **1143.45** cu.ft as DEP required.

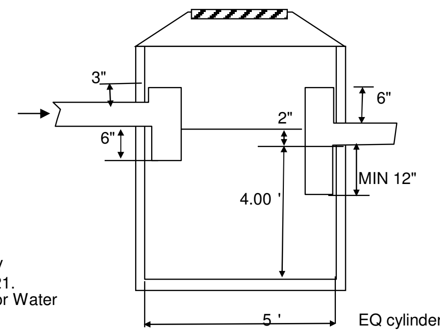
TSS Removal Calculations for Water Quality Inlet or Oil/Grit Separator

Project:	128 Main Street					
User:	DSW		Date:	7/19/2018	Revision:	
	Creative Land & Water Engineering, LLC					
Impervious Area:	0.14 acres		Target TSS removal:	80.00%	O/G volume	
Treatment Standard:	1 in		Initial Tank volume:	78.51 cu. ft.	587	gallon
Treatment Volume:	515.46 cu. ft.		Initial depth:	4.00 ft	Dimension	5-ft diameter 4 ft deep
Total TSS Factor (NJ DEP):	0.9		depth:	2 ft		(Exterior)
Total TSS Factor (Sand):	0.95		O.V.F treatment ratio:	0.14		

	Particle size* d, µm	Distribution %	Specific Gravity	Settling Velocity Vs, ft/s	Effective Depth h, ft	Effective Treatment Time Td, min.	Average Dynamic Removal Rate %	Weighted Removal Rate	Total with CB
NJ DEP	1	5	2.65	0.0012	3	219.33	89.64%	4.48	
	4	15	2.65	0.0012	3	219.33	89.64%	13.45	
	29	25	2.65	0.0025	3	219.33	91.38%	22.84	
	75	15	2.65	0.0133	3	219.33	91.40%	13.71	
	175	30	2.65	0.0619	3	219.33	91.40%	27.42	
	375	5	2.65	0.1953	3	219.33	91.40%	4.57	
	750	5	2.65	0.4266	3	219.33	91.40%	4.57	
Average								**91.04%**	**93.28%**
	150	60	2.65	0.0475	3	219.33	95.70%	57.42	
Sand	400	20	2.65	0.2123	3	219.33	95.70%	19.14	
	2000	20	2.65	0.9417	3	219.33	95.70%	19.14	
								95.70%	

*Particle size distribution according to NJDEP (clay, silt, sand)

Removal rate = $1 - e^{-(Vs/h)Td}$



Assumption: 0.5" first flush contains 80-85% of the total TSS in runoff
1.0" runoff contains 90-95% of the total TSS in runoff
Bypass for above design flow should be provided to avoid resuspension.

Trt. Vol. / TSS Size	Treatment Factors 05"	1"
NJ DEP	0.8	0.9
Sand	0.85	0.95

References:

Wang, D. and J. Carr (1996). "Pollutant Removal Rates for Stormwater Detention Ponds," Hydrology and Hydrogeology of Urban and Urbanization Areas, American Institute of Hydrology, pp. ABMP12-21.
Urbonas, Ben, and Stahre, Peter (1993). Stormwater - Best Management Practices and Detention for Water Quality, Drainage, and CSO Management,
U.S. EPA (1986) Methodology for Analysis of Detention Basins for Control of Urban Runoff Quality, Nonpoint Source Branch, Office of Water, Washington, D.C., EPA -440-5-87-001.

APPENDIX D: INFILTRATION CALCULATIONS
by Desheng Wang, Ph.D., P.E., © 2000

This appendix presents the calculation method for an infiltration rate. The whole method includes: effective infiltration area, infiltration rate, and water quality benefit. It is noted that infiltration facilities should only be used in very permeable soils.

1.0 Effective Infiltration Area

To keep an infiltration facility functioning, the most important thing is to prevent sediment from entering the effective infiltration area. It is recommended that storm runoff be pretreated by sediment sumps before be discharged to the infiltration facility. If a basin does become severely clogged, partial or complete replacement of the structure may be required [1]. It is recommended that for an infiltration facility such as an infiltration basin, only the sides of the basin should be used as the effective infiltration area. The reason for this is that the bottom eventually is sealed by the accumulation of sediments. For a recharge galley or infiltration basin filled with crushed stone, the bottom area can be counted as part of the effective area, providing there is a sump with access for sediment removal.

2.0 Design of the Basin

There are two aspects to consider in the design of an infiltration basin: one is the function in reducing runoff peak flow; the other is stormwater quality control. Water quality control is controlled by the volume of the basin. The peak flow is controlled by the infiltration rate of the basin. The infiltration rate of a basin is determined by the on-site soil condition and the size of the basin.

2.1 Volume of the Basin

To maximize the pollutant attenuation, the volume of the infiltration basin can be designed as large as possible. However, studies (Griffin et al., 1980; MD WRA, 1986) showed that a great port of pollutant loads is delivered during the early part of storms or the first flush of the storm. The first flush storm is the runoff due to the first half of an inch of rain. To store this part of runoff is the key to achieve better stormwater quality. Two basic rules are commonly used to determine the basin volume for water quality benefit. The first rule is to size the basin storage volume as 0.5 inches of runoff volume per impervious acre in the contributing watershed (MD WPA, 1986), using

$$V = 0.5 * A * Imp$$

where, V = Volume of the porous of the basin (ac-in);
A = Watershed area (acre);
Imp = fraction of site imperviousness.
The second rule is to size the basin so that it is capable of storing runoff produced from a one inch storm over the contributing watershed (Schueler 1987), using

$$V = 1.0\, R_v\, A$$

where, R_v = Runoff coefficient, R_v=0.05+0.009 (I); I = the percent of site imperviousness.

The expected pollutant removal rate for a basin with this design volume is presented in the following table.

Table A.1: Estimated Long-term Pollutant Removal Rate (%) for Full Exfiltration Basin (Shueler 1987)

Pollutant	Removal Rate	
	Rule 1	**Rule 2**
Sediment	75%	90%
Total Phosphorus	50-55%	60-70%
Total Nitrogen	45-55%	55-60%
Trace Metals	75-80%	85-90%
BOD	70%	80%
Bacteria	75%	90%

If catch basins are all equipped with sediment sumps, the final pollutant removal rates are expected higher for both rules. Table A.2 presents average removal rates for selected pollutants from catch basin sumps (Aronson et al 1983).

Table A.4 Average Removal Rates of Catch Basins for Selected Contaminants

Contaminant	Average Removal Rate (%)
TSS	58
TN	17
P	4
TM	50

* P = Phosphates; TM = Total metals.

2.2 Infiltration Rate

It is important to know that there is an unsaturated zone underneath an infiltration basin. However, it is not necessary to have this zone for infiltration to take place. In case of on-site sewage disposal design, this unsaturated zone is important for bio-treatment of waste water. In general, a 2 to 5 ft. separation from the water table to the bottom of the basin is recommended or required by state regulations (Finnemore, 1993). It is not necessary to have such a zone for a stormwater recharge basin. The calculation method here is based on the permeability test which can be used for both saturated infiltration flow and flow penetration into the water table [4].

One of the most common on-site constant head test [4] uses the following formula to calculate soil

$$k = \frac{Q}{5.5rH}$$

permeability:
where, k = permeability,
Q = constant rate of flow into the test hole,
r = internal radius of casing, and
H = differential head of water.

This formula requires that the aquifer thickness underneath the pipe should be larger than 10r. From this formula, we can conclude that for a given soil condition, the infiltration rate will be proportional to the free water depth in the basin. The most effective depth of free water in the basins was found to be four feet. Significantly lesser or greater depths resulted in reduced rates of infiltration, the former because of inadequate entrance head and the latter because of increasing weight-compaction of the soil (Baumann, 1965). Based on this formula, we can calculate the infiltration rate through bottom surface Q_1 can be calculated in the following ways.

For a circular surface:

$$Q_1 = 5.5\ rHk$$

For a rectangular surface with width B and length L, the above formula can be modified to account for the change in shape (Wang 1999):

$$Q_1 = 3.50\ kHB(0.5 + L/2B)$$

The infiltration rate through side surface Q_2 is calculated by Darcy's formula assuming the hydraulic gradient equals 1.0 [3] and assuming that the recharge galley does not penetrate the water table.

$$Q_2 = k\,A_s$$

Where, A_s = side surface area of the basin, = $2BrH$ for a circular section; = $2(B+L)H$ for a rectangular section.

The total infiltration rate is the summation of rates through bottom surface and side surfaces:

$$Q = Q_1 + Q_2$$

3.0 Overflow Structure

Overflow structures should be installed at the end of the recharge basins. Typical overflow structures are weirs. It is recommended that the overflow water leaves as sheet flow to the downgradient area to avoid possible erosion. Wells of small diameters should also be installed in the ends of each basin for dual purposes of (a) measurement of the distance to and sampling of ground water and (b) aiding in the expulsion of air as the mound rises. Trapped air may cause slow infiltration, especially when there is a large separation between the basin and the normal water table.

4.0 Summary

This appendix presents the design method of an infiltration basin. The design criteria include water flood control and water quality management. For a given hydrological condition (runoff hydrograph), the size of the basin can be easily determined by the formulas given in this appendix. A computer program is designed to carry out the computations. Flood routing can be further applied to a determined larger flood when overflows may occur.

References:

[1] Shueler, T. (1987) *Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs,* Dept. of Environmental Programs, Metropolitan Washington Council of Governments, Washington D. C.

[2] Shueler, T. (1992) *Design of Stormwater Wetland Systems: Guidelines for Creating Diverse and Effective Stormwater Wetland Systems in the Mid-Atlantic Region*, Anacostia Restoration Team, Dept. of Environmental Programs, Metropolitan Washington Council of Governments, Washington D. C.

[3] Urbonas, Ben, and Stahre, Peter (1993) *Stormwater --Best Management Practices and Infiltration for Water Quality, Drainage, and CSO Management*, PTR Prentice Hall, Englewood Cliffs, New Jersey.

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[5] "Underground Disposal of Storm Water Runoff Design Guidelines Manual," U.S. Dept. of Transportation, Federal Highway Administration, Offices of Research and Development Implementation Division (HDV-21) FHWA-TS-80-218, February 1980.

[6] Todd, David K. (1980) *Groundwater Hydrology*, 2nd Edition, John Wiley & Sons, New York.

[7] Finnemore, J. (1993) "Estimation of Groundwater Mounding Beneath Septic Drain Fields," *Ground Water*, Assoc. of Ground Water Scientists and Engineers, Vol. 31, No. 6, 884-889.

[8] Finnemore, J. (1983) "Ground-water Mounding due to on-site Sewage Disposal," J. of Irrigation and Drainage Engineering, Vol. 109, No. 2, 199-210.

[9] Hantush, M. S. (1967) "Growth and Decay of Groundwater-Mounds in Response to Uniform Percolation," *Water Resources Research*, Vol. 3, No. 1, First Quarter, 1967, 227-234.

[10] Marino, M. A. (1967) "Hele-Shaw Model Study of the Growth and Decay of Groundwater Ridges," *J. of Geophysical Research*, Vol. 72, No. 4, 1195-1205.

[11] Baumann, P. (1965) "Technical Development in Ground Water Recharge," *Advances in Hydroscience*, Vol. 2, New York, Academic Press, 209-279.

[12] Williams, J. and Willey, R. E. (1967) "Northern Part Ten Mile and Taunton River Basins," Massachusetts Basic-data Report No. 10, Ground-water Series, USGS.

[13] Wang, D. S. (1999). "A simple mathematical model for infiltration BMP design," Proceeding of Fourth USA/CIS Joint Conference: Hydrologic Issues of the 21st Century: Ecology, Environment and Human Health, November 7-10, 1999, San Francisco, CA, p117.

Three deep hole test pits were done on the site to obtain groundwater and infiltration rate data. TP-1 done by Eric Dickinson on 9/21/2017, TP-2 and TP-3 by Desheng Wang on 1/11/2018. See the following soil logs and permeability test analysis sheets for details.

TP-1 (by Eric Dickinson, 9/21/2017), Approx. ground elevation = 191

Depth, inches	Horizon	Texture	Matrix Color	Remarks
0 – 24	^A	Fill	wood, metal, strapping,	cobbles, plaster, misc.
24- 36	Bw	S.L.	10 YR 4/6	Friable
36-126+	C	Co. g S	2.5 Y 5/3	Loose, gravel 25%, 10% cobbles

Weeping = none
Standing water = none
Estimated high ground water = 10.5+' (180.5 - ft)
Permeability at not tested

TP-2 (rear left, Desheng Wang, 1/11/2018), Approx. ground elevation = 191

Depth, inches	Horizon	Texture	Matrix Color	Remarks
0 – 24	^A	SL	2.5 Y 6/4	Friable
24- 36	A	S.L.	2.5 Y 4/3	Friable
36-60	Bw	LS	2.5 Y 6/6	Friable
60-132+	C	Co. g S	2.5 Y 6/4	Loose, gravel 20%

Weeping = none
Standing water = none
Estimated high ground water = 11+' (180- ft)
Permeability at 85" = 0.005583ft/s, use half rate for design =120.6 in/hr

TP-3 (Rear right, Desheng Wang 1/11/2018), Approx. ground elevation = 191

Depth, inches	Horizon	Texture	Matrix Color	Remarks
0 – 30	^A	Fill	10 YR 2/1	Friable
30- 60	Bw	L.S.	2.5 Y 6/6	friable
60-132+	C	Co. g S	2.5 Y 5/4	Loose, gravel 20%

Weeping = none
Standing water = none
Estimated high ground water = 11+' (180- ft)
Permeability at 87" = 0.00103ft/s, use half rate for design =22.27 in/hr

Creative Land & Water Engineering, LLC
Environmental Science and Resource Management
P.O. Box 584, Southborough, MA 01772
Tel: (508)281-1694 Fax: (508)281-1694

Subject: Permeability Test
128 Main Street
Ashland, MA
Email: deshengw@yahoo.com

By: dsw **Date:** 1/11/2018
Calc.: dsw **Date:** 27-Jan-18
Job No.: J14-8 **Sheet:** 1 of 2

Site Condition

Hole #: TP-2
Soil: Co. M. S
Depth to Bed Rock (ft): >11
Depth to GW (ft): 6.00
Landform: terace
Position: see plan

Casing Dia., 2r, (in): 6
Depth to the bottom (ft): 7.00
Casing height (ft): 3.13
Exposed casing (ft): 1

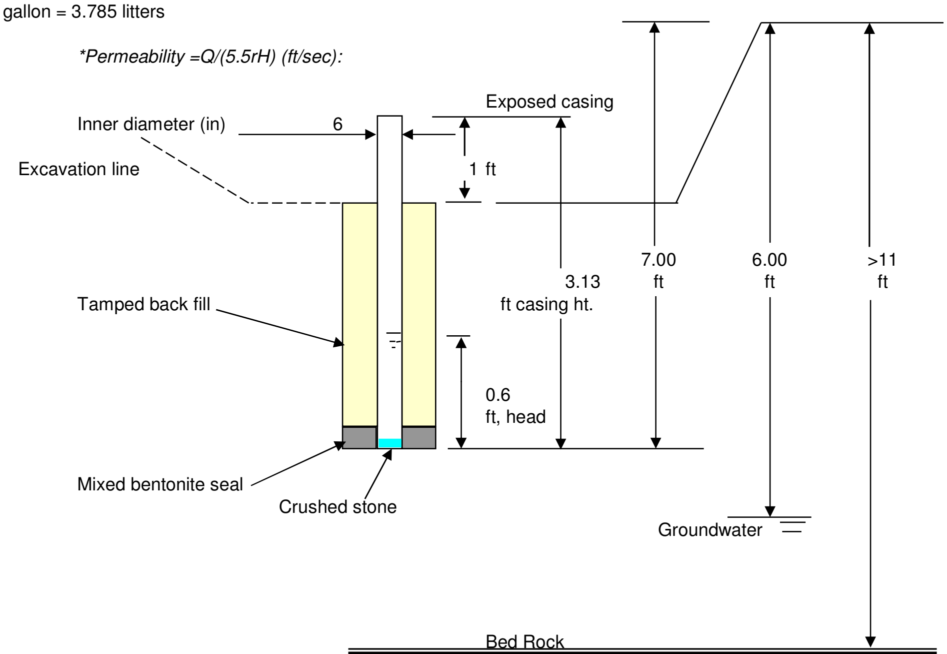
Summary of Constant Head Test (Method E-18, USDI)

Standard Temperature for Permeability Calculation (oC): 20 (68 F)

Test	Time	Head	Volume	Temp.	Correct. Ceof.	Permeability (ft/sec)*	
#	sec	ft	gallon	oC		Field	Standard
1	9.040	0.600	0.264	10	1.2966	4.7360E-03	6.1409E-03
2	9.62	0.600	0.264	10	1.2966	4.4504E-03	5.7706E-03
3	9.5	0.600	0.264	10	1.2966	4.5067E-03	5.8435E-03
4	9.95	0.600	0.264	10	1.2966	4.3028E-03	5.5792E-03
5	9.84	0.600	0.264	10	1.2966	4.3509E-03	5.6416E-03
6	9.9	0.600	0.264	10	1.2966	4.3246E-03	5.6074E-03

1 gallon = 3.785 litters

**Permeability =Q/(5.5rH) (ft/sec):*



Permeability Rate at 95% Confidence Level		degree of freedom	$t_{0.05}$
No. of tests, n:	6	1	6.314
Degree of freedon, n-1:	5	2	2.920
Mean permeability (ft/sec), m:	5.76E-03	3	2.353
Standard deviation (ft/sec), s:	0.000219	4	2.132
t distribution, $\alpha=0.05$:	2.015	5	2.015
Permeability at 95% confidence level (ft/sec):	**0.005583**	6	1.943
(Half rate in/hr):	120.60	7	1.895

Permeability Calculation V1.1 method 1, by Desheng Wang, Ph.D., P.E, Creative Land & Water Engineering, LLC., Southborough, MA

Creative Land & Water Engineering, LLC
Environmental Science and Resource Management
P.O. Box 584, Southborough, MA 01772
Tel: (508)281-1694 Fax: (508)281-1694

Subject: Permeability Test
128 Main Street
Ashland, MA
Email: deshengw@yahoo.com

By: dsw **Date:** 1/11/2018
Calc.: dsw **Date:** 27-Jan-18
Job No.: FJ14-8

Site Condition

Hole #: TP-3
Soil: Co.M.S
Depth to Bed Rock (ft): >11
Depth to GW (ft): 6.00
Landform: terace
Position: see plan

Casing Dia., 2r, (in): 6
Depth to the bottom (ft): 7.25
Casing height (ft): 3.13
Exposed casing (ft): 1

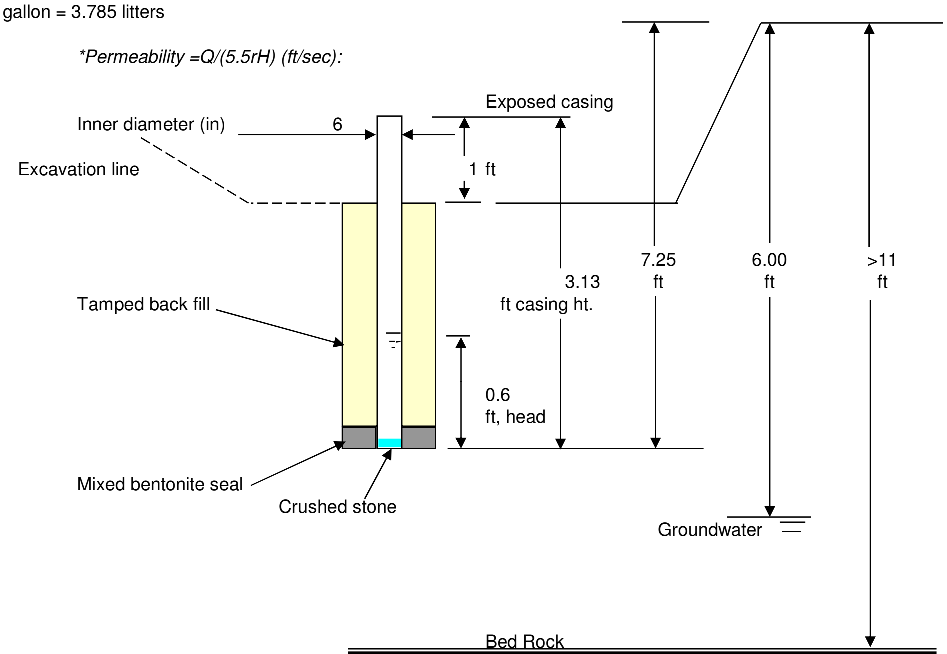
Summary of Constant Head Test (Method E-18, USDI)

Standard Temperature for Permeability Calculation (oC): 20 (68 F)

Test	Time	Head	Volume	Temp.	Correct. Ceof.	Permeability (ft/sec)*	
#	sec	ft	gallon	oC		Field	Standard
1	51.290	0.600	0.264	10	1.2966	8.3473E-04	1.0823E-03
2	52.650	0.600	0.264	10	1.2966	8.1317E-04	1.0544E-03
3	53.950	0.600	0.264	10	1.2966	7.9357E-04	1.0290E-03
4	53.330	0.600	0.264	10	1.2966	8.0280E-04	1.0409E-03
5	53.130	0.600	0.264	10	1.2966	8.0582E-04	1.0449E-03
6	53.720	0.600	0.264	10	1.2966	7.9697E-04	1.0334E-03
7	53.610	0.600	0.264	10	1.2966	7.9861E-04	1.0355E-03

1 gallon = 3.785 litters

**Permeability =Q/(5.5rH) (ft/sec):*



Permeability Rate at 95% Confidence Level

		degree of freedom	$t_{0.05}$
No. of tests, n:	7	1	6.314
Degree of freedon, n-1:	6	2	2.920
Mean permeability (ft/sec), m:	1.05E-03	3	2.353
Standard deviation (ft/sec), s:	2.01E-05	4	2.132
t distribution, $\alpha=0.05$:	1.943	5	2.015
Permeability at 95% confidence level (ft/sec):	**0.001031**	6	1.943
(Half rate in/hr):	22.27	7	1.895

Appendix E: OPERATION AND MAINTENANCE PLAN FOR STORMWATER BMPs

	During Construction	**Post-construction**
BMB Owner:	Carlos Hanzi	Carlos Hanzi
Party of Plan Responsibility:	Carlos Hanzi	Carlos Hanzi
Signature		

The stormwater management system is depicted in the engineering plan by Creative Land & Water Engineering, LLC: Proposed Stormwater Management Plan, 128 Main Street, Ashland, MA, dated July 26, 2018

Illicit discharges into stormwater management system per 310 CMR 1.04 are perpetually prohibited.

<u>Routine Operation and Maintenance</u>

Item 1: During construction, **weekly or biweekly** inspection of erosion control wattles and silt fences should be conducted by a qualified staff of the responsible party or an independent sediment and erosion control expert hired by the responsible party. Any displaced hay bales or broken siltation fences should be restored or repaired immediately. All silt fences and hay bales shall be installed at the property line or as agreed by Conservation Commission.

Item 2: The catch basin in the **parking lot** should be inspected **before** and **after** rainstorms, if the basin is filled with sediment to half of its depth, the basin should be cleaned up with an orange peel bucket or a gradall excavator. **After the construction completed**, the observation port of the infiltration trench, distribution manhole, oil/grit separator and water quality swale should be inspected three times a year: once after leaf fall, once before the arrival of hurricane season, the third in the early or mid spring after the snow melt and road sweeping. Any excessive sediment should be cleaned out as during the construction phase. The parking lot will be swept twice a year: one before hurricane season, the other in the spring after snowmelt, or per the Town of Ashland standard practice.

Item 3: Install oil trap elbows in all deep sump catchbasins. It is recommended that the vertical length of the oil trap below the outlet invert be at least 12 inches.

Item 4: Bookkeeping. All maintenance conducted shall be recorded and the records shall be kept on site for at least 3 year for auditing by approving authorities. See attached record forms for reference.

<u>Emergency Reaction or Accidental Spill Plan</u>

In case of an accident in the parking lot or driveways, where significant gasoline or other petroleum products are released, the following procedure must be followed.

Step. 1. First of all, plug the outlet pipe from the catch basin to the manhole and the outlet pipe from the manhole to infiltration trench. <u>Immediately</u> notify **Ashland** Fire Department, Board of

Health, Conservation Commission, and the Mass. Department of Environmental Protection (DEP). **Ashland** is in the Northeast Region of DEP, and their main office is presently at 205B Lowell Street, Wilmington, Massachusetts 01887 and their phone number is (978)694-3200.

Step 2. If any of those three agencies so direct, a clean up firm shall be immediately contacted. If the materials have remained trapped in the catch basin and manhole, then the catch basin shall be pumped out. If the volume of the spill is such that materials have flowed out of the catch basin sump or the trench, then corrective actions will be extended to the receiving **water** and beyond. For an oil release in excess of on site storage capacity, a floating boom shall be used to prevent oil release from spreading in any receiving area. For materials which are partially soluble in water, e.g., components of gasoline, then DEP or clean-up firm recommendations shall be followed. These might include, but are not limited to (1) pumping out the entire trench, (2) air stripping, or (3) excavation of an interceptor basin to allow air stripping in the downgradient soils. Since the technology of containment and control is steadily advancing, clean-up and recovery technology shall be specified on site just after the spill.

Mosquito Control in Sumps

In general, mosquito breeding occurs in standing water that lasts five days or more. The catch basin during high groundwater season may have standing water. Thus mosquito control may be needed. In case of mosquitoes breeding in the catch basin, there are many methods available to control them including biological control and chemical control. Biological controls are preferred since the biological controls specifically target mosquito larvae and are harmless to humans, unlike many chemicals even at standard does. It is not recommended any chemicals be used in the inlet box or the catch basins due to their frequent flushing and water quality issues in the receiving waters. The following is the recommended biological control.

Bacillus thuringiensis israeliensus (Bti) is an effective control for mosquitoes and flies and is widely used in various forms in U.S. This is a bacterium, which kills larvae of target insects. Commercial Bti is considered safe to add to drinking water (WRRI 1989) and is available at most hardware stores.

Summary

The maintenance steps outlined above are sufficient to prevent sediment accumulation from affecting the long term performance of the BMP system. If maintenance is not conducted, then the detention basin and catch basin will be filled up with sediment, which will impede the function of stormwater treatment. Routine maintenance is the most cost-effective in the long run.

If you have any questions about the plan, please feel free to contact us.

Sincerely,

Creative Land & Water Engineering, LLC
by

Desheng Wang, Ph.D. P.E.
Senior Environmental/Hydraulic Engineer

Operation/Maintenance Form

Project Site:

Operator: **Date of O/M:**

BMPs	**Location**	**Description of Maintenance**
Parking sweeping		
Infiltration Trench		
Catchbasin		
Distribution manhole		
Oil/grit separator		
Others		

Notes: 1) Sediment deposit depth and other pollutants shall be recorded in structural BMPs for record, such as, 12" of sediment is cleaned out of the Catchbasin. 2)The O/M staff can expand the form on separate sheet for different BMPs.

References:

[1] J. McLean (1995) “Mosquitoes in Constructed Wetlands -- A Management Bugaboo,” Watershed Protection Techniques, Vol. 1, No. 4, Center for Watershed Protection, 203-208.

[2] Water Resources Research Institute (1989) Report No. 247: Proceedings of Workshop on Management of Aquatic Weeds and Mosquitoes in Impoundments, March 14-15, 1989 UNC Charlotte.

[3] Mian, L. S., Mulla, M. S., and Wilson, B. A. (1986) •Studies of Potential Biological Control Agents of Immature Mosquitoes in Sewage Wastewater in Southern California, • J. Am. Mosquito Control Assoc. 2(3), 329-335.

[4] MA DEP *Stormwater Management Standards - Stormwater Management Handbook*, 200