Exhibit #8

MILONE & MACBROOM

May 28, 2019

Mr. Dennis Goderre, ASLA, AICP CUD
City Planner
City of Groton
Department of Planning & Economic Development
295 Meridian Street
Groton, CT 06340

RECEIVED
AUG 0 8 2019
CITY OF GROTON CONNECTICUT
ZONING AND BUILDING DEPARTMENT

RE: Westside Elementary School
Groton, Connecticut
MMI #1777-39

Dear Mr. Goderre:

It is my professional opinion that the proposed stormwater management plan for the above-referenced project conforms to the requirements of Section 7.7.C of the City of Groton's Zoning Regulations effective December 1, 2016, recently amended to April 3, 2019. The attached engineering report includes the Water Quality Volume (WQV) and Water Quality Flow (WQF) calculations per Section 7.4 of the Connecticut Department of Energy & Environmental Protection *Stormwater Quality Manual* and the Groundwater Recharge Volume (GRV) computations per Section 7.5 of the *Stormwater Quality Manual*. The engineering report also includes the results of the hydrologic and hydraulic models demonstrating Peak Flow Control for the 10-year, 25-year, and 100-year storm events and hydraulic conveyances of the 25-year storm event per Section 7.6 of the *Stormwater Quality Manual*.

Very truly yours,

MILONE & MACBROOM, INC.

Thomas J. Daly

Thomas J. Daly, PE, Vice President
Senior Project Manager, Civil Engineering

Attachments

cc: Joe Banks, Perkins Eastman

1777-39-m2819-ltr

Exhibit 9

RECEIVED
AUG 08 2019
CITY OF GROTON CONNECTICUT
ZONING AND BUILDING DEPARTMENT

Engineering Report

Cutler Elementary School
160 Fishtown Road
Groton, Connecticut
June 21, 2019
(Revised July 26, 2019)

Prepared for:
Mr. Joseph Banks, AIA, LEED AP
Perkins-Eastman Architects DPC
677 Washington Boulevard, Suite 101
Stamford, Connecticut 06901

MMI #1777-38-05

Prepared by:
MILONE & MACBROOM, INC.
99 Realty Drive
Cheshire, Connecticut 06410
(203) 271-1773
www.mminc.com

MILONE & MACBROOM
ENGINEERING | PLANNING | LANDSCAPE ARCHITECTURE | ENVIRONMENTAL SCIENCE

STATE OF CONNECTICUT
THOMAS J. DALY
LICENSED
PROFESSIONAL ENGINEER

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LIST OF APPENDICES

1.0 PROJECT OVERVIEW

The descriptions and computations included within this engineering report are provided in support of the proposed construction of the new Cutler Elementary School building to be located on two abutting parcels of land in the town of Groton, Connecticut. The proposed redevelopment project includes construction of a new three-story elementary school building that will replace the existing Cutler Arts and Humanities Magnet Middle School currently located on the ±47-acre site. All construction activities will generally occur within the currently maintained school grounds.

The subject parcels are located on the east side of Fishtown Road and lies within the single-family residential (RS-20) zone. The new school site will have three driveway entrances off Fishtown Road that will provide access to the new parking area, the reconfigured bus drop-off loop, and the service area in the south side of the new building. An internal drive will meander through the campus to a central area where another parking area will be constructed to serve the new multipurpose/soccer and baseball fields.

The project will be serviced by the existing municipal water and sewer systems. Domestic and fire protection water services will be provided to the proposed school by an extension of the existing water main in Fishtown Road. Domestic sewage will be collected by a new gravity sewer system that will run around the east and south sides of the proposed building and connect to the existing sanitary sewer main in Fishtown Road. The existing sewer main flows to the adjacent sewer pump station owned by the Town of Groton. All other utilities such as electric, telephone, cable, and gas service will be located underground through extensions of the existing services in Fishtown Road. More detailed design information regarding the proposed utilities are depicted on the site plans.

The stormwater management system for this site has been designed utilizing Best Management Practices (BMPs) to provide water quality management while attenuating peak-flow rates from the site. The design goal is to provide water quality treatment and groundwater recharge in accordance with the Connecticut Department of Energy & Environmental Protection (CTDEEP) *2004 Stormwater Quality Manual* and prevent increases in the predevelopment runoff rates from the redeveloped site. The proposed system will use one subsurface detention system along with water quality measures before discharging stormwater runoff from the project site. The proposed stormwater treatment train includes catch basins with 2-foot-deep sumps, water quality devices such as hydrodynamic separators, and an underground stormwater chamber system with isolator rows. Temporary sediment and erosion (S&E) controls will be employed during construction to help prevent sediment transport from the site until construction is complete and permanent cover is established.

For more detailed information regarding stormwater quantity, refer to Sections 3.0 and 4.0 of this report. Refer to Section 5.0 for stormwater quality management provided in the proposed design. Design computations and other relevant information are provided in the Appendix of this report.

2.0 EXISTING SITE CONDITIONS

The project site is located in the southern portion of the town of Groton. The overall property is ±47.4 acres in size and consists of two abutting parcels located at 120 Fishtown Road (6.9 acres) and 160 Fishtown Road (40.5 acres). Redevelopment of the existing Cutler Middle School is proposed within the currently maintained school grounds on the property, an area size of approximately 13 acres. The site is located southeast of the intersection of Fishtown Road and Rhonda Drive in a residential area within the Mystic district of the town of Groton.

The school grounds within the property include the school buildings, parking areas, two tennis courts, and two basketball courts in the north end of the site; a multipurpose athletic field to the east of the school building; and baseball and softball fields to the south. Fishtown Road defines the western boundary of the site. The north, south, and eastern portions of the property include forested, undeveloped land extending to the property limits in each direction. Single-family residential communities surround the property, and Beebe Pond Park is located east of the property. A woodland edge borders the developed portion of the site, beyond which Fishtown Brook flows southwest through the center of the property. Fishtown Brook is culverted under Fishtown Road before it confluences with Eccleston Brook and drains to Palmer Cove and Long Island Sound.

The inland wetlands and watercourses were delineated on the site in June 2018 by Milone & MacBroom, Inc. (MMI). Wetland systems on the property are comprised of red maple forested wetlands hydrologically connected with Fishtown Brook, two man-made quarry ponds, and one isolated successional scrub-shrub wetland in the northern portion of the site. In addition to wetland communities, three upland ecosystems were mapped on the property. These areas are comprised of manicured lawn/pavement and urban structure, woodland edge, and beech-maple mesic forest.

Under existing conditions, stormwater runoff from a portion of the northwest side of the school drains overland to the existing drainage system in Fishtown Road. This existing drainage system drains northerly on Fishtown Road and turns east, at a location approximately 220 feet south of the intersection with Rhonda Drive, toward the discharge into the existing ponds on the northern portion of the property. The school building drains to the east via a 12-inch reinforced concrete pipe (RCP) roof leader. This pipe daylights into the wetlands associated with Fishtown Brook through a concrete endwall.

The existing Carl C. Cutler School is located in a raised area northeast of the confluence of Eccleston Brook and Fishtown Brook as shown on the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) included in the Appendix of this report. The existing area of the property presently used for school and active recreation does not lie within the Special Flood Hazard Area (SFHA) as delineated by FEMA. The regulatory floodway and Zone AE floodplain area associated with Fishtown Brook borders the east side of the developed school grounds. The Zone AE floodplain area has a base flood elevation (BFE) varying from elevation 23 feet near the tennis courts to elevation 21 feet near the Fishtown Brook crossing under Fishtown Road.

The entire project site is located within the Southeast Shoreline watershed. This watershed is located within the Southeast Shoreline Regional Basin, which is located within the Southeast Coast Major Basin, identified as Regional Basin 2000 on the CTDEEP *Atlas of Public Water Supply Sources and Drainage Basins*. Furthermore, the site is not located within an aquifer protection zone. The groundwater in the site is classified as GA and the nearby surface water is classified as A on the CTDEEP Environmental Conditions Online website.

The entirety of the Cutler Middle School property is located within a mapped Natural Diversity Database (NDDB) area of endangered, threatened, or special concern species, so a determination is being sought from the CTDEEP. All proposed activities, from both a direct and indirect perspective, will be located within the existing 13-acre school campus comprised of buildings, access, parking, manicured lawn, and recreational areas.

3.0 STORMWATER MANAGEMENT DESIGN

Stormwater management was achieved by collecting stormwater runoff and conveying it to the proposed underground detention system, which has been designed to attenuate the proposed peak flows before discharging to the existing wetland areas or storm drainage systems downstream. Retention storage will be provided below the outlet pipe invert with adequate volume to recharge groundwater through the open-bottom gallery system. The goal of the storm drainage system design is to remove Total Suspended Solids (TSS) and other potential stormwater pollutants while attenuating the postdevelopment peak runoff rates. The stormwater management design will incorporate the use of water quality measures such as catch basins with deep sumps, retention storage, hydrodynamic separators, and an isolator row incorporated into the underground detention system. More information regarding water quantity and quality is provided in the following sections.

The computer program entitled *Hydraflow Storm Sewers Extension for AutoCAD Civil 3D 2016* by Autodesk, Inc., Version 10.5, was used for designing the proposed stormwater collection system. Storm drainage computations performed include pipe conveyance capacity and hydraulic grade line calculations. The overall watershed was divided into subbasins to determine the drainage area and land coverage to each individual drainage inlet. These values were used to determine the stormwater runoff to each inlet using the rational method. The rainfall intensities utilized in the storm drainage computations were obtained from the National Oceanic and Atmospheric Administration (NOAA) Atlas 14, Volume 10 Precipitation Frequency Data Server.

The proposed storm drainage systems were designed according to the town's standards to provide adequate pipe capacity to convey the 25-year storm event. In addition, the storm drainage design includes a hydraulic grade line computation for the storm drainage systems designed showing adequate capacity to meet the 25-year storm event. Furthermore, the outlet pipe from the outlet control structure of the proposed detention area was sized with adequate capacity to convey the 100-year storm event. All storm drainage computations described in this section are included in the Appendix of this report.

The proposed stormwater management system balances the safe conveyance of stormwater runoff with the attenuation of peak rates of runoff while maintaining stormwater quality from the project site. The design of the stormwater management system minimizes potential impacts to existing wetland areas, watercourses, and developed areas downstream of the site.

4.0 HYDROLOGIC ANALYSIS

A hydrologic study has been conducted to analyze the predevelopment and postdevelopment peak-flow rates from the site. Three analysis points that represent specific locations where stormwater runoff leaves the site were analyzed. Analysis Point A represents the area from the site draining to the existing drainage system in Fishtown Road. Analysis Point B consists of the area draining to the existing ponds and wetlands on the northern portion of the site. Analysis Point C represents the area discharging directly to the eastern wetland areas associated with Fishtown Brook.

The existing watersheds were delineated based on current site conditions including the contributing off-site upstream areas. The existing watersheds were then modified and subdivided further to reflect the proposed changes to the site and to analyze the hydrology under proposed conditions. The total watershed area delineated is approximately 17.15 acres under both existing and proposed conditions. Watershed maps are included in the Appendix of this report.

The method of predicting the surface water runoff rates utilized in this analysis is a computer program entitled *Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2019* by Autodesk, Inc., Version 2020. The *Hydrographs* program is a computer model that utilizes the methodologies set forth in the *Technical Release No. 55* (TR-55) manual and *Technical Release No. 20* (TR-20) computer model, originally developed by the United States Department of Agriculture – Natural Resources Conservation Service (USDA-NRCS). The *Hydrographs* computer modeling program is primarily used for conducting hydrology studies such as this.

The *Hydrographs* computer program forecasts the rate of surface water runoff based upon several factors. The input data includes information on land use, hydrologic soil type, vegetation, contributing watershed area, time of concentration, rainfall data, storage volumes, and the hydraulic capacity of structures. The computer model predicts the amount of runoff as a function of time, with the ability to include the attenuation effect due to dams, lakes, large wetlands, floodplains, and stormwater management basins. The input data for rainfalls with statistical recurrence frequencies of 2, 10, 25, 50, and 100 years were obtained from the NOAA Atlas 14 database.

24-Hour NOAA Precipitation Amounts (Groton, Connecticut)

Storm Frequency	**Rainfall (inches)**
2-Year	3.43
10-Year	5.10
25-Year	6.14
50-Year	6.94
100-Year	7.74

Land use for the site under existing and proposed conditions was determined from field survey, the city's Geographic Information System (GIS) mapping, and aerial photogrammetry. Land use types used in the analysis included open space/lawn areas, bare soil, woods, gravel, buildings, and paved/impervious surfaces. Soil types in the watershed were determined from the GIS database of the USDA-NRCS soil survey for New London County, Connecticut. The soil survey identifies the soils on the property as "B," "C," and "D" Hydrologic Soil Groups.

The existing conditions were modeled with the *Hydrographs* program to determine the peak-flow rates for the various storm events at each analysis point. A revised model was developed incorporating the proposed site conditions, and the flows obtained with the revised model were then compared to the results of the existing conditions model. Peak-flow rates from the project site are controlled using an underground storage area that was created using multiple rows of Stormtech® MC-3500™ chamber systems. The underground chamber system has been designed such that the estimated water surface elevation within the chambers during a 100-year storm event does not exceed the top of the stone layer above the chambers.

No increases in peak rates of runoff from the overall site are anticipated from the project site due to a planned stormwater management system and the detention capability of the underground storage area. All *Hydrographs* input computations and model results are included in the Appendix of this report. The table below summarizes the peak rates of runoff from the site under both existing and proposed conditions that were obtained from the *Hydrographs* hydrology results:

Point of Analysis A	Peak Runoff Rate (cubic feet per second)				
Storm Frequency (years)	**2**	**10**	**25**	**50**	**100**
Existing Conditions	1.3	2.7	3.6	4.2	4.9
Proposed Conditions	0.3	0.7	1.0	1.2	1.4

Point of Analysis B	Peak Runoff Rate (cubic feet per second)				
Storm Frequency (years)	**2**	**10**	**25**	**50**	**100**
Existing Conditions	2.3	5.7	8.1	10.0	12.0
Proposed Conditions	0.7	2.6	4.2	5.5	6.9

Point of Analysis C	Peak Runoff Rate (cubic feet per second)				
Storm Frequency (years)	**2**	**10**	**25**	**50**	**100**
Existing Conditions	11.5	24.4	33.3	40.3	47.3
Proposed Conditions	9.0	20.1	28.7	38.2	44.9

	Water Surface Elevation (feet)				
Storm Frequency (years)	**2**	**10**	**25**	**50**	**100**
Stormwater System 310	24.62	25.73	26.37	26.74	27.14

(Bottom of Chambers Elev.=22.75 feet)
(Top of Chambers Elev.=26.50 feet)
(Top Elevation of Stone Above Chambers =27.5 feet)

The summary of the results above shows that no increases in peak rates of runoff are anticipated at any of the analysis points. Instead, a decrease in flow rate for each of the storm events modeled can be anticipated due to the stormwater management system and the detention provided. The stormwater management system achieves the goal of attenuating the peak rates of runoff from the proposed site, minimizing potential impacts to existing receiving waters and developed areas downstream of the site.

5.0 WATER QUALITY MANAGEMENT

Water quality measures or BMPs are incorporated into the stormwater management design to maintain water quality. All of the treatment measures described in this section will help maintain water quality of the stormwater runoff from the proposed site.

Stormwater runoff will be collected and conveyed via a subsurface pipe and catch basin drainage system. The drainage system will include catch basins with 2-foot sumps that trap coarse sediments. The underground chamber galleries incorporate an isolator row as recommended by the manufacturer, which consists of an extra row of chambers where stormwater is further treated prior to entering the storage chamber system, thus enhancing TSS removal and protecting the storage chambers from sediment accumulation.

Hydrodynamic separators such as the CDS® system, manufactured by Contech® Engineered Solutions, or approved equivalent proprietary device, will be installed prior to final discharges from the proposed site. These units will further remove suspended solids before discharging downgradient, which in turn removes other potential pollutants that tend to attach to the suspended solids and effectively removes other debris and floatables that may be present in the stormwater runoff. The CDS® units have been designed to meet the criteria recommended by the CTDEEP *2004 Stormwater Quality Manual*. The units were designed based on the determined Water Quality Flow (WQF), which is the peak-flow rate associated with the Water Quality Volume (WQV), and sized based on manufacturer's specifications.

The proposed underground detention system will consist of open-bottom arched plastic chambers sitting on a gravel stone bed. The proposed configuration of the system will provide retention storage by setting the outlet pipe invert slightly above the bottom of the basin's bottom elevation. The retention storage volume and the open bottom system will allow for some infiltration to occur thus providing groundwater recharge. However, the sizing of the underground detention system did not account for any infiltration.

The CTDEEP *2004 Stormwater Quality Manual* (Chapter 7) was used to calculate the required Groundwater Recharge Volume (GRV). The GRV provides adequate volume to maintain the predevelopment annual groundwater recharge and promote infiltration based on the soils found on the site. When provided, the GRV will achieve similar stormwater infiltration capabilities and maintain adequate groundwater recharge. The GRV for the site has been provided within the retention volume in the bottom of the proposed underground detention system. Supporting calculations for the retention volume provided as well as the required GRV computations have been included in the Appendix of this report.

A Sediment and Erosion (S&E) Control Plan has been developed to mitigate the short-term impacts of the development during construction. The S&E Control Plan includes descriptive specifications concerning land grading, topsoiling, temporary and permanent vegetative cover, vegetative cover selection and mulching, and erosion checks. Details have been provided for all erosion controls with corresponding labels on the S&E control site plan. In all cases, the S&E Control Plan shall be implemented in accordance with the *2002 Connecticut Guidelines for Soil Erosion and Sediment Control.*

The construction areas are to be surrounded by geotextile sediment filter fence that will be fortified with staked hay bales upgradient of any wetland areas or watercourses. A construction entrance has been provided at the entrance locations as well as temporary topsoil stockpile areas encircled with sediment filter fencing. Inlet protection is proposed at each of the catch basin inlets to prevent sediment from entering the storm drainage system during construction. The temporary diversion berm and swales are provided to direct the stormwater runoff from the site to temporary sediment traps during construction and will include stone check dams to slow potential erosive velocities. The S&E controls are to be modified with the changing grades on site to ensure the protection of the surrounding areas throughout the construction process.

6.0 CONCLUSION

The hydrology results demonstrated that there will be no increases in flows to any of the analysis points through the use of the on-site underground detention system. The underground storage area consists of multiple rows of plastic chambers laying over a crushed stone bed. The underground chamber system will incorporate an isolator row, which consists of an extra row of chambers where stormwater is further treated prior to entering the storage chamber system, thus enhancing TSS removal and protecting the storage chambers from sediment accumulation.

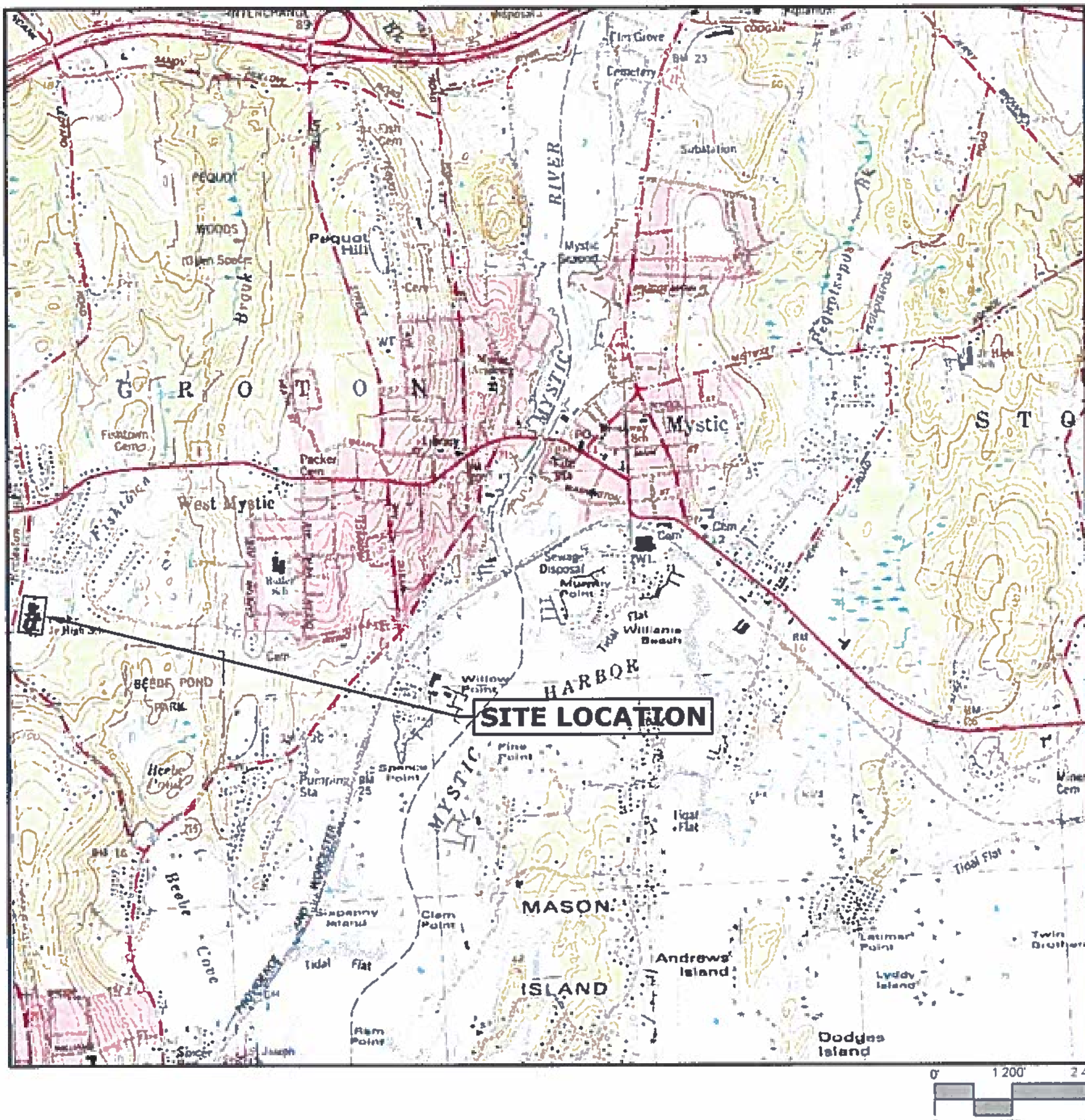
Hydrodynamic separators will be employed to pretreat stormwater runoff generated from the proposed impervious surfaces prior to entering the stormwater management areas. A High Efficiency CDS® unit, manufactured by Contech® Engineered Solutions, was selected and sized based on the contributing Water Quality Flow (WQF), which is the peak-flow rate associated with the Water Quality Volume (WQV). Equivalent stormwater chamber devices from other manufacturers will be considered prior to final construction. Furthermore, the CTDEEP Ground Recharge volume (GRV) has been provided within the retention storage volume available in the proposed underground detention system.

The provided stormwater control measures include short-term erosion controls to be implemented during the construction phase and long-term TSS removal from stormwater runoff for the completed project. These measures will serve to mitigate water quality impacts during construction and improve the quality of stormwater runoff from the site after the site is developed. The focus of the water quality measures was to remove suspended solids and other potential pollutants as well as to protect against excessive erosion during and after construction. The S&E Control Plan will provide protection of the existing wetlands and watercourses by preventing sediment transport to areas downgradient of the site during construction and while the site is permanently established. The BMPs and S&E control measures described in this report will help maintain the water quality of the stormwater runoff from the proposed project.

1777-38-05-jl2519-rpt

APPENDIX A

USGS LOCATION MAP



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USGS QUADRANGLE MAP, QUAD NO. 103

CUTLER ELEMENTARY SCHOOL

160 FISHTOWN ROAD
MYSTIC, CONNECTICUT

DATE	JUNE 21, 2019	
SCALE	1"=2,400'	
PROJ. NO.	1777-38	
DESIGNED ---	DRAWN MCB	CHECKED ---
DRAWING NAME	LOC	

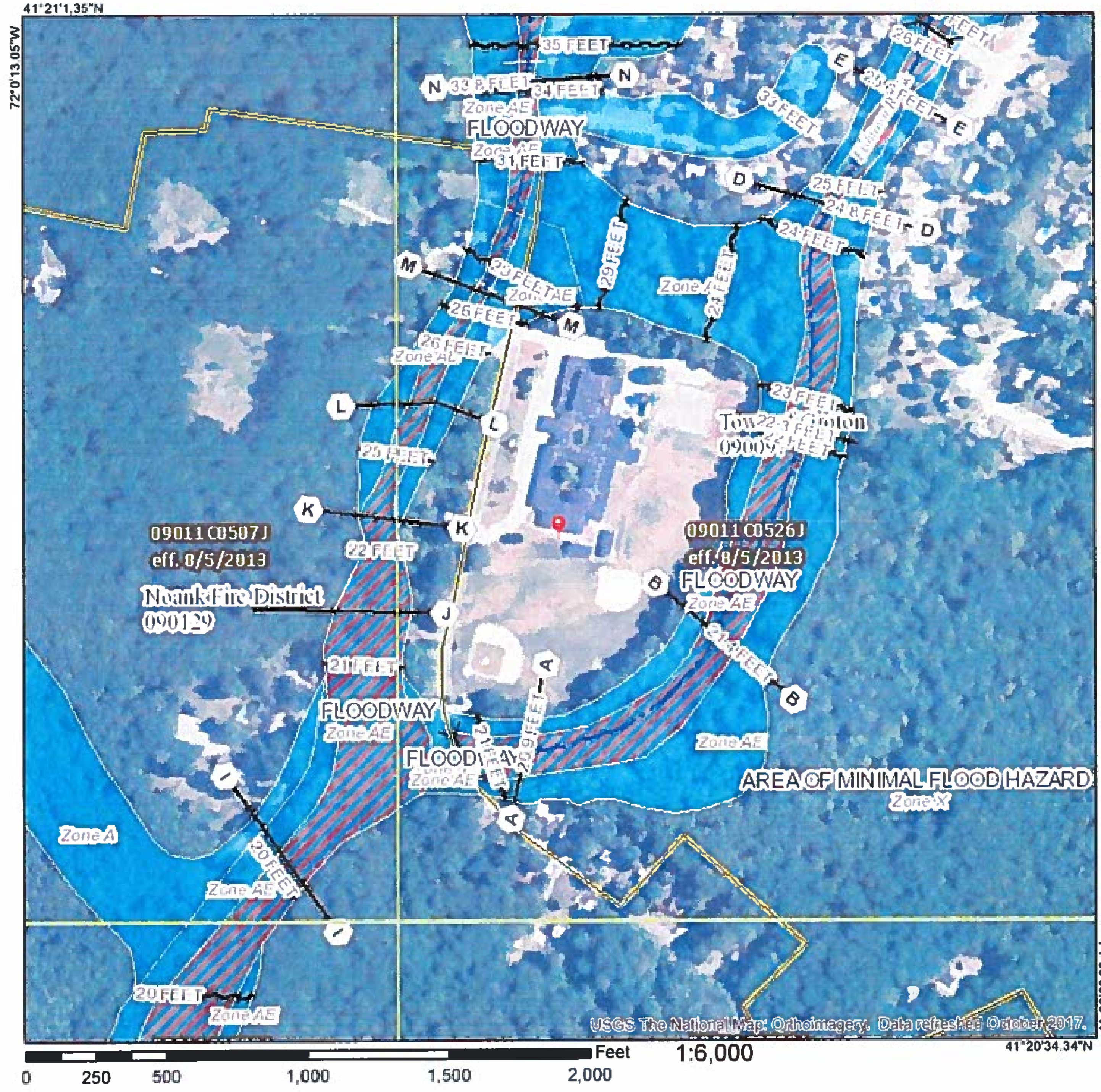
PROJECT PHASE REV ---

APPENDIX B

FEMA FLOOD INSURANCE RATE MAP

National Flood Hazard Layer FIRMette

FEMA



Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) — Zone A, V, A99
- With BFE or Depth — Zone AE, AO, AH, VE, AR
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile — Zone X
- Future Conditions 1% Annual Chance Flood Hazard — Zone X
- Area with Reduced Flood Risk due to Levee. See Notes. — Zone X
- Area with Flood Risk due to Levee — Zone D

OTHER AREAS
- NO SCREEN — Area of Minimal Flood Hazard — Zone X
- Effective LOMRs
- Area of Undetermined Flood Hazard — Zone D

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 / 17.5 — Cross Sections with 1% Annual Chance Water Surface Elevation
- Coastal Transect
- Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

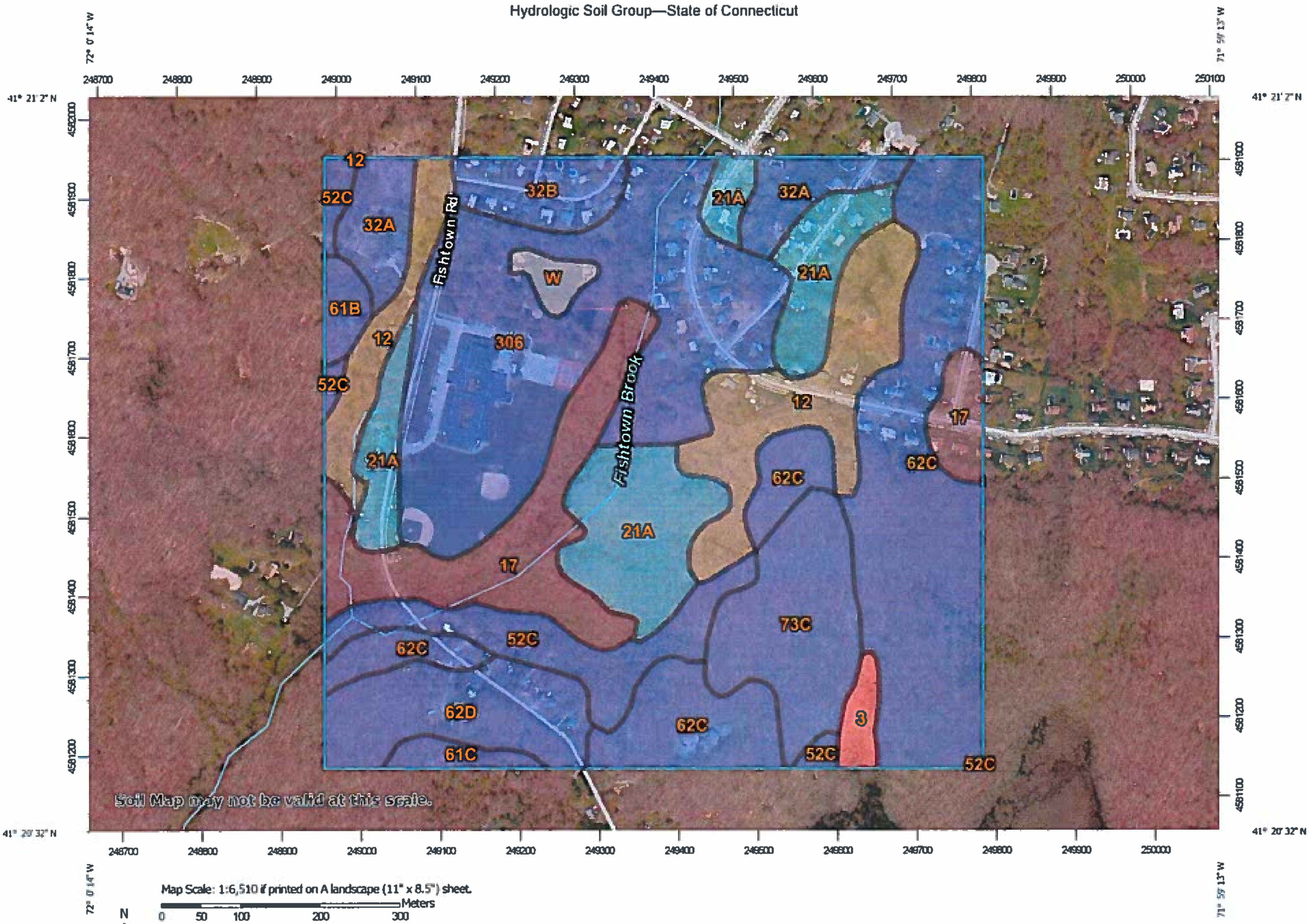
This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 8/8/2018 at 1:53:11 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

APPENDIX C

NRCS HYDROLOGIC SOIL GROUP MAP



Map Scale: 1:6,510 if printed on A landscape (11" x 8.5") sheet.

Meters: 0 50 100 200 300

Feet: 0 300 600 1200 1800

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils

Soil Rating Polygons
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:12,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: State of Connecticut
Survey Area Data: Version 16, Sep 15, 2017

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

Date(s) aerial images were photographed: Mar 30, 2011—May 1, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
3	Ridgebury, Leicester, and Whitman soils, 0 to 8 percent slopes, extremely stony	D	1.4	0.9%
12	Raypol silt loam	C/D	15.6	9.9%
17	Timakwa and Natchaug soils, 0 to 2 percent slopes	B/D	14.3	9.0%
21A	Ninigret and Tisbury soils, 0 to 5 percent slopes	C	17.4	11.0%
32A	Haven and Enfield soils, 0 to 3 percent slopes	B	6.6	4.2%
32B	Haven and Enfield soils, 3 to 8 percent slopes	B	4.3	2.7%
52C	Sutton fine sandy loam, 2 to 15 percent slopes, extremely stony	B	8.9	5.6%
61B	Canton and Charlton fine sandy loams, 0 to 8 percent slopes, very stony	B	1.5	1.0%
61C	Canton and Charlton fine sandy loams, 8 to 15 percent slopes, very stony	B	1.4	0.9%
62C	Canton and Charlton fine sandy loams, 3 to 15 percent slopes, extremely stony	B	33.8	21.4%
62D	Canton and Charlton fine sandy loams, 15 to 35 percent slopes, extremely stony	B	8.8	5.6%
73C	Charlton-Chatfield complex, 0 to 15 percent slopes, very rocky	B	10.2	6.5%
306	Udorthents-Urban land complex	B	32.4	20.5%
W	Water		1.3	0.8%
Totals for Area of Interest			**158.0**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

APPENDIX D

ON-SITE SOIL TESTING RESULTS

TEST BORING LOG

MILONE & MACBROOM
99 Realty Drive
Cheshire, CT 06410
(203) 271-1773

PROJECT:	PROPOSED CUTLER ELEMENTARY SCHOOL	BORING NO.: MM 1	SHEET: 1 of 1
LOCATION:	160 FISHTOWN ROAD, MYSTIC, CONNECTICUT	CONTRACTOR: SITE, LLC	
PROJ. NO:	1777-42	FOREMAN: J. DEANGELIS	
CLIENT:	PERKINS EASTMAN	INSPECTOR: J. MONTAGNO	
DATE:	MARCH 18, 2019	GROUND SURFACE ELEVATION: ±29.0'	

EQUIPMENT:	AUGER	CASING	SAMPLER	COREBRL.	GROUNDWATER DEPTH (FT.)			TYPE OF RIG:
TYPE	HSA	-	SS	-	DATE	TIME	WATER DEPTH	TRACK W/ AUTOHAMMER
SIZE ID (IN.)	2 1/4	-	1 3/8	-	2019-03-18		NOT ENCOUNTERED	RIG MODEL:
HMR. WT (LB.)	-	-	140	-				
HMR. FALL (IN.)	-	-	30	-				CME-55 LCX

Depth (FT)	SAMPLE NUMBER	RECOVERY (IN)	BLOWS PER 6"	SOIL AND ROCK CLASSIFICATION-DESCRIPTION BURMISTER SYSTEM (SOIL) U.S. CORPS OF ENGINEERS SYSTEM (ROCK)	DEPTH (FT.)	STRATUM DESCRIPTION	ELEV. (FT.)	Remark
1	S-1	10	1 4 7 5	S-1: Medium dense, dark brown, fine to medium SAND, some Silt, trace fine Gravel, trace Roots.	1.0'	TOPSOIL	28.0'	
2	S-2	4	6 50/1"	S-2: Very dense, light brown, fine to coarse SAND, little fine to coarse Gravel, little Silt.				
3								
4								
5								
6						SAND		
7								
8								
9								
10	S-3	18	6 7 7 9	S-3: Medium dense, gray-brown, fine to medium SAND, trace fine to coarse Gravel, trace Silt.	12.0'		17.0'	
12				Bottom of Exploration ±12.0'				
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								

Remarks:

COHESIONLESS SOILS	COHESIVE SOILS	SAMPLE TYPE	PROPORTIONS
N = 0-4 = VERY LOOSE	N = 0-2 = VERY SOFT	C = ROCK CORE	trace = <10%
4-10 = LOOSE	2-4 = SOFT	S = SPLIT SPOON	little = 10% - 20%
10-30 = MEDIUM DENSE	4-8 = MEDIUM	UP = UNDISTURBED PISTON	some = 20% - 35%
30-50 = DENSE	8-15 = STIFF	UT = UNDISTURBED THINWALL	and = 35% - 50%
50+ = VERY DENSE	15-30 = VERY STIFF		
	30 + = HARD		

TEST BORING LOG

MILONE & MACBROOM 99 Realty Drive Cheshire, CT 06410 (203) 271-1773		
PROJECT: PROPOSED CUTLER ELEMENTARY SCHOOL	BORING NO.: MM-5	SHEET: 1 of 2
LOCATION: 160 FISHTOWN ROAD, MYSTIC, CONNECTICUT	CONTRACTOR: SITE, LLC	
PROJ. NO: 1777-42	FOREMAN: J. DEANGELIS	
CLIENT: PERKINS EASTMAN	INSPECTOR: J. MONTAGNO	
DATE: MARCH 18, 2019	GROUND SURFACE ELEVATION: ±27.0'	

EQUIPMENT:	AUGER	CASING	SAMPLER	COREBRL	GROUNDWATER DEPTH (FT.) DATE	TIME	WATER DEPTH	TYPE OF RIG:
TYPE	HSA	-	SS	-	DATE	TIME	WATER DEPTH	TRACK W/ AUTOHAMMER
SIZE ID (IN.)	2 1/4	-	1 3/8	-	2019-03-18		±6.9'	RIG MODEL:
HMR. WT (LB.)	-	-	140	-				CME-55 LCX
HMR. FALL (IN.)	-	-	30	-				

Depth (FT)	SAMPLE NUMBER	RECOVERY (IN)	BLOWS PER 6"	SOIL AND ROCK CLASSIFICATION-DESCRIPTION BURMISTER SYSTEM (SOIL) U.S. CORPS OF ENGINEERS SYSTEM (ROCK)	DEPTH (FT.)	STRATUM DESCRIPTION	ELEV. (FT.)	Remark
1	S-1	16	1 3 5 6	S-1: Loose, Top 8": Light brown, fine to medium SAND and SILT. Bottom 8": Light brown, fine to coarse SAND, little fine to coarse Gravel, trace Silt.	0.7'	FILL	26.3'	
2–3	S-2	18	5 9 14 18	S-2: Medium dense, light brown, fine to coarse SAND, some Silt, trace fine Gravel.				
4								
5–6	S-3	18	5 6 6 6	S-3: Medium dense, light brown, fine to coarse SAND, little fine to coarse Gravel, little Silt.	6.9'	G.W.T. ▼	20.1'	
7–9								
10–11	S-4	21	2 2 2 2	S-4: Loose, light brown, fine to medium SAND, trace Silt, trace fine Gravel.		SAND		
12–14								
15–16	S-5	20	3 4 2 2	S-5: Loose, light brown, fine to medium SAND, little fine Gravel, trace Silt.				
17–19								
20–21	S-6	23	3 3 4 2	S-6: Loose, Top 5": Light brown, fine to coarse SAND, little Silt, trace fine Gravel. Bottom 18": Light brown, fine SAND, some Silt.				
22								

Remarks:

COHESIONLESS SOILS	COHESIVE SOILS	SAMPLE TYPE	PROPORTIONS
N = 0 - 4 = VERY LOOSE	N = 0 - 2 = VERY SOFT	C = ROCK CORE	trace = <10%
4-10 = LOOSE	2 - 4 = SOFT	S = SPLIT SPOON	little = 10% - 20%
10-30 = MEDIUM DENSE	4 - 8 = MEDIUM	UP = UNDISTURBED PISTON	some = 20% - 35%
30-50 = DENSE	8 - 15 = STIFF	UT = UNDISTURBED THINWALL	and = 35% - 50%
50+ = VERY DENSE	15-30 = VERY STIFF		
	30 + = HARD		

TEST BORING LOG

MILONE & MACBROOM
99 Realty Drive
Cheshire, CT 06410
(203) 271-1773

PROJECT:	PROPOSED CUTLER ELEMENTARY SCHOOL	BORING NO.: MM-5	SHEET: 2 of 2
LOCATION:	160 FISHTOWN ROAD, MYSTIC, CONNECTICUT	CONTRACTOR: SITE, LLC	
PROJ. NO:	1777-42	FOREMAN: J. DEANGELIS	
CLIENT:	PERKINS EASTMAN	INSPECTOR: J. MONTAGNO	
DATE:	MARCH 18, 2019	GROUND SURFACE ELEVATION: ±27.0'	

EQUIPMENT:	AUGER	CASING	SAMPLER	COREBRL	GROUNDWATER DEPTH (FT.)			TYPE OF RIG:
TYPE	HSA	-	SS	-	DATE	TIME	WATER DEPTH	TRACK W/ AUTOHAMMER
SIZE ID (IN.)	2 1/4	-	1 3/8	-	2019-03-18		±6.9'	RIG MODEL:
HMR. WT (LB.)		-	140	-				CME-55 LCX
HMR. FALL (IN.)	-	-	30	-				

Depth (FT)	SAMPLE NUMBER	RECOVERY (IN)	BLOWS PER 6"	SOIL AND ROCK CLASSIFICATION-DESCRIPTION BURMISTER SYSTEM (SOIL) U.S. CORPS OF ENGINEERS SYSTEM (ROCK)	DEPTH (FT.)	STRATUM DESCRIPTION	ELEV. (FT.)	Remark
24								
25	S-7	24	1 / 1 / 4 / 4	S-7: Loose, light brown, fine to coarse SAND, little Silt		SAND		
26								
27								
28					28.5'		-1.5'	
29								
30	S-8	22	4 / 3 / 4 / 4	S-8: Loose, gray, SILT, little fine Sand.		SILT & SAND		
31								
32								
33								
34								
35	S-9	24	WOH / 1 / 1 / 4	S-9: Very loose, gray, SILT, little fine Sand				
36								
37								
38								
39								
40	S-10	24	3 / 4 / 4 / 4	S-10: Loose, gray, SILT, little fine Sand.				
41								
42				Bottom of Exploration ±42.0'	42.0'		-15.0'	
43								
44								
45								

Remarks:

COHESIONLESS SOILS	COHESIVE SOILS	SAMPLE TYPE	PROPORTIONS
N = 0 - 4 = VERY LOOSE	N = 0 - 2 = VERY SOFT	C = ROCK CORE	trace = <10%
4-10 = LOOSE	2 - 4 = SOFT	S = SPLIT SPOON	little = 10% - 20%
10-30 = MEDIUM DENSE	4 - 8 = MEDIUM	UP = UNDISTURBED PISTON	some = 20% - 35%
30-50 = DENSE	8 - 15 = STIFF	UT = UNDISTURBED THINWALL	and = 35% - 50%
50+ = VERY DENSE	15-30 = VERY STIFF		
	30 + = HARD		

TEST BORING LOG

MILONE & MACBROOM
99 Realty Drive
Cheshire, CT 06410
(203) 271-1773

PROJECT:	PROPOSED CUTLER ELEMENTARY SCHOOL	BORING NO.: MM-19	SHEET: 1 of 2
LOCATION:	160 FISHTOWN ROAD, MYSTIC, CONNECTICUT	CONTRACTOR: SITE, LLC	
PROJ. NO:	1777-42	FOREMAN: J. DEANGELIS	
CLIENT:	PERKINS EASTMAN	INSPECTOR: J. MONTAGNO	
DATE:	MARCH 20, 2019	GROUND SURFACE ELEVATION: ±30.0'	

EQUIPMENT:	AUGER	CASING	SAMPLER	COREBRL	GROUNDWATER DEPTH (FT.)			TYPE OF RIG:
TYPE	HSA	-	SS	-	DATE	TIME	WATER DEPTH	TRACK W/ AUTOHAMMER
SIZE ID (IN.)	2 1/4	-	1 3/8	-	2019-03-20		±8.3'	RIG MODEL:
HMR. WT (LB.)		-	140	-				CME-55 LCX
HMR. FALL (IN.)		-	30	-				

Depth (FT)	SAMPLE NUMBER	RECOVERY (IN)	BLOWS PER 6"	SOIL AND ROCK CLASSIFICATION-DESCRIPTION BURMISTER SYSTEM (SOIL) U.S. CORPS OF ENGINEERS SYSTEM (ROCK)	DEPTH (FT.)	STRATUM DESCRIPTION	ELEV. (FT.)	Remark
1	S-1	17	1, 2, 5, 12	S-1: Loose, Top 11": Dark brown, fine to medium SAND, some Silt, trace fine Gravel, trace Roots. Bottom 6": Light brown, fine to coarse SAND, little fine to coarse Gravel, trace Silt	0.9'	TOPSOIL	29.1'	
2–4	S-2	7	11, 11, 9, 7	S-2: Medium dense, light brown, fine to coarse SAND, little fine Gravel, little Silt	2.0'	SUBSOIL	28.0'	
					4.0'	FILL	26.0'	1
5–7	S-3	14	5, 8, 15, 30	S-3: Medium dense, gray-brown, fine to coarse SAND, little fine Gravel, trace Silt.	5.0'	TOPSOIL	25.0'	
8–9					8.3'	G.W.T. ▼	21.7'	
10–12	S-4	6	16, 16, 14, 14	S-4: Dense, gray, fine to coarse SAND, little Silt.		SAND		
13–14								
15–17	S-5	19	10, 11, 9, 12	S-5: Medium dense, gray, fine to coarse SAND, some fine to coarse Gravel, trace Silt.				
18–19								
20–22	S-6	23	2, 2, 3, 2	S-6: Loose, gray-brown, fine to coarse SAND, trace Silt.				

Remarks: 1. Buried topsoil/subsoil found in auger spoils at ±4.5'.

COHESIONLESS SOILS	COHESIVE SOILS	SAMPLE TYPE	PROPORTIONS
N = 0 - 4 = VERY LOOSE	N = 0 -2 = VERY SOFT	C = ROCK CORE	trace = <10%
4-10 = LOOSE	2 - 4 = SOFT	S = SPLIT SPOON	little = 10% - 20%
10-30 = MEDIUM DENSE	4 - 8 = MEDIUM	UP = UNDISTURBED PISTON	some = 20% - 35%
30-50 = DENSE	8 -15 = STIFF	UT = UNDISTURBED THINWALL	and = 35% - 50%
50+ = VERY DENSE	15-30 = VERY STIFF		
	30 + = HARD		

TEST BORING LOG

MILONE & MACBROOM
99 Realty Drive
Cheshire, CT 06410
(203) 271-1773

PROJECT:	PROPOSED CUTLER ELEMENTARY SCHOOL	BORING NO.: MM-19	SHEET: 2 of 2
LOCATION:	150 FISHTOWN ROAD, MYSTIC, CONNECTICUT	CONTRACTOR: SITE, LLC	
PROJ. NO:	1777-42	FOREMAN: J. DEANGELIS	
CLIENT:	PERKINS EASTMAN	INSPECTOR: J. MONTAGNO	
DATE:	MARCH 20, 2019	GROUND SURFACE ELEVATION: ±30.0'	

EQUIPMENT:	AUGER	CASING	SAMPLER	COREBRL	GROUNDWATER DEPTH (FT.)			TYPE OF RIG:
TYPE	HSA	-	SS	-	DATE	TIME	WATER DEPTH	TRACK W/ AUTOHAMMER
SIZE ID (IN.)	2 1/4	-	1 3/8	-	2019-03-20		±8.3'	RIG MODEL:
HMR. WT (LB.)	-	-	140	-				CME-55 LCX
HMR. FALL (IN.)	-	-	30	-				

Depth (FT)	SAMPLE NUMBER	RECOVERY (IN)	BLOWS PER 6"	SOIL AND ROCK CLASSIFICATION-DESCRIPTION BURMISTER SYSTEM (SOIL) U.S. CORPS OF ENGINEERS SYSTEM (ROCK)	DEPTH (FT.)	STRATUM DESCRIPTION	ELEV. (FT.)	Remark
24								
25	S-7	24	5 / 3 / 4 / 6	S-7: Loose, gray-brown, fine to coarse SAND, trace Silt.		SAND		
26								
27				Bottom of Exploration ±27.0'	27.0'		3.0'	
28								
29								
30								
31								
32								
33								
34								
35								
36								
37								
38								
39								
40								
41								
42								
43								
44								
45								

Remarks	COHESIONLESS SOILS	COHESIVE SOILS	SAMPLE TYPE	PROPORTIONS
1. Buried topsoil/subsoil found in auger spoils at ±4.5'	N = 0-4 = VERY LOOSE	N = 0-2 = VERY SOFT	C = ROCK CORE	trace = <10%
	4-10 = LOOSE	2-4 = SOFT	S = SPLIT SPOON	little = 10% - 20%
	10-30 = MEDIUM DENSE	4-8 = MEDIUM	UP = UNDISTURBED PISTON	some = 20% - 35%
	30-50 = DENSE	8-15 = STIFF	UT = UNDISTURBED THINWALL	and = 35% - 50%
	50+ = VERY DENSE	15-30 = VERY STIFF		
		30+ = HARD		

TEST BORING LOG

MILONE & MACBROOM
99 Realty Drive
Cheshire, CT 06410
(203) 271-1773

PROJECT:	PROPOSED CUTLER ELEMENTARY SCHOOL	BORING NO.: MM-20	SHEET: 1 of 2
LOCATION:	160 FISHTOWN ROAD, MYSTIC, CONNECTICUT	CONTRACTOR: SITE, LLC	
PROJ. NO:	1777 42	FOREMAN: J. DEANGELIS	
CLIENT:	PERKINS EASTMAN	INSPECTOR: J. MONTAGNO	
DATE:	MARCH 20, 2019	GROUND SURFACE ELEVATION: ±30.0'	

EQUIPMENT:	AUGER	CASING	SAMPLER	COREBRL	GROUNDWATER DEPTH (FT.)			TYPE OF RIG:
TYPE	HSA	-	SS	-	DATE	TIME	WATER DEPTH	TRACK W/ AUTOHAMMER
SIZE ID (IN.)	2 1/4	-	1 3/8	-	2019-03-20		±8.6'	RIG MODEL:
HMR. WT (LB.)			140	-				CME 55 LCX
HMR. FALL (IN.)		-	30					

Depth (FT)	SAMPLE NUMBER	RECOVERY (IN)	BLOWS PER 6"	SOIL AND ROCK CLASSIFICATION-DESCRIPTION BURMISTER SYSTEM (SOIL) U.S. CORPS OF ENGINEERS SYSTEM (ROCK)	DEPTH (FT.)	STRATUM DESCRIPTION	ELEV. (FT.)	Remark
1	S-1	18	1, 3, 8, 10	S-1: Medium dense, Top 11": Dark brown, fine to medium SAND, some Silt, trace fine Gravel, trace Roots. Bottom 7": Light brown, fine to coarse SAND and fine to coarse GRAVEL, trace Silt	0.9'	TOPSOIL	29.1'	
2					2.7'	FILL	27.3'	
3	S-2	19	10, 9, 8, 8	S-2: Medium dense, Top 8": Light brown, fine to coarse SAND, little Silt, trace fine Gravel, trace Roots. Middle 5": Dark brown, fine to medium SAND, some Silt, trace fine Gravel. Bottom 6": Light brown, fine to medium SAND and SILT, little fine to coarse Gravel.	3.1'	TOPSOIL	26.9'	
4					4.5'	SUBSOIL	25.5'	
5								
6	S 3	16	12, 24, 30, 26	S-3: Very dense, gray-brown, fine to coarse GRAVEL and fine to coarse SAND, trace Silt				
7								
8					8.6'	G.W.T. ▼	21.4'	
9								
10								
11	S-4	14	7, 16, 22, 21	S-4: Dense, gray, fine to coarse SAND, some fine to coarse Gravel, trace Silt.				
12								
13						SAND & GRAVEL		
14								
15								
16	S 5	16	2, 3, 6, 4	S 5: Loose, gray, fine to coarse SAND and fine to coarse GRAVEL, trace Silt				
17								
18					18.5'		11.5'	
19								
20								
21	S-6	19	2, 1, 1, 2	S-6: Very loose, gray, fine to medium SAND, trace Silt, trace fine Gravel.		SAND		
22								

Remarks:

COHESIONLESS SOILS	COHESIVE SOILS	SAMPLE TYPE	PROPORTIONS
N = 0 - 4 = VERY LOOSE	N = 0 - 2 = VERY SOFT	C = ROCK CORE	trace = <10%
4-10 = LOOSE	2 - 4 = SOFT	S = SPLIT SPOON	little = 10% - 20%
10-30 = MEDIUM DENSE	4 - 8 = MEDIUM	UP = UNDISTURBED PISTON	some = 20% - 35%
30-50 = DENSE	8 - 15 = STIFF	UT = UNDISTURBED THINWALL	and = 35% - 50%
50+ = VERY DENSE	15-30 = VERY STIFF		
	30 + = HARD		

TEST BORING LOG

MILONE & MACBROOM 99 Realty Drive Cheshire, CT 06410 (203) 271-1773	PROJECT: PROPOSED CUTLER ELEMENTARY SCHOOL		BORING NO.: MM-20	SHEET: 2 of 2
	LOCATION: 150 FISHTOWN ROAD, MYSTIC, CONNECTICUT		CONTRACTOR: SITE, LLC	
	PROJ. NO: 1777-42		FOREMAN: J. DEANGELIS	
	CLIENT: PERKINS EASTMAN		INSPECTOR: J. MONTAGNO	
	DATE: MARCH 20, 2019		GROUND SURFACE ELEVATION: ±30.0'	

EQUIPMENT:	AUGER	CASING	SAMPLER	COREBRL.	GROUNDWATER DEPTH (FT.)			TYPE OF RIG:
TYPE	HSA	-	SS	-	DATE	TIME	WATER DEPTH	TRACK W/ AUTOHAMMER
SIZE ID (IN.)	2 1/4	-	1 3/8	-	2019-03-20		±8.6'	RIG MODEL:
HMR. WT (LB.)	-	-	140	-				CME-55 LCX
HMR. FALL (IN.)	-	-	30	-				

Depth (FT)	SAMPLE NUMBER	RECOVERY (IN)	BLOWS PER 6"	SOIL AND ROCK CLASSIFICATION-DESCRIPTION BURMISTER SYSTEM (SOIL) U.S. CORPS OF ENGINEERS SYSTEM (ROCK)	DEPTH (FT.)	STRATUM DESCRIPTION	ELEV. (FT.)	Remark
24								
25			3	S-7: Loose, gray, fine to medium SAND, little Silt.		SAND		
26	S-7	20	2 4					
			3		27.0'		3.0'	
27				Bottom of Exploration ±27.0'				
28								
29								
30								
31								
32								
33								
34								
35								
36								
37								
38								
39								
40								
41								
42								
43								
44								
45								

Remarks:

COHESIONLESS SOILS	COHESIVE SOILS	SAMPLE TYPE	PROPORTIONS
N = 0 - 4 = VERY LOOSE	N = 0 - 2 = VERY SOFT	C = ROCK CORE	trace = <10%
4-10 = LOOSE	2 - 4 = SOFT	S = SPLIT SPOON	little = 10% - 20%
10-30 = MEDIUM DENSE	4 - 8 = MEDIUM	UP = UNDISTURBED PISTON	some = 20% - 35%
30-50 = DENSE	8 - 15 = STIFF	UT = UNDISTURBED THINWALL	and = 35% - 50%
50+ = VERY DENSE	15-30 = VERY STIFF		
	30 + = HARD		

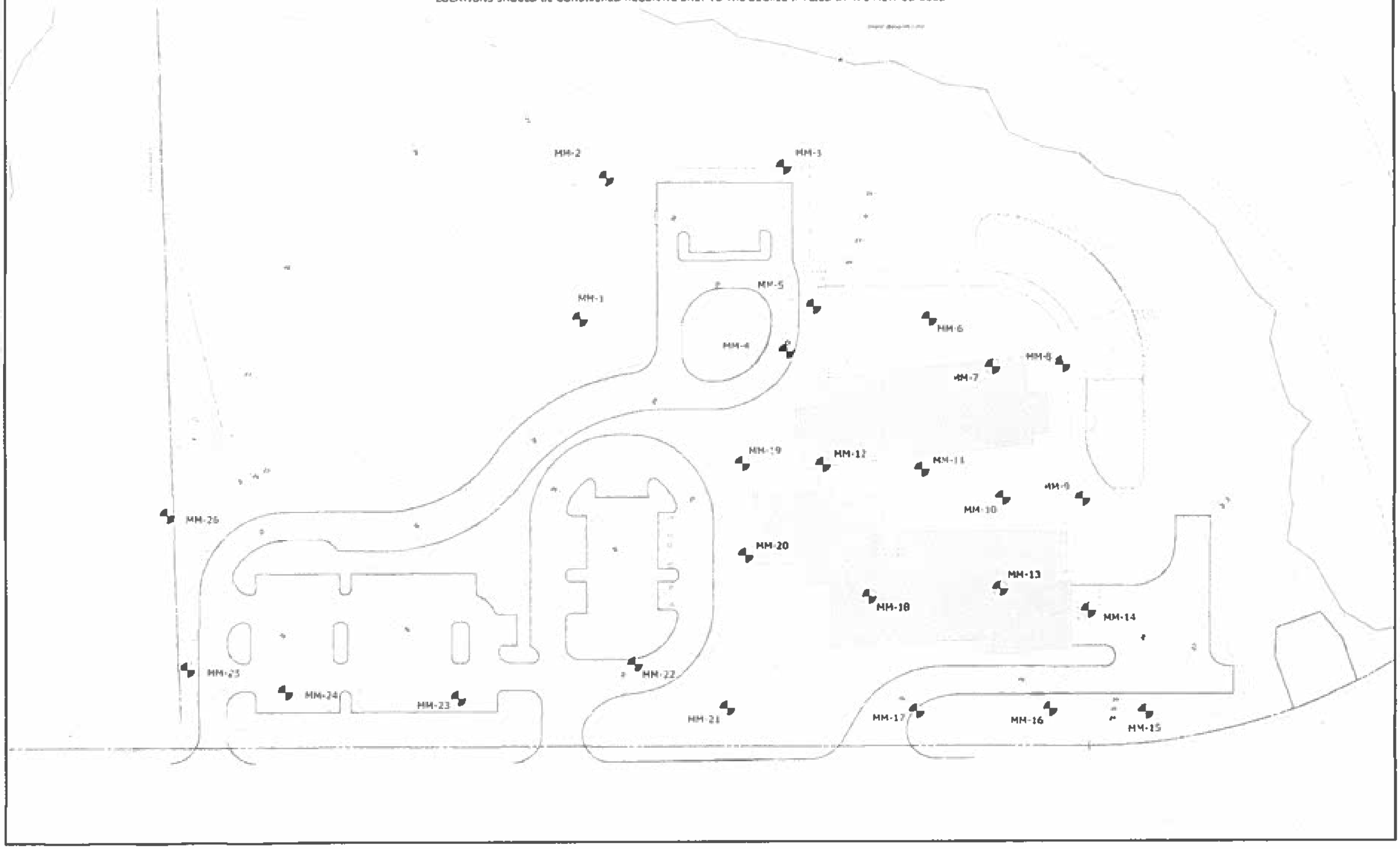
LEGEND:

BORING BY MILONE & MACBROOM, INC.

MM-1

NOTES:

1. BASEMAP DEVELOPED FROM AN ELECTRONIC FILE BY PERKINS EASTMAN TITLED "SITE PLAN UTILITIES" DATED 5/1/2019.
2. BORINGS BY MILONE & MACBROOM, INC. WERE PERFORMED BY SITE, LLC ON 3/18/2019 - 3/21/2019.
3. THE LOCATIONS OF THE BORINGS WERE DETERMINED BY TAPING/PACING FROM EXISTING SITE FEATURES. THESE LOCATIONS SHOULD BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHOD USED



MILONE & MACBROOM

SUBSURFACE EXPLORATION LOCATION PLAN

PROPOSED CUTLER ELEMENTARY SCHOOL

160 FISHTOWN ROAD
MYSTIC, CONNECTICUT

JWK RDG JWK

1"=80'

MAY 15, 2019

1777-42

FIG. 2

APPENDIX E
STORM DRAINAGE COMPUTATIONS

Rational Method Individual Basin Calculations

Project: Cutler Elementary School By: MCB Date: Rev 7/26/19
Location: Mystic, Connecticut Checked: Date:
Watershed:

Basin Name	Impervious Area C=0.9 (sf)	Grassed Area C=0.3 (sf)	Wooded Area C=0.2 (sf)	Total Area (sf)	Total Area (ac)	Weighted C	Tc (min)
AD 2A	0	777	0	777	0.02	0.30	5.00
AD 3	1607	3134	0	4741	0.11	0.50	13.00
YD 5	151	9739	0	9890	0.23	0.31	13.00
AD 6	0	1342	0	1342	0.03	0.30	5.00
CCB 7	6519	0	0	6519	0.15	0.90	5.00
CCB 8	7413	350	0	7763	0.18	0.87	5.00
CCB 9	4056	1269	0	5325	0.12	0.76	5.00
CCB 13	11744	2498	0	14242	0.33	0.79	5.00
CDS 15	0	1188	0	1188	0.03	0.30	5.00
CCB 17	5767	211	0	5978	0.14	0.88	5.00
CCB 18	12198	3764	0	15962	0.37	0.76	5.00
CCB 19	10658	0	0	10658	0.24	0.90	5.00
CCB 20	15104	4322	0	19425	0.45	0.77	5.00
CCB 21	8900	1649	0	10549	0.24	0.81	5.00
CCB 22	9752	3624	0	13376	0.31	0.74	11.50
MH 23	1847	1779	0	3626	0.08	0.61	5.00
CCB 24	5909	2002	0	7911	0.18	0.75	5.00
CCB 25	10907	5316	0	16223	0.37	0.70	10.90
YD 26	321	8093	0	8414	0.19	0.32	14.20
YD 27	426	3944	0	4370	0.10	0.36	5.00
CCB 28	6694	2421	0	9115	0.21	0.74	5.00
AD 30	17	108	0	125	0.00	0.38	5.00
AD 31	0	28526	0	28526	0.65	0.30	23.40
AD 32	0	27230	0	27230	0.63	0.30	20.80
AD 33	0	17826	0	17826	0.41	0.30	18.80

Time of Concentration (T_c) or Travel Time (T_t) Worksheet

Project:	Cutler Elementary School	By:	MCB	Date:	06/21/19
Location:	160 Fishtown Road, Mystic, CT	Checked:	FAB	Date:	06/21/19
Circle one:	Present ***Developed***	Watershed:	AD 3		
Circle one:	***T_c*** T_t	Subwatershed:			

Sheet flow (applicable to T_c only)

	Unit	Segment ID: A-B		Total
1. Surface description (Table 3-1)		GRASS		
2. Manning's roughness coeff. for sheet flow, n (Table 3-1)		0.240		
3. Flow Length, L (< 300ft)	ft.	87.8		
4. Two-year 24-hr rainfall, P_2	in.	3.43		
5. Land slope, s	ft./ft.	0.018		
6. $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5}(s^{0.4})}$	hr.	0.216	=	0.216

Shallow concentrated flow (assume hyd. radius = depth of flow)

	Unit	Segment ID								
7. Surface description										
8. Manning's roughness coeff., n										
9. Paved or unpaved										
10. Depth of flow, d (default values: d=.4 unpaved, d=.2 paved)	ft.									
11. Flow Length, L	ft.									
12. Watercourse slope, s	ft./ft.									
13. Average velocity, $V = \frac{1.49}{n}(d^{2/3})(s^{1/2})$	fps.									
14. $T_t = \frac{L}{3600 * V}$	hr.		+		+		+		=	0.000

Channel flow

	Unit	Segment ID								
15. Channel Bottom width, b	ft.									
16. Horizontal side slope component, z (z horiz:1 vert)	ft.									
17. Depth of flow, d	ft.									
18. Cross sectional flow area, A (assume trapazoidal)	$ft.^2$									
19. Wetted perimeter, P_w	ft.									
20. Hydraulic Radius, $R = \frac{A}{P_w}$	ft.									
21. Channel slope, s	ft./ft.									
22. Manning's roughness coeff., n										
23. $V = \frac{1.49}{n}(R^{2/3})(s^{1/2})$	fps.									
24. Flow length, L	ft.									
25. $T_t = \frac{L}{3600 * V}$	hr.		+				+		=	0.000

26. Watershed or subarea T_c or T_t (add T_t in steps 6, 14 & 25) hr. 0.216

Milone & MacBroom Inc.

Time of Concentration (T_c) or Travel Time (T_t) Worksheet

Project: Cutler Elementary School
Location: 160 Fishtown Road, Mystic, CT
Circle one: Present **Developed**
Circle one: **T_c** T_t

By: MCB Date: 06/21/19
Checked: FAB Date: 06/21/19
Watershed: YD 5
Subwatershed:

Sheet flow (applicable to T_c only)

	Unit	Segment ID: A-B	
1. Surface description (Table 3-1)		GRASS	
2. Manning's roughness coeff. for sheet flow, n (Table 3-1)		0.240	
3. Flow Length, L (< 300ft)	ft.	91.0	
4. Two-year 24-hr rainfall, P_2	in.	3.43	
5. Land slope, s	ft./ft.	0.019	
6. $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5}(s^{0.4})}$	hr.	0.217	= 0.217

Shallow concentrated flow (assume hyd. radius = depth of flow)

	Unit	Segment ID				
7. Surface description						
8. Manning's roughness coeff., n						
9. Paved or unpaved						
10. Depth of flow, d (default values: d=.4 unpaved, d=.2 paved)	ft.					
11. Flow Length, L	ft.					
12. Watercourse slope, s	ft./ft.					
13. Average velocity, $V = \frac{1.49}{n}(d^{2/3})(s^{1/2})$	fps.					
14. $T_t = \frac{L}{3600 * V}$	hr.		+	+	+	= 0.000

Channel flow

	Unit	Segment ID				
15. Channel Bottom width, b	ft.					
16. Horizontal side slope component, z (z horiz:1 vert)	ft.					
17. Depth of flow, d	ft.					
18. Cross sectional flow area, A (assume trapazoidal)	$ft.^2$					
19. Wetted perimeter, P_w	ft.					
20. Hydraulic Radius, $R = \frac{A}{P_w}$	ft.					
21. Channel slope, s	ft./ft.					
22. Manning's roughness coeff., n						
23. $V = \frac{1.49}{n}(R^{2/3})(s^{1/2})$	fps.					
24. Flow length, L	ft.					
25. $T_t = \frac{L}{3600 * V}$	hr.		+	+	+	= 0.000

26. Watershed or subarea T_c or T_t (add T_t in steps 6, 14 & 25) hr. 0.217

Time of Concentration (T_c) or Travel Time (T_t) Worksheet

Project: Cutler Elementary School | By: MCB | Date: 06/21/19
Location: 160 Fishtown Road, Mystic, CT | Checked: FAB | Date: 06/21/19
Circle one: Present ***Developed*** | Watershed: CCB 22
Circle one: ***T_c*** T_t | Subwatershed:

Sheet flow (applicable to T_c only)

	Units	Segment ID: A-B		Total
1. Surface description (Table 3-1)		GRASS		
2. Manning's roughness coeff. for sheet flow, n (Table 3-1)		0.240		
3. Flow Length, L (< 300ft)	ft.	44.4		
4. Two-year 24-hr rainfall, P_2	in.	3.43		
5. Land slope, s	ft./ft.	0.007		
6. $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5}(s^{0.4})}$	hr.	0.183	=	0.183

Shallow concentrated flow (assume hyd. radius = depth of flow)

	Units	Segment ID: B-C								
7. Surface description		BIT								
8. Manning's roughness coeff., n		0.015								
9. Paved or unpaved		PVD								
10. Depth of flow, d (default values: d=.4 unpaved, d=.2 paved)	ft.	0.20								
11. Flow Length, L	ft.	137.0								
12. Watercourse slope, s	ft./ft.	0.018								
13. Average velocity, $V = \frac{1.49}{n}(d^{2/3})(s^{1/2})$	fps.	4.56								
14. $T_t = \frac{L}{3600 * V}$	hr.	0.008	+		+		+		=	0.008

Channel flow

	Units	Segment ID								
15. Channel Bottom width, b	ft.									
16. Horizontal side slope component, z (z horiz:1 vert)	ft.									
17. Depth of flow, d	ft.									
18. Cross sectional flow area, A (assume trapazoidal)	$ft.^2$									
19. Wetted perimeter, P_w	ft.									
20. Hydraulic Radius, $R = \frac{A}{P_w}$	ft.									
21. Channel slope, s	ft./ft.									
22. Manning's roughness coeff., n										
23. $V = \frac{1.49}{n}(R^{2/3})(s^{1/2})$	fps.									
24. Flow length, L	ft.									
25. $T_t = \frac{L}{3600 * V}$	hr.		+				+		=	0.000

26. Watershed or subarea T_c or T_t (add T_t in steps 6, 14 & 25) — hr. 0.191

Time of Concentration (T_c) or Travel Time (T_t) Worksheet

Project: Cutler Elementary School — By: MCB — Date: 06/21/19

Location: 160 Fishtown Road, Mystic, CT — Checked: FAB — Date: 06/21/19

Circle one: Present ***Developed*** — Watershed: CCB 25

Circle one: ***T_c*** T_t — Subwatershed:

Sheet flow (applicable to T_c only)

	Units	Segment ID A-B		Total
1. Surface description (Table 3-1)		GRASS		
2. Manning's roughness coeff. for sheet flow, n (Table 3-1)		0.240		
3. Flow Length, L (< 300ft)	ft.	78.0		
4. Two-year 24-hr rainfall, P_2	in.	3.43		
5. Land slope, s	ft./ft.	0.023		
6. $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5}(s^{0.4})}$	hr.	0.178	=	0.178

Shallow concentrated flow (assume hyd. radius = depth of flow)

	Units	Segment ID B-C								Total
7. Surface description		BIT								
8. Manning's roughness coeff., n		0.015								
9. Paved or unpaved		PVD								
10. Depth of flow, d (default values: d=.4 unpaved, d=.2 paved)	ft.	0.20								
11. Flow Length, L	ft.	52.1								
12. Watercourse slope, s	ft./ft.	0.013								
13. Average velocity, $V = \frac{1.49}{n}(d^{2/3})(s^{1/2})$	fps.	3.87								
14. $T_t = \frac{L}{3600 * V}$	hr.	0.004	+		+		+		=	0.004

Channel flow

	Units	Segment ID								Total
15. Channel Bottom width, b	ft.									
16. Horizontal side slope component, z (z horiz:1 vert)	ft.									
17. Depth of flow, d	ft.									
18. Cross sectional flow area, A (assume trapazoidal)	$ft.^2$									
19. Wetted perimeter, P_w	ft.									
20. Hydraulic Radius, $R = \frac{A}{P_w}$	ft.									
21. Channel slope, s	ft./ft.									
22. Manning's roughness coeff., n										
23. $V = \frac{1.49}{n}(R^{2/3})(s^{1/2})$	fps.									
24. Flow length, L	ft.									
25. $T_t = \frac{L}{3600 * V}$	hr		+				+		=	0.000

26. Watershed or subarea T_c or T_t (add T_t in steps 6, 14 & 25) — hr. — 0.182

Time of Concentration (T_c) or Travel Time (T_t) Worksheet

Project: Cutler Elementary School — By: MCB — Date: 06/21/19
Location: 160 Fishtown Road, Mystic, CT — Checked: FAB — Date: 06/21/19
Circle one: Present **Developed** — Watershed: YD 26
Circle one: **T_c** T_t — Subwatershed:

Sheet flow (applicable to T_c only)

	Unit	Segment ID: A-B	
1. Surface description (Table 3-1)		GRASS	
2. Manning's roughness coeff. for sheet flow, n (Table 3-1)		0.240	
3. Flow Length, L (< 300ft)	ft.	80.6	
4. Two-year 24-hr rainfall, P_2	in.	3.43	
5. Land slope, s	ft./ft.	0.012	
6. $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5}(s^{0.4})}$	hr.	0.237	= 0.237

Shallow concentrated flow (assume hyd. radius = depth of flow)

	Unit	Segment ID				
7. Surface description						
8. Manning's roughness coeff., n						
9. Paved or unpaved						
10. Depth of flow, d (default values: d=.4 unpaved, d=.2 paved)	ft.					
11. Flow Length, L	ft.					
12. Watercourse slope, s	ft./ft.					
13. Average velocity, $V = \frac{1.49}{n}(d^{2/3})(s^{1/2})$	fps.					
14. $T_t = \frac{L}{3600 * V}$	hr.		+	+	+	= 0.000

Channel flow

	Unit	Segment ID				
15. Channel Bottom width, b	ft.					
16. Horizontal side slope component, z (z horiz:1 vert)	ft.					
17. Depth of flow, d	ft.					
18. Cross sectional flow area, A (assume trapazoidal)	$ft.^2$					
19. Wetted perimeter, P_w	ft.					
20. Hydraulic Radius, $R = \frac{A}{P_w}$	ft.					
21. Channel slope, s	ft./ft.					
22. Manning's roughness coeff., n						
23. $V = \frac{1.49}{n}(R^{2/3})(s^{1/2})$	fps.					
24. Flow length, L	ft.					
25. $T_t = \frac{L}{3600 * V}$	hr.		+		+	= 0.000
26. Watershed or subarea T_c or T_t (add T_t in steps 6, 14 & 25)	hr.					0.237

Time of Concentration (T_c) or Travel Time (T_t) Worksheet

Project: Cutler Elementary School | By: MCB | Date: 06/21/19
Location: 160 Fishtown Road, Mystic, CT | Checked: FAB | Date: 06/21/19
Circle one: Present **_Developed_** | Watershed: AD 31
Circle one: **_T_c_** T_t | Subwatershed:

Sheet flow (applicable to T_c only)

	Unit	Segment ID A-B	Total
1. Surface description (Table 3-1)		GRASS	
2. Manning's roughness coeff. for sheet flow, n (Table 3-1)		0.240	
3. Flow Length, L (< 300ft)	ft.	100.0	
4. Two-year 24-hr rainfall, P_2	in.	3.43	
5. Land slope, s	ft./ft.	0.007	
6. $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5}(s^{0.4})}$	hr.	0.350	= 0.350

Shallow concentrated flow (assume hyd. radius = depth of flow)

	Unit	Segment ID B-C				Total
7. Surface description		GRASS				
8. Manning's roughness coeff., n		0.080				
9. Paved or unpaved		UNPVD				
10. Depth of flow, d (default values: d=.4 unpaved, d=.2 paved)	ft.	0.40				
11. Flow Length, L	ft.	131.7				
12. Watercourse slope, s	ft./ft.	0.008				
13. Average velocity, $V = \frac{1.49}{n}(d^{2/3})(s^{1/2})$	fps.	0.90				
14. $T_t = \frac{L}{3600 * V}$	hr.	0.040	+	+	+	= 0.040

Channel flow

	Unit	Segment ID				Total
15. Channel Bottom width, b	ft.					
16. Horizontal side slope component, z (z horiz:1 vert)	ft.					
17. Depth of flow, d	ft.					
18. Cross sectional flow area, A (assume trapazoidal)	$ft.^2$					
19. Wetted perimeter, P_w	ft.					
20. Hydraulic Radius, $R = \frac{A}{P_w}$	ft.					
21. Channel slope, s	ft./ft.					
22. Manning's roughness coeff., n						
23. $V = \frac{1.49}{n}(R^{2/3})(s^{1/2})$	fps.					
24. Flow length, L	ft.					
25. $T_t = \frac{L}{3600 * V}$	hr.		+		+	= 0.000

26. Watershed or subarea T_c or T_t (add T_t in steps 6, 14 & 25) hr. 0.390

Time of Concentration (T_c) or Travel Time (T_t) Worksheet

Project: Cutler Elementary School — By: MCB — Date: 06/21/19

Location: 160 Fishtown Road, Mystic, CT — Checked: FAB — Date: 06/21/19

Circle one: Present ***Developed*** — Watershed: AD 32

Circle one: ***T_c*** T_t — Subwatershed:

Sheet flow (applicable to T_c only)

	Unit	Segment ID: A-B	
1. Surface description (Table 3-1)		GRASS	
2. Manning's roughness coeff. for sheet flow, n (Table 3-1)		0.240	
3. Flow Length, L (< 300ft)	ft.	100.0	
4. Two-year 24-hr rainfall, P_2	in.	3.43	
5. Land slope, s	ft./ft.	0.010	
6. $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5}(s^{0.4})}$	hr.	0.303	= 0.303

Shallow concentrated flow (assume hyd. radius = depth of flow)

	Unit	Segment ID: B-C				
7. Surface description		GRASS				
8. Manning's roughness coeff., n		0.080				
9. Paved or unpaved		UNPVD				
10. Depth of flow, d (default values: d=.4 unpaved, d=.2 paved)	ft.	0.40				
11. Flow Length, L	ft.	124.6				
12. Watercourse slope, s	ft./ft.	0.006				
13. Average velocity, $V = \frac{1.49}{n}(d^{2/3})(s^{1/2})$	fps.	0.78				
14. $T_t = \frac{L}{3600 * V}$	hr.	0.044	+	+	+	= 0.044

Channel flow

	Unit	Segment ID				
15. Channel Bottom width, b	ft.					
16. Horizontal side slope component, z (z horiz:1 vert)	ft.					
17. Depth of flow, d	ft.					
18. Cross sectional flow area, A (assume trapazoidal)	$ft.^2$					
19. Wetted perimeter, P_w	ft.					
20. Hydraulic Radius, $R = \frac{A}{P_w}$	ft.					
21. Channel slope, s	ft./ft.					
22. Manning's roughness coeff., n						
23. $V = \frac{1.49}{n}(R^{2/3})(s^{1/2})$	fps.					
24. Flow length, L	ft.					
25. $T_t = \frac{L}{3600 * V}$	hr.		+		+	= 0.000

26. Watershed or subarea T_c or T_t (add T_t in steps 6, 14 & 25) — hr. 0.347

Time of Concentration (T_c) or Travel Time (T_t) Worksheet

Project: Cutler Elementary School — By: MCB — Date: 06/21/19
Location: 160 Fishtown Road, Mystic, CT — Checked: FAB — Date: 06/21/19
Circle one: Present **Developed** — Watershed: AD 33
Circle one: **T_c** T_t — Subwatershed:

Sheet flow (applicable to T_c only)

	Unit		
Segment ID		A-B	
1. Surface description (Table 3-1)		GRASS	
2. Manning's roughness coeff. for sheet flow, n (Table 3-1)		0.240	
3. Flow Length, L (< 300ft)	ft.	100.0	
4. Two-year 24-hr rainfall, P_2	in.	3.43	
5. Land slope, s	ft./ft.	0.013	
6. $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5}(s^{0.4})}$	hr.	0.273	= 0.273

Shallow concentrated flow (assume hyd. radius = depth of flow)

	Unit					
Segment ID		B-C				
7. Surface description		GRASS				
8. Manning's roughness coeff., n		0.080				
9. Paved or unpaved		UNPVD				
10. Depth of flow, d (default values: d=.4 unpaved, d=.2 paved)	ft.	0.40				
11. Flow Length, L	ft.	92.5				
12. Watercourse slope, s	ft./ft.	0.004				
13. Average velocity, $V = \frac{1.49}{n}(d^{2/3})(s^{1/2})$	fps.	0.64				
14. $T_t = \frac{L}{3600 * V}$	hr.	0.040	+	+	+	= 0.040

Channel flow

	Unit					
Segment ID						
15. Channel Bottom width, b	ft.					
16. Horizontal side slope component, z (z horiz:1 vert)	ft.					
17. Depth of flow, d	ft.					
18. Cross sectional flow area, A (assume trapazoidal)	$ft.^2$					
19. Wetted perimeter, P_w	ft.					
20. Hydraulic Radius, $R = \frac{A}{P_w}$	ft.					
21. Channel slope, s	ft./ft.					
22. Manning's roughness coeff., n						
23. $V = \frac{1.49}{n}(R^{2/3})(s^{1/2})$	fps.					
24. Flow length, L	ft.					
25. $T_t = \frac{L}{3600 * V}$	hr.		+		+	= 0.000

26. Watershed or subarea T_c or T_t (add T_t in steps 6, 14 & 25) — hr. 0.313

Milone & MacBroom Inc.

NOAA Atlas 14, Volume 10, Version 2
Location name: Mystic, Connecticut, USA*
Latitude: 41.3474°, Longitude: -71.9979°
Elevation: 29.64 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sandra Pavlovic, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Orlan Wilhite

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	4.04 (3.07-5.32)	4.84 (3.67-6.36)	6.13 (4.64-8.09)	7.21 (5.42-9.55)	8.70 (6.37-11.9)	9.84 (7.09-13.6)	11.0 (7.74-15.6)	12.5 (8.35-17.8)	14.5 (9.35-21.0)	16.0 (10.1-23.5)
10-min	2.86 (2.17-3.76)	3.43 (2.60-4.51)	4.34 (3.29-5.73)	5.11 (3.85-6.76)	6.16 (4.52-8.39)	6.97 (5.02-9.63)	7.78 (5.48-11.0)	8.84 (5.91-12.6)	10.2 (6.62-14.9)	11.3 (7.16-16.7)
15-min	2.24 (1.70-2.95)	2.69 (2.04-3.54)	3.41 (2.58-4.50)	4.01 (3.02-5.30)	4.83 (3.54-6.58)	5.47 (3.94-7.55)	6.10 (4.30-8.65)	6.94 (4.64-9.88)	8.04 (5.19-11.7)	8.87 (5.61-13.1)
30-min	1.59 (1.21-2.09)	1.90 (1.44-2.50)	2.40 (1.82-3.17)	2.82 (2.12-3.74)	3.40 (2.49-4.63)	3.84 (2.77-5.31)	4.29 (3.02-6.08)	4.88 (3.26-6.95)	5.65 (3.65-8.22)	6.24 (3.95-9.19)
60-min	1.03 (0.781-1.35)	1.23 (0.931-1.62)	1.55 (1.17-2.05)	1.82 (1.37-2.41)	2.19 (1.61-2.99)	2.48 (1.79-3.42)	2.76 (1.95-3.92)	3.14 (2.10-4.48)	3.64 (2.35-5.30)	4.02 (2.54-5.92)
2-hr	0.674 (0.518-0.876)	0.805 (0.616-1.05)	1.02 (0.780-1.33)	1.20 (0.911-1.57)	1.44 (1.07-1.94)	1.63 (1.19-2.23)	1.82 (1.29-2.55)	2.06 (1.39-2.91)	2.39 (1.55-3.44)	2.63 (1.67-3.84)
3-hr	0.521 (0.403-0.672)	0.622 (0.481-0.804)	0.787 (0.606-1.02)	0.924 (0.708-1.20)	1.11 (0.829-1.49)	1.26 (0.920-1.71)	1.40 (1.00-1.96)	1.59 (1.08-2.23)	1.84 (1.20-2.64)	2.03 (1.29-2.95)
6-hr	0.332 (0.260-0.424)	0.396 (0.309-0.505)	0.500 (0.389-0.639)	0.586 (0.454-0.752)	0.704 (0.530-0.932)	0.796 (0.588-1.07)	0.887 (0.638-1.22)	1.00 (0.685-1.40)	1.16 (0.762-1.65)	1.28 (0.820-1.84)
12-hr	0.204 (0.162-0.258)	0.243 (0.192-0.306)	0.306 (0.241-0.387)	0.358 (0.281-0.454)	0.430 (0.327-0.563)	0.486 (0.362-0.645)	0.541 (0.393-0.738)	0.613 (0.421-0.844)	0.708 (0.468-0.996)	0.779 (0.504-1.11)
24-hr	0.120 (0.096-0.149)	0.143 (0.115-0.178)	0.181 (0.145-0.226)	0.213 (0.169-0.266)	0.256 (0.197-0.331)	0.289 (0.218-0.381)	0.323 (0.237-0.437)	0.368 (0.255-0.501)	0.427 (0.284-0.597)	0.472 (0.307-0.669)
2-day	0.066 (0.054-0.082)	0.080 (0.065-0.098)	0.102 (0.083-0.126)	0.121 (0.097-0.149)	0.146 (0.114-0.187)	0.166 (0.127-0.216)	0.185 (0.138-0.249)	0.213 (0.148-0.288)	0.249 (0.167-0.345)	0.277 (0.181-0.389)
3-day	0.048 (0.039-0.058)	0.057 (0.047-0.070)	0.073 (0.060-0.090)	0.086 (0.070-0.106)	0.104 (0.082-0.133)	0.118 (0.091-0.153)	0.132 (0.099-0.177)	0.152 (0.106-0.204)	0.176 (0.120-0.245)	0.197 (0.129-0.276)
4-day	0.038 (0.031-0.046)	0.046 (0.038-0.056)	0.058 (0.048-0.071)	0.068 (0.056-0.083)	0.082 (0.065-0.104)	0.093 (0.072-0.120)	0.104 (0.078-0.138)	0.119 (0.084-0.159)	0.139 (0.094-0.191)	0.154 (0.101-0.215)
7-day	0.026 (0.022-0.031)	0.030 (0.025-0.037)	0.038 (0.031-0.046)	0.044 (0.036-0.054)	0.053 (0.042-0.066)	0.060 (0.046-0.076)	0.066 (0.050-0.087)	0.075 (0.053-0.099)	0.087 (0.059-0.116)	0.095 (0.063-0.132)
10-day	0.021 (0.018-0.025)	0.024 (0.020-0.029)	0.030 (0.025-0.036)	0.034 (0.028-0.041)	0.041 (0.032-0.050)	0.045 (0.035-0.057)	0.050 (0.038-0.065)	0.056 (0.040-0.074)	0.064 (0.044-0.087)	0.071 (0.047-0.097)
20-day	0.015 (0.013-0.017)	0.017 (0.014-0.020)	0.020 (0.017-0.023)	0.022 (0.019-0.026)	0.026 (0.021-0.031)	0.028 (0.022-0.035)	0.031 (0.023-0.039)	0.033 (0.024-0.044)	0.037 (0.026-0.050)	0.040 (0.027-0.054)
30-day	0.012 (0.011-0.014)	0.014 (0.012-0.016)	0.016 (0.013-0.018)	0.017 (0.015-0.021)	0.020 (0.016-0.024)	0.022 (0.017-0.027)	0.024 (0.018-0.030)	0.025 (0.018-0.033)	0.027 (0.019-0.037)	0.029 (0.020-0.040)
45-day	0.010 (0.009-0.012)	0.011 (0.010-0.013)	0.013 (0.011-0.015)	0.014 (0.012-0.016)	0.016 (0.013-0.019)	0.017 (0.014-0.021)	0.018 (0.014-0.023)	0.019 (0.014-0.025)	0.021 (0.014-0.027)	0.022 (0.015-0.029)
60-day	0.009 (0.008-0.010)	0.010 (0.008-0.011)	0.011 (0.009-0.013)	0.012 (0.010-0.014)	0.013 (0.011-0.016)	0.014 (0.011-0.017)	0.015 (0.012-0.019)	0.016 (0.012-0.021)	0.017 (0.012-0.023)	0.018 (0.012-0.024)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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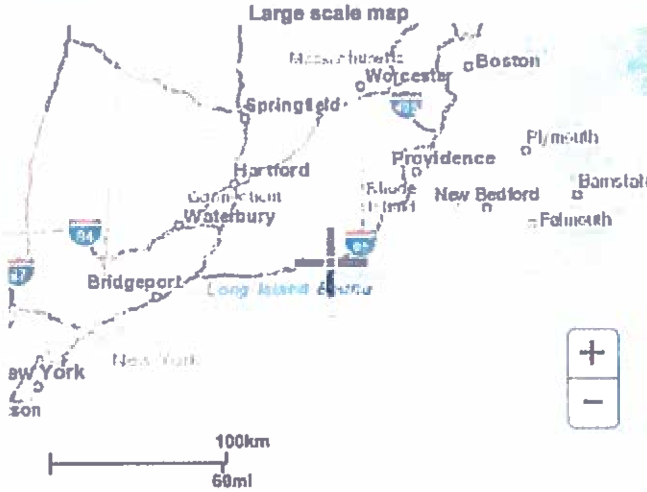
Large scale terrain

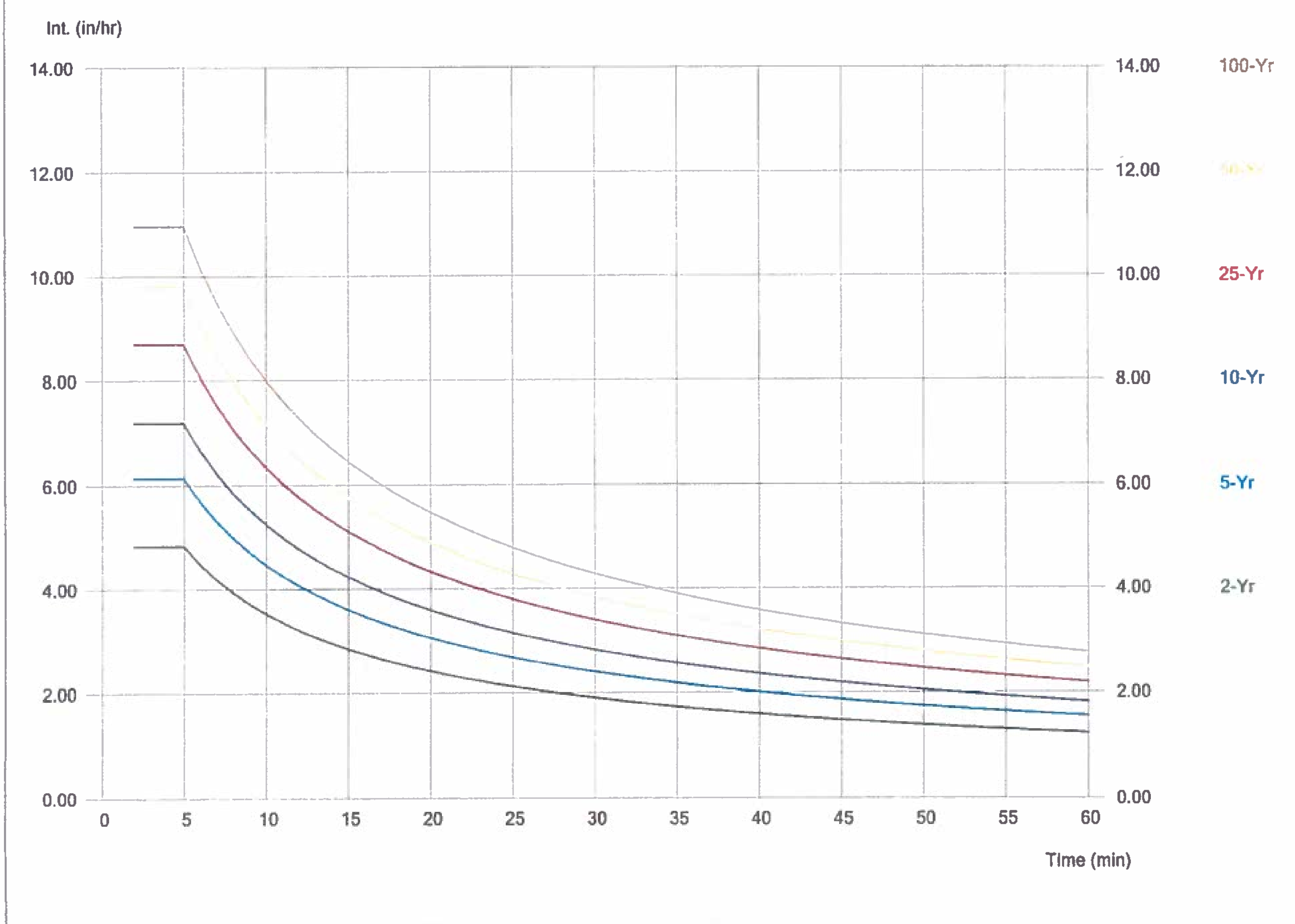
Large scale map



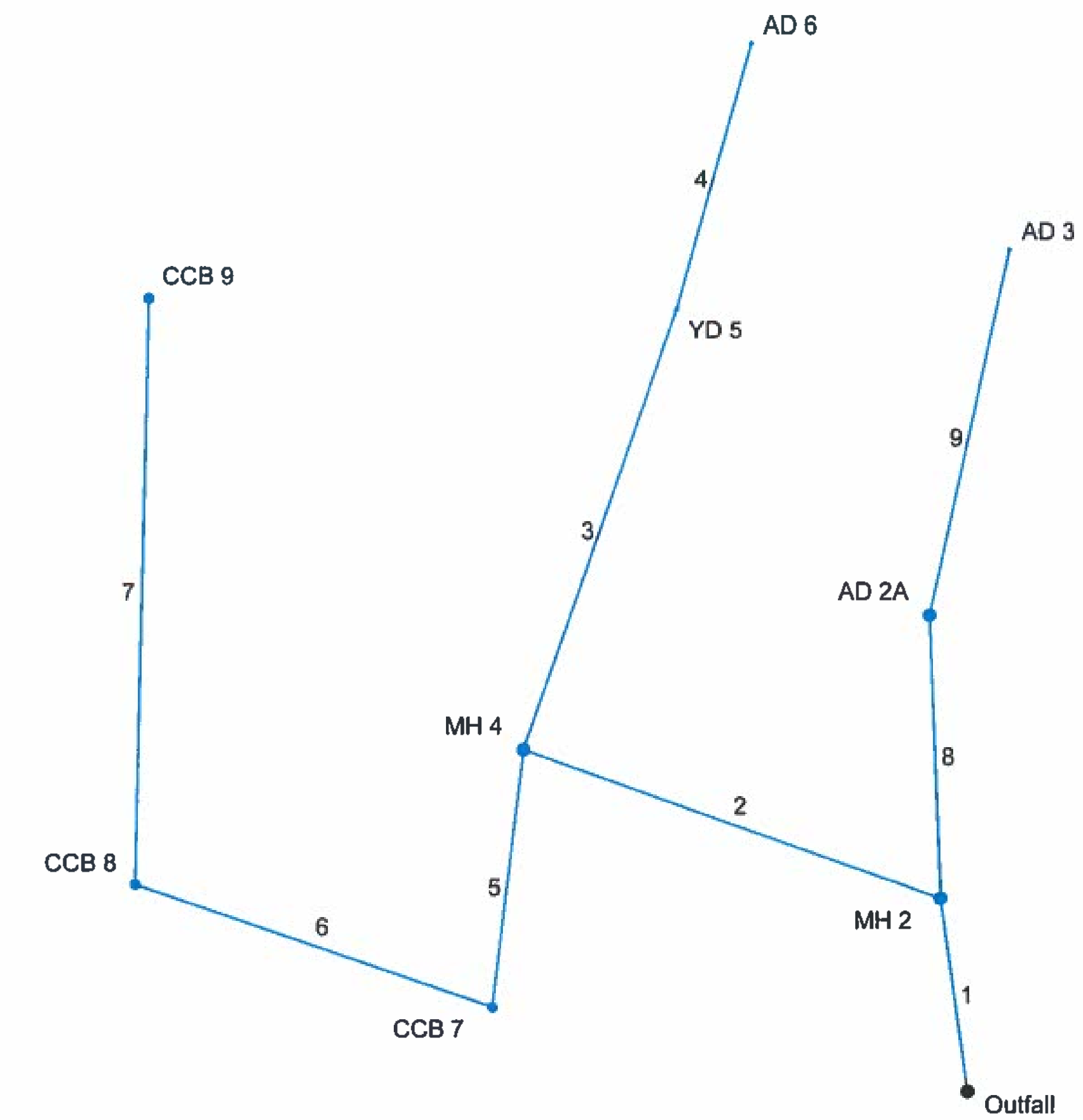
Large scale aerial

Storm Sewer IDF Curves

IDF file: Cutler.IDF



Hydraflow Storm Sewers Extension for Autodesk® AutoCAD® Civil 3D® Plan



Project File: Proposed Storm - Service Drive.stm	Number of lines: 9	Date: 7/25/2019

Storm Sewer Inventory Report

Line No.	Alignment				Flow Data				Physical Data								Line ID
	Dnstr Line No.	Line Length (ft)	Defl angle (deg)	Junc Type	Known Q (cfs)	Drng Area (ac)	Runoff Coeff (C)	Inlet Time (min)	Invert El Dn (ft)	Line Slope (%)	Invert El Up (ft)	Line Size (in)	Line Shape	N Value (n)	J-Loss Coeff (K)	Inlet/ Rim El (ft)	
1	End	58.000	-98.955	MH	0.00	0.00	0.00	0.0	21.10	0.52	21.40	15	Cir	0.012	0.92	28.10	OUTFALL - MH 2
2	1	150.000	-63.872	MH	0.00	0.00	0.00	0.0	21.40	0.53	22.20	15	Cir	0.012	1.00	28.20	MH 2 - MH 4
3	2	140.000	94.994	DrGrt	0.00	0.23	0.31	13.0	22.30	1.57	24.50	12	Cir	0.012	0.50	27.50	MH 4 - YD 5
4	3	83.000	-4.059	DrGrt	0.00	0.03	0.30	5.0	24.50	1.20	25.50	12	Cir	0.012	1.00	28.50	YD 5 - AD 6
5	2	77.000	-99.064	Comb	0.00	0.15	0.90	5.0	22.20	0.91	22.90	15	Cir	0.012	1.50	26.00	MH 4 - CCB 7
6	5	128.000	98.515	Comb	0.00	0.18	0.87	5.0	22.90	0.55	23.60	15	Cir	0.012	1.46	26.63	CCB 7 - CCB 8
7	6	173.000	75.057	Comb	0.00	0.12	0.76	5.0	23.60	0.52	24.50	15	Cir	0.012	1.00	27.70	CCB 8 - CCB 9
8	1	84.000	6.422	DrGrt	0.00	0.02	0.30	5.0	21.90	1.43	23.10	12	Cir	0.012	0.51	28.30	MH 2 - AD 2A
9	8	111.000	16.997	DrGrt	0.00	0.11	0.50	13.0	23.10	1.26	24.50	12	Cir	0.012	1.00	27.50	MH 2 - AD 3

Project File: Proposed Storm - Service Drive.stm | Number of lines: 9 | Date: 7/25/2019

Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line		Incr	Total		Incr	Total	Inlet	Syst					Size	Slope	Dn	Up	Dn	Up	Dn	Up	
		(ft)	(ac)	(ac)	(C)			(min)	(min)	(in/hr)	(cfs)	(cfs)	(ft/s)	(in)	(%)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	
1	End	58.000	0.00	0.84	0.00	0.00	0.52	0.0	15.0	6.0	3.16	5.03	2.73	15	0.52	21.10	21.40	22.35	22.44	22.83	28.10	OUTFALL - MH 2
2	1	150.000	0.00	0.71	0.00	0.00	0.46	0.0	14.3	6.1	2.85	5.11	3.30	15	0.53	21.40	22.20	22.56	22.88	28.10	28.20	MH 2 - MH 4
3	2	140.000	0.23	0.26	0.31	0.07	0.08	13.0	13.0	6.4	0.51	4.84	1.86	12	1.57	22.30	24.50	22.88	24.80	28.20	27.50	MH 4 - YD 5
4	3	83.000	0.03	0.03	0.30	0.01	0.01	5.0	5.0	8.2	0.07	4.23	0.97	12	1.20	24.50	25.50	24.80	25.61	27.50	28.50	YD 5 - AD 6
5	2	77.000	0.15	0.45	0.90	0.14	0.38	5.0	7.0	7.7	2.93	6.67	4.28	15	0.91	22.20	22.90	22.88	23.59	28.20	26.00	MH 4 - CCB 7
6	5	128.000	0.18	0.30	0.87	0.16	0.25	5.0	6.4	7.8	1.94	5.17	3.25	15	0.55	22.90	23.60	23.59	24.15	26.00	26.63	CCB 7 - CCB 8
7	6	173.000	0.12	0.12	0.76	0.09	0.09	5.0	5.0	8.2	0.75	5.05	2.11	15	0.52	23.60	24.50	24.15	24.84	26.63	27.70	CCB 8 - CCB 9
8	1	84.000	0.02	0.13	0.30	0.01	0.06	5.0	13.8	6.2	0.38	4.61	1.55	12	1.43	21.90	23.10	22.56	23.35	28.10	28.30	MH 2 - AD 2A
9	8	111.000	0.11	0.11	0.50	0.06	0.06	13.0	13.0	6.4	0.35	4.33	2.29	12	1.26	23.10	24.50	23.35	24.74	28.30	27.50	MH 2 - AD 3

Project File: Proposed Storm - Service Drive.stm | Number of lines: 9 | Run Date: 7/25/2019

NOTES:Intensity = 102.61 / (Inlet time + 16.50) ^ 0.82; Return period =Yrs. 25 ; c = cir e = ellip b = box

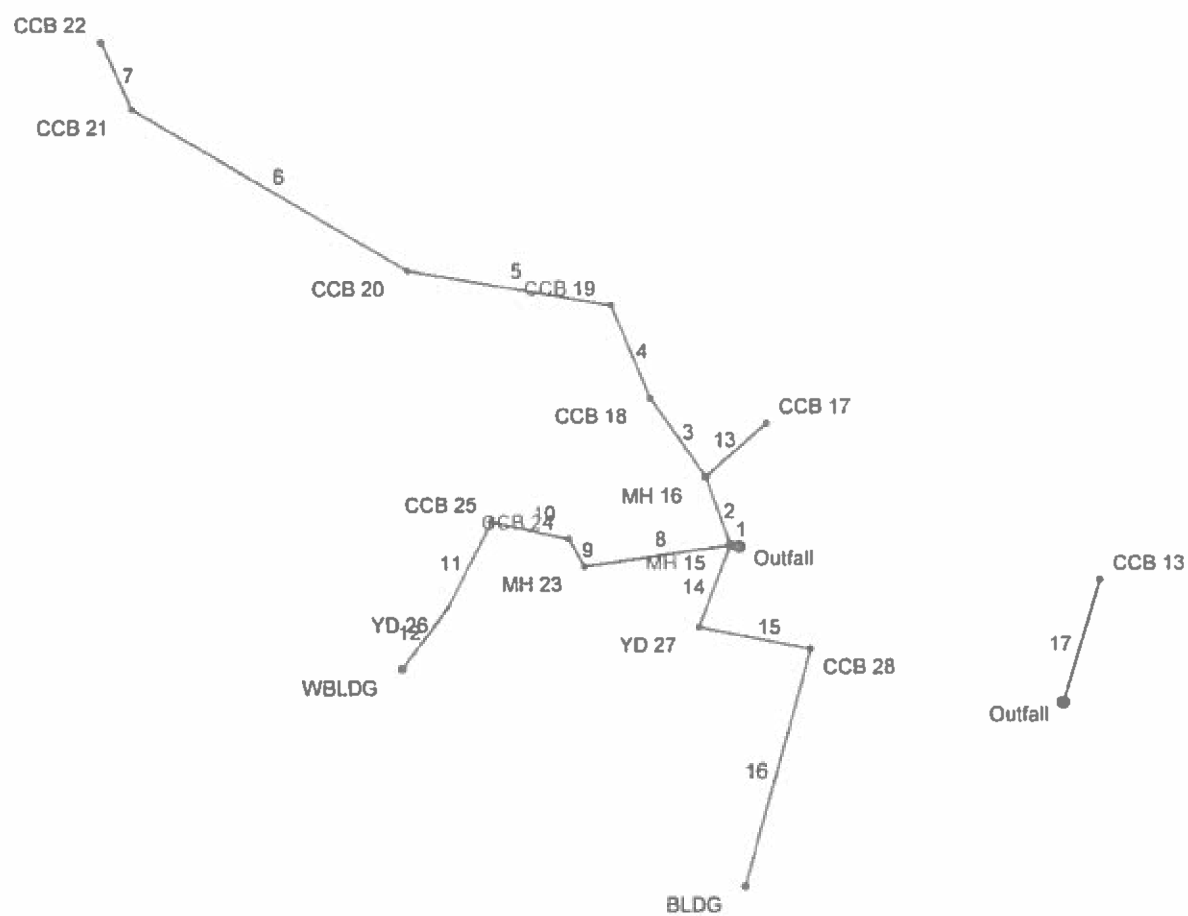
Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
			Invert elev	HGL elev	Depth	Area	Vel	Vel head	EGL elev	Sf		Invert elev	HGL elev	Depth	Area	Vel	Vel head	EGL elev	Sf	Ave Sf	Enrgy loss		
	(in)	(cfs)	(ft)	(ft)	(ft)	(sqft)	(ft/s)	(ft)	(ft)	(%)	(ft)	(ft)	(ft)	(ft)	(sqft)	(ft/s)	(ft)	(ft)	(%)	(%)	(ft)	(K)	(ft)
1	15	3.16	21.10	22.35	1.25	1.23	2.57	0.10	22.45	0.204	58.000	21.40	22.44	1.04	1.09	2.90	0.13	22.57	0.199	0.201	0.117	0.92	0.12
2	15	2.85	21.40	22.56	1.16	0.68	2.40	0.27	22.83	0.000	150.000	22.20	22.88 j	0.68**	0.68	4.19	0.27	23.15	0.000	0.000	n/a	1.00	n/a
3	12	0.51	22.30	22.88	0.58	0.19	1.09	0.11	22.98	0.000	140.000	24.50	24.80 j	0.30**	0.19	2.62	0.11	24.90	0.000	0.000	n/a	0.50	0.05
4	12	0.07	24.50	24.80	0.30	0.05	0.38	0.04	24.83	0.000	83.000	25.50	25.61 j	0.11**	0.05	1.56	0.04	25.65	0.000	0.000	n/a	1.00	0.04
5	15	2.93	22.20	22.88	0.68	0.68	4.32	0.28	23.16	0.000	77.000	22.90	23.59	0.69**	0.69	4.24	0.28	23.87	0.000	0.000	n/a	1.50	n/a
6	15	1.94	22.90	23.59	0.69	0.53	2.81	0.21	23.80	0.000	128.000	23.60	24.15 j	0.55**	0.53	3.70	0.21	24.37	0.000	0.000	n/a	1.46	0.31
7	15	0.75	23.60	24.15	0.55	0.27	1.43	0.12	24.28	0.000	173.000	24.50	24.84 j	0.34**	0.27	2.80	0.12	24.96	0.000	0.000	n/a	1.00	n/a
8	12	0.38	21.90	22.56	0.66	0.16	0.69	0.09	22.65	0.000	84.000	23.10	23.35 j	0.25**	0.16	2.41	0.09	23.44	0.000	0.000	n/a	0.51	0.05
9	12	0.35	23.10	23.35	0.25	0.15	2.22	0.09	23.44	0.000	111.000	24.50	24.74 j	0.24**	0.15	2.36	0.09	24.83	0.000	0.000	n/a	1.00	0.09

Project File: Proposed Storm - Service Drive.stm | Number of lines: 9 | Run Date: 7/25/2019

Notes: ; ** Critical depth.; j-Line contains hyd. jump ; c = cir e = ellip b = box

Hydraflow Storm Sewers Extension for Autodesk® AutoCAD® Civil 3D® Plan



Project File: Proposed Storm - to UG 310.stm	Number of lines: 17	Date: 6/17/2019

Storm Sewers v10.514

Storm Sewer Inventory Report

Line No.	Alignment				Flow Data				Physical Data								Line ID
	Dnstr Line No.	Line Length (ft)	Defl angle (deg)	Junc Type	Known Q (cfs)	Drng Area (ac)	Runoff Coeff (C)	Inlet Time (min)	Invert El Dn (ft)	Line Slope (%)	Invert El Up (ft)	Line Size (in)	Line Shape	N Value (n)	J-Loss Coeff (K)	Inlet/ Rim El (ft)	
1	End	5.000	-166.318	MH	0.00	0.03	0.30	5.0	23.00	2.00	23.10	24	Cir	0.012	0.99	28.50	DET 110 - MH 15
2	1	42.000	56.690	MH	0.00	0.00	0.00	0.0	23.10	0.60	23.35	24	Cir	0.012	0.94	29.50	MH 15 - MH 16
3	2	56.000	-15.532	Comb	0.00	0.37	0.76	5.0	23.35	0.54	23.65	18	Cir	0.012	0.50	28.50	MH 16 - CCB 18
4	3	59.000	12.692	Comb	0.00	0.25	0.90	5.0	23.65	0.51	23.95	18	Cir	0.012	1.31	28.50	CCB 18 - CCB 19
5	4	120.000	-57.670	Comb	0.00	0.45	0.77	5.0	23.95	0.50	24.55	18	Cir	0.012	0.61	29.50	CCB 19 - CCB 20
6	5	186.000	20.790	Comb	0.00	0.24	0.81	5.0	24.55	0.51	25.50	15	Cir	0.012	0.94	29.00	CCB 20 - CCB 21
7	6	43.000	35.160	Comb	0.00	0.31	0.74	11.5	25.50	0.70	25.80	12	Cir	0.012	1.00	28.50	CCB 21 - CCB 22
8	1	86.000	-22.150	DrGrt	0.00	0.08	0.61	5.0	23.80	0.70	24.40	18	Cir	0.012	1.42	28.50	MH 15 - MH 23
9	8	19.000	69.649	Comb	0.00	0.18	0.75	5.0	24.40	1.05	24.60	15	Cir	0.012	1.18	28.30	MH 23 - CCB 24
10	9	46.000	-48.205	Comb	0.00	0.37	0.70	10.9	24.60	0.87	25.00	15	Cir	0.012	1.47	28.30	CCB 24 - CCB 25
11	10	57.000	-76.272	DrGrt	0.00	0.19	0.32	14.2	25.00	0.88	25.50	15	Cir	0.012	0.50	28.50	CCB 25 - YD 26
12	11	45.000	10.141	MH	2.25	0.00	0.00	0.0	25.50	0.67	25.80	12	Cir	0.012	1.00	29.00	YD 26 - WBLDG
13	2	47.000	68.351	Comb	0.00	0.14	0.88	5.0	24.60	0.85	25.00	15	Cir	0.012	1.00	28.50	MH 16 - CCB 17
14	1	52.000	-82.629	DrGrt	0.00	0.10	0.36	5.0	23.20	0.96	23.70	18	Cir	0.012	1.50	28.50	MH 16 - YD 27
15	14	66.000	-99.474	Comb	0.00	0.21	0.74	5.0	23.70	0.76	24.20	18	Cir	0.012	1.50	28.30	YD 27 - CCB 28
16	15	143.000	93.967	MH	5.33	0.00	0.00	0.0	24.20	0.50	24.92	18	Cir	0.012	1.00	29.00	CCB 28 - BLDG
17	End	75.000	-73.110	Comb	0.00	0.33	0.79	5.0	23.20	0.93	23.90	15	Cir	0.012	1.00	27.40	DET 110 - CCB 13

Project File: Proposed Storm - to UG 310.stm | Number of lines: 17 | Date: 6/17/2019

Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line		Incr	Total		Incr	Total	Inlet	Syst					Size	Slope	Dn	Up	Dn	Up	Dn	Up	
		(ft)	(ac)	(ac)	(C)			(min)	(min)	(in/hr)	(cfs)	(cfs)	(ft/s)	(in)	(%)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	
1	End	5.000	0.03	2.92	0.30	0.01	2.10	5.0	15.5	5.0	18.14	34.65	5.77	24	2.00	23.00	23.10	26.37	26.40	28.90	28.50	DET 110 - MH 15
2	1	42.000	0.00	1.76	0.00	0.00	1.40	0.0	14.9	5.1	7.18	18.90	2.29	24	0.60	23.10	23.35	26.91	26.95	28.50	29.50	MH 15 - MH 16
3	2	56.000	0.37	1.62	0.76	0.28	1.28	5.0	14.6	5.2	6.61	8.33	3.74	18	0.54	23.35	23.65	27.02	27.21	29.50	28.50	MH 16 - CCB 18
4	3	59.000	0.25	1.25	0.90	0.23	1.00	5.0	14.3	5.2	5.22	8.11	2.95	18	0.51	23.65	23.95	27.32	27.45	28.50	28.50	CCB 18 - CCB 19
5	4	120.000	0.45	1.00	0.77	0.35	0.77	5.0	13.5	5.4	4.18	8.04	2.36	18	0.50	23.95	24.55	27.62	27.79	28.50	29.50	CCB 19 - CCB 20
6	5	186.000	0.24	0.55	0.81	0.19	0.42	5.0	11.9	5.8	2.45	5.00	2.00	15	0.51	24.55	25.50	27.84	28.07	29.50	29.00	CCB 20 - CCB 21
7	6	43.000	0.31	0.31	0.74	0.23	0.23	11.5	11.5	5.9	1.35	3.22	1.72	12	0.70	25.50	25.80	28.13	28.18	29.00	28.50	CCB 21 - CCB 22
8	1	86.000	0.08	0.82	0.61	0.05	0.50	5.0	15.0	5.1	4.83	9.50	2.73	18	0.70	23.80	24.40	26.91	27.07	28.50	28.50	MH 15 - MH 23
9	8	19.000	0.18	0.74	0.75	0.14	0.45	5.0	14.9	5.1	4.58	7.18	3.74	15	1.05	24.40	24.60	27.23	27.31	28.50	28.30	MH 23 - CCB 24
10	9	46.000	0.37	0.56	0.70	0.26	0.32	10.9	14.7	5.2	3.91	6.52	3.18	15	0.87	24.60	25.00	27.57	27.71	28.30	28.30	CCB 24 - CCB 25
11	10	57.000	0.19	0.19	0.32	0.06	0.06	14.2	14.2	5.3	2.57	6.55	2.09	15	0.88	25.00	25.50	27.94	28.02	28.30	28.50	CCB 25 - YD 26
12	11	45.000	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	2.25	3.15	2.87	12	0.67	25.50	25.80	28.05	28.21	28.50	29.00	YD 26 - WBLDG
13	2	47.000	0.14	0.14	0.88	0.12	0.12	5.0	5.0	8.7	1.07	6.45	0.87	15	0.85	24.60	25.00	27.02	27.03	29.50	28.50	MH 16 - CCB 17
14	1	52.000	0.10	0.31	0.36	0.04	0.19	5.0	5.3	8.5	6.96	11.16	3.94	18	0.96	23.20	23.70	26.91	27.11	28.50	28.50	MH 16 - YD 27
15	14	66.000	0.21	0.21	0.74	0.16	0.16	5.0	5.0	8.7	6.68	9.90	3.78	18	0.76	23.70	24.20	27.47	27.69	28.50	28.30	YD 27 - CCB 28
16	15	143.000	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	5.33	8.07	3.02	18	0.50	24.20	24.92	28.03	28.34	28.30	29.00	CCB 28 - BLDG
17	End	75.000	0.33	0.33	0.79	0.26	0.26	5.0	5.0	8.7	2.27	6.76	1.85	15	0.93	23.20	23.90	26.37	26.45	28.80	27.40	DET 110 - CCB 1

Project File: Proposed Storm - to UG 310.stm | Number of lines: 17 | Run Date: 6/17/2019

NOTES:Intensity = 38.34 / (Inlet time + 3.60) ^ 0.69; Return period =Yrs. 25 ; c = cir e = ellip b = box

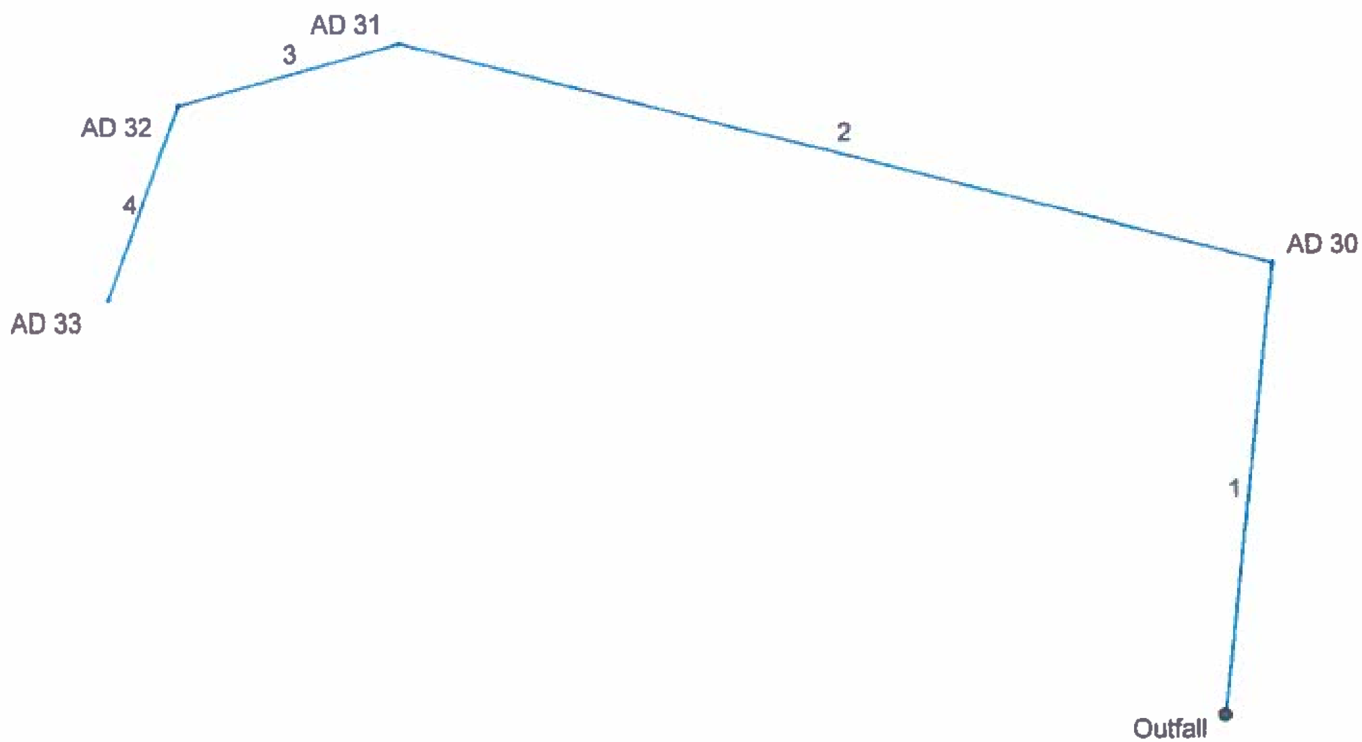
Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
			Invert elev	HGL elev	Depth	Area	Vel	Vel head	EGL elev	Sf		Invert elev	HGL elev	Depth	Area	Vel	Vel head	EGL elev	Sf	Ave Sf	Enrgy loss		
	(in)	(cfs)	(ft)	(ft)	(ft)	(sqft)	(ft/s)	(ft)	(ft)	(%)	(ft)	(ft)	(ft)	(ft)	(sqft)	(ft/s)	(ft)	(ft)	(%)	(%)	(ft)	(K)	(ft)
1	24	18.14	23.00	26.37	2.00	3.14	5.77	0.52	26.89	0.548	5.000	23.10	26.40	2.00	3.14	5.77	0.52	26.92	0.548	0.548	0.027	0.99	0.51
2	24	7.18	23.10	26.91	2.00	3.14	2.29	0.08	26.99	0.086	42.000	23.35	26.95	2.00	3.14	2.29	0.08	27.03	0.086	0.086	0.036	0.94	0.08
3	18	6.61	23.35	27.02	1.50	1.77	3.74	0.22	27.24	0.338	56.000	23.65	27.21	1.50	1.77	3.74	0.22	27.43	0.338	0.338	0.189	0.50	0.11
4	18	5.22	23.65	27.32	1.50	1.77	2.96	0.14	27.46	0.211	59.000	23.95	27.45	1.50	1.77	2.95	0.14	27.58	0.211	0.211	0.124	1.31	0.18
5	18	4.18	23.95	27.62	1.50	1.77	2.36	0.09	27.71	0.135	120.000	24.55	27.79	1.50	1.77	2.36	0.09	27.87	0.135	0.135	0.162	0.61	0.05
6	15	2.45	24.55	27.84	1.25	1.23	2.00	0.06	27.90	0.123	186.000	25.50	28.07	1.25	1.23	2.00	0.06	28.13	0.123	0.123	0.229	0.94	0.06
7	12	1.35	25.50	28.13	1.00	0.79	1.72	0.05	28.17	0.123	43.000	25.80	28.18	1.00	0.79	1.72	0.05	28.23	0.123	0.123	0.053	1.00	0.05
8	18	4.83	23.80	26.91	1.50	1.77	2.73	0.12	27.03	0.180	86.000	24.40	27.07	1.50	1.77	2.73	0.12	27.18	0.180	0.180	0.155	1.42	0.16
9	15	4.58	24.40	27.23	1.25	1.23	3.74	0.22	27.45	0.430	19.000	24.60	27.31	1.25	1.23	3.74	0.22	27.53	0.429	0.429	0.082	1.18	0.26
10	15	3.91	24.60	27.57	1.25	1.23	3.18	0.16	27.73	0.312	46.000	25.00	27.71	1.25	1.23	3.18	0.16	27.87	0.312	0.312	0.143	1.47	0.23
11	15	2.57	25.00	27.94	1.25	1.23	2.09	0.07	28.01	0.135	57.000	25.50	28.02	1.25	1.23	2.09	0.07	28.09	0.135	0.135	0.077	0.50	0.03
12	12	2.25	25.50	28.05	1.00	0.79	2.87	0.13	28.18	0.340	45.000	25.80	28.21	1.00	0.79	2.86	0.13	28.33	0.340	0.340	0.153	1.00	0.13
13	15	1.07	24.60	27.02	1.25	1.23	0.87	0.01	27.03	0.023	47.000	25.00	27.03	1.25	1.23	0.87	0.01	27.05	0.023	0.023	0.011	1.00	0.01
14	18	6.96	23.20	26.91	1.50	1.77	3.94	0.24	27.15	0.374	52.000	23.70	27.11	1.50	1.77	3.94	0.24	27.35	0.374	0.374	0.195	1.50	0.36
15	18	6.68	23.70	27.47	1.50	1.77	3.78	0.22	27.69	0.345	66.000	24.20	27.69	1.50	1.77	3.78	0.22	27.92	0.345	0.345	0.228	1.50	0.33
16	18	5.33	24.20	28.03	1.50	1.77	3.02	0.14	28.17	0.220	143.000	24.92	28.34	1.50	1.77	3.02	0.14	28.48	0.220	0.220	0.314	1.00	0.14
17	15	2.27	23.20	26.37	1.25	1.23	1.85	0.05	26.42	0.105	75.000	23.90	26.45	1.25	1.23	1.85	0.05	26.50	0.105	0.105	0.079	1.00	0.05

Project File: Proposed Storm - to UG 310.stm | Number of lines: 17 | Run Date: 6/17/2019

c = cir e = ellip b = box

Hydraflow Storm Sewers Extension for Autodesk® AutoCAD® Civil 3D® Plan



Project File: Proposed Storm - Baseball Field.stm	Number of lines: 4	Date: 6/13/2019

Storm Sewer Inventory Report

Line No.	Alignment				Flow Data				Physical Data								Line ID
	Dnstr Line No.	Line Length (ft)	Defl angle (deg)	Junc Type	Known Q (cfs)	Drng Area (ac)	Runoff Coeff (C)	Inlet Time (min)	Invert El Dn (ft)	Line Slope (%)	Invert El Up (ft)	Line Size (in)	Line Shape	N Value (n)	J-Loss Coeff (K)	Inlet/ Rim El (ft)	
1	End	164.000	-83.869	DrGrt	0.00	0.00	0.38	5.0	21.50	0.55	22.40	12	Cir	0.012	1.49	26.60	OUTFALL - AD 30
2	1	325.000	-81.814	DrGrt	0.00	0.66	0.30	23.4	22.40	0.52	24.10	12	Cir	0.012	0.83	26.80	AD 30 - AD 31
3	2	83.000	-29.831	DrGrt	0.00	0.63	0.30	20.8	24.10	0.60	24.60	12	Cir	0.012	1.27	26.80	AD 31 - AD 32
4	3	75.000	-54.425	DrGrt	0.00	0.41	0.30	18.8	24.60	0.53	25.00	8	Cir	0.012	1.00	26.80	AD 32 - AD 33

Project File: Proposed Storm - Baseball Field.stm | Number of lines: 4 | Date: 6/13/2019

Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line		Incr	Total		Incr	Total	Inlet	Syst					Size	Slope	Dn	Up	Dn	Up	Dn	Up	
		(ft)	(ac)	(ac)	(C)			(min)	(min)	(in/hr)	(cfs)	(cfs)	(ft/s)	(in)	(%)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	
1	End	164.000	0.00	1.70	0.38	0.00	0.51	5.0	25.0	3.8	1.94	2.86	3.17	12	0.55	21.50	22.40	22.50	23.01	24.00	26.60	OUTFALL - AD 3
2	1	325.000	0.66	1.70	0.30	0.20	0.51	23.4	23.4	4.0	2.02	2.79	3.33	12	0.52	22.40	24.10	23.36	24.71	26.60	26.80	AD 30 - AD 31
3	2	83.000	0.63	1.04	0.30	0.19	0.31	20.8	20.8	4.2	1.32	2.99	3.08	12	0.60	24.10	24.60	24.71	25.09	26.80	26.80	AD 31 - AD 32
4	3	75.000	0.41	0.41	0.30	0.12	0.12	18.8	18.8	4.5	0.55	0.96	2.50	8	0.53	24.60	25.00	25.09	25.35	26.80	26.80	AD 32 - AD 33

Project File: Proposed Storm - Baseball Field.stm

Number of lines: 4

Run Date: 6/13/2019

NOTES:Intensity = 38.34 / (Inlet time + 3.60) ^ 0.69; Return period =Yrs. 25 ; c = cir e = ellip b = box

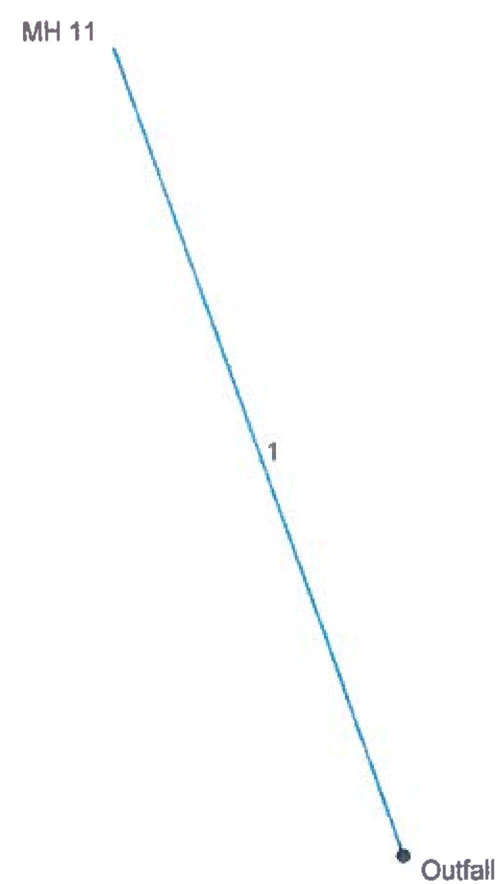
Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
			Invert elev	HGL elev	Depth	Area	Vel	Vel head	EGL elev	Sf		Invert elev	HGL elev	Depth	Area	Vel	Vel head	EGL elev	Sf	Ave Sf	Enrgy loss		
	(in)	(cfs)	(ft)	(ft)	(ft)	(sqft)	(ft/s)	(ft)	(ft)	(%)	(ft)	(ft)	(ft)	(ft)	(sqft)	(ft/s)	(ft)	(ft)	(%)	(%)	(ft)	(K)	(ft)
1	12	1.94	21.50	22.50	1.00	0.79	2.47	0.09	22.59	0.252	164.000	22.40	23.01	0.61	0.50	3.88	0.23	23.24	0.537	0.395	0.647	1.49	0.35
2	12	2.02	22.40	23.36	0.96	0.50	2.61	0.11	23.46	0.237	325.000	24.10	24.71	0.61**	0.50	4.05	0.26	24.96	0.588	0.413	n/a	0.83	0.21
3	12	1.32	24.10	24.71	0.61	0.38	2.66	0.19	24.90	0.000	83.000	24.60	25.09 j	0.49**	0.38	3.50	0.19	25.28	0.000	0.000	n/a	1.27	0.24
4	8	0.55	24.60	25.09	0.49	0.18	2.03	0.06	25.15	0.230	75.000	25.00	25.35	0.35**	0.19	2.98	0.14	25.49	0.605	0.417	0.313	1.00	0.14

Project File: Proposed Storm - Baseball Field.stm | Number of lines: 4 | Run Date: 6/13/2019

Notes: ; ** Critical depth.; j-Line contains hyd. jump ; c = cir e = ellip b = box

Hydraflow Storm Sewers Extension for Autodesk® AutoCAD® Civil 3D® Plan



Project File: Proposed Storm - UG 310 Outlet.stm	Number of lines: 1	Date: 6/13/2019

Storm Sewer Inventory Report

Line No.	Alignment				Flow Data				Physical Data								Line ID
	Dnstr Line No.	Line Length (ft)	Defl angle (deg)	Junc Type	Known Q (cfs)	Drng Area (ac)	Runoff Coeff (C)	Inlet Time (min)	Invert El Dn (ft)	Line Slope (%)	Invert El Up (ft)	Line Size (in)	Line Shape	N Value (n)	J-Loss Coeff (K)	Inlet/ Rim El (ft)	
1	End	101.000	-109.408	MH	16.49	0.00	0.00	0.0	23.00	0.50	23.50	24	Cir	0.012	1.00	29.30	FES 10 - MH 11

Project File: Proposed Storm - UG 310 Outlet.stm | Number of lines: 1 | Date: 6/13/2019

Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line		Incr	Total		Incr	Total	Inlet	Syst					Size	Slope	Dn	Up	Dn	Up	Dn	Up	
		(ft)	(ac)	(ac)	(C)			(min)	(min)	(in/hr)	(cfs)	(cfs)	(ft/s)	(in)	(%)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	
1	End	101.000	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	16.49	17.24	5.29	24	0.50	23.00	23.50	25.00	25.42	25.00	29.30	FES 10 - MH 11

Project File: Proposed Storm - UG 310 Outlet.stm

Number of lines: 1

Run Date: 6/13/2019

NOTES: Intensity = 49.06 / (Inlet time + 3.70) ^ 0.69; Return period =Yrs. 100 ; c = cir e = ellip b = box

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
			Invert elev	HGL elev	Depth	Area	Vel	Vel head	EGL elev	Sf		Invert elev	HGL elev	Depth	Area	Vel	Vel head	EGL elev	Sf	Ave Sf	Enrgy loss		
	(in)	(cfs)	(ft)	(ft)	(ft)	(sqft)	(ft/s)	(ft)	(ft)	(%)	(ft)	(ft)	(ft)	(ft)	(sqft)	(ft/s)	(ft)	(ft)	(%)	(%)	(ft)	(K)	(ft)
1	24	16.49	23.00	25.00	2.00	3.14	5.25	0.43	25.43	0.453	101.000	23.50	25.42	1.92	3.10	5.33	0.44	25.86	0.394	0.423	0.428	1.00	0.44

Project File: Proposed Storm - UG 310 Outlet.stm | Number of lines: 1 | Run Date: 6/13/2019

; c = cir e = ellip b = box

Rational Method Roof Drain System Calculations

Project: Cutler Elementary School — By: MCB — Date: 6/21/19
Location: Mystic, Connecticut — Checked: ______ — Date: ______

Q = C x I x A, Where:
C = Runoff Coefficient
I = Rainfall Intensity (in/hr) => Tc = 5 min => I= 8.70 in/hr (25-year storm)
A = Area (acres)
Q = Flow (cfs)

Total Roof Runoff to Proposed Storm Drainage System (In Hydraflow Model)

	West Bldg to YD 26 (12")	West and East Bldg to CCB 28 (18")
C	0.90	0.90
I	8.70	8.70
A	0.29	0.68
Q	2.27	5.32

Roof Runoff to Roof Drain Lines

	West Bldg to CCB 28 (12")	East Bldg to CCB 28 (12")	West and East Bldg to CCB 28 (15")
C	0.90	0.90	0.90
I	8.70	8.70	8.70
A	0.32	0.16	0.48
Q	2.51	1.25	3.76

	SLOPE (%)	CAPACITY (CFS)
12" HDPE	0.50	2.73
15" HDPE	0.50	4.95

Note:
- Pipe capacity was estimated using Manning's Equation
- n = 0.012 (HDPE)
- NOAA Atlas 14 Vol. 10 Rainfall Intensity

Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Thursday, Jun 13 2019

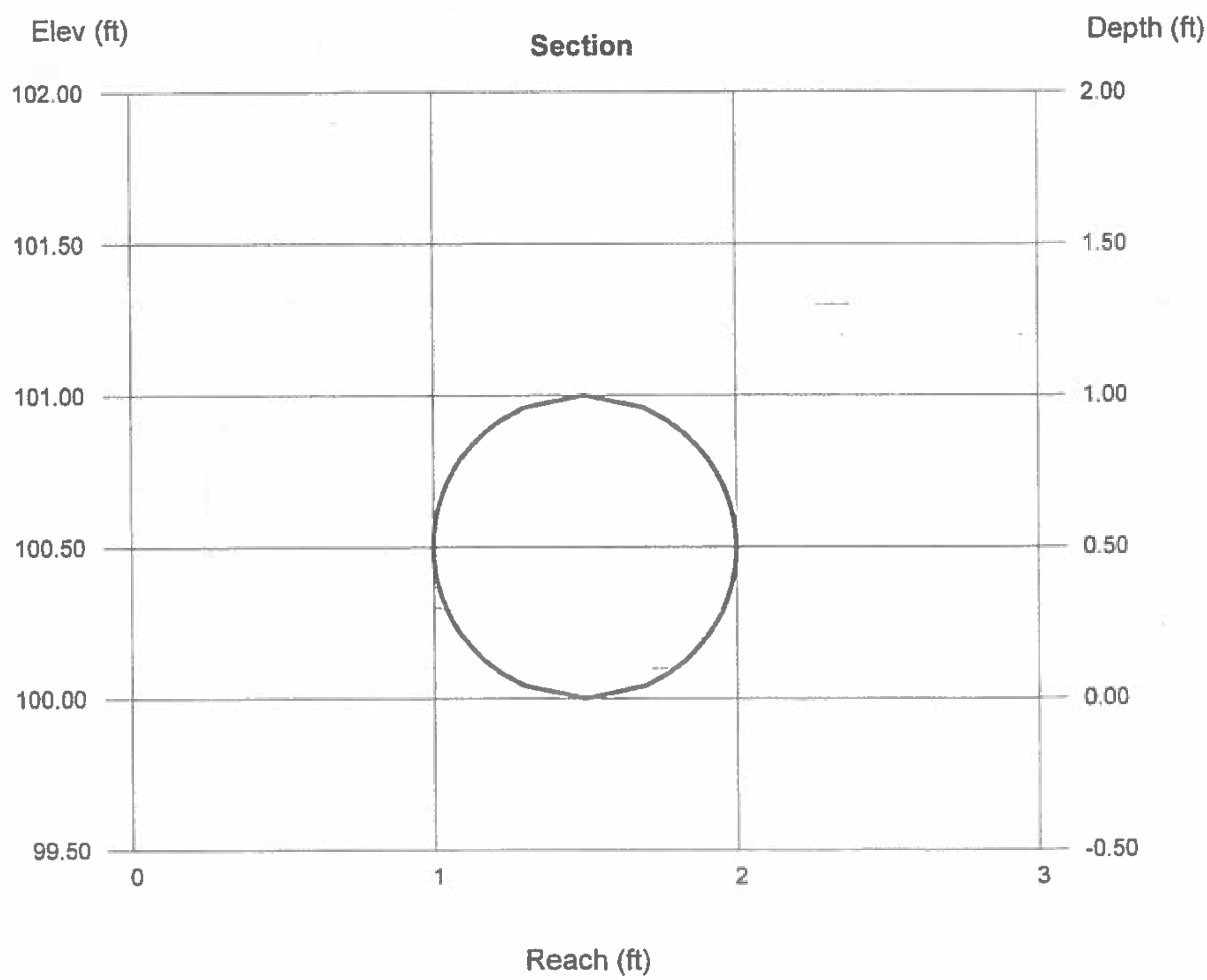
<Name>

Circular
Diameter (ft) = 1.00

Invert Elev (ft) = 100.00
Slope (%) = 0.50
N-Value = 0.012

Calculations
Compute by: Q vs Depth
No. Increments = 10

Highlighted
Depth (ft) = 1.00
Q (cfs) = 2.728
Area (sqft) = 0.79
Velocity (ft/s) = 3.47
Wetted Perim (ft) = 3.14
Crit Depth, Yc (ft) = 0.71
Top Width (ft) = 0.00
EGL (ft) = 1.19

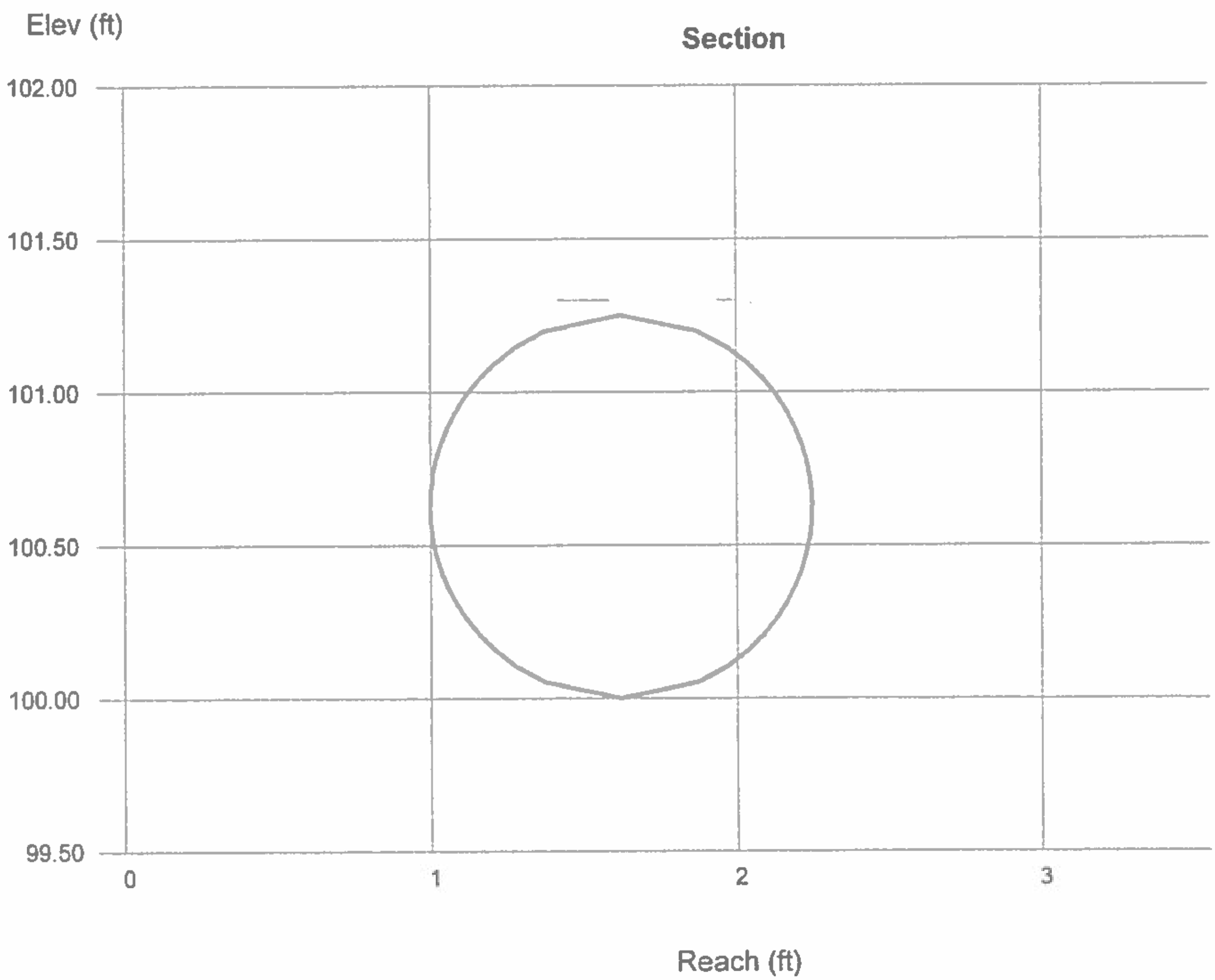


Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Thursday, Jun 13 2019

<Name>

Circular		**Highlighted**	
Diameter (ft)	= 1.25	Depth (ft)	= 1.25
		Q (cfs)	= 4.946
		Area (sqft)	= 1.23
Invert Elev (ft)	= 100.00	Velocity (ft/s)	= 4.03
Slope (%)	= 0.50	Wetted Perim (ft)	= 3.93
N-Value	= 0.012	Crit Depth, Yc (ft)	= 0.91
		Top Width (ft)	= 0.00
Calculations		EGL (ft)	= 1.50
Compute by:	Q vs Depth		
No. Increments	= 10		



Outlet Protection Calculations

Project: Cutler Elementary School — By: FAB — Date: Rev 7/26/2019
Location: 160 Fishtown Road — Checked: — Date:
Outlet I.D. **FES 1**

*Based on Connecticut DOT Drainage Manual, Section 11.13

Description:
Preformed Scour Hole Level Spreader at FES 1

Design Criteria (25-yr Storm Event):

Q (cfs) =	3.16	R_p (ft)=	1.25
D (in) =	15	S_p (ft) =	1.25
V (fps) =	2.73	Tw (ft)=	1.25

Q= Flow rate at discharge point in cubic feet per second (cfs)
D= Outlet pipe diameter (in)
V= Flow velocity at discharge point (ft/s)
R_p= Maximum inside pipe rise (ft)
S_p= inside diametere for circular sections of maximum inside pipe span for non-circular sections (ft)
T_w= Tailwater depth (ft)

A *Preformed Scour Hole* is used *One Half Pipe Rise Depression (Type I)*

Rip Rap Stone Size:

D_{50} Computed (ft)	Rip Rap Specification	D_{50} Stone Size Required
0.03	Modified	5 inches

Preformed Scour Hole Dimensions:

$F = 0.5(R_p)$	=	0.625 ft
$C = 3.0(S_p)+6.0(F)$	=	8ft
$B = 2.0(S_p)+6.0(F)$	=	6ft
d (Depth of Stone)	=	12 inches

Outlet Protection Calculations

Project: Cutler Elementary School   By: MCB   Date: 6/21/2019
Location: 160 Fishtown Road   Checked: Date:
Outlet I.D. **FES 10**

*Based on Connecticut DOT Drainage Manual, Section 11.13

Description:
Preformed Scour Hole Level Spreader at FES 10

Design Criteria (100-yr Storm Event):

Q (cfs) =	16.49	R_p (ft)=	2
D (in) =	24	S_p (ft) =	2
V (fps) =	5.45	Tw (ft)=	2

Q= Flow rate at discharge point in cubic feet per second (cfs)
D= Outlet pipe diameter (in)
V= Flow velocity at discharge point (ft/s)
R_p= Maximum inside pipe rise (ft)
S_p= inside diametere for circular sections of maximum inside pipe span for non-circular sections (ft)
T_w= Tailwater depth (ft)

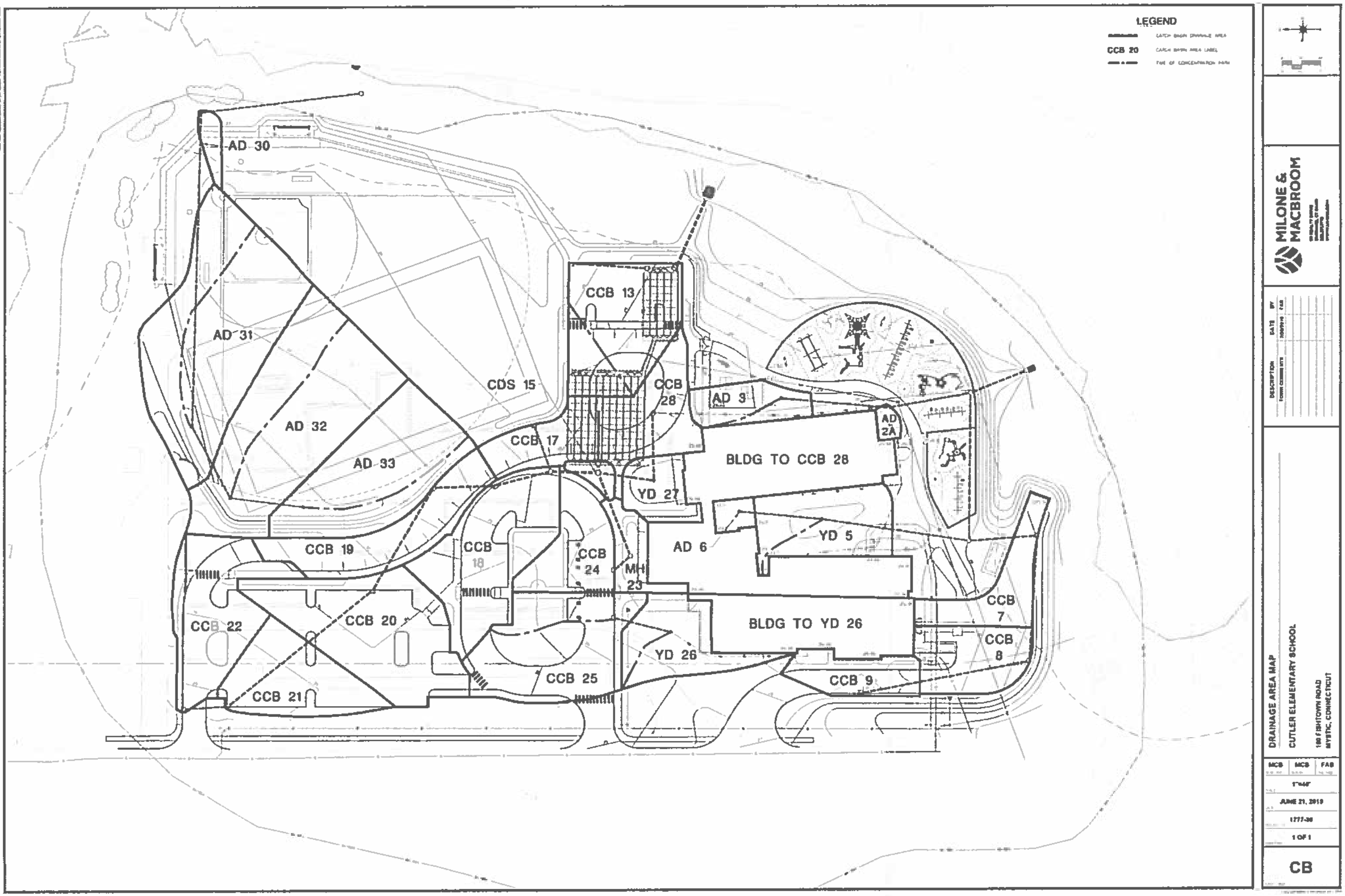
Based on **Table 11.13.1**, A *Preformed Scour Hole* is used *One Half Pipe Rise Depression (Type I)*

Rip Rap Stone Size:

D_{50} Computed (ft)	Rip Rap Specification	D_{50} Stone Size Required
0.10	Modified	5 inches

Preformed Scour Hole Dimensions:

$F = 0.5(R_p)$	=	1 ft
$C = 3.0(S_p)+6.0(F)$	=	12ft
$B = 2.0(S_p)+6.0(F)$	=	10ft
d (Depth of Stone)	=	12 inches



LEGEND
CCB 20
AD 30
AD 31
AD 32
AD 33
CDS 15
CCB 13
CCB 28
AD 3
AD 2A
BLDG TO CCB 28
CCB 17
YD 27
AD 6
YD 5
CCB 19
CCB 18
CCB 24
MH 23
CCB 20
CCB 22
CCB 21
CCB 25
YD 26
BLDG TO YD 26
CCB 7
CCB 8
CCB 9
MILONE & MACBROOM
DESCRIPTION
DATE
BY
TOWN COMMENTS
FAB
DRAINAGE AREA MAP
CUTLER ELEMENTARY SCHOOL
MYSTIC, CONNECTICUT
MCB
MCB
FAB
JUNE 21, 2019
1 OF 1
CB

APPENDIX F
WATER QUALITY COMPUTATIONS

STORMWATER QUALITY CALCULATIONS:
Groundwater Recharge Volume (GRV)

Area ID	Total Site Area (ac.)	Pr Impervious Area (ac.)	Percent Impervious	Recharge Depth[1], D (in.)	GRV (ac-ft)	Total Volume Provided[2] (ac-ft)
Development Area *	17.15	5.02	29.3%	0.25	0.105	*0.196*

* Development Area consists of the total area of Proposed WS 10, WS 20, WS 30, WS 31 and WS 32

1. - Depth of Runoff to be Recharged or Recharge Depth taken from Table 7-4 found on page 7-6 of the CT DEP Stormwater Quality Manual.

2. - Groundwater recharge volume is provided within the bottom stone and lower section of the galleries below the 10" low flow orifices.

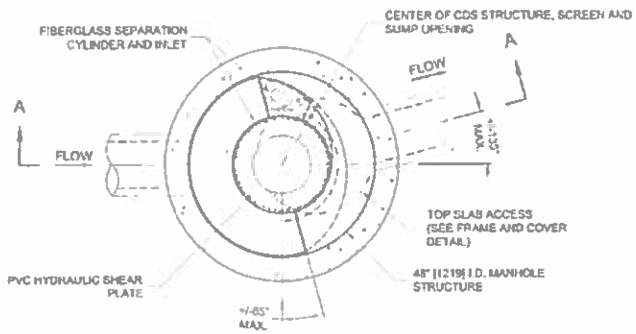
$$GRV = \frac{D \times A \times I}{12}$$

Where: GRV = Groundwater Recharge Volume in acre-feet

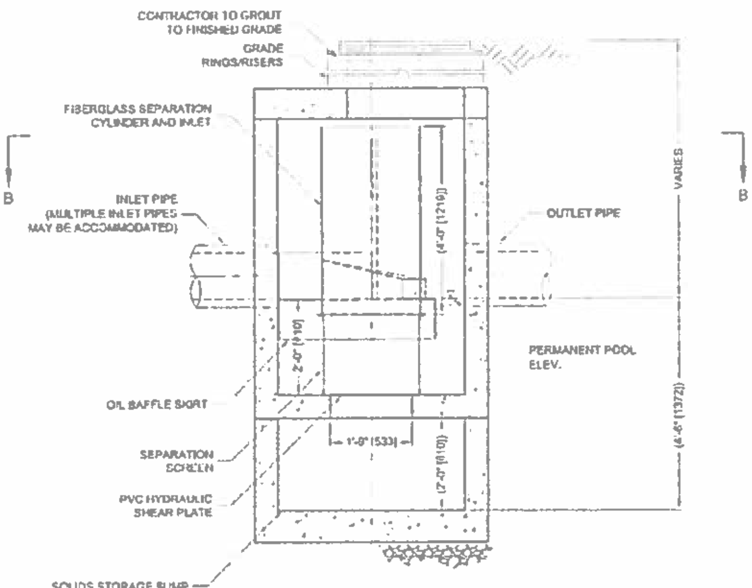
D = Depth of Runoff to be Recharged in inches

A = Contributing Area in acres (B soil)

I = Site Imperviousness as decimal



PLAN VIEW B-B
N.T.S.

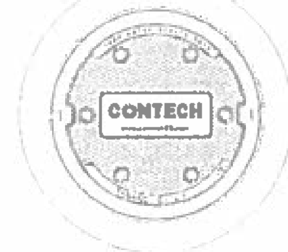


ELEVATION A-A
N.T.S.

CDS2015-4-C DESIGN NOTES

THE STANDARD CDS2015-4-C CONFIGURATION IS SHOWN. ALTERNATE CONFIGURATIONS ARE AVAILABLE AND ARE LISTED BELOW. SOME CONFIGURATIONS MAY BE COMBINED TO SUIT SITE REQUIREMENTS.

CONFIGURATION DESCRIPTION
GRATED INLET ONLY (NO INLET PIPE)
GRATED INLET WITH INLET PIPE OR PIPES
CURB INLET ONLY (NO INLET PIPE)
CURB INLET WITH INLET PIPE OR PIPES
SEPARATE OIL BAFFLE (SINGLE INLET PIPE REQUIRED FOR THIS CONFIGURATION)
SEDIMENT WEIR FOR NJDEP / NJCAT CONFORMING UNITS



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

SITE SPECIFIC DATA REQUIREMENTS

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

* PER ENGINEER OF RECORD

GENERAL NOTES
1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. DIMENSIONS MARKED WITH ( ) ARE REFERENCE DIMENSIONS. ACTUAL DIMENSIONS MAY VARY.
3. FOR FABRICATION DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHTS, PLEASE CONTACT YOUR CONTECH ENGINEERED SOLUTIONS LLC REPRESENTATIVE. www.contechES.com
4. CDS WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING.
5. STRUCTURE SHALL MEET AASHTO HS20 AND CASTINGS SHALL MEET HS20 (AASHTO M 306) LOAD RATING, ASSUMING GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION.
6. PVC HYDRAULIC SHEAR PLATE IS PLACED ON SHELF AT BOTTOM OF SCREEN CYLINDER. REMOVE AND REPLACE AS NECESSARY DURING MAINTENANCE CLEANING.

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

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

CDS2015-4-C
INLINE CDS
STANDARD DETAIL

	MILONE AND MACBROOM, INC.	Project	**1777-38**
	COMPUTATION SHEET - WATER QUALITY FLOW (WQF)	Made By:	MCB
Subject:	**Cutler Elementary School**	Date:	6/21/2019
	160 Fishtown Road, Mystic, CT	Chkd by:	
		Date:	

CDS Unit (MH 2)

Contributing Basins	Imperv. Area (acres)	Total Area (acres)
Total	0.44	0.81

Table 4.1: WQV = $(P)(R_v)(A)/12$ = 0.036 acre-feet

Where:

I = % of Impervious Cover = 54%

R_v = volumetric runoff coeff. 0.05 + 0.009(I) = 0.539

P = design precipitation (1.0" for water quality storm) = 1 inch

A = site area (acres) = 0.81 acres = 0.0013 miles^2

Q = runoff depth (in watershed inches) = [WQV(acrefeet)]*[12(inches/foot)]/drainage area (acres)

Q = 0.539

CN = $1000 / [10+ 5P + 10Q -10(Q^2 + 1.25QP)^{0.5}]$ = 95

Where:

Q = runoff depth (in watershed inches)

t_c = 0.241 hours

Type III Rainfall Distribution:

From Table 4-1, Ia = 0.105 Ia/P = 0.105

(TR-55)

From Exhibit 4-III, q_u = 525 csm/in.

(TR-55)

WQF = (qu)(A)(Q) = 0.36 cfs

CONTECH ENGINEERED SOLUTIONS

CDS

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

NORTH HAVEN
CT

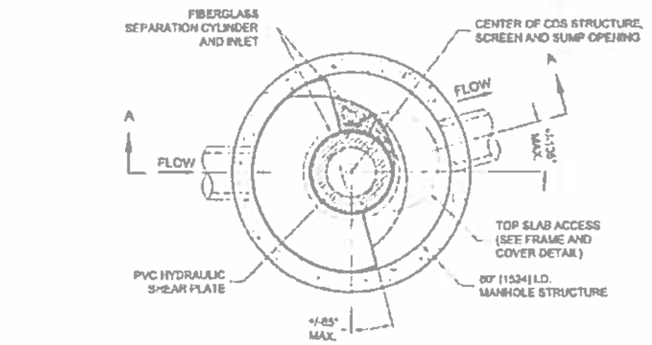
Area	0.81 ac	Unit Site Designation	MH 2
Weighted C	0.63	Rainfall Station #	35
t_c	14 min		
CDS Model	2015-4	CDS Treatment Capacity	1.4 cfs

Rainfall Intensity[1] (in/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (cfs)	Treated Flowrate (cfs)	Incremental Removal (%)
0.08	41.6%	41.6%	0.04	0.04	39.7
0.16	21.0%	62.6%	0.08	0.08	19.6
0.24	11.1%	73.7%	0.12	0.12	10.1
0.32	6.6%	80.3%	0.16	0.16	5.9
0.40	3.6%	83.9%	0.20	0.20	3.2
0.48	2.5%	86.4%	0.24	0.24	2.1
0.56	1.8%	88.2%	0.28	0.28	1.5
0.64	1.1%	89.3%	0.32	0.32	0.9
0.72	1.4%	90.7%	0.37	0.37	1.1
0.80	1.5%	92.1%	0.41	0.41	1.1
1.00	1.7%	93.9%	0.51	0.51	1.2
1.20	1.4%	95.2%	0.61	0.61	0.9
1.40	1.4%	96.7%	0.71	0.71	0.9
1.60	0.6%	97.3%	0.81	0.81	0.3
1.80	0.7%	97.9%	0.91	0.91	0.4
2.00	0.4%	98.3%	1.01	1.01	0.2
3.00	1.3%	99.6%	1.52	1.40	0.4
4.00	0.4%	100.0%	2.03	1.40	0.1
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
					89.5

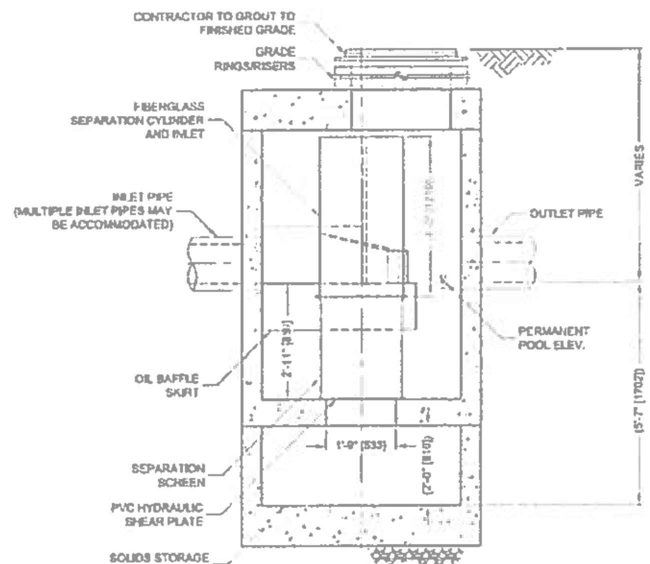
Removal Efficiency Adjustment[2] =	0.0%
Predicted % Annual Rainfall Treated =	99.8%
Predicted Net Annual Load Removal Efficiency =	**89.5%**

1 - Based on 14 years of 15-minute precipitation data from NCDC station 5445, Norfolk 2 SW, Litchfield County, CT

2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.



PLAN VIEW B-B
N.T.S.

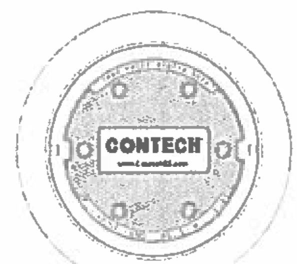


ELEVATION A-A
N.T.S.

CDS2025-5-C DESIGN NOTES

THE STANDARD CDS2025-5-C CONFIGURATION IS SHOWN. ALTERNATE CONFIGURATIONS ARE AVAILABLE AND ARE LISTED BELOW. SOME CONFIGURATIONS MAY BE COMBINED TO SUIT SITE REQUIREMENTS.

CONFIGURATION DESCRIPTION
GRATED INLET ONLY (NO INLET PIPE)
GRATED INLET WITH INLET PIPE OR PIPES
CURB INLET ONLY (NO INLET PIPE)
CURB INLET WITH INLET PIPE OR PIPES
SEPARATE OIL BAFFLE (SINGLE INLET PIPE REQUIRED FOR THIS CONFIGURATION)
SEDIMENT WEIR FOR NJDEP / NJCAT CONFORMING UNITS



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

SITE SPECIFIC DATA REQUIREMENTS

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

* PER ENGINEER OF RECORD

GENERAL NOTES
1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. DIMENSIONS MARKED WITH ( ) ARE REFERENCE DIMENSIONS. ACTUAL DIMENSIONS MAY VARY.
3. FOR FABRICATION DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHTS, PLEASE CONTACT YOUR CONTECH ENGINEERED SOLUTIONS LLC REPRESENTATIVE. www.ContechES.com
4. CDS WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING.
5. STRUCTURE SHALL MEET AASHTO HS20 AND CASTINGS SHALL MEET HS20 (AASHTO M 306) LOAD RATING, ASSUMING GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION.
6. PVC HYDRAULIC SHEAR PLATE IS PLACED ON SHELF AT BOTTOM OF SCREEN CYLINDER. REMOVE AND REPLACE AS NECESSARY DURING MAINTENANCE CLEANING.

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

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

CDS2025-5-C
INLINE CDS
STANDARD DETAIL

	MILONE AND MACBROOM, INC.	Project	**1777-38**
	COMPUTATION SHEET - WATER QUALITY FLOW (WQF)	Made By:	MCB
Subject:	**Cutler Elementary School**	Date:	6/21/2019
	160 Fishtown Road, Mystic, CT	Chkd by:	
		Date:	

CDS Unit (MH 18)

Contributing Basins	Imperv. Area (acres)	Total Area (acres)
Total	3.26	4.27

Table 4.1: WQV = $(P)(R_v)(A)/12$ = 0.262 acre-feet

Where:

I = % of Impervious Cover = 76%

R_v = volumetric runoff coeff. 0.05 + 0.009(I) = 0.737

P = design precipitation (1.0" for water quality storm) = 1 inch

A = site area (acres) = 4.27 acres = 0.0067 $miles^2$

Q = runoff depth (in watershed inches) = [WQV(acrefeet)]*[12(inches/foot)]/drainage area (acres)

Q = 0.737

CN = $1000 / [10+ 5P + 10Q -10(Q^2 + 1.25QP)^{0.5}]$ = 97

Where:

Q = runoff depth (in watershed inches)

t_c = 0.276 hours

Type III Rainfall Distribution:

From Table 4-1, Ia = 0.062 Ia/P = 0.062

(TR-55)

From Exhibit 4-III, q_u = 550 csm/in.

(TR-55)

WQF = (qu)(A)(Q) = 2.71 cfs

CONTECH ENGINEERED SOLUTIONS

CDS

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

NORTH HAVEN
CT

Area	4.27 ac	Unit Site Designation	MH 18
Weighted C	0.76	Rainfall Station #	35
t_c	17 min		
CDS Model	2025-5	CDS Treatment Capacity	3.2 cfs

Rainfall Intensity[1] (in/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (cfs)	Treated Flowrate (cfs)	Incremental Removal (%)
0.08	41.6%	41.6%	0.26	0.26	39.6
0.16	21.0%	62.6%	0.52	0.52	18.8
0.24	11.1%	73.7%	0.78	0.78	9.3
0.32	6.6%	80.3%	1.04	1.04	5.2
0.40	3.6%	83.9%	1.29	1.29	2.7
0.48	2.5%	86.4%	1.55	1.55	1.7
0.56	1.8%	88.2%	1.81	1.81	1.1
0.64	1.1%	89.3%	2.07	2.07	0.6
0.72	1.4%	90.7%	2.33	2.33	0.7
0.80	1.5%	92.1%	2.59	2.59	0.7
1.00	1.7%	93.9%	3.24	3.20	0.6
1.20	1.4%	95.2%	3.88	3.20	0.4
1.40	1.4%	96.7%	4.53	3.20	0.3
1.60	0.6%	97.3%	5.18	3.20	0.1
1.80	0.7%	97.9%	5.83	3.20	0.1
2.00	0.4%	98.3%	6.47	3.20	0.1
3.00	1.3%	99.6%	9.71	3.20	0.1
4.00	0.4%	100.0%	12.95	3.20	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
					82.2

Removal Efficiency Adjustment[2] = 0.0%

Predicted % Annual Rainfall Treated = 97.4%

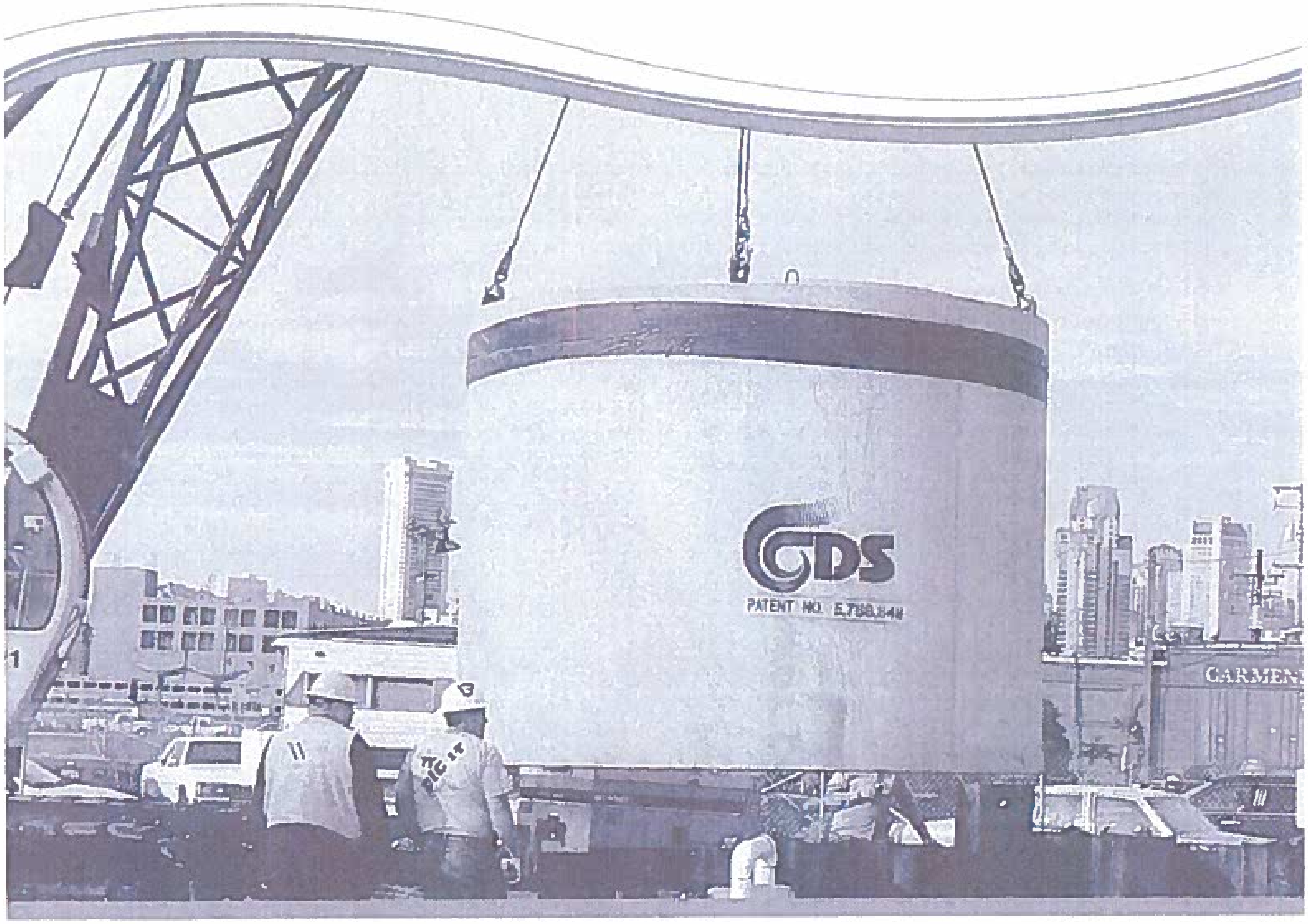
Predicted Net Annual Load Removal Efficiency = 82.2%

1 - Based on 14 years of 15-minute precipitation data from NCDC station 5445, Norfolk 2 SW, Litchfield County, CT

2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.

CONTECH
ENGINEERED SOLUTIONS

CDS Guide
Operation, Design, Performance and Maintenance



CDS®

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

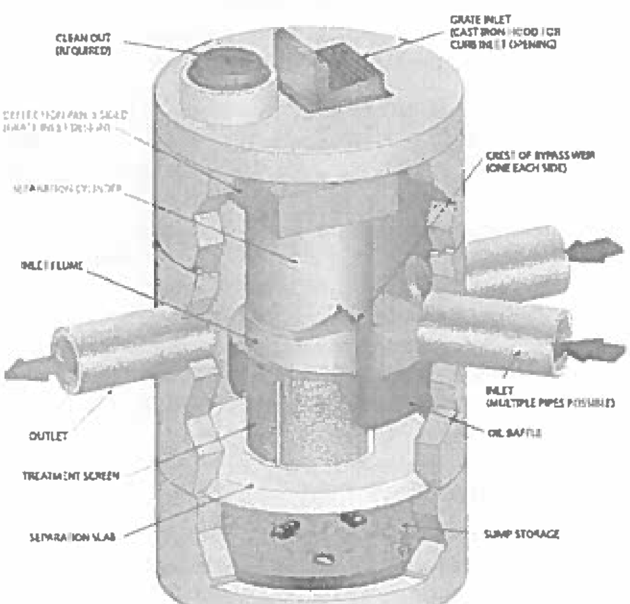
Operation Overview

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

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

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

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



Design Basics

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

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

Water Quality Flow Rate Method

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

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

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

Rational Rainfall Method™

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

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

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

Probabilistic Rational Method

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

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

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

Treatment Flow Rate

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

Hydraulic Capacity

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

Performance

Full-Scale Laboratory Test Results

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

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

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

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

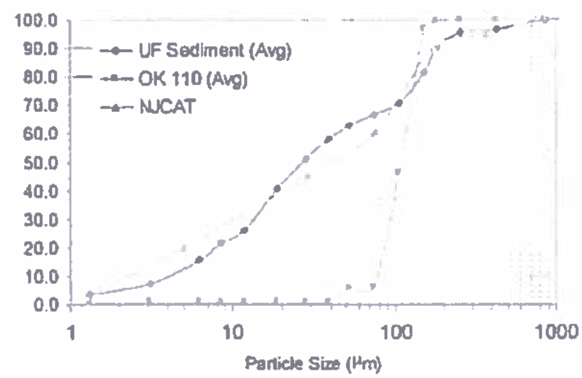


Figure 1 Particle size distributions

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

Results and Modeling

Based on the data from the University of Florida, a performance model was developed for the CDS system. A regression analysis was used to develop a fitting curve representative of the scattered data points at various design flow rates. This model, which demonstrated good agreement with the laboratory data, can then be used to predict CDS system performance with respect to SSC removal for any particle size gradation, assuming the particles are inorganic sandy-silt. Figure 2 shows CDS predictive performance for two typical particle size gradations (NJCAT gradation and OK-110 sand) as a function of operating rate.

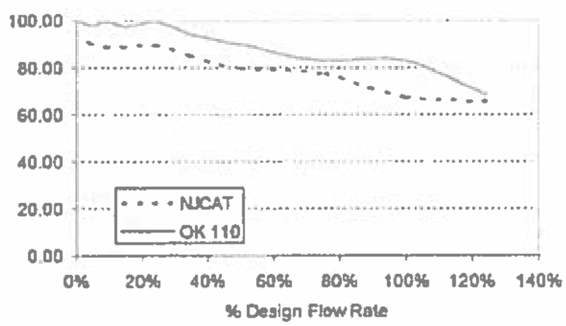


Figure 2. CDS stormwater treatment predictive performance for various particle gradations as a function of operating rate.

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

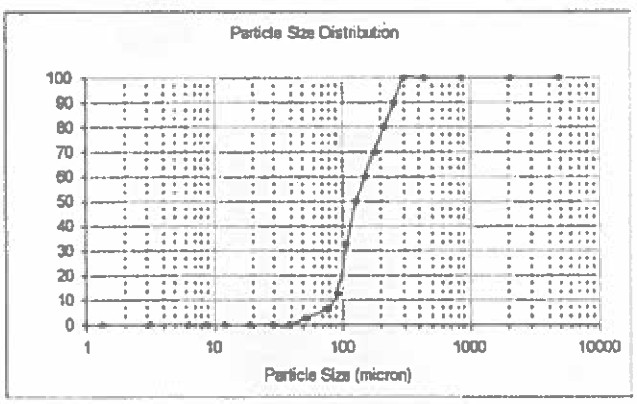


Figure 3. WASDOE PSD

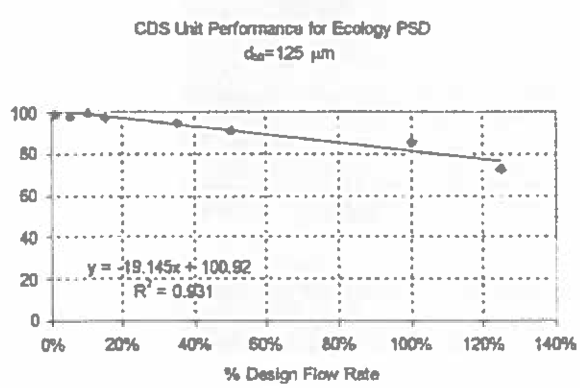


Figure 4. Modeled performance for WASDOE PSD.

Maintenance

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

Inspection

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

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

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

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

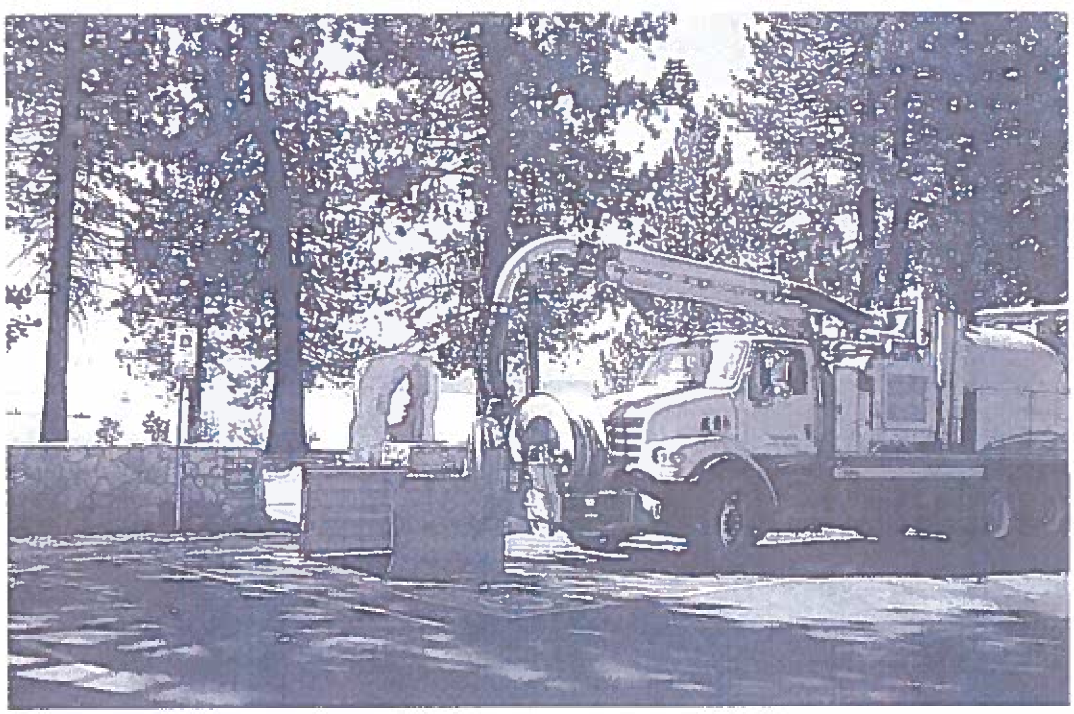
The CDS system should be cleaned when the level of sediment has reached 75% of capacity in the isolated sump or when an appreciable level of hydrocarbons and trash has accumulated. If absorbent material is used, it should be replaced when significant discoloration has occurred. Performance will not be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

Cleaning

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

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

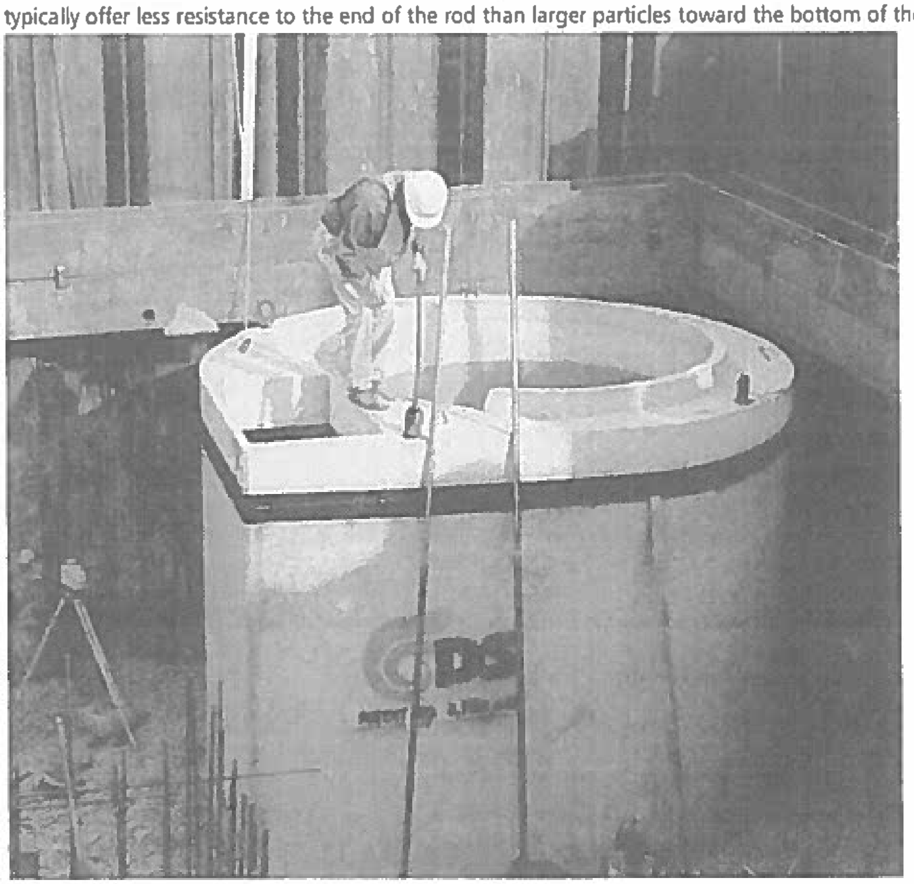
Manhole covers should be securely seated following cleaning activities to prevent leakage of runoff into the system from above and also to ensure that proper safety precautions have been followed. Confined space entry procedures need to be followed if physical access is required. Disposal of all material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



CDS Model	Diameter		Distance from Water Surface to Top of Sediment Pile		Sediment Storage Capacity	
	ft	m	ft	m	y³	m³
CDS1515	3	0.9	3.0	0.9	0.5	0.4
CDS2015	4	1.2	3.0	0.9	0.9	0.7
CDS2015	5	1.5	3.0	0.9	1.3	1.0
CDS2020	5	1.5	3.5	1.1	1.3	1.0
CDS2025	5	1.5	4.0	1.2	1.3	1.0
CDS3020	6	1.8	4.0	1.2	2.1	1.6
CDS3025	6	1.8	4.0	1.2	2.1	1.6
CDS3030	6	1.8	4.6	1.4	2.1	1.6
CDS3035	6	1.8	5.0	1.5	2.1	1.6
CDS4030	8	2.4	4.6	1.4	5.6	4.3
CDS4040	8	2.4	5.7	1.7	5.6	4.3
CDS4045	8	2.4	6.2	1.9	5.6	4.3
CDS5640	10	3.0	6.3	1.9	8.7	6.7
CDS5653	10	3.0	7.7	2.3	8.7	6.7
CDS5668	10	3.0	9.3	2.8	8.7	6.7
CDS5678	10	3.0	10.3	3.1	8.7	6.7

Table 1: CDS Maintenance Indicators and Sediment Storage Capacities

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



CDS Inspection & Maintenance Log

CDS Model: ______________________ Location: ______________________

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

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

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

APPENDIX G

HYDROLOGIC ANALYSIS – INPUT COMPUTATIONS

Worksheet 2: Runoff curve number and runoff

Project: Cutler Elementary School
Location: 160 Fishtown Road, Mystic, CT
Circle one: ***Present*** Developed

By: FAB
Checked:
Watershed: WS 10 - Existing Conditions

Date: 06/21/19
Date:

1.) Runoff curve number (CN)

Soil Name and Hydrologic Group (appendix A)	Cover Description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN Value [1.] Table 2-2	CN Value [1.] Figure 2-3	CN Value [1.] Figure 2-4	Area (Acres) Sq. Ft. %	Product of CN x Area
B soil	Open space - good condition	61			0.60	36.57
N/A	Paved / Impervious cover	98			0.42	41.63
N/A	Existing building	98			0.04	4.36
				Totals =	1.07	82.56

[1.] Use only one CN value source per line.

(0.00167 sq mi)

CN (weighted) = total product / total area = 82.56 / 1.07

Use CN = 77

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Worksheet 2: Runoff curve number and runoff

Project:	Cutler Elementary School	By:	FAB	Date:	06/21/19
Location:	160 Fishtown Road, Mystic, CT	Checked:		Date:	
Circle one:	***Present*** Developed	Watershed:	WS 20 - Existing Conditions		

1.) Runoff curve number (CN)

Soil Name and Hydrologic Group (appendix A)	Cover Description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN Value [1.] Table 2-2	Figure 2-3	Figure 2-4	Area (Acres) Sq. Ft. %	Product of CN x Area
B soil	Woods - good condition	55			1.98	108.83
B soil	Open space - good condition	61			0.97	59.08
B soil	Gravel	85			0.12	10.59
N/A	Paved / Impervious cover	98			0.96	93.85
N/A	Existing building	98			0.01	1.17
				Totals =	4.04	273.52
					(0.00631	sq mi)

[1.] Use only one CN value source per line.

CN (weighted) = $\frac{\text{total product}}{\text{total area}}$ = $\frac{273.52}{4.04}$ Use CN = **68**

Worksheet 2: Runoff curve number and runoff

Project: Cutler Elementary School By: FAB Date: 06/21/19
Location: 160 Fishtown Road, Mystic, CT Checked: ______ Date: ______
Circle one: ***Present*** Developed Watershed: WS 30 - Existing Conditions

1.) Runoff curve number (CN)

Soil Name and Hydrologic Group (appendix A)	Cover Description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN Value [1.]			Area (Acres) Sq. Ft. %	Product of CN x Area
		Table 2-2	Figure 2-3	Figure 2-4		
B soil	Woods - good condition	55			0.05	2.84
B soil	Open space - good condition	61			6.49	396.04
B soil	Bare soil, no vegetation	86			0.51	44.11
C soil	Open space - good condition	74			0.32	23.61
C soil	Bare soil, no vegetation	91			0.01	1.11
D soil	Woods - good condition	77			0.82	63.34
D soil	Open space - good condition	80			0.80	64.35
N/A	Paved / Impervious cover	98			1.20	118.06
N/A	Existing building	98			1.82	178.73
					Totals = 12.04	892.18

[1.] Use only one CN value source per line.

(0.01882 sq mi)

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{892.18}{12.04}$ Use CN = **74**

Worksheet 2: Runoff curve number and runoff

Project: Cutler Elementary School | By: MCB | Date: 06/21/19
Location: 160 Fishtown Road, Mystic, CT | Checked: | Date:
Circle one: Present ***Developed*** | Watershed: WS 10 - Proposed Conditions

1.) Runoff curve number (CN)

Soil Name and Hydrologic Group (appendix A)	Cover Description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN Value [1.]			Area (Acres) Sq. Ft. %	Product of CN x Area
		Table 2-2	Figure 2-3	Figure 2-4		
B soil	Open space - good condition	61			0.26	15.57
N/A	Paved/Impervious	98			0.08	7.66
				Totals =	0.33	23.23

[1.] Use only one CN value source per line.

(0.00052 sq mi)

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{23.23}{0.33}$ Use CN = **70**

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Worksheet 2: Runoff curve number and runoff

Project:	Cutler Elementary School	By:	MCB	Date:	06/21/19
Location:	160 Fishtown Road, Mystic, CT	Checked:		Date:	
Circle one:	Present ***Developed***	Watershed:	WS 20 - Proposed Conditions		

1.) Runoff curve number (CN)

Soil Name and Hydrologic Group (appendix A)	Cover Description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN Value [1.]			Area (Acres) Sq. Ft. %	Product of CN x Area
		Table 2-2	Figure 2-3	Figure 2-4		
B soil	Woods - good condition	55			1.99	109.47
B soil	Open space - good condition	61			1.27	77.50
N/A	Paved/Impervious	98			0.03	3.24
				Totals =	3.29	190.20
					(0.00515	sq mi)

1. Use only one CN value source per line.

CN (weighted) = total product / total area = 190.20 / 3.29

Use CN = **58**

Worksheet 2: Runoff curve number and runoff

Project:	Cutler Elementary School	By:	MCB	Date:	06/21/19
Location:	160 Fishtown Road, Mystic, CT	Checked:		Date:	
Circle one:	Present ***Developed***	Watershed:	WS 30 - Proposed Conditions		

1.) Runoff curve number (CN)

Soil Name and Hydrologic Group (appendix A)	Cover Description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN Value [1.] Table 2-2	CN Value [1.] Figure 2-3	CN Value [1.] Figure 2-4	Area (Acres) Sq. Ft. %	Product of CN x Area
B soil	Woods - good condition	55			0.05	2.79
B soil	Open space - good condition	61			3.94	240.35
B soil	Bare soil, no vegetation	86			0.03	2.20
C soil	Open space - good condition	74			0.29	21.74
D soil	Woods - good condition	77			0.82	63.32
D soil	Open space - good condition	80			0.85	67.85
N/A	Paved/Impervious	98			1.65	161.41
					Totals = 7.63	559.66

(0.01192 sq mi)

[1.] Use only one CN value source per line.

$$\text{CN (weighted)} = \frac{\text{total product}}{\text{total area}} = \frac{559.66}{7.63}$$

Use CN = **73**

Worksheet 2: Runoff curve number and runoff

Project: Cutler Elementary School — By: MCB — Date: 06/21/19
Location: 160 Fishtown Road, Mystic, CT — Checked: ______ — Date: ______
Circle one: Present ***Developed*** — Watershed: WS 31 - Proposed Conditions

1.) Runoff curve number (CN)

Soil Name and Hydrologic Group (appendix A)	Cover Description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN Value [1.]			Area (Acres) Sq. Ft. %	Product of CN x Area
		Table 2-2	Figure 2-3	Figure 2-4		
B soil	Open space - good condition	61			0.95	57.70
N/A	Proposed Building	98			0.97	95.22
N/A	Paved/Impervious	98			2.29	224.60
				Totals =	4.21	377.52

[1.] Use only one CN value source per line.

(0.00658 sq mi)

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{377.52}{4.21}$ Use CN = **90**

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Worksheet 2: Runoff curve number and runoff

Project: Cutler Elementary School | By: MCB | Date: 06/21/19
Location: 160 Fishtown Road, Mystic, CT | Checked: | Date:
Circle one: Present *Developed* | Watershed: WS 32 - Proposed Conditions

1.) Runoff curve number (CN)

Soil Name and Hydrologic Group (appendix A)	Cover Description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN Value[1.] Table 2-2	CN Value[1.] Figure 2-3	CN Value[1.] Figure 2-4	Area (Acres) Sq. Ft. %	Product of CN x Area
B soil	Open space - good condition	61			1.66	101.22
B soil	Bare soil, no vegetation	86			0.03	2.59
				Totals =	1.69	103.81

(0.00264 sq mi)

[1.] Use only one CN value source per line.

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{103.81}{1.69}$ Use CN = **61**

Time of Concentration (T_c) or Travel Time (T_t) Worksheet

Project: Cutler Elementary School — By: MCB — Date: 06/21/19
Location: 160 Fishtown Road, Mystic, CT — Checked: FAB — Date: 06/21/19
Circle one: ***Present*** Developed — Watershed: WS 10 - Existing Conditions
Circle one: ***T_c*** T_t — Subwatershed:

Sheet flow (applicable to T_c only)

	Units	Segment ID A-B	
1. Surface description (Table 3-1)		GRASS	
2. Manning's roughness coeff. for sheet flow, n (Table 3-1)		0.240	
3. Flow Length, L (< 300ft)	ft.	90.0	
4. Two-year 24-hr rainfall, P_2	in.	3.43	
5. Land slope, s	ft./ft.	0.030	
6. $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5}(s^{0.4})}$	hr.	0.180	= 0.180

Shallow concentrated flow (assume hyd. radius = depth of flow)

	Units	Segment ID B-C				
7. Surface description		BIT				
8. Manning's roughness coeff., n		0.015				
9. Paved or unpaved		PVD				
10. Depth of flow, d (default values: d=.4 unpaved, d=.2 paved)	ft.	0.20				
11. Flow Length, L	ft.	60.0				
12. Watercourse slope, s	ft./ft.	0.016				
13. Average velocity, $V = \frac{1.49}{n}(d^{2/3})(s^{1/2})$	fps.	4.30				
14. $T_t = \frac{L}{3600 * V}$	hr.	0.004	+	+	+	= 0.004

Channel flow

	Units	Segment ID				
15. Channel Bottom width, b	ft.					
16. Horizontal side slope component, z (z horiz:1 vert)	ft.					
17. Depth of flow, d	ft.					
18. Cross sectional flow area, A (assume trapazoidal)	$ft.^2$					
19. Wetted perimeter, P_w	ft.					
20. Hydraulic Radius, $R = \frac{A}{P_w}$	ft.					
21. Channel slope, s	ft./ft.					
22. Manning's roughness coeff., n						
23. $V = \frac{1.49}{n}(R^{2/3})(s^{1/2})$	fps.					
24. Flow length, L	ft.					
25. $T_t = \frac{L}{3600 * V}$	hr		+	+	+	= 0.000

26. Watershed or subarea T_c or T_t (add T_t in steps 6, 14 & 25) — hr. 0.183

Time of Concentration (T_c) or Travel Time (T_t) Worksheet

Project: Cutler Elementary School | By: MCB | Date: 06/21/19

Location: 160 Fishtown Road, Mystic, CT | Checked: FAB | Date: 06/21/19

Circle one: ***Present*** Developed | Watershed: WS 20 - Existing Conditions

Circle one: ***T_c*** T_t | Subwatershed:

Sheet flow (applicable to T_c only)

	Units	Segment ID: A-B		Total
1. Surface description (Table 3-1)		WOODS		
2. Manning's roughness coeff. for sheet flow, n (Table 3-1)		0.400		
3. Flow Length, L (< 300ft)	ft.	100.0		
4. Two-year 24-hr rainfall, P_2	in.	3.43		
5. Land slope, s	ft./ft.	0.020		
6. $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5}(s^{0.4})}$	hr.	0.346	=	0.346

Shallow concentrated flow (assume hyd. radius = depth of flow)

	Units	Segment ID: B-C								Total
7. Surface description		WOODS								
8. Manning's roughness coeff., n		0.100								
9. Paved or unpaved		UNPVD								
10. Depth of flow, d (default values: d=.4 unpaved, d=.2 paved)	ft.	0.40								
11. Flow Length, L	ft.	190.0								
12. Watercourse slope, s	ft./ft.	0.011								
13. Average velocity, $V = \frac{1.49}{n}(d^{2/3})(s^{1/2})$	fps.	0.85								
14. $T_t = \frac{L}{3600 * V}$	hr.	0.062	+		+		+		=	0.062

Channel flow

	Units	Segment ID								Total
15. Channel Bottom width, b	ft.									
16. Horizontal side slope component, z (z horiz:1 vert)	ft.									
17. Depth of flow, d	ft.									
18. Cross sectional flow area, A (assume trapazoidal)	$ft.^2$									
19. Wetted perimeter, P_w	ft.									
20. Hydraulic Radius, $R = \frac{A}{P_w}$	ft.									
21. Channel slope, s	ft./ft.									
22. Manning's roughness coeff., n										
23. $V = \frac{1.49}{n}(R^{2/3})(s^{1/2})$	fps.									
24. Flow length, L	ft.									
25. $T_t = \frac{L}{3600 * V}$	hr		+		+		+		=	0.000
26. Watershed or subarea T_c or T_t (add T_t in steps 6, 14 & 25)	hr.									0.408

Time of Concentration (T_c) or Travel Time (T_t) Worksheet

Project: Cutler Elementary School | By: MCB | Date: 06/21/19

Location: 160 Fishtown Road, Mystic, CT | Checked: FAB | Date: 06/21/19

Circle one: **Present** Developed | Watershed: WS 30 - Existing Conditions

Circle one: **T_c** T_t | Subwatershed:

Sheet flow (applicable to T_c only)

Segment ID		A-B	
1. Surface description (Table 3-1)		GRASS	
2. Manning's roughness coeff. for sheet flow, n (Table 3-1)		0.240	
3. Flow Length, L (< 300ft)	ft.	100.0	
4. Two-year 24-hr rainfall, P_2	in.	3.43	
5. Land slope, s	ft./ft.	0.030	
6. $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5}(s^{0.4})}$	hr.	0.195	= 0.195

Shallow concentrated flow (assume hyd. radius = depth of flow)

Segment ID		B-C	C-D			
7. Surface description		GRASS	WOODS			
8. Manning's roughness coeff., n		0.080	0.100			
9. Paved or unpaved		UNPVD	UNPVD			
10. Depth of flow, d (default values: d=.4 unpaved, d=.2 paved)	ft.	0.40	0.40			
11. Flow Length, L	ft.	390.0	35.0			
12. Watercourse slope, s	ft./ft.	0.015	0.060			
13. Average velocity, $V = \frac{1.49}{n}(d^{2/3})(s^{1/2})$	fps.	1.24	1.98			
14. $T_t = \frac{L}{3600 * V}$	hr.	0.087	+ 0.005	+	+	= 0.092

Channel flow

Segment ID						
15. Channel Bottom width, b	ft.					
16. Horizontal side slope component, z (z horiz:1 vert)	ft.					
17. Depth of flow, d	ft.					
18. Cross sectional flow area, A (assume trapazoidal)	$ft.^2$					
19. Wetted perimeter, P_w	ft.					
20. Hydraulic Radius, $R = \frac{A}{P_w}$	ft.					
21. Channel slope, s	ft./ft.					
22. Manning's roughness coeff., n						
23. $V = \frac{1.49}{n}(R^{2/3})(s^{1/2})$	fps.					
24. Flow length, L	ft.					
25. $T_t = \frac{L}{3600 * V}$	hr.		+	+	+	= 0.000
26. Watershed or subarea T_c or T_t (add T_t in steps 6, 14 & 25)					hr.	0.288

Time of Concentration (T_c) or Travel Time (T_t) Worksheet

Project: Cutler Elementary School — By: MCB — Date: 06/21/19
Location: 160 Fishtown Road, Mystic, CT — Checked: FAB — Date: 06/21/19
Circle one: Present **Developed** — Watershed: WS 10 - Proposed Conditions
Circle one: **T_c** T_t — Subwatershed:

Sheet flow (applicable to T_c only)

		Segment ID	A-B		
1.	Surface description (Table 3-1)		GRASS		
2.	Manning's roughness coeff. for sheet flow, n (Table 3-1)		0.240		
3.	Flow Length, L (< 300ft)	ft.	30.0		
4.	Two-year 24-hr rainfall, P_2	in.	3.43		
5.	Land slope, s	ft./ft.	0.020		
6.	$T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5}(s^{0.4})}$	hr.	0.088	=	0.088

Shallow concentrated flow (assume hyd. radius = depth of flow)

		Segment ID	B-C								
7.	Surface description		BIT								
8.	Manning's roughness coeff., n		0.015								
9.	Paved or unpaved		PVD								
10.	Depth of flow, d (default values: d=.4 unpaved, d=.2 paved)	ft.	0.20								
11.	Flow Length, L	ft.	15.0								
12.	Watercourse slope, s	ft./ft.	0.020								
13.	Average velocity, $V = \frac{1.49}{n}(d^{2/3})(s^{1/2})$	fps.	4.80								
14.	$T_t = \frac{L}{3600 * V}$	hr.	0.001	+		+		+		=	0.001

Channel flow

		Segment ID									
15.	Channel Bottom width, b	ft.									
16.	Horizontal side slope component, z (z horiz:1 vert)	ft.									
17.	Depth of flow, d	ft.									
18.	Cross sectional flow area, A (assume trapazoidal)	$ft.^2$									
19.	Wetted perimeter, P_w	ft.									
20.	Hydraulic Radius, $R = \frac{A}{P_w}$	ft.									
21.	Channel slope, s	ft./ft.									
22.	Manning's roughness coeff., n										
23.	$V = \frac{1.49}{n}(R^{2/3})(s^{1/2})$	fps.									
24.	Flow length, L	ft.									
25.	$T_t = \frac{L}{3600 * V}$	hr.		+		+		+		=	0.000

26. Watershed or subarea T_c or T_t (add T_t in steps 6, 14 & 25) — hr. ~~0.089~~

Tc min = 0.1 hr.

Time of Concentration (T_c) or Travel Time (T_t) Worksheet

Project: Cutler Elementary School — By: MCB — Date: 06/21/19

Location: 160 Fishtown Road, Mystic, CT — Checked: FAB — Date: 06/21/19

Circle one: Present ***Developed*** — Watershed: WS 20 - Proposed Conditions

Circle one: ***T_c*** T_t — Subwatershed:

Sheet flow (applicable to T_c only)

	Units		
Segment ID		A-B	
1. Surface description (Table 3-1)		WOODS	
2. Manning's roughness coeff. for sheet flow, n (Table 3-1)		0.400	
3. Flow Length, L (< 300ft)	ft.	100.0	
4. Two-year 24-hr rainfall, P_2	in.	3.43	
5. Land slope, s	ft./ft.	0.020	
6. $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5}(s^{0.4})}$	hr.	0.346	= 0.346

Shallow concentrated flow (assume hyd. radius = depth of flow)

	Units					
Segment ID		B-C				
7. Surface description		WOODS				
8. Manning's roughness coeff., n		0.100				
9. Paved or unpaved		UNPVD				
10. Depth of flow, d (default values: d=.4 unpaved, d=.2 paved)	ft.	0.40				
11. Flow Length, L	ft.	190.0				
12. Watercourse slope, s	ft./ft.	0.011				
13. Average velocity, $V = \frac{1.49}{n}(d^{2/3})(s^{1/2})$	fps.	0.85				
14. $T_t = \frac{L}{3600 * V}$	hr.	0.062	+	+	+	= 0.062

Channel flow

	Units					
Segment ID						
15. Channel Bottom width, b	ft.					
16. Horizontal side slope component, z (z horiz:1 vert)	ft.					
17. Depth of flow, d	ft.					
18. Cross sectional flow area, A (assume trapazoidal)	$ft.^2$					
19. Wetted perimeter, P_w	ft.					
20. Hydraulic Radius, $R = \frac{A}{P_w}$	ft.					
21. Channel slope, s	ft./ft.					
22. Manning's roughness coeff., n						
23. $V = \frac{1.49}{n}(R^{2/3})(s^{1/2})$	fps.					
24. Flow length, L	ft.					
25. $T_t = \frac{L}{3600 * V}$	hr.		+	+	+	= 0.000

26. Watershed or subarea T_c or T_t (add T_t in steps 6, 14 & 25) — hr. 0.408

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Time of Concentration (T_c) or Travel Time (T_t) Worksheet

Project: Cutler Elementary School | By: MCB | Date: 06/21/19
Location: 160 Fishtown Road, Mystic, CT | Checked: FAB | Date: 06/21/19
Circle one: Present ***Developed*** | Watershed: WS 30 - Proposed Conditions
Circle one: ***T_c*** T_t | Subwatershed:

Sheet flow (applicable to T_c only)

	Unit	Segment ID: A-B	
1. Surface description (Table 3-1)		GRASS	
2. Manning's roughness coeff. for sheet flow, n (Table 3-1)		0.240	
3. Flow Length, L (< 300ft)	ft.	100.0	
4. Two-year 24-hr rainfall, P_2	in.	3.43	
5. Land slope, s	ft./ft.	0.010	
6. $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5}(s^{0.4})}$	hr.	0.303	= 0.303

Shallow concentrated flow (assume hyd. radius = depth of flow)

	Unit	B-C	C-D	D-E	E-F	
7. Surface description		GRASS	BIT	GRASS	WOODS	
8. Manning's roughness coeff., n		0.080	0.015	0.080	0.100	
9. Paved or unpaved		UNPVD	PVD	UNPVD	UNPVD	
10. Depth of flow, d (default values: d=.4 unpaved, d=.2 paved)	ft.	0.40	0.20	0.40	0.40	
11. Flow Length, L	ft.	115.5	6.0	92.3	24.4	
12. Watercourse slope, s	ft./ft.	0.009	0.009	0.011	0.246	
13. Average velocity, $V = \frac{1.49}{n}(d^{2/3})(s^{1/2})$	fps.	0.96	3.22	1.06	4.01	
14. $T_t = \frac{L}{3600 * V}$	hr.	0.033	+ 0.001	+ 0.024	+ 0.002	= 0.060

Channel flow

	Unit	Segment ID				
15. Channel Bottom width, b	ft.					
16. Horizontal side slope component, z (z horiz:1 vert)	ft.					
17. Depth of flow, d	ft.					
18. Cross sectional flow area, A (assume trapazoidal)	$ft.^2$					
19. Wetted perimeter, P_w	ft.					
20. Hydraulic Radius, $R = \frac{A}{P_w}$	ft.					
21. Channel slope, s	ft./ft.					
22. Manning's roughness coeff., n						
23. $V = \frac{1.49}{n}(R^{2/3})(s^{1/2})$	fps.					
24. Flow length, L	ft.					
25. $T_t = \frac{L}{3600 * V}$	hr				+	= 0.000

26. Watershed or subarea T_c or T_t (add T_t in steps 6, 14 & 25) hr. 0.363

Time of Concentration (T_c) or Travel Time (T_t) Worksheet

Project: Cutler Elementary School | By: MCB | Date: 06/21/19
Location: 160 Fishtown Road, Mystic, CT | Checked: FAB | Date: 06/21/19
Circle one: Present ***Developed*** | Watershed: WS 31 - Proposed Conditions
Circle one: ***T_c*** T_t | Subwatershed:

Sheet flow (applicable to T_c only)

	Units	Segment ID A-B	
1. Surface description (Table 3-1)		GRASS	
2. Manning's roughness coeff. for sheet flow, n (Table 3-1)		0.240	
3. Flow Length, L (< 300ft)	ft.	80.6	
4. Two-year 24-hr rainfall, P_2	in.	3.43	
5. Land slope, s	ft./ft.	0.012	
6. $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5}(s^{0.4})}$	hr.	0.237	= 0.237

Shallow concentrated flow (assume hyd. radius = depth of flow)

	Units	Segment ID				
7. Surface description						
8. Manning's roughness coeff., n						
9. Paved or unpaved						
10. Depth of flow, d (default values: d=.4 unpaved, d=.2 paved)	ft.					
11. Flow Length, L	ft.					
12. Watercourse slope, s	ft./ft.					
13. Average velocity, $V = \frac{1.49}{n}(d^{2/3})(s^{1/2})$	fps.					
14. $T_t = \frac{L}{3600 * V}$	hr.		+	+	+	= 0.000

Channel flow

	Units	Segment ID B-C				
15. Channel Bottom width, b	ft.	12" HDPE				
16. Horizontal side slope component, z (z horiz:1 vert)	ft.	—				
17. Depth of flow, d	ft.	FULL				
18. Cross sectional flow area, A (assume trapazoidal)	$ft.^2$	0.79				
19. Wetted perimeter, P_w	ft.	3.14				
20. Hydraulic Radius, $R = \frac{A}{P_w}$	ft.	0.25				
21. Channel slope, s	ft./ft.	0.008				
22. Manning's roughness coeff., n		0.012				
23. $V = \frac{1.49}{n}(R^{2/3})(s^{1/2})$	fps.	4.51				
24. Flow length, L	ft.	636.1				
25. $T_t = \frac{L}{3600 * V}$	hr.	0.039	+		+	= 0.039
26. Watershed or subarea T_c or T_t (add T_t in steps 6, 14 & 25)	hr.					0.276

Time of Concentration (T_c) or Travel Time (T_t) Worksheet

Project: Cutler Elementary School — By: MCB — Date: 06/21/19
Location: 160 Fishtown Road, Mystic, CT — Checked: FAB — Date: 06/21/19
Circle one: Present ***Developed*** — Watershed: WS 32 - Proposed Conditions
Circle one: ***T_c*** T_t — Subwatershed:

Sheet flow (applicable to T_c only)

	Units	Segment ID A-B		Total
1. Surface description (Table 3-1)		GRASS		
2. Manning's roughness coeff. for sheet flow, n (Table 3-1)		0.240		
3. Flow Length, L (< 300ft)	ft.	100.0		
4. Two-year 24-hr rainfall, P_2	in.	3.43		
5. Land slope, s	ft./ft.	0.007		
6. $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5}(s^{0.4})}$	hr.	0.350	=	0.350

Shallow concentrated flow (assume hyd. radius = depth of flow)

	Units	Segment ID B-C							Total
7. Surface description		GRASS							
8. Manning's roughness coeff., n		0.080							
9. Paved or unpaved		UNPVD							
10. Depth of flow, d (default values: d=.4 unpaved, d=.2 paved)	ft.	0.40							
11. Flow Length, L	ft.	131.7							
12. Watercourse slope, s	ft./ft.	0.008							
13. Average velocity, $V = \frac{1.49}{n}(d^{2/3})(s^{1/2})$	fps.	0.90							
14. $T_t = \frac{L}{3600 * V}$	hr.	0.040	+		+		+		= 0.040

Channel flow

	Units	Segment ID C-D							Total
15. Channel Bottom width, b	ft.	12" HDPE							
16. Horizontal side slope component, z (z horiz:1 vert)	ft.	---							
17. Depth of flow, d	ft.	FULL							
18. Cross sectional flow area, A (assume trapazoidal)	$ft.^2$	0.79							
19. Wetted perimeter, P_w	ft.	3.14							
20. Hydraulic Radius, $R = \frac{A}{P_w}$	ft.	0.25							
21. Channel slope, s	ft./ft.	0.005							
22. Manning's roughness coeff., n		0.012							
23. $V = \frac{1.49}{n}(R^{2/3})(s^{1/2})$	fps.	3.32							
24. Flow length, L	ft.	518.0							
25. $T_t = \frac{L}{3600 * V}$	hr.	0.043	+				+		= 0.043
26. Watershed or subarea T_c or T_t (add T_t in steps 6, 14 & 25)	hr.								0.433

NOAA Atlas 14, Volume 10, Version 2
Location name: Mystic, Connecticut, USA*
Latitude: 41.3474°, Longitude: -71.9979°
Elevation: 29.64 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sandra Pavlovic, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Orlan Wilhite
NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.337 (0.256-0.443)	0.403 (0.306-0.530)	0.511 (0.387-0.674)	0.601 (0.452-0.796)	0.725 (0.531-0.988)	0.820 (0.591-1.13)	0.916 (0.645-1.30)	1.04 (0.698-1.48)	1.21 (0.779-1.75)	1.33 (0.842-1.98)
10-min	0.477 (0.362-0.627)	0.571 (0.433-0.751)	0.724 (0.548-0.955)	0.852 (0.641-1.13)	1.03 (0.753-1.40)	1.16 (0.837-1.61)	1.30 (0.913-1.84)	1.47 (0.985-2.10)	1.71 (1.10-2.49)	1.89 (1.19-2.78)
15-min	0.561 (0.426-0.738)	0.672 (0.509-0.884)	0.852 (0.645-1.12)	1.00 (0.754-1.33)	1.21 (0.886-1.65)	1.37 (0.985-1.89)	1.53 (1.07-2.16)	1.73 (1.16-2.47)	2.01 (1.30-2.92)	2.22 (1.40-3.27)
30-min	0.795 (0.604-1.05)	0.949 (0.720-1.25)	1.20 (0.909-1.59)	1.41 (1.06-1.87)	1.70 (1.25-2.32)	1.92 (1.39-2.66)	2.15 (1.51-3.04)	2.44 (1.63-3.47)	2.83 (1.83-4.11)	3.12 (1.97-4.60)
60-min	1.03 (0.781-1.35)	1.23 (0.931-1.62)	1.55 (1.17-2.05)	1.82 (1.37-2.41)	2.19 (1.61-2.99)	2.48 (1.79-3.42)	2.76 (1.95-3.92)	3.14 (2.10-4.48)	3.64 (2.35-5.30)	4.02 (2.54-5.92)
2-hr	1.35 (1.04-1.75)	1.61 (1.24-2.09)	2.04 (1.56-2.66)	2.39 (1.82-3.13)	2.88 (2.13-3.88)	3.26 (2.37-4.45)	3.64 (2.56-5.10)	4.13 (2.78-5.82)	4.77 (3.10-6.86)	5.26 (3.35-7.69)
3-hr	1.56 (1.21-2.02)	1.87 (1.44-2.41)	2.36 (1.82-3.06)	2.78 (2.13-3.61)	3.34 (2.49-4.47)	3.78 (2.76-5.13)	4.22 (3.01-5.87)	4.78 (3.23-6.71)	5.52 (3.61-7.92)	6.08 (3.89-8.84)
6-hr	1.99 (1.56-2.54)	2.37 (1.85-3.02)	2.99 (2.33-3.83)	3.51 (2.72-4.50)	4.22 (3.16-5.58)	4.77 (3.52-6.40)	5.31 (3.82-7.32)	6.02 (4.10-8.36)	6.94 (4.56-9.88)	7.64 (4.91-11.0)
12-hr	2.46 (1.95-3.10)	2.93 (2.32-3.69)	3.69 (2.91-4.66)	4.32 (3.39-5.47)	5.18 (3.94-6.78)	5.85 (4.37-7.77)	6.52 (4.73-8.90)	7.38 (5.07-10.2)	8.53 (5.64-12.0)	9.39 (6.07-13.4)
24-hr	2.88 (2.31-3.58)	3.43 (2.75-4.28)	4.35 (3.47-5.42)	5.10 (4.05-6.39)	6.14 (4.73-7.95)	6.94 (5.24-9.13)	7.74 (5.69-10.5)	8.82 (6.11-12.0)	10.2 (6.82-14.3)	11.3 (7.37-16.1)
2-day	3.19 (2.59-3.92)	3.84 (3.12-4.72)	4.91 (3.97-6.05)	5.80 (4.68-7.17)	7.02 (5.47-8.99)	7.96 (6.08-10.4)	8.90 (6.62-12.0)	10.2 (7.13-13.8)	12.0 (8.02-16.6)	13.3 (8.69-18.7)
3-day	3.43 (2.81-4.19)	4.13 (3.38-5.04)	5.27 (4.29-6.45)	6.21 (5.03-7.63)	7.51 (5.89-9.57)	8.52 (6.55-11.0)	9.52 (7.12-12.7)	10.9 (7.66-14.7)	12.8 (8.61-17.6)	14.2 (9.32-19.6)
4-day	3.67 (3.02-4.45)	4.39 (3.61-5.33)	5.57 (4.57-6.78)	6.56 (5.34-8.01)	7.91 (6.23-10.0)	8.95 (6.90-11.5)	9.99 (7.49-13.3)	11.4 (8.04-15.3)	13.3 (9.01-18.3)	14.8 (9.74-20.6)
7-day	4.35 (3.61-5.22)	5.12 (4.25-6.15)	6.39 (5.28-7.69)	7.44 (6.12-8.99)	8.88 (7.06-11.1)	10.00 (7.77-12.7)	11.1 (8.37-14.6)	12.6 (8.92-16.7)	14.6 (9.88-19.8)	16.0 (10.6-22.2)
10-day	5.03 (4.21-5.99)	5.83 (4.88-6.96)	7.15 (5.96-8.56)	8.24 (6.82-9.90)	9.75 (7.79-12.1)	10.9 (8.52-13.8)	12.1 (9.11-15.7)	13.5 (9.64-17.9)	15.5 (10.5-21.0)	16.9 (11.2-23.3)
20-day	7.13 (6.05-8.39)	8.01 (6.78-9.43)	9.43 (7.98-11.1)	10.6 (8.90-12.6)	12.2 (9.88-15.0)	13.5 (10.6-16.7)	14.8 (11.2-18.8)	16.1 (11.8-21.0)	17.8 (12.3-23.9)	19.1 (12.8-26.1)
30-day	8.90 (7.61-10.4)	9.82 (8.39-11.5)	11.3 (9.64-13.3)	12.6 (10.6-14.8)	14.3 (11.6-17.3)	15.7 (12.4-19.2)	17.0 (12.9-21.3)	18.2 (13.2-23.6)	19.8 (13.7-26.4)	21.0 (14.1-28.5)
45-day	11.1 (9.55-12.8)	12.1 (10.4-14.0)	13.7 (11.8-16.0)	15.1 (12.6-17.6)	17.0 (13.8-20.3)	18.4 (14.6-22.3)	19.8 (15.0-24.6)	20.9 (15.2-26.9)	22.4 (15.6-29.7)	23.5 (15.8-31.7)
60-day	12.9 (11.2-14.9)	14.0 (12.1-16.1)	15.7 (13.6-18.2)	17.2 (14.7-20.0)	19.2 (15.7-22.8)	20.7 (16.5-25.0)	22.3 (16.9-27.4)	23.3 (17.0-29.9)	24.7 (17.2-32.6)	25.8 (17.4-34.7)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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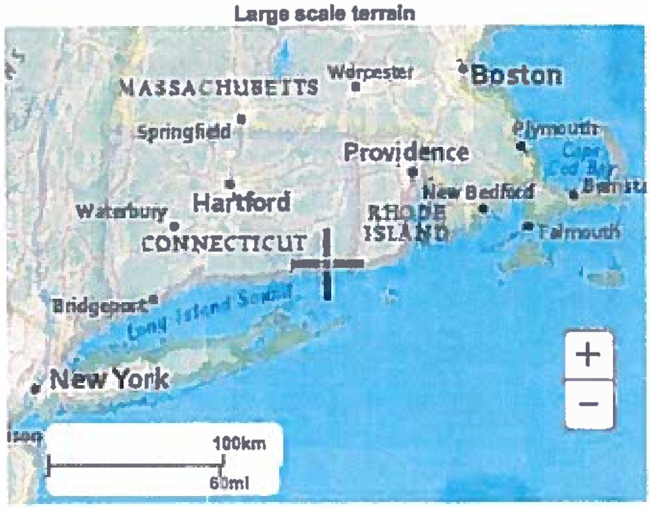
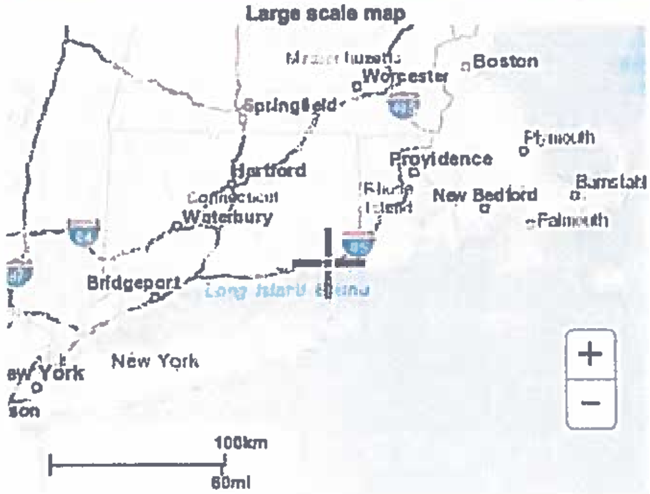
Large scale terrain



Large scale map



Large scale aerial

APPENDIX H

HYDROLOGIC ANALYSIS – COMPUTER MODEL RESULTS

Hydrographs Peak Flowrate Summary (cfs)

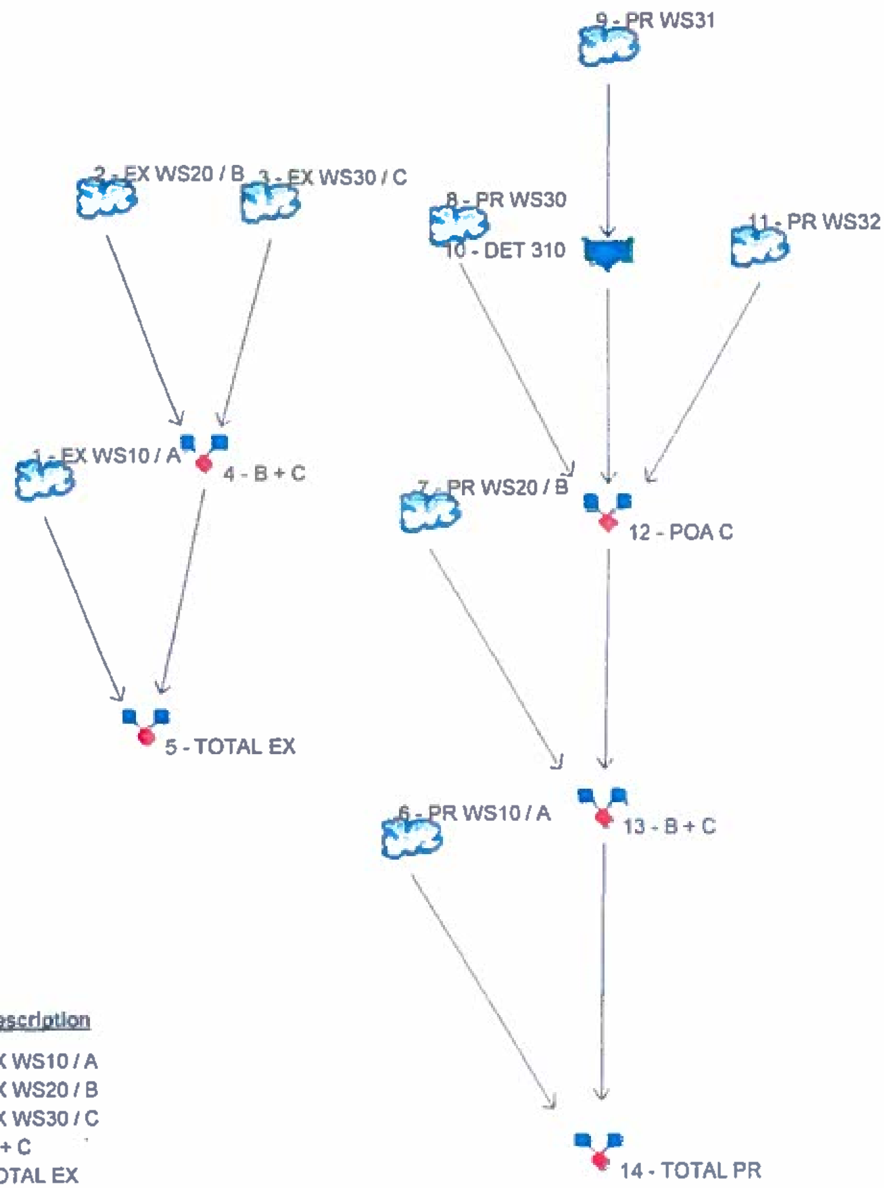
Existing vs. Proposed

Storm Event	2yr		10yr		25yr		50yr		100yr	
	Exist	Prop	Exist	Prop	Exist	Prop	Exist	Prop	Exist	Prop
Point of Analysis A	1.3	0.3	2.7	0.7	3.6	1.0	4.2	1.2	4.9	1.4
Point of Analysis B	2.3	0.7	5.7	2.6	8.1	4.2	10.0	5.5	12.0	6.9
Point of Analysis C	11.5	9.0	24.4	20.1	33.3	28.7	40.3	38.2	47.3	44.9
DET 310 W.S. Elev. (ft) Top Elev. of Stone Above Galleries = 27.5	---	24.62	---	25.73	---	26.37	---	26.74	---	27.14

Study Area	**Description**
A	Existing Drainage to Fishtown Road
B	Existing Northern Wetland
C	Existing Eastern Wetlands

Watershed Model Schematic

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020



Legend

Hyd.	Origin	Description
1	SCS Runoff	EX WS10 / A
2	SCS Runoff	EX WS20 / B
3	SCS Runoff	EX WS30 / C
4	Combine	B + C
5	Combine	TOTAL EX
6	SCS Runoff	PR WS10 / A
7	SCS Runoff	PR WS20 / B
8	SCS Runoff	PR WS30
9	SCS Runoff	PR WS31
10	Reservoir	DET 310
11	SCS Runoff	PR WS32
12	Combine	POA C
13	Combine	B + C
14	Combine	TOTAL PR

Hydraflow Table of Contents

Hydrograph Return Period Recap

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	------	-------	1.329	-------	-------	2.671	3.556	4.248	4.946	EX WS10 / A
2	SCS Runoff	------	-------	2.288	-------	-------	5.679	8.056	9.995	12.00	EX WS20 / B
3	SCS Runoff	------	-------	11.48	-------	-------	24.44	33.27	40.25	47.34	EX WS30 / C
4	Combine	2, 3	-------	13.69	-------	-------	29.91	40.91	49.66	58.68	B + C
5	Combine	1, 4	-------	14.87	-------	-------	32.22	44.20	53.70	63.38	TOTAL EX
6	SCS Runoff	------	-------	0.300	-------	-------	0.703	0.982	1.205	1.433	PR WS10 / A
7	SCS Runoff	------	-------	0.672	-------	-------	2.613	4.195	5.522	6.923	PR WS20 / B
8	SCS Runoff	------	-------	6.090	-------	-------	13.19	18.09	21.98	25.93	PR WS30
9	SCS Runoff	------	-------	8.327	-------	-------	13.61	16.87	19.37	21.86	PR WS31
10	Reservoir	9	-------	3.200	-------	-------	7.281	10.43	14.64	16.49	DET 310
11	SCS Runoff	------	-------	0.471	-------	-------	1.535	2.352	3.034	3.748	PR WS32
12	Combine	8, 10, 11	-------	8.996	-------	-------	20.89	28.66	38.22	44.94	POA C
13	Combine	7, 12	-------	9.655	-------	-------	23.50	32.79	43.62	51.86	B + C
14	Combine	6, 13	-------	9.788	-------	-------	23.81	33.21	44.13	52.52	TOTAL PR

Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (acft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (acft)	Hydrograph Description
1	SCS Runoff	1.329	3	729	0.123	------	------	------	EX WS10 / A
2	SCS Runoff	2.288	3	738	0.283	------	------	------	EX WS20 / B
3	SCS Runoff	11.48	3	735	1.233	------	------	------	EX WS30 / C
4	Combine	13.69	3	735	1.516	2, 3	------	------	B + C
5	Combine	14.87	3	735	1.639	1, 4	------	------	TOTAL EX
6	SCS Runoff	0.300	3	726	0.025	------	------	------	PR WS10 / A
7	SCS Runoff	0.672	3	747	0.114	------	------	------	PR WS20 / B
8	SCS Runoff	6.090	3	738	0.702	------	------	------	PR WS30
9	SCS Runoff	8.327	3	732	0.862	------	------	------	PR WS31
10	Reservoir	3.200	3	756	0.663	9	24.62	0.405	DET 310
11	SCS Runoff	0.471	3	750	0.076	------	------	------	PR WS32
12	Combine	8.996	3	744	1.441	8, 10, 11	------	------	POA C
13	Combine	9.655	3	744	1.555	7, 12	------	------	B + C
14	Combine	9.788	3	744	1.580	6, 13	------	------	TOTAL PR

Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (acft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (acft)	Hydrograph Description
1	SCS Runoff	2.671	3	729	0.241	------	------	------	EX WS10 / A
2	SCS Runoff	5.679	3	738	0.640	------	------	------	EX WS20 / B
3	SCS Runoff	24.44	3	732	2.529	------	------	------	EX WS30 / C
4	Combine	29.91	3	735	3.170	2, 3	------	------	B + C
5	Combine	32.22	3	732	3.411	1, 4	------	------	TOTAL EX
6	SCS Runoff	0.703	3	726	0.054	------	------	------	PR WS10 / A
7	SCS Runoff	2.613	3	741	0.327	------	------	------	PR WS20 / B
8	SCS Runoff	13.19	3	735	1.463	------	------	------	PR WS30
9	SCS Runoff	13.61	3	732	1.437	------	------	------	PR WS31
10	Reservoir	7.281	3	750	1.238	9	25.73	0.586	DET 310
11	SCS Runoff	1.535	3	744	0.201	------	------	------	PR WS32
12	Combine	20.89	3	741	2.902	8, 10, 11	------	------	POA C
13	Combine	23.50	3	741	3.229	7, 12	------	------	B + C
14	Combine	23.81	3	741	3.283	6, 13	------	------	TOTAL PR

Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (acft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (acft)	Hydrograph Description
1	SCS Runoff	3.556	3	729	0.321	------	------	------	EX WS10 / A
2	SCS Runoff	8.056	3	738	0.896	------	------	------	EX WS20 / B
3	SCS Runoff	33.27	3	732	3.418	------	------	------	EX WS30 / C
4	Combine	40.91	3	735	4.313	2, 3	------	------	B + C
5	Combine	44.20	3	732	4.634	1, 4	------	------	TOTAL EX
6	SCS Runoff	0.982	3	726	0.075	------	------	------	PR WS10 / A
7	SCS Runoff	4.195	3	738	0.493	------	------	------	PR WS20 / B
8	SCS Runoff	18.09	3	735	1.987	------	------	------	PR WS30
9	SCS Runoff	16.87	3	732	1.803	------	------	------	PR WS31
10	Reservoir	10.43	3	747	1.603	9	26.37	0.669	DET 310
11	SCS Runoff	2.352	3	741	0.296	------	------	------	PR WS32
12	Combine	28.66	3	741	3.886	8, 10, 11	------	------	POA C
13	Combine	32.79	3	741	4.379	7, 12	------	------	B + C
14	Combine	33.21	3	741	4.454	6, 13	------	------	TOTAL PR

Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (acft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (acft)	Hydrograph Description
1	SCS Runoff	4.248	3	729	0.384	------	------	------	EX WS10 / A
2	SCS Runoff	9.995	3	735	1.103	------	------	------	EX WS20 / B
3	SCS Runoff	40.25	3	732	4.128	------	------	------	EX WS30 / C
4	Combine	49.66	3	732	5.232	2, 3	------	------	B + C
5	Combine	53.70	3	732	5.616	1, 4	------	------	TOTAL EX
6	SCS Runoff	1.205	3	726	0.092	------	------	------	PR WS10 / A
7	SCS Runoff	5.522	3	738	0.633	------	------	------	PR WS20 / B
8	SCS Runoff	21.98	3	735	2.408	------	------	------	PR WS30
9	SCS Runoff	19.37	3	732	2.086	------	------	------	PR WS31
10	Reservoir	14.64	3	744	1.886	9	26.74	0.699	DET 310
11	SCS Runoff	3.034	3	741	0.374	------	------	------	PR WS32
12	Combine	38.22	3	741	4.668	8, 10, 11	------	------	POA C
13	Combine	43.62	3	741	5.301	7, 12	------	------	B + C
14	Combine	44.13	3	741	5.393	6, 13	------	------	TOTAL PR

Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (acft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (acft)	Hydrograph Description
1	SCS Runoff	4.946	3	729	0.449	------	------	------	EX WS10 / A
2	SCS Runoff	12.00	3	735	1.319	------	------	------	EX WS20 / B
3	SCS Runoff	47.34	3	732	4.857	------	------	------	EX WS30 / C
4	Combine	58.68	3	732	6.175	2, 3	------	------	B + C
5	Combine	63.38	3	732	6.625	1, 4	------	------	TOTAL EX
6	SCS Runoff	1.433	3	726	0.109	------	------	------	PR WS10 / A
7	SCS Runoff	6.923	3	738	0.782	------	------	------	PR WS20 / B
8	SCS Runoff	25.93	3	735	2.839	------	------	------	PR WS30
9	SCS Runoff	21.86	3	732	2.370	------	------	------	PR WS31
10	Reservoir	16.49	3	744	2.170	9	27.14	0.732	DET 310
11	SCS Runoff	3.748	3	741	0.457	------	------	------	PR WS32
12	Combine	44.94	3	738	5.467	8, 10, 11	------	------	POA C
13	Combine	51.86	3	738	6.249	7, 12	------	------	B + C
14	Combine	52.52	3	738	6.358	6, 13	------	------	TOTAL PR

CU-Hydro01 - with raised outlet.gpw	Return Period: 100 Year	Thursday, 06 / 13 / 2019

Pond Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Thursday, 06 / 13 / 2019

Pond No. 2 - DET 310

Pond Data

UG Chambers -Invert elev. = 22.75 ft, Rise x Span = 3.75 x 6.42 ft, Barrel Len = 7.17 ft, No. Barrels = 177, Slope = 0.00%, Headers = No
Encasement -Invert elev. = 22.00 ft, Width = 6.72 ft, Height = 5.50 ft, Voids = 40.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (acft)	Total storage (acft)
0.00	22.00	n/a	0.000	0.000
0.55	22.55	n/a	0.043	0.043
1.10	23.10	n/a	0.082	0.125
1.65	23.65	n/a	0.104	0.229
2.20	24.20	n/a	0.102	0.331
2.75	24.75	n/a	0.098	0.429
3.30	25.30	n/a	0.092	0.521
3.85	25.85	n/a	0.083	0.604
4.40	26.40	n/a	0.069	0.674
4.95	26.95	n/a	0.045	0.718
5.50	27.50	n/a	0.043	0.761

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 24.00	10.00	6.00	0.00
Span (in)	= 24.00	10.00	6.00	0.00
No. Barrels	= 1	2	3	0
Invert El. (ft)	= 23.50	23.50	25.00	0.00
Length (ft)	= 101.00	0.00	0.00	0.00
Slope (%)	= 0.50	0.00	0.00	n/a
N-Value	= .012	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	Yes	Yes	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 5.00	0.00	0.00	0.00
Crest El. (ft)	= 26.15	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	---	---	---
Multi-Stage	= Yes	No	No	No

Exfil.(in/hr) = 0.000 (by Wet area)
TW Elev. (ft) = 0.00

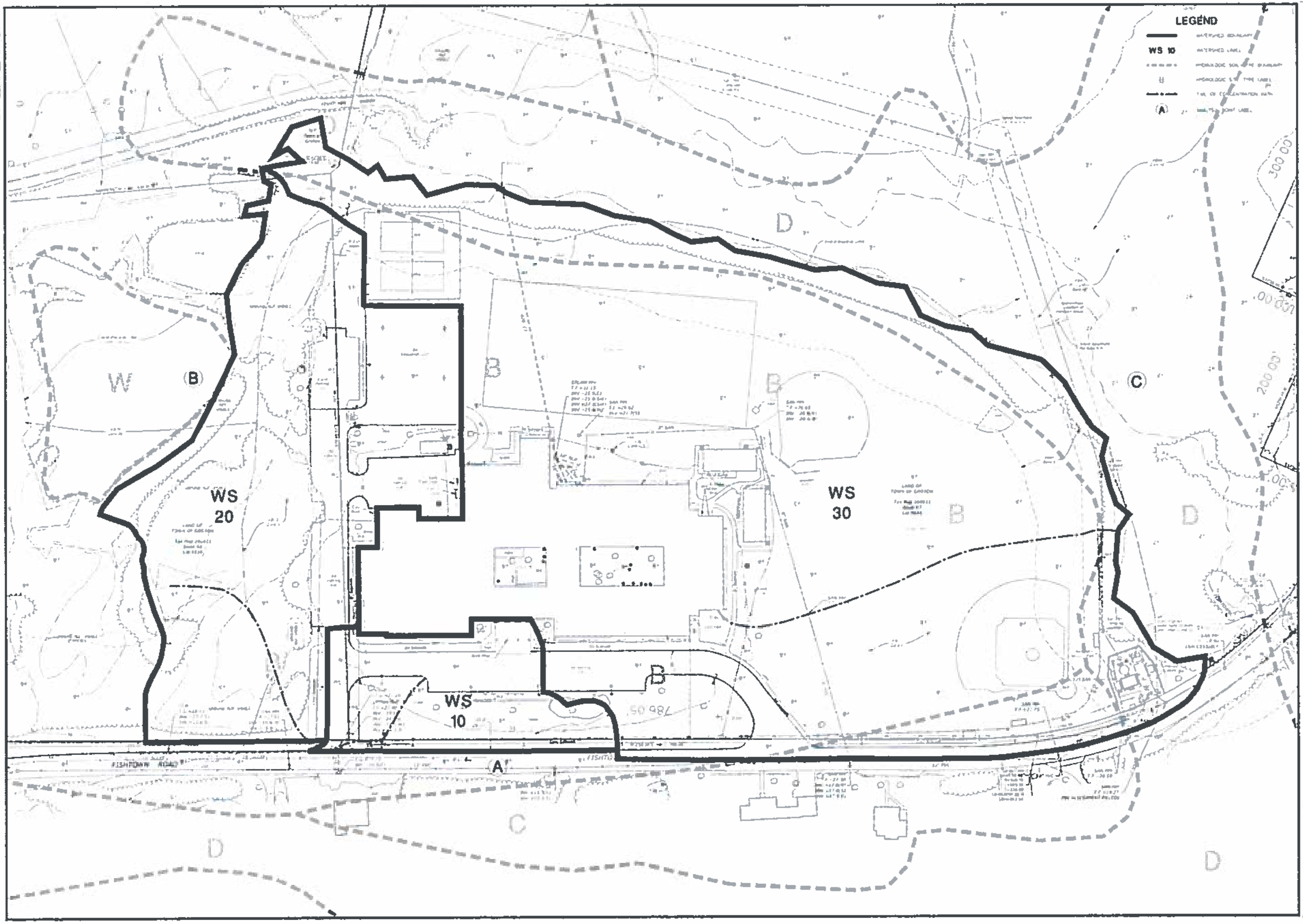
Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s)

Stage / Storage / Discharge Table

Stage ft	Storage acft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0.000	22.00	0.00	0.00	0.00	---	0.00	---	---	---	---	---	0.000
0.55	0.043	22.55	0.00	0.00	0.00	---	0.00	---	---	---	---	---	0.000
1.10	0.125	23.10	0.00	0.00	0.00	---	0.00	---	---	---	---	---	0.000
1.65	0.229	23.65	0.11 ic	0.11 ic	0.00	---	0.00	---	---	---	---	---	0.105
2.20	0.331	24.20	1.82 ic	1.82 ic	0.00	---	0.00	---	---	---	---	---	1.820
2.75	0.429	24.75	3.54 ic	3.54 ic	0.00	---	0.00	---	---	---	---	---	3.544
3.30	0.521	25.30	5.46 ic	4.70 ic	0.69 ic	---	0.00	---	---	---	---	---	5.387
3.85	0.604	25.85	7.71 oc	5.51 ic	2.20 ic	---	0.00	---	---	---	---	---	7.708
4.40	0.674	26.40	10.85 oc	5.68 ic	3.04 ic	---	2.08	---	---	---	---	---	10.81
4.95	0.718	26.95	15.53 oc	5.21 ic	2.81 ic	---	7.51 ic	---	---	---	---	---	15.53
5.50	0.761	27.50	23.00 oc	3.21 ic	1.73 ic	---	18.07 s	---	---	---	---	---	23.00

APPENDIX I

WATERSHED MAPS



MILONE & MACBROOM

WATERSHED MAP - EXISTING CONDITIONS

CUTLER ELEMENTARY SCHOOL

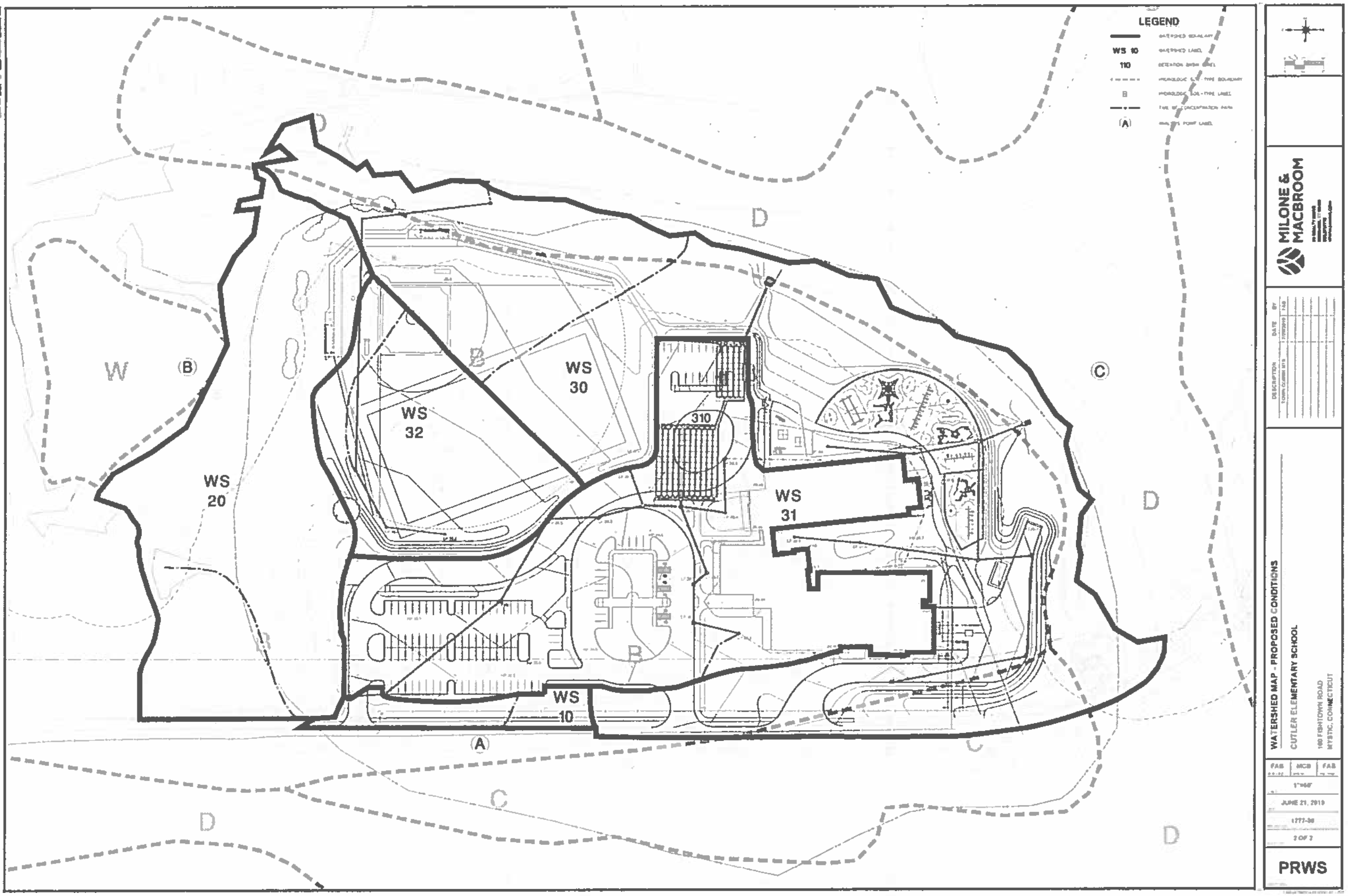
FISHTOWN ROAD
MYSTIC, CONNECTICUT

FAB | MCB | FAB

1777-30

1 OF 2

EXWS


LEGEND
WS 10
110
B
A
WS 20
WS 30
WS 31
WS 32
WS 10
310
A
B
C
D
W
MILONE & MACBROOM
DESCRIPTION
DATE
BY
WATERSHED MAP - PROPOSED CONDITIONS
CUTLER ELEMENTARY SCHOOL
160 FISHTOWN ROAD
MYSTIC, CONNECTICUT
FAB
MCB
1"=60'
JUNE 21, 2019
1777-30
2 OF 2
PRWS