TECHNICAL REPORT IN SUPPORT OF SITE PLAN APPROVAL

501 & 600 GRIFFIN BROOK DRIVE

METHUEN, MASSACHUSETTS

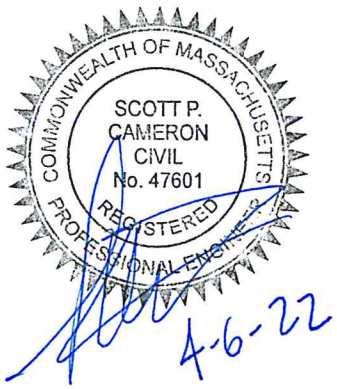
APRIL 6, 2022

SUBMITTED TO:

CITY OF METHUEN
PLANNING BOARD
CITY HALL
SEARLES BUILDING
41 PLEASANT STREET
METHUEN, MA 01844

APPLICANT:

GRIFFIN BROOK DRIVE OWNER LLC
55 CAMBRIDGE STREET
BURLINGTON, MA 01803



TECHNICAL REPORT
NARRATIVE

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TECHNICAL REPORT NARRATIVE

I. EXECUTIVE SUMMARY

Griffin Brook Drive Owner LLC., the 'Applicant', proposes to develop the property located at 501 & 600 Griffin Brook Drive to an allowed industrial use in the Limited Industrial Zoning District. The site consists of approximately 22.27 acres of land and has 212.15± feet (ft.) of frontage along Griffin Brook Drive. Vehicular access to the new 101,250 ± square foot ("SF") industrial facility will be provided by modifying the existing parking and driveways at the former 3M Touch Systems site located at 501 Griffin Brook Drive to accommodate new site driveways. Parking, loading and utility infrastructure will also be constructed to support of the new building. The existing building parking area will be improved with new stormwater best management practices and to minimize impervious surface area. The project previously received a variance from the Methuen Board of Appeals, dated February 23, 2022, to modify building height. This project also requires Site Plan Review from the Community Development Board and an Order of Conditions from the Conservation Commission. The site will be subject to the EPA/NPDES Stormwater Pollution Prevention Plan during construction.

II. EXISTING SITE DESCRIPTION

The existing site consists of two parcels located at 501 & 600 Griffin Brook Drive, which encompasses a total area of 22.27 acres (970,081± sf). The property located at 501 Griffin Brook Drive was developed for manufacturing use by 3M Touch Systems. Refer to Figure 1: USGS Map and Figure 2: 2019 Ortho Map for the parcel location. The site is identified by the Methuen Assessor's Department on Map 220 Lot 9E & Lot 9D and sits within the Limited Industrial District (IL). The existing building extends into 600 Griffin Brook Drive as the lots are under single ownership. However, they exist as separate lots due to their commercial zoning designation. The developed area consists of the 59,918± sf building, paved driveways, parking areas, loading zones and landscaped areas which consists of lawn and intermittent trees. The rear portion of the lot consists of undeveloped, wooded land.

The property is abutted to the south by Griffin Brook Drive and a developed, industrial building. To the north and east by Hickory Hill Golf Course and to the west by undeveloped, limited industrial zoned land.

In 1995, Methuen granted permits for the development of the entire tract for a 112,400 sf building of industrial use, parking, loading, and supporting infrastructure. Only a portion of that project was constructed. However, portions of the utility infrastructure were installed including a sewer main which extends north and west of the parking area. The land was also partially cleared near the westerly wetland system for the construction of parking and an access drive that were ultimately not constructed. Please see attached Exhibit Plan prepared by Symmes Maini and Mckee Associates, Inc. on February 6, 1995.

The existing building is serviced by fire supply, domestic water, sanitary sewer, gas, electric and communications. Stormwater is primarily managed by a closed drainage system consisting of catch basins, conveyance pipes and manholes. There are no apparent mitigation measures on the site. However a hydrodynamic stormwater treatment system, V2B1, was installed prior to the stormwater discharge to the westerly wetland. The majority of the front parking area, half of the existing roof and other tributary landscape areas receive treatment from this proprietary technology. Stormwater runoff from the existing loading dock, half of the existing roof and a portion of the parking area drain to catch basins before discharging to a common drainage system southeast of the site.

Existing grades on site are moderately flat in the developed portions of the property with a high elevation of around 70 feet (NAVD88) at Griffin Brook Drive to a low elevation of 60 feet near the westerly wetland system. The undeveloped portions of the property contain steep slopes with elevations ranging from 88 feet near the northern part of the property to 58 feet in the easterly wetland. The United States Department of Agriculture (USDA) Natural Resources Conservation Services (NRCS) has the soils on site mapped as:

- 40% Rock outcrop and 30% Charlton soil, 3 to 15 percent slopes (717C);
- 50% Ridgebury, 3 to 8% extremely stony (715B);
- 85% birdsall, 0 to 3% slopes (9A)

See Figure 3: SCS Soils Map and Appendix J for detailed soil descriptions).

In situ soil testing performed by MCG on February 7 & 8, 2022 confirmed that soils throughout the development area consist of well drained, A-type loamy sands with gravel and cobbles. The depth of soil extended below the reach of the 12-foot excavator around the perimeter of the development area. Near the high elevation of the property, a shallower bedrock ridge was identified at approximately to an elevation of 78 to 80 feet (NAVD88) or about 6 to 8 feet below grade. Surface cobbles and boulders can be observed throughout the wooded area.

Wetland resource areas were delineated by LEC Environmental, LLC in May 2021. The wetland boundaries were affirmed by the Methuen Conservation Commission through the issuance of an Order of Resource Area Delineation, MassDEP File No. 219-1265. There is a large bordering vegetated wetland ('BVW') on the east side of the property. Another BVW is situated at the west of the property. The BVW's have a jurisdictional buffer zone which extends 100' from the edge of the BVW. A perennial stream is situated offsite and has an associated 200 ft. Riverfront Area zone of jurisdiction with the Conservation Commission that encroaches into the site at the southwestern property corner.

The property is not within a Zone A to a surface water drinking supply or a Zone II or Interim Wellhead Protection Zone to a groundwater drinking supply. The property is not within priority

or estimate habitats of rare or endangered species. The property is not within an Area of Critical Environmental Concern.

Most of the site and the entire developable area is situated within the FEMA Zone X as shown on the FEMA Federal Insurance Rate Map (FIRM) #25009C0203F with and effective date of July 3, 2012. A small portion of the site in the south westerly corner contains a Zone AE 100-year flood survey mapping. This flood zone will not be impacted by the project but does have a 100' buffer zone under the Methuen Wetlands Ordinance. See Figure 4: FEMA Map.

III. PROPOSED SITE DESCRIPTION

A. Building

The development of 501 & 600 Griffin Brook Drive will include construction of a 101,250 s.f. industrial building generally situated in the northeastern part of the property that is currently undeveloped woodland area. The building will have recessed loading docks, parking for employees and visitors, emergency vehicle access around all sides of the building and supporting infrastructure. The building will be of steel frame construction, Type IIA and fully sprinklered. The roof will consist of a rubber membrane with downspouts internally plumped to a retention basin to the north of the building. The building will be a single story with a height of 45'-0" from the mean finished grade around the building to the peak of the roof ridge, complying with the height limitation as measured from mean grade. However, a variance was required and obtained to extend the height to 67' since the definition of height in the Methuen Zoning Ordinance requires the measurement of height to occur from the average grade at the abutting street. The street, as noted previously, occurs at elevation 58 feet whereas the slab of the proposed building is at elevation 82 feet.

B. Driveways, Parking and Loading

The site will be primarily accessed from Griffin Brook Drive through a new 28-foot wide driveway. The driveway is situated almost entirely within the existing parking area or previously developed portions of the site. These existing parking areas will be modified to accommodate the new driveway. Heading north along the new drive, delivery trucks up to a WB-65 (53' trailer) will be able to access the north-westerly loading dock. A turnaround will be provided there. Employees and guests will also be able to access the parking area through this drive. Other delivery trucks will access the south-easterly loading dock through the existing site drive which extends behind the existing building. A turnaround will also be provided at this loading dock. Emergency vehicles will be able to access all sides of the building with the construction of a 20-foot wide gravel driveway. A swept path analysis is included herewith illustrating the truck movements utilizing the truck turning application AutoCAD Civil3D.

C. Earthwork and Land Disturbance

The site has been designed to balance earth cuts and fills to the maximum extent practicable. The majority of the excavation work will occur in the footprint of the proposed building. Some bedrock extending to a depth of approximately 4 feet will need to be removed. However most of the site is expected to be within excavatable, sandy soils. Excavated rock will be utilized on

site to stabilize slopes or construct short walls. Other excavated soils will be compacted in fill areas to minimize the need for importing or exporting ordinary fill. Select structural fill will need to be imported as required by Mass Building Code or general best practices for utility and stormwater management construction. Land clearing will consist of ## acres in the northerly portion of the site. A vegetated buffer of mature trees is expected to remain with the limit of work generally following the building setback line along the northerly boundary. East and west of the building/limit of work, extensive wooded buffers within protected wetland systems exist on site and offsite.

D. Stormwater Management Overview

The stormwater management system was designed in full compliance with the Massachusetts Stormwater Handbook and consists of a variety of best management practices including retention basins and proprietary hydrodynamic particle and oil separators. A small portion of the existing site near Griffin Brook Drive will be retrofitted to include stormwater mitigation and renovation measures to improve existing conditions to the maximum extent practicable. Further explanation of the stormwater management system and design methodology can be found later in this report. The closed drainage system pipes were sized using the rational method and Darcy's Law. The tributary watersheds for each catch basin are illustrated in the attached rational method calculation areas plan.

E. Open Space and Preservation of Natural Features

The project will be situated primarily within areas of previously developed land or upland, dry areas and therefore it will not require any alteration to wetland resource areas. Throughout the entire new development area, the Methuen Wetlands Ordinance 50' wetland no-disturb setback was respected. The work nearest the westerly wetland resource areas and riverfront area will occur entirely within previously developed land and will not require the removal of any trees. While work is necessary within the no-disturb setbacks in this area due to the existing site constraints, a 9,600 SF portion of previously developed land will be restored to offset the impacts of this work. Further, a portion of the existing parking area will be retrofitted with a new infiltration basin that will provide mitigation of runoff and groundwater recharge where it does not exist today. This will improve water quality and the sites ability to retain water on site.

The property will preserve 65% of the total landscaped or natural open space. This land primarily occurs to the west of the site although wooded buffers have been provided on all sides of the development except the southerly lot line which consists of a shared driveway. The parking areas will have at least 5% of the space dedicated to landscaping islands and shad trees. Other site amenities include an outdoor seating area and volleyball court between the buildings.

F. Utilities

The property will be serviced by a new fire and water service extended from the main in Griffin Brook Drive and across the existing parking field. Hydrants will be situated at key locations around the front and side of the building to the satisfaction of the Methuen Fire Department. Sanitary Sewer will be extended from the existing sewer main within the site and will have a new manhole connection. The sewer was previously constructed as part of the originally, permitted

site development effort. Electric and gas will be coordinated with National Grid as will individual communications services with their respective providers.

G. Schedule

A construction start date has not been determined as it is contingent upon tenant agreements not yet established. Construction of the site and building is expected to take approximately 18 months to complete.

IV. STORMWATER MANAGEMENT

The proposed stormwater management system for the project will consist of various Best Management Practice (BMP) techniques in both mitigating and renovating stormwater runoff. The entire stormwater system was designed in accordance with the Massachusetts Stormwater Management Handbook. A comprehensive Grading and Drainage Plan is included in the plan set illustrating these measures. The existing watershed characteristics, flow paths and drainage patterns were matched to the extent practicable in the proposed condition to ensure that there are no adverse impacts to adjacent properties or wetland resource areas. The following is a detailed description of the stormwater management system design and documentation of compliance with the Massachusetts Stormwater Handbook.

A. Existing Watershed Description

Drainage on site has been divided into 6 (six) distinct sub-catchment areas, as shown on the Existing Watershed Plan attached hereto. The table below shows the total area for each subcatchment.

Summary of Existing Subcatchments

Existing Subcatchment	Total Area (SF)	% Impervious	Curve Number
ES1	208,519	0.03	31
ES2	84,210	51.00	76
ES3	15,025	74.58	83
ES4	164,415	0.57	37
ES5	126,089	68.99	79
ES6	15,714	73.77	85
Totals	**613,972**	**26.35%**	

B. Evaluation of Design Points

To asses the impacts of developing a site on adjacent property, stormwater runoff is evaluated at a single point which is representative of the aggregation of various subcatchments, conveyances and stormwater mitigation ponds. The design point is typically measured where stormwater runoff exits the site at its lowest point or where an area is identified of concern for stormwater impacts. The subject site was evaluated at four (4) design points. Design point 1

was modelled as the northeast wetland. Design point 2 is the southeast wetland. Design point 3 was evaluated as the catch basin located on the access driveway, adjacent to the end of Griffin Brook Drive. Design point 4 was evaluated as the westerly wetland. The design points were verified in the field by the design engineer.

C. Proposed Watershed Description

The proposed post development drainage analysis was performed by matching existing design points and drainage patterns to the extent practicable as shown in the Proposed Watershed Plan. The table below shows the total area for each subcatchment.

Summary of Proposed Subcatchments

Proposed Subcatchment	Total Area (SF)	% Impervious	Curve Number
PS1	71,570	0.00	31
PS1a	15,854	0.00	64
PS2	66,442	68.7	82
PS3	15,025	74.58	83
PS4	71,594	0.00	43
PS5	88,896	75.17	84
PS5a	19,372	76.35	85
PS6	13,676	81.79	87
PS7	86,432	80.90	89
PS8	112,169	90.27	92
PS9	52,942	43.21	67
Totals	**613,972**	**55.98**	

D. Hydrologic Analysis

The purpose of the stormwater analysis is to demonstrate that the proposed development will not adversely impact either the on-site or surrounding land. The industry standard for stormwater management design in Massachusetts is governed by the Massachusetts Stormwater Management Handbook ("Handbook") published by the Mass Department of Environmental Protection, January 2008. The Regulations require applicants to comply with the Handbook standards for development projects. The Handbook lists 10 standards covering among other things mitigation (retention-detention) and renovation (treatment) of stormwater runoff. A full discussion on the project compliance with the standards can be found at the end of this report. However, the following section will summarize the project's compliance with the mitigation standards 1 and 2 of the Handbook relating to reducing peak rates of runoff and creating no adverse down gradient impacts.

To demonstrate that there will be no downstream impacts because of developing the site, a stormwater analysis was performed using the U.S. Soil Conservation Service (S.C.S) method of analysis contained in Technical Release #20 (TR-20) published by the U.S. Conservation Service, along with the extreme precipitation values published by the Northeast Regional Climate Center

(NRCC 24-Hr D Rainfall for Methuen Massachusetts). The software application HydroCAD was utilized to analyze the pre- and post-development watershed conditions. This analysis allows the engineer to verify that a given drainage system is adequate for the area under consideration, and further allows the engineer to predict where flooding or erosion are most likely to occur. The HydroCAD model was used to analyze the storm drainage system designed for the development to demonstrate that the drainage system complies with the State's Stormwater Management Standards. To more accurately represent the runoff generated from the variety of surface covers and hydrologic soil groups, the HydroCAD analysis was performed using a weighted curve number generated from each subcatchment.

The HydroCAD analysis was performed by examining the stormwater runoff at four (4) design points that were previously described. The following is a listing of the total pre-and post-development rates of stormwater runoff for the proposed development for the 2, 10, and 100-year rainfall events:

Comparison of Existing and Proposed Rates of Runoff

Design Point	Storm Event (Years)	Existing Conditions (Peak CFS)	Proposed Conditions (Peak CFS)	Change in Peak (CFS)
DP-1	2	0	0	0
	10	0	0	0
	100	0.27	0.21	0.06
				0
DP-2	2	1.97	1.81	0.16
	10	4.47	3.67	0.80
	100	8.77	7.38	1.39
				0
DP-3	2	0.63	0.61	0.02
	10	1.20	1.12	0.08
	100	2.12	1.93	0.19
				0
DP-4	2	2.61	2.61	0
	10	5.66	5.12	0.54
	100	10.87	10.27	0.60

As shown in the table above the proposed development will maintain or reduce or match peak flow rates at all design points for the 2, 10 and 100-year design storms as required by the Massachusetts Stormwater Management Handbook.

E. Stormwater Management Standards

The proposed site development will comply with all Stormwater Management Standards 1 through 10. The following is an assessment of each Standard:

1. **STANDARD:** No stormwater conveyance system discharges untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth.

   SUMMARY OF MITIGATING MEASURES: The project meets this standard as there are no untreated discharges from the new project site. The existing drainage patterns will be maintained to the extent practicable, and the stormwater discharge locations will generally be maintained. Treatment of stormwater is proposed through the use of best management practices (BMPs) including deep-sump, hooded catch basins, hydrodynamic separators, surface retention ponds and subsurface retention galleys. The outfalls of all the systems will be reinforced with rip rap outlet protection to prevent erosion.

   CONCLUSION: The proposed development meets this standard.

2. **STANDARD:** The stormwater management system shall be designed such that post-development peak rates of stormwater runoff and volumes do not exceed pre-development rates for the 2- and 10-year storm events. Cannot cause downstream flooding in the 100-year storm event.

   SUMMARY OF MITIGATING MEASURES: The project will utilize surface and subsurface retention basins to control the rate and volume of release of stormwater. As a result, the peak rate of stormwater runoff in the post-development condition will match or reduce the rate under existing conditions at all design points. The 100-year storm rate of runoff will also be mitigated at all design points.

   Of note, the site will provide mitigation for a portion of the existing parking area. This system was not added due to an increase in impervious area as would ordinarily be required. This basin was added to address the increase in the subcatchment CN by reducing the overall area of the subcatchment, a large portion of that removed area consisted of pervious surface areas. This commonly occurs in hydrologic modelling in HSG A type soils. The retention system has the added benefit of providing stormwater treatment for a portion of the existing parking area.

   CONCLUSION: The proposed development meets this standard.

3. **STANDARD:** Loss of annual recharge to groundwater shall be eliminated or minimized through the use of infiltration measures including environmentally sensitive site design, low impact development techniques, stormwater best management practices, and good operation and maintenance. At a minimum, the annual recharge from the post-development site shall approximate the annual recharge from pre-development conditions based on soil type. This Standard is met when the stormwater management system is designed to infiltrate the required recharge volume as determined in accordance with the Massachusetts Stormwater handbook.

   SUMMARY OF MITIGATING MEASURES: To promote groundwater recharge, the site has been designed to include numerous surface and subsurface retention basins spread out around the development site. Treated stormwater runoff entering the retention basins will be infiltrated back into the groundwater where native soils confirmed by soil testing, are capable of receiving the water. The infiltration measures were placed away from areas

of shallow bedrock. A portion of the existing parking area will be retrofitted with a shallow retention basin providing mitigation where none exists today.

CONCLUSION: The proposed development meets this standard.

4. **STANDARD:** Stormwater management systems shall be designed to remove 80% of the average annual post-construction load of Total Suspended Solids (TSS). In addition, 44% pretreatment must be provided for this site which qualifies as a land use subject to higher potential pollutant load due to the pavement area.

   SUMMARY OF MITIGATING MEASURES: The stormwater management system will use treatment trains of deep-sump, hooded catch basins, proprietary hydrodynamic separators, retention basins, prior to discharge into the retention/detention systems or directly to daylight. Pre-treatment of stormwater is provided for all new mitigation systems.

   Redevelopment waiver request:
   A portion of the existing eastern loading and parking area currently drains untreated to the stormwater system and wetlands at the eastern portion of the site. As a part of this development. A new infiltration basin will be added to capture this runoff. This basin includes a pretreatment, peastone filter strip in accordance with the Stormwater Handbook. However, 44% TSS removal is not possible ahead of the retention basin due to the elevation of the existing parking area relative to the existing closed drainage system and adjacent wetland. This retention basin complies with the setback requirements to the wetland per the stormwater handbook and in all other respects will provide 80% TSS removal prior to recharge. The overflow from the basin passes through the existing hydrodynamic separator so that all stormwater discharges fully meet the treatment requirement prior to discharge to the wetland. A waiver is hereby requested to reduce the 44% pretreatment requirement down to 25% on the existing retrofit where all other treatment standards are fully met for the project.

   CONCLUSION: The proposed development meets this standard for all new development work and complies with the redevelopment standard to the maximum extent practicable under a minor waiver request from 44% to 25% pretreatment.

5. **STANDARD:** For land uses with higher potential pollutant loads (LUHPPL), source control and pollution prevention shall be implemented in accordance with the Massachusetts Stormwater handbook to eliminate or reduce the discharge of stormwater runoff from such land uses to the maximum extent practicable.

   SUMMARY OF MITIGATING MEASURES: The project is not considered a land use with a higher potential pollutant load.

   CONCLUSION: The proposed development meets this standard.

6. **STANDARD:** Stormwater discharges within the Zone II or Interim Wellhead Protection Area of a public water supply, and stormwater discharges near or to any other critical area, require the use of the specific source control and pollution prevention measures and the specific structural stormwater best management practices determined by the Department to be suitable for managing discharges to such areas, as provided in the Massachusetts Stormwater Management handbook.

SUMMARY OF MITIGATING MEASURES: The site is not within a MassDEP Zone II or interim wellhead protection zone. It is not within a Zone A surface water supply watershed. There are no rapidly draining soils with infiltration rates greater than 2.4 inches per hour.

CONCLUSION: The proposed development meets this standard.

7. **STANDARD:** A redevelopment project is required to meet the following Stormwater Management Standards only to the maximum extent practicable: Standard 2, Standard 3, and the pretreatment and structural best management practice requirements of Standards 4, 5 and 6. Existing stormwater discharges shall comply with Standard 1 only to the maximum extent practicable. A redevelopment project shall also comply with all other requirements of the Stormwater Management Standards and improve existing conditions.

   SUMMARY OF MITIGATING MEASURES: See standard 4, redevelopment waiver request. The site fully complies with all stormwater management standards with the exception of the pretreatment waiver request.

   CONCLUSION: The proposed development meets this standard.

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

   SUMMARY OF MITIGATING MEASURES: Refer to the Construction Phase Best Management Practices prepared by MCG, dated April 6, 2022. Since the project will disturb greater than one acre of land a SWPPP will be prepared and a NPDES Construction General Permit will be obtained prior to commencement of land disturbing activities on site.

   CONCLUSION: The proposed development meets this standard.

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

   SUMMARY OF MITIGATING MEASURES: Refer to the Long-Term Best Management Practices Operation and Maintenance Plan prepared by MCG, dated April 6, 2022.

   CONCLUSION: The proposed development meets this standard.

10. **STANDARD:** There shall be no new illicit discharges created as a result of the project.

    SUMMARY OF MITIGATING MEASURES: To the best of our knowledge and belief there are no illicit discharges being created as a result of the proposed project. An illicit discharge statement is included herein.

    CONCLUSION: The proposed development meets this standard.

V. CONCLUSION

The proposed site development project for 501 and 600 Griffin Brook Drive, as proposed, is in full compliance with the MassDEP Stormwater Management Handbook and Methuen Ordinances

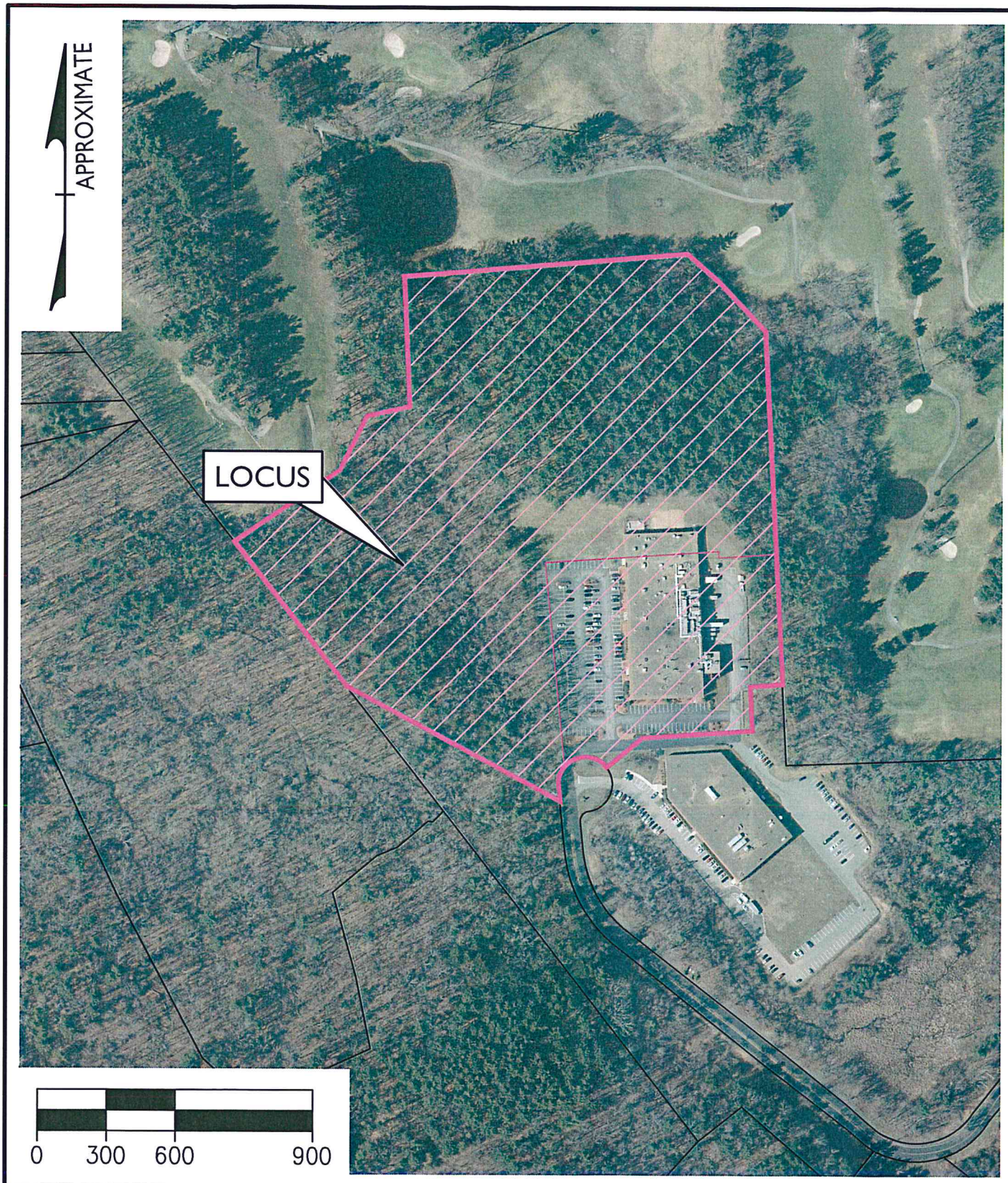
with the exception of a minor redevelopment waiver request to required to retrofit an existing parking area with stormwater mitigation where none exists today. Peak rates of stormwater runoff and volumes leaving the site under proposed conditions are no greater than under existing conditions at all design points. Recharge to groundwater will be increased by adding surface infiltration systems distributed around the property. All stormwater leaving the proposed development will be fully treated and there are no illicit discharges to the waters of the Commonwealth.

For questions regarding this report, please contact The Morin-Cameron Group, Inc. between the hours of 7:30am to 4:30pm at (978) 373-0310.

FIGURES

APPENDICIES

FIGURES



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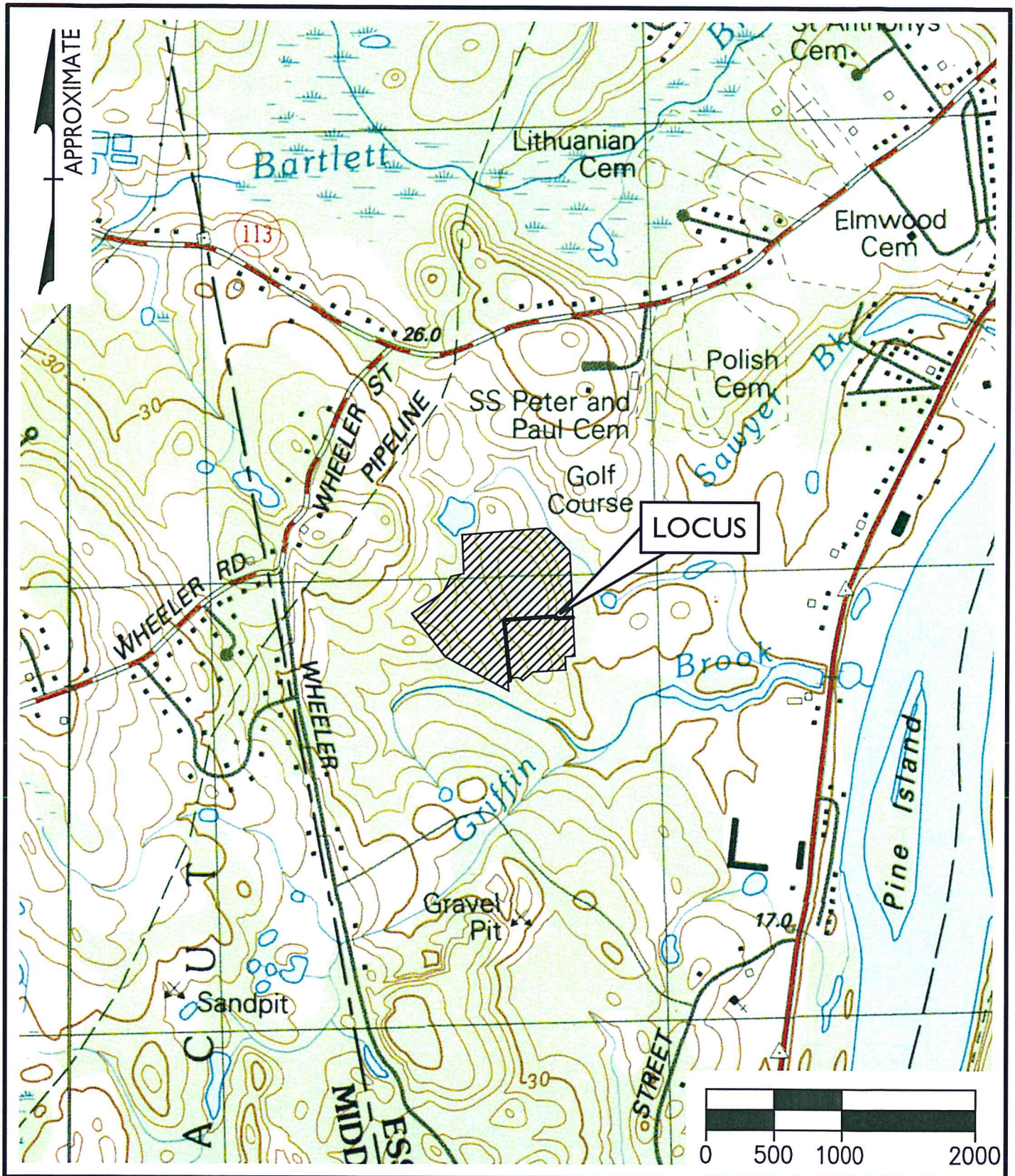
2019 ORTHO MAP

501 & 600 GRIFFIN BROOK DRIVE
IN
METHUEN, MA

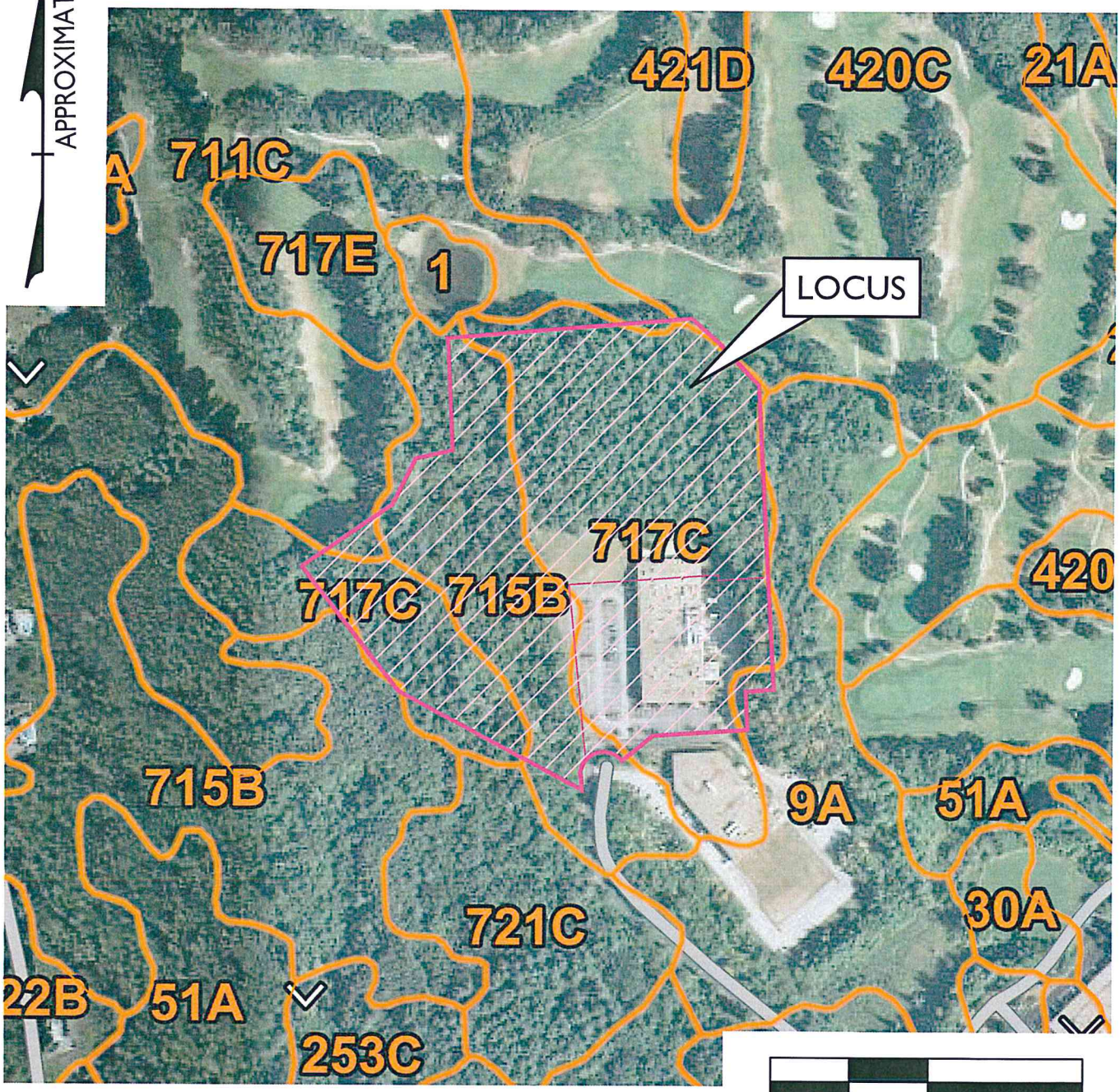
DATE: APRIL 6, 2022

Scale: 1" = 300'

FIGURE #1



THE MORIN-CAMERON GROUP, INC. 25 KENOZA AVENUE, HAVERHILL, MA 01830 **P | 978.373.0310** WWW.MORINCAMERON.COM		USGS MAP 501 & 600 GRIFFIN BROOK DRIVE IN METHUEN, MA
DATE: APRIL 6, 2022	SCALE: 1" = 1,000'	**FIGURE #2**



LEGEND:

9A	BIRDSALL SILT LOAM, 0-3% SLOPES
420C	CANTON FINE SANDY LOAM, 8-15% SLOPES
711C	CHARLTON-ROCK OUTCROP-HOLLIS COMPLEX, 8-15% SLOPES
715B	RIDGEBURY AND LEICESTER FINE SANDY LOAMS, 3-8% SLOPES, EXTREMELY STONY
717C	ROCK OUTCROP-CHARLTON-HOLLIS COMPLEX, 3-15% SLOPES
⩔	ROCK OUTCROP

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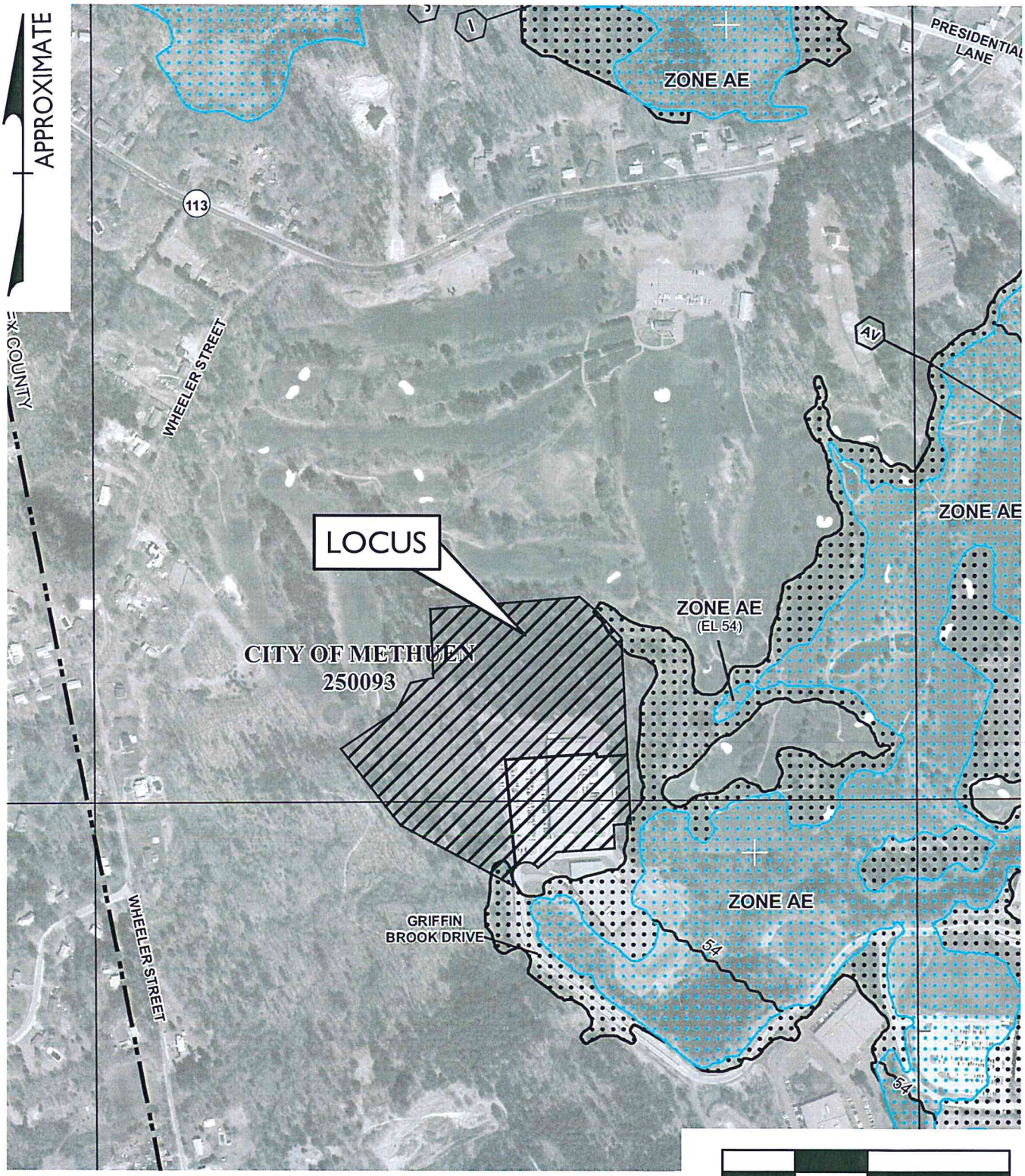
SCS SOILS MAP

501 & 600 GRIFFIN BROOK DRIVE
IN
METHUEN, MA

DATE: APRIL 6, 2022 | SCALE: 1" = 400'

FIGURE #3



FEMA MAP No: 25009C0203F
EFFECTIVE DATE: JULY 3, 2012

THE MORIN-CAMERON GROUP, INC.
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FEMA MAP ADDRESS IN METHUEN, MA

DATE: APRIL 6, 2022

Scale: 1" = 1,000'

FIGURE #4

APPENDICIES

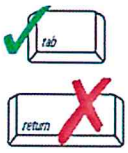
APPENDIX A:
MASSDEP STORMWATER MANANGEMENT REPORT CHECKLIST

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

A. Introduction

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.



A Stormwater Report must be submitted with the Notice of Intent permit application to document compliance with the Stormwater Management Standards. The following checklist is NOT a substitute for the Stormwater Report (which should provide more substantive and detailed information) but is offered here as a tool to help the applicant organize their Stormwater Management documentation for their Report and for the reviewer to assess this information in a consistent format. As noted in the Checklist, the Stormwater Report must contain the engineering computations and supporting information set forth in Volume 3 of the Massachusetts Stormwater Handbook. The Stormwater Report must be prepared and certified by a Registered Professional Engineer (RPE) licensed in the Commonwealth.

The Stormwater Report must include:

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

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

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

To ensure that the Stormwater Report is complete, applicants are required to fill in the Stormwater Report Checklist by checking the box to indicate that the specified information has been included in the Stormwater Report. If any of the information specified in the checklist has not been submitted, the applicant must provide an explanation. The completed Stormwater Report Checklist and Certification must be submitted with the Stormwater Report.

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

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

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

B. Stormwater Checklist and Certification

The following checklist is intended to serve as a guide for applicants as to the elements that ordinarily need to be addressed in a complete Stormwater Report. The checklist is also intended to provide conservation commissions and other reviewing authorities with a summary of the components necessary for a comprehensive Stormwater Report that addresses the ten Stormwater Standards.

Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the item is not applicable (N.A.) and provide the reasons for that determination.

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

Registered Professional Engineer's Certification

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

Registered Professional Engineer Block and Signature

4-6-22

Signature and Date

Checklist

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

☐ New development

☐ Redevelopment

☒ Mix of New Development and Redevelopment

Checklist for Stormwater Report

Checklist (continued)

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

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

Standard 1: No New Untreated Discharges

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

Checklist for Stormwater Report

Checklist (continued)

Standard 2: Peak Rate Attenuation

☐ Standard 2 waiver requested because the project is located in land subject to coastal storm flowage and stormwater discharge is to a wetland subject to coastal flooding.

☒ Evaluation provided to determine whether off-site flooding increases during the 100-year 24-hour storm.

☒ Calculations provided to show that post-development peak discharge rates do not exceed pre-development rates for the 2-year and 10-year 24-hour storms. If evaluation shows that off-site flooding increases during the 100-year 24-hour storm, calculations are also provided to show that post-development peak discharge rates do not exceed pre-development rates for the 100-year 24-hour storm.

Standard 3: Recharge

☒ Soil Analysis provided.

☒ Required Recharge Volume calculation provided.

☐ Required Recharge volume reduced through use of the LID site Design Credits.

☒ Sizing the infiltration, BMPs is based on the following method: Check the method used.

☒ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

☒ Runoff from all impervious areas at the site discharging to the infiltration BMP.

☐ Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume.

☒ Recharge BMPs have been sized to infiltrate the Required Recharge Volume.

☐ Recharge BMPs have been sized to infiltrate the Required Recharge Volume *only* to the maximum extent practicable for the following reason:

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

☒ Calculations showing that the infiltration BMPs will drain in 72 hours are provided.

☐ Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.

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

Checklist for Stormwater Report

Checklist (continued)

Standard 3: Recharge (continued)

☐ The infiltration BMP is used to attenuate peak flows during storms greater than or equal to the 10-year 24-hour storm and separation to seasonal high groundwater is less than 4 feet and a mounding analysis is provided.

☒ Documentation is provided showing that infiltration BMPs do not adversely impact nearby wetland resource areas.

Standard 4: Water Quality

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

- Good housekeeping practices;
- Provisions for storing materials and waste products inside or under cover;
- Vehicle washing controls;
- Requirements for routine inspections and maintenance of stormwater BMPs;
- Spill prevention and response plans;
- Provisions for maintenance of lawns, gardens, and other landscaped areas;
- Requirements for storage and use of fertilizers, herbicides, and pesticides;
- Pet waste management provisions;
- Provisions for operation and management of septic systems;
- Provisions for solid waste management;
- Snow disposal and plowing plans relative to Wetland Resource Areas;
- Winter Road Salt and/or Sand Use and Storage restrictions;
- Street sweeping schedules;
- Provisions for prevention of illicit discharges to the stormwater management system;
- Documentation that Stormwater BMPs are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from LUHPPL;
- Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan;
- List of Emergency contacts for implementing Long-Term Pollution Prevention Plan.

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

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

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

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

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

Checklist for Stormwater Report

Checklist (continued)

Standard 4: Water Quality (continued)

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

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

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

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

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

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

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

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

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

☐ All exposure has been eliminated.

☐ All exposure has ***not*** been eliminated and all BMPs selected are on MassDEP LUHPPL list.

☐ The LUHPPL has the potential to generate runoff with moderate to higher concentrations of oil and grease (e.g. all parking lots with >1000 vehicle trips per day) and the treatment train includes an oil grit separator, a filtering bioretention area, a sand filter or equivalent.

Standard 6: Critical Areas

☐ The discharge is near or to a critical area and the treatment train includes only BMPs that MassDEP has approved for stormwater discharges to or near that particular class of critical area.

☒ Critical areas and BMPs are identified in the Stormwater Report.

Checklist for Stormwater Report

Checklist (continued)

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

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

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

☒ Certain standards are not fully met (Standard No. 1, 8, 9, and 10 must always be fully met) and an explanation of why these standards are not met is contained in the Stormwater Report.

☒ The project involves redevelopment and a description of all measures that have been taken to improve existing conditions is provided in the Stormwater Report. The redevelopment checklist found in Volume 2 Chapter 3 of the Massachusetts Stormwater Handbook may be used to document that the proposed stormwater management system (a) complies with Standards 2, 3 and the pretreatment and structural BMP requirements of Standards 4-6 to the maximum extent practicable and (b) improves existing conditions.

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

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

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

☒ A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan containing the information set forth above has been included in the Stormwater Report.

Checklist for Stormwater Report

Checklist (continued)

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control (continued)

☐ The project is highly complex and information is included in the Stormwater Report that explains why it is not possible to submit the Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan with the application. A Construction Period Pollution Prevention and Erosion and Sedimentation Control has ***not*** been included in the Stormwater Report but will be submitted ***before*** land disturbance begins.

☐ The project is ***not*** covered by a NPDES Construction General Permit.

☐ The project is covered by a NPDES Construction General Permit and a copy of the SWPPP is in the Stormwater Report.

☒ The project is covered by a NPDES Construction General Permit but no SWPPP been submitted. The SWPPP will be submitted BEFORE land disturbance begins.

Standard 9: Operation and Maintenance Plan

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

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

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

- ☐ A copy of the legal instrument (deed, homeowner's association, utility trust or other legal entity) that establishes the terms of and legal responsibility for the operation and maintenance of the project site stormwater BMPs;
- ☐ A plan and easement deed that allows site access for the legal entity to operate and maintain BMP functions.

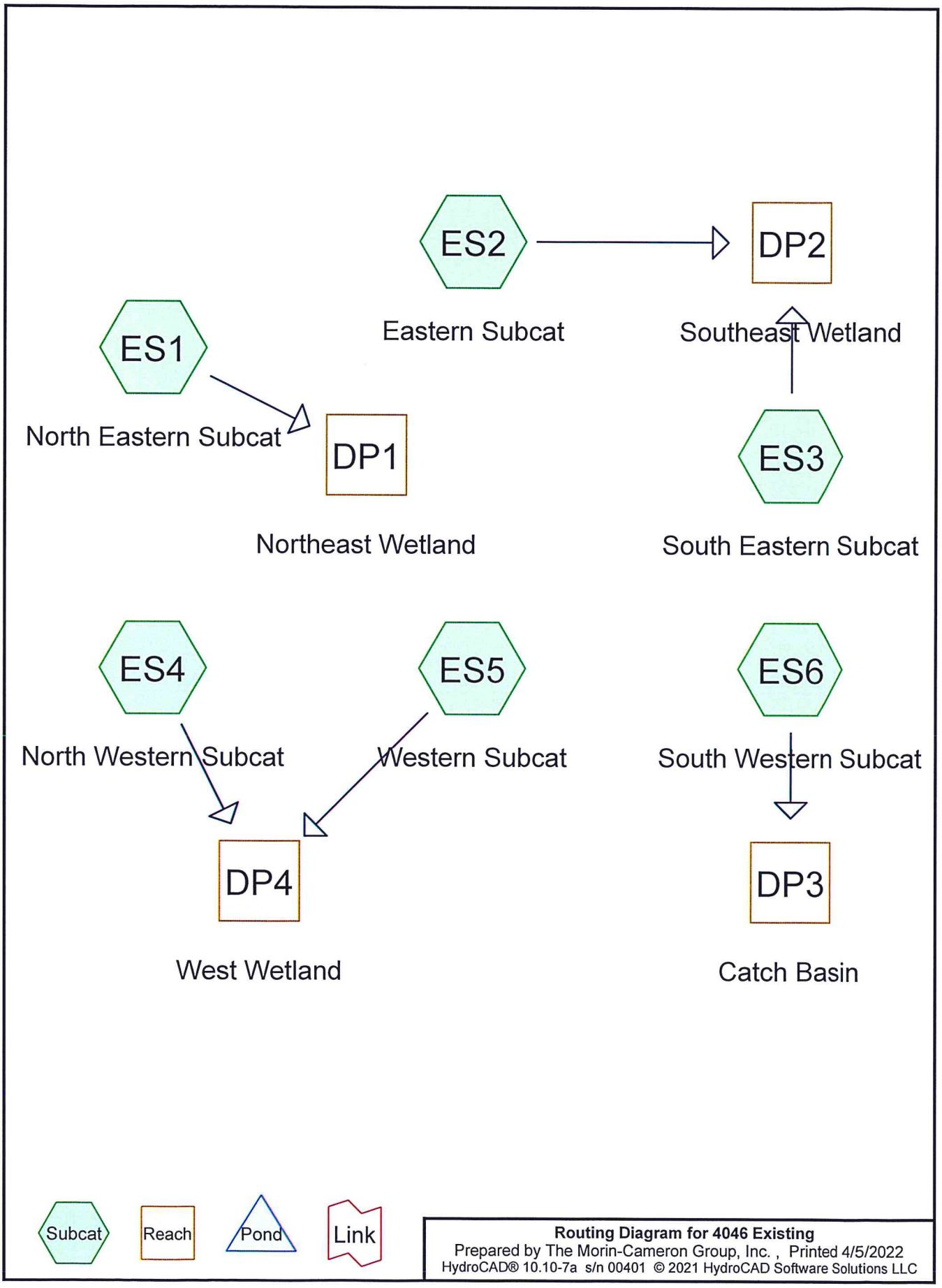
Standard 10: Prohibition of Illicit Discharges

☒ The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;

☒ An Illicit Discharge Compliance Statement is attached;

☐ NO Illicit Discharge Compliance Statement is attached but will be submitted ***prior to*** the discharge of any stormwater to post-construction BMPs.

APPENDIX B:
EXISTING CONDITIONS
HYDROLOGIC ANALYSIS



Routing Diagram for 4046 Existing
Prepared by The Morin-Cameron Group, Inc. , Printed 4/5/2022

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment ES1: North Eastern Subcat Runoff Area=208,519 sf 0.03% Impervious Runoff Depth>0.29"
Flow Length=388' Tc=43.8 min CN=31 Runoff=0.27 cfs 5,061 cf

Subcatchment ES2: Eastern Subcat Runoff Area=84,210 sf 60.57% Impervious Runoff Depth>4.45"
Flow Length=400' Tc=15.6 min CN=76 Runoff=7.45 cfs 31,194 cf

Subcatchment ES3: South Eastern Subcat Runoff Area=15,025 sf 74.58% Impervious Runoff Depth>5.22"
Flow Length=228' Tc=7.5 min CN=83 Runoff=1.97 cfs 6,540 cf

Subcatchment ES4: North Western Subcat Runoff Area=164,415 sf 0.57% Impervious Runoff Depth>0.67"
Flow Length=1,386' Tc=54.3 min CN=37 Runoff=0.75 cfs 9,129 cf

Subcatchment ES5: Western Subcat Runoff Area=126,089 sf 68.99% Impervious Runoff Depth>4.77"
Flow Length=875' Tc=19.1 min CN=79 Runoff=10.81 cfs 50,105 cf

Subcatchment ES6: South Western Subcat Runoff Area=15,714 sf 73.77% Impervious Runoff Depth>5.44"
Flow Length=226' Tc=7.4 min CN=85 Runoff=2.12 cfs 7,118 cf

Reach DP1: Northeast Wetland Inflow=0.27 cfs 5,061 cf
Outflow=0.27 cfs 5,061 cf

Reach DP2: Southeast Wetland Inflow=8.77 cfs 37,734 cf
Outflow=8.77 cfs 37,734 cf

Reach DP3: Catch Basin Inflow=2.12 cfs 7,118 cf
Outflow=2.12 cfs 7,118 cf

Reach DP4: West Wetland Inflow=10.87 cfs 59,235 cf
Outflow=10.87 cfs 59,235 cf

Total Runoff Area = 613,972 sf Runoff Volume = 109,147 cf Average Runoff Depth = 2.13"
73.65% Pervious = 452,179 sf 26.35% Impervious = 161,793 sf

Summary for Subcatchment ES1: North Eastern Subcat

Runoff = 0.00 cfs @ 5.00 hrs, Volume= 0 cf, Depth= 0.00"
Routed to Reach DP1 : Northeast Wetland

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 2-yr Rainfall=3.12"

Area (sf)	CN	Description
60	98	Paved parking, HSG A
190,891	30	Woods, Good, HSG A
111	55	Woods, Good, HSG B
17,457	39	>75% Grass cover, Good, HSG A
208,519	31	Weighted Average
208,459		99.97% Pervious Area
60		0.03% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
42.4	50	0.0500	0.02		**Sheet Flow, Sheet** Woods: Light underbrush n= 0.400 P2= 0.13"
0.6	176	0.0994	5.08		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
0.8	162	0.0402	3.23		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
43.8	388	Total			

Summary for Subcatchment ES2: Eastern Subcat

Runoff = 1.62 cfs @ 12.25 hrs, Volume= 6,685 cf, Depth> 0.95"
Routed to Reach DP2 : Southeast Wetland

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 2-yr Rainfall=3.12"

Area (sf)	CN	Description
18,272	98	Paved parking, HSG A
18,322	39	>75% Grass cover, Good, HSG A
9,078	30	Woods, Good, HSG A
1,775	98	Paved parking, HSG C
2,635	74	>75% Grass cover, Good, HSG C
3,171	70	Woods, Good, HSG C
30,957	98	Roofs, HSG A
84,210	76	Weighted Average
33,206		39.43% Pervious Area
51,004		60.57% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.1	50	0.1100	0.06		**Sheet Flow, Sheet Flow** Grass: Short n= 0.150 P2= 0.13"
0.1	47	0.1311	5.83		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
0.9	183	0.0283	3.41		**Shallow Concentrated Flow, Shallow** Paved Kv= 20.3 fps
0.5	120	0.0657	4.13		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
15.6	400	Total			

Summary for Subcatchment ES3: South Eastern Subcat

Runoff = 0.55 cfs @ 12.15 hrs, Volume= 1,725 cf, Depth> 1.38"
Routed to Reach DP2 : Southeast Wetland

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 2-yr Rainfall=3.12"

Area (sf)	CN	Description
11,205	98	Paved parking, HSG A
3,820	39	>75% Grass cover, Good, HSG A
15,025	83	Weighted Average
3,820		25.42% Pervious Area
11,205		74.58% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.3	16	0.1313	0.05		**Sheet Flow, Sheet Flow** Grass: Short n= 0.150 P2= 0.13"
1.4	34	0.0853	0.40		**Sheet Flow, Sheet** Smooth surfaces n= 0.011 P2= 0.13"
0.8	178	0.0337	3.73		**Shallow Concentrated Flow, Shallow** Paved Kv= 20.3 fps
7.5	228	Total			

Summary for Subcatchment ES4: North Western Subcat

Runoff = 0.00 cfs @ 5.00 hrs, Volume= 0 cf, Depth= 0.00"
Routed to Reach DP4 : West Wetland

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 2-yr Rainfall=3.12"

Area (sf)	CN	Description
938	98	Paved parking, HSG A
14,830	39	>75% Grass cover, Good, HSG A
111,641	30	Woods, Good, HSG A
12,716	61	>75% Grass cover, Good, HSG B
24,290	55	Woods, Good, HSG B
164,415	37	Weighted Average
163,477		99.43% Pervious Area
938		0.57% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
48.4	50	0.0360	0.02		**Sheet Flow, Sheet Flow** Woods: Light underbrush n= 0.400 P2= 0.13"
0.2	46	0.0867	4.74		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
0.2	79	0.1259	5.71		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
0.8	153	0.0392	3.19		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
4.7	1,058	0.0113	3.77	25.43	**Trap/Vee/Rect Channel Flow, Stream Channel** Bot.W=3.00' D=1.50' Z= 1.0 '/' Top.W=6.00' n= 0.040 Earth, cobble bottom, clean sides
54.3	1,386	Total			

Summary for Subcatchment ES5: Western Subcat

Runoff = 2.61 cfs @ 12.29 hrs, Volume= 11,751 cf, Depth> 1.12"
Routed to Reach DP4 : West Wetland

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 2-yr Rainfall=3.12"

Area (sf)	CN	Description
51,222	98	Paved parking, HSG A
30,492	39	>75% Grass cover, Good, HSG A
8,501	30	Woods, Good, HSG A
6,810	98	Paved parking, HSG B
103	61	>75% Grass cover, Good, HSG B
28,961	98	Roofs, HSG A
126,089	79	Weighted Average
39,096		31.01% Pervious Area
86,993		68.99% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.0	50	0.0800	0.05		**Sheet Flow, Sheet Flow** Grass: Short n= 0.150 P2= 0.13"
0.2	52	0.0763	4.45		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
0.2	64	0.1871	6.96		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
0.9	165	0.0226	3.05		**Shallow Concentrated Flow, Shallow** Paved Kv= 20.3 fps
0.7	276	0.0148	6.94	8.51	**Pipe Channel, Pipe (CB to DMH)** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.012 Concrete pipe, finished
0.2	75	0.0104	7.16	12.66	**Pipe Channel, Pipe (DMH to water treatment unit)** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.011 Concrete pipe, straight & clean
0.4	59	0.0300	2.79		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
0.5	134	0.0140	4.19	28.31	**Trap/Vee/Rect Channel Flow, Stream Channel** Bot.W=3.00' D=1.50' Z= 1.0 '/' Top.W=6.00' n= 0.040 Earth, cobble bottom, clean sides
19.1	875	Total			

Summary for Subcatchment ES6: South Western Subcat

Runoff = 0.63 cfs @ 12.15 hrs, Volume= 1,985 cf, Depth> 1.52"
Routed to Reach DP3 : Catch Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 2-yr Rainfall=3.12"

Area (sf)	CN	Description
8,862	98	Paved parking, HSG A
2,695	39	>75% Grass cover, Good, HSG A
2,731	98	Paved parking, HSG B
1,426	61	>75% Grass cover, Good, HSG B
15,714	85	Weighted Average
4,121		26.23% Pervious Area
11,593		73.77% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	15	0.1313	0.05		**Sheet Flow, Sheet Flow** Grass: Short n= 0.150 P2= 0.13"
1.7	35	0.0571	0.34		**Sheet Flow, Sheet** Smooth surfaces n= 0.011 P2= 0.13"
0.7	176	0.0392	4.02		**Shallow Concentrated Flow, Shallow** Paved Kv= 20.3 fps
7.4	226	Total			

Summary for Reach DP1: Northeast Wetland

Inflow Area = 208,519 sf, 0.03% Impervious, Inflow Depth = 0.00" for 2-yr event
Inflow = 0.00 cfs @ 5.00 hrs, Volume= 0 cf
Outflow = 0.00 cfs @ 5.00 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Summary for Reach DP2: Southeast Wetland

Inflow Area = 99,235 sf, 62.69% Impervious, Inflow Depth > 1.02" for 2-yr event
Inflow = 1.97 cfs @ 12.22 hrs, Volume= 8,410 cf
Outflow = 1.97 cfs @ 12.22 hrs, Volume= 8,410 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Summary for Reach DP3: Catch Basin

Inflow Area = 15,714 sf, 73.77% Impervious, Inflow Depth > 1.52" for 2-yr event
Inflow = 0.63 cfs @ 12.15 hrs, Volume= 1,985 cf
Outflow = 0.63 cfs @ 12.15 hrs, Volume= 1,985 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Summary for Reach DP4: West Wetland

Inflow Area = 290,504 sf, 30.27% Impervious, Inflow Depth > 0.49" for 2-yr event
Inflow = 2.61 cfs @ 12.29 hrs, Volume= 11,751 cf
Outflow = 2.61 cfs @ 12.29 hrs, Volume= 11,751 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Summary for Subcatchment ES1: North Eastern Subcat

Runoff = 0.00 cfs @ 20.00 hrs, Volume= 6 cf, Depth> 0.00"
Routed to Reach DP1 : Northeast Wetland

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 10-yr Rainfall=4.91"

Area (sf)	CN	Description
60	98	Paved parking, HSG A
190,891	30	Woods, Good, HSG A
111	55	Woods, Good, HSG B
17,457	39	>75% Grass cover, Good, HSG A
208,519	31	Weighted Average
208,459		99.97% Pervious Area
60		0.03% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
42.4	50	0.0500	0.02		**Sheet Flow, Sheet** Woods: Light underbrush n= 0.400 P2= 0.13"
0.6	176	0.0994	5.08		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
0.8	162	0.0402	3.23		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
43.8	388	Total			

Summary for Subcatchment ES2: Eastern Subcat

Runoff = 3.75 cfs @ 12.24 hrs, Volume= 15,362 cf, Depth> 2.19"
Routed to Reach DP2 : Southeast Wetland

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 10-yr Rainfall=4.91"

Area (sf)	CN	Description
18,272	98	Paved parking, HSG A
18,322	39	>75% Grass cover, Good, HSG A
9,078	30	Woods, Good, HSG A
1,775	98	Paved parking, HSG C
2,635	74	>75% Grass cover, Good, HSG C
3,171	70	Woods, Good, HSG C
30,957	98	Roofs, HSG A
84,210	76	Weighted Average
33,206		39.43% Pervious Area
51,004		60.57% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.1	50	0.1100	0.06		**Sheet Flow, Sheet Flow** Grass: Short n= 0.150 P2= 0.13"
0.1	47	0.1311	5.83		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
0.9	183	0.0283	3.41		**Shallow Concentrated Flow, Shallow** Paved Kv= 20.3 fps
0.5	120	0.0657	4.13		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
15.6	400	Total			

Summary for Subcatchment ES3: South Eastern Subcat

Runoff = 1.09 cfs @ 12.15 hrs, Volume= 3,508 cf, Depth> 2.80"
Routed to Reach DP2 : Southeast Wetland

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 10-yr Rainfall=4.91"

Area (sf)	CN	Description
11,205	98	Paved parking, HSG A
3,820	39	>75% Grass cover, Good, HSG A
15,025	83	Weighted Average
3,820		25.42% Pervious Area
11,205		74.58% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.3	16	0.1313	0.05		**Sheet Flow, Sheet Flow** Grass: Short n= 0.150 P2= 0.13"
1.4	34	0.0853	0.40		**Sheet Flow, Sheet** Smooth surfaces n= 0.011 P2= 0.13"
0.8	178	0.0337	3.73		**Shallow Concentrated Flow, Shallow** Paved Kv= 20.3 fps
7.5	228	Total			

Summary for Subcatchment ES4: North Western Subcat

Runoff = 0.05 cfs @ 17.20 hrs, Volume= 937 cf, Depth> 0.07"
Routed to Reach DP4 : West Wetland

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 10-yr Rainfall=4.91"

Area (sf)	CN	Description
938	98	Paved parking, HSG A
14,830	39	>75% Grass cover, Good, HSG A
111,641	30	Woods, Good, HSG A
12,716	61	>75% Grass cover, Good, HSG B
24,290	55	Woods, Good, HSG B
164,415	37	Weighted Average
163,477		99.43% Pervious Area
938		0.57% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
48.4	50	0.0360	0.02		**Sheet Flow, Sheet Flow** Woods: Light underbrush n= 0.400 P2= 0.13"
0.2	46	0.0867	4.74		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
0.2	79	0.1259	5.71		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
0.8	153	0.0392	3.19		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
4.7	1,058	0.0113	3.77	25.43	**Trap/Vee/Rect Channel Flow, Stream Channel** Bot.W=3.00' D=1.50' Z= 1.0 '/' Top.W=6.00' n= 0.040 Earth, cobble bottom, clean sides
54.3	1,386	Total			

Summary for Subcatchment ES5: Western Subcat

Runoff = 5.66 cfs @ 12.28 hrs, Volume= 25,581 cf, Depth> 2.43"
Routed to Reach DP4 : West Wetland

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 10-yr Rainfall=4.91"

Area (sf)	CN	Description
51,222	98	Paved parking, HSG A
30,492	39	>75% Grass cover, Good, HSG A
8,501	30	Woods, Good, HSG A
6,810	98	Paved parking, HSG B
103	61	>75% Grass cover, Good, HSG B
28,961	98	Roofs, HSG A
126,089	79	Weighted Average
39,096		31.01% Pervious Area
86,993		68.99% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.0	50	0.0800	0.05		**Sheet Flow, Sheet Flow** Grass: Short n= 0.150 P2= 0.13"
0.2	52	0.0763	4.45		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
0.2	64	0.1871	6.96		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
0.9	165	0.0226	3.05		**Shallow Concentrated Flow, Shallow** Paved Kv= 20.3 fps
0.7	276	0.0148	6.94	8.51	**Pipe Channel, Pipe (CB to DMH)** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.012 Concrete pipe, finished
0.2	75	0.0104	7.16	12.66	**Pipe Channel, Pipe (DMH to water treatment unit)** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.011 Concrete pipe, straight & clean
0.4	59	0.0300	2.79		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
0.5	134	0.0140	4.19	28.31	**Trap/Vee/Rect Channel Flow, Stream Channel** Bot.W=3.00' D=1.50' Z= 1.0 '/' Top.W=6.00' n= 0.040 Earth, cobble bottom, clean sides
19.1	875	Total			

Summary for Subcatchment ES6: South Western Subcat

Runoff = 1.20 cfs @ 12.14 hrs, Volume= 3,910 cf, Depth> 2.99"
Routed to Reach DP3 : Catch Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 10-yr Rainfall=4.91"

Area (sf)	CN	Description
8,862	98	Paved parking, HSG A
2,695	39	>75% Grass cover, Good, HSG A
2,731	98	Paved parking, HSG B
1,426	61	>75% Grass cover, Good, HSG B
15,714	85	Weighted Average
4,121		26.23% Pervious Area
11,593		73.77% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	15	0.1313	0.05		**Sheet Flow, Sheet Flow** Grass: Short n= 0.150 P2= 0.13"
1.7	35	0.0571	0.34		**Sheet Flow, Sheet** Smooth surfaces n= 0.011 P2= 0.13"
0.7	176	0.0392	4.02		**Shallow Concentrated Flow, Shallow** Paved Kv= 20.3 fps
7.4	226	Total			

Summary for Reach DP1: Northeast Wetland

Inflow Area = 208,519 sf, 0.03% Impervious, Inflow Depth > 0.00" for 10-yr event
Inflow = 0.00 cfs @ 20.00 hrs, Volume= 6 cf
Outflow = 0.00 cfs @ 20.00 hrs, Volume= 6 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Summary for Reach DP2: Southeast Wetland

Inflow Area = 99,235 sf, 62.69% Impervious, Inflow Depth > 2.28" for 10-yr event
Inflow = 4.47 cfs @ 12.22 hrs, Volume= 18,870 cf
Outflow = 4.47 cfs @ 12.22 hrs, Volume= 18,870 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Summary for Reach DP3: Catch Basin

Inflow Area = 15,714 sf, 73.77% Impervious, Inflow Depth > 2.99" for 10-yr event
Inflow = 1.20 cfs @ 12.14 hrs, Volume= 3,910 cf
Outflow = 1.20 cfs @ 12.14 hrs, Volume= 3,910 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Summary for Reach DP4: West Wetland

Inflow Area = 290,504 sf, 30.27% Impervious, Inflow Depth > 1.10" for 10-yr event
Inflow = 5.66 cfs @ 12.28 hrs, Volume= 26,518 cf
Outflow = 5.66 cfs @ 12.28 hrs, Volume= 26,518 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Summary for Subcatchment ES1: North Eastern Subcat

Runoff = 0.27 cfs @ 13.51 hrs, Volume= 5,061 cf, Depth> 0.29"
Routed to Reach DP1 : Northeast Wetland

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 100-yr Rainfall=7.74"

Area (sf)	CN	Description
60	98	Paved parking, HSG A
190,891	30	Woods, Good, HSG A
111	55	Woods, Good, HSG B
17,457	39	>75% Grass cover, Good, HSG A
208,519	31	Weighted Average
208,459		99.97% Pervious Area
60		0.03% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
42.4	50	0.0500	0.02		**Sheet Flow, Sheet** Woods: Light underbrush n= 0.400 P2= 0.13"
0.6	176	0.0994	5.08		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
0.8	162	0.0402	3.23		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
43.8	388	Total			

Summary for Subcatchment ES2: Eastern Subcat

Runoff = 7.45 cfs @ 12.24 hrs, Volume= 31,194 cf, Depth> 4.45"
Routed to Reach DP2 : Southeast Wetland

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 100-yr Rainfall=7.74"

Area (sf)	CN	Description
18,272	98	Paved parking, HSG A
18,322	39	>75% Grass cover, Good, HSG A
9,078	30	Woods, Good, HSG A
1,775	98	Paved parking, HSG C
2,635	74	>75% Grass cover, Good, HSG C
3,171	70	Woods, Good, HSG C
30,957	98	Roofs, HSG A
84,210	76	Weighted Average
33,206		39.43% Pervious Area
51,004		60.57% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.1	50	0.1100	0.06		**Sheet Flow, Sheet Flow** Grass: Short n= 0.150 P2= 0.13"
0.1	47	0.1311	5.83		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
0.9	183	0.0283	3.41		**Shallow Concentrated Flow, Shallow** Paved Kv= 20.3 fps
0.5	120	0.0657	4.13		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
15.6	400	Total			

Summary for Subcatchment ES3: South Eastern Subcat

Runoff = 1.97 cfs @ 12.14 hrs, Volume= 6,540 cf, Depth> 5.22"
Routed to Reach DP2 : Southeast Wetland

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 100-yr Rainfall=7.74"

Area (sf)	CN	Description
11,205	98	Paved parking, HSG A
3,820	39	>75% Grass cover, Good, HSG A
15,025	83	Weighted Average
3,820		25.42% Pervious Area
11,205		74.58% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.3	16	0.1313	0.05		**Sheet Flow, Sheet Flow** Grass: Short n= 0.150 P2= 0.13"
1.4	34	0.0853	0.40		**Sheet Flow, Sheet** Smooth surfaces n= 0.011 P2= 0.13"
0.8	178	0.0337	3.73		**Shallow Concentrated Flow, Shallow** Paved Kv= 20.3 fps
7.5	228	Total			

Summary for Subcatchment ES4: North Western Subcat

Runoff = 0.75 cfs @ 12.99 hrs, Volume= 9,129 cf, Depth> 0.67"
Routed to Reach DP4 : West Wetland

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 100-yr Rainfall=7.74"

Area (sf)	CN	Description
938	98	Paved parking, HSG A
14,830	39	>75% Grass cover, Good, HSG A
111,641	30	Woods, Good, HSG A
12,716	61	>75% Grass cover, Good, HSG B
24,290	55	Woods, Good, HSG B
164,415	37	Weighted Average
163,477		99.43% Pervious Area
938		0.57% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
48.4	50	0.0360	0.02		**Sheet Flow, Sheet Flow** Woods: Light underbrush n= 0.400 P2= 0.13"
0.2	46	0.0867	4.74		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
0.2	79	0.1259	5.71		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
0.8	153	0.0392	3.19		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
4.7	1,058	0.0113	3.77	25.43	**Trap/Vee/Rect Channel Flow, Stream Channel** Bot.W=3.00' D=1.50' Z= 1.0 '/' Top.W=6.00' n= 0.040 Earth, cobble bottom, clean sides
54.3	1,386	Total			

Summary for Subcatchment ES5: Western Subcat

Runoff = 10.81 cfs @ 12.28 hrs, Volume= 50,105 cf, Depth> 4.77"
Routed to Reach DP4 : West Wetland

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 100-yr Rainfall=7.74"

Area (sf)	CN	Description
51,222	98	Paved parking, HSG A
30,492	39	>75% Grass cover, Good, HSG A
8,501	30	Woods, Good, HSG A
6,810	98	Paved parking, HSG B
103	61	>75% Grass cover, Good, HSG B
28,961	98	Roofs, HSG A
126,089	79	Weighted Average
39,096		31.01% Pervious Area
86,993		68.99% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.0	50	0.0800	0.05		**Sheet Flow, Sheet Flow** Grass: Short n= 0.150 P2= 0.13"
0.2	52	0.0763	4.45		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
0.2	64	0.1871	6.96		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
0.9	165	0.0226	3.05		**Shallow Concentrated Flow, Shallow** Paved Kv= 20.3 fps
0.7	276	0.0148	6.94	8.51	**Pipe Channel, Pipe (CB to DMH)** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.012 Concrete pipe, finished
0.2	75	0.0104	7.16	12.66	**Pipe Channel, Pipe (DMH to water treatment unit)** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.011 Concrete pipe, straight & clean
0.4	59	0.0300	2.79		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
0.5	134	0.0140	4.19	28.31	**Trap/Vee/Rect Channel Flow, Stream Channel** Bot.W=3.00' D=1.50' Z= 1.0 '/' Top.W=6.00' n= 0.040 Earth, cobble bottom, clean sides
19.1	875	Total			

Summary for Subcatchment ES6: South Western Subcat

Runoff = 2.12 cfs @ 12.14 hrs, Volume= 7,118 cf, Depth> 5.44"
Routed to Reach DP3 : Catch Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 100-yr Rainfall=7.74"

Area (sf)	CN	Description
8,862	98	Paved parking, HSG A
2,695	39	>75% Grass cover, Good, HSG A
2,731	98	Paved parking, HSG B
1,426	61	>75% Grass cover, Good, HSG B
15,714	85	Weighted Average
4,121		26.23% Pervious Area
11,593		73.77% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	15	0.1313	0.05		**Sheet Flow, Sheet Flow** Grass: Short n= 0.150 P2= 0.13"
1.7	35	0.0571	0.34		**Sheet Flow, Sheet** Smooth surfaces n= 0.011 P2= 0.13"
0.7	176	0.0392	4.02		**Shallow Concentrated Flow, Shallow** Paved Kv= 20.3 fps
7.4	226	Total			

Summary for Reach DP1: Northeast Wetland

Inflow Area = 208,519 sf, 0.03% Impervious, Inflow Depth > 0.29" for 100-yr event
Inflow = 0.27 cfs @ 13.51 hrs, Volume= 5,061 cf
Outflow = 0.27 cfs @ 13.51 hrs, Volume= 5,061 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Summary for Reach DP2: Southeast Wetland

Inflow Area = 99,235 sf, 62.69% Impervious, Inflow Depth > 4.56" for 100-yr event
Inflow = 8.77 cfs @ 12.21 hrs, Volume= 37,734 cf
Outflow = 8.77 cfs @ 12.21 hrs, Volume= 37,734 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Summary for Reach DP3: Catch Basin

Inflow Area = 15,714 sf, 73.77% Impervious, Inflow Depth > 5.44" for 100-yr event
Inflow = 2.12 cfs @ 12.14 hrs, Volume= 7,118 cf
Outflow = 2.12 cfs @ 12.14 hrs, Volume= 7,118 cf, Atten= 0%, Lag= 0.0 min

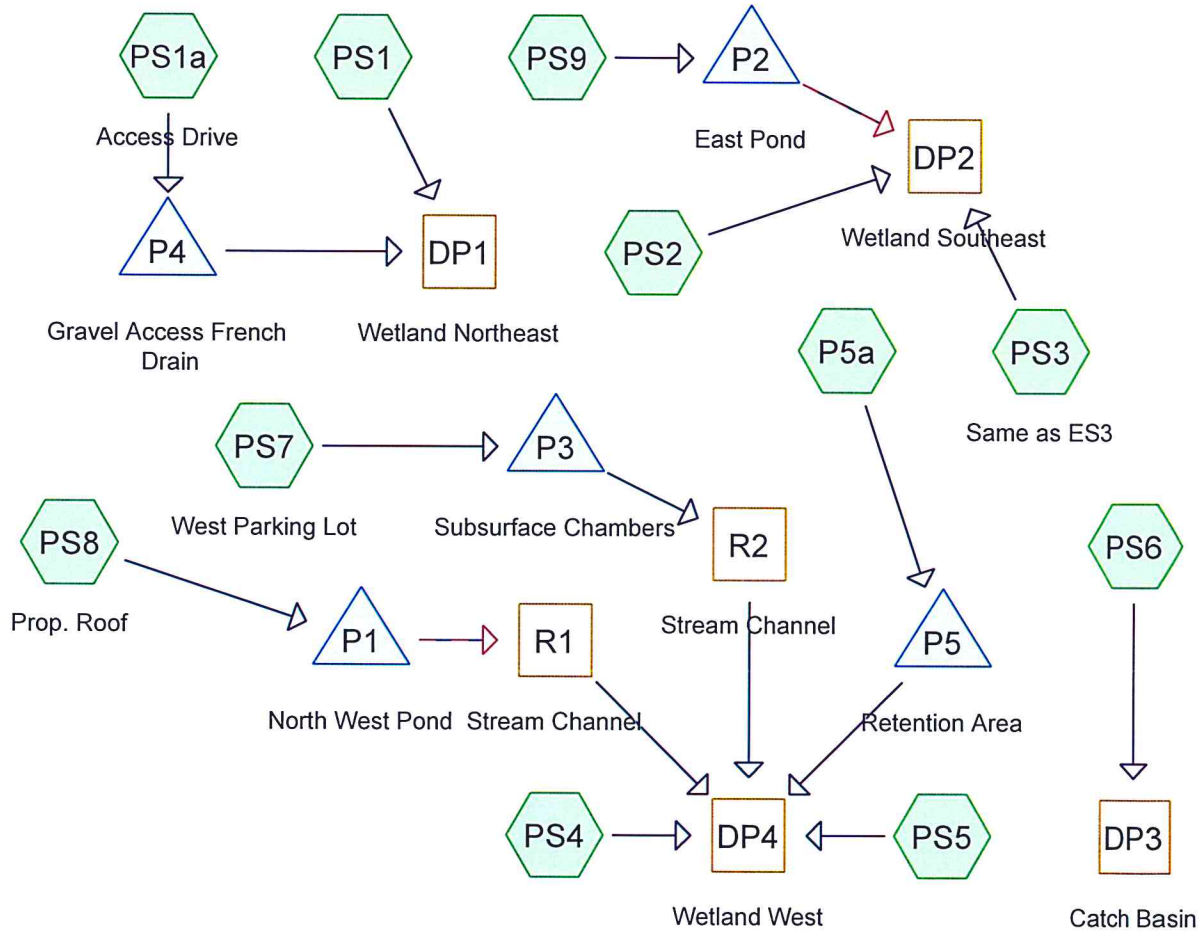
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Summary for Reach DP4: West Wetland

Inflow Area = 290,504 sf, 30.27% Impervious, Inflow Depth > 2.45" for 100-yr event
Inflow = 10.87 cfs @ 12.28 hrs, Volume= 59,235 cf
Outflow = 10.87 cfs @ 12.28 hrs, Volume= 59,235 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

APPENDIX C:
PROPOSED CONDITIONS
HYDROLOGIC ANALYSIS



Subcat Reach Pond Link

Routing Diagram for 4046 Proposed
Prepared by The Morin-Cameron Group, Inc. , Printed 4/5/2022

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment P5a: Runoff Area=19,372 sf 76.35% Impervious Runoff Depth=5.96"
Flow Length=280' Tc=19.8 min CN=85 Runoff=1.82 cfs 9,626 cf

Subcatchment PS1: Runoff Area=71,570 sf 0.00% Impervious Runoff Depth=0.42"
Flow Length=384' Tc=18.4 min CN=31 Runoff=0.10 cfs 2,525 cf

Subcatchment PS1a: Access Drive Runoff Area=15,854 sf 0.00% Impervious Runoff Depth=3.58"
Flow Length=384' Tc=18.4 min CN=64 Runoff=0.95 cfs 4,723 cf

Subcatchment PS2: Runoff Area=66,442 sf 68.70% Impervious Runoff Depth=5.61"
Flow Length=304' Tc=20.5 min CN=82 Runoff=5.83 cfs 31,080 cf

Subcatchment PS3: Same as ES3 Runoff Area=15,025 sf 74.58% Impervious Runoff Depth=5.73"
Flow Length=262' Tc=7.5 min CN=83 Runoff=2.01 cfs 7,174 cf

Subcatchment PS4: Runoff Area=71,594 sf 0.00% Impervious Runoff Depth=1.41"
Flow Length=1,297' Tc=39.5 min CN=43 Runoff=0.87 cfs 8,422 cf

Subcatchment PS5: Runoff Area=88,896 sf 75.17% Impervious Runoff Depth=5.85"
Flow Length=705' Tc=15.5 min CN=84 Runoff=9.15 cfs 43,307 cf

Subcatchment PS6: Runoff Area=13,676 sf 81.79% Impervious Runoff Depth=6.20"
Flow Length=226' Tc=7.4 min CN=87 Runoff=1.93 cfs 7,062 cf

Subcatchment PS7: West Parking Lot Runoff Area=86,432 sf 80.90% Impervious Runoff Depth=6.43"
Flow Length=274' Tc=6.0 min CN=89 Runoff=13.14 cfs 46,327 cf

Subcatchment PS8: Prop. Roof Runoff Area=112,169 sf 90.27% Impervious Runoff Depth=6.79"
Flow Length=697' Slope=0.0200 '/' Tc=6.0 min CN=92 Runoff=17.54 cfs 63,433 cf

Subcatchment PS9: Runoff Area=52,942 sf 43.21% Impervious Runoff Depth=3.91"
Flow Length=304' Tc=15.1 min CN=67 Runoff=3.81 cfs 17,235 cf

Reach DP1: Wetland Northeast Inflow=0.21 cfs 2,820 cf
Outflow=0.21 cfs 2,820 cf

Reach DP2: Wetland Southeast Inflow=7.38 cfs 44,119 cf
Outflow=7.38 cfs 44,119 cf

Reach DP3: Catch Basin Inflow=1.93 cfs 7,062 cf
Outflow=1.93 cfs 7,062 cf

Reach DP4: Wetland West Inflow=10.27 cfs 74,673 cf
Outflow=10.27 cfs 74,673 cf

Reach R1: Stream Channel Avg. Flow Depth=0.49' Max Vel=2.02 fps Inflow=4.07 cfs 16,775 cf
n=0.040 L=1,058.0' S=0.0104 '/' Capacity=24.40 cfs Outflow=3.42 cfs 16,775 cf

Reach R2: Stream Channel Avg. Flow Depth=0.11' Max Vel=1.46 fps Inflow=0.52 cfs 3,080 cf
n=0.030 L=629.3' S=0.0175 '/' Capacity=42.18 cfs Outflow=0.51 cfs 3,080 cf

Pond P1: North West Pond Peak Elev=80.27' Storage=28,691 cf Inflow=17.54 cfs 63,433 cf
Discarded=0.43 cfs 35,550 cf Primary=4.07 cfs 16,775 cf Secondary=0.00 cfs 0 cf Outflow=4.50 cfs 52,325 cf

Pond P2: East Pond Peak Elev=60.87' Storage=5,305 cf Inflow=3.81 cfs 17,235 cf
Discarded=0.15 cfs 11,210 cf Primary=1.84 cfs 5,865 cf Secondary=0.00 cfs 0 cf Outflow=1.99 cfs 17,075 cf

Pond P3: Subsurface Chambers Peak Elev=69.12' Storage=23,013 cf Inflow=13.14 cfs 46,327 cf
Discarded=0.40 cfs 38,487 cf Primary=0.52 cfs 3,080 cf Outflow=0.92 cfs 41,567 cf

Pond P4: Gravel Access French Drain Peak Elev=74.54' Storage=1,711 cf Inflow=0.95 cfs 4,723 cf
Discarded=0.08 cfs 4,428 cf Primary=0.11 cfs 296 cf Outflow=0.18 cfs 4,723 cf

Pond P5: Retention Area Peak Elev=62.00' Storage=2,417 cf Inflow=1.82 cfs 9,626 cf
Discarded=0.11 cfs 6,536 cf Primary=1.59 cfs 3,089 cf Outflow=1.70 cfs 9,626 cf

Total Runoff Area = 613,972 sf Runoff Volume = 240,912 cf Average Runoff Depth = 4.71"
44.02% Pervious = 270,264 sf 55.98% Impervious = 343,708 sf

Summary for Subcatchment P5a:

Runoff = 0.53 cfs @ 12.29 hrs, Volume= 2,727 cf, Depth= 1.69"
Routed to Pond P5 : Retention Area

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 2-yr Rainfall=3.12"

Area (sf)	CN	Description
4,096	39	>75% Grass cover, Good, HSG A
14,790	98	Paved parking, HSG A
486	61	>75% Grass cover, Good, HSG B
19,372	85	Weighted Average
4,582		23.65% Pervious Area
14,790		76.35% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.0	25	0.0200	0.03		**Sheet Flow, Sheet Flow** Grass: Short n= 0.150 P2= 0.13"
2.0	25	0.0200	0.21		**Sheet Flow, Sheet Flow** Smooth surfaces n= 0.011 P2= 0.13"
0.9	135	0.0160	2.57		**Shallow Concentrated Flow, Shallow Concentrated Flow** Paved Kv= 20.3 fps
0.9	95	0.0110	1.69		**Shallow Concentrated Flow, Shallow Concetnrated Flow** Unpaved Kv= 16.1 fps
19.8	280	Total			

Summary for Subcatchment PS1:

Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Depth= 0.00"
Routed to Reach DP1 : Wetland Northeast

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 2-yr Rainfall=3.12"

Area (sf)	CN	Description
62,057	30	Woods, Good, HSG A
9,402	39	>75% Grass cover, Good, HSG A
111	55	Woods, Good, HSG B
71,570	31	Weighted Average
71,570		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.9	50	0.0700	0.05		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 0.13"
0.3	114	0.0967	6.31		**Shallow Concentrated Flow, Shallow** Paved Kv= 20.3 fps
1.2	220	0.0368	3.09		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
18.4	384	Total			

Summary for Subcatchment PS1a: Access Drive

Runoff = 0.10 cfs @ 12.31 hrs, Volume= 690 cf, Depth= 0.52"
Routed to Pond P4 : Gravel Access French Drain

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 2-yr Rainfall=3.12"

Area (sf)	CN	Description
10,872	76	Gravel roads, HSG A
4,982	39	>75% Grass cover, Good, HSG A
15,854	64	Weighted Average
15,854		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.9	50	0.0700	0.05		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 0.13"
0.3	114	0.0967	6.31		**Shallow Concentrated Flow, Shallow** Paved Kv= 20.3 fps
1.2	220	0.0368	3.09		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
18.4	384	Total			

Summary for Subcatchment PS2:

Runoff = 1.56 cfs @ 12.30 hrs, Volume= 8,162 cf, Depth= 1.47"
Routed to Reach DP2 : Wetland Southeast

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 2-yr Rainfall=3.12"

Area (sf)	CN	Description
12,915	98	Paved parking, HSG A
11,308	39	>75% Grass cover, Good, HSG A
3,681	30	Woods, Good, HSG A
1,775	98	Paved parking, HSG C
2,635	74	>75% Grass cover, Good, HSG C
3,171	70	Woods, Good, HSG C
30,957	98	Roofs, HSG A
66,442	82	Weighted Average
20,795		31.30% Pervious Area
45,647		68.70% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
19.4	50	0.0500	0.04		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 0.13"
0.4	98	0.0336	3.72		**Shallow Concentrated Flow, Shallow** Paved Kv= 20.3 fps
0.7	156	0.0525	3.69		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
20.5	304	Total			

Summary for Subcatchment PS3: Same as ES3

Runoff = 0.56 cfs @ 12.15 hrs, Volume= 1,933 cf, Depth= 1.54"
Routed to Reach DP2 : Wetland Southeast

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 2-yr Rainfall=3.12"

Area (sf)	CN	Description
11,205	98	Paved parking, HSG A
3,820	39	>75% Grass cover, Good, HSG A
15,025	83	Weighted Average
3,820		25.42% Pervious Area
11,205		74.58% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.3	16	0.1313	0.05		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 0.13"
1.4	34	0.0853	0.40		**Sheet Flow, Sheet** Smooth surfaces n= 0.011 P2= 0.13"
0.8	212	0.0420	4.16		**Shallow Concentrated Flow, Shallow** Paved Kv= 20.3 fps
7.5	262	Total			

Summary for Subcatchment PS4:

Runoff = 0.00 cfs @ 24.09 hrs, Volume= 96 cf, Depth= 0.02"
Routed to Reach DP4 : Wetland West

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 2-yr Rainfall=3.12"

Area (sf)	CN	Description
35,572	30	Woods, Good, HSG A
637	39	>75% Grass cover, Good, HSG A
30,664	55	Woods, Good, HSG B
4,721	61	>75% Grass cover, Good, HSG B
71,594	43	Weighted Average
71,594		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
33.5	50	0.0904	0.02		**Sheet Flow, Sheet flow** Woods: Light underbrush n= 0.400 P2= 0.13"
0.5	141	0.0710	4.29		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
5.5	1,106	0.0090	3.36	22.70	**Trap/Vee/Rect Channel Flow, Stream Channel** Bot.W=3.00' D=1.50' Z= 1.0 '/' Top.W=6.00' n= 0.040
39.5	1,297	Total			

Summary for Subcatchment PS5:

Runoff = 2.61 cfs @ 12.24 hrs, Volume= 11,968 cf, Depth= 1.62"
Routed to Reach DP4 : Wetland West

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 2-yr Rainfall=3.12"

Area (sf)	CN	Description
17,286	39	>75% Grass cover, Good, HSG A
33,716	98	Paved parking, HSG A
4,150	98	Paved parking, HSG B
2,521	61	>75% Grass cover, Good, HSG B
2,262	55	Woods, Good, HSG B
28,961	98	Roofs, HSG A
88,896	84	Weighted Average
22,069		24.83% Pervious Area
66,827		75.17% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.9	50	0.1380	0.06		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 0.13"
0.0	16	0.1546	6.33		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
1.1	177	0.0172	2.66		**Shallow Concentrated Flow, Shallow** Paved Kv= 20.3 fps
0.6	256	0.0159	7.19	8.82	**Pipe Channel, Pipe (CB to DMH)** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.012 Concrete pipe, finished
0.0	13	0.0104	6.57	11.61	**Pipe Channel, Pipe (DMH to Treat. Unit.)** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012 Concrete pipe, finished
0.4	59	0.0300	2.79		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
0.5	134	0.0140	4.19	28.31	**Trap/Vee/Rect Channel Flow, Stream Channel** Bot.W=3.00' D=1.50' Z= 1.0 '/' Top.W=6.00' n= 0.040
15.5	705	Total			

Summary for Subcatchment PS6:

Runoff = 0.61 cfs @ 12.15 hrs, Volume= 2,102 cf, Depth= 1.84"
Routed to Reach DP3 : Catch Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 2-yr Rainfall=3.12"

Area (sf)	CN	Description
2,419	39	>75% Grass cover, Good, HSG A
8,112	98	Paved parking, HSG A
3,074	98	Paved parking, HSG B
71	61	>75% Grass cover, Good, HSG B
13,676	87	Weighted Average
2,490		18.21% Pervious Area
11,186		81.79% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	15	0.1313	0.05		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 0.13"
1.7	35	0.0571	0.34		**Sheet Flow, Sheet** Smooth surfaces n= 0.011 P2= 0.13"
0.7	176	0.0392	4.02		**Shallow Concentrated Flow, Shallow** Paved Kv= 20.3 fps
7.4	226	Total			

Summary for Subcatchment PS7: West Parking Lot

Runoff = 4.38 cfs @ 12.13 hrs, Volume= 14,468 cf, Depth= 2.01"
Routed to Pond P3 : Subsurface Chambers

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 2-yr Rainfall=3.12"

Area (sf)	CN	Description
11,299	39	>75% Grass cover, Good, HSG A
69,798	98	Paved parking, HSG A
5,208	76	Gravel roads, HSG A
127	98	Paved parking, HSG B
86,432	89	Weighted Average
16,507		19.10% Pervious Area
69,925		80.90% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	50	0.0260	0.27		**Sheet Flow, Sheet** Smooth surfaces n= 0.011 P2= 0.13"
1.2	224	0.0232	3.09		**Shallow Concentrated Flow, Shallow** Paved Kv= 20.3 fps
1.7					**Direct Entry, Adjusment for 0.1 hr**
6.0	274	Total			

Summary for Subcatchment PS8: Prop. Roof

Runoff = 6.29 cfs @ 12.13 hrs, Volume= 21,262 cf, Depth= 2.27"
Routed to Pond P1 : North West Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 2-yr Rainfall=3.12"

Area (sf)	CN	Description
101,251	98	Roofs, HSG A
10,544	39	>75% Grass cover, Good, HSG A
374	76	Gravel roads, HSG A
112,169	92	Weighted Average
10,918		9.73% Pervious Area
101,251		90.27% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.5	50	0.0200	0.24		**Sheet Flow, Sheet Roof** Smooth surfaces n= 0.011 P2= 0.13"
2.5	647	0.0200	4.38	0.86	**Pipe Channel, Roof drain** 6.0" Round Area= 0.2 sf Perim= 1.6' r= 0.13' n= 0.012 Corrugated PP, smooth interior
6.0	697	Total			

Summary for Subcatchment PS9:

Runoff = 0.52 cfs @ 12.26 hrs, Volume= 2,848 cf, Depth= 0.65"
Routed to Pond P2 : East Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 2-yr Rainfall=3.12"

Area (sf)	CN	Description
22,877	98	Unconnected pavement, HSG A
26,663	39	>75% Grass cover, Good, HSG A
3,402	76	Gravel roads, HSG A
52,942	67	Weighted Average
30,065		56.79% Pervious Area
22,877		43.21% Impervious Area
22,877		100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.1	50	0.1100	0.06		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 0.13"
1.0	254	0.0473	4.41		**Shallow Concentrated Flow, Shallow** Paved Kv= 20.3 fps
15.1	304	Total			

Summary for Reach DP1: Wetland Northeast

Inflow Area = 87,424 sf, 0.00% Impervious, Inflow Depth = 0.00" for 2-yr event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Reach DP2: Wetland Southeast

Inflow Area = 134,409 sf, 59.32% Impervious, Inflow Depth = 0.90" for 2-yr event
Inflow = 1.81 cfs @ 12.28 hrs, Volume= 10,095 cf
Outflow = 1.81 cfs @ 12.28 hrs, Volume= 10,095 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Reach DP3: Catch Basin

Inflow Area = 13,676 sf, 81.79% Impervious, Inflow Depth = 1.84" for 2-yr event
Inflow = 0.61 cfs @ 12.15 hrs, Volume= 2,102 cf
Outflow = 0.61 cfs @ 12.15 hrs, Volume= 2,102 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Reach DP4: Wetland West

Inflow Area = 378,463 sf, 66.79% Impervious, Inflow Depth = 0.38" for 2-yr event
Inflow = 2.61 cfs @ 12.24 hrs, Volume= 12,064 cf
Outflow = 2.61 cfs @ 12.24 hrs, Volume= 12,064 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Reach R1: Stream Channel

Inflow Area = 112,169 sf, 90.27% Impervious, Inflow Depth = 0.00" for 2-yr event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min
Routed to Reach DP4 : Wetland West

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 0.00 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 0.00 fps, Avg. Travel Time= 0.0 min

Peak Storage= 0 cf @ 0.00 hrs
Average Depth at Peak Storage= 0.00'
Bank-Full Depth= 1.50' Flow Area= 6.8 sf, Capacity= 24.40 cfs

3.00' x 1.50' deep channel, n= 0.040
Side Slope Z-value= 1.0 '/' Top Width= 6.00'
Length= 1,058.0' Slope= 0.0104 '/'
Inlet Invert= 65.00', Outlet Invert= 54.00'

Summary for Reach R2: Stream Channel

Inflow Area = 86,432 sf, 80.90% Impervious, Inflow Depth = 0.00" for 2-yr event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min
Routed to Reach DP4 : Wetland West

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 0.00 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 0.00 fps, Avg. Travel Time= 0.0 min

Peak Storage= 0 cf @ 0.00 hrs
Average Depth at Peak Storage= 0.00'
Bank-Full Depth= 1.50' Flow Area= 6.8 sf, Capacity= 42.18 cfs

3.00' x 1.50' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 1.0 '/' Top Width= 6.00'
Length= 629.3' Slope= 0.0175 '/'
Inlet Invert= 65.00', Outlet Invert= 54.00'

Summary for Pond P1: North West Pond

Inflow Area = 112,169 sf, 90.27% Impervious, Inflow Depth = 2.27" for 2-yr event
Inflow = 6.29 cfs @ 12.13 hrs, Volume= 21,262 cf
Outflow = 0.26 cfs @ 15.03 hrs, Volume= 20,850 cf, Atten= 96%, Lag= 173.7 min
Discarded = 0.26 cfs @ 15.03 hrs, Volume= 20,850 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Reach R1 : Stream Channel
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Reach R1 : Stream Channel

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 77.29' @ 15.03 hrs Surf.Area= 4,669 sf Storage= 11,106 cf

Plug-Flow detention time= 471.5 min calculated for 20,850 cf (98% of inflow)
Center-of-Mass det. time= 459.6 min (1,273.2 - 813.6)

Volume	Invert	Avail.Storage	Storage Description
#1	74.00'	35,103 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
74.00	1,804	0	0
75.00	2,970	2,387	2,387
76.00	3,684	3,327	5,714
77.00	4,437	4,061	9,775
78.00	5,229	4,833	14,608
79.00	6,060	5,645	20,252
80.00	6,931	6,496	26,748
81.00	9,779	8,355	35,103

Device	Routing	Invert	Outlet Devices
#1	Primary	74.00'	**18.0" Round Culvert** L= 120.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 74.00' / 70.00' S= 0.0333 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 1.77 sf
#2	Device 1	79.80'	**4.0' long Outlet Structure Weir** 2 End Contraction(s)
#3	Secondary	80.50'	**15.0' long x 5.0' breadth Broad-Crested Rectangular Weir**

Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50
Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

#4	Discarded	74.00'	**2.410 in/hr Exfiltration over Surface area** Phase-In= 0.01'

Discarded OutFlow Max=0.26 cfs @ 15.03 hrs HW=77.29' (Free Discharge)
↑ **4=Exfiltration** (Exfiltration Controls 0.26 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=74.00' (Free Discharge)
↑ **1=Culvert** (Controls 0.00 cfs)
↑ **2=Outlet Structure Weir** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=74.00' (Free Discharge)
↑ **3=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond P2: East Pond

Inflow Area = 52,942 sf, 43.21% Impervious, Inflow Depth = 0.65" for 2-yr event
Inflow = 0.52 cfs @ 12.26 hrs, Volume= 2,848 cf
Outflow = 0.08 cfs @ 13.91 hrs, Volume= 2,848 cf, Atten= 85%, Lag= 99.5 min
Discarded = 0.08 cfs @ 13.91 hrs, Volume= 2,848 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Reach DP2 : Wetland Southeast
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Reach DP2 : Wetland Southeast

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 58.67' @ 13.91 hrs Surf.Area= 1,406 sf Storage= 820 cf

Plug-Flow detention time= 107.6 min calculated for 2,847 cf (100% of inflow)
Center-of-Mass det. time= 107.6 min (1,044.5 - 936.9)

Volume	Invert	Avail.Storage	Storage Description
#1	58.00'	12,526 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
58.00	1,050	0	0
59.00	1,583	1,317	1,317
60.00	2,160	1,872	3,188
61.00	2,773	2,467	5,655
62.00	3,426	3,100	8,754
63.00	4,117	3,772	12,526

Device	Routing	Invert	Outlet Devices
#1	Primary	58.00'	**18.0" Round Culvert** L= 70.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 58.00' / 57.00' S= 0.0143 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 1.77 sf
#2	Device 1	60.60'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

#3	Secondary	61.00'	**10.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#4	Discarded	58.00'	**2.410 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.08 cfs @ 13.91 hrs HW=58.67' (Free Discharge)
└**4=Exfiltration** (Exfiltration Controls 0.08 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=58.00' (Free Discharge)
└**1=Culvert** (Controls 0.00 cfs)
└**2=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=58.00' (Free Discharge)
└**3=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond P3: Subsurface Chambers

Inflow Area = 86,432 sf, 80.90% Impervious, Inflow Depth = 2.01" for 2-yr event
Inflow = 4.38 cfs @ 12.13 hrs, Volume= 14,468 cf
Outflow = 0.31 cfs @ 13.58 hrs, Volume= 14,468 cf, Atten= 93%, Lag= 87.0 min
Discarded = 0.31 cfs @ 13.58 hrs, Volume= 14,468 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Reach R2 : Stream Channel

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 65.50' @ 13.58 hrs Surf.Area= 5,480 sf Storage= 5,403 cf

Plug-Flow detention time= 156.3 min calculated for 14,464 cf (100% of inflow)
Center-of-Mass det. time= 156.3 min (987.2 - 831.0)

Volume	Invert	Avail.Storage	Storage Description
#1A	64.00'	4,492 cf	**24.00'W x 200.00'L x 6.17'H Basin 3 Z=1.0** 38,431 cf Overall - 27,200 cf Embedded = 11,231 cf x 40.0% Voids
#2A	64.50'	21,264 cf	**retain_it retain_it 5.0'** x 75 Inside #1 Inside= 84.0"W x 60.0"H => 36.41 sf x 8.00'L = 291.3 cf Outside= 96.0"W x 68.0"H => 45.33 sf x 8.00'L = 362.7 cf 3 Rows adjusted for 581.8 cf perimeter wall
		25,757 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	64.00'	**18.0" Round Culvert** L= 250.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 64.00' / 61.30' S= 0.0108 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 1.77 sf
#2	Device 1	69.00'	**4.0' long 100-Year Control Weir** 2 End Contraction(s)
#3	Discarded	64.00'	**2.410 in/hr Exfiltration over Surface area** Phase-In= 0.01'

Discarded OutFlow Max=0.31 cfs @ 13.58 hrs HW=65.50' (Free Discharge)
└**3=Exfiltration** (Exfiltration Controls 0.31 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=64.00' (Free Discharge)
└**1=Culvert** (Controls 0.00 cfs)
└**2=100-Year Control Weir** (Controls 0.00 cfs)

Summary for Pond P4: Gravel Access French Drain

Inflow Area = 15,854 sf, 0.00% Impervious, Inflow Depth = 0.52" for 2-yr event
Inflow = 0.10 cfs @ 12.31 hrs, Volume= 690 cf
Outflow = 0.08 cfs @ 12.26 hrs, Volume= 690 cf, Atten= 25%, Lag= 0.0 min
Discarded = 0.08 cfs @ 12.26 hrs, Volume= 690 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Reach DP1 : Wetland Northeast

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 72.05' @ 12.47 hrs Surf.Area= 1,361 sf Storage= 27 cf

Plug-Flow detention time= 3.4 min calculated for 690 cf (100% of inflow)
Center-of-Mass det. time= 3.4 min (959.4 - 956.0)

Volume	Invert	Avail.Storage	Storage Description
#1A	72.00'	1,086 cf	**3.75'W x 363.00'L x 2.58'H Field A** 3,518 cf Overall - 804 cf Embedded = 2,714 cf x 40.0% Voids
#2A	72.50'	650 cf	**ADS N-12 18"** x 18 Inside #1 Inside= 18.2"W x 18.2"H => 1.80 sf x 20.00'L = 36.0 cf Outside= 21.0"W x 21.0"H => 2.23 sf x 20.00'L = 44.5 cf Row Length Adjustment= +1.00' x 1.80 sf x 1 rows
		1,735 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	67.60'	**12.0" Round Culvert** L= 40.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 67.60' / 66.00' S= 0.0400 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf
#2	Device 1	74.50'	**4.0' long Overflow Weir** 2 End Contraction(s)
#3	Discarded	72.00'	**2.410 in/hr Exfiltration over Surface area** Phase-In= 0.01'

Discarded OutFlow Max=0.08 cfs @ 12.26 hrs HW=72.03' (Free Discharge)
└**3=Exfiltration** (Exfiltration Controls 0.08 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=72.00' (Free Discharge)
└**1=Culvert** (Passes 0.00 cfs of 6.59 cfs potential flow)
└**2=Overflow Weir** (Controls 0.00 cfs)

Summary for Pond P5: Retention Area

Inflow Area = 19,372 sf, 76.35% Impervious, Inflow Depth = 1.69" for 2-yr event
Inflow = 0.53 cfs @ 12.29 hrs, Volume= 2,727 cf
Outflow = 0.07 cfs @ 13.62 hrs, Volume= 2,727 cf, Atten= 87%, Lag= 80.0 min
Discarded = 0.07 cfs @ 13.62 hrs, Volume= 2,727 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Reach DP4 : Wetland West

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 61.13' @ 13.62 hrs Surf.Area= 1,271 sf Storage= 1,021 cf

Plug-Flow detention time= 152.2 min calculated for 2,727 cf (100% of inflow)
Center-of-Mass det. time= 152.2 min (1,015.6 - 863.4)

Volume	Invert	Avail.Storage	Storage Description
#1	60.00'	2,914 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
60.00	547	0	0
61.00	1,171	859	859
62.00	1,926	1,549	2,408
62.25	2,124	506	2,914

Device	Routing	Invert	Outlet Devices
#1	Primary	59.60'	**12.0" Round Culvert** L= 45.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 59.60' / 58.70' S= 0.0200 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 0.79 sf
#2	Device 1	61.85'	**1.8" x 1.8" Horiz. Grate X 7.00 columns** X 7 rows C= 0.600 in 24.0" x 24.0" Grate (28% open area) Limited to weir flow at low heads
#3	Discarded	60.00'	**2.410 in/hr Exfiltration over Surface area** Phase-In= 0.01'

Discarded OutFlow Max=0.07 cfs @ 13.62 hrs HW=61.13' (Free Discharge)
↑—**3=Exfiltration** (Exfiltration Controls 0.07 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=60.00' (Free Discharge)
↑—**1=Culvert** (Passes 0.00 cfs of 0.50 cfs potential flow)
↑—**2=Grate** (Controls 0.00 cfs)

Summary for Subcatchment P5a:

Runoff = 1.03 cfs @ 12.28 hrs, Volume= 5,303 cf, Depth= 3.28"
Routed to Pond P5 : Retention Area

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 10-yr Rainfall=4.91"

Area (sf)	CN	Description
4,096	39	>75% Grass cover, Good, HSG A
14,790	98	Paved parking, HSG A
486	61	>75% Grass cover, Good, HSG B
19,372	85	Weighted Average
4,582		23.65% Pervious Area
14,790		76.35% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.0	25	0.0200	0.03		**Sheet Flow, Sheet Flow** Grass: Short n= 0.150 P2= 0.13"
2.0	25	0.0200	0.21		**Sheet Flow, Sheet Flow** Smooth surfaces n= 0.011 P2= 0.13"
0.9	135	0.0160	2.57		**Shallow Concentrated Flow, Shallow Concentrated Flow** Paved Kv= 20.3 fps
0.9	95	0.0110	1.69		**Shallow Concentrated Flow, Shallow Concetnrated Flow** Unpaved Kv= 16.1 fps
19.8	280	Total			

Summary for Subcatchment PS1:

Runoff = 0.00 cfs @ 24.05 hrs, Volume= 55 cf, Depth= 0.01"
Routed to Reach DP1 : Wetland Northeast

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 10-yr Rainfall=4.91"

Area (sf)	CN	Description
62,057	30	Woods, Good, HSG A
9,402	39	>75% Grass cover, Good, HSG A
111	55	Woods, Good, HSG B
71,570	31	Weighted Average
71,570		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.9	50	0.0700	0.05		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 0.13"
0.3	114	0.0967	6.31		**Shallow Concentrated Flow, Shallow** Paved Kv= 20.3 fps
1.2	220	0.0368	3.09		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
18.4	384	Total			

Summary for Subcatchment PS1a: Access Drive

Runoff = 0.38 cfs @ 12.29 hrs, Volume= 2,011 cf, Depth= 1.52"
Routed to Pond P4 : Gravel Access French Drain

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 10-yr Rainfall=4.91"

Area (sf)	CN	Description
10,872	76	Gravel roads, HSG A
4,982	39	>75% Grass cover, Good, HSG A
15,854	64	Weighted Average
15,854		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.9	50	0.0700	0.05		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 0.13"
0.3	114	0.0967	6.31		**Shallow Concentrated Flow, Shallow** Paved Kv= 20.3 fps
1.2	220	0.0368	3.09		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
18.4	384	Total			

Summary for Subcatchment PS2:

Runoff = 3.18 cfs @ 12.30 hrs, Volume= 16,603 cf, Depth= 3.00"
Routed to Reach DP2 : Wetland Southeast

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 10-yr Rainfall=4.91"

Area (sf)	CN	Description
12,915	98	Paved parking, HSG A
11,308	39	>75% Grass cover, Good, HSG A
3,681	30	Woods, Good, HSG A
1,775	98	Paved parking, HSG C
2,635	74	>75% Grass cover, Good, HSG C
3,171	70	Woods, Good, HSG C
30,957	98	Roofs, HSG A
66,442	82	Weighted Average
20,795		31.30% Pervious Area
45,647		68.70% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
19.4	50	0.0500	0.04		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 0.13"
0.4	98	0.0336	3.72		**Shallow Concentrated Flow, Shallow** Paved Kv= 20.3 fps
0.7	156	0.0525	3.69		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
20.5	304	Total			

Summary for Subcatchment PS3: Same as ES3

Runoff = 1.11 cfs @ 12.15 hrs, Volume= 3,872 cf, Depth= 3.09"
Routed to Reach DP2 : Wetland Southeast

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 10-yr Rainfall=4.91"

Area (sf)	CN	Description
11,205	98	Paved parking, HSG A
3,820	39	>75% Grass cover, Good, HSG A
15,025	83	Weighted Average
3,820		25.42% Pervious Area
11,205		74.58% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.3	16	0.1313	0.05		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 0.13"
1.4	34	0.0853	0.40		**Sheet Flow, Sheet** Smooth surfaces n= 0.011 P2= 0.13"
0.8	212	0.0420	4.16		**Shallow Concentrated Flow, Shallow** Paved Kv= 20.3 fps
7.5	262	Total			

Summary for Subcatchment PS4:

Runoff = 0.08 cfs @ 13.13 hrs, Volume= 1,962 cf, Depth= 0.33"
Routed to Reach DP4 : Wetland West

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 10-yr Rainfall=4.91"

Area (sf)	CN	Description
35,572	30	Woods, Good, HSG A
637	39	>75% Grass cover, Good, HSG A
30,664	55	Woods, Good, HSG B
4,721	61	>75% Grass cover, Good, HSG B
71,594	43	Weighted Average
71,594		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
33.5	50	0.0904	0.02		**Sheet Flow, Sheet flow** Woods: Light underbrush n= 0.400 P2= 0.13"
0.5	141	0.0710	4.29		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
5.5	1,106	0.0090	3.36	22.70	**Trap/Vee/Rect Channel Flow, Stream Channel** Bot.W=3.00' D=1.50' Z= 1.0 '/' Top.W=6.00' n= 0.040
39.5	1,297	Total			

Summary for Subcatchment PS5:

Runoff = 5.12 cfs @ 12.24 hrs, Volume= 23,618 cf, Depth= 3.19"
Routed to Reach DP4 : Wetland West

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 10-yr Rainfall=4.91"

Area (sf)	CN	Description
17,286	39	>75% Grass cover, Good, HSG A
33,716	98	Paved parking, HSG A
4,150	98	Paved parking, HSG B
2,521	61	>75% Grass cover, Good, HSG B
2,262	55	Woods, Good, HSG B
28,961	98	Roofs, HSG A
88,896	84	Weighted Average
22,069		24.83% Pervious Area
66,827		75.17% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.9	50	0.1380	0.06		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 0.13"
0.0	16	0.1546	6.33		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
1.1	177	0.0172	2.66		**Shallow Concentrated Flow, Shallow** Paved Kv= 20.3 fps
0.6	256	0.0159	7.19	8.82	**Pipe Channel, Pipe (CB to DMH)** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.012 Concrete pipe, finished
0.0	13	0.0104	6.57	11.61	**Pipe Channel, Pipe (DMH to Treat. Unit.)** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012 Concrete pipe, finished
0.4	59	0.0300	2.79		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
0.5	134	0.0140	4.19	28.31	**Trap/Vee/Rect Channel Flow, Stream Channel** Bot.W=3.00' D=1.50' Z= 1.0 '/' Top.W=6.00' n= 0.040
15.5	705	Total			

Summary for Subcatchment PS6:

Runoff = 1.12 cfs @ 12.14 hrs, Volume= 3,969 cf, Depth= 3.48"
Routed to Reach DP3 : Catch Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 10-yr Rainfall=4.91"

Area (sf)	CN	Description
2,419	39	>75% Grass cover, Good, HSG A
8,112	98	Paved parking, HSG A
3,074	98	Paved parking, HSG B
71	61	>75% Grass cover, Good, HSG B
13,676	87	Weighted Average
2,490		18.21% Pervious Area
11,186		81.79% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	15	0.1313	0.05		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 0.13"
1.7	35	0.0571	0.34		**Sheet Flow, Sheet** Smooth surfaces n= 0.011 P2= 0.13"
0.7	176	0.0392	4.02		**Shallow Concentrated Flow, Shallow** Paved Kv= 20.3 fps
7.4	226	Total			

Summary for Subcatchment PS7: West Parking Lot

Runoff = 7.79 cfs @ 12.13 hrs, Volume= 26,548 cf, Depth= 3.69"
Routed to Pond P3 : Subsurface Chambers

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 10-yr Rainfall=4.91"

Area (sf)	CN	Description
11,299	39	>75% Grass cover, Good, HSG A
69,798	98	Paved parking, HSG A
5,208	76	Gravel roads, HSG A
127	98	Paved parking, HSG B
86,432	89	Weighted Average
16,507		19.10% Pervious Area
69,925		80.90% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	50	0.0260	0.27		**Sheet Flow, Sheet** Smooth surfaces n= 0.011 P2= 0.13"
1.2	224	0.0232	3.09		**Shallow Concentrated Flow, Shallow** Paved Kv= 20.3 fps
1.7					**Direct Entry, Adjusment for 0.1 hr**
6.0	274	Total			

Summary for Subcatchment PS8: Prop. Roof

Runoff = 10.69 cfs @ 12.13 hrs, Volume= 37,403 cf, Depth= 4.00"
Routed to Pond P1 : North West Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 10-yr Rainfall=4.91"

Area (sf)	CN	Description
101,251	98	Roofs, HSG A
10,544	39	>75% Grass cover, Good, HSG A
374	76	Gravel roads, HSG A
112,169	92	Weighted Average
10,918		9.73% Pervious Area
101,251		90.27% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.5	50	0.0200	0.24		**Sheet Flow, Sheet Roof** Smooth surfaces n= 0.011 P2= 0.13"
2.5	647	0.0200	4.38	0.86	**Pipe Channel, Roof drain** 6.0" Round Area= 0.2 sf Perim= 1.6' r= 0.13' n= 0.012 Corrugated PP, smooth interior
6.0	697	Total			

Summary for Subcatchment PS9:

Runoff = 1.64 cfs @ 12.24 hrs, Volume= 7,679 cf, Depth= 1.74"
Routed to Pond P2 : East Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 10-yr Rainfall=4.91"

Area (sf)	CN	Description
22,877	98	Unconnected pavement, HSG A
26,663	39	>75% Grass cover, Good, HSG A
3,402	76	Gravel roads, HSG A
52,942	67	Weighted Average
30,065		56.79% Pervious Area
22,877		43.21% Impervious Area
22,877		100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.1	50	0.1100	0.06		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 0.13"
1.0	254	0.0473	4.41		**Shallow Concentrated Flow, Shallow** Paved Kv= 20.3 fps
15.1	304	Total			

Summary for Reach DP1: Wetland Northeast

Inflow Area = 87,424 sf, 0.00% Impervious, Inflow Depth = 0.01" for 10-yr event
Inflow = 0.00 cfs @ 24.05 hrs, Volume= 55 cf
Outflow = 0.00 cfs @ 24.05 hrs, Volume= 55 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Reach DP2: Wetland Southeast

Inflow Area = 134,409 sf, 59.32% Impervious, Inflow Depth = 1.83" for 10-yr event
Inflow = 3.67 cfs @ 12.27 hrs, Volume= 20,476 cf
Outflow = 3.67 cfs @ 12.27 hrs, Volume= 20,476 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Reach DP3: Catch Basin

Inflow Area = 13,676 sf, 81.79% Impervious, Inflow Depth = 3.48" for 10-yr event
Inflow = 1.12 cfs @ 12.14 hrs, Volume= 3,969 cf
Outflow = 1.12 cfs @ 12.14 hrs, Volume= 3,969 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Reach DP4: Wetland West

Inflow Area = 378,463 sf, 66.79% Impervious, Inflow Depth = 0.82" for 10-yr event
Inflow = 5.12 cfs @ 12.24 hrs, Volume= 25,803 cf
Outflow = 5.12 cfs @ 12.24 hrs, Volume= 25,803 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Reach R1: Stream Channel

Inflow Area = 112,169 sf, 90.27% Impervious, Inflow Depth = 0.00" for 10-yr event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min
Routed to Reach DP4 : Wetland West

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 0.00 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 0.00 fps, Avg. Travel Time= 0.0 min

Peak Storage= 0 cf @ 0.00 hrs
Average Depth at Peak Storage= 0.00'
Bank-Full Depth= 1.50' Flow Area= 6.8 sf, Capacity= 24.40 cfs

3.00' x 1.50' deep channel, n= 0.040
Side Slope Z-value= 1.0 '/' Top Width= 6.00'
Length= 1,058.0' Slope= 0.0104 '/'
Inlet Invert= 65.00', Outlet Invert= 54.00'

Summary for Reach R2: Stream Channel

Inflow Area = 86,432 sf, 80.90% Impervious, Inflow Depth = 0.00" for 10-yr event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min
Routed to Reach DP4 : Wetland West

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 0.00 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 0.00 fps, Avg. Travel Time= 0.0 min

Peak Storage= 0 cf @ 0.00 hrs
Average Depth at Peak Storage= 0.00'
Bank-Full Depth= 1.50' Flow Area= 6.8 sf, Capacity= 42.18 cfs

3.00' x 1.50' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 1.0 '/' Top Width= 6.00'
Length= 629.3' Slope= 0.0175 '/'
Inlet Invert= 65.00', Outlet Invert= 54.00'

Summary for Pond P1: North West Pond

Inflow Area = 112,169 sf, 90.27% Impervious, Inflow Depth = 4.00" for 10-yr event
Inflow = 10.69 cfs @ 12.13 hrs, Volume= 37,403 cf
Outflow = 0.35 cfs @ 16.22 hrs, Volume= 30,268 cf, Atten= 97%, Lag= 245.3 min
Discarded = 0.35 cfs @ 16.22 hrs, Volume= 30,268 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Reach R1 : Stream Channel
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Reach R1 : Stream Channel

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 79.26' @ 16.22 hrs Surf.Area= 6,289 sf Storage= 21,876 cf

Plug-Flow detention time= 576.6 min calculated for 30,268 cf (81% of inflow)
Center-of-Mass det. time= 488.1 min (1,281.9 - 793.8)

Volume	Invert	Avail.Storage	Storage Description
#1	74.00'	35,103 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
74.00	1,804	0	0
75.00	2,970	2,387	2,387
76.00	3,684	3,327	5,714
77.00	4,437	4,061	9,775
78.00	5,229	4,833	14,608
79.00	6,060	5,645	20,252
80.00	6,931	6,496	26,748
81.00	9,779	8,355	35,103

Device	Routing	Invert	Outlet Devices
#1	Primary	74.00'	**18.0" Round Culvert** L= 120.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 74.00' / 70.00' S= 0.0333 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 1.77 sf
#2	Device 1	79.80'	**4.0' long Outlet Structure Weir** 2 End Contraction(s)
#3	Secondary	80.50'	**15.0' long x 5.0' breadth Broad-Crested Rectangular Weir**

Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50
Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

#4	Discarded	74.00'	**2.410 in/hr Exfiltration over Surface area** Phase-In= 0.01'

Discarded OutFlow Max=0.35 cfs @ 16.22 hrs HW=79.26' (Free Discharge)
└**4=Exfiltration** (Exfiltration Controls 0.35 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=74.00' (Free Discharge)
└**1=Culvert** (Controls 0.00 cfs)
└**2=Outlet Structure Weir** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=74.00' (Free Discharge)
└**3=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond P2: East Pond

Inflow Area =	52,942 sf,	43.21% Impervious,	Inflow Depth =	1.74"	for 10-yr event
Inflow =	1.64 cfs @	12.24 hrs, Volume=	7,679 cf		
Outflow =	0.12 cfs @	15.25 hrs, Volume=	7,679 cf,	Atten= 92%,	Lag= 181.0 min
Discarded =	0.12 cfs @	15.25 hrs, Volume=	7,679 cf		
Primary =	0.00 cfs @	0.00 hrs, Volume=	0 cf		
Routed to Reach DP2 : Wetland Southeast					
Secondary =	0.00 cfs @	0.00 hrs, Volume=	0 cf		
Routed to Reach DP2 : Wetland Southeast					

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 60.13' @ 15.25 hrs Surf.Area= 2,237 sf Storage= 3,465 cf

Plug-Flow detention time= 345.2 min calculated for 7,679 cf (100% of inflow)
Center-of-Mass det. time= 345.2 min (1,241.5 - 896.4)

Volume	Invert	Avail.Storage	Storage Description
#1	58.00'	12,526 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
58.00	1,050	0	0
59.00	1,583	1,317	1,317
60.00	2,160	1,872	3,188
61.00	2,773	2,467	5,655
62.00	3,426	3,100	8,754
63.00	4,117	3,772	12,526

Device	Routing	Invert	Outlet Devices
#1	Primary	58.00'	**18.0" Round Culvert** L= 70.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 58.00' / 57.00' S= 0.0143 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 1.77 sf
#2	Device 1	60.60'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

#3	Secondary	61.00'	**10.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#4	Discarded	58.00'	**2.410 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.12 cfs @ 15.25 hrs HW=60.13' (Free Discharge)
↑└**4=Exfiltration** (Exfiltration Controls 0.12 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=58.00' (Free Discharge)
↑└**1=Culvert** (Controls 0.00 cfs)
↑└**2=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=58.00' (Free Discharge)
↑└**3=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond P3: Subsurface Chambers

Inflow Area = 86,432 sf, 80.90% Impervious, Inflow Depth = 3.69" for 10-yr event
Inflow = 7.79 cfs @ 12.13 hrs, Volume= 26,548 cf
Outflow = 0.34 cfs @ 14.83 hrs, Volume= 26,548 cf, Atten= 96%, Lag= 162.1 min
Discarded = 0.34 cfs @ 14.83 hrs, Volume= 26,548 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Reach R2 : Stream Channel

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 66.99' @ 14.83 hrs Surf.Area= 6,175 sf Storage= 12,360 cf

Plug-Flow detention time= 355.1 min calculated for 26,548 cf (100% of inflow)
Center-of-Mass det. time= 355.1 min (1,164.0 - 808.9)

Volume	Invert	Avail.Storage	Storage Description
#1A	64.00'	4,492 cf	**24.00'W x 200.00'L x 6.17'H Basin 3 Z=1.0** 38,431 cf Overall - 27,200 cf Embedded = 11,231 cf x 40.0% Voids
#2A	64.50'	21,264 cf	**retain_it retain_it 5.0'** x 75 Inside #1 Inside= 84.0"W x 60.0"H => 36.41 sf x 8.00'L = 291.3 cf Outside= 96.0"W x 68.0"H => 45.33 sf x 8.00'L = 362.7 cf 3 Rows adjusted for 581.8 cf perimeter wall
		25,757 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	64.00'	**18.0" Round Culvert** L= 250.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 64.00' / 61.30' S= 0.0108 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 1.77 sf
#2	Device 1	69.00'	**4.0' long 100-Year Control Weir** 2 End Contraction(s)
#3	Discarded	64.00'	**2.410 in/hr Exfiltration over Surface area** Phase-In= 0.01'

Discarded OutFlow Max=0.34 cfs @ 14.83 hrs HW=66.99' (Free Discharge)
└**3=Exfiltration** (Exfiltration Controls 0.34 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=64.00' (Free Discharge)
└**1=Culvert** (Controls 0.00 cfs)
└**2=100-Year Control Weir** (Controls 0.00 cfs)

Summary for Pond P4: Gravel Access French Drain

Inflow Area = 15,854 sf, 0.00% Impervious, Inflow Depth = 1.52" for 10-yr event
Inflow = 0.38 cfs @ 12.29 hrs, Volume= 2,011 cf
Outflow = 0.08 cfs @ 12.00 hrs, Volume= 2,011 cf, Atten= 80%, Lag= 0.0 min
Discarded = 0.08 cfs @ 12.00 hrs, Volume= 2,011 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Reach DP1 : Wetland Northeast

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 72.87' @ 13.28 hrs Surf.Area= 1,361 sf Storage= 493 cf

Plug-Flow detention time= 47.2 min calculated for 2,011 cf (100% of inflow)
Center-of-Mass det. time= 47.2 min (957.0 - 909.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	72.00'	1,086 cf	**3.75'W x 363.00'L x 2.58'H Field A** 3,518 cf Overall - 804 cf Embedded = 2,714 cf x 40.0% Voids
#2A	72.50'	650 cf	**ADS N-12 18"** x 18 Inside #1 Inside= 18.2"W x 18.2"H => 1.80 sf x 20.00'L = 36.0 cf Outside= 21.0"W x 21.0"H => 2.23 sf x 20.00'L = 44.5 cf Row Length Adjustment= +1.00' x 1.80 sf x 1 rows
		1,735 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	67.60'	**12.0" Round Culvert** L= 40.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 67.60' / 66.00' S= 0.0400 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf
#2	Device 1	74.50'	**4.0' long Overflow Weir** 2 End Contraction(s)
#3	Discarded	72.00'	**2.410 in/hr Exfiltration over Surface area** Phase-In= 0.01'

Discarded OutFlow Max=0.08 cfs @ 12.00 hrs HW=72.03' (Free Discharge)
└**3=Exfiltration** (Exfiltration Controls 0.08 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=72.00' (Free Discharge)
└**1=Culvert** (Passes 0.00 cfs of 6.59 cfs potential flow)
└**2=Overflow Weir** (Controls 0.00 cfs)

Summary for Pond P5: Retention Area

Inflow Area = 19,372 sf, 76.35% Impervious, Inflow Depth = 3.28" for 10-yr event
Inflow = 1.03 cfs @ 12.28 hrs, Volume= 5,303 cf
Outflow = 0.20 cfs @ 13.05 hrs, Volume= 5,303 cf, Atten= 80%, Lag= 46.0 min
Discarded = 0.10 cfs @ 13.05 hrs, Volume= 5,081 cf
Primary = 0.10 cfs @ 13.05 hrs, Volume= 222 cf
Routed to Reach DP4 : Wetland West

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 61.87' @ 13.05 hrs Surf.Area= 1,831 sf Storage= 2,170 cf

Plug-Flow detention time= 234.4 min calculated for 5,302 cf (100% of inflow)
Center-of-Mass det. time= 234.4 min (1,073.2 - 838.8)

Volume	Invert	Avail.Storage	Storage Description
#1	60.00'	2,914 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
60.00	547	0	0
61.00	1,171	859	859
62.00	1,926	1,549	2,408
62.25	2,124	506	2,914

Device	Routing	Invert	Outlet Devices
#1	Primary	59.60'	**12.0" Round Culvert** L= 45.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 59.60' / 58.70' S= 0.0200 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 0.79 sf
#2	Device 1	61.85'	**1.8" x 1.8" Horiz. Grate X 7.00 columns** X 7 rows C= 0.600 in 24.0" x 24.0" Grate (28% open area) Limited to weir flow at low heads
#3	Discarded	60.00'	**2.410 in/hr Exfiltration over Surface area** Phase-In= 0.01'

Discarded OutFlow Max=0.10 cfs @ 13.05 hrs HW=61.87' (Free Discharge)
↑—**3=Exfiltration** (Exfiltration Controls 0.10 cfs)

Primary OutFlow Max=0.09 cfs @ 13.05 hrs HW=61.87' (Free Discharge)
↑—**1=Culvert** (Passes 0.09 cfs of 3.98 cfs potential flow)
↑—**2=Grate** (Weir Controls 0.09 cfs @ 0.50 fps)

Summary for Subcatchment P5a:

Runoff = 1.82 cfs @ 12.28 hrs, Volume= 9,626 cf, Depth= 5.96"
Routed to Pond P5 : Retention Area

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 100-yr Rainfall=7.74"

Area (sf)	CN	Description
4,096	39	>75% Grass cover, Good, HSG A
14,790	98	Paved parking, HSG A
486	61	>75% Grass cover, Good, HSG B
19,372	85	Weighted Average
4,582		23.65% Pervious Area
14,790		76.35% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.0	25	0.0200	0.03		**Sheet Flow, Sheet Flow** Grass: Short n= 0.150 P2= 0.13"
2.0	25	0.0200	0.21		**Sheet Flow, Sheet Flow** Smooth surfaces n= 0.011 P2= 0.13"
0.9	135	0.0160	2.57		**Shallow Concentrated Flow, Shallow Concentrated Flow** Paved Kv= 20.3 fps
0.9	95	0.0110	1.69		**Shallow Concentrated Flow, Shallow Concetnrated Flow** Unpaved Kv= 16.1 fps
19.8	280	Total			

Summary for Subcatchment PS1:

Runoff = 0.10 cfs @ 13.02 hrs, Volume= 2,525 cf, Depth= 0.42"
Routed to Reach DP1 : Wetland Northeast

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 100-yr Rainfall=7.74"

Area (sf)	CN	Description
62,057	30	Woods, Good, HSG A
9,402	39	>75% Grass cover, Good, HSG A
111	55	Woods, Good, HSG B
71,570	31	Weighted Average
71,570		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.9	50	0.0700	0.05		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 0.13"
0.3	114	0.0967	6.31		**Shallow Concentrated Flow, Shallow** Paved Kv= 20.3 fps
1.2	220	0.0368	3.09		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
18.4	384	Total			

Summary for Subcatchment PS1a: Access Drive

Runoff = 0.95 cfs @ 12.28 hrs, Volume= 4,723 cf, Depth= 3.58"
Routed to Pond P4 : Gravel Access French Drain

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 100-yr Rainfall=7.74"

Area (sf)	CN	Description
10,872	76	Gravel roads, HSG A
4,982	39	>75% Grass cover, Good, HSG A
15,854	64	Weighted Average
15,854		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.9	50	0.0700	0.05		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 0.13"
0.3	114	0.0967	6.31		**Shallow Concentrated Flow, Shallow** Paved Kv= 20.3 fps
1.2	220	0.0368	3.09		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
18.4	384	Total			

Summary for Subcatchment PS2:

Runoff = 5.83 cfs @ 12.29 hrs, Volume= 31,080 cf, Depth= 5.61"
Routed to Reach DP2 : Wetland Southeast

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 100-yr Rainfall=7.74"

Area (sf)	CN	Description
12,915	98	Paved parking, HSG A
11,308	39	>75% Grass cover, Good, HSG A
3,681	30	Woods, Good, HSG A
1,775	98	Paved parking, HSG C
2,635	74	>75% Grass cover, Good, HSG C
3,171	70	Woods, Good, HSG C
30,957	98	Roofs, HSG A
66,442	82	Weighted Average
20,795		31.30% Pervious Area
45,647		68.70% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
19.4	50	0.0500	0.04		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 0.13"
0.4	98	0.0336	3.72		**Shallow Concentrated Flow, Shallow** Paved Kv= 20.3 fps
0.7	156	0.0525	3.69		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
20.5	304	Total			

Summary for Subcatchment PS3: Same as ES3

Runoff = 2.01 cfs @ 12.15 hrs, Volume= 7,174 cf, Depth= 5.73"
Routed to Reach DP2 : Wetland Southeast

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 100-yr Rainfall=7.74"

Area (sf)	CN	Description
11,205	98	Paved parking, HSG A
3,820	39	>75% Grass cover, Good, HSG A
15,025	83	Weighted Average
3,820		25.42% Pervious Area
11,205		74.58% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.3	16	0.1313	0.05		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 0.13"
1.4	34	0.0853	0.40		**Sheet Flow, Sheet** Smooth surfaces n= 0.011 P2= 0.13"
0.8	212	0.0420	4.16		**Shallow Concentrated Flow, Shallow** Paved Kv= 20.3 fps
7.5	262	Total			

Summary for Subcatchment PS4:

Runoff = 0.87 cfs @ 12.60 hrs, Volume= 8,422 cf, Depth= 1.41"
Routed to Reach DP4 : Wetland West

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 100-yr Rainfall=7.74"

Area (sf)	CN	Description
35,572	30	Woods, Good, HSG A
637	39	>75% Grass cover, Good, HSG A
30,664	55	Woods, Good, HSG B
4,721	61	>75% Grass cover, Good, HSG B
71,594	43	Weighted Average
71,594		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
33.5	50	0.0904	0.02		**Sheet Flow, Sheet flow** Woods: Light underbrush n= 0.400 P2= 0.13"
0.5	141	0.0710	4.29		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
5.5	1,106	0.0090	3.36	22.70	**Trap/Vee/Rect Channel Flow, Stream Channel** Bot.W=3.00' D=1.50' Z= 1.0 '/' Top.W=6.00' n= 0.040
39.5	1,297	Total			

Summary for Subcatchment PS5:

Runoff = 9.15 cfs @ 12.23 hrs, Volume= 43,307 cf, Depth= 5.85"
Routed to Reach DP4 : Wetland West

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 100-yr Rainfall=7.74"

Area (sf)	CN	Description
17,286	39	>75% Grass cover, Good, HSG A
33,716	98	Paved parking, HSG A
4,150	98	Paved parking, HSG B
2,521	61	>75% Grass cover, Good, HSG B
2,262	55	Woods, Good, HSG B
28,961	98	Roofs, HSG A
88,896	84	Weighted Average
22,069		24.83% Pervious Area
66,827		75.17% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.9	50	0.1380	0.06		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 0.13"
0.0	16	0.1546	6.33		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
1.1	177	0.0172	2.66		**Shallow Concentrated Flow, Shallow** Paved Kv= 20.3 fps
0.6	256	0.0159	7.19	8.82	**Pipe Channel, Pipe (CB to DMH)** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.012 Concrete pipe, finished
0.0	13	0.0104	6.57	11.61	**Pipe Channel, Pipe (DMH to Treat. Unit.)** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.012 Concrete pipe, finished
0.4	59	0.0300	2.79		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
0.5	134	0.0140	4.19	28.31	**Trap/Vee/Rect Channel Flow, Stream Channel** Bot.W=3.00' D=1.50' Z= 1.0 '/' Top.W=6.00' n= 0.040
15.5	705	Total			

Summary for Subcatchment PS6:

Runoff = 1.93 cfs @ 12.14 hrs, Volume= 7,062 cf, Depth= 6.20"
Routed to Reach DP3 : Catch Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 100-yr Rainfall=7.74"

Area (sf)	CN	Description
2,419	39	>75% Grass cover, Good, HSG A
8,112	98	Paved parking, HSG A
3,074	98	Paved parking, HSG B
71	61	>75% Grass cover, Good, HSG B
13,676	87	Weighted Average
2,490		18.21% Pervious Area
11,186		81.79% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	15	0.1313	0.05		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 0.13"
1.7	35	0.0571	0.34		**Sheet Flow, Sheet** Smooth surfaces n= 0.011 P2= 0.13"
0.7	176	0.0392	4.02		**Shallow Concentrated Flow, Shallow** Paved Kv= 20.3 fps
7.4	226	Total			

Summary for Subcatchment PS7: West Parking Lot

Runoff = 13.14 cfs @ 12.13 hrs, Volume= 46,327 cf, Depth= 6.43"
Routed to Pond P3 : Subsurface Chambers

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 100-yr Rainfall=7.74"

Area (sf)	CN	Description
11,299	39	>75% Grass cover, Good, HSG A
69,798	98	Paved parking, HSG A
5,208	76	Gravel roads, HSG A
127	98	Paved parking, HSG B
86,432	89	Weighted Average
16,507		19.10% Pervious Area
69,925		80.90% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	50	0.0260	0.27		**Sheet Flow, Sheet** Smooth surfaces n= 0.011 P2= 0.13"
1.2	224	0.0232	3.09		**Shallow Concentrated Flow, Shallow** Paved Kv= 20.3 fps
1.7					**Direct Entry, Adjusment for 0.1 hr**
6.0	274	Total			

Summary for Subcatchment PS8: Prop. Roof

Runoff = 17.54 cfs @ 12.13 hrs, Volume= 63,433 cf, Depth= 6.79"
Routed to Pond P1 : North West Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 100-yr Rainfall=7.74"

Area (sf)	CN	Description
101,251	98	Roofs, HSG A
10,544	39	>75% Grass cover, Good, HSG A
374	76	Gravel roads, HSG A
112,169	92	Weighted Average
10,918		9.73% Pervious Area
101,251		90.27% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.5	50	0.0200	0.24		**Sheet Flow, Sheet Roof** Smooth surfaces n= 0.011 P2= 0.13"
2.5	647	0.0200	4.38	0.86	**Pipe Channel, Roof drain** 6.0" Round Area= 0.2 sf Perim= 1.6' r= 0.13' n= 0.012 Corrugated PP, smooth interior
6.0	697	Total			

Summary for Subcatchment PS9:

Runoff = 3.81 cfs @ 12.23 hrs, Volume= 17,235 cf, Depth= 3.91"
Routed to Pond P2 : East Pond

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 100-yr Rainfall=7.74"

Area (sf)	CN	Description
22,877	98	Unconnected pavement, HSG A
26,663	39	>75% Grass cover, Good, HSG A
3,402	76	Gravel roads, HSG A
52,942	67	Weighted Average
30,065		56.79% Pervious Area
22,877		43.21% Impervious Area
22,877		100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.1	50	0.1100	0.06		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 0.13"
1.0	254	0.0473	4.41		**Shallow Concentrated Flow, Shallow** Paved Kv= 20.3 fps
15.1	304	Total			

Summary for Reach DP1: Wetland Northeast

Inflow Area = 87,424 sf, 0.00% Impervious, Inflow Depth = 0.39" for 100-yr event
Inflow = 0.21 cfs @ 13.14 hrs, Volume= 2,820 cf
Outflow = 0.21 cfs @ 13.14 hrs, Volume= 2,820 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Reach DP2: Wetland Southeast

Inflow Area = 134,409 sf, 59.32% Impervious, Inflow Depth = 3.94" for 100-yr event
Inflow = 7.38 cfs @ 12.37 hrs, Volume= 44,119 cf
Outflow = 7.38 cfs @ 12.37 hrs, Volume= 44,119 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Reach DP3: Catch Basin

Inflow Area = 13,676 sf, 81.79% Impervious, Inflow Depth = 6.20" for 100-yr event
Inflow = 1.93 cfs @ 12.14 hrs, Volume= 7,062 cf
Outflow = 1.93 cfs @ 12.14 hrs, Volume= 7,062 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Reach DP4: Wetland West

Inflow Area = 378,463 sf, 66.79% Impervious, Inflow Depth = 2.37" for 100-yr event
Inflow = 10.27 cfs @ 12.27 hrs, Volume= 74,673 cf
Outflow = 10.27 cfs @ 12.27 hrs, Volume= 74,673 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

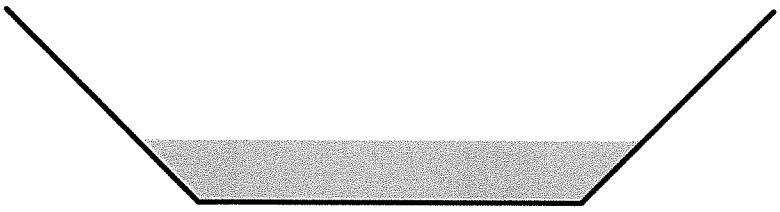
Summary for Reach R1: Stream Channel

Inflow Area = 112,169 sf, 90.27% Impervious, Inflow Depth = 1.79" for 100-yr event
Inflow = 4.07 cfs @ 12.35 hrs, Volume= 16,775 cf
Outflow = 3.42 cfs @ 12.66 hrs, Volume= 16,775 cf, Atten= 16%, Lag= 18.3 min
Routed to Reach DP4 : Wetland West

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.02 fps, Min. Travel Time= 8.8 min
Avg. Velocity = 0.56 fps, Avg. Travel Time= 31.7 min

Peak Storage= 1,797 cf @ 12.51 hrs
Average Depth at Peak Storage= 0.49' , Surface Width= 3.97'
Bank-Full Depth= 1.50' Flow Area= 6.8 sf, Capacity= 24.40 cfs

3.00' x 1.50' deep channel, n= 0.040
Side Slope Z-value= 1.0 '/' Top Width= 6.00'
Length= 1,058.0' Slope= 0.0104 '/'
Inlet Invert= 65.00', Outlet Invert= 54.00'



Summary for Reach R2: Stream Channel

Inflow Area = 86,432 sf, 80.90% Impervious, Inflow Depth = 0.43" for 100-yr event
Inflow = 0.52 cfs @ 13.48 hrs, Volume= 3,080 cf
Outflow = 0.51 cfs @ 13.70 hrs, Volume= 3,080 cf, Atten= 2%, Lag= 13.2 min
Routed to Reach DP4 : Wetland West

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.46 fps, Min. Travel Time= 7.2 min
Avg. Velocity = 0.74 fps, Avg. Travel Time= 14.3 min

Peak Storage= 219 cf @ 13.58 hrs
Average Depth at Peak Storage= 0.11' , Surface Width= 3.22'
Bank-Full Depth= 1.50' Flow Area= 6.8 sf, Capacity= 42.18 cfs

3.00' x 1.50' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 1.0 '/' Top Width= 6.00'
Length= 629.3' Slope= 0.0175 '/'
Inlet Invert= 65.00', Outlet Invert= 54.00'

Summary for Pond P1: North West Pond

Inflow Area = 112,169 sf, 90.27% Impervious, Inflow Depth = 6.79" for 100-yr event
Inflow = 17.54 cfs @ 12.13 hrs, Volume= 63,433 cf
Outflow = 4.50 cfs @ 12.35 hrs, Volume= 52,325 cf, Atten= 74%, Lag= 13.4 min
Discarded = 0.43 cfs @ 12.35 hrs, Volume= 35,550 cf
Primary = 4.07 cfs @ 12.35 hrs, Volume= 16,775 cf
Routed to Reach R1 : Stream Channel
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Reach R1 : Stream Channel

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 80.27' @ 12.35 hrs Surf.Area= 7,688 sf Storage= 28,691 cf

Plug-Flow detention time= 419.9 min calculated for 52,325 cf (82% of inflow)
Center-of-Mass det. time= 335.4 min (1,112.4 - 777.0)

Volume	Invert	Avail.Storage	Storage Description
#1	74.00'	35,103 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
74.00	1,804	0	0
75.00	2,970	2,387	2,387
76.00	3,684	3,327	5,714
77.00	4,437	4,061	9,775
78.00	5,229	4,833	14,608
79.00	6,060	5,645	20,252
80.00	6,931	6,496	26,748
81.00	9,779	8,355	35,103

Device	Routing	Invert	Outlet Devices
#1	Primary	74.00'	**18.0" Round Culvert** L= 120.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 74.00' / 70.00' S= 0.0333 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 1.77 sf
#2	Device 1	79.80'	**4.0' long Outlet Structure Weir** 2 End Contraction(s)
#3	Secondary	80.50'	**15.0' long x 5.0' breadth Broad-Crested Rectangular Weir**

Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50
Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

#4	Discarded	74.00'	**2.410 in/hr Exfiltration over Surface area** Phase-In= 0.01'

Discarded OutFlow Max=0.43 cfs @ 12.35 hrs HW=80.27' (Free Discharge)
└**4=Exfiltration** (Exfiltration Controls 0.43 cfs)

Primary OutFlow Max=4.06 cfs @ 12.35 hrs HW=80.27' (Free Discharge)
└**1=Culvert** (Passes 4.06 cfs of 19.98 cfs potential flow)
└**2=Outlet Structure Weir** (Weir Controls 4.06 cfs @ 2.23 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=74.00' (Free Discharge)
└**3=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond P2: East Pond

Inflow Area = 52,942 sf, 43.21% Impervious, Inflow Depth = 3.91" for 100-yr event
Inflow = 3.81 cfs @ 12.23 hrs, Volume= 17,235 cf
Outflow = 1.99 cfs @ 12.44 hrs, Volume= 17,075 cf, Atten= 48%, Lag= 12.6 min
Discarded = 0.15 cfs @ 12.44 hrs, Volume= 11,210 cf
Primary = 1.84 cfs @ 12.44 hrs, Volume= 5,865 cf
Routed to Reach DP2 : Wetland Southeast
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Reach DP2 : Wetland Southeast

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 60.87' @ 12.44 hrs Surf.Area= 2,695 sf Storage= 5,305 cf

Plug-Flow detention time= 277.8 min calculated for 17,070 cf (99% of inflow)
Center-of-Mass det. time= 272.6 min (1,138.6 - 866.0)

Volume	Invert	Avail.Storage	Storage Description
#1	58.00'	12,526 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
58.00	1,050	0	0
59.00	1,583	1,317	1,317
60.00	2,160	1,872	3,188
61.00	2,773	2,467	5,655
62.00	3,426	3,100	8,754
63.00	4,117	3,772	12,526

Device	Routing	Invert	Outlet Devices
#1	Primary	58.00'	**18.0" Round Culvert** L= 70.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 58.00' / 57.00' S= 0.0143 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 1.77 sf
#2	Device 1	60.60'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

#3	Secondary	61.00'	**10.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#4	Discarded	58.00'	**2.410 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.15 cfs @ 12.44 hrs HW=60.87' (Free Discharge)
↑—**4=Exfiltration** (Exfiltration Controls 0.15 cfs)

Primary OutFlow Max=1.83 cfs @ 12.44 hrs HW=60.87' (Free Discharge)
↑—**1=Culvert** (Passes 1.83 cfs of 9.79 cfs potential flow)
↑—**2=Sharp-Crested Rectangular Weir** (Weir Controls 1.83 cfs @ 1.71 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=58.00' (Free Discharge)
↑—**3=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond P3: Subsurface Chambers

Inflow Area = 86,432 sf, 80.90% Impervious, Inflow Depth = 6.43" for 100-yr event
Inflow = 13.14 cfs @ 12.13 hrs, Volume= 46,327 cf
Outflow = 0.92 cfs @ 13.48 hrs, Volume= 41,567 cf, Atten= 93%, Lag= 81.1 min
Discarded = 0.40 cfs @ 13.48 hrs, Volume= 38,487 cf
Primary = 0.52 cfs @ 13.48 hrs, Volume= 3,080 cf
Routed to Reach R2 : Stream Channel

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 69.12' @ 13.48 hrs Surf.Area= 7,197 sf Storage= 23,013 cf

Plug-Flow detention time= 487.5 min calculated for 41,556 cf (90% of inflow)
Center-of-Mass det. time= 431.4 min (1,221.1 - 789.7)

Volume	Invert	Avail.Storage	Storage Description
#1A	64.00'	4,492 cf	**24.00'W x 200.00'L x 6.17'H Basin 3 Z=1.0** 38,431 cf Overall - 27,200 cf Embedded = 11,231 cf x 40.0% Voids
#2A	64.50'	21,264 cf	**retain_it retain_it 5.0'** x 75 Inside #1 Inside= 84.0"W x 60.0"H => 36.41 sf x 8.00'L = 291.3 cf Outside= 96.0"W x 68.0"H => 45.33 sf x 8.00'L = 362.7 cf 3 Rows adjusted for 581.8 cf perimeter wall
		25,757 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	64.00'	**18.0" Round Culvert** L= 250.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 64.00' / 61.30' S= 0.0108 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 1.77 sf
#2	Device 1	69.00'	**4.0' long 100-Year Control Weir** 2 End Contraction(s)
#3	Discarded	64.00'	**2.410 in/hr Exfiltration over Surface area** Phase-In= 0.01'

Discarded OutFlow Max=0.40 cfs @ 13.48 hrs HW=69.12' (Free Discharge)
↑—**3=Exfiltration** (Exfiltration Controls 0.40 cfs)

Primary OutFlow Max=0.52 cfs @ 13.48 hrs HW=69.12' (Free Discharge)
↑—**1=Culvert** (Passes 0.52 cfs of 14.04 cfs potential flow)
↑—**2=100-Year Control Weir** (Weir Controls 0.52 cfs @ 1.12 fps)

Summary for Pond P4: Gravel Access French Drain

Inflow Area = 15,854 sf, 0.00% Impervious, Inflow Depth = 3.58" for 100-yr event
Inflow = 0.95 cfs @ 12.28 hrs, Volume= 4,723 cf
Outflow = 0.18 cfs @ 13.14 hrs, Volume= 4,723 cf, Atten= 81%, Lag= 51.7 min
Discarded = 0.08 cfs @ 11.40 hrs, Volume= 4,428 cf
Primary = 0.11 cfs @ 13.14 hrs, Volume= 296 cf
Routed to Reach DP1 : Wetland Northeast

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 74.54' @ 13.14 hrs Surf.Area= 1,361 sf Storage= 1,711 cf

Plug-Flow detention time= 218.2 min calculated for 4,722 cf (100% of inflow)
Center-of-Mass det. time= 218.2 min (1,095.5 - 877.3)

Volume	Invert	Avail.Storage	Storage Description
#1A	72.00'	1,086 cf	**3.75'W x 363.00'L x 2.58'H Field A** 3,518 cf Overall - 804 cf Embedded = 2,714 cf x 40.0% Voids
#2A	72.50'	650 cf	**ADS N-12 18"** x 18 Inside #1 Inside= 18.2"W x 18.2"H => 1.80 sf x 20.00'L = 36.0 cf Outside= 21.0"W x 21.0"H => 2.23 sf x 20.00'L = 44.5 cf Row Length Adjustment= +1.00' x 1.80 sf x 1 rows
		1,735 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	67.60'	**12.0" Round Culvert** L= 40.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 67.60' / 66.00' S= 0.0400 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf
#2	Device 1	74.50'	**4.0' long Overflow Weir** 2 End Contraction(s)
#3	Discarded	72.00'	**2.410 in/hr Exfiltration over Surface area** Phase-In= 0.01'

Discarded OutFlow Max=0.08 cfs @ 11.40 hrs HW=72.03' (Free Discharge)
↑—**3=Exfiltration** (Exfiltration Controls 0.08 cfs)

Primary OutFlow Max=0.10 cfs @ 13.14 hrs HW=74.54' (Free Discharge)
↑—**1=Culvert** (Passes 0.10 cfs of 8.47 cfs potential flow)
↑—**2=Overflow Weir** (Weir Controls 0.10 cfs @ 0.65 fps)

Summary for Pond P5: Retention Area

Inflow Area = 19,372 sf, 76.35% Impervious, Inflow Depth = 5.96" for 100-yr event
Inflow = 1.82 cfs @ 12.28 hrs, Volume= 9,626 cf
Outflow = 1.70 cfs @ 12.35 hrs, Volume= 9,626 cf, Atten= 7%, Lag= 3.8 min
Discarded = 0.11 cfs @ 12.35 hrs, Volume= 6,536 cf
Primary = 1.59 cfs @ 12.35 hrs, Volume= 3,089 cf
Routed to Reach DP4 : Wetland West

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 62.00' @ 12.35 hrs Surf.Area= 1,930 sf Storage= 2,417 cf

Plug-Flow detention time= 178.4 min calculated for 9,626 cf (100% of inflow)
Center-of-Mass det. time= 178.4 min (995.7 - 817.2)

Volume	Invert	Avail.Storage	Storage Description
#1	60.00'	2,914 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
60.00	547	0	0
61.00	1,171	859	859
62.00	1,926	1,549	2,408
62.25	2,124	506	2,914

Device	Routing	Invert	Outlet Devices
#1	Primary	59.60'	**12.0" Round Culvert** L= 45.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 59.60' / 58.70' S= 0.0200 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 0.79 sf
#2	Device 1	61.85'	**1.8" x 1.8" Horiz. Grate X 7.00 columns** X 7 rows C= 0.600 in 24.0" x 24.0" Grate (28% open area) Limited to weir flow at low heads
#3	Discarded	60.00'	**2.410 in/hr Exfiltration over Surface area** Phase-In= 0.01'

Discarded OutFlow Max=0.11 cfs @ 12.35 hrs HW=62.00' (Free Discharge)
↑—**3=Exfiltration** (Exfiltration Controls 0.11 cfs)

Primary OutFlow Max=1.59 cfs @ 12.35 hrs HW=62.00' (Free Discharge)
↑—**1=Culvert** (Passes 1.59 cfs of 4.12 cfs potential flow)
↑—**2=Grate** (Weir Controls 1.59 cfs @ 1.29 fps)

APPENDIX D:
STORMWATER MANAGEMENT CALCULATIONS

Stormwater Management Calculations Outline

- Groundwater Recharge Calculation
- Drawdown Calculation
- Pond Storage Tables
- Contech Water Quality Volume Calculations
- TSS Removal Worksheets

April 6, 2022

Stormwater Management Calculations

STANDARD 3: Recharge To Groundwater: Static Method

1. Calculate Impervious Area *(From HydroCAD Model)*
   - New Impervious Area (HSG A Soil) = 184,105 SF
   - New Impervious Area (HSG B Soil) = -2,190 SF

2. Determine Rainfall Depth to be Recharged
   (MassDEP Stormwater Management Handbook: Table 2.3.2)

Hydrologic Soil Group	Recharge Rainfall Depth
A	0.60"
B	0.35"

3. Calculate Recharge Volume

   Soil A *'Rv'* = [(0.60" x 184,105 SF) / 12 SF-In] = 9205 CF

   Soil B *'Rv'* - [(0.35" x 2,190 SF) / 12 SF-In] = - 64 CF

   Total *'Rv'* = 9,141 CF

   Capture Area Adjustment
   Schedule of Areas Tributary to Recharge Systems

HCAD Node ID	Tributary Impervious Area
P1	101,251 sf
P2	22,877 sf
P3	69,925 sf
P5	14,790 sf
Total:	**208, 843 sf**

   Total New Impervious Area = 181,915 SF
   Capture Area Adjustment = 181,915 sf / 208,843 sf = **0.87**

   Area adjustment < 1

4. Calculate Provided Recharge
   Proposed recharge provided in infiltration basins

HCAD System ID	Bottom of Infiltration	Lowest System Outlet	Total Recharge Volume Provided (cf)	10-YR STORM EVENT PEAK ELEVATION*
P1	74.0	79.80	**25,379**	**80.39**
P2	58.0	60.60	**4,594**	**60.87**
P3	64.0	69.00	**22,404**	**69.12**
P5	140.0	61.85	**2,127**	**62.00**
TOTAL			**55,873**	

Required Recharge Volume Summary

Total Volume Provided Below Outlets = 55,873 cf
Total Volume Required = 9,141 CF

55,873 cf provided > 9,141 cf required

Verify Drawdown, Maximum 72-Hours: Static Method

HCAD System ID	Recharge Volume (CF)	Bottom Surface Area (SF)	Infiltration Rate Inches/Hour	Drawdown Time Rv / (K x A) (Hours)	Description
P1	**25,379**	1,804	2.41	70.04	Retention Basin
P2	**2,523**	1,050	2.41	11.96	Retention Basin
P3	**22,404**	4,800	2.41	22.34	Concrete Galleys
P5	**1,089**	547	2.41	9.91	Retention Basin

Design Complies with Recharge Volume Standard*

STANDARD 4: Water Quality Volume

See proprietary hydrodynamic separator and TSS calculations sheets.

Stage-Area-Storage for Pond P1: North West Pond

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
74.00	1,804	0
74.10	1,921	186
74.20	2,037	384
74.30	2,154	594
74.40	2,270	815
74.50	2,387	1,048
74.60	2,504	1,292
74.70	2,620	1,548
74.80	2,737	1,816
74.90	2,853	2,096
75.00	2,970	2,387
75.10	3,041	2,688
75.20	3,113	2,995
75.30	3,184	3,310
75.40	3,256	3,632
75.50	3,327	3,961
75.60	3,398	4,298
75.70	3,470	4,641
75.80	3,541	4,991
75.90	3,613	5,349
76.00	3,684	5,714
76.10	3,759	6,086
76.20	3,835	6,466
76.30	3,910	6,853
76.40	3,985	7,248
76.50	4,061	7,650
76.60	4,136	8,060
76.70	4,211	8,477
76.80	4,286	8,902
76.90	4,362	9,335
77.00	4,437	9,775
77.10	4,516	10,222
77.20	4,595	10,678
77.30	4,675	11,141
77.40	4,754	11,613
77.50	4,833	12,092
77.60	4,912	12,579
77.70	4,991	13,074
77.80	5,071	13,578
77.90	5,150	14,089
78.00	5,229	14,608
78.10	5,312	15,135
78.20	5,395	15,670
78.30	5,478	16,214
78.40	5,561	16,766
78.50	5,645	17,326
78.60	5,728	17,894
78.70	5,811	18,471
78.80	5,894	19,057
78.90	5,977	19,650
79.00	6,060	20,252
79.10	6,147	20,862
79.20	6,234	21,481
79.30	6,321	22,109
79.40	6,408	22,746
79.50	6,496	23,391
79.60	6,583	24,045
79.70	6,670	24,707
79.80	6,757	25,379
79.90	6,844	26,059
80.00	6,931	26,748
80.10	7,216	27,455
80.20	7,501	28,191
80.30	7,785	28,955
80.40	8,070	29,748
80.50	8,355	30,569
80.60	8,640	31,419
80.70	8,925	32,297
80.80	9,209	33,204
80.90	9,494	34,139
81.00	**9,779**	**35,103**

Stage-Area-Storage for Pond P2: East Pond

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
58.00	1,050	0
58.05	1,077	53
58.10	1,103	108
58.15	1,130	163
58.20	1,157	221
58.25	1,183	279
58.30	1,210	339
58.35	1,237	400
58.40	1,263	463
58.45	1,290	526
58.50	1,317	592
58.55	1,343	658
58.60	1,370	726
58.65	1,396	795
58.70	1,423	866
58.75	1,450	937
58.80	1,476	1,011
58.85	1,503	1,085
58.90	1,530	1,161
58.95	1,556	1,238
59.00	1,583	1,317
59.05	1,612	1,396
59.10	1,641	1,478
59.15	1,670	1,560
59.20	1,698	1,645
59.25	1,727	1,730
59.30	1,756	1,817
59.35	1,785	1,906
59.40	1,814	1,996
59.45	1,843	2,087
59.50	1,872	2,180
59.55	1,900	2,274
59.60	1,929	2,370
59.65	1,958	2,467
59.70	1,987	2,566
59.75	2,016	2,666
59.80	2,045	2,768
59.85	2,073	2,870
59.90	2,102	2,975
59.95	2,131	3,081
60.00	2,160	3,188
60.05	2,191	3,297
60.10	2,221	3,407
60.15	2,252	3,519
60.20	2,283	3,632
60.25	2,313	3,747
60.30	2,344	3,864
60.35	2,375	3,982
60.40	2,405	4,101
60.45	2,436	4,222
60.50	2,467	4,345
60.55	2,497	4,469
60.60	2,528	4,594

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
60.65	2,558	4,721
60.70	2,589	4,850
60.75	2,620	4,980
60.80	2,650	5,112
60.85	2,681	5,245
60.90	2,712	5,380
60.95	2,742	5,517
61.00	2,773	5,655
61.05	2,806	5,794
61.10	2,838	5,935
61.15	2,871	6,078
61.20	2,904	6,222
61.25	2,936	6,368
61.30	2,969	6,516
61.35	3,002	6,665
61.40	3,034	6,816
61.45	3,067	6,968
61.50	3,100	7,123
61.55	3,132	7,278
61.60	3,165	7,436
61.65	3,197	7,595
61.70	3,230	7,756
61.75	3,263	7,918
61.80	3,295	8,082
61.85	3,328	8,247
61.90	3,361	8,415
61.95	3,393	8,584
62.00	3,426	8,754
62.05	3,461	8,926
62.10	3,495	9,100
62.15	3,530	9,276
62.20	3,564	9,453
62.25	3,599	9,632
62.30	3,633	9,813
62.35	3,668	9,995
62.40	3,702	10,180
62.45	3,737	10,366
62.50	3,772	10,553
62.55	3,806	10,743
62.60	3,841	10,934
62.65	3,875	11,127
62.70	3,910	11,321
62.75	3,944	11,518
62.80	3,979	11,716
62.85	4,013	11,916
62.90	4,048	12,117
62.95	4,082	12,321
63.00	**4,117**	**12,526**

Stage-Area-Storage for Pond P3: Subsurface Chambers

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
64.00	4,800	0
64.10	4,845	193
64.20	4,890	388
64.30	4,935	584
64.40	4,980	782
64.50	5,025	982
64.60	5,070	1,418
64.70	5,116	1,855
64.80	5,161	2,293
64.90	5,206	2,734
65.00	5,252	3,177
65.10	5,298	3,621
65.20	5,343	4,067
65.30	5,389	4,515
65.40	5,435	4,965
65.50	5,481	5,416
65.60	5,527	5,870
65.70	5,573	6,325
65.80	5,619	6,782
65.90	5,666	7,241
66.00	5,712	7,702
66.10	5,758	8,165
66.20	5,805	8,629
66.30	5,852	9,096
66.40	5,898	9,564
66.50	5,945	10,034
66.60	5,992	10,506
66.70	6,039	10,980
66.80	6,086	11,456
66.90	6,133	11,933
67.00	6,180	12,413
67.10	6,227	12,894
67.20	6,275	13,378
67.30	6,322	13,863
67.40	6,369	14,350
67.50	6,417	14,839
67.60	6,465	15,330
67.70	6,512	15,823
67.80	6,560	16,317
67.90	6,608	16,814
68.00	6,656	17,313
68.10	6,704	17,813
68.20	6,752	18,316
68.30	6,800	18,820
68.40	6,849	19,326
68.50	6,897	19,834
68.60	6,945	20,344
68.70	6,994	20,857
68.80	7,043	21,371
68.90	7,091	21,887
69.00	7,140	22,404
69.10	7,189	22,924
69.20	7,238	23,446
69.30	7,287	23,970
69.40	7,336	24,496
69.50	7,385	25,023
69.60	7,434	25,128
69.70	7,484	25,234
69.80	7,533	25,342
69.90	7,582	25,453
70.00	7,632	25,565
70.10	**7,682**	**25,679**

Stage-Area-Storage for Pond P5: Retention Area

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
60.00	547	0
60.05	578	28
60.10	609	58
60.15	641	89
60.20	672	122
60.25	703	156
60.30	734	192
60.35	765	230
60.40	797	269
60.45	828	309
60.50	859	352
60.55	890	395
60.60	921	441
60.65	953	487
60.70	984	536
60.75	1,015	586
60.80	1,046	637
60.85	1,077	690
60.90	1,109	745
60.95	1,140	801
61.00	1,171	859
61.05	1,209	918
61.10	1,247	980
61.15	1,284	1,043
61.20	1,322	1,108
61.25	1,360	1,175
61.30	1,397	1,244
61.35	1,435	1,315
61.40	1,473	1,388
61.45	1,511	1,462
61.50	1,549	1,539
61.55	1,586	1,617
61.60	1,624	1,698
61.65	1,662	1,780
61.70	1,700	1,864
61.75	1,737	1,950
61.80	1,775	2,037
61.85	1,813	2,127
61.90	1,850	2,219
61.95	1,888	2,312
62.00	1,926	2,408
62.05	1,966	2,505
62.10	2,005	2,604
62.15	2,045	2,705
62.20	2,084	2,809
62.25	**2,124**	**2,914**

Project:	**501 & 600 Griffin Brook Dr**
Location:	**Methuen, MA**
Prepared For:	**Morin-Cameron Group**

CONTECH ENGINEERED SOLUTIONS

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

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

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

Compute Q Rate using the following equation:

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

where:

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

Structure Name	Impv. (acres)	A (miles^2)	t_c (min)	t_c (hr)	WQV (in)	qu (csm/in.)	Q (cfs)
ST-1	0.70	0.0010938	6.0	0.100	1.00	774.00	0.85
ST-2	1.03	0.0016094	6.0	0.100	1.00	774.00	1.25
ST-3	0.48	0.0007484	6.0	0.100	1.00	774.00	0.58

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

CONTECH ENGINEERED SOLUTIONS

CDS TECHNOLOGIES

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

501 & 600 GRIFFIN BROOK DR METHUEN, MA

Area	0.70 ac	Unit Site Designation	ST-1
Weighted C	0.9	Rainfall Station #	69
t_c	6 min		
CDS Model	1515-3	CDS Treatment Capacity	1.0 cfs

Rainfall Intensity[1] (in/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (cfs)	Treated Flowrate (cfs)	Incremental Removal (%)
0.02	10.2%	10.2%	0.01	0.01	9.8
0.04	9.6%	19.8%	0.03	0.03	9.2
0.06	9.4%	29.3%	0.04	0.04	8.9
0.08	7.7%	37.0%	0.05	0.05	7.3
0.10	8.6%	45.6%	0.06	0.06	8.0
0.12	6.3%	51.9%	0.08	0.08	5.8
0.14	4.7%	56.5%	0.09	0.09	4.3
0.16	4.6%	61.2%	0.10	0.10	4.2
0.18	3.5%	64.7%	0.11	0.11	3.2
0.20	4.3%	69.1%	0.13	0.13	3.9
0.25	8.0%	77.1%	0.16	0.16	6.9
0.30	5.6%	82.7%	0.19	0.19	4.7
0.35	4.4%	87.0%	0.22	0.22	3.6
0.40	2.5%	89.5%	0.25	0.25	2.0
0.45	2.5%	92.1%	0.28	0.28	2.0
0.50	1.4%	93.5%	0.32	0.32	1.0
0.75	5.0%	98.5%	0.47	0.47	3.3
1.00	1.0%	99.5%	0.63	0.63	0.6
1.50	0.0%	99.5%	0.95	0.95	0.0
2.00	0.0%	99.5%	1.26	1.00	0.0
3.00	0.5%	100.0%	1.89	1.00	0.1
					88.6
				Removal Efficiency Adjustment[2] =	6.5%
				Predicted % Annual Rainfall Treated =	93.3%
				Predicted Net Annual Load Removal Efficiency =	**82.2%**

1 - Based on 10 years of hourly precipitation data from NCDC Station 770, Boston WSFO AP, Suffolk County, MA
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.

CONTECH ENGINEERED SOLUTIONS

CDS TECHNOLOGIES

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

501 & 600 GRIFFIN BROOK DR METHUEN, MA

Area	1.03 ac	Unit Site Designation	ST-2
Weighted C	0.9	Rainfall Station #	69
t_c	6 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 (%)
0.02	10.2%	10.2%	0.02	0.02	9.8
0.04	9.6%	19.8%	0.04	0.04	9.2
0.06	9.4%	29.3%	0.06	0.06	8.9
0.08	7.7%	37.0%	0.07	0.07	7.2
0.10	8.6%	45.6%	0.09	0.09	7.9
0.12	6.3%	51.9%	0.11	0.11	5.8
0.14	4.7%	56.5%	0.13	0.13	4.2
0.16	4.6%	61.2%	0.15	0.15	4.2
0.18	3.5%	64.7%	0.17	0.17	3.2
0.20	4.3%	69.1%	0.19	0.19	3.8
0.25	8.0%	77.1%	0.23	0.23	6.9
0.30	5.6%	82.7%	0.28	0.28	4.7
0.35	4.4%	87.0%	0.32	0.32	3.6
0.40	2.5%	89.5%	0.37	0.37	2.0
0.45	2.5%	92.1%	0.42	0.42	1.9
0.50	1.4%	93.5%	0.46	0.46	1.0
0.75	5.0%	98.5%	0.70	0.70	3.2
1.00	1.0%	99.5%	0.93	0.93	0.5
1.50	0.0%	99.5%	1.39	1.39	0.0
2.00	0.0%	99.5%	1.85	1.40	0.0
3.00	0.5%	100.0%	2.78	1.40	0.1
					88.2
				Removal Efficiency Adjustment[2] =	6.5%
				Predicted % Annual Rainfall Treated =	93.3%
				Predicted Net Annual Load Removal Efficiency =	**81.7%**

1 - Based on 10 years of hourly precipitation data from NCDC Station 770, Boston WSFO AP, Suffolk County, MA
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.

CONTECH ENGINEERED SOLUTIONS

CDS TECHNOLOGIES

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

501 & 600 GRIFFIN BROOK DR METHUEN, MA

Area	0.48 ac	Unit Site Designation	ST-3
Weighted C	0.9	Rainfall Station #	69
t_c	6 min		
CDS Model	1515-3	CDS Treatment Capacity	1.0 cfs

Rainfall Intensity[1] (in/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (cfs)	Treated Flowrate (cfs)	Incremental Removal (%)
0.02	10.2%	10.2%	0.01	0.01	9.8
0.04	9.6%	19.8%	0.02	0.02	9.3
0.06	9.4%	29.3%	0.03	0.03	9.0
0.08	7.7%	37.0%	0.03	0.03	7.3
0.10	8.6%	45.6%	0.04	0.04	8.1
0.12	6.3%	51.9%	0.05	0.05	5.9
0.14	4.7%	56.5%	0.06	0.06	4.3
0.16	4.6%	61.2%	0.07	0.07	4.3
0.18	3.5%	64.7%	0.08	0.08	3.3
0.20	4.3%	69.1%	0.09	0.09	4.0
0.25	8.0%	77.1%	0.11	0.11	7.2
0.30	5.6%	82.7%	0.13	0.13	4.9
0.35	4.4%	87.0%	0.15	0.15	3.8
0.40	2.5%	89.5%	0.17	0.17	2.2
0.45	2.5%	92.1%	0.19	0.19	2.1
0.50	1.4%	93.5%	0.22	0.22	1.1
0.75	5.0%	98.5%	0.32	0.32	3.8
1.00	1.0%	99.5%	0.43	0.43	0.7
1.50	0.0%	99.5%	0.65	0.65	0.0
2.00	0.0%	99.5%	0.86	0.86	0.0
3.00	0.5%	100.0%	1.29	1.00	0.1
					91.2
				Removal Efficiency Adjustment[2] =	6.5%
				Predicted % Annual Rainfall Treated =	93.4%
				Predicted Net Annual Load Removal Efficiency =	**84.8%**

1 - Based on 10 years of hourly precipitation data from NCDC Station 770, Boston WSFO AP, Suffolk County, MA
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.

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Standard 4: Total Suspended Solids Calculation for Infiltration System (P5)

Name: Griffin Brook Drive
Location: Griffin Brook Drive
Methuen, MA
County: Essex County
Applicant: Griffin Brook Owner LLC

Proj. No.: 4046
Date: 3/29/2022
Revised:
Computed by: Leticia Oliveira
Checked by: Scott P, Cameron, P.E.

TSS Removal Calculation

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

Note: Grass & gravel filter strip utilized for pretreatment as referenced on Page 25 of Structural BMPs in Volume 2 Chapter 2 of the Massachusetts Stormwater Handbook

Total TSS Removal = **80%**

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

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

THE MORIN-CAMERON GROUP, INC.
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Haverhill, MA 01830
p | 978.373.310

Standard 4: Total Suspended Solids Calculation for Retention System (P1)

Name: Griffin Brook Drive
Location: 501 & 600 Griffin Brook Drive
Methuen, MA
County: Essex County
Applicant: Griffin Brook Owner LLC

Proj. No.: 4046
Date: 4/5/2022
Revised: 4/5/2022
Computed by: Leticia Oliveira
Checked by: Scott P, Cameron, P.E.

TSS Removal Calculation

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

Note: Grass & gravel filter strip utilized for pretreatment as referenced on Page 25 of Structural BMPs in Volume 2 Chapter 2 of the Massachusetts Stormwater Handbook

Total TSS Removal = **80%**

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

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

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Haverhill, MA 01830
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Standard 4: Total Suspended Solids Calculation for Retention System (P2.1)

Name: Griffin Brook Drive
Location: 501 & 600 Griffin Brook Drive
Methuen, MA
County: Essex County
Applicant: Griffin Brook Owner LLC

Proj. No.: 4046
Date: 4/5/2022
Revised: 4/5/2022
Computed by: Leticia Oliveira
Checked by: Scott P, Cameron, P.E.

TSS Removal Calculation

B BMP	C TSS Removal Rate	D Starting TSS Load (*F)	E Amount Removed (C*D)	F Remaining Load (D-E)
Deep Sump and Hooded Catch Basin	0.25	1.00	0.25	0.75
Proprietary Treatment Practice	0.85	0.75	0.64	0.11
	0.00	0.11	0.00	0.11
	0.00	0.11	0.00	0.11
	0.00	0.11	0.00	0.11

Note: Grass & gravel filter strip utilized for pretreatment as referenced on Page 25 of Structural BMPs in Volume 2 Chapter 2 of the Massachusetts Stormwater Handbook

Total TSS Removal = 89%

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

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

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Standard 4: Total Suspended Solids Calculation for Retention System (P2)

Name: Griffin Brook Drive
Location: 501 & 600 Griffin Brook Drive
Methuen, MA
County: Essex County
Applicant: Griffin Brook Owner LLC

Proj. No.: 4046
Date: 4/5/2022
Revised: 4/5/2022
Computed by: Leticia Oliveira
Checked by: Scott P, Cameron, P.E.

TSS Removal Calculation

B BMP	C TSS Removal Rate	D Starting TSS Load (*F)	E Amount Removed (C*D)	F Remaining Load (D-E)
Infiltration Basin	**0.80**	**1.00**	**0.80**	**0.20**
Deep Sump and Hooded Catch Basin	**0.25**	**0.20**	**0.05**	**0.15**
	0.00	**0.15**	**0.00**	**0.15**
	0.00	**0.15**	**0.00**	**0.15**
	0.00	**0.15**	**0.00**	**0.15**

Note: Grass & gravel filter strip utilized for pretreatment as referenced on Page 25 of Structural BMPs in Volume 2 Chapter 2 of the Massachusetts Stormwater Handbook

Total TSS Removal = **85%**

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

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

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Standard 4: Total Suspended Solids Calculation for Retention System (P3.1)

Name: Griffin Brook Drive
Location: 501 & 600 Griffin Brook Drive
Methuen, MA
County: Essex County
Applicant: Griffin Brook Owner LLC

Proj. No.: 4046
Date: 4/5/2022
Revised: 4/5/2022
Computed by: Leticia Oliveira
Checked by: Scott P, Cameron, P.E.

TSS Removal Calculation

B BMP	C TSS Removal Rate	D Starting TSS Load (*F)	E Amount Removed (C*D)	F Remaining Load (D-E)
Deep Sump and Hooded Catch Basin	**0.25**	**1.00**	**0.25**	**0.75**
Proprietary Treatment Practice	**0.82**	**0.75**	**0.62**	**0.14**
	0.00	**0.14**	**0.00**	**0.14**
	0.00	**0.14**	**0.00**	**0.14**
	0.00	**0.14**	**0.00**	**0.14**

Note: Grass & gravel filter strip utilized for pretreatment as referenced on Page 25 of Structural BMPs in Volume 2 Chapter 2 of the Massachusetts Stormwater Handbook

Total TSS Removal = **87%**

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

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

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Haverhill, MA 01830
p | 978.373.310

Standard 4: Total Suspended Solids Calculation for Retention System (P3.2)

Name: Griffin Brook Drive
Location: 501 & 600 Griffin Brook Drive
Methuen, MA
County: Essex County
Applicant: Griffin Brook Owner LLC

Proj. No.: 4046
Date: 4/5/2022
Revised: 4/5/2022
Computed by: Leticia Oliveira
Checked by: Scott P, Cameron, P.E.

TSS Removal Calculation

B BMP	C TSS Removal Rate	D Starting TSS Load (*F)	E Amount Removed (C*D)	F Remaining Load (D-E)
Deep Sump and Hooded Catch Basin	**0.25**	**1.00**	**0.25**	**0.75**
Proprietary Treatment Practice	**0.82**	**0.75**	**0.62**	**0.14**
	0.00	**0.14**	**0.00**	**0.14**
	0.00	**0.14**	**0.00**	**0.14**
	0.00	**0.14**	**0.00**	**0.14**

Note: Grass & gravel filter strip utilized for pretreatment as referenced on Page 25 of Structural BMPs in Volume 2 Chapter 2 of the Massachusetts Stormwater Handbook

Total TSS Removal = **87%**

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

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

THE MORIN-CAMERON GROUP, INC.
25 Kenoza Avenue
Haverhill, MA 01830
p | 978.373.310

Standard 4: Total Suspended Solids Calculation for Retention System (P3)

Name: Griffin Brook Drive
Location: 501 & 600 Griffin Brook Drive
Methuen, MA
County: Essex County
Applicant: Griffin Brook Owner LLC

Proj. No.: 4046
Date: 4/5/2022
Revised: 4/5/2022
Computed by: Leticia Oliveira
Checked by: Scott P, Cameron, P.E.

TSS Removal Calculation

B BMP	C TSS Removal Rate	D Starting TSS Load (*F)	E Amount Removed (C*D)	F Remaining Load (D-E)
Subsurface Infiltration Structure	**0.80**	**1.00**	**0.80**	**0.20**
Deep Sump and Hooded Catch Basin	**0.25**	**0.20**	**0.05**	**0.15**
	0.00	**0.15**	**0.00**	**0.15**
	0.00	**0.15**	**0.00**	**0.15**
	0.00	**0.15**	**0.00**	**0.15**

Note: Grass & gravel filter strip utilized for pretreatment as referenced on Page 25 of Structural BMPs in Volume 2 Chapter 2 of the Massachusetts Stormwater Handbook

Total TSS Removal = **85%**

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

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

APPENDIX E:
CONSTRUCTION PHASE BEST MANAGEMENT PRACTICES

DRAFT

Construction Phase Best Management Practices (BMP's)

Erosion and Sedimentation will be controlled at the site by utilizing Structural Practices, Stabilization Practices, and Dust Control. These practices correspond with plans entitled "Site Plan of Land" in Methuen, Massachusetts, 501 & 600 Griffin Brook Drive prepared by The Morin-Cameron Group, Inc. dated April 6, 2022 as revised and approved by the City of Methuen, hereinafter referred to as the Site Plans.

Responsible Party Contact Information:
Stormwater Management System Owner:

Methuen Department of Public Services:	DPW Division Management 10 Ditson Place, Suite 100 Methuen, MA 01844 P: (978) 983-8545
Methuen Planning Division:	Searles Building 41 Pleasant Street Methuen, MA 01960 P: (978) 983-8560
Methuen Conservation Commission:	Searles Building 41 Pleasant Street Methuen, MA 01960 P: (978) 983-8650
Site Design Engineer Information:	The Morin-Cameron Group, Inc. 25 Kenoza Avenue Haverhill, MA 01830 Phone: (978) 373-0310

Structural Practices:

1) **Silt Fence & Silt Sock** – A siltation fence and sock barrier shall be installed in accordance with the approved plans where high rates of stormwater runoff are anticipated.
   a) Installation Schedule: Prior to Start of land disturbance

   a) Maintenance and Inspection: The site supervisor shall inspect the barrier at least once per week or after a storm event (0.25 inches of rainfall within a twenty-four-hour period) and shall repair any damaged or affected areas of the barrier at the time they are noted. Remove sediment deposits promptly after storm events to provide adequate storage volume for the next rain and to reduce pressure on the barrier. Sediment will be removed from in front of the barrier when it becomes about 4" deep at the barrier. Take care to avoid undermining the barrier during cleanout.

2) **Inlet Protection** – Inlet Protection will be utilized around the catch basin grates in the street layout in the closest down gradient structure and existing onsite catch basins. The inlet protection will allow the storm drain inlets to be used before final stabilization. This structural practice will allow early use of the drainage system. Siltsack or equivalent will be utilized for the inlet protection. Siltsack is manufactured by ACF Environmental. The telephone number is 800-448-3636. Regular flow siltsack will be utilized, and if it does not allow enough storm water flow, hi-flow siltsack will be utilized.

Silt Sack (or equivalent) Inlet Protection Inspection/Maintenance Requirements *

a) The silt sack trapping devices and the catch basins should be inspected after every rain storm and repairs made as necessary.

b) Sediment should be removed from the silt sack after the sediment has reached a maximum depth of one-half the depth of the trap.

c) Sediment should be disposed of in a suitable area and protected from erosion by either structural or vegetative means. Sediment material removed shall be disposed of in accordance with all applicable local, state, and federal regulations.

d) The silt sack must be replaced if it is ripped or torn in any way.

e) Temporary traps should be removed and the area repaired as soon as the contributing drainage area to the inlet has been completely stabilized.

3) **Sediment Track-Out:** The site supervisor will inspect and ensure that sediment is not tracked into the roadway. If tracking onto the roadway is noted, it shall be removed immediately via by hand or a mechanical street sweeper. Stabilized Construction Exits will be installed at all construction entrances to the site to prevent trucks from tracking material onto the road from the construction site. If, at any point during the project, the tracking pad becomes ineffective due to accumulation of soil, the crushed stone and sediment shall be removed and shall be replaced with new crushed stone. Details for construction of the stabilized entrance can be found on the Site Plans. The site supervisor will inspect the tracking pads weekly to ensure that they are properly limiting the tracking of soil onto the road. If tracking onto the roadway is noted, it shall be removed immediately via by hand or a mechanical street sweeper.

Stabilization Practices:

Stabilization measures shall be implemented as soon as practicable in portions of the site where construction activities have temporarily or permanently ceased, but in no case more than 14 days after the construction activity in that portion of the site has temporarily or permanently ceased, with the following exceptions.

- Where the initiation of stabilization measures by the 14th day after construction activity temporary or permanently cease is precluded by snow cover, stabilization measures shall be initiated as soon as practicable.

- Where construction activity will resume on a portion of the site within 21 days from when activities ceased, (e.g. the total time period that construction activity is temporarily ceased is less than 21 days) then stabilization measures do not have to be initiated on that portion of the site by the 14th day after construction activity temporarily ceased.

1) **Temporary Seeding** – Temporary seeding will allow a short-term vegetative cover on disturbed site areas that may be in danger of erosion. Temporary seeding will be done at stock piles and disturbed portions of the site where construction activity will temporarily cease for at least 21 days. The temporary seeding will stabilize cleared and unvegetated areas that will not be brought into final grade for several weeks or months.

   Temporary Seeding Planting Procedures *

   a) Planting should preferably be done between April 1st and June 30th, and September 1st through September 31st. If planting is done in the months of July and August, irrigation may be required. If planting is done between October 1st and March 31st, mulching shall be applied immediately after planting.

   b) Before seeding, install structural practice controls. Utilize Amoco supergro or equivalent.

   c) Select the appropriate seed species for temporary cover from the following table.

Species	Seeding Rate (lbs./1,000 sq.)	Seeding Rate (lbs./acre)	Recommended Seeding Dates	Seed Cover required
Annual Ryegrass	1	40	April 1st to June 1st August 15th to Sept. 15th	¼ inch
Foxtail Millet	0.7	30	May 1st to June 30th	½ to ¾ inch
Oats	2	80	April 1st to July 1st August 15th to Sept. 15th	1 to 1-½ inch
Winter Rye	3	120	August 15th to Oct. 15th	1 to 1-½ inch

Apply the seed uniformly by hydroseeding, broadcasting, or by hand.

d) Use effective mulch, such as clean grain straw; tacked and/or tied with netting to protect seedbed and encourage plant growth.

Temporary Seeding Inspection/Maintenance *

a) Inspect within 6 weeks of planting to see if stands are adequate. Check for damage within 24 hours of the end to a heavy rainfall, defined as a 2-year storm event (i.e., 3.30 inches of rainfall within a twenty-four-hour period). Stands should be uniform and dense. Reseed and mulch damaged and sparse areas immediately. Tack or tie down mulch as necessary.

b) Seeds should be supplied with adequate moisture. Furnish water as needed, especially in abnormally hot or dry weather. Water application rates should be controlled to prevent runoff.

2) **Geotextiles** - Geotextiles such as jute netting will be used in combination with other practices such as mulching to stabilize steep slopes. The following geotextile materials or equivalent are to be utilized for structural and nonstructural controls as shown in the following table.

Practice	Manufacturer	Product	Remarks
Sediment Fence	Amoco	Woven polypropylene 1198 or equivalent	0.425 mm opening
Construction Entrance	Amoco	Woven polypropylene 2002 or equivalent	0.300 mm opening
Outlet Protection	Amoco	Nonwoven polypropylene 4551 or equivalent	0.150 mm opening
Erosion Control (slope stability)	Amoco	Supergro or equivalent	Erosion control revegetation mix, open polypropylene fiber on degradable polypropylene net scrim

Amoco may be reached at (800) 445-7732

Geotextile Installation

a) Netting and matting require firm, continuous contact between the materials and the soil. If there is no contact, the material will not hold the soil and erosion will occur underneath the material.

Geotextile Inspection/Maintenance *

a) In the field, regular inspections should be made to check for cracks, tears, or breaches in the fabric. Appropriate repairs should be made when necessary.

3) **Mulching and Netting** – Mulching will provide immediate protection to exposed soils during the period of short construction delays, or over winter months through the application of plant residues, or other suitable materials, to exposed soil areas. In areas, which have been seeded either for temporary or permanent cover, mulching should immediately follow seeding. On steep slopes, mulch must be supplemented with netting. The preferred mulching material is straw.

Mulch (Straw) Materials and Installation

a) Straw has been found to be one of the most effective organic mulch materials. The specifications for straw are described below, but other material may be appropriate. The straw should be air-dried; free of undesirable seeds & coarse materials. The application rate per 1,000 sq. is 90-100 lbs. (2-3 bales) and the application rate per acre is 2 tons (100-120 bales). The application should cover about 90% of the surface. The use of straw mulch is appropriate where mulch is maintained for more than three months. Straw mulch is subject to wind blowing unless anchored, is the most commonly used mulching material and has the best microenvironment for germinating seeds.

Mulch Maintenance *

a) Inspect after rainstorms to check for movement of mulch or erosion. If washout, breakage, or erosion occurs, repair surface, reseed, remulch, and install new netting as necessary.

b) Straw or grass mulches that blow or wash away should be repaired promptly.

c) If netting is used to anchor mulch, care should be taken during initial mowing to keep the mower height high to not damage the netting. After a period of time, the netting degrades and will become less of a problem.

d) Continue inspections until vegetation is well established.

4) **Land Grading** – Grading on fill slopes, cut slopes, and stockpile areas will be done with full siltation controls in place.

Land Grading Design/Installation Requirements

a) Areas to be graded should be cleared and grubbed of all timber, logs, brush, rubbish, and vegetated matter that will interfere with the grading operation.

Topsoil should be stripped and stockpiled for use on critical disturbed areas for establishment of vegetation. Cut slopes to be topsoiled should be thoroughly scarified to a minimum depth of 3-inches prior to placement of topsoil.

b) Fill materials should be free of brush, rubbish, rocks, and stumps. Frozen materials or soft and easily compressible materials should not be used in fills intended to support buildings, parking lots, roads, conduits, or other structures.

c) Earth fill intended to support structural measures should be compacted to a minimum of 95 percent of Standard Proctor Test density with proper moisture control, or as otherwise specified by the engineer responsible for material installation inspections. Compaction of other fills should be to the density required to control sloughing, erosion or excessive moisture content. Maximum thickness of fill layers prior to compaction should not exceed 9 inch lifts.

d) The uppermost one foot of fill slopes should be compacted to at least 85 percent of the maximum unit weight (based on the modified AASHTO compaction test). This is accomplished by running appropriate compaction equipment over the fill.

e) Fill should consist of material from borrow areas and excess cut that is stockpiled on site. All disturbed areas should be free draining, left with a neat and finished appearance, and should be protected from erosion.

Land Grading Stabilization Inspection/Maintenance *

a) All slopes should be checked periodically to see that vegetation is in good condition. Any rills or damage from erosion and animal burrowing should be repaired immediately to avoid further damage.

b) If seepage develop on the slopes, the area should be evaluated to determine if the seepage will cause an unstable condition. Subsurface drains or a gravel mulch may be required to alleviate excessive seepage.

c) Areas requiring revegetation should be repaired immediately. Control undesirable vegetation such as weeds and woody growth to avoid bank stability problems in the future.

5) **Topsoiling *** – Topsoiling will help establish vegetation on all disturbed areas throughout the site during the seeding process. The soil texture of the topsoil to be used shall be a sandy loam to silt loam texture with 15% to 20% organic content.

Topsoiling Placement

a) Topsoil should not be placed while in a frozen or muddy condition, when the subgrade is excessively wet, or when conditions exist that may otherwise be detrimental to proper grading or proposed seeding.

b) Do not place topsoil on slopes steeper than 2:1 without additional structural practices implemented, as it will tend to erode.

c) If topsoil and subsoil are not properly bonded, water will not infiltrate the soil profile evenly and it will be difficult to establish vegetation. The best method is to work the topsoil into the layer below for a depth of at least 3 inches.

6) **Permanent Seeding** – Permanent Seeding shall be done immediately after the final design grades are achieved. Native species of plants should be used to establish perennial vegetative cover on disturbed areas. The revegetation should be done early enough in the fall so that a good cover is established before cold weather comes and growth stops until the spring. A good cover is defined as vegetation covering 75 percent or more of the ground surface.

Permanent Seeding Seedbed Preparation

a) In infertile or coarse-textured subsoil, it is best to stockpile topsoil and re-spread it over the finished slope at a minimum 3 to 6-inch depth and roll it to provide a firm seedbed. The topsoil must have a sandy loam to silt loam texture with 15% to 20% organic content. If construction fill operations have left soil exposed with a loose, rough, or irregular surface, smooth with blade and roll.

b) Loosen the soil to a depth of 3-5 inches with suitable agricultural or construction equipment.

c) Areas not to receive topsoil shall be treated to firm the seedbed after incorporation of the lime and fertilizer so that it is depressed no more than ½ - 1 inch when stepped on. Areas to receive topsoil shall not be firmed until after topsoiling and lime and fertilizer is applied and incorporated, at which time it shall be treated to firm the seedbed as described above.

Permanent Seeding Grass Selection/Application

a) Select an appropriate cool or warm season grass based on site conditions and seeding date. Apply the seed uniformly by hydro-seeding, broadcasting, or by hand. Uniform seed distribution is essential. On steep slopes, hydroseeding may be the most effective seeding method. Surface roughening is particularly important when preparing slopes for hydroseeding.

b) Lime and fertilize. Organic fertilizer shall be utilized in areas within the 100-foot buffer zone to a wetland resource area.

c) Mulch the seedings with straw applied at the rate of ½ tons per acre. Anchor the mulch with erosion control netting or fabric on sloping areas. Amoco supergro or equivalent should be utilized.

Permanent Seeding Inspection/Maintenance *

a) Frequently inspect seeded areas for failure and make necessary repairs and reseed immediately. Conduct or follow-up survey after one year and replace failed plants where necessary.

b) If vegetative cover is inadequate to prevent rill erosion, overseed and fertilize in accordance with soil test results.

c) If a stand has less than 40% cover, reevaluate choice of plant materials and quantities of lime and fertilizer. Re-establish the stand following seedbed preparation and seeding recommendations, omitting lime and fertilizer in the absence of soil test results. If the season prevents resowing, mulch or jute netting shall be installed as an effective temporary cover.

d) Seeded areas should be fertilized during the second growing season. Lime and fertilize thereafter at periodic intervals, as needed. Organic fertilizer shall be utilized in areas within the 100-foot buffer zone to a wetland resource area.

Dust Control:

Dust control will be utilized throughout the entire construction process of the site. For example, keeping disturbed surfaces moist during windy periods will be an effective control measure, especially for construction access roads. The use of dust control will prevent the movement of soil to offsite areas. However, care must be taken to not create runoff from excessive use of water to control dust. The following are methods of Dust Control that may be used on-site:

- Vegetative Cover – The most practical method for disturbed areas not subject to traffic.
- Calcium Chloride – Calcium chloride may be applied by mechanical spreader as loose, dry granules or flakes at a rate that keeps the surface moist but not so high as to cause water pollution or plant damage.
- Sprinkling – The site may be sprinkled until the surface is wet. Sprinkling will be effective for dust control on haul roads and other traffic routes.
- Stone – Stone will be used to stabilize construction roads and will provide dust control.

The site supervisor shall employ an on-site water vehicle for the control of dust as necessary.

De-Watering Practices:

- De-watering is anticipated at the job site. If necessary, dewatering practices shall conform to the following guidelines:
    - Any water that is pumped and discharged from a trench and/or excavation shall be filtered by an approved method prior to its discharge into a receiving water or drainage system.
    - Under no circumstances shall the Contractor discharge water directly to wetland resource areas. When constructing near a wetland resource area, the Contractor shall discharge uncontaminated water from dewatering

operations directly to the nearest drainage system, stream, or waterway after filtering by an approved method.

- The pumped water shall be filtered through either: bailed straw, a vegetative filter strip, a vegetative channel, dewatering bag or a mechanical tank system to trap sediment occurring as a result of the construction operations. Vegetated channels, if utilized shall be constructed such that the discharge flow rate shall not exceed a velocity of more than 1 foot per second. Accumulated sediment shall be cleared from the channel periodically.

Sediment material removed shall be disposed of in accordance with all applicable local, state, and federal regulations.

The developer and site general contractor will comply with the E.P.A.'s Final General Permit for Construction De-watering Discharges, (N.P.D.E.S., Section 402 and 40 C.F.R. 122.26(b) (14) (x).

Inspection/Maintenance:

Operator personnel must inspect the construction site at least once every 14 calendar days and within 24 hours of a storm event of ½-inch or greater. The applicant shall be responsible to secure the services of a design professional or similar professional (inspector) on an on-going basis throughout all phases of the project. Refer to the Inspection/Maintenance Requirements presented earlier in the "Structural and Stabilization Practices." The inspector should review the erosion and sediment controls with respect to the following:

- Whether or not the measure was installed/performed correctly.
- Whether or not there has been damage to the measure since it was installed or performed.
- What should be done to correct any problems with the measure.

The inspector should document the findings and should request the required maintenance or repair for the pollution prevention measures when the inspector finds that it is necessary for the measure to be effective. The inspector should notify the appropriate person to make the required changes.

It is essential that the inspector document the inspection of the pollution prevention measures. These records will be used to request maintenance and repair and to prove that the inspection and maintenance were performed. The forms list each of the measures to be inspected on the site, the inspector's name, the date of the inspection, the condition of the measure/area inspected, maintenance or repair performed and any changes which should be made to the Operation and Maintenance Plan to control or eliminate unforeseen pollution of storm water.

APPENDIX F:
LONG TERM BEST MANAGEMENT PRACTICES O&M PLAN

DRAFT
Long Term Best Management Practices
Operation and Maintenance Plan
for
501 & 600 Griffin Brook Drive
Methuen, Massachusetts
April 6, 2022

The following operation and maintenance plan has been provided to satisfy the requirements of Standard 9 of the Mass DEP Stormwater Management Handbook associated with development of the site and associated infrastructure. The success of the Stormwater Management Plan depends on the proper implementation, operation and maintenance of several management components. The following procedures shall be implemented to ensure success of the Stormwater Management Plan:

1. The contractor shall comply with the details of construction of the site as shown on the approved plans.
2. The stormwater management system shall be inspected and maintained as indicated below.
3. Effective erosion control measurers during and after construction shall be maintained until a stable turf is established on all altered areas.
4. A Stormwater Management Maintenance Log is included at the end of this Appendix.

Basic Information
Stormwater Management System Owner:

Methuen Department of Public Services:	DPW Division Management 10 Ditson Place, Suite 100 Methuen, MA 01844 P: (978) 983-8545
Methuen Planning Division:	Searles Building 41 Pleasant Street Methuen, MA 01960 P: (978) 983-8560
Methuen Conservation Commission:	Searles Building 41 Pleasant Street Methuen, MA 01960 P: (978) 983-8650
Site Design Engineer Information:	The Morin-Cameron Group, Inc. 25 Kenoza Avenue Haverhill, MA 01830 Phone: (978) 373-0310

Erosion and Sedimentation Controls during Construction:

The site and drainage construction contractor shall be responsible for managing stormwater during construction. Routine monitoring of disturbed soils shall be performed to ensure adequate runoff and pollution control during construction.

A sediment and erosion control barrier will be placed as shown on the Erosion and Sediment Control Plan prior to the commencement of any clearing, grubbing, and earth removal or construction activity. The integrity of the erosion control barrier will be maintained by periodic inspection and replacement as necessary. The erosion control barrier will remain in place until the first course of pavement has been placed and all side slopes have been loamed and seeded and vegetation has been established. Silt sacks shall be placed in new catch basins once constructed while construction activities are ongoing.

Operations and maintenance plans for the Stormwater Management construction phase and long term operation of the system have been attached to this report.

General Conditions

1. The site contractor shall be responsible for scheduling regular inspections and maintenance of the stormwater BMP's until the project has been completed. The BMP maintenance shall be conducted as detailed in the following long-term pollution prevention plan and on the approved design plans:
   "Site Plan of Land" in Methuen, Massachusetts, 501 & 600 Griffin Brook Drive prepared by The Morin-Cameron Group, Inc. dated April 6, 2022 as revised and approved by the City of Methuen, hereinafter referred to as the Site Plans.
2. All Stormwater BMP's shall be operated and maintained in accordance with the design plans and the following Long-Term Pollution Prevention Plan.
3. The owner shall:
   a. Maintain an Operation and Maintenance Log for the last three years. The Log shall include all BMP inspections, repairs, replacement activities and disposal activities (disposal material and disposal location shall be included in the Log);
   b. Make the log available to the Methuen Planning Board, Conservation Commission and Department of Public Services upon request;
   c. Allow members and agents of the Methuen Planning Board and Conservation Commission to enter the premises and ensure that the Owner has complied with the Operation and Maintenance Plan requirements for each BMP.
4. A recommended inspection and maintenance schedule is outlined below based on statewide averages. This inspection and maintenance schedule shall be adhered to at a minimum for the first year of service of all BMP's referenced in this document. At the commencement of the first year of service, a more accurate inspection/maintenance schedule shall be determined based on the level of service for this site.

Long-Term Pollution Prevention Plan (LTPPP)

Vegetated Areas:

Immediately after construction, monitoring of the erosion control systems shall occur until establishment of adequate vegetation ground cover. Afterwards, vegetated areas shall be maintained as such. Vegetation shall be replaced as necessary to ensure proper stabilization of the site.

Cost: Included with annual landscaping budget. Consult with local landscape contractors.

Paved Areas:

Sweepers shall sweep paved areas periodically during dry weather to remove excess sediments and to reduce the amount of sediments that the drainage system shall have to remove from the runoff. The sweeping shall be conducted primarily between March 15th and November 15th. Special attention should be made to sweeping paved surfaces in March and April before spring rains wash residual sand into the drainage system.

Cost: Consult with local mechanical sweeping companies for associated costs if necessary.

Salt used for de-icing on the access driveways during winter months shall be limited as much as possible as this will reduce the need for removal and treatment. Sand containing the minimum amount of calcium chloride (or approved equivalent) needed for handling may be applied as part of the routine winter maintenance activities.

Deep Sump Hooded Catch Basins:

The catch basin grates shall be checked quarterly and following heavy rainfalls to verify that the inlet openings are not clogged by debris. Debris shall be removed from the grates and disposed of properly. Deep sump catch basins shall be inspected four times per year and cleaned as needed when accumulated sediments exceeds 2' from the bottom of the sump (approximately 1/2 of the sump capacity). Catch basins shall be inspected annually to check oil build-up and outlet obstructions. Material shall be removed from catch basins and disposed of in accordance with all applicable regulations

Cost: Estimated $50 - $100 per cleaning per catch basin as needed. The Owner shall consult local vacuum cleaning contractors for detailed cost estimates.

Public Safety Concerns: Catch basins shall not be left open and unattended at any time during inspection, cleaning or otherwise. Broken or missing grates or frames shall be replaced immediately. At no time shall any person enter the basin structure unless measures have been taken to ensure safe access in accordance with OSHA enclosed space regulations.

Proprietary Water Quality Units (CDS, StormFilter):

The CDS water quality pretreatment units shall be inspected twice per year in April and October. The unit shall be cleaned per manufacturer instructions included herein.

Pea Stone Filter Strip:

The pea stone filter strip shall be checked for debris accumulation twice per year. Additional inspections should be scheduled during the first few months to make sure that the filter strip is functioning as intended. Trash, leaves, branches, etc. shall be removed from surface. Silt, sand and sediment, if significant accumulation occurs, shall be removed as required. Material removed from the filter strip shall be disposed of in accordance with all applicable local, state, and federal regulations. If stone becomes full of sediment, stone shall be removed and replaced with clean

washed stone. The filter strip shall be kept free of woody vegetation and removal of woody vegetation shall be conducted between October 15th and April 15th. Any slope erosion shall be stabilized and repaired immediately and additional rip-rap added as required. Damaged sections shall be replaced with sod and secured to underlying soil with the use of landscaping staples or equivalent.

Cost: Consult with local landscaping for associated costs if necessary.

Infiltration Basins/Detention Basin:
The best management practices shall be inspected after every major storm event for the first 3 months after construction; a major storm event is 3.30 inches of rainfall in a 24 hour period (2 year storm). Thereafter, the basin shall be inspected twice per year, typically in the spring and fall. If erosion or loss of vegetation is observed in the basin, it shall be repaired immediately and new vegetation shall be established. Trash, leaves, branches, etc. shall be removed from basins. The infiltration, detention basin and water quality swale shall be mowed twice per year. Reseed as required. Inspect swales to make sure vegetation is adequate, check dams are in place and functioning and slopes are not eroding. Check for rilling and gullying. Repair eroded areas and revegetate as needed.

The outlet structures and overflow spillways shall be inspected annually for obstructions, structural integrity and trash accumulations. The inspections shall be conducted by qualified personnel.

Cost: Consult with local landscaping companies for associated costs if necessary.

Rip-Rap Outfalls:
The rip-rap outfalls shall be checked for debris accumulation twice per year. Additional inspections should be scheduled during the first few months to make sure that the outfall is functioning as intended. Trash, leaves, branches, etc. shall be removed from outfall. Silt, sand and sediment, if significant accumulation occurs, shall be removed as required by means of mechanical excavation. Material removed shall be disposed of in accordance with all applicable local, state, and federal regulations. The outfall shall be kept free of woody vegetation and removal of woody vegetation shall be conducted between October 15th and April 15th. Any slope erosion within the outfall shall be stabilized and repaired immediately and additional rip-rap added as required.

Cost: $500-$1000 per cleaning if excavator is necessary to remove sediment. The owner should consult local landscape contractors for a detailed cost estimate.

Subsurface Detention System:
The subsurface chamber system shall be monitored annually to ensure that it is draining properly. In the case that water remains in the system for greater than three (3) days after a storm event, an inspection is warranted and necessary maintenance or repairs should be addressed as necessary. The inspections shall be conducted by qualified personnel. Refer to retain-it owners maintenance manual included herein.

Cost: Consult with local landscaping companies for associated costs if necessary.

Public Safety Concerns: Manhole covers or inspection port covers shall not be left open and unattended at any time during inspection, cleaning or otherwise. Broken covers or frames shall be replaced immediately. At no time shall any person enter the subsurface structure unless measures have been taken to ensure safe access in accordance with OSHA enclosed space regulations.

Overall Site Grading and Stormwater Management:
After construction, and during the initial vegetation establishment period, the site should be inspected after every rainfall. Mowing, litter removal, and spot vegetation repair should be performed on a regular basis.

Debris & Litter:

All debris and litter shall be removed from the access driveways and parking lots regularly to prevent migration into the drainage system.

Pesticides, Herbicides, and Fertilizers:
Pesticides and herbicides shall be used sparingly. Fertilizers shall be restricted to the use of organic fertilizers only. All fertilizers, herbicides, pesticides, sand and salt for deicing and the like shall be stored in dry area that is protected from weather.

Cost: Included in the routine landscaping maintenance schedule. The Owner shall consult local landscaping contractors for details.

Public Safety Concerns: Chemicals shall be stored in a secure area to prevent children from obtaining access to them. Any major spills shall be reported to municipal officials.

Prevention of Illicit Discharges:
Illicit discharges to the stormwater management system are not allowed. Illicit discharges are discharges that are not comprised entirely of stormwater. Pursuant to Mass DEP Stormwater Standards the following activities or facilities are not considered illicit discharges: firefighting, water line flushing, landscape irrigation, uncontaminated groundwater, potable water sources, foundation drains, air conditioning condensation, footing drains, individual resident car washing, flows from riparian habitats and wetlands, dechlorinated water from swimming pools, water used for street washing and water used to clean residential building without detergents.

To prevent illicit discharges to the stormwater management system the following policies should be implemented:

1. Good Housekeeping Practices
   - The site shall be kept clean of litter and debris and continuously maintained in accordance with the Long-Term Pollution Prevention Plan as noted above. All chemicals shall be covered and stored in secured location. Any land disturbances that change drainage characteristics shall be remedied to pre-disturbance characteristics (i.e. rutting from vehicles, land disturbance from plowing, etc.) as soon as possible to ensure proper treatment of all stormwater runoff.
2. Provisions for Storing Materials and Waste Products Inside or Under Cover
   - All chemicals and chemical waste products shall be stored inside or in a secured covered location to prevent potential discharge. Any major spills shall be reported to municipal officials and a remediation plan shall be implemented immediately.
3. Vehicle Maintenance
   - Any vehicle maintenance shall be done with care to prevent discharge of illicit fluids. If fluids are accidentally spilled, immediate action shall be implemented to clean and remove the fluid to prevent discharge into the stormwater management system and/or infiltrating into the groundwater.
4. Spill Prevention and Response Plans
   - If a major spill of an illicit substance occurs, town officials (including but not limited to the Methuen Fire Department and find

- Police Department) shall be notified immediately. A response plan shall then be implemented immediately to prevent any illicit discharges from entering the stormwater management system and ultimately surface waters of the Commonwealth.

5. Solid waste
   - All domestic solid waste shall be disposed of in accordance with all applicable local, state and federal regulations. Waste shall be placed into covered dumpsters and/or covered waste bins to prevent water intrusion and potentially contaminated runoff. No household chemicals, hazardous materials, construction debris or non-household generated refuse shall be disposed of in the on-site waste disposal containers. Domestic solid waste disposal and collection shall be coordinated with a qualified waste refuse company.

Snow Storage:

Property owner shall inform their snow removal contractor of the designated areas for snow storage shown on the Site Plans.

APPENDIX G:
ILLICIT DISCHARGE STATEMENT

Illicit Discharge Compliance Statement

I, Scott P. Cameron, P.E., hereby notify the Methuen Planning Board that I have not witnessed, nor am aware of any existing illicit discharges at the site known as 501 & 600 Griffin Brook Drive in Methuen, Massachusetts. I also hereby certify that the development of said property as illustrated on the final plans entitled "Site Plan of Land," prepared by The Morin-Cameron Group, Inc. dated April 6, 2022 and as revised and approved by the Methuen Planning Board and maintenance thereof in accordance with the "Stormwater Pollution Prevention Plan" and "Long-Term Pollution Prevention Plan" prepared by The Morin-Cameron Group, Inc dated April 6, 2022 and as revised and approved by the Methuen Planning Board will not create any new illicit discharges. There is no warranty implied regarding future illicit discharges that may occur as a result of improper construction or maintenance of the stormwater management system or unforeseen accidents.

Name: Scott P. Cameron, P.E.

Company: The Morin-Cameron Group, Inc.

Title: Owner's Representative

Signature: 

Date: 4-6-22

APPENDIX H:
SOIL EVALUATION
FORMS

Commonwealth of Massachusetts
City/Town of Methuen

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

A. Facility Information

Griffin Brook Drive Owner, LLC
Owner Name

501 & 600 Griffin Brook Drive
Street Address

Map 220, Lots 9D & 9E
Map/Lot #

Methuen
City

MA
State

Zip Code

B. Site Information

1. (Check one) ☐ New Construction ☐ Upgrade ☐ Repair N/A

2. Soil Survey Available? ☒ Yes ☐ No If yes: NRCS (Source) 715B & 717C (Soil Map Unit)

715B—Ridgebury and Leicester fine sandy loams, 3 to 8 percent slopes, extremely stony
717C—Rock outcrop-Charlton-Hollis complex, 3 to 15 percent

Shallow Ledge
Soil Limitations

Soil Parent material

Landform

3. Surficial Geological Report Available? ☒ Yes ☐ No If yes: 1958/Castle (Year Published/Source) Qgm (Map Unit)

Description of Geologic Map Unit:

4. Flood Rate Insurance Map Within a regulatory floodway? ☐ Yes ☒ No

5. Within a velocity zone? ☐ Yes ☒ No

6. Within a Mapped Wetland Area? ☐ Yes ☒ No If yes, MassGIS Wetland Data Layer: Wetland Type

7. Current Water Resource Conditions (USGS): 2/2022 (Month/Day/ Year) Range: ☒ Above Normal ☐ Normal ☐ Below Normal

8. Other references reviewed: MAGIS

Commonwealth of Massachusetts
City/Town of Methuen

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

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

Deep Observation Hole Number: 22-1 (Hole #) | 2/7/2022 (Date) | (Time) | 30°F, Snow flurry (Weather) | 42°41'36"N ± (Latitude) | 71°14'13.49"W ± (Longitude:)

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

Description of Location: See plan

2. Soil Parent Material: : Friable coarse-loamy eolian deposits over friable coarse-loamy basal till derived from granite and gneiss | (Landform) | (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances from: Open Water Body >100 feet | Drainage Way >25 feet | Wetlands >100 feet
Property Line >10 feet | Drinking Water Well >100 feet | Other _____ feet

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

5. Groundwater Observed: ☐ Yes ☐ No If yes: _____ Depth Weeping from Pit _____ Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-12	Ap	SL	10YR3/4						Gran	Fri	
12-132	C1	GrLS	2.5Y7/2				5-10	5	SG	Loose	Rounded gravels

Additional Notes:
Refusal @ 132", No ESHWT/No Observed water @132"

Commonwealth of Massachusetts
City/Town of Methuen

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

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

Deep Observation Hole Number: 22-2 (Hole #) | 2/7/2022 (Date) | _____ (Time) | 30°F, Snow flurry (Weather) | 42°41'36"N ± (Latitude) | 71°14'13.49"W ± (Longitude:)

1. Land Use: Woods (e.g., woodland, agricultural field, vacant lot, etc.) | Mature trees (Vegetation) | Some stones (Surface Stones (e.g., cobbles, stones, boulders, etc.)) | _____ (Slope (%))

Description of Location: See plan

2. Soil Parent Material: : Friable coarse-loamy eolian deposits over friable coarse-loamy basal till derived from granite and gneiss | _____ (Landform) | _____ (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances from: Open Water Body >100 feet | Drainage Way >25 feet | Wetlands >100 feet | Property Line >10 feet | Drinking Water Well >100 feet | Other _____ feet

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

5. Groundwater Observed: ☐ Yes ☐ No If yes: _____ Depth Weeping from Pit _____ Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-48	Fill										Topsoil/Stone mix
48-52	Ab	10YR3/4	SL						Gran	Fri	
52-64	Bw	10YR5/6	SL						WBlky	VFri	
64-216	C1	2.5Y7/2	LS				5-10	5	SG	Loose	

Additional Notes:
Refusal @ 216", No ESHWT/No Observed water @216", Roots to 76"±

Commonwealth of Massachusetts
City/Town of Methuen

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

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

Deep Observation Hole Number: 22-3 (Hole #) | 2/8/2022 (Date) | _____ (Time) | 30°F, Snow flurry (Weather) | 42°41'36"N ± (Latitude) | 71°14'13.49"W ± (Longitude:)

1. Land Use: Woods (e.g., woodland, agricultural field, vacant lot, etc.) | Mature trees (Vegetation) | Some stones (Surface Stones (e.g., cobbles, stones, boulders, etc.)) | _____ (Slope (%))

Description of Location: See plan

2. Soil Parent Material: : Friable coarse-loamy eolian deposits over friable coarse-loamy basal till derived from granite and gneiss | _____ (Landform) | _____ (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances from: Open Water Body >100 feet | Property Line >10 feet | Drainage Way >25 feet | Drinking Water Well >100 feet | Wetlands >100 feet | Other _____ feet

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

5. Groundwater Observed: ☐ Yes ☐ No If yes: _____ Depth Weeping from Pit _____ Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-4	A/O	FSL	10YR3/4						Gran	Fri	
4-22	Bw	SL	10YR5/6						WBlky	Fri	Angular cobbles
22-48	C1	SL	2.5Y5/4						WBlky	Fri	
48-180	2C1	LS	2.5Y7/2				5-10		SG	Loose	SA rounded gravels

Additional Notes:
No refusal @ 180", No ESHWT/No observed water @180", Roots to 46"±

Commonwealth of Massachusetts
City/Town of Methuen

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

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

Deep Observation Hole Number: 22-4 (Hole #) | 2/7/2022 (Date) | (Time) | 30°F, Snow flurry (Weather) | 42°41'36"N ± (Latitude) | 71°14'13.49"W ± (Longitude:)

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

Description of Location: See plan

2. Soil Parent Material: : Friable coarse-loamy eolian deposits over friable coarse-loamy basal till derived from granite and gneiss | (Landform) | (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances from: Open Water Body >100 feet | Drainage Way >25 feet | Wetlands >100 feet | Property Line >10 feet | Drinking Water Well >100 feet | Other _____ feet

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

5. Groundwater Observed: ☐ Yes ☐ No If yes: 124" Depth Weeping from Pit _____ Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-8	A/O	SL	10YR3/4						Gran	Fri	
8-36	Bw	SL	10YR5/6						WBlky	VFri	
36-120	C1	FLS	2.5Y7/2	112"	7.5YR5/8, 5Y6/1		5-10	5	SG	Loose	
120-142	C2	SL	2.5Y7/2						WBlky	Fri	Compacted

Additional Notes:
Roots to 82"±, ESHWT @ 112", Weep @ 124", Refusal @ 142"

Commonwealth of Massachusetts
City/Town of Methuen

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

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

Deep Observation Hole Number: 22-5 (Hole #) | 2/7/2022 (Date) | _____ (Time) | 30°F, Snow flurry (Weather) | 42°41'36"N ± (Latitude) | 71°14'13.49"W ± (Longitude:)

1. Land Use: Woods (e.g., woodland, agricultural field, vacant lot, etc.) | Mature trees (Vegetation) | Some stones (Surface Stones (e.g., cobbles, stones, boulders, etc.)) | _____ (Slope (%))

Description of Location: See plan

2. Soil Parent Material: : Friable coarse-loamy eolian deposits over friable coarse-loamy basal till derived from granite and gneiss | _____ (Landform) | _____ (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances from: Open Water Body >100 feet | Drainage Way >25 feet | Wetlands >100 feet | Property Line >10 feet | Drinking Water Well >100 feet | Other _____ feet

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

5. Groundwater Observed: ☐ Yes ☐ No If yes: _____ Depth Weeping from Pit _____ Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-3	A/O	SL	10YR3/4						Gran	Fri	
3-22	Bw	GrSL	10YR5/6				15-20		VWBlky	VFri	
22-168	C1	FLS	2.5Y7/2				5-10		SG	Loose	

Additional Notes:
Roots to 52"±, No ESHWT/No Observed Water @ 168", Refusal @ 168"

Commonwealth of Massachusetts
City/Town of Methuen

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

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

Deep Observation Hole Number: 22-6 (Hole #) | 2/7/2022 (Date) | _____ (Time) | 30°F, Snow flurry (Weather) | 42°41'36"N ± (Latitude) | 71°14'13.49"W ± (Longitude:)

1. Land Use: Woods (e.g., woodland, agricultural field, vacant lot, etc.) | Mature trees (Vegetation) | Some stones (Surface Stones (e.g., cobbles, stones, boulders, etc.)) | _____ (Slope (%))

Description of Location: See plan

2. Soil Parent Material: : Friable coarse-loamy eolian deposits over friable coarse-loamy basal till derived from granite and gneiss | _____ (Landform) | _____ (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances from: Open Water Body >100 feet | Drainage Way >25 feet | Wetlands >100 feet | Property Line >10 feet | Drinking Water Well >100 feet | Other _____ feet

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

5. Groundwater Observed: ☐ Yes ☐ No If yes: _____ Depth Weeping from Pit _____ Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-3	A/O	SL	10YR3/4						Gran	Fri	
3-26	Bw	SL	10YR5/6				15-20		WBlky	Fri	

Additional Notes:
Refusual @ 26", Ledge diving(towards golf course), Test pit at top of knoll, No C present, No ESHWT/No observed @ 26"

Commonwealth of Massachusetts
City/Town of Methuen

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

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

Deep Observation Hole Number: 22-7 (Hole #) | 2/8/2022 (Date) | (Time) | 30°F, Snow flurry (Weather) | 42°41'36"N ± (Latitude) | 71°14'13.49"W ± (Longitude)

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

Description of Location: See plan

2. Soil Parent Material: : Friable coarse-loamy eolian deposits over friable coarse-loamy basal till derived from granite and gneiss | (Landform) | (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances from: Open Water Body >100 feet | Drainage Way >25 feet | Wetlands >100 feet | Property Line >10 feet | Drinking Water Well >100 feet | Other _____ feet

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

5. Groundwater Observed: ☐ Yes ☐ No If yes: _____ Depth Weeping from Pit _____ Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-5	A/O	FSL	10YR3/4						Gran	Fri	
5-26	Bw	SL	10YR5/6						WBlky	Fri	
26-122	C1	LS	2.5Y7/2				5-10		WBlky	VFri	
122-146	2C1	SL	2.5Y7/2	122"	7.5YR5/8, 5Y6/1				SABK	Firm	

Additional Notes:
Roots to 48", 2C1=compacted with stratified lenses, Refusal @ 146", ESHWT@122" (lenses), No observed water @ 146"

Commonwealth of Massachusetts
City/Town of Methuen

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

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

Deep Observation Hole Number: 22-8 (Hole #) | 2/8/2022 (Date) | _____ (Time) | 30°F, Snow flurry (Weather) | 42°41'36"N ± (Latitude) | 71°14'13.49"W ± (Longitude:)

1. Land Use: Woods (e.g., woodland, agricultural field, vacant lot, etc.) | Mature trees (Vegetation) | Some stones (Surface Stones (e.g., cobbles, stones, boulders, etc.)) | _____ (Slope (%))

Description of Location: See plan

2. Soil Parent Material: : Friable coarse-loamy eolian deposits over friable coarse-loamy basal till derived from granite and gneiss | _____ (Landform) | _____ (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances from: Open Water Body >100 feet | Drainage Way >25 feet | Wetlands >100 feet | Property Line >10 feet | Drinking Water Well >100 feet | Other _____ feet

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

5. Groundwater Observed: ☐ Yes ☐ No If yes: 112" Depth Weeping from Pit | _____ Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-4	A/O	FSL	10YR3/4						Gran	Fri	
4-18	Bw	SL	10YR5/6						WBlky	Fri	
18-34	C1	SL	2.5Y5/4						WBlky	VFri	
34-108	2C1	LS	2.5Y7/2				5-10		SG	Loose	SA Rounded
108-118	2C2	SL	2.5Y7/2	108"	7.5YR5/8, 5Y6/1				Platy/SABK	Firm	

Additional Notes:
Valley between knolls, Weep @ 112", Refusal @ 118", ESHWT @ 108"

Commonwealth of Massachusetts
City/Town of Methuen

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

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

Deep Observation Hole Number: 22-9 (Hole #) | 2/8/2022 (Date) | _____ (Time) | 30°F, Snow flurry (Weather) | 42°41'36"N ± (Latitude) | 71°14'13.49"W ± (Longitude:)

1. Land Use: Woods (e.g., woodland, agricultural field, vacant lot, etc.) | Mature trees (Vegetation) | Some stones (Surface Stones (e.g., cobbles, stones, boulders, etc.)) | _____ (Slope (%))

Description of Location: See plan

2. Soil Parent Material: : Friable coarse-loamy eolian deposits over friable coarse-loamy basal till derived from granite and gneiss | _____ (Landform) | _____ (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances from: Open Water Body >100 feet | Drainage Way >25 feet | Wetlands >100 feet
Property Line >10 feet | Drinking Water Well >100 feet | Other _____ feet

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

5. Groundwater Observed: ☐ Yes ☐ No If yes: _____ Depth Weeping from Pit _____ Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-8	A	SL	10YR3/4						Gran	Fri	
8-26	Fill	SL/Mix									
26-38	Bb	FSL	10YR6/8						Mass	Firm	
38-68	Cd	FSL	2.5Y6/3						Mass	VFirm	
68"+/-	Cr										Weathered bedrock

Additional Notes:
Lawn/Woods line off volleyball court, Refusal @ 68", No ESHWT/No Observed water @ 68"

Commonwealth of Massachusetts
City/Town of Methuen

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

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

Deep Observation Hole Number: 22-10 (Hole #) | 2/8/2022 (Date) | _____ (Time) | 30°F, Snow flurry (Weather) | 42°41'36"N ± (Latitude) | 71°14'13.49"W ± (Longitude:)

1. Land Use: Woods (e.g., woodland, agricultural field, vacant lot, etc.) | Mature trees (Vegetation) | Some stones (Surface Stones (e.g., cobbles, stones, boulders, etc.)) | _____ (Slope (%))

Description of Location: See plan

2. Soil Parent Material: : Friable coarse-loamy eolian deposits over friable coarse-loamy basal till derived from granite and gneiss | _____ (Landform) | _____ (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances from: Open Water Body >100 feet | Drainage Way >25 feet | Wetlands >100 feet | Property Line >10 feet | Drinking Water Well >100 feet | Other _____ feet

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

5. Groundwater Observed: ☐ Yes ☐ No If yes: _____ Depth Weeping from Pit _____ Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-4	A/O	FSL	10YR3/4						Gran	Fri	
4-28	Bw	SL	10YR5/6				5	5	WBlky	Fri	Angular grav/cob
28-64	C1	LS	2.5Y7/2				5-10		SG	Loose	

Additional Notes:
Refusal @ 64", No ESHWT/No Observed water @ 64", Roots to 48"±

Commonwealth of Massachusetts
City/Town of Methuen

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

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

Deep Observation Hole Number: 22-11 (Hole #) | 2/8/2022 (Date) | _____ (Time) | 30°F, Snow flurry (Weather) | 42°41'36"N ± (Latitude) | 71°14'13.49"W ± (Longitude:)

1. Land Use: Woods (e.g., woodland, agricultural field, vacant lot, etc.) | Mature trees (Vegetation) | Some stones (Surface Stones (e.g., cobbles, stones, boulders, etc.)) | _____ (Slope (%))

Description of Location: See plan

2. Soil Parent Material: : Friable coarse-loamy eolian deposits over friable coarse-loamy basal till derived from granite and gneiss | _____ (Landform) | _____ (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances from: Open Water Body >100 feet | Drainage Way >25 feet | Wetlands >100 feet | Property Line >10 feet | Drinking Water Well >100 feet | Other _____ feet

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

5. Groundwater Observed: ☐ Yes ☐ No If yes: _____ Depth Weeping from Pit _____ Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-4	A/O	FSL	10YR3/4						Gran	Fri	
4-22	Bw	SL	10YR5/6						WBlky	Fri	
22-84	C1	LS	2.5Y7/2				5-10		SG	Loose	

Additional Notes:
Corse sand and decomposed bedrock at bottom, Roots to 58"±, Refusal at 84"

Commonwealth of Massachusetts
City/Town of Methuen

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

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

Deep Observation Hole Number: 22-12 (Hole #) | 2/8/2022 (Date) | _____ (Time) | 30°F, Snow flurry (Weather) | 42°41'36"N ± (Latitude) | 71°14'13.49"W ± (Longitude:)

1. Land Use: Woods (e.g., woodland, agricultural field, vacant lot, etc.) | Mature trees (Vegetation) | Some stones (Surface Stones (e.g., cobbles, stones, boulders, etc.)) | _____ (Slope (%))

Description of Location: See plan

2. Soil Parent Material: : Friable coarse-loamy eolian deposits over friable coarse-loamy basal till derived from granite and gneiss | _____ (Landform) | _____ (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances from: Open Water Body >100 feet | Drainage Way >25 feet | Wetlands >100 feet | Property Line >10 feet | Drinking Water Well >100 feet | Other _____ feet

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

5. Groundwater Observed: ☐ Yes ☐ No If yes: _____ Depth Weeping from Pit _____ Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-4	A/O	FSL	10YR3/4						Gran	Fri	
4-16	Bw	SL	10YR5/6						WBlky	Fri	
16-30	C1	SL	2.5Y5/4				5-10	5	WBlky	Fri	Angular grav and cob
30-60	2C1	LS	2.5Y7/2				5-10	5	SG	Loose	Sub-angular grav and cob

Additional Notes:
Roots to 44"±, Refusal @ 60", No ESHWT/No Observed water @ 60"

Commonwealth of Massachusetts
City/Town of Methuen

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

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

Deep Observation Hole Number: 22-13 (Hole #) | 2/8/2022 (Date) | _____ (Time) | 30°F, Snow flurry (Weather) | 42°41'36"N ± (Latitude) | 71°14'13.49"W ± (Longitude:)

1. Land Use: Woods (e.g., woodland, agricultural field, vacant lot, etc.) | Mature trees (Vegetation) | Some stones (Surface Stones (e.g., cobbles, stones, boulders, etc.)) | _____ (Slope (%))

Description of Location: See plan

2. Soil Parent Material: : Friable coarse-loamy eolian deposits over friable coarse-loamy basal till derived from granite and gneiss | _____ (Landform) | _____ (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances from: Open Water Body >100 feet | Drainage Way >25 feet | Wetlands >100 feet | Property Line >10 feet | Drinking Water Well >100 feet | Other _____ feet

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

5. Groundwater Observed: ☐ Yes ☐ No If yes: 120" Depth Weeping from Pit | _____ Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-4	A/O	FSL	10YR3/4						Gran	Fri	
4-24	Bw	SL	10YR5/6						WBlky	Fri	
24-45	C1	SL	2.5Y5/4				5-10	5	WBlky	Fri	Angular grav and cob
45p-154	2C1	GrLS	2.5Y7/2				5-10	5	SG	Loose	Sub-angular grav and cob

Additional Notes:
Roots to 40"±, Weep/ESHWT @ 120" (Follows valley), Refusal @ 154", Large stones @ 64"

Commonwealth of Massachusetts
City/Town of Methuen

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

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

Deep Observation Hole Number: 22-14 (Hole #) | 2/8/2022 (Date) | _____ (Time) | 30°F, Snow flurry (Weather) | 42°41'36"N ± (Latitude) | 71°14'13.49"W ± (Longitude:)

1. Land Use: Woods (e.g., woodland, agricultural field, vacant lot, etc.) | Mature trees (Vegetation) | Some stones (Surface Stones (e.g., cobbles, stones, boulders, etc.)) | _____ (Slope (%))

Description of Location: See plan

2. Soil Parent Material: : Friable coarse-loamy eolian deposits over friable coarse-loamy basal till derived from granite and gneiss | _____ (Landform) | _____ (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances from: Open Water Body >100 feet | Drainage Way >25 feet | Wetlands >100 feet | Property Line >10 feet | Drinking Water Well >100 feet | Other _____ feet

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

5. Groundwater Observed: ☐ Yes ☐ No If yes: _____ Depth Weeping from Pit _____ Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-4	A/O	FSL	10YR3/4						Gran	Fri	
4-18	Bw	SL	10YR5/6						WBlky	Fri	
18-36	C1	SL	2.5Y5/4				5-10		WBlky	Fri	Angular grav and cob
36-68	2C1	LS	2.5Y7/2				5		Mass	Fri	Angular grav

Additional Notes:
Roots to 48"±, Minimal gravel in 2C1, No ESHWT/No Observed water @ 68", Ledge follows valley

Commonwealth of Massachusetts
City/Town of Methuen

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

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

Deep Observation Hole Number: 22-15 (Hole #) | 2/8/2022 (Date) | _____ (Time) | 30°F, Snow flurry (Weather) | 42°41'36"N ± (Latitude) | 71°14'13.49"W ± (Longitude:)

1. Land Use: Woods (e.g., woodland, agricultural field, vacant lot, etc.) | Mature trees (Vegetation) | Some stones (Surface Stones (e.g., cobbles, stones, boulders, etc.)) | _____ (Slope (%))

   Description of Location: See plan

2. Soil Parent Material: : Friable coarse-loamy eolian deposits over friable coarse-loamy basal till derived from granite and gneiss | _____ (Landform) | _____ (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances from: Open Water Body >100 feet | Drainage Way >25 feet | Wetlands >100 feet | Property Line >10 feet | Drinking Water Well >100 feet | Other _____ feet

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

5. Groundwater Observed: ☐ Yes ☐ No If yes: _____ Depth Weeping from Pit _____ Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-3	A/O	FSL	10YR3/4						Gran	Fri	
3-18	Bw	SL	10YR5/6				5		WBlky	Fri	Angular grav
18-60	C1	LS	2.5Y7/2				5-10		Mass	Fri	Angular grav and cobb

Additional Notes:
Roots to 40"±, Refusal @ 60", No ESHWT/No observed water @ 60", @ top of valley

Commonwealth of Massachusetts
City/Town of Methuen

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

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

Deep Observation Hole Number: 22-16 (Hole #) | 2/8/2022 (Date) | _____ (Time) | 30°F, Snow flurry (Weather) | 42°41'36"N ± (Latitude) | 71°14'13.49"W ± (Longitude:)

1. Land Use: Woods (e.g., woodland, agricultural field, vacant lot, etc.) | Mature trees (Vegetation) | Some stones (Surface Stones (e.g., cobbles, stones, boulders, etc.)) | _____ (Slope (%))

Description of Location: See plan

2. Soil Parent Material: : Friable coarse-loamy eolian deposits over friable coarse-loamy basal till derived from granite and gneiss | _____ (Landform) | _____ (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances from: Open Water Body >100 feet | Drainage Way >25 feet | Wetlands >100 feet | Property Line >10 feet | Drinking Water Well >100 feet | Other _____ feet

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

5. Groundwater Observed: ☐ Yes ☐ No If yes: _____ Depth Weeping from Pit _____ Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-4	A/O	FSL	10YR3/4						Gran	Fri	
4-26	Bw	SL	10YR5/6						WBlky	Fri	
26-68	C1	LS	2.5Y7/2				5-10	5	SG	Loose	SA rounded grav

Additional Notes:
Roots to 40"±, Refusal @ 68", No ESHWT/No observed water @ 68"

Commonwealth of Massachusetts
City/Town of Methuen

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

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

Deep Observation Hole Number: 22-17 (Hole #) | 2/8/2022p (Date) | _____ (Time) | 30°F, Snow flurry (Weather) | 42°41'36"N ± (Latitude) | 71°14'13.49"W ± (Longitude:)

1. Land Use: Woods (e.g., woodland, agricultural field, vacant lot, etc.) | Mature trees (Vegetation) | Some stones (Surface Stones (e.g., cobbles, stones, boulders, etc.)) | _____ (Slope (%))

   Description of Location: See plan

2. Soil Parent Material: : Friable coarse-loamy eolian deposits over friable coarse-loamy basal till derived from granite and gneiss | _____ (Landform) | _____ (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances from: Open Water Body >100 feet | Drainage Way >25 feet | Wetlands >100 feet | Property Line >10 feet | Drinking Water Well >100 feet | Other _____ feet

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

5. Groundwater Observed: ☐ Yes ☐ No If yes: _____ Depth Weeping from Pit _____ Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-4	A/O	FSL	10YR3/4						Gran	Fri	
4-24	Bw	SL	10YR5/6						WBlky	Fri	
24-150	C1	LS	2.5Y7/2				5-10	5	SG	Loose	

Additional Notes:
Roots to 48"±, Refusal @ 150"

Commonwealth of Massachusetts
City/Town of Methuen

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

F. Certification

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

Signature of Soil Evaluator	2/14/2022 Date
Will Schkuta, SE#14030 Typed or Printed Name of Soil Evaluator / License #	06//302022 Expiration Date of License
Name of Approving Authority Witness	Approving Authority

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

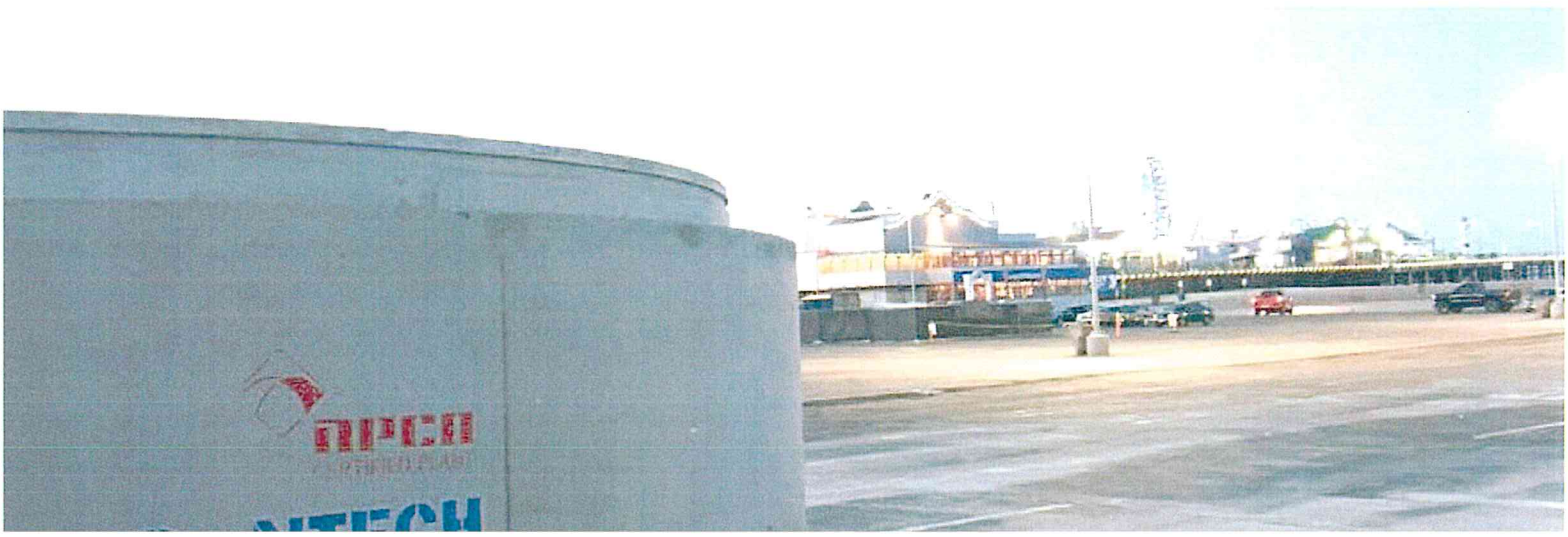
Field Diagrams: Use this area for field diagrams:

See Plan.

APPENDIX I:
MANUFACTURER BROCHURES

CONTECH®
ENGINEERED SOLUTIONS

CDS® Hydrodynamic Separator



The experts you need to solve your stormwater management challenges

Contech is the leader in stormwater management solutions, helping engineers, contractors and owners with infrastructure and land development projects throughout North America.

With our responsive team of stormwater experts, local regulatory expertise and flexible solutions, Contech is the trusted partner you can count on for stormwater management solutions.

Your Contech Team

STORMWATER CONSULTANT

It's my job to recommend the best solution to meet permitting requirements.

STORMWATER DESIGN ENGINEER

I work with consultants to design the best approved solution to meet your project's needs.

REGULATORY MANAGER

I understand the local stormwater regulations and what solutions will be approved.

SALES ENGINEER

I make sure our solutions meet the needs of the contractor during construction.

Unique screening technology for stormwater runoff – CDS®

The CDS hydrodynamic separator uses swirl concentration and continuous deflective separation to screen, separate and trap trash, debris, sediment, and hydrocarbons from stormwater runoff.

At the heart of the CDS system is a unique screening technology used to capture and retain trash and debris. The screen face is louvered so that it is smooth in the downstream direction. The effect created is called "Continuous Deflective Separation." The power of the incoming flow is harnessed to continually shear debris off the screen and to direct trash and sediment toward the center of the separation cylinder. This results in a screen that is self-cleaning and provides 100% removal of floatables and neutrally buoyant material debris 4.7 mm or larger, without blinding.

CDS is used to meet trash Total Maximum Daily Load (TMDL) requirements, for stormwater quality control, inlet and outlet pollution control, and as pretreatment for filtration, detention/infiltration, bioretention, rainwater harvesting systems, and a variety of green infrastructure practices.

CDS® Features and Benefits

FEATURE	BENEFIT
Captures and retains 100% of floatables and neutrally buoyant debris 4.7mm or larger	Superior pollutant removal
Self-cleaning screen	Ease of maintenance
Isolated storage sump eliminates scour potential	Excellent pollutant retention
Internal bypass	Eliminates the need for additional structures
Multiple pipe inlets and 90-180° angles	Design flexibility
Clear access to sump and stored pollutants	Fast, easy maintenance

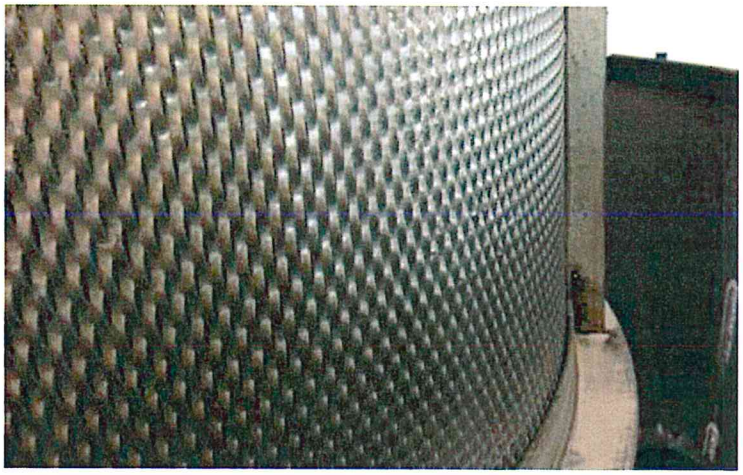
APPLICATION TIPS

- Because of its internal peak bypass weirs, CDS systems can provide cost savings by eliminating the need for additional structures.
- Pretreating detention, infiltration, and green infrastructure practices with CDS can protect downstream structures and provide for easy maintenance.
- The CDS an ideal solution for retrofit applications due to its compact footprint and configuration flexibility.

The CDS® Screen

A fundamentally different approach to trash control ...

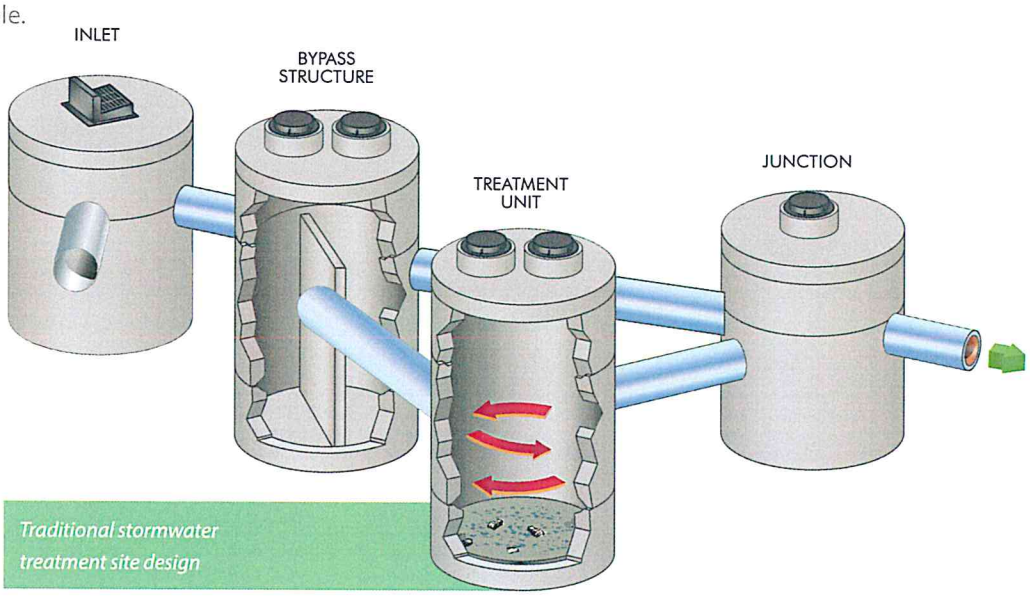
Traditional approaches to trash control typically involve "direct screening" that can easily become clogged, as trash is pinned to the screen as water passes through. Clogged screens can lead to flooding as water backs up. The design of the CDS screen is fundamentally different. Flow is introduced to the screen face which is louvered so that it is smooth in the downstream direction. The effect created is called "Continuous Deflective Separation." The power of the incoming flow is harnessed to continually shear debris off the screen and to direct trash and sediment toward the center of the separation cylinder.



CDS® Design Configuration

Why use traditional stormwater design when ONE system can do it all ...

The CDS effectively treats stormwater runoff while reducing the number of structures on your site. Inline, offline, grate inlet, and drop inlet configurations available. Internal and external peak bypass options also available.

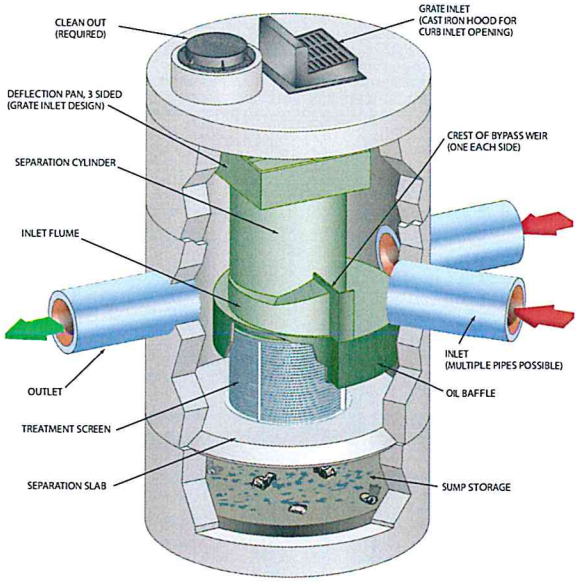


Traditional stormwater treatment site design

A Traditional Stormwater Treatment Site Design would require several structures on your site. With CDS, one system can do it all!

CDS® Advantages

- Grate inlet option available
- Internal bypass weir
- Accepts multiple inlets at a variety of angles
- Advanced hydrodynamic separator
- Captures and retains 100% of floatables and neutrally buoyant debris 4.7 mm or larger
- Indirect screening capability keeps screen from clogging
- Retention of all captured pollutants, even at high flows
- Performance verified by NJCAT, WA Ecology, and ETV Canada



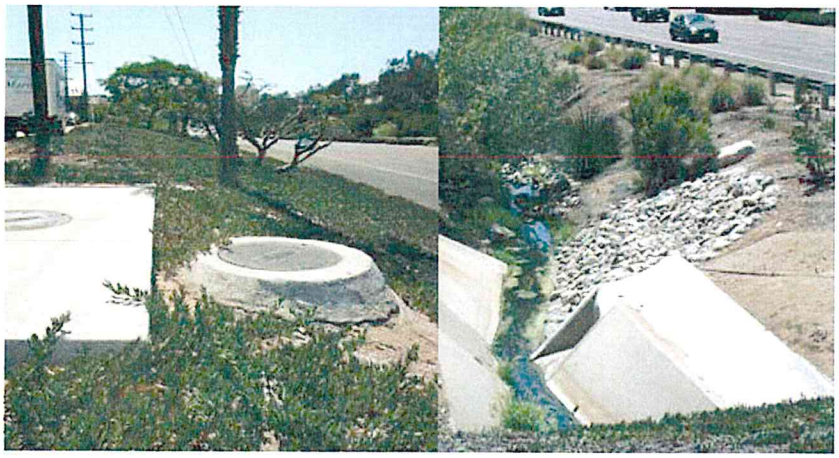
Learn More:
www.ContechES.com/cds

CDS® Applications

CDS is commonly used in the following stormwater applications:

- Stormwater quality control – trash, debris, sediment, and hydrocarbon removal
- Urban retrofit and redevelopment
- Inlet and outlet protection
- Pretreatment for filtration, detention/infiltration, bioretention, rainwater harvesting systems, and Low Impact Development designs

CDS® provides trash control



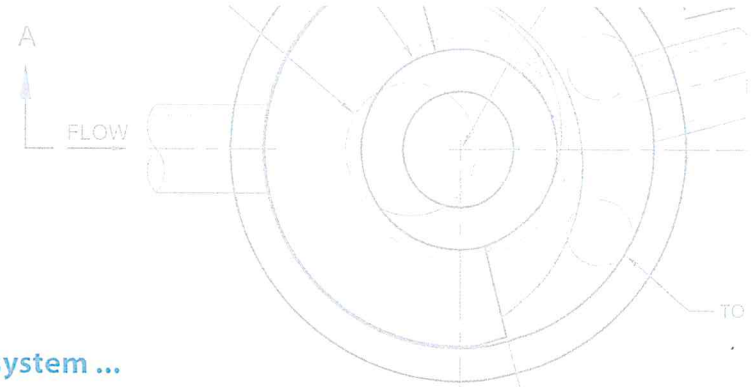
CDS® pretreats a bioswale

Select CDS® Certifications and Verifications

CDS has been verified by some of the most stringent stormwater technology evaluation organizations in North America, including:

- Washington State Department of Ecology (GULD) - Pretreatment
- New Jersey Department of Environmental Protection (NJDEP)
- Canadian Environmental Technology Verification (ETV)
- California Statewide Trash Amendments Full Capture System Certified*

**The CDS System has been certified by the California State Water Resources Control Board as a Full Capture System provided that it is sized to treat the peak flow rate from the region specific 1-year, 1-hour design storm, or the peak flow capacity of the corresponding storm drain, whichever is less.*



CDS® Maintenance

Select a cost-effective and easy-to-access treatment system ...

Systems vary in their maintenance needs, and the selection of a cost-effective and easy-to-access treatment system can mean a huge difference in maintenance expenses for years to come.

A CDS unit is designed to minimize maintenance and make it as easy and inexpensive as possible to keep our systems working properly.

INSPECTION

Inspection is the key to effective maintenance. Pollutant deposition and transport may vary from year to year and site to site. Semi-annual inspections will help ensure that the system is cleaned out at the appropriate time. Inspections should be performed more frequently where site conditions may cause rapid accumulation of pollutants.

Most CDS® units can easily be cleaned within thirty minutes.

RECOMMENDATIONS FOR CDS MAINTENANCE

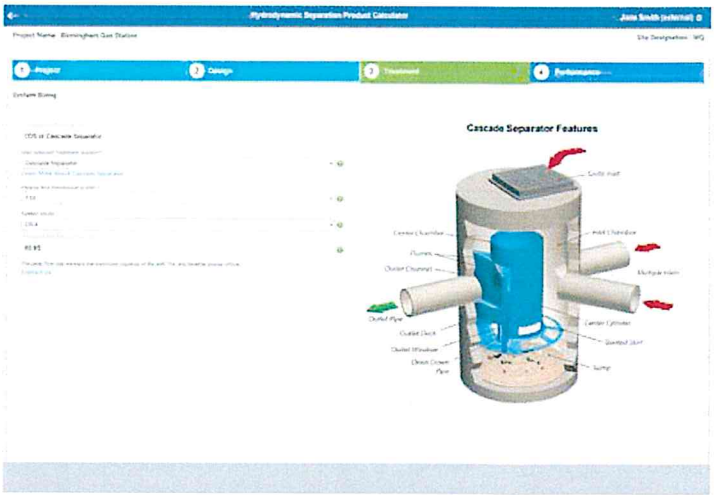
The recommended cleanout of solids within the CDS unit's sump should occur at 75% of the sump capacity. Access to the CDS unit is typically achieved through two manhole access covers – one allows inspection and cleanout of the separation chamber and sump, and another allows inspection and cleanout of sediment captured and retained behind the screen. A vacuum truck is recommended for cleanout of the CDS unit and can be easily accomplished in less than 30 minutes for most installations.

Hydrodynamic Separator Selection & Sizing Tool

Quickly prepare designs for estimates and project meetings ...

Part of the Contech Design Center, this free, online tool fully automates the layout process for identifying the proper hydrodynamic separator for your site.

- Multiple sizing methods available.
- Site-specific questions ensure the selected unit will comply with site constraints.
- Multiple treatment options may be available based on regulations and site parameters.
- Follow up reports contain a site-specific design, sizing summary, standard detail, and specification.



Learn More:
www.ContechES.com/designcenter

A partner you can rely on

STORMWATER SOLUTIONS

PIPE SOLUTIONS

STRUCTURES SOLUTIONS

Few companies offer the wide range of high-quality stormwater resources you can find with us — state-of-the-art products, decades of expertise, and all the maintenance support you need to operate your system cost-effectively.

THE CONTECH WAY

Contech® Engineered Solutions provides innovative, cost-effective site solutions to engineers, contractors, and developers on projects across North America. Our portfolio includes bridges, drainage, erosion control, retaining wall, sanitary sewer and stormwater management products.

TAKE THE NEXT STEP

For more information: www.ContechES.com

CONTECH® ENGINEERED SOLUTIONS

Get social with us:

800-338-1122 | www.ContechES.com

retain-it®
Stormwater Management Systems

TECHNICAL OPERATIONS MANUAL

retain-it, LLC
560 Salmon Brook Street
Granby, CT 06035
(860) 413-3050

retain-it ®

Technical Operations Manual

Table of Contents

Description

retain-it ® is a subsurface Storm Water Management system constructed of precast concrete structures. They are installed in a side by side configuration creating a continuous internal flow channel integrated throughout the system. Systems are constructed with designated inlet and outlet modules, some with multiple inlets and outlets depending on the site storm water system layout. Infiltration systems typically have an inlet and sidewalls/ base constructed on a stone infiltration blanket with geofabric installed at the native soil interface. Other systems incorporate outlet flow control devices. Detention systems are typically lined with a watertight membrane and have inlet and outlet control devices.

The retain-it ® system can consist of multiple varying layouts, with no two the same. Given this, it should be noted that the operation and maintenance requirements are very similar regardless of the intended layout. It is important that the end user know the specific elements of each system so as to understand how best to optimize it's operation.

Engineering Design Specifications

The maintenance staff should be familiar with the engineering design specifications. Staff should obtain the approved drawings, specifications and calculations for review. Although, most systems are similar in design and installation, some have design specifics that may require special operation and maintenance procedures.

System components

The systems are broken down into modules designed for various applications. The following generally describes the basic modules and related functions. See plan for system layout.

Standard Structure modules: consist of varying configurations of a similar precast concrete structure. In general, the footprint of all modules is 8' x 8'. The height is determined by the hydraulic design requirements and is manufactured in 3', 4' & 5' or custom ordered sizes (inside height dimension) increments. The roof/base is an H-20 loading, 8" thick (roof)/6" thick (base), in some cases cast into the legs (walls) of the structure. In other cases, the unit will be specified to be installed "upside down" with a separate 8" thick slab applied as a roof section. It is not uncommon for an access hole to be specified in the units' roof sections. Wall sections typically include some combination of solid or perforated sections with beams, weirs, orifices or an open window section developing internal flow channels within the system. Depending on the design, any possible combination can be found, and shall be referenced on the design drawing.

Typically, the modules are placed on 6" of structural stone leveling pad wrapped in a Mirafi 140 N (or 160 N) geofabric. Detention systems require a minimum of a 30 mil HDPE water tight liner with padded material to protect against rips or tears.

Inlet/Outlet modules: consist of a modified standard structure designed to receive the on-site drain pipes, directing flows into or out of the system. They may also consist of a structure with an inlet grate installed on top of the roof slab. In some cases the module shall be installed "upside down" with a separate roof slab.

Depending on the design application, the modules may specify additional "sump" depths at a lower elevation than the rest of the system or the installation of precast concrete splash pads, outlet elbows and tees, or flow splitter devices. Other modules may have a trash rack grate or filter installed. Outlet modules typically have flow control devices such as riser pipes with orifices and overflow weirs. Some have connections to under drain systems installed in the stone base.

Typically the inlet/outlet pipes will be installed in precast holes with size, location and elevation as determined by design. On watertight systems (detention) a rubber boot shall be supplied for a watertight connection between the structures, the water tight membrane and the pipe. On recharge systems (infiltration) a hole will be supplied and a masonry filled joint will suffice. On internal elbows and tees a hole will be supplied per specification and a masonry filled joint or an optional rubber boot may be used for installing pipes. Additional pipe straps may be specified.

These modules generally are supplied with a minimum 24" diameter access manhole to grade for inspection and maintenance purposes. Design options may specify alternative access methods, including larger diameter manholes, hatchways, ladders and safety features. Please note that entering a completed system is considered a "confined space" governed by all pertinent OSHA requirements for entry.

Storage and Attenuation Channel modules: consist of a standard structure with varying configurations of solid/perforated walls, internal beams, weirs, and open "windows" as per design specification. All internal flow control devices' sizes, locations, shapes, elevations and general configurations shall be per design specifications. Internal flow channel configuration shall be per hydraulic design. Storage modules number and size are designed to contain a given volume, whereas the schematic layout configuration determines the hydraulic flow routing.

In general, the storage and attenuation channel modules dictate the average module height. Note that the "base" of the system is thus designated as the bottom of the module structure, where addition depth below the "base" indicates the structural stone leveling layer with the fabric wrap and shall be credited for additional storage volume. All elevations above the "base" describe the module storage volume, the structure column and cover requirements to finish grade.

Treatment and Specialized modules: consist of standard structures that have been modified to perform some form of water quality treatment or the conditioning of flow characteristics for a specific application. Configurations including elevation and dimensional specific locations, hydraulically sized control piping, under drains, pumps, flow control devices, or solids/liquid storage areas specified to design.

In storm water management applications, treatment units are used for oil and water separation, trash and debris collection or suspended solids separation. But configurations for advance treatment may incorporate chemical additive pumps, recirculation pumps, screens, filters, absorbent pads, sand or media filters or other design specifications.

Others system types include pumps for water harvesting, sumps, flow splitters, velocity reduction inducers or other configurations per design specification.

These modules shall all be equipped with a minimum 24" diameter access manhole for inspection and maintenance.

General Operations Guide

Installation per Design: Operation is simple to follow where the installation was performed in accordance with the design specifications, drawings and calculations. Specifics shall be identified in the design drawings. As-built drawings will benefit the locating of specific design modules where the system has been buried below a parking lot area. Optional access manholes or removable grates may be installed above every inlet/outlet pipe and at critical design elements designated by the design.

Daily Operation and Long Term Maintenance: In general, daily usage of the system is self sufficient and will operate without requiring any outside assistance, except for periodic inspection to verify optimal performance and maintenance for removal of collected pollutants. A longer term maintenance program should incorporate a more thorough inspection of the all elements of the system to verify proper operating condition. This is more important with the infiltration type of systems where the soil infiltration surface may become restricted due to fine particle build up. Long term maintenance should include provisions for cleaning and removal of collected solids, oils and debris from the system.

System Operation: The system operational function is initiated according to rainfall runoff flows entering the structure. Internally, the runoff flows in a set pattern or sequence throughout the module layout in accordance with the hydraulic design conditions. The flows primarily operate on system head derived from the changes in elevation from the internal water surface and the outlet invert elevation. Some designs incorporate internal flow controls to satisfy hydraulic conditions that enhance water quality treatment or other intended purposes. Modified systems may incorporate a pump, but in general there are no mechanical apparatus required.

End user operations primarily consist of inspection and maintenance of the system over time.

Periodic Inspection: Important note - All storm water management systems react differently depending on the conditions that are characteristic to the contributing water shed. Variables such as storm intensity, runoff flow rates, site geology, surface stabilization and pollution load will affect the system operation. As does the inspection and maintenance frequency to ensure optimum effectiveness.

Inspections should be done periodically, with a greater number scheduled during the system start up and less frequently as the operator becomes familiar with the system performance characteristics. It is recommended that the end user keep records of the performance using the inspection log record sheet found in the back of this manual. These records shall identify the cycle of maintenance "system calibration" required for the specific applications based on the contributing water shed variables operating under "normal" conditions.

Please note that immediate maintenance may be required during "non-normal" events such as during adverse weather conditions or emergency fuel spills. See information on emergency spills in this manual.

Visual inspection of all assessable components shall be performed throughout the lifetime of the system. Access has been supplied at critical points to monitor hydraulic performance and removed pollutants buildup.

Standard Maintenance:

After construction has been completed and all disturbed surfaces have been stabilized by means of vegetation, asphalt or concrete surfaces, and all drainage system components have been constructed and are free of construction debris and sediments; then the storm water management system can be considered in an operational status.

Periodic visual inspections will help to identify issues of concern.The usual indicators are signs of slow flows, backed up water, visible oil, trash and debris or an excessive amount of sediment in the storage area.

Normal operational flows can be observed to flow freely at the predicted design elevations, from the inlet to the outlet module, following a serpintine path thru the storage and attenuation modules. Note that some modules are designed to permanently retain water where others may hold water and slowly release it over a typical 24 hour period. During a storm water event, the flows and water surface elevations will fluctuate from a low flow to a high flow/ storage status. The storage modules should fill during the event and drain down within a 24 hour period after the event has stopped. All pipes, orifices, weirs and standpipes should pass flows freely and at optimum capacity.

Standard maintenance is performed using a vacuum truck to suction the accumulated sediments, oils and greases and trash and debris from the system. Whereas an on-site maintenance staff can remove these items by hand, it is preferred that the vacuum truck be used as dictated by specific system conditions. When a specialized module designed to have a permanent water level is used, the vacuum truck should pump the liquid level down to inspect the below water elevation structures and sump storage areas.

Oils and greases can be handled by on-site staff by utilizing absorbent products that soak up the oils (and not) converting the oils from a liquid into a manageable solid form. These oil soaked absorbent materials should be disposed of in an approved manner.

Sediments, trash and debris shall be removed and disposed of in an approved manner.

Any indications of hazardous material, determined by visual inspection, testing, smell or abnormality, should be reported and handled per appropriate regulations.

Flow Conditions

System operators should familiarize themselves with proper hydraulic flow condition indicators, acceptable depths of sedimentation, debris and trash build up, and concentrations of oils and greases.

Hydraulic flow conditions are those that are established by the design as either a flow/storage or as a water quality treatment function. Both have performance characteristics that can be visually identified so as to determine the effective and efficient operation of the system.

The engineering design drawings should note the various expected water surface level elevations that are achieved during different design storms within the various modules. Since it is difficult for a visual inspection to coincide with the exact time given water elevations are predicted, the following guidelines are given for evaluation.

Visual Inspection Guide:

Internal Flow Evaluation

Low flow: water should flow freely from the inlet to the outlet, travelling the intended attenuation path thru the system with the water surface elevation below the structure beam height (12" deep), the system should drain completely 24 hours after a storm event,

Medium flow: the system should hold and maintain a water level during the 24 hour storm event and yet continually fill as the storm increases or drain downward as the event recedes. Flow within the system should occur freely from inlet to outlet only being restricted when a flow control structure has been integrally designed in place. Flow control devices may result in a water level backing up either temporarily or permanently; noting devices such as water quality modules may require a permanent water level to operate properly (see water quality treatment). Other system applications should drain completely 24 hours after a storm event.

High flow: the system should fill to the maximum design storm water level elevation (hydraulic grade line) per design. In most cases, that is the highest storage elevation available in the system, at the underside of the module top slab, or the invert of the overflow pipe. As the storm event recedes, the water level should begin to drain down via flow thru the system and discharge. The system should drain completely within 24 hours after a storm event.

Pollutant Storage Capacities

Oil and Grease

Oil and Grease Collection (with optional Oil water separator module specified) - Oil and grease accumulation is generally a function related to vehicle parking lot and drive areas, oil generating land uses or emergency spill conditions. It is important to maintain the system from accumulating excessive volumes of oils in that they may wash over into other sections of the system potentially clogging and reducing the infiltration capacity, blocking control devices and contaminating the overall system. The following standards apply.

Oil should not accumulate more than a visible sheen on the water surface in the oil water separation module only. A sheen is described as a fine, thin oil layer on the water surface identified by the glossy rainbow colors. A dipstick (dry wooden stick) can be used as a probe to determine the thickness of oil on the surface.

Accumulated oils could be associated with insufficient maintenance or a potential large volume oil resource. Any accumulation of oil should be promptly maintained by an experienced waste handler. Emergency spills such as those generated by an accidental spill shall be contained and removed immediately before the next storm event. Spills shall be handled in accordance with local environmental regulations. See spill and accumulated oil maintenance procedures.

Sediments

Sediments (with optional primary grit module or sedimentation modules specified) - Sediments shall be periodically removed from the system as they accumulate within the designated storage modules. The inlet modules are generally equipped with a sediment storage sump located in the base of the inlet structure. Inspection should be performed after major storm events or a minimum of annually, unless a different inspection cycle has been determined to be sufficient. Inspection shall consist of using a probe to determine the presence of and depth of the accumulated solids. Access is via the 24" manhole.

Note that excessive volumes of sediments will reduce the performance and efficiency of the system. Regional accumulations of solids such as those associated with ice and snow, may result in large springtime volumes of sand and gravels used for traction and ice control.

Trash and Debris

Trash and Debris (with optional trash and debris module specified) - Trash and debris accumulates in the inlet module in three forms; floating debris, neutrally buoyant, and heavy material. The floating debris is visible from the access manhole floating on the water surface in the form of but not limited to wood, paper, plastic, foam, bottles and cans. The neutrally buoyant material resides below the surface and combines with the natural flow regime of the system. It is hard to detect and can only be recognized when at a high concentration appears as a thickening of the water viscosity. Heavier material will simply settle to the sump base and combine with the sediments.

Note that trash and debris typically cause the most problems when they become lodged in a flow control device such as an outlet elbow, riser pipe, and orifice or weir structure. This can be detected visibly when the system is pumped down during maintenance. It can also be evaluated as a condition when flow is impeded and the water level backs up higher than the design elevations.

Emergency Spill Conditions (with optional emergency spill control module specified):

Emergency spill conditions are defined as an excessive accumulation of hydrocarbons such as oil, gasoline, diesel fuel, transmission oil or antifreeze usually resulting from an accidental discharge. Excessive accumulation is described as any amount larger than a thin "sheen" visible on the water surface.

Care should be given in handling these types of fluids. The incident should be reported to the appropriate authorities and should be mitigated by a hazardous waste consultant approved for such matters.

retain-it ®

Maintenance Log

Storm Water Management System

Location: ID #:

Date	Inspection Notes	Inspector

Note the following conditions:

Inlet Module

Outlet Module

Water Quality Module

Oil Elbow

Oil Accumulation

Sedimentation Accumulation

Trash and Debris Quantity

Flow Conditions

Flow Control Outlet Structure

Overflow Pipe

APPENDIX J:
REFERENCES AND SOURCES

References and Sources:

- Massachusetts Stormwater Handbook and Stormwater Standards, February 2008
- City of Methuen Code of Ordinances, Revised September, 2017
- City of Methuen GIS database, https://mimap.mvpc.org/map/index.html?viewer=Methuen
- United States Department of Agriculture, Natural Resources Conservation Service, Web Soil Survey

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

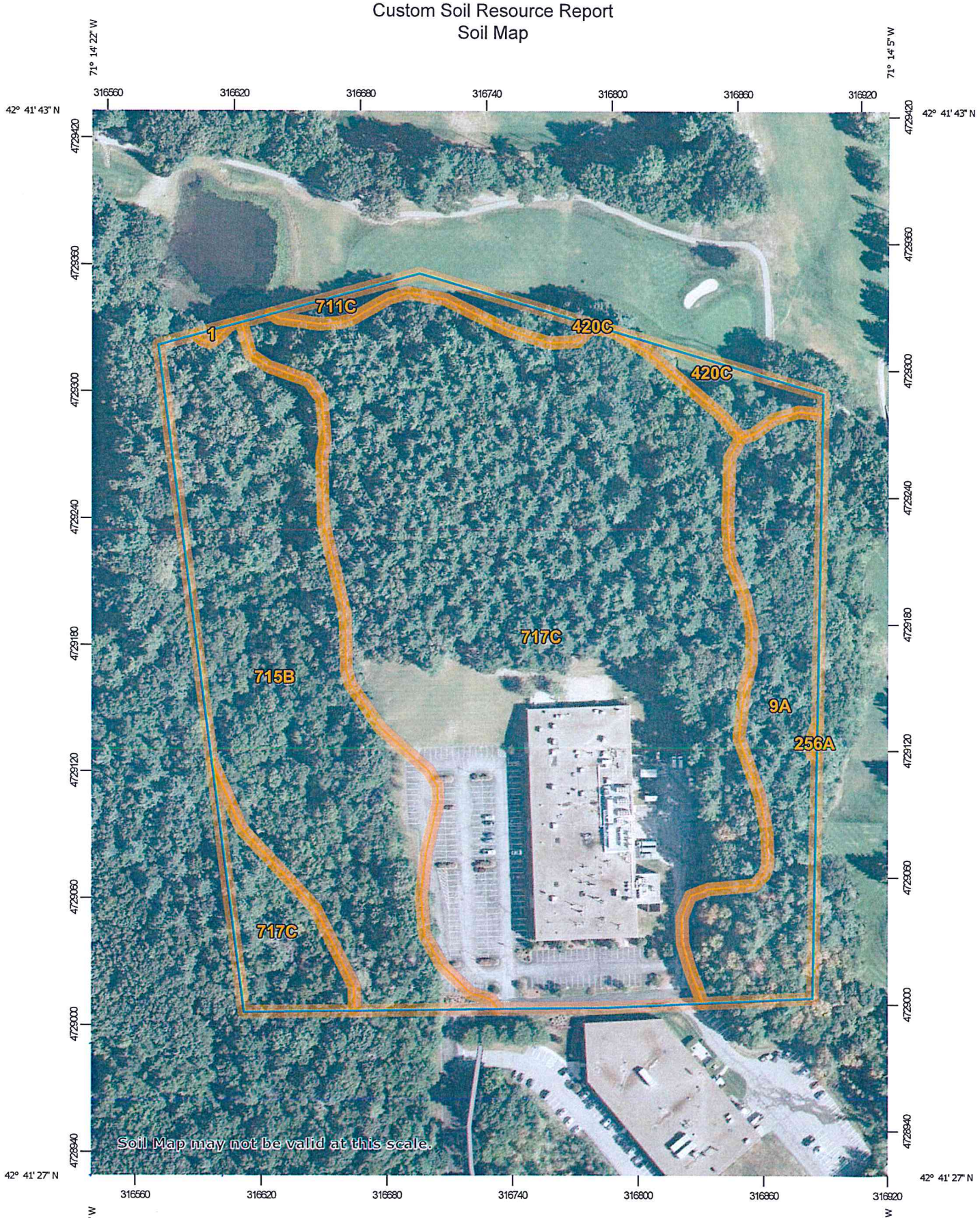
A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Essex County, Massachusetts, Northern Part

January 26, 2022

Contents

Custom Soil Resource Report
Soil Map



Map Scale: 1:2,460 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 35, 70, 140, 210

Feet: 0, 100, 200, 400, 600

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

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features

- Streams and Canals

Transportation

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

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

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: Essex County, Massachusetts, Northern Part
Survey Area Data: Version 17, Sep 2, 2021

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

Date(s) aerial images were photographed: Aug 13, 2020—Sep 15, 2020

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
1	Water	0.0	0.1%
9A	Birdsall silt loam, 0 to 3 percent slopes	2.7	11.4%
256A	Deerfield loamy fine sand, 0 to 3 percent slopes	0.0	0.0%
420C	Canton fine sandy loam, 8 to 15 percent slopes	0.4	1.6%
711C	Charlton-Rock outcrop-Hollis complex, 8 to 15 percent slopes	0.4	1.7%
715B	Ridgebury and Leicester fine sandy loams, 3 to 8 percent slopes, extremely stony	5.6	23.5%
717C	Rock outcrop-Charlton-Hollis complex, 3 to 15 percent slopes	14.6	61.7%
Totals for Area of Interest		**23.7**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a

given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Essex County, Massachusetts, Northern Part

1—Water

Map Unit Setting

National map unit symbol: vjx4
Frost-free period: 125 to 165 days
Farmland classification: Not prime farmland

Map Unit Composition

Water: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

9A—Birdsall silt loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: vj2y
Elevation: 0 to 100 feet
Mean annual precipitation: 45 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 145 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Birdsall

Setting

Landform: Depressions
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Soft coarse-silty glaciolacustrine deposits derived from mica schist

Typical profile

H1 - 0 to 8 inches: silt loam
H2 - 8 to 25 inches: very fine sandy loam
H3 - 25 to 60 inches: silt loam

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 0 to 12 inches
Frequency of flooding: None

Frequency of ponding: Frequent
Available water supply, 0 to 60 inches: Very high (about 12.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: C/D
Ecological site: F144AY031MA - Very Wet Outwash
Hydric soil rating: Yes

Minor Components

Raynham

Percent of map unit: 5 percent
Landform: Depressions
Hydric soil rating: Yes

Freetown

Percent of map unit: 5 percent
Landform: Bogs
Hydric soil rating: Yes

Maybid

Percent of map unit: 5 percent
Landform: Depressions
Hydric soil rating: Yes

256A—Deerfield loamy fine sand, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 2xfg8
Elevation: 0 to 1,100 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 145 to 240 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

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

Description of Deerfield

Setting

Landform: Outwash terraces, outwash deltas, outwash plains, kame terraces
Landform position (three-dimensional): Tread
Down-slope shape: Concave, convex, linear
Across-slope shape: Convex, linear, concave
Parent material: Sandy outwash derived from granite, gneiss, and/or quartzite

Typical profile

Ap - 0 to 9 inches: loamy fine sand
Bw - 9 to 25 inches: loamy fine sand
BC - 25 to 33 inches: fine sand
Cg - 33 to 60 inches: sand

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to very high (1.42 to 99.90 in/hr)
Depth to water table: About 15 to 37 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Sodium adsorption ratio, maximum: 11.0
Available water supply, 0 to 60 inches: Moderate (about 6.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: A
Ecological site: F144AY027MA - Moist Sandy Outwash
Hydric soil rating: No

Minor Components

Windsor

Percent of map unit: 7 percent
Landform: Outwash terraces, kame terraces, outwash deltas, outwash plains
Landform position (three-dimensional): Tread
Down-slope shape: Concave, convex, linear
Across-slope shape: Convex, linear, concave
Hydric soil rating: No

Wareham

Percent of map unit: 5 percent
Landform: Drainageways, depressions
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Sudbury

Percent of map unit: 2 percent
Landform: Outwash plains, kame terraces, outwash deltas, outwash terraces
Landform position (three-dimensional): Tread
Down-slope shape: Concave, convex, linear
Across-slope shape: Convex, linear, concave
Hydric soil rating: No

Ninigret

Percent of map unit: 1 percent
Landform: Kame terraces, outwash plains, outwash terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex, linear

Across-slope shape: Convex, concave
Hydric soil rating: No

420C—Canton fine sandy loam, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2w817
Elevation: 0 to 1,330 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

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

Description of Canton

Setting

Landform: Hills, moraines, ridges
Landform position (two-dimensional): Backslope, shoulder, summit
Landform position (three-dimensional): Side slope, crest, nose slope
Down-slope shape: Convex, linear
Across-slope shape: Convex
Parent material: Coarse-loamy over sandy melt-out till derived from gneiss, granite, and/or schist

Typical profile

Ap - 0 to 7 inches: fine sandy loam
Bw1 - 7 to 15 inches: fine sandy loam
Bw2 - 15 to 26 inches: gravelly fine sandy loam
2C - 26 to 65 inches: gravelly loamy sand

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: 19 to 39 inches to strongly contrasting textural stratification
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.14 to 14.17 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Very low (about 2.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e

Hydrologic Soil Group: B
Ecological site: F144AY034CT - Well Drained Till Uplands
Hydric soil rating: No

Minor Components

Montauk

Percent of map unit: 6 percent
Landform: Moraines, ground moraines, hills, drumlins
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex, linear
Across-slope shape: Convex
Hydric soil rating: No

Scituate

Percent of map unit: 6 percent
Landform: Hills, drumlins, ground moraines
Landform position (two-dimensional): Footslope, backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex, linear
Across-slope shape: Convex
Hydric soil rating: No

Charlton

Percent of map unit: 4 percent
Landform: Ridges, ground moraines, hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex, linear
Across-slope shape: Convex
Hydric soil rating: No

Newfields

Percent of map unit: 4 percent
Landform: Ground moraines, hills, moraines
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: No

711C—Charlton-Rock outcrop-Hollis complex, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: vj71
Elevation: 0 to 280 feet
Mean annual precipitation: 45 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 125 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Charlton and similar soils: 60 percent
Rock outcrop: 16 percent
Hollis and similar soils: 15 percent
Minor components: 9 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Charlton

Setting

Landform: Hills, ridges
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Friable coarse-loamy eolian deposits over friable coarse-loamy basal till derived from granite and gneiss

Typical profile

H1 - 0 to 4 inches: fine sandy loam
H2 - 4 to 28 inches: gravelly fine sandy loam
H3 - 28 to 60 inches: gravelly fine sandy loam

Properties and qualities

Slope: 8 to 15 percent
Surface area covered with cobbles, stones or boulders: 1.6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 7.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: A
Ecological site: F144AY034CT - Well Drained Till Uplands
Hydric soil rating: No

Description of Rock Outcrop

Setting

Parent material: Granite and gneiss

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: 0 inches to lithic bedrock

Interpretive groups

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

Description of Hollis

Setting

Landform: Hills, ridges
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Shallow, friable loamy basal till derived from granite and gneiss over granite and gneiss

Typical profile

O - 0 to 1 inches: muck
H2 - 1 to 6 inches: fine sandy loam
H3 - 6 to 17 inches: gravelly fine sandy loam
H4 - 17 to 20 inches: unweathered bedrock

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: 10 to 60 inches to lithic bedrock
Drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 to 0.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Very low (about 2.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: D
Ecological site: F144AY033MA - Shallow Dry Till Uplands
Hydric soil rating: No

Minor Components

Woodbridge

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

Ridgebury

Percent of map unit: 4 percent
Landform: Depressions
Hydric soil rating: Yes

715B—Ridgebury and Leicester fine sandy loams, 3 to 8 percent slopes, extremely stony

Map Unit Setting

National map unit symbol: 2xffv
Elevation: 0 to 370 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 145 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Ridgebury, extremely stony, and similar soils: 50 percent
Leicester, extremely stony, and similar soils: 35 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Ridgebury, Extremely Stony

Setting

Landform: Ground moraines, hills, drainageways, depressions, drumlins
Landform position (two-dimensional): Toeslope, footslope
Landform position (three-dimensional): Base slope, head slope
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Coarse-loamy lodgment till derived from gneiss, granite, and/or schist

Typical profile

Oe - 0 to 1 inches: moderately decomposed plant material
A - 1 to 6 inches: fine sandy loam
Bw - 6 to 10 inches: sandy loam
Bg - 10 to 19 inches: gravelly sandy loam
Cd - 19 to 66 inches: gravelly sandy loam

Properties and qualities

Slope: 3 to 8 percent
Surface area covered with cobbles, stones or boulders: 9.0 percent
Depth to restrictive feature: 15 to 35 inches to densic material
Drainage class: Poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.14 in/hr)
Depth to water table: About 0 to 6 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)

Available water supply, 0 to 60 inches: Low (about 3.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: D
Ecological site: F144AY009CT - Wet Till Depressions
Hydric soil rating: Yes

Description of Leicester, Extremely Stony

Setting

Landform: Depressions, hills, ground moraines, drainageways
Landform position (two-dimensional): Toeslope, footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear, concave
Across-slope shape: Concave
Parent material: Coarse-loamy melt-out till derived from gneiss, granite, and/or schist

Typical profile

Oe - 0 to 1 inches: moderately decomposed plant material
A - 1 to 7 inches: fine sandy loam
Bg - 7 to 18 inches: fine sandy loam
BC - 18 to 24 inches: fine sandy loam
C1 - 24 to 39 inches: gravelly fine sandy loam
C2 - 39 to 65 inches: gravelly fine sandy loam

Properties and qualities

Slope: 3 to 8 percent
Surface area covered with cobbles, stones or boulders: 9.0 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.14 to 14.17 in/hr)
Depth to water table: About 0 to 6 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: High (about 9.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: B/D
Ecological site: F144AY009CT - Wet Till Depressions
Hydric soil rating: Yes

Minor Components

Sutton, extremely stony

Percent of map unit: 5 percent
Landform: Ground moraines, hills
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave

Across-slope shape: Linear
Hydric soil rating: No

Woodbridge, extremely stony

Percent of map unit: 5 percent
Landform: Ground moraines, hills, drumlins
Landform position (two-dimensional): Backslope, footslope, summit
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Convex
Across-slope shape: Linear
Hydric soil rating: No

Whitman, extremely stony

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

717C—Rock outcrop-Charlton-Hollis complex, 3 to 15 percent slopes

Map Unit Setting

National map unit symbol: vjr6
Elevation: 0 to 280 feet
Mean annual precipitation: 45 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 125 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Rock outcrop: 40 percent
Charlton and similar soils: 30 percent
Hollis and similar soils: 15 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Rock Outcrop

Setting

Parent material: Granite and gneiss

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: 0 inches to lithic bedrock

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8s

Hydric soil rating: Unranked

Description of Charlton

Setting

Landform: Ridges, hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Friable coarse-loamy eolian deposits over friable coarse-loamy basal till derived from granite and gneiss

Typical profile

H1 - 0 to 4 inches: fine sandy loam
H2 - 4 to 28 inches: gravelly fine sandy loam
H3 - 28 to 60 inches: gravelly fine sandy loam

Properties and qualities

Slope: 8 to 15 percent
Surface area covered with cobbles, stones or boulders: 1.6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 7.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: A
Ecological site: F144AY034CT - Well Drained Till Uplands
Hydric soil rating: No

Description of Hollis

Setting

Landform: Ridges, hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Shallow, friable loamy eolian deposits over granite and gneiss

Typical profile

O - 0 to 1 inches: muck
H2 - 1 to 6 inches: fine sandy loam
H3 - 6 to 17 inches: gravelly fine sandy loam
H4 - 17 to 20 inches: unweathered bedrock

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: 10 to 60 inches to lithic bedrock
Drainage class: Somewhat excessively drained

Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 to 0.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Very low (about 2.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: D
Ecological site: F144AY033MA - Shallow Dry Till Uplands
Hydric soil rating: No

Minor Components

Leicester

Percent of map unit: 5 percent
Landform: Depressions
Hydric soil rating: Yes

Chatfield

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

Sutton

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

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