TECHNICAL REPORT IN SUPPORT OF A COMPREHENSIVE PERMIT

57 PERKINS ROW

TOPSFIELD, MASSACHUSETTS

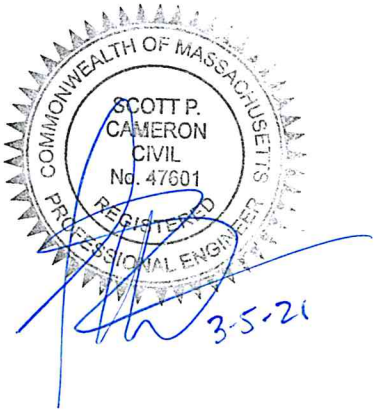
March 5, 2021

SUBMITTED TO:

TOWN OF TOPSFIELD
ZONING BOARD OF APPEALS
TOWN HALL
8 WEST COMMON STREET
TOPSFIELD, MA 01983

APPLICANT:

PERIKINS LANDING, LLC
383 MAIN STREET
MEDFIELD, MA 02052



TECHNICAL REPORT

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TECHNICAL REPORT NARRATIVE

I. EXECUTIVE SUMMARY

Perkins Landing, LLC, the applicant, proposes to redevelop the property located at 57 Perkins Row (the "site") from a single family dwelling to a 40-unit, two-family dwelling development. The site has 159.46' of frontage along Perkins Row and is bounded by the Ipswich River in the south and residential properties to the east and west. Perkins Row intersects with High Street 0.4± miles to the west and Boston Road (Route 1) 0.9± miles to the west. The intersection of Perkins Row and Boston Road is located 3.5 miles northeast of Route 95.

The applicant received Site Approval Project Eligibility pursuant to Massachusetts General Laws Chapter 40B from the Mass Housing for the site in October 2019. The project is eligible for the development of forty-four (44) home ownership units. However, during design and development the number of units was reduced to forty (40) units to better conform to the site topography and to address some of the comments received from the Town. The proposed development includes twenty (20) two-family dwellings with associated infrastructure, including a new private road off Perkins Row, a comprehensive stormwater management system, on-site sanitary disposal system, new utilities and a shared outdoor amenity space.

II. EXISTING SITE DESCRIPTION

The existing site consists of a single parcel located at 57 Perkins Row, which encompasses a total area of 356,838 sf (8.2 acres) and was developed as a single-family residence in 1952 (See Figure 1: USGS Map and Figure 2: 2013 Ortho Map for parcel location). The site is identified on the Topsfield Assessor's map as Map 58, Lot 25. During construction of the existing dwelling, a driveway was constructed across a linear wetland which bifurcates the property near Perkins Row. The dwelling was constructed on a high point on the property and the majority of the area surrounding the dwelling has been cleared and maintained for residential uses since the 1950's. Other existing improvements include 2 drinking water wells located between the house and driveway, utility poles with overhead wires between Perkins Row and the dwelling and a septic system located between the house and the Ipswich River.

In 2015 a five (5) lot definitive subdivision was filed with the Topsfield Planning Board as well as a Notice of Intent application with the Topsfield Conservation Commission. The application was withdrawn from the Topsfield Planning Board in 2018 as a result of the inability to obtain the necessary Order of Conditions for the roadway construction from the Topsfield Conservation Commission under the local bylaw. An Order of Conditions (DEP File No. 307-0724) was issued on December 18, 2015 under the Wetlands Protection Act and was extended to be valid until December 18, 2021.

Existing grades on site are moderate with a high elevation of 73 ft. (NAVD88) immediately to the East of the existing home to a low elevation of 34 ft. at the southeast corner of the lot adjacent

to the Ipswich River. The United States Department of Agriculture (USDA) Natural Resources Conservation Services (NRCS) has the soils on site mapped as Scarboro mucky fine sandy loam, 0 to 3 percent slopes (6A), Whitman fine sandy loam, 0 to 3 percent slopes, extremely stony (73A), Charlton fine sandy loam, 3 to 8 percent slopes (405B), Charlton fine sandy loam, 8 to 15 percent slopes (405C), Charlton fine sandy loam, 15 to 25 percent slopes, very stony (406D), Canton fine sandy loam, 3 to 8 percent slopes (420B) and Saco variant silt loam, 0 to 3 percent slopes (718A)(See Figure 3: SCS Soils Map). In situ soil testing performed by the Morin-Cameron Group in July 2014 confirmed the soils to be moderately well drained. Groundwater depths varied from 3 feet to greater than 10 feet. Soil testing located in areas mapped as HSG A/B determined the soils to predominantly be of a loamy sand texture.

The southeast portion of the site contains a bordering vegetated wetland that is adjacent to the Ipswich River and is also located within a FEMA flood hazard zone AE (Elev. 36.5 – NAVD), as shown on the FEMA Federal Insurance Rate Map (FIRM) #25009c0-268F with and effective date of July 3, 2012 (See Figure 4: FEMA Map). The remaining portion of the site is located within a FEMA flood hazard zone X (above the 100-year flood elevation).

Wetland resource areas and jurisdictional buffer zones on the site are shown on the Existing Conditions Plan, including approximate locations of offsite wetland resource areas and jurisdictional buffer zones. The Ipswich River forms the property's southern boundary and contains a 200' riverfront area from the channel of the river. Bordering vegetated wetlands are found along the river edge and near Perkins Row. There is a 100' buffer zone associated with the wetlands. An Order of Resource Area Determination DEP File No. 307-0720 issued by the Topsfield Conservation Commission in May 14, 2015 and reaffirmed with the issuance of an Order of Conditions DEP File No. 307-0724 issued on December 18, 2015 and extended to December 18, 2021.

III. PROPOSED SITE DESCRIPTION

A. Dwelling Units

There is a total of 40 dwelling units proposed, in 20 separate buildings. Each proposed two-family dwelling will contain two-units, with a mix of thirty-two (32) two-bedroom units and eight (8) three-bedroom units. Each unit will have an 8'x10' deck on the rear, an entry porch on the front and a garage space for parking one vehicle. Each dwelling unit will have a 24' wide driveway for access and parking for one additional vehicle. A total of 10 dwelling units (25% of the total) will be restricted as affordable for low-or moderate-income persons or families.

B. Roadway

The project includes construction of a new twenty-two foot wide private roadway, curbing and sidewalks which has been divided into two sections (Road "A" and Road "B"), totaling approximately 1,358 linear feet. The maximum roadway grade is 8%, with a minimum k-value of 26 for sag curves and 12 for crest curves, which correlates to a design speed of 25 mph. The roadway has been designed with a crown along the centerline and a cape-cod berm at the

gutter line to convey roadway runoff to closed drainage infrastructure (i.e. catch basins), before being directed to stormwater best management practices for treatment prior to infiltration or discharge. A box culvert has been designed to hydraulically connect the wetland resource areas that are currently bifurcated by the existing driveway. The new culvert will also serve as a wildlife passage, and has been designed to comply with the Massachusetts River & Stream Crossing Standards. The culvert has been designed to replicate existing conditions to the extent practicable in order to prevent any alteration to the upstream and downstream wetland resource areas.

C. Earthwork and Land Disturbance

The site has been designed to manage cut and fill to the extent practicable. The grading of the site was driven by guidelines for maximum roadway grades and sight distances, along with the elevation of the existing wetland crossing and the requirements for the proposed on-site soil absorption system per Title 5. The use of retaining walls was incorporated into the design in order to limit the overall land disturbance. The majority of the site development was limited to the rear of the property with the exception of the roadway entrance, utilities and a portion of the stormwater best management practices. A majority of the frontage along Perkins Row will remain undeveloped. The forested frontage will remain relatively the same with only the widening of the driveway and sidewalks being added. This will fit the character of the surrounding neighborhood as there is minimal change.

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 subsurface infiltration and detention systems, a constructed wetland and stormwater pretreatment with hydrodynamic separators. A closed-drainage system will be installed in the roadway, which will convey runoff to best management practice systems to provide treatment, peak rate mitigation and groundwater recharge. Further explanation of the stormwater management system and design methodology can be found later in this report.

E. Open Space and Preservation of Natural Features

The project was designed such that a significant percentage of the site will remain undisturbed. Of the 8.2 acre total parcel area, 3.4 acres will not be disturbed (41.5 percent). Most of this area is comprised of forested buffer zone area and bordering vegetated wetland, which will be protected in perpetuity in accordance with the Wetlands Protection Act. The proposed site layout includes a clustered dwelling layout, which maximizes land use efficiency by filling the need for housing in the state while still protecting natural resources.

The site design includes a playground/recreational area for use by residents of the new development. This is located adjacent to the proposed soil absorption system, which will be loamed and seeded with grass that can also be used as open space by residents. A mail kiosk with turnout has been designed near the proposed roadway intersection and Perkins Row. A

bus stop bench will also be located near the intersection of Perkins Row. A bituminous concrete sidewalk will allow for safe pedestrian circulation throughout the site and out to Perkins Row.

F. Utilities

The project will include the extension of the water system and electric system to service the dwelling units. Cable, fiber optic and other communications services will also be extended throughout the proposed development. Two new hydrants will be installed within the development, one at the intersection of "Road A" and "Road B" and the other at the end of "Road B". The existing water main in Perkins Row will be extended approximately 975 lf to service the proposed development. The water main will be extended to the northern property line with a new hydrant proposed along Perkins Row in this location. Domestic sewage will be collected on site with the use of a sewer main and sewer manholes and directed to a series of septic tanks and a pump chamber before being distributed to the proposed soil absorption system. The proposed sewage system is designed for a capacity of 9,680 GPD and will comply with the requirements of Title 5.

G. Schedule

Construction of the proposed development is anticipated to start in the fall of 2021 and will take approximately 2 years 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 Comprehensive Permit plan set. 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.

A. Existing Watershed Description

Drainage on site has been divided into four distinct sub-catchment areas, as shown on Figure 5: Existing Watershed Plan. Figure 7: Offsite Watershed Plan illustrates the area to the north of the subject property which drains into the on-site wetland near the existing driveway crossing. This off-site area is included in subcatchment E2. The table below shows the total area for each subcatchment.

Summary of Existing Subcatchments

Existing Subcatchment	Total Area (SF)	% Impervious
E1	12,199	5.4
E2	176,482**	6.9
E3	49,990	15.4
E4	169,037	0.9
Totals	**407,708**	**5.4**

** Total Drainage area for E2 includes 60,806 SF on site and 115,662 SF off site

- **Subcatchment E1:** E1 is located near Perkins Row at the northeast end of the property. It is comprised mostly of woodland and includes a portion of the existing paved driveway. It sheet flows directly to Perkins Row which is Design Point 3 (DP3).
- **Subcatchment E2:** E2 is a wooded area between the western property boundary and the existing driveway and includes the bordering vegetated wetland upstream of the driveway crossing. It also includes the off-site area which flows toward the wetland on the subject property. It drains under the driveway through the large stone of the driveway crossing toward DP2.
- **Subcatchment E3:** E3 is an area located along the East property boundary to the West side of the driveway and up to the existing house. It includes mostly trees, grass, pavement, building and some wetlands. It discharges directly to DP2.
- **Subcatchment E4**: encompasses the entire South end of the property from the house to the Ipswich River. A portion of the area is wooded and a portion is comprised of buildings and grass area. Runoff from this subcatchment flows in a westerly direction toward the edge of the bordering vegetated wetland, which is DP1.
- **Pond S1 & Existing Driveway Crossing**: This is the existing ponding area within the bordering vegetated wetland near Perkins Row. The existing driveway crossing is comprised of large stone fill at the pond outlet location, which allows stormwater from the wetland to flow under the driveway to the downstream side. This unique condition was modeled in HydroCAD by using a partially filled pipe that effectively restricts the rate of water passing through, similar to water passing through voids in the large stone driveway fill. It is an approximation, but it was corroborated by field observation of the water level by MCG during storms of varying intensities.

B. Proposed Watershed Description

The proposed post development drainage analysis was performed by dividing the study area into twelve distinct sub-catchment areas (See Figure 6: Proposed Watershed Plan and Figure 7: Offsite Watershed Plan). The proposed dwelling roof areas (labeled with an "R" designation) are to be captured with the system of gutters and roof leaders and piped directly to infiltration systems. The table below shows the total area for each subcatchment.

Summary of Proposed Subcatchments

Proposed Subcatchment	Total Area (SF)	% Impervious
P1	10,881	4.9
P2A	181,730**	6.5
P2B	18,405	86.5
P3	9,228	7.0
P4	86,576	0
P5	21,566	32.6
P6	10,133	69.6
P7	34,653	42.6
P8	8,936	63.2

R1	8,960	100
R2	14,080	100
R3	2,560	100
Totals	**407,708**	**21.8**

** Total Drainage area for P2A includes 66,068 sf on site and 115,662 sf off site

- **Subcatchment P1:** P1 is located near Perkins Row at the northeast end of the property. It is comprised mostly of woodland and includes a small portion of the new roadway. The majority of this subcatchment area will be the same in post-development conditions as it is in existing conditions. Runoff from this area sheet flows directly to Perkins Row which is Design Point 3 (DP3).
- **Subcatchment P2A:** P2A is comprised of woods, grass, wetlands and it includes an area off site on the tributary stream upstream of the ponding area. Runoff from this area flows directly into the existing wetland as no proposed surface cover requires stormwater to be treated. It will remain substantially unchanged in the post-development condition.
- **Subcatchment P2B:** This area is comprised mostly of the pavement area of "Road A" from the high point just off Perkins Row to the area between dwelling Unit 15 and Unit 20. Stormwater is collected in a closed drainage system comprised of deep sump hooded catch basins and drain manholes before discharging into the proposed pocket wetland for treatment and mitigation. An outlet control structure controls the outflow, which ultimately discharges on the downstream side of the weir within the proposed box culvert.
- **Subcatchment P3**: This area is located on the east of the site with a portion of the area behind dwelling Units 1,2,3 & 4 and a small area to east of "Road A". The area includes woods, grass cover and impervious retaining wall. Runoff from this area flows directly offsite towards the existing wetland as no proposed surface cover requires stormwater to be treated.
- **Subcatchment P4**: This area is located mostly in the rear of the proposed development and includes woods and grass cover. Runoff from this area flows to the south towards Design Point 1 (DP1).
- **Subcatchment P5**: This area is comprised of grass and pavement area from "Road B". Runoff is collected in a closed drainage system with the aid of deep sump hooded catch basins before being piped to a proprietary hydrodynamic separator where it converges with flow from P6. After being treated, the stormwater is then discharged into an underground detention system. With the use of an outlet control structure, stormwater is discharged from the detention system toward DP1.
- **Subcatchment P6**: This area is comprised of pavement from "Road A" and grass cover. Runoff is captured in deep sump hooded catch basins located at the intersection of "Road A" and "Road B" and is then piped to a proprietary hydrodynamic separator where it converges with flow from P5.
- **Subcatchment P7**: This area is comprised of pavement from "Road B" and grass. Runoff is captured by deep sump hooded catch basins and treated with a proprietary

hydrodynamic separator before discharging into recharge system 2. Recharge system 2 is an underground concrete galley system with an outlet control structure to control the outflow before discharging to DP1. This recharge system also receives inflow from roof areas and excess flow from subcatchment P8.

- **Subcatchment P8**: This area is comprised of pavement from "Road B" and grass. Runoff is captured by deep sump hooded catch basins and treated with a proprietary hydrodynamic separator before discharging into recharge system 1. Recharge system 1 is an underground concrete galley system with an outlet control structure to control the outflow before discharging into recharge system 2. Recharge system 1 also receives inflow from roof areas.
- **Subcatchment R1**: This drainage area is comprised of seven of the two-family dwelling roof areas (Units 1, 2, 3, 4, 5, 6 & 7). Since roof area is considered "clean", it does not need treatment prior to infiltrating. These roof areas will be collected with a system of gutters and roof leaders prior to being discharged into recharge system 1.
- **Subcatchment R2**: This drainage area is comprised of eleven of the two-family dwelling roof areas (Units 8, 9, 10, 11, 12, 15, 16, 17, 18, 19 & 20). These roof areas will be collected with a system of gutters and roof leaders prior to being discharged into recharge system 3. Recharge system 3 is a linear precast concrete galley system located in the front of the dwellings. All of the infiltration chambers are piped together with a connected pipe and have an emergency outlet that ultimately connected to the detention system.
- **Subcatchment R3**: This drainage area is comprised of two of the two-family dwelling roof areas (Units 13 & 14). These roof areas will be collected with a system of gutters and roof leaders prior to being discharged into recharge system 4. Recharge system 4 has an emergency outlet that ultimately connects to the detention system.
- **Pond S1 & Proposed Culvert/Wildlife Crossing**: The existing ponding area will remain unchanged in the post-development condition, and the intent of the design is to mimic the existing water level experienced today during various storm events. The proposed culvert will have a natural bottom and has been designed in accordance with the Massachusetts River & Stream Crossing Standards. It includes a custom-designed weir in the middle of the culvert which will control the rate at which water flows out of the pond so that the existing conditions are generally maintained.

C. 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 both mitigation and renovation 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. 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. In order 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 flow rate generated from each subcatchment.

The HydroCAD analysis was performed by examining three 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	0.3	0.3	0
	10	1.6	1.0	-0.6
	100	6.5	6.5	0
DP-2	2	0.4	0.4	0
	10	1.3	0.7	-0.6
	100	3.2	3.2	0
DP-3	2	0	0	0
	10	0.2	0.2	0
	100	0.8	0.7	-0.1

As shown in the table above the proposed development will maintain or reduce peak flow rates to DP 1, 2 and 3 for the 2, 10 and 100-year design storms as required by the Massachusetts Stormwater Management Handbook.

D. Stormwater Management Standards

The proposed site development will comply with all Stormwater Management Standards. Measures will also be implemented to provide the required total suspended solids (TSS) removal to ensure the stormwater runoff from the site is renovated prior to discharge. 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 new untreated discharges from the 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, underground infiltration chambers, a pocket wetland and an underground detention system. 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 do not exceed pre-development rates for the 2- and 10-year storm events.

   SUMMARY OF MITIGATING MEASURES: The project will utilize several BMPs including underground infiltration chambers, roof recharge systems, a pocket wetland and an underground detention system that include outlet structures to control the rate 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. The 100-year storm event was also evaluated and the BMPs were designed to match the existing conditions peak 100-year storm rate of runoff to prevent storm damage and prevent off-site flooding.

   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 subsurface recharge systems. The systems were strategically placed in the HSG A soil areas within the site in order to maximize the infiltration capabilities of the systems. The system will accept either pre-treated

stormwater or direct roof runoff prior to infiltration. The BMPs will provide recharge to groundwater in excess of what is assumed in the existing condition.

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).

   SUMMARY OF MITIGATING MEASURES: The stormwater management system will use treatment trains of deep sump hooded catch basins, proprietary treatment structures and infiltration/detention systems, and a pocket wetland to treat stormwater prior to discharge. Pre-treatment of stormwater is provided for all systems. The proposed pocket wetland was selected for use near the front of the site adjacent to the existing bordering vegetated wetland. This is a benefit to the site because it is a natural, surface-based system supported by native plants and soil biology to treat stormwater runoff. All stormwater will be treated to a minimum of 80% TSS removal prior to discharging to the proposed design points.

   CONCLUSION: The proposed development meets this standard.

5. **STANDARD:** For land uses with higher potential pollutant loads, 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: None.

   CONCLUSION: The proposed development meets this standard as it does not apply to this project.

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: None.

   CONCLUSION: The proposed development meets this standard as it does not apply to this project.

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: None.

   CONCLUSION: The proposed development meets this standard as it does not apply to this project.

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 June 9, 2020. 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 June 9, 2020.

   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.

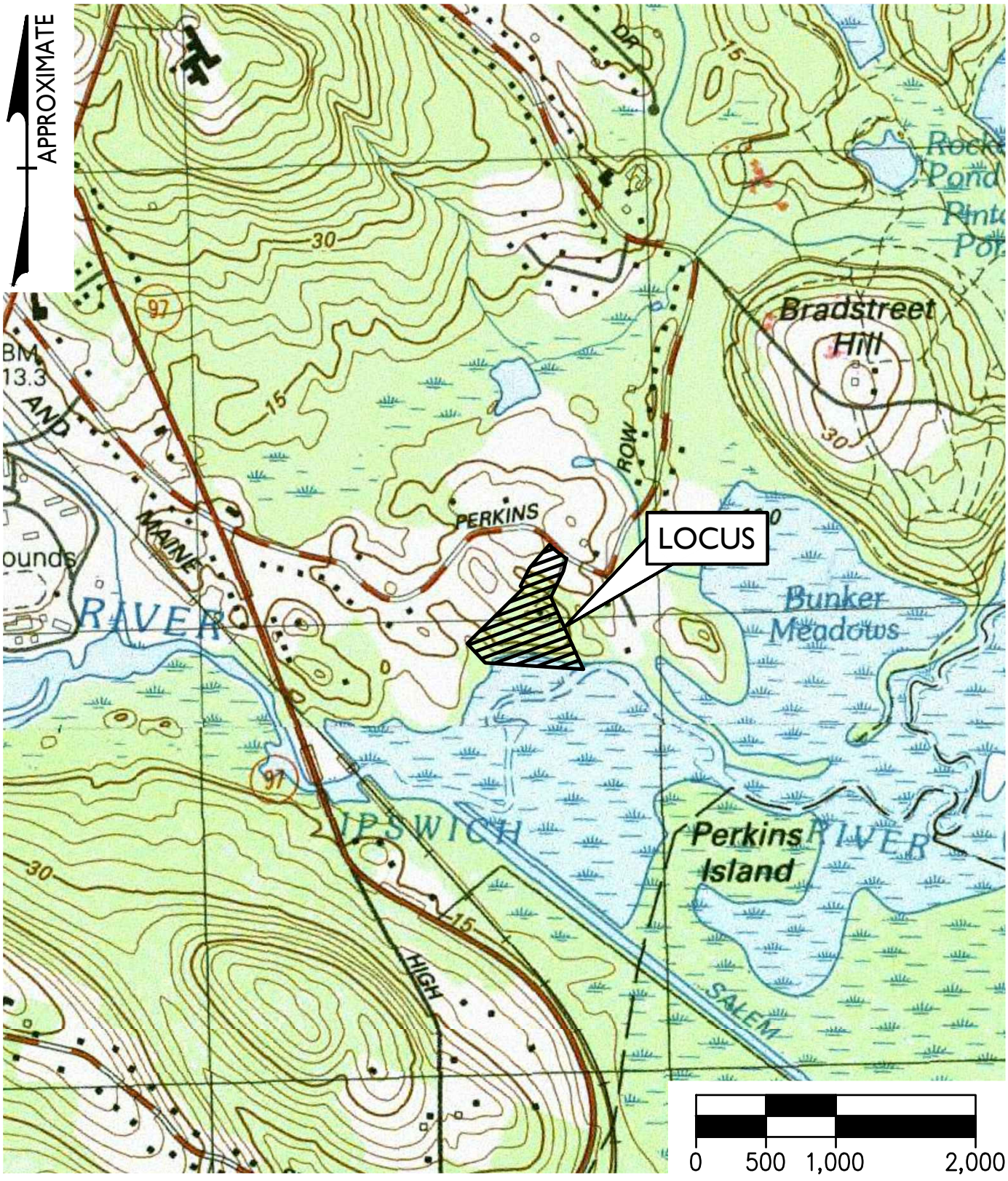
V. CONCLUSION

The proposed site development project for Perkins Landing, as proposed, is in full compliance with the MassDEP Stormwater Management Handbook and utilizes generally accepted engineering practices for site development. Peak rates of stormwater runoff leaving the site under proposed conditions are no greater than under existing conditions. Recharge to groundwater will be increased by adding subsurface infiltration systems. All stormwater leaving the proposed development will be fully treated and there are no illicit discharges to the waters of the Commonwealth.

The clustered development footprint allows for the provision of local housing units while maximizing the protection of open space and natural resource areas. A total of 10 dwelling units (25% of the total) will be restricted as affordable for low-or moderate-income persons or families. As such, the proposed project will be a benefit to the Town of Topsfield by incorporating innovative land use techniques, providing local affordable housing units and protecting the wetland and water resources 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) 777-8586.

FIGURES



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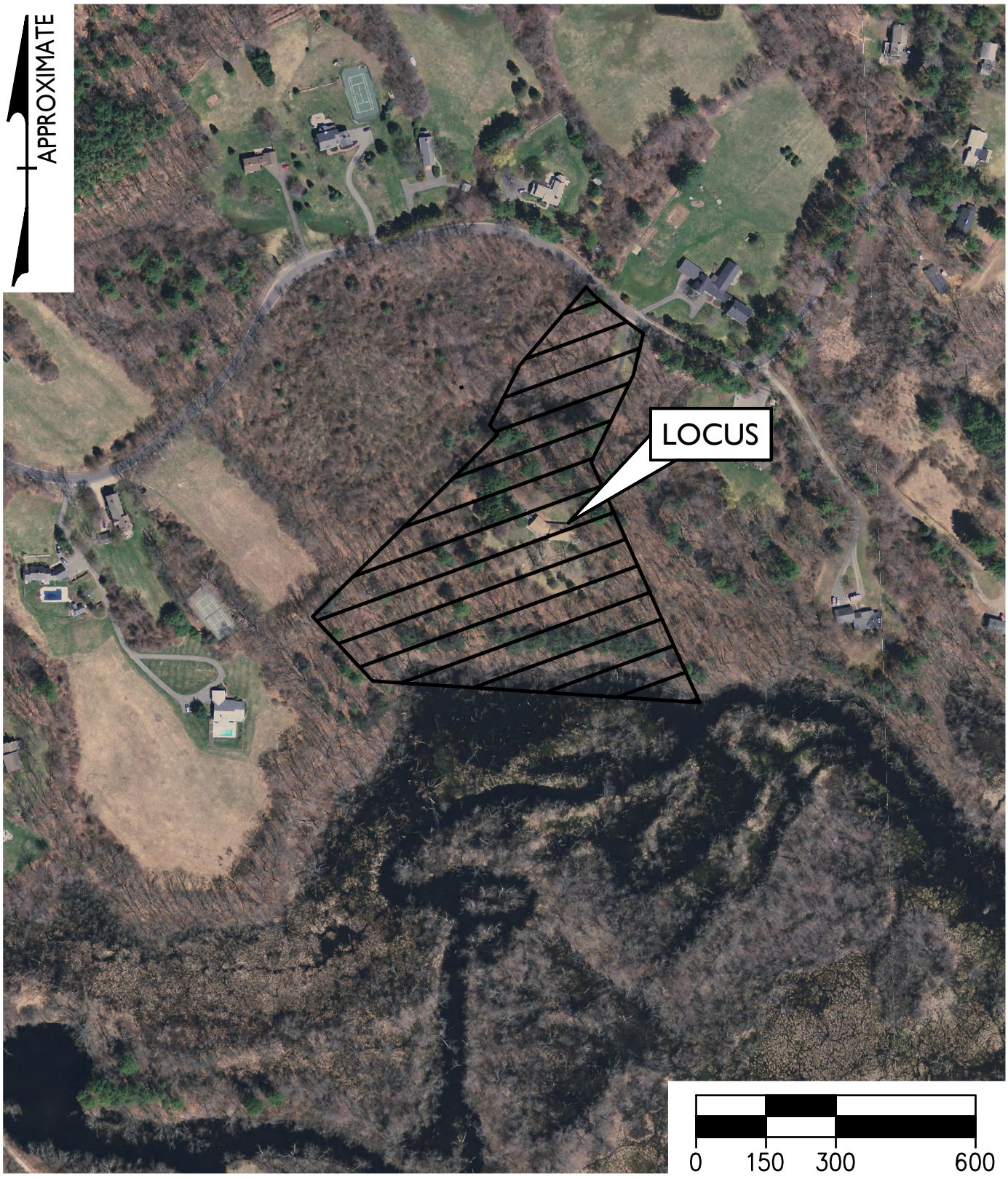
USGS MAP
57 PERKINS ROW
IN
TOPSFIELD, MA

DATE: MARCH 5, 2021

SCALE: 1" = 1,000'

FIGURE #1



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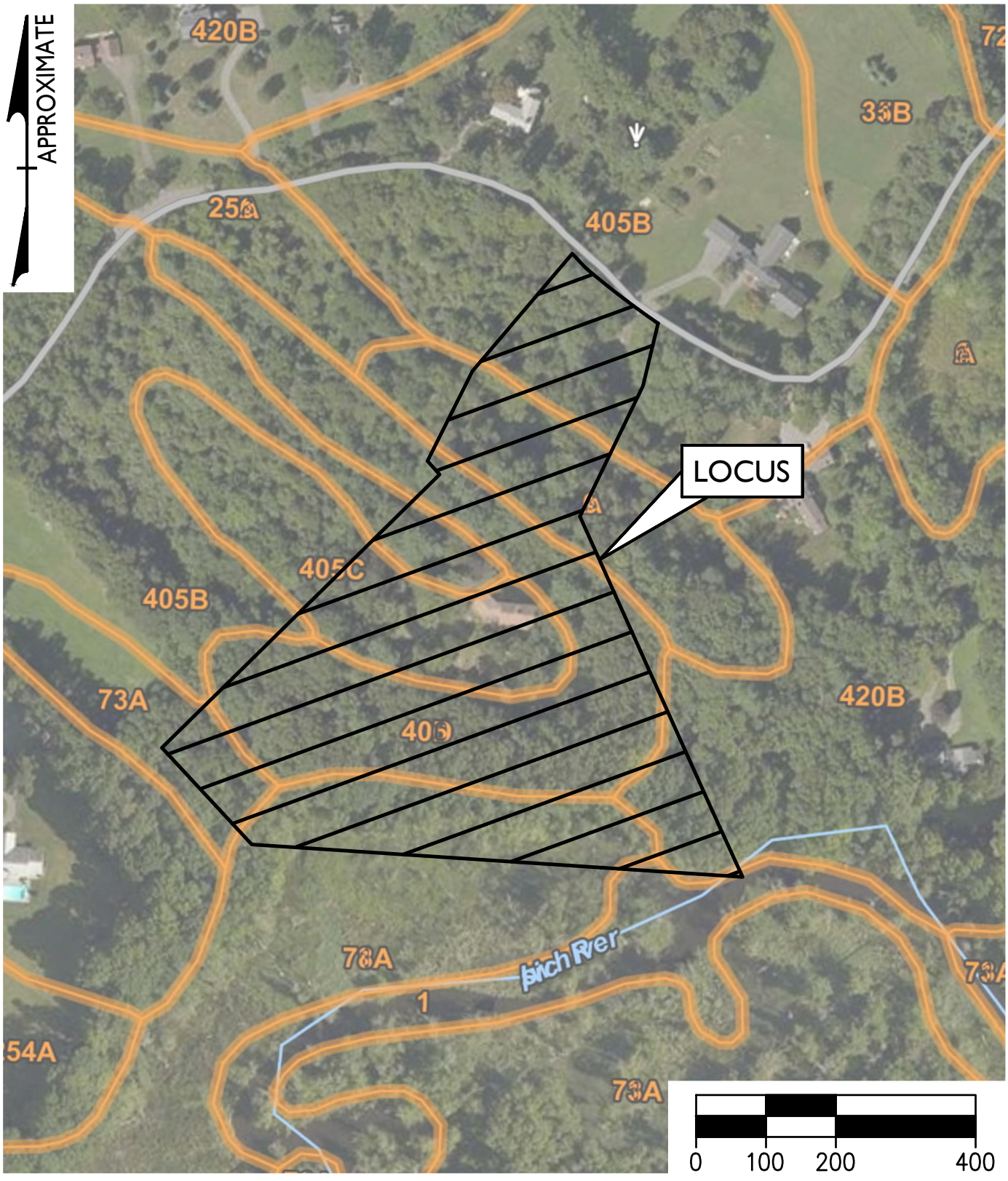
2013 ORTHO MAP
57 PERKINS ROW
IN
TOPSFIELD, MA

DATE: MARCH 5, 2021

SCALE: 1" = 300'

FIGURE #2



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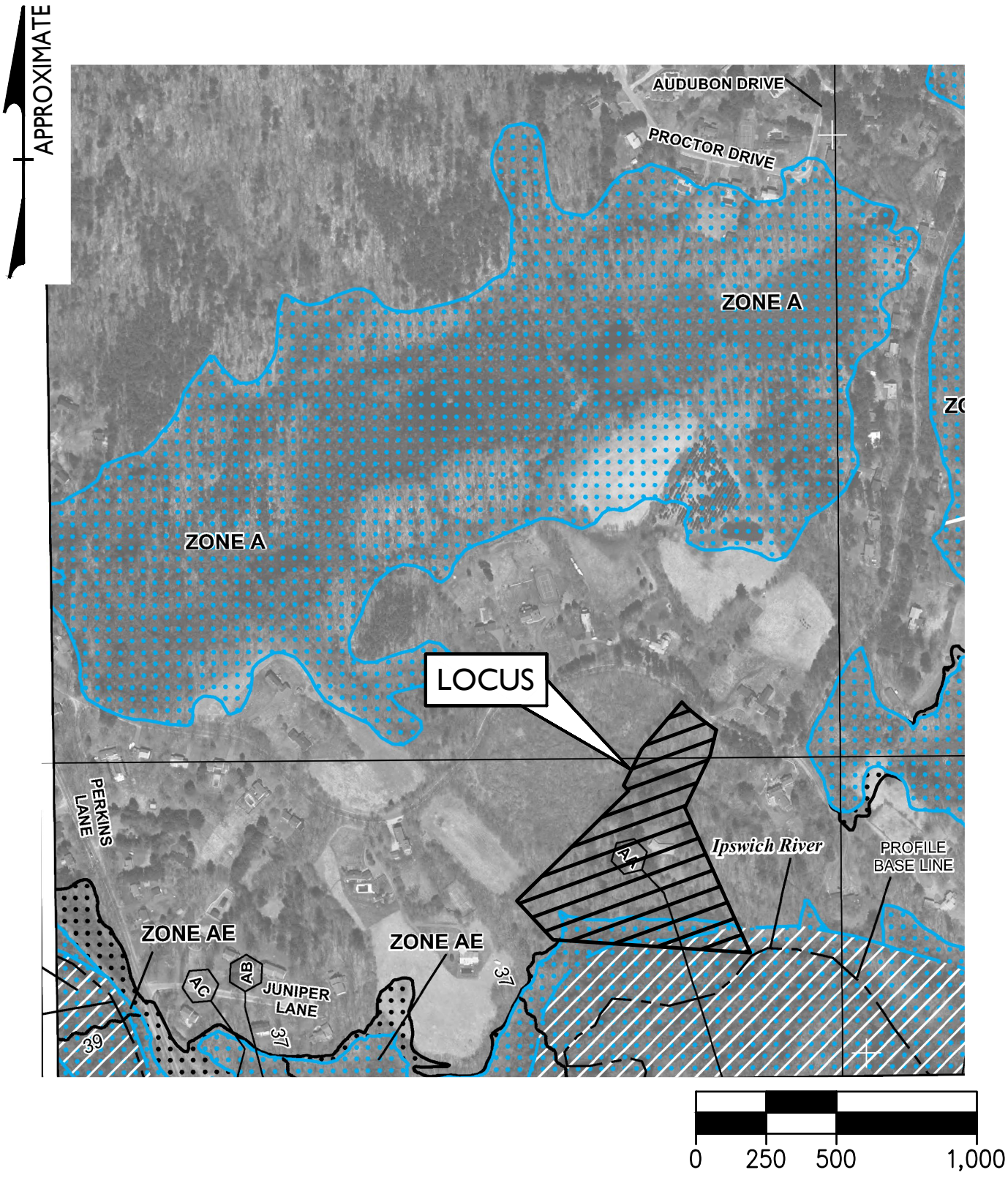
SCS SOILS MAP
57 PERKINS ROW
IN
TOPSFIELD, MA

DATE: MARCH 5, 2021

SCALE: 1" = 200'

FIGURE #3



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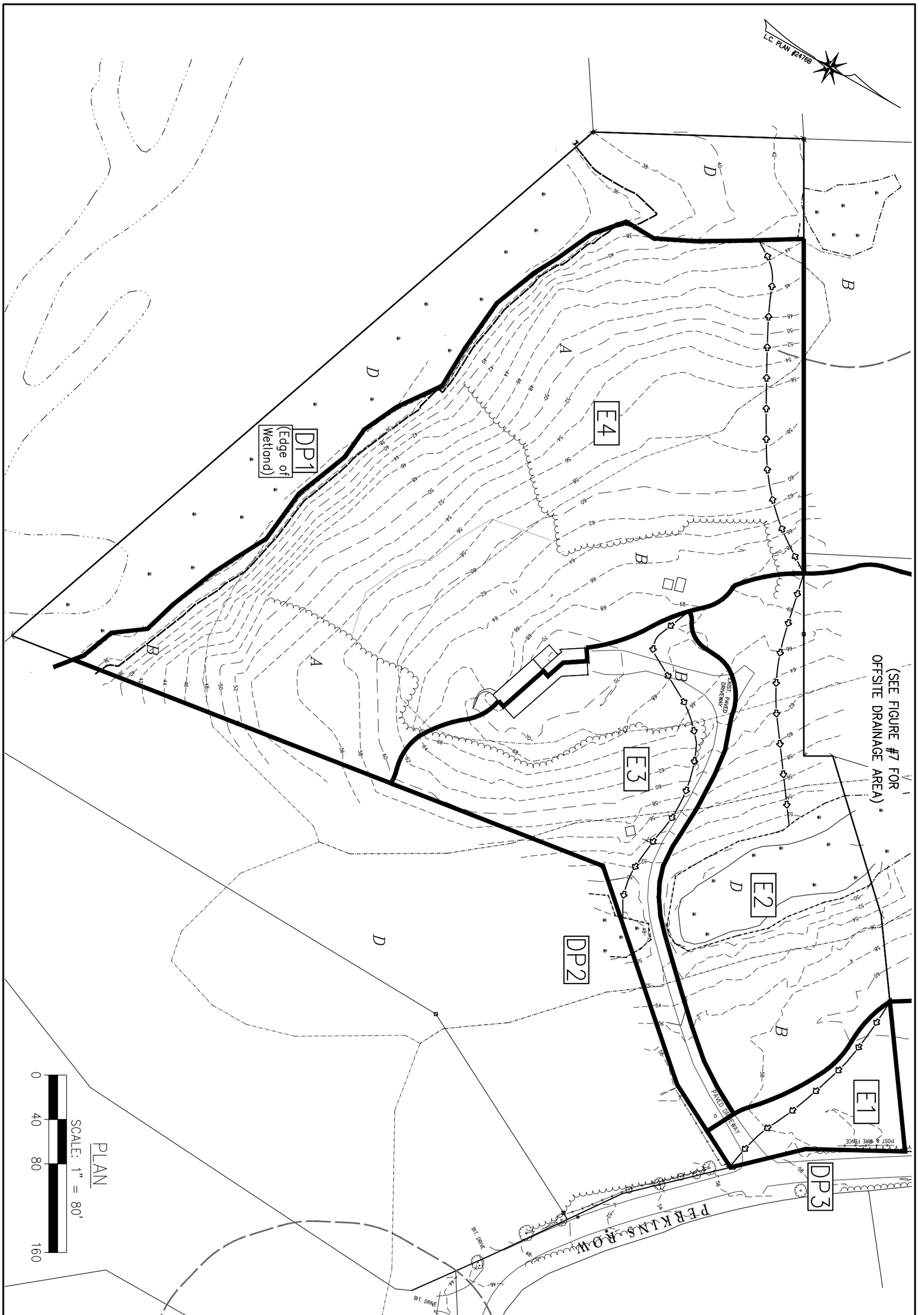
FEMA MAP
57 PERKINS ROW
IN
TOPSFIELD, MA

DATE: MARCH 5, 2021

SCALE: 1" = 500'

FIGURE #4



EXISTING WATERSHED PLAN

AT:

57 PERKINS ROW
TOPSFIELD, MASSACHUSETTS

DATE: MARCH 5, 2021
SCALE: 1" = 80'

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FIGURE #5

(SEE FIGURE #7 FOR OFFSITE DRAINAGE AREA)

L.C. PLAN #24768

P1

P2A

P2B

P3

P4

P5

P6

P7

P8

DP1 (Edge of Wetland)

DP2

DP3

PERKINS ROW

PROP. DETENTION SYSTEM 1 (DS1) (SEE DETAIL – SHEETS 13 &14)

PROP. RECHARGE SYSTEM 3 (RS3) (SEE DETAIL – SHEETS 13 & 14)

PROP. RECHARGE SYSTEM 2 (RS2) (SEE DETAIL – SHEETS 13 & 14)

PROP. RECHARGE SYSTEM 1 (RS1) (SEE DETAIL – SHEETS 13 & 14)

LIMIT OF FEMA FLOOD ZONE AE (ELEV. 36.5–NAVD) AS ILLUSTRATED ON THE LETTER FLOOD INSURANCE RATE MAP #25009C0–268F, WHICH HAS AN EFFECTIVE DATE OF 7/3/2012

214.16'
150.00'
26.22'
556.45'
189.91'
89.45'
89.17'
207.73'
372.16'
693.57'

PLAN
SCALE: 1" = 80'
0 40 80 160

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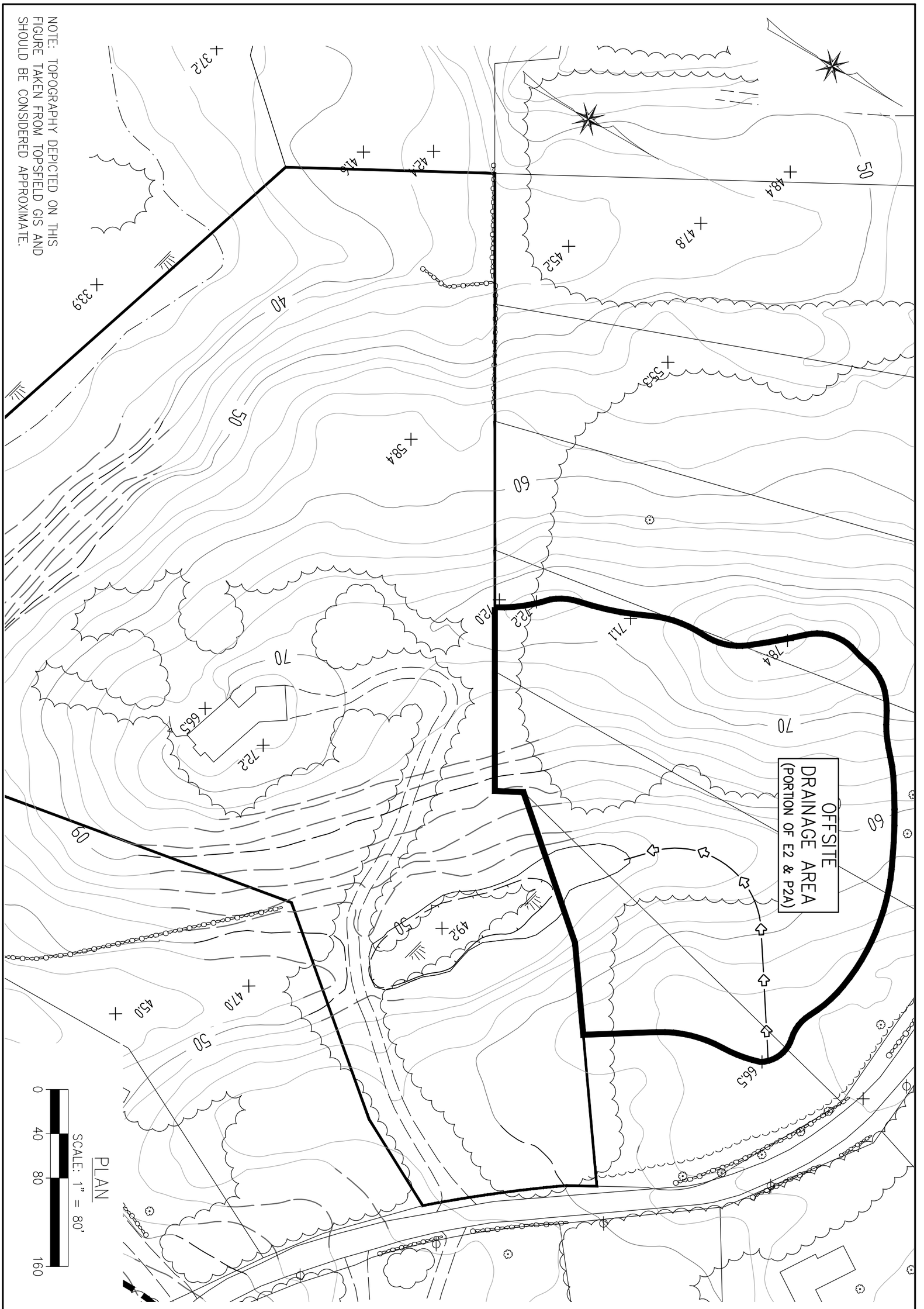
DATE: MARCH 5, 2021
SCALE: 1" = 80'

PROPOSED WATERSHED PLAN

AT:
57 PERKINS ROW
TOPSFIELD, MASSACHUSETTS

FIGURE #6



OFFSITE WATERSHED PLAN

AT:

57 PERKINS ROW
TOPSFIELD, MASSACHUSETTS

DATE: MARCH 5, 2021
SCALE: 1" = 80'

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FIGURE #7

APPENDIX A:

MASSDEP STORMWATER

MANAGEMENT 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

3-5-21

Signature and Date

Checklist

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

☐ New development

☐ Redevelopment

☒ Mix of New Development and Redevelopment

Checklist for Stormwater Report

Checklist (continued)

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

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

Standard 1: No New Untreated Discharges

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

Checklist for Stormwater Report

Checklist (continued)

Standard 2: Peak Rate Attenuation

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

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

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

Standard 3: Recharge

☒ Soil Analysis provided.

☒ Required Recharge Volume calculation provided.

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

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

☒ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

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

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

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

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

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

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

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

[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;

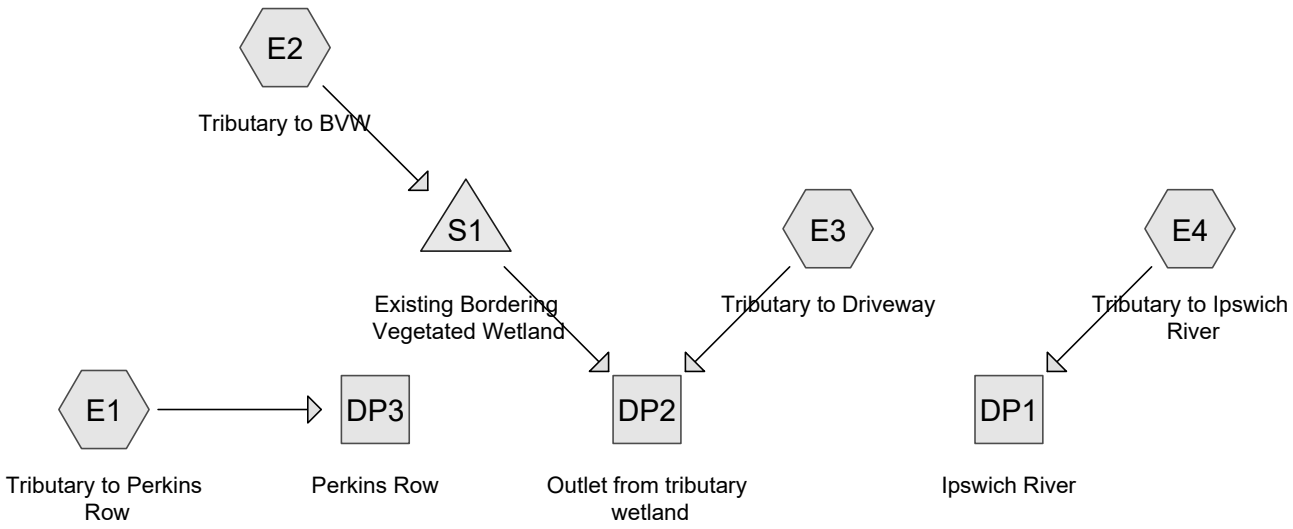
☒ An Illicit Discharge Compliance Statement is attached;

☐ 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



Subcat Reach Pond Link

Routing Diagram for 3274.a Pre Development Watershed Analysis
Prepared by The Morin-Cameron Group, Inc., Printed 3/4/2021

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
9,984	39	>75% Grass cover, Good, HSG A (E3, E4)
51,771	61	>75% Grass cover, Good, HSG B (E1, E2, E3, E4)
991	98	Pavement, HSG A (E3)
4,926	98	Pavement, HSG B (E1, E2, E3)
1,673	98	Pavement, HSG D (E3)
2,608	98	Roofs, HSG B (E3, E4)
2,354	98	Water Surface(OFFSITE), HSG D (E2)
9,512	98	Water Surface, HSG D (E2)
31,995	30	Woods(OFFSITE), Good, HSG A (E2)
70,262	55	Woods(OFFSITE), Good, HSG B (E2)
11,051	77	Woods(OFFSITE), Good, HSG D (E2)
122,945	30	Woods, Good, HSG A (E2, E3, E4)
64,774	55	Woods, Good, HSG B (E1, E2, E3, E4)
22,862	77	Woods, Good, HSG D (E2, E3)

Soil Listing (all nodes)

Area (sq-ft)	Soil Group	Subcatchment Numbers
165,915	HSG A	E2, E3, E4
194,341	HSG B	E1, E2, E3, E4
0	HSG C	
47,452	HSG D	E2, E3
0	Other	

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-Q
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment E1: Tributary to Perkins Row Runoff Area=12,199 sf 5.42% Impervious Runoff Depth=0.41"
Flow Length=210' Tc=17.7 min CN=WQ Runoff=0.0 cfs 412 cf

Subcatchment E2: Tributary to BVW Runoff Area=176,482 sf 6.91% Impervious Runoff Depth=0.52"
Flow Length=284' Tc=10.5 min CN=WQ Runoff=1.4 cfs 7,621 cf

Subcatchment E3: Tributary to Driveway Runoff Area=49,990 sf 15.38% Impervious Runoff Depth=0.74"
Flow Length=318' Tc=17.4 min CN=WQ Runoff=0.5 cfs 3,073 cf

Subcatchment E4: Tributary to Ipswich Runoff Area=169,037 sf 0.90% Impervious Runoff Depth=0.15"
Flow Length=310' Tc=7.1 min CN=WQ Runoff=0.3 cfs 2,070 cf

Reach DP1: Ipswich River Inflow=0.3 cfs 2,070 cf
Outflow=0.3 cfs 2,070 cf

Reach DP2: Outlet from tributary wetland Inflow=0.6 cfs 9,970 cf
Outflow=0.6 cfs 9,970 cf

Reach DP3: Perkins Row Inflow=0.0 cfs 412 cf
Outflow=0.0 cfs 412 cf

Pond S1: Existing Bordering Vegetated Peak Elev=48.15' Storage=3,606 cf Inflow=1.4 cfs 7,621 cf
Outflow=0.1 cfs 6,897 cf

Summary for Subcatchment E1: Tributary to Perkins Row

Runoff = 0.0 cfs @ 12.30 hrs, Volume= 412 cf, Depth= 0.41"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

	Area (sf)	CN	Description
*	661	98	Pavement, HSG B
	1,566	61	>75% Grass cover, Good, HSG B
	9,972	55	Woods, Good, HSG B
	12,199		Weighted Average
	11,538		94.58% Pervious Area
	661		5.42% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.5	50	0.0100	0.05		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
1.2	160	0.0200	2.28		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
17.7	210	Total			

Summary for Subcatchment E2: Tributary to BVW

Runoff = 1.4 cfs @ 12.19 hrs, Volume= 7,621 cf, Depth= 0.52"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

	Area (sf)	CN	Description
*	322	98	Pavement, HSG B
	7,050	30	Woods, Good, HSG A
	22,713	55	Woods, Good, HSG B
	15,848	77	Woods, Good, HSG D
	5,375	61	>75% Grass cover, Good, HSG B
	9,512	98	Water Surface, HSG D
*	31,995	30	Woods(OFFSITE), Good, HSG A
*	70,262	55	Woods(OFFSITE), Good, HSG B
*	11,051	77	Woods(OFFSITE), Good, HSG D
*	2,354	98	Water Surface(OFFSITE), HSG D
	176,482		Weighted Average
	164,294		93.09% Pervious Area
	12,188		6.91% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.5	50	0.0400	0.09		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
1.0	234	0.0600	3.94		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
10.5	284	Total			

Summary for Subcatchment E3: Tributary to Driveway

Runoff = 0.5 cfs @ 12.26 hrs, Volume= 3,073 cf, Depth= 0.74"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

	Area (sf)	CN	Description
	1,083	98	Roofs, HSG B
*	991	98	Pavement, HSG A
*	3,943	98	Pavement, HSG B
*	1,673	98	Pavement, HSG D
	17,607	30	Woods, Good, HSG A
	1,249	55	Woods, Good, HSG B
	7,014	77	Woods, Good, HSG D
	2,515	39	>75% Grass cover, Good, HSG A
	13,915	61	>75% Grass cover, Good, HSG B
	49,990		Weighted Average
	42,300		84.62% Pervious Area
	7,690		15.38% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.5	50	0.0100	0.05		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
0.9	268	0.0865	4.74		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
17.4	318	Total			

Summary for Subcatchment E4: Tributary to Ipswich River

Runoff = 0.3 cfs @ 12.16 hrs, Volume= 2,070 cf, Depth= 0.15"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

Area (sf)	CN	Description
98,288	30	Woods, Good, HSG A
30,840	55	Woods, Good, HSG B
7,469	39	>75% Grass cover, Good, HSG A
30,915	61	>75% Grass cover, Good, HSG B
1,525	98	Roofs, HSG B
169,037		Weighted Average
167,512		99.10% Pervious Area
1,525		0.90% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.1	50	0.1200	0.14		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
1.0	260	0.0800	4.55		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
7.1	310	Total			

Summary for Reach DP1: Ipswich River

Inflow Area = 169,037 sf, 0.90% Impervious, Inflow Depth = 0.15" for 2-Year event
Inflow = 0.3 cfs @ 12.16 hrs, Volume= 2,070 cf
Outflow = 0.3 cfs @ 12.16 hrs, Volume= 2,070 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3

Summary for Reach DP2: Outlet from tributary wetland

Inflow Area = 226,472 sf, 8.78% Impervious, Inflow Depth > 0.53" for 2-Year event
Inflow = 0.6 cfs @ 12.27 hrs, Volume= 9,970 cf
Outflow = 0.6 cfs @ 12.27 hrs, Volume= 9,970 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3

Summary for Reach DP3: Perkins Row

Inflow Area = 12,199 sf, 5.42% Impervious, Inflow Depth = 0.41" for 2-Year event
Inflow = 0.0 cfs @ 12.30 hrs, Volume= 412 cf
Outflow = 0.0 cfs @ 12.30 hrs, Volume= 412 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3

Summary for Pond S1: Existing Bordering Vegetated Wetland

Inflow Area = 176,482 sf, 6.91% Impervious, Inflow Depth = 0.52" for 2-Year event
Inflow = 1.4 cfs @ 12.19 hrs, Volume= 7,621 cf
Outflow = 0.1 cfs @ 15.43 hrs, Volume= 6,897 cf, Atten= 92%, Lag= 194.7 min
Primary = 0.1 cfs @ 15.43 hrs, Volume= 6,897 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3

Peak Elev= 48.15' @ 15.43 hrs Surf.Area= 10,765 sf Storage= 3,606 cf

Plug-Flow detention time= 422.3 min calculated for 6,895 cf (90% of inflow)
Center-of-Mass det. time= 371.6 min (1,244.3 - 872.8)

Volume	Invert	Avail.Storage	Storage Description
#1	47.80'	65,726 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
47.80	9,945	0	0
50.00	15,123	27,575	27,575
52.00	23,028	38,151	65,726

Device	Routing	Invert	Outlet Devices
#1	Primary	47.80'	**12.0" Round Culvert w/ 9.0" inside fill** L= 20.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 47.05' / 47.00' S= 0.0025 '/' Cc= 0.900 n= 0.030 Rubble masonry, cemented, Flow Area= 0.15 sf
#2	Primary	51.10'	**20.0' 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

Primary OutFlow Max=0.1 cfs @ 15.43 hrs HW=48.15' TW=0.00' (Dynamic Tailwater)
↑
└─**1=Culvert** (Barrel Controls 0.1 cfs @ 0.76 fps)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.0 cfs)

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-Q
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment E1: Tributary to Perkins Row Runoff Area=12,199 sf 5.42% Impervious Runoff Depth=1.14"
Flow Length=210' Tc=17.7 min CN=WQ Runoff=0.2 cfs 1,164 cf

Subcatchment E2: Tributary to BVW Runoff Area=176,482 sf 6.91% Impervious Runoff Depth=1.21"
Flow Length=284' Tc=10.5 min CN=WQ Runoff=4.0 cfs 17,746 cf

Subcatchment E3: Tributary to Driveway Runoff Area=49,990 sf 15.38% Impervious Runoff Depth=1.44"
Flow Length=318' Tc=17.4 min CN=WQ Runoff=1.1 cfs 5,995 cf

Subcatchment E4: Tributary to Ipswich Runoff Area=169,037 sf 0.90% Impervious Runoff Depth=0.44"
Flow Length=310' Tc=7.1 min CN=WQ Runoff=1.6 cfs 6,268 cf

Reach DP1: Ipswich River Inflow=1.6 cfs 6,268 cf
Outflow=1.6 cfs 6,268 cf

Reach DP2: Outlet from tributary wetland Inflow=1.3 cfs 21,961 cf
Outflow=1.3 cfs 21,961 cf

Reach DP3: Perkins Row Inflow=0.2 cfs 1,164 cf
Outflow=0.2 cfs 1,164 cf

Pond S1: Existing Bordering Vegetated Peak Elev=48.64' Storage=9,168 cf Inflow=4.0 cfs 17,746 cf
Outflow=0.2 cfs 15,966 cf

Summary for Subcatchment E1: Tributary to Perkins Row

Runoff = 0.2 cfs @ 12.29 hrs, Volume= 1,164 cf, Depth= 1.14"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

	Area (sf)	CN	Description
*	661	98	Pavement, HSG B
	1,566	61	>75% Grass cover, Good, HSG B
	9,972	55	Woods, Good, HSG B
	12,199		Weighted Average
	11,538		94.58% Pervious Area
	661		5.42% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.5	50	0.0100	0.05		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
1.2	160	0.0200	2.28		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
17.7	210	Total			

Summary for Subcatchment E2: Tributary to BVW

Runoff = 4.0 cfs @ 12.19 hrs, Volume= 17,746 cf, Depth= 1.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

	Area (sf)	CN	Description
*	322	98	Pavement, HSG B
	7,050	30	Woods, Good, HSG A
	22,713	55	Woods, Good, HSG B
	15,848	77	Woods, Good, HSG D
	5,375	61	>75% Grass cover, Good, HSG B
	9,512	98	Water Surface, HSG D
*	31,995	30	Woods(OFFSITE), Good, HSG A
*	70,262	55	Woods(OFFSITE), Good, HSG B
*	11,051	77	Woods(OFFSITE), Good, HSG D
*	2,354	98	Water Surface(OFFSITE), HSG D
	176,482		Weighted Average
	164,294		93.09% Pervious Area
	12,188		6.91% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.5	50	0.0400	0.09		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
1.0	234	0.0600	3.94		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
10.5	284	Total			

Summary for Subcatchment E3: Tributary to Driveway

Runoff = 1.1 cfs @ 12.26 hrs, Volume= 5,995 cf, Depth= 1.44"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

	Area (sf)	CN	Description
	1,083	98	Roofs, HSG B
*	991	98	Pavement, HSG A
*	3,943	98	Pavement, HSG B
*	1,673	98	Pavement, HSG D
	17,607	30	Woods, Good, HSG A
	1,249	55	Woods, Good, HSG B
	7,014	77	Woods, Good, HSG D
	2,515	39	>75% Grass cover, Good, HSG A
	13,915	61	>75% Grass cover, Good, HSG B
	49,990		Weighted Average
	42,300		84.62% Pervious Area
	7,690		15.38% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.5	50	0.0100	0.05		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
0.9	268	0.0865	4.74		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
17.4	318	Total			

Summary for Subcatchment E4: Tributary to Ipswich River

Runoff = 1.6 cfs @ 12.15 hrs, Volume= 6,268 cf, Depth= 0.44"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

Area (sf)	CN	Description
98,288	30	Woods, Good, HSG A
30,840	55	Woods, Good, HSG B
7,469	39	>75% Grass cover, Good, HSG A
30,915	61	>75% Grass cover, Good, HSG B
1,525	98	Roofs, HSG B
169,037		Weighted Average
167,512		99.10% Pervious Area
1,525		0.90% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.1	50	0.1200	0.14		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
1.0	260	0.0800	4.55		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
7.1	310	Total			

Summary for Reach DP1: Ipswich River

Inflow Area = 169,037 sf, 0.90% Impervious, Inflow Depth = 0.44" for 10-Year event
Inflow = 1.6 cfs @ 12.15 hrs, Volume= 6,268 cf
Outflow = 1.6 cfs @ 12.15 hrs, Volume= 6,268 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3

Summary for Reach DP2: Outlet from tributary wetland

Inflow Area = 226,472 sf, 8.78% Impervious, Inflow Depth > 1.16" for 10-Year event
Inflow = 1.3 cfs @ 12.27 hrs, Volume= 21,961 cf
Outflow = 1.3 cfs @ 12.27 hrs, Volume= 21,961 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3

Summary for Reach DP3: Perkins Row

Inflow Area = 12,199 sf, 5.42% Impervious, Inflow Depth = 1.14" for 10-Year event
Inflow = 0.2 cfs @ 12.29 hrs, Volume= 1,164 cf
Outflow = 0.2 cfs @ 12.29 hrs, Volume= 1,164 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3

Summary for Pond S1: Existing Bordering Vegetated Wetland

Inflow Area = 176,482 sf, 6.91% Impervious, Inflow Depth = 1.21" for 10-Year event
Inflow = 4.0 cfs @ 12.19 hrs, Volume= 17,746 cf
Outflow = 0.2 cfs @ 16.14 hrs, Volume= 15,966 cf, Atten= 94%, Lag= 237.3 min
Primary = 0.2 cfs @ 16.14 hrs, Volume= 15,966 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3

Peak Elev= 48.64' @ 16.14 hrs Surf.Area= 11,919 sf Storage= 9,168 cf

Plug-Flow detention time= 490.6 min calculated for 15,966 cf (90% of inflow)
Center-of-Mass det. time= 437.4 min (1,303.4 - 866.0)

Volume	Invert	Avail.Storage	Storage Description
#1	47.80'	65,726 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
47.80	9,945	0	0
50.00	15,123	27,575	27,575
52.00	23,028	38,151	65,726

Device	Routing	Invert	Outlet Devices
#1	Primary	47.80'	**12.0" Round Culvert w/ 9.0" inside fill** L= 20.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 47.05' / 47.00' S= 0.0025 '/' Cc= 0.900 n= 0.030 Rubble masonry, cemented, Flow Area= 0.15 sf
#2	Primary	51.10'	**20.0' 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

Primary OutFlow Max=0.2 cfs @ 16.14 hrs HW=48.64' TW=0.00' (Dynamic Tailwater)
1=Culvert (Barrel Controls 0.2 cfs @ 1.57 fps)
2=Broad-Crested Rectangular Weir (Controls 0.0 cfs)

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-Q
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment E1: Tributary to Perkins Row Runoff Area=12,199 sf 5.42% Impervious Runoff Depth=3.82"
Flow Length=210' Tc=17.7 min CN=WQ Runoff=0.8 cfs 3,887 cf

Subcatchment E2: Tributary to BVW Runoff Area=176,482 sf 6.91% Impervious Runoff Depth=3.63"
Flow Length=284' Tc=10.5 min CN=WQ Runoff=12.7 cfs 53,319 cf

Subcatchment E3: Tributary to Driveway Runoff Area=49,990 sf 15.38% Impervious Runoff Depth=3.76"
Flow Length=318' Tc=17.4 min CN=WQ Runoff=2.9 cfs 15,667 cf

Subcatchment E4: Tributary to Ipswich Runoff Area=169,037 sf 0.90% Impervious Runoff Depth=1.92"
Flow Length=310' Tc=7.1 min CN=WQ Runoff=6.5 cfs 27,115 cf

Reach DP1: Ipswich River Inflow=6.5 cfs 27,115 cf
Outflow=6.5 cfs 27,115 cf

Reach DP2: Outlet from tributary wetland Inflow=3.2 cfs 53,535 cf
Outflow=3.2 cfs 53,535 cf

Reach DP3: Perkins Row Inflow=0.8 cfs 3,887 cf
Outflow=0.8 cfs 3,887 cf

Pond S1: Existing Bordering Vegetated Peak Elev=50.35' Storage=33,150 cf Inflow=12.7 cfs 53,319 cf
Outflow=0.5 cfs 37,868 cf

Summary for Subcatchment E1: Tributary to Perkins Row

Runoff = 0.8 cfs @ 12.27 hrs, Volume= 3,887 cf, Depth= 3.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 100-Year Rainfall=8.94"

	Area (sf)	CN	Description
*	661	98	Pavement, HSG B
	1,566	61	>75% Grass cover, Good, HSG B
	9,972	55	Woods, Good, HSG B
	12,199		Weighted Average
	11,538		94.58% Pervious Area
	661		5.42% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.5	50	0.0100	0.05		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
1.2	160	0.0200	2.28		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
17.7	210	Total			

Summary for Subcatchment E2: Tributary to BVW

Runoff = 12.7 cfs @ 12.18 hrs, Volume= 53,319 cf, Depth= 3.63"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 100-Year Rainfall=8.94"

	Area (sf)	CN	Description
*	322	98	Pavement, HSG B
	7,050	30	Woods, Good, HSG A
	22,713	55	Woods, Good, HSG B
	15,848	77	Woods, Good, HSG D
	5,375	61	>75% Grass cover, Good, HSG B
	9,512	98	Water Surface, HSG D
*	31,995	30	Woods(OFFSITE), Good, HSG A
*	70,262	55	Woods(OFFSITE), Good, HSG B
*	11,051	77	Woods(OFFSITE), Good, HSG D
*	2,354	98	Water Surface(OFFSITE), HSG D
	176,482		Weighted Average
	164,294		93.09% Pervious Area
	12,188		6.91% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.5	50	0.0400	0.09		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
1.0	234	0.0600	3.94		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
10.5	284	Total			

Summary for Subcatchment E3: Tributary to Driveway

Runoff = 2.9 cfs @ 12.26 hrs, Volume= 15,667 cf, Depth= 3.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 100-Year Rainfall=8.94"

	Area (sf)	CN	Description
	1,083	98	Roofs, HSG B
*	991	98	Pavement, HSG A
*	3,943	98	Pavement, HSG B
*	1,673	98	Pavement, HSG D
	17,607	30	Woods, Good, HSG A
	1,249	55	Woods, Good, HSG B
	7,014	77	Woods, Good, HSG D
	2,515	39	>75% Grass cover, Good, HSG A
	13,915	61	>75% Grass cover, Good, HSG B
	49,990		Weighted Average
	42,300		84.62% Pervious Area
	7,690		15.38% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.5	50	0.0100	0.05		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
0.9	268	0.0865	4.74		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
17.4	318	Total			

Summary for Subcatchment E4: Tributary to Ipswich River

Runoff = 6.5 cfs @ 12.15 hrs, Volume= 27,115 cf, Depth= 1.92"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 100-Year Rainfall=8.94"

Area (sf)	CN	Description
98,288	30	Woods, Good, HSG A
30,840	55	Woods, Good, HSG B
7,469	39	>75% Grass cover, Good, HSG A
30,915	61	>75% Grass cover, Good, HSG B
1,525	98	Roofs, HSG B
169,037		Weighted Average
167,512		99.10% Pervious Area
1,525		0.90% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.1	50	0.1200	0.14		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
1.0	260	0.0800	4.55		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
7.1	310	Total			

Summary for Reach DP1: Ipswich River

Inflow Area = 169,037 sf, 0.90% Impervious, Inflow Depth = 1.92" for 100-Year event
Inflow = 6.5 cfs @ 12.15 hrs, Volume= 27,115 cf
Outflow = 6.5 cfs @ 12.15 hrs, Volume= 27,115 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3

Summary for Reach DP2: Outlet from tributary wetland

Inflow Area = 226,472 sf, 8.78% Impervious, Inflow Depth > 2.84" for 100-Year event
Inflow = 3.2 cfs @ 12.26 hrs, Volume= 53,535 cf
Outflow = 3.2 cfs @ 12.26 hrs, Volume= 53,535 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3

Summary for Reach DP3: Perkins Row

Inflow Area = 12,199 sf, 5.42% Impervious, Inflow Depth = 3.82" for 100-Year event
Inflow = 0.8 cfs @ 12.27 hrs, Volume= 3,887 cf
Outflow = 0.8 cfs @ 12.27 hrs, Volume= 3,887 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3

Summary for Pond S1: Existing Bordering Vegetated Wetland

Inflow Area = 176,482 sf, 6.91% Impervious, Inflow Depth = 3.63" for 100-Year event
Inflow = 12.7 cfs @ 12.18 hrs, Volume= 53,319 cf
Outflow = 0.5 cfs @ 19.01 hrs, Volume= 37,868 cf, Atten= 96%, Lag= 409.7 min
Primary = 0.5 cfs @ 19.01 hrs, Volume= 37,868 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3

Peak Elev= 50.35' @ 19.01 hrs Surf.Area= 16,516 sf Storage= 33,150 cf

Plug-Flow detention time= 646.8 min calculated for 37,857 cf (71% of inflow)
Center-of-Mass det. time= 525.6 min (1,377.4 - 851.7)

Volume	Invert	Avail.Storage	Storage Description
#1	47.80'	65,726 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
47.80	9,945	0	0
50.00	15,123	27,575	27,575
52.00	23,028	38,151	65,726

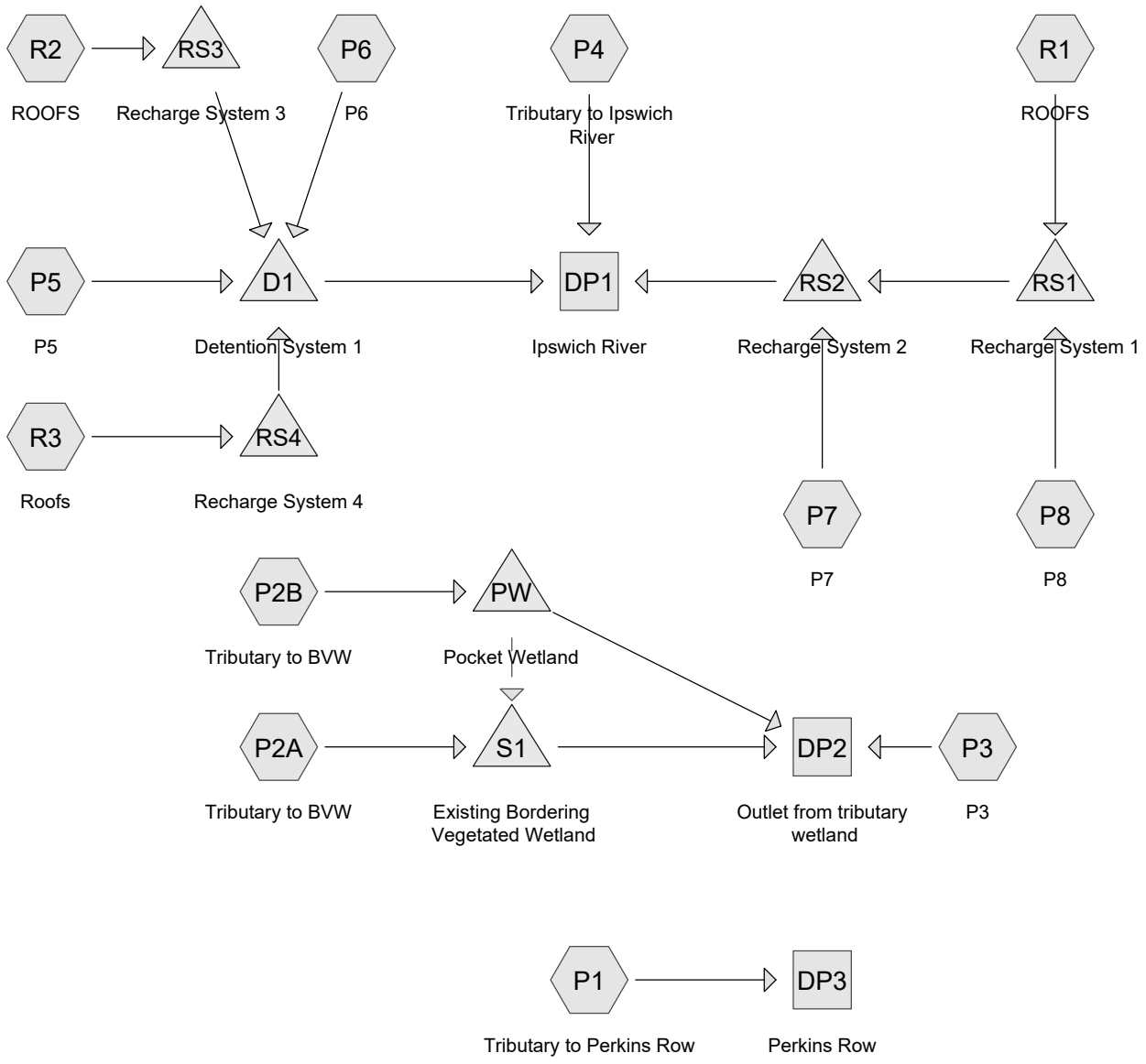
Device	Routing	Invert	Outlet Devices
#1	Primary	47.80'	**12.0" Round Culvert w/ 9.0" inside fill** L= 20.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 47.05' / 47.00' S= 0.0025 '/' Cc= 0.900 n= 0.030 Rubble masonry, cemented, Flow Area= 0.15 sf
#2	Primary	51.10'	**20.0' long x 10.0' 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

Primary OutFlow Max=0.5 cfs @ 19.01 hrs HW=50.35' TW=0.00' (Dynamic Tailwater)
1=Culvert (Barrel Controls 0.5 cfs @ 3.01 fps)
2=Broad-Crested Rectangular Weir (Controls 0.0 cfs)

APPENDIX C:

PROPOSED CONDITIONS

HYDROLOGIC ANALYSIS



Subcat Reach Pond Link

Routing Diagram for 3274.a Post Development Watershed Analysis
Prepared by The Morin-Cameron Group, Inc., Printed 3/4/2021

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
58,895	39	>75% Grass cover, Good, HSG A (P2A, P3, P4, P5, P6, P7, P8)
57,498	61	>75% Grass cover, Good, HSG B (P1, P2A, P2B, P4, P5, P6, P7, P8)
3,225	80	>75% Grass cover, Good, HSG D (P2A, P3)
7,022	98	Paved, HSG A (P5)
15,220	98	Pavement, HSG A (P2B, P6, P7, P8)
24,311	98	Pavement, HSG B (P1, P2B, P6, P7, P8)
4,362	98	Pavement, HSG D (P2B)
17,089	98	Roofs, HSG A (R1, R2, R3)
7,809	98	Roofs, HSG B (R1, R2)
702	98	Roofs, HSG D (R1)
63	98	Wall, HSG B (P3)
578	98	Wall, HSG D (P3)
2,354	98	Water Surface(OFFSITE), HSG D (P2A)
9,512	98	Water Surface, HSG D (P2A)
31,995	30	Woods(OFFSITE), Good, HSG A (P2A)
70,262	55	Woods(OFFSITE), Good, HSG B (P2A)
11,051	77	Woods(OFFSITE), Good, HSG D (P2A)
35,694	30	Woods, Good, HSG A (P2A, P4)
34,398	55	Woods, Good, HSG B (P1, P2A, P3, P4)
15,668	77	Woods, Good, HSG D (P2A, P3)

Soil Listing (all nodes)

Area (sq-ft)	Soil Group	Subcatchment Numbers
165,915	HSG A	P2A, P2B, P3, P4, P5, P6, P7, P8, R1, R2, R3
194,341	HSG B	P1, P2A, P2B, P3, P4, P5, P6, P7, P8, R1, R2
0	HSG C	
47,452	HSG D	P2A, P2B, P3, R1
0	Other	

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-Q
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment P1: Tributary to Perkins Row Runoff Area=10,881 sf 4.86% Impervious Runoff Depth=0.40"
Flow Length=173' Slope=0.0100 '/' Tc=17.8 min CN=WQ Runoff=0.0 cfs 359 cf

Subcatchment P2A: Tributary to BVW Runoff Area=181,730 sf 6.53% Impervious Runoff Depth=0.51"
Flow Length=265' Tc=6.5 min CN=WQ Runoff=1.7 cfs 7,782 cf

Subcatchment P2B: Tributary to BVW Runoff Area=18,405 sf 86.50% Impervious Runoff Depth=2.58"
Tc=6.0 min CN=WQ Runoff=1.1 cfs 3,959 cf

Subcatchment P3: P3 Runoff Area=9,228 sf 6.95% Impervious Runoff Depth=0.67"
Flow Length=168' Tc=5.6 min CN=WQ Runoff=0.2 cfs 515 cf

Subcatchment P4: Tributary to Ipswich Runoff Area=86,576 sf 0.00% Impervious Runoff Depth=0.07"
Flow Length=311' Tc=7.3 min CN=WQ Runoff=0.1 cfs 499 cf

Subcatchment P5: P5 Runoff Area=21,566 sf 32.56% Impervious Runoff Depth=1.13"
Flow Length=231' Tc=6.0 min CN=WQ Runoff=0.5 cfs 2,025 cf

Subcatchment P6: P6 Runoff Area=10,133 sf 69.55% Impervious Runoff Depth=2.15"
Flow Length=144' Slope=0.0800 '/' Tc=6.0 min CN=WQ Runoff=0.5 cfs 1,819 cf

Subcatchment P7: P7 Runoff Area=34,653 sf 42.56% Impervious Runoff Depth=1.42"
Flow Length=375' Tc=6.0 min CN=WQ Runoff=1.1 cfs 4,114 cf

Subcatchment P8: P8 Runoff Area=8,936 sf 63.17% Impervious Runoff Depth=1.91"
Tc=6.0 min CN=WQ Runoff=0.4 cfs 1,425 cf

Subcatchment R1: ROOFS Runoff Area=8,960 sf 100.00% Impervious Runoff Depth=2.92"
Tc=6.0 min CN=WQ Runoff=0.6 cfs 2,179 cf

Subcatchment R2: ROOFS Runoff Area=14,080 sf 100.00% Impervious Runoff Depth=2.92"
Tc=6.0 min CN=WQ Runoff=0.9 cfs 3,423 cf

Subcatchment R3: Roofs Runoff Area=2,560 sf 100.00% Impervious Runoff Depth=2.92"
Tc=6.0 min CN=98 Runoff=0.2 cfs 622 cf

Reach DP1: Ipswich River Inflow=0.3 cfs 4,337 cf
Outflow=0.3 cfs 4,337 cf

Reach DP2: Outlet from tributary wetland Inflow=0.4 cfs 9,086 cf
Outflow=0.4 cfs 9,086 cf

Reach DP3: Perkins Row Inflow=0.0 cfs 359 cf
Outflow=0.0 cfs 359 cf

Pond D1: Detention System 1 Peak Elev=42.52' Storage=1,043 cf Inflow=1.0 cfs 3,844 cf
Outflow=0.3 cfs 3,838 cf

Pond PW: Pocket Wetland Peak Elev=51.22' Storage=905 cf Inflow=1.1 cfs 3,959 cf
Primary=0.3 cfs 3,949 cf Secondary=0.0 cfs 0 cf Outflow=0.3 cfs 3,949 cf

Pond RS1: Recharge System 1 Peak Elev=54.35' Storage=837 cf Inflow=1.0 cfs 3,604 cf
Discarded=0.1 cfs 3,604 cf Primary=0.0 cfs 0 cf Outflow=0.1 cfs 3,604 cf

Pond RS2: Recharge System 2 Peak Elev=50.86' Storage=1,104 cf Inflow=1.1 cfs 4,114 cf
Discarded=0.1 cfs 4,114 cf Primary=0.0 cfs 0 cf Outflow=0.1 cfs 4,114 cf

Pond RS3: Recharge System 3 Peak Elev=51.39' Storage=932 cf Inflow=0.9 cfs 3,423 cf
Discarded=0.1 cfs 3,423 cf Primary=0.0 cfs 0 cf Outflow=0.1 cfs 3,423 cf

Pond RS4: Recharge System 4 Peak Elev=50.94' Storage=146 cf Inflow=0.2 cfs 622 cf
Discarded=0.0 cfs 622 cf Primary=0.0 cfs 0 cf Outflow=0.0 cfs 622 cf

Pond S1: Existing Bordering Vegetated Peak Elev=48.28' Storage=5,029 cf Inflow=1.7 cfs 7,782 cf
Outflow=0.1 cfs 4,621 cf

Summary for Subcatchment P1: Tributary to Perkins Row

Runoff = 0.0 cfs @ 12.31 hrs, Volume= 359 cf, Depth= 0.40"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

Area (sf)	CN	Description
529	98	Pavement, HSG B
8,654	55	Woods, Good, HSG B
1,698	61	>75% Grass cover, Good, HSG B
10,881		Weighted Average
10,352	56	95.14% Pervious Area
529	98	4.86% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.5	50	0.0100	0.05		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
1.3	123	0.0100	1.61		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
17.8	173	Total			

Summary for Subcatchment P2A: Tributary to BVW

Runoff = 1.7 cfs @ 12.14 hrs, Volume= 7,782 cf, Depth= 0.51"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

	Area (sf)	CN	Description
	5,851	30	Woods, Good, HSG A
	14,652	55	Woods, Good, HSG B
	14,317	77	Woods, Good, HSG D
	3,568	39	>75% Grass cover, Good, HSG A
	16,932	61	>75% Grass cover, Good, HSG B
	1,236	80	>75% Grass cover, Good, HSG D
	9,512	98	Water Surface, HSG D
*	31,995	30	Woods(OFFSITE), Good, HSG A
*	70,262	55	Woods(OFFSITE), Good, HSG B
*	11,051	77	Woods(OFFSITE), Good, HSG D
*	2,354	98	Water Surface(OFFSITE), HSG D
	181,730		Weighted Average
	169,864	53	93.47% Pervious Area
	11,866	98	6.53% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.7	50	0.0200	0.15		**Sheet Flow, Sheet Flow** Grass: Short n= 0.150 P2= 3.10"
0.4	87	0.0460	3.45		**Shallow Concentrated Flow, Grass** Unpaved Kv= 16.1 fps
0.4	128	0.0900	4.83		**Shallow Concentrated Flow, Woods** Unpaved Kv= 16.1 fps
6.5	265	Total			

Summary for Subcatchment P2B: Tributary to BVW

Runoff = 1.1 cfs @ 12.13 hrs, Volume= 3,959 cf, Depth= 2.58"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

	Area (sf)	CN	Description
*	3,470	98	Pavement, HSG A
*	8,089	98	Pavement, HSG B
*	4,362	98	Pavement, HSG D
	2,484	61	>75% Grass cover, Good, HSG B
	18,405		Weighted Average
	2,484	61	13.50% Pervious Area
	15,921	98	86.50% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Tc Min = 6 Min**

Summary for Subcatchment P3: P3

Runoff = 0.2 cfs @ 12.13 hrs, Volume= 515 cf, Depth= 0.67"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

	Area (sf)	CN	Description
*	63	98	Wall, HSG B
*	578	98	Wall, HSG D
	59	55	Woods, Good, HSG B
	1,351	77	Woods, Good, HSG D
	5,188	39	>75% Grass cover, Good, HSG A
	1,989	80	>75% Grass cover, Good, HSG D
	9,228		Weighted Average
	8,587	55	93.05% Pervious Area
	641	98	6.95% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.7	50	0.0600	0.23		**Sheet Flow, Sheet Flow** Grass: Short n= 0.150 P2= 3.10"
0.3	72	0.0500	3.60		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.2	46	0.0600	3.94		**Shallow Concentrated Flow, Woods** Unpaved Kv= 16.1 fps
1.4					**Direct Entry, Min Tc = 6min**
5.6	168	Total			

Summary for Subcatchment P4: Tributary to Ipswich River

Runoff = 0.1 cfs @ 12.17 hrs, Volume= 499 cf, Depth= 0.07"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

Area (sf)	CN	Description
29,843	30	Woods, Good, HSG A
11,033	55	Woods, Good, HSG B
37,723	39	>75% Grass cover, Good, HSG A
7,977	61	>75% Grass cover, Good, HSG B
86,576		Weighted Average
86,576	40	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.2	50	0.0165	0.13		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.10"
0.5	61	0.0170	2.10		**Shallow Concentrated Flow, Grass** Unpaved Kv= 16.1 fps
0.6	200	0.1100	5.34		**Shallow Concentrated Flow, Woods** Unpaved Kv= 16.1 fps
7.3	311	Total			

Summary for Subcatchment P5: P5

Runoff = 0.5 cfs @ 12.13 hrs, Volume= 2,025 cf, Depth= 1.13"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

	Area (sf)	CN	Description
	5,561	39	>75% Grass cover, Good, HSG A
	8,983	61	>75% Grass cover, Good, HSG B
*	7,022	98	Paved, HSG A
	21,566		Weighted Average
	14,544	53	67.44% Pervious Area
	7,022	98	32.56% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.0	50	0.1000	0.28		**Sheet Flow, Grass** Grass: Short n= 0.150 P2= 3.10"
0.2	75	0.1000	5.09		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.5	106	0.0280	3.40		**Shallow Concentrated Flow, Paved** Paved Kv= 20.3 fps
2.3					**Direct Entry, Min Tc = 6 min**
6.0	231	Total			

Summary for Subcatchment P6: P6

Runoff = 0.5 cfs @ 12.13 hrs, Volume= 1,819 cf, Depth= 2.15"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

	Area (sf)	CN	Description
	93	39	>75% Grass cover, Good, HSG A
	2,992	61	>75% Grass cover, Good, HSG B
*	924	98	Pavement, HSG A
*	6,124	98	Pavement, HSG B
	10,133		Weighted Average
	3,085	60	30.45% Pervious Area
	7,048	98	69.55% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	22	0.0800	0.22		**Sheet Flow, Grass** Grass: Short n= 0.150 P2= 3.10"
0.4	122	0.0800	5.74		**Shallow Concentrated Flow, Pavement** Paved Kv= 20.3 fps
3.9					**Direct Entry, Min Tc = 6 Min**
6.0	144	Total			

Summary for Subcatchment P7: P7

Runoff = 1.1 cfs @ 12.13 hrs, Volume= 4,114 cf, Depth= 1.42"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

	Area (sf)	CN	Description
	4,970	39	>75% Grass cover, Good, HSG A
	14,933	61	>75% Grass cover, Good, HSG B
*	7,550	98	Pavement, HSG A
*	7,200	98	Pavement, HSG B
	34,653		Weighted Average
	19,903	56	57.44% Pervious Area
	14,750	98	42.56% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.3	50	0.0820	0.26		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.10"
1.1	325	0.0969	5.01		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
1.6					**Direct Entry, Adjust to Minimum 0.1 Hours**
6.0	375	Total			

Summary for Subcatchment P8: P8

Runoff = 0.4 cfs @ 12.13 hrs, Volume= 1,425 cf, Depth= 1.91"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

	Area (sf)	CN	Description
	1,792	39	>75% Grass cover, Good, HSG A
	1,499	61	>75% Grass cover, Good, HSG B
*	3,276	98	Pavement, HSG A
*	2,369	98	Pavement, HSG B
	8,936		Weighted Average
	3,291	49	36.83% Pervious Area
	5,645	98	63.17% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Min Tc = 6 Min**

Summary for Subcatchment R1: ROOFS

Runoff = 0.6 cfs @ 12.13 hrs, Volume= 2,179 cf, Depth= 2.92"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

Area (sf)	CN	Description
8,115	98	Roofs, HSG A
702	98	Roofs, HSG D
143	98	Roofs, HSG B
8,960		Weighted Average
8,960	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Min Tc = 6min**

Summary for Subcatchment R2: ROOFS

Runoff = 0.9 cfs @ 12.13 hrs, Volume= 3,423 cf, Depth= 2.92"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

Area (sf)	CN	Description
6,414	98	Roofs, HSG A
7,666	98	Roofs, HSG B
14,080		Weighted Average
14,080	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Min Tc = 6 Min**

Summary for Subcatchment R3: Roofs

Runoff = 0.2 cfs @ 12.13 hrs, Volume= 622 cf, Depth= 2.92"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

Area (sf)	CN	Description
2,560	98	Roofs, HSG A
2,560	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Min Tc = 6 Min**

Summary for Reach DP1: Ipswich River

Inflow Area = 187,464 sf, 32.04% Impervious, Inflow Depth > 0.28" for 2-Year event
Inflow = 0.3 cfs @ 12.27 hrs, Volume= 4,337 cf
Outflow = 0.3 cfs @ 12.27 hrs, Volume= 4,337 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3

Summary for Reach DP2: Outlet from tributary wetland

Inflow Area = 209,363 sf, 13.58% Impervious, Inflow Depth > 0.52" for 2-Year event
Inflow = 0.4 cfs @ 12.15 hrs, Volume= 9,086 cf
Outflow = 0.4 cfs @ 12.15 hrs, Volume= 9,086 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3

Summary for Reach DP3: Perkins Row

Inflow Area = 10,881 sf, 4.86% Impervious, Inflow Depth = 0.40" for 2-Year event
Inflow = 0.0 cfs @ 12.31 hrs, Volume= 359 cf
Outflow = 0.0 cfs @ 12.31 hrs, Volume= 359 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3

Summary for Pond D1: Detention System 1

Inflow Area = 48,339 sf, 63.53% Impervious, Inflow Depth = 0.95" for 2-Year event
Inflow = 1.0 cfs @ 12.13 hrs, Volume= 3,844 cf
Outflow = 0.3 cfs @ 12.35 hrs, Volume= 3,838 cf, Atten= 72%, Lag= 13.0 min
Primary = 0.3 cfs @ 12.35 hrs, Volume= 3,838 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 42.52' @ 12.35 hrs Surf.Area= 684 sf Storage= 1,043 cf

Plug-Flow detention time= 79.4 min calculated for 3,837 cf (100% of inflow)
Center-of-Mass det. time= 78.6 min (861.5 - 782.9)

Volume	Invert	Avail.Storage	Storage Description
#1	41.00'	3,420 cf	**7.33'W x 13.33'L x 5.00'H Chambers** x 7
#2	46.00'	0 cf	**7.33'W x 13.33'L x 0.67'H Prismatoid** x 7 458 cf Overall x 0.0% Voids
		3,420 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	41.00'	**12.0" Round Culvert** L= 10.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 41.00' / 40.80' S= 0.0200 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf
#2	Device 1	41.00'	**2.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	42.00'	**3.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Device 1	43.00'	**3.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#5	Device 1	44.00'	**3.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#6	Device 1	45.00'	**3.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#7	Device 1	45.80'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Primary OutFlow Max=0.3 cfs @ 12.35 hrs HW=42.52' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Passes 0.3 cfs of 3.0 cfs potential flow)
  ├─**2=Orifice/Grate** (Orifice Controls 0.1 cfs @ 5.78 fps)
  ├─**3=Orifice/Grate** (Orifice Controls 0.1 cfs @ 3.04 fps)
  ├─**4=Orifice/Grate** (Controls 0.0 cfs)
  ├─**5=Orifice/Grate** (Controls 0.0 cfs)
  ├─**6=Orifice/Grate** (Controls 0.0 cfs)
  └─**7=Broad-Crested Rectangular Weir** (Controls 0.0 cfs)

Summary for Pond PW: Pocket Wetland

Inflow Area =	18,405 sf,	86.50% Impervious,	Inflow Depth =	2.58" for 2-Year event
Inflow =	1.1 cfs @	12.13 hrs, Volume=	3,959 cf	
Outflow =	0.3 cfs @	12.31 hrs, Volume=	3,949 cf,	Atten= 70%, Lag= 11.0 min
Primary =	0.3 cfs @	12.31 hrs, Volume=	3,949 cf	
Secondary =	0.0 cfs @	0.00 hrs, Volume=	0 cf	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 51.22' @ 12.31 hrs Surf.Area= 1,468 sf Storage= 905 cf

Plug-Flow detention time= 56.5 min calculated for 3,948 cf (100% of inflow)
Center-of-Mass det. time= 55.1 min (820.4 - 765.3)

Volume	Invert	Avail.Storage	Storage Description
#1	50.50'	4,466 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
50.50	1,061	0	0
51.00	1,326	597	597
52.00	1,969	1,648	2,244
52.50	2,218	1,047	3,291
53.00	2,481	1,175	4,466

Device	Routing	Invert	Outlet Devices
#1	Primary	49.00'	**12.0" Round Culvert** L= 14.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 49.00' / 48.93' S= 0.0050 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf
#2	Device 1	50.50'	**4.0" Vert. Orifice** C= 0.600 Limited to weir flow at low heads
#3	Device 1	51.50'	**4.0" Vert. Orifice** C= 0.600 Limited to weir flow at low heads
#4	Device 1	52.30'	**12.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#5	Secondary	52.50'	**8.0' long x 6.0' breadth Stone Spillway 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) 2.37 2.51 2.70 2.68 2.68 2.67 2.65 2.65 2.65 2.65 2.66 2.66 2.67 2.69 2.72 2.76 2.83

Primary OutFlow Max=0.3 cfs @ 12.31 hrs HW=51.22' TW=0.00' (Dynamic Tailwater)
- **1=Culvert** (Passes 0.3 cfs of 3.9 cfs potential flow)
  - **2=Orifice** (Orifice Controls 0.3 cfs @ 3.58 fps)
  - **3=Orifice** (Controls 0.0 cfs)
  - **4=Orifice/Grate** (Controls 0.0 cfs)

Secondary OutFlow Max=0.0 cfs @ 0.00 hrs HW=50.50' TW=47.80' (Dynamic Tailwater)
- **5=Stone Spillway Weir** (Controls 0.0 cfs)

Summary for Pond RS1: Recharge System 1

Inflow Area =	17,896 sf,	81.61% Impervious,	Inflow Depth =	2.42"	for 2-Year event
Inflow =	1.0 cfs @	12.13 hrs, Volume=	3,604 cf		
Outflow =	0.1 cfs @	12.60 hrs, Volume=	3,604 cf,	Atten= 85%,	Lag= 28.4 min
Discarded =	0.1 cfs @	12.60 hrs, Volume=	3,604 cf		
Primary =	0.0 cfs @	0.00 hrs, Volume=	0 cf		

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 54.35' @ 12.60 hrs Surf.Area= 1,764 sf Storage= 837 cf

Plug-Flow detention time= 34.3 min calculated for 3,603 cf (100% of inflow)
Center-of-Mass det. time= 34.3 min (798.0 - 763.8)

Volume	Invert	Avail.Storage	Storage Description
#1	53.50'	353 cf	**Stone Bed (Prismatic)**Listed below (Recalc) 882 cf Overall x 40.0% Voids
#2	54.00'	4,104 cf	**7.33'W x 13.33'L x 3.00'H Chambers**x 14 -Impervious
#3	57.00'	0 cf	**7.33'W x 13.33'L x 0.67'H Prismatoid**x 14 917 cf Overall x 0.0% Voids
		4,457 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
53.50	1,764	0	0
54.00	1,764	882	882

Device	Routing	Invert	Outlet Devices
#1	Primary	54.00'	**12.0" Round Culvert** L= 40.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 54.00' / 53.90' S= 0.0025 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf
#2	Device 1	55.20'	**2.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	56.40'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#4	Discarded	53.50'	**2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 51.50' Phase-In= 0.01'

Discarded OutFlow Max=0.1 cfs @ 12.60 hrs HW=54.35' (Free Discharge)
└**4=Exfiltration** (Controls 0.1 cfs)

Primary OutFlow Max=0.0 cfs @ 0.00 hrs HW=53.50' TW=49.50' (Dynamic Tailwater)
└**1=Culvert** (Controls 0.0 cfs)
  └**2=Orifice/Grate** (Controls 0.0 cfs)
  └**3=Broad-Crested Rectangular Weir** (Controls 0.0 cfs)

Summary for Pond RS2: Recharge System 2

Inflow Area = 52,549 sf, 55.86% Impervious, Inflow Depth = 0.94" for 2-Year event
Inflow = 1.1 cfs @ 12.13 hrs, Volume= 4,114 cf
Outflow = 0.1 cfs @ 12.97 hrs, Volume= 4,114 cf, Atten= 89%, Lag= 50.6 min
Discarded = 0.1 cfs @ 12.97 hrs, Volume= 4,114 cf
Primary = 0.0 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 50.86' @ 12.97 hrs Surf.Area= 1,296 sf Storage= 1,104 cf

Plug-Flow detention time= 64.7 min calculated for 4,112 cf (100% of inflow)
Center-of-Mass det. time= 64.7 min (851.2 - 786.6)

Volume	Invert	Avail.Storage	Storage Description
#1	49.50'	259 cf	**Stone Bed (Prismatic)**Listed below (Recalc) 648 cf Overall x 40.0% Voids
#2	50.00'	3,908 cf	**7.33'W x 13.33'L x 4.00'H Chambers**x 10 -Impervious
#3	54.00'	0 cf	**7.33'W x 13.33'L x 0.67'H Prismatoid**x 10 655 cf Overall x 0.0% Voids
		4,168 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
49.50	1,296	0	0
50.00	1,296	648	648

Device	Routing	Invert	Outlet Devices
#1	Primary	50.00'	**12.0" Round Culvert** L= 2.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 50.00' / 49.90' S= 0.0500 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf
#2	Device 1	51.10'	**2.0" Vert. Orifice/Grate X 2.00** C= 0.600 Limited to weir flow at low heads
#3	Device 1	52.10'	**3.0" Vert. Orifice/Grate X 2.00** C= 0.600 Limited to weir flow at low heads
#4	Device 1	52.50'	**4.0" Vert. Orifice/Grate X 2.00** C= 0.600 Limited to weir flow at low heads
#5	Device 1	53.80'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#6	Discarded	49.50'	**2.410 in/hr Exfiltration over Surface area**

Conductivity to Groundwater Elevation = 47.50' Phase-In= 0.01'

Discarded OutFlow Max=0.1 cfs @ 12.97 hrs HW=50.86' (Free Discharge)
└**6=Exfiltration** (Controls 0.1 cfs)

Primary OutFlow Max=0.0 cfs @ 0.00 hrs HW=49.50' TW=0.00' (Dynamic Tailwater)
└**1=Culvert** (Controls 0.0 cfs)
  ├**2=Orifice/Grate** (Controls 0.0 cfs)
  ├**3=Orifice/Grate** (Controls 0.0 cfs)
  ├**4=Orifice/Grate** (Controls 0.0 cfs)
  └**5=Broad-Crested Rectangular Weir**(Controls 0.0 cfs)

Summary for Pond RS3: Recharge System 3

Inflow Area =	14,080 sf,100.00% Impervious,		Inflow Depth =	2.92"	for 2-Year event
Inflow =	0.9 cfs @	12.13 hrs, Volume=	3,423 cf		
Outflow =	0.1 cfs @	12.73 hrs, Volume=	3,423 cf,	Atten= 88%,	Lag= 36.2 min
Discarded =	0.1 cfs @	12.73 hrs, Volume=	3,423 cf		
Primary =	0.0 cfs @	0.00 hrs, Volume=	0 cf		

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 51.39' @ 12.73 hrs Surf.Area= 1,200 sf Storage= 932 cf

Plug-Flow detention time= 55.3 min calculated for 3,422 cf (100% of inflow)
Center-of-Mass det. time= 55.3 min (816.1 - 760.8)

Volume	Invert	Avail.Storage	Storage Description
#1	50.00'	240 cf	**Stone Bed (Prismatic)**Listed below (Recalc) 600 cf Overall x 40.0% Voids
#2	50.50'	3,127 cf	**7.33'W x 13.33'L x 4.00'H Chambers**x 8 -Impervious
#3	54.50'	0 cf	**7.33'W x 13.33'L x 0.67'H Prismatoid**x 8 524 cf Overall x 0.0% Voids
		3,367 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
50.00	1,200	0	0
50.50	1,200	600	600

Device	Routing	Invert	Outlet Devices
#1	Primary	53.50'	**6.0" Round Culvert** L= 35.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 53.50' / 53.30' S= 0.0057 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.20 sf
#2	Device 1	54.40'	**6.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Discarded	50.00'	**2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 48.00' Phase-In= 0.01'

Discarded OutFlow Max=0.1 cfs @ 12.73 hrs HW=51.39' (Free Discharge)
└**3=Exfiltration** (Controls 0.1 cfs)

Primary OutFlow Max=0.0 cfs @ 0.00 hrs HW=50.00' TW=41.00' (Dynamic Tailwater)
└**1=Culvert** (Controls 0.0 cfs)
└**2=Orifice/Grate** (Controls 0.0 cfs)

Summary for Pond RS4: Recharge System 4

Inflow Area = 2,560 sf,100.00% Impervious, Inflow Depth = 2.92" for 2-Year event
Inflow = 0.2 cfs @ 12.13 hrs, Volume= 622 cf
Outflow = 0.0 cfs @ 12.59 hrs, Volume= 622 cf, Atten= 85%, Lag= 27.9 min
Discarded = 0.0 cfs @ 12.59 hrs, Volume= 622 cf
Primary = 0.0 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 50.94' @ 12.59 hrs Surf.Area= 300 sf Storage= 146 cf

Plug-Flow detention time= 34.6 min calculated for 622 cf (100% of inflow)
Center-of-Mass det. time= 34.6 min (795.4 - 760.8)

Volume	Invert	Avail.Storage	Storage Description
#1	50.00'	60 cf	**Stone Bed (Prismatic)**Listed below (Recalc) 150 cf Overall x 40.0% Voids
#2	50.50'	586 cf	**7.33'W x 13.33'L x 3.00'H Chambers**x 2 -Impervious
#3	53.50'	0 cf	**7.33'W x 13.33'L x 0.67'H Prismatoid**x 2 131 cf Overall x 0.0% Voids
		646 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
50.00	300	0	0
50.50	300	150	150

Device	Routing	Invert	Outlet Devices
#1	Primary	53.00'	**6.0" Round Culvert** L= 4.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 53.00' / 52.90' S= 0.0250 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.20 sf
#2	Discarded	50.00'	**2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 48.00' Phase-In= 0.01'

Discarded OutFlow Max=0.0 cfs @ 12.59 hrs HW=50.94' (Free Discharge)
└**2=Exfiltration** (Controls 0.0 cfs)

Primary OutFlow Max=0.0 cfs @ 0.00 hrs HW=50.00' TW=41.00' (Dynamic Tailwater)
└**1=Culvert** (Controls 0.0 cfs)

Summary for Pond S1: Existing Bordering Vegetated Wetland

Inflow Area = 181,730 sf, 6.53% Impervious, Inflow Depth = 0.51" for 2-Year event
Inflow = 1.7 cfs @ 12.14 hrs, Volume= 7,782 cf
Outflow = 0.1 cfs @ 20.82 hrs, Volume= 4,621 cf, Atten= 96%, Lag= 520.4 min
Primary = 0.1 cfs @ 20.82 hrs, Volume= 4,621 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 48.28' @ 20.82 hrs Surf.Area= 11,071 sf Storage= 5,029 cf

Plug-Flow detention time= 655.7 min calculated for 4,620 cf (59% of inflow)
Center-of-Mass det. time= 493.0 min (1,364.8 - 871.9)

Volume	Invert	Avail.Storage	Storage Description
#1	47.80'	65,726 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
47.80	9,945	0	0
50.00	15,123	27,575	27,575
52.00	23,028	38,151	65,726

Device	Routing	Invert	Outlet Devices
#1	Primary	47.80'	**120.0" W x 50.0" H Box BoxCulvert** L= 35.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 47.80' / 46.60' S= 0.0343 '/' Cc= 0.900 n= 0.040 Earth, cobble bottom, clean sides, Flow Area= 41.67 sf
#2	Device 1	47.80'	**20.0 deg x 2.00' rise Sharp-Crested Vee/Trap Weir** Cv= 2.69 (C= 3.36)
#3	Device 1	49.80'	**10.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Primary OutFlow Max=0.1 cfs @ 20.82 hrs HW=48.28' TW=0.00' (Dynamic Tailwater)
└─**1=BoxCulvert** (Passes 0.1 cfs of 10.6 cfs potential flow)
  ├─**2=Sharp-Crested Vee/Trap Weir** (Weir Controls 0.1 cfs @ 1.86 fps)
  └─**3=Broad-Crested Rectangular Weir** (Controls 0.0 cfs)

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-Q
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment P1: Tributary to Perkins Row Runoff Area=10,881 sf 4.86% Impervious Runoff Depth=1.13"
Flow Length=173' Slope=0.0100 '/' Tc=17.8 min CN=WQ Runoff=0.2 cfs 1,029 cf

Subcatchment P2A: Tributary to BVW Runoff Area=181,730 sf 6.53% Impervious Runoff Depth=1.21"
Flow Length=265' Tc=6.5 min CN=WQ Runoff=4.9 cfs 18,258 cf

Subcatchment P2B: Tributary to BVW Runoff Area=18,405 sf 86.50% Impervious Runoff Depth=4.14"
Tc=6.0 min CN=WQ Runoff=1.7 cfs 6,357 cf

Subcatchment P3: P3 Runoff Area=9,228 sf 6.95% Impervious Runoff Depth=1.37"
Flow Length=168' Tc=5.6 min CN=WQ Runoff=0.3 cfs 1,056 cf

Subcatchment P4: Tributary to Ipswich Runoff Area=86,576 sf 0.00% Impervious Runoff Depth=0.30"
Flow Length=311' Tc=7.3 min CN=WQ Runoff=0.4 cfs 2,195 cf

Subcatchment P5: P5 Runoff Area=21,566 sf 32.56% Impervious Runoff Depth=2.07"
Flow Length=231' Tc=6.0 min CN=WQ Runoff=1.0 cfs 3,715 cf

Subcatchment P6: P6 Runoff Area=10,133 sf 69.55% Impervious Runoff Depth=3.57"
Flow Length=144' Slope=0.0800 '/' Tc=6.0 min CN=WQ Runoff=0.8 cfs 3,015 cf

Subcatchment P7: P7 Runoff Area=34,653 sf 42.56% Impervious Runoff Depth=2.53"
Flow Length=375' Tc=6.0 min CN=WQ Runoff=1.9 cfs 7,293 cf

Subcatchment P8: P8 Runoff Area=8,936 sf 63.17% Impervious Runoff Depth=3.15"
Tc=6.0 min CN=WQ Runoff=0.6 cfs 2,344 cf

Subcatchment R1: ROOFS Runoff Area=8,960 sf 100.00% Impervious Runoff Depth=4.59"
Tc=6.0 min CN=WQ Runoff=0.9 cfs 3,430 cf

Subcatchment R2: ROOFS Runoff Area=14,080 sf 100.00% Impervious Runoff Depth=4.59"
Tc=6.0 min CN=WQ Runoff=1.4 cfs 5,390 cf

Subcatchment R3: Roofs Runoff Area=2,560 sf 100.00% Impervious Runoff Depth=4.59"
Tc=6.0 min CN=98 Runoff=0.3 cfs 980 cf

Reach DP1: Ipswich River Inflow=1.0 cfs 9,936 cf
Outflow=1.0 cfs 9,936 cf

Reach DP2: Outlet from tributary wetland Inflow=0.7 cfs 21,867 cf
Outflow=0.7 cfs 21,867 cf

Reach DP3: Perkins Row Inflow=0.2 cfs 1,029 cf
Outflow=0.2 cfs 1,029 cf

Pond D1: Detention System 1 Peak Elev=43.53' Storage=1,734 cf Inflow=1.8 cfs 6,730 cf
Outflow=0.6 cfs 6,724 cf

Pond PW: Pocket Wetland Peak Elev=51.60' Storage=1,504 cf Inflow=1.7 cfs 6,357 cf
Primary=0.4 cfs 6,347 cf Secondary=0.0 cfs 0 cf Outflow=0.4 cfs 6,347 cf

Pond RS1: Recharge System 1 Peak Elev=54.93' Storage=1,630 cf Inflow=1.5 cfs 5,774 cf
Discarded=0.2 cfs 5,774 cf Primary=0.0 cfs 0 cf Outflow=0.2 cfs 5,774 cf

Pond RS2: Recharge System 2 Peak Elev=51.82' Storage=2,041 cf Inflow=1.9 cfs 7,293 cf
Discarded=0.2 cfs 6,277 cf Primary=0.2 cfs 1,017 cf Outflow=0.3 cfs 7,293 cf

Pond RS3: Recharge System 3 Peak Elev=52.38' Storage=1,706 cf Inflow=1.4 cfs 5,390 cf
Discarded=0.1 cfs 5,390 cf Primary=0.0 cfs 0 cf Outflow=0.1 cfs 5,390 cf

Pond RS4: Recharge System 4 Peak Elev=51.60' Storage=276 cf Inflow=0.3 cfs 980 cf
Discarded=0.0 cfs 980 cf Primary=0.0 cfs 0 cf Outflow=0.0 cfs 980 cf

Pond S1: Existing Bordering Vegetated Peak Elev=48.66' Storage=9,365 cf Inflow=4.9 cfs 18,258 cf
Outflow=0.3 cfs 14,464 cf

Summary for Subcatchment P1: Tributary to Perkins Row

Runoff = 0.2 cfs @ 12.28 hrs, Volume= 1,029 cf, Depth= 1.13"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

Area (sf)	CN	Description
529	98	Pavement, HSG B
8,654	55	Woods, Good, HSG B
1,698	61	>75% Grass cover, Good, HSG B
10,881		Weighted Average
10,352	56	95.14% Pervious Area
529	98	4.86% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.5	50	0.0100	0.05		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
1.3	123	0.0100	1.61		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
17.8	173	Total			

Summary for Subcatchment P2A: Tributary to BVW

Runoff = 4.9 cfs @ 12.14 hrs, Volume= 18,258 cf, Depth= 1.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

	Area (sf)	CN	Description
	5,851	30	Woods, Good, HSG A
	14,652	55	Woods, Good, HSG B
	14,317	77	Woods, Good, HSG D
	3,568	39	>75% Grass cover, Good, HSG A
	16,932	61	>75% Grass cover, Good, HSG B
	1,236	80	>75% Grass cover, Good, HSG D
	9,512	98	Water Surface, HSG D
*	31,995	30	Woods(OFFSITE), Good, HSG A
*	70,262	55	Woods(OFFSITE), Good, HSG B
*	11,051	77	Woods(OFFSITE), Good, HSG D
*	2,354	98	Water Surface(OFFSITE), HSG D
	181,730		Weighted Average
	169,864	53	93.47% Pervious Area
	11,866	98	6.53% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.7	50	0.0200	0.15		**Sheet Flow, Sheet Flow** Grass: Short n= 0.150 P2= 3.10"
0.4	87	0.0460	3.45		**Shallow Concentrated Flow, Grass** Unpaved Kv= 16.1 fps
0.4	128	0.0900	4.83		**Shallow Concentrated Flow, Woods** Unpaved Kv= 16.1 fps
6.5	265	Total			

Summary for Subcatchment P2B: Tributary to BVW

Runoff = 1.7 cfs @ 12.13 hrs, Volume= 6,357 cf, Depth= 4.14"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

	Area (sf)	CN	Description
*	3,470	98	Pavement, HSG A
*	8,089	98	Pavement, HSG B
*	4,362	98	Pavement, HSG D
	2,484	61	>75% Grass cover, Good, HSG B
	18,405		Weighted Average
	2,484	61	13.50% Pervious Area
	15,921	98	86.50% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Tc Min = 6 Min**

Summary for Subcatchment P3: P3

Runoff = 0.3 cfs @ 12.13 hrs, Volume= 1,056 cf, Depth= 1.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

	Area (sf)	CN	Description
*	63	98	Wall, HSG B
*	578	98	Wall, HSG D
	59	55	Woods, Good, HSG B
	1,351	77	Woods, Good, HSG D
	5,188	39	>75% Grass cover, Good, HSG A
	1,989	80	>75% Grass cover, Good, HSG D
	9,228		Weighted Average
	8,587	55	93.05% Pervious Area
	641	98	6.95% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.7	50	0.0600	0.23		**Sheet Flow, Sheet Flow** Grass: Short n= 0.150 P2= 3.10"
0.3	72	0.0500	3.60		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.2	46	0.0600	3.94		**Shallow Concentrated Flow, Woods** Unpaved Kv= 16.1 fps
1.4					**Direct Entry, Min Tc = 6min**
5.6	168	Total			

Summary for Subcatchment P4: Tributary to Ipswich River

Runoff = 0.4 cfs @ 12.15 hrs, Volume= 2,195 cf, Depth= 0.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

Area (sf)	CN	Description
29,843	30	Woods, Good, HSG A
11,033	55	Woods, Good, HSG B
37,723	39	>75% Grass cover, Good, HSG A
7,977	61	>75% Grass cover, Good, HSG B
86,576		Weighted Average
86,576	40	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.2	50	0.0165	0.13		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.10"
0.5	61	0.0170	2.10		**Shallow Concentrated Flow, Grass** Unpaved Kv= 16.1 fps
0.6	200	0.1100	5.34		**Shallow Concentrated Flow, Woods** Unpaved Kv= 16.1 fps
7.3	311	Total			

Summary for Subcatchment P5: P5

Runoff = 1.0 cfs @ 12.13 hrs, Volume= 3,715 cf, Depth= 2.07"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

	Area (sf)	CN	Description
	5,561	39	>75% Grass cover, Good, HSG A
	8,983	61	>75% Grass cover, Good, HSG B
*	7,022	98	Paved, HSG A
	21,566		Weighted Average
	14,544	53	67.44% Pervious Area
	7,022	98	32.56% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.0	50	0.1000	0.28		**Sheet Flow, Grass** Grass: Short n= 0.150 P2= 3.10"
0.2	75	0.1000	5.09		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.5	106	0.0280	3.40		**Shallow Concentrated Flow, Paved** Paved Kv= 20.3 fps
2.3					**Direct Entry, Min Tc = 6 min**
6.0	231	Total			

Summary for Subcatchment P6: P6

Runoff = 0.8 cfs @ 12.13 hrs, Volume= 3,015 cf, Depth= 3.57"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

	Area (sf)	CN	Description
	93	39	>75% Grass cover, Good, HSG A
	2,992	61	>75% Grass cover, Good, HSG B
*	924	98	Pavement, HSG A
*	6,124	98	Pavement, HSG B
	10,133		Weighted Average
	3,085	60	30.45% Pervious Area
	7,048	98	69.55% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	22	0.0800	0.22		**Sheet Flow, Grass** Grass: Short n= 0.150 P2= 3.10"
0.4	122	0.0800	5.74		**Shallow Concentrated Flow, Pavement** Paved Kv= 20.3 fps
3.9					**Direct Entry, Min Tc = 6 Min**
6.0	144	Total			

Summary for Subcatchment P7: P7

Runoff = 1.9 cfs @ 12.13 hrs, Volume= 7,293 cf, Depth= 2.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

	Area (sf)	CN	Description
	4,970	39	>75% Grass cover, Good, HSG A
	14,933	61	>75% Grass cover, Good, HSG B
*	7,550	98	Pavement, HSG A
*	7,200	98	Pavement, HSG B
	34,653		Weighted Average
	19,903	56	57.44% Pervious Area
	14,750	98	42.56% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.3	50	0.0820	0.26		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.10"
1.1	325	0.0969	5.01		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
1.6					**Direct Entry, Adjust to Minimum 0.1 Hours**
6.0	375	Total			

Summary for Subcatchment P8: P8

Runoff = 0.6 cfs @ 12.13 hrs, Volume= 2,344 cf, Depth= 3.15"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

	Area (sf)	CN	Description
	1,792	39	>75% Grass cover, Good, HSG A
	1,499	61	>75% Grass cover, Good, HSG B
*	3,276	98	Pavement, HSG A
*	2,369	98	Pavement, HSG B
	8,936		Weighted Average
	3,291	49	36.83% Pervious Area
	5,645	98	63.17% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Min Tc = 6 Min**

Summary for Subcatchment R1: ROOFS

Runoff = 0.9 cfs @ 12.13 hrs, Volume= 3,430 cf, Depth= 4.59"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

Area (sf)	CN	Description
8,115	98	Roofs, HSG A
702	98	Roofs, HSG D
143	98	Roofs, HSG B
8,960		Weighted Average
8,960	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Min Tc = 6min**

Summary for Subcatchment R2: ROOFS

Runoff = 1.4 cfs @ 12.13 hrs, Volume= 5,390 cf, Depth= 4.59"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

Area (sf)	CN	Description
6,414	98	Roofs, HSG A
7,666	98	Roofs, HSG B
14,080		Weighted Average
14,080	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Min Tc = 6 Min**

Summary for Subcatchment R3: Roofs

Runoff = 0.3 cfs @ 12.13 hrs, Volume= 980 cf, Depth= 4.59"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

Area (sf)	CN	Description
2,560	98	Roofs, HSG A
2,560	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Min Tc = 6 Min**

Summary for Reach DP1: Ipswich River

Inflow Area = 187,464 sf, 32.04% Impervious, Inflow Depth > 0.64" for 10-Year event
Inflow = 1.0 cfs @ 12.19 hrs, Volume= 9,936 cf
Outflow = 1.0 cfs @ 12.19 hrs, Volume= 9,936 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3

Summary for Reach DP2: Outlet from tributary wetland

Inflow Area = 209,363 sf, 13.58% Impervious, Inflow Depth > 1.25" for 10-Year event
Inflow = 0.7 cfs @ 12.14 hrs, Volume= 21,867 cf
Outflow = 0.7 cfs @ 12.14 hrs, Volume= 21,867 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3

Summary for Reach DP3: Perkins Row

Inflow Area = 10,881 sf, 4.86% Impervious, Inflow Depth = 1.13" for 10-Year event
Inflow = 0.2 cfs @ 12.28 hrs, Volume= 1,029 cf
Outflow = 0.2 cfs @ 12.28 hrs, Volume= 1,029 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3

Summary for Pond D1: Detention System 1

Inflow Area = 48,339 sf, 63.53% Impervious, Inflow Depth = 1.67" for 10-Year event
Inflow = 1.8 cfs @ 12.13 hrs, Volume= 6,730 cf
Outflow = 0.6 cfs @ 12.29 hrs, Volume= 6,724 cf, Atten= 66%, Lag= 9.7 min
Primary = 0.6 cfs @ 12.29 hrs, Volume= 6,724 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 43.53' @ 12.29 hrs Surf.Area= 684 sf Storage= 1,734 cf

Plug-Flow detention time= 74.3 min calculated for 6,722 cf (100% of inflow)
Center-of-Mass det. time= 73.8 min (858.9 - 785.1)

Volume	Invert	Avail.Storage	Storage Description
#1	41.00'	3,420 cf	**7.33'W x 13.33'L x 5.00'H Chambers** x 7
#2	46.00'	0 cf	**7.33'W x 13.33'L x 0.67'H Prismatoid** x 7 458 cf Overall x 0.0% Voids
		3,420 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	41.00'	**12.0" Round Culvert** L= 10.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 41.00' / 40.80' S= 0.0200 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf
#2	Device 1	41.00'	**2.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	42.00'	**3.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Device 1	43.00'	**3.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#5	Device 1	44.00'	**3.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#6	Device 1	45.00'	**3.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#7	Device 1	45.80'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Primary OutFlow Max=0.6 cfs @ 12.29 hrs HW=43.53' TW=0.00' (Dynamic Tailwater)
- **1=Culvert** (Passes 0.6 cfs of 4.3 cfs potential flow)
  - **2=Orifice/Grate** (Orifice Controls 0.2 cfs @ 7.54 fps)
  - **3=Orifice/Grate** (Orifice Controls 0.3 cfs @ 5.72 fps)
  - **4=Orifice/Grate** (Orifice Controls 0.2 cfs @ 3.08 fps)
  - **5=Orifice/Grate** (Controls 0.0 cfs)
  - **6=Orifice/Grate** (Controls 0.0 cfs)
  - **7=Broad-Crested Rectangular Weir** (Controls 0.0 cfs)

Summary for Pond PW: Pocket Wetland

Inflow Area =	18,405 sf,	86.50% Impervious,	Inflow Depth =	4.14"	for 10-Year event
Inflow =	1.7 cfs @	12.13 hrs, Volume=	6,357 cf		
Outflow =	0.4 cfs @	12.35 hrs, Volume=	6,347 cf,	Atten= 74%,	Lag= 13.5 min
Primary =	0.4 cfs @	12.35 hrs, Volume=	6,347 cf		
Secondary =	0.0 cfs @	0.00 hrs, Volume=	0 cf		

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 51.60' @ 12.35 hrs Surf.Area= 1,710 sf Storage= 1,504 cf

Plug-Flow detention time= 53.7 min calculated for 6,347 cf (100% of inflow)
Center-of-Mass det. time= 52.7 min (810.5 - 757.8)

Volume	Invert	Avail.Storage	Storage Description
#1	50.50'	4,466 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
50.50	1,061	0	0
51.00	1,326	597	597
52.00	1,969	1,648	2,244
52.50	2,218	1,047	3,291
53.00	2,481	1,175	4,466

Device	Routing	Invert	Outlet Devices
#1	Primary	49.00'	**12.0" Round Culvert** L= 14.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 49.00' / 48.93' S= 0.0050 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf
#2	Device 1	50.50'	**4.0" Vert. Orifice** C= 0.600 Limited to weir flow at low heads
#3	Device 1	51.50'	**4.0" Vert. Orifice** C= 0.600 Limited to weir flow at low heads
#4	Device 1	52.30'	**12.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#5	Secondary	52.50'	**8.0' long x 6.0' breadth Stone Spillway 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) 2.37 2.51 2.70 2.68 2.68 2.67 2.65 2.65 2.65 2.65 2.66 2.66 2.67 2.69 2.72 2.76 2.83

Primary OutFlow Max=0.4 cfs @ 12.35 hrs HW=51.60' TW=0.00' (Dynamic Tailwater)
- **1=Culvert** (Passes 0.4 cfs of 4.3 cfs potential flow)
  - **2=Orifice** (Orifice Controls 0.4 cfs @ 4.65 fps)
  - **3=Orifice** (Orifice Controls 0.0 cfs @ 1.06 fps)
  - **4=Orifice/Grate** (Controls 0.0 cfs)

Secondary OutFlow Max=0.0 cfs @ 0.00 hrs HW=50.50' TW=47.80' (Dynamic Tailwater)
- **5=Stone Spillway Weir** (Controls 0.0 cfs)

Summary for Pond RS1: Recharge System 1

Inflow Area =	17,896 sf,	81.61% Impervious,	Inflow Depth =	3.87"	for 10-Year event
Inflow =	1.5 cfs @	12.13 hrs, Volume=	5,774 cf		
Outflow =	0.2 cfs @	12.88 hrs, Volume=	5,774 cf,	Atten= 89%,	Lag= 44.9 min
Discarded =	0.2 cfs @	12.88 hrs, Volume=	5,774 cf		
Primary =	0.0 cfs @	0.00 hrs, Volume=	0 cf		

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 54.93' @ 12.88 hrs Surf.Area= 1,764 sf Storage= 1,630 cf

Plug-Flow detention time= 67.0 min calculated for 5,774 cf (100% of inflow)
Center-of-Mass det. time= 67.0 min (824.0 - 757.0)

Volume	Invert	Avail.Storage	Storage Description
#1	53.50'	353 cf	**Stone Bed (Prismatic)**Listed below (Recalc) 882 cf Overall x 40.0% Voids
#2	54.00'	4,104 cf	**7.33'W x 13.33'L x 3.00'H Chambers**x 14 -Impervious
#3	57.00'	0 cf	**7.33'W x 13.33'L x 0.67'H Prismatoid**x 14 917 cf Overall x 0.0% Voids
		4,457 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
53.50	1,764	0	0
54.00	1,764	882	882

Device	Routing	Invert	Outlet Devices
#1	Primary	54.00'	**12.0" Round Culvert** L= 40.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 54.00' / 53.90' S= 0.0025 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf
#2	Device 1	55.20'	**2.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	56.40'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#4	Discarded	53.50'	**2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 51.50' Phase-In= 0.01'

Discarded OutFlow Max=0.2 cfs @ 12.88 hrs HW=54.93' (Free Discharge)
└**4=Exfiltration** (Controls 0.2 cfs)

Primary OutFlow Max=0.0 cfs @ 0.00 hrs HW=53.50' TW=49.50' (Dynamic Tailwater)
└**1=Culvert** (Controls 0.0 cfs)
  └**2=Orifice/Grate** (Controls 0.0 cfs)
  └**3=Broad-Crested Rectangular Weir** (Controls 0.0 cfs)

Summary for Pond RS2: Recharge System 2

Inflow Area = 52,549 sf, 55.86% Impervious, Inflow Depth = 1.67" for 10-Year event
Inflow = 1.9 cfs @ 12.13 hrs, Volume= 7,293 cf
Outflow = 0.3 cfs @ 12.58 hrs, Volume= 7,293 cf, Atten= 83%, Lag= 26.8 min
Discarded = 0.2 cfs @ 12.58 hrs, Volume= 6,277 cf
Primary = 0.2 cfs @ 12.58 hrs, Volume= 1,017 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 51.82' @ 12.58 hrs Surf.Area= 1,296 sf Storage= 2,041 cf

Plug-Flow detention time= 85.1 min calculated for 7,293 cf (100% of inflow)
Center-of-Mass det. time= 85.1 min (873.9 - 788.9)

Volume	Invert	Avail.Storage	Storage Description
#1	49.50'	259 cf	**Stone Bed (Prismatic)**Listed below (Recalc) 648 cf Overall x 40.0% Voids
#2	50.00'	3,908 cf	**7.33'W x 13.33'L x 4.00'H Chambers**x 10 -Impervious
#3	54.00'	0 cf	**7.33'W x 13.33'L x 0.67'H Prismatoid**x 10 655 cf Overall x 0.0% Voids
		4,168 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
49.50	1,296	0	0
50.00	1,296	648	648

Device	Routing	Invert	Outlet Devices
#1	Primary	50.00'	**12.0" Round Culvert** L= 2.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 50.00' / 49.90' S= 0.0500 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf
#2	Device 1	51.10'	**2.0" Vert. Orifice/Grate X 2.00** C= 0.600 Limited to weir flow at low heads
#3	Device 1	52.10'	**3.0" Vert. Orifice/Grate X 2.00** C= 0.600 Limited to weir flow at low heads
#4	Device 1	52.50'	**4.0" Vert. Orifice/Grate X 2.00** C= 0.600 Limited to weir flow at low heads
#5	Device 1	53.80'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#6	Discarded	49.50'	**2.410 in/hr Exfiltration over Surface area**

Conductivity to Groundwater Elevation = 47.50' Phase-In= 0.01'

Discarded OutFlow Max=0.2 cfs @ 12.58 hrs HW=51.82' (Free Discharge)
└**6=Exfiltration** (Controls 0.2 cfs)

Primary OutFlow Max=0.2 cfs @ 12.58 hrs HW=51.82' TW=0.00' (Dynamic Tailwater)
└**1=Culvert** (Passes 0.2 cfs of 3.4 cfs potential flow)
  ├**2=Orifice/Grate** (Orifice Controls 0.2 cfs @ 3.85 fps)
  ├**3=Orifice/Grate** (Controls 0.0 cfs)
  ├**4=Orifice/Grate** (Controls 0.0 cfs)
  └**5=Broad-Crested Rectangular Weir**(Controls 0.0 cfs)

Summary for Pond RS3: Recharge System 3

Inflow Area = 14,080 sf,100.00% Impervious, Inflow Depth = 4.59" for 10-Year event
Inflow = 1.4 cfs @ 12.13 hrs, Volume= 5,390 cf
Outflow = 0.1 cfs @ 12.95 hrs, Volume= 5,390 cf, Atten= 90%, Lag= 49.6 min
Discarded = 0.1 cfs @ 12.95 hrs, Volume= 5,390 cf
Primary = 0.0 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 52.38' @ 12.95 hrs Surf.Area= 1,200 sf Storage= 1,706 cf

Plug-Flow detention time= 92.7 min calculated for 5,388 cf (100% of inflow)
Center-of-Mass det. time= 92.7 min (843.9 - 751.2)

Volume	Invert	Avail.Storage	Storage Description
#1	50.00'	240 cf	**Stone Bed (Prismatic)**Listed below (Recalc) 600 cf Overall x 40.0% Voids
#2	50.50'	3,127 cf	**7.33'W x 13.33'L x 4.00'H Chambers**x 8 -Impervious
#3	54.50'	0 cf	**7.33'W x 13.33'L x 0.67'H Prismatoid**x 8 524 cf Overall x 0.0% Voids
		3,367 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
50.00	1,200	0	0
50.50	1,200	600	600

Device	Routing	Invert	Outlet Devices
#1	Primary	53.50'	**6.0" Round Culvert** L= 35.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 53.50' / 53.30' S= 0.0057 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.20 sf
#2	Device 1	54.40'	**6.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Discarded	50.00'	**2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 48.00' Phase-In= 0.01'

Discarded OutFlow Max=0.1 cfs @ 12.95 hrs HW=52.38' (Free Discharge)
└**3=Exfiltration** (Controls 0.1 cfs)

Primary OutFlow Max=0.0 cfs @ 0.00 hrs HW=50.00' TW=41.00' (Dynamic Tailwater)
└**1=Culvert** (Controls 0.0 cfs)
└**2=Orifice/Grate** (Controls 0.0 cfs)

Summary for Pond RS4: Recharge System 4

Inflow Area = 2,560 sf,100.00% Impervious, Inflow Depth = 4.59" for 10-Year event
Inflow = 0.3 cfs @ 12.13 hrs, Volume= 980 cf
Outflow = 0.0 cfs @ 12.79 hrs, Volume= 980 cf, Atten= 88%, Lag= 39.8 min
Discarded = 0.0 cfs @ 12.79 hrs, Volume= 980 cf
Primary = 0.0 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 51.60' @ 12.79 hrs Surf.Area= 300 sf Storage= 276 cf

Plug-Flow detention time= 63.5 min calculated for 980 cf (100% of inflow)
Center-of-Mass det. time= 63.5 min (814.6 - 751.2)

Volume	Invert	Avail.Storage	Storage Description
#1	50.00'	60 cf	**Stone Bed (Prismatic)**Listed below (Recalc) 150 cf Overall x 40.0% Voids
#2	50.50'	586 cf	**7.33'W x 13.33'L x 3.00'H Chambers**x 2 -Impervious
#3	53.50'	0 cf	**7.33'W x 13.33'L x 0.67'H Prismatoid**x 2 131 cf Overall x 0.0% Voids
		646 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
50.00	300	0	0
50.50	300	150	150

Device	Routing	Invert	Outlet Devices
#1	Primary	53.00'	**6.0" Round Culvert** L= 4.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 53.00' / 52.90' S= 0.0250 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.20 sf
#2	Discarded	50.00'	**2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 48.00' Phase-In= 0.01'

Discarded OutFlow Max=0.0 cfs @ 12.79 hrs HW=51.60' (Free Discharge)
└**2=Exfiltration** (Controls 0.0 cfs)

Primary OutFlow Max=0.0 cfs @ 0.00 hrs HW=50.00' TW=41.00' (Dynamic Tailwater)
└**1=Culvert** (Controls 0.0 cfs)

Summary for Pond S1: Existing Bordering Vegetated Wetland

Inflow Area = 181,730 sf, 6.53% Impervious, Inflow Depth = 1.21" for 10-Year event
Inflow = 4.9 cfs @ 12.14 hrs, Volume= 18,258 cf
Outflow = 0.3 cfs @ 14.73 hrs, Volume= 14,464 cf, Atten= 93%, Lag= 155.3 min
Primary = 0.3 cfs @ 14.73 hrs, Volume= 14,464 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 48.66' @ 14.73 hrs Surf.Area= 11,958 sf Storage= 9,365 cf

Plug-Flow detention time= 454.4 min calculated for 14,460 cf (79% of inflow)
Center-of-Mass det. time= 356.2 min (1,220.5 - 864.3)

Volume	Invert	Avail.Storage	Storage Description
#1	47.80'	65,726 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
47.80	9,945	0	0
50.00	15,123	27,575	27,575
52.00	23,028	38,151	65,726

Device	Routing	Invert	Outlet Devices
#1	Primary	47.80'	**120.0" W x 50.0" H Box BoxCulvert** L= 35.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 47.80' / 46.60' S= 0.0343 '/' Cc= 0.900 n= 0.040 Earth, cobble bottom, clean sides, Flow Area= 41.67 sf
#2	Device 1	47.80'	**20.0 deg x 2.00' rise Sharp-Crested Vee/Trap Weir** Cv= 2.69 (C= 3.36)
#3	Device 1	49.80'	**10.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Primary OutFlow Max=0.3 cfs @ 14.73 hrs HW=48.66' TW=0.00' (Dynamic Tailwater)
└─**1=BoxCulvert** (Passes 0.3 cfs of 25.4 cfs potential flow)
  ├─**2=Sharp-Crested Vee/Trap Weir** (Weir Controls 0.3 cfs @ 2.49 fps)
  └─**3=Broad-Crested Rectangular Weir** (Controls 0.0 cfs)

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-Q
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment P1: Tributary to Perkins Row Runoff Area=10,881 sf 4.86% Impervious Runoff Depth=3.81"
Flow Length=173' Slope=0.0100 '/' Tc=17.8 min CN=WQ Runoff=0.7 cfs 3,459 cf

Subcatchment P2A: Tributary to BVW Runoff Area=181,730 sf 6.53% Impervious Runoff Depth=3.64"
Flow Length=265' Tc=6.5 min CN=WQ Runoff=15.4 cfs 55,082 cf

Subcatchment P2B: Tributary to BVW Runoff Area=18,405 sf 86.50% Impervious Runoff Depth=8.09"
Tc=6.0 min CN=WQ Runoff=3.2 cfs 12,407 cf

Subcatchment P3: P3 Runoff Area=9,228 sf 6.95% Impervious Runoff Depth=3.81"
Flow Length=168' Tc=5.6 min CN=WQ Runoff=0.8 cfs 2,933 cf

Subcatchment P4: Tributary to Ipswich Runoff Area=86,576 sf 0.00% Impervious Runoff Depth=1.74"
Flow Length=311' Tc=7.3 min CN=WQ Runoff=2.9 cfs 12,538 cf

Subcatchment P5: P5 Runoff Area=21,566 sf 32.56% Impervious Runoff Depth=4.98"
Flow Length=231' Tc=6.0 min CN=WQ Runoff=2.4 cfs 8,947 cf

Subcatchment P6: P6 Runoff Area=10,133 sf 69.55% Impervious Runoff Depth=7.30"
Flow Length=144' Slope=0.0800 '/' Tc=6.0 min CN=WQ Runoff=1.6 cfs 6,163 cf

Subcatchment P7: P7 Runoff Area=34,653 sf 42.56% Impervious Runoff Depth=5.73"
Flow Length=375' Tc=6.0 min CN=WQ Runoff=4.5 cfs 16,542 cf

Subcatchment P8: P8 Runoff Area=8,936 sf 63.17% Impervious Runoff Depth=6.51"
Tc=6.0 min CN=WQ Runoff=1.3 cfs 4,849 cf

Subcatchment R1: ROOFS Runoff Area=8,960 sf 100.00% Impervious Runoff Depth=8.70"
Tc=6.0 min CN=WQ Runoff=1.7 cfs 6,496 cf

Subcatchment R2: ROOFS Runoff Area=14,080 sf 100.00% Impervious Runoff Depth=8.70"
Tc=6.0 min CN=WQ Runoff=2.6 cfs 10,208 cf

Subcatchment R3: Roofs Runoff Area=2,560 sf 100.00% Impervious Runoff Depth=8.70"
Tc=6.0 min CN=98 Runoff=0.5 cfs 1,856 cf

Reach DP1: Ipswich River Inflow=6.5 cfs 36,123 cf
Outflow=6.5 cfs 36,123 cf

Reach DP2: Outlet from tributary wetland Inflow=3.2 cfs 66,068 cf
Outflow=3.2 cfs 66,068 cf

Reach DP3: Perkins Row Inflow=0.7 cfs 3,459 cf
Outflow=0.7 cfs 3,459 cf

Pond D1: Detention System 1 Peak Elev=45.93' Storage=3,372 cf Inflow=4.1 cfs 15,726 cf
Outflow=2.1 cfs 15,719 cf

Pond PW: Pocket Wetland Peak Elev=52.34' Storage=2,945 cf Inflow=3.2 cfs 12,407 cf
Primary=1.0 cfs 12,397 cf Secondary=0.0 cfs 0 cf Outflow=1.0 cfs 12,397 cf

Pond RS1: Recharge System 1 Peak Elev=56.42' Storage=3,670 cf Inflow=2.9 cfs 11,345 cf
Discarded=0.2 cfs 10,134 cf Primary=0.2 cfs 1,211 cf Outflow=0.4 cfs 11,345 cf

Pond RS2: Recharge System 2 Peak Elev=53.88' Storage=4,049 cf Inflow=4.6 cfs 17,753 cf
Discarded=0.2 cfs 9,887 cf Primary=2.1 cfs 7,866 cf Outflow=2.4 cfs 17,753 cf

Pond RS3: Recharge System 3 Peak Elev=54.76' Storage=3,367 cf Inflow=2.6 cfs 10,208 cf
Discarded=0.3 cfs 9,679 cf Primary=0.6 cfs 528 cf Outflow=0.9 cfs 10,208 cf

Pond RS4: Recharge System 4 Peak Elev=53.15' Storage=578 cf Inflow=0.5 cfs 1,856 cf
Discarded=0.0 cfs 1,768 cf Primary=0.1 cfs 88 cf Outflow=0.1 cfs 1,856 cf

Pond S1: Existing Bordering Vegetated Peak Elev=49.67' Storage=22,710 cf Inflow=15.4 cfs 55,082 cf
Outflow=2.3 cfs 50,738 cf

Summary for Subcatchment P1: Tributary to Perkins Row

Runoff = 0.7 cfs @ 12.27 hrs, Volume= 3,459 cf, Depth= 3.81"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 100-Year Rainfall=8.94"

Area (sf)	CN	Description
529	98	Pavement, HSG B
8,654	55	Woods, Good, HSG B
1,698	61	>75% Grass cover, Good, HSG B
10,881		Weighted Average
10,352	56	95.14% Pervious Area
529	98	4.86% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.5	50	0.0100	0.05		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
1.3	123	0.0100	1.61		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
17.8	173	Total			

Summary for Subcatchment P2A: Tributary to BVW

Runoff = 15.4 cfs @ 12.14 hrs, Volume= 55,082 cf, Depth= 3.64"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 100-Year Rainfall=8.94"

	Area (sf)	CN	Description
	5,851	30	Woods, Good, HSG A
	14,652	55	Woods, Good, HSG B
	14,317	77	Woods, Good, HSG D
	3,568	39	>75% Grass cover, Good, HSG A
	16,932	61	>75% Grass cover, Good, HSG B
	1,236	80	>75% Grass cover, Good, HSG D
	9,512	98	Water Surface, HSG D
*	31,995	30	Woods(OFFSITE), Good, HSG A
*	70,262	55	Woods(OFFSITE), Good, HSG B
*	11,051	77	Woods(OFFSITE), Good, HSG D
*	2,354	98	Water Surface(OFFSITE), HSG D
	181,730		Weighted Average
	169,864	53	93.47% Pervious Area
	11,866	98	6.53% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.7	50	0.0200	0.15		**Sheet Flow, Sheet Flow** Grass: Short n= 0.150 P2= 3.10"
0.4	87	0.0460	3.45		**Shallow Concentrated Flow, Grass** Unpaved Kv= 16.1 fps
0.4	128	0.0900	4.83		**Shallow Concentrated Flow, Woods** Unpaved Kv= 16.1 fps
6.5	265	Total			

Summary for Subcatchment P2B: Tributary to BVW

Runoff = 3.2 cfs @ 12.13 hrs, Volume= 12,407 cf, Depth= 8.09"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 100-Year Rainfall=8.94"

	Area (sf)	CN	Description
*	3,470	98	Pavement, HSG A
*	8,089	98	Pavement, HSG B
*	4,362	98	Pavement, HSG D
	2,484	61	>75% Grass cover, Good, HSG B
	18,405		Weighted Average
	2,484	61	13.50% Pervious Area
	15,921	98	86.50% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Tc Min = 6 Min**

Summary for Subcatchment P3: P3

Runoff = 0.8 cfs @ 12.13 hrs, Volume= 2,933 cf, Depth= 3.81"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 100-Year Rainfall=8.94"

	Area (sf)	CN	Description
*	63	98	Wall, HSG B
*	578	98	Wall, HSG D
	59	55	Woods, Good, HSG B
	1,351	77	Woods, Good, HSG D
	5,188	39	>75% Grass cover, Good, HSG A
	1,989	80	>75% Grass cover, Good, HSG D
	9,228		Weighted Average
	8,587	55	93.05% Pervious Area
	641	98	6.95% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.7	50	0.0600	0.23		**Sheet Flow, Sheet Flow** Grass: Short n= 0.150 P2= 3.10"
0.3	72	0.0500	3.60		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.2	46	0.0600	3.94		**Shallow Concentrated Flow, Woods** Unpaved Kv= 16.1 fps
1.4					**Direct Entry, Min Tc = 6min**
5.6	168	Total			

Summary for Subcatchment P4: Tributary to Ipswich River

Runoff = 2.9 cfs @ 12.15 hrs, Volume= 12,538 cf, Depth= 1.74"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 100-Year Rainfall=8.94"

Area (sf)	CN	Description
29,843	30	Woods, Good, HSG A
11,033	55	Woods, Good, HSG B
37,723	39	>75% Grass cover, Good, HSG A
7,977	61	>75% Grass cover, Good, HSG B
86,576		Weighted Average
86,576	40	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.2	50	0.0165	0.13		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.10"
0.5	61	0.0170	2.10		**Shallow Concentrated Flow, Grass** Unpaved Kv= 16.1 fps
0.6	200	0.1100	5.34		**Shallow Concentrated Flow, Woods** Unpaved Kv= 16.1 fps
7.3	311	Total			

Summary for Subcatchment P5: P5

Runoff = 2.4 cfs @ 12.13 hrs, Volume= 8,947 cf, Depth= 4.98"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 100-Year Rainfall=8.94"

	Area (sf)	CN	Description
	5,561	39	>75% Grass cover, Good, HSG A
	8,983	61	>75% Grass cover, Good, HSG B
*	7,022	98	Paved, HSG A
	21,566		Weighted Average
	14,544	53	67.44% Pervious Area
	7,022	98	32.56% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.0	50	0.1000	0.28		**Sheet Flow, Grass** Grass: Short n= 0.150 P2= 3.10"
0.2	75	0.1000	5.09		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.5	106	0.0280	3.40		**Shallow Concentrated Flow, Paved** Paved Kv= 20.3 fps
2.3					**Direct Entry, Min Tc = 6 min**
6.0	231	Total			

Summary for Subcatchment P6: P6

Runoff = 1.6 cfs @ 12.13 hrs, Volume= 6,163 cf, Depth= 7.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 100-Year Rainfall=8.94"

	Area (sf)	CN	Description
	93	39	>75% Grass cover, Good, HSG A
	2,992	61	>75% Grass cover, Good, HSG B
*	924	98	Pavement, HSG A
*	6,124	98	Pavement, HSG B
	10,133		Weighted Average
	3,085	60	30.45% Pervious Area
	7,048	98	69.55% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	22	0.0800	0.22		**Sheet Flow, Grass** Grass: Short n= 0.150 P2= 3.10"
0.4	122	0.0800	5.74		**Shallow Concentrated Flow, Pavement** Paved Kv= 20.3 fps
3.9					**Direct Entry, Min Tc = 6 Min**
6.0	144	Total			

Summary for Subcatchment P7: P7

Runoff = 4.5 cfs @ 12.13 hrs, Volume= 16,542 cf, Depth= 5.73"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 100-Year Rainfall=8.94"

	Area (sf)	CN	Description
	4,970	39	>75% Grass cover, Good, HSG A
	14,933	61	>75% Grass cover, Good, HSG B
*	7,550	98	Pavement, HSG A
*	7,200	98	Pavement, HSG B
	34,653		Weighted Average
	19,903	56	57.44% Pervious Area
	14,750	98	42.56% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.3	50	0.0820	0.26		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.10"
1.1	325	0.0969	5.01		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
1.6					**Direct Entry, Adjust to Minimum 0.1 Hours**
6.0	375	Total			

Summary for Subcatchment P8: P8

Runoff = 1.3 cfs @ 12.13 hrs, Volume= 4,849 cf, Depth= 6.51"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 100-Year Rainfall=8.94"

	Area (sf)	CN	Description
	1,792	39	>75% Grass cover, Good, HSG A
	1,499	61	>75% Grass cover, Good, HSG B
*	3,276	98	Pavement, HSG A
*	2,369	98	Pavement, HSG B
	8,936		Weighted Average
	3,291	49	36.83% Pervious Area
	5,645	98	63.17% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Min Tc = 6 Min**

Summary for Subcatchment R1: ROOFS

Runoff = 1.7 cfs @ 12.13 hrs, Volume= 6,496 cf, Depth= 8.70"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 100-Year Rainfall=8.94"

Area (sf)	CN	Description
8,115	98	Roofs, HSG A
702	98	Roofs, HSG D
143	98	Roofs, HSG B
8,960		Weighted Average
8,960	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Min Tc = 6min**

Summary for Subcatchment R2: ROOFS

Runoff = 2.6 cfs @ 12.13 hrs, Volume= 10,208 cf, Depth= 8.70"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 100-Year Rainfall=8.94"

Area (sf)	CN	Description
6,414	98	Roofs, HSG A
7,666	98	Roofs, HSG B
14,080		Weighted Average
14,080	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Min Tc = 6 Min**

Summary for Subcatchment R3: Roofs

Runoff = 0.5 cfs @ 12.13 hrs, Volume= 1,856 cf, Depth= 8.70"

Runoff by SCS TR-20 method, UH=SCS, Weighted-Q, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NRCC 24-hr D 100-Year Rainfall=8.94"

Area (sf)	CN	Description
2,560	98	Roofs, HSG A
2,560	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Min Tc = 6 Min**

Summary for Reach DP1: Ipswich River

Inflow Area = 187,464 sf, 32.04% Impervious, Inflow Depth = 2.31" for 100-Year event
Inflow = 6.5 cfs @ 12.21 hrs, Volume= 36,123 cf
Outflow = 6.5 cfs @ 12.21 hrs, Volume= 36,123 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3

Summary for Reach DP2: Outlet from tributary wetland

Inflow Area = 209,363 sf, 13.58% Impervious, Inflow Depth > 3.79" for 100-Year event
Inflow = 3.2 cfs @ 12.55 hrs, Volume= 66,068 cf
Outflow = 3.2 cfs @ 12.55 hrs, Volume= 66,068 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3

Summary for Reach DP3: Perkins Row

Inflow Area = 10,881 sf, 4.86% Impervious, Inflow Depth = 3.81" for 100-Year event
Inflow = 0.7 cfs @ 12.27 hrs, Volume= 3,459 cf
Outflow = 0.7 cfs @ 12.27 hrs, Volume= 3,459 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3

Summary for Pond D1: Detention System 1

Inflow Area = 48,339 sf, 63.53% Impervious, Inflow Depth = 3.90" for 100-Year event
Inflow = 4.1 cfs @ 12.13 hrs, Volume= 15,726 cf
Outflow = 2.1 cfs @ 12.22 hrs, Volume= 15,719 cf, Atten= 48%, Lag= 5.4 min
Primary = 2.1 cfs @ 12.22 hrs, Volume= 15,719 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 45.93' @ 12.22 hrs Surf.Area= 684 sf Storage= 3,372 cf

Plug-Flow detention time= 64.3 min calculated for 15,714 cf (100% of inflow)
Center-of-Mass det. time= 64.1 min (848.1 - 783.9)

Volume	Invert	Avail.Storage	Storage Description
#1	41.00'	3,420 cf	**7.33'W x 13.33'L x 5.00'H Chambers** x 7
#2	46.00'	0 cf	**7.33'W x 13.33'L x 0.67'H Prismatoid** x 7 458 cf Overall x 0.0% Voids
		3,420 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	41.00'	**12.0" Round Culvert** L= 10.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 41.00' / 40.80' S= 0.0200 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf
#2	Device 1	41.00'	**2.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	42.00'	**3.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Device 1	43.00'	**3.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#5	Device 1	44.00'	**3.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#6	Device 1	45.00'	**3.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#7	Device 1	45.80'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Primary OutFlow Max=2.1 cfs @ 12.22 hrs HW=45.93' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Passes 2.1 cfs of 6.3 cfs potential flow)
  ├─**2=Orifice/Grate** (Orifice Controls 0.2 cfs @ 10.60 fps)
  ├─**3=Orifice/Grate** (Orifice Controls 0.5 cfs @ 9.39 fps)
  ├─**4=Orifice/Grate** (Orifice Controls 0.4 cfs @ 8.06 fps)
  ├─**5=Orifice/Grate** (Orifice Controls 0.3 cfs @ 6.47 fps)
  ├─**6=Orifice/Grate** (Orifice Controls 0.2 cfs @ 4.32 fps)
  └─**7=Broad-Crested Rectangular Weir** (Weir Controls 0.5 cfs @ 1.01 fps)

Summary for Pond PW: Pocket Wetland

Inflow Area = 18,405 sf, 86.50% Impervious, Inflow Depth = 8.09" for 100-Year event
Inflow = 3.2 cfs @ 12.13 hrs, Volume= 12,407 cf
Outflow = 1.0 cfs @ 12.31 hrs, Volume= 12,397 cf, Atten= 70%, Lag= 10.8 min
Primary = 1.0 cfs @ 12.31 hrs, Volume= 12,397 cf
Secondary = 0.0 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 52.34' @ 12.31 hrs Surf.Area= 2,139 sf Storage= 2,945 cf

Plug-Flow detention time= 49.1 min calculated for 12,393 cf (100% of inflow)
Center-of-Mass det. time= 48.7 min (798.5 - 749.8)

Volume	Invert	Avail.Storage	Storage Description
#1	50.50'	4,466 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
50.50	1,061	0	0
51.00	1,326	597	597
52.00	1,969	1,648	2,244
52.50	2,218	1,047	3,291
53.00	2,481	1,175	4,466

Device	Routing	Invert	Outlet Devices
#1	Primary	49.00'	**12.0" Round Culvert** L= 14.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 49.00' / 48.93' S= 0.0050 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf
#2	Device 1	50.50'	**4.0" Vert. Orifice** C= 0.600 Limited to weir flow at low heads
#3	Device 1	51.50'	**4.0" Vert. Orifice** C= 0.600 Limited to weir flow at low heads
#4	Device 1	52.30'	**12.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#5	Secondary	52.50'	**8.0' long x 6.0' breadth Stone Spillway 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) 2.37 2.51 2.70 2.68 2.68 2.67 2.65 2.65 2.65 2.65 2.66 2.66 2.67 2.69 2.72 2.76 2.83

Primary OutFlow Max=1.0 cfs @ 12.31 hrs HW=52.34' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Passes 1.0 cfs of 5.0 cfs potential flow)
  ├─**2=Orifice** (Orifice Controls 0.5 cfs @ 6.23 fps)
  ├─**3=Orifice** (Orifice Controls 0.3 cfs @ 3.95 fps)
  └─**4=Orifice/Grate** (Weir Controls 0.1 cfs @ 0.66 fps)

Secondary OutFlow Max=0.0 cfs @ 0.00 hrs HW=50.50' TW=47.80' (Dynamic Tailwater)
└─**5=Stone Spillway Weir** (Controls 0.0 cfs)

Summary for Pond RS1: Recharge System 1

Inflow Area =	17,896 sf,	81.61% Impervious,	Inflow Depth =	7.61" for 100-Year event
Inflow =	2.9 cfs @	12.13 hrs, Volume=	11,345 cf	
Outflow =	0.4 cfs @	12.65 hrs, Volume=	11,345 cf,	Atten= 86%, Lag= 31.5 min
Discarded =	0.2 cfs @	12.65 hrs, Volume=	10,134 cf	
Primary =	0.2 cfs @	12.65 hrs, Volume=	1,211 cf	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 56.42' @ 12.65 hrs Surf.Area= 1,764 sf Storage= 3,670 cf

Plug-Flow detention time= 108.1 min calculated for 11,342 cf (100% of inflow)
Center-of-Mass det. time= 108.1 min (859.1 - 751.0)

Volume	Invert	Avail.Storage	Storage Description
#1	53.50'	353 cf	**Stone Bed (Prismatic)**Listed below (Recalc) 882 cf Overall x 40.0% Voids
#2	54.00'	4,104 cf	**7.33'W x 13.33'L x 3.00'H Chambers**x 14 -Impervious
#3	57.00'	0 cf	**7.33'W x 13.33'L x 0.67'H Prismatoid**x 14 917 cf Overall x 0.0% Voids
		4,457 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
53.50	1,764	0	0
54.00	1,764	882	882

Device	Routing	Invert	Outlet Devices
#1	Primary	54.00'	**12.0" Round Culvert** L= 40.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 54.00' / 53.90' S= 0.0025 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf
#2	Device 1	55.20'	**2.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	56.40'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#4	Discarded	53.50'	**2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 51.50' Phase-In= 0.01'

Discarded OutFlow Max=0.2 cfs @ 12.65 hrs HW=56.42' (Free Discharge)
└**4=Exfiltration** (Controls 0.2 cfs)

Primary OutFlow Max=0.2 cfs @ 12.65 hrs HW=56.42' TW=52.94' (Dynamic Tailwater)
└**1=Culvert** (Passes 0.2 cfs of 4.1 cfs potential flow)
  └**2=Orifice/Grate** (Orifice Controls 0.1 cfs @ 5.14 fps)
  └**3=Broad-Crested Rectangular Weir** (Weir Controls 0.0 cfs @ 0.44 fps)

Summary for Pond RS2: Recharge System 2

Inflow Area = 52,549 sf, 55.86% Impervious, Inflow Depth = 4.05" for 100-Year event
Inflow = 4.6 cfs @ 12.13 hrs, Volume= 17,753 cf
Outflow = 2.4 cfs @ 12.23 hrs, Volume= 17,753 cf, Atten= 48%, Lag= 5.7 min
Discarded = 0.2 cfs @ 12.23 hrs, Volume= 9,887 cf
Primary = 2.1 cfs @ 12.23 hrs, Volume= 7,866 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 53.88' @ 12.23 hrs Surf.Area= 1,296 sf Storage= 4,049 cf

Plug-Flow detention time= 79.7 min calculated for 17,748 cf (100% of inflow)
Center-of-Mass det. time= 79.7 min (870.0 - 790.3)

Volume	Invert	Avail.Storage	Storage Description
#1	49.50'	259 cf	**Stone Bed (Prismatic)**Listed below (Recalc) 648 cf Overall x 40.0% Voids
#2	50.00'	3,908 cf	**7.33'W x 13.33'L x 4.00'H Chambers**x 10 -Impervious
#3	54.00'	0 cf	**7.33'W x 13.33'L x 0.67'H Prismatoid**x 10 655 cf Overall x 0.0% Voids
		4,168 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
49.50	1,296	0	0
50.00	1,296	648	648

Device	Routing	Invert	Outlet Devices
#1	Primary	50.00'	**12.0" Round Culvert** L= 2.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 50.00' / 49.90' S= 0.0500 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf
#2	Device 1	51.10'	**2.0" Vert. Orifice/Grate X 2.00** C= 0.600 Limited to weir flow at low heads
#3	Device 1	52.10'	**3.0" Vert. Orifice/Grate X 2.00** C= 0.600 Limited to weir flow at low heads
#4	Device 1	52.50'	**4.0" Vert. Orifice/Grate X 2.00** C= 0.600 Limited to weir flow at low heads
#5	Device 1	53.80'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#6	Discarded	49.50'	**2.410 in/hr Exfiltration over Surface area**

Conductivity to Groundwater Elevation = 47.50' Phase-In= 0.01'

Discarded OutFlow Max=0.2 cfs @ 12.23 hrs HW=53.88' (Free Discharge)
└**6=Exfiltration** (Controls 0.2 cfs)

Primary OutFlow Max=2.1 cfs @ 12.23 hrs HW=53.88' TW=0.00' (Dynamic Tailwater)
└**1=Culvert** (Passes 2.1 cfs of 5.5 cfs potential flow)
  ├**2=Orifice/Grate** (Orifice Controls 0.3 cfs @ 7.90 fps)
  ├**3=Orifice/Grate** (Orifice Controls 0.6 cfs @ 6.19 fps)
  ├**4=Orifice/Grate** (Orifice Controls 0.9 cfs @ 5.30 fps)
  └**5=Broad-Crested Rectangular Weir** (Weir Controls 0.2 cfs @ 0.78 fps)

Summary for Pond RS3: Recharge System 3

Inflow Area =	14,080 sf,	100.00% Impervious,	Inflow Depth =	8.70"	for 100-Year event
Inflow =	2.6 cfs @	12.13 hrs, Volume=	10,208 cf		
Outflow =	0.9 cfs @	12.30 hrs, Volume=	10,208 cf,	Atten= 67%,	Lag= 10.5 min
Discarded =	0.3 cfs @	12.30 hrs, Volume=	9,679 cf		
Primary =	0.6 cfs @	12.30 hrs, Volume=	528 cf		

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 54.76' @ 12.30 hrs Surf.Area= 1,982 sf Storage= 3,367 cf

Plug-Flow detention time= 144.5 min calculated for 10,205 cf (100% of inflow)
Center-of-Mass det. time= 144.5 min (885.7 - 741.2)

Volume	Invert	Avail.Storage	Storage Description
#1	50.00'	240 cf	**Stone Bed (Prismatic)**Listed below (Recalc) 600 cf Overall x 40.0% Voids
#2	50.50'	3,127 cf	**7.33'W x 13.33'L x 4.00'H Chambers** x 8 -Impervious
#3	54.50'	0 cf	**7.33'W x 13.33'L x 0.67'H Prismatoid** x 8 524 cf Overall x 0.0% Voids
		3,367 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
50.00	1,200	0	0
50.50	1,200	600	600

Device	Routing	Invert	Outlet Devices
#1	Primary	53.50'	**6.0" Round Culvert** L= 35.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 53.50' / 53.30' S= 0.0057 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.20 sf
#2	Device 1	54.40'	**6.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Discarded	50.00'	**2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 48.00' Phase-In= 0.01'

Discarded OutFlow Max=0.3 cfs @ 12.30 hrs HW=54.72' (Free Discharge)
└**3=Exfiltration** (Controls 0.3 cfs)

Primary OutFlow Max=0.5 cfs @ 12.30 hrs HW=54.72' TW=45.86' (Dynamic Tailwater)
└**1=Culvert** (Passes 0.5 cfs of 0.7 cfs potential flow)
└**2=Orifice/Grate** (Orifice Controls 0.5 cfs @ 2.74 fps)

Summary for Pond RS4: Recharge System 4

Inflow Area = 2,560 sf,100.00% Impervious, Inflow Depth = 8.70" for 100-Year event
Inflow = 0.5 cfs @ 12.13 hrs, Volume= 1,856 cf
Outflow = 0.1 cfs @ 12.41 hrs, Volume= 1,856 cf, Atten= 80%, Lag= 17.0 min
Discarded = 0.0 cfs @ 12.41 hrs, Volume= 1,768 cf
Primary = 0.1 cfs @ 12.41 hrs, Volume= 88 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 53.15' @ 12.41 hrs Surf.Area= 300 sf Storage= 578 cf

Plug-Flow detention time= 109.7 min calculated for 1,855 cf (100% of inflow)
Center-of-Mass det. time= 109.7 min (850.9 - 741.2)

Volume	Invert	Avail.Storage	Storage Description
#1	50.00'	60 cf	**Stone Bed (Prismatic)**Listed below (Recalc) 150 cf Overall x 40.0% Voids
#2	50.50'	586 cf	**7.33'W x 13.33'L x 3.00'H Chambers**x 2 -Impervious
#3	53.50'	0 cf	**7.33'W x 13.33'L x 0.67'H Prismatoid**x 2 131 cf Overall x 0.0% Voids
		646 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
50.00	300	0	0
50.50	300	150	150

Device	Routing	Invert	Outlet Devices
#1	Primary	53.00'	**6.0" Round Culvert** L= 4.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 53.00' / 52.90' S= 0.0250 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.20 sf
#2	Discarded	50.00'	**2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 48.00' Phase-In= 0.01'

Discarded OutFlow Max=0.0 cfs @ 12.41 hrs HW=53.15' (Free Discharge)
└**2=Exfiltration** (Controls 0.0 cfs)

Primary OutFlow Max=0.1 cfs @ 12.41 hrs HW=53.15' TW=45.77' (Dynamic Tailwater)
└**1=Culvert** (Inlet Controls 0.1 cfs @ 1.05 fps)

Summary for Pond S1: Existing Bordering Vegetated Wetland

Inflow Area = 181,730 sf, 6.53% Impervious, Inflow Depth = 3.64" for 100-Year event
Inflow = 15.4 cfs @ 12.14 hrs, Volume= 55,082 cf
Outflow = 2.3 cfs @ 12.78 hrs, Volume= 50,738 cf, Atten= 85%, Lag= 38.3 min
Primary = 2.3 cfs @ 12.78 hrs, Volume= 50,738 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 49.67' @ 12.78 hrs Surf.Area= 14,346 sf Storage= 22,710 cf

Plug-Flow detention time= 258.0 min calculated for 50,738 cf (92% of inflow)
Center-of-Mass det. time= 215.0 min (1,063.9 - 848.9)

Volume	Invert	Avail.Storage	Storage Description
#1	47.80'	65,726 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
47.80	9,945	0	0
50.00	15,123	27,575	27,575
52.00	23,028	38,151	65,726

Device	Routing	Invert	Outlet Devices
#1	Primary	47.80'	**120.0" W x 50.0" H Box BoxCulvert** L= 35.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 47.80' / 46.60' S= 0.0343 '/' Cc= 0.900 n= 0.040 Earth, cobble bottom, clean sides, Flow Area= 41.67 sf
#2	Device 1	47.80'	**20.0 deg x 2.00' rise Sharp-Crested Vee/Trap Weir** Cv= 2.69 (C= 3.36)
#3	Device 1	49.80'	**10.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Primary OutFlow Max=2.3 cfs @ 12.78 hrs HW=49.67' TW=0.00' (Dynamic Tailwater)
└─**1=BoxCulvert** (Passes 2.3 cfs of 82.1 cfs potential flow)
  ├─**2=Sharp-Crested Vee/Trap Weir** (Weir Controls 2.3 cfs @ 3.68 fps)
  └─**3=Broad-Crested Rectangular Weir** (Controls 0.0 cfs)

APPENDIX D:

SUPPLEMENTAL STORMWATER MANAGEMENT CALCULATIONS

March 5, 2021

Stormwater Management Calculations

STANDARD 3: Recharge To Groundwater: Static Method

- Calculate Impervious Area *(From HydroCAD Model)*

  Existing Impervious Area HSG A Soil = 991 SF
  Existing Impervious Area HSG B Soil = 7,534 SF
  Existing Impervious Area HSG D Soil = 1,673 SF
  Proposed Impervious Area HSG A Soil = 31,784 SF
  Proposed Impervious Area HSG B Soil = 24,965 SF
  Proposed Impervious Area HSG D Soil = 5,718 SF

- 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"
D	0.10"

- Calculate Recharge Volume

  '*Rv*' = [0.60" x 31,784 SF + 0.35" x 24,965 SF + 0.10" x 5,718 SF] - [0.60" x 991 SF + 0.35" x 7,534 SF + 0.10" x 1,673 SF]
  '*Rv*' = [28,380 SF – 3,399 SF] / 12 SF-In = 2,082 CF
  '*Rv*' = 2,082 CF

- Capture Area Adjustment
  Schedule of Areas Tributary to Recharge Systems

HCAD Node ID	Tributary Impervious Area
P6	7,048 sf
P7	14,750 sf
P8	5,645 sf
R1	3,840 sf
R2	5,120 sf
R3	14,080 sf
R4	2,560 sf
Total:	**53,043 sf**

Total Impervious Area = 62,497 SF
Capture Area Adjustment = 62,497 sf / 53,043 sf = **1.18**

Required Recharge Volume ***'Rv'*** = 1.18 x Rv = 1.18 x 2,082 CF = **2,457 CF**

- Calculate Provided Recharge
  Schedule of Proposed Recharge System Volumes

HCAD System ID	Bottom of System	Lowest System Outlet or Top of Galley	Total Recharge Volume Provided
RS1	53.50	55.20	1,994
RS2	49.50	51.10	1,334
RS3	50.00	54.40	3,289
RS4	50.00	53.00	549
		Total Volume: 7,166	

Recharge volume provided measured to lowest system outlet.

Required Recharge Volume Summary

Total Volume Provided Below Outlets = 7,166 CF
Total Volume Required = 2,457 CF

March 5, 2021

Verify Drawdown, Maximum 72-Hours: Static Method

HCAD System ID	Recharge Volume (CF)	Bottom Surface Area (SF)	Rawls Rate Inches/Hour	Drawdown Time Rv / (K x A) (Hours)	Description
RS1	1,994	1,764	2.41	5.7	Concrete Galleys
RS2	1,334	1,296	2.41	5.2	Concrete Galleys
RS3	3,289	1,200	2.41	13.7	Concrete Galleys
RS4	549	300	2.41	9.2	Concrete Galleys

*****Design Complies with Recharge Volume Standard*****

Project: 57 Perkins Row
Location: Topsfield, MA
Prepared For: Morin-Cameron

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)
HS1	0.13	0.0002025	6.0	0.100	1.00	774.00	0.16
HS2	0.34	0.0005291	6.0	0.100	1.00	774.00	0.41
HS3	0.32	0.0005047	6.0	0.100	1.00	774.00	0.39

CONTECH ENGINEERED SOLUTIONS

CDS TECHNOLOGIES

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

57 PERKINS ROW
TOPSFIELD, MA

Area	**0.13 ac**	Unit Site Designation	**HS1**
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%	0.00	0.00	9.9
0.04	9.6%	19.8%	0.00	0.00	9.4
0.06	9.4%	29.3%	0.01	0.01	9.1
0.08	7.7%	37.0%	0.01	0.01	7.5
0.10	8.6%	45.6%	0.01	0.01	8.3
0.12	6.3%	51.9%	0.01	0.01	6.1
0.14	4.7%	56.5%	0.02	0.02	4.5
0.16	4.6%	61.2%	0.02	0.02	4.5
0.18	3.5%	64.7%	0.02	0.02	3.4
0.20	4.3%	69.1%	0.02	0.02	4.2
0.25	8.0%	77.1%	0.03	0.03	7.6
0.30	5.6%	82.7%	0.03	0.03	5.3
0.35	4.4%	87.0%	0.04	0.04	4.1
0.40	2.5%	89.5%	0.05	0.05	2.4
0.45	2.5%	92.1%	0.05	0.05	2.4
0.50	1.4%	93.5%	0.06	0.06	1.3
0.75	5.0%	98.5%	0.09	0.09	4.6
1.00	1.0%	99.5%	0.12	0.12	0.9
1.50	0.0%	99.5%	0.17	0.17	0.0
2.00	0.0%	99.5%	0.23	0.23	0.0
3.00	0.5%	100.0%	0.35	0.35	0.4
					95.6
				Removal Efficiency Adjustment[2] =	6.5%
				Predicted % Annual Rainfall Treated =	93.5%
				Predicted Net Annual Load Removal Efficiency =	**89.1%**

1 - Based on 10 years of 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

57 PERKINS ROW
TOPSFIELD, MA

Area	**0.34 ac**	Unit Site Designation	**HS2**
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%	0.01	0.01	9.3
0.06	9.4%	29.3%	0.02	0.02	9.1
0.08	7.7%	37.0%	0.02	0.02	7.4
0.10	8.6%	45.6%	0.03	0.03	8.2
0.12	6.3%	51.9%	0.04	0.04	6.0
0.14	4.7%	56.5%	0.04	0.04	4.4
0.16	4.6%	61.2%	0.05	0.05	4.4
0.18	3.5%	64.7%	0.05	0.05	3.3
0.20	4.3%	69.1%	0.06	0.06	4.0
0.25	8.0%	77.1%	0.08	0.08	7.4
0.30	5.6%	82.7%	0.09	0.09	5.1
0.35	4.4%	87.0%	0.11	0.11	3.9
0.40	2.5%	89.5%	0.12	0.12	2.3
0.45	2.5%	92.1%	0.14	0.14	2.2
0.50	1.4%	93.5%	0.15	0.15	1.2
0.75	5.0%	98.5%	0.23	0.23	4.1
1.00	1.0%	99.5%	0.30	0.30	0.8
1.50	0.0%	99.5%	0.46	0.46	0.0
2.00	0.0%	99.5%	0.61	0.61	0.0
3.00	0.5%	100.0%	0.91	0.91	0.2
					92.9
				Removal Efficiency Adjustment[2] =	6.5%
				Predicted % Annual Rainfall Treated =	93.5%
				Predicted Net Annual Load Removal Efficiency =	**86.5%**

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

57 PERKINS ROW
TOPSFIELD, MA

Area	**0.32 ac**	Unit Site Designation	**HS3**
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%	0.01	0.01	9.3
0.06	9.4%	29.3%	0.02	0.02	9.1
0.08	7.7%	37.0%	0.02	0.02	7.4
0.10	8.6%	45.6%	0.03	0.03	8.2
0.12	6.3%	51.9%	0.03	0.03	6.0
0.14	4.7%	56.5%	0.04	0.04	4.4
0.16	4.6%	61.2%	0.05	0.05	4.4
0.18	3.5%	64.7%	0.05	0.05	3.3
0.20	4.3%	69.1%	0.06	0.06	4.1
0.25	8.0%	77.1%	0.07	0.07	7.4
0.30	5.6%	82.7%	0.09	0.09	5.1
0.35	4.4%	87.0%	0.10	0.10	3.9
0.40	2.5%	89.5%	0.12	0.12	2.3
0.45	2.5%	92.1%	0.13	0.13	2.2
0.50	1.4%	93.5%	0.15	0.15	1.2
0.75	5.0%	98.5%	0.22	0.22	4.2
1.00	1.0%	99.5%	0.29	0.29	0.8
1.50	0.0%	99.5%	0.44	0.44	0.0
2.00	0.0%	99.5%	0.58	0.58	0.0
3.00	0.5%	100.0%	0.87	0.87	0.2
					93.1
				Removal Efficiency Adjustment[2] =	6.5%
				Predicted % Annual Rainfall Treated =	93.5%
				Predicted Net Annual Load Removal Efficiency =	**86.7%**

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.

VERIFY PIPE CAPACITY-25 YEAR STORM

Pipe Sizing Calculation Spreadsheet:

THE MORIN-CAMERON GROUP, INC.
66 Elm Street
Danvers, MA 01923
P: (978) 777-8586
F: (978) 774-3488
W: www.morincameron.com

Name: 57 Perkins Row
Location: 57 Perkins Row
Topsfield, Massachusetts
County: Essex County
Owner: Perkins Landing, LLC

Proj. No.: 3274.a
Date: 3/5/2021
Revised:
Computed by: Daniel J. Powers, P.E.
Checked by: Scott P, Cameron, P.E.

Design Parameters:
IDF Curve
25 Year Storm Boston, MA
k_e= 0.2

DESCRIPTION	LOCATION		AREA (AC.)	C	C x A	SUM C x A	FLOW TIME (MIN)		i*	DESIGN					CAPACITY		PIPE PROFILE				
	FROM	TO					PIPE	CONC. TIME		Q cfs	V fps	n	PIPE SIZE	SLOPE	Q full ft^3/s	V full ft/s	LENGTH ft	FALL ft	RIM	INV UPPER	INV LOWER
CB-5	CB-5	DMH-3	0.07	0.84	0.05	0.05	0.32	6.0	5.7	0.3	4.3	0.012	12	0.070	10.2	13.0	83	5.80	65.80	62.80	57.00
CB-3	CB-3	DMH-3	0.08	0.90	0.07	0.07	0.04	6.0	5.7	0.4	2.9	0.012	12	0.014	4.6	5.9	7	0.10	60.30	57.10	57.00
CB-4	CB-4	DMH-3	0.05	0.90	0.04	0.04	0.05	6.0	5.7	0.2	2.3	0.012	12	0.014	4.6	5.9	7	0.10	60.30	57.10	57.00
DMH-3	DMH-3	DMH-2	-	-	-	0.17	0.15	6.3	5.7	1.0	6.3	0.012	12	0.068	10.1	12.8	56	3.81	60.40	57.00	53.19
DMH-2	DMH-2	DMH-1	-	-	-	0.17	0.51	6.5	5.6	1.0	3.4	0.012	12	0.010	3.9	4.9	104	1.04	57.20	53.19	52.15
CB-1	CB-1	DMH-1	0.13	0.90	0.11	0.11	0.03	6.0	5.7	0.7	3.6	0.012	12	0.017	5.0	6.3	6	0.10	55.00	52.25	52.15
CB-2	CB-2	DMH-1	0.14	0.69	0.09	0.09	0.06	6.0	5.7	0.5	2.8	0.012	12	0.010	3.9	4.9	10	0.10	55.00	52.25	52.15
DMH-1	DMH-1	FES-1	-	-	-	0.38	0.14	7.0	5.5	2.1	4.2	0.012	12	0.010	3.9	4.9	35	0.35	55.20	52.15	51.80
PW	PW	OCS-1	-	-	-	-	-	-	-	2.2	5.6	0.012	12	0.020	5.5	6.9	50	1.00	-	49.00	48.00
OCS-1	OCS-1	WALL	-	-	-	-	-	-	-	0.9	3.3	0.012	12	0.010	3.9	4.9	58	0.58	55.10	48.00	47.42
CB-12	CB-12	DMH-6	0.36	0.46	0.16	0.16	0.07	6.0	5.7	0.9	3.4	0.012	12	0.010	3.9	4.9	14	0.14	54.80	51.80	51.66
CB-13	CB-13	DMH-6	0.14	0.70	0.10	0.10	0.02	6.0	5.7	0.6	4.0	0.012	12	0.035	7.2	9.2	4	0.14	54.80	51.80	51.66
DMH-6	DMH-6	DMH-7	-	-	-	0.26	0.33	6.1	5.7	1.5	3.8	0.012	12	0.010	3.9	4.9	77	0.77	55.10	51.66	50.89
CB-10	CB-10	DMH-5	0.11	0.79	0.09	0.09	0.17	6.0	5.7	0.5	4.6	0.012	12	0.054	9.0	11.5	48	2.61	60.00	56.00	53.39
CB-11	CB-11	DMH-5	0.13	0.68	0.09	0.09	0.09	6.0	5.7	0.5	5.4	0.012	12	0.093	11.8	15.0	28	2.61	60.00	56.00	53.39
DMH-5	DMH-5	DMH-7	-	-	-	0.17	0.14	6.2	5.7	1.0	5.8	0.012	12	0.050	8.6	11.0	50	2.50	58.90	53.39	50.89
HS-3	HS-3	DMH-7	-	-	-	0.43	0.03	6.4	5.6	2.4	5.7	0.012	12	0.020	5.5	6.9	11	0.22	57.50	50.89	50.67
DMH-8	DMH-8	DMH-9	0.09	0.90	0.08	0.08	0.29	6.0	5.7	0.5	4.3	0.012	6	0.030	1.1	5.4	75	2.25	59.30	55.15	52.90
DMH-9	DMH-9	RS-3	0.09	0.90	0.08	0.08	0.31	6.3	5.7	0.4	4.3	0.012	6	0.030	1.1	5.4	80	2.40	58.30	52.90	50.50
DMH-7	DMH-7	DS-1	-	-	-	0.86	0.12	6.4	5.6	4.9	8.8	0.012	12	0.040	7.7	9.8	65	2.60	57.70	47.10	44.50
OCS-4	OCS-4	FES-3	-	-	-	-	-	-	-	0.8	4.0	0.012	12	0.020	5.5	6.9	25	0.50	48.20	41.00	40.50
CB-6	CB-6	HS-1	0.09	0.70	0.06	0.06	0.09	6.0	5.7	0.4	2.8	0.012	12	0.017	5.1	6.5	15	0.26	60.00	56.66	56.40
CB-7	CB-7	HS-1	0.11	0.70	0.08	0.08	0.13	6.0	5.7	0.4	2.7	0.012	12	0.012	4.2	5.3	22	0.26	60.00	56.66	56.40
HS-1	HS-1	DMH-4	-	-	-	0.14	0.33	6.1	5.7	0.8	3.2	0.012	12	0.010	3.9	4.9	65	0.65	59.40	56.40	55.75
DMH-4	DMH-4	RS-1	0.12	0.90	0.11	0.25	0.34	6.5	5.6	1.4	3.8	0.012	12	0.010	3.9	4.9	78	0.78	60.20	55.75	54.97
CB-8	CB-8	HS-2	0.50	0.53	0.27	0.27	0.18	6.0	5.7	1.5	3.9	0.012	12	0.010	3.9	4.9	42	0.42	58.10	53.70	53.28
CB-9	CB-9	HS-2	0.30	0.68	0.20	0.20	0.15	6.0	5.7	1.1	3.8	0.012	12	0.012	4.2	5.4	35	0.42	57.10	53.70	53.28

Pipe Sizing Calculation Spreadsheet:

THE MORIN-CAMERON GROUP, INC.
66 Elm Street
Danvers, MA 01923
P: (978) 777-8586
F: (978) 774-3488
W: www.morincameron.com

Name: 57 Perkins Row
Location: 57 Perkins Row
Topsfield, Massachusetts
County: Essex County
Owner: Perkins Landing, LLC

Proj. No.: 3274.a
Date: 3/5/2021
Revised:
Computed by: Daniel J. Powers, P.E.
Checked by: Scott P, Cameron, P.E.

Design Parameters:
IDF Curve
25 **Year Storm** Boston, MA
k_e= **0.2**

DESCRIPTION	LOCATION		AREA (AC.)	C	C x A	SUM C x A	FLOW TIME (MIN)		i*	DESIGN					CAPACITY		PIPE PROFILE				
	FROM	TO					PIPE	CONC. TIME		Q cfs	V fps	n	PIPE SIZE	SLOPE	Q full ft^3/s	V full ft/s	LENGTH ft	FALL ft	RIM	INV UPPER	INV LOWER
HS-2	HS-2	RS-2	-	-	-	0.47	0.21	6.2	5.7	2.7	4.6	0.012	12	0.010	3.9	4.9	58	0.58	57.10	53.28	52.70
OCS-3	OCS-3	FES-2	-	-	-	-	-	-	-	0.5	3.7	0.012	12	0.025	6.1	7.8	20	0.50	55.10	50.00	49.50

THE MORIN-CAMERON GROUP, INC.
66 Elm Street,
Danvers, MA 01923
p | 978.777.8586 m | 781.520.9496

Standard 4: Total Suspended Solids Calculation for RS1
Pretreatment Standard for Rapidly Draining Soil

Name:
Location: 57 Perkins Row, Topsfield, MA
County: Essex
Applicant: Perkins Landing, LLC

Proj. No.: 3274.a
Date: 3/5/2021
Revised:
Computed by: Daniel J. Powers, P.E.
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	**0.89**	**0.75**	**0.67**	**0.08**
	0.00	**0.08**	**0.00**	**0.08**
	0.00	**0.08**	**0.00**	**0.08**
	0.00	**0.08**	**0.00**	**0.08**

Total TSS Removal = **92%**

Notes: Proprietary Treatment Unit is Contech CDS Water Quality Unit.
Pretreament prior to infiltrating BMP

*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.
66 Elm Street,
Danvers, MA 01923
p | 978.777.8586 m | 781.520.9496

Standard 4: Total Suspended Solids Calculation for RS1
Treatment Standard for Rapidly Draining Soil

Name:
Location: 57 Perkins Row, Topsfield, MA
County: Essex
Applicant: Perkins Landing, LLC

Proj. No.: 3274.a
Date: 3/5/2021
Revised:
Computed by: Daniel J. Powers, P.E.
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**

Total TSS Removal = **80%**

Note: Subsurface Infiltration Structures are precast concrete galleys

*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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66 Elm Street,
Danvers, MA 01923
p | 978.777.8586 m | 781.520.9496

Standard 4: Total Suspended Solids Calculation for RS2
Pretreatment Standard for Rapidly Draining Soil

Name:
Location: 57 Perkins Row, Topsfield, MA
County: Essex
Applicant: Perkins Landing, LLC

Proj. No.: 3274.a
Date: 3/5/2021
Revised:
Computed by: Daniel J. Powers, P.E.
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	**0.86**	**0.75**	**0.65**	**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**

Total TSS Removal = **90%**

Notes: Proprietary Treatment Unit is Contech CDS Water Quality Unit.
Pretreament prior to infiltrating BMP

*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.
66 Elm Street,
Danvers, MA 01923
p | 978.777.8586 m | 781.520.9496

Standard 4: Total Suspended Solids Calculation for RS2
Treatment Standard for Rapidly Draining Soil

Name:
Location: 57 Perkins Row, Topsfield, MA
County: Essex
Applicant: Perkins Landing, LLC

Proj. No.: 3274.a
Date: 3/5/2021
Revised:
Computed by: Daniel J. Powers, P.E.
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**

Total TSS Removal = **80%**

Note: Subsurface Infiltration Structures are precast concrete galleys

*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.
66 Elm Street,
Danvers, MA 01923
p | 978.777.8586 m | 781.520.9496

Standard 4: Total Suspended Solids Calculation for DS1
Treatment Standard for Rapidly Draining Soil

Name:
Location: 57 Perkins Row, Topsfield, MA
County: Essex
Applicant: Perkins Landing, LLC

Proj. No.: 3274.a
Date: 3/5/2021
Revised:
Computed by: Daniel J. Powers, P.E.
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	**0.87**	**0.75**	**0.65**	**0.10**
Dry Detention Basin	**0.00**	**0.10**	**0.00**	**0.10**
	0.00	**0.10**	**0.00**	**0.10**
	0.00	**0.10**	**0.00**	**0.10**

Total TSS Removal = **90%**

Note: Subsurface Detention Structures are precast concrete galleys

*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.
66 Elm Street,
Danvers, MA 01923
p | 978.777.8586 m | 781.520.9496

Standard 4: Total Suspended Solids Calculation for Pocket Wetland
Pretreatment Standard for Constructed Stormwater Wetland

Name:
Location: 57 Perkins Row, Topsfield, MA
County: Essex
Applicant: Perkins Landing, LLC

Proj. No.: 3274.a
Date: 3/5/2021
Revised:
Computed by: Daniel J. Powers, P.E.
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**
Sediment Forebay	**0.25**	**0.75**	**0.19**	**0.56**
	0.00	**0.56**	**0.00**	**0.56**
	0.00	**0.56**	**0.00**	**0.56**
	0.00	**0.56**	**0.00**	**0.56**

Total TSS Removal = **44%**

*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.
66 Elm Street,
Danvers, MA 01923
p | 978.777.8586 m | 781.520.9496

Standard 4: Total Suspended Solids Calculation for Pocket Wetland
Treatment Standard for Rapidly Draining Soil

Name:
Location: 57 Perkins Row
Topsfield, MA
County: Essex
Applicant: Perkins Landing, LLC

Proj. No.: 3274.a
Date: 3/5/2021
Revised:
Computed by: Daniel J. Powers, P.E.
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)
Constructed Stormwater Wetland	**0.80**	**1.00**	**0.80**	**0.20**
	0.00	**0.20**	**0.00**	**0.20**
	0.00	**0.20**	**0.00**	**0.20**
	0.00	**0.20**	**0.00**	**0.20**
	0.00	**0.20**	**0.00**	**0.20**

Total TSS Removal = **80%**

*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

This spreadsheet will calculate the height of a groundwater mound beneath a stormwater infiltration basin. More information can be found in the U.S. Geological Survey Scientific Investigations Report 2010-5102 "Simulation of groundwater mounding beneath hypothetical stormwater infiltration basins".

The user must specify infiltration rate (R), specific yield (Sy), horizontal hydraulic conductivity (Kh), basin dimensions (x, y), duration of infiltration period (t), and the initial thickness of the saturated zone (hi(0), height of the water table if the bottom of the aquifer is the datum). For a square basin the half width equals the half length (x = y). For a rectangular basin, if the user wants the water-table changes perpendicular to the long side, specify x as the short dimension and y as the long dimension. Conversely, if the user wants the values perpendicular to the short side, specify y as the short dimension, x as the long dimension. All distances are from the center of the basin. Users can change the distances from the center of the basin at which water-table aquifer thickness are calculated.
Cells highlighted in yellow are values that can be changed by the user. Cells highlighted in red are output values based on user-specified inputs. The user MUST click the blue "Re-Calculate Now" button each time ANY of the user-specified inputs are changed otherwise necessary iterations to converge on the correct solution will not be done and values shown will be incorrect. Use consistent units for all input values (for example, feet and days)

use consistent units (e.g. feet & days **or** inches & hours)

Input Values		
4.8200	***R***	**Recharge (infiltration) rate (feet/day)**
0.210	**Sy**	**Specific yield, Sy (dimensionless, between 0 and 1)**
48.20	**K**	**Horizontal hydraulic conductivity, Kh (feet/day)***
15.000	**x**	**1/2 length of basin (x direction, in feet)**
20.600	**y**	**1/2 width of basin (y direction, in feet)**
1.500	**t**	**duration of infiltration period (days)**
45.000	**hi(0)**	**initial thickness of saturated zone (feet)**

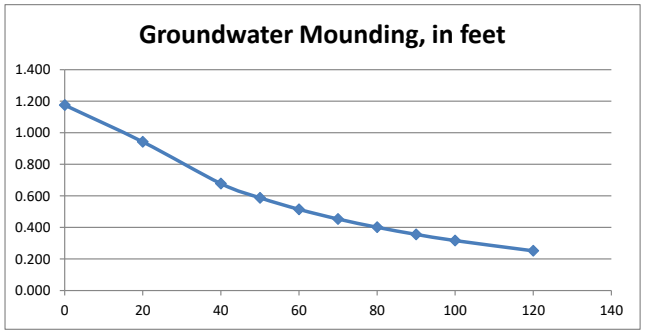
46.175	**h(max)**	**maximum thickness of saturated zone (beneath center of basin at end of infiltration period)**
1.175	**Δh(max)**	**maximum groundwater mounding (beneath center of basin at end of infiltration period)**

Conversion Table	
inch/hour	**feet/day**
0.67	1.33
2.00	4.00
hours	**days**
36	1.50

In the report accompanying this spreadsheet (USGS SIR 2010-5102), vertical soil permeability (ft/d) is assumed to be one-tenth horizontal hydraulic conductivity (ft/d).

Ground-water Mounding, in feet	**Distance from center of basin in x direction, in feet**
1.175	**0**
0.942	**20**
0.678	**40**
0.588	**50**
0.515	**60**
0.453	**70**
0.401	**80**
0.356	**90**
0.317	**100**
0.252	**120**

Re-Calculate Now



Disclaimer

This spreadsheet solving the Hantush (1967) equation for ground-water mounding beneath an infiltration basin is made available to the general public as a convenience for those wishing to replicate values documented in the USGS Scientific Investigations Report 2010-5102 "Groundwater mounding beneath hypothetical stormwater infiltration basins" or to calculate values based on user-specified site conditions. Any changes made to the spreadsheet (other than values identified as user-specified) after transmission from the USGS could have unintended, undesirable consequences. These consequences could include, but may not be limited to: erroneous output, numerical instabilities, and violations of underlying assumptions that are inherent in results presented in the accompanying USGS published report. The USGS assumes no responsibility for the consequences of any changes made to the spreadsheet. If changes are made to the spreadsheet, the user is responsible for documenting the changes and justifying the results and conclusions.

This spreadsheet will calculate the height of a groundwater mound beneath a stormwater infiltration basin. More information can be found in the U.S. Geological Survey Scientific Investigations Report 2010-5102 "Simulation of groundwater mounding beneath hypothetical stormwater infiltration basins".

The user must specify infiltration rate (R), specific yield (Sy), horizontal hydraulic conductivity (Kh), basin dimensions (x, y), duration of infiltration period (t), and the initial thickness of the saturated zone (hi(0), height of the water table if the bottom of the aquifer is the datum). For a square basin the half width equals the half length (x = y). For a rectangular basin, if the user wants the water-table changes perpendicular to the long side, specify x as the short dimension and y as the long dimension. Conversely, if the user wants the values perpendicular to the short side, specify y as the short dimension, x as the long dimension. All distances are from the center of the basin. Users can change the distances from the center of the basin at which water-table aquifer thickness are calculated.
Cells highlighted in yellow are values that can be changed by the user. Cells highlighted in red are output values based on user-specified inputs. The user MUST click the blue "Re-Calculate Now" button each time ANY of the user-specified inputs are changed otherwise necessary iterations to converge on the correct solution will not be done and values shown will be incorrect. Use consistent units for all input values (for example, feet and days)

use consistent units (e.g. feet & days **or** inches & hours)

Input Values		
4.8200	***R***	**Recharge (infiltration) rate (feet/day)**
0.210	**Sy**	**Specific yield, Sy (dimensionless, between 0 and 1)**
48.20	**K**	**Horizontal hydraulic conductivity, Kh (feet/day)***
9.000	**x**	**1/2 length of basin (x direction, in feet)**
36.000	**y**	**1/2 width of basin (y direction, in feet)**
1.500	**t**	**duration of infiltration period (days)**
45.000	**hi(0)**	**initial thickness of saturated zone (feet)**

Conversion Table

inch/hour	feet/day
0.67	1.33
2.00	4.00

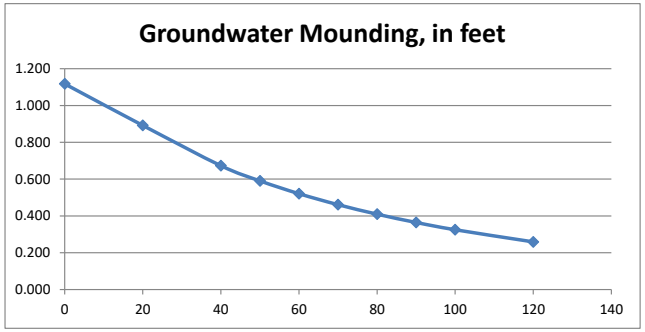
hours	days
36	1.50

In the report accompanying this spreadsheet (USGS SIR 2010-5102), vertical soil permeability (ft/d) is assumed to be one-tenth horizontal hydraulic conductivity (ft/d).

46.118	**h(max)**	**maximum thickness of saturated zone (beneath center of basin at end of infiltration period)**
1.118	**Δh(max)**	**maximum groundwater mounding (beneath center of basin at end of infiltration period)**

Ground-water Mounding, in feet	Distance from center of basin in x direction, in feet
1.118	**0**
0.892	**20**
0.673	**40**
0.590	**50**
0.521	**60**
0.461	**70**
0.410	**80**
0.364	**90**
0.325	**100**
0.259	**120**

Re-Calculate Now



Disclaimer

This spreadsheet solving the Hantush (1967) equation for ground-water mounding beneath an infiltration basin is made available to the general public as a convenience for those wishing to replicate values documented in the USGS Scientific Investigations Report 2010-5102 "Groundwater mounding beneath hypothetical stormwater infiltration basins" or to calculate values based on user-specified site conditions. Any changes made to the spreadsheet (other than values identified as user-specified) after transmission from the USGS could have unintended, undesirable consequences. These consequences could include, but may not be limited to: erroneous output, numerical instabilities, and violations of underlying assumptions that are inherent in results presented in the accompanying USGS published report. The USGS assumes no responsibility for the consequences of any changes made to the spreadsheet. If changes are made to the spreadsheet, the user is responsible for documenting the changes and justifying the results and conclusions.

This spreadsheet will calculate the height of a groundwater mound beneath a stormwater infiltration basin. More information can be found in the U.S. Geological Survey Scientific Investigations Report 2010-5102 "Simulation of groundwater mounding beneath hypothetical stormwater infiltration basins".

The user must specify infiltration rate (R), specific yield (Sy), horizontal hydraulic conductivity (Kh), basin dimensions (x, y), duration of infiltration period (t), and the initial thickness of the saturated zone (hi(0), height of the water table if the bottom of the aquifer is the datum). For a square basin the half width equals the half length (x = y). For a rectangular basin, if the user wants the water-table changes perpendicular to the long side, specify x as the short dimension and y as the long dimension. Conversely, if the user wants the values perpendicular to the short side, specify y as the short dimension, x as the long dimension. All distances are from the center of the basin. Users can change the distances from the center of the basin at which water-table aquifer thickness are calculated.
Cells highlighted in yellow are values that can be changed by the user. Cells highlighted in red are output values based on user-specified inputs. The user MUST click the blue "Re-Calculate Now" button each time ANY of the user-specified inputs are changed otherwise necessary iterations to converge on the correct solution will not be done and values shown will be incorrect. Use consistent units for all input values (for example, feet and days)

use consistent units (e.g. feet & days **or** inches & hours)

Input Values		
4.8200	***R***	**Recharge (infiltration) rate (feet/day)**
0.210	**Sy**	**Specific yield, Sy (dimensionless, between 0 and 1)**
48.20	**K**	**Horizontal hydraulic conductivity, Kh (feet/day)***
5.000	**x**	**1/2 length of basin (x direction, in feet)**
60.000	**y**	**1/2 width of basin (y direction, in feet)**
1.500	**t**	**duration of infiltration period (days)**
45.000	**hi(0)**	**initial thickness of saturated zone (feet)**

Conversion Table

inch/hour	feet/day
0.67	1.33
2.00	4.00

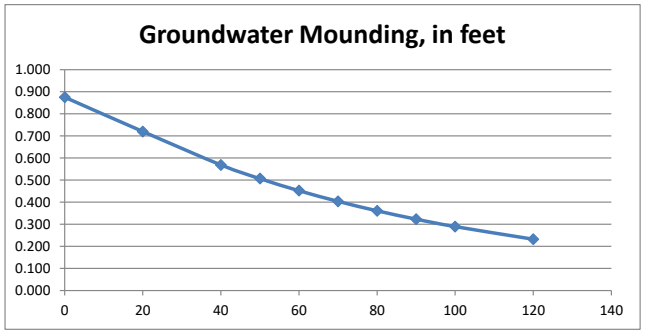
hours	days
36	1.50

In the report accompanying this spreadsheet (USGS SIR 2010-5102), vertical soil permeability (ft/d) is assumed to be one-tenth horizontal hydraulic conductivity (ft/d).

45.875	**h(max)**	**maximum thickness of saturated zone (beneath center of basin at end of infiltration period)**
0.875	**Δh(max)**	**maximum groundwater mounding (beneath center of basin at end of infiltration period)**

Ground-water Mounding, in feet	**Distance from center of basin in x direction, in feet**
0.875	**0**
0.720	**20**
0.569	**40**
0.507	**50**
0.452	**60**
0.404	**70**
0.361	**80**
0.323	**90**
0.289	**100**
0.232	**120**

Re-Calculate Now



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This spreadsheet will calculate the height of a groundwater mound beneath a stormwater infiltration basin. More information can be found in the U.S. Geological Survey Scientific Investigations Report 2010-5102 "Simulation of groundwater mounding beneath hypothetical stormwater infiltration basins".

The user must specify infiltration rate (R), specific yield (Sy), horizontal hydraulic conductivity (Kh), basin dimensions (x, y), duration of infiltration period (t), and the initial thickness of the saturated zone (hi(0), height of the water table if the bottom of the aquifer is the datum). For a square basin the half width equals the half length (x = y). For a rectangular basin, if the user wants the water-table changes perpendicular to the long side, specify x as the short dimension and y as the long dimension. Conversely, if the user wants the values perpendicular to the short side, specify y as the short dimension, x as the long dimension. All distances are from the center of the basin. Users can change the distances from the center of the basin at which water-table aquifer thickness are calculated.
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use consistent units (e.g. feet & days **or** inches & hours)

Input Values		
4.8200	***R***	**Recharge (infiltration) rate (feet/day)**
0.210	**Sy**	**Specific yield, Sy (dimensionless, between 0 and 1)**
48.20	**K**	**Horizontal hydraulic conductivity, Kh (feet/day)***
5.000	**x**	**1/2 length of basin (x direction, in feet)**
15.000	**y**	**1/2 width of basin (y direction, in feet)**
1.500	**t**	**duration of infiltration period (days)**
45.000	**hi(0)**	**initial thickness of saturated zone (feet)**

Conversion Table

inch/hour	feet/day
0.67	1.33
2.00	4.00

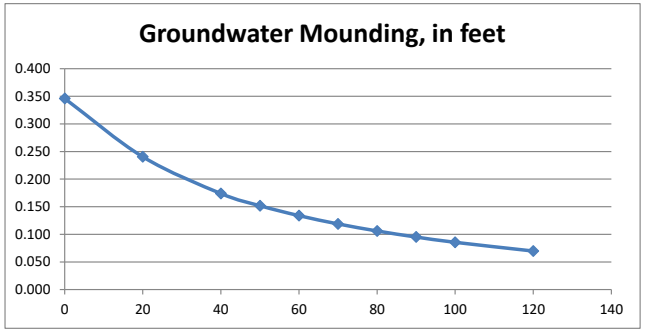
hours	days
36	1.50

In the report accompanying this spreadsheet (USGS SIR 2010-5102), vertical soil permeability (ft/d) is assumed to be one-tenth horizontal hydraulic conductivity (ft/d).

45.346	**h(max)**	**maximum thickness of saturated zone (beneath center of basin at end of infiltration period)**
0.346	**Δh(max)**	**maximum groundwater mounding (beneath center of basin at end of infiltration period)**

Ground-water Mounding, in feet	**Distance from center of basin in x direction, in feet**
0.346	**0**
0.240	**20**
0.174	**40**
0.152	**50**
0.134	**60**
0.119	**70**
0.106	**80**
0.095	**90**
0.086	**100**
0.070	**120**

Re-Calculate Now



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APPENDIX E:

CONSTRUCTION PHASE

BEST MANAGEMENT PRACTICES

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 "Comprehensive Permit Plans in Topsfield, Massachusetts, 57 Perkins Row," prepared by The Morin-Cameron Group, Inc. dated March 5, 2021 as revised and approved by the Topsfield Planning Board, hereinafter referred to as the Site Plans.

Responsible Party Contact Information:

Stormwater Management System Owner:	Perkins Landing, LLC 383 Main Street Medfield, MA 02052 P: (978) 837-6677
Topsfield Department of Public Works:	279 Boston Street Topsfield, MA 01983 P: (978) 887-1542
Topsfield Planning Board:	Town Hall 8 West Common Street Topsfield, MA 01983 P: (978) 887-1504
Topsfield Zoning Board Of Appeals:	Town Hall 8 West Common Street Topsfield, MA 01983 P: (978) 887-1504
Topsfield Conservation Commission:	Town Hall 8 West Common Street Topsfield, MA 01983 P: (978) 887-1510
Site Design Engineer Information:	The Morin-Cameron Group, Inc. 66 Elm Street Danvers, MA 01923 Phone: (978) 777-8586

Structural Practices:

1) **Hay-Bales/Silt Fence** – Hay-bales and siltation fence 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 major storm (3.15 inches of rainfall within a twenty-four-hour period). event 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 along the frontage of the property. 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:** Stabilized Construction Exit: Prior to the commencement of site work, crushed stone anti-tracking pads will be installed at the entrance to the site. This will 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 shall be replaced. Details for construction of the stabilized entrance can be found in the details sheet that is part of the comprehensive permit plan set associated with the project. 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 should 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., 3.15 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 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. The appropriate repairs should be made.

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 (Hay or 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.

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

c) If plastic netting is used to anchor mulch, care should be taken during initial mowing to keep the mower height high. Otherwise, the netting can wrap up on the mower blade shafts. After a period of time, the netting degrades and becomes 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 generally 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 90 percent of Standard Proctor Test density with proper moisture control, or as otherwise specified by the engineer responsible for the design. 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 inches.

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 usually accomplished by running heavy equipment over the fill.

e) Fill should consist of material from borrow areas and excess cut will be 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 seeps develop on the slopes, the area should be evaluated to determine if the seep will cause an unstable condition. Subsurface drains or a gravel mulch may be required to solve seep problems.

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 will be a sandy loam to a 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 2.5:1, 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 actually work the topsoil into the layer below for a depth of at least 6 inches.

6) **Permanent Seeding** – Permanent Seeding should 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 2 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 with a shoe. 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 is 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 general contractor shall employ an on-site water vehicle for the control of dust as necessary.

Non-Stormwater Discharges:

The construction de-watering and all non-stormwater discharges will be directed into a sediment dirt bag (or equivalent inlet protection) or a sediment basin. 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 complete a Stormwater Management Construction Phase BMP Inspection Schedule and Evaluation Checklist for documenting 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

Long Term Stormwater Best Management Practices
Operation and Maintenance Plan
for
Comprehensive Permit
57 Perkins Row
Topsfield, Massachusetts
Issued March 5, 2021

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 catch basins, subsurface detention and recharge galleys, pocket wetland and CDS water quality units 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:	Perkins Landing, LLC 383 Main Street Medfield, MA 02052 P: (978) 837-6677
Topsfield Department of Public Works:	279 Boston Street Topsfield, MA 01983 P: (978) 887-1542
Topsfield Planning Board:	Town Hall 8 West Common Street Topsfield, MA 01983 P: (978) 887-1504
Topsfield Zoning Board Of Appeals:	Town Hall 8 West Common Street Topsfield, MA 01983 P: (978) 887-1504
Topsfield Conservation Commission	Town Hall 8 West Common Street Topsfield, MA 01983 P: (978) 887-1510

Erosion and Sedimentation Controls during Construction:

The site and drainage construction contractor shall be responsible for maintaining the stormwater system during construction. Routine maintenance of all items shall be performed to ensure adequate runoff and pollution control during construction.

A proposed silt fence and haybale barrier will be placed as shown on the Demolition and Erosion 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 will also be placed over the new catch basins once constructed.

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 developer shall be responsible for scheduling regular inspections and maintenance of the stormwater BMP's until such time when the homeowner's association is established at which time the homeowner's association shall become the responsible party. The BMP maintenance shall be conducted as detailed in the following long-term pollution prevention plan and illustrated on the approved design plans:
   "Comprehensive Permit Plans in Topsfield, Massachusetts, 57 Perkins Row," prepared by The Morin-Cameron Group, Inc. dated March 5, 2021 as revised and approved by the Topsfield Zoning Board of Appeals.
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 Topsfield Department of Public Works, Zoning Board of Appeals, Planning Board and Conservation Commission upon request;
   c. Allow members and agents of the Topsfield Department of Public Works, Zoning Board of Appeals, 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 natural vegetation. 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. Sweeeping shall occur at a minimum of twice per year (Spring and Fall).

Cost: $100-$300 per sweeping

Salt used for de-icing on the roadway 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 twice per year and cleaned as needed when accumulated sediments exceeds 2' from the bottom of the sump (approximately 1/2 of the sump capacity). The catch basins shall also be inspected 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.

CDS Water Quality Unit:

The CDS Water Quality Unit shall be inspected after every major storm event for the first 3 months after construction; a major storm event is 3.15 inches of rainfall within a twenty-four-hour period. Thereafter, the system shall be inspected twice per year in April and October. The units shall be cleaned per manufacturer's instructions included herein.

Cost: The owner shall consult local landscaping contractor for details.

Public Safety Concerns: The manhole covers shall not be left open and unattended at any time during inspection, cleaning or otherwise. Broken covers or frames shall be replaced immediately.

Subsurface Detention and Recharge Galleys:
The subsurface detention and recharge galleys and outlet structures shall be checked for debris accumulation twice per year. Each system is equipped with an inspection manhole on the first tank in the series and on the last tank in the series. Additional inspections should be scheduled during the first few months to make sure that the facility is functioning as intended. Trash, leaves, branches, etc. shall be removed from facility. Silt, sand and sediment, if significant accumulation occurs, shall be removed annually. Material removed from the galleys shall be disposed of in accordance with all applicable local, state, and federal regulations. In the case that water remains in the infiltration facilities 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 outlet structure shall be inspected annually for structural integrity. The inspections shall be conducted by qualified personnel.

Cost: $500-$2,500 per cleaning depending on the volume of material/liquids that need to be removed.

Public Safety Concerns: The manhole 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.

Pocket Wetland:
The pocket wetland shall remain free from foreign objects and contamination. During the first growing season, vegetation should be inspected every 2 to 3 weeks. During the first 2 years, the constructed wetland should be inspected at least 4 times per year and after major storms (3.15 inches of rainfall within a twenty-four-hour period). Inspections should access the vegetation, erosion, flow channelization, bank stability, outlet conditions, and sediment/debris accumulation. Problems should be corrected as soon as possible. Wetland and buffer vegetation may require support – watering, weeding, mulching, replanting, etc. – during the first 3 years. Undesirable species should be removed, and desirable replacements planted, if necessary. Once established, the constructed wetland should require little maintenance aside from regular inspections and removal of litter and debris.

Sediment dredging within the pocket wetland may be required every 10-years depending sediment accumulation.

Cost: $1000-$2000 per cleaning. Consult local pumping companies for costs associated with cleaning of basin if necessary to remove sediment.

Overall Site Grading and Stormwater Management on Lots:
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 driveway/parking area as necessary 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. Provisions For Storing Materials And Waste Products Inside Or Under Cover
2. Vehicle Maintenance And Washing Controls
3. Requirements for Routine Inspections of the Stormwater Management System (i.e.: catch basins, hydrodynamic separator units, pocket wetland & subsurface recharge system.)
4. Spill Prevention and Response Plans.

Stormwater System Maintenance Log

Perkins Landing

57 Perkins Row, Topsfield, MA

The Following structures shall be inspected and maintained by the owner until the homeowner's association is established.

BMP STRUCTURE	INSPECTION DATE	WORK PERFORMED	DATE WORK PERFORMED	COMMENTS
Stormwater Management Infrastructure				
Catch Basin - CB-1				
Catch Basin - CB-2				
Catch Basin - CB-3				
Catch Basin - CB-4				
Catch Basin CB-5				
Catch Basin CB-6				
Catch Basin CB-7				
Catch Basin CB-8				
Catch Basin CB-9				
Catch Basin CB-10				
Catch Basin CB-11				
Drain Manhole DMH-1				
Drain Manhole 4 DMH-2				
Drain Manhole DMH-2				
Drain Manhole 4 DMH-3				
Drain Manhole DMH-3				
Drain Manhole 4 DMH-4				
Drain Manhole 4 DMH-5				
Drain Manhole 4 DMH-6				
Drain Manhole 4 DMH-7				
Drain Manhole 4 DMH-10				

CDS Unit - HS1				
CDS Unit - HS2				
CDS Unit - HS3				
Pocket Wetland				
Detention System				
Recharge System - RS1				
Recharge System - RS2				
Recharge System - RS3				
Flared End Section - FES 1				
Flared End Section - FES 2				
Flared End Section - FES 3				
Box Culvert				
Additional Comments:				

APPENDIX G:

ILLICIT

DISCHARGE STATEMENT

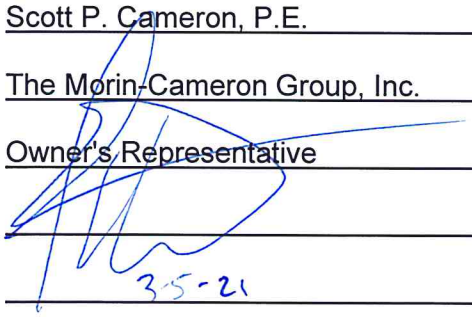
Illicit Discharge Compliance Statement

I, Scott P. Cameron, P.E., hereby notify the Topsfield Zoning Board Of Appeals that I have not witnessed, nor am aware of any existing illicit discharges at the site known as 57 Perkins Row in Topsfield, Massachusetts. I also hereby certify that the development of said property as illustrated on the final plans entitled "Comprehensive Permit Plans in Topsfield, Massachusetts, 57 Perkins Row," prepared by The Morin-Cameron Group, Inc. dated June 9, 2020 and as revised and approved by the Topsfield Zoning Board Of Appeals and maintenance thereof in accordance with the "Construction Period Pollution Prevention Plan" and "Long-Term Pollution Prevention Plan" prepared by The Morin-Cameron Group, Inc dated March 5, 2021 and as revised and approved by the Topsfield Zoning Board Of Appeals 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: 3-5-21