BEALS·ASSOCIATES INC.
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STORMWATER MANAGEMENT REPORT

PATTON HOMESTEAD DEVELOPMENT
650 ASBURY STREET
HAMILTON, MASSACHUSETTS

NOVEMBER 26, 2014

Prepared for:

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Project Number:
C-840

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1.0 Introduction

On behalf of C.P. Berry Residences, LLC, Beals Associates, Inc. has prepared this Stormwater Management Report to assess the stormwater runoff impacts of the introduction of a new Senior Housing development project at 650 Asbury Street in Hamilton, MA. This report will review the onsite stormwater management requirements for the development, which will be located within an approximately 4.4 acre, defined portion of the property commonly known as the "Patton Homestead" (the Property). This report will also analyze the potential impacts that the project may have on the surrounding watershed area which includes the Ipswich River. This report has been prepared in accordance with the Massachusetts Department of Environmental Protection's Stormwater Management Handbook as well as other industry standard methodologies.

The project area is currently undeveloped, and is generally located on top of a hill within the Property. This area has previously been cleared and features scrub growth and grasses, as well as three large Copper Beech trees. The entire development area ultimately drains to the Ipswich River via overland flow or through an existing culvert beneath Wood Road. There are a number of wetland resource areas adjacent to the project site. These include bordering vegetated wetlands to the northwest, west and south, and the Ipswich River which flows from south to north approximately 350 feet west of the development site.

The proposed development will feature twelve senior housing units, with the majority to be constructed as stand-alone units with the exception of one triplex unit. A new shared driveway will be constructed which will connect the development site to Asbury Street. Stormwater management within the proposed development will be achieved through low impact development techniques such as a biofiltration area, infiltration pond, and vegetated swale. A small number of catch basins and subsurface drainage pipes will also be utilized in certain areas where overland flow is either not feasible or is susceptible to wintertime disruption. The project's stormwater management features have been designed to meet or exceed the Massachusetts standards regarding quality, rate and volume of runoff.

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2.0 Hamilton, MA Stormwater Management Standards Narrative

2.1 Names, addresses, and telephone numbers of the owner, Applicant, and person(s) or firm(s) preparing the plan

Owner: C.P. Berry Residences, LLC

Applicant: C.P. Berry Residences, LLC/Town of Hamilton

Firm Preparing the Plan: Beals Associates, Inc.

2.2 A Locus map with title, date, north arrow, names of abutters, existing zoning and land uses, scale, and legend

See attached Locus Map

2.3 Existing and proposed zoning and land use

The site is located within the RA zoning district. The site is currently undeveloped with the exception of an unpaved cart path.

The general proposal is for construction of twelve (12) units of Senior Housing that has been planned and designed in a clustered configuration utilizing nine (9) individual structures and one (1) triplex unit. The project site will be accessed via a private roadway that will be constructed off Asbury Street. The roadway will be 24 feet wide and will feature a cul-de-sac at the end that will be designed in accordance with the Town of Hamilton Fire Safety officer's review. No changes are being proposed to the site zoning.

2.4 Location of existing and proposed utilities

See attached Site Plan

2.5 Location and description of natural features including;

a. Watercourses and water bodies, wetland resource areas and all floodplain information, including the 100-year flood elevation based upon the most recent Flood Insurance Rate Map, or as calculated by a professional engineer for areas not assessed on these maps

There are a number of wetland resource areas adjacent to the project site. These include bordering vegetated wetlands to the northwest, west and south. The 100-year flood elevation based on the most recent Flood Insurance Rate Map is El. 36 in

the vicinity of the project site. The Ipswich River flows from south to north approximately 350 feet west of the development site.

b. Existing vegetation including tree lines, canopy layer, shrub layer, and ground cover, and trees with a caliper twelve (12) inches or larger, noting specimen trees and forest communities

The project area is located on the top of a hillside that has been previously cleared and features scrub growth and grasses with the exception of three large Copper Beech trees. One of these trees is severely diseased and infested with carpenter ants, and as such will be removed. The other two will be preserved in their natural state. The site features natural wooded buffers that form the perimeter of the hilltop and provide protection to the wetland resource areas and the riverfront area. These buffers will also be preserved.

c. Habitats mapped by the Massachusetts Natural Heritage & Endangered Species Program as Endangered, Threatened or of Special Concern, Estimated Habitats of Rare Wildlife and Certified Vernal Pools, and Priority Habitats of Rare Species within one hundred (100) feet of any construction activity

The edge of a Priority Habitat of Rare Species is located adjacent to the development site to the south and west. All proposed buildings and impervious surfaces are located outside of the limits of the Priority Habitat area. Approximately 17,750 sf of the disturbed area will be within the Priority Habitats of Rare Species, however this will be limited to lawns or other types of vegetation.

No Estimated Habitats of Rare Wildlife or Certified Vernal Pools were determined to be within 100 feet of the proposed construction activity.

2.6 Lines of existing abutting streets showing drainage and driveway locations and curb cuts

Access to the proposed development will be from a driveway off of Asbury Street. This will be the only curb cut required for the project. An existing catch basin is located within Asbury Street approximately 150 feet south of the proposed driveway entrance

2.7 Existing soils, volume and nature of imported soil materials;

Based on NRCS mapping, existing soils within the development site consist mainly of Hydrologic Soil Group A soils, with relatively small areas in the eastern and southern portions of the site consisting of Hydrologic Soil Type B, C and D soils.

The proposed development has been designed to minimize import and export of soil materials to the maximum extent practicable. It is estimated that the proposed development will require a net import of soil material not to exceed approximately 2,000 cubic yards.

2.8 The site's existing and proposed topography with contours at 2 foot intervals

The project area is located on the top of a hill that has been cleared of vegetation. The hilltop sits approximately 20 feet higher than the surrounding fields and wetland areas. The proposed site design will utilize the existing grades to the maximum extent possible. To achieve this, the proposed residences will be constructed at or near the top of the hill, and the entrance driveway will slope down at an approximately 5% grade to Asbury Street.

See the attached Grading and Drainage Plan for further information.

2.9 Surveyed property lines showing distances and monument locations, all existing and proposed easements, rights-of-way, and other encumbrances, the size of the entire parcel, and the delineation and number of square feet of the land area to be disturbed

Total Parcel Area = 13.5± acres

Total Land Area to be Disturbed during Construction = 226,500± square feet

The project site will be divided into a smaller parcel that will be carved out of the main parcel of land. This new senior housing development parcel of 4.4 acres will be conveyed for the condominium development and the remaining 9.1 acres will remain in the ownership of the Town of Hamilton.

See the attached Site Plan for additional property information.

2.10 A description and delineation of existing stormwater conveyances, impoundments, and wetlands on or adjacent to the site or into which stormwater flows

Stormwater runoff at the site currently flows to one of three locations. Stormwater runoff from the eastern portion of the site generally flows to the south, where it reaches an impoundment at Wood Road and enters a concrete culvert. Runoff from the southern and southwestern portion of the site is directed via sheet flow into bordering vegetated wetlands and ultimately into the Ipswich River. Runoff from the northwestern and northern portions of the site flow to the bordering vegetated wetland adjacent to the development site to the northwest.

2.11 A delineation of 100-year flood plains, if applicable;

See attached Site Plan

2.12 Estimated seasonal high groundwater elevation (November to April) in areas to be used for stormwater retention, detention, or infiltration

Beals Associates, Inc. observed deep observation holes at the approximate locations of the proposed stormwater infiltration areas on July 30, 2014. A total of two observation holes were observed in these areas, with one hole (RG1) located at the top of the hill at the approximate location of the proposed rain garden, and a second hole (IP1) located at the bottom of the hill at the approximate location of the proposed stormwater infiltration area.

At RG1, no soil redoxymorphic features were observed, which implies that seasonal high groundwater in this area is below the bottom elevation of the test pit which was approximately El. 53.0.

At IP1, soil redoxymorphic features were observed at 31 inches below the ground surface, which equates to a seasonal high groundwater elevation of approximately 36.5 in this area.

2.13 The existing and proposed vegetation and ground surfaces with runoff coefficients for each

Within the development area, existing ground surfaces generally consist of scrub growth and grasses. Proposed ground surfaces will consist of bituminous pavement, residential buildings, paved walkways, and lawns. The underlying soils across the development site consist of Hydrologic Soil Groups (HSG) A, B, C, and D.

See Section 2.19B for a listing of Runoff Coefficients for each existing and proposed ground surface.

2.14 A drainage area map showing pre and post construction watershed boundaries, drainage area and stormwater flow paths

See attached Watershed Plans

2.15 Location and details of proposed erosion and sediment control measures with a narrative of the construction sequence/phasing of the project, including both operation and maintenance for structural and non-structural measures, interim grading, and material stockpile areas

See attached Erosion and Sediment Control Plan

2.16 Drainage patterns and approximate slopes anticipated after major grading activities (Construction Phase Grading Plans)

This information will be included with the application for a Stomrwater Management Permit from the Town of Hamilton, to be completed prior to construction.

2.17 A description and drawings of all components of the proposed drainage system including;

a. locations, cross sections and profiles of all brooks, streams, drainage swales and their method of stabilization

A vegetated swale will be constructed to the north of the proposed site access driveway. The swale will convey runoff from the lower portion of the roadway and from portions of the lawns and roofs of the lower housing units to the forebay and infiltration pond. The swale will also convey excess flows from the biofiltration area into the infiltration pond.

b. all measures for the detention, retention or infiltration of water

A biofiltration area will be constructed to the north of the proposed roadway in the upper portion of the development site to collect runoff from the upper access drive and housing units.

c. all measures for the protection of water quality

Both the biofiltration area and forebay have been sized to meet Massachusetts Stormwater Management standards for water quality. The two deep sump catch basins will also provide additional stormwater quality management.

The following table outlines the Total Suspended Removal achieved by the various stormwater management features within the site:

Table 2.17C: TSS Removal by Treatment Train

Treatment Train	Structure	Starting Load	TSS Removal	Remaining Load
1	**Upper Forebay**	100%	25%	75%
	Rain Garden	75%	90%	7.5%
	Lower Forebay	7.5%	25%	5.6%
	Infiltration Pond	5.6%	80%	1.1%
2	**Lower Forebay**	100%	25%	75%
	Infiltration Pond	75%	80%	15%

A minimum of 85% removal is achieved throughout the development site. Catch basins were not included in the above calculations, but will also add additional treatment within the system.

d. the structural details for all components of the proposed drainage systems and stormwater management facilities

See attached plans.

e. notes on drawings specifying materials to be used, construction specifications, and typicals

See attached plans.

f. expected hydrology with supporting calculations

See attached Stormwater Calculations

2.18 Path and mechanism to divert uncontaminated water around disturbed areas, to the maximum extent practicable

All construction period runoff will be directed to the proposed forebay for treatment. Flows of uncontaminated water from surrounding areas onto the construction site will be minimal due to the fact that the proposed project is located on a hilltop.

2.19 Stormwater runoff calculations in accordance with the Department of Environmental Protection's Stormwater Management Policy. Include hydrologic and hydraulic design calculations for the pre-development and post-development conditions for the design storms specified in this Regulation. Such calculations shall include:

a. Description of the design storm frequency, intensity and duration; time of concentration

Rainfall values used for this project are as follows:

- 2-Year, 24-Hour rainfall – 3.15 inches
- 10-Year, 24-Hour rainfall – 4.69 inches
- 25-Year, 24-Hour rainfall – 5.86 inches
- 100-Year, 24-Hour rainfall – 8.29 inches

The 2, 10, and 25-year storms were used as the design storms for the stormwater management calculations. The 100-year storm was also analyzed to assess potential flooding or other detrimental impacts to the site and surrounding areas.

Times of concentration for each of the existing and proposed drainage areas are contained in the attached calculations.

b. Soil Runoff Curve Number (RCN) based on land use and soil hydrologic group

A summary of soil RCNs assumed for various areas are as follows:

Existing Site HSG A Areas: 30

Existing Site HSG B Areas: 58

Existing Site HSG C Areas: 71

Existing Site HSG D Areas: 78

Proposed HSG A Lawn Areas: 39

Proposed HSG B Lawn Areas: 61

Proposed HSG C Lawn Areas: 74

Proposed Pavement: 98

c. Peak runoff rates and for each watershed area

Table 2.19A: Peak Runoff Rates for Each Watershed

Point of Analysis	Storm (freq.)	Existing Peak Runoff (CFS)	Proposed Peak Runoff (CFS)
Wood Road Culvert (POA#1)	**2 yr**	0.18	0.24
	10 yr	1.78	1.78
	25 yr	3.85	3.61
	100 yr	9.51	10.66
Northern Wetland (POA#3)	**2 yr**	0.00	0.00
	10 yr	0.02	0.03
	25 yr	0.10	0.15
	100 yr	1.27	1.45
Ipswich River (POA#2)	**2 yr**	0.00	0.00
	10 yr	0.01	0.02
	25 yr	0.09	0.12
	100 yr	1.38	1.87

The 2, 10 and 25-year storms were considered as design storms for the analysis. The 100-year storm was also analyzed to investigate the possibility of flooding or other detrimental impacts at the individual points of analysis.

Table 2.19B: Peak Runoff Rates and Volumes for Entire Site

Location	Storm (freq.)	Existing Peak Runoff (CFS)	Proposed Peak Runoff (CFS)
Entire Site	**2 yr**	0.18	0.24
	10 yr	1.78	1.78
	25 yr	3.86	3.85
	100 yr	12.13	13.40

The 2, 10 and 25-year storms were considered as design storms for the analysis. The 100-year storm was also analyzed to investigate the possibility of flooding or other detrimental impacts to the overall site and surrounding areas.

The calculations indicate that the peak discharge rates will increase at the Northern Wetland and Ipswich River points of analysis for the 2, 10 and 25-year design storms, as shown in Table 2.19A. However, when the site is analyzed as a whole (Table 2.19B), the peak discharge rates is shown to generally be equal or slightly lower for the 2, 10, and 25-year storms (the increase of 0.06 CFS during the 2-year storm is assumed to be below the precision of the modeling software).

At the Wood Road Culvert point of analysis, the proposed peak discharge rates for the design storms are also shown to generally be equal to or below existing conditions, with the same 0.06 CFS increase during the 2-year storm which is assumed to be de-minimus.

d. Information on construction measures used to maintain the infiltration capacity of the soil where any kind of infiltration is proposed

Care will be taken by the contractor to minimize the amount of construction equipment that travels over the locations of the proposed bioretention area, forebay, and infiltration pond. The stormwater management features are generally located on the northern extent of the development site, so the need for construction equipment to travel over the proposed areas will be minimal.

e. Infiltration rates, where applicable

Beals Associates, Inc. observed deep hole excavations at the approximate locations of the proposed stormwater infiltration areas on July 30, 2014. A total of two observation holes were performed in these areas, with one hole (RG1) located at the top of the hill at the approximate location of the proposed rain garden, and a second hole (IP1) located at the bottom of the hill at the approximate location of the proposed stormwater infiltration area.

At RG1, the soils that were encountered at the approximate depth of the proposed bioretention area generally consisted of sand and loamy sand. These types of soils correspond with HSG A, and were conservatively estimated to have an infiltration capacity of 2.41 inches per hour based on the Rawls Rate methodology.

At IP1, the soils that were encountered at the depth of the proposed infiltration pond generally consisted of sandy loam which corresponds with HSG B. The soils in this area were estimated to have an infiltration capacity of 1.02 inches per hour based on the Rawls Rate methodology.

f. Culvert capacities

Refer to the attached stormwater calculations.

g. Flow velocities

Refer to the attached stormwater calculations.

h. Data on the increase in rate and volume of runoff for the specified design storms

See Section 2.19C

i. Documentation of sources for all computation methods and field test results

Rainfall data for this project was obtained from the Atlas of Precipitation Extremes for the Northeastern United States and Southeastern Canada, prepared by the Northeast Regional Climate Center at Cornell University.

2.20 Timing, schedules, and sequence of development including clearing, stripping, rough grading, construction, final grading, vegetative controls, and other stabilization measures

The project will be sequenced to ensure that proper erosion control and stabilization measures are put in place in a timely manner to avoid offsite transport of sediment.

Below is a general outline of the construction sequence for this project:

1. Preconstruction meeting
2. Install crushed stone stabilized construction entrance/exit
3. Install perimeter silt fencing
4. Install storm drainage features, including temporary inlet protection devices
5. Complete subgrade preparation for driveways, houses, walkways, etc.
6. Install base material as required for pavement
7. Construct all improvements shown on the plans
8. Remove temporary inlet protection around inlets no more than 48 hours prior to placing stabilized base course
9. Inspect and clean storm drainage system
10. Remove silt fencing after completion of paving and restoration of all exposed surfaces
11. Remove temporary construction exist only prior to pavement construction in these areas

2.21 A description of construction and waste materials expected to be stored on-site. The Plan shall include a description of controls to reduce pollutants from these materials, including storage practices to minimize exposure of the materials to stormwater, and spill prevention and response;

A Stormwater Pollution Prevention Plan (SWPPP) will be prepared for this project in order to comply with the EPA Construction General Permit. This document will include

full provisions for stormwater runoff and pollutant control. A copy of this document will be submitted to the Town of Hamilton prior to construction.

2.22 A maintenance schedule for the period of construction

See the attached Construction Period Operation and Maintenance Plan.

2.23 A description of provisions for phasing the project where one acre of area or greater is to be altered or disturbed

See Section 2.20

2.24 Plans must be stamped and certified by a qualified Professional Engineer registered in Massachusetts

See attached plans.

2.25 Low Impact Development Techniques

This development will be constructed using the most current ecologically-friendly Low Impact Development (LID) approaches to site development and storm-water management. LID designs aim to mimic natural hydrology and mitigate development impacts to land, water and air. This project utilizes a grassed swales, rain garden and infiltration area to naturally replenish groundwater and improve water quality. The soil conditions at this site are ideal for the LID concept. The project proponent also intends to use recycled construction materials for roadwork and building preparation including crushed concrete.

Soft methods of stormwater management include the implementation of bio filtration and rain gardens to treat runoff from paved surfaces. The majority of runoff will be infiltrated, providing groundwater recharge. All surface runoff from paved and impervious surfaces will be directed away from natural resource areas. The proposed roadway includes a continuous cross slope to allow the surface to shed runoff with minimal use of hard structures such as catch basins and manholes.

The proposed roadway has been designed to be 24 feet wide which provides a degree of safety for traffic passing in both directions without adding excess pavement for breakdown lanes. Grassed shoulders will also be installed for increased runoff infiltration. The proposed cul-de-sac has been designed to the minimum diameter possible in order to provide a safe travel way for fire department apparatus while minimizing the use of pavement.

The development features twelve (12) dwelling units clustered into nine (9) individual buildings and one triplex. This results in a much smaller development footprint than a

traditional residential subdivision that would feature twelve individual lots and single family homes.

The subsurface wastewater disposal system has been design to accommodate the entire development in one system rather than feature individual systems for each unit or building. This helps reduce the overall footprint of the project.

3.0 Erosion and Sediment Control

3.1 Erosion/Sediment Control Devices

The following erosion and sediment control devices shall be implemented by the Contractor as part of the site development. These devices shall be installed as indicated on the final construction plans and details. For additional reference, refer to the Stormwater Pollution Prevention Plan (SWPPP) for the project.

- Siltation fence shall be installed downstream of any disturbed areas to trap runoff borne sediments until the site has been stabilized. The silt fence shall be installed per the details on the construction plans and inspected immediately after each rainfall and at least daily during prolonged rainfall. Repairs shall be made immediately by the Contractor if there are any signs of erosion or sedimentation below the silt fence line. Proper placement of stakes and fabric into the ground is critical for the filter's effectiveness. If there are signs of undercutting at the center or the edges, or impounding of large volumes of water behind the fence, the barrier shall be replaced with a stone check dam.

- Catch basin inlet protection shall be installed in all on-site catch basins until binder is installed on proposed site access driveway

- Silt sacks shall be installed in all on-site catch basins following installation of binder on proposed site access driveway

- Stabilized construction entrances shall be constructed at the vehicular access point onto Asbury Street to prevent the tracking of soil onto public roadways.

- Stone check dams shall be installed in the vegetated swale, and shall be removed only after the grass has matured sufficiently to protect the waterway.

- Curlex blankets shall be installed as noted on the project plans to protect vegetated slopes adjacent to the proposed infiltration pond.

- Loam and seed is intended to serve as the primary permanent revegetative measure for all denuded areas not provided with other forms of stabilization.

- Dirtbag devices shall be used for temporary dewatering of trenches and foundation excavations.

3.2 Temporary Erosion and Sediment Control Measures

The following are planned as temporary erosion/sedimentation control measures during construction:

- Temporary stockpiles shall be stabilized within seven (7) days by either temporarily seeding the stockpile with a hydro seed method containing an emulsified mulch tackifier or by covering the stockpile with mulch.

- For work which is conducted between November 1 and April 15 of any calendar year, all denuded areas shall be stabilized within seven (7) days or immediately in advance of a predicted rainfall event.

- Asbury Street shall be swept to control mud and dust as necessary. A street sweeper shall be available on immediate notice.

- Temporary diversion berms may be used to direct runoff around work zones or to stabilize conveyance measures.

3.3 Timing and Sequence of Erosion/Sediment Control Measures

The following general construction sequence shall be required to insure the effectiveness of the erosion and sedimentation control measures will be optimized. The sequence applies to all phases of construction.

A. A preconstruction meeting shall be held by the Owner's engineer prior to land disturbing activities.
B. Install crushed stone stabilized construction entrance as shown on the construction plans
C. Install perimeter fencing.
D. Complete subgrade preparation for access driveway.
E. Install storm drainage features, including temporary inlet protection devices.
F. Complete subgrade preparation for driveways, houses, walkways, etc.

G. Install base material as required for pavement.
H. Construct all improvements shown on the plans.
I. Remove temporary inlet protection around inlets no more than 48 hours prior to placing stabilized base course.
J. Complete final grading.
K. Inspect and clean storm drainage system.
L. Remove silt fencing only after all paving is complete and exposed surfaces are stabilized.
M. Remove temporary construction exits only prior to pavement construction in these areas.

3.4 Provisions for the Maintenance of the Erosion/Sedimentation Control Features

This project is subject to the requirements of a US EPA NPDES permit and an accompanying Stormwater Pollution Prevention Plan (SWPPP.) These documents require the Contractor to prepare a list and designate by name, address and telephone number all individuals who will be responsible for implementation, inspection and maintenance of all erosion control measures identified within this section and as contained within the contract drawings. Specific responsibilities of the inspector(s) will include, but not be limited to:

- Execution of the Contractor/Subcontractor certification by any and all parties responsible for erosion control measures on the site as required by the SWPPP.

- Assuring and certifying the Owner's construction sequence is in conformance with the specified schedule of this section. A weekly certification stating compliance, any deviations, and corrective measures necessary to comply with the erosion control requirements of this section shall be prepared and signed by the inspector(s).

- In addition to the weekly certifications, the inspector(s) shall maintain written reports recording construction activities on site which include dates when major grading activities occur in a particular area; dates when major construction activities cease in a particular area, either temporary or permanent; dates when an area is stabilized.

- Inspection of the project work site at least once every seven (7) calendar days and before and after each significant rainfall event (0.1 inches or more in any 24-hour period) during construction until permanent erosion control measures have

been properly installed and the site has been stabilized. Inspection of the project work site shall include:

A. Identification of proper erosion control measure installation in accordance with the erosion control detail sheet or as specified in this section.
B. Determine whether each erosion control measure is properly operating. If not, identify damage to the control device and determine remedial measures.
C. Identify areas that appear vulnerable to erosion and determine additional erosion control measures that should be used to improve conditions.
D. Inspect areas of recent seeding to determine percent catch of grass. A minimum catch of 90 percent is required prior to removal of erosion control measures.
E. Record date of installation of sorbent bags in catch basins, dates of paving, dates removed, and the disposal method and location.

- If inspection of the site indicates a change should be made to the erosion control plan, either to improve effectiveness or correct a site-specific deficiency, the inspector shall immediately implement the corrective measure and notify the owner of the change.

Once construction has been completed, long term maintenance of the facilities will be the responsibility of the applicant.

4.0 Long Term Stormwater Operations and Maintenance

Stormwater management systems are an integral part of any development project. The complexity and goals of these systems vary with the nature of the receiving water, as well as the type of development proposed. In general, stormwater runoff from developed areas contains a number of contaminants which can have an adverse impact on receiving waters. The installation of stormwater management systems that are properly designed, installed and maintained can significantly reduce the non-point discharge from developed areas and also enhance the stormwater runoff quality. Source control measures, such as vacuuming, litter removal and prohibitions on pesticides can also significantly improve water quality by reducing the amount of pollutants entering the system.

This Long Term Stormwater Operations and Maintenance (O&M) Manual shall be implemented at the Patton Homestead development site to ensure that the stormwater management system functions as designed for the life of the system. The Owner has the primary responsibility for overseeing and implementing the O&M plan and ensuring proper operation and maintenance of the stormwater structures.

Future property owners shall also be notified of the presence of the stormwater management system and the requirements for proper implementation of the O&M plan.

Included in this manual are logs and inspection forms for tracking the inspections and maintenance. Refer to the project plans for the locations of stormwater management structures.

4.1 Responsibility

The purpose of the Stormwater Operations and Maintenance Manual is to ensure the inspection of the system, removal of accumulated sediments, oils and debris, and implementation of corrective action and record keeping activities. The ongoing responsibility is the Owner, its successors and assigns. Adequate maintenance is defined in this document as good working condition.

Contact information is provided below:

4.2 Responsibility for Operation and Maintenance

Name: C.P. Berry Residences, LLC

Address: 460 Boston Street, Suite 5

City, State: Topsfield, Massachusetts, 01983

Telephone: 978.887.1188

4.3 Documentation

An Inspection and Maintenance Record Log and Schedule shall be kept by the Owner or Property Manager summarizing inspections, maintenance, repairs and any corrective actions taken. The log will include the date on which each inspection or maintenance task was performed, a description of the inspection findings or maintenance completed, and the name of the inspector or maintenance personnel performing the task. If a maintenance task requires the clean-out of any sediments or debris, the location where the sediment and debris was disposed after removal will be indicated. Inspection and Maintenance Logs shall be kept on file at the property management office.

4.4 Maintenance Program

The Owner, Property Manager and maintenance staff shall conduct the Operation and Maintenance program set forth in this document. The Owner or Property Manager will ensure that inspections and record keeping are timely and accurate and that cleaning and maintenance are performed in accordance with the recommended frequency for each stormwater component. Inspection and Maintenance Log Forms (provided herein) shall include the date and amount of the last significant storm event in excess of on (1) inch of rain in a 24-hour period, physical conditions of structures, depth of sediment in structures, evidence of overtopping or debris blockage and maintenance required of each structure. The estimated annual cost of the Maintenance Program is approximately $5,000.

The following areas, facilities and measures will be inspected by the Owner or Property Manager and maintained as specified below. Identified deficiencies will be corrected. Accumulated sediments and debris will be properly handled and disposed of off-site, in accordance with local, state and federal guidelines and regulations. Refer to the attached Stormwater Management O&M Plan for the location of the components of the stormwater management system.

4.4.1 Routine Maintenance Tasks

- Routine maintenance of lawns, gardens, and other landscaped areas shall occur as necessary to maintain the property in a neat and orderly fashion. Clippings and/or mulch shall not be washed into the drainage infrastructure.

- Maintenance of the Stormwater Management System shall be in accordance with the Operations and Maintenance Checklist below.

- Snow shall be stored in a manner that does not impact the stormwater management system.

- Good housekeeping – all areas should be kept free of trash and debris. Any storage of materials and waste products shall be inside or under cover. Fertilizers, herbicides and pesticides, if stored on site, shall be stored properly contained and under over. Storage of salt or deicing chemicals, if any, shall be on impervious area, covered and protected from runoff.

4.4.2 Catch Basins and Manholes

Regular maintenance of catch basins and manholes is an essential piece of a stormwater operation and maintenance routine. Deep sump catch basins must be cleaned frequently in order to remain effective at removing pollutants. Once 50% of the sump volume is filled, a catch basin may not be able to retain additional sediment.

Deep sumps should be cleaned at least four times per year and at the end of the foliage and snow removal seasons. Sediments should also be removed four times per year or whenever the depth of deposits is greater than or equal to one half the depth from the bottom of the invert of the lowest pipe in the basin.

Clamshell buckets are typically used to remove sediment; however, vacuum trucks are preferable. Vacuum trucks remove more trapped sediment than clamshells, they are faster at removing sediment, and are less likely to damage the hood within the deep sump catch basin.

The safety of the staff cleaning deep sump catch basins should always be considered. Cleaning a deep sump catch basin within an active roadway or parking lot can be dangerous, and a police detail may be necessary to ensure the safety of workers.

Although catch basin debris often contains oil and hazardous material such as petroleum hydrocarbons and metals, MassDEP classifies the debris as solid waste. MassDEP does not require catch basin debris to be tested prior to disposal unless there is clear evidence that the debris has been contaminated. Contaminated catch basin debris must be evaluated in accordance with the Hazardous Waste Regulations, 310 CMR 30.000, and handled as hazardous waste.

In the absence of evidence of contamination, catch basin debris may be taken to a landfill or other facility permitted by MassDEP to accept solid waste without any prior approval by MassDEP. However, some landfills may require testing before they accept the debris.

4.4.3 Street Sweeping

Paved areas within the site shall be swept once a year after snowmelt to prevent clogging of catch basins and manholes. The Owner shall be responsible for street sweeping.

4.4.4 Infiltration Pond, Biofiltration Area, and Forebay

These areas shall be inspected yearly during wet weather to ensure that they are functioning as designed. At least twice during the growing season, basin side slopes, emergency spillways and embankments should be mowed and accumulated trash and debris removed. Sediment shall be removed as necessary, but not less than once every 10 years.

The flared end outlets should be inspected bi-monthly the first year, and accumulated sediment shall be removed. Vegetated slopes at the outlets should be inspected for erosion, and any depressions or channels should be repaired. Bare areas should be seeded.

Responsibility for the long term maintenance of the detention basins will be that of the owner.

4.4.5 Vegetated Swales / Grass Channels

Swales shall be inspected on a semi-annual basis for slope integrity, soil moisture, vegetative health, soil stability, soil compaction, soil erosion, ponding and sedimentation.

Regular maintenance should include mowing, pruning, and weed/pest control. Swales should be mowed at least once per year. Grass should not be cut shorter than four (4) inches.

Sediment and debris should be removed manually at least once per year, or when the sediment depth reaches three (3) inches. Periodic reseeding may be required.

Responsibility for the long term maintenance of the vegetated swales and grass channels will be that of the owner.

4.5 Winter Maintenance Program

Ensure structures are not blocked by ice, snow, debris or trash during winter months. Snow shall be stored in a manner that does not impact the stormwater management system.

4.6 Fertilizer

The goal of fertilizer use should be to enhance the ground cover of the facility, but not result in adverse water quality impacts. The following guidelines are recommended.

4.6.1 Fertilizer Selection

Only slow-release organic low phosphorus fertilizers shall be used in any landscaped areas to limit the amount of nutrients that could enter the stormwater management system.

4.6.2 Fertilizer Storage

Fertilizer should be stored in a weatherproof area with containers protected from damage. Fertilizer from any damaged containers should be placed in appropriate weatherproof containers.

4.6.3 Fertilizer Application

Fertilizer should be applied with appropriate mechanical equipment properly calibrated to meet the recommended application rates of the soil tests and manufacturer. The Owner or his agents should instruct personnel on the use of equipment and the proper measurement of the fertilizer.

Personnel assigned to application of fertilizer should be instructed that over-application of fertilizer can have adverse impacts on the landscaped areas and the environment. Fertilizer should not be applied to steep slopes, saturated ground, during periods of precipitation, or immediately prior to major rain events.

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Stormwater Management System Maintenance Program Summary Checklist					
		Frequency			
Item	Commentary	Monthly	Quarterly	Semi-Annual	Annual
Catch Basins and Manholes	Inspect for sediment quarterly; inspect at tend of foliage and at end of snowmelt; remove upon accumulation		X		
Infiltration Basin	Inspect for accumulated sediment immediately after construction; inspect semi-annually thereafter			X	
Biofiltration Area	Inspect for accumulated sediment immediately after construction; inspect semi-annually thereafter			X	
Forebays	Inspect for accumulated sediment immediately after construction; inspect semi-annually thereafter			X	
Grass Channel	Inspect for accumulated sediment immediately after construction; inspect semi-annually thereafter			X	
Street Sweeping	Inspect daily for accumulated sediment in roadways near construction entrance/exit				X

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STORMWATER MANAGEMENT SYSTEM
OPERATIONS AND MAINTENANCE MANUAL
PATTON HOMESTEAD

CATCH BASINS/MANHOLES

Name of Inspector: _____ Title of Inspector: _____

Inspector's Signature: _____

Inspection Date	Satisfactory			Location	Maintenance Needed and Description	Implementation Date of Maintenance
	Yes	No	N/A			

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BIOFILTRATION AREA AND FOREBAY

Name of Inspector: _____Title of Inspector: _____

Inspector's Signature: _____

Inspection Date	Satisfactory			Location	Maintenance Needed and Description	Implementation Date of Maintenance
	Yes	No	N/A			

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STORMWATER MANAGEMENT SYSTEM
OPERATIONS AND MAINTENANCE MANUAL
PATTON HOMESTEAD

DETENTION POND AND FOREBAY

Name of Inspector: _____Title of Inspector: _____

Inspector's Signature: _____

Inspection Date	Satisfactory			Location	Maintenance Needed and Description	Implementation Date of Maintenance
	Yes	No	N/A			

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STORMWATER MANAGEMENT SYSTEM
OPERATIONS AND MAINTENANCE MANUAL
PATTON HOMESTEAD

VEGETATED SWALES/GRASS CHANNELS

Name of Inspector: _____Title of Inspector: _____

Inspector's Signature: _____

Inspection Date	Satisfactory			Location	Maintenance Needed and Description	Implementation Date of Maintenance
	Yes	No	N/A			

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Appendix A

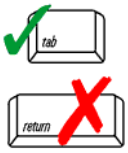
MassDEP Checklist for Stormwater Report

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.

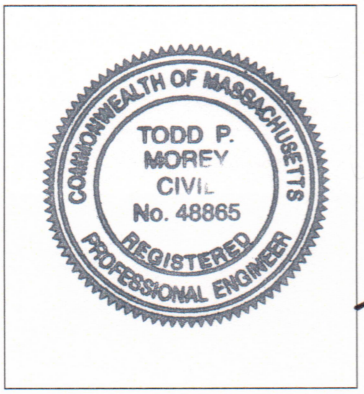
Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the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



11.25.14

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

Documenting Compliance

Documenting Compliance

Items in bold below indicate how the proposed project will comply with each of the Stormwater Management Standards.

REQUIRED DOCUMENTATION INCLUDING COMPUTATIONS FOR EACH STORMWATER STANDARD

STANDARD 1. NO UNTREATED DISCHARGES OR EROSION TO WETLANDS

Applicants must demonstrate that there are no new untreated discharges. To demonstrate that all new discharges are adequately treated, applicants may rely on the computations required to demonstrate compliance with Standards 4 through 6. No additional computations are required.

To demonstrate that new discharges do not cause or contribute to erosion in wetlands or waters of the Commonwealth, the following computations are provided.

To evaluate whether the discharge will cause erosion or scour, the first step is to determine the stormwater discharge velocity at each outlet. The second step is to perform computations and select materials or practices to reduce that velocity or armor the ground to withstand the shearing force caused by the discharged stormwater.

Stormwater Discharge Velocity: Determine maximum discharge or velocity at each outlet for all conveyances. The maximum discharge or velocity is dependent on the size of the conveyance. Include gravitational forces in the computations when proposing to discharge stormwater above the receiving practice. Tailwater conditions in the receiving wetland must also be factored into the analysis. For sheet flow, the maximum velocity to evaluate is the runoff from the 2-year 24-hour storm. Engineers shall select an accepted method to determine maximum velocity.

All new stormwater discharges are routed into forebays prior to discharge to the infiltration pond. Additional detail related to the treatment train can be found in the computations demonstrating compliance with Standards 4 and 6 within this document.

The outfall discharge velocities have been calculated for each stormwater catchment area. A table of outlets and their associated velocities are listed below.

Outlet	Max Velocity
Wood Road Culvert (POA#1)	0.8
Northern Wetland (POA#2)	1.8
Ipswich River (POA#3)	2.3
*Velocity units in feet per second (fps)	

Ability of Ground Surface to Resist Erosion: Determine ability of ground or lining materials to resist erosion from the velocity computed in part (a). Banks opposite a stormwater discharge point may need to be evaluated to assess their ability to resist scour when banks are close to the outlets (e.g., a narrow stream channel). This may be done by performing computations to estimate the size/weight of stone or bioengineered materials needed to resist the force of water or comparing the discharge velocity against a "permissible velocity table" that provides information on the ability of different types of materials/vegetation to resist shear.

All new stormwater discharges have been calculated. Beals Associates, Inc. has proposed to loam and seed all disturbed surfaces to protect against scour and erosion of lawn areas.

The references that follow include several different computational methods and permissible velocity tables that are acceptable.

Channel Slope	**Lining** [1]	**Permissible Velocity (feet/second)**
0 - 5%	Tall fescue Kentucky bluegrass Grass-legume mixture Red fescue Redtop Sericea lespedeza Annual lespedeza Small grains	5 4 2.5
5 - 10%	Tall fescue Kentucky bluegrass Grass-legume mixture	4 3
Greater Than 10%	Tall fescue Kentucky bluegrass	 3

Table 2.3.1: Example of Permissible Velocity Table, Modified from Soil and Water Conservation Engineering, 1992, Schwab et al, John Wiley and Sons

All new stormwater discharges have been calculated. Beals Associates, Inc. has proposed to loam and seed all disturbed surfaces to protect against scour and erosion of lawn areas.

[1] Before selecting a vegetated lining, consult the list of plants banned for sale, trade, purchase, or distribution in Massachusetts by the Department of Agricultural Resources, pursuant to M.G.L. Chapter 128 Section 2 and Sections 16 through 31A. See http://www.mass.gov/agr/farmproducts/proposed_prohibited_plant_list_v12-12-05.htm

STANDARD 2. PEAK RATE ATTENUATION

The stormwater management system was designed to manage post development peak runoff to not exceed pre-development peak runoff for the 2, 10, and 25 year storms. The 100-year storm was also analyzed to assess for potential flooding or other detrimental impacts to the site and surrounding areas. Please see the attached HydroCAD analysis for details. The table below is a summary of the peak runoff rates at each discharge point.

Table 3- Peak rates of Runoff

Drainage Area	**2-year 2.79”**		**10-year 4.15”**		**25-year 5.19”**		**100-year 7.34”**	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Wood Road Culvert	0.18	0.24	1.78	1.78	3.85	3.61	9.51	10.66
Northern Wetland	0.00	0.00	0.02	0.03	0.10	0.15	1.27	1.45
Ipswich River	0.00	0.00	0.01	0.02	0.09	0.12	1.38	1.87
Entire Site	0.18	0.24	1.78	1.78	3.86	3.85	12.13	13.40

The table shows that over the entire site, peak discharges during the 2, 10, and 25-year storms under the proposed conditions are generally equal to or below the existing conditions. The increase of 0.06 CFS during the 2-year storm is assumed to be below the precision of the modeling software.

STANDARD 3. STORMWATER RECHARGE

Required Computations or Demonstrations:

Multiple computations are necessary:

a. Impervious Area
b. Required Recharge Volume
c. Bottom Area Sizing for Infiltration Structures

See below and MassDEP *Hydrology Handbook for Conservation Commissioners*, Chapter 8.

RECHARGE REQUIREMENTS

- Minimum infiltration rate: Must be at least 0.17 inches/hour at the actual location where infiltration is proposed on site soil. No stormwater recharge systems shall be sited in soils that infiltrate lower than 0.17 inches/hour[2] due to the potential for failure.
  - When "*Static"* or " *Simple Dynamic"* Methods are used to size the recharge practice: whether the soils exfiltrate faster than 0.17 inches/hour is determined based on a soil textural analysis (see Soil Evaluation Section in this Chapter) and the rates specified by Rawls 1982 (See Table 2.3.3).
  - When the "*Dynamic Field"* method is used: whether the soils exfiltrate faster than 0.17 inches/hour is based on 50% of the actual in-situ *saturated hydraulic conductivity* rate. (See Soil Evaluation Section in this Chapter).
- Rapid Infiltration Rate: Rapid infiltration rate for purposes of stormwater infiltration is considered to be *saturated hydraulic conductivity* greater than 2.4 inches/hour (25 mpi) at the specific location(s) where infiltration is proposed.
  - When "*Static"* or " *Simple Dynamic"* Methods are used for design, use rate specified by Rawls 1982 (see Table 2.3.3) for the soil type at the location where infiltration is proposed based on a soil textual analysis (see Soil Evaluation Section of this Chapter) to determine whether soil is classified as having a rapid infiltration rate.
  - When the "*Dynamic Field"* Method is used for design: 50% of the actual *in-situ saturated hydraulic conductivity* rate is used to determine whether the soil has a rapid infiltration rate.
    - *Example*: If the *in-situ* rate established by field-testing is 5.1 inches/hour (11.8 mpi), 50% of that rate = 2.55 inches/hour (23.6 mpi). The soil has a rapid infiltration rate, since 2.55 inches/hour>2.4 inches/hour.
- TSS Pretreatment: Stormwater Infiltration BMPs are infiltration basins, infiltration trenches, dry wells, subsurface infiltration structures and bioretention cells configured specifically to exfiltrate.
  - At least 44% TSS pretreatment is required prior to discharge to the stormwater infiltration BMP when:
    - The infiltration BMP is located within an area with a rapid infiltration
    - Runoff from a land use with a higher potential pollutant load (LUHPPL) is directed to the infiltration BMP.
    - The infiltration BMP is located within a Zone II or an Interim Wellhead Protection Area (IWPA) of a Public Drinking Water Source/Supply.
    - The discharge from the infiltration BMP is to or near another *critical area.* These critical areas are Outstanding Resource Waters, Special Resource Waters, shellfish growing areas, bathing beaches, and cold-water fisheries.
  - At least 80% TSS pretreatment is required prior to discharge to stormwater infiltration BMP when:
    - The "*Dynamic Field"* method is proposed for sizing purposes.

[2] According to Rawls 1982, the lower end of soils assigned to Hydrologic Soil Group C have an average infiltration rate of 0.17 inches per hour. See Table 2.3.3. Hydrologic Soil Groups A and B are more conducive to stormwater recharge than "C" soils, so care must be exercised when designing stormwater recharge system in "C" soils.

SOIL EVALUATION

An evaluation must be undertaken to classify the Hydrologic Soil Groups (HSG) soils on site using classification methodologies developed by U.S. Natural Resources Conservation Service (NRCS). The Hydrologic Soil Groups are used in conjunction with impervious areas on a site to calculate the *Required Recharge Volume*. The following steps are required, and were performed, to identify the Hydrologic Soil Groups at English Common:

STAGE 1) Review NRCS (formerly SCS) Soil Surveys

A review of the NRCS Soil Survey was conducted, and results are included within the Stormwater Management Report. The soils at the site were classified as Hydrologic Groups A, B, C and D. Please find a description of the soils from the NRCS Web Soil Survey within this report.

STAGE 1A) Site Visit

After completion of STAGE 1, a "*Competent Soils Professional*[3]" must conduct a site visit to confirm the NRCS soil survey. The site visit will allow for observation of noticeable deviations in site conditions (i.e., bedrock outcrops, open gravel/sand areas, recent filling). The site visit must establish whether the on-site soils have been disturbed, filled, or altered in a way that affects the natural drainage of the site.

The "*Competent Soils Professional"* shall perform the following tasks:

a. Conduct site visit. Determine whether any noticeable deviations on site exist from the NRCS Soil Survey (i.e., bedrock outcrops, open gravel/sand areas, recent filling). Determine whether the on-site soils have been disturbed, filled, or altered in any way.

   Beals Associates, Inc. performed numerous visits to the site throughout the design process. Both visual observations and historical accounts indicate that the proposed development area has previously been cleared, and soil excavation is likely to have taken place during the site's use as a sand and gravel deposit.

b. Review any existing field test pit data and available boring logs and compare with NRCS information published in the Soil Survey. Boring logs and test pit data often indicate the soil textural class and varying soil strata (i.e., restrictive layers) and may assist in further refinements of soil delineations.

   Beals Associates, Inc. observed deep hole excavations at the approximate locations of the proposed stormwater infiltration areas on July 30, 2014.

[3] A *Competent Soils Professional* is an individual with demonstrated expertise in soil science, including, but not limited to, a Massachusetts Registered Professional Engineer, Engineer in Training (EIT certificate) with a concentration in civil, sanitary or environmental engineering, or Bachelor of Arts or Sciences degree or more advanced degree in Soil Science, Geology, or Groundwater Hydrology from an accredited college or university.

c. Review any existing USGS geologic maps for general rock types and bedrock depths. The presence of bedrock, including rock outcrops, is a significant factor in the potential for groundwater recharge. Knowledge of the bedrock and rock type at the site will be beneficial in further characterizing existing recharge conditions.

Data from USGS geologic maps, visual observations, and subsurface explorations were was used to determine the location and extent of bedrock within the proposed development site. Bedrock is expected generally be present at depths greater than 60 inches throughout the site.

d. Review available aerial photographs. If a detailed site map is not available at the time of the initial investigation, an aerial photograph may provide additional information for delineating impervious and pervious areas.

Aerial photographs have been reviewed and verified by site visits and on the ground survey of the project area. Aerial photography from 2008 shows the existing development area. Previously this area was used as a sand and gravel deposit.

e. When the Soil Survey does not identify the Hydrologic Soil Group(s) at the site or when the site conditions are not consistent with the NRCS Soil Survey, the *Competent Soils Professional* shall complete STAGE 1B. When the NRCS Soil Survey identifies the Hydrologic Soil Group(s) at the site, and the STAGE 1A investigation indicates site conditions are consistent with the NRCS Soil Survey, proceed to STAGE 2.

The Stage 1A investigation indicated that site conditions are generally consistent with the NRCS soil survey.

STAGE 1B) Additional Measures When the NRCS Soil Survey Does Not Identify Hydrologic Soil Group(s) At the Site or When Site Conditions Are Found That Are Inconsistent with the NRCS Soil Survey

STAGE 2) Determine Site Conditions at Specific Location Where Recharge is Proposed

The areas of proposed recharge are currently covered by a mowed meadow.

STAGE 3) Identify Hydrologic Soil Groups On-site and At Location Where Recharge Proposed

Beals Associates, Inc. observed deep hole excavations at the approximate locations of the proposed stormwater infiltration areas on July 30, 2014. A total of two observation holes were performed in these areas, with one hole (RG1) located at the top of the hill at the approximate location of the proposed rain garden, and a second hole (IP1) located at the bottom of the hill at the approximate location of the proposed stormwater infiltration area.

At RG1, the soils that were encountered at the approximate depth of the proposed bioretention area generally consisted of sand and loamy sand. These types of soils correspond with Hydrologic Soil Group A.

At IP1, the soils that were encountered at the depth of the proposed infiltration pond generally consisted of sandy loam which corresponds with Hydrologic Soil Group B.

STAGE 4: Prepare a Plan identifying Hydrologic Soil Groups for the Site

Refer to Sheet C-303 Existing Watershed Plan and Sheet C-304 Proposed Watershed Plan of the project plans which identify Hydrologic Soil Groups for the site.

CONTRIBUTING DRAINAGE AREA

The contributing drainage area must be determined for purposes of determining compliance with Standards 2, 3, and 4. The contributing drainage area for Standard 2 includes all areas contributing drainage to a site, including off-site locations. For purposes of Standards 3 and 4, only the impervious areas on the project site are used for purposes of calculating the *Required Recharge Volume* and the *Required Water Quality Volumes.*

Refer to Sheet C-303 Existing Watershed Plan and Sheet C-304 Proposed Watershed Plan of the project plans which identify contributing drainage areas for the existing and proposed conditions.

IMPERVIOUS AREA

Impervious area must be determined in order to calculate the *Required Recharge Volume* and the *Required Water Quality Volume.* The impervious area is a subset of the contributing drainage area. For purposes of Standards 3 and 4, impervious surfaces include roads, rooftops, parking lots, and sidewalks, when they are paved with concrete, asphalt, or brick pavers. Various credits can be used to reduce the *Required Recharge Volume* and the *Required Water Quality Volume,* for Standards 3 and 4. See LID Site Design Credit Section of this Chapter.

Porous pavement is considered to be an impervious surface for purposes of calculating the *Required Water Quality Volume* and the *Required Recharge Volume.* When using porous pavement, the larger of the *Required Water Quality Volume* or *Required Recharge Volume* must be used to size the storage media under the porous pavement.

Similarly, a green roof is considered to be an impervious surface for purposes of sizing the growing media that treats the *Required Water Quality Volume* and determining the total *Required Recharge Volume* for the site. A green roof is a treatment device and does not recharge the groundwater.

RECHARGE VOLUME

STEP 1) REQUIRED RECHARGE VOLUME

Calculate *Required Recharge Volume*.[4] The *Required Recharge Volume* equals a depth of runoff corresponding to the soil type times the impervious areas covering that soil type at the post-development site.

Rv = F x impervious area *Equation (1)*

Rv = *Required Recharge Volume*, expressed in Ft^3, cubic yards, or acre-feet
F = Target Depth Factor associated with each Hydrologic Soil Group
Impervious Area = pavement and rooftop area on site

Attention must be given to ensure consistency in units. In particular, the Target Depth Factors must be converted to feet.

NRCS HYDROLOGIC SOIL TYPE	APPROX. SOIL TEXTURE	TARGET DEPTH FACTOR (F)
A	sand	**0.6-inch**
B	loam	**0.35-inch**
C	silty loam	**0.25-inch**
D	clay	**0.1-inch**

Table 2.3.2: Recharge Target Depth by Hydrologic Soil Group

The proposed project contains approximately 75,934 S.F. of impervious surface, including buildings, parking, driveways and walkways. The soils underlying the site are classified as Hydrologic Soil Type B, based on NRCS Soil Survey of site soils. The calculations below determine the required volume of recharge based on a target depth factor of 0.35 inches for Type B soils.

Calculated required recharge volume:

Class B impervious Areas = 75,934 s.f. x (0.35 in.) x (1 ft / 12 in.) = 2,215 c.f.

Total = 2,215 c.f. recharge

Evaluate Where Recharge Is Directed

[4] MassDEP recognizes that along MassHighway Projects, because of right-of-way limitations it may be difficult to recharge the *Required Recharge Volume* at every point along redevelopment and add-a-lane projects. MassHighway may use a macro approach to meet this requirement by recharging more than the *Required Recharge Volume* at certain locations within a subwatershed (rest stops, exit ramps, median strips) to compensate for other locations within the same subwatershed where it is not able to infiltrate the *Required Recharge Volume*. MassDEP and MassHighway intend to work together to revise the 2004 MassHighway Handbook for Highways and Bridges to elaborate on this approach as it applies to redevelopment and add-a-lane projects and to reflect the 2008 changes to the Stormwater Management Standards.

The infiltration BMP must be evaluated to determine if the proposed recharge location will alter a Wetland Resource Area by causing changes to the hydrologic regime. For example, if Watershed "A" contains a vernal pool within a Bordering Vegetated Wetland, and the vernal pool is fed by groundwater, and runoff from Watershed "A" is proposed to be directed to Watershed "B" for infiltration, an evaluation is necessary to determine if redirecting the runoff will cause an alteration to the vernal pool. In such instances, Water Budgeting using the Thornthwaite method or equivalent must be employed. TR-20/TR-55 methods are not sufficient for water budgeting purposes. Water budgeting analysis is not required, if the recharge is directed to the same subwatershed where the impervious surfaces are proposed.

STEP 2) SIZING STORAGE VOLUME

Determine the Storage Volume. The Storage Volume is the volume of the basin, chamber, or voids that must be constructed in order to hold the *Required Recharge Volume*. Three methods may be used to determine the Storage Volume:

1. The "*Static" Method;*
2. The "*Simple Dynamic" Method;* or
3. The "*Dynamic Field" Method.*

The "*Static*" Method assumes that there is no exfiltration until the entire recharge device is filled to the elevation associated with the *Required Recharge Volume*.

The two "*Dynamic"* Methods assume stormwater exfiltrates into the groundwater as the storage chamber is filling. [5] The *"Simple Dynamic"* Method assumes that the *Required Recharge Volume* is discharged to the infiltration BMP over 2 hours and exfiltrates over the 2-hour period at the Rawls Rate.

The "*Dynamic Field"* Method assumes that the *Required Recharge Volume* discharges to the infiltration BMP over 12 hours and infiltrates at no more than 50% of the *in-situ saturated hydraulic conductivity rate*.[6] The "*Static"* Method produces a larger storage volume than either *Dynamic* Method and produces the most conservative result. The "*Dynamic Field"* Method may be used only for sizing an infiltration BMP that is used solely for disposal of stormwater (i.e., 80% TSS removal must occur prior to directing runoff to the infiltration BMP)[7].

[5] Rich Claytor**,** Bethany Eisenberg, and Tom Maguire were instrumental in the development of the two *Dynamic* Methods**.**

[6] 50% is used as a factor of safety to represent the anticipated long-term exfiltration rate due to clogging of the underlying media/soil that occurs over time.

[7] Even if 80 % TSS removal is not required because the *"Dynamic Field"* Method has been used to size the infiltration BMP, 44% TSS removal may be required prior to discharge to the infiltration BMP. 44% TSS removal is required prior to discharge to an infiltration BMP if the *saturated hydraulic conductivity* is greater than 2.4 inches/hour based on the Rawls Rate for the "*Static"* and "*Simple Dynamic"* Methods. 44% TSS removal is also required prior to discharge to the infiltration BMP if runoff is from a LUHPPL or directed to a Zone II or IWPA, or near or to another critical area.

When using the "*Static"* or "*Simple Dynamic"* Methods, only a textural soil analysis is required to determine the corresponding Hydrologic Soil Group. Textural soil analysis is explained in the Hydrologic Soil Group Section above. The "*Dynamic Field"* Method requires more soil testing to determine the *in-situ saturated hydraulic conductivity.*

STEP 3) *STATIC* METHOD:

a. Assume the entire *Required Recharge Volume* determined by following the procedures set forth in STEP 1 is discharged to infiltration device before infiltration begins.

b. Size the volume of the basin, chamber or total voids to hold the *Required Recharge Volume* determined under STEP 1.

c. Go to STEP 5 to confirm that the bottom of the infiltration BMP is large enough to ensure that the system will completely drain in 72 hours or less.

STEP 4) Dynamic Method.

STEP 5) DRAWDOWN WITHIN 72 HOURS

Use the same infiltration rate that is used for sizing the infiltration BMP to confirm that the infiltration BMP will drain completely within 72 hours. For the "*Static"* and "*Simple Dynamic"* Methods, the Rawls Rates associated with the slowest of the Hydrologic Soil Groups determined to exist at the point where recharge is actually proposed shall be used. For the "*Dynamic Field"* Method, 50% of the lowest value obtained from the test results for *saturated hydraulic conductivity* measured in the field at the actual location and soil layer where recharge is proposed shall be used.

a. For infiltration BMPs sized using the "*Static"* Method or the "*Simple Dynamic*" Method, the drawdown analysis is based on the *Required Recharge Volume* exfiltrating at the Rawls Rates based on the soil textural analysis conducted at the proposed exfiltration location. The slowest Rawls Rate (1982) at the actual location where the recharge is proposed is used for purposes of the drawdown analysis.
b. For infiltration BMPs sized using the "*Dynamic Field"* Method, the drawdown analysis must be based on the *Required Recharge Volume* infiltrating at 50% of the lowest *in-situ saturated hydraulic conductivity* rate at the location and specific soil layer where exfiltration is proposed.
c. The infiltration rate shall be assumed to be constant for purposes of the drawdown analysis. [8]
d. Only the bottom surface shall be considered. No credit shall be afforded to sidewall exfiltration.
e. If the drawdown analysis indicates the entire volume cannot be drawn down within 72 hours, the bottom area of the infiltration BMP must be increased or the *Required*

[8] The drawdown analysis also assumes that the water table does not fluctuate during the draw down period.

Recharge Volume must be reduced. The *Required Recharge Volume* may be reduced by reducing the amount of impervious surfaces on the site or by taking advantage of the Low Impact Development Site Design Credits.

To determine whether an infiltration BMP will drain within 72 hours, the following formula must be used[9]:

$$Time_{drawdown} = \frac{Rv}{(K)(Bottom\ Area)}$$

Where:
Rv = Required Recharge Volume
K = Saturated Hydraulic Conductivity For "Static" and "Simple Dynamic" Methods, use Rawls Rate (see Table 2.3.3). For "Dynamic Field" Method, use 50% of the in-situ saturated hydraulic conductivity.
Bottom Area = Bottom Area of Recharge Structure[10]

The required recharge will be routed from roofs, paved areas, and grassed areas through a closed drainage system as well as a vegetated swale into an infiltration pond. A Rawls Infiltration Rate of 1.02 inches per hour was assumed for the following calculation. This was based on the results of direct observations of soil characteristics at the approximate location of infiltration during deep hole testing.

Drawdown Time = 2,215 c.f. / (1.02 inch/hr) x (1 foot/12 inch) x (1,459 s.f.) = 17.86 hours

9 In some cases, the infiltration structure may be designed to treat the *Required Water Quality Volume* and/or to attenuate peak discharges in addition to infiltrating the *Required Recharge Volume*. In that event, the storage volume of the structure must be used in the formula for determining drawdown time in place of the *Required Recharge Volume*.

10 To account for the porosity of the stone, a different formula is required to determine whether the Required Recharge Volume drains within 72 hours if the infiltration structure is a trench filled with stone**.** In that event, the drawdown time would be calculated as follows with n = porosity of the stone:

$$Time_{drawdown} = \frac{Rv}{(K)(Trench\ Bottom\ Area)(n)}$$

Table 2.3.3. 1982 Rawls Rates[11]

Texture Class	NRCS Hydrologic Soil Group (HSG)	Infiltration Rate Inches/Hour
Sand	A	8.27
Loamy Sand	A	2.41
Sandy Loam	B	1.02
Loam	B	0.52
Silt Loam	C	0.27
Sandy Clay Loam	C	0.17
Clay Loam	D	0.09
Silty Clay Loam	D	0.06
Sandy Clay	D	0.05
Silty Clay	D	0.04
Clay	D	0.02

OTHER CONSIDERATIONS FOR STANDARD 3
CAPTURE AREA ADJUSTMENT: DETERMINING IF ENOUGH RUNOFF IS DIRECTED TO THE RECHARGE PRACTICE[12]

Sufficient runoff must be directed to the infiltration BMPs to ensure infiltration of the *Required Recharge Volume.*

MOUNDING ANALYSIS

Mounding analysis is required when the vertical separation from the bottom of an exfiltration system to seasonal high groundwater is less than four (4) feet *and* the recharge system is proposed to attenuate the peak discharge from a 10-year or higher 24-hour storm (e.g., 10-year, 25-year, 50-year, or 100-year 24-hour storm).

Initial soil testing to the south of the proposed infiltration pond indicates that redoxymorphic features were present at approximately 31 inches below the ground surface. Based on these results, a mounding analysis may be required. Additional soil testing will be performed prior to obtaining a stormwater management permit from the Town of Hamilton which will confirm or refute these assumptions.

STANDARD 4. WATER QUALITY

Source Control and Pollution Prevention Measures must be identified in the Pollution Prevention Plan[13]

[11] Rawls, Brakensiek and Saxton, 1982

[12] A similar adjustment must be made if runoff from all impervious surfaces is not directed to the treatment BMPs.

[13] See Volume 1, Chapter 1 and Volume 2, Chapter 1.

Computations that are or may be necessary:

a. Required Water Quality Volume
b. TSS removal rate
c. Weight determination

WATER QUALITY TREATMENT VOLUME[14]

V_{WQ} = (D_{WQ}/12 inches/foot) * (A_{IMP} * 43,560 square feet/acre) ***Equation (2)***

V_{WQ} = *Required Water Quality Volume* (in cubic feet)
D_{WQ} = Water Quality Depth: one-inch for discharges within a Zone II or Interim Wellhead Protection Area, to or near another critical area, runoff from a LUHPPL, or exfiltration to soils with infiltration rate greater than 2.4 inches/hour or greater; ½-inch for discharges near or to other areas.
A_{IMP} = Impervious Area (in acres)

TSS REMOVAL PERCENTAGE COMPUTATIONS

Treatment Train	Structure	Starting Load	TSS Removal	Remaining Load
1	**Upper Forebay**	100%	25%	75%
	Rain Garden	75%	90%	7.5%
	Lower Forebay	7.5%	25%	5.6%
	Infiltration Pond	5.6%	80%	1.1%
2	**Lower Forebay**	100%	25%	75%
	Infiltration Pond	75%	80%	15%

For stormwater discharges that require 44% TSS pretreatment (e.g., within areas with rapid infiltration rates, Zone IIs, Interim Wellhead Protection Areas, or near or to other Critical Areas), the form must also be submitted to demonstrate that 44% TSS removal has been achieved prior to discharge to an infiltration BMP.

The proposed development site is located within a Zone II Wellhead Protection Area. See the TSS Removal Calculations provided above.

[14] Some proprietary BMPs are sized based on a flow rate. Applicants proposing such BMPs must provide documentation that the BMPs have been sized to treat the *Required Water Quality Volume.* MassDEP intends to provide detailed guidance on how to convert a flow rate to the *Required Water Quality Volume.*

STANDARD 5. LAND USES WITH HIGHER POTENTIAL POLLUTANT LOADS

The single family residences proposed at the site are not considered to be a land use with higher pollutant loads.

STANDARD 6. CRITICAL AREAS

Required Computations or Demonstrations

Standard 6 applies to discharges within Zone II, Interim Wellhead Protection Areas or near or to other Critical Areas: Shellfish Growing Areas, Bathing Beaches, Outstanding Resource Waters, Special Resource Waters, and Cold-Water Fisheries.

Source control and pollution prevention prevention measures must be identified in a long-term pollution prevention plan.

Use BMPs determined to be suitable for the particular critical area.
One-inch rule is used to calculate the *Required Water Quality Volume.*
44% TSS removal must be achieved prior to discharge to the infiltration BMP.

The site is located within a Zone II Wellhead Protection Area. TSS Removal Calculations are provided below:

Treatment Train	Structure	Starting Load	TSS Removal	Remaining Load
1	**Upper Forebay**	100%	25%	75%
	Rain Garden	75%	90%	7.5%
	Lower Forebay	7.5%	25%	5.6%
	Infiltration Pond	5.6%	80%	1.1%
2	**Lower Forebay**	100%	25%	75%
	Infiltration Pond	75%	80%	15%

STANDARD 7. REDEVELOPMENT

This project will not be considered a redevelopment project.

STANDARD 8. CONSTRUCTION PERIOD CONTROLS

Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan as required by Standard 8.[15]

A Construction Period Storm Water Pollution Prevention Plan and Erosion and Sedimentation Control Plan have been prepared for the project. Copies of the plans are attached to this document.

STANDARD 9. OPERATION AND MAINTENANCE PLAN

Operation and Maintenance Plan as required by Standard 9 must be submitted.[16]

A Long Term Operation and Maintenance Plan has been prepared for the project. A copy is attached to the Stormwater Management Report.

No computations are necessary.

STANDARD 10. ILLICIT DISCHARGES TO DRAINAGE SYSTEM

Measures to prevent illicit discharges must be included in Pollution Prevention Plan. Illicit Discharge Compliance Statement must be submitted[17].

No illicit discharges to the drainage system have been made. An illicit discharge statement is attached to this document.

No computations are necessary.

LOW IMPACT DEVELOPMENT SITE DESIGN CREDITS

Low impact development site design credits are not being requested.

[15] For projects subject to jurisdiction under the Wetlands Protection Act, the construction period pollution prevention erosion and sedimentation control plan should be included as part of the Stormwater Report submitted with the Notice of Intent. For highly complex projects where the proponent demonstrates that submission with the Notice of Intent is not possible, the issuing authority has discretion to issue an Order of Conditions authorizing the project prior to submission of the construction period erosion and sedimentation control plan. All Orders of Conditions shall provide that the construction period erosion and sedimentation control plan shall be submitted prior to the commencement of any land disturbance activity. Information on the erosion and sedimentation control plan is set forth in Volume 2, Chapter 1.

[16] Information on the Operation and Maintenance Plan is set forth in Volume 1, Chapter 1 and Volume 2, Chapter 1.

[17] For projects subject to jurisdiction under the Wetlands Protection Act, the Illicit Discharge Compliance Statement may be included in the Stormwater Report submitted with the Notice of Intent. The Illicit Discharge Compliance Statement must be submitted before stormwater is discharged to the post-construction stormwater BMPs.

Appendix C

NRCS Soils Report

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Essex County, Massachusetts, Northern Part; and Essex County, Massachusetts, Southern Part

March 6, 2014

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (http://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means

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How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the

individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map

MAP LEGEND

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

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

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

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

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

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

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

Soil Survey Area: Essex County, Massachusetts, Northern Part
Survey Area Data: Version 9, Dec 17, 2013

Soil Survey Area: Essex County, Massachusetts, Southern Part
Survey Area Data: Version 10, Dec 17, 2013

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

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

Date(s) aerial images were photographed: Jun 20, 2010—May 1, 2011

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

Map Unit Legend

Essex County, Massachusetts, Northern Part (MA605)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
1	Water	0.2	0.3%
52A	Freetown muck, 0 to 1 percent slopes	1.3	2.2%
253C	Hinckley loamy sand, 8 to 15 percent slopes	0.0	0.0%
Subtotals for Soil Survey Area		**1.5**	**2.5%**
Totals for Area of Interest		**59.3**	**100.0%**

Essex County, Massachusetts, Southern Part (MA606)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
1	Water	0.2	0.3%
52A	Freetown muck, 0 to 1 percent slopes	6.0	10.1%
102C	Chatfield-Hollis-Rock outcrop complex, 3 to 15 percent slopes	5.2	8.7%
242B	Hinckley gravelly fine sandy loam, 3 to 8 percent slopes	5.0	8.4%
242D	Hinckley gravelly fine sandy loam, 15 to 25 percent slopes	3.6	6.1%
242E	Hinckley gravelly fine sandy loam, 25 to 45 percent slopes	4.6	7.8%
254B	Merrimac fine sandy loam, 3 to 8 percent slopes	10.1	17.0%
256A	Deerfield loamy fine sand, 0 to 3 percent slopes	3.1	5.3%
260B	Sudbury fine sandy loam, 3 to 8 percent slopes	0.3	0.5%
306D	Paxton fine sandy loam, 15 to 25 percent slopes, very stony	1.1	1.8%
310B	Woodbridge fine sandy loam, 3 to 8 percent slopes	6.6	11.1%
311C	Woodbridge fine sandy loam, 8 to 15 percent slopes, very stony	2.0	3.4%
392E	Paxton and Montauk fine sandy loams, 25 to 45 percent slopes, extremely stony	0.7	1.2%
602	Urban land	0.0	0.0%
616A	Fluvaquents, frequently flooded, 0 to 3 percent slopes	9.3	15.7%
Subtotals for Soil Survey Area		**57.8**	**97.5%**
Totals for Area of Interest		**59.3**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly

indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Essex County, Massachusetts, Northern Part

1—Water

Map Unit Setting
Frost-free period: 125 to 165 days

Map Unit Composition
Water: 100 percent

52A—Freetown muck, 0 to 1 percent slopes

Map Unit Setting
Elevation: 0 to 1,110 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 240 days

Map Unit Composition
Freetown and similar soils: 85 percent
Minor components: 15 percent

Description of Freetown

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

Properties and qualities
Slope: 0 to 1 percent
Surface area covered with cobbles, stones or boulders: 0.0 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 5.95 in/hr)
Depth to water table: About 0 to 6 inches
Frequency of flooding: Rare
Frequency of ponding: Frequent
Available water capacity: Very high (about 19.2 inches)

Interpretive groups
Farmland classification: Farmland of unique importance
Land capability (nonirrigated): 5w
Hydrologic Soil Group: A/D

Typical profile
0 to 2 inches: Mucky peat
2 to 79 inches: Muck

Minor Components

Whitman

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

Scarboro

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

Swansea

Percent of map unit: 5 percent
Landform: Kettles, depressions, marshes, swamps, bogs
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Talf
Down-slope shape: Concave
Across-slope shape: Concave

253C—Hinckley loamy sand, 8 to 15 percent slopes

Map Unit Setting

Elevation: 0 to 1,000 feet
Mean annual precipitation: 45 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 145 to 240 days

Map Unit Composition

Hinckley and similar soils: 80 percent
Minor components: 20 percent

Description of Hinckley

Setting

Landform: Terraces, drainageways, kames
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope, riser
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Loose sandy and gravelly glaciofluvial deposits

Properties and qualities

Slope: 8 to 15 percent

Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High to very high (6.00 to 20.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 3.1 inches)

Interpretive groups

Farmland classification: Not prime farmland
Land capability (nonirrigated): 4s
Hydrologic Soil Group: A

Typical profile

0 to 1 inches: Muck
1 to 8 inches: Loamy sand
8 to 20 inches: Very gravelly loamy sand
20 to 60 inches: Stratified cobbly coarse sand to very gravelly loamy fine sand

Minor Components

Windsor

Percent of map unit: 15 percent

Carver

Percent of map unit: 2 percent

Sudbury

Percent of map unit: 1 percent

Swansea

Percent of map unit: 1 percent
Landform: Bogs

Wareham

Percent of map unit: 1 percent
Landform: Terraces

Essex County, Massachusetts, Southern Part

1—Water

Map Unit Setting
Frost-free period: 145 to 175 days

Map Unit Composition
Water: 100 percent

52A—Freetown muck, 0 to 1 percent slopes

Map Unit Setting
Elevation: 0 to 1,110 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 240 days

Map Unit Composition
Freetown and similar soils: 85 percent
Minor components: 15 percent

Description of Freetown

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

Properties and qualities
Slope: 0 to 1 percent
Surface area covered with cobbles, stones or boulders: 0.0 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 5.95 in/hr)
Depth to water table: About 0 to 6 inches
Frequency of flooding: Rare
Frequency of ponding: Frequent
Available water capacity: Very high (about 19.2 inches)

Interpretive groups
Farmland classification: Farmland of unique importance
Land capability (nonirrigated): 5w
Hydrologic Soil Group: A/D

Typical profile
0 to 2 inches: Mucky peat
2 to 79 inches: Muck

Minor Components

Scarboro

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

Swansea

Percent of map unit: 5 percent
Landform: Swamps, bogs, kettles, depressions, marshes
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Talf
Down-slope shape: Concave
Across-slope shape: Concave

Whitman

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

102C—Chatfield-Hollis-Rock outcrop complex, 3 to 15 percent slopes

Map Unit Setting

Elevation: 100 to 1,000 feet
Mean annual precipitation: 45 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 145 to 240 days

Map Unit Composition

Chatfield and similar soils: 40 percent
Hollis and similar soils: 25 percent
Rock outcrop: 20 percent
Minor components: 15 percent

Description of Chatfield

Setting

Landform: Hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Friable, moderately deep coarse-loamy basal till derived from granite and gneiss over granite and gneiss

Properties and qualities

Slope: 8 to 15 percent
Surface area covered with cobbles, stones or boulders: 9.0 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 4.3 inches)

Interpretive groups

Farmland classification: Not prime farmland
Land capability (nonirrigated): 7s
Hydrologic Soil Group: B

Typical profile

0 to 5 inches: Fine sandy loam
5 to 34 inches: Gravelly very fine sandy loam
34 to 60 inches: Unweathered bedrock

Description of Hollis

Setting

Landform: Ridges on hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Friable, shallow loamy basal till derived from granite and gneiss over granite and gneiss

Properties and qualities

Slope: 8 to 15 percent
Surface area covered with cobbles, stones or boulders: 9.0 percent
Depth to restrictive feature: 10 to 20 inches to lithic bedrock
Drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Very low (about 2.1 inches)

Interpretive groups

Farmland classification: Not prime farmland
Land capability (nonirrigated): 7s
Hydrologic Soil Group: C/D

Typical profile

0 to 2 inches: Muck
2 to 5 inches: Fine sandy loam
5 to 20 inches: Gravelly fine sandy loam
20 to 60 inches: Unweathered bedrock

Description of Rock Outcrop

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: 0 inches to lithic bedrock

Interpretive groups

Farmland classification: Not prime farmland
Land capability (nonirrigated): 8s
Hydrologic Soil Group: D

Minor Components

Canton

Percent of map unit: 4 percent

Woodbridge

Percent of map unit: 2 percent

Montauk

Percent of map unit: 2 percent

Paxton

Percent of map unit: 2 percent

Whitman

Percent of map unit: 2 percent
Landform: Depressions

Freetown

Percent of map unit: 1 percent
Landform: Bogs

Ridgebury

Percent of map unit: 1 percent
Landform: Depressions

Swansea

Percent of map unit: 1 percent
Landform: Bogs

242B—Hinckley gravelly fine sandy loam, 3 to 8 percent slopes

Map Unit Setting

Elevation: 0 to 1,000 feet
Mean annual precipitation: 45 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 145 to 240 days

Map Unit Composition

Hinckley and similar soils: 85 percent
Minor components: 15 percent

Description of Hinckley

Setting

Landform: Flood plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Friable sandy and gravelly glaciofluvial deposits derived from granite and gneiss

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High to very high (6.00 to 20.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 3.1 inches)

Interpretive groups

Farmland classification: Farmland of statewide importance
Land capability (nonirrigated): 3s
Hydrologic Soil Group: A

Typical profile

0 to 8 inches: Gravelly fine sandy loam
8 to 17 inches: Gravelly loamy sand
17 to 60 inches: Stratified cobbly coarse sand to very gravelly loamy fine sand

Minor Components

Windsor

Percent of map unit: 10 percent

Sudbury

Percent of map unit: 3 percent

Wareham

Percent of map unit: 1 percent
Landform: Terraces

Swansea

Percent of map unit: 1 percent
Landform: Bogs

242D—Hinckley gravelly fine sandy loam, 15 to 25 percent slopes

Map Unit Setting

Elevation: 0 to 1,000 feet
Mean annual precipitation: 45 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 145 to 240 days

Map Unit Composition

Hinckley and similar soils: 100 percent

Description of Hinckley

Setting

Landform: Ridges, hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Friable sandy and gravelly glaciofluvial deposits derived from granite and gneiss

Properties and qualities

Slope: 15 to 25 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High to very high (6.00 to 20.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 3.1 inches)

Interpretive groups

Farmland classification: Not prime farmland
Land capability (nonirrigated): 6s
Hydrologic Soil Group: A

Typical profile

0 to 8 inches: Gravelly fine sandy loam
8 to 17 inches: Gravelly loamy sand
17 to 60 inches: Stratified cobbly coarse sand to very gravelly loamy fine sand

242E—Hinckley gravelly fine sandy loam, 25 to 45 percent slopes

Map Unit Setting

Elevation: 0 to 1,000 feet
Mean annual precipitation: 45 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 145 to 240 days

Map Unit Composition

Hinckley and similar soils: 85 percent
Minor components: 15 percent

Description of Hinckley

Setting

Landform: Ridges, hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Friable sandy and gravelly glaciofluvial deposits derived from granite and gneiss

Properties and qualities

Slope: 25 to 35 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High to very high (6.00 to 20.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 3.1 inches)

Interpretive groups

Farmland classification: Not prime farmland
Land capability (nonirrigated): 7s
Hydrologic Soil Group: A

Typical profile

0 to 8 inches: Gravelly fine sandy loam
8 to 17 inches: Gravelly loamy sand
17 to 60 inches: Stratified cobbly coarse sand to very gravelly loamy fine sand

Minor Components

Swansea

Percent of map unit: 15 percent
Landform: Bogs

254B—Merrimac fine sandy loam, 3 to 8 percent slopes

Map Unit Setting

Mean annual precipitation: 45 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 145 to 240 days

Map Unit Composition

Merrimac and similar soils: 85 percent
Minor components: 15 percent

Description of Merrimac

Setting

Landform: Terraces, flats
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Tread, rise
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Friable loamy eolian deposits over loose sandy and gravelly glaciofluvial deposits derived from granite and gneiss

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 4.6 inches)

Interpretive groups

Farmland classification: All areas are prime farmland
Land capability (nonirrigated): 2s
Hydrologic Soil Group: A

Typical profile

0 to 10 inches: Fine sandy loam
10 to 15 inches: Gravelly fine sandy loam
15 to 22 inches: Gravelly sandy loam
22 to 60 inches: Stratified very gravelly coarse sand to sand

Minor Components

Sudbury

Percent of map unit: 10 percent

Hinckley

Percent of map unit: 3 percent

Walpole
Percent of map unit: 2 percent
Landform: Terraces

256A—Deerfield loamy fine sand, 0 to 3 percent slopes

Map Unit Setting
Elevation: 0 to 1,000 feet
Mean annual precipitation: 45 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 145 to 240 days

Map Unit Composition
Deerfield and similar soils: 85 percent
Minor components: 15 percent

Description of Deerfield

Setting
Landform: Terraces
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Tread
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Loose sandy glaciofluvial deposits derived from granite and gneiss

Properties and qualities
Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): High to very high (6.00 to 20.00 in/hr)
Depth to water table: About 18 to 36 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 3.7 inches)

Interpretive groups
Farmland classification: Farmland of statewide importance
Land capability (nonirrigated): 3w
Hydrologic Soil Group: B

Typical profile
0 to 2 inches: Muck
2 to 7 inches: Loamy fine sand
7 to 26 inches: Loamy fine sand
26 to 60 inches: Fine sand

Minor Components

Windsor
Percent of map unit: 10 percent

Wareham
Percent of map unit: 5 percent
Landform: Terraces

260B—Sudbury fine sandy loam, 3 to 8 percent slopes

Map Unit Setting
Elevation: 0 to 2,100 feet
Mean annual precipitation: 45 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 145 to 240 days

Map Unit Composition
Sudbury and similar soils: 85 percent
Minor components: 15 percent

Description of Sudbury

Setting
Landform: Flats, drainageways
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Friable loamy eolian deposits over loose sandy glaciofluvial deposits derived from granite and gneiss

Properties and qualities
Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: About 18 to 36 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 5.0 inches)

Interpretive groups
Farmland classification: All areas are prime farmland
Land capability (nonirrigated): 2e
Hydrologic Soil Group: B

Typical profile
0 to 13 inches: Fine sandy loam
13 to 19 inches: Sandy loam
19 to 26 inches: Gravelly coarse sand

26 to 60 inches: Stratified very gravelly coarse sand

Minor Components

Merrimac
Percent of map unit: 10 percent

Walpole
Percent of map unit: 5 percent
Landform: Terraces

306D—Paxton fine sandy loam, 15 to 25 percent slopes, very stony

Map Unit Setting
Mean annual precipitation: 45 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 145 to 240 days

Map Unit Composition
Paxton and similar soils: 85 percent
Minor components: 15 percent

Description of Paxton

Setting
Landform: Hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Friable coarse-loamy eolian deposits over dense coarse-loamy lodgment till derived from granite and gneiss

Properties and qualities
Slope: 15 to 25 percent
Surface area covered with cobbles, stones or boulders: 1.6 percent
Depth to restrictive feature: 15 to 38 inches to densic material
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: About 18 to 36 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Very low (about 3.0 inches)

Interpretive groups
Farmland classification: Not prime farmland
Land capability (nonirrigated): 6s
Hydrologic Soil Group: C

Typical profile
0 to 4 inches: Fine sandy loam

4 to 23 inches: Fine sandy loam
23 to 60 inches: Gravelly fine sandy loam

Minor Components

Woodbridge
Percent of map unit: 15 percent

310B—Woodbridge fine sandy loam, 3 to 8 percent slopes

Map Unit Setting
Mean annual precipitation: 45 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 145 to 240 days

Map Unit Composition
Woodbridge and similar soils: 85 percent
Minor components: 15 percent

Description of Woodbridge

Setting
Landform: Flats
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope, rise
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Friable coarse-loamy eolian deposits over dense coarse-loamy lodgment till derived from granite and gneiss

Properties and qualities
Slope: 3 to 8 percent
Depth to restrictive feature: 20 to 38 inches to densic material
Drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: About 18 to 36 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 3.4 inches)

Interpretive groups
Farmland classification: All areas are prime farmland
Land capability (nonirrigated): 2e
Hydrologic Soil Group: C

Typical profile
0 to 6 inches: Fine sandy loam
6 to 25 inches: Fine sandy loam
25 to 60 inches: Gravelly fine sandy loam

Minor Components

Ridgebury
Percent of map unit: 10 percent
Landform: Depressions

Whitman
Percent of map unit: 5 percent
Landform: Depressions

311C—Woodbridge fine sandy loam, 8 to 15 percent slopes, very stony

Map Unit Setting
Mean annual precipitation: 45 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 145 to 240 days

Map Unit Composition
Woodbridge and similar soils: 90 percent
Minor components: 10 percent

Description of Woodbridge

Setting
Landform: Ridges, hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Friable coarse-loamy eolian deposits over dense coarse-loamy lodgment till derived from granite and gneiss

Properties and qualities
Slope: 8 to 15 percent
Surface area covered with cobbles, stones or boulders: 1.6 percent
Depth to restrictive feature: 20 to 38 inches to densic material
Drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: About 18 to 36 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 3.3 inches)

Interpretive groups
Farmland classification: Farmland of statewide importance
Land capability (nonirrigated): 6s
Hydrologic Soil Group: C

Typical profile
0 to 6 inches: Fine sandy loam

6 to 25 inches: Fine sandy loam
25 to 60 inches: Gravelly fine sandy loam

Minor Components

Paxton
Percent of map unit: 7 percent

Ridgebury
Percent of map unit: 3 percent
Landform: Depressions

392E—Paxton and Montauk fine sandy loams, 25 to 45 percent slopes, extremely stony

Map Unit Setting
Elevation: 0 to 400 feet
Mean annual precipitation: 45 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 145 to 240 days

Map Unit Composition
Paxton and similar soils: 65 percent
Montauk and similar soils: 20 percent
Minor components: 15 percent

Description of Paxton

Setting
Landform: Ridges, hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Friable coarse-loamy eolian deposits over dense coarse-loamy lodgment till derived from granite and gneiss

Properties and qualities
Slope: 25 to 35 percent
Surface area covered with cobbles, stones or boulders: 9.0 percent
Depth to restrictive feature: 15 to 38 inches to densic material
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: About 18 to 36 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Very low (about 3.0 inches)

Interpretive groups
Farmland classification: Not prime farmland

Land capability (nonirrigated): 7s
Hydrologic Soil Group: C

Typical profile

0 to 4 inches: Fine sandy loam
4 to 23 inches: Fine sandy loam
23 to 60 inches: Gravelly fine sandy loam

Description of Montauk

Setting

Landform: Ridges, hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Friable coarse-loamy eolian deposits over dense sandy lodgment till derived from granite and gneiss

Properties and qualities

Slope: 25 to 35 percent
Surface area covered with cobbles, stones or boulders: 9.0 percent
Depth to restrictive feature: 20 to 36 inches to densic material
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.60 in/hr)
Depth to water table: About 24 to 30 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 3.4 inches)

Interpretive groups

Farmland classification: Not prime farmland
Land capability (nonirrigated): 7s
Hydrologic Soil Group: C

Typical profile

0 to 2 inches: Fine sandy loam
2 to 22 inches: Fine sandy loam
22 to 60 inches: Gravelly sandy loam

Minor Components

Hollis

Percent of map unit: 15 percent

602—Urban land

Map Unit Setting

Frost-free period: 145 to 175 days

Map Unit Composition
Urban land: 80 percent
Minor components: 20 percent

Description of Urban Land

Setting
Parent material: Excavated, filled, and made land

Minor Components

Udorthents
Percent of map unit: 7 percent

Hollis
Percent of map unit: 5 percent

Whitman
Percent of map unit: 3 percent
Landform: Depressions

Maybid
Percent of map unit: 1 percent
Landform: Depressions

Swansea
Percent of map unit: 1 percent
Landform: Bogs

Whately variant
Percent of map unit: 1 percent
Landform: Glacial lakes (relict)

Scarboro
Percent of map unit: 1 percent
Landform: Terraces

Freetown
Percent of map unit: 1 percent
Landform: Bogs

616A—Fluvaquents, frequently flooded, 0 to 3 percent slopes

Map Unit Setting
Mean annual precipitation: 45 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 145 to 240 days

Map Unit Composition
Fluvaquents and similar soils: 85 percent
Minor components: 15 percent

Description of Fluvaquents

Setting

Landform: Alluvial flats
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Friable loamy alluvium over friable sandy eolian deposits

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
Depth to water table: About 0 to 12 inches
Frequency of flooding: Frequent
Frequency of ponding: None

Minor Components

Swansea

Percent of map unit: 10 percent
Landform: Bogs

Unnamed soils

Percent of map unit: 5 percent

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Appendix D

Subsurface Investigation Data

Commonwealth of Massachusetts
City/Town of Hamilton

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

DEP has provided this form for use by on-site professionals and local Boards of Health. Other forms may be used, but the information must be substantially the same as provided here. Before using this form, check with your local Board of Health to determine the form they use.

A. Facility Information

1. Facility Information

Town of Hamilton
Owner Name

650 Asbury Street — Map/Lot 207/ Parcel 15
Street Address

Hamilton — MA — 01936
City/Town — State — Zip Code

B. Site Information

1. (Check one) New Construction ☒ Upgrade ☐ Repair ☐

2. Published Soil Survey available? Yes X No If yes: 2013 (Year Published) 1:20,000 (Publication Scale) HaB (Soil Map Unit)

Hinckley (Soil Name) N/A (Soil limitations)

3. Surficial Geological Report available? Yes X No If yes: 2006 (Year Published) 1:250,000 (Publication Scale) Stratified deopsit (Map Unit)

Glacial Outwash (Geologic Material) Outwash Plain (Landform)

4. Flood Rate Insurance Map:

Above the 500 year flood boundary? Yes ☒ No ☐ Within the 100 year flood boundary? Yes No X

Within the 500 year flood boundary? Yes No ☒ Within a Velocity Zone? Yes ☐ No X

5. Wetland Area: National Wetland Inventory Map N/A (Map Unit) _____ (Name)

Wetlands Conservancy Program Map N/A (Map Unit) _____ (Name)

Commonwealth of Massachusetts
City/Town of Hamilton
Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

6. Current Water Resource Conditions (USGS) July, 2014 (Month/Year) Range: Above Normal ☐ Normal ☒ Below Normal ☐

7. Other references reviewed: Aerial Photo's

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

Deep Observation Hole Number: RG1 Date 07-30-14 Time 11:05am Weather Sunny 75°

1. Location

Ground Elevation at Surface of Hole 57'

Location (Identify on Plan)

2. Land Use: Field (e.g. woodland, agricultural field, vacant lot, etc.) N/A Surface Stones 0-3 Slope (%)

Grass Vegetation Outwash Plain Landform TS Position on landscape (attach sheet)

3. Distances from: Open Water Body ≥ 200' feet Drainage Way ≥ 200' feet Possible Wet Area ≥100' feet
Property Line ≥ 25' feet Drinking Water Well ≥ 200' feet Other

4. Parent Material: Glacial outwash Unsuitable Materials Present: Yes ☐ No ☒

If Yes: Disturbed Soil☐ Fill Material☐ Impervious Layer(s) ☐ Weathered/Fractured Rock☐ Bedrock☐

5. Groundwater Observed: Yes ☐ No ☒
If Yes: Depth Weeping from Pit Depth Standing Water in Hole N/A

Commonwealth of Massachusetts
City/Town of Hamilton

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

Estimated Depth to High Groundwater: >48" (Inches) <53' (elevation)

Deep Observation Hole Number: RG1

Depth (In.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0"-8"	Ap	10YR4/3				Fine Sandy Loam			Granular	Friable	
8-22"	Bw	7.5YR4/4				Loamy Fine Sand	30%		Granular	Friable	
22-30"	C1	10YR4/6				Loamy Sand			Massive	Friable	
30-48"	C2	10YR4/3				Sand			Single Grain	Loose	

Additional Notes _____

Commonwealth of Massachusetts
City/Town of Hamilton
Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

D. Determination of High Groundwater Elevation

1. Method used:
   - ☐ Depth observed standing water in observation hole — A. _____ inches B. _____ inches
   - ☐ Depth weeping from side of observation hole — A. _____ inches B. _____ inches
   - ☒ Depth to soil redoximorphic features (mottles) — A. None obs. inches B. _____ inches
   - ☐ Groundwater adjustment (USGS methodology) — A. _____ inches B. _____ inches

2. Index Well Number _____ Reading Date _____ Index Well Level _____

   Adjustment Factor _____ Adjusted Groundwater Level _____

E. Depth of Pervious Material

1. Depth of Naturally Occurring Pervious Material

   a. Does at least four feet of naturally occurring pervious material exist in all areas observed throughout the area proposed for the soil absorption system? Yes ☒ No ☐

   b. If yes, at what depth was it observed? Upper boundary: 22" inches Lower boundary: < 48" inches

F. Certification

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

Signature of Soil Evaluator — Date: 07-30-14

Christian O. Smith, PE
Typed or Printed Name of Soil Evaluator

October, 2005
*Date of Soil Evaluator Exam

Leslie Whelan
Name of Board of Health Witness

Hamilton, MA
Board of Health

Commonwealth of Massachusetts
City/Town of Hamilton
Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

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

Use this sheet for field diagrams:

Commonwealth of Massachusetts
City/Town of Hamilton

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

DEP has provided this form for use by on-site professionals and local Boards of Health. Other forms may be used, but the information must be substantially the same as provided here. Before using this form, check with your local Board of Health to determine the form they use.

A. Facility Information

1. Facility Information

Town of Hamilton
Owner Name

650 Asbury Street — Map/Lot 207/ Parcel 15
Street Address

Hamilton — MA — 01936
City/Town — State — Zip Code

B. Site Information

1. (Check one) New Construction ☒ Upgrade ☐ Repair ☐

2. Published Soil Survey available? Yes X No If yes: 2013 (Year Published) 1:20,000 (Publication Scale) 310B (Soil Map Unit)

Woodbridge (Soil Name) N/A (Soil limitations)

3. Surficial Geological Report available? Yes X No If yes: 2006 (Year Published) 1:250,000 (Publication Scale) Stratified deopsit (Map Unit)

Glacial Outwash (Geologic Material) Outwash Plain (Landform)

4. Flood Rate Insurance Map:

Above the 500 year flood boundary? Yes ☐ No ☒ Within the 100 year flood boundary? Yes ☐ No X

Within the 500 year flood boundary? Yes ☒ No ☐ Within a Velocity Zone? Yes ☐ No X

5. Wetland Area: National Wetland Inventory Map N/A (Map Unit) _____ (Name)

Wetlands Conservancy Program Map N/A (Map Unit) _____ (Name)

Commonwealth of Massachusetts
City/Town of Hamilton
Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

6. Current Water Resource Conditions (USGS) July, 2014 (Month/Year) Range: Above Normal ☐ Normal ☒ Below Normal ☐

7. Other references reviewed: Aerial Photo's

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

Deep Observation Hole Number: IP1 07-30-14 (Date) 12:05 pm (Time) Sunny 75° (Weather)

1. Location

Ground Elevation at Surface of Hole 39'

Location (Identify on Plan)

2. Land Use: Field (e.g. woodland, agricultural field, vacant lot, etc.) N/A (Surface Stones) 3 (Slope (%))

Grass (Vegetation) Outwash Plain (Landform) Toe of Slope (Position on landscape (attach sheet))

3. Distances from: Open Water Body ≥ 200' feet Drainage Way ≥ 200' feet Possible Wet Area ≥100' feet
Property Line ≥ 25' feet Drinking Water Well ≥ 200' feet Other

4. Parent Material: Glacial outwash Unsuitable Materials Present: Yes ☐ No ☒

If Yes: Disturbed Soil☐ Fill Material☐ Impervious Layer(s) ☐ Weathered/Fractured Rock☐ Bedrock☐

5. Groundwater Observed: Yes ☐ No ☒
If Yes: Depth Weeping from Pit Depth Standing Water in Hole N/A

Commonwealth of Massachusetts
City/Town of Hamilton

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

Estimated Depth to High Groundwater: >31" (Inches) 36.5' (elevation)

Deep Observation Hole Number: IP1

Depth (In.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0"-10"	Ap	10YR3/3				Fine Sandy Loam			Granular	Friable	
10-31"	Bw	10YR5/6				Fine Sandy Loam			Platey	Friable	
31-47"	C1	2.5Y5/4	31"	5YR4/6	6%	Silt Loam			Blocky	Friable	
47-68"	C2	7.5YR4/3		5YR4/6	10%	Medium Sand	40%	5%	Massive	Firm	

Additional Notes _____

Commonwealth of Massachusetts
City/Town of Hamilton
Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

D. Determination of High Groundwater Elevation

1. Method used:
   - ☐ Depth observed standing water in observation hole — A. _____ inches B. _____ inches
   - ☐ Depth weeping from side of observation hole — A. _____ inches B. _____ inches
   - ☒ Depth to soil redoximorphic features (mottles) — A. 31 inches B. _____ inches
   - ☐ Groundwater adjustment (USGS methodology) — A. _____ inches B. _____ inches

2. Index Well Number _____ Reading Date _____ Index Well Level _____

   Adjustment Factor _____ Adjusted Groundwater Level _____

E. Depth of Pervious Material

1. Depth of Naturally Occurring Pervious Material

   a. Does at least four feet of naturally occurring pervious material exist in all areas observed throughout the area proposed for the soil absorption system? Yes ☐ No ☒

   b. If yes, at what depth was it observed? Upper boundary: ____ inches Lower boundary: _____ inches

F. Certification

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

Signature of Soil Evaluator — Date: 07-30-14

Christian O. Smith, PE
Typed or Printed Name of Soil Evaluator

October, 2005
*Date of Soil Evaluator Exam

Leslie Whelan
Name of Board of Health Witness

Hamilton, MA
Board of Health

Commonwealth of Massachusetts
City/Town of Hamilton
Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

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

Use this sheet for field diagrams:

Commonwealth of Massachusetts
City/Town of Hamilton
Percolation Test
Form 12

Percolation test results must be submitted with the Soil Suitability Assessment for On-site Sewage Disposal. DEP has provided this form for use by local Boards of Health. Other forms may be used, but the information must be substantially the same as that provided here. Before using this form, check with the local Board of Health to determine the form they use.

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

A. Site Information

Town of Hamilton
Owner Name

650 Asbury Street
Street Address or Lot #

Hamilton	MA	01936
City/Town	State	Zip Code

Todd Morey, PE	(617) 242-1120
Contact Person (if different from Owner)	Telephone Number

B. Test Results

	7-30-14	12:25		
	Date	Time	Date	Time
Observation Hole #	IP1			
Depth of Perc	30"			
Start Pre-Soak	12:30			
End Pre-Soak	12:47			
Time at 12”	12:51			
Time at 9”	12:56			
Time at 6”	1:01			
Time (9”-6”)	5-min			
Rate (Min./Inch)	1.67 min/inch			
	Test Passed: ☒		Test Passed: ☐	
	Test Failed: ☐		Test Failed: ☐	

Christian O. Smith, PE
Test Performed By:

Leslie Whelan
Witnessed By:

Comments:

use <2min/inch for design

Appendix E

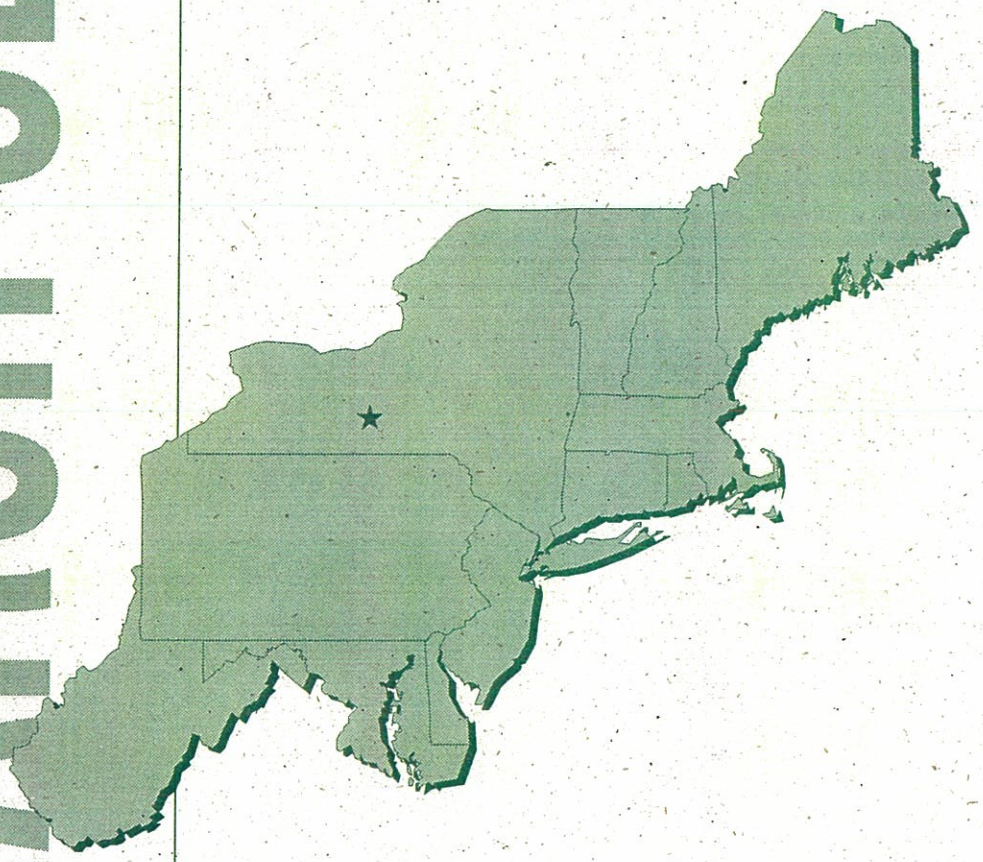
Rainfall Data

RESEARCH SERIES

NORTHEAST REGIONAL CLIMATE CENTER

Atlas of Precipitation Extremes for the Northeastern United States and Southeastern Canada

Daniel S. Wilks
Richard P. Cember



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Atlas of Precipitation Extremes for the Northeastern United States and Southeastern Canada

Daniel S. Wilks
Richard P. Cember

Northeast Regional Climate Center
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INTRODUCTION

Extreme precipitation events have the potential to produce localized or widespread flooding, with concomitant damage to property and potential loss of life. The climatology of these very large precipitation events is therefore an important component of engineering design for structures and facilities that must withstand or protect against such events.

The most widely used atlas of precipitation extremes in the U.S., *Rainfall Frequency Atlas of the United States* (Hershfield 1961), also known as Technical Paper 40, is now more than thirty years old. This standard work was based on fitting the Gumbel probability distribution to extreme rainfall data from relatively few stations, with average record length of only 22.6 years. Operationally, it has been found that Technical Paper 40 often underestimates the largest extreme precipitation events (Angel and Huff 1991). It is not clear to what extent this systematic underestimation results from inadequacy of the Gumbel distribution for extrapolation to the important rare events (Jenkinson 1955), or from the insufficient length of record available in 1961. However, it is widely agreed that updating and revision of that document is warranted.

This atlas presents updated statistics of extreme precipitation for the 12-state region designated as the northeastern states for purposes of the Regional Climate Centers program of the National Weather Service, National Oceanic and Atmospheric Administration. These states are Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, and West Virginia. Data from the states of Ohio, Kentucky, Michigan and Virginia, as well as from the Canadian provinces of Ontario, Quebec, and New Brunswick, have also been included in this project to complete the representation of the mapped fields within the map rectangle encompassing the northeastern U.S.

USING THE ATLAS

The maps in this atlas express extreme precipitation amounts using isohyets corresponding to "average return periods" for 1-day, 2-day, 5-day, and 10-day precipitation totals. That is, it is estimated that precipitation events as large or larger than the magnitudes shown on the maps will be separated, on average, by the number of years given by the return period. It is important to realize that the actual times between two precipitation events of a particular magnitude are not expected to correspond exactly to the return period. Rather, over the course of centuries, the average of the separation times between pairs of these events should be close to the specified return period. Thus the "hundred-year storm," or precipitation amount corresponding to the one hundred year return period, might not occur in a given century, but could occur more than once in some other century. In a hypothetical average over many centuries, however, one would expect about as many occurrences of the hundred-year event at a given location as the number of centuries being averaged.

The data records for most of the stations on which this atlas is based are shorter than one hundred years. This fact implies that the precipitation estimates for the one hundred year return period have been extrapolated beyond the observed data. These extrapolations have been achieved by fitting a theoretical probability function to the observed extreme precipitation data at each station. Precipitation amounts corresponding to shorter (i.e., not necessarily extrapolated) return periods have also been computed using the fitted probability functions, in order to smooth out sampling irregularities in the observed data. The extreme amounts corresponding to particular return periods are computed using equations, given below in the "Technical Details" section, relating probabilities of rare events to the average return periods.

In all cases, the observed data have been represented using the Beta-P distribution (Mielke and Johnson 1974), which was found in exploratory work to give the best results among many candidate distributions for extreme precipitation data in the northeastern U.S. (Wilks 1993). For all stations used to construct the atlas, the underlying data consist of once-daily precipitation measurements. Of the many daily precipitation observations actually available for each station, Beta-P distributions were fit only to the "partial-duration" data, with sample sizes approximately equal to the number of years in each stations's data record. That is, the n largest precipitation amounts observed at each station were used, where n equals approximately the number of years of precipitation data available for that station.

Separate maps are presented for 1-day, 2-day, 5-day, and 10-day precipitation accumulations. For the 1-day maps, the once-daily observations appearing in the climatological records for each station were used directly. For the remaining maps, the daily observations were totaled over pairs, sequences of five, and sequences of ten days, respectively. When constructing the partial-duration data for the 2-day, 5-day and 10-day accumulations, care was taken to exclude any overlapping sequences from the analysis. That is, the precipitation observation for any single day can be included in at most one of the sequences making up the partial-duration data for a given accumulation period. When constructing the data for the 2-day accumulation, for example, a day on which a very large precipitation amount was received would make up a pair with either the preceding day or the following day, whichever had the larger precipitation observation. The analysis would not produce two precipitation amounts in the partial duration data that both included a day in common.

Precipitation is routinely observed at a fixed time each day at a given location, which results in a somewhat arbitrary division of time into 24-hour slices. When an important storm is in progress at the scheduled daily observation time, that precipitation will be reported to have occurred over two (or possibly more) days. Many users will find it more meaningful to think in terms of 24-, 48-, 120- and 240-hour precipitation events, rather than the 1-, 2-, 5-, and 10-day accumulations directly available from the climatological record and reported here. One might like to know, for example, the 100-year precipitation for the wettest consecutive 24 hours, regardless of when those hours happened to occur in relation to the standard observation time.

While it is not possible to determine exactly the relationship between, say, the wettest 24 hours and the wettest 1-day precipitation observation for a given storm on the basis of the available daily data, the average relationship can be estimated using the empirical factors given in Table 1, taken from Hershfield (1961). It is important to realize that these empirical factors have *not* been incorporated into the maps in this atlas, in order that the maps reflect only results for the data as observed. The conversion factors in Table 1 are provided for those users who may require estimates of the larger precipitation accumulations that would have been reported if the

Table 1. Empirical adjustment factors that can be used to transform precipitation amounts pertaining to calendar day observations, to estimates of maximum precipitation regardless of observation time. From Hershfield (1961).

To convert from precipitation over this many days	To maximum precipitation over this many hours	Multiply by
1	24	1.13
2	48	1.05
5	120	1.01
10	240	1.01

Table 2. Empirical adjustment factors that can be used to transform precipitation amounts pertaining to 24-hour accumulations to estimates of precipitation for shorter time periods. From Huff and Angel (1992).

To estimate maximum precipitation over	Multiply the precipitation amount from the 1-day maps by
18 hours	1.06
12 hours	0.98
6 hours	0.85
3 hours	0.72
2 hours	0.66
1 hour	0.53
30 minutes	0.42
15 minutes	0.31
10 minutes	0.24
5 minutes	0.14

observations were not constrained to occur at fixed times. Notice that these empirical conversion factors decrease quite sharply for the longer accumulation periods, indicating that a substantial fraction of the precipitation in the wettest 24 hours is expected on average to be distributed over a second daily observation, but that the 5- and 10-day periods are long enough that there is usually very little difference between calendar-day observations and arbitrarily located observation windows of the same lengths.

Similarly, many users will require estimates of extreme precipitation amounts occurring over periods shorter than 24 hours. While these can not be obtained directly from daily observations, they can be estimated using the empirical adjustment factors given in Table 2. These factors have been taken from Huff and Angel (1992), and correspond closely to those given in Hershfield (1961).

Example: Suppose the 100-year, 1-day precipitation for a location of interest, from Map 6, is 5.00 inches. The corresponding 100-year 24-hour precipitation (i.e., the estimated 24-hour, hundred-year precipitation regardless of the observation time) would be obtained by multiplying by the factor 1.13 from Table 1, yielding 5.00 x 1.13 = 5.65 inches. The estimated 100-year event for a 1-hour precipitation accumulation at this same location would be obtained, using Table 2, as 5.00 x 0.53 = 2.65 inches.

Finally, it should be realized that the maps in this atlas are likely to exhibit a bias in regions containing large topographic variations. This is because the places where the precipitation measurements have been made tend to be locations where people live and work, which are generally valley locations in preference to those at higher elevations. Cember and Wilks (1993) found that the existing station locations effectively underestimate average elevations in mountainous areas of the northeastern U.S. by about 500 feet.

Therefore, the mapped quantities in this atlas should accurately reflect climatological conditions at locations typical of the observing stations, but should be expected to underestimate extreme precipitation amounts at elevations substantially above the local settlements.

THE UNDERLYING DATA

This atlas has been prepared using daily precipitation data for the 1473 stations listed in Table 3. These data were obtained from the archives of the Northeast Regional Climate Center (Ithaca, New York), the National Climatic Data Center (Asheville, North Carolina), and the Canadian Climate Centre (Downsview, Ontario). The locations of most of the stations listed in Table 3 are shown in Figure 1, on the same base map used to represent the precipitation extremes in this atlas. Those stations not shown in Figure 1 were included in the analysis to improve the representation at the edges of the maps. They are located within about 1° of longitude of the map rectangle to the east and west, within about 2° of latitude to the north, and extend to the southern borders of Virginia and Kentucky to the south.

Data from climatological stations within the domain of this atlas were included only if they contained at least 30 years of record. That is, a station was included only if at least 10,958 daily observations passing quality-control screening existed in its record. The average record length of included stations was 51.3 years, with more than 100 years being available at a few stations. The maps have been constructed in a way that gives more weight in the spatial analysis to stations with longer data records.

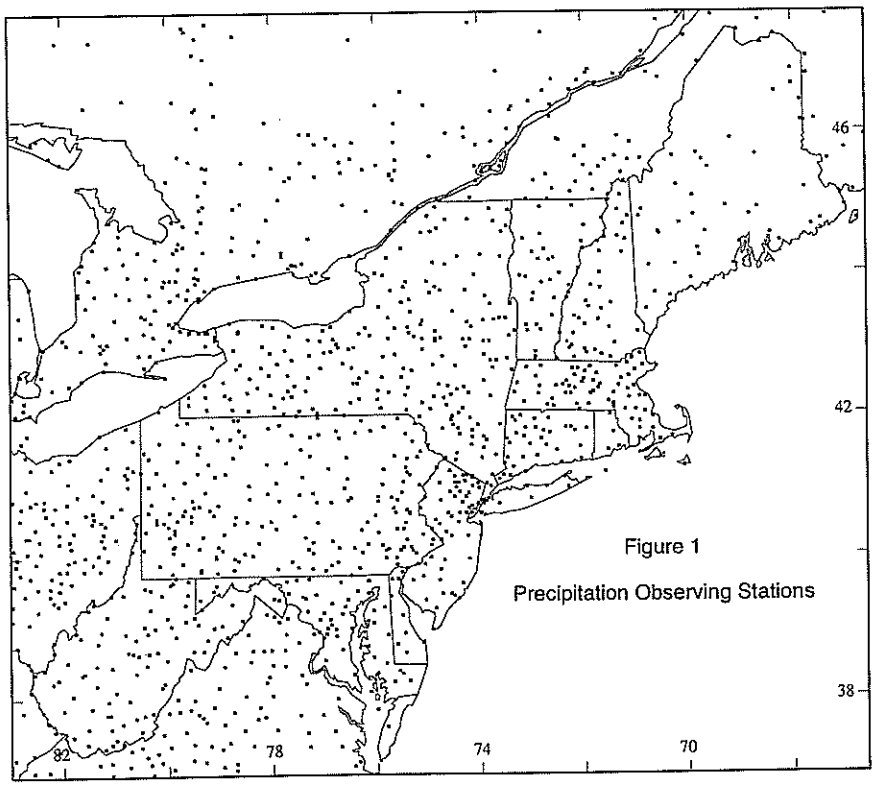

Figure 1

Precipitation Observing Stations

TECHNICAL DETAILS

The Beta-P Distribution and Computation of Return Periods. Smoothing and extrapolation of the observed extreme precipitation data for all stations was done by fitting the Beta-P distribution (Mielke and Johnson, 1974). The probability density function for this distribution is

$$f(x) = \frac{\alpha\theta}{\beta}\left(\frac{x}{\beta}\right)^{\theta-1}\left[1+\left(\frac{x}{\beta}\right)^{\theta}\right]^{-(\alpha+1)}, \quad (1)$$

where x is the random variable (here, partial-duration precipitation amounts), which must be nonnegative. The distribution has three parameters: α and θ are dimensionless shape parameters, and β is a scale parameter having the same physical units as the random variable. The three parameters are constrained to be positive. The distributions were fit to data for each station by maximum likelihood, using the Levenberg-Marquardt method (Press et al. 1986), as described in Wilks (1993). One convenient feature of the Beta-P distribution is that it is analytically integrable, so that its cumulative distribution function can be written in closed form. That is, Beta-P probabilities can be obtained using

$$F(x) = \Pr\{X \le x\} = \int_0^x f(x)\,dx = 1 - \left[1+\left(\frac{x}{\beta}\right)^{\theta}\right]^{-\alpha}. \quad (2)$$

Average return periods, R, relate to cumulative probabilities, F, of the distributions of partial-duration data according to

$$R = \frac{1}{\omega\,[1-F(x)]}, \quad (3)$$

where ω is the average frequency with which the partial-duration data samples the full record of daily observations, in years^{-1}. For the present analysis, the average sampling frequency was chosen to be close to 1 yr^{-1}, but because individual data records may start and stop on different dates and may contain different numbers of missing data, ω varies slightly from station to station. Let N represent the number of daily observations passing the quality control screening that are available for a particular station. The partial-duration data were then constructed to consist of the largest n precipitation accumulations, where n is the greatest integer not exceeding N/365.25. This convention results in the average sampling frequency being

$$\omega = \frac{365.25\ n}{N}\ \text{yr}^{-1}. \quad (4)$$

Precipitation amounts, x, corresponding to specified return periods are obtained by inverting Equation 2 (i.e., solving it for x), and substituting the expression $F(x) = 1 - 1/\omega R$ obtained by rearrangement of Equation 3. These operations yield the expression for precipitation amounts as a function of return period, and of the parameters of the fitted Beta-P distribution,

$$x = \beta\,[\,(\omega R)^{1/\alpha} - 1\,]^{1/\theta}. \quad (5)$$

Quality Control Procedure. Quality control of extreme precipitation amounts is difficult, owing to the high spatial and temporal variability of this quantity. Daily amounts larger than 5 inches were screened here for coherence with nearby locations. To be considered valid, precipitation amounts of 10 inches or more had to be corroborated by occurrence of at least 5 inches of precipitation at each of at least two

stations within 200 miles on the same day, the previous day, or the following day. Precipitation amounts between 5 inches and 10 inches were considered valid if corroborated by at least two stations within 200 miles reporting at least 3 inches of precipitation on the same day, the previous day, or the following day.

In the data-sparse regions of the northwestern and northeastern corners of the domain, these criteria were relaxed to allow corroboration if only one station within the 200 mile radius reported a large precipitation amount as specified above. Early in the climatological record, the station density is too sparse to allow spatial comparison of precipitation amounts in this way. The quality control procedure was implemented beginning in 1927 for stations in the U.S., in 1871 for stations in Ontario, in 1883 for stations in Quebec, and in 1891 for stations in New Brunswick. All reasonable data values for records preceding these dates have been accepted into the analysis.

Interpolation, Gridding, Smoothing and Contouring. This atlas has been prepared by first gridding individual station values, and then producing the contour maps from the gridded fields by automated means.

Precipitation amounts corresponding to the specified return periods were cast into a 54 x 82 (latitude x longitude) grid, with points spaced at 0.2° intervals. This grid is confined to the map rectangle, but stations outside the rectangle were also used to improve the representation at the map edge, as noted above. The gridding algorithm finds the smallest circle around each gridpoint that encloses at least two stations, where the circle radius is an integer multiple of 0.2 great circle degrees. If the circle has a radius of 1.4° or less, the grid point is assigned a weighted average of the station values enclosed. Otherwise, the grid point is assigned a missing value code.

Each grid point value is computed as

$$z_g(\lambda_g, \phi_g) = \frac{\sum_{i=1}^{I} w_i(\lambda_g, \phi_g, \lambda_i, \phi_i)\, z_i(\lambda_i, \phi_i)}{\sum_{i=1}^{I} w_i(\lambda_g, \phi_g, \lambda_i, \phi_i)}, \qquad (6)$$

where w_i is a modified McLain (1974) weighting function

$$w_i(\lambda_g, \phi_g, \lambda_i, \phi_i) = \frac{\sqrt{N_i}\, \exp\left[- \dfrac{\cos^2\phi_0\, (\lambda_g-\lambda_i)^2 + (\phi_g-\phi_i)^2}{d_{scale}^2} \right]}{f + \dfrac{\cos^2\phi_0\, (\lambda_g-\lambda_i)^2 + (\phi_g-\phi_i)^2}{d_{scale}^2}}. \qquad (7)$$

Here z represents precipitation amount, λ is longitude, ϕ is latitude, the subscript g refers to the grid point, the subscript i distinguishes among the I individual stations within each circle, and N_i is the sample size of the precipitation data at station i. The parameter d_{scale} = 1.2° is a scaling distance, ϕ_0 = 42.45° is a reference latitude, and f = 10^{-6} is a small constant used to prevent division by zero.

The gridded fields were smoothed using the moving average in a 3 x 3 cell window, i.e., by an unweighted averaging of each grid point with its eight adjacent neighbors. These smoothed gridded values were contoured and plotted using the NCAR Graphics software package, version 3.00 (Clare and Kennison 1989).

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Table 3. List of stations used, their locations, and digitally available periods of record.

Station number	Station name	Latitude (degrees)	Longitude (degrees)	Record begins	Record ends
CONNECTICUT					
060299	BARKHAMSTED	41.92	72.95	1948	1993
060806	BRIDGEPORT WSO AP	41.17	73.13	1948	1993
060918	BROOKLYN	41.78	71.95	1950	1983
060961	BULLS BRIDGE DAM	41.65	73.48	1948	1993
060973	BURLINGTON	41.80	72.93	1937	1993
061488	COCKAPONSET RANGER STN	41.47	72.52	1948	1993
061689	COVENTRY	41.80	72.35	1957	1992
061715	CREAM HILL	41.90	73.32	1926	1972
061762	DANBURY	41.38	73.47	1948	1993
062658	FALLS VILLAGE	41.95	73.37	1948	1993
063207	GROTON	41.35	72.05	1948	1993
063451	HARTFORD BRAINARD FLD	41.73	72.65	1920	1993
063456	HARTFORD WSO AP	41.93	72.68	1954	1993
064488	MANSFIELD HOLLOW LAKE	41.75	72.18	1952	1993
064767	MIDDLETOWN 4 W	41.55	72.72	1948	1993
065077	MOUNT CARMEL	41.40	72.90	1936	1993
065445	NORFOLK 2 SW	41.97	73.22	1942	1993
065893	NORWALK GAS PLANT	41.12	73.42	1956	1989
065910	NORWICH PUB UTIL PLANT	41.53	72.07	1956	1993
066655	PUTNAM LAKE	41.08	73.63	1948	1993
066966	ROCKY RIVER DAM	41.58	73.43	1948	1993
067002	ROUND POND	41.30	73.53	1948	1993
067157	SAUGATUCK RESERVOIR	41.25	73.35	1948	1993
067373	SHEPAUG DAM	41.72	73.30	1948	1993
067432	SHUTTLE MEADOW RESVR	41.65	72.82	1948	1993
067970	STAMFORD 5 N	41.13	73.55	1955	1993
068065	STEVENSON DAM	41.38	73.17	1948	1993
068138	STORRS	41.80	72.25	1888	1993
068436	TORRINGTON	41.80	73.12	1948	1993
068911	WATERBURY CITY HALL	41.57	73.03	1926	1958
069067	WESTBROOK	41.30	72.43	1940	1978
069162	WEST HARTFORD	41.75	72.78	1948	1993
069568	WIGWAM RESERVOIR	41.68	73.15	1948	1993
DELAWARE					
071330	BRIDGEVILLE 1 NW	38.75	75.62	1948	1985
072730	DOVER	39.15	75.52	1948	1993
073570	GEORGETOWN 5 SW	38.63	75.45	1948	1993
075320	LEWES	38.77	75.13	1948	1993
075852	MIDDLETOWN 1 WSW	39.43	75.75	1952	1988
075915	MILFORD 2 WSW	38.90	75.47	1948	1991
076410	NEWARK UNIV FARM	39.67	75.73	1948	1993
079595	WILMINGTON WSO AP	39.67	75.60	1948	1993
079605	WILMINGTON PORTER RESVR	39.77	75.53	1948	1993
KENTUCKY					
150254	ASHLAND	38.45	82.62	1932	1991
150381	BARBOURVILLE	36.87	83.88	1948	1991
150450	BAXTER	36.85	83.33	1948	1991
151120	BURDINE 2 NE	37.22	82.58	1952	1991
151576	CLAY CITY WATER WORKS	37.87	83.93	1955	1991
152791	FARMERS 2 S	38.12	83.55	1932	1991
152903	FLEMINGSBURG	38.42	83.73	1948	1991
153046	FREEBURN 2 SW	37.55	82.17	1951	1987
153052	FRENCHBURG 2 W	37.95	83.67	1948	1991
153714	HAZARD WATER WORKS	37.25	83.18	1950	1991
153741	HEIDELBERG LOCK 14	37.55	83.77	1932	1991
154196	JACKSON	37.55	83.38	1948	1984
154255	JEREMIAH 1 S	37.15	82.93	1948	1991
154946	LOUISA 2 SW	38.12	82.63	1951	1991
155111	MANCHESTER 4 W	37.15	83.82	1951	1991
155243	MAYSVILLE SEWAGE PLANT	38.68	83.78	1948	1991
155389	MIDDLESBORO	36.60	83.73	1928	1991
155640	MOUNT STERLING	38.07	83.93	1948	1991
156028	ONEIDA	37.27	83.65	1957	1991
156136	PAINTSVILLE 1 E	37.82	82.78	1933	1991
MAINE					
170275	AUGUSTA FAA AP	44.32	69.80	1948	1993
170355	BANGOR FAA AP	44.80	68.82	1953	1993
170371	BAR HARBOR 3 NW	44.42	68.25	1948	1982
170480	BELFAST	44.40	69.00	1948	1993
170600	BINGHAM WYMAN DAM	45.07	69.90	1957	1993
170814	BRASSUA DAM	45.67	69.82	1948	1993
170833	BRIDGEWATER	46.42	67.85	1957	1993
170844	BRIDGTON 3 NNW	44.08	70.73	1955	1993
170934	BRUNSWICK	43.90	69.93	1952	1993
171175	CARIBOU WSO AP	46.87	68.02	1939	1993
171628	CORINNA	44.92	69.27	1948	1993
172426	EASTPORT	44.92	67.00	1926	1993
172620	ELLSWORTH	44.53	68.43	1948	1993
172765	FARMINGTON	44.68	70.15	1926	1993
172868	FORT FAIRFIELD 5 NE	46.80	67.77	1936	1980
172878	FORT KENT	47.25	68.58	1945	1993
173046	GARDINER	44.22	69.78	1948	1993
173261	GRAND LAKE STREAM	45.18	67.78	1948	1993
173353	GREENVILLE	45.47	69.60	1920	1975
173892	HOULTON FAA AP	46.12	67.78	1948	1993
173897	HOULTON	46.13	67.83	1936	1985
174086	JACKMAN	45.63	70.27	1948	1993
174183	JONESBORO	44.65	67.65	1948	1993
MAINE (continued)					
174566	LEWISTON	44.10	70.22	1926	1993
174781	LONG FALLS DAM	45.22	70.20	1953	1993
174878	MACHIAS	44.72	67.47	1948	1993
174927	MADISON	44.80	69.88	1948	1993
175261	MIDDLE DAM	44.78	70.92	1948	1993
175304	MILLINOCKET	45.65	68.70	1948	1993
175460	MOOSEHEAD	45.58	69.72	1948	1993
176430	ORONO	44.90	68.67	1948	1993
176905	PORTLAND WSMO AP	43.65	70.32	1920	1993
176937	PRESQUE ISLE	46.65	68.00	1926	1993
177174	RIPOGENUS DAM	45.88	69.18	1948	1993
177250	ROCKLAND	44.10	69.12	1937	1976
177325	RUMFORD 1 SSE	44.53	70.53	1948	1993
177330	RUMFORD	44.55	70.55	1926	1959
177479	SANFORD 2 NNW	43.47	70.78	1953	1993
178398	SQUA PAN DAM	46.55	68.33	1948	1993
178942	UPPER DAM	44.87	70.87	1948	1993
179151	WATERVILLE PUMP STN	44.55	69.65	1958	1993
179314	WEST BUXTON 2 NNW	43.70	70.62	1953	1993
MARYLAND					
180015	ABERDEEN PHILLIPS FLD	39.47	76.17	1948	1993
180193	ANNAPOLIS POLICE BRKS	38.98	76.50	1951	1993
180465	BALTIMORE WSO AP	39.18	76.67	1948	1993
180470	BALTIMORE WSO CI	39.28	76.62	1893	1993
180700	BELTSVILLE	39.03	76.88	1948	1993
180732	BENSON POLICE BARRACKS	39.50	76.38	1948	1993
181052	BOYDS 2 NW	39.22	77.33	1953	1991
181125	BRIGHTON DAM	39.20	77.02	1948	1991
181385	CAMBRIDGE WTR TRMT PLT	38.57	76.07	1948	1992
181627	CENTREVILLE	39.05	76.07	1953	1985
181750	CHESTERTOWN	39.22	76.07	1948	1993
181995	COLLEGE PARK	38.98	76.95	1948	1993
182060	CONOWINGO DAM	39.65	76.17	1941	1992
182325	DALECARLIA RESERVOIR DC	38.93	77.12	1948	1993
182523	DENTON 2 E	38.88	75.80	1952	1989
182770	EDGEMONT	39.67	77.55	1948	1993
182906	EMMITSBURG 2 SE	39.68	77.30	1956	1993
183348	FREDERICK POLICE BRKS	39.42	77.43	1948	1993
183355	FREDERICK 3 E	39.40	77.37	1948	1990
183675	GLENN DALE BELL STN	38.97	76.80	1948	1993
183975	HAGERSTOWN	39.65	77.73	1948	1993
184030	HANCOCK FRUIT LAB	39.70	78.18	1948	1993
184780	KEEDYSVILLE	39.48	77.70	1923	1960
185080	LA PLATA 1 W	38.53	77.00	1948	1993
185111	LAUREL 3 W	39.10	76.90	1949	1993
185894	MERRILL	39.60	79.08	1951	1993
185985	MILLINGTON 2 WNW	39.27	75.87	1948	1993
186350	NATIONAL ARBORETUM DC	38.90	76.97	1948	1993
186620	OAKLAND 1 SE	39.40	79.40	1948	1993
186770	OWINGS FERRY LANDING	38.68	76.67	1948	1993
186844	PARKTON 2 SW	39.63	76.70	1953	1986
187330	PRINCESS ANNE	38.22	75.68	1948	1993
187705	ROCKVILLE 1 NE	39.10	77.10	1948	1993
187806	ROYAL OAK 2 SSW	38.72	76.18	1948	1993
188000	SALISBURY	38.37	75.58	1948	1993
188005	SALISBURY FAA AP	38.33	75.52	1948	1993
188065	SAVAGE RIVER DAM	39.52	79.13	1948	1993
188380	SNOW HILL 4 N	38.23	75.38	1948	1993
188877	TOWSON	39.38	76.57	1948	1991
189030	UNIONVILLE	39.45	77.18	1948	1993
189070	UPPER MARLBORO 3 NNW	38.87	76.78	1956	1993
189140	VIENNA	38.48	75.83	1949	1993
189750	WOODSTOCK	39.33	76.87	1895	1993
MASSACHUSETTS					
190049	ADAMS	42.65	73.10	1930	1978
190120	AMHERST	42.38	72.53	1926	1993
190190	ASHBURNHAM	42.65	71.88	1948	1993
190408	BARRE FALLS DAM	42.43	72.03	1959	1993
190535	BEDFORD	42.48	71.28	1957	1993
190551	BEECHWOOD	42.23	70.82	1948	1993
190562	BELCHERTOWN	42.28	72.35	1948	1993
190666	BIRCH HILL DAM	42.63	72.12	1948	1993
190736	BLUE HILL WSO	42.22	71.12	1926	1993
190770	BOSTON WSO AP	42.37	71.03	1920	1993
190801	BOYLSTON	42.35	71.72	1948	1985
190860	BROCKTON	42.05	71.00	1948	1993
190998	BUFFUMVILLE LAKE	42.12	71.90	1959	1993
191436	CHESTERFIELD	42.38	72.85	1948	1993
191447	CHESTNUT HILL	42.33	71.15	1948	1986
191561	CLINTON	42.40	71.68	1948	1985
192107	EAST BRIMFIELD LAKE	42.12	72.13	1962	1993
192451	EAST WAREHAM	41.77	70.67	1926	1993
192501	EDGARTOWN	41.38	70.52	1948	1993
192806	FITCHBURG 4 SE	42.55	71.75	1948	1978
192975	FRAMINGHAM	42.28	71.42	1948	1989
192997	FRANKLIN	42.08	71.42	1948	1993
193052	GARDNER	42.58	71.98	1948	1993
193401	HARDWICK	42.35	72.18	1948	1993
193471	HATCHVILLE	41.62	70.53	1948	1993

Station number	Station name	Latitude (degrees)	Longitude (degrees)	Record begins	Record ends
MASSACHUSETTS (continued)					
193505	HAVERHILL	42.77	71.07	1948	1993
193549	HEATH	42.67	72.82	1948	1993
193624	HINGHAM	42.23	70.92	1960	1993
193702	HOLYOKE	42.20	72.60	1948	1994
193772	HUBBARDSTON	42.48	72.00	1948	1980
193821	HYANNIS	41.67	70.30	1926	1993
193876	IPSWICH	42.67	70.87	1948	1993
193985	KNIGHTVILLE DAM	42.28	72.87	1948	1993
194105	LAWRENCE	42.70	71.17	1926	1993
194313	LOWELL	42.65	71.37	1948	1993
194449	MANSFIELD	42.05	71.20	1948	1993
194711	MIDDLEBORO	41.88	70.92	1948	1993
194744	MIDDLETON	42.60	71.02	1948	1993
194760	MILFORD	42.17	71.52	1948	1993
195246	NEW BEDFORD	41.63	70.93	1948	1993
195285	NEWBURYPORT	42.83	70.92	1948	1993
195306	NEW SALEM	42.45	72.33	1948	1993
196251	PELHAM	42.40	72.40	1948	1990
196262	PEMBROKE	42.02	70.82	1948	1991
196322	PETERSHAM 3 N	42.53	72.18	1948	1993
196414	PITTSFIELD	42.43	73.28	1925	1970
196425	PLAINFIELD	42.52	72.92	1948	1993
196486	PLYMOUTH	41.95	70.67	1948	1993
196699	QUABBIN INTAKE	42.37	72.28	1948	1991
196783	READING	42.52	71.13	1960	1993
196938	ROCHESTER	41.78	70.92	1951	1993
196977	ROCKPORT 1 ESE	42.65	70.60	1948	1983
197627	SOUTHBRIDGE 3 SW	42.05	72.08	1948	1993
198046	SPRINGFIELD	42.10	72.58	1926	1984
198154	STERLING	42.45	71.82	1948	1985
198181	STOCKBRIDGE	42.30	73.33	1948	1985
198367	TAUNTON	41.90	71.07	1948	1993
198573	TULLY LAKE	42.63	72.22	1949	1993
198793	WARE	42.27	72.25	1948	1993
199191	WESTFIELD	42.12	72.70	1948	1993
199316	WEST MEDWAY	42.13	71.43	1957	1993
199360	WESTON	42.38	71.32	1929	1968
199371	WEST OTIS	42.17	73.15	1948	1993
199923	WORCESTER WSO AP	42.27	71.87	1948	1993
199928	WORCESTER	42.30	71.82	1926	1962
MICHIGAN					
200230	ANN ARBOR UNIV OF MICH	42.30	83.72	1901	1991
200417	BAD AXE	43.82	83.00	1925	1991
201299	CARO REGIONAL CENTER	43.45	83.40	1928	1991
202015	DEARBORN	42.32	83.23	1952	1991
202423	EAST TAWAS	44.28	83.50	1931	1991
202846	FLINT WSO AP	42.97	83.75	1948	1991
203477	GROSSE POINTE FARMS	42.38	82.90	1950	1991
203529	HALE LOUD DAM	44.47	83.72	1948	1991
203585	HARBOR BEACH 1 SSE	43.83	82.63	1931	1991
203947	HOWELL WWTP	42.60	83.93	1948	1991
204655	LAPEER	43.05	83.35	1931	1991
205452	MILFORD GM PROVING GROU	42.58	83.70	1931	1991
205488	MILLINGTON 3 SW	43.23	83.57	1948	1991
205558	MONROE WATERWORKS	41.92	83.40	1931	1991
205650	MOUNT CLEMENS ANG BASE	42.60	82.83	1948	1991
206658	PONTIAC STATE HOSPITAL	42.65	83.30	1948	1991
206680	PORT HURON SEWAGE PLANT	42.98	82.42	1931	1991
207350	SANDUSKY	43.42	82.83	1948	1991
207419	SEBEWAING	43.73	83.45	1948	1991
207820	STANDISH 5 SW	43.95	84.03	1948	1991
209014	WILLIS 5 SSW	42.08	83.58	1948	1983
209188	YALE	43.15	82.80	1948	1991
NEW HAMPSHIRE					
270690	BERLIN	44.45	71.18	1926	1993
270703	BETHLEHEM	44.28	71.68	1948	1993
270741	BLACKWATER DAM	43.32	71.72	1948	1992
270910	BRADFORD	43.25	71.97	1948	1993
271683	CONCORD WSO AP	43.20	71.50	1921	1993
272023	DIXVILLE NOTCH	44.87	71.33	1948	1993
272174	DURHAM	43.15	70.95	1926	1993
272842	ERROL	44.78	71.13	1948	1993
272999	FIRST CONN LAKE	45.08	71.28	1948	1993
273024	FITZWILLIAM 2 W	42.78	72.18	1948	1992
273182	FRANKLIN FALLS DAM	43.47	71.65	1948	1993
273530	GRAFTON	43.57	71.95	1955	1993
273850	HANOVER	43.70	72.28	1926	1993
274399	KEENE	42.92	72.27	1926	1993
274475	LAKEPORT	43.55	71.47	1948	1982
274480	LAKEPORT 2	43.55	71.47	1948	1993
274556	LANCASTER	44.48	71.58	1948	1993
274656	LEBANON FAA AIRPORT	43.63	72.32	1948	1993
275013	MACDOWELL DAM	42.90	71.98	1950	1993
275150	MARLOW	43.12	72.20	1951	1993
275211	MASSABESIC LAKE	42.98	71.40	1948	1993
275400	MILAN 7 NNW	44.67	71.22	1948	1981
275412	MILFORD	42.82	71.65	1948	1993
275500	MONROE 5 NNE	44.32	72.00	1948	1993
275629	MOUNT SUNAPEE	43.33	72.08	1957	1993
275712	NASHUA 2 NNW	42.78	71.48	1948	1993
275868	NEWPORT	43.37	72.18	1948	1993
276234	NORTH STRATFORD	44.75	71.63	1948	1993
276550	OTTER BROOK LAKE	42.95	72.23	1958	1993
276697	PETERBORO 2 S	42.85	71.95	1948	1992
276818	PINKHAM NOTCH	44.27	71.25	1948	1993
276945	PLYMOUTH 1 E	43.77	71.67	1951	1993
277967	SOUTH DANBURY	43.50	71.90	1948	1981
278081	SOUTH LYNDEBORO	42.88	71.78	1948	1993
278539	SURRY MOUNTAIN LAKE	43.00	72.32	1948	1993
279474	WEST RUMNEY	43.80	71.85	1948	1986
279940	WOODSTOCK	43.98	71.68	1948	1980
279966	YORK POND	44.50	71.33	1948	1993
NEW JERSEY					
280311	ATLANTIC CITY WSO AP	39.45	74.57	1958	1993
280325	ATLANTIC CITY	39.38	74.43	1948	1993
280346	AUDUBON	39.88	75.08	1950	1990
280690	BELLEPLAIN STA FOREST	39.25	74.87	1926	1993
280729	BELVIDERE	40.83	75.08	1926	1981
280907	BOONTON 1 SE	40.90	74.40	1926	1993
280927	BOUND BROOK 2 W	40.55	74.57	1956	1993
281327	CANISTEAR RESERVOIR	41.12	74.50	1948	1993
281335	CANOE BROOK	40.75	74.35	1931	1993
281351	CAPE MAY 2 NW	38.95	74.93	1948	1993
281582	CHARLOTTEBURG RESERVOIR	41.03	74.43	1926	1993
282644	ELIZABETH	40.67	74.23	1931	1970
282768	ESSEX FELLS SERV BLDG	40.83	74.28	1949	1993
283029	FLEMINGTON	40.50	74.87	1926	1993
283181	FREEHOLD	40.27	74.25	1931	1987
283291	GLASSBORO	39.70	75.12	1948	1993
283516	GREENWOOD LAKE	41.13	74.33	1948	1993
283662	HAMMONTON 2 NNE	39.65	74.80	1948	1990
283951	HIGHTSTOWN 2 W	40.27	74.57	1931	1993
284229	INDIAN MILLS 2 W	39.80	74.78	1926	1993
284339	JERSEY CITY	40.73	74.05	1948	1993
284635	LAMBERTVILLE	40.37	74.95	1931	1993
284735	LAYTON 3 NW	41.25	74.85	1926	1962
284887	LITTLE FALLS	40.88	74.23	1948	1993
284987	LONG BRANCH OAKHURST	40.27	74.00	1928	1993
285003	LONG VALLEY	40.78	74.78	1931	1993
285104	MAHWAH	41.10	74.17	1956	1988
285346	MAYS LANDING 1 W	39.45	74.75	1948	1993
285503	MIDLAND PARK	40.98	74.15	1948	1993
285581	MILLVILLE FAA AIRPORT	39.37	75.07	1948	1993
285728	MOORESTOWN	39.97	74.97	1926	1993
285769	MORRIS PLAINS 1 W	40.83	74.50	1948	1990
286026	NEWARK WSO AP	40.70	74.17	1948	1993
286062	NEW BRUNSWICK EXP STN	40.47	74.43	1912	1968
286146	NEW MILFORD	40.95	74.03	1948	1993
286177	NEWTON ST PAUL'S ABBEY	41.03	74.80	1948	1993
286460	OAK RIDGE RESERVOIR	41.03	74.50	1948	1993
286843	PEMBERTON 3 S	39.93	74.70	1948	1993
286974	PHILLIPSBURG	40.68	75.18	1931	1977
287079	PLAINFIELD	40.60	74.40	1931	1993
287131	PLEASANTVILLE 1 N	39.42	74.52	1926	1958
287328	PRINCETON WATER WORKS	40.33	74.67	1949	1986
287393	RAHWAY	40.60	74.27	1948	1993
287587	RINGWOOD	41.13	74.27	1948	1993
288194	SOMERVILLE 3 NW	40.60	74.63	1931	1993
288402	SPLIT ROCK POND	40.97	74.47	1948	1993
288644	SUSSEX 1 SE	41.20	74.60	1948	1993
288816	TOMS RIVER	39.95	74.22	1948	1993
288883	TRENTON	40.22	74.77	1931	1993
288899	TUCKERTON	39.60	74.35	1948	1993
289187	WANAQUE RAYMOND DAM	41.05	74.30	1948	1993
289363	WERTSVILLE	40.45	74.80	1956	1991
289608	WEST WHARTON	40.90	74.60	1959	1990
289832	WOODCLIFF LAKE	41.02	74.05	1948	1993
289910	WOODSTOWN	39.65	75.32	1948	1993
NEW YORK					
300023	ADDISON	42.10	77.22	1948	1991
300042	ALBANY WSO AP	42.75	73.80	1938	1993
300047	ALBANY	42.65	73.75	1922	1970
300055	ALBION 2 NE	43.28	78.17	1948	1993
300063	ALCOVE DAM	42.47	73.93	1948	1993
300085	ALFRED	42.25	77.78	1926	1993
300093	ALLEGANY STATE PARK	42.10	78.75	1948	1993
300183	ANGELICA	42.30	78.02	1926	1993
300220	ARCADE	42.53	78.42	1948	1993
300254	ARKVILLE 2 W	42.13	74.65	1948	1993
300321	AUBURN 2 NE	42.93	76.53	1926	1993
300331	AURORA RESEARCH FARM	42.73	76.65	1956	1993
300343	AVON	42.92	77.75	1948	1993
300360	BAINBRIDGE	42.28	75.45	1948	1993
300379	BALDWINSVILLE	43.15	76.33	1948	1993
300443	BATAVIA	42.98	78.18	1948	1993
300448	BATH	42.35	77.35	1953	1993
300452	BATTENVILLE	43.10	73.43	1955	1993
300500	BEAVER FALLS	43.88	75.43	1948	1993

Table 3 (continued)

Station number	Station name	Latitude (degrees)	Longitude (degrees)	Record begins	Record ends
NEW YORK (continued)					
300608	BENNETTS BRIDGE	43.53	75.95	1948	1993
300641	BERLIN 5 S	42.62	73.37	1955	1993
300668	BIG MOOSE 3 SE	43.80	74.87	1948	1993
300687	BINGHAMTON WSO AP	42.22	75.98	1951	1993
300691	BINGHAMTON	42.10	75.92	1926	1968
300785	BOONVILLE 2 SSW	43.45	75.35	1949	1993
300870	BREWERTON LOCK 23	43.23	76.20	1948	1993
300889	BRIDGEHAMPTON	40.95	72.30	1930	1993
300929	BROADALBIN	43.05	74.20	1948	1993
300937	BROCKPORT 2 NW	43.25	77.97	1950	1993
301012	BUFFALO WSCMO AP	42.93	78.73	1922	1993
301110	CAMDEN 2 NW	43.37	75.78	1948	1993
301152	CANANDAIGUA 3 S	42.85	77.28	1948	1993
301160	CANASTOTA	43.08	75.77	1948	1983
301168	CANDOR	42.23	76.33	1948	1993
301173	CANISTEO 1 S	42.27	77.62	1949	1993
301185	CANTON 4 SE	44.57	75.12	1922	1993
301207	CARMEL 1 SW	41.42	73.70	1926	1993
301265	CAYUGA LOCK 1	42.95	76.73	1948	1993
301387	CHASM FALLS	44.75	74.22	1948	1993
301401	CHAZY	44.88	73.43	1926	1993
301413	CHEMUNG	42.00	76.63	1948	1993
301424	CHEPACHET	42.92	75.12	1957	1993
301436	CHERRY VALLEY 2 NNE	42.82	74.73	1949	1993
301492	CINCINNATUS	42.53	75.90	1948	1993
301521	CLARYVILLE	41.92	74.57	1948	1993
301580	CLYDE LOCK 26	43.07	76.83	1948	1993
301593	COBLESKILL 2	42.68	74.48	1955	1986
301623	COLDEN 1 N	42.67	78.68	1957	1993
301664	COLTON 2 N	44.58	74.95	1948	1993
301708	CONKLINGVILLE DAM	43.32	73.93	1948	1993
301752	COOPERSTOWN	42.70	74.92	1926	1993
301799	CORTLAND	42.60	76.18	1948	1993
301966	DANNEMORA	44.72	73.72	1926	1993
301974	DANSVILLE	42.57	77.70	1941	1993
302036	DELHI 2 SE	42.25	74.90	1926	1993
302060	DEPOSIT	42.07	75.43	1962	1993
302079	DE RUYTER 4 N	42.82	75.88	1948	1984
302129	DOBBS FERRY	41.02	73.87	1948	1993
302137	DOLGEVILLE	43.08	74.77	1948	1993
302169	DOWNSVILLE DAM	42.08	74.97	1959	1993
302234	EAGLE BAY 3 SE	43.75	74.77	1953	1993
302554	ELIZABETHTOWN	44.22	73.60	1948	1993
302574	ELLENBURG DEPOT	44.90	73.80	1948	1993
302582	ELLENVILLE	41.72	74.40	1948	1993
302610	ELMIRA 2 SE	42.08	76.78	1926	1993
302829	FISHS EDDY	41.97	75.18	1953	1993
303010	FRANKFORT LOCK 19	43.07	75.12	1948	1993
303025	FRANKLINVILLE 1 SSW	42.33	78.47	1949	1993
303033	FREDONIA	42.45	79.30	1926	1993
303050	FREEVILLE 1 NE	42.52	76.33	1948	1993
303076	FROST VALLEY	41.97	74.55	1948	1981
303138	GARDINER	41.68	74.15	1956	1987
303144	GARDNERVILLE	41.35	74.48	1956	1993
303177	GENEVA EXP STATION	42.88	77.00	1921	1968
303259	GLENHAM	41.52	73.93	1948	1993
303284	GLENS FALLS FARM	43.33	73.73	1948	1993
303294	GLENS FALLS FAA AP	43.35	73.62	1948	1993
303319	GLOVERSVILLE	43.05	74.33	1948	1993
303346	GOUVERNEUR 3 NW	44.35	75.52	1948	1993
303354	GOWANDA PSYCHIATRIC CTR	42.48	78.93	1948	1993
303360	GRAFTON	42.78	73.47	1950	1993
303365	GRAHAMSVILLE	41.85	74.53	1948	1993
303444	GREENE	42.32	75.77	1948	1993
303464	GREENPORT POWER HOUSE	41.10	72.37	1958	1993
303507	GRIFFISS AIR FORCE BASE	43.23	75.40	1961	1993
303722	HASKINVILLE	42.42	77.57	1948	1993
303773	HEMLOCK	42.78	77.62	1926	1993
303851	HIGHMARKET	43.58	75.52	1948	1993
303889	HINCKLEY 2 NE	43.32	75.12	1948	1993
303961	HOOKER 4 N	43.75	75.73	1948	1993
303970	HOPE	43.30	74.25	1948	1993
303983	HORNELL ALMOND DAM	42.35	77.70	1950	1993
304025	HUDSON CORRECTIONAL FAC	42.25	73.80	1957	1993
304102	INDIAN LAKE 2 SW.	43.75	74.28	1948	1993
304174	ITHACA CORNELL UNIV	42.45	76.45	1893	1993
304206	JAMESTOWN	42.10	79.25	1926	1960
304473	KORTRIGHT 2	42.42	74.80	1960	1993
304525	LAKE DELAWARE	42.25	74.90	1948	1981
304555	LAKE PLACID 2 S	44.25	73.98	1948	1993
304647	LAWRENCEVILLE	44.75	74.65	1948	1993
304731	LIBERTY 1 NE	41.80	74.73	1950	1993
304772	LINDLEY	42.03	77.13	1953	1993
304791	LITTLE FALLS CITY RES	43.07	74.87	1926	1993
304796	LITTLE FALLS MILL ST	43.03	74.87	1926	1993
304808	LITTLE VALLEY	42.25	78.80	1948	1993
304836	LOCKE 2 W	42.67	76.47	1948	1993
304844	LOCKPORT 2 NE	43.18	78.65	1926	1993
304849	LOCKPORT 4 NE	43.20	78.63	1961	1993
304912	LOWVILLE	43.80	75.48	1926	1993
304944	LYONS FALLS	43.62	75.37	1948	1993
304952	MACEDON	43.07	77.30	1948	1993
305032	MANORKILL	42.38	74.32	1948	1993
305134	MASSENA FAA AP	44.93	74.85	1948	1993
305171	MAYS POINT LOCK 25	43.00	76.77	1948	1993
305276	MERRIMAN DAM	41.80	74.43	1961	1993
305310	MIDDLETOWN 2 NW	41.45	74.45	1951	1993
305334	MILLBROOK	41.85	73.62	1948	1993
305377	MINEOLA	40.73	73.63	1948	1993
305426	MOHONK LAKE	41.77	74.15	1948	1993
305512	MORRISVILLE 3 S	42.85	75.65	1926	1993
305597	MOUNT MORRIS 2 W	42.73	77.90	1948	1993
305604	MT PLEASANT FARM	42.45	76.37	1957	1993
305639	NARROWSBURG 4 SE	41.57	75.02	1956	1993
305673	NEW ALBION	42.30	78.90	1948	1993
305679	NEWARK	43.05	77.08	1948	1993
305687	NEW BERLIN	42.62	75.33	1948	1993
305714	NEWCOMB 3 E	43.97	74.10	1959	1993
305743	NEW KINGSTON	42.23	74.70	1948	1989
305751	NEW LONDON LOCK 22	43.22	75.65	1948	1993
305796	NEW YORK AVE V BROOKLYN	40.60	73.98	1948	1993
305801	N Y CNTRL PK WSFO CI	40.78	73.97	1876	1993
305804	NEW YORK LAUREL HILL	40.73	73.93	1922	1983
305811	N Y LAGUARDIA WSO AP	40.77	73.90	1948	1993
305821	N Y WESTERLEIGH STAT IS	40.60	74.17	1948	1992
305869	NORFOLK	44.80	75.00	1948	1993
305925	NORTH CREEK	43.67	73.90	1948	1993
306062	NORTHVILLE	43.23	74.17	1955	1993
306085	NORWICH	42.53	75.53	1926	1993
306164	OGDENSBURG 4 NE	44.73	75.43	1926	1993
306184	OLD FORGE	43.72	74.98	1948	1993
306196	OLEAN	42.08	78.45	1948	1993
306314	OSWEGO EAST	43.47	76.50	1926	1993
306411	PARISHVILLE 1 WNW	44.63	74.83	1948	1981
306441	PATCHOGUE 2 N	40.80	73.02	1948	1993
306464	PAVILION	42.88	78.03	1956	1992
306510	PENN YAN	42.67	77.07	1948	1984
306538	PERU 2 WSW	44.57	73.57	1948	1993
306567	PHOENICIA	42.08	74.33	1948	1993
306623	PISECO	43.45	74.53	1948	1993
306659	PLATTSBURGH AFB	44.65	73.47	1948	1993
306674	PLEASANTVILLE	41.13	73.77	1948	1993
306745	PORTAGEVILLE	42.57	78.05	1956	1993
306774	PORT JERVIS	41.38	74.68	1926	1993
306817	POUGHKEEPSIE	41.68	73.93	1928	1971
306820	POUGHKEEPSIE FAA AP	41.63	73.88	1948	1993
306831	PRATTSBURG 2 NW	42.53	77.30	1948	1986
306839	PRATTSVILLE 3 N	42.35	74.45	1948	1993
307134	RIVERHEAD RESEARCH FARM	40.97	72.72	1948	1993
307167	ROCHESTER WSO AP	43.12	77.67	1926	1993
307195	ROCKDALE	42.38	75.40	1948	1993
307274	ROSENDALE 2 E	41.85	74.05	1956	1993
307317	ROXBURY	42.28	74.57	1926	1972
307329	RUSHFORD 1 W	42.40	78.27	1954	1993
307348	SABATTIS 3 NE	44.12	74.67	1948	1979
307405	SALEM	43.17	73.32	1948	1993
307413	SALISBURY	43.17	74.87	1926	1975
307484	SARATOGA SPRINGS 4 SW	43.03	73.82	1955	1993
307497	SCARSDALE	40.98	73.80	1948	1991
307513	SCHENECTADY	42.83	73.92	1943	1985
307633	SETAUKET	40.97	73.10	1926	1993
307705	SHERBURNE 2 S	42.65	75.48	1948	1993
307713	SHERMAN	42.17	79.60	1951	1993
307721	SHOKAN BROWN STATION	41.95	74.20	1953	1993
307772	SINCLAIRVILLE	42.27	79.27	1959	1993
307780	SKANEATELES	42.95	76.43	1948	1993
307799	SLIDE MOUNTAIN	42.02	74.42	1948	1993
307818	SMITHS BASIN	43.35	73.50	1948	1993
307842	SODUS CENTER	43.20	77.02	1948	1993
308058	SOUTH WALES EMERY PARK	42.72	78.60	1931	1982
308088	SPENCER 1 SW	42.18	76.50	1948	1993
308160	STAMFORD	42.40	74.63	1948	1993
308248	STILLWATER RESERVOIR	43.88	75.03	1948	1993
308322	SUFFERN WATER WORKS	41.12	74.15	1956	1993
308383	SYRACUSE WSO AP	43.12	76.12	1922	1993
308455	THERESA	44.22	75.80	1948	1979
308578	TRENTON FALLS	43.27	75.15	1948	1993
308586	TRIBES HILL	42.95	74.28	1948	1993
308594	TROUPSBURG 4 NE	42.07	77.48	1948	1993
308600	TROY LOCK AND DAM 2	42.75	73.68	1932	1993
308631	TUPPER LAKE SUNMOUNT	44.23	74.43	1948	1993
308737	UTICA FAA AP	43.15	75.38	1950	1993
308739	UTICA 3 W	43.10	75.28	1948	1991
308902	WALDEN 2 NE	41.57	74.17	1926	1959
308936	WALTON	42.17	75.13	1956	1993
308944	WANAKENA RANGER SCHOOL	44.15	74.90	1926	1993
308959	WARRENSBURG 4 NW	43.55	73.80	1948	1993
308962	WARSAW 5 SW	42.68	78.20	1952	1993
308987	WATERLOO	42.90	76.87	1948	1993
309000	WATERTOWN	43.97	75.87	1926	1993
309005	WATERTOWN FAA AP	44.00	76.02	1949	1993
309072	WELLSVILLE	42.12	77.95	1956	1993

Station number	Station name	Latitude (degrees)	Longitude (degrees)	Record begins	Record ends
NEW YORK (continued)					
309189	WESTFIELD 3 SW	42.28	79.60	1948	1993
309250	WEST MILTON	43.03	73.93	1955	1986
309292	WEST POINT	41.38	73.97	1948	1993
309389	WHITEHALL	43.55	73.40	1932	1993
309425	WHITESVILLE	42.03	77.77	1954	1993
309437	WHITNEY POINT	42.35	75.97	1944	1993
309507	WILSON 2 NE	43.32	78.80	1948	1993
309516	WINDHAM 2 E	42.30	74.22	1948	1993
309544	WOLCOTT 3 NW	43.25	76.87	1948	1993
OHIO					
330058	AKRON-CANTON WSO AP	40.92	81.43	1948	1993
330083	ALEXANDRIA 4 WSW	40.08	82.68	1948	1988
330141	AMESVILLE	39.40	81.97	1953	1988
330256	ASHLAND 2 SW	40.83	82.35	1936	1993
330264	ASHTABULA	41.85	80.80	1951	1993
330274	ATHENS 5 NW	39.38	82.18	1948	1980
330279	ATHENS	39.33	82.10	1948	1991
330298	ATWOOD LAKE	40.52	81.28	1949	1987
330430	BARNESVILLE-FRIENDS SCH	39.98	81.15	1940	1993
330493	BEACH CITY LAKE	40.63	81.57	1948	1987
330563	BELLEFONTAINE SEWAGE	40.35	83.77	1936	1993
330823	BOLIVAR DAM	40.65	81.43	1949	1987
330854	BOURNEVILLE 1 SSW	39.27	83.17	1955	1986
330862	BOWLING GREEN SEWAGE PL	41.38	83.62	1936	1993
331057	BUCKEYE LAKE 2 WNW	39.93	82.52	1956	1993
331072	BUCYRUS	40.82	82.97	1936	1993
331152	CADIZ	40.27	81.00	1903	1993
331178	CALDWELL 6 NW	39.82	81.60	1936	1990
331197	CAMBRIDGE WATER PLANT	40.02	81.58	1948	1993
331245	CANFIELD 1 S	41.02	80.77	1917	1993
331315	CARROLLTON 3 NNE	40.62	81.07	1948	1987
331399	CENTERBURG	40.30	82.70	1948	1981
331404	CENTERBURG 2 SE	40.30	82.65	1950	1993
331458	CHARDON	41.58	81.18	1945	1993
331466	CHARLES MILL LAKE	40.73	82.37	1939	1987
331523	CHILLICOTHE	39.33	82.97	1936	1972
331541	CHIPPEWA LAKE	41.07	81.90	1936	1993
331592	CIRCLEVILLE	39.62	82.95	1942	1993
331642	CLENDENING LAKE	40.27	81.28	1948	1987
331657	CLEVELAND WSO AP	41.42	81.87	1948	1993
331778	COLUMBUS OHIO STN UNIV	40.00	83.02	1900	1957
331781	COLUMBUS SULLIVANT AVE	39.95	83.12	1952	1983
331783	COLUMBUS VLY CROSSING	39.90	82.90	1948	1993
331786	COLUMBUS WSO AP	40.00	82.88	1948	1993
331858	COOPERDALE	40.22	82.07	1948	1993
331890	COSHOCTON SEWAGE PLANT	40.25	81.87	1936	1993
331905	COSHOCTON AGR RSCH STN	40.37	81.80	1956	1993
332119	DELAWARE	40.28	83.07	1936	1993
332124	DELAWARE LAKE	40.37	83.07	1949	1987
332251	DORSET	41.68	80.67	1956	1993
332272	DOVER DAM	40.57	81.42	1949	1987
332599	ELYRIA 3 E	41.38	82.07	1949	1993
332626	ENTERPRISE	39.57	82.48	1948	1993
332786	FINDLAY FAA AP	41.02	83.67	1948	1993
332791	FINDLAY SEWAGE PLANT	41.05	83.67	1936	1993
332956	FREDERICKTOWN 4 S	40.42	82.53	1948	1993
332974	FREMONT	41.33	83.12	1948	1993
333021	GALION WATER WORKS	40.72	82.80	1948	1993
333029	GALLIPOLIS	38.82	82.18	1936	1993
333393	GREER	40.52	82.20	1948	1993
333730	HIGGINSPORT	38.78	83.97	1948	1982
333758	HILLSBORO	39.20	83.62	1900	1993
333780	HIRAM	41.30	81.15	1900	1993
333874	HOYTVILLE 2 NE	41.22	83.77	1952	1993
333915	HUNTSVILLE 3 N	40.48	83.82	1948	1993
333971	IRONTON	38.53	82.68	1900	1982
333987	IRWIN	40.12	83.48	1941	1993
334004	JACKSON 2 NW	39.07	82.65	1936	1991
334189	KENTON	40.65	83.60	1900	1993
334363	LAKEVIEW 3 NE	40.52	83.88	1948	1983
334383	LANCASTER 2 NW	39.73	82.63	1936	1993
334409	LA RUE	40.58	83.38	1948	1991
334434	LAURELVILLE	39.47	82.73	1951	1993
334473	LEESVILLE LAKE	40.47	81.20	1949	1987
334616	LITHOPOLIS 2 S	39.78	82.82	1951	1988
334681	LONDON WATER WORKS	39.88	83.45	1936	1993
334728	LOUISVILLE	40.83	81.25	1948	1993
334865	MANSFIELD WSO AP	40.82	82.52	1948	1993
334874	MANSFIELD 5 W	40.77	82.62	1948	1993
334924	MARIETTA LOCK 1	39.42	81.45	1948	1993
334942	MARION 2 N	40.62	83.13	1936	1993
334967	MARSHALLVILLE 1 SSW	40.88	81.73	1948	1993
334979	MARYSVILLE	40.23	83.37	1936	1993
335029	MC ARTHUR	39.25	82.48	1957	1993
335041	MC CONNELLSVILLE LOCK 7	39.65	81.85	1900	1993
335199	MIDDLEBOURNE	40.05	81.33	1948	1987
335297	MILLERSBURG	40.55	81.92	1936	1993
335315	MILLPORT 2 NW	40.72	80.90	1936	1993
335356	MINERAL RIDGE WATER WKS	41.15	80.78	1940	1993
335398	MOHAWK DAM	40.35	82.08	1949	1987
OHIO (continued)					
335406	MOHICANVILLE DAM	40.73	82.15	1949	1987
335505	MOSQUITO CREEK LAKE	41.30	80.77	1948	1993
335535	MT GILEAD LAKES PARK	40.55	82.82	1952	1993
335718	NELSONVILLE 1 W	39.47	82.25	1951	1993
335747	NEWARK WATER WORKS	40.08	82.42	1936	1993
335857	NEW LEXINGTON 2 NW	39.73	82.22	1942	1993
335894	NEW PHILADELPHIA	40.50	81.45	1948	1993
335904	NEW PHILADELPHIA 1 A	40.50	81.45	1949	1990
335947	NEW STRAITSVILLE	39.58	82.25	1951	1990
336118	NORWALK WST WTR TRT PL	41.27	82.62	1900	1993
336136	NORWICH 1 E	39.98	81.78	1948	1986
336196	OBERLIN	41.27	82.22	1936	1993
336389	PAINESVILLE 4 NW	41.75	81.30	1950	1993
336405	PANDORA	40.95	83.97	1949	1993
336600	PHILO 3 SW	39.83	81.92	1948	1993
336616	PIEDMONT LAKE	40.18	81.22	1949	1987
336630	PIKETON AEC PUMP STN	39.07	83.02	1948	1993
336702	PLEASANT HILL LAKE	40.62	82.33	1949	1987
336729	PLYMOUTH 2 WSW	40.98	82.70	1935	1982
336781	PORTSMOUTH	38.75	82.88	1936	1993
336786	PORTSMOUTH US GRANT BR	38.73	83.00	1948	1993
336861	PROSPECT	40.45	83.18	1948	1993
336882	PUT IN BAY PERRY MON	41.65	82.80	1936	1993
336949	RAVENNA 2 S	41.13	81.28	1948	1993
337120	RIPLEY EXP FARM	38.78	83.80	1959	1993
337255	ROSEVILLE	39.82	82.07	1961	1993
337447	SANDUSKY	41.45	82.72	1936	1993
337476	SAYRE	39.68	82.05	1951	1989
337538	SEDALIA	39.73	83.48	1948	1993
337559	SENECAVILLE LAKE	39.92	81.43	1940	1987
337932	SPRINGFIELD WW TREAT PL	39.92	83.85	1952	1988
338025	STEUBENVILLE	40.38	80.63	1941	1993
338148	SUMMERFIELD 2 NE	39.82	81.30	1948	1987
338240	TAPPAN LAKE	40.35	81.23	1949	1987
338313	TIFFIN	41.12	83.17	1936	1993
338357	TOLEDO EXPRESS WSO AP	41.58	83.80	1955	1993
338366	TOLEDO BLADE	41.65	83.53	1948	1993
338378	TOM JENKINS LAKE	39.55	82.07	1953	1987
338534	UPPER SANDUSKY	40.83	83.28	1936	1993
338552	URBANA SEWAGE PLANT	40.10	83.78	1936	1993
338560	UTICA	40.25	82.45	1948	1993
338769	WARREN 3 S	41.20	80.82	1936	1993
338794	WASHINGTON COURT HOUSE	39.52	83.42	1936	1993
338830	WAVERLY	39.12	82.98	1936	1993
338951	WESTERVILLE	40.13	82.95	1952	1993
339211	WILLS CREEK LAKE	40.15	81.85	1949	1987
339219	WILMINGTON 3 N	39.48	83.82	1936	1993
339312	WOOSTER EXP STATION	40.78	81.92	1900	1993
339361	XENIA 6 SSE	39.62	83.90	1936	1993
339406	YOUNGSTOWN WSO AP	41.25	80.67	1948	1993
339417	ZANESVILLE FAA AP	39.95	81.90	1946	1993
PENNSYLVANIA					
360022	ACMETONIA LOCK 3	40.53	79.82	1948	1993
360106	ALLENTOWN WSO AP	40.65	75.43	1948	1993
360134	ALTOONA HORSESHOE CURVE	40.50	78.48	1926	1967
360313	AUSTINBURG 2 W	42.00	77.53	1948	1981
360355	BAKERSTOWN 3 WNW	40.65	79.98	1948	1990
360409	BARNES	41.67	79.03	1948	1991
360457	BEAR GAP	40.83	76.50	1948	1993
360475	BEAVER FALLS 1 NE	40.77	80.32	1948	1993
360482	BEAVERTOWN 1 NE	40.77	77.15	1948	1993
360488	BECHTELSVILLE 1 ENE	40.38	75.62	1958	1993
360629	BETHLEHEM	40.62	75.38	1948	1981
360634	BETHLEHEM LEHIGH UNIV	40.60	75.37	1926	1964
360763	BLOSERVILLE 1 N	40.27	77.37	1948	1993
360821	BOSWELL 1 SW	40.15	79.03	1960	1991
360861	BRADDOCK LOCK 2	40.40	79.87	1948	1993
360865	BRADFORD FAA AIRPORT	41.80	78.63	1957	1993
360867	BRADFORD CNTRL FIRE STN	41.95	78.65	1948	1993
360868	BRADFORD 4 W RES 1	41.95	78.73	1948	1993
361002	BROOKVILLE FAA AIRPORT	41.15	79.10	1926	1962
361033	BRUCETON 1 S	40.30	79.98	1948	1993
361087	BUFFALO MILLS	39.95	78.65	1948	1993
361105	BURGETTSTOWN 2 W	40.38	80.43	1948	1989
361130	BUTLER	40.87	79.90	1927	1965
361234	CARLISLE	40.20	77.22	1926	1980
361255	CARROLLTOWN 2 SSE	40.58	78.70	1948	1990
361301	CEDAR RUN	41.52	77.45	1948	1986
361342	CHADDS FORD	39.87	75.62	1948	1993
361354	CHAMBERSBURG 1 ESE	39.93	77.63	1948	1993
361377	CHARLEROI LOCK 4	40.15	79.90	1948	1993
361480	CLARENCE	41.05	77.93	1950	1993
361485	CLARION 3 SW	41.20	79.43	1948	1993
361505	CLAUSSVILLE	40.62	75.65	1948	1993
361512	CLAYSVILLE 3 W	40.12	80.47	1926	1971
361519	CLEARFIELD	41.02	78.45	1926	1993
361534	CLERMONT 4 NW	41.73	78.53	1961	1992
361589	COATESVILLE 1 SW	39.97	75.83	1948	1982
361705	CONFLUENCE 1 SW DAM	39.80	79.37	1948	1993
361710	CONFLUENCE 1 NW	39.83	79.37	1948	1981

Table 3 (continued)

Station number	Station name	Latitude (degrees)	Longitude (degrees)	Record begins	Record ends
PENNSYLVANIA (continued)					
361737	CONSHOHOCKEN	40.07	75.32	1948	1993
361749	COOKSBURG	41.33	79.22	1955	1991
361773	CORAOPOLIS NEVILLE IS	40.50	80.08	1948	1989
361790	CORRY	41.92	79.63	1926	1993
361806	COUDERSPORT 4 NW	41.83	78.07	1956	1986
361833	COVINGTON 2 WSW	41.73	77.12	1956	1993
361881	CREEKSIDE	40.68	79.20	1948	1992
362013	DANVILLE	40.97	76.62	1948	1993
362108	DERRY 4 SW	40.30	79.33	1926	1993
362116	DEVAULT 1 W	40.08	75.55	1951	1988
362183	DONEGAL 2 NW	40.13	79.40	1948	1993
362190	DONORA 1 SW	40.17	79.87	1926	1993
362221	DOYLESTOWN	40.30	75.13	1948	1993
362260	DU BOIS FAA AP	41.18	78.90	1962	1993
362343	EAGLES MERE	41.40	76.58	1948	1987
362466	EBENSBURG	40.48	78.72	1926	1963
362644	ENGLISH CENTER	41.43	77.28	1948	1984
362662	EPHRATA	40.17	76.17	1948	1984
362671	EQUINUNK 2 WNW	41.87	75.27	1957	1993
362682	ERIE WSO AP	42.08	80.18	1926	1993
362721	EVERETT	40.02	78.37	1943	1993
362814	FARRELL-SHARON	41.22	80.52	1948	1980
362942	FORD CITY 4 S DAM	40.72	79.50	1943	1993
363028	FRANKLIN	41.38	79.82	1926	1993
363056	FREELAND	41.02	75.90	1926	1989
363130	GALETON	41.73	77.63	1948	1993
363200	GEORGE SCHOOL	40.22	74.93	1926	1978
363218	GETTYSBURG	39.83	77.23	1926	1982
363311	GLEN HAZEL 2 NE DAM	41.57	78.60	1953	1993
363321	GLENMOORE	40.10	75.78	1959	1993
363343	GLENWILLARD DASH DAM	40.55	80.22	1948	1993
363394	GOULDSBORO	41.25	75.45	1948	1987
363437	GRATERFORD 1 E	40.23	75.43	1960	1993
363503	GREENSBORO LOCK 7	39.78	79.92	1948	1993
363526	GREENVILLE 2 NE	41.42	80.37	1926	1993
363662	HANOVER	39.80	76.98	1948	1993
363699	HARRISBURG FAA AP	40.22	76.85	1926	1993
363758	HAWLEY	41.48	75.17	1926	1993
364008	HOLLISTERVILLE	41.38	75.43	1948	1993
364019	HOLTWOOD	39.83	76.33	1948	1993
364043	HONESDALE 4 NW	41.62	75.32	1948	1993
364047	HONEY BROOK 1 S	40.08	75.83	1957	1993
364159	HUNTINGDON	40.50	78.02	1926	1974
364166	HUNTSDALE	40.10	77.30	1948	1986
364190	HYNDMAN	39.82	78.73	1948	1993
364214	INDIANA 3 SE	40.60	79.12	1948	1993
364325	JAMESTOWN 2 NW	41.50	80.47	1948	1993
364385	JOHNSTOWN	40.33	78.92	1926	1993
364432	KANE 1 NNE	41.68	78.80	1948	1993
364481	KEGG	39.98	78.72	1951	1991
364611	KITTANNING LOCK 7	40.82	79.53	1951	1993
364672	KRESGEVILLE 2 W	40.90	75.53	1948	1990
364758	LANCASTER 2NE PUMP STN	40.05	76.28	1926	1974
364778	LANDISVILLE 2 NW	40.12	76.43	1952	1993
364853	LAURELTON STATE VILLAGE	40.90	77.22	1948	1993
364873	LAWRENCEVILLE 2 S	41.97	77.13	1926	1974
364934	LEHIGHTON	40.83	75.72	1948	1993
364972	LE ROY	41.68	76.72	1948	1993
364992	LEWISTOWN	40.58	77.58	1948	1993
365104	LOCK HAVEN	41.13	77.42	1926	1977
365160	LONG POND 2 W	41.05	75.50	1948	1993
365336	MADERA	40.83	78.43	1949	1990
365381	MAPLETON DEPOT	40.40	77.93	1948	1993
365390	MARCUS HOOK	39.82	75.42	1948	1993
365408	MARION CENTER 2 SE	40.75	79.03	1948	1993
365470	MATAMORAS	41.37	74.70	1948	1993
365573	MC KEESPORT	40.35	79.87	1948	1993
365606	MEADVILLE 1 S	41.63	80.17	1948	1993
365651	MERCER	41.22	80.23	1950	1993
365662	MERCERSBURG	39.83	77.90	1948	1990
365686	MEYERSDALE 2 SSW	39.78	79.05	1963	1993
365790	MILLHEIM	40.88	77.48	1949	1993
365817	MILLVILLE 2 SW	41.10	76.57	1950	1992
365902	MONTGOMERY LOCK AND DAM	40.65	80.38	1961	1993
365915	MONTROSE	41.83	75.87	1926	1993
365956	MORGANTOWN	40.15	75.90	1951	1986
366055	MOUNT POCONO 2 N	41.15	75.37	1926	1960
366126	MYERSTOWN	40.37	76.30	1948	1993
366151	NATRONA LOCK 4	40.62	79.72	1948	1993
366194	NESHAMINY FALLS	40.15	74.95	1948	1993
366233	NEW CASTLE 1 N	41.02	80.37	1926	1993
366246	NEWELL	40.08	79.90	1926	1980
366289	NEW PARK	39.73	76.50	1948	1993
366297	NEWPORT	40.48	77.13	1948	1992
366310	NEW STANTON 1 SW	40.20	79.63	1952	1993
366326	NEW TRIPOLI 4 E	40.68	75.68	1948	1982
366370	NORRISTOWN	40.12	75.35	1948	1987
366622	ORWELL 2 NW	41.92	76.30	1961	1993
366681	PALM 3 SE	40.38	75.50	1948	1993
366689	PALMERTON	40.80	75.62	1926	1993
366721	PARKER	41.08	79.68	1952	1993
366762	PAUPACK 2 WNW	41.40	75.23	1948	1993
366889	PHILADELPHIA WSCMO AP	39.88	75.23	1948	1993
366904	PHILADELPHIA SHAWMONT	40.03	75.25	1926	1957
366916	PHILIPSBURG FAA AP	40.90	78.08	1948	1993
366927	PHOENIXVILLE 1 E	40.12	75.50	1948	1992
366993	PITTSBURGH WSCMO2 AP	40.50	80.22	1952	1993
366997	PITTSBURGH WSO CI	40.45	80.00	1926	1979
367029	PLEASANT MOUNT 1 W	41.73	75.45	1948	1993
367116	PORT CLINTON	40.58	76.03	1948	1979
367229	PUTNEYVILLE 2 SE DAM	40.93	79.28	1948	1993
367310	RAYMOND	41.87	77.87	1948	1992
367318	READING WB CITY	40.33	75.97	1926	1973
367409	RENOVO	41.33	77.73	1948	1993
367477	RIDGWAY	41.42	78.75	1926	1993
367727	RUSHVILLE	41.78	76.12	1949	1993
367782	SALINA 3 W	40.52	79.55	1953	1993
367846	SAXTON	40.20	78.25	1948	1993
367863	SCHENLEY LOCK 5	40.68	79.67	1948	1993
367902	SCRANTON	41.42	75.67	1926	1975
367931	SELINSGROVE 2 S	40.77	76.87	1926	1993
367978	SHAMOKIN	40.80	76.55	1948	1993
368073	SHIPPENSBURG	40.05	77.22	1948	1993
368145	SINNEMAHONING	41.32	78.10	1951	1993
368184	SLIPPERY ROCK 1 SSW	41.05	80.07	1949	1993
368244	SOMERSET	40.00	79.08	1949	1993
368249	SOMERSET MAIN ST	40.02	79.08	1926	1958
368308	SOUTH MOUNTAIN	39.85	77.50	1948	1993
368379	SPRING GROVE	39.87	76.87	1948	1993
368449	STATE COLLEGE	40.80	77.87	1926	1993
368560	STOYSTOWN	40.10	78.95	1961	1992
368570	STRAUSSTOWN	40.48	76.18	1948	1993
368596	STROUDSBURG	41.00	75.18	1926	1993
368692	SUSQUEHANNA	41.95	75.60	1948	1993
368758	TAMAQUA	40.78	75.98	1948	1993
368763	TAMAQUA 4 N DAM	40.85	75.98	1948	1993
368873	TIONESTA 2 SE LAKE	41.48	79.43	1948	1993
368888	TITUSVILLE WATER WORKS	41.63	79.70	1954	1993
368893	TOBYHANNA	41.18	75.42	1961	1993
368905	TOWANDA 1 ESE	41.75	76.42	1926	1993
368959	TROY 1 NE	41.78	76.78	1951	1993
369042	UNION CITY FILT PLANT	41.90	79.82	1950	1993
369050	UNIONTOWN 1 NE	39.92	79.72	1926	1993
369128	VANDERGRIFT	40.60	79.55	1948	1988
369298	WARREN	41.85	79.15	1926	1993
369367	WAYNESBURG 1 E	39.90	80.17	1948	1993
369408	WELLSBORO 3 S	41.70	77.27	1926	1993
369464	WEST CHESTER 1 W	39.97	75.63	1948	1991
369507	WEST HICKORY	41.58	79.40	1952	1993
369655	WHITESBURG	40.73	79.40	1948	1993
369702	WILKES-BARRE	41.23	75.88	1948	1993
369714	WILLIAMSBURG	40.45	78.20	1949	1989
369728	WILLIAMSPORT WSO AP	41.25	76.92	1948	1993
369823	WOLFSBURG	40.05	78.53	1950	1993
369933	YORK 3 SSW PUMP STN	39.92	76.75	1926	1993
369950	YORK HAVEN	40.12	76.72	1948	1993
369995	ZIONSVILLE 3 SE	40.47	75.45	1950	1993
RHODE ISLAND					
370896	BLOCK ISLAND WSO AP	41.17	71.58	1948	1993
374266	KINGSTON	41.48	71.53	1926	1993
375215	NEWPORT	41.52	71.32	1957	1993
376698	PROVIDENCE WSO AP	41.73	71.43	1948	1993
379423	WOONSOCKET	41.98	71.50	1948	1993
VERMONT					
430499	BELLOWS FALLS	43.13	72.45	1948	1993
430661	BETHEL 4 N	43.88	72.63	1958	1993
431081	BURLINGTON WSO AP	44.47	73.15	1920	1993
431213	CANAAN	45.00	71.53	1948	1993
431243	CAVENDISH	43.38	72.60	1948	1993
431360	CHELSEA	43.98	72.45	1948	1993
431433	CHITTENDEN	43.70	72.95	1948	1993
431580	CORNWALL	43.95	73.22	1926	1993
431786	DORSET 1 S	43.25	73.10	1948	1993
432769	ENOSBURG FALLS	44.92	72.82	1948	1993
433341	GILMAN	44.42	71.72	1948	1993
434052	HUNTINGTON CENTER	44.28	72.97	1955	1993
434882	MANCHESTER	43.17	73.07	1948	1992
435278	MONTPELIER FAA AP	44.20	72.57	1948	1993
435416	MOUNT MANSFIELD	44.53	72.82	1954	1993
435542	NEWPORT	44.93	72.20	1930	1993
435733	NORTHFIELD	44.17	72.65	1926	1974
436335	PERU	43.25	72.90	1948	1993
436761	READSBORO 1 SE	42.75	72.93	1948	1993
436893	ROCHESTER	43.85	72.80	1948	1993
436995	RUTLAND	43.60	72.97	1948	1993
437054	SAINT JOHNSBURY	44.42	72.02	1926	1993
437098	SALISBURY	43.93	73.10	1948	1993
437152	SEARSBURG STATION	42.87	72.92	1948	1993
437617	SOUTH LONDONDERRY	43.18	72.82	1948	1984
437646	SOUTH NEWBURY	44.05	72.08	1948	1993

Station number	Station name	Latitude (degrees)	Longitude (degrees)	Record begins	Record ends
VERMONT (continued)					
438556	UNION VILLAGE DAM	43.80	72.27	1950	1993
438600	VERNON	42.77	72.52	1948	1993
438644	WAITSFIELD 2 WSW	44.18	72.85	1955	1993
438815	WATERBURY 2 SSE	44.32	72.75	1958	1992
439099	WEST BURKE	44.65	71.98	1948	1993
439735	WHITINGHAM 1 W	42.80	72.92	1948	1993
439984	WOODSTOCK 2 WSW	43.62	72.55	1948	1987
VIRGINIA					
440135	ALLISONIA 2 S	36.90	80.75	1952	1993
440166	ALTAVISTA	37.10	79.30	1948	1993
440193	AMISSVILLE	38.68	78.02	1948	1982
440243	APPOMATTOX	37.37	78.83	1948	1993
440327	ASHLAND	37.75	77.48	1948	1993
440385	BACK BAY WILDLIFE RFG	36.67	75.92	1953	1993
440551	BEDFORD	37.35	79.52	1948	1993
440670	BERRYVILLE	39.15	77.98	1948	1987
440720	BIG MEADOWS	38.52	78.43	1948	1993
440766	BLACKSBURG 3 SE	37.18	80.42	1952	1993
440792	BLAND	37.10	81.10	1951	1993
440993	BREMO BLUFF	37.70	78.30	1948	1993
441082	BROOKNEAL	37.03	78.95	1950	1986
441121	BUCHANAN	37.53	79.68	1930	1993
441136	BUCKINGHAM	37.55	78.55	1948	1993
441159	BUENA VISTA	37.73	79.35	1948	1993
441209	BURKES GARDEN	37.08	81.33	1948	1993
441585	CHARLOTTE COURT H 3 W	37.07	78.70	1948	1993
441593	CHARLOTTESVILLE 2 W	38.03	78.52	1948	1993
441598	CHARLOTTESVILLE 1 W	38.03	78.52	1930	1971
441606	CHASE CITY	36.83	78.47	1949	1993
441614	CHATHAM	36.82	79.40	1930	1993
441746	CLARKSVILLE	36.62	78.57	1948	1993
441801	CLIFTON FORGE	37.82	79.80	1948	1983
441929	COLUMBIA 2 SSE	37.73	78.15	1930	1986
441955	CONCORD 5 S	37.28	78.97	1950	1993
441999	COPPER HILL 1 NNE	37.10	80.13	1948	1993
442009	CORBIN	38.20	77.37	1959	1993
442041	COVINGTON	37.80	80.00	1948	1993
442044	COVINGTON FILT PLANT	37.80	80.00	1960	1993
442155	CULPEPER	38.47	78.00	1930	1990
442208	DALE ENTERPRISE	38.45	78.93	1948	1993
442237	DANTE	36.98	82.28	1927	1958
442245	DANVILLE (BRIDGE ST)	36.58	79.38	1948	1993
442368	DIAMOND SPRINGS	36.90	76.20	1948	1980
442504	DRIVER 4 NE	36.88	76.48	1948	1986
442729	ELKWOOD 6 SE	38.45	77.77	1948	1983
442790	EMPORIA 1 WNW	36.68	77.55	1948	1993
442941	FARMVILLE 2 N	37.33	78.38	1914	1993
443071	FLOYD 2 NE	36.93	80.30	1948	1993
443192	FREDERICKSBURG NAT PK	38.32	77.45	1930	1993
443213	FREE UNION	38.08	76.13	1955	1993
443267	GALAX RADIO WBOB	36.67	80.92	1948	1993
443397	GLEN LYN	37.37	80.87	1930	1993
443470	GOSHEN	37.98	79.50	1948	1993
443640	GRUNDY	37.27	82.08	1948	1993
443991	HILLSVILLE 1 S	36.73	80.73	1948	1993
444044	HOLLAND 1 E	36.68	76.78	1948	1993
444101	HOPEWELL	37.30	77.30	1930	1993
444128	HOT SPRINGS	38.00	79.83	1948	1991
444148	HUDDLESTON 4 SW	37.13	79.53	1950	1993
444234	INDEPENDENCE 2	36.65	81.17	1953	1989
444414	JOHN H KERR DAM	36.60	78.28	1951	1993
444565	KERRS CREEK 6 WNW	37.85	79.58	1948	1993
444676	LAFAYETTE 1 NE	37.23	80.22	1951	1993
444720	LANGLEY AIR FORCE BASE	37.08	76.35	1930	1993
444768	LAWRENCEVILLE 5 W	36.77	77.93	1948	1993
444876	LEXINGTON	37.78	79.43	1948	1993
444909	LINCOLN	39.12	77.72	1930	1993
445050	LOUISA	38.03	78.00	1948	1993
445096	LURAY 5 E	38.67	78.38	1948	1993
445120	LYNCHBURG WSO AP	37.33	79.20	1930	1993
445213	MANASSAS 3 NW	38.78	77.50	1950	1985
445300	MARTINSVILLE FILT PL	36.70	79.88	1948	1993
445453	MEADOWS OF DAN 5 SW	36.67	80.45	1950	1993
445685	MONTEBELLO 2 NE	37.88	79.13	1948	1991
445698	MONTEREY	38.42	79.58	1948	1990
445851	MOUNT WEATHER	39.07	77.88	1948	1993
446012	NEW CASTLE	37.50	80.10	1948	1985
446046	NEWPORT 2 NNW	37.32	80.52	1948	1993
446054	NEWPORT NEWS PRESS BLDG	37.02	76.45	1948	1980
446139	NORFOLK WSO AP	36.90	76.20	1948	1993
446475	PAINTER 2 W	37.58	75.82	1955	1993
446491	PALMYRA 1 E	37.87	78.25	1957	1993
446593	PEDLAR DAM	37.67	79.28	1948	1988
446626	PENNINGTON GAP	36.75	83.05	1931	1993
446692	PHILPOTT DAM 2	36.78	80.03	1953	1993
446712	PIEDMONT RESEARCH STN	38.22	78.12	1948	1993
446723	PILOT 1 ENE	37.07	80.35	1948	1985
446906	POWHATAN	37.55	77.93	1950	1993
446955	PULASKI 2 E	37.05	80.75	1948	1993
447025	RANDOLPH 5 NNE	36.98	78.70	1930	1983
VIRGINIA (continued)					
447033	RAPIDAN	38.30	78.07	1931	1981
447201	RICHMOND WSO AP	37.50	77.33	1948	1993
447285	ROANOKE WSO AP	37.32	79.97	1948	1993
447312	ROCKFISH	37.80	78.75	1948	1990
447338	ROCKY MOUNT	37.00	79.90	1948	1993
447501	SALTVILLE	36.88	81.77	1930	1962
447971	SPEEDWELL	36.82	81.17	1948	1985
448022	STAFFORDSVILLE 3 ENE	37.27	80.72	1951	1993
448062	STAUNTON SEWAGE PLANT	38.15	79.03	1948	1993
448192	SUFFOLK LAKE KILBY	36.73	76.60	1948	1993
448323	TANGIER ISLAND	37.83	76.00	1952	1991
448396	THE PLAINS 2 NNE	38.90	77.75	1954	1993
448448	TIMBERVILLE 3 E	38.65	78.72	1948	1990
448547	TROUT DALE	36.67	81.40	1948	1993
448600	TYE RIVER 1 SE	37.63	78.93	1948	1993
448737	VIENNA DUNN LORING	38.90	77.22	1948	1993
448829	WALKERTON 2 NW	37.75	77.05	1932	1993
448837	WALLACETON LK DRUMMOND	36.60	76.43	1930	1993
448888	WARRENTON 3 SE	38.68	77.77	1951	1993
448894	WARSAW 2 NW	37.98	76.77	1951	1993
448902	WASHINGTON 3 SSW	38.67	78.18	1948	1981
448906	WASH NATL WSCMO AP	38.85	77.03	1948	1993
449025	WEST POINT 2 SW	37.52	76.83	1954	1993
449151	WILLIAMSBURG 2 N	37.30	76.70	1948	1993
449186	WINCHESTER 3 ESE	39.18	78.12	1948	1993
449215	WISE 1 SE	36.97	82.57	1955	1993
449263	WOODSTOCK 2 NE	38.90	78.47	1930	1993
449272	WOOLWINE	36.72	80.28	1951	1993
449301	WYTHEVILLE 1 S	36.93	81.08	1930	1993
WEST VIRGINIA					
460094	ALBRIGHT	39.48	79.63	1953	1993
460102	ALDERSON	37.73	80.63	1948	1993
460355	ATHENS CONCORD COLLEGE	37.43	81.00	1948	1993
460527	BAYARD	39.27	79.37	1926	1993
460580	BECKLEY V A HOSPITAL	37.78	81.18	1948	1993
460582	BECKLEY WSO AP	37.78	81.12	1963	1993
460633	BELINGTON	39.03	79.95	1948	1993
460687	BENS RUN 1 SSE	39.47	81.10	1948	1985
460921	BLUEFIELD FAA AIRPORT	37.30	81.22	1959	1993
460939	BLUESTONE LAKE	37.65	80.88	1948	1993
461075	BRANCHLAND 1 N	38.23	82.20	1948	1993
461083	BRANDONVILLE	39.67	79.62	1948	1989
461204	BRUSHY RUN	38.83	79.25	1948	1984
461215	BUCKEYE 1 SE	38.17	80.13	1952	1993
461220	BUCKHANNON 2 W	39.00	80.27	1948	1993
461282	BURNSVILLE LAKE	38.85	80.63	1949	1993
461328	CAIRO 3 S	39.17	81.17	1948	1981
461363	CAMDEN ON GAULEY	38.37	80.62	1948	1993
461393	CANAAN VALLEY	39.05	79.43	1948	1993
461526	CENTRALIA	38.62	80.58	1951	1993
461570	CHARLESTON WSFO AP	38.37	81.60	1948	1993
461575	CHARLESTON 1	38.35	81.65	1926	1974
461677	CLARKSBURG 1	39.27	80.35	1926	1993
461696	CLAY 1 SW	38.45	81.08	1948	1993
461723	CLENDENIN 1 SW	38.48	81.37	1951	1993
462054	CRESTON	38.95	81.28	1948	1993
462462	DRY CREEK	37.87	81.47	1961	1993
462718	ELKINS WSO AP	38.88	79.85	1926	1993
462920	FAIRMONT	39.47	80.13	1926	1993
463072	FLAT TOP	37.58	81.10	1931	1993
463215	FRANKLIN 2 NE	38.67	79.32	1948	1993
463353	GARY	37.37	81.55	1926	1989
463361	GASSAWAY	38.67	80.77	1951	1993
463544	GLENVILLE 1 ENE	38.93	80.82	1926	1993
463798	HACKER VALLEY	38.65	80.38	1960	1993
463846	HAMLIN	38.28	82.10	1948	1993
464128	HICO 1 SE	38.10	81.00	1956	1993
464200	HOGSETT GALLIPOLIS DAM	38.68	82.18	1948	1993
464378	HUNTINGTON 1	38.42	82.37	1926	1957
464393	HUNTINGTON WSO AP	38.37	82.55	1961	1993
464408	IAEGER	37.47	81.82	1948	1993
464763	KEARNEYVILLE WSO	39.38	77.88	1930	1993
464816	KERMIT	37.83	82.40	1948	1985
465002	LAKE LYNN	39.72	79.85	1948	1993
465224	LEWISBURG 2 SSW	37.77	80.47	1948	1993
465353	LOGAN	37.85	82.00	1948	1993
465365	LONDON LOCKS	38.20	81.37	1936	1993
465563	MADISON	38.05	81.82	1948	1993
465621	MANNINGTON 1 N	39.55	80.35	1926	1979
465626	MANNINGTON 6 NW	39.57	80.45	1948	1993
465672	MARLINTON	38.22	80.08	1926	1993
465707	MARTINSBURG FAA AP	39.40	77.98	1926	1993
465739	MATHIAS	38.87	78.87	1948	1993
465871	MC ROSS	37.98	80.75	1955	1988
465963	MIDDLEBOURNE 2 ESE	39.48	80.87	1948	1993
466163	MOOREFIELD 2 SSE	39.03	78.97	1948	1993
466202	MORGANTOWN FAA AP	39.65	79.92	1948	1993
466212	MORGANTOWN LOCK AND DAM	39.62	79.97	1948	1993
466442	NEW CUMBERLAND	40.50	80.60	1948	1988
466591	OAK HILL	37.97	81.15	1948	1993

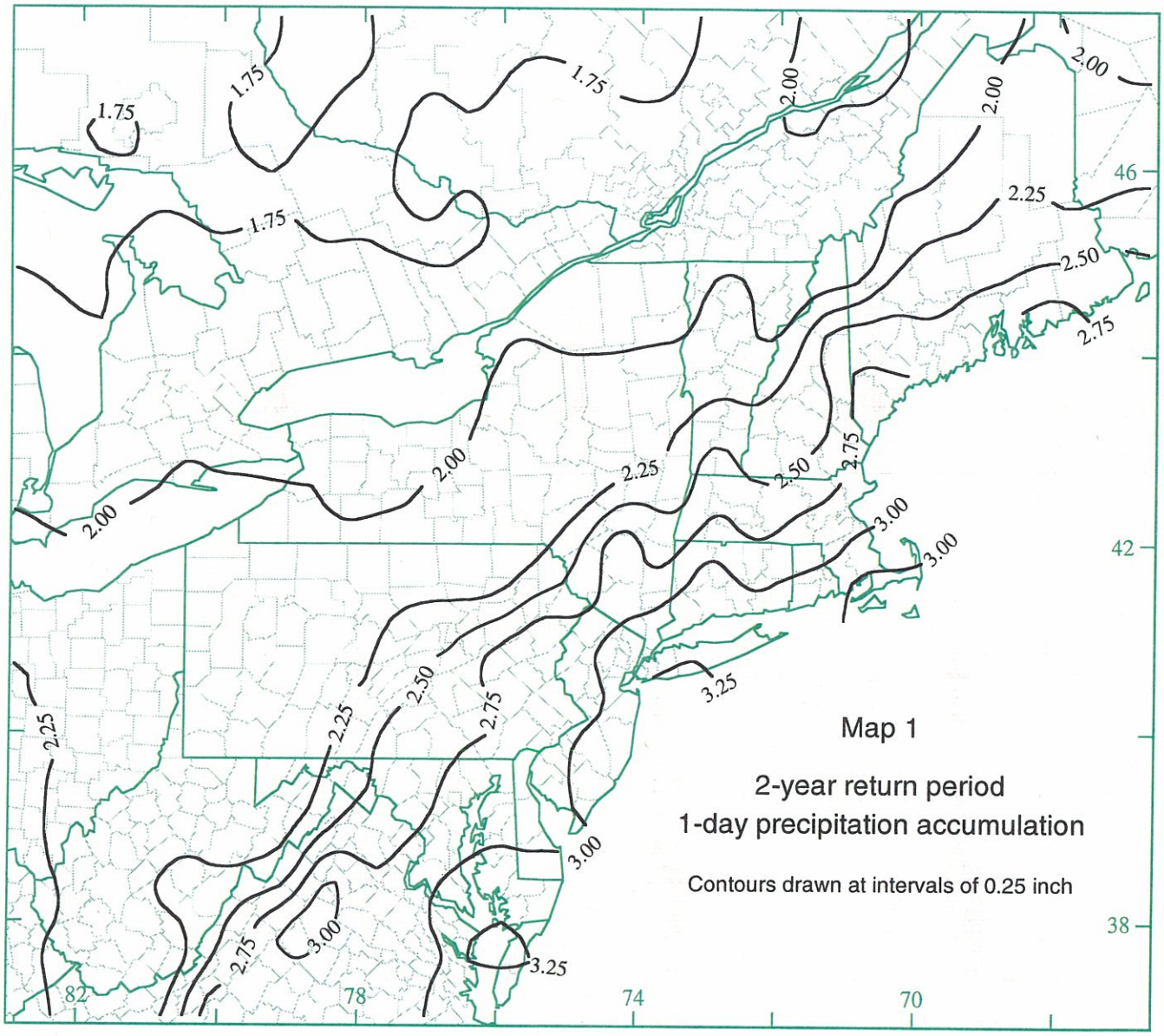
Table 3 (continued)

Station number	Station name	Latitude (degrees)	Longitude (degrees)	Record begins	Record ends
WEST VIRGINIA (continued)					
466849	PARKERSBURG FAA AP	39.35	81.43	1948	1993
466859	PARKERSBURG 1 E	39.27	81.53	1926	1993
466867	PARSONS 1 SE	39.10	79.67	1948	1993
466954	PETERSBURG	39.00	79.12	1939	1971
466982	PHILIPPI	39.15	80.03	1948	1993
466991	PICKENS 1	38.67	80.22	1948	1986
467004	PIEDMONT	39.48	79.03	1926	1966
467029	PINEVILLE	37.58	81.53	1941	1993
467207	PRINCETON	37.37	81.08	1948	1993
467352	RAVENSWOOD LOCK PARK	38.95	81.77	1948	1980
467552	RIPLEY 4 NNE	38.88	81.68	1948	1993
467730	ROMNEY 1 SW	39.33	78.77	1948	1993
467785	ROWLESBURG 1	39.33	79.68	1948	1993
468384	SPENCER 1 SE	38.80	81.35	1926	1993
468433	SPRUCE KNOB	38.68	79.52	1951	1988
468662	SUTTON LAKE	38.65	80.68	1948	1993
468807	THOMAS	39.15	79.50	1948	1993
469011	UNION 3 SSE	37.55	80.53	1948	1993
469086	VALLEY HEAD	38.55	80.03	1948	1993
469104	VANDALIA	38.93	80.40	1948	1980
469281	WARDENSVILLE R M FARM	39.10	78.58	1926	1993
469333	WEBSTER SPRINGS 1 E	38.48	80.42	1948	1989
469368	WELLSBURG WTR TRTMT PL	40.28	80.62	1948	1989
469436	WESTON	39.03	80.47	1948	1993
469492	WHEELING WARWOOD DAM 12	40.10	80.70	1926	1976
469522	WHITE SULPHUR SPRINGS	37.80	80.30	1926	1993
469605	WILLIAMSON	37.67	82.28	1926	1993
469610	WILLIAMSON 2	37.68	82.30	1951	1993
469683	WINFIELD LOCKS	38.53	81.92	1948	1993
ONTARIO					
6060773	BISCOTASING	47.30	82.10	1914	1990
6061359	CHAPLEAU 2	47.83	83.43	1886	1966
6061847	CONISTON	46.47	80.82	1921	1976
6067211	RUEL	47.30	81.45	1915	1959
6068980	TURBINE	46.38	81.57	1914	1990
6070027	ABITIBI CANYON	49.88	81.57	1931	1963
6071712	COCHRANE	49.07	81.03	1910	1990
6072225	EARLTON A	47.70	79.85	1938	1990
6072325	ENGLEHART	47.82	79.90	1948	1990
6073138	HAILEYBURY	47.45	79.63	1893	1977
6073420	HEASLIP	47.80	79.83	1928	1967
6073810	IROQUOIS FALLS	48.75	80.67	1913	1990
6073840	ISLAND FALLS	49.58	81.38	1955	1990
6073960	KAPUSKASING CDA	49.40	82.43	1918	1990
6073975	KAPUSKASING A	49.42	82.47	1937	1990
6074209	KIRKLAND LAKE	48.15	80.02	1950	1990
6075379	MONTREAL RIVER	47.12	79.48	1910	1967
6075400	MOOSE FACTORY	51.23	80.50	1877	1938
6075425	MOOSONEE	51.27	80.65	1932	1990
6075594	NEW LISKEARD	47.50	79.67	1923	1984
6077845	SMOKY FALLS	50.07	82.17	1933	1990
6078285	TIMMINS A	48.57	81.37	1955	1990
6079415	WAWAITIN	48.35	81.40	1913	1965
6080189	ALGONQUIN PARK	45.58	78.55	1917	1960
6081928	CRYSTAL FALLS	46.45	79.87	1922	1988
6084770	MADAWASKA	45.50	77.98	1915	1990
6085682	NORTH BAY	46.32	79.47	1887	1982
6085700	NORTH BAY A	46.35	79.43	1939	1990
6087255	RUTHERGLEN	46.25	79.07	1891	1940
6092915	GORE BAY	45.92	82.47	1881	1983
6092925	GORE BAY A	45.88	82.57	1947	1990
6096755	PROVIDENCE BAY	45.67	82.23	1897	1940
6097915	SOUTH BAYMOUTH	45.58	82.02	1954	1990
6100969	BROCKVILLE	44.60	75.70	1871	1980
6101440	CHATS FALLS	45.47	76.23	1950	1990
6101494	CHENAUX	45.58	76.68	1950	1990
6101658	CLONTARF	45.38	77.15	1882	1957
6101820	COMBERMERE	45.37	77.62	1956	1990
6101874	CORNWALL	45.02	74.75	1950	1990
6101901	CORNWALL ONT HYDRO	45.03	74.80	1954	1990
6101955	DALHOUSIE L HIGH FALLS	44.97	76.62	1923	1983
6104025	KEMPTVILLE	45.00	75.63	1928	1990
6104125	KILLALOE	45.57	77.42	1938	1972
6104185	KINGSTON QUEENS U	44.25	76.50	1872	1957
6104733	MACCUE	44.88	76.17	1883	1918
6105460	MORRISBURG	44.92	75.18	1913	1990
6105887	OTTAWA	45.40	75.72	1872	1935
6105976	OTTAWA CDA	45.38	75.72	1889	1990
6106000	OTTAWA INT'L A	45.32	75.67	1938	1990
6106090	OTTAWA NRC	45.45	75.62	1951	1984
6106362	PEMBROKE EDDY MATCH	45.83	77.15	1866	1969
6106400	PETAWAWA NAT FORESTRY	45.98	77.43	1931	1990
6106779	PURDY	45.32	77.72	1955	1990
6107003	RENFREW	45.43	76.65	1882	1929
6107955	SOUTH MOUNTAIN	44.97	75.48	1960	1990
6108060	STONECLIFFE	46.15	78.10	1876	1921
6110270	ANGUS	44.32	79.87	1930	1965
6110549	BARRIE	44.40	79.68	1866	1958
6110605	BEATRICE	45.13	79.38	1876	1979
6110661	BEETON	44.10	79.78	1916	1970
6110745	BINGHAM CHUTE	46.08	79.40	1933	1970
6111045	BURKS FALLS	45.60	79.57	1888	1986
6111467	CHATSWORTH	44.40	80.90	1952	1990
6111766	COLDWATER	44.70	79.67	1883	1954
6111793	COLLINGWOOD	44.48	80.22	1869	1974
6112171	DURHAM	44.18	80.82	1882	1990
6112313	EMSDALE	45.50	79.23	1895	1952
6112340	ESSA ONT HYDRO	44.37	79.80	1958	1990
6112350	EUGENIA	44.33	80.55	1916	1969
6113000	GRAVENHURST	44.92	79.37	1870	1949
6113660	HUNTSVILLE	45.32	79.25	1879	1961
6114805	MAGNETAWAN	45.67	79.78	1924	1958
6115099	MIDHURST	44.45	79.77	1947	1990
6115127	MIDLAND	44.75	79.90	1889	1986
6115525	MUSKOKA A	44.97	79.30	1934	1990
6115810	ORILLIA	44.62	79.40	1871	1961
6116128	OWEN SOUND	44.57	80.92	1878	1962
6116254	PARRY SOUND	45.33	80.00	1874	1976
6117663	SCOTIA	45.52	79.30	1924	1978
6118187	SUTTON WEST	44.32	79.30	1871	1908
6119325	WASHAGO	44.75	79.33	1927	1970
6119495	WIARTON	44.75	81.13	1883	1936
6119500	WIARTON A	44.75	81.10	1947	1990
6120315	ARKONA	43.03	81.92	1882	1915
6120819	BLYTH	43.72	81.38	1959	1990
6121025	BRUCEFIELD	43.55	81.55	1903	1990
6122450	FOREST	43.10	82.00	1924	1964
6122845	GODERICH	43.75	81.70	1866	1950
6122848	GODERICH LIGHTHOUSE	43.75	81.72	1874	1911
6122851	GODERICH TOWNSHIP	43.72	81.70	1912	1970
6124127	KINCARDINE	44.17	81.62	1870	1903
6124700	LUCKNOW	43.95	81.50	1885	1990
6125705	NORTH BRUCE	44.38	81.42	1888	1922
6126558	POINT CLARK	44.08	81.68	1871	1913
6127513	SARNIA	42.97	82.37	1882	1961
6127887	SOUTHAMPTON	44.50	81.37	1872	1982
6128320	TOBERMORY	45.25	81.67	1888	1983
6129235	WALKERTON	44.13	81.15	1902	1971
6131081	CALEDONIA	43.08	79.95	1931	1966
6131386	CHATHAM	42.40	82.20	1933	1967
6131388	CHATHAM 2	42.40	82.20	1879	1946
6131910	COTTAM	42.12	82.75	1882	1926
6131982	DELHI CDA	42.87	80.55	1934	1990
6133047	GRIMSBY	43.20	79.57	1910	1985
6133057	GRIMSBY ROCK CHAPEL	43.18	79.58	1914	1966
6133120	HAGERSVILLE	42.97	80.07	1948	1990
6133360	HARROW CDA	42.03	82.90	1917	1990
6134390	LEAMINGTON	42.05	82.63	1916	1978
6134610	LONG POINT	42.55	80.05	1936	1985
6135583	NEW GLASGOW	42.52	81.63	1957	1990
6135638	NIAGARA FALLS	43.13	79.08	1902	1990
6135660	NIAGARA FALLS ONT HYDRO	43.08	79.08	1921	1972
6136335	PELEE ISLAND	41.75	82.68	1888	1987
6136626	PORT DALHOUSIE	43.18	79.27	1874	1990
6136643	PORT DOVER	42.78	80.22	1874	1983
6136694	PORT STANLEY	42.67	81.22	1871	1990
6137147	RIDGETOWN	42.45	81.88	1883	1986
6137285	ST CATHARINES	43.20	79.25	1882	1990
6137301	ST CATHARINES CDA	43.18	79.23	1928	1964
6137361	ST THOMAS	42.78	81.17	1882	1980
6137399	ST WILLIAMS	42.70	80.45	1954	1988
6137735	SIMCOE	42.87	80.33	1866	1961
6139145	VINELAND STATION	43.18	79.40	1924	1988
6139265	WALLACEBURG	42.58	82.40	1905	1990
6139445	WELLAND	43.00	79.27	1872	1990
6139520	WINDSOR	42.35	83.10	1866	1929
6139525	WINDSOR A	42.27	82.97	1940	1990
6139600	WOODSLEE CDA	42.22	82.73	1946	1986
6140941	BRANTFORD	43.13	80.27	1876	1963
6141095	CAMBRIDGE GALT MOE	43.33	80.32	1879	1990
6142400	FERGUS SHAND DAM	43.73	80.33	1939	1990
6142803	GLEN ALLAN	43.68	80.72	1955	1990
6143083	GUELPH OAC	43.52	80.23	1881	1973
6144232	KITCHENER	43.43	80.50	1914	1977
6144442	LISTOWEL	43.75	80.97	1880	1966
6144475	LONDON A	43.03	81.15	1940	1990
6144500	LONDON SHARON DRIVE	43.03	81.28	1956	1990
6144505	LONDON SOUTH	42.98	81.22	1883	1932
6144665	LUCAN	43.18	81.42	1871	1975
6145267	MONTICELLO	43.97	80.40	1954	1990
6145503	MOUNT FOREST	43.98	80.75	1891	1986
6146240	PARIS	43.18	80.45	1870	1967
6146711	PRESTON	43.40	80.42	1953	1990
6146939	REDICKVILLE	44.23	80.22	1944	1985
6148100	STRATFORD	43.38	81.00	1865	1959
6148105	STRATFORD MOE	43.37	81.00	1959	1990
6148120	STRATHROY	42.95	81.65	1879	1990
6149454	WESTMINSTER	42.93	81.28	1882	1933
6149625	WOODSTOCK	43.13	80.77	1870	1990
6150100	ALBION	43.93	79.83	1956	1990
6150243	ALTON	43.85	80.08	1887	1964

Station number	Station name	Latitude (degrees)	Longitude (degrees)	Record begins	Record ends
ONTARIO (continued)					
6150395	AURORA	43.95	79.40	1883	1919
6150689	BELLEVILLE	44.15	77.40	1866	1990
6150815	BLOOMFIELD	43.98	77.22	1896	1990
6151064	BURLINGTON TS	43.33	79.83	1951	1990
6151137	CAMPBELLFORD	44.30	77.80	1915	1990
6152605	FRENCHMANS BAY	43.82	79.08	1959	1990
6152691	GEORGETOWN	43.65	79.95	1882	1966
6152833	GLEN HAFFY MONO MILLS	43.93	79.95	1959	1990
6153192	HAMILTON	43.27	79.90	1866	1958
6153300	HAMILTON RBG	43.28	79.88	1950	1990
6153410	HEART LAKE	43.73	79.78	1957	1989
6155071	MEYERSBURG	44.25	77.80	1930	1971
6155183	MILLGROVE	43.32	79.97	1951	1990
6155722	OAK RIDGES	43.97	79.47	1918	1979
6155788	ORANGEVILLE	43.92	80.05	1883	1967
6155854	ORONO	43.97	78.62	1923	1990
6156533	PICTON	44.02	77.13	1915	1990
6156670	PORT HOPE	43.95	78.28	1882	1990
6157012	RICHMOND HILL	43.88	79.45	1959	1990
6157685	SHARON	44.10	79.43	1886	1990
6157831	SMITHFIELD CDA	44.08	77.67	1949	1987
6158065	STONEY CREEK	43.22	79.75	1884	1927
6158350	TORONTO	43.67	79.40	1840	1990
6158363	TORONTO AGINCOURT	43.78	79.27	1895	1968
6158417	TORONTO DEER PARK	43.68	79.38	1890	1933
6158665	TORONTO ISLAND A	43.63	79.40	1957	1990
6158733	TORONTO PEARSON INT'L A	43.67	79.63	1937	1990
6158875	TRENTON A	44.12	77.53	1935	1990
6158885	TRENTON ONT HYDRO	44.13	77.60	1915	1990
6159010	TWEED	44.50	77.28	1925	1972
6159575	WOODBRIDGE	43.80	79.60	1948	1990
6160297	APSLEY	44.77	78.08	1922	1957
6160465	BANCROFT	45.05	77.85	1882	1985
6162375	FENELON FALLS	44.53	78.73	1915	1970
6163156	HALIBURTON A	45.00	78.58	1883	1990
6164297	LAKEFIELD	44.47	78.23	1874	1990
6164430	LINDSAY	44.35	78.75	1880	1971
6165195	MINDEN	44.93	78.72	1883	1990
6166416	PETERBOROUGH	44.28	78.32	1866	1970
QUEBEC					
7010720	BERTHIERVILLE	46.05	73.18	1919	1990
7011600	CHUTE PANET	46.87	71.87	1949	1982
7012070	DONNACONA	46.67	71.75	1918	1964
7012071	DONNACONA 2	46.68	71.73	1952	1990
7013360	JOLIETTE	46.03	73.43	1913	1972
7014160	L'ASSOMPTION CDA	45.82	73.43	1930	1990
7014290	LES CEDRES	45.30	74.05	1913	1990
7015730	OKA	45.50	74.07	1937	1990
7016280	QUEBEC	46.80	71.22	1872	1959
7016294	QUEBEC A	46.80	71.38	1943	1990
7016800	ST ALBAN	46.72	72.08	1949	1990
7016840	STE ANNE DE LA PERADE	46.58	72.23	1949	1990
7016960	ST CHARLES DE MANDEVILLE	46.35	73.35	1921	1990
7017000	STE CHRISTINE	46.82	71.92	1950	1990
7017080	ST COME	46.28	73.75	1950	1990
7017270	ST GABRIEL DE BRANDON	46.30	73.38	1919	1985
7017480	ST LIN DES LAURENTIDES	45.85	73.75	1913	1981
7017640	ST PAULIN	46.42	73.02	1950	1990
7017760	ST TITE	46.73	72.57	1920	1985
7018000	SHAWINIGAN	46.57	72.75	1902	1990
7018564	TROIS RIVIERES	46.37	72.60	1934	1986
7020040	ABERCORN	45.03	72.67	1950	1985
7020360	ASBESTOS	45.77	71.95	1948	1987
7020800	BISHOPTON	45.58	71.57	1948	1990
7020840	BROME	45.18	72.57	1875	1990
7020860	BROMPTONVILLE	45.50	71.97	1957	1990
7021320	CHARTIERVILLE	45.28	71.20	1951	1990
7021580	CHUTE HEMMINGS	45.87	72.45	1931	1986
7021840	COATICOOK	45.15	71.80	1949	1990
7022000	DISRAELI	45.92	71.32	1908	1990
7022160	DRUMMONDVILLE	45.88	72.48	1913	1990
7022280	EAST ANGUS	45.48	71.67	1919	1985
7022300	EAST HEREFORD	45.08	71.50	1949	1990
7022320	FARNHAM	45.30	72.93	1917	1990
7022720	GEORGEVILLE	45.13	72.23	1951	1990
7022800	GRANBY	45.38	72.70	1948	1990
7023240	HUNTINGDON	45.05	74.17	1870	1990
7023800	LAKE MEGANTIC	45.60	70.88	1913	1947
7024000	LAMBTON	45.83	71.08	1915	1990
7024080	LA PATRIE	45.40	71.25	1949	1981
7024280	LENNOXVILLE CDA	45.37	71.83	1888	1990
7024320	LINGWICK	45.63	71.37	1952	1990
7024400	MACDONALD COLLEGE	45.42	73.93	1906	1976
7024440	MAGOG	45.27	72.12	1948	1990
7024920	MILAN	45.58	71.12	1949	1990
7025250	MONTREAL/DORVAL INT'L A	45.47	73.75	1941	1990
7025257	MONTREAL JAR BOT	45.57	73.55	1948	1989
7025280	MONTREAL MCGILL	45.50	73.58	1871	1990
7025440	NICOLET	46.20	72.62	1913	1990
7026040	PHILIPSBURG	45.03	73.08	1950	1990
7026465	RICHMOND	45.63	72.13	1871	1990
7032440	FORT COULONGE	45.82	76.75	1948	1989
7033120	HIGH FALLS	45.85	75.65	1933	1972
7033160	HUBERDEAU	45.97	74.63	1913	1980
7034350	LUCERNE	45.53	75.97	1911	1945
7034480	MANIWAKI	46.38	75.97	1953	1990
7034481	MANIWAKI 2	46.38	75.98	1913	1975
7035112	MONTEBELLO SEIGNIORY	45.65	74.95	1930	1975
7035158	MONT LAURIER	46.57	75.50	1920	1963
7035360	MORIN HEIGHTS	45.92	74.27	1948	1982
7035520	NOMININGUE	46.38	75.05	1913	1990
7035680	NOTRE DAME DU LAUS	46.12	75.63	1929	1990
7035760	OTTER LAKE	45.85	76.43	1948	1990
7036000	PERKINS	45.60	75.62	1911	1990
7036760	STE AGATHE DES MONTS	46.05	74.28	1899	1958
7037400	ST JEROME	45.80	74.05	1932	1990
7038040	SHAWVILLE	45.62	76.47	1948	1990
7038080	SHEENBORO	45.97	77.25	1948	1990
7038880	WALTHAM	45.92	76.92	1953	1990
7040440	BAIE COMEAU A	49.13	68.20	1947	1990
7040680	BERSIMIS	48.97	68.62	1923	1961
7041710	CLARKE CITY	50.18	66.63	1902	1981
7042840	GRANDES BERGERONNES	48.25	69.52	1951	1990
7043000	HARRINGTON HARBOUR	50.53	59.50	1911	1978
7043540	LABRIEVILLE B1	49.30	69.55	1955	1990
7043960	LA MALBAIE	47.67	70.15	1913	1990
7045400	NATASHQUAN A	50.18	61.82	1914	1990
7047250	ST FEREOL	47.12	70.83	1915	1983
7047770	ST URBAIN	47.57	70.55	1957	1990
7047910	SEPT-ILES A	50.22	66.27	1944	1990
7048320	TADOUSSAC	48.15	69.70	1913	1990
7050198	ANTICOSTI HEATH POINT	49.10	61.70	1882	1935
7050200	ANTICOSTI SW POINT	49.40	63.55	1872	1954
7050210	ANTICOSTI WEST POINT	49.87	64.53	1882	1933
7050240	ARMAGH	46.75	70.53	1916	1990
7050455	BARRAGE LAC MORIN	47.65	69.52	1942	1984
7050463	BARRAGE MITIS	48.33	67.90	1926	1966
7050760	BIC	48.37	68.70	1882	1968
7050790	BIRD ROCKS	47.85	61.13	1881	1934
7051040	CAP CHAT	49.08	66.75	1882	1974
7051120	CAPLAN	48.10	65.68	1947	1990
7051160	CAP MADELEINE	49.23	65.32	1882	1990
7051200	CAUSAPSCAL	48.37	67.23	1913	1990
7052600	GASPE	48.83	64.48	1895	1985
7052960	GRINDSTONE ISLAND	47.38	61.87	1871	1983
7054095	LA POCATIERE CDA	47.35	70.03	1899	1990
7055120	MONT JOLI A	48.60	68.22	1943	1990
7055200	MONT LOUIS	49.23	65.73	1933	1990
7055380	MURDOCHVILLE	48.95	65.52	1952	1990
7056067	POINTE AU PERE	48.50	68.48	1873	1982
7056120	PORT DANIEL	48.15	64.98	1927	1990
7056200	PORT MENIER	49.82	64.35	1929	1974
7056240	PRICE	48.60	68.13	1931	1985
7056480	RIMOUSKI	48.45	68.52	1952	1990
7056600	RIVIERE BLEUE	47.43	69.03	1950	1990
7057160	ST ELZEAR DE BONAVENTURE	48.18	65.35	1948	1990
7057600	ST PAMPHILE	46.97	69.78	1950	1990
7057680	ST RAPHAEL	46.82	70.75	1949	1982
7057720	STE ROSE DU DEGELIS	47.57	68.63	1932	1990
7058520	TRINITE DES MONTS	48.13	68.47	1950	1990
7058560	TROIS PISTOLES	48.15	69.13	1951	1990
7060080	ALBANEL	48.88	72.45	1922	1990
7060320	ARVIDA	48.43	71.17	1931	1989
7060400	BAGOTVILLE A	48.33	71.00	1942	1990
7061440	CHICOUTIMI	48.42	71.08	1871	1979
7061480	CHUTE A MURDOCK	48.52	71.25	1921	1957
7061520	CHUTE AUX GALETS	48.65	71.20	1919	1963
7063320	ISLE MALIGNE	48.58	71.63	1924	1990
7063320	ISLE MALIGNE	48.58	71.63	1926	1990
7063400	KENOGAMI	48.42	71.25	1916	1972
7063560	LAC BOUCHETTE	48.27	72.18	1949	1990
7063683	LAC ONATCHIWAY	48.90	71.03	1920	1981
7063690	LAC STE CROIX	48.42	71.75	1958	1990
7064998	MISTASSINI	48.85	72.20	1912	1990
7065640	NORMANDIN CDA	48.85	72.53	1936	1990
7065960	PERIBONCA	48.77	72.03	1951	1990
7066080	PORTAGE DES ROCHES	48.30	71.22	1926	1984
7066685	ROBERVAL A	48.52	72.27	1957	1990
7066688	ROBERVAL NORD	48.53	72.23	1888	1967
7066820	ST AMBROISE	48.57	71.33	1954	1990
7068160	SHIPSHAW	48.45	71.22	1943	1990
7070448	BARRAGE A LAC KEMPT	47.55	74.18	1913	1970
7070451	BGE C LAC CHATEAUVERT	47.77	73.90	1942	1982
7070454	BARRAGE GOUIN	48.35	74.10	1913	1982
7070456	BARRAGE MATTAWIN	46.85	73.65	1929	1982
7074240	LA TUQUE	47.40	72.78	1911	1990
7074600	MANOUAN SANMAUR	47.90	73.80	1919	1972
7076360	RAPIDE BLANC	47.80	72.97	1931	1974
7080449	BARRAGE CABONGA	47.32	76.47	1929	1969
7080452	BARRAGE DES QUINZE	47.55	79.23	1911	1990
7080468	BARRAGE TEMISCAMINGUE	46.72	79.10	1910	1990

Table 3 (continued)

Station number	Station name	Latitude (degrees)	Longitude (degrees)	Record begins	Record ends
QUEBEC (continued)					
7080600	BELLETERRE	47.38	78.70	1951	1990
7082880	GRAND LAC VICTORIA	47.83	77.37	1927	1984
7083480	KIPAWA LANIEL	47.05	79.27	1920	1990
7084560	MANNEVILLE	48.55	78.48	1949	1990
7086400	RAPIDE-SEPT	47.77	78.30	1941	1975
7088760	VILLE MARIE	47.35	79.43	1913	1990
7090050	ABITIBI POST	48.72	79.37	1896	1936
7090120	AMOS	48.57	78.13	1913	1990
7092480	FORT GEORGE	53.83	79.00	1915	1969
7094120	LA SARRE	48.78	79.22	1951	1990
7095000	MISTASSINI POST	50.42	73.88	1885	1980
7095480	NITCHEQUON	53.20	70.90	1942	1985
7098360	TASCHEREAU	48.67	78.70	1951	1990
7098600	VAL D'OR A	48.07	77.78	1951	1990
NEW BRUNSWICK					
8100100	ACADIA FOREST EXP ST	45.98	66.37	1955	1990
8100200	ALMA	45.60	64.95	1950	1990
8100300	AROOSTOOK	46.80	67.72	1929	1990
8100500	BATHURST	47.62	65.65	1872	1972
8100701	CAMPBELLTON POWER ST	48.00	66.68	1937	1978
8100990	CHATHAM	47.05	65.48	1873	1947
8101000	CHATHAM A	47.02	65.45	1943	1990
8101100	CHIPMAN	46.18	65.87	1931	1967
8101170	DALHOUSIE	48.07	66.37	1872	1916
8101200	DOAKTOWN	46.55	66.15	1934	1990
8101300	EDMUNDSTON	47.37	68.33	1913	1957
8101301	EDMUNDSTON FRASER CO	47.37	68.33	1949	1979
8101500	FREDERICTON A	45.87	66.53	1951	1990
8101600	FREDERICTON CDA	45.92	66.62	1913	1990
8101700	FREDERICTON UNB	45.95	66.60	1871	1952
8101800	GAGETOWN 2	45.78	66.15	1897	1990
8101900	GRAND FALLS	47.05	67.73	1913	1966
8101920	GRAND MANAN	44.73	66.77	1874	1965
8102200	HARVEY STATION	45.73	67.00	1920	1976
8102300	KEDGWICK	47.65	67.35	1931	1990
8102600	MCADAM	45.58	67.33	1872	1976
8103000	MINTO	46.03	66.03	1954	1990
8103100	MONCTON	46.10	64.78	1881	1990
8103200	MONCTON A	46.12	64.68	1939	1990
8103400	MUSQUASH	45.20	66.33	1922	1981
8103500	NEPISIGUIT FALLS	47.40	65.78	1922	1990
8103800	OROMOCTO	45.83	66.47	1957	1990
8104100	POINT ESCUMINAC	47.12	64.82	1885	1951
8104200	POINT LEPREAU	45.07	66.47	1872	1952
8104400	REXTON	46.67	64.87	1922	1990
8104500	SACKVILLE	45.90	64.38	1878	1980
8104600	ST ANDREWS	45.08	67.08	1874	1990
8104700	ST GEORGE	45.13	66.83	1919	1981
8104800	SAINT JOHN	45.28	66.08	1871	1970
8104900	SAINT JOHN A	45.32	65.88	1946	1990
8105200	SUSSEX	45.72	65.53	1897	1990
8105600	WOODSTOCK	46.15	67.58	1886	1990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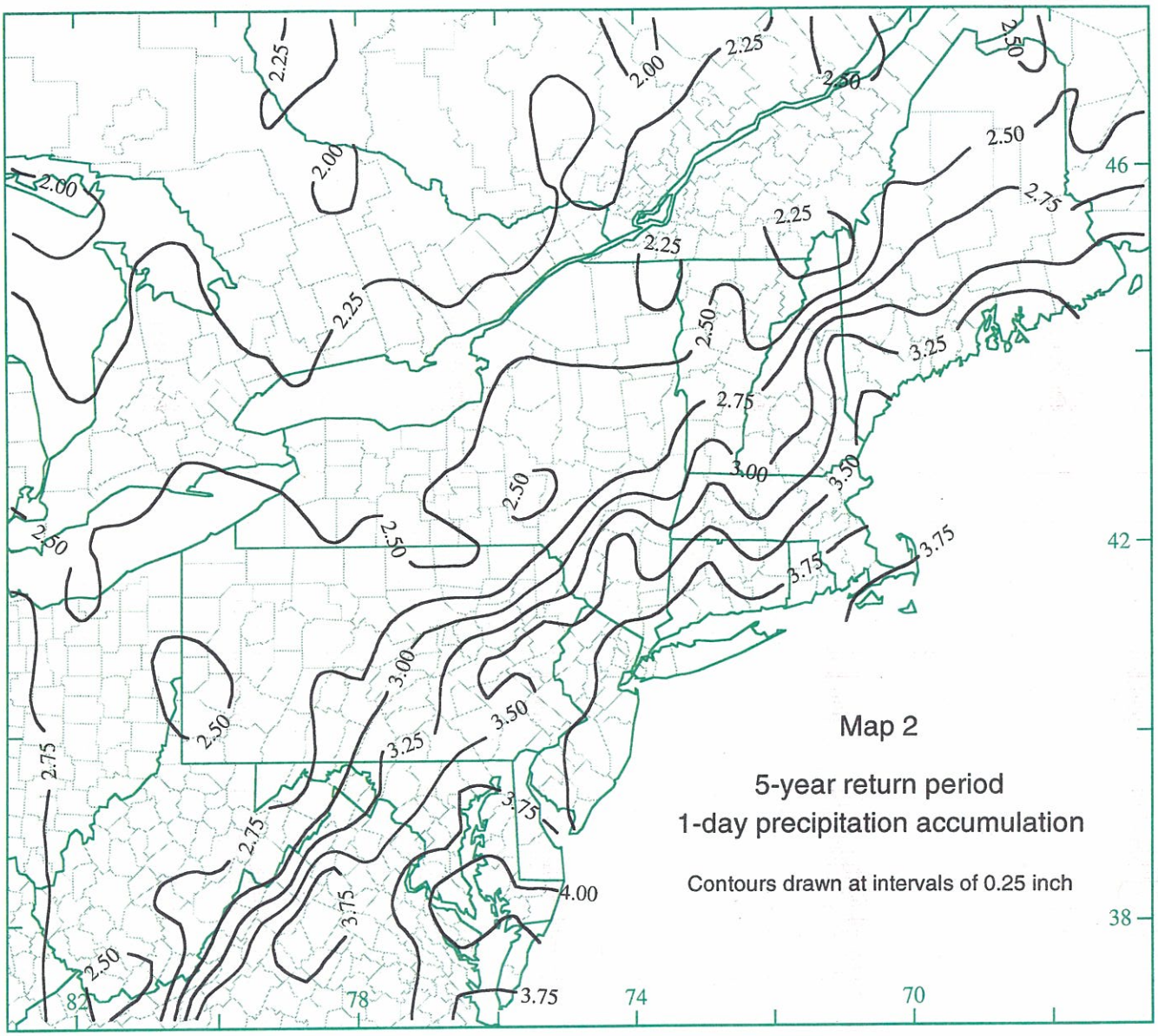
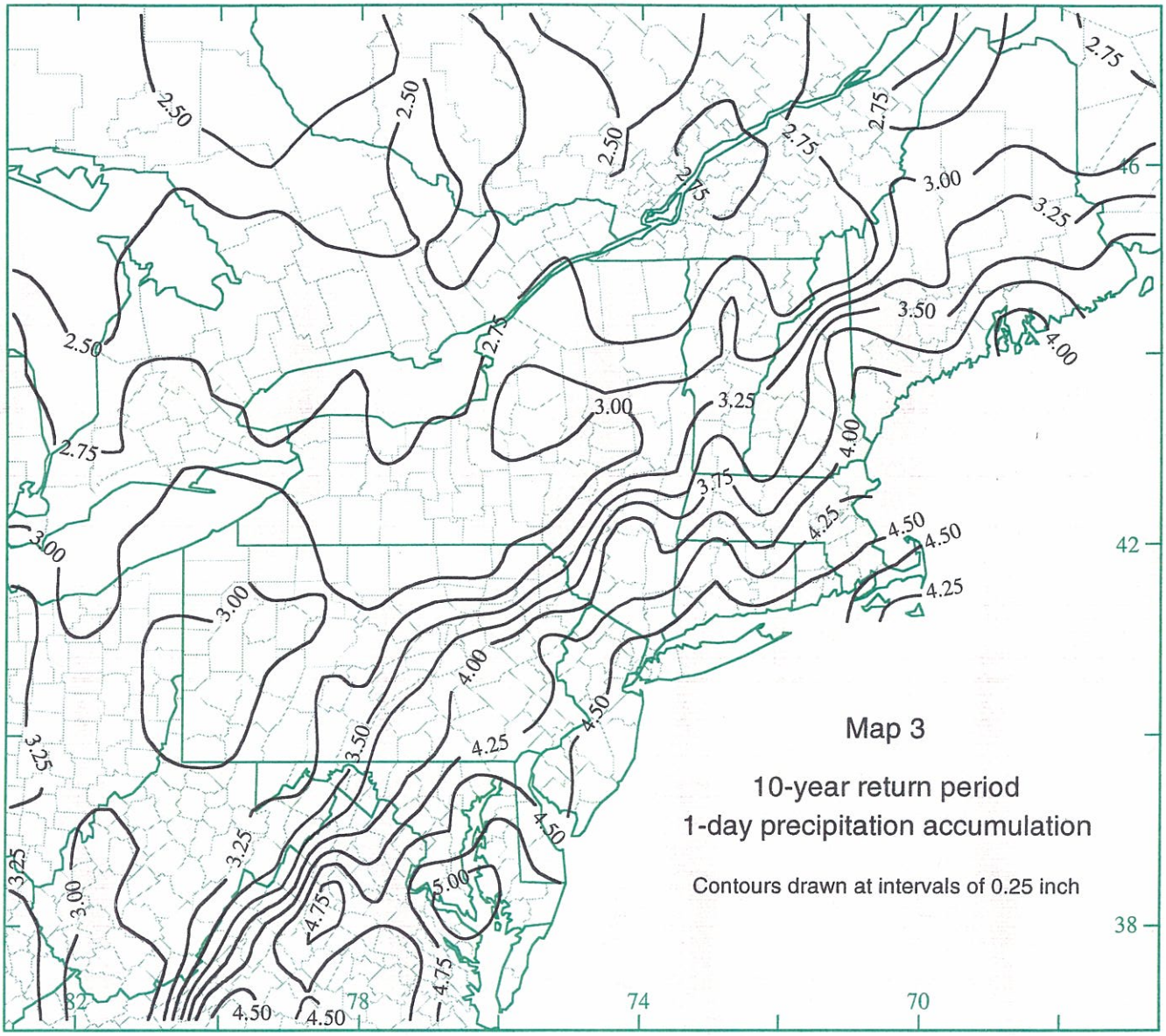
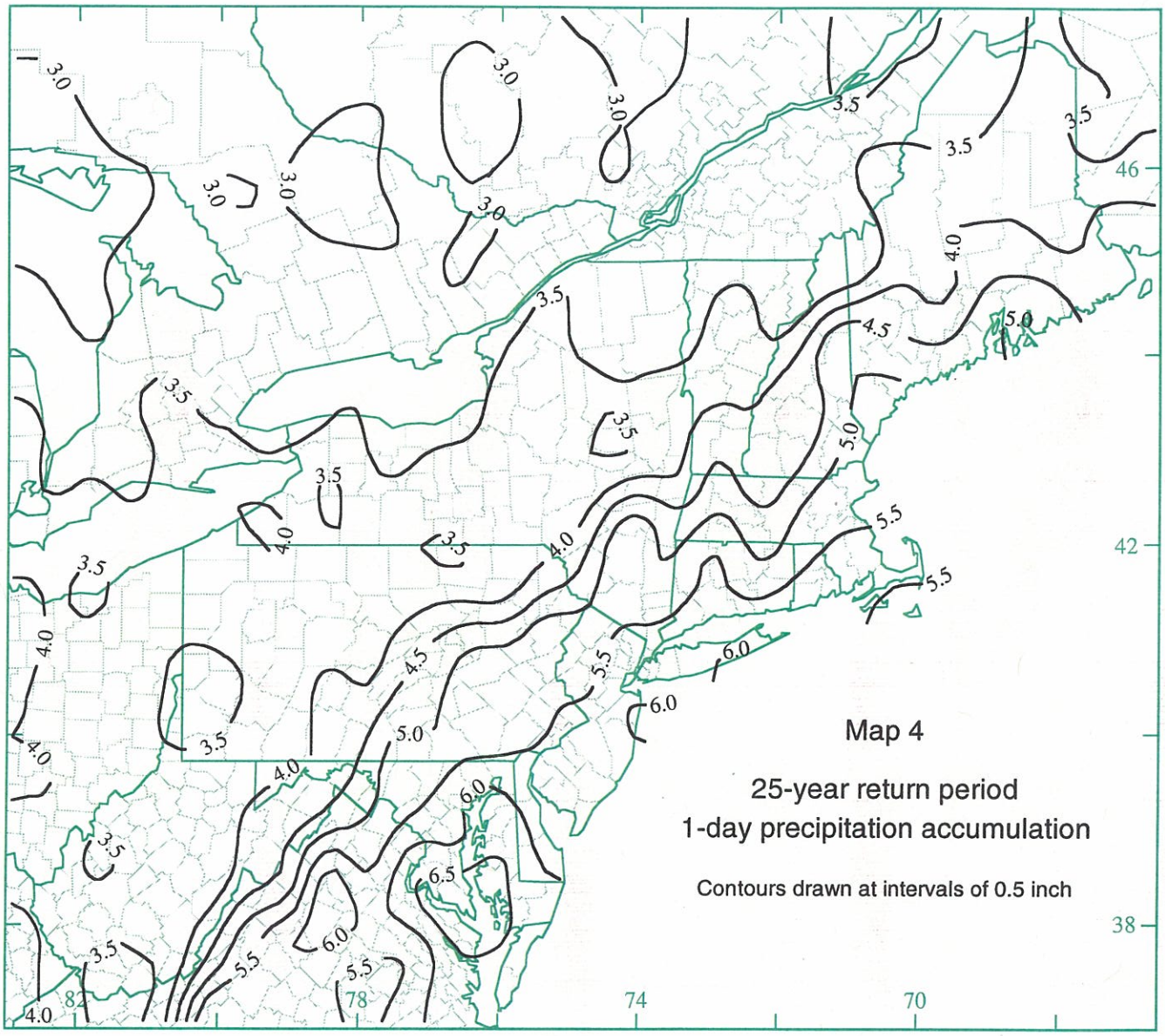
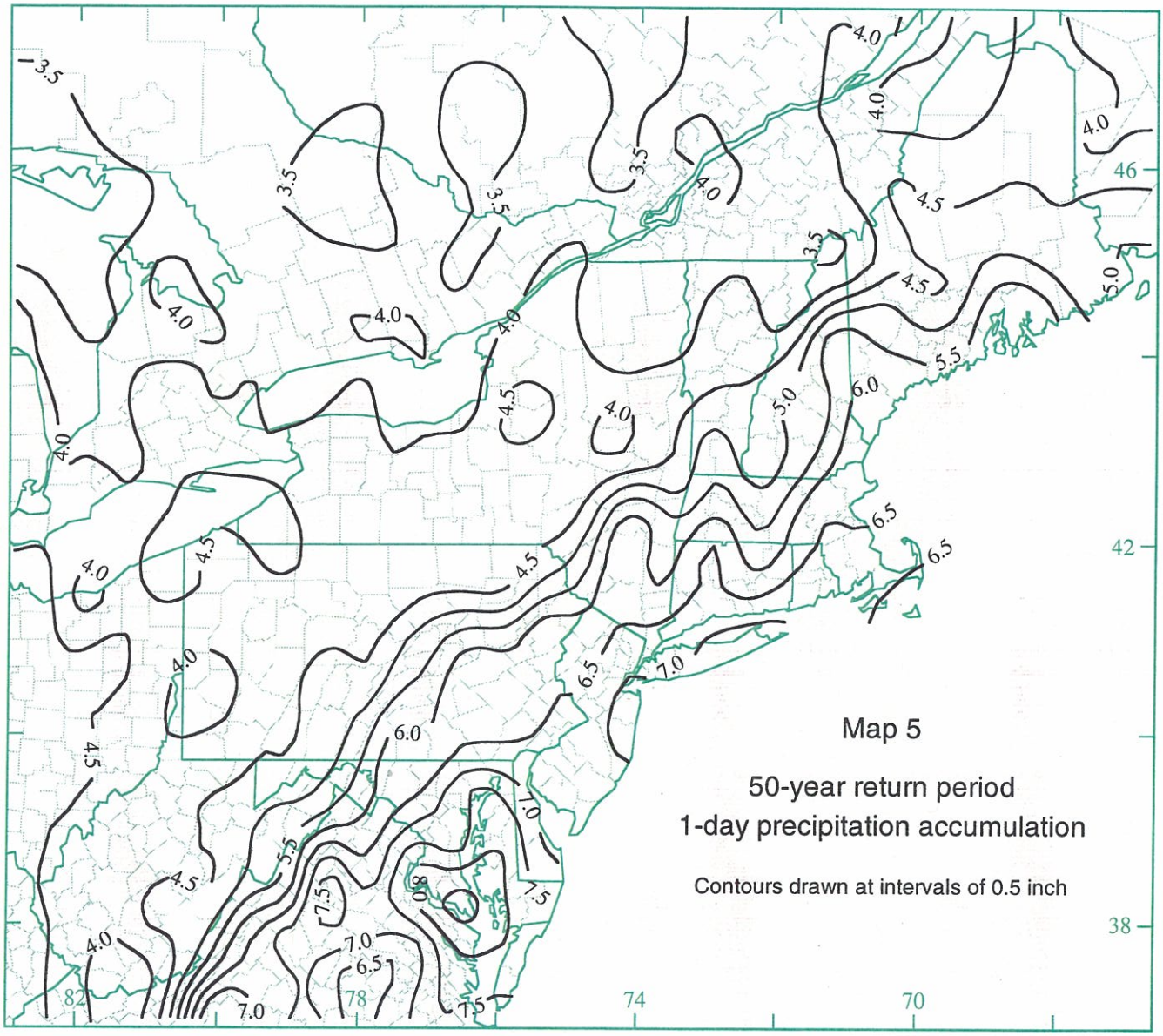
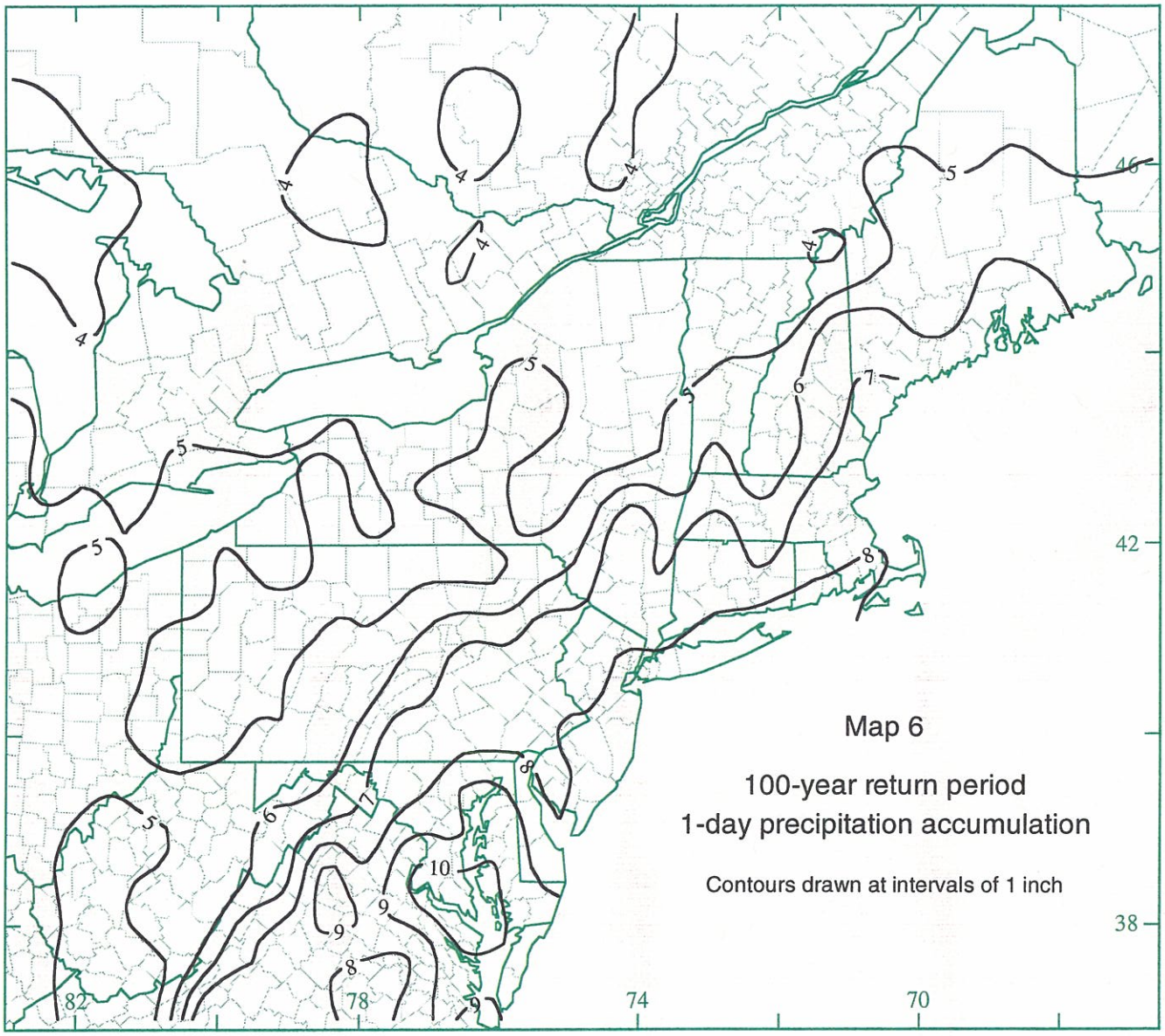
2.25
2.50
2.75
2.25
2.50
2.75
3.00
3.00
3.25
2.25
2.25
2.50
2.75
3.00
2.75
3.00
3.25
46
42
38
82
78
74
70
Map 1
2-year return period
1-day precipitation accumulation
Contours drawn at intervals of 0.25 inch

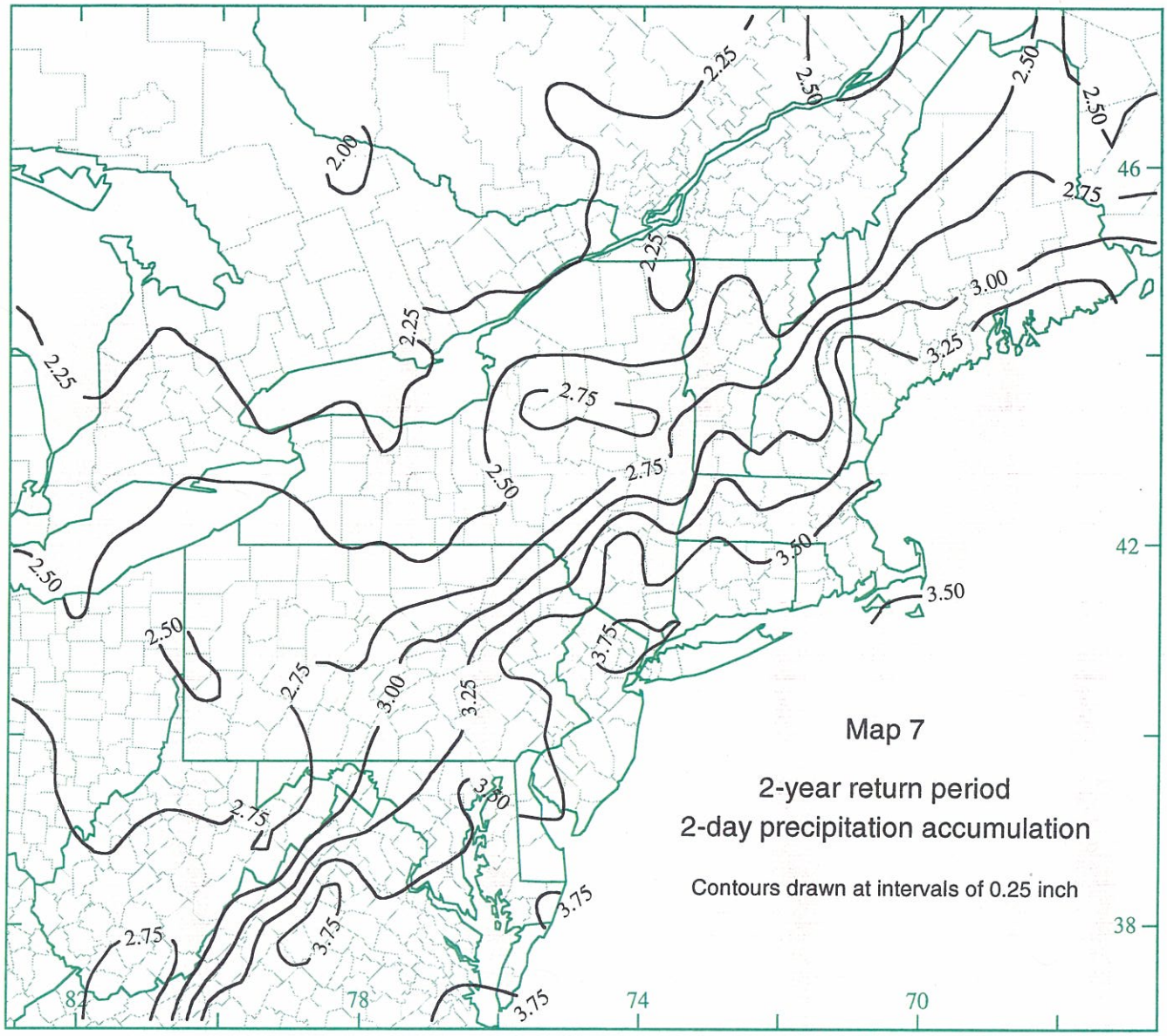

Map 2
5-year return period
1-day precipitation accumulation
Contours drawn at intervals of 0.25 inch
46
42
38
82
78
74
70

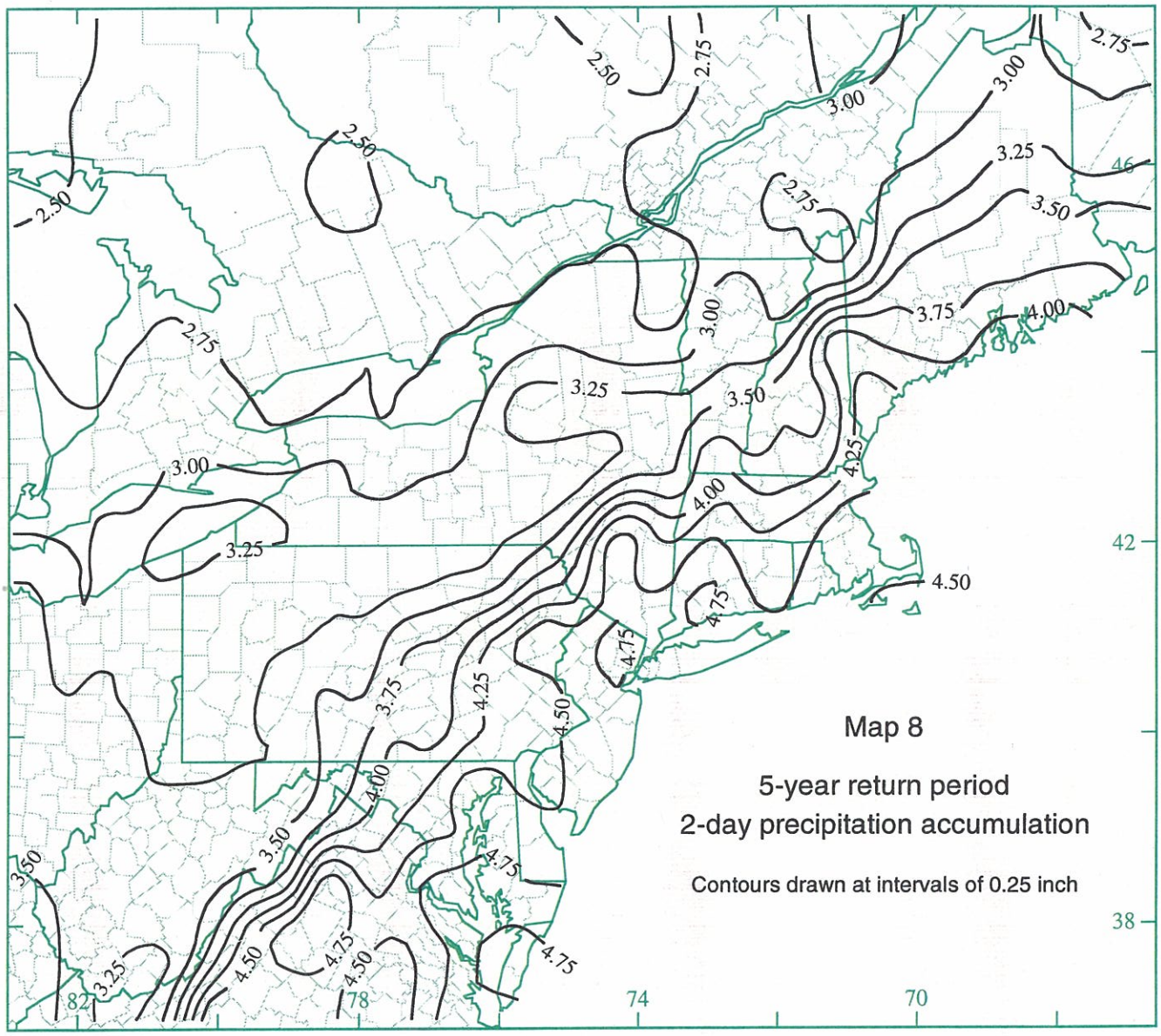

Map 3
10-year return period
1-day precipitation accumulation
Contours drawn at intervals of 0.25 inch
46
42
38
82
78
74
70

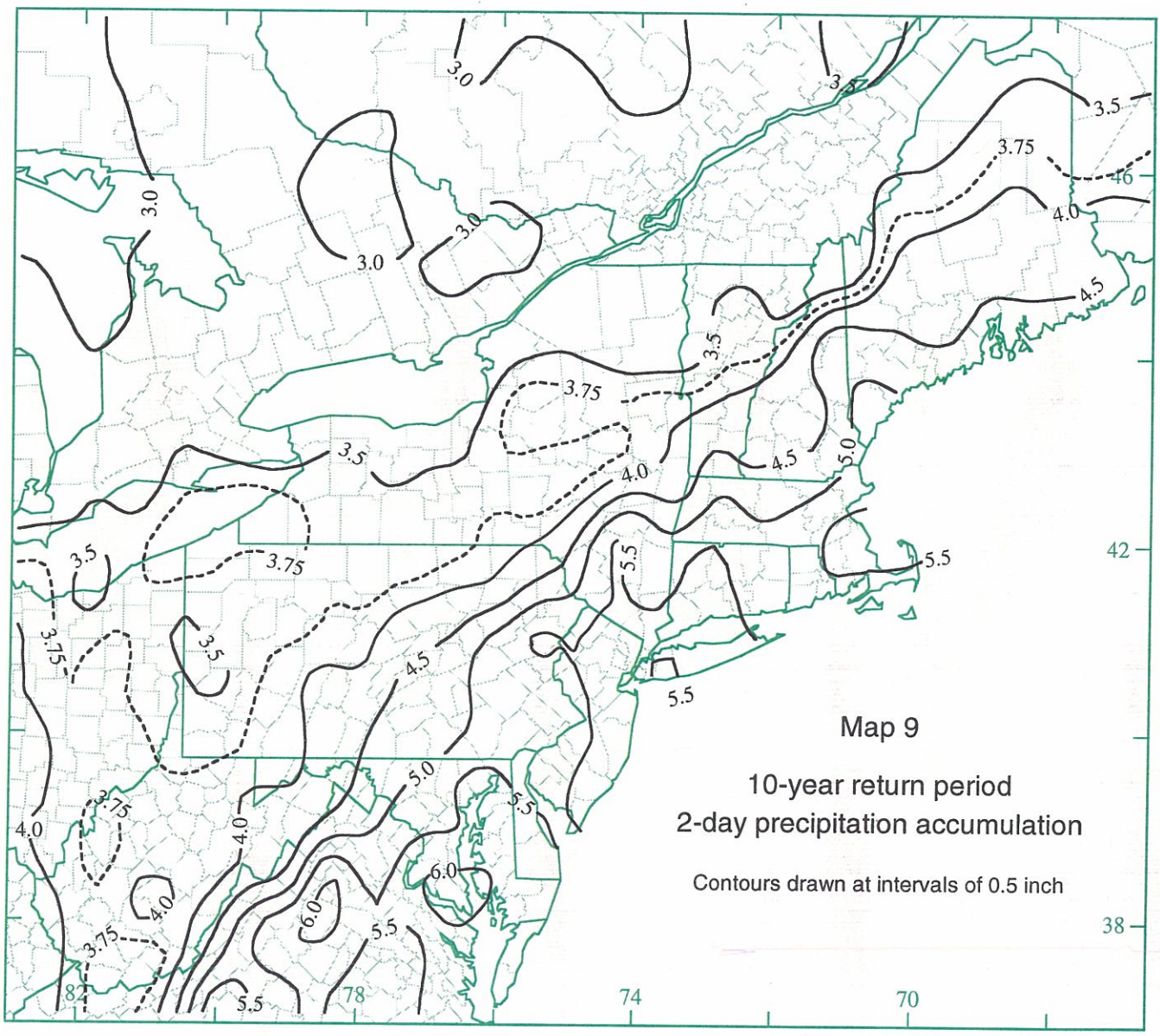

Map 4
25-year return period
1-day precipitation accumulation
Contours drawn at intervals of 0.5 inch
46
42
38
82
78
74
70

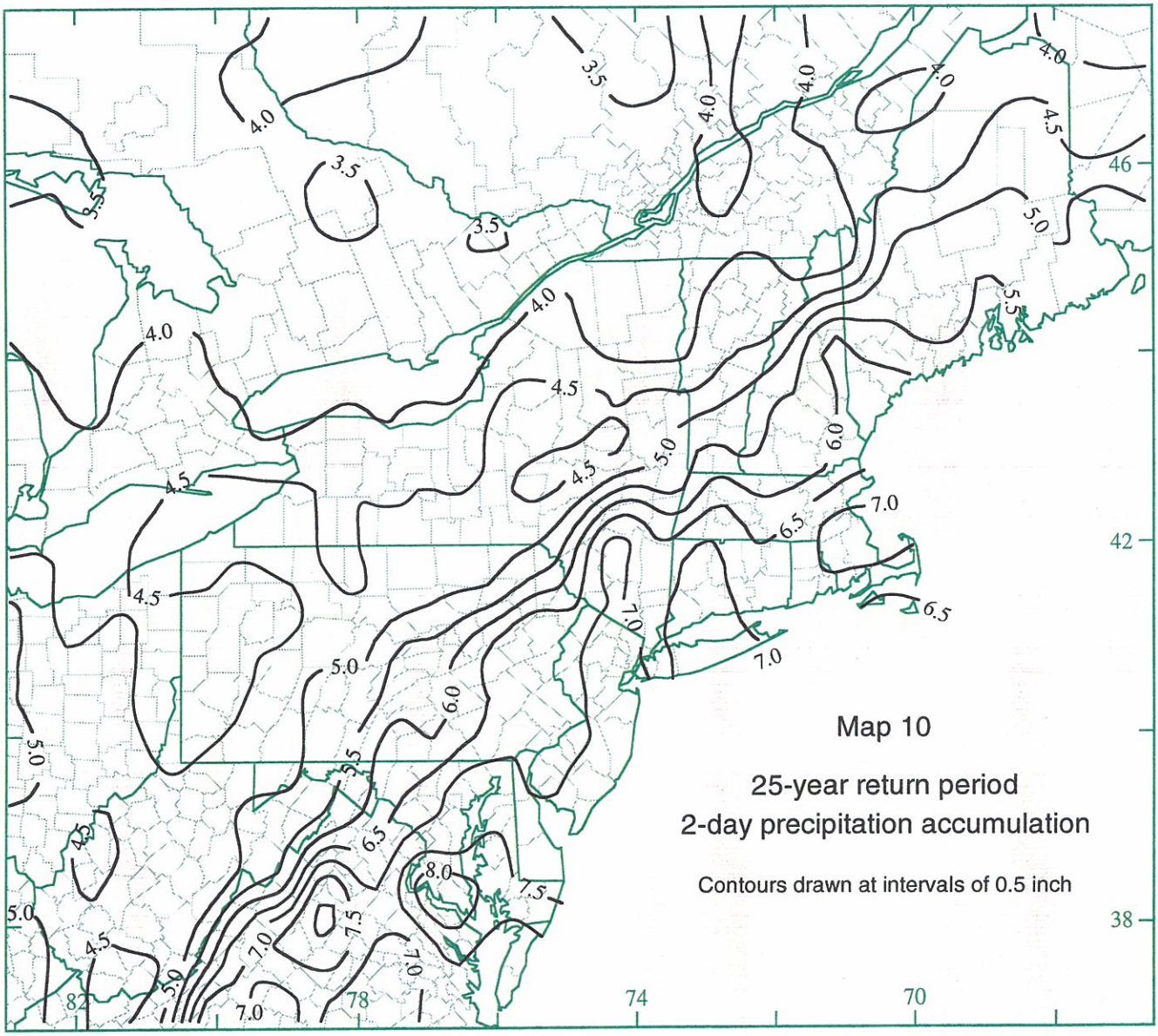

Map 5
50-year return period
1-day precipitation accumulation
Contours drawn at intervals of 0.5 inch
46
42
38
82
78
74
70

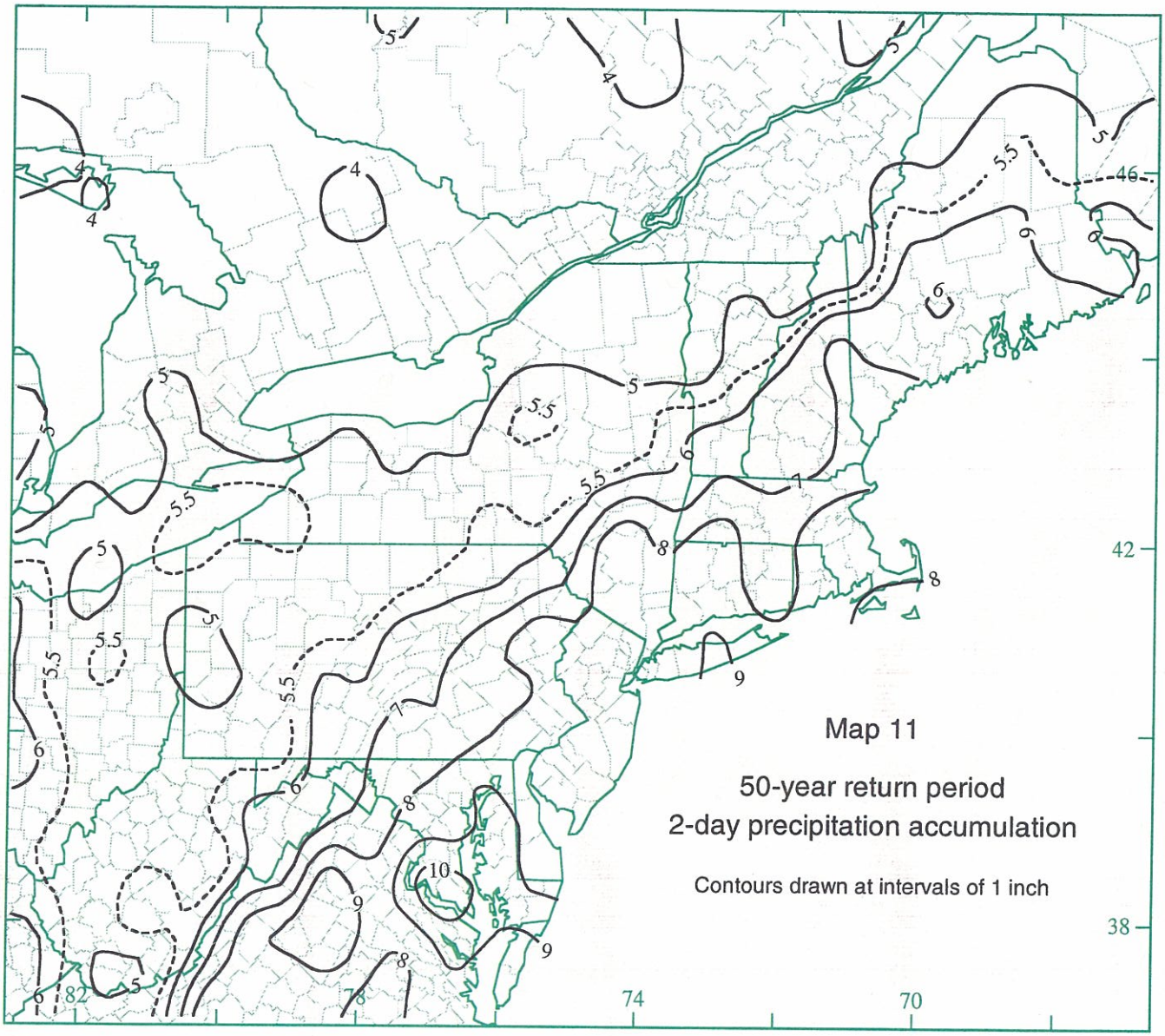

Map 6
100-year return period
1-day precipitation accumulation
Contours drawn at intervals of 1 inch
46
42
38
82
78
74
70

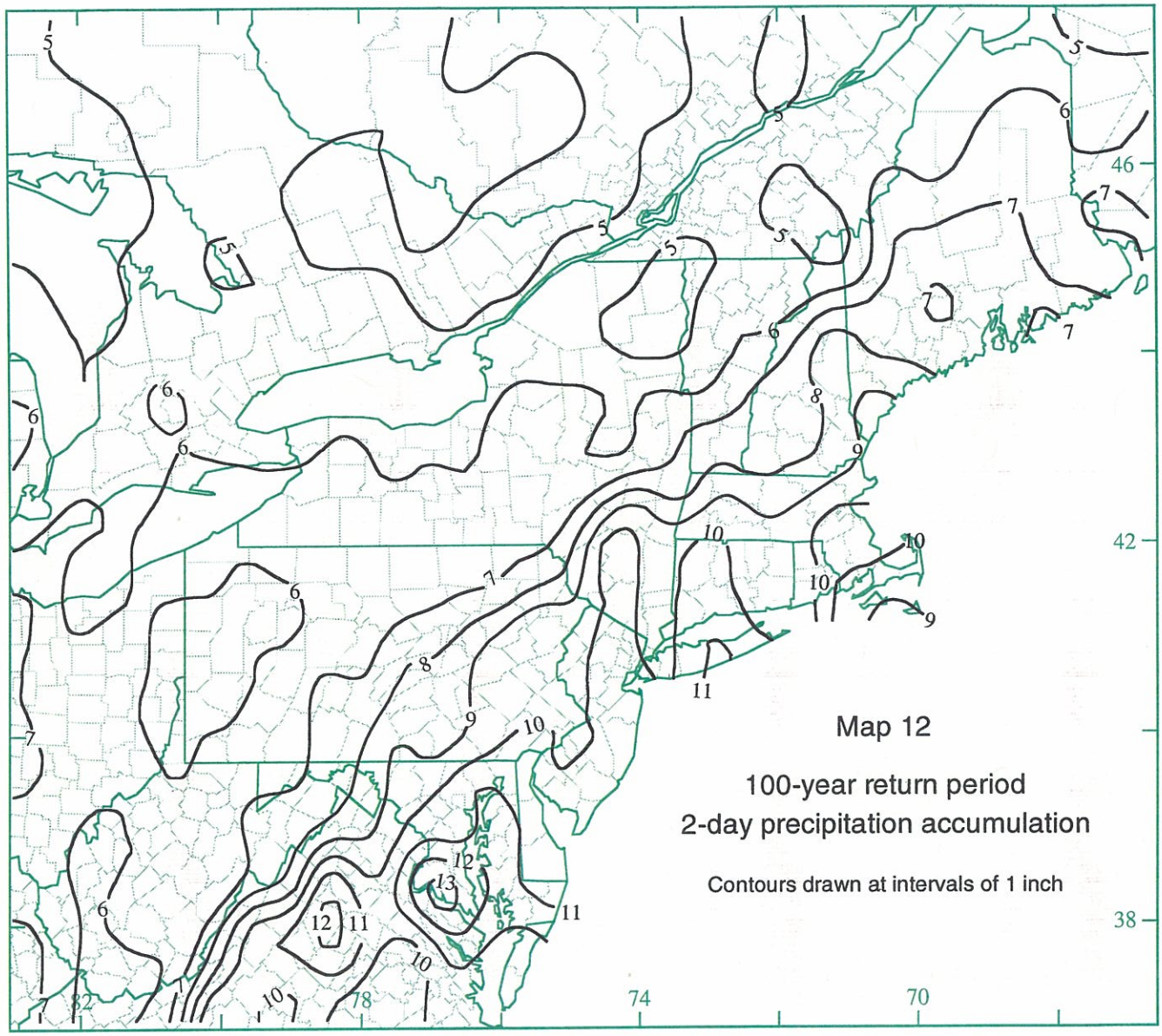

Map 7
2-year return period
2-day precipitation accumulation
Contours drawn at intervals of 0.25 inch
2.00
2.25
2.50
2.75
3.00
3.25
3.50
3.75
46
42
38
82
78
74
70

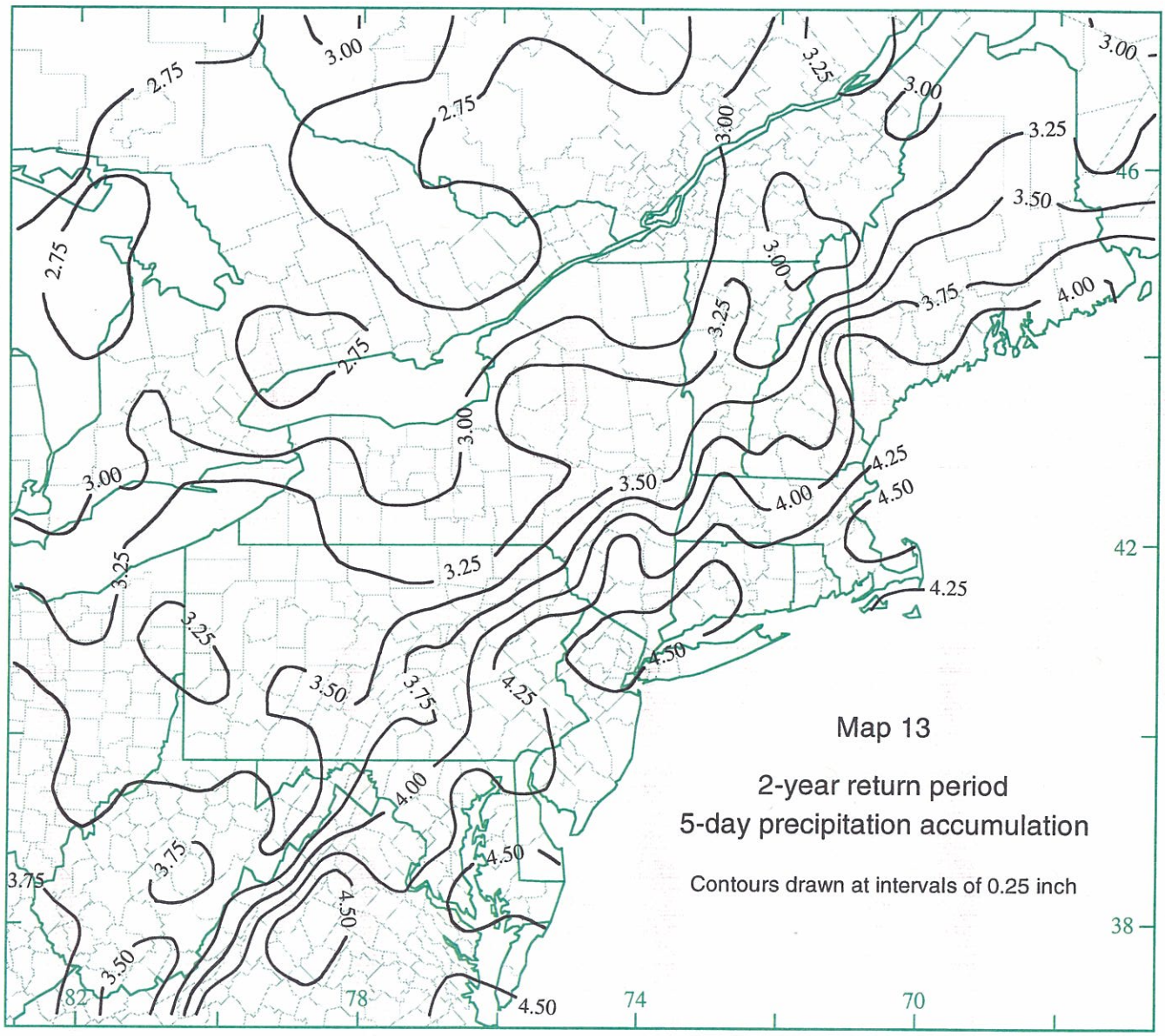

Map 8
5-year return period
2-day precipitation accumulation
Contours drawn at intervals of 0.25 inch
46
42
38
82
78
74
70

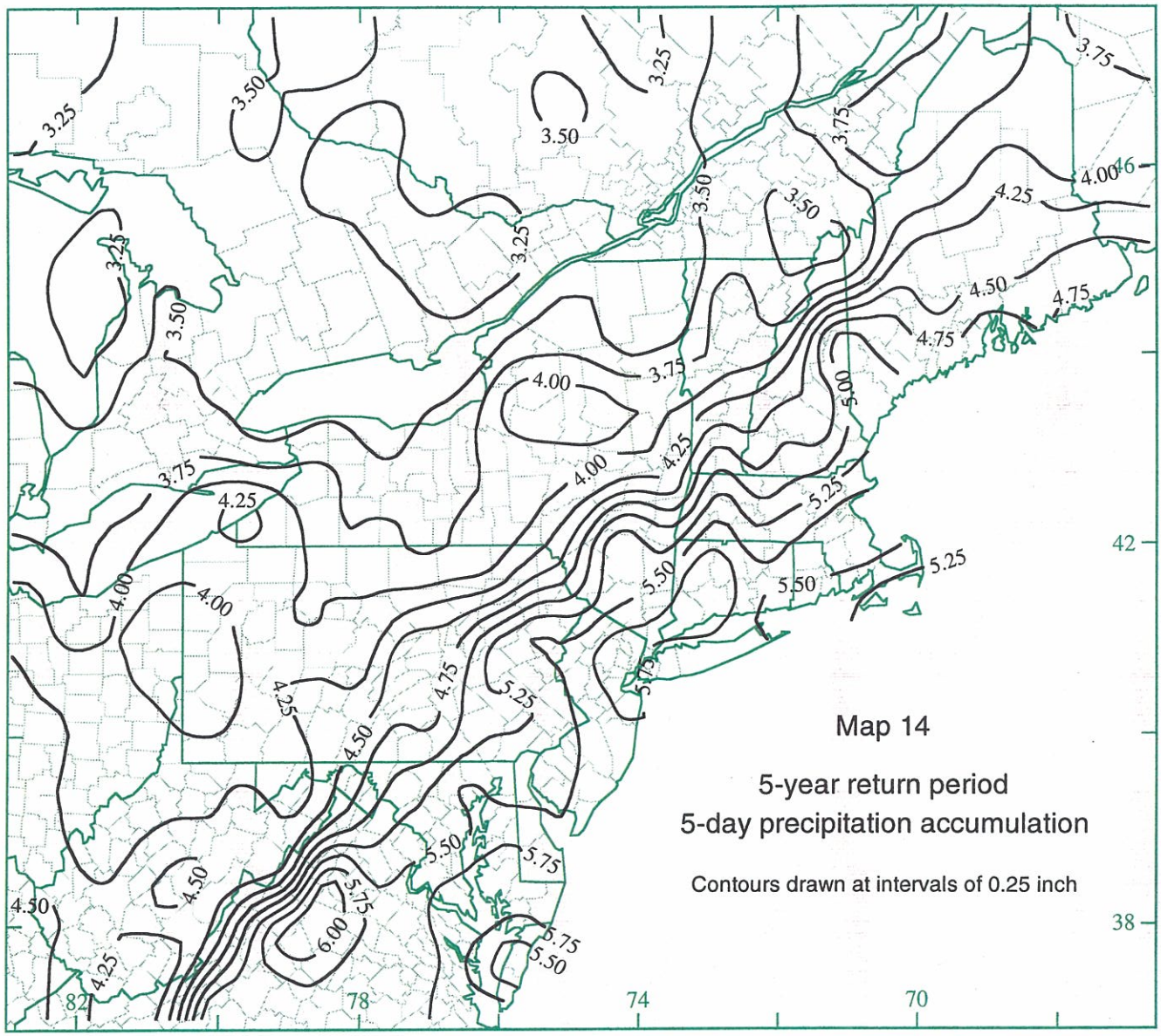

Map 9
10-year return period
2-day precipitation accumulation
Contours drawn at intervals of 0.5 inch
46
42
38
82
78
74
70

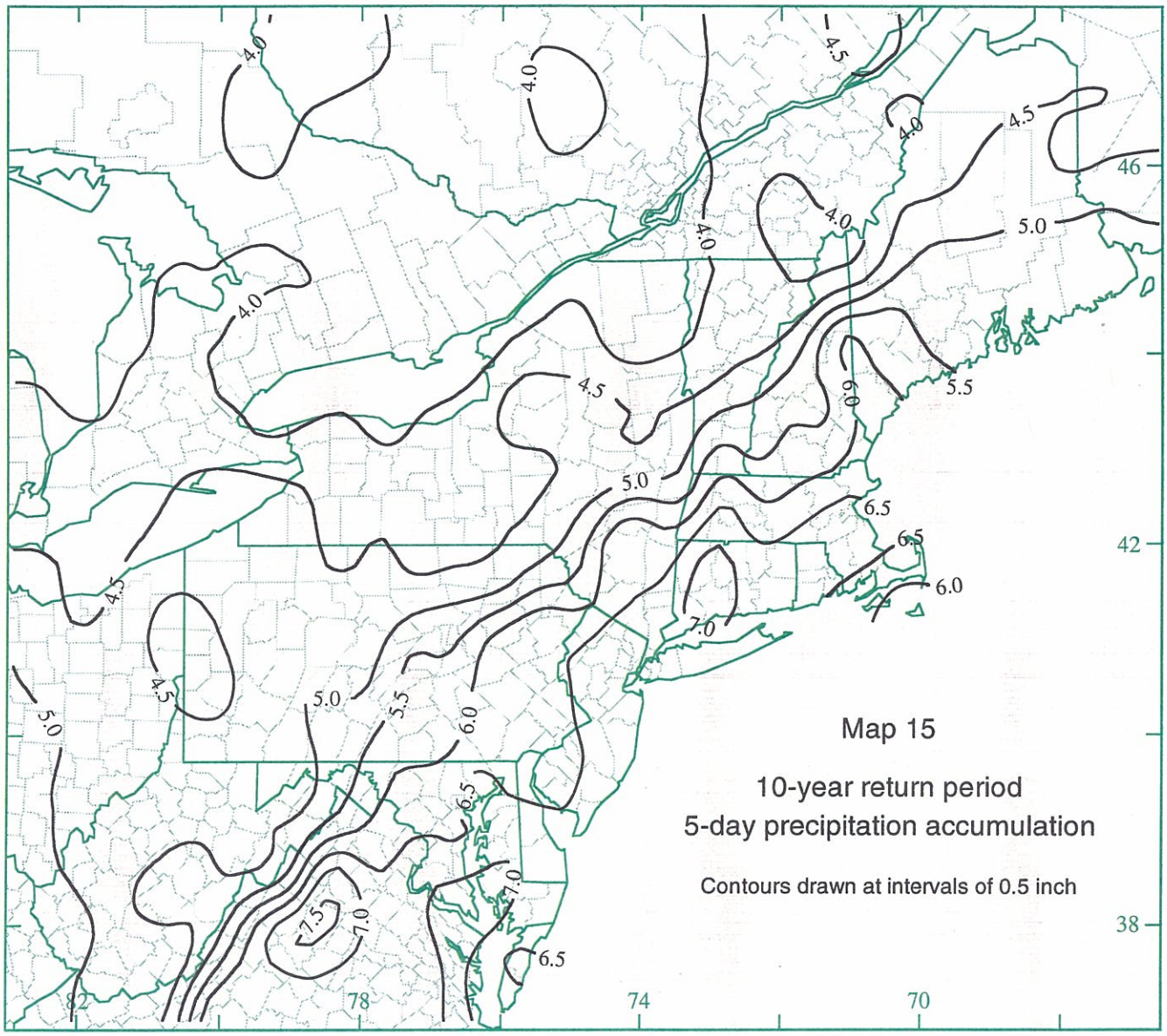

Map 10
25-year return period
2-day precipitation accumulation
Contours drawn at intervals of 0.5 inch
46
42
38
82
78
74
70

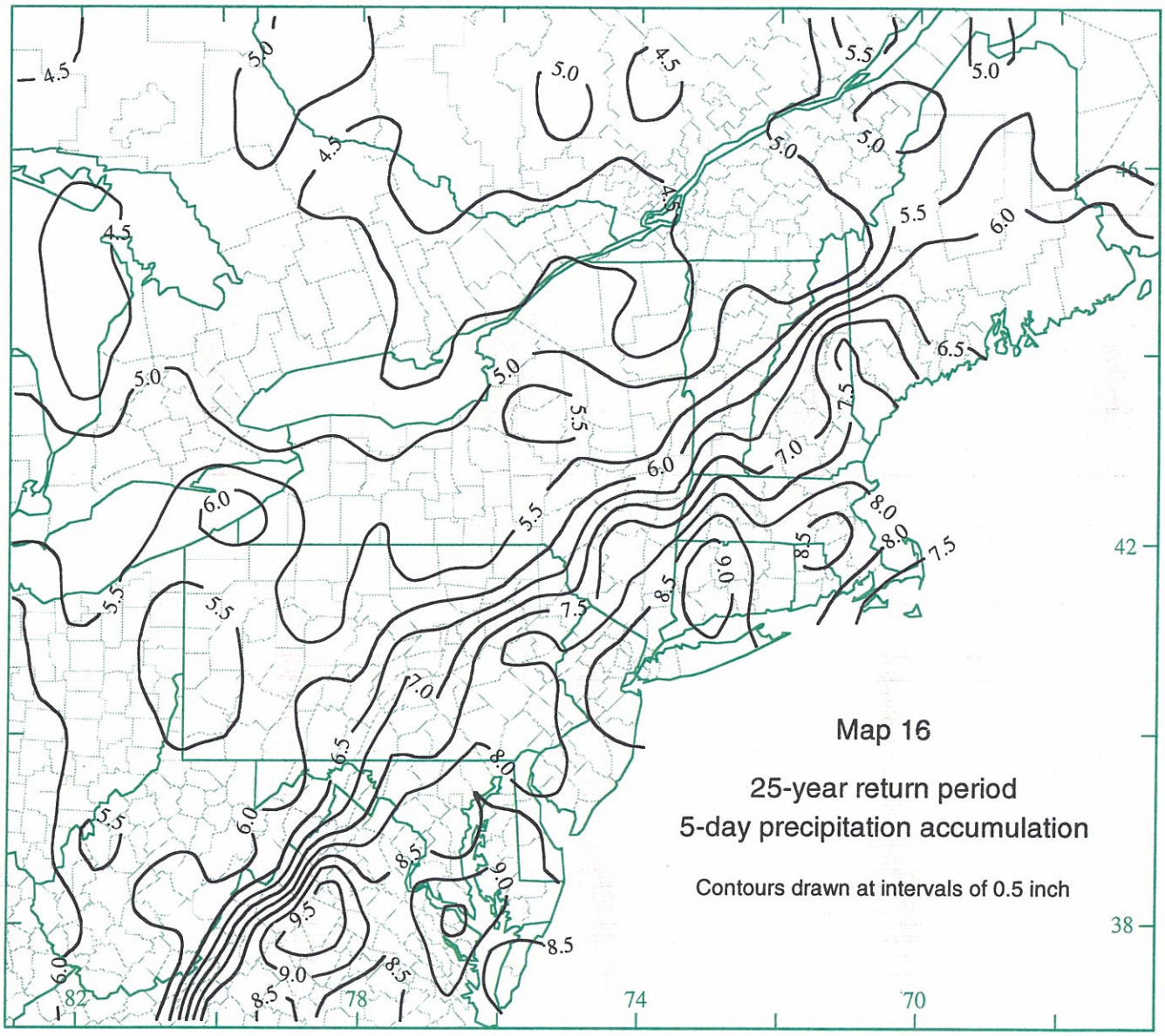

Map 11
50-year return period
2-day precipitation accumulation
Contours drawn at intervals of 1 inch
46
42
38
82
78
74
70

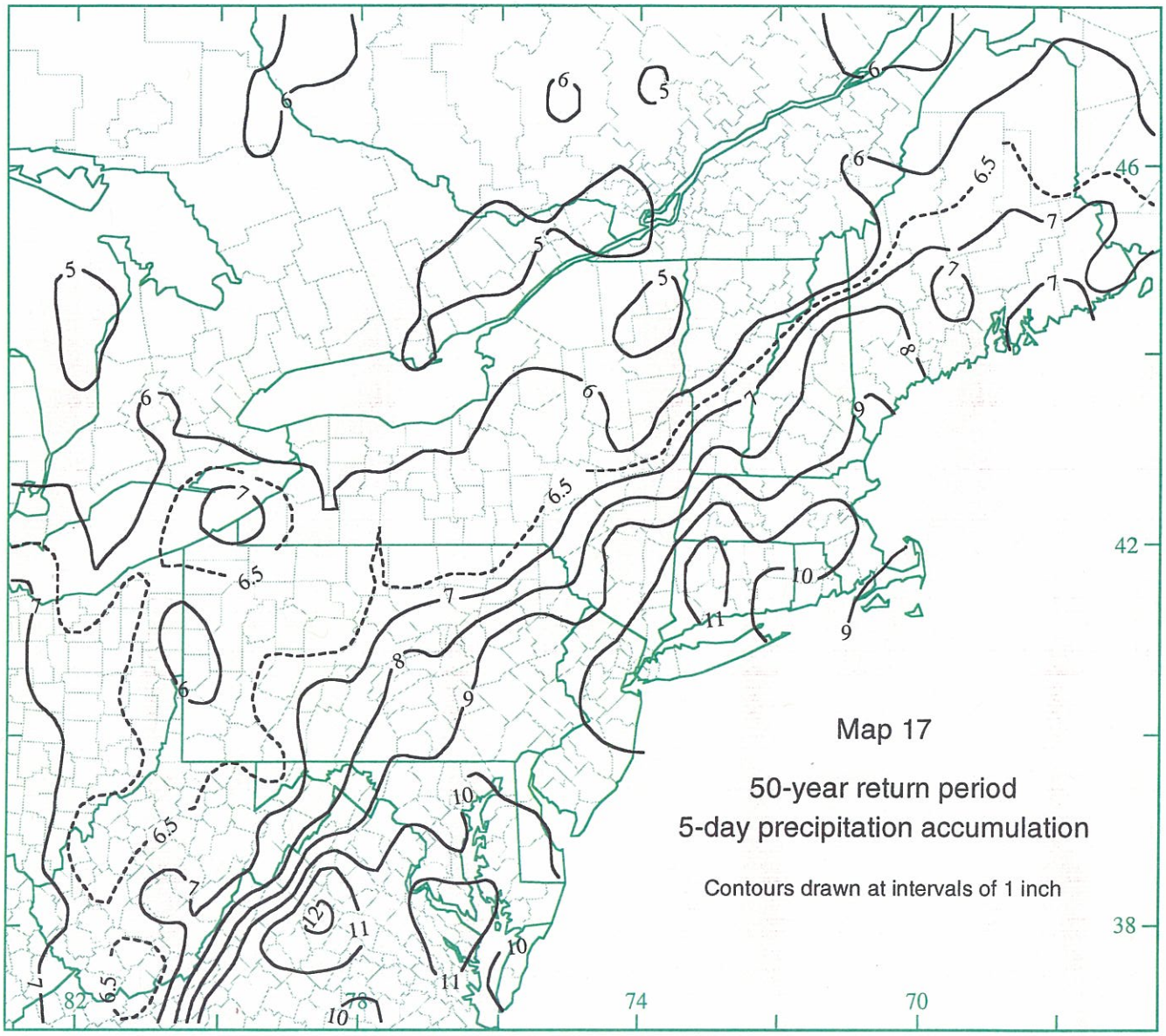

Map 12
100-year return period
2-day precipitation accumulation
Contours drawn at intervals of 1 inch
46
42
38
82
78
74
70

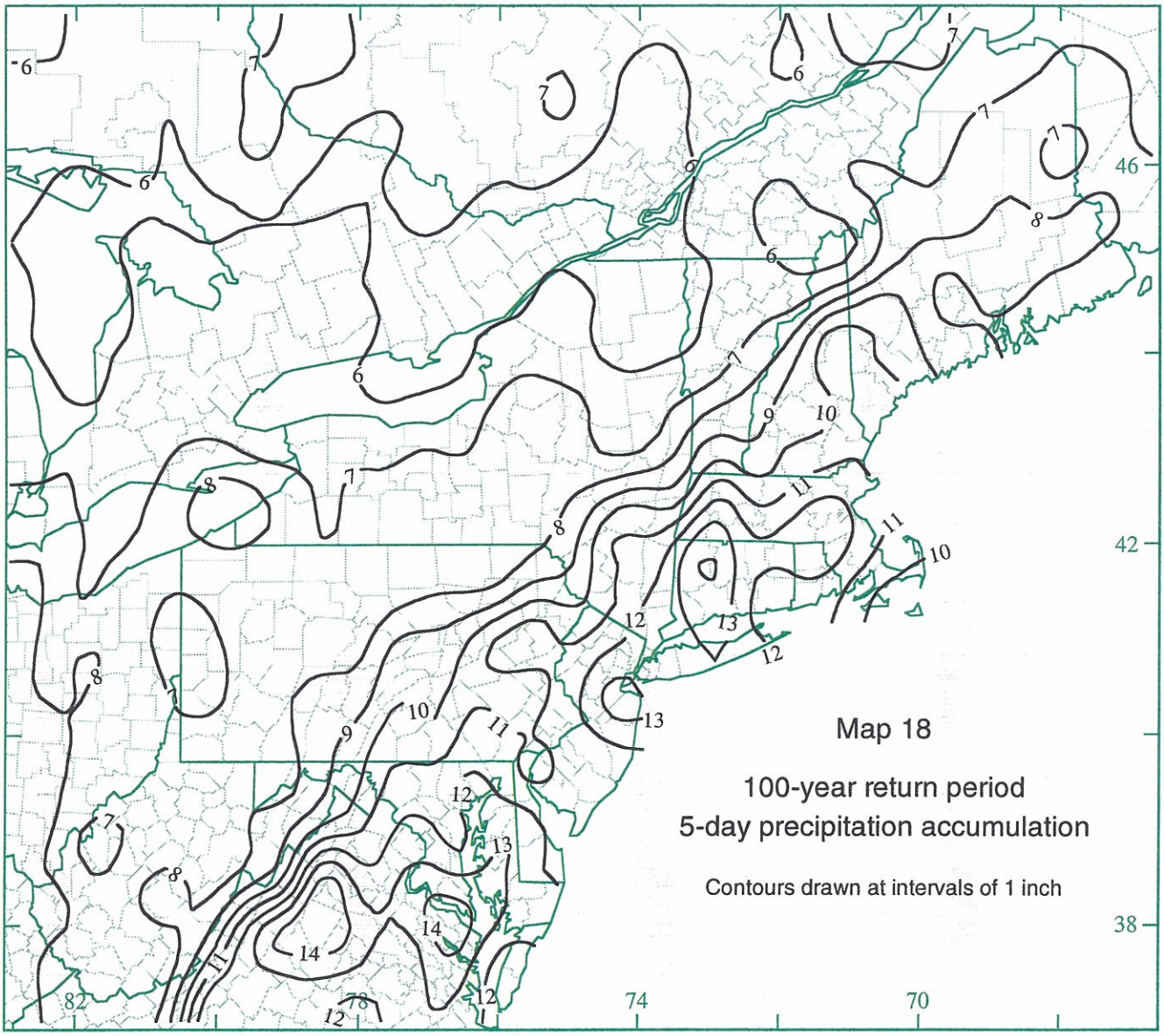

Map 13
2-year return period
5-day precipitation accumulation
Contours drawn at intervals of 0.25 inch
46
42
38
82
78
74
70

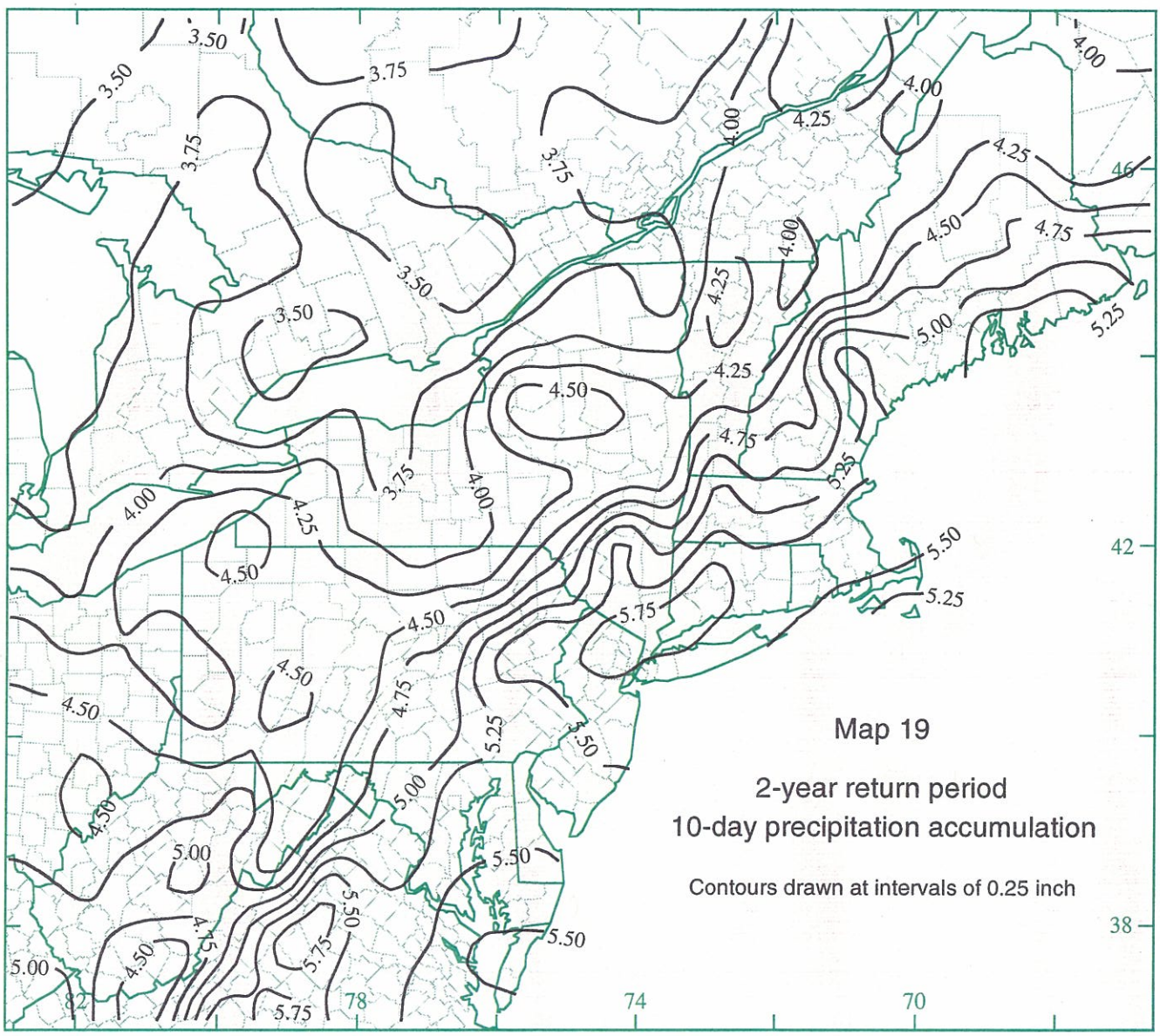

Map 14
5-year return period
5-day precipitation accumulation
Contours drawn at intervals of 0.25 inch
46
42
38
82
78
74
70

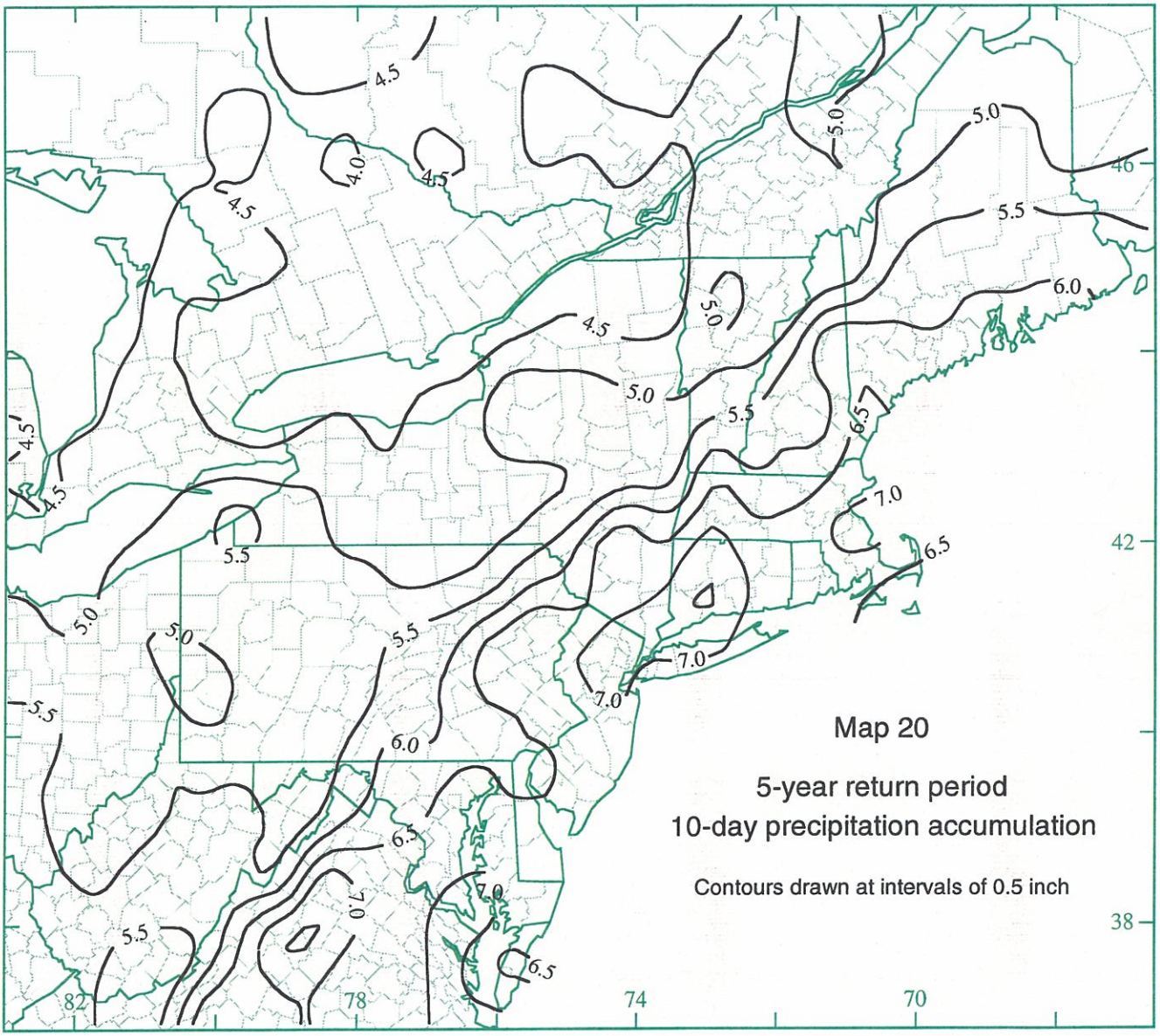

Map 15
10-year return period
5-day precipitation accumulation
Contours drawn at intervals of 0.5 inch
46
42
38
82
78
74
70

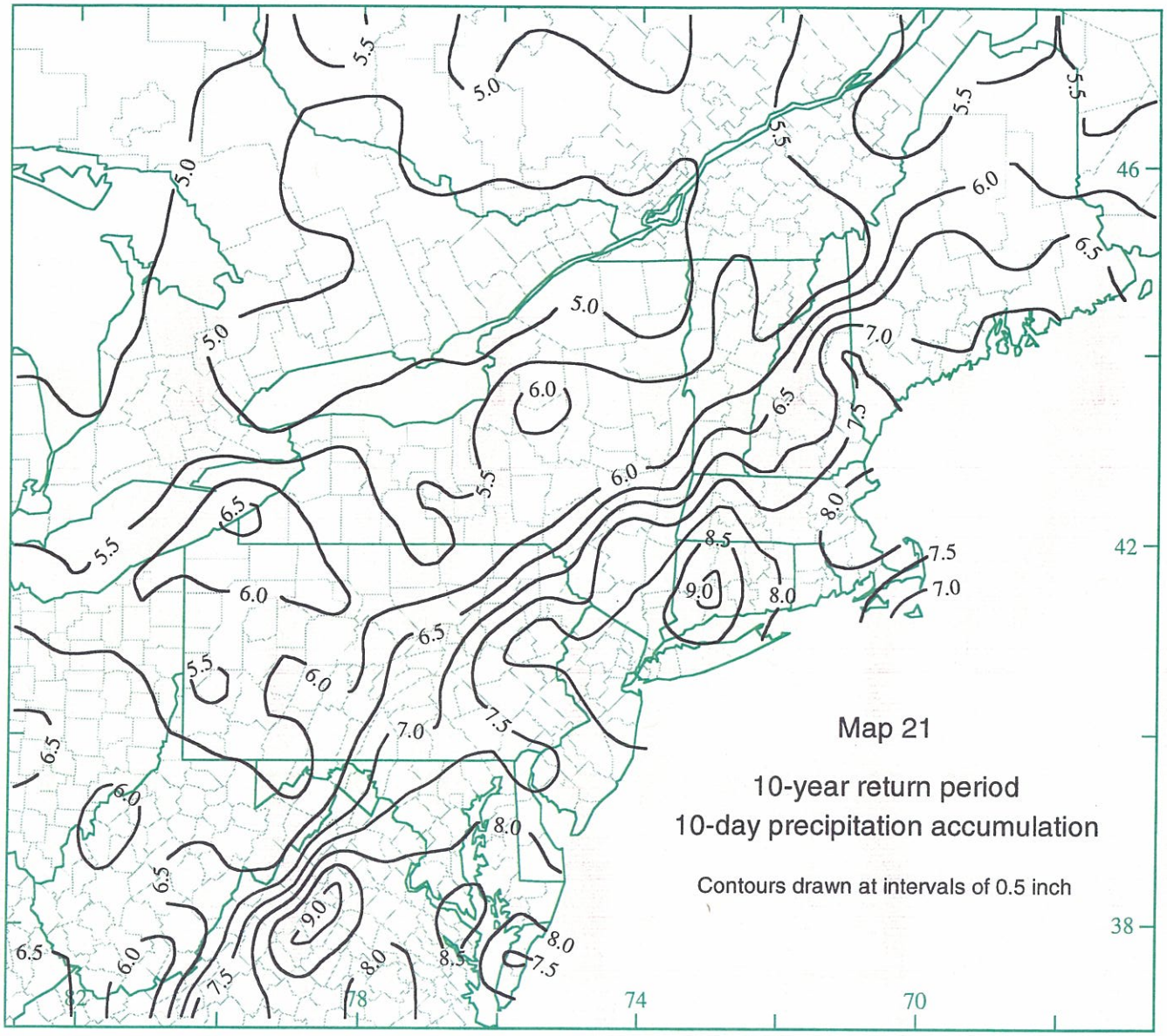

Map 16
25-year return period
5-day precipitation accumulation
Contours drawn at intervals of 0.5 inch
46
42
38
82
78
74
70

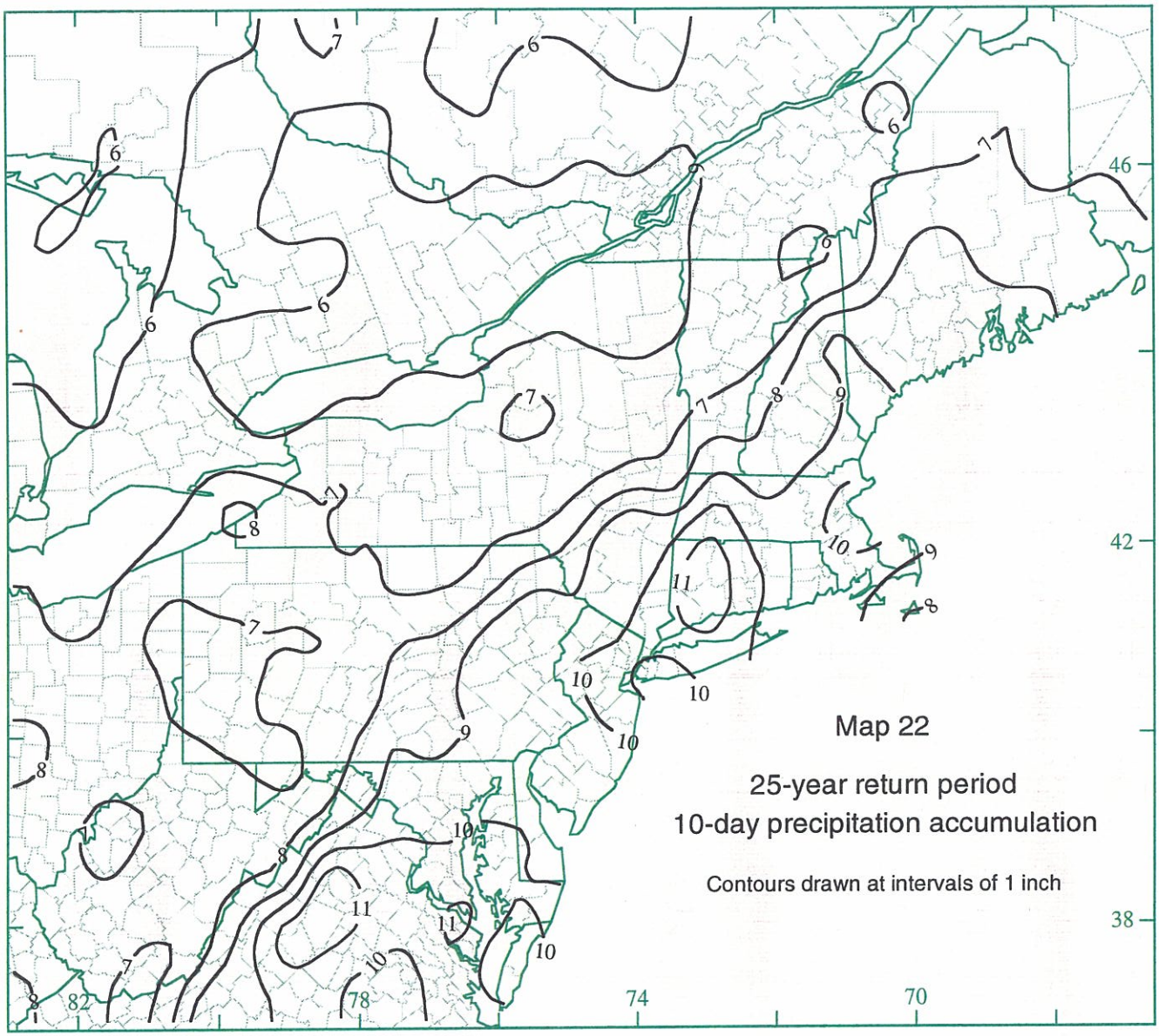

Map 17
50-year return period
5-day precipitation accumulation
Contours drawn at intervals of 1 inch
46
42
38
82
78
74
70

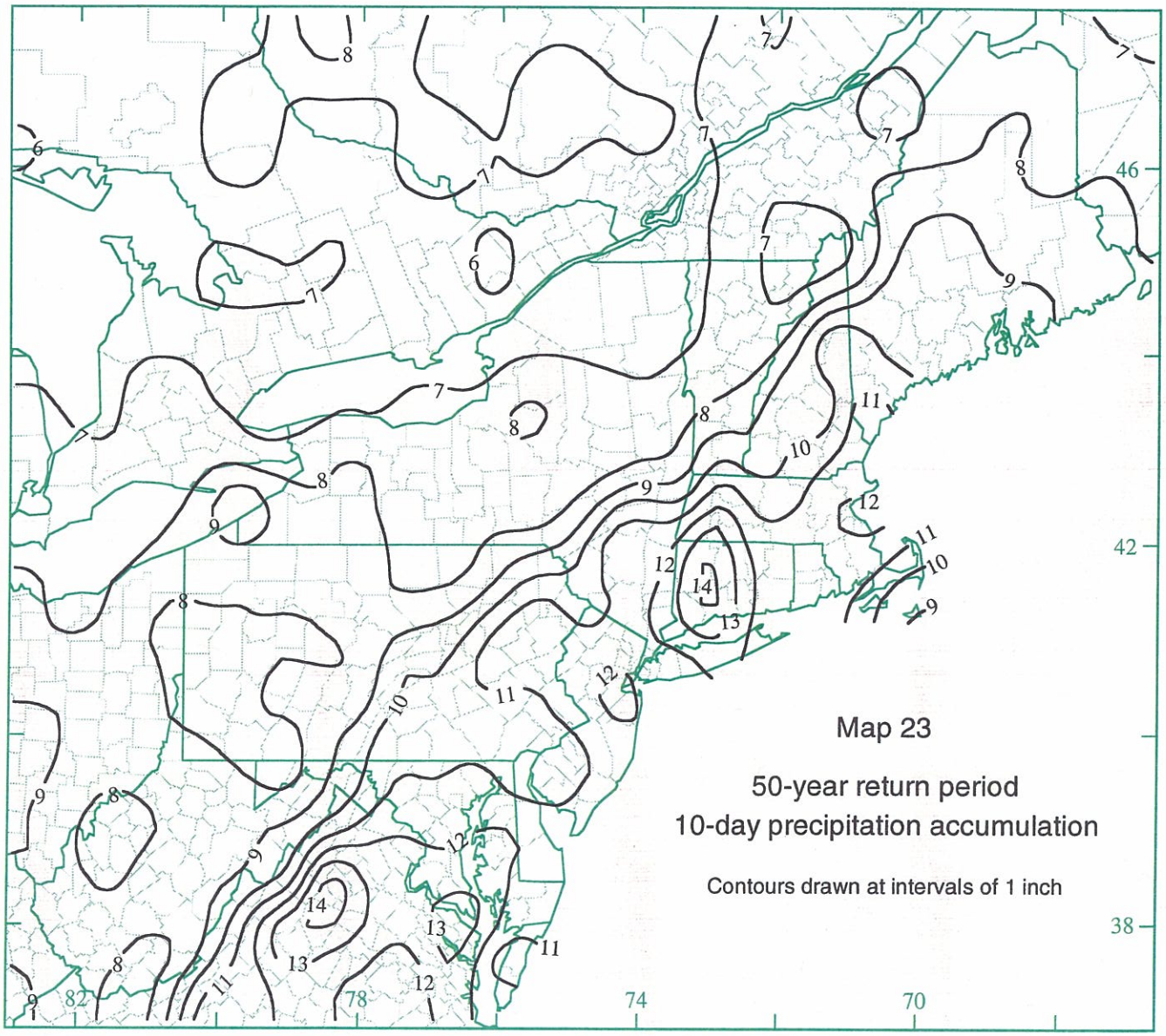

Map 18
100-year return period
5-day precipitation accumulation
Contours drawn at intervals of 1 inch
46
42
38
82
78
74
70

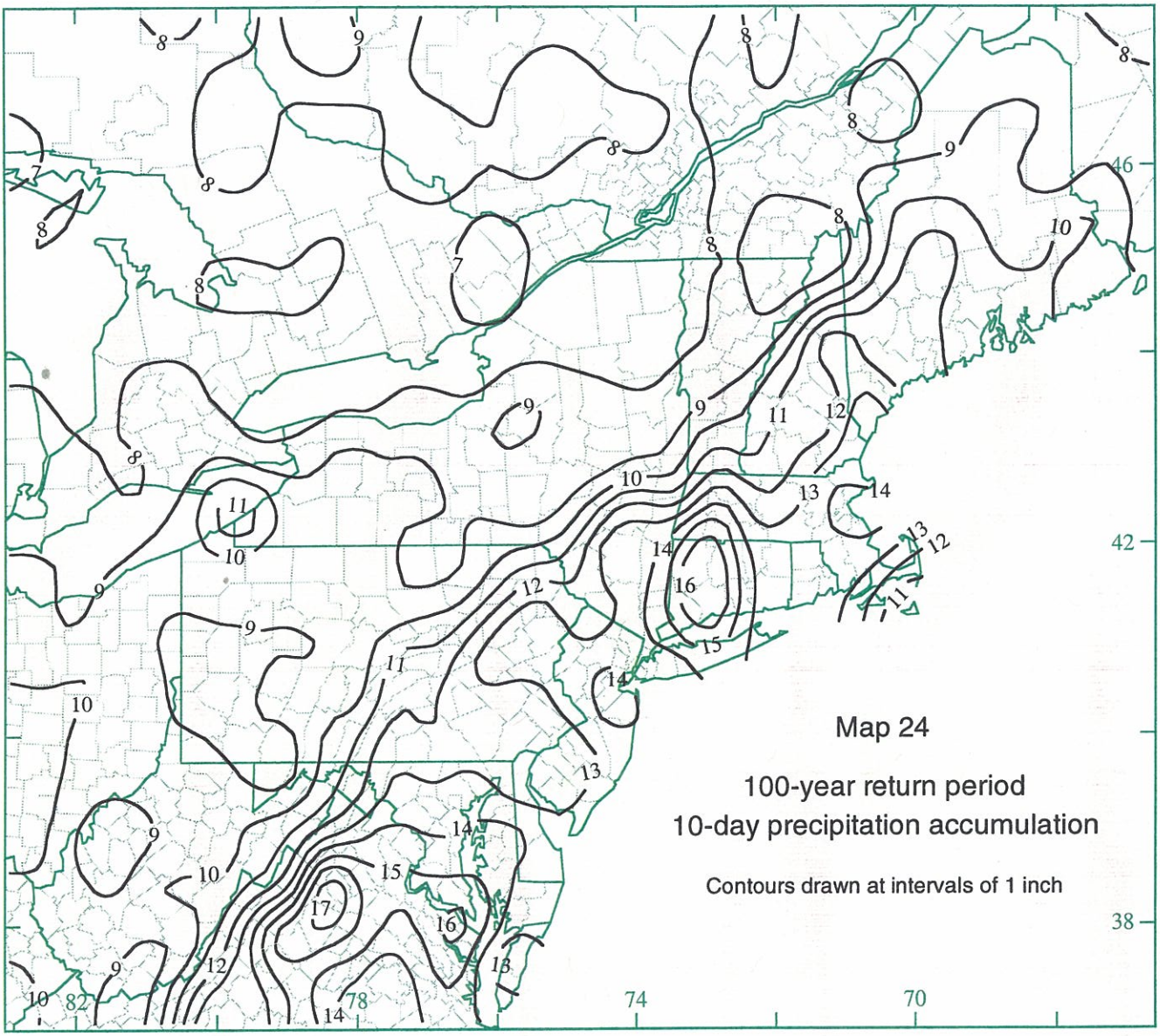

Map 19
2-year return period
10-day precipitation accumulation
Contours drawn at intervals of 0.25 inch
46
42
38
82
78
74
70


Map 20
5-year return period
10-day precipitation accumulation
Contours drawn at intervals of 0.5 inch
46
42
38
82
78
74
70


Map 21
10-year return period
10-day precipitation accumulation
Contours drawn at intervals of 0.5 inch
46
42
38
82
78
74
70


Map 22
25-year return period
10-day precipitation accumulation
Contours drawn at intervals of 1 inch
46
42
38
82
78
74
70


Map 23
50-year return period
10-day precipitation accumulation
Contours drawn at intervals of 1 inch
46
42
38
82
78
74
70


Map 24
100-year return period
10-day precipitation accumulation
Contours drawn at intervals of 1 inch
46
42
38
82
78
74
70

NRCC RESEARCH SERIES

Knapp, W.W. and K.L. Eggleston, *Some Impacts of Recent Climate Variability on the Northeast,* NRCC Research Publication RR 91-1.

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DeGaetano, A.T., K.L. Eggleston, and W.W. Knapp, *Daily Solar Radiation Estimates for the Northeastern United States,* NRCC Research Publication RR 93-4.

NRCC DIGITAL DATA SETS

Eggleston, K.L. and D.S. Wilks, *Gridded Monthly Precipitation Distribution Parameters for the Continental United States,* NRCC Data Set DS 92-1.

Cember, R.P., K.L. Eggleston, and D.S. Wilks, *Digital Snowfall and Snow Depth Probabilities for the Northeastern United States and Southeastern Canada,* NRCC Data Set DS 93-1.

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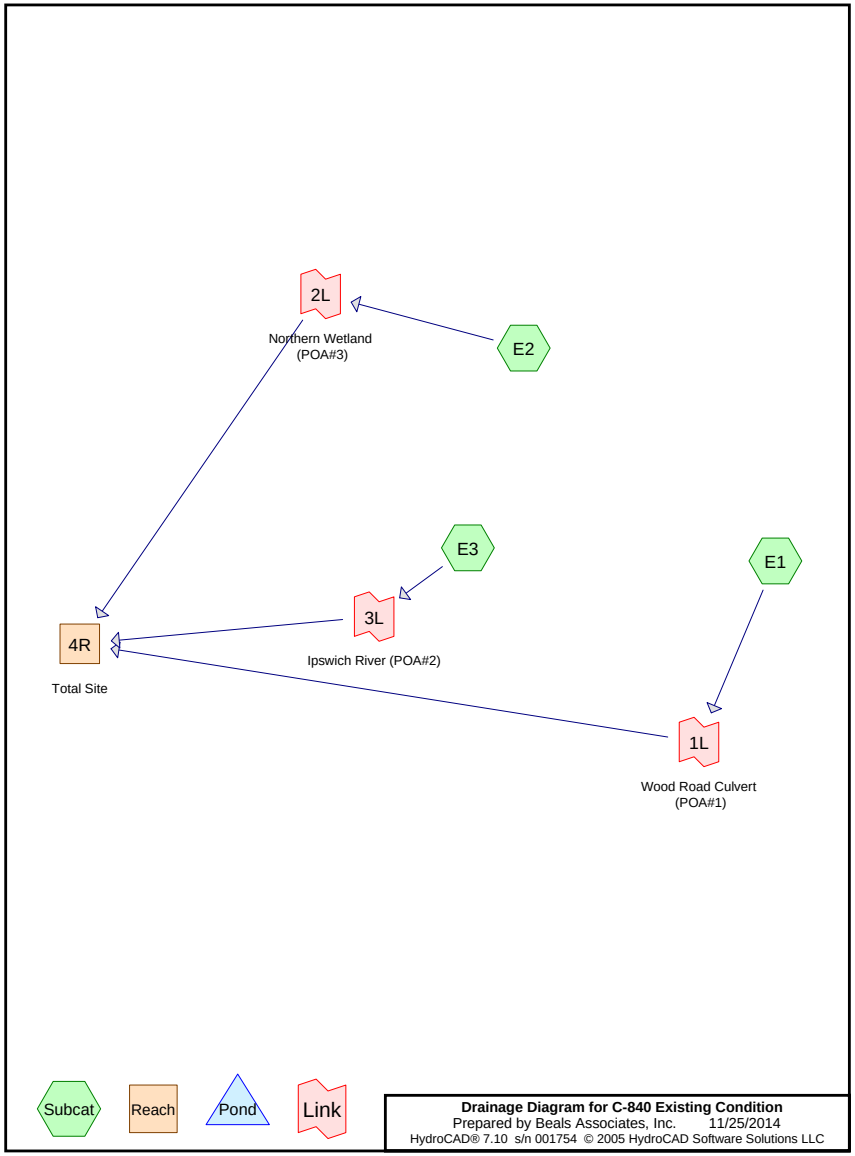
Ithaca, New York 14853

Produced by
Northeast Regional Climate Center
4/99 2C/6C 125-8365

Appendix F

Runoff Calculations - Existing



Time span=0.00-30.00 hrs, dt=0.05 hrs, 601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment E1: Runoff Area=266,375 sf Runoff Depth=0.16"
Flow Length=627' Tc=34.2 min CN=52 Runoff=0.18 cfs 3,582 cf

Subcatchment E2: Runoff Area=179,265 sf Runoff Depth=0.00"
Flow Length=701' Tc=26.2 min CN=34 Runoff=0.00 cfs 0 cf

Subcatchment E3: Runoff Area=256,905 sf Runoff Depth=0.00"
Flow Length=368' Tc=16.6 min CN=32 Runoff=0.00 cfs 0 cf

Reach 4R: Total Site Inflow=0.18 cfs 3,582 cf
Outflow=0.18 cfs 3,582 cf

Link 1L: Wood Road Culvert (POA#1) Inflow=0.18 cfs 3,582 cf
Primary=0.18 cfs 3,582 cf

Link 2L: Northern Wetland (POA#3) Inflow=0.00 cfs 0 cf
Primary=0.00 cfs 0 cf

Link 3L: Ipswich River (POA#2) Inflow=0.00 cfs 0 cf
Primary=0.00 cfs 0 cf

Total Runoff Area = 702,545 sf Runoff Volume = 3,582 cf Average Runoff Depth = 0.06"

Subcatchment E1:

Runoff = 0.18 cfs @ 12.92 hrs, Volume= 3,582 cf, Depth= 0.16"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.15"

Area (sf)	CN	Description
87,667	30	Meadow, non-grazed, HSG A
103,137	58	Meadow, non-grazed, HSG B
75,571	71	Meadow, non-grazed, HSG C
266,375	52	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.3	100	0.0060	0.1		**Sheet Flow, A to B** Grass: Dense n= 0.240 P2= 3.15"
5.2	227	0.0110	0.7		**Shallow Concentrated Flow, B to C** Short Grass Pasture Kv= 7.0 fps
5.7	300	0.0230	0.9	0.01	**Trap/Vee/Rect Channel Flow, C to POA1** Bot.W=0.10' D=0.10' Z= 0.0 & 0.5 '/' Top.W=0.15' n= 0.030 Earth, grassed & winding
34.2	627	Total			

Subcatchment E2:

[45] Hint: Runoff=Zero

Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.15"

Area (sf)	CN	Description
157,790	30	Meadow, non-grazed, HSG A
16,611	58	Meadow, non-grazed, HSG B
4,864	71	Meadow, non-grazed, HSG C
179,265	34	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
19.0	100	0.0100	0.1		**Sheet Flow, A to B** Grass: Dense n= 0.240 P2= 3.15"
7.2	601	0.0400	1.4		**Shallow Concentrated Flow, B to POA 2** Short Grass Pasture Kv= 7.0 fps
26.2	701	Total			

Subcatchment E3:

[45] Hint: Runoff=Zero

Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.15"

Area (sf)	CN	Description
246,482	30	Meadow, non-grazed, HSG A
10,423	78	Meadow, non-grazed, HSG D
256,905	32	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.4	100	0.0200	0.1		**Sheet Flow, A to B** Grass: Dense n= 0.240 P2= 3.15"
2.2	268	0.0828	2.0		**Shallow Concentrated Flow, B to POA 3** Short Grass Pasture Kv= 7.0 fps
16.6	368	Total			

Reach 4R: Total Site

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 702,545 sf, Inflow Depth = 0.06" for 2 yr event
Inflow = 0.18 cfs @ 12.92 hrs, Volume= 3,582 cf
Outflow = 0.18 cfs @ 12.92 hrs, Volume= 3,582 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Link 1L: Wood Road Culvert (POA#1)

Inflow Area = 266,375 sf, Inflow Depth = 0.16" for 2 yr event
Inflow = 0.18 cfs @ 12.92 hrs, Volume= 3,582 cf
Primary = 0.18 cfs @ 12.92 hrs, Volume= 3,582 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Link 2L: Northern Wetland (POA#3)

Inflow Area = 179,265 sf, Inflow Depth = 0.00" for 2 yr event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Link 3L: Ipswich River (POA#2)

Inflow Area = 256,905 sf, Inflow Depth = 0.00" for 2 yr event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Time span=0.00-30.00 hrs, dt=0.05 hrs, 601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment E1: Runoff Area=266,375 sf Runoff Depth=0.67"
Flow Length=627' Tc=34.2 min CN=52 Runoff=1.78 cfs 14,868 cf

Subcatchment E2: Runoff Area=179,265 sf Runoff Depth=0.03"
Flow Length=701' Tc=26.2 min CN=34 Runoff=0.02 cfs 482 cf

Subcatchment E3: Runoff Area=256,905 sf Runoff Depth=0.01"
Flow Length=368' Tc=16.6 min CN=32 Runoff=0.01 cfs 191 cf

Reach 4R: Total Site Inflow=1.78 cfs 15,541 cf
Outflow=1.78 cfs 15,541 cf

Link 1L: Wood Road Culvert (POA#1) Inflow=1.78 cfs 14,868 cf
Primary=1.78 cfs 14,868 cf

Link 2L: Northern Wetland (POA#3) Inflow=0.02 cfs 482 cf
Primary=0.02 cfs 482 cf

Link 3L: Ipswich River (POA#2) Inflow=0.01 cfs 191 cf
Primary=0.01 cfs 191 cf

Total Runoff Area = 702,545 sf Runoff Volume = 15,541 cf Average Runoff Depth = 0.27"

Subcatchment E1:

Runoff = 1.78 cfs @ 12.62 hrs, Volume= 14,868 cf, Depth= 0.67"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.69"

Area (sf)	CN	Description
87,667	30	Meadow, non-grazed, HSG A
103,137	58	Meadow, non-grazed, HSG B
75,571	71	Meadow, non-grazed, HSG C
266,375	52	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.3	100	0.0060	0.1		**Sheet Flow, A to B** Grass: Dense n= 0.240 P2= 3.15"
5.2	227	0.0110	0.7		**Shallow Concentrated Flow, B to C** Short Grass Pasture Kv= 7.0 fps
5.7	300	0.0230	0.9	0.01	**Trap/Vee/Rect Channel Flow, C to POA1** Bot.W=0.10' D=0.10' Z= 0.0 & 0.5 '/' Top.W=0.15' n= 0.030 Earth, grassed & winding
34.2	627	Total			

Subcatchment E2:

Runoff = 0.02 cfs @ 17.48 hrs, Volume= 482 cf, Depth= 0.03"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.69"

Area (sf)	CN	Description
157,790	30	Meadow, non-grazed, HSG A
16,611	58	Meadow, non-grazed, HSG B
4,864	71	Meadow, non-grazed, HSG C
179,265	34	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
19.0	100	0.0100	0.1		**Sheet Flow, A to B** Grass: Dense n= 0.240 P2= 3.15"
7.2	601	0.0400	1.4		**Shallow Concentrated Flow, B to POA 2** Short Grass Pasture Kv= 7.0 fps
26.2	701	Total			

Subcatchment E3:

Runoff = 0.01 cfs @ 23.07 hrs, Volume= 191 cf, Depth= 0.01"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.69"

Area (sf)	CN	Description
246,482	30	Meadow, non-grazed, HSG A
10,423	78	Meadow, non-grazed, HSG D
256,905	32	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.4	100	0.0200	0.1		**Sheet Flow, A to B** Grass: Dense n= 0.240 P2= 3.15"
2.2	268	0.0828	2.0		**Shallow Concentrated Flow, B to POA 3** Short Grass Pasture Kv= 7.0 fps
16.6	368	Total			

Reach 4R: Total Site

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 702,545 sf, Inflow Depth = 0.27" for 10 yr event
Inflow = 1.78 cfs @ 12.62 hrs, Volume= 15,541 cf
Outflow = 1.78 cfs @ 12.62 hrs, Volume= 15,541 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Link 1L: Wood Road Culvert (POA#1)

Inflow Area = 266,375 sf, Inflow Depth = 0.67" for 10 yr event
Inflow = 1.78 cfs @ 12.62 hrs, Volume= 14,868 cf
Primary = 1.78 cfs @ 12.62 hrs, Volume= 14,868 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Link 2L: Northern Wetland (POA#3)

Inflow Area = 179,265 sf, Inflow Depth = 0.03" for 10 yr event
Inflow = 0.02 cfs @ 17.48 hrs, Volume= 482 cf
Primary = 0.02 cfs @ 17.48 hrs, Volume= 482 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Link 3L: Ipswich River (POA#2)

Inflow Area = 256,905 sf, Inflow Depth = 0.01" for 10 yr event
Inflow = 0.01 cfs @ 23.07 hrs, Volume= 191 cf
Primary = 0.01 cfs @ 23.07 hrs, Volume= 191 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Time span=0.00-30.00 hrs, dt=0.05 hrs, 601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment E1: Runoff Area=266,375 sf Runoff Depth=1.22"
Flow Length=627' Tc=34.2 min CN=52 Runoff=3.85 cfs 27,002 cf

Subcatchment E2: Runoff Area=179,265 sf Runoff Depth=0.18"
Flow Length=701' Tc=26.2 min CN=34 Runoff=0.10 cfs 2,732 cf

Subcatchment E3: Runoff Area=256,905 sf Runoff Depth=0.11"
Flow Length=368' Tc=16.6 min CN=32 Runoff=0.09 cfs 2,428 cf

Reach 4R: Total Site Inflow=3.86 cfs 32,161 cf
Outflow=3.86 cfs 32,161 cf

Link 1L: Wood Road Culvert (POA#1) Inflow=3.85 cfs 27,002 cf
Primary=3.85 cfs 27,002 cf

Link 2L: Northern Wetland (POA#3) Inflow=0.10 cfs 2,732 cf
Primary=0.10 cfs 2,732 cf

Link 3L: Ipswich River (POA#2) Inflow=0.09 cfs 2,428 cf
Primary=0.09 cfs 2,428 cf

Total Runoff Area = 702,545 sf Runoff Volume = 32,161 cf Average Runoff Depth = 0.55"

Subcatchment E1:

Runoff = 3.85 cfs @ 12.56 hrs, Volume= 27,002 cf, Depth= 1.22"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.86"

Area (sf)	CN	Description
87,667	30	Meadow, non-grazed, HSG A
103,137	58	Meadow, non-grazed, HSG B
75,571	71	Meadow, non-grazed, HSG C
266,375	52	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.3	100	0.0060	0.1		**Sheet Flow, A to B** Grass: Dense n= 0.240 P2= 3.15"
5.2	227	0.0110	0.7		**Shallow Concentrated Flow, B to C** Short Grass Pasture Kv= 7.0 fps
5.7	300	0.0230	0.9	0.01	**Trap/Vee/Rect Channel Flow, C to POA1** Bot.W=0.10' D=0.10' Z= 0.0 & 0.5 '/' Top.W=0.15' n= 0.030 Earth, grassed & winding
34.2	627	Total			

Subcatchment E2:

Runoff = 0.10 cfs @ 14.05 hrs, Volume= 2,732 cf, Depth= 0.18"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.86"

Area (sf)	CN	Description
157,790	30	Meadow, non-grazed, HSG A
16,611	58	Meadow, non-grazed, HSG B
4,864	71	Meadow, non-grazed, HSG C
179,265	34	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
19.0	100	0.0100	0.1		**Sheet Flow, A to B** Grass: Dense n= 0.240 P2= 3.15"
7.2	601	0.0400	1.4		**Shallow Concentrated Flow, B to POA 2** Short Grass Pasture Kv= 7.0 fps
26.2	701	Total			

Subcatchment E3:

Runoff = 0.09 cfs @ 15.15 hrs, Volume= 2,428 cf, Depth= 0.11"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.86"

Area (sf)	CN	Description
246,482	30	Meadow, non-grazed, HSG A
10,423	78	Meadow, non-grazed, HSG D
256,905	32	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.4	100	0.0200	0.1		**Sheet Flow, A to B** Grass: Dense n= 0.240 P2= 3.15"
2.2	268	0.0828	2.0		**Shallow Concentrated Flow, B to POA 3** Short Grass Pasture Kv= 7.0 fps
16.6	368	Total			

Reach 4R: Total Site

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 702,545 sf, Inflow Depth = 0.55" for 25 yr event
Inflow = 3.86 cfs @ 12.57 hrs, Volume= 32,161 cf
Outflow = 3.86 cfs @ 12.57 hrs, Volume= 32,161 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Link 1L: Wood Road Culvert (POA#1)

Inflow Area = 266,375 sf, Inflow Depth = 1.22" for 25 yr event
Inflow = 3.85 cfs @ 12.56 hrs, Volume= 27,002 cf
Primary = 3.85 cfs @ 12.56 hrs, Volume= 27,002 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Link 2L: Northern Wetland (POA#3)

Inflow Area = 179,265 sf, Inflow Depth = 0.18" for 25 yr event
Inflow = 0.10 cfs @ 14.05 hrs, Volume= 2,732 cf
Primary = 0.10 cfs @ 14.05 hrs, Volume= 2,732 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Link 3L: Ipswich River (POA#2)

Inflow Area = 256,905 sf, Inflow Depth = 0.11" for 25 yr event
Inflow = 0.09 cfs @ 15.15 hrs, Volume= 2,428 cf
Primary = 0.09 cfs @ 15.15 hrs, Volume= 2,428 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Time span=0.00-30.00 hrs, dt=0.05 hrs, 601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment E1: Runoff Area=266,375 sf Runoff Depth=2.65"
Flow Length=627' Tc=34.2 min CN=52 Runoff=9.51 cfs 58,804 cf

Subcatchment E2: Runoff Area=179,265 sf Runoff Depth=0.82"
Flow Length=701' Tc=26.2 min CN=34 Runoff=1.27 cfs 12,184 cf

Subcatchment E3: Runoff Area=256,905 sf Runoff Depth=0.65"
Flow Length=368' Tc=16.6 min CN=32 Runoff=1.38 cfs 13,817 cf

Reach 4R: Total Site Inflow=12.13 cfs 84,805 cf
Outflow=12.13 cfs 84,805 cf

Link 1L: Wood Road Culvert (POA#1) Inflow=9.51 cfs 58,804 cf
Primary=9.51 cfs 58,804 cf

Link 2L: Northern Wetland (POA#3) Inflow=1.27 cfs 12,184 cf
Primary=1.27 cfs 12,184 cf

Link 3L: Ipswich River (POA#2) Inflow=1.38 cfs 13,817 cf
Primary=1.38 cfs 13,817 cf

Total Runoff Area = 702,545 sf Runoff Volume = 84,805 cf Average Runoff Depth = 1.45"

Subcatchment E1:

Runoff = 9.51 cfs @ 12.52 hrs, Volume= 58,804 cf, Depth= 2.65"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=8.29"

Area (sf)	CN	Description
87,667	30	Meadow, non-grazed, HSG A
103,137	58	Meadow, non-grazed, HSG B
75,571	71	Meadow, non-grazed, HSG C
266,375	52	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.3	100	0.0060	0.1		**Sheet Flow, A to B** Grass: Dense n= 0.240 P2= 3.15"
5.2	227	0.0110	0.7		**Shallow Concentrated Flow, B to C** Short Grass Pasture Kv= 7.0 fps
5.7	300	0.0230	0.9	0.01	**Trap/Vee/Rect Channel Flow, C to POA1** Bot.W=0.10' D=0.10' Z= 0.0 & 0.5 '/' Top.W=0.15' n= 0.030 Earth, grassed & winding
34.2	627	Total			

Subcatchment E2:

Runoff = 1.27 cfs @ 12.58 hrs, Volume= 12,184 cf, Depth= 0.82"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=8.29"

Area (sf)	CN	Description
157,790	30	Meadow, non-grazed, HSG A
16,611	58	Meadow, non-grazed, HSG B
4,864	71	Meadow, non-grazed, HSG C
179,265	34	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
19.0	100	0.0100	0.1		**Sheet Flow, A to B** Grass: Dense n= 0.240 P2= 3.15"
7.2	601	0.0400	1.4		**Shallow Concentrated Flow, B to POA 2** Short Grass Pasture Kv= 7.0 fps
26.2	701	Total			

Subcatchment E3:

Runoff = 1.38 cfs @ 12.50 hrs, Volume= 13,817 cf, Depth= 0.65"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=8.29"

Area (sf)	CN	Description
246,482	30	Meadow, non-grazed, HSG A
10,423	78	Meadow, non-grazed, HSG D
256,905	32	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.4	100	0.0200	0.1		**Sheet Flow, A to B** Grass: Dense n= 0.240 P2= 3.15"
2.2	268	0.0828	2.0		**Shallow Concentrated Flow, B to POA 3** Short Grass Pasture Kv= 7.0 fps
16.6	368	Total			

Reach 4R: Total Site

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 702,545 sf, Inflow Depth = 1.45" for 100 yr event
Inflow = 12.13 cfs @ 12.52 hrs, Volume= 84,805 cf
Outflow = 12.13 cfs @ 12.52 hrs, Volume= 84,805 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Link 1L: Wood Road Culvert (POA#1)

Inflow Area = 266,375 sf, Inflow Depth = 2.65" for 100 yr event
Inflow = 9.51 cfs @ 12.52 hrs, Volume= 58,804 cf
Primary = 9.51 cfs @ 12.52 hrs, Volume= 58,804 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Link 2L: Northern Wetland (POA#3)

Inflow Area = 179,265 sf, Inflow Depth = 0.82" for 100 yr event
Inflow = 1.27 cfs @ 12.58 hrs, Volume= 12,184 cf
Primary = 1.27 cfs @ 12.58 hrs, Volume= 12,184 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

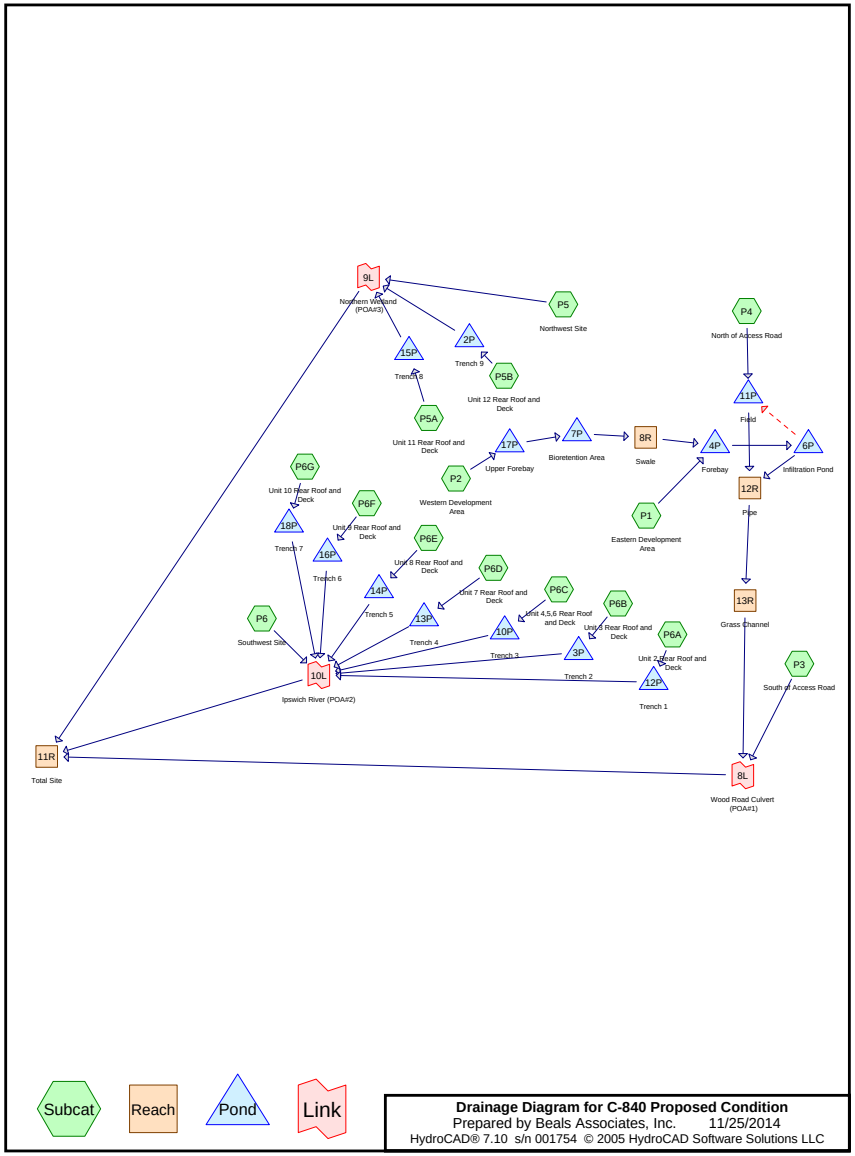
Link 3L: Ipswich River (POA#2)

Inflow Area = 256,905 sf, Inflow Depth = 0.65" for 100 yr event
Inflow = 1.38 cfs @ 12.50 hrs, Volume= 13,817 cf
Primary = 1.38 cfs @ 12.50 hrs, Volume= 13,817 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Appendix G

Runoff Calculations - Proposed



Drainage Diagram for C-840 Proposed Condition
Prepared by Beals Associates, Inc. 11/25/2014
HydroCAD® 7.10 s/n 001754 © 2005 HydroCAD Software Solutions LLC

Time span=0.00-30.00 hrs, dt=0.05 hrs, 601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment P1: Eastern Development Area Runoff Area=46,973 sf Runoff Depth=0.95"
Flow Length=394' Tc=19.9 min CN=73 Runoff=0.75 cfs 3,723 cf

Subcatchment P2: Western Development Area Runoff Area=62,740 sf Runoff Depth=1.18"
Flow Length=401' Tc=15.3 min CN=77 Runoff=1.43 cfs 6,150 cf

Subcatchment P3: South of Access Road Runoff Area=87,233 sf Runoff Depth=0.08"
Flow Length=278' Tc=13.6 min CN=48 Runoff=0.02 cfs 595 cf

Subcatchment P4: North of Access Road Runoff Area=136,212 sf Runoff Depth=0.29"
Flow Length=262' Tc=25.5 min CN=57 Runoff=0.34 cfs 3,329 cf

Subcatchment P5: Northwest Site Runoff Area=137,163 sf Runoff Depth=0.00"
Flow Length=549' Tc=21.8 min CN=36 Runoff=0.00 cfs 0 cf

Subcatchment P5A: Unit 11 Rear Roof and Deck Runoff Area=1,554 sf Runoff Depth=2.92"
Flow Length=25' Tc=6.0 min CN=98 Runoff=0.11 cfs 378 cf

Subcatchment P5B: Unit 12 Rear Roof and Deck Runoff Area=1,554 sf Runoff Depth=2.92"
Tc=0.0 min CN=98 Runoff=0.12 cfs 378 cf

Subcatchment P6: Southwest Site Runoff Area=215,576 sf Runoff Depth=0.00"
Flow Length=234' Tc=10.9 min CN=34 Runoff=0.00 cfs 0 cf

Subcatchment P6A: Unit 2 Rear Roof and Deck Runoff Area=1,554 sf Runoff Depth=2.92"
Flow Length=25' Tc=6.0 min CN=98 Runoff=0.11 cfs 378 cf

Subcatchment P6B: Unit 3 Rear Roof and Deck Runoff Area=1,554 sf Runoff Depth=2.92"
Flow Length=25' Tc=6.0 min CN=98 Runoff=0.11 cfs 378 cf

Subcatchment P6C: Unit 4,5,6 Rear Roof and Deck Runoff Area=3,110 sf Runoff Depth=2.92"
Flow Length=25' Tc=6.0 min CN=98 Runoff=0.21 cfs 756 cf

Subcatchment P6D: Unit 7 Rear Roof and Deck Runoff Area=1,554 sf Runoff Depth=2.92"
Flow Length=25' Tc=6.0 min CN=98 Runoff=0.11 cfs 378 cf

Subcatchment P6E: Unit 8 Rear Roof and Deck Runoff Area=1,554 sf Runoff Depth=2.92"
Flow Length=25' Tc=6.0 min CN=98 Runoff=0.11 cfs 378 cf

Subcatchment P6F: Unit 9 Rear Roof and Deck Runoff Area=1,554 sf Runoff Depth=2.92"
Tc=0.0 min CN=98 Runoff=0.12 cfs 378 cf

Subcatchment P6G: Unit 10 Rear Roof and Deck Runoff Area=1,554 sf Runoff Depth=2.92"
Tc=0.0 min CN=98 Runoff=0.12 cfs 378 cf

Reach 8R: Swale Peak Depth=0.08' Max Vel=1.4 fps Inflow=0.37 cfs 746 cf
n=0.035 L=292.0' S=0.0334 '/' Capacity=34.69 cfs Outflow=0.34 cfs 746 cf

Reach 11R: Total Site Inflow=0.24 cfs 3,943 cf
Outflow=0.24 cfs 3,943 cf

Reach 12R: Pipe Peak Depth=0.13' Max Vel=3.1 fps Inflow=0.23 cfs 3,348 cf
D=18.0" n=0.011 L=95.0' S=0.0151 '/' Capacity=15.23 cfs Outflow=0.23 cfs 3,348 cf

Reach 13R: Grass Channel Peak Depth=0.06' Max Vel=0.8 fps Inflow=0.23 cfs 3,348 cf
n=0.035 L=240.0' S=0.0167 '/' Capacity=23.29 cfs Outflow=0.23 cfs 3,348 cf

Pond 2P: Trench 9 Peak Elev=7.98' Storage=100 cf Inflow=0.12 cfs 378 cf
Discarded=0.02 cfs 378 cf Primary=0.00 cfs 0 cf Outflow=0.02 cfs 378 cf

Pond 3P: Trench 2 Peak Elev=7.98' Storage=100 cf Inflow=0.11 cfs 378 cf
Discarded=0.02 cfs 378 cf Primary=0.00 cfs 0 cf Outflow=0.02 cfs 378 cf

Pond 4P: Forebay Peak Elev=43.59' Storage=428 cf Inflow=0.75 cfs 4,468 cf
Discarded=0.01 cfs 652 cf Primary=0.95 cfs 3,604 cf Outflow=0.96 cfs 4,255 cf

Pond 6P: Infiltration Pond Peak Elev=39.67' Storage=2,278 cf Inflow=0.95 cfs 3,604 cf
Discarded=0.05 cfs 3,206 cf Primary=0.00 cfs 22 cf Secondary=0.00 cfs 0 cf Outflow=0.06 cfs 3,228 cf

Pond 7P: Bioretention Area Peak Elev=54.56' Storage=1,862 cf Inflow=1.42 cfs 4,295 cf
Discarded=0.10 cfs 3,549 cf Primary=0.37 cfs 746 cf Outflow=0.47 cfs 4,295 cf

Pond 10P: Trench 3 Peak Elev=7.57' Storage=168 cf Inflow=0.21 cfs 756 cf
Discarded=0.05 cfs 756 cf Primary=0.00 cfs 0 cf Outflow=0.05 cfs 756 cf

Pond 11P: Field Peak Elev=40.22' Storage=337 cf Inflow=0.34 cfs 3,329 cf
12.0" x 18.0' Culvert Outflow=0.23 cfs 3,326 cf

Pond 12P: Trench 1 Peak Elev=7.76' Storage=100 cf Inflow=0.11 cfs 378 cf
Discarded=0.02 cfs 378 cf Primary=0.00 cfs 0 cf Outflow=0.02 cfs 378 cf

Pond 13P: Trench 4 Peak Elev=7.91' Storage=98 cf Inflow=0.11 cfs 378 cf
Discarded=0.02 cfs 378 cf Primary=0.00 cfs 0 cf Outflow=0.02 cfs 378 cf

Pond 14P: Trench 5 Peak Elev=7.97' Storage=100 cf Inflow=0.11 cfs 378 cf
Discarded=0.02 cfs 378 cf Primary=0.00 cfs 0 cf Outflow=0.02 cfs 378 cf

Pond 15P: Trench 8 Peak Elev=8.23' Storage=106 cf Inflow=0.11 cfs 378 cf
Discarded=0.02 cfs 378 cf Primary=0.00 cfs 0 cf Outflow=0.02 cfs 378 cf

Pond 16P: Trench 6 Peak Elev=7.58' Storage=85 cf Inflow=0.12 cfs 378 cf
Discarded=0.03 cfs 378 cf Primary=0.00 cfs 0 cf Outflow=0.03 cfs 378 cf

Pond 17P: Upper Forebay Peak Elev=54.86' Storage=583 cf Inflow=1.43 cfs 6,150 cf
Discarded=0.03 cfs 1,743 cf Primary=1.42 cfs 4,295 cf Outflow=1.46 cfs 6,037 cf

Pond 18P: Trench 7 Peak Elev=7.58' Storage=85 cf Inflow=0.12 cfs 378 cf
Discarded=0.03 cfs 378 cf Primary=0.00 cfs 0 cf Outflow=0.03 cfs 378 cf

Link 8L: Wood Road Culvert (POA#1) Inflow=0.24 cfs 3,943 cf
Primary=0.24 cfs 3,943 cf

Link 9L: Northern Wetland (POA#3) Inflow=0.00 cfs 0 cf
Primary=0.00 cfs 0 cf

Link 10L: Ipswich River (POA#2) Inflow=0.00 cfs 0 cf
Primary=0.00 cfs 0 cf

Total Runoff Area = 701,439 sf Runoff Volume = 17,575 cf Average Runoff Depth = 0.30"

Subcatchment P1: Eastern Development Area

Runoff = 0.75 cfs @ 12.30 hrs, Volume= 3,723 cf, Depth= 0.95"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.15"

Area (sf)	CN	Description
19,843	98	Paved parking & roofs
13,827	39	>75% Grass cover, Good, HSG A
2,370	61	>75% Grass cover, Good, HSG B
10,933	74	>75% Grass cover, Good, HSG C
46,973	73	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.9	77	0.0129	0.1		**Sheet Flow, A to B** Grass: Dense n= 0.240 P2= 3.15"
0.1	5	0.0150	0.7		**Sheet Flow, B to C** Smooth surfaces n= 0.011 P2= 3.15"
1.2	4	0.0150	0.1		**Sheet Flow, C to D** Grass: Dense n= 0.240 P2= 3.15"
0.2	14	0.0285	1.1		**Sheet Flow, D to E** Smooth surfaces n= 0.011 P2= 3.15"
0.1	32	0.1150	6.9		**Shallow Concentrated Flow, E to F** Paved Kv= 20.3 fps
4.4	262	0.0460	1.0	5.95	**Channel Flow, F to G** Area= 6.0 sf Perim= 9.3' r= 0.65' n= 0.240 Sheet flow over Dense Grass
19.9	394	Total			

Subcatchment P2: Western Development Area

Runoff = 1.43 cfs @ 12.22 hrs, Volume= 6,150 cf, Depth= 1.18"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.15"

Area (sf)	CN	Description
40,549	98	Paved parking & roofs
22,191	39	>75% Grass cover, Good, HSG A
62,740	77	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	98	0.0224	0.1		**Sheet Flow, A to B** Grass: Dense n= 0.240 P2= 3.15"
1.2	160	0.0112	2.1		**Shallow Concentrated Flow, B to C** Paved Kv= 20.3 fps
0.6	143	0.0210	4.1	0.81	**Circular Channel (pipe), C to D** Diam= 6.0" Area= 0.2 sf Perim= 1.6' r= 0.13' n= 0.013 Corrugated PE, smooth interior
15.3	401	Total			

Subcatchment P3: South of Access Road

Runoff = 0.02 cfs @ 14.76 hrs, Volume= 595 cf, Depth= 0.08"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.15"

Area (sf)	CN	Description
32,400	30	Meadow, non-grazed, HSG A
50,084	58	Meadow, non-grazed, HSG B
4,749	71	Meadow, non-grazed, HSG C
87,233	48	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.6	25	0.3200	0.3		**Sheet Flow, A to B** Grass: Dense n= 0.240 P2= 3.15"
8.7	75	0.0400	0.1		**Sheet Flow, B to C** Grass: Dense n= 0.240 P2= 3.15"
3.3	178	0.0168	0.9		**Shallow Concentrated Flow, C to D** Short Grass Pasture Kv= 7.0 fps
13.6	278	Total			

Subcatchment P4: North of Access Road

Runoff = 0.34 cfs @ 12.58 hrs, Volume= 3,329 cf, Depth= 0.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.15"

Area (sf)	CN	Description
31,204	30	Meadow, non-grazed, HSG A
48,458	58	Meadow, non-grazed, HSG B
56,550	71	Meadow, non-grazed, HSG C
136,212	57	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.3	100	0.0060	0.1		**Sheet Flow, A to B** Grass: Dense n= 0.240 P2= 3.15"
2.2	162	0.0310	1.2		**Shallow Concentrated Flow, B to C** Short Grass Pasture Kv= 7.0 fps
25.5	262	Total			

Subcatchment P5: Northwest Site

[45] Hint: Runoff=Zero

Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.15"

Area (sf)	CN	Description
102,199	30	Meadow, non-grazed, HSG A
16,611	58	Meadow, non-grazed, HSG B
5,517	71	Meadow, non-grazed, HSG C
12,836	39	>75% Grass cover, Good, HSG A
137,163	36	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.6	100	0.0120	0.1		**Sheet Flow, A to B** Grass: Dense n= 0.240 P2= 3.15"
4.2	449	0.0660	1.8		**Shallow Concentrated Flow, B to POA 3** Short Grass Pasture Kv= 7.0 fps
21.8	549	Total			

Subcatchment P5A: Unit 11 Rear Roof and Deck

Runoff = 0.11 cfs @ 12.09 hrs, Volume= 378 cf, Depth= 2.92"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.15"

Area (sf)	CN	Description
1,554	98	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.2	25	0.2000	2.6		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.15"
0.2	25	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P5B: Unit 12 Rear Roof and Deck

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 0.12 cfs @ 12.00 hrs, Volume= 378 cf, Depth= 2.92"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.15"

Area (sf)	CN	Description
1,554	98	

Subcatchment P6: Southwest Site

[45] Hint: Runoff=Zero

Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.15"

Area (sf)	CN	Description
172,547	30	Meadow, non-grazed, HSG A
11,073	78	Meadow, non-grazed, HSG D
31,956	39	>75% Grass cover, Good, HSG A
215,576	34	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.4	22	0.3180	0.3		**Sheet Flow, A to B** Grass: Dense n= 0.240 P2= 3.15"
8.3	50	0.0200	0.1		**Sheet Flow, B to C** Grass: Dense n= 0.240 P2= 3.15"
1.2	162	0.1046	2.3		**Shallow Concentrated Flow, C to POA #3** Short Grass Pasture Kv= 7.0 fps
10.9	234	Total			

Subcatchment P6A: Unit 2 Rear Roof and Deck

Runoff = 0.11 cfs @ 12.09 hrs, Volume= 378 cf, Depth= 2.92"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.15"

Area (sf)	CN	Description
1,554	98	Paved parking & roofs

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.2	25	0.2000	2.6		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.15"
0.2	25	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P6B: Unit 3 Rear Roof and Deck

Runoff = 0.11 cfs @ 12.09 hrs, Volume= 378 cf, Depth= 2.92"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.15"

Area (sf)	CN	Description
1,554	98	Paved parking & roofs

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.2	25	0.2000	2.6		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.15"
0.2	25	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P6C: Unit 4,5,6 Rear Roof and Deck

Runoff = 0.21 cfs @ 12.09 hrs, Volume= 756 cf, Depth= 2.92"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.15"

Area (sf)	CN	Description
3,110	98	Paved parking & roofs

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.2	25	0.2000	2.6		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.15"
0.2	25	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P6D: Unit 7 Rear Roof and Deck

Runoff = 0.11 cfs @ 12.09 hrs, Volume= 378 cf, Depth= 2.92"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.15"

Area (sf)	CN	Description
1,554	98	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.2	25	0.2000	2.6		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.15"
0.2	25	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P6E: Unit 8 Rear Roof and Deck

Runoff = 0.11 cfs @ 12.09 hrs, Volume= 378 cf, Depth= 2.92"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.15"

Area (sf)	CN	Description
1,554	98	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.2	25	0.2000	2.6		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.15"
0.2	25	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P6F: Unit 9 Rear Roof and Deck

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 0.12 cfs @ 12.00 hrs, Volume= 378 cf, Depth= 2.92"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.15"

Area (sf)	CN	Description
1,554	98	

Subcatchment P6G: Unit 10 Rear Roof and Deck

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 0.12 cfs @ 12.00 hrs, Volume= 378 cf, Depth= 2.92"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.15"

Area (sf)	CN	Description
1,554	98	

Reach 8R: Swale

[65] Warning: Inlet elevation not specified

Inflow Area = 62,740 sf, Inflow Depth = 0.14" for 2 yr event
Inflow = 0.37 cfs @ 12.68 hrs, Volume= 746 cf
Outflow = 0.34 cfs @ 12.81 hrs, Volume= 746 cf, Atten= 9%, Lag= 7.9 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.4 fps, Min. Travel Time= 3.6 min
Avg. Velocity = 0.6 fps, Avg. Travel Time= 8.1 min

Peak Depth= 0.08' @ 12.74 hrs
Capacity at bank full= 34.69 cfs
3.00' x 1.00' deep channel, n= 0.035 High grass
Side Slope Z-value= 3.0 '/' Top Width= 9.00'
Length= 292.0' Slope= 0.0334 '/'

Reach 11R: Total Site

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 701,439 sf, Inflow Depth > 0.07" for 2 yr event
Inflow = 0.24 cfs @ 13.09 hrs, Volume= 3,943 cf
Outflow = 0.24 cfs @ 13.09 hrs, Volume= 3,943 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Reach 12R: Pipe

[52] Hint: Inlet conditions not evaluated
[81] Warning: Exceeded Pond 6P by 0.65' @ 12.60 hrs

Inflow Area = 245,925 sf, Inflow Depth > 0.16" for 2 yr event
Inflow = 0.23 cfs @ 12.92 hrs, Volume= 3,348 cf
Outflow = 0.23 cfs @ 12.93 hrs, Volume= 3,348 cf, Atten= 0%, Lag= 1.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.1 fps, Min. Travel Time= 0.5 min
Avg. Velocity = 1.7 fps, Avg. Travel Time= 0.9 min

Peak Depth= 0.13' @ 12.92 hrs
Capacity at bank full= 15.23 cfs
Inlet Invert= 39.53', Outlet Invert= 38.10'
18.0" Diameter Pipe, n= 0.011 Concrete pipe, straight & clean
Length= 95.0' Slope= 0.0151 '/'

Reach 13R: Grass Channel

Inflow Area = 245,925 sf, Inflow Depth > 0.16" for 2 yr event
Inflow = 0.23 cfs @ 12.93 hrs, Volume= 3,348 cf
Outflow = 0.23 cfs @ 13.08 hrs, Volume= 3,348 cf, Atten= 1%, Lag= 8.7 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 0.8 fps, Min. Travel Time= 5.0 min
Avg. Velocity = 0.4 fps, Avg. Travel Time= 9.6 min

Peak Depth= 0.06' @ 12.99 hrs
Capacity at bank full= 23.29 cfs
Inlet Invert= 36.00', Outlet Invert= 32.00'
5.00' x 1.00' deep channel, n= 0.035 High grass
Side Slope Z-value= 0.2 '/' Top Width= 5.40'
Length= 240.0' Slope= 0.0167 '/'

Pond 2P: Trench 9

Inflow Area = 1,554 sf, Inflow Depth = 2.92" for 2 yr event
Inflow = 0.12 cfs @ 12.00 hrs, Volume= 378 cf
Outflow = 0.02 cfs @ 12.42 hrs, Volume= 378 cf, Atten= 83%, Lag= 24.9 min
Discarded = 0.02 cfs @ 12.42 hrs, Volume= 378 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 7.98' @ 12.42 hrs Surf.Area= 256 sf Storage= 100 cf
Plug-Flow detention time= 29.6 min calculated for 377 cf (100% of inflow)
Center-of-Mass det. time= 29.5 min (780.7 - 751.2)

Volume	Invert	Avail.Storage	Storage Description
#1	7.00'	323 cf	**Custom Stage Data (Irregular)**Listed below (Recalc) 808 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
7.00	256	136.0	0	0	256
8.00	256	136.0	256	256	392
9.00	256	136.0	256	512	528
10.00	256	136.0	256	768	664
10.01	10,000	2,000.0	40	808	317,502

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**2.410 in/hr Exfiltration over Wetted area**
#2	Primary	10.00'	**10.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=0.02 cfs @ 12.42 hrs HW=7.98' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.02 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=7.00' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 3P: Trench 2

Inflow Area = 1,554 sf, Inflow Depth = 2.92" for 2 yr event
Inflow = 0.11 cfs @ 12.09 hrs, Volume= 378 cf
Outflow = 0.02 cfs @ 12.51 hrs, Volume= 378 cf, Atten= 80%, Lag= 25.4 min
Discarded = 0.02 cfs @ 12.51 hrs, Volume= 378 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 7.98' @ 12.51 hrs Surf.Area= 256 sf Storage= 100 cf
Plug-Flow detention time= 29.6 min calculated for 377 cf (100% of inflow)
Center-of-Mass det. time= 29.6 min (786.3 - 756.7)

Volume	Invert	Avail.Storage	Storage Description
#1	7.00'	607 cf	**Custom Stage Data (Irregular)** Listed below (Recalc) 1,519 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
7.00	256	136.0	0	0	256
8.00	256	136.0	256	256	392
9.00	256	136.0	256	512	528
10.00	256	136.0	256	768	664
10.10	20,000	3,000.0	751	1,519	715,389

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**2.410 in/hr Exfiltration over Wetted area**
#2	Primary	10.00'	**10.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=0.02 cfs @ 12.51 hrs HW=7.98' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.02 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=7.00' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 4P: Forebay

[88] Warning: Qout>Qin may require Finer Routing>1

Inflow Area = 109,713 sf, Inflow Depth = 0.49" for 2 yr event
Inflow = 0.75 cfs @ 12.30 hrs, Volume= 4,468 cf
Outflow = 0.96 cfs @ 12.26 hrs, Volume= 4,255 cf, Atten= 0%, Lag= 0.0 min
Discarded = 0.01 cfs @ 12.25 hrs, Volume= 652 cf
Primary = 0.95 cfs @ 12.26 hrs, Volume= 3,604 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 43.59' @ 12.25 hrs Surf.Area= 465 sf Storage= 428 cf
Plug-Flow detention time= 70.1 min calculated for 4,248 cf (95% of inflow)
Center-of-Mass det. time= 45.5 min (910.7 - 865.3)

Volume	Invert	Avail.Storage	Storage Description
#1	42.00'	646 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
42.00	119	0	0
43.00	293	206	206
44.00	586	440	646

Device	Routing	Invert	Outlet Devices
#1	Primary	43.50'	**15.0' long x 6.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.37 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
#2	Discarded	0.00'	**1.020 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.01 cfs @ 12.25 hrs HW=43.59' (Free Discharge)
└**2=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=0.82 cfs @ 12.26 hrs HW=43.58' (Free Discharge)
└**1=Broad-Crested Rectangular Weir** (Weir Controls 0.82 cfs @ 0.7 fps)

Pond 6P: Infiltration Pond

Inflow Area = 109,713 sf, Inflow Depth = 0.39" for 2 yr event
Inflow = 0.95 cfs @ 12.26 hrs, Volume= 3,604 cf
Outflow = 0.06 cfs @ 15.54 hrs, Volume= 3,228 cf, Atten= 94%, Lag= 196.8 min
Discarded = 0.05 cfs @ 15.54 hrs, Volume= 3,206 cf
Primary = 0.00 cfs @ 15.54 hrs, Volume= 22 cf
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 39.67' @ 15.54 hrs Surf.Area= 2,325 sf Storage= 2,278 cf
Plug-Flow detention time= 436.5 min calculated for 3,228 cf (90% of inflow)
Center-of-Mass det. time= 393.2 min (1,246.3 - 853.1)

Volume	Invert	Avail.Storage	Storage Description
#1	38.50'	18,402 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
38.50	1,459	0	0
39.00	1,957	854	854
40.00	2,510	2,234	3,088
41.00	3,120	2,815	5,903
42.00	3,786	3,453	9,356
43.00	4,509	4,148	13,503
44.00	5,289	4,899	18,402

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	39.63'	**4.0" Vert. Orifice/Grate** C= 0.600
#3	Primary	41.17'	**5.0" Vert. Orifice/Grate** C= 0.600
#4	Primary	42.60'	**2.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#5	Secondary	43.36'	**10.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Discarded OutFlow Max=0.05 cfs @ 15.54 hrs HW=39.67' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.05 cfs)

Primary OutFlow Max=0.00 cfs @ 15.54 hrs HW=39.67' (Free Discharge)
├**2=Orifice/Grate** (Orifice Controls 0.00 cfs @ 0.6 fps)
├**3=Orifice/Grate** (Controls 0.00 cfs)
└**4=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=38.50' (Free Discharge)
└**5=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 7P: Bioretention Area

Inflow Area =	62,740 sf,	Inflow Depth =	0.82"	for	2 yr event
Inflow =	1.42 cfs @	12.22 hrs,	Volume=	4,295 cf	
Outflow =	0.47 cfs @	12.68 hrs,	Volume=	4,295 cf,	Atten= 67%, Lag= 27.3 min
Discarded =	0.10 cfs @	12.68 hrs,	Volume=	3,549 cf	
Primary =	0.37 cfs @	12.68 hrs,	Volume=	746 cf	

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 54.56' @ 12.68 hrs Surf.Area= 1,828 sf Storage= 1,862 cf
Plug-Flow detention time= 191.1 min calculated for 4,295 cf (100% of inflow)
Center-of-Mass det. time= 191.0 min (1,009.3 - 818.3)

Volume	Invert	Avail.Storage	Storage Description
#1	53.00'	2,748 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
53.00	593	0	0
54.00	1,350	972	972
55.00	2,202	1,776	2,748

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	54.50'	**10.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Discarded OutFlow Max=0.10 cfs @ 12.68 hrs HW=54.56' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.10 cfs)

Primary OutFlow Max=0.37 cfs @ 12.68 hrs HW=54.56' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** (Weir Controls 0.37 cfs @ 0.6 fps)

Pond 10P: Trench 3

Inflow Area =	3,110 sf,	Inflow Depth =	2.92"	for	2 yr event
Inflow =	0.21 cfs @	12.09 hrs,	Volume=	756 cf	
Outflow =	0.05 cfs @	12.46 hrs,	Volume=	756 cf,	Atten= 75%, Lag= 22.4 min
Discarded =	0.05 cfs @	12.46 hrs,	Volume=	756 cf	
Primary =	0.00 cfs @	0.00 hrs,	Volume=	0 cf	

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 7.57' @ 12.46 hrs Surf.Area= 736 sf Storage= 168 cf
Plug-Flow detention time= 18.5 min calculated for 755 cf (100% of inflow)
Center-of-Mass det. time= 18.4 min (775.2 - 756.7)

Volume	Invert	Avail.Storage	Storage Description
#1	7.00'	1,063 cf	**Custom Stage Data (Irregular)** Listed below (Recalc) 2,656 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
7.00	736	376.0	0	0	736
8.00	736	376.0	736	736	1,112
9.00	736	376.0	736	1,472	1,488
10.00	736	376.0	736	2,208	1,864
10.10	10,000	2,000.0	448	2,656	308,924

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**2.420 in/hr Exfiltration over Wetted area**
#2	Primary	10.00'	**10.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=0.05 cfs @ 12.46 hrs HW=7.57' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.05 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=7.00' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 11P: Field

Inflow Area = 136,212 sf, Inflow Depth = 0.29" for 2 yr event
Inflow = 0.34 cfs @ 12.58 hrs, Volume= 3,329 cf
Outflow = 0.23 cfs @ 12.92 hrs, Volume= 3,326 cf, Atten= 32%, Lag= 19.9 min
Primary = 0.23 cfs @ 12.92 hrs, Volume= 3,326 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 40.22' @ 12.92 hrs Surf.Area= 2,606 sf Storage= 337 cf
Plug-Flow detention time= 29.5 min calculated for 3,326 cf (100% of inflow)
Center-of-Mass det. time= 29.1 min (989.7 - 960.6)

Volume	Invert	Avail.Storage	Storage Description
#1	40.00'	15,029 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
40.00	480	0	0
41.00	10,219	5,350	5,350
41.50	28,498	9,679	15,029

Device	Routing	Invert	Outlet Devices
#1	Primary	40.00'	**12.0" x 18.0' long Culvert** RCP, rounded edge headwall, Ke= 0.100 Outlet Invert= 39.77' S= 0.0128 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean

Primary OutFlow Max=0.23 cfs @ 12.92 hrs HW=40.22' (Free Discharge)
└**1=Culvert** (Barrel Controls 0.23 cfs @ 2.7 fps)

Pond 12P: Trench 1

Inflow Area = 1,554 sf, Inflow Depth = 2.92" for 2 yr event
Inflow = 0.11 cfs @ 12.09 hrs, Volume= 378 cf
Outflow = 0.02 cfs @ 11.70 hrs, Volume= 378 cf, Atten= 83%, Lag= 0.0 min
Discarded = 0.02 cfs @ 11.70 hrs, Volume= 378 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 7.76' @ 12.55 hrs Surf.Area= 328 sf Storage= 100 cf
Plug-Flow detention time= 31.3 min calculated for 377 cf (100% of inflow)
Center-of-Mass det. time= 31.3 min (788.0 - 756.7)

Volume	Invert	Avail.Storage	Storage Description
#1	7.00'	555 cf	**Custom Stage Data (Irregular)**Listed below (Recalc) 1,389 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
7.00	328	172.0	0	0	328
8.00	328	172.0	328	328	500
9.00	328	172.0	328	656	672
10.00	328	172.0	328	984	844
10.10	10,000	2,000.0	405	1,389	316,800

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	10.00'	**10.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=0.02 cfs @ 11.70 hrs HW=7.03' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.02 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=7.00' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 13P: Trench 4

Inflow Area = 1,554 sf, Inflow Depth = 2.92" for 2 yr event
Inflow = 0.11 cfs @ 12.09 hrs, Volume= 378 cf
Outflow = 0.02 cfs @ 12.50 hrs, Volume= 378 cf, Atten= 79%, Lag= 25.0 min
Discarded = 0.02 cfs @ 12.50 hrs, Volume= 378 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 7.91' @ 12.50 hrs Surf.Area= 268 sf Storage= 98 cf
Plug-Flow detention time= 27.8 min calculated for 377 cf (100% of inflow)
Center-of-Mass det. time= 27.8 min (784.5 - 756.7)

Volume	Invert	Avail.Storage	Storage Description
#1	7.00'	480 cf	**Custom Stage Data (Irregular)**Listed below (Recalc) 1,201 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
7.00	268	142.0	0	0	268
8.00	268	142.0	268	268	410
9.00	268	142.0	268	536	552
10.00	268	142.0	268	804	694
10.10	10,000	2,000.0	397	1,201	317,399

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**2.420 in/hr Exfiltration over Wetted area**
#2	Primary	10.00'	**10.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=0.02 cfs @ 12.50 hrs HW=7.91' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.02 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=7.00' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 14P: Trench 5

Inflow Area = 1,554 sf, Inflow Depth = 2.92" for 2 yr event
Inflow = 0.11 cfs @ 12.09 hrs, Volume= 378 cf
Outflow = 0.02 cfs @ 12.51 hrs, Volume= 378 cf, Atten= 80%, Lag= 25.3 min
Discarded = 0.02 cfs @ 12.51 hrs, Volume= 378 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 7.97' @ 12.51 hrs Surf.Area= 256 sf Storage= 100 cf
Plug-Flow detention time= 29.4 min calculated for 377 cf (100% of inflow)
Center-of-Mass det. time= 29.4 min (786.1 - 756.7)

Volume	Invert	Avail.Storage	Storage Description
#1	7.00'	465 cf	**Custom Stage Data (Irregular)** Listed below (Recalc) 1,163 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
7.00	256	136.0	0	0	256
8.00	256	136.0	256	256	392
9.00	256	136.0	256	512	528
10.00	256	136.0	256	768	664
10.10	10,000	2,000.0	395	1,163	317,502

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**2.420 in/hr Exfiltration over Wetted area**
#2	Primary	10.00'	**10.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=0.02 cfs @ 12.51 hrs HW=7.97' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.02 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=7.00' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 15P: Trench 8

Inflow Area = 1,554 sf, Inflow Depth = 2.92" for 2 yr event
Inflow = 0.11 cfs @ 12.09 hrs, Volume= 378 cf
Outflow = 0.02 cfs @ 12.53 hrs, Volume= 378 cf, Atten= 81%, Lag= 26.4 min
Discarded = 0.02 cfs @ 12.53 hrs, Volume= 378 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 8.23' @ 12.53 hrs Surf.Area= 216 sf Storage= 106 cf
Plug-Flow detention time= 35.7 min calculated for 377 cf (100% of inflow)
Center-of-Mass det. time= 35.7 min (792.4 - 756.7)

Volume	Invert	Avail.Storage	Storage Description
#1	7.00'	415 cf	**Custom Stage Data (Irregular)** Listed below (Recalc) 1,038 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
7.00	216	116.0	0	0	216
8.00	216	116.0	216	216	332
9.00	216	116.0	216	432	448
10.00	216	116.0	216	648	564
10.10	10,000	2,000.0	390	1,038	317,803

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**2.420 in/hr Exfiltration over Wetted area**
#2	Primary	10.00'	**10.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=0.02 cfs @ 12.53 hrs HW=8.23' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.02 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=7.00' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 16P: Trench 6

Inflow Area = 1,554 sf, Inflow Depth = 2.92" for 2 yr event
Inflow = 0.12 cfs @ 12.00 hrs, Volume= 378 cf
Outflow = 0.03 cfs @ 12.37 hrs, Volume= 378 cf, Atten= 79%, Lag= 22.0 min
Discarded = 0.03 cfs @ 12.37 hrs, Volume= 378 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 7.58' @ 12.37 hrs Surf.Area= 364 sf Storage= 85 cf
Plug-Flow detention time= 18.8 min calculated for 377 cf (100% of inflow)
Center-of-Mass det. time= 18.8 min (770.0 - 751.2)

Volume	Invert	Avail.Storage	Storage Description
#1	7.00'	600 cf	**Custom Stage Data (Irregular)**Listed below (Recalc) 1,501 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
7.00	364	190.0	0	0	364
8.00	364	190.0	364	364	554
9.00	364	190.0	364	728	744
10.00	364	190.0	364	1,092	934
10.10	10,000	2,000.0	409	1,501	316,371

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**2.410 in/hr Exfiltration over Wetted area**
#2	Primary	10.00'	**10.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=0.03 cfs @ 12.37 hrs HW=7.58' (Free Discharge)
1=Exfiltration (Exfiltration Controls 0.03 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=7.00' (Free Discharge)
2=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Pond 17P: Upper Forebay

[88] Warning: Qout>Qin may require Finer Routing>1

Inflow Area = 62,740 sf, Inflow Depth = 1.18" for 2 yr event
Inflow = 1.43 cfs @ 12.22 hrs, Volume= 6,150 cf
Outflow = 1.46 cfs @ 12.22 hrs, Volume= 6,037 cf, Atten= 0%, Lag= 0.0 min
Discarded = 0.03 cfs @ 12.22 hrs, Volume= 1,743 cf
Primary = 1.42 cfs @ 12.22 hrs, Volume= 4,295 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 54.86' @ 12.22 hrs Surf.Area= 544 sf Storage= 583 cf
Plug-Flow detention time= 76.0 min calculated for 6,027 cf (98% of inflow)
Center-of-Mass det. time= 66.1 min (928.0 - 861.9)

Volume	Invert	Avail.Storage	Storage Description
#1	53.00'	644 cf	**Custom Stage Data (Prismatic)**Listed below

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
53.00	88	0	0
54.00	309	199	199
55.00	581	445	644

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	54.75'	**15.0' long x 3.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 Coef. (English) 2.44 2.58 2.68 2.67 2.65 2.64 2.64 2.68 2.68 2.72 2.81 2.92 2.97 3.07 3.32

Discarded OutFlow Max=0.03 cfs @ 12.22 hrs HW=54.86' (Free Discharge)
1=Exfiltration (Exfiltration Controls 0.03 cfs)

Primary OutFlow Max=1.39 cfs @ 12.22 hrs HW=54.86' (Free Discharge)
2=Broad-Crested Rectangular Weir (Weir Controls 1.39 cfs @ 0.8 fps)

Pond 18P: Trench 7

Inflow Area = 1,554 sf, Inflow Depth = 2.92" for 2 yr event
Inflow = 0.12 cfs @ 12.00 hrs, Volume= 378 cf
Outflow = 0.03 cfs @ 12.37 hrs, Volume= 378 cf, Atten= 79%, Lag= 22.0 min
Discarded = 0.03 cfs @ 12.37 hrs, Volume= 378 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 7.58' @ 12.37 hrs Surf.Area= 364 sf Storage= 85 cf
Plug-Flow detention time= 18.8 min calculated for 378 cf (100% of inflow)
Center-of-Mass det. time= 18.7 min (769.9 - 751.2)

Volume	Invert	Avail.Storage	Storage Description
#1	7.00'	453 cf	**Custom Stage Data (Irregular)**Listed below (Recalc) 1,133 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
7.00	364	190.0	0	0	364
8.00	364	190.0	364	364	554
9.00	364	190.0	364	728	744
10.00	364	190.0	364	1,092	934
10.01	10,000	2,000.0	41	1,133	316,371

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**2.410 in/hr Exfiltration over Wetted area**
#2	Primary	10.00'	**10.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=0.03 cfs @ 12.37 hrs HW=7.58' (Free Discharge)
1=Exfiltration (Exfiltration Controls 0.03 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=7.00' (Free Discharge)
2=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Link 8L: Wood Road Culvert (POA#1)

Inflow Area = 333,158 sf, Inflow Depth > 0.14" for 2 yr event
Inflow = 0.24 cfs @ 13.09 hrs, Volume= 3,943 cf
Primary = 0.24 cfs @ 13.09 hrs, Volume= 3,943 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Link 9L: Northern Wetland (POA#3)

Inflow Area = 140,271 sf, Inflow Depth = 0.00" for 2 yr event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Link 10L: Ipswich River (POA#2)

Inflow Area = 228,010 sf, Inflow Depth = 0.00" for 2 yr event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Time span=0.00-30.00 hrs, dt=0.05 hrs, 601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment P1: Eastern Development Area Runoff Area=46,973 sf Runoff Depth=2.04"
Flow Length=394' Tc=19.9 min CN=73 Runoff=1.71 cfs 7,986 cf

Subcatchment P2: Western Development Area Runoff Area=62,740 sf Runoff Depth=2.37"
Flow Length=401' Tc=15.3 min CN=77 Runoff=2.98 cfs 12,369 cf

Subcatchment P3: South of Access Road Runoff Area=87,233 sf Runoff Depth=0.48"
Flow Length=278' Tc=13.6 min CN=48 Runoff=0.44 cfs 3,465 cf

Subcatchment P4: North of Access Road Runoff Area=136,212 sf Runoff Depth=0.94"
Flow Length=262' Tc=25.5 min CN=57 Runoff=1.71 cfs 10,711 cf

Subcatchment P5: Northwest Site Runoff Area=137,163 sf Runoff Depth=0.07"
Flow Length=549' Tc=21.8 min CN=36 Runoff=0.03 cfs 778 cf

Subcatchment P5A: Unit 11 Rear Roof and Deck Runoff Area=1,554 sf Runoff Depth=4.45"
Flow Length=25' Tc=6.0 min CN=98 Runoff=0.16 cfs 577 cf

Subcatchment P5B: Unit 12 Rear Roof and Deck Runoff Area=1,554 sf Runoff Depth=4.45"
Tc=0.0 min CN=98 Runoff=0.19 cfs 577 cf

Subcatchment P6: Southwest Site Runoff Area=215,576 sf Runoff Depth=0.03"
Flow Length=234' Tc=10.9 min CN=34 Runoff=0.02 cfs 580 cf

Subcatchment P6A: Unit 2 Rear Roof and Deck Runoff Area=1,554 sf Runoff Depth=4.45"
Flow Length=25' Tc=6.0 min CN=98 Runoff=0.16 cfs 577 cf

Subcatchment P6B: Unit 3 Rear Roof and Deck Runoff Area=1,554 sf Runoff Depth=4.45"
Flow Length=25' Tc=6.0 min CN=98 Runoff=0.16 cfs 577 cf

Subcatchment P6C: Unit 4,5,6 Rear Roof and Deck Runoff Area=3,110 sf Runoff Depth=4.45"
Flow Length=25' Tc=6.0 min CN=98 Runoff=0.32 cfs 1,154 cf

Subcatchment P6D: Unit 7 Rear Roof and Deck Runoff Area=1,554 sf Runoff Depth=4.45"
Flow Length=25' Tc=6.0 min CN=98 Runoff=0.16 cfs 577 cf

Subcatchment P6E: Unit 8 Rear Roof and Deck Runoff Area=1,554 sf Runoff Depth=4.45"
Flow Length=25' Tc=6.0 min CN=98 Runoff=0.16 cfs 577 cf

Subcatchment P6F: Unit 9 Rear Roof and Deck Runoff Area=1,554 sf Runoff Depth=4.45"
Tc=0.0 min CN=98 Runoff=0.19 cfs 577 cf

Subcatchment P6G: Unit 10 Rear Roof and Deck Runoff Area=1,554 sf Runoff Depth=4.45"
Tc=0.0 min CN=98 Runoff=0.19 cfs 577 cf

Reach 8R: Swale Peak Depth=0.26' Max Vel=2.7 fps Inflow=2.67 cfs 5,584 cf
n=0.035 L=292.0' S=0.0334 '/' Capacity=34.69 cfs Outflow=2.61 cfs 5,584 cf

Reach 11R: Total Site Inflow=1.78 cfs 23,490 cf
Outflow=1.78 cfs 23,490 cf

Reach 12R: Pipe Peak Depth=0.33' Max Vel=5.6 fps Inflow=1.58 cfs 18,667 cf
D=18.0" n=0.011 L=95.0' S=0.0151 '/' Capacity=15.23 cfs Outflow=1.58 cfs 18,667 cf

Reach 13R: Grass Channel Peak Depth=0.18' Max Vel=1.7 fps Inflow=1.58 cfs 18,667 cf
n=0.035 L=240.0' S=0.0167 '/' Capacity=23.29 cfs Outflow=1.58 cfs 18,667 cf

Pond 2P: Trench 9 Peak Elev=8.69' Storage=173 cf Inflow=0.19 cfs 577 cf
Discarded=0.03 cfs 577 cf Primary=0.00 cfs 0 cf Outflow=0.03 cfs 577 cf

Pond 3P: Trench 2 Peak Elev=8.69' Storage=173 cf Inflow=0.16 cfs 577 cf
Discarded=0.03 cfs 577 cf Primary=0.00 cfs 0 cf Outflow=0.03 cfs 577 cf

Pond 4P: Forebay Peak Elev=43.74' Storage=504 cf Inflow=4.24 cfs 13,570 cf
Discarded=0.01 cfs 694 cf Primary=4.26 cfs 12,661 cf Outflow=4.27 cfs 13,355 cf

Pond 6P: Infiltration Pond Peak Elev=41.22' Storage=6,590 cf Inflow=4.26 cfs 12,661 cf
Discarded=0.08 cfs 3,748 cf Primary=0.51 cfs 7,959 cf Secondary=0.00 cfs 0 cf Outflow=0.59 cfs 11,708 cf

Pond 7P: Bioretention Area Peak Elev=54.72' Storage=2,174 cf Inflow=2.95 cfs 10,379 cf
Discarded=0.11 cfs 4,795 cf Primary=2.67 cfs 5,584 cf Outflow=2.78 cfs 10,379 cf

Pond 10P: Trench 3 Peak Elev=8.04' Storage=306 cf Inflow=0.32 cfs 1,154 cf
Discarded=0.06 cfs 1,154 cf Primary=0.00 cfs 0 cf Outflow=0.06 cfs 1,154 cf

Pond 11P: Field Peak Elev=40.53' Storage=1,625 cf Inflow=1.71 cfs 10,711 cf
12.0" x 18.0' Culvert Outflow=1.11 cfs 10,708 cf

Pond 12P: Trench 1 Peak Elev=8.39' Storage=182 cf Inflow=0.16 cfs 577 cf
Discarded=0.02 cfs 577 cf Primary=0.00 cfs 0 cf Outflow=0.02 cfs 577 cf

Pond 13P: Trench 4 Peak Elev=8.59' Storage=170 cf Inflow=0.16 cfs 577 cf
Discarded=0.03 cfs 577 cf Primary=0.00 cfs 0 cf Outflow=0.03 cfs 577 cf

Pond 14P: Trench 5 Peak Elev=8.69' Storage=173 cf Inflow=0.16 cfs 577 cf
Discarded=0.03 cfs 577 cf Primary=0.00 cfs 0 cf Outflow=0.03 cfs 577 cf

Pond 15P: Trench 8 Peak Elev=9.10' Storage=181 cf Inflow=0.16 cfs 577 cf
Discarded=0.03 cfs 577 cf Primary=0.00 cfs 0 cf Outflow=0.03 cfs 577 cf

Pond 16P: Trench 6 Peak Elev=8.06' Storage=154 cf Inflow=0.19 cfs 577 cf
Discarded=0.03 cfs 577 cf Primary=0.00 cfs 0 cf Outflow=0.03 cfs 577 cf

Pond 17P: Upper Forebay Peak Elev=54.94' Storage=615 cf Inflow=2.98 cfs 12,369 cf
Discarded=0.03 cfs 1,875 cf Primary=2.95 cfs 10,379 cf Outflow=2.98 cfs 12,254 cf

Pond 18P: Trench 7 Peak Elev=8.06' Storage=154 cf Inflow=0.19 cfs 577 cf
Discarded=0.03 cfs 577 cf Primary=0.00 cfs 0 cf Outflow=0.03 cfs 577 cf

Link 8L: Wood Road Culvert (POA#1) Inflow=1.78 cfs 22,132 cf
Primary=1.78 cfs 22,132 cf

Link 9L: Northern Wetland (POA#3) Inflow=0.03 cfs 778 cf
Primary=0.03 cfs 778 cf

Link 10L: Ipswich River (POA#2) Inflow=0.02 cfs 580 cf
Primary=0.02 cfs 580 cf

Total Runoff Area = 701,439 sf Runoff Volume = 41,657 cf Average Runoff Depth = 0.71"

Subcatchment P1: Eastern Development Area

Runoff = 1.71 cfs @ 12.29 hrs, Volume= 7,986 cf, Depth= 2.04"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.69"

Area (sf)	CN	Description
19,843	98	Paved parking & roofs
13,827	39	>75% Grass cover, Good, HSG A
2,370	61	>75% Grass cover, Good, HSG B
10,933	74	>75% Grass cover, Good, HSG C
46,973	73	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.9	77	0.0129	0.1		**Sheet Flow, A to B** Grass: Dense n= 0.240 P2= 3.15"
0.1	5	0.0150	0.7		**Sheet Flow, B to C** Smooth surfaces n= 0.011 P2= 3.15"
1.2	4	0.0150	0.1		**Sheet Flow, C to D** Grass: Dense n= 0.240 P2= 3.15"
0.2	14	0.0285	1.1		**Sheet Flow, D to E** Smooth surfaces n= 0.011 P2= 3.15"
0.1	32	0.1150	6.9		**Shallow Concentrated Flow, E to F** Paved Kv= 20.3 fps
4.4	262	0.0460	1.0	5.95	**Channel Flow, F to G** Area= 6.0 sf Perim= 9.3' r= 0.65' n= 0.240 Sheet flow over Dense Grass
19.9	394	Total			

Subcatchment P2: Western Development Area

Runoff = 2.98 cfs @ 12.22 hrs, Volume= 12,369 cf, Depth= 2.37"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.69"

Area (sf)	CN	Description
40,549	98	Paved parking & roofs
22,191	39	>75% Grass cover, Good, HSG A
62,740	77	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	98	0.0224	0.1		**Sheet Flow, A to B** Grass: Dense n= 0.240 P2= 3.15"
1.2	160	0.0112	2.1		**Shallow Concentrated Flow, B to C** Paved Kv= 20.3 fps
0.6	143	0.0210	4.1	0.81	**Circular Channel (pipe), C to D** Diam= 6.0" Area= 0.2 sf Perim= 1.6' r= 0.13' n= 0.013 Corrugated PE, smooth interior
15.3	401	Total			

Subcatchment P3: South of Access Road

Runoff = 0.44 cfs @ 12.39 hrs, Volume= 3,465 cf, Depth= 0.48"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.69"

Area (sf)	CN	Description
32,400	30	Meadow, non-grazed, HSG A
50,084	58	Meadow, non-grazed, HSG B
4,749	71	Meadow, non-grazed, HSG C
87,233	48	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.6	25	0.3200	0.3		**Sheet Flow, A to B** Grass: Dense n= 0.240 P2= 3.15"
8.7	75	0.0400	0.1		**Sheet Flow, B to C** Grass: Dense n= 0.240 P2= 3.15"
3.3	178	0.0168	0.9		**Shallow Concentrated Flow, C to D** Short Grass Pasture Kv= 7.0 fps
13.6	278	Total			

Subcatchment P4: North of Access Road

Runoff = 1.71 cfs @ 12.43 hrs, Volume= 10,711 cf, Depth= 0.94"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.69"

Area (sf)	CN	Description
31,204	30	Meadow, non-grazed, HSG A
48,458	58	Meadow, non-grazed, HSG B
56,550	71	Meadow, non-grazed, HSG C
136,212	57	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.3	100	0.0060	0.1		**Sheet Flow, A to B** Grass: Dense n= 0.240 P2= 3.15"
2.2	162	0.0310	1.2		**Shallow Concentrated Flow, B to C** Short Grass Pasture Kv= 7.0 fps
25.5	262	Total			

Subcatchment P5: Northwest Site

Runoff = 0.03 cfs @ 15.54 hrs, Volume= 778 cf, Depth= 0.07"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.69"

Area (sf)	CN	Description
102,199	30	Meadow, non-grazed, HSG A
16,611	58	Meadow, non-grazed, HSG B
5,517	71	Meadow, non-grazed, HSG C
12,836	39	>75% Grass cover, Good, HSG A
137,163	36	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.6	100	0.0120	0.1		**Sheet Flow, A to B** Grass: Dense n= 0.240 P2= 3.15"
4.2	449	0.0660	1.8		**Shallow Concentrated Flow, B to POA 3** Short Grass Pasture Kv= 7.0 fps
21.8	549	Total			

Subcatchment P5A: Unit 11 Rear Roof and Deck

Runoff = 0.16 cfs @ 12.09 hrs, Volume= 577 cf, Depth= 4.45"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.69"

Area (sf)	CN	Description
1,554	98	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.2	25	0.2000	2.6		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.15"
0.2	25	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P5B: Unit 12 Rear Roof and Deck

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 0.19 cfs @ 12.00 hrs, Volume= 577 cf, Depth= 4.45"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.69"

Area (sf)	CN	Description
1,554	98	

Subcatchment P6: Southwest Site

Runoff = 0.02 cfs @ 17.23 hrs, Volume= 580 cf, Depth= 0.03"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.69"

Area (sf)	CN	Description
172,547	30	Meadow, non-grazed, HSG A
11,073	78	Meadow, non-grazed, HSG D
31,956	39	>75% Grass cover, Good, HSG A
215,576	34	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.4	22	0.3180	0.3		**Sheet Flow, A to B** Grass: Dense n= 0.240 P2= 3.15"
8.3	50	0.0200	0.1		**Sheet Flow, B to C** Grass: Dense n= 0.240 P2= 3.15"
1.2	162	0.1046	2.3		**Shallow Concentrated Flow, C to POA #3** Short Grass Pasture Kv= 7.0 fps
10.9	234	Total			

Subcatchment P6A: Unit 2 Rear Roof and Deck

Runoff = 0.16 cfs @ 12.09 hrs, Volume= 577 cf, Depth= 4.45"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.69"

Area (sf)	CN	Description
1,554	98	Paved parking & roofs

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.2	25	0.2000	2.6		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.15"
0.2	25	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P6B: Unit 3 Rear Roof and Deck

Runoff = 0.16 cfs @ 12.09 hrs, Volume= 577 cf, Depth= 4.45"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.69"

Area (sf)	CN	Description
1,554	98	Paved parking & roofs

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.2	25	0.2000	2.6		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.15"
0.2	25	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P6C: Unit 4,5,6 Rear Roof and Deck

Runoff = 0.32 cfs @ 12.09 hrs, Volume= 1,154 cf, Depth= 4.45"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.69"

Area (sf)	CN	Description
3,110	98	Paved parking & roofs

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.2	25	0.2000	2.6		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.15"
0.2	25	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P6D: Unit 7 Rear Roof and Deck

Runoff = 0.16 cfs @ 12.09 hrs, Volume= 577 cf, Depth= 4.45"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.69"

Area (sf)	CN	Description
1,554	98	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.2	25	0.2000	2.6		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.15"
0.2	25	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P6E: Unit 8 Rear Roof and Deck

Runoff = 0.16 cfs @ 12.09 hrs, Volume= 577 cf, Depth= 4.45"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.69"

Area (sf)	CN	Description
1,554	98	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.2	25	0.2000	2.6		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.15"
0.2	25	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P6F: Unit 9 Rear Roof and Deck

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 0.19 cfs @ 12.00 hrs, Volume= 577 cf, Depth= 4.45"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.69"

Area (sf)	CN	Description
1,554	98	

Subcatchment P6G: Unit 10 Rear Roof and Deck

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 0.19 cfs @ 12.00 hrs, Volume= 577 cf, Depth= 4.45"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.69"

Area (sf)	CN	Description
1,554	98	

Reach 8R: Swale

[65] Warning: Inlet elevation not specified

Inflow Area = 62,740 sf, Inflow Depth = 1.07" for 10 yr event
Inflow = 2.67 cfs @ 12.28 hrs, Volume= 5,584 cf
Outflow = 2.61 cfs @ 12.35 hrs, Volume= 5,584 cf, Atten= 2%, Lag= 4.5 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.7 fps, Min. Travel Time= 1.8 min
Avg. Velocity = 0.9 fps, Avg. Travel Time= 5.3 min

Peak Depth= 0.26' @ 12.31 hrs
Capacity at bank full= 34.69 cfs
3.00' x 1.00' deep channel, n= 0.035 High grass
Side Slope Z-value= 3.0 '/' Top Width= 9.00'
Length= 292.0' Slope= 0.0334 '/'

Reach 11R: Total Site

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 701,439 sf, Inflow Depth > 0.40" for 10 yr event
Inflow = 1.78 cfs @ 12.82 hrs, Volume= 23,490 cf
Outflow = 1.78 cfs @ 12.82 hrs, Volume= 23,490 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Reach 12R: Pipe

[52] Hint: Inlet conditions not evaluated
[81] Warning: Exceeded Pond 6P by 0.64' @ 12.20 hrs
[79] Warning: Submerged Pond 11P Primary device # 1 OUTLET by 0.09'

Inflow Area = 245,925 sf, Inflow Depth > 0.91" for 10 yr event
Inflow = 1.58 cfs @ 12.79 hrs, Volume= 18,667 cf
Outflow = 1.58 cfs @ 12.79 hrs, Volume= 18,667 cf, Atten= 0%, Lag= 0.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.6 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 2.6 fps, Avg. Travel Time= 0.6 min

Peak Depth= 0.33' @ 12.78 hrs
Capacity at bank full= 15.23 cfs
Inlet Invert= 39.53', Outlet Invert= 38.10'
18.0" Diameter Pipe, n= 0.011 Concrete pipe, straight & clean
Length= 95.0' Slope= 0.0151 '/'

Reach 13R: Grass Channel

Inflow Area = 245,925 sf, Inflow Depth > 0.91" for 10 yr event
Inflow = 1.58 cfs @ 12.79 hrs, Volume= 18,667 cf
Outflow = 1.58 cfs @ 12.86 hrs, Volume= 18,667 cf, Atten= 0%, Lag= 4.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.7 fps, Min. Travel Time= 2.4 min
Avg. Velocity = 0.7 fps, Avg. Travel Time= 5.7 min

Peak Depth= 0.18' @ 12.82 hrs
Capacity at bank full= 23.29 cfs
Inlet Invert= 36.00', Outlet Invert= 32.00'
5.00' x 1.00' deep channel, n= 0.035 High grass
Side Slope Z-value= 0.2 '/' Top Width= 5.40'
Length= 240.0' Slope= 0.0167 '/'

Pond 2P: Trench 9

Inflow Area = 1,554 sf, Inflow Depth = 4.45" for 10 yr event
Inflow = 0.19 cfs @ 12.00 hrs, Volume= 577 cf
Outflow = 0.03 cfs @ 12.45 hrs, Volume= 577 cf, Atten= 86%, Lag= 27.2 min
Discarded = 0.03 cfs @ 12.45 hrs, Volume= 577 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 8.69' @ 12.45 hrs Surf.Area= 256 sf Storage= 173 cf
Plug-Flow detention time= 46.0 min calculated for 577 cf (100% of inflow)
Center-of-Mass det. time= 45.9 min (789.4 - 743.5)

Volume	Invert	Avail.Storage	Storage Description
#1	7.00'	323 cf	**Custom Stage Data (Irregular)** Listed below (Recalc) 808 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
7.00	256	136.0	0	0	256
8.00	256	136.0	256	256	392
9.00	256	136.0	256	512	528
10.00	256	136.0	256	768	664
10.01	10,000	2,000.0	40	808	317,502

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**2.410 in/hr Exfiltration over Wetted area**
#2	Primary	10.00'	**10.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=0.03 cfs @ 12.45 hrs HW=8.69' (Free Discharge)
1=Exfiltration (Exfiltration Controls 0.03 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=7.00' (Free Discharge)
2=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Pond 3P: Trench 2

Inflow Area = 1,554 sf, Inflow Depth = 4.45" for 10 yr event
Inflow = 0.16 cfs @ 12.09 hrs, Volume= 577 cf
Outflow = 0.03 cfs @ 12.55 hrs, Volume= 577 cf, Atten= 83%, Lag= 27.9 min
Discarded = 0.03 cfs @ 12.55 hrs, Volume= 577 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 8.69' @ 12.55 hrs Surf.Area= 256 sf Storage= 173 cf
Plug-Flow detention time= 46.0 min calculated for 576 cf (100% of inflow)
Center-of-Mass det. time= 45.9 min (795.0 - 749.1)

Volume	Invert	Avail.Storage	Storage Description
#1	7.00'	607 cf	**Custom Stage Data (Irregular)**Listed below (Recalc) 1,519 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
7.00	256	136.0	0	0	256
8.00	256	136.0	256	256	392
9.00	256	136.0	256	512	528
10.00	256	136.0	256	768	664
10.10	20,000	3,000.0	751	1,519	715,389

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**2.410 in/hr Exfiltration over Wetted area**
#2	Primary	10.00'	**10.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=0.03 cfs @ 12.55 hrs HW=8.69' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.03 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=7.00' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 4P: Forebay

[88] Warning: Qout>Qin may require Finer Routing>1

Inflow Area = 109,713 sf, Inflow Depth = 1.48" for 10 yr event
Inflow = 4.24 cfs @ 12.34 hrs, Volume= 13,570 cf
Outflow = 4.27 cfs @ 12.35 hrs, Volume= 13,355 cf, Atten= 0%, Lag= 0.4 min
Discarded = 0.01 cfs @ 12.35 hrs, Volume= 694 cf
Primary = 4.26 cfs @ 12.35 hrs, Volume= 12,661 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Peak Elev= 43.74' @ 12.35 hrs Surf.Area= 510 sf Storage= 504 cf
Plug-Flow detention time= 24.8 min calculated for 13,355 cf (98% of inflow)
Center-of-Mass det. time= 15.5 min (840.3 - 824.8)

Volume	Invert	Avail.Storage	Storage Description
#1	42.00'	646 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
42.00	119	0	0
43.00	293	206	206
44.00	586	440	646

Device	Routing	Invert	Outlet Devices
#1	Primary	43.50'	**15.0' long x 6.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.37 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
#2	Discarded	0.00'	**1.020 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.01 cfs @ 12.35 hrs HW=43.74' (Free Discharge)
└**2=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=4.25 cfs @ 12.35 hrs HW=43.74' (Free Discharge)
└**1=Broad-Crested Rectangular Weir** (Weir Controls 4.25 cfs @ 1.2 fps)

Pond 6P: Infiltration Pond

Inflow Area = 109,713 sf, Inflow Depth = 1.38" for 10 yr event
Inflow = 4.26 cfs @ 12.35 hrs, Volume= 12,661 cf
Outflow = 0.59 cfs @ 13.24 hrs, Volume= 11,708 cf, Atten= 86%, Lag= 53.2 min
Discarded = 0.08 cfs @ 13.24 hrs, Volume= 3,748 cf
Primary = 0.51 cfs @ 13.24 hrs, Volume= 7,959 cf
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 41.22' @ 13.24 hrs Surf.Area= 3,263 sf Storage= 6,590 cf
Plug-Flow detention time= 213.2 min calculated for 11,708 cf (92% of inflow)
Center-of-Mass det. time= 180.7 min (1,001.4 - 820.7)

Volume	Invert	Avail.Storage	Storage Description
#1	38.50'	18,402 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
38.50	1,459	0	0
39.00	1,957	854	854
40.00	2,510	2,234	3,088
41.00	3,120	2,815	5,903
42.00	3,786	3,453	9,356
43.00	4,509	4,148	13,503
44.00	5,289	4,899	18,402

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	39.63'	**4.0" Vert. Orifice/Grate** C= 0.600
#3	Primary	41.17'	**5.0" Vert. Orifice/Grate** C= 0.600
#4	Primary	42.60'	**2.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#5	Secondary	43.36'	**10.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Discarded OutFlow Max=0.08 cfs @ 13.24 hrs HW=41.22' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.08 cfs)

Primary OutFlow Max=0.51 cfs @ 13.24 hrs HW=41.22' (Free Discharge)
├**2=Orifice/Grate** (Orifice Controls 0.50 cfs @ 5.7 fps)
├**3=Orifice/Grate** (Orifice Controls 0.01 cfs @ 0.7 fps)
└**4=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=38.50' (Free Discharge)
└**5=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 7P: Bioretention Area

Inflow Area = 62,740 sf, Inflow Depth = 1.99" for 10 yr event
Inflow = 2.95 cfs @ 12.22 hrs, Volume= 10,379 cf
Outflow = 2.78 cfs @ 12.28 hrs, Volume= 10,379 cf, Atten= 6%, Lag= 3.6 min
Discarded = 0.11 cfs @ 12.28 hrs, Volume= 4,795 cf
Primary = 2.67 cfs @ 12.28 hrs, Volume= 5,584 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 54.72' @ 12.28 hrs Surf.Area= 1,968 sf Storage= 2,174 cf
Plug-Flow detention time= 113.2 min calculated for 10,361 cf (100% of inflow)
Center-of-Mass det. time= 113.4 min (938.3 - 824.9)

Volume	Invert	Avail.Storage	Storage Description
#1	53.00'	2,748 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
53.00	593	0	0
54.00	1,350	972	972
55.00	2,202	1,776	2,748

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	54.50'	**10.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Discarded OutFlow Max=0.11 cfs @ 12.28 hrs HW=54.72' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.11 cfs)

Primary OutFlow Max=2.63 cfs @ 12.28 hrs HW=54.72' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** (Weir Controls 2.63 cfs @ 1.2 fps)

Pond 10P: Trench 3

Inflow Area = 3,110 sf, Inflow Depth = 4.45" for 10 yr event
Inflow = 0.32 cfs @ 12.09 hrs, Volume= 1,154 cf
Outflow = 0.06 cfs @ 12.52 hrs, Volume= 1,154 cf, Atten= 80%, Lag= 25.8 min
Discarded = 0.06 cfs @ 12.52 hrs, Volume= 1,154 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 8.04' @ 12.52 hrs Surf.Area= 736 sf Storage= 306 cf
Plug-Flow detention time= 31.0 min calculated for 1,152 cf (100% of inflow)
Center-of-Mass det. time= 30.9 min (780.0 - 749.1)

Volume	Invert	Avail.Storage	Storage Description
#1	7.00'	1,063 cf	**Custom Stage Data (Irregular)** Listed below (Recalc) 2,656 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
7.00	736	376.0	0	0	736
8.00	736	376.0	736	736	1,112
9.00	736	376.0	736	1,472	1,488
10.00	736	376.0	736	2,208	1,864
10.10	10,000	2,000.0	448	2,656	308,924

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**2.420 in/hr Exfiltration over Wetted area**
#2	Primary	10.00'	**10.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=0.06 cfs @ 12.52 hrs HW=8.04' (Free Discharge)
1=Exfiltration (Exfiltration Controls 0.06 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=7.00' (Free Discharge)
2=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Pond 11P: Field

Inflow Area = 136,212 sf, Inflow Depth = 0.94" for 10 yr event
Inflow = 1.71 cfs @ 12.43 hrs, Volume= 10,711 cf
Outflow = 1.11 cfs @ 12.75 hrs, Volume= 10,708 cf, Atten= 35%, Lag= 19.1 min
Primary = 1.11 cfs @ 12.75 hrs, Volume= 10,708 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 40.53' @ 12.75 hrs Surf.Area= 5,647 sf Storage= 1,625 cf
Plug-Flow detention time= 24.9 min calculated for 10,690 cf (100% of inflow)
Center-of-Mass det. time= 25.0 min (934.1 - 909.1)

Volume	Invert	Avail.Storage	Storage Description
#1	40.00'	15,029 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
40.00	480	0	0
41.00	10,219	5,350	5,350
41.50	28,498	9,679	15,029

Device	Routing	Invert	Outlet Devices
#1	Primary	40.00'	**12.0" x 18.0' long Culvert** RCP, rounded edge headwall, Ke= 0.100 Outlet Invert= 39.77' S= 0.0128 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean

Primary OutFlow Max=1.11 cfs @ 12.75 hrs HW=40.53' (Free Discharge)
1=Culvert (Barrel Controls 1.11 cfs @ 3.8 fps)

Pond 12P: Trench 1

Inflow Area = 1,554 sf, Inflow Depth = 4.45" for 10 yr event
Inflow = 0.16 cfs @ 12.09 hrs, Volume= 577 cf
Outflow = 0.02 cfs @ 11.60 hrs, Volume= 577 cf, Atten= 89%, Lag= 0.0 min
Discarded = 0.02 cfs @ 11.60 hrs, Volume= 577 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 8.39' @ 12.71 hrs Surf.Area= 328 sf Storage= 182 cf
Plug-Flow detention time= 64.0 min calculated for 576 cf (100% of inflow)
Center-of-Mass det. time= 63.9 min (813.0 - 749.1)

Volume	Invert	Avail.Storage	Storage Description
#1	7.00'	555 cf	**Custom Stage Data (Irregular)**Listed below (Recalc) 1,389 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
7.00	328	172.0	0	0	328
8.00	328	172.0	328	328	500
9.00	328	172.0	328	656	672
10.00	328	172.0	328	984	844
10.10	10,000	2,000.0	405	1,389	316,800

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	10.00'	**10.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=0.02 cfs @ 11.60 hrs HW=7.03' (Free Discharge)
1=Exfiltration (Exfiltration Controls 0.02 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=7.00' (Free Discharge)
2=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Pond 13P: Trench 4

Inflow Area = 1,554 sf, Inflow Depth = 4.45" for 10 yr event
Inflow = 0.16 cfs @ 12.09 hrs, Volume= 577 cf
Outflow = 0.03 cfs @ 12.55 hrs, Volume= 577 cf, Atten= 83%, Lag= 27.6 min
Discarded = 0.03 cfs @ 12.55 hrs, Volume= 577 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 8.59' @ 12.55 hrs Surf.Area= 268 sf Storage= 170 cf
Plug-Flow detention time= 43.6 min calculated for 576 cf (100% of inflow)
Center-of-Mass det. time= 43.5 min (792.6 - 749.1)

Volume	Invert	Avail.Storage	Storage Description
#1	7.00'	480 cf	**Custom Stage Data (Irregular)**Listed below (Recalc) 1,201 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
7.00	268	142.0	0	0	268
8.00	268	142.0	268	268	410
9.00	268	142.0	268	536	552
10.00	268	142.0	268	804	694
10.10	10,000	2,000.0	397	1,201	317,399

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**2.420 in/hr Exfiltration over Wetted area**
#2	Primary	10.00'	**10.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=0.03 cfs @ 12.55 hrs HW=8.59' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.03 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=7.00' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 14P: Trench 5

Inflow Area = 1,554 sf, Inflow Depth = 4.45" for 10 yr event
Inflow = 0.16 cfs @ 12.09 hrs, Volume= 577 cf
Outflow = 0.03 cfs @ 12.55 hrs, Volume= 577 cf, Atten= 83%, Lag= 27.8 min
Discarded = 0.03 cfs @ 12.55 hrs, Volume= 577 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 8.69' @ 12.55 hrs Surf.Area= 256 sf Storage= 173 cf
Plug-Flow detention time= 45.7 min calculated for 576 cf (100% of inflow)
Center-of-Mass det. time= 45.6 min (794.7 - 749.1)

Volume	Invert	Avail.Storage	Storage Description
#1	7.00'	465 cf	**Custom Stage Data (Irregular)** Listed below (Recalc) 1,163 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
7.00	256	136.0	0	0	256
8.00	256	136.0	256	256	392
9.00	256	136.0	256	512	528
10.00	256	136.0	256	768	664
10.10	10,000	2,000.0	395	1,163	317,502

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**2.420 in/hr Exfiltration over Wetted area**
#2	Primary	10.00'	**10.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=0.03 cfs @ 12.55 hrs HW=8.69' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.03 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=7.00' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 15P: Trench 8

Inflow Area = 1,554 sf, Inflow Depth = 4.45" for 10 yr event
Inflow = 0.16 cfs @ 12.09 hrs, Volume= 577 cf
Outflow = 0.03 cfs @ 12.56 hrs, Volume= 577 cf, Atten= 84%, Lag= 28.6 min
Discarded = 0.03 cfs @ 12.56 hrs, Volume= 577 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 9.10' @ 12.56 hrs Surf.Area= 216 sf Storage= 181 cf
Plug-Flow detention time= 53.7 min calculated for 576 cf (100% of inflow)
Center-of-Mass det. time= 53.7 min (802.8 - 749.1)

Volume	Invert	Avail.Storage	Storage Description
#1	7.00'	415 cf	**Custom Stage Data (Irregular)** Listed below (Recalc) 1,038 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
7.00	216	116.0	0	0	216
8.00	216	116.0	216	216	332
9.00	216	116.0	216	432	448
10.00	216	116.0	216	648	564
10.10	10,000	2,000.0	390	1,038	317,803

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**2.420 in/hr Exfiltration over Wetted area**
#2	Primary	10.00'	**10.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=0.03 cfs @ 12.56 hrs HW=9.10' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.03 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=7.00' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 16P: Trench 6

Inflow Area = 1,554 sf, Inflow Depth = 4.45" for 10 yr event
Inflow = 0.19 cfs @ 12.00 hrs, Volume= 577 cf
Outflow = 0.03 cfs @ 12.42 hrs, Volume= 577 cf, Atten= 83%, Lag= 25.3 min
Discarded = 0.03 cfs @ 12.42 hrs, Volume= 577 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 8.06' @ 12.42 hrs Surf.Area= 364 sf Storage= 154 cf
Plug-Flow detention time= 31.4 min calculated for 577 cf (100% of inflow)
Center-of-Mass det. time= 31.3 min (774.9 - 743.5)

Volume	Invert	Avail.Storage	Storage Description
#1	7.00'	600 cf	**Custom Stage Data (Irregular)**Listed below (Recalc) 1,501 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
7.00	364	190.0	0	0	364
8.00	364	190.0	364	364	554
9.00	364	190.0	364	728	744
10.00	364	190.0	364	1,092	934
10.10	10,000	2,000.0	409	1,501	316,371

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**2.410 in/hr Exfiltration over Wetted area**
#2	Primary	10.00'	**10.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=0.03 cfs @ 12.42 hrs HW=8.06' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.03 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=7.00' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 17P: Upper Forebay

Inflow Area = 62,740 sf, Inflow Depth = 2.37" for 10 yr event
Inflow = 2.98 cfs @ 12.22 hrs, Volume= 12,369 cf
Outflow = 2.98 cfs @ 12.22 hrs, Volume= 12,254 cf, Atten= 0%, Lag= 0.3 min
Discarded = 0.03 cfs @ 12.22 hrs, Volume= 1,875 cf
Primary = 2.95 cfs @ 12.22 hrs, Volume= 10,379 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 54.94' @ 12.22 hrs Surf.Area= 564 sf Storage= 615 cf
Plug-Flow detention time= 40.3 min calculated for 12,234 cf (99% of inflow)
Center-of-Mass det. time= 35.3 min (876.6 - 841.3)

Volume	Invert	Avail.Storage	Storage Description
#1	53.00'	644 cf	**Custom Stage Data (Prismatic)**Listed below

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
53.00	88	0	0
54.00	309	199	199
55.00	581	445	644

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	54.75'	**15.0' long x 3.0' breadth Broad-Crested Rectangular Weir**

Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50
Coef. (English) 2.44 2.58 2.68 2.67 2.65 2.64 2.64 2.68 2.68 2.72 2.81 2.92 2.97 3.07 3.32

Discarded OutFlow Max=0.03 cfs @ 12.22 hrs HW=54.93' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.03 cfs)

Primary OutFlow Max=2.90 cfs @ 12.22 hrs HW=54.93' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** (Weir Controls 2.90 cfs @ 1.0 fps)

Pond 18P: Trench 7

Inflow Area = 1,554 sf, Inflow Depth = 4.45" for 10 yr event
Inflow = 0.19 cfs @ 12.00 hrs, Volume= 577 cf
Outflow = 0.03 cfs @ 12.42 hrs, Volume= 577 cf, Atten= 83%, Lag= 25.3 min
Discarded = 0.03 cfs @ 12.42 hrs, Volume= 577 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 8.06' @ 12.42 hrs Surf.Area= 364 sf Storage= 154 cf
Plug-Flow detention time= 31.3 min calculated for 576 cf (100% of inflow)
Center-of-Mass det. time= 31.3 min (774.8 - 743.5)

Volume	Invert	Avail.Storage	Storage Description
#1	7.00'	453 cf	**Custom Stage Data (Irregular)**Listed below (Recalc) 1,133 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
7.00	364	190.0	0	0	364
8.00	364	190.0	364	364	554
9.00	364	190.0	364	728	744
10.00	364	190.0	364	1,092	934
10.01	10,000	2,000.0	41	1,133	316,371

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**2.410 in/hr Exfiltration over Wetted area**
#2	Primary	10.00'	**10.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=0.03 cfs @ 12.42 hrs HW=8.06' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.03 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=7.00' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Link 8L: Wood Road Culvert (POA#1)

Inflow Area = 333,158 sf, Inflow Depth > 0.80" for 10 yr event
Inflow = 1.78 cfs @ 12.82 hrs, Volume= 22,132 cf
Primary = 1.78 cfs @ 12.82 hrs, Volume= 22,132 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Link 9L: Northern Wetland (POA#3)

Inflow Area = 140,271 sf, Inflow Depth = 0.07" for 10 yr event
Inflow = 0.03 cfs @ 15.54 hrs, Volume= 778 cf
Primary = 0.03 cfs @ 15.54 hrs, Volume= 778 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Link 10L: Ipswich River (POA#2)

Inflow Area = 228,010 sf, Inflow Depth = 0.03" for 10 yr event
Inflow = 0.02 cfs @ 17.23 hrs, Volume= 580 cf
Primary = 0.02 cfs @ 17.23 hrs, Volume= 580 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Time span=0.00-30.00 hrs, dt=0.05 hrs, 601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment P1: Eastern Development Area Runoff Area=46,973 sf Runoff Depth=2.97"
Flow Length=394' Tc=19.9 min CN=73 Runoff=2.52 cfs 11,637 cf

Subcatchment P2: Western Development Area Runoff Area=62,740 sf Runoff Depth=3.36"
Flow Length=401' Tc=15.3 min CN=77 Runoff=4.24 cfs 17,552 cf

Subcatchment P3: South of Access Road Runoff Area=87,233 sf Runoff Depth=0.94"
Flow Length=278' Tc=13.6 min CN=48 Runoff=1.20 cfs 6,826 cf

Subcatchment P4: North of Access Road Runoff Area=136,212 sf Runoff Depth=1.59"
Flow Length=262' Tc=25.5 min CN=57 Runoff=3.20 cfs 18,067 cf

Subcatchment P5: Northwest Site Runoff Area=137,163 sf Runoff Depth=0.26"
Flow Length=549' Tc=21.8 min CN=36 Runoff=0.15 cfs 3,023 cf

Subcatchment P5A: Unit 11 Rear Roof and Deck Runoff Area=1,554 sf Runoff Depth=5.62"
Flow Length=25' Tc=6.0 min CN=98 Runoff=0.20 cfs 728 cf

Subcatchment P5B: Unit 12 Rear Roof and Deck Runoff Area=1,554 sf Runoff Depth=5.62"
Tc=0.0 min CN=98 Runoff=0.23 cfs 728 cf

Subcatchment P6: Southwest Site Runoff Area=215,576 sf Runoff Depth=0.18"
Flow Length=234' Tc=10.9 min CN=34 Runoff=0.12 cfs 3,285 cf

Subcatchment P6A: Unit 2 Rear Roof and Deck Runoff Area=1,554 sf Runoff Depth=5.62"
Flow Length=25' Tc=6.0 min CN=98 Runoff=0.20 cfs 728 cf

Subcatchment P6B: Unit 3 Rear Roof and Deck Runoff Area=1,554 sf Runoff Depth=5.62"
Flow Length=25' Tc=6.0 min CN=98 Runoff=0.20 cfs 728 cf

Subcatchment P6C: Unit 4,5,6 Rear Roof and Deck Runoff Area=3,110 sf Runoff Depth=5.62"
Flow Length=25' Tc=6.0 min CN=98 Runoff=0.40 cfs 1,457 cf

Subcatchment P6D: Unit 7 Rear Roof and Deck Runoff Area=1,554 sf Runoff Depth=5.62"
Flow Length=25' Tc=6.0 min CN=98 Runoff=0.20 cfs 728 cf

Subcatchment P6E: Unit 8 Rear Roof and Deck Runoff Area=1,554 sf Runoff Depth=5.62"
Flow Length=25' Tc=6.0 min CN=98 Runoff=0.20 cfs 728 cf

Subcatchment P6F: Unit 9 Rear Roof and Deck Runoff Area=1,554 sf Runoff Depth=5.62"
Tc=0.0 min CN=98 Runoff=0.23 cfs 728 cf

Subcatchment P6G: Unit 10 Rear Roof and Deck Runoff Area=1,554 sf Runoff Depth=5.62"
Tc=0.0 min CN=98 Runoff=0.23 cfs 728 cf

Reach 8R: Swale Peak Depth=0.32' Max Vel=3.1 fps Inflow=4.02 cfs 9,918 cf
n=0.035 L=292.0' S=0.0334 '/' Capacity=34.69 cfs Outflow=3.94 cfs 9,918 cf

Reach 11R: Total Site Inflow=3.85 cfs 46,583 cf
Outflow=3.85 cfs 46,583 cf

Reach 12R: Pipe Peak Depth=0.47' Max Vel=6.8 fps Inflow=3.20 cfs 33,450 cf
D=18.0" n=0.011 L=95.0' S=0.0151 '/' Capacity=15.23 cfs Outflow=3.20 cfs 33,450 cf

Reach 13R: Grass Channel Peak Depth=0.28' Max Vel=2.2 fps Inflow=3.20 cfs 33,450 cf
n=0.035 L=240.0' S=0.0167 '/' Capacity=23.29 cfs Outflow=3.19 cfs 33,449 cf

Pond 2P: Trench 9 Peak Elev=9.27' Storage=232 cf Inflow=0.23 cfs 728 cf
Discarded=0.03 cfs 728 cf Primary=0.00 cfs 0 cf Outflow=0.03 cfs 728 cf

Pond 3P: Trench 2 Peak Elev=9.26' Storage=232 cf Inflow=0.20 cfs 728 cf
Discarded=0.03 cfs 728 cf Primary=0.00 cfs 0 cf Outflow=0.03 cfs 728 cf

Pond 4P: Forebay Peak Elev=43.81' Storage=541 cf Inflow=6.45 cfs 21,555 cf
Discarded=0.01 cfs 727 cf Primary=6.44 cfs 20,612 cf Outflow=6.46 cfs 21,339 cf

Pond 6P: Infiltration Pond Peak Elev=42.19' Storage=10,094 cf Inflow=6.44 cfs 20,612 cf
Discarded=0.09 cfs 4,085 cf Primary=1.24 cfs 15,386 cf Secondary=0.00 cfs 0 cf Outflow=1.33 cfs 19,470 cf

Pond 7P: Bioretention Area Peak Elev=54.79' Storage=2,312 cf Inflow=4.21 cfs 15,466 cf
Discarded=0.11 cfs 5,548 cf Primary=4.02 cfs 9,918 cf Outflow=4.13 cfs 15,466 cf

Pond 10P: Trench 3 Peak Elev=8.41' Storage=416 cf Inflow=0.40 cfs 1,457 cf
Discarded=0.07 cfs 1,457 cf Primary=0.00 cfs 0 cf Outflow=0.07 cfs 1,457 cf

Pond 11P: Field Peak Elev=40.76' Storage=3,177 cf Inflow=3.20 cfs 18,067 cf
12.0" x 18.0' Culvert Outflow=1.99 cfs 18,064 cf

Pond 12P: Trench 1 Peak Elev=8.91' Storage=251 cf Inflow=0.20 cfs 728 cf
Discarded=0.02 cfs 728 cf Primary=0.00 cfs 0 cf Outflow=0.02 cfs 728 cf

Pond 13P: Trench 4 Peak Elev=9.13' Storage=228 cf Inflow=0.20 cfs 728 cf
Discarded=0.03 cfs 728 cf Primary=0.00 cfs 0 cf Outflow=0.03 cfs 728 cf

Pond 14P: Trench 5 Peak Elev=9.26' Storage=231 cf Inflow=0.20 cfs 728 cf
Discarded=0.03 cfs 728 cf Primary=0.00 cfs 0 cf Outflow=0.03 cfs 728 cf

Pond 15P: Trench 8 Peak Elev=9.80' Storage=242 cf Inflow=0.20 cfs 728 cf
Discarded=0.03 cfs 728 cf Primary=0.00 cfs 0 cf Outflow=0.03 cfs 728 cf

Pond 16P: Trench 6 Peak Elev=8.44' Storage=209 cf Inflow=0.23 cfs 728 cf
Discarded=0.04 cfs 728 cf Primary=0.00 cfs 0 cf Outflow=0.04 cfs 728 cf

Pond 17P: Upper Forebay Peak Elev=54.98' Storage=637 cf Inflow=4.24 cfs 17,552 cf
Discarded=0.03 cfs 1,969 cf Primary=4.21 cfs 15,466 cf Outflow=4.24 cfs 17,435 cf

Pond 18P: Trench 7 Peak Elev=8.44' Storage=209 cf Inflow=0.23 cfs 728 cf
Discarded=0.04 cfs 728 cf Primary=0.00 cfs 0 cf Outflow=0.04 cfs 728 cf

Link 8L: Wood Road Culvert (POA#1) Inflow=3.61 cfs 40,275 cf
Primary=3.61 cfs 40,275 cf

Link 9L: Northern Wetland (POA#3) Inflow=0.15 cfs 3,023 cf
Primary=0.15 cfs 3,023 cf

Link 10L: Ipswich River (POA#2) Inflow=0.12 cfs 3,285 cf
Primary=0.12 cfs 3,285 cf

Total Runoff Area = 701,439 sf Runoff Volume = 67,671 cf Average Runoff Depth = 1.16"

Subcatchment P1: Eastern Development Area

Runoff = 2.52 cfs @ 12.28 hrs, Volume= 11,637 cf, Depth= 2.97"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.86"

Area (sf)	CN	Description
19,843	98	Paved parking & roofs
13,827	39	>75% Grass cover, Good, HSG A
2,370	61	>75% Grass cover, Good, HSG B
10,933	74	>75% Grass cover, Good, HSG C
46,973	73	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.9	77	0.0129	0.1		**Sheet Flow, A to B** Grass: Dense n= 0.240 P2= 3.15"
0.1	5	0.0150	0.7		**Sheet Flow, B to C** Smooth surfaces n= 0.011 P2= 3.15"
1.2	4	0.0150	0.1		**Sheet Flow, C to D** Grass: Dense n= 0.240 P2= 3.15"
0.2	14	0.0285	1.1		**Sheet Flow, D to E** Smooth surfaces n= 0.011 P2= 3.15"
0.1	32	0.1150	6.9		**Shallow Concentrated Flow, E to F** Paved Kv= 20.3 fps
4.4	262	0.0460	1.0	5.95	**Channel Flow, F to G** Area= 6.0 sf Perim= 9.3' r= 0.65' n= 0.240 Sheet flow over Dense Grass
19.9	394	Total			

Subcatchment P2: Western Development Area

Runoff = 4.24 cfs @ 12.21 hrs, Volume= 17,552 cf, Depth= 3.36"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.86"

Area (sf)	CN	Description
40,549	98	Paved parking & roofs
22,191	39	>75% Grass cover, Good, HSG A
62,740	77	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	98	0.0224	0.1		**Sheet Flow, A to B** Grass: Dense n= 0.240 P2= 3.15"
1.2	160	0.0112	2.1		**Shallow Concentrated Flow, B to C** Paved Kv= 20.3 fps
0.6	143	0.0210	4.1	0.81	**Circular Channel (pipe), C to D** Diam= 6.0" Area= 0.2 sf Perim= 1.6' r= 0.13' n= 0.013 Corrugated PE, smooth interior
15.3	401	Total			

Subcatchment P3: South of Access Road

Runoff = 1.20 cfs @ 12.25 hrs, Volume= 6,826 cf, Depth= 0.94"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.86"

Area (sf)	CN	Description
32,400	30	Meadow, non-grazed, HSG A
50,084	58	Meadow, non-grazed, HSG B
4,749	71	Meadow, non-grazed, HSG C
87,233	48	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.6	25	0.3200	0.3		**Sheet Flow, A to B** Grass: Dense n= 0.240 P2= 3.15"
8.7	75	0.0400	0.1		**Sheet Flow, B to C** Grass: Dense n= 0.240 P2= 3.15"
3.3	178	0.0168	0.9		**Shallow Concentrated Flow, C to D** Short Grass Pasture Kv= 7.0 fps
13.6	278	Total			

Subcatchment P4: North of Access Road

Runoff = 3.20 cfs @ 12.40 hrs, Volume= 18,067 cf, Depth= 1.59"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.86"

Area (sf)	CN	Description
31,204	30	Meadow, non-grazed, HSG A
48,458	58	Meadow, non-grazed, HSG B
56,550	71	Meadow, non-grazed, HSG C
136,212	57	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.3	100	0.0060	0.1		**Sheet Flow, A to B** Grass: Dense n= 0.240 P2= 3.15"
2.2	162	0.0310	1.2		**Shallow Concentrated Flow, B to C** Short Grass Pasture Kv= 7.0 fps
25.5	262	Total			

Subcatchment P5: Northwest Site

Runoff = 0.15 cfs @ 12.72 hrs, Volume= 3,023 cf, Depth= 0.26"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.86"

Area (sf)	CN	Description
102,199	30	Meadow, non-grazed, HSG A
16,611	58	Meadow, non-grazed, HSG B
5,517	71	Meadow, non-grazed, HSG C
12,836	39	>75% Grass cover, Good, HSG A
137,163	36	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.6	100	0.0120	0.1		**Sheet Flow, A to B** Grass: Dense n= 0.240 P2= 3.15"
4.2	449	0.0660	1.8		**Shallow Concentrated Flow, B to POA 3** Short Grass Pasture Kv= 7.0 fps
21.8	549	Total			

Subcatchment P5A: Unit 11 Rear Roof and Deck

Runoff = 0.20 cfs @ 12.09 hrs, Volume= 728 cf, Depth= 5.62"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.86"

Area (sf)	CN	Description
1,554	98	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.2	25	0.2000	2.6		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.15"
0.2	25	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P5B: Unit 12 Rear Roof and Deck

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 0.23 cfs @ 12.00 hrs, Volume= 728 cf, Depth= 5.62"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.86"

Area (sf)	CN	Description
1,554	98	

Subcatchment P6: Southwest Site

Runoff = 0.12 cfs @ 13.82 hrs, Volume= 3,285 cf, Depth= 0.18"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.86"

Area (sf)	CN	Description
172,547	30	Meadow, non-grazed, HSG A
11,073	78	Meadow, non-grazed, HSG D
31,956	39	>75% Grass cover, Good, HSG A
215,576	34	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.4	22	0.3180	0.3		**Sheet Flow, A to B** Grass: Dense n= 0.240 P2= 3.15"
8.3	50	0.0200	0.1		**Sheet Flow, B to C** Grass: Dense n= 0.240 P2= 3.15"
1.2	162	0.1046	2.3		**Shallow Concentrated Flow, C to POA #3** Short Grass Pasture Kv= 7.0 fps
10.9	234	Total			

Subcatchment P6A: Unit 2 Rear Roof and Deck

Runoff = 0.20 cfs @ 12.09 hrs, Volume= 728 cf, Depth= 5.62"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.86"

Area (sf)	CN	Description
1,554	98	Paved parking & roofs

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.2	25	0.2000	2.6		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.15"
0.2	25	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P6B: Unit 3 Rear Roof and Deck

Runoff = 0.20 cfs @ 12.09 hrs, Volume= 728 cf, Depth= 5.62"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.86"

Area (sf)	CN	Description
1,554	98	Paved parking & roofs

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.2	25	0.2000	2.6		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.15"
0.2	25	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P6C: Unit 4,5,6 Rear Roof and Deck

Runoff = 0.40 cfs @ 12.09 hrs, Volume= 1,457 cf, Depth= 5.62"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.86"

Area (sf)	CN	Description
3,110	98	Paved parking & roofs

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.2	25	0.2000	2.6		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.15"
0.2	25	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P6D: Unit 7 Rear Roof and Deck

Runoff = 0.20 cfs @ 12.09 hrs, Volume= 728 cf, Depth= 5.62"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.86"

Area (sf)	CN	Description
1,554	98	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.2	25	0.2000	2.6		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.15"
0.2	25	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P6E: Unit 8 Rear Roof and Deck

Runoff = 0.20 cfs @ 12.09 hrs, Volume= 728 cf, Depth= 5.62"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.86"

Area (sf)	CN	Description
1,554	98	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.2	25	0.2000	2.6		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.15"
0.2	25	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P6F: Unit 9 Rear Roof and Deck

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 0.23 cfs @ 12.00 hrs, Volume= 728 cf, Depth= 5.62"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.86"

Area (sf)	CN	Description
1,554	98	

Subcatchment P6G: Unit 10 Rear Roof and Deck

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 0.23 cfs @ 12.00 hrs, Volume= 728 cf, Depth= 5.62"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.86"

Area (sf)	CN	Description
1,554	98	

Reach 8R: Swale

[65] Warning: Inlet elevation not specified

Inflow Area = 62,740 sf, Inflow Depth = 1.90" for 25 yr event
Inflow = 4.02 cfs @ 12.25 hrs, Volume= 9,918 cf
Outflow = 3.94 cfs @ 12.30 hrs, Volume= 9,918 cf, Atten= 2%, Lag= 2.9 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.1 fps, Min. Travel Time= 1.6 min
Avg. Velocity = 1.0 fps, Avg. Travel Time= 4.7 min

Peak Depth= 0.32' @ 12.27 hrs
Capacity at bank full= 34.69 cfs
3.00' x 1.00' deep channel, n= 0.035 High grass
Side Slope Z-value= 3.0 '/' Top Width= 9.00'
Length= 292.0' Slope= 0.0334 '/'

Reach 11R: Total Site

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 701,439 sf, Inflow Depth > 0.80" for 25 yr event
Inflow = 3.85 cfs @ 12.77 hrs, Volume= 46,583 cf
Outflow = 3.85 cfs @ 12.77 hrs, Volume= 46,583 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Reach 12R: Pipe

[52] Hint: Inlet conditions not evaluated
[81] Warning: Exceeded Pond 6P by 0.70' @ 12.00 hrs
[79] Warning: Submerged Pond 11P Primary device # 1 OUTLET by 0.23'

Inflow Area = 245,925 sf, Inflow Depth > 1.63" for 25 yr event
Inflow = 3.20 cfs @ 12.77 hrs, Volume= 33,450 cf
Outflow = 3.20 cfs @ 12.78 hrs, Volume= 33,450 cf, Atten= 0%, Lag= 0.8 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 6.8 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 3.0 fps, Avg. Travel Time= 0.5 min

Peak Depth= 0.47' @ 12.78 hrs
Capacity at bank full= 15.23 cfs
Inlet Invert= 39.53', Outlet Invert= 38.10'
18.0" Diameter Pipe, n= 0.011 Concrete pipe, straight & clean
Length= 95.0' Slope= 0.0151 '/'

Reach 13R: Grass Channel

Inflow Area = 245,925 sf, Inflow Depth > 1.63" for 25 yr event
Inflow = 3.20 cfs @ 12.78 hrs, Volume= 33,450 cf
Outflow = 3.19 cfs @ 12.83 hrs, Volume= 33,449 cf, Atten= 0%, Lag= 2.7 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.2 fps, Min. Travel Time= 1.8 min
Avg. Velocity = 0.8 fps, Avg. Travel Time= 4.8 min

Peak Depth= 0.28' @ 12.80 hrs
Capacity at bank full= 23.29 cfs
Inlet Invert= 36.00', Outlet Invert= 32.00'
5.00' x 1.00' deep channel, n= 0.035 High grass
Side Slope Z-value= 0.2 '/' Top Width= 5.40'
Length= 240.0' Slope= 0.0167 '/'

Pond 2P: Trench 9

Inflow Area = 1,554 sf, Inflow Depth = 5.62" for 25 yr event
Inflow = 0.23 cfs @ 12.00 hrs, Volume= 728 cf
Outflow = 0.03 cfs @ 12.47 hrs, Volume= 728 cf, Atten= 87%, Lag= 28.1 min
Discarded = 0.03 cfs @ 12.47 hrs, Volume= 728 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 9.27' @ 12.47 hrs Surf.Area= 256 sf Storage= 232 cf
Plug-Flow detention time= 56.9 min calculated for 727 cf (100% of inflow)
Center-of-Mass det. time= 56.8 min (796.7 - 739.9)

Volume	Invert	Avail.Storage	Storage Description
#1	7.00'	323 cf	**Custom Stage Data (Irregular)** Listed below (Recalc) 808 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
7.00	256	136.0	0	0	256
8.00	256	136.0	256	256	392
9.00	256	136.0	256	512	528
10.00	256	136.0	256	768	664
10.01	10,000	2,000.0	40	808	317,502

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**2.410 in/hr Exfiltration over Wetted area**
#2	Primary	10.00'	**10.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=0.03 cfs @ 12.47 hrs HW=9.27' (Free Discharge)
1=Exfiltration (Exfiltration Controls 0.03 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=7.00' (Free Discharge)
2=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Pond 3P: Trench 2

Inflow Area = 1,554 sf, Inflow Depth = 5.62" for 25 yr event
Inflow = 0.20 cfs @ 12.09 hrs, Volume= 728 cf
Outflow = 0.03 cfs @ 12.57 hrs, Volume= 728 cf, Atten= 84%, Lag= 28.9 min
Discarded = 0.03 cfs @ 12.57 hrs, Volume= 728 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 9.26' @ 12.57 hrs Surf.Area= 256 sf Storage= 232 cf
Plug-Flow detention time= 56.9 min calculated for 728 cf (100% of inflow)
Center-of-Mass det. time= 56.8 min (802.3 - 745.5)

Volume	Invert	Avail.Storage	Storage Description
#1	7.00'	607 cf	**Custom Stage Data (Irregular)**Listed below (Recalc) 1,519 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
7.00	256	136.0	0	0	256
8.00	256	136.0	256	256	392
9.00	256	136.0	256	512	528
10.00	256	136.0	256	768	664
10.10	20,000	3,000.0	751	1,519	715,389

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**2.410 in/hr Exfiltration over Wetted area**
#2	Primary	10.00'	**10.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=0.03 cfs @ 12.57 hrs HW=9.26' (Free Discharge)
1=Exfiltration (Exfiltration Controls 0.03 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=7.00' (Free Discharge)
2=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Pond 4P: Forebay

[88] Warning: Qout>Qin may require Finer Routing>1

Inflow Area = 109,713 sf, Inflow Depth = 2.36" for 25 yr event
Inflow = 6.45 cfs @ 12.29 hrs, Volume= 21,555 cf
Outflow = 6.46 cfs @ 12.30 hrs, Volume= 21,339 cf, Atten= 0%, Lag= 0.3 min
Discarded = 0.01 cfs @ 12.30 hrs, Volume= 727 cf
Primary = 6.44 cfs @ 12.30 hrs, Volume= 20,612 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Peak Elev= 43.81' @ 12.30 hrs Surf.Area= 531 sf Storage= 541 cf
Plug-Flow detention time= 16.7 min calculated for 21,339 cf (99% of inflow)
Center-of-Mass det. time= 10.6 min (826.2 - 815.6)

Volume	Invert	Avail.Storage	Storage Description
#1	42.00'	646 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
42.00	119	0	0
43.00	293	206	206
44.00	586	440	646

Device	Routing	Invert	Outlet Devices
#1	Primary	43.50'	**15.0' long x 6.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.37 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
#2	Discarded	0.00'	**1.020 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.01 cfs @ 12.30 hrs HW=43.81' (Free Discharge)
2=Exfiltration (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=6.43 cfs @ 12.30 hrs HW=43.81' (Free Discharge)
1=Broad-Crested Rectangular Weir (Weir Controls 6.43 cfs @ 1.4 fps)

Pond 6P: Infiltration Pond

Inflow Area = 109,713 sf, Inflow Depth = 2.25" for 25 yr event
Inflow = 6.44 cfs @ 12.30 hrs, Volume= 20,612 cf
Outflow = 1.33 cfs @ 12.93 hrs, Volume= 19,470 cf, Atten= 79%, Lag= 37.8 min
Discarded = 0.09 cfs @ 12.93 hrs, Volume= 4,085 cf
Primary = 1.24 cfs @ 12.93 hrs, Volume= 15,386 cf
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 42.19' @ 12.93 hrs Surf.Area= 3,924 sf Storage= 10,094 cf
Plug-Flow detention time= 169.5 min calculated for 19,470 cf (94% of inflow)
Center-of-Mass det. time= 143.7 min (957.7 - 814.0)

Volume	Invert	Avail.Storage	Storage Description
#1	38.50'	18,402 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
38.50	1,459	0	0
39.00	1,957	854	854
40.00	2,510	2,234	3,088
41.00	3,120	2,815	5,903
42.00	3,786	3,453	9,356
43.00	4,509	4,148	13,503
44.00	5,289	4,899	18,402

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	39.63'	**4.0" Vert. Orifice/Grate** C= 0.600
#3	Primary	41.17'	**5.0" Vert. Orifice/Grate** C= 0.600
#4	Primary	42.60'	**2.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#5	Secondary	43.36'	**10.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Discarded OutFlow Max=0.09 cfs @ 12.93 hrs HW=42.19' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.09 cfs)

Primary OutFlow Max=1.24 cfs @ 12.93 hrs HW=42.19' (Free Discharge)
├**2=Orifice/Grate** (Orifice Controls 0.65 cfs @ 7.5 fps)
├**3=Orifice/Grate** (Orifice Controls 0.59 cfs @ 4.3 fps)
└**4=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=38.50' (Free Discharge)
└**5=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 7P: Bioretention Area

[79] Warning: Submerged Pond 17P Primary device # 2 by 0.04'

Inflow Area = 62,740 sf, Inflow Depth = 2.96" for 25 yr event
Inflow = 4.21 cfs @ 12.22 hrs, Volume= 15,466 cf
Outflow = 4.13 cfs @ 12.25 hrs, Volume= 15,466 cf, Atten= 2%, Lag= 1.9 min
Discarded = 0.11 cfs @ 12.25 hrs, Volume= 5,548 cf
Primary = 4.02 cfs @ 12.25 hrs, Volume= 9,918 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 54.79' @ 12.25 hrs Surf.Area= 2,026 sf Storage= 2,312 cf
Plug-Flow detention time= 90.5 min calculated for 15,466 cf (100% of inflow)
Center-of-Mass det. time= 90.5 min (912.5 - 822.0)

Volume	Invert	Avail.Storage	Storage Description
#1	53.00'	2,748 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
53.00	593	0	0
54.00	1,350	972	972
55.00	2,202	1,776	2,748

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	54.50'	**10.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Discarded OutFlow Max=0.11 cfs @ 12.25 hrs HW=54.79' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.11 cfs)

Primary OutFlow Max=4.01 cfs @ 12.25 hrs HW=54.79' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** (Weir Controls 4.01 cfs @ 1.4 fps)

Pond 10P: Trench 3

Inflow Area = 3,110 sf, Inflow Depth = 5.62" for 25 yr event
Inflow = 0.40 cfs @ 12.09 hrs, Volume= 1,457 cf
Outflow = 0.07 cfs @ 12.54 hrs, Volume= 1,457 cf, Atten= 82%, Lag= 27.3 min
Discarded = 0.07 cfs @ 12.54 hrs, Volume= 1,457 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 8.41' @ 12.54 hrs Surf.Area= 736 sf Storage= 416 cf
Plug-Flow detention time= 39.9 min calculated for 1,457 cf (100% of inflow)
Center-of-Mass det. time= 39.8 min (785.3 - 745.5)

Volume	Invert	Avail.Storage	Storage Description
#1	7.00'	1,063 cf	**Custom Stage Data (Irregular)** Listed below (Recalc) 2,656 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
7.00	736	376.0	0	0	736
8.00	736	376.0	736	736	1,112
9.00	736	376.0	736	1,472	1,488
10.00	736	376.0	736	2,208	1,864
10.10	10,000	2,000.0	448	2,656	308,924

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**2.420 in/hr Exfiltration over Wetted area**
#2	Primary	10.00'	**10.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=0.07 cfs @ 12.54 hrs HW=8.41' (Free Discharge)
1=Exfiltration (Exfiltration Controls 0.07 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=7.00' (Free Discharge)
2=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Pond 11P: Field

Inflow Area = 136,212 sf, Inflow Depth = 1.59" for 25 yr event
Inflow = 3.20 cfs @ 12.40 hrs, Volume= 18,067 cf
Outflow = 1.99 cfs @ 12.73 hrs, Volume= 18,064 cf, Atten= 38%, Lag= 19.6 min
Primary = 1.99 cfs @ 12.73 hrs, Volume= 18,064 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 40.76' @ 12.73 hrs Surf.Area= 7,882 sf Storage= 3,177 cf
Plug-Flow detention time= 25.3 min calculated for 18,064 cf (100% of inflow)
Center-of-Mass det. time= 25.1 min (916.0 - 890.9)

Volume	Invert	Avail.Storage	Storage Description
#1	40.00'	15,029 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
40.00	480	0	0
41.00	10,219	5,350	5,350
41.50	28,498	9,679	15,029

Device	Routing	Invert	Outlet Devices
#1	Primary	40.00'	**12.0" x 18.0' long Culvert** RCP, rounded edge headwall, Ke= 0.100 Outlet Invert= 39.77' S= 0.0128 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean

Primary OutFlow Max=1.98 cfs @ 12.73 hrs HW=40.76' (Free Discharge)
1=Culvert (Barrel Controls 1.98 cfs @ 4.3 fps)

Pond 12P: Trench 1

Inflow Area = 1,554 sf, Inflow Depth = 5.62" for 25 yr event
Inflow = 0.20 cfs @ 12.09 hrs, Volume= 728 cf
Outflow = 0.02 cfs @ 11.35 hrs, Volume= 728 cf, Atten= 91%, Lag= 0.0 min
Discarded = 0.02 cfs @ 11.35 hrs, Volume= 728 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 8.91' @ 12.94 hrs Surf.Area= 328 sf Storage= 251 cf
Plug-Flow detention time= 94.5 min calculated for 727 cf (100% of inflow)
Center-of-Mass det. time= 94.3 min (839.8 - 745.5)

Volume	Invert	Avail.Storage	Storage Description
#1	7.00'	555 cf	**Custom Stage Data (Irregular)** Listed below (Recalc) 1,389 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
7.00	328	172.0	0	0	328
8.00	328	172.0	328	328	500
9.00	328	172.0	328	656	672
10.00	328	172.0	328	984	844
10.10	10,000	2,000.0	405	1,389	316,800

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	10.00'	**10.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=0.02 cfs @ 11.35 hrs HW=7.03' (Free Discharge)
1=Exfiltration (Exfiltration Controls 0.02 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=7.00' (Free Discharge)
2=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Pond 13P: Trench 4

Inflow Area = 1,554 sf, Inflow Depth = 5.62" for 25 yr event
Inflow = 0.20 cfs @ 12.09 hrs, Volume= 728 cf
Outflow = 0.03 cfs @ 12.56 hrs, Volume= 728 cf, Atten= 84%, Lag= 28.7 min
Discarded = 0.03 cfs @ 12.56 hrs, Volume= 728 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 9.13' @ 12.56 hrs Surf.Area= 268 sf Storage= 228 cf
Plug-Flow detention time= 54.3 min calculated for 727 cf (100% of inflow)
Center-of-Mass det. time= 54.2 min (799.7 - 745.5)

Volume	Invert	Avail.Storage	Storage Description
#1	7.00'	480 cf	**Custom Stage Data (Irregular)** Listed below (Recalc) 1,201 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
7.00	268	142.0	0	0	268
8.00	268	142.0	268	268	410
9.00	268	142.0	268	536	552
10.00	268	142.0	268	804	694
10.10	10,000	2,000.0	397	1,201	317,399

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**2.420 in/hr Exfiltration over Wetted area**
#2	Primary	10.00'	**10.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=0.03 cfs @ 12.56 hrs HW=9.13' (Free Discharge)
1=Exfiltration (Exfiltration Controls 0.03 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=7.00' (Free Discharge)
2=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Pond 14P: Trench 5

Inflow Area = 1,554 sf, Inflow Depth = 5.62" for 25 yr event
Inflow = 0.20 cfs @ 12.09 hrs, Volume= 728 cf
Outflow = 0.03 cfs @ 12.57 hrs, Volume= 728 cf, Atten= 84%, Lag= 28.8 min
Discarded = 0.03 cfs @ 12.57 hrs, Volume= 728 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 9.26' @ 12.57 hrs Surf.Area= 256 sf Storage= 231 cf
Plug-Flow detention time= 56.5 min calculated for 728 cf (100% of inflow)
Center-of-Mass det. time= 56.5 min (802.0 - 745.5)

Volume	Invert	Avail.Storage	Storage Description
#1	7.00'	465 cf	**Custom Stage Data (Irregular)** Listed below (Recalc) 1,163 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
7.00	256	136.0	0	0	256
8.00	256	136.0	256	256	392
9.00	256	136.0	256	512	528
10.00	256	136.0	256	768	664
10.10	10,000	2,000.0	395	1,163	317,502

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**2.420 in/hr Exfiltration over Wetted area**
#2	Primary	10.00'	**10.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=0.03 cfs @ 12.57 hrs HW=9.26' (Free Discharge)
1=Exfiltration (Exfiltration Controls 0.03 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=7.00' (Free Discharge)
2=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Pond 15P: Trench 8

Inflow Area = 1,554 sf, Inflow Depth = 5.62" for 25 yr event
Inflow = 0.20 cfs @ 12.09 hrs, Volume= 728 cf
Outflow = 0.03 cfs @ 12.58 hrs, Volume= 728 cf, Atten= 85%, Lag= 29.4 min
Discarded = 0.03 cfs @ 12.58 hrs, Volume= 728 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 9.80' @ 12.58 hrs Surf.Area= 216 sf Storage= 242 cf
Plug-Flow detention time= 65.5 min calculated for 728 cf (100% of inflow)
Center-of-Mass det. time= 65.4 min (810.9 - 745.5)

Volume	Invert	Avail.Storage	Storage Description
#1	7.00'	415 cf	**Custom Stage Data (Irregular)** Listed below (Recalc) 1,038 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
7.00	216	116.0	0	0	216
8.00	216	116.0	216	216	332
9.00	216	116.0	216	432	448
10.00	216	116.0	216	648	564
10.10	10,000	2,000.0	390	1,038	317,803

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**2.420 in/hr Exfiltration over Wetted area**
#2	Primary	10.00'	**10.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=0.03 cfs @ 12.58 hrs HW=9.80' (Free Discharge)
1=Exfiltration (Exfiltration Controls 0.03 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=7.00' (Free Discharge)
2=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Pond 16P: Trench 6

Inflow Area = 1,554 sf, Inflow Depth = 5.62" for 25 yr event
Inflow = 0.23 cfs @ 12.00 hrs, Volume= 728 cf
Outflow = 0.04 cfs @ 12.44 hrs, Volume= 728 cf, Atten= 85%, Lag= 26.7 min
Discarded = 0.04 cfs @ 12.44 hrs, Volume= 728 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 8.44' @ 12.44 hrs Surf.Area= 364 sf Storage= 209 cf
Plug-Flow detention time= 40.2 min calculated for 727 cf (100% of inflow)
Center-of-Mass det. time= 40.2 min (780.1 - 739.9)

Volume	Invert	Avail.Storage	Storage Description
#1	7.00'	600 cf	**Custom Stage Data (Irregular)** Listed below (Recalc) 1,501 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
7.00	364	190.0	0	0	364
8.00	364	190.0	364	364	554
9.00	364	190.0	364	728	744
10.00	364	190.0	364	1,092	934
10.10	10,000	2,000.0	409	1,501	316,371

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**2.410 in/hr Exfiltration over Wetted area**
#2	Primary	10.00'	**10.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=0.04 cfs @ 12.44 hrs HW=8.44' (Free Discharge)
↑**1=Exfiltration** (Exfiltration Controls 0.04 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=7.00' (Free Discharge)
↑**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 17P: Upper Forebay

Inflow Area = 62,740 sf, Inflow Depth = 3.36" for 25 yr event
Inflow = 4.24 cfs @ 12.21 hrs, Volume= 17,552 cf
Outflow = 4.24 cfs @ 12.22 hrs, Volume= 17,435 cf, Atten= 0%, Lag= 0.3 min
Discarded = 0.03 cfs @ 12.22 hrs, Volume= 1,969 cf
Primary = 4.21 cfs @ 12.22 hrs, Volume= 15,466 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 54.98' @ 12.22 hrs Surf.Area= 577 sf Storage= 637 cf
Plug-Flow detention time= 29.9 min calculated for 17,406 cf (99% of inflow)
Center-of-Mass det. time= 26.3 min (857.6 - 831.2)

Volume	Invert	Avail.Storage	Storage Description
#1	53.00'	644 cf	**Custom Stage Data (Prismatic)** Listed below

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
53.00	88	0	0
54.00	309	199	199
55.00	581	445	644

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	54.75'	**15.0' long x 3.0' breadth Broad-Crested Rectangular Weir**

Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50
Coef. (English) 2.44 2.58 2.68 2.67 2.65 2.64 2.64 2.68 2.68 2.72 2.81 2.92 2.97 3.07 3.32

Discarded OutFlow Max=0.03 cfs @ 12.22 hrs HW=54.98' (Free Discharge)
↑**1=Exfiltration** (Exfiltration Controls 0.03 cfs)

Primary OutFlow Max=4.15 cfs @ 12.22 hrs HW=54.98' (Free Discharge)
↑**2=Broad-Crested Rectangular Weir** (Weir Controls 4.15 cfs @ 1.2 fps)

Pond 18P: Trench 7

Inflow Area = 1,554 sf, Inflow Depth = 5.62" for 25 yr event
Inflow = 0.23 cfs @ 12.00 hrs, Volume= 728 cf
Outflow = 0.04 cfs @ 12.44 hrs, Volume= 728 cf, Atten= 85%, Lag= 26.7 min
Discarded = 0.04 cfs @ 12.44 hrs, Volume= 728 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 8.44' @ 12.44 hrs Surf.Area= 364 sf Storage= 209 cf
Plug-Flow detention time= 40.2 min calculated for 727 cf (100% of inflow)
Center-of-Mass det. time= 40.1 min (780.1 - 739.9)

Volume	Invert	Avail.Storage	Storage Description
#1	7.00'	453 cf	**Custom Stage Data (Irregular)** Listed below (Recalc) 1,133 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
7.00	364	190.0	0	0	364
8.00	364	190.0	364	364	554
9.00	364	190.0	364	728	744
10.00	364	190.0	364	1,092	934
10.01	10,000	2,000.0	41	1,133	316,371

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**2.410 in/hr Exfiltration over Wetted area**
#2	Primary	10.00'	**10.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=0.04 cfs @ 12.44 hrs HW=8.44' (Free Discharge)
↑**1=Exfiltration** (Exfiltration Controls 0.04 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=7.00' (Free Discharge)
↑**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Link 8L: Wood Road Culvert (POA#1)

Inflow Area = 333,158 sf, Inflow Depth > 1.45" for 25 yr event
Inflow = 3.61 cfs @ 12.76 hrs, Volume= 40,275 cf
Primary = 3.61 cfs @ 12.76 hrs, Volume= 40,275 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Link 9L: Northern Wetland (POA#3)

Inflow Area = 140,271 sf, Inflow Depth = 0.26" for 25 yr event
Inflow = 0.15 cfs @ 12.72 hrs, Volume= 3,023 cf
Primary = 0.15 cfs @ 12.72 hrs, Volume= 3,023 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Link 10L: Ipswich River (POA#2)

Inflow Area = 228,010 sf, Inflow Depth = 0.17" for 25 yr event
Inflow = 0.12 cfs @ 13.82 hrs, Volume= 3,285 cf
Primary = 0.12 cfs @ 13.82 hrs, Volume= 3,285 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Time span=0.00-30.00 hrs, dt=0.05 hrs, 601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment P1: Eastern Development Area Runoff Area=46,973 sf Runoff Depth=5.07"
Flow Length=394' Tc=19.9 min CN=73 Runoff=4.32 cfs 19,837 cf

Subcatchment P2: Western Development Area Runoff Area=62,740 sf Runoff Depth=5.54"
Flow Length=401' Tc=15.3 min CN=77 Runoff=6.95 cfs 28,970 cf

Subcatchment P3: South of Access Road Runoff Area=87,233 sf Runoff Depth=2.21"
Flow Length=278' Tc=13.6 min CN=48 Runoff=3.63 cfs 16,074 cf

Subcatchment P4: North of Access Road Runoff Area=136,212 sf Runoff Depth=3.21"
Flow Length=262' Tc=25.5 min CN=57 Runoff=6.94 cfs 36,438 cf

Subcatchment P5: Northwest Site Runoff Area=137,163 sf Runoff Depth=1.00"
Flow Length=549' Tc=21.8 min CN=36 Runoff=1.44 cfs 11,381 cf

Subcatchment P5A: Unit 11 Rear Roof and Deck Runoff Area=1,554 sf Runoff Depth=8.05"
Flow Length=25' Tc=6.0 min CN=98 Runoff=0.28 cfs 1,042 cf

Subcatchment P5B: Unit 12 Rear Roof and Deck Runoff Area=1,554 sf Runoff Depth=8.05"
Tc=0.0 min CN=98 Runoff=0.33 cfs 1,042 cf

Subcatchment P6: Southwest Site Runoff Area=215,576 sf Runoff Depth=0.82"
Flow Length=234' Tc=10.9 min CN=34 Runoff=1.86 cfs 14,652 cf

Subcatchment P6A: Unit 2 Rear Roof and Deck Runoff Area=1,554 sf Runoff Depth=8.05"
Flow Length=25' Tc=6.0 min CN=98 Runoff=0.28 cfs 1,042 cf

Subcatchment P6B: Unit 3 Rear Roof and Deck Runoff Area=1,554 sf Runoff Depth=8.05"
Flow Length=25' Tc=6.0 min CN=98 Runoff=0.28 cfs 1,042 cf

Subcatchment P6C: Unit 4,5,6 Rear Roof and Deck Runoff Area=3,110 sf Runoff Depth=8.05"
Flow Length=25' Tc=6.0 min CN=98 Runoff=0.57 cfs 2,086 cf

Subcatchment P6D: Unit 7 Rear Roof and Deck Runoff Area=1,554 sf Runoff Depth=8.05"
Flow Length=25' Tc=6.0 min CN=98 Runoff=0.28 cfs 1,042 cf

Subcatchment P6E: Unit 8 Rear Roof and Deck Runoff Area=1,554 sf Runoff Depth=8.05"
Flow Length=25' Tc=6.0 min CN=98 Runoff=0.28 cfs 1,042 cf

Subcatchment P6F: Unit 9 Rear Roof and Deck Runoff Area=1,554 sf Runoff Depth=8.05"
Tc=0.0 min CN=98 Runoff=0.33 cfs 1,042 cf

Subcatchment P6G: Unit 10 Rear Roof and Deck Runoff Area=1,554 sf Runoff Depth=8.05"
Tc=0.0 min CN=98 Runoff=0.33 cfs 1,042 cf

Reach 8R: Swale Peak Depth=0.43' Max Vel=3.6 fps Inflow=6.70 cfs 20,050 cf
n=0.035 L=292.0' S=0.0334 '/' Capacity=34.69 cfs Outflow=6.59 cfs 20,050 cf

Reach 11R: Total Site Inflow=13.40 cfs 111,519 cf
Outflow=13.40 cfs 111,519 cf

Reach 12R: Pipe Peak Depth=0.84' Max Vel=9.0 fps Inflow=9.20 cfs 69,384 cf
D=18.0" n=0.011 L=95.0' S=0.0151 '/' Capacity=15.23 cfs Outflow=9.19 cfs 69,384 cf

Reach 13R: Grass Channel Peak Depth=0.55' Max Vel=3.3 fps Inflow=9.19 cfs 69,384 cf
n=0.035 L=240.0' S=0.0167 '/' Capacity=23.29 cfs Outflow=9.16 cfs 69,384 cf

Pond 2P: Trench 9 Peak Elev=10.00' Storage=307 cf Inflow=0.33 cfs 1,042 cf
Discarded=0.17 cfs 1,042 cf Primary=0.00 cfs 0 cf Outflow=0.17 cfs 1,042 cf

Pond 3P: Trench 2 Peak Elev=10.00' Storage=307 cf Inflow=0.28 cfs 1,042 cf
Discarded=0.17 cfs 1,040 cf Primary=0.00 cfs 2 cf Outflow=0.18 cfs 1,042 cf

Pond 4P: Forebay Peak Elev=43.93' Storage=607 cf Inflow=10.91 cfs 39,887 cf
Discarded=0.01 cfs 787 cf Primary=10.86 cfs 38,883 cf Outflow=10.87 cfs 39,670 cf

Pond 6P: Infiltration Pond Peak Elev=43.36' Storage=15,164 cf Inflow=10.86 cfs 38,883 cf
Discarded=0.11 cfs 4,631 cf Primary=5.70 cfs 32,949 cf Secondary=0.00 cfs 0 cf Outflow=5.81 cfs 37,581 cf

Pond 7P: Bioretention Area Peak Elev=54.91' Storage=2,549 cf Inflow=6.87 cfs 26,725 cf
Discarded=0.12 cfs 6,505 cf Primary=6.70 cfs 20,050 cf Outflow=6.81 cfs 26,555 cf

Pond 10P: Trench 3 Peak Elev=9.23' Storage=657 cf Inflow=0.57 cfs 2,086 cf
Discarded=0.09 cfs 2,086 cf Primary=0.00 cfs 0 cf Outflow=0.09 cfs 2,086 cf

Pond 11P: Field Peak Elev=41.19' Storage=7,899 cf Inflow=6.94 cfs 36,438 cf
12.0" x 18.0' Culvert Outflow=3.61 cfs 36,435 cf

Pond 12P: Trench 1 Peak Elev=10.00' Storage=394 cf Inflow=0.28 cfs 1,042 cf
Discarded=0.03 cfs 1,032 cf Primary=0.01 cfs 11 cf Outflow=0.04 cfs 1,042 cf

Pond 13P: Trench 4 Peak Elev=10.00' Storage=322 cf Inflow=0.28 cfs 1,042 cf
Discarded=0.16 cfs 1,040 cf Primary=0.01 cfs 2 cf Outflow=0.16 cfs 1,042 cf

Pond 14P: Trench 5 Peak Elev=10.00' Storage=308 cf Inflow=0.28 cfs 1,042 cf
Discarded=0.17 cfs 1,039 cf Primary=0.01 cfs 4 cf Outflow=0.18 cfs 1,042 cf

Pond 15P: Trench 8 Peak Elev=10.01' Storage=260 cf Inflow=0.28 cfs 1,042 cf
Discarded=0.20 cfs 1,034 cf Primary=0.01 cfs 9 cf Outflow=0.22 cfs 1,042 cf

Pond 16P: Trench 6 Peak Elev=9.27' Storage=330 cf Inflow=0.33 cfs 1,042 cf
Discarded=0.04 cfs 1,042 cf Primary=0.00 cfs 0 cf Outflow=0.04 cfs 1,042 cf

Pond 17P: Upper Forebay Peak Elev=55.07' Storage=644 cf Inflow=6.95 cfs 28,970 cf
Discarded=0.03 cfs 2,127 cf Primary=6.87 cfs 26,725 cf Outflow=6.90 cfs 28,852 cf

Pond 18P: Trench 7 Peak Elev=9.27' Storage=330 cf Inflow=0.33 cfs 1,042 cf
Discarded=0.04 cfs 1,042 cf Primary=0.00 cfs 0 cf Outflow=0.04 cfs 1,042 cf

Link 8L: Wood Road Culvert (POA#1) Inflow=10.66 cfs 85,458 cf
Primary=10.66 cfs 85,458 cf

Link 9L: Northern Wetland (POA#3) Inflow=1.45 cfs 11,390 cf
Primary=1.45 cfs 11,390 cf

Link 10L: Ipswich River (POA#2) Inflow=1.87 cfs 14,671 cf
Primary=1.87 cfs 14,671 cf

Total Runoff Area = 701,439 sf Runoff Volume = 137,779 cf Average Runoff Depth = 2.36"

Subcatchment P1: Eastern Development Area

Runoff = 4.32 cfs @ 12.27 hrs, Volume= 19,837 cf, Depth= 5.07"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=8.29"

Area (sf)	CN	Description
19,843	98	Paved parking & roofs
13,827	39	>75% Grass cover, Good, HSG A
2,370	61	>75% Grass cover, Good, HSG B
10,933	74	>75% Grass cover, Good, HSG C
46,973	73	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.9	77	0.0129	0.1		**Sheet Flow, A to B** Grass: Dense n= 0.240 P2= 3.15"
0.1	5	0.0150	0.7		**Sheet Flow, B to C** Smooth surfaces n= 0.011 P2= 3.15"
1.2	4	0.0150	0.1		**Sheet Flow, C to D** Grass: Dense n= 0.240 P2= 3.15"
0.2	14	0.0285	1.1		**Sheet Flow, D to E** Smooth surfaces n= 0.011 P2= 3.15"
0.1	32	0.1150	6.9		**Shallow Concentrated Flow, E to F** Paved Kv= 20.3 fps
4.4	262	0.0460	1.0	5.95	**Channel Flow, F to G** Area= 6.0 sf Perim= 9.3' r= 0.65' n= 0.240 Sheet flow over Dense Grass
19.9	394	Total			

Subcatchment P2: Western Development Area

Runoff = 6.95 cfs @ 12.21 hrs, Volume= 28,970 cf, Depth= 5.54"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=8.29"

Area (sf)	CN	Description
40,549	98	Paved parking & roofs
22,191	39	>75% Grass cover, Good, HSG A
62,740	77	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	98	0.0224	0.1		**Sheet Flow, A to B** Grass: Dense n= 0.240 P2= 3.15"
1.2	160	0.0112	2.1		**Shallow Concentrated Flow, B to C** Paved Kv= 20.3 fps
0.6	143	0.0210	4.1	0.81	**Circular Channel (pipe), C to D** Diam= 6.0" Area= 0.2 sf Perim= 1.6' r= 0.13' n= 0.013 Corrugated PE, smooth interior
15.3	401	Total			

Subcatchment P3: South of Access Road

Runoff = 3.63 cfs @ 12.21 hrs, Volume= 16,074 cf, Depth= 2.21"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=8.29"

Area (sf)	CN	Description
32,400	30	Meadow, non-grazed, HSG A
50,084	58	Meadow, non-grazed, HSG B
4,749	71	Meadow, non-grazed, HSG C
87,233	48	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.6	25	0.3200	0.3		**Sheet Flow, A to B** Grass: Dense n= 0.240 P2= 3.15"
8.7	75	0.0400	0.1		**Sheet Flow, B to C** Grass: Dense n= 0.240 P2= 3.15"
3.3	178	0.0168	0.9		**Shallow Concentrated Flow, C to D** Short Grass Pasture Kv= 7.0 fps
13.6	278	Total			

Subcatchment P4: North of Access Road

Runoff = 6.94 cfs @ 12.37 hrs, Volume= 36,438 cf, Depth= 3.21"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=8.29"

Area (sf)	CN	Description
31,204	30	Meadow, non-grazed, HSG A
48,458	58	Meadow, non-grazed, HSG B
56,550	71	Meadow, non-grazed, HSG C
136,212	57	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.3	100	0.0060	0.1		**Sheet Flow, A to B** Grass: Dense n= 0.240 P2= 3.15"
2.2	162	0.0310	1.2		**Shallow Concentrated Flow, B to C** Short Grass Pasture Kv= 7.0 fps
25.5	262	Total			

Subcatchment P5: Northwest Site

Runoff = 1.44 cfs @ 12.47 hrs, Volume= 11,381 cf, Depth= 1.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=8.29"

Area (sf)	CN	Description
102,199	30	Meadow, non-grazed, HSG A
16,611	58	Meadow, non-grazed, HSG B
5,517	71	Meadow, non-grazed, HSG C
12,836	39	>75% Grass cover, Good, HSG A
137,163	36	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.6	100	0.0120	0.1		**Sheet Flow, A to B** Grass: Dense n= 0.240 P2= 3.15"
4.2	449	0.0660	1.8		**Shallow Concentrated Flow, B to POA 3** Short Grass Pasture Kv= 7.0 fps
21.8	549	Total			

Subcatchment P5A: Unit 11 Rear Roof and Deck

Runoff = 0.28 cfs @ 12.09 hrs, Volume= 1,042 cf, Depth= 8.05"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=8.29"

Area (sf)	CN	Description
1,554	98	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.2	25	0.2000	2.6		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.15"
0.2	25	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P5B: Unit 12 Rear Roof and Deck

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 0.33 cfs @ 12.00 hrs, Volume= 1,042 cf, Depth= 8.05"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=8.29"

Area (sf)	CN	Description
1,554	98	

Subcatchment P6: Southwest Site

Runoff = 1.86 cfs @ 12.35 hrs, Volume= 14,652 cf, Depth= 0.82"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=8.29"

Area (sf)	CN	Description
172,547	30	Meadow, non-grazed, HSG A
11,073	78	Meadow, non-grazed, HSG D
31,956	39	>75% Grass cover, Good, HSG A
215,576	34	Weighted Average

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.4	22	0.3180	0.3		**Sheet Flow, A to B** Grass: Dense n= 0.240 P2= 3.15"
8.3	50	0.0200	0.1		**Sheet Flow, B to C** Grass: Dense n= 0.240 P2= 3.15"
1.2	162	0.1046	2.3		**Shallow Concentrated Flow, C to POA #3** Short Grass Pasture Kv= 7.0 fps
10.9	234	Total			

Subcatchment P6A: Unit 2 Rear Roof and Deck

Runoff = 0.28 cfs @ 12.09 hrs, Volume= 1,042 cf, Depth= 8.05"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=8.29"

Area (sf)	CN	Description
1,554	98	Paved parking & roofs

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.2	25	0.2000	2.6		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.15"
0.2	25	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P6B: Unit 3 Rear Roof and Deck

Runoff = 0.28 cfs @ 12.09 hrs, Volume= 1,042 cf, Depth= 8.05"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=8.29"

Area (sf)	CN	Description
1,554	98	Paved parking & roofs

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.2	25	0.2000	2.6		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.15"
0.2	25	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P6C: Unit 4,5,6 Rear Roof and Deck

Runoff = 0.57 cfs @ 12.09 hrs, Volume= 2,086 cf, Depth= 8.05"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=8.29"

Area (sf)	CN	Description
3,110	98	Paved parking & roofs

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.2	25	0.2000	2.6		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.15"
0.2	25	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P6D: Unit 7 Rear Roof and Deck

Runoff = 0.28 cfs @ 12.09 hrs, Volume= 1,042 cf, Depth= 8.05"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=8.29"

Area (sf)	CN	Description
1,554	98	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.2	25	0.2000	2.6		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.15"
0.2	25	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P6E: Unit 8 Rear Roof and Deck

Runoff = 0.28 cfs @ 12.09 hrs, Volume= 1,042 cf, Depth= 8.05"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=8.29"

Area (sf)	CN	Description
1,554	98	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.2	25	0.2000	2.6		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.15"
0.2	25	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P6F: Unit 9 Rear Roof and Deck

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 0.33 cfs @ 12.00 hrs, Volume= 1,042 cf, Depth= 8.05"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=8.29"

Area (sf)	CN	Description
1,554	98	

Subcatchment P6G: Unit 10 Rear Roof and Deck

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 0.33 cfs @ 12.00 hrs, Volume= 1,042 cf, Depth= 8.05"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=8.29"

Area (sf)	CN	Description
1,554	98	

Reach 8R: Swale

[65] Warning: Inlet elevation not specified

Inflow Area = 62,740 sf, Inflow Depth = 3.83" for 100 yr event
Inflow = 6.70 cfs @ 12.23 hrs, Volume= 20,050 cf
Outflow = 6.59 cfs @ 12.27 hrs, Volume= 20,050 cf, Atten= 2%, Lag= 2.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.6 fps, Min. Travel Time= 1.3 min
Avg. Velocity = 1.1 fps, Avg. Travel Time= 4.5 min

Peak Depth= 0.43' @ 12.25 hrs
Capacity at bank full= 34.69 cfs
3.00' x 1.00' deep channel, n= 0.035 High grass
Side Slope Z-value= 3.0 '/' Top Width= 9.00'
Length= 292.0' Slope= 0.0334 '/'

Reach 11R: Total Site

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 701,439 sf, Inflow Depth = 1.91" for 100 yr event
Inflow = 13.40 cfs @ 12.55 hrs, Volume= 111,519 cf
Outflow = 13.40 cfs @ 12.55 hrs, Volume= 111,519 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Reach 12R: Pipe

[52] Hint: Inlet conditions not evaluated
[81] Warning: Exceeded Pond 6P by 0.68' @ 11.35 hrs
[79] Warning: Submerged Pond 11P Primary device # 1 INLET by 0.37'

Inflow Area = 245,925 sf, Inflow Depth = 3.39" for 100 yr event
Inflow = 9.20 cfs @ 12.59 hrs, Volume= 69,384 cf
Outflow = 9.19 cfs @ 12.60 hrs, Volume= 69,384 cf, Atten= 0%, Lag= 0.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 9.0 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 3.5 fps, Avg. Travel Time= 0.4 min

Peak Depth= 0.84' @ 12.59 hrs
Capacity at bank full= 15.23 cfs
Inlet Invert= 39.53', Outlet Invert= 38.10'
18.0" Diameter Pipe, n= 0.011 Concrete pipe, straight & clean
Length= 95.0' Slope= 0.0151 '/'

Reach 13R: Grass Channel

Inflow Area = 245,925 sf, Inflow Depth = 3.39" for 100 yr event
Inflow = 9.19 cfs @ 12.60 hrs, Volume= 69,384 cf
Outflow = 9.16 cfs @ 12.63 hrs, Volume= 69,384 cf, Atten= 0%, Lag= 2.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.3 fps, Min. Travel Time= 1.2 min
Avg. Velocity = 1.0 fps, Avg. Travel Time= 3.8 min

Peak Depth= 0.55' @ 12.61 hrs
Capacity at bank full= 23.29 cfs
Inlet Invert= 36.00', Outlet Invert= 32.00'
5.00' x 1.00' deep channel, n= 0.035 High grass
Side Slope Z-value= 0.2 '/' Top Width= 5.40'
Length= 240.0' Slope= 0.0167 '/'

Pond 2P: Trench 9

[85] Warning: Oscillations may require Finer Routing>1

Inflow Area = 1,554 sf, Inflow Depth = 8.05" for 100 yr event
Inflow = 0.33 cfs @ 12.00 hrs, Volume= 1,042 cf
Outflow = 0.17 cfs @ 12.20 hrs, Volume= 1,042 cf, Atten= 48%, Lag= 11.8 min
Discarded = 0.17 cfs @ 12.20 hrs, Volume= 1,042 cf
Primary = 0.00 cfs @ 12.20 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 10.00' @ 12.20 hrs Surf.Area= 277 sf Storage= 307 cf
Plug-Flow detention time= 65.9 min calculated for 1,042 cf (100% of inflow)
Center-of-Mass det. time= 65.8 min (801.0 - 735.2)

Volume	Invert	Avail.Storage	Storage Description
#1	7.00'	323 cf	**Custom Stage Data (Irregular)** Listed below (Recalc) 808 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
7.00	256	136.0	0	0	256
8.00	256	136.0	256	256	392
9.00	256	136.0	256	512	528
10.00	256	136.0	256	768	664
10.01	10,000	2,000.0	40	808	317,502

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**2.410 in/hr Exfiltration over Wetted area**
#2	Primary	10.00'	**10.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=0.05 cfs @ 12.20 hrs HW=10.00' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.05 cfs)

Primary OutFlow Max=0.00 cfs @ 12.20 hrs HW=10.00' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** (Weir Controls 0.00 cfs)

Pond 3P: Trench 2

[85] Warning: Oscillations may require Finer Routing>1

Inflow Area = 1,554 sf, Inflow Depth = 8.05" for 100 yr event
Inflow = 0.28 cfs @ 12.09 hrs, Volume= 1,042 cf
Outflow = 0.18 cfs @ 12.30 hrs, Volume= 1,042 cf, Atten= 38%, Lag= 12.7 min
Discarded = 0.17 cfs @ 12.30 hrs, Volume= 1,040 cf
Primary = 0.00 cfs @ 12.30 hrs, Volume= 2 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 10.00' @ 12.30 hrs Surf.Area= 352 sf Storage= 307 cf
Plug-Flow detention time= 66.1 min calculated for 1,041 cf (100% of inflow)
Center-of-Mass det. time= 66.0 min (806.8 - 740.8)

Volume	Invert	Avail.Storage	Storage Description
#1	7.00'	607 cf	**Custom Stage Data (Irregular)**Listed below (Recalc) 1,519 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
7.00	256	136.0	0	0	256
8.00	256	136.0	256	256	392
9.00	256	136.0	256	512	528
10.00	256	136.0	256	768	664
10.10	20,000	3,000.0	751	1,519	715,389

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**2.410 in/hr Exfiltration over Wetted area**
#2	Primary	10.00'	**10.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=0.13 cfs @ 12.30 hrs HW=10.00' (Free Discharge)
↑**1=Exfiltration** (Exfiltration Controls 0.13 cfs)

Primary OutFlow Max=0.00 cfs @ 12.30 hrs HW=10.00' (Free Discharge)
↑**2=Broad-Crested Rectangular Weir** (Weir Controls 0.00 cfs @ 0.1 fps)

Pond 4P: Forebay

Inflow Area = 109,713 sf, Inflow Depth = 4.36" for 100 yr event
Inflow = 10.91 cfs @ 12.27 hrs, Volume= 39,887 cf
Outflow = 10.87 cfs @ 12.28 hrs, Volume= 39,670 cf, Atten= 0%, Lag= 0.3 min
Discarded = 0.01 cfs @ 12.28 hrs, Volume= 787 cf
Primary = 10.86 cfs @ 12.28 hrs, Volume= 38,883 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Peak Elev= 43.93' @ 12.28 hrs Surf.Area= 566 sf Storage= 607 cf
Plug-Flow detention time= 9.5 min calculated for 39,604 cf (99% of inflow)
Center-of-Mass det. time= 6.6 min (814.3 - 807.7)

Volume	Invert	Avail.Storage	Storage Description
#1	42.00'	646 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
42.00	119	0	0
43.00	293	206	206
44.00	586	440	646

Device	Routing	Invert	Outlet Devices
#1	Primary	43.50'	**15.0' long x 6.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.37 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
#2	Discarded	0.00'	**1.020 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.01 cfs @ 12.28 hrs HW=43.93' (Free Discharge)
↑**2=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=10.76 cfs @ 12.28 hrs HW=43.93' (Free Discharge)
↑**1=Broad-Crested Rectangular Weir** (Weir Controls 10.76 cfs @ 1.7 fps)

Pond 6P: Infiltration Pond

Inflow Area = 109,713 sf, Inflow Depth = 4.25" for 100 yr event
Inflow = 10.86 cfs @ 12.28 hrs, Volume= 38,883 cf
Outflow = 5.81 cfs @ 12.58 hrs, Volume= 37,581 cf, Atten= 46%, Lag= 17.9 min
Discarded = 0.11 cfs @ 12.58 hrs, Volume= 4,631 cf
Primary = 5.70 cfs @ 12.58 hrs, Volume= 32,949 cf
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 43.36' @ 12.58 hrs Surf.Area= 4,788 sf Storage= 15,164 cf
Plug-Flow detention time= 121.6 min calculated for 37,581 cf (97% of inflow)
Center-of-Mass det. time= 104.2 min (912.1 - 807.9)

Volume	Invert	Avail.Storage	Storage Description
#1	38.50'	18,402 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
38.50	1,459	0	0
39.00	1,957	854	854
40.00	2,510	2,234	3,088
41.00	3,120	2,815	5,903
42.00	3,786	3,453	9,356
43.00	4,509	4,148	13,503
44.00	5,289	4,899	18,402

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	39.63'	**4.0" Vert. Orifice/Grate** C= 0.600
#3	Primary	41.17'	**5.0" Vert. Orifice/Grate** C= 0.600
#4	Primary	42.60'	**2.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#5	Secondary	43.36'	**10.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Discarded OutFlow Max=0.11 cfs @ 12.58 hrs HW=43.35' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.11 cfs)

Primary OutFlow Max=5.67 cfs @ 12.58 hrs HW=43.35' (Free Discharge)
├**2=Orifice/Grate** (Orifice Controls 0.79 cfs @ 9.1 fps)
├**3=Orifice/Grate** (Orifice Controls 0.92 cfs @ 6.8 fps)
└**4=Sharp-Crested Rectangular Weir** (Weir Controls 3.96 cfs @ 2.8 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=38.50' (Free Discharge)
└**5=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 7P: Bioretention Area

[79] Warning: Submerged Pond 17P Primary device # 2 by 0.16'

Inflow Area = 62,740 sf, Inflow Depth = 5.11" for 100 yr event
Inflow = 6.87 cfs @ 12.21 hrs, Volume= 26,725 cf
Outflow = 6.81 cfs @ 12.23 hrs, Volume= 26,555 cf, Atten= 1%, Lag= 1.4 min
Discarded = 0.12 cfs @ 12.23 hrs, Volume= 6,505 cf
Primary = 6.70 cfs @ 12.23 hrs, Volume= 20,050 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 54.91' @ 12.23 hrs Surf.Area= 2,124 sf Storage= 2,549 cf
Plug-Flow detention time= 63.0 min calculated for 26,511 cf (99% of inflow)
Center-of-Mass det. time= 59.6 min (873.4 - 813.8)

Volume	Invert	Avail.Storage	Storage Description
#1	53.00'	2,748 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
53.00	593	0	0
54.00	1,350	972	972
55.00	2,202	1,776	2,748

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	54.50'	**10.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Discarded OutFlow Max=0.12 cfs @ 12.23 hrs HW=54.91' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.12 cfs)

Primary OutFlow Max=6.63 cfs @ 12.23 hrs HW=54.91' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** (Weir Controls 6.63 cfs @ 1.6 fps)

Pond 10P: Trench 3

Inflow Area = 3,110 sf, Inflow Depth = 8.05" for 100 yr event
Inflow = 0.57 cfs @ 12.09 hrs, Volume= 2,086 cf
Outflow = 0.09 cfs @ 12.57 hrs, Volume= 2,086 cf, Atten= 84%, Lag= 29.0 min
Discarded = 0.09 cfs @ 12.57 hrs, Volume= 2,086 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 9.23' @ 12.57 hrs Surf.Area= 736 sf Storage= 657 cf
Plug-Flow detention time= 56.6 min calculated for 2,083 cf (100% of inflow)
Center-of-Mass det. time= 56.6 min (797.3 - 740.8)

Volume	Invert	Avail.Storage	Storage Description
#1	7.00'	1,063 cf	**Custom Stage Data (Irregular)** Listed below (Recalc) 2,656 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
7.00	736	376.0	0	0	736
8.00	736	376.0	736	736	1,112
9.00	736	376.0	736	1,472	1,488
10.00	736	376.0	736	2,208	1,864
10.10	10,000	2,000.0	448	2,656	308,924

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**2.420 in/hr Exfiltration over Wetted area**
#2	Primary	10.00'	**10.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=0.09 cfs @ 12.57 hrs HW=9.23' (Free Discharge)
1=Exfiltration (Exfiltration Controls 0.09 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=7.00' (Free Discharge)
2=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Pond 11P: Field

Inflow Area = 136,212 sf, Inflow Depth = 3.21" for 100 yr event
Inflow = 6.94 cfs @ 12.37 hrs, Volume= 36,438 cf
Outflow = 3.61 cfs @ 12.76 hrs, Volume= 36,435 cf, Atten= 48%, Lag= 23.2 min
Primary = 3.61 cfs @ 12.76 hrs, Volume= 36,435 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 41.19' @ 12.76 hrs Surf.Area= 17,054 sf Storage= 7,899 cf
Plug-Flow detention time= 28.0 min calculated for 36,374 cf (100% of inflow)
Center-of-Mass det. time= 28.1 min (897.1 - 869.0)

Volume	Invert	Avail.Storage	Storage Description
#1	40.00'	15,029 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
40.00	480	0	0
41.00	10,219	5,350	5,350
41.50	28,498	9,679	15,029

Device	Routing	Invert	Outlet Devices
#1	Primary	40.00'	**12.0" x 18.0' long Culvert** RCP, rounded edge headwall, Ke= 0.100 Outlet Invert= 39.77' S= 0.0128 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean

Primary OutFlow Max=3.61 cfs @ 12.76 hrs HW=41.19' (Free Discharge)
1=Culvert (Barrel Controls 3.61 cfs @ 4.9 fps)

Pond 12P: Trench 1

Inflow Area = 1,554 sf, Inflow Depth = 8.05" for 100 yr event
Inflow = 0.28 cfs @ 12.09 hrs, Volume= 1,042 cf
Outflow = 0.04 cfs @ 12.71 hrs, Volume= 1,042 cf, Atten= 87%, Lag= 37.2 min
Discarded = 0.03 cfs @ 12.71 hrs, Volume= 1,032 cf
Primary = 0.01 cfs @ 12.71 hrs, Volume= 11 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 10.00' @ 12.71 hrs Surf.Area= 470 sf Storage= 394 cf
Plug-Flow detention time= 159.9 min calculated for 1,041 cf (100% of inflow)
Center-of-Mass det. time= 159.7 min (900.4 - 740.8)

Volume	Invert	Avail.Storage	Storage Description
#1	7.00'	555 cf	**Custom Stage Data (Irregular)**Listed below (Recalc) 1,389 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
7.00	328	172.0	0	0	328
8.00	328	172.0	328	328	500
9.00	328	172.0	328	656	672
10.00	328	172.0	328	984	844
10.10	10,000	2,000.0	405	1,389	316,800

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	10.00'	**10.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=0.03 cfs @ 12.71 hrs HW=10.00' (Free Discharge)
1=Exfiltration (Exfiltration Controls 0.03 cfs)

Primary OutFlow Max=0.01 cfs @ 12.71 hrs HW=10.00' (Free Discharge)
2=Broad-Crested Rectangular Weir (Weir Controls 0.01 cfs @ 0.2 fps)

Pond 13P: Trench 4

Inflow Area = 1,554 sf, Inflow Depth = 8.05" for 100 yr event
Inflow = 0.28 cfs @ 12.09 hrs, Volume= 1,042 cf
Outflow = 0.16 cfs @ 12.35 hrs, Volume= 1,042 cf, Atten= 42%, Lag= 15.8 min
Discarded = 0.16 cfs @ 12.35 hrs, Volume= 1,040 cf
Primary = 0.01 cfs @ 12.35 hrs, Volume= 2 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 10.00' @ 12.35 hrs Surf.Area= 371 sf Storage= 322 cf
Plug-Flow detention time= 66.7 min calculated for 1,041 cf (100% of inflow)
Center-of-Mass det. time= 66.6 min (807.3 - 740.8)

Volume	Invert	Avail.Storage	Storage Description
#1	7.00'	480 cf	**Custom Stage Data (Irregular)**Listed below (Recalc) 1,201 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
7.00	268	142.0	0	0	268
8.00	268	142.0	268	268	410
9.00	268	142.0	268	536	552
10.00	268	142.0	268	804	694
10.10	10,000	2,000.0	397	1,201	317,399

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**2.420 in/hr Exfiltration over Wetted area**
#2	Primary	10.00'	**10.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=0.14 cfs @ 12.35 hrs HW=10.00' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.14 cfs)

Primary OutFlow Max=0.01 cfs @ 12.35 hrs HW=10.00' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** (Weir Controls 0.01 cfs @ 0.2 fps)

Pond 14P: Trench 5

[85] Warning: Oscillations may require Finer Routing>1

Inflow Area = 1,554 sf, Inflow Depth = 8.05" for 100 yr event
Inflow = 0.28 cfs @ 12.09 hrs, Volume= 1,042 cf
Outflow = 0.18 cfs @ 12.30 hrs, Volume= 1,042 cf, Atten= 37%, Lag= 12.7 min
Discarded = 0.17 cfs @ 12.30 hrs, Volume= 1,039 cf
Primary = 0.01 cfs @ 12.30 hrs, Volume= 4 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 10.00' @ 12.30 hrs Surf.Area= 373 sf Storage= 308 cf
Plug-Flow detention time= 65.8 min calculated for 1,041 cf (100% of inflow)
Center-of-Mass det. time= 65.7 min (806.5 - 740.8)

Volume	Invert	Avail.Storage	Storage Description
#1	7.00'	465 cf	**Custom Stage Data (Irregular)** Listed below (Recalc) 1,163 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
7.00	256	136.0	0	0	256
8.00	256	136.0	256	256	392
9.00	256	136.0	256	512	528
10.00	256	136.0	256	768	664
10.10	10,000	2,000.0	395	1,163	317,502

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**2.420 in/hr Exfiltration over Wetted area**
#2	Primary	10.00'	**10.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=0.15 cfs @ 12.30 hrs HW=10.00' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.15 cfs)

Primary OutFlow Max=0.01 cfs @ 12.30 hrs HW=10.00' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** (Weir Controls 0.01 cfs @ 0.2 fps)

Pond 15P: Trench 8

[85] Warning: Oscillations may require Finer Routing>1

Inflow Area = 1,554 sf, Inflow Depth = 8.05" for 100 yr event
Inflow = 0.28 cfs @ 12.09 hrs, Volume= 1,042 cf
Outflow = 0.22 cfs @ 12.17 hrs, Volume= 1,042 cf, Atten= 24%, Lag= 5.0 min
Discarded = 0.20 cfs @ 12.17 hrs, Volume= 1,034 cf
Primary = 0.01 cfs @ 12.17 hrs, Volume= 9 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 10.01' @ 12.15 hrs Surf.Area= 365 sf Storage= 260 cf
Plug-Flow detention time= 62.3 min calculated for 1,041 cf (100% of inflow)
Center-of-Mass det. time= 62.2 min (803.0 - 740.8)

Volume	Invert	Avail.Storage	Storage Description
#1	7.00'	415 cf	**Custom Stage Data (Irregular)** Listed below (Recalc) 1,038 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
7.00	216	116.0	0	0	216
8.00	216	116.0	216	216	332
9.00	216	116.0	216	432	448
10.00	216	116.0	216	648	564
10.10	10,000	2,000.0	390	1,038	317,803

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**2.420 in/hr Exfiltration over Wetted area**
#2	Primary	10.00'	**10.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=0.17 cfs @ 12.17 hrs HW=10.00' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.17 cfs)

Primary OutFlow Max=0.01 cfs @ 12.17 hrs HW=10.00' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** (Weir Controls 0.01 cfs @ 0.2 fps)

Pond 16P: Trench 6

Inflow Area = 1,554 sf, Inflow Depth = 8.05" for 100 yr event
Inflow = 0.33 cfs @ 12.00 hrs, Volume= 1,042 cf
Outflow = 0.04 cfs @ 12.47 hrs, Volume= 1,042 cf, Atten= 87%, Lag= 28.1 min
Discarded = 0.04 cfs @ 12.47 hrs, Volume= 1,042 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 9.27' @ 12.47 hrs Surf.Area= 364 sf Storage= 330 cf
Plug-Flow detention time= 56.9 min calculated for 1,041 cf (100% of inflow)
Center-of-Mass det. time= 56.8 min (792.0 - 735.2)

Volume	Invert	Avail.Storage	Storage Description
#1	7.00'	600 cf	**Custom Stage Data (Irregular)**Listed below (Recalc) 1,501 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
7.00	364	190.0	0	0	364
8.00	364	190.0	364	364	554
9.00	364	190.0	364	728	744
10.00	364	190.0	364	1,092	934
10.10	10,000	2,000.0	409	1,501	316,371

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**2.410 in/hr Exfiltration over Wetted area**
#2	Primary	10.00'	**10.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=0.04 cfs @ 12.47 hrs HW=9.26' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.04 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=7.00' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 17P: Upper Forebay

[93] Warning: Storage range exceeded by 0.07'

Inflow Area = 62,740 sf, Inflow Depth = 5.54" for 100 yr event
Inflow = 6.95 cfs @ 12.21 hrs, Volume= 28,970 cf
Outflow = 6.90 cfs @ 12.21 hrs, Volume= 28,852 cf, Atten= 1%, Lag= 0.2 min
Discarded = 0.03 cfs @ 12.10 hrs, Volume= 2,127 cf
Primary = 6.87 cfs @ 12.21 hrs, Volume= 26,725 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Peak Elev= 55.07' @ 12.21 hrs Surf.Area= 581 sf Storage= 644 cf
Plug-Flow detention time= 20.1 min calculated for 28,852 cf (100% of inflow)
Center-of-Mass det. time= 17.5 min (834.5 - 817.0)

Volume	Invert	Avail.Storage	Storage Description
#1	53.00'	644 cf	**Custom Stage Data (Prismatic)**Listed below

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
53.00	88	0	0
54.00	309	199	199
55.00	581	445	644

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	54.75'	**15.0' long x 3.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 Coef. (English) 2.44 2.58 2.68 2.67 2.65 2.64 2.64 2.68 2.68 2.72 2.81 2.92 2.97 3.07 3.32

Discarded OutFlow Max=0.03 cfs @ 12.10 hrs HW=55.02' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.03 cfs)

Primary OutFlow Max=6.81 cfs @ 12.21 hrs HW=55.07' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** (Weir Controls 6.81 cfs @ 1.4 fps)

Pond 18P: Trench 7

Inflow Area = 1,554 sf, Inflow Depth = 8.05" for 100 yr event
Inflow = 0.33 cfs @ 12.00 hrs, Volume= 1,042 cf
Outflow = 0.04 cfs @ 12.47 hrs, Volume= 1,042 cf, Atten= 87%, Lag= 28.1 min
Discarded = 0.04 cfs @ 12.47 hrs, Volume= 1,042 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 9.27' @ 12.47 hrs Surf.Area= 364 sf Storage= 330 cf
Plug-Flow detention time= 56.8 min calculated for 1,042 cf (100% of inflow)
Center-of-Mass det. time= 56.7 min (791.9 - 735.2)

Volume	Invert	Avail.Storage	Storage Description
#1	7.00'	453 cf	**Custom Stage Data (Irregular)**Listed below (Recalc) 1,133 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
7.00	364	190.0	0	0	364
8.00	364	190.0	364	364	554
9.00	364	190.0	364	728	744
10.00	364	190.0	364	1,092	934
10.01	10,000	2,000.0	41	1,133	316,371

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**2.410 in/hr Exfiltration over Wetted area**
#2	Primary	10.00'	**10.0' long x 1.0' breadth Broad-Crested Rectangular Weir**
			Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00
			Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=0.04 cfs @ 12.47 hrs HW=9.26' (Free Discharge)
1=Exfiltration (Exfiltration Controls 0.04 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=7.00' (Free Discharge)
2=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Link 8L: Wood Road Culvert (POA#1)

Inflow Area = 333,158 sf, Inflow Depth = 3.08" for 100 yr event
Inflow = 10.66 cfs @ 12.59 hrs, Volume= 85,458 cf
Primary = 10.66 cfs @ 12.59 hrs, Volume= 85,458 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Link 9L: Northern Wetland (POA#3)

Inflow Area = 140,271 sf, Inflow Depth = 0.97" for 100 yr event
Inflow = 1.45 cfs @ 12.47 hrs, Volume= 11,390 cf
Primary = 1.45 cfs @ 12.47 hrs, Volume= 11,390 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Link 10L: Ipswich River (POA#2)

Inflow Area = 228,010 sf, Inflow Depth = 0.77" for 100 yr event
Inflow = 1.87 cfs @ 12.35 hrs, Volume= 14,671 cf
Primary = 1.87 cfs @ 12.35 hrs, Volume= 14,671 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Attachment H

Watershed Maps

[under separate cover]