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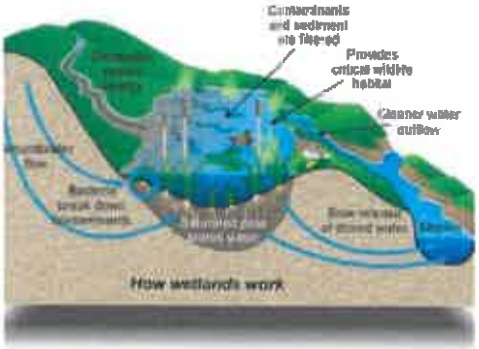
Land Surveying - Civil Engineering - Site Planning



Stormwater Management Report

January 20, 2015

Project Location:

0 Barton Road, Stow, MA
586 Main Street, Hudson, MA

Stow Assessors Map/Lot:

U-2/54; R-25/13, 16A, 16B, 17

Hudson Assessors Map/Lot:

35/3

Owner/Applicant:

Collings Foundation, Inc.
P.O. Box 248
Stow, MA 01775

Representative:

Andrews Survey & Engineering, Inc.
104 Mendon Street
Uxbridge, MA 01569

ASE Project #2014-021

STORMWATER MANAGEMENT REPORT

Collings Foundation, Inc.
P.O. Box 248
Stow, MA 01775

January 21, 2015

Prepared for:

J.M. Coull, Inc.
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Maynard, MA 01754

Prepared by:

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ASE Project #2014-021

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Reviewed by: _____ 1.20.15
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PART 1 – SUMMARY

1.0 PROJECT DESCRIPTION

Collings Foundation, Inc. is a non-profit, Educational Foundation (501c-3), founded in 1979. The purpose of the Collings Foundation, Inc. is to organize and support "living history" events that enable Americans to learn more about their heritage through direct participation. The original focus of the Foundation was transportation-related events such as antique car rallies, hill climbs, carriage and sleigh rides, along with a winter ice-cutting festival in the surrounding areas. During the mid-1980's, these activities were broadened to include aviation-related events such as air shows, barnstorming, historical reunions, Wings of Freedom Tour, Vietnam Memorial Flights, joint museum displays, and living history events.

J.M. Coull, Inc. intends to construct a 66,000± s.f. museum building for the Collings Foundation, Inc. on their property located off Barton Road in Stow, MA. The property is currently comprised of a 32,000± s.f.museum building, a 7,500± s.f. museum and office building, and a single-family dwelling. The proposed building will house new exhibits being acquired by the Foundation.

Located in the Residential zoning district, the property used for the Collings Foundation contains approximately 41.25 acres of land situated on the west side of Barton Road and the east side of the Assabet River. The site is primarily open field surrounded on the perimeter by mature forest. Topography can be classified as undulating with areas that are relatively flat and other areas with slopes in excess of 10%.

According to the DEP's Priority Resources Map, there are no public water supply wells within one-half mile of the property and the project site is not located within a Zone II water supply protection area.

With the exception of the western portion of the property along the Assabet River, much of the property lies outside the 100-year flood plain according to the current Stow Flood Insurance Rate Map (FIRM) Panel 25017C0344E, as shown in Appendix.

The proposed building will be serviced by overhead and underground electricity and telephone, private water, and an onsite sewage disposal system.

According to the latest Edition of the Massachusetts Natural Heritage Atlas, Priority Habitat of Rare Species and Estimated Habitat of Rare Wetlands Wildlife are not located on or bordering the property. No known certified vernal pools or Areas of Critical Environmental Concern (ACEC) are located on or bordering the property.

2.0 BACKGROUND DATA

Soils explorations were performed on the property by Andrews Survey & Engineering, Inc. on March 20, 2014. The U.S. Natural Resources Conservation Service (NRCS), formerly SCS Soil Survey, Maps indicate that soils with hydrologic soil group classification A are predominant throughout the site. The mapped soil conditions were confirmed by the soil explorations.

Mapped soils are as follows:

Hinckley loamy sand	Hydrologic Soil Group "A"
Udorthents (Sandy)	Hydrologic Soil Group "A"

3.0 STORMWATER MANAGEMENT CONCEPT

Since the project is not classified as redevelopment, it shall conform to the Massachusetts Stormwater Management Standards. Although there will be an increase in the impervious surface, through the use of "Best Management Practices (BMPs)," the rate and volume of runoff will be maintained. Runoff will be collected and treated for quality in conformance with the state and local requirements.

The stormwater management systems shall be designed using BMPs, as found in the most recent version of Massachusetts Department of Environmental Protection (DEP) Stormwater Management Standards. The applicant shall submit a stormwater management plan implementing the highest practicable level of stormwater treatment.

4.0 DEP STORMWATER MANAGEMENT STANDARDS

Stormwater discharges occur as rainfall and snowmelt carry pollutants to surface and groundwater. New development increases impervious surfaces, which alters natural drainage features, increases peak discharge rates and volumes, and reduces recharge that maintains wetlands and base flows in streams. Development also results in corresponding increases in the concentration and types of pollutant loadings, including nutrients, solids, metals, salt, pathogens, pesticides, and hydrocarbons.

To protect the wetlands and waters of the Commonwealth from the adverse impacts of stormwater runoff, DEP issued a Stormwater Management Policy in November 1996, concurrently with its Guidance for the Rivers Protection Act. DEP developed the policy to address stormwater impacts through implementation of performance standards under existing environmental protection programs. The Stormwater Management Standards establish guidelines for stormwater management in Massachusetts.

The Standards are designed for use under multiple statutory and regulatory authorities of the Department of Environmental Protection, including the Wetlands Protection Act, as amended by the Rivers Protection Act, and the Clean Waters Act.

The Standards address both water quality (pollutants) and water quantity (flood control) by establishing the level of required controls that can be achieved through the use of site planning, nonstructural measures, and Best Management Practices (BMPs). BMPs reduce or prevent pollutants from reaching water bodies and control the quantity of runoff from a site.

For new development and redevelopment, conservation commissions (or DEP on appeal) must implement the Stormwater Management Standards through an Order of Conditions whenever jurisdiction is established under the Wetlands Protection Act. If stormwater is managed under the Wetlands Protection Act, DEP will presume that the discharge complies with all other state regulatory requirements for stormwater.

Proposed work, including installation of stormwater management structures and alterations that result in a stormwater discharge within a resource area, will require an Order of Conditions. Activities within the 100-foot buffer zone also require an Order if they will alter any resource area. The Stormwater Management Standards must be applied to these activities.

Jurisdiction under the Wetlands Protection Act does not extend beyond resource areas, including the riverfront area, and the 100-foot buffer zone unless and until an activity outside this area actually causes an alteration of a resource area.

DEP presumes that projects meeting the Stormwater Management Standards satisfy regulatory requirements. When one or more of the Standards described below cannot be met, an applicant may demonstrate that an equivalent level of environmental protection will be provided.

4.1 Untreated Stormwater (Standard 1)

No new Stormwater conveyances (e.g., outfalls) may discharge untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth.

Treated stormwater is defined to be stormwater that meets the requirement in Standards 2 through 9. Rooftop runoff, except from certain metal roofs, generally should be considered uncontaminated for the purposes of these Standards and therefore can be infiltrated directly without treatment.

4.2 Post-Development Peak Rates (Standard 2)

Stormwater management systems must be designed so that post-development peak discharge rates do not exceed pre-development peak discharge rates.

To meet Standard 2, controls must be developed for the 2-year and the 10-year 24-hour storm events. The 100-year 24-hour storm event must be evaluated to demonstrate that there will not be increased flooding impacts off-site.

Measurement of peak discharge rates must be calculated using the point of discharge or the down gradient property boundary. The topography of the site may require evaluation at more than one location if flow leaves the property in more than one direction. An applicant may demonstrate that a feature beyond the property boundary (e.g. culvert) is more appropriate as a design point.

4.3 Recharge to Groundwater (Standard 3)

The prescribed stormwater runoff volume to be recharged to groundwater should be determined using the existing site (pre-development) soil conditions from a U.S. Natural Resources Conservation Service (NRCSA, formerly SCS) County Soils Survey, onsite soil evaluation, or other geologic information and these rates.

Hydrologic Soil Group	Volume to Recharge (x Total Impervious Area)
A	0.60 inches of runoff
B	0.35 inches of runoff
C	0.25 inches of runoff
D	0.10 inches of runoff

Loss of annual recharge to groundwater should be minimized through the use of infiltration measures to the maximum extent practicable. The annual recharge from the post-development site should approximate the annual recharge from the pre-development or existing site, based on soil types. This standard is met when the stormwater management system is designed to infiltrate the required recharge volume. Additionally, infiltration structures must be able to drain fully within 72 hours.

4.4 Removal of 80% TSS (Standard 4)

For new developments stormwater management systems must be designed to remove 80% of the average annual load (post-development conditions) of Total Suspended Solids (TSS). It is presumed that this standard is met when:

- Suitable nonstructural practices for source control and pollution prevention are implemented.
- Stormwater management Best Management Practices (BMPs) are sized to capture the prescribed runoff volume; and
- Stormwater management BMPs are maintained as designed.

BMPs must be selected so that a total of 80% TSS removal is provided by one or more BMPs as shown on Table 4.4. BMPs not listed there should be evaluated based on data on removal efficiencies provided by the applicant. The 80% TSS removal requirement applies to post-development conditions after the site is stabilized. Monitoring should not be required.

4.5 Land Uses with Higher Potential Pollutant Loads (Standard 5)

Stormwater discharges from areas with higher potential pollutant loads require the use of specific stormwater management BMPs. The use of infiltration practices without pretreatment is prohibited.

Retail, office, and storage/warehouse development and roads normally will not yield high potential pollutant loads.

4.6 Critical Areas (Standard 6)

Stormwater discharges to critical areas must utilize certain stormwater management BMPs approved for critical areas. Critical areas are Outstanding Resource Waters (ORWs), shellfish beds, swimming beaches, coldwater fisheries and recharge areas for public water supplies.

The runoff volume to be treated for water quality (Standards 4 to 6) is based on the following:

- For discharges to critical areas, the volume to be treated is calculated as 1.0 inch of runoff times the total impervious area of the post-development project site.

- For all other discharges, volume to be treated is calculated as 0.5 inches of runoff times the total impervious area of the post-development project site.

Using the impervious area as the basis for calculating stormwater runoff promotes the use of simple volume calculations. The total impervious area of a site is determined based on final project site plans, not on pre-existing site conditions. Roof runoff (except from certain metal roofs) may be infiltrated, and any infiltrated volume may be subtracted from the total runoff volume.

TABLE 4.4 TSS REMOVAL RATES (adapted from Schueler, 1996 & EPA, 1993)			
BMP List	Design Rate	Range of Average TSS Removal Rates	Brief Design Requirements
Extended Detention Pond	70%	60-80%	Sediment forebay
Wet Pond (a)	70%	60-80%	Sediment forebay
Constructed Wetland (b)	80%	65-80%	Designed to infiltrate or retain
Water Quality Swale	70%	60-80%	Designed to infiltrate or retain
Infiltration Trench	80%	75-80%	Pretreatment critical
Infiltration Basin	80%	75-80% (predicted)	Pretreatment critical
Dry Well	80%	80% (predicted)	Rooftop runoff (Uncontaminated only)
Sand Filter (c)	80%	80%	Pretreatment
Organic Filter (d)	80%	80%+	Pretreatment
Water Quality Inlet	25%	15-35% w/cleanout	Off-line only; 0.1" minimum Water Quality
Sediment Trap (Forebay)	25%	25% w/cleanout	Storm flows for 2 year event must not cause erosion; 0.1" minimum WQV storage
Drainage Channel	25%	25%	Check dams; non-erosive for 2 yr.
Deep Sump and Hooded Catch Basin	25%	25% w/cleanout	Deep sump general rule = 4 x pipe diameter or 4.0 for pipes 18" or less
Street Sweeping	0-10%	0-10%	Discretionary non-structural credit, must be part of approved plan

Notes:

(a) Includes wet extended detention ponds, wet ponds, multiple pond designs.

(b) Includes shallow marsh, extended detention wetlands, pocket wetland, and pond/wetland designs

(c) Includes surface, underground, pocket and perimeter designs.

(d) Includes compost, peat/sand and bio/filtration designs.

Generally, BMP's approved for use near critical areas and designed to treat 1.0 inch of runoff times the total impervious surface of the post-development project site are limited to (see Table 4.6):

- Extended detention basins
- Wet ponds
- Constructed wetlands
- Water quality swales
- Sand filters
- Organic filters
- Infiltration basins
- Infiltration trenches
- Deep sump and hooded catch basin (used with other BMPs)

Stormwater management systems near public water supplies and other critical resources should incorporate designs that allow for shutdown and containment in the event of an emergency spill or other unexpected contamination event.

For the purposes of this standard "near" means those locations where there is a strong likelihood of a significant impact occurring to a critical area, taking into account site-specific factors.

4.7 Redevelopment (Standard 7)

Redevelopment projects are defined as follows:

- Maintenance and improvement of existing roadways, including widening less than a single lane, adding shoulders, and correcting substandard intersections and drainage and repaving; and

- Development, rehabilitation, expansion and phased projects on previously developed sites, provided the redevelopment results in no net increase in impervious area.

Components of redevelopment project, which include development of previously undeveloped sites, do not fall under Standard 7.

Redevelopment of previously developed sites must meet the Stormwater Management Standards to the maximum extent practicable. However, if it is not practicable to meet all the Standards, new (retrofitted or expanded) stormwater management systems must be designed to improve existing conditions.

TABLE 4.6
RESTRICTIONS ON BMP TECHNOLOGIES BY RESOURCE TYPE
FOR AREAS SUPPLYING SURFACE AND GROUND DRINKING WATER

BMP Category	BMP Technology	Use?	Considerations and Restrictions
Source Control	Pollution Prevention Snow Management	YES	Implement Pollution Prevention Plans; proper storage of road salt; minimize use.
Pretreatment	Water Quality Inlets Sediment Traps Drainage Channels Deep Sump Catch Basins	RST	Use as pretreatment only. Setback outside Zone I and Zone A of reservoir and first 100 feet from the tributary. Required use with infiltration BMPs.
Detention/Retention and Vegetative Treatment	Extended Detention Basin Wet Pond Constructed Wetlands	YES	Setback outside Zone I/Zone A of Reservoir and first 100 feet from the tributary.
	Water Quality Swales	YES	After full water quality treatment, can be utilized within Zone I or Zone A of reservoir and first 100 feet from the tributary, when there are no practicable alternatives.
Infiltration	Infiltration Trenches Infiltration Basins	YES	Setback outside Zone I/Zone A of reservoir and first 100 feet from the tributary, when there are no practicable alternatives.
	Dry Wells	RST	Uncontaminated rooftop runoff only.
Filtration	Sand Filters Organic Filters	YES	Use as pretreatment before infiltration. Therefore, setback outside Zone I/Zone A of reservoir and first 100 feet from the tributary.

Legend:

YES Required
RST Restricted Use
NO Not Allowed

Definitions:

Zone 1: Means the protected radius required around a public water supply well or wellfield. For Public water supply system wells with approved yields of 100,000 gallons per day (gpd) or greater, the protective radius is 400 feet. Tubular wellfields require a 250- foot protective radius. Protective radii for all other public water supply system wells are determined by the following equation: Zone+ I radius in feet = (150 x log of pumping rate in gpd) – 350. This equation is equivalent to the chart in the DEP Water Supply Guidelines. A default Zone I radius or a Zone I radius otherwise computed and determined by the DEP shall be applied to transient non-community (TNC) and non-transient non-community (NTNC) wells when there is no metered rate of withdrawal or no approved pumping rate. The default Zone I radius shall be 100 feet for TNC wells and 250 feet for NTNC wells.

Interim Wellhead Protection Area (IWPA): For public water systems using wells or wellfields that lack a DEP approved Zone II, DEP will apply an interim wellhead protection area (IWPA). This interim wellhead protection area shall be a one-half mile radius measured from the well or wellfield for sources whose approved pumping rate is 100,000 gallons per day (gpd) or greater. For wells or wellfields that pump less than 100,000 gpd, the IWPA radius is proportional to the approved pumping rate which may be calculated according to the following equation: IWPA radius in feet = (32 x pumping rate in gallons per minute) + 400. A default IWPA radius or an IWPA radius otherwise computed and determined by the DEP shall be applied to transient non-community (TNC) and non-transient non-community (NTNC) wells when there is no metered rate of withdrawal or no approved pumping area. The default IWPA radius shall be 500 feet for TNC wells and 750 feet for NTNC wells.

4.8 Erosion and Sedimentation Control (Standard 8)

Erosion and sediment controls must be implemented to prevent impacts during construction or land disturbance activities.

Examples of BMPs for erosion and sedimentation control are staked straw wattles or bales, silt fences, hydroseeding, and phased development. Many Stormwater BMP technologies (e.g. infiltration technologies) are not designed to handle the high concentrations of sediment typically found in construction runoff and must be protected from construction-related sediment loadings. Construction BMPs must be maintained.

4.9 Operation and Maintenance Plans (Standard 9)

All Stormwater management systems must have an operation and maintenance plan to ensure that systems function are designed.

An operation and maintenance plan (O&M Plan) should, at a minimum identify:

- Stormwater management system(s) owner(s);
- The party or parties responsible for operation and maintenance;
- A schedule for inspection and maintenance; and
- The routine and non-routine maintenance tasks to be undertaken.

The owner of the BMP is generally considered to be the landowner of the property on which the BMP is located, unless other legally binding agreements are established with another entity. The Order of Conditions and Certificate of Compliance, when applicable, should be written to allow for routine maintenance during construction and post-development phases of the project as defined in the O&M Plan. A continuing condition in the Certificate of Compliance will ensure that maintenance can be performed without triggering further filings under the Wetlands Protection Act.

4.10 Illicit Discharges (Standard 10)

All Stormwater management systems must have an Illicit Discharge Compliance Statement.

An Illicit Discharge Compliance Statement must be filed for projects within wetlands jurisdiction, and at minimum include:

- Verification that no illicit discharges exist on the site; and
- Measures within the pollution prevention plan to prevent illicit discharges, including:
    - Wastewater discharges
    - Stormwater contaminated by contact with process waste, raw materials, toxic pollutants, hazardous substances, oil, and grease.

For redevelopment projects, the Illicit Discharge Compliance Statement shall also document all actions taken to identify and remove illicit discharges, including.

- Visual screening;
- Dye or smoke testing; and
- The removal of any sources of illicit discharges to the stormwater management system.

5.0 COMPLIANCE WITH STORMWATER STANDARDS

5.1 Untreated Stormwater (Standard 1)

The project is designed so that new stormwater conveyances (outfalls/discharges) do not discharge untreated stormwater into, or cause erosion to, wetlands.

Standard #1 is met.

5.2 Post-Development Peak Rates (Standard 2)

Hydrologic calculations were performed to determine the rate of runoff for the 2, 10, 25 and 100-year storm events under pre-development (present) conditions. This value was established as the future (post-development) maximum allowable rate. Unmitigated post-development rates were then computed in a similar manner. It is the intent of the stormwater management system to minimize impacts to drainage patterns of downstream property and wetlands while simultaneously providing water quality treatment to runoff prior to its release from the site or discharge to wetlands.

The U.S.D.A. Soil Conservation Service (SCS) Technical Release 55 (TR-55), 1986, was used as the procedure for estimating runoff. A SCS TR-20-based computer program, "HydroCAD," was used for estimating peak discharges. TR-55 is a generally accepted model for use on small sites that begins with a rainfall amount uniformly imposed on the watershed over a specified time distribution. Mass rainfall is converted to mass runoff by using a runoff curve number (CN). CN is based on soils, ground cover, impervious areas, interception and surface storage. Runoff is then transformed into a hydrograph that depends on runoff travel time through segments of the watershed.

Development in a watershed changes its response to precipitation. The most common effects are reduced infiltration and decreased travel time, which result in significantly higher peak rates of runoff. The volume of runoff is determined primarily by the amount of precipitation and by infiltration characteristics related to soil type, antecedent rainfall, and type of vegetative cover, impervious surfaces, and surface retention. Travel time is determined primarily by slope, flow length, depth of flow surfaces. Peak rates of discharge are based on the relationship of the above parameters as well as the total drainage area of the watershed, the location of the development in relation to the total drainage area, and the effect of any flood control works or other manmade storage. Peak rates of discharge are also influenced by the distribution of rainfall within a given storm event.

Runoff will be collected and conveyed overland and via closed pipes and will discharge into infiltration basins for recharge. The piping system is designed to contain and withstand maximum storm flows and velocities. The treatment train will serve the purpose of settling out sediments in runoff prior to discharge or recharge.

Stormwater management computations for the project site were performed using SCS-based Hydrocad for existing and proposed conditions, curve numbers, time of concentration, and unit hydrograph computations. The following were considered as part of runoff calculations.

Since urban areas are seldom completely covered by impervious structure, soils and soil properties are an important factor in estimating the total volume of direct runoff. The infiltration and percolation rates of soils indicate their potential to absorb rainfall and thereby reduce the amount of direct runoff. Soils having a high infiltration rate (sands or gravels) have a low runoff potential, and soils having a low infiltration rate (clays) have a high runoff potential. Urbanization on soils with a high infiltration rate increases the volume of runoff and peak discharge more than urbanization on soils with a low infiltration rate.

The type of surface cover and its hydrologic condition affects runoff volume through its influence on the infiltration rate of the soil. Unused cultivated land yields more runoff than forested land for a given soil type. Covering areas with impervious material reduces surface storage and infiltration and increases the volume of runoff.

Some rainfall is retained on the ground surface and by vegetation before runoff begins. Interception is rainfall that is caught by foliage, twigs, branches, leaves, etc. This rainfall is lost to evaporation and thus never reaches the ground surface. Increasing the vegetative cover increases the amount of interception.

Surface depression storage begins when precipitation exceeds infiltration. Overland flow starts when the surface depressions are full. The water in depression storage is not available as direct runoff.

Initial abstraction is the sum of interception, depression, storage, and infiltration before runoff begins. It occurs on all types of cover, from lawn in good condition to pavement. However, the amount of initial abstraction is less on pavement than on lawn.

Travel time (Tt) is the time it takes water to travel from one location to another in a watershed. Tt is a component of time of concentration (Tc) that is the time for runoff to travel from the hydraulically most distant point of the watershed to a point of interest within the watershed. Tc is computed by summing all the travel time for consecutive components of the drainage conveyance system. Tc

influences the shape and peak of the runoff hydrograph. Urbanization usually decreases Tc thereby increasing the peak discharge.

Development can change the effective slope of a watershed if flow paths are altered by channeling and by changing the surface grading for building lots, roads and ditches. The slopes of street gutters, roads and overland flow areas as well as stream channels are significant in determining travel times through urban watersheds.

Flow length may be reduced if natural meandering streams are changed to straight channels. It may be increased if overland flows are diverted through ditches, storm drains, or street gutters to larger collections systems.

Surface roughness is also a consideration. Flow velocity normally increases significantly when the flow path is changed from flow over rough surfaces of woodland, grassland and natural channels to sheet flow over smooth surfaces of parking lots, storm drains, gutters and lined channels.

5.2.1 Existing Conditions

Physical characteristics and land use are described in Section 1.0.

Soils information was taken from U.S.D.A. SCS Soil Survey Middlessex County (See Appendix). The SCS (now NRCS), website soils mapping indicates the following:

- 253A – Hinckley Loamy Sand, 0 to 3 percent slopes (HSG A)
- 253B – Hinckley Loamy Sand, 3 to 8 percent slopes (HSG A)
- 253C – Hinckley Loamy Sand, 8 to 15 percent slopes (HSG A)
- 653 – Udorthents (HSG A)

For the purpose of the analysis of the existing conditions, the project site was divided into two (2) separate areas, as shown on the plan within the Appendix entitled "EXISTING CONDITIONS WATERSHED MAP". Analysis Point #1 (AP#1) is along the southwestern boundary at the edge of a wetland leading to the Assabet River. Analysis Point #2 (AP#2) is within the existing "fire pond" east of the proposed building.

5.2.2 Proposed Conditions

Under the proposed conditions, existing drainage patterns on the site will be essentially maintained. There is no increase in overall contributing watershed area due to the development.

Increases in the peak runoff rates and volumes are mitigated through the construction of infiltration areas (subsurface chambers and surface basins). For the purpose of the analysis of the proposed conditions the

project site was divided into four (4) separate subcatchments (SC), as shown on the plan within the Appendix entitled "DEVELOPED CONDITIONS WATERSHED MAP". Runoff in SC1 runs overland from east to west to AP1. Runoff in SC2 runs overland from west to east to AP2. Runoff in SC3 has been disconnected from other areas within the watershed tributary to AP1 and will be conveyed overland to a proposed infiltration basin for recharge. Stormwater runoff from the proposed building flows via gutters and is conveyed to the infiltration basin as well.

Although watershed areas to the north of the proposed building may be altered during the project, the Watershed Maps illustrate that there is a reduction in this area as there is an increase in the area of SC2. Therefore runoff will be decreased in the area to the north, and the added area to SC2 are analyzed in the "fire pond".

Post-development peak rates and volumes were determined and routed through the infiltration BMP's with the resulting hydrographs added to the hydrographs for the undeveloped, undetained areas. Based upon these analyses, the peak rates and volumes of runoff for the 2, 10, 25, and 100-year storm events are as follows:

Table 5.2.2.1 – Stormwater Runoff Peak Rate Summary

Reference	Design Storm Discharges (cfs)			
	2-year(3.10")	10-year(4.50")	25-year (5.30")	100-year (6.5")
Pre AP1	0.00	0.09	0.44	2.03
Post AP1	0.00	0.10	0.35	2.00
Pre AP2	0.00	0.06	0.21	1.15
Post AP2*	0.01	0.28	1.05	3.00

* Although there are increases in the runoff in the Proposed Condition of AP2, AP2 is located within an existing "fire pond" and the enclosed computations demonstrate that with the additional runoff the capacity of the pond is not exceeded and therefore the runoff never leaves the property.

Standard #2 is met.

5.3 Recharge to Groundwater (Standard 3)

Although runoff volumes will not increase after construction; recharge shall be provided. Therefore, stormwater runoff volume to be recharged to groundwater should be determined using the existing site (pre-development) soil conditions and the annual recharge from the post-development site should approximate the annual recharge from the pre-development or existing site, based on soil types.

Hydrologic Soil Group	Volume to Recharge (x Total Impervious Area)
A	0.60 inches of runoff
B	0.35 inches of runoff
C	0.25 inches of runoff
D	0.10 inches of runoff

5.3.1 Soil Textures

Soils information obtained from U.S.D.A. NRCS Soil Survey Report for Middlesex County (see Appendix) determined that the stormwater runoff volume to be recharged is based on the Hydrologic Soil Classification Group A.

The hydrologic design methods presented in this appendix are based on the utilization of two hydrologic soil properties, the effective water capacity (Cw) and the minimum infiltration rate (f) of the specific soil textural groups, as shown in Table 5.3.1. The effective water capacity of a soil is the fraction of the void spaces available for water storage, measured in inches per inch. The minimum infiltration rate is the final rate that water passes through the soil profile during saturated conditions, measured in terms of inches per hour. The hydrologic soil properties are obtained by identifying the soil textures by a gradation test for each change in soil profile. The soil textures presented in Table 5.3.1 correspond to the soil textures of the U.S. Department of Agriculture (USDA) Textural Triangle.

The data presented in Table 5.3.1 are based on the analysis of over 5,000 soil samples by the USDA under carefully controlled procedures. The use of the soil properties established in Table 5.3.1 for design and review procedures offers two advantages. First, it provides for consistency of results in the design procedures. Second, it eliminates the need for the laborious and costly process of conducting field and laboratory infiltration and permeability tests.

Table 5.3.1 – Hydrologic Soil Properties Classified by Soil Texture*

Texture Class	Effective Water Capacity (C_w) (inch per inch)	Minimum Infiltration Rate (f) (inch per hour)	NRCS Hydrologic Soil Group
Sand	0.35	8.27	A
Loamy Sand	0.31	2.41	A
Sandy Loam	0.25	1.02	B
Loam	0.19	0.52	B
Silt Loam	0.17	0.27	C
Sandy Clay Loam	0.14	0.17	C
Clay Loam	0.14	0.09	D
Silty Clay Loam	0.11	0.06	D

Sandy Clay	0.09	0.05	D
Silty Clay	0.09	0.04	D
Clay	0.08	0.02	D

* Source: Rawls, Brakensiek, & Saxton, 1982

Based on the soil textural classes and the corresponding minimum infiltration rates, a restriction is established to eliminate unsuitable soil conditions. Soil textures with minimum infiltration rates less than 0.52 inches per hour are not suitable for usage of infiltration practices. These include soils that have a 30 percent clay content, making these soils susceptible to frost heaving and structurally unstable, in addition to having a poor capacity to percolate runoff. Soil textures that are recommended for infiltration systems include those soils with infiltration rates of 0.52 inches per hour or greater, which include loam, sandy loam, and sand.

Required Recharge Volume

The impervious area for the entire site is used for this calculation
0.60 inches runoff x total impervious area = Recharge Volume, "A" soil
0.60 inches x (1ft. /12in.) x (180,851) sq. ft. = 9,042 cubic feet.

Total Volume Required for Recharge = 9,042 cubic feet

Recharge Volume Provided

- Infiltration Basin #4 = 11,504 cu. Ft under outlet
- Infiltration Basin #3 = 4,260 cu Ft. under outlet

Total Recharge Volume Provided = 15,764 cu. ft.

Comparison of Required Recharge Volume to Provided Recharge
Provided Recharge - Required Recharge = Additional Recharge
15,764 cu. ft. – 9042 cu. ft. = 6,722 cu. ft.

The proposed infiltration basin can completely infiltrate a 100-year storm (36,3296 c.f.) from its inflow area including the entire proposed roof area. Furthermore, infiltration will be promoted throughout the site with the proposed flat grass areas on sandy soils.

Drawdown Time

Based on the HydroCAD analysis the infiltration BMP's will drawdown within 72 hours for up to a 100 year storm. Copies of the hydrographs tables for the infiltration BMP's are illustrated below. In addition, "Static" Method computations below confirm that the required drawdown time is met.

Drawdown Time = Rv ÷ (K)(Bottom Area)

Where:
Rv = Storage Volume
K = Saturated Hydraulic Conductivity *(for "Static" and "Simple Dynamic" Methods, use Rawls Rate)*
Bottom Area = Bottom Area of Recharge Structure

Infiltration Basin #4
Drawdown Time = 11504 c.f. ÷ (2.41 in/hr) x (1ft/12in) x (6200 s.f.)

Drawdown Time = 9.24 hours

10-yr storm	100-yr storm
9.24 hours ≤ 24 hours	9.24 hours ≤ 72 hours

Infiltration Basin #3
Drawdown Time = 4260 c.f. ÷ (2.41 in/hr) x (1ft/12in) x (875 s.f.)

Drawdown Time = 6.55 hours

10-yr storm	100-yr storm
24 hours ≤ 24 hours	24 hours ≤ 72 hours

Standard #3 is met.

5.4 Removal of 80% TSS (Standard 4)

There is a negligible amount of impervious area generating Total Suspended Solids (TSS) as part of this project. The largest impervious surface is the roof which shall not generate TSS. Other impervious surfaces are proposed site driveways, parking area, and concrete apron. The proposed driveways and parking area shall be constructed of Recycled Asphalt Pavement (RAP). Runoff from the largest portion of the parking area will flow through a broad grass swale to a water quality basin that contains the necessary volume for treatment of runoff. Furthermore, pea stone diaphragm has been added along the driveway portions to allow for pretreatment of these areas.

WQ for parking area:

16,100 s.f. x 0.5in/12 = 671 c.f.

Volume provided in water quality basin = 850 c.f.

Standard #4 is met.

5.5 Land Uses with Higher Potential (Standard 5)

This project does not contain areas with higher potential for pollution however stormwater runoff will be routed through specific BMP's prior to infiltration.

Standard #5 is met.

5.6 Critical Areas (Standard 6 – Water Quality Treatments)

This site does not lie within a critical area and water quality treatment of 1" of runoff is not required under Standard #6.

Standard #6 is met.

5.7 Redevelopment (Standard 7)

Redevelopment projects are those that involve development, rehabilitation or expansion on previously developed sites provided the redevelopment results in no net increase in impervious area. Furthermore, components of redevelopment project, which include development of previously undeveloped sites, do not fall under Standard 7. In addition, redevelopment of previously developed sites must meet the Stormwater Management Standards to the maximum extent practicable. However, if it is not practicable to meet all the Standards, new (retrofitted or expanded) stormwater management systems must be designed to improve existing conditions. This is not a redevelopment project.

Standard #7 is not applicable.

5.8 Erosion and Sedimentation Controls (Standard 8)

An Erosion and Sedimentation Control Plan is provided as part of the site plan application.

Standard #8 is met.

5.9 Operation and Maintenance Plan (Standard 9)

BMP owner:
Collings Foundation, Inc.
P.O. Box 248
Stow, MA 01775

Party responsible for operation and maintenance during construction:
J.M. Coull, Inc.
20 Powder Mill Road
Maynard, MA 01754

Party responsible for operation and maintenance post construction:
Collings Foundation, Inc.
P.O. Box 248
Stow, MA 01775

Long Term Pollution Prevention Plan

Schedule for Inspection and Maintenance:

Grassed Channel
At a minimum, grass channels shall be inspected after every major storm event (1/2-inch of rain or greater) for the first six (6) months and twice per year thereafter. Sediment and debris shall be removed from the grass channel once per year. Sediment should be removed from the channel by hand methods in a manner to limit the disturbance of vegetation and underlying soils. Grass within the channel shall be mowed as necessary to maintain the grass height between three (3) and six (6) inches. Remove grass clippings and inspect for signs of erosion and the formation of rills and/or gullies. Reseed or re-sod with an alternative grass species if the original grass cover is not successfully established. When reseeding, incorporate practices such as hydroseeding with a tackifier, blanket or similar practice to ensure that no scour occurs in the grass channel, while the seeds germinate and develop roots. Use deep tilling to break up clogged surfaces, and re-vegetate immediately if area becomes clogged.

Infiltration basins
Shall be inspected two (2) times per year and after every time drainage discharges through the outlet. Inspections shall also occur after every major storm event – equal to or greater than a 2-year, 24-hour storm (generally 3.1 to 4.6 inches in a 24-hour period). Inspections shall include signs of differential settlement, cracking, erosion, leakage in the embankments, tree growth on the embankments, condition of riprap, sediment accumulation, and health of the turf.

For the first 6 months after construction inspect lawns after each significant rainfall (½" or more) to ensure surface vegetation is healthy, discharge devices are not blocked and banks are not eroding, clean/repair as required. At least twice per year, mow the buffer areas, side slopes, and basin bottom. Remove grass clippings and accumulated organic matter to prevent an impervious organic mat from forming. Remove trash and debris at the same time. Use deep tilling to break up clogged surfaces, and re-vegetate immediately if area becomes clogged.

A maintenance log detailing the date and result of each inspection shall be kept by the responsible party and made available to the Planning Board, DPW, and

Conservation Commission upon request. Routine maintenance as well as follow-up actions taken as a result of inspections or incidents shall be detailed and dated in the log. Materials removed from catch basins, oil water separators and infiltration basin must be disposed of in accordance with 310 CMR 19 and 310 CMR 30 as applicable.

Pollution Prevention Plan During Construction

A. Good Housekeeping

The following good house keeping practices will be followed onsite during the construction project.

1. An effort will be made to store only enough products required to do the job.
2. All materials stored onsite will be stored in a neat, orderly manner and, if possible, under a roof or in a containment area. At a minimum, all containers will be stored with lids on when not in use. Drip pans shall be provided under all dispensers.
3. Products will be kept in their original containers with the original manufacturer's label in legible condition.
4. Substances will not be mixed with one another unless recommended by the manufacturer.
5. Whenever possible, all of a product will be used up before disposing of the container.
6. Manufacturer's recommendations for proper use and disposal will be followed.
7. The job site superintendent will be responsible for daily inspections to ensure proper use and disposal of materials.

B. Vehicle Washing

1. No construction vehicle washing shall be allowed onsite during and after construction.

C. Inspection and Maintenance Procedures

1. All controls will be inspected at least once every seven days and within 24 hours following a rainfall event of one-half (½) inch or more.
2. All measures will be maintained in good working order; if repairs or other measures are found to be necessary, they will be initiated within 24 hours of report.
3. Built up sediment will be removed from silt fence when it has reached one-third the height of the fence.

4. Silt fences will be inspected for depth of sediment, tears, etc., to see if the fabric is securely attached to the fence posts, and to see that the fence posts are securely in the ground.
5. Temporary and permanent seeding and all other stabilization measures will be inspected for bare spots, washouts, and healthy growth.
6. Disturbed areas and materials storage areas will be inspected for evidence of or potential pollutants entering the stormwater system.
7. Release of hazardous substances or oil in excess or reportable quantities (as established under 40 CFR 110, 40 CFR 117 or 40 CFR 302) must be reported.
8. BMP Maintenance:
    a. Pavement to be swept a minimum of two (2) times per year, or more often if required. At a minimum, sweeping will be conducted once in the spring (March/April) and once in the fall (October/November).
    b. Infiltration Basin shall be inspected two (2) times per year and after every time drainage discharges through over the outlet weir. Inspections shall also occur after every major storm event – equal to or greater than a 2-year, 24-hour storm (generally 3.1 to 4.6 inches in a 24-hour period).

D. Spill Prevention and Response

1. In order to minimize the potential for a spill of hazardous materials to come into contact with stormwater, the following steps will be implemented:
    a. All materials with hazardous properties(such as pesticides, petroleum products, fertilizers, detergents, construction chemical, acids, paints, paint solvents, cleaning solvents, additives for soil stabilization, concrete curing compounds and additives, etc.) will be stored in a secure location, with their lids on, preferably under cover, when not in use.
    b. The minimum quantity of all such materials will be kept on the job site.
    c. A spill control and containment kit (containing, for example, absorbent materials, acid neutralizing powder, brooms, dust pans, mops, rags, gloves, goggles, plastic and metal trash containers, etc.) will be provided at the storage site.
    d. Manufacturer's recommended methods for spill cleanup will be clearly posted and site personnel will be trained regarding these procedures and the location of the information and cleanup supplies.

2. In the event of a spill, the following procedures should be followed:
    a. All spills will be cleaned up immediately after discovery.

b. The spill area will be kept well ventilated and personnel will wear appropriate protective clothing to prevent injury from contact with hazardous substances.
c. The project manager and the engineer of record will be notified immediately.
d. Spills of toxic or hazardous materials will be reported to the appropriate federal state, and/or local government agency, regardless of the size of the spill. Spills in the amounts that exceed Reportable Quantities of certain substances specifically mentioned in federal regulations (40 CFR 110, 40 CFR 117, and 40 CFR 302) must be immediately reported to the EPA National Response Center, telephone 1-800-424-8802

3. The job site superintendent will be the spill prevention and response coordinator. He will designate the individuals who will receive spill prevention and response training. These individuals will each become responsible for a particular phase of prevention and response. The names of these personnel will be posted in the material storage area and in the office trailer onsite.

E. Lawn and Landscape Maintenance

1. For the first 6 months after construction inspect lawns after each significant rainfall (0.5 inches or more) to ensure surface vegetation is healthy, discharge devices are not blocked and banks are not eroding, clean/repair as required.
2. Inspect for diseased/dying trees, shrubs, ground cover, grass, replace as required.
3. Fertilizers will be not be applied.

F. Snow Removal

1. Any stockpiling of snow will be conducted in designated areas only.
2. Salt and/or de-icing agents will be prohibited during and after completion of the project.

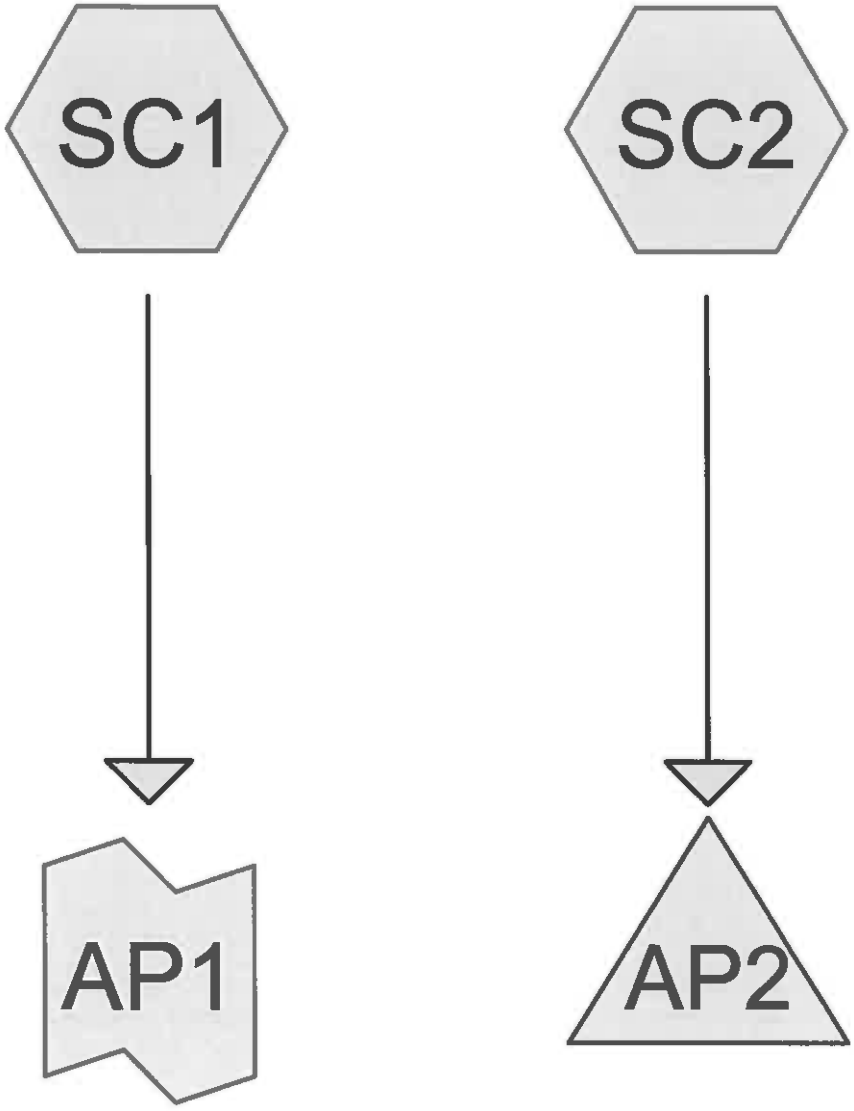
Standard #9 is met.

5.10 Illicit Discharges (Standard 10)

An Illicit Discharge Statement is included herewith. See Appendix

A pollution prevention plan is incorporated into this report to prevent illicit discharges during and after construction.

Standard #10 is met.



Subcat Reach Pond Link

Routing Diagram for Pre Development
Prepared by Andrews Survey & Engineering, Printed 1/21/2015

Summary for Subcatchment SC1:

Runoff = 0.00 cfs @ 1.00 hrs, Volume= 0 cf, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.20"

Area (sf)	CN	Description
991,026	30	Woods, Good, HSG A
553,759	39	Pasture/grassland/range, Good, HSG A
1,544,785	33	Weighted Average
1,544,785		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.4	50	0.0110	0.08		**Sheet Flow, Segment A** Grass: Dense n= 0.240 P2= 3.20"
7.1	1,007	0.0216	2.37		**Shallow Concentrated Flow, Segment B** Unpaved Kv= 16.1 fps
17.5	1,057	Total			

Summary for Subcatchment SC2:

Runoff = 0.00 cfs @ 1.00 hrs, Volume= 0 cf, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.20"

Area (ac)	CN	Description
7.730	30	Woods, Good, HSG A
0.150	98	Water Surface, HSG A
0.320	96	Gravel surface, HSG A
1.800	39	>75% Grass cover, Good, HSG A
10.000	35	Weighted Average
9.850		98.50% Pervious Area
0.150		1.50% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.8	50	0.0080	0.07		**Sheet Flow, Segment AB** Grass: Dense n= 0.240 P2= 3.20"
6.0	519	0.0080	1.44		**Shallow Concentrated Flow, Segment BC** Unpaved Kv= 16.1 fps
0.4	105	0.0950	4.96		**Shallow Concentrated Flow, Segment CD** Unpaved Kv= 16.1 fps
18.2	674	Total			

Summary for Pond AP2: FIRE POND

Inflow Area = 435,600 sf, 1.50% Impervious, Inflow Depth = 0.00" for 2-Year event
Inflow = 0.00 cfs @ 1.00 hrs, Volume= 0 cf
Outflow = 0.00 cfs @ 1.00 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min
Discarded = 0.00 cfs @ 1.00 hrs, Volume= 0 cf

Routing by Dyn-Stor-Ind method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 185.00' @ 1.00 hrs Surf.Area= 6,180 sf Storage= 0 cf
Flood Elev= 196.00' Surf.Area= 50,919 sf Storage= 249,026 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no inflow)

Volume	Invert	Avail.Storage	Storage Description
#1	185.00'	249,026 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
185.00	6,180	380.0	0	0	6,180
186.00	14,107	554.4	9,875	9,875	19,156
188.00	20,910	628.7	34,795	44,669	26,251
190.00	28,565	704.6	49,276	93,946	34,414
192.00	38,067	785.4	66,405	160,351	44,109
194.00	50,919	902.8	88,675	249,026	59,971

Device	Routing	Invert	Outlet Devices
#1	Discarded	185.00'	**2.410 in/hr Exfiltration over Wetted area** Conductivity to Groundwater Elevation = 184.99'

Discarded OutFlow Max=0.00 cfs @ 1.00 hrs HW=185.00' (Free Discharge)
↑**1=Exfiltration** (Passes 0.00 cfs of 0.34 cfs potential flow)

Summary for Link AP1:

Inflow Area = 1,544,785 sf, 0.00% Impervious, Inflow Depth = 0.00" for 2-Year event
Inflow = 0.00 cfs @ 1.00 hrs, Volume= 0 cf
Primary = 0.00 cfs @ 1.00 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs

Summary for Subcatchment SC1:

Runoff = 0.09 cfs @ 21.70 hrs, Volume= 2,513 cf, Depth= 0.02"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.70"

Area (sf)	CN	Description
991,026	30	Woods, Good, HSG A
553,759	39	Pasture/grassland/range, Good, HSG A
1,544,785	33	Weighted Average
1,544,785		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.4	50	0.0110	0.08		**Sheet Flow, Segment A** Grass: Dense n= 0.240 P2= 3.20"
7.1	1,007	0.0216	2.37		**Shallow Concentrated Flow, Segment B** Unpaved Kv= 16.1 fps
17.5	1,057	Total			

Summary for Subcatchment SC2:

Runoff = 0.06 cfs @ 15.83 hrs, Volume= 1,803 cf, Depth= 0.05"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.70"

Area (ac)	CN	Description
7.730	30	Woods, Good, HSG A
0.150	98	Water Surface, HSG A
0.320	96	Gravel surface, HSG A
1.800	39	>75% Grass cover, Good, HSG A
10.000	35	Weighted Average
9.850		98.50% Pervious Area
0.150		1.50% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.8	50	0.0080	0.07		**Sheet Flow, Segment AB** Grass: Dense n= 0.240 P2= 3.20"
6.0	519	0.0080	1.44		**Shallow Concentrated Flow, Segment BC** Unpaved Kv= 16.1 fps
0.4	105	0.0950	4.96		**Shallow Concentrated Flow, Segment CD** Unpaved Kv= 16.1 fps
18.2	674	Total			

Summary for Pond AP2: FIRE POND

Inflow Area = 435,600 sf, 1.50% Impervious, Inflow Depth = 0.05" for 10-Year event
Inflow = 0.06 cfs @ 15.83 hrs, Volume= 1,803 cf
Outflow = 0.06 cfs @ 15.83 hrs, Volume= 1,803 cf, Atten= 0%, Lag= 0.0 min
Discarded = 0.06 cfs @ 15.83 hrs, Volume= 1,803 cf

Routing by Dyn-Stor-Ind method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 185.00' @ 1.00 hrs Surf.Area= 6,180 sf Storage= 0 cf
Flood Elev= 196.00' Surf.Area= 50,919 sf Storage= 249,026 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.0 min (1,142.3 - 1,142.3)

Volume	Invert	Avail.Storage	Storage Description
#1	185.00'	249,026 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
185.00	6,180	380.0	0	0	6,180
186.00	14,107	554.4	9,875	9,875	19,156
188.00	20,910	628.7	34,795	44,669	26,251
190.00	28,565	704.6	49,276	93,946	34,414
192.00	38,067	785.4	66,405	160,351	44,109
194.00	50,919	902.8	88,675	249,026	59,971

Device	Routing	Invert	Outlet Devices
#1	Discarded	185.00'	**2.410 in/hr Exfiltration over Wetted area** Conductivity to Groundwater Elevation = 184.99'

Discarded OutFlow Max=0.00 cfs @ 15.83 hrs HW=185.00' (Free Discharge)
↑**1=Exfiltration** (Passes 0.00 cfs of 0.34 cfs potential flow)

Summary for Link AP1:

Inflow Area = 1,544,785 sf, 0.00% Impervious, Inflow Depth = 0.02" for 10-Year event
Inflow = 0.09 cfs @ 21.70 hrs, Volume= 2,513 cf
Primary = 0.09 cfs @ 21.70 hrs, Volume= 2,513 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs

Summary for Subcatchment SC1:

Runoff = 0.44 cfs @ 15.27 hrs, Volume= 12,267 cf, Depth= 0.10"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=5.50"

Area (sf)	CN	Description
991,026	30	Woods, Good, HSG A
553,759	39	Pasture/grassland/range, Good, HSG A
1,544,785	33	Weighted Average
1,544,785		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.4	50	0.0110	0.08		**Sheet Flow, Segment A** Grass: Dense n= 0.240 P2= 3.20"
7.1	1,007	0.0216	2.37		**Shallow Concentrated Flow, Segment B** Unpaved Kv= 16.1 fps
17.5	1,057	Total			

Summary for Subcatchment SC2:

Runoff = 0.21 cfs @ 14.73 hrs, Volume= 5,686 cf, Depth= 0.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=5.50"

Area (ac)	CN	Description
7.730	30	Woods, Good, HSG A
0.150	98	Water Surface, HSG A
0.320	96	Gravel surface, HSG A
1.800	39	>75% Grass cover, Good, HSG A
10.000	35	Weighted Average
9.850		98.50% Pervious Area
0.150		1.50% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.8	50	0.0080	0.07		**Sheet Flow, Segment AB** Grass: Dense n= 0.240 P2= 3.20"
6.0	519	0.0080	1.44		**Shallow Concentrated Flow, Segment BC** Unpaved Kv= 16.1 fps
0.4	105	0.0950	4.96		**Shallow Concentrated Flow, Segment CD** Unpaved Kv= 16.1 fps
18.2	674	Total			

Summary for Pond AP2: FIRE POND

Inflow Area = 435,600 sf, 1.50% Impervious, Inflow Depth = 0.16" for 25-Year event
Inflow = 0.21 cfs @ 14.73 hrs, Volume= 5,686 cf
Outflow = 0.21 cfs @ 14.73 hrs, Volume= 5,686 cf, Atten= 0%, Lag= 0.0 min
Discarded = 0.21 cfs @ 14.73 hrs, Volume= 5,686 cf

Routing by Dyn-Stor-Ind method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 185.00' @ 14.73 hrs Surf.Area= 6,180 sf Storage= 0 cf
Flood Elev= 196.00' Surf.Area= 50,919 sf Storage= 249,026 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.0 min (1,051.8 - 1,051.8)

Volume	Invert	Avail.Storage	Storage Description
#1	185.00'	249,026 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
185.00	6,180	380.0	0	0	6,180
186.00	14,107	554.4	9,875	9,875	19,156
188.00	20,910	628.7	34,795	44,669	26,251
190.00	28,565	704.6	49,276	93,946	34,414
192.00	38,067	785.4	66,405	160,351	44,109
194.00	50,919	902.8	88,675	249,026	59,971

Device	Routing	Invert	Outlet Devices
#1	Discarded	185.00'	**2.410 in/hr Exfiltration over Wetted area** Conductivity to Groundwater Elevation = 184.99'

Discarded OutFlow Max=0.34 cfs @ 14.73 hrs HW=185.00' (Free Discharge)
↑**1=Exfiltration** (Controls 0.34 cfs)

Summary for Link AP1:

Inflow Area = 1,544,785 sf, 0.00% Impervious, Inflow Depth = 0.10" for 25-Year event
Inflow = 0.44 cfs @ 15.27 hrs, Volume= 12,267 cf
Primary = 0.44 cfs @ 15.27 hrs, Volume= 12,267 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs

Summary for Subcatchment SC1:

Runoff = 2.03 cfs @ 12.63 hrs, Volume= 39,089 cf, Depth= 0.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=6.70"

Area (sf)	CN	Description
991,026	30	Woods, Good, HSG A
553,759	39	Pasture/grassland/range, Good, HSG A
1,544,785	33	Weighted Average
1,544,785		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.4	50	0.0110	0.08		**Sheet Flow, Segment A** Grass: Dense n= 0.240 P2= 3.20"
7.1	1,007	0.0216	2.37		**Shallow Concentrated Flow, Segment B** Unpaved Kv= 16.1 fps
17.5	1,057	Total			

Summary for Subcatchment SC2:

Runoff = 1.18 cfs @ 12.57 hrs, Volume= 15,011 cf, Depth= 0.41"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=6.70"

Area (ac)	CN	Description
7.730	30	Woods, Good, HSG A
0.150	98	Water Surface, HSG A
0.320	96	Gravel surface, HSG A
1.800	39	>75% Grass cover, Good, HSG A
10.000	35	Weighted Average
9.850		98.50% Pervious Area
0.150		1.50% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.8	50	0.0080	0.07		**Sheet Flow, Segment AB** Grass: Dense n= 0.240 P2= 3.20"
6.0	519	0.0080	1.44		**Shallow Concentrated Flow, Segment BC** Unpaved Kv= 16.1 fps
0.4	105	0.0950	4.96		**Shallow Concentrated Flow, Segment CD** Unpaved Kv= 16.1 fps
18.2	674	Total			

Summary for Pond AP2: FIRE POND

Inflow Area = 435,600 sf, 1.50% Impervious, Inflow Depth = 0.41" for 100-Year event
Inflow = 1.18 cfs @ 12.57 hrs, Volume= 15,011 cf
Outflow = 1.15 cfs @ 12.62 hrs, Volume= 15,011 cf, Atten= 3%, Lag= 3.2 min
Discarded = 1.15 cfs @ 12.62 hrs, Volume= 15,011 cf

Routing by Dyn-Stor-Ind method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 185.02' @ 12.62 hrs Surf.Area= 6,326 sf Storage= 143 cf
Flood Elev= 196.00' Surf.Area= 50,919 sf Storage= 249,026 cf

Plug-Flow detention time= 0.7 min calculated for 15,000 cf (100% of inflow)
Center-of-Mass det. time= 0.7 min (986.1 - 985.4)

Volume	Invert	Avail.Storage	Storage Description
#1	185.00'	249,026 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
185.00	6,180	380.0	0	0	6,180
186.00	14,107	554.4	9,875	9,875	19,156
188.00	20,910	628.7	34,795	44,669	26,251
190.00	28,565	704.6	49,276	93,946	34,414
192.00	38,067	785.4	66,405	160,351	44,109
194.00	50,919	902.8	88,675	249,026	59,971

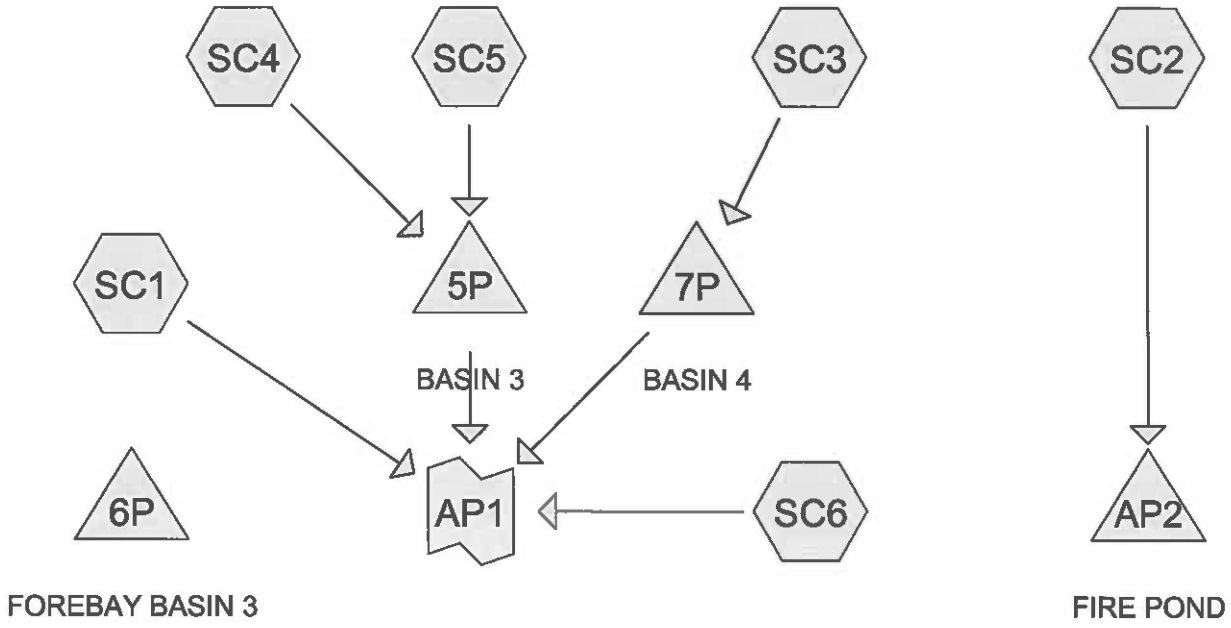
Device	Routing	Invert	Outlet Devices
#1	Discarded	185.00'	**2.410 in/hr Exfiltration over Wetted area** Conductivity to Groundwater Elevation = 184.99'

Discarded OutFlow Max=1.14 cfs @ 12.62 hrs HW=185.02' (Free Discharge)
↑**1=Exfiltration** (Controls 1.14 cfs)

Summary for Link AP1:

Inflow Area = 1,544,785 sf, 0.00% Impervious, Inflow Depth = 0.30" for 100-Year event
Inflow = 2.03 cfs @ 12.63 hrs, Volume= 39,089 cf
Primary = 2.03 cfs @ 12.63 hrs, Volume= 39,089 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs



Subcat Reach Pond Link

Routing Diagram for Post Development
Prepared by Andrews Survey & Engineering, Printed 1/21/2015

Summary for Subcatchment SC1:

Runoff = 0.00 cfs @ 1.00 hrs, Volume= 0 cf, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.20"

Area (sf)	CN	Description
325,297	30	Woods, Good, HSG A
390,660	39	Pasture/grassland/range, Good, HSG A
715,957	35	Weighted Average
715,957		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.8	50	0.0100	0.08		**Sheet Flow, Segment A** Grass: Dense n= 0.240 P2= 3.20"
5.7	936	0.0290	2.74		**Shallow Concentrated Flow, Segment B** Unpaved Kv= 16.1 fps
16.5	986	Total			

Summary for Subcatchment SC2:

Runoff = 0.01 cfs @ 22.93 hrs, Volume= 212 cf, Depth= 0.01"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.20"

Area (sf)	CN	Description
33,106	98	Paved parking, HSG A
149,846	30	Woods, Good, HSG A
177,289	39	>75% Grass cover, Good, HSG A
360,241	41	Weighted Average
327,135		90.81% Pervious Area
33,106		9.19% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.6	50	0.0040	0.05		**Sheet Flow, Segment AB** Grass: Dense n= 0.240 P2= 3.20"
5.6	541	0.0100	1.61		**Shallow Concentrated Flow, Segment BC** Unpaved Kv= 16.1 fps
0.3	86	0.1050	5.22		**Shallow Concentrated Flow, Segment CD** Unpaved Kv= 16.1 fps
21.5	677	Total			

Summary for Subcatchment SC3:

Runoff = 0.22 cfs @ 12.63 hrs, Volume= 4,950 cf, Depth= 0.13"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.20"

Area (sf)	CN	Description
55,215	98	Roofs, HSG A
32,652	98	Paved parking, HSG A
587	96	Gravel surface, HSG A
38,727	30	Woods, Good, HSG A
334,837	39	Pasture/grassland/range, Good, HSG A
462,018	50	Weighted Average
374,151		80.98% Pervious Area
87,867		19.02% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	20	0.0100	0.76		**Sheet Flow, Segment A** Smooth surfaces n= 0.011 P2= 3.20"
7.2	30	0.0100	0.07		**Sheet Flow, Segment B** Grass: Dense n= 0.240 P2= 3.20"
1.4	121	0.0080	1.44		**Shallow Concentrated Flow, Segment C** Unpaved Kv= 16.1 fps
0.3	97	0.1030	5.17		**Shallow Concentrated Flow, Segment D** Unpaved Kv= 16.1 fps
5.5	654	0.0153	1.99		**Shallow Concentrated Flow, Segment E** Unpaved Kv= 16.1 fps
14.8	922	Total			

Summary for Subcatchment SC4:

Runoff = 0.00 cfs @ 1.00 hrs, Volume= 0 cf, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.20"

Area (sf)	CN	Description
35,395	30	Woods, Good, HSG A
5,007	96	Gravel surface, HSG A
19,147	39	>75% Grass cover, Good, HSG A
59,549	38	Weighted Average
59,549		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.8	50	0.2140	0.17		**Sheet Flow, Segment A** Woods: Light underbrush n= 0.400 P2= 3.20"
0.8	241	0.1010	5.12		**Shallow Concentrated Flow, Segment B** Unpaved Kv= 16.1 fps
5.6	291	Total			

Summary for Subcatchment SC5:

Runoff = 0.01 cfs @ 21.65 hrs, Volume= 145 cf, Depth= 0.01"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.20"

Area (sf)	CN	Description
70,843	30	Woods, Good, HSG A
9,784	96	Gravel surface, HSG A
40,040	39	>75% Grass cover, Good, HSG A
8,373	98	Paved parking, HSG A
129,040	42	Weighted Average
120,667		93.51% Pervious Area
8,373		6.49% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	50	0.0160	0.06		**Sheet Flow, Segment A** Woods: Light underbrush n= 0.400 P2= 3.20"
0.8	163	0.0454	3.43		**Shallow Concentrated Flow, Segment B** Unpaved Kv= 16.1 fps
0.0	17	0.3824	9.96		**Shallow Concentrated Flow, Segment C** Unpaved Kv= 16.1 fps
0.6	225	0.0289	6.09	24.37	**Channel Flow, Segment D** Area= 4.0 sf Perim= 6.5' r= 0.62' n= 0.030
0.3	125	0.0240	7.03	5.52	**Pipe Channel, CMP_Round 12"** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior
15.2	580	Total			

Summary for Subcatchment SC6:

Runoff = 0.00 cfs @ 1.00 hrs, Volume= 0 cf, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.20"

Area (sf)	CN	Description
345,192	30	Woods, Good, HSG A
2,133	39	Pasture/grassland/range, Good, HSG A
347,325	30	Weighted Average
347,325		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.3	50	0.1660	0.16		**Sheet Flow, Segment A** Woods: Light underbrush n= 0.400 P2= 3.20"
0.3	100	0.1320	5.85		**Shallow Concentrated Flow, Segment** Unpaved Kv= 16.1 fps
5.6	150	Total			

Summary for Pond 5P: BASIN 3

Inflow Area = 188,589 sf, 4.44% Impervious, Inflow Depth = 0.01" for 2-Year event
Inflow = 0.01 cfs @ 21.65 hrs, Volume= 145 cf
Outflow = 0.01 cfs @ 21.65 hrs, Volume= 145 cf, Atten= 0%, Lag= 0.0 min
Discarded = 0.01 cfs @ 21.65 hrs, Volume= 145 cf
Primary = 0.00 cfs @ 1.00 hrs, Volume= 0 cf

Routing by Dyn-Stor-Ind method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 184.00' @ 1.00 hrs Surf.Area= 875 sf Storage= 0 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.0 min (1,219.6 - 1,219.6)

Volume	Invert	Avail.Storage	Storage Description
#1	184.00'	9,137 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
184.00	875	161.0	0	0	875
186.00	2,202	261.0	2,977	2,977	4,260
188.00	4,052	331.0	6,161	9,137	7,610

Device	Routing	Invert	Outlet Devices
#1	Primary	187.00'	**20.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#2	Discarded	184.00'	**2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 0.00'

Discarded OutFlow Max=0.00 cfs @ 21.65 hrs HW=184.00' (Free Discharge)
↑—**2=Exfiltration** (Passes 0.00 cfs of 0.05 cfs potential flow)

Primary OutFlow Max=0.00 cfs @ 1.00 hrs HW=184.00' TW=0.00' (Dynamic Tailwater)
↑—**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond 6P: FOREBAY BASIN 3

Volume	Invert	Avail.Storage	Storage Description
#1	185.00'	113 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
185.00	37	24.0	0	0	37
186.00	214	75.0	113	113	442

Summary for Pond 7P: BASIN 4

Inflow Area = 462,018 sf, 19.02% Impervious, Inflow Depth = 0.13" for 2-Year event
Inflow = 0.22 cfs @ 12.63 hrs, Volume= 4,950 cf
Outflow = 0.22 cfs @ 12.63 hrs, Volume= 4,950 cf, Atten= 0%, Lag= 0.0 min
Discarded = 0.22 cfs @ 12.63 hrs, Volume= 4,950 cf
Primary = 0.00 cfs @ 1.00 hrs, Volume= 0 cf

Routing by Dyn-Stor-Ind method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 184.00' @ 12.63 hrs Surf.Area= 6,199 sf Storage= 0 cf

Plug-Flow detention time= 0.0 min calculated for 4,947 cf (100% of inflow)
Center-of-Mass det. time= 0.0 min (1,018.1 - 1,018.1)

Volume	Invert	Avail.Storage	Storage Description
#1	184.00'	40,746 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
184.00	6,199	634.0	0	0	6,199
186.00	10,192	683.0	16,226	16,226	11,501
188.00	14,451	726.0	24,519	40,746	16,524

Device	Routing	Invert	Outlet Devices
#1	Discarded	184.00'	**2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 0.00'
#2	Primary	187.00'	**20.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Discarded OutFlow Max=0.35 cfs @ 12.63 hrs HW=184.00' (Free Discharge)
↑—**1=Exfiltration** (Controls 0.35 cfs)

Primary OutFlow Max=0.00 cfs @ 1.00 hrs HW=184.00' TW=0.00' (Dynamic Tailwater)
↑—**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond AP2: FIRE POND

Inflow Area = 360,241 sf, 9.19% Impervious, Inflow Depth = 0.01" for 2-Year event
Inflow = 0.01 cfs @ 22.93 hrs, Volume= 212 cf
Outflow = 0.01 cfs @ 22.93 hrs, Volume= 212 cf, Atten= 0%, Lag= 0.0 min
Discarded = 0.01 cfs @ 22.93 hrs, Volume= 212 cf

Routing by Dyn-Stor-Ind method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 185.00' @ 1.00 hrs Surf.Area= 6,180 sf Storage= 0 cf
Flood Elev= 196.00' Surf.Area= 50,919 sf Storage= 249,026 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.0 min (1,275.4 - 1,275.4)

Volume	Invert	Avail.Storage	Storage Description
#1	185.00'	249,026 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
185.00	6,180	380.0	0	0	6,180
186.00	14,107	554.4	9,875	9,875	19,156
188.00	20,910	628.7	34,795	44,669	26,251
190.00	28,565	704.6	49,276	93,946	34,414
192.00	38,067	785.4	66,405	160,351	44,109
194.00	50,919	902.8	88,675	249,026	59,971

Device	Routing	Invert	Outlet Devices
#1	Discarded	185.00'	**2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 184.99'

Discarded OutFlow Max=0.00 cfs @ 22.93 hrs HW=185.00' (Free Discharge)
↑**1=Exfiltration** (Passes 0.00 cfs of 0.34 cfs potential flow)

Summary for Link AP1:

Inflow Area = 1,713,889 sf, 5.62% Impervious, Inflow Depth = 0.00" for 2-Year event
Inflow = 0.00 cfs @ 1.00 hrs, Volume= 0 cf
Primary = 0.00 cfs @ 1.00 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs

Summary for Subcatchment SC1:

Runoff = 0.10 cfs @ 15.80 hrs, Volume= 2,964 cf, Depth= 0.05"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.70"

Area (sf)	CN	Description
325,297	30	Woods, Good, HSG A
390,660	39	Pasture/grassland/range, Good, HSG A
715,957	35	Weighted Average
715,957		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.8	50	0.0100	0.08		**Sheet Flow, Segment A** Grass: Dense n= 0.240 P2= 3.20"
5.7	936	0.0290	2.74		**Shallow Concentrated Flow, Segment B** Unpaved Kv= 16.1 fps
16.5	986	Total			

Summary for Subcatchment SC2:

Runoff = 0.28 cfs @ 12.74 hrs, Volume= 6,147 cf, Depth= 0.20"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.70"

Area (sf)	CN	Description
33,106	98	Paved parking, HSG A
149,846	30	Woods, Good, HSG A
177,289	39	>75% Grass cover, Good, HSG A
360,241	41	Weighted Average
327,135		90.81% Pervious Area
33,106		9.19% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.6	50	0.0040	0.05		**Sheet Flow, Segment AB** Grass: Dense n= 0.240 P2= 3.20"
5.6	541	0.0100	1.61		**Shallow Concentrated Flow, Segment BC** Unpaved Kv= 16.1 fps
0.3	86	0.1050	5.22		**Shallow Concentrated Flow, Segment CD** Unpaved Kv= 16.1 fps
21.5	677	Total			

Summary for Subcatchment SC3:

Runoff = 3.11 cfs @ 12.34 hrs, Volume= 22,100 cf, Depth= 0.57"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.70"

Area (sf)	CN	Description
55,215	98	Roofs, HSG A
32,652	98	Paved parking, HSG A
587	96	Gravel surface, HSG A
38,727	30	Woods, Good, HSG A
334,837	39	Pasture/grassland/range, Good, HSG A
462,018	50	Weighted Average
374,151		80.98% Pervious Area
87,867		19.02% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	20	0.0100	0.76		**Sheet Flow, Segment A** Smooth surfaces n= 0.011 P2= 3.20"
7.2	30	0.0100	0.07		**Sheet Flow, Segment B** Grass: Dense n= 0.240 P2= 3.20"
1.4	121	0.0080	1.44		**Shallow Concentrated Flow, Segment C** Unpaved Kv= 16.1 fps
0.3	97	0.1030	5.17		**Shallow Concentrated Flow, Segment D** Unpaved Kv= 16.1 fps
5.5	654	0.0153	1.99		**Shallow Concentrated Flow, Segment E** Unpaved Kv= 16.1 fps
14.8	922	Total			

Summary for Subcatchment SC4:

Runoff = 0.02 cfs @ 14.69 hrs, Volume= 577 cf, Depth= 0.12"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.70"

Area (sf)	CN	Description
35,395	30	Woods, Good, HSG A
5,007	96	Gravel surface, HSG A
19,147	39	>75% Grass cover, Good, HSG A
59,549	38	Weighted Average
59,549		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.8	50	0.2140	0.17		**Sheet Flow, Segment A** Woods: Light underbrush n= 0.400 P2= 3.20"
0.8	241	0.1010	5.12		**Shallow Concentrated Flow, Segment B** Unpaved Kv= 16.1 fps
5.6	291	Total			

Summary for Subcatchment SC5:

Runoff = 0.17 cfs @ 12.56 hrs, Volume= 2,565 cf, Depth= 0.24"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.70"

Area (sf)	CN	Description
70,843	30	Woods, Good, HSG A
9,784	96	Gravel surface, HSG A
40,040	39	>75% Grass cover, Good, HSG A
8,373	98	Paved parking, HSG A
129,040	42	Weighted Average
120,667		93.51% Pervious Area
8,373		6.49% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	50	0.0160	0.06		**Sheet Flow, Segment A** Woods: Light underbrush n= 0.400 P2= 3.20"
0.8	163	0.0454	3.43		**Shallow Concentrated Flow, Segment B** Unpaved Kv= 16.1 fps
0.0	17	0.3824	9.96		**Shallow Concentrated Flow, Segment C** Unpaved Kv= 16.1 fps
0.6	225	0.0289	6.09	24.37	**Channel Flow, Segment D** Area= 4.0 sf Perim= 6.5' r= 0.62' n= 0.030
0.3	125	0.0240	7.03	5.52	**Pipe Channel, CMP_Round 12"** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior
15.2	580	Total			

Summary for Subcatchment SC6:

Runoff = 0.00 cfs @ 23.99 hrs, Volume= 1 cf, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.70"

Area (sf)	CN	Description
345,192	30	Woods, Good, HSG A
2,133	39	Pasture/grassland/range, Good, HSG A
347,325	30	Weighted Average
347,325		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.3	50	0.1660	0.16		**Sheet Flow, Segment A** Woods: Light underbrush n= 0.400 P2= 3.20"
0.3	100	0.1320	5.85		**Shallow Concentrated Flow, Segment** Unpaved Kv= 16.1 fps
5.6	150	Total			

Summary for Pond 5P: BASIN 3

Inflow Area = 188,589 sf, 4.44% Impervious, Inflow Depth = 0.20" for 10-Year event
Inflow = 0.17 cfs @ 12.57 hrs, Volume= 3,142 cf
Outflow = 0.07 cfs @ 17.15 hrs, Volume= 3,146 cf, Atten= 58%, Lag= 274.7 min
Discarded = 0.07 cfs @ 17.15 hrs, Volume= 3,146 cf
Primary = 0.00 cfs @ 1.00 hrs, Volume= 0 cf

Routing by Dyn-Stor-Ind method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 184.71' @ 17.15 hrs Surf.Area= 1,276 sf Storage= 757 cf

Plug-Flow detention time= 130.3 min calculated for 3,142 cf (100% of inflow)
Center-of-Mass det. time= 130.8 min (1,139.4 - 1,008.6)

Volume	Invert	Avail.Storage	Storage Description
#1	184.00'	9,137 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
184.00	875	161.0	0	0	875
186.00	2,202	261.0	2,977	2,977	4,260
188.00	4,052	331.0	6,161	9,137	7,610

Device	Routing	Invert	Outlet Devices
#1	Primary	187.00'	**20.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#2	Discarded	184.00'	**2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 0.00'

Discarded OutFlow Max=0.07 cfs @ 17.15 hrs HW=184.71' (Free Discharge)
↑—**2=Exfiltration** (Controls 0.07 cfs)

Primary OutFlow Max=0.00 cfs @ 1.00 hrs HW=184.00' TW=0.00' (Dynamic Tailwater)
↑—**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond 6P: FOREBAY BASIN 3

Volume	Invert	Avail.Storage	Storage Description
#1	185.00'	113 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
185.00	37	24.0	0	0	37
186.00	214	75.0	113	113	442

Summary for Pond 7P: BASIN 4

Inflow Area = 462,018 sf, 19.02% Impervious, Inflow Depth = 0.57" for 10-Year event
Inflow = 3.11 cfs @ 12.34 hrs, Volume= 22,100 cf
Outflow = 0.47 cfs @ 15.97 hrs, Volume= 22,106 cf, Atten= 85%, Lag= 217.3 min
Discarded = 0.47 cfs @ 15.97 hrs, Volume= 22,106 cf
Primary = 0.00 cfs @ 1.00 hrs, Volume= 0 cf

Routing by Dyn-Stor-Ind method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 185.13' @ 15.97 hrs Surf.Area= 8,333 sf Storage= 8,178 cf

Plug-Flow detention time= 209.4 min calculated for 22,091 cf (100% of inflow)
Center-of-Mass det. time= 209.5 min (1,141.0 - 931.5)

Volume	Invert	Avail.Storage	Storage Description
#1	184.00'	40,746 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
184.00	6,199	634.0	0	0	6,199
186.00	10,192	683.0	16,226	16,226	11,501
188.00	14,451	726.0	24,519	40,746	16,524

Device	Routing	Invert	Outlet Devices
#1	Discarded	184.00'	**2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 0.00'
#2	Primary	187.00'	**20.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Discarded OutFlow Max=0.47 cfs @ 15.97 hrs HW=185.13' (Free Discharge)
↑—**1=Exfiltration** (Controls 0.47 cfs)

Primary OutFlow Max=0.00 cfs @ 1.00 hrs HW=184.00' TW=0.00' (Dynamic Tailwater)
↑—**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond AP2: FIRE POND

Inflow Area = 360,241 sf, 9.19% Impervious, Inflow Depth = 0.20" for 10-Year event
Inflow = 0.28 cfs @ 12.74 hrs, Volume= 6,147 cf
Outflow = 0.28 cfs @ 12.74 hrs, Volume= 6,147 cf, Atten= 0%, Lag= 0.0 min
Discarded = 0.28 cfs @ 12.74 hrs, Volume= 6,147 cf

Routing by Dyn-Stor-Ind method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 185.00' @ 12.74 hrs Surf.Area= 6,180 sf Storage= 0 cf
Flood Elev= 196.00' Surf.Area= 50,919 sf Storage= 249,026 cf

Plug-Flow detention time= 0.0 min calculated for 6,147 cf (100% of inflow)
Center-of-Mass det. time= 0.0 min (1,017.4 - 1,017.4)

Volume	Invert	Avail.Storage	Storage Description
#1	185.00'	249,026 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
185.00	6,180	380.0	0	0	6,180
186.00	14,107	554.4	9,875	9,875	19,156
188.00	20,910	628.7	34,795	44,669	26,251
190.00	28,565	704.6	49,276	93,946	34,414
192.00	38,067	785.4	66,405	160,351	44,109
194.00	50,919	902.8	88,675	249,026	59,971

Device	Routing	Invert	Outlet Devices
#1	Discarded	185.00'	**2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 184.99'

Discarded OutFlow Max=0.34 cfs @ 12.74 hrs HW=185.00' (Free Discharge)
↑**1=Exfiltration** (Controls 0.34 cfs)

Summary for Link AP1:

Inflow Area = 1,713,889 sf, 5.62% Impervious, Inflow Depth = 0.02" for 10-Year event
Inflow = 0.10 cfs @ 15.80 hrs, Volume= 2,966 cf
Primary = 0.10 cfs @ 15.80 hrs, Volume= 2,966 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs

Summary for Subcatchment SC1:

Runoff = 0.35 cfs @ 14.70 hrs, Volume= 9,346 cf, Depth= 0.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=5.50"

Area (sf)	CN	Description
325,297	30	Woods, Good, HSG A
390,660	39	Pasture/grassland/range, Good, HSG A
715,957	35	Weighted Average
715,957		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.8	50	0.0100	0.08		**Sheet Flow, Segment A** Grass: Dense n= 0.240 P2= 3.20"
5.7	936	0.0290	2.74		**Shallow Concentrated Flow, Segment B** Unpaved Kv= 16.1 fps
16.5	986	Total			

Summary for Subcatchment SC2:

Runoff = 1.07 cfs @ 12.58 hrs, Volume= 12,131 cf, Depth= 0.40"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=5.50"

Area (sf)	CN	Description
33,106	98	Paved parking, HSG A
149,846	30	Woods, Good, HSG A
177,289	39	>75% Grass cover, Good, HSG A
360,241	41	Weighted Average
327,135		90.81% Pervious Area
33,106		9.19% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.6	50	0.0040	0.05		**Sheet Flow, Segment AB** Grass: Dense n= 0.240 P2= 3.20"
5.6	541	0.0100	1.61		**Shallow Concentrated Flow, Segment BC** Unpaved Kv= 16.1 fps
0.3	86	0.1050	5.22		**Shallow Concentrated Flow, Segment CD** Unpaved Kv= 16.1 fps
21.5	677	Total			

Summary for Subcatchment SC3:

Runoff = 6.12 cfs @ 12.27 hrs, Volume= 34,937 cf, Depth= 0.91"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=5.50"

Area (sf)	CN	Description
55,215	98	Roofs, HSG A
32,652	98	Paved parking, HSG A
587	96	Gravel surface, HSG A
38,727	30	Woods, Good, HSG A
334,837	39	Pasture/grassland/range, Good, HSG A
462,018	50	Weighted Average
374,151		80.98% Pervious Area
87,867		19.02% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	20	0.0100	0.76		**Sheet Flow, Segment A** Smooth surfaces n= 0.011 P2= 3.20"
7.2	30	0.0100	0.07		**Sheet Flow, Segment B** Grass: Dense n= 0.240 P2= 3.20"
1.4	121	0.0080	1.44		**Shallow Concentrated Flow, Segment C** Unpaved Kv= 16.1 fps
0.3	97	0.1030	5.17		**Shallow Concentrated Flow, Segment D** Unpaved Kv= 16.1 fps
5.5	654	0.0153	1.99		**Shallow Concentrated Flow, Segment E** Unpaved Kv= 16.1 fps
14.8	922	Total			

Summary for Subcatchment SC4:

Runoff = 0.10 cfs @ 12.42 hrs, Volume= 1,338 cf, Depth= 0.27"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=5.50"

Area (sf)	CN	Description
35,395	30	Woods, Good, HSG A
5,007	96	Gravel surface, HSG A
19,147	39	>75% Grass cover, Good, HSG A
59,549	38	Weighted Average
59,549		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.8	50	0.2140	0.17		**Sheet Flow, Segment A** Woods: Light underbrush n= 0.400 P2= 3.20"
0.8	241	0.1010	5.12		**Shallow Concentrated Flow, Segment B** Unpaved Kv= 16.1 fps
5.6	291	Total			

Summary for Subcatchment SC5:

Runoff = 0.52 cfs @ 12.47 hrs, Volume= 4,872 cf, Depth= 0.45"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=5.50"

Area (sf)	CN	Description
70,843	30	Woods, Good, HSG A
9,784	96	Gravel surface, HSG A
40,040	39	>75% Grass cover, Good, HSG A
8,373	98	Paved parking, HSG A
129,040	42	Weighted Average
120,667		93.51% Pervious Area
8,373		6.49% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	50	0.0160	0.06		**Sheet Flow, Segment A** Woods: Light underbrush n= 0.400 P2= 3.20"
0.8	163	0.0454	3.43		**Shallow Concentrated Flow, Segment B** Unpaved Kv= 16.1 fps
0.0	17	0.3824	9.96		**Shallow Concentrated Flow, Segment C** Unpaved Kv= 16.1 fps
0.6	225	0.0289	6.09	24.37	**Channel Flow, Segment D** Area= 4.0 sf Perim= 6.5' r= 0.62' n= 0.030
0.3	125	0.0240	7.03	5.52	**Pipe Channel, CMP_Round 12"** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior
15.2	580	Total			

Summary for Subcatchment SC6:

Runoff = 0.03 cfs @ 21.06 hrs, Volume= 832 cf, Depth= 0.03"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=5.50"

Area (sf)	CN	Description
345,192	30	Woods, Good, HSG A
2,133	39	Pasture/grassland/range, Good, HSG A
347,325	30	Weighted Average
347,325		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.3	50	0.1660	0.16		**Sheet Flow, Segment A** Woods: Light underbrush n= 0.400 P2= 3.20"
0.3	100	0.1320	5.85		**Shallow Concentrated Flow, Segment** Unpaved Kv= 16.1 fps
5.6	150	Total			

Summary for Pond 5P: BASIN 3

Inflow Area = 188,589 sf, 4.44% Impervious, Inflow Depth = 0.40" for 25-Year event
Inflow = 0.61 cfs @ 12.46 hrs, Volume= 6,210 cf
Outflow = 0.11 cfs @ 17.48 hrs, Volume= 6,211 cf, Atten= 82%, Lag= 301.5 min
Discarded = 0.11 cfs @ 17.48 hrs, Volume= 6,211 cf
Primary = 0.00 cfs @ 1.00 hrs, Volume= 0 cf

Routing by Dyn-Stor-Ind method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 185.74' @ 17.48 hrs Surf.Area= 1,998 sf Storage= 2,437 cf

Plug-Flow detention time= 285.8 min calculated for 6,206 cf (100% of inflow)
Center-of-Mass det. time= 285.9 min (1,253.0 - 967.2)

Volume	Invert	Avail.Storage	Storage Description
#1	184.00'	9,137 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
184.00	875	161.0	0	0	875
186.00	2,202	261.0	2,977	2,977	4,260
188.00	4,052	331.0	6,161	9,137	7,610

Device	Routing	Invert	Outlet Devices
#1	Primary	187.00'	**20.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#2	Discarded	184.00'	**2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 0.00'

Discarded OutFlow Max=0.11 cfs @ 17.48 hrs HW=185.74' (Free Discharge)
↑**2=Exfiltration** (Controls 0.11 cfs)

Primary OutFlow Max=0.00 cfs @ 1.00 hrs HW=184.00' TW=0.00' (Dynamic Tailwater)
↑**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond 6P: FOREBAY BASIN 3

Volume	Invert	Avail.Storage	Storage Description
#1	185.00'	113 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
185.00	37	24.0	0	0	37
186.00	214	75.0	113	113	442

Summary for Pond 7P: BASIN 4

Inflow Area = 462,018 sf, 19.02% Impervious, Inflow Depth = 0.91" for 25-Year event
Inflow = 6.12 cfs @ 12.27 hrs, Volume= 34,937 cf
Outflow = 0.58 cfs @ 16.53 hrs, Volume= 34,955 cf, Atten= 91%, Lag= 255.6 min
Discarded = 0.58 cfs @ 16.53 hrs, Volume= 34,955 cf
Primary = 0.00 cfs @ 1.00 hrs, Volume= 0 cf

Routing by Dyn-Stor-Ind method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 186.03' @ 16.53 hrs Surf.Area= 10,258 sf Storage= 16,574 cf

Plug-Flow detention time= 354.7 min calculated for 34,930 cf (100% of inflow)
Center-of-Mass det. time= 355.0 min (1,266.7 - 911.6)

Volume	Invert	Avail.Storage	Storage Description
#1	184.00'	40,746 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
184.00	6,199	634.0	0	0	6,199
186.00	10,192	683.0	16,226	16,226	11,501
188.00	14,451	726.0	24,519	40,746	16,524

Device	Routing	Invert	Outlet Devices
#1	Discarded	184.00'	**2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 0.00'
#2	Primary	187.00'	**20.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Discarded OutFlow Max=0.58 cfs @ 16.53 hrs HW=186.03' (Free Discharge)
↑—**1=Exfiltration** (Controls 0.58 cfs)

Primary OutFlow Max=0.00 cfs @ 1.00 hrs HW=184.00' TW=0.00' (Dynamic Tailwater)
↑—**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond AP2: FIRE POND

Inflow Area = 360,241 sf, 9.19% Impervious, Inflow Depth = 0.40" for 25-Year event
Inflow = 1.07 cfs @ 12.58 hrs, Volume= 12,131 cf
Outflow = 1.05 cfs @ 12.63 hrs, Volume= 12,131 cf, Atten= 2%, Lag= 3.2 min
Discarded = 1.05 cfs @ 12.63 hrs, Volume= 12,131 cf

Routing by Dyn-Stor-Ind method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 185.02' @ 12.63 hrs Surf.Area= 6,308 sf Storage= 126 cf
Flood Elev= 196.00' Surf.Area= 50,919 sf Storage= 249,026 cf

Plug-Flow detention time= 0.6 min calculated for 12,131 cf (100% of inflow)
Center-of-Mass det. time= 0.6 min (975.3 - 974.7)

Volume	Invert	Avail.Storage	Storage Description
#1	185.00'	249,026 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
185.00	6,180	380.0	0	0	6,180
186.00	14,107	554.4	9,875	9,875	19,156
188.00	20,910	628.7	34,795	44,669	26,251
190.00	28,565	704.6	49,276	93,946	34,414
192.00	38,067	785.4	66,405	160,351	44,109
194.00	50,919	902.8	88,675	249,026	59,971

Device	Routing	Invert	Outlet Devices
#1	Discarded	185.00'	**2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 184.99'

Discarded OutFlow Max=1.05 cfs @ 12.63 hrs HW=185.02' (Free Discharge)
↑—**1=Exfiltration** (Controls 1.05 cfs)

Summary for Link AP1:

Inflow Area = 1,713,889 sf, 5.62% Impervious, Inflow Depth = 0.07" for 25-Year event
Inflow = 0.35 cfs @ 14.70 hrs, Volume= 10,177 cf
Primary = 0.35 cfs @ 14.70 hrs, Volume= 10,177 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs

Summary for Subcatchment SC1:

Runoff = 1.99 cfs @ 12.54 hrs, Volume= 24,672 cf, Depth= 0.41"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=6.70"

Area (sf)	CN	Description
325,297	30	Woods, Good, HSG A
390,660	39	Pasture/grassland/range, Good, HSG A
715,957	35	Weighted Average
715,957		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.8	50	0.0100	0.08		**Sheet Flow, Segment A** Grass: Dense n= 0.240 P2= 3.20"
5.7	936	0.0290	2.74		**Shallow Concentrated Flow, Segment B** Unpaved Kv= 16.1 fps
16.5	986	Total			

Summary for Subcatchment SC2:

Runoff = 3.06 cfs @ 12.47 hrs, Volume= 24,078 cf, Depth= 0.80"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=6.70"

Area (sf)	CN	Description
33,106	98	Paved parking, HSG A
149,846	30	Woods, Good, HSG A
177,289	39	>75% Grass cover, Good, HSG A
360,241	41	Weighted Average
327,135		90.81% Pervious Area
33,106		9.19% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.6	50	0.0040	0.05		**Sheet Flow, Segment AB** Grass: Dense n= 0.240 P2= 3.20"
5.6	541	0.0100	1.61		**Shallow Concentrated Flow, Segment BC** Unpaved Kv= 16.1 fps
0.3	86	0.1050	5.22		**Shallow Concentrated Flow, Segment CD** Unpaved Kv= 16.1 fps
21.5	677	Total			

Summary for Subcatchment SC3:

Runoff = 11.84 cfs @ 12.24 hrs, Volume= 57,857 cf, Depth= 1.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=6.70"

Area (sf)	CN	Description
55,215	98	Roofs, HSG A
32,652	98	Paved parking, HSG A
587	96	Gravel surface, HSG A
38,727	30	Woods, Good, HSG A
334,837	39	Pasture/grassland/range, Good, HSG A
462,018	50	Weighted Average
374,151		80.98% Pervious Area
87,867		19.02% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	20	0.0100	0.76		**Sheet Flow, Segment A** Smooth surfaces n= 0.011 P2= 3.20"
7.2	30	0.0100	0.07		**Sheet Flow, Segment B** Grass: Dense n= 0.240 P2= 3.20"
1.4	121	0.0080	1.44		**Shallow Concentrated Flow, Segment C** Unpaved Kv= 16.1 fps
0.3	97	0.1030	5.17		**Shallow Concentrated Flow, Segment D** Unpaved Kv= 16.1 fps
5.5	654	0.0153	1.99		**Shallow Concentrated Flow, Segment E** Unpaved Kv= 16.1 fps
14.8	922	Total			

Summary for Subcatchment SC4:

Runoff = 0.37 cfs @ 12.30 hrs, Volume= 2,967 cf, Depth= 0.60"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=6.70"

Area (sf)	CN	Description
35,395	30	Woods, Good, HSG A
5,007	96	Gravel surface, HSG A
19,147	39	>75% Grass cover, Good, HSG A
59,549	38	Weighted Average
59,549		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.8	50	0.2140	0.17		**Sheet Flow, Segment A** Woods: Light underbrush n= 0.400 P2= 3.20"
0.8	241	0.1010	5.12		**Shallow Concentrated Flow, Segment B** Unpaved Kv= 16.1 fps
5.6	291	Total			

Summary for Subcatchment SC5:

Runoff = 1.38 cfs @ 12.32 hrs, Volume= 9,397 cf, Depth= 0.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=6.70"

Area (sf)	CN	Description
70,843	30	Woods, Good, HSG A
9,784	96	Gravel surface, HSG A
40,040	39	>75% Grass cover, Good, HSG A
8,373	98	Paved parking, HSG A
129,040	42	Weighted Average
120,667		93.51% Pervious Area
8,373		6.49% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	50	0.0160	0.06		**Sheet Flow, Segment A** Woods: Light underbrush n= 0.400 P2= 3.20"
0.8	163	0.0454	3.43		**Shallow Concentrated Flow, Segment B** Unpaved Kv= 16.1 fps
0.0	17	0.3824	9.96		**Shallow Concentrated Flow, Segment C** Unpaved Kv= 16.1 fps
0.6	225	0.0289	6.09	24.37	**Channel Flow, Segment D** Area= 4.0 sf Perim= 6.5' r= 0.62' n= 0.030
0.3	125	0.0240	7.03	5.52	**Pipe Channel, CMP_Round 12"** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior
15.2	580	Total			

Summary for Subcatchment SC6:

Runoff = 0.17 cfs @ 14.71 hrs, Volume= 4,717 cf, Depth= 0.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=6.70"

Area (sf)	CN	Description
345,192	30	Woods, Good, HSG A
2,133	39	Pasture/grassland/range, Good, HSG A
347,325	30	Weighted Average
347,325		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.3	50	0.1660	0.16		**Sheet Flow, Segment A** Woods: Light underbrush n= 0.400 P2= 3.20"
0.3	100	0.1320	5.85		**Shallow Concentrated Flow, Segment** Unpaved Kv= 16.1 fps
5.6	150	Total			

Summary for Pond 5P: BASIN 3

Inflow Area = 188,589 sf, 4.44% Impervious, Inflow Depth = 0.79" for 100-Year event
Inflow = 1.75 cfs @ 12.32 hrs, Volume= 12,364 cf
Outflow = 0.31 cfs @ 15.45 hrs, Volume= 12,365 cf, Atten= 82%, Lag= 187.6 min
Discarded = 0.17 cfs @ 15.45 hrs, Volume= 11,730 cf
Primary = 0.13 cfs @ 15.45 hrs, Volume= 635 cf

Routing by Dyn-Stor-Ind method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 187.02' @ 15.45 hrs Surf.Area= 3,075 sf Storage= 5,654 cf

Plug-Flow detention time= 417.3 min calculated for 12,356 cf (100% of inflow)
Center-of-Mass det. time= 417.6 min (1,349.3 - 931.7)

Volume	Invert	Avail.Storage	Storage Description
#1	184.00'	9,137 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
184.00	875	161.0	0	0	875
186.00	2,202	261.0	2,977	2,977	4,260
188.00	4,052	331.0	6,161	9,137	7,610

Device	Routing	Invert	Outlet Devices
#1	Primary	187.00'	**20.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#2	Discarded	184.00'	**2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 0.00'

Discarded OutFlow Max=0.17 cfs @ 15.45 hrs HW=187.02' (Free Discharge)
↑**2=Exfiltration** (Controls 0.17 cfs)

Primary OutFlow Max=0.13 cfs @ 15.45 hrs HW=187.02' TW=0.00' (Dynamic Tailwater)
↑**1=Broad-Crested Rectangular Weir** (Weir Controls 0.13 cfs @ 0.35 fps)

Summary for Pond 6P: FOREBAY BASIN 3

Volume	Invert	Avail.Storage	Storage Description
#1	185.00'	113 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
185.00	37	24.0	0	0	37
186.00	214	75.0	113	113	442

Summary for Pond 7P: BASIN 4

Inflow Area = 462,018 sf, 19.02% Impervious, Inflow Depth = 1.50" for 100-Year event
Inflow = 11.84 cfs @ 12.24 hrs, Volume= 57,857 cf
Outflow = 1.49 cfs @ 14.51 hrs, Volume= 57,875 cf, Atten= 87%, Lag= 136.2 min
Discarded = 0.70 cfs @ 14.51 hrs, Volume= 52,340 cf
Primary = 0.79 cfs @ 14.51 hrs, Volume= 5,535 cf

Routing by Dyn-Stor-Ind method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 187.06' @ 14.51 hrs Surf.Area= 12,363 sf Storage= 28,197 cf

Plug-Flow detention time= 455.6 min calculated for 57,834 cf (100% of inflow)
Center-of-Mass det. time= 456.0 min (1,348.5 - 892.5)

Volume	Invert	Avail.Storage	Storage Description
#1	184.00'	40,746 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
184.00	6,199	634.0	0	0	6,199
186.00	10,192	683.0	16,226	16,226	11,501
188.00	14,451	726.0	24,519	40,746	16,524

Device	Routing	Invert	Outlet Devices
#1	Discarded	184.00'	**2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 0.00'
#2	Primary	187.00'	**20.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Discarded OutFlow Max=0.70 cfs @ 14.51 hrs HW=187.06' (Free Discharge)
↑—**1=Exfiltration** (Controls 0.70 cfs)

Primary OutFlow Max=0.79 cfs @ 14.51 hrs HW=187.06' TW=0.00' (Dynamic Tailwater)
↑—**2=Broad-Crested Rectangular Weir** (Weir Controls 0.79 cfs @ 0.63 fps)

Summary for Pond AP2: FIRE POND

Inflow Area = 360,241 sf, 9.19% Impervious, Inflow Depth = 0.80" for 100-Year event
Inflow = 3.06 cfs @ 12.47 hrs, Volume= 24,078 cf
Outflow = 3.00 cfs @ 12.53 hrs, Volume= 24,078 cf, Atten= 2%, Lag= 3.6 min
Discarded = 3.00 cfs @ 12.53 hrs, Volume= 24,078 cf

Routing by Dyn-Stor-Ind method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 185.08' @ 12.53 hrs Surf.Area= 6,671 sf Storage= 490 cf
Flood Elev= 196.00' Surf.Area= 50,919 sf Storage= 249,026 cf

Plug-Flow detention time= 1.4 min calculated for 24,061 cf (100% of inflow)
Center-of-Mass det. time= 1.4 min (940.5 - 939.1)

Volume	Invert	Avail.Storage	Storage Description
#1	185.00'	249,026 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
185.00	6,180	380.0	0	0	6,180
186.00	14,107	554.4	9,875	9,875	19,156
188.00	20,910	628.7	34,795	44,669	26,251
190.00	28,565	704.6	49,276	93,946	34,414
192.00	38,067	785.4	66,405	160,351	44,109
194.00	50,919	902.8	88,675	249,026	59,971

Device	Routing	Invert	Outlet Devices
#1	Discarded	185.00'	**2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 184.99'

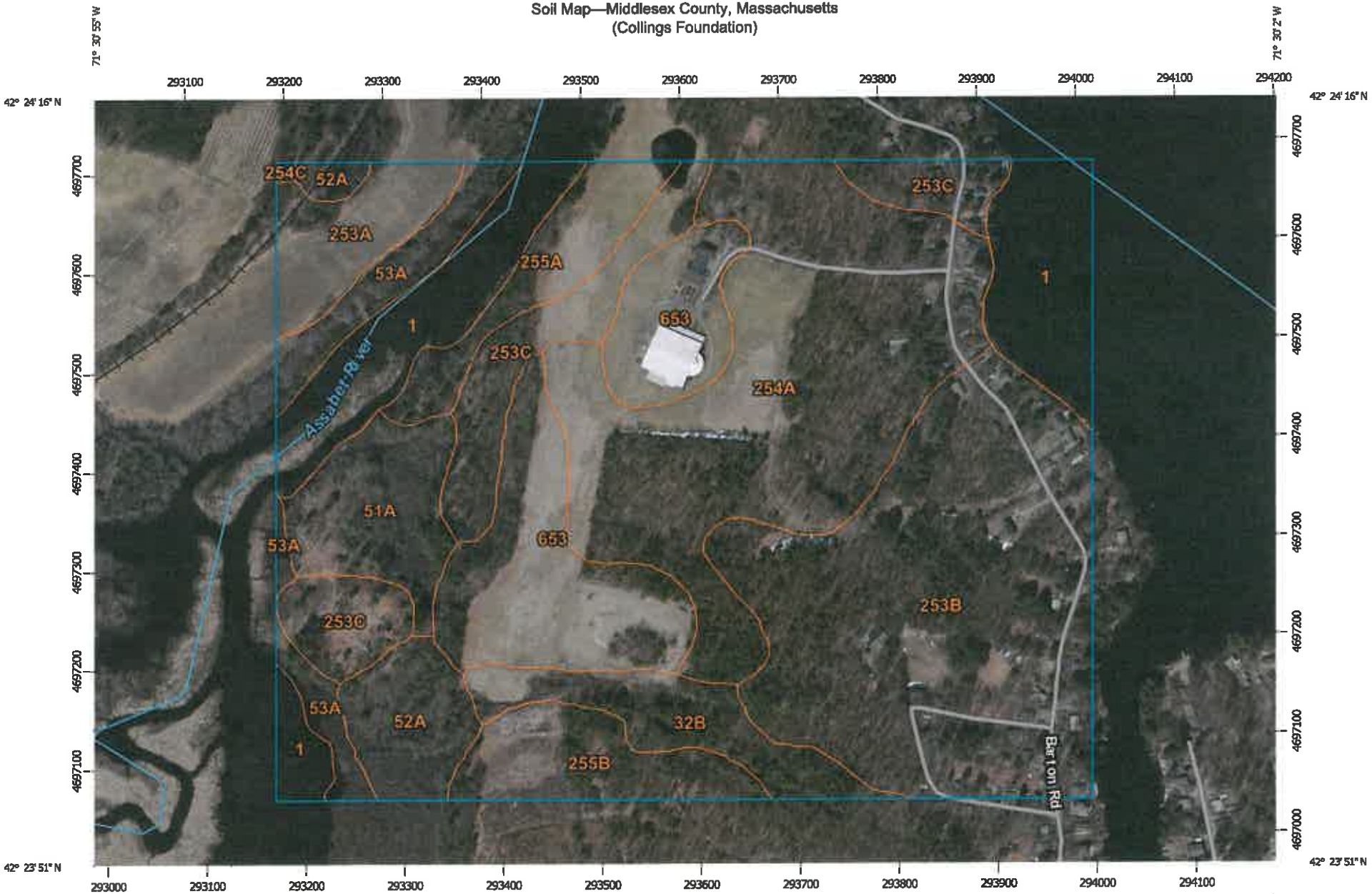
Discarded OutFlow Max=2.99 cfs @ 12.53 hrs HW=185.08' (Free Discharge)
↑**1=Exfiltration** (Controls 2.99 cfs)

Summary for Link AP1:

Inflow Area = 1,713,889 sf, 5.62% Impervious, Inflow Depth = 0.25" for 100-Year event
Inflow = 2.00 cfs @ 12.55 hrs, Volume= 35,560 cf
Primary = 2.00 cfs @ 12.55 hrs, Volume= 35,560 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs

Soil Map—Middlesex County, Massachusetts
(Collings Foundation)



Map Scale: 1:5,460 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 50 100 200 300

Feet
0 250 500 1000 1500

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

MAP LEGEND

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

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

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

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:25,000.

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

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

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: 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: Middlesex County, Massachusetts
Survey Area Data: Version 13, Dec 17, 2013

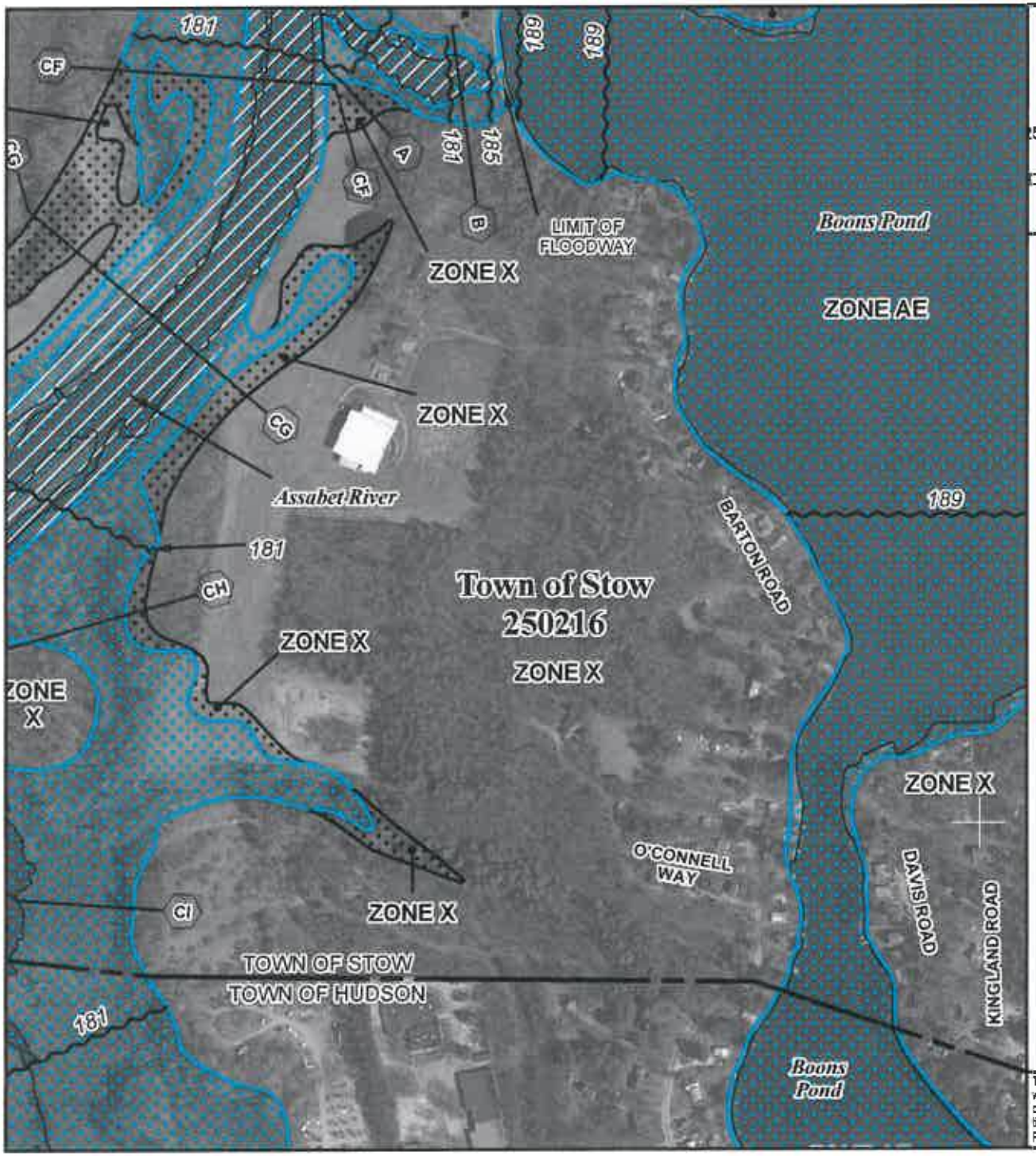
Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

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

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

Map Unit Legend

Middlesex County, Massachusetts (MA017)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
1	Water	13.7	10.4%
32B	Wareham loamy fine sand, 0 to 5 percent slopes	5.3	4.0%
51A	Swansea muck, 0 to 1 percent slopes	6.0	4.6%
52A	Freetown muck, 0 to 1 percent slopes	4.8	3.6%
53A	Freetown muck, ponded, 0 to 1 percent slopes MLRA 144A	4.9	3.7%
253A	Hinckley loamy sand, 0 to 3 percent slopes	4.4	3.3%
253B	Hinckley loamy sand, 3 to 8 percent slopes	29.9	22.7%
253C	Hinckley loamy sand, 8 to 15 percent slopes	10.0	7.6%
254A	Merrimac fine sandy loam, 0 to 3 percent slopes	28.2	21.4%
254C	Merrimac fine sandy loam, 8 to 15 percent slopes	0.1	0.1%
255A	Windsor loamy sand, 0 to 3 percent slopes	4.6	3.5%
255B	Windsor loamy sand, 3 to 8 percent slopes	5.3	4.0%
653	Udorthents, sandy	14.6	11.1%
Totals for Area of Interest		**131.9**	**100.0%**



MAP SCALE 1" = 500'

50 0 500 1000

FEET

METER

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0344E

FIRM

FLOOD INSURANCE RATE MAP

MIDDLESEX COUNTY, MASSACHUSETTS
(ALL JURISDICTIONS)

PANEL 344 OF 656

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

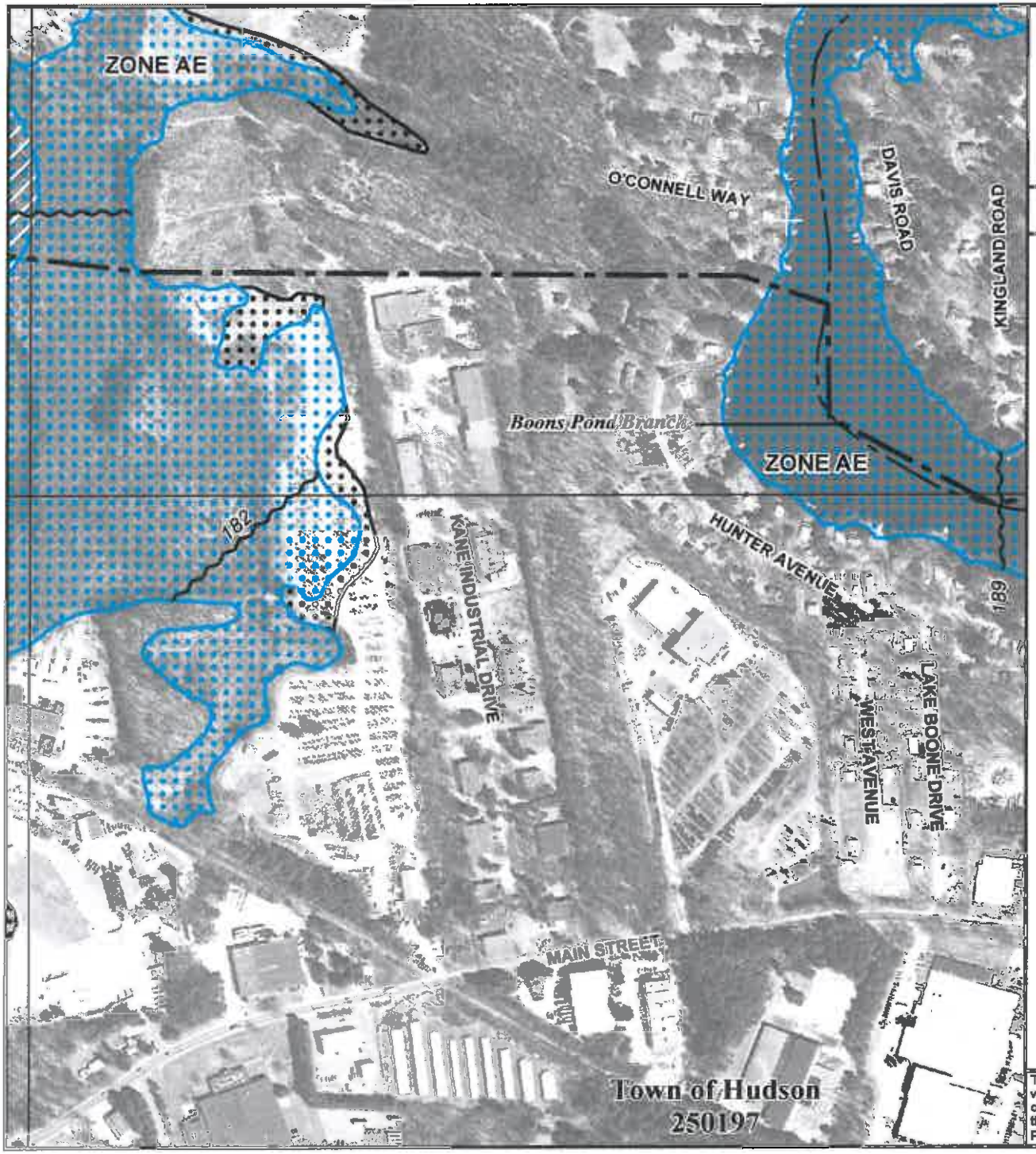
COMMUNITY	NUMBER	PANEL	SUFFIX
HUDSON, TOWN OF	250197	0344	E
MARLBOROUGH, CITY OF	250203	0344	E
STOW, TOWN OF	250216	0344	E

Notice to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.

MAP NUMBER
25017C0344E

EFFECTIVE DATE
JUNE 4, 2010

Federal Emergency Management Agency



MAP SCALE 1" = 500'

250 0 500 1000 FEET

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0344F

FIRM

FLOOD INSURANCE RATE MAP

MIDDLESEX COUNTY, MASSACHUSETTS (ALL JURISDICTIONS)

PANEL 344 OF 656

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

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MAP NUMBER
25017C0344F

MAP REVISED
JULY 7, 2014

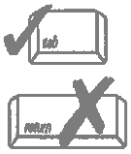
Federal Emergency Management Agency

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

Signature and Date 1.20.15

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.

Massachusetts Stormwater Standards

Standard 10 - Illicit Discharge Compliance Statement

Site Address: 0 Barton Road, Stow, MA 01775
Owner: Collings Foundation, Inc.
Applicant, if different:
Plan Reference: Collings Foundation – Site Development
DEP File Number:

As required by Standard 10 of the Massachusetts Stormwater Standards, I, the undersigned, being the Owner of the subject property do hereby certify that the stormwater system, as shown on the referenced plan, does not permit any illicit discharges to enter the stormwater management system. I also certify that the existing use of the property does not permit any illicit discharges.

Illicit discharges are discharges not associated with the following: stormwater; water from fire fighting; water line flushing or street washing; landscape watering and irrigation; uncontaminated groundwater; potable water; foundation or footing drains; air conditioning condensate; residential vehicle washing; residential non-detergent building cleaning water, de-chlorinated water from swimming pools; flows from riparian habitats or wetlands.

Further, I certify that the stormwater management system shown on the referenced plan will be maintained in accordance with the Operations and Maintenance Manual submitted with the Definitive Subdivision and approved by the Planning Board.

Signed: Rob Collings

Print: _____ 1-21-2015
Owner or Authorized Applicant — Date

TSS REMOVAL - INFILTRATION BASIN #1

A	B	C	D	E
BMP	**TSS Removal Rate**	**Starting TSS Load***	**Amount Removed (B x C)**	**Remaining Load (C - D)**
Infiltration Basin w/ sediment forebay	80.0%	100.0%	80.0%	20.0%
		Total TSS Removal =	80.0%	

* Equals remaining load from previous BMP (E)

TSS REMOVAL - INFILTRATION BASIN #2

A	B	C	D	E
BMP	**TSS Removal Rate**	**Starting TSS Load***	**Amount Removed (B x C)**	**Remaining Load (C - D)**
Infiltration Basin w/ sediment forebay	80.0%	100.0%	80.0%	20.0%
		Total TSS Removal =	80.0%	

* Equals remaining load from previous BMP (E)