
HANCOCK ASSOCIATES

Stormwater Report *In Support of*

Comprehensive Permit Filing *for* **40 Oak Street Development, LLC** 40 Oak Street (Map 95, Parcel 089x) Peabody, MA

CITY OF PEABODY
2021 APR - 8 AM 10:35
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Prepared For:
40 Oak Street Development, LLC
March 2020
Revised April 2021



A handwritten signature in black ink, appearing to read "Joseph D. Peznola", written below the professional seal.

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Introduction

40 Oak Street Development, LLC proposes to construct a 72-unit apartment building, and 8 townhouse units at 40 Oak Street in Peabody, MA (MA 95 Parcel 089X). Site improvements associated with construction of the new building will include: paved vehicular and pedestrian access, landscaped areas, connections to municipal utility services, and a stormwater management system.

A rectangular shaped parcel, the 1.5± acre site is bounded by Oak Street to the southwest, residential lots of Washington Street along the southeastern property line leading to an isolated pocket wetland to the east of the site, Littles Lane and the residences of Sanborn Street along the northwestern property line, and single lot fronting on Main Street to the northeast.

Presently, the project site is occupied by an existing lodge in the southwest side of the and a large parking area that effectively covers the rest of the site except for a lawn and landscaped area between the lodge and Oak Street. Currently, the site is 81.8% impervious. Topography of the site is generally flat, sloping in a westerly direction toward a series of catch basins in the southwest side of the site. The highest elevation onsite is 25± (NAVD88) on the northwest corner of the site and the low elevation onsite is elevation 19.9± and is located at one of the aforementioned catch basins.

The site is located within the 100-yr flood plain according to current FEMA Flood mapping, with a 100-year floodplain elevation of 27± (NAVD88). This area of Peabody is subject to frequent localized flooding, and there is currently a section of City owned storm drain that crosses the site. There is an isolated pocket wetland just to the east of the project, located on the Peabody Historical Society property. The project site is considered a “redevelopment site” under MassDEP standards. Therefore, this project is subject to stormwater standards 2 through 7 to the maximum extent practicable.

In addition to the site improvements referenced above, the applicant will construct an on-site stormwater management system to attenuate peak flows from the buildings and paved areas prior to discharge to the City system. As part of the stormwater improvements, the applicant is proposing to detain and mitigate stormwater from the the existing City-owned drain line in a Stormtrap detention system onsite. Also, the imperviousness of the site will be reduced from the current 81.8% to 78.2% under the current development scenario. The combination of reduction in site imperviousness, on-site attenuation, and the detention of municipal flows onsite should improve the function of the downstream system during rainfall events.

Standard 1: No New Untreated Discharges

The Massachusetts Stormwater Handbook states that no new stormwater conveyances may discharge untreated stormwater directly to or cause erosions in wetlands or waters of the Commonwealth. The project will not include new stormwater conveyances.

Standard 2: Peak Rate Attenuation

The Massachusetts Stormwater Handbook states that stormwater management systems shall be designed so that post-development peak discharge rates do not exceed pre-development peak discharge rates. A summary of the existing and proposed discharge rates follows. The proposed condition discharge rates of runoff are at or below the existing rates to the same discharge points. Please see the attached "Existing Drainage Areas" and "Proposed Drainage Areas" figures (Appendix IV) and Hydrocad output (Appendix V) for more information.

For the purpose of these calculations the following assumption was made:

- The same total watershed area of the drainage areas is used to compare the existing and proposed conditions.

- The Natural Resources Conservation Service (NRCS) Web Soil Survey of Essex County defines soils in the project area as 626 B - Merrimac-Urban land complex, 0 to 8 percent slopes which is considered to be Hydrologic Soil Group A, indicative of rapid infiltration when thoroughly wet. Two test pits were also performed by Hancock Associates on January 28, 2020. The soils were found to be loamy sand. Therefore, a Rawls Rate of 2.41 is used when modeling this project. Please see the attached NRCS Web Soil Survey summary (Appendix I) and Soil Testing Results (Appendix II).
- Four test pits were performed throughout the site. Test pits 1 and 4 were located on the south side of the site. Test Pit 1 indicated a 1-foot crushed pavement layer over a medium to gravely sand layer to at least 76 inches below ground surface (bgs). Test pit 4 indicated loamy sand to a depth of 84 inches that was underlain by an 8-inch layer of peat/organics. This layer was underlain by sand to the final depth of the test pit. The peat/organic layer would be removed if an infiltration system is installed above it.

Test pits 2 and 3 are in the north side of the site. Test Pit 2 was found to be 64 inches of fill over sandy loam, and Test Pit 3 was found to be 84 inches of loamy sand over 2.25 feet of peat/organics. This organics layer is underlain by a crushed pavement layer. The previous version of the site plans included a proposed perforated pipe infiltration system in the location Test Pit 4. This infiltration system has been removed in the current plan set because the soils in the area of Test Pit 4 were found to be unsuitable for infiltration BMPs.

The estimated seasonal high groundwater elevations for each test pit are as follows:

- Test Pit 1: 48 inches bgs
- Test Pit 2: 46 inches bgs
- Test Pit 3: 52 inches bgs
- Test Pit 4: 68 inches bgs

See the Grading and Utility plan for the test pit logs and locations.

Presently, the project site is subject to flooding due to the large amount of impervious area onsite and comparatively undersized and flat storm drainage pipes. To best model the onsite drainage under existing conditions, the possible ponding above catch basins was included in the HydroCAD Model. This ponding occurs at Catch Basin 1C in the existing site. The existing onsite drainage system flows to municipal storm drain system in Oak Street (DP1). A small second watershed (EX2) is located in the eastern corner of the site discharges to the existing offsite isolated pocket wetland (DP2). Stormwater from this watershed flows overland directly to this resource area.

Offsite areas drain onto the project site and are also modeled in the existing and proposed HydroCAD calculations to accurately depict onsite drainage patterns. The residences of Sanborn Street drain onto the west side of the site via overland flow. Also, approximately half of the Littles Lane, Elliott Place, and Park Street block drain to an existing CB to the north of the project site at the intersection of Littles Lane and Elliott Place. This catch basin is an in-line catch basin on the city drain line that runs through the project site. These sub-watersheds are incorporated into the existing and proposed HydroCAD calculations and shown on the watershed plans. These areas eventually drain to the Oak Street Drain system (DP1) under existing or proposed conditions.

Additionally, the offsite pocket isolated wetland (DP2) is modeled in the HydroCAD Calculations. A small portion of the project site discharges to this area under existing and proposed conditions. The area draining to the pocket wetland is generally the area bounded by Oak Street, Washington Street, Main Street and the southeast bound of the project site. There is no increase in peak flow from the project site to this isolated pocket wetland.

Under proposed conditions, the HydroCAD model was similarly broken up for each individual catch basin with any possible ponding occurring above said catch basins.

The proposed site has one connection to the municipal drain system in Oak Street (DP1) and a separate watershed discharges to the offsite isolated pocket wetland (DP2) to the east.

- All onsite catch basins, roof areas, and some landscaped areas eventually discharge to Oak Street. Also, a drain connection from the existing city line in Littles Lane will connect to the onsite drain system at proposed drain manhole D2. This existing city drain line carries all stormwater from the existing areas in the offsite watershed PRC1O.

To approximate the flood storage by the existing onsite ponding, an inline Stormtrap Chamber System (System S3) is proposed to approximate this storage underground on the west side of the proposed apartment building . The offsite watersheds PRC1O and PRD1O, catch basins CBB2 and CBD1, and Townhouse buildings 2 and 3 drain to this system.

Catch basin CBD2 is also located along the west side of the proposed apartment building but is positioned downstream of Stormtank System S3. Ponding was modeled in catch basins CBD1 and CBD2 to ensure ponding was limited to five inches in a 25 year storm.

The apartment building roof is a blue roof which mitigates stormwater runoff prior to flow to Infiltration System S1. The catch basins CBA3 and CBA1 are in the drive located east of the proposed apartment building. Ponding was also modeled for catch basin CBA1 and the HydroCAD model shows that stormwater will not overtop the grate of this catch basin in a 25-year storm.

- Watershed PR2 is located in the eastern corner of the project site and land cover is exclusively pervious grass or landscaped areas. Stormwater flows overland in an easterly direction to the offsite isolated pocket wetland (DP2). Offsite Watershed PR2O discharges into the pocket isolated wetland via overland flows.

Additional attenuation of stormwater onsite is provided by a blue roof located above the proposed apartment building, and a subsurface Stormtrap chamber system on the southwest side of the site. The blue roof stores stormwater runoff and releases the water at a given rate via specially designed orifices instead of conventional roof drains. Stormtrap chambers are watertight concrete chambers that can be placed below the groundwater elevation that will provide stormwater attenuation of the main drain line.

There will be some ponding onsite in the 25 and 100-year storm events due to the large flows from the offsite Littles Lane storm line. The 25-year storm event will cause approximately three inches of flooding onsite west of the proposed apartment building and the 100-year storm event will cause approximately 1.1 feet of flooding onsite. While the 100-year storm event and the 100-year flooding events can be different, additional flooding of the site may occur due to the 100-year storm event.

The following table compares the peak rates of runoff under the existing and proposed conditions:

Discharge Point	2-Year Storm (3.1" Rainfall Depth)		10-Year Storm (4.5" Rainfall Depth)		25-Year Storm (5.4" Rainfall Depth)		100-Year Storm (7.0" Rainfall Depth)	
	Existing (cfs)	Proposed (cfs)	Existing (cfs)	Proposed (cfs)	Existing (cfs)	Proposed (cfs)	Existing (cfs)	Proposed (cfs)
DP1	4.80	1.33	8.66	3.63	9.08	5.85	9.67	7.03
DP2	1.65	1.65	6.77	6.77	10.49	10.49	18.42	18.43

cfs - Cubic Feet per Second

- *Flood-routing effect and offset times of concentration results in a combined peak runoff rate that can be less than the sum of the peak rates for the individual watersheds.*

Standard 3: Recharge

The Massachusetts Stormwater Handbook states that loss of annual recharge to groundwater shall be eliminated or minimized. The annual recharge from the post-development site shall approximate the annual recharge from the pre-development conditions based on soil type. There is an overall decrease in impervious area onsite under proposed conditions and therefore the project is considered a redevelopment project. Therefore, the increase in permeable land cover onsite would provide more recharge than what is provided under existing conditions. However, subsurface infiltration system S1 will provide additional recharge to the project site. Infiltration System S1 accepts stormwater from the apartment building, and it is sized to infiltrate stormwater from the proposed roof area.

The previous set of site plans included a second infiltration system (System S2) in the northern area of the site. Test pits were performed in the area of infiltration systems S1 and S2 since the last submittal. The test pit over Infiltration System S1 had acceptable soils for infiltration, but the test pit at Infiltration System S2 indicated a peat/ organics layer over crushed pavement. Therefore, Infiltration System S2 was removed from the site plans and calculations because the soils in that area are not suitable for infiltration BMPs.

As discussed under Standard 2, surficial soils on-site are assumed to be Hydrologic Soil Group A. Therefore, the required recharge volume is calculated based on a target depth of 0.60" over the proposed roof area. The required and provided volumes for the recharge system is as follows:

Infiltration System S1

Required Recharge Volume = Target Depth * Impervious Area = 0.60" * 18,630 SF = 931 Cubic Feet

Provided Recharge Volume=1,040 Cubic Feet

Infiltration System S1 is composed of a series of HDPE Stormtech SC-310 Chambers surrounded by crushed stone and enveloped in filter fabric. The outlet in the outlet manhole is set 1-foot higher than the bottom elevation of the chambers.

The Massachusetts Stormwater Handbook states that the recharge volume must drain within 72 hours. The following "drawdown" calculation assumes a Rawl's Rate of 2.41 inches per hour, corresponding to texture class "Loamy Sand".

Infiltration System S1

Drawdown Time = Storage Volume / (Rawl's Rate * Bottom Area)

$$= 1,040 \text{ CF} / (2.41 \text{ in/hr} * 1287 \text{ SF}) = \underline{4.0 \text{ Hours}}$$

Since the drawdown time of 4.0 hours is less than 72 hours, this requirement is met.

This project site has relatively high groundwater and it is also in the 100-year floodplain. Filling the floodplain is not an option for the site. Therefore, the proposed infiltration system is within 2-feet of groundwater. Given the sandy nature of the soils in this area, we believe Infiltration System S1 should drain in a time period well under the 72-hour drawdown time due to the soils high infiltration rate. The recharge system is included with the design because provide an improvement in recharge over existing conditions.

A capture area adjustment calculation was not included in the recharge calculations because the project is exempt from this portion of the standard as it is a redevelopment project. Stormwater will be recharged to the maximum extent practicable. The current groundwater elevation is within two to four feet of the ground surface throughout most the site, and these areas are in the 100-year floodplain so they cannot be filled. Therefore, subsurface recharge will be constructed where there is enough cover over groundwater to build those BMPs. The impervious area draining to the infiltration system onsite is 18,600 sf or 27% of the site.

Standard 4: Water Quality

The Massachusetts Stormwater Handbook states that systems shall be designed to remove 80% of the average annual post-development construction load of Total Suspended Solids (TSS).

The onsite soils are considered to have rapid infiltration (2.41 in/hr), therefore stormwater runoff must undergo TSS removal to a 1-inch water quality standard prior to discharge offsite and stormwater must undergo 44% pretreatment prior to discharge to the infiltration system.

Stormwater runoff from the proposed roof areas is considered “clean” and can drain directly to the infiltration system so pretreatment is not required. Stormwater runoff from onsite paved areas will undergo 80% TSS removal through the installation of four Stormceptor Water Quality Devices along the proposed drain lines. The Stormceptor Units were sized using the water quality flow rates to 1-inch standard. See Appendix VIII.

Standard 5: Land Uses with Higher Potential Pollutant Loads

There will be less than 1000 vehicle trips per day generated by the proposed development. Therefore, the project is not considered a Land Use with Higher Potential Pollutant Loads. Stormwater runoff from the project site will undergo 80% TSS removal.

Standard 6: Critical Areas

The proposed project is not in a critical area. Therefore this standard is not applicable.

Standard 7: Redevelopment

The proposed project is considered a redevelopment of the existing 40 Oak Street site. Therefore it is subject to the stormwater management standards to the maximum extent practicable. The project will provide a beneficial decrease in peak rate stormwater runoff, increase in onsite recharge, and improvement in water quality over existing conditions.

In particular, this site does not meet the groundwater recharge requirement for capture area adjustment due to high groundwater and work within the 100-year floodplain that limits the filling of the site. Groundwater is too high and the ground elevation is too low to install recharge BMPs for the catch basins at the lowest points onsite. The project will increase groundwater recharge through the reduction in impervious area under post development conditions, and the installation of a subsurface infiltration system in the area onsite with more cover. Therefore, this development will provide an overall increase in stormwater recharge.

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

Best management practices (BMP) for erosion and sedimentation control are staked straw wattles, filter fences, hydro seeding, and phased development. Many stormwater BMP technologies (e.g., infiltration technologies) are not designed to handle the high concentrations of sediments typically found in construction runoff and must be protected from construction-related sediment loadings. Construction BMP's **must** be maintained. In developing the proposed project certain measures will be implemented to minimize impacts erosion and sedimentation could have on surrounding areas. This section addresses items that involve proper construction techniques, close surveillance of workmanship, and immediate response to emergency situations. The developer must be prepared to provide whatever reasonable measures are necessary to protect the environment during construction and to stabilize all disturbed areas as soon as construction ends.

Pre-Construction

1. The contractor shall have a stockpile of materials required to control erosion on-site to be used to supplement or repair erosion control devices. These materials shall include, but are not limited to straw wattles, silt fence and crushed stone.
2. The contractor is responsible for erosion control on site and shall utilize erosion control measures where needed, regardless of whether the measures are specified on the plan or in the order of conditions.

Preliminary Site Work

1. Excavated materials should be stockpiled, separating the topsoil for future use on the site. Erosion control shall be utilized along the down slope side of the piles and side slopes shall not exceed 2:1.
2. If intense rainfall is anticipated, the installation of supplemental straw bale dikes, silt fences, or armored dikes shall be considered.
3. Unsuitable excavated material shall be removed from the site.
4. Construction entrance shall be installed.
5. Existing catchbasins shall be protected with silt sacks.

Ongoing Site Work

1. Erosion control measures shall be regularly inspected and replaced as needed.
2. Dewatering shall be done in a manner so as not to transmit silt, sand or particulate matter to the receiving water or existing drainage system.

Landscaping

1. Landscaping shall occur as soon as possible to provide permanent stabilization of disturbed surfaces.
2. If the season or adverse weather conditions do not allow the establishment of vegetation, temporary mulching with straw or wood chips weighted with snow fence or branches, or other methods shall be provided.
3. A minimum of 4 inches of topsoil shall be placed and its surface smoothed to the specified grades.
4. The use of herbicides is strongly discouraged.
5. Hydro seeding is encouraged for steep slopes. Application rates on slopes greater than 3:1 shall have a minimum seeding rate of 5-lbs/1000 SF. A latex or fiber tackifier shall be used on these slopes at a minimum rate of 50 lbs. of tackifier per 500 gallons of water used.

Standard 9: Operations and Maintenance Plan

The information provided herein is intended to provide the base information for operation and maintenance of the site in perpetuity subject to updates and revisions as required at a future date. As such, all future property owners must be notified in writing of this plan and be provided with a copy of this plan, a complete set of the design drawings and/or a completed as-built plan showing all the drainage features as they were constructed, which are considered part of this document. Please see the attached Operations and Maintenance Log (Appendix IX).

Stormwater management system owner: 40 Oak Street Development, LLC
The party responsible for operation and maintenance: 40 Oak Street Development, LLC
P.O. Box 129
Medfield, Massachusetts 02052

Illicit Discharge - Practices to Minimize Storm Water Contamination

- All waste materials will be collected and stored in a securely lidded metal dumpster.
- All trash and debris from the site will be deposited in the dumpster. The dumpster will be emptied on a regular schedule prior to being over full.
- All personnel will be instructed regarding the correct procedure for waste disposal.
- Good housekeeping and spill control practices will be followed to minimize storm water contamination from petroleum products, paints, and cleaning products.
- All site vehicles will be monitored for leaks and receive regular preventive maintenance to reduce the chance of leakage.
- Spill kits will be provided with any activity that could provide contamination.
- All paint containers and curing compounds will be tightly sealed and stored when not required for use. Excess paint will not be discharged to the storm sewers, but will be properly disposed according to the manufacturer's instructions.
- All spills will be cleaned up immediately upon discovery. Spills large enough to reach the storm sewers will be reported to the Massachusetts Department of Environmental Protection Northeast Regional Office at 1-888-304-1133.

Infiltration BMP

The infiltration BMP (subsurface chamber system) shall be inspected after every major storm for the first few months to ensure it is stabilized and functioning properly. If necessary, corrective action shall be taken until the system functions properly. Inspectors should note how long water remains standing in the inspection port after a storm; standing water within the basin 48 to 72 hours after a storm indicates that the infiltration capacity may have been overestimated. If the ponding is due to clogging, immediately address the reasons for the clogging. Thereafter, inspect the infiltration BMP at least twice per year.

Stormceptors

The Stormceptor treatment chambers shall be maintained in strict conformance with the Manufacturer's recommendations. During the first year the Stormceptors are to be monitored four times and the sediment removed when it reaches an 8-inch depth. Based on the monitoring results from the first year, a cleaning schedule shall be established based on an 8-inch sediment depth removal.

Blue Roof

The blue roof shall be maintained in strict conformance with the Manufacturer's recommendations. Roof outlets shall be inspected four (4) times per year remove any debris that collects around the roof outlets. Any damage to the roof membrane shall be repaired.

Stormtrap System

The Stormtrap system shall be maintained in strict conformance with the Manufacturer's recommendations. The system is to be inspected every six months in the first year and a cleaning schedule to be determined from the sediment from those inspections. The system is to be inspected at least once per year. The system is to be cleaned when sediment reaches a 4-inch depth with a vacuum truck.

Vegetated Areas Maintenance

Although not a structural component of the drainage system, the maintenance of vegetated areas may affect the functioning of stormwater management practices. This includes the health/density of vegetative cover and activities such as the application and disposal of lawn and garden care products, disposal of leaves and yard trimmings.

Initial Post-Construction Inspection

During the initial period of vegetation establishment, pruning and weeding are required twice in the first year by contractor or owner. Any dead vegetation/plantings found after the first year will be replaced. Proper mulching is mandatory and regular watering may be required initially to ensure proper establishment of new vegetation.

Long-Term Maintenance

The planted areas shall be inspected on a semi-annual basis and any litter removed. Weeds and invasive plant species shall be removed by hand. Maintain planted areas adjacent to pavement to prevent soil washout. Immediately clean any soil deposits on pavement. Leaf litter and other detritus shall be removed twice per year. If needed to maintain aesthetic appearance, perennial plantings may be trimmed at the end of the growing season. Fertilizers, herbicides and pesticides shall be used to the minimum extent practicable.

Trees and shrubs shall be inspected twice per year to evaluate health and attended to as necessary. Seeded ground cover or grass areas shall not receive mulching. Re-seed bare areas; install appropriate erosion control measures when native soil is exposed or erosion channels are forming. Plant alternative mixtures of grass species in the event of unsuccessful establishment. The grass vegetation should not be cut to a height less than four inches.

Project walks and drives shall be swept clean four (4) times per year. Once in early spring after winter sanding has ended, again in late spring, once in the early fall, and once in late fall after the foliage has fallen.

Pesticide/Herbicide Usage

No pesticides are to be used unless a single spot treatment is required for a specific control application.

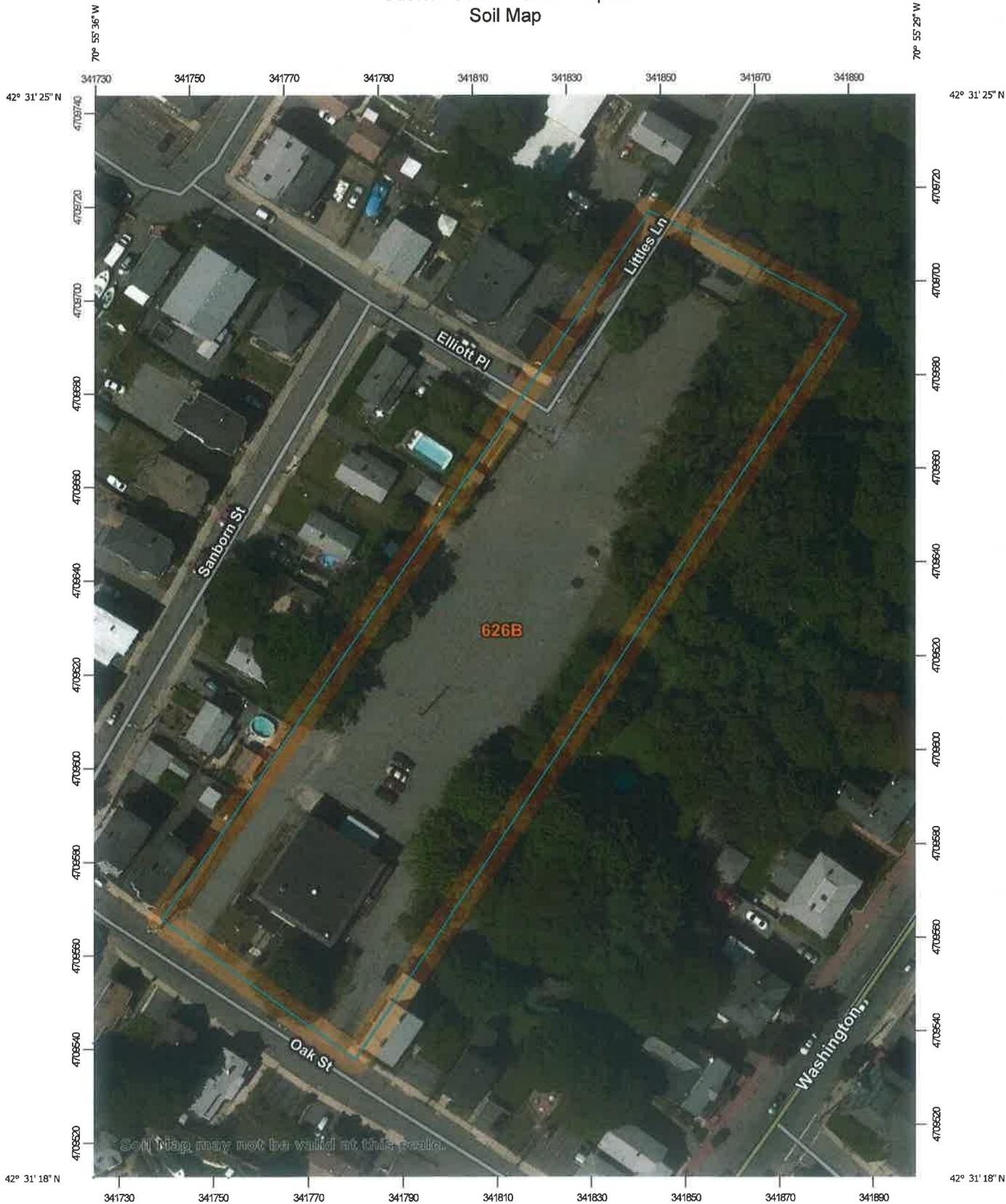
Conclusion

Significant attention and consideration has been given to proper management of stormwater runoff from the project site. The unique site-specific characteristics and hydrologic setting has been carefully studied to develop a comprehensive plan that fully utilizes and recognizes these attributes. Disposition of stormwater has been considered with respect to its peak rate, total volume and water quality aspects, to ensure appropriate mitigation upon project completion.

- There will be no adverse impact to any surrounding areas.
- The drainage system has been properly designed to handle the design flow rates.

Appendix I. NRCS Soils Map

Custom Soil Resource Report Soil Map



Soil map may not be valid at this scale.

Map Scale: 1:1,130 if printed on A portrait (8.5" x 11") sheet.



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

MAP LEGEND

MAP INFORMATION

- 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
- Water Features**
 - Streams and Canals
- Transportation**
 - Rails
 - Interstate Highways
 - US Routes
 - Major Roads
 - Local Roads
- Background**
 - Aerial Photography

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

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

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

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

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

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

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

Soil Survey Area: Essex County, Massachusetts, Southern Part
 Survey Area Data: Version 16, Sep 13, 2019

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

Date(s) aerial images were photographed: Aug 10, 2014—Aug 25, 2014

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres In AOI	Percent of AOI
626B	Merrimac-Urban land complex, 0 to 8 percent slopes	2.3	100.0%
Totals for Area of Interest		2.3	100.0%

Map Unit Descriptions

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

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

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

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

Custom Soil Resource Report

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

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

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

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

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

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

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

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

Essex County, Massachusetts, Southern Part

626B—Merrimac-Urban land complex, 0 to 8 percent slopes

Map Unit Setting

National map unit symbol: 2tyr9
Elevation: 0 to 820 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 250 days
Farmland classification: Not prime farmland

Map Unit Composition

Merrimac and similar soils: 45 percent
Urban land: 40 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Merrimac

Setting

Landform: Moraines, outwash plains, kames, eskers, outwash terraces
Landform position (two-dimensional): Backslope, footslope, summit, shoulder
Landform position (three-dimensional): Crest, side slope, riser, tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loamy glaciofluvial deposits derived from granite, schist, and gneiss over sandy and gravelly glaciofluvial deposits derived from granite, schist, and gneiss

Typical profile

Ap - 0 to 10 inches: fine sandy loam
Bw1 - 10 to 22 inches: fine sandy loam
Bw2 - 22 to 26 inches: stratified gravel to gravelly loamy sand
2C - 26 to 65 inches: stratified gravel to very gravelly sand

Properties and qualities

Slope: 0 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to very high (1.42 to 99.90 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 2 percent
Salinity, maximum in profile: Nonsaline (0.0 to 1.4 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 1.0
Available water storage in profile: Low (about 4.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: A

Custom Soil Resource Report

Hydric soil rating: No

Description of Urban Land

Typical profile

M - 0 to 10 inches: cemented material

Properties and qualities

Slope: 0 to 8 percent

Depth to restrictive feature: 0 inches to manufactured layer

Runoff class: Very high

Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 to 0.00 in/hr)

Available water storage in profile: Very low (about 0.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 8

Hydrologic Soil Group: D

Hydric soil rating: Unranked

Minor Components

Windsor

Percent of map unit: 5 percent

Landform: Dunes, deltas, outwash terraces, outwash plains

Landform position (three-dimensional): Tread, riser

Down-slope shape: Convex, linear

Across-slope shape: Convex, linear

Hydric soil rating: No

Sudbury

Percent of map unit: 5 percent

Landform: Outwash plains, terraces, deltas

Landform position (two-dimensional): Footslope

Landform position (three-dimensional): Tread, dip

Down-slope shape: Concave

Across-slope shape: Linear

Hydric soil rating: No

Hinckley

Percent of map unit: 5 percent

Landform: Outwash plains, kames, eskers, deltas

Landform position (two-dimensional): Summit, shoulder, backslope

Landform position (three-dimensional): Nose slope, head slope, side slope, crest, rise

Down-slope shape: Convex

Across-slope shape: Linear, convex

Hydric soil rating: No

Soil Evaluation for Drainage
 January 28, 2020
 Evaluation by: James Polakiewicz

40 Oak Street
 Peabody, MA



See Site Plan for Locations
 TP1

Depth (in)	Soil Horizon/ Layer	Matrix: Color- Moist (Munsell)	Redoximorphic Features (mottles)		Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Consistence (Moist)
			Depth	Color		Percent	Gravel	
0-4	Pavement							
4-13	Fill							
13-25	Fill				Medium Sand			
25-48	Bw				Gravelly Loamy Sand			
48-76+	C				Gravelly Sand			
Redox @ 48", Weep @ 58"								

* See Below

* Crushed pavement, firm in place, large root or wood pipe encountered on S. side of TP

TP2

Depth (in)	Soil Horizon/ Layer	Matrix: Color- Moist (Munsell)	Redoximorphic Features (mottles)		Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Consistence (Moist)
			Depth	Color		Percent	Gravel	
0-3	Pavement							
3-5	Fill							Crushed Pave
8-24	Fill				Gravelly Loamy Sand			Angular Crushed Stone
24-64	Fill							Crushed pave, cinder blocks, br
64-88+	C				Sandy Loam			
Weep @ 46"								

Appendix III. FEMA Firmette

National Flood Hazard Layer FIRMette



42°31'32.79"N



USGS The National Map: Orthoimagery. Data refreshed April, 2019. 70°55'16.63"W 42°31'6.27"N



Legend

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

SPECIAL FLOOD HAZARD AREAS

- Without Base Flood Elevation (BFE) Zone A, V, AH9
- With BFE or Depth Zone AE, AO, AH, VE, AR
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD

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

OTHER AREAS

- Area of Minimal Flood Hazard Zone X
- Effective LOMRS
- Area of Undetermined Flood Hazard Zone D

GENERAL STRUCTURES

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

OTHER FEATURES

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

MAP PANELS

- Digital Data Available
- No Digital Data Available
- Unmapped

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

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 3/4/2020 at 8:56:55 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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

Appendix IV. Stormwater Checklist



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.

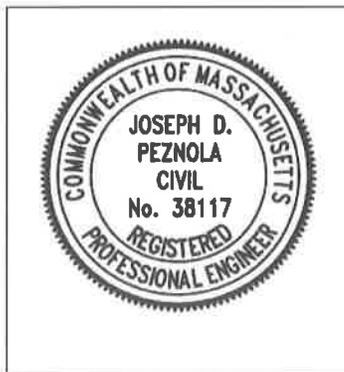
Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the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



Joseph D. Peznola
Signature and Date

2/24/21

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): Subsurface Infiltration Systems, Blue Roof, Subsurface Detention System

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 Field¹
- Runoff from all impervious areas at the site discharging to the infiltration BMP.
- Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume.
- Recharge BMPs have been sized to infiltrate the Required Recharge Volume.
- Recharge BMPs have been sized to infiltrate the Required Recharge Volume *only* to the maximum extent practicable for the following reason:
 - Site is comprised solely of C and D soils and/or bedrock at the land surface
 - M.G.L. c. 21E sites pursuant to 310 CMR 40.0000
 - Solid Waste Landfill pursuant to 310 CMR 19.000
 - Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable.
- Calculations showing that the infiltration BMPs will drain in 72 hours are provided.
- Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.

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



Checklist for Stormwater Report

Checklist (continued)

Standard 3: Recharge (continued)

- The infiltration BMP is used to attenuate peak flows during storms greater than or equal to the 10-year 24-hour storm and separation to seasonal high groundwater is less than 4 feet and a mounding analysis is provided.
- Documentation is provided showing that infiltration BMPs do not adversely impact nearby wetland resource areas.

Standard 4: Water Quality

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

- Good housekeeping practices;
 - Provisions for storing materials and waste products inside or under cover;
 - Vehicle washing controls;
 - Requirements for routine inspections and maintenance of stormwater BMPs;
 - Spill prevention and response plans;
 - Provisions for maintenance of lawns, gardens, and other landscaped areas;
 - Requirements for storage and use of fertilizers, herbicides, and pesticides;
 - Pet waste management provisions;
 - Provisions for operation and management of septic systems;
 - Provisions for solid waste management;
 - Snow disposal and plowing plans relative to Wetland Resource Areas;
 - Winter Road Salt and/or Sand Use and Storage restrictions;
 - Street sweeping schedules;
 - Provisions for prevention of illicit discharges to the stormwater management system;
 - Documentation that Stormwater BMPs are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from LUHPPL;
 - Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan;
 - List of Emergency contacts for implementing Long-Term Pollution Prevention Plan.
- A Long-Term Pollution Prevention Plan is attached to Stormwater Report and is included as an attachment to the Wetlands Notice of Intent.
 - Treatment BMPs subject to the 44% TSS removal pretreatment requirement and the one inch rule for calculating the water quality volume are included, and discharge:
 - is within the Zone II or Interim Wellhead Protection Area
 - is near or to other critical areas
 - is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)
 - involves runoff from land uses with higher potential pollutant loads.
 - The Required Water Quality Volume is reduced through use of the LID site Design Credits.
 - Calculations documenting that the treatment train meets the 80% TSS removal requirement and, if applicable, the 44% TSS removal pretreatment requirement, are provided.



Checklist for Stormwater Report

Checklist (continued)

Standard 4: Water Quality (continued)

- The BMP is sized (and calculations provided) based on:
 - The ½" or 1" Water Quality Volume or
 - The equivalent flow rate associated with the Water Quality Volume and documentation is provided showing that the BMP treats the required water quality volume.
- The applicant proposes to use proprietary BMPs, and documentation supporting use of proprietary BMP and proposed TSS removal rate is provided. This documentation may be in the form of the propriety BMP checklist found in Volume 2, Chapter 4 of the Massachusetts Stormwater Handbook and submitting copies of the TARP Report, STEP Report, and/or other third party studies verifying performance of the proprietary BMPs.
- A TMDL exists that indicates a need to reduce pollutants other than TSS and documentation showing that the BMPs selected are consistent with the TMDL is provided.

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

- The NPDES Multi-Sector General Permit covers the land use and the Stormwater Pollution Prevention Plan (SWPPP) has been included with the Stormwater Report.
- The NPDES Multi-Sector General Permit covers the land use and the SWPPP will be submitted *prior to* the discharge of stormwater to the post-construction stormwater BMPs.
- The NPDES Multi-Sector General Permit does *not* cover the land use.
- LUHPPLs are located at the site and industry specific source control and pollution prevention measures have been proposed to reduce or eliminate the exposure of LUHPPLs to rain, snow, snow melt and runoff, and been included in the long term Pollution Prevention Plan.
- All exposure has been eliminated.
- All exposure has *not* been eliminated and all BMPs selected are on MassDEP LUHPPL list.
- The LUHPPL has the potential to generate runoff with moderate to higher concentrations of oil and grease (e.g. all parking lots with >1000 vehicle trips per day) and the treatment train includes an oil grit separator, a filtering bioretention area, a sand filter or equivalent.

Standard 6: Critical Areas

- The discharge is near or to a critical area and the treatment train includes only BMPs that MassDEP has approved for stormwater discharges to or near that particular class of critical area.
- Critical areas and BMPs are identified in the Stormwater Report.



Checklist for Stormwater Report

Checklist (continued)

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

- The project is subject to the Stormwater Management Standards only to the maximum Extent Practicable as a:
- Limited Project
 - Small Residential Projects: 5-9 single family houses or 5-9 units in a multi-family development provided there is no discharge that may potentially affect a critical area.
 - Small Residential Projects: 2-4 single family houses or 2-4 units in a multi-family development with a discharge to a critical area
 - Marina and/or boatyard provided the hull painting, service and maintenance areas are protected from exposure to rain, snow, snow melt and runoff
 - Bike Path and/or Foot Path
 - Redevelopment Project
 - Redevelopment portion of mix of new and redevelopment.
- Certain standards are not fully met (Standard No. 1, 8, 9, and 10 must always be fully met) and an explanation of why these standards are not met is contained in the Stormwater Report.
- The project involves redevelopment and a description of all measures that have been taken to improve existing conditions is provided in the Stormwater Report. The redevelopment checklist found in Volume 2 Chapter 3 of the Massachusetts Stormwater Handbook may be used to document that the proposed stormwater management system (a) complies with Standards 2, 3 and the pretreatment and structural BMP requirements of Standards 4-6 to the maximum extent practicable and (b) improves existing conditions.

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

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

- Narrative;
 - Construction Period Operation and Maintenance Plan;
 - Names of Persons or Entity Responsible for Plan Compliance;
 - Construction Period Pollution Prevention Measures;
 - Erosion and Sedimentation Control Plan Drawings;
 - Detail drawings and specifications for erosion control BMPs, including sizing calculations;
 - Vegetation Planning;
 - Site Development Plan;
 - Construction Sequencing Plan;
 - Sequencing of Erosion and Sedimentation Controls;
 - Operation and Maintenance of Erosion and Sedimentation Controls;
 - Inspection Schedule;
 - Maintenance Schedule;
 - Inspection and Maintenance Log Form.
- A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan containing the information set forth above has been included in the Stormwater Report.



Checklist for Stormwater Report

Checklist (continued)

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

- The project is highly complex and information is included in the Stormwater Report that explains why it is not possible to submit the Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan with the application. A Construction Period Pollution Prevention and Erosion and Sedimentation Control has *not* been included in the Stormwater Report but will be submitted *before* land disturbance begins.
- The project is *not* covered by a NPDES Construction General Permit.
- The project is covered by a NPDES Construction General Permit and a copy of the SWPPP is in the Stormwater Report.
- The project is covered by a NPDES Construction General Permit but no SWPPP been submitted. The SWPPP will be submitted BEFORE land disturbance begins.

Standard 9: Operation and Maintenance Plan

- The Post Construction Operation and Maintenance Plan is included in the Stormwater Report and includes the following information:
 - Name of the stormwater management system owners;
 - Party responsible for operation and maintenance;
 - Schedule for implementation of routine and non-routine maintenance tasks;
 - Plan showing the location of all stormwater BMPs maintenance access areas;
 - Description and delineation of public safety features;
 - Estimated operation and maintenance budget; and
 - Operation and Maintenance Log Form.
- The responsible party is *not* the owner of the parcel where the BMP is located and the Stormwater Report includes the following submissions:
 - A copy of the legal instrument (deed, homeowner's association, utility trust or other legal entity) that establishes the terms of and legal responsibility for the operation and maintenance of the project site stormwater BMPs;
 - A plan and easement deed that allows site access for the legal entity to operate and maintain BMP functions.

Standard 10: Prohibition of Illicit Discharges

- The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;
- An Illicit Discharge Compliance Statement is attached;
- NO Illicit Discharge Compliance Statement is attached but will be submitted *prior to* the discharge of any stormwater to post-construction BMPs.

Appendix V. Existing and Proposed Drainage Figures

Prepared for:

40
OAK STREET

PEABODY, MA

HANCOCK ASSOCIATES

Civil Engineers
Land Surveyors
Wetland Scientists

185 CENTRE STREET
DANVERS, MA. 01923
VOICE (978) 777-3050
FAX (978) 774-7816

EXISTING DRAINAGE AREAS

DATE: 12/23/19

DWG: 20312existing-R1.dwg

SCALE: 1" = 40'

DESIGN: JJP

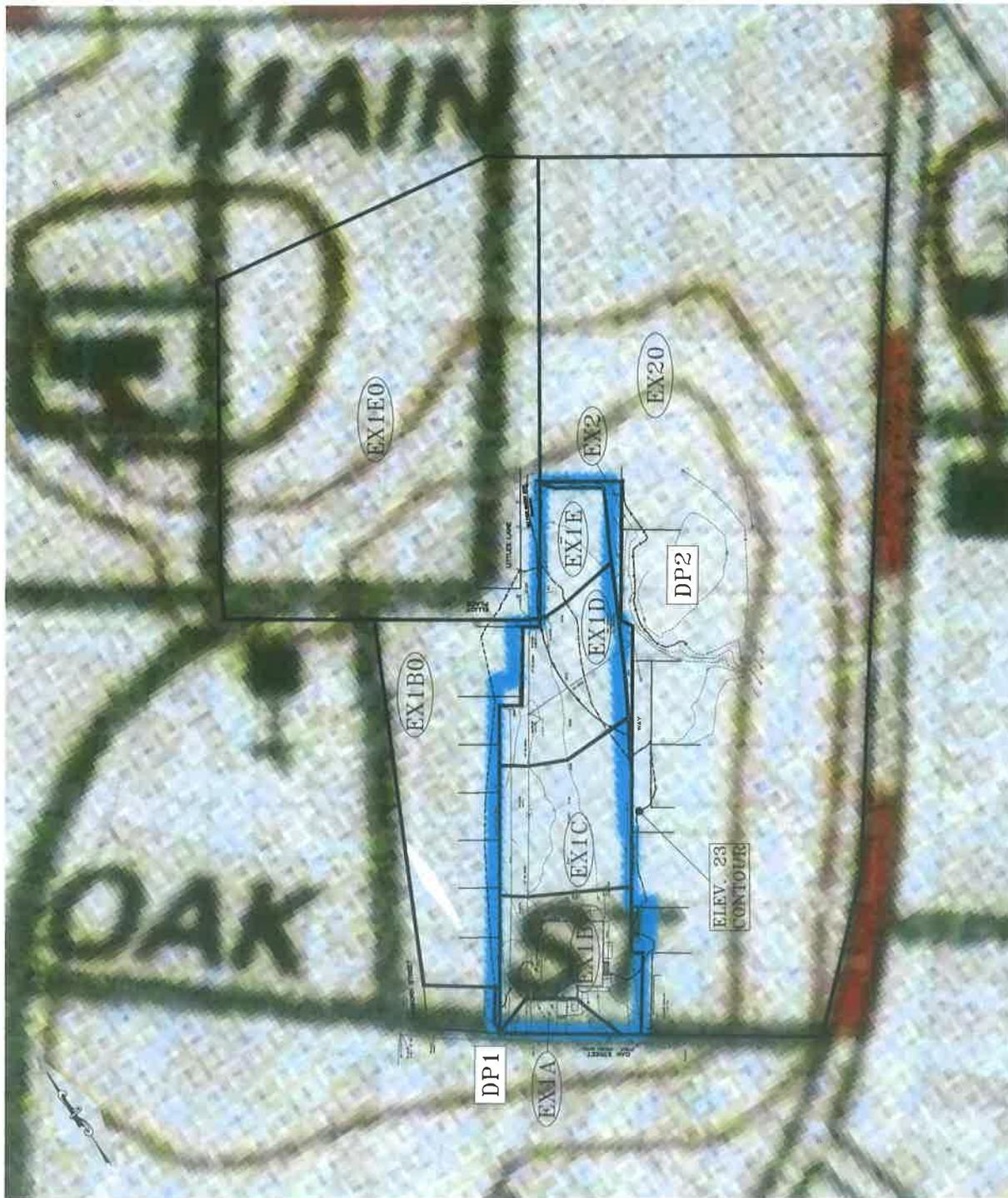
LAYOUT: EX

DRAWN: JJP

SHEET: 1 OF 2

JOB NO.: 20312

EX



Prepared for:

40
OAK STREET

PEABODY, MA

HANCOCK ASSOCIATES

Civil Engineers
Land Surveyors
Wetland Scientists

185 CENTRE STREET
DANVERS, MA. 01923
VOICE (978) 777-3050
FAX (978) 774-7816

PROPOSED DRAINAGE AREAS

DATE: 4/2/21

DWG: 20312proposed-R2.dwg

SCALE: 1" = 40'

DESIGN: DTW

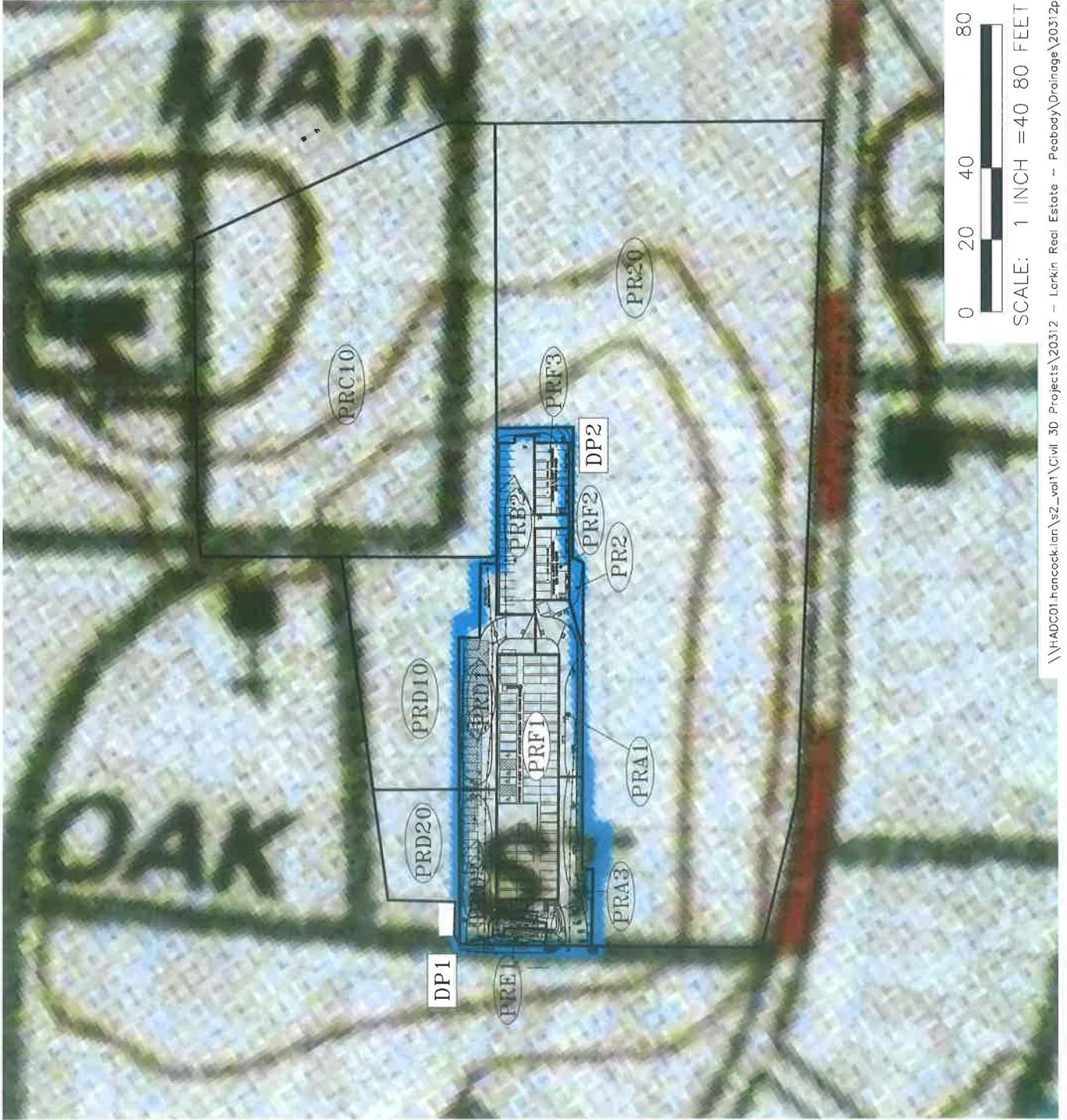
LAYOUT: PR

DRAWN: JJP

SHEET: 2 OF 2

DATE: 2021 04 21

PR



Appendix VI. Hydrocad Output

Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
 Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
 Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

SubcatchmentEX1A: Runoff Area=3,263 sf 38.06% Impervious Runoff Depth>0.40"
 Tc=6.0 min CN=61 Runoff=0.02 cfs 110 cf

SubcatchmentEX1B: Runoff Area=17,781 sf 79.95% Impervious Runoff Depth>1.75"
 Tc=6.0 min CN=86 Runoff=0.84 cfs 2,588 cf

SubcatchmentEX1BO: Offsite Flow Runoff Area=42,336 sf 38.00% Impervious Runoff Depth>0.40"
 Flow Length=120' Slope=0.0300 '/' Tc=6.0 min CN=61 Runoff=0.27 cfs 1,421 cf

SubcatchmentEX1C: Runoff Area=20,136 sf 89.48% Impervious Runoff Depth>2.25"
 Tc=6.0 min CN=92 Runoff=1.20 cfs 3,781 cf

SubcatchmentEX1D: Runoff Area=18,096 sf 95.72% Impervious Runoff Depth>2.54"
 Tc=6.0 min CN=95 Runoff=1.18 cfs 3,838 cf

SubcatchmentEX1E: Runoff Area=7,864 sf 94.56% Impervious Runoff Depth>2.54"
 Tc=6.0 min CN=95 Runoff=0.51 cfs 1,668 cf

SubcatchmentEX1EO: Offsite Flow Runoff Area=141,884 sf 38.00% Impervious Runoff Depth>0.40"
 Flow Length=120' Slope=0.0300 '/' Tc=6.0 min CN=61 Runoff=0.91 cfs 4,764 cf

SubcatchmentEX2: Runoff Area=2,952 sf 0.00% Impervious Runoff Depth=0.00"
 Tc=6.0 min CN=39 Runoff=0.00 cfs 0 cf

SubcatchmentEX2O: Offsite Flow to Runoff Area=259,227 sf 38.00% Impervious Runoff Depth>0.40"
 Flow Length=329' Slope=0.0638 '/' Tc=6.0 min CN=61 Runoff=1.65 cfs 8,703 cf

Reach DP1: Municipal System (Oak Street) Inflow=4.80 cfs 18,121 cf
 Outflow=4.80 cfs 18,121 cf

Reach DP2: Abutting Properties Inflow=0.00 cfs 0 cf
 Outflow=0.00 cfs 0 cf

Pond 1P: Littles Lane CB Peak Elev=21.70' Storage=0 cf Inflow=1.37 cfs 6,431 cf
 Primary=1.37 cfs 6,402 cf Secondary=0.01 cfs 29 cf Outflow=1.37 cfs 6,431 cf

Pond CB1A: CB1A Peak Elev=20.04' Inflow=3.47 cfs 11,719 cf
 Outflow=3.47 cfs 11,719 cf

Pond CB1B: CB1B Peak Elev=19.09' Storage=72 cf Inflow=3.45 cfs 11,657 cf
 Primary=3.45 cfs 11,609 cf Secondary=0.00 cfs 0 cf Outflow=3.45 cfs 11,609 cf

Pond ER2P: Offsite Isolated Wetland Peak Elev=20.19' Storage=1,475 cf Inflow=1.65 cfs 8,703 cf
 Discarded=0.51 cfs 8,670 cf Primary=0.00 cfs 0 cf Outflow=0.51 cfs 8,670 cf

Summary for Subcatchment EX1A:

Runoff = 0.02 cfs @ 12.13 hrs, Volume= 110 cf, Depth> 0.40"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.10"

Area (sf)	CN	Description
2,021	39	>75% Grass cover, Good, HSG A
1,242	98	Paved parking, HSG A
3,263	61	Weighted Average
2,021		61.94% Pervious Area
1,242		38.06% Impervious Area

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

Summary for Subcatchment EX1B:

Runoff = 0.84 cfs @ 12.09 hrs, Volume= 2,588 cf, Depth> 1.75"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.10"

Area (sf)	CN	Description
3,565	39	>75% Grass cover, Good, HSG A
8,623	98	Paved parking, HSG A
5,593	98	Roofs, HSG A
17,781	86	Weighted Average
3,565		20.05% Pervious Area
14,216		79.95% Impervious Area

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

Summary for Subcatchment EX1BO: Offsite Flow

Runoff = 0.27 cfs @ 12.13 hrs, Volume= 1,421 cf, Depth> 0.40"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.10"

Area (sf)	CN	Description
42,336	61	1/4 acre lots, 38% imp, HSG A
26,248		62.00% Pervious Area
16,088		38.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.0	100	0.0300	1.62		Sheet Flow, Smooth surfaces n= 0.011 P2= 3.20"
0.1	20	0.0300	2.79		Shallow Concentrated Flow, Unpaved Kv= 16.1 fps
4.9					Direct Entry, 1/10 Hour Minumum
6.0	120	Total			

Summary for Subcatchment EX1C:

Runoff = 1.20 cfs @ 12.09 hrs, Volume= 3,781 cf, Depth> 2.25"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.10"

Area (sf)	CN	Description
2,119	39	>75% Grass cover, Good, HSG A
18,017	98	Paved parking, HSG A
20,136	92	Weighted Average
2,119		10.52% Pervious Area
18,017		89.48% Impervious Area

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

Summary for Subcatchment EX1D:

Runoff = 1.18 cfs @ 12.08 hrs, Volume= 3,838 cf, Depth> 2.54"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.10"

Area (sf)	CN	Description
774	39	>75% Grass cover, Good, HSG A
17,322	98	Paved parking, HSG A
18,096	95	Weighted Average
774		4.28% Pervious Area
17,322		95.72% Impervious Area

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

Summary for Subcatchment EX1E:

Runoff = 0.51 cfs @ 12.08 hrs, Volume= 1,668 cf, Depth> 2.54"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.10"

Area (sf)	CN	Description
428	39	>75% Grass cover, Good, HSG A
7,436	98	Paved parking, HSG A
7,864	95	Weighted Average
428		5.44% Pervious Area
7,436		94.56% Impervious Area

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

Summary for Subcatchment EX1EO: Offsite Flow

Runoff = 0.91 cfs @ 12.13 hrs, Volume= 4,764 cf, Depth> 0.40"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.10"

Area (sf)	CN	Description
141,884	61	1/4 acre lots, 38% imp, HSG A
87,968		62.00% Pervious Area
53,916		38.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.0	100	0.0300	1.62		Sheet Flow, Smooth surfaces n= 0.011 P2= 3.20"
0.1	20	0.0300	2.79		Shallow Concentrated Flow, Unpaved Kv= 16.1 fps
4.9					Direct Entry, 1/10 Hour Minumum
6.0	120	Total			

Summary for Subcatchment EX2:

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

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.10"

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Type III 24-hr 2-year Rainfall=3.10"

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Area (sf)	CN	Description
2,952	39	>75% Grass cover, Good, HSG A
2,952		100.00% Pervious Area

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

Summary for Subcatchment EX2O: Offsite Flow to Isolated Pocket Wetland (From Peabody GIS)

Runoff = 1.65 cfs @ 12.13 hrs, Volume= 8,703 cf, Depth> 0.40"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.10"

Area (sf)	CN	Description
259,227	61	1/4 acre lots, 38% imp, HSG A
160,721		62.00% Pervious Area
98,506		38.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	100	0.0638	2.19		Sheet Flow, Smooth surfaces n= 0.011 P2= 3.20"
0.9	229	0.0638	4.07		Shallow Concentrated Flow, Unpaved Kv= 16.1 fps
4.3					Direct Entry, 1/10 Hour Minimum
6.0	329	Total			

Summary for Reach DP1: Municipal System (Oak Street)

Inflow Area = 251,360 sf, 51.02% Impervious, Inflow Depth > 0.87" for 2-year event
Inflow = 4.80 cfs @ 12.10 hrs, Volume= 18,121 cf
Outflow = 4.80 cfs @ 12.10 hrs, Volume= 18,121 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Summary for Reach DP2: Abutting Properties

Inflow Area = 262,179 sf, 37.57% Impervious, Inflow Depth = 0.00" for 2-year event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Summary for Pond 1P: Littles Lane CB

Inflow Area = 149,748 sf, 40.97% Impervious, Inflow Depth > 0.52" for 2-year event
 Inflow = 1.37 cfs @ 12.11 hrs, Volume= 6,431 cf
 Outflow = 1.37 cfs @ 12.11 hrs, Volume= 6,431 cf, Atten= 0%, Lag= 0.0 min
 Primary = 1.37 cfs @ 12.11 hrs, Volume= 6,402 cf
 Secondary = 0.01 cfs @ 12.11 hrs, Volume= 29 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
 Peak Elev= 21.70' @ 12.11 hrs Surf.Area= 4 sf Storage= 0 cf

Plug-Flow detention time= 0.0 min calculated for 6,429 cf (100% of inflow)
 Center-of-Mass det. time= 0.0 min (882.4 - 882.4)

Volume	Invert	Avail.Storage	Storage Description
#1	21.70'	358 cf	Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
21.70	1	0	0
22.00	300	45	45
22.50	950	313	358

Device	Routing	Invert	Outlet Devices
#1	Primary	18.76'	12.0" Round Culvert L= 350.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 18.76' / 17.36' S= 0.0040 '/ Cc= 0.900 n= 0.011, Flow Area= 0.79 sf
#2	Secondary	21.70'	10.0' long x 5.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Primary OutFlow Max=3.69 cfs @ 12.11 hrs HW=21.70' (Free Discharge)
 ↑1=Culvert (Barrel Controls 3.69 cfs @ 4.69 fps)

Secondary OutFlow Max=0.00 cfs @ 12.11 hrs HW=21.70' (Free Discharge)
 ↑2=Broad-Crested Rectangular Weir(Weir Controls 0.00 cfs @ 0.13 fps)

Summary for Pond CB1A: CB1A

Inflow Area = 101,612 sf, 65.82% Impervious, Inflow Depth > 1.38" for 2-year event
 Inflow = 3.47 cfs @ 12.09 hrs, Volume= 11,719 cf
 Outflow = 3.47 cfs @ 12.09 hrs, Volume= 11,719 cf, Atten= 0%, Lag= 0.0 min
 Primary = 3.47 cfs @ 12.09 hrs, Volume= 11,719 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
 Peak Elev= 20.04' @ 12.09 hrs
 Flood Elev= 22.78'

Device	Routing	Invert	Outlet Devices
#1	Primary	18.70'	12.0" Round Culvert L= 130.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 18.70' / 16.70' S= 0.0154 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 0.79 sf
#2	Primary	22.80'	24.0" W x 24.0" H Vert. Orifice/Grate C= 0.600

Primary OutFlow Max=3.46 cfs @ 12.09 hrs HW=20.04' (Free Discharge)

- 1=Culvert (Inlet Controls 3.46 cfs @ 4.41 fps)
- 2=Orifice/Grate (Controls 0.00 cfs)

Summary for Pond CB1B: CB1B

Inflow Area = 98,349 sf, 66.74% Impervious, Inflow Depth > 1.42" for 2-year event
 Inflow = 3.45 cfs @ 12.09 hrs, Volume= 11,657 cf
 Outflow = 3.45 cfs @ 12.09 hrs, Volume= 11,609 cf, Atten= 0%, Lag= 0.2 min
 Primary = 3.45 cfs @ 12.09 hrs, Volume= 11,609 cf
 Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
 Peak Elev= 19.09' @ 12.09 hrs Surf.Area= 13 sf Storage= 72 cf
 Flood Elev= 20.66' Surf.Area= 5,433 sf Storage= 1,884 cf

Plug-Flow detention time= 4.6 min calculated for 11,609 cf (100% of inflow)
 Center-of-Mass det. time= 2.1 min (815.1 - 813.0)

Volume	Invert	Avail.Storage	Storage Description
#1	19.96'	57,787 cf	Custom Stage Data (Prismatic) Listed below (Recalc)
#2	13.40'	82 cf	4.00'D x 6.56'H Vertical Cone/Cylinder
		57,869 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
19.96	4	0	0
20.00	37	1	1
21.00	8,193	4,115	4,116
22.00	23,641	15,917	20,033
23.00	51,867	37,754	57,787

Device	Routing	Invert	Outlet Devices
#1	Primary	17.10'	12.0" Round Culvert L= 125.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 17.10' / 16.80' S= 0.0024 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 0.79 sf
#2	Secondary	22.90'	15.0' long x 10.0' breadth Broad-Crested Weir (Oak Street) Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=3.44 cfs @ 12.09 hrs HW=19.09' (Free Discharge)

↑1=Culvert (Barrel Controls 3.44 cfs @ 4.39 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=13.40' (Free Discharge)

↑2=Broad-Crested Weir (Oak Street)(Controls 0.00 cfs)

Summary for Pond ER2P: Offsite Isolated Wetland

Inflow Area = 262,179 sf, 37.57% Impervious, Inflow Depth > 0.40" for 2-year event
 Inflow = 1.65 cfs @ 12.13 hrs, Volume= 8,703 cf
 Outflow = 0.51 cfs @ 12.66 hrs, Volume= 8,670 cf, Atten= 69%, Lag= 31.8 min
 Discarded = 0.51 cfs @ 12.66 hrs, Volume= 8,670 cf
 Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
 Peak Elev= 20.19' @ 12.66 hrs Surf.Area= 9,083 sf Storage= 1,475 cf

Plug-Flow detention time= 23.1 min calculated for 8,666 cf (100% of inflow)
 Center-of-Mass det. time= 21.1 min (938.9 - 917.8)

Volume	Invert	Avail.Storage	Storage Description
#1	20.00'	61,224 cf	Custom Stage Data (Prismatic) Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
20.00	6,704	0	0
21.00	19,440	13,072	13,072
22.00	24,701	22,071	35,143
23.00	27,462	26,082	61,224

Device	Routing	Invert	Outlet Devices
#1	Primary	22.96'	24.0' long x 15.0' 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) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63
#2	Discarded	20.00'	2.410 in/hr Exfiltration over Surface area

Discarded OutFlow Max=0.51 cfs @ 12.66 hrs HW=20.19' (Free Discharge)

↑2=Exfiltration (Exfiltration Controls 0.51 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=20.00' (Free Discharge)

↑1=Broad-Crested Rectangular Weir(Controls 0.00 cfs)

Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
 Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
 Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

SubcatchmentEX1A: Runoff Area=3,263 sf 38.06% Impervious Runoff Depth>1.11"
 Tc=6.0 min CN=61 Runoff=0.09 cfs 301 cf

SubcatchmentEX1B: Runoff Area=17,781 sf 79.95% Impervious Runoff Depth>3.05"
 Tc=6.0 min CN=86 Runoff=1.45 cfs 4,514 cf

SubcatchmentEX1BO: Offsite Flow Runoff Area=42,336 sf 38.00% Impervious Runoff Depth>1.11"
 Flow Length=120' Slope=0.0300 '/' Tc=6.0 min CN=61 Runoff=1.11 cfs 3,900 cf

SubcatchmentEX1C: Runoff Area=20,136 sf 89.48% Impervious Runoff Depth>3.65"
 Tc=6.0 min CN=92 Runoff=1.89 cfs 6,120 cf

SubcatchmentEX1D: Runoff Area=18,096 sf 95.72% Impervious Runoff Depth>3.97"
 Tc=6.0 min CN=95 Runoff=1.79 cfs 5,988 cf

SubcatchmentEX1E: Runoff Area=7,864 sf 94.56% Impervious Runoff Depth>3.97"
 Tc=6.0 min CN=95 Runoff=0.78 cfs 2,602 cf

SubcatchmentEX1EO: Offsite Flow Runoff Area=141,884 sf 38.00% Impervious Runoff Depth>1.11"
 Flow Length=120' Slope=0.0300 '/' Tc=6.0 min CN=61 Runoff=3.71 cfs 13,069 cf

SubcatchmentEX2: Runoff Area=2,952 sf 0.00% Impervious Runoff Depth>0.12"
 Tc=6.0 min CN=39 Runoff=0.00 cfs 29 cf

SubcatchmentEX2O: Offsite Flow to Runoff Area=259,227 sf 38.00% Impervious Runoff Depth>1.11"
 Flow Length=329' Slope=0.0638 '/' Tc=6.0 min CN=61 Runoff=6.77 cfs 23,878 cf

Reach DP1: Municipal System (Oak Street) Inflow=8.66 cfs 36,445 cf
 Outflow=8.66 cfs 36,445 cf

Reach DP2: Abutting Properties Inflow=0.00 cfs 0 cf
 Outflow=0.00 cfs 0 cf

Pond 1P: Littles Lane CB Peak Elev=21.80' Storage=5 cf Inflow=4.47 cfs 15,671 cf
 Primary=3.74 cfs 15,432 cf Secondary=0.73 cfs 239 cf Outflow=4.47 cfs 15,671 cf

Pond CB1A: CB1A Peak Elev=20.91' Inflow=4.95 cfs 21,013 cf
 Outflow=4.95 cfs 21,013 cf

Pond CB1B: CB1B Peak Elev=20.38' Storage=672 cf Inflow=6.91 cfs 20,761 cf
 Primary=4.87 cfs 20,712 cf Secondary=0.00 cfs 0 cf Outflow=4.87 cfs 20,712 cf

Pond ER2P: Offsite Isolated Wetland Peak Elev=20.71' Storage=8,005 cf Inflow=6.77 cfs 23,907 cf
 Discarded=0.88 cfs 23,836 cf Primary=0.00 cfs 0 cf Outflow=0.88 cfs 23,836 cf

Summary for Subcatchment EX1A:

Runoff = 0.09 cfs @ 12.10 hrs, Volume= 301 cf, Depth> 1.11"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=4.55"

Area (sf)	CN	Description
2,021	39	>75% Grass cover, Good, HSG A
1,242	98	Paved parking, HSG A
3,263	61	Weighted Average
2,021		61.94% Pervious Area
1,242		38.06% Impervious Area

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

Summary for Subcatchment EX1B:

Runoff = 1.45 cfs @ 12.09 hrs, Volume= 4,514 cf, Depth> 3.05"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=4.55"

Area (sf)	CN	Description
3,565	39	>75% Grass cover, Good, HSG A
8,623	98	Paved parking, HSG A
5,593	98	Roofs, HSG A
17,781	86	Weighted Average
3,565		20.05% Pervious Area
14,216		79.95% Impervious Area

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

Summary for Subcatchment EX1BO: Offsite Flow

Runoff = 1.11 cfs @ 12.10 hrs, Volume= 3,900 cf, Depth> 1.11"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=4.55"

Area (sf)	CN	Description
42,336	61	1/4 acre lots, 38% imp, HSG A
26,248		62.00% Pervious Area
16,088		38.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.0	100	0.0300	1.62		Sheet Flow, Smooth surfaces n= 0.011 P2= 3.20"
0.1	20	0.0300	2.79		Shallow Concentrated Flow, Unpaved Kv= 16.1 fps
4.9					Direct Entry, 1/10 Hour Minumum
6.0	120	Total			

Summary for Subcatchment EX1C:

Runoff = 1.89 cfs @ 12.08 hrs, Volume= 6,120 cf, Depth> 3.65"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=4.55"

Area (sf)	CN	Description
2,119	39	>75% Grass cover, Good, HSG A
18,017	98	Paved parking, HSG A
20,136	92	Weighted Average
2,119		10.52% Pervious Area
18,017		89.48% Impervious Area

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

Summary for Subcatchment EX1D:

Runoff = 1.79 cfs @ 12.08 hrs, Volume= 5,988 cf, Depth> 3.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=4.55"

Area (sf)	CN	Description
774	39	>75% Grass cover, Good, HSG A
17,322	98	Paved parking, HSG A
18,096	95	Weighted Average
774		4.28% Pervious Area
17,322		95.72% Impervious Area

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

Summary for Subcatchment EX1E:

Runoff = 0.78 cfs @ 12.08 hrs, Volume= 2,602 cf, Depth> 3.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=4.55"

Area (sf)	CN	Description
428	39	>75% Grass cover, Good, HSG A
7,436	98	Paved parking, HSG A
7,864	95	Weighted Average
428		5.44% Pervious Area
7,436		94.56% Impervious Area

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

Summary for Subcatchment EX1EO: Offsite Flow

Runoff = 3.71 cfs @ 12.10 hrs, Volume= 13,069 cf, Depth> 1.11"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=4.55"

Area (sf)	CN	Description
141,884	61	1/4 acre lots, 38% imp, HSG A
87,968		62.00% Pervious Area
53,916		38.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.0	100	0.0300	1.62		Sheet Flow, Smooth surfaces n= 0.011 P2= 3.20"
0.1	20	0.0300	2.79		Shallow Concentrated Flow, Unpaved Kv= 16.1 fps
4.9					Direct Entry, 1/10 Hour Minumum
6.0	120	Total			

Summary for Subcatchment EX2:

Runoff = 0.00 cfs @ 14.66 hrs, Volume= 29 cf, Depth> 0.12"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=4.55"

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Type III 24-hr 10-year Rainfall=4.55"

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Area (sf)	CN	Description
2,952	39	>75% Grass cover, Good, HSG A
2,952		100.00% Pervious Area

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

Summary for Subcatchment EX2O: Offsite Flow to Isolated Pocket Wetland (From Peabody GIS)

Runoff = 6.77 cfs @ 12.10 hrs, Volume= 23,878 cf, Depth> 1.11"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=4.55"

Area (sf)	CN	Description
259,227	61	1/4 acre lots, 38% imp, HSG A
160,721		62.00% Pervious Area
98,506		38.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	100	0.0638	2.19		Sheet Flow, Smooth surfaces n= 0.011 P2= 3.20"
0.9	229	0.0638	4.07		Shallow Concentrated Flow, Unpaved Kv= 16.1 fps
4.3					Direct Entry, 1/10 Hour Minimum
6.0	329	Total			

Summary for Reach DP1: Municipal System (Oak Street)

Inflow Area = 251,360 sf, 51.02% Impervious, Inflow Depth > 1.74" for 10-year event
Inflow = 8.66 cfs @ 12.13 hrs, Volume= 36,445 cf
Outflow = 8.66 cfs @ 12.13 hrs, Volume= 36,445 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Summary for Reach DP2: Abutting Properties

Inflow Area = 262,179 sf, 37.57% Impervious, Inflow Depth = 0.00" for 10-year event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Summary for Pond 1P: Littles Lane CB

Inflow Area = 149,748 sf, 40.97% Impervious, Inflow Depth > 1.26" for 10-year event
 Inflow = 4.47 cfs @ 12.10 hrs, Volume= 15,671 cf
 Outflow = 4.47 cfs @ 12.10 hrs, Volume= 15,671 cf, Atten= 0%, Lag= 0.1 min
 Primary = 3.74 cfs @ 12.10 hrs, Volume= 15,432 cf
 Secondary = 0.73 cfs @ 12.10 hrs, Volume= 239 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
 Peak Elev= 21.80' @ 12.10 hrs Surf.Area= 100 sf Storage= 5 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
 Center-of-Mass det. time= 0.0 min (860.5 - 860.5)

Volume	Invert	Avail.Storage	Storage Description
#1	21.70'	358 cf	Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
21.70	1	0	0
22.00	300	45	45
22.50	950	313	358

Device	Routing	Invert	Outlet Devices
#1	Primary	18.76'	12.0" Round Culvert L= 350.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 18.76' / 17.36' S= 0.0040 ' Cc= 0.900 n= 0.011, Flow Area= 0.79 sf
#2	Secondary	21.70'	10.0' long x 5.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Primary OutFlow Max=3.74 cfs @ 12.10 hrs HW=21.80' (Free Discharge)
 ↖1=Culvert (Barrel Controls 3.74 cfs @ 4.76 fps)

Secondary OutFlow Max=0.73 cfs @ 12.10 hrs HW=21.80' (Free Discharge)
 ↖2=Broad-Crested Rectangular Weir(Weir Controls 0.73 cfs @ 0.74 fps)

Summary for Pond CB1A: CB1A

Inflow Area = 101,612 sf, 65.82% Impervious, Inflow Depth > 2.48" for 10-year event
 Inflow = 4.95 cfs @ 12.15 hrs, Volume= 21,013 cf
 Outflow = 4.95 cfs @ 12.15 hrs, Volume= 21,013 cf, Atten= 0%, Lag= 0.0 min
 Primary = 4.95 cfs @ 12.15 hrs, Volume= 21,013 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
 Peak Elev= 20.91' @ 12.15 hrs
 Flood Elev= 22.78'

Device	Routing	Invert	Outlet Devices
#1	Primary	18.70'	12.0" Round Culvert L= 130.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 18.70' / 16.70' S= 0.0154 ' /' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 0.79 sf
#2	Primary	22.80'	24.0" W x 24.0" H Vert. Orifice/Grate C= 0.600

Primary OutFlow Max=4.95 cfs @ 12.15 hrs HW=20.91' (Free Discharge)

1=Culvert (Inlet Controls 4.95 cfs @ 6.30 fps)

2=Orifice/Grate (Controls 0.00 cfs)

Summary for Pond CB1B: CB1B

Inflow Area = 98,349 sf, 66.74% Impervious, Inflow Depth > 2.53" for 10-year event
 Inflow = 6.91 cfs @ 12.09 hrs, Volume= 20,761 cf
 Outflow = 4.87 cfs @ 12.15 hrs, Volume= 20,712 cf, Atten= 29%, Lag= 3.6 min
 Primary = 4.87 cfs @ 12.15 hrs, Volume= 20,712 cf
 Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
 Peak Elev= 20.38' @ 12.15 hrs Surf.Area= 3,112 sf Storage= 672 cf
 Flood Elev= 20.66' Surf.Area= 5,433 sf Storage= 1,884 cf

Plug-Flow detention time= 3.1 min calculated for 20,712 cf (100% of inflow)
 Center-of-Mass det. time= 1.7 min (804.6 - 803.0)

Volume	Invert	Avail.Storage	Storage Description
#1	19.96'	57,787 cf	Custom Stage Data (Prismatic) Listed below (Recalc)
#2	13.40'	82 cf	4.00'D x 6.56'H Vertical Cone/Cylinder
		57,869 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
19.96	4	0	0
20.00	37	1	1
21.00	8,193	4,115	4,116
22.00	23,641	15,917	20,033
23.00	51,867	37,754	57,787

Device	Routing	Invert	Outlet Devices
#1	Primary	17.10'	12.0" Round Culvert L= 125.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 17.10' / 16.80' S= 0.0024 ' /' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 0.79 sf
#2	Secondary	22.90'	15.0' long x 10.0' breadth Broad-Crested Weir (Oak Street) Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=4.87 cfs @ 12.15 hrs HW=20.37' (Free Discharge)

↑1=Culvert (Barrel Controls 4.87 cfs @ 6.20 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=13.40' (Free Discharge)

↑2=Broad-Crested Weir (Oak Street)(Controls 0.00 cfs)

Summary for Pond ER2P: Offsite Isolated Wetland

Inflow Area = 262,179 sf, 37.57% Impervious, Inflow Depth > 1.09" for 10-year event
 Inflow = 6.77 cfs @ 12.10 hrs, Volume= 23,907 cf
 Outflow = 0.88 cfs @ 13.11 hrs, Volume= 23,836 cf, Atten= 87%, Lag= 60.4 min
 Discarded = 0.88 cfs @ 13.11 hrs, Volume= 23,836 cf
 Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
 Peak Elev= 20.71' @ 13.11 hrs Surf.Area= 15,775 sf Storage= 8,005 cf

Plug-Flow detention time= 99.9 min calculated for 23,827 cf (100% of inflow)
 Center-of-Mass det. time= 98.2 min (976.9 - 878.7)

Volume	Invert	Avail.Storage	Storage Description
#1	20.00'	61,224 cf	Custom Stage Data (Prismatic) Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
20.00	6,704	0	0
21.00	19,440	13,072	13,072
22.00	24,701	22,071	35,143
23.00	27,462	26,082	61,224

Device	Routing	Invert	Outlet Devices
#1	Primary	22.96'	24.0' long x 15.0' 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) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63
#2	Discarded	20.00'	2.410 in/hr Exfiltration over Surface area

Discarded OutFlow Max=0.88 cfs @ 13.11 hrs HW=20.71' (Free Discharge)

↑2=Exfiltration (Exfiltration Controls 0.88 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=20.00' (Free Discharge)

↑1=Broad-Crested Rectangular Weir(Controls 0.00 cfs)

Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
 Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
 Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

SubcatchmentEX1A:	Runoff Area=3,263 sf 38.06% Impervious Runoff Depth>1.61" Tc=6.0 min CN=61 Runoff=0.13 cfs 439 cf
SubcatchmentEX1B:	Runoff Area=17,781 sf 79.95% Impervious Runoff Depth>3.84" Tc=6.0 min CN=86 Runoff=1.81 cfs 5,687 cf
SubcatchmentEX1BO: Offsite Flow Flow Length=120'	Runoff Area=42,336 sf 38.00% Impervious Runoff Depth>1.61" Slope=0.0300 '/' Tc=6.0 min CN=61 Runoff=1.71 cfs 5,690 cf
SubcatchmentEX1C:	Runoff Area=20,136 sf 89.48% Impervious Runoff Depth>4.48" Tc=6.0 min CN=92 Runoff=2.29 cfs 7,512 cf
SubcatchmentEX1D:	Runoff Area=18,096 sf 95.72% Impervious Runoff Depth>4.81" Tc=6.0 min CN=95 Runoff=2.14 cfs 7,256 cf
SubcatchmentEX1E:	Runoff Area=7,864 sf 94.56% Impervious Runoff Depth>4.81" Tc=6.0 min CN=95 Runoff=0.93 cfs 3,153 cf
SubcatchmentEX1EO: Offsite Flow Flow Length=120'	Runoff Area=141,884 sf 38.00% Impervious Runoff Depth>1.61" Slope=0.0300 '/' Tc=6.0 min CN=61 Runoff=5.74 cfs 19,069 cf
SubcatchmentEX2:	Runoff Area=2,952 sf 0.00% Impervious Runoff Depth>0.29" Tc=6.0 min CN=39 Runoff=0.01 cfs 71 cf
SubcatchmentEX2O: Offsite Flow to Flow Length=329'	Runoff Area=259,227 sf 38.00% Impervious Runoff Depth>1.61" Slope=0.0638 '/' Tc=6.0 min CN=61 Runoff=10.49 cfs 34,840 cf
Reach DP1: Municipal System (Oak Street)	Inflow=9.08 cfs 48,758 cf Outflow=9.08 cfs 48,758 cf
Reach DP2: Abutting Properties	Inflow=0.00 cfs 0 cf Outflow=0.00 cfs 0 cf
Pond 1P: Littles Lane CB	Peak Elev=21.94' Storage=30 cf Inflow=6.66 cfs 22,223 cf Primary=3.82 cfs 20,869 cf Secondary=2.84 cfs 1,354 cf Outflow=6.66 cfs 22,223 cf
Pond CB1A: CB1A	Peak Elev=21.17' Inflow=5.31 cfs 27,889 cf Outflow=5.31 cfs 27,889 cf
Pond CB1B: CB1B	Peak Elev=20.75' Storage=2,420 cf Inflow=10.75 cfs 27,499 cf Primary=5.22 cfs 27,450 cf Secondary=0.00 cfs 0 cf Outflow=5.22 cfs 27,450 cf
Pond ER2P: Offsite Isolated Wetland	Peak Elev=21.02' Storage=13,489 cf Inflow=10.49 cfs 34,911 cf Discarded=1.09 cfs 34,816 cf Primary=0.00 cfs 0 cf Outflow=1.09 cfs 34,816 cf

Summary for Subcatchment EX1A:

Runoff = 0.13 cfs @ 12.10 hrs, Volume= 439 cf, Depth> 1.61"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-year Rainfall=5.40"

Area (sf)	CN	Description
2,021	39	>75% Grass cover, Good, HSG A
1,242	98	Paved parking, HSG A
3,263	61	Weighted Average
2,021		61.94% Pervious Area
1,242		38.06% Impervious Area

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

Summary for Subcatchment EX1B:

Runoff = 1.81 cfs @ 12.09 hrs, Volume= 5,687 cf, Depth> 3.84"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-year Rainfall=5.40"

Area (sf)	CN	Description
3,565	39	>75% Grass cover, Good, HSG A
8,623	98	Paved parking, HSG A
5,593	98	Roofs, HSG A
17,781	86	Weighted Average
3,565		20.05% Pervious Area
14,216		79.95% Impervious Area

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

Summary for Subcatchment EX1BO: Offsite Flow

Runoff = 1.71 cfs @ 12.10 hrs, Volume= 5,690 cf, Depth> 1.61"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-year Rainfall=5.40"

Area (sf)	CN	Description
42,336	61	1/4 acre lots, 38% imp, HSG A
26,248		62.00% Pervious Area
16,088		38.00% Impervious Area