STORMWATER ANALYSIS AND DRAINAGE REPORT

Littleton Drive Affordable Housing Project

Wareham, Massachusetts

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1.0 STORMWATER AND DRAINAGE NARRATIVE

This Stormwater Management Report provides a summary of the proposed stormwater management for the Littleton Drive Affordable Housing Project. The purpose of this report is to describe the pre- and post-development site conditions and the practices to be used for reducing stormwater runoff and pollutants during and after construction. The proposed project has been developed to incorporate a series of green stormwater infrastructure (GSI) practices into the overall site and landscape design. The design includes surface GSI bioretention facilities for pre-treatment, recharge and water quality management for 1" of runoff from impervious surfaces. Two surface infiltration basins and four underground chamber systems provide storage for peak flow attenuation for the 2-year, 10-year, and 100-year storms.

Due to the proximity of the proposed Project to existing wetlands, adherence to the Massachusetts Stormwater Standards (MASWS) (revised in January 2008) is required. The proposed site design conforms to the Standards by providing stormwater runoff treatment or the first 1-inch runoff from proposed impervious areas contributing to site runoff. On-site attenuation and infiltration is proposed to match or reduce peak runoff conditions for the 2, 10 and 100-year storm events. The proposed stormwater controls will be maintained during and after construction as part of the development regular landscape maintenance and as described further in the Operations and Maintenance Plan.

1.1. Existing Conditions

The project site is located at 4 Littleton Drive in the Town of Wareham, Massachusetts (Latitude 41.749903, Longitude -70.729243) The Town of Wareham identifies the Subject Property as Map 56 Lot 1. Refer to Figures 1 and 2 for regional location and general layout of the Subject Property, respectively.

According to the Town of Wareham Assessors Office, the Subject Property consists of 12.92-acres of land. The Wareham Redevelopment Authority, in its January 2020 RFP, confirms that the actual size of the property is approximately 16.1 acres; the discrepancy is due to previously defined rights-of-way within the Subject Property that will be removed prior to construction.

The Subject Property is mostly wooded with a few paths with bare earth and historic subgrade utility services installed during a failed subdivision project between approximately 1971 and 1978. There are no formal buildings, structures, or asphalt paved roads on the Subject Property, though there are a few buildings encroaching from neighboring properties. Entry into the Subject Property was gained by following a walking path off Littleton Drive.

Wetland resource areas were previously identified and delineated by Green Seal Environmental Inc. in December 2019. Horsley Witten Group, Inc. (HW) wetland scientist reviewed this boundary and made minor adjustments to the wetland boundary as now shown on the existing conditions plan. Wetland resource areas were determined in accordance with methods developed by MassDEP, the Massachusetts Wetlands Protection Act regulations.

The existing drainage area to Study Point 1 at Flax Pond is 18.19 acres (792,419 square feet) and is comprised of the following land cover:

Table 1: Study Point 1 Existing Land Coverage

Coverage	Area (ft2)	Area (acres)	%
Roadway	1,175	0.03	0.1
Bare Soil-A/B	45,768	1.05	5.8
Roof	15,804	0.36	2.0
Woods-A/B	0	0.00	0.0
Woods-A	598,576	13.74	75.5
Grass- A/B	94,811	2.18	12.0
Grass-A	19,568	0.45	2.5
TOTAL	792,419	18.19	100%

The existing conditions site draining to Study Point 1 (SP1) includes nearly all of the subject property comprised of woodlands and bare soil paths and off-site areas consisting of a very small area of paved roads, rooftops, woods and grass areas. The area slopes very gently towards Flax Pond in the southeast corner at SP1.

The existing drainage area to Study Point 2 at the existing Littleton Drive is 1.70 acres (73,959 square feet) and is comprised of the following land cover:

Table 2: Study Point 2 Existing Land Coverage

Coverage	Area (ft2)	Area (acres)	%
Roadway	0	0.00	0.0
Bare Soil-A/B	5,417	0.12	7.3
Roof	902	0.02	1.2
Woods-A/B	67,640	1.55	91.5
Grass- A/B	0	0.00	0.0
TOTAL	73,959	1.70	100%

The existing conditions site draining to Study Point 2 (SP1) includes the northeast corner of the property, which is mostly woodlands with a bare soil path.

1.1.1. Soils

According to the Commonwealth of Massachusetts Bureau of Geographical Information ("MassGIS"), soils underlying the Subject Property are classified as Deerfield and Windsor soils (Figure 3). The United States Department of Agriculture Soil Conservation Service identifies these soils as well drained to excessively drained.

The NRCS Soil Map is located in **Appendix A**.

1.2. Proposed Conditions

The proposed project includes the construction of a residential community consisting of a three-story Seniors Only building consisting of 44 one-bedroom housing units and 10 multi-unit dwellings offering mixed-income housing. The buildings will be accessed by an internal road, and parking will be provided for each unit. Other site amenities include a community building, community gardens and walking trails. The site will be accessed via Littleton Drive, off Swifts Beach Road. A second, emergency-only point of egress will connect to the low-density residential neighborhood to the site's south and west. The site is to be serviced by Town water and sewer, natural gas, electric and cable service accessed from Littleton Drive. The Applicant has applied for wastewater allocation to support the proposed housing development. Other site features include:

- Approximately 2,300 linear feet of 24' wide paved streets with perpendicular parking spaces for the 10 multi-unit residential buildings
- A total of 133 paved parking spaces
- ADA accessible sidewalks
- Interior landscaped areas, open spaces, and lighting.

1.2.1. Stormwater Management

The proposed stormwater management includes a GSI approach to capture, treat, infiltrate, and retain runoff, when applicable and to the maximum extent practicable, by using the following Stormwater Control Measures (SCM)s.

Bioretention Areas (BIO)

A bioretention area (sometimes referred to as a "rain garden" or a "biofilter") is a stormwater management practice to manage and treat stormwater runoff using a conditioned planting soil bed or "filter" media and plants to filter runoff captured in a shallow depression. The method combines physical filtering and adsorption with bio-geochemical processes to remove pollutants. The system consists of an inflow component, a pretreatment element, an overflow structure, a shallow ponding area (6 inches deep), a well-drained planting soil bed, and plants.

Underground Recharge Chambers (URC)

Underground recharge chambers capture, and store stormwater collected from surrounding rooftops and other impervious areas after treatment of the first inch of runoff from upgradient bioretention areas. Drainage pipes direct surface stormwater to subsurface interconnected storage units. Some of the stored water is released directly into the ground mimicking pre-development conditions. Use of stormwater recharge chambers allows stored water to infiltrate and recharge groundwater. Larger storms beyond the infiltration rate of the underlying soils fill the chambers before being discharged either to the down-gradient infiltration basins, or directly to Flax Pond.

Infiltration Basins (IB)

The infiltration basins are surface stormwater facilities designed to collect and temporarily store runoff before infiltration into the subsoil. The infiltration basins allow stored water to infiltrate and recharge groundwater. Infiltration basins only receive runoff from adjacent pervious and rooftop areas, and after treatment of the one-inch runoff from upgradient bioretention areas.

Sediment Forebays

Sediment forebays are also provided at the bioretention areas for pretreatment of the surface water runoff from the proposed pavement and concrete surfaces to allow for sediment to settle from the incoming stormwater runoff prior to conveyance to the bioretention and infiltration basin/chamber systems. The forebays are designed to provide 0.1” of runoff volume as required by the Massachusetts Stormwater Standards. The sediment forebays are designed to be easily accessed on a regular basis for cleanout and sediment removal. See the Stormwater Operation and Maintenance Plan.

1.2.2. Drainage Areas

The proposed development will occur within an approximately 9.0 acre development area generally in the center of the 16.1 acre parcel with buffers of not less than 50 feet and up to 150 feet to adjacent property lines to remain undeveloped. A 24-foot wide access street will connect into existing Littleton Drive at the northeast corner of the property. A looping path/trail is proposed to surround the development envelope. The proposed site development includes a low impact stormwater management approach, public sewer and water, natural gas and other associated utilities. The total proposed development is comprised of the following land cover:

Table 3: Proposed Land Coverage

Coverage	Area (ft2)	Area (acres)	%
Paved	103,128	2.37	11.8
Bare Soil-A/B	15,541	0.36	1.8
Roof	68,286	1.57	7.8
BMP	35,873	0.91	4.5
Meadow	75,160	1.64	8.2
Woods-A/B	318,843	7.32	36.4
Woods-A	94,810	2.18	10.8
Grass- A/B	145,837	3.35	16.7
Grass- A	17,673	0.41	2.0
Total	875,153	20.09	**100%**

The proposed site drainage is divided into eleven subcatchments: DA0, DA1E, DA1W, DA2, DA3, DA3R, DA4, DA1OS, DA2OS, DA3OS, and DA4OS. DA1OS and DA4OS drain to the existing Littleton Drive (SP2), while the other 9 drainage areas ultimately drain to the Flax Pond study point (SP1) as outlined in the existing conditions above. Pre and Post Drainage maps can be found in **Appendix B**. The 0.20 acre increase in post-developed conditions drainage area is due to the proposed grading at the beginning of the entrance driveway off of Littleton Drive where this small area of drainage will be managed by SCM P1.

DA0 is approximately 0.20 acres, located in the eastern portion of the property, and includes paved roads, open lawn, and the SCM. This area retains the 100-Year Storm within the SCM but is mapped to SP1.

DA1E is approximately 0.50 acres, also located in eastern portion of the property and includes the upper portion of Littleton Drive, sidewalks, the northern parking lot to the senior building, the SCM and open lawn areas. Runoff drains first to Bioretention area (BIO) P2, which overflows to the underground recharge chambers (C1), located under the parking lot, before discharging to SP1.

DA1W is approximately 0.52 acres, located in the central portion of Littleton Drive The area includes a portion of the roof from the senior building, paved roadway, sidewalks, the SCM, and open lawn/landscaped areas. Roof runoff drains directly to the underground recharge chambers (C1), located under the parking lot, before discharging to SP1. Surface runoff drains first to BIO P3, which overflows to chambers C1 before discharging to SP1.

DA2 is approximately 0.65 acres, located along the southwestern boundary of the site. The area includes a portion of the emergency access road, sidewalks, a portion of the rooftop from the senior building, the southern parking lot serving the senior building, the SCM, the community garden, and open lawn/landscaped areas. The area slopes from southeast to northwest. Roof runoff drains directly to the underground recharge chambers (C2), located under the southern parking lot, before discharging to SP1. Surface runoff drains first to BIO P5, which overflows to chambers C2 before discharging to SP1.

DA3 is approximately 2.28 acres, located in the central portion of the loop road and multi-unit townhouses and includes the community center. The area includes rooftops, parking for the townhouses and community center, roadway and sidewalks serving the multi-unit townhouses, the SCM, and open lawn/landscaped areas. Runoff drains first to BIO P4, which overflows to the underground recharge chambers (C3), located under the common open lawn/landscaped area, before discharging to the infiltration basin IB1.

DA3R is approximately 0.24 acres, located in the eastern side of the loop road. The area includes only the rooftops of three multi-unit townhouses. These rooftops drain to a small underground chamber system (C4) before overflowing to the proposed infiltration basin (IB2) . The area slopes to the northeast and retains the 100-Year Storm within IB2 but is mapped to SP2.

DA4 is approximately 1.28 acres, located in the northern portion of the loop road and multi-unit townhouses. The area includes rooftops, parking for the townhouses, roadway and sidewalks serving the multi-unit townhouses, the SCM, and open lawn/landscaped areas. Runoff drains first to BIO P6, which overflows to the infiltration basin IB2.

DA1OS is approximately 1.15 acres, located on the northern, mostly undeveloped area of the site. The area includes mostly undeveloped woods and open lawn/landscaped areas. The small underground chamber system (C4) draining the rooftops in DA3R overflows during larger storms to the proposed surface infiltration basin (IB2). Surface runoff drains to IB2. The area slopes to the northeast and retains the 100-Year Storm within surface infiltration basin IB2 but is mapped to SP2.

DA2OS is approximately 1.41 acres, located to the southern portion of the site adjacent to Flax Pond and SP1. The area includes mostly natural undeveloped woods and the existing bare soil pathway. The area slopes directly to Flax Pond and discharged to SP1.

DA3OS is approximately 10.29 acres, located to the northwest of the property and includes off-site existing developed lots consisting of mostly undeveloped woods, existing residential rooftops, portions of the townhouse rooftops, lawns, the SCM (IB1), and the existing bare soil pathway. The area slopes to the proposed surface infiltration basin (IB1) and retains storms in excess of the 100-year event but is mapped to SP1.

DA4OS is approximately 1.56 acres, located to the northeast of the property and includes off-site existing developed lots consisting of mostly undeveloped woods, the proposed formalized soil pathway and planted areas behind the houses. The area slopes to the east to SP2.

2.0 DRAINAGE DESIGN METHODOLOGY AND ANALYSIS

The drainage design was completed by performing the following series of tasks:

- Site soil evaluations (6 test pits) and soil borings (17 borings) (**Appendix A**)
- Delineation of drainage areas and sub catchments (**Appendix B**)
- Sizing the bioretention areas, and underground recharge chambers (**Appendix C**)
- Modeling the proposed drainage network with HydroCAD® software (**Appendix D**)
- TSS and Recharge calculations (**Appendix E**)
- Operation and Maintenance Guide (**Appendix F)**
- Groundwater mounding analyses using the Hantush Method (**Appendix G)**

Six soil test pits were excavated on the site to assess the subsurface conditions and determine its suitability for the construction of stormwater management practices. The soil test pit data are included in **Appendix A**. Six test pits are located across the site in locations deemed proximate to proposed infiltration systems but distributed across the site to allow for comparison of groundwater elevations.

The soil map unit comprising the majority of the site is “Deerfield loamy sand 0 to 3 percent slopes.” The Deerfield series is described in the 1969 Soils Survey as consisting “of very deep, moderately well drained soils on terraces, deltas, and outwash plains. They formed in thick deposits of sand derived mainly from granite, gneiss, and quartzite. Typically, these soils have a very dark grayish brown loamy sand surface layer 9 inches thick. The subsoil from 9 to 19 inches is yellowish-brown loamy that is mottled. The subsoil from 19 to 27 inches is mottled sand. The substratum from 27 to 65 inches is olive gray sand. Slopes range from 0 to 15 percent.” MassGIS and the 1969 Plymouth County Soils Survey list Deerfield soils as HSG B while the 2010 on-line Plymouth County Soils Survey HSG List has Deerfield identified as HSG A. Our field observations confirmed a fine sand soil layer as shallow as 41” that confines downward water movement. For hydrologic calculations, we split the difference between HSG A and B for both pre-development and post-development conditions.

The test pits revealed a soil column that consisted of approximately 3 to 5 inches of organic matter, 2 to 9-inches of loamy sand woodland topsoil overlying 2 inches to 24 inches of loamy sand subsoil. The underlying fine sand substratum extends to the bottom of the deep observation test pits to a depth of up to approximately 10 feet. The entirety of the soil column was a single-grained texture and of a friable consistency.

Groundwater was observed in four test holes (TP-1, TP-2, TP-5 and TP-6), which are distributed across the site. Observed depth to water ranged from 48 inches to 91 inches feet below grade. Redoxymorphic (Redox) features were observed in 5 out of 6 test holes. The Estimated Seasonal High Ground Water (ESHGW) elevation was determined by depth to observed Redox. Using this method, the highest estimated groundwater elevation was determined to be at elevation 9.8. Perforated pipes were installed in two test pits (TP-2 and Tp-4) to allow for future observation of groundwater prior to development of final construction drawings.

A double-ring infiltrometer test was performed at TP-6, at a depth of 44 inches in the fine sand layer. Results ranged from 9.3 in/hr. to 10.3 in/hr. To be conservative in the HydroCAD drainage model, 50% of the lowest observed rate (4.5 in/hr) will be used in the design of all proposed infiltration areas. This rate coincides with the requirements set forth in the Massachusetts Stormwater Management Standards. Based on the infiltration test data results, existing subsoils, and deep depth to groundwater, this site is feasible for stormwater infiltration.

Soil test pit logs are provided in **Appendix A** and the test pits locations are located on the Grading and Drainage Plan. 17 soil borings were completed by Terracon on December 9, 2020. The Geotechnical Engineering Report for the overall site and building construction, including the Exploration Plan and Soil Boring Logs are also contained in **Appendix A.** The full geotechnical report was completed on January 13, 2021.

The Stormwater Management System has been designed to accomplish the following major objectives:

- To capture and treat, at a minimum, the “first flush” (first one-inch of stormwater runoff) from the impervious surfaces to maintain or improve water quality conditions when compared to existing conditions.

- To provide groundwater recharge to the greatest extent practicable in conformance with the Massachusetts Department of Environmental Protection groundwater recharge criteria.

- To meet or reduce peak flow rates for post-developed conditions as compared to pre-developed conditions at the two study points located along the perimeter of Flax Pond and Littleton Drive

These objectives are met through the use of the following stormwater management measures:

- Bioretention systems sized to treat the first one-inch of stormwater runoff for water quality treatment of runoff from the driveway, walkways, and parking areas. The systems are equipped with overflows to convey runoff from larger storm events into proposed underground recharge chambers and/or the surface infiltration basins. (**Appendix C**)

- Underground recharge chambers and surface infiltration basins sized to infiltrate and retain onsite runoff.

- Underground recharge chambers and to capture rooftop runoff from three of the multi-unit townhouse buildings.

The proposed Stormwater Management System was designed to accommodate pre-development site hydrologic conditions as well as reduce stormwater pollution from the proposed site conditions. Stormwater runoff quantity was evaluated for the 2-year, 10-year, and 100-year Type III, 24-hour storm events for both pre-development and post-development conditions. Pre-development and post-development conditions were modeled using HydroCAD software, which combines USDA Soil Conservation Service hydrology and hydraulic techniques (commonly known as SCS TR-55 and TR-20) to generate hydrographs (See **Appendix B** for both "Pre-developed" and "Post-developed" Drainage Area Maps). The rainfall amounts used for calculating runoff for the storm events are the NOAA+ values (NOAA Atlas 14 90% Upper Confidence value multiplied by 0.9). Rainfall values are listed below in Table 4. A summary table of pre- and post-development runoff peak flow rates and volumes is provided in Table 5.

Table 4: Precipitation Values for Design and Hydrological/Hydraulic Analysis

Storm Frequency (24-hour – Type III Storm)	Precipitation Value (inches) (NOAA+)
Water Quality Event (WQv)	1” per impervious acre[1]
2-year	3.69
10-Year	5.44
100-Year	8.76

Stormwater runoff quality was evaluated to ensure that pollutant export from the project site was minimized to the maximum extent practicable. The stormwater management system for the site was designed in accordance with the MASWS and the applicable criteria within the Town’s Subdivision Regulations and Zoning Bylaw (i.e. the 20-year frequency Storm).

Table 5: Peak Flow and Volume Comparison

STUDY POINT 1 – Flax Pond Wetland Perimeter

DESIGN STORM	PRE-DEVELOPMENT		POST-DEVELOPMENT		PERCENT REDUCTION	
	PEAK FLOW (CFS)	VOLUME (AF)	PEAK FLOW (CFS)	VOLUME (AF)	PEAK FLOW	VOLUME
2 YR	0.14	0.089	0.02	0.011	85.7%	87.6%
10 YR	1.79	0.624	0.57	0.073	68.2%	88.3%
100 YR (NRCC)	14.92	2.959	8.16	0.66	45.3%	77.7%

STUDY POINT 2 – Existing Littleton Drive

DESIGN STORM	PRE-DEVELOPMENT		POST-DEVELOPMENT		PERCENT REDUCTION	
	PEAK FLOW (CFS)	VOLUME (AF)	PEAK FLOW (CFS)	VOLUME (AF)	PEAK FLOW	VOLUME
2 YR	0.03	0.016	0.01	0.008	66.7%	50.0%
10 YR	0.38	0.083	0.19	0.043	50.0%	48.2%
100 YR (NRCC)	2.09	0.304	1.07	0.156	48.8%	48.7%

3.0 COMPLIANCE WITH MADEP STORMWATER STANDARDS

The Massachusetts Stormwater Standards were revised in February 2008 to include ten stormwater management standards, established jointly by the DEP and the Office of Coastal Zone Management, and published in the 2008 update of the Stormwater Management Handbook. Projects that are within the jurisdiction of the Wetlands Protection Act Regulations, 310 CMR 10.00 are subjected to these Stormwater Management Standards. For this project, adherence to the Handbook is required as the project is within the jurisdiction of the Wetlands Protection Act. Therefore, the stormwater management system was designed in accordance with the MASWS.

The following is a list of Stormwater Management Standards and accompanying documentation describing compliance of the proposed retrofit project with each 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.

No new untreated stormwater will discharge to wetland areas. The proposed GSI practices have been sized to meet the water quality volume (WQV). Stormwater runoff will flow through the GSI practices before being infiltrated or reaching the study point. Infiltration chambers and infiltration basins have been designed to ensure that post-development peak flow rates for the 2-, 10- and 100-Year storm events match predevelopment rates for Study Point 1 at the perimeter of the wetland at Flax Pond and Study Point 2 at the existing Littleton Drive.

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

Discharge rates for pre and post-development were calculated using HydroCAD® v10.10-6a, and SCS-TR20 based stormwater modeling computer program (**Appendix D**). Post-development peak discharge rates are less than pre-development rates for the 2-, 10-, and 100-year storms. A summary table of these precipitation events is provided in Table 5. Updated NOAA+ rainfall values from NOAA Atlas 14 were utilized for this analysis.

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

Under the proposed design, the stormwater runoff is being directed to surface infiltrating bioretention, underground recharge chambers, and surface infiltration basins. The intent is to recharge groundwater to the maximum extent practicable as required by Standard 3. Recharge calculations are provided in **Appendix E**. The site is characterized with a high infiltration rate (greater than 2.4 in/hr.), so at least 44% of the total suspended solids must be removed prior to discharge to the infiltration structure. The required TSS pretreatment will be done through bioretention practices. TSS calculations are provided in **Appendix E**. Storms equal to or great than the 10-year storm are being infiltrated into soils with a separation distance to the seasonal high groundwater elevation of less than four feet, so a groundwater mounding analysis is provided in **Appendix G**.

4. Stormwater management systems shall be designed to remove 80% of the average annual post-construction load of Total Suspended Solids (TSS). This Standard is met when:

- **Suitable practices for source control and pollution prevention are identified in a long-term pollution prevention plan, and thereafter are implemented and maintained;**
- **Structural stormwater best management practices are sized to capture the required water quality volume determined in accordance with the Massachusetts Stormwater Handbook; and**
- **Pretreatment is provided in accordance with the Massachusetts Stormwater Handbook.**

The stormwater management practices are sized to capture the require water quality volume (**Appendix C**).

The stormwater management pretreatment and treatment systems for the sites have been selected and sized for the most removal of the average annual load of TSS possible. The following removal rates were taken MA Stormwater Handbook:

Bioretention (with sediment forebay): Recommended design rate: 90%

TSS calculations are provided in **Appendix E.** Source controls and pollution prevention will be controlled by the methods outlined in **Sections 5.0 and 7.0**. The proposed Operation and Maintenance Plan was developed to ensure that the stormwater system continues to function as it was designed into the future (**Appendix F**).

5. For land uses with higher potential pollutant loads, source control and pollution prevention shall be implemented in accordance with the Massachusetts Stormwater Handbook to eliminate or reduce the discharge of stormwater runoff from such land uses to the maximum extent practicable. If through source control and/or pollution prevention all land uses with higher potential pollutant loads cannot be completely protected from exposure to rain, snow, snow melt, and stormwater runoff, the proponent shall use the specific structural stormwater SCMs determined by the Department to be suitable for such uses as provided in the Massachusetts Stormwater Handbook. Stormwater discharges from land uses with higher potential pollutant loads shall also comply with the requirements of the Massachusetts Clean Waters Act, M.G.L. c. 21, §§ 26-53 and the regulations promulgated thereunder at 314 CMR 3.00, 314 CMR 4.00 and 314 CMR 5.00.

The site is not considered a LUHPPL; thus, this standard is not applicable.

6. Stormwater discharges within the Zone II or Interim Wellhead Protection Area of a public water supply, and stormwater discharges near or to any other critical area, require the use of the specific source control and pollution prevention measures and the specific structural stormwater best management practices determined by the Department to be suitable for managing discharges to such areas, as provided in the Massachusetts Stormwater Handbook. A discharge is near a critical area if there is a strong likelihood of a significant impact occurring to said area, taking into account site-specific factors. Stormwater discharges to Outstanding Resource Waters and Special Resource Waters shall be removed and set back from the receiving water or wetland and receive the highest and best practical method of treatment. A "storm water discharge" as defined in 314 CMR 3.04(2)(a)1 or (b) to an Outstanding Resource Water or Special Resource Water shall comply with 314 CMR 3.00 and 314 CMR 4.00. Stormwater discharges to a Zone I or Zone A are prohibited unless essential to the operation of a public water supply.

The project site is not located within a Zone II but is considered a Nitrogen Sensitive Area

The project proposed to use stormwater pretreatment, treatment, and infiltration SCMs identified in Standard 6 for discharges within sensitive areas. Infiltrated stormwater likely drains to both the Wareham River and Marks Cove, both of which have been identified a nitrogen sensitive in the 2014 Massachusetts Estuary Project "Report for the Linked Watershed-Embayment Model to Determine Critical Nitrogen Loading Thresholds for the Wareham River, Broad Marsh and

Mark's Cove Embayment System, Wareham, Massachusetts." Sediment forebays with filtering bioretention areas are approved treatment SCMs with 44% TSS reduction prior to infiltration occurring, and subsurface structures, and infiltration basins are approved infiltration SCMs. All are appropriate to maximize nitrogen removal.

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

This project is not a redevelopment project, therefore, Standard 7 does not apply.

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

An Erosion and Sediment Control Plan is included in construction documents, and a Pollutant Prevention Plan is included in this Report. Silt fence and/or silt socks are proposed at the limit of work; silt socks are proposed along the downgradient edges of the area of disturbance. Disturbed areas will be stabilized with seeding and mulching, as soon as possible to minimize erosion and sedimentation. Additional pollutant controls during construction are described in **Section 5.0** and on the plans. A Stormwater Pollution Plan (SWPPP) is required as part of the NPDES Construction General Permit and will be submitted prior to construction.

The contractor will be required to establish erosion controls prior to beginning any other project-related work. The Erosion and Sediment Control Plan will also establish the limit of work, beyond which the contractor will not be allowed to perform any project work. It is the contractor's responsibility to monitor and correct erosion control practices throughout the duration of the project. Erosion control measures will not be removed until the project reaches completion as directed by the project engineer or landscape architect.

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

The long-term stormwater operation and maintenance plan for each stormwater best management practice is discussed in **Section 6.0** and provided with this report in **Appendix F**.

10. All illicit discharges to the stormwater management system are prohibited.

There will be no illicit discharges to the stormwater management system. The Long-Term Pollution Prevention Plan provided includes measures to prevent illicit discharges.

4.0 CONSTRUCTION ACTIVITIES AND GENERAL CONSTRUCTION SEQUENCE

Construction activities will involve site preparation and earthwork necessary for construction of the proposed project. These activities primarily include the following:

- Erosion control installation
- Clearing and grubbing of existing vegetation within the proposed limits of work
- Excavation stockpiling, and hauling of excavated foundation, topsoil and subsoils
- Rough grading of all disturbed areas
- Construction of stormwater management system
- Construction of new housing units,
- Installation of utilities
- Paving
- Finish grading, final site stabilization and landscaping

Erosion and sediment control (ESC) measures will be installed per the construction plans and specifications prior to commencement of any soil disturbing activities. ESC measures will remain in place until final site stabilization is complete. Topsoil will be separated from the remaining soil and stockpiled on-site for use during site finish grading. The stockpiled topsoil will be protected to prevent erosion and sedimentation.

5.0 POLLUTANT CONTROLS DURING CONSTRUCTION

Controls will be used to reduce erosion during the construction period. Perimeter controls and sediment settling devices will be installed during construction to minimize sediment movement in stormwater and to protect the adjacent properties and buffers on the property.

5.1. Structural Practices

The following are the structural practices that will be implemented as part of the construction activity.

- Silt Fence & Sediment Silt Sock Barrier will be installed prior to commencement of construction. This type of practice creates erosion control barriers to intercept sediment in diffuse runoff. The Town will be informed upon installation so that they may inspect these barriers prior to construction. Portions of the erosion control barriers will be replaced and/or repaired as necessary to prevent erosion. Barriers will be installed parallel to land slope at the perimeter of the work site. In addition, silt fence barriers will be installed around the bioretention areas during construction.

- Silt Sacks (or approved equivalent) will be installed at identified existing catch basins and structure following construction of the proposed catch basins to prevent sedimentation during the any additional construction. The Silt Sack will be replaced and disposed of off-site if damage is observed.

- Bioretention Area(s) will be graded to within one foot of design elevations until site is fully stabilized to capture sediment during construction. Heavy equipment will not be allowed to operate on the surface location where the systems are planned because soil compaction would adversely impact their long-term performance. Silt fence will be utilized around the perimeter of the bioretention systems during construction, if upgradient drainage is not stabilized before being brought on-line. Light earth-moving equipment will be used for excavation and construction of the systems. All excavated materials from the area will be removed and disposed of in an approved location. All bioretention areas will be inspected at least once every seven calendar days and immediately after storm events by the Site Superintendent.

- Slope Stabilization will be installed immediately upon obtaining final grades as shown on the project site plans. Areas that fail to stabilize will be re-graded to final grade and stabilized as necessary. Amount of land disturbed will be minimized to reduce potential for erosion and sedimentation. Stabilization measures shall be initiated within 14 days following the end of construction at each portion of the site and as soon as practicable.

The entire stormwater management systems including overflow spillways and sediment forebays will be inspected upon completion of construction. Sediment will be removed from all elements of the stormwater management system. All control measures must be installed and maintained in accordance with manufacturer's specifications, good engineering practices, and in accordance with this Plan (every seven calendar days and after storm events). If inspections show that a control has failed or been installed incorrectly, the Operator must replace or modify it within 24 hours.

Structural controls will be regularly inspected to ensure proper performance. The following operation and maintenance provisions will be provided:

- Silt fences will be inspected for depth of sediment, tears, to determine if the fabric is securely attached to the fence posts, and to determine if the fence posts are firmly in the ground. Silt fence will be replaced when necessary.

- Silt Socks shall be inspected for depth of sediment and any breaches will promptly be repaired or replaced when necessary.

- Sediment shall be removed where accumulation reaches one-third the above ground height of any barrier.

- Once each workday structural control measures receiving flows from areas that have not been stabilized shall be inspected.

- Remedial action shall be taken in areas where temporary and permanent seeding is deemed inefficient through weekly inspections to establish a stabilized surface.

- All SCMs will be cleared of accumulated foreign debris, including leaves and lawn cuttings.
- All SCMs will be inspected for slope integrity and erosion.
- All control measures will be inspected at least once every 7-calendar days and within 24 hours after storm events of 0.5 inches or more.
- All measures will be maintained in good working order, if a repair is necessary, it will be initiated within 24 hours of discovery.

5.2. Stabilization Practices

The amount of land disturbed during construction will be minimized to reduce the potential for erosion and sedimentation. Prompt surface stabilization will be practiced to control erosion in areas where disturbances cannot be avoided during construction. Stabilization measures shall be initiated within 14 days following the end of construction at each portion of the site. Exceptions to this requirement are allowable when snow cover prevents the initiation of stabilization within 14 days, in which case such measures shall be undertaken as soon as possible.

Stabilization measures that may be used during construction are described below:

- Temporary Seeding – Temporary seeding of disturbed surfaces with fast-growing grasses (annual rye) to provide greater resistance to stormwater runoff and/or wind erosion for areas where construction has temporarily ceased.
- Permanent Seeding – Permanent seeding of surfaces with vegetation, including but not limited to grass, trees, bushes, and shrubs, to stabilize the soil. Establishing a permanent and sustainable ground cover at a site stabilizes the soil while reducing the sediment content in runoff.
- Permanent Planting – the contractor shall install and adequately establish all planting as required at the completion of the project.
- Mulching/Hydro mulching – hydro mulch will be placed on the soil surface to cover and hold in place disturbed soils.

Temporary seeding or other soil stabilization measures will be provided where construction activities have ceased at the site. Topsoil stockpiles will be temporarily seeded or covered to prevent erosion and will be surrounded with silt fence. When the site's final grade has been established, permanent vegetation will be planted on the disturbed areas. The vegetation will consist of grass, shrubs, bushes, and trees.

5.3. Other Types of Controls

Additional controls/practices will be undertaken to reduce pollution in stormwater runoff flows which include, but are not limited to, control of off-site mud tracking from construction site, dust suppression, proper sanitary waste disposal, earthwork procedures timed and conducted in manners aimed to minimize erosion and sedimentation, snow removal plans, proper management of waste materials, proper management of hazardous waste, proper material stockpiling, and spill prevention and control measures.

- Dust Suppression – Water sprays shall be used to control dust during extended dry periods during construction.

- Sanitary Wastes – All sanitary wastes will be collected from the portable units by a licensed sanitary waste management contractor (as required by local regulations).

- Earthwork – The exposure of disturbed surfaces to stormwater and potential stormwater erosion will be minimized by well-organized earthwork procedures. Stabilization procedures shall be undertaken in accordance with this report. Grubbing during wet seasons will be avoided if feasible.

- Snow Removal Plan – Plowed snow collected from the parking areas will be deposited onto free draining, pervious surfaces, away from the site's drainage conveyance structures to maximize infiltration. Snowmelt runoff that is not infiltrated will be directed to the site's stormwater management system. Snow is not to be plowed or piled onto the stormwater management facility or wetlands.

- Waste Materials – Dumpsters rented from a licensed solid waste management company will be used to store solid waste and debris that cannot be recycled, reused or salvaged. The dumpsters will meet all local and state solid waste management regulations. Dumpsters will be covered when refuse is not being directly deposited or withdrawn from them. Potentially hazardous wastes will be separated from normal wastes, including segregation of storage areas and proper labeling of containers. Removal of all waste from the site will be performed by licensed contractors in accordance with applicable regulatory requirements and disposed of at either local or regional approved facilities. Waste materials will not be buried on-site. All site personnel will be instructed regarding the correct procedures for waste disposal. Notices stating these procedures will be posted at the site. Solvents and flushing materials used during construction and pre-operational cleaning will be provided, handled, managed, and removed by the contractor for appropriate off-site disposal.

- Hazardous Waste Materials – Any disposal of hazardous materials will be completed using the required paperwork. Copies will be provided to the Engineer and to the Town.

- Spill Prevention and Control Measures – To minimize the risk of spills or other accidental exposure of materials and substances to stormwater runoff, the following material management practices will be used throughout the project:

    - An effort will be made to store only enough products required to do the job.
    - All materials stored on-site will be stored in a neat, orderly manner in their appropriate containers and, if possible, under a roof or other enclosure.

- Products will be kept in their original containers with the original manufacturer's label.
- Substances will not be mixed with one another unless recommended by the manufacturer.
- Whenever possible, the maximum amount of a product will be used before disposing of the container.
- Manufacturers' recommendations for proper use and disposal will be followed.
- The site superintendent will conduct daily inspections to ensure proper use and disposal of materials.

To reduce the risk associated with hazardous materials used on the site, the following practices will be used:

- Products will be kept in original containers unless they are not resealable.
- Original labels and material safety data sheets will be retained and kept on-site; they contain important product information.
- If surplus product must be disposed of, manufacturers' or local and state recommended methods for proper disposal will be followed.

- Materials List - Materials or substances listed below are expected to be present on-site during construction:

- Concrete	- Fertilizers
- Asphalt	- Petroleum Based Products
- Paints (enamel and latex)	- Cleaning Solvents
- Metal Studs	- Wood
- Concrete	- Tar
- Sealants	- Adhesives

The following product-specific practices will be followed on-site:

- Petroleum Products - All on-site vehicles will be monitored for leaks and receive preventative maintenance to reduce the chance of leakage. Petroleum products will be stored in tightly sealed containers which area clearly labeled. Any asphalt substances used on-site will be applied according to the manufacturers' recommendations.

- Fertilizers – Fertilizers used will be applied only in the minimum amounts recommended by the manufacturer. Once applied, fertilizer will be worked into the soil to limit exposure to stormwater. Products will be stored in a covered shed. The contents of any partially used bags of fertilizer will be transferred to a sealable plastic bin to avoid spills.

- Paints – All containers will be tightly sealed and stored indoors when not required for use. Excess paint will not be discharged to the storm sewer system but will be properly disposed of according to the manufacturers' instructions or state and local regulations.

- Concrete Trucks – Concrete trucks will not be allowed to wash out or discharge surplus concrete or drum wash water on the site.

In addition to the good housekeeping and material management practices discussed in the previous sections of this plan, the following practices will be followed for spill prevention and cleanup:

- Manufacturers' recommended methods for spill cleanup will be clearly posted, and site personnel will be made aware of the procedures and location of the information and cleanup supplies.

- Materials and equipment necessary for spill cleanup will be kept in the material storage area on-site. Equipment and materials will include, but not be limited to, brooms, dustpans, mops, rags, gloves, goggles, speedi-dry, sand, sawdust, and plastic and metal trash containers specifically for this purpose.

- All spills will be cleaned up immediately after discovery. Spills large enough to reach the storm water system will be reported to the National Response Center at 1-800-424-8802.

- The spill area will be kept well ventilated and personnel will wear appropriate protective clothing to prevent injury from contact with a hazardous substance.

- Spills of toxic or hazardous material will be reported to the appropriate state or local government agency, regardless of the size.

- The site superintendent responsible for the day-to-day site operations will be the spill prevention and clean-up coordinator. He will designate at least three other site personnel who will receive spill prevention and cleanup training. These individuals will each become responsible for a particular phase of prevention and cleanup. The names of responsible spill personnel will be posted in the material storage area and in the on-site office trailer.

6.0 STORMWATER OPERATION AND MAINTENANCE PLAN

All stormwater management measures and controls identified in this report shall be operated and maintained appropriately during the construction phase of the project and during regular operation of the site in the post-construction period as required on the construction drawings and the separate Stormwater Management Maintenance Plan (**Appendix F**).

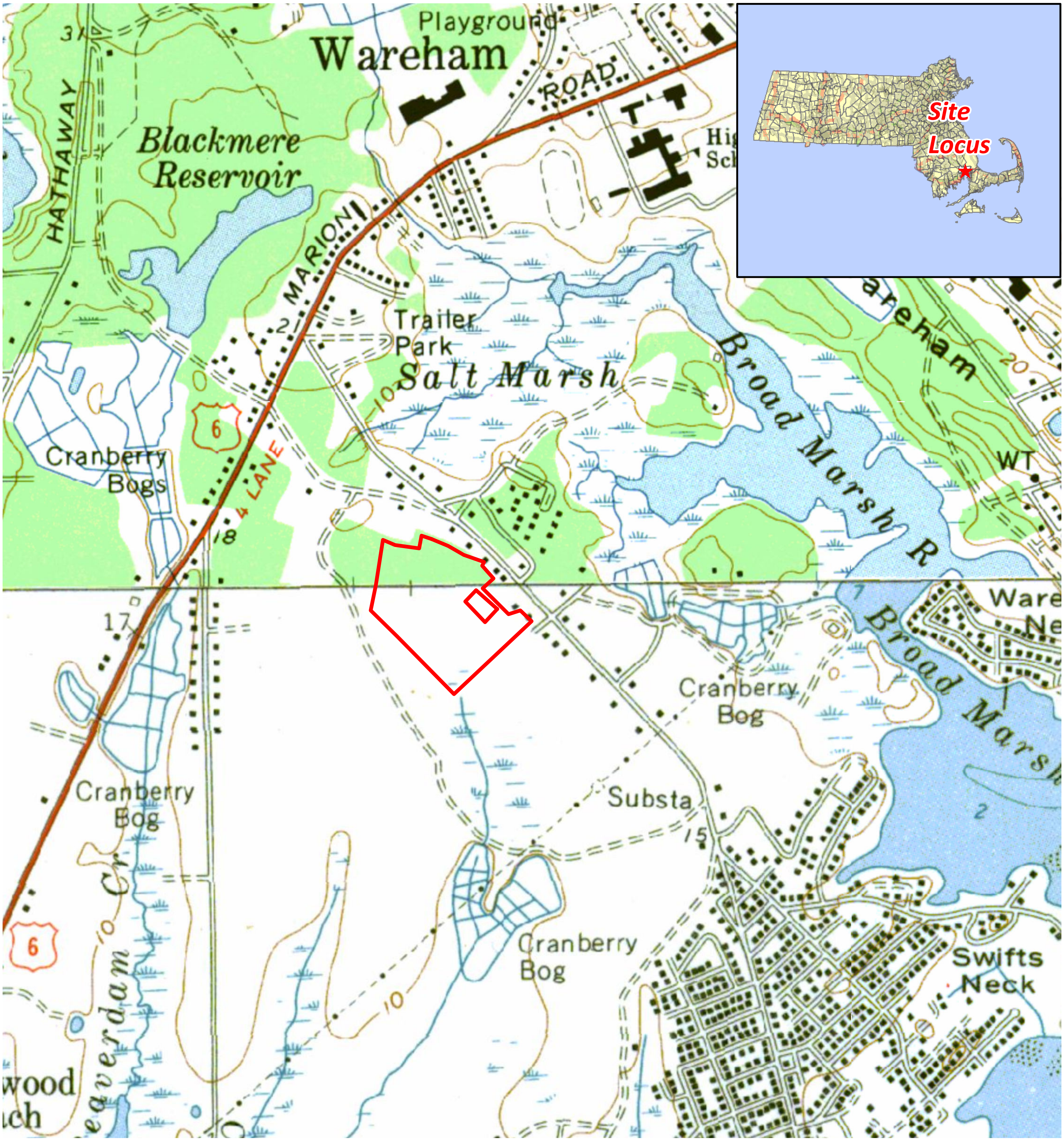
7.0 REFERENCES

1. MADEP (Massachusetts Department of Environmental Protection). 2008. Massachusetts Stormwater Standards Manual.

2. NOAA's National Weather Service: Hydrometeorological Design Studies Center, Precipitation Frequency Data Server for Atlas 14 Point Precipitation Frequency Estimates: MA https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=ma

3. Northeast Regional Climate Center and Natural Resources Conservation Service. 2010-2018. Extreme Precipitation for New York and New England. Version 1.12. http://precip.eas.cornell.edu/

FIGURES



Document Path: H:\Projects\2020\20107 Littleton Drive Wareham\GIS\Maps\NOI\USGS_Locus.mxd

*Wareham/Onset USGS Topographic Quadrangles

Legend

Subject Property

N

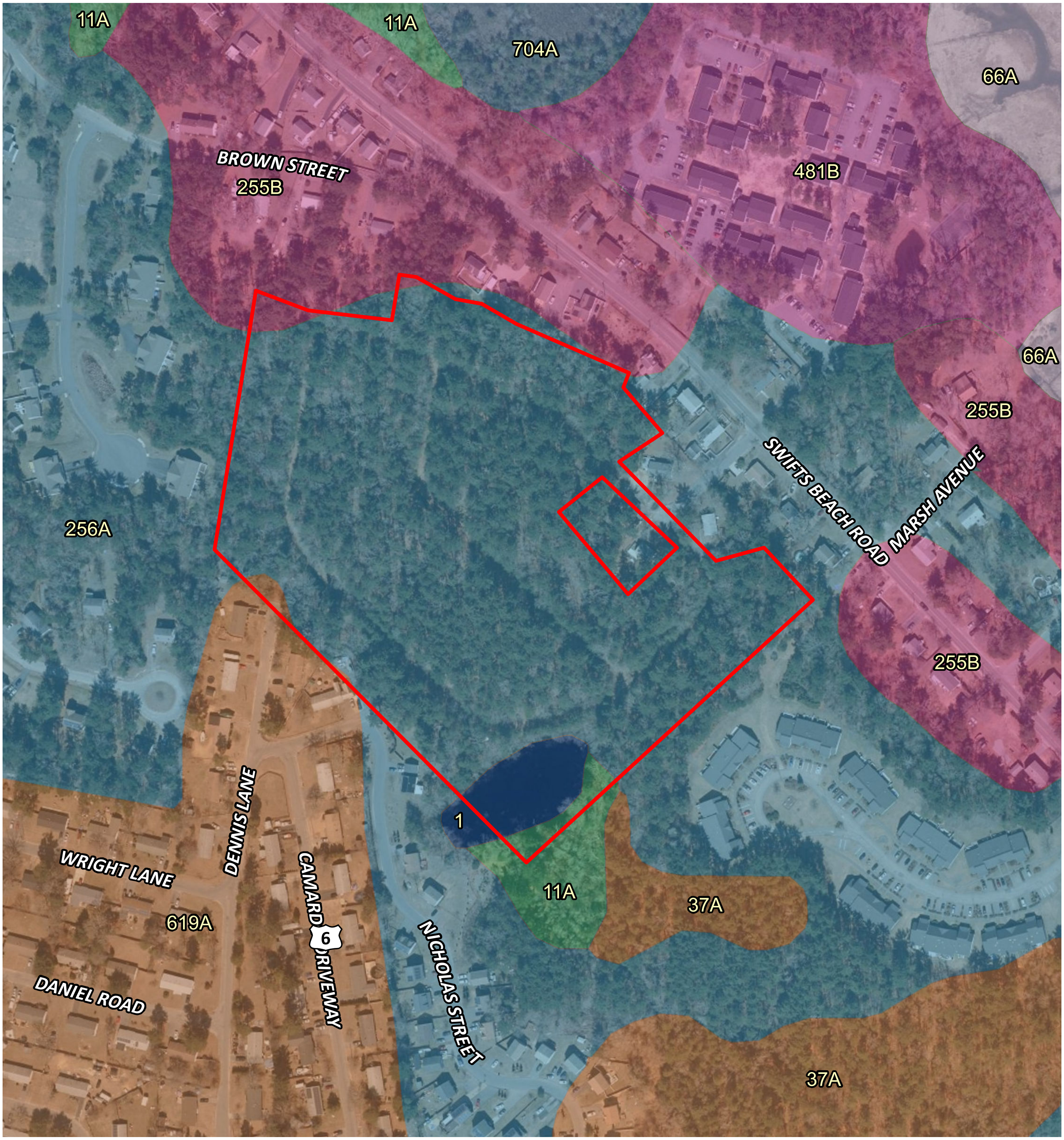
0 1,000 Feet

Horsley Witten Group
Sustainable Environmental Solutions
90 Route 6A • Unit 1 • Sandwich, MA 02563
508-833-6600 • horsleywitten.com

USGS Locus
Undeveloped Land
4 Littleton Drive
Wareham, MA

Date: 12/16/2020

Figure 1



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Basemap: Massachusetts 2019 USGS Color Ortho Imagery

Legend

- Subject Property
- 1, Water
- 256A, Deerfield, B
- 11A, Rainberry, D
- 255B, Windsor, A
- 37A, Mashpee, D
- 481B, Carver, A
- 619A, Urban land
- 704A, Freetown, D

N

0 200 Feet

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Sustainable Environmental Solutions
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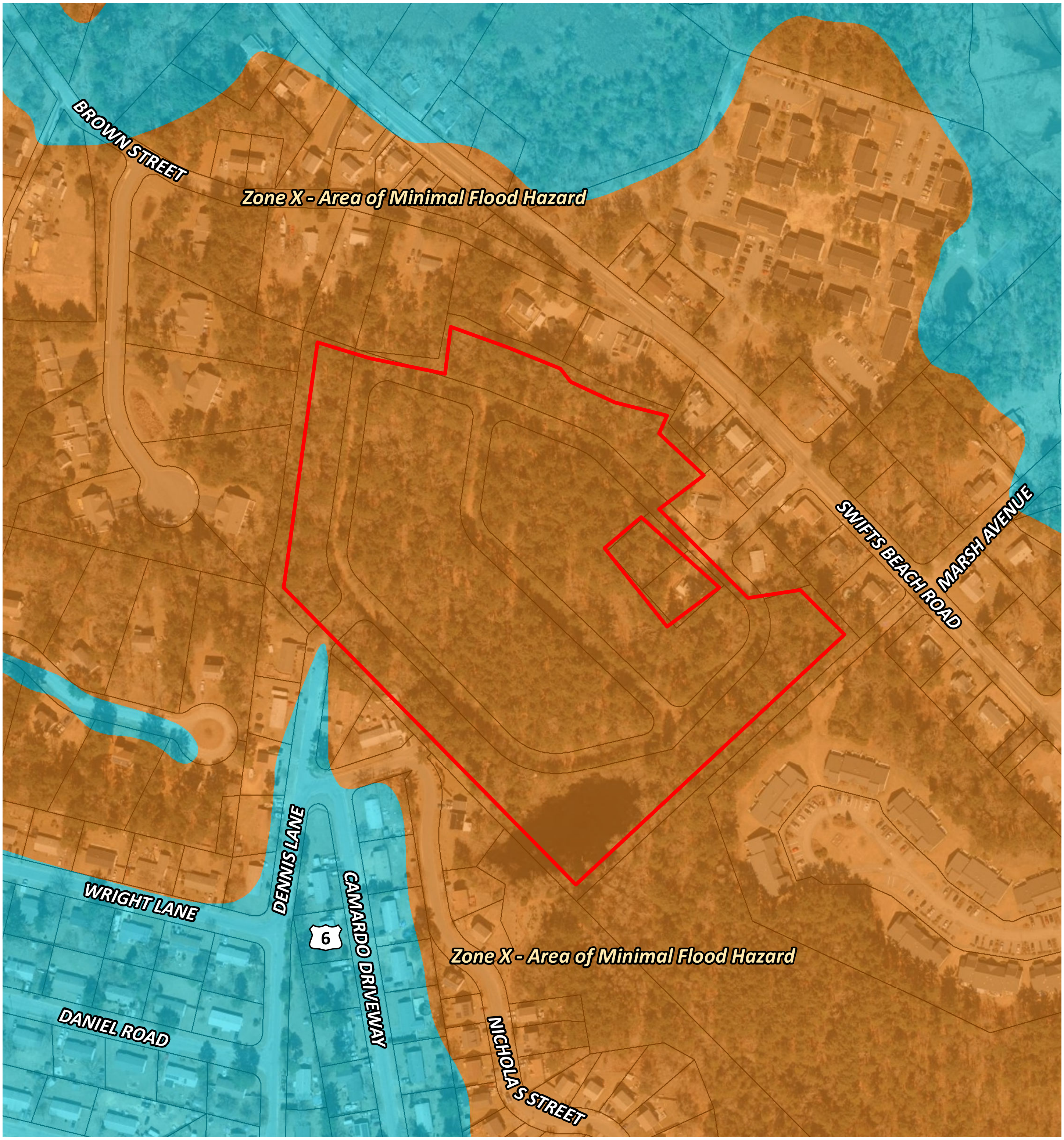
508-833-6600 • horsleywitten.com

NRCS Soils Map
Undeveloped Land
4 Littleton Drive
Wareham, MA

Date: 12/16/2020

Figure 2



Document Path: H:\Projects\2020\20107 Littleton Drive Wareham\GIS\Maps\NOI\FEMA.mxd

Legend

*2016 NAIP imagery service

Subject Property

Parcels

FEMA Flood Hazard

AE: 1% Annual Chance of Flooding, with BFE

X: 0.2% Annual Chance of Flooding

N

0 200 Feet

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Sustainable Environmental Solutions
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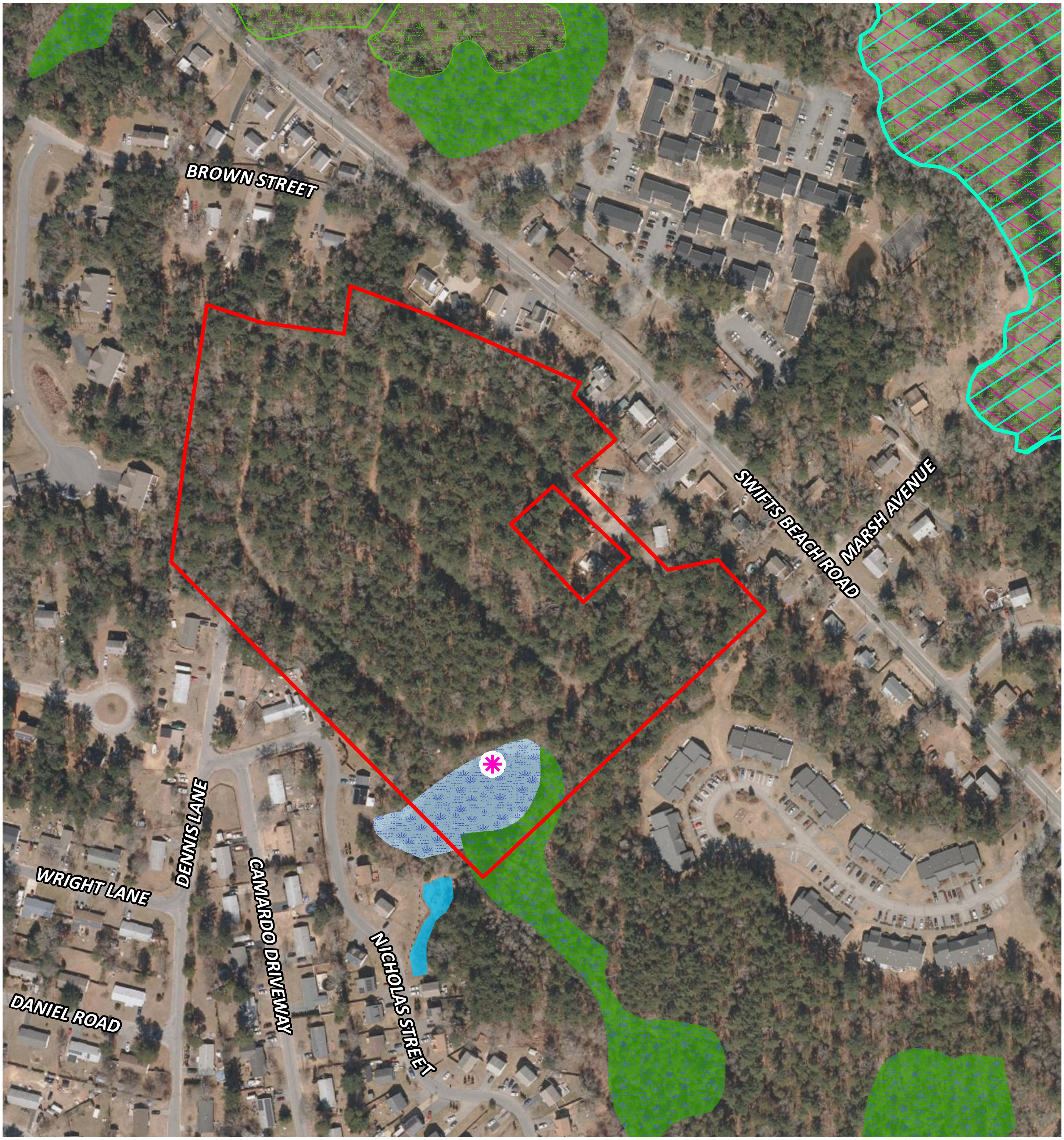
FEMA's National Flood Hazard Layer
Undeveloped Land
4 Littleton Drive
Wareham, MA

Date: 12/16/2020 Figure 3



Document Path: H:\Projects\2020\20107 Littleton Drive Wareham\GIS\Maps\NOI\Existing_Constraints.mxd

Basemap: Massachusetts 2019 USGS Color Ortho Imagery

Legend

- Subject Property
- Potential Vernal Pools

Natural Heritage Atlas (14th Ed.)

- NHESP Priority Habitats of Rare Species
- NHESP Estimated Habitats of Rare Wildlife

MassDEP Wetlands (2005)

- Marsh/Bog
- Wooded marsh
- Salt Marsh
- Open Water

N

0 200 Feet

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Existing Constraints
Undeveloped Land
4 Littleton Drive
Wareham, MA

Date: 12/16/2020

Figure 4

APPENDIX A

Site Soil Evaluations

NRCS Soils Report

Geotechnical Ex. Plan and Boring Logs

Commonwealth of Massachusetts

City/Town of Wareham

Soil Suitability Assessment

On-Site Review

Deep Observation Hole Number: 1 (Hole #) | 12/18/2020 (Date) | 8:00 am- 3:00 pm (Time) | 38F, Cloudy (Weather) | ______ (Latitude) | ______ (Longitude)

1. Land Use: Woods (e.g. woodland, agricultural field, vacant lot, etc.) | low brush/woods (Vegetation) | None (Surface Stones (e.g. cobbles, stones, boulders, etc.)) | 0-3% (Slope (%))

Description of Location: see site plan

2. Soil Parent Material: Outwash | Outwash plain (Landform) | ______ (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances From: Open Water Body >100' feet | Drainage Way >100' feet | Wetlands >100' feet

Property Line >100' feet | Drinking Water Well NA feet | Other ______ feet

4. Unsuitable Materials Present: ☐ Yes ☑ No If Yes: ☐ Disturbed Soil ☐ Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☑ Yes ☐ No If Yes: ______ Depth weeping from pit 90" Depth standing water in hole

Soil Log

Depth (in)	Soil Horizon/ Layer	Soil Texture (USDA)	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles/Stones			
5-0	O			-	-	-	-	-			
0-9	Ap	LS	10 YR 4/1	-	-	-	<1	<1	M	L	
9-33	Bw	LS	10 YR 6/6	-	-	-	<1	<1	M	L	
33-96	C	FMS	10 YR 7/3	64"	7.5 YR 6/8 10 YR 8/2	25%	<1	<1	M	Fr	

Additional Notes:

Commonwealth of Massachusetts

City/Town of Wareham

Soil Suitability Assessment

On-Site Review

Deep Observation Hole Number: 2 (Hole #) 12/18/2020 (Date) 8:00 am- 3:00 pm (Time) 38F, Cloudy (Weather) ______ (Latitude) ______ (Longitude)

1. Land Use: Woods (e.g. woodland, agricultural field, vacant lot, etc.) low brush/woods (Vegetation) None (Surface Stones (e.g. cobbles, stones, boulders, etc.)) 0-3% (Slope (%))

Description of Location: see site plan

2. Soil Parent Material: Outwash Outwash plain (Landform) ______ (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances From: Open Water Body >100' feet Drainage Way >100' feet Wetlands >100' feet
Property Line >100' feet Drinking Water Well NA feet Other ______ feet

4. Unsuitable Materials Present: ☐ Yes ☑ No If Yes: ☐ Disturbed Soil ☐ Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☑ Yes ☐ No If Yes: 91" Depth weeping from pit ______ Depth standing water in hole

Soil Log

Depth (in)	Soil Horizon/ Layer	Soil Texture (USDA)	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles/Stones			
3-0	O			-	-	-	-	-			
0-2	A	LS	10 YR 5/1	-	-	-	<1	<1	M	L	
2-4	Bw_1	LS	10 YR 3/3	-	-	-	<1	<1	M	L	
4-24	Bw_2	LS	10 YR 7/6				<1	<1	M	L	
24-100	C	FS	10 YR 7/3	48"	5 YR 5/8 5 YR 7/1	25%	<1	<1	M	Fr	

Additional Notes:

Commonwealth of Massachusetts

City/Town of Wareham

Soil Suitability Assessment

On-Site Review

Deep Observation Hole Number: 3 (Hole #) | 12/18/2020 (Date) | 8:00 am- 3:00 pm (Time) | 38F, Cloudy (Weather) | ______ (Latitude) | ______ (Longitude)

1. Land Use: Woods (e.g. woodland, agricultural field, vacant lot, etc.) | low brush/woods (Vegetation) | None (Surface Stones (e.g. cobbles, stones, boulders, etc.)) | 0-3% (Slope (%))

Description of Location: see site plan

2. Soil Parent Material: Outwash | Outwash plain (Landform) | ______ (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances From: Open Water Body >100' feet | Drainage Way >100' feet | Wetlands >100' feet
Property Line >100' feet | Drinking Water Well NA feet | Other ______ feet

4. Unsuitable Materials Present: ☐ Yes ☑ No If Yes: ☐ Disturbed Soil ☐ Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☐ Yes ☑ No If Yes: NA Depth weeping from pit NA Depth standing water in hole

Soil Log

Depth (in)	Soil Horizon/ Layer	Soil Texture (USDA)	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles/Stones			
4-0	O			-	-	-	-	-			
0-2	A	LS	10 YR 4/1	-	-	-	<1	<1	M	L	
2-4	E	LS	10 YR 5/1	-	-	-	<1	<1	M	L	
4-24	Bw	LS	10 YR 6/6	-	-	-	<1	<1	M	L	
24-32	C_1	CS	10 YR 6/6	-	-	-	5	<1	M	L	
32-126	C_2	FS	10 YR 7/4	-	-	-	<1	<1	M	Fr	

Additional Notes:

Commonwealth of Massachusetts

City/Town of Wareham

Soil Suitability Assessment

On-Site Review

Deep Observation Hole Number: 4 (Hole #) | 12/18/2020 (Date) | 8:00 am- 3:00 pm (Time) | 38F, Cloudy (Weather) | ______ (Latitude) | ______ (Longitude)

1. Land Use: Woods (e.g. woodland, agricultural field, vacant lot, etc.) | low brush/woods (Vegetation) | None (Surface Stones (e.g. cobbles, stones, boulders, etc.)) | 0-3% (Slope (%))

Description of Location: see site plan

2. Soil Parent Material: Outwash | Outwash plain (Landform) | ______ (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances From: Open Water Body >100' feet | Drainage Way >100' feet | Wetlands >100' feet

Property Line >100' feet | Drinking Water Well NA feet | Other ______ feet

4. Unsuitable Materials Present: ☐ Yes ☑ No If Yes: ☐ Disturbed Soil ☐ Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☐ Yes ☑ No If Yes: NA Depth weeping from pit NA Depth standing water in hole

Soil Log

Depth (in)	Soil Horizon/ Layer	Soil Texture (USDA)	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles/Stones			
5-0	O			-	-	-	-	-			
0-2	A	LS	10 YR 3/1	-	-	-	<1	<1	M	L	
2-4	E	LS	10 YR 7/1	-	-	-	<1	<1	M	L	
4-6	Bw_1	LS	10 YR 3/4	-	-	-	<1	<1	M	L	
6-18	Bw_2	LS	10 YR 6/8	-	-	-	<1	<1	M	L	
18-24	C_1	CS	10 YR 6/8	-	-	-	15	<1	M	L	
24-108	C_2	FS	10 YR 7/4	-	-	-	<1	<1	M	Fr	

Additional Notes:

Commonwealth of Massachusetts

City/Town of Wareham

Soil Suitability Assessment

On-Site Review

Deep Observation Hole Number: 5 (Hole #) | 12/18/2020 (Date) | 8:00 am- 3:00 pm (Time) | 38F, Cloudy (Weather) | ____ (Latitude) | ____ (Longitude)

1. Land Use: Woods (e.g. woodland, agricultural field, vacant lot, etc.) | low brush/woods (Vegetation) | None (Surface Stones (e.g. cobbles, stones, boulders, etc.)) | 0-3% (Slope (%))

Description of Location: see site plan

2. Soil Parent Material: Outwash | Outwash plain (Landform) | ____ (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances From: Open Water Body >100' feet | Drainage Way >100' feet | Wetlands >100' feet

Property Line >100' feet | Drinking Water Well NA feet | Other ____ feet

4. Unsuitable Materials Present: ☐ Yes ☑ No If Yes: ☐ Disturbed Soil ☐ Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☐ Yes ☑ No If Yes: NA Depth weeping from pit 84" Depth standing water in hole

Soil Log

Depth (in)	Soil Horizon/ Layer	Soil Texture (USDA)	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles/Stones			
3-0	O			-	-	-	-	-			
0-3	A	LS	10 YR 3/1	-	-	-	<1	<1	M	L	
3-5	E	LS	10 YR 7/1	-	-	-	<1	<1	M	L	
5-9	Bw_1	LS	10 YR 5/6	-	-	-	<1	<1	M	L	
9-21	Bw_2	LS	10 YR 6/6	-	-	-	<1	<1	M	L	
21-30	C_1	CS	10 YR 6/6	-	-	-	10	<1	M	L	
30-90	C_2	FS	10 YR 7/2	60"	10 YR 7/8 10 YR 7/3	25%	<1	<1	M	Fr	

Additional Notes: ____

Commonwealth of Massachusetts

City/Town of Wareham

Soil Suitability Assessment

On-Site Review

Deep Observation Hole Number: 6 (Hole #) | 12/18/2020 (Date) | 8:00 am- 3:00 pm (Time) | 38F, Cloudy (Weather) | ______ (Latitude) | ______ (Longitude)

1. Land Use: Woods (e.g. woodland, agricultural field, vacant lot, etc.) | low brush/woods (Vegetation) | None (Surface Stones (e.g. cobbles, stones, boulders, etc.)) | 0-3% (Slope (%))

Description of Location: see site plan

2. Soil Parent Material: Outwash | Outwash plain (Landform) | ______ (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances From: Open Water Body >100' feet | Drainage Way >100' feet | Wetlands >100' feet

Property Line >100' feet | Drinking Water Well NA feet | Other ______ feet

4. Unsuitable Materials Present: ☐ Yes ☑ No If Yes: ☐ Disturbed Soil ☐ Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☐ Yes ☑ No If Yes: NA Depth weeping from pit 70" Depth standing water in hole

Soil Log

Depth (in)	Soil Horizon/ Layer	Soil Texture (USDA)	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles/Stones			
3-0	O			-	-	-	-	-			
0-3	A	LS	10 YR 3/1	-	-	-	<1	<1	M	L	
3-5	E	LS	10 YR 7/2	-	-	-	<1	<1	M	L	
5-9	Bw_1	LS	10 YR 4/4	-	-	-	<1	<1	M	L	
9-24	Bw_2	LS	10 YR 8/2	-	-	-	<1	<1	M	L	
24-41	C_1	CS	10 YR 7/4	-	-	-	10	<1	M	L	
41-96	C_2	FS	10 YR 8/3	48"	10 YR 7/8 10 YR 7/3	25%	<1	<1	M	Fr	

Additional Notes:

Horsley Witten Group, Inc.
Sustainable Environmental Solutions
www.horsleywitten.com

Double Ring Infiltrometer Test Results
Project: Littleton Drive Affordable Housing
Project No: 20107
Calculated By: JEH
Checked By: RAC

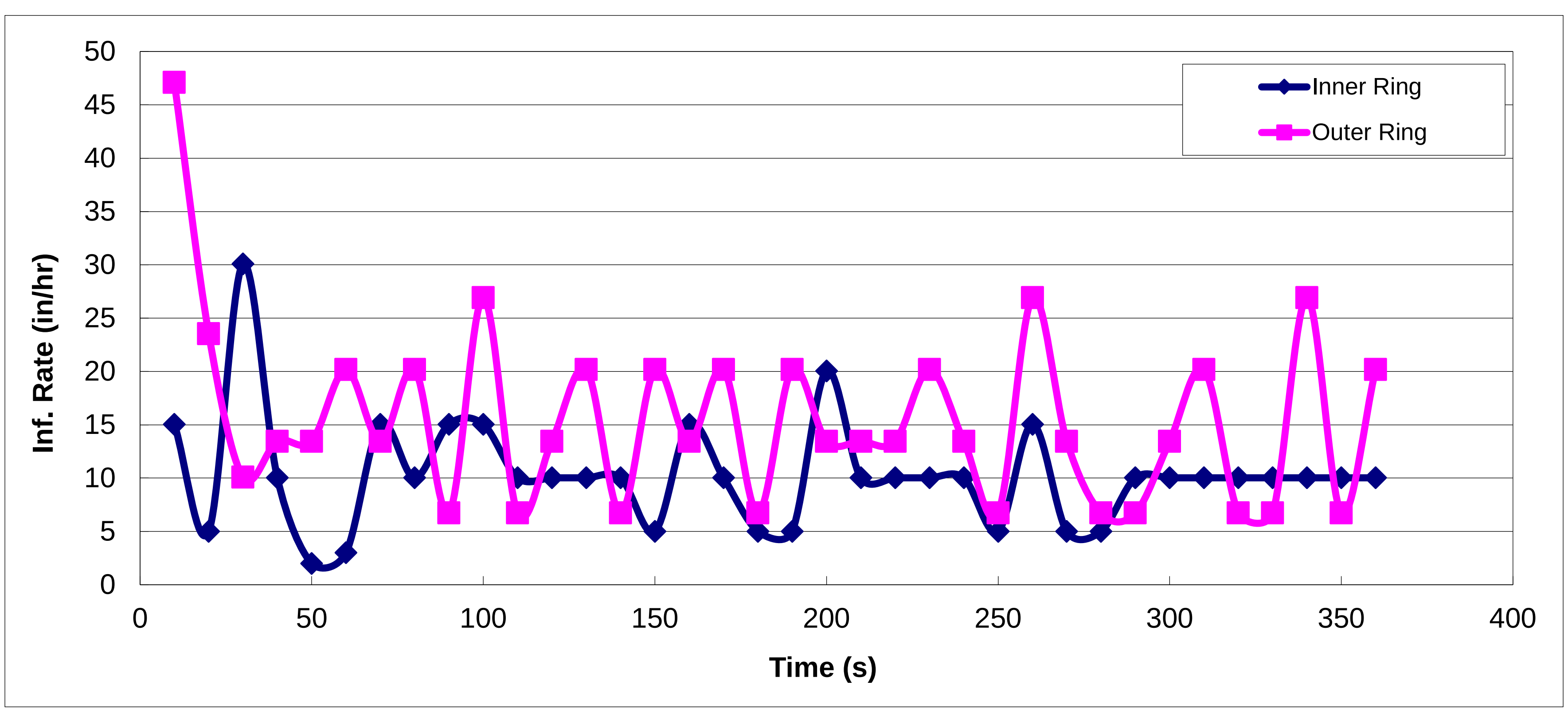
Location: TP-6
Date: 12/18/20
Time: 14:00
Depth of Test: 44"

	Depth of Water, H (in)		Ring Penetration Depth (in)	
	inner	outer	inner	outer
H_{init}	3	3	5	5
H_{final}	3	3		

Weather: Mostly sunny
Air (°F): 35 **H_2O (°F):** 40

Time (mm:ss)	Time (s)	Δ Time (s)	Inner Ring Level (cm3)	Inner Ring D Level (cm3)	Inner Ring IC (cm/s)	Inner Ring IC (cm/hr)	IC (in/hr)	Outer Ring Level (cm3)	Outer Ring D Level (cm3)	Outer Ring IR (cm/s)	Outer Ring IR (cm/hr)	IC (in/hr)
00:00	0	0		-	-	-	-	0	-	-	-	-
00:10	10	10	75	75	0.011	38	15	700	700	0.033	120	47
00:20	20	10	100	25	0.004	13	5	1050	350	0.017	60	24
00:30	30	10	250	150	0.021	76	30	1200	150	0.007	26	10
00:40	40	10	300	50	0.007	25	10	1400	200	0.009	34	13
00:50	50	10	310	10	0.001	5	2	1600	200	0.009	34	13
01:00	60	10	325	15	0.002	8	3	1900	300	0.014	51	20
01:10	70	10	400	75	0.011	38	15	2100	200	0.009	34	13
01:20	80	10	450	50	0.007	25	10	2400	300	0.014	51	20
01:30	90	10	525	75	0.011	38	15	2500	100	0.005	17	7
01:40	100	10	600	75	0.011	38	15	2900	400	0.019	68	27
01:50	110	10	650	50	0.007	25	10	3000	100	0.005	17	7
02:00	120	10	700	50	0.007	25	10	3200	200	0.009	34	13
02:10	130	10	750	50	0.007	25	10	3500	300	0.014	51	20
02:20	140	10	800	50	0.007	25	10	3600	100	0.005	17	7
02:30	150	10	825	25	0.004	13	5	3900	300	0.014	51	20
02:40	160	10	900	75	0.011	38	15	4100	200	0.009	34	13
02:50	170	10	950	50	0.007	25	10	4400	300	0.014	51	20
03:00	180	10	975	25	0.004	13	5	4500	100	0.005	17	7
03:10	190	10	1000	25	0.004	13	5	4800	300	0.014	51	20
03:30	200	10	1100	100	0.014	51	20	5000	200	0.009	34	13
03:40	210	10	1150	50	0.007	25	10	5200	200	0.009	34	13
03:50	220	10	1200	50	0.007	25	10	5400	200	0.009	34	13
04:00	230	10	1250	50	0.007	25	10	5700	300	0.014	51	20
04:10	240	10	1300	50	0.007	25	10	5900	200	0.009	34	13
04:20	250	10	1325	25	0.004	13	5	6000	100	0.005	17	7
04:30	260	10	1400	75	0.011	38	15	6400	400	0.019	68	27
04:40	270	10	1425	25	0.004	13	5	6600	200	0.009	34	13
04:50	280	10	1450	25	0.004	13	5	6700	100	0.005	17	7
05:00	290	10	1500	50	0.007	25	10	6800	100	0.005	17	7
05:10	300	10	1550	50	0.007	25	10	7000	200	0.009	34	13
05:20	310	10	1600	50	0.007	25	10	7300	300	0.014	51	20
05:30	320	10	1650	50	0.007	25	10	7400	100	0.005	17	7
05:40	330	10	1700	50	0.007	25	10	7500	100	0.005	17	7
05:50	340	10	1750	50	0.007	25	10	7900	400	0.019	68	27
06:00	350	10	1800	50	0.007	25	10	8000	100	0.005	17	7
06:10	360	10	1850	50	0.007	25	10	8300	300	0.014	51	20
			.		Avg	26.2	10.3			Avg	39.4	15.5

Area Inner Ring (cm2)	**707**
Area Outer Ring (cm2)	**2827**
Area Annular Space (cm2)	**2107**



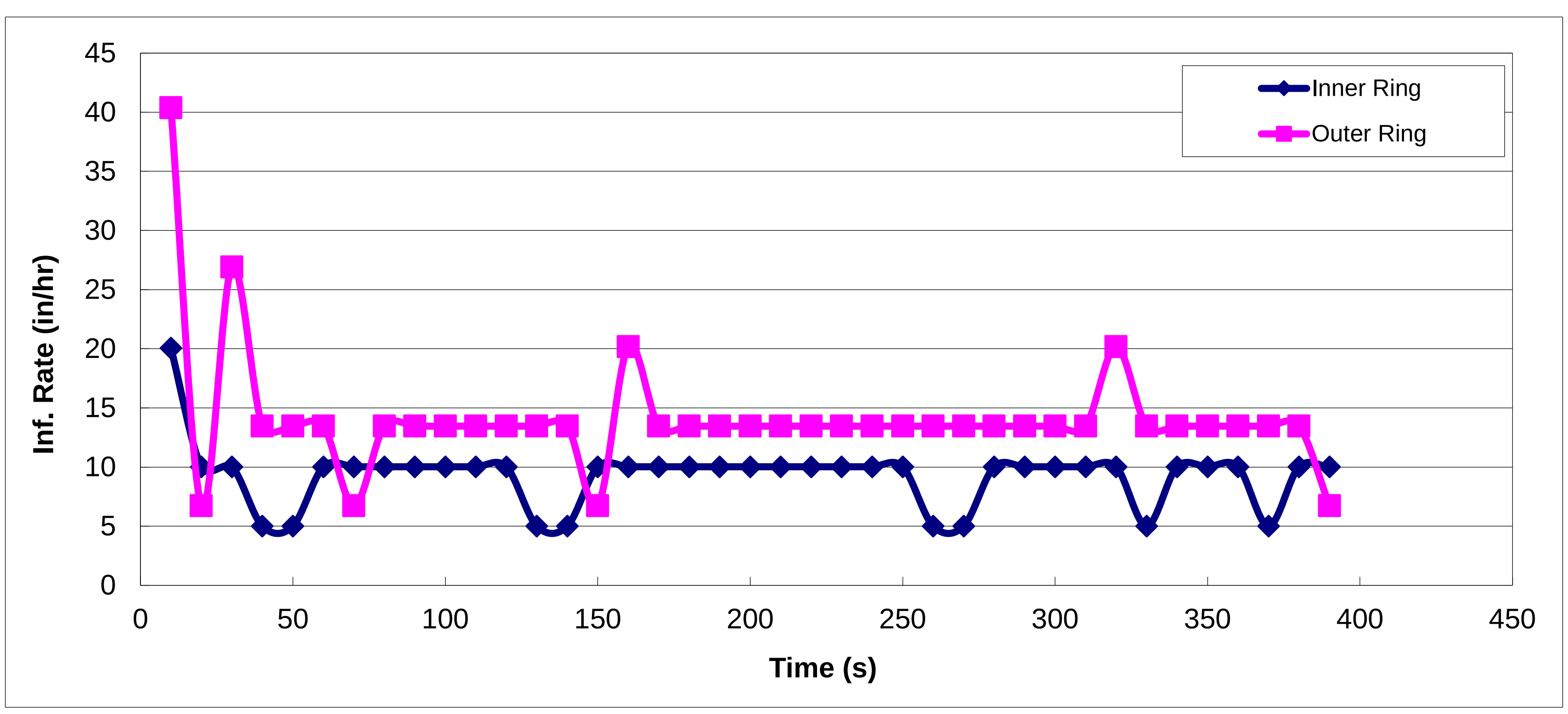
Horsley Witten Group, Inc.
Sustainable Environmental Solutions
www.horsleywitten.com

Double Ring Infiltrometer Test Results
Project: Littleton Drive Affordable Housing
Project No: 20107
Calculated By: JEH
Checked By: RAC

			Depth of Water, H (in)		Ring Penetration Depth (in)			
Location:	**TP-6**		**inner**	**outer**	**inner**	**outer**	**Weather: Mostly sunny**	
Date:	**12/18/20**	H_{init}	3	3	5	5	**Air (°F):** 35	**H_2O (°F):** 40
Time:	**14:00**	H_{final}	3	3				
Depth of Test:	**44"**							

Time (mm:ss)	Time (s)	Δ Time (s)	Inner Ring Level (cm3)	D Level (cm3)	IC (cm/s)	IC (cm/hr)	IC (in/hr)	Outer Ring Level (cm3)	D Level (cm3)	IR (cm/s)	IR (cm/hr)	IC (in/hr)
00:00	0	0		-	-	-	-	0	-	-	-	-
00:10	10	10	100	100	0.014	51	20	600	600	0.028	103	40
00:20	20	10	150	50	0.007	25	10	700	100	0.005	17	7
00:30	30	10	200	50	0.007	25	10	1100	400	0.019	68	27
00:40	40	10	225	25	0.004	13	5	1300	200	0.009	34	13
00:50	50	10	250	25	0.004	13	5	1500	200	0.009	34	13
01:00	60	10	300	50	0.007	25	10	1700	200	0.009	34	13
01:10	70	10	350	50	0.007	25	10	1800	100	0.005	17	7
01:20	80	10	400	50	0.007	25	10	2000	200	0.009	34	13
01:30	90	10	450	50	0.007	25	10	2200	200	0.009	34	13
01:40	100	10	500	50	0.007	25	10	2400	200	0.009	34	13
01:50	110	10	550	50	0.007	25	10	2600	200	0.009	34	13
02:00	120	10	600	50	0.007	25	10	2800	200	0.009	34	13
02:10	130	10	625	25	0.004	13	5	3000	200	0.009	34	13
02:20	140	10	650	25	0.004	13	5	3200	200	0.009	34	13
02:30	150	10	700	50	0.007	25	10	3300	100	0.005	17	7
02:40	160	10	750	50	0.007	25	10	3600	300	0.014	51	20
02:50	170	10	800	50	0.007	25	10	3800	200	0.009	34	13
03:00	180	10	850	50	0.007	25	10	4000	200	0.009	34	13
03:10	190	10	900	50	0.007	25	10	4200	200	0.009	34	13
03:30	200	10	950	50	0.007	25	10	4400	200	0.009	34	13
03:40	210	10	1000	50	0.007	25	10	4600	200	0.009	34	13
03:50	220	10	1050	50	0.007	25	10	4800	200	0.009	34	13
04:00	230	10	1100	50	0.007	25	10	5000	200	0.009	34	13
04:10	240	10	1150	50	0.007	25	10	5200	200	0.009	34	13
04:20	250	10	1200	50	0.007	25	10	5400	200	0.009	34	13
04:30	260	10	1225	25	0.004	13	5	5600	200	0.009	34	13
04:40	270	10	1250	25	0.004	13	5	5800	200	0.009	34	13
04:50	280	10	1300	50	0.007	25	10	6000	200	0.009	34	13
05:00	290	10	1350	50	0.007	25	10	6200	200	0.009	34	13
05:10	300	10	1400	50	0.007	25	10	6400	200	0.009	34	13
05:20	310	10	1450	50	0.007	25	10	6600	200	0.009	34	13
05:30	320	10	1500	50	0.007	25	10	6900	300	0.014	51	20
05:40	330	10	1525	25	0.004	13	5	7100	200	0.009	34	13
05:50	340	10	1575	50	0.007	25	10	7300	200	0.009	34	13
06:00	350	10	1625	50	0.007	25	10	7500	200	0.009	34	13
06:10	360	10	1675	50	0.007	25	10	7700	200	0.009	34	13
06:20	370	10	1700	25	0.004	13	5	7900	200	0.009	34	13
06:30	380	10	1750	50	0.007	25	10	8100	200	0.009	34	13
06:40	390	10	1800	50	0.007	25	10	8200	100	0.005	17	7
					Avg	**23.5**	**9.3**			**Avg**	**35.9**	**14.1**

Area Inner Ring (cm2)	**707**
Area Outer Ring (cm2)	**2827**
Area Annular Space (cm2)	**2107**



United States Department of Agriculture

NRCS

Natural Resources Conservation Service

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

Custom Soil Resource Report for
Plymouth County, Massachusetts

Littleton Village

November 17, 2020

Preface

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

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

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

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

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

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

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Contents

How Soil Surveys Are Made

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

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

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

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

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

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

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

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

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

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

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

Soil Map

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

Soil Map

Map Scale: 1:8,390 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0, 100, 200, 400, 600

Feet: 0, 400, 800, 1600, 2400

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 1:12,000.

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: Plymouth County, Massachusetts
Survey Area Data: Version 13, Jun 9, 2020

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

Date(s) aerial images were photographed: Dec 31, 2009—Jul 3, 2017

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
1	Water	1.6	0.5%
11A	Rainberry coarse sand, 0 to 3 percent slopes	3.8	1.1%
37A	Massasoit - Mashpee complex, 0 to 3 percent slopes	12.3	3.7%
60A	Swansea coarse sand, 0 to 2 percent slopes	13.4	4.0%
66A	Ipswich - Pawcatuck - Matunuck complex, 0 to 2 percent slopes, very frequently flooded	34.0	10.2%
255B	Windsor loamy sand, 3 to 8 percent slopes	71.0	21.2%
256A	Deerfield loamy fine sand, 0 to 3 percent slopes	111.5	33.3%
256B	Deerfield loamy fine sand, 3 to 8 percent slopes	12.0	3.6%
480B	Plymouth - Carver complex, 3 to 8 percent slopes	8.3	2.5%
481B	Plymouth - Carver complex, 3 to 8 percent slopes, bouldery	13.1	3.9%
608	Water, ocean	12.1	3.6%
619A	Deerfield-Urban land complex, 0 to 3 percent slopes	32.5	9.7%
665B	Udipsamments, 0 to 8 percent slopes	0.9	0.3%
700A	Udipsamments, wet substratum, 0 to 3 percent slopes	0.0	0.0%
704A	Freetown and Swansea coarse sands, 0 to 3 percent slopes, sanded surface and inactive	8.3	2.5%
Totals for Area of Interest		**334.9**	**100.0%**

Map Unit Descriptions

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

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

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

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

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

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

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

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

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

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

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

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

Plymouth County, Massachusetts

1—Water

Map Unit Setting

National map unit symbol: bd0b
Elevation: 0 to 330 feet
Mean annual precipitation: 41 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 145 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Water: 98 percent
Minor components: 2 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Minor Components

Swansea

Percent of map unit: 1 percent
Landform: Kettles, bogs, swamps, marshes, depressions
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Talf
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Freetown

Percent of map unit: 1 percent
Landform: Bogs, marshes, kettles, swamps, depressions
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Talf
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

11A—Rainberry coarse sand, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 9y41
Elevation: 0 to 400 feet
Mean annual precipitation: 41 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 145 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

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

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Rainberry

Setting

Landform: Kettles, depressions
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Sandy and gravelly glaciofluvial deposits

Typical profile

Oi - 0 to 4 inches: slightly decomposed plant material
Oe - 4 to 7 inches: moderately decomposed plant material
A - 7 to 9 inches: coarse sand
Eg - 9 to 13 inches: coarse sand
Bhs1 - 13 to 15 inches: coarse sand
Bhs2 - 15 to 17 inches: coarse sand
Bs - 17 to 21 inches: coarse sand
Bhs3 - 21 to 29 inches: gravelly coarse sand
Cg1 - 29 to 33 inches: gravelly coarse sand
Cg2 - 33 to 67 inches: gravelly sand

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to very high (1.42 to 19.98 in/hr)
Depth to water table: About 0 to 6 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Available water capacity: Very low (about 2.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: A/D
Ecological site: F149BY008MA - Very Wet Outwash
Hydric soil rating: Yes

Minor Components

Massasoit

Percent of map unit: 5 percent
Landform: Depressions, drainageways, terraces
Landform position (two-dimensional): Footslope, toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Mashpee

Percent of map unit: 5 percent
Landform: Terraces, depressions, drainageways

Landform position (two-dimensional): Footslope, toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Swansea

Percent of map unit: 3 percent
Landform: Depressions, kettles, bogs, swamps, marshes
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Talf
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Deerfield

Percent of map unit: 2 percent
Landform: Outwash plains, terraces, deltas
Landform position (two-dimensional): Footslope, summit
Landform position (three-dimensional): Tread
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: No

37A—Massasoit - Mashpee complex, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: bd1q
Elevation: 0 to 400 feet
Mean annual precipitation: 41 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 145 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Massasoit and similar soils: 55 percent
Mashpee and similar soils: 35 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Massasoit

Setting

Landform: Terraces, drainageways, depressions
Landform position (two-dimensional): Footslope, toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Sandy and gravelly glaciofluvial deposits

Typical profile

Oe - 0 to 1 inches: moderately decomposed plant material
Oa - 1 to 3 inches: highly decomposed plant material
A - 3 to 5 inches: fine sand
Eg1 - 5 to 11 inches: fine sand
Eg2 - 11 to 13 inches: fine sand
Bhs - 13 to 17 inches: fine sand
Bsm - 17 to 23 inches: fine sand
Bs - 23 to 26 inches: fine sand
BC - 26 to 43 inches: fine sand
Cg - 43 to 80 inches: loamy very fine sand

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: 7 to 20 inches to ortstein
Drainage class: Poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.01 in/hr)
Depth to water table: About 0 to 12 inches
Frequency of flooding: None
Frequency of ponding: Occasional
Available water capacity: Very low (about 1.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4w
Hydrologic Soil Group: D
Ecological site: F144AY028MA - Wet Outwash
Hydric soil rating: Yes

Description of Mashpee

Setting

Landform: Terraces, depressions, drainageways
Landform position (two-dimensional): Footslope, toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Sandy and gravelly glaciofluvial deposits

Typical profile

Oe1 - 0 to 2 inches: moderately decomposed plant material
Oe2 - 2 to 4 inches: moderately decomposed plant material
Oa - 4 to 5 inches: highly decomposed plant material
AE - 5 to 7 inches: loamy fine sand
Eg - 7 to 11 inches: fine sand
Bh1 - 11 to 13 inches: fine sand
Bh2 - 13 to 17 inches: fine sand
Bs - 17 to 24 inches: loamy fine sand
C1 - 24 to 39 inches: fine sand
C2 - 39 to 65 inches: fine sand

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches

Drainage class: Poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (1.42 to 5.95 in/hr)
Depth to water table: About 0 to 12 inches
Frequency of flooding: None
Frequency of ponding: Occasional
Available water capacity: Low (about 4.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4w
Hydrologic Soil Group: A/D
Ecological site: F144AY028MA - Wet Outwash
Hydric soil rating: Yes

Minor Components

Deerfield

Percent of map unit: 5 percent
Landform: Outwash plains, terraces, deltas
Landform position (two-dimensional): Footslope, summit
Landform position (three-dimensional): Tread
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: No

Rainberry

Percent of map unit: 3 percent
Landform: Depressions, kettles
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Concave
Across-slope shape: Linear
Hydric soil rating: Yes

Squamscott

Percent of map unit: 2 percent
Landform: Lake plains, lake terraces
Landform position (two-dimensional): Footslope, toeslope
Landform position (three-dimensional): Talf
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

60A—Swansea coarse sand, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 2w68y
Elevation: 0 to 170 feet

Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 145 to 240 days
Farmland classification: Farmland of unique importance

Map Unit Composition

Swansea, sanded surface, and similar soils: 86 percent
Minor components: 14 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Swansea, Sanded Surface

Setting

Landform: Depressions, bogs, kettles
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Sandy human-transported material over highly decomposed organic material over sandy and gravelly glaciofluvial deposits

Typical profile

^Ap - 0 to 15 inches: coarse sand
2Oab - 15 to 36 inches: muck
2Cg - 36 to 79 inches: sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.14 to 14.17 in/hr)
Depth to water table: About 0 to 6 inches
Frequency of flooding: FrequentNone
Frequency of ponding: None
Available water capacity: Very high (about 12.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: B/D
Ecological site: F144AY043MA - Acidic Organic Wetlands
Hydric soil rating: Yes

Minor Components

Freetown, sanded surface

Percent of map unit: 5 percent
Landform: Kettles, depressions, bogs
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Aquic udipsamments

Percent of map unit: 3 percent
Landform: Depressions
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Tread

Down-slope shape: Linear, convex, concave
Across-slope shape: Linear, convex, concave
Hydric soil rating: No

Rainberry, sanded surface

Percent of map unit: 3 percent
Landform: Depressions, kettles
Down-slope shape: Concave
Across-slope shape: Linear
Hydric soil rating: Yes

Tihonet

Percent of map unit: 3 percent
Landform: Bogs
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope, tread
Down-slope shape: Linear, concave
Across-slope shape: Linear, concave
Hydric soil rating: Yes

66A—Ipswich - Pawcatuck - Matunuck complex, 0 to 2 percent slopes, very frequently flooded

Map Unit Setting

National map unit symbol: 2tyqm
Elevation: 0 to 10 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

Ipswich and similar soils: 50 percent
Pawcatuck and similar soils: 25 percent
Matunuck and similar soils: 15 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Ipswich

Setting

Landform: Tidal marshes
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Partially- decomposed herbaceous organic material

Typical profile

Oe - 0 to 42 inches: mucky peat
Oa - 42 to 59 inches: muck

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to very high (0.14 to 99.90 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: Very frequent
Frequency of ponding: None
Calcium carbonate, maximum content: 5 percent
Maximum salinity: Nonsaline to strongly saline (1.0 to 112.0 mmhos/cm)
Sodium adsorption ratio, maximum: 20.0
Available water capacity: Very high (about 26.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8w
Hydrologic Soil Group: A/D
Ecological site: R144AY002CT - Tidal Salt High Marsh mesic very frequently flooded, R144AY001CT - Tidal Salt Low Marsh mesic very frequently flooded
Hydric soil rating: Yes

Description of Pawcatuck

Setting

Landform: Tidal marshes
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Partially- decomposed herbaceous organic material over sandy mineral material

Typical profile

Oe - 0 to 46 inches: mucky peat
Cg - 46 to 60 inches: mucky sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to very high (0.14 to 99.90 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: Very frequent
Frequency of ponding: None
Calcium carbonate, maximum content: 5 percent
Maximum salinity: Nonsaline to strongly saline (1.0 to 112.0 mmhos/cm)
Sodium adsorption ratio, maximum: 20.0
Available water capacity: Very high (about 21.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8w
Hydrologic Soil Group: A/D

Ecological site: R144AY002CT - Tidal Salt High Marsh mesic very frequently flooded, R144AY001CT - Tidal Salt Low Marsh mesic very frequently flooded
Hydric soil rating: Yes

Description of Matunuck

Setting

Landform: Tidal marshes
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Partially- decomposed herbaceous organic material over glaciofluvial deposits and/or sandy marine deposits

Typical profile

Oe - 0 to 12 inches: mucky peat
Cg - 12 to 72 inches: sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to very high (0.14 to 99.90 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: Very frequent
Frequency of ponding: None
Calcium carbonate, maximum content: 5 percent
Maximum salinity: Nonsaline to strongly saline (1.0 to 112.0 mmhos/cm)
Sodium adsorption ratio, maximum: 20.0
Available water capacity: Moderate (about 8.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8w
Hydrologic Soil Group: A/D
Ecological site: R144AY002CT - Tidal Salt High Marsh mesic very frequently flooded, R144AY001CT - Tidal Salt Low Marsh mesic very frequently flooded
Hydric soil rating: Yes

Minor Components

Hooksan

Percent of map unit: 5 percent
Landform: Dunes
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Succotash

Percent of map unit: 5 percent
Landform: Spits on back-barrier flats
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear

Hydric soil rating: No

255B—Windsor loamy sand, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 2svkf
Elevation: 0 to 1,210 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Windsor, loamy sand, and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Windsor, Loamy Sand

Setting

Landform: Deltas, outwash plains, dunes, outwash terraces
Landform position (three-dimensional): Riser, tread
Down-slope shape: Linear, convex
Across-slope shape: Linear, convex
Parent material: Loose sandy glaciofluvial deposits derived from granite and/or loose sandy glaciofluvial deposits derived from schist and/or loose sandy glaciofluvial deposits derived from gneiss

Typical profile

O - 0 to 1 inches: moderately decomposed plant material
A - 1 to 3 inches: loamy sand
Bw - 3 to 25 inches: loamy sand
C - 25 to 65 inches: sand

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Runoff class: 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
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water capacity: Low (about 4.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2s
Hydrologic Soil Group: A
Ecological site: F144AY022MA - Dry Outwash
Hydric soil rating: No

Minor Components

Hinckley, loamy sand

Percent of map unit: 10 percent
Landform: Deltas, outwash plains, eskers, kames
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Head slope, nose slope, side slope, crest, rise
Down-slope shape: Convex
Across-slope shape: Convex, linear
Hydric soil rating: No

Deerfield, loamy sand

Percent of map unit: 5 percent
Landform: Outwash plains, terraces, deltas
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Tread, talf
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

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

Map Unit Setting

National map unit symbol: 2xfg8
Elevation: 0 to 1,100 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 145 to 240 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Deerfield and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Deerfield

Setting

Landform: Kame terraces, outwash plains, outwash deltas, outwash terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex, linear, concave
Across-slope shape: Concave, linear, convex

Parent material: Sandy outwash derived from granite, gneiss, and/or quartzite

Typical profile

Ap - 0 to 9 inches: loamy fine sand
Bw - 9 to 25 inches: loamy fine sand
BC - 25 to 33 inches: fine sand
Cg - 33 to 60 inches: sand

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to very high (1.42 to 99.90 in/hr)
Depth to water table: About 15 to 37 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Sodium adsorption ratio, maximum: 11.0
Available water capacity: Moderate (about 6.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: A
Ecological site: F144AY027MA - Moist Sandy Outwash
Hydric soil rating: No

Minor Components

Windsor

Percent of map unit: 7 percent
Landform: Outwash deltas, kame terraces, outwash terraces, outwash plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear, concave, convex
Across-slope shape: Concave, linear, convex
Hydric soil rating: No

Wareham

Percent of map unit: 5 percent
Landform: Drainageways, depressions
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Sudbury

Percent of map unit: 2 percent
Landform: Kame terraces, outwash plains, outwash terraces, outwash deltas
Landform position (three-dimensional): Tread
Down-slope shape: Convex, linear, concave
Across-slope shape: Concave, linear, convex
Hydric soil rating: No

Ninigret

Percent of map unit: 1 percent
Landform: Outwash terraces, outwash plains, kame terraces
Landform position (three-dimensional): Tread

Down-slope shape: Linear, convex
Across-slope shape: Concave, convex
Hydric soil rating: No

256B—Deerfield loamy fine sand, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 2xfg9
Elevation: 0 to 1,190 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 145 to 240 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Deerfield and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Deerfield

Setting

Landform: Kame terraces, outwash plains, outwash terraces, outwash deltas
Landform position (three-dimensional): Tread
Down-slope shape: Convex, linear, concave
Across-slope shape: Concave, linear, convex
Parent material: Sandy outwash derived from granite, gneiss, and/or quartzite

Typical profile

Ap - 0 to 9 inches: loamy fine sand
Bw - 9 to 25 inches: loamy fine sand
BC - 25 to 33 inches: fine sand
Cg - 33 to 60 inches: sand

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well 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: About 15 to 37 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Sodium adsorption ratio, maximum: 11.0
Available water capacity: Moderate (about 6.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w

Hydrologic Soil Group: A
Hydric soil rating: No

Minor Components

Windsor
Percent of map unit: 7 percent
Landform: Outwash deltas, kame terraces, outwash plains, outwash terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear, concave, convex
Across-slope shape: Concave, linear, convex
Hydric soil rating: No

Wareham
Percent of map unit: 5 percent
Landform: Depressions, drainageways
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Sudbury
Percent of map unit: 2 percent
Landform: Outwash deltas, kame terraces, outwash plains, outwash terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear, concave, convex
Across-slope shape: Concave, linear, convex
Hydric soil rating: No

Ninigret
Percent of map unit: 1 percent
Landform: Kame terraces, outwash terraces, outwash plains
Landform position (three-dimensional): Tread
Down-slope shape: Convex, linear
Across-slope shape: Convex, concave
Hydric soil rating: No

480B—Plymouth - Carver complex, 3 to 8 percent slopes

Map Unit Setting
National map unit symbol: bcyz
Elevation: 0 to 400 feet
Mean annual precipitation: 41 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 145 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition
Plymouth and similar soils: 45 percent
Carver and similar soils: 40 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Plymouth

Setting

Landform: Outwash plains, moraines
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Interfluve, tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Sandy and gravelly supraglacial meltout till over sandy and gravelly glaciofluvial deposits

Typical profile

Oi - 0 to 4 inches: slightly decomposed plant material
Oe - 4 to 6 inches: moderately decomposed plant material
A - 6 to 7 inches: loamy coarse sand
E - 7 to 11 inches: coarse sand
Bs - 11 to 15 inches: loamy coarse sand
Bw - 15 to 20 inches: coarse sand
BC - 20 to 29 inches: coarse sand
C - 29 to 64 inches: gravelly coarse sand

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 3.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2s
Hydrologic Soil Group: A
Ecological site: F149BY005MA - Dry Outwash
Hydric soil rating: No

Description of Carver

Setting

Landform: Outwash plains, pitted outwash plains, moraines
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Sandy glaciofluvial deposits

Typical profile

Oi - 0 to 2 inches: slightly decomposed plant material
Oe - 2 to 3 inches: moderately decomposed plant material
A - 3 to 7 inches: coarse sand
E - 7 to 10 inches: coarse sand
Bw1 - 10 to 15 inches: coarse sand

Bw2 - 15 to 28 inches: coarse sand
BC - 28 to 32 inches: coarse sand
C - 32 to 67 inches: coarse sand

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to very high (1.42 to 14.17 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Very low (about 2.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: A
Ecological site: F149BY005MA - Dry Outwash
Hydric soil rating: No

Minor Components

Barnstable

Percent of map unit: 10 percent
Landform: Moraines
Landform position (two-dimensional): Shoulder, summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Merrimac

Percent of map unit: 5 percent
Landform: Outwash plains, terraces, kames
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

481B—Plymouth - Carver complex, 3 to 8 percent slopes, bouldery

Map Unit Setting

National map unit symbol: bcz2
Elevation: 0 to 400 feet
Mean annual precipitation: 41 to 54 inches
Mean annual air temperature: 43 to 54 degrees F

Frost-free period: 145 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Plymouth, bouldery, and similar soils: 45 percent
Carver, bouldery, and similar soils: 40 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Plymouth, Bouldery

Setting

Landform: Outwash plains, moraines
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Interfluve, tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Sandy and gravelly supraglacial meltout till over sandy and gravelly glaciofluvial deposits

Typical profile

Oi - 0 to 4 inches: slightly decomposed plant material
Oe - 4 to 6 inches: moderately decomposed plant material
A - 6 to 7 inches: loamy coarse sand
E - 7 to 11 inches: coarse sand
Bs - 11 to 15 inches: loamy coarse sand
Bw - 15 to 20 inches: coarse sand
BC - 20 to 29 inches: coarse sand
C - 29 to 64 inches: gravelly coarse sand

Properties and qualities

Slope: 3 to 8 percent
Surface area covered with cobbles, stones or boulders: 0.1 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 3.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2s
Hydrologic Soil Group: A
Ecological site: F149BY005MA - Dry Outwash
Hydric soil rating: No

Description of Carver, Bouldery

Setting

Landform: Outwash plains, pitted outwash plains, moraines
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Tread
Down-slope shape: Convex

Across-slope shape: Convex
Parent material: Sandy glaciofluvial deposits

Typical profile
Oi - 0 to 2 inches: slightly decomposed plant material
Oe - 2 to 3 inches: moderately decomposed plant material
A - 3 to 7 inches: coarse sand
E - 7 to 10 inches: coarse sand
Bw1 - 10 to 15 inches: coarse sand
Bw2 - 15 to 28 inches: coarse sand
BC - 28 to 32 inches: coarse sand
C - 32 to 67 inches: coarse sand

Properties and qualities
Slope: 3 to 8 percent
Surface area covered with cobbles, stones or boulders: 0.1 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to very high (1.42 to 14.17 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Very low (about 2.6 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: A
Ecological site: F149BY005MA - Dry Outwash
Hydric soil rating: No

Minor Components

Barnstable, bouldery
Percent of map unit: 5 percent
Landform: Moraines
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Poquonock, bouldery
Percent of map unit: 5 percent
Landform: Drumlins, ground moraines, till plains
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Merrimac
Percent of map unit: 5 percent
Landform: Outwash plains, terraces, kames
Landform position (two-dimensional): Summit, shoulder

Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

608—Water, ocean

Map Unit Setting

National map unit symbol: bqv2
Elevation: 0 to 70 feet
Mean annual precipitation: 41 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 145 to 240 days

Map Unit Composition

Water, ocean: 95 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Minor Components

Beaches, sandy

Percent of map unit: 5 percent
Landform: Shores, back-barrier beaches, barrier beaches, beaches
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Riser
Down-slope shape: Convex
Across-slope shape: Linear
Hydric soil rating: Unranked

619A—Deerfield-Urban land complex, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 2xfgb
Elevation: 0 to 210 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Deerfield and similar soils: 45 percent
Urban land: 35 percent
Minor components: 20 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Deerfield

Setting

Landform: Kame terraces, outwash plains, outwash terraces, outwash deltas
Landform position (three-dimensional): Tread
Down-slope shape: Convex, linear, concave
Across-slope shape: Concave, linear, convex
Parent material: Sandy outwash derived from granite, gneiss, and/or quartzite

Typical profile

Ap - 0 to 9 inches: loamy fine sand
Bw - 9 to 25 inches: loamy fine sand
BC - 25 to 33 inches: fine sand
Cg - 33 to 60 inches: sand

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to very high (1.42 to 99.90 in/hr)
Depth to water table: About 15 to 37 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Sodium adsorption ratio, maximum: 11.0
Available water capacity: Moderate (about 6.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: A
Ecological site: F144AY027MA - Moist Sandy Outwash
Hydric soil rating: No

Description of Urban Land

Setting

Landform: Outwash plains
Down-slope shape: Linear
Across-slope shape: Linear

Typical profile

M - 0 to 10 inches: cemented material

Properties and qualities

Slope: 0 to 3 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 capacity: 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

Walpole

Percent of map unit: 7 percent
Landform: Outwash plains, outwash terraces, outwash deltas, depressions
Landform position (three-dimensional): Tread
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Udorthents

Percent of map unit: 5 percent
Landform: Outwash plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Windsor

Percent of map unit: 5 percent
Landform: Outwash plains, outwash terraces, outwash deltas, kame terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear, concave, convex
Across-slope shape: Concave, linear, convex
Hydric soil rating: No

Merrimac

Percent of map unit: 3 percent
Landform: Kame terraces, outwash terraces, outwash deltas
Landform position (three-dimensional): Tread
Down-slope shape: Convex, concave, linear
Across-slope shape: Linear, concave, convex
Hydric soil rating: No

665B—Udipsamments, 0 to 8 percent slopes

Map Unit Setting

National map unit symbol: 2pr8k
Elevation: 0 to 390 feet
Mean annual precipitation: 41 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 145 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Udipsamments and similar soils: 80 percent

Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Udipsamments

Setting

Landform: Dikes
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Tread
Down-slope shape: Linear, convex
Across-slope shape: Linear
Parent material: Sandy human transported material over sandy and gravelly glaciofluvial deposits

Typical profile

^Ap - 0 to 9 inches: loamy sand
C1 - 9 to 22 inches: sand
C2 - 22 to 49 inches: coarse sand
C3 - 49 to 54 inches: sand
C4 - 54 to 79 inches: coarse sand

Properties and qualities

Slope: 0 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to very high (1.42 to 14.17 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 3.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3s
Hydrologic Soil Group: A
Hydric soil rating: No

Minor Components

Udipsamments, wet substratum

Percent of map unit: 10 percent
Landform: Dikes
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear, convex
Across-slope shape: Linear
Hydric soil rating: No

Udorthents, loamy

Percent of map unit: 5 percent
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Tihonet

Percent of map unit: 5 percent
Landform: Bogs
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: Yes

700A—Udipsamments, wet substratum, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: bd02
Elevation: 0 to 390 feet
Mean annual precipitation: 40 to 50 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 195 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Udipsamments, wet substratum, and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Udipsamments, Wet Substratum

Setting

Landform: Dikes
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear, convex
Across-slope shape: Linear
Parent material: Sandy human transported material over sandy and gravelly glaciofluvial deposits

Typical profile

^Ap - 0 to 3 inches: loamy fine sand
^C1 - 3 to 20 inches: fine sand
Ab - 20 to 24 inches: loamy fine sand
Bwb - 24 to 31 inches: fine sand
BC - 31 to 44 inches: fine sand
C2 - 44 to 51 inches: fine sand
C3 - 51 to 72 inches: very fine sand

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Runoff class: Negligible

Capacity of the most limiting layer to transmit water (Ksat): Moderately high to very high (1.42 to 14.17 in/hr)
Depth to water table: About 20 to 48 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 3.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: A/D
Ecological site: R149BY002MA - Coastal Dunes
Hydric soil rating: No

Minor Components

Tihonet

Percent of map unit: 10 percent
Landform: Bogs
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread, dip
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: F144AY028MA - Wet Outwash
Hydric soil rating: Yes

Udipsamments

Percent of map unit: 5 percent
Landform: Dikes
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Tread
Down-slope shape: Linear, convex
Across-slope shape: Linear
Ecological site: R149BY002MA - Coastal Dunes
Hydric soil rating: No

Udorthents, wet substratum

Percent of map unit: 5 percent
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

704A—Freetown and Swansea coarse sands, 0 to 3 percent slopes, sanded surface and inactive

Map Unit Setting

National map unit symbol: 2tx05
Elevation: 0 to 140 feet
Mean annual precipitation: 40 to 52 inches

Mean annual air temperature: 48 to 55 degrees F
Frost-free period: 190 to 250 days
Farmland classification: Farmland of unique importance

Map Unit Composition

Freetown, sanded surface, inactive, and similar soils: 50 percent
Swansea, sanded surface, inactive, and similar soils: 40 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Freetown, Sanded Surface, Inactive

Setting

Landform: Kettles, depressions, bogs
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Talf
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Sandy human transported material over organic material

Typical profile

^Ap - 0 to 15 inches: coarse sand
2Oa - 15 to 79 inches: muck

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.14 to 14.17 in/hr)
Depth to water table: About 0 to 6 inches
Frequency of flooding: FrequentNone
Frequency of ponding: None
Available water capacity: Very high (about 20.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: B/D
Hydric soil rating: Yes

Description of Swansea, Sanded Surface, Inactive

Setting

Landform: Kettles, depressions, bogs
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Talf
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Highly decomposed organic material over loose sandy and gravelly glaciofluvial deposits

Typical profile

^Ap - 0 to 15 inches: coarse sand
Oa - 15 to 36 inches: muck
2Cg - 36 to 79 inches: coarse sand

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.14 to 14.17 in/hr)
Depth to water table: About 0 to 6 inches
Frequency of flooding: Rare
Frequency of ponding: Frequent
Available water capacity: High (about 11.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: B/D
Ecological site: F144AY043MA - Acidic Organic Wetlands
Hydric soil rating: Yes

Minor Components

Rainberry, sanded surface

Percent of map unit: 5 percent
Landform: Kettles, depressions
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Concave
Across-slope shape: Linear
Hydric soil rating: Yes

Tihonet

Percent of map unit: 5 percent
Landform: Outwash plains
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: Yes

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Geotechnical Engineering Report

Littleton Drive Multi-Unit Housing
Wareham, Massachusetts
January 13, 2021
Terracon Project No. J1205096

Prepared for:
Pennrose
Boston, Massachusetts

Prepared by:
Terracon Consultants, Inc.
Manchester, New Hampshire

January 13, 2021

Pennrose
50 Milk Street
Boston, MA 02109

Attn: Mr. Ryan Kiracofe
P: (513) 739 2072
E: rkiracofe@pennrose.com

Re: Geotechnical Engineering Report
Littleton Drive Multi-Unit Housing
4 Littleton Drive
Wareham, Massachusetts
Terracon Project No. J1205096

Dear Mr. Kiracofe:

We have completed the Geotechnical Engineering services for the above referenced project. This study was performed in general accordance with Terracon Proposal No. PJ1205096 dated December 4, 2020. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations and floor slabs for the proposed project.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or if we may be of further service, please contact us.

Sincerely,
Terracon Consultants, Inc.

Carl W. Thunberg, P.E
Geotechnical Department Manager

Erich L. Christiansen, P.E.(NJ)
Principal

REPORT TOPICS

Note: This report was originally delivered in a web-based format. **Orange Bold** text in the report indicates a referenced section heading. The PDF version also includes hyperlinks which direct the reader to that section and clicking on the ***GeoReport*** logo will bring you back to this page. For more interactive features, please view your project online at client.terracon.com.

ATTACHMENTS

Note: Refer to each individual Attachment for a listing of contents.

REPORT SUMMARY

Topic [1]	Overview Statement [2]
Project Description	The project consists of constructing an apartment complex comprising of 93 units in 11 buildings and a community building. The Senior Building footprint is approximately 12,000 square feet and is planned to be a three-story building. The individual family Townhouses and Community Building footprint areas are planned to be approximately 2,800 square feet. The buildings are presumed to be of slab-on-grade construction (non-basement).
Geotechnical Characterization	Seventeen soil borings were drilled at the site. Subsurface conditions consisted of granular outwash sand deposits with varying amounts of silt and gravel. Groundwater was encountered at depths varying from 6.5 to 10 feet. While fill was not encountered in the widely spaced borings, the possibility exists that fill may be present in areas between the borings or in areas of previous earthwork for roadway construction and utility installation.
Earthwork	Remove existing fill where encountered within the proposed buildings. The sandy outwash may be problematic to compact when below optimum moisture content and may require moisture conditioning. If earthwork proceeds during seasonally wet conditions, temporary construction dewatering may be required. It is envisioned that filtered sumps and pumps would be sufficient for groundwater control.
Shallow Foundations	Shallow foundations are recommended Net allowable bearing pressure: 3,000 pounds per square foot (psf) Expected settlements: 1-inch total, 2/3-inch differential Detect and remove zones of fill as noted in **Earthwork**.
Below-Grade Structures	The buildings are planned to be of slab on-grade construction (i.e. no basements) Site grading plans were not available at the date of this report. We have included lateral earth pressure recommendation in the event site retaining walls are required.
General Comments	This section contains important information about the limitations of this geotechnical engineering report.

1. If the reader is reviewing this report as a pdf, the topics above can be used to access the appropriate section of the report by simply clicking on the topic itself.
2. This summary is for convenience only. It should be used in conjunction with the entire report for design purposes.

Geotechnical Engineering Report

Littleton Drive Multi-Unit Housing
4 Littleton Drive
Wareham, Massachusetts
Terracon Project No. J1205096
January 13, 2021

INTRODUCTION

This report presents the results of our subsurface exploration and geotechnical engineering services performed for the proposed multi-unit housing to be located at 4 Littleton Drive in Wareham, Massachusetts. The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- Subsurface soil conditions
- Groundwater conditions
- Site preparation and earthwork
- Excavation considerations
- Dewatering considerations
- Construction Materials Testing considerations
- Foundation design and construction
- Floor slab design and construction
- Seismic site classification per Massachusetts State Building Code, 9th Edition
- Lateral earth pressures
- Pavement design and construction
- Frost considerations

The geotechnical field Scope of Services for this project included the advancement of seventeen test borings to depths ranging from approximately 10 to 22 feet below existing site grades.

Maps showing the site and boring locations are shown in the **Site Location** and **Exploration Plan** sections, respectively. The results of the laboratory testing performed on soil samples obtained from the site during the field exploration are included as separate graphs in the **Exploration Results** section.

SITE CONDITIONS

The following description of site conditions is derived from our site visit in association with the field exploration and our review of publicly available geologic and topographic maps.

Item	Description
Parcel Information	The project is located at 4 Littleton Drive in Wareham, Massachusetts. The property is approximately 16 acres and is located at approximate coordinates 41.7502°, -70.7304°. See **Site Location**
Existing Improvements	The site development area is currently undeveloped and wooded. Based on a review of satellite imagery, there appears to be a partially overgrown unpaved loop road that may have been cut as part of a previous site development scheme. These unpaved access roads are designated as Sussex Drive and Littleton Drive on the USGS topographic map. We understand that water service has been previously installed as part of a proposed prior development.
Current Ground Cover	Wooded site with trees, woody vegetation, and undergrowth with forest topsoil and leaf litter. Flax Pond is located in the southeast corner of the site, outside the site development area.
Existing Topography (from Google Earth™ imagery)	The site is relatively level, with site grades varying from Elevation (El) 10 feet in the southeast corner of the site to El 16 feet in the northwest corner of the site.
Geology	Due to previous earthwork on the site, portions of the site may have been filled during unpaved road construction. NRCS SSURGO mapping shows the naturally deposited consist of granular sand and gravel outwash deposits. USGS bedrock mapping shows bedrock as Granite or Gneiss. Depth to groundwater is mapped as 3 to 5 feet. Depth to bedrock is not shown. The subsurface conditions encountered in the borings were consistent with the borings.

PROJECT DESCRIPTION

Our initial understanding of the project was provided in our proposal and was discussed during project planning. A period of collaboration has transpired since the project was initiated, and our final understanding of the project conditions is as follows:

Item	Description
Information Provided	Pennrose provided the following information: ■ Concept Civil Site Plan, prepared by Horsley Whitten Group and The Architectural Team (TAT), progress print dated 10/08/2020 with marked up requested boring and test pit locations ■ Existing Conditions Plan Sheet EX-1, prepared by Horsley Whitten Group and The Architectural Team (TAT), progress print dated 11/12/2020 ■ Email dated November 13, 2020 with a description of the site development concept.
Project Description	It is our understanding that the project consists of constructing an apartment complex comprising 93 units in 11 buildings and a community building. Additional site civil design features include paved parking and access roads, site drainage, stormwater treatment areas, utilities, lighting, etc.
Proposed Structure	The Senior Building footprint is approximately 12,000 square feet and is planned to be a three-story building. The individual family Townhouses and Community Building footprint areas are planned to be approximately 2,800 square feet each. The buildings are presumed to be of slab-on-grade construction (non-basement).
Finished Floor Elevation	Not available at this time.
Maximum Loads	Unknown at this time, but the following loads are assumed. ■ Columns: 30 to 60 kips ■ Walls: 1 to 3 kips per linear foot (klf) ■ Slabs: 100 to 250 pounds per square foot (psf)
Grading/Slopes	Preliminary grading plans were not available at the time of this proposal. There is approximately 6 to 8 feet of topographic relief across the site, with gradual grade changes. Cuts and fills are expected to be relatively minor, on the order of 6 feet or less.
Below-Grade Structures	No basements are anticipated.
Free-Standing Retaining Walls	The preliminary plans do not indicate free-standing retaining walls. Concrete headwalls may potentially be required where treated stormwater discharges to Flax Pond.

Item	Description
Pavements	We assume access drives and parking will consist of flexible (asphalt) pavement sections and rigid (concrete) pavement will be required at the dumpster enclosure pads. For design purposes, we assume NAPA Class II and Class III Equivalent Single Axle Loads (ESALs) will be suitable for Standard and Heavy-Duty pavements, respectively. ■ Standard Duty Parking: Class II - 27,000 ESALs ■ Heavy Duty Access Roads: Class III - 110,000 ESALs Pavement design life of 20 years
Estimated Start of Construction	Unknown at this time.

GEOTECHNICAL CHARACTERIZATION

We have developed a general characterization of the subsurface conditions based upon our review of the subsurface exploration, laboratory data, geologic setting and our understanding of the project. This characterization, termed GeoModel, forms the basis of our geotechnical calculations and evaluation of site preparation and foundation options. Conditions encountered at each exploration point are indicated on the individual logs. The individual logs can be found in the **Exploration Results** section and the GeoModel can be found in the **Figures** section of this report.

As part of our analyses, we identified the following model layers within the subsurface profile. For a more detailed view of the model layer depths at each boring location, refer to the GeoModel.

Model Layer	Layer Name	General Description
1	**Sands**	Poorly Graded Sand, Silty Sand and Silty Sand with Gravel, as well as Poorly Graded Sand with Gravel trace silt; orangish brown to light brown, very loose to medium dense

Groundwater Conditions

Groundwater measurements are summarized in the following table and are noted on the boring logs in the **Exploration Results** section. The groundwater levels were measured at the completion of drilling and may not represent stabilized levels.

Boring No.	Approximate Ground Surface Elevation (feet) [1]	Approximate Groundwater Depth (feet)	Approximate Groundwater Elevation (feet) [1]
B-1	15	8.5	6.5
B-2	17	7.5	9.5
B-3	15	7.5	7.5
B-4	15	9.5	5.5
B-5	15	7.5	7.5
B-6	15	7	8
B-7	15	9	6
B-8	17	10.5	6.5
B-9	16	10.5	5.5
B-10	16	7	9
B-11	14	6.5	7.5
B-12	16	10	6
B-13	15	8	7
B-14	15	6.5	8.5
B-15	14	6.5	7.5
B-16	14	6.5	7.5
B-17	14	6.5	7.5

1. Elevations were interpolated from ground surface elevation contours on the Existing Conditions Plan provided.

Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the borings were performed. Therefore, groundwater levels during construction or at other times in the life of the structure may be higher or lower than the levels indicated on the boring logs. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

GEOTECHNICAL OVERVIEW

The subsurface conditions encountered in the borings consist of sandy soils with varying amounts of silt and gravel exhibiting loose to medium dense relative density. The sand generally grades finer with depth to silty sand in the lower portion of the borings. While fill soils were not encountered in the widely spaced borings, fill may potentially be encountered in areas between the borings, reflecting previous earthwork for installation of utilities and road construction. Groundwater was encountered at depths varying from 6.5 to 10.5 feet deep while drilling, which are not expected to significantly impact the design or construction of typical shallow foundations, if constructed during favorable weather conditions. Groundwater may potentially impact excavation of deeper utilities, or if the excavations for utilities and foundations proceed during seasonally wet conditions or during spring thaw.

The near surface sandy soils may become problematic to compact if below the optimum moisture content per ASTM D1557 and may require moisture conditioning to achieve compaction. While the sandy soils are not inherently sensitive to disturbance, they could become unstable with typical earthwork and construction traffic, especially after precipitation events or seasonally wet conditions. The effective drainage should be completed early in the construction sequence and maintained after construction to avoid potential issues. If possible, the grading should be performed during the warmer and drier times of the year. If grading is performed during the winter months, an increased risk for possible undercutting and replacement of unstable subgrade may persist. Additional site preparation recommendations, including subgrade preparation and fill placement, are provided in the **Earthwork** section.

The **Shallow Foundations** section addresses support of the foundations bearing on proofrolled undisturbed native sandy soils. The **Floor Slabs** section addresses slab-on-grade support on a minimum 6 inches of Floor Slab Base Course over proofrolled native sandy soils.

The **General Comments** section provides an understanding of the report limitations.

EARTHWORK

Earthwork is anticipated to include clearing and grubbing, excavations, and fill placement. The following sections provide recommendations for use in the preparation of specifications for the work. Recommendations include critical quality criteria, as necessary, to render the site in the state considered in our geotechnical engineering evaluation for foundations, floor slabs, and pavements.

Site Preparation

Prior to placing fill, existing vegetation and root mat should be removed. Complete stripping of the topsoil and subsoil should be performed in the proposed building and parking/driveway areas.

The subgrade should be proofrolled with an adequately loaded vehicle such as a fully-loaded tandem-axle dump truck. The proofrolling should be performed under the direction of the Geotechnical Engineer. Areas excessively deflecting under the proofroll should be delineated and subsequently addressed by the Geotechnical Engineer. Excessively wet or dry material should either be removed or moisture conditioned and recompacted.

Fill Material Types

Fill required to achieve design grade should be classified as Structural Fill and General Fill. Structural Fill is material used below, or within 10 feet of structures, pavements or constructed slopes. General Fill is material used to achieve grade outside of these areas. Earthen materials used for Structural and General Fill should meet the following material property requirements:

Fill Type [1]	Massachusetts Department of Transportation (MassDOT) Item	Acceptable Location for Placement
General Fill [1, 2]	M1.02.0 Special Borrow	General raise in grade fill. General Fill should not be placed within the foundation bearing zone of settlement sensitive structures.
Structural Fill[3]	M1.03.0 Gravel Borrow Type C	Beneath foundations.
Crushed Stone	M2.01.4 Crushed Stone	Backfill of underdrains and over wet subgrades as needed.
Non-Frost Susceptible Fill [4]	M1.03.1 Processed Gravel for Subbase or M2.01.4 Crushed Stone	Exterior slabs, sidewalks.
Floor Slab/Pavement Base Course	M2.01.7 Dense Graded Crushed Stone for Sub-base	Below floor slabs or pavements as aggregate base course.
Pavement Sub-base Course	M1.03.1 Processed Gravel for Subbase	Below pavement areas as sub-base course below aggregate base course.

1. General fill should consist of approved onsite or imported materials that are free of organic matter and debris. Frozen material should not be used. Fill should not be placed on frozen subgrade.
2. General Fill should have a maximum particle size of 6 inches and no more than 25 percent by weight passing the No. 200 sieve.
3. Portions of the onsite soils could be reused as Structural Fill if approved by the Geotechnical Engineer
4. Non-Frost Susceptible (NFS) Fill should contain less than 5 percent material passing No. 200 sieve size.

Fill Compaction Requirements

Fill materials should meet the following compaction requirements.

Item	Description
Maximum Layer Thickness	8 inches or less in loose thickness
Minimum Compaction Requirements [1, 2]	At least 95% of the material's maximum Modified Proctor dry density (ASTM D1557) for Structural Fill or dimensioned select materials (i.e. pavement and floor slab base) At least 95% of maximum Standard Proctor dry density (ASTM D698) for General Fill only

Item	Description
Water Content Range [1]	±3% for granular material

1. Maximum density and optimum water content as determined by the Modified Proctor test (ASTM D1557, Method C).
2. We recommend testing fill for moisture content and compaction during placement. If the results of in-place density tests indicate the specified moisture or compaction limits have not been met, the area represented by the test should be reworked and retested, as required, until the specified moisture and compaction requirements are achieved.

Utility Trench Backfill

Trench excavations should be made with sufficient working space to permit construction including backfill placement and compaction. Trenches should be backfilled with material that approximately matches the permeability characteristics of the surrounding soil. Fill placed as backfill for utilities located below the slab should consist of compacted Structural Fill or suitable bedding material.

Grading and Drainage

All grades must provide effective drainage away from the building during and after construction and should be maintained throughout the life of the structure. Water retained next to the building can result in soil movements greater than those discussed in this report. Greater movements can result in unacceptable differential floor slab and/or foundation movements, cracked slabs and walls, and roof leaks. The roof should have gutters/drains with downspouts that discharge onto splash blocks at a distance of at least 10 feet from the building.

Exposed ground should be sloped and maintained at a minimum 5% away from the building for at least 10 feet beyond the perimeter of the building. Locally, flatter grades may be necessary to transition ADA access requirements for flatwork. After building construction and landscaping have been completed, final grades should be verified to document effective drainage has been achieved. Grades around the structure should also be periodically inspected and adjusted, as necessary, as part of the structure's maintenance program. Where paving or flatwork abuts the structure, a maintenance program should be established to effectively seal and maintain joints and prevent surface water infiltration.

Earthwork Construction Considerations

Shallow excavations for the proposed structure are anticipated to be accomplished with conventional construction equipment. Upon completion of filling and grading, care should be taken to maintain the subgrade water content prior to construction of floor slabs. Construction traffic over the completed subgrades should be avoided. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. Water collecting over or adjacent to construction areas should be removed. If the subgrade freezes, desiccates, saturates, or is disturbed, the affected material should be removed, or the materials should be scarified, moisture conditioned, and recompacted prior to floor slab construction.

The groundwater table could affect deep utility installation, if any, and for foundation excavation during seasonally wet conditions. A temporary dewatering system consisting of filtered sumps with pumps could be necessary to achieve the required depth over-excavation. The Contractor should be responsible for selecting appropriate means and methods for construction dewatering.

As a minimum, excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, “Excavations” and its appendices, and in accordance with any applicable local, and/or state regulations.

Construction site safety is the sole responsibility of the contractor who controls the means, methods, and sequencing of construction operations. Under no circumstances shall the information provided herein be interpreted to mean Terracon is assuming responsibility for construction site safety, or the contractor's activities; such responsibility shall neither be implied nor inferred.

Construction Observation and Testing

The earthwork efforts should be monitored under the direction of the Geotechnical Engineer. Monitoring should include documentation of adequate removal of vegetation and topsoil, proofrolling, and mitigation of areas delineated by the proofroll to require mitigation.

Each lift of compacted fill should be tested, evaluated, and reworked, as necessary, until approved by the Geotechnical Engineer prior to placement of additional lifts. Each lift of fill should be tested for density and water content at a frequency of at least one test for every 2,500 square feet of compacted fill in the building areas and 5,000 square feet in pavement areas. One density and water content test should be performed for every 50 linear feet of compacted utility trench backfill.

In areas of foundation excavations, the bearing subgrade should be evaluated under the direction of the Geotechnical Engineer. If unanticipated conditions are encountered, the Geotechnical Engineer should prescribe mitigation options.

In addition to the documentation of the essential parameters necessary for construction, the continuation of the Geotechnical Engineer into the construction phase of the project provides the continuity to maintain the Geotechnical Engineer’s evaluation of subsurface conditions, including assessing variations and associated design changes.

SHALLOW FOUNDATIONS

If the site has been prepared in accordance with the requirements noted in the **Earthwork** section, the following design parameters are applicable for shallow foundations.

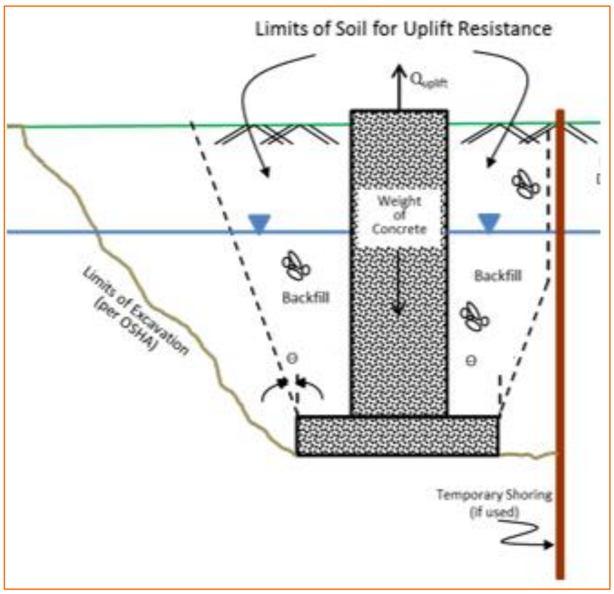
Design Parameters – Compressive Loads

Item	Description
Maximum Net Allowable Bearing Pressure [1, 2]	3,000 psf
Required Bearing Stratum [3]	Undisturbed native sandy soils
Minimum Foundation Dimensions	Columns: 30 inches Continuous: 18 inches
Ultimate Passive Resistance [4] **(Equivalent Fluid Pressures)**	390 pcf (granular backfill)
Ultimate Coefficient of Sliding Friction [5]	0.55 (granular material)
Minimum Embedment below Finished Grade [6]	Exterior footings in heated areas: 48 inches Interior footings in heated areas: 18 inches
Estimated Total Settlement from Structural Loads [2]	Less than about 1 inch
Estimated Differential Settlement [2, 7]	About 2/3 of total settlement

1. The maximum net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. An appropriate factor of safety has been applied. Values assume that exterior grades are no steeper than 20% within 10 feet of structure.
2. Values provided are for maximum loads noted in **Project Description**.
3. Unsuitable or soft soils should be over-excavated and replaced per the recommendations presented in the **Earthwork** section.
4. Use of passive earth pressures require the sides of the excavation for the spread footing foundation to be nearly vertical and the concrete placed neat against these vertical faces or that the footing forms be removed and compacted Structural Fill be placed against the vertical footing face.
5. Can be used to compute sliding resistance where foundations are placed on suitable soil/materials. Should be neglected for foundations subject to net uplift conditions.
6. Embedment necessary to minimize the effects of frost and/or seasonal water content variations. For sloping ground, maintain depth below the lowest adjacent exterior grade within 5 horizontal feet of the structure.
7. Differential settlements are as measured over a span of 50 feet.

Design Parameters - Uplift Loads

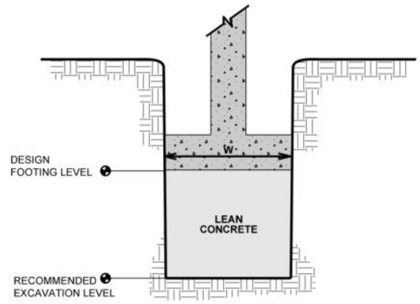
Uplift resistance of spread footings can be developed from the effective weight of the footing and the overlying soils. As illustrated on the subsequent figure, the effective weight of the soil prism defined by diagonal planes extending up from the top of the perimeter of the foundation to the ground surface at an angle, θ, of 20 degrees from the vertical can be included in uplift resistance. The maximum allowable uplift capacity should be taken as a sum of the effective weight of soil plus the dead weight of the foundation, divided by an appropriate factor of safety. A maximum total unit weight of 100 pcf should be used for the backfill. This unit weight should be reduced to 40 pcf for portions of the backfill or natural soils below the groundwater elevation.



Foundation Construction Considerations

As noted in the **Earthwork** section the footing excavations should be evaluated under the direction of the Geotechnical Engineer. The base of all foundation excavations should be free of water and loose soil, prior to placing concrete. Concrete should be placed soon after excavating to reduce bearing soil disturbance. Care should be taken to prevent wetting or drying of the bearing materials during construction. Excessively wet or dry material or any loose/disturbed material in the bottom of the footing excavations should be removed/reconditioned before foundation concrete is placed.

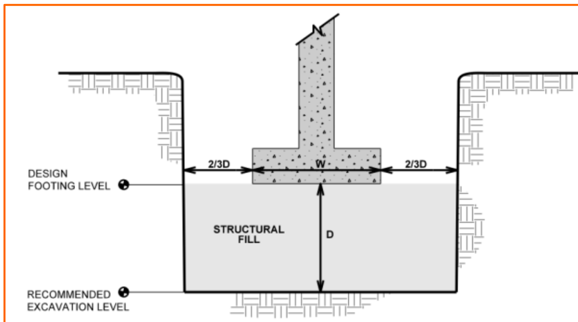
If unsuitable bearing soils are encountered at the base of the planned footing excavation, the excavation should be extended deeper to suitable soils, and the footings could bear directly on these soils at the lower level or on lean concrete backfill placed in the excavations. This is illustrated on the sketch below.



LEAN CONCRETE BACKFILL

NOTE: EXCAVATIONS ARE SHOWN VERTICAL; HOWEVER, THE SIDEWALLS SHOULD BE SLOPED AS NECESSARY FOR SAFETY

Over-excavation for Structural Fill placement below footings should be conducted as shown below. The over-excavation should be backfilled up to the footing base elevation, with structural fill placed, as recommended in the **Earthwork** section.



OVER-EXCAVATION / BACKFILL ZONE

NOTE: EXCAVATIONS ARE SHOWN VERTICAL; HOWEVER, THE SIDEWALLS SHOULD BE SLOPED AS NECESSARY FOR SAFETY

SEISMIC CONSIDERATIONS

The seismic design requirements for buildings and other structures are based on Seismic Design Category. Site Classification is required to determine the Seismic Design Category for a structure. The Site Classification is based on the upper 100 feet of the site profile defined by a weighted average value of either shear wave velocity, standard penetration resistance, or undrained shear strength in accordance with Section 20.4 of ASCE 7 and the International Building Code (IBC). Based on the soil properties encountered at the site and as described on the exploration logs and results, it is our professional opinion that the Seismic Site Classification is D. Subsurface explorations at this site were extended to a maximum depth of 22 feet. The site properties below the boring depth to 100 feet were estimated based on our experience and knowledge of geologic conditions of the general area. Additional deeper borings or geophysical testing may be performed to confirm the conditions below the current boring depth.

LIQUEFACTION

Based on the relative density and groundwater depths encountered in the borings, we have evaluated liquefaction susceptibility per the requirements of Figure 1804.6b of the Massachusetts State Building Code, 9th Edition. It is our professional opinion that soils beneath site are not susceptible to liquefaction in the event of a seismic disturbance.

FLOOR SLABS

Design parameters for floor slabs assume the requirements in the **Earthwork** section have been followed. Specific attention should be given to positive drainage away from the structure and positive drainage of the aggregate base beneath the floor slab.

Floor Slab Design Parameters

Item	Description
Floor Slab Support [1]	Minimum 4 inches of well graded aggregate compacted to at least 95% of ASTM D 1557 [2]
Estimated Modulus of Subgrade Reaction [2]	150 pounds per square inch per inch (psi/in) for point loads
Modulus Correction Factor	$K_c=k((b+1)/2b)^2$

1. Floor slabs should be structurally independent of building footings or walls to reduce the possibility of floor slab cracking caused by differential movements between the slab and foundation.
2. Modulus of subgrade reaction is an estimated value based upon our experience with the subgrade condition, the requirements noted in **Earthwork**, and the floor slab support as noted in this table. It is provided for point loads. It is common to reduce the k-value to account for dimensional effects of large loaded areas using the modulus correction factor provided, where kc is the corrected or design modulus value and b is the mat width (short dimension) or tributary loaded area.

The use of a vapor retarder should be considered beneath concrete slabs on grade covered with wood, tile, carpet, or other moisture sensitive or impervious coverings, or when the slab will support equipment sensitive to moisture. When conditions warrant the use of a vapor retarder, the slab designer should refer to ACI 302 and/or ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder.

Saw-cut control joints should be placed in the slab to help control the location and extent of cracking. For additional recommendations refer to the ACI Design Manual. Joints or cracks should be sealed with a water-proof, non-extruding compressible compound specifically recommended for heavy duty concrete pavement and wet environments.

Floor Slab Construction Considerations

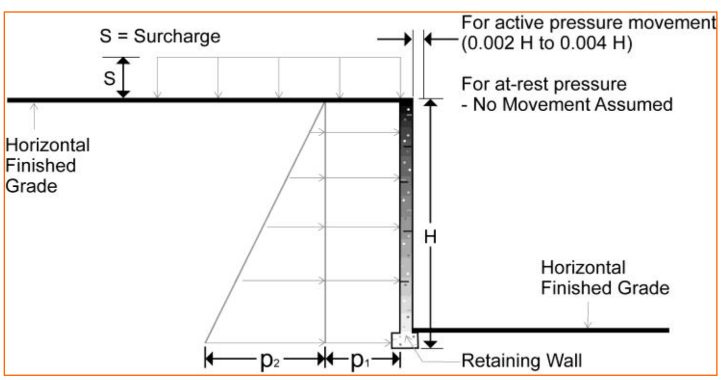
Finished subgrade, within and for at least 10 feet beyond the floor slab, should be protected from traffic, rutting, or other disturbance and maintained in a relatively moist condition until floor slabs are constructed. If the subgrade should become damaged or desiccated prior to construction of floor slabs, the affected material should be removed and Structural Fill should be added to replace the resulting excavation. Final conditioning of the finished subgrade should be performed immediately prior to placement of the floor slab support course.

The Geotechnical Engineer should approve the condition of the floor slab subgrades immediately prior to placement of the floor slab support course, reinforcing steel, and concrete. Attention should be paid to high traffic areas that were rutted and disturbed earlier, and to areas where backfilled trenches are located.

LATERAL EARTH PRESSURES

Design Parameters

Structures with unbalanced backfill levels on opposite sides should be designed for earth pressures at least equal to values indicated in the following table. Earth pressures will be influenced by structural design of the walls, conditions of wall restraint, methods of construction and/or compaction and the strength of the materials being restrained. Two wall restraint conditions are shown in the diagram below. Active earth pressure is commonly used for design of free-standing cantilever retaining walls and assumes wall movement. The "at-rest" condition assumes no wall movement and is commonly used for basement walls, loading dock walls, or other walls restrained at the top. The recommended design lateral earth pressures do not include a factor of safety and do not provide for possible hydrostatic pressure on the walls (unless stated).



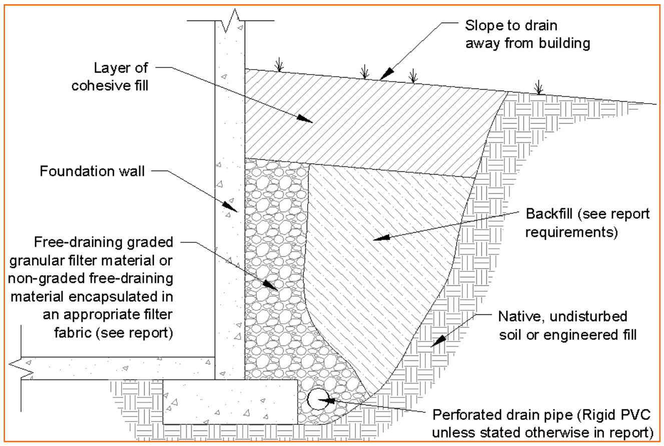
Lateral Earth Pressure Design Parameters				
Earth Pressure Condition [1]	**Coefficient for Backfill Type**[2]	**Surcharge Pressure** [3, 4, 5] **p_1 (psf)**	**Effective Fluid Pressures (psf)** [2, 4, 5]	
			Unsaturated [6]	**Submerged** [6]
Active (Ka)	Granular - 0.31	(0.31)S	(40)H	(80)H
At-Rest (Ko)	Granular - 0.47	(0.47)S	(55)H	(90)H
Passive (Kp)	Granular - 3.25	---	(390)H	(250)H

1. For active earth pressure, wall must rotate about base, with top lateral movements 0.002 H to 0.004 H, where H is wall height. For passive earth pressure, wall must move horizontally to mobilize resistance.
2. Uniform, horizontal backfill, compacted to at least 95% of the ASTM D 1557 maximum dry density, rendering a maximum unit weight of 120 pcf.
3. Uniform surcharge, where S is surcharge pressure.
4. Loading from heavy compaction equipment is not included.
5. No safety factor is included in these values.
6. To achieve "Unsaturated" conditions, follow guidelines in **Subsurface Drainage for Below-Grade Walls** below. "Submerged" conditions are recommended when drainage behind walls is not incorporated into the design.

Backfill placed against structures should consist of granular soils or low plasticity cohesive soils. For the granular values to be valid, the granular backfill must extend out and up from the base of the wall at an angle of at least 45 and 60 degrees from vertical for the active and passive cases, respectively.

Subsurface Drainage for Below-Grade Walls

A perforated rigid plastic drain line installed behind the base of walls and extends below adjacent grade is recommended to prevent hydrostatic loading on the walls. The invert of a drain line around a below-grade building area or exterior retaining wall should be placed near foundation bearing level. The drain line should be sloped to provide positive gravity drainage to daylight or to a sump pit and pump. The drain line should be surrounded by clean, free-draining granular material having less than 5% passing the No. 200 sieve, such as No. 57 aggregate. The free-draining aggregate should be encapsulated in a filter fabric. The granular fill should extend to within 2 feet of final grade, where it should be capped with compacted cohesive fill to reduce infiltration of surface water into the drain system.



As an alternative to free-draining granular fill, a pre-fabricated drainage structure may be used. A pre-fabricated drainage structure is a plastic drainage core or mesh which is covered with filter fabric to prevent soil intrusion, and is fastened to the wall prior to placing backfill.

FROST CONSIDERATIONS

The soils on this site are frost susceptible, and small amounts of water can affect the performance of the slabs on-grade and sidewalks. Exterior slabs should be anticipated to heave during winter months. If frost action needs to be eliminated in critical areas, we recommend the use of Non-Frost Susceptible (NFS) Fill or structural slabs (for instance, structural stoops in front of building doors). Placement of NFS Fill in large areas may not be feasible; however, the following recommendations are provided to help reduce potential frost heave:

- Provide surface drainage away from the building and slabs, and toward the site storm drainage system.
- Install drains around the perimeter of the building, stoops, below exterior slabs and connect them to the storm drainage system.
- Grade subgrades, so groundwater potentially perched in overlying more permeable subgrades, such as sand or aggregate base, slope toward a site drainage system.
- Place NFS Fill as backfill beneath sidewalks and slabs critical to the project.
- Place a 3 horizontal to 1 vertical (3H:1V) transition zone between NFS Fill and other soils.

As an alternative to extending NFS Fill to the full frost depth, consideration can be made to placing extruded polystyrene or cellular concrete under a buffer of at least 2 feet of NFS Fill.

PAVEMENTS

Pavement Subgrade Preparation

It is our understanding that at-grade parking and access roads would be constructed and/or near the current site grades. The results of our investigation did not encounter fill however there may be zones of fill placed during the previous development efforts. If it is desired to eliminate the risk of unacceptable pavement performance, fill materials if encountered should be removed in their entirety and replaced with compacted structural fill.

However, if the costs associated with improving these materials in accordance with the Earthwork section are deemed excessive, it is our opinion that the risk of unacceptable pavement performance can be significantly reduced (but not eliminated) by employing the following improvement efforts:

- Exposed subgrades should be proofrolled and compacted to a dense and stable consistency with at least 10 passes of a 10 ton (minimum total weight) vibratory roller.
- Materials (existing fill or native soils) that are unstable under the proofrolling equipment or are observed to contain concentrations of deleterious materials, should be removed and replaced under the guidance of our engineer.
- The excavation should be backfilled with structural fill in accordance with the recommendations provided in Earthwork.

Pavement subgrades should also be carefully evaluated for disturbance or softening from construction activities or weather as the time for pavement construction approaches. Unless the procedures recommended above are conducted immediately prior to paving, the subgrades should be rechecked and proofrolled prior to placing the pavement base course with a loaded tandem-axle dump truck. Particular attention should be paid to high traffic areas that were rutted and disturbed, to areas where backfilled trenches are located, and to areas of in-situ fill materials or other site improvements.

Areas where unsuitable conditions are located should be repaired by replacing the materials with properly compacted fill. When proofrolling/subgrade stabilization has been completed to the satisfaction of the geotechnical engineer, base may be placed.

Pavement Maintenance

Future performance of pavements constructed on the site will be dependent upon maintaining stable moisture contents of the subgrade soil. The performance of pavements may be enhanced by reducing excess moisture that can reach the subgrade soils. The following recommendations should be considered at a minimum:

- Grading the site to a minimum 2 percent slope away from the pavements;
- Installing an edge drain at the edge of the pavement on the higher side(s) of the site;
- Placing compacted backfill against the exterior side of curb and gutter; and,
- Placing curb and gutter directly on subgrade soils without the use of base course materials.

Preventative maintenance should be planned and provided through an on-going pavement management program in order to enhance future pavement performance, slow the rate of pavement deterioration, and preserve the pavement investment. Preventative maintenance, which consists of both localized maintenance, e.g., crack and joint sealing and patching, and global maintenance, e.g., surface sealing, is usually the first priority when implementing a planned pavement maintenance program, and provides the highest return on investment for pavements.

Prior to implementing such a program, additional engineering observation is recommended to assess the type and extent of preventative maintenance.

Pavement Design Parameters

Provided that the pavement subgrade is prepared in accordance with the recommendations of the Pavement Subgrade Section, we recommend designing the parking lot and drive aisles/access road pavement section using a preliminary CBR value of 10. In addition, we recommend that the pavement section contain at least 6 inches of aggregate base course to enhance drainage and long-term pavement performance.

Please note, however, that CBR values are highly dependent on the final subgrade material and condition of the subgrade at the time of construction. A Terracon geotechnical engineer should evaluate the subgrade and, if necessary, perform CBR testing on the final subgrade materials at the time of construction to confirm these preliminary design recommendations.

GENERAL COMMENTS

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Natural variations will occur between exploration point locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. Terracon should be retained as the Geotechnical Engineer, where noted in this report, to provide observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Our Scope of Services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence or collaboration through this system are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third-party beneficiaries intended. Any third-party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client, and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

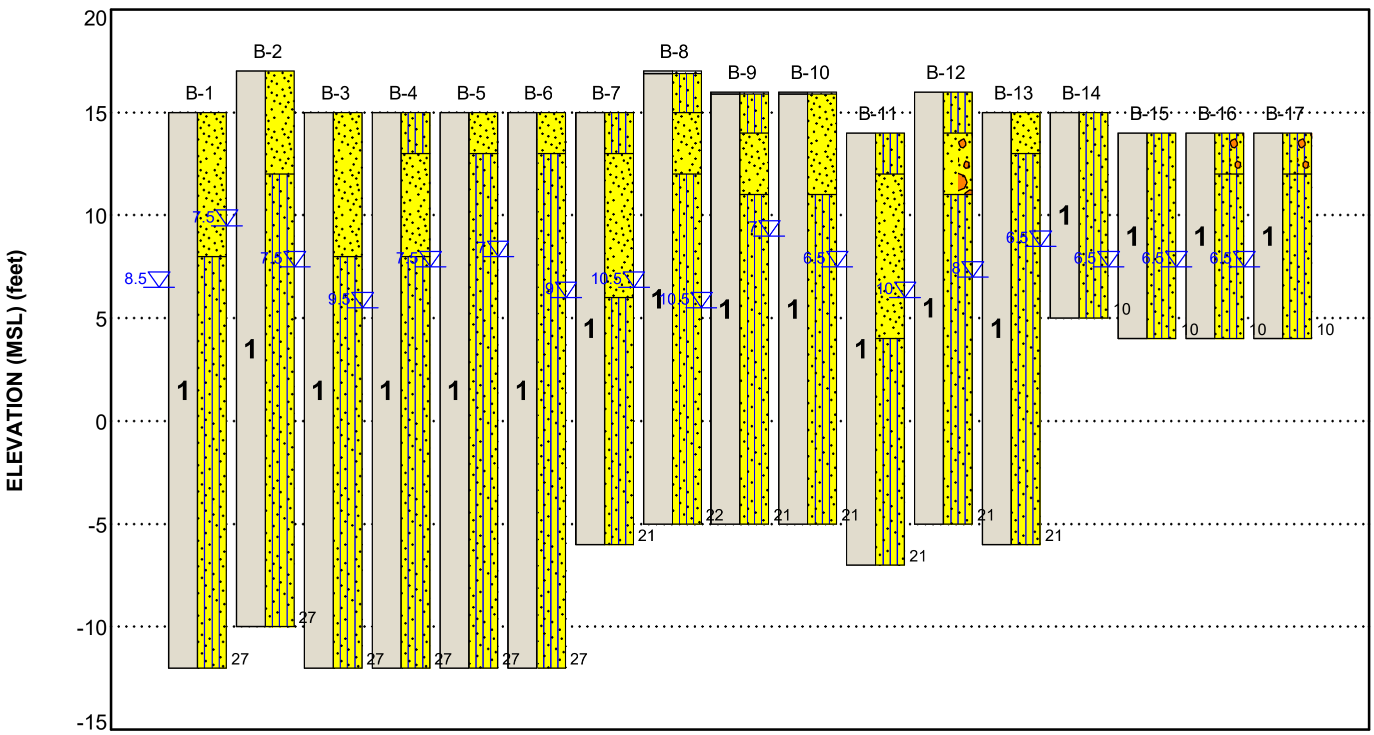
Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly impact excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety, and cost estimating including, excavation support, and dewatering requirements/design are the responsibility of others. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

FIGURES

Contents:

GEOMODEL

Pennrose Littleton Drive ■ Wareham, MA
Terracon Project No. J1205096



This is not a cross section. This is intended to display the Geotechnical Model only. See individual logs for more detailed conditions.

Model Layer	Layer Name	General Description
1	Sands	Poorly Graded Sand, Silty Sand and Silty Sand with Gravel, as well as Poorly Graded Sand with Gravel trace silt; orangish brown to light brown, very loose to medium dense

LEGEND

Poorly-graded Sand
Poorly-graded Sand with Gravel
Silty Sand
Silty Sand with Gravel
Topsoil

First Water Observation

Groundwater levels are temporal. The levels shown are representative of the date and time of our exploration. Significant changes are possible over time.
Water levels shown are as measured during and/or after drilling. In some cases, boring advancement methods mask the presence/absence of groundwater. See individual logs for details.

NOTES:
Layering shown on this figure has been developed by the geotechnical engineer for purposes of modeling the subsurface conditions as required for the subsequent geotechnical engineering for this project.
Numbers adjacent to soil column indicate depth below ground surface.

ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES

Field Exploration

Number of Borings	Boring Depth (feet)	Location
6	25	Senior Building
7	20	Townhouses and Community Building
4	10	Roadways

Boring Layout and Elevations: Unless otherwise noted, Terracon personnel provided the boring layout. Coordinates were obtained with a handheld GPS unit (estimated horizontal accuracy of about ±10 feet) and approximate elevations were obtained by interpolation from the Existing Conditions Plan provided.

Subsurface Exploration Procedures: We advanced the borings with a track-mounted rotary drill rig using continuous flight augers (solid stem and/or hollow stem, as necessary, depending on soil conditions). Four samples were obtained in the upper 10 feet of each boring and at intervals of 5 feet thereafter.. In the split-barrel sampling procedure, a standard 2-inch outer diameter split-barrel sampling spoon was driven into the ground by a 140-pound automatic hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration is recorded as the Standard Penetration Test (SPT) resistance value. The SPT resistance values, also referred to as N-values, are indicated on the boring logs at the test depths. We observed and recorded groundwater levels during drilling and sampling. For safety purposes, all borings were backfilled with auger cuttings after their completion.

The sampling depths, penetration distances, and other sampling information was recorded on the field boring logs. The samples were placed in appropriate containers and taken to our soil laboratory for testing and classification by a Geotechnical Engineer. A field engineer team prepared field boring logs as part of the drilling operations. These field logs included visual classifications of the materials encountered during drilling and our interpretation of the subsurface conditions between samples. Final boring logs were prepared from the field logs. The final boring logs represent the Geotechnical Engineer's interpretation of the field logs and include modifications based on observations and tests of the samples in our laboratory.

Laboratory Testing

The project engineer reviewed the field data and assigned laboratory tests to understand the engineering properties of the various soil strata, as necessary, for this project. Procedural standards noted below are for reference to methodology in general. In some cases, variations to methods were applied because of local practice or professional judgment. Standards noted below include reference to other, related standards. Such references are not necessarily applicable to describe the specific test performed.

- ASTM D422 Standard Test Method for Particle-Size Analysis of Soils

The laboratory testing program included examination of soil samples by an engineer. Based on the material's texture and plasticity, we described and classified the soil samples in accordance with the Unified Soil Classification System.

SITE LOCATION AND EXPLORATION PLANS

Contents:

Note: All attachments are one page unless noted above.

SITE LOCATION

Littleton Drive Multi-Unit Housing ■ Wareham, Massachusetts
January 13, 2021 ■ Terracon Project No. J1205096

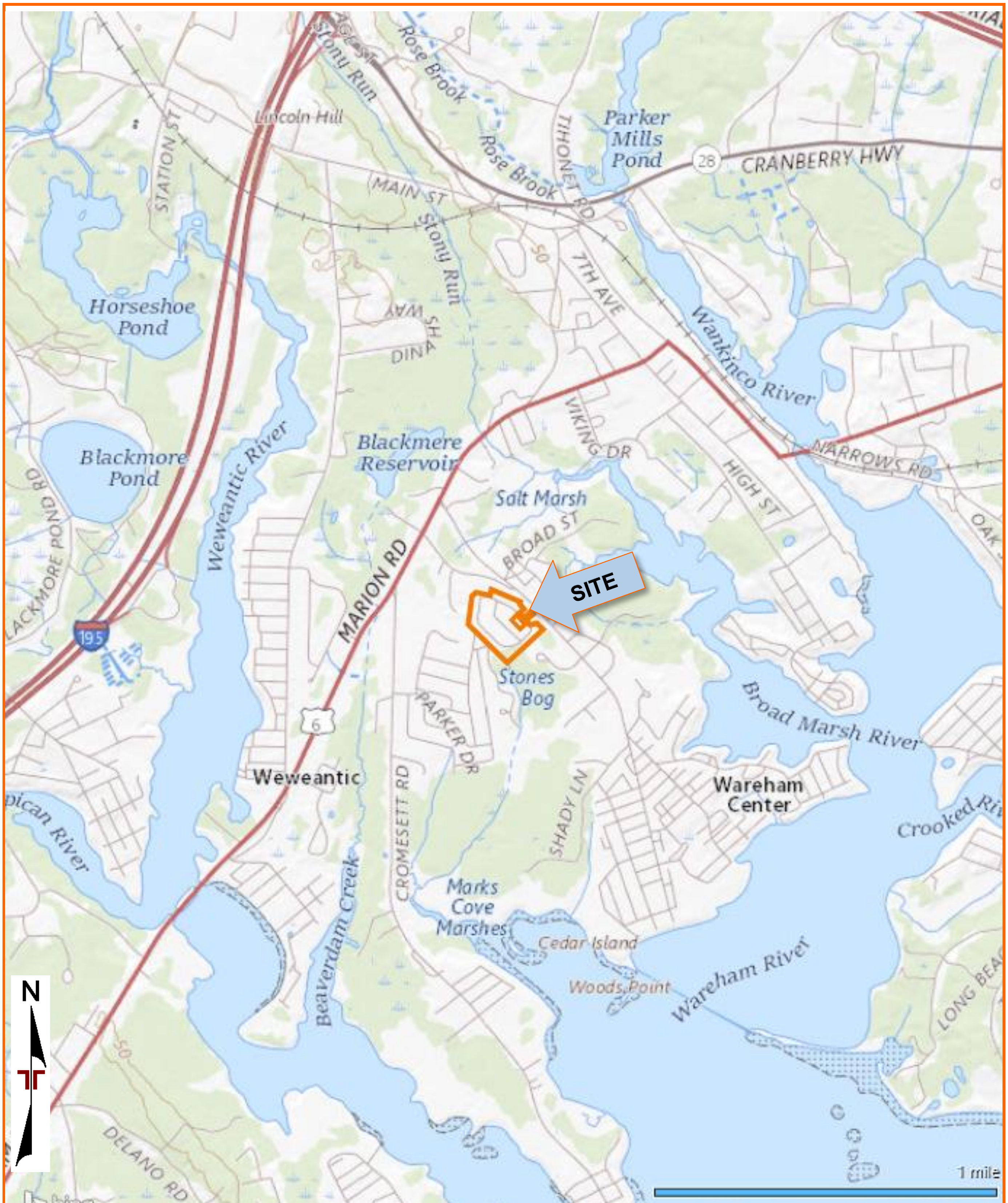


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP COURTESY OF THE U.S. GEOLOGICAL SURVEY

EXPLORATION PLAN – AERIAL OVERLAY

Littleton Drive Multi-Unit Housing ■ Wareham, Massachusetts
January 13, 2021 ■ Terracon Project No. J1205096

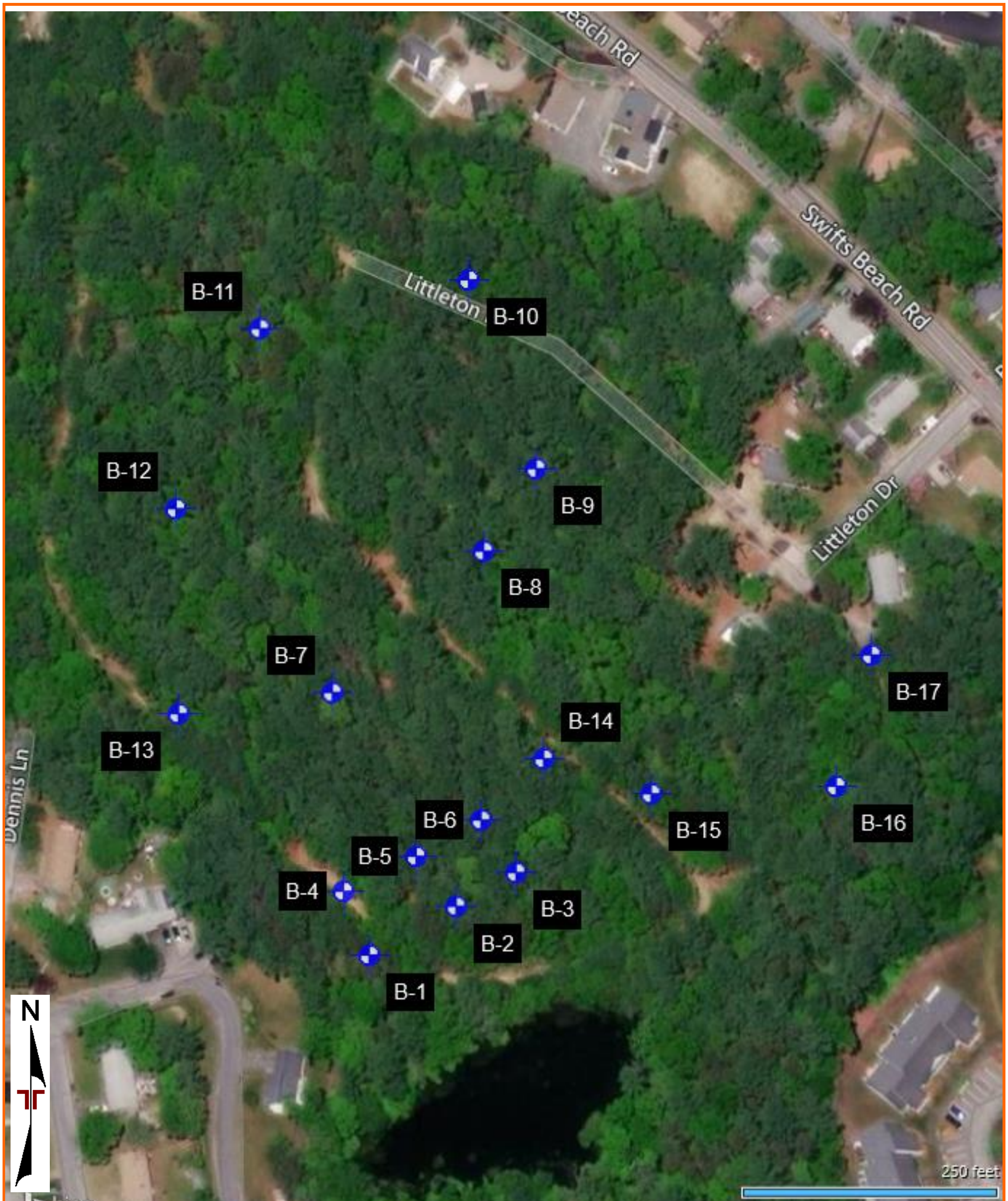


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

EXPLORATION PLAN – PLAN OVERLAY

Littleton Drive Multi-Unit Housing ■ Wareham, Massachusetts
January 13, 2021 ■ Terracon Project No. J1205096

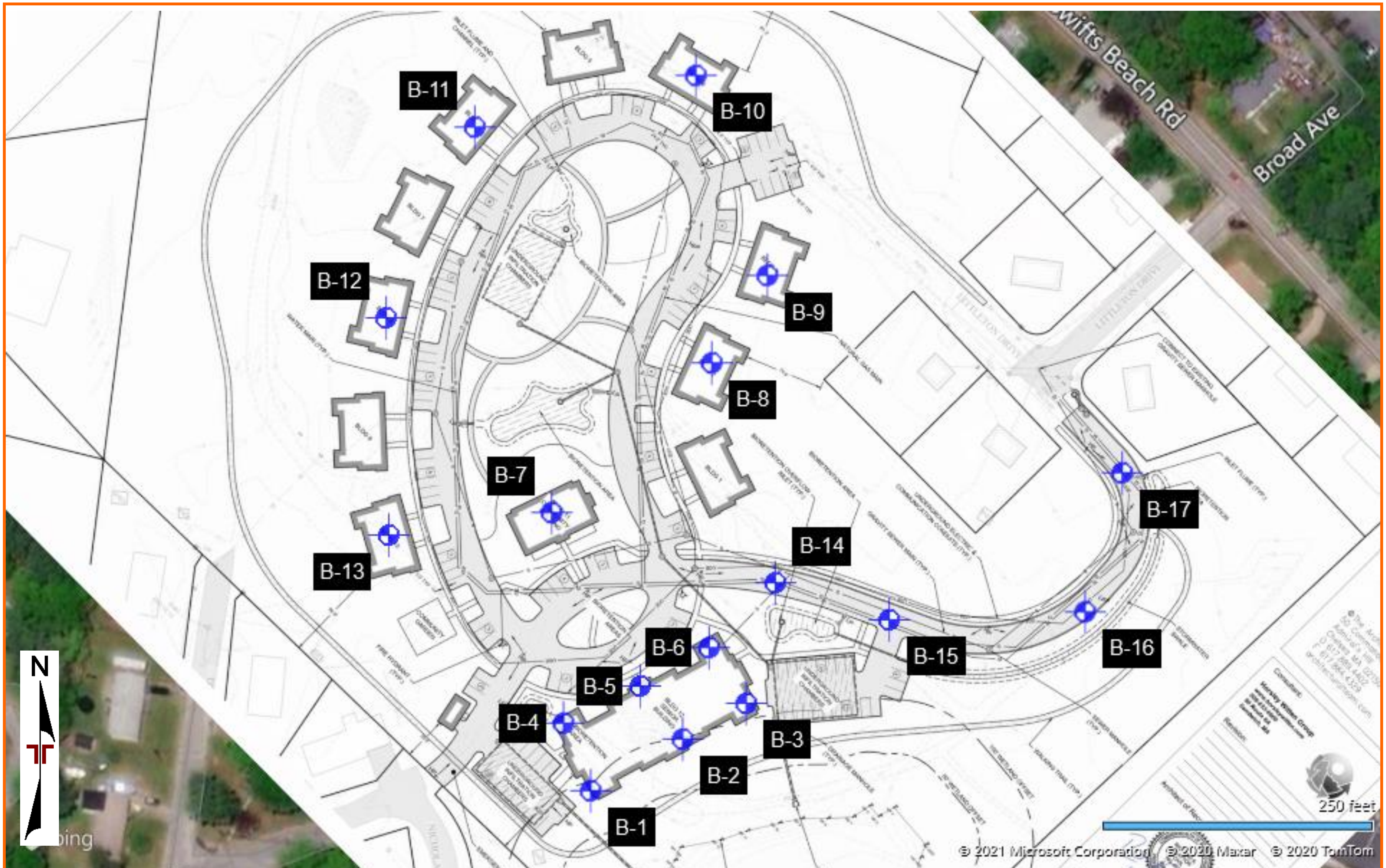


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

EXPLORATION RESULTS

Contents:

Note: All attachments are one page unless noted above.

BORING LOG NO. B-1

PROJECT: Pennrose Littleton Drive

CLIENT: Pennrose Properties, LLC Boston, MA

SITE: 4 Litttleton Drive Wareham, MA

LOCATION See Exploration Plan

Latitude: 41.7488° Longitude: -70.7293°

Approximate Surface Elev.: 15 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH / DESCRIPTION / ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS
1		**POORLY GRADED SAND (SP)**, trace silt and gravel, orangish brown, loose to medium dense			X	18	2-3-4-4 N=7
					X	18	7-8-8-7 N=16
			5		X	16	3-5-5-8 N=10
		7.0 — 8+/-					
		SILTY SAND (SM), light brown, loose to medium dense		▽	X	16	7-7-8-9 N=15
			10		X	24	3-4-5-6 N=9
			15		X	18	6-8-11-11 N=19
			20		X	20	5-6-7-9 N=13
			25		X	21	5-6-7-7 N=13
		27.0 — -12+/-					

Boring Terminated at 27 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.
Samples obtained using a 2" O.D. split spoon sampler

Hammer Type: Automatic

Advancement Method:
2-1/4-inch I.D. hollow stem augers

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *8.5 feet while drilling*

Terracon
77 Sundial Ave, Ste 401W
Manchester, NH

Boring Started: 12-10-2020	Boring Completed: 12-10-2020
Drill Rig: CME-850X	Driller: P. Michaud
Project No.: J1205096	

BORING LOG NO. B-2

PROJECT: Pennrose Littleton Drive

**CLIENT: Pennrose Properties, LLC
Boston, MA**

**SITE: 4 Litttleton Drive
Wareham, MA**

LOCATION See Exploration Plan

Latitude: 41.7489° Longitude: -70.7290°

Approximate Surface Elev.: 17 (Ft.) +/-

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS
1		**POORLY GRADED SAND (SP)**, trace silt, orangish brown to light brown, very loose to loose				X	12	1-1-1-2 N=2
		Similar, trace gravel				X	10	4-4-4-4 N=8
	5.0		12+/-	5				
		SILTY SAND (SM), light brown, loose to medium dense				X	20	5-5-6-7 N=11
					▽	X	15	4-5-5-5 N=10
				10		X	24	4-5-4-5 N=9
				15		X	20	4-9-9-11 N=18
				20		X	24	3-5-6-5 N=11
	27.0		-10+/-	25		X	24	5-5-5-5 N=10
		Boring Terminated at 27 Feet						

Stratification lines are approximate. In-situ, the transition may be gradual.
Samples obtained using a 2" O.D. split spoon sampler

Hammer Type: Automatic

Advancement Method:
2-1/4-inch I.D. hollow stem augers

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *7.5 feet while drilling*

Terracon
77 Sundial Ave, Ste 401W
Manchester, NH

Boring Started: 12-10-2020	Boring Completed: 12-10-2020
Drill Rig: CME-850X	Driller: P. Michaud
Project No.: J1205096	

BORING LOG NO. B-3

PROJECT: Pennrose Littleton Drive

CLIENT: Pennrose Properties, LLC
Boston, MA

SITE: 4 Litttleton Drive
Wareham, MA

LOCATION See Exploration Plan

Latitude: 41.7490° Longitude: -70.7288°

Approximate Surface Elev.: 15 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS
1		**POORLY GRADED SAND (SP)**, trace silt, orangish brown to light brown, very loose to loose				X	16	1-1-2-2 N=3
		Similar, trace gravel				X	15	4-4-4-4 N=8
				5		X	15	3-5-6-8 N=11
		7.0	8+/-		▽			
		SILTY SAND (SM), light brown, loose to medium dense				X	15	4-6-7-6 N=13
				10		X	20	2-2-3-4 N=5
				15		X	24	2-5-7-8 N=12
				20		X	24	4-6-6-6 N=12
				25		X	24	4-6-6-6 N=12
		27.0	-12+/-					
		Boring Terminated at 27 Feet						

Stratification lines are approximate. In-situ, the transition may be gradual.
Samples obtained using a 2" O.D. split spoon sampler

Hammer Type: Automatic

Advancement Method:
2-1/4-inch I.D. hollow stem augers

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *7.5 feet while drilling*

Terracon
77 Sundial Ave, Ste 401W
Manchester, NH

Boring Started: 12-10-2020	Boring Completed: 12-10-2020
Drill Rig: CME-850X	Driller: P. Michaud
Project No.: J1205096	

BORING LOG NO. B-4

PROJECT: Pennrose Littleton Drive

SITE: 4 Litttleton Drive, Wareham, MA

CLIENT: Pennrose Properties, LLC, Boston, MA

LOCATION See Exploration Plan

Latitude: 41.7489° Longitude: -70.7294°

Approximate Surface Elev.: 15 (Ft.) +/-

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS
1		**SILTY SAND (SM)**, orangish brown, loose				X	12	3-3-4-4 N=7
	2.0		13+/-					
		POORLY GRADED SAND (SP), light brown, medium dense				X	14	5-5-5-5 N=10
				5		X	20	4-5-6-7 N=11
	7.0		8+/-					
		SILTY SAND (SM), light brown, loose to medium dense				X	14	6-6-7-5 N=13
					▽			
				10		X	20	4-4-5-9 N=9
				15		X	24	4-5-5-7 N=10
				20		X	24	3-6-7-8 N=13
				25		X	24	3-5-8-8 N=13
	27.0		-12+/-					
		Boring Terminated at 27 Feet						

Stratification lines are approximate. In-situ, the transition may be gradual.
Samples obtained using a 2" O.D. split spoon sampler

Hammer Type: Automatic

Advancement Method:
2-1/4-inch I.D. hollow stem augers

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *9.5 feet while drilling*

Terracon
77 Sundial Ave, Ste 401W
Manchester, NH

Boring Started: 12-10-2020	Boring Completed: 12-10-2020
Drill Rig: CME-850X	Driller: P. Michaud
Project No.: J1205096	

BORING LOG NO. B-5

PROJECT: Pennrose Littleton Drive

CLIENT: Pennrose Properties, LLC
Boston, MA

SITE: 4 Litttleton Drive
Wareham, MA

LOCATION See Exploration Plan

Latitude: 41.7490° Longitude: -70.7292°

Approximate Surface Elev.: 15 (Ft.) +/-

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS
1		**POORLY GRADED SAND (SP)**, trace silt and gravel, orangish brown, loose				X	10	1-2-2-2 N=4
	2.0		13+/-					
		SILTY SAND (SM), light brown, loose to medium dense				X	12	4-5-5-4 N=10
				5		X	18	3-5-4-6 N=9
					▽	X	12	3-5-6-5 N=11
				10		X	20	3-4-4-4 N=8
				15		X	20	3-4-5-7 N=9
				20		X	24	2-3-4-7 N=7
				25		X	24	3-4-7-7 N=11
	27.0		-12+/-					
		Boring Terminated at 27 Feet						

Stratification lines are approximate. In-situ, the transition may be gradual.
Samples obtained using a 2" O.D. split spoon sampler

Hammer Type: Automatic

Advancement Method:
2-1/4-inch I.D. hollow stem augers

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *7.5 feet while drilling*

Terracon
77 Sundial Ave, Ste 401W
Manchester, NH

Boring Started: 12-10-2020	Boring Completed: 12-10-2020
Drill Rig: CME-850X	Driller: P. Michaud
Project No.: J1205096	

BORING LOG NO. B-6

PROJECT: Pennrose Littleton Drive

CLIENT: Pennrose Properties, LLC
Boston, MA

SITE: 4 Litttleton Drive
Wareham, MA

LOCATION See Exploration Plan

Latitude: 41.7491° Longitude: -70.7289°

Approximate Surface Elev.: 15 (Ft.) +/-

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS
1		**POORLY GRADED SAND (SP)**, trace silt, orangish brown, very loose				X	18	2-2-1-1 N=3
	2.0		13+/-					
		SILTY SAND (SM), light brown, loose to medium dense				X	8	2-3-3-3 N=6
				5		X	20	3-4-5-5 N=9
					▽	X	14	3-4-4-3 N=8
				10		X	24	2-3-3-5 N=6
				15		X	20	5-8-6-7 N=14
				20		X	18	3-4-3-4 N=7
				25		X	18	4-4-6-5 N=10
	27.0		-12+/-					

Boring Terminated at 27 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.
Samples obtained using a 2" O.D. split spoon sampler

Hammer Type: Automatic

Advancement Method:
2-1/4-inch I.D. hollow stem augers

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *7 feet while drilling*

Terracon
77 Sundial Ave, Ste 401W
Manchester, NH

Boring Started: 12-10-2020	Boring Completed: 12-10-2020
Drill Rig: CME-850X	Driller: P. Michaud
Project No.: J1205096	

BORING LOG NO. B-7

PROJECT: Pennrose Littleton Drive

CLIENT: Pennrose Properties, LLC
Boston, MA

SITE: 4 Litttleton Drive
Wareham, MA

LOCATION See Exploration Plan

Latitude: 41.7495° Longitude: -70.7295°

Approximate Surface Elev.: 15 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH	Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS
1		2.0	**SILTY SAND (SM)**, orangish brown, very loose	13+/-			X	12	1-1-1-1 N=2
		9.0	**POORLY GRADED SAND (SP)**, trace silt and gravel, orangish brown, loose	6+/-			X	12	2-2-2-3 N=4
					5		X	19	4-5-5-6 N=10
						▽	X	14	5-5-4-5 N=9
		21.0	**SILTY SAND (SM)**, light brown, loose to medium dense	-6+/-	10		X	20	4-6-9-12 N=15
					15		X	15	4-8-12-12 N=20
					20		X	24	7-7-10-11 N=17
			Boring Terminated at 21 Feet						

Stratification lines are approximate. In-situ, the transition may be gradual.
Samples obtained using a 2" O.D. split spoon sampler

Hammer Type: Automatic

Advancement Method:
2-1/4-inch I.D. hollow stem augers

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *9 feet while drilling*

Terracon
77 Sundial Ave, Ste 401W
Manchester, NH

Boring Started: 12-09-2020	Boring Completed: 12-09-2020
Drill Rig: CME-850X	Driller: P. Michaud
Project No.: J1205096	

BORING LOG NO. B-8

PROJECT: Pennrose Littleton Drive

CLIENT: Pennrose Properties, LLC
Boston, MA

SITE: 4 Litttleton Drive
Wareham, MA

LOCATION See Exploration Plan

Latitude: 41.7498° Longitude: -70.7289°

Approximate Surface Elev.: 17 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS
1		0.1	1-inch of topsoil with roots, brown	17+/-			X	18	1-1-1-1 N=2
		2.0	**SILTY SAND (SM)**, trace gravel, orangish brown, very loose	15+/-			X	10	3-3-4-3 N=7
		5.0	**POORLY GRADED SAND (SP)**, orangish brown, loose	12+/-	5				
			SILTY SAND (SM), light brown, loose to medium dense				X	20	3-5-7-8 N=12
							X	14	7-7-7-7 N=14
					10	▽	X	24	6-7-5-6 N=12
					15		X	14	3-3-5-6 N=8
		22.0		-5+/-	20		X	17	4-7-7-8 N=14

Boring Terminated at 22 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.
Samples obtained using a 2" O.D. split spoon sampler

Hammer Type: Automatic

Advancement Method:
2-1/4-inch I.D. hollow stem augers

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *10.5 feet while drilling*

Terracon
77 Sundial Ave, Ste 401W
Manchester, NH

Boring Started: 12-09-2020	Boring Completed: 12-09-2020
Drill Rig: CME-850X	Driller: P. Michaud
Project No.: J1205096	

BORING LOG NO. B-9

PROJECT: Pennrose Littleton Drive

CLIENT: Pennrose Properties, LLC
Boston, MA

SITE: 4 Litttleton Drive
Wareham, MA

LOCATION See Exploration Plan

Latitude: 41.7501° Longitude: -70.7287°

Approximate Surface Elev.: 16 (Ft.) +/-

MODEL LAYER	DEPTH	MATERIAL DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS
1	0.1	1-inch of topsoil with roots, dark brown	16+/-					
	2.0	**SILTY SAND (SM)**, trace gravel, orangish brown, very loose	14+/-			X	8	1-1-1-1 N=2
	5.0	**POORLY GRADED SAND (SP)**, light brown, loose	11+/-	5		X	12	2-3-4-5 N=7
	21.0	**SILTY SAND (SM)**, light brown, medium dense	-5+/-			X	20	3-5-6-7 N=11
				10		X	15	6-7-6-6 N=13
					▽	X	18	7-6-6-7 N=12
				15		X	22	3-4-6-8 N=10
				20		X	24	7-12-15-15 N=27

Boring Terminated at 21 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.
Samples obtained using a 2" O.D. split spoon sampler

Hammer Type: Automatic

Advancement Method:
2-1/4-inch I.D. hollow stem augers

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *10.5 feet while drilling*

Terracon
77 Sundial Ave, Ste 401W
Manchester, NH

Boring Started: 12-09-2020	Boring Completed: 12-09-2020
Drill Rig: CME-850X	Driller: P. Michaud
Project No.: J1205096	

BORING LOG NO. B-10

PROJECT: Pennrose Littleton Drive

CLIENT: Pennrose Properties, LLC
Boston, MA

SITE: 4 Litttleton Drive
Wareham, MA

LOCATION See Exploration Plan

Latitude: 41.7506° Longitude: -70.7290°

Approximate Surface Elev.: 16 (Ft.) +/-

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS
1	0.1	1-inch of topsoil with roots, brown	16+/-					
		POORLY GRADED SAND (SP), light brown, loose				X	14	3-3-3-3 N=6
						X	13	5-5-5-5 N=10
	5.0	**SILTY SAND (SM)**, light brown, medium dense	11+/-	5				
					▽	X	20	4-7-8-9 N=15
						X	12	7-7-8-9 N=15
				10		X	20	3-5-8-10 N=13
				15		X	22	10-14-15-14 N=29
	21.0		-5+/-	20		X	20	10-10-14-13 N=24

Boring Terminated at 21 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.
Samples obtained using a 2" O.D. split spoon sampler

Hammer Type: Automatic

Advancement Method:
2-1/4-inch I.D. hollow stem augers

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *7 feet while drilling*

Terracon
77 Sundial Ave, Ste 401W
Manchester, NH

Boring Started: 12-09-2020	Boring Completed: 12-09-2020
Drill Rig: CME-850X	Driller: P. Michaud
Project No.: J1205096	

BORING LOG NO. B-11

PROJECT: Pennrose Littleton Drive

CLIENT: Pennrose Properties, LLC
Boston, MA

SITE: 4 Litttleton Drive
Wareham, MA

LOCATION See Exploration Plan

Latitude: 41.7504° Longitude: -70.7297°

Approximate Surface Elev.: 14 (Ft.) +/-

MODEL LAYER	DEPTH	Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS
1		**SILTY SAND (SM)**, brown to orangish brown, very loose				X	12	1-1-2-3 N=3
	2.0		12+/-					
		POORLY GRADED SAND (SP), trace silt, orangish brown to light brown, loose to medium dense				X	14	4-5-5-4 N=10
				5				
					▽	X	16	2-4-5-7 N=9
						X	24	4-6-6-6 N=12
	10.0		4+/-	10				
		SILTY SAND (SM), light brown, medium dense				X	18	4-5-5-5 N=10
				15		X	24	3-5-12-12 N=17
				20		X	24	5-8-9-9 N=17
	21.0		-7+/-					
		Boring Terminated at 21 Feet						

Stratification lines are approximate. In-situ, the transition may be gradual.
Samples obtained using a 2" O.D. split spoon sampler

Hammer Type: Automatic

Advancement Method:
2-1/4-inch I.D. hollow stem augers

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *6.5 feet while drilling*

Terracon
77 Sundial Ave, Ste 401W
Manchester, NH

Boring Started: 12-09-2020	Boring Completed: 12-09-2020
Drill Rig: CME-850X	Driller: P. Michaud
Project No.: J1205096	

BORING LOG NO. B-12

PROJECT: Pennrose Littleton Drive

CLIENT: Pennrose Properties, LLC
Boston, MA

SITE: 4 Litttleton Drive
Wareham, MA

LOCATION See Exploration Plan

Latitude: 41.7499° Longitude: -70.7300°

Approximate Surface Elev.: 16 (Ft.) +/-

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS
1		**SILTY SAND (SM)**, trace gravel, orangish brown, very loose				X	15	1-2-1-2 N=3
	2.0	**POORLY GRADED SAND WITH GRAVEL (SP)**, light brown, medium dense	14+/-			X	10	5-6-6-6 N=12
	5.0	**SILTY SAND (SM)**, light brown, loose to medium dense	11+/-	5		X	14	5-5-5-7 N=10
		Similar, trace oxidation				X	12	5-5-5-5 N=10
				10	▽	X	18	3-4-5-6 N=9
				15		X	24	7-12-11-12 N=23
	21.0		-5+/-	20		X	24	8-8-9-9 N=17
		Boring Terminated at 21 Feet						

Stratification lines are approximate. In-situ, the transition may be gradual.
Samples obtained using a 2" O.D. split spoon sampler

Hammer Type: Automatic

Advancement Method:
2-1/4-inch I.D. hollow stem augers

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *10 feet while drilling*

Terracon
77 Sundial Ave, Ste 401W
Manchester, NH

Boring Started: 12-09-2020	Boring Completed: 12-09-2020
Drill Rig: CME-850X	Driller: P. Michaud
Project No.: J1205096	

BORING LOG NO. B-13

PROJECT: Pennrose Littleton Drive

CLIENT: Pennrose Properties, LLC
Boston, MA

SITE: 4 Litttleton Drive
Wareham, MA

LOCATION See Exploration Plan

Latitude: 41.7494° Longitude: -70.7300°

Approximate Surface Elev.: 15 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS
		POORLY GRADED SAND (SP), trace silt, orangish brown, loose				X	18	2-2-3-3 N=5
		2.0	13+/-					
1		**SILTY SAND (SM)**, light brown, loose to medium dense				X	12	3-4-3-4 N=7
				5		X	12	4-5-5-5 N=10
					▽	X	24	4-5-4-5 N=9
				10		X	15	4-8-9-11 N=17
				15		X	24	7-11-15-15 N=26
				20		X	24	7-8-9-10 N=17
		21.0	-6+/-					
		Boring Terminated at 21 Feet						

Stratification lines are approximate. In-situ, the transition may be gradual.
Samples obtained using a 2" O.D. split spoon sampler

Hammer Type: Automatic

Advancement Method:
2-1/4-inch I.D. hollow stem augers

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *8 feet while drilling*

Terracon
77 Sundial Ave, Ste 401W
Manchester, NH

Boring Started: 12-09-2020	Boring Completed: 12-09-2020
Drill Rig: CME-850X	Driller: P. Michaud
Project No.: J1205096	

BORING LOG NO. B-14

PROJECT: Pennrose Littleton Drive

CLIENT: Pennrose Properties, LLC
Boston, MA

SITE: 4 Litttleton Drive
Wareham, MA

LOCATION See Exploration Plan

Latitude: 41.7493° Longitude: -70.7287°

Approximate Surface Elev.: 15 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH / DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS
1		**SILTY SAND (SM)**, light brown to brown, loose				X	20	3-4-3-4 N=7
						X	18	4-5-4-5 N=9
		Similar, trace oxidation		5				
					▽	X	15	4-4-5-5 N=9
		10.0	5+/-	10		X		4-5-4-4 N=9
		Boring Terminated at 10 Feet						

Stratification lines are approximate. In-situ, the transition may be gradual.
Samples obtained using a 2" O.D. split spoon sampler

Hammer Type: Automatic

Advancement Method:
2-1/4-inch I.D. hollow stem augers

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *6.5 feet while drilling*

Terracon
77 Sundial Ave, Ste 401W
Manchester, NH

Boring Started: 12-11-2020	Boring Completed: 12-11-2020
Drill Rig: CME-850X	Driller: P. Michaud
Project No.: J1205096	

BORING LOG NO. B-15

PROJECT: Pennrose Littleton Drive

CLIENT: Pennrose Properties, LLC
Boston, MA

SITE: 4 Litttleton Drive
Wareham, MA

LOCATION See Exploration Plan

Latitude: 41.7492° Longitude: -70.7283°

Approximate Surface Elev.: 14 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS
1		**SILTY SAND (SM)**, trace gravel, brown to light brown, loose to medium dense				X	20	5-6-7-5 N=13
						X	8	6-5-5-5 N=10
				5				
					▽	X	21	4-5-4-6 N=9
		Similar, trace oxidation				X	22	6-6-6-6 N=12
		10.0	4+/-	10				
		Boring Terminated at 10 Feet						

Stratification lines are approximate. In-situ, the transition may be gradual.
Samples obtained using a 2" O.D. split spoon sampler

Hammer Type: Automatic

Advancement Method:
2-1/4-inch I.D. hollow stem augers

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *6.5 feet while drilling*

Terracon
77 Sundial Ave, Ste 401W
Manchester, NH

Boring Started: 12-11-2020	Boring Completed: 12-11-2020
Drill Rig: CME-850X	Driller: P. Michaud
Project No.: J1205096	

BORING LOG NO. B-16

PROJECT: Pennrose Littleton Drive

CLIENT: Pennrose Properties, LLC
Boston, MA

SITE: 4 Litttleton Drive
Wareham, MA

LOCATION See Exploration Plan

Latitude: 41.7492° Longitude: -70.7277°

Approximate Surface Elev.: 14 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS
1			**SILTY SAND WITH GRAVEL (SM)**, orangish brown, medium dense				X	15	7-6-5-4 N=11
		2.0		12+/-					
			SILTY SAND (SM), trace oxidation, light brown, loose to medium dense				X	14	6-7-7-6 N=14
					5				
						▽	X	18	3-3-2-4 N=5
							X	20	3-3-3-3 N=6
		10.0		4+/-	10				
			Boring Terminated at 10 Feet						

Stratification lines are approximate. In-situ, the transition may be gradual.
Samples obtained using a 2" O.D. split spoon sampler

Hammer Type: Automatic

Advancement Method:
2-1/4-inch I.D. hollow stem augers

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *6.5 feet while drilling*

Terracon
77 Sundial Ave, Ste 401W
Manchester, NH

Boring Started: 12-11-2020	Boring Completed: 12-11-2020
Drill Rig: CME-850X	Driller: P. Michaud
Project No.: J1205096	

BORING LOG NO. B-17

PROJECT: Pennrose Littleton Drive

**CLIENT: Pennrose Properties, LLC
Boston, MA**

**SITE: 4 Litttleton Drive
Wareham, MA**

LOCATION See Exploration Plan

Latitude: 41.7496° Longitude: -70.7275°

Approximate Surface Elev.: 14 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS
1			**SILTY SAND WITH GRAVEL (SM)**, brown, loose				X	16	5-4-3-4 N=7
		2.0		12+/-					
			SILTY SAND (SM), oxidized, light brown, medium dense				X	10	4-5-5-4 N=10
					5				
						▽	X	12	3-4-6-6 N=10
			Similar, trace oxidation				X		6-6-6-6 N=12
		10.0		4+/-	10				
			Boring Terminated at 10 Feet						

Stratification lines are approximate. In-situ, the transition may be gradual.
Samples obtained using a 2" O.D. split spoon sampler

Hammer Type: Automatic

Advancement Method:
2-1/4-inch I.D. hollow stem augers

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

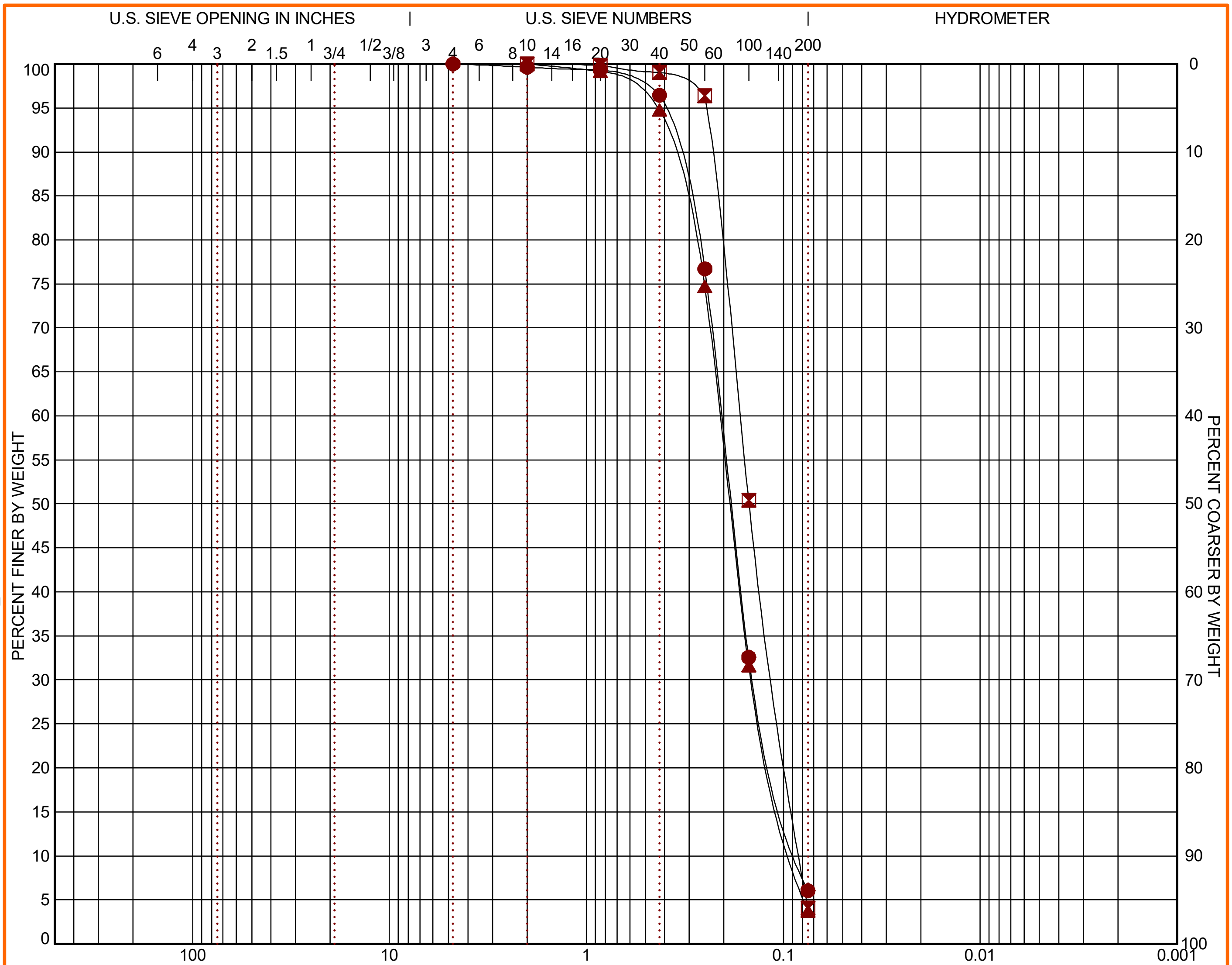
▽ *6.5 feet while drilling*

Terracon
77 Sundial Ave, Ste 401W
Manchester, NH

Boring Started: 12-11-2020	Boring Completed: 12-11-2020
Drill Rig: CME-850X	Driller: P. Michaud
Project No.: J1205096	

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
●	B-1	5 - 7	0.0	0.0	94.0		6.0		SP
⊠	B-3	5 - 7	0.0	0.0	96.0		4.0		SP
▲	B-4	5 - 7	0.0	0.0	96.3		3.7		SP

GRAIN SIZE			
	●	⊠	▲
D_{60}	0.206	0.167	0.21
D_{30}	0.14	0.111	0.144
D_{10}	0.083	0.082	0.088

COEFFICIENTS			
	●	⊠	▲
C_C	1.15	0.89	1.13
C_U	2.48	2.04	2.39

●		⊠		▲	
Sieve	% Finer	Sieve	% Finer	Sieve	% Finer
#4	100.0	#10	100.0	#10	100.0
#10	99.63	#20	99.81	#20	99.15
#20	99.34	#40	99.06	#40	94.76
#40	96.44	#60	96.36	#60	74.7
#60	76.71	#100	50.42	#100	31.6
#100	32.56	#200	4.04	#200	3.69
#200	6.03				

SOIL DESCRIPTION	
●	POORLY GRADED SAND (SP)
⊠	POORLY GRADED SAND (SP)
▲	POORLY GRADED SAND (SP)

REMARKS	
●	
⊠	
▲	

PROJECT: Pennrose Littleton Drive

PROJECT NUMBER: J1205096

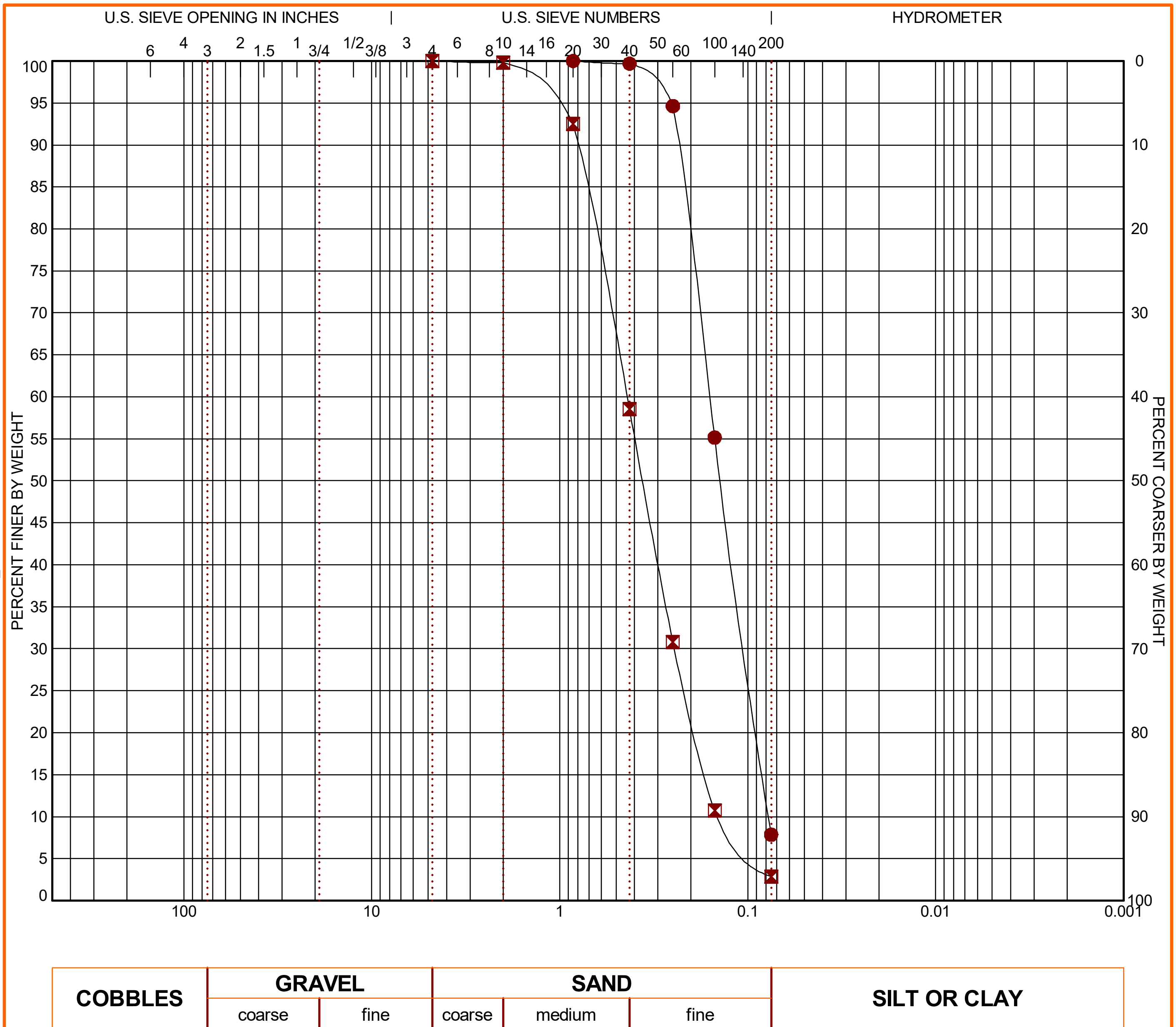
SITE: 4 Litttleton Drive
Wareham, MA

Terracon
77 Sundial Ave, Ste 401W
Manchester, NH

CLIENT: Pennrose Properties, LLC
Boston, MA

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



	BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
●	**B-7**	7 - 9	0.0	0.0	92.2		7.8		SP
⊠	**B-11**	5 - 7	0.0	0.0	97.1		2.9		SP

GRAIN SIZE

	●	⊠	
D_{60}	0.16	0.438	
D_{30}	0.104	0.245	
D_{10}	0.077	0.141	

COEFFICIENTS

	●	⊠	
C_C	0.87	0.97	
C_U	2.06	3.11	

● Sieve	● % Finer	⊠ Sieve	⊠ % Finer	Sieve	% Finer
#20	100.0	#4	100.0		
#40	99.69	#10	99.78		
#60	94.63	#20	92.48		
#100	55.15	#40	58.54		
#200	7.85	#60	30.8		
		#100	10.73		
		#200	2.86		

SOIL DESCRIPTION

● POORLY GRADED SAND (SP)

⊠ POORLY GRADED SAND (SP)

REMARKS

●

⊠

PROJECT: Pennrose Littleton Drive

SITE: 4 Litttleton Drive
Wareham, MA

Terracon
77 Sundial Ave, Ste 401W
Manchester, NH

PROJECT NUMBER: J1205096

CLIENT: Pennrose Properties, LLC
Boston, MA

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: USCS 1 J1205096 PENNROSE LITTLETON DRIVE.GPJ TERRACON_DATATEMPLATE.GDT 1/11/21

SUPPORTING INFORMATION

Contents:

Note: All attachments are one page unless noted above.

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

Pennrose Littleton Drive ■ Wareham, MA

Terracon Project No. J1205096

Terracon GeoReport

SAMPLING	WATER LEVEL	FIELD TESTS
Standard Penetration Test	**Water Initially Encountered** **Water Level After a Specified Period of Time** **Water Level After a Specified Period of Time** **Cave In Encountered** Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.	**N** **Standard Penetration Test Resistance (Blows/Ft.)** **(HP)** **Hand Penetrometer** **(T)** **Torvane** **(DCP)** **Dynamic Cone Penetrometer** **UC** **Unconfined Compressive Strength** **(PID)** **Photo-Ionization Detector** **(OVA)** **Organic Vapor Analyzer**

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification as noted on the soil boring logs is based Unified Soil Classification System. Where sufficient laboratory data exist to classify the soils consistent with ASTM D2487 "Classification of Soils for Engineering Purposes" this procedure is used. ASTM D2488 "Description and Identification of Soils (Visual-Manual Procedure)" is also used to classify the soils, particularly where insufficient laboratory data exist to classify the soils in accordance with ASTM D2487. In addition to USCS classification, coarse grained soils are classified on the basis of their in-place relative density, and fine-grained soils are classified on the basis of their consistency. See "Strength Terms" table below for details. The ASTM standards noted above are for reference to methodology in general. In some cases, variations to methods are applied as a result of local practice or professional judgment.

LOCATION AND ELEVATION NOTES

Exploration point locations as shown on the Exploration Plan and as noted on the soil boring logs in the form of Latitude and Longitude are approximate. See Exploration and Testing Procedures in the report for the methods used to locate the exploration points for this project. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

STRENGTH TERMS

RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance		**CONSISTENCY OF FINE-GRAINED SOILS** (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance		
Descriptive Term (Density)	**Standard Penetration or N-Value Blows/Ft.**	**Descriptive Term (Consistency)**	**Unconfined Compressive Strength Qu, (tsf)**	**Standard Penetration or N-Value Blows/Ft.**
Very Loose	0 - 3	Very Soft	less than 0.25	0 - 1
Loose	4 - 9	Soft	0.25 to 0.50	2 - 4
Medium Dense	10 - 29	Medium Stiff	0.50 to 1.00	4 - 8
Dense	30 - 50	Stiff	1.00 to 2.00	8 - 15
Very Dense	> 50	Very Stiff	2.00 to 4.00	15 - 30
		Hard	> 4.00	> 30

RELEVANCE OF SOIL BORING LOG

The soil boring logs contained within this document are intended for application to the project as described in this document. Use of these soil boring logs for any other purpose may not be appropriate.

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]					Soil Classification	
					Group Symbol	**Group Name** [B]
Coarse-Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$ [E]		GW	Well-graded gravel [F]
			$Cu < 4$ and/or [Cc<1 or Cc>3.0] [E]		GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH		GM	Silty gravel [F, G, H]
			Fines classify as CL or CH		GC	Clayey gravel [F, G, H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$ [E]		SW	Well-graded sand [I]
			$Cu < 6$ and/or [Cc<1 or Cc>3.0] [E]		SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH		SM	Silty sand [G, H, I]
			Fines classify as CL or CH		SC	Clayey sand [G, H, I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots on or above "A" line [J]		CL	Lean clay [K, L, M]
			PI < 4 or plots below "A" line [J]		ML	Silt [K, L, M]
		Organic:	Liquid limit - oven dried	< 0.75	OL	Organic clay [K, L, M, N]
			Liquid limit - not dried			Organic silt [K, L, M, O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line		CH	Fat clay [K, L, M]
			PI plots below "A" line		MH	Elastic Silt [K, L, M]
		Organic:	Liquid limit - oven dried	< 0.75	OH	Organic clay [K, L, M, P]
			Liquid limit - not dried			Organic silt [K, L, M, Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor				PT	Peat

[A] Based on the material passing the 3-inch (75-mm) sieve.

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay.

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.

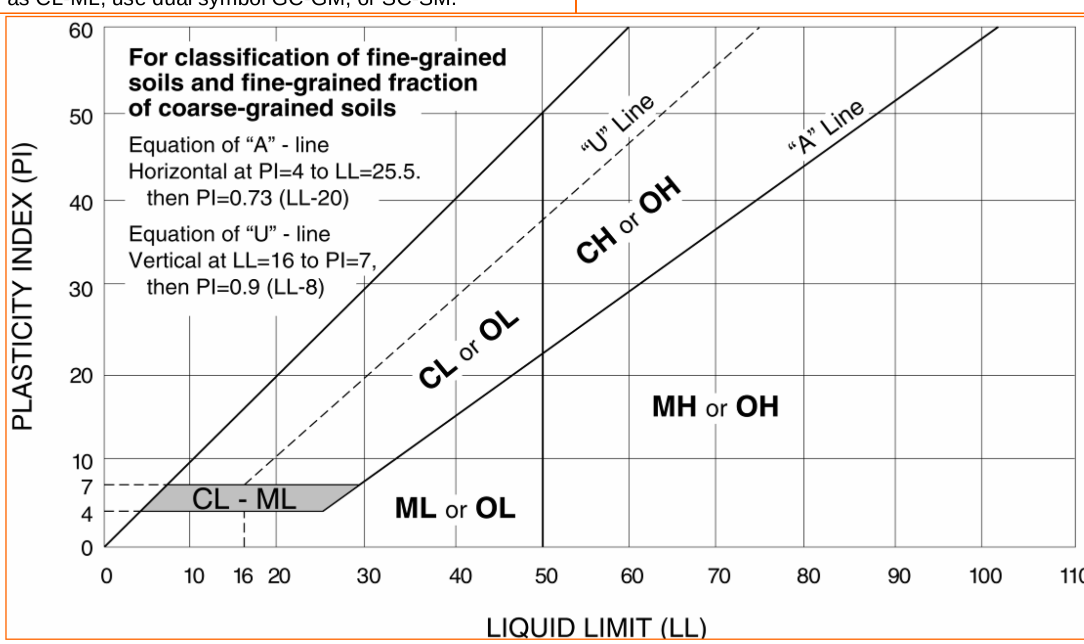
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ≥ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.



APPENDIX B

Drainage Area Maps

Revisions

Rev.	Date	By	Appr.	Description

Horsley Witten Group, Inc.
Sustainable Environmental Solutions
90 Route 6A
Sandwich, MA 02563
508-833-6600 voice
508-833-3150 fax

Date: JANUARY 2022 | Design By: N/A | Drawn By: EWH | Checked By: RAC

Plan Set:

LITTLETON DRIVE
WAREHAM, MA

Plan Title:

EXISTING DRAINAGE AREA MAP

Prepared For:
Pennrose Properties, LLC
50 Milk Street, 16th Floor
Boston, MA 02109
Phone:----
Fax: ----

Survey Provided By:
Horsley Witten Group, Inc.
90 Route 6A
Phone:(508) 833-6600
Fax:(508) 833-3150
Dated: ----

Registration:

Project Number: 20107

Sheet Number: 1 of 2

Revisions

Rev.	Date	By	Appr.	Description
1	01/19/2021	JLV	RAC	Revised per comments from peer review, water dept., and fire dept.

Horsley Witten Group, Inc.
Sustainable Environmental Solutions
90 Route 6A
Sandwich, MA 02563
508-833-6600 voice
508-833-3150 fax

Date: JANUARY 2022 | Design By: N/A | Drawn By: EWH | Checked By: RAC

Plan Set:

LITTLETON DRIVE
WAREHAM, MA

Plan Title:

PROPOSED DRAINAGE AREA MAP

Prepared For:
Pennrose Properties, LLC
50 Milk Street, 16th Floor
Boston, MA 02109
Phone:----
Fax: ----

Survey Provided By:
Horsley Witten Group, Inc.
90 Route 6A
Phone:(508) 833-6600
Fax:(508) 833-3150
Dated: ----

Registration:

Project Number: 20107

Sheet Number: 2 of 2

APPENDIX C

GSI Sizing Calculations

Horsley Witten Group
Sustainable Environmental Solutions

Project: Littleton Drive **Project No:** 20107
Project Location: Littleton Drive Wareham, MA
Calculated By: EWH
Checked By: RAC
Date : 2/4/2022

Instructions: Enter values in [ ] cells only. All other cells are formulas or links and do not need to be edited. See cell comments for descriptions and formulas used.

Water Quality Volume (WQv)
Based upon 1-inch of rainfall times the contributing impervious area contributing impervious area

WQv (cf) = (1" rainfall/12) * Imp. Area (sf)

Storm Type: 1 ***Inch***

DA	Description	% Imp.	Drainage Area		Imp. Area		WQv Required*	WQv required
		%	sf	ac	sf	ac	cf	af
DA0	Littleton Dr North	51%	8,758	0.20	4,446	0.10	371	0.009
DA1E	East of Parking	75%	21,714	0.50	16,292	0.37	1,358	0.031
DA1W	West of Parking	63%	22,713	0.52	14,370	0.33	1,198	0.027
DA3	Middle	54%	99,503	2.28	54,213	1.24	4,518	0.104
DA2	Community Garden	68%	28,273	0.65	19,208	0.44	1,601	0.037
DA4	Middle North	55%	55,717	1.28	30,834	0.71	2,570	0.059
	TOTALS		236678	5.43	139,363	3.20	11,614	0.267

Infiltrating BMP Sizing Calculations

Sizing Equations: Infiltrating BMP

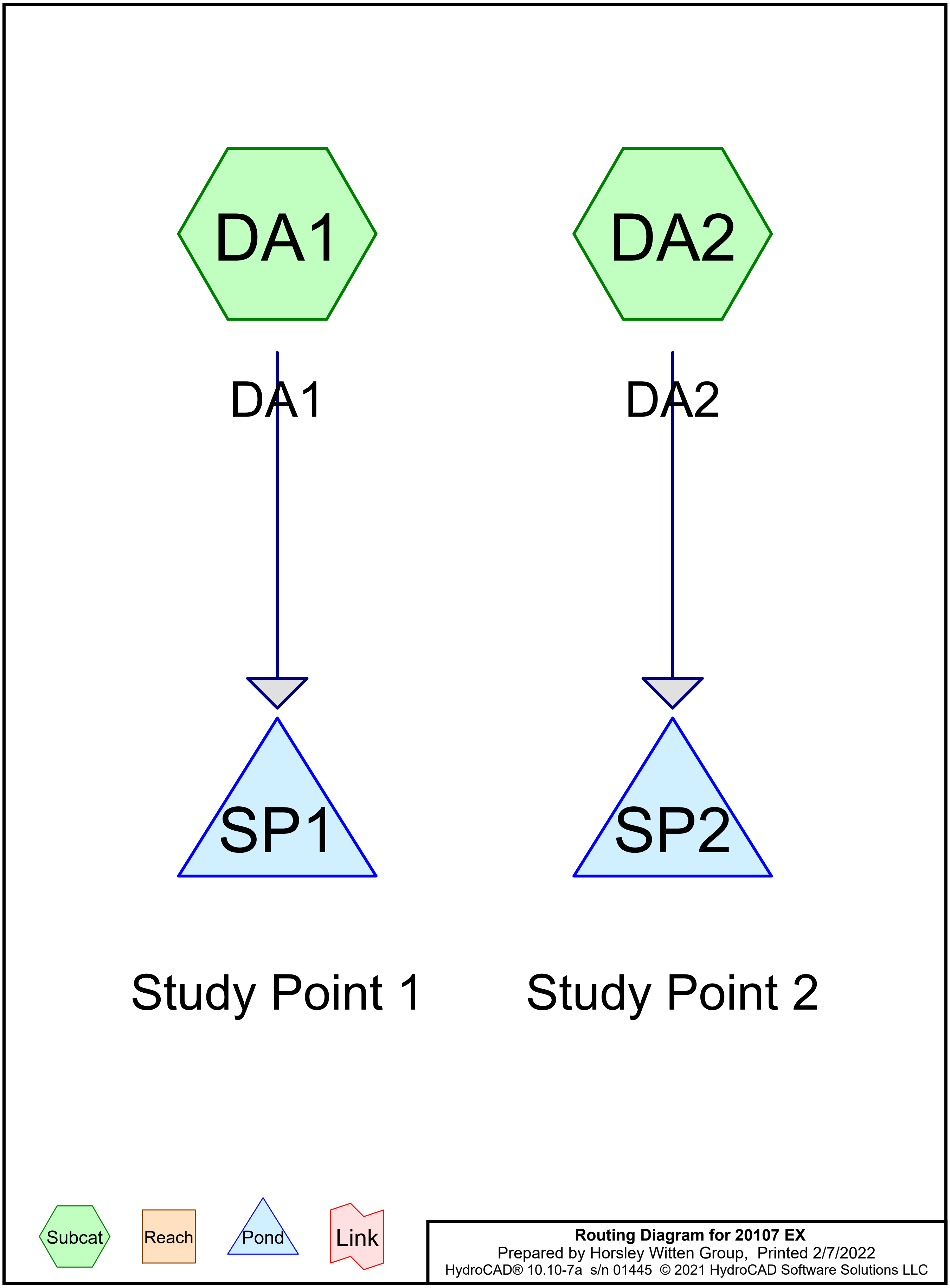
Required Surface Area (sf) = (WQv) (df) / [(k) (hf + df) (tf)]
Where: df = Filter bed depth (ft) k = Coefficient of permeability of filter media (ft/day)
hf = Ave. height of water above filter bed (ft) tf = Design filter bed drain time (days)

BIORETENTION SIZING:

BMP Area	Drainage Area Name	WQv Required (af)	df (ft)	K (ft/day)	hmax-Height of water above filter (in.)	hf=avg of above (ft)	tf (days)	Surface Area Required (sf)	Surface Area Provided (sf)	Sediment Forebay Required [0.0081WQV min] (sf)	Sediment Forebay Provided (sf)	WQV Treatment Provided (af)
DA0	Littleton Dr North	0.009	1.50	1	6	0.25	2	159	794	3	15	0.043
DA1E	East of Parking	0.031	1.50	1	6	0.25	2	582	866	11	40	0.046
DA1W	West of Parking	0.027	1.50	1	6	0.25	2	513	546	10	18	0.029
DA3	Middle	0.104	1.50	1	6	0.25	2	1936	2281	37	40	0.122
DA2	Community Garden	0.037	1.50	1	6	0.25	2	686	690	13	20	0.037
DA4	Middle North	0.059	1.50	1	6	0.25	2	1101	1133	21	20	0.061
	TOTALS	0.267						4977	6310	94	153	0.338
					Percentage of Treatment Provided				**127%**		**163%**	**127%**

APPENDIX D

HydroCAD Modeling


DA1
DA2
DA1
DA2
SP1
SP2
Study Point 1
Study Point 2
Subcat
Reach
Pond
Link
Routing Diagram for 20107 EX
Prepared by Horsley Witten Group, Printed 2/7/2022
HydroCAD® 10.10-7a s/n 01445 © 2021 HydroCAD Software Solutions LLC

Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2yr NOAA+	Type III 24-hr		Default	24.00	1	3.69	2
2	10yr NOAA+	Type III 24-hr		Default	24.00	1	5.44	2
3	100yr NOAA+	Type III 24-hr		Default	24.00	1	8.76	2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.384	39	>75% Grass cover, Good, HSG A (DA1)
0.449	50	>75% Grass cover, Good, HSG A/B (DA1)
1.175	77	Dirt roads, HSG A/B (DA1, DA2)
0.027	98	Paved roads w/curbs & sewers, HSG A (DA1)
0.384	98	Roofs, HSG A (DA1, DA2)
2.177	30	Woods, Good, HSG A (DA1)
15.294	42	Woods, Good, HSG A/B (DA1, DA2)
19.889	**44**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
19.889	HSG A	DA1, DA2
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
0.000	Other	
19.889		**TOTAL AREA**

Time span=0.00-40.00 hrs, dt=0.05 hrs, 801 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment DA1: DA1 Runoff Area=792,419 sf 2.14% Impervious Runoff Depth=0.09"
Flow Length=1,236' Tc=53.5 min CN=44 Runoff=0.23 cfs 0.143 af

Subcatchment DA2: DA2 Runoff Area=73,959 sf 1.22% Impervious Runoff Depth=0.12"
Flow Length=410' Tc=31.5 min CN=45 Runoff=0.03 cfs 0.016 af

Pond SP1: Study Point 1 Inflow=0.23 cfs 0.143 af
Primary=0.23 cfs 0.143 af

Pond SP2: Study Point 2 Inflow=0.03 cfs 0.016 af
Primary=0.03 cfs 0.016 af

Total Runoff Area = 19.889 ac Runoff Volume = 0.159 af Average Runoff Depth = 0.10"
97.94% Pervious = 19.479 ac 2.06% Impervious = 0.410 ac

Summary for Subcatchment DA1: DA1

Runoff = 0.23 cfs @ 15.39 hrs, Volume= 0.143 af, Depth= 0.09"
Routed to Pond SP1 : Study Point 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type III 24-hr 2yr NOAA+ Rainfall=3.69"

	Area (sf)	CN	Description
	1,175	98	Paved roads w/curbs & sewers, HSG A
*	45,768	77	Dirt roads, HSG A/B
	15,804	98	Roofs, HSG A
*	598,576	42	Woods, Good, HSG A/B
	94,811	30	Woods, Good, HSG A
*	19,568	50	>75% Grass cover, Good, HSG A/B
	16,717	39	>75% Grass cover, Good, HSG A
	792,419	44	Weighted Average
	775,440		97.86% Pervious Area
	16,979		2.14% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
27.3	100	0.0100	0.06		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.44"
3.5	175	0.0280	0.84		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
22.7	961	0.0050	0.71		**Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps
53.5	1,236	Total			

Summary for Subcatchment DA2: DA2

Runoff = 0.03 cfs @ 14.13 hrs, Volume= 0.016 af, Depth= 0.12"
Routed to Pond SP2 : Study Point 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type III 24-hr 2yr NOAA+ Rainfall=3.69"

	Area (sf)	CN	Description
	0	98	Paved roads w/curbs & sewers, HSG A
*	5,417	77	Dirt roads, HSG A/B
	902	98	Roofs, HSG A
*	67,640	42	Woods, Good, HSG A/B
*	0	50	>75% Grass cover, Good, HSG A/B
	0	39	>75% Grass cover, Good, HSG A
	0	30	Woods, Good, HSG A
	73,959	45	Weighted Average
	73,057		98.78% Pervious Area
	902		1.22% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
27.3	100	0.0100	0.06		**Sheet Flow, Sheet** Woods: Light underbrush n= 0.400 P2= 3.44"
2.1	110	0.0300	0.87		**Shallow Concentrated Flow, Concentrated in trees** Woodland Kv= 5.0 fps
2.1	200	0.0100	1.61		**Shallow Concentrated Flow, Concentrated on path** Unpaved Kv= 16.1 fps
31.5	410	Total			

Summary for Pond SP1: Study Point 1

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

Inflow Area =	18.191 ac,	2.14% Impervious,	Inflow Depth = 0.09"	for 2yr NOAA+ event
Inflow =	0.23 cfs @	15.39 hrs, Volume=	0.143 af	
Primary =	0.23 cfs @	15.39 hrs, Volume=	0.143 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs

Summary for Pond SP2: Study Point 2

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

Inflow Area = 1.698 ac, 1.22% Impervious, Inflow Depth = 0.12" for 2yr NOAA+ event
Inflow = 0.03 cfs @ 14.13 hrs, Volume= 0.016 af
Primary = 0.03 cfs @ 14.13 hrs, Volume= 0.016 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs

Time span=0.00-40.00 hrs, dt=0.05 hrs, 801 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment DA1: DA1 Runoff Area=792,419 sf 2.14% Impervious Runoff Depth=0.54"
Flow Length=1,236' Tc=53.5 min CN=44 Runoff=2.67 cfs 0.813 af

Subcatchment DA2: DA2 Runoff Area=73,959 sf 1.22% Impervious Runoff Depth=0.59"
Flow Length=410' Tc=31.5 min CN=45 Runoff=0.38 cfs 0.083 af

Pond SP1: Study Point 1 Inflow=2.67 cfs 0.813 af
Primary=2.67 cfs 0.813 af

Pond SP2: Study Point 2 Inflow=0.38 cfs 0.083 af
Primary=0.38 cfs 0.083 af

Total Runoff Area = 19.889 ac Runoff Volume = 0.896 af Average Runoff Depth = 0.54"
97.94% Pervious = 19.479 ac 2.06% Impervious = 0.410 ac

Summary for Subcatchment DA1: DA1

Runoff = 2.67 cfs @ 13.00 hrs, Volume= 0.813 af, Depth= 0.54"
Routed to Pond SP1 : Study Point 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type III 24-hr 10yr NOAA+ Rainfall=5.44"

	Area (sf)	CN	Description
	1,175	98	Paved roads w/curbs & sewers, HSG A
*	45,768	77	Dirt roads, HSG A/B
	15,804	98	Roofs, HSG A
*	598,576	42	Woods, Good, HSG A/B
	94,811	30	Woods, Good, HSG A
*	19,568	50	>75% Grass cover, Good, HSG A/B
	16,717	39	>75% Grass cover, Good, HSG A
	792,419	44	Weighted Average
	775,440		97.86% Pervious Area
	16,979		2.14% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
27.3	100	0.0100	0.06		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.44"
3.5	175	0.0280	0.84		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
22.7	961	0.0050	0.71		**Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps
53.5	1,236	Total			

Summary for Subcatchment DA2: DA2

Runoff = 0.38 cfs @ 12.64 hrs, Volume= 0.083 af, Depth= 0.59"
Routed to Pond SP2 : Study Point 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type III 24-hr 10yr NOAA+ Rainfall=5.44"

	Area (sf)	CN	Description
	0	98	Paved roads w/curbs & sewers, HSG A
*	5,417	77	Dirt roads, HSG A/B
	902	98	Roofs, HSG A
*	67,640	42	Woods, Good, HSG A/B
*	0	50	>75% Grass cover, Good, HSG A/B
	0	39	>75% Grass cover, Good, HSG A
	0	30	Woods, Good, HSG A
	73,959	45	Weighted Average
	73,057		98.78% Pervious Area
	902		1.22% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
27.3	100	0.0100	0.06		**Sheet Flow, Sheet** Woods: Light underbrush n= 0.400 P2= 3.44"
2.1	110	0.0300	0.87		**Shallow Concentrated Flow, Concentrated in trees** Woodland Kv= 5.0 fps
2.1	200	0.0100	1.61		**Shallow Concentrated Flow, Concentrated on path** Unpaved Kv= 16.1 fps
31.5	410	Total			

Summary for Pond SP1: Study Point 1

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

Inflow Area = 18.191 ac, 2.14% Impervious, Inflow Depth = 0.54" for 10yr NOAA+ event
Inflow = 2.67 cfs @ 13.00 hrs, Volume= 0.813 af
Primary = 2.67 cfs @ 13.00 hrs, Volume= 0.813 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs

Summary for Pond SP2: Study Point 2

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

Inflow Area = 1.698 ac, 1.22% Impervious, Inflow Depth = 0.59" for 10yr NOAA+ event
Inflow = 0.38 cfs @ 12.64 hrs, Volume= 0.083 af
Primary = 0.38 cfs @ 12.64 hrs, Volume= 0.083 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs

Time span=0.00-40.00 hrs, dt=0.05 hrs, 801 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment DA1: DA1 Runoff Area=792,419 sf 2.14% Impervious Runoff Depth=2.04"
Flow Length=1,236' Tc=53.5 min CN=44 Runoff=15.73 cfs 3.091 af

Subcatchment DA2: DA2 Runoff Area=73,959 sf 1.22% Impervious Runoff Depth=2.15"
Flow Length=410' Tc=31.5 min CN=45 Runoff=2.09 cfs 0.304 af

Pond SP1: Study Point 1 Inflow=15.73 cfs 3.091 af
Primary=15.73 cfs 3.091 af

Pond SP2: Study Point 2 Inflow=2.09 cfs 0.304 af
Primary=2.09 cfs 0.304 af

Total Runoff Area = 19.889 ac Runoff Volume = 3.395 af Average Runoff Depth = 2.05"
97.94% Pervious = 19.479 ac 2.06% Impervious = 0.410 ac

Summary for Subcatchment DA1: DA1

Runoff = 15.73 cfs @ 12.82 hrs, Volume= 3.091 af, Depth= 2.04"
Routed to Pond SP1 : Study Point 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type III 24-hr 100yr NOAA+ Rainfall=8.76"

	Area (sf)	CN	Description
	1,175	98	Paved roads w/curbs & sewers, HSG A
*	45,768	77	Dirt roads, HSG A/B
	15,804	98	Roofs, HSG A
*	598,576	42	Woods, Good, HSG A/B
	94,811	30	Woods, Good, HSG A
*	19,568	50	>75% Grass cover, Good, HSG A/B
	16,717	39	>75% Grass cover, Good, HSG A
	792,419	44	Weighted Average
	775,440		97.86% Pervious Area
	16,979		2.14% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
27.3	100	0.0100	0.06		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.44"
3.5	175	0.0280	0.84		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
22.7	961	0.0050	0.71		**Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps
53.5	1,236	Total			

Summary for Subcatchment DA2: DA2

Runoff = 2.09 cfs @ 12.50 hrs, Volume= 0.304 af, Depth= 2.15"
Routed to Pond SP2 : Study Point 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type III 24-hr 100yr NOAA+ Rainfall=8.76"

	Area (sf)	CN	Description
	0	98	Paved roads w/curbs & sewers, HSG A
*	5,417	77	Dirt roads, HSG A/B
	902	98	Roofs, HSG A
*	67,640	42	Woods, Good, HSG A/B
*	0	50	>75% Grass cover, Good, HSG A/B
	0	39	>75% Grass cover, Good, HSG A
	0	30	Woods, Good, HSG A
	73,959	45	Weighted Average
	73,057		98.78% Pervious Area
	902		1.22% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
27.3	100	0.0100	0.06		**Sheet Flow, Sheet** Woods: Light underbrush n= 0.400 P2= 3.44"
2.1	110	0.0300	0.87		**Shallow Concentrated Flow, Concentrated in trees** Woodland Kv= 5.0 fps
2.1	200	0.0100	1.61		**Shallow Concentrated Flow, Concentrated on path** Unpaved Kv= 16.1 fps
31.5	410	Total			

Summary for Pond SP1: Study Point 1

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

Inflow Area =	18.191 ac,	2.14% Impervious,	Inflow Depth = 2.04"	for 100yr NOAA+ event	
Inflow =	15.73 cfs @	12.82 hrs,	Volume=	3.091 af	
Primary =	15.73 cfs @	12.82 hrs,	Volume=	3.091 af,	Atten= 0%, Lag= 0.0 min

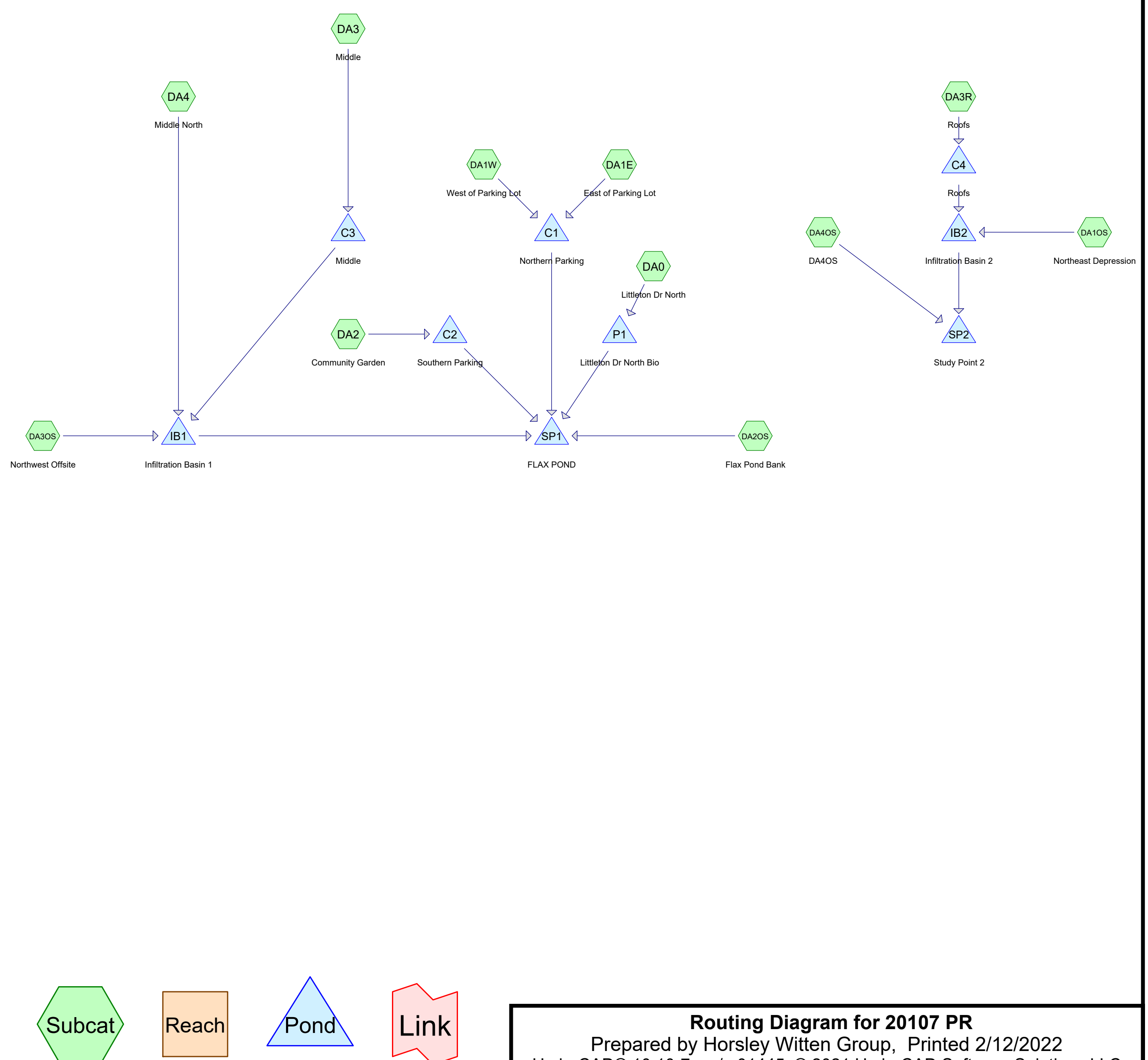
Routing by Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs

Summary for Pond SP2: Study Point 2

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

Inflow Area = 1.698 ac, 1.22% Impervious, Inflow Depth = 2.15" for 100yr NOAA+ event
Inflow = 2.09 cfs @ 12.50 hrs, Volume= 0.304 af
Primary = 2.09 cfs @ 12.50 hrs, Volume= 0.304 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs



Routing Diagram for 20107 PR
Prepared by Horsley Witten Group, Printed 2/12/2022
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Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2yr NOAA+	Type III 24-hr		Default	24.00	1	3.69	2
2	10yr NOAA+	Type III 24-hr		Default	24.00	1	5.44	2
3	100yr NOAA+	Type III 24-hr		Default	24.00	1	8.76	2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.406	39	>75% Grass cover, Good, HSG A (DA3OS)
3.329	50	>75% Grass cover, Good, HSG A/B (DA0, DA1E, DA1OS, DA1W, DA2, DA2OS, DA3, DA3OS, DA4, DA4OS)
0.299	77	Dirt roads, HSG A/B (DA0, DA1E, DA2, DA2OS, DA3OS, DA4OS)
1.636	44	Meadow, non-grazed, HSG A/B (DA1OS, DA3OS, DA4OS)
2.367	98	Paved parking, HSG A (DA0, DA1E, DA1W, DA2, DA3, DA4)
1.568	98	Roofs, HSG A (DA1W, DA2, DA3, DA3OS, DA3R, DA4)
0.824	98	Water Surface, HSG A (DA0, DA1E, DA1OS, DA1W, DA2, DA3, DA3OS, DA4)
2.177	30	Woods, Good, HSG A (DA3OS)
6.791	42	Woods, Good, HSG A/B (DA1OS, DA2OS, DA3OS, DA4OS)
19.397	**56**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
19.397	HSG A	DA0, DA1E, DA1OS, DA1W, DA2, DA2OS, DA3, DA3OS, DA3R, DA4, DA4OS
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
0.000	Other	
19.397		**TOTAL AREA**

Time span=0.00-60.00 hrs, dt=0.02 hrs, 3001 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment DA0: Littleton Dr North Runoff Area=8,758 sf 49.27% Impervious Runoff Depth=1.37"
Tc=5.0 min CN=74 Runoff=0.33 cfs 0.023 af

Subcatchment DA1E: East of Parking Lot Runoff Area=21,714 sf 74.16% Impervious Runoff Depth=2.27"
Tc=5.0 min CN=86 Runoff=1.37 cfs 0.094 af

Subcatchment DA1OS: Northeast Runoff Area=50,188 sf 2.79% Impervious Runoff Depth=0.12"
Flow Length=180' Tc=38.0 min CN=45 Runoff=0.02 cfs 0.011 af

Subcatchment DA1W: West of Parking Lot Runoff Area=22,713 sf 63.27% Impervious Runoff Depth=1.79"
Tc=5.0 min CN=80 Runoff=1.13 cfs 0.078 af

Subcatchment DA2: Community Garden Runoff Area=28,273 sf 66.34% Impervious Runoff Depth=1.94"
Tc=5.0 min CN=82 Runoff=1.53 cfs 0.105 af

Subcatchment DA2OS: Flax Pond Bank Runoff Area=61,501 sf 0.00% Impervious Runoff Depth=0.14"
Flow Length=400' Slope=0.0100 '/' Tc=37.3 min CN=46 Runoff=0.03 cfs 0.016 af

Subcatchment DA3: Middle Runoff Area=99,503 sf 54.48% Impervious Runoff Depth=1.50"
Tc=5.0 min CN=76 Runoff=4.10 cfs 0.286 af

Subcatchment DA3OS: Northwest Offsite Runoff Area=448,118 sf 12.66% Impervious Runoff Depth=0.19"
Flow Length=450' Slope=0.0100 '/' Tc=39.0 min CN=48 Runoff=0.34 cfs 0.161 af

Subcatchment DA3R: Roofs Runoff Area=10,603 sf 100.00% Impervious Runoff Depth=3.46"
Tc=5.0 min CN=98 Runoff=0.90 cfs 0.070 af

Subcatchment DA4: Middle North Runoff Area=55,717 sf 55.34% Impervious Runoff Depth=1.57"
Tc=5.0 min CN=77 Runoff=2.41 cfs 0.168 af

Subcatchment DA4OS: DA4OS Runoff Area=37,837 sf 0.00% Impervious Runoff Depth=0.12"
Flow Length=405' Tc=31.3 min CN=45 Runoff=0.01 cfs 0.008 af

Pond C1: Northern Parking Peak Elev=13.95' Storage=2,589 cf Inflow=2.49 cfs 0.172 af
Discarded=0.27 cfs 0.172 af Primary=0.00 cfs 0.000 af Outflow=0.27 cfs 0.172 af

Pond C2: Southern Parking Peak Elev=13.56' Storage=1,407 cf Inflow=1.53 cfs 0.105 af
Discarded=0.21 cfs 0.105 af Primary=0.00 cfs 0.000 af Outflow=0.21 cfs 0.105 af

Pond C3: Middle Peak Elev=13.73' Storage=3,671 cf Inflow=4.10 cfs 0.286 af
Discarded=0.60 cfs 0.286 af Primary=0.00 cfs 0.000 af Outflow=0.60 cfs 0.286 af

Pond C4: Roofs Peak Elev=13.30' Storage=742 cf Inflow=0.90 cfs 0.070 af
Discarded=0.16 cfs 0.070 af Primary=0.00 cfs 0.000 af Outflow=0.16 cfs 0.070 af

Pond IB1: Infiltration Basin 1 Peak Elev=12.31' Storage=1,570 cf Inflow=2.41 cfs 0.329 af
Discarded=0.67 cfs 0.329 af Primary=0.00 cfs 0.000 af Outflow=0.67 cfs 0.329 af

Pond IB2: Infiltration Basin 2 Peak Elev=13.00' Storage=2 cf Inflow=0.02 cfs 0.011 af
Discarded=0.02 cfs 0.011 af Primary=0.00 cfs 0.000 af Outflow=0.02 cfs 0.011 af

Pond P1: Littleton Dr North Bio Peak Elev=13.91' Storage=206 cf Inflow=0.33 cfs 0.023 af
Outflow=0.11 cfs 0.023 af

Pond SP1: FLAX POND Inflow=0.03 cfs 0.016 af
Primary=0.03 cfs 0.016 af

Pond SP2: Study Point 2 Inflow=0.01 cfs 0.008 af
Primary=0.01 cfs 0.008 af

Total Runoff Area = 19.397 ac Runoff Volume = 1.021 af Average Runoff Depth = 0.63"
75.46% Pervious = 14.638 ac 24.54% Impervious = 4.759 ac

Summary for Subcatchment DA0: Littleton Dr North

Runoff = 0.33 cfs @ 12.08 hrs, Volume= 0.023 af, Depth= 1.37"
Routed to Pond P1 : Littleton Dr North Bio

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Type III 24-hr 2yr NOAA+ Rainfall=3.69"

	Area (sf)	CN	Description
	3,521	98	Paved parking, HSG A
*	4,312	50	>75% Grass cover, Good, HSG A/B
	794	98	Water Surface, HSG A
*	131	77	Dirt roads, HSG A/B
	8,758	74	Weighted Average
	4,443		50.73% Pervious Area
	4,315		49.27% Impervious Area

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

Summary for Subcatchment DA1E: East of Parking Lot

Runoff = 1.37 cfs @ 12.07 hrs, Volume= 0.094 af, Depth= 2.27"
Routed to Pond C1 : Northern Parking

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Type III 24-hr 2yr NOAA+ Rainfall=3.69"

	Area (sf)	CN	Description
	15,238	98	Paved parking, HSG A
*	5,422	50	>75% Grass cover, Good, HSG A/B
	866	98	Water Surface, HSG A
*	188	77	Dirt roads, HSG A/B
	21,714	86	Weighted Average
	5,610		25.84% Pervious Area
	16,104		74.16% Impervious Area

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

Summary for Subcatchment DA1OS: Northeast Depression

Runoff = 0.02 cfs @ 14.31 hrs, Volume= 0.011 af, Depth= 0.12"
Routed to Pond IB2 : Infiltration Basin 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Type III 24-hr 2yr NOAA+ Rainfall=3.69"

	Area (sf)	CN	Description
	1,400	98	Water Surface, HSG A
*	22,538	42	Woods, Good, HSG A/B
*	5,962	50	>75% Grass cover, Good, HSG A/B
*	20,288	44	Meadow, non-grazed, HSG A/B
	50,188	45	Weighted Average
	48,788		97.21% Pervious Area
	1,400		2.79% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
36.1	100	0.0050	0.05		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.44"
1.9	80	0.0200	0.71		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
38.0	180	Total			

Summary for Subcatchment DA1W: West of Parking Lot

Runoff = 1.13 cfs @ 12.08 hrs, Volume= 0.078 af, Depth= 1.79"
Routed to Pond C1 : Northern Parking

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Type III 24-hr 2yr NOAA+ Rainfall=3.69"

	Area (sf)	CN	Description
	6,891	98	Paved parking, HSG A
*	8,343	50	>75% Grass cover, Good, HSG A/B
	6,933	98	Roofs, HSG A
	546	98	Water Surface, HSG A
	22,713	80	Weighted Average
	8,343		36.73% Pervious Area
	14,370		63.27% Impervious Area

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

Summary for Subcatchment DA2: Community Garden

Runoff = 1.53 cfs @ 12.08 hrs, Volume= 0.105 af, Depth= 1.94"
Routed to Pond C2 : Southern Parking

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Type III 24-hr 2yr NOAA+ Rainfall=3.69"

	Area (sf)	CN	Description
	11,054	98	Paved parking, HSG A
*	9,065	50	>75% Grass cover, Good, HSG A/B
	691	98	Water Surface, HSG A
	7,011	98	Roofs, HSG A
*	452	77	Dirt roads, HSG A/B
	28,273	82	Weighted Average
	9,517		33.66% Pervious Area
	18,756		66.34% Impervious Area

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

Summary for Subcatchment DA2OS: Flax Pond Bank

Runoff = 0.03 cfs @ 14.05 hrs, Volume= 0.016 af, Depth= 0.14"
Routed to Pond SP1 : FLAX POND

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Type III 24-hr 2yr NOAA+ Rainfall=3.69"

	Area (sf)	CN	Description
*	6,319	77	Dirt roads, HSG A/B
*	51,676	42	Woods, Good, HSG A/B
*	3,506	50	>75% Grass cover, Good, HSG A/B
	61,501	46	Weighted Average
	61,501		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
27.3	100	0.0100	0.06		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.44"
10.0	300	0.0100	0.50		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
37.3	400	Total			

Summary for Subcatchment DA3: Middle

Runoff = 4.10 cfs @ 12.08 hrs, Volume= 0.286 af, Depth= 1.50"
Routed to Pond C3 : Middle

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Type III 24-hr 2yr NOAA+ Rainfall=3.69"

	Area (sf)	CN	Description
	44,383	98	Paved parking, HSG A
*	45,290	50	>75% Grass cover, Good, HSG A/B
	7,549	98	Roofs, HSG A
	2,281	98	Water Surface, HSG A
	99,503	76	Weighted Average
	45,290		45.52% Pervious Area
	54,213		54.48% Impervious Area

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

Summary for Subcatchment DA3OS: Northwest Offsite

Runoff = 0.34 cfs @ 13.04 hrs, Volume= 0.161 af, Depth= 0.19"
Routed to Pond IB1 : Infiltration Basin 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Type III 24-hr 2yr NOAA+ Rainfall=3.69"

	Area (sf)	CN	Description
	0	98	Paved roads w/curbs & sewers, HSG A
*	2,762	77	Dirt roads, HSG A/B
	28,530	98	Roofs, HSG A
	28,182	98	Water Surface, HSG A
*	193,879	42	Woods, Good, HSG A/B
	94,810	30	Woods, Good, HSG A
*	37,887	50	>75% Grass cover, Good, HSG A/B
	17,673	39	>75% Grass cover, Good, HSG A
*	44,395	44	Meadow, non-grazed, HSG A/B
	448,118	48	Weighted Average
	391,406		87.34% Pervious Area
	56,712		12.66% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
27.3	100	0.0100	0.06		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.44"
11.7	350	0.0100	0.50		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
39.0	450	Total			

Summary for Subcatchment DA3R: Roofs

Runoff = 0.90 cfs @ 12.07 hrs, Volume= 0.070 af, Depth= 3.46"
Routed to Pond C4 : Roofs

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Type III 24-hr 2yr NOAA+ Rainfall=3.69"

Area (sf)	CN	Description
10,603	98	Roofs, HSG A
10,603		100.00% Impervious Area

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

Summary for Subcatchment DA4: Middle North

Runoff = 2.41 cfs @ 12.08 hrs, Volume= 0.168 af, Depth= 1.57"
Routed to Pond IB1 : Infiltration Basin 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Type III 24-hr 2yr NOAA+ Rainfall=3.69"

	Area (sf)	CN	Description
	22,041	98	Paved parking, HSG A
*	24,883	50	>75% Grass cover, Good, HSG A/B
	7,660	98	Roofs, HSG A
	1,133	98	Water Surface, HSG A
	55,717	77	Weighted Average
	24,883		44.66% Pervious Area
	30,834		55.34% Impervious Area

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

Summary for Subcatchment DA4OS: DA4OS

Runoff = 0.01 cfs @ 14.15 hrs, Volume= 0.008 af, Depth= 0.12"
Routed to Pond SP2 : Study Point 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Type III 24-hr 2yr NOAA+ Rainfall=3.69"

	Area (sf)	CN	Description
	0	98	Paved roads w/curbs & sewers, HSG A
*	3,185	77	Dirt roads, HSG A/B
	0	98	Roofs, HSG A
*	27,728	42	Woods, Good, HSG A/B
*	6,581	44	Meadow, non-grazed, HSG A/B
*	343	50	>75% Grass cover, Good, HSG A/B
	37,837	45	Weighted Average
	37,837		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
27.3	100	0.0100	0.06		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.44"
1.8	95	0.0300	0.87		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
2.2	210	0.0100	1.61		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
31.3	405	Total			

Summary for Pond C1: Northern Parking

Inflow Area = 1.020 ac, 68.59% Impervious, Inflow Depth = 2.02" for 2yr NOAA+ event
Inflow = 2.49 cfs @ 12.08 hrs, Volume= 0.172 af
Outflow = 0.27 cfs @ 11.72 hrs, Volume= 0.172 af, Atten= 89%, Lag= 0.0 min
Discarded = 0.27 cfs @ 11.72 hrs, Volume= 0.172 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Pond SP1 : FLAX POND

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Peak Elev= 13.95' @ 12.87 hrs Surf.Area= 2,600 sf Storage= 2,589 cf

Plug-Flow detention time= 74.5 min calculated for 0.172 af (100% of inflow)
Center-of-Mass det. time= 74.5 min (898.7 - 824.2)

Volume	Invert	Avail.Storage	Storage Description
#1A	12.25'	2,609 cf	**34.75'W x 74.82'L x 4.25'H Field A** 11,049 cf Overall - 3,216 cf Embedded = 7,834 cf x 33.3% Voids
#2A	13.00'	3,216 cf	**ADS_StormTech SC-740 +Cap** x 70 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 70 Chambers in 7 Rows
		5,824 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	12.25'	**4.500 in/hr Exfiltration over Surface area** Phase-In= 0.01'
#2	Device 3	15.00'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#3	Primary	14.50'	**18.0" Round Culvert** L= 85.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 14.50' / 13.50' S= 0.0118 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf

Discarded OutFlow Max=0.27 cfs @ 11.72 hrs HW=12.30' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.27 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=12.25' TW=0.00' (Dynamic Tailwater)
└─**3=Culvert** (Controls 0.00 cfs)
  └─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond C1: Northern Parking - Chamber Wizard Field A

Chamber Model = ADS_StormTechSC-740 +Cap (ADS StormTech®SC-740 with cap length)
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

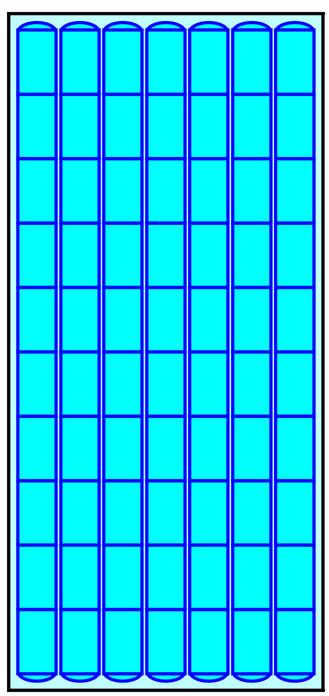
10 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 72.82' Row Length +12.0" End Stone x 2 = 74.82' Base Length
7 Rows x 51.0" Wide + 6.0" Spacing x 6 + 12.0" Side Stone x 2 = 34.75' Base Width
9.0" Stone Base + 30.0" Chamber Height + 12.0" Stone Cover = 4.25' Field Height

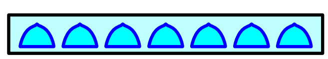
70 Chambers x 45.9 cf = 3,215.8 cf Chamber Storage

11,049.5 cf Field - 3,215.8 cf Chambers = 7,833.7 cf Stone x 33.3% Voids = 2,608.6 cf Stone Storage

Chamber Storage + Stone Storage = 5,824.4 cf = 0.134 af
Overall Storage Efficiency = 52.7%
Overall System Size = 74.82' x 34.75' x 4.25'

70 Chambers
409.2 cy Field
290.1 cy Stone





Summary for Pond C2: Southern Parking

Inflow Area = 0.649 ac, 66.34% Impervious, Inflow Depth = 1.94" for 2yr NOAA+ event
Inflow = 1.53 cfs @ 12.08 hrs, Volume= 0.105 af
Outflow = 0.21 cfs @ 11.78 hrs, Volume= 0.105 af, Atten= 86%, Lag= 0.0 min
Discarded = 0.21 cfs @ 11.78 hrs, Volume= 0.105 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Pond SP1 : FLAX POND

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Peak Elev= 13.56' @ 12.63 hrs Surf.Area= 2,031 sf Storage= 1,407 cf

Plug-Flow detention time= 46.7 min calculated for 0.105 af (100% of inflow)
Center-of-Mass det. time= 46.7 min (875.3 - 828.6)

Volume	Invert	Avail.Storage	Storage Description
#1A	12.25'	2,048 cf	**30.00'W x 67.70'L x 4.25'H Field A** 8,631 cf Overall - 2,481 cf Embedded = 6,151 cf x 33.3% Voids
#2A	13.00'	2,481 cf	**ADS_StormTech SC-740 +Cap** x 54 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 54 Chambers in 6 Rows
		4,529 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	12.25'	**4.500 in/hr Exfiltration over Surface area** Phase-In= 0.01'
#2	Device 3	15.00'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#3	Primary	14.50'	**10.0" Round Culvert** L= 70.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 14.50' / 14.20' S= 0.0043 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.55 sf

Discarded OutFlow Max=0.21 cfs @ 11.78 hrs HW=12.30' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.21 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=12.25' TW=0.00' (Dynamic Tailwater)
└─**3=Culvert** (Controls 0.00 cfs)
  └─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond C2: Southern Parking - Chamber Wizard Field A

Chamber Model = ADS_StormTech SC-740 +Cap (ADS StormTech® SC-740 with cap length)
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

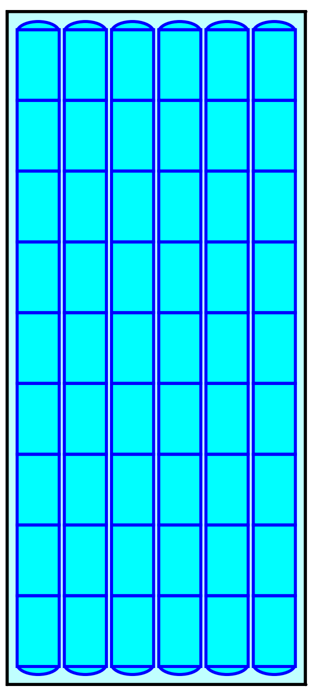
9 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 65.70' Row Length +12.0" End Stone x 2 = 67.70' Base Length
6 Rows x 51.0" Wide + 6.0" Spacing x 5 + 12.0" Side Stone x 2 = 30.00' Base Width
9.0" Stone Base + 30.0" Chamber Height + 12.0" Stone Cover = 4.25' Field Height

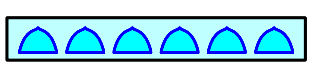
54 Chambers x 45.9 cf = 2,480.8 cf Chamber Storage

8,631.3 cf Field - 2,480.8 cf Chambers = 6,150.6 cf Stone x 33.3% Voids = 2,048.1 cf Stone Storage

Chamber Storage + Stone Storage = 4,528.9 cf = 0.104 af
Overall Storage Efficiency = 52.5%
Overall System Size = 67.70' x 30.00' x 4.25'

54 Chambers
319.7 cy Field
227.8 cy Stone





Summary for Pond C3: Middle

Inflow Area = 2.284 ac, 54.48% Impervious, Inflow Depth = 1.50" for 2yr NOAA+ event
Inflow = 4.10 cfs @ 12.08 hrs, Volume= 0.286 af
Outflow = 0.60 cfs @ 11.84 hrs, Volume= 0.286 af, Atten= 85%, Lag= 0.0 min
Discarded = 0.60 cfs @ 11.84 hrs, Volume= 0.286 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Pond IB1 : Infiltration Basin 1

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Peak Elev= 13.73' @ 12.65 hrs Surf.Area= 5,759 sf Storage= 3,671 cf

Plug-Flow detention time= 43.9 min calculated for 0.286 af (100% of inflow)
Center-of-Mass det. time= 43.9 min (890.5 - 846.6)

Volume	Invert	Avail.Storage	Storage Description
#1A	12.50'	5,703 cf	**49.00'W x 117.54'L x 4.25'H Field A** 24,477 cf Overall - 7,350 cf Embedded = 17,127 cf x 33.3% Voids
#2A	13.25'	7,350 cf	**ADS_StormTech SC-740 +Cap** x 160 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 160 Chambers in 10 Rows
		13,054 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	12.50'	**4.500 in/hr Exfiltration over Surface area** Phase-In= 0.01'
#2	Device 3	15.25'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#3	Primary	13.60'	**15.0" Round Culvert** L= 112.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 13.60' / 13.00' S= 0.0054 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf

Discarded OutFlow Max=0.60 cfs @ 11.84 hrs HW=12.55' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.60 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=12.50' TW=12.25' (Dynamic Tailwater)
└─**3=Culvert** (Controls 0.00 cfs)
  └─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond C3: Middle - Chamber Wizard Field A

Chamber Model = ADS_StormTech SC-740 +Cap (ADS StormTech® SC-740 with cap length)
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

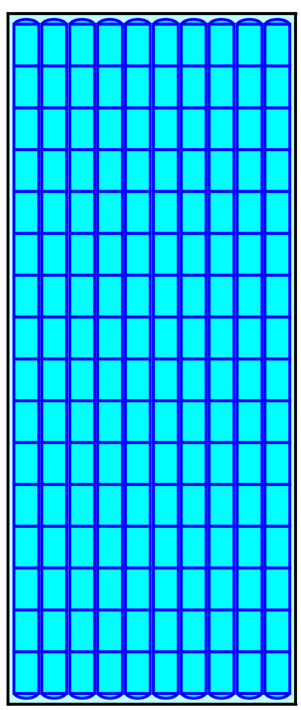
16 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 115.54' Row Length +12.0" End Stone x 2 = 117.54' Base Length
10 Rows x 51.0" Wide + 6.0" Spacing x 9 + 12.0" Side Stone x 2 = 49.00' Base Width
9.0" Stone Base + 30.0" Chamber Height + 12.0" Stone Cover = 4.25' Field Height

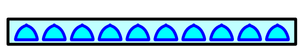
160 Chambers x 45.9 cf = 7,350.4 cf Chamber Storage

24,477.0 cf Field - 7,350.4 cf Chambers = 17,126.6 cf Stone x 33.3% Voids = 5,703.2 cf Stone Storage

Chamber Storage + Stone Storage = 13,053.6 cf = 0.300 af
Overall Storage Efficiency = 53.3%
Overall System Size = 117.54' x 49.00' x 4.25'

160 Chambers
906.6 cy Field
634.3 cy Stone





Summary for Pond C4: Roofs

Inflow Area = 0.243 ac,100.00% Impervious, Inflow Depth = 3.46" for 2yr NOAA+ event
Inflow = 0.90 cfs @ 12.07 hrs, Volume= 0.070 af
Outflow = 0.16 cfs @ 11.76 hrs, Volume= 0.070 af, Atten= 82%, Lag= 0.0 min
Discarded = 0.16 cfs @ 11.76 hrs, Volume= 0.070 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Pond IB2 : Infiltration Basin 2

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Peak Elev= 13.30' @ 12.51 hrs Surf.Area= 1,530 sf Storage= 742 cf

Plug-Flow detention time= 23.8 min calculated for 0.070 af (100% of inflow)
Center-of-Mass det. time= 23.8 min (776.4 - 752.6)

Volume	Invert	Avail.Storage	Storage Description
#1A	12.25'	1,553 cf	**25.25'W x 60.58'L x 4.25'H Field A** 6,501 cf Overall - 1,838 cf Embedded = 4,663 cf x 33.3% Voids
#2A	13.00'	1,838 cf	**ADS_StormTech SC-740 +Cap** x 40 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 40 Chambers in 5 Rows
		3,390 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	12.25'	**4.500 in/hr Exfiltration over Surface area** Phase-In= 0.01'
#2	Primary	14.50'	**8.0" Round Culvert** L= 50.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 14.50' / 14.00' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.35 sf

Discarded OutFlow Max=0.16 cfs @ 11.76 hrs HW=12.30' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.16 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=12.25' TW=13.00' (Dynamic Tailwater)
└─**2=Culvert** (Controls 0.00 cfs)

Pond C4: Roofs - Chamber Wizard Field A

Chamber Model = ADS_StormTech SC-740 +Cap (ADS StormTech® SC-740 with cap length)
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

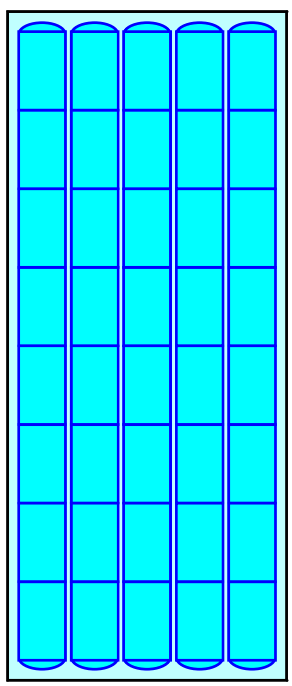
8 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 58.58' Row Length +12.0" End Stone x 2 = 60.58' Base Length
5 Rows x 51.0" Wide + 6.0" Spacing x 4 + 12.0" Side Stone x 2 = 25.25' Base Width
9.0" Stone Base + 30.0" Chamber Height + 12.0" Stone Cover = 4.25' Field Height

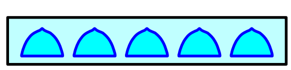
40 Chambers x 45.9 cf = 1,837.6 cf Chamber Storage

6,500.6 cf Field - 1,837.6 cf Chambers = 4,663.0 cf Stone x 33.3% Voids = 1,552.8 cf Stone Storage

Chamber Storage + Stone Storage = 3,390.4 cf = 0.078 af
Overall Storage Efficiency = 52.2%
Overall System Size = 60.58' x 25.25' x 4.25'

40 Chambers
240.8 cy Field
172.7 cy Stone





Summary for Pond IB1: Infiltration Basin 1

Inflow Area = 13.851 ac, 23.50% Impervious, Inflow Depth = 0.28" for 2yr NOAA+ event
Inflow = 2.41 cfs @ 12.08 hrs, Volume= 0.329 af
Outflow = 0.67 cfs @ 12.48 hrs, Volume= 0.329 af, Atten= 72%, Lag= 24.4 min
Discarded = 0.67 cfs @ 12.48 hrs, Volume= 0.329 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Pond SP1 : FLAX POND

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Peak Elev= 12.31' @ 12.48 hrs Surf.Area= 28,387 sf Storage= 1,570 cf

Plug-Flow detention time= 16.1 min calculated for 0.329 af (100% of inflow)
Center-of-Mass det. time= 16.1 min (946.3 - 930.3)

Volume	Invert	Avail.Storage	Storage Description
#1	12.25'	104,000 cf	**Custom Stage Data (Conic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
12.25	28,100	0	0	28,100
12.50	29,400	7,187	7,187	29,409
13.00	32,200	15,395	22,582	32,226
14.00	40,000	36,030	58,611	40,055
15.00	51,000	45,389	104,000	51,081

Device	Routing	Invert	Outlet Devices
#1	Discarded	12.25'	**1.020 in/hr Exfiltration over Wetted area** Phase-In= 0.01'
#2	Primary	14.30'	**8.0" Round Culvert X 2.00** L= 325.0' CPP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 14.30' / 14.10' S= 0.0006 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.35 sf

Discarded OutFlow Max=0.67 cfs @ 12.48 hrs HW=12.31' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.67 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=12.25' TW=0.00' (Dynamic Tailwater)
└─**2=Culvert** (Controls 0.00 cfs)

Summary for Pond IB2: Infiltration Basin 2

Inflow Area = 1.396 ac, 19.74% Impervious, Inflow Depth = 0.10" for 2yr NOAA+ event
Inflow = 0.02 cfs @ 14.31 hrs, Volume= 0.011 af
Outflow = 0.02 cfs @ 14.33 hrs, Volume= 0.011 af, Atten= 0%, Lag= 1.0 min
Discarded = 0.02 cfs @ 14.33 hrs, Volume= 0.011 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Pond SP2 : Study Point 2

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Peak Elev= 13.00' @ 14.33 hrs Surf.Area= 1,404 sf Storage= 2 cf

Plug-Flow detention time= 1.6 min calculated for 0.011 af (100% of inflow)
Center-of-Mass det. time= 1.6 min (1,063.5 - 1,061.9)

Volume	Invert	Avail.Storage	Storage Description
#1	13.00'	6,950 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
13.00	1,400	0	0
14.00	5,000	3,200	3,200
14.50	10,000	3,750	6,950

Device	Routing	Invert	Outlet Devices
#1	Discarded	13.00'	**4.500 in/hr Exfiltration over Surface area** Phase-In= 0.01'
#2	Primary	14.00'	**30.0' long x 30.0' 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

Discarded OutFlow Max=0.02 cfs @ 14.33 hrs HW=13.00' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.02 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=13.00' TW=0.00' (Dynamic Tailwater)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond P1: Littleton Dr North Bio

Inflow Area = 0.201 ac, 49.27% Impervious, Inflow Depth = 1.37" for 2yr NOAA+ event
Inflow = 0.33 cfs @ 12.08 hrs, Volume= 0.023 af
Outflow = 0.11 cfs @ 12.42 hrs, Volume= 0.023 af, Atten= 67%, Lag= 20.6 min
Discarded = 0.11 cfs @ 12.42 hrs, Volume= 0.023 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Peak Elev= 13.91' @ 12.42 hrs Surf.Area= 1,904 sf Storage= 206 cf

Plug-Flow detention time= 14.2 min calculated for 0.023 af (100% of inflow)
Center-of-Mass det. time= 14.2 min (866.8 - 852.6)

Volume	Invert	Avail.Storage	Storage Description
#1	13.75'	3,534 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
13.75	700	0	0
14.00	2,600	413	413
14.25	2,800	675	1,088
15.00	3,725	2,447	3,534

Device	Routing	Invert	Outlet Devices
#1	Discarded	13.75'	**2.410 in/hr Exfiltration over Surface area above 13.00'** Excluded Surface area = 0 sf Phase-In= 0.01'

Discarded OutFlow Max=0.11 cfs @ 12.42 hrs HW=13.91' (Free Discharge)
└—**1=Exfiltration** (Exfiltration Controls 0.11 cfs)

Summary for Pond SP1: FLAX POND

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

Inflow Area =	17.133 ac, 26.17% Impervious, Inflow Depth = 0.01"		for 2yr NOAA+ event	
Inflow =	0.03 cfs @	14.05 hrs, Volume=	0.016 af	
Primary =	0.03 cfs @	14.05 hrs, Volume=	0.016 af,	Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs

Summary for Pond SP2: Study Point 2

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

Inflow Area =	2.264 ac,	12.17% Impervious,	Inflow Depth = 0.04"	for 2yr NOAA+ event	
Inflow =	0.01 cfs @	14.15 hrs,	Volume=	0.008 af	
Primary =	0.01 cfs @	14.15 hrs,	Volume=	0.008 af,	Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs

Time span=0.00-60.00 hrs, dt=0.02 hrs, 3001 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment DA0: Littleton Dr North Runoff Area=8,758 sf 49.27% Impervious Runoff Depth=2.72"
Tc=5.0 min CN=74 Runoff=0.66 cfs 0.046 af

Subcatchment DA1E: East of Parking Lot Runoff Area=21,714 sf 74.16% Impervious Runoff Depth=3.88"
Tc=5.0 min CN=86 Runoff=2.30 cfs 0.161 af

Subcatchment DA1OS: Northeast Runoff Area=50,188 sf 2.79% Impervious Runoff Depth=0.59"
Flow Length=180' Tc=38.0 min CN=45 Runoff=0.24 cfs 0.057 af

Subcatchment DA1W: West of Parking Lot Runoff Area=22,713 sf 63.27% Impervious Runoff Depth=3.28"
Tc=5.0 min CN=80 Runoff=2.07 cfs 0.143 af

Subcatchment DA2: Community Garden Runoff Area=28,273 sf 66.34% Impervious Runoff Depth=3.48"
Tc=5.0 min CN=82 Runoff=2.72 cfs 0.188 af

Subcatchment DA2OS: Flax Pond Bank Runoff Area=61,501 sf 0.00% Impervious Runoff Depth=0.64"
Flow Length=400' Slope=0.0100 '/' Tc=37.3 min CN=46 Runoff=0.34 cfs 0.076 af

Subcatchment DA3: Middle Runoff Area=99,503 sf 54.48% Impervious Runoff Depth=2.90"
Tc=5.0 min CN=76 Runoff=8.04 cfs 0.552 af

Subcatchment DA3OS: Northwest Offsite Runoff Area=448,118 sf 12.66% Impervious Runoff Depth=0.76"
Flow Length=450' Slope=0.0100 '/' Tc=39.0 min CN=48 Runoff=3.15 cfs 0.651 af

Subcatchment DA3R: Roofs Runoff Area=10,603 sf 100.00% Impervious Runoff Depth=5.20"
Tc=5.0 min CN=98 Runoff=1.34 cfs 0.106 af

Subcatchment DA4: Middle North Runoff Area=55,717 sf 55.34% Impervious Runoff Depth=3.00"
Tc=5.0 min CN=77 Runoff=4.65 cfs 0.319 af

Subcatchment DA4OS: DA4OS Runoff Area=37,837 sf 0.00% Impervious Runoff Depth=0.59"
Flow Length=405' Tc=31.3 min CN=45 Runoff=0.19 cfs 0.043 af

Pond C1: Northern Parking Peak Elev=15.20' Storage=4,654 cf Inflow=4.37 cfs 0.304 af
Discarded=0.27 cfs 0.272 af Primary=0.97 cfs 0.031 af Outflow=1.24 cfs 0.304 af

Pond C2: Southern Parking Peak Elev=14.86' Storage=3,252 cf Inflow=2.72 cfs 0.188 af
Discarded=0.21 cfs 0.188 af Primary=0.00 cfs 0.000 af Outflow=0.21 cfs 0.188 af

Pond C3: Middle Peak Elev=15.24' Storage=9,842 cf Inflow=8.04 cfs 0.552 af
Discarded=0.60 cfs 0.552 af Primary=0.00 cfs 0.000 af Outflow=0.60 cfs 0.552 af

Pond C4: Roofs Peak Elev=13.83' Storage=1,360 cf Inflow=1.34 cfs 0.106 af
Discarded=0.16 cfs 0.106 af Primary=0.00 cfs 0.000 af Outflow=0.16 cfs 0.106 af

Pond IB1: Infiltration Basin 1 Peak Elev=12.83' Storage=17,337 cf Inflow=4.69 cfs 0.970 af
Discarded=0.74 cfs 0.970 af Primary=0.00 cfs 0.000 af Outflow=0.74 cfs 0.970 af

Pond IB2: Infiltration Basin 2 Peak Elev=13.07' Storage=115 cf Inflow=0.24 cfs 0.057 af
Discarded=0.17 cfs 0.057 af Primary=0.00 cfs 0.000 af Outflow=0.17 cfs 0.057 af

Pond P1: Littleton Dr North Bio Peak Elev=14.06' Storage=557 cf Inflow=0.66 cfs 0.046 af
Outflow=0.15 cfs 0.046 af

Pond SP1: FLAX POND Inflow=1.17 cfs 0.107 af
Primary=1.17 cfs 0.107 af

Pond SP2: Study Point 2 Inflow=0.19 cfs 0.043 af
Primary=0.19 cfs 0.043 af

Total Runoff Area = 19.397 ac Runoff Volume = 2.341 af Average Runoff Depth = 1.45"
75.46% Pervious = 14.638 ac 24.54% Impervious = 4.759 ac

Summary for Subcatchment DA0: Littleton Dr North

Runoff = 0.66 cfs @ 12.08 hrs, Volume= 0.046 af, Depth= 2.72"
Routed to Pond P1 : Littleton Dr North Bio

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Type III 24-hr 10yr NOAA+ Rainfall=5.44"

	Area (sf)	CN	Description
	3,521	98	Paved parking, HSG A
*	4,312	50	>75% Grass cover, Good, HSG A/B
	794	98	Water Surface, HSG A
*	131	77	Dirt roads, HSG A/B
	8,758	74	Weighted Average
	4,443		50.73% Pervious Area
	4,315		49.27% Impervious Area

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

Summary for Subcatchment DA1E: East of Parking Lot

Runoff = 2.30 cfs @ 12.07 hrs, Volume= 0.161 af, Depth= 3.88"
Routed to Pond C1 : Northern Parking

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Type III 24-hr 10yr NOAA+ Rainfall=5.44"

	Area (sf)	CN	Description
	15,238	98	Paved parking, HSG A
*	5,422	50	>75% Grass cover, Good, HSG A/B
	866	98	Water Surface, HSG A
*	188	77	Dirt roads, HSG A/B
	21,714	86	Weighted Average
	5,610		25.84% Pervious Area
	16,104		74.16% Impervious Area

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

Summary for Subcatchment DA1OS: Northeast Depression

Runoff = 0.24 cfs @ 12.72 hrs, Volume= 0.057 af, Depth= 0.59"
Routed to Pond IB2 : Infiltration Basin 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Type III 24-hr 10yr NOAA+ Rainfall=5.44"

	Area (sf)	CN	Description
	1,400	98	Water Surface, HSG A
*	22,538	42	Woods, Good, HSG A/B
*	5,962	50	>75% Grass cover, Good, HSG A/B
*	20,288	44	Meadow, non-grazed, HSG A/B
	50,188	45	Weighted Average
	48,788		97.21% Pervious Area
	1,400		2.79% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
36.1	100	0.0050	0.05		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.44"
1.9	80	0.0200	0.71		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
38.0	180	Total			

Summary for Subcatchment DA1W: West of Parking Lot

Runoff = 2.07 cfs @ 12.07 hrs, Volume= 0.143 af, Depth= 3.28"
Routed to Pond C1 : Northern Parking

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Type III 24-hr 10yr NOAA+ Rainfall=5.44"

	Area (sf)	CN	Description
	6,891	98	Paved parking, HSG A
*	8,343	50	>75% Grass cover, Good, HSG A/B
	6,933	98	Roofs, HSG A
	546	98	Water Surface, HSG A
	22,713	80	Weighted Average
	8,343		36.73% Pervious Area
	14,370		63.27% Impervious Area

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

Summary for Subcatchment DA2: Community Garden

Runoff = 2.72 cfs @ 12.07 hrs, Volume= 0.188 af, Depth= 3.48"
Routed to Pond C2 : Southern Parking

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Type III 24-hr 10yr NOAA+ Rainfall=5.44"

	Area (sf)	CN	Description
	11,054	98	Paved parking, HSG A
*	9,065	50	>75% Grass cover, Good, HSG A/B
	691	98	Water Surface, HSG A
	7,011	98	Roofs, HSG A
*	452	77	Dirt roads, HSG A/B
	28,273	82	Weighted Average
	9,517		33.66% Pervious Area
	18,756		66.34% Impervious Area

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

Summary for Subcatchment DA2OS: Flax Pond Bank

Runoff = 0.34 cfs @ 12.71 hrs, Volume= 0.076 af, Depth= 0.64"
Routed to Pond SP1 : FLAX POND

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Type III 24-hr 10yr NOAA+ Rainfall=5.44"

	Area (sf)	CN	Description
*	6,319	77	Dirt roads, HSG A/B
*	51,676	42	Woods, Good, HSG A/B
*	3,506	50	>75% Grass cover, Good, HSG A/B
	61,501	46	Weighted Average
	61,501		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
27.3	100	0.0100	0.06		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.44"
10.0	300	0.0100	0.50		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
37.3	400	Total			

Summary for Subcatchment DA3: Middle

Runoff = 8.04 cfs @ 12.08 hrs, Volume= 0.552 af, Depth= 2.90"
Routed to Pond C3 : Middle

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Type III 24-hr 10yr NOAA+ Rainfall=5.44"

	Area (sf)	CN	Description
	44,383	98	Paved parking, HSG A
*	45,290	50	>75% Grass cover, Good, HSG A/B
	7,549	98	Roofs, HSG A
	2,281	98	Water Surface, HSG A
	99,503	76	Weighted Average
	45,290		45.52% Pervious Area
	54,213		54.48% Impervious Area

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

Summary for Subcatchment DA3OS: Northwest Offsite

Runoff = 3.15 cfs @ 12.70 hrs, Volume= 0.651 af, Depth= 0.76"
Routed to Pond IB1 : Infiltration Basin 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Type III 24-hr 10yr NOAA+ Rainfall=5.44"

	Area (sf)	CN	Description
	0	98	Paved roads w/curbs & sewers, HSG A
*	2,762	77	Dirt roads, HSG A/B
	28,530	98	Roofs, HSG A
	28,182	98	Water Surface, HSG A
*	193,879	42	Woods, Good, HSG A/B
	94,810	30	Woods, Good, HSG A
*	37,887	50	>75% Grass cover, Good, HSG A/B
	17,673	39	>75% Grass cover, Good, HSG A
*	44,395	44	Meadow, non-grazed, HSG A/B
	448,118	48	Weighted Average
	391,406		87.34% Pervious Area
	56,712		12.66% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
27.3	100	0.0100	0.06		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.44"
11.7	350	0.0100	0.50		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
39.0	450	Total			

Summary for Subcatchment DA3R: Roofs

Runoff = 1.34 cfs @ 12.07 hrs, Volume= 0.106 af, Depth= 5.20"
Routed to Pond C4 : Roofs

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Type III 24-hr 10yr NOAA+ Rainfall=5.44"

Area (sf)	CN	Description
10,603	98	Roofs, HSG A
10,603		100.00% Impervious Area

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

Summary for Subcatchment DA4: Middle North

Runoff = 4.65 cfs @ 12.08 hrs, Volume= 0.319 af, Depth= 3.00"
Routed to Pond IB1 : Infiltration Basin 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Type III 24-hr 10yr NOAA+ Rainfall=5.44"

	Area (sf)	CN	Description
	22,041	98	Paved parking, HSG A
*	24,883	50	>75% Grass cover, Good, HSG A/B
	7,660	98	Roofs, HSG A
	1,133	98	Water Surface, HSG A
	55,717	77	Weighted Average
	24,883		44.66% Pervious Area
	30,834		55.34% Impervious Area

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

Summary for Subcatchment DA4OS: DA4OS

Runoff = 0.19 cfs @ 12.63 hrs, Volume= 0.043 af, Depth= 0.59"
Routed to Pond SP2 : Study Point 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Type III 24-hr 10yr NOAA+ Rainfall=5.44"

	Area (sf)	CN	Description
	0	98	Paved roads w/curbs & sewers, HSG A
*	3,185	77	Dirt roads, HSG A/B
	0	98	Roofs, HSG A
*	27,728	42	Woods, Good, HSG A/B
*	6,581	44	Meadow, non-grazed, HSG A/B
*	343	50	>75% Grass cover, Good, HSG A/B
	37,837	45	Weighted Average
	37,837		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
27.3	100	0.0100	0.06		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.44"
1.8	95	0.0300	0.87		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
2.2	210	0.0100	1.61		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
31.3	405	Total			

Summary for Pond C1: Northern Parking

Inflow Area = 1.020 ac, 68.59% Impervious, Inflow Depth = 3.57" for 10yr NOAA+ event
Inflow = 4.37 cfs @ 12.07 hrs, Volume= 0.304 af
Outflow = 1.24 cfs @ 12.42 hrs, Volume= 0.304 af, Atten= 72%, Lag= 20.5 min
Discarded = 0.27 cfs @ 11.44 hrs, Volume= 0.272 af
Primary = 0.97 cfs @ 12.42 hrs, Volume= 0.031 af
Routed to Pond SP1 : FLAX POND

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Peak Elev= 15.20' @ 12.42 hrs Surf.Area= 2,600 sf Storage= 4,654 cf

Plug-Flow detention time= 130.0 min calculated for 0.304 af (100% of inflow)
Center-of-Mass det. time= 130.0 min (938.3 - 808.3)

Volume	Invert	Avail.Storage	Storage Description
#1A	12.25'	2,609 cf	**34.75'W x 74.82'L x 4.25'H Field A**
			11,049 cf Overall - 3,216 cf Embedded = 7,834 cf x 33.3% Voids
#2A	13.00'	3,216 cf	**ADS_StormTech SC-740 +Cap** x 70 Inside #1
			Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
			Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap
			70 Chambers in 7 Rows
		5,824 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	12.25'	**4.500 in/hr Exfiltration over Surface area** Phase-In= 0.01'
#2	Device 3	15.00'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir**
			Head (feet) 0.20 0.40 0.60 0.80 1.00
			Coef. (English) 2.80 2.92 3.08 3.30 3.32
#3	Primary	14.50'	**18.0" Round Culvert**
			L= 85.0' CPP, projecting, no headwall, Ke= 0.900
			Inlet / Outlet Invert= 14.50' / 13.50' S= 0.0118 '/' Cc= 0.900
			n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf

Discarded OutFlow Max=0.27 cfs @ 11.44 hrs HW=12.29' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.27 cfs)

Primary OutFlow Max=0.97 cfs @ 12.42 hrs HW=15.20' TW=0.00' (Dynamic Tailwater)
└─**3=Culvert** (Passes 0.97 cfs of 1.80 cfs potential flow)
  └─**2=Broad-Crested Rectangular Weir** (Weir Controls 0.97 cfs @ 1.24 fps)

Pond C1: Northern Parking - Chamber Wizard Field A

Chamber Model = ADS_StormTech SC-740 +Cap (ADS StormTech® SC-740 with cap length)
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

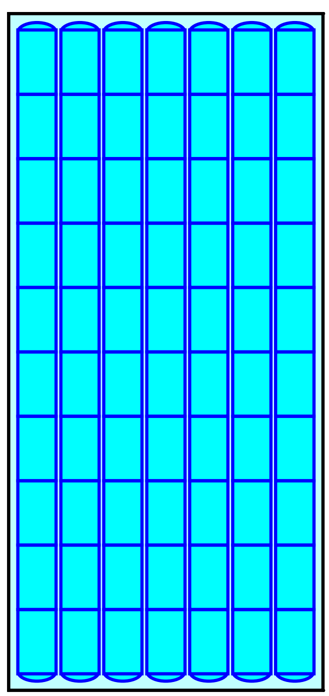
10 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 72.82' Row Length +12.0" End Stone x 2 = 74.82' Base Length
7 Rows x 51.0" Wide + 6.0" Spacing x 6 + 12.0" Side Stone x 2 = 34.75' Base Width
9.0" Stone Base + 30.0" Chamber Height + 12.0" Stone Cover = 4.25' Field Height

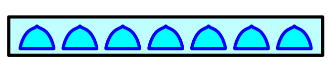
70 Chambers x 45.9 cf = 3,215.8 cf Chamber Storage

11,049.5 cf Field - 3,215.8 cf Chambers = 7,833.7 cf Stone x 33.3% Voids = 2,608.6 cf Stone Storage

Chamber Storage + Stone Storage = 5,824.4 cf = 0.134 af
Overall Storage Efficiency = 52.7%
Overall System Size = 74.82' x 34.75' x 4.25'

70 Chambers
409.2 cy Field
290.1 cy Stone





Summary for Pond C2: Southern Parking

Inflow Area = 0.649 ac, 66.34% Impervious, Inflow Depth = 3.48" for 10yr NOAA+ event
Inflow = 2.72 cfs @ 12.07 hrs, Volume= 0.188 af
Outflow = 0.21 cfs @ 11.62 hrs, Volume= 0.188 af, Atten= 92%, Lag= 0.0 min
Discarded = 0.21 cfs @ 11.62 hrs, Volume= 0.188 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Pond SP1 : FLAX POND

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Peak Elev= 14.86' @ 13.25 hrs Surf.Area= 2,031 sf Storage= 3,252 cf

Plug-Flow detention time= 130.4 min calculated for 0.188 af (100% of inflow)
Center-of-Mass det. time= 130.3 min (942.3 - 811.9)

Volume	Invert	Avail.Storage	Storage Description
#1A	12.25'	2,048 cf	**30.00'W x 67.70'L x 4.25'H Field A** 8,631 cf Overall - 2,481 cf Embedded = 6,151 cf x 33.3% Voids
#2A	13.00'	2,481 cf	**ADS_StormTech SC-740 +Cap** x 54 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 54 Chambers in 6 Rows
		4,529 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	12.25'	**4.500 in/hr Exfiltration over Surface area** Phase-In= 0.01'
#2	Device 3	15.00'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#3	Primary	14.50'	**10.0" Round Culvert** L= 70.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 14.50' / 14.20' S= 0.0043 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.55 sf

Discarded OutFlow Max=0.21 cfs @ 11.62 hrs HW=12.29' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.21 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=12.25' TW=0.00' (Dynamic Tailwater)
└─**3=Culvert** (Controls 0.00 cfs)
  └─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond C2: Southern Parking - Chamber Wizard Field A

Chamber Model = ADS_StormTech SC-740 +Cap (ADS StormTech® SC-740 with cap length)
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

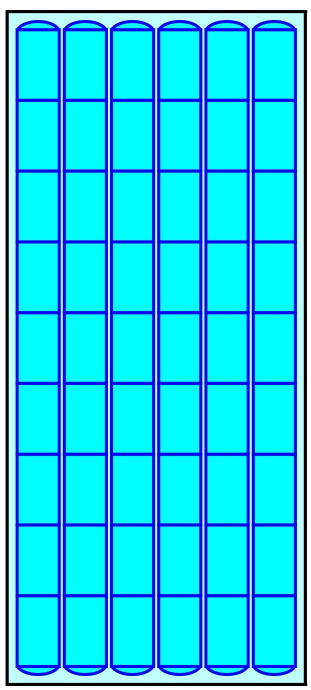
9 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 65.70' Row Length +12.0" End Stone x 2 = 67.70' Base Length
6 Rows x 51.0" Wide + 6.0" Spacing x 5 + 12.0" Side Stone x 2 = 30.00' Base Width
9.0" Stone Base + 30.0" Chamber Height + 12.0" Stone Cover = 4.25' Field Height

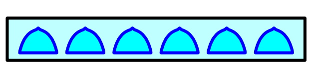
54 Chambers x 45.9 cf = 2,480.8 cf Chamber Storage

8,631.3 cf Field - 2,480.8 cf Chambers = 6,150.6 cf Stone x 33.3% Voids = 2,048.1 cf Stone Storage

Chamber Storage + Stone Storage = 4,528.9 cf = 0.104 af
Overall Storage Efficiency = 52.5%
Overall System Size = 67.70' x 30.00' x 4.25'

54 Chambers
319.7 cy Field
227.8 cy Stone





Summary for Pond C3: Middle

Inflow Area = 2.284 ac, 54.48% Impervious, Inflow Depth = 2.90" for 10yr NOAA+ event
Inflow = 8.04 cfs @ 12.08 hrs, Volume= 0.552 af
Outflow = 0.60 cfs @ 11.66 hrs, Volume= 0.552 af, Atten= 93%, Lag= 0.0 min
Discarded = 0.60 cfs @ 11.66 hrs, Volume= 0.552 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Pond IB1 : Infiltration Basin 1

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Peak Elev= 15.24' @ 13.57 hrs Surf.Area= 5,759 sf Storage= 9,842 cf

Plug-Flow detention time= 148.5 min calculated for 0.552 af (100% of inflow)
Center-of-Mass det. time= 148.4 min (975.9 - 827.5)

Volume	Invert	Avail.Storage	Storage Description
#1A	12.50'	5,703 cf	**49.00'W x 117.54'L x 4.25'H Field A** 24,477 cf Overall - 7,350 cf Embedded = 17,127 cf x 33.3% Voids
#2A	13.25'	7,350 cf	**ADS_StormTech SC-740 +Cap** x 160 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 160 Chambers in 10 Rows
		13,054 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	12.50'	**4.500 in/hr Exfiltration over Surface area** Phase-In= 0.01'
#2	Device 3	15.25'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#3	Primary	13.60'	**15.0" Round Culvert** L= 112.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 13.60' / 13.00' S= 0.0054 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf

Discarded OutFlow Max=0.60 cfs @ 11.66 hrs HW=12.55' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.60 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=12.50' TW=12.25' (Dynamic Tailwater)
└─**3=Culvert** (Controls 0.00 cfs)
  └─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond C3: Middle - Chamber Wizard Field A

Chamber Model = ADS_StormTech SC-740 +Cap (ADS StormTech® SC-740 with cap length)
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

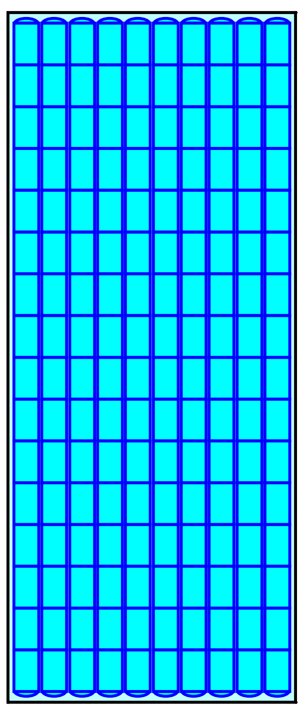
16 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 115.54' Row Length +12.0" End Stone x 2 = 117.54' Base Length
10 Rows x 51.0" Wide + 6.0" Spacing x 9 + 12.0" Side Stone x 2 = 49.00' Base Width
9.0" Stone Base + 30.0" Chamber Height + 12.0" Stone Cover = 4.25' Field Height

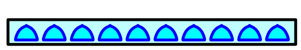
160 Chambers x 45.9 cf = 7,350.4 cf Chamber Storage

24,477.0 cf Field - 7,350.4 cf Chambers = 17,126.6 cf Stone x 33.3% Voids = 5,703.2 cf Stone Storage

Chamber Storage + Stone Storage = 13,053.6 cf = 0.300 af
Overall Storage Efficiency = 53.3%
Overall System Size = 117.54' x 49.00' x 4.25'

160 Chambers
906.6 cy Field
634.3 cy Stone





Summary for Pond C4: Roofs

Inflow Area = 0.243 ac,100.00% Impervious, Inflow Depth = 5.20" for 10yr NOAA+ event
Inflow = 1.34 cfs @ 12.07 hrs, Volume= 0.106 af
Outflow = 0.16 cfs @ 11.68 hrs, Volume= 0.106 af, Atten= 88%, Lag= 0.0 min
Discarded = 0.16 cfs @ 11.68 hrs, Volume= 0.106 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Pond IB2 : Infiltration Basin 2

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Peak Elev= 13.83' @ 12.61 hrs Surf.Area= 1,530 sf Storage= 1,360 cf

Plug-Flow detention time= 50.9 min calculated for 0.105 af (100% of inflow)
Center-of-Mass det. time= 50.9 min (796.6 - 745.7)

Volume	Invert	Avail.Storage	Storage Description
#1A	12.25'	1,553 cf	**25.25'W x 60.58'L x 4.25'H Field A** 6,501 cf Overall - 1,838 cf Embedded = 4,663 cf x 33.3% Voids
#2A	13.00'	1,838 cf	**ADS_StormTech SC-740 +Cap** x 40 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 40 Chambers in 5 Rows
		3,390 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	12.25'	**4.500 in/hr Exfiltration over Surface area** Phase-In= 0.01'
#2	Primary	14.50'	**8.0" Round Culvert** L= 50.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 14.50' / 14.00' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.35 sf

Discarded OutFlow Max=0.16 cfs @ 11.68 hrs HW=12.31' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.16 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=12.25' TW=13.00' (Dynamic Tailwater)
└─**2=Culvert** (Controls 0.00 cfs)

Pond C4: Roofs - Chamber Wizard Field A

Chamber Model = ADS_StormTech SC-740 +Cap (ADS StormTech® SC-740 with cap length)
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

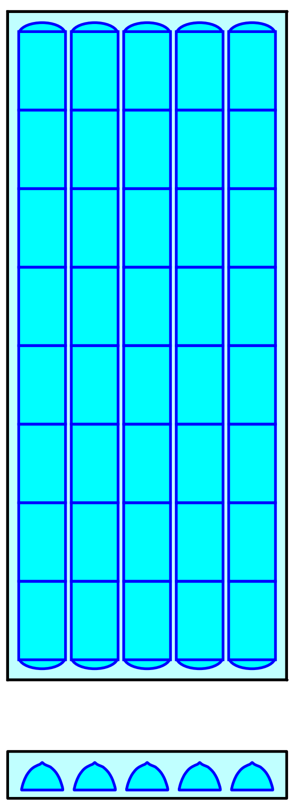
8 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 58.58' Row Length +12.0" End Stone x 2 = 60.58' Base Length
5 Rows x 51.0" Wide + 6.0" Spacing x 4 + 12.0" Side Stone x 2 = 25.25' Base Width
9.0" Stone Base + 30.0" Chamber Height + 12.0" Stone Cover = 4.25' Field Height

40 Chambers x 45.9 cf = 1,837.6 cf Chamber Storage

6,500.6 cf Field - 1,837.6 cf Chambers = 4,663.0 cf Stone x 33.3% Voids = 1,552.8 cf Stone Storage

Chamber Storage + Stone Storage = 3,390.4 cf = 0.078 af
Overall Storage Efficiency = 52.2%
Overall System Size = 60.58' x 25.25' x 4.25'

40 Chambers
240.8 cy Field
172.7 cy Stone



Summary for Pond IB1: Infiltration Basin 1

Inflow Area = 13.851 ac, 23.50% Impervious, Inflow Depth = 0.84" for 10yr NOAA+ event
Inflow = 4.69 cfs @ 12.08 hrs, Volume= 0.970 af
Outflow = 0.74 cfs @ 16.25 hrs, Volume= 0.970 af, Atten= 84%, Lag= 250.4 min
Discarded = 0.74 cfs @ 16.25 hrs, Volume= 0.970 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Pond SP1 : FLAX POND

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Peak Elev= 12.83' @ 16.25 hrs Surf.Area= 31,260 sf Storage= 17,337 cf

Plug-Flow detention time= 256.5 min calculated for 0.970 af (100% of inflow)
Center-of-Mass det. time= 256.4 min (1,161.9 - 905.5)

Volume	Invert	Avail.Storage	Storage Description
#1	12.25'	104,000 cf	**Custom Stage Data (Conic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
12.25	28,100	0	0	28,100
12.50	29,400	7,187	7,187	29,409
13.00	32,200	15,395	22,582	32,226
14.00	40,000	36,030	58,611	40,055
15.00	51,000	45,389	104,000	51,081

Device	Routing	Invert	Outlet Devices
#1	Discarded	12.25'	**1.020 in/hr Exfiltration over Wetted area** Phase-In= 0.01'
#2	Primary	14.30'	**8.0" Round Culvert X 2.00** L= 325.0' CPP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 14.30' / 14.10' S= 0.0006 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.35 sf

Discarded OutFlow Max=0.74 cfs @ 16.25 hrs HW=12.83' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.74 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=12.25' TW=0.00' (Dynamic Tailwater)
└─**2=Culvert** (Controls 0.00 cfs)

Summary for Pond IB2: Infiltration Basin 2

Inflow Area = 1.396 ac, 19.74% Impervious, Inflow Depth = 0.49" for 10yr NOAA+ event
Inflow = 0.24 cfs @ 12.72 hrs, Volume= 0.057 af
Outflow = 0.17 cfs @ 13.09 hrs, Volume= 0.057 af, Atten= 26%, Lag= 22.2 min
Discarded = 0.17 cfs @ 13.09 hrs, Volume= 0.057 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Pond SP2 : Study Point 2

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Peak Elev= 13.07' @ 13.09 hrs Surf.Area= 1,670 sf Storage= 115 cf

Plug-Flow detention time= 3.5 min calculated for 0.057 af (100% of inflow)
Center-of-Mass det. time= 3.5 min (964.8 - 961.3)

Volume	Invert	Avail.Storage	Storage Description
#1	13.00'	6,950 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
13.00	1,400	0	0
14.00	5,000	3,200	3,200
14.50	10,000	3,750	6,950

Device	Routing	Invert	Outlet Devices
#1	Discarded	13.00'	**4.500 in/hr Exfiltration over Surface area** Phase-In= 0.01'
#2	Primary	14.00'	**30.0' long x 30.0' 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

Discarded OutFlow Max=0.17 cfs @ 13.09 hrs HW=13.07' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.17 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=13.00' TW=0.00' (Dynamic Tailwater)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond P1: Littleton Dr North Bio

Inflow Area = 0.201 ac, 49.27% Impervious, Inflow Depth = 2.72" for 10yr NOAA+ event
Inflow = 0.66 cfs @ 12.08 hrs, Volume= 0.046 af
Outflow = 0.15 cfs @ 12.50 hrs, Volume= 0.046 af, Atten= 78%, Lag= 25.3 min
Discarded = 0.15 cfs @ 12.50 hrs, Volume= 0.046 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Peak Elev= 14.06' @ 12.50 hrs Surf.Area= 2,644 sf Storage= 557 cf

Plug-Flow detention time= 28.6 min calculated for 0.046 af (100% of inflow)
Center-of-Mass det. time= 28.6 min (861.0 - 832.4)

Volume	Invert	Avail.Storage	Storage Description
#1	13.75'	3,534 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
13.75	700	0	0
14.00	2,600	413	413
14.25	2,800	675	1,088
15.00	3,725	2,447	3,534

Device	Routing	Invert	Outlet Devices
#1	Discarded	13.75'	**2.410 in/hr Exfiltration over Surface area above 13.00'** Excluded Surface area = 0 sf Phase-In= 0.01'

Discarded OutFlow Max=0.15 cfs @ 12.50 hrs HW=14.06' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.15 cfs)

Summary for Pond SP1: FLAX POND

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

Inflow Area =	17.133 ac,	26.17% Impervious,	Inflow Depth =	0.08"	for 10yr NOAA+ event
Inflow =	1.17 cfs @	12.43 hrs,	Volume=	0.107 af	
Primary =	1.17 cfs @	12.43 hrs,	Volume=	0.107 af,	Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs

Summary for Pond SP2: Study Point 2

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

Inflow Area = 2.264 ac, 12.17% Impervious, Inflow Depth = 0.23" for 10yr NOAA+ event
Inflow = 0.19 cfs @ 12.63 hrs, Volume= 0.043 af
Primary = 0.19 cfs @ 12.63 hrs, Volume= 0.043 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs

Time span=0.00-60.00 hrs, dt=0.02 hrs, 3001 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment DA0: Littleton Dr North Runoff Area=8,758 sf 49.27% Impervious Runoff Depth=5.61"
Tc=5.0 min CN=74 Runoff=1.36 cfs 0.094 af

Subcatchment DA1E: East of Parking Lot Runoff Area=21,714 sf 74.16% Impervious Runoff Depth=7.07"
Tc=5.0 min CN=86 Runoff=4.07 cfs 0.294 af

Subcatchment DA1OS: Northeast Runoff Area=50,188 sf 2.79% Impervious Runoff Depth=2.15"
Flow Length=180' Tc=38.0 min CN=45 Runoff=1.29 cfs 0.207 af

Subcatchment DA1W: West of Parking Lot Runoff Area=22,713 sf 63.27% Impervious Runoff Depth=6.34"
Tc=5.0 min CN=80 Runoff=3.92 cfs 0.276 af

Subcatchment DA2: Community Garden Runoff Area=28,273 sf 66.34% Impervious Runoff Depth=6.58"
Tc=5.0 min CN=82 Runoff=5.03 cfs 0.356 af

Subcatchment DA2OS: Flax Pond Bank Runoff Area=61,501 sf 0.00% Impervious Runoff Depth=2.27"
Flow Length=400' Slope=0.0100 '/' Tc=37.3 min CN=46 Runoff=1.71 cfs 0.267 af

Subcatchment DA3: Middle Runoff Area=99,503 sf 54.48% Impervious Runoff Depth=5.85"
Tc=5.0 min CN=76 Runoff=16.05 cfs 1.114 af

Subcatchment DA3OS: Northwest Offsite Runoff Area=448,118 sf 12.66% Impervious Runoff Depth=2.49"
Flow Length=450' Slope=0.0100 '/' Tc=39.0 min CN=48 Runoff=13.78 cfs 2.139 af

Subcatchment DA3R: Roofs Runoff Area=10,603 sf 100.00% Impervious Runoff Depth=8.52"
Tc=5.0 min CN=98 Runoff=2.16 cfs 0.173 af

Subcatchment DA4: Middle North Runoff Area=55,717 sf 55.34% Impervious Runoff Depth=5.98"
Tc=5.0 min CN=77 Runoff=9.15 cfs 0.637 af

Subcatchment DA4OS: DA4OS Runoff Area=37,837 sf 0.00% Impervious Runoff Depth=2.15"
Flow Length=405' Tc=31.3 min CN=45 Runoff=1.07 cfs 0.156 af

Pond C1: Northern Parking Peak Elev=16.13' Storage=5,501 cf Inflow=7.99 cfs 0.569 af
Discarded=0.27 cfs 0.356 af Primary=6.29 cfs 0.213 af Outflow=6.56 cfs 0.569 af

Pond C2: Southern Parking Peak Elev=16.13' Storage=4,277 cf Inflow=5.03 cfs 0.356 af
Discarded=0.21 cfs 0.254 af Primary=2.21 cfs 0.102 af Outflow=2.42 cfs 0.356 af

Pond C3: Middle Peak Elev=16.65' Storage=12,863 cf Inflow=16.05 cfs 1.114 af
Discarded=0.60 cfs 0.740 af Primary=7.52 cfs 0.375 af Outflow=8.12 cfs 1.114 af

Pond C4: Roofs Peak Elev=14.84' Storage=2,413 cf Inflow=2.16 cfs 0.173 af
Discarded=0.16 cfs 0.160 af Primary=0.28 cfs 0.013 af Outflow=0.44 cfs 0.173 af

Pond IB1: Infiltration Basin 1 Peak Elev=14.68' Storage=88,503 cf Inflow=20.78 cfs 3.150 af
Discarded=1.12 cfs 2.989 af Primary=0.29 cfs 0.162 af Outflow=1.41 cfs 3.150 af

Pond IB2: Infiltration Basin 2 Peak Elev=13.91' Storage=2,751 cf Inflow=1.54 cfs 0.219 af
Discarded=0.49 cfs 0.219 af Primary=0.00 cfs 0.000 af Outflow=0.49 cfs 0.219 af

Pond P1: Littleton Dr North Bio Peak Elev=14.40' Storage=1,516 cf Inflow=1.36 cfs 0.094 af
Outflow=0.17 cfs 0.094 af

Pond SP1: FLAX POND Inflow=8.58 cfs 0.743 af
Primary=8.58 cfs 0.743 af

Pond SP2: Study Point 2 Inflow=1.07 cfs 0.156 af
Primary=1.07 cfs 0.156 af

Total Runoff Area = 19.397 ac Runoff Volume = 5.711 af Average Runoff Depth = 3.53"
75.46% Pervious = 14.638 ac 24.54% Impervious = 4.759 ac

Summary for Subcatchment DA0: Littleton Dr North

Runoff = 1.36 cfs @ 12.07 hrs, Volume= 0.094 af, Depth= 5.61"
Routed to Pond P1 : Littleton Dr North Bio

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Type III 24-hr 100yr NOAA+ Rainfall=8.76"

	Area (sf)	CN	Description
	3,521	98	Paved parking, HSG A
*	4,312	50	>75% Grass cover, Good, HSG A/B
	794	98	Water Surface, HSG A
*	131	77	Dirt roads, HSG A/B
	8,758	74	Weighted Average
	4,443		50.73% Pervious Area
	4,315		49.27% Impervious Area

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

Summary for Subcatchment DA1E: East of Parking Lot

Runoff = 4.07 cfs @ 12.07 hrs, Volume= 0.294 af, Depth= 7.07"
Routed to Pond C1 : Northern Parking

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Type III 24-hr 100yr NOAA+ Rainfall=8.76"

	Area (sf)	CN	Description
	15,238	98	Paved parking, HSG A
*	5,422	50	>75% Grass cover, Good, HSG A/B
	866	98	Water Surface, HSG A
*	188	77	Dirt roads, HSG A/B
	21,714	86	Weighted Average
	5,610		25.84% Pervious Area
	16,104		74.16% Impervious Area

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

Summary for Subcatchment DA1OS: Northeast Depression

Runoff = 1.29 cfs @ 12.61 hrs, Volume= 0.207 af, Depth= 2.15"
Routed to Pond IB2 : Infiltration Basin 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Type III 24-hr 100yr NOAA+ Rainfall=8.76"

	Area (sf)	CN	Description
	1,400	98	Water Surface, HSG A
*	22,538	42	Woods, Good, HSG A/B
*	5,962	50	>75% Grass cover, Good, HSG A/B
*	20,288	44	Meadow, non-grazed, HSG A/B
	50,188	45	Weighted Average
	48,788		97.21% Pervious Area
	1,400		2.79% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
36.1	100	0.0050	0.05		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.44"
1.9	80	0.0200	0.71		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
38.0	180	Total			

Summary for Subcatchment DA1W: West of Parking Lot

Runoff = 3.92 cfs @ 12.07 hrs, Volume= 0.276 af, Depth= 6.34"
Routed to Pond C1 : Northern Parking

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Type III 24-hr 100yr NOAA+ Rainfall=8.76"

	Area (sf)	CN	Description
	6,891	98	Paved parking, HSG A
*	8,343	50	>75% Grass cover, Good, HSG A/B
	6,933	98	Roofs, HSG A
	546	98	Water Surface, HSG A
	22,713	80	Weighted Average
	8,343		36.73% Pervious Area
	14,370		63.27% Impervious Area

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

Summary for Subcatchment DA2: Community Garden

Runoff = 5.03 cfs @ 12.07 hrs, Volume= 0.356 af, Depth= 6.58"
Routed to Pond C2 : Southern Parking

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Type III 24-hr 100yr NOAA+ Rainfall=8.76"

	Area (sf)	CN	Description
	11,054	98	Paved parking, HSG A
*	9,065	50	>75% Grass cover, Good, HSG A/B
	691	98	Water Surface, HSG A
	7,011	98	Roofs, HSG A
*	452	77	Dirt roads, HSG A/B
	28,273	82	Weighted Average
	9,517		33.66% Pervious Area
	18,756		66.34% Impervious Area

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

Summary for Subcatchment DA2OS: Flax Pond Bank

Runoff = 1.71 cfs @ 12.58 hrs, Volume= 0.267 af, Depth= 2.27"
Routed to Pond SP1 : FLAX POND

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Type III 24-hr 100yr NOAA+ Rainfall=8.76"

	Area (sf)	CN	Description
*	6,319	77	Dirt roads, HSG A/B
*	51,676	42	Woods, Good, HSG A/B
*	3,506	50	>75% Grass cover, Good, HSG A/B
	61,501	46	Weighted Average
	61,501		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
27.3	100	0.0100	0.06		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.44"
10.0	300	0.0100	0.50		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
37.3	400	Total			

Summary for Subcatchment DA3: Middle

Runoff = 16.05 cfs @ 12.07 hrs, Volume= 1.114 af, Depth= 5.85"
Routed to Pond C3 : Middle

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Type III 24-hr 100yr NOAA+ Rainfall=8.76"

	Area (sf)	CN	Description
	44,383	98	Paved parking, HSG A
*	45,290	50	>75% Grass cover, Good, HSG A/B
	7,549	98	Roofs, HSG A
	2,281	98	Water Surface, HSG A
	99,503	76	Weighted Average
	45,290		45.52% Pervious Area
	54,213		54.48% Impervious Area

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

Summary for Subcatchment DA3OS: Northwest Offsite

Runoff = 13.78 cfs @ 12.60 hrs, Volume= 2.139 af, Depth= 2.49"
Routed to Pond IB1 : Infiltration Basin 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Type III 24-hr 100yr NOAA+ Rainfall=8.76"

	Area (sf)	CN	Description
	0	98	Paved roads w/curbs & sewers, HSG A
*	2,762	77	Dirt roads, HSG A/B
	28,530	98	Roofs, HSG A
	28,182	98	Water Surface, HSG A
*	193,879	42	Woods, Good, HSG A/B
	94,810	30	Woods, Good, HSG A
*	37,887	50	>75% Grass cover, Good, HSG A/B
	17,673	39	>75% Grass cover, Good, HSG A
*	44,395	44	Meadow, non-grazed, HSG A/B
	448,118	48	Weighted Average
	391,406		87.34% Pervious Area
	56,712		12.66% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
27.3	100	0.0100	0.06		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.44"
11.7	350	0.0100	0.50		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
39.0	450	Total			

Summary for Subcatchment DA3R: Roofs

Runoff = 2.16 cfs @ 12.07 hrs, Volume= 0.173 af, Depth= 8.52"
Routed to Pond C4 : Roofs

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Type III 24-hr 100yr NOAA+ Rainfall=8.76"

Area (sf)	CN	Description
10,603	98	Roofs, HSG A
10,603		100.00% Impervious Area

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

Summary for Subcatchment DA4: Middle North

Runoff = 9.15 cfs @ 12.07 hrs, Volume= 0.637 af, Depth= 5.98"
Routed to Pond IB1 : Infiltration Basin 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Type III 24-hr 100yr NOAA+ Rainfall=8.76"

	Area (sf)	CN	Description
	22,041	98	Paved parking, HSG A
*	24,883	50	>75% Grass cover, Good, HSG A/B
	7,660	98	Roofs, HSG A
	1,133	98	Water Surface, HSG A
	55,717	77	Weighted Average
	24,883		44.66% Pervious Area
	30,834		55.34% Impervious Area

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

Summary for Subcatchment DA4OS: DA4OS

Runoff = 1.07 cfs @ 12.50 hrs, Volume= 0.156 af, Depth= 2.15"
Routed to Pond SP2 : Study Point 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Type III 24-hr 100yr NOAA+ Rainfall=8.76"

	Area (sf)	CN	Description
	0	98	Paved roads w/curbs & sewers, HSG A
*	3,185	77	Dirt roads, HSG A/B
	0	98	Roofs, HSG A
*	27,728	42	Woods, Good, HSG A/B
*	6,581	44	Meadow, non-grazed, HSG A/B
*	343	50	>75% Grass cover, Good, HSG A/B
	37,837	45	Weighted Average
	37,837		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
27.3	100	0.0100	0.06		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.44"
1.8	95	0.0300	0.87		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
2.2	210	0.0100	1.61		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
31.3	405	Total			

Summary for Pond C1: Northern Parking

Inflow Area = 1.020 ac, 68.59% Impervious, Inflow Depth = 6.70" for 100yr NOAA+ event
Inflow = 7.99 cfs @ 12.07 hrs, Volume= 0.569 af
Outflow = 6.56 cfs @ 12.12 hrs, Volume= 0.569 af, Atten= 18%, Lag= 3.2 min
Discarded = 0.27 cfs @ 10.38 hrs, Volume= 0.356 af
Primary = 6.29 cfs @ 12.12 hrs, Volume= 0.213 af
Routed to Pond SP1 : FLAX POND

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Peak Elev= 16.13' @ 12.12 hrs Surf.Area= 2,600 sf Storage= 5,501 cf

Plug-Flow detention time= 97.2 min calculated for 0.569 af (100% of inflow)
Center-of-Mass det. time= 97.2 min (888.2 - 791.0)

Volume	Invert	Avail.Storage	Storage Description
#1A	12.25'	2,609 cf	**34.75'W x 74.82'L x 4.25'H Field A** 11,049 cf Overall - 3,216 cf Embedded = 7,834 cf x 33.3% Voids
#2A	13.00'	3,216 cf	**ADS_StormTech SC-740 +Cap** x 70 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 70 Chambers in 7 Rows
		5,824 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	12.25'	**4.500 in/hr Exfiltration over Surface area** Phase-In= 0.01'
#2	Device 3	15.00'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#3	Primary	14.50'	**18.0" Round Culvert** L= 85.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 14.50' / 13.50' S= 0.0118 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf

Discarded OutFlow Max=0.27 cfs @ 10.38 hrs HW=12.29' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.27 cfs)

Primary OutFlow Max=6.26 cfs @ 12.12 hrs HW=16.12' TW=0.00' (Dynamic Tailwater)
↑—**3=Culvert** (Inlet Controls 6.26 cfs @ 3.54 fps)
↑—**2=Broad-Crested Rectangular Weir** (Passes 6.26 cfs of 15.72 cfs potential flow)

Pond C1: Northern Parking - Chamber Wizard Field A

Chamber Model = ADS_StormTech SC-740 +Cap (ADS StormTech® SC-740 with cap length)
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

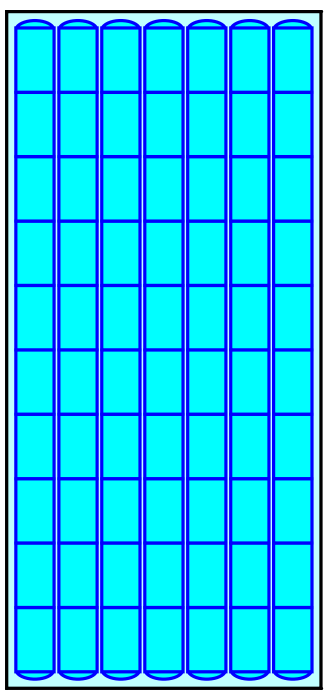
10 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 72.82' Row Length +12.0" End Stone x 2 = 74.82' Base Length
7 Rows x 51.0" Wide + 6.0" Spacing x 6 + 12.0" Side Stone x 2 = 34.75' Base Width
9.0" Stone Base + 30.0" Chamber Height + 12.0" Stone Cover = 4.25' Field Height

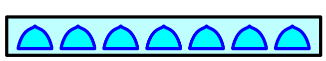
70 Chambers x 45.9 cf = 3,215.8 cf Chamber Storage

11,049.5 cf Field - 3,215.8 cf Chambers = 7,833.7 cf Stone x 33.3% Voids = 2,608.6 cf Stone Storage

Chamber Storage + Stone Storage = 5,824.4 cf = 0.134 af
Overall Storage Efficiency = 52.7%
Overall System Size = 74.82' x 34.75' x 4.25'

70 Chambers
409.2 cy Field
290.1 cy Stone





Summary for Pond C2: Southern Parking

Inflow Area = 0.649 ac, 66.34% Impervious, Inflow Depth = 6.58" for 100yr NOAA+ event
Inflow = 5.03 cfs @ 12.07 hrs, Volume= 0.356 af
Outflow = 2.42 cfs @ 12.21 hrs, Volume= 0.356 af, Atten= 52%, Lag= 8.5 min
Discarded = 0.21 cfs @ 10.80 hrs, Volume= 0.254 af
Primary = 2.21 cfs @ 12.21 hrs, Volume= 0.102 af
Routed to Pond SP1 : FLAX POND

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Peak Elev= 16.13' @ 12.21 hrs Surf.Area= 2,031 sf Storage= 4,277 cf

Plug-Flow detention time= 106.3 min calculated for 0.356 af (100% of inflow)
Center-of-Mass det. time= 106.2 min (900.2 - 793.9)

Volume	Invert	Avail.Storage	Storage Description
#1A	12.25'	2,048 cf	**30.00'W x 67.70'L x 4.25'H Field A** 8,631 cf Overall - 2,481 cf Embedded = 6,151 cf x 33.3% Voids
#2A	13.00'	2,481 cf	**ADS_StormTech SC-740 +Cap** x 54 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 54 Chambers in 6 Rows
		4,529 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	12.25'	**4.500 in/hr Exfiltration over Surface area** Phase-In= 0.01'
#2	Device 3	15.00'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#3	Primary	14.50'	**10.0" Round Culvert** L= 70.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 14.50' / 14.20' S= 0.0043 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.55 sf

Discarded OutFlow Max=0.21 cfs @ 10.80 hrs HW=12.29' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.21 cfs)

Primary OutFlow Max=2.21 cfs @ 12.21 hrs HW=16.13' TW=0.00' (Dynamic Tailwater)
└─**3=Culvert** (Barrel Controls 2.21 cfs @ 4.04 fps)
  └─**2=Broad-Crested Rectangular Weir** (Passes 2.21 cfs of 15.86 cfs potential flow)

Pond C2: Southern Parking - Chamber Wizard Field A

Chamber Model = ADS_StormTech SC-740 +Cap (ADS StormTech® SC-740 with cap length)
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

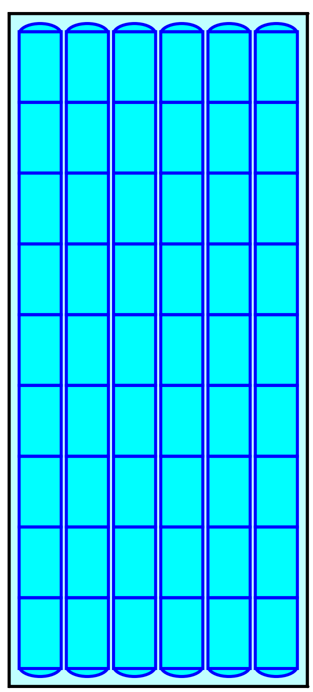
9 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 65.70' Row Length +12.0" End Stone x 2 = 67.70' Base Length
6 Rows x 51.0" Wide + 6.0" Spacing x 5 + 12.0" Side Stone x 2 = 30.00' Base Width
9.0" Stone Base + 30.0" Chamber Height + 12.0" Stone Cover = 4.25' Field Height

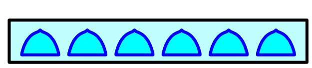
54 Chambers x 45.9 cf = 2,480.8 cf Chamber Storage

8,631.3 cf Field - 2,480.8 cf Chambers = 6,150.6 cf Stone x 33.3% Voids = 2,048.1 cf Stone Storage

Chamber Storage + Stone Storage = 4,528.9 cf = 0.104 af
Overall Storage Efficiency = 52.5%
Overall System Size = 67.70' x 30.00' x 4.25'

54 Chambers
319.7 cy Field
227.8 cy Stone





Summary for Pond C3: Middle

Inflow Area = 2.284 ac, 54.48% Impervious, Inflow Depth = 5.85" for 100yr NOAA+ event
Inflow = 16.05 cfs @ 12.07 hrs, Volume= 1.114 af
Outflow = 8.12 cfs @ 12.21 hrs, Volume= 1.114 af, Atten= 49%, Lag= 7.9 min
Discarded = 0.60 cfs @ 10.88 hrs, Volume= 0.740 af
Primary = 7.52 cfs @ 12.21 hrs, Volume= 0.375 af
Routed to Pond IB1 : Infiltration Basin 1

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Peak Elev= 16.65' @ 12.21 hrs Surf.Area= 5,759 sf Storage= 12,863 cf

Plug-Flow detention time= 109.7 min calculated for 1.114 af (100% of inflow)
Center-of-Mass det. time= 109.6 min (917.0 - 807.4)

Volume	Invert	Avail.Storage	Storage Description
#1A	12.50'	5,703 cf	**49.00'W x 117.54'L x 4.25'H Field A** 24,477 cf Overall - 7,350 cf Embedded = 17,127 cf x 33.3% Voids
#2A	13.25'	7,350 cf	**ADS_StormTech SC-740 +Cap** x 160 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 160 Chambers in 10 Rows
		13,054 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	12.50'	**4.500 in/hr Exfiltration over Surface area** Phase-In= 0.01'
#2	Device 3	15.25'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#3	Primary	13.60'	**15.0" Round Culvert** L= 112.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 13.60' / 13.00' S= 0.0054 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf

Discarded OutFlow Max=0.60 cfs @ 10.88 hrs HW=12.55' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.60 cfs)

Primary OutFlow Max=7.52 cfs @ 12.21 hrs HW=16.65' TW=12.73' (Dynamic Tailwater)
└─**3=Culvert** (Barrel Controls 7.52 cfs @ 6.13 fps)
  └─**2=Broad-Crested Rectangular Weir** (Passes 7.52 cfs of 21.94 cfs potential flow)

Pond C3: Middle - Chamber Wizard Field A

Chamber Model = ADS_StormTechSC-740 +Cap (ADS StormTech®SC-740 with cap length)
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

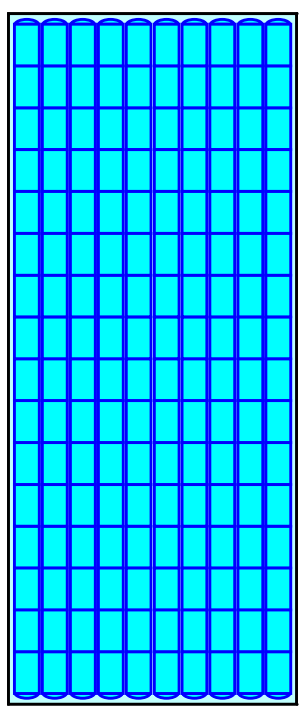
16 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 115.54' Row Length +12.0" End Stone x 2 = 117.54' Base Length
10 Rows x 51.0" Wide + 6.0" Spacing x 9 + 12.0" Side Stone x 2 = 49.00' Base Width
9.0" Stone Base + 30.0" Chamber Height + 12.0" Stone Cover = 4.25' Field Height

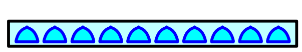
160 Chambers x 45.9 cf = 7,350.4 cf Chamber Storage

24,477.0 cf Field - 7,350.4 cf Chambers = 17,126.6 cf Stone x 33.3% Voids = 5,703.2 cf Stone Storage

Chamber Storage + Stone Storage = 13,053.6 cf = 0.300 af
Overall Storage Efficiency = 53.3%
Overall System Size = 117.54' x 49.00' x 4.25'

160 Chambers
906.6 cy Field
634.3 cy Stone





Summary for Pond C4: Roofs

Inflow Area = 0.243 ac,100.00% Impervious, Inflow Depth = 8.52" for 100yr NOAA+ event
Inflow = 2.16 cfs @ 12.07 hrs, Volume= 0.173 af
Outflow = 0.44 cfs @ 12.48 hrs, Volume= 0.173 af, Atten= 79%, Lag= 24.5 min
Discarded = 0.16 cfs @ 11.32 hrs, Volume= 0.160 af
Primary = 0.28 cfs @ 12.48 hrs, Volume= 0.013 af
Routed to Pond IB2 : Infiltration Basin 2

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Peak Elev= 14.84' @ 12.48 hrs Surf.Area= 1,530 sf Storage= 2,413 cf

Plug-Flow detention time= 87.8 min calculated for 0.173 af (100% of inflow)
Center-of-Mass det. time= 87.8 min (827.0 - 739.2)

Volume	Invert	Avail.Storage	Storage Description
#1A	12.25'	1,553 cf	**25.25'W x 60.58'L x 4.25'H Field A** 6,501 cf Overall - 1,838 cf Embedded = 4,663 cf x 33.3% Voids
#2A	13.00'	1,838 cf	**ADS_StormTech SC-740 +Cap** x 40 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 40 Chambers in 5 Rows
		3,390 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	12.25'	**4.500 in/hr Exfiltration over Surface area** Phase-In= 0.01'
#2	Primary	14.50'	**8.0" Round Culvert** L= 50.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 14.50' / 14.00' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.35 sf

Discarded OutFlow Max=0.16 cfs @ 11.32 hrs HW=12.30' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.16 cfs)

Primary OutFlow Max=0.28 cfs @ 12.48 hrs HW=14.84' TW=13.39' (Dynamic Tailwater)
└─**2=Culvert** (Inlet Controls 0.28 cfs @ 1.57 fps)

Pond C4: Roofs - Chamber Wizard Field A

Chamber Model = ADS_StormTech SC-740 +Cap (ADS StormTech® SC-740 with cap length)
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

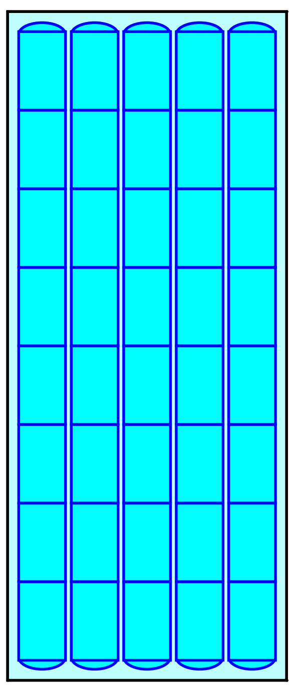
8 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 58.58' Row Length +12.0" End Stone x 2 = 60.58' Base Length
5 Rows x 51.0" Wide + 6.0" Spacing x 4 + 12.0" Side Stone x 2 = 25.25' Base Width
9.0" Stone Base + 30.0" Chamber Height + 12.0" Stone Cover = 4.25' Field Height

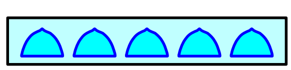
40 Chambers x 45.9 cf = 1,837.6 cf Chamber Storage

6,500.6 cf Field - 1,837.6 cf Chambers = 4,663.0 cf Stone x 33.3% Voids = 1,552.8 cf Stone Storage

Chamber Storage + Stone Storage = 3,390.4 cf = 0.078 af
Overall Storage Efficiency = 52.2%
Overall System Size = 60.58' x 25.25' x 4.25'

40 Chambers
240.8 cy Field
172.7 cy Stone





Summary for Pond IB1: Infiltration Basin 1

Inflow Area = 13.851 ac, 23.50% Impervious, Inflow Depth = 2.73" for 100yr NOAA+ event
Inflow = 20.78 cfs @ 12.43 hrs, Volume= 3.150 af
Outflow = 1.41 cfs @ 17.18 hrs, Volume= 3.150 af, Atten= 93%, Lag= 285.1 min
Discarded = 1.12 cfs @ 17.18 hrs, Volume= 2.989 af
Primary = 0.29 cfs @ 17.18 hrs, Volume= 0.162 af
Routed to Pond SP1 : FLAX POND

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Peak Elev= 14.68' @ 17.18 hrs Surf.Area= 47,390 sf Storage= 88,503 cf

Plug-Flow detention time= 836.9 min calculated for 3.149 af (100% of inflow)
Center-of-Mass det. time= 837.1 min (1,701.7 - 864.5)

Volume	Invert	Avail.Storage	Storage Description
#1	12.25'	104,000 cf	**Custom Stage Data (Conic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
12.25	28,100	0	0	28,100
12.50	29,400	7,187	7,187	29,409
13.00	32,200	15,395	22,582	32,226
14.00	40,000	36,030	58,611	40,055
15.00	51,000	45,389	104,000	51,081

Device	Routing	Invert	Outlet Devices
#1	Discarded	12.25'	**1.020 in/hr Exfiltration over Wetted area** Phase-In= 0.01'
#2	Primary	14.30'	**8.0" Round Culvert X 2.00** L= 325.0' CPP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 14.30' / 14.10' S= 0.0006 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.35 sf

Discarded OutFlow Max=1.12 cfs @ 17.18 hrs HW=14.68' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 1.12 cfs)

Primary OutFlow Max=0.29 cfs @ 17.18 hrs HW=14.68' TW=0.00' (Dynamic Tailwater)
└─**2=Culvert** (Barrel Controls 0.29 cfs @ 1.02 fps)

Summary for Pond IB2: Infiltration Basin 2

Inflow Area = 1.396 ac, 19.74% Impervious, Inflow Depth = 1.88" for 100yr NOAA+ event
Inflow = 1.54 cfs @ 12.55 hrs, Volume= 0.219 af
Outflow = 0.49 cfs @ 13.40 hrs, Volume= 0.219 af, Atten= 68%, Lag= 50.9 min
Discarded = 0.49 cfs @ 13.40 hrs, Volume= 0.219 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Pond SP2 : Study Point 2

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Peak Elev= 13.91' @ 13.40 hrs Surf.Area= 4,666 sf Storage= 2,751 cf

Plug-Flow detention time= 55.9 min calculated for 0.219 af (100% of inflow)
Center-of-Mass det. time= 55.9 min (956.0 - 900.2)

Volume	Invert	Avail.Storage	Storage Description
#1	13.00'	6,950 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
13.00	1,400	0	0
14.00	5,000	3,200	3,200
14.50	10,000	3,750	6,950

Device	Routing	Invert	Outlet Devices
#1	Discarded	13.00'	**4.500 in/hr Exfiltration over Surface area** Phase-In= 0.01'
#2	Primary	14.00'	**30.0' long x 30.0' 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

Discarded OutFlow Max=0.49 cfs @ 13.40 hrs HW=13.91' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.49 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=13.00' TW=0.00' (Dynamic Tailwater)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond P1: Littleton Dr North Bio

Inflow Area = 0.201 ac, 49.27% Impervious, Inflow Depth = 5.61" for 100yr NOAA+ event
Inflow = 1.36 cfs @ 12.07 hrs, Volume= 0.094 af
Outflow = 0.17 cfs @ 12.68 hrs, Volume= 0.094 af, Atten= 88%, Lag= 36.2 min
Discarded = 0.17 cfs @ 12.68 hrs, Volume= 0.094 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs
Peak Elev= 14.40' @ 12.68 hrs Surf.Area= 2,983 sf Storage= 1,516 cf

Plug-Flow detention time= 76.8 min calculated for 0.094 af (100% of inflow)
Center-of-Mass det. time= 76.8 min (888.5 - 811.7)

Volume	Invert	Avail.Storage	Storage Description
#1	13.75'	3,534 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
13.75	700	0	0
14.00	2,600	413	413
14.25	2,800	675	1,088
15.00	3,725	2,447	3,534

Device	Routing	Invert	Outlet Devices
#1	Discarded	13.75'	**2.410 in/hr Exfiltration over Surface area above 13.00'** Excluded Surface area = 0 sf Phase-In= 0.01'

Discarded OutFlow Max=0.17 cfs @ 12.68 hrs HW=14.40' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.17 cfs)

Summary for Pond SP1: FLAX POND

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

Inflow Area =	17.133 ac,	26.17% Impervious,	Inflow Depth = 0.52"	for 100yr NOAA+ event
Inflow =	8.58 cfs @	12.14 hrs,	Volume=	0.743 af
Primary =	8.58 cfs @	12.14 hrs,	Volume=	0.743 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs

Summary for Pond SP2: Study Point 2

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

Inflow Area = 2.264 ac, 12.17% Impervious, Inflow Depth = 0.83" for 100yr NOAA+ event
Inflow = 1.07 cfs @ 12.50 hrs, Volume= 0.156 af
Primary = 1.07 cfs @ 12.50 hrs, Volume= 0.156 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.02 hrs

APPENDIX E

TSS and Recharge Calculations

Location: Subcatchment DA0

TSS Removal Calculation Worksheet

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Bioretention Area	**0.90**	**1.00**	**0.90**	**0.10**
	0.00	**0.10**	**0.00**	**0.10**
	0.00	**0.10**	**0.00**	**0.10**
	0.00	**0.10**	**0.00**	**0.10**
	0.00	**0.10**	**0.00**	**0.10**

Total TSS Removal = 90%

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: **20107**
Prepared By: **RAC**
Date: **1/12/2022**

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

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

Location: Subcatchment DA1E & DA1W to SP1

TSS Removal Calculation Worksheet

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Bioretention Area	**0.90**	**1.00**	**0.90**	**0.10**
Subsurface Infiltration Structure	**0.80**	**0.10**	**0.08**	**0.02**
	0.00	**0.02**	**0.00**	**0.02**
	0.00	**0.02**	**0.00**	**0.02**
	0.00	**0.02**	**0.00**	**0.02**

Total TSS Removal = **98%**

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: **20107**
Prepared By: **RAC**
Date: **1/12/2022**

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

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

TSS Removal Calculation Worksheet

Location: Subcatchment DA2 to Study Point 1

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Bioretention Area	0.90	1.00	0.90	0.10
Subsurface Infiltration Structure	0.80	0.10	0.08	0.02
	0.00	0.02	0.00	0.02
	0.00	0.02	0.00	0.02
	0.00	0.02	0.00	0.02

Total TSS Removal = 98%

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: 20107
Prepared By: RAC
Date: 1/12/2022

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

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

TSS Removal Calculation Worksheet

Location: Subcatchment DA3 to Surface Infiltration Basin (SP1)

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Bioretention Area	**0.90**	**1.00**	**0.90**	**0.10**
Subsurface Infiltration Structure	**0.80**	**0.10**	**0.08**	**0.02**
Infiltration Basin	**0.80**	**0.02**	**0.02**	**0.00**
	0.00	**0.00**	**0.00**	**0.00**
	0.00	**0.00**	**0.00**	**0.00**

Total TSS Removal = **100%**

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: **20107**
Prepared By: **RAC**
Date: **1/12/2022**

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

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

TSS Removal Calculation Worksheet

Location: Subcatchment DA4 to Surface Infiltration Basin (SP1)

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Bioretention Area	**0.90**	**1.00**	**0.90**	**0.10**
Infiltration Basin	**0.80**	**0.10**	**0.08**	**0.02**
	0.00	**0.02**	**0.00**	**0.02**
	0.00	**0.02**	**0.00**	**0.02**
	0.00	**0.02**	**0.00**	**0.02**

Total TSS Removal = 98%

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: **20107**
Prepared By: **RAC**
Date: **1/12/2022**

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

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

TSS Removal Calculation Worksheet

Location: DA1OS to Infiltration Basin D2 (SP2)

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Infiltration Basin	0.80	1.00	0.80	0.20
	0.00	0.20	0.00	0.20
	0.00	0.20	0.00	0.20
	0.00	0.20	0.00	0.20
	0.00	0.20	0.00	0.20

Total TSS Removal = 80%

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: 20107
Prepared By: RAC
Date: 1/12/2022

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

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

TSS Removal Calculation Worksheet

Location: DA2OS to SP1 (no new imp. Cover)

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
	0.00	1.00	0.00	1.00
	0.00	1.00	0.00	1.00
	0.00	1.00	0.00	1.00
	0.00	1.00	0.00	1.00
	0.00	1.00	0.00	1.00

Total TSS Removal = 0%

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: 20107
Prepared By: RAC
Date: 1/12/2022

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

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

TSS Removal Calculation Worksheet

Location: DA3OS to Surface Infiltration Basin

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Infiltration Basin	0.80	1.00	0.80	0.20
	0.00	0.20	0.00	0.20
	0.00	0.20	0.00	0.20
	0.00	0.20	0.00	0.20
	0.00	0.20	0.00	0.20

Total TSS Removal = 80%

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: **20107**
Prepared By: **RAC**
Date: **1/12/2022**

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

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

Location: DA3R to Subsurface Chambers & Basin D2 (SP2)

TSS Removal Calculation Worksheet

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Subsurface Infiltration Structure	0.80	1.00	0.80	0.20
Infiltration Basin	0.80	0.20	0.16	0.04
	0.00	0.04	0.00	0.04
	0.00	0.04	0.00	0.04
	0.00	0.04	0.00	0.04

Total TSS Removal = 96%

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: 20107
Prepared By: RAC
Date: 1/12/2022

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

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

Horsley Witten Group
Sustainable Environmental Solutions

Project Name: Littleton Drive, Wareham
Project No: 20107
Calculated by: EWH
Checked: RAC
Date: 2/4/2022

STANDARD 3-RECHARGE REQUIREMENTS

TOTAL DRAINAGE AREA	875,153	sf
	20.09	acres
TOTAL IMPERVIOUS AREA	226,658	sf
	5.20	acres
TOTAL IMPERVIOUS TO RECHARGE	226,658	sf
	5.20	acres
US TO BE RECHARGED	100	%

SOIL TYPE	A	
RECHARGE VOLUME REQUIRED (Rv)	**11,333**	cft
INFILTRATION RATE	1.02	in/hr
BOTTOM SURFACE AREA OF CHAMBERS	11,920	sf
ESTIMATED DRAWDOWN TIME FOR Rv*	**11.19**	**hr**
*Must be less than 72 HRS		

RECHARGE VOLUMES		
RAINFALL	1	in
VOLUME OF CHAMBER 1	5,820	cf
VOLUME OF CHAMBER 2	4,530	cf
VOLUME OF CHAMBER 3	13,050	cf
VOLUME OF CHAMBER 4	3,400	cf
TOTAL RECHARGE VOLUME PROVIDED	**26,800**	**cf**
TOTAL RECHARGE VOLUME REQUIRED	**11,333**	**cf**

Soil Type	Target Depth (in)	Target Depth (ft)
A	0.6	0.05
B	0.35	0.029
C	0.25	0.021
D	0.1	0.008

Rawls Table

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

Calculate *Required Recharge Volume*.[7] The *Required Recharge Volume* equals a depth of runoff corresponding to the soil type times the impervious areas covering that soil type at the post-development site.

$$Rv = F \times \text{impervious area} \qquad \textbf{Equation (1)}$$

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

To determine whether an infiltration BMP will drain within 72 hours, the following formula must be used[21]:

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

Where:
Rv = Storage Volume
K = Saturated Hydraulic Conductivity For "Static" and "Simple Dynamic" Methods, use Rawls Rate (see Table 2.3.3). For "Dynamic Field" Method, use 50% of the in-situ saturatec hydraulic conductivity.
Bottom Area = Bottom Area of Recharge Structure[22]

[20] The drawdown analysis also assumes that the water table does not fluctuate during the draw down period.
[21] In some cases, the infiltration structure may be designed to treat the *Required Water Quality Volume* and/or to attenuate peak discharges in

[illegible] addition to infiltrating the *Required Recharge Volume*. In that event, the storage volume of the structure must be used in the formula for determining drawdown time in place of the *Required Recharge Volume*.

APPENDIX F

Stormwater Operation and Maintenance Plan

(bound separately)

APPENDIX G

Groundwater Mounding Analysis

Groundwater Modeling for Underground Infiltration Chambers (C1)

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

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

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

Input Values		
1.9691	***R***	**Recharge (infiltration) rate (feet/day)**
0.200	**Sy**	**Specific yield, Sy (dimensionless, between 0 and 1)**
90.00	**K**	**Horizontal hydraulic conductivity, Kh (feet/day)***
17.400	**x**	**1/2 length of basin (x direction, in feet)**
37.400	**y**	**1/2 width of basin (y direction, in feet)**
3.000	**t**	**duration of infiltration period (days)**
40.000	**hi(0)**	**initial thickness of saturated zone (feet)**

Conversion Table

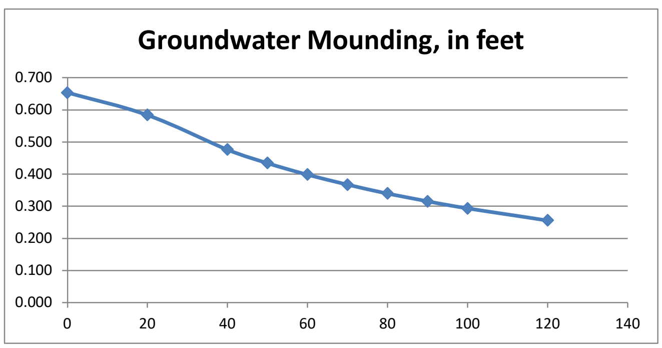
inch/hour	**feet/day**
0.67	1.33
2.00	4.00
hours	**days**
36	1.50

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

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

Ground-water Mounding, in feet	**Distance from center of basin in x direction, in feet**
0.653	**0**
0.584	**20**
0.476	**40**
0.434	**50**
0.398	**60**
0.367	**70**
0.340	**80**
0.315	**90**
0.293	**100**
0.256	**120**

Re-Calculate Now



Disclaimer

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

Groundwater Modeling for Underground Infiltration Chambers (C2)

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

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

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

Input Values			
1.8132	***R***	**Recharge (infiltration) rate (feet/day)**
0.200	**Sy**	**Specific yield, Sy (dimensionless, between 0 and 1)**
90.00	**K**	**Horizontal hydraulic conductivity, Kh (feet/day)***
15.000	**x**	**1/2 length of basin (x direction, in feet)**
33.850	**y**	**1/2 width of basin (y direction, in feet)**
3.000	**t**	**duration of infiltration period (days)**
40.000	**hi(0)**	**initial thickness of saturated zone (feet)**

Conversion Table

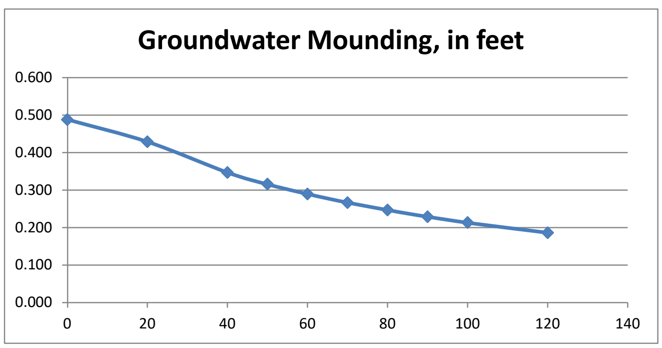
inch/hour	**feet/day**
0.67	1.33
2.00	4.00
hours	**days**
36	1.50

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

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

Ground-water Mounding, in feet	**Distance from center of basin in x direction, in feet**
0.488	**0**
0.429	**20**
0.347	**40**
0.316	**50**
0.290	**60**
0.267	**70**
0.247	**80**
0.229	**90**
0.213	**100**
0.186	**120**

Re-Calculate Now



Disclaimer

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Groundwater Modeling for Underground Infiltration Chambers (C3)

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

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

Input Values

1.8454	***R***	**Recharge (infiltration) rate (feet/day)**
0.200	**Sy**	**Specific yield, Sy (dimensionless, between 0 and 1)**
90.00	**K**	**Horizontal hydraulic conductivity, Kh (feet/day)***
24.500	**x**	**1/2 length of basin (x direction, in feet)**
58.750	**y**	**1/2 width of basin (y direction, in feet)**
3.000	**t**	**duration of infiltration period (days)**
40.000	**hi(0)**	**initial thickness of saturated zone (feet)**

Conversion Table

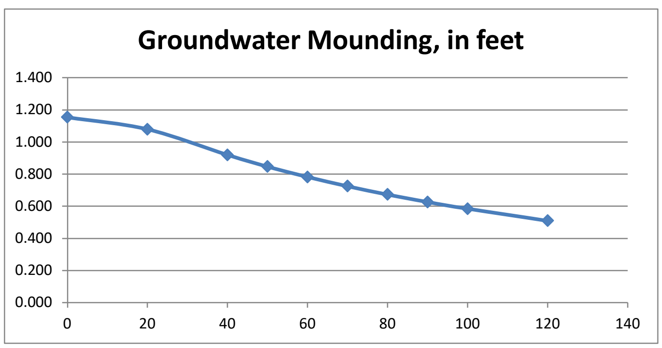
inch/hour	**feet/day**
0.67	1.33
2.00	4.00
hours	**days**
36	1.50

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

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

Ground-water Mounding, in feet	**Distance from center of basin in x direction, in feet**
1.153	**0**
1.079	**20**
0.919	**40**
0.847	**50**
0.782	**60**
0.725	**70**
0.673	**80**
0.626	**90**
0.584	**100**
0.510	**120**

Re-Calculate Now



Disclaimer

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Groundwater Modeling for Underground Infiltration Chambers (C4)

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

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

Input Values			
1.5113	*R*	**Recharge (infiltration) rate (feet/day)**
0.200	Sy	**Specific yield, Sy (dimensionless, between 0 and 1)**
90.00	K	**Horizontal hydraulic conductivity, Kh (feet/day)***
12.100	x	**1/2 length of basin (x direction, in feet)**
30.300	y	**1/2 width of basin (y direction, in feet)**
3.000	t	**duration of infiltration period (days)**
40.000	hi(0)	**initial thickness of saturated zone (feet)**

Conversion Table

inch/hour	**feet/day**
0.67	1.33
2.00	4.00

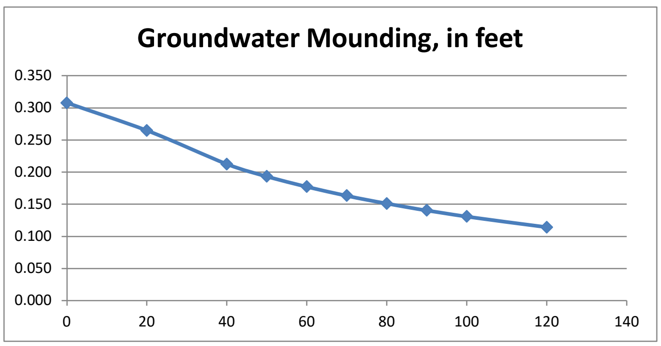
hours	**days**
36	1.50

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

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

Ground-water Mounding, in feet	**Distance from center of basin in x direction, in feet**
0.308	0
0.265	20
0.212	40
0.193	50
0.177	60
0.163	70
0.151	80
0.140	90
0.131	100
0.114	120

Re-Calculate Now



Disclaimer

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Groundwater Modeling for Infiltration Basin (IB1)

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

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

Input Values

0.9678	*R*	**Recharge (infiltration) rate (feet/day)**
0.200	Sy	**Specific yield, Sy (dimensionless, between 0 and 1)**
90.00	K	**Horizontal hydraulic conductivity, Kh (feet/day)***
25.179	x	**1/2 length of basin (x direction, in feet)**
280.000	y	**1/2 width of basin (y direction, in feet)**
3.000	t	**duration of infiltration period (days)**
40.000	hi(0)	**initial thickness of saturated zone (feet)**

Conversion Table

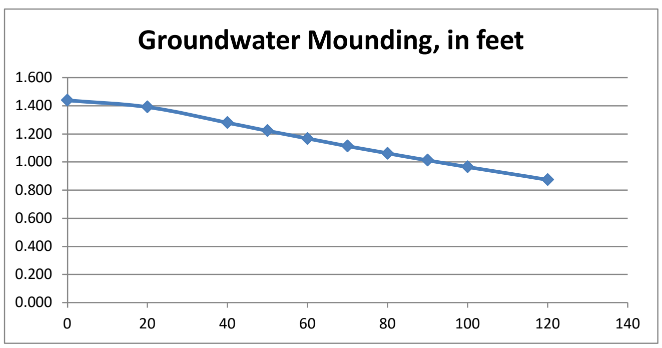
inch/hour	**feet/day**
0.67	1.33
2.00	4.00
hours	**days**
36	1.50

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

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

Ground-water Mounding, in feet	**Distance from center of basin in x direction, in feet**
1.440	0
1.392	20
1.280	40
1.223	50
1.167	60
1.114	70
1.063	80
1.013	90
0.965	100
0.874	120

Re-Calculate Now



Disclaimer

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Groundwater Modeling for Infiltration Basin (IB2)

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

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

Input Values

0.6098	***R***	**Recharge (infiltration) rate (feet/day)**
0.200	**Sy**	**Specific yield, Sy (dimensionless, between 0 and 1)**
90.00	**K**	**Horizontal hydraulic conductivity, Kh (feet/day)***
120.000	**x**	**1/2 length of basin (x direction, in feet)**
6.000	**y**	**1/2 width of basin (y direction, in feet)**
3.000	**t**	**duration of infiltration period (days)**
40.000	**hi(0)**	**initial thickness of saturated zone (feet)**

Conversion Table

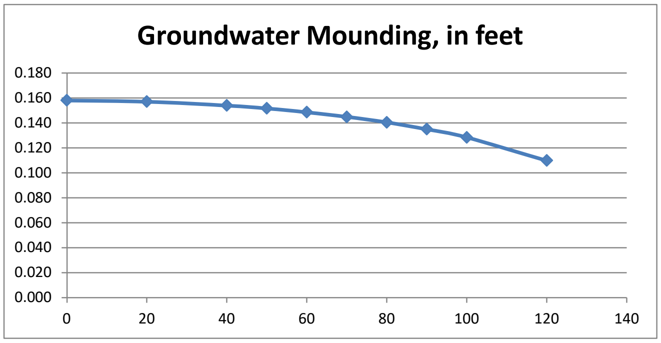
inch/hour	**feet/day**
0.67	1.33
2.00	4.00
hours	**days**
36	1.50

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

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

Ground-water Mounding, in feet	**Distance from center of basin in x direction, in feet**
0.158	**0**
0.157	**20**
0.154	**40**
0.152	**50**
0.149	**60**
0.145	**70**
0.140	**80**
0.135	**90**
0.128	**100**
0.110	**120**

Re-Calculate Now



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Combined Groundwater Modeling for Underground Infiltration Chambers (C3) and Infiltration Basin (IB1)

100 - Year Storm Groundwater Mounding Evaluation for Two Basins 200 Feet Apart

Basin IB1 Peak Mound	Basin C3 Peak Mound	Basin IB1 Mound @ Basin C3	Basin C3 Mound @ Basin IB1	Total Basin IB1 Mound	Total Basin C3 Mound	Basin IB1 - Initial GW Separation	**Basin IB1 - Mounded GW Separation**	Basin C3 - Initial GW Separation	**Basin C3 - Mounded GW Separation**
1.44	1.15	0.40	0.30	1.74	1.55	3.00	**1.45**	2.70	**1.15**

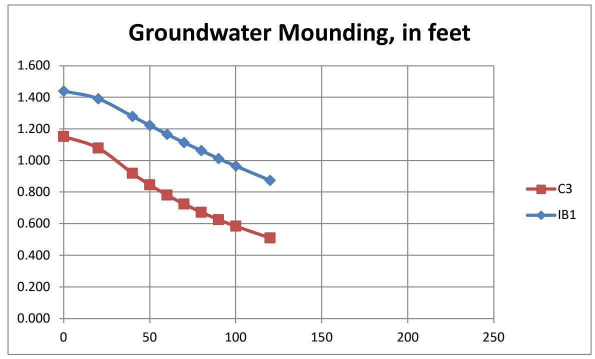
table updated 1/18/22 by EWH

IB1

1.440	**0**
1.392	**20**
1.280	**40**
1.223	**50**
1.167	**60**
1.114	**70**
1.063	**80**
1.013	**90**
0.965	**100**
0.874	**120**
	140
	160
	180
	200
	220

C3

1.153	**0**
1.079	**20**
0.919	**40**
0.847	**50**
0.782	**60**
0.725	**70**
0.673	**80**
0.626	**90**
0.584	**100**
0.510	**120**
	140
	160
	180
	200
	220



Combined Groundwater Modeling for Underground Infiltration Chambers (C4) and Infiltration Basin (IB2)

100 - Year Storm Groundwater Mounding Evaluation for Two Basins 200 Feet Apart

Basin IB2 Peak Mound	Basin C4 Peak Mound	Basin IB2 Mound @ Basin C4	Basin C4 Mound @ Basin IB2	Total Basin IB2 Mound	Total Basin C4 Mound	Basin IB2 - Initial GW Separation	**Basin IB2 - Mounded GW Separation**	Basin C4 - Initial GW Separation	**Basin C4- Mounded GW Separation**
0.16	0.31	0.05	0.10	0.26	0.36	5.00	**4.64**	5.75	**5.39**

Updated 2/4/22 by EWH

IB2

0.158	**0**
0.157	**20**
0.154	**40**
0.152	**50**
0.149	**60**
0.145	**70**
0.140	**80**
0.135	**90**
0.128	**100**
0.110	**120**
	140
	160
	180
	200
	220

C4

0.308	**0**
0.265	**20**
0.212	**40**
0.193	**50**
0.177	**60**
0.163	**70**
0.151	**80**
0.140	**90**
0.131	**100**
0.114	**120**
	140
	160
	180
	200
	220