Engineering Watershed Study Report

Highway 236/Dennett Road Hydrologic Watershed Study

Town of Kittery, Maine

Prepared for

Town of Kittery

200 Rogers Road
Kittery, Maine 03904

December 2023

Barton&Loguidice

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Prepared for:

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200 Rogers Road
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List of Acronyms

B&L: Barton & Loguidice
BMPs: Best Management Practices
CFS: Cubic Feet per Second
DEM: Digital Elevation Model
DEP: Maine Department of Environmental Protection
DOT: Maine Department of Transportation
FBE: FB Environmental Associates, LLC
FEMA: Federal Emergency Management Agency
FIRM: Flood Insurance Rate Map
GI: Green Infrastructure
gSURRGO: Gridded Soil Survey Geographic Database
GWFL-E: Generalized Watershed Loading Function Enhanced (GWFL-E)
h:min Hours and Minutes
HSG: Hydrologic Soil Group
HW/D: Headwater to Depth Ratio
HVAC: Heating, Ventilation and Air Conditioning
I-95: Interstate 95
I/I: Inflow and Infiltration
Lbs.: Pounds
LID: Low Impact Development
MMW: Model My Watershed
MS4: Multiple Separate Storm Sewer System
NSCD: National Soil Characterization Database
NHD: National Hydrography Dataset
NOAA: National Oceanic and Atmospheric Administration
NRCS: Natural Resources Conservation Service
Qpk: Peak Discharge Rate
Rt. 236: Maine State Highway 236
SMFG: Southern Maine Fish and Game Club
Tc: Time of Concentration
USDA: United States Department of Agriculture
USEPA: United States Environmental Protection Agency
USGS: United States Geological Survey

EXECUTIVE SUMMARY

The Town of Kittery, Maine, progressed with procured Barton & Loguidice, L.L.C. (B&L) to conduct an engineering study in the area bounded by Interstate 95 (I-95) to the south, Dennett Road to the west, Martin Road to the north and Highway 236 to the east. The purpose of the study was to evaluate existing flooding concerns voiced by residents, including assessing the potential drainage and stormwater management considerations that may arise in association with potential future development in commercially zoned areas (Business Park and Highway 236 corridor). The study evaluates the existing causes of localized flooding, the impact potential development could have on flood frequency and magnitude, and the development of alternatives to mitigate flood impacts for existing and future conditions. In addition to minimizing the frequency and extent of localized flooding, the Town also aims to provide water quality improvements to natural resources. Additionally, identification of potential future funding resources available to implement the recommended mitigation alternatives was developed.

Increased concern with stormwater quantity and quality within the Town has elevated the need for building community resiliency and protecting community assets from stormwater impacts. All concerned have the desire to mitigate the potential impacts of future storm events, minimize localized flooding, and provide water quality improvements to receiving waters. This Engineering Watershed Study Report provides an overview of the site investigation and design process conducted by B&L and partners Streamworks, PLLC (Streamworks) and FB Environmental Associates, LLC (FBE). Provided within is an existing conditions assessment including a summary of previous reports data collection activities, a stormwater system capacity evaluation (hydrologic and hydraulic modeling), a nutrient/pollutant loading evaluation, an evaluation of mitigation alternatives, an expanded analysis of six (6) potential water quality/flood mitigation projects, an evaluation of conservation/enhancement opportunities, and an evaluation of potential funding sources for implementation of the recommended projects.

Prior to the start of work, B&L reviewed previous studies and reports provided by the Town. Throughout the course of the project, additional information was obtained from Town residents through a public outreach effort consisting of public meetings, community survey, and use of an interactive mapper where residents could identify drainage concerns and potential opportunity areas. The initial public meeting was held on December 15, 2022 and project update public meetings were held on March 22 and August 9, 2023. Community input received at each of these meetings were incorporated into the analysis and report. A final project presentation was held on December 14, 2023.

Field data collection was used to develop a hydrologic and hydraulic model utilizing HydroCAD® that represents existing conditions to evaluate the stormwater system capacity and identify existing infrastructure elements within the community at risk for flood impacts. Separate model runs were developed to evaluate potential build-out scenarios (50% and 100%) for non-residential zoned areas. Additionally, a pollutant load evaluation was conducted for the study area to evaluate phosphorus, nitrogen and sediment loads from subwatersheds within the Study Area.

A retrofit opportunity matrix was developed to evaluate potential stormwater mitigation alternatives. The alternatives were based on information obtained from field data collection activities, hydrologic and hydraulic modeling scenarios, pollutant load model results, and public input. The potential alternatives comprise a wide range of practices for flood mitigation and water quality improvement. The projects were ranked based on criteria associated with stormwater benefits (quantity and quality), constructability, cost and co-benefits. The project advisory team utilized this matrix and recommendations from the B&L project team to select six projects to progress to more detailed analysis.

The goal for selection of the six projects was to include a diverse collection of projects. The projects selected, therefore, were not necessarily ranked as the six highest overall scores. The projects were selected based on range of scale and cost, location, and retrofit practice. The purpose was to utilize this matrix as a template that can be referenced by the Town to progress additional projects as future funding becomes available.

The projects selected for further evaluation include:

1. Right-Sizing Critical Infrastructure (Culvert and Drainage System Modifications)
2. Martin Road Sewer Line Study
3. Martin Road/Highway 236 Storage Modifications
4. Identification of Potential Conservation Areas
5. Storage Modifications at the '98 Dennett' Parcel
6. Providing Low Impact Development Considerations for Future Build-Out Scenarios

This document provides an in-depth discussion and comparison of the aforementioned projects. Design considerations and preliminary cost estimates (based on 2023 dollars) for select projects are also included as future funding becomes available.

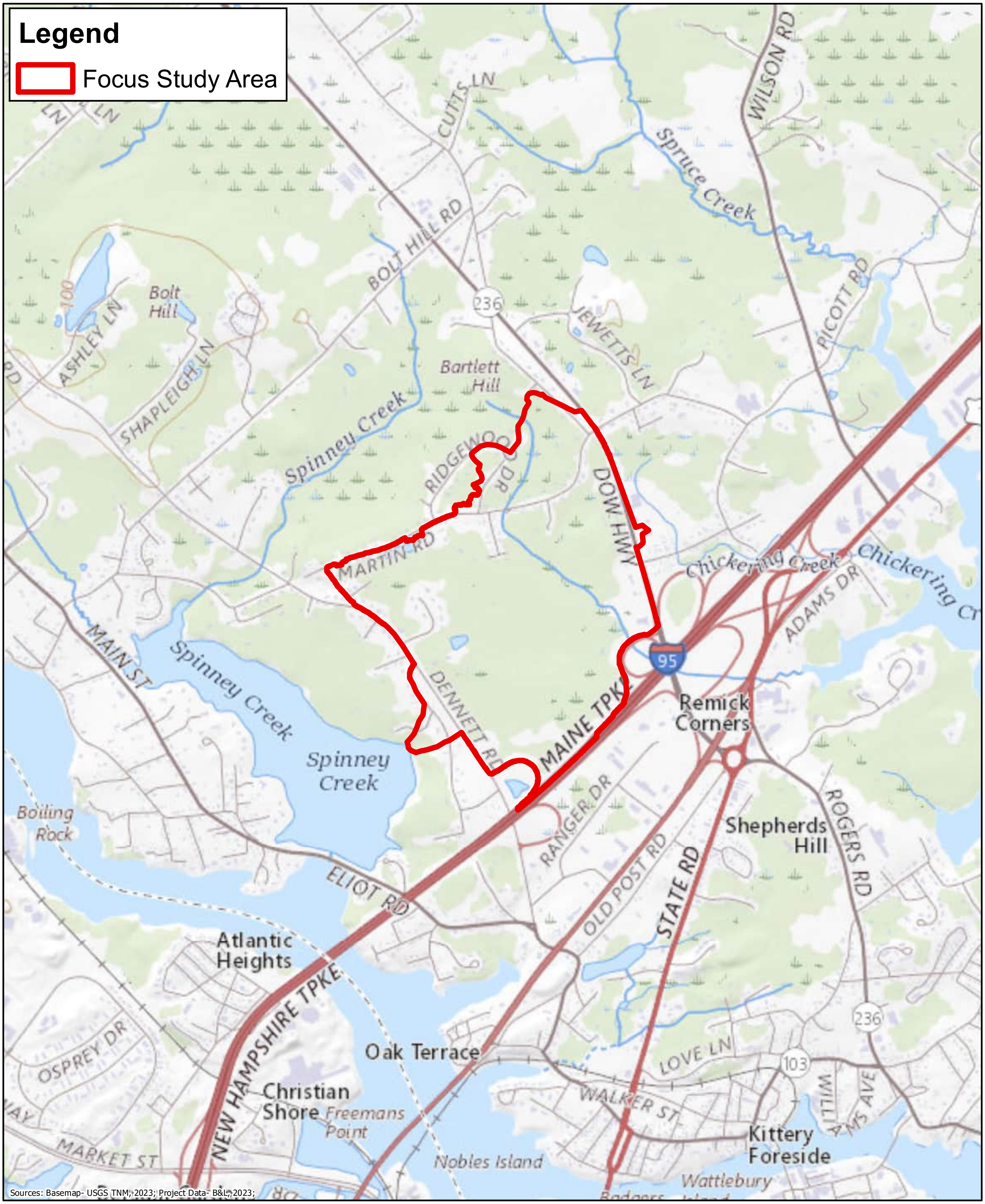
1.0 PROJECT BACKGROUND & HISTORY

1.1 Project Background

Recurring flooding at residential properties in the Town, in combination with potential development of the area north of Interstate 95 (I-95) between Highway 236 and Dennett Road, initiated the Town to progress an engineering watershed study to assess the existing causes of flood impacts, the impact potential development could have on flood frequency and magnitude, and the development of alternatives to mitigate flood concerns for existing and future conditions. In addition to minimizing the frequency and extent of localized flooding, the Town aims to provide water quality improvements to its natural resources. The primary focus area for the study includes the area bounded I-95 to the south, Highway 236 to the east, Martin Road to the north, and Dennett Road to the west. This area includes the existing developed commercial Highway 236 corridor, several residential neighborhoods for which development has occurred since the 1960's, and a large undeveloped tract of forested and wetland area located centrally within the study area. A topographic map showing the general location of the study area is provided as **Figure 1-1**. An aerial map showing the focus study area is included as **Figure 1-2.** Elevation contours within the focus study area are shown on **Figure 1-3**, and **Figure 1-4** depicts the focus area subwatersheds.

1.2 Environmental Setting

The study area comprises six separate drainage areas, further subdelineated into subwatersheds as illustrated above in **Figure 1-4**. Each drainage area ultimately directs stormwater runoff to Spinney Creek to the west, the Piscataqua River to the southwest, or Spruce Creek to the southeast. Drainage areas vary in geologic conditions (*e.g.,* soil type, depth to bedrock, groundwater level, and slope). Soils are classified into hydrologic soil groups (HSG) to indicate the minimum rate of infiltration, or rate at which water enters the soil at soil surface, for bare soil after prolonged wetting. HSGs consist of Groups A, B, C, and D soils. In general, Group A soils (e.g., sandy soils) have the lowest runoff potential and highest infiltration rates, whereas Group D soils (e.g., clayey soils) have the highest runoff potential and lowest infiltration rates. Another significant contribution factor to runoff potential is the interaction between surface hydrology and groundwater. For example, even HSG A soils may have excessive runoff potential during instances of a high groundwater table. The interaction between depth of groundwater, surface hydrology, and resulting runoff potential will be further discussed as part of this study. Soil properties and qualities are summarized for each drainage area in **Table 1-1**. Distribution of HSGs is included as **Figure 1-5,** along with **Figure 1-6** that illustrates variance in drainage classifications (USDA, 2017). A majority of the study area (62%) consists of Group C/D soils, which exhibit higher runoff potential and lower infiltration rates.



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1 inch = 2,500 feet

Town of Kittery

General Study Area Location Map

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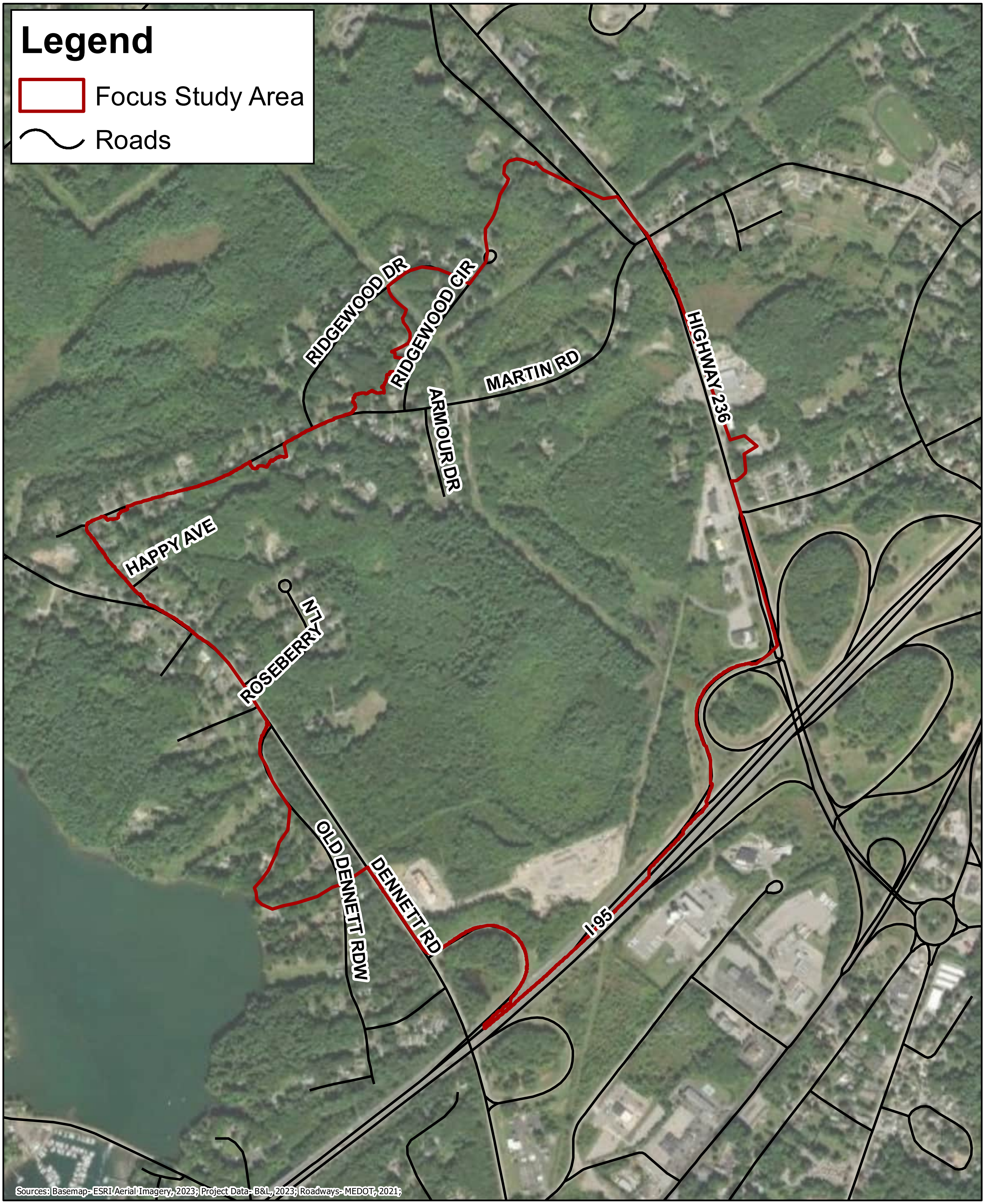
Figure 1-1

Project No. 2687.001



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Aerial Study Area Map

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Figure 1-2

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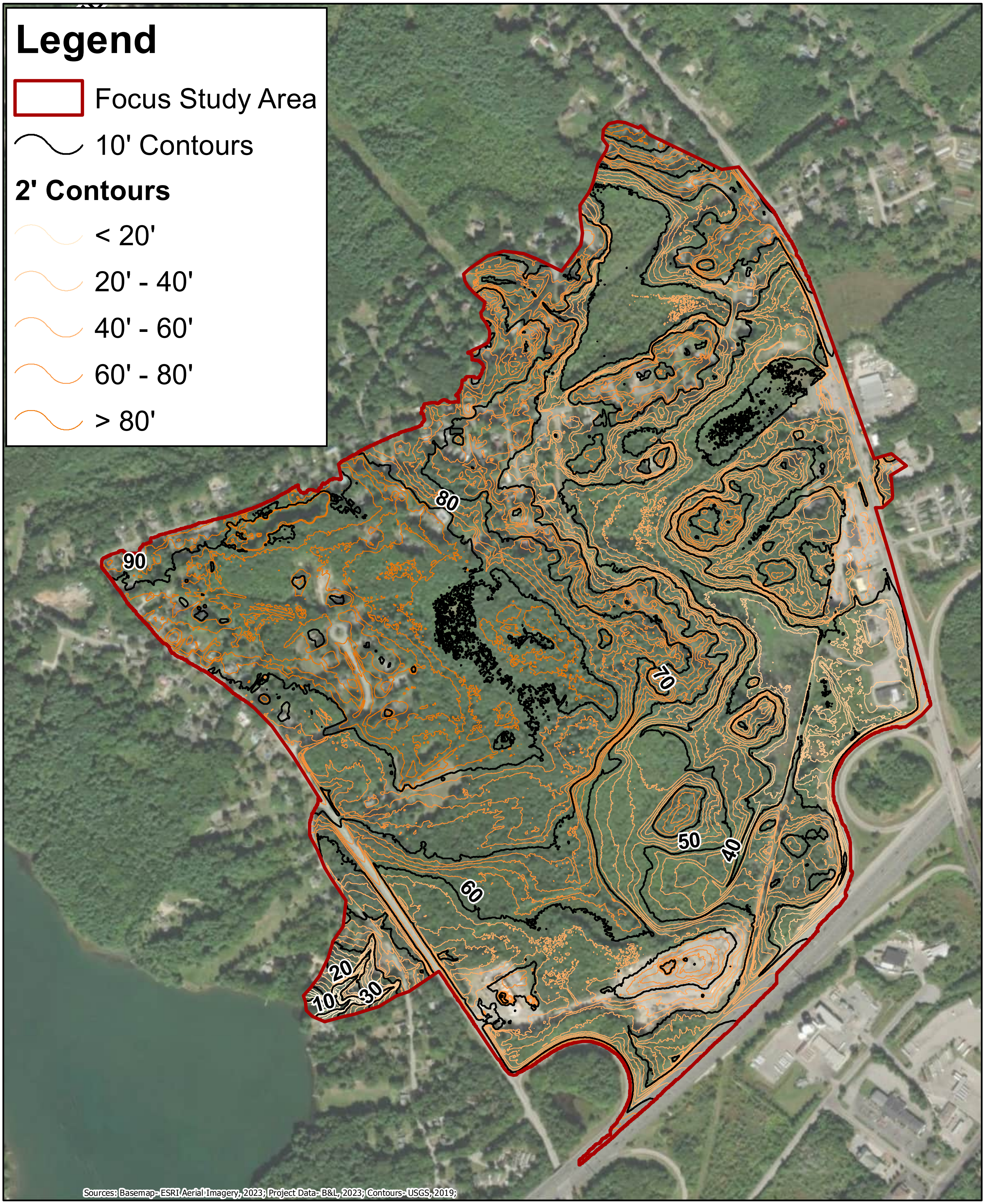

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Focus Study Area Elevation Contours

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Figure 1-3

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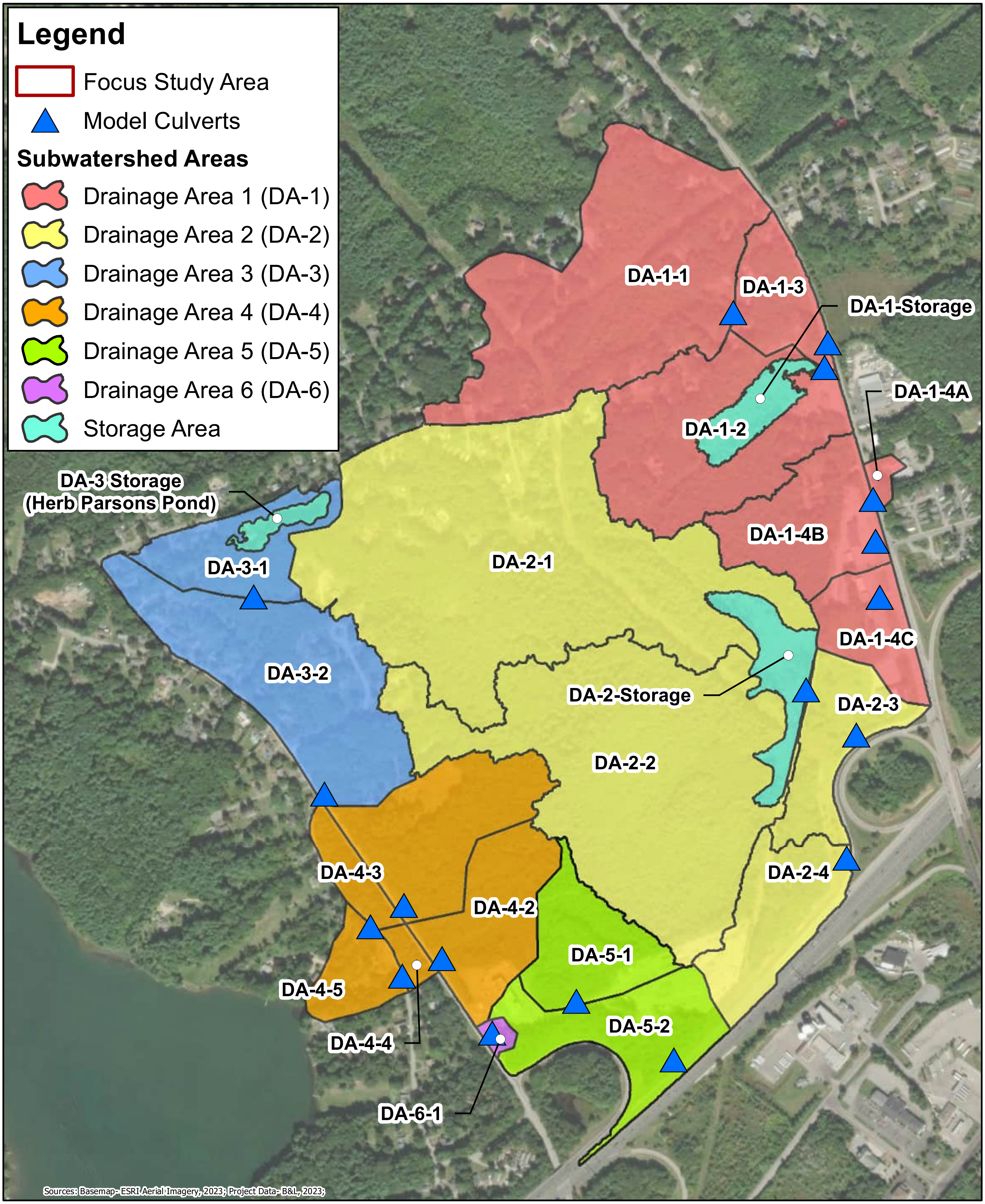

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Study Area Subwatersheds

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Figure 1-4

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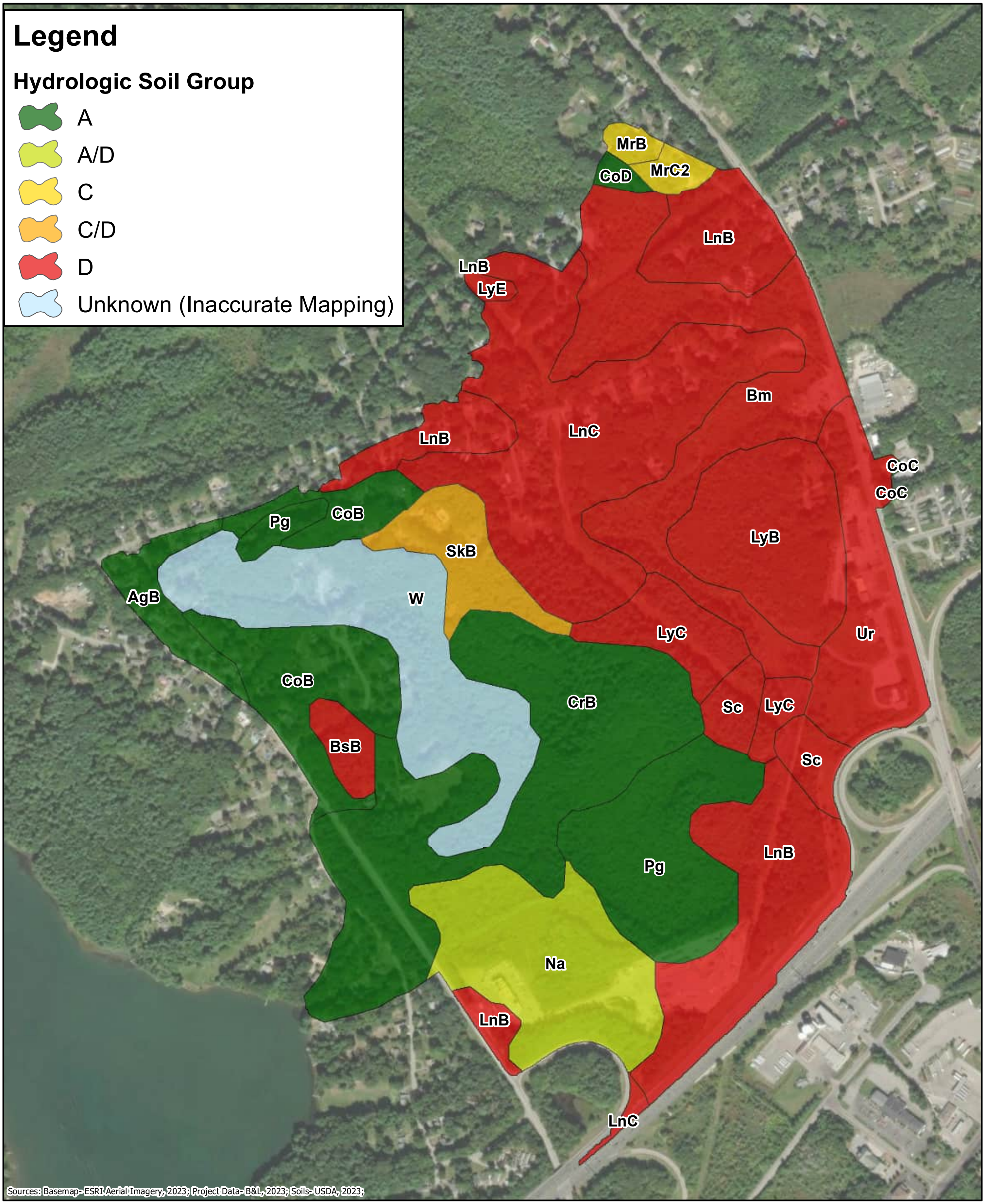
Table 1-1: Study Area Soils Data						
Soil Unit Symbol	Soil Unit Name	HSG	Drainage Class	Depth to Water Table (ft.)	Acres in Study Area	Percent of Study Area
AgB	Adams-Urban land complex, 0 to 8% slopes	A	Somewhat excessively drained	6.6	5.8	1.7%
Bm	Biddeford mucky peat, 0 to 3% slopes	D	Very poorly drained	0.0	33.8	9.8%
BsB	Brayton and Westbury very stony fine sandy loams, 0 to 8% slopes	D	Poorly drained	0.5	4.4	1.3%
CoB	Colton gravelly sandy loam, 0 to 8% slopes	A	Excessively drained	6.6	23	6.6%
CoD	Colton gravelly sandy loam, 15 to 25% slopes	A	Excessively drained	6.6	0.8	0.2%
CrB	Croghan loamy fine sand, 0 to 8% slopes, wooded	A	Moderately well drained	2.0	38.1	11.0%
LnB	Lyman loam, 3 to 8% slopes, rocky	D	Somewhat excessively drained	6.6	41.1	11.9%
LnC	Lyman loam, 8 to 15% slopes, rocky	D	Somewhat excessively drained	6.6	46.1	13.3%
LyB	Lyman-Rock outcrop complex, 3 to 8% slopes	D	Somewhat excessively drained	6.6	19.8	5.7%
LyC	Lyman-Rock outcrop complex, 8 to 15% slopes	D	Somewhat excessively drained	6.6	9.8	2.8%
LyE	Lyman-Rock outcrop complex, 15 to 80% slopes	D	Somewhat excessively drained	6.6	0.3	0.1%
MrB	Marlow fine sandy loam, 3 to 8% slopes	C	Well drained	6.6	0.8	0.2%
MrC2	Marlow fine sandy loam, 8 to 15% slopes	C	Well drained	6.6	1.9	0.6%
Na	Naumburg sand	A/D	Poorly drained	0.6	30	8.7%
Pg	Pits, gravel	A	Excessively drained	6.6	22.8	6.6%
Sc	Scantic silt loam, 0 to 3% slopes	D	Poorly drained	0.5	6.5	1.9%
SkB	Skerry fine sandy loam, 0 to 8% slopes	C/D	Moderately well drained	1.7	8.9	2.6%
Ur	Urban land	D	Moderately well drained	4.0	15.8	4.6%
W	Water bodies	Unknown	Unknown	Unknown	30.6	8.8%



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Hydrologic Soil Groups

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Figure 1-5

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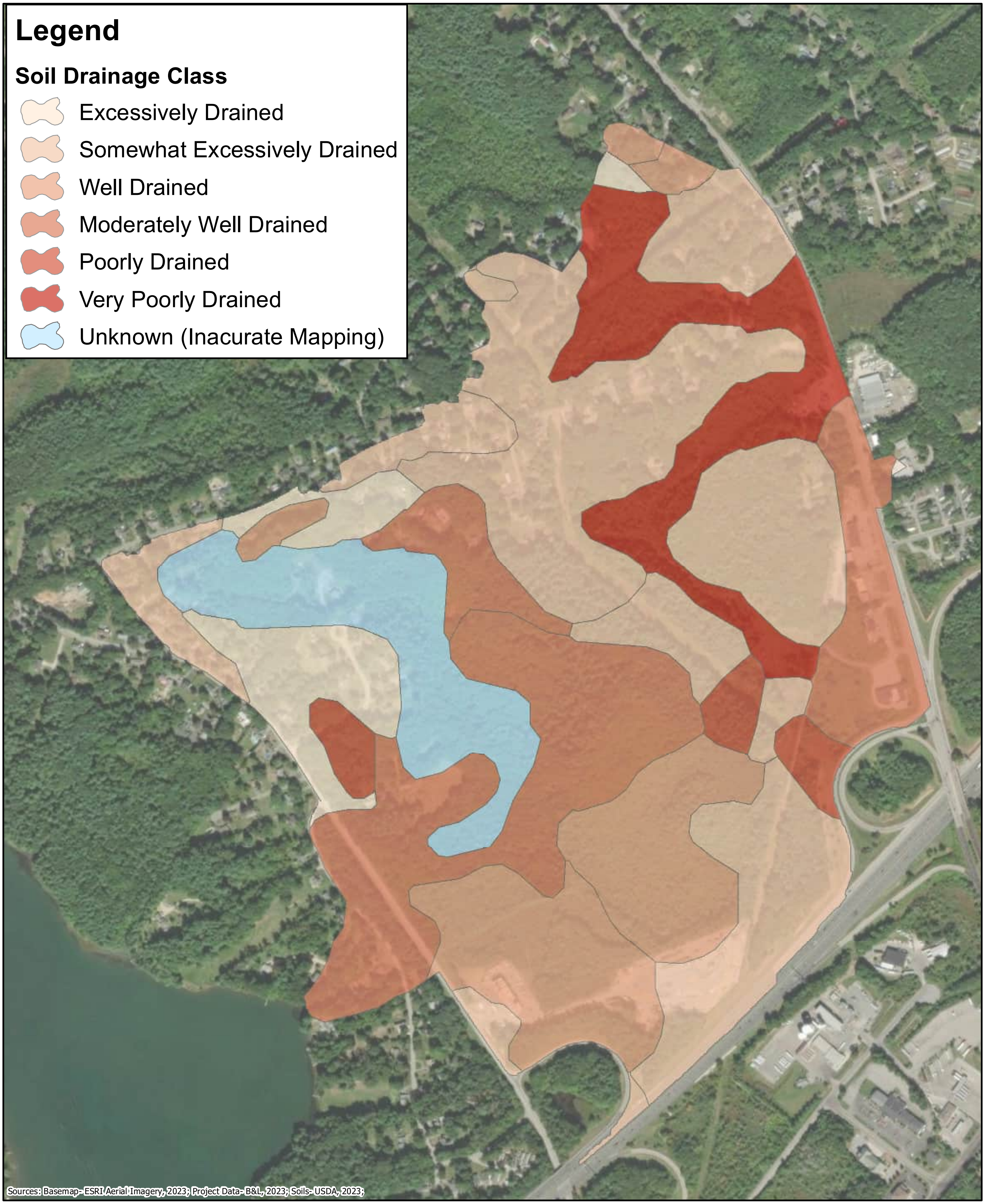

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Soil Drainage Class Designations

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Figure 1-6

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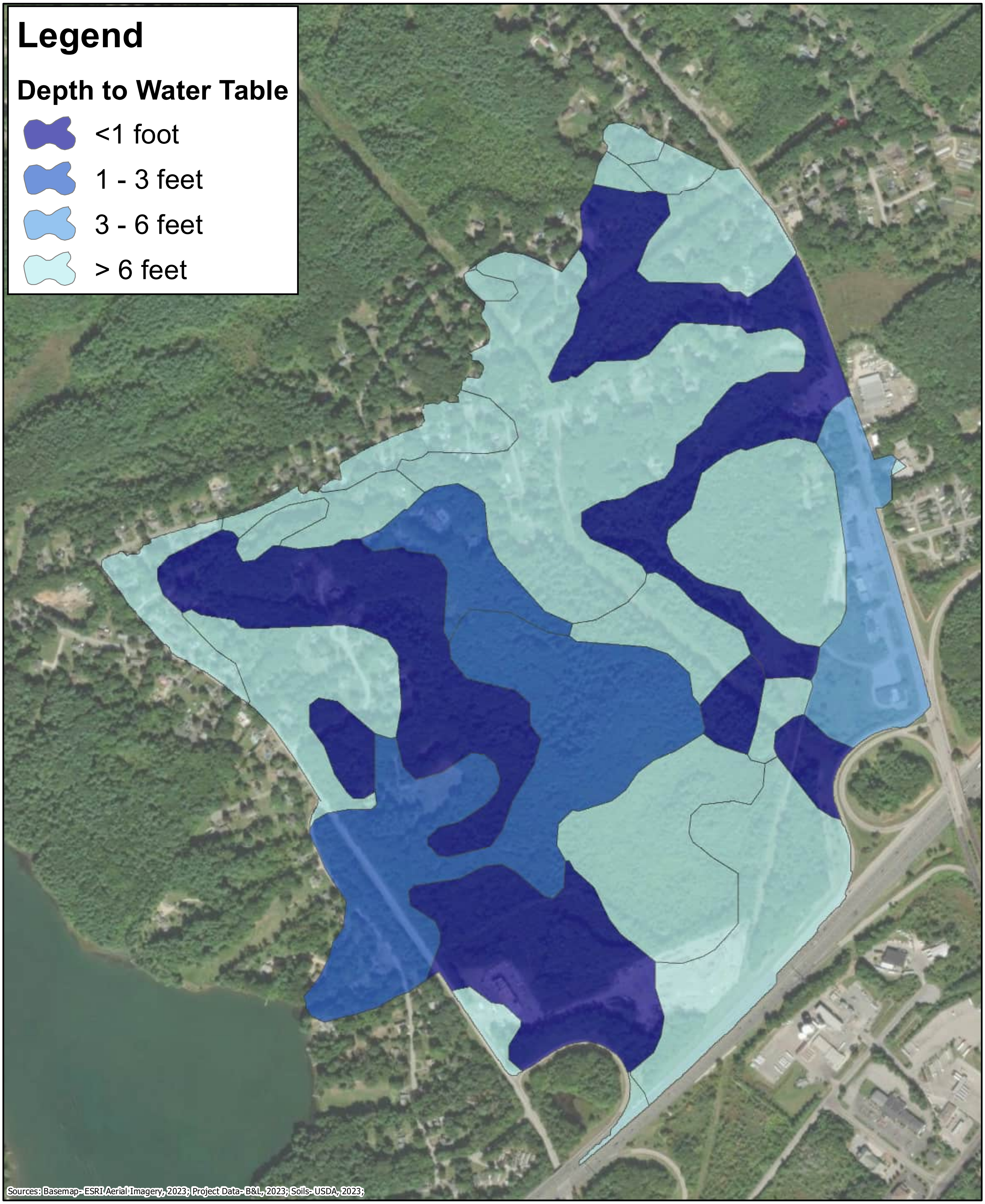
Within the focus area, higher elevations are generally found in the northern and central areas along Martin Road. Additionally, steeper slopes are more prominent in the western half of the focus study area, directing runoff west and southwest toward Spinney Creek and the Piscataqua River, as shown on **Figure 1-3**. The central, south-central, and eastern portions of the focused study area are characterized by more moderate slopes directing stormwater flows to the east and southeast toward Spruce Creek.

The hydrologic and hydraulic evaluation of the study area, as further discussed in **Section 2.4** below, is comprised of multiple factors including land use, land cover types, soil classifications, topography and drainage routes. Land cover is critical to drainage characteristics within a watershed, and also exerts considerable influence on the chemical, physical, and biological characteristics of waterbodies. Land cover classifies the vegetation (or lack thereof) covering the ground. Removal of natural vegetation can reduce infiltration and filtering capacity and can potentially increase erosion. Lack of natural vegetative cover typically results in increased amounts of runoff and potential nutrient transport. Within the Watershed Study Area, land cover varies with population density, where more impervious cover types are generally located within closer proximity to the roadways along the focused study area boundaries, while more pervious cover, primarily forest, is generally located centrally within the study area.

The groundwater level varies greatly between soil groups and topography and has a significant impact upon runoff potential. Groundwater fills the interstitial (void) space of soils, leaving less room for infiltration of runoff. Developed properties located in areas characterized by a high seasonal groundwater table are more susceptible to localized flooding due to a lack of infiltration capacity during precipitation events. Further, properties developed within areas characterized by high seasonal groundwater tables may be subject to instances of inundation in the absence of precipitation and stormwater runoff as groundwater levels vary on a seasonal and inter-annual basis, and may require mitigation alternatives that differ from conventional stormwater best management practices (BMPs). Approximate groundwater levels, as defined by Soil Survey Database (gSSURGO, 2016), are included within **Figure 1-7**.

A floodplain is a nearly flat plain near a surface waterbody that is naturally subject to flooding during normal (2-year) to extreme (100-year) precipitation events. Floodplains generally contribute to localized flooding, however, offer much needed nutrient filtration and downstream flood minimization. Floodplains exist within the study area, originating mostly within Drainage Area 1 (DA-1) to the northeast. The 100-year floodplain boundaries are shown on the 1984 Federal Emergency Management Agency (FEMA) Flood Rate Insurance Maps (FIRMs) included as **Appendix A**.



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1 inch = 1,000 feet

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Depth to Water Table

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Figure 1-7

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1.3 Land Ownership

Lands located within the focus study area consist primarily of privately owned lands; therefore, potential mitigation alternatives to alleviate localized flooding will require cooperation and collaboration with current landowners. Private landowner buy-in and partnerships will likely be required to increase the potential for funding assistance from state and/or federal grant programs for implementation of potential stormwater improvement projects.

Identifying select parcels that have the greatest potential to maximize water quality improvements and flood reduction benefits can accommodate potential future build-out while also mitigating existing flooding issues. The following factors were reviewed to identify priority areas for implementation of mitigation alternatives:

- Watershed Area
- Location
- Existing Land Use
- Ownership
- Zoning
- HSG

Larger watershed areas were identified as more favorable than smaller areas with similar characteristics for certain mitigation opportunities, such as conservation of natural areas or implementation of large retrofit practices. These larger watershed areas have greater potential to treat a larger volume of water quality and quantity from stormwater runoff when compared to smaller areas: basically the economy of scale. The existing land use compared to the Town's zoning was also reviewed. Current zoning for the Town of Kittery is included as **Appendix B**. Areas that are directly adjacent to receiving waters were considered more favorable as potential mitigation or conservation areas.

2.0 EXISTING FACILITIES & PRESENT CONDITION

2.1 Field Data Collection and Survey

Issues arising from localized flooding and associated water quality degradation may be mitigated after better understanding the root causes and influencing factors of flooding. A field survey was completed in November 2022 to collect supplemental information to assess the causes of flooding in the study area. Prior to the field reconnaissance efforts, B&L conducted a desktop-based delineation of subwatersheds using publicly available LIDAR mapping, the Town's online GIS database, and other desktop resources used to identify drainage divides, buried drainage facilities, and common outlet points. A pre-field reconnaissance meeting was conducted with Town officials to further document existing areas of concern. The goals of the preliminary watershed reconnaissance included:

- Catalog location, type, and condition data for critical stormwater infrastructure not included in the Town's GIS database, as well as for confirmation of existing data for infrastructure located in priority areas;
- Collect detailed elevation data at features critical to the accurate hydrologic and hydraulic modeling of areas subject to recurrent inundation with stormwater or groundwater; and
- Confirm and refine subwatershed delineations.

Additionally, FBE conducted a preliminary wetland reconnaissance effort in fall 2022 to better understand the extent and function of potential wetland resources within the primary focus area. Wetland boundaries were identified based on the United States Army Corps of Engineers' (1987) Wetland Delineation Manual and the 2012 Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Northcentral and Northeast Region, Version 2.0. Approximate boundaries were geolocated using a Garmin GPSMAP 78 handheld GPS unit with an accuracy of approximately 30 feet. Although performed at the reconnaissance level, preliminary mapping of wetland resources within the focus area plays a critical role in the identification of potential conservation areas and features that may affect hydrologic and hydraulic modeling of the study area (e.g., storage of flood areas). A memo of findings developed by FBE following their 2022 wetland reconnaissance efforts, including a map of identified wetlands and watercourses, is included as **Appendix C**.

2.2 Public Engagement

In order to better understand existing conditions and to collect supplemental information from various stakeholders, a series of public engagement meetings were conducted. Presentation content from each of these public engagement meetings is included **Appendix D.** Additional opportunities were provided to Town residents to provide information for review and consideration, including an interactive mapper and a public survey. The interactive mapper consisted of an open-source website in which stakeholders could select specific areas for identification of existing concerns and potential enhancement opportunities. The results of the interactive mapper, including graphical summaries of responses, are provided in **Appendix E.**

Additionally, the public survey afforded a means for public stakeholders to provide additional background information through a series of guided questions. The results of the public survey are included as **Appendix E.**

General themes from input received through the public outreach included:

Interactive Mapper Summary:

- Intersection of Martin Rd./236 – historical flooding, impacts of high groundwater table, beaver dams implications, culvert sizing considerations
- Herb Parsons Pond – changes to water level
- Happy Avenue – historical basement flooding
- Dennett Road – historical flooding

Public Survey Summary:

- 10 respondents experienced flooding at their property
- Observed combination of seasonal and ongoing flooding, with most respondents identifying increased flooding during the Spring season
- Multiple respondents have incurred costs associated with flooding
- Majority of respondents suspect flooding is more groundwater than surface water related
- Respondents believe increased development, wetland alteration and modifications to natural drainage paths are primary factors contributing to localized flooding.

2.3 Priority Areas

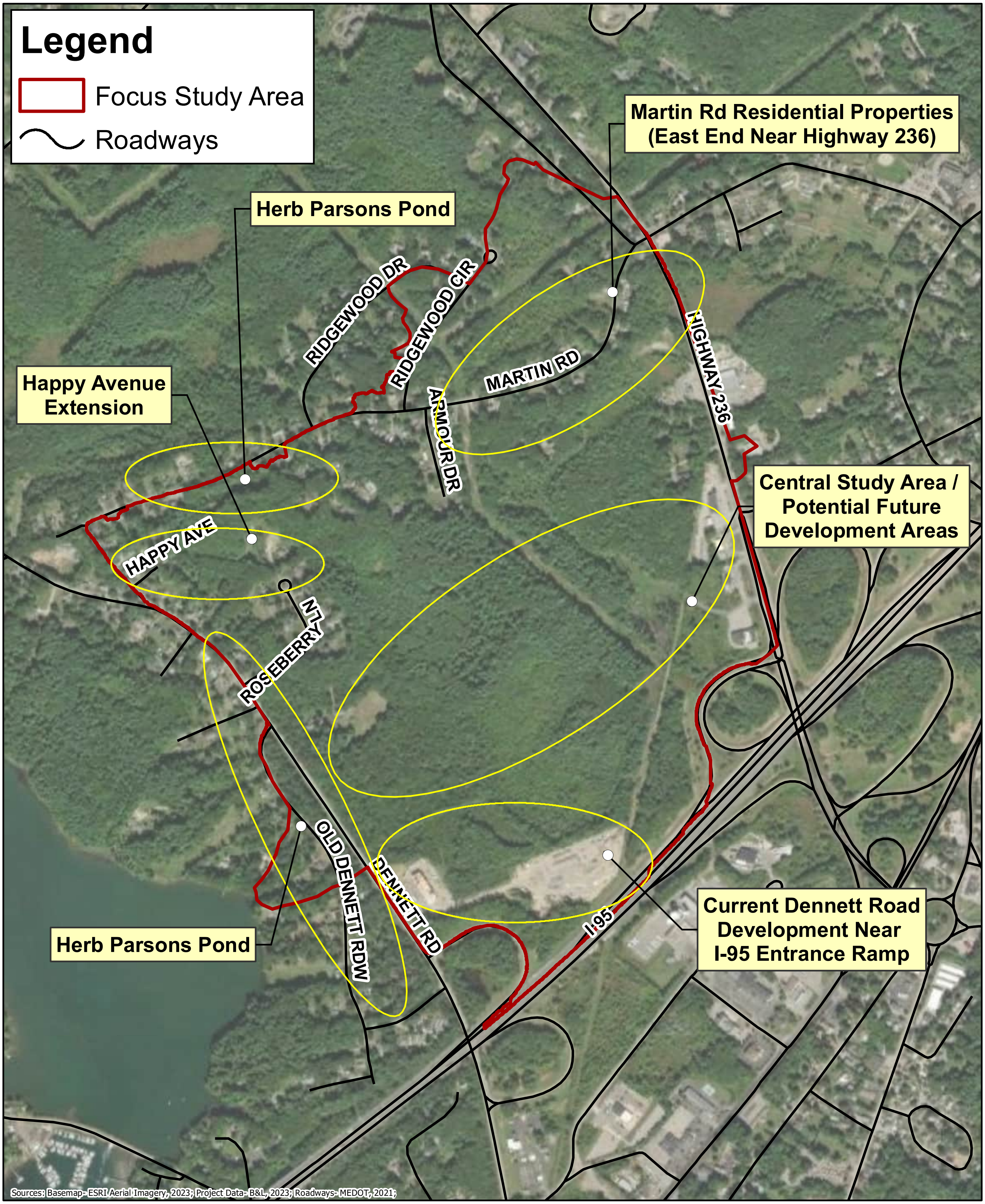
Prior to development of hydrologic and hydraulic models for the focus area, priority areas were identified through correspondence with Town officials, public engagement, field reconnaissance, and evaluation of existing literature and desktop resources. The following areas were identified as priority areas:

- Residential properties along Martin Road, primarily within close proximity to Highway 236;
- Herb Parson Pond;
- Central study area (potential future development areas);
- Residential properties along Dennett Road;
- Happy Avenue access road;
- Residential properties along Old Dennett Road, located west of Dennett Road; and

- Ongoing Dennett Road development near I-95 on-ramp.

Priority areas listed above are identified on **Figure 2-2** and are further discussed in **Section 6.0**.

Figure 2-1: Interactive Mapper Interface



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Priority Areas

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Figure 2-2

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2.4 Hydrologic and Hydraulic Evaluation

A hydrologic and hydraulic model was developed using HydroCAD® software to identify areas of localized flooding and predict anticipated peak flows (runoff rates and volumes) during specific storm events, and to provide an existing conditions model that can be referenced to evaluate potential mitigation alternatives.

The focus study area was separated into six distinct drainage areas (Drainage Areas 1, 2, 3, 4, 5, and 6) representing distinct outflows from the focus area. Each drainage catchment within the study area has variable slopes directing stormwater from the outer extents of each subwatershed toward one of six modeled outfalls to surrounding receiving water bodies. Generally, the steeper the slope, the shorter the time of concentration is, which produces a higher peak flow. Drainage Areas 1 through 5 were comprised of smaller subwatersheds, some that included ponds and reaches. Ponds were utilized within the model to represent areas which provide notable storage and attenuation of stormwater flows. Reaches were utilized to represent channelized flow. Modeling assumed reaches operate under free discharge conditions based on normal open channel flow.

The HydroCAD® model develops runoff hydrographs from rainfall. The runoff reflects watershed precipitation, topography, soil type, land cover, and land use. The following data and corresponding sources were utilized to parameterize the model:

- Precipitation Data:
  - National Oceanic and Atmospheric Administration (NOAA) Atlas 14 rainfall data (see **Appendix F**) was used to develop hyetographs and peak precipitation depths for the model
  - For future conditions (see Section 4.0), current precipitation depths were increased 15% per the New Hampshire Coastal Flood Risk Summary, Part II: Guidance (as no similar resource currently exists in Maine)
- Topography:
  - Elevation maps were developed to calculate slopes and to supplement lidar mapping to approximate inverts and flood elevations using 2019 USGS 1 meter digital elevation model (DEM) data (USGS, 2022). DEM data was geoprocessed and converted to contours at 2-foot intervals. This mapping was also utilized to evaluate the time of concentration (Tc), which is the time required for runoff to travel from the hydraulically most distant point in the watershed to the design point. Tc is an important input into the model to determine runoff timing
- Soil Type:
  - Obtained from the United States Department of Agriculture (USDA) National Resources Conservation Service (NRCS) SSURGO dataset (USDA, 2016)
    - USDA NRCS SSURGO mapping for the focus study area included an inaccuracy to the south of Herb Parsons Pond, where a combination of

wetland and uplands are designated as open water (Soil Unit ‘w’). These areas were treated as HSG D soils based on presence of surrounding wetlands with limited infiltration potential.

- Land Cover and Land Use:
  - Obtained from the 2019 National Land Cover Database (Dewitz, 2021)

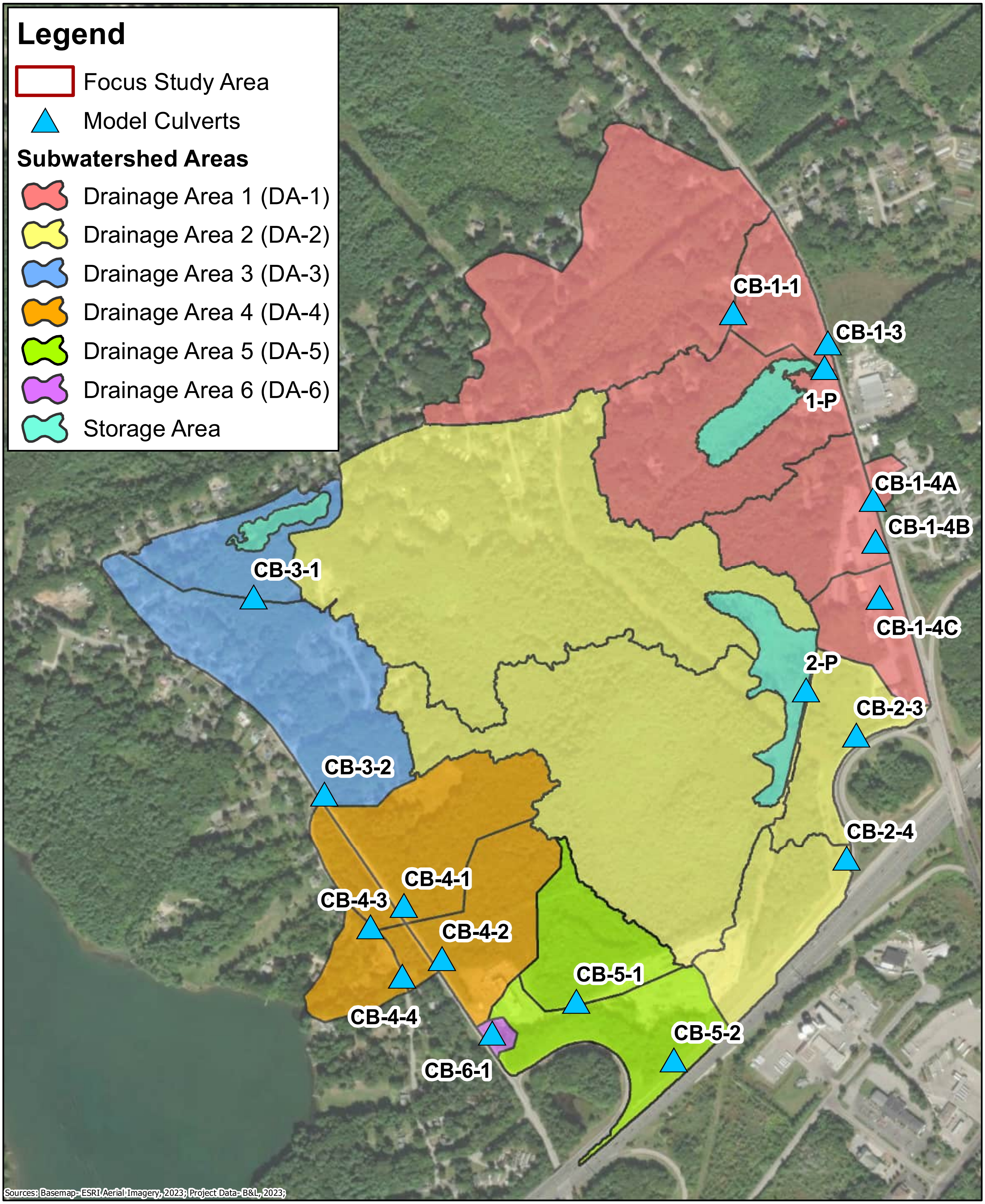
Prior to analysis of future development scenarios, an existing conditions model was developed to determine current vulnerable locations and stormwater infrastructure components. Each subwatershed was evaluated for peak discharge rate (Qpk), time of the peak discharge (hours), and total runoff volume (acre-ft). Each of these parameters plays a key role in the evaluation of how a subwatershed responds to various precipitation and development scenarios. Model results were observed at culvert locations serving as the final discharge location for each subwatershed (**Figure 2-3**). **Table 2-1** provides an overview of these culvert design points used for model evaluation. A summary of peak discharge rates and maximum ponding depths for the 1-, 10-, and 100-year storm events are provided in **Figure 2-4** and **Figure 2-5**, respectively. Due to large file sizes, results from all HydroCAD models developed for the project have been provided electronically to the Town of Kittery. Additional model scenarios were run to simulate various weather, build-out and mitigation alternatives, as discussed in subsequent sections. A list of all model runs completed for the project is included as **Appendix G**.

Table 2-1: HydroCAD Model Culvert Design Point Profiles

Culvert ID	Inflow Location	Contributing Drainage Area	Inflow Area (acres)	Inflow Area - % Impervious Area
1-P	Parcel #29-1 elevated driveway.	DA-1-2: Residential, wooded, and wetland areas located south of Martin Road and west of Highway 236, more specifically west of the Parcel #29-1 driveway.	26.5	5%
2-P	Utility right-of-way at eastern terminus of '98 Dennett' property (Parcel #12-3-1).	DA-2-1 and DA-2-2: Primarily wooded and wetland areas including much of the '98 Dennett' property (Parcel #12-3-1) as well as wooded and residential properties along central portion of Martin Road, between Herb Parsons Pond and Ridgewood Drive.	124.9	2%
3-P	Herb Parsons Pond.	DA-3-1-P: Contributing drainage area for Herb Parsons Pond, including pond area.	1.8	0%
CB-1-1	Martin Road, approximately 650 feet west of Highway 236.	DA-1-1: Residential, wooded, and wetland areas north of Martin Road, between Rt-236 and Ridgewood Drive.	40.9	6%
CB-1-3	Highway 236 at eastern extent of Parcel #29-1.	DA-1-3: Residential, wooded, and wetland areas south of Martin Road and west of Highway 236. Includes all inflow from DA-1-1 and DA-1-2.	74.7	6%
CB-1-4A	Highway 236 at western extent of Parcel #29-44-1.	DA-1-4A: Impervious and wooded portions of Parcel #29-44-1.	1.0	37%
CB-1-4B	Ditch on west side of Highway 236 at Parcel #21-19.	DA-1-4B: Commercial, residential and wooded lands west of Highway 236 between Dana Avenue and boat yard. Includes all inflow from DA-1-4A.	14.0	24%

Table 2-1: HydroCAD Model Culvert Design Point Profiles				
Culvert ID	Inflow Location	Contributing Drainage Area	Inflow Area (acres)	Inflow Area - % Impervious Area
CB-1-4C	Ditch on west side of Highway 236 immediately east of Parcel 21-19A.	DA-1-4C: Primarily commercial land with some forested/wetland area west of Highway 236, across from on-ramp for I-95 South.	7.3	46%
CB-2-3	North side of I-95 South off-ramp, east of Highway 236.	DA-2-3: Mixed tree and grass cover with intermixed wetland areas. Contributing area located west of Highway 236 between I-95 ramp and utility right-of-way.	134.8	3%
CB-2-4	West side of I-95 South off-ramp, east of Highway 236.	DA-2-4: Mixed tree and grass cover with small wetland area and small portion of commercial property at western extent. Contributing area located west of Highway 236 between I-95 ramp and utility right-of-way.	11.9	32%
CB-3-1	North side of Happy Avenue extension.	DA-3-1: Residential and wooded areas along western extent of Martin Road within focus study area. Includes Herb Parsons Pond; however, modeling indicates discharge from pond to this receiving culvert as being extremely unlikely.	10.3	23%
CB-3-2	East side of Dennett Road across from intersection with Old Dennett Road.	DA-3-2: Residential and wooded areas located south of the Happy Avenue Extension, predominantly between Roseberry Lane and Happy Avenue. Includes drainage from DA-3-1 conveyed through Happy Avenue Extension culverts.	36.0	14%
CB-4-1	Dennett Road, approximately 750 feet south of CB-3-2.	DA-4-1: Wooded and residential areas east of Dennett Road.	15.7	2%

Table 2-1: HydroCAD Model Culvert Design Point Profiles				
Culvert ID	**Inflow Location**	**Contributing Drainage Area**	**Inflow Area (acres)**	**Inflow Area - % Impervious Area**
CB-4-2	Dennett Road, approximately 380 feet south of CB-4-1.	DA-4-2: Primarily wooded areas east of Dennett Road, including portion of developed Seacoast Residences property.	12.2	9%
CB-4-3	Old Dennett Road, southern corner of cemetery approximately 200 feet southwest of CB-4-1.	DA-4-3: Portion of wooded/shrub area between Dennett Road and Old Dennett Road.	19.1	5%
CB-4-4	Old Dennett Road, approximately 220 feet southwest of CB-4-2.	DA-4-4: Portion of wooded/shrub area between Dennett Road and Old Dennett Road.	13.6	10%
CB-5-1	North side of Seacost Residences access drive.	DA-5-1: Primarily wooded areas with a portion of the developed Seacoast Residences property. Contributing drainage area located east of Dennett Road and north of I-95.	10.4	0%
CB-5-2	North side of I-95 on east side of I-95 south on-ramp.	DA-5-2: Wooded areas and the majority of the developed Seacoast Residences Property. Contributing drainage area located east of Dennett Road and north of I-95.	23.5	5%
CB-6-1	East side of Dennett Road on north side of I-95 south on-ramp.	DA-6-1: Small drainage area consisting of wooded area and very small portion of Seacost Residences lot. Contributing drainage area located east of Dennett Road and north of I-95.	0.7	20%



Barton & Loguidice

1 inch = 1,000 feet

Town of Kittery

Focus Study Area Culvert Mapping

York County | November 2023 | New York

Figure 2-3

Project No. 2687.001

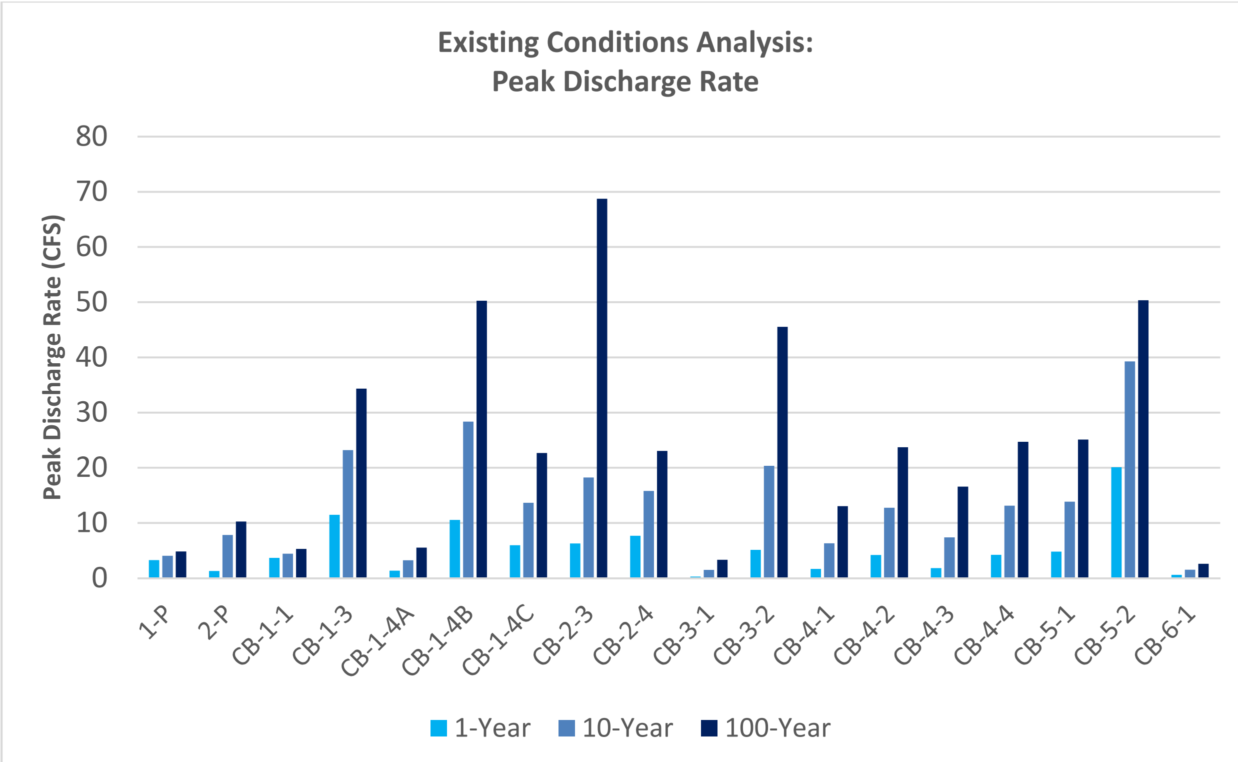


Figure 2-4: Existing Conditions Model Results Summary – Peak Discharge Rate

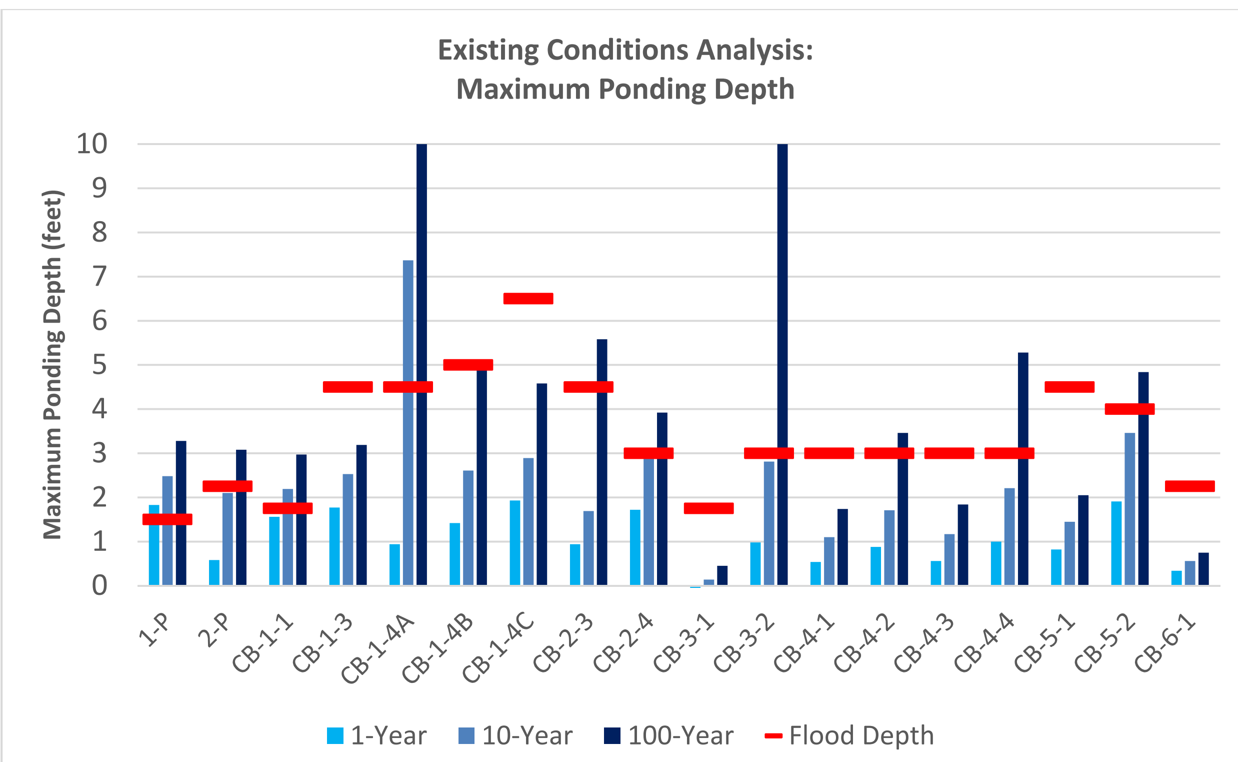


Figure 2-5: Existing Conditions Model Results Summary – Maximum Ponding Depth

2.5 Modeled Nutrient and Sediment Loads

The modeling analysis for the study was completed using the Model My Watershed (MMW) tool, a web-based watershed modeling application that includes a Watershed Multi-Year Model. Model My Watershed provides a continuous simulation model that evaluates stormwater quality impacts using the Generalized Watershed Loading Function Enhanced (GWLF-E) model. The GWLF-E model was initially developed by Barry M. Evans, Ph.D., and his team at Penn State University for use with the MapShed desktop modeling application. The MMW Multi-Year Model utilizes regional geospatial data layers embedded within the program's web interface and provides estimated annual nutrient loadings based on 30 years of simulated water, nutrient, and sediment fluxes over a user defined Study Area.

The GWLF-E estimates external nutrient and sediment loads as a function of precipitation data, land cover, topography, soil type, soil nutrients, groundwater nitrogen, baseflow, animal farming operations, and wastewater inputs. Sources for each required dataset are as follows:

- Precipitation data: USEPA's National Climate Data (USEPA, 2006)
- Land cover: 2011 National Land Cover Database (Homer et al., 2015)
- Soil type: USDA-NRCS GSSURGO (USDA, 2016)
- Soil nitrogen: USDA National Soil Characterization Database (NSCD) (Hargrove and Luxmoore, 1998)
- Soil phosphorus: USGS (Smith et al. 2014)
- Groundwater nitrogen: USGS (Nolan and Hitt, 2006)
- Base flow: USGS (Wolock, 2003)
- Topography: National Elevation Dataset (USGS, 2009)
- Animal farming operations: USDA (USDA, 2012)
- Streams: Continental US Medium Resolution Stream Network (NHD Plus V2, 2017)

Additionally, MMW serves as a valuable tool for assessing the effectiveness of various alternatives as compared to an established baseline condition. The following Tables present the annual sediment, phosphorus and nitrogen loading results under existing conditions for each of the main drainage areas within the study area. This data was utilized to inform priority locations for potential retrofit projects to achieve maximum co-benefits with stormwater attenuation practices and land use controls. The Model My Watershed Pollutant Loading summary reports are provided as **Appendix H.**

Table 2-2. Annual Sediment Loading Summary				
Drainage Area	**Area (ac)**	**Sediment Loading Rates (lb./ac)**	**Sediment Loading (lbs.)**	**Percent of Total Sediment Loading (%)**
DA-1	95.2	29.13	2,771.3	42.5%
DA-2	146.97	19.87	2,921.6	44.9%
DA-3	35.98	12.74	459.5	7.1%
DA-4	27.87	3.92	110.4	1.7%
DA-5	23.57	9.11	231.8	3.6%
DA-6	0.74	26.21	19.4	0.2%
Total	330.3	*N/A*	6,514	100%

Table 2-3. Annual Phosphorus Loading Summary				
Drainage Area	**Area (ac)**	**Phosphorus Loading Rates (lb./ac)**	**Phosphorus Loading (lbs.)**	**Percent of Total Phosphorus Loading (%)**
DA-1	95.2	0.06	5.7	30.5%
DA-2	146.97	0.05	8	42.7%
DA-3	35.98	0.06	2.2	11.8%
DA-4	27.87	0.05	1.4	7.5%
DA-5	23.57	0.06	1.3	7%
DA-6	0.74	0.09	0.1	0.5%
Total	330.3	*N/A*	18.7	100%

Table 2-4. Annual Nitrogen Loading Summary				
Drainage Area	**Area (ac)**	**Nitrogen Loading Rates (lb./ac)**	**Nitrogen Loading (lbs.)**	**Percent of Total Nitrogen Loading (%)**
DA-1	95.2	1.49	141.3	27.7%
DA-2	146.97	1.51	221.3	43.3%
DA-3	35.98	1.74	62.8	12.3%
DA-4	27.87	1.51	42.7	8.4%
DA-5	23.57	1.77	41.6	8.1%
DA-6	0.74	1.43	1.1	0.2%
Total	330.3	*N/A*	510.8	100%

3.0 BUILD-OUT ANALYSIS

In addition to evaluating existing conditions and alternatives to alleviate existing localized flooding and impacts of high groundwater tables, a primary goal of the project is to evaluate hydrologic impacts of potential future development. A build-out analysis was completed to better understand what portions of the focus area would be most susceptible to hydrologic impacts as a result of future development, as well as potential mitigation alternatives to assist with mitigating development impacts. This build-out analysis consisted of developing HydroCAD models for two build-out alternatives that are compared to the existing conditions base model discussed in Section 2.0: 1) 50% Build-Out scenario; and 2) 100% Build-Out scenario. ***Of critical note, the Build-Out Analysis presented below, does not account for stormwater management that would be required in accordance with state and local regulations/ordinances.***

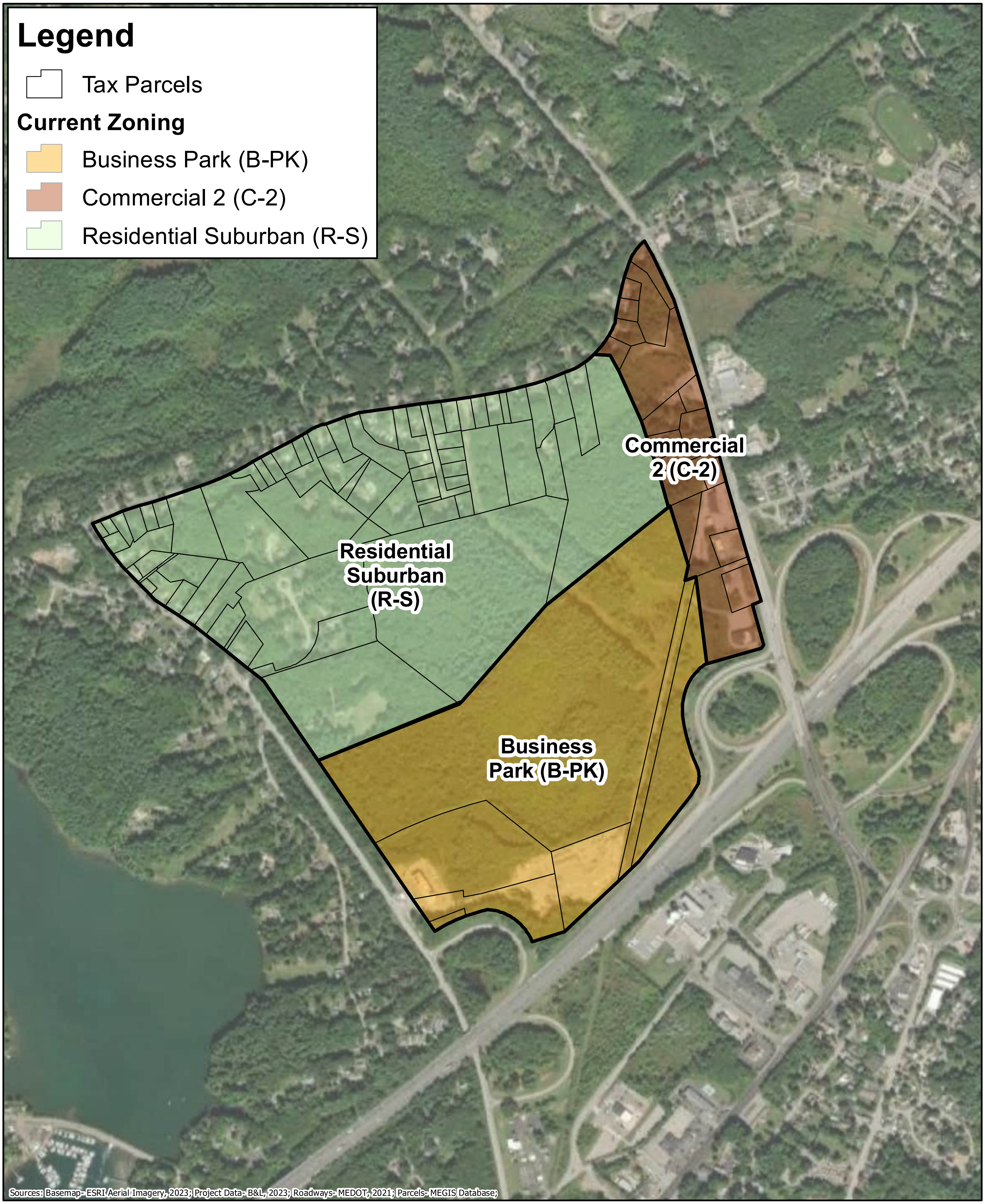
The 50% build-out and 100% build-out models consisted of modifying the land use classifications in the existing conditions model. Whereas the existing conditions model described in **Section 2.4** utilized detailed land cover data provided through the 2019 NLCD, the two build-out scenarios assumed different developed land uses would occur depending on the zoning of each area which is shown in **Figure 3-1** below.

For land parcels located within areas zoned as Business Park (B-PK) or Commercial 2 (C-2), the build-out analysis models were developed through designation of parcels as either built-out, or not built-out, in accordance with existing zoning regulations. For example, for areas located along Highway 236 that are zoned for commercial use, parcels containing commercial properties were identified as built-out, while forested parcels were designated as not built-out. Parcels containing mixed land use (i.e., half commercial and half forested) were bisected, and each sub-parcel was given the appropriate designation. Following designation of each parcel and sub-parcel with the appropriate aggregate land use, associated runoff curve numbers were assigned to each parcel area. Simplification of parcel land uses for build-out analysis was not completed for areas zoned as Residential Suburban (R-S) as substantial build out is not anticipated in these areas. Therefore, existing NLCD data was retained in HydroCAD models for R-S zoned areas under each build out scenario. A visual representation of the Build-Out analysis parcel designation is depicted in **Figure 3-2** below.

Designated land use was modified for development of the build-out scenario models. This process consisted of converting 50% of the total area as not built-out to the built-out designation and assigning the corresponding runoff curve numbers to the new area totals for each land use. For example, within the area zoned as Business Park in the southern extent of the focus area, 50% of the aggregate wooded area would be converted to commercial.

The final build-out scenario model, representing the 100% build-out scenario, was developed by converting all areas designated as not ‘built-out’ to the maximum built-out land use allowable by existing zoning. For example, in the eastern extent of the focus area currently zoned as ‘Commercial 2 (C-2)’, all areas designated as wooded, residential, etc. would be converted to commercial lands in the HydroCAD model and assigned the appropriate runoff curve number. Under the assumption that wetland areas and vegetated right-of-way areas will generally not be subject to development, these areas remained constant in each build-out model iteration.

Results from the modeling efforts for each build-out scenario are summarized in the following **Figure 3-3** through **3-8** below.



Barton & Loguidice

1 inch = 1,200 feet

Town of Kittery

Existing Zoning Within Focus Study Area

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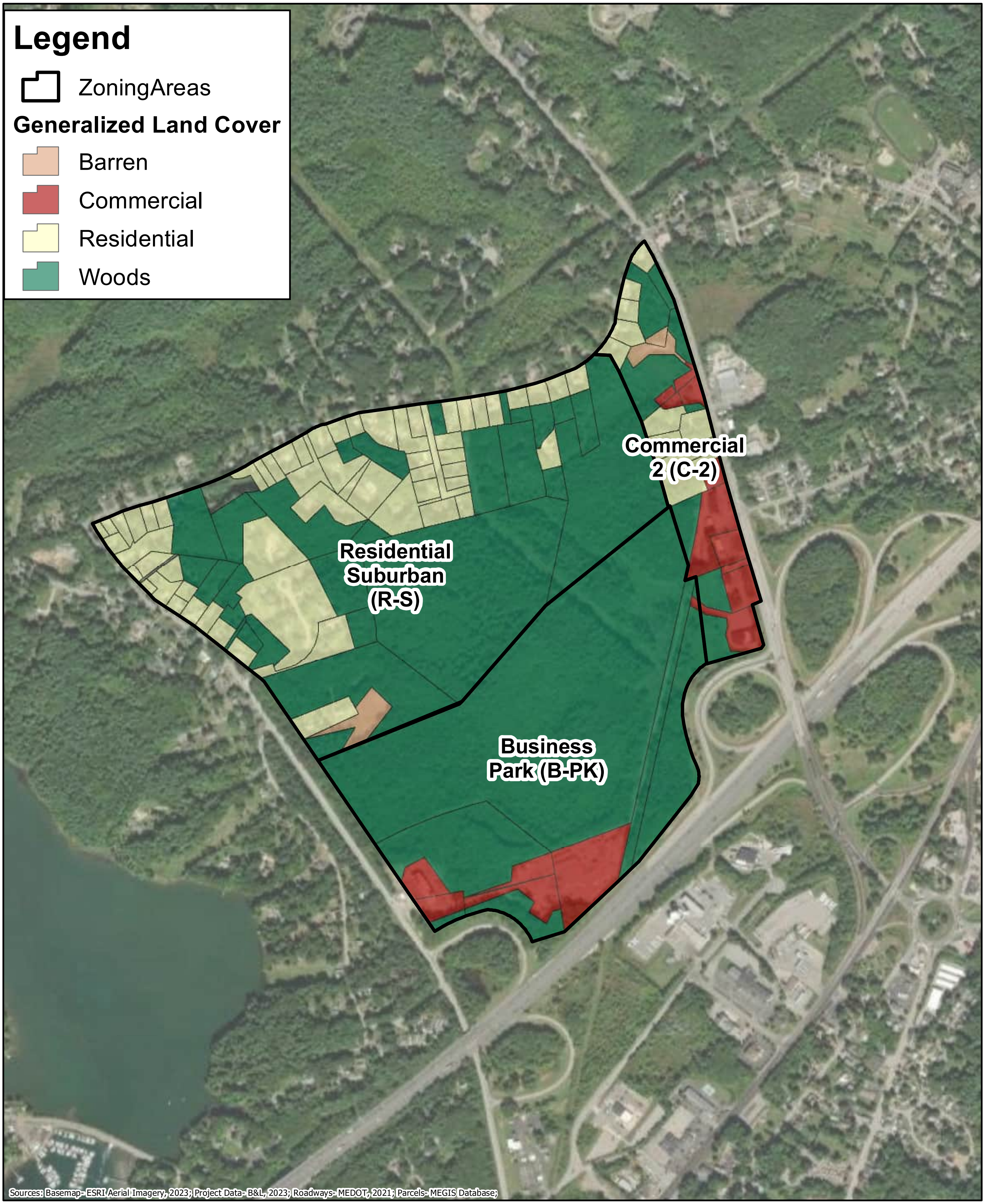
Figure 3-1

Project No. 2687.001



Barton & Loguidice

1 inch = 1,200 feet

Town of Kittery

Build-Out Analysis
Parcel Identification

York County November 2023 New York

Figure 3-2

Project No. 2687.001

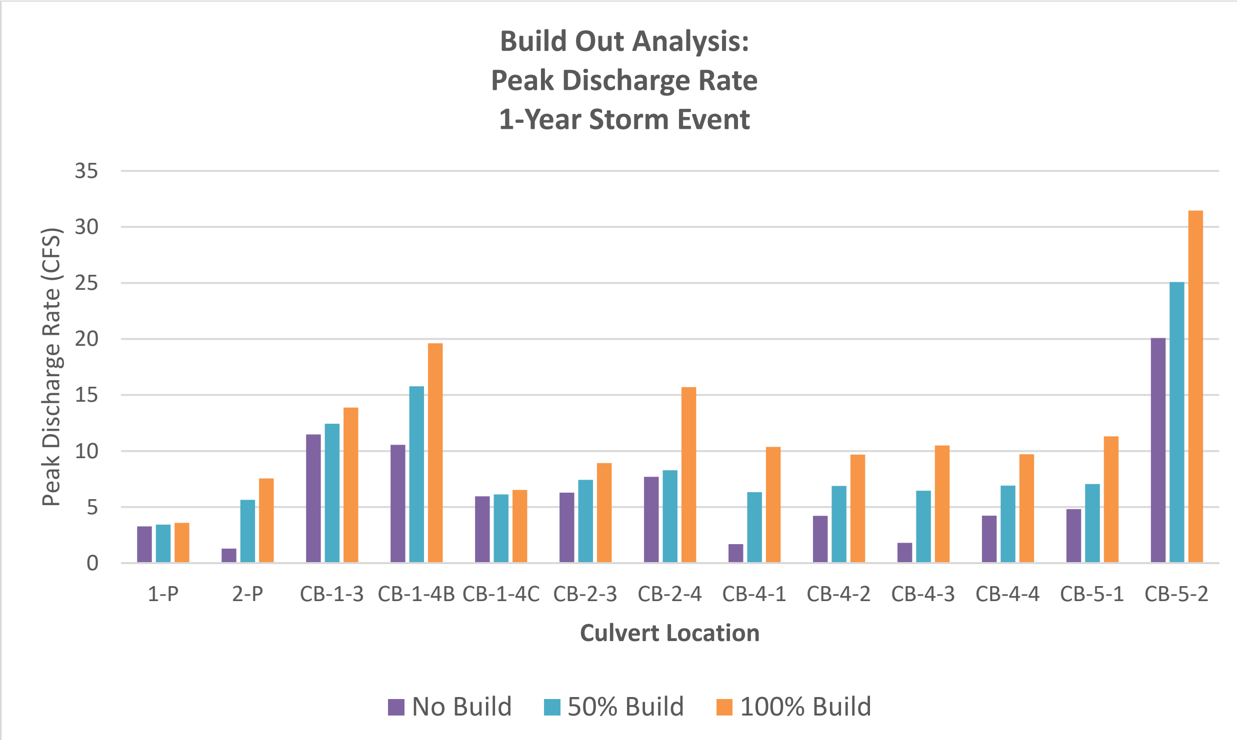


Figure 3-3: Build Out Analysis — Peak Discharge Rates (1-Year Storm)

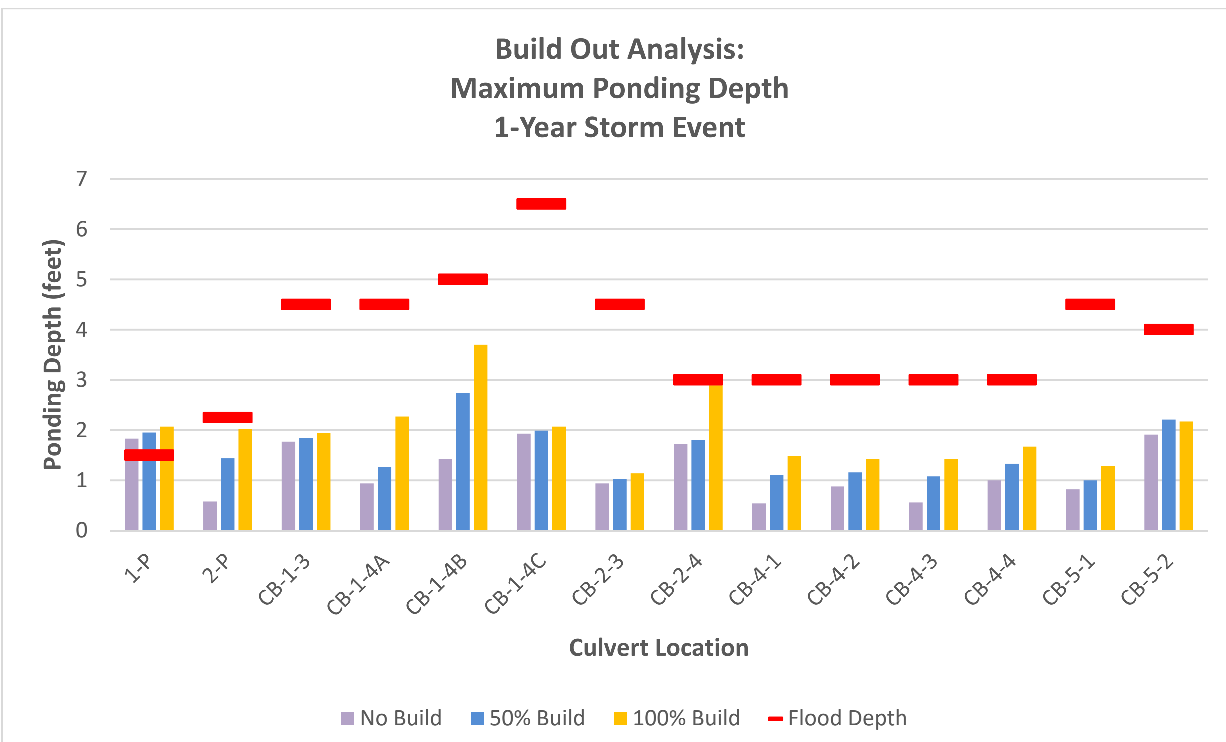


Figure 3-4: Build Out Analysis — Maximum Ponding Depth (1-Year Storm)

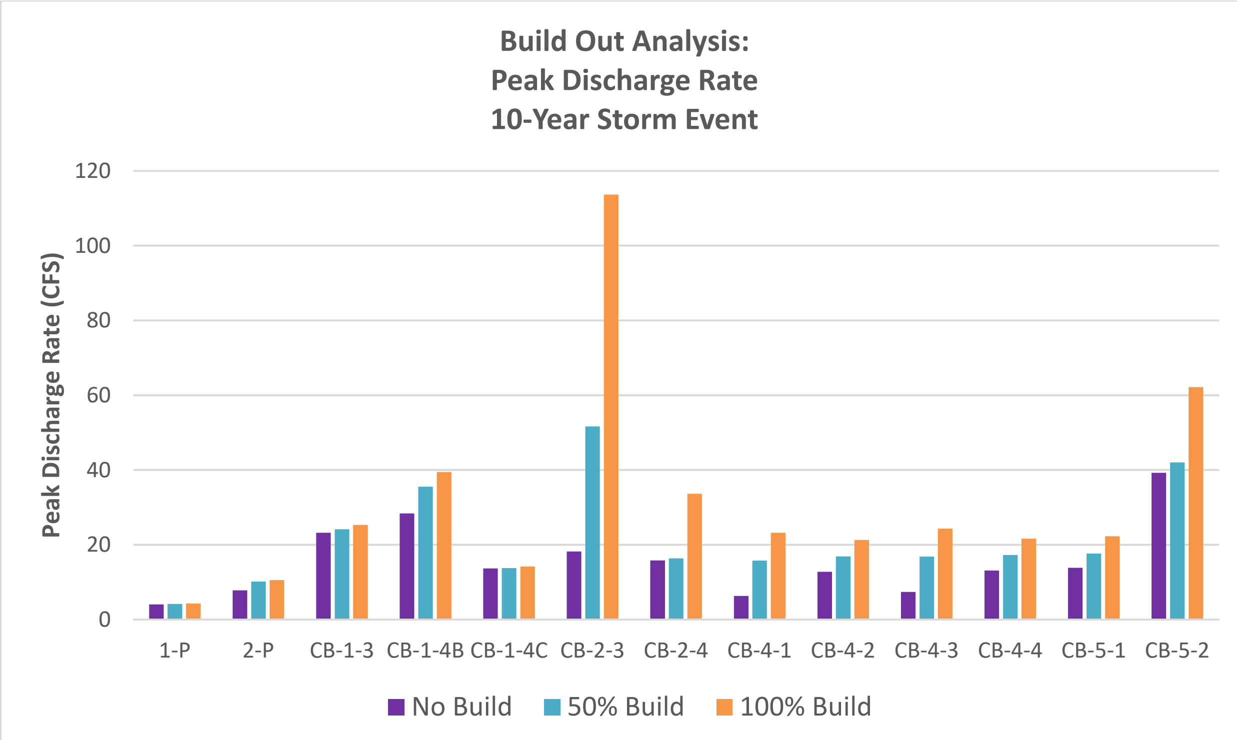


Figure 3-5: Build Out Analysis — Peak Discharge Rates (10-Year Storm)

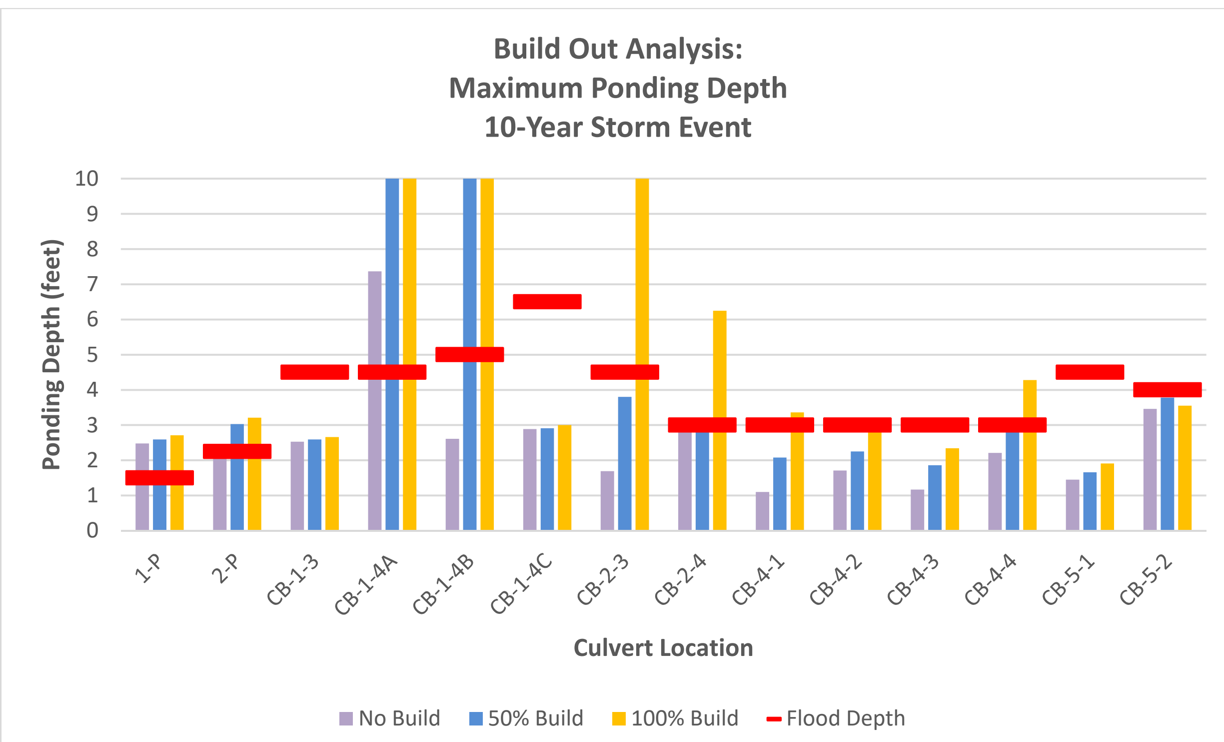


Figure 3-6: Build Out Analysis — Peak Discharge Rates (10-Year Storm)

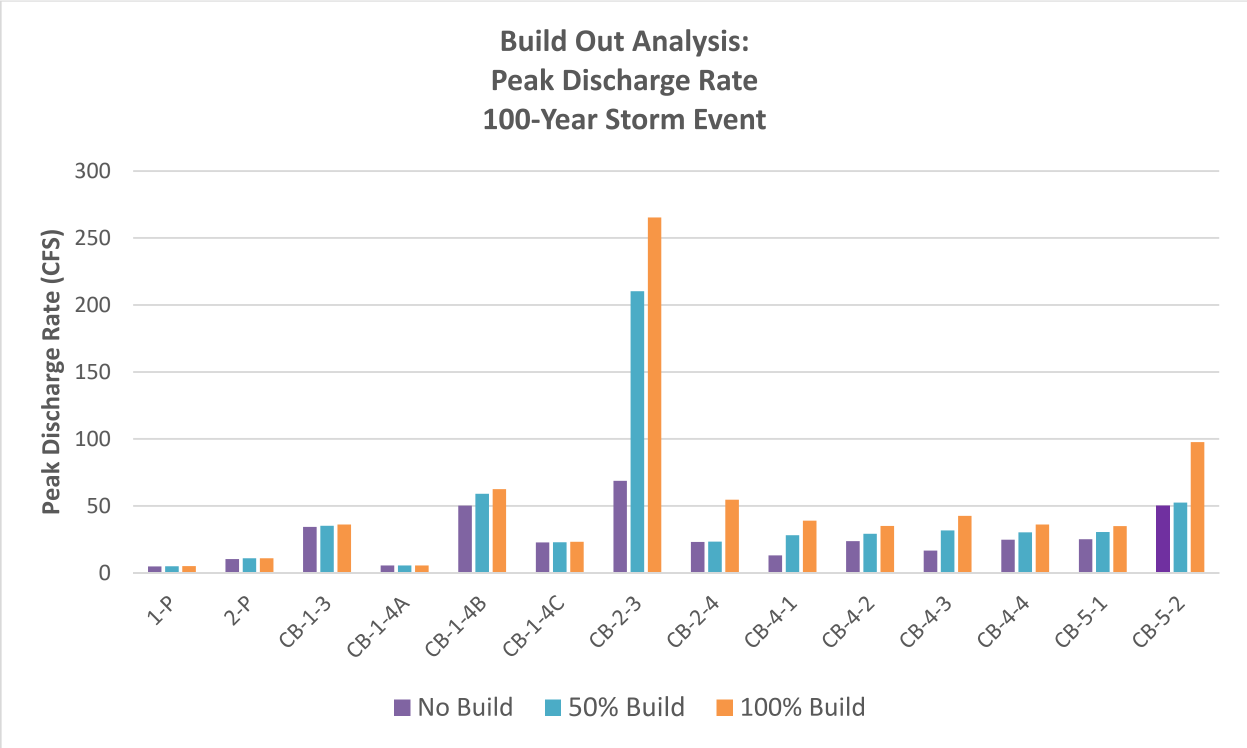


Figure 3-7: Build Out Analysis — Peak Discharge Rates (100-Year Storm)

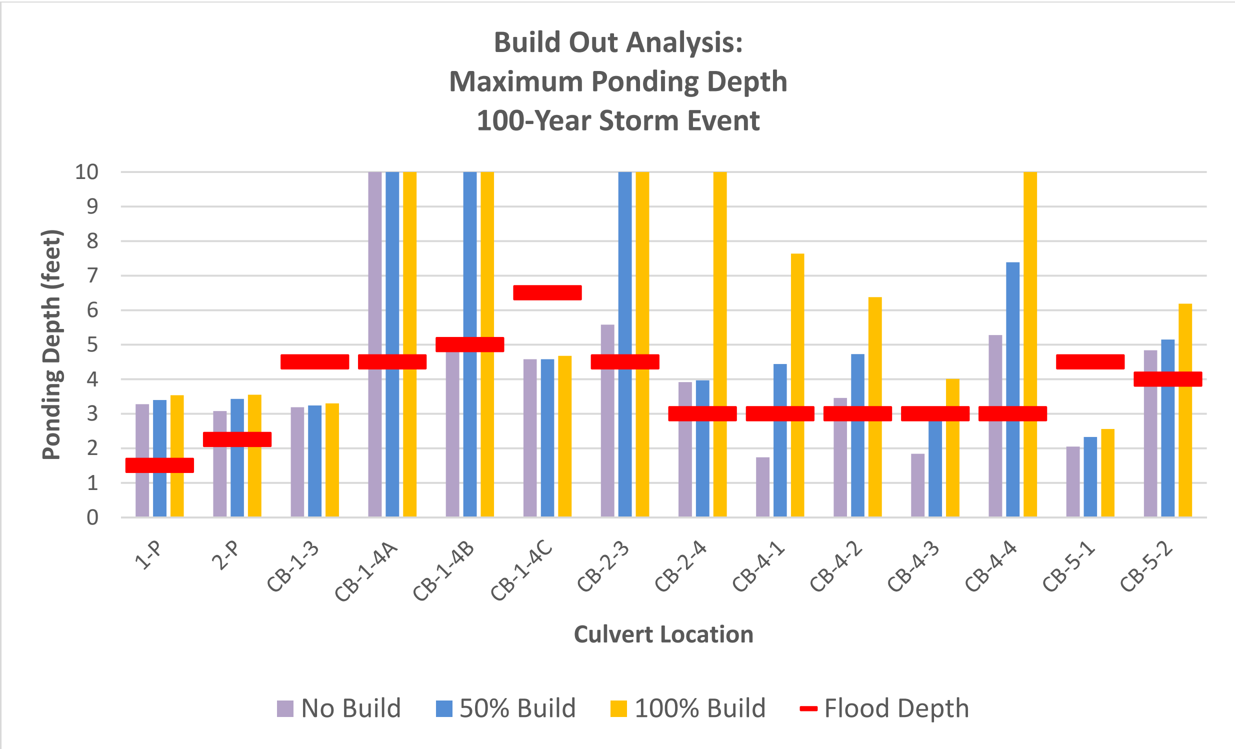


Figure 3-8: Build Out Analysis — Peak Discharge Rates (100-Year Storm)

4.0 EXTREME PRECIPITATION SCENARIOS

Climate change has the potential to impart more extreme weather events including an increased frequency and duration of drought as well increase of total stormwater volume and peak flow rates. In turn, this could amplify existing instances of localized flooding, cause greater seasonal and annual variation in groundwater tables, and further exacerbate any adverse impacts from future development. Additionally, an increase in the frequency and magnitude of extreme storm events could provide additional loading of nutrients and sediment to receiving waterbodies. In order to model extreme precipitation scenarios, the precipitation amounts were increased by 15% for each storm event. **Figures 4-1** and **4-2** indicate the changes that may be anticipated with increased rainfall amounts and intensities.

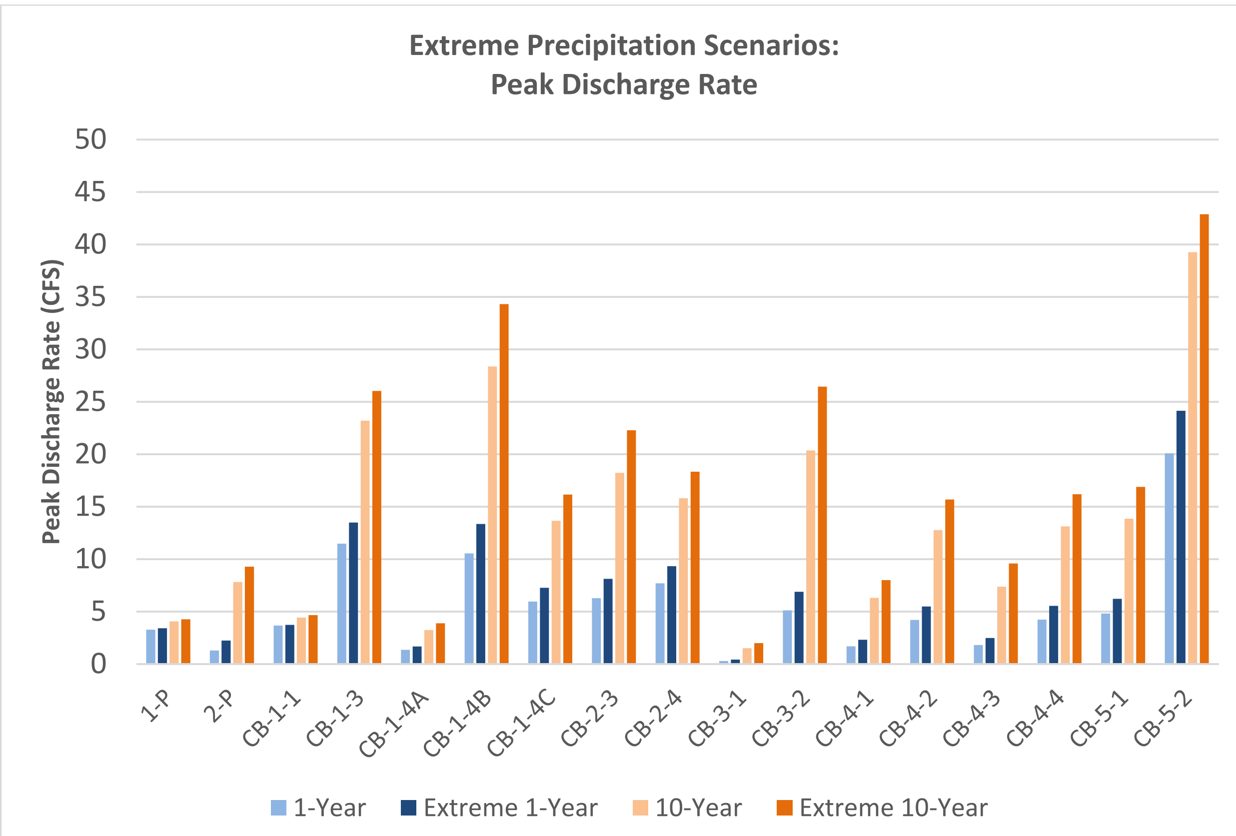


Figure 4-1: Peak Discharge Rates – Extreme Precipitation Scenarios

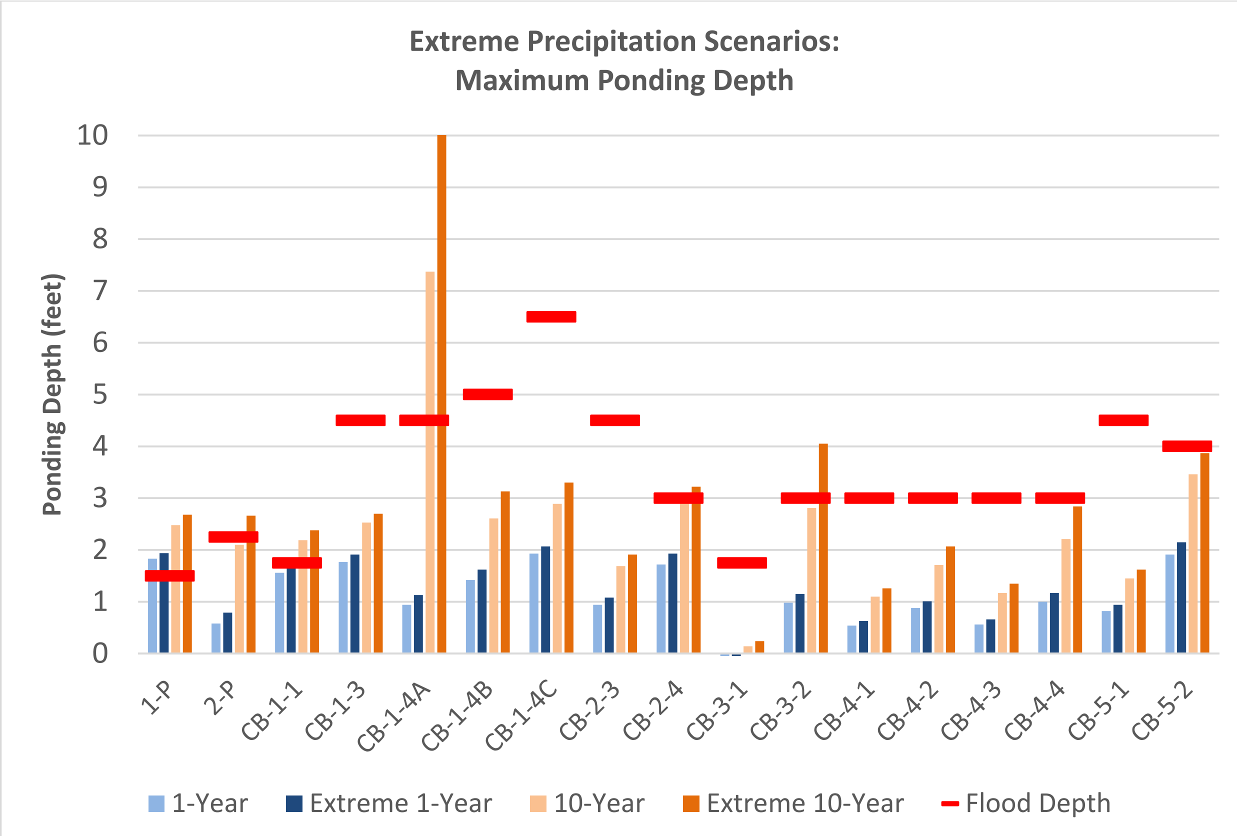


Figure 4-2: Maximum Ponding Depth – Extreme Precipitation Scenarios

5.0 CULVERT ANALYSIS

B&L assessed the capacity of 18 culvert locations using the results of the hydrologic models for existing, 50% and 100% Build Out scenarios. The culvert analysis focused on the headwater to depth ratios (HW/D) of culverts. General hydraulic guidance allows for a HW/D ratio up to 1.5 times the depth (or diameter) of culverts at peak discharge conditions (for culverts <60-inches in diameter). Higher ratios can commonly cause issues with water routing through the road subbase, potentially causing damage to embankments. B&L assumed culverts at state-owned road crossings to be sized to safely convey the 50-year return storm peak discharge in accordance with Maine DOT design criteria. For local and county roads, B&L assumed a safe conveyance of a 10-year return storm peak discharge. Note that HW/D ratios outside design recommendations do not necessarily mean that local flooding occurs at the design storm event. Similarly; HW/D ratios less than 1.5 do not necessarily mean that the road is not overtopping.

The analysis indicated that 6 of 18 culverts assessed are potentially undersized as summarized in **Table 5-1** and on **Figure 5-1**. Potential land development activities may exacerbate hydraulic conditions, but do not cause any additional culverts to exceed HW/D design recommendations for build out scenarios. A site-specific hydraulic analysis is required to size replacement culverts and determine if a jurisdictional stream exists (and in-stream sizing requirements apply which require a minimum width equal to 120% of the bankfull width of the undisturbed stream).

Table 5-1: Critical Infrastructure Culvert Analysis

Model Node ID	Design Storm	Existing Culvert Size (in dia.)	HW/D Ratio Per Scenario @ Design Storm Peak Discharge: Existing Conditions	50% Build Out	100% Build Out
1-P	10-Year	12	**2.48**	**2.59**	**2.71**
CB-1-1	10-Year	14	**1.88**	**1.88**	**1.88**
CB-1-3	10-Year	36	0.84	0.86	0.89
CB-1-4A	10-Year	12	**8.50**	**10.62**	**11.65**
CB-1-4B	10-Year	24	**3.32**	**5.22**	**6.55**
CB-1-4C	10-Year	24	1.44	1.45	1.49
2-P	10-Year	18	1.40	2.02	2.14
CB-2-3	50-Year	36	0.85	8.28	15.81
CB-2-4	50-year	24	**1.82**	**1.85**	**1.91**
CB-3-1*	10-Year	14	0.12	0.12	0.12
CB-3-2	10-Year	24	1.40	1.40	1.40
CB-4-1	10-Year	24	0.55	1.04	1.68
CB-4-2	10-Year	24	0.86	1.13	1.49
CB-4-3	10-Year	36	0.37	0.62	0.78
CB-4-4	10-Year	24	1.11	1.55	2.14
CB-5-1	10-Year	36	0.48	0.55	0.64
CB-5-2	50-Year	32	**1.67**	**1.78**	**1.85**
CB-6-1	10-Year	18	0.37	0.36	0.36

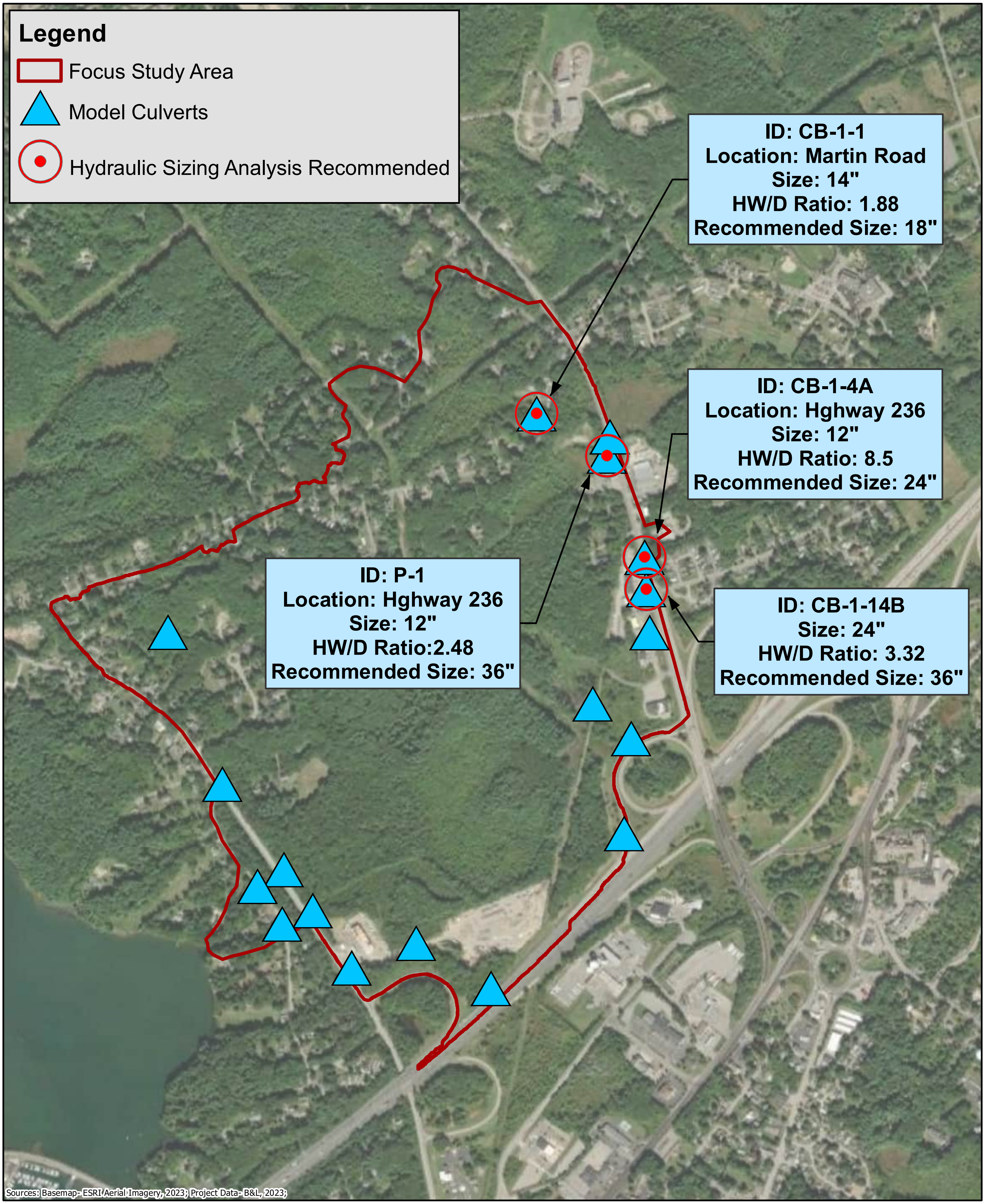
* Multiple culverts modeled at this node location. Largest diameter reported for hydraulic capacity. Locations in **BOLD** exceed a 1.5 HW/D ratio and additional hydraulic analysis may be warranted.

Table 5-2 below provides preliminary sizing considerations to reduce the HW/D ratio to less than 1.5. Note that a more detailed site specific analysis is required to determine final sizing requirements in accordance with state and local requirements. It should be noted that analysis of, and modifications to, culverts associated with I-95 would not be under the Town's jurisdiction and would default to the Maine Department of Transportation (DOT).

Table 5-2: Critical Infrastructure Culvert Analysis – Preliminary Sizing Considerations

Model Node ID	Existing Culvert Size (in dia.)	Recommended Culvert Size (in dia.)	Revised HW/D Ratio (Existing Conditions)
1-P	12	36	0.71
CB-1-1	14	18	1.29
CB-1-4A	12	24	1.17
CB-1-4B	24	36	1.11
CB-2-4	24	36	1.39
CB-5-2*	32	N/A	N/A

*CB-5-2 observed a HW/D ration in excess of 1.5; however, the HydroCAD model was simplified in this area to include one 32" culvert, although two additional 12" culverts exist in this vicinity to aid in effectively draining DA-5-2. Therefore, it is assumed that additional subdelineation would be warranted to assess the effectiveness of these culverts. Due to the location CB-5-2 in a topographic low spot with minimal flood risk and a lack of structural risks downstream of this location, a culvert sizing recommendation was not provided.



Barton & Loguidice

1 inch = 1,300 feet

Town of Kittery

Recommended Culvert Sizing Analysis Locations

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Figure 5-1

Project No. 2687.001

6.0 PRIORITY AREA FINDINGS

Throughout the course of the study, priority areas were identified through field reconnaissance, evaluation of modeling results, and receipt of public input. The following is a summary of findings associated with these priority areas.

6.1 Martin Road Residential Properties (East End Near Highway 236)

Comments received from the public during public outreach efforts for the project indicate a recent history of high groundwater and flooding concerns at properties located on the south side of Martin Road in close proximity to the intersection with Highway 236. These residents identify a trend of tree loss related to high water table with 2009 being the first instance of tree loss following the introduction of fill adjacent to the wetland complex at parcel #29-1 (41 Route 236), located immediately south of these properties.

Representative photo of fill area between Martin Road and Highway 236.

During desktop review of the areas surrounding these Martin Road residential properties, it was determined that soils in the area are characterized as HSG D, indicating poor drainage qualities. Additionally, soil mapping indicated less than one foot depth to groundwater in the vicinity of the wetlands in close proximity to the residences. Based on available mapping and the wetland delineation completed by FBE, a number of residences along Martin Road were determined to be constructed within, or within close proximity to, wetland areas, likely prior to the adoption of wetland setback development criteria. During a site visit conducted by B&L and Streamworks in November 2022, observations were made of a tree which was leaning, close to falling. Beneath the tree, the groundwater table was observed in the area in which the roots had previously anchored the tree to the slope, as shown in the photo below.

Observed falling tree with evidence of high water table.

B&L and Streamworks continued the field reconnaissance effort downstream to Parcel #29-1, which was surrounded by wetland areas ultimately discharging through a series of culverts conveying flow east under Highway 236.

Drainage channel conveying drainage from area north of Martin Road (DA-1-1) toward Highway 236 (CB-1-3).

The majority of drainage collected in this wetland complex, however, flows to the south of the fill location where it is conveyed beneath the properties elevated driveway via a 12” culvert, before ultimately discharging under Highway 236 to the east. (which for reference, has a 36” culvert). It is assumed that the introduction of fill to this parcel in 2009, and particularly the driveway constricting the broad, shallow wetland flow to the 12” culvert, may have raised wetland water levels and/or restricted outflows and increased detention of stormwater within the wetland areas. It is possible that these two effects, respectively, may permanently change the average groundwater table and increase the seasonal high ground water level due to increased infiltration of stored stormwater into the groundwater table.

6.2 Herb Parson Pond

Herb Parsons Pond is an approximately one-acre pond located adjacent to Southern Maine Fish and Game Club (SMFG) on Martin Road. The pond is located at a topographic high point and has a relatively small drainage area of two to three acres along Martin Road and directly abutting properties (**Figure 1-3**). No storm drains or culverts were observed flowing into the pond aside from one basement sump pump which likely has an insignificant impact on pond levels due to its moving groundwater from one location to another. No discernible outlet was identified in a site visit conducted by Streamworks on January 14, 2023 and hydrologic modeling described in previous sections yielded a conclusion that even extreme rainfalls would not cause the pond, in its current condition, to overtop its banks. The unique setting of Herb Parsons Pond, which first appears on US Geological Topographic Maps in 1941, is most likely due to its use as a former gravel pit as identified in US Department of Agriculture soil mapping and confirmed anecdotally by Town residents.

Through the Project's Interactive Map, community engagement meetings, and interviews with the property owners, numerous residents have noted a change in the function of Herb Parsons Pond over time. In its current condition, residents have noted that Herb Parsons Pond is relatively shallow, its water quality has degraded, and the pond has less abundant wildlife than it historically hosted. Most residents note that water levels in Herb Parsons Pond were historically higher and the pond provided habitat for numerous terrestrial and aquatic species, evidenced by the SMFG's use of the pond for fishing derbies. The timing of when the condition of Herb Parsons Pond changed differs but several residents and SMFG have pointed to a change between 2015 and 2019 and suspected that installation of a new sanitary sewer line along Martin Road may have contributed to the change.

Photo submitted via the Interactive Map showing the historical condition of Herb Parsons Pond, date not provided.

Photo submitted via the Interactive Map showing the current condition of Herb Parsons Pond

To investigate the condition of Herb Parsons Pond, Streamworks conducted site visits in January 2023 and July 2023. As part of the site visits, Streamworks identified defined bank scarps along the entirety of the pond which, along with woody vegetation atop the flat ground surrounding the pond and a stain line on an exposed boulder, are evidence of the historical high water mark of the pond (see photos below). Due to its small drainage area, lack of a defined outlet, and abundant sandy substrate, Streamworks assessed the pond is groundwater-fed. Such sands, which are also identified in the Surficial Geologic Map of the area, are relatively free-draining (hence their value for construction) as evidenced by their high infiltration rate in the USDA soil survey. Therefore, Streamworks assessed the water level of Herb Parsons under current conditions fluctuates with the groundwater level and the pond water level is essentially the local groundwater elevation. This also explains some of the seasonal and inter-annual variability of pond levels noted by residents: groundwater levels tend to be higher in the spring after snowmelt and spring rains and the pond would also appear higher in relatively “wet” years. Groundwater variations of three to five feet are typical for the underlying geologic formation. Of note is that the period from 2015 to 2020 noted as the period of time that water quality declined in Herb Parsons Pond also correlates to a period of decreased annual precipitation following several years of above-average precipitation (refer to **Figure 6-1** below).

Herb Parsons Pond in January 2023; note scarps and bare surface along pond banks which indicate a current and/or historic high water mark.

Boulder in Herb Parsons pond; stain line is likely indicative of historic pond level and correlates closely to the top of bank scarping.

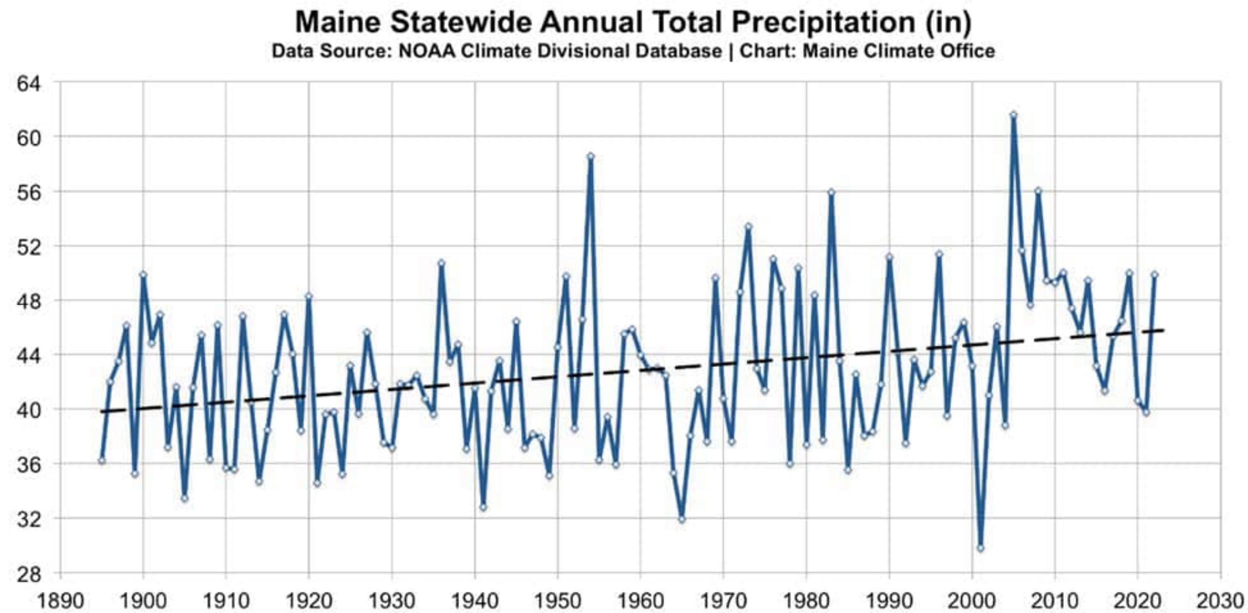


Figure 6-1: Maine Statewide Annual Total Precipitation (inches; source: Maine Climate Office) {note that the average annual rainfall has increased approximately six inches since 1895 which would generally increase groundwater levels.}

To respond to resident concerns and support the development of alternatives at Herb Parsons Pond, Streamworks reviewed the Kleinfelder (2016) record drawings for the Martin Road sanitary sewer extension to assess the potential for the sanitary sewer line to influence water levels of Herb Parsons Pond. On the Kleinfelder (2016) Record Drawings, Herb Parsons Pond may be found on sheets C-21 and C-22 at stations 626+00 to 631+00 (**Appendix I**). Although there were borings performed here and elsewhere along the sanitary sewer line, boring information is not provided except to indicate if bedrock (refusal) was reached. There were two borings across from Herb Parsons pond (RP-112 and B-110): RP-112 was terminated at a depth below grade of 15 feet and B-110 hit refusal (assumed bedrock) at 16.5 feet below grade. Another boring near to the Pond (B-105) hit refusal at 15.5 feet. None of the borings gave groundwater information on the plans.

As is evident from these drawings, across from Herb Parsons Pond the sanitary sewer was constructed 10 to 11 feet below grade, with the pipe bedding (crushed stone) at least 0.5 feet deeper. Given that the Herb Parsons Pond water surface reflects groundwater elevation (approximately four feet below road grade), and that this groundwater elevation is higher than the sanitary sewer along Martin Road (10+ feet below grade), Streamworks concluded that the sanitary sewer along Martin Road most likely intercepts groundwater near Herb Parsons Pond during portions of the year.

Although the sanitary sewer pipe may intercept groundwater, its effect on groundwater is dependent on its ability to convey flow. In Streamworks opinion, the most likely feature to convey groundwater is the sewer bedding which, per the sewer trench cross section detail on sheet C-27 of the Kleinfelder (2016) Record Drawings, includes at least six inches of crushed stone backfill around the 8-inch diameter PVC sewer pipe. The plans do not indicate that anti-seep collars were used in the construction of the sewer which would restrict the conveyance of flow/intercepted groundwater along the bedding. The combination of this relatively free-draining backfill (similar in function to a French drain) and the gradient of the sewer pipe, which decreases in elevation from Herb Parsons Road east to Highway 236, is conducive to conveying groundwater in that direction particularly if the bedding extends to locations above the local groundwater table (thus establishing a hydraulic gradient from high groundwater levels near Herb Parsons Pond to lower groundwater levels somewhere east.) Therefore, it is possible, but inconclusive, that the construction of the sanitary sewer along Martin Road intercepted local groundwater proximal to Herb Parsons Pond and therefore lowered the water level in Herb Parsons Pond.

6.3 Central Study Area (Potential Future Development Areas)

The '98 Dennett' parcel (parcel #12-3-1), which is currently underdeveloped as compared to what is allowable by current zoning, consists predominantly of forest cover with intermixed wetland areas. A wetland complex is located along the eastern extent of the parcel where it interfaces with a utility right-of-way, separating the '98 Dennett' parcel with properties located along Highway 236 (parcel #21-18 and #21-18A). Drainage conditions are highly variable across the approximately 82-acre parcel, including a range of slopes and soil conditions, including some of the HSG A soils in the focus area.

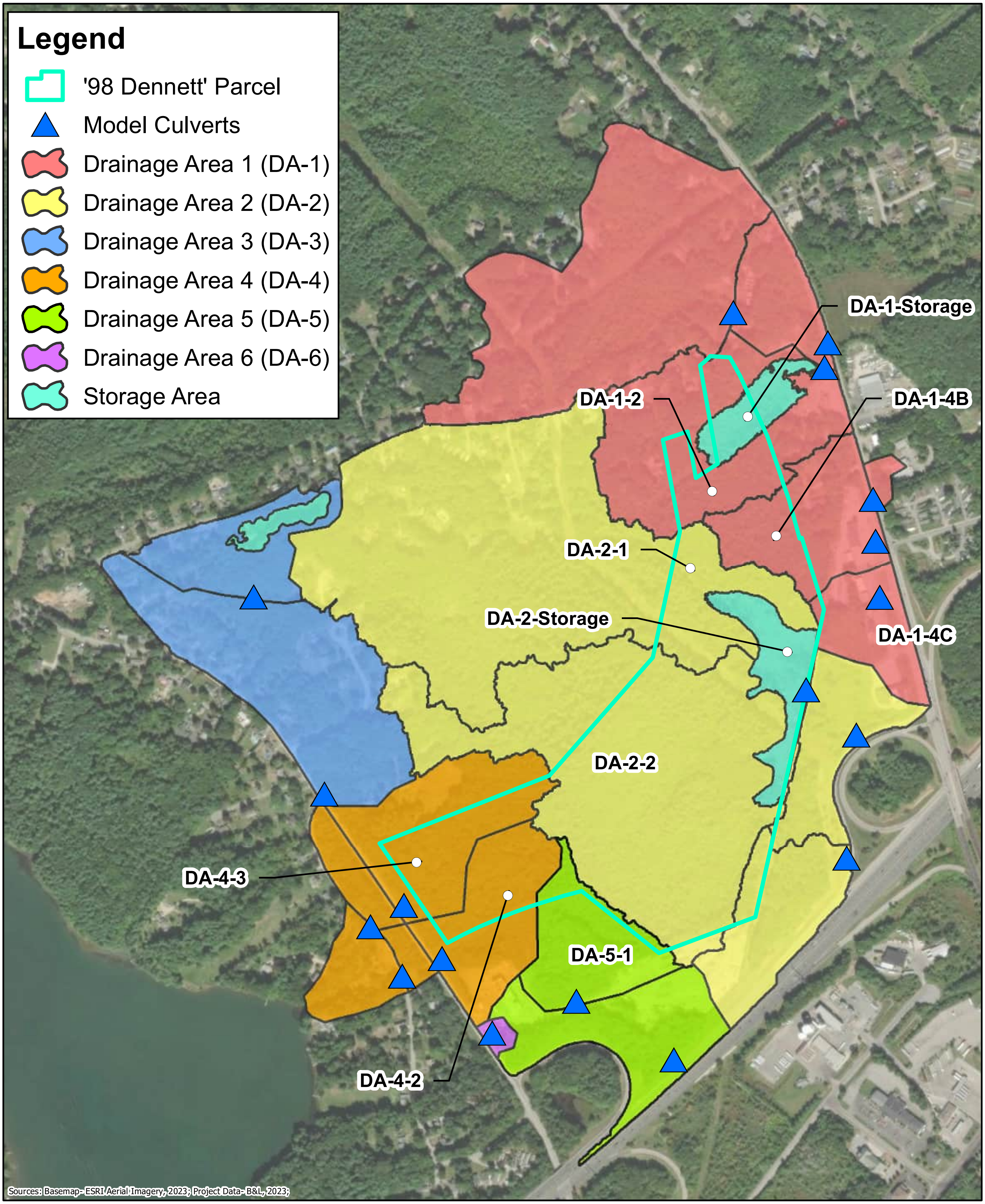
Wetland storage area located at eastern extent of '98 Dennett' parcel.

In addition to variable drainage characteristics, the ’98 Dennet’ Parcel includes portions of multiple subwatershed areas, including portions of DA-1 (Spruce Creek), DA-2 (Chickering Creek), DA-4 (Spinney Creek) and DA-5 (Spinney Creek) watersheds. The majority of the ’98 Dennett’ parcel is located within the DA-2-2 subwatershed, which drains in combination with DA-2-1 to wetland storage located at the eastern extent of the parcel (**Figure 6-2**). Drainage collected within this wetland feature ultimately discharges east beneath the utility right-of-way access drive to another downstream wetland complex, which ultimately drains south beneath the I-95 exit ramp to Highway 236. Although most of the drainage at the ‘98 Dennett’ parcel is routed through DA-2 to this wetland storage area, it should be noted that this parcel also accounts for significant portions of DA-4-2 and DA-4-1, noting that DA-4-2 is a headwater to Culvert CB-4-4 identified in Section 5 as one of the existing culverts sensitive to buildout.

Hydrologic analysis revealed that the storage accounted for in the wetland area at the eastern extent of the parcel (designated as node P-2 in the project’s HydroCAD models) provide significant storage and attenuation of routine and extreme storm events under existing conditions. No overtopping of the utility right-of way (i.e., spillway) at the P-2 outlet culvert location was observed for the 1-year and 10-year storms under existing conditions; however, the model indicates the potential for overtopping of this right-of-way for the 100-year, 24-hour storm event. A summary of discharge characteristics under existing conditions is provided in **Table 6-1** below.

Table 6-1: ’98 Dennett’ Storage Inflow and Outflow Peak Discharge Rates

Storm Recurrence Interval	Inflow Peak Discharge Rate (CFS)	Cumulative Peak Discharge Rate (CFS)
1-Year	23.83	1.29
10-Year	77.84	7.82
25-Year	104.56	13.49
50-Year	124.81	32.17
100-Year	147.93	64.37



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1 inch = 1,000 feet

Town of Kittery

'98 Dennett' Parcel Drainage Map

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Figure 6-2

Project No. 2687.001

6.4 Happy Avenue Access Road

Happy Avenue is located off of the Dennett Road Extension and includes a short public portion that is paved near its eastern end at the Dennett Road Extension and a longer, private gravel portion towards its western end where it is separated by a gate from Roseberry Lane. The gravel portion of Happy Avenue ("Happy Avenue extension") was constructed in the late 1990s and crosses a broad wetland that drains the area south of Herb Parsons Pond south towards drainage infrastructure along Dennett Road that is eventually conveyed towards Spinney Creek.

Groundwater levels in this area are generally high, evidenced by above-grade septic systems in this part of the study area. A public comment supports this assessment: one resident identified that when a percolation test was run along the Happy Avenue private way in the 1980s, "the water table was so high it would not [percolate]." Wetlands north of the Happy Avenue extension are also indicative of an elevated groundwater table.

Specific resident concerns reported in this area through outreach meetings and the Interactive Map include basement flooding of the residences along the eastern end of Happy Avenue. A timeline that was submitted documents a history of basement flooding at one Happy Avenue residence that culminated with the removal of an approximately 20-year old finished space in the basement in the 2000s. Of note, this timing coincides with a lower-than-average rainfall from approximately the mid-1980s to mid-2000s, as shown on **Figure 6-1**. From approximately 2005 to 2015, annual rainfall was above average which would be expected to elevate groundwater tables in comparison to the preceding below-average period. Although not definitive, the reported change in basement flooding could be due to natural variability in precipitation.

Residents also expressed concerns that basement flooding in this area was correlated to the construction of the Happy Avenue extension, specifically: "basement flooding occurred 22 years ago when Happy Avenue was extended…[and] increased approximately 5 years [ago] when more fill was brought in to develop what is now called Condominium Way." Based on lidar mapping from 2006 and 2020 (**Figure 1-3**), contours clearly flow south from Herb Parsons Pond towards Dennett Road such that the original construction and reported 2018 reconstruction of the Happy Avenue extension did not change the direction of flow of the wetland area due north of the Happy Avenue extension. Further, one-meter resolution lidar mapping from 2020 shows a topographic high point of at least Elevation 88 at the start of the Happy Avenue extension (paved to gravel transition) whereas the wetland areas are approximately Elevation 86 and the crest of the Happy Avenue extension is Elevation 87. In other words, water in the wetland north of the Happy Avenue extension would have to flow uphill a vertical distance of two feet to contribute to surface water flooding along Happy Avenue.

Although the Happy Avenue extension does not contribute additional surface flow towards the public portion of Happy Avenue, standing water observed in the wetland north of the extension may indicate it contributes to increased groundwater levels. A differential survey of the culverts installed along the Happy Avenue extension demonstrated the inlet of the culverts (on the northern side) sit several inches above the low point of the wetland. Thus, several inches of standing water would have to pond before it can flow out the culverts. Until such point, all standing water would eventually infiltrate into the groundwater table that may have previously runoff.

This potential increase in infiltration to groundwater was assessed in the hydrologic model by adding an “infiltration” component to the storage node that was used to represent the wetland north of the Happy Avenue extension. Hydrologic modeling indicated that appreciable runoff from the watershed would not occur until at least half an inch of rain fell and that it would take at least an additional half-inch (one inch total) of rain for water to pond to an elevation that the culverts beneath the Happy Avenue extension would convey water. Therefore, in comparison to undisturbed conditions, the culverts would appear to cause the total infiltration of storms between one-half inch and one inch that would be expected to have partly runoff prior to the construction of Happy Avenue.

Based on daily rainfall records at Portsmouth, NH, daily precipitation totals of between one-half and one inch contribute, over a typical year, 30 percent of the annual precipitation. However, the hydrologic model yielded that 95% of the precipitation falling during such storms would infiltrate anyways in an undisturbed condition. Therefore, the additional ponding caused by the offset of the Happy Avenue extension culverts may cause a modest few percent more of the total annual rainfall to infiltrate to the groundwater instead of runoff as surface flow, likely having a de minimis impact. Of further note is that the one-inch storm is the state’s standard for the design of stormwater infiltration practices and the Department of Environmental Protection has ruled that the infiltration of such runoff to groundwater is a de minimis impact, providing further evidence that the potential increase in stormwater infiltration at the Happy Avenue extension is unlikely to adversely impact properties on Happy Avenue.

Based on the review of available data and hydrologic modeling, the consultant team identified that the natural seasonal and inter-annual variability of groundwater levels are the most likely cause of basement flooding along Happy Avenue. The most effective mitigation solutions will include property protection measures, such as foundation drains and sump pumps, that would locally lower groundwater levels in proximity to residences and are further described in **Section 9.0**.

Resetting the culverts beneath the Happy Avenue extension to the low point of the upstream wetland area or constructing a permeable road base (“rock sandwich”) beneath the extension would help to reduce upstream ponding and restore natural runoff processes. However, such efforts are not expected to yield measurable benefits to affected Happy Avenue residences. More extensive groundwater control measures on the neighborhood scale (gravity-drained underdrains, etc.) are likely infeasible in terms of both cost and impact: groundwater levels are sufficiently high and well-connected that extensive infrastructure would be required. In addition, the degree to which groundwater would need to be lowered to prevent basement flooding could cause ground settling in the affected area. Further, due to the permeable nature of the underlying substrate, groundwater changes are likely to extend beyond the immediate area of Happy Avenue and could adversely impact regulated wetlands in the vicinity of the Happy Avenue extension.

6.5 Residential Properties Along Dennett Road and Old Dennett Road

Feedback received during public outreach efforts revealed a recent history of localized flooding and drainage concerns along Dennett Road and Old Dennet Road. Multiple attendees and/or respondents indicated that development activities in DA-3, outside of those already outlined in **Section 6.4**, have resulted in the need for enhanced home flood-proofing measures.

A review of USDA soil mapping indicated HSGs as being variable along Dennett Road, with well-drained HSG A being the predominant HSG amongst properties in the northern and central portions of the street. Due to their high infiltration, unmitigated development of HSG A soils tends to generate more runoff and associated adverse impacts than development on other HSGs. Areas located in the more southern extents of Dennett Road within the focus study area are characterized by poorly drained HSG soils, as well as by moderate-to-steep slopes. Elevation contours indicate that runoff originating in DA-3-2 subwatershed is ultimately routed toward the west side of Roseberry Lane (eastern end of Happy Avenue), which is mapped by the United States Fish and Wildlife Service as wetland. This feature was confirmed during FBE's field reconnaissance, as well as a smaller wetland feature located immediately northwest of this same residential property. This wetland area is located close proximity to the culvert serving as this subwatershed's design point (CB-3-2), and is consistent with the general location of multiple drainage deficiencies identified by the public. It is anticipated that these drainage concerns are primarily a result of development located at the topographical low point of DA-3-2, and further aggravated by poor drainage conditions and localized high water table associated with this wetland area.

HydroCAD modeling results suggest that drainage infrastructure along Dennett Road within DA-3 and DA-4, which convey flows from upgradient portions of the focus study area to the east of Dennet Road, are adequately sized and do not post a substantial risk of localized flooding. Wetland areas were encountered in both DA-4-3 and DA-4-4 during FBE's field reconnaissance effort. The wetland area identified in DA-3 is positioned immediately east of Dennett Road within the 98 Dennett Road parcel, in close proximity to the culvert serving as the DA-4-3 design point (CB-4-1); however, the nearest residential property to this location is located approximately 225 feet northwest of the wetland feature at 100 Dennett Road, which is positioned at a higher elevation than the wetland feature and surrounding areas.

In addition to localized flooding occurrences along Dennett Road, information received from the public identified a recent history of drainage concerns along the north side of Old Dennett Road. Similar to Dennett Road, soil mapping indicates that the majority of lands surrounding Old

Dennett Road consist of well drained soils. Stormwater originating in DA-4-1 and DA-4-2 discharges to the downslope side of Dennett Road, where drainage flows down a short but generally steep slope where drains to two culverts along Old Dennett Road, ultimately discharging to open drainage channels leading to Spinney Creek.

HydroCAD modeling indicates that drainage infrastructure conveying stormwater beneath Old Dennett Road is adequately sized to protect adjacent properties from localized flooding associated with roadway overtopping, or in the case of the Old Dennett Road cemetery, backwater conditions. However, although infrastructure sizing does not appear to play a role in recurring localized flooding instances along Old Dennett Road, it is anticipated that this location is naturally conducive to ponding based on available soil mapping. Soil mapping indicates the presence of a high groundwater table along Old Dennett road within the focus study area, as well as upgradient of Old Dennett Road to the northeast of Dennett Road. In some instances, soil mapping suggests groundwater may be encountered as little as one-foot beneath the ground surface. Additionally, HSG A soils in this area promote infiltration and groundwater recharge.

Similar to findings discussed in **Section 6.2** and **Section 6.4**, it is anticipated that natural seasonal and inter-annual variability of groundwater levels are the most likely cause of drainage concerns along Dennett and Old Dennett Road.

6.6 Current Dennett Road Development Near I-95 Entrance Ramp

Recently, a portion of forested area located primarily within DA-5 and DA-5, as well as DA-6-1, has been built-out and converted into a developed apartment complex. Slopes within DA-5 are generally modest, and soils are classified as either HSG D, or dual HSG A/D indicating a high runoff potential when soils are saturated. Both DA-5-1 and DA-5-2 ultimately route runoff toward the southeast to multiple culverts draining DA-5 runoff beneath I-95. CB-5-2 observed a HW/D ratio slightly in excess of 1.5; however, the HydroCAD model was simplified in this area to include one 32” culvert, although two additional 12” culverts exist in this vicinity to aid in effectively draining DA-5-2. Therefore, it is assumed that additional subdelineation would be warranted to assess the effectiveness of these culverts. Due to the location CB-5-2 in a topographic low spot with minimal flood risk and a lack of structural risks downstream of this location, a culvert sizing recommendation was not provided. The access drive developed for this property serves as the drainage divide between DA-5-1 and DA-5-2, and preliminary modeling suggests that the culvert structure at this location is adequately sized. Unless localized flooding is observed regularly near the I-95 culvert locations, it is not recommended that any additional analysis is completed at this location at this time.

7.0 ALTERNATIVES ANALYSIS

A primary goal of the project was to determine what alternatives would address the stormwater challenges identified in the study and have support from both the Town and the general public, particularly due to private ownership of the majority of lands within the study area. A conceptual overview of the alternative selection process is described in detail below.

7.1 Alternative Matrix and Overview

A retrofit opportunity matrix was developed to evaluate potential stormwater mitigation alternatives based on information obtained from prior studies and field data collection activities. In addition to alternatives identified by the project team to resolve challenges identified in this study, the identified alternatives also include those suggested by the public and Town staff. Alternatives considered include the following types:

- Modifications to Existing Drainage System – this practice focuses on right-sizing, repairing, or otherwise improving under-performing stormwater infrastructure, such as culverts or closed drainage systems (including inlets to such systems). These drainage system deficiencies are primarily identified through known failures or review of hydrologic and hydraulic modeling results. Examples include culvert replacements, drainage system modifications, inlet/outlet modifications, and daylighting of closed drainage systems (conversion to open channels).
- Installation of Stormwater Retrofits – this practice focuses on providing localized storage to a drainage area to allow either detention and sedimentation or retention and infiltration, reducing downstream peak flows, runoff volume, total nutrients, and sediment loads. Examples include upstream stormwater/wetland retention facilities, modifications to existing storage areas, and stream restorations that provide connectivity to flood storage areas.
- Flood Protection and Planning – this practice focuses on localized improvements to structures located within areas with high frequencies of localized flooding or groundwater-related inundation. This practice may be completed at the individual homeowner level, or on a larger scale for protection of infrastructure. Examples range from installation of homeowner sump pumps, reduction of impervious areas, installing/maintaining homeowner drainage (gutters and downspouts), improving residential lot grading, backflow prevention, elevating utilities, installation of flood vents, and use of flood resistant materials.
- Groundwater Interception Trenches – This practice focuses on interception and redirection of groundwater flows to avoid inundation of infrastructure located in areas characterized by high seasonal groundwater tables.
- Seepage/Cutoff Collars - This practice is intended to reduce interception and conveyance of groundwater by linear utility pipeline trenches. These features typically

intersect the bedding layer and interrupt the conveyance of flow along the bedding layer to a point that the permeability matches that of the adjacent natural substrate.

- Evaluation of Land Use Planning and Zoning – This practice includes evaluation of existing policies and zoning areas to protect areas vulnerable to stormwater or groundwater related damages under existing conditions, as well as to avoid future development in areas viewed as vulnerable to the hydrologic effects of build-out where tangible mitigation practices are less feasible. Examples include incorporation of "Low Impact Development" considerations.
- Water Quality Treatment Practices and Green Infrastructure Opportunities – this practice focuses on capture and treatment of stormwater at, or near, its source, including stormwater management while providing recreational and wildlife benefits. Generally, peak flows are reduced while providing nutrient treatment. Alternatives will also evaluate opportunities to replace existing or proposed impervious areas with permeable options that capture and infiltrate stormwater runoff. These techniques require careful evaluation of subsurface conditions (soils, depth to groundwater and bedrock) to ensure infiltration is feasible and will not contribute to localized groundwater impacts (i.e. increased basement flooding). Examples include:
    - Permeable pavements
    - Bioswales/vegetative swales
    - Rain gardens
    - Silva Cells®
    - Stormwater Tree Trenches
    - Infiltration basins
    - Rainwater harvesting
    - Rain barrels
    - Native plantings
    - Rooftop disconnects
- Conservation Opportunities – this practice focuses on identification of areas best suited for conservation to assist with the off-set of future Build-Out conditions. Examples include preserving well-drained soils conducsive to infiltration (HSG A), minimizing disturbance on steep slopes and maintaining stream/wetland buffers. Provisions of conservation areas can provide for a path for future development that minimize hydrologic impacts and reduce the reliance on new stormwater infrastructure.
- Wetland creation/expansion – this practice focuses on utilizing existing or suitable areas to create suitable vegetated areas typically influenced by groundwater that provide extended detention storage to treat significant water quality and reduce peak flows.

- Riparian buffer restoration – this practice focuses on restoring the naturally vegetated areas that serve as the transition zone between terrestrial (land) and aquatic (water) habitats. If sufficiently structured, protected, and maintained, riparian buffers serve to mitigate the volume and intensity of stormwater runoff entering the adjacent waterbody, and can act to mitigate the discharge of pollutants to the waterway often associated with stormwater runoff.

The projects were ranked based on criteria associated with stormwater benefits (quantity and quality), constructability, cost and co-benefits. The rankings were based on the following criteria with total available points for each criterion in parentheses. **Appendix J** includes the detailed ranking matrix).

- Stormwater Benefits (total 50 out of 100 points)
  - Water Quantity Flood Reduction (40 points)
  - TSS reduction (5 points)
  - Nutrient: phosphorus and sediment reduction (5 points)

- Constructability (total 20 out of 100 points)
  - Land Acquisition/Public Ownership Potential (10 points)
  - Known constraints (5 points)
  - Permitting (5 points)
- Cost (total 20 out of 100 points)
  - Construction Cost – not included due to natural differences in project scales
  - Maintenance Cost (5 points)
  - Fundability (15 points)
- Co-Benefits (total 10 out of 100 points)
  - Energy and air quality impacts (2 points)
  - Habitat and biodiversity (2 points)
  - Community and aesthetic benefits (2 points)
  - Human health benefits (2 points)
  - Educational Opportunities/Visibility (2 points)

7.2 Selection of Prioritized Alternatives

Based on the matrix rankings, the project advisory team selected six projects to progress to a more detailed analysis. The goal for selection of the six projects is to include a diverse collection of projects. The projects selected for more detailed analysis were not necessarily ranked based on the six highest overall scores, rather were prioritized on potential implementation. The ranking matrix can be used as a template that can be repeated by the Town to progress additional projects as future funding becomes available, or barriers to implementation are addressed.

The projects selected for further evaluation included options to address current conditions and potential Build-Out scenarios as follows:

Projects to Address Existing Flood & Water Quality Concerns:

1. Right-Sizing Critical Infrastructure (Culvert and Drainage System Modifications)
2. Martin Road Sewer Line Study
3. Martin Road/Highway 236 Storage Modifications

Projects to Address Potential Build-Out Drainage Concerns:

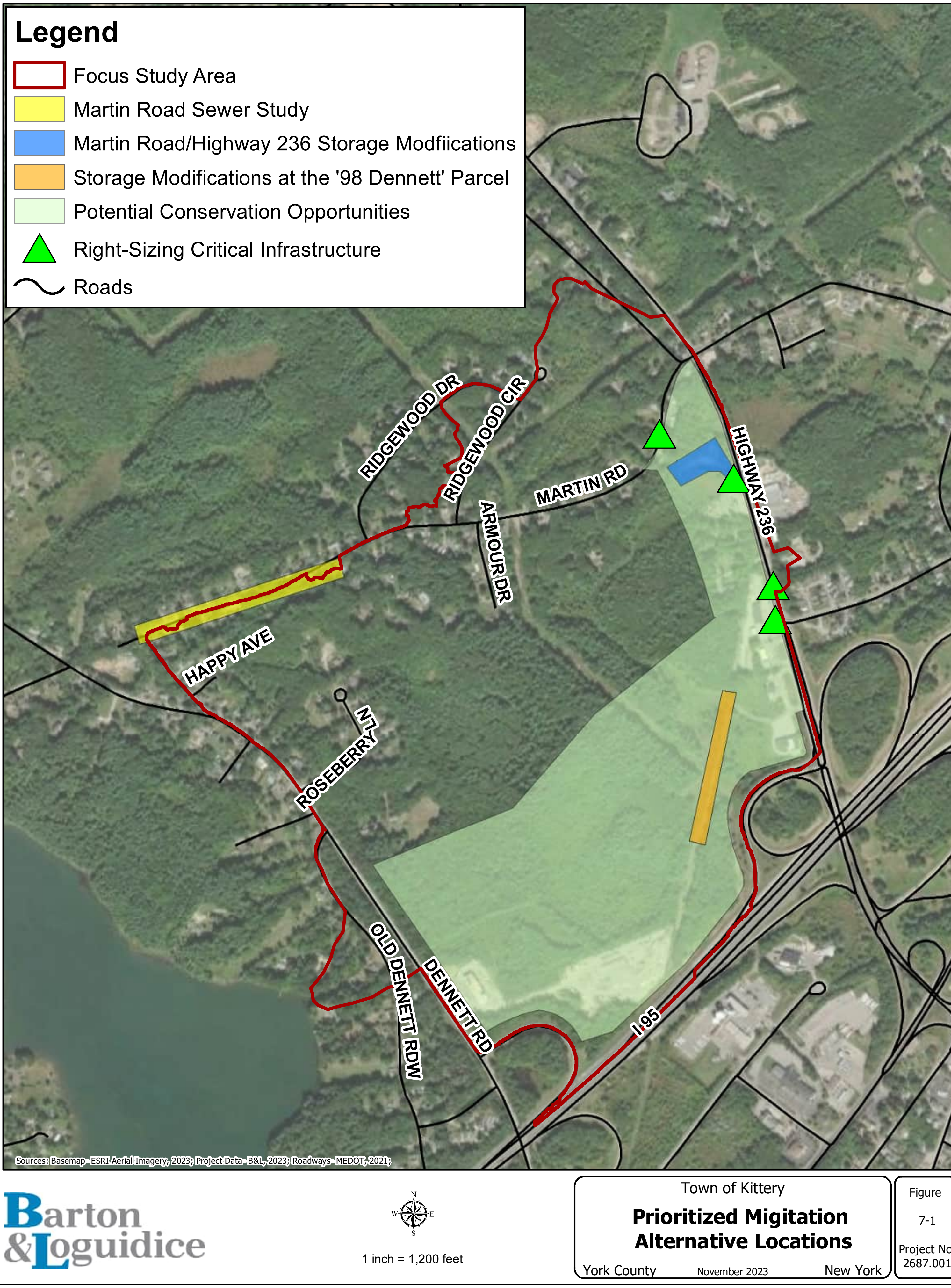
4. Identification of Potential Conservation Areas
5. Storage Modifications at the '98' Dennett Parcel
6. Providing Low Impact Development Considerations for Future Build-Out Scenarios

The locations of mitigation alternatives selected to progress to more detailed analysis are provided on **Figure 7-1.**

7.3 Evaluation of Alternatives

The six projects that progressed to supplemental analysis were incorporated into the hydrologic/hydraulic models to identify a quantifiable benefit of each alternative (as applicable). For the six prioritized alternatives, supplemental information will be provided including:

- Hydrologic/Hydraulic modeling analysis
- Financial Considerataions
- Permitting Considerations
- Funding Opportunities



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Town of Kittery

Prioritized Migitation Alternative Locations

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Figure 7-1

Project No. 2687.001

7.3.1 Right-Sizing Critical Infrastructure

Drainage infrastructure deficiencies were identified during the preliminary data gathering portions of the project through reports of localized flooding. These infrastructure areas of concern were screened first through correspondence with Town of Kittery staff and through public outreach efforts. Following initial identification, members of the B&L and Streamworks teams completed a field reconnaissance effort to collect more data corresponding to these infrastructure components, including location, size, material, elevation, and condition. These infrastructure components were included in HydroCAD hydrologic and hydraulic modeling to evaluate performance over a range of storm events and model scenarios. The drainage system within the focus study area is comprised primarily of natural drainage (streams, wetlands, natural flow paths) and constructed open drainage systems consisting of open ditch and swale systems connected by culverts. Therefore, due to a lack of closed drainage networks within identified areas of concern, infrastructure evaluation was limited primarily to performance analysis of culverts which serve as connections between subwatershed areas. Culverts with insufficient capacity may be a result of poorly located or inadequately sized infrastructure, as well as from modifications to land use or land cover upstream of culvert connections which may have negatively impacted the ability to adequately convey stormwater. For this study, HW/D ratios were used as a surrogate to assess flood risks to roadways, infrastructure, and adjacent private property although future efforts should account for more site specific-criteria including depth to shoulder, depth to road subbase, and lower HW/Ds where adverse impacts to private property may occur at standard criteria.

As discussed in **Section 5.0**, the following culverts were identified as being potentially undersized:

- 1-P
- CB-1-1
- CB-1-4A
- CB-1-4B
- CB-2-4

Adequate sizing of culverts is critical to achieving optimal drainage performance, including provision of safe, non-erosive conveyance of surface water and stormwater flows beneath driveways and roads for both routine and extreme storm events. However, it is important to note that in some situations, such as those culverts that temporarily impound significant volumes of water, oversizing culverts can lead to negative downstream impacts including erosive flows and localized flooding. For that reason, it is critical to perform a detailed hydraulic analysis of potentially undersized culverts in advance of design progression. In general, this analysis should include hydrologic and hydraulic modeling of the contributing drainage area and downstream drainage network which goes beyond the scope of this report.

7.3.2 Martin Road Sewer Line Study

Key concerns at Herb Parsons Pond discussed in detail in **Section 6.2** include pond levels lower than historically occurred and degraded water quality. The ideal solution to respond to public concerns would include raising the pond levels of Herb Parsons Pond to the top of the historic banks. Water quality would generally be expected to improve due to the deeper water depths and increased groundwater recharge. However, the processes controlling the water level of Herb Parsons Pond are complex due to its small drainage area, dependency of pond levels on groundwater which fluctuate seasonally and interannually with rainfall, the location of the pond at a topographic high point such that increasing pond levels could raise groundwater levels elsewhere downslope of Herb Parsons Pond (e.g., Happy Avenue), and the potential that the Martin Road sewer extension may be acting as a French drain that lowers groundwater levels in the vicinity of Herb Parsons Pond. Additionally, these processes are beyond the capabilities of the developed stormwater model to assess. Therefore, a phased approach is recommended to improve the condition of Herb Parsons Pond.

As a first step, inflow and infiltration (I/I) testing is recommended to be performed along the Martin Road sewer extension. The I/I test would be comprised of measuring the flow in the sewer pipe over a period of time to quantify the fluctuation in flow rates. Typically, sanitary sewer flow rates are lowest in the early morning so a relatively high flow rate at this hour, relative to the rest of the day, would suggest potential groundwater infiltration into the sewer pipe. If this is the case, it could be reasonably inferred that the pipe bedding is also conveying groundwater. This testing could be paired with groundwater level monitoring via mini-piezometers or small-diameter driven wells to inform the groundwater gradient in the area and where groundwater levels are higher than the pipe bedding (creating a pressure gradient promoting inflow into the pipe) and where groundwater levels are lower than the pipe and its bedding (creating a pressure gradient promoting outflow from the pipe.)

Should the I/I testing suggest that the Martin Road sanitary sewer bedding may be conveying groundwater flow from Herb Parsons Pond and contributing to lowering the groundwater table in that location, a groundwater study comprised of mini-piezometers/small-diameter wells along Martin Road, Herb Parsons Pond, and downgradient areas (e.g., Happy Avenue) is recommended to monitor groundwater levels overtime. These observations can be used to inform a groundwater model to quantify the degree to which the Martin Road sewer extension may be affecting water levels in the vicinity of Herb Parsons Pond. The groundwater model could also be used to predict the impact to groundwater levels in Herb Parsons Pond and downgradient areas if the groundwater conveyance along the Martin Road sewer line were reduced.

Should the groundwater model indicate that reducing the groundwater conveyance along the Martin Road sanitary sewer extension would benefit water levels of Herb Parsons Pond without adversely impacting other down-gradient properties, potential mitigation measures could include seepage cutoffs/collars along the Martin Road sewer extension. These seepage collars could include poured concrete, plastic “fins”, or compacted clay constructed in a trench that intersects the sanitary sewer line and its bedding. The seepage cutoffs would be intended to intersect the bedding layer and interrupt the conveyance of flow along the bedding layer to a point that the permeability matches that of the adjacent natural substrate. However, it should be recognized that if groundwater flow along the bedding layer is reduced, the expected result would be a rise in the groundwater table which could then lead to increased sewer infiltration at pipe joints. Therefore, before the installation of any seep collars, an I/I study should be performed as a baseline, and then repeated during high annual groundwater levels after anti-seep collars are installed. If sewer interception does increase after the implementation of anti-seep collars, then the sewer joints will require lining/sealing.

Beyond efforts to restore water levels in Herb Parsons Pond, limiting the usage of fertilizer in the area draining to Herb Parsons Pond would reduce the nutrients conveyed to the pond which can contribute to algal blooms and degraded water quality.

7.3.3 Stormwater Storage Modifications Upstream of Martin Road

Residents located on the south side of Martin Road’s eastern extent, near its intersection with Highway 236, have reported drainage concerns at their properties since approximately 2009, as indicated in **Section 6.3**. Following a review of the environmental setting, subsequent field reconnaissance effort to the wetland areas adjacent to these properties, and hydrologic modeling of this region of the study area, it was suspected that fill located to the south of these Martin Road properties may be leading to restriction of drainage flowing east toward Spruce Creek.

To assess the impact of the elevated driveway at parcel #29-1 on drainage efficiency, a model scenario was run to evaluate the impacts of this fill on water surface elevation in relation to the existing conditions model. The alternative was modeled by deleting the “driveway node” used to model the hydraulic effect of the driveway and consolidating the storage area from the “driveway node” into the “Highway 236 node,” thereby representing the hydraulic function of the existing wetland in the absence of the driveway culvert. **Table 7-1** shows a summary of HydroCAD peak storage height output for existing conditions and the alternative scenario for 1-, 10-, and 100-year regional storm events.

Table 7-1: Martin Road Storage Modification HydroCAD Summary						
Storm Recurrence Interval	**Peak Storage Elevation (feet amsl)**		**Total Runoff Stored (acre-feet)**		**Peak Discharge Rate (CFS)**	
	Existing Conditions	**Storage Modification**	**Existing Conditions**	**Storage Modification**	**Existing Conditions**	**Storage Modification**
1-Year	39.74	39.24	0.51	0.02	11.48	21.59
10-Year	40.39	39.90	2.91	1.01	23.20	32.82
25-Year	40.69	40.09	4.49	1.71	27.34	36.06
50-Year	40.93	40.23	5.79	2.30	30.68	38.25
100-Year	41.19	40.38	7.34	3.00	34.34	40.52

The modeling results summarized in **Table 7-1** indicate that increasing the hydraulic capacity of this portion of the study area will increase the conveyance of runoff DA-1-1 and DA-1-2 and reduce the water surface level and volume of stormwater temporary stored in the wetland throughout the duration of the storm event. The more rapid conveyance of runoff through the area would in turn result in less infiltration of stormwater flow to groundwater as would occur with longer residence times. Although the model provides evidence of increased peak discharge rates at the DA-3 outlet (CB-1-3), this water discharges directly to a large wetland complex generally consisting of standing water and wetland vegetation; therefore, downstream flood impacts are not anticipated to result from this mitigation alternative.

In general, it is anticipated that removal of the elevated driveway restriction may result in more effective draining of the areas immediately south of the Martin Road properties experiencing tree loss as a result of high groundwater levels. It should be noted that although this alternative identifies changes in storage and discharge characteristics associated with removal of fill associated with developed portions of the property (i.e., elevated driveway) and associated culvert, similar benefits could be achieved to a lesser degree through upsizing of the driveway culvert to allow for a more effective conveyance of water out of this storage area.

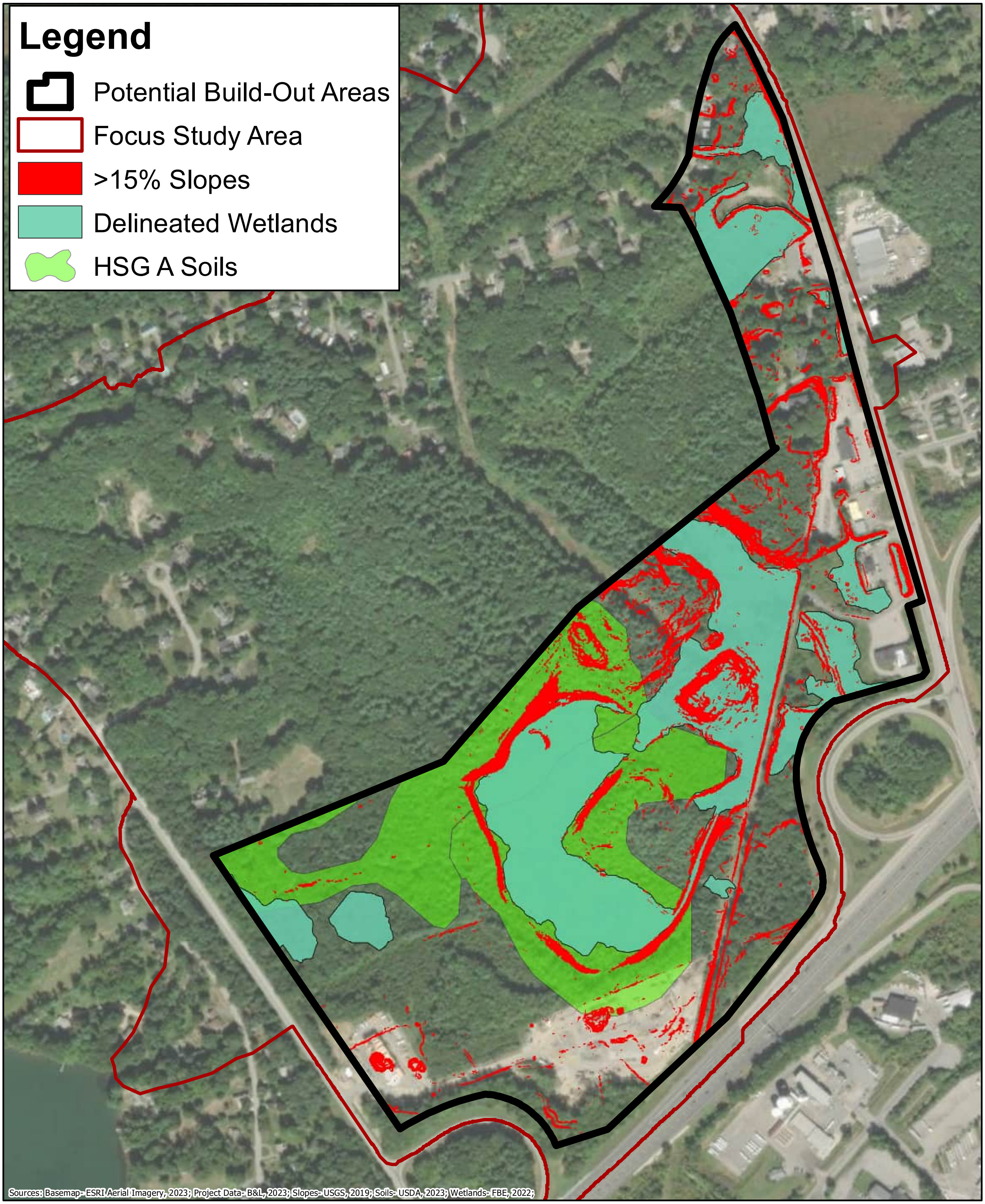
7.3.4 Identification of Potential Conservation Areas

Preemptive identification of potential conservation opportunities can serve as a critical component in the planning stages of future development. Conserving areas that maximize stormwater attenuation and flood reduction benefits will reduce the reliance on future stormwater management infrastructure and maintenance.

Proximity to receiving waters and position within the watershed should be considered based on the ability to provide attenuation and filtration prior to discharging to these resources. Areas that are directly adjacent to receiving waters are considered more favorable as potential conservation areas. In addition to maintaining natural resource buffers, potential conservation opportunities should focus on minimizing development of HSG A soils and steep slopes.

To maximize flood reduction benefits, areas that could serve as attenuation or infiltration areas were identified based on the factors discussed above through GIS analysis. It is anticipated that Maine DEP permitting regulations would restrict development in wetland areas (without approved mitigation); therefore, it is anticipated that conservation of wetland areas will be achieved through regulatory mechanisms. Prospective conservation opportunity areas identified through evaluation of these criteria are shown on **Figure 7-2** below**.**

To effectively ensure long-term benefits, permanent conservation easements would be required. Given the lack of municipal-owned parcels, private/public partnerships would be required to pursue conservation opportunities within the focus study area. In addition to flood attenuation benefits, provisions of conservation opportunities provides numerous co-benefits including air/water quality, habitat diversity and recreational opportunities.



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1 inch = 750 feet

Town of Kittery

Potential Conservation Opportunity Areas

York County November 2023 New York

Figure 7-2

Project No. 2687.001

7.3.5 Stormwater Storage Modifications at "98 Dennett" Parcel

Developmental interest at the '98 Dennett' parcel has resulted in the need to evaluate current drainage conditions throughout the undeveloped tract, as well as to identify and mitigate any potential negative drainage impacts associated with buildout of the parcel. In general, State of Maine and federal stormwater-related development laws and permitting requirements, in combination with Town zoning regulations, require mitigation for alterations in hydrology for large developments. These requirements generally include mitigation of stormwater discharge rate, volume, and quality related to conversion of undeveloped areas to developed lands with impervious surface cover. These regulations generally require mitigation of these hydrologic characteristics back to pre-development levels; however, the Town and/or prospective developers may wish to mitigate potential future stormwater impacts beyond what is required by regulatory agencies for development. Additionally, it may be in the best interest of the Town and its stakeholders to preemptively mitigate stormwater impacts related to potential future increases in high magnitude precipitation events associated with climate uncertainty. It should be noted that for portions of the '98 Dennett' parcel located within DA-2, property downstream of the existing wetland storage include a partially developed commercial property and I-95 right-of-way. Also, the Town has a more direct interest in protecting its two sanitary sewer pipes that are conveyed through the right-of-way embankment and serve much of the focus area. Overtopping of the embankment could potentially jeopardize these sanitary sewer lines and risk severing sanitary services to affected residences and risk discharge of untreated sanitary waste to downstream waters.

Results from the existing conditions HydroCAD model developed for the study area indicate that the wetland complex at the eastern end of the '98 Dennett' parcel provides adequate storage for up to the 10-year, 24-hour storm event (5.32") without overtopping the elevated right-of-way immediately bordering the wetland storage and serving as an informal spillway. It should also be noted that under existing conditions, no spillway overtopping was observed for the extreme 10-year precipitation event either.

If the Town desires to provide additional resiliency measures to preemptively mitigate potential increases in future stormwater discharge from extreme precipitation events, and/or provide additional storage in advance of potential development-related changes in hydrology, modifications could be made to the existing right-of-way elevation at the eastern extent of the '98 Dennett' parcel. This right-of-way currently serves as an emergency spillway, retaining water within the storage area during small and moderate scale precipitation events and providing an overflow location during high magnitude events. For routine and moderate storm evens which do not cause overtopping of this spillway, all discharge is routed through the 18-inch culvert serving as the system's primary outlet. The existing conditions HydroCAD report suggests that overtopping of the right-of-way begins at the 25-year storm event. **Table 7-2** provides a summary of peak storage elevations and peak discharge rates volumes for runoff overtopping this informal spillway provided by the right-of-way access road.

Table 7-2: '98 Dennett' Storage Spillway Modification Summary				
Storm Recurrence Interval	**Peak Storage Elevation (feet amsl)**		**Cumulative Discharge Rate[2] (CFS)**	
	Existing Conditions (El. 38.4')	**Spillway Modification (El. 39.4')**	**Existing Conditions (El. 38.4')**	**Spillway Modification (El. 39.4')**
10-Year	37.68	37.68	7.82	7.82
25-Year	38.44[1]	38.56	13.49	10.03
50-Year	38.54[1]	39.22	32.17	11.43
100-Year	38.66[1]	39.50[1]	64.37	24.65
10-Year (Extreme)	38.24	38.24	9.28	9.28

1 – Overtops scenario spillway elevation.
2 – Cumulative discharge volume includes total discharge from culvert outlet and spillway overtopping (as applicable).

To assess the potential benefits of formalizing the pond and utility right-of-way into a stormwater pond, the consultant team modeled the hydrologic impacts of raising the utility right-of-way one foot to temporarily detain larger-magnitude events and slowly release them via the existing 18-inch culvert. Note that this assessment is a simplification to demonstrate the potential benefits; any design to modify this area would be expected to have a more extensive alternatives analysis considering varying normal pool elevations, right-of-way / overtopping elevations, and/or outlet control structures. Particular attention should be paid to the structural height of the embankment and maximum impounded volume to ensure the modified structure complies with dam safety criteria if it meets the legal definition of a dam per Title 37B, Chapter 24 of the Maine Revised Statutes. Results of the storage modification are provided in Table X.

Model results summarized in **Table 7-2** suggest that the proposed one foot increase in spillway elevation would limit instances of overtopping to the 100-year storm event and greater. It could also accommodate projected increases in precipitation depths due to climate change and buffer unmitigated upstream development. Table X also shows the impact to downstream receiving waters: the proposed project would reduce the total peak discharge for all design events in comparison to existing conditions. This reduction in peak discharge would be expected to reduce the potential for erosion of downstream watercourses. Additionally, the increased volume stored behind the right-of-way would be anticipated to promote the additional settling of sediment and nutrients, improving downstream water quality. A properly designed forebay could manage the maintenance excavation of these sediments and a wetland fringe could uptake some of the delivered nutrients.

As this right-of-way land is not publicly-owned property, coordination would be required with the current owner of the utility easement prior to any potential modifications to this area.

7.3.6 Low Impact Development Considerations for Future Build-Out Scenarios

Low impact development (LID), commonly referred to as green infrastructure (GI), is a planning and development process which mimics natural hydrology to promote infiltration and evapotranspiration, reduce runoff, improve water quality through management of stormwater at its source. In contrast to "end of pipe" stormwater management such as stormwater ponds, the goal of LID is to distribute small BMPs across the developed area to mitigate impacts at their source where they are smaller and easier to manage. Ideally, LID would be more cost-effective, equitable, and result in efficiencies to the entire downstream drainage network (i.e., smaller drainage infrastructure.) When deployed correctly, LID practices provide numerous benefits, including but not limited to the following (MEDEP, 2016):

- Water quality enhancement;
- Provision of open space and natural landscapes;
- Reduction in stream erosion associated with increased storm flows;
- Minimization of impacts associated with localized flooding;
- Reduction in development costs associated with land clearing and grading; and
- Reduction in infrastructure maintenance costs.

The Maine Department of Environmental Protection (DEP) highly recommends incorporation of LID techniques into development and redevelopment activities. Volume III of the Maine Stormwater Management Design Manual (MEDEP, 2016) Chapter 10 is dedicated to LID measures and techniques, planning considerations, and minimum design standards. A copy of this resource is included as **Appendix K**.

Issuance of the updated 2022 General Permit for Stormwater Discharges to Municipal Separate Storm Sewer Systems (MS4s) required the 30 municipalities in the state of Maine (including the Town of Kittery) which meet regulated MS4 population density criteria to promote LID strategies to developers. Accordingly, a cooperative effort from the Southern Maine Planning and Development Commission, Cumberland County Soil & Water Conservation District, and Integrated Environmental Engineering resulted in development of a Maine Model Ordinance for Low Impact Development Strategies (SMPDC et al., 2022). Following development of this model ordinance, all MS4 municipalities have been required to review applicable elements of the ordinance for adoption and submit to DEP a model LID ordinance for stormwater management on new and redevelopment sites. Development of the Maine model LID ordinance was conducted in a way which allowed the local law to be tailored to the specific needs and local regulatory review requirements of each municipality. As such, minimum technical standards were mandated in some instances, while also allowing for flexibility of each municipality to create more stringent regulations, as needed, to address the variable and dynamic development-related stormwater issues faced by each.

As a regulated MS4, the Town of Kittery submitted the Kittery Proposed Ordinance for Low Impact Development Strategies (SMPDC et al., 2022) for DEP review as well as public comment. A copy of the Town of Kittery Proposed Ordinance Content for Low Impact Development Strategies is provided as **Appendix L**.

Following a review of the history, environmental setting, and hydrologic modeling results for the focus study area, the consulting team completed a detailed review of the Kittery proposed LID ordinance to provide an opinion on the anticipated effectiveness of the ordinance as it relates to potential future development of areas underdeveloped as comparted to current zoning. More specifically, this document was reviewed to assess the likelihood of future development adequately preserving existing hydrology and minimizing drainage-related risks to downstream properties and infrastructure through incorporation of the required LID measures and performance standards.

In general, a review of the Main model LID ordinance determined that the base-level LID measures and performance standards provide adequate protection against detrimental drainage and water quality impacts associated with development and redevelopment activities. Overall the Kittery model LID law generally follows the minimum performance standards outlined in the model law, however some deviations were noted which were determined to be slightly more stringent (i.e. greater stormwater benefit) than the model law. **Table 7-3** below identifies instances in which the proposed Kittery LID ordinance exceeds the requirements outlined by the model LID ordinance and approved by DEP.

Table 7-3: Kittery LID Ordinance Review Summary

Criteria	Model LID Ordinance Requirement	Proposed Kittery LID Ordinance Requirement
Applicability	Applies to any project for which an application for subdivision or site plan approval is filed with the municipality which results in: 1. Disturbed Area of one or more acres of land, or 2. Disturbance Area less than one acre that is part of a larger Common Plan of Development	Applies to *__any project in the Town's Urbanized Area__* which results in: 1. Disturbed Area of one or more acres of land, or 2. Disturbance Area less than one acre that is part of a larger Common Plan of Development or Sale which would create a

	or Sale which would create a cumulative disturbed area of one acre or more. Under the model ordinance, *certain performance standards are only considered required criteria for applicable zoning areas* within the municipalities Urbanized Area.	cumulative disturbed area of one acre or more. Under the proposed Town of Kittery LID ordinance, all performance standards would be adopted for *any development within the Town's Urbanized Area requiring reviews and approvals by the Town Charter*, and *not necessarily dictated by zoning area*.
Impervious Area Definition	Allows municipality to *exclude* pervious pavement, pervious pavers, pervious concrete, and under-drained artificial turf fields from calculation of impervious areas if designed to be infiltration Stormwater Treatment Measures.	Requires pervious pavement, pervious pavers, pervious concrete, and under-drained artificial turf fields *to be considered impervious* in calculation of impervious areas.
Open Space Preservation for Rural and Suburban New Development	Provision of the following criteria as *optional and not required for approval of local ordinance*: Rural New Developments shall preserve at least 40% of the Site as open space and Suburban New Developments shall preserve 25% of the Site as open space.	The Town of Kittery intends to adopt this optional performance standard, citing that Kittery Cluster Subdivision Ordinance is currently more stringent than this requirement.

In conclusion, it is the opinion of the consulting team that the Town of Kittery proposed LID ordinance is more stringent than the Maine model LID ordinance and provides a means of adequately preserving existing hydrology and minimizing drainage-related risks to downstream properties and infrastructure. The Town's local regulations should be reviewed as needed in the future to ensure they adhere to regulatory changes and climate uncertainties.

8.0 FINANCIAL CONSIDERATIONS AND PERMITTING

8.1 Preliminary Cost Estimates

Preliminary cost estimates for each recommended mitigation alternative were developed by the consultant team. **Table 8-1** summarizes these approximations. Note that the cost estimate approach for each mitigation alternative differed in that some alternatives focused on direct infrastructure enhancements, while other alternatives consisted of, or are preceded by, planning and analysis efforts. As such, varied levels of contingency were applied to each estimated cost, as specified below. Further, the opinions of probably cost provided by the consultant team for each alternative consist of ranges due to uncertainties with future approaches. Of further note is that the reported costs are in 2023 dollars; such costs will need to be adjusted by an appropriate escalation factor if the work is performed in future years.

Table 8-1: Opinions of Probably Cost

Mitigation Alternative	Components	Cost Estimate
Alternative 1: Right-Sizing Critical Infrastructure	Detailed Hydraulic Analysis	$10,000 - $15,000 / Culvert
	Design, Permitting and Construction	$150,000 - $300,000 /Culvert
Alternative 2: Martin Road Sewer Line Study	Engineering Study	$15,000 - $30,000
	Design, Permitting and Construction (as needed)	$75,000 - $150,000
Alternative 3: Martin Road/Highway 236 Storage Modifications	Design, Permitting and Construction	$90,000 - $225,000
Alternative 5: Stormwater Storage Modifications at '98 Dennett' Parcel	Design, Permitting and Construction	$250,000 - $350,000

The primary cost associated with Alternative 4 (Identification of Potential Conservation Opportunities) relates to development planning; therefore, an opinion of probably cost was not provided. Additionally, no cost estimate was provided for Alternative 6 (Low Impact Development Considerations for Future Build-Out Scenarios) as the establishment and enforcement of these policies would be carried out by existing local regulatory authorities.

8.2 Potential Funding Options

An evaluation was conducted to determine potential funding opportunities for the selected alternatives. **Table 8-2** summarizes programs offered through various State and federal agencies which were identified as possible sources of financial assistance for implementation of one or more mitigation alternatives.

Table 8-2: Potential Funding Options for Prioritized Alternatives			
Program	**Agency**	**Description**	**Web Link**
State Funding Programs			
Coastal Community Grant Program	Maine DEP	Up to $50,000 for projects in Maine's coastal zone. Most recently this program prioritizes climate resiliency projects.	Link
Public Infrastructure Grant Program	Maine DEP	Up to $1,000,000 for public infrastructure projects, including projects associated with storm drainage.	Link
Municipal Partnership Initiative	Maine DOT	Up to $500,000 for projects of municipal interest also benefitting MaineDOT infrastructure	Link
Community Action Grants	Governor's Office of Policy Innovation and the Future	Up to $50,000 to increase resiliency of community to climate change	Link
Federal Funding Programs			
Clean Water State Revolving Fund (CWSRF)	EPA	A funding cooperative program which provides low-interest or interest-free financing for a variety of projects, including green and grey infrastructure stormwater management projects.	Link
EPA 319 Grant Program (Nonpoint Source Grant Program)	EPA (via MaineDEP)	Funding program which provides federal funds to state agencies for distribution, with funding potential up to $125,000.	Link
Five Star and Urban Waters Restoration Grant Program	NFWF	Federal funding program which provides financial assistance for stormwater management, as well as wetland, forest, riparian, and coastal habitat restoration. In general, provides funding up to $50,000.	Link
Hazard Mitigation Grant Program (HMGP)	FEMA	Funding assistance covering a diverse array of projects and initiatives to reduce risk of, and impacts from, future climate events.	Link
Building Resilient Infrastructure and Communities (BRIC) Program	FEMA	Funding assistance aimed at addressing future risks to natural disasters, including flood mitigation projects.	Link

Watershed Protection and Flood Prevention (WFBO) Program	FEMA	Federal financial assistance targeting planning and implementation of watershed management efforts, including flood prevention, water quality management, and flood prevention.	Link

8.3 Permitting and Approvals

Each recommended mitigation alternative selected for prioritization was evaluated to determine what, if any, approvals and permitting requirements may be needed for implementation. **Table 8-3** summarizes permitting applicability for the prioritized mitigation alternatives. As the scope of these mitigation alternatives has yet to be fully defined, this list should be seen as a starting point for permitting considerations rather than an all-encompassing list of required approvals.

Table 8-3: Considerations for Permitting and Approvals

	Wetland Permitting	NRPA and 401/404 "Stream" Permitting	Threatened and Endangered Species Coordination	Stormwater Construction General Permit	DOT / Highway Department Approval	Property Access / Ownership
Right-Sizing Critical Infrastructure	X	X	X		X	
Martin Road Sewer Line Study						
Martin Road/Rt 236 Storage Modifications	X	X	X	X		X
Identification of Potential Conservation Areas						X
Storage Modifications at the '98 Dennett' Parcel	X	X	X	X		X

Due to the nature of the 'Low Impact Development Considerations for Future Build-Out Scenarios' alternatives, permitting is not applicable in the same sense it is for the other projects resulting in disturbance, infrastructure improvements, etc.; however, it should be noted that finalization of Kittery's Local Low Impact Development Ordinance would require approval from the DEP in accordance with requirements outlined in Maine DEP's MS4 permit.

9.0 HOMEOWNER FLOOD PROTECTION MEASURES

While the potential stormwater retrofit and improvement projects outlined above may assist with reducing localized flooding concerns, additional homeowner flood protection measures should also be considered to manage flooding, particularly as the result of groundwater. The following homeowner flood protection recommendations were developed by FEMA (https://www.fema.gov/sites/default/files/documents/fema_protect-your-home-from-flooding-brochure_2020.pdf).

Exterior Homeowner Flood Protection Measures

- Maintain proper water runoff and drainage. Routinely clean and maintain gutters, downspouts, and splash pads. Ensure drainage ditches and storm drains are clear of debris and functioning properly.

- Improve lot grading. If necessary, consider building up any sunken areas around the foundation, digging small depressions to properly channel water (while avoiding adverse impacts to abutters), and grade properties to slopes away from structures.

- Reduce impervious surfaces. Where adequate separation to groundwater is available, retaining and creating natural green space around properties can help reduce stormwater runoff. Consider options such as rain gardens, vegetated swales, or pervious pavements, which allow more water to be absorbed by the ground.

- Install a rain barrel. Rain barrels are typically connected to gutter downspouts and collect the runoff from roofs. The stored water can be used for non-potable uses such as watering the lawn and gardens.

- Elevate utilities and service equipment. Raise and anchor air conditioning condensers, heat pumps, water meters and other service equipment onto pedestals or platforms that are at least 1 foot above the potential flood elevation.

- Anchor outdoor fuel tanks. Attach outdoor fuel tanks to a large concrete slab that weighs enough to resist the force of floodwaters, or install ground anchors that are connected across the top of the tank with metal straps. If located in an identified high-risk zone, fuel tanks should also be elevated to or above the regulatory flood elevation. If not feasible then all filling and ventilation tubes should be elevated so that floodwaters cannot enter the tank.

Interior Homeowner Flood Protection Measures

- Protect valuable possessions. Move important documents and valuables above the potential flood elevation and/or inside watertight containers.

- Seal foundations and basement walls. Close any foundation cracks with mortar and masonry caulk or hydraulic cement, which expands and fills gaps completely. Seal basement walls with waterproofing compounds to avoid seepage. Make sure any floor drains are clear of obstructions.

- Install flood vents. Flood vents are small permanent openings that allow floodwater to flow freely through an enclosure such as a crawlspace or garage. Properly positioned and installed flood vents protect homes during floods by preventing water pressure buildup that can destroy walls and foundations. Flood openings may be required for lower enclosures of homes being built in high-risk flood zones, but they can also be installed in existing homes. Once installed, make sure your flood vents are kept free of debris and will allow the free-flow of floodwater.

- Install a sump pump. Sump pumps, which pump groundwater away from a structure, can prevent or minimize basement seepage and flooding. They draw in the groundwater from around a structure and direct it away from the structure through drainage pipes. Water powered or battery-backup systems are recommended in case of electrical power failure.

- Prevent sewer backups. Install drain plugs for all basement floor drains to prevent sewer backups. Another recommended option, regardless of the potential flood elevation, is to install sewer backflow valves for all pipes entering the building. These devices, which allow water to flow only one direction, prevent floodwater and wastewater from backing up into toilets, sinks, and other drains. A qualified, licensed plumber should install all measures.

- Use flood-resistant building materials. Examples include tile, vinyl, rubber, lime plaster, cement board, concrete, or pressure-treated and decay-resistant wood.

- Raise electrical system components. Increase the height of electric service panels (fuse and circuit breaker boxes) and all outlets, switches, and wiring to at least 1 foot above the potential flood elevation. A licensed electrician should make these modifications.

- Protect utilities and service equipment. Move the main parts of heating, ventilation, and air conditioning (HVAC) systems to a higher floor. Consider raising other major appliances. If relocation or elevation is not possible, service equipment can be protected using low floodwalls and shields.

- Anchor indoor fuel tanks. Anchor fuel tanks by attaching them to a large concrete slab that weighs enough to resist the force of floodwaters.

- Install a flood alert system. A variety of flood sensors and other early warning devices can alert the risk of imminent flooding so preventative or protective actions can be taken.

10.0 SUMMARY, RECOMMENDATIONS & NEXT STEPS

The primary objectives of the Town of Kittery Highway 236/Dennett Road Hydrologic Watershed Study were to:

1. Understand the root causes and concerns with current localized flooding;
2. Evaluate the potential hydrologic and water quality impacts associated with changing climate conditions and potential future development within the primary study area; and
3. Identify potential mitigation alternatives to address existing flooding concerns and potential future impacts associated with development and changing climate scenarios.

Through public input, field reconnaissance, and hydrologic/hydraulic evaluation the following priority watershed area findings were noted:

East End Martin Road Residential Properties (near Highway 236)

Residents in this area noted frequent basement inundation and loss of trees on the south side of Martin Road (near Parcel #29-1, Property Address 41 Route 236). Soils in this area are very poorly drained and several properties are located adjacent to wetlands; groundwater levels are relatively close to the surface. Fill placed at 41 Route 236 may have restricted the flow across Route 236, leading to increased detention of stormwater. This increased stormwater detention could further increase the elevated groundwater levels. The consultant team evaluated the benefit of removing the fill and elevated driveway at the 41 Route 236 property and/or potential modifications to the adjacent Route 236 culvert. It was concluded that such a project would reduce the peak water levels and duration of inundation of the wetland behind properties along Martin Road during storm events, which would be expected to reduce the frequency of basement flooding and some tree loss reported in this area.

Herb Parson Pond

The Herb Parson Pond located adjacent to the Southern Maine Fish and Game Club has been anecdotally noted to have a decreased water level and degrading water quality. The pond was a former gravel pit and is located at a high point within the subwatershed with limited drainage area or inflows. The pond water surface elevation was determined to be reflective of the surrounding groundwater elevation and will fluctuate with seasonal variations within the water table.

Based on review of existing literature, the consultant team concluded the Martin Road sanitary sewer (and associated pipe bedding) that was installed circa 2016 intercepts the groundwater table. While it could not be confirmed or ruled out, the pipe and/or its bedding may convey groundwater from Herb Parsons Pond towards Highway 236 and possibly contribute to the decreased water levels of Herb Parsons Pond. Additional evaluation, including inflow and infiltration (I&I) testing and groundwater level monitoring are recommended to determine if the sewer line is impacting the Herb Parson Pond level. If the additional evaluation concluded that the sewer line contributes to the Pond water level, design retrofits including installation of sewer line/pipe bedding anti-seepage collars and/or sewer joint lining/sealing could be evaluated. Limiting the usage of nutrients and fertilizers in proximity to the Pond would also provide water quality benefits.

Happy Avenue Access Road

Residents in this area have noted an increased frequency in basement flooding following the construction of the Happy Avenue extension in the late 1990's. The literature review and hydrologic and hydraulic modeling conducted as part of this study concluded that changes to stormwater runoff likely have an insignificant effect on stormwater flooding and groundwater levels along Happy Avenue. Reported basement flooding was assessed to be most likely a result of natural seasonal and variable annual weather conditions impacting very poorly drained soils in proximity to the residential properties. Culverts below the Happy Avenue extension could be reconfigured to reduce potential adverse impacts, however a negligible benefit to Happy Avenue residents is expected. Due to the elevated groundwater table, neighborhood scale groundwater controls (i.e. underdrains) would likely also be infeasible and adversely impact adjacent wetlands. The most practical mitigation alternative for properties along Happy Avenue may be increased homeowner flood protection as described in Section 9.0.

Drainage Infrastructure Sizing

The hydrologic and hydraulic modeling indicates that at least five (6) existing culverts within the primary study area may be undersized. "Right-sizing" these culverts could improve existing localized drainage conditions and minimize future issues associated with potential development and changing climate conditions. Although this study provides preliminary sizing for drainage system modifications, more detailed analysis would be required to ensure the safety and protection of downgradient infrastructure.

Stormwater Storage Modifications at "98 Dennett"

Any significant future development of "98 Dennett" will be required to follow state and local stormwater regulations requiring the mitigation of runoff to pre-development conditions. A large portion of the "98 Dennett" parcel drains east to a wetland complex that abuts a utility right-of-way. This wetland complex has adequate storage under existing conditions to attenuate the 10-yr, 24-hr storm event of 5.32-inches. Consideration could be given to expanding the wetland storage to provide additional stormwater benefits under existing conditions and reduce the potential for overtopping flows to damage the Town's sanitary sewer lines within this right-of-way. The increased stormwater benefits of this modification would, in effect, serve as a new pre-development baseline of stormwater routing which, by regulation, future development would need to meet. This additional storage would also create increased resiliency to increased storm events associated with changing climate conditions. Modifications to the wetland storage would require coordination with private property owners and consultation with existing utility easements associated with the adjacent right-of-way.

Identification of Potential Conservation Areas

Conservation of sensitive areas including well-drained soils with high infiltration capacity, areas on steep slopes, and lands in close proximity to regulated resources (wetlands and watercourses) could assist with off-setting future development and deliver efficiencies to the sizing and need for newly constructed stormwater infrastructure. The watershed study identifies potential priority conservation areas for consideration. These areas are currently privately owned and would require public/private partnerships.

Low Impact Development Considerations

Incorporation of Low Impact Development (LID) planning and use of green infrastructure stormwater practices can play an important role in mitigating runoff from new or redevelopment projects. Some of the conservation considerations mentioned above, including maintaining areas of open space and riparian buffers, are key tenants of LID planning. LID practices focus on mimicking or preserving natural drainage processes and promoting source infiltration of stormwater. These LID planning and design considerations can improve water quality, protect natural habitat, provide aesthetic and air quality benefits, reduce the reliance on stormwater infrastructure and maintenance; all while still allowing development. As a regulated MS4, the Town of Kittery has proposed an “Ordinance for Low Impact Development Strategies” that exceeds the minimum requirements of the Maine DEP model ordinance. Implementation of the Town’s LID Ordinance, in both the planning and design of projects, will greatly assist in managing runoff from newly developed properties.

Homeowner Flood Proofing

As outlined throughout this study, there are several localized areas of existing flood concern. Many of these localized instances of surface and groundwater related flooding issues are the result of historical development within areas of poorly drained soils and adjacent to wetlands/floodplains. Although the myriad of potential stormwater improvement projects evaluated as part of this study can assist with flood mitigation, no feasible, stand-alone solution was identified to prevent all future flood related impacts. The importance of homeowner flood protection measures is paramount. There are several exterior and interior homeowner considerations outlined in Section 9.0 that can help reduce the impacts of residential flooding at the parcel level.

Development or redevelopment of any land has the potential to increase stormwater volume and runoff rates if left unmitigated. Regulatory mechanisms, including current state and local laws, are in place to mitigate runoff from future development exceeding one acre of disturbance. The alternatives evaluated as part of this engineering watershed study could assist in further alleviating the frequency and magnitude of flood-related impacts associated with current conditions, potential future development scenarios, and storm events associated with changing climate conditions. There are existing funding programs that can be pursued to assist with implementation funding. Funding programs are constantly changing and additional opportunities may be become available in the future. The engineering watershed study identifies priority area findings and concept level alternatives for implementation of select projects. Additional planning and design would be required prior to full implementation of the alternatives evaluated. Several additional alternatives were included in the Stormwater Opportunity Ranking Matrix (Appendix L) that should be reviewed periodically as new grant programs and priorities are developed. Given the private ownership of the parcels within the priority study area, continued public/private cooperation will be required to further progress the objectives of this study.

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Appendix A

1984 Federal Emergency Management Agency (FEMA) Flood Rate Insurance Maps (FIRMs)

ELEVATION REFERENCE MARKS

REFERENCE MARK	ELEVATION IN FT. (NGVD)[1]	DESCRIPTION OF LOCATION
RM 5	41.10	MSHC & JWS Co. disk in U.S. Route 1 southbound bridge over Interstate Route 95

[1] National Geodetic Vertical Datum of 1929

KEY TO MAP

500-Year Flood Boundary	ZONE B
100-Year Flood Boundary	
Zone Designations*	ZONE A1 / ZONE A5
100-Year Flood Boundary	
500-Year Flood Boundary	ZONE B
Base Flood Elevation Line With Elevation In Feet**	513
Base Flood Elevation in Feet Where Uniform Within Zone**	(EL 987)
Elevation Reference Mark	RM7×
Zone D Boundary	
River Mile	•M1.5

**Referenced to the National Geodetic Vertical Datum of 1929

*EXPLANATION OF ZONE DESIGNATIONS

ZONE	EXPLANATION
A	Areas of 100-year flood; base flood elevations and flood hazard factors not determined.
A0	Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet; average depths of inundation are shown, but no flood hazard factors are determined.
AH	Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet; base flood elevations are shown, but no flood hazard factors are determined.
A1-A30	Areas of 100-year flood; base flood elevations and flood hazard factors determined.
A99	Areas of 100-year flood to be protected by flood protection system under construction; base flood elevations and flood hazard factors not determined.
B	Areas between limits of the 100-year flood and 500-year flood; or certain areas subject to 100-year flooding with average depths less than one (1) foot or where the contributing drainage area is less than one square mile; or areas protected by levees from the base flood. (Medium shading)
C	Areas of minimal flooding. (No shading)
D	Areas of undetermined, but possible, flood hazards.
V	Areas of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors not determined.
V1-V30	Areas of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors determined.

NOTES TO USER

Certain areas not in the special flood hazard areas (zones A and V) may be protected by flood control structures.

This map is for flood insurance and flood plain management purposes only; it does not necessarily show all areas subject to flooding in the community or all planimetric features outside special flood hazard areas. The coastal flooding elevations shown may differ significantly from those developed by the National Weather Service for hurricane evacuation planning.

For adjoining map panels, see separately printed Index To Map Panels.

Coastal base flood elevations shown on this map include the effects of wave action.

Coastal base flood elevations apply only landward of the shoreline shown on this map.

INITIAL IDENTIFICATION:
NOVEMBER 1, 1974
FLOOD HAZARD BOUNDARY MAP REVISIONS:
SEPTEMBER 24, 1976
OCTOBER 1, 1983

FLOOD INSURANCE RATE MAP EFFECTIVE:
JULY 5, 1984
FLOOD INSURANCE RATE MAP REVISIONS:

Refer to the FLOOD INSURANCE RATE MAP EFFECTIVE date shown on this map to determine when actuarial rates apply to structures in the zones where elevations or depths have been established.

To determine if flood insurance is available in this community, contact your insurance agent, or call the National Flood Insurance Program, at (800) 638-6620.

APPROXIMATE SCALE
400 0 400 FEET

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

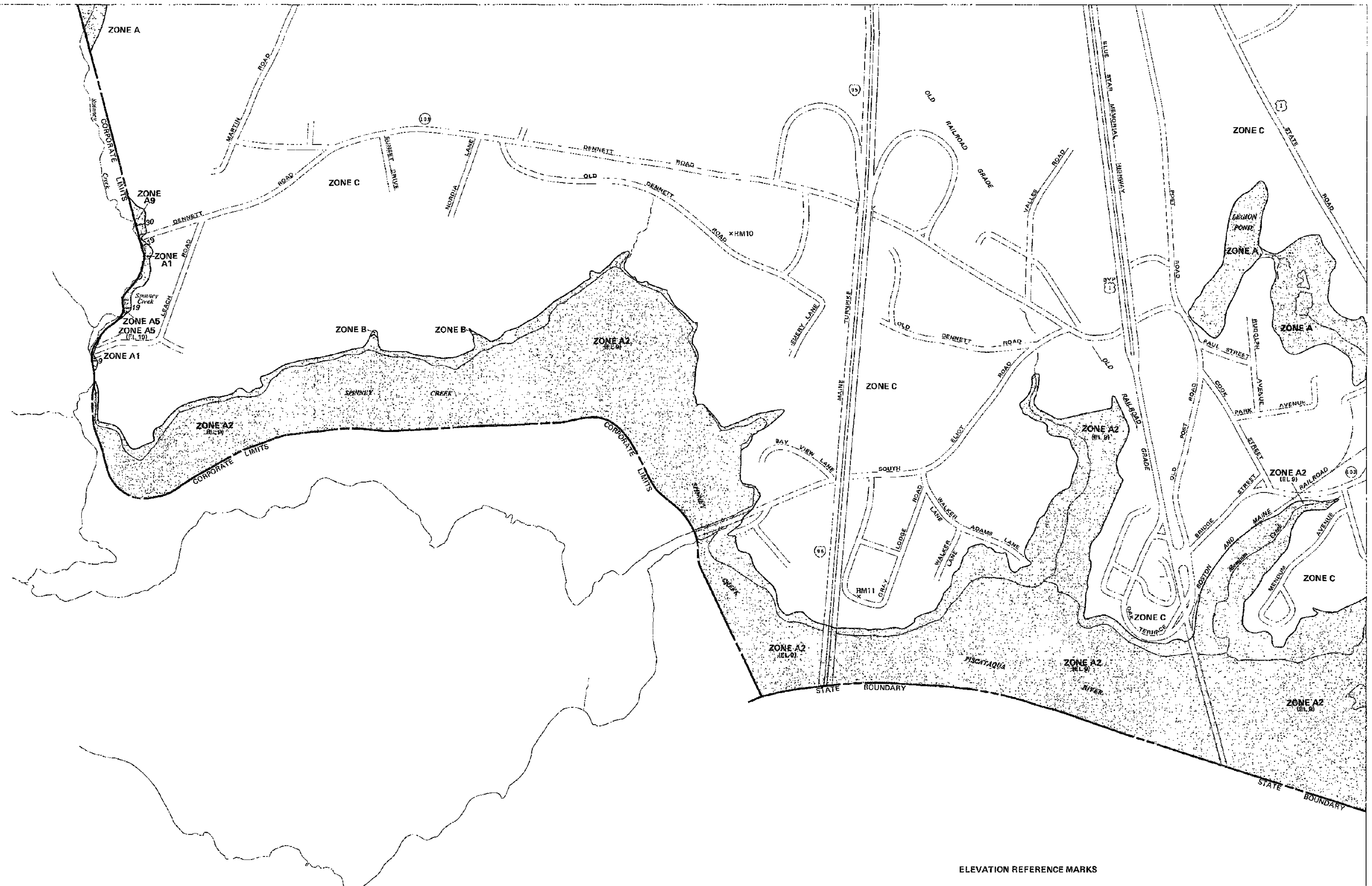
TOWN OF
KITTERY, MAINE
YORK COUNTY

PANEL 4 OF 10
(SEE MAP INDEX FOR PANELS NOT PRINTED)

COMMUNITY-PANEL NUMBER
230171 0004 C

EFFECTIVE DATE:
JULY 5, 1984

Federal Emergency Management Agency



ELEVATION REFERENCE MARKS

REFERENCE MARK	ELEVATION IN FT. (NGVD)[1]	DESCRIPTION OF LOCATION
RM 10	46.11	Railroad spike in pole No. 17 on southwest side of Dennett Road.
RM 11	48.64	MSHC & JWS Co. disk on northeast side of Gray Lodge Road east of interstate 95 bridge over the Piscataqua River

[1] National Geodetic Vertical Datum of 1929

KEY TO MAP

500-Year Flood Boundary	ZONE B
100-Year Flood Boundary	
Zone Designations*	ZONE A1 / ZONE A5
100-Year Flood Boundary	
500-Year Flood Boundary	ZONE B
Base Flood Elevation Line With Elevation In Feet**	513
Base Flood Elevation in Feet Where Uniform Within Zone**	(EL 987)
Elevation Reference Mark	RM7×
Zone D Boundary	
River Mile	•M1.5

**Referenced to the National Geodetic Vertical Datum of 1929

*EXPLANATION OF ZONE DESIGNATIONS

ZONE	EXPLANATION
A	Areas of 100-year flood; base flood elevations and flood hazard factors not determined.
A0	Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet; average depths of inundation are shown, but no flood hazard factors are determined.
AH	Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet; base flood elevations are shown, but no flood hazard factors are determined.
A1-A30	Areas of 100-year flood; base flood elevations and flood hazard factors determined.
A99	Areas of 100-year flood to be protected by flood protection system under construction; base flood elevations and flood hazard factors not determined.
B	Areas between limits of the 100-year flood and 500-year flood; or certain areas subject to 100-year flooding with average depths less than one (1) foot or where the contributing drainage area is less than one square mile; or areas protected by levees from the base flood. (Medium shading)
C	Areas of minimal flooding. (No shading)
D	Areas of underermined, but possible, flood hazards.
V	Areas of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors not determined.
V1-V30	Areas of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors determined.

NOTES TO USER

Certain areas not in the special flood hazard areas (zones A and V) may be protected by flood control structures.

This map is for flood insurance and flood plain management purposes only; it does not necessarily show all areas subject to flooding in the community or all planimetric features outside special flood hazard areas. The coastal flooding elevations shown may differ significantly from those developed by the National Weather Service for hurricane evacuation planning.

For adjoining map panels, see separately printed Index To Map Panels.

Coastal base flood elevations shown on this map include the effects of wave action.

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INITIAL IDENTIFICATION:
NOVEMBER 1, 1974

FLOOD HAZARD BOUNDARY MAP REVISIONS:
SEPTEMBER 24, 1976
OCTOBER 1, 1983

FLOOD INSURANCE RATE MAP EFFECTIVE:
JULY 5, 1984

FLOOD INSURANCE RATE MAP REVISIONS:

Refer to the FLOOD INSURANCE RATE MAP EFFECTIVE date shown on this map to determine when actuarial rates apply to structures in the zones where elevations or depths have been established.

To determine if flood insurance is available in this community, contact your insurance agent, or call the National Flood Insurance Program, at (800) 638-6620.

APPROXIMATE SCALE

400 0 400 FEET

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

TOWN OF
KITTERY, MAINE
YORK COUNTY

PANEL 7 OF 10
(SEE MAP INDEX FOR PANELS NOT PRINTED)

COMMUNITY-PANEL NUMBER
230171 0007 C

EFFECTIVE DATE:
JULY 5, 1984

Federal Emergency Management Agency

Appendix B

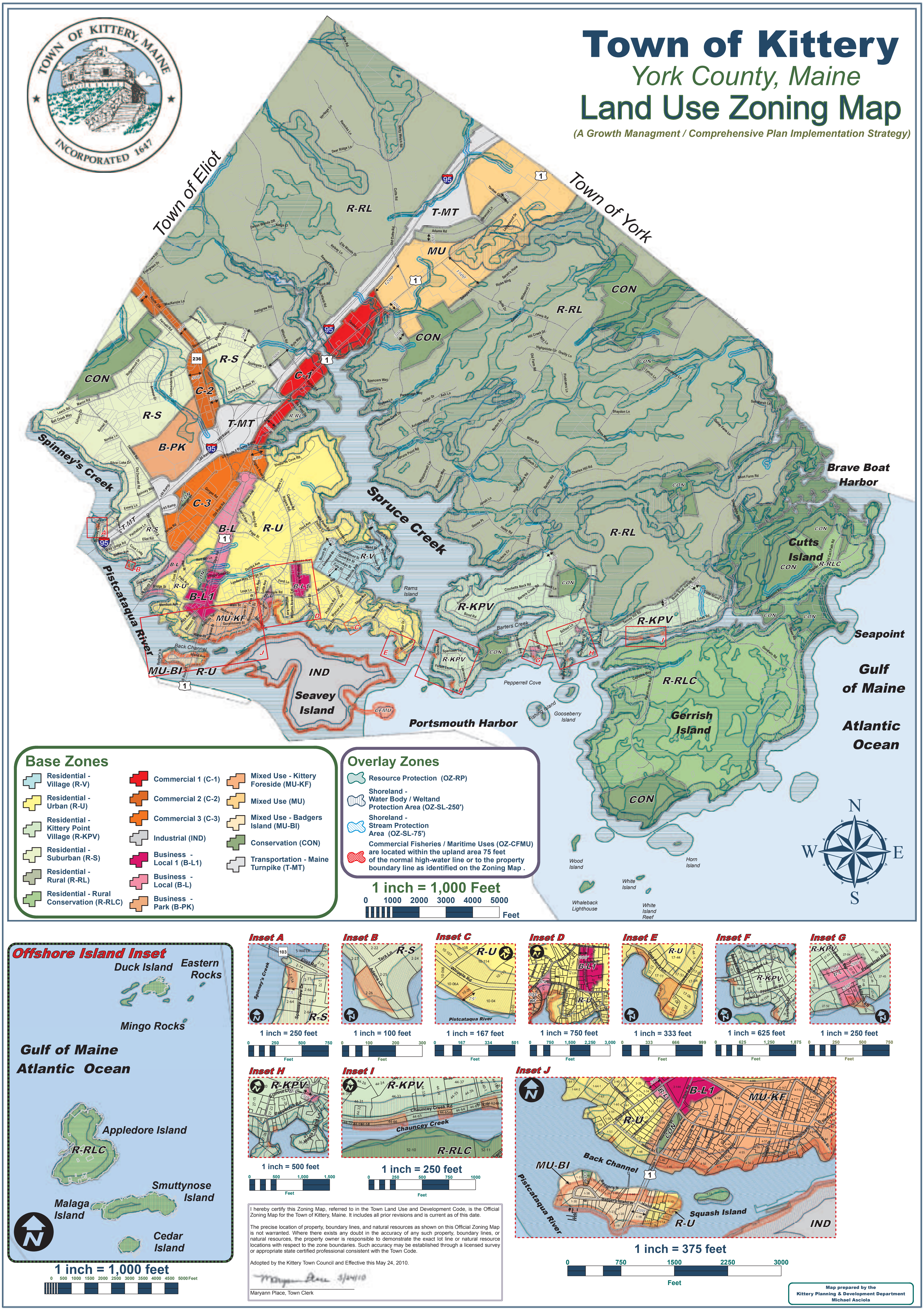
Current Town of Kittery Zoning

Town of Kittery

York County, Maine

Land Use Zoning Map

(A Growth Managment / Comprehensive Plan Implementation Strategy)



I hereby certify this Zoning Map, referred to in the Town Land Use and Development Code, is the Official Zoning Map for the Town of Kittery, Maine. It includes all prior revisions and is current as of this date.

The precise location of property, boundary lines, and natural resources as shown on this Official Zoning Map is not warranted. Where there exists any doubt in the accuracy of any such property, boundary lines, or natural resources, the property owner is responsible to demonstrate the exact lot line or natural resource locations with respect to the zone boundaries. Such accuracy may be established through a licensed survey or appropriate state certified professional consistent with the Town Code.

Adopted by the Kittery Town Council and Effective this May 24, 2010.

Maryann Place, Town Clerk

Appendix C

FB Environmental Wetland Reconnaissance

TO:	David Hanny, Barton & Loguidice	
FROM:	Sarah Large, FB Environmental Associates	
SUBJECT:	**Kittery Wetland Reconnaissance**	
DATE:	December 19, 2022	
CC:	Forrest Bell and Kevin Ryan, FB Environmental Associates, James Woidt, Streamworks	
Attachments:	1) Cowardin Wetland Classification System Chart; 2) Wetland Reconnaissance Map; 3) Site Photographs.	

MEMORANDUM

As requested by Barton & Loguidice, LLC, FB Environmental Associates (FBE) conducted reconnaissance-level wetland assessment and mapping within an approximately 300-acre survey area located between Dennett Road, Interstate 95, Route 236, and Martin Road in Kittery, Maine (from here on out referred to as the Survey Area). The wetland assessment presented herein was done in conjunction with a hydrologic study lead by Barton & Loguidice and Streamworks, PLLC for the Town of Kittery.

Prior to the site visit, FBE reviewed existing information relevant to wetlands on the site including aerial imagery dating back to 1985, National Wetlands Inventory (NWI) maps, and soil maps. FBE Wetland Scientist Sarah Large and Project Scientist II Jordan Foulds, conducted the field investigation on November 1, 4, and 10, 2022.

WETLAND RECONNAISSANCE METHODOLOGY

FBE geo-located the approximate boundaries of wetlands encountered during the survey using an Eos Arrow 100 GPS unit. Although cursory, the delineation of hydrologic features within the project area was based on the protocols described in the *1987 United States Army Corps of Engineers (USACE) Wetlands Delineation Manual*[1] and the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Northcentral and Northeast Region, Version 2.0*.[2] This methodology involves identifying wetlands based on three criteria: the presence of hydrophytic vegetation, hydric soils, and wetland hydrology. For a given area to be considered a wetland, all three of these parameters must be met, with some exceptions for disturbed areas.

All wetlands were classified using the classification system outlined in the 1979 manual *Classification of Wetlands and Deepwater Habitats of the United States*[3] (Attachment 1). This water resource classification system was developed by the United States Fish and Wildlife Service (USFWS) and is commonly referred to as "Cowardin Classification". The Cowardin Classification is used to define wetlands and other aquatic resources by their landscape position, cover type, and hydrologic regime. Special modifiers can be added that describe water regime/chemistry, soil types, or disturbances.

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[1] Environmental Laboratory. (1987). Corps of Engineers Wetlands Delineation Manual, Technical Report Y-87-1, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

[2] U.S. Army Corps of Engineers. (2012). Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Northcentral and Northeast Region (Version 2.0), ed. J. S. Wakeley, R. W. Lichvar, C. V. Noble, and J. F. Berkowitz. ERDC/EL TR-12-1. Vicksburg, MS: U.S. Army Engineer Research and Development Center.

[3] Cowardin, L. M., V. Carter, F. C. Golet, E. T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. 131 pp.

FBE also assessed the site for the presence of potential vernal pools according to protocols set forth in the Maine Association of Wetland Scientists 2014 Vernal Pool Technical Committee Vernal Pool Survey Protocol[4]. In addition, FBE conducted reconnaissance-level wetland functional assessments pursuant to the approach described by the Army Corps Highway Methodology Workbook Supplement: Wetland Functions and Values[5] (USACE, 1995). In this "Descriptive Approach" to functional assessment, evaluators first determine if specific functions and values are present and why, followed by a determination of what functions and values are principal and why. Functions and values can be considered "principal" if they are an important physical component of a wetland ecosystem (function only), and/or are considered of special value to society, from a local, regional, and/or national perspective.

WETLANDS OF SPECIAL SIGNIFICANCE

In Maine, Wetlands of Special Significance (WoSS) are regulated by the Maine Department of Environmental Protection (MDEP) under Chapter 310 of the Maine Natural Resources Protection Act. All coastal wetlands and great ponds (inland bodies of water >10 acres in size) are classified as WoSS. In addition, a freshwater wetland may be considered one of special significance if it: (1) contains a natural community that is critically imperiled or imperiled as defined by the Maine Natural Areas Program; (2) contains significant wildlife habitat; (3) is located within 250 feet of a coastal wetland; (4) is located within 250 feet of a great pond; (5) contains at least 20,000 square feet (SF) of aquatic vegetation, emergent marsh vegetation, or open water; (6) is inundated with floodwater during a 100-year flood event based on flood insurance maps; (7) contains peatlands; or (8) is located within 25 feet of a river, stream or brook. FBE assessed the survey area for the presence of WoSS.

GENERAL SITE DESCRIPTION

The Survey Area encompasses urban and residential development, an electrical utility line and sewer line, and areas of mixed forest, open water, and wetlands. Tree species observed within the upland (non-wetland) forest include red oak (*Quercus rubra*), American beech *(Fagus grandifolia)*, white pine (*Pinus strobus*), and red maple *(Acer rubrum)*. The topography of the site is relatively flat in its northwest portion and then slopes southwest. Topography in the eastern half of the site forms a basin.

Twenty-three separate wetland areas and five watercourses were identified and mapped within the Survey Area. Several roadside drainage ditches were also mapped.

Non-native, invasive plants are present throughout the Survey Area, in some areas growing in very high density. Observed species include glossy false buckthorn *(Frangula alnus)*, multiflora rose *(Rosa multiflora)*, barberry *(Berberis sp.)*, burning bush *(Euonymus alatus)*, Asiatic bittersweet *(Celastrus orbiculatus)*, common reed *(Phragmites australis)*, and purple loosestrife *(Lythrum salicaria)*. Non-native, invasive plants reach their highest density within disturbed areas such as along roadsides and in wetlands in close proximity to commercial and residential development.

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[4] Maine Association of Wetland Scientists Vernal Pool Technical Committee. (2014). Vernal Pool Survey Protocol. Available at: https://static1.squarespace.com/static/5113deede4b0a785ada17b27/t/537415c4e4b003ad4653fb5a/1400116676556/Complete+MAWS+2014+VP+Survey+Protocol_v3_05.14.2014.pdf

[5] U.S. Army Corps of Engineers. 1995. *The Highway Methodology Workbook Supplement. Wetland Functions and Values: A Descriptive Approach*. U.S. Army Corps of Engineers, New England Division. NENEP-360-1-30a. 32 pp.

WETLANDS AND WATERCOURSES

Twenty-three wetland areas, including four potential vernal pools, and five streams were identified within the Survey Area. Wetland areas located within 25 feet of streams meet the criteria to be considered WoSS due to their association with a watercourse. FBE observed several wetlands containing 20,000 square feet or more of emergent marsh vegetation or open water, thus qualifying these areas as WoSS as well.

A few areas were not surveyed due to access restrictions. Parcels 6-15B, 6-16A, 6-17A, and 13-04 in the southwest corner of the Survey Area were posted with no trespassing signs and actively under construction. An area of residential homes along Martin Road and New England Tree Services at 166 Dennett Road (Parcel 11-05) were also not surveyed due to access limitations.

Detailed descriptions of wetlands and the watercourse encountered within the Survey Area and their functions and values are below.

Wetland SL-A

Wetland A is a roadside ditch along Route 236 that meets the classification of an excavated, intermittently flooded palustrine emergent wetland with persistent vegetation (PEM1Jx). Some shrubs are present but are not dominant within the system. Wetland vegetation observed includes broad-leaved cattail *(Typha latifolia)*, speckled alder *(Alnus incana)*, multiflora rose, Asiatic bittersweet, and purple loosestrife. During the survey, the wetland contained very shallow standing water.

The primary function provided by Wetland SL-A is Sediment/Toxicant/Pathogen Retention.

Wetland SL-B

Wetland SL-B is a large basin surrounded by commercial development and a gravel road associated with a sewer line. The wetland is a seasonally flooded/saturated palustrine broad-leaved deciduous scrub-shrub/emergent wetland with persistent vegetation (PSS1/PEM1E) associated with a segment of Stream 1.

Wetland SL-B is hydrologically connected to Wetland SL-C through a culvert carrying Stream 1 under the road/sewer line. The wetland is also hydrologically connected to wetlands JF-B and JF-C through a culvert carrying flow under the Interstate 95 on/off ramp.

Dominant vegetation in the wetland consists of dense, non-native, invasive species. Other vegetation observed includes speckled alder, glossy false buckthorn, willow *(Salix sp.)*, grey birch *(Betula populifolia)* saplings, meadowsweet *(Spirea alba)*, broad-leaved cattail, woolgrass *(Scirpus cyperinus)*, common soft rush *(Juncus effusus)*, royal fern *(Osmunda regalis)*, and sensitive fern *(Onoclea sensibilis).*

During the field investigation soil was saturated throughout much of the wetland. The soil profile contained redoximorphic features near the soil surface.

Wetland SL-B meets several criteria to be considered a WoSS. The wetland contains over 20,000 SF of emergent marsh vegetation and is associated with Stream 1.

Floodflow alteration/storage, sediment/toxicant/pathogen retention, and wildlife habitat are the primary functions provided by Wetland SL-B.

Wetland SL-C

Wetland SL-C is a wetland complex with seasonally flooded/saturated palustrine broad-leaved deciduous forested scrub-shrub and semipermanently flooded emergent marsh with persistent vegetation components (PFO1/PSS1E & PEM1F). The wetland is situated within a large basin spanning from Martin Road east towards Route 236 behind residential homes and south to the center of the site and bounded by the gravel road/sewer line traversing the southeast corner of the site.

The wetland is a riparian system associated with segments of Stream 1, Stream 2, and Stream 3. The complex is hydrologically connected to wetlands SL-B and JF-E through culverts carrying flow under gravel roads. Several woods roads and a power line corridor traverse through the wetland and forest. Beaver (*Castor canadensis*) activity in the form of several gnawed trees were observed in the wetland.

Vegetation within Wetland SL-C includes white pine, red maple, paper birch *(Betula papyrifera)*, highbush blueberry *(Vaccinium corymbosum)*, arrowwood *(Viburnum dentatum)*, common winterberry *(Ilex verticillata)*, glossy false buckthorn, burning bush, multiflora rose, Asiatic bittersweet, sedges (*Carex* spp.), cinnamon fern *(Osmundastrum cinnamomeum)*, sensitive fern, broad-leaved cattail, and common reed. Soils in the wetland consist of areas of thick muck and areas having a thin surface layer of dark silt loam underlain by a layer with a depleted matrix and prominent redoximorphic features.

Wetland SL-C meets several criteria to be considered a WoSS. Portions of the wetland within 25-feet of the stream are WoSS as are the emergent marsh and open water portions of the complex, as these areas are in excess of 20,000 square feet in size. FEMA currently does not have regulated floodplains mapped through this area of Kittery, however there is preliminary zoning within the limits of Wetland SL-C. Additional areas of Wetland SL-C may be classified as WoSS in the future once the zoning is finalized.

Primary functions of Wetland SL-C are floodflow alteration/storage, wildlife habitat, sediment/toxicant/pathogen retention, nutrient removal/retention/transformation, and shoreline stabilization.

Wetland SL-D

Wetland SL-D is a seasonally flooded/saturated palustrine broad leaved deciduous forested wetland (PFO1E) and a potential vernal pool. It is situated west of Route 236 behind commercial businesses and an apartment complex.

Vegetation within the wetland includes red oak, white pine, American beech, arrowwood saplings, and New York fern (*Thelypteris noveboracensis*). Soils in the wetland consist of a depleted layer with redoximorphic features in the top 6-inches. Signs of hydrology included water-stained leaves and many of the trees within the wetland had moss trimmed trunks.

Wildlife habitat is the primary function provided by Wetland SL-D.

Wetland SL-E (Herb Parsons Pond)

Wetland SL-E is Herb Parsons Pond; it is a permanently flooded diked/impounded pond with an unconsolidated bottom surrounded by a seasonally flooded/saturated palustrine broad leaved deciduous forested wetland (PUB3Hh/PFO1E). The pond is located adjacent to the Southern Maine Fish and Game Club and south of Martin Road.

Vegetation within the forested portion of the wetland includes red oak, white pine, meadowsweet, speckled alder, highbush blueberry, and cinnamon fern. The soil profile consists of a thick dark layer underlain by a layer of depleted sand with redoximorphic features.

The water level within the pond was very low at the time of the field survey, however there was evidence of variable water levels. The open water portion of Wetland SL-E meets the criteria of WoSS as the pond is over 20,000 SF in size.

Wildlife habitat, fish/shellfish habitat, and recreation are the primary functions of Wetland SL-E.

Wetland SL-F

Wetland SL-F is a seasonally flooded/saturated palustrine broad leaved deciduous forested wetland (PFO1E). The wetland is situated east of Dennett Road and south of Wetland SL-E; it is traversed by Happy Avenue. Vegetation within the wetland includes red oak, white pine, American beech, highbush blueberry, meadowsweet, cinnamon fern, sensitive fern, and royal fern.

Sediment/toxicant/pathogen retention, wildlife habitat, and nutrient removal/retention/transformation are the primary functions of Wetland SL-F.

Wetland SL-G

Wetland SL-G is a seasonally flooded/saturated palustrine broad leaved deciduous forested wetland (PFO1E). The wetland is situated east of Dennett Road and north of a residential home at 100 Dennett Road. The wetland serves as a drainage way conveying flow adjacent to the property to a culvert under Dennett Road. Vegetation within the wetland includes red oak, white pine, American beech, arrowwood, sensitive fern, highbush blueberry, meadowsweet, royal fern, cinnamon fern, multiflora rose, glossy false buckthorn, and barberry.

Sediment/toxicant/pathogen retention and nutrient removal/retention/transformation are the primary functions of Wetland SL-G.

Wetland SL-H

Wetland SL-H has seasonally flooded/saturated palustrine emergent and broad leaved deciduous forested wetland components (PEM1/PFO1E). The wetland is situated east of Dennett Road and east of Wetland SL-G behind the residential home at 100 Dennett Road. Vegetation within the wetland includes red oak, red maple, highbush blueberry, tussock sedge (*Carex stricta*), sweetgale (*Myrica gale*), meadowsweet, and buckthorn.

Wildlife habitat is the primary function of Wetland SL-H.

Wetland SL-I

Wetland SL-I is a seasonally flooded/saturated palustrine broad leaved deciduous forested wetland (PFO1E) situated along the east side of Dennett Road. A portion of the wetland is ditched, conveying water towards a culvert carrying flow west under the road.

Vegetation within the wetland includes green ash (*Fraxinus pennsylvanica*), red oak, winterberry, highbush blueberry, arrowwood, speckled alder, meadowsweet, multiflora rose, glossy false buckthorn, *Carex* sp., sensitive fern, royal fern, and cinnamon fern. Soils in the wetland consist of a dark surface underlain by a depleted layer of sand with prominent redoximorphic features and a hydrogen sulfide odor.

Sediment/toxicant/pathogen retention, nutrient removal/retention/transformation, and wildlife habitat are the primary functions of Wetland SL-I.

Wetland SL-J

Wetland SL-J is a small seasonally flooded/saturated broad leaved deciduous palustrine forested wetland (PFO1E). The wetland is situated south of Martin Road and west of Commanders Way, a private residential road. During seasonally wet times of the year or during rain events, water from Wetland SL-J flows east through a culvert under the private road to Wetland SL-C. Vegetation within the wetland includes red maple, eastern hemlock, *Carex* sp., cinnamon fern, and sensitive fern.

Sediment/toxicant/pathogen retention and nutrient removal/retention/transformation are the primary functions of Wetland SL-J.

Wetland SL-K

Wetland SL-K is a seasonally flooded/saturated palustrine broad leaved deciduous forested wetland (PFO1E) and a potential vernal pool. The wetland is located to the east of Dennett Road and of Wetland SL-I. Vegetation within the wetland includes paper birch, white pine, American beech, red oak, highbush blueberry, arrowwood, multiflora rose, royal fern, cinnamon fern, and meadowsweet.

Wildlife habitat, sediment/toxicant/pathogen retention, and nutrient removal/retention/transformation are primary functions of Wetland SL-K.

Wetland SL-L

Wetland SL-L is situated in the center of the Survey Area, east of residential homes located along Roseberry Lane and west of the powerline right-of-way traversing the site. The wetland is a seasonally flooded/saturated palustrine system with both forested and emergent marsh components (PFO1/PEM1E). The wetland is also a potential vernal pool surrounded by intact upland forest.

Vegetation within the wetland includes white pine, red oak, red maple, highbush blueberry, black huckleberry (*Gaylussacia baccata*), woolgrass, winterberry, common soft rush, tussock sedge, and cinnamon fern. Water-stained leaves and two areas of isolated standing water up to 4-inches deep were observed within the wetland.

Soils within the wetland consist of a thick (approximately 18”) muck layer underlain by a depleted mineral layer with redoximorphic features.

Wildlife habitat, nutrient removal/retention/transformation, floodflow alteration/retention, and sediment/toxicant/pathogen retention are the primary functions of Wetland SL-L.

Wetland SL-M

Wetland SL-M is a permanently flooded excavated pond with an unconsolidated bottom surrounded by a seasonally flooded/saturated palustrine broad leaved deciduous forested wetland (PUB3Hx/PFO1E). The wetland and pond are situated within the Interstate 95 on ramp loop off Dennett Road at the southwest corner of the Survey Area.

Vegetation within the forested portion includes red maple, white pine, paper birch, speckled alder, winterberry, American witch hazel *(Hamamelis virginiana)*, highbush blueberry, sensitive fern, and cinnamon fern. Soils consist of a depleted silty loam with redoximorphic features within the first 6-inches of the soil surface. Vegetation growing within and along the open water portion of Wetland SL-M includes highbush blueberry, buttonbush (*Cephalanthus occidentalis*), winterberry, woolgrass, broadleaved cattail, and purple loosestrife.

The open water portion of Wetland SL-M meets the criteria of WoSS as the pond is over 20,000 SF in size.

Wildlife habitat, floodflow alteration/retention, sediment/toxicant/pathogen retention, and shoreline stabilization are the primary functions of Wetland SL-M.

Wetland JF-A

Wetland JF-A is a ditch situated west of Route 236 in front of a commercial building. The ditch meets the classification of an excavated, intermittently flooded palustrine emergent wetland with persistent vegetation (PEM1Jx). Vegetation within the wetland includes meadowsweet, broad leaved cattail, multiflora rose, and oriental bittersweet.

Sediment/toxicant/pathogen retention and nutrient removal/retention/transformation are the primary functions of Wetland JF-A.

Wetland JF-B

Wetland JF-B is situated within the Interstate 95 on and off ramp loop in the southeast corner of the Survey Area. The system is a floodplain wetland associated with Stream 1 meeting the classification of a seasonally flooded/saturated palustrine forested and scrub shrub wetland having broad-leaved, deciduous vegetation (PFO1/PSS1E). The portion of wetland within 25-feet of the stream meet the criteria of WoSS, due to the association with the stream.

Vegetation within the wetland includes white pine, red oak, red maple, winterberry, sensitive fern, multiflora rose, and broad-leaved cattail.

Floodflow alteration, nutrient removal/retention/transformation, and sediment/toxicant/pathogen retention are the primary functions of Wetland JF-B.

Wetland JF-C

Wetland JF-C is a floodplain wetland associated with Stream 1 and a seasonally flooded/saturated palustrine system with forested and emergent marsh components (PFO1/PEM1E). It is situated within the Interstate 95 on and off ramp loop adjacent to Wetland JF-B. Vegetation within the wetland includes white pine, red maple, and sensitive fern.

The portion of wetland within 25-feet of the stream meet the criteria of WoSS, due to the association with the stream.

Sediment/toxicant/pathogen retention and nutrient removal/retention/transformation are the primary functions of Wetland JF-C.

Wetland JF-D

Wetland JF-D is situated adjacent to the powerlines that traverse the Survey Area in the southern section. The complex is a seasonally flooded/saturated palustrine wetland with forested and scrub shrub components (PFO1/PSS1E); it is also a potential vernal pool.

Vegetation within the wetland includes American beech, common soft rush, buckthorn, speckled alder, sedge species, broadleaved cattail, and meadowsweet.

Nutrient removal/retention/transformation and wildlife habitat are the primary functions of Wetland JF-D.

Wetland JF-E

Wetland JF-E is associated with Stream 4 and is a seasonally flooded/saturated palustrine wetland with forested and emergent marsh components (PFO1/PEM1E). The wetland is situated west of Route 236 and east of Martin Road. Vegetation within the wetland includes red maple, speckled alder, multiflora rose, cinnamon fern, and sensitive fern.

Owing to its association with a stream, the portions of wetland within 25-feet of the stream meet the criteria of WoSS. FEMA currently does not have regulated floodplains mapped through this area of Kittery, however there is preliminary zoning within the limits of Wetland JF-E. Additional areas of Wetland JF-E may be classified as WoSS in the future once the zoning is finalized.

Floodflow alteration/storage, nutrient removal/retention/transformation and sediment/toxicant/pathogen retention are the primary functions of Wetland JF-E.

Wetland JF-F

Wetland JF-F is a small seasonally flooded/saturated palustrine forested wetland with broad leaved deciduous vegetation (PFO1E). The wetland is situated west of Route 236 in front of a residential home. Vegetation within the wetland includes white pine, red oak, paper birch, speckled alder, meadowsweet, cinnamon fern, and sensitive fern.

Sediment/toxicant/pathogen retention and nutrient removal/retention/transformation are the primary functions of Wetland JF-F.

Wetland JF-G

Wetland JF-G is a seasonally flooded/saturated palustrine forested and scrub shrub wetland with broad leaved deciduous vegetation (PFO1/PSS1E). The wetland is situated west of Route 236 and in front of a residential home. Standing water up to 2-inches and water-stained leaves were present in the wetland during the field investigation. Vegetation within the wetland includes red oak, white pine, winterberry, multiflora rose, and sensitive fern.

Sediment/toxicant/pathogen retention is the primary function of Wetland JF-G.

Wetland JF-H

Wetland JF-H is a ditch is situated west of Route 236 in front of a commercial building. The wetland is an excavated, intermittently flooded palustrine emergent wetland with persistent vegetation (PEM1Jx). Vegetation within the wetland includes narrow leaved cattail *(Typha angustifolia)*, white pine, staghorn sumac *(Rhus hirta)*, meadowsweet, and sensitive fern.

Sediment/toxicant/pathogen retention is the primary function of Wetland JF-H.

Wetland JF-I

Wetland JF-I is a seasonally flooded/saturated palustrine emergent and broad leaved deciduous forested wetland (PEM1/PFO1E). The wetland is situated west of Route 236 directly behind a commercial business. Vegetation within the wetland includes red oak, white pine, narrow leaved cattails, purple loosestrife, multiflora rose, sensitive fern, and cinnamon fern.

Floodflow alteration and sediment/toxicant/pathogen retention are the primary functions of Wetland JF-I.

Wetland JF-J

Wetland JF-J is a ditch situated north of I-95 perpendicular to Stream 1 near the southern boundary of the Survey Area. The wetland meets the classification of an excavated, intermittently flooded emergent marsh with persistent vegetation (PEM1Jx).

Vegetation within the wetland includes multiflora rose, narrow leaved cattail, common reed, meadowsweet, purple loosestrife, and speckled alder. The wetland has been partially mowed. Owing to its association with Stream 1, the portions of wetland within 25-feet of the stream meet the criteria of WoSS.

Sediment/toxicant/pathogen retention and nutrient removal/retention/transformation are the primary functions of Wetland JF-J.

Stream 1

Stream 1 originates north of the Survey Area and flows south through Wetland SL-C, Wetland SL-B, Wetland JF-B, Wetland JF-C, and Wetland JF-J. The watercourse is an upper perennial stream with a mud substrate (R3UB3).

Segments of the stream were well-defined, however in some areas the stream channel becomes diffuse and indistinguishable. Where measurable, during the field investigation wetted width of the stream was approximately 14 inches with water depth ranging from 0.5 to 4 inches.

The stream is impounded at the southern end of Wetland SL-C and as such a large area of ponded water is situated within the wetland and along the dirt road traversing the southeast corner of the Survey Area. This dirt road separates Wetland SL-C from Wetland SL-B.

Stream 2

Stream 2 is an upper perennial stream with sand and organic substrate (R3UB2/4). The watercourse begins within Wetland SL-C near the center of the Survey Area and flows east. During the field investigation wetted width was approximately 20 inches with water depth of the stream ranging from 4 to 6 inches.

Stream 3

Stream 3 starts within the southwest corner of Wetland SL-C and flows northeast towards Streams 2 and 1 through a narrow trail corridor created by/used by ATVs or other off-road vehicles. It drains to the open water area of Wetland SL-C.

The watercourse is intermittent with a streambed composed of sand and organic substrate (R4SB4/6). During the field investigation the wetted width of the channel was approximately 15 to 20 inches with water depths ranging from 4 to 6 inches.

Stream 4

Stream 4 begins outside of the survey area to the northeast and is associated with Wetland JF-E. The watercourse is an upper perennial stream with a cobble-gravel, sand, and mud substrate (R3UB1/2/3) that flows west to east and then south to a culvert. During the field investigation the wetted width of the stream channel ranged 12 to 14 inches with water depths ranging approximately 4 to 5 inches.

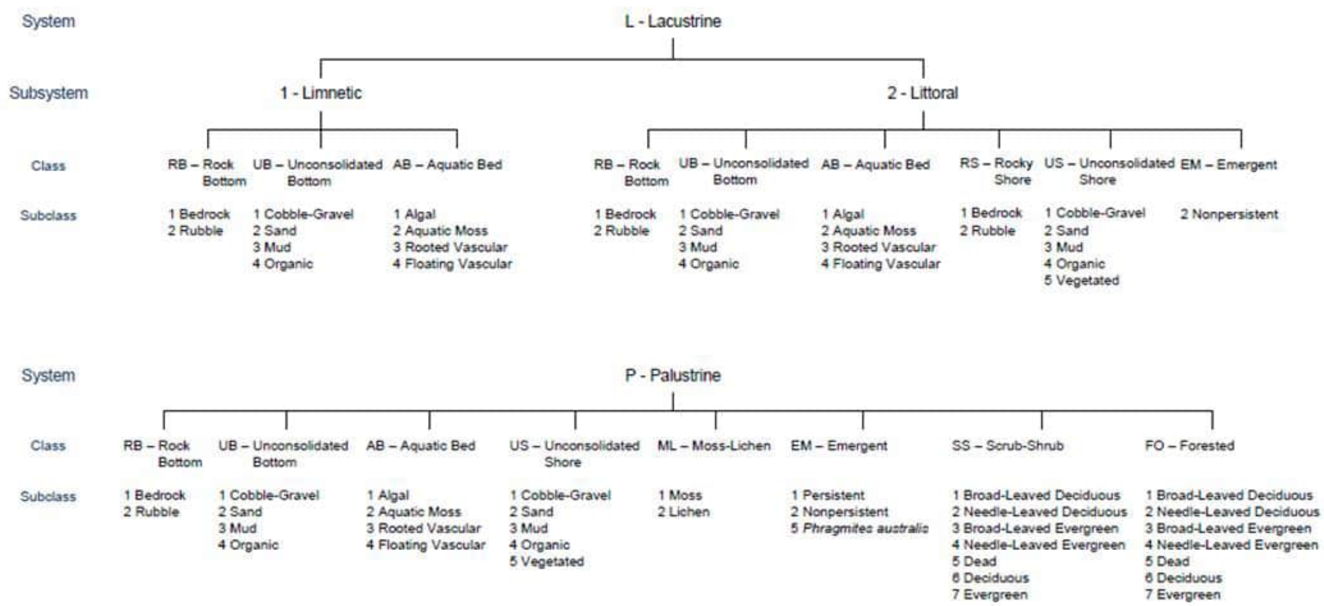
Stream 5

Stream 5 starts within the survey area and flows west under Dennett Road. The watercourse is an upper perennial stream with a cobble-gravel and sand substrate (R3UB1/2). During the field investigation wetted width was approximately 12 inches with water depths ranging from 1 to 2 inches.

The properties at 76 and 70 Dennett Road (Parcels 6-15B, 6-15A, and 13-04) were posted for no trespassing and were actively under construction. As such, the upper reaches of Stream 5 were not surveyed due to access constraints.

ATTACHMENT 1. COWARDIN CLASSIFICATION SYSTEM CHART

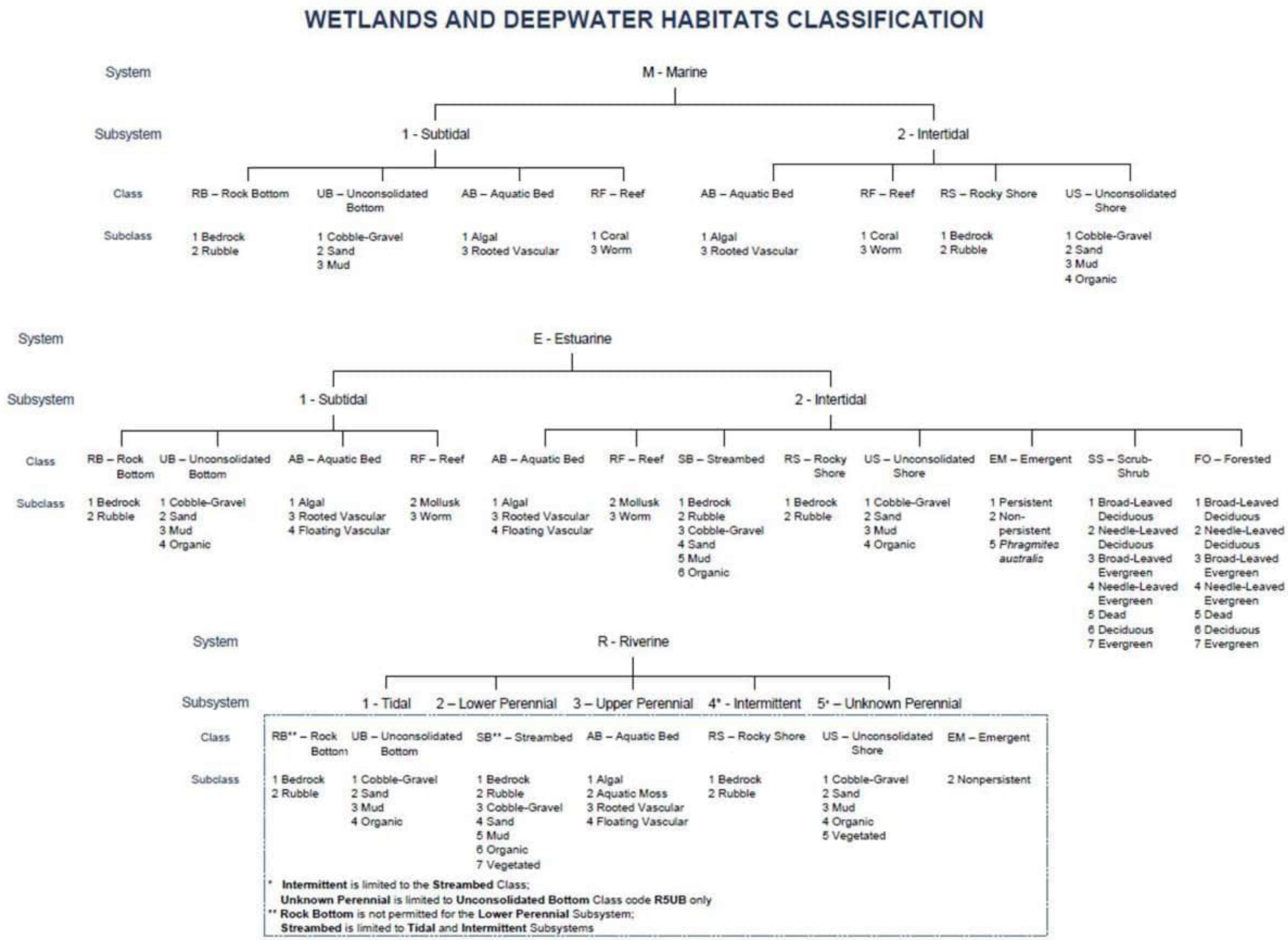
WETLANDS AND DEEPWATER HABITATS CLASSIFICATION



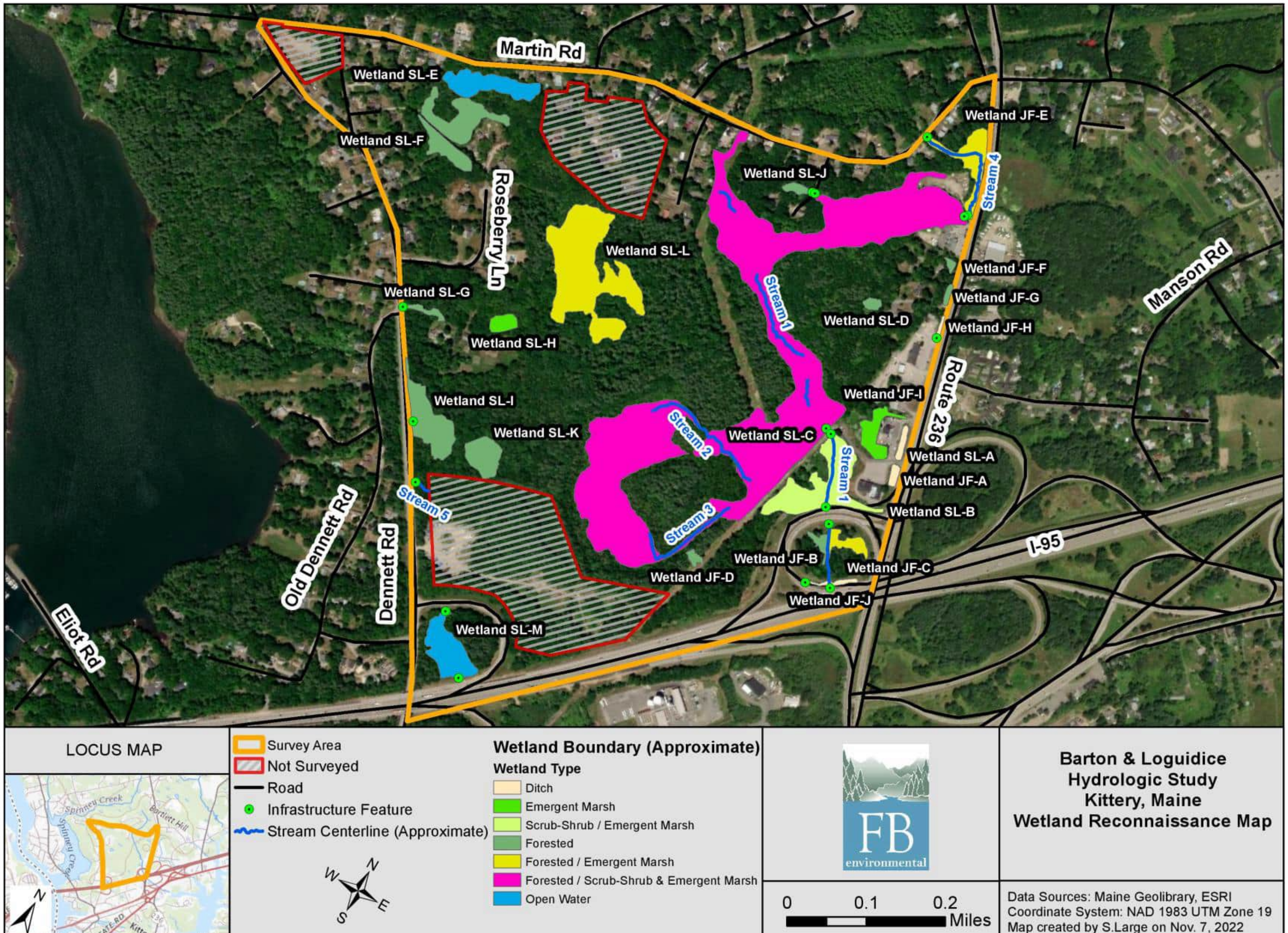
MODIFIERS

In order to more adequately describe the wetland and deepwater habitats, one or more of the water regime, water chemistry, soil, or special modifiers may be applied at the class or lower level in the hierarchy. The farmed modifier may also be applied to the ecological system.

Water Regime			Special Modifiers	Water Chemistry			Soil
Nontidal	**Saltwater Tidal**	**Freshwater Tidal**		**Coastal Halinity**	**Inland Salinity**	**pH Modifiers for all Fresh Water**	
A Temporarily Flooded	L Subtidal	S Temporarily Flooded-Tidal	b Beaver	1 Hyperhaline	7 Hypersaline	a Acid	g Organic
B Saturated	M Irregularly Exposed	R Seasonally Flooded-Tidal	d Partly Drained/Ditched	2 Euhaline	8 Eusaline	t Circumneutral	n Mineral
C Seasonally Flooded	N Regularly Flooded	T Semipermanently Flooded-Tidal	f Farmed	3 Mixohaline (Brackish)	9 Mixosaline	i Alkaline	
E Seasonally Flooded/ Saturated	P Irregularly Flooded	V Permanently Flooded-Tidal	h Diked/Impounded	4 Polyhaline	0 Fresh		
F Semipermanently Flooded			r Artificial	5 Mesohaline			
G Intermittently Exposed			s Spoil	6 Oligohaline			
H Permanently Flooded			x Excavated	0 Fresh			
J Intermittently Flooded							
K Artificially Flooded							


WETLANDS AND DEEPWATER HABITATS CLASSIFICATION
System
M - Marine
Subsystem
1 - Subtidal
2 - Intertidal
Class
RB – Rock Bottom
UB – Unconsolidated Bottom
AB – Aquatic Bed
RF – Reef
AB – Aquatic Bed
RF – Reef
RS – Rocky Shore
US – Unconsolidated Shore
Subclass
1 Bedrock
2 Rubble
1 Cobble-Gravel
2 Sand
3 Mud
1 Algal
3 Rooted Vascular
1 Coral
3 Worm
1 Algal
3 Rooted Vascular
1 Coral
3 Worm
1 Bedrock
2 Rubble
1 Cobble-Gravel
2 Sand
3 Mud
4 Organic
System
E - Estuarine
Subsystem
1 - Subtidal
2 - Intertidal
Class
RB – Rock Bottom
UB – Unconsolidated Bottom
AB – Aquatic Bed
RF – Reef
AB – Aquatic Bed
RF – Reef
SB – Streambed
RS – Rocky Shore
US – Unconsolidated Shore
EM – Emergent
SS – Scrub-Shrub
FO – Forested
Subclass
1 Bedrock
2 Rubble
1 Cobble-Gravel
2 Sand
3 Mud
4 Organic
1 Algal
3 Rooted Vascular
4 Floating Vascular
2 Mollusk
3 Worm
1 Algal
3 Rooted Vascular
4 Floating Vascular
2 Mollusk
3 Worm
1 Bedrock
2 Rubble
3 Cobble-Gravel
4 Sand
5 Mud
6 Organic
1 Bedrock
2 Rubble
1 Cobble-Gravel
2 Sand
3 Mud
4 Organic
1 Persistent
2 Non-persistent
5 Phragmites australis
1 Broad-Leaved Deciduous
2 Needle-Leaved Deciduous
3 Broad-Leaved Evergreen
4 Needle-Leaved Evergreen
5 Dead
6 Deciduous
7 Evergreen
1 Broad-Leaved Deciduous
2 Needle-Leaved Deciduous
3 Broad-Leaved Evergreen
4 Needle-Leaved Evergreen
5 Dead
6 Deciduous
7 Evergreen
System
R - Riverine
Subsystem
1 - Tidal
2 – Lower Perennial
3 – Upper Perennial
4* - Intermittent
5* – Unknown Perennial
Class
RB** – Rock Bottom
UB – Unconsolidated Bottom
SB** – Streambed
AB – Aquatic Bed
RS – Rocky Shore
US – Unconsolidated Shore
EM – Emergent
Subclass
1 Bedrock
2 Rubble
1 Cobble-Gravel
2 Sand
3 Mud
4 Organic
1 Bedrock
2 Rubble
3 Cobble-Gravel
4 Sand
5 Mud
6 Organic
7 Vegetated
1 Algal
2 Aquatic Moss
3 Rooted Vascular
4 Floating Vascular
1 Bedrock
2 Rubble
1 Cobble-Gravel
2 Sand
3 Mud
4 Organic
5 Vegetated
2 Nonpersistent
* Intermittent is limited to the Streambed Class;
Unknown Perennial is limited to Unconsolidated Bottom Class code R5UB only
** Rock Bottom is not permitted for the Lower Perennial Subsystem;
Streambed is limited to Tidal and Intermittent Subsystems

ATTACHMENT 2. WETLAND RECONNAISSANCE MAP



Notes: 1. This map represents a preliminary wetland assessment of the survey area; depicted wetland boundaries are approximate. 2. This map does not represent an official wetland delineation, nor does it depict all wetlands that might be present within the survey area boundary 3. Areas not surveyed were inaccessible.

ATTACHMENT 3. SITE PHOTOGRAPHS

Photo 1. Wetland SL-A is a ditch situated along Route 236.

Photo 2. Wetland SL-B is a scrub-shrub and emergent complex associated with Stream 1.

Photo 3. Representative view of the forested/scrub-shrub portion of Wetland SL-C.

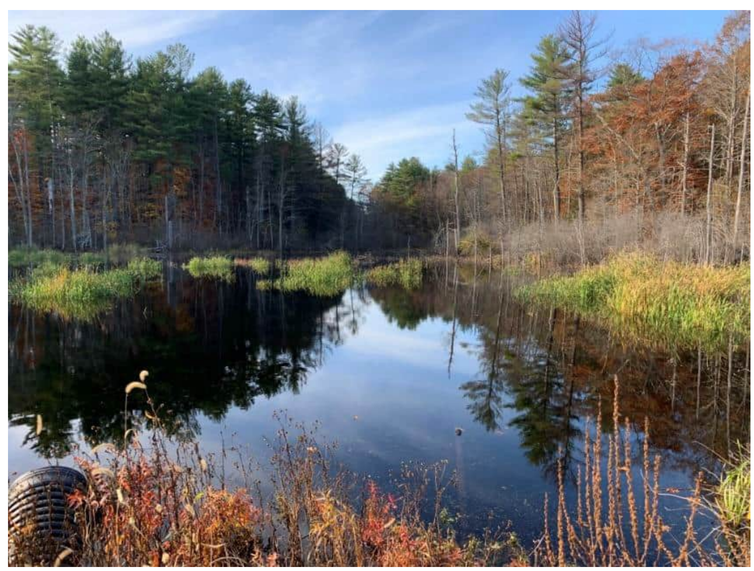


Photo 4. A view of the open water and emergent marsh portion of Wetland SL-C. Wetland SL-C's primary functions are floodflow alteration/ storage and wildlife habitat.

Photo 5. Wetland SL-D is a small, discrete depression in the wooded area behind an apartment complex along Route 236.

Photo 6. Herb Parsons Pond, Wetland SL-E. The water level was very low during the field investigation.

Photo 7. Highbush blueberry (*Vaccinium corymbosum*) growing within Wetland SL-F which is a forested system.

Photo 8. Wetland SL-G is a seasonally flooded/saturated palustrine forested wetland with broad leaved deciduous vegetation (PFO1E).

Photo 9. Wetland SL-H is a shallow basin with emergent marsh vegetation.

Photo 10. Wetland SL-I is a seasonally flooded/saturated palustrine broad leaved deciduous forested wetland (PFO1E).

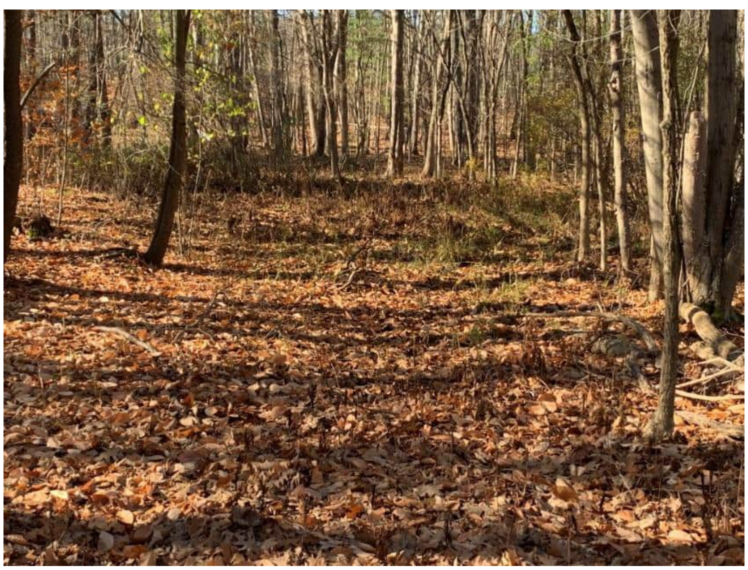


Photo 11. Wetland SL-J is a small, forested wetland that is hydrologically connected to Wetland SL-C by a culvert under Commanders Way, a private residential road.

Photo 12. Wetland SL-K is a seasonally flooded/saturated palustrine broad leaved deciduous forested wetland (PFO1E).

Photo 13. A representative view of the scrub-shrub portion of Wetland SL-L.

Photo 14. Two open water and emergent marsh areas within Wetland SL-L were identified as potential vernal pools.

Photo 15. Wetland SL-M is a permanently flooded excavated pond with an unconsolidated bottom surrounded by a seasonally flooded/saturated palustrine broad leaved deciduous forested wetland (PUB3Hx/PFO1E).

Photo 16. A representative view of the forested portion of Wetland SL-M.

Photo 17. Wetland JF-A is a ditch situated along Route 236.

Photo 18. Wetland JF-B is a forested/scrub-shrub wetland complex associated with Stream 1.

Photo 19. Representative view of the forested portion of Wetland JF-C.

Photo 20. FBE identified wetland JF-D as a potential vernal pool.

Photo 21. Wetland JF-E is a seasonally flooded/saturated palustrine broad leaved deciduous forested and emergent wetland (PFO1/PEM1E) that is hydrologically connected to Wetland SL-C through a culvert under a dirt road.

Photo 22. Wetland JF-F is a forested wetland located between Route 236 and near a residence.

Photo 23. A representative photo of Wetland JF-G.

Photo 24. Wetland JF-H is a ditch situated along Route 236.

Photo 22. A representative view of the forested portion of Wetland JF-I.

Photo 23. Wetland JF-J is a ditch within the I-95 on/off ramp in the southeast corner of the Survey Area.

Photo 24. Stream 1 is a perennial watercourse with a mud substrate flowing through Wetland JF-B and JF-C.

Photo 25. View of a reach of Stream 1 that flows through Wetland SL-C.

Photo 26. A representative view of Stream 2, a perennial mud-bottomed stream.

Photo 27. Stream 3 flows through an ATV/off-road vehicle path.

Photo 28. Stream 4 is a perennial watercourse with a mud substrate flowing through Wetland JF-E.

Photo 29. Stream 5 is a perennial stream with a substrate consisting of cobble-gravel and sand.

Photo 30. A gravel road carrying a sewer line traverses the southeast portion of the Survey Area.

Photo 31. A view of the powerline right-of-way from Martin Road.

Photo 32. Evidence of beaver activity in and around Wetland SL-C.

Photo 33. Woodpecker holes in a tree near Wetland SL-C.

Appendix D

Public Engagement Meeting Presentations

Barton & Loguidice | The Experience to Listen. The Power to Solve.

Town of Kittery Highway 236/Dennett Road Hydrologic Watershed Study

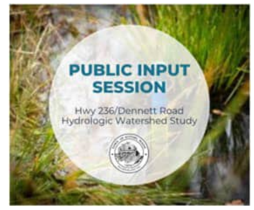
PUBLIC MEETING #1 December 15, 2022

1

Barton & Loguidice

Agenda

I. Project Team Introductions
II. Watershed Study Overview
III. Priority Areas
IV. Public Participation
V. Project Schedule



PUBLIC MEETING #1 – DECEMBER 15, 2022

2

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Project Team Introductions

PUBLIC MEETING #1 – DECEMBER 15, 2022

3

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Project Team Introductions

- Town of Kittery
- Barton & Loguidice, D.P.C.
- Streamworks, PLLC
- FB Environmental Associates
- Stake Holders

PUBLIC MEETING #1 – DECEMBER 15, 2022

4

Watershed Study Overview

PUBLIC MEETING #1 – DECEMBER 15, 2022

5

Watershed Study Goals

I. Evaluate Existing Conditions / Areas of Concern

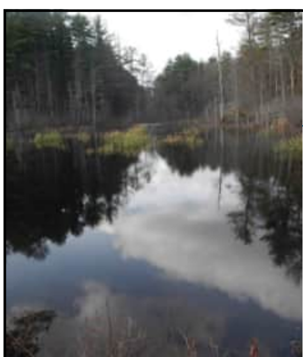
II. Evaluate Future Hydrologic Scenarios

III. Nutrient Pollutant Loading Analysis

IV. Develop Mitigation Alternatives

PUBLIC MEETING #1 – DECEMBER 15, 2022

6

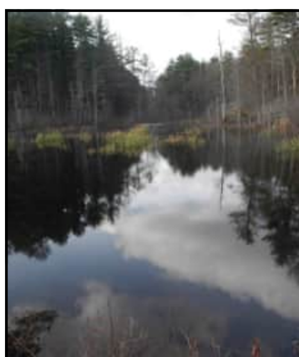


Evaluate Existing Conditions

- Data Collection
  - Desktop Delineation
  - Inventory of Known Flooding Locations
  - Inventory of Resources

PUBLIC MEETING #1 – DECEMBER 15, 2022

7

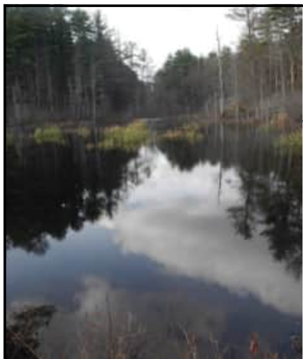


Evaluate Existing Conditions

- Field Reconnaissance
  - Catalog Stormwater Infrastructure
  - Assessment of Known Flooding Locations
  - Refine Subwatershed Delineations
  - Wetland Mapping

PUBLIC MEETING #1 – DECEMBER 15, 2022

8



Evaluate Existing Conditions

- Hydrologic & Hydraulic Modeling
  - Model a range of flood discharges
  - Determine existing stormflow volumes and peak discharge rates
  - Develop comprehensive detailed analysis of existing flood conditions

PUBLIC MEETING #1 – DECEMBER 15, 2022

9

Evaluate Future Hydrologic Scenarios

- Modeling Evaluation of Three Build-Out Scenarios
  - No Build
  - Low Density Build-Out
  - High Density Build-Out
  - Extreme Storm Event/Climate Change Scenarios

PUBLIC MEETING #1 – DECEMBER 15, 2022

10

Nutrient Pollutant Loading Analysis

- Estimate Nutrient Loading From Study Area Subwatersheds

- Evaluate existing water quality conditions
- Inform mitigation alternative ranking and selection
- Incorporate Previous Studies (Spruce Creek Watershed Management Plan)

PUBLIC MEETING #1 – DECEMBER 15, 2022

11

Development of Mitigation Alternatives

- Mitigation Alternative Categories
  - Modifications to the Existing Drainage System
  - Installation of Stormwater Detention
  - Installation of Green Infrastructure Stormwater Retrofits
  - Property Protection
  - Flood Damage Protection and Planning
  - Structural Projects
  - Evaluation of Land Use Planning and Zoning
  - Water Quality Improvements
  - Natural Resource Protection / Conservation Opportunities

PUBLIC MEETING #1 – DECEMBER 15, 2022

12

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Development of Mitigation Alternatives

- Develop Ranking Matrix of Potential Alternatives
- Select Prioritized Alternatives

PUBLIC MEETING #1 – DECEMBER 15, 2022

13

Mitigation Alternative Matrix - Prioritization

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RANKING

- Stormwater Benefits (total 55 out of 100 points)
  - Flood reduction (45 points)
  - Nutrient reduction – water quality benefit (10 points)
- Constructability (total 20 out of 100 points)
  - Ownership: public or private (10 points)
  - Known constraints (5 points)
  - Permitting (5 points)
- Cost (total 20 out of 100 points)
  - Construction Cost – (10 points)
  - Maintenance Cost (5 points)
  - Fundability (5 points)
- Co-Benefits (total 5 out of 100 points)
  - Energy and air quality impacts (1 point)
  - Habitat and biodiversity (1 point)
  - Community and aesthetic benefits (1 point)
  - Human health benefits (1 point)
  - Educational opportunities/visibility (1 point)

PUBLIC MEETING #1 – DECEMBER 15, 2022

14

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Areas of Interest

PUBLIC MEETING #1 – DECEMBER 15, 2022

15

Preliminary Areas of Interest

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PUBLIC MEETING #1 – DECEMBER 15, 2022

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Preliminary Areas of Interest

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Martin Rd / Hwy-236


Fish and Game Pond


Martin Rd / Hwy-236


Spruce Creek Wetlands


Central Study Area

PUBLIC MEETING #1 – DECEMBER 15, 2022

17

Preliminary Wetland Inventory

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PUBLIC MEETING #1 – DECEMBER 15, 2022

18

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Public Participation

PUBLIC MEETING #1 – NOVEMBER 10, 2022

19

Public Participation Resources

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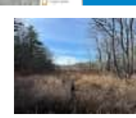
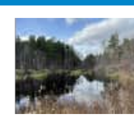
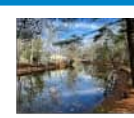
- Interactive Mapper - Identify problem areas or potential opportunities for watershed improvement
- Community Survey – Identify stakeholder priorities and perceptions of the watershed

- Town of Kittery Website
- Interactive Mapper
- Community Survey







www.kitteryme.gov/watershedinputsession

PUBLIC MEETING #1 – DECEMBER 15, 2022

20

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Project Schedule & Next Steps

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Project Schedule

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- Public Information Meeting #1 – December 2022 – Project Introduction
- Public Information Meeting #2 – February 2023 – Preliminary Modeling Results, Nutrient Loading, and Resource Inventory
- Public Information Meeting #3 – April 2023 – Evaluation of Mitigation Alternative Recommendations, Draft Report
- Town Council / Public Information Meeting #4 – June 2023 – Final Report / Presentation of Findings

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Barton & Loguidice

Contact Information

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dhanny@bartonandloguidice.com

Jack Williams, Barton & Loguidice, D.P.C.
jwilliams@bartonandloguidice.com

Project Information
(Survey and Interactive Mapper)

www.kitteryme.gov/watershedinputsession

Project Information

23

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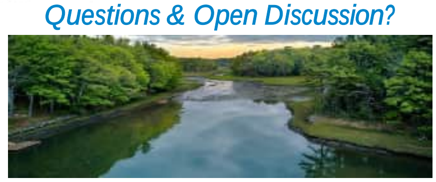
Questions & Open Discussion?



Project Information
(Survey and Interactive Mapper)
www.kitteryme.gov/watershedinputsession

bartonandloguidice.com

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Town of Kittery Highway 236/Dennett Road Hydrologic Watershed Study

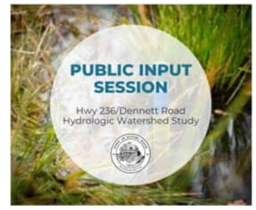
PUBLIC MEETING #2 MARCH 22, 2023

1

Barton & Loguidice

Agenda

I. Project Recap / Progress Review
II. Public Input Summary
III. Preliminary Modeling Results
IV. Nutrient Loading Overview
V. Herb Parson Pond
VI. Next Steps & Project Schedule



PUBLIC MEETING #2 – MARCH 22, 2023

2

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Project Recap

PUBLIC MEETING #2 – MARCH 22, 2023

3

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Project Team

- Town of Kittery
- Barton & Loguidice, D.P.C.
- Streamworks, PLLC
- FB Environmental Associates
- Stakeholders

PUBLIC MEETING #2 – MARCH 22, 2023

4

Barton & Loguidice

Project Goals

I. Evaluate Existing Conditions / Areas of Concern

II. Evaluate Potential Future Development

III. Evaluate Mitigation Alternatives
   I. Improve Existing Conditions
   II. Evaluate Future Development Decisions

PUBLIC MEETING #2 – MARCH 22, 2023

5

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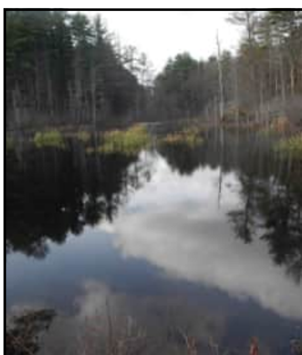
Progress Summary

PUBLIC MEETING #2 – MARCH 22, 2023

6



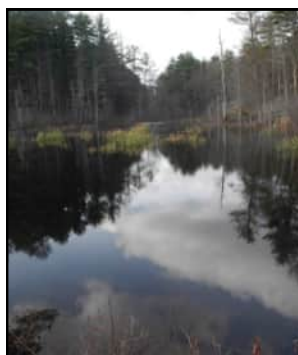
Barton & Loguidice

Evaluate Existing Conditions

- Desktop Review
  - Drainage Patterns
  - Soil Types
  - Resource Identification
- Identify Existing Areas of Concern
  - Public outreach
  - Stakeholder input
  - *(www.kitteryme.gov/watershedinputsession)*

PUBLIC MEETING #2 – MARCH 22, 2023

7



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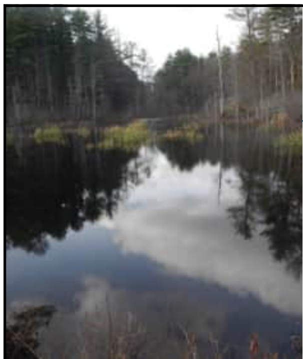
Evaluate Existing Conditions

- Data Collection
  - Inventory of Critical Drainage Infrastructure
  - Inventory of Known Flooding Locations
  - Inventory of Resources

PUBLIC MEETING #2 – MARCH 22, 2023

8



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Evaluate Existing Conditions

- Field Reconnaissance
  - Catalog Stormwater Infrastructure
  - Assessment of Known Flooding Locations
  - Refine Subwatershed Delineations
  - Wetland Mapping

PUBLIC MEETING #2 – MARCH 22, 2023

9

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Areas of Interest

PUBLIC MEETING #2 – MARCH 22, 2023

10

Preliminary Areas of Interest

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PUBLIC MEETING #2 – MARCH 22, 2023

11

Preliminary Areas of Interest

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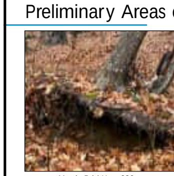

Martin Rd / Hwy-236

Herb Parson Pond

Martin Rd / Hwy-236

Spruce Creek Wetlands

Central Study Area

PUBLIC MEETING #2 – MARCH 22, 2023

12

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Public Input Summary (To-Date)

PUBLIC MEETING #2 – MARCH 22, 2023

13

Interactive Mapper – Results Overview

Pond History /
Lack of Pond Inflow

History of Flooding

- History of Flooding
- High Water Table
- Beaver Dams
- Potentially Undersized Infrastructure

PUBLIC MEETING #2 – MARCH 22, 2023

14

Community Survey – Summary & Takeaways

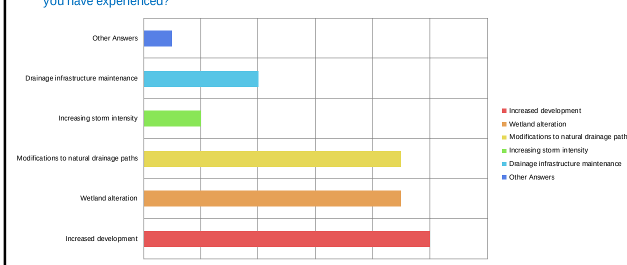
- Over ½ of respondents have experienced flooding at their property (62%)
    - Variability between start of flood occurrences
    - Combination of seasonal and ongoing flooding
    - Most residents identified Spring as most frequent flooding season
    - Multiple respondents indicated costs have been incurred related to residential flooding
    - 66% suspect flooding to be more groundwater related than surface water related
- Most respondents reside on Martin Road, followed by Dennett Road
- Most respondents indicated living in close proximity to a surface water resource (stream, wetland)

PUBLIC MEETING #2 – MARCH 22, 2023

15

Community Survey – Summary & Takeaways

Question: What do you feel are the primary contributing factors to localized flooding that you have experienced?



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Environmental Setting

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Full Study Area and Focus Study Area

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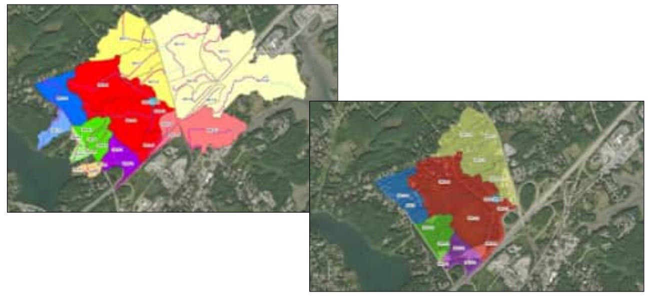

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Environmental Setting – Resource Inventory

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Environmental Setting – Land Cover (NLCD, 2019)

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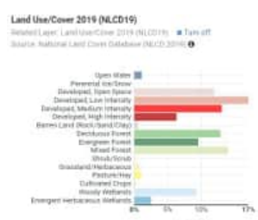

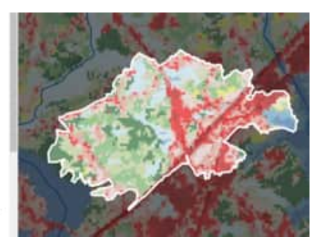

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Environmental Setting – Hydrologic Soil Group

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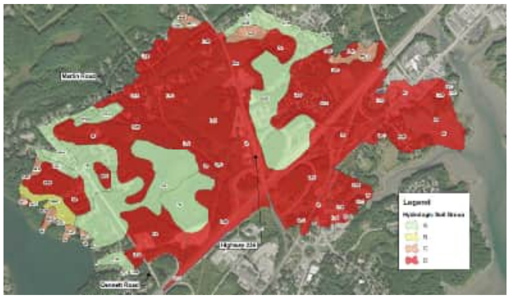

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Environmental Setting – Depth to Water Table

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HydroCAD Modeling Approach

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HydroCAD Modeling Software

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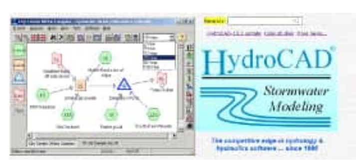
- HydroCAD is currently utilized by hundreds of municipal, regulatory, educational, and professional design organizations, including:
  - Maine Department of Environmental Protection
  - Maine Department of Transportation
  - U.S. Army Corps of Engineers
  - U.S. Department of Energy
  - University of New Hampshire



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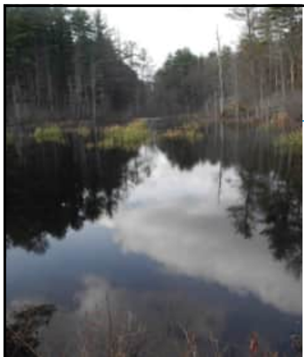

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Hydrologic & Hydraulic Modeling

- Model a range of flood intervals
  - 1-Year (2.64")
    - Anticipated on an annual basis
  - 10-Year (4.83")
    - 10% annual chance
  - 100-Year, etc. (8.78")
    - 1% annual chance
- Model stormflow volumes, peak discharge rates, and timing

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Current and Future Hydrologic & Hydraulic Modeling Scenarios

- No Build Scenario
  - (existing conditions)
- 50% Build Out
- 100% Build Out
- Extreme Storm Event/Climate Change Scenarios (next meeting)

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HydroCAD Base Model – Full Study Area

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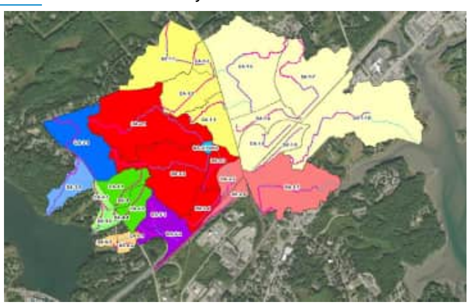

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HydroCAD Base Model – Focus Study Area

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Town of Kittery Zoning

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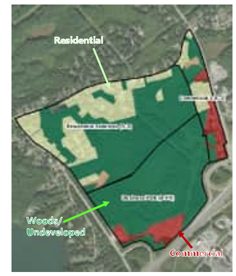
Zoning and Existing Build Out



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Preliminary Modeling Results

NOTE: Build out scenarios do NOT currently incorporate stormwater mitigation associated with future development

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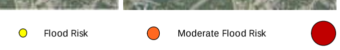
Preliminary Modeling Results: **No Build Scenario**

1-Year Storm (2.64" Rainfall) | 10-Year Storm (4.83" Rainfall) | 100-Year Storm (8.78" Rainfall)



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Preliminary Modeling Results: **1-Year Storm (2.64" Rainfall)**

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NO BUILD | 50% BUILD OUT | 100% BUILD OUT

Flood Risk | Moderate Flood Risk | Significant Flood Risk

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Preliminary Modeling Results: **10-Year Storm (4.83" Rainfall)**

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NO BUILD | 50% BUILD OUT | 100% BUILD OUT

Flood Risk | Moderate Flood Risk | Significant Flood Risk

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Preliminary Modeling Results: **100-Year Storm (8.78" Rainfall)**

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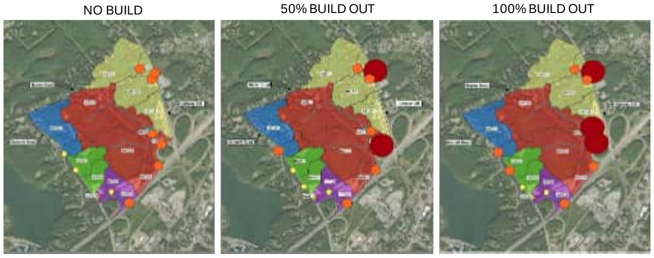
NO BUILD | 50% BUILD OUT | 100% BUILD OUT



Flood Risk | Moderate Flood Risk | Significant Flood Risk

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Preliminary Modeling Takeaways

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- No Build Scenario
  - Indicators of localized stormwater-related flood risk during 1-year storm event
  - Moderate risk of stormwater-related flooding during 10- and 100-year storm events
  - Eastern and southern extents of project area most vulnerable during high intensity precipitation events

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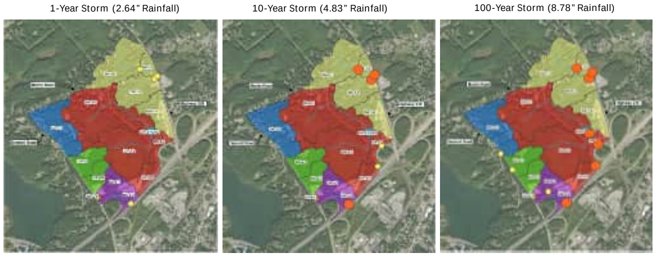
Preliminary Modeling Results: **No Build Scenario**

1-Year Storm (2.64" Rainfall) | 10-Year Storm (4.83" Rainfall) | 100-Year Storm (8.78" Rainfall)



Flood Risk | Moderate Flood Risk | Significant Flood Risk

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Preliminary Modeling Takeaways

- 50% Build Out Scenario
  - Potential moderate risk of stormwater-related flooding during 1-year storm event
  - Moderate risk of stormwater-related flooding during 10-year storm event (similar to No Build Scenario)
  - Increased flood risk potential along Dennett Road (10-year and 100-year events)
  - Significant risk of stormwater-related flooding near Highway 236 / Martin Road intersection during 100-year event

NOTE: Build out scenarios do NOT currently incorporate stormwater mitigation associated with future development

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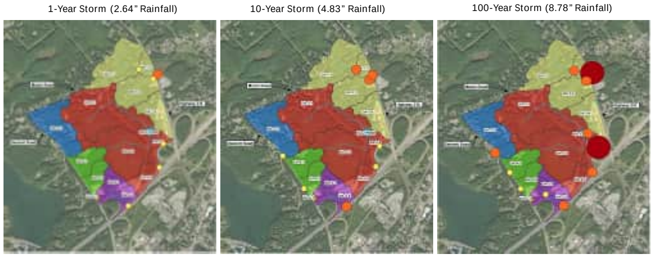
Preliminary Modeling Results: **50% Build Out Scenario**

1-Year Storm (2.64" Rainfall) | 10-Year Storm (4.83" Rainfall) | 100-Year Storm (8.78" Rainfall)



Flood Risk | Moderate Flood Risk | Significant Flood Risk

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Preliminary Modeling Takeaways

- 100% Build Out Scenario
  - Similar to 50% Build Out Scenario results, however with increased indicators of flood risk at discharge points along I-95 and Highway 236

NOTE: Build out scenarios do NOT currently incorporate stormwater mitigation associated with future development

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Preliminary Modeling Results: **100% Build Out Scenario**

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1-Year Storm (2.64" Rainfall) | 10-Year Storm (4.83" Rainfall) | 100-Year Storm (8.78" Rainfall)

Flood Risk · Moderate Flood Risk · Significant Flood Risk

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Nutrient Loading Analysis

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Nutrient Pollutant Loading Analysis – Study Area Overview

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Model My Watershed®

- Study will also evaluate water quality in addition to quantity
- Average nutrient loads were modeled under existing conditions
- Will be evaluated with build out scenarios to advise selection of mitigation alternatives with water quality treatment benefits (co-benefits)

Average annual loads from 30-years of daily fluxes

Related Layer: Weather Stations used in this model ✔ Turn on

Weather Source: USEPA National Climate Data

Simulated by the GWLF-E (MapShed) model

Sources	Sediment	Total Nitrogen	Total Phosphorus
Total Loads (lb)	81,453.1	1,418.3	86.7
Loading Rates (lb/ac)	112.35	1.96	0.12
Mean Annual Concentration (mg/L)	26.86	0.47	0.03
Mean Low-Flow Concentration (mg/L)	56.12	2.00	0.21

Mean Flow: 48,584,899 (ft^3/year) and 1.54 (ft^3/s)

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Herb Parson Pond

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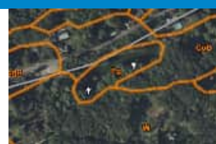
Herb Parson Pond Evaluation

- Historical Overview
  - Gravel pit per USDA Soil Survey
  - History of high groundwater (raised-bed septic systems)
  - Lower water level observed as compared to recent history
  - Water quality concerns



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Herb Parson Pond Evaluation

- Site Visits 11/15/23 (B&L and Streamworks) and 1/14/23 (Streamworks)
  - Low water level observed
  - Locally high-ground and limited drainage area
  - Underlain by well-draining gravelly, sandy loams

KEY TAKEAWAYS

- Limited inflows; no discernible outflow
- Pond levels reflective of local groundwater elevations
  - Expected higher in spring (after snowmelt plus spring rains)
  - Expected lower in summer (drier, less rainfall)
  - No discernible change in seasonal stain lines (ordinary high water)
- Development unlikely to have affected pond levels – impervious cover likely diverts water that otherwise would have infiltrated to groundwater
- Modifying overall groundwater levels likely infeasible; but could be managed at the property scales

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Initial Findings and Key Takeaways

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Initial Findings and Key Takeaways

- Soils are key
- Role of, and interaction between, surface runoff and groundwater
- Herb Parsons Pond – Former gravel pit with water levels driven by groundwater
- Flood indicators from preliminary modeling:
  - Corner of Martin Road / Highway 236 – greatest potential need for mitigation under no build scenario based on preliminary modeling indicators
  - Build out scenarios indicate increased flood risk without incorporation of stormwater mitigation practices

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Project Schedule & Next Steps

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Next Steps

- Refine Model
- Evaluate Mitigation Alternatives
- Draft Report

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Potential Mitigation Alternatives

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- Modifications to the Existing Drainage System
- Installation of Stormwater Detention
- Flood Damage Protection and Planning
- Structural Projects
- Homeowner flood-proofing
- Groundwater interception trench
- Evaluation of Land Use Planning and Zoning
- Water Quality Treatment Practices
- Natural Resource Protection / Conservation Opportunities
- Installation of Green Infrastructure Stormwater Retrofits

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Mitigation Alternative Matrix - Prioritization

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RANKING

- Stormwater Benefits (total 55 out of 100 points)
  - Flood reduction (45 points)
  - Nutrient reduction – water quality benefit (10 points)
- Constructability (total 20 out of 100 points)
  - Ownership: public or private (10 points)
  - Known constraints (5 points)
  - Permitting (5 points)
- Cost (total 20 out of 100 points)
  - Construction Cost – (10 points)
  - Maintenance Cost (5 points)
  - Fundability (5 points)
- Co-Benefits (total 5 out of 100 points)
  - Energy and air quality impacts (1 point)
  - Habitat and biodiversity (1 point)
  - Community and aesthetic benefits (1 point)
  - Human health benefits (1 point)
  - Educational opportunities/visibility (1 point)

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Project Schedule

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Public Information Meeting #2
March 2023

Public Information Meeting #3
June 2023

Town Council / Public Information Meeting #4
July 2023

Preliminary Modeling Results, Nutrient Loading, and Resource Inventory

Extreme Precipitation, Evaluation of Mitigation Alternative Recommendations, Draft Report

Final Report / Presentation of Findings

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Presenter Contact Information

Jessa Kellogg, Town of Kittery DPW
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David Hanny, Barton & Loguidice, D.P.C.
dhanny@bartonandloguidice.com

Jack Williams, Barton & Loguidice, D.P.C.
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Dr. Thomas Ballestero, Streamworks, P.L.L.C.
Tom.Ballestero@unh.edu

Project Information

Project Information
(Survey and Interactive Mapper)

www.kitteryme.gov/watershedinputsession

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Questions & Open Discussion?

Project Information
(Survey and Interactive Mapper)
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Town of Kittery Highway 236/Dennett Road Hydrologic Watershed Study

PUBLIC MEETING #3 AUGUST 9, 2023

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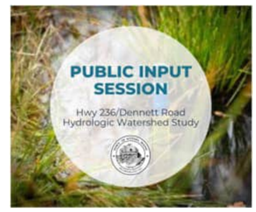
Agenda

I. Project Recap / Progress Review
II. Stormwater Modeling Results
   I. Quantity and Quality
III. Priority Area Findings
IV. Stormwater Opportunity Matrix
V. Initial Recommendations
   I. Six Projects for further evaluation
VI. Next Steps & Project Schedule



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Project Recap

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Project Team

- Town of Kittery
- Barton & Loguidice, D.P.C.
- Streamworks, PLLC
- FB Environmental Associates
- Stakeholders

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Project Goals

I. Evaluate Existing Conditions / Areas of Concern

II. Evaluate Potential Future Development

III. Evaluate Mitigation Alternatives
   I. Improve Existing Conditions
   II. Future Development Considerations

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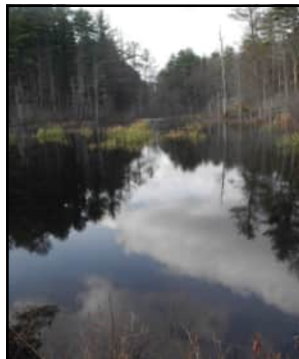

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Project Status

- Desktop Review/GIS Mapping
- Identify Existing Areas of Concern
  - Public outreach
  - *www.kitteryme.gov/watershedinputsession*
- Data Collection/Field Reconnaissance
- Drainage Modeling
- Pollutant Load Modeling
- Stormwater Opportunity Matrix
- Draft Stormwater Engineering Report

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Areas of Interest

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Stormwater Modeling Results

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HydroCAD Modeling Software

- HydroCAD is currently utilized by hundreds of municipal, regulatory, educational, and professional design organizations, including:
  - Maine Department of Environmental Protection
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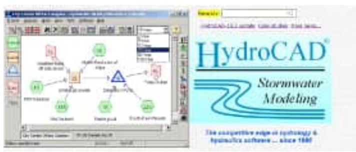

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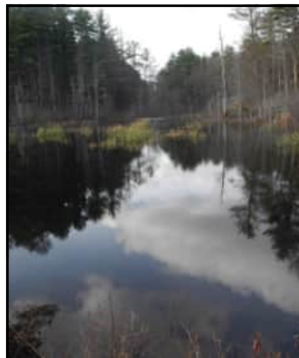

Hydrologic & Hydraulic Modeling

- Model a range of flood intervals
  - 1-Year (2.64")
    - Anticipated on an annual basis
  - 10-Year (4.83")
    - 10% annual chance
  - 100-Year, etc. (8.78")
    - 1% annual chance
- Model stormflow volumes, peak discharge rates, and timing

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Modeling Scenarios

- Existing Conditions
- Extreme Storm Event/Climate Change Scenarios
- Business Park and Commercial Development Scenarios
  - 50% Build Out
  - 100% Build Out

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Existing Conditions Modeling Summary

- Largest *Existing* Contributors of Runoff
  - DA-1-1
  - DA-1-2
  - DA-2-1
- Function of:
  - Drainage Area Size
  - Slope
  - Cover Type

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Culvert Sizing Analysis – Existing Conditions

Critical Culvert Infrastructure	
Model Node ID	Existing Culvert Size (in dia.)
2-P	18
CB-1-1	14
CB-1-3	36
CB-1-4	24
CB-2-3	36
CB-2-4	24
CB-3-2	24
CB-5-2	32

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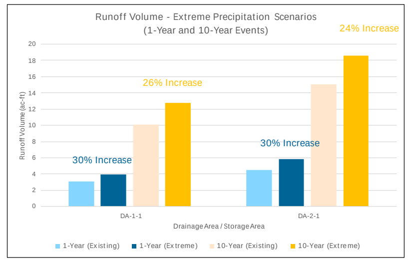
Future Projections - Extreme Storm Event Runoff Volumes



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Build Out Scenarios

NOTE: Build out scenarios do <u>NOT</u> currently incorporate stormwater mitigation associated with future development

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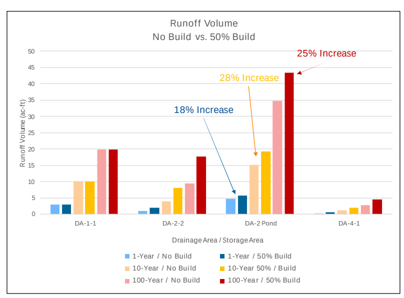
50% Build–Out Scenario - Runoff Volume



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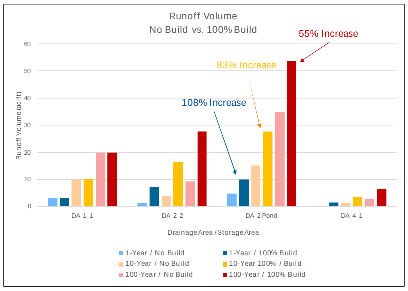
100% Build–Out Scenario - Runoff Volume



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Summary of Water Quantity Modeling Results

- Existing Conditions
  - Indicators of localized stormwater-related flood risk during 1-year storm event
  - Moderate risk of stormwater-related flooding during 10- and 100-year storm events
  - Eastern and southern extents of project area most vulnerable during high intensity rain events
- Build Out Scenarios
  - Increased flood risk potential downstream of Commercial/Business Park zoned areas

NOTE: Build out scenarios do NOT currently incorporate stormwater mitigation associated with future development

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Pollutant Loading Summary Tables

Annual Sediment Loading Summary

Drainage Area	Area (ac)	Sediment Loading Rates (lb./ac)	Sediment Loading (lbs.)	Percent of Total Sediment Loading (%)
DA-1	95.2	29.13	2,771.3	42.5%
DA-2	146.97	19.87	2,921.6	44.9%
DA-3	35.98	12.74	459.5	7.1%
DA-4	27.87	3.92	110.4	1.7%
DA-5	23.57	9.11	231.8	3.6%
DA-6	0.74	26.21	19.4	0.2%
Total	330.3	-	6,514	100%

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Pollutant Loading Summary Tables

Annual Phosphorus Loading Summary

Drainage Area	Area (ac)	Phosphorus Loading Rates (lb./ac)	Phosphorus Loading (lbs.)	Percent of Total Phosphorus Loading (%)
DA-1	95.2	0.06	5.7	30.5%
DA-2	146.97	0.05	8	42.7%
DA-3	35.98	0.06	2.2	11.8%
DA-4	27.87	0.05	1.4	7.5%
DA-5	23.57	0.06	1.3	7%
DA-6	0.74	0.09	0.1	0.5%
Total	330.3	-	18.7	100%

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Priority Area Findings

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Priority Area Findings

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- Soils are key
- Role of, and interaction between, surface runoff and groundwater
  - Herb Parsons Pond – Former gravel pit with water levels driven by groundwater
- Evaluation of Critical Drainage Infrastructure
  - Culvert Sizing
- Flood indicators from drainage modeling:
  - Corner of Martin Road / Highway 236 – greatest potential opportunity for mitigation under no build scenario
  - Build out scenarios indicate increased flood risk without incorporation of stormwater mitigation practices

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Stormwater Opportunities Matrix & Initial Recommendations

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Project Type	Location	Stormwater Benefits Total	Constructability Total	Cost Total	Co-Benefits Total	Project Ranking Total
Expanding Stormwater Storage	98 Dennett Parcel	50	11	18	10	89
Expanding Stormwater Storage	East of Old Dennett Road	50	9	18	10	87
Upstream Detention/Wetland Expansion	Above Martin Rd.	50	7	16	10	83
Low-Impact Development Considerations	Areas currently zoned B-PK and C-2	30	20	15	10	75
Sizing of Critical Infrastructure - Culvert and Drainage Modifications	Martin Rd., Rt-236, Dennett and Old Dennett Rds., I-95	30	16	15	5	66
Land Conservation	Areas currently zoned B-PK and C-2	30	15	10	10	65
Wetland Restoration	41 Rt. 236 (Martin Rd/Rt-236)	20	9	16	10	55

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Project Type	Location	Stormwater Benefits Total	Constructability Total	Cost Total	Co-Benefits Total	Project Ranking Total
Tree Planting/Slope Stabilization	Behind residential properties on South side of Martin Rd.	20	15	8	9	52
Homeowner Floodproofing	Residential Properties	10	20	10	10	50
Installation of Sewer Line Seep Collars	Martin Rd.	10	18	10	1	39
Drainage Infrastructure Modifications	Roseberry Lane	10	16	10	1	37
Culvert Modifications	Old Dennett Road	10	16	10	1	37
Access Road Culvert Improvements	Happy Avenue Extension	10	13	10	1	34
Drainage Improvements	Summer Lane	10	11	10	1	32
OTHERS……						

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Potential Projects for Additional Evaluation

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1. Right-Sizing Critical Infrastructure – culvert and drainage system modifications
2. Seep Collars along Martin Road Sewer Line
3. Upstream Detention/Wetland Expansion (above Martin Rd.)
4. Identification of potential conservation areas (requires easements or land acquisition)
5. Provision of additional stormwater storage at “98 Dennett” Parcel for future Build-Out scenarios
6. Providing Low Impact Development considerations for future Build-Out scenarios

The Report also includes recommendations for Homeowner Flood Protection Considerations.

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Project Schedule & Next Steps

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Next Steps

- Town will provide direction to the Consulting Team on Six projects to progress to additional evaluation
- Incorporate additional public participation to potential project recommendations
- Submit comments by Friday, August 25th
  - Additional Interactive Mapper Input
  - Contact Jessa Kellogg
    - jkellogg@kitteryme.org

PUBLIC MEETING #3 – AUGUST 9, 2023

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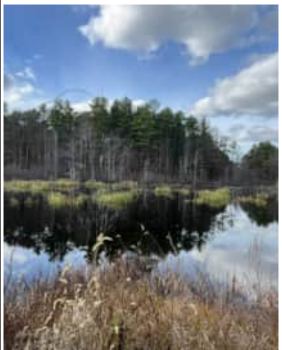

Next Steps

- Evaluation of Recommended Mitigation Alternatives
  - Flood Protection & Water Quality Benefits
  - Implementation and Maintenance Cost Estimates
  - Land Use and Permitting Considerations
  - Funding Opportunities
- Draft Report
  - Will be made available for Public Review
- Final Report Presentation Meeting
  - November

PUBLIC MEETING #3 – AUGUST 9, 2023

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Project Schedule

Public Information Meeting #3 – August 9, 2023 → Draft Report for Public Comment – October 2023 → Town Council / Public Information Meeting #4 – November 2023

Public Information Meeting #3:
- Project Status Meeting
- Selection of 6 Recommended Alternatives

Draft Report for Public Comment:
- Evaluation of Recommended Alternatives
- Draft Report for Public Comment

Town Council / Public Information Meeting #4:
- Final Report
- Presentation of Findings
- Steps for Implementation

PUBLIC MEETING #3 – AUGUST 9, 2023

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Presenter Contact Information

Jessa Kellogg, Town of Kittery DPW
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Jack Williams, Barton & Loguidice, D.P.C.
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Project Information

Project Information
(Survey and Interactive Mapper)

www.kitteryme.gov/watershedinputsession

PUBLIC MEETING #3 – AUGUST 9, 2023

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Barton & Loguidice | The Experience to Listen. The Power to Solve.

Questions & Open Discussion?

Project Information
(Survey and Interactive Mapper)
www.kitteryme.gov/watershedinputsession

bartonandloguidice.com

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Appendix E

Public Survey and Interactive Mapper Summary

Type	Comment	Location
Local Flooding	KLT wetland is partial in the floodplain. But has flooded from beaver activity. There is a former beaver dam remnants on Chickering Creek near the outlet of the wetland	32 Route 236 Unit 1
Potentially Undersized storm drainage	12" CPP culvert under the existing is likely undersized. See drainage calculations for proposed project at 41 Rt 236	37 Route 236
Other	Per 1956 Rt 236 highway plans...a 1'x2' stone culvert drained Chickering Creek under the abandoned railroad bed here. The stone culvert was abandoned when the current 36" RCP drain was installed as part of roadway construction.	41 Route 236
Potentially Undersized Storm Drainage	15" CMP may be undersized. See drainage calculation from the downstream 41 Rt 236 project. Outlet is "hanging" about one foot above the water level creating a manmade barrier for aquatic species to pass.	124 Martin Rd
Local Flooding	Neighbors on Martin water displacement during the first fill/development of this wetland2009 for an extension of a boat yard. When more fill was added in 2015, residents began to lose trees in the remaining buffer area between them and the yard with one resident losing everything including furnace. The flooding worsened so a professional, permanent sump pump was installed. Trees continue to die and the remaining buffer barely exists on some of the properties. 1941 map of creek running to wetland	122 Martin Rd
Other	Drainage from this wetland is to the northeast, refer to Town GIS / LiDAR. Drainage across the Martin Road from this wetland is incorrectly shown on many maps since 1956.	91 Martin Rd
Other	Culvert pipe 12 in black goes down side of road and empties into swamp. Not sure if pipe end is crushed, might be hard to find with all the leaves. They put timbers in for an excavator to go through power line section.	92 Martin Rd
Local Flooding	Development on wetland at the end of Summer Ave. a couple of years ago. After 2 homes were built, the runoff now runs down Summer Lane, sheets across Martin into properties. I have very clear video, but am unable to attach. It is important to note that there are many inaccuracies with the GIS map. One of the most obvious is the lack of wetlands marked out.	64 Martin Rd
Other	Pond used to be a gravel pit, story goes the pond was dry at one point and steamshovel excavator hit a spring when digging and it flooded the pond over a weekend.	Club pond on Martin Rd
Potentially Undersized Culvert	Herb Parsons Pond was created accidentally in the 40s when excavating was taking place for the Navy Yard. It remained a healthy and popular pond for 80 years until development began on the southerly side beginning with Roseberry, then Condo Way, then when a sewer line was installed in 2015 on Martin. The most notable change occurred around 2019. By 2020 it was clear that water was being redirected away from the pond through culverts that were installed for sewer and water hookup for development.	Club pond on Martin Rd
Local Flooding	Homes and properties flooded from development/displaced water from filling of wetlands and placement of culverts. Timeline attached.	Happy Ave
Local Flooding	Basement flooding occurred 22 years ago when Happy Ave was extended. It increased approximately 5 years when more fill was brought in to develop what is now called Condominium Way. This has redirected the water from an old pond into residents yards and basements.	Happy Ave
Local Flooding	All through this area continuing South on Dennett experienced flooding with at least one home with basement flooding with the development of Roseberry Ave. Needed to place large culverts, but the yard continues to flood along with other areas.	118 Dennet Rd
Local Flooding	in 2018 a new grave was dug. The water table was so high, there was appox. 6" to 12" of water causing the coffin to float. In 2020, the gravesite sunk by approx the same amount and needed to be repaired.	next to 80 Old Dennet Rd

Legend

- Localized Flooding
- Potentially Undersized Culvert
- Potentially Undersized Storm Drainage
- Other Issue
- Project Area

TimeLine Happy Ave Flooding

1980's: 40+ years ago Mike and Brenda Crouse, family of Bob and Betty Kraft tried to buy land directly off the current ROW on Happy Ave but the water table was so high it would not perk.

1980's– The Stihman's owned 6 Happy Ave and had renovated the house- adding a finished recreational room with flooring, paneling and tiki bar it as a Rec room for many years.

1990's – in the mid to late 1990's water table changes started to occur when development occurred and in land around Happy Ave- with the development of homes and the clearing of trees. They worked hard to try and mitigate the situation by addressing the water coming into the foundation from the ground and outside by digging trenches and putting in pipes to redirect the water.

2000's Flooding became a regular occurrence during this time period and caused loss and damage to the basement of the house, forcing the owner to remove the finished walls and flooring property that had been in the space for over 50 years without incident.

2015 – A new owner purchased the property and after a significant water situation Jeffery put in an $18,000. a French drain system with a buried sump pump was added around 2015/2016. This system pumps water out into the yard and fills my land with the expelled water.

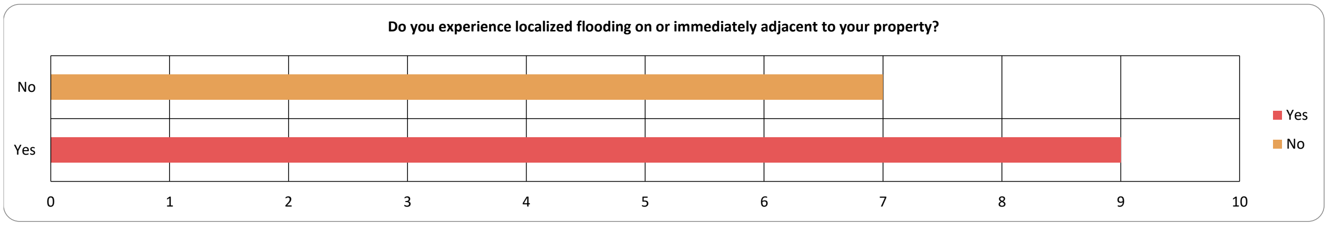
2017 I purchased the home assuming that the elaborate water mitigations system would remove any water and I could restore the space in the basement to useful space. Unfortunately as we suffered power losses and sump pump burn outs, I quickly realized that I would be living with this issue all year long. I have replaced the pump twice because it has burned out and had to install a battery system for close to $900.00 because when we lose power the pump would fail and I ended up with a flooded basement again. The first year I owned the house the basement flooded 4 times and I lost many of my belongings. There are many health hazards associated with having standing (or running in some cases) water rise up through the ground. I have worked hard to deal with this situation to reduce any more harm. Listening to the pump go off all night long has been disruptive to my sleep and affects my health beyond the physical water.

Present: The property behind my house that runs along the ROW has seen a change in wetlands according to the maps at the town website I have reviewed. There is definitely flooding from run off due to the culvert pipes that Bill Cullen created when he rebuilt the right of way to the property he built and sold in 2018 as well as his house. There seems to be 3 or 4 culverts that direct the water to run from the wetland on the opposite side of theROW (Maine F&G property) to my property. The ROW was built up to accommodate a sewer line and to support heavy equipment and put in Culverts/drain pipes that stretch on either side so the road would not flood.

Project Survey: Kittery Watershed Study

Do you experience localized flooding on or immediately adjacent to your property?

Choice	Responses	
Yes	9	56.25%
No	7	43.75%
Answered	**16**	
Skipped	**0**	



Project Survey: Kittery Watershed Study

Is there a specific point in time (year) that you first started noticing flooding on your property?

Response	
Huge rain storm on frozen ground	
Ever since the boat storage was filled in	
It floods all the time but starts with heavy spring rains	
right after the sewer project	
s[pring	
Always-I have wetlands	
No	
Spring	
I have a lot of wetlands and 2 vernal pools. every spring there is standing water. in past 2 drought years	
Answered	**9**
Skipped	**7**

Project Survey: Kittery Watershed Study

If you experience flooding at your property, how frequent is this flooding? Monthly, seasonally, annually, or once every several years?

Response	
Seasonally	
Ongoing	
Constant unless there is a drought. I have been experiencing it since we received the recent rains and it continues.	
monthly (without snow)	
heavy rains and Spring until early summer	
Not applicable	
Seasonally	
Annually. Wet areas persist Feb through May	
Answered	**8**
Skipped	**8**

Project Survey: Kittery Watershed Study

If seasonal flooding occurs, what months is it most prevalent?

Response	
March. April	
Most prevalent in spring, summer and fall.	
spring	
spring	
April through June	
N/A	
March through November	
Usually Feb through May, early June. This year it started earlier	
Answered	**8**
Skipped	**8**

Project Survey: Kittery Watershed Study

Please insert any dates you can recall (date, or year and month) of significant flood events that affected your property. Also include magnitude of flood impacts (e.g. 6 inches of water in basement on June 30, 2020).

Response	
I have installed more sump pumps	
Flooding occurs in the back of our property.	
Since I have a fancy french drain system my sump pump which is below ground 12" goes off constantly - however if we loose power I will see an average of 3-4 inches in my basement. I have not lost power recently but had flooding in Spring of 2017 and 2018.	
rainstorms - normally 1-2 inches of water in basement	
I get water in my basement with heavy rains	
Many many times over the year. It’s been this way for years here.	
My basement takes in some water with any heavy rains	
Answered	**7**
Skipped	**9**

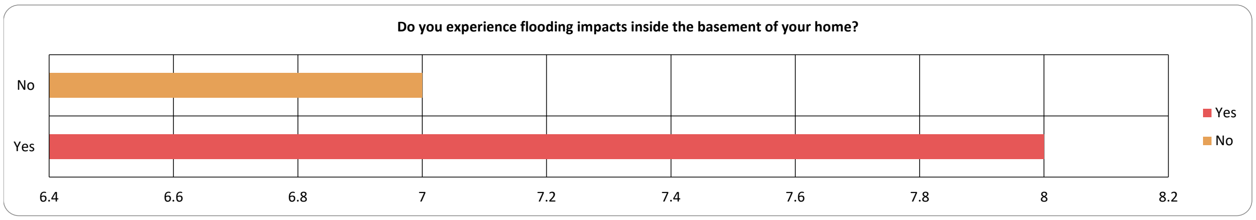
Project Survey: Kittery Watershed Study
If you have experienced flooding, have you incurred any out-of-pocket costs to fix damage? If so, how much?

Response	
No ability to fix drainage systems.	
The french drain cost $18,000. when installed, since then I have installed a back up battery which was $800. and a maintenance. Additionally, I have replaced 3 of the lolly columns that were rusted by the years of repeated flooding before I bought the house. Which was $1200. and need to replace more. I also have to run a dehumidifier which has an increased cost of approx $50. a month on my electric bill. The previous owners lost everything in the basement- which was completely finished and I am sure it was upwards 10's of thousands of dollars.	
2 Sump pumps installed mold removal over 2000 dollars	
yes on going	
Missed work, still paying, Serv Pro, pump, dehumidifer, mops, shop vac, est $2000	
No, I have raised areas for storage in my cellar	
Yes. Foundation and drainage expenses	
I have wash out in my gravel drive. I have ground and surface water that impacts my cellar. It rusted out my oil tank. 2 Humidifiers in place to prevent rot in flooring joists and decrease rust	
Answered	**8**
Skipped	**8**

Project Survey: Kittery Watershed Study

Do you experience flooding impacts inside the basement of your home?

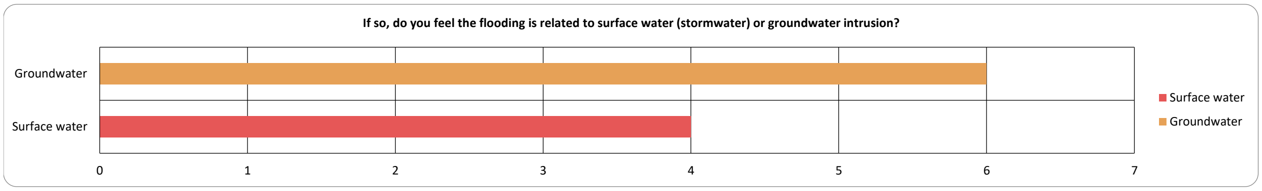
Choice	Responses	
Yes	8	53.33%
No	7	46.67%
Answered	**15**	
Skipped	**1**	



Project Survey: Kittery Watershed Study

If so, do you feel the flooding is related to surface water (stormwater) or groundwater intrusion?

Choice	Responses	
Surface water	4	40.00%
Groundwater	6	60.00%
Answered	**10**	
Skipped	**6**	



Project Survey: Kittery Watershed Study

Where is your home located within the study area?

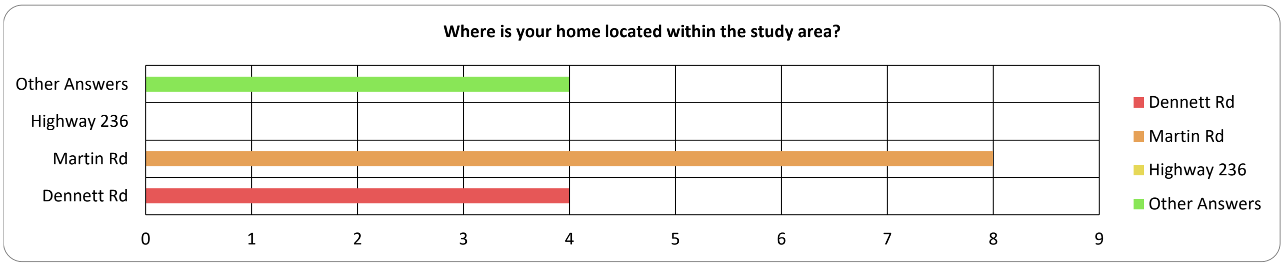
Choice	Responses	
Dennett Rd	4	25.00%
Martin Rd	8	50.00%
Highway 236	0	0.00%
Other Answers	4	25.00%

19 Adams Dr19 Adams Dr, Kittery Me

Happy Ave off Dennett Rd

Happy Avenue

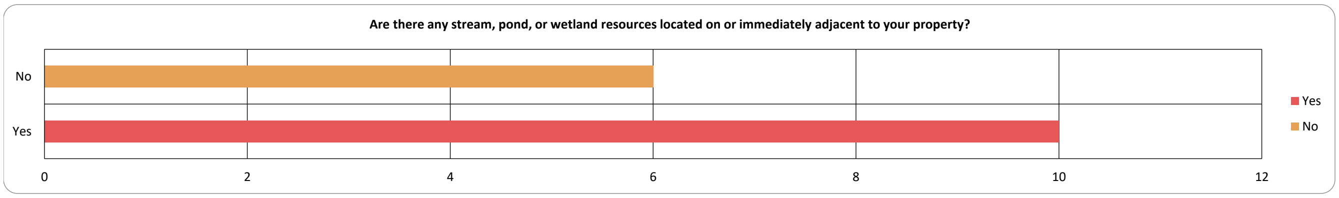
31 Walker Ave



Project Survey: Kittery Watershed Study

Are there any stream, pond, or wetland resources located on or immediately adjacent to your property?

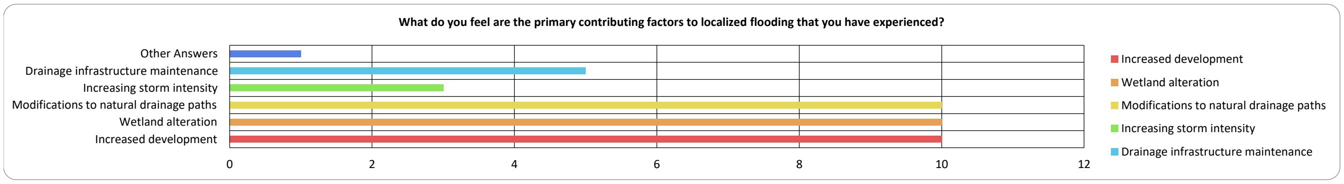
Choice	Responses	
Yes	10	62.50%
No	6	37.50%
Answered	**16**	
Skipped	**0**	



Project Survey: Kittery Watershed Study

What do you feel are the primary contributing factors to localized flooding that you have experienced?

Choice	Responses	
Increased development	10	76.92%
Wetland alteration	10	76.92%
Modifications to natural drainage paths	10	76.92%
Increasing storm intensity	3	23.08%
Drainage infrastructure maintenance	5	38.46%
Other Answers	1	7.69%
sewer project blasting		
Answered	**13**	
Skipped	**3**	



Project Survey: Kittery Watershed Study

Identify any changes within the study area that you feel may have impacted flooding frequency.

Response	
Not in the study area.	
following the sewer installation on Martin Road I have observed changes at the Herb Parsons Pond by the fisheries/wildlife place on Martin Road	
Filling of wetlands.	
There has been a lot of development in the area behind my property that was once a wetland. There is fill and new houses that have redirected the flow of the water.	
Poor, if any, oversight to local development in the area. un-approved or un-appropriate filled in wetland areas with no recourse.	
Since mr Cullen built on land off right of way	
No storm drains	
My 92 Dennett Road parcel with the Dennett graveyard. There is a drain pipe and open culvert that bounds the south side of the cemetery alongside the stone wall. There is significant runoff from Dennett Road into this drain. The water table in the grave yard is high. The last grave dug in February 2018 filled with a foot of water and the sod over the grave sunk in 2020 and needed to be refilled. There is a “stream” about 50 feet away from the north side of the of the graveyard that runs east-west towards old Dennett Road that floods regularly in the spring and with heavy rain. The runoff from Dennett Road and Roseberry Lane has caused flooding to property on Old Dennett Road, especially 103 Old Dennett.	
No change. No flooding.	
Improper development	
Drainage pipe to the south of Dennett graveyard impacted by runoff from Dennett Road and 76 Dennett development. Roseberry Lane development has changed water supply to old well on north side of property	
Answered	**11**
Skipped	**5**

Project Survey: Kittery Watershed Study
Identify any other water quality concerns within the study area.

Response	
At the Herb Parsons Pond on Martin road I have observed drastic fluctuations and excessive green algae growth. I walk by with my dog EVERY DAY. I believe the water levels began big changes after the sewer project, the blasting etc. I am also concerned with the 236 disruptions in the wetlands near Martin/Stevenson.	
Stagnant water .	
Herb Parson's pond has died since all the fill back in 2016 was brought in for Happy Ave Ext. Nobody from the town was watching. No up to date permits were filed. Shame on you, you need to fix this ASAP.	
Blasting for sewer line lost wildlife habitat and appears to have made flooding worse.	
All runoff from newly developed land goes downhill to the east on the 236 side, creating marshy areas and the Piscataqua River on the west side	
Home and property damage creates polluted runoff into our creeks, residents properties, and has stopped the natural flow to a local pond.	
I am concerned about the level of the pond on Martin Rd.It is no longer thriving as it once was. It is VERY low as well.	
water that collects in area off 236 between Martin Road down to new pump station?	
Answered	**8**
Skipped	**8**

Project Survey: Kittery Watershed Study

Your name (optional):

Response	
Donald Gray	
Ellen Mitchell	
King	
Jodie Curtis	
Andrew Bedard	
Sarah Dennett	
Rod Welles	
Dennett Sarah	
Answered	**8**
Skipped	**8**

Appendix F

National Oceanic and Atmospheric Administration (NOAA) Atlas 14 Rainfall Data

NOAA Atlas 14, Volume 10, Version 3
Location name: Kittery, Maine, USA*
Latitude: 43.1059°, Longitude: -70.7556°
Elevation: 78 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sandra Pavlovic, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Orlan Wilhite

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.307** (0.233-0.405)	**0.370** (0.280-0.488)	**0.473** (0.357-0.626)	**0.558** (0.419-0.743)	**0.675** (0.494-0.937)	**0.763** (0.549-1.08)	**0.856** (0.601-1.26)	**0.960** (0.642-1.44)	**1.11** (0.718-1.72)	**1.23** (0.781-1.94)
10-min	**0.435** (0.330-0.574)	**0.524** (0.397-0.692)	**0.670** (0.506-0.887)	**0.791** (0.594-1.05)	**0.957** (0.700-1.33)	**1.08** (0.778-1.53)	**1.21** (0.851-1.78)	**1.36** (0.909-2.04)	**1.57** (1.02-2.43)	**1.75** (1.11-2.75)
15-min	**0.512** (0.388-0.675)	**0.617** (0.467-0.814)	**0.788** (0.595-1.04)	**0.930** (0.699-1.24)	**1.12** (0.823-1.56)	**1.27** (0.914-1.80)	**1.43** (1.00-2.09)	**1.60** (1.07-2.40)	**1.85** (1.20-2.86)	**2.06** (1.30-3.24)
30-min	**0.688** (0.522-0.908)	**0.830** (0.629-1.10)	**1.06** (0.802-1.41)	**1.25** (0.942-1.67)	**1.52** (1.11-2.11)	**1.72** (1.24-2.44)	**1.93** (1.35-2.83)	**2.17** (1.45-3.24)	**2.52** (1.62-3.89)	**2.80** (1.78-4.42)
60-min	**0.865** (0.656-1.14)	**1.04** (0.790-1.38)	**1.34** (1.01-1.77)	**1.58** (1.19-2.10)	**1.91** (1.40-2.66)	**2.16** (1.56-3.07)	**2.42** (1.71-3.57)	**2.73** (1.82-4.09)	**3.18** (2.05-4.92)	**3.55** (2.25-5.60)
2-hr	**1.16** (0.880-1.51)	**1.40** (1.07-1.84)	**1.80** (1.37-2.38)	**2.14** (1.62-2.83)	**2.60** (1.92-3.60)	**2.94** (2.13-4.17)	**3.31** (2.35-4.88)	**3.75** (2.51-5.60)	**4.42** (2.86-6.82)	**5.00** (3.17-7.85)
3-hr	**1.36** (1.04-1.78)	**1.66** (1.26-2.16)	**2.14** (1.63-2.81)	**2.54** (1.92-3.35)	**3.09** (2.29-4.28)	**3.50** (2.55-4.96)	**3.95** (2.82-5.82)	**4.49** (3.01-6.68)	**5.31** (3.45-8.18)	**6.02** (3.83-9.44)
6-hr	**1.77** (1.36-2.30)	**2.17** (1.66-2.82)	**2.82** (2.16-3.67)	**3.36** (2.56-4.40)	**4.10** (3.04-5.64)	**4.65** (3.40-6.55)	**5.24** (3.76-7.71)	**5.97** (4.02-8.85)	**7.09** (4.61-10.9)	**8.05** (5.14-12.6)
12-hr	**2.23** (1.72-2.88)	**2.75** (2.12-3.56)	**3.60** (2.77-4.67)	**4.31** (3.30-5.62)	**5.29** (3.95-7.24)	**6.01** (4.41-8.43)	**6.79** (4.89-9.93)	**7.74** (5.23-11.4)	**9.20** (6.01-14.1)	**10.5** (6.70-16.3)
24-hr	**2.63** (2.04-3.38)	**3.31** (2.56-4.25)	**4.41** (3.41-5.68)	**5.32** (4.10-6.90)	**6.58** (4.95-9.00)	**7.50** (5.56-10.5)	**8.52** (6.20-12.5)	**9.81** (6.65-14.4)	**11.9** (7.76-18.1)	**13.6** (8.76-21.2)
2-day	**2.93** (2.29-3.74)	**3.77** (2.94-4.82)	**5.15** (4.00-6.59)	**6.28** (4.86-8.10)	**7.85** (5.96-10.8)	**8.99** (6.73-12.7)	**10.3** (7.59-15.2)	**12.0** (8.16-17.6)	**14.9** (9.77-22.6)	**17.5** (11.3-27.1)
3-day	**3.19** (2.50-4.05)	**4.10** (3.21-5.21)	**5.58** (4.36-7.12)	**6.81** (5.29-8.75)	**8.51** (6.48-11.6)	**9.73** (7.32-13.7)	**11.1** (8.27-16.5)	**13.0** (8.88-19.1)	**16.3** (10.7-24.7)	**19.2** (12.4-29.7)
4-day	**3.44** (2.70-4.36)	**4.38** (3.44-5.56)	**5.92** (4.63-7.54)	**7.20** (5.60-9.22)	**8.96** (6.84-12.2)	**10.2** (7.71-14.4)	**11.7** (8.70-17.3)	**13.7** (9.33-20.0)	**17.1** (11.2-25.9)	**20.2** (13.0-31.1)
7-day	**4.16** (3.28-5.25)	**5.16** (4.06-6.51)	**6.78** (5.32-8.59)	**8.13** (6.35-10.4)	**9.98** (7.64-13.5)	**11.3** (8.55-15.8)	**12.8** (9.57-18.9)	**14.9** (10.2-21.8)	**18.5** (12.2-27.8)	**21.6** (14.0-33.3)
10-day	**4.85** (3.84-6.10)	**5.88** (4.65-7.40)	**7.56** (5.95-9.55)	**8.95** (7.01-11.4)	**10.9** (8.33-14.6)	**12.3** (9.26-17.0)	**13.8** (10.3-20.1)	**15.9** (10.9-23.1)	**19.4** (12.8-29.2)	**22.5** (14.6-34.5)
20-day	**6.88** (5.47-8.59)	**8.01** (6.36-10.0)	**9.85** (7.80-12.4)	**11.4** (8.96-14.4)	**13.5** (10.3-17.9)	**15.1** (11.3-20.4)	**16.7** (12.3-23.7)	**18.8** (13.0-27.1)	**21.8** (14.5-32.6)	**24.4** (15.9-37.3)
30-day	**8.55** (6.82-10.6)	**9.76** (7.78-12.2)	**11.7** (9.32-14.7)	**13.4** (10.6-16.8)	**15.6** (12.0-20.5)	**17.3** (13.0-23.3)	**19.1** (13.9-26.7)	**21.0** (14.6-30.2)	**23.8** (15.9-35.5)	**26.0** (16.9-39.7)
45-day	**10.6** (8.50-13.2)	**11.9** (9.53-14.8)	**14.1** (11.2-17.5)	**15.8** (12.5-19.8)	**18.2** (14.0-23.8)	**20.1** (15.1-26.8)	**22.0** (15.9-30.3)	**23.9** (16.6-34.2)	**26.4** (17.6-39.2)	**28.2** (18.4-43.0)
60-day	**12.4** (9.92-15.3)	**13.7** (11.0-17.0)	**16.0** (12.8-19.9)	**17.8** (14.2-22.3)	**20.4** (15.7-26.5)	**22.4** (16.8-29.7)	**24.4** (17.6-33.3)	**26.2** (18.3-37.5)	**28.6** (19.2-42.5)	**30.3** (19.8-46.1)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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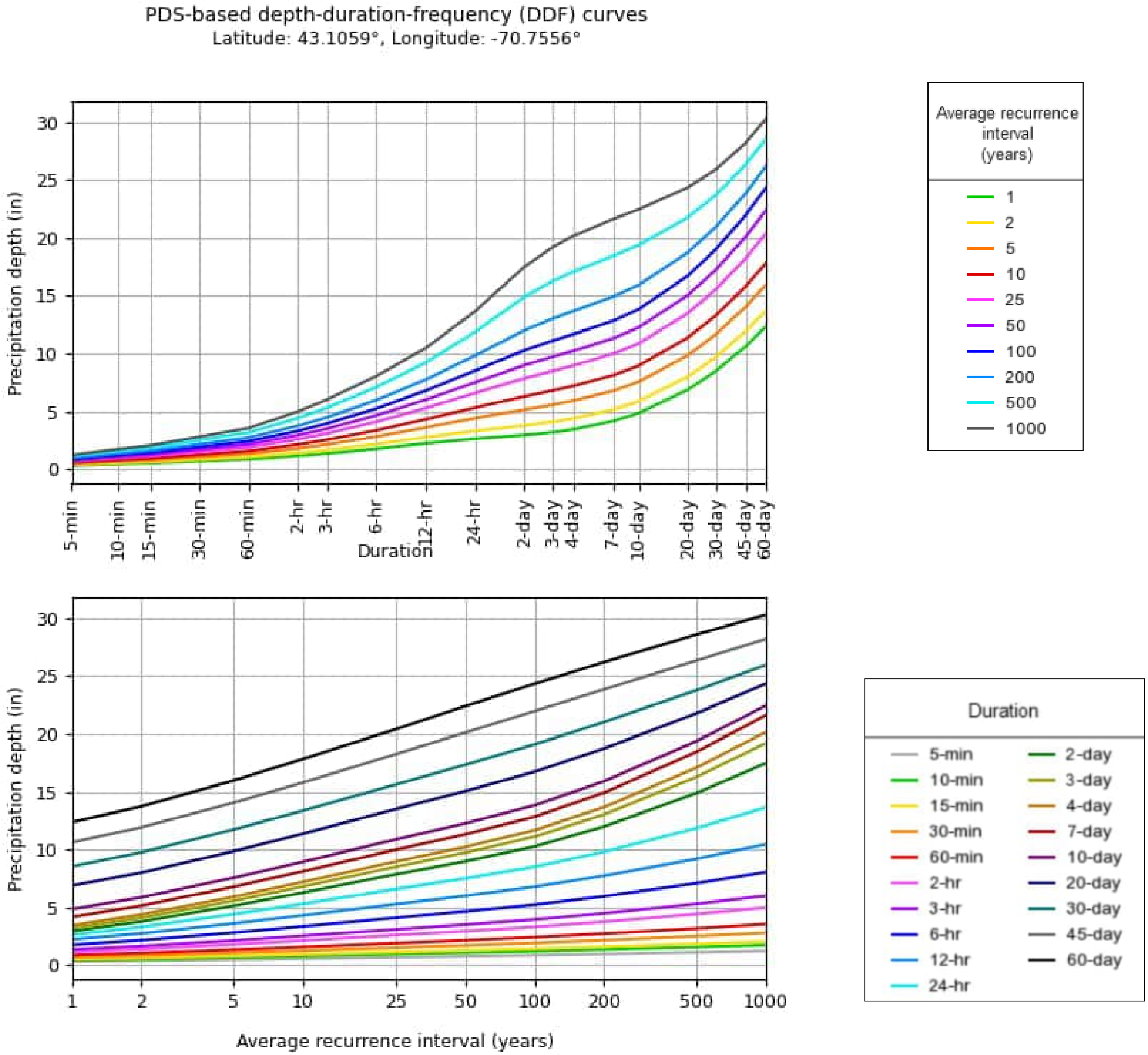
PF graphical



NOAA Atlas 14, Volume 10, Version 3 Created (GMT): Mon Aug 7 11:25:18 2023

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Maps & aerials

Small scale terrain

Appendix G

List of HydroCAD Model Scenarios

HydroCAD Model Scenarios

Highway 236/Dennett Road Hydrologic Watershed Study

- Existing Conditions (Baseline)
- 50% Build-Out
- 100% Build-Out
- Right-Sizing Critical Infrastructure
- Martin Road Storage Modifications
- Dennett Road Storage Modifications

Appendix H

Model My Watershed Existing Conditions Nutrient Load Summary Reports

Drainage Area 1 (DA-1)

Sources	Sediment	Total Nitrogen	Total Phosphorus
Total Loads (lb)	2,771.60	141.3	5.7
Loading Rates (lb/ac)	29.13	1.49	0.06

Sources	Sediment (lb)	Total Nitrogen (lb)	Total Phosphorus (lb)
Hay/Pasture	0	0	0
Cropland	0	0	0
Wooded Areas	28.2	9.1	0.5
Wetlands	0	13.2	0.7
Open Land	9.7	0.7	0
Barren Areas	1	0.8	0
Low-Density Mixed	153.40	3.9	0.4
Medium-Density Mixed	712.80	14.9	1.5
High-Density Mixed	250.40	5.2	0.5
Low-Density Open Space	180.9	4.6	0.5
Farm Animals	0	0	0
Stream Bank Erosion	1,435.20	2.2	0
Subsurface Flow	0	57.6	1.5
Point Sources	0	0	0
Septic Systems	0	29.1	0

Drainage Area 2 (DA-2)

Sources	Sediment	Total Nitrogen	Total Phosphorus
Total Loads (lb)	2,921.60	221.3	8
Loading Rates (lb/ac)	19.87	1.51	0.05

Sources	Sediment (lb)	Total Nitrogen (lb)	Total Phosphorus (lb)
Hay/Pasture	0	0	0
Cropland	0	0	0
Wooded Areas	56.6	16.2	0.9
Wetlands	13.2	9.7	0.5
Open Land	9.5	0.4	0
Barren Areas	0	0.2	0
Low-Density Mixed	162.5	4.2	0.5
Medium-Density Mixed	511.60	10.7	1.1
High-Density Mixed	182.70	3.8	0.4
Low-Density Open Space	166.6	4.3	0.5
Farm Animals	0	0	0
Stream Bank Erosion	1,818.80	2.2	0
Subsurface Flow	0	158.7	4.2
Point Sources	0	0	0
Septic Systems	0	10.9	0

Drainage Area 3 (DA-3)

Sources	Sediment	Total Nitrogen	Total Phosphorus
Total Loads (lb)	459.5	62.8	2.2
Loading Rates (lb/ac)	12.74	1.74	0.06

Sources	Sediment (lb)	Total Nitrogen (lb)	Total Phosphorus (lb)
Hay/Pasture	0	0	0
Cropland	0	0	0
Wooded Areas	0	0.6	0
Wetlands	0.1	1.1	0.1
Open Land	0	0	0
Barren Areas	0	0	0
Low-Density Mixed	110.5	2.9	0.3
Medium-Density Mixed	214	3.6	0.4
High-Density Mixed	0	0	0
Low-Density Open Space	110.5	2.9	0.3
Farm Animals	0	0	0
Stream Bank Erosion	24.3	0	0
Subsurface Flow	0	44.4	1.2
Point Sources	0	0	0
Septic Systems	0	7.3	0

Drainage Area 4 (DA-4)

Sources	Sediment	Total Nitrogen	Total Phosphorus
Total Loads (lb)	110.4	42.7	1.4
Loading Rates (lb/ac)	3.92	1.51	0.05

Sources	Sediment (lb)	Total Nitrogen (lb)	Total Phosphorus (lb)
Hay/Pasture	0	0	0
Cropland	0	0	0
Wooded Areas	0.9	1.5	0.1
Wetlands	0	0.4	0
Open Land	0	0	0
Barren Areas	0	0.7	0
Low-Density Mixed	57	1.7	0.2
Medium-Density Mixed	21.4	0.4	0
High-Density Mixed	13.1	0.5	0.1
Low-Density Open Space	11.4	0.3	0
Farm Animals	0	0	0
Stream Bank Erosion	6.6	0	0
Subsurface Flow	0	37.2	1
Point Sources	0	0	0
Septic Systems	0	0	0

Drainage Area 5 (DA-5)

Sources	Sediment	Total Nitrogen	Total Phosphorus
Total Loads (lb)	213.8	41.6	1.3
Loading Rates (lb/ac)	9.11	1.77	0.06

Sources	Sediment (lb)	Total Nitrogen (lb)	Total Phosphorus (lb)
Hay/Pasture	0	0	0
Cropland	0	0	0
Wooded Areas	8.9	2.7	0.2
Wetlands	0	0.3	0
Open Land	28.9	1.1	0.1
Barren Areas	0	0.7	0
Low-Density Mixed	15	0.5	0
Medium-Density Mixed	80.1	2	0.2
High-Density Mixed	68.6	1.7	0.2
Low-Density Open Space	3.4	0.1	0
Farm Animals	0	0	0
Stream Bank Erosion	8.8	0	0
Subsurface Flow	0	25.4	0.7
Point Sources	0	0	0
Septic Systems	0	7.3	0

Drainage Area 6 (DA-6)

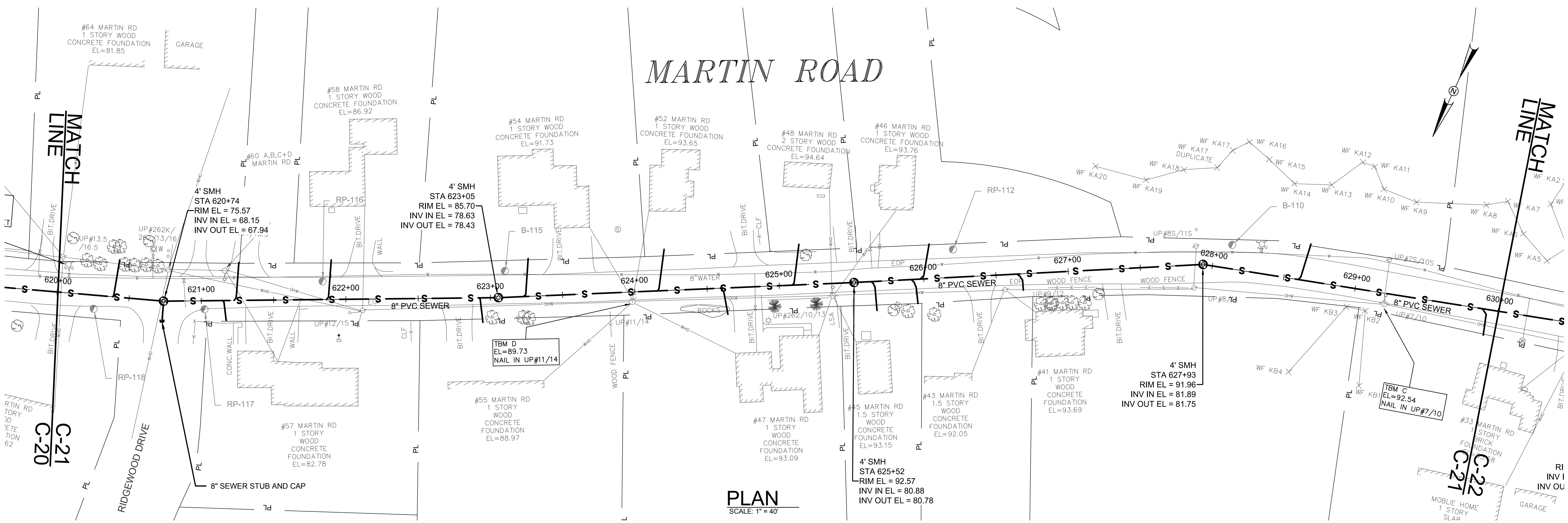
Sources	Sediment	Total Nitrogen	Total Phosphorus
Total Loads (lb)	19.4	1.1	0.1
Loading Rates (lb/ac)	26.21	1.43	0.09

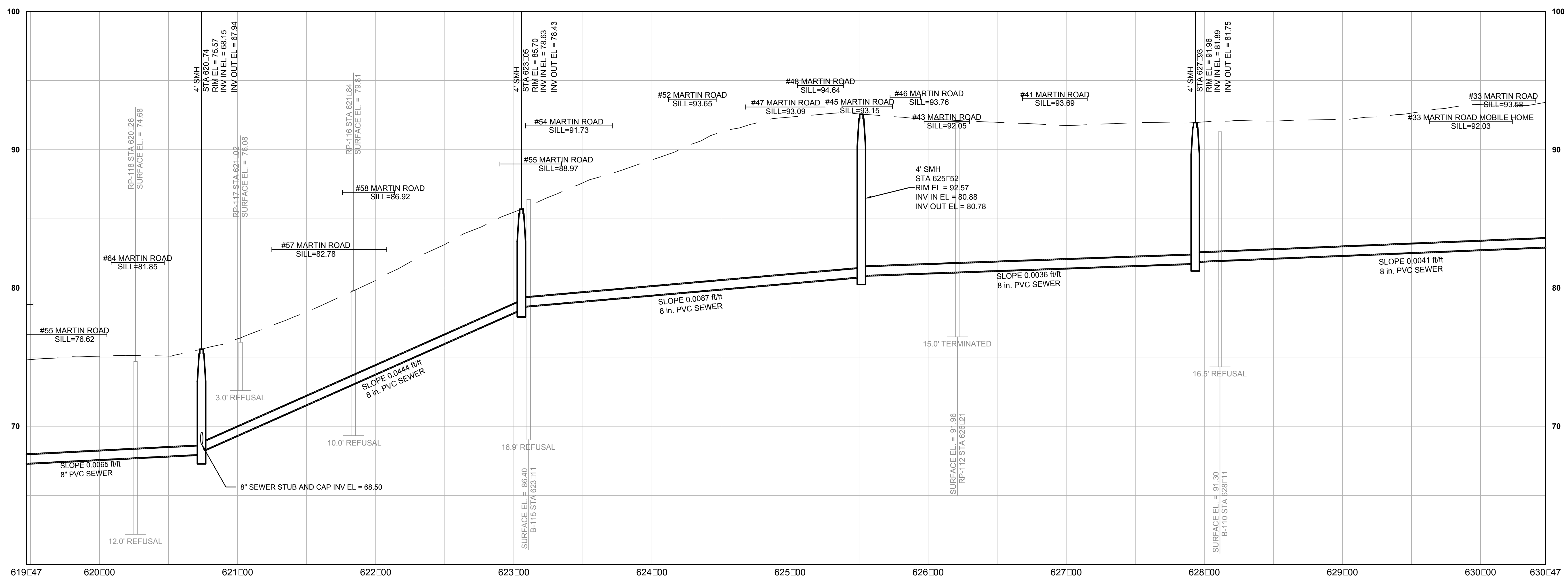
Sources	Sediment (lb)	Total Nitrogen (lb)	Total Phosphorus (lb)
Hay/Pasture	0	0	0
Cropland	0	0	0
Wooded Areas	0	0	0
Wetlands	0	0	0
Open Land	0	0	0
Barren Areas	0	0	0
Low-Density Mixed	15	0.5	0
Medium-Density Mixed	0	0	0
High-Density Mixed	0	0	0
Low-Density Open Space	0	0	0
Farm Animals	0	0	0
Stream Bank Erosion	4.4	0	0
Subsurface Flow	0	0.6	0
Point Sources	0	0	0
Septic Systems	0	0	0

Appendix I

Kleinfelder Sewer Extension Record Drawings (2016)

PLOTTED: 10/10/2016 11:32 AM BY: bryan webb





HORIZONTALSCALE: 1" = 40'

40 20 0 40 80

4 2 0 4 8

VERTICAL SCALE: 1"=4'

PROFILE

HORIZONTAL SCALE: 1"=40'
VERTICAL SCALE: 1"=4'

RECORD DRAWINGS

KLEINFELDER
Bright People. Right Solutions.

REVISIONS

DATE	OCTOBER 2016
PROJECT NO.	20140119
DRAWN BY	BW
CHECKED BY	DTP
FILE NAME	Sewer Extension Record Drawings 06072016

MARTIN ROAD SEWER PLAN AND PROFILE
STA. 620+00 TO STA. 630+00

TOWN OF KITTERY, MAINE
ROUTE 236 SEWER EXTENSION PROJECT

SHEET
C-21

CAD FILE: G:_clients\Kittery, ME\20153873 - Rte 236 Sewer Extensions - ESDC\Construction Administration\Drawings\Record Drawings\CAD\20140119 - Kittery Sewer Extension\Sewer Extension Record Drawings 06072016.dwg LAYOUT: C-21

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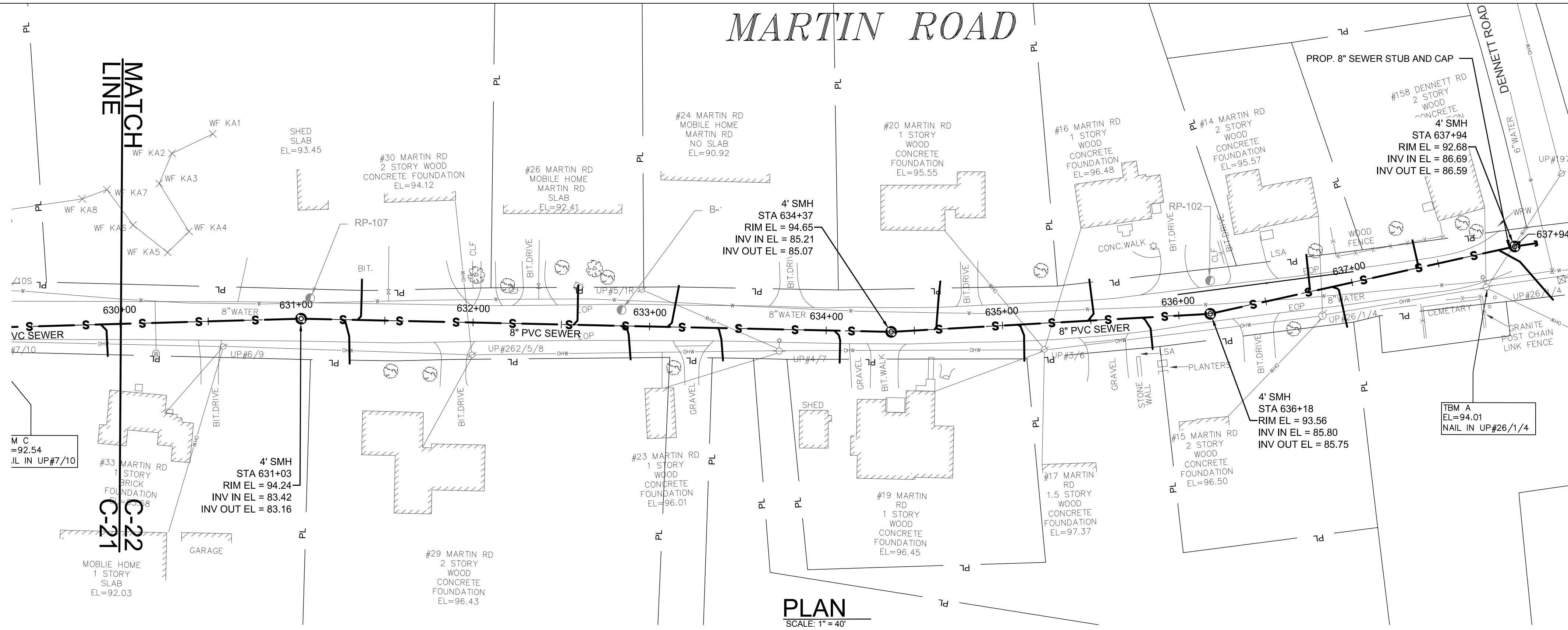

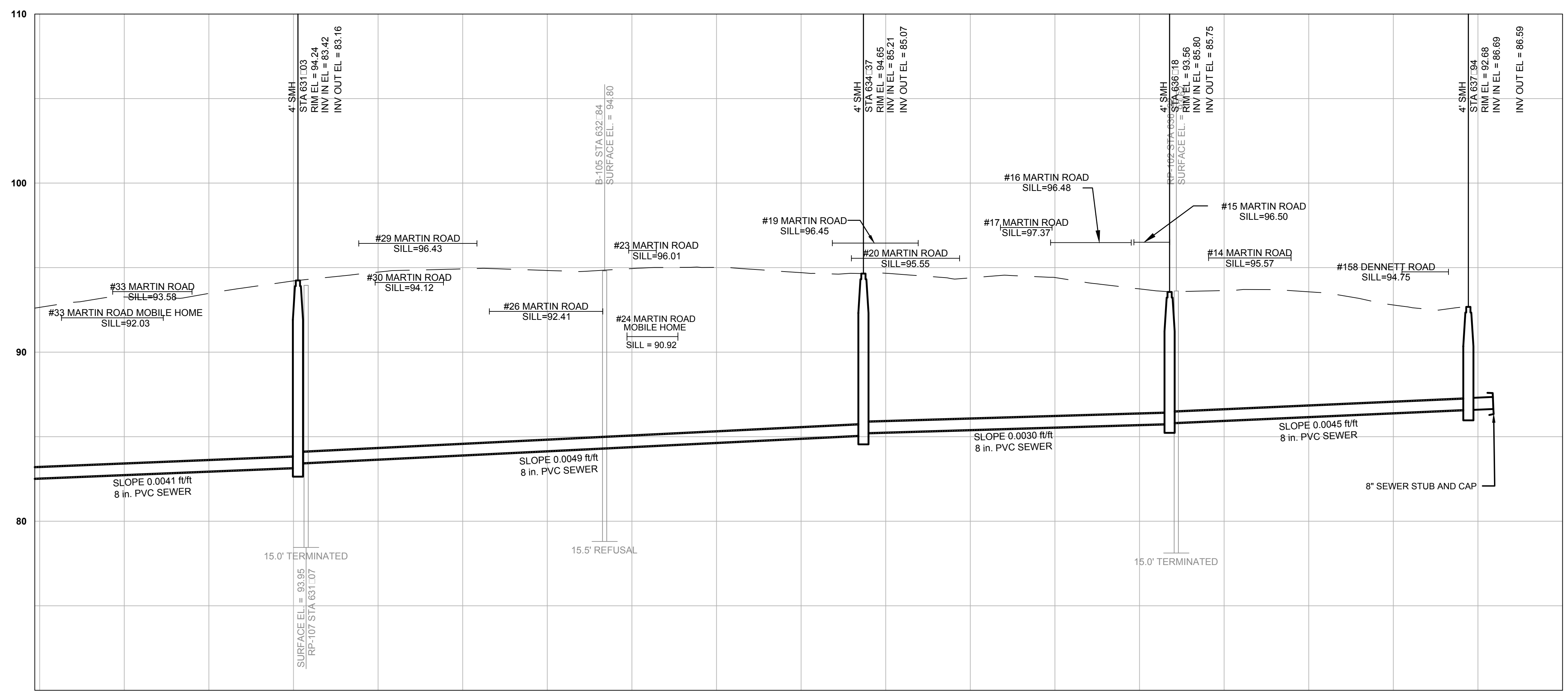

HORIZONTALSCALE: 1" = 40'

40 20 0 40 80

4 2 0 4 8

VERTICAL SCALE: 1"=4'

PROFILE

HORIZONTAL SCALE: 1"=40'
VERTICAL SCALE: 1"=4'

RECORD DRAWINGS

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REVISIONS

DATE	OCTOBER 2016
PROJECT NO.	20140119
DRAWN BY	BW
CHECKED BY	DTP
FILE NAME	Sewer Extension Record Drawings 06072016

MARTIN ROAD SEWER PLAN AND PROFILE
STA. 630+00 TO STA. 637+77

TOWN OF KITTERY, MAINE
ROUTE 236 SEWER EXTENSION PROJECT

SHEET
C-22

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Appendix J

Stormwater Opportunity Ranking Matrix

			40	5	5	10	5	5	5	15	2	2	2	2	2	50	20	20	10	100
			Stormwater Benefits			Constructability			Cost		Co-Benefits									
Subcatchment	Project Type	Location	Water Quantity / Flood Reduction	TSS Reduction	Nutrient Reduction	Land Acquisition or Public Partnership Potential	Known Constraints (utilities, depth to groundwater, site access, soils)	Permitting	Maintenance	Fundability	Energy and Air Quality Impacts	Habitat & Biodiversity	Community & Aesthetic Benefits	Human Health Benefits	Educational Opportunities/ Visibility	Stormwater Benefits Total	Constructability Total	Cost Total	Co-Benefits Total	Project Ranking Total
DA-2-Pond	Expanding Stormwater Storage	98 Dennett Parcel	40	5	5	5	5	1	3	15	2	2	2	2	2	50	11	18	10	89
DA-4-1, DA-4-2	Expanding Stormwater Storage	East side of Dennett Road	40	5	5	5	3	1	3	15	2	2	2	2	2	50	9	18	10	87
DA-1-1	Upstream Detention/Wetland Expansion	Above Martin Rd.	40	5	5	5	1	1	1	15	2	2	2	2	2	50	7	16	10	83
All	Low-Impact Development Considerations	Areas currently zoned B-PK and C-2	20	5	5	10	5	5	5	10	2	2	2	2	2	30	20	15	10	75
Multiple	Sizing of Critical Infrastructure - Culvert and Drainage Modifications	Martin Rd., Rt-236, Dennett and Old Dennett Rds., I-95	30	0	0	10	3	3	5	10	0	0	2	2	1	30	16	15	5	66
DA-2-1, DA-2-2, DA-2-4, DA-4-1, DA-4-2, DA-1-2, DA-1-4	Land Conservation	Areas currently zoned B-PK and C-2	20	5	5	5	5	5	5	5	2	2	2	2	2	30	15	10	10	65
DA-1-2, DA-1-3	Wetland Restoration	41 Rt. 236	10	5	5	5	3	1	1	15	2	2	2	2	2	20	9	16	10	55
All Residential	Homeowner Floodproofing	All Residential	10	0	0	10	5	5	5	5	2	2	2	2	2	10	20	10	10	50
DA-3-1; DA-2-1, DA-1-1	Installation of Sewer Line Seep Collars	Martin Rd.	10	0	0	10	3	5	5	5	0	0	0	1	0	10	18	10	1	39
DA-3	Drainage Infrastructure Modifications	Roseberry Lane	10	0	0	10	3	3	5	5	0	0	0	1	0	10	16	10	1	37
DA-3-1	Culvert Modifications	Old Dennett Road	10	0	0	10	3	3	5	5	0	0	0	1	0	10	16	10	1	37
DA-3-1	Access Road Culvert Improvements	Happy Avenue	10	0	0	5	3	5	5	5	0	0	0	1	0	10	13	10	1	34
DA-2-1	Drainage Improvements	Summer Lane	10	0	0	5	3	3	5	5	0	0	0	1	0	10	11	10	1	32
															Appenidx					

Notes - Initiall construction/implementation cost not included in priority ranking. Intent is to develop projects with a varying range of costs.
Projects in BOLD represent the 6 projects selected for further evaluation as part of Engineering Study Report.
Recommendations for Homeowner Floodproofing are also provided in the Report.

Stormwater Benefits:

Quantity:
- 0 - negligible reduction in peak flow.
- 10 - addresses lot level localized flooding or potenitally minimizes groundwater intrusion
- 20 - assists with off-setting potential drainage issues associated with future development
- 30 - addresses localized flooding (road/culvert overtopping) or GI practice that promotes infiltration or impervious reduction 1,000 - 100,000 sf
- 40 - creation of stormwater attenuation or impervious reduction over 100,000 sf

TSS & Nutrients:
- 0 - negligibile benefit
- 5 - water quality benefit

Constructability:

Ownership
- 0 - uninterested private owner
- 5 - interested private owner or unknown interest level private owner
- 10 - public

Known Constraints
- 1 - Constraints identified
- 3 - Possible constraints identified
- 5 - No constraints identified

Permitting
- 1 - Multiple permits required (MDEP, ACOE, Local ROW, etc.) and Project is located on Private Property
- 3 - Multiple permits required (MDEP, ACOE, Local ROW, etc.) and Project is located on Public Property
- 5 - Low permitting demand anticipated

Cost:

Maintenance
- 1 - Hiigh $
- 3 - Medium $
- 5 - Low $

Fundability
- 5- not fundable through existing stormwater management and flooding prevention grants
- 10 - Grant assistance possible
- 15 - Grant assitance likely

Co-Benefits modified from "The Value of Green Infrastructure: A Guide to Recognizing its Economic, Environmental, and Social Benefits," Center for Neighborhood Technology and American Rivers, 2010 and "Green Infrastructure Practices and Benefits", National Oceanic and Atmospheric Administration, 2014"

Co-benefits on a scale from 0 (no benefit) to 2 (significant benefit)
Energy and Air Quality Impacts includes: energy use reduction, air quality improvements and atmospheric C02 reduction
Habitat and Biodiversity includes: increases biodiversity, increases habitat connectivity, and provides pollinator habitat
Community and Aesthetic Benefits includes: improved aesthetics, increased recreational opportunities, and increased property values
Human health benefits includes health benefits and accident reduction

Appendix K

Maine Stormwater Management Design Manual LID Considerations

Chapter 10- Low Impact Development Practices

Low impact development (LID) is a process of developing land that mimic the natural hydrologic regime. LID begins at the design phase of a new development, incorporating planning techniques that minimize site clearing and impervious surfaces to reduce impact and stormwater runoff generated from the site. By reducing the volume of water leaving a site, the pollutant loading is also reduced. Other techniques that will reduce the volume and peak flow rates of runoff from the development are then incorporated throughout the site. LID is an effective tool that reduces pollutant loading, thermal impacts, stream flows, and minimizes stream channel erosion. More information is available in Volume I of this manual on LID measures.

IMPORTANT:
Maine DEP strongly encourages the use of LID measures. LID is not a rigid set of standards or a one size fits all approach and has many benefits:

- **Benefits to the Developer:** The owner and developer will see reduced costs for land clearing and grading, infrastructure and stormwater management while seeing an increased aesthetic value in the development.
- **Benefits to the Municipality:** The local government and community will benefit from reduced infrastructure maintenance costs and reduces property damage from flooding while having more open space, protected natural resources and better quality drinking water.
- **Benefits to the Environment:** The hydrologic cycle is preserved; streams are less prone to erosion; and stream flows are maintained while benefiting fish and wildlife.

IMPORTANT:
LID goals and objectives should be incorporated into the site planning process as early as possible. The following steps serve as a guideline to use in the planning stage:

- Identify and preserve sensitive areas that will affect the hydrology of the site. Features that should be protected are highly permeable soils.
- Minimize site disturbance and impervious areas with an alternative layout for the development.
- Minimize the impervious surfaces directly connected to drainage conveyance systems to reduce the time of concentration.
- Break the site into smaller drainage areas that can be handled through basic LID practices

PLANNING FOR LID

Minimize Site Clearing: Development typically involves new impervious surfaces such as roads and buildings and landscaped areas for lawns. Avoid developing high-permeable soils by protecting areas that are less sensitive to disturbance and that will sustain groundwater recharge and reduce runoff. For example, developing a vegetated, tight clay soil area will have less impact on stormwater runoff than developing a forested area on sandy soils. Once the sensitive areas have been identified, the layout of the development should be aligned with the conservation of these areas.

Minimize Impervious Areas: The traffic distribution network (roadways, sidewalks, driveways, and parking areas) is generally the greatest source of site imperviousness and these should be the focus for reducing impervious area.

- *Alternative Roadway Layout*: Alternative road layouts can be used to reduce total pavement, while allowing for the same amount of development. Clustering will decrease imperviousness.
- *Narrow Road Sections:* The width of pavement can be reduced by including the primary driving surface, a pervious base for the shoulders, and ditch drainage swale in place of curb and gutter.
- *Sidewalks:* Sidewalks should be reduced to one side of the road or be eliminated.
- *On-Street Parking:* Reduction to one side or elimination of on-street parking can potentially reduce overall site imperviousness by 25 to 30 percent.
- *Rooftops:* The number and size of buildings dictates the impervious area associated with rooftops and vertical construction is preferred over horizontal construction.
- *Driveways:* Minimizing paved driveway area can be accomplished through narrower driveways or length reduction. Shared driveways will also reduce imperviousness. In addition, pervious materials would minimize runoff.

Minimize Connected Impervious Areas: The impacts from impervious surfaces can be minimized by disconnecting these areas from piped drainage networks and by treating these at the sources.

- Paved driveways and roads should be directed to stabilized, vegetated areas.
- Flows from large paved surfaces should be broken up and for on-site treatment of smaller flows. Breaking flows up allows the flows to be directed to vegetation as sheet flow.
- LID techniques should be dispersed throughout the development, such as at individual house lots to obtain the most benefit. They can be incorporated into the landscaping of the property to provide a natural treatment system.

Maintain Time of Concentration: When development occurs, the time of concentration (Tc) is often shortened due from the impervious area, causing greater flows over a shorter period of time. LID practices can maintain the pre-development Tc by:

- Minimizing land disturbance,
- Detaining flows on site,
- Increasing the flow length,
- Increasing the surface roughness of the flow path,
- Creating flatter slopes, or
- Disconnecting impervious areas, which will decrease their travel rates.

Manage Stormwater at the Source: The impact from a development should be mitigated at the source by reestablishing a more natural hydrologic cycle that sustains a clean stream base flow. Typically, the most economical and simplistic stormwater management strategy is achieved by controlling runoff at the source with a variety of small treatment structures that will result in the reduction of stormwater discharge and more flexibility in the site design.

Soil Considerations:

- *Minimize Compaction:* Compaction reduces the natural infiltrating ability of soils; and disturbance from heavy equipment should be avoided. If possible, impervious surfaces and development disturbances should be directed towards the more impermeable soils of a site, leaving the pervious soils to continue infiltrating runoff.
- *Increase Organic Content of Soils:* When constructing many of the LID vegetated techniques, a quality topsoil is necessary to optimize pollutant removal. The soil bed should consist of at least 20-30% organic material and 30% planting or topsoil. This highly organic layer traps contaminants, absorbs more runoff and provides a medium for biological activity that helps break down pollutants. Planting soil provides a healthy growing medium for vegetation by encouraging strong root growth. In addition, microbes found in healthy soils transform nutrients for plant growth. Compost or other organic amendments can be added at the site preparation level, typically by the truckload. It is also available for little or no cost from many community leaf compost programs. For rain gardens and

bioretention areas, compost addition is also valuable in absorbing and retaining moisture for plant life, filtering pollutants and providing an active layer for microorganisms to reside and reproduce. A healthy microorganism population is key to the decomposition of many pollutants, whether in the home rain garden or in a parking lot.

- *Avoid Pesticides/Herbicides:* Healthy soil is alive with microorganisms that decompose and inactivate pollutants, but these may be killed by excessive chemicals. Although the soil microorganisms are not typically the target of these chemicals, many of them may fall victim to the use of pesticides. Additionally, insect species that prey on pests are also killed by pesticides. Since the predatory species tend to have slower reproduction than the pest species, a natural defense against insect pests may be lost.

LID TECHNIQUES

Many of the LID techniques rely on infiltration, retention, and evapotranspiration of stormwater to reduce runoff. When infiltration is not a possibility, the initial planning techniques described above should be the primary focus, followed by the use of small disconnected underdrained systems that rely on soil and vegetation to retain runoff. Examples of LID design standards and techniques are shown on Table 11.1 and Table 11.2.

- *Filters (Bioretention Cells and Rain gardens):* Bioretention areas or rain gardens are built with a specific soil filter media (containing organic material and planted with vegetation that can handle wet and dry conditions) that will reduce the volume of runoff through absorption and evapotranspiration. A slight depression allows the ponding of stormwater as it filtrates through the soil media and into the groundwater or to an underdrain for surface discharge. Refer to Chapter 7.2 and 7.3 of this manual for further information on the performance and design of bioretention practices.
- *Infiltration:* Infiltration reduces runoff and mimics the natural hydrologic cycle by redirecting water into the ground rather than to a piped system. It is best to use many smaller infiltration basins that fit into the natural landscape. The design information in Chapter 6.0 should be followed for any infiltration practice.
- *Buffers:* Vegetated buffer use soils and vegetation to remove pollutants from stormwater. Buffers can be used as a stormwater BMP for small developments by minimizing the amount of runoff generated through infiltration and evapotranspiration. Filter strips are typically used as pretreatment devices for bioretention cells and other infiltration practices. Refer to Chapter 5.0 for information on the performance and design of vegetated buffers.
- *Collection Cisterns:* In a commercial setting, the collection of rain runoff can be put to use in the building to off-set the cost of their water supply. Cisterns can be located either above or below ground, and in out-of-the-way places that can easily be incorporated into a site design. Commercially available systems are typically constructed of high-density plastics and can include pumps and filtration devices. Rain barrels are inexpensive, effective, and easily maintainable when used in residential applications to capture roof runoff for later watering of lawns and gardens.
- *Vegetated Rooftops:* Vegetated rooftops provide three primary benefits: attenuation of stormwater runoff and peak flows, reductions of the heat island effects with an increase in building insulation, and a longer life expectancy for the base roof material. The stormwater benefit is the smaller more common storm events are absorbed, minimizing peak runoff and the net volume of runoff typically produced by roofs. Refer to Chapter 7.6 for further information on the performance of rooftop greening.
- *Porous Pavement:* Porous pavement is a permeable surface (pervious asphalt, concrete or pavers), a granular base, and subbase materials which allow the penetration of runoff into the underlying soils. The efficiency of pavement alternative systems depends on whether the pavement is designed to store and infiltrate most runoff, or only limited volumes of runoff (e.g., "first-flush") with the remainder discharged to a storm drainage system or overland flow. Maintenance is essential for long-term use and effectiveness. Pavement alternatives vary in load bearing capacities but are generally appropriate for low traffic areas such as sidewalks, parking lots, overflow parking and residential

roads. It is important to choose a material appropriate for the desired use (light, moderate or heavy use). Refer to Chapter 7.7 for further information on the performance of porous pavement and other manmade pervious surfaces.

- *<u>Other Techniques:</u>* As previously stated, LID is about creativity. Multiple practices can be implemented and adapted into various sites and situations. However, they are mostly dependent upon the layout of the development and the disconnection of its individual elements.

<u>Table 10.1 – LID Measures and Techniques</u>

LID Measure	Technique	Design
Protect natural drainage system	• Maintain a minimum 25 foot buffer on all natural water resources including intermittent channels • Do not divert stormwater from its natural sub-watershed	Design practices developed at the planning phase that will help mitigate environmental impacts. Ideally, these are cost-effective and environmentally friendly.
Minimize the decrease in time of concentration	• Break up or disconnect the flow of runoff over impervious surfaces • Sheet flow over pavement that is less than 100 feet	
Minimize impervious area or the effect of impervious area	• Go vertical with multi story buildings and parking garages • More than 25% of pavement area (overflow) in pervious pavement All pedestrian walkways are pavers or pervious pavement • Infiltrate as much roof runoff as standards allow	
Minimize soil compaction	• Minimize the construction window • Rototilling all areas to be revegetated	
Minimize lawns and maximize landscaping that encourages runoff retention	• Low maintenance Maine native plants • No invasive plants • No pesticides • Fertilizer application only during initial planting and repair of damaged areas	
Provide vegetated open-channel conveyance systems	• No curb/gutters and no roof gutters • Level spreaders to buffers where possible • Underdrained swales	
Rain Collection Cisterns	Rainwater is stored for later reuse for the building or landscape	
Buffers	Design, size, install and maintain per the Maine recommended guidelines found in this manual.	Chapter 5
Infiltration (basins, trenches, dry wells, etc.)		Chapter 6
Underdrained grass filters		Chapter 7.1
Underdrained filter bioretention		Chapter 7.2
Roofline filtration		Chapter 7.5
Roof Greening		**Chapter 7.5**
Pervious Pavement		**Chapter 7.7**

Table 10.2 - LID Minimum Design Standards		
Each standard should be addressed	**Residential Subdivisions**	**Commercial, Industrial, or Institutional Developments**
Protect as much undisturbed land as possible to maintain pre-development hydrology and allow rainfall infiltration	• *Clustered development with remaining land protected by deed restriction*	• *Clustered development with protected land by deed restriction* • *Maximum 1000 ft road per 10 lots or with buffers only*
Protect natural drainage systems such as wetlands, watercourses, ponds and vernal pools to the maximum extent practicable	• *25 ft wooded buffer on all natural resources, including intermittent channels* • *Wetland impact no greater than 4300 sqft and is limited to crossings* • *No diversion of stormwater from its natural subwatershed*	
Minimize land disturbance including clearing and drainage to the extent practicable	• *10000 sq.ft maximum development for house lots (house/driveway/lawn/septic)*	• *25 feet max. disturbance around buildings and pavement (or be rototilled, revegetated and maintained as meadow grass)*
Minimize the decrease in the time of concentration from pre-construction to post-construction to the extent practicable	• *Raingardens for pretreatment (18 inches of filter media, no underdrain, with 6 inch ponding and an overflow), or* • *Buffers only for treatment*	• *1 acre or less per stormwater management structure (buffer, filter, infiltration)* • *Maximize sheet flow* • *Rain collection for reuse in building*
Minimize soil compaction to the extent practicable	• *Rototilling all areas to be revegetated*	• *A construction window that is no more than 25 feet around structures* • *Rototilling all compacted areas to be revegetated*
Utilize low-maintenance landscaping that encourages the retention and planting of native vegetation, and minimizes the use of lawns, fertilizers and pesticides	• *Maine native plants, no invasive* • *No pesticides/fertilizers/herbicides except during initial planting and repair of damaged areas* • *Mulch all landscape with wood waste*	
Minimize impervious surfaces and break up or disconnect the flow of runoff over impervious surfaces to the extent practicable	• *Road width that is 18 feet or less*	• *Multi-story buildings and, if feasible, parking garages* • *1 acre or less per stormwater structure (filter, infiltration)* • *Sheet flow over pavement that is less than 100 feet or intercepted by and underdrained vegetated depression island* • *Parking lots must have 25% of area (overflow) in pervious pavement or grass* • *All pedestrian walkways are pavers or pervious pavement*
Provide vegetated open-channel conveyance systems discharging into and through stable vegetated areas	• *No curb/gutters or roof gutters* • *Level spreaders to buffers* • *Underdrained swales* • *No direct connection (piped discharge) to a resource*	
Provide other source controls to prevent or minimize the use or exposure of pollutants at the site in order to prevent or minimize the release of those pollutants into stormwater runoff	• *No salt use*	• *No development with 'dirty' outdoor practices (fueling stations, car washing/maintenance, etc.)* • *Good housekeeping practices according to Multi-sector program* • *No salt use*

Appendix L

Town of Kittery Proposed Ordinance Content for Low Impact Development Strategies

Kittery Proposed Ordinance Content for Low Impact Development Strategies

Prepared for submittal to Maine Department of Environmental Protection as required by the Maine General Permit for Stormwater Discharges from Municipal Separate Storm Sewer Systems
Date of Revisions: 8/9/2022 – Draft for DEP Review and public comment.

Kittery intends to update their Code of Ordinances to incorporate the Definitions, Submittals and Performance Standards in this document.

This document is based on the Maine Model Ordinance for Low Impact Development Strategies (see credits this page).

The Town process for ordinance changes requires review by Planning Board and Town Council, Public Hearings, and approval by Town Council.

Items shown in Blue Italics were listed as optional in the Model Ordinance.

Credits: The Kittery Proposed LID Strategies are based on the model ordinance prepared by SMPDC, CCSWCD, and Integrated Environmental Engineering, Inc. under award CZM NA21NOS4190082 to the Maine Coastal Program from the National Oceanic and Atmospheric Administration, U.S. Department of Commerce. The statements, findings, conclusions, and recommendations are those of the author(s) and do not necessarily reflect the views of NOAA or the Department of Commerce.

DRAFT for DEP Review and Public Comment

LOW IMPACT DEVELOPMENT STRATEGIES

Table of Contents

Note to Maine DEP: The Purpose and Objectives shown here may change slightly but are shown for context.

ARTICLE I GENERAL

A. Purpose

The Purpose of this "Low Impact Development Strategies Ordinance" (the Ordinance) is to provide for the health, safety, and general welfare of the citizens of the Town of Kittery through review and approval of Low Impact Development Strategies as required by federal and State law.

This Ordinance establishes methods for implementing Low Impact Development Strategies to comply with minimum control measure requirements of the federal Clean Water Act, of federal regulations and of Maine's Small Municipal Separate Storm Sewer Systems General Permit.

B. Objectives

The Objective of this Ordinance is to minimize the adverse effects of new development and redevelopment on the environment specifically through protecting sensitive areas, providing on-site stormwater volume control, providing treatment of stormwater, and minimizing impervious areas.

C. Applicability

This ordinance applies to <u>any development in the Town's Urbanized Area</u> that creates:

a. Disturbed Area of one or more acres of land, or
b. Disturbed Area that is less than one acre of land if the Construction Activity creating Disturbed Area is less than one acre of land and is part of a larger Common Plan of Development or Sale that as approved or amended would create Disturbed Area of one acre or more.

D. Definitions

Note to Maine DEP: Definitions may change slightly based on detailed cross comparison to existing definitions in Town Ordinances.

Buffers – Means all three kinds of buffers listed below unless a subset of the three is specifically called out:

- Stormwater Vegetative Buffer – a buffer constructed in accordance with Appendix F in Chapter 500 for the purposes of providing pollutant removal.
- Shoreland Zoning Setback Buffer – A buffer required by <u>Chapter 44 Shoreland Zoning Ordinance</u> to protect a water of the State.
- Buffer – a buffer area as described in <u>Chapter 16.7.11 Performance Standards for General Developments or 16.8.10 Performance Standards for Subdivisions</u>.

Chapter 500 – Means Chapter 500 of the Maine Department of Environmental Protection's Rules ("Stormwater Management Rules").
Chapter 502 - Means Chapter 502 of the Maine Department of Environmental Protection's Rules ("Direct Watersheds of Lakes Most at Risk from New Development, and Urban Impaired Streams").
Climate Resilient Northeast Native Vegetation – Means plants identified as native to the Northeast as identified by the Northeast Regional Invasive Species & Climate Change (RISCC) Network or a Maine Licensed Landscape Architect.
Common Plan of Development or Sale - Means a "subdivision" as defined in Title 30-A M.R.S. §§ 4401 *et seq*. (the Maine Subdivision statute) and in the Municipality's code of ordinances.

> Note: Common Plan of Dev. or Sale a term required to be used by the MS4 General Permit. §§ 4401.4 "Subdivision" means the division of a tract or parcel of land into 3 or more lots within any 5-year period that begins on or after September 23, 1971. This definition applies whether the division is accomplished by sale, lease, development, buildings or otherwise. The term "subdivision" also includes the construction or placement of 3 or more dwelling units on a single tract or parcel of land.

Construction Activity – Means any activity on a Site that results in Disturbed Area.

Discharge - Means any spilling, leaking, pumping, pouring, emptying, dumping, disposing or other addition of pollutants to the Waters of the State, other than groundwater.

Disturbed Area - Means all land areas of a Site that are stripped, graded, grubbed, filled, or excavated at any time during the site preparation or removing vegetation for, or construction of, a Project. Cutting of trees, without grubbing, stump removal, disturbance, or exposure of soil is not considered Disturbed Area. Disturbed Area does not include routine maintenance but does include Redevelopment and new Impervious Areas. "Routine maintenance" is maintenance performed to maintain the original line and grade, hydraulic capacity, and original purpose of the facility. Paving impervious gravel surfaces provided that an applicant or permittee can prove the original line and grade and hydraulic capacity shall be maintained and original purpose of the gravel surface remains the same is considered routine maintenance. Replacement of a building is not considered routine maintenance of the building and is therefore considered Disturbed Area.

> Note: Disturbed Area definition is from the MS4 General Permit <u>plus</u> addition of the last sentence to ensure that Redevelopment Projects removing buildings take into account that area as Disturbed Area.

Drainageway – Means the same as "Drainageway" defined in Chapter 500

General Permit – Means the General Permit for the Discharge of Stormwater from Small Municipal Separate Storm Sewer Systems (MS4) approved October 15, 2020, and modified November 23, 2021, and any amendment or renewal thereof.

High Intensity Soil Survey – Means a Class A survey defined by the March 2009 Guidelines for Maine Certified Soil Scientist for Soil Identification and Mapping, prepared by the Maine Association of Professional Soil Scientists.

High Permeability Soils – Means hydrologic soil groups A or B as determined by on-site soil testing by a certified soil scientist using a High Intensity Soil Survey.

Impervious Area - Means the total area of a Parcel covered with a low-permeability material that is highly resistant to infiltration by water, such as asphalt, concrete, or rooftop, and areas such as gravel roads and unpaved parking areas that will be compacted through design or use to reduce their permeability. Common Impervious Areas include, but are not limited to, rooftops, walkways, patios, driveways, parking lots or storage areas, concrete or asphalt paving, gravel roads, packed earthen materials, and macadam or other surfaces which similarly impede the natural infiltration of stormwater. Pervious pavement, pervious pavers, pervious concrete, and under drained artificial turf fields are all considered impervious.

> Note: this definition is the same as Chapter 500 definition of Impervious Area except Chapter 500 has a sentence at the end was removed, saying that the DEP can exclude Pervious pavement from calculation of Impervious Area was modified.

Lot – Means the same as it is defined under the Municipality's zoning ordinance.

Low Impact Development (LID) - Means a broad approach to site planning that preserves natural resources, processes, and habitat, defines what portions of the Site are suitable for development and then utilizes Stormwater Treatment Measures to manage Runoff from the proposed developed impervious areas. In LID, Stormwater Treatment Measures using natural processes such as vegetated buffers are given preference over constructed treatment Stormwater Treatment Measures. The goals of LID are to minimize the environmental impacts of the development.

Maine Licensed Landscape Architect – Means a person who has an active Landscape Architect license from the Maine Board of Licensure for Architects, Landscape Architects, and Interior Designers.

Maine Native Vegetation – Means vegetation including grass seed mixtures, identified as native to Maine from lists maintained by: US Department of Agriculture Hardiness Zones by the Maine Cooperative Extension, Wild Seed Project, Regional Soil and Water Conservation District, Maine YardScaping Program, or a Maine Licensed Landscape Architect.

Municipal Separate Storm Sewer Systems (MS4) - Means a conveyance or system of conveyances designed or used for collecting or conveying Stormwater (other than a publicly owned treatment works (POTW), as defined at 40 CFR 122.2, or a combined sewer), including, but not limited to, roads with drainage systems, municipal roads, catch basins, curbs, gutters, ditches, human-made channels or storm drains owned or operated by any municipality, sewer or sewage district, Maine Department of Transportation (MDOT), Maine Turnpike Authority (MTA), State agency or Federal agency or other public entity that Discharges to Waters of the State other than groundwater.

Municipality – Means the City/Town of Kittery.

New Development – Means the same as “New Development or Construction” defined in the General Permit.

The General Permit defines “New Development or Construction” as follows: “New Development or Construction” means activity undertaken to develop property, including but not limited to: the construction of buildings, parking lots, roads and other new impervious surfaces; landscaping; and other activities that disturb land areas. New Development or Construction does not include Redevelopment or maintenance. Permitted municipalities may define New Development more stringently.)

Parcel – Means the same as "Tract or parcel of land" as defined at 30 M.R.S. §4401.6 *et seq*. *(or alternately, the municipality may reference their own definition of parcel).*

§4401.6 Tract or Parcel of land means all contiguous land in the same ownership, except that lands located on opposite sides of a public or private road are considered each a separate tract or parcel of land unless the road was established by the owner of land on both sides of the road after September 22, 1971.

Permitting Authority - Means the Code Enforcement Officer, Building Inspector, Planning Board, or other official or body authorized by State law or the Municipality’s ordinances to approve Development or Redevelopment of Sites.

Project – Means Construction Activity undertaken for Major Development, Minor Development or Subdivisions, both as defined in the General Permit, located on a Site that will Discharge Stormwater to a Small MS4 located partially or entirely within the Urbanized Area.

Protected Natural Resource - Means coastal sand dunes, coastal wetlands, significant wildlife habitat, fragile mountain areas, freshwater wetlands, community public water system primary protection areas, great ponds, or rivers, streams or brooks as defined in the *Natural Resources Protection Act* at 38 M.R.S. §480-B.

Redevelopment – Means the same as “Redevelopment” defined in the General Permit.

The General Permit defines “Redevelopment” as follows: “Redevelopment” means an activity, not including maintenance, undertaken to redevelop or otherwise improve property in which the newly developed area is located within the same footprint as the existing developed area.

Regulated Small MS4 - Means any Small MS4 authorized by the most recent, in-force General Permit or the general permits for the Discharge of Stormwater from MDOT and MTA Small MS4s or state or federally owned or operated Small MS4s including all those located partially or entirely within the Urbanized Area.

Runoff – Means the part of precipitation from rain or melting ice and snow that flows across a surface as sheet flow, shallow concentrated flow or in Drainageways.

Small MS4 - Means any MS4 that is not already covered by the Phase I MS4 stormwater program including municipally owned or operated storm sewer systems, state, or federally owned systems, such as colleges, universities, prisons, military bases and facilities, and transportation entities such as MDOT and MTA road systems and facilities. See also 40 CFR 122.26(b)(16).

Significant and Essential Wildlife Habitats – Means the areas identified as Significant or Essential Habitats of endangered or threatened species as identified by the Maine Department of Inland Fisheries and Wildlife either on the Beginning with Habitat viewer or in consultation with the Maine Department of Inland Fisheries and Wildlife.

Site - Means the portion of a Lot, Parcel, or Common Plan of Development which is proposed for Construction Activity, including open space, Stormwater Treatment Measures, and Disturbed Area, subject to this Ordinance.

Stormwater- Means the part of precipitation including Runoff from rain or melting ice and snow that flows across the surface as sheet flow, shallow concentrated flow, or in Drainageways. “Stormwater” has the same meaning as “storm water”.

Stream Crossing - Means the mechanism by which any road, sidewalk, or other structural feature of a Site will cross or pass over or through a Water of the State which has a stream bank full width of 6 feet or less.

Stream Crossing designed in accordance with Maine Stream Smart Principles – Means a Stream Crossing designed by a Maine Professional Engineer who has completed the Maine Audubon Society Stream Smart Workshops (Parts I and II), which includes the standards recommended by that program’s stream span, elevation, slope and skew and substrate to promote passage of fish and other organisms and to limit road-damaging flows from extreme weather.

Stormwater Treatment Measure – Means a Stormwater management system or innovative treatment measure as described in Chapter 500 4.c.(3) Types of treatment measures allowed. These measures include wet ponds, vegetated soil filters, infiltration, buffers, or innovative treatment measures. For purposes of this Ordinance these are cumulatively referred to as Stormwater Treatment Measures, or individually referred to as Stormwater Treatment Wet Pond, Stormwater Treatment Vegetated Soil Filter, Stormwater Treatment Infiltration Measure, Stormwater Treatment Buffer, or Stormwater Treatment Innovative Measure.

Time of Concentration – Means the same as “Time of concentration” defined in Chapter 500.

Urbanized Area - Means the area of the Municipality so defined by the inclusive sum of the 2000 decennial census and the 2010 decennial census by the U.S. Census Bureau.

Waters of the State – See 38 M.R.S. §361-A (7).

E. Procedure

Review and approval of projects subject to this Ordinance will be conducted concurrently with their Site Plan Review or Subdivision review.

F. Submission Requirements

The following submission items are required to be submitted with any Subdivision Final Plan application, or any Application for Site Plan:

1 Project Narrative

The applicant shall provide a Project narrative describing:

- *the overall approach to Stormwater management at the Project Site,*
- *a listing of Stormwater Treatment Measures that will be in use, stating which will be maintained privately and which will be offered to the Municipality for acceptance and operation,*
- *how they have prioritized protection of the sensitive areas from disturbance as required in Technical Appendix A and*
- *a rationale for any waivers from performance standards in Technical Appendix A.*

2 Project Contacts and Qualifications

The applicant shall provide contact information (i.e., name, company if applicable, phone number, physical address, and email address) as described below:

- Maine Licensed Landscape Architect
- Maine Certified Soil Scientist
- Maine Professional Engineer

3 Project Plans Contents

The applicants Project Plans shall consist of a graphic representation of the Site at a scale no smaller than 1 inch = 100 feet showing:

- Waters of the State and their associated Shoreland Protection areas
- Protected Natural Resources
- Predevelopment drainage areas, Drainageways and associated Time of Concentration
- High Permeability Soils
- Maine Native and Climate-Resilient Northeastern Native Vegetation in General Buffer areas and Shoreland Zoning Buffer areas
- Significant and Essential Wildlife Habitats
- Limits of disturbance
- Post-development drainage areas, Drainageways and associated Time of Concentration
- Locations of snow storage areas
- Stormwater Treatment Measures to be used

4 Submittals related to Infiltration Performance Standard

The applicant shall submit the following to permit review of the Project application under the LID Performance Standards for infiltration:

- Information required by Chapter 500 Section (7)(D)(5)(c) Infiltration Submittals including a plan for use of de-icing materials, pesticides and fertilizers within the drainage area of any infiltration Stormwater Treatment Measures.
- Locations of any Maine Uncontrolled Hazardous Substance Sites, Maine Voluntary Response Action Program sites, federal Resource Conservation and Recovery Act ("RCRA") Corrective Action sites, or Petroleum Remediation sites on or adjacent to the Site.

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G. Performance Standards

The applicant shall incorporate the performance standards contained in Technical Appendix A into their site design, shall implement them during construction and shall maintain and inspect them in accordance with Chapter 16.7.11.D Post-Construction Stormwater Management.

H. Enforcement – to be developed as part of final ordinance

I. Severability and Conflicts - to be developed as part of final ordinance

J. Waivers - to be developed as part of final ordinance

K. Authority

The Municipality enacts the Ordinance for Low Impact Development Strategies provisions pursuant to Maine Constitution Art. VIII, Part Second, §1 and 30-A M.R.S. §§3001 et seq. (municipal home rule authority), 38 M.R.S. §413 (the Wastewater Discharge Law), 33 USC §§1251 et seq. (the Clean Water Act), and 40 CFR Part 122 (US Environmental Protection Agency's regulations governing the National Pollution Discharge Elimination System (NPDES)). The Maine Department of Environmental Protection, through its promulgation of the General Permit for the Discharge of Stormwater from Small Municipal Separate Storm Sewer Systems has listed the Municipality as having a Regulated Small MS4; under this General Permit, listing as a Regulated Small MS4 necessitates enactment of elements of this Ordinance as part of the Municipality's Stormwater management program in order to satisfy the minimum control measures for Post Construction Stormwater Management in New Development and Redevelopment.

Technical Appendices

These Technical Appendices detail the required LID Performance Standards.

Technical Appendix A - LID Performance Standards

Note to Maine DEP:
The following table shows the Performance Standards the Town will adopt, which LID Measures are addressed by the Performance Standard as well as notes for future adoption by the Town. This information is provided to facilitate review by Maine DEP and for public comment.

The last two columns of the table will not be included in the Town's Ordinances and Regulations.

Regarding Maintenance of Stormwater Treatment Measures, MS4 communities maintain a Post-Construction Runoff Control Ordinance which automatically covers any Stormwater Treatment Measures required under the LID performance standards. Therefore, no Maintenance requirements are contained here. Non-MS4 communities implementing these LID strategies should also adopt the Post Construction Maintenance Ordinance.

Performance Standard	LID Measure(s) addressed (shown only for informational purposes)	Additional Notes for Kittery Adoption
Prioritize the protection of the following sensitive areas as listed below (highest priority listed first) by not disturbing land in these areas: i. Waters of the State and associated shoreland protection areas. ii. Protected Natural Resources iii. Predevelopment Drainageways iv. High Permeability Soils	1. Minimize Site Clearing 2. Protect Natural Drainage System 4. Minimize Impervious Area 5. Minimize Effect of Impervious Area 6. Minimize Soil Compaction	The Town intends to adopt this Performance Standard pending reviews and approvals as required by the Town Charter.

v. Maine Native Vegetation and Climate Resilient Northeastern Native Vegetation in General Buffer areas and Shoreland Zoning Setback Buffer areas vi. Significant and Essential Wildlife Habitats Note that the applicant will need to provide a description in their narrative of how they have prioritized these areas for protection from disturbance. These areas may be counted toward the open space requirements. Exception: Removal of Maine Native Vegetation and Climate Resilient Northeastern Native Vegetation that is diseased or in poor condition is allowed.		
Project Plans shall depict limits of disturbance. Limits of disturbance shall be established on-site prior to disturbance using flagging, fencing, signs or other means to provide a clear indication.	1. Minimize Site Clearing 6. Minimize Soil Compaction	The Town intends to adopt this Performance Standard pending reviews and approvals as required by the Town Charter.
Optional: Rural New Developments shall preserve at least 40% of the Site as open space and Suburban New Developments shall preserve 25% of the Site as open space. *Exception: Municipalities may allow exceptions per their municipal ordinances. For example, applicants may be allowed to pay a fee-in-lieu which is dedicated to open space or may provide open space in an alternate locations within the same watershed.*	1. Minimize Site Clearing 4. Minimize Impervious Area 7. Minimize Lawns and Maximize Landscaping that Encourages Runoff Retention.	Kittery Cluster Subdivision Ordinance contains 50% common open space requirements for developments in most rural and suburban zones and this is the permitted use. This requirement is balanced with lot size, maximum building coverage percentages and side and rear yard requirements. In addition, the Town is in the process of amending the cluster subdivision to require more upland open space and greater protections to sensitive environmental features. The Town intends to adopt this Performance Standard pending reviews and approvals as required by the Town Charter.

Stream Crossings for Waters of the State shall be designed in accordance with Maine Stream Smart Principles to preserve natural pre-development Drainageways. Exception: Stream Crossings over portions of streams that are artificially channelized are not subject to this standard.	2. Protect natural Drainage System 3. Minimize Decrease in Time of Concentration	The Town intends to adopt this Performance Standard pending reviews and approvals as required by the Town Charter.
Rural and Suburban Projects shall preserve the natural pre-development Drainageways on the Site by using the natural flow patterns and pathways for the post-construction drainage system. Exceptions are allowed if the Time of Concentration for a predevelopment Drainageway is the same as or shorter than the post-development Drainageway. Exception: The applicant may submit an "alternative analysis" which demonstrates that this performance standard is impracticable.	2. Protect Natural Drainage System 3. Minimize Decrease in Time of Concentration	The Town intends to adopt this Performance Standard pending reviews and approvals as required by the Town Charter.
Projects that have a Disturbed Area of one acre of land or more shall include Stormwater Treatment Measures in accordance with Chapter 500 Section 4.C General Standards, 4.C.(2) Treatment requirements, 4.C.(3) Types of treatment measures allowed, and 4.D Phosphorus standard (for lake watersheds only) and additionally: • Individual Stormwater Treatment Measure may not treat more than one acre of Impervious Area • Vegetation used in Buffer Areas and/or Stormwater Treatment Measures shall be Maine Native Vegetation or Climate Resilient Northeastern Native Vegetation	2. Protect Natural Drainage System 5. Minimize Effect of Impervious Area 7. Minimize Lawns and Maximize Landscaping that Encourages Runoff Retention. 10. Stormwater Quality Treatment and Retention Requirements	The Town intends to adopt this Performance Standard pending reviews and approvals as required by the Town Charter.

Note that although Chapter 500 General Standards and Phosphorus standard have higher thresholds for developed and Impervious Area, these standards apply to sites within the Urbanized Area of the Municipality at a lower threshold. Exception: Notwithstanding other provisions in municipal ordinances or state law, requirements to plant "Maine Native Vegetation" or "Climate Resilient Northeast Native Vegetation" shall not be construed as a restriction on the rights of individuals to engage in agricultural practices that are legally protected by the Maine Agriculture Protection Act and the "Right to Food" provision in the Maine Constitution (Constitution, Art. I, §25).		
Infiltration Standard: Provide volume control on-site (through infiltration or storage) in accordance with the following: • Volume to be controlled = (total area of Impervious Area after New Development and Redevelopment – total area that existed before New Development and Redevelopment) x Rd • Where Rd is the groundwater recharge depth based on the USDA/NRCDS hydrologic soil group as follows: Rd = 0.40 inches or rain for type A soils, 0.25 inches of rain for type B soils, 0.10 inches of rain for type C soils and 0 for type D soils • Stormwater Treatment Measures with liners may not be used to meet the volume requirement via storage. • Restrictions and requirements identified in Sections D(2) through D(4) of Appendix D	2. Protect the Natural Drainage System 3. Minimize the Decrease in Time of Concentration 5. Minimize Effect of Impervious Area	The Town intends to adopt this Performance Standard pending reviews and approvals as required by the Town Charter.

Infiltration basins, drywells, and subsurface fluid distribution systems; of Chapter 500 apply. Exception: For Sites in Rural and Suburban areas where infiltration will disrupt the preservation of the predevelopment Drainageways, an exception from the infiltration standard will be allowed. Exception: If any Uncontrolled Hazardous Substance Sites, Voluntary Response Action Program sites, RCRA Corrective Action sites, or Petroleum Remediation sites are on or adjacent to the Site, the Site does not need to meet the volume control standard. Exception: Municipalities may allow infiltration on an alternate site within the same watershed in-lieu of on-site infiltration.		
Minimize Impervious Area and the Effect of Impervious Area from road runoff: • At least 70% of roadway Runoff shall be directed into a Stormwater Treatment Measure *Optional:* • *Dead-end streets shall be no longer than 1000 feet (Rural and Suburban Areas).* • *Dead-end roads shall be constructed to provide a hammerhead (when less than 200 feet), or a tear drop cul-de-sac turn-around with a center that is vegetated, used for open space, and/or a Stormwater Treatment Measure as described below (Rural and Suburban Areas).* • *Cul-de-sac roads shall be constructed with the center island used for Stormwater Treatment*	4. Minimize Impervious Area 5. Minimize Effect of Impervious Area	The Town intends to adopt this Performance Standard pending reviews and approvals as required by the Town Charter. The Town will not adopt the optional performance standards.

Measures or vegetation unless type A or B soils are present in the center, in which case this area should be used to promote natural infiltration on-site.		
Minimize Impervious Area from parking areas: • Vehicle parking stall dimension standard: maximum of 9-foot x 18-foot stall Exceptions for public safety *Optional: (not fully developed as part of this ordinance) Establish "In-Lieu of" Parking programs with the following components:* • *Fee in-lieu of parking* • *Car-share in-lieu of parking* • *Transit in-lieu* • *Bike/pedestrian infrastructure improvements* *Note that the in-lieu program may optionally be tied to incentives, such as density or height bonuses.* *Establish shared parking provisions* *Minimum parking requirements shall be based on reasonable parking needs instead of peak use, and maximum parking limits should be established for appropriate areas. Establish maximum parking requirements at current minimum standards.* *Reductions in parking volume requirements should consider presence of transit routes within ¼ mile, existing on-road parking, and transportation/parking demand management plan for Sites over a certain size.*	4. Minimize Impervious Area	The Town intends to adopt this Performance Standard pending reviews and approvals as required by the Town Charter. Kittery will not adopt the optional performance standards.

• *Commercial parking space size shall be a maximum 9-foot width and an 18-foot length with an allowance for reduction in length at a 1 to 1 ratio for available overhang (1 foot reduction allowed if 1 foot overhang possible).* • *Parking lot travel aisles shall be a maximum of 22 feet wide.* *Require garages/under above building where appropriate, optionally tied to a density or height bonus*		
Runoff from on-site roofs, sidewalks, and peak-use overflow parking Runoff shall be directed into Stormwater Treatment Buffers or Stormwater Treatment Infiltration Measures.	5. Minimize Effect of Impervious Area 8. Provide Vegetated Open-Channel Conveyance Systems	The Town intends to adopt this Performance Standard pending reviews and approvals as required by the Town Charter.
Construction equipment movement, laydown areas and parking shall be restricted to the Disturbed Area. Areas to be vegetated shall be tilled and the soils amended with organic matter as needed based on the results of soil tests.	6. Minimize Soil Compaction	The Town intends to adopt this Performance Standard pending reviews and approvals as required by the Town Charter.
Snow storage areas shall be depicted on site plans. The location of snow storage areas in Stormwater Treatment Measures and Shoreland Zoning Setback Buffers shall be prohibited.	5. Minimize Effect of Impervious Area	The Town intends to adopt this Performance Standard pending reviews and approvals as required by the Town Charter.
Optional Standard: Require the implementation of precipitation storage (e.g., cisterns or rain barrels) for later reuse for landscaping.	9. Rainwater Capture and Reuse	Kittery will not implement this optional performance standard.

The experience to
listen
The power to
solve℠

Barton
&Loguidice

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