FEDERAL EMERGENCY MANAGEMENT AGENCY

PAYMENT INFORMATION FORM

Community Name:

Project Identifier: 18 Industrial Drive Holden MA

THIS FORM MUST BE MAILED, ALONG WITH THE APPROPRIATE FEE, TO THE ADDRESS BELOW OR FAXED TO THE FAX NUMBER BELOW.

Please make check or money order payable to the National Flood Insurance Program.

Type of Request:

☐ MT-1 application
☒ MT-2 application

LOMC Clearinghouse
3601 Eisenhower Ave. Suite 500
Alexandria, VA 22304-6426
Attn.: LOMC Manager

☐ EDR application

FEMA Project Library
3601 Eisenhower Ave. Suite 500
Alexandria, VA 22304-6426
FAX (703) 960-9125

Request No. (if known): ____________ **Check No.:** ____________ **Amount:** 0

☐ INITIAL FEE* ☒ FINAL FEE ☐ FEE BALANCE** ☐ MASTER CARD ☐ VISA ☐ CHECK ☐ MONEY ORDER

*Note: Check only for EDR and/or Alluvial Fan requests (as appropriate).

****Note: Check only if submitting a corrected fee for an ongoing request.**

COMPLETE THIS SECTION *ONLY* IF PAYING BY CREDIT CARD

CARD NUMBER EXP. DATE

☐☐☐☐ – ☐☐☐☐ – ☐☐☐☐ – ☐☐☐☐ ☐☐ – ☐☐
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 Month Year

____________ ____
Date Signature

NAME *(AS IT APPEARS ON CARD)*: ______________________
(please print or type)

ADDRESS: ______________________________
(*for your credit card receipt-please print or type*) ______________________________

DAYTIME PHONE: ______________________

Online Letter of Map Change

LOMC Application

Application ID: R3575765831710

Revision

Revision Review

Project Type

Project Type: LOMR

Payment Total

Fee: $0.00 (LOMR Based Solely on Submission of More Detailed Data)

Project Name/Identifier

Project Name/Identifier: 18 Industrial Drive Holden

Community Information

State, District or Territory:	MA
County:	Worcester County
Community Name:	HOLDEN, TOWN OF
Map Panel Number - Effective Date:	2503090015B - 07/02/1981
CID:	250309

Flooding

Flooding Source: Old Salisbury Wetlands

Types of Flooding: Riverine

Basis for Request

The basis for this revision request is: Hydraulic Analysis , Hydrologic Analysis , Improved Methodology/Data

Zone Designation

FEMA Zone designations affected: A

Revision Structures

The area of revision encompasses the following structures: No Project

Primary Contact Information

Title:	Mr.
First Name:	Andrew
Last Name:	Walker
Address 1:	100 International Drive
City:	Portsmouth
State, District or Territory:	NH
ZIP Code:	03820
E-mail Address:	getchellj@wseinc.com
Company/Organization:	Weston Sampson
Phone:	603-431-3937

Community Official Information

Title:	Mr.
First Name:	David
Last Name:	Lindberg
Professional Title:	Building Commissioner
Community Name:	HOLDEN, TOWN OF
Address 1:	1196 Main Street
City:	Holden
State, District or Territory:	MA
ZIP Code:	01520
E-mail Address:	dlindberg@holdenma.gov
Phone:	508-210-5536

As the CEO or designee responsible for the floodplain management, I hereby acknowledge that we have received and reviewed this Letter of Map Revision (LOMR) or conditional LOMR request. Based upon the community's review, we find the completed or proposed project meets or is designed to meet all of the community floodplain management requirements, including the requirement for when fill is placed in the regulatory floodway, and that all necessary Federal, State, and local permits have been, or in the case of a conditional LOMR, will be obtained. For conditional LOMR request, the applicant has documented Endangered Species Act (ESA) compliance to DHS/FEMA prior to DHS/FEMA's review of the Conditional LOMR application. For LOMR request, I acknowledge that compliance with sections 9 and 10 of the ESA has been achieved independently of DHS/FEMA's process. For actions authorized, funded, or being carried out by Federal or State agencies, existing or proposed structures to be removed from the SFHA are or will be reasonably safe from flooding as defined in 44 CFR 65.2(c), and that we have available upon request by DHS/FEMA, all analyses and documentation used to make this determination.

Community Official Signature: David Lindberg

Date: 3 SEPT 19

Certification by Registered Professional Engineer and/or Land Surveyor

Certification by Registered Professional Engineer and/or Land Surveyor

This certification is to be signed and sealed by a licensed land surveyor, registered professional engineer, or architect authorized by law to certify elevation information data, hydrologic and hydraulic analysis, and any other supporting information as per NFIP regulations paragraph 65.2(b) and as described in the MT-2 Forms instruction. All documents submitted in support of this request are correct to the best of my knowledge. I understand that any false statement may be punishable by fine or imprisonment under Title 18 of the United States Code, Section 1001.

First Name:	James
Last Name:	Pearson
License Number:	50675 (PE)
Expiration Date:	6/30/2022
Company Name:	Weston & Sampson
E-mail Address:	pearsonj@wseinc.com
Telephone Number:	978-532-1900
Fax Number:	N/A
Certifier's Signature:	
Date:	9/22/2020

From: John Woodsmall <jwoodsmall@holdenma.gov>
Sent: Thursday, September 17, 2020 11:53 AM
To: Walker, Andrew <walkera@wseinc.com>; Pearson, James <PearsonJ@wseinc.com>
Subject: Re: Flood Study-18 Industrial Drive

LOL

With that said, let's go with Old Salisbury Wetlands. Sounds a bit more distinguished than "Industrial Wetlands."

On 9/17/2020 11:51 AM, Walker, Andrew wrote:
Woodsmall Wetland is nice… almost as nice as Walker Swamp.

From: Pearson, James <PearsonJ@wseinc.com>
Sent: Thursday, September 17, 2020 11:49 AM
To: jwoodsmall@holdenma.gov
Cc: Walker, Andrew <walkera@wseinc.com>
Subject: RE: Flood Study-18 Industrial Drive

It seems that the choice is entirely yours, I have no objection to either of those. Does Woodsmall Wetland have a nice ring to it?

James I. Pearson, PE
SENIOR PROJECT MANAGER
direct: 978-532-1900 ext. 2346

Weston & Sampson *(We've Moved!)*
55 Walkers Brook Drive, Suite 100 | Reading, MA 01867
tel: 978-532-1900
westonandsampson.com

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From: John Woodsmall <jwoodsmall@holdenma.gov>
Sent: Thursday, September 17, 2020 10:52 AM
To: Pearson, James <PearsonJ@wseinc.com>
Cc: Walker, Andrew <walkera@wseinc.com>
Subject: Re: Flood Study-18 Industrial Drive

Hi James,

Thanks for the update.

Did you have any thoughts on that name? Perhaps its just me, but I don't automatically associate those wetlands with Chaffin Pond. Would Industrial Wetlands or Old Salisbury Wetlands be more appropriate, given the wetlands are located in between those two streets?

-John

On 9/15/2020 12:35 PM, Pearson, James wrote:
Hi John,

We are trying to close the loop with FEMA on the remaining items with the flood study. One of the things they wanted from us was some input on what to name the wetland behind the property for formal mapping purposes and apparently they want a written response confirming the name. Their suggestion was "Chaffin Pond North," or you could provide a different name if desired. Let me know either way.

Thank you,

James I. Pearson, PE
SENIOR PROJECT MANAGER
direct: 978-532-1900 ext. 2346

Weston & Sampson *(We've Moved!)*
55 Walkers Brook Drive, Suite 100 | Reading, MA 01867
tel: 978-532-1900
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U.S. DEPARTMENT OF HOMELAND SECURITY
FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERINE HYDROLOGY & HYDRAULICS FORM

O.M.B No. 1660-0016
Expires February 28, 2014

PAPERWORK BURDEN DISCLOSURE NOTICE

Public reporting burden for this form is estimated to average 3.5 hours per response. The burden estimate includes the time for reviewing instructions, searching existing data sources, gathering and maintaining the needed data, and completing, reviewing, and submitting the form. You are not required to respond to this collection of information unless a valid OMB control number appears in the upper right corner of this form. Send comments regarding the accuracy of the burden estimate and any suggestions for reducing this burden to: Information Collections Management, Department of Homeland Security, Federal Emergency Management Agency, 1800 South Bell Street, Arlington VA 20958-3005, Paperwork Reduction Project (1660-0016). Submission of the form is required to obtain or retain benefits under the National Flood Insurance Program. **Please do not send your completed survey to the above address.**

PRIVACY ACT STATEMENT

AUTHORITY: The National Flood Insurance Act of 1968, Public Law 90-448, as amended by the Flood Disaster Protection Act of 1973, Public Law 93-234.

PRINCIPAL PURPOSE(S): This information is being collected for the purpose of determining an applicant's eligibility to request changes to National Flood Insurance Program (NFIP) Flood Insurance Rate Maps (FIRM).

ROUTINE USE(S): The information on this form may be disclosed as generally permitted under 5 U.S.C § 552a(b) of the Privacy Act of 1974, as amended. This includes using this information as necessary and authorized by the routine uses published in DHS/FEMA/NFIP/LOMA-1 National Flood Insurance Program (NFIP); Letter of Map Amendment (LOMA) February 15, 2006, 71 FR 7990.

DISCLOSURE: The disclosure of information on this form is voluntary; however, failure to provide the information requested may delay or prevent FEMA from processing a determination regarding a requested change to a NFIP Flood Insurance Rate Maps (FIRM).

Flooding Source: Old Salisbury Wetlands

Note: Fill out one form for each flooding source studied

A. HYDROLOGY

1. Reason for New Hydrologic Analysis (check all that apply)

☐ Not revised (skip to section B) ☒ No existing analysis ☐ Improved data
☐ Alternative methodology ☐ Proposed Conditions (CLOMR) ☐ Changed physical condition of watershed

2. Comparison of Representative 1%-Annual-Chance Discharges

Location	Drainage Area (Sq. Mi.)	Effective/FIS (cfs)	Revised (cfs)
Old Salisbury Wetlands	0.0875		203.1
Drainage Swale	0.0055		14.7

3. Methodology for New Hydrologic Analysis (check all that apply)

☐ Statistical Analysis of Gage Records ☒ Precipitation/Runoff Model → Specify Model: HEC-HMS
☐ Regional Regression Equations ☐ Other (please attach description)

Please enclose all relevant models in digital format, maps, computations (including computation of parameters), and documentation to support the new analysis.

4. Review/Approval of Analysis

If your community requires a regional, state, or federal agency to review the hydrologic analysis, please attach evidence of approval/review.

5. Impacts of Sediment Transport on Hydrology

Is the hydrology for the revised flooding source(s) affected by sediment transport? ☐ Yes ☒ No

If yes, then fill out Section F (Sediment Transport) of Form 3. If No, then attach your explanation..

B. HYDRAULICS

1. Reach to be Revised

	Description	Cross Section	Water-Surface Elevations (ft.) Effective	Proposed/Revised
Downstream Limit*	563517, 2950035 (2011 MA State Plane Ft)			
Upstream Limit*	Boston & Maine Railroad			

*Proposed/Revised elevations must tie-into the Effective elevations within 0.5 foot at the downstream and upstream limits of revision.

2. Hydraulic Method/Model Used: HEC-HMS (See Attached Memorandum)

3. Pre-Submittal Review of Hydraulic Models*

DHS-FEMA has developed two review programs, CHECK-2 and CHECK-RAS, to aid in the review of HEC-2 and HEC-RAS hydraulic models, respectively. We recommend that you review your HEC-2 and HEC-RAS models with CHECK-2 and CHECK-RAS.

4.

Models Submitted	Natural Run		Floodway Run		Datum
Duplicate Effective Model*	File Name:	Plan Name:	File Name:	Plan Name:	
Corrected Effective Model*	File Name:	Plan Name:	File Name:	Plan Name:	
Existing or Pre-Project Conditions Model	File Name:	Plan Name:	File Name:	Plan Name:	
Revised or Post-Project Conditions Model	File Name:	Plan Name:	File Name:	Plan Name:	
Other - (attach description)	File Name: _See HEC-HMS__	Plan Name:	File Name:	Plan Name:	_FtNAVD88__

* For details, refer to the corresponding section of the instructions.

☒ Digital Models Submitted? (Required)

C. MAPPING REQUIREMENTS

A **certified topographic work map** must be submitted showing the following information (where applicable): the boundaries of the effective, existing, and proposed conditions 1%-annual-chance floodplain (for approximate Zone A revisions) or the boundaries of the 1%- and 0.2%-annual-chance floodplains and regulatory floodway (for detailed Zone AE, AO, and AH revisions); location and alignment of all cross sections with stationing control indicated; stream, road, and other alignments (e.g., dams, levees, etc.); current community easements and boundaries; boundaries of the requester's property; certification of a registered professional engineer registered in the subject State; location and description of reference marks; and the referenced vertical datum (NGVD, NAVD, etc.).

☒ Digital Mapping (GIS/CADD) Data Submitted (preferred)

Topographic Information: LiDAR (2011 Northeast)

Source: MassGIS Date: Winter-Spring 2011

Accuracy: Non-Vegitative Vertical Accuracy=0.30 Meters

Note that the boundaries of the existing or proposed conditions floodplains and regulatory floodway to be shown on the revised FIRM and/or FBFM must tie-in with the effective floodplain and regulatory floodway boundaries. Please attach **a copy of the effective FIRM and/or FBFM**, at the same scale as the original, annotated to show the boundaries of the revised 1%-and 0.2%-annual-chance floodplains and regulatory floodway that tie-in with the boundaries of the effective 1%-and 0.2%-annual-chance floodplain and regulatory floodway at the upstream and downstream limits of the area on revision.

☒ Annotated FIRM and/or FBFM (Required)

D. COMMON REGULATORY REQUIREMENTS*

1. For LOMR/CLOMR requests, do Base Flood Elevations (BFEs) increase? ☐ Yes ☒ No

   a. For CLOMR requests, if either of the following is true, please submit **evidence of compliance with Section 65.12 of the NFIP regulations**:

   - The proposed project encroaches upon a regulatory floodway and would result in increases above 0.00 foot compared to pre-project conditions.
   - The proposed project encroaches upon a SFHA with or without BFEs established and would result in increases above 1.00 foot compared to pre-project conditions.

   b. Does this LOMR request cause increase in the BFE and/or SFHA compared with the effective BFEs and/or SFHA? ☐ Yes ☒ No
   If Yes, please attach **proof of property owner notification and acceptance (if available)**. Elements of and examples of property owner notifications can be found in the MT-2 Form 2 Instructions.

2. Does the request involve the placement or proposed placement of fill? ☐ Yes ☒ No

   If Yes, the community must be able to certify that the area to be removed from the special flood hazard area, to include any structures or proposed structures, meets all of the standards of the local floodplain ordinances, and is reasonably safe from flooding in accordance with the NFIP regulations set forth at 44 CFR 60.3(A)(3), 65.5(a)(4), and 65.6(a)(14). Please see the MT-2 instructions for more information.

3. For LOMR requests, is the regulatory floodway being revised? ☐ Yes ☒ No

   If Yes, attach **evidence of regulatory floodway revision notification**. As per Paragraph 65.7(b)(1) of the NFIP Regulations, notification is required for requests involving revisions to the regulatory floodway. (Not required for revisions to approximate 1%-annual-chance floodplains [studied Zone A designation] unless a regulatory floodway is being established. Elements and examples of regulatory floodway revision notification can be found in the MT-2 Form 2 Instructions.)

4. For CLOMR requests, please submit documentation to FEMA and the community to show that you have complied with Sections 9 and 10 of the Endangered Species Act (ESA).

For actions authorized, funded, or being carried out by Federal or State agencies, please submit documentation from the agency showing its compliance with Section 7(a)(2) of the ESA. Please see the MT-2 instructions for more detail.

* Not inclusive of all applicable regulatory requirements. For details, see 44 CFR parts 60 and 65.

55 Walkers Brook Drive, Suite 100, Reading, MA 01867
Tel: 978.532.1900

MEMORANDUM

TO: Project File

FROM: Jill Getchell; Andrew Walker, PH-SW, CFM

DATE: 8/19/2020

SUBJECT: 18 Industrial Drive Flood Study

Revision Request Narrative

In support of the Town's development of 18 Industrial Drive, Holden, Massachusetts, Weston & Sampson evaluated the 100-year Base Flood Elevation (BFE) and associated flooding extents in and near the project site. As shown in Figure 1, a portion of the site is currently mapped within a FEMA A Zone, for which no BFE has been determined. The goal of this scope of work was to define the BFE through detailed hydrologic and hydraulic analyses, consistent with FEMA standards, and to delineate the 100-year flood zone associated with that BFE. We understand that these analyses form the basis of the submittal of a Letter of Map Revision, which may result in a change to FEMA's flood insurance mapping in this area.

The waterbody in question is a large, predominantly forested wetland ("Old Salisbury Wetlands") located between Industrial Drive to the East, Salisbury Street to the west, and a railroad bed to the north. The southern border of Old Salisbury Wetlands is formed by a natural embankment running generally east-west. Based on field observations made during a 6/27/2019 site visit, it was clear that stormwater is discharged from Old Salisbury Wetlands via a natural outlet at its northeast corner as opposed to the natural embankment at its southern end, as suggested in existing USGS topographic maps and FEMA flood maps. Discharge from Old Salisbury Wetlands enters a drainage swale that runs west to east immediately south of the nearby railbed. A high ground, perhaps a former driveway or embankment carrying underground utilities, extends from the project site towards the railbed, bisecting the drainage swale and preventing significant stormwater from continuing downstream to an existing storm drain system in and along Industrial Drive.

While MassDCR alerted the project team to the presence of a conduit through the high ground, which connects Old Salisbury Wetlands with the downstream storm drain system, a site visit on 8/17/2020 confirmed that the conduit is:

1. Actually 18 inches in diameter instead of 24 inches as shown on some historical drawings;
2. More than 50% blocked by hard-packed soil at both its upstream and downstream ends;
3. Further blocked by accumulated woody debris at its upstream end; and
4. At least partially open as indicated by Town staff who have witnessed discharge from its outlet in the past as well as the observation of cool air being emitted from the conduit's upstream during the most recent site visit.

While the conduit is expected to pass stormwater during small events, hydraulic calculations indicate that, given the alignment of the conduit and its significantly deteriorated condition, its peak discharge capacity is less than 2 cfs, compared to the nearly 120 cfs peak discharge associated with the 100-year, 72-hour flood event described below. Large flood events would be expected to mobilize additional woody debris, further obstructing the culvert's inlet and reducing its capacity. The hydraulic capacity of conduit is also less than that of the downstream storm drain system beneath Industrial Drive, posing little to no threat of flooding in that area.

Therefore, for the purposes of identifying the 100-year inundation extents associated with the project site, it was assumed that neither runoff volumes nor peak discharge rates through or from the project site would be impacted by the significantly obstructed conduit. Discharge from Old Salisbury Wetlands was assumed to pool in the upper (western) half of the drainage swale. The high ground that bisects the swale is approximately 1.5 feet higher than the railbed; under extreme flooding conditions, the swale may overflow northward across the railbed, causing shallow flooding of Main Street and the businesses and parking areas at the southwest corner of Main Street and Industrial Drive. During large flood events, both Old Salisbury Wetlands and drainage swale are expected to act as impoundments, resulting in flat upstream water surfaces as opposed to sloped surfaces consistent with more typical riverine conditions. Based on this understanding of the site, Weston & Sampson conducted hydrologic and hydraulic evaluations of Old Salisbury Wetlands and drainage swale and of area of shallow flooding around Main Street to determine their BFE and inundation extents during the 100-year flood event.

Hydrologic Analyses

Weston & Sampson prepared a rainfall-runoff model of two sub-basins, one upgradient of Old Salisbury Wetlands and one of the land downgradient of Old Salisbury Wetlands but upgradient of the drainage swale. The model was developed with the US Army Corps of Engineer's software HEC-HMS 4.3 (latest version), employing the Soil Conservation Service (SCS) unit hydrograph method. This method is consistent with FEMA requirements as outlined at https://www.fema.gov/numerical-models-meeting-minimum-requirements-national-flood-insurance-program. The HEC-HMS computer program uses the Natural Resources Conservation Service (NRCS) unit hydrograph method to compute stormwater runoff from a watershed or sub-basin. That method determines runoff rates for a given drainage area over a specified duration of time. The parameters required for this method include the drainage area, Curve Number (CN), time of concentration, and rainfall depth and distribution. The major inputs for the hydrologic study are summarized below.

Drainage Area. The drainage area of Old Salisbury Wetlands and drainage swale sub-basins were delineated using a series of ArcGIS tools from the Spatial Analyst toolkit, applied to the latest LiDAR elevation data available from MassGIS, the 2011 LiDAR for the Northeast dataset. These delineations, shown in Figure 1, were hand-checked to confirm their accuracy. The total drainage area of Old Salisbury Wetlands and drainage swale sub-basins are 56 acres and 3.5 acres, respectively.

Land Cover, Soils, and Curve Numbers. Under the SCS rainfall-runoff methodology incorporated into HEC-HMS, a sub-basin's Curve Number (CN) represents its ability to infiltrate an event's initial rainfall. The Curve Number for the Old Salisbury Wetlands and gully sub-basins were determined using standard reference values typical of the land cover and hydrologic soil group combinations found within the watershed. Land cover data was taken from the National Land Cover Dataset for Massachusetts from the USDA NRCS Geospatial Data Gateway. The hydrologic soil groups found in the watershed were determined from the Gridded Soil Survey Geographic for Massachusetts, also from the USDA NRCS Geospatial Data Gateway. The distribution of land cover types within the study area are shown in Figure 2.

The Old Salisbury Wetlands sub-basin is underlain by 56% Group A soils and 44% Group B soils while the drainage swale sub-basin soils are 88% Group A and 12% Group B. Land cover types within the Old Salisbury Wetlands sub-basin are Woody Wetlands (30%), Low Intensity Development (24%), Deciduous Forest (24%), Medium Intensity Development (15%), Open Space Development (2%), Evergreen Forest (2%), Mixed Forests (2%) and High Intensity Development (1%). Land cover types within the drainage swale sub-basin are High Intensity Development (48%), Medium Intensity Development (33%), Evergreen Forest (9%), Deciduous Forest (5%) and Woody Wetlands (5%). The distribution of HSGs within the study area are shown in Figure 2.

Based on the combination of HSGs and land covers described above, the calculated CNs for the Old Salisbury Wetlands and drainage swale sub-basins are 69 and 78, respectively.

Time of Concentration. In general, the time of concentration indicates the length of time it takes for a single raindrop to move from the furthest reaches of a watershed to its mouth. The times of concentration for the Old Salisbury Wetlands and drainage swale sub-basins were determined using the TR-55 multi-segment method, as defined in the NCS National Engineering Handbook. Times of concentration were calculated for each of three separate flow paths within each sub-basin (Figure 1), the largest of which was incorporated into the HEC-HMS model.

Rainfall. In rainfall-runoff models using the SCS unit hydrograph method rainfall events are simulated as the distribution of user-defined rainfall depth over time. The rainfall depth values used to define the 100-year event over 60-minute, 24-hour, and 3-day durations were 2.41 inches, 7.6 inches, and 9.51 inches, respectively. The rainfall depths were obtained from NOAA's Precipitation Frequency Estimates. Given the relatively small size of the watersheds, an SCS Type III rainfall distribution was used to define the distribution of that rainfall depth over time. A moderate antecedent moisture condition (AMC II) was assumed.

Weston & Sampson conducted hydrologic analyses of the two sub-basins to determine the peak runoff rates and total runoff volumes predicted for each of the 100-year storm events described above. The results of those analyses are presented in Table 1.

Table 1: Simulated Peak and Total Runoff

Design Event	Peak Runoff (cfs)		Total Runoff (ac-ft.)	
	Old Salisbury Wetlands	Drainage Swale	Old Salisbury Wetlands	Drainage Swale
100-year, 60-min	10.2	0.5	1.8	0.1
100-year, 24-hour	143.9	14.3	18.6	1.3
100-year, 3-day	203.1	19.8	26.5	1.8

Hydraulic Analyses

As described above, under flood conditions, Old Salisbury Wetlands and the drainage swale will behave as impoundments. Therefore, instead of evaluating peak water levels through a dynamic hydraulic model, such as HEC-RAS, flood levels were determined by incorporating Old Salisbury Wetlands and drainage swale directly into the HEC-HMS model as impoundments.

Impoundments and Outlets. Old Salisbury Wetlands and the drainage swale were defined through two types of relationships, an elevation-storage function that describes an impoundment's ability to store runoff, and a storage-discharge function that describes the discharge capacity of its outlet. The elevation-storage functions were determined by applying the equation for the volume of a trapezoidal prism to surface areas developed from the latest LiDAR data at 1-foot intervals. The starting water level in each impoundment was based on the surveyed edge of water on May 8th, 2019.

Storage-discharge functions were developed by applying the equation for a broad-crested weir to the outlet of each impoundment. As described above, overflows from Old Salisbury Wetlands discharge via a natural outlet, with almost no defined channel, at the pond's northeast corner. Overflows from the drainage swale would discharge over the railbed to the north. Weston & Sampson modeled both outlets as broad-crested weirs; the length of the weirs was allowed to vary and was calculated from the latest LiDAR data at 0.5-foot intervals. It should be noted that while HEC-HMS does not readily support the dynamic evaluation of stage-discharge due to a tailwater condition, both impoundments are expected to effectively experience free discharge conditions during the 100-year flood event.

Weston & Sampson evaluated 100-year flood conditions in Old Salisbury Wetlands and drainage swale under a variety of rainfall durations, ranging from a 60-minute event to a 3-day event. Given the relatively small size of the contributing drainage area and the relatively large storage volume of Old Salisbury Wetlands, we expected longer duration events to result in higher peak water levels. The range of rainfall event durations was selected to confirm that hypothesis and identify a conservatively high BFE. Table 2 summarizes the peak water levels simulated in both impoundments during all three design events.

Table 2: Simulated Peak Water Level Summary

Design Event	Peak Water Level (ft. NAVD88)	
	Old Salisbury Wetlands	Drainage Swale
100-year, 60-min	729.9	728.0
100-year, 24-hour	730.5	728.5
100-year, 3-day	730.6	728.6

As expected, peak simulated water levels increased in both Old Salisbury Wetlands and drainage swale as the duration of the design event increased. Based on these results, Weston & Sampson conservatively estimated the BFE of Old Salisbury Wetlands and the drainage swale to be El. 730.6 ft. and 728.6 ft. NAVD88, respectively. The inundation extents corresponding to these elevations were delineated by drawing a polygon around all areas of Old Salisbury Wetlands and the drainage swale at or below those BFEs as indicated by the latest LiDAR data. Given the precision of LiDAR and the low topographic relief of Old Salisbury Wetlands, this exercise resulted in hundreds of very small "islands" within Old Salisbury Wetlands that lie above the estimated BFE. For simplicity, all such islands with an area of less than 100 square feet were assumed to be flooded as well, as represented in the flooding extents depicted in Figure 3.

As noted above, during the 100-year event, water levels in the drainage swale are expected to exceed the railroad embankment, resulting in the discharge of floodwaters into the broad, relatively flat Main Street area. The extents and depths of flooding that are expected to occur as a result were evaluated through development of a 1D hydraulic model of the area using HEC-RAS (v.5.3.0). The model was used in steady-state mode to route the peak discharge crossing the railroad embankment (120.6 cfs) through this area of shallow flooding and into the woodlands to the northeast. Inputs to the model primarily include the geometry and hydraulic roughness coefficients of cross-sections selected to represent the area of shallow flooding.

The model extent includes approximately 844 linear feet from the railroad embankment to the top of a steep slope down into the woodlands to the northeast. That reach is defined by a series of 14 cross-sections. Cross-section locations were selected based on the topography of the area and the presence of any dwellings or businesses. The geometries of the cross-sections were developed from the latest

LiDAR data available from MassGIS (2013-2014 Sandy), which is generally consistent with visual observations made at the site. In addition to their X/Y coordinates, HEC-RAS cross-sections are defined by their hydraulic roughness coefficients; Manning's “n” roughness values were assigned to the “channel” and “overbanks” of each cross-section based on field observations, aerial imagery, and standard reference values.

To evaluate the maximum extents and depth of flooding possible, a steady-state analysis was performed, in which a constant discharge rate was applied to each of the 14 cross-sections. The constant discharge rate used, 120.6 cfs, is the peak discharge expected to overtop the railroad embankment from the drainage swale noted above during the 100-year, 3-day event. This analysis is conservative as it does not consider the attenuation that would be expected to occur due to flood storage and friction forces. However, in this case, attenuation is expected to be relatively minor given the broad, flat nature of the area, and so the steady-state results represent a reasonable approximation of the extents and depth of flooding in this area of shallow flooding. The simulated extents of flooding and the simulated peak water levels at each cross-section (base flood elevations) are shown in Figure 3.

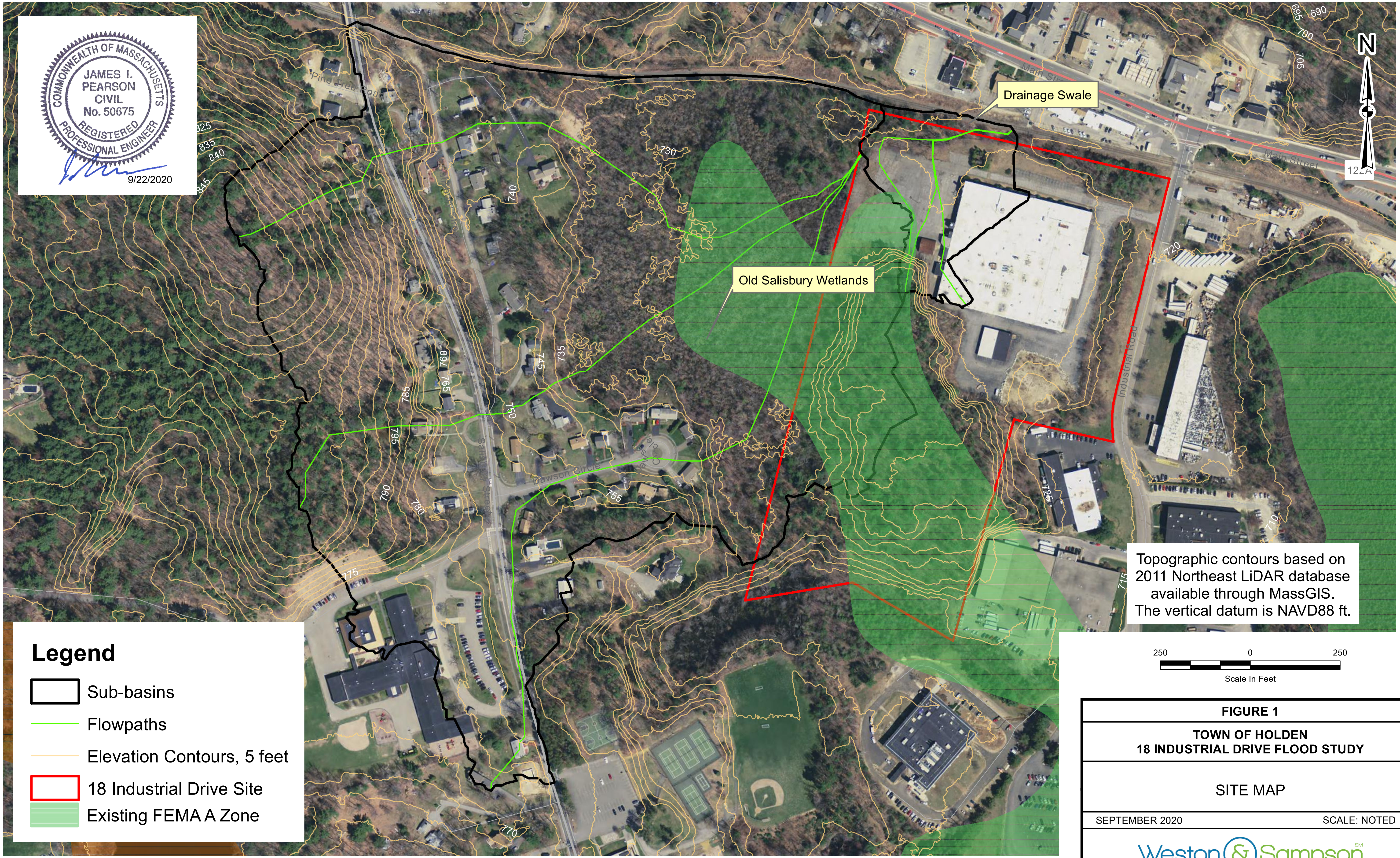

FIGURE 1

TOWN OF HOLDEN
18 INDUSTRIAL DRIVE FLOOD STUDY

SITE MAP

SEPTEMBER 2020 | SCALE: NOTED

Weston & Sampson

Path: P:\MA\Holden MA\Flood Study-18 Industrial Drive\GIS\Mapfiles\Site Map.mxd **User:** GetchellJ **Saved:** 9/21/2020 9:27:48 AM **Opened:** 9/21/2020 9:56:00 AM

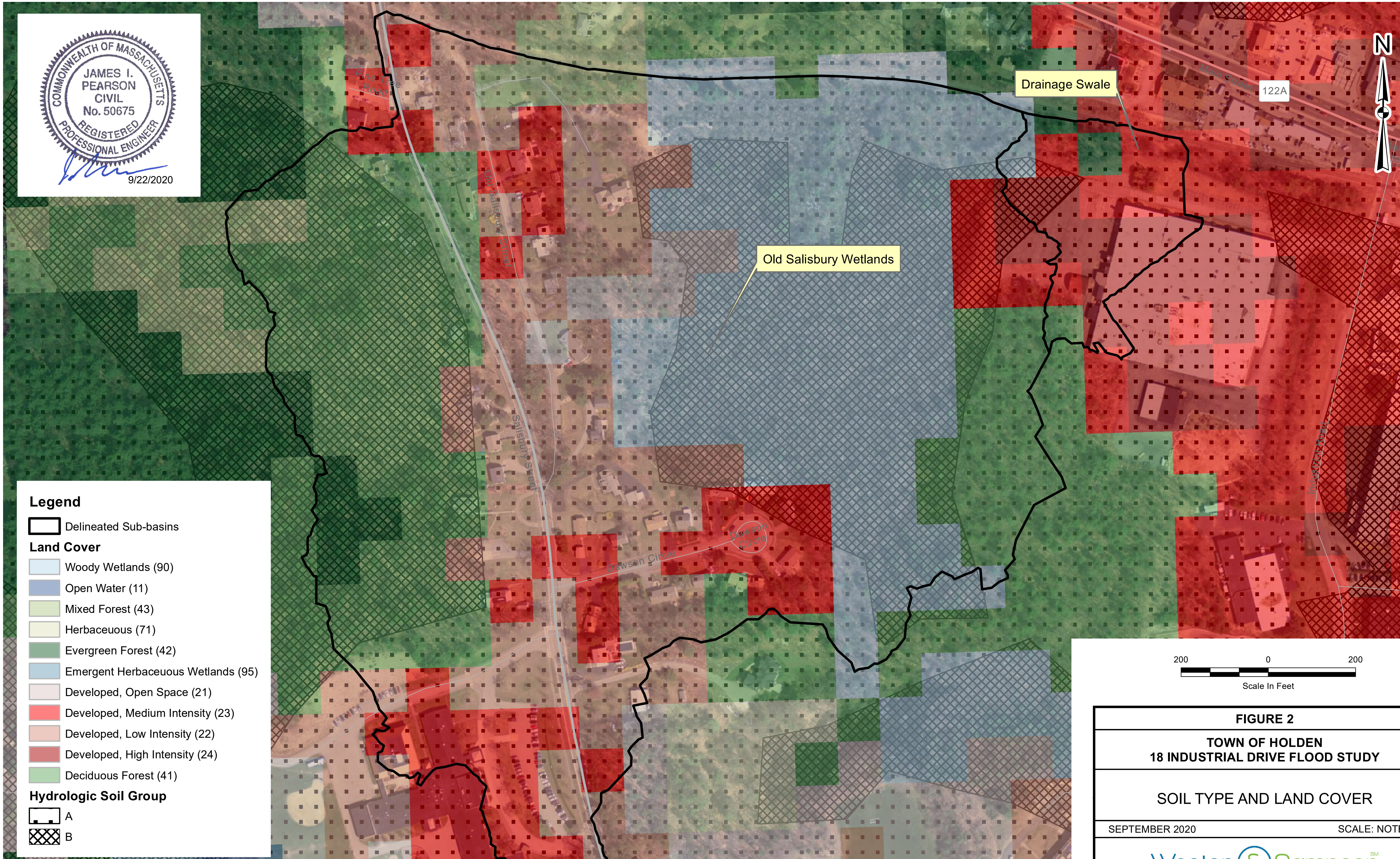

FIGURE 2

TOWN OF HOLDEN
18 INDUSTRIAL DRIVE FLOOD STUDY

SOIL TYPE AND LAND COVER

SEPTEMBER 2020 | SCALE: NOTED

Weston & Sampson

Path: P:\MA\Holden MA\Flood Study-18 Industrial Drive\GIS\Mapfiles\Land Cover and Soil Type2.mxd **User:** GetchellJ **Saved:** 9/21/2020 8:52:58 AM **Opened:** 9/21/2020 10:07:25 AM

NOAA Atlas 14, Volume 10, Version 3
Location name: Holden, Massachusetts, USA*
Latitude: 42.3405°, Longitude: -71.8481°
Elevation: 730.2 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	0.347 (0.274-0.431)	0.404 (0.319-0.503)	0.497 (0.391-0.621)	0.575 (0.450-0.723)	0.682 (0.515-0.896)	0.763 (0.563-1.02)	0.847 (0.604-1.18)	0.937 (0.635-1.35)	1.06 (0.691-1.58)	1.16 (0.736-1.
10-min	0.491 (0.388-0.611)	0.572 (0.452-0.713)	0.705 (0.554-0.880)	0.814 (0.637-1.02)	0.966 (0.729-1.27)	1.08 (0.798-1.45)	1.20 (0.855-1.67)	1.33 (0.899-1.91)	1.51 (0.979-2.24)	1.65 (1.04-2.5
15-min	0.578 (0.457-0.719)	0.673 (0.531-0.838)	0.829 (0.652-1.04)	0.959 (0.750-1.21)	1.14 (0.858-1.49)	1.27 (0.939-1.71)	1.41 (1.01-1.97)	1.56 (1.06-2.24)	1.77 (1.15-2.64)	1.94 (1.23-2.9
30-min	0.778 (0.615-0.968)	0.908 (0.717-1.13)	1.12 (0.881-1.40)	1.30 (1.01-1.63)	1.54 (1.16-2.02)	1.72 (1.27-2.31)	1.91 (1.36-2.66)	2.12 (1.43-3.04)	2.40 (1.56-3.57)	2.63 (1.66-4.0
60-min	0.978 (0.773-1.22)	1.14 (0.902-1.42)	1.41 (1.11-1.77)	1.63 (1.28-2.06)	1.94 (1.46-2.55)	2.17 (1.60-2.92)	2.42 (1.72-3.36)	2.67 (1.81-3.84)	3.03 (1.97-4.51)	3.31 (2.10-5.0
2-hr	1.23 (0.980-1.52)	1.45 (1.16-1.80)	1.82 (1.44-2.26)	2.12 (1.67-2.65)	2.54 (1.93-3.33)	2.85 (2.12-3.82)	3.18 (2.30-4.45)	3.57 (2.42-5.09)	4.14 (2.70-6.13)	4.62 (2.93-6.9
3-hr	1.41 (1.12-1.73)	1.67 (1.34-2.06)	2.11 (1.68-2.61)	2.47 (1.95-3.07)	2.97 (2.27-3.88)	3.33 (2.50-4.47)	3.73 (2.72-5.22)	4.21 (2.86-5.98)	4.93 (3.22-7.27)	5.54 (3.53-8.3
6-hr	1.76 (1.42-2.15)	2.12 (1.71-2.59)	2.70 (2.17-3.31)	3.18 (2.54-3.93)	3.85 (2.96-5.00)	4.34 (3.27-5.78)	4.87 (3.57-6.79)	5.52 (3.77-7.80)	6.51 (4.26-9.55)	7.36 (4.70-11.
12-hr	2.19 (1.78-2.66)	2.66 (2.15-3.22)	3.41 (2.76-4.16)	4.04 (3.24-4.95)	4.90 (3.80-6.33)	5.54 (4.20-7.33)	6.24 (4.59-8.62)	7.07 (4.85-9.92)	8.34 (5.48-12.1)	9.42 (6.03-14
24-hr	2.61 (2.13-3.14)	3.18 (2.60-3.83)	4.11 (3.35-4.97)	4.89 (3.95-5.94)	5.95 (4.64-7.63)	6.74 (5.14-8.86)	7.60 (5.62-10.4)	8.62 (5.94-12.0)	10.2 (6.71-14.7)	11.5 (7.40-17
2-day	2.96 (2.44-3.53)	3.63 (2.99-4.34)	4.72 (3.87-5.66)	5.62 (4.58-6.78)	6.86 (5.39-8.74)	7.78 (5.98-10.2)	8.78 (6.55-12.0)	10.0 (6.92-13.9)	11.9 (7.86-17.1)	13.5 (8.70-19
3-day	3.22 (2.66-3.82)	3.94 (3.25-4.68)	5.11 (4.21-6.11)	6.09 (4.98-7.32)	7.43 (5.86-9.43)	8.42 (6.50-11.0)	9.50 (7.11-13.0)	10.8 (7.51-14.9)	12.9 (8.54-18.4)	14.7 (9.45-21
4-day	3.45 (2.87-4.09)	4.21 (3.49-4.99)	5.45 (4.50-6.49)	6.47 (5.31-7.76)	7.88 (6.24-9.97)	8.93 (6.90-11.6)	10.1 (7.54-13.7)	11.5 (7.96-15.7)	13.6 (9.03-19.4)	15.5 (9.99-22
7-day	4.12 (3.45-4.85)	4.95 (4.13-5.83)	6.29 (5.23-7.45)	7.41 (6.12-8.83)	8.95 (7.11-11.2)	10.1 (7.83-13.0)	11.3 (8.50-15.2)	12.8 (8.93-17.5)	15.1 (10.0-21.4)	17.0 (11.0-24.
10-day	4.79 (4.02-5.62)	5.65 (4.73-6.63)	7.05 (5.89-8.32)	8.22 (6.81-9.75)	9.82 (7.83-12.2)	11.0 (8.57-14.1)	12.3 (9.23-16.4)	13.8 (9.65-18.8)	16.0 (10.7-22.6)	17.9 (11.6-25.
20-day	6.85 (5.79-7.97)	7.76 (6.55-9.04)	9.24 (7.78-10.8)	10.5 (8.75-12.3)	12.2 (9.75-15.0)	13.5 (10.5-16.9)	14.8 (11.1-19.3)	16.2 (11.4-21.9)	18.2 (12.2-25.4)	19.7 (12.8-28
30-day	8.58 (7.29-9.95)	9.52 (8.08-11.0)	11.1 (9.34-12.9)	12.3 (10.3-14.4)	14.1 (11.3-17.2)	15.4 (12.0-19.2)	16.8 (12.5-21.6)	18.1 (12.8-24.3)	19.8 (13.4-27.6)	21.1 (13.7-30
45-day	10.7 (9.17-12.4)	11.7 (9.99-13.5)	13.3 (11.3-15.4)	14.6 (12.3-17.1)	16.4 (13.2-19.9)	17.9 (14.0-22.1)	19.2 (14.3-24.5)	20.5 (14.6-27.3)	22.0 (14.9-30.5)	23.0 (15.0-32
60-day	12.6 (10.8-14.4)	13.6 (11.6-15.6)	15.2 (12.9-17.6)	16.6 (14.0-19.3)	18.5 (14.9-22.2)	20.0 (15.6-24.5)	21.3 (15.9-27.0)	22.5 (16.1-29.9)	23.9 (16.2-33.0)	24.8 (16.3-35

[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 estima (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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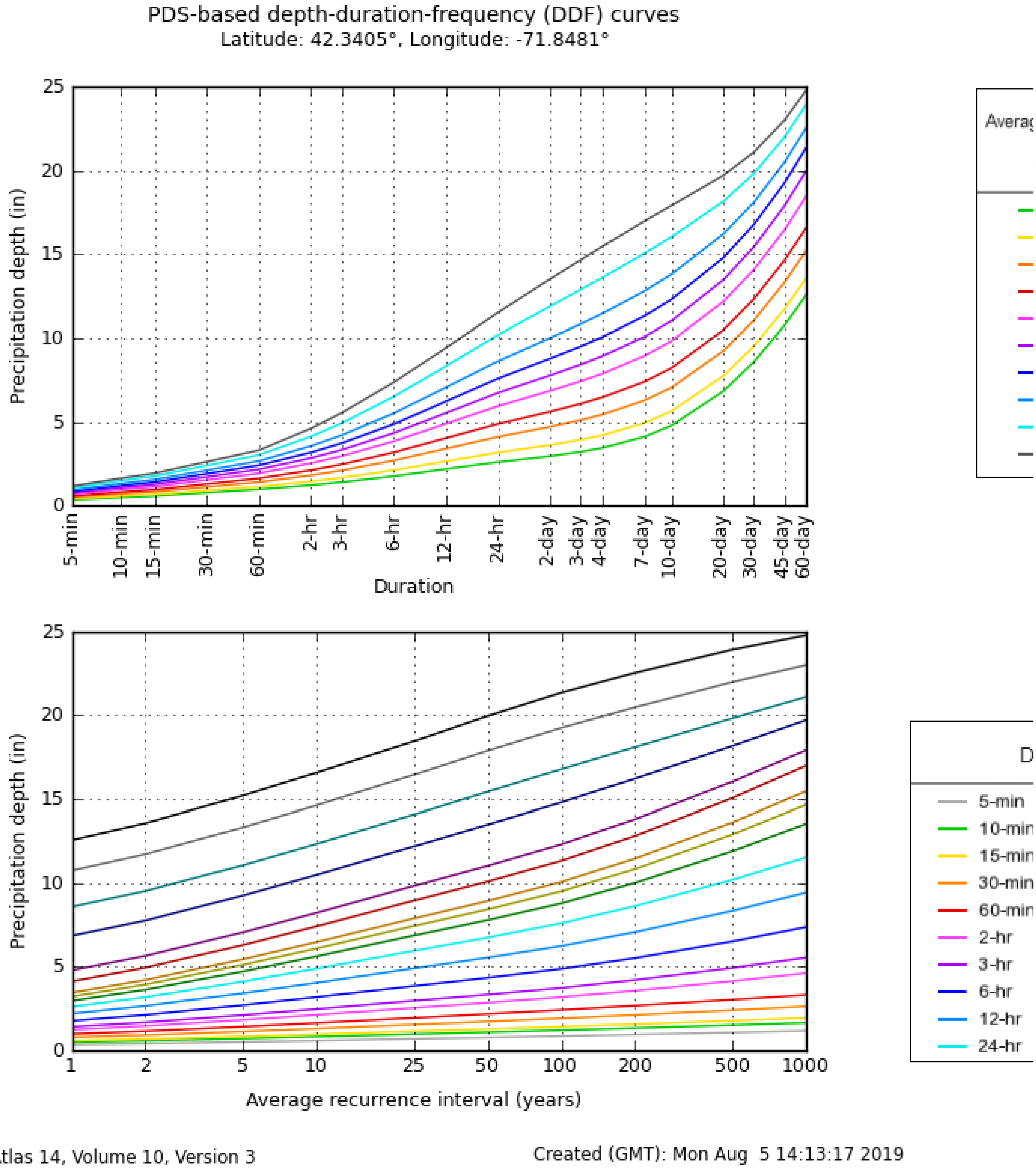
PF graphical



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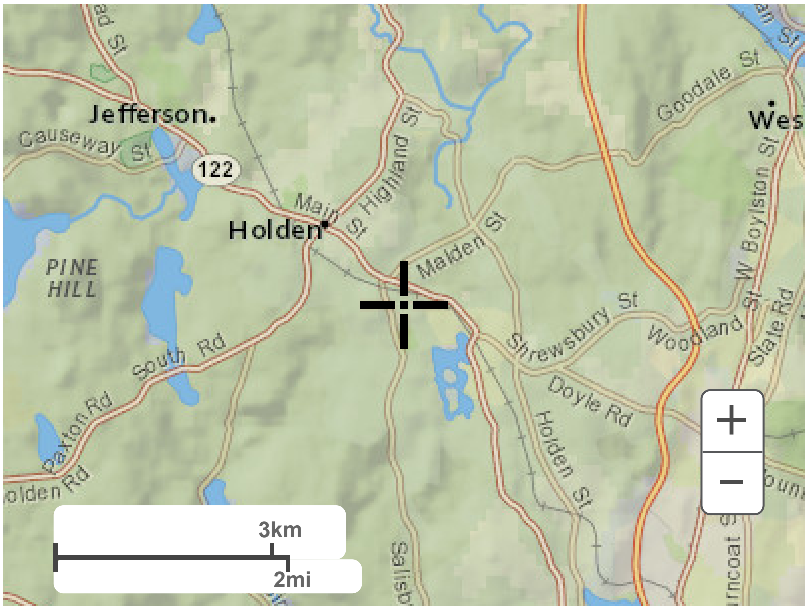
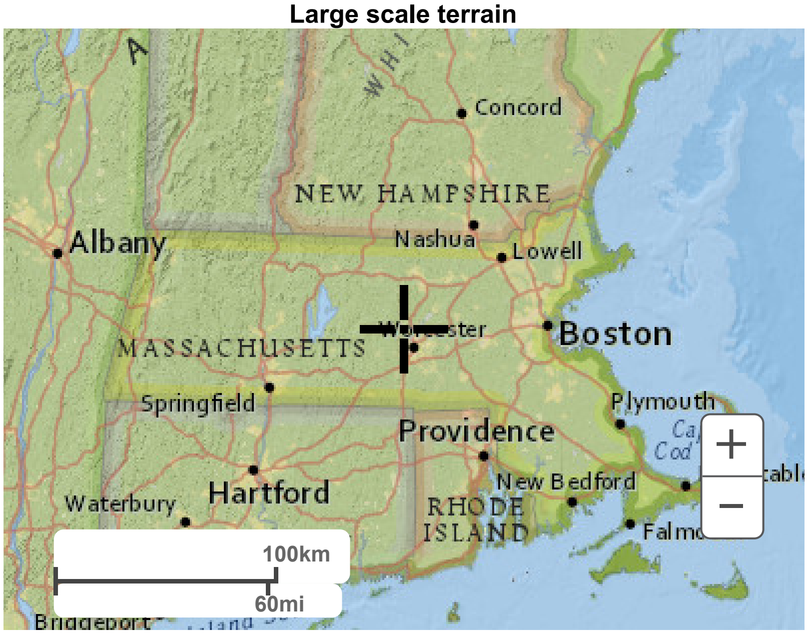
Maps & aerials

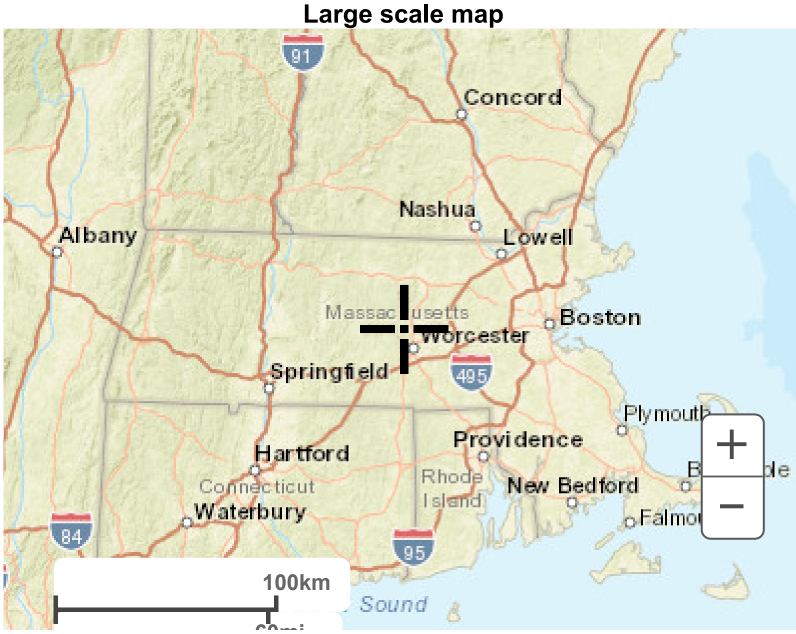
Small scale terrain



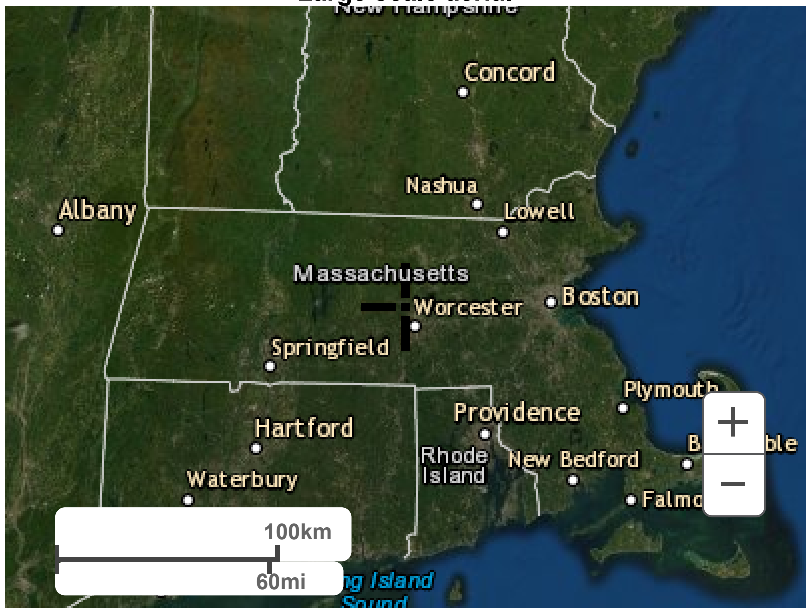
Large scale terrain



Large scale map



Large scale aerial



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National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

18 Industrial Drive, Holden MA
TR-20 Method
Sub-Basin CN

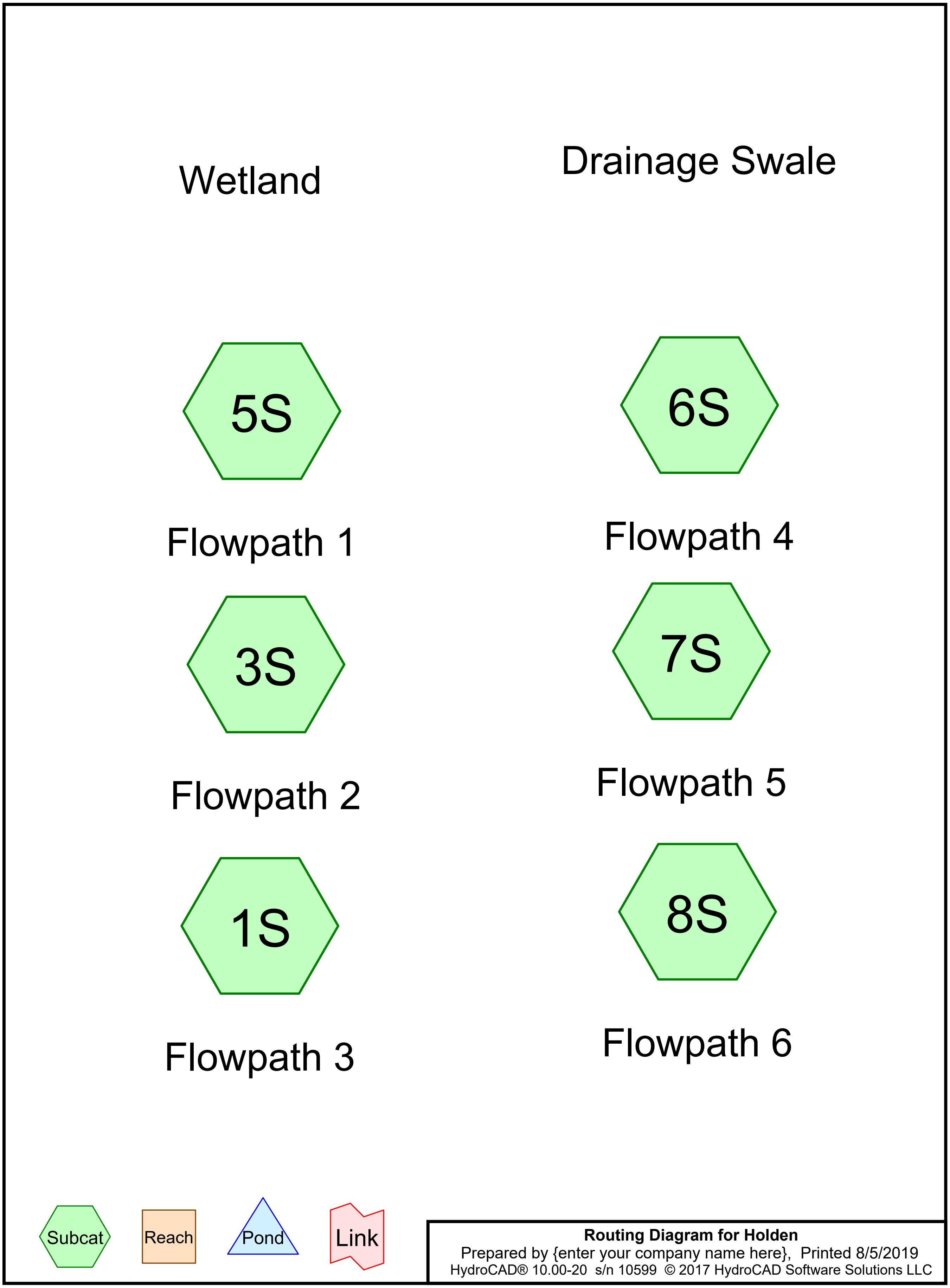
Row Labels	Sum of CN*Area	Sum of Area_ac
Drainage Swale	270	3.4761
Old Salisbury Wetlands	3900	56.1296
Grand Total	**4171**	**60**

Avg. CN	Sub-basin
78	**Drainage Swale**
69	**Old Salisbury Wetlands**

Sample Calculations

Basin ID	Hydrologic Soil Group (HSG)	HSG # (1=A, 2=B, etc.)	NLCD Land Use Code	Area_ac	Curve Number (CN)	CN*Area
Old Salisbury Wetlands	A	1	23	0.1522	77	11.7
Old Salisbury Wetlands	A	1	43	0.7836	30	23.5
Old Salisbury Wetlands	A	1	41	0.0094	30	0.3
Old Salisbury Wetlands	A	1	23	0.3283	77	25.3
Old Salisbury Wetlands	A	1	22	1.3327	57	76.0
Old Salisbury Wetlands	A	1	42	0.0108	30	0.3
Old Salisbury Wetlands	B	2	42	0.1830	55	10.1
Old Salisbury Wetlands	A	1	22	0.2224	57	12.7
Old Salisbury Wetlands	A	1	23	0.8896	77	68.5
Old Salisbury Wetlands	A	1	23	0.2224	77	17.1
Old Salisbury Wetlands	B	2	21	0.3105	61	18.9
Old Salisbury Wetlands	A	1	21	0.6757	39	26.4
Old Salisbury Wetlands	B	2	23	0.6802	85	57.8
Old Salisbury Wetlands	A	1	23	0.2712	77	20.9
Old Salisbury Wetlands	B	2	43	0.3009	55	16.5
Old Salisbury Wetlands	A	1	21	0.1523	39	5.9
Old Salisbury Wetlands	B	2	24	0.2157	92	19.8
Old Salisbury Wetlands	A	1	24	0.1570	89	14.0
Old Salisbury Wetlands	B	2	42	0.6940	55	38.2
Old Salisbury Wetlands	B	2	42	0.2285	55	12.6
Old Salisbury Wetlands	A	1	23	0.2224	77	17.1
Old Salisbury Wetlands	B	2	23	0.4011	85	34.1
Old Salisbury Wetlands	A	1	23	1.4927	77	114.9
Old Salisbury Wetlands	A	1	23	0.6705	77	51.6
Old Salisbury Wetlands	B	2	41	8.2562	55	454.1
Old Salisbury Wetlands	A	1	41	2.0150	30	60.5
Old Salisbury Wetlands	A	1	41	0.4164	30	12.5
Old Salisbury Wetlands	B	2	90	11.4305	98	1120.2
Old Salisbury Wetlands	A	1	90	5.1438	98	504.1
Old Salisbury Wetlands	B	2	41	0.7697	55	42.3
Old Salisbury Wetlands	A	1	41	2.2487	30	67.5
Old Salisbury Wetlands	B	2	22	0.7086	72	51.0
Old Salisbury Wetlands	B	2	22	0.3049	72	22.0
Old Salisbury Wetlands	A	1	22	10.0415	57	572.4
Old Salisbury Wetlands	A	1	23	0.2027	77	15.6
Old Salisbury Wetlands	A	1	21	0.0985	39	3.8
Old Salisbury Wetlands	A	1	23	2.5145	77	193.6
Old Salisbury Wetlands	B	2	22	0.0006	72	0.0
Old Salisbury Wetlands	A	1	22	0.5800	57	33.1
Old Salisbury Wetlands	B	2	21	0.0291	61	1.8
Old Salisbury Wetlands	B	2	22	0.1647	72	11.9
Old Salisbury Wetlands	A	1	22	0.3853	57	22.0
Old Salisbury Wetlands	B	2	23	0.1970	85	16.7
Old Salisbury Wetlands	A	1	23	0.0150	77	1.2
Drainage Swale	A	1	42	0.0815	30	2.4
Drainage Swale	A	1	24	0.0582	89	5.2
Drainage Swale	B	2	23	0.0470	85	4.0
Drainage Swale	A	1	23	0.1754	77	13.5
Drainage Swale	A	1	42	0.2224	30	6.7
Drainage Swale	A	1	23	0.1605	77	12.4
Drainage Swale	A	1	23	0.0254	77	2.0
Drainage Swale	B	2	24	0.2777	92	25.5
Drainage Swale	A	1	24	1.3415	89	119.4
Drainage Swale	B	2	90	0.0841	98	8.2
Drainage Swale	A	1	90	0.0965	98	9.5
Drainage Swale	A	1	41	0.1715	30	5.1
Drainage Swale	B	2	23	0.0008	85	0.1
Drainage Swale	A	1	23	0.7334	77	56.5

NLCD Code	Land Cover Type	HSG					Notes
		A	*B*	*C*	*D*	*NA*	
11	Open Water	98	98	98	98	98	
12	Perennial Ice/Snow	-99	-99	-99	-99	-99	
21	Developed, Open Space (<20%)	39	61	74	80	98	good condition, > 75% grass cover
22	Developed, Low Intensity (20-49%)	57	72	81	86	98	residential, 1/3 ac, 30% imp
23	Developed, Medium Intensity (49-75%)	77	85	90	92	98	residential, 1/8 ac, 65% imp
24	Developed, High Intensity (>75%)	89	92	94	95	98	commercial, 85% imp
31	Barren Land	77	86	91	94	98	fallow, bare soil
41	Deciduous Forest	30	55	70	77	98	woods - good
42	Evergreen Forest	30	55	70	77	98	woods - good
43	Mixed Forest	30	55	70	77	98	woods - good
51	Dwarf Scrub	35	56	70	77	98	brush - fair (40-75% cover)
52	Shrub/Scrub	35	56	70	77	98	brush - fair (40-75% cover)
71	Grassland/Herbaceous	39	61	74	80	98	pasture/grassland - good
72	Sedge/Herbaceous	39	61	74	80	98	pasture/grassland - good
73	Lichens	39	61	74	80	98	pasture/grassland - good
74	Moss	39	61	74	80	98	pasture/grassland - good
81	Pasture/Hay	39	61	74	80	98	pasture/grassland - good
82	Cultivated Crops	64	75	82	85	98	row crops - SR + CR - good
90	Woody Wetlands	98	98	98	98	98	
95	Herbaceous Wetlands	98	98	98	98	98	



Routing Diagram for Holden
Prepared by {enter your company name here}, Printed 8/5/2019
HydroCAD® 10.00-20 s/n 10599 © 2017 HydroCAD Software Solutions LLC

Summary for Subcatchment 1S: Flowpath 3

Runoff = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Rainfall not specified

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.4	149	0.0500	0.26		**Sheet Flow, Sheet;short grass** Grass: Short n= 0.150 P2= 3.18"
1.1	104	0.0470	1.52		**Shallow Concentrated Flow, Sh conc flow; Grass** Short Grass Pasture Kv= 7.0 fps
3.1	410	0.0120	2.22		**Shallow Concentrated Flow, sh conc flow; paved** Paved Kv= 20.3 fps
10.9	268	0.0034	0.41		**Shallow Concentrated Flow, sh conc flow;grass** Short Grass Pasture Kv= 7.0 fps
1.6	365	0.0340	3.74		**Shallow Concentrated Flow, sh conc flow; paved** Paved Kv= 20.3 fps
1.1	95	0.0440	1.47		**Shallow Concentrated Flow, sh conc flow;grass** Short Grass Pasture Kv= 7.0 fps
1.6	70	0.0220	0.74		**Shallow Concentrated Flow, sh conc flow;woodland** Woodland Kv= 5.0 fps
4.9	921		3.11		**Lake or Reservoir,** Mean Depth= 0.30'
33.7	2,382	Total			

Summary for Subcatchment 3S: Flowpath 2

Runoff = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Rainfall not specified

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.4	61	0.0590	0.11		**Sheet Flow, Sheet;woods** Woods: Light underbrush n= 0.400 P2= 3.18"
4.8	456	0.0990	1.57		**Shallow Concentrated Flow, sh conc flow;woodland** Woodland Kv= 5.0 fps
0.8	130	0.1570	2.77		**Shallow Concentrated Flow, sh conc flow,;grass** Short Grass Pasture Kv= 7.0 fps
0.8	196	0.0450	4.31		**Shallow Concentrated Flow, sh conc flow;paved** Paved Kv= 20.3 fps
1.8	80	0.0110	0.73		**Shallow Concentrated Flow, sh conc flow;Grass** Short Grass Pasture Kv= 7.0 fps
5.6	1,041		3.11		**Lake or Reservoir,** Mean Depth= 0.30'
23.2	1,964	Total			

Summary for Subcatchment 5S: Flowpath 1

Runoff = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Rainfall not specified

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.4	75	0.0890	0.13		**Sheet Flow, sheet flow;woods** Woods: Light underbrush n= 0.400 P2= 3.18"
3.2	404	0.1780	2.11		**Shallow Concentrated Flow, woodlands** Woodland Kv= 5.0 fps
0.1	60	0.1250	7.18		**Shallow Concentrated Flow, Paved** Paved Kv= 20.3 fps
0.6	123	0.2130	3.23		**Shallow Concentrated Flow, Grass** Short Grass Pasture Kv= 7.0 fps
0.3	20	0.0025	1.02		**Shallow Concentrated Flow, Paved** Paved Kv= 20.3 fps
6.7	306	0.0120	0.77		**Shallow Concentrated Flow, Grass** Short Grass Pasture Kv= 7.0 fps
6.6	101	0.0026	0.25		**Shallow Concentrated Flow, Woodlands** Woodland Kv= 5.0 fps
5.1	959		3.11		**Lake or Reservoir,** Mean Depth= 0.30'
32.0	2,048	Total			

Summary for Subcatchment 6S: Flowpath 4

Runoff = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Rainfall not specified

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.4	44	0.0311	0.08		**Sheet Flow, sheet;woods/light underbrush** Woods: Light underbrush n= 0.400 P2= 3.18"
3.8	713		3.11		**Lake or Reservoir,** Mean Depth= 0.30'
13.2	757	Total			

Summary for Subcatchment 7S: Flowpath 5

Runoff = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Rainfall not specified

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.3	58	0.0544	0.10		**Sheet Flow, Sheet flow; woods light underbrush** Woods: Light underbrush n= 0.400 P2= 3.18"
3.3	615		3.11		**Lake or Reservoir,** Mean Depth= 0.30'
12.6	673	Total			

Summary for Subcatchment 8S: Flowpath 6

Runoff = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Rainfall not specified

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.5	24	0.0090	0.04		**Sheet Flow, Sheet flow; woods light underbrush** Woods: Light underbrush n= 0.400 P2= 3.18"
3.7	691		3.11		**Lake or Reservoir,** Mean Depth= 0.30'
13.2	715	Total			

Old Salisbury Wetlands Stage-Storage

Elevation (ft)	Area (Ac)	Cumulative Area (Ac)	Incremental Volume (ac-ft)	Total Volume (Ac-ft)
728.3	0.0002	0.0002	0.0000	0.0000
728.6	0.0002	0.0005	0.0001	0.0001
728.7	0.001	0.001	0.000	0.000
728.8	0.003	0.005	0.000	0.001
728.9	0.006	0.011	0.001	0.001
729.0	0.010	0.020	0.002	0.003
729.1	0.028	0.049	0.003	0.006
729.2	0.048	0.097	0.007	0.014
729.3	0.103	0.200	0.015	0.028
729.4	0.266	0.467	0.033	0.062
729.5	0.521	0.987	0.073	0.134
729.6	0.805	1.792	0.139	0.273
729.7	1.177	2.970	0.238	0.512
729.8	1.406	4.375	0.367	0.879
729.9	1.487	5.863	0.512	1.391
730.0	1.468	7.330	0.660	2.050
730.1	1.368	8.698	0.801	2.852
730.2	1.227	9.925	0.931	3.783
730.3	1.033	10.958	1.044	4.827
730.4	0.833	11.791	1.137	5.965
730.5	0.663	12.454	1.212	7.177
730.6	0.518	12.972	1.271	8.448
730.7	0.386	13.357	1.316	9.764
730.8	0.302	13.659	1.351	11.115
730.9	0.238	13.897	1.378	12.493
731.0	0.199	14.097	1.400	13.893
731.1	0.172	14.269	1.418	15.311
731.2	0.198	14.467	1.437	16.748
731.3	0.137	14.604	1.454	18.201
731.4	0.123	14.727	1.467	19.668
731.5	0.118	14.845	1.479	21.147
731.6	0.117	14.962	1.490	22.637
731.7	0.108	15.071	1.502	24.139
731.8	0.112	15.182	1.513	25.651
731.9	0.117	15.299	1.524	27.175
732.0	0.111	15.410	1.535	28.711
732.1	0.117	15.526	1.547	30.258
732.2	0.122	15.648	1.559	31.816
732.3	0.107	15.755	1.570	33.387
732.4	0.101	15.856	1.581	34.967
732.5	0.100	15.956	1.591	36.558
732.6	0.095	16.051	1.600	38.158
732.7	0.098	16.149	1.610	39.768
732.8	0.103	16.253	1.620	41.388
732.9	0.092	16.345	1.630	43.018

Old Salisbury Wetlands Stage-Storage

Elevation (ft)	Area (Ac)	Cumulative Area (Ac)	Incremental Volume (ac-ft)	Total Volume (Ac-ft)
733.0	0.100	16.445	1.640	44.658
733.1	0.085	16.530	1.649	46.306
733.2	0.102	16.633	1.658	47.965
733.3	0.138	16.770	1.670	49.635
733.4	0.097	16.867	1.682	51.317
733.5	0.094	16.961	1.691	53.008
733.6	0.100	17.061	1.701	54.709
733.7	0.105	17.166	1.711	56.420
733.8	0.107	17.273	1.722	58.142
733.9	0.110	17.383	1.733	59.875
734.0	0.115	17.499	1.744	61.619
734.1	0.103	17.601	1.755	63.374
734.2	0.090	17.692	1.765	65.139
734.3	0.066	17.757	1.772	66.911
734.4	0.065	17.823	1.779	68.690
734.5	0.068	17.891	1.786	70.476
734.6	0.062	17.952	1.792	72.268
734.7	0.061	18.013	1.798	74.066
734.8	0.064	18.077	1.805	75.871
734.9	0.067	18.144	1.811	77.682
735.0	0.055	18.199	1.817	79.499

Old Salisbury Wetlands Elevation Profile

X Location	Elevation (ft)	X Location	Elevation (ft)	X Location	Elevation (ft)
0	736.425	193.594	729.840	385.978	733.670
3.129	735.983	196.786	729.840	389.131	733.786
6.257	735.670	199.979	730.258	392.284	733.802
9.386	735.456	203.171	731.320	395.437	733.822
12.514	735.204	206.364	731.616		
15.643	735.088	209.517	731.720		
18.772	734.941	212.670	731.789		
21.900	734.590	215.823	731.612		
25.029	734.236	218.976	731.523		
28.157	733.697	222.130	731.316		
31.286	733.669	225.283	731.284		
34.415	733.822	228.436	731.545		
37.543	734.163	231.589	731.676		
40.672	734.095	234.742	731.566		
43.917	733.603	237.895	731.319		
47.163	732.924	241.047	731.463		
50.409	732.232	244.200	731.640		
53.654	731.524	247.353	731.710		
56.900	731.145	250.506	731.710		
60.145	731.078	253.659	731.775		
63.391	731.070	256.812	731.761		
66.637	730.745	259.965	731.775		
69.882	730.447	263.117	731.846		
73.128	730.434	266.270	731.857		
76.373	730.449	269.423	731.872		
79.619	730.433	272.576	732.017		
82.864	730.305	275.729	732.014		
86.110	730.170	278.874	732.032		
89.356	730.036	282.018	732.082		
92.601	729.877	285.163	732.200		
95.847	729.840	288.308	732.286		
99.092	729.840	291.452	732.292		
102.338	729.840	294.597	732.293		
105.584	729.933	297.742	732.349		
108.829	730.174	300.887	732.362		
111.930	730.823	304.031	732.395		
115.031	731.077	307.176	732.482		
118.132	731.151	310.321	732.561		
121.233	731.101	313.465	732.651		
124.334	731.009	316.610	732.780		
127.435	730.948	319.763	732.925		
130.535	730.971	322.916	733.015		
133.636	731.026	326.069	733.074		
136.737	731.128	329.222	733.181		
139.838	731.102	332.375	733.277		
142.939	731.015	335.528	733.238		
146.040	730.997	338.682	733.183		
149.141	730.973	341.835	733.223		
152.242	731.124	344.988	733.179		
155.342	731.326	348.141	733.182		
158.443	731.583	351.294	733.197		
161.544	731.625	354.447	733.279		
164.768	731.430	357.600	733.395		
167.992	731.431	360.753	733.390		
171.216	731.585	363.906	733.351		
174.439	732.109	367.059	733.378		
177.632	731.669	370.212	733.463		
180.824	731.085	373.365	733.448		
184.017	730.850	376.518	733.499		
187.209	730.269	379.671	733.536		
190.402	729.840	382.825	733.566		

Elevation (ft)	Secondary (ft)	Primary (ft)	Total Weir Length (ft)	Flow (cfs)
729.84	7	7	14	0
730	17	10	27	4
730.5	42	15	57	79
731	55	23	78	253
731.5	0	152	152	845
732	0	221	221	1824

Drainage Swale Stage-Storage

Elevation (ft)	Area (Ac)	Cumulative Area (Ac)	Incremental Volume (ac-ft)	Total Volume (Ac-ft)
723.4	0.001	0.0007	0.0000	0.0000
723.5	0.002	0.0025	0.0002	0.0002
723.6	0.003	0.005	0.000	0.001
723.7	0.003	0.008	0.001	0.001
723.8	0.003	0.012	0.001	0.002
723.9	0.003	0.015	0.001	0.004
724.0	0.001	0.015	0.001	0.005
724.1	0.001	0.017	0.002	0.007
724.2	0.002	0.019	0.002	0.008
724.3	0.004	0.022	0.002	0.011
724.4	0.002	0.024	0.002	0.013
724.5	0.002	0.026	0.003	0.015
724.6	0.002	0.029	0.003	0.018
724.7	0.002	0.031	0.003	0.021
724.8	0.001	0.032	0.003	0.024
724.9	0.002	0.034	0.003	0.028
725.0	0.005	0.039	0.004	0.031
725.1	0.005	0.044	0.004	0.035
725.2	0.003	0.047	0.005	0.040
725.3	0.004	0.051	0.005	0.045
725.4	0.005	0.056	0.005	0.050
725.5	0.003	0.059	0.006	0.056
725.6	0.004	0.063	0.006	0.062
725.7	0.005	0.068	0.007	0.068
725.8	0.004	0.071	0.007	0.075
725.9	0.005	0.077	0.007	0.083
726.0	0.007	0.083	0.008	0.091
726.1	0.004	0.087	0.009	0.099
726.2	0.006	0.093	0.009	0.108
726.3	0.005	0.098	0.010	0.118
726.4	0.006	0.104	0.010	0.128
726.5	0.006	0.110	0.011	0.139
726.6	0.007	0.118	0.011	0.150
726.7	0.008	0.125	0.012	0.162
726.8	0.007	0.132	0.013	0.175
726.9	0.007	0.139	0.014	0.189
727.0	0.014	0.153	0.015	0.203
727.1	0.013	0.166	0.016	0.219
727.2	0.017	0.183	0.017	0.237
727.3	0.012	0.195	0.019	0.256
727.4	0.014	0.209	0.020	0.276
727.5	0.012	0.221	0.022	0.297
727.6	0.015	0.237	0.023	0.320
727.7	0.013	0.249	0.024	0.345
727.8	0.012	0.262	0.026	0.370

Drainage Swale Stage-Storage

Elevation (ft)	Area (Ac)	Cumulative Area (Ac)	Incremental Volume (ac-ft)	Total Volume (Ac-ft)
727.9	0.013	0.274	0.027	0.397
728.0	0.012	0.286	0.028	0.425
728.1	0.014	0.300	0.029	0.454
728.2	0.014	0.314	0.031	0.485
728.3	0.014	0.328	0.032	0.517
728.4	0.014	0.342	0.033	0.551
728.5	0.012	0.354	0.035	0.585
728.6	0.016	0.369	0.036	0.621
728.7	0.019	0.388	0.038	0.659
728.8	0.023	0.411	0.040	0.699
728.9	0.026	0.438	0.042	0.742
729.0	0.028	0.466	0.045	0.787
729.1	0.049	0.515	0.049	0.836
729.2	0.052	0.567	0.054	0.890
729.3	0.061	0.628	0.060	0.950
729.4	0.066	0.694	0.066	1.016
729.5	0.070	0.764	0.073	1.089
729.6	0.071	0.834	0.080	1.169
729.7	0.078	0.912	0.087	1.256
729.8	0.085	0.997	0.095	1.351
729.9	0.074	1.071	0.103	1.455
730.0	0.081	1.152	0.111	1.566
730.1	0.074	1.226	0.119	1.685
730.2	0.063	1.289	0.126	1.811
730.3	0.050	1.339	0.131	1.942
730.4	0.048	1.386	0.136	2.078
730.5	0.036	1.422	0.140	2.219
730.6	0.042	1.464	0.144	2.363
730.7	0.044	1.507	0.149	2.512
730.8	0.050	1.557	0.153	2.665
730.9	0.047	1.604	0.158	2.823
731.0	0.043	1.647	0.163	2.985
731.1	0.043	1.690	0.167	3.152
731.2	0.051	1.741	0.172	3.324
731.3	0.037	1.778	0.176	3.500
731.4	0.041	1.818	0.180	3.679
731.5	0.045	1.863	0.184	3.863
731.6	0.041	1.904	0.188	4.052
731.7	0.043	1.948	0.193	4.244
731.8	0.043	1.990	0.197	4.441
731.9	0.037	2.028	0.201	4.642
732.0	0.042	2.069	0.205	4.847
732.1	0.037	2.107	0.209	5.056
732.2	0.040	2.146	0.213	5.269
732.3	0.039	2.185	0.217	5.485

Drainage Swale Stage-Storage

Elevation (ft)	Area (Ac)	Cumulative Area (Ac)	Incremental Volume (ac-ft)	Total Volume (Ac-ft)
732.4	0.044	2.229	0.221	5.706
732.5	0.044	2.273	0.225	5.931
732.6	0.038	2.310	0.229	6.160
732.7	0.037	2.348	0.233	6.393
732.8	0.037	2.385	0.237	6.630
732.9	0.037	2.423	0.240	6.870
733.0	0.038	2.461	0.244	7.114
733.1	0.046	2.507	0.248	7.362
733.2	0.047	2.554	0.253	7.616
733.3	0.056	2.610	0.258	7.874
733.4	0.033	2.643	0.263	8.136
733.5	0.034	2.677	0.266	8.402
733.6	0.041	2.718	0.270	8.672
733.7	0.041	2.758	0.274	8.946
733.8	0.053	2.811	0.278	9.224
733.9	0.060	2.871	0.284	9.508
734.0	0.060	2.931	0.290	9.798
734.1	0.059	2.990	0.296	10.094
734.2	0.083	3.073	0.303	10.398
734.3	0.083	3.155	0.311	10.709
734.4	0.054	3.210	0.318	11.027
734.5	0.027	3.237	0.322	11.350
734.6	0.018	3.254	0.325	11.674
734.7	0.022	3.276	0.327	12.001
734.8	0.010	3.286	0.328	12.329
734.9	0.001	3.288	0.329	12.657
735.0	0.001	3.289	0.329	12.986

Drainage Swale Elevation Profile

X Location	Elevation (ft)	X Location	Elevation (ft)
0	732.792	193.974	729.084
3.216	732.659	197.115	729.023
6.433	732.446	200.257	729.003
9.649	732.312	203.398	728.999
12.866	732.045	206.611	728.922
16.082	731.891	209.824	728.873
19.299	731.750	213.037	728.927
22.515	731.620	216.250	728.824
25.732	731.505	219.463	728.713
28.948	731.419	222.676	728.624
32.165	731.459	225.889	728.672
35.381	731.514	229.102	728.571
38.598	731.397	232.315	728.499
41.814	731.198	235.528	728.469
45.031	730.949	238.741	728.408
48.247	731.015	241.954	728.349
51.464	730.991	245.166	728.355
54.391	730.944	248.379	728.333
57.318	730.881	251.592	728.262
60.245	730.835	254.805	728.310
63.172	730.847	258.018	728.296
66.099	730.887	261.231	728.176
69.026	730.868	264.444	728.103
71.953	730.765	267.657	728.060
75.205	730.685	270.560	728.046
78.456	730.640	273.463	728.000
81.708	730.622	276.366	728.000
84.960	730.628	279.269	728.000
88.211	730.531	282.172	728.000
91.463	730.566	285.075	728.000
94.715	730.484	287.978	728.000
97.967	730.419	294.245	728.000
101.218	730.370	297.378	728.000
104.470	730.292	325.356	729.122
107.722	730.252	328.452	729.355
110.973	730.269	331.549	729.463
114.225	730.231	334.645	729.459
117.477	730.214	337.741	729.283
120.728	730.137	340.837	729.378
123.980	730.097	343.933	729.771
127.232	730.013	347.005	729.993
130.484	729.879	350.076	730.097
133.735	729.814	353.147	730.259
136.987	729.865	356.218	730.433
140.239	729.815	359.289	730.600
143.490	729.704	362.360	730.699
146.742	729.641	365.431	730.830
149.994	729.584	368.502	730.922
153.135	729.595	371.573	731.107
156.277	729.582	374.645	731.279
159.418	729.523	377.716	731.408
162.560	729.422	380.787	731.516
165.701	729.449	383.858	731.669
168.842	729.409	387.079	731.715
171.984	729.365	390.301	731.783
175.125	729.341	393.522	731.967
178.267	729.222	396.744	732.142
181.408	729.232	399.965	732.315
184.550	729.238		
187.691	729.185		
190.833	729.163		

Elevation (ft)	Weir Length (ft)	Flow (cfs)
728	24	0
728.5	52	48
729	125	325
729.5	182	869
730	223	1640
730.5	269	2765
731	322	4350

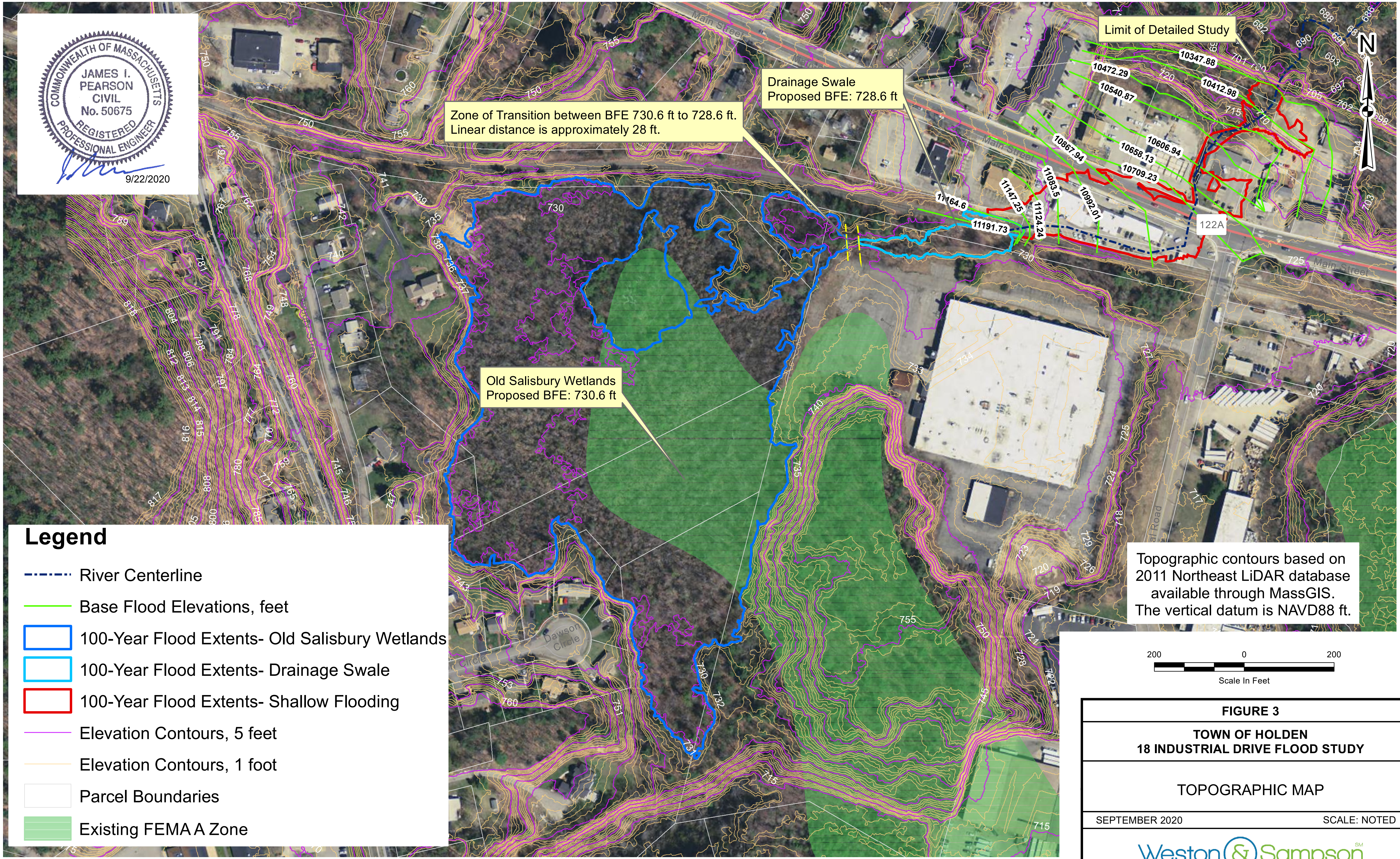


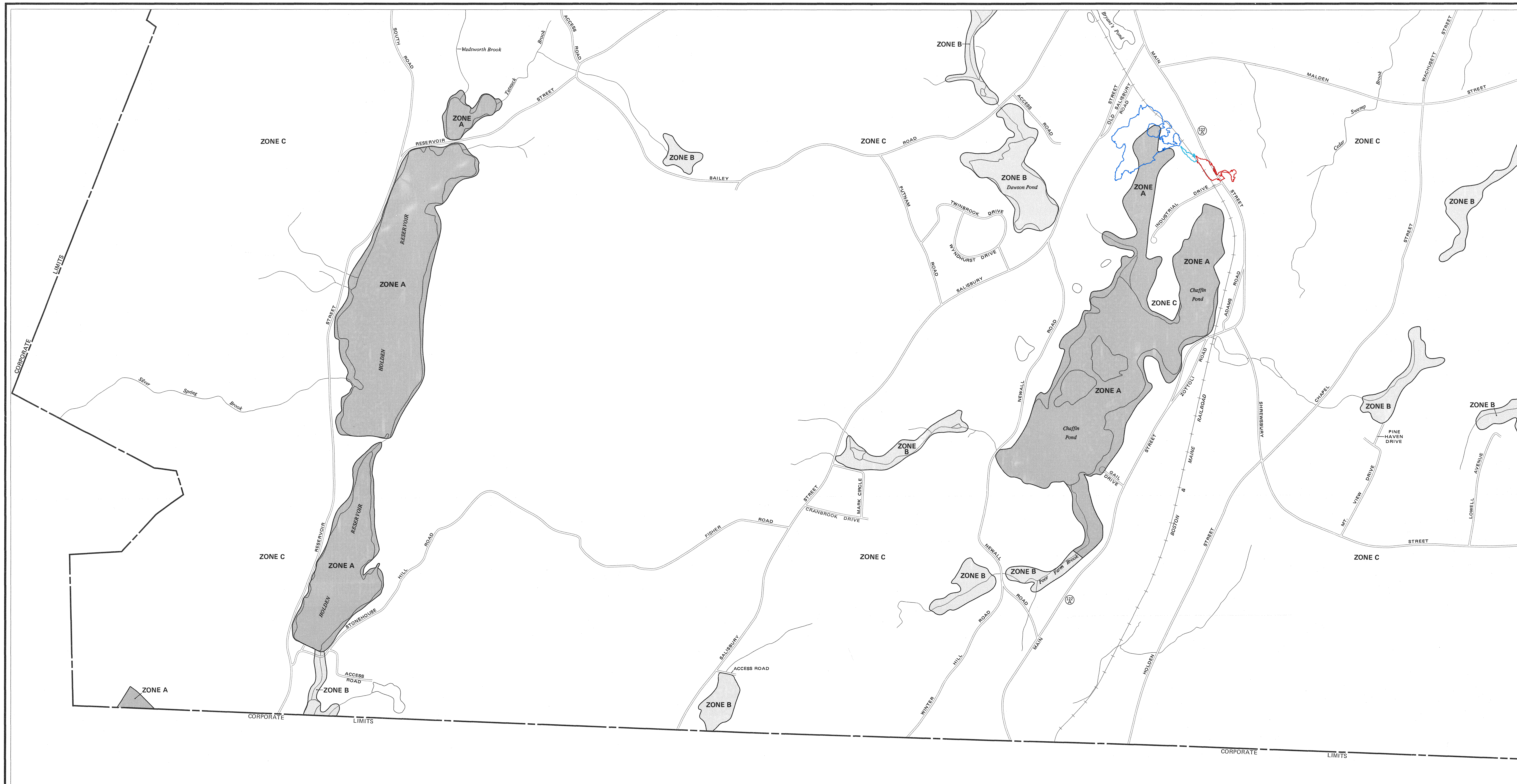
FIGURE 3

TOWN OF HOLDEN
18 INDUSTRIAL DRIVE FLOOD STUDY

TOPOGRAPHIC MAP

SEPTEMBER 2020 | SCALE: NOTED

Weston & Sampson



KEY TO MAP

500-Year Flood Boundary — ZONE B

100-Year Flood Boundary — ZONE A1 DATE

Zone Designations* With Date of Identification e.g., 12/2/74 — ZONE A5 DATE

100-Year Flood Boundary — ZONE B

500-Year Flood Boundary

Base Flood Elevation Line With Elevation In Feet** — 513

Base Flood Elevation in Feet Where Uniform Within Zone** — (EL 987)

Elevation Reference Mark — RM7×

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 purposes only; it does not necessarily show all areas subject to flooding in the community or all planimetric features outside special flood hazard areas.

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

INITIAL IDENTIFICATION:
SEPTEMBER 6, 1974
FLOOD HAZARD BOUNDARY MAP REVISIONS:
APRIL 8, 1977

FLOOD INSURANCE RATE MAP EFFFCTIVE:
JULY 2, 1981
FLOOD INSURANCE RATE MAP REVISIONS:

Old Salisbury Wetlands

Drainage Swale

Shallow Flooding North of the Drainage Swale/Railroad Embankment

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, or (800) 424-8872.

APPROXIMATE SCALE
800 0 800 FEET

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

TOWN OF
HOLDEN,
MASSACHUSETTS
WORCESTER COUNTY

PANEL 15 OF 20
(SEE MAP INDEX FOR PANELS NOT PRINTED)

COMMUNITY-PANEL NUMBER
250309 0015 B

EFFECTIVE DATE:
JULY 2, 1981

federal emergency management agency
federal insurance administration

Through our hydraulic analyses of Old Salisbury Wetlands, the Drainage Swale, and the area of shallow flooding north of the drainage swale/railroad embankment, we have identified a total of 22 parcels that intersect with the proposed floodplain in that area. Those parcels are identified below. Notification letters will be mailed following approval of the LOMR application.

Map-Lot-Parcel	Book/Page	Property Location	Owner Name	Other Owner Name	Owner Mailing Address	Owner Town	Owner State	Owner Zip
186-47	26801/0388	148 SALISBURY ST	RICCIARDI, STEVE M	RICCIARDI, WENDY	148 SALISBURY ST	HOLDEN	MA	01520
186-27	54767/0299	34 DAWSON CIR	HOLMAN, MARTIN J	HOLMAN, CARIE M	34 DAWSON CIR	HOLDEN	MA	01520
186-25	17076/0313	26 DAWSON CIR	PENA, MARTIN P	PENA, LAURA J	26 DAWSON CIRCLE	HOLDEN	MA	01520
173-56	23959/0078	MAIN ST	COLE, EDWARD T	BULL, RUTH J	473 WORCESTER RD	BARRE	MA	01005
173-24-2	13205/0209	72 OLD SALISBURY ST	HIMMER, ROBERT P	HIMMER, DOROTHY A	72 OLD SALISBURY ST	HOLDEN	MA	01520
173-26	5244/0179	50 OLD SALISBURY ST	HOWARTH, JAMES E, II	HOWARTH, KAREN A	50 OLD SALISBURY ST	HOLDEN	MA	01520
173-29	34466/0101	20 OLD SALISBURY ST	DUGUAY, KEVIN J	DUGUAY, SANDRA A	20 OLD SALISBURY ST	HOLDEN	MA	01520
186-35	11187/0187	DAWSON CIR	BLAIR, CLEALAND B		87 MAIN ST	RUTLAND	MA	01543
187-70	5613/0091	RR P&W R/W	PROV AND WORC R R		P O BOX 1188	WORCESTER	MA	01601
186-43	57355/0277	18 INDUSTRIAL DR	HOLDEN TOWN OF		1204 MAIN ST	HOLDEN	MA	01520
173-30	44184/0209	6 OLD SALISBURY ST	DOW, GARRY A	DOW, PAULA R	6 OLD SALISBURY ST	HOLDEN	MA	01520
186-26	23002/0066	30 DAWSON CIR	REDFEARN, DIANE K		30 DAWSON CIR	HOLDEN	MA	01520
187-1	6101/0336	787 MAIN ST	J & J HOLDEN, LLC.		20 NIPMUC RD	PAXTON	MA	01612
187-45	6730/0287	MAIN ST	J & J HOLDEN, LLC.		20 NIPMUC RD	PAXTON	MA	01612
187-60	8393/0359	MAIN ST	J & J HOLDEN, LLC.		20 NIPMUC RD	PAXTON	MA	01612
173-21	22560/0351	795 MAIN ST	S&M HOLDEN ASSOCIATES		30 DOROTHY AVE	HOLDEN	MA	01520
175-37	21670/0175	768 MAIN ST	HANNY, GAIL M TRUSTEE	C Z LINDEN & H Z DEGENER TRUSTEES	42 ZOTTOLI RD	HOLDEN	MA	01520
187-2	21670/0175	760 MAIN ST	HANNY, GAIL M TRUSTEE	C Z LINDEN & H Z DEGENER TRUSTEES	42 ZOTTOLI RD	HOLDEN	MA	01520
175-38	21670/0175	MAIN ST	HANNY, GAIL M TRUSTEE	C Z LINDEN & H Z DEGENER TRUSTEES	42 ZOTTOLI RD	HOLDEN	MA	01520
175-39	50249/0163	SHERWOOD HILL DR	MORGAN, EDITH M TRUSTE	800 MAIN ST MALL LLC RLTY TRUST	33 THOMPSON RD	PRINCETON	MA	01541
187-65	51845/0236	752 MAIN ST	HHC REALTY, LLC		PO BOX 563	HOLDEN	MA	01520
173-21	22560/0351	795 MAIN ST	S&M HOLDEN ASSOCIATES		30 DOROTHY AVE	HOLDEN	MA	01520