Discovery Report

Lower Connecticut Watershed, 01080205
Hartford, Middlesex, New Haven, New London, and Tolland Counties, Connecticut; Hampden County, Massachusetts
Communities listed inside cover

08/31/2018

FEMA

Project Area Community List

Community Name
Hartford County, CT
Town of Avon
Town of Berlin
Town of Bloomfield
Town of East Granby
Town of East Hartford
Town of East Windsor
Town of Enfield
Town of Farmington
Town of Glastonbury
City of Hartford
Town of Manchester
Town of Marlborough
City of New Britain
Town of Newington
Town of Plainville
Town of Rocky Hill
Town of Simsbury
Town of South Windsor
Town of Southington
Town of Suffield
Town of West Hartford
Town of Wethersfield
Town of Windsor
Town of Windsor Locks
Middlesex County, CT
Town of Chester
Town of Cromwell
Town of Deep River

Community Name
Middlesex County, CT (cont'd)
Town of Durham
Town of East Haddam
Town of East Hampton
Town of Essex
Borough of Fenwick
Town of Haddam
Town of Killingworth
Town of Middlefield
City of Middletown
Town of Old Saybrook
Town of Portland
Town of Westbrook
New Haven County, CT
Town of Guilford
Town of Madison
City of Meriden
Town of North Branford
Town of Wallingford
New London County, CT
Town of Colchester
Town of East Lyme
Town of Lebanon
Town of Lyme
Town of Old Lyme
Town of Salem
more on next page

Community Name	Community Name
Tolland County, CT	
Town of Andover	
Town of Bolton	
Town of Columbia	
Town of Ellington	
Town of Hebron	
Town of Somers	
Town of Stafford	
Town of Tolland	
Town of Vernon	
Hampden County, MA	
Town of Agawam	
Town of East Longmeadow	
Town of Hampden	
Town of Longmeadow	
Town of Monson	
Town of Southwick	
City of Springfield	
Town of Wilbraham	

Table of Contents

I. General Information

The Lower Connecticut HUC8 Watershed is an inland watershed drained by the lower portion of Connecticut River and its minor tributaries in central Connecticut and south-central Massachusetts. The watershed is primarily urban, draining all or portions of the Cities of Hartford, Middletown, New Britain, and Springfield and their suburbs. The terrain is moderately hilly. The Lower Connecticut Watershed drains 1,085 square miles through 2,660 catalogued river miles. The major rivers draining the watershed include – alphabetically – Connecticut River, Eightmile River, Hockanum River, Mattabesset River, Mill River, Park River, Salmon River, and Scantic River.

Because of the moderate population density in most of the study area, many communities and flooding sources in the Lower Connecticut Watershed have been prioritized in the past for detailed flood studies. Many reaches are currently mapped as Zones AE with high levels of detail in available flooding information (566 total miles, according to CNMS [FEMA, 2015a]). However, there are also many miles of Zones A, indicating areas of approximate study (460 total miles).

The Lower Connecticut Watershed is an inland area (except the mouth of Connecticut River itself) with a centroid latitude of 41.7 degrees. The typical climate (Connecticut Climate Division 2) is an average January temperature of 25.5 °F, an average July temperature of 71.0 °F, and an average annual precipitation total of 46.77 inches (NOAA, 2018).

There are 67 communities in 6 counties and 2 states that touch the study area in the Lower Connecticut Watershed. (See the cover and the Project Area Community List.) According to the 2010 census (USCB, 2010), the 67 communities have a total population of 1,527,953. Many of the peripheral communities have some area outside the watershed, so the total population inside the watershed is estimated from census block-level analysis to be 1,037,710. The Lower Connecticut Watershed study area has a population density of about 956 people per square mile.

FEMA's Discovery effort in the Lower Connecticut Watershed study area involves data collection, cursory analysis, and community outreach for the purpose of prioritizing work for new engineering analysis (surveying, hydrology, and hydraulics) and floodplain mapping within a limited financial budget.

II. Watershed Stakeholder Coordination

Watershed stakeholders include the communities in or touching the Lower Connecticut Watershed, non-governmental organizations (NGOs) such as watershed associations and regional planning commissions, and state and Federal agencies. The Federal agencies involved in Discovery for the Lower Connecticut Watershed study are FEMA – the agency initiating the study – and the U.S. Geological Survey (USGS), the mapping partner performing the study. In Connecticut, the Department of Energy and Environmental Protection (CTDEEP) manages the National Flood Insurance Program (NFIP) and is directly involved with Discovery. In Massachusetts, the Department of Conservation and Recreation (MADCR) manages the NFIP. The 67 communities and 7 NGOs in Connecticut and Massachusetts that touch the Lower Connecticut Watershed were contacted in October 2016 through an invitation letter to the Discovery Meeting. The full list of stakeholders contacted is included in this report as Appendix 1.

Community and NGO stakeholders were invited to submit data collection questionnaires and supporting technical data throughout the Discovery timeline. Data collection questionnaires were available as an online webform, a hardcopy paper form, and a digital Excel spreadsheet available online after the Discovery Meeting. Overall, stakeholder engagement was minimally effective, positive, and informative.

III. Data Analysis

Data collected for or during Discovery are described below and discussed in two different categories – data that can be used directly for Flood Risk Projects, and other data. Other data include data that provide information that assists in the selection during Discovery of high-priority reaches for study in a potential Flood Risk Project, but that are likely not useful to the analysis in any other way.

i. Data that can be used for Flood Risk Projects

This section describes the availability and analysis of data that could potentially be used in the development of regulatory and (or) non-regulatory products in a Flood Risk Project (RiskMAP program).

Topographic Data

Lidar elevation data are available for the entire Lower Connecticut Watershed. The Connecticut side of the watershed will have a new lidar dataset available in 2018 covering the entire state with better data quality than that of the datasets it supersedes. When the 2018 Connecticut statewide dataset becomes available, a mosaicked lidar dataset for the entire watershed will be created and will be available for floodplain mapping and analysis in a Flood Risk Project.

Basemap Data

Transportation features shown on the Discovery Map were obtained from the U.S. Census Bureau as part of the TIGER/Line Files (USCB, 2016). Hydrography and watershed features shown on the Discovery and Community Information Map were obtained from the U.S. Geological Survey as part of the National Hydrography Dataset (USGS, 2010). Political boundary and effective flood hazard features were obtained from FEMA as part of the National Flood Hazard Layer (FEMA, 2016a). All basemap features will be useful in the FIRM database for a potential flood risk project.

First Order Approximation Data

First Order Approximation (FOA) is a FEMA initiative, taking place during Discovery, that involves performing an approximate engineering analysis, updated floodplain mapping, and CNMS validation for all Zones A in the watershed (FEMA, 2015b). In the Lower Connecticut Watershed study, FOA was performed for all reaches in the watershed with drainage area greater than one square mile and without an existing detailed engineering study (FEMA, 2016b). Draft floodplain mapping was performed for these reaches. The results of the analysis and mapping could be useful in a potential flood risk project. Results include water surfaces for the 10%, 4%, 2%, 1%, and 0.2%-annual-chance floods for all analyzed reaches. The floodplains can be used directly in updated regulatory mapping (i.e., FIRM panels), and the water surfaces and depth grids can be used directly in non-regulatory products, such as the Flood Risk Report and the Hazus loss analysis that accompanies it. Water surfaces can also be used in the validation of Letters of Map Change (LOMCs) that FEMA receives regarding properties that are mapped in Zones A. Currently, it is difficult to determine if a property or structure is actually above the

flood level, because no numerical water surface is available. With the creation of these new water surfaces, a numerical value for the flood height is now available for comparison with the property and structure elevations to determine the validity of a LOMC.

Effective FIS/FIRM Data

All counties touching the Lower Connecticut Watershed except Tolland County had a countywide FIS and digital FIRM (with database) released during the Map Modernization program. Of the 67 communities touching the watershed, 59 have a countywide FIS and digital FIRMs and database.

Portions of the effective FIS reports in digital format can be copied directly into revisions of those reports for a potential flood risk project. Likewise, much of the content of the effective FIRM database and panels can be copied directly into revisions of the database and panels, with minor or no editing necessary. These include tables such as the FIRM panel index, the political areas, and the areas of coastal flooding, which would not be updated, since the flood risk project following this Discovery would focus on riverine flooding sources only.

ii. Other Data and Information

This section describes the availability and analysis of data that could not potentially be used directly in the development of regulatory and (or) non-regulatory products, but instead could be very useful in directing the scope, focus, and outreach of a flood risk project.

Community Data

Large volumes of aggregate community data related to the NFIP were downloaded from the Community Information System (CIS), an online FEMA database with restricted access. There are many available CIS reports, some of which report the same information. Among CIS reports that contained the same information, there were some small discrepancies in values for some communities. In cases of discrepancies, the value from the first report consulted was kept. Many of the data obtained from CIS were used to fill out the Community Information Sheets distributed to the community stakeholders before the Discovery Meeting.

Community populations were obtained from the 2010 national census (USCB, 2010). This information was also included on the Community Information Sheets. The Community Information Sheets and corresponding maps are included as Appendices 2 and 3, respectively, to this report.

CNMS Data

The most recent Coordinated Needs Management Strategy (CNMS) validation of effective Zones AE in FEMA Region I (New England) that was consulted was that which was completed on August 31, 2015. CNMS is a FEMA spatial database that tracks the viability of effective studies and alerts FEMA when an effective study is considered obsolete based on updates in available topography, hydrology, or human development (FEMA, 2015a). Re-assessment of all reaches in CNMS is required by law every five years.

According to the 2015 CNMS assessment, Zone AE reaches summarized below in Table 1 are "Unverified," indicating that at least one critical (C) element and/or at least four secondary (S) elements have failed for the reach. Reaches are ranked from most to least critical elements failing and then most to least secondary elements failing.

Table 1: Prioritization of Restudy Reaches Based on CNMS Assessment

Number of Critical Elements Failing	Number of Secondary Elements Failing	Reaches
3	1	Carr Brook Tributary A
2	2	Meadow Brook
2	2	Willow Brook
2	1	Roaring Brook
2	1	Wash Brook
2	0	Salmon River
2	0	Stony Brook
1	4	Willow Brook
1	3	Birch Mountain Brook
1	3	North Branch Mill River
1	2	Bancroft Brook
1	2	Beaver Brook
1	2	Coles Road Brook
1	2	Cromwell Creek
1	2	Folly Brook
1	2	Grape Brook

Number of Critical Elements Failing	Number of Secondary Elements Failing	Reaches
1	2	Hart Meadow
1	2	Hills Pond Branch
1	2	Hubbard Brook
1	2	Jawbuck Brook
1	2	Longhill Brook Diversion Channel
1	2	North Branch Park River
1	2	Pewterpot River
1	2	Piper Brook
1	2	Schultz Pond Brook
1	2	Smith Brook
1	2	South Branch Mill River
1	2	Trout Brook
1	2	Tumbledown Brook
1	1	Coginchaug River
1	1	Goff Brook
1	1	Hockanum River
1	1	John Hall Brook
1	1	Mason Pond Brook
1	1	Ponset Brook

Number of Critical Elements Failing	Number of Secondary Elements Failing	Reaches
1	1	Reservoir Brook
1	1	South Branch Park River
1	1	Still Brook
1	1	Tributary A to Goff Brook
1	1	Tributary A to Roaring Brook
1	1	Two Stone Brook
1	1	Unnamed Tributary
1	1	Watchaug Brook
1	0	Broad Brook
1	0	Carr Brook
1	0	Coginchaug River
1	0	East Branch Eightmile River
1	0	Eightmile River
1	0	Eightmile River
1	0	Hales Brook
0	5	North Brook
0	4	Batterson Park Pond Brook
0	4	Flat Brook
0	4	Freshwater Brook

Number of Critical Elements Failing	Number of Secondary Elements Failing	Reaches
0	4	Pattaconk Brook
0	4	Tributary C
0	4	Webster Brook

Effective FIS/FIRM Data

Floodplain Mapping

An inventory of Letters of Map Change (LOMCs) for each of the 6 counties touching the Lower Connecticut Watershed was obtained from FEMA, with a grand total of 2,984 LOMCs, most of which are not in the Shetucket Watershed. The inventory lists the flooding source for most valid LOMCs. The flooding sources with the most associated valid LOMCs are ranked in Table 2. "Local flooding" (usually designating unnamed Zones A) is left out of this table, since it is impossible to trace the exact flooding source. A high number of LOMCs indicates faulty or imprecise mapping that should be considered a high priority for restudy or redelineation.

Table 2: Prioritization of Redelineation Reaches Based on Number of LOMCs

Flooding Source	Number of valid LOMCs
Connecticut River (Hampden County)	112
Mattabesset River (Hartford County)	42
Willow Brook (Berlin & New Britain)	37
Bass Brook	28
Belcher Brook	25
Farm Brook	20
Beaver Brook (Hartford County)	19
Connecticut River (Hartford County)	19

Flooding Source	Number of valid LOMCs
Grape Brook	19
Roaring Brook	19
Salmon Brook	19
Goff Brook	18
Lydall Brook	18
Connecticut River (Middlesex County)	16
Hatchery Brook	16
Two Stone Brook	16
Folly Brook (Wethersfield)	14
Freshwater Brook	14
Hop Brook	14
Porter Brook (East Hartford)	14
Burnham Brook	13
Creamery Brook	13
Trout Brook	12
Jawbuck Brook	11
Willow Brook (Cromwell)	11
Falls River	10
North Branch Park River (Bloomfield)	9

Flooding Source	Number of valid LOMCs
Tributary C (to North Branch Mill River)	9
Tumbledown Brook (West Hartford)	9
Willow Brook (East Hartford)	9
Mill Brook (Hartford County)	8
Pocotopaug Creek	8
Wash Brook	8
Coginchaug River (Durham & Middlefield)	7
Hockanum River (Manchester)	7
Rockledge Brook	7
Stocking Brook	7
Sumner Brook	7
Foot Sawmill Brook (Marlborough)	6
Pewterpot River	6
Bigelow Brook	5
Eightmile River (Middlesex County)	5
North Brook	5
Piper Brook	5
Podunk River	5

Hydrology

The "Summary of Discharges" table from each county's effective FIS report was analyzed for accuracy against nearby U.S. Geological Survey streamgages, where available. Fourteen reaches were found to compare poorly to streamgage statistics.

The "Summary of Discharges" tables were also analyzed for discontinuities in discharge, such as a lower discharge at a point further downstream in a reach, due to very different analyses performed in different communities and counties touching a single reach. Problems in either hydrologic analysis were used to choose reaches that may be in need of updated analysis. No reaches were identified by this analysis.

Hydraulics

There were no high-water marks (HWMs) available for analysis to evaluate the effective hydraulic models.

First Order Approximation Results

In the Lower Connecticut Watershed, FOA was performed for all reaches with at least one square mile of drainage area and without an existing detailed engineering study (see section on "First Order Approximation Data" on page 3). Reach-specific FOA results would be applicable in the prioritization of reaches for detailed study in potential future Flood Risk projects in this watershed, but reach-specific results were not readily available from the analysis. The particular result that is useful in evaluating each reach is a pass/fail metric based on a numerical evaluation of the effective floodplain against two of the new water-surface elevations generated in FOA. The two water surfaces are the "1%+" and "1%-" – the surfaces calculated from the 1%-annual-chance flows plus the positive standard error from regression equations and minus the negative standard error, respectively. Along the boundary of the effective floodplain, a point is created every 100 feet. Within a 37.5-foot radius around each point, the ground surface elevation from the lidar DEM is compared against the water-surface elevations – plus a vertical tolerance buffer – of the 1%+ and 1%- profiles at the point. (The value of the vertical tolerance is one half of the contour interval used to map the effective Zone A.) If the ground surface elevation is between the buffered 1%+ and 1%- water-surface elevations, then the point passes; otherwise, it fails. For each reach, all passing and failing points are counted, and a reach passes if 95% or more of the points pass and fails otherwise. For a more thorough discussion of the FOA process and the Zone A evaluation metrics, see the FOA report (FEMA, 2016b) and its appendices for more details.

A summary of FOA pass/fail results was generated on an aggregated basis for HUC12 sub-basins in the Lower Connecticut Watershed. These results are in Table 3. There were many Zones A that scored poorly in the FOA validation, and some were selected for detailed study, but because of the coarse level on which results are available (HUC12 sub-basins only), this metric was not used explicitly in the evaluation of reaches for detailed study.

Table 3: Pass/Fail Results of FOA Zone A Validation

Vertical Tolerance	Total HUC12s	Passing	Failing
With	30	1	29

State NFIP Coordinator Priorities

The NFIP Coordinator's office for Connecticut was consulted for a list of mapping priorities in the Lower Connecticut Watershed. No priorities were provided by the Connecticut office.

The coordinator's list of ranked priorities is copied below as Table 4.

Table 4: State NFIP Coordinator's Top Mapping Priorities

State	Rank	Description	Cited Reason
CT	**1**	none	none

Community Interviews

The communities in the watershed were solicited for information about their flood risk and mitigation capabilities. Communities were asked for the following types of information:

- Desired study areas
- Existing data studies
- Funding
- Levees
- Mitigation planning
- Mitigation projects
- Areas of Mitigation Interest (AOMIs)
- Environmentally sensitive areas
- GIS data
- Communication and outreach
- Compliance and training

Responses in the category of desired study areas can be used to prioritize reaches for a potential flood risk project. Mapping needs identified by communities are included in supplemental data for the Discovery submission.

Reach Selection

By synthesizing the results of all analyses presented above, as well as study age, map age, and risk (how many structures and people are in the effective floodplain), a final list of reaches was selected for updated engineering and mapping. The selection is presented in Table 5 below. The list of all reaches considered is included as Appendix 4.

Table 5: Final Reach Selection List

Flooding Source	Study Length (mi)	Study Limits
Beaver Brook	2.8	From confluence with Connecticut River, Wethersfield, CT, to effective limit of detailed study immediately below Jordan Lane, Wethersfield, CT
Coginchaug River	14.1	From confluence with Mattabesset River, Middletown, CT, to effective limit of detailed study at county boundary, Durham, CT
Falls River	7.7	From confluence with Connecticut River, Essex, CT, to headwaters at Messerschmidt Pond, Deep River and Westbrook, CT
Farm Brook	0.6	From confluence with Plum Gulley Brook, South Windsor, CT, to effective limit of detailed study immediately above Oakland Road, South Windsor, CT
Folly Brook	2.2	From upstream end of underground tunnel below Stillman Road, Wethersfield, CT, to effective limit of detailed study below Dix Road, Wethersfield, CT
Freshwater Brook	6.9	From confluence with Connecticut River, Enfield, CT, to effective limit of detailed study at state boundary, Enfield, CT
Gages Brook	4.2	From confluence with Railroad Brook at headwaters of Tankerhoosen River, Vernon, CT, to Mountain Spring Road, Tolland, CT
Goff Brook	3.6	From effective limit of detailed study at Interstate 91, Wethersfield, CT, to headwaters at 1860 Reservoir, Wethersfield, CT

Flooding Source	Study Length (mi)	Study Limits
Hockanum River	13.7	From confluence with Connecticut River, East Hartford, CT, to Wells Road, Vernon, CT
Judd Brook	3.2	From effective limit of detailed study at Old Hebron Road, Colchester, CT, to effective limit of detailed study at Halls Hill Road, Colchester, CT
Lydall Brook	3.2	From confluence with Hockanum River, Manchester, CT, to effective limit of detailed study approximately 1,100 feet below Lake Street, Manchester, CT
Mattabesset River	15.8	From confluence with Connecticut River, Cromwell and Middletown, CT, to headwaters at Harts Ponds, Berlin, CT
Plum Gulley Brook	3.6	From confluence with Podunk River, South Windsor, CT, to effective limit of detailed study approximately 300 feet above Nevers Road, South Windsor, CT
Scantic River	10.7	From Somersville Pond Dam, Somers, CT, to unnamed dam approximately 900 feet above Somers Road, Hampden, MA
Sumner Brook	5.4	From confluence with Connecticut River, Middletown, CT, to effective limit of detailed study approximately 1,800 feet below corporate boundary, Middletown, CT
Tributary A to Goff Brook	0.9	From confluence with Goff Brook, Wethersfield, CT, to effective limit of detailed study approximately 100 feet above Coppermill Road, Wethersfield, CT
Willow Brook	5.0	From confluence with Mattabesset River, Berlin, CT, to effective limit of detailed study approximately 400 feet below New Hampshire Drive, New Britain, CT

IV. Discovery Meeting

Two Discovery Meetings were hosted by FEMA and the USGS in the Lower Connecticut Watershed. The meetings are summarized below in Table 6. Invitations are included as Appendix 5. Lists of attendees at and minutes from the meeting are also included as Appendices 6 and 7, respectively. An opening presentation (Appendix 8) was made, followed by breakout sessions in which stakeholders were given the opportunity to consult with project team members on flood risk issues particular to their communities or watersheds. Community input on mapping and other needs was received during these breakout sessions and during the four weeks following the meetings. After the four weeks, all information received from the stakeholders was aggregated and used with other data sources to prioritize mapping needs for the Lower Connecticut Watershed.

Table 6: Discovery Meetings

Date	Time	Location
Thursday, November 10, 2016	9:30 AM	Haddam Firehouse 439 Saybrook Road Higganum, CT 06441
Thursday, November 10, 2016	1:30 PM	Council Chambers, South Windsor Town Hall 1540 Sullivan Avenue South Windsor, CT 06074

V. Sources Cited

Sources cited are listed in Table 7 below.

Table 7: Sources Cited

Citation	Reference
FEMA, 2015a	"CNMS Technical Reference." *Guidelines and Standards for Flood Risk Analysis and Mapping*. Washington, D.C.: Federal Emergency Management Agency, May 2015. Print.
FEMA, 2015b	"First Order Approximation." *Guidance for Flood Risk Analysis and Mapping.* Washington, D.C.: Federal Emergency Management Agency, November 2015. Print.
FEMA, 2016a	*National Flood Hazard Layer*. Washington, D.C.: Federal Emergency Management Agency, 2016. Web. <http://msc.fema.gov>
FEMA, 2016b	*Lower Connecticut River Watershed, CT: First Order Approximation (FOA) Results*. Washington, D.C.: Federal Emergency Management Agency, Feb 2016. Print.
NOAA, 2018	*NOAA National Centers for Environmental Information, Climate at a Glance: U.S. Time Series*. National Oceanic and Atmospheric Administration, Oct 2017. Web. 21 Aug 2018. <http://www.ncdc.noaa.gov/cag/>.
USCB, 2010	"2010 Census." *Census.gov*. U.S. Census Bureau, 21 Dec 2010. Web. 1 Apr 2015. <http://www.census.gov/2010census/>.
USCB, 2016	*TIGER/Line Files.* Washington, D.C.: U.S. Census Bureau, 2016. Web. 20 Dec 2016. <https://www.census.gov/geo/maps-data/data/tiger-line.html>
USGS, 2010	*National Hydrography Dataset.* Reston, VA: U.S. Geological Survey, 2010. Web. <http://nhd.usgs.gov>

VI. Appendix and Tables

Table 8: Appendices

No.	Description	File Name	File Size (MB)
1	List of stakeholders contacted during Discovery	stakeholder_list.xlsx	0.1
2	Community Information Sheets	CIS.pdf	0.4
3	Community Information Maps	CIM.pdf	44.6
4	Complete list of reaches considered in prioritization for restudy	priority_ranking.xlsx	0.1
5	Discovery Meeting invitations	Invitations.zip	2.7
6	Discovery Meeting attendees	Attendance.xlsx	0.1
7	Discovery Meeting minutes	Minutes.zip	0.1
8	Discovery Meeting presentation	Presentation.zip	6.8