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Rocky Hill, CT 06067
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REPORT

August 2023

TOWN OF
Watertown
CONNECTICUT

Hydrology Report
Project No. 153-125
Steele Brook Greenway

Prepared By: Lauren Coles, P.E. Date: 8/30/2023
Lauren Coles, PE

Checked By: Date: 8/30/2023
Raju Vasamsetti, PE

Raju Vasamsetti, PE
CTDOT Approved Hydraulic Engineer

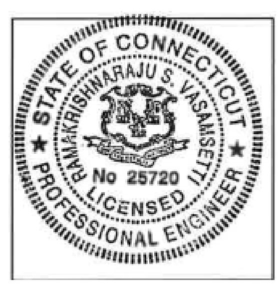


TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

1.0 PROJECT OVERVIEW

Weston & Sampson was retained by the Town of Watertown, Connecticut to perform design services for the Steele Brook Greenway (Project). The Project is funded through the Transportation Alternatives Program administered by the Connecticut Department of Transportation (CTDOT). This Hydrology Report is prepared in accordance with the requirements of the CTDOT *Drainage Manual*.

The Project includes the section of the Steele Brook Greenway parallel to Route 63 to the west and Edward Avenue to the east. Steele Brook is located to the west of the Greenway. The proposed section of the Steele Brook Greenway connects two existing sections. The southern section begins south of the parking lot for the UNICO soccer fields while the northern section begins north of French Street. The proposed greenway has a length of approximately 3,800 linear feet beginning at the parking lot for the UNICO fields and extending north to French Street. The project area is in a FEMA Floodplain. See Figure 1 for Project Location Map.

The improvements include a paved trail and a new prefabricated pedestrian bridge over Steele Brook south of French Street. The project also includes minor drainage improvements, fencing, landscaping, a trailhead parking lot with illumination, and crosswalk with Rectangular Rapid Flashing Beacons (RRFBs) at French Street.

The recommended design flows will be utilized to support hydraulic analysis to be performed for the proposed prefabricated pedestrian bridge crossing across Steele Brook and to evaluate the impacts of the proposed trail on the existing floodplain. The proposed prefabricated pedestrian bridge will span beyond the existing floodplain limits and above the 100-year flood elevation. The proposed trail will closely match the existing grade within the FEMA floodplain limits and will be designed to have no adverse impacts to existing floodplain. A detailed hydraulic analysis and a hydraulic report will be submitted at latter phases.

FIGURE 1: LOCATION MAP

STEELE BROOK GREENWAY - WATERTOWN, CT

Weston & Sampson

DRAWN BY:	LEC
REFERENCE:	NA
DATE:	7/27/2023
PROJECT #:	ENG23-0694

N

0 250 500 Feet

0 0.05 0.1 Miles

Coordinate System: NAD 1983 2011 StatePlane Connecticut FIPS 0600 Ft US

2.0 HYDROLOGY

The Project area is adjacent to Steele Brook between French Street and UNICO Fields. A proposed prefabricated pedestrian bridge will be designed to connect the Steele Brook Greenway to French Street. This section of Steele Brook is approximately 200-feet south of French Street.

2.1 Watershed

The portion of Steele Brook adjacent to the Greenway is located within Connecticut Department of Environmental Protection (DEP) Local Basin No. 6912-00. The watershed is part of the Naugatuck River DEP Regional Basin and the Housatonic River DEP Major Basin. The DEP Local Basin No. 6912-00 extends north into the northwestern portion of the Town of Watertown south of Judd Pond Reservoir. The watershed consists mostly of residential, forested, agricultural, and recreational areas.

The watershed of Steele Brook at French Street has a drainage area of 6.45 square miles (sq. mi.). A map of the watershed computed by StreamStats is included in Appendix A. The StreamStats Report is included in Appendix B.

2.2 FEMA FIRM Map

Steele Brook in the vicinity of the Project area is shown on the Town of Watertown FEMA Flood Insurance Rate Map (FIRM) Community-Panel Number 090058006B effective date November 5, 1980, which is included in Appendix C. According to the FEMA FIRM Map, the Project is located within FEMA Zone A5 and Zone 4A with no regulatory Floodway. The FEMA Firm Map is included in Appendix A. The flood elevation south of French Street is 472 (Datum NGVD 29), and the flood elevation south of Knight Street is 463 (Datum NGVD 29). Knight Street is located to the west of Steele Brook across from the UNICO fields.

3.0 HYDROLOGIC DESIGN METHODS

The CTDOT *Drainage Manual (Chapter 6)* identifies the various hydrology methods that can be used to analyze waterbodies as discussed below.

3.1 StreamStats

StreamStats utilizes multi-variable regression equations (developed by the USGS) based on drainage area, 24-hour rainfall and mean basin elevation. StreamStats is a web-based application that computes peak discharges using an interactive map.

StreamStats was used to determine the watershed area and peak flows. The chosen analysis point along Steele Brooke is just downstream of French Street at the proposed location of the prefabricated pedestrian bridge. At this point, the watershed to Steele Brook has an area of 6.45 sq. mi. The peak flows are listed in Table 2 in Section 4 (Recommended Design Flows).

3.2 FEMA Flood Insurance Study Discharge Rates

FEMA conducted a Flood Insurance Study (FIS) for the Town of Watertown dated May 1980. The discharge frequencies for Steele Brook were developed based on the FIS for the community of Waterbury, Connecticut. The hydrologic study for the FIS for Waterbury used a USGS Flood flow Formulas Method (Weir, 1975) conducted in November 1977. The Steele Brook flows were adjusted for Watertown by multiplying the adopted discharges in Waterbury by a factor equal to the ratio of the drainage areas to a calculated exponent.

3.3 Other Methods

3.3.1 Rational Method

The Rational Method is not applicable because drainage area of the subject watershed is greater than 200 acres.

3.3.2 Stream Gage Data

The Stream Gage Data Method is not applicable because there are no active or previously active stream gages on Steele Brook.

3.3.3 USGS Regression Equations

This method is now superseded by StreamStats, refer to Consulting Engineers General Memorandum 07-06. Applicability of this method is discussed in 3.1 StreamStats above.

3.3.4 Computer Models for Hydrograph Generation

The *Drainage Manual* would allow the use of computer programs such as HEC-HMS or WinTR-20 to estimate peak flows at the project site. Weston & Sampson does not recommend undertaking such a detailed modeling approach for the large watershed due to the applicability of StreamStats flows being close to the FEMA flows at this particular site.

3.3.5 SCEL – Stream Channel Encroachment Discharge Rates

The SCEL method is not applicable because there are no established Stream Channel Encroachment Lines within the project reach.

3.3.6 Tidal Hydrology

The Tidal Hydrology method is not applicable to the project site because the area is non-tidal.

4.0 RECOMMENDED DESIGN FLOWS

Based on the review of hydrologic design methods, it appears that the FIS estimated flows and the StreamStats are the only two applicable methods for the project site. The FIS includes flows at various locations. The location closest to the Project is Hemingway Pond, which is approximately 2,500 feet north of French Street. The drainage area for Steele Brook at Hemingway Pond is 5.7 sq. mi., which is 0.75 sq. mi. less than the drainage area downstream of French Street. See Table 1 for a comparison of the FIS and StreamStats peak flows.

Table 1. Comparison of Peak Discharge Rates

	FIS At Hemingway Pond	StreamStats
Drainage Area (sq. mi.)	5.7	6.45
Return Frequency (Year)	Peak Discharge (cfs)	Peak Discharge (cfs)
10	820	963
50	1,600	1,720
100	2,060	2,110
500	3,600	3,010

Weston & Sampson recommends that the design flows should be based on the StreamStats computed estimates because the flows closely match the FEMA FIS flows and the drainage area more closely matches the watershed contributing to the location of Steele Brook where the prefabricated pedestrian bridge is proposed. Table 2 shows the project design discharges for various storm events at the site. FEMA flows will be used to model floodplain impacts.

Table 2. Project Design Discharges

Return Frequency (Year)	StreamStats Peak Discharge (cfs)
Average Daily	11.6
Average Spring	22.8
2	347
10	963
25	1,370
50	1,720
100	2,110
200	2,440
500	3,010

5.0 FLOOD HISTORY

5.1 FEMA Flood Insurance Study

According to the FEMA FIS (1980), Steele Brook has a history of damaging floods. The FEMA FIS (1980) report is included in Appendix C. The watershed has limited natural storage in the upper basin, so floodwaters converge from the fan-shaped drainage area, exceed the channel capacity and overflow into the floodplain. Areas close to the brook are susceptible to intense and sudden floods due to the steep sloping streets and terrain. Restrictions including low bridges, overhanging buildings, private dams, and sharp bends in the channel contribute to flooding problems.

Within the timespan of the FIS (1980), the most serious flood occurred in August 1955 due to heavy rainfall from Hurricane Connie (4 to 8 inches) and Hurricane Diane (10 to 13 inches). In June 1973 and June 1975, Steele Brook overflowed its banks and resulted in extensive damage to commercial and manufacturing properties, homes, and town installations.

Table 3 summarizes known flood events along Steele Brook in the vicinity of the Project area. The flood events were compiled from previous study reports prepared by the Town. Data obtained from National Centers for Environmental Information National Oceanic and Atmospheric Administration (NOAA) Climate Data was included.

Table 3. Known Flood Events

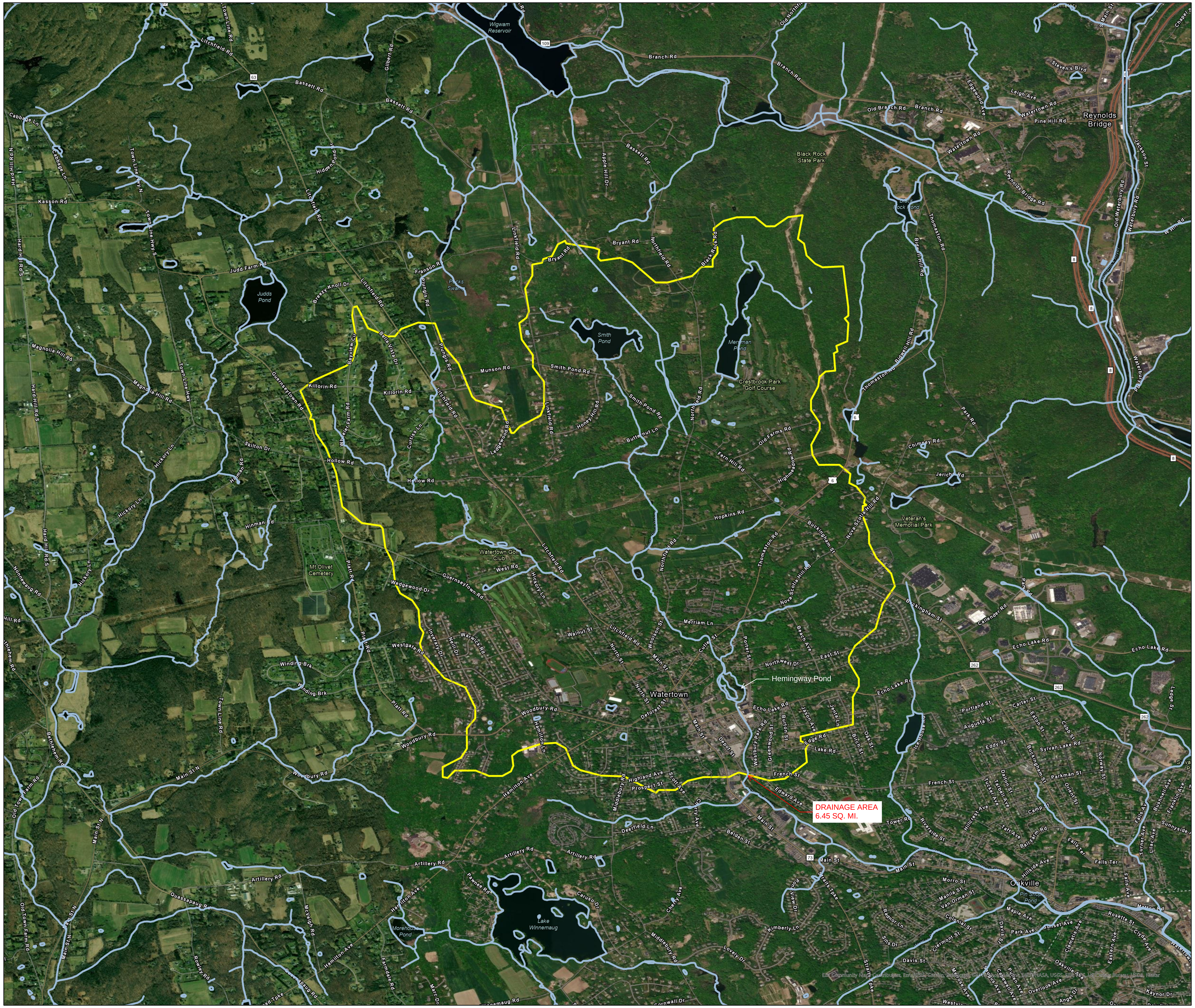
	Event Rainfall (Regional)	
Flood Event	Total (Inches)	Duration (Days)
8/11 – 8/15/1955 (Hurricane Connie[1])	7-9	4-5
8/17 – 8/20/1955 (Hurricane Diane[1])	9-12	2-3
10/14- 10/17/1955[1]	8	3-4
7/10- 7/16/1975[1]	6-7	6-7
9/23- 9/27/1975 (Remnants of Hurricane Eloise[1])	8-9	4-5
8/27 -8/28/2011 (Tropical Storm Irene[2])	5-7	1-2
9/6 – 9/8/2011 (Remnants of Tropical Storm Lee[2])	4-10	2-3
9/2/2021 (Remnants of Ida[1])	5.05	1

[1]Regional rainfall data obtained from Climate Data Online, National Climatic Data Center, National Oceanic and Atmospheric Administration, US Department of Commerce
[2]Unofficial private regional rainfall data from Weather Underground website

APPENDIX A

Maps

Watershed Map
FEMA FIRM Map



LEGEND

CT_Hydrography

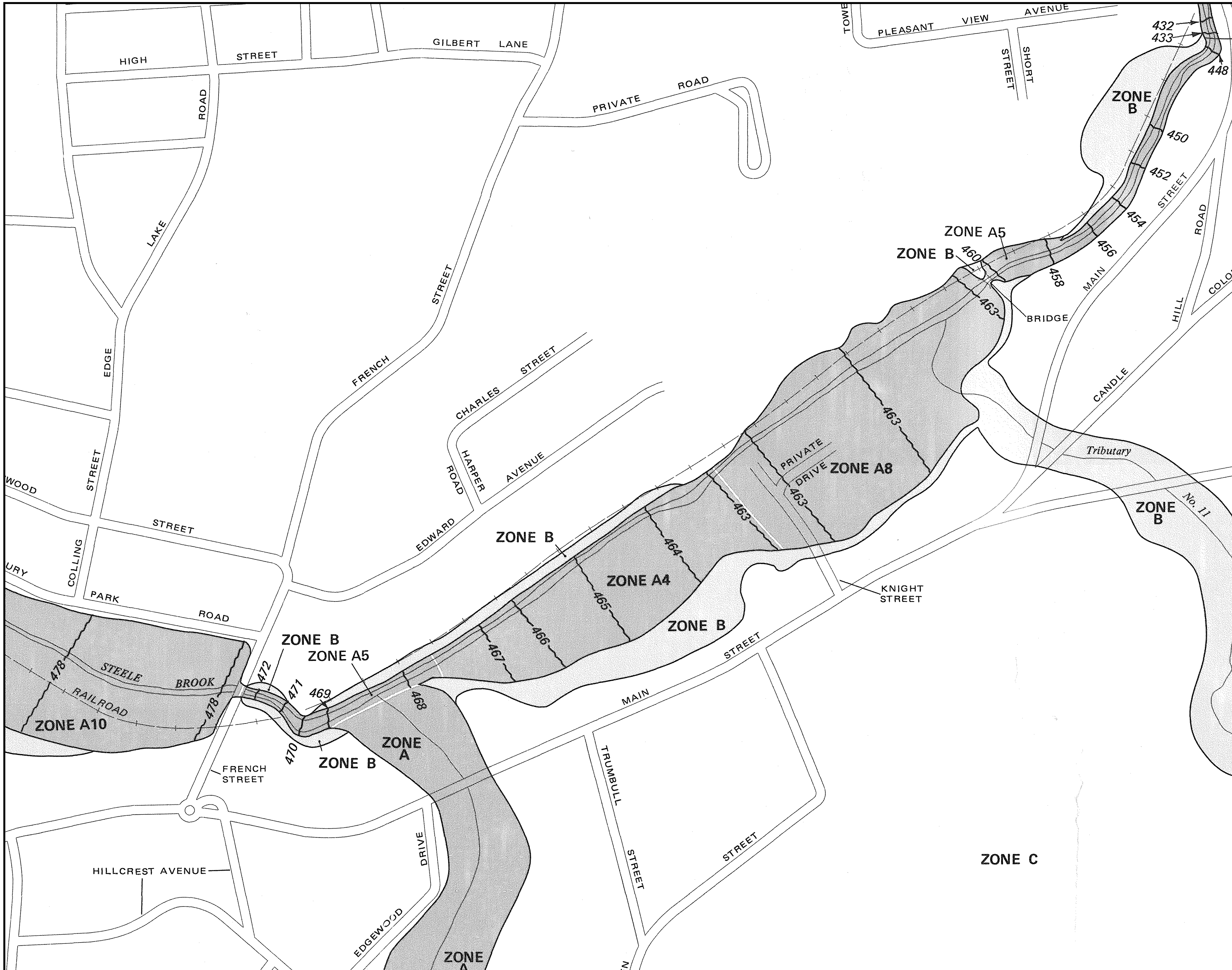
Watershed-French-St

N

0 1,000 2,000 4,000 6,000 8,000 Feet

WATERSHED MAP

STEELE BROOK
WATERTOWN, CT



ct your insurance agent, or call the National Flood Insurance
am at (800) 638-6620, or (800) 424-8872.

APPROXIMATE SCALE

400 0 400 FEET

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

TOWN OF
WATERTOWN, CONNECTICUT
LITCHFIELD COUNTY

PANEL 6 OF 11
(SEE MAP INDEX FOR PANELS NOT PRINTED)

COMMUNITY-PANEL NUMBER
090058 0006 B

EFFECTIVE DATE:
NOVEMBER 5, 1980

federal emergency management agency
federal insurance administration

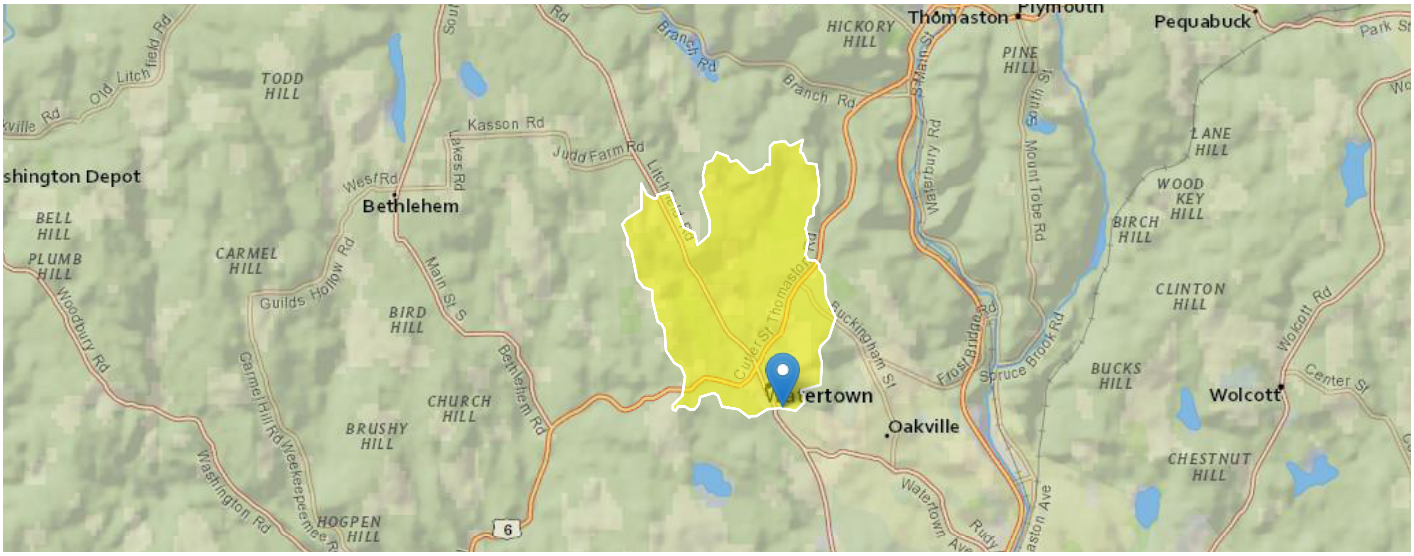
This is an official FIRMette showing a portion of the above-referenced flood map created from the MSC FIRMette Web tool. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For additional information about how to make sure the map is current, please see the Flood Hazard Mapping Updates Overview Fact Sheet available on the FEMA Flood Map Service Center home page at https://msc.fema.gov.

APPENDIX B

StreamStats

StreamStats Report - Steele Brook Greenway

Region ID: CT
Workspace ID: CT20230712204315232000
Clicked Point (Latitude, Longitude): 41.59842, -73.11174
Time: 2023-07-12 16:43:36 -0400



Steele Brook at French Street.

Collapse All

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CRSDFT	Percentage of area of coarse-grained stratified drift	3.32	percent
DRNAREA	Area that drains to a point on a stream	6.45	square miles
ELEV	Mean Basin Elevation	711	feet
I24H100Y	Maximum 24-hour precipitation that occurs on average once in 100 years	9.01	inches
I24H10Y	Maximum 24-hour precipitation that occurs on average once in 10 years	5.59	inches
I24H200Y	Maximum 24-hour precipitation that occurs on average once in 200 years	10.61	inches
I24H25Y	Maximum 24-hour precipitation that occurs on average once in 25 years	6.95	inches
I24H2Y	Maximum 24-hour precipitation that occurs on average once in 2 years - Equivalent to precipitation intensity index	3.2	inches
I24H500Y	Maximum 24-hour precipitation that occurs on average once in 500 years	12.72	inches
I24H50Y	Maximum 24-hour precipitation that occurs on average once in 50 years	7.98	inches
I24H5Y	Maximum 24-hour precipitation that occurs on average once in 5 years	4.56	inches
PRCWINTER	Mean annual precipitation for December through February	3.8	inches
SSURGOCCDD	Percentage of area with hydrologic soil types C, D, or C/D from SSURGO	0.561	percent

> Peak-Flow Statistics

Peak-Flow Statistics Parameters [Statewide DA only SIR 2020 5054]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	6.45	square miles	0.69	325

Peak-Flow Statistics Parameters [Statewide Multiparameter SIR 2020 5054]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	6.45	square miles	0.69	325
I24H2Y	24 Hour 2 Year Precipitation	3.2	inches	2.77	3.32
SSURGOCCDD	Percent soil type C or D from SSURGO	0.561	percent	0.118	0.945
I24H5Y	24 Hour 5 Year Precipitation	4.56	inches	4	4.7
I24H10Y	24 Hour 10 Year Precipitation	5.59	inches	4.86	5.79
I24H25Y	24 Hour 25 Year Precipitation	6.95	inches	5.99	7.22
I24H50Y	24 Hour 50 Year Precipitation	7.98	inches	6.81	8.3
I24H100Y	24 Hour 100 Year Precipitation	9.01	inches	7.62	9.38
I24H200Y	24 Hour 200 YearPrecipitation	10.61	inches	8.7	11.22
I24H500Y	24 Hour 500 Year Precipitation	12.72	inches	10.1	13.64

Peak-Flow Statistics Flow Report [Statewide DA only SIR 2020 5054]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	ASEp
Drainage Area Only 50-percent AEP flood	273	ft^3/s	35
Drainage Area Only 20-percent AEP flood	473	ft^3/s	35
Drainage Area Only 10-percent AEP flood	639	ft^3/s	36.3
Drainage Area Only 4-percent AEP flood	887	ft^3/s	37.8
Drainage Area Only 2-percent AEP flood	1100	ft^3/s	39.8
Drainage Area Only 1-percent AEP flood	1330	ft^3/s	42.4
Drainage Area Only 0.5-percent AEP flood	1600	ft^3/s	44.4
Drainage Area Only 0.2-percent AEP flood	2000	ft^3/s	48

Peak-Flow Statistics Flow Report [Statewide Multiparameter SIR 2020 5054]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	PIu	ASEp
50-percent AEP flood	347	ft^3/s	87.4	1380	26.5
20-percent AEP flood	694	ft^3/s	158	3040	26.3
10-percent AEP flood	963	ft^3/s	202	4580	28.4
4-percent AEP flood	1370	ft^3/s	260	7230	31.5
2-percent AEP flood	1720	ft^3/s	296	9990	34.3
1-percent AEP flood	2110	ft^3/s	330	13500	37.1
0.5-percent AEP flood	2440	ft^3/s	430	13800	40.6
0.2-percent AEP flood	3010	ft^3/s	564	16100	45

Peak-Flow Statistics Flow Report [Area-Averaged]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	ASEp		
Drainage Area Only 50-percent AEP flood	273	ft^3/s	35		
Drainage Area Only 20-percent AEP flood	473	ft^3/s	35		
Drainage Area Only 10-percent AEP flood	639	ft^3/s	36.3		
Drainage Area Only 4-percent AEP flood	887	ft^3/s	37.8		
Drainage Area Only 2-percent AEP flood	1100	ft^3/s	39.8		
Drainage Area Only 1-percent AEP flood	1330	ft^3/s	42.4		
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Drainage Area Only 0.2-percent AEP flood	2000	ft^3/s	48		
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4-percent AEP flood	1370	ft^3/s	260	7230	31.5
2-percent AEP flood	1720	ft^3/s	296	9990	34.3
1-percent AEP flood	2110	ft^3/s	330	13500	37.1
0.5-percent AEP flood	2440	ft^3/s	430	13800	40.6
0.2-percent AEP flood	3010	ft^3/s	564	16100	45

Peak-Flow Statistics Citations

Ahearn, E.A., and Hodgkins, G.A.,2020, Estimating flood magnitude and frequency on streams and rivers in Connecticut, based on data through water year 2015: U.S. Geological Survey Scientific Investigations Report 2020–5054, 42 p. (https://doi.org/10.3133/sir20205054)

Seasonal Flow Statistics

Seasonal Flow Statistics Parameters [Duration Flow 2010 5052]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	6.45	square miles	0.92	150
PRCWINTER	Mean Annual Winter Precipitation	3.8	inches	3.19	4.4
CRSDFT	Percent Coarse Stratified Drift	3.32	percent	0.1	55.1

Seasonal Flow Statistics Flow Report [Duration Flow 2010 5052]

Statistic	Value	Unit
25 Percent Duration December to February	16.1	ft^3/s
50 Percent Duration December to February	9.48	ft^3/s
75 Percent Duration December to February	5.63	ft^3/s
95 Percent Duration DEC FEB	2.52	ft^3/s
99 Percent Duration December to February	1.27	ft^3/s
25 Percent Duration March to April	27.3	ft^3/s
50 Percent Duration March to April	17.4	ft^3/s
75 Percent Duration March to April	11.2	ft^3/s
95 Percent Duration March to April	6.36	ft^3/s
99 Percent Duration March to April	4.48	ft^3/s

Statistic	Value	Unit
25 Percent Duration July to October	3.85	ft^3/s
50 Percent Duration July to October	1.55	ft^3/s
75 Percent Duration July to October	0.692	ft^3/s
80 Percent Duration July to October	0.573	ft^3/s
99 Percent Duration July to October	0.0816	ft^3/s

Seasonal Flow Statistics Citations

Ahearn, E.A.,2010, Regional regression equations to estimate flow-duration statistics in Connecticut: U. S. Geological Survey Scientific Investigations Report 2010-5052, 45 p. (http://pubs.usgs.gov/sir/2010/5052/)

Flow-Duration Statistics

Flow-Duration Statistics Parameters [Duration Flow 2010 5052]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	6.45	square miles	0.92	150
ELEV	Mean Basin Elevation	711	feet	168	1287
CRSDFT	Percent Coarse Stratified Drift	3.32	percent	0.1	55.1

Flow-Duration Statistics Flow Report [Duration Flow 2010 5052]

Statistic	Value	Unit
25 Percent Duration	14.8	ft^3/s
99 Percent Duration	0.154	ft^3/s

Flow-Duration Statistics Citations

Ahearn, E.A.,2010, Regional regression equations to estimate flow-duration statistics in Connecticut: U. S. Geological Survey Scientific Investigations Report 2010-5052, 45 p. (http://pubs.usgs.gov/sir/2010/5052/)

Maximum Probable Flood Statistics

Maximum Probable Flood Statistics Parameters [Crippen Bue Region 1]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	6.45	square miles	0.1	10000

Maximum Probable Flood Statistics Flow Report [Crippen Bue Region 1]

Statistic	Value	Unit
Maximum Flood Crippen Bue Regional	13800	ft^3/s

Maximum Probable Flood Statistics Citations

Crippen, J.R. and Bue, Conrad D.1977, Maximum Floodflows in the Conterminous United States, Geological Survey Water-Supply Paper 1887, 52p. (https://pubs.usgs.gov/wsp/1887/report.pdf)

Bankfull Statistics

Bankfull Statistics Parameters [Appalachian Highlands D Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	6.45	square miles	0.07722	940.1535

Bankfull Statistics Parameters [New England P Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	6.45	square miles	3.799224	138.999861

Bankfull Statistics Parameters [USA Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	6.45	square miles	0.07722	59927.7393

Bankfull Statistics Flow Report [Appalachian Highlands D Bieger 2015]

Statistic	Value	Unit
Bieger_D_channel_width	32.9	ft
Bieger_D_channel_depth	1.91	ft
Bieger_D_channel_cross_sectional_area	64.1	ft^2

Bankfull Statistics Flow Report [New England P Bieger 2015]

Statistic	Value	Unit
Bieger_P_channel_width	42.6	ft
Bieger_P_channel_depth	2.07	ft
Bieger_P_channel_cross_sectional_area	89.6	ft^2

Bankfull Statistics Flow Report [USA Bieger 2015]

Statistic	Value	Unit
Bieger_USA_channel_width	23.9	ft
Bieger_USA_channel_depth	1.79	ft
Bieger_USA_channel_cross_sectional_area	46.8	ft^2

Bankfull Statistics Flow Report [Area-Averaged]

Statistic	Value	Unit
Bieger_D_channel_width	32.9	ft
Bieger_D_channel_depth	1.91	ft
Bieger_D_channel_cross_sectional_area	64.1	ft^2
Bieger_P_channel_width	42.6	ft
Bieger_P_channel_depth	2.07	ft
Bieger_P_channel_cross_sectional_area	89.6	ft^2
Bieger_USA_channel_width	23.9	ft
Bieger_USA_channel_depth	1.79	ft
Bieger_USA_channel_cross_sectional_area	46.8	ft^2

Bankfull Statistics Citations

Bieger, Katrin; Rathjens, Hendrik; Allen, Peter M.; and Arnold, Jeffrey G.,2015, Development and Evaluation of Bankfull Hydraulic Geometry Relationships for the Physiographic Regions of the United States, Publications from USDA-ARS / UNL Faculty, 17p. (https://digitalcommons.unl.edu/usdaarsfacpub/1515?utm_source=digitalcommons.unl.edu%2Fusdaarsfacpub%2F1515&utm_medium=PDF&utm_campaign=PDFCoverPages)

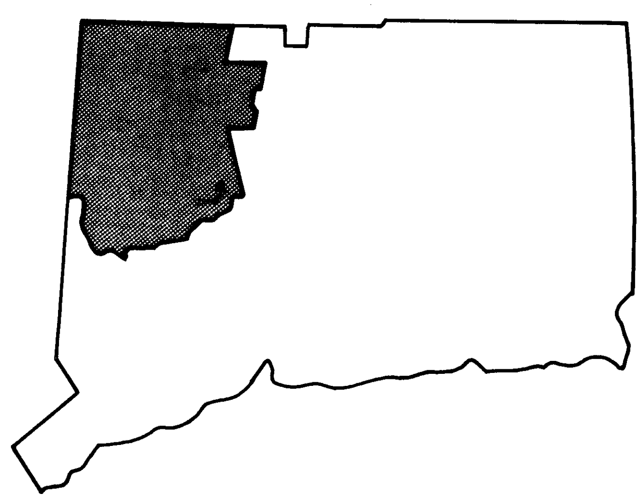
Application Version: 4.16.0
StreamStats Services Version: 1.2.22
NSS Services Version: 2.2.1

APPENDIX C

Relevant Except from
FEMA FIS

FLOOD INSURANCE STUDY

TOWN OF WATERTOWN, CONNECTICUT
LITCHFIELD COUNTY



MAY 1980

federal emergency management agency
federal insurance administration

COMMUNITY NUMBER - 090058

TABLE OF CONTENTS

TABLE OF CONTENTS - continued

FIGURES

TABLES

EXHIBITS

FLOOD INSURANCE STUDY
TOWN OF WATERTOWN, CONNECTICUT

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the Town of Watertown, Litchfield County, Connecticut, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study will be used to convert Watertown to the regular program of flood insurance by the Federal Insurance Administration (FIA). Local and regional planners will use this study in their efforts to promote sound flood plain management.

In some states or communities, flood plain management criteria or regulations may exist that are more restrictive or comprehensive than those on which these federally-supported studies are based. These criteria take precedence over the minimum federal criteria for purposes of regulating development in the flood plain, as set forth in the Code of Federal Regulations at 24 CFR, 1910.1(d). In such cases, however, it shall be understood that the state (or other jurisdictional agency) shall be able to explain these requirements and criteria.

1.2 Authority and Acknowledgements

The source of authority for this Flood Insurance Study is the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for this study were prepared by the U. S. Army Corps of Engineers for the Federal Insurance Administration, under Inter-Agency Agreement Nos. IAA-H-7-76 and IAA-H-10-77. This work, which was completed in December, 1978, covered all significant flooding sources in the Town of Watertown. Approximate flood boundaries for small streams were determined in May, 1974 by Michael Baker, Jr., Inc., under contract to the Federal Insurance Administration.

1.3 Coordination

An initial Consultation and Coordination Officer's (CCO) meeting was held in December 1975 to discuss the purpose and scope of this study. Representatives of the FIA, the U. S. Army Corps of Engineers (COE, the study contractor) and the town attended the meeting. Results of the hydrologic analyses were coordinated with the Soil Conservation Service (SCS). The results of this study were reviewed at a final CCO meeting held on December 19, 1979. Representatives of the FIA, the study contractor and the town attended the meeting.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated area of the Town of Watertown, Litchfield County, Connecticut. Not included in the study is U. S. Government- owned land. The area of study is shown on the Vicinity Map (Figure 1).

The Naugatuck River and Branch Brook were studied by detailed methods in their entirety within the town. Steele Brook was studied by detailed methods from the downstream corporate limits to the crossing of State Route 63. The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development and proposed construction for the next five years, through December, 1983.

Steele Brook, from State Route 63 to Hollow Road, Turkey Brook, Wattles Brook, Lake Winnemaug, Morehouse Pond, Smith Pond Brook, Smith Pond, Penn Brook, Pecks Swamp, the Nonewaug River and Tributary Nos. 1 through 14 were studied by approximate methods. Approximate methods of analysis were used to study those areas having low development potential and minimal flood hazards as identified at the initiation of the study. The scope and methods of study were proposed to and agreed upon by the FIA.

2.2 Community Description

The Town of Watertown is located in the southeastern corner of Litchfield County in northwestern Connecticut approximately 24 miles southwest of the City of Hartford. It is bordered on the east by the Town of Thomaston; on the north by the Town of Morris; on the west by the Towns of Bethlehem and Woodbury; and on the south by the Town of Middlebury and the City of Waterbury.

Watertown's boundaries encompass an area of almost 30 square miles. Watertown is part of the Central Naugatuck Region along with 12 other communities, surrounding and including the City of Waterbury.

The population of Watertown has increased steadily from 3,100 in 1900 to 18,610 in 1970. This population growth is a reflection of the change in Watertown from rural and agricultural in character to urban and suburban. Thirty percent of the town's land area, however, is still used for agricultural purposes. A modern superhighway system, which connects Watertown to the City of Waterbury, reducing commuting time, encourages suburban development.

Residential development in Watertown, as a whole, consists mainly of single- family detached houses. The most developed portion of the town's land area is arranged in a land use pattern consisting of an elongated urban core surrounded by suburban areas, that extend northwestward into rural countryside.

Watertown has only a small supply of easily developable land available. Much of the land presents problems for urban development because of uneven topography and less than ideal subsoil conditions.

The climate in Watertown is variable, with the average annual precipitation ranging between 44 and 52 inches. Temperatures in the area range from below 0 degrees Fahrenheit (°F) to greater than 100°F, with an annual average of approximately 50°F.

2.3 Principal Flood Problems

Numerous damaging floods have occurred in the Naugatuck River basin which have affected the Town of Watertown. Floods causing significant damage in this century occurred in 1927, 1936, 1938, 1948 and 1955.

The August, 1955 flood was the greatest flood ever recorded in the Naugatuck River basin with peak discharges three to four times the magnitude of any other flood. Between August 11-15, Hurricane Connie brought 4 to 8 inches of rainfall to the basin. Due to the unusually dry antecedent conditions, very little runoff resulted from this storm. However, when Hurricane Diane deposited 10 to 13 inches of rainfall in 24 hours, runoff of major proportions occurred due to the saturated condition of the soil. The failure of many dams and bridges contributed substantially to peak discharges. Downstream of the Thomaston Dam, the Naugatuck River claimed 36 lives and caused an estimated loss of nearly 193,000,000 dollars. Over 80 percent of this loss occurred in Waterbury, Watertown, Naugatuck and Ansonia.

High-water mark data were recorded at 332.5, 326.4, 314.9 and 309.9 feet, for the Naugatuck River at the mouth of Jericho Brook, at the mouth of Nibbling Brook, at Frost Bridge, and 0.1 mile below Frost Bridge, respectively.

Major floods occurred in the upper Naugatuck River basin in November 1927, March 1936, September 1938, December 1948, August 1955, and October 1955. With the exception of the August 1955 flood, the peak discharges of the other events generally ranged from 15,000 to 20,000 cubic feet per second (cfs) in the Naugatuck River at Waterbury, with estimated frequencies ranging from approximately 15 to 30 years. The August 1955 event was the greatest flood of record, by far, with a flow in the Naugatuck River at Waterbury of 90,000 cfs, with a corresponding frequency considered in excess of 100 years. The peak discharge on Branch Brook in 1955 was estimated at 10,300 cfs, approximately equal to the Leadmine Brook peak flow of 10,400 cfs.

In addition to the Naugatuck River, Steele Brook also has a history of damaging floods, the most serious of which occurred in August 1955. Areas close to the brook are susceptible to intense and sudden floods as a result of the steep sloping streets and terrain of the basin. The floodwaters converge from the fan-shaped drainage area and due to the limited natural storage in the upper basin, quickly exceed the channel capacity and overflow into the flood plain. Additionally, numerous restrictions such as low bridges, overhanging buildings, private dams and sharp bends in the channel all contribute to the flooding problems. In June 1973, and again in July 1975, Steele Brook overflowed its banks and resulted in extensive damage to commercial and manufacturing properties, homes and town installations.

Since 1955, the COE has constructed a system of reservoirs in the basin which will modify all future floods. In a repeat of historic flood events, the system would generally reduce flows on the Naugatuck River at Waterbury by 60 to 75 percent depending on storm orientation. Black Rock Reservoir on Branch Brook would generally maintain flows to safe channel capacity.

2.4 Flood Protection Measures

Following the devastating flood of 1955 along the Naugatuck River, the COE completed seven flood control dams and reservoirs in the Naugatuck River basin. Four of these, namely Thomaston, Hancock Brook, Black Rock and Northfield Brook, provided protection to the Town of Watertown.

the drainage area of 20.4 square miles. At spillway crest elevation, the reservoir is about 1.8 miles long and has a surface of about 190 acres. Project construction was initiated in 1966 and completed in July 1970.

Wigwam Dam is located on the Thomaston-Watertown boundary, 1.8 miles upstream of Black Rock Dam. Wigwam Dam is a water supply dam, and is not used for flood control.

There are no existing flood control devices on Steele Brook. Flood stages near the mouth of the brook are produced primarily by backwater from the Naugatuck River and are, therefore, affected in part by the COE reservoirs at Thomaston, Black Rock, Hancock Brook and Northfield Brook. Even though these four COE dams significantly modify recurring flood levels, flows from the uncontrolled portions of the Naugatuck, coinciding with flows discharging from Steele Brook along with the high level State Route 8 highway bridge over Steele Brook reducing the width of the brook; will probably effect a rise in the water-surface elevation. This rise will bring the water level above levels experienced through backwater from the Naugatuck River during the floods of 1955. Recent channel work done by the SCS proved effective in preventing flood losses during high-water events that occurred in March 1977.

The Waterbury-Watertown local protection project, completed by the COE in 1961, consists of earth dikes and concrete floodwalls along the Naugatuck River from Thomaston Avenue downstream to a point below the Chase Brass access bridge. The improvement, acting in conjunction with the five COE reservoirs upstream of the project, protects the Chase Brass plant, an adjoining residential area, and vulnerable sections of Thomaston Avenue and the Devon-Torrington Branch of the Penn Central Railroad against the recurrence of major floods similar to the August 1955 event.

The aqueduct located along Branch Brook is used exclusively by the City of Waterbury to transport potable water from Wigwam Reservoir to consumers within the Waterbury water supply system. This aqueduct would have no effect on the discharge of floodwaters along Branch Brook.

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data for this study. Flood events of a magnitude which are expected to be equalled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for flood plain management and for flood insurance premium rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10-, 2-, 1-, and 0.2-percent chance, respectively, of being equalled or exceeded during any year. Although the recurrence interval represents the long-term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than one year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (one-percent chance of annual occurrence) in any 50-year period is about 40 percent (four in ten) and, for any 90-year period, the risk increases to about 60 percent (six in ten). The analyses reported here reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for floods of the selected recurrence intervals for each flooding source studied in detail affecting the community.

Discharge frequencies were developed for both the Naugatuck River and Steele Brook in conjunction with a Flood Insurance Study for the community of Waterbury, Connecticut (Reference 1). These discharge frequencies were reviewed and adopted at the downstream corporate limits for both streams in Watertown. The Naugatuck River flows in Watertown were developed based on data contained in a 1973 COE Flood Plain Information Report (FPIR) on the Naugatuck River (Reference 2). Peak discharge frequencies, natural and modified by reservoirs, contained in the FPIR were developed from historical flow data using a standard log-Pearson Type III analysis and a comprehensive reservoir systems study (Reference 3). The 500-year discharge in Watertown was determined by applying the ratio of the 100- and 500-year discharges at the Waterbury-Watertown corporate limits to the 100-year discharge in Watertown.

The Steele Brook flows were adjusted for Watertown by multiplying the adopted discharges in Waterbury by a factor equal to the ratio of the drainage areas to a calculated exponent. A regional frequency study was conducted utilizing the discharge data from a majority of gaging stations in New England. For the purpose of having a common basis, the log of the 2-year flood for each station was reduced to represent values of 1 square mile. A relationship was developed between the log of the 2-year flood and the drainage area and it was found that for New England, discharges vary in accordance with the drainage area raised to the exponent power of 0.70.

There are no discharge records for Branch Brook. In 1970, the COE completed Black Rock Dam, located on Branch Brook about two miles above the mouth. Discharges from the dam are controlled by gate operations. The anticipated releases for the 10- and 50-year events would probably not exceed the nondamaging downstream channel capacity and these releases would not be made until downstream flood conditions subsided. The 100- and 500-year discharges are estimated based on hydrographs of major events routed through the reservoir. On Branch Brook above Wigwam Reservoir, peak discharge frequencies were determined by using relationships based on records for the USGS gaging station on nearby Leadmine Brook and then relating it to the Branch Brook watershed based on a direct drainage area relationship. A regional study was not undertaken to determine the drainage area-discharge relationship for Leadmine and Branch Brooks. However, the runoff characteristics of Leadmine Brook are considered to be similar to those of Branch Brook.

A summary of drainage area-peak discharge relationships is shown in Table 1, "Summary of Discharges."

TABLE 1 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
NAUGATUCK RIVER					
At downstream corporate limits	137	5,300	5,400	8,000	21,600
At upstream corporate limits	131	5,000	5,000	5,200	14,000
BRANCH BROOK					
At mouth	22.8	800	800	900	2,300
At Black Rock Dam	20.4	800	800	900	2,300
At Wigwam Dam	17.5	2,200	5,300	7,600	16,500
STEELE BROOK					
At downstream corporate limits	12.4	1,410	2,740	3,550	6,245
Above Wattles Brook	9.0	1,130	2,200	2,840	5,000
At Hemingway Pond	5.7	820	1,600	2,060	3,600
Below Smith Pond Brook confluence	4.0	640	1,250	1,600	2,800

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of the flooding sources studied in detail were carried out to provide estimates of the elevations of floods of the selected recurrence intervals along each of these flooding sources.

The 10-, 50-, 100- and 500-year flood elevations were computed for all streams using the COE HEC-2 computer program (Reference 4). Starting water-surface elevations for the Naugatuck River and Steele Brook were taken from the Waterbury Flood Insurance Study (Reference 1). Starting water-surface elevations for Branch Brook were calculated using the slope/area method.

Field surveys were conducted at all bridges and road crossings on the Naugatuck River, Steele Brook and Branch Brook. The location of intermediate valley and channel cross sections were taken from photogrammetric maps (Reference 5).

Manning's roughness coefficients used in the backwater computations were selected based on engineering experience and judgment. The roughness coefficients were 0.02 for the channel and varied from 0.04 to 0.08 for the overbank areas of the Naugatuck River. For Branch Brook's channel and overbank areas, the values were 0.035 and 0.06, respectively. For Steele Brook, the values ranged from 0.035 to 0.045 for the channel and from 0.04 to 0.06 for the overbank areas.

Flood profiles were drawn showing computed water-surface elevations to an accuracy of 0.5 foot for floods of the selected recurrence intervals. Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway is computed (Section 4.2), selected cross-section locations are also shown on the Flood Boundary and Floodway Map (Exhibit 1).

All elevations used in this study are referenced to the National Geodetic Vertical Datum of 1929 (NGVD), formerly referred to as Sea Level Datum of 1929. Locations of the elevation reference marks used in the study are shown on the maps.

The hydraulic analyses for this study are based on the effects of unobstructed flow. The flood elevations shown on the profiles are valid only if hydraulic structures remain unobstructed, and dams and other flood control structures operate properly and do not fail.

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FT.)	SECTION AREA (SQ. FT.)	MEAN VELOCITY (F.P.S.)	REGULATORY (NGVD)	WITHOUT FLOODWAY (NGVD)	WITH FLOODWAY (NGVD)	INCREASE (FEET)
Steele Brook (continued)								
T	6,180	55	238	11.9	456.5	456.5	456.5	0.0
U	6,560	104	516	5.5	459.9	459.9	459.9	0.0
V	6,660	130	1,058	2.7	462.6	462.6	462.6	0.0
W	7,160	286	1,876	1.5	462.7	462.7	462.7	0.0
X	7,900	160	413	6.9	462.8	462.8	462.8	0.0
Y	8,100	376	665	4.3	463.3	463.3	463.8	0.5
Z	9,110	92	467	6.1	466.2	466.2	467.0	0.8
AA	9,510	90	455	6.2	467.5	467.5	468.0	0.5
AB	10,030	73	411	6.9	469.1	469.1	469.4	0.3
AC	10,370	51	233	12.2	472.1	472.1	472.1	0.0
AD	10,460	166	1,122	2.5	478.2	478.2	478.2	0.0
AE	10,780	280	1,660	2.7	478.3	478.3	478.3	0.0
AF	11,390	195	1,101	2.6	478.4	478.4	478.5	0.1
AG	11,870	47	349	8.1	478.5	478.5	478.5	0.0
AH	11,925	302	4,735	0.6	482.6	482.6	482.6	0.0
AI	12,310	66	707	4.0	482.6	482.6	482.6	0.0
AJ	12,370	182	1,095	2.6	484.4	484.4	484.4	0.0
AK	12,550	226	1,022	2.8	484.4	484.4	484.4	0.0

[1] Feet above corporate limits

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

TOWN OF WATERTOWN, CT
(LITCHFIELD CO.)

FLOODWAY DATA

STEELE BROOK

TABLE 2

Base flood elevation lines show the locations of the expected whole-foot water-surface elevations of the base (100-year) flood. This map is developed in accordance with the latest flood insurance map preparation guidelines published by the FIA.

6.0 OTHER STUDIES

An FPIR on the Naugatuck River supplied some data for this study (Reference 2). The SCS prepared a report in conjunction with this study on Steele Brook (Reference 8). Flood Insurance Studies for the adjacent Towns of Waterbury, Middlebury, Woodbury, Morris and Thomaston, when completed will be in exact agreement with this study (References 1, 9, 10, 11 and 12).

This study is authoritative for purposes of the Flood Insurance Program, and the data presented here either supersede or are compatible with previous determinations.

7.0 LOCATION OF DATA

Survey, hydrologic, hydraulic, and other pertinent data used in this study can be obtained by contacting the office of the Insurance and Mitigation Division of the Federal Emergency Management Agency, Regional Director, Region I Office, 15 New Chardon Street, Boston, Massachusetts 02114.

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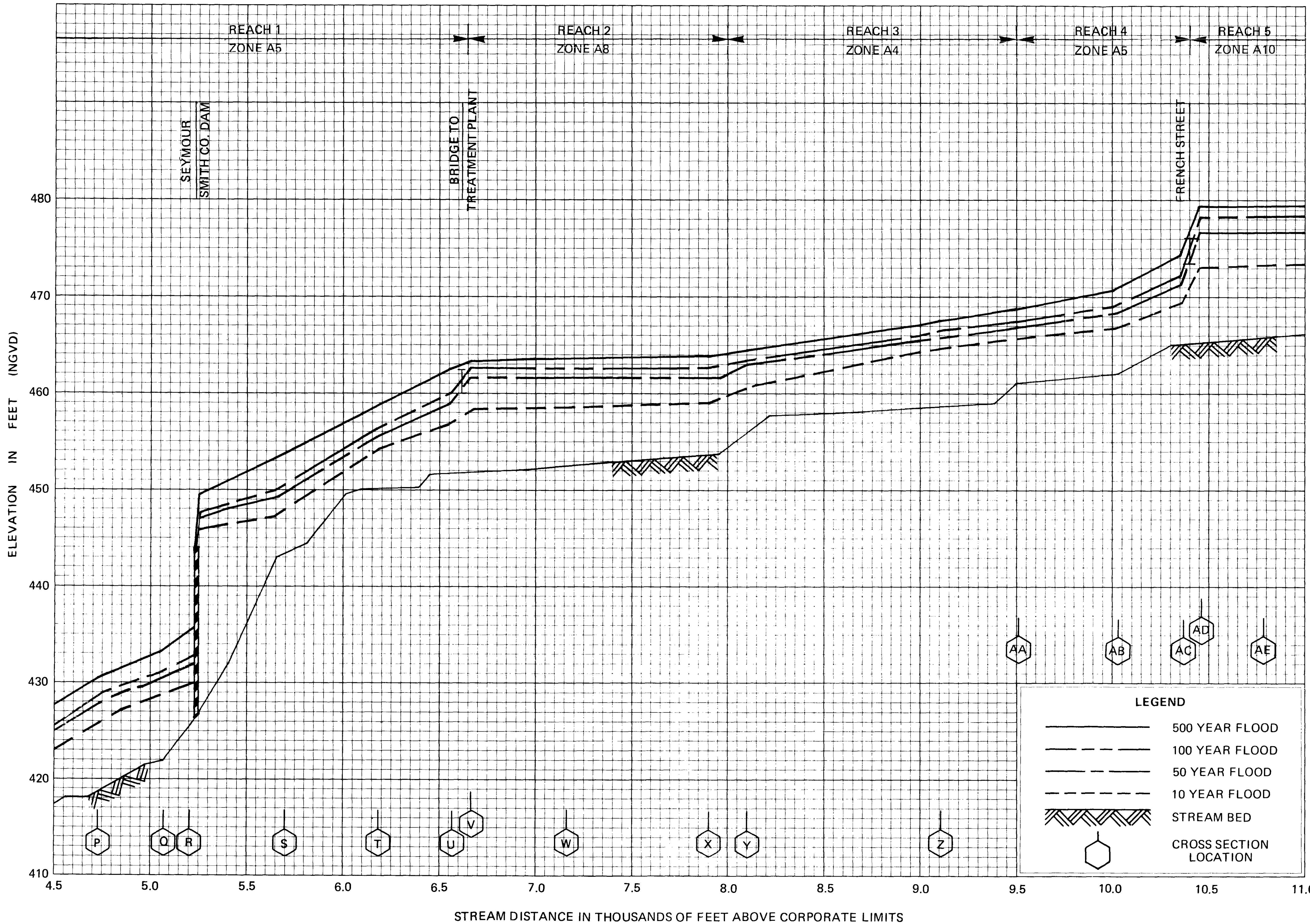

FLOOD PROFILES

STEELE BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

TOWN OF WATERTOWN, CT
(LITCHFIELD CO.)

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APPENDIX D

Photos

Photo Index

Photo 1 Looking south, Steele Brook where pedestrian bridge is proposed

Photo 2 Looking south, location of Proposed Steele Brook Greenway

Photo 3 Looking north, Steele Brook east of UNICO fields

Photo 4 Looking south, gravel path west of UNICO fields