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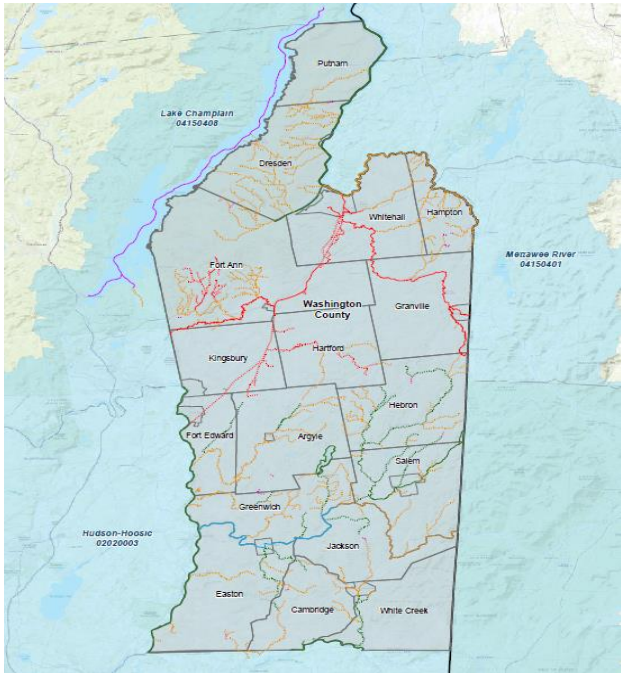
Flood Risk Project

Washington County, New York,
Hydrology Meeting

November 12, 2019



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Presentation Agenda

- **Project Introduction**
  - History
  - Location and Study Streams
  - Scope
- **Hydrology**
  - Gage Analysis
  - Regression Analysis
  - Rainfall-runoff Modeling
  - Direct Volume Calculation
  - Model Verification and Comparison to Effective Flows
- **Next Steps**

Presentation Recap

- **History**
  - Kickoff Meeting March 6, 2019
  - Engineering Models Notification to communities March 29, 2019
  - Hydrology Study April 2019 – Present
  - Survey April 2019 –November 2019
- **Three HUC8 Watersheds**
  - Lake Champlain (04150408)
  - Mettawee River (04150401)
  - Hudson-Hoosic (02020003)
- **Locations and Study Streams**
  - USGS Regression Equations (410.4 miles)
  - Rainfall-Runoff Modeling (134.4 stream miles & 4 ponds/lakes)
  - Lake Gage Analysis (Lake George and Dunham’s Bay)
  - Direct Volume Calculations (22 ponds/lakes)
  - Previous Studies (191.2 miles)
    - 2018 Husdon-Hoosic Watershed Study
    - 2018 Lake Champlain Study

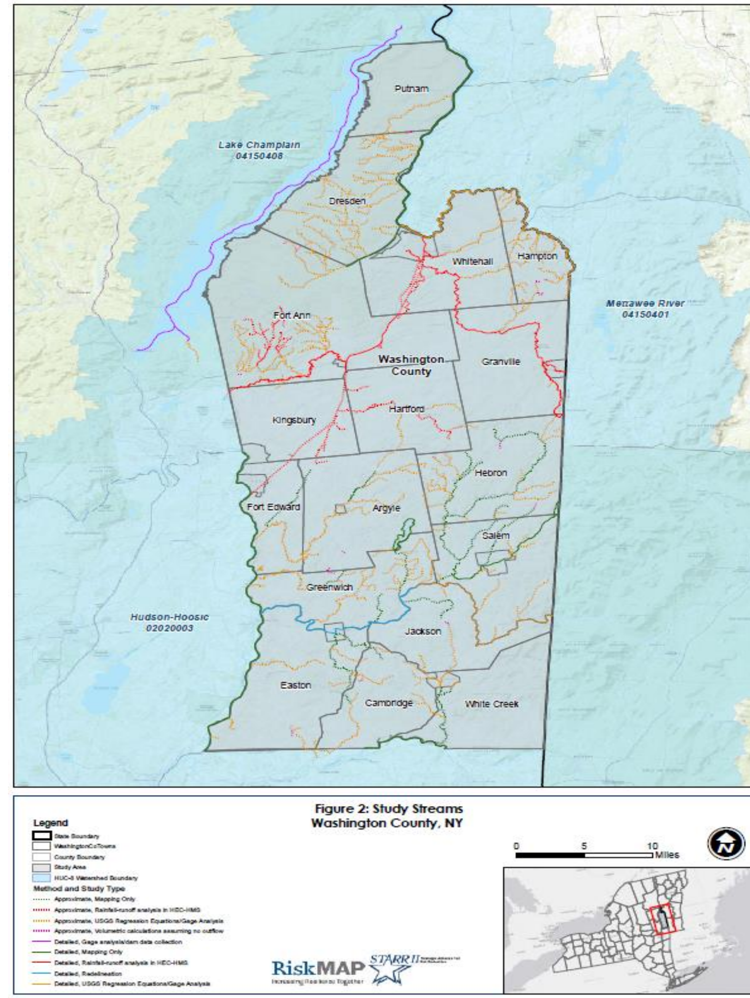
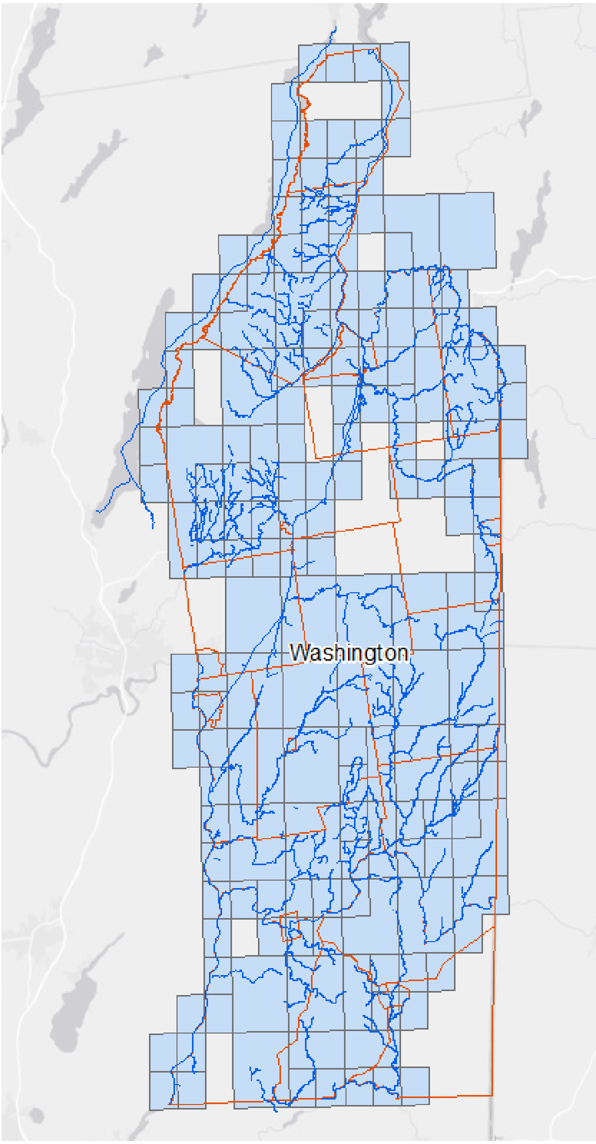


Figure 2: Study Streams
Washington County, NY

Project Scope

- **First time digital countywide maps**
- **Additional flooding sources studied**
  - 101 miles - Detailed (AE) streams and lakes
  - 459 miles – Approximate (A) streams and lakes
- **Includes Lake Champlain and Hudson-Hoosic Watershed study**
- **25 affected communities**
- **174 map panels**
- **Multiple touchpoints**



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Project Scope
Flood Frequency Terminology

- **Recurrence Interval vs. Annual Exceedance Probability (AEP)**
  - "100-year" vs. "1%-Annual-Chance"
  - Indicates event has *x*% chance of occurring in any given year
  - Interchangeable Terms – DO NOT represent cyclical rain patterns

Recurrence intervals and probabilities of occurrences

Recurrence interval, years	Annual exceedance probability, percent
2	50
5	20
10	10
25	4
50	2
100	1
200	0.5
500	0.2

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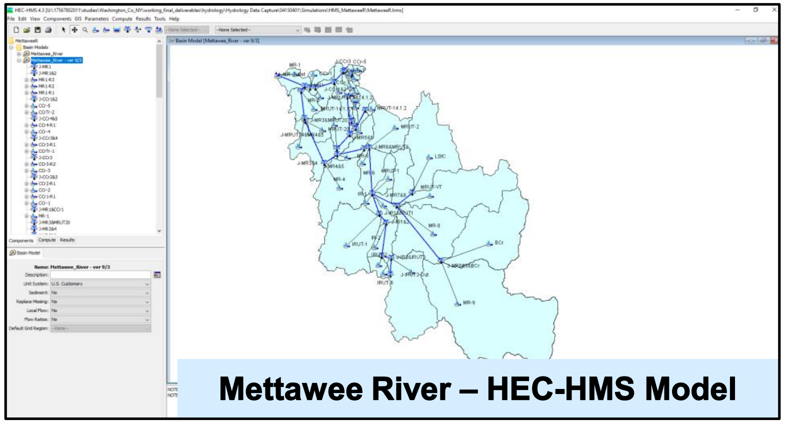
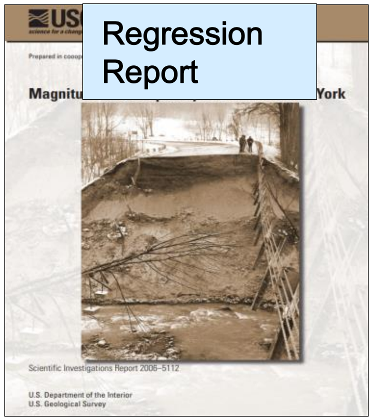
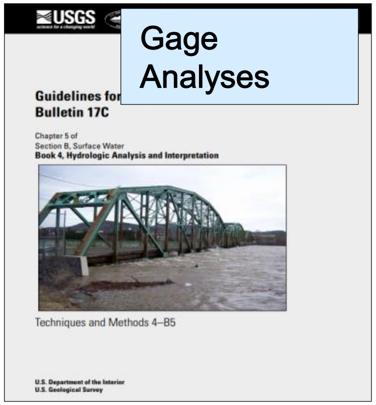
Hydrologic Analysis Methods

- **Typical FEMA methods**
  - Statistical gage analyses
  - Regression analyses
  - Rainfall-runoff analyses
- **Develop inputs for hydraulic analysis**
- **Statistical Gage analyses**
  - Statistical analyses of flow/stage gage data
  - HEC-SSP program
- **Regression analyses**
  - Regional equations published by USGS
  - USGS StreamStats web application
- **Rainfall-runoff analyses**
  - Physical modeling
  - USACE HEC-HMS program







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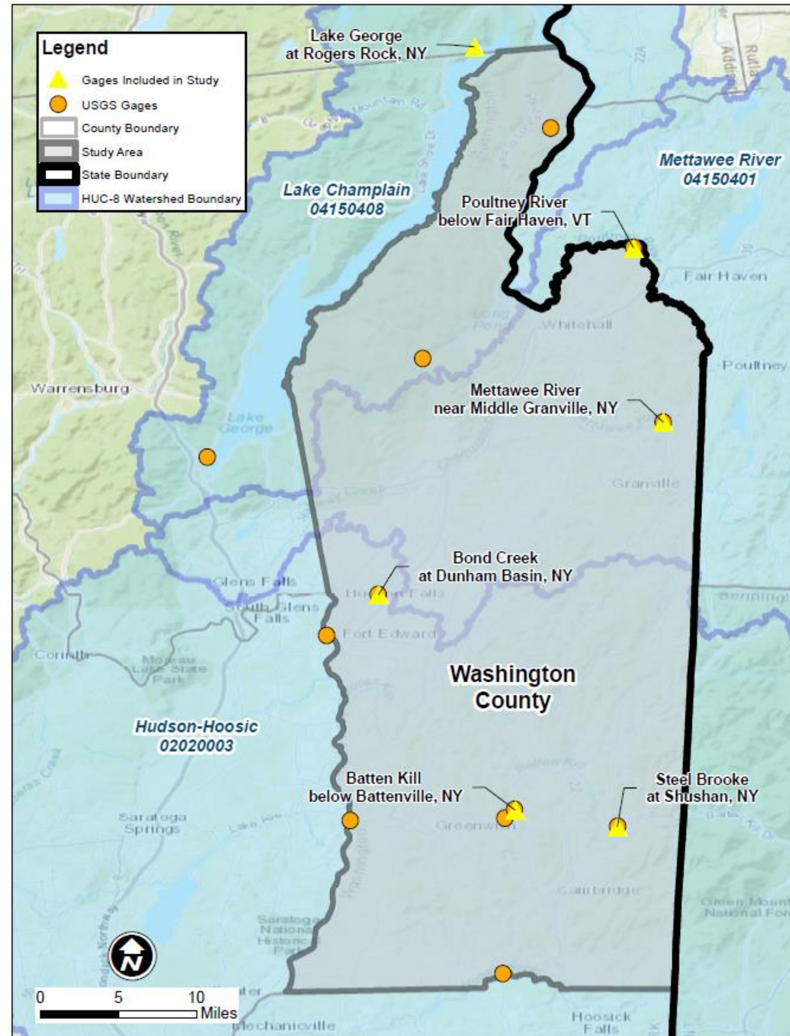
Gage Analysis

- **USACE HEC-SSP used to perform Log-Pearson Type III Analysis of gage data**
- **All discharges and levels estimated according to Bulletin 17C Methodology**
- **Stream Gage Locations**
  - Batten Kill
  - Bond Creek
  - Steele Brook
  - Poultney River
  - **Mettawee River**
    - *Mettawee River Gage used to verify HEC-HMS model*
- **Lake Level Gage Location**
  - Lake George



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Gage Analysis
Gages and Periods of Record

Flooding Source	Gage Identifier	Site Name	Drainage Area (mi^2)	Period of Record From	Period of Record To
Bond Creek	1328000	Bond Creek at Dunham Basin, NY	14	3/20/1948	5/29/1984
Steele Brook	1329154	Steel Brook at Shushan, NY	3	3/5/1979	1/13/2018
Batten Kill	1329490	Batten Kill below Mill at Battenville, NY	396	04/1904	1/13/2018
Poultney River	4280000	Poultney River below Fair Haven, VT	187	3/16/1929	1/13/2018
Mettawee River	4280450	Mettawee River near Middle Granville, NY	167	3/14/1977	7/2/2017
Lake George	4278000	Lake George at Rogers Rock, NY	233	1/1/1914	1/1/2018

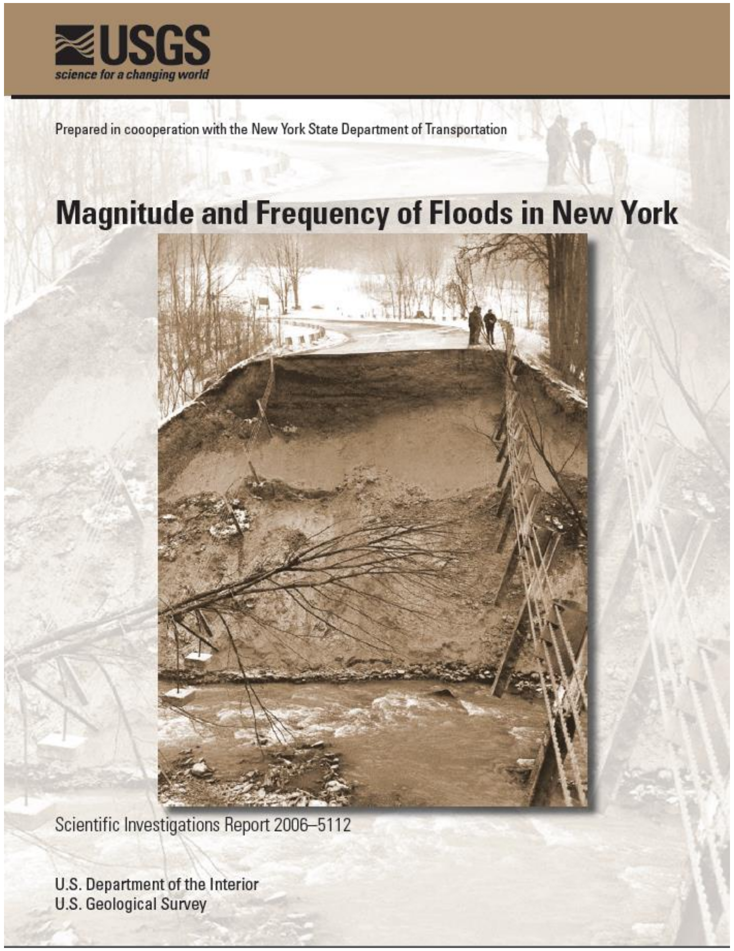
Gage Analysis
Recommended Discharges and Elevations

Gage Site	Discharges				
	10% (10-Yr)	4% (25-Yr)	2% (50-Yr)	1% (100-Yr)	0.2% (500-Yr)
	cfs	cfs	cfs	cfs	cfs
Bond Creek	1,061	1,257	1,405	1,558	1,920
Steele Brook	143	185	219	254	340
Batten Kill	11,765	15,346	18,339	21,607	30,488
Poultney River	7,356	9,413	11,036	12,745	17,035
Mettawee River	8,103	10,921	13,315	15,984	23,502

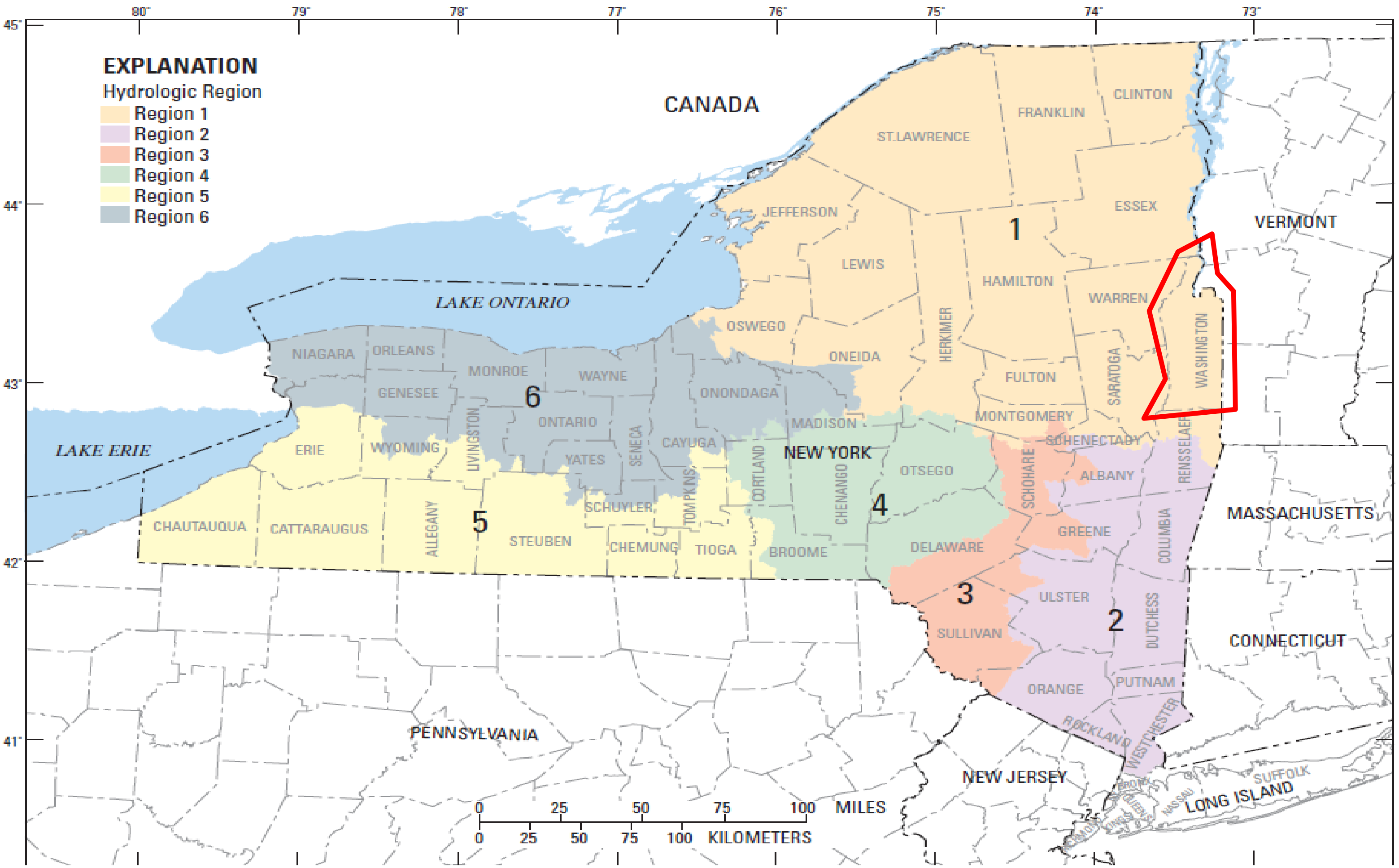
Gage Site	Elevations (NAVD88)				
	10% (10-Yr)	4% (25-Yr)	2% (50-Yr)	1% (100-Yr)	0.2% (500-Yr)
	ft	ft	ft	ft	ft
Lake George	320.3	320.4	320.6	320.7	321.0
Dunham's Bay	320.3	320.4	320.6	320.7	321.0

Regression Analysis

- **Discharges estimated from regional equations provided in USGS SIR2006-5112 – *Magnitude and Frequency of Floods in New York***
- **Equations developed based on five basin characteristic variables**
  - Drainage Area
  - Mean Annual Precipitation
  - Lag Factor
  - Forested Area
  - Storage
- **Flow Changes Locations**
  - Upstream and Downstream of all reaches
  - Initially targeted 20% change in discharge
- **Watershed boundaries and characteristics produced using StreamStats online Batch Processing Tool**



Regression Analysis



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Regression Equations
New York Region 1

New York Region 1 Regression Equations

$$Q_{10} = 2310\,(A)^{0.968}\,(ST+1)^{-0.184}\,(P)^{1.241}\,(LAG+1)^{-0.482}\,(FOR+80)^{-1.549} \quad (4.1)$$

$$Q_{25} = 4580\,(A)^{0.965}\,(ST+1)^{-0.192}\,(P)^{1.167}\,(LAG+1)^{-0.500}\,(FOR+80)^{-1.582} \quad (4.2)$$

$$Q_{50} = 7030\,(A)^{0.963}\,(ST+1)^{-0.197}\,(P)^{1.131}\,(LAG+1)^{-0.511}\,(FOR+80)^{-1.610} \quad (4.3)$$

$$Q_{100} = 10300\,(A)^{0.962}\,(ST+1)^{-0.202}\,(P)^{1.106}\,(LAG+1)^{-0.520}\,(FOR+80)^{-1.638} \quad (4.4)$$

$$Q_{500} = 22000\,(A)^{0.959}\,(ST+1)^{-0.210}\,(P)^{1.067}\,(LAG+1)^{-0.539}\,(FOR+80)^{-1.704} \quad (4.5)$$

Where,

A is Drainage Area, the area that drains to a point on a stream

ST is Storage, the percentage of the drainage area that is comprised of lakes, ponds, reservoirs, and wetlands

P is Precipitation, the mean annual preicpitation

LAG is the lag factor, the main channel length divided by the square root of the product of the upper half slope of the main channel (plus one) and the lower half slope of the main channel (plus one)

FOR is Forest, the percentage of the drainage area covered by forest

Regression Analysis
Watershed in Vermont

In cases where watersheds overlapped with areas of Vermont, discharges were calculated using the Vermont Regression Equations (Olson & Veileux, 2014)

$$Q_{10} = 0.199(A)^{0.875}(W)^{-0.280}(P)^{1.685} \quad (4.6)$$

$$Q_{25} = 0.219(A)^{0.866}(W)^{-0.286}(P)^{1.740} \quad (4.7)$$

$$Q_{50} = 0.237(A)^{0.860}(W)^{-0.291}(P)^{1.774} \quad (4.8)$$

$$Q_{100} = 0.251(A)^{0.854}(W)^{-0.297}(P)^{1.809} \quad (4.9)$$

$$Q_{500} = 0.289(A)^{0.844}(W)^{-0.309}(P)^{1.879} \quad (4.10)$$

Where,

A	*is Drainage Area*
W	*is Storage*
P	*is Precipitation*

A final, weighted average discharge was then calculated based on the ratio of the total drainage area within New York or Vermont.

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Regression Analysis
Ungaged Site Along a Gaged Stream

At points along a stream with an existing USGS stream gage, regression results were weighted with the results of the Log-Pearson Type III analysis performed for that gage to determine a final weighted discharge.

3. If the ungaged site for which flood-frequency estimates are needed is on a gaged stream, and if the site's drainage area is between 50 and 150 percent of the drainage area of the stream at the gage, the weighted estimate for the ungaged site can be computed by the following equation (Ries and Crouse, 2002):

$$Q_{T(U)w} = \frac{2\Delta A}{A_g} Q_{T(U)r} + \left(1 - \frac{2\Delta A}{A_g}\right) Q_{T(U)g} \quad , \qquad (4)$$

where

$Q_{T(U)w}$ is the weighted estimate of discharge Q_T for recurrence interval T at the ungaged site, is the absolute value of the difference between the drainage areas of the streamflow-gaging station, (A_g) and the ungaged site,

ΔA (A_u), $|A_g - A_u|$,

$Q_{T(U)r}$ is the peak-flow estimate for recurrence interval T at the ungaged site, derived from the applicable regional regression equation (table 1),

and

$Q_{T(U)g}$ is the peak-flow estimate for recurrence interval T at the ungaged site, derived from the weighted estimate of peak discharge at the streamflow-gaging station, $Q_{T(w)}$ (see method for gaged sites), by adjusting for the effect of the difference in drainage area between the streamflow-gaging station and the ungaged site.

$Q_{T(U)g}$ is computed as:

$$Q_{T(U)g} = \left(\frac{A_u}{A_g}\right)^b \cdot Q_{T(w)} \quad , \qquad (5)$$

where

depending on the hydrologic region and the recurrence interval T, b is the exponent from the appropriate drainage-area-only equation (table 3).

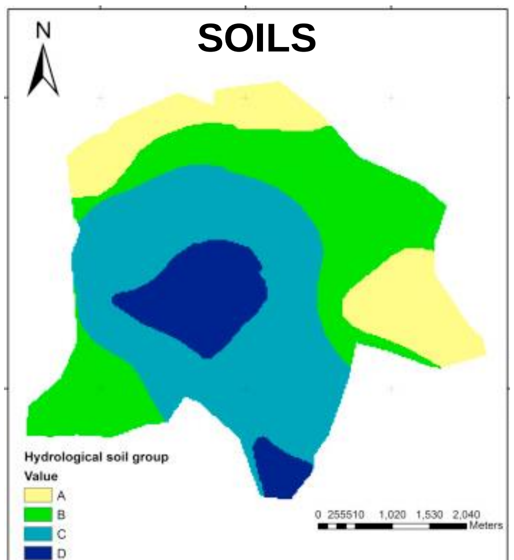
The weighting procedure is only applicable when the ratio of drainage areas between the ungaged location and the stream gage site is between 0.5 and 1.5.

Rainfall Runoff Modeling

- **Software Program: HEC-HMS 4.3**
- **Topography:**
  - LiDAR Digital Elevation Models (DEM)
    - 10m resolution used for watershed delineation
    - 1 and 2m resolution used for flow path delineations, length and slope calculations
- **Rainfall:**
  - NOAA Atlas 14
- **Loss Methodology:**
  - SCS Curve Number, Antecedent Moisture Condition = 2
- **Hydrograph Methodology: SCS Unit Hydrograph**
  - Standard Peak Rate Factor (484)
  - Lag Time (60% of Time of Concentration)
- **Channel Routing:**
  - Muskingum-Cunge using 8-point cross-sections
- **1-minute time step for hydrographs**

Rainfall-Runoff Modeling
SCS Curve Numbers

- Runoff = Rainfall – initial abstractions – infiltration
- Function of empirical parameter: Curve Number (CN)
- NRCS Soil Data – Soils Survey Geographic Database (SSURGO)
- USGS Landuse Data – National Land Cover Dataset (NLCD)



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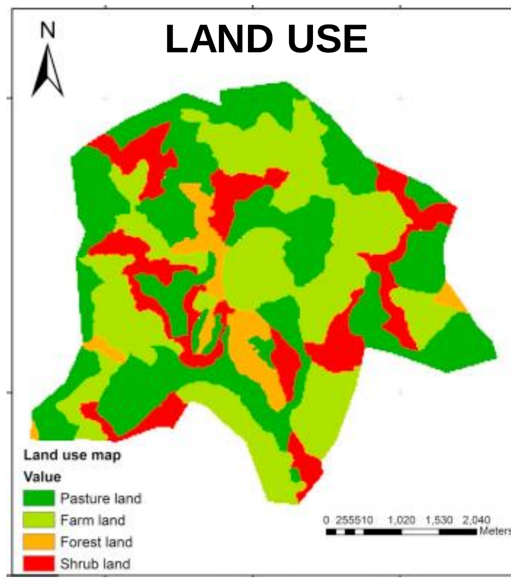

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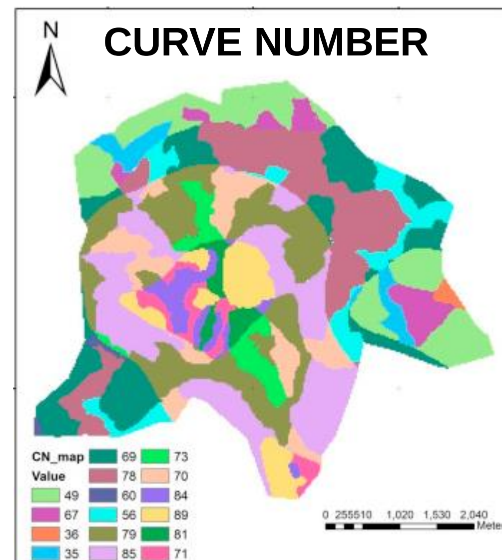

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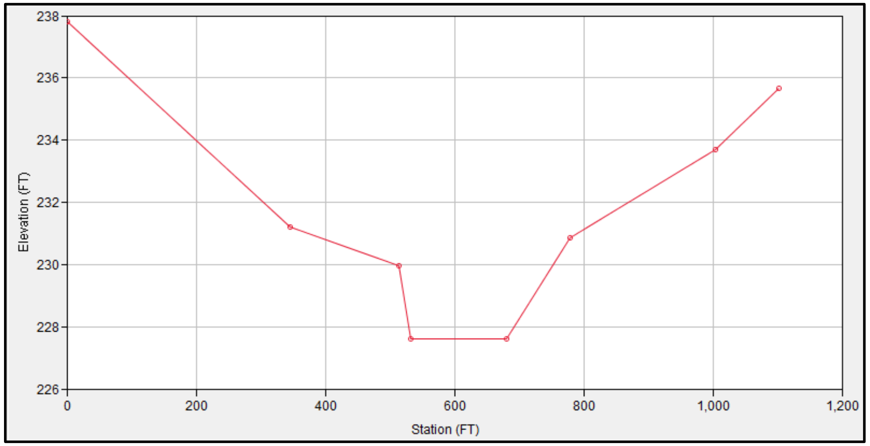
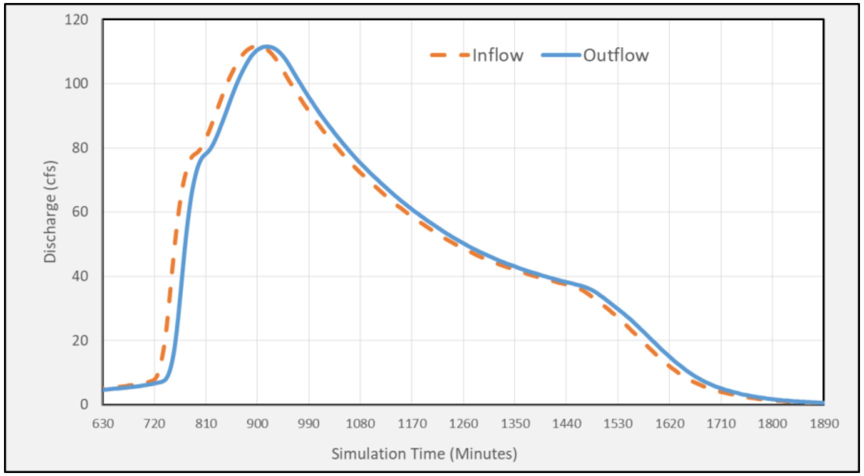
Rainfall-Runoff Modeling
Time of Concentration (Tc) and Lag Time

- **Tc = time for runoff to travel from hydraulically distant point to the outlet of a basin or sub-basin**
- **Longest flow paths developed from project DEM**
- **Flow paths split into different types**
  - Sheet flow maximum = 100 ft
  - Shallow concentrated flow: from end of sheet flow segment to visual open channel or known storm sewer
  - Channel flow: begins at end of shallow concentrated flow segment and ends at sub-basin outlet
  - Pipe flow
- **Lag times = 60% of Tc**

Rainfall-Runoff Modeling
Reach Routing

- Account for flow attenuation and travel time of flood waves
- Individual sub-basin hydrographs routed downstream along the channels
- Eight point cross-sections capture channel and overbank
- Length, elevations, and slope determined from DEM
- Channel and overbank Manning's n values determined from imagery





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Rainfall-Runoff Modeling
Frequency Storm Rainfall Data

- **Temporal Distribution for Northeastern Region 1**
  - 1st Quartile
  - 50th Percentile Occurrence
- **Precipitation Depths from NOAA Atlas 14 Gridded Rainfall Files**

Table A.5.1. Total number of precipitation cases and number (and percent) of cases in each quartile for selected durations for Interior region (1) and Coastal region (2).

Duration	Region	All	First quartile	Second quartile	Third quartile	Fourth quartile
6-hour	1	4138	1355 (33%)	1188 (28%)	1063 (26%)	532 (13%)
	2	2308	451 (20%)	645 (28%)	790 (34%)	422 (18%)
12-hour	1	4303	1313 (30%)	1107 (26%)	1190 (28%)	693 (16%)
	2	2425	449 (19%)	682 (28%)	773 (32%)	521 (21%)
24-hour	1	3943	1240 (32%)	1107 (28%)	909 (23%)	687 (17%)
	2	2229	515 (23%)	679 (31%)	648 (29%)	387 (17%)
96-hour	1	3771	1588 (42%)	766 (20%)	739 (20%)	678 (18%)
	2	2163	998 (46%)	463 (21%)	325 (15%)	377 (18%)

Rainfall Depths for Frequency Storms

	AREA	0.2%	1%	2%	4%	10%
	Acres	**24 Hour**	**24 Hour**	**24 Hour**	**24 Hour**	**24 Hour**
Lake Champlain Canal	33,103	7.00	5.54	4.99	4.45	3.75
Hadlock Pond	12,382	7.07	5.63	5.07	4.54	3.83
Mettawee River	37,569	7.35	5.77	5.18	4.62	3.87
Halfway Creek	32,327	7.02	5.59	5.03	4.50	3.80
TOTAL / AVERAGE	*115,381*	*7.14*	*5.64*	*5.07*	*4.52*	*3.81*

Rainfall-Runoff Modeling
Reach Routing

- Account for flow attenuation and travel time of flood waves
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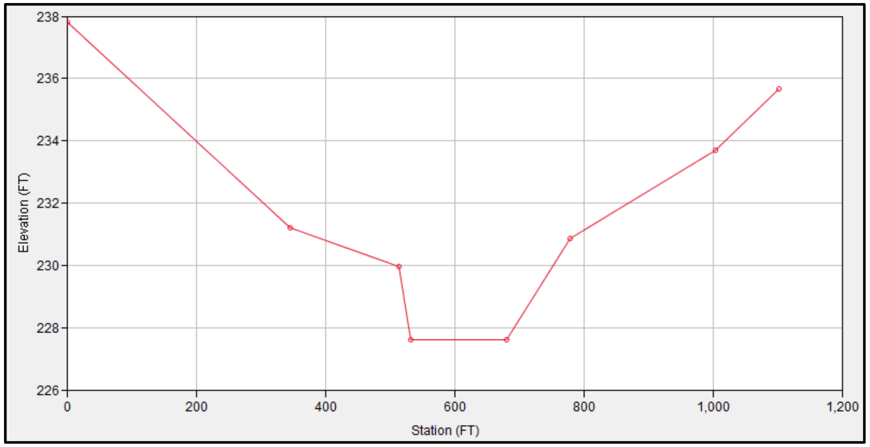
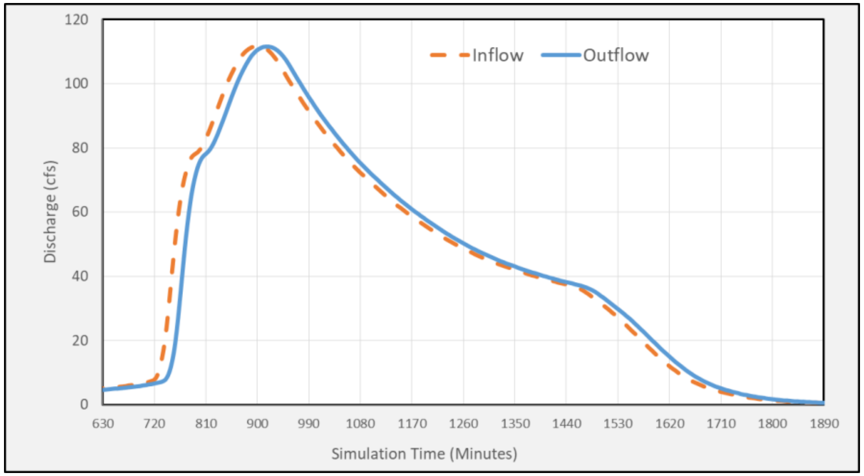
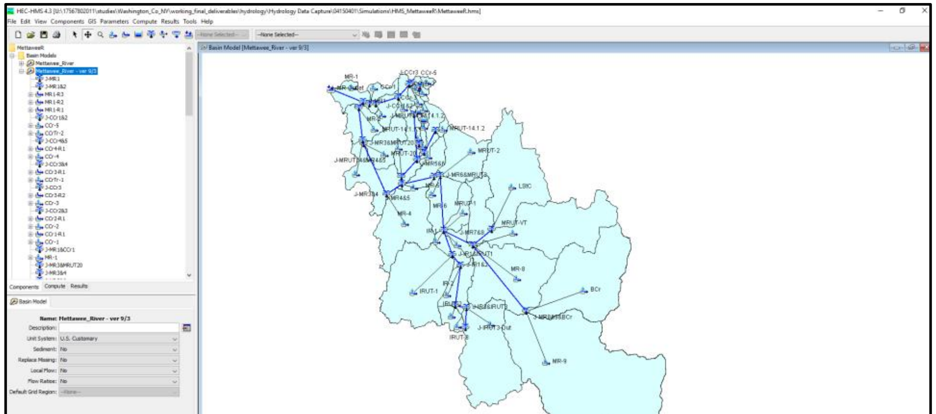




Rainfall-Runoff Modeling
Watersheds

- **Mettawee River**
  - Mettawee River
  - Castle Creek & Tributaries
  - Indian River & Tributaries
- **Fort Ann**
  - Hadlock Pond
  - Copeland Pond
  - Lake Nebo
  - Lakes Pond
- **Halfway Creek**
  - Halfway Creek
  - Bishop Brook & Tributaries
  - Unnamed Stream 5 & Tributaries
- **Champlain Canal**
  - Champlain Canal & Tributaries
  - Wood Creek
  - Wood Creek West
  - Wood Creek East
  - Unnamed Stream 18 & Tributary
  - Mud Brook
  - Big Creek



Mettawee River – HEC-HMS Model

Rainfall-Runoff Modeling
Discharge Verification

- **USGS 4280450 (Mettawee River) is the only active stream gage within the rainfall-runoff modeled watersheds**
  - Curve Numbers were decreased by 11 points within the Mettawee River model to match gage flow for 1%-annual-chance-event

	Pre-Verification	Post-Verification	USGS 4280450	Post-Verification Difference (%)
1% annual chance Q (cfs)	24,910	15,578	15,984	2.6%

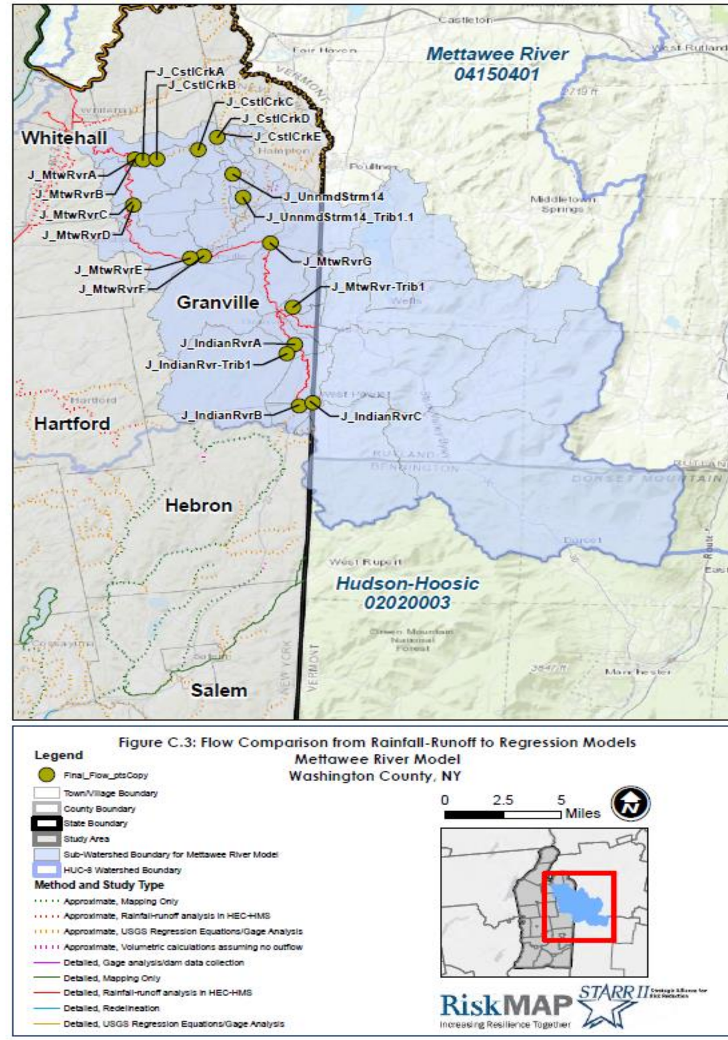
- **Global Adjustment**
  - Consistent with the Mettawee Pre-Verification discharges, results from other HEC-HMS models were considerably higher than Regression Equations, ranging from 40-60%
    - *31% is the standard error for the 1%-annual-chance discharge for NY Region 1 Regression Equations*
  - Curve Numbers for all models were therefore decreased by 11 points to follow Mettawee River verification and match upper limit of Regression results

Rainfall-Runoff Modeling
Mettawee River

- **Flows from SE to NW and outlets into Champlain Canal south of Town of Whitehall**
- **Drainage Area = 210 square miles**
  - Approximately 65% in Vermont
- **13 Streams**
- **48 Miles**

COMPARISON TO REGRESSION RESULTS – SELECT LOCATIONS

	Drainage Area (mi^2)	10%	4%	2%	1%	0.2%
Average Difference (%)	2.2%	25.2%	23.5%	28.8%	35.7%	60.5%



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Rainfall-Runoff Modeling

Fort Ann

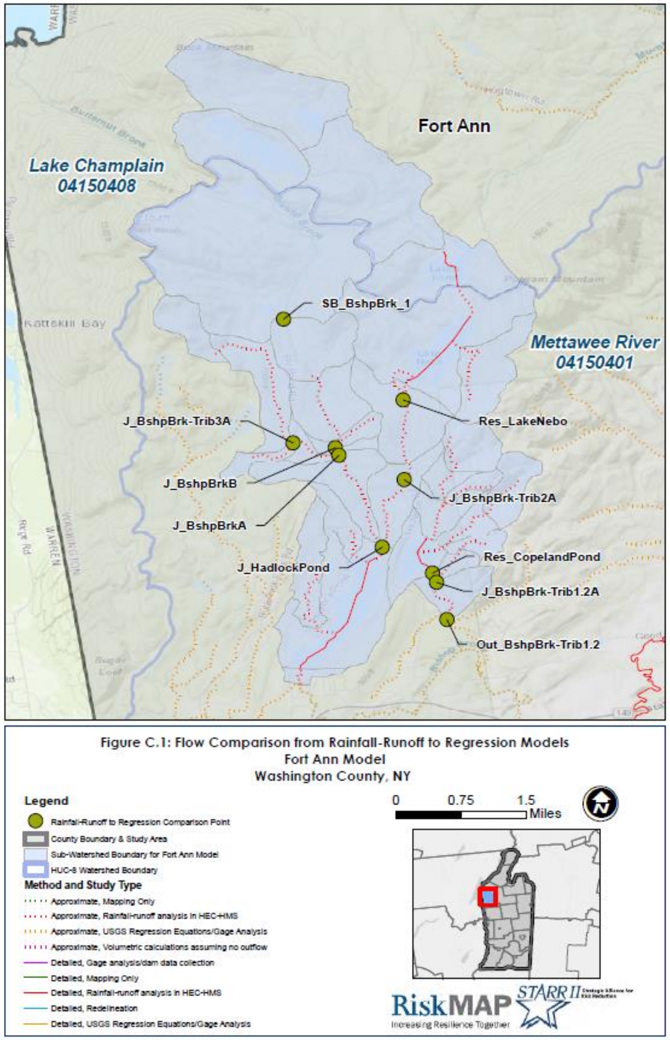


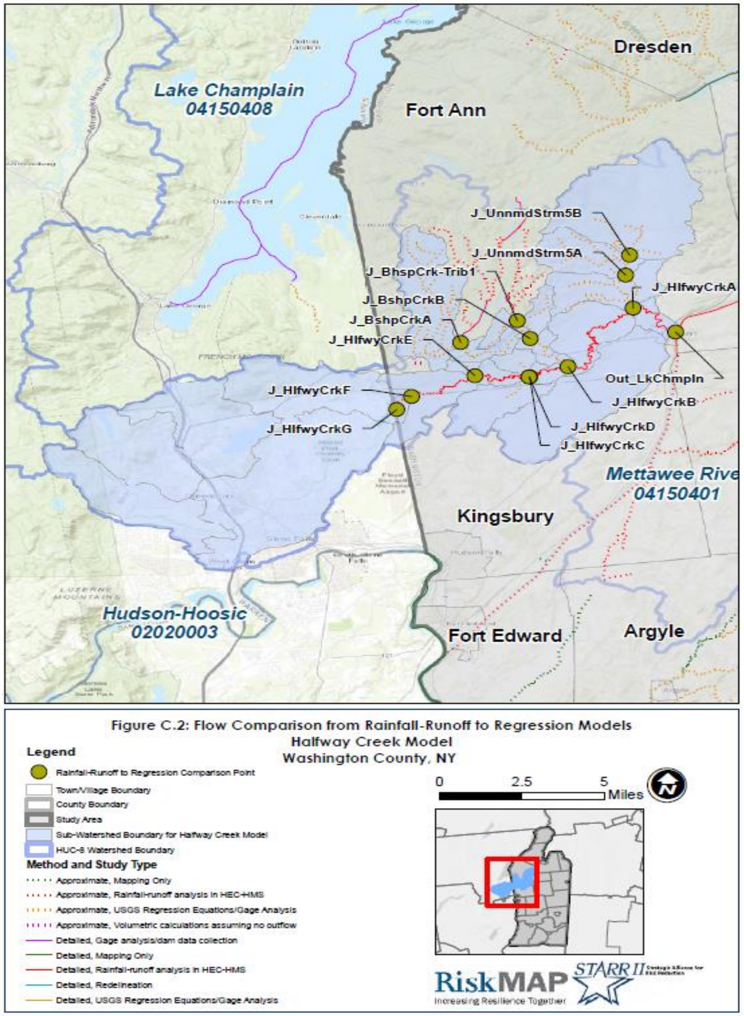
Figure C.1: Flow Comparison from Rainfall-Runoff to Regression Models
Fort Ann Model
Washington County, NY

- **Drainage Area = 14 square miles**
  - Lakes Pond (3.4 square miles) outlets north into Lake Champlain watershed
  - Hadlock Pond and Copeland Pond outlet south into Mettawee River watershed
- **14 Streams, 4 Lakes/Ponds**
- **14.5 Miles**

COMPARISON TO REGRESSION RESULTS – SELECT LOCATIONS						
	Drainage Area (mi^2)	10%	4%	2%	1%	0.2%
Average Difference (%)	2.6%	31.9%	27.9%	28.5%	28.2%	33.6%

Rainfall-Runoff Modeling
Halfway Creek

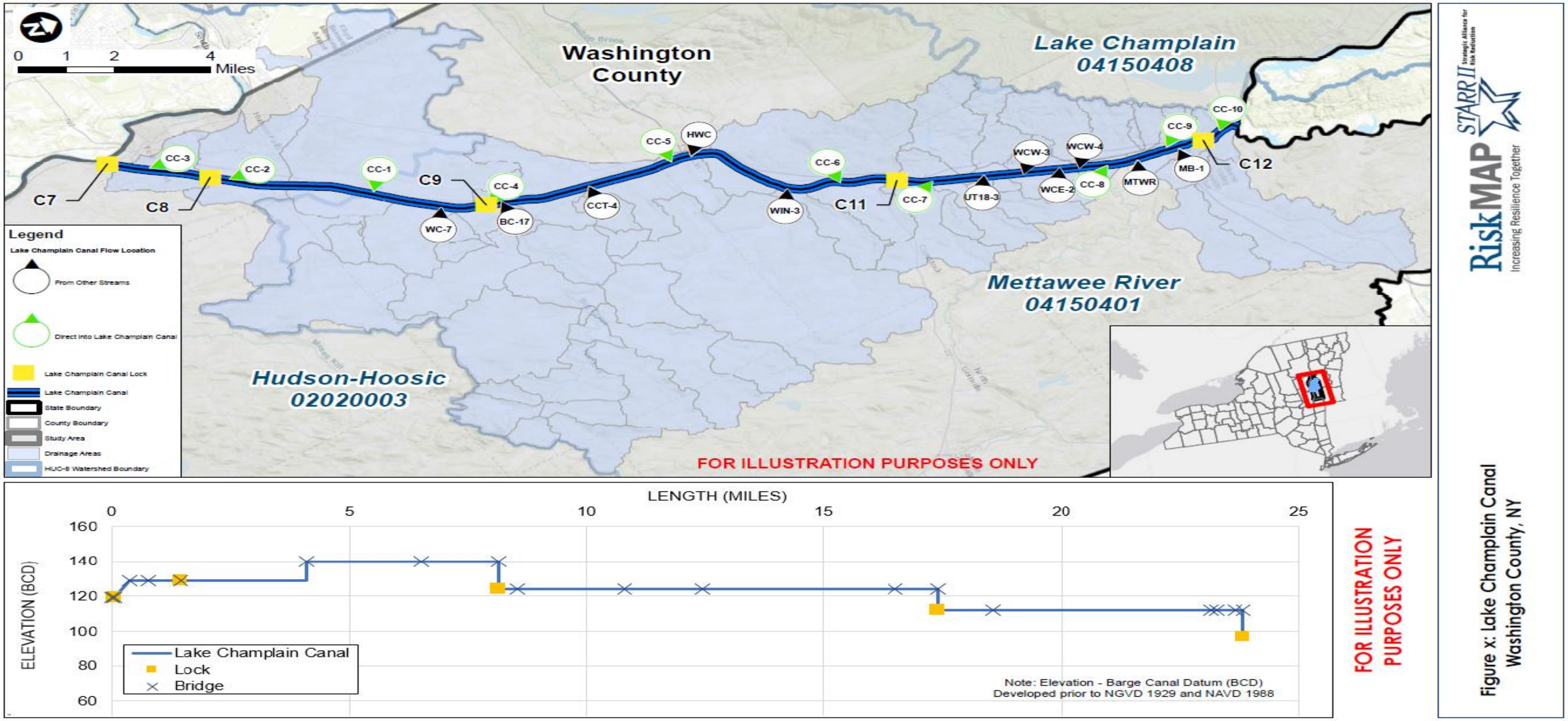
- **Flows W to E and outlets into Champlain Canal north of the Village of Fort Ann**
- **Drainage Area = 88 square miles**
  - Approximately 40% in Warren County
  - Includes Ft. Ann Watershed
- **30 Streams**
- **57 Miles**



COMPARISON TO REGRESSION RESULTS – SELECT LOCATIONS						
	Drainage Area (mi^2)	10%	4%	2%	1%	0.2%
Average Difference (%)	7.5%	33.5%	21.1%	15.7%	16.4%	29.1%

Rainfall-Runoff Modeling
Champlain Canal

- **Champlain Canal is a series of constructed locks and dams**
- **Hydrologic Analysis consisted of developing hydrographs and determining outlet locations**
- **Discharges from sub-watersheds and direct tributary areas will be routed through canal system using un-steady hydraulic analysis**



Rainfall-Runoff Modeling
Champlain Canal

Flow Location	Drainage Area (mi^2)	1% Annual Chance (cfs)
BC-17	34.13	5215.8
CC-1	18.37	2827.1
CC-2	4.25	378.5
CC-3	2.32	311.7
CC-4	0.63	109.2
CC-5	7.15	987.6
CC-6	10.77	1320.3
CC-7	1.76	146.3
CC-8	0.33	88.9
CC-9	1.34	243.9

Flow Location	Drainage Area (mi^2)	1% Annual Chance (cfs)
CC-10	1.14	232.2
HWC	0.00*	6027.4
MB-1	10.64	1452.5
MTWR	0.00*	17885.5
UT18-3	6.77	1083.7
WC-7	14.01	2309.6
WCE-2	1.56	248.4
WCW-3	5.78	889.2
WCW-4	5.02	805.8
WIN-3	19.88	3021.6

** Hydrograph input directly from other HEC-HMS models*

COMPARISON TO REGRESSION RESULTS – SELECT LOCATIONS						
	Drainage Area (mi^2)	10%	4%	2%	1%	0.2%
Average Difference (%)	4.2%	15.3%	12.9%	14.6%	18.5%	27.8%

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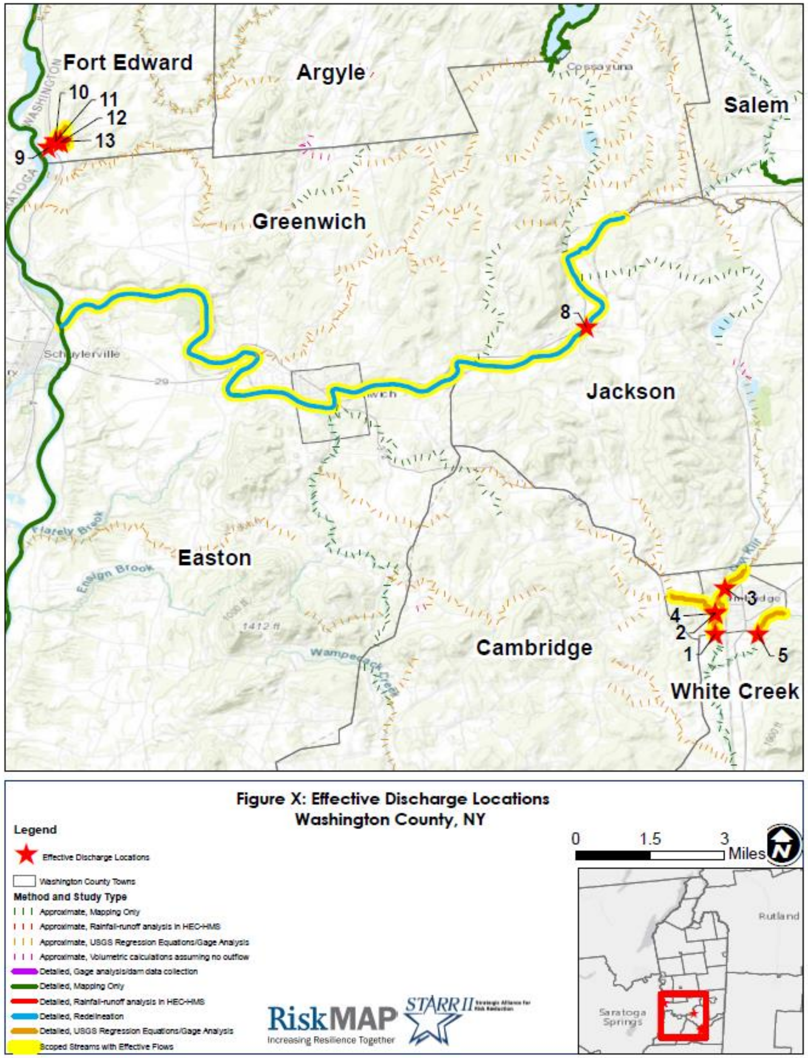
Rainfall-Runoff Modeling

Comparison to Effective Discharges



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Rainfall-Runoff Modeling
Comparison to Effective Discharges

Detailed Studies				Effective		Calculated	
FIS Report	Date	Flooding Source and Location	Location ID	Drainage Area (mi^2)	1% Annual Chance	Drainage Area (mi^2)	1% Annual Chance
Village of Cambridge	January 2, 2008	**Owl Kill**					
		Downstream corporate limits	1	17.9	1,725	17.5	1,891
		Upstream of confluence with Cambridge Creek	2	9.9	920	9.5	1,255
		Upstream of Tributary approx. 750' upstream of Spring St.	3	8.7	820	8.4	815
		Cambridge Creek					
		Upstream of confluence with Owl Kill	4	7.6	1,000	7.5	1,137
		White Creek					
		Downstream corporate limits	5	19.4	2,400	19.2	2,931

FEMA

RiskMAP
Increasing Resilience Together

Rainfall-Runoff Modeling
Comparison to Effective Discharges

Detailed Studies				Effective		Calculated	
FIS Report	**Date**	**Flooding Source and Location**	**Location ID**	**Drainage Area (mi^2)**	**1% Annual Chance**	**Drainage Area (mi^2)**	**1% Annual Chance**
Town of Fort Edward	June 15, 1982	**Tributary A**					
		Confluence with Champlain Canal	9	1.33	844	1.3	304
		Upstream of confluence with Tributary B	10	0.569	393	0.6	164
		Tributary B					
		Confluence with Tributary A	11	0.734	508	0.7	148
		Upstream of confluence with Tributary C	12	0.527	394	0.5	101
		Tributary C					
		Confluence with Tributary B	13	0.197	159	0.2	111

FEMA

RiskMAP
Increasing Resilience Together

Rainfall-Runoff Modeling
Comparison to Effective Discharges/Elevations

Detailed Studies				Effective		Calculated	
FIS Report	**Date**	**Flooding Source and Location**	**Location ID**	**Drainage Area (mi²)**	**1% Annual Chance**	**Drainage Area (mi²)**	**1% Annual Chance**
Town of Easton	November 20, 1991	**Batten Kill**					
Town of Greenwich	March 16, 1992						
Village of Greenwich	May 4, 2000	USGS Battenville gaging station	8	394.0	20,400	396.0	21,607
Town of Jackson	March 16, 1992						

Detailed Studies			Stillwater Elevations (NAVD 88)			
FIS Report	**Date**	**Flooding Source and Location**	**10% Annual Chance**	**2% Annual Chance**	**1% Annual Chance**	**0.2% Annual Chance**
Town of Easton	November 20, 1991	**Lake George**	-	-	320.6	-
Town of Greenwich	March 16, 1992					
Washington County	October 1, 2019*		320.4	320.6	320.7	320.8

* *Ongoing*

FEMA

RiskMAP
Increasing Resilience Together

Direct Volume Calculation

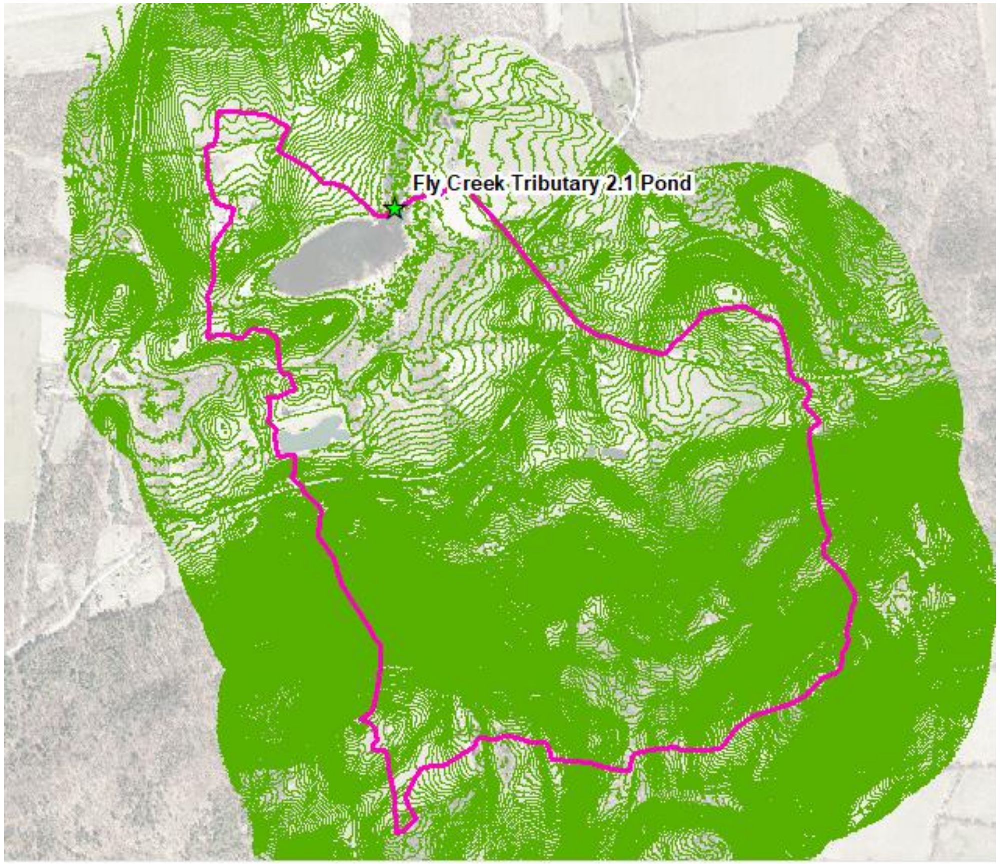
- **Direct Runoff Calculation**
  - Computation of runoff depth and volume based on TR-55 methodology
  - Curve Numbers determined using same approach as Rainfall-Runoff Modeling

$$Q = \frac{(P - I_a)^2}{(P - I_a) + S} \quad \text{[eq. 2-1]}$$

where

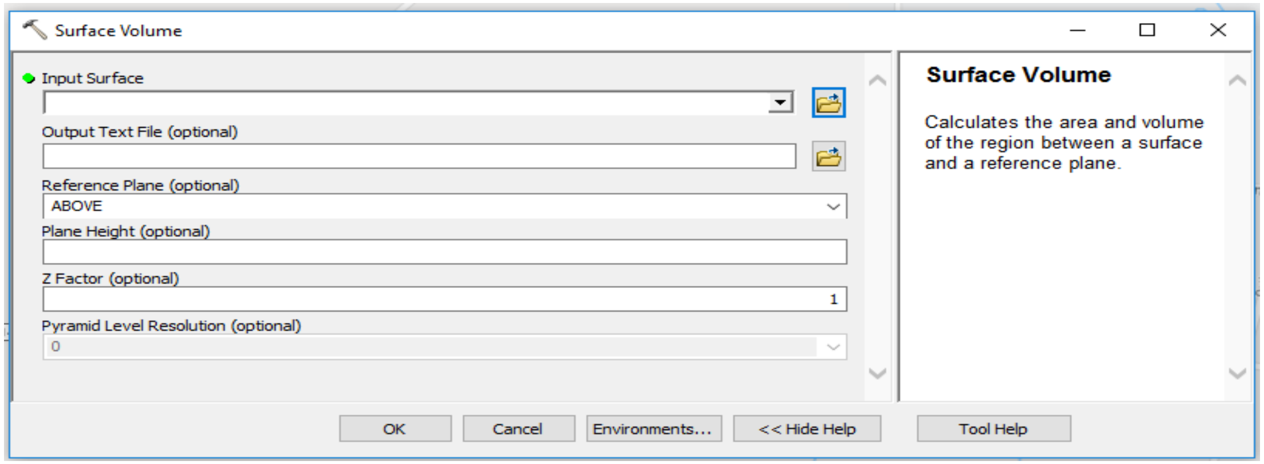
Q = runoff (in)
P = rainfall (in)
S = potential maximum retention after runoff begins (in) and
I_a = initial abstraction (in)

$$I_a = 0.2S \quad \text{[eq. 2-2]}$$



Direct Volume Calculation
Methodology

- **Ponding Volume**
  - Stage-Storage Curves for each lake/pond developed using Surface Volume Tool in ArcGIS
  - Assumed no outlet from pond other than overtopping
- **Ponding Depth/Elevation**
  - Approximate stillwater elevations determined for the 10%, 4%, 2%, 1% and 0.2% annual chance events
  - Elevations determined by comparing direct runoff volume to available storage and interpolating elevation



FEMA

RiskMAP
Increasing Resilience Together

Direct Volume Calculation
Results

Flooding Source	Elevations (feet NAVD88)				
	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Beaver Brook	650.2	650.2	650.2	650.2	650.2
Big Creek Trib 2	685.0	685.0	685.0	685.0	685.0
Black Creek	743.6	743.6	743.6	743.6	743.6
Bumps Pond	2,011.5	2,011.9	2,012.3	2,012.7	2,012.7
Dead Creek Trib 1	987.5	987.5	987.5	987.5	987.5
Dead Creek Trib 1.1	992.4	992.8	993.0	993.0	993.0
Dead Lake	536.0	536.2	536.4	536.5	537.1
Dunhams Bay	620.7	620.7	620.7	620.7	620.7
Fly Creek Trib 2.1	697.7	697.8	697.9	697.9	698.0
Hill Pond	584.0	584.0	584.0	584.0	584.0
Kidney Creek	474.5	474.5	474.5	474.5	474.5
Mill Brook Trib	650.2	650.2	650.2	650.2	650.2

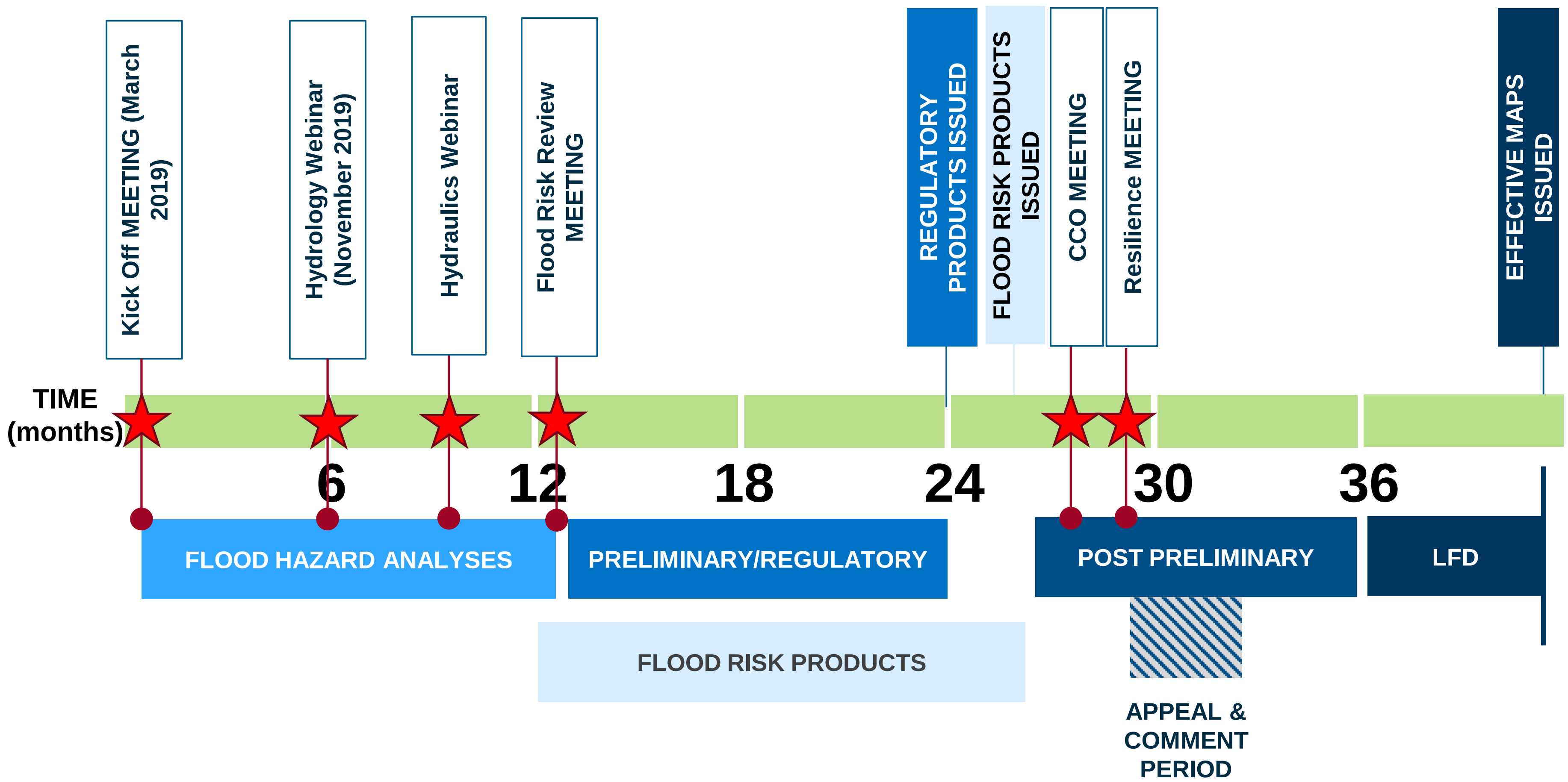
Direct Volume Calculation
Results

Flooding Source	Elevations (feet NAVD88)				
	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Moses Kill Trib 1	483.0	483.0	483.0	483.0	483.0
Pine Lake Trib 1	1,237.0	1,237.0	1,237.0	1,237.0	1,237.0
Poultney River Trib 5.1	704.5	704.5	704.5	704.5	704.5
Schoolhouse Lake	532.2	532.8	533.3	533.8	535.1
Sheltered Lake	1,370.2	1,370.2	1,370.2	1,370.2	1,370.2
Slocum Creek	431.5	431.5	431.5	431.5	431.5
Slocum Creek Trib	437.4	437.6	437.6	437.6	437.6
Spectacle Pond	1,646.9	1,646.9	1,646.9	1,646.9	1,646.9
Unnamed Stream 14	629.0	629.0	629.0	629.0	629.0
Unnamed Stream 6	463.8	463.9	464.1	464.2	464.7
Unnamed Stream 8	454.5	454.5	454.5	454.5	454.5

Next Steps

- **Field Reconnaissance**
- **Hydraulics Modeling and Report**
- **Hydraulics Submittal**
- **Hydraulics Public Webinar**
- **Dam Breach Analysis**
- **Mapping**

Schedule



Kick Off MEETING (March 2019)
Hydrology Webinar (November 2019)
Hydraulics Webinar
Flood Risk Review MEETING
REGULATORY PRODUCTS ISSUED
FLOOD RISK PRODUCTS ISSUED
CCO MEETING
Resilience MEETING
EFFECTIVE MAPS ISSUED
TIME (months)
6
12
18
24
30
36
FLOOD HAZARD ANALYSES
PRELIMINARY/REGULATORY
POST PRELIMINARY
LFD
FLOOD RISK PRODUCTS
APPEAL & COMMENT PERIOD

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Thank You!

- **Questions?**
- **Comments?**