Flood Risk Project

St. Lawrence County, New York

Hydrology Review Meeting

September 13, 2021

FEMA

Agenda

Recap/Refresh

Hydrology Analysis Review

Path Forward

Project Recap

- Discovery Projects in St. Lawrence County
- North Country Watersheds
  - Meetings held in September 2019
  - Discovery project completed in March 2020
- Headwaters to the St. Lawrence River Watershed
  - Meetings held in November 2013
  - Discovery project completed in July 2016
- Current St. Lawrence Study Progress
  - Kickoff meeting: Held virtually due to COVID19 – February 11, 2021
  - Engineering models notification to communities: February 17, 2021
  - Field survey: Fall 2020 – Fall 2021
  - Hydrologic analysis: February 2021 – Present

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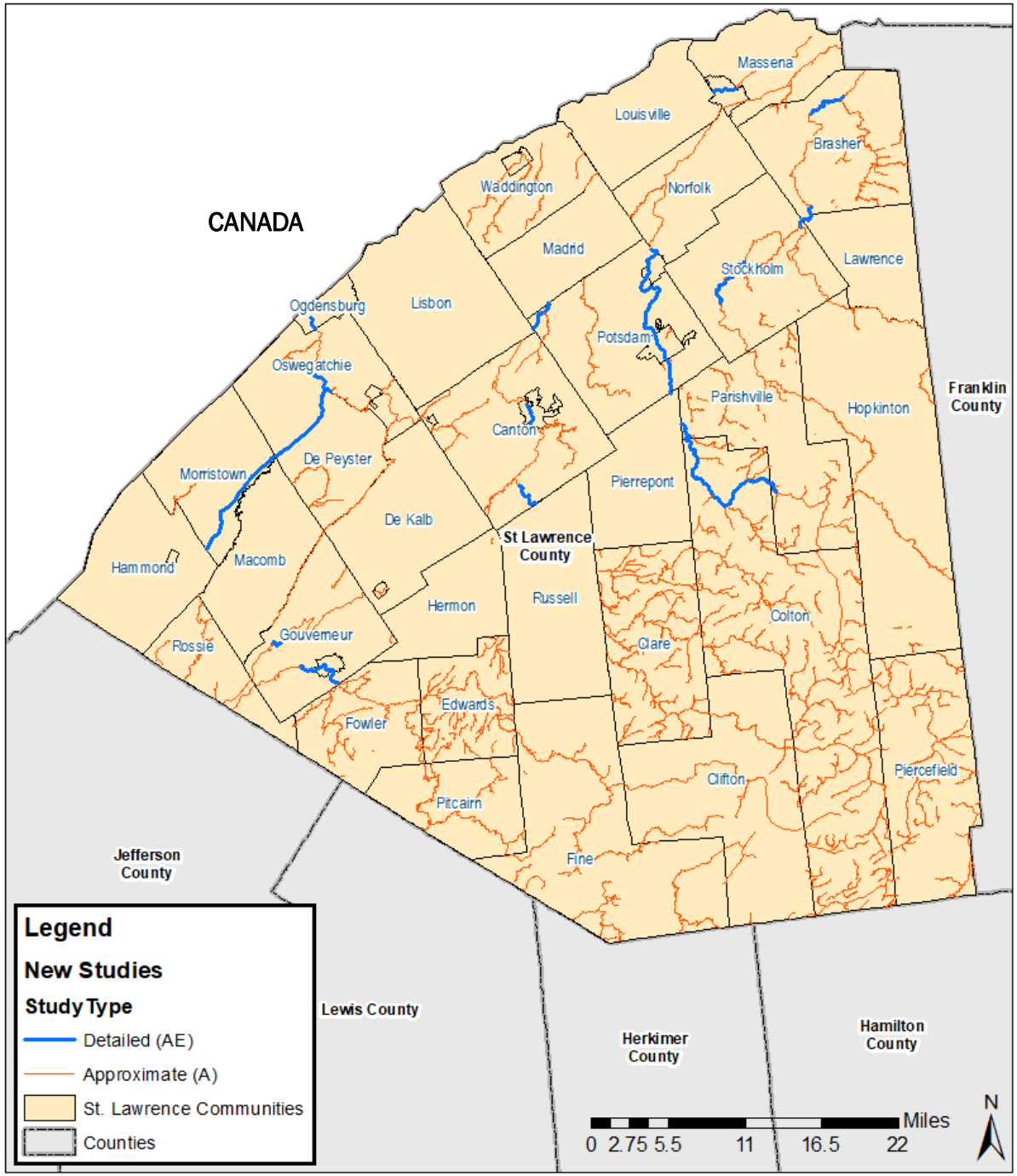

Leveraged Data - *Recap*

- Regression Hydrology from North Country Watersheds studies
- BLE studies for detailed – 71.3 miles
  - Black Lake
  - Five Falls Lake
  - Grass River
  - Oswegatchie River
  - Raquette River
  - Saint Regis River
  - West Branch Saint Regis River
- Approximate – 1212.9 miles

Project Scope

- First time digital maps
- Flooding sources analyzed
  - Detailed riverine studies (AE Zone) 6 –streams, 59.2 miles
  - Detailed lake studies (AE) – 3 lakes, 91.2 miles
  - Approximate (A) studies – multiple streams, 2450.6 miles
- 45 Updated Communities – 402 Map Panels
- Review Meetings
  - Hydrology Meeting
  - Hydraulics Meeting
  - Flood Risk Review Meeting

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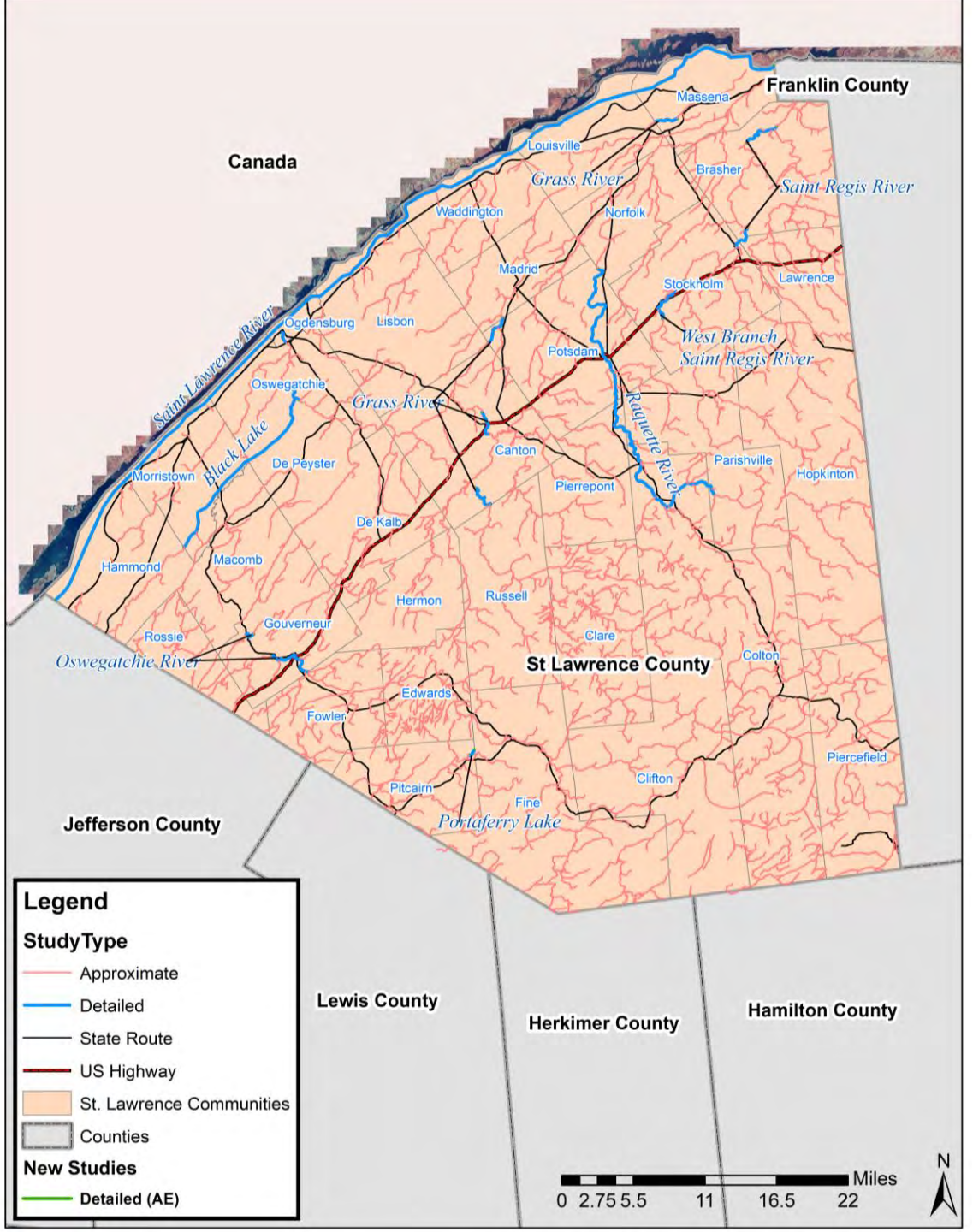
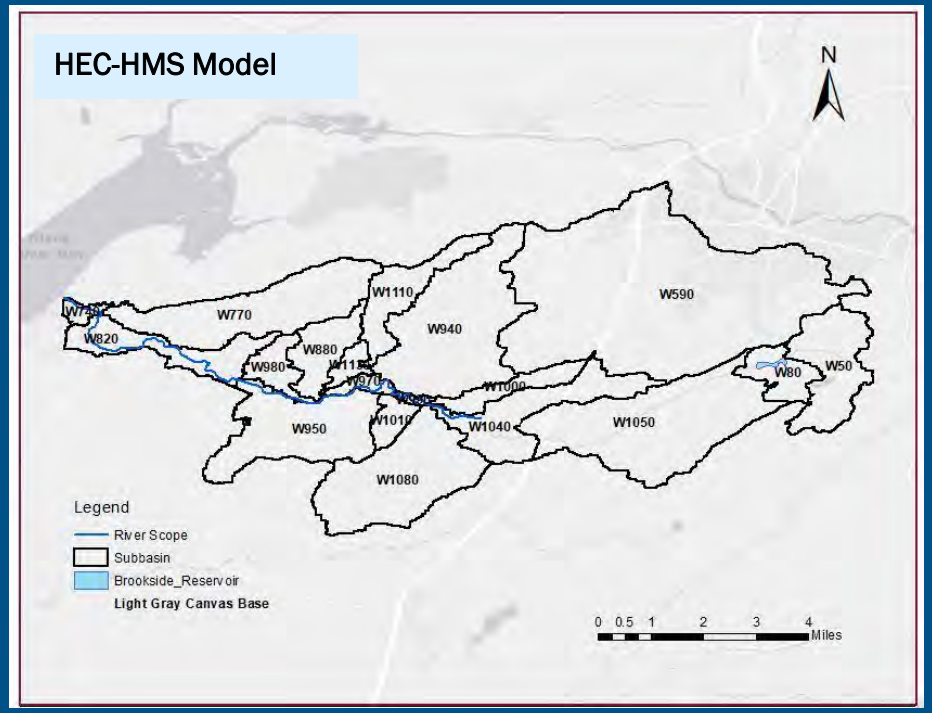
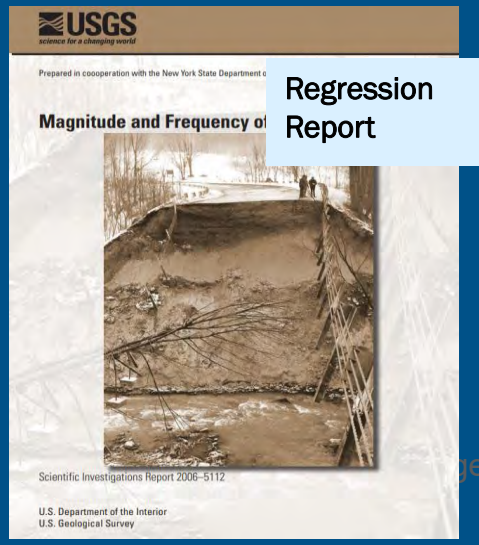
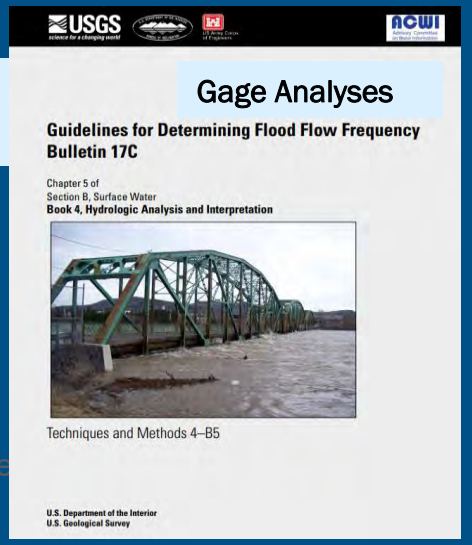


Hydrologic Analysis Methods

- Typical Methods FEMA utilizes
  - Statistical Gage Analyses
  - Regression Analyses
  - Rainfall Runoff Modeling
- Gage/Regression are based on availability stream gage data
- Rainfall-Runoff physical modeling chosen due to limited gage data
- Discharges developed for
  - 10%, 4%, 2%, 1%, 1%+, 1%-, 0.2%
  - Inputs for hydraulic analyses







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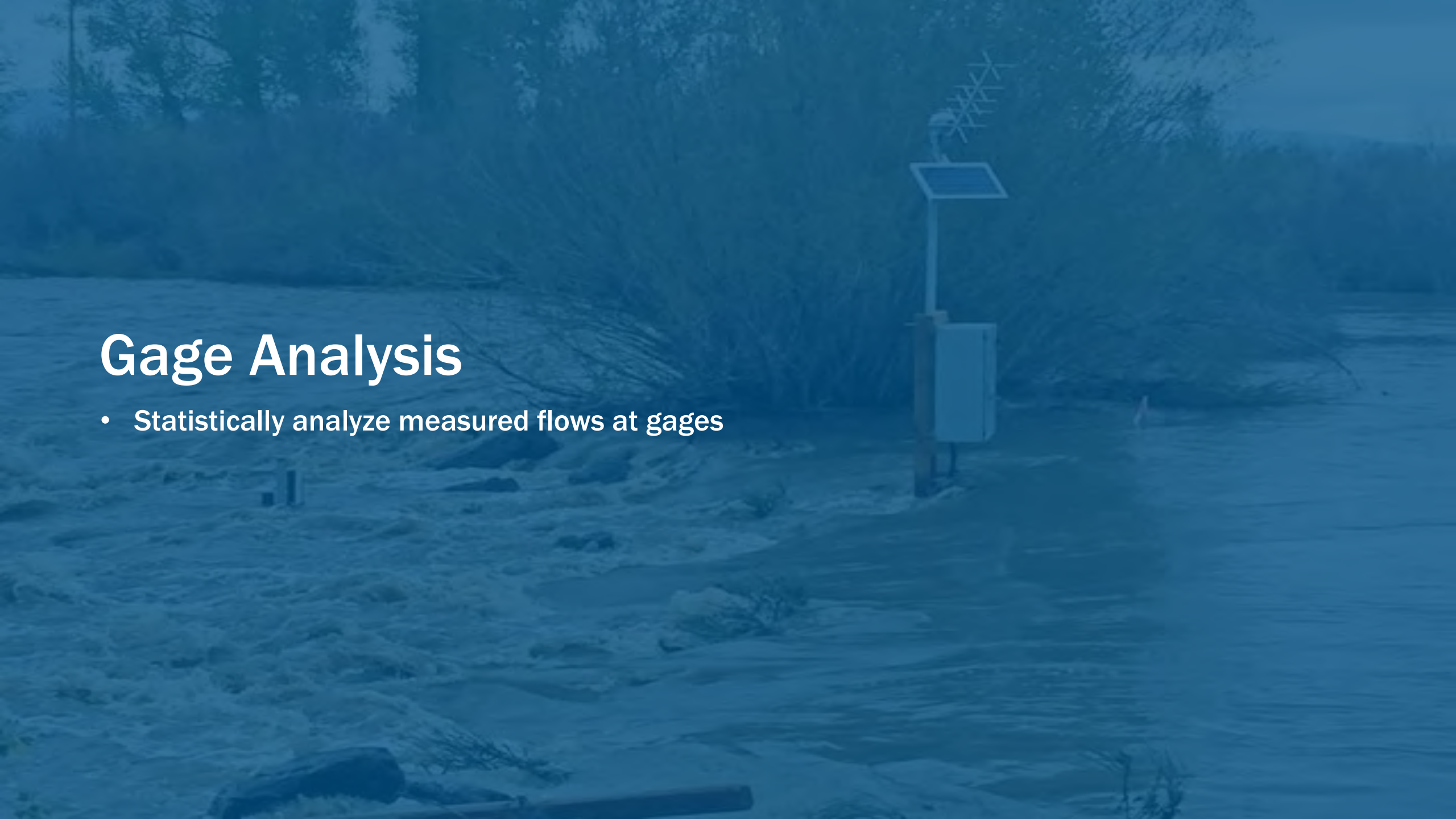


Gage Analysis

- Statistically analyze measured flows at gages

Hydrology – Gage Analysis

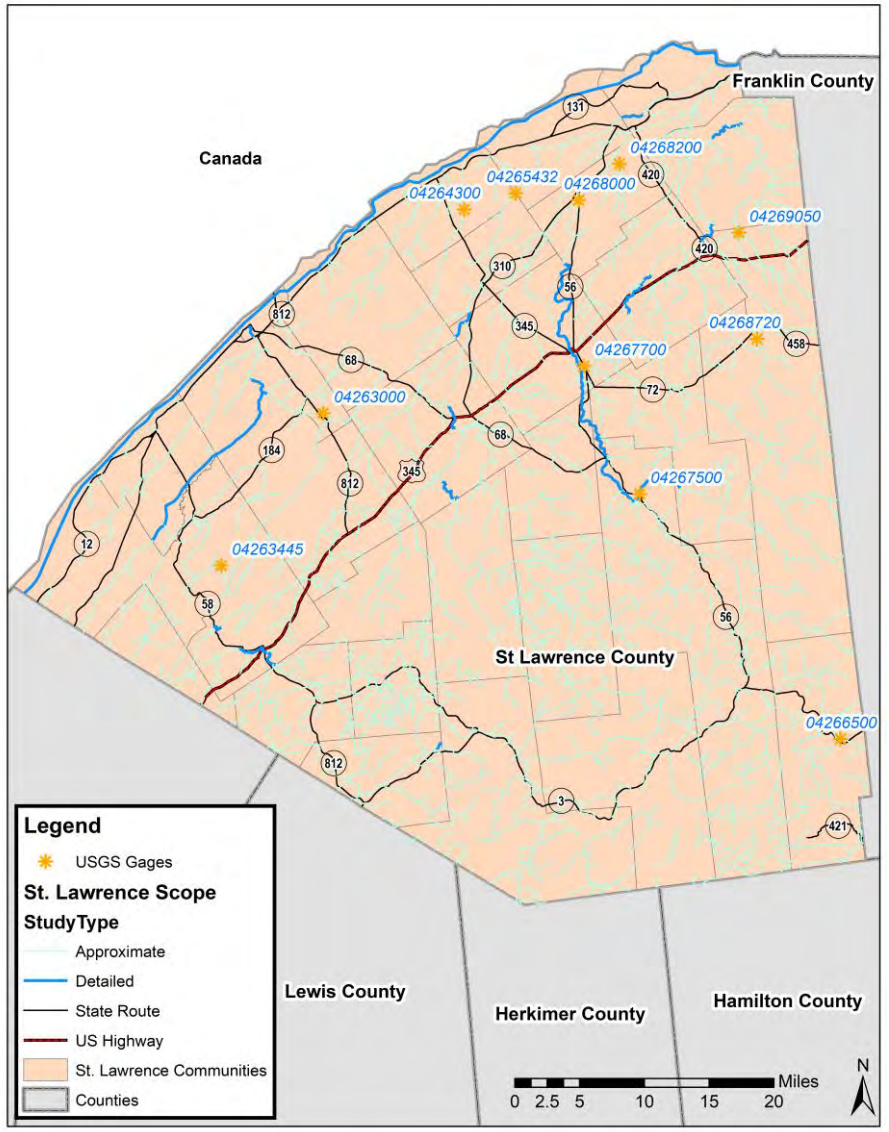
Flooding Source and Location	Drainage Area (Square Miles)	Number of Annual Peaks	Period of Record	1-percent-annual-chance Q (cfs)	
				Regression	Updated Estimates
Brandy Brook near Waddington, NY (04264300)	27	23	1959-1986[3]	1,490	1,477 (1169-2090)
Oswegatchie river near Heuvelton, NY(04263000)	986	103	1917-2019	18700	18410 (17230-20100)
Grass river at Chase Mills NY (04265432)	598	16	2004-2019	NA	14270 (12520-17360)
Raquette River at Piercefield, NY (04266500)	721	111	1900-2019	NA	9639 (9122-10186)
Raquette River at South Colton, NY (04267500)	941	50	1953-2002	NA	11230 (10433-12088)
Parkhurst Brook near Potsdam, NY (04267700)	17.2	19	1959-1977		1290 (1049-586)
Raquette River at Raymondville, NY (04268000)	1130	77	1944-2019	13900	13990 (12957-15106)
Plum Brook Near Grantville, NY (04268200)	42.8	59	1959-2019[3]	NA	1878 (1651-2137)
Hopkinton Brook at Hopkinton, NY (04268720)	20.0	23	1962,1965-1969, 1971-1986[3]	1520	1097 (953.2 – 1347)
Allen Brook near Brasher falls, NY (04269050)	16.00	25	1962-1986	1250	1710 (1416 – 2233)
Birch Creek at Pierces Corners, NY (04263445)	1.67	11	1976-1986[3]	117	122.5 (102.1 – 163.8)

Flow gage analysis performed in support of regression analysis

Viable gage = minimum 10 years current record

Bulletin 17C methodology

Hydrology – Gage Analysis



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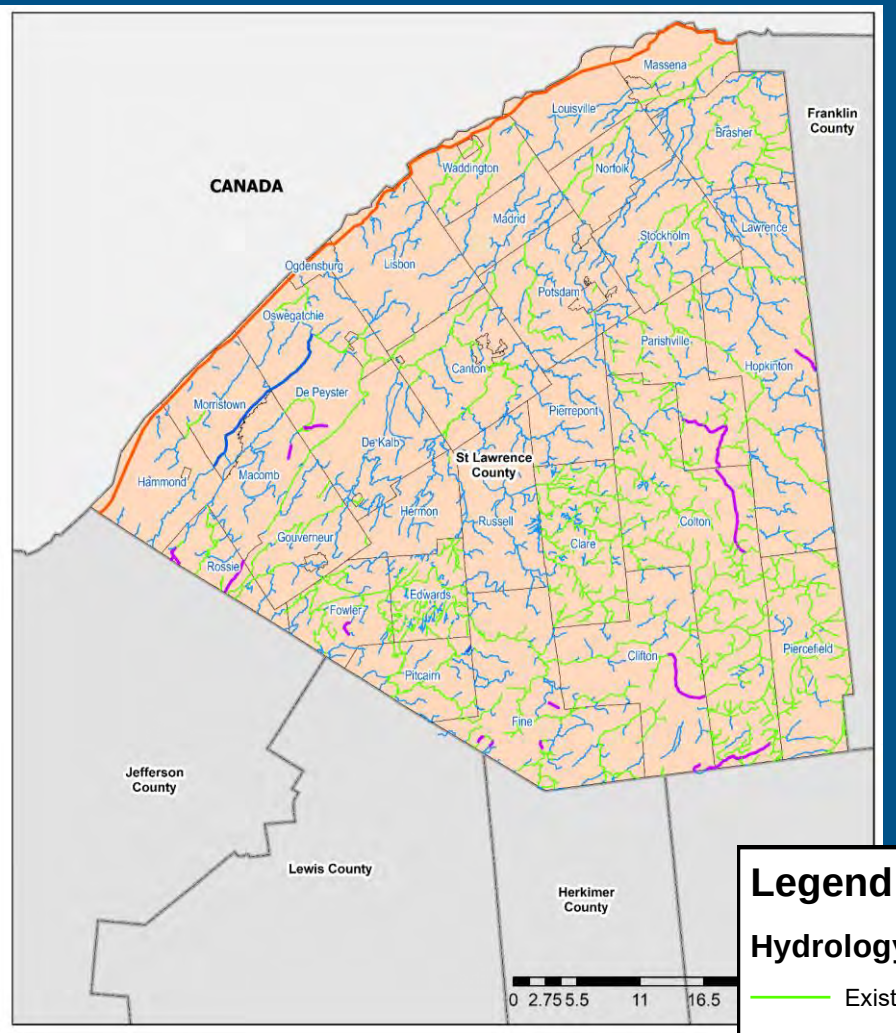
Regression Analysis

- USGS Stream Stats Discharges
- Relationships between peak flows and watershed characteristics
- Regional Regression Equations
- Gage Weighting
- Urban Regression Equations

Hydrology – Regression Analysis

- Regression Analysis = St. Lawrence (1289 miles)
  - 59.2 miles of Detailed streams (AE Zone)
  - 1230.2 miles of Approximate streams (A Zone)
  - Approximate mileages – exact mileages will be reported during Hydraulics Meeting



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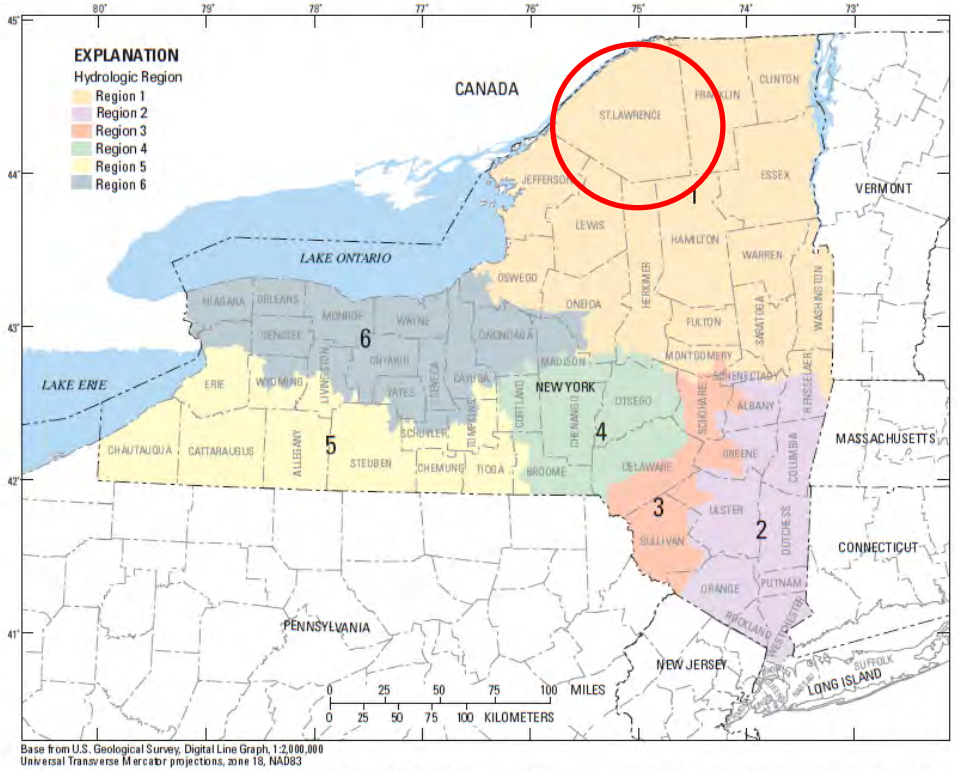
Hydrology – Regression Analysis

- USGS New York regression equations
  - SIR 2006-5112
- Study area falls within USGS NY regression Region 1
- USGS StreamStats v5.02 p7
- Primary method for Zone A streams



Base from U.S. Geological Survey, Digital Line Graph, 1:2,000,000
Universal Transverse Mercator projections, zone 18, NAD83

Figure 2. Six hydrologic regions of New York and locations of 388 streamflow-gaging stations represented in this study. (Map numbers refer to streamflow-gaging stations shown in tables 7 and 8.)

Summary of Regression Equations

Factors Considered

- Drainage area (square miles)
- Basin storage (percentage of total drainage area)
- Mean annual precipitation (inches per year)
- Lag factor (Main-channel stream length, in miles)
  - Slope of lower half of main channel (feet/mile)
  - Slope of upper half of main channel (feet/mile)
- Basin forested area (% total area)

Summary of Gage Weighting Streams with Regression Discharges

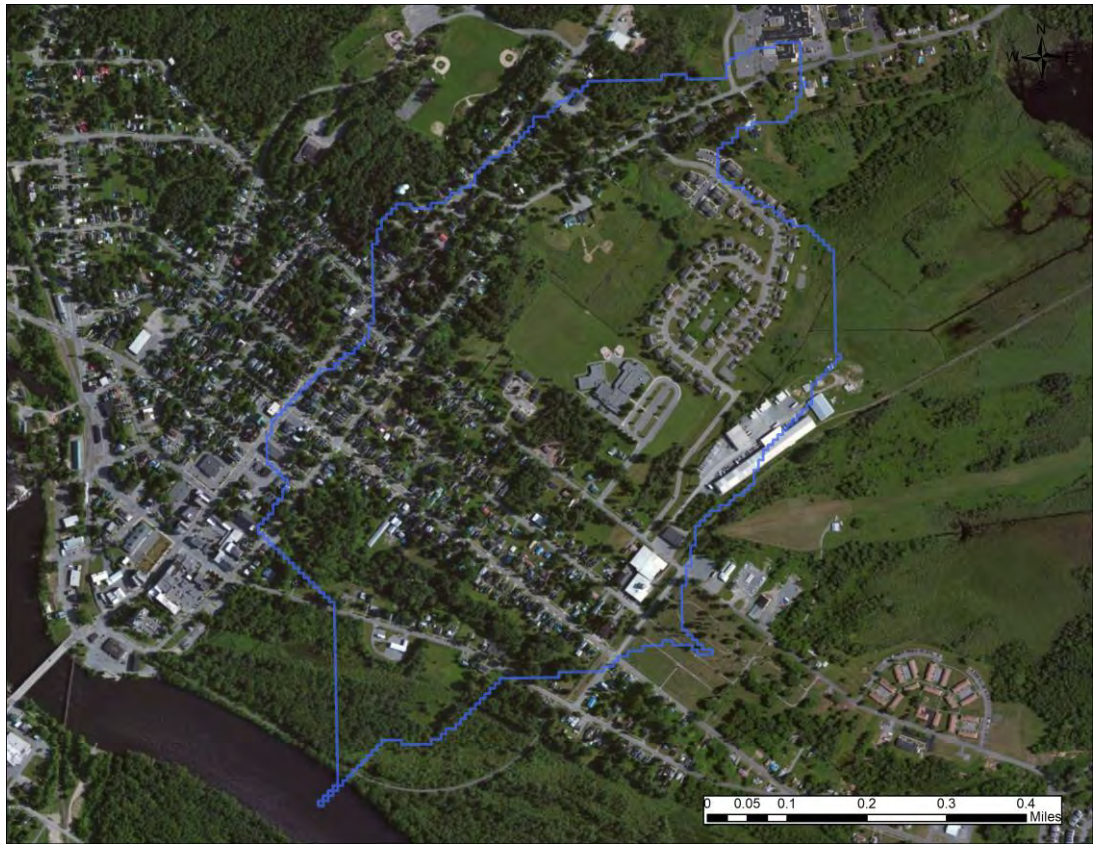
- Gaged Sites
  - Log Pearson Type III, Bulletin 17C analysis to determine the discharges
  - Regulated rivers - Discharges from the Bulletin 17C analysis
  - Unregulated rivers – Discharges from the Bulletin 17C analysis are weighted with those from regression equations.

Example stream gage. Source: USGS/ Robert Swanson

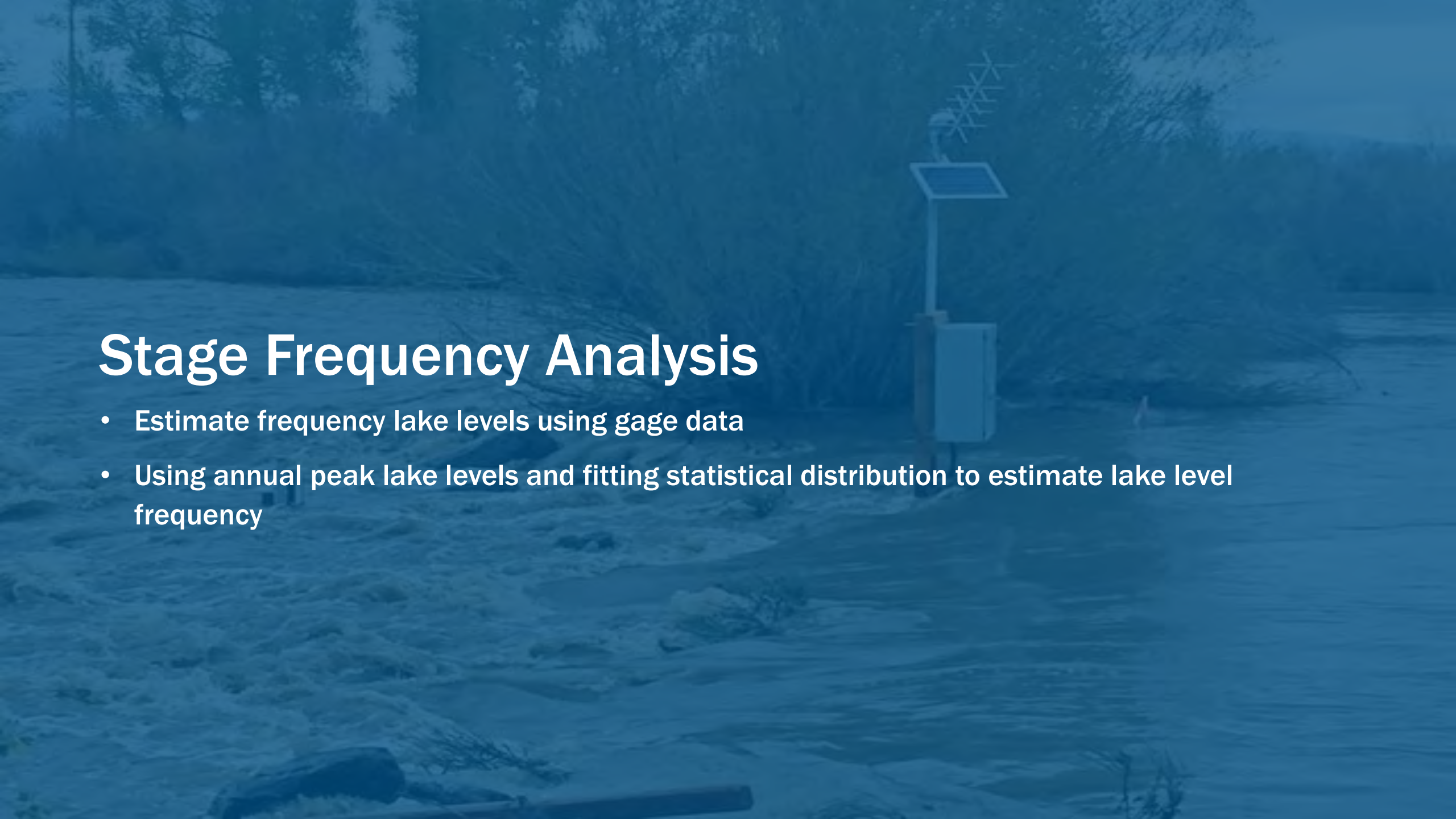
Summary of Gage Weighting Streams with Regression Discharges

- Ungaged Sites on Gaged Streams
  - For unregulated streams, the gage discharge is weighted with the regression discharge.
    - Performed at all the flow change locations within 50% to 150% of the gage drainage area
  - For regulated streams, the gage discharge is transferred to other flow change locations using the drainage area ratio of the gage and the ungaged site.

Urban Adjustment



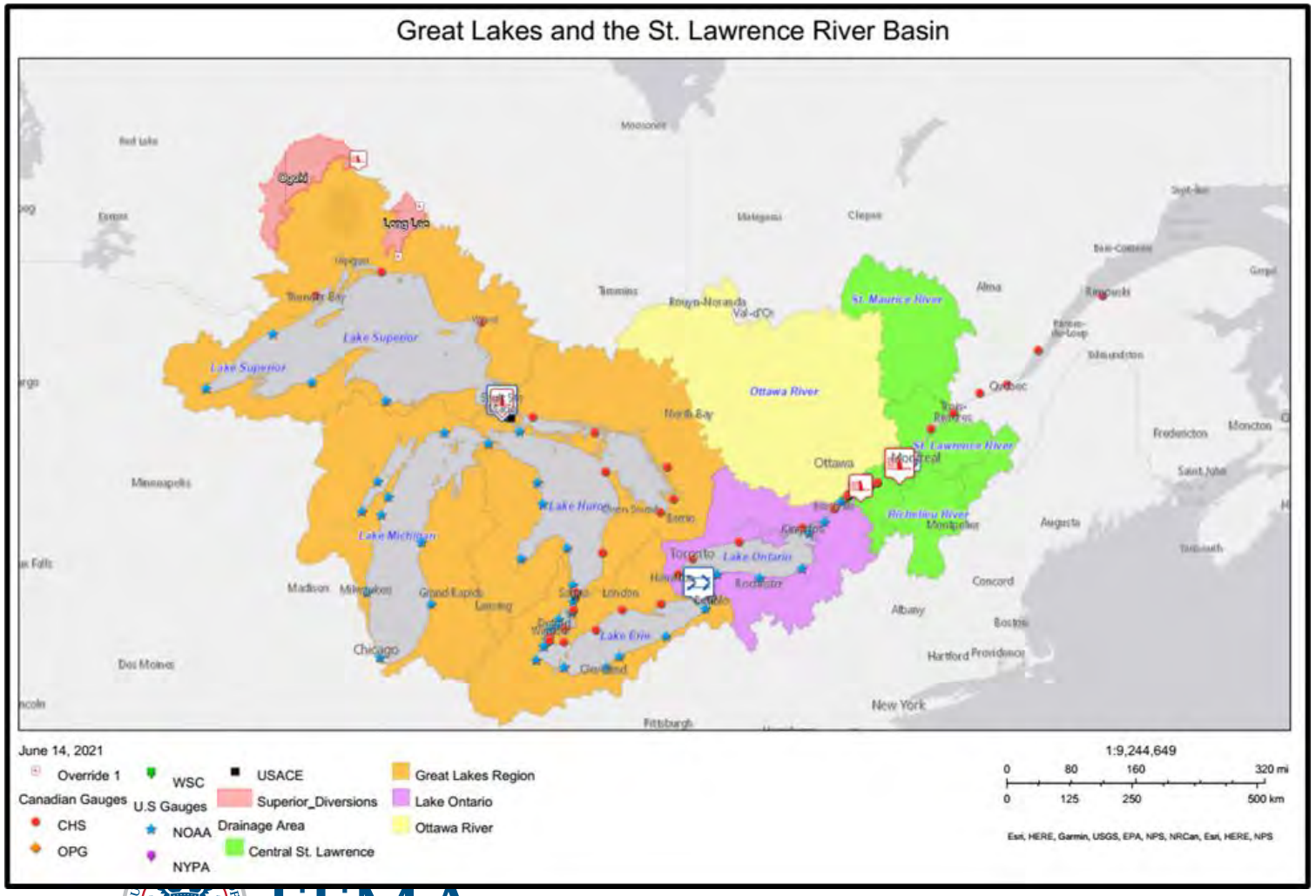
- Base regression equations not applicable to urban areas
- Peak flows adjusted for basins with >15% urban land use (from NLCD layer) based on USGS WSP 2207 (1983)
- Affected Detailed Reaches:
  - None
- Affected Approximate Reaches:
  - Only one stream



Stage Frequency Analysis

- Estimate frequency lake levels using gage data
- Using annual peak lake levels and fitting statistical distribution to estimate lake level frequency

St. Lawrence River



- Entire Segment of the River within the county
- Exceptionally Large Drainage Area (298,000 square miles at Massena, NY)
- Includes All Great Lakes
- Gages – NOAA and Fisheries and Oceans Canada (DFO)
- Scope – analyze historic water level data to estimate BFEs

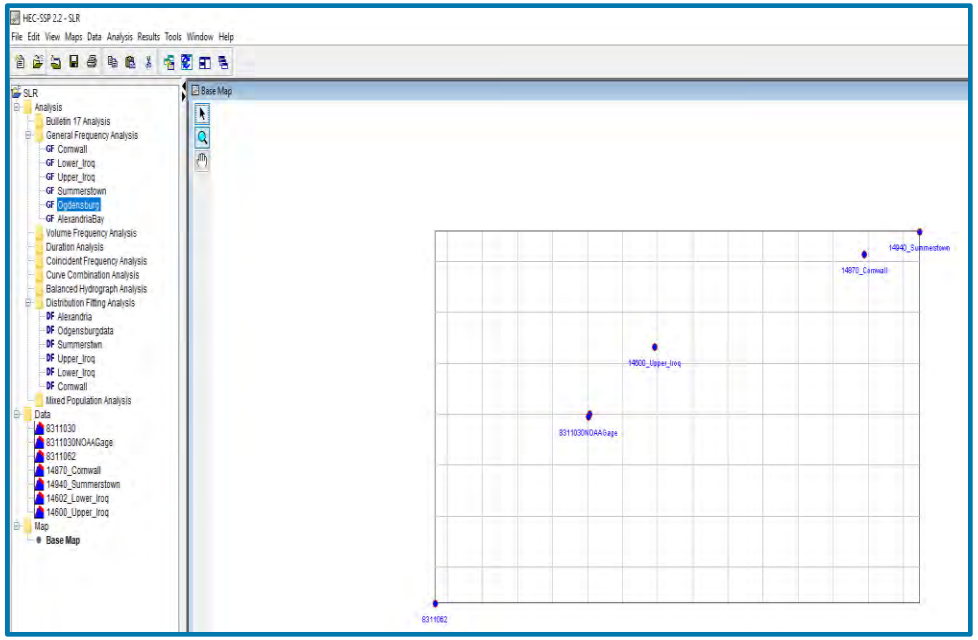
St. Lawrence River – Stage Analysis

Location	Data Availability	Source
Alexandria Bay, NY	1983 - 2020	NOAA ✓
Ogdensburg, NY	1934 - 2020	NOAA ✓
Upper Iroquois, ON	1961 - 2020	DFO ✓
Lower Iroquois, ON	1961 - 2020	DFO ✓
Cornwall, ON	1961 – 2020	DFO ✓
Summerstown, ON	1962 - 2020	DFO ✓
Long Sault, ON	1962 - 2000	DFO
Prescott, ON	1962 - 1976	DFO
Brockville, ON	1980 - 2020	DFO

- 2 NOAA gages and 4 DFO's utilized
- Data past 1959 utilized (After Moses Saunders Dam)
- Annual maximum WSELs extracted from daily records

St. Lawrence River – Stage Analysis

- HEC-SSP Computer Program

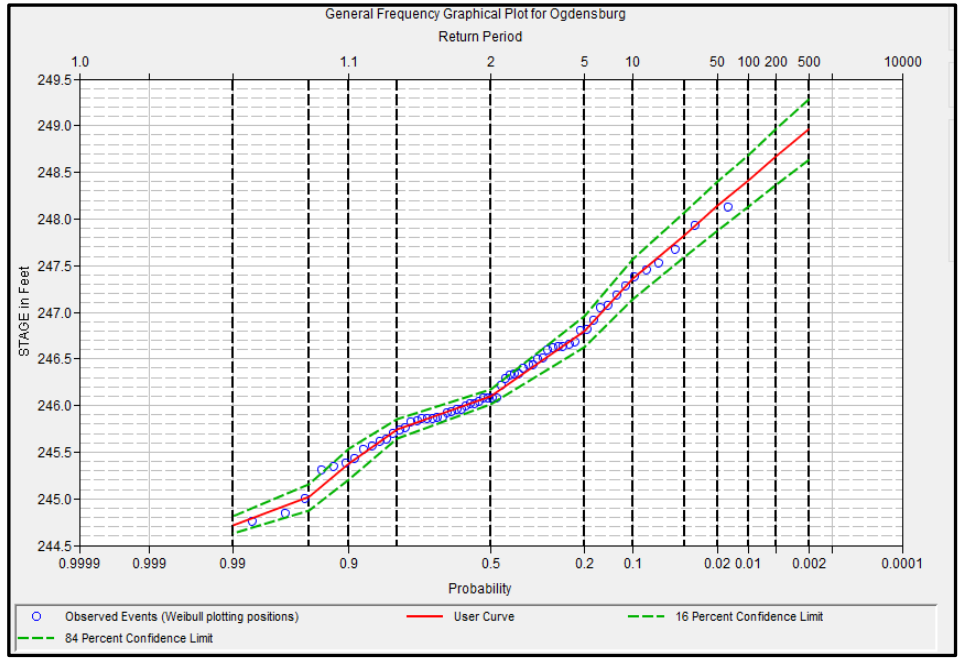


- Stage Frequency Analysis was done using HEC-SSP
- Weibull Statistical Distribution was used for analysis
- Two Types of Statistical Analyses
  - Distribution Fitting
  - Graphical Fitting
- Test Statistics Reviewed for Picking Distributions

Komogorov-Smirnov Test Statistic					
Alexandria Bay, NY	Ogdensburg, NY	Upper Iroquois, ON	Lower Iroquois, ON	Cornwall, ON	Summerstown, ON
0.116	0.075	0.061	0.059	0.091	0.089

St. Lawrence River – Stage Analysis

- HEC-SSP Computer Program



- Final Selection Combination of
  - Distribution Fitting &
  - Graphical Fitting

Gage Location	Number of Annual Peaks	Period of Record	Water Surface Elevation (Feet, IGLD85)				
			10-Percent AEP	4-Percent AEP	2-Percent AEP	1-Percent AEP	0.2-Percent AEP
Alexandria Bay, NY	38	1983-2020	247.60	248.22	248.65	249.02	249.77
Ogdensburg, NY	62	1959-2020	247.36	247.83	248.14	248.41	248.96
Upper Iroquois, ON	59	1962-2020	245.30	246.18	246.56	246.84	247.44
Lower Iroquois, ON	59	1962-2020	244.37	244.69	244.83	244.96	245.22
Cornwall, ON	59	1962-2020	156.13	156.40	156.56	156.69	156.94
Summerstown, ON	59	1962-2020	154.50	154.57	154.65	154.72	154.87

St. Lawrence River – Stage Analysis

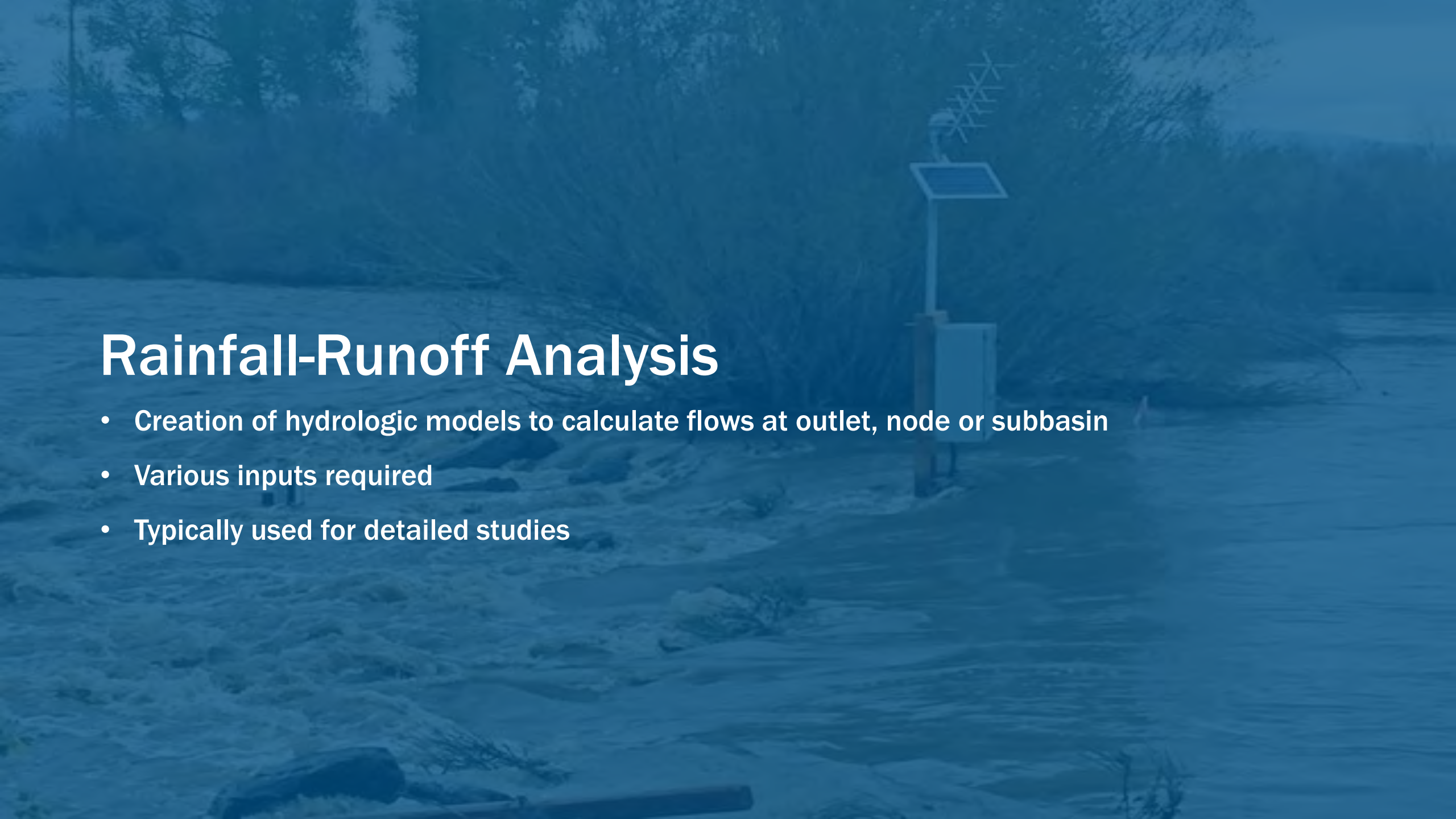
Comparisons to Other Studies and Recent Events

- Effective Study is Zone A
- Several LOMA's have used USACE, Phase II Revised Report on Great Lakes Open-Coast Flood Elevation, April 1988, Detroit, MI.

Gage Location	Number of Annual Peaks	Period of Record	1-Percent AEP Water Surface Elevation (Feet, NGVD29)		Difference (Feet)
			HEC-SSP	1988 Report	
Ogdensburg, NY	62	1959-2020	248.83	248.55	0.28

- Recent Events

Year	Observed WSE at Ogdensburg, NY, Ft, IGLD 85	HEC-SSP, 1-Perecnt-Annual-Chance, Ft, IGLD 85
2017	247.92	248.41
2018	247.04	
2019	248.12	
2020	247.28	



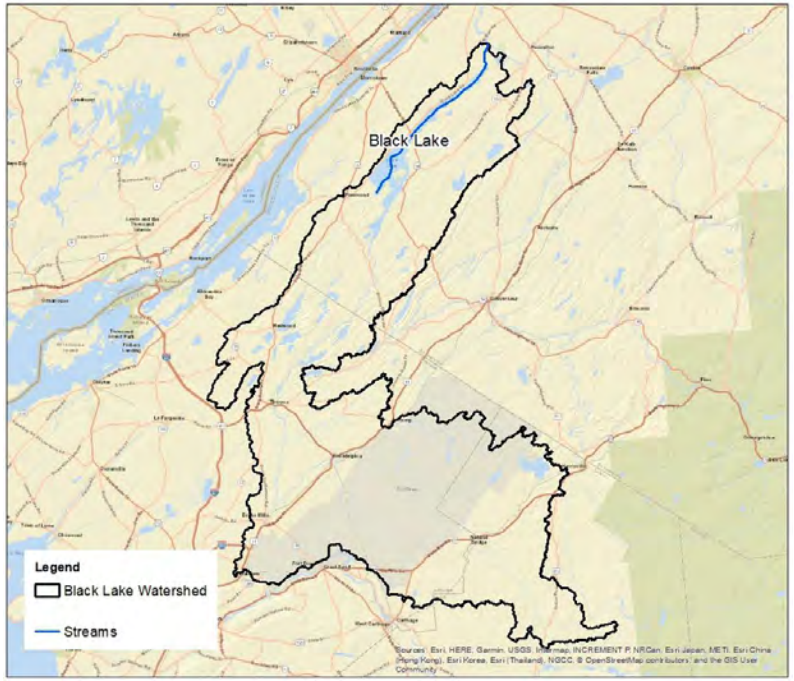
Rainfall-Runoff Analysis

- Creation of hydrologic models to calculate flows at outlet, node or subbasin
- Various inputs required
- Typically used for detailed studies

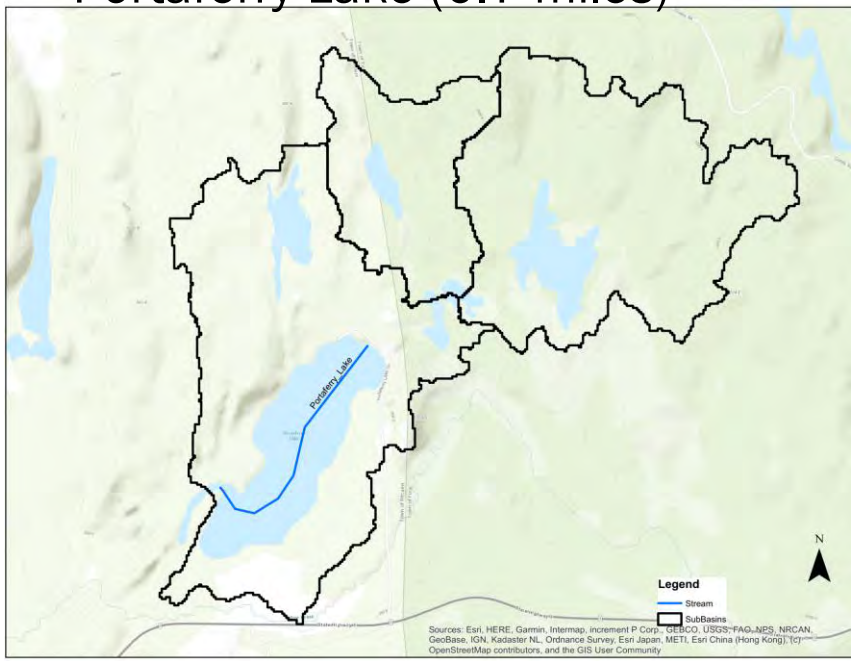
Hydrology – Rainfall-Runoff Modeling

- Total 2 streams of 16 miles studied

- Streams located within Black Lake watershed
- Black Lake (15.3 miles)



- Streams located in Portaferry Lake watershed
- Portaferry Lake (0.7 miles)

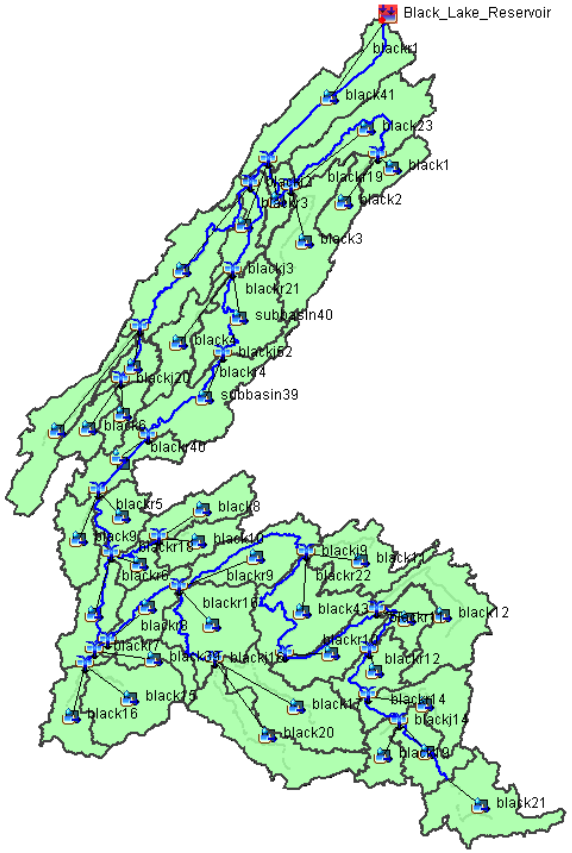


Rainfall-Runoff Methodology

- HEC-HMS 4.8 was used
- Rainfall Depths: NOAA Atlas 14 Precipitation Frequency Data Server, 24-hour duration.
- Frequency Storm temporal distribution
- Loss Methodology: SCS Curve Number (TR-55), with average antecedent runoff condition
- Hydrograph Methodology: SCS Unit Hydrograph
  - Lag Time (Basin Lag method used for Black Lake Watershed, NRCS method and 60% of Time of Concentration used for Portaferry Lake Watershed)
- Channel Routing: Combination of Muskingum-Cunge using 8-point cross-sections and Modified Puls used for Black Lake Watershed.
  - No Routing used in Portaferry Model as the watershed is very small and the contributing subbasins flow directly into lake.

Rainfall-Runoff Methodology

Black Lake HEC-HMS Model
- 1 studied stream
- 40 subbasins modeled



Portaferry Lake HEC-HMS Model
- 1 studied stream
- 3 subbasins modeled

NOAA Atlas 14 Rainfall Data

- NOAA Atlas 14 Rainfall Data:

NOAA Atlas 14, Volume 10, Version 3
Location name: Theresa, New York, USA*
Latitude: 44.2167°, Longitude: -75.8°
Elevation: 385.42 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

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

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

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

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.298 (0.226-0.381)	0.363 (0.275-0.464)	0.469 (0.355-0.601)	0.558 (0.419-0.718)	0.679 (0.499-0.908)	0.769 (0.556-1.05)	0.866 (0.614-1.22)	0.984 (0.657-1.39)	1.16 (0.750-1.69)	1.32 (0.833-1.95)
10-min	0.422 (0.321-0.539)	0.514 (0.390-0.657)	0.665 (0.503-0.851)	0.790 (0.594-1.02)	0.962 (0.706-1.29)	1.09 (0.787-1.49)	1.23 (0.869-1.73)	1.39 (0.929-1.97)	1.65 (1.06-2.40)	1.87 (1.18-2.76)
15-min	0.497 (0.377-0.634)	0.605 (0.459-0.773)	0.782 (0.592-1.00)	0.929 (0.699-1.20)	1.13 (0.831-1.51)	1.28 (0.927-1.75)	1.44 (1.02-2.04)	1.64 (1.10-2.32)	1.94 (1.25-2.82)	2.19 (1.39-3.24)
30-min	0.662 (0.503-0.845)	0.809 (0.614-1.03)	1.05 (0.794-1.34)	1.25 (0.940-1.61)	1.52 (1.12-2.04)	1.73 (1.25-2.35)	1.95 (1.38-2.75)	2.21 (1.48-3.13)	2.62 (1.69-3.81)	2.96 (1.87-4.37)
60-min	0.827 (0.628-1.06)	1.01 (0.769-1.29)	1.32 (0.996-1.69)	1.57 (1.18-2.02)	1.92 (1.41-2.56)	2.17 (1.57-2.96)	2.45 (1.74-3.46)	2.79 (1.86-3.95)	3.29 (2.13-4.79)	3.73 (2.36-5.51)
2-hr	1.04 (0.795-1.32)	1.28 (0.976-1.62)	1.67 (1.27-2.12)	1.99 (1.51-2.54)	2.43 (1.80-3.23)	2.76 (2.01-3.73)	3.12 (2.23-4.36)	3.55 (2.39-4.97)	4.21 (2.74-6.05)	4.77 (3.05-6.96)
3-hr	1.18 (0.908-1.49)	1.45 (1.11-1.83)	1.89 (1.44-2.39)	2.25 (1.71-2.86)	2.75 (2.04-3.63)	3.11 (2.28-4.19)	3.51 (2.52-4.88)	4.00 (2.71-5.56)	4.73 (3.10-6.75)	5.36 (3.45-7.76)
6-hr	1.46 (1.13-1.83)	1.77 (1.37-2.22)	2.27 (1.75-2.86)	2.69 (2.06-3.40)	3.27 (2.44-4.27)	3.70 (2.72-4.91)	4.16 (3.00-5.69)	4.70 (3.21-6.46)	5.51 (3.65-7.77)	6.20 (4.03-8.86)
12-hr	1.78 (1.38-2.21)	2.11 (1.64-2.63)	2.66 (2.06-3.32)	3.11 (2.40-3.90)	3.74 (2.81-4.83)	4.21 (3.11-5.51)	4.70 (3.40-6.33)	5.26 (3.63-7.15)	6.06 (4.06-8.43)	6.72 (4.41-9.48)
24-hr	2.08 (1.63-2.57)	2.42 (1.90-3.00)	2.99 (2.33-3.71)	3.46 (2.69-4.31)	4.11 (3.11-5.26)	4.60 (3.43-5.96)	5.11 (3.72-6.77)	5.67 (3.95-7.61)	6.45 (4.36-8.86)	7.07 (4.69-9.85)

Data from Theresa, NY was used for the Black Lake watershed

NOAA Atlas 14 Rainfall Data

- NOAA Atlas 14 Rainfall Data:

NOAA Atlas 14, Volume 10, Version 3
Location name: Theresa, New York, USA*
Latitude: 44.2167°, Longitude: -75.8°
Elevation: 385.42 ft**
* source: ESRI Maps
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POINT PRECIPITATION FREQUENCY ESTIMATES

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NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.268 (0.214-0.331)	0.338 (0.270-0.419)	0.453 (0.362-0.563)	0.550 (0.435-0.686)	0.682 (0.521-0.891)	0.780 (0.583-1.04)	0.886 (0.643-1.23)	1.01 (0.685-1.41)	1.20 (0.777-1.73)	1.36 (0.858-1.99)
10-min	0.379 (0.303-0.469)	0.479 (0.383-0.594)	0.643 (0.512-0.799)	0.780 (0.617-0.974)	0.967 (0.738-1.26)	1.11 (0.827-1.48)	1.25 (0.911-1.74)	1.43 (0.970-2.00)	1.70 (1.10-2.45)	1.92 (1.22-2.82)
15-min	0.446 (0.357-0.552)	0.564 (0.451-0.699)	0.757 (0.603-0.941)	0.917 (0.726-1.15)	1.14 (0.869-1.49)	1.30 (0.973-1.74)	1.48 (1.07-2.05)	1.69 (1.14-2.36)	2.00 (1.30-2.88)	2.26 (1.43-3.32)
30-min	0.600 (0.480-0.742)	0.762 (0.610-0.945)	1.03 (0.818-1.28)	1.25 (0.989-1.56)	1.55 (1.19-2.03)	1.78 (1.33-2.37)	2.02 (1.47-2.80)	2.31 (1.56-3.23)	2.73 (1.78-3.94)	3.09 (1.96-4.54)
60-min	0.753 (0.603-0.932)	0.961 (0.768-1.19)	1.30 (1.04-1.62)	1.58 (1.25-1.98)	1.97 (1.51-2.57)	2.26 (1.69-3.01)	2.57 (1.86-3.55)	2.93 (1.99-4.10)	3.47 (2.26-5.01)	3.93 (2.49-5.77)
2-hr	0.964 (0.777-1.19)	1.22 (0.978-1.50)	1.63 (1.31-2.01)	1.97 (1.57-2.44)	2.44 (1.88-3.17)	2.79 (2.11-3.70)	3.16 (2.33-4.36)	3.62 (2.48-5.01)	4.32 (2.84-6.17)	4.92 (3.16-7.14)
3-hr	1.11 (0.896-1.36)	1.38 (1.12-1.70)	1.83 (1.47-2.25)	2.20 (1.76-2.72)	2.72 (2.11-3.51)	3.09 (2.35-4.08)	3.51 (2.60-4.81)	4.01 (2.77-5.52)	4.78 (3.17-6.78)	5.45 (3.52-7.85)
6-hr	1.40 (1.14-1.70)	1.70 (1.38-2.07)	2.19 (1.78-2.68)	2.61 (2.10-3.20)	3.18 (2.48-4.06)	3.60 (2.75-4.69)	4.05 (3.02-5.48)	4.60 (3.21-6.26)	5.44 (3.65-7.62)	6.16 (4.03-8.76)
12-hr	1.73 (1.42-2.09)	2.05 (1.68-2.48)	2.57 (2.10-3.12)	3.01 (2.44-3.66)	3.60 (2.83-4.55)	4.05 (3.12-5.21)	4.52 (3.39-6.01)	5.07 (3.58-6.82)	5.87 (3.99-8.12)	6.53 (4.33-9.18)
24-hr	2.09 (1.73-2.51)	2.42 (2.00-2.91)	2.96 (2.43-3.56)	3.40 (2.78-4.11)	4.01 (3.17-5.01)	4.48 (3.47-5.68)	4.96 (3.72-6.46)	5.47 (3.92-7.28)	6.19 (4.27-8.46)	6.77 (4.55-9.40)

Data from South Edwards 1E, NY was used for Portaferry Watershed

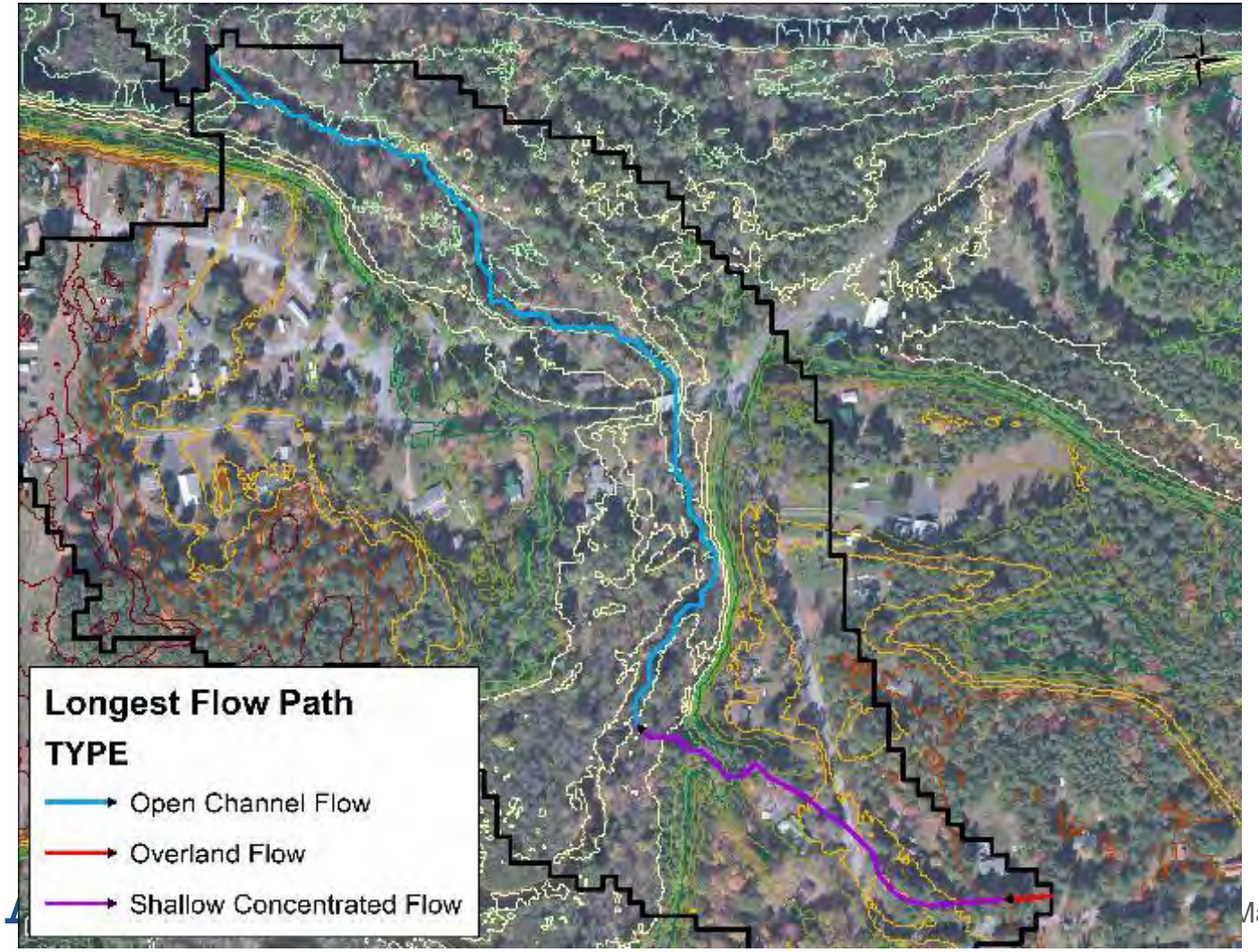
Rainfall-Runoff Modeling – SCS Curve Numbers

- Soil Data from USGS SSURGO database
- Land use data from 2016 National Land Use Database (NLCD)
- Composite CN calculated for each sub-basin (TR-55 Methodology)
- Land use compared to recent aerial imagery to confirm

Rainfall-Runoff Modeling – Time of Concentration (Tc) / Lag Time

- Longest flow path = longest time that a drop of water would take to travel through a watershed
  - Developed from USGS topography and HEC-HMS tools
- Black Lake Watershed utilized Basin Lag Method to calculate lag time directly
  - Uses inputs calculated in HEC-HMS (flow length, average watershed land slope, and maximum potential retention)
- Portaferry Lake Watershed utilized NRCS method to calculate time of concentration
  - Flow paths split into different types:
    - Sheet flow maximum = 100 ft
    - Shallow concentrated flow: from end of sheet flow segment to visual open channel
    - Channel flow: begins at end of shallow concentrated flow segment and ends at sub-basin outlet
  - Lag times = 60% of Time of Concentration

Longest Flow Path Example



Model Validation / Results

- Check computed flows against regression estimates
- No effective FIS discharges or gage estimates to compare with

Streamstats comparison

Watershed	Location	Flow from Streamstats	Lower Confidence Limit	Upper Confidence Limit	Flow from HEC-HMS Model
Black Lake	At the Lake Outlet	8,640	Not Given	Not Given	6,784
Portaferry Lake	At the Lake Outlet	102	70.6	133.4	58.4

Rainfall-Runoff Modeling – Comparison to Effective Flows

- Study results:
  - Compare well with regression analysis for Black Lake
  - Slightly different from regression for Portaferry watershed.

Volumetric Calculations

- Small lakes with no outflows
- Runoff depths/volumes from rainfall
- NRCS TR-55

Hydrology – Rainfall-Runoff Modeling

- Total 6 lakes studied
  - **Hickory Lake**
  - **Lake Ozonia**
  - **Star Lake**
  - **Streeter Lake**
  - **Sylvia Lake**
  - **Yellow Lake**
- Calculations:
  - Used NOAA Atlas 14 Vol 10 rainfall depths (24 hr) at Theresa, NY (Station ID- 30-8455).
  - Runoff depth calculated using Curve Number
  - Runoff volume and water surface elevations were calculated

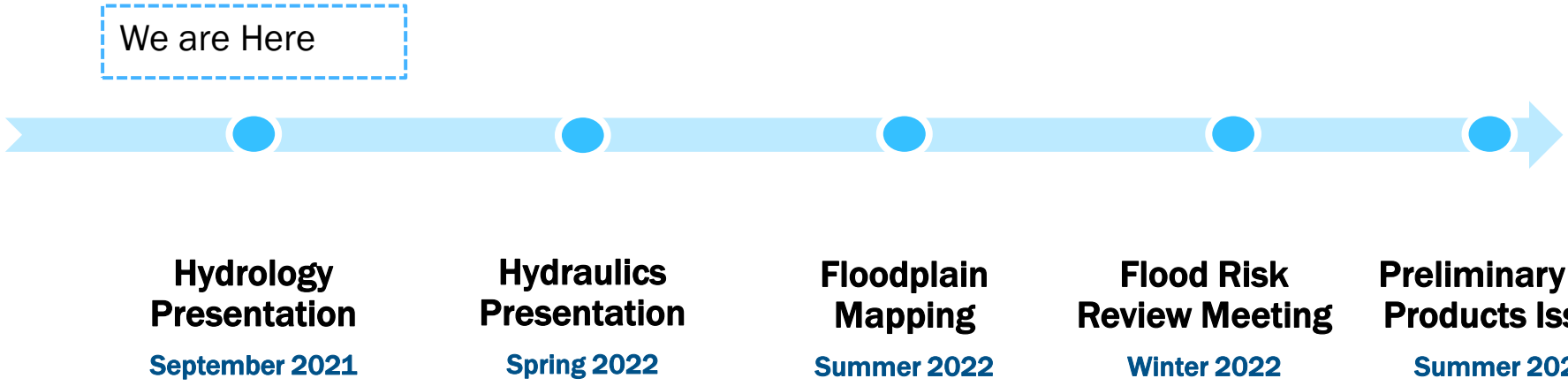
FEMA

St. Lawrence County Next Steps

St. Lawrence County County Next Steps

- Field reconnaissance
- Hydraulic analysis
  - Hydraulic modeling/report/submittal
  - Hydraulic analysis webinar
- Floodplain Mapping
- Flood Risk Review meeting
  - Comment period for communities

Project Timeline towards Preliminary Issuance



*Current timeline could be impacted by Flood Risk Review or Preliminary Map Comments

Graphic Above Not to Scale

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Thank you!

FEMA