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Flood Risk Project

Essex County, New York, Hydrology Meeting

April 28, 2021

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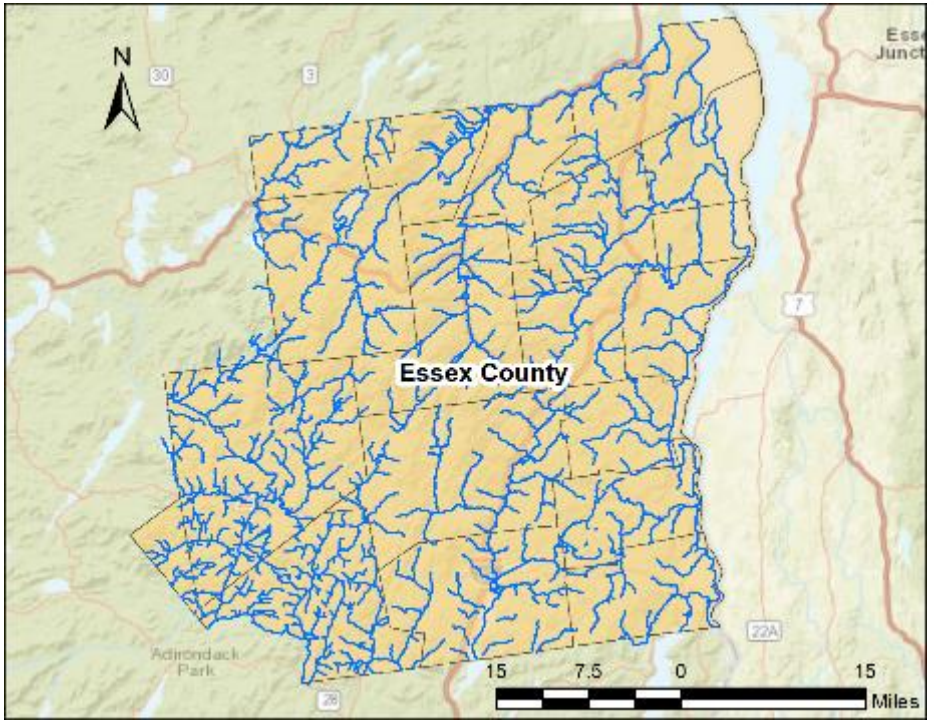


Agenda

Recap/Refresh

Hydrology Analysis Review

Path Forward

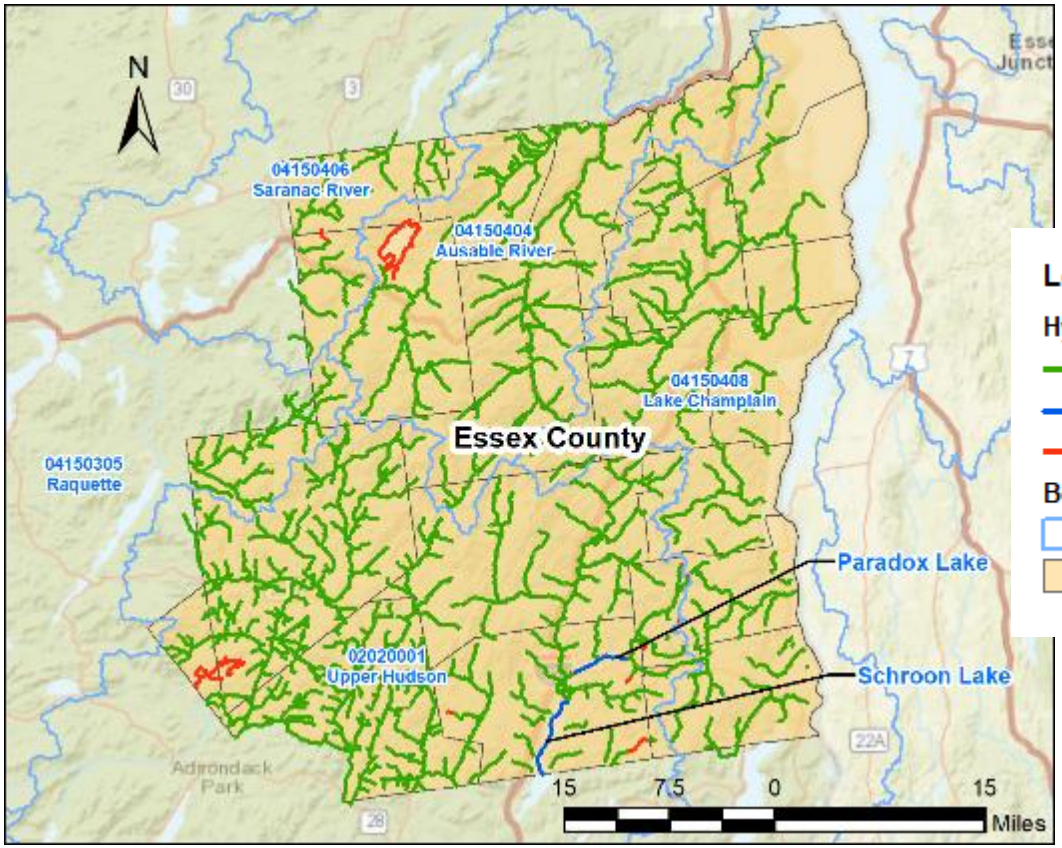
Project Recap

- **Two Discovery Meetings**
  - June 2016 for Lake Champlain watershed
  - July 2018 for Upper Hudson watershed, Ausable River watershed, and Saranac River watershed

- **This Study**
  - Kickoff meeting: Held online due to COVID19 – May 6, 2020
  - Engineering models notification to communities: August 14, 2020
  - Field survey: Spring 2020 – April 2021
  - Hydrologic analysis: April 2020 – Present

Project Scope

- **First time digital countywide maps**



- **Location and Study Streams**
  - 1,340 miles of regression analysis
  - 10 miles of rainfall-runoff modeling
  - 31 miles of volumetric calculations

Legend

Hydrologic Method

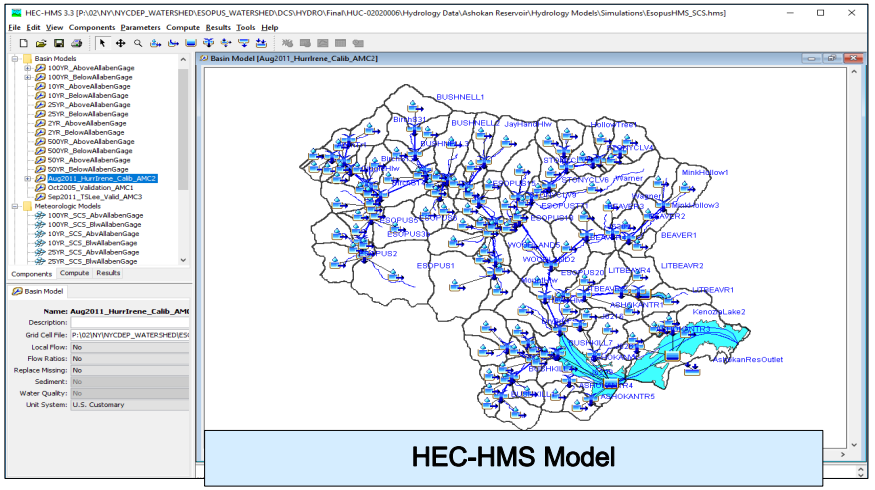
- USGS Regression Analysis / Gage Analysis
- Detailed Rainfall-Runoff Analysis in HEC-HMS
- Approximate Volumetric Calculations Assuming No Outflow

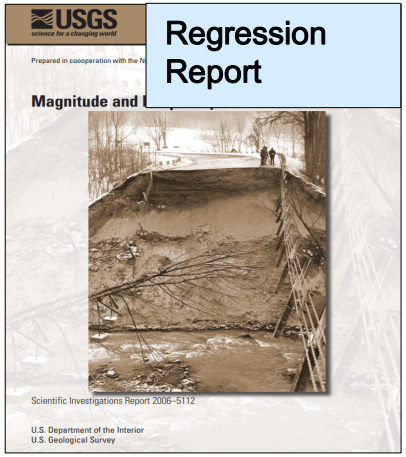
Boundaries

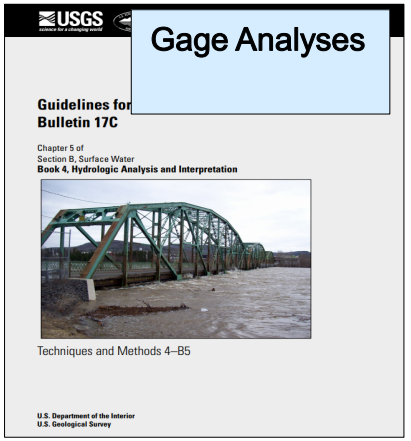
- HUC-8 Watershed Boundaries
- Essex County

Hydrologic Analysis Methods

- **Develop inputs for hydraulic analysis**
- **Discharges developed**
  - 10%, 4%, 2%, 1% (Base Flood), 0.2%
  - 1%+ and 1%-
- **Typical FEMA methods**
  - Regression analyses
    - Regional equations published by USGS
    - USGS StreamStats web application
  - Statistical gage analyses
    - Statistical analyses of flow/stage gage data
    - HEC-SSP Program
  - Rainfall runoff analyses
    - Physical modeling
    - USACE HEC-HMS program







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Regression Analysis

- **USGS StreamStats Database**
- **Relationships between peak flows and watershed characteristics**

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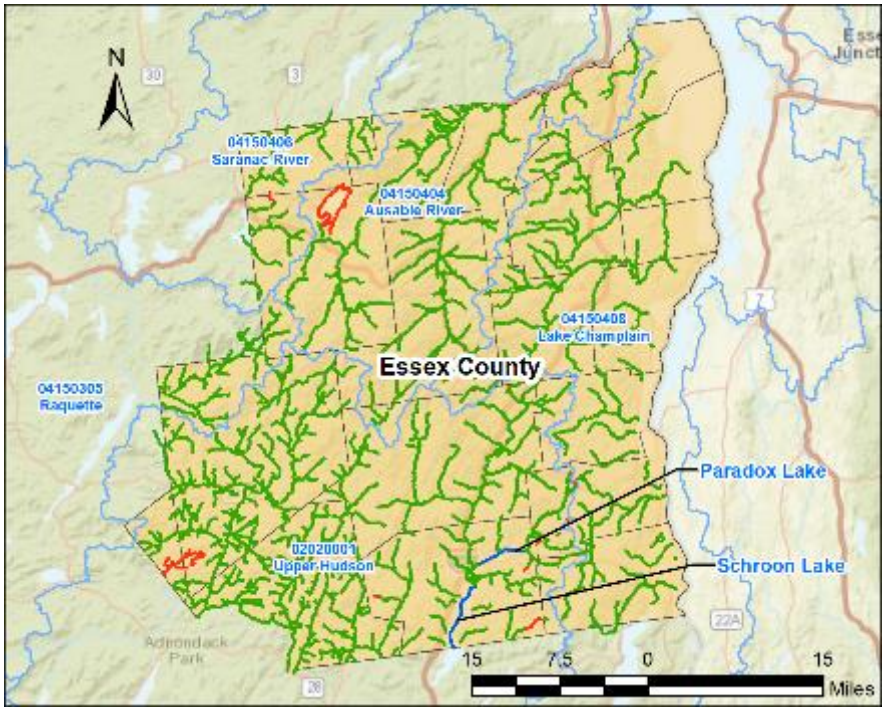
Hydrology – Regression Analysis

- Regression Analysis = Green (1,340 miles)



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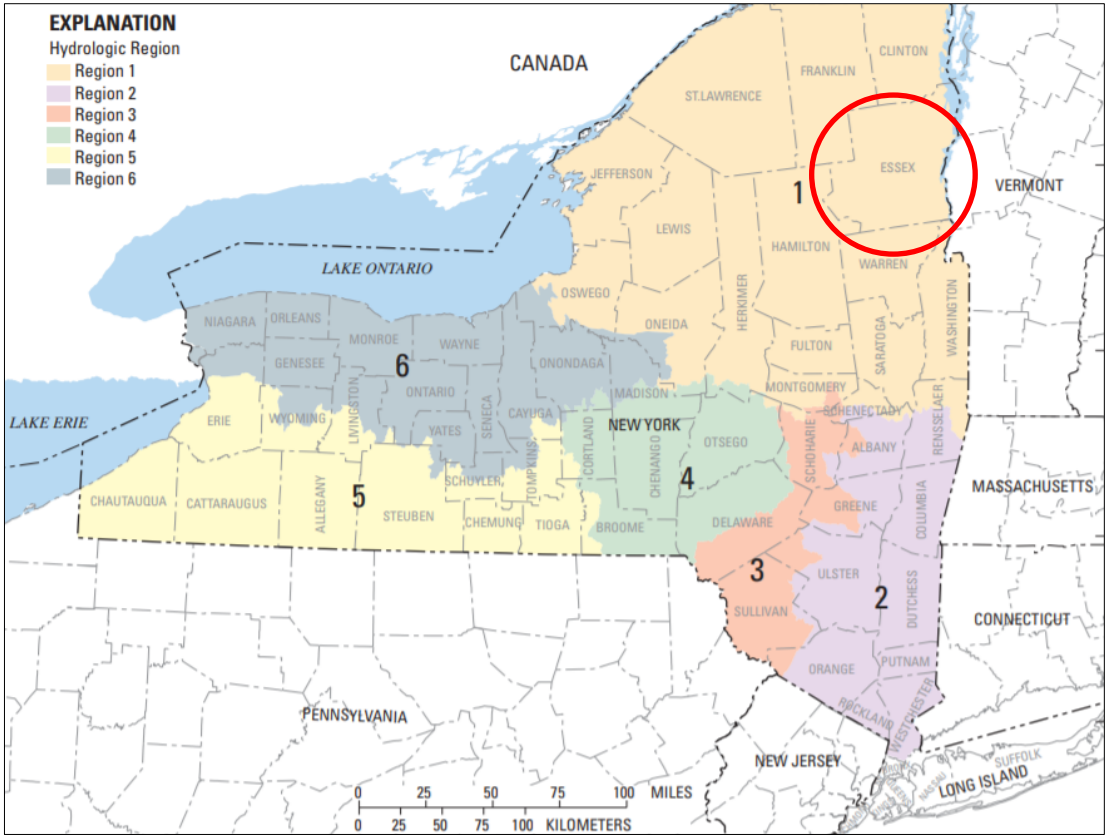
Regional Regression Equations and Analysis

- USGS New York regression equation: SIR 2006-5112
- Study area falls within USGS NY regression Region 1
- USGS StreamStats v 4.3.8 web application employed
- Primary method for Zone A and AE streams



Summary of Regression Equations

USGS NYS Hydrologic Region 1

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

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

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

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

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

where,

Q_x = peak flow for x-year storm event (cubic feet per second)

A = drainage area (square miles)

ST = storage, the percent of drainage area that is comprised of lakes, ponds, reservoirs and wetland (%)

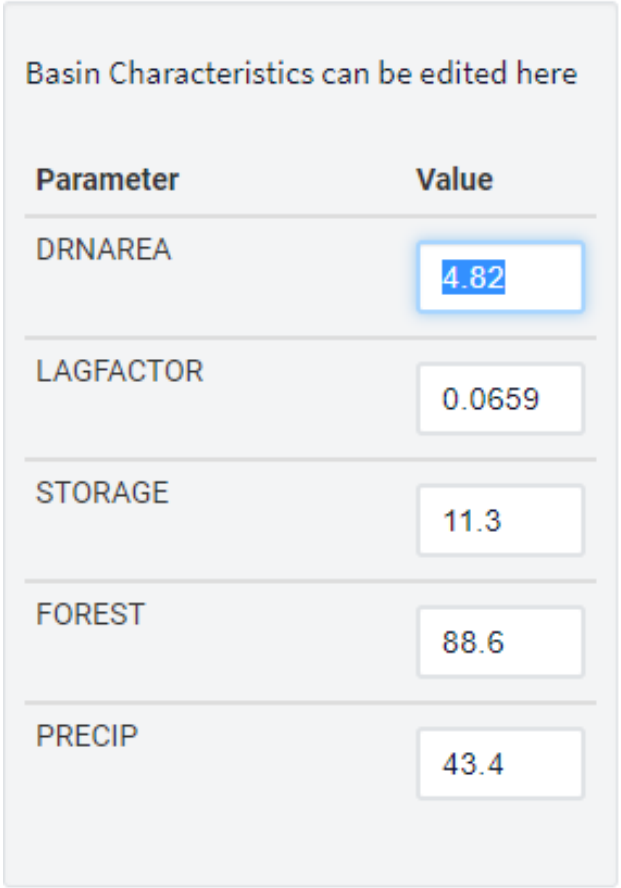
P = precipitation, the mean annual precipitation (in)

LAG = 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) (dimensionless)

FOR = forest, the percentage of the drainage area covered by forest (%)

Manual Basin Adjustments

- Reviewed StreamStats basin delineations against project DEM
- Adjusted basin boundaries as necessary within GIS
- StreamStats used to manually update drainage area parameter and re-compute flow results
  - Other parameters were assumed to be unchanged



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Rainfall-Runoff Analysis

- **Creation of hydrologic models to calculate lake elevations**
- **Various inputs required**
- **Typically used for detailed studies**

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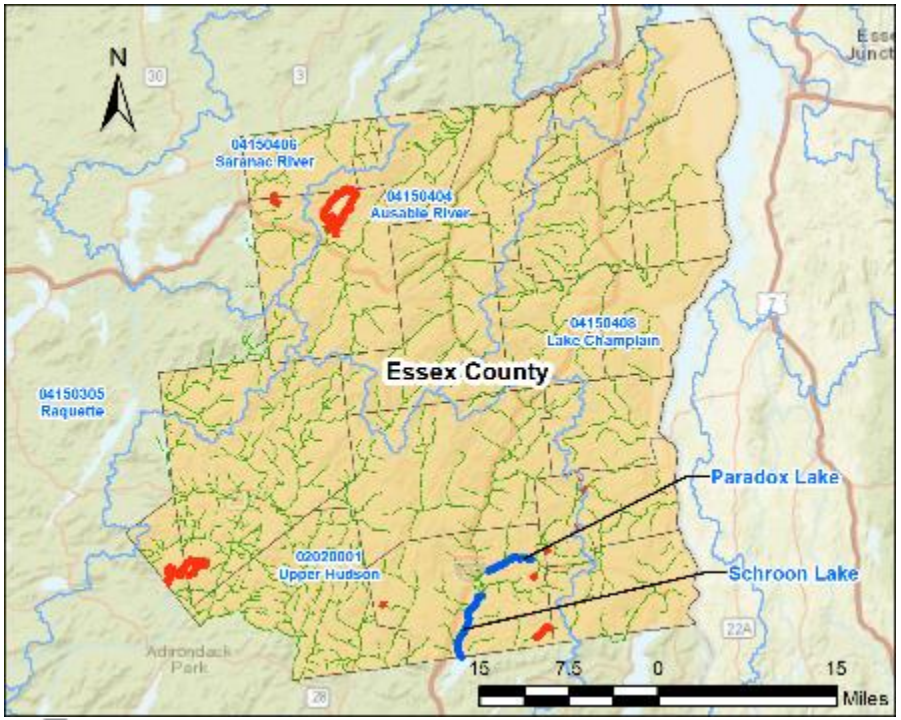
Hydrology – Rainfall-Runoff Modeling

- Rainfall-Runoff Analysis = Blue (10 miles)
- Volumetric Analysis = Red (included in models, 31 miles)



Legend

Hydrologic Method

- USGS Regression Analysis / Gage Analysis
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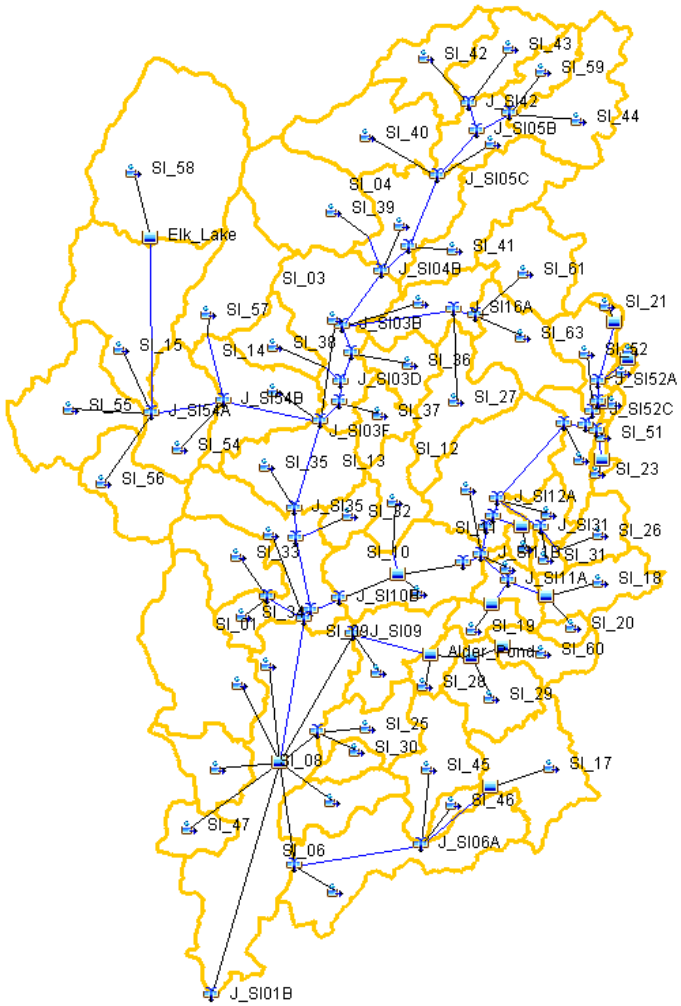
Rainfall-Runoff Methodology

- Software Program: HEC-HMS 4.5
- Rainfall: NOAA Atlas 14 Precipitation Frequency Data Server, 50th percentile, 2nd quartile, 24-hour temporal distribution
- Loss Methodology: SCS Curve Number (TR-55), with average antecedent runoff condition
- 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



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Rainfall-Runoff Modeling
Rainfall Data

- NOAA Atlas 14 Rainfall Data
- Gridded Data – Average Values

Rainfall Amounts for the Schroon Lake Basin		
Storm Frequency	Raw Values	With 0.91 ARF
50% AEP	2.65	2.41
10% AEP	3.80	3.46
4% AEP	4.52	4.11
2% AEP	5.06	4.61
1% AEP	5.62	5.12
0.2% AEP	7.08	6.44

- Area Reduction Factors were applied (Figure 15, TP-40)
- ARF of 0.91 applied to the Schroon Lake model based on the 400 square mile combined drainage area

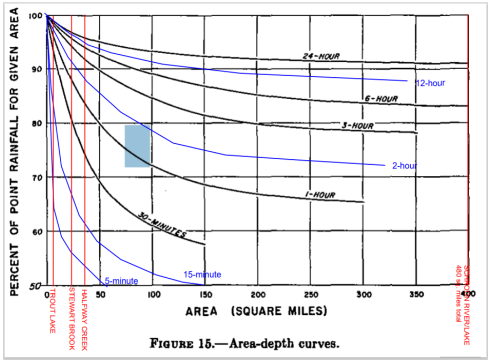

FIGURE 15.—Area-depth curves.

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Rainfall-Runoff Modeling
SCS Curve Numbers

- Soil Data from USGS SSURGO database
- Land use data from National Land Use Database (NLCD)
- Composite CN calculated for each sub-basin (TR-55 Methodology)
- Land use compared to recent aerial imagery to confirm
- Manual adjustments to land use made as necessary
- Calculated composite Curve Numbers range from 50-81

Table 2-2a Runoff curve numbers for urban areas [1/]

Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	Average percent impervious area [2/]	A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3/]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89

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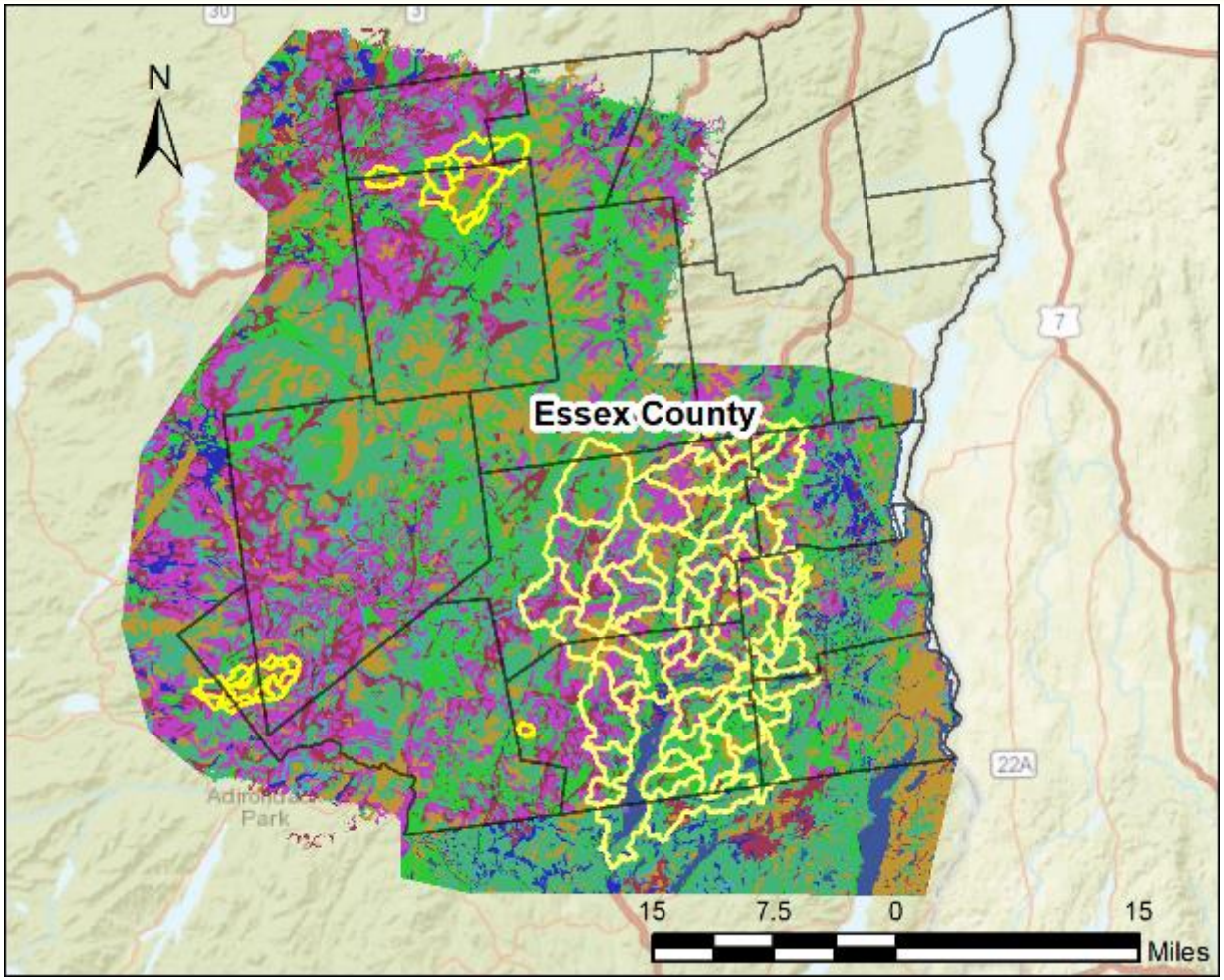
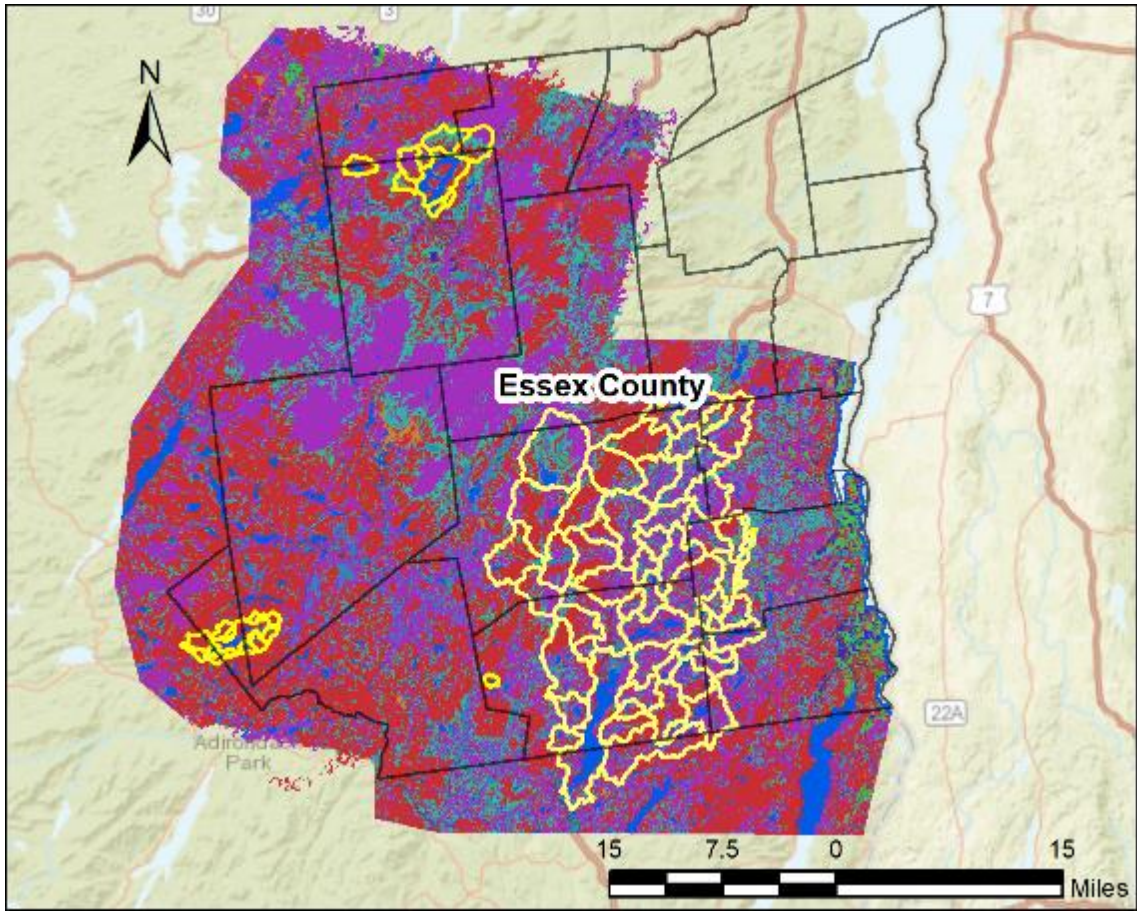
Rainfall-Runoff Modeling
Hydrologic Soil Groups



Rainfall-Runoff Modeling
Land Use



Legend

Jurisdication Boundaries

Rainfall-Runoff Sub-basin

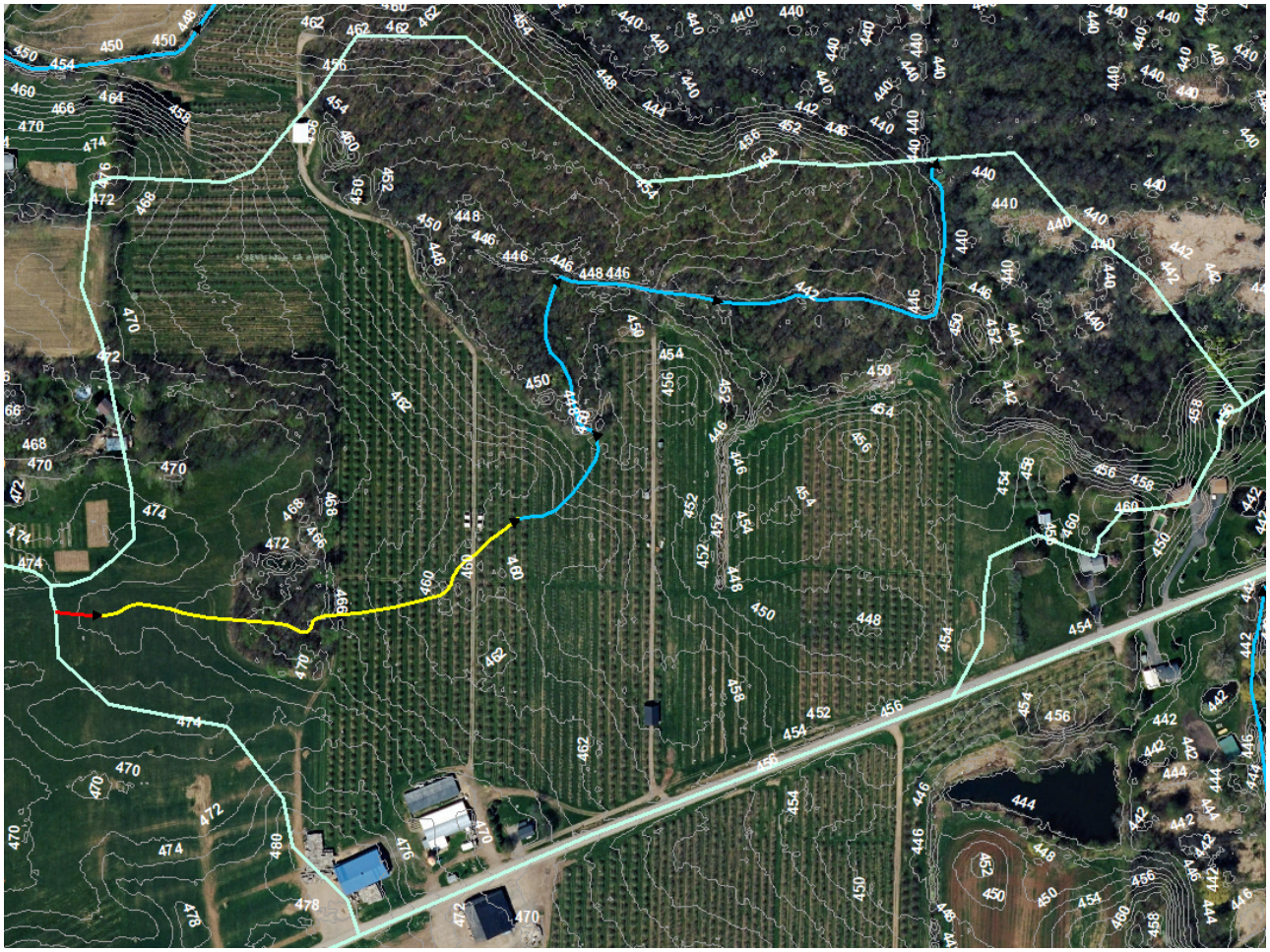
Landuse

- 11 *Open Water*
- 21 *Developed. Open Space*
- 22 *Developed, Low Intensity*
- 23 *Developed, Medium Intensity*
- 24 *Developed, High Intensity*
- 31 *Barren Land*
- 41 *Deciduous Forest*
- 42 *Evergreen Forest*
- 43 *Mixed Forest*
- 52 *Shrub/Scrub*
- 71 *Grasslands/Herbaceous*
- 81 *Pasture/Hay*
- 82 *Cultivated Crops*
- 90 *Woody Wetland*
- 95 *Evergreen Herbaceous Wetland*

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 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 1,000 ft maximum
  - Channel flow: begins at end of shallow concentrated flow segment and ends at sub-basin outlet
  - Flow segments further subdivided at locations of representative slope
- **Lag times = 60% of Time of Concentration**

Longest Flow Path Example



Flow Regime

- Open Channel Flow
- Overland Flow
- Shallow Concentrated Flow

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Gage Analysis

- **Statistically analyze measured flows at gages**

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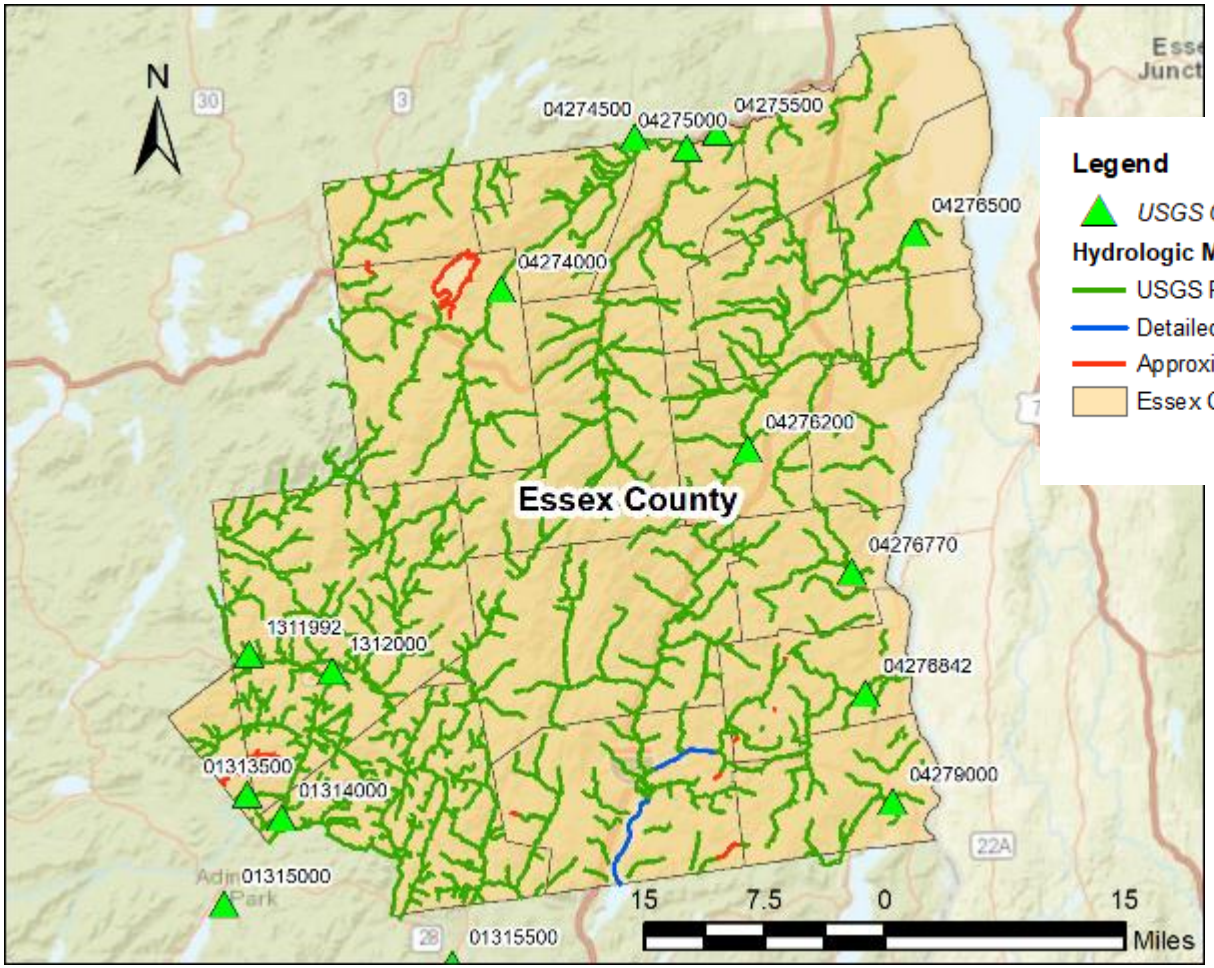
Hydrology – Gage Analysis

- **Gage analysis performed in support of rainfall-runoff model validation**
- Viable gage = minimum 10 years current record
- Bulletin 17C methodology

USGS Gage No.	Description	Drainage Area (sq. mi)	Period of Record	Number of Records
01313500	Cedar River near Indian Lake, NY	160	1931-1969	36
01314000	Hudson River near Indian Lake, NY	419	1917-1968	52
01315000	Indian River near Indian Lake, NY	132	1913-2019	104
01315500	Hudson River at North Creek, NY	792	1908-2019	112
04274000	West Branch Ausable River near Lake Placid, NY	116	1920-2019	86
04274500	Black Brook at Black Brook, NY	49.4	1925-1961	37
04275000	East Branch Ausable River at AU Sable Forks, NY	198	1924-2019	95
04276200	Boquet River at New Russia, NY	37.6	1948-1979	31
04276770	Mill Brook at Port Henry, NY	27	1990-2000	11
04276842	Putnam Creek East of Crown Point Center, NY	51.6	1990-2019	27
04279000	La Chute at Ticonderoga, NY	234	1943-2019	37
01312000	Hudson River near Newcomb, NY	192	1926-2019	94
01311992	Arbutus Pond Outlet near Newcomb, NY	1.22	1990-2019	29
04276500	Boquet River at Willsboro, NY	270	1924-2019	80
04275500	Ausable River near Ausable Forks NY	446	1911-2019	88
01313500	Cedar River near Indian Lake, NY	160	1931-1969	36
01314000	Hudson River near Indian Lake, NY	419	1917-1968	52

Hydrology – Gage Analysis



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Model Validation / Results

- **Check computed flows against results that one would expect from nearby gages**
- **Adjust certain model inputs as needed**

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Rainfall-Runoff Modeling
Model Validation

Rainfall-Runoff Results were compared a two locations:

1. Schroon River upstream of confluence with Paradox Creek

2. Paradox Creek upstream of Paradox Lake

Computed Discharge (cfs)				
Site	Effective 1%-Annual Chance	Regression 1%-Annual Chance	HEC-HMS 1%-Annual Chance	Rainfall-Runoff/Regression Difference (%)
Schroon River Upstream of Confluence with Paradox Creek	6,625	7,980	10,413	30%
Paradox Creek Upstream of Paradox Lake	1,415	2,150	2,196	2%

- Adjust CN and lag time until model output is within range of expected regression output
- Peak flows for all computed 1%-AEP were reviewed and deemed to be valid

Results
Comparison to Effective Flows

- **Final discharges for the hydraulics will be from the regression and gage analysis only**
- **New study found to be consistent with effective flows (between 20% lower and up to 20% higher)**
- **Rainfall-runoff models will be used for stillwater elevations only**

Results

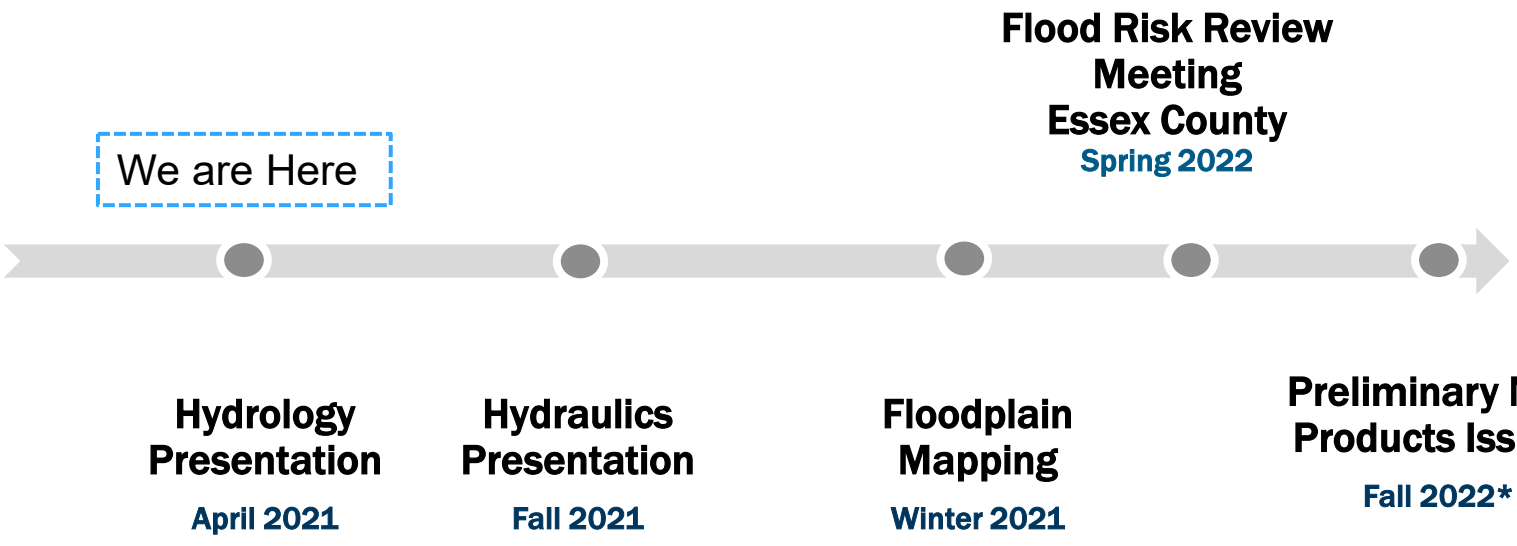
- **Regression and Rainfall-Runoff:** refer to Hydrology Report for Results Tables
- **Stillwater elevations from rainfall-runoff analyses:**

Computed Stillwater Elevations (NAVD88)							
Site	10%-Annual Chance	4%-Annual Chance	2%-Annual Chance	1%-Annual Chance	0.2%-Annual Chance	1% Plus – Annual Chance	1% Minus – Annual Chance
Schroon Lake	808.2	808.7	809.2	809.7	811.2	811.7	810.7
Paradox Lake	817.5	818.0	818.4	818.8	820.1	820.5	819.7

Essex County Next Steps

- **Field Survey/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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Questions? Comments?

Thank you!

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