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Flood Risk Project

Wayne County, New York,
Hydrology Meeting

April 22, 2021

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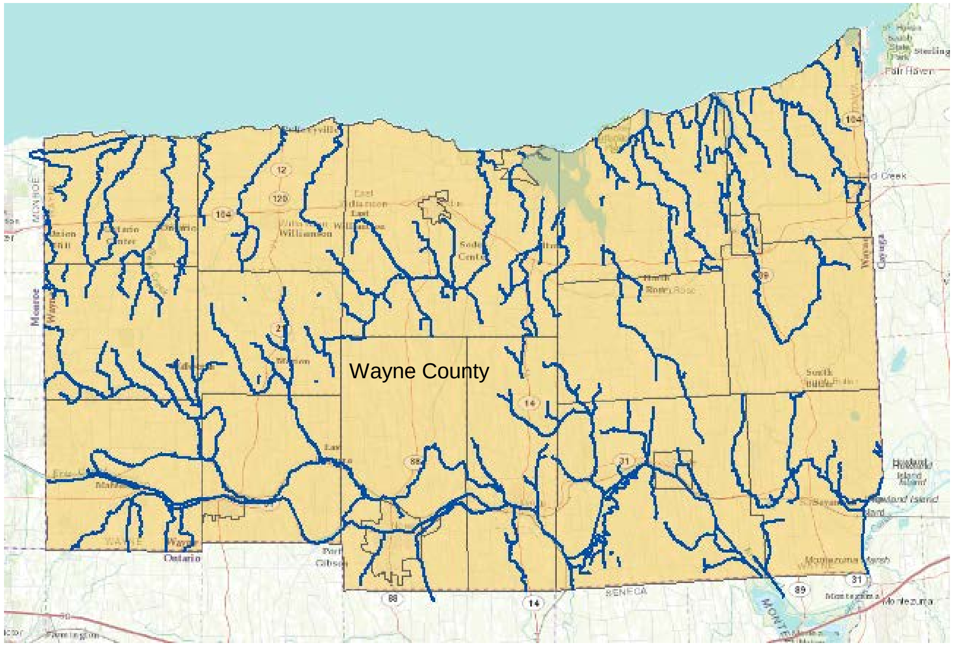


Agenda

Recap/Refresh

Hydrology Analysis Review

Path Forward

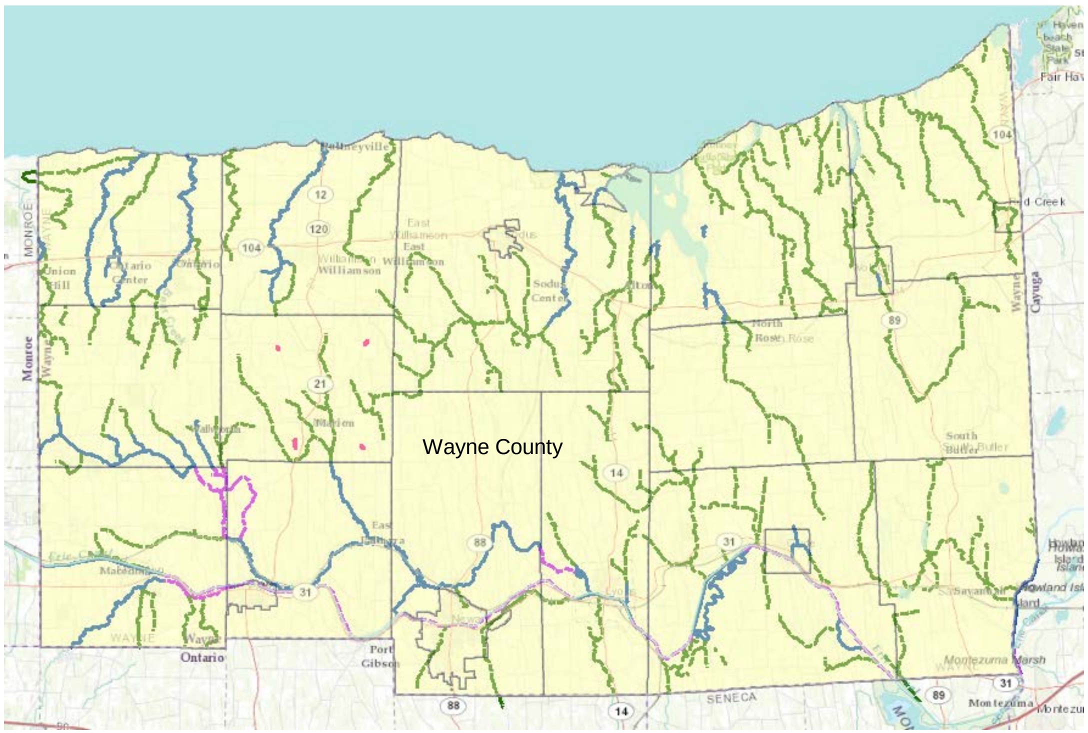
Project Recap

- **Two Discovery Meetings**
  - Irondequoit Ninemile Watershed November 12, 2013
  - Seneca River Watershed May 13, 2014

- **This Study**
  - Kickoff meeting: Held online due to COVID19 – May 7, 2020
  - Engineering models notification to communities: August 14, 2020
  - Field survey: Spring 2020 – January 2021
  - Hydrologic analysis: April 2020 – Present

Project Scope

- **First time digital countywide maps**



- **Location and Study Streams**
  - 167 miles of rainfall-runoff modeling
  - 370 miles of regression analysis (includes additional scope)
  - 0.7 miles of volumetric calculations

Legend

Method and Study Type

- Detailed, Rainfall-Runoff analysis in HEC-HMS
- Approximate, Rainfall-Runoff analysis in HEC-HMS
- Approximate, USGS Regression Analysis / Gage Analyses
- Approximate, Volumetric calculations assuming no outflow

Boundaries

- Wayne County
- HUC-8 Watershed Boundary

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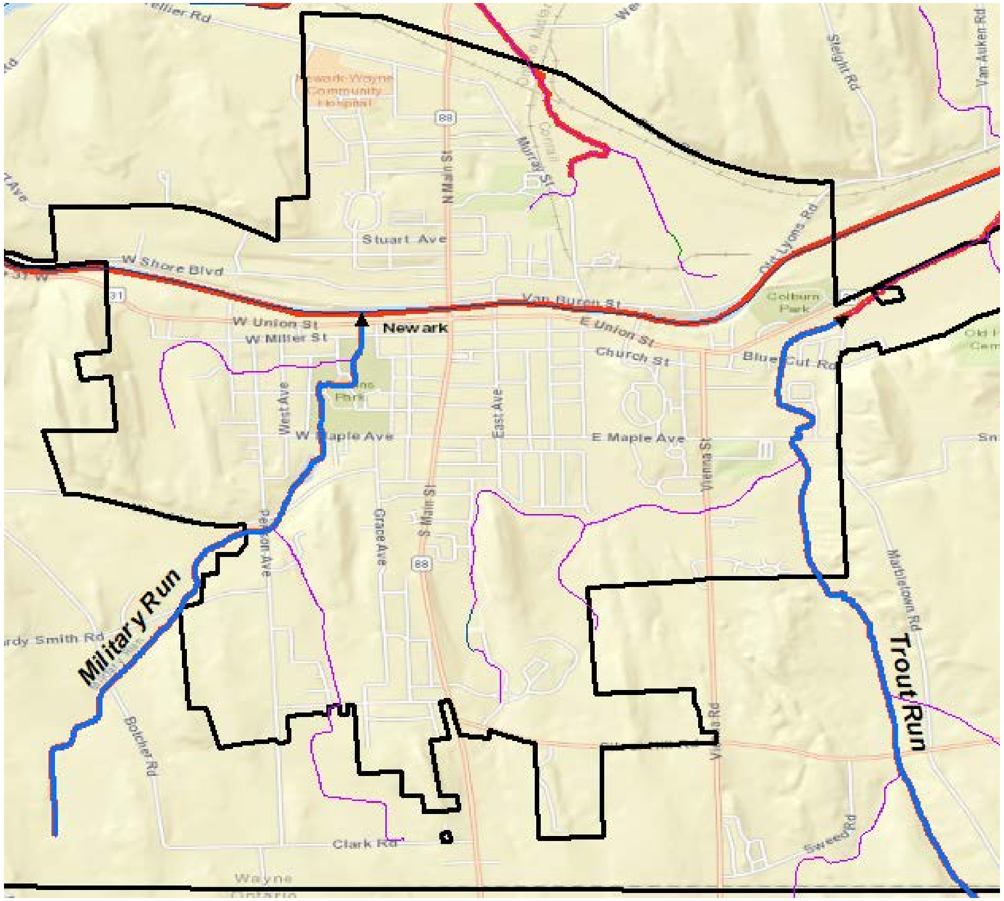
Post-Kickoff Scoped Streams Regression Analysis

- **Village of Newark**
  - Military Run (2.7 miles)
  - Trout Run (3.3 miles)



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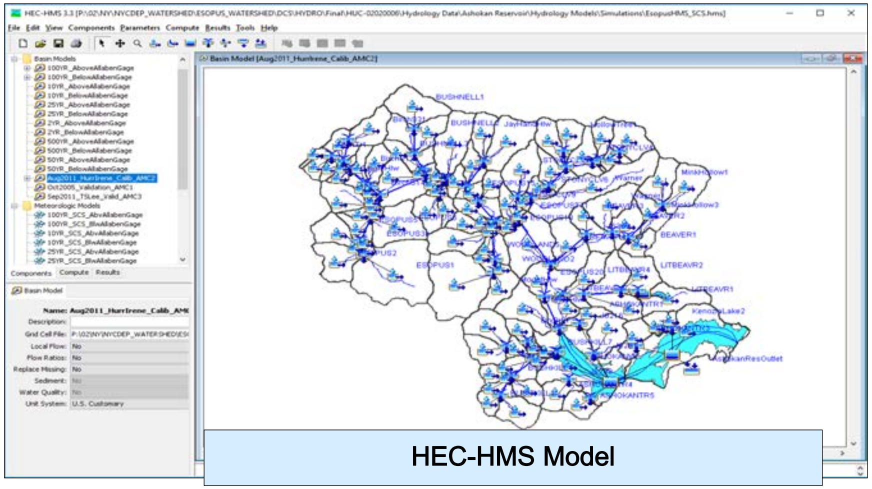
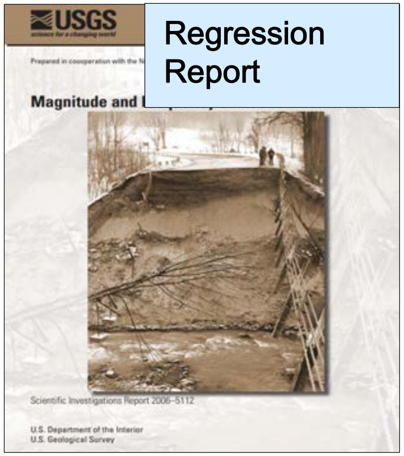
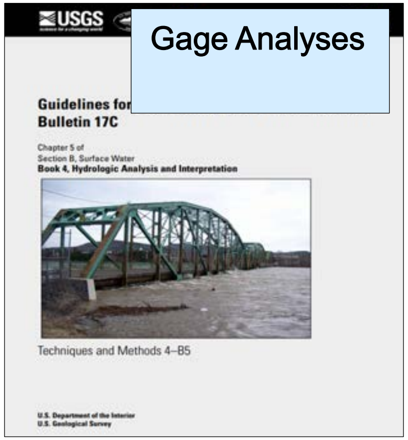
Hydrologic Analysis Methods

- **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


HEC-HMS Model



Regression Report



Gage Analyses

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Regression Analysis

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

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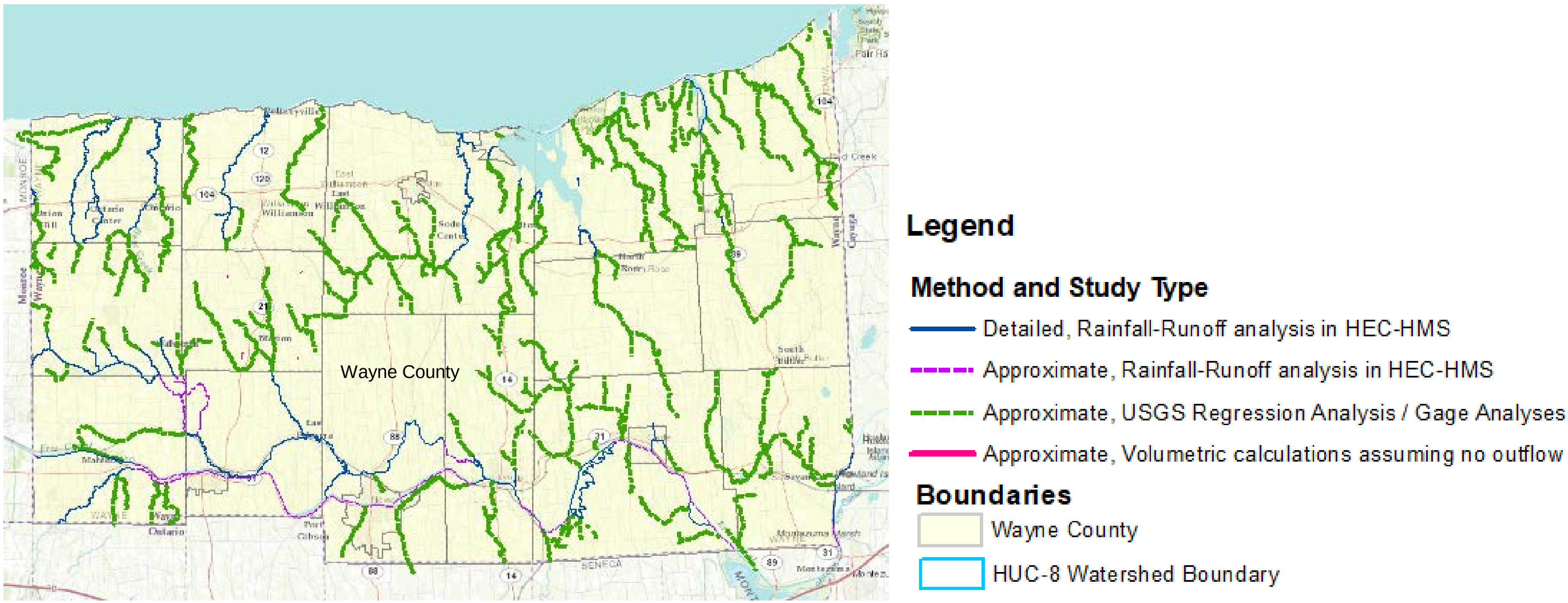
Hydrology – Regression Analysis

- Regression Analysis = Green (370 miles)



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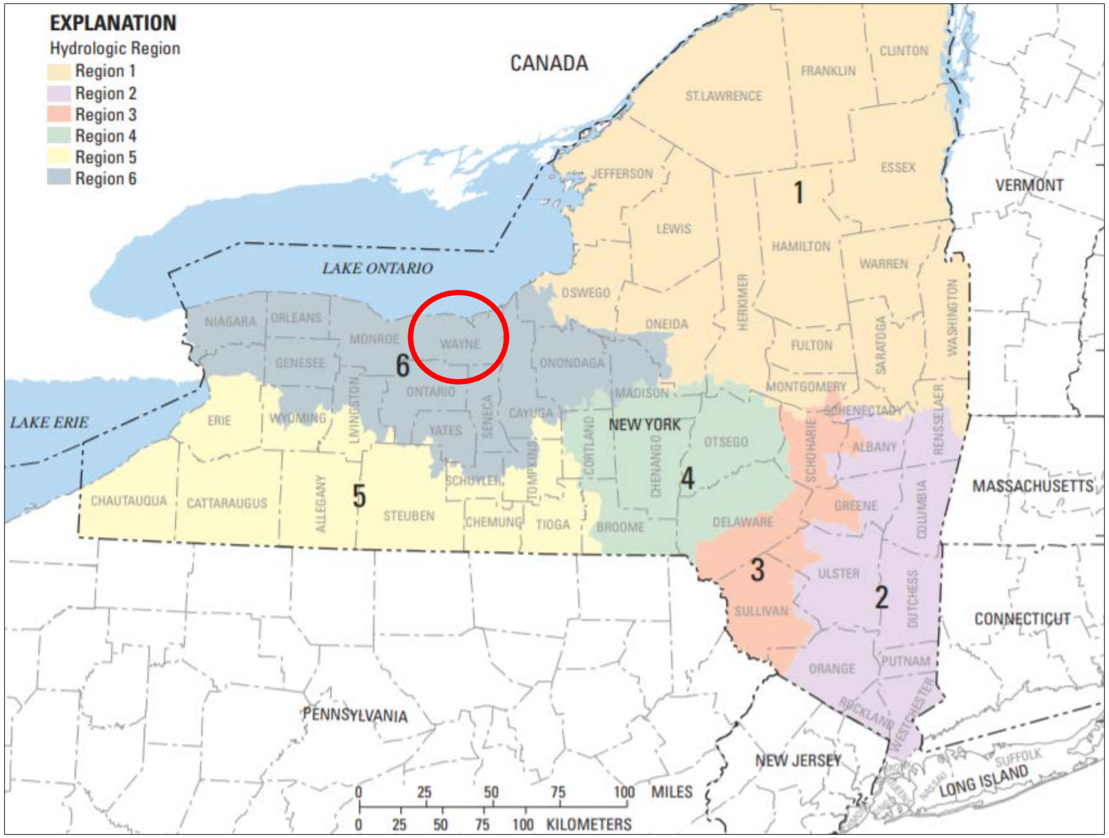
Regional Regression Equations and Analysis

- USGS New York regression equation: SIR 2006-5112
- Study area falls within USGS NY regression Region 6
- USGS StreamStats v 4.3.8 web application employed
- Primary method for Zone A streams



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Summary of Regression Equations

USGS NYS Hydrologic Region 6

$$Q_2 = 8.98A^{0.807}(ST + 0.5)^{-0.258}(RUNF)^{0.740}(EL12 + 1)^{0.093}(SR)^{0.209}$$

$$Q_{10} = 23.4A^{0.810}(ST + 0.5)^{-0.218}(RUNF)^{0.600}(EL12 + 1)^{0.133}(SR)^{0.268}$$

$$Q_{25} = 32.1A^{0.815}(ST + 0.5)^{-0.200}(RUNF)^{0.555}(EL12 + 1)^{0.148}(SR)^{0.290}$$

$$Q_{50} = 39.0A^{0.819}(ST + 0.5)^{-0.188}(RUNF)^{0.528}(EL12 + 1)^{0.157}(SR)^{0.305}$$

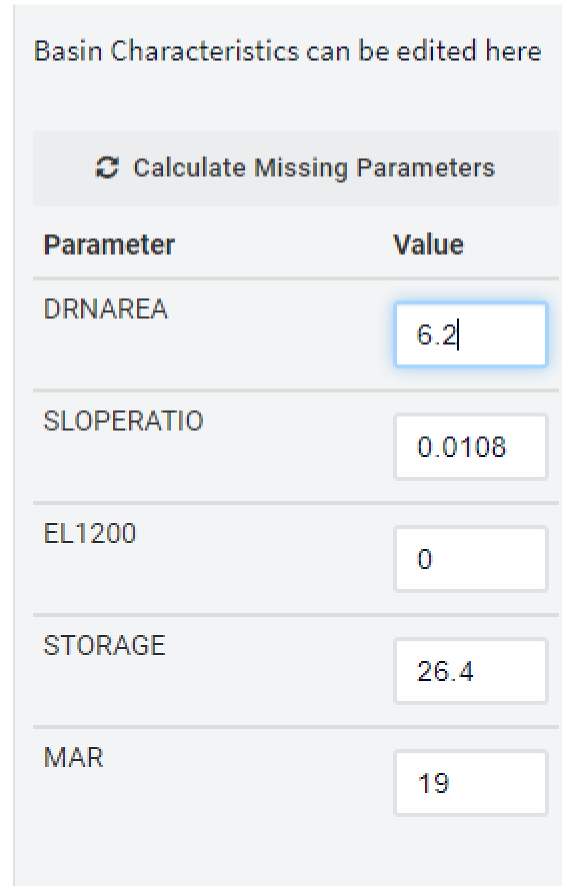
$$Q_{100} = 46.0A^{0.823}(ST + 0.5)^{-0.177}(RUNF)^{0.505}(EL12 + 1)^{0.166}(SR)^{0.318}$$

$$Q_{500} = 62.7A^{0.834}(ST + 0.5)^{-0.155}(RUNF)^{0.466}(EL12 + 1)^{0.183}(SR)^{0.345}$$

where,
Q_x = peak flow for x-year storm event (cubic feet per second)
A = drainage area (square miles)
ST = basin storage (percentage of total drainage area)
RUNF = mean annual runoff (inches)
EL12 = percentage of drainage basin at or greater than 1,200 feet above sea level
SR = ratio of main-channel slope to basin slope within the drainage basin

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



Urban Adjustment Factor Equations

- Base regression equations not applicable to urban areas
- Peak flows adjusted for basins with >15% urban land use (from NLCD layer)
- Affected reaches: Dennison Creek, Dennison Creek Tributary 1, Fourmile Creek Tributary 2, Ontario Tributary 2, Red Creek (Walworth), Salmon Creek (Sodus) Tributary 3, Second Creek Tributary 1, Trout Run Tributary 1, Wolcott Creek Tributary 4, Wolcott Creek Tributary 5

$$UQ_5 = 10.6A^{0.17}(13 - BDF)^{-0.39}RQ_5{}^{0.78}$$

$$UQ_{10} = 9.51A^{0.16}(13 - BDF)^{-0.36}RQ_{10}{}^{0.79}$$

$$UQ_{25} = 8.68A^{0.15}(13 - BDF)^{-0.34}RQ_{25}{}^{0.80}$$

$$UQ_{50} = 8.04A^{0.15}(13 - BDF)^{-0.32}RQ_{50}{}^{0.81}$$

$$UQ_{100} = 7.70A^{0.15}(13 - BDF)^{-0.32}RQ_{100}{}^{0.82}$$

$$UQ_{500} = 7.47A^{0.16}(13 - BDF)^{-0.30}RQ_{500}{}^{0.82}$$

where,

UQx = urban-adjusted peak flow for x-year storm event (cubic feet per second)

A = drainage area (square miles)

BDF = basin development factor, calculated using the methods described in Sauer and Others (Sauer, 1983)

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

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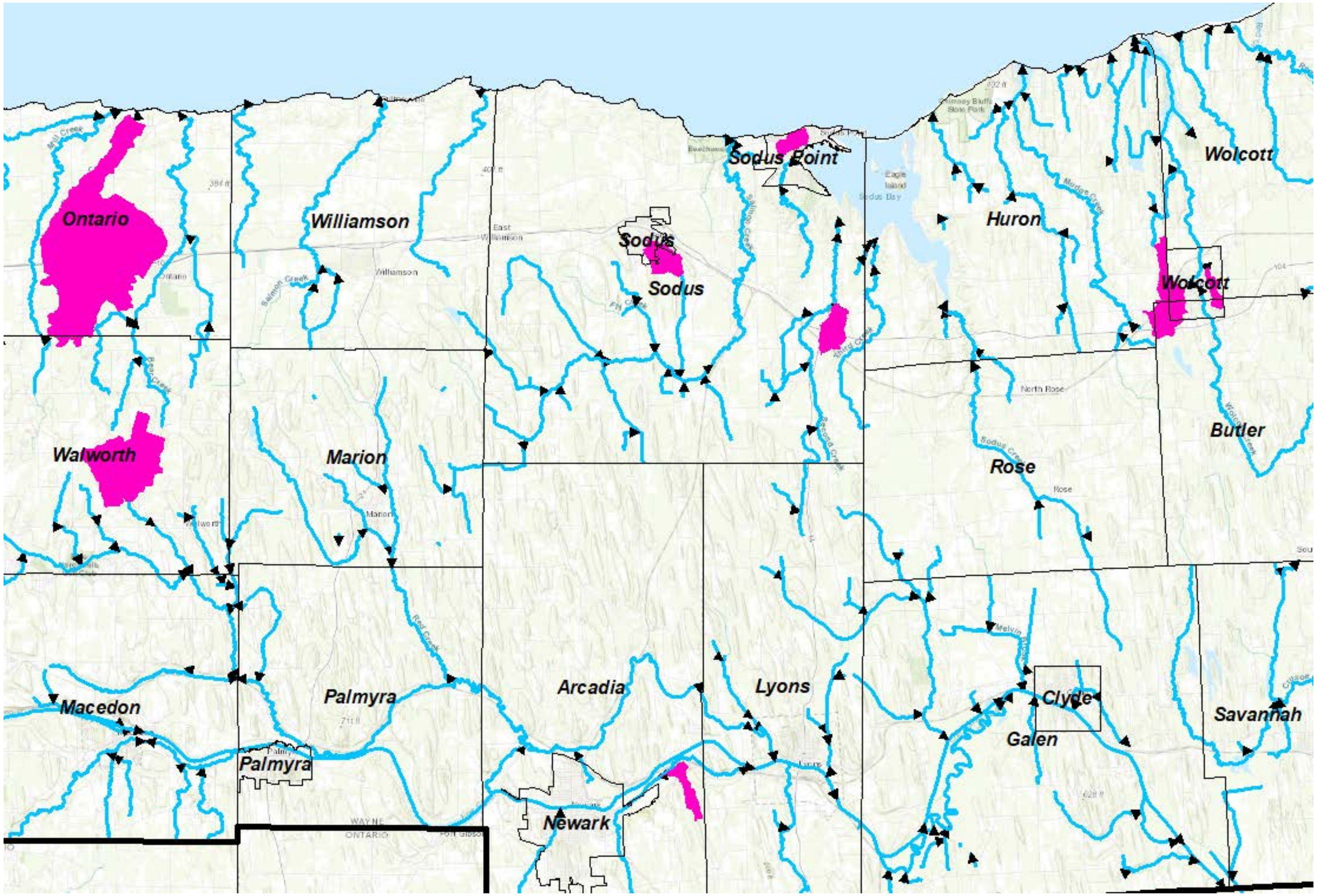
Urban Adjustment Factor Basins



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Rainfall-Runoff Analysis

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

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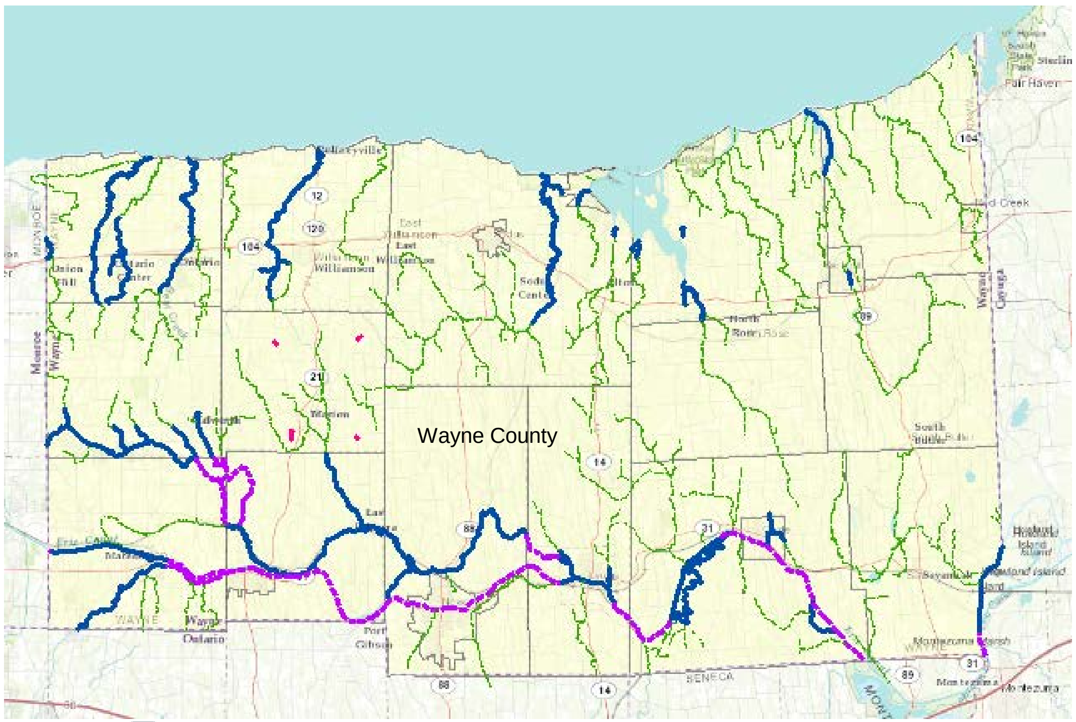
Hydrology – Rainfall-Runoff Modeling

- Rainfall-Runoff Analysis = Blue and Purple (167 miles)
- Volumetric Analysis = Red (included in models, 0.7 miles)



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
- Area Reduction Factors were applied (TP-60)

Point Rainfall Amounts at Select Monitoring Stations		
Storm Frequency	Sodus Creek	Newark
50% AEP	2.30	2.18
10% AEP	3.33	3.17
4% AEP	3.97	3.79
2% AEP	4.46	4.26
1% AEP	4.96	4.74
0.2% AEP	6.31	6.06

2-7

TABLE 2-3

PRINCIPAL SPILLWAY VOLUME ADJUSTMENTS

A. Minimum Areal Adjustment Ratios for Precipitation

Area Sq. Mi.	Area/Point Ratio for: 1 Day	10 Days	Area Sq. Mi.	Area/Point Ratio for: 1 Day	10 Days
10. or less	1.000	1.000	45.	0.951	0.976
15.	0.977	0.991	50.	0.948	0.974
20.	0.969	0.987	60.	0.944	0.972
25.	0.965	0.983	70.	0.940	0.970
30.	0.961	0.981	80.	0.937	0.969
35.	0.957	0.979	90.	0.935	0.967
40.	0.954	0.977	100.	0.932	0.966

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: Cover type and hydrologic condition	Average percent impervious area [2/]	Curve numbers for hydrologic soil group: 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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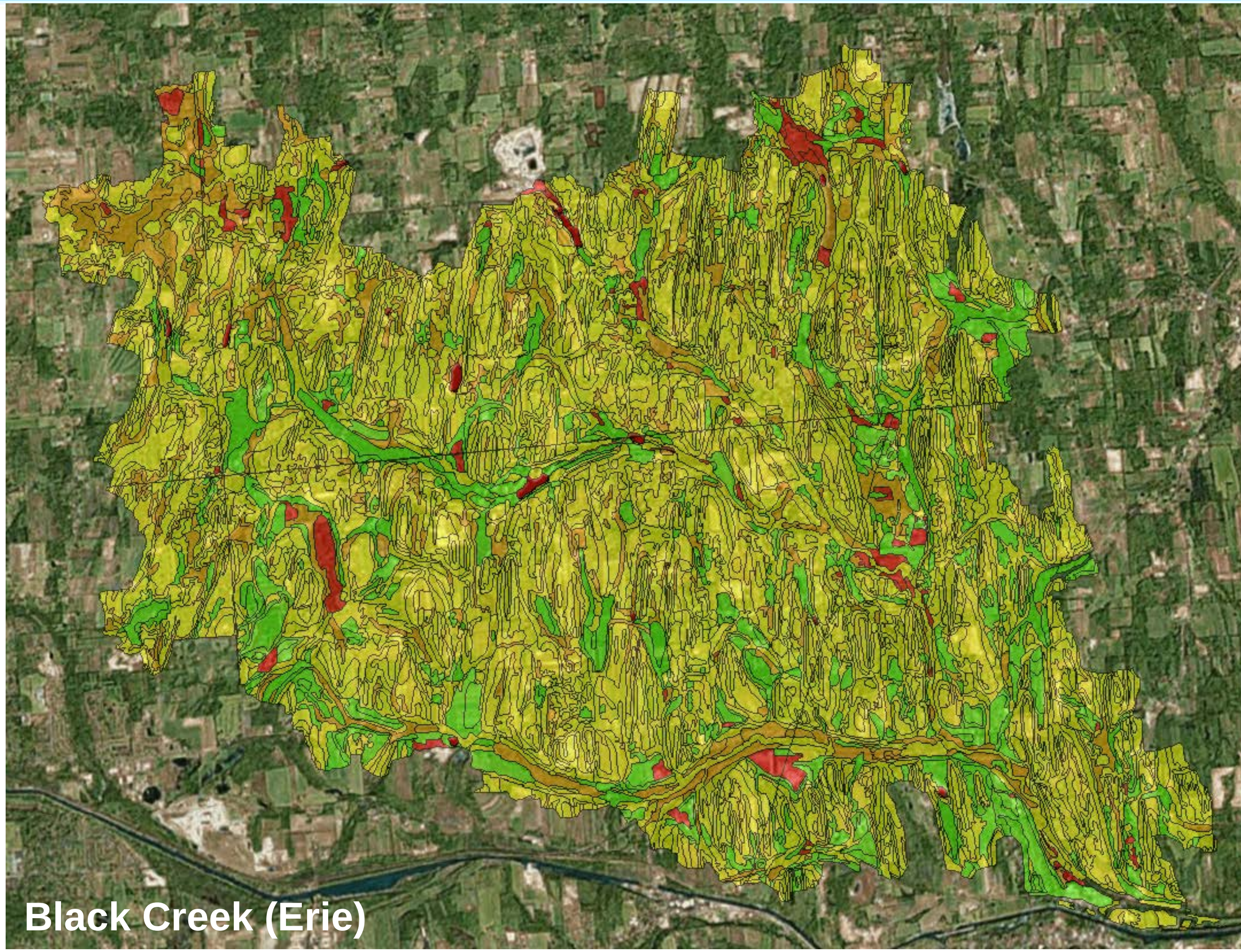
Rainfall-Runoff Modeling
Hydrologic Soil Groups

Hydrologic Soil Group

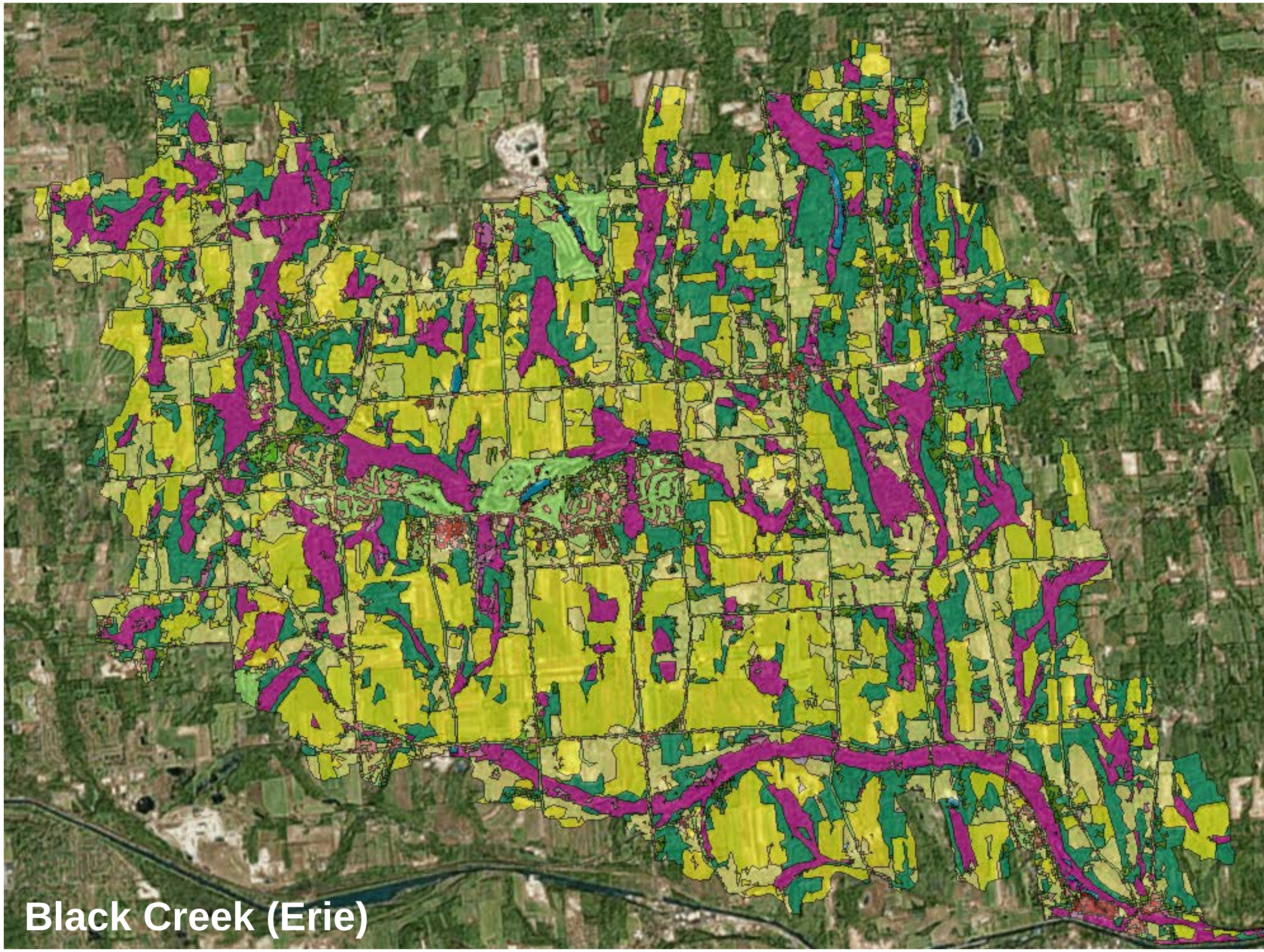
- A
- B
- C
- D



Rainfall-Runoff Modeling
Land Use

Land Use

- Open Water
- Developed, Open Space
- Developed, Low Intensity
- Developed, Medium Intensity
- Developed, High Intensity
- Barren Land
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Shurb / Scrub
- Grassland / Herbaceous
- Pasture / Hay
- Cultivated Crops
- Woody Wetlands
- Emergent Herbaceous Wetlands



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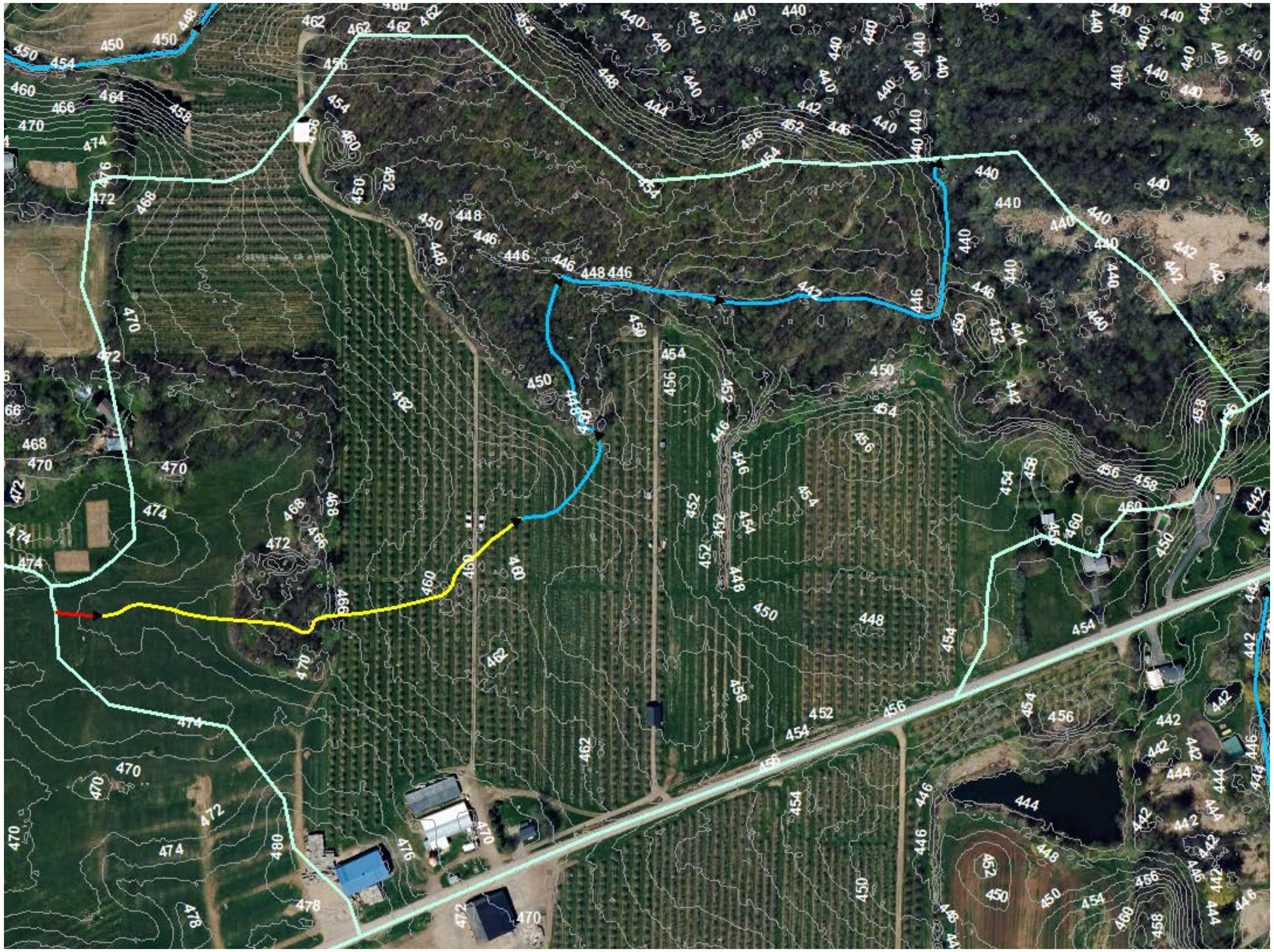
Rainfall-Runoff Modeling
Time of Concentration (Tc) / Lag Time

- **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

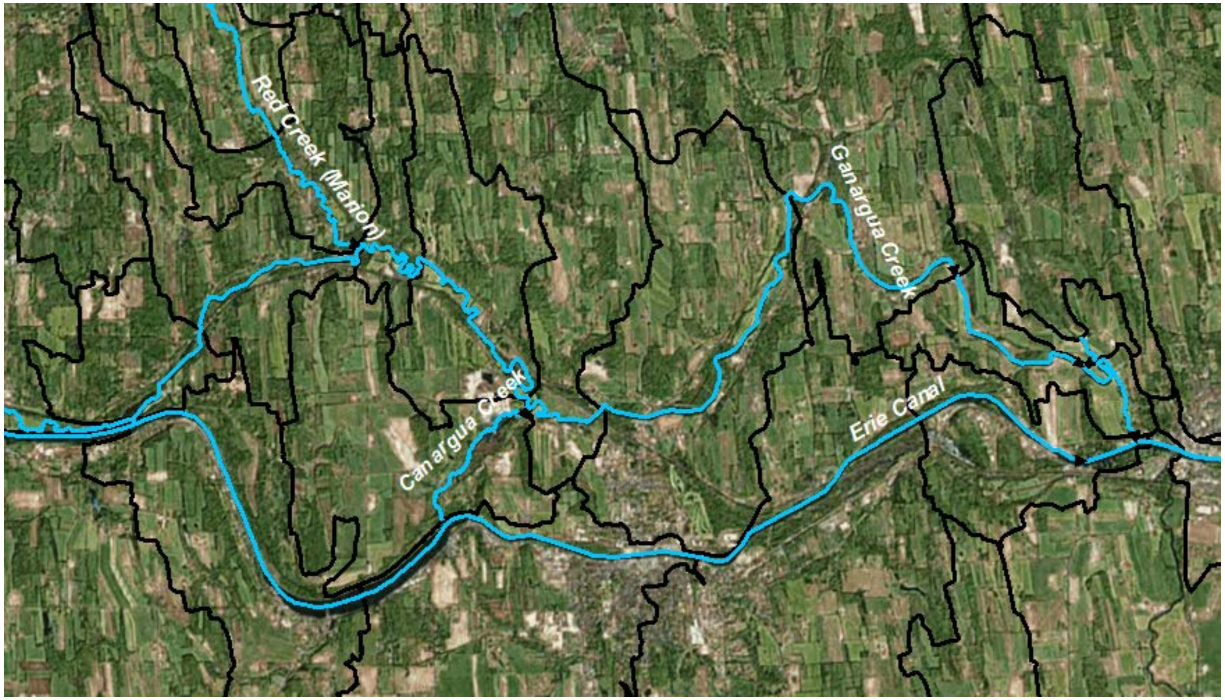


Flow Regime

- Open Channel Flow
- Overland Flow
- Shallow Concentrated Flow

Erie Canal – Flow Diversions

- Complex system with various flow diversions
- Hydrology assumes 100% of flow follows a single path
- Will be further refined during hydraulic analysis



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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
04235000	Canandaigua Outlet at Chapin, NY[1]	195	1940-2019	80
04235250	Flint Creek at Phelps, NY	102	1960-2018	53
04234200	Mud Creek at East Victor, NY	64.2	1958-2019	57
04219000	Erie (Barge) Canal at Lock 30 at Macedon, NY[1]	-	1951-2019	69
042320578	Bear Creek at Ontario, NY	6.74	1971-2019	48
04234138	Schaeffer Creek near Canandaigua, NY	7.84	1979-2019	41
04235255	Canandaigua Outlet Tributary near Alloway, NY	2.94	1977-2018	42
04235600	Seneca River (Erie Canal) near Port Byron, NY[1]	2815	1996-2018	23

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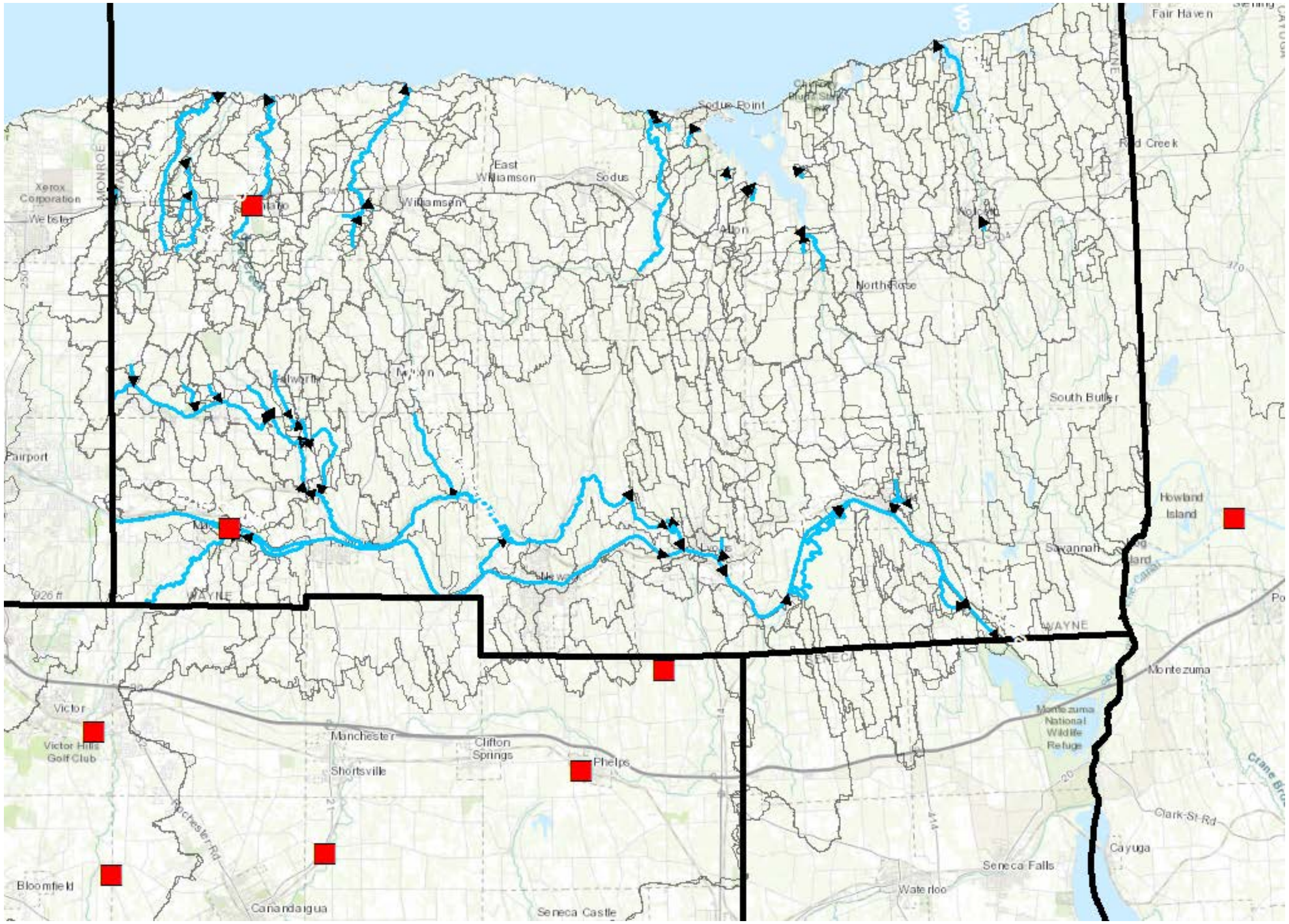
Hydrology – Gage Analysis



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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

1. Compare drainage areas

- Drainage area of modeled location between 0.5 and 1.5 times that of gage

2. Estimate results that one would expect from gage using Drainage Area Ratio Method (USGS, 2008)

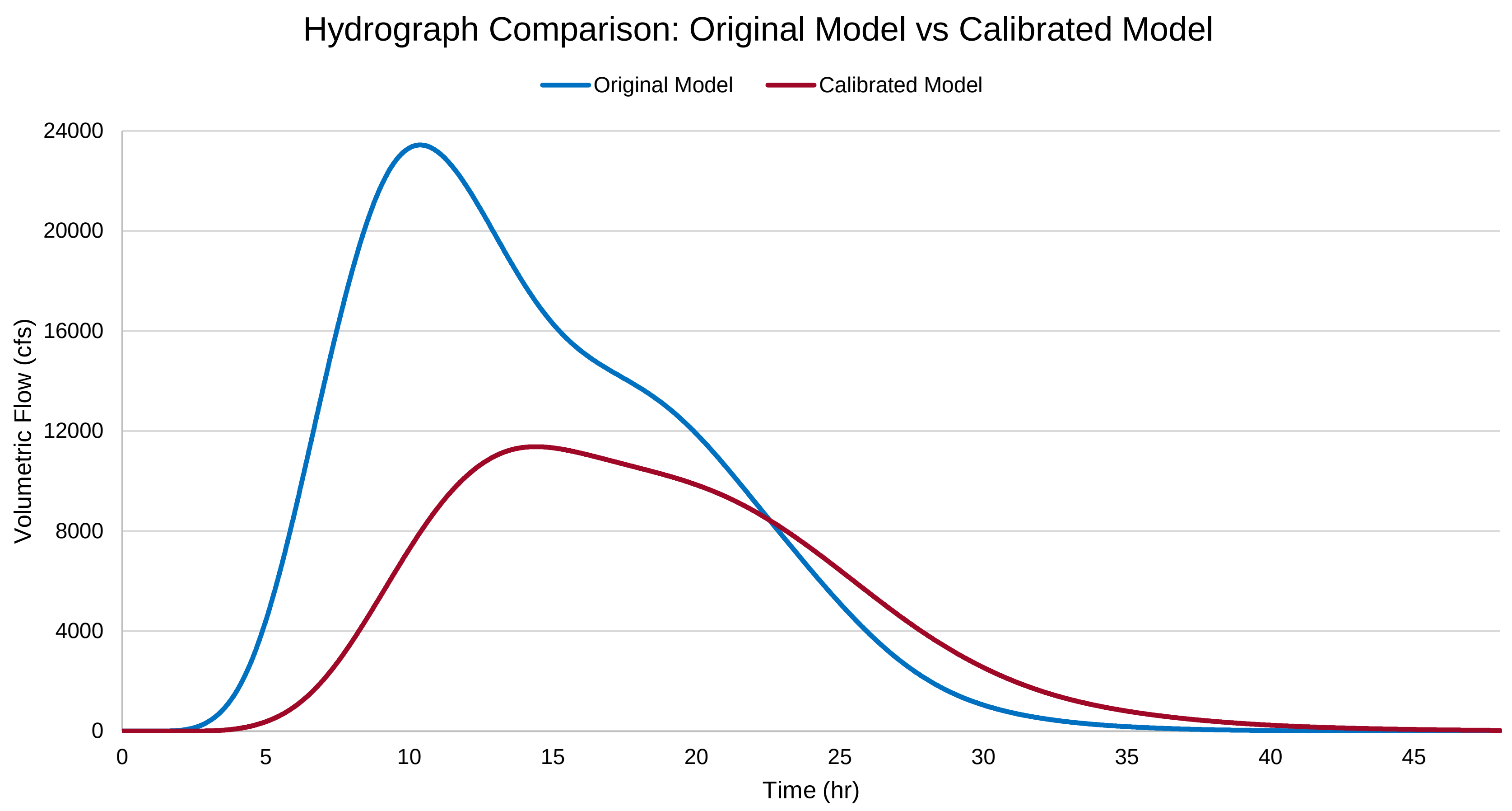
3. Adjust CN and lag time until model output is within 20% of expected gage output

- Adjustments within reasonable ranges of TR-55 tables – check imagery

4. At locations where no suitable gage comparison exists, make same average CN and lag time adjustments from nearby model locations

5. Peak flows for all computed 1%-AEP were reviewed and deemed to be valid

Rainfall-Runoff Modeling
Model Validation



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Rainfall-Runoff Modeling
Comparison to Effective Flows

- **New study found to be inconsistent with effective flows**
  - Attributed to a difference in methodology and outdated data sources
- **On average, updated flows 28% lower than effective**

Results

- **Regression and Rainfall-Runoff:** refer to Hydrology Report for results tables
- **Stillwater elevations from volumetric 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
Wolcott Creek (Downstream Lake)	244.4	244.5	244.6	244.7	245.3	244.8	244.6
Wolcott Creek (Upstream Lake)	346.1	346.3	346.5	346.6	347.2	346.8	346.5
Unnamed Lake 1	472.0	472.1	472.1	472.1	472.1	472.2	472.0
Unnamed Lake 2	457.7	457.7	457.7	457.7	457.7	457.7	457.7
Unnamed Lake 3	468.0	468.1	468.1	468.1	468.2	468.2	468.2
Unnamed Lake 4	457.2	457.2	457.2	457.2	457.2	457.2	457.2

Wayne 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

We are Here

Hydrology Presentation
April 2021

Hydraulics Presentation
Fall 2021

Floodplain Mapping
Winter 2021

Flood Risk Review Meeting Wayne County
Spring 2022

Preliminary Map Products Issued
Fall 2022*

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

Graphic Above Not to Scale

Contacts

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Questions? Comments?

Thank you!