Engineering Field Handbook Chapter 2: Estimating Runoff and Peak Discharges

New York EFH-2 Supplement Number 2 (August 24, 2016)

Introduction / Background

This Supplement revises Supplement 2012-1 dated 18 December 2012. This Supplement to EFH-2 concerns the use of rainfall data developed by the National Oceanic and Atmospheric Administration (NOAA) Atlas 14 Volume 10 and rainfall distributions based on the NOAA data. These rainfall data and rainfall distributions will replace rainfall data from Northeast Regional Climate Center (NRCC) and the NRCC rainfall distributions NRCC_A, NRCC_B, NRCC_C and NRCC_D and standard NRCS rainfall distributions Type II and Type III.

This supplement will be implemented by replacing the state/county rainfall database (county.NY) and rainfall distribution types (type.rf) used with the EFH-2 computer program.

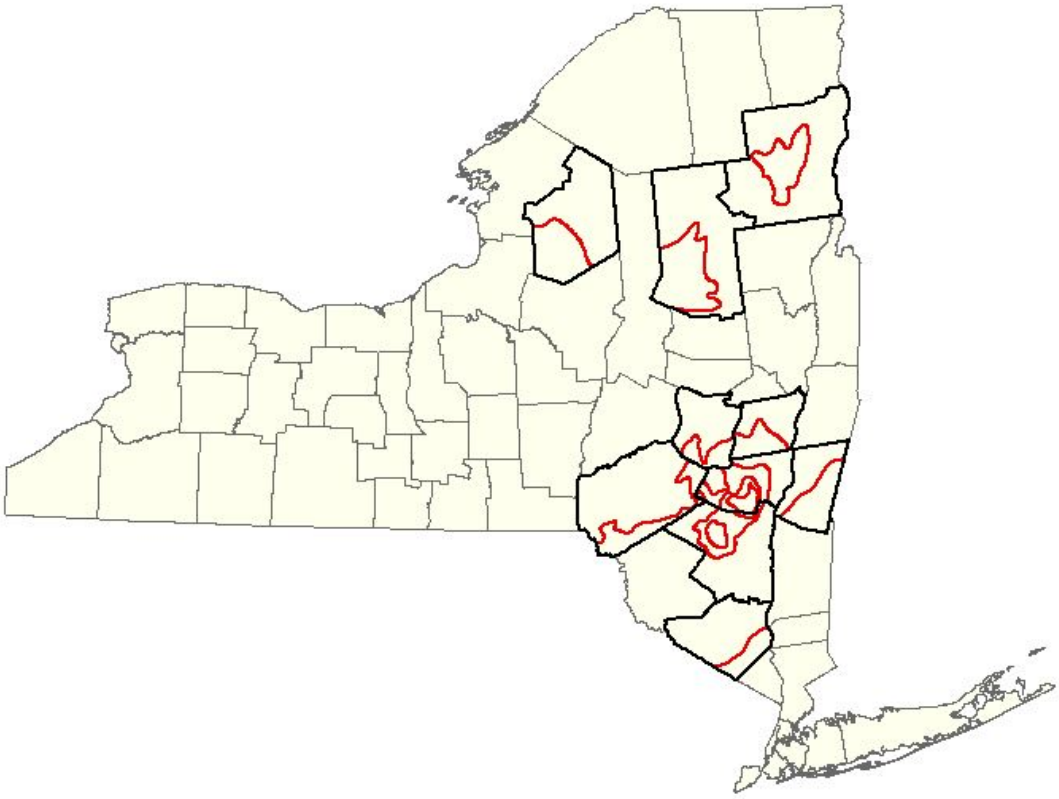
The EFH-2 computer program User Guide contains information, guidance, and examples concerning runoff curve number, average watershed slope, watershed length, input/output operations, and limitations. This supplement includes information related to rainfall data and rainfall distribution for use with the EFH-2 computer program in New York. Additional technical information is available from the NOAA web site (http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?) and from NRCS technical directives such as National Engineering Handbook Part 630 – Hydrology, Chapter 4, Storm Rainfall Depth and Distribution.

Rainfall Data

NOAA has completed Volume 10 of Atlas 14 precipitation-frequency analysis in 2015. Prior to the release of NOAA Atlas 14 Volume 10, NRCC released a comprehensive rainfall-frequency analysis for the northeast states in 2012 (Extreme Precipitation in New York and New England, An Interactive Web Tool for Extreme Precipitation Analysis) which replaced TP-40. Atlas 14 Volume 10 data are available for specific locations from an interactive web site (http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=ny).

Alternatively, data for representative locations in New York counties are included in a rainfall file **county.NY** for use with the EFH-2 computer program. Figure 1 of the State of New York indicates counties of New York and sub-county boundaries. Detailed topographic quadrant maps showing designated rainfall distribution for New York counties by county splits are included in Appendix 1 of this Supplement.

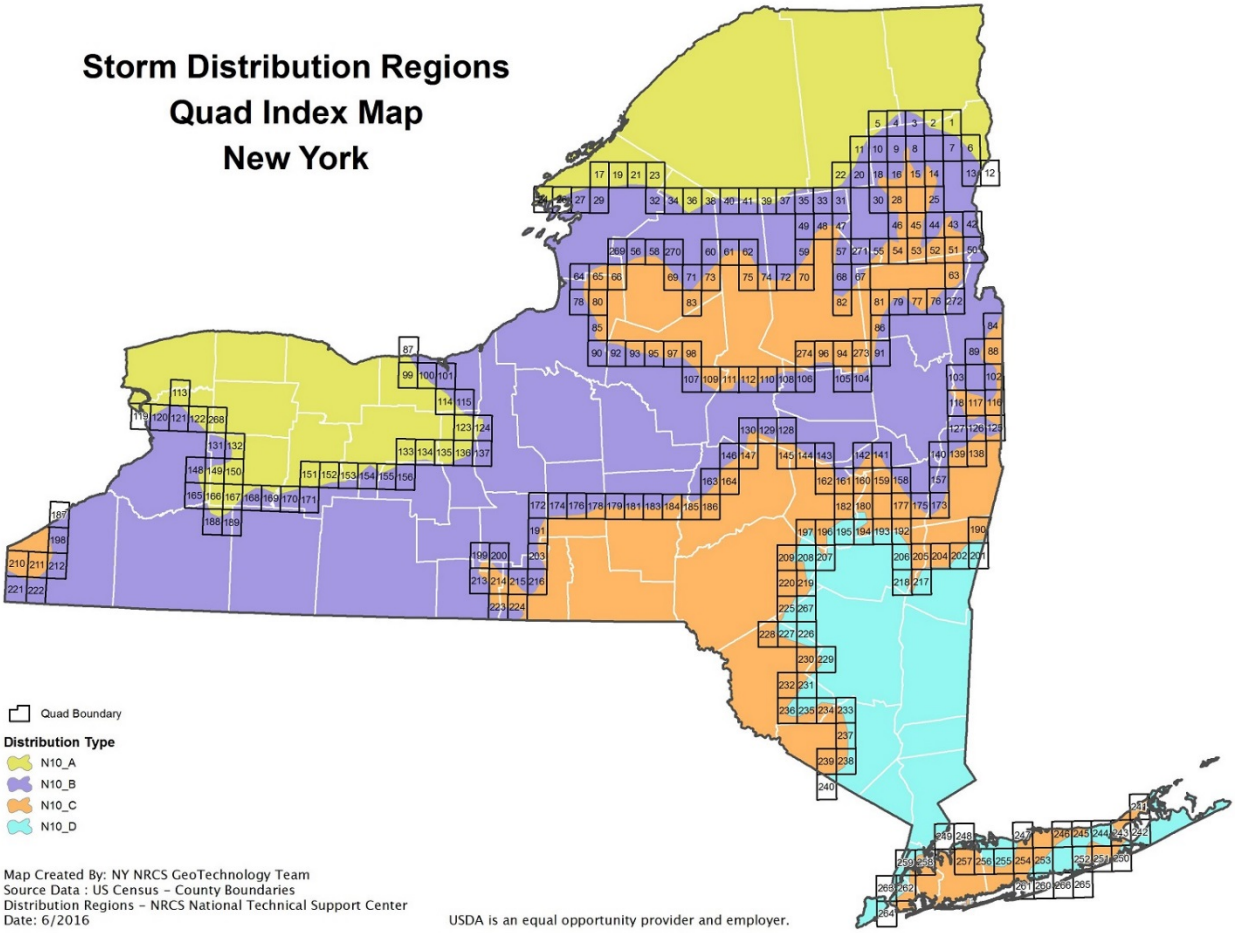
Figure 1: New York State County Rainfall Map and Topographic Quadrant Boundary



Rainfall Distributions

Four rainfall distributions have been developed for New York and other northeast states (CT, MA, ME, NH, RI, and VT). These were developed based on the NOAA Atlas 14 Volume 10 data. All four of these distributions extend into New York and are represented in Figure 2 of the State of New York indicating counties of New York and sub-county boundaries.

Figure 2: New York State Distribution Map and Topographic Quadrant Boundary



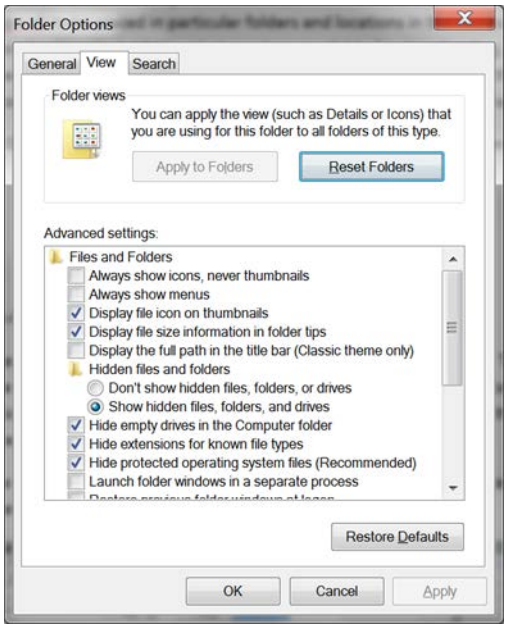
The EFH-2 computer program uses equations to relate unit peak discharge (cubic feet per second per inch of runoff per square mile of drainage area) to time of concentration in hours. Rainfall distribution N10_A is close to the old rainfall distribution Type II. Rainfall distribution N10_B is flatter than N10_A. Rainfall distribution N10_C is close to the old rainfall distribution Type III. Rainfall distribution N10_D is flatter than N10_C. The flatter the rainfall distribution the lower the peak runoff.

New York county rainfall data (county.NY) are listed in Appendix 2. The equations and coefficients for the four N_10 rainfall distributions and Type II and Type III are included in Appendix 3. Plots of the rainfall distributions are included in Appendix 4. Comparison of NOAA 14 versus NRCC rainfall distributions and county rainfall data to evaluate EFH-2 results is included in Appendix 5

Updating Input Files for EFH-2

EFH-2 runoff and peak discharge software requires a rainfall database (county.NY) and rainfall distribution types (type.rf) to be placed in particular folders and locations in the computer. These databases are located on the New York NRCS website and are available for downloading. The following steps describe the process of initially loading or updating obsolete databases for use by the EFH2 computer program. This process will need to be completed by each user on each computer that will be using EFH2.

1. Go to ***Start\Control Panel\Appearance and Personalization\Folder Options*** and select the ***view*** tab



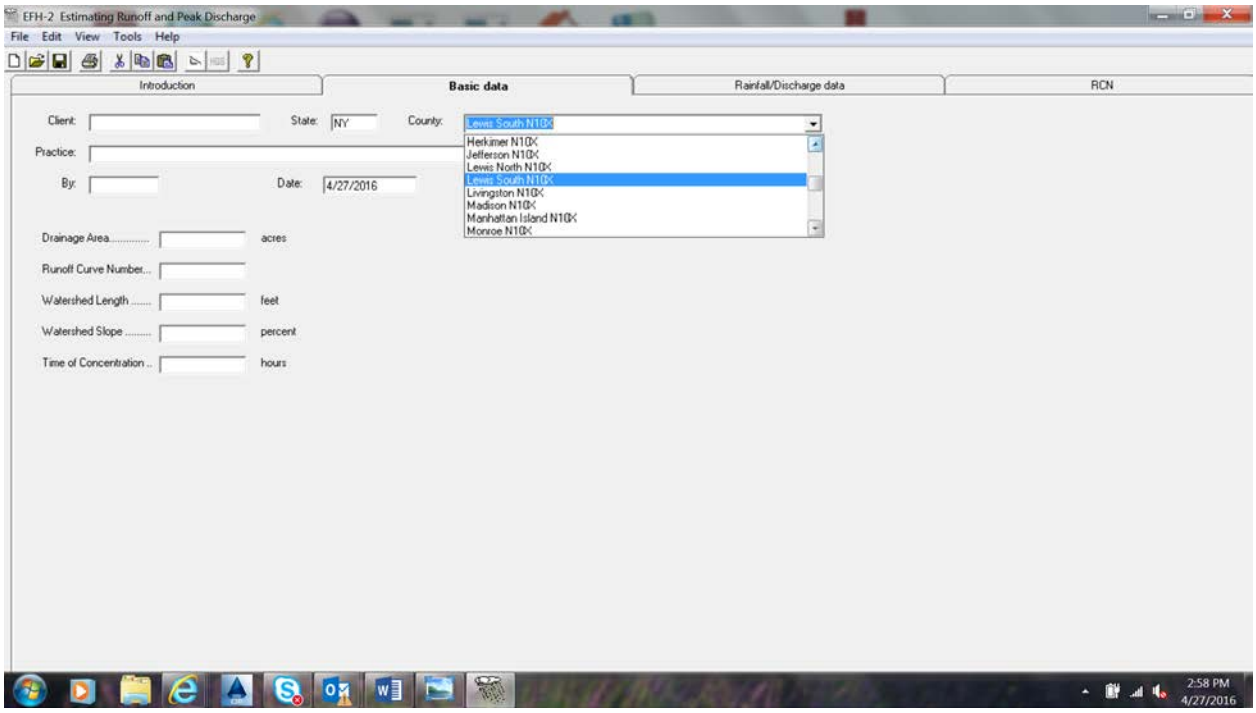
2. Under Hidden files and Folders, select the button tab for show ***hidden files, folders, and drives***
3. Select ***Apply*** and then ***OK***
4. Go to **C:\Users\user.name\AppData\Local\VirtualStore\ProgramFiles(x86)\USDA\EFH2**
5. Cut and paste **county.NY** and **type.rf** to this location

Important Note: In some cases, you may need to create these folders "Program Files (x86)", "USDA" and "EFH2". Any county.ny and type.rf files located at C:\ProgramFiles(X86)\USDA\EFH2 will only be used by the EFH-2 computer program if no database files exist at the location in #4 above. The EFH-2 Program will only read files with the extension .NY or .rf. If a database files has any other extension name then change the extension to the acceptable name.

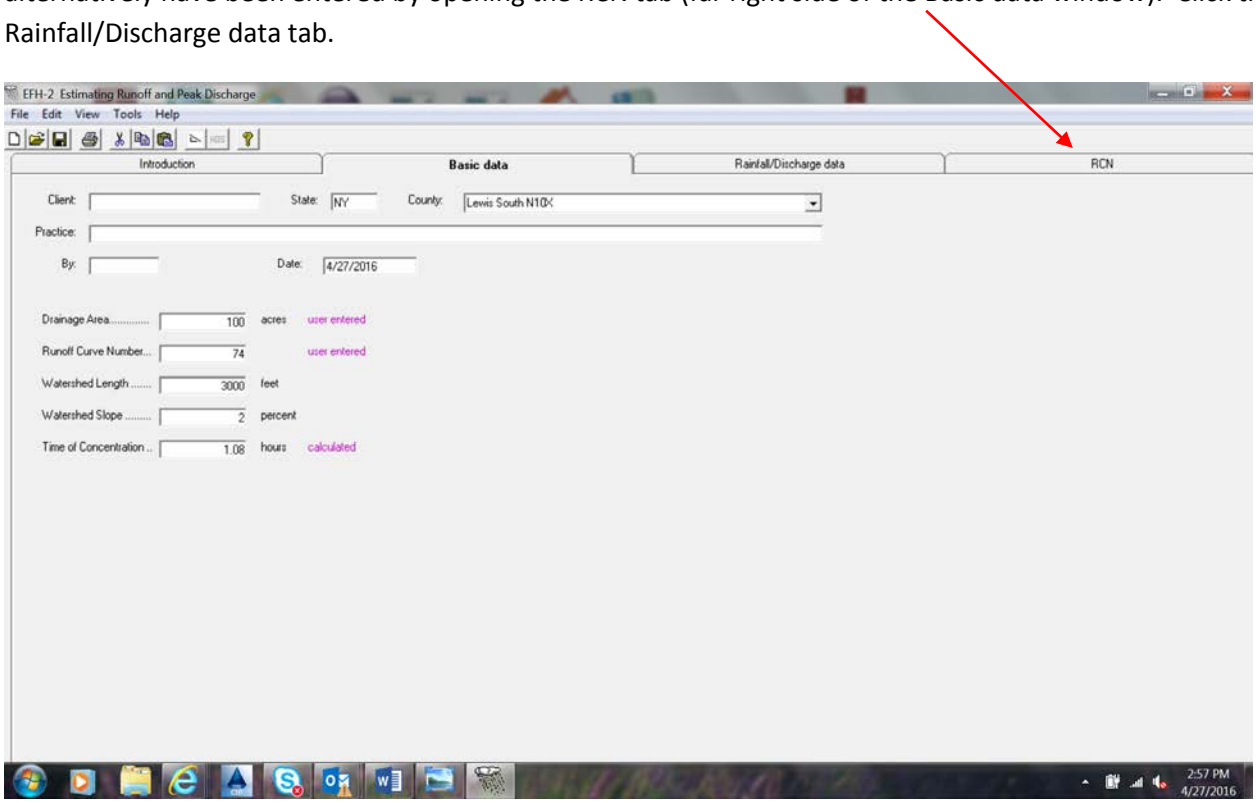
Example Application of the EFH-2 Computer Program in New York

For this example, we select a small watershed in Southern Lewis County. The drainage area is 100 acres, the curve number is 74, length is 3000 feet, and watershed slope is 2 percent. From the rainfall distribution map above, the rainfall distribution region is "N10_C". From the county rainfall map shown above the site is located in the Lewis South region.

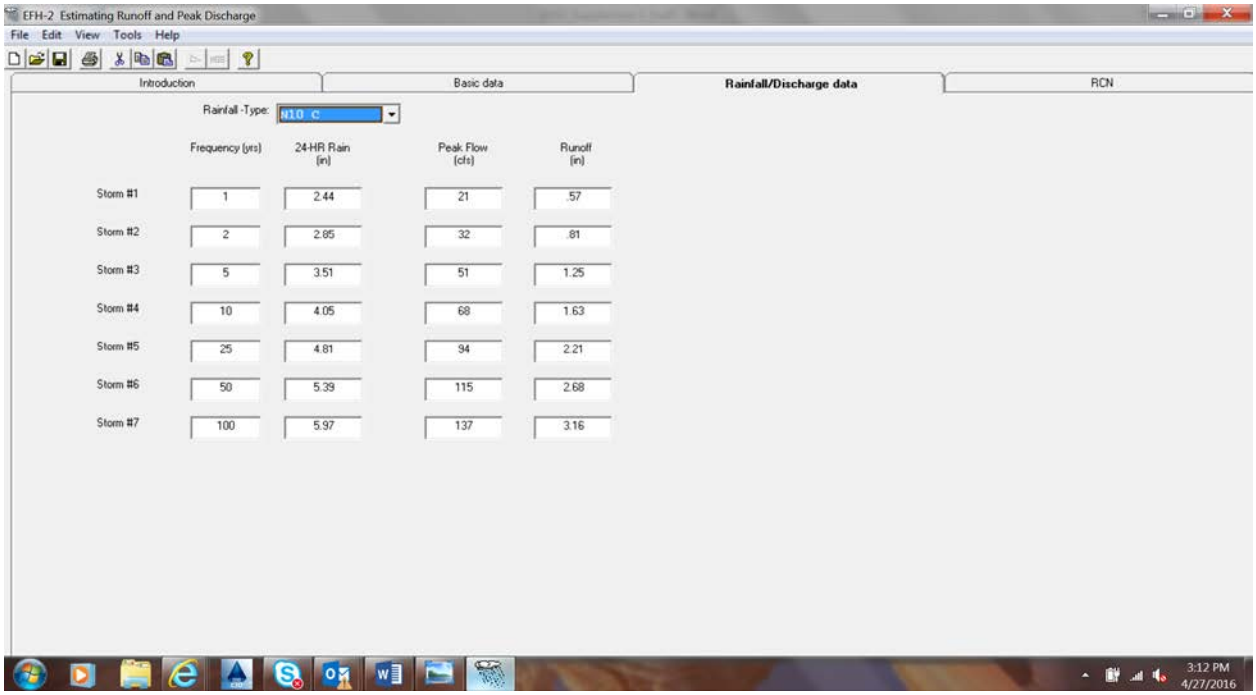
Open the EFH-2 computer program and open the Basic Data tab. Enter State: NY and use the County pull-down menu to select Lewis South N10X County.



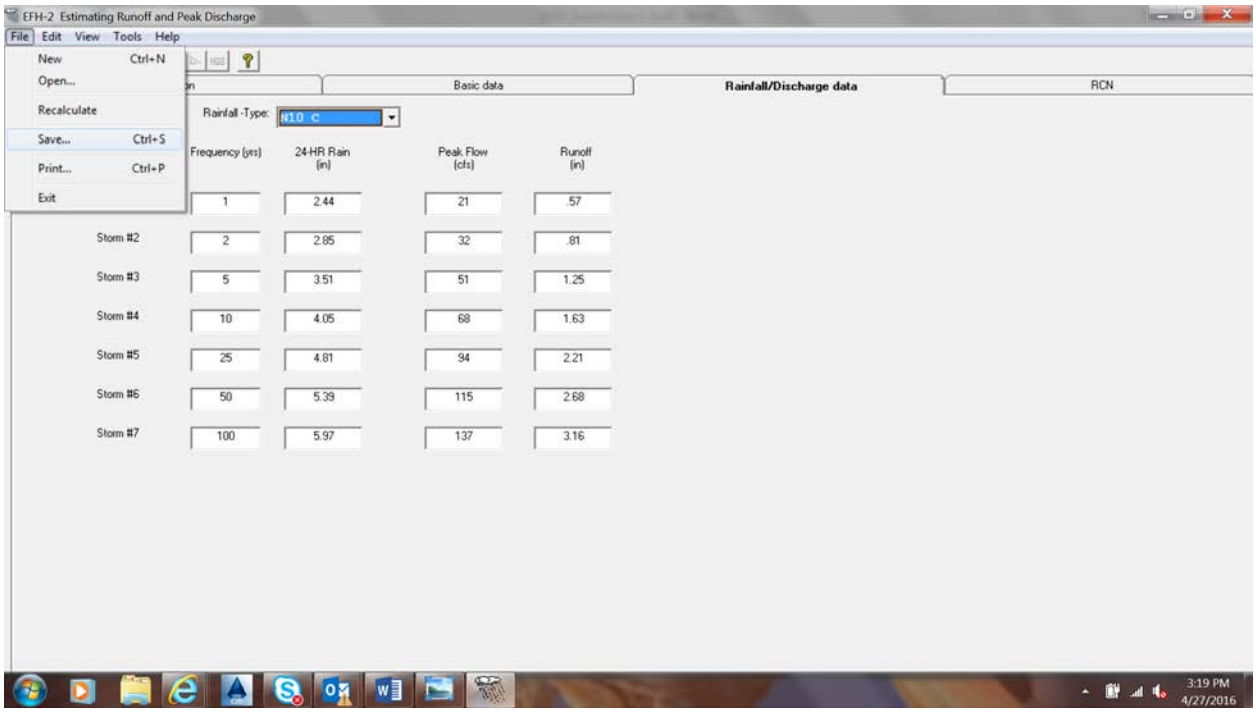
Enter the remaining data on this window. The Drainage Area and Runoff Curve Number could alternatively have been entered by opening the RCN tab (far right side of the Basic data window). Click the Rainfall/Discharge data tab.



From the rainfall distribution map in Appendix 1, the rainfall distribution region for Lewis South County is either “N10_B” or “N10_C”. Determine your specific location on the Topographic Quadrant maps. Use the Rainfall Type pull down menu and select N10_C.



The peak discharge and runoff volumes have been calculated and automatically entered into the table. To complete the project, click File Save and File Print.



Appendix 1. Split County Rainfall Precipitation maps

Figure 3: Albany County Rainfall Precipitation Split

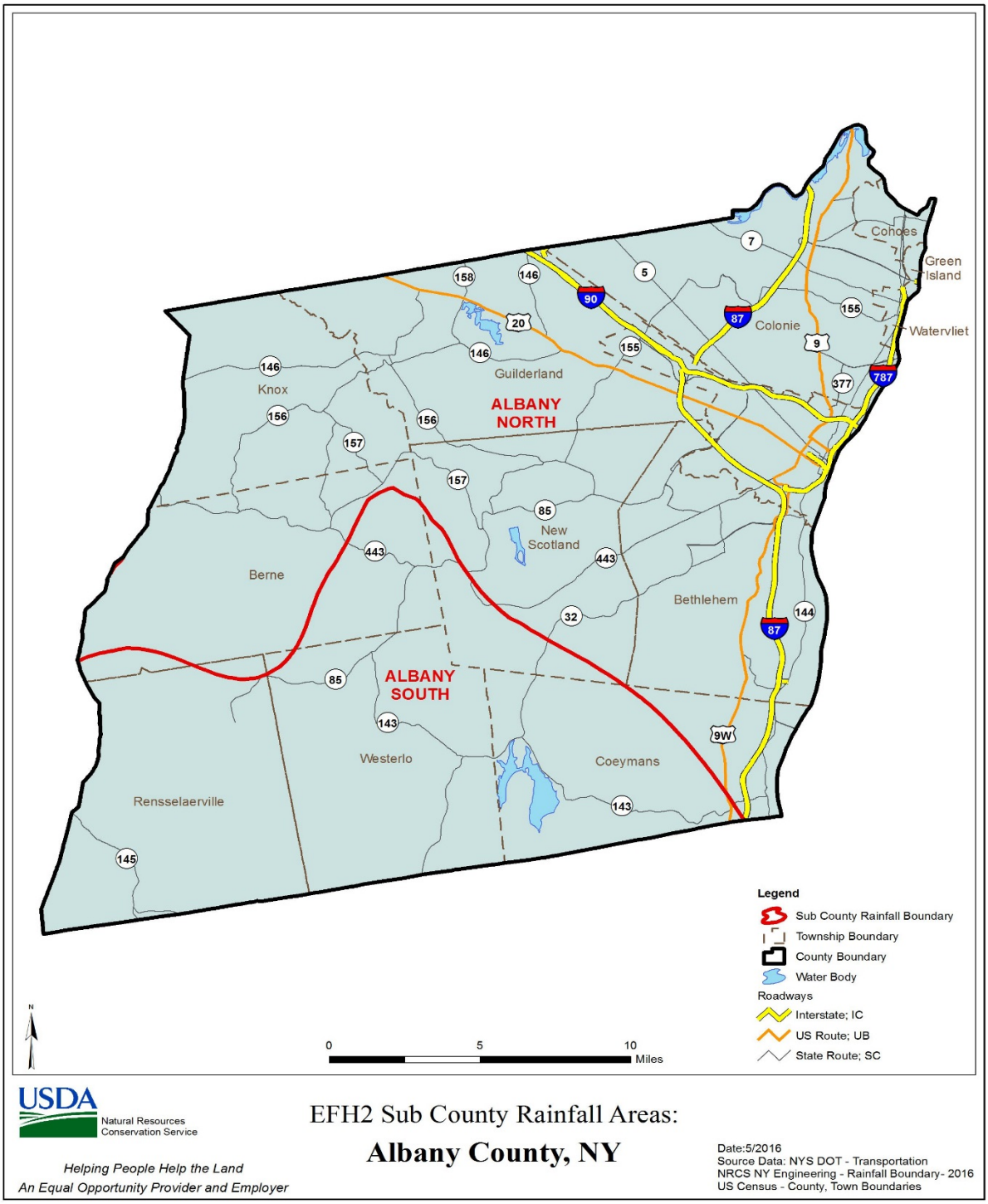
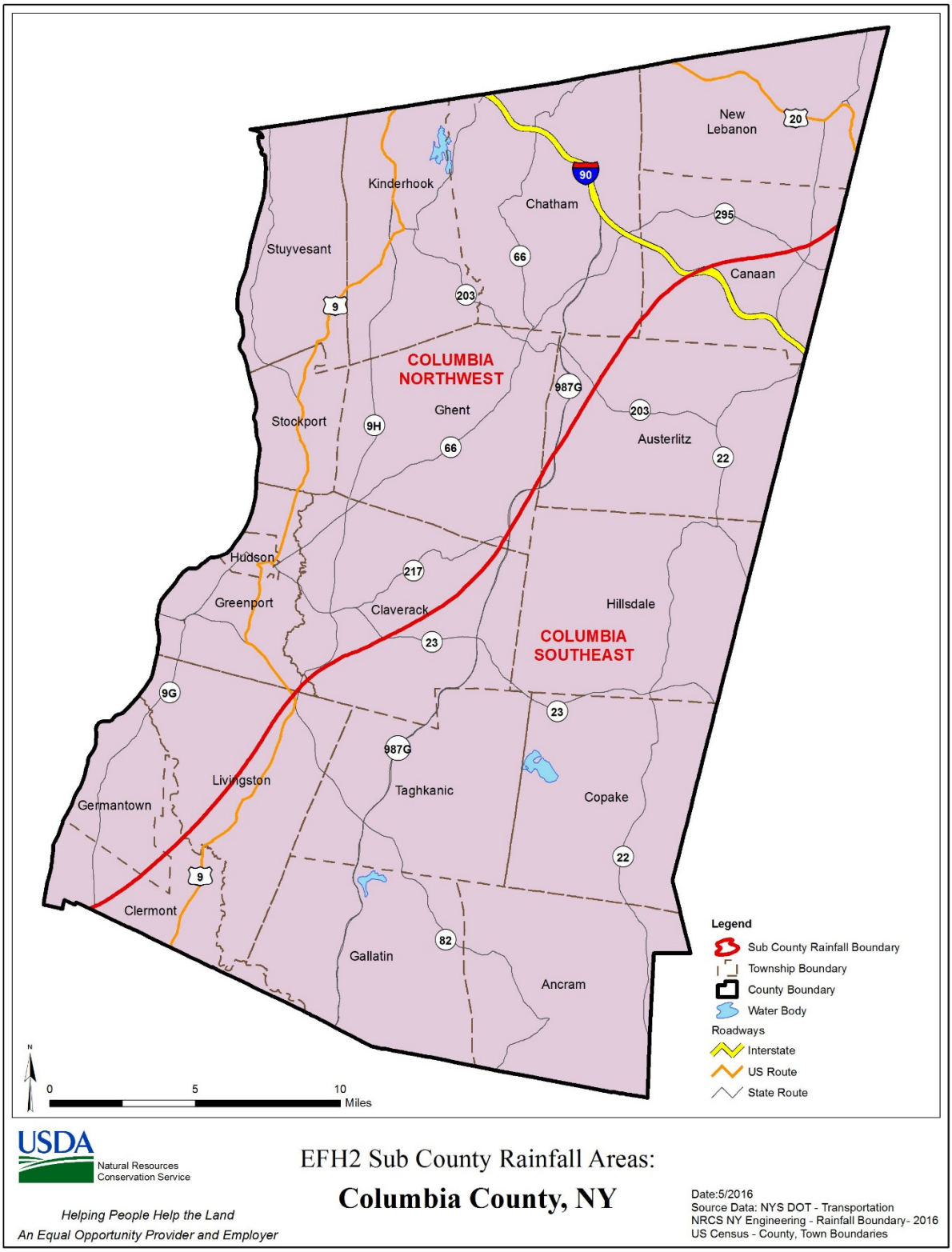


Figure 4: Columbia County Rainfall Precipitation Split



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EFH2 Sub County Rainfall Areas:

Columbia County, NY

Date:5/2016
Source Data: NYS DOT - Transportation
NRCS NY Engineering - Rainfall Boundary- 2016
US Census - County, Town Boundaries

Figure 5: Delaware County Rainfall Precipitation Split

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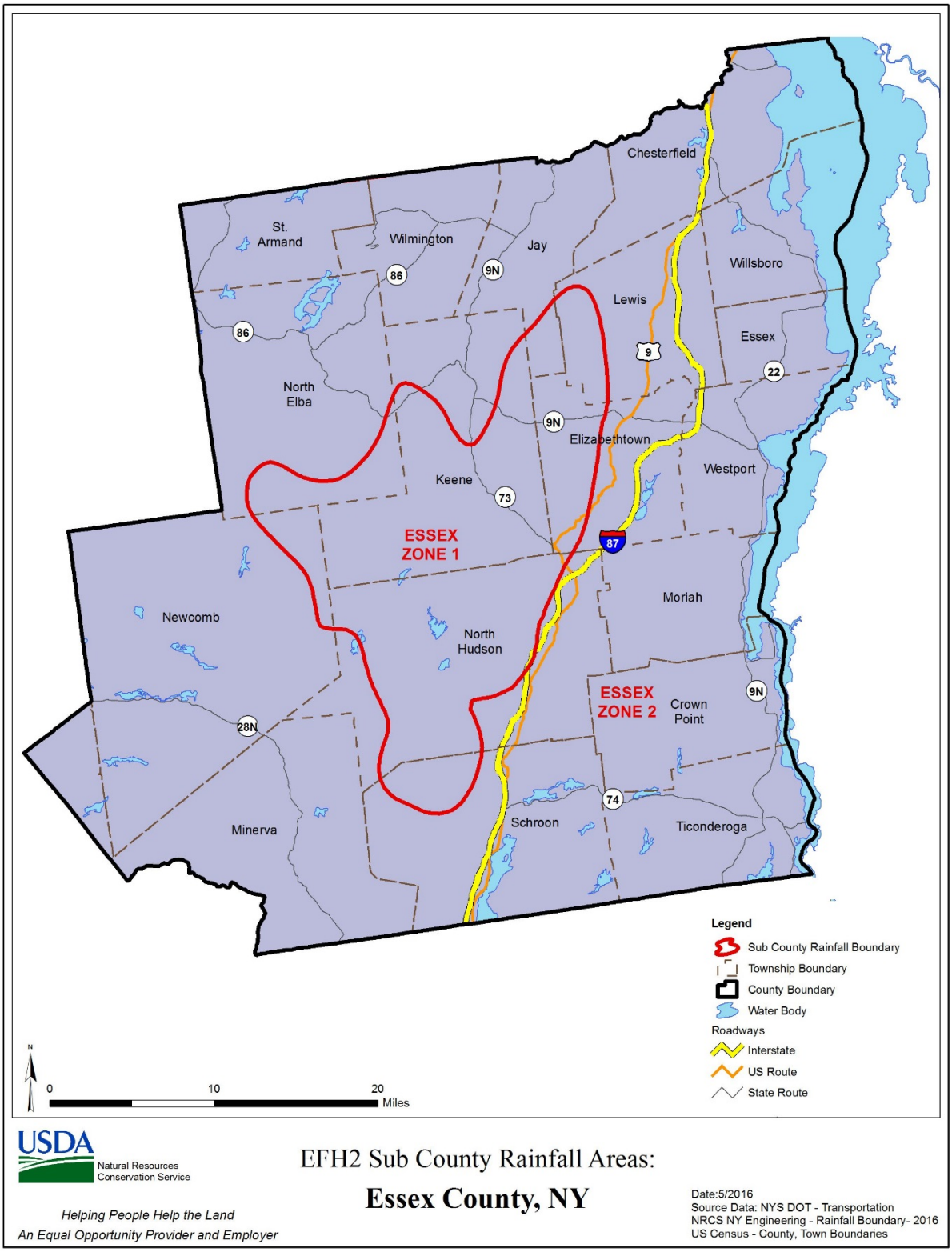
EFH2 Sub County Rainfall Areas:

Delaware County, NY

Date:5/2016
Source Data: NYS DOT - Transportation
NRCS NY Engineering - Rainfall Boundary- 2016
US Census - County, Town Boundaries

Figure 6: Essex County Rainfall Precipitation Split



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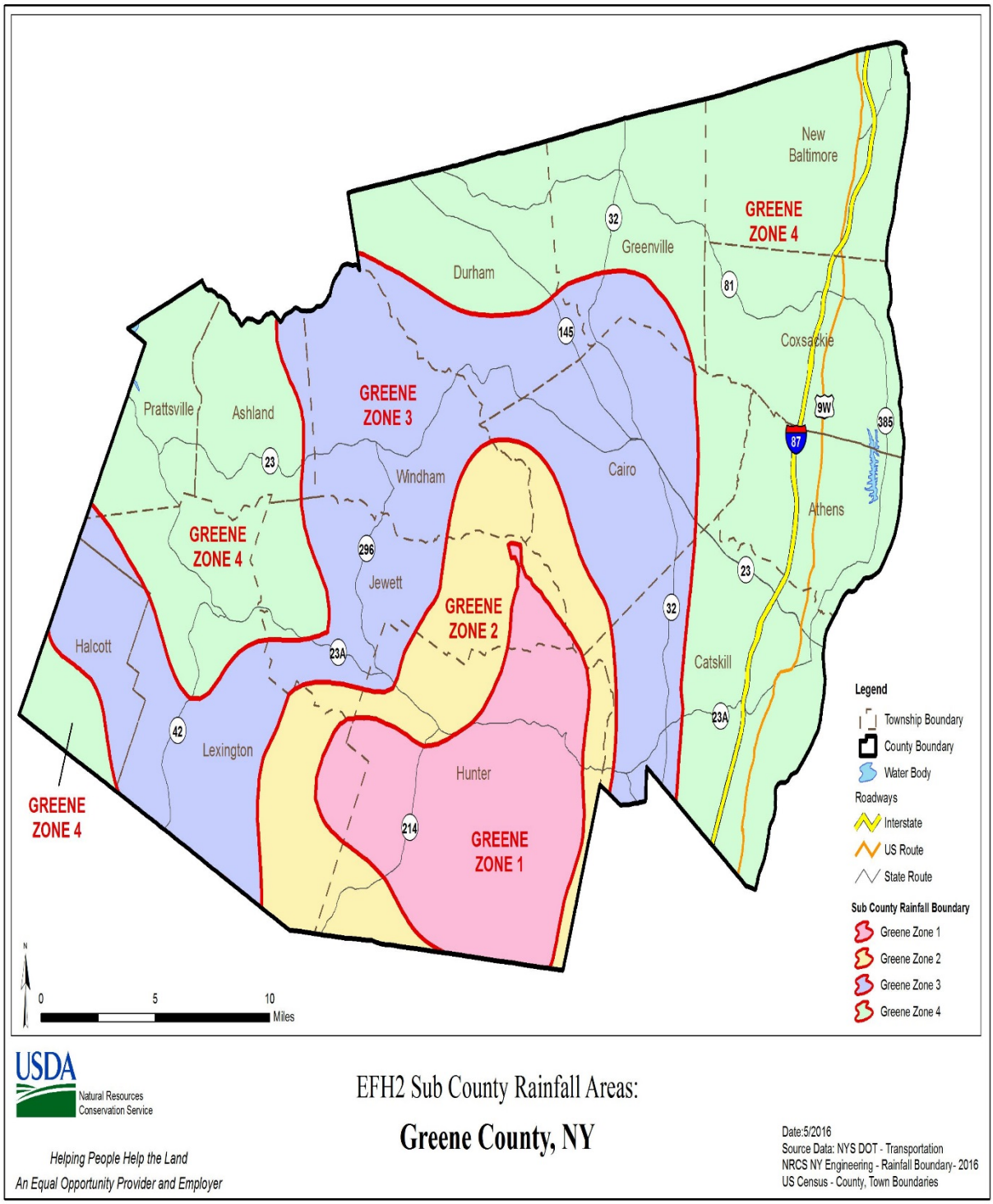
EFH2 Sub County Rainfall Areas:

Essex County, NY

Date:5/2016
Source Data: NYS DOT - Transportation
NRCS NY Engineering - Rainfall Boundary- 2016
US Census - County, Town Boundaries

Figure 7: Greene County Rainfall Precipitation Split



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EFH2 Sub County Rainfall Areas:

Greene County, NY

Date:5/2016
Source Data: NYS DOT - Transportation
NRCS NY Engineering - Rainfall Boundary- 2016
US Census - County, Town Boundaries

Figure 8: Hamilton County Rainfall Precipitation Split

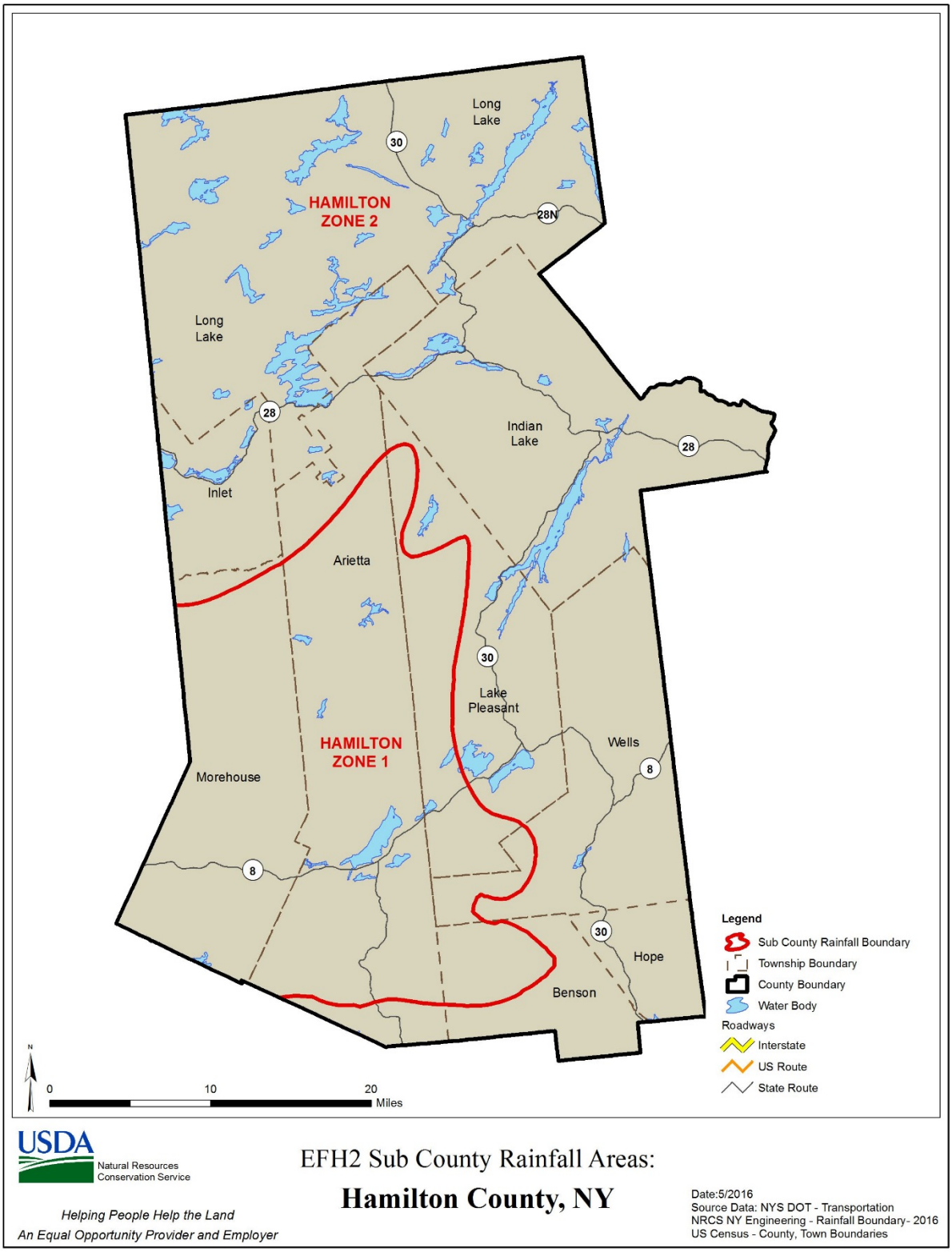
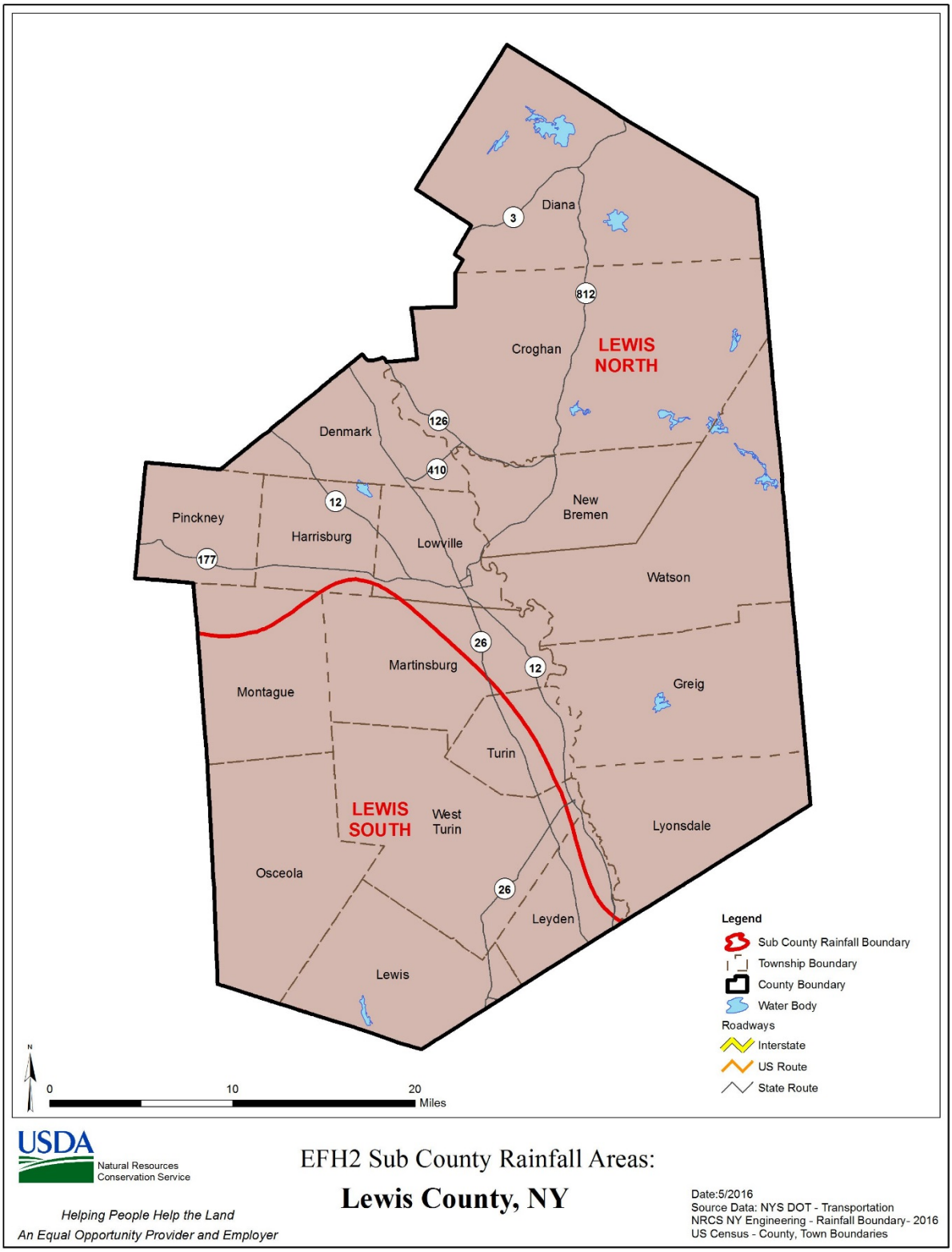


Figure 9: Lewis County Rainfall Precipitation Split



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EFH2 Sub County Rainfall Areas:

Lewis County, NY

Date:5/2016
Source Data: NYS DOT - Transportation
NRCS NY Engineering - Rainfall Boundary- 2016
US Census - County, Town Boundaries

Figure 10: Orange County Rainfall Precipitation Split

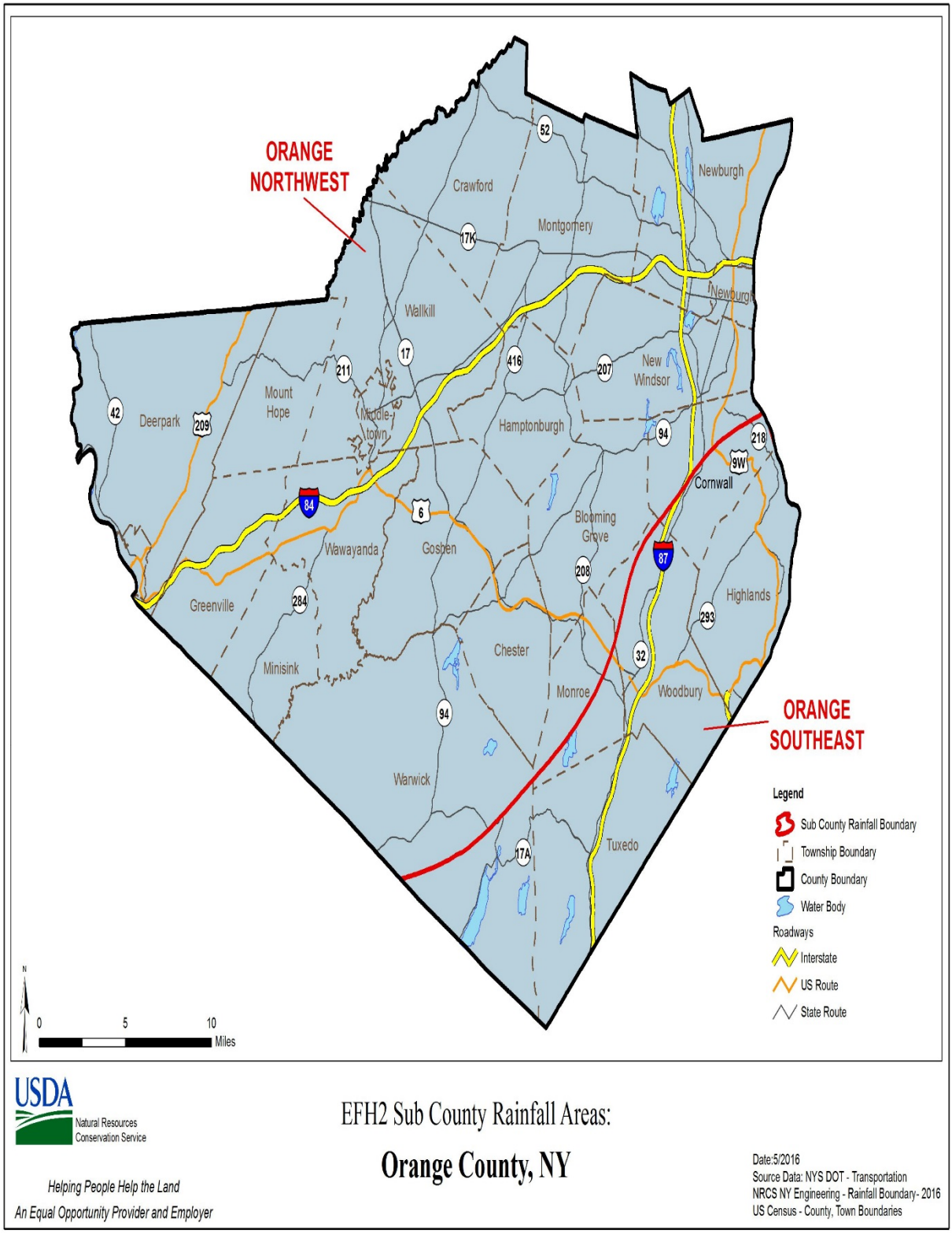


Figure 11: Schoharie County Rainfall Precipitation Split

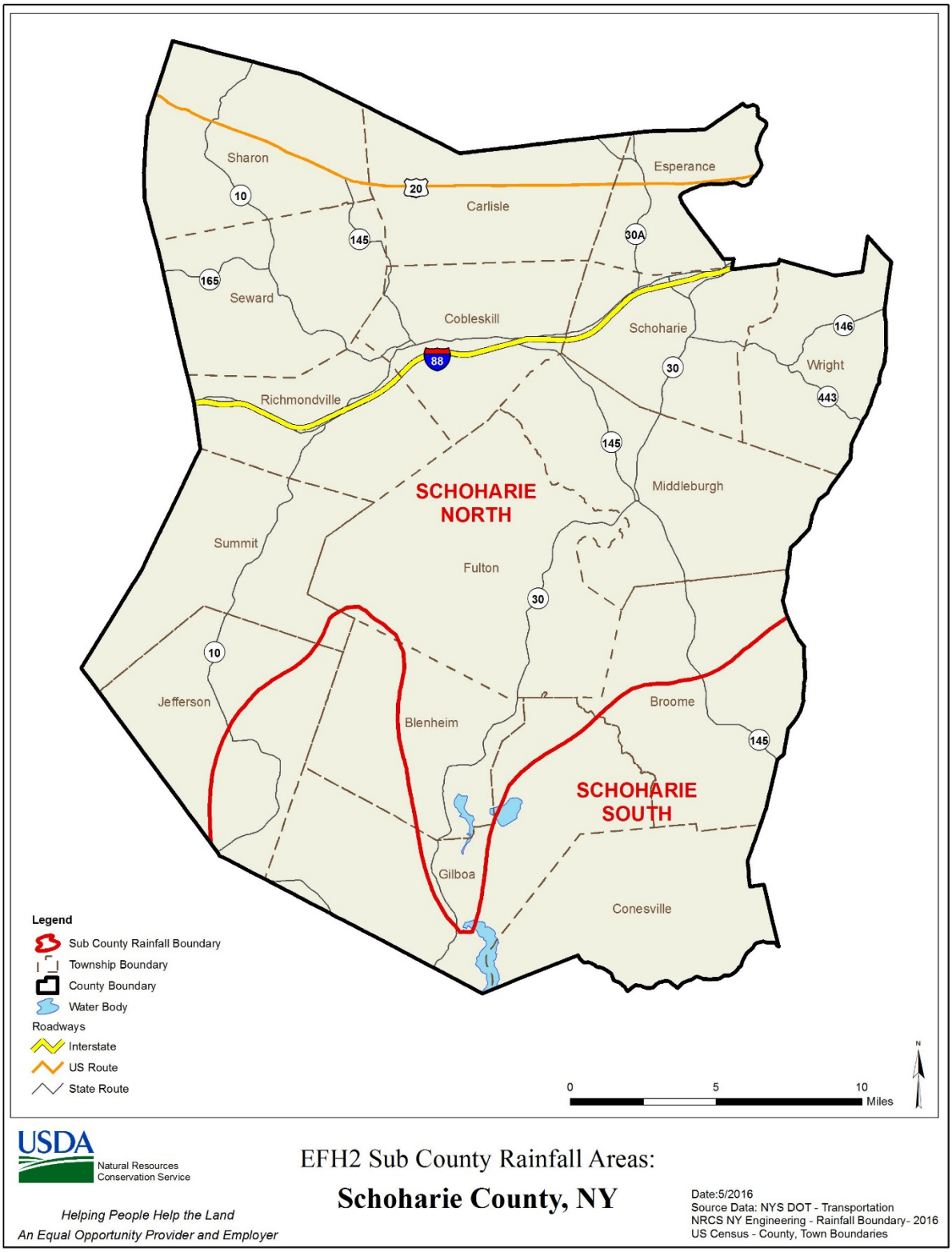
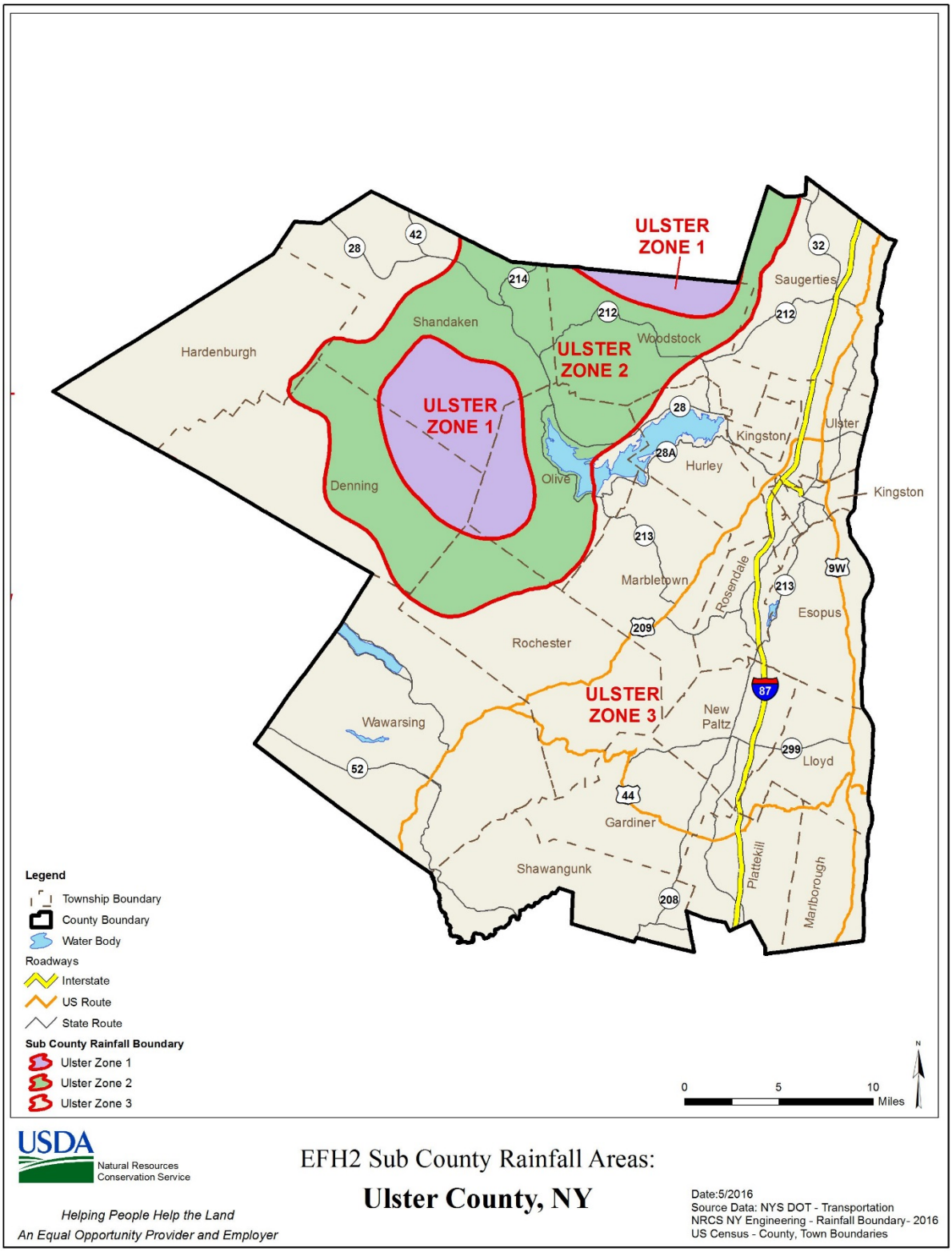


Figure 12: Ulster County Rainfall Precipitation Split



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EFH2 Sub County Rainfall Areas:

Ulster County, NY

Date:5/2016
Source Data: NYS DOT - Transportation
NRCS NY Engineering - Rainfall Boundary- 2016
US Census - County, Town Boundaries

Appendix 2: County rainfall database (county.NY) (Note: The 24 hour rainfall duration values are in inches)

Table 1: New York State County Rainfall Precipitation by Frequency

County	1-Yr	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Albany North N10X	2.17	2.61	3.33	3.93	4.75	5.39	6.02
Albany South N10X	2.35	2.88	3.74	4.46	5.44	6.20	6.96
Allegany N10X	1.95	2.35	3.01	3.55	4.30	4.87	5.45
Bronx N10X	2.78	3.42	4.47	5.34	6.53	7.46	8.38
Brooklyn N10X	2.83	3.48	4.54	5.42	6.63	7.57	8.50
Broome N10X	2.13	2.61	3.38	4.02	4.91	5.59	6.27
Cattaraugus N10X	1.96	2.36	3.02	3.57	4.33	4.91	5.49
Cayuga N10X	1.94	2.32	2.94	3.46	4.17	4.72	5.27
Chautauqua N10X	2.10	2.52	3.20	3.77	4.55	5.15	5.75
Chemung N10X	2.00	2.44	3.16	3.76	4.58	5.21	5.84
Chenango N10X	2.10	2.52	3.23	3.81	4.61	5.22	5.84
Clinton N10X	1.86	2.21	2.78	3.25	3.90	4.40	4.90
Columbia Northwest N10X	2.32	2.86	3.75	4.48	5.49	6.27	7.05
Columbia Southeast N10X	2.46	3.08	4.09	4.92	6.08	6.96	7.85
Cortland N10X	1.98	2.42	3.13	3.72	4.54	5.16	5.79
Delaware Northwest N10X	2.29	2.79	3.29	3.79	4.29	4.79	5.29
Delaware Southeast N10X	2.55	3.09	3.97	4.71	5.72	6.50	7.28
Dutchess N10X	2.50	3.15	4.20	5.07	6.26	7.19	8.11
Erie N10X	1.91	2.29	2.92	3.44	4.15	4.70	5.25
Essex Zone 1 N10X	2.32	2.72	3.38	3.93	4.68	5.27	5.85
Essex Zone 2 N10X	2.21	2.56	3.13	3.61	4.26	4.77	5.27
Franklin N10X	1.98	2.32	2.87	3.32	3.95	4.44	4.92
Fulton N10X	2.24	2.58	3.14	3.61	4.25	4.74	5.23
Genesee N10X	1.93	2.27	2.82	3.28	3.91	4.40	4.89
Greene Zone 1 N10X	3.73	4.64	6.12	7.35	9.04	10.35	11.66
Greene Zone 2 N10X	3.29	4.09	5.40	6.49	7.99	9.14	10.30
Greene Zone 3 N10X	2.77	3.43	4.51	5.41	6.64	7.60	8.55
Greene Zone 4 N10X	2.44	3.00	3.94	4.71	5.77	6.59	7.41
Hamilton Zone 1 N10X	2.46	2.85	3.50	4.04	4.77	5.34	5.91
Hamilton Zone 2 N10X	2.24	2.58	3.14	3.60	4.24	4.73	5.22
Herkimer N10X	2.28	2.64	3.22	3.71	4.37	4.89	5.40
Jefferson N10X	2.08	2.43	3.00	3.46	4.11	4.61	5.11
Lewis North N10X	2.15	2.50	3.06	3.53	4.18	4.68	5.18
Lewis South N10X	2.44	2.85	3.51	4.05	4.81	5.39	5.97
Livingston N10X	1.90	2.22	2.76	3.20	3.81	4.28	4.75
Madison N10X	2.13	2.50	3.10	3.60	4.29	4.83	5.36

County	1-Yr	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Manhattan Island N10X	2.86	3.53	4.63	5.55	6.80	7.77	8.74
Monroe N10X	1.87	2.18	2.70	3.13	3.73	4.18	4.64
Montgomery N10X	2.12	2.47	3.04	3.52	4.17	4.67	5.17
Nassau N10X	2.80	3.43	4.45	5.30	6.46	7.36	8.26
Niagara N10X	1.84	2.17	2.71	3.17	3.79	4.27	4.75
Oneida N10X	2.26	2.63	3.24	3.74	4.43	4.97	5.50
Onondaga N10X	2.02	2.39	3.00	3.50	4.19	4.72	5.25
Ontario N10X	1.88	2.21	2.76	3.22	3.85	4.33	4.81
Orange Northwest N10X	2.53	3.14	4.13	4.96	6.09	6.96	7.84
Orange Southeast N10X	2.85	3.56	4.71	5.67	6.99	8.00	9.02
Orleans N10X	1.82	2.16	2.70	3.16	3.78	4.26	4.74
Oswego N10X	2.15	2.51	3.11	3.60	4.28	4.80	5.32
Otsego N10X	2.09	2.50	3.18	3.74	4.51	5.11	5.70
Putnam N10X	2.88	3.54	4.62	5.52	6.76	7.71	8.66
Queens N10X	2.74	3.37	4.39	5.25	6.42	7.32	8.22
Rensselaer N10X	2.37	2.82	3.56	4.17	5.01	5.66	6.31
Rockland N10X	2.88	3.57	4.70	5.64	6.92	7.92	8.91
Saratoga N10X	2.31	2.69	3.31	3.83	4.54	5.08	5.63
Schenectady N10X	2.20	2.59	3.23	3.75	4.48	5.04	5.60
Schoharie North N10X	2.15	2.58	3.28	3.86	4.67	5.28	5.90
Schoharie South N10X	2.34	2.88	3.76	4.49	5.50	6.27	7.05
Schuyler N10X	1.97	2.39	3.09	3.66	4.46	5.07	5.68
Seneca N10X	1.89	2.26	2.86	3.35	4.04	4.57	5.10
St Lawrence N10X	2.00	2.33	2.86	3.31	3.92	4.39	4.86
Staten Island N10X	2.84	3.54	4.68	5.62	6.92	7.93	8.93
Steuben N10X	2.08	2.47	3.10	3.63	4.35	4.91	5.47
Suffolk N10X	2.85	3.52	4.61	5.51	6.75	7.70	8.66
Sullivan N10X	2.54	3.11	4.05	4.83	5.91	6.73	7.56
Tioga N10X	2.01	2.46	3.20	3.82	4.66	5.31	5.96
Tomkins N10X	1.98	2.43	3.17	3.78	4.62	5.26	5.91
Ulster Zone 1 N10X	3.51	4.34	5.70	6.83	8.39	9.59	10.79
Ulster Zone 2 N10X	3.08	3.81	4.99	5.98	7.33	8.38	9.42
Ulster Zone 3 N10X	2.64	3.27	4.28	5.13	6.29	7.18	8.08
Warren N10X	2.33	2.70	3.31	3.81	4.51	5.04	5.58
Washington N10X	2.29	2.68	3.31	3.84	4.56	5.12	5.68
Wayne N10X	1.92	2.26	2.81	3.27	3.90	4.38	4.87
Westchester N10X	2.96	3.59	4.62	5.47	6.64	7.55	8.45
Wyoming N10X	1.97	2.32	2.89	3.36	4.01	4.51	5.01
Yates N10X	1.97	2.34	2.95	3.46	4.15	4.68	5.22

Appendix 3. Equations and Rainfall Distribution Database (type.rf)

Peak discharge results of EFH-2 are derived from results of WinTR-20 runs. To simplify the estimation of peak discharge, WinTR-20 was run for times of concentration of 0.1 to 10.0 hours and Ia/P ratios of 0.1, 0.25, 0.3, 0.4, and 0.5. Ia is initial abstraction in units of inches. Initial abstraction includes all losses before runoff begins (interception, depression storage, early storm infiltration, etc…). P is the storm rainfall in units of inches.

Ia = 0.2 x ((1000/CN)-10) (Equation 1)

Where CN is NRCS runoff curve number.

Equations to relate time of concentration to unit peak discharge were then developed based on the WinTR-20 peak discharges. The equation used to compute the unit peak discharge (q) for the EFH-2 computer program is:

q=10 ^ (Coeff 1+ Coeff 2 * (LOG(Tc) + Coeff 3 * (LOG(Tc)) ^ 2) (Equation 2)

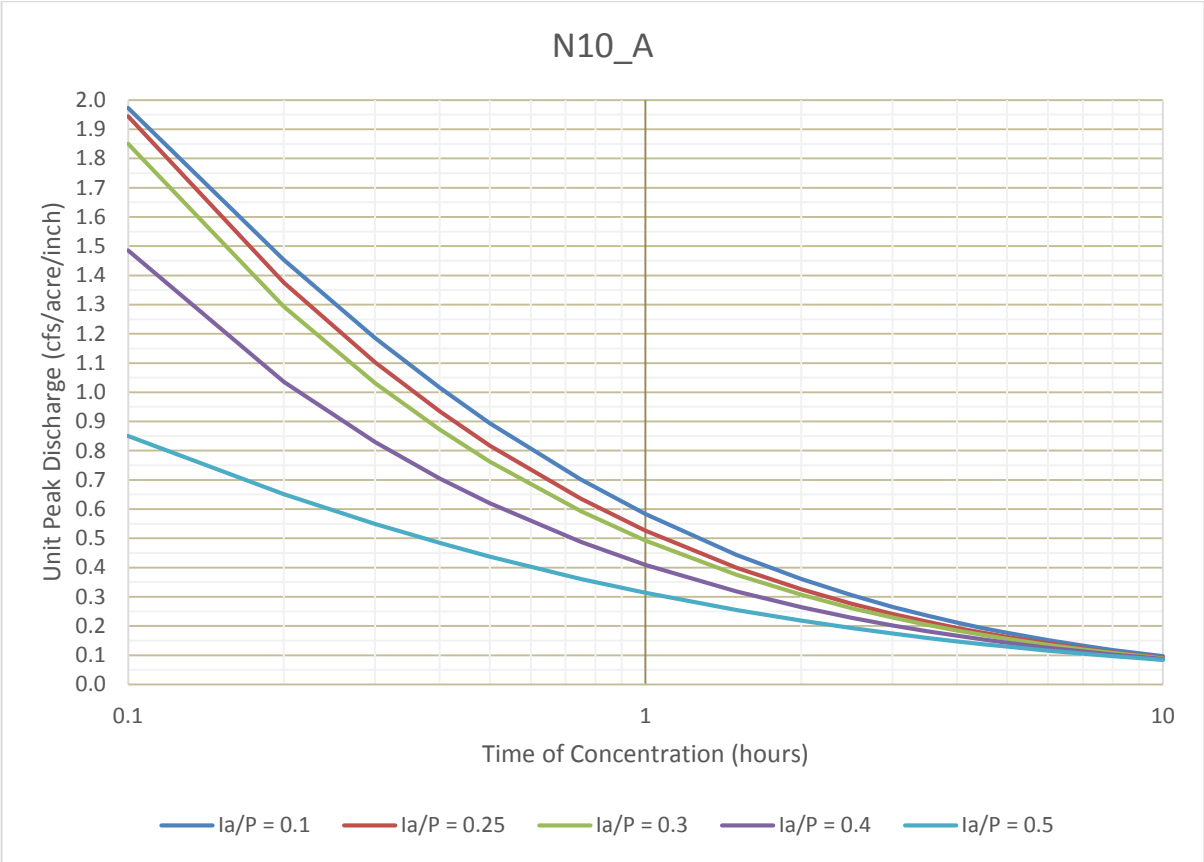
The coefficients to be used with each rainfall distribution are tabulated below. For example, the equation application to the N10_C rainfall distribution region of New York and a Ia/P of 0.1 is:

q=10 ^ (2.4686 - 0.623 * (LOG(Tc) - 0.0944 * (LOG(Tc)) ^ 2) (Equation 3)

For a time of concentration of 0.50 hours and a Ia/P of 0.1, the unit peak discharge is q= 453.88 cfs/square mile/inch. If the drainage area is 100 acres (0.156 square miles) and runoff of 2 inches the peak discharge is:

Q = 453.88 * 0.156 * 2 = 141.61 cfs (Equation 4)

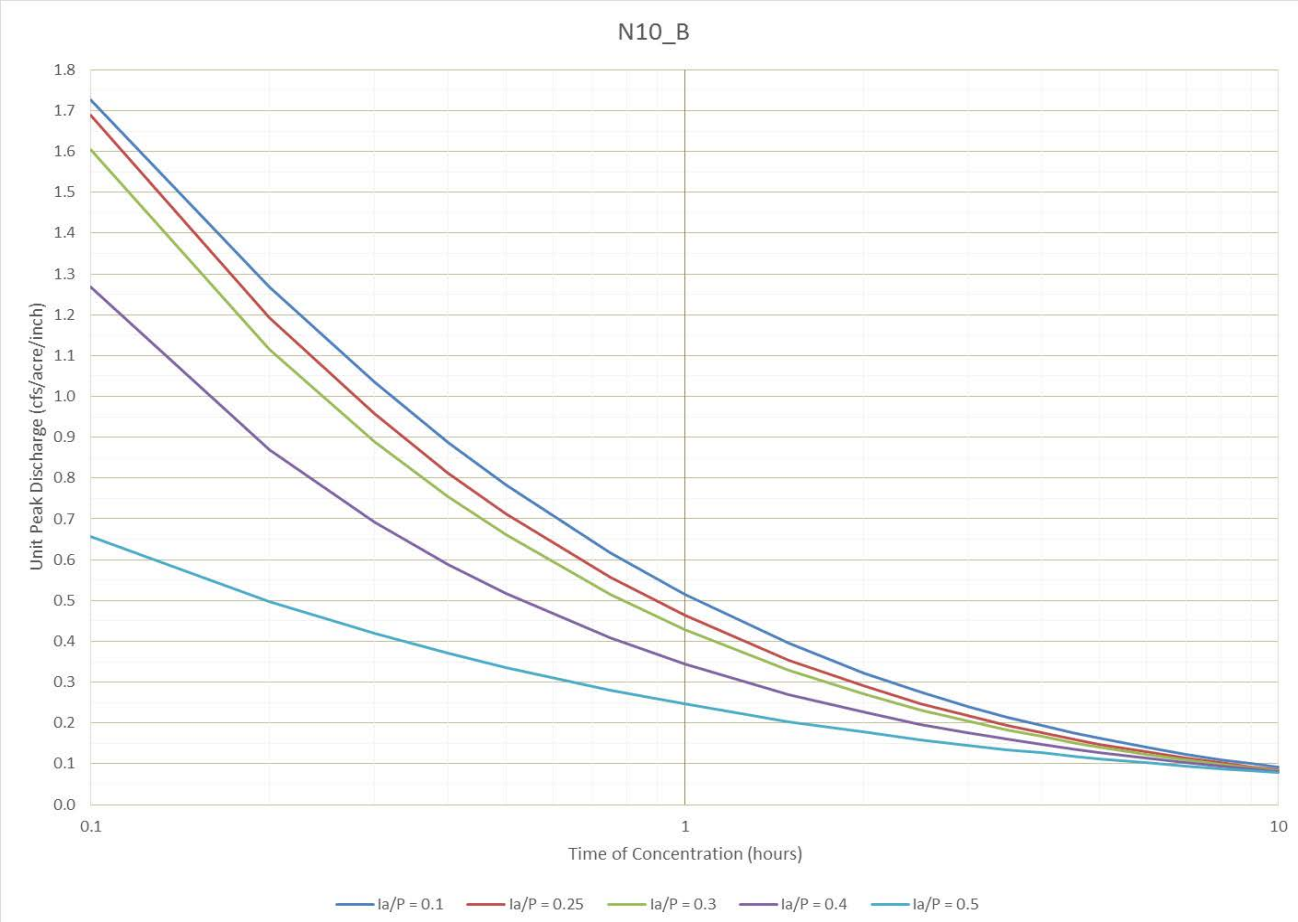
Figure 13: EFH-2 Peak Discharge Curves for N10_A



N10_A Rainfall Distribution Coefficients Database

Ia/P	Coeff 1	Coeff 2	Coeff 3
0.1	2.572	-0.6549	-0.1257
0.25	2.5277	-0.664	-0.0967
0.3	2.4983	-0.6577	-0.0827
0.4	2.4183	-0.6155	-0.0556
0.5	2.3023	-0.4024	-0.0691

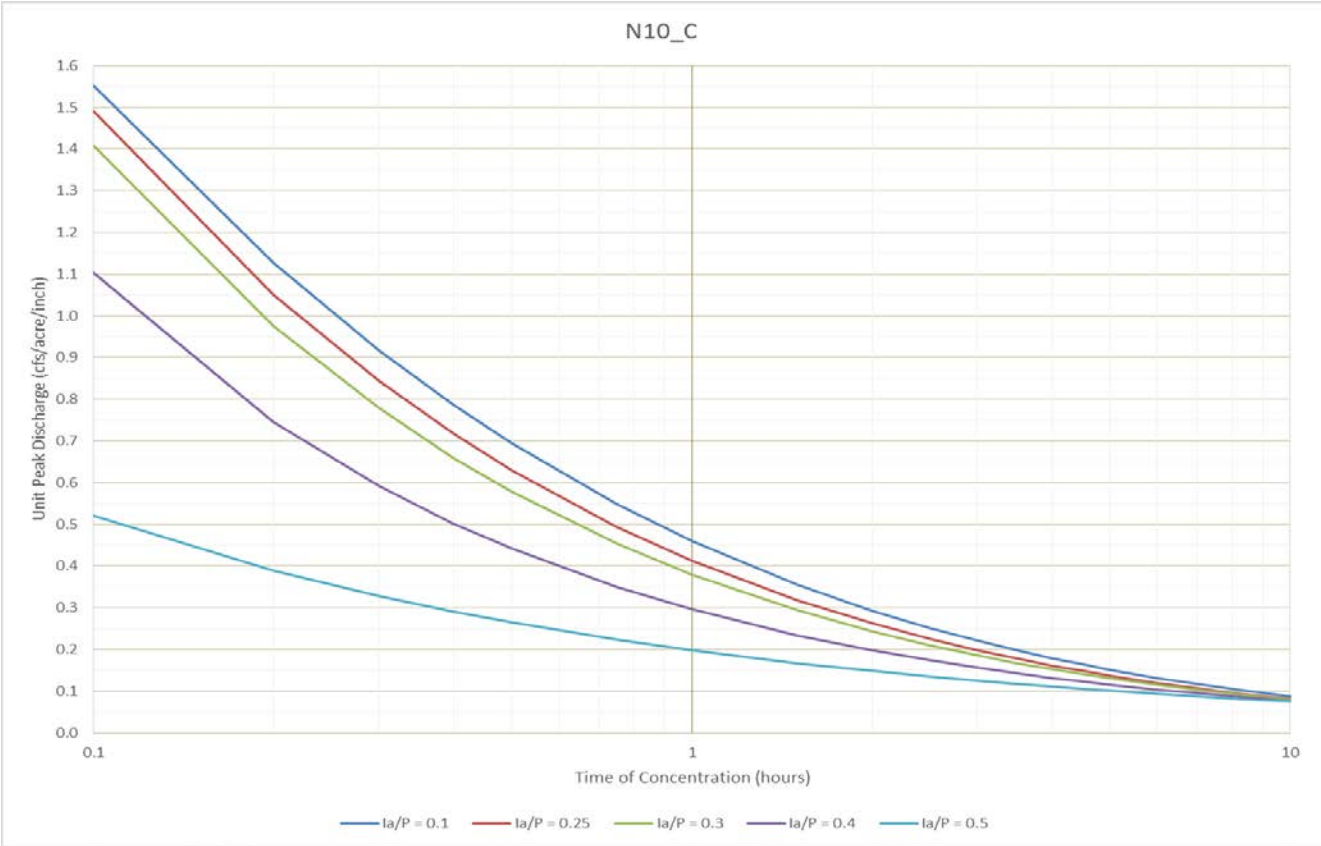
Figure 14: EFH-2 Peak Discharge Curves for N10_B



N10_B Rainfall Distribution Coefficients Database

Ia/P	Coeff 1	Coeff 2	Coeff 3
0.1	2.5181	-0.6379	-0.1126
0.25	2.4719	-0.6479	-0.0859
0.3	2.4391	-0.6418	-0.0694
0.4	2.3428	-0.5963	-0.0299
0.5	2.1975	-0.4601	-0.0341

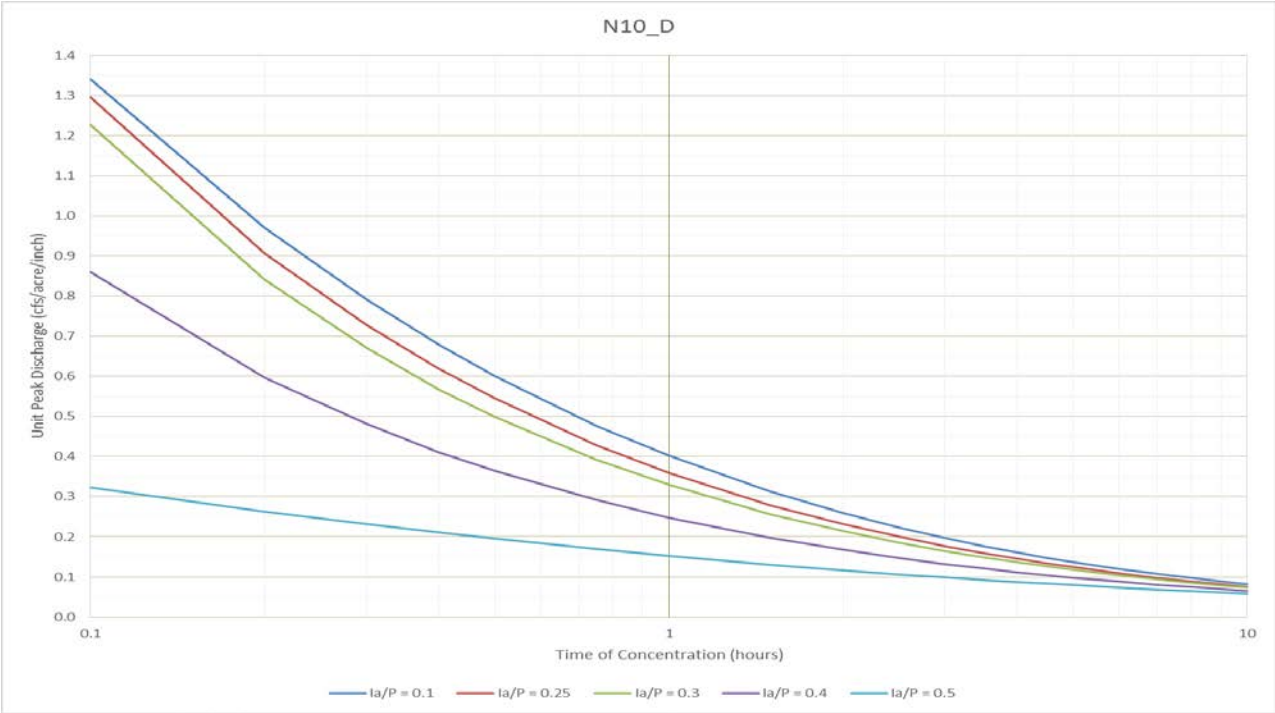
Figure 15: EFH-2 Peak Discharge Curves for N10_C



N10_C Rainfall Distribution Coefficients Database

Ia/p	Coeff 1	Coeff 2	Coeff 3
0.1	2.4686	-0.623	-0.0944
0.25	2.4218	-0.6325	-0.0746
0.3	2.3858	-0.624	-0.0551
0.4	2.2776	-0.5792	-0.0077
0.5	2.1034	-0.4198	-0.0001

Figure 16: EFH-2 Peak Discharge Curves for N10_D



N10_D Rainfall Distribution Coefficients Database

Ia/p	Coeff 1	Coeff 2	Coeff 3
0.1	2.4099	-0.6077	-0.084
0.25	2.3621	-0.6166	-0.0598
0.3	2.3242	-0.6106	-0.0397
0.4	2.2008	-0.5611	-0.0213
0.5	1.9901	-0.3712	-0.0465

Type II Rainfall Distribution Coefficients Database

Ia/p	Coeff 1	Coeff 2	Coeff 3
0.1	2.55323	-0.61512	-0.16403
0.3	2.46532	-0.62257	-0.11657
0.35	2.41896	-0.61594	-0.0882
0.4	2.36409	-0.59857	-0.05621
0.45	2.29238	-0.57005	-0.02281
0.5	2.20282	-0.51599	0.01259

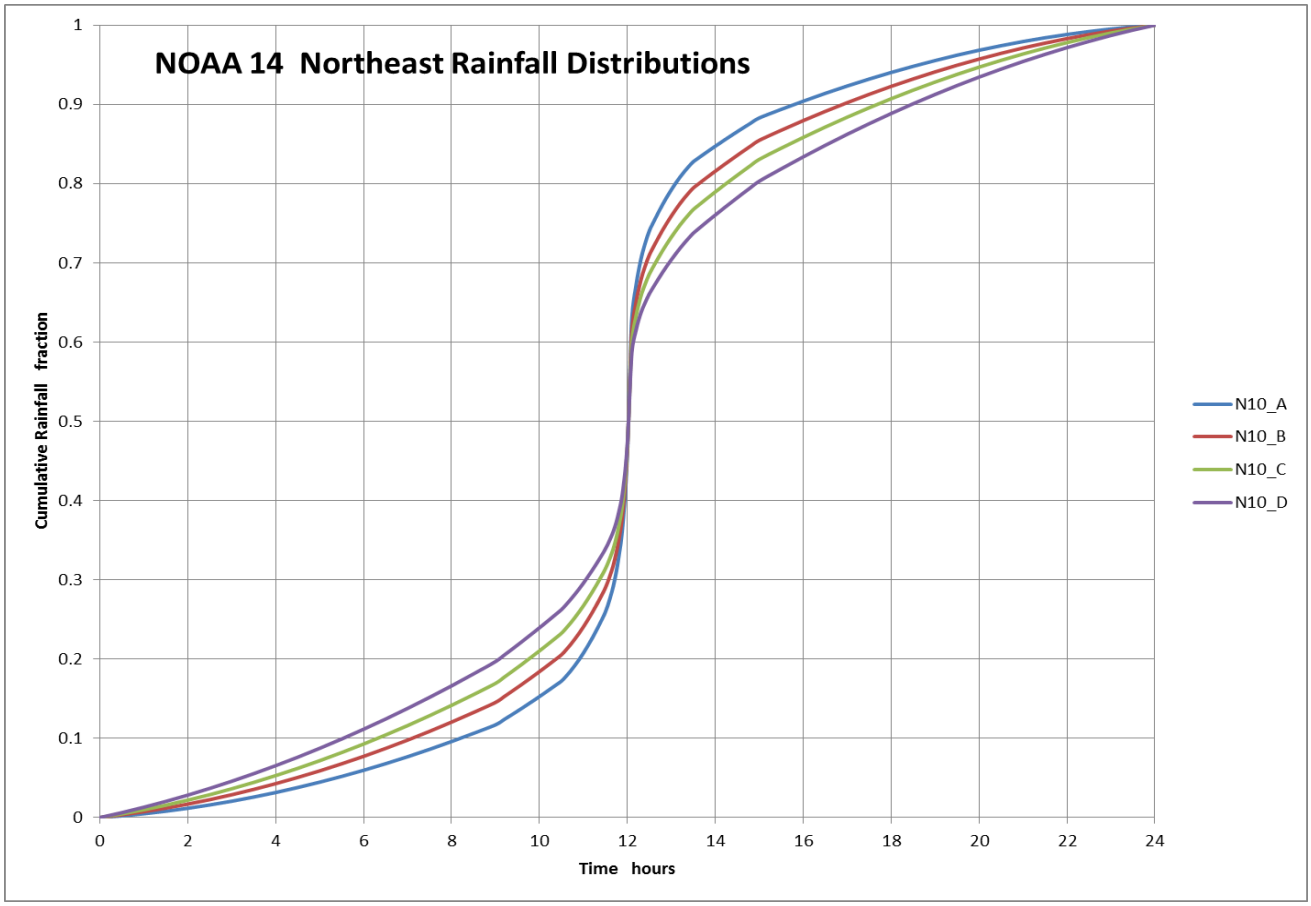
Type III Rainfall Distribution Coefficients Database

Ia/p	Coeff 1	Coeff 2	Coeff 3
0.1	2.47317	-0.51848	-0.17083
0.3	2.39628	-0.51202	-0.13245
0.35	2.35477	-0.49735	-0.11985
0.4	2.30726	-0.46541	-0.11094
0.45	2.24876	-0.41314	-0.11508
0.5	2.17772	-0.36803	-0.09525

Appendix 4: Plots of Rainfall Distributions

The following plots are for use with 24-hour design storms. They represent the accumulated rainfall during the 24-hour storm duration on a non-dimensional basis. The maximum accumulated rainfall in the plot is 1.0 which represents the total storm 24-hour rainfall.

Figure 17: NOAA 14 Volume 10 New York Rainfall Distributions



Appendix 5: EFH-2 Comparison of NOAA Atlas 14 Volume 10 versus NRCC Precipitation Data

William Merkel, Hydraulic Engineer, NRCS, Beltsville, MD

October 6, 2015

Modified 29 July 2016 – Removed New England State figures

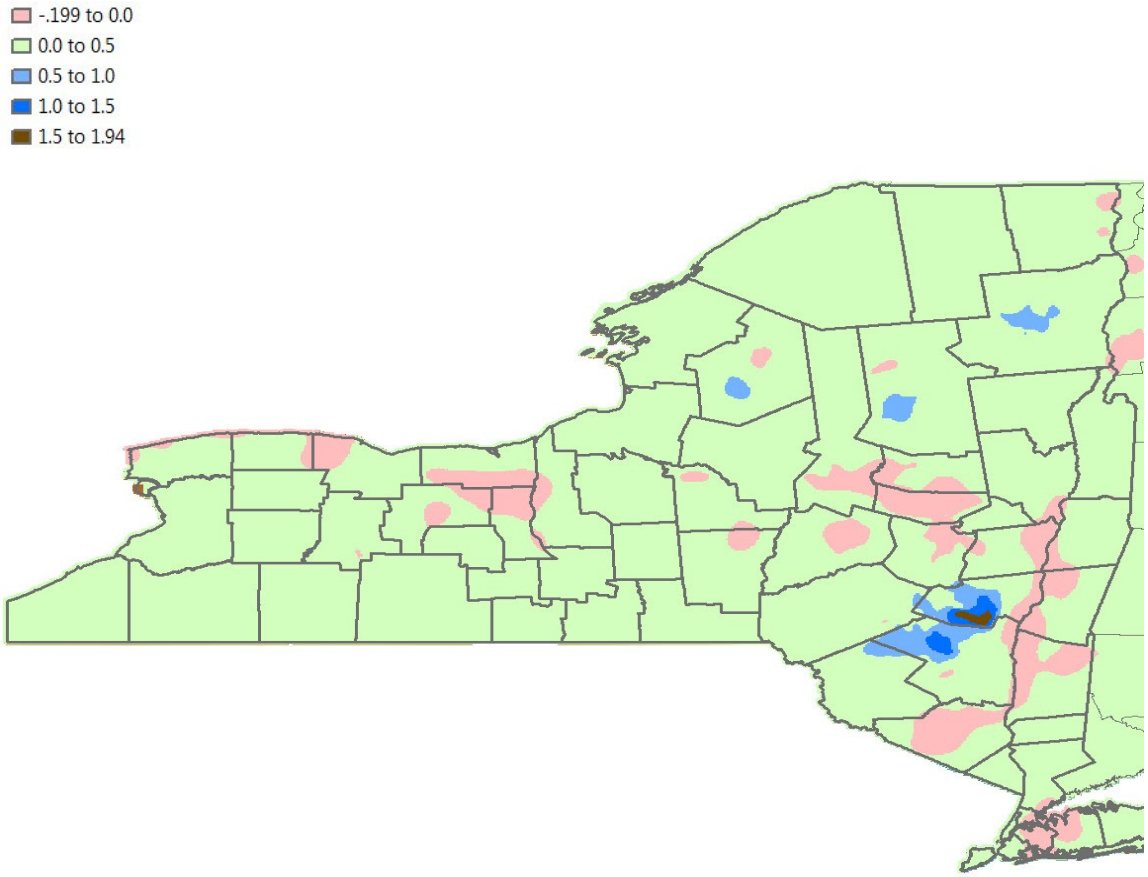
Background

In 2012 the Northeast Regional Climate Center (NRCC) published a precipitation frequency atlas for New York and New England states. In 2015, NOAA National Weather Service (NWS) published Volume 10 of NOAA Atlas 14.

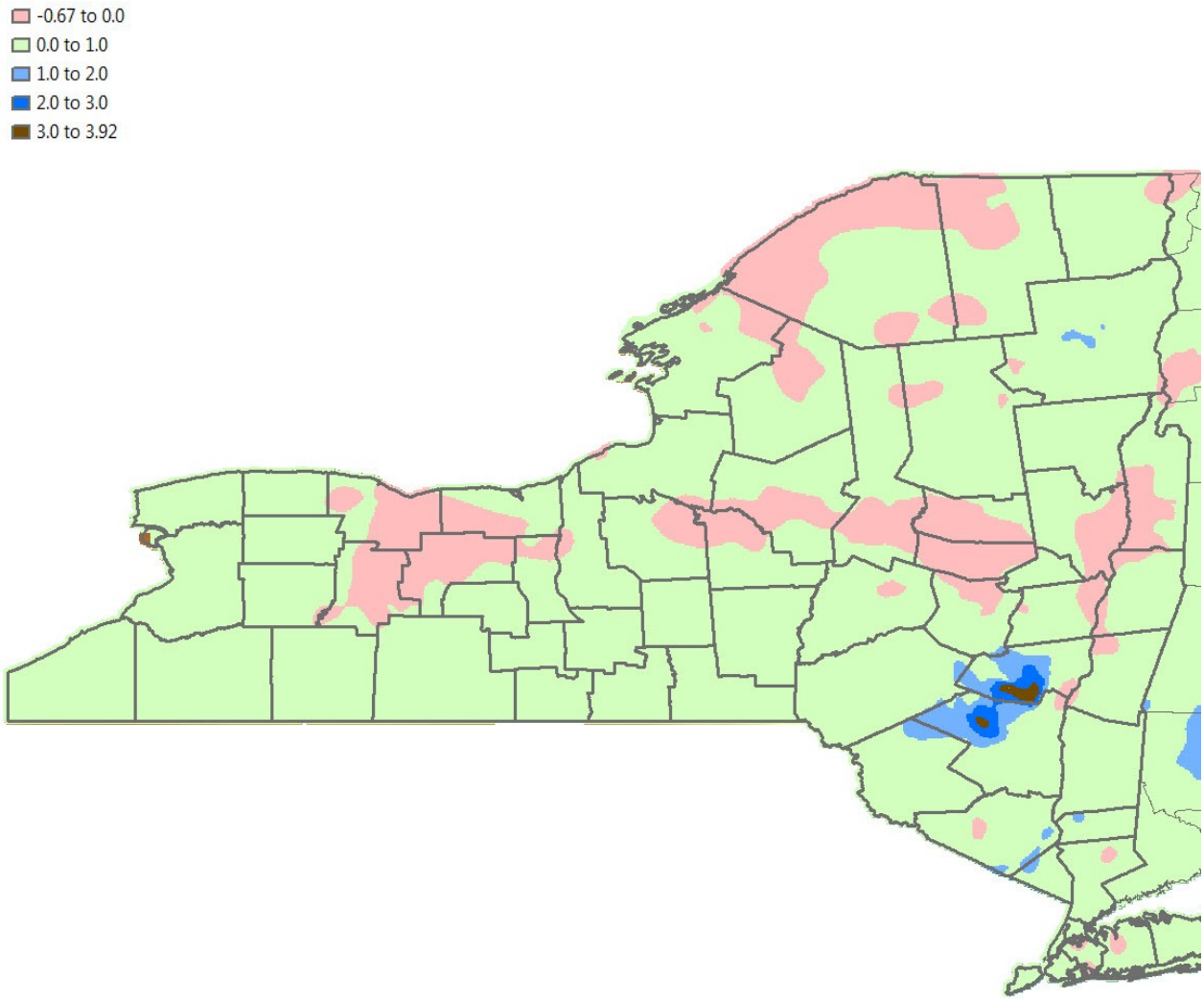
This brief document shows the differences between NOAA Atlas 14 and NRCC precipitation values for the 2-year 24-hour, 25-year-24-hour, and 100-year 24-hour precipitation values. GIS grids were downloaded for the respective web sites and prepared for display.

Comparisons

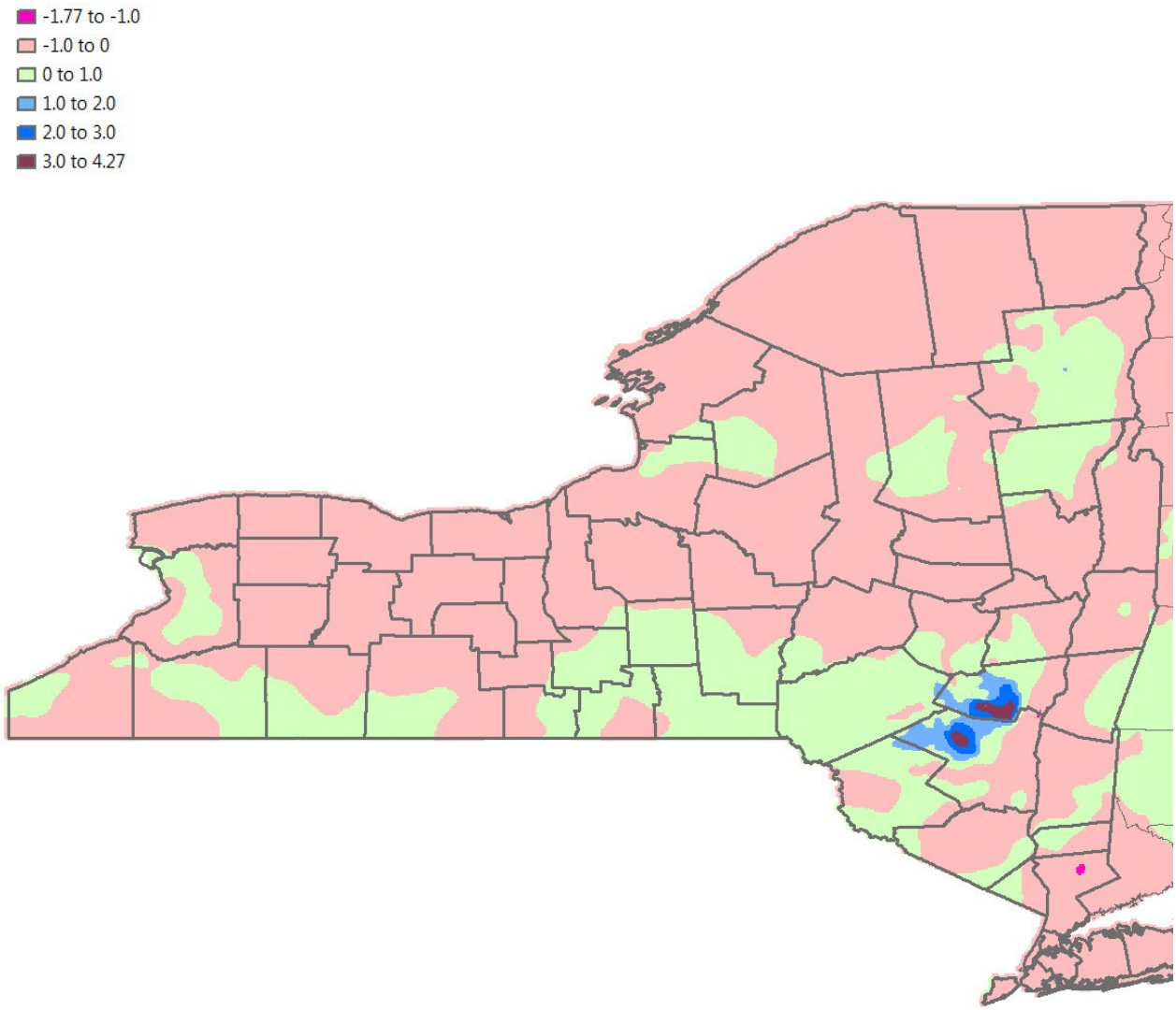
The difference computed from the GIS grids are the value from NOAA Atlas 14 minus the value from the NRCC. The differences are computed in units of inches. So a positive difference means the NOAA Atlas 14 value is larger and a negative difference means the NOAA Atlas 14 value is less than the NRCC value.



Difference in 2-year 24-hour precipitation in inches (map above and legend below)



Difference in 25-year 24-hour precipitation in inches (map above and legend below)



Difference in 100-year 24-hour precipitation in inches (map above and legend below)

Discussion

NOAA Atlas 14 is generally greater for the 2-year and 25-year 24-hour precipitations. NOAA Atlas 14 is generally lower for the 100-year 24-hour precipitation.

The following table shows the percentages of area that are in each of the categories included in the 2-year 24-hour legend.

Range of 2-yr 24-hr Precipitation Difference (Inches)	Percent of Total Area
-0.199 to 0.0	8.04
0.0 to 0.5	89.19
0.5 to 1.0	2.46
1.0 to 1.5	0.26
1.5 to 1.94	0.05
Total	100.00

The following table shows the percentages of area that are in each of the categories included in the 25-year 24-hour legend.

Range of 25-yr 24-hr Precipitation (Inches)	Percent of Total Area
-0.67 to 0.0	16.33
0.0 to 1.0	81.51
1.0 to 2.0	1.88
2.0 to 3.0	0.23
3.0 to 3.92	0.05
Total	100.00

The following table shows the percentages of area that are in each of the categories included in the 100-year 24-hour legend.

Range of 100-yr 24-hr Precipitation (Inches)	Percent of Total Area
-1.77 to -1.0	2.29
-1.0 to 0.0	71.93
0.0 to 1.0	24.59
1.0 to 2.0	0.93
2.0 to 3.0	0.19
3.0 to 4.27	0.07
Total	100.00

NOAA Atlas 14 tended to be higher than the NRCC values for the 2-year 24-hour precipitation. 97% of the area was within plus or minus 0.5 inch difference. The major areas where NOAA Atlas 14 was significantly higher were in the Catskill Mountains of NY and the White Mountains of NH.

NOAA Atlas 14 tended to be higher than the NRCC values for the 25year 24-hour precipitation. Nearly 98% of the area was within plus or minus 1.0 inch difference. Similar to the 2-year 24-hour difference, the major areas where NOAA Atlas 14 was significantly higher were in the Catskill Mountains of NY and the White Mountains of NH.

NOAA Atlas 14 tended to be lower than the NRCC values for the 100-year 24-hour precipitation. 96% of the area was within plus or minus 1.0 inch difference. The major areas where NOAA Atlas 14 was significantly higher were in the Catskill Mountains of NY and the White Mountains of NH.

The most likely reason for the differences in the Catskill and White mountains could be that NWS used the PRISM system to estimate spatial precipitation values. For more information on the PRISM system, please refer to other NOAA Atlas 14 volumes. The NRCC did not use an orographic component in their spatial analysis.