Village of Afton Strategic Plan

Task 7: Feasibility and Planning Study for Waterfront Revitalization

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TABLE OF CONTENTS

1. EXECUTIVE SUMMARY

The objectives of the waterfront revitalization study were to address waterfront park development, flood mitigation, water quality, and wetland restoration, by mitigating flooding in the areas that have historically and are predicted to be affected by flooding. Maps illustrating the Study Area and the core area of the Village of Afton are included in this document (**Figs. 1 & 2**). The scope of work included:

1. An analysis of the various past flood events
2. An analysis of the various flood mitigation options that would promote the goals of the study
3. Cost/benefit analysis associated with implementing the various mitigation options

2. RECOMMENDATION

The study identified five potential options, four of which can be used in collaboration to radically reduce flooding within the Village of Afton.

1. Status Quo – do nothing
2. Watershed management / Best Management Practices (BMPs)
3. Relocation of flood-prone structures within the village
4. Hard-path solutions
5. Soft-path solutions

Options three and four will have the greatest impact on flooding with option four addressing the regional impact of the culvert under the I-88 connector. Option two would cause the least environmental damage while also including the community as a part of the solution. Option five would be a positive addition to any of the above-listed options.

3. BACKGROUND

It is commonly accepted among scientists, government agencies and the general public that global climate change has produced extreme weather events such as flooding, hurricanes and radical temperature fluctuations (IPCC, 2015). The Village of Afton, NY has experienced recurrent flooding issues due to their close proximity to the Susquehanna River. This watershed-scale problem is common for many cities, rural and urban communities alike, where natural landscapes (i.e., floodplains) have been encroached upon and converted to artificial surfaces for human habitation (Cech, 2010). As of 2017, 42% of properties within the Village of Afton are considered at risk for flooding with a combined value of over $13.7 million dollars. In a recent statement by the New York Energy Research and Development Authority (NYSERDA), climate projections show that the extreme weather conditions of the recent past may only be an introduction to the climate of the future. NYSERDA's projections show increased rainfall levels for the region, which will lead to amplified flooding along the Susquehanna River (Horton et al., 2014).

The Village of Afton lies along the main channel of the upper portion of the Susquehanna River in the Southern Tier of New York (**Figs. 1 & 2**). The Susquehanna River is the sixteenth largest river in the United States and is the largest river in the US that flows into the Atlantic Ocean. The Susquehanna River and its hundreds of tributaries drain 27,510 square miles, an area nearly the size of South Carolina, spread over parts of the states of New York, Pennsylvania, and Maryland. The river meanders 444 miles from its origin at Otsego Lake near Cooperstown, N.Y., until it empties into the Chesapeake Bay at Havre de Grace, MD. The Susquehanna contributes roughly one-half of the freshwater flow to the Chesapeake Bay (**Fig. 3**). This area has a rich settlement history with community originating back to the late 1700's (Shaker et al., 2012). In the Northeast US, many forested areas have decreased in size and become increasingly fragmented due to human development.

According to Chris Duffy, a civil and environmental engineering professor at Penn State, in a 2009 interview with *The Sentinel*, the Susquehanna is one of the most flood-prone rivers in America. The flooding phenomenon has been well known for centuries, and early settlers referred to the Susquehanna River as "a mile wide and a foot deep." Although this folk-saying likely refers to the Susquehanna's lower segments, the sentiment reveals the geological forces impacting the River, which makes it exceptionally likely to flood. The main stem of the Susquehanna has flooded 15 times since 1810, and even the Native Americans who once lived in the area spoke of the River's flood frequency (SRBC, 2017).

The recorded history of flooding on the Susquehanna River began roughly 200 years ago. Residents of the Village have experienced more than ten floods since 1810. With major floods occurring in: 1810, 1865, 1889, 1894, 1935, 1936, 1946, 1955, 1964, 1972, 1975, 1996, 2004, 2006, and 2011 (SRBC, 2017). In September 2011, the second largest flood in the history of Afton occurred. This stimulated a change for the Village. In response, Village residents created the Flood Mitigation Committee chaired by April Leggett. This process led to a search for scientific expertise, Afton's Flood Mitigation Committee contacted Dr. Richard Ross Shaker, assistant professor at Binghamton University, State University of New York. Over the course of two years, Dr. Shaker collected remote and in situ data and resources from varied sources including: geographic information systems (GIS), remote sensing (RS), Village of Afton, Chenango County, New York State, and Federal Emergency Management Agency (FEMA).

In the course of Dr. Shaker's research, he found flooding issues in Afton to be influenced by global, regional, and local climate; as well as geographical, and hydrological phenomena.

3.1 Globally

Atmospheric greenhouse gasses continue to increase, resulting in the warmest decade in Earth's recorded history (Seneviratne et al., 2014). These increased temperatures melt glaciers, ice sheets, and expand oceans, which exacerbate sea level rise (Dutton et al., 2015). Warming and expanding tropical ocean waters are increasing the range, magnitude and related disasters of hurricanes (Webster et al., 2005). The macroscale impacts of climate change are well recognized in the Southern Tier, experts and research groups have warned that the "Susquehanna River basin will flood with increasing frequency" (NYSERDA, 2013). In correspondence with the Afton Village Justice, Dr. Shaker received a memo from the Kopernik Observatory and Science Center dated 19 July 2013; NYSERDA) has projected that by 2080 regional temperatures are expected to rise by 4.5. to 8.5 degrees Fahrenheit and precipitation increases by more than 10% (Horton et. al. 2014). Lastly, the Susquehanna River basin runs mostly north-south, which is ideal for tropical storms and hurricanes to fill the basin as those storms move away from their origin, the Gulf of Mexico.

3.2 Regionally

The Village of Afton sits at the upper sub-watersheds of the Susquehanna River basin in New York's Southern Tier (**Fig. 4**). Its landscapes are characterized by small but relatively steep mountains associated with the Allegheny Plateau as well as by a temperate-continental climate, which has average annual precipitation of 41.5 inches (USGS). The total drainage area for the Village of Afton is 1,720 square miles, reaching past the communities of West Winfield, Richfield Springs, and Cherry Valley. As of 2006 data, the Village of Afton's watershed was dominated by forest land cover (56%), followed by agricultural lands (30%), and then urban (5%); wetlands and rangeland occupy roughly 4% each (Shaker et al., 2012). When investigating the River's substrate from the Village of Afton up to the communities of West Winfield, Richfield Springs, and Cherry Valley, most samples rendered exposed bedrock or shallow cobble, sand, and silt then bedrock. With minimal substrate roughness, precipitation events cause flash flooding, especially under previous saturation. Locations across the Upper Susquehanna River have shown to reach flood stage within a 24-hour period with soils close to their saturation point. When investigating the spatial distribution of the top five major storm/precipitation events associated with past flooding for Afton, peak precipitation areas did not occur within its upstream watershed suggesting that past flooding events could have rendered more significant flooding. Based on digital elevation model (DEM) and air photograph maps (**Figs. 5 & 6**), created by Dr. Shaker and locally validated, the Village of Afton's watershed is characterized by *meanders*, *cutoffs, meander scars*, and *backswam*ps. These *backswamps* and local wetlands are due to the Susquehanna's meandering movement within the floodplain, creation of oxbow lakes at cutoff points, and transition to wetlands through geological-time. Geological evidence suggests that the flow of the ancient Susquehanna River predates the formation of the Appalachian Mountains over 300 million years ago; implicating the River to be one of the oldest in the world dating back to the Paleozoic Era (543 to 248 million years ago) (Lizlovs, 2009).

In the Village of Afton alone there is evidence supporting three different "main channels" the Susquehanna River has traversed.

Lastly, regionally there has been increased flooding due to the infill of wetlands and land cover change associated with the Interstate 88 (I-88) corridor between Binghamton and Schenectady. I-88 was assigned in 1968 and was not completed until 1989. Ironically, due to its early designation, most of I-88's sub-sections were likely not required to complete Environmental Impact Assessments (EIAs), which came with the National Environmental Policy Act of 1969 becoming United States environmental law on January 1, 1970 (NEPA, 1970). NEPA's purpose is to:

> ''To declare a national policy which will encourage productive and enjoyable harmony between man and his [sic.] environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; to enrich the understanding of the ecological systems and natural resources important to the Nation; and to establish a Council on Environmental Quality." (NEPA, 1970)

EIA, commonly defined by the International Association for Impact Assessment (IAIA, 1999), is designated as:

> ''The process of identifying, predicting, evaluating, and mitigating the biophysical, social, and other relevant effects of development proposals prior to major decisions being taken and commitments made."

3.3 Locally

Investigating the local flooding issues for the Village of Afton, first the physical hydrological features were recorded. The average width of the Susquehanna River channel was recorded to be an average of 278 ft. wide at average *stage height* (water depth) of 4 ft. deep. Averages were calculated using the *reach* of the Susquehanna River, centered at the Village of Afton; a river or stream *reach* is most commonly calculated as the product of 35 times the width of the stream (Simonovic, 2012). In the Village of Afton's case, the Susquehanna River *reach* is equal to 2,975 ft. Regarding discharge, the nearest gauging station (USGS 01502632) at Bainbridge, NY. In accordance with the US Geological Survey at Bainbridge, NY, flood-related stages for "Action," "Minor," "Moderate," and "Major" are 13', 15', 20' and 22', respectively. Albeit, it is important to note that "Flood Stage" is listed at 15' or at the "Minor" stage listing. The two greatest flood stages for the Bainbridge gauging station were recorded on 6/29/2006 (27.05 ft) and 9/8/2011 (22.10 ft), with the record being maintained at 27 feet. Regarding discharge, the average discharge over the last decade is one *thousand cubic feet per second* (kcfs). In accordance with the US Geological Survey at Bainbridge, NY, flood-related stages for "Action," "Minor," "Moderate," and "Major" are 18, 22, 34 and 39 kcfs, respectively. The two greatest flood discharges for the Bainbridge gauging station were recorded on 6/29/2006 (58.7 kcfs) and 9/8/2011 (48.3 kcfs), with the record being maintained at 58.7 kcfs.

The Village of Afton's land cover is primarily low-density developments and zoned residential, with small proportions designated as agricultural and parks (**Figs. 7 & 8**). After the 2011 flood, 108 homes claimed damages due to flooding, 20 of those were restricted and four were deemed unsafe. One property was bought by the Village and shall remain forever green with the intention of creating a Riverfront Park in its place. According to local survey results, close to half of Village residents are concerned about flooding. Only about 10% of residents have flood insurance while around 1/3rd of the Village is at risk for flooding. According to the same survey results, 80% of respondents do not want to move the portions of the Village that are at highest risk for flooding, however, close to 60% of residents do not want things to remain the same. 32% of respondents said they would be willing to relocate if their home is in the natural floodplain. 36% of respondents said they would be willing to relocate for a buyout or a buyout and relocation to improved housing while 31% of respondents said they are not willing to relocate.

By investigating the alluvial deposits, with the floodplain centered north-south at the Village of Afton bridge, a west-east transect of alluvial material spans an astounding one-mile width. From the alluvial deposit investigation, and assessing soils and land cover data, it is apparent that the connector between the Village and I-88 also infilled a portion of the floodplain and wetlands, which previously absorbed Susquehanna River overflows. The I-88 connector to the Village of Afton was previously acknowledged by the Flood Mitigation Committee as a magnifying cause for local upstream flooding. After field observations, GIS work, and consulting resources from independent government agencies (FEMA, NCRS, USDA), it was validated that the I-88 connector is serving as an impoundment during flooding events. The I-88 connector acts similar to a levy or earthen dam with only a two-foot diameter culvert to drain the hydric soils of the wetland it bisected. Corroborating the uneven flooding impacts of the I-88 connector to the Village of Afton, work from two independent federal agencies confirm that flood stage (water level) on the upstream (north) side of the connector is higher than the downstream (south) side.

The U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) was contacted previous to Dr. Shaker's involvement in the flood assessment in Afton. High-water marks were placed by local residents during the 2011 flood. Next, a NRCS surveyor/engineer (L. Lockrel, 2012; **Appendix S1**) measured those two locations (setting the culvert as the survey baseline) using standard surveying equipment. According to those measurements, the inlet (north) high-water mark was set at 112.3 ft. with the outlet (south) set at 108.3 ft., a four-foot difference was recorded and accepted. This 4-foot difference further supports the direct cause and effect of how the I-88 connector exacerbates the flooding problem for the Village of Afton. Overlaying the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) flood zones from 2006 within a GIS, Dr. Shaker calculated the high-water mark to be 8.9 feet above the 100-year flood level. Second, historic and current FEMA FIRM maps (**Appendices S2 & S3**), with the current FEMA zones updated after the 2006 flood. Both the 1992 and 2010 FEMA maps independently acknowledged at a three-foot minimum difference in *flood stage* elevation when comparing the upstream (north) side (972 ft. above sea-level) of the connector with the downstream (south) side (969 ft.).

GeoEco Design created new flood inundation maps (**Figs. 9-13**) to assess flood-loss property values and visualize the specific property parcels at risk of being flooded in the Village. Based on the 2017 cadastral data obtained from Chenango County's Department of Planning and Development and Tax Map office, 472 properties within the Village of Afton total $39,451,102 in value. Of the Village's 472 parcels, 139 (42%) were deemed at-risk to future flooding and totaled $13,708,112 worth of unsafe tax assets (**Appendix S4**). Geographically, four distinct Village flood districts were created and designated as North, South, East, and West for the purpose of this study (**Fig. 13**). The at-risk property values summed to $3.74, $2.88, $4.37, and $2.71 million across the four designated districts North, South, East, and West, respectively. The district northeast and upstream of the I-88 connector (East) proved to be the most monetarily at-risk to flooding. Lastly, while some of the flooding is a result of backflow due to the small sized culvert under the I-88 connector, the majority of future flooding will continue to increase in frequency and intensity due to large-scale changes in global climate.

4. CURRENT WATER RESOURCES AND RIVER ACCESS

4.1 Water Quality

The Federal Clean Water Act (1972) has a goal of restoring and maintaining the chemical, physical, and biological integrity of the Nation's waters. The Act also defined pollution as any human activity that degrades a water body's integrity (Shaker et al., 2017), and required all states to assess and report on the quality of waters within their borders. It also requires states to identify impaired waters where designated uses are not supported. The Village of Afton sits on an *impaired* segment of the Susquehanna River (**Fig. 14**). *Impaired* is a designation given by the New York State Department of Environmental Conservation (DEC) and identifies those waters that do not support appropriate uses and that may require development of a Total Maximum Daily Load (TMDL; NYDEC, 2016). The section of the Susquehanna River that runs through Afton is designated as a Class B(T) due to mercury loading from atmospheric deposition. This section of the Susquehanna River is not included in the 2016 section 303(d) list because the assessment of TMDL was deemed necessary at this location (NYDEC, 2016). Fish consumption in this portion of the Susquehanna River is impaired (**Fig. 15**) due to mercury contamination (USDOH 2016).

Drinking water in the Village comes from a groundwater well with water drawn from a single 133-foot deep drilled well and six springs located off NYS Route 41 on a protected 100-acre parcel of land owned by the Village. The water is mixed and treated at the Spring Water Treatment Plant. After being treated it is stored in steel tanks. As required by state regulations the water is routinely tested. There is an annual drinking water quality report that documents all contaminant violations and their likely sources. For 2015 and 2016 (**Appendices S5 & S6**), there were no drinking water violations recorded for the Village. According to a study by the USGS (Reddy et. al. 2012), Radon-222 was detected in every well sampled in the upper Susquehanna watershed. All of the wells tested ranged between 22-1140pCi/L with the median activity being 600pCi/L. While the Village of Afton does have radiological testing conducted (**Appendix S7**), it does not appear that the Village of Afton tests for radon-222 so current levels are unknown. The Village does test for Radon-228 and Radon-226, both were not detected in the last report, however, we do not know the sampling methodologies used for this and based on geologic conditions and local results from the USGS, we feel further testing should be conducted to ensure the safety of drinking water within the Village. Radon testing is heavily dependent on many environmental variables. Considering that every well the USGS has tested resulted in a positive Radon detection, it seems suspect that the well in Afton would have undetectable levels of Radon.

4.2 Waterfront Park Development

The Village obtained a property on its southern border on the eastern bank of the Susquehanna River. This is where Mayor Sally Muller would like to create a waterfront park (**Fig. 16**). One design-option for this parcel would be a *demonstration park* where people could come and see firsthand green and natural solutions for flooding and stormwater management. This would be a positive move towards remediating local flooding, educating the public, as well as being a potential tourist attraction in the Southern Tier. To have a greater impact on remediating flooding, with the creation of a waterfront park, land acquisition along the entirety of the Susquehanna River, especially upstream from the Village of Afton is important. The potential to connect rural communities as well as alleviate flooding risks in the Southern Tier is grand. For flood risk to decrease for all upper Susquehanna River communities, flood mitigation plans similar to those taking place in Sydney and the Village of Afton would need to be replicated and connected across the watershed. However, confined to the local scope of this project, land acquisition for nature-based solutions for flood mitigation is an important way to offer some protection to the Village of Afton and communities downstream. Besides local, county, and state government-owned properties within the Village (**Fig. 17**), privately owned flood-prone properties should also be considered for BMPs implementation and other landscape-based flood mitigation strategies. (Further explanations and examples of nature-based solutions can be seen in (**Appendix S8**).

Options for nature-based solutions include:

1. Restoring the natural floodplain
2. Building a flood friendly culvert
3. Raingardens

4. Floodwater detention and retention basins
5. Bioswales

4.3 Public Access to the River and Water-Related Activities

The Village of Afton is home to one public boat launch, which is listed as an NY Department of Environmental Conservation (DEC) Boat Launch and Fishing Public Access Area. This area has not been well utilized and is somewhat unknown to Village residents. The DEC lists this area as having space for 12 cars and trailers. This area is in need of enhancement as it has been underutilized and not properly kept up. There is a large sandbar blocking the boat launch that may need to be removed if the boat launch is to function properly.

Fish consumption from the Susquehanna River and associated tributaries is severely limited due to high mercury levels. Any size walleye and all other fish are listed as 'do not eat' by women under 50 and children under 15 years old by the NY Department of Health. Walleye greater than 22" are ok to eat up to 1 meal/month while Walleye less than 22" are ok to eat up to 4 meals/month (NYSDOH).

The proposed waterfront park in the above section will also have the potential to increase public access to the River.

5. FLOOD RISK MITIGATION OPTIONS, COSTS, AND BENEFITS

The following options are presented to give the Village the freedom to choose how to proceed concerning flooding and the continued damage to property within the Village. Each option is presented with social costs and benefits. Selected key organizations are also listed to offer options for collaboration.

1. Status Quo – do nothing
   - Cost
     - Continued and worsening flooding
     - Damage to properties
     - Potential loss of life
     - Continued decrease in Village amenities and economic stability
   - Benefit
     - No direct monetary cost
   - Key collaborative organizations

2. Watershed Management / Best Management Practices - Increase and restore wetlands, create bioretention ponds, rain gardens, tree plantings, rain barrels.
   - Cost

        - Some of these options would require acquisition of land by the Village to increase wetlands along the Susquehanna River.
        - Monetary cost would be negotiable by Village governance and the property owner.
        - Other options here would require property owner investment or coordination with programs such as 'save the rain' and other community action organizations.

    - Benefit
        - Studies (USEPA, 2018) have showen that wetlands can hold anywhere from 5-60% of floodwaters dispersing them slowly while also filtering many pollutants and sediments out of the water.
        - Less flood damage and increased water quality.
        - Increased biodiversity leading to a more sustainable environment.
        - Community and remaining property values increase

    - Key collaborative organizations:
        - Upper Susquehanna Coalition
        - Susquehanna River Basin Commission
        - Save the Rain
        - Southern Tier East
        - Cornell Cooperative Extension
        - Southern Tier Regional Development
        - The Wetland Trust
        - NY DEC
        - US EPA

3. Relocation of flood-prone properties within the village
    - Cost
        - Buyout of at-risk properties
            - Investigate offset costs of "hard-path solutions" from the Army Corps of Engineers. As with examples such as Soldiers Grove, WI (FEMA, 2007), could these funds be transferred to the "soft-path solution" of relocating the flood-prone properties of the village?
            - FEMA, HUD, Village, property owners – all have a stake in buyout options

    - Benefit
        - Village could require new buildings to have specific energy standards such as LEED-certified buildings, solar or other green technologies built into new buildings, etc.

        - Radically reduce the risk of flooding
        - Enhance economic stability
        - Create an energy efficient, resilient and sustainable Village
        - Potential to increase tourism

    - Key Collaborative Organizations:
        - FEMA
        - HUD
        - Village of Afton Government
        - NYSERDA

4. Hard-path solutions (Gleick, 2003) – culvert enlargement, convert culvert and connector into a flood control structure, large-scale dam and lake project, levees, dykes, dredging, bank stabilization, river channelization (Chech 2010).
    - Cost
        - These options would cause extensive environmental damage and would need Environmental assessment.
        - Culvert enlargement would push the flooding problem downstream, which would further endanger lives downstream.
        - Culvert and connector as flood control and similar large-scale dam and lake this would be a large environmental undertaking and would need an environmental impact statement, as well as movement of some Village homes.
        - A levee or dyke could decrease public access to the waterfront as well as decrease the visual value of the River.
        - Dredging is not a long-term solution and is not a solution for flood control.
            - Dredging requires continued maintenance.
            - Dredging can actually increase local flood damage.
        - Bank stabilization would have monetary costs, continued maintenance, chance of failure during a large-scale flooding event
        - River channelization increases the flow of the river, pushes the flooding problem downstream. Can increase damage during a large-scale flooding event.
        - Estimated monetary and environmental cost of any of these options would be high

    - Benefit
        - Possible alleviation of flood risk, however, due to the risk associated with global climate change, the long-term benefit here is more difficult to ascertain.
        - Creation of a dam and lake for flood control could also increase tourism within the Village.

        - Bank stabilization would help to maintain existing infrastructure and control erosion

    - Key collaborative Organizations
        - New York State Department of Transportation
        - US Army corps of Engineers
        - NY State Empire State Development
        - NY State Department of Health
        - NY State Environmental Facilities Corporation

5. Soft-path solutions (Gleick, 2003) – early warning, text messages, phone call, flood alert solutions, websites, alarm systems such as the Susquehanna Flood Forecast and Warning System
    - Cost
        - Lowest monetary cost.
        - Does not alleviate most flood damage to properties

    - Benefit
        - Early warnings help prevent loss of lives
        - Can lessen property damage

    - Key collaborative organizations:
        - Upper Susquehanna Coalition
        - Susquehanna River Basin Commission
        - Village of Afton Government

6. FLOOD RISK MITIGATION RECOMMENDATION

The Village of Afton's long-term sustainability is contingent on both flood mitigation and economic development. Therefore, GeoEco Design recommends taking a progressive approach to stimulating the local economy while acknowledging the limitations future flooding will bring to the at-risk districts within the Village. Specifically, the Village should capitalize on its small-town charm, seek funds to rejuvenate Main Street, and attract boutique-style shops to fill vacant spaces. The Village should also consider branding a bi-monthly/weekly farmers market, which would pay tribute to its surrounding agricultural influences, attract tourists, and meet the nutritional needs of Village residents. Maintaining a population base is important for the Village's long-term survival, thus attracting and retaining families is a necessity for maintaining such Village amenities as a functioning school system and local grocery store. Green energy, specifically solar and small-scale hydrological power should be considered as other avenues for generating income for the Village. Other opportunities exist for the Village to connect to the Greater Binghamton Area through its economic revitalization and renewable energy initiatives. Regarding past and future flooding, the Village of Afton needs to consider all of its options for remediating risk to its citizens. From retrofitting existing residential structures (i.e., lifting the house and increasing foundation height), to seeking funds to move entire flood-prone districts of the Village to non-floodable locations (see Soldiers Grove, WI), flooding is a major limitation to the Village's current land use and residential layout. Due to the macroscale watershed impacts of flooding, the Village of Afton, along with other Upper Susquehanna communities, should seek state and federal funding for wetland restoration and best management practices for basin-wide remediation strategies. Indeed, the Village should also consider wetland restoration within its geographical limits. It is important to note that the I-88 connector has proved to be an impediment, similar to a flood control levee, which causes increased flooding upstream (north) of the connector. The Village should continue a dialog with the Department of Transportation (DOT) to come up with a suitable resolution for this obvious inequality caused by the original planning and engineering negligence of the connector in relation to past and future Susquehanna River flooding. To end, the Village of Afton has a long-standing Southern Tier presence, has many beautiful and historic structures, and now has an opportunity to reinvent itself and serve as a sustainable rural community for the region. GeoEco Design's time and commitment to this project serve as an enduring example of the value the Village of Afton could play at revitalizing rural communities throughout upstate New York.

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8. LIST OF FIGURES

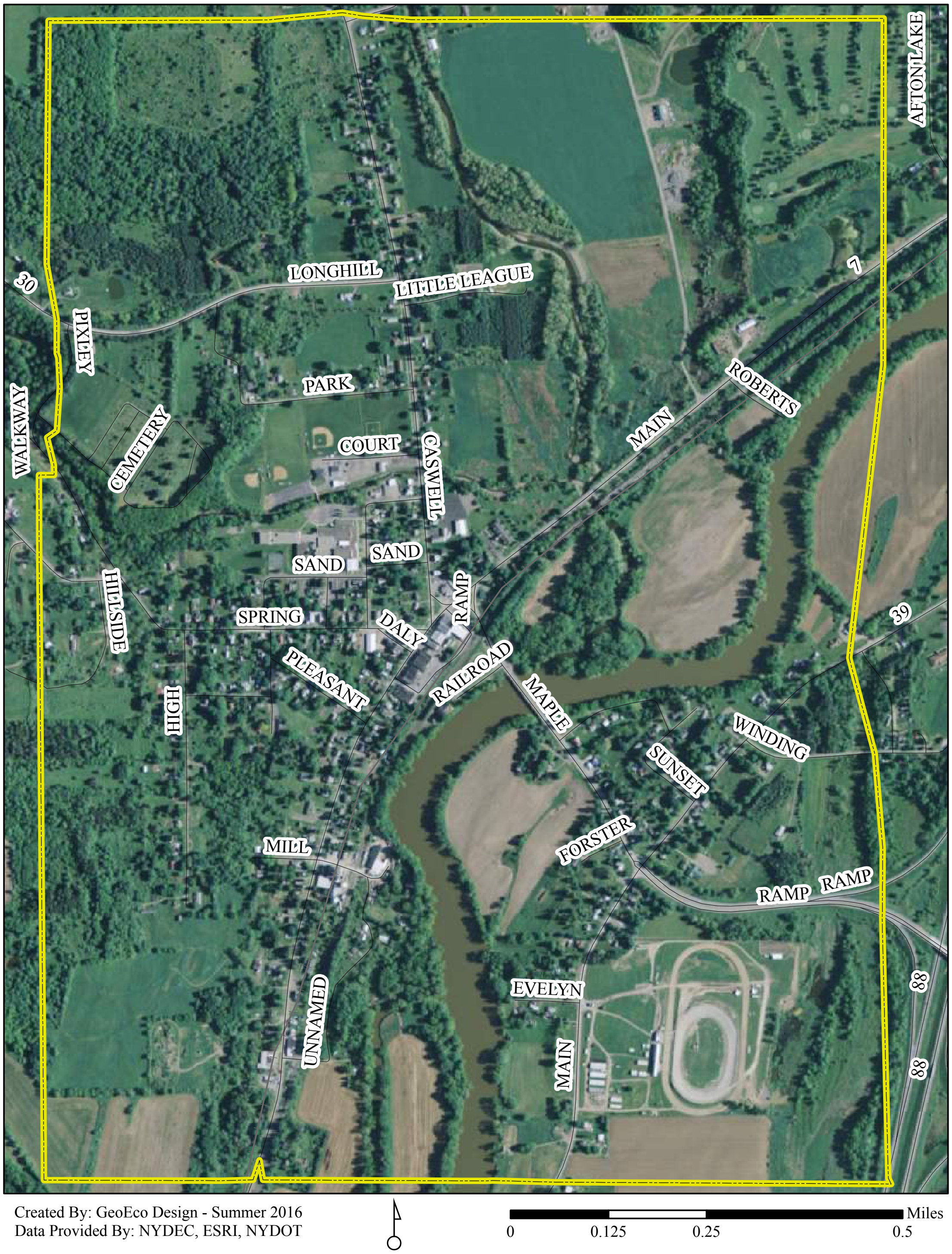


Figure 1. Study area map of the Village of Afton.

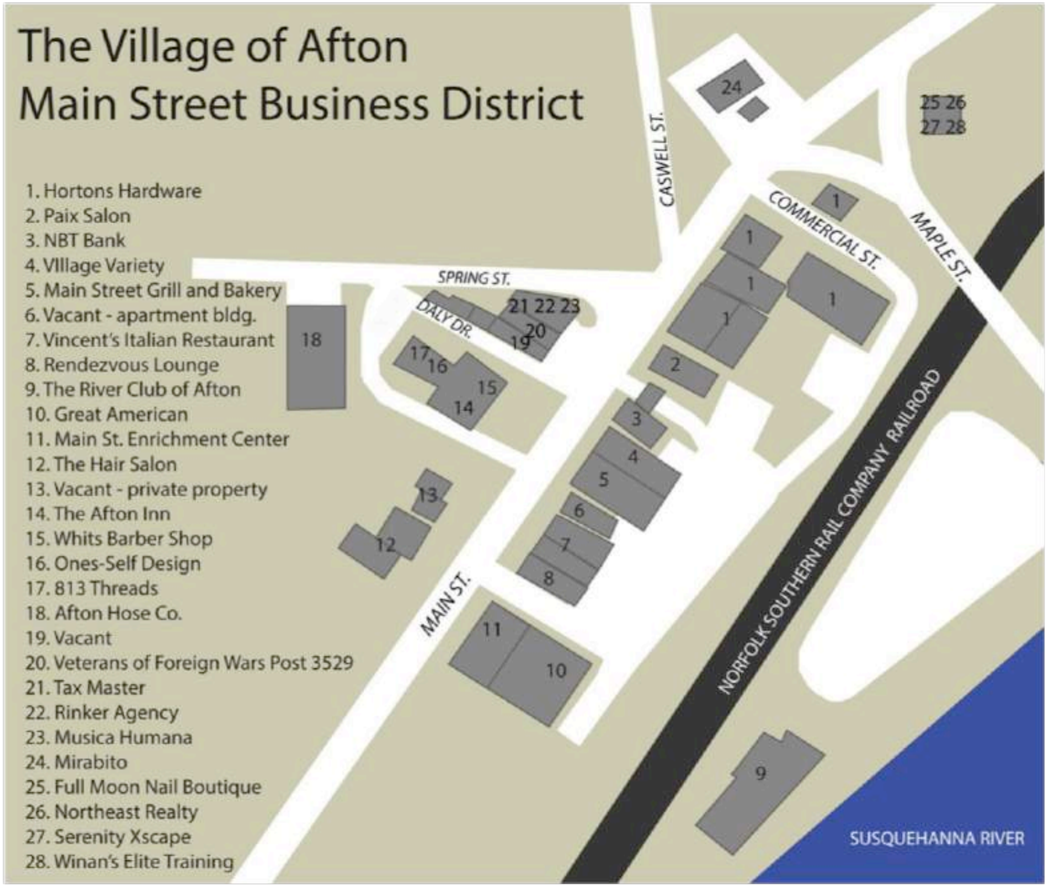


Figure 2. Map of the Village of Afton's central business district (CBD). Businesses correspond to those present during the socioeconomic survey conducted for this study.

Figure 3. Map of the Susquehanna River watershed from it headwaters in New York State to its outlet in the Chesapeake Bay.

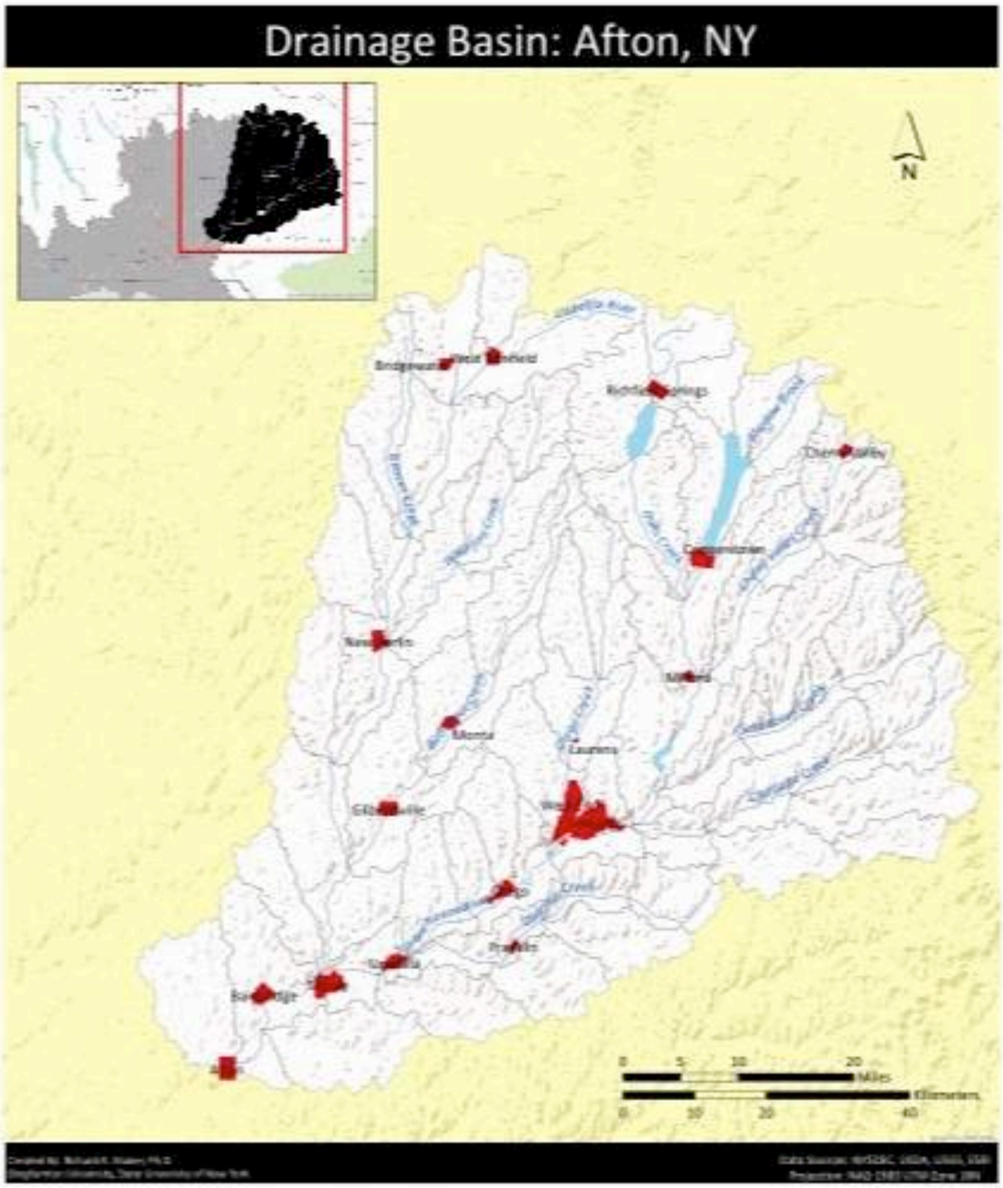


Figure 4. Map illustrating the Village of Afton’s drainage basin within the headwaters of the Susquehanna River.

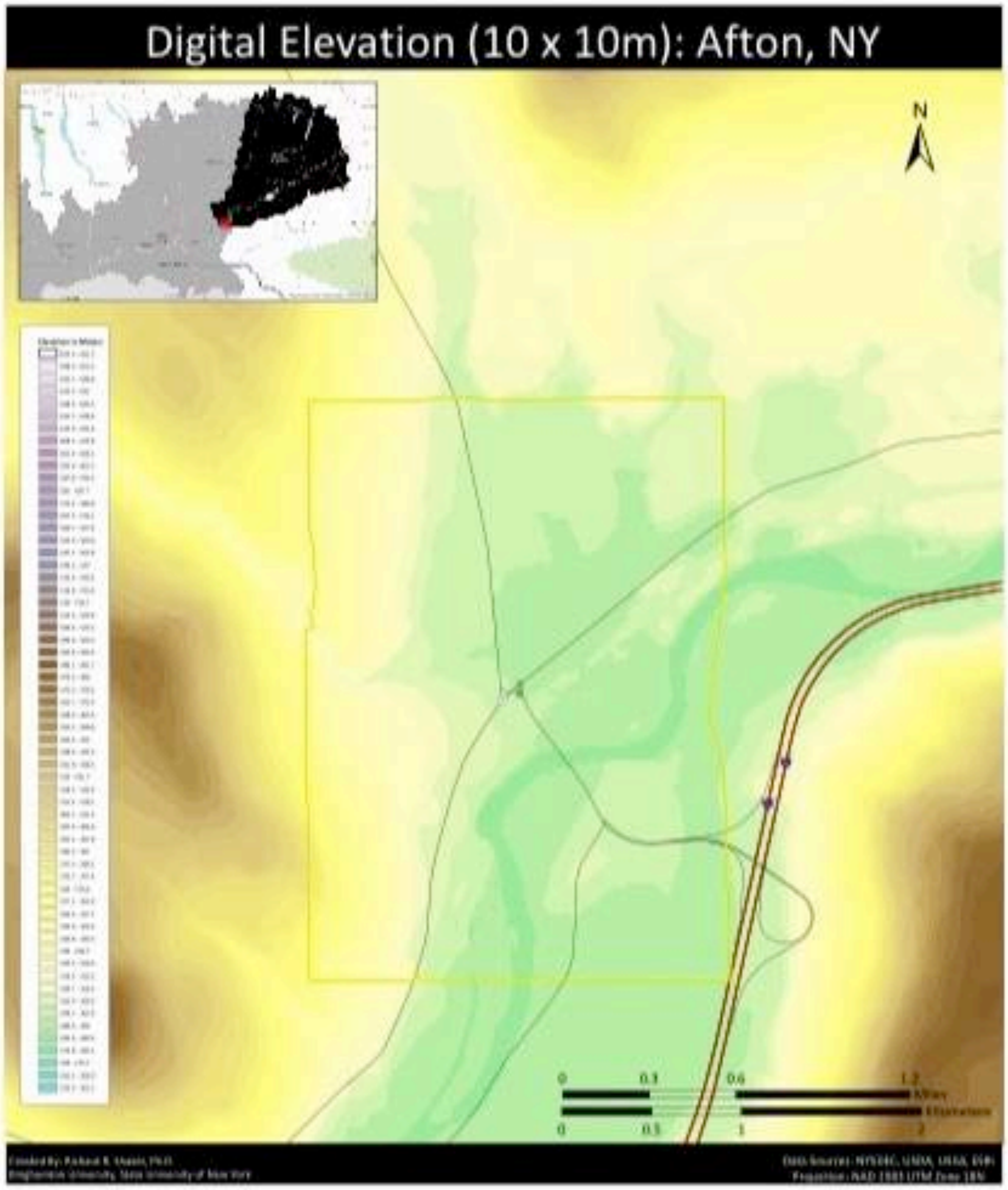


Figure 5. Digital elevation map (DEM) for the Village of Afton.

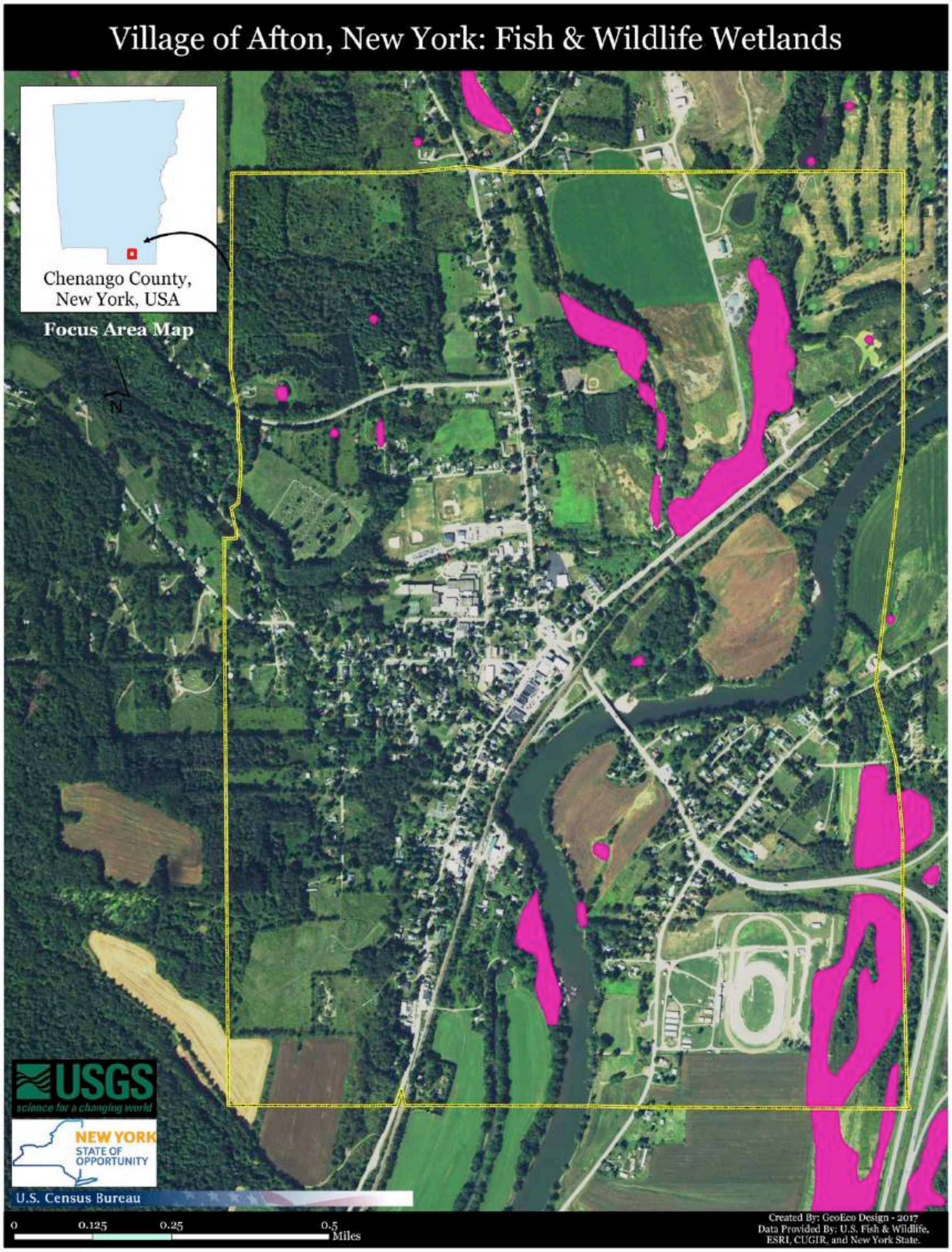


Figure 6. Orthophoto map of the Village of Afton overlaid with United States Fish and Wildlife designated wetlands.

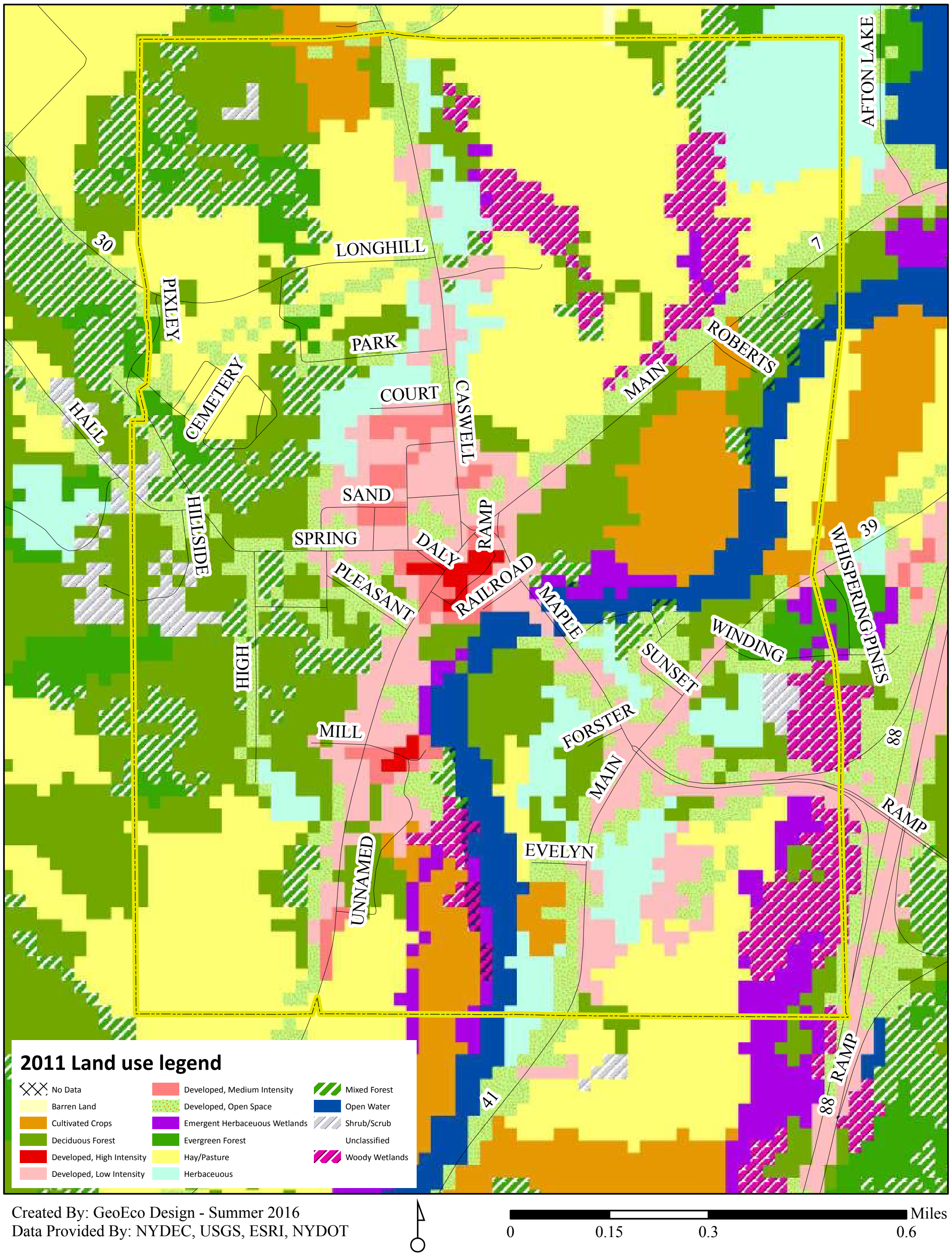


Figure 7. Map illustrating 2011 Land use/land cover for the Village of Afton. The classification system is used by the U.S. Geological Survey, and is modified from the Anderson Land Cover Classification System. For details see: https://www.mrlc.gov/nlcd11_leg.php

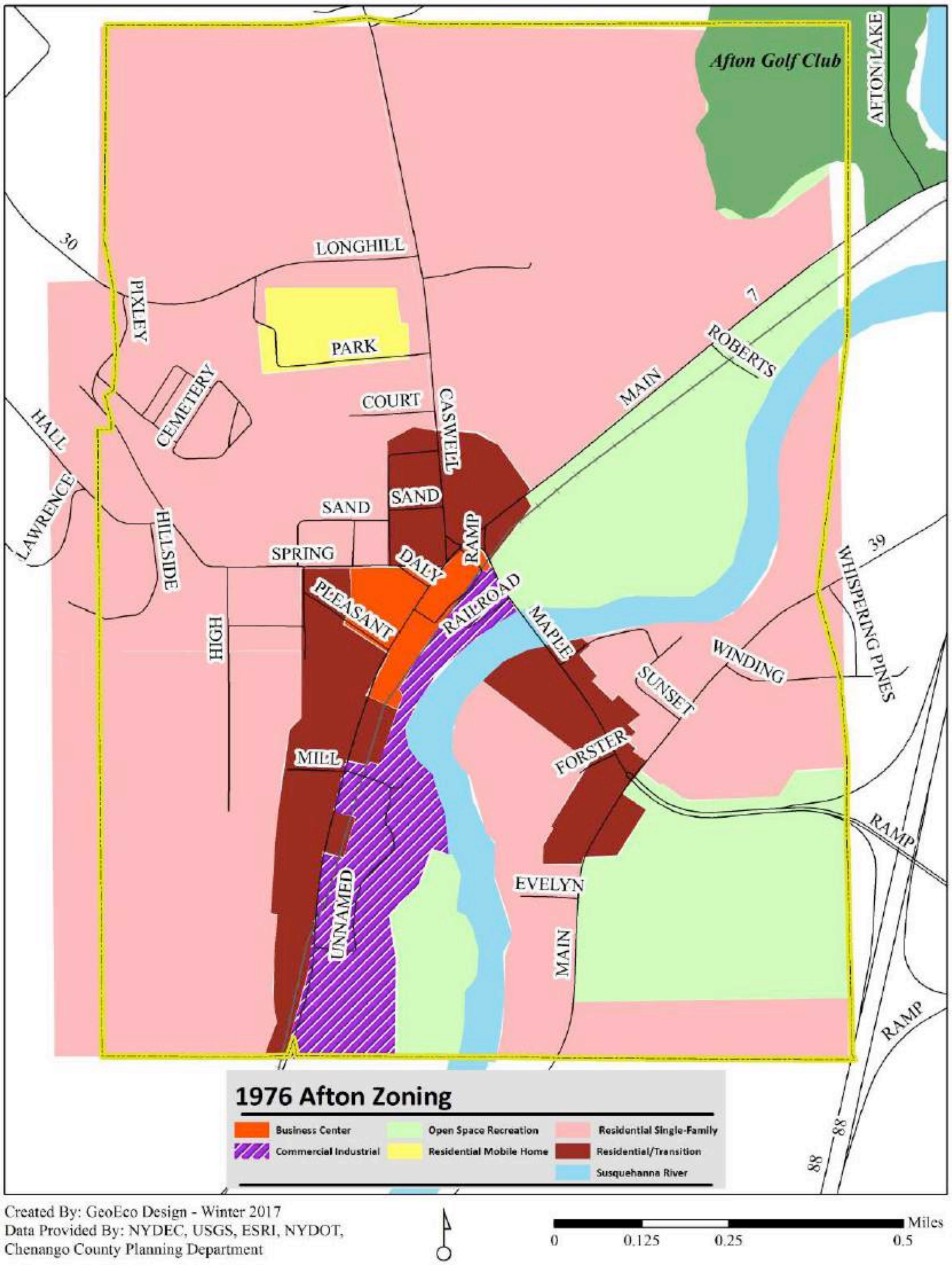


Figure 8. Map illustrating 1976 zoning for the Village of Afton.

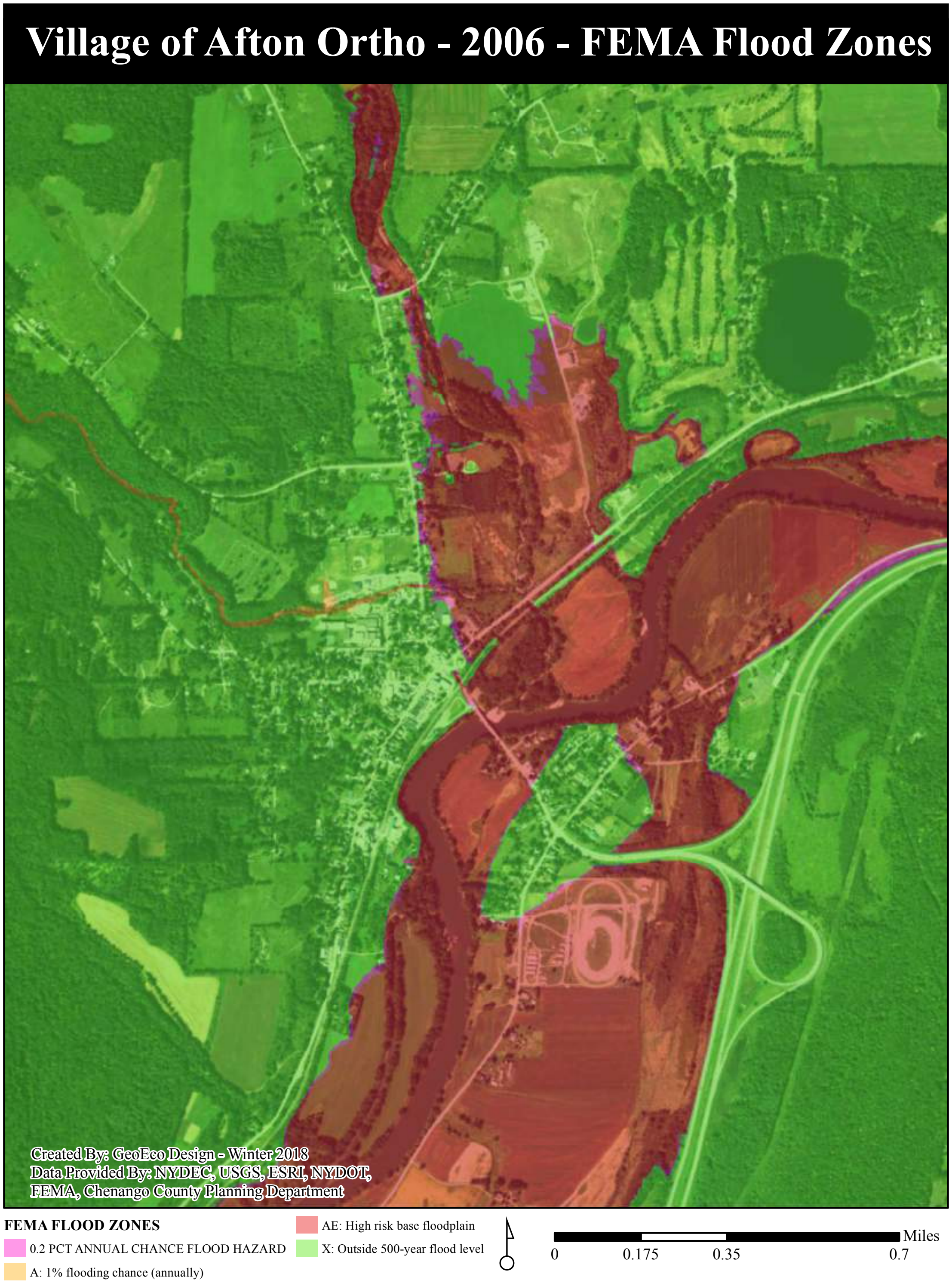


Figure 9. Current FEMA flood zones overlaid across the Village of Afton.

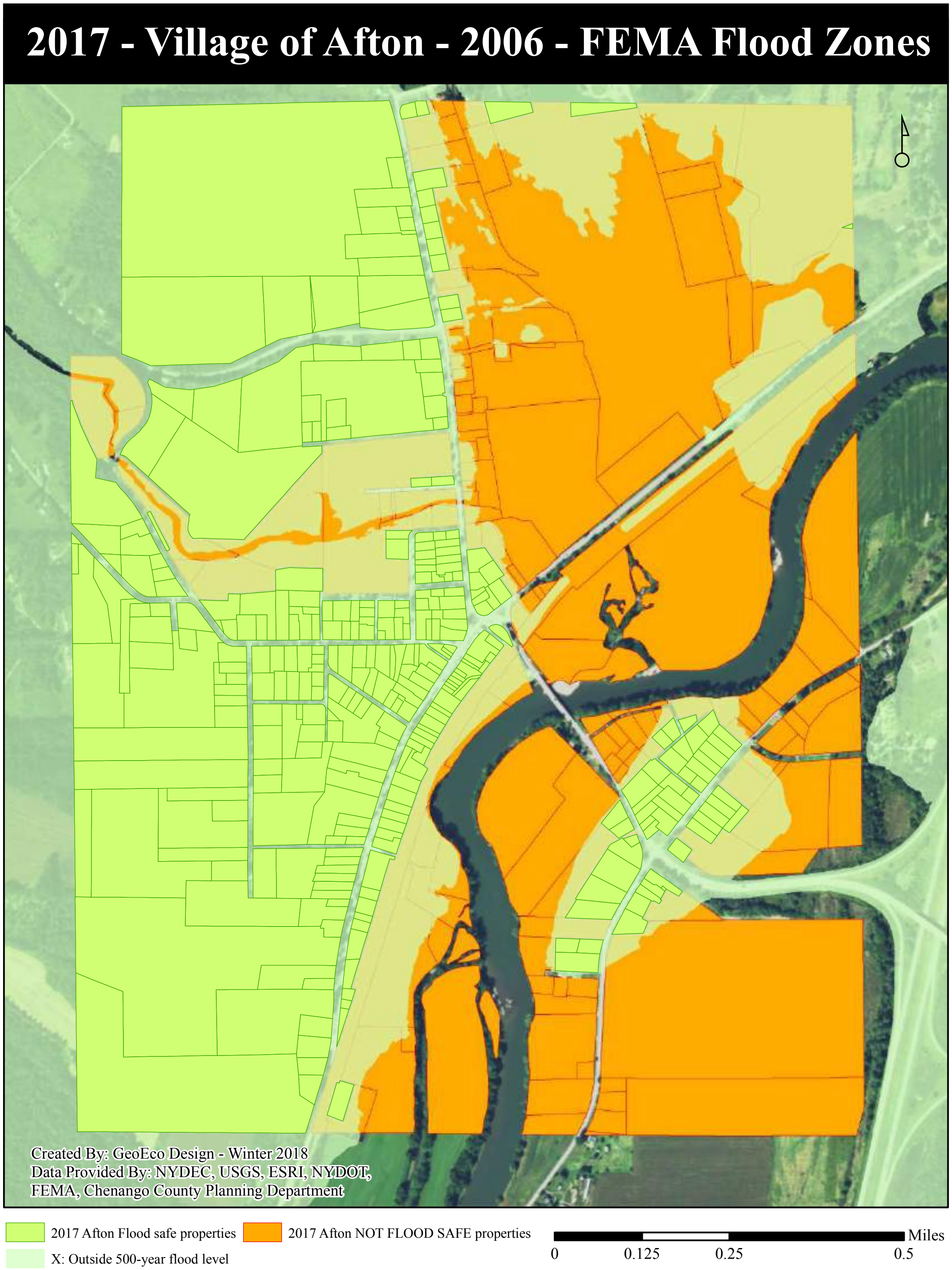


Figure 10. FEMA flood zones overlaid across the Village of Afton's 2017 property-parcel (cadastral) data.

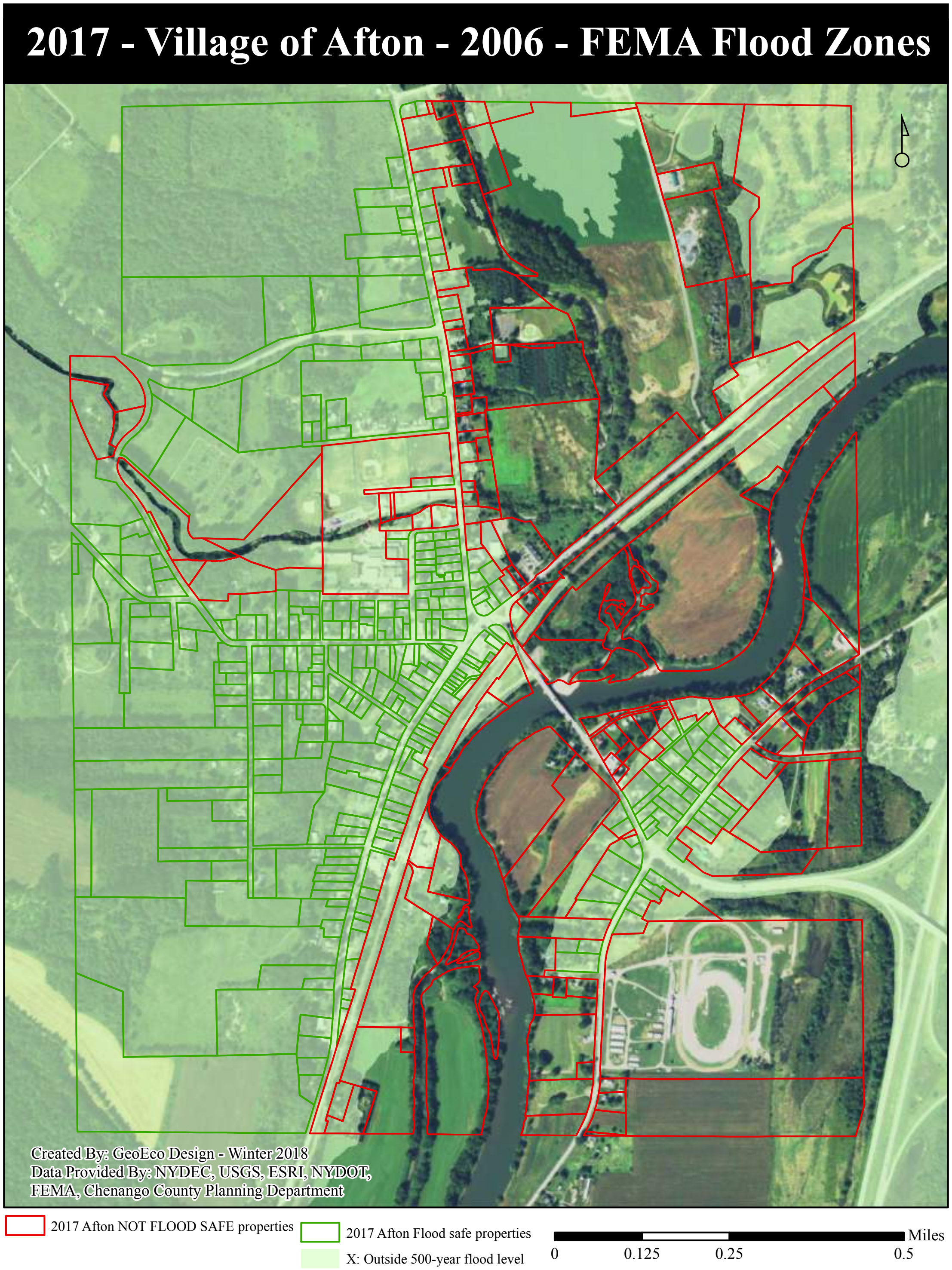


Figure 11. Village of Afton's 2017 property-parcels, with "NOT Flood-Safe" properties transparent.

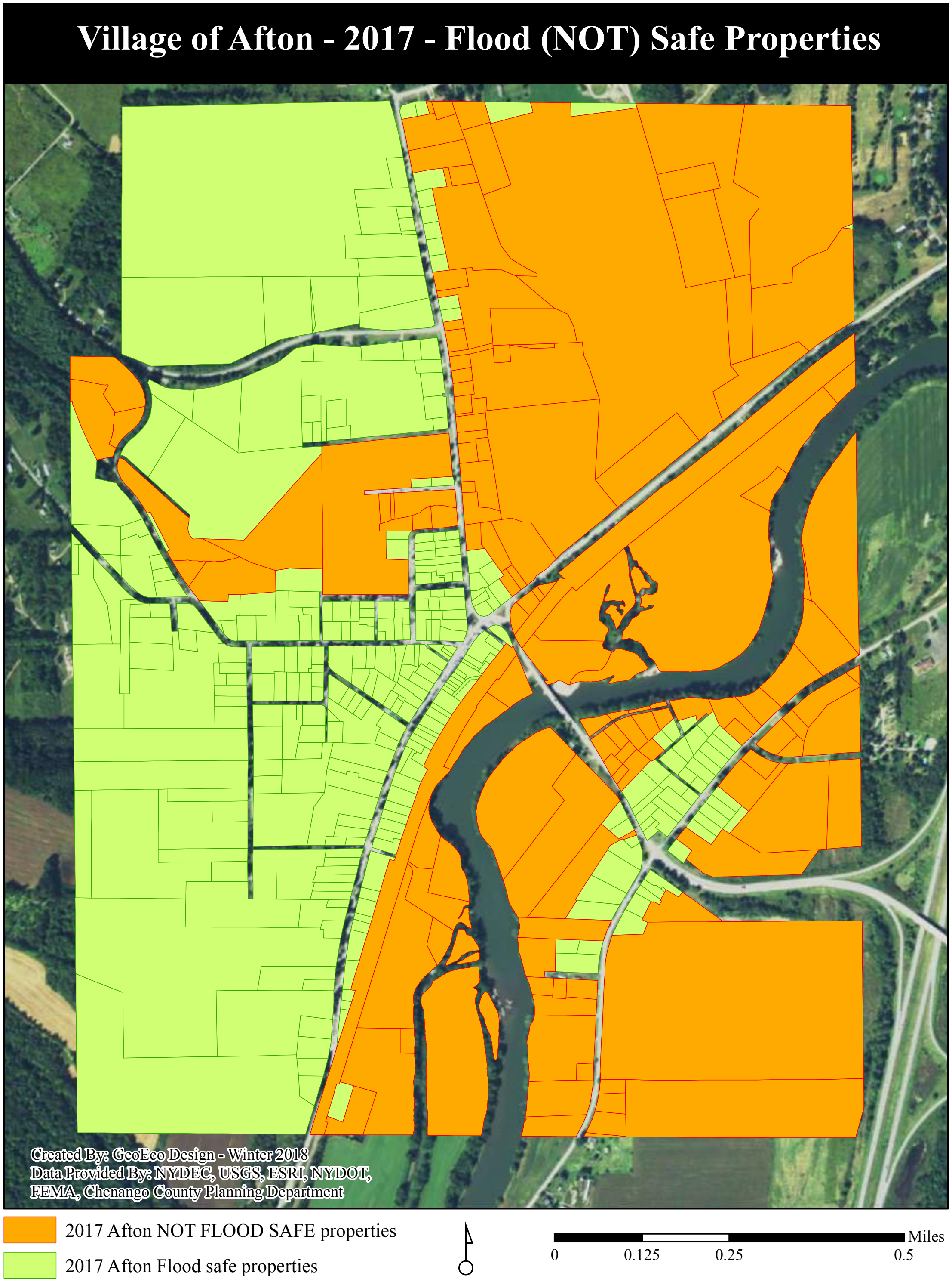


Figure 12. Map displaying 333 flood-safe, and 139 "Not Flood-Safe," properties from the 2017 cadastral data for the Village of Afton.

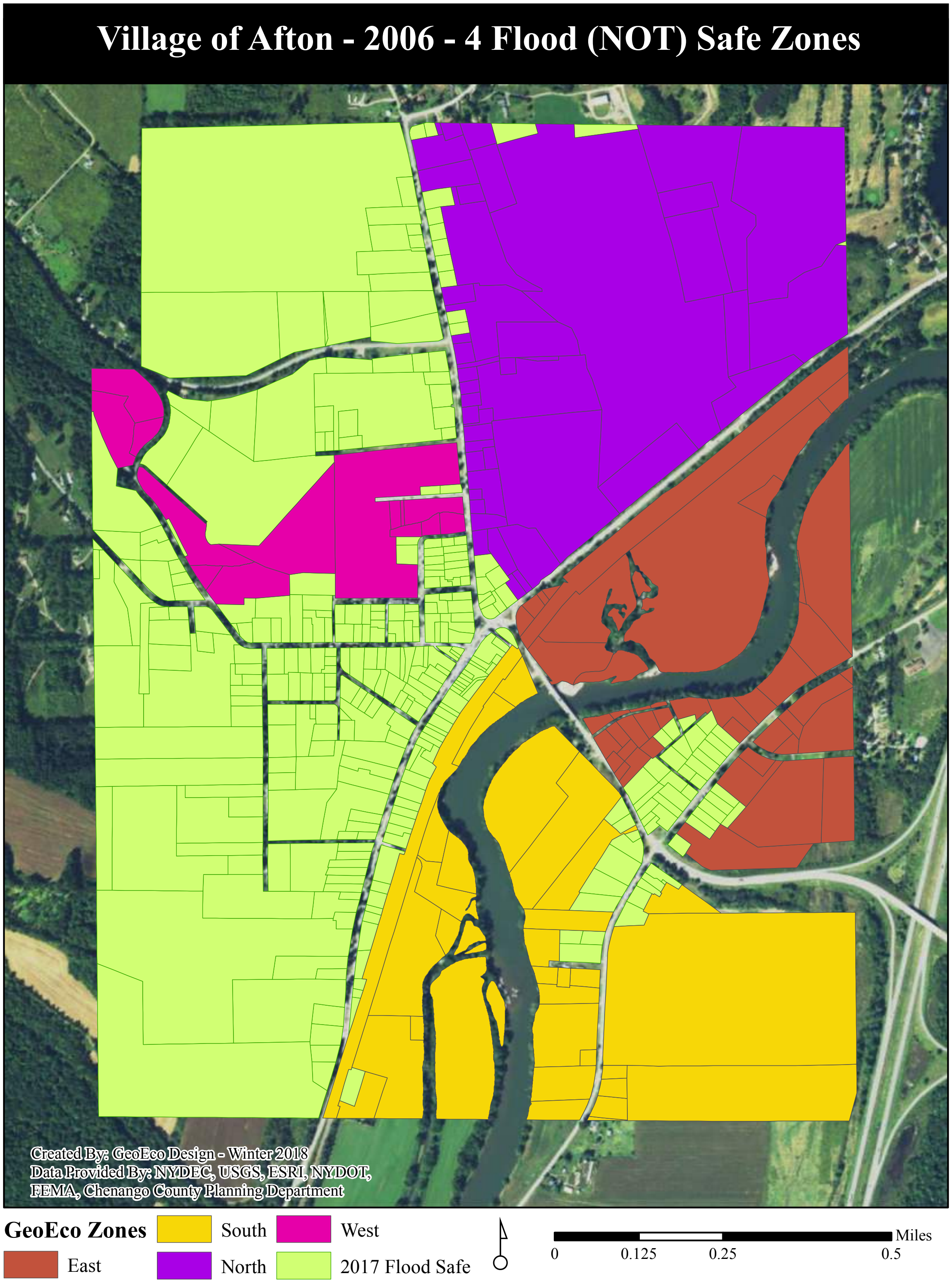


Figure 13. Map displaying four distinct flood districts across the Village of Afton.

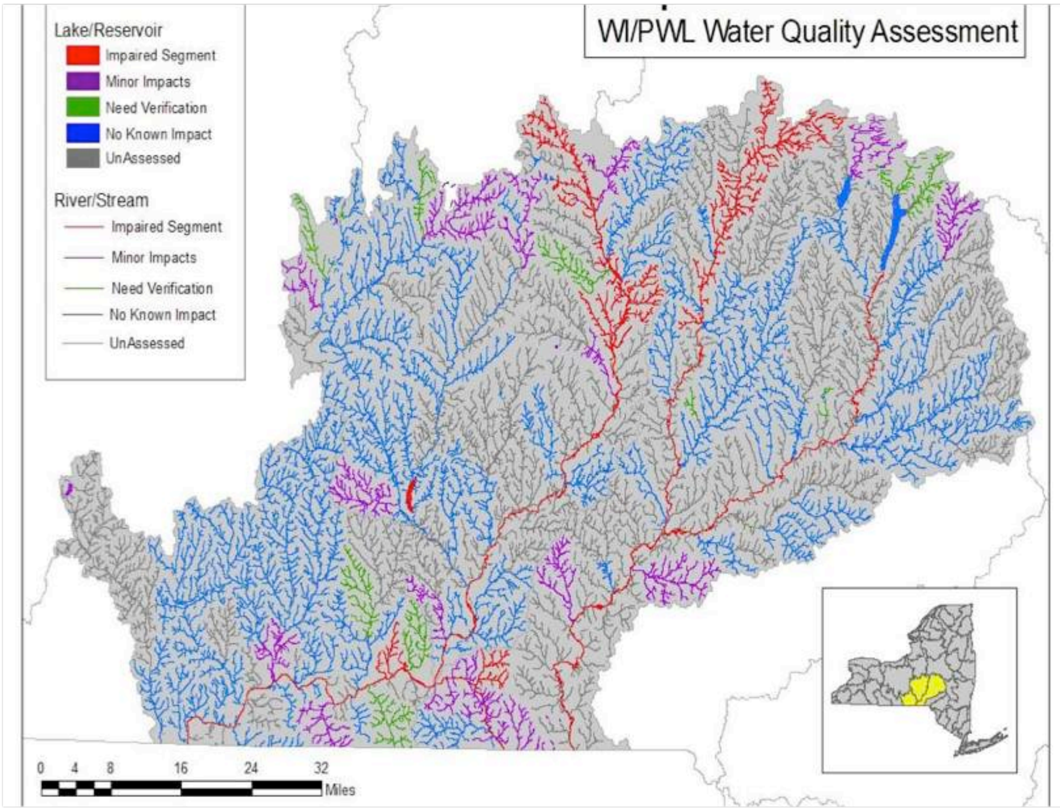


Figure 14. Map displaying impaired waterways for the headwaters of the Susquehanna River in New York.

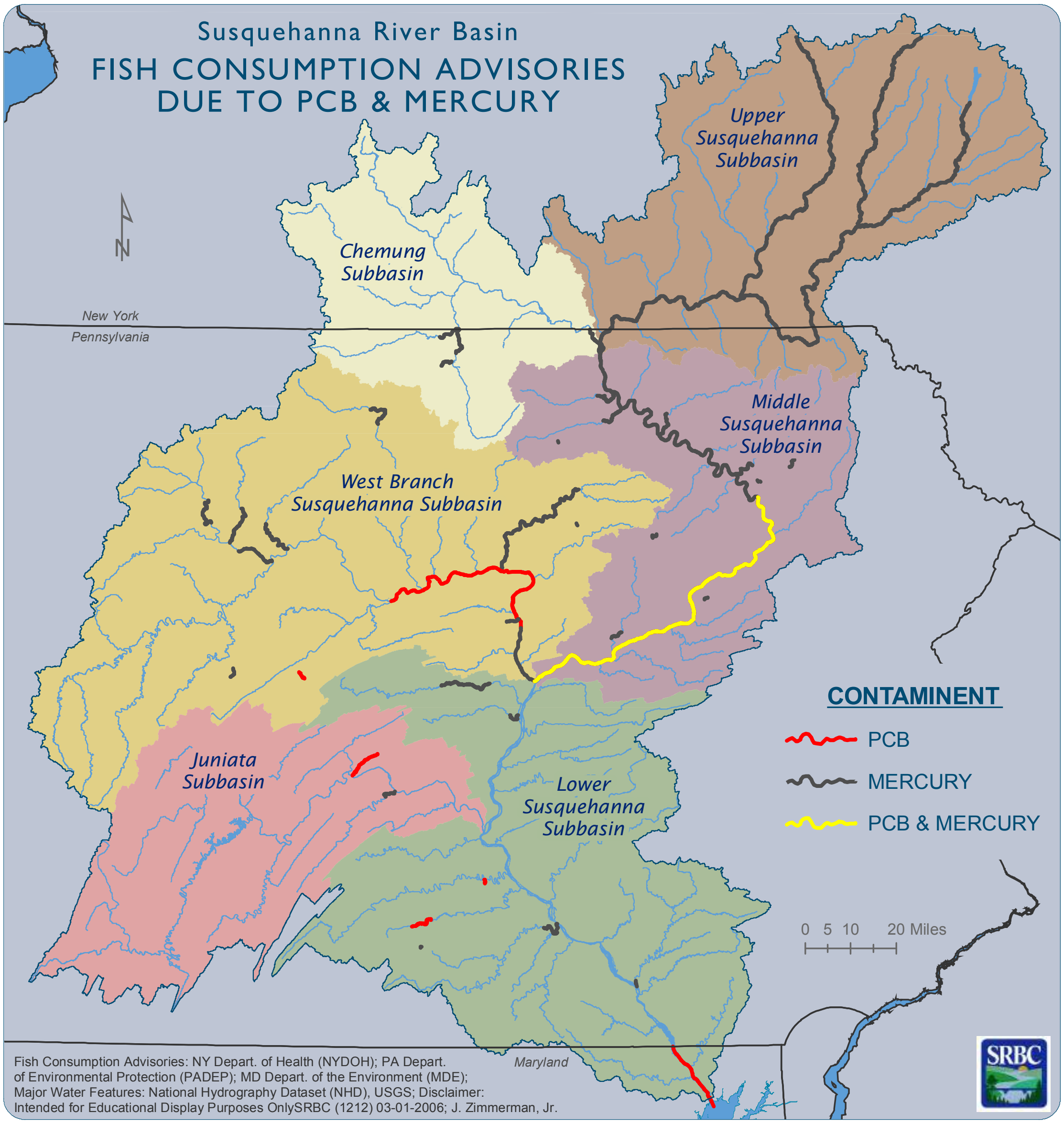


Figure 15. Map displaying heavy-metal water contaminants for the waterways of the Susquehanna River watershed.

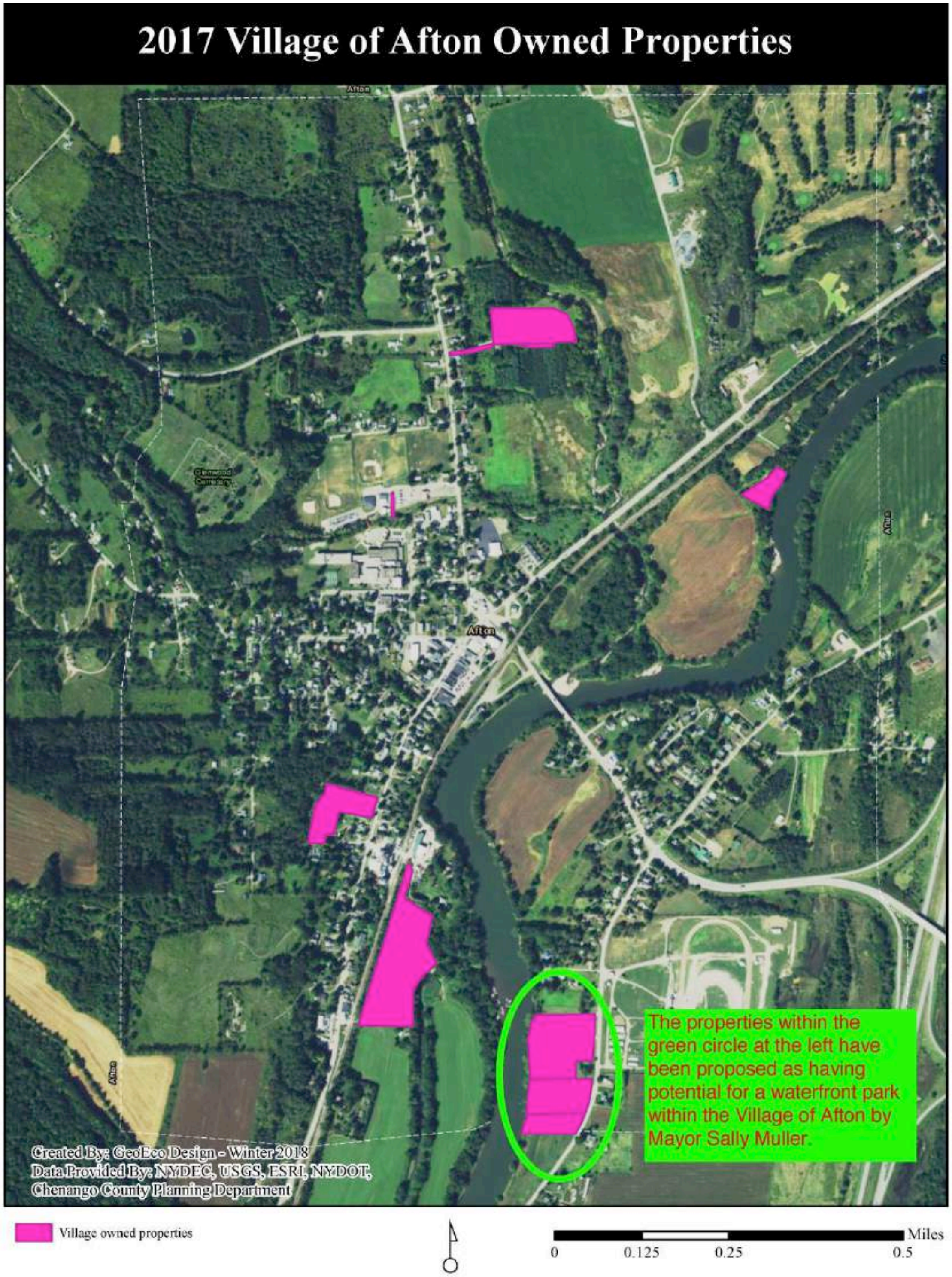


Figure 16. Map displaying potential location for Waterfront Park within the Village of Afton.

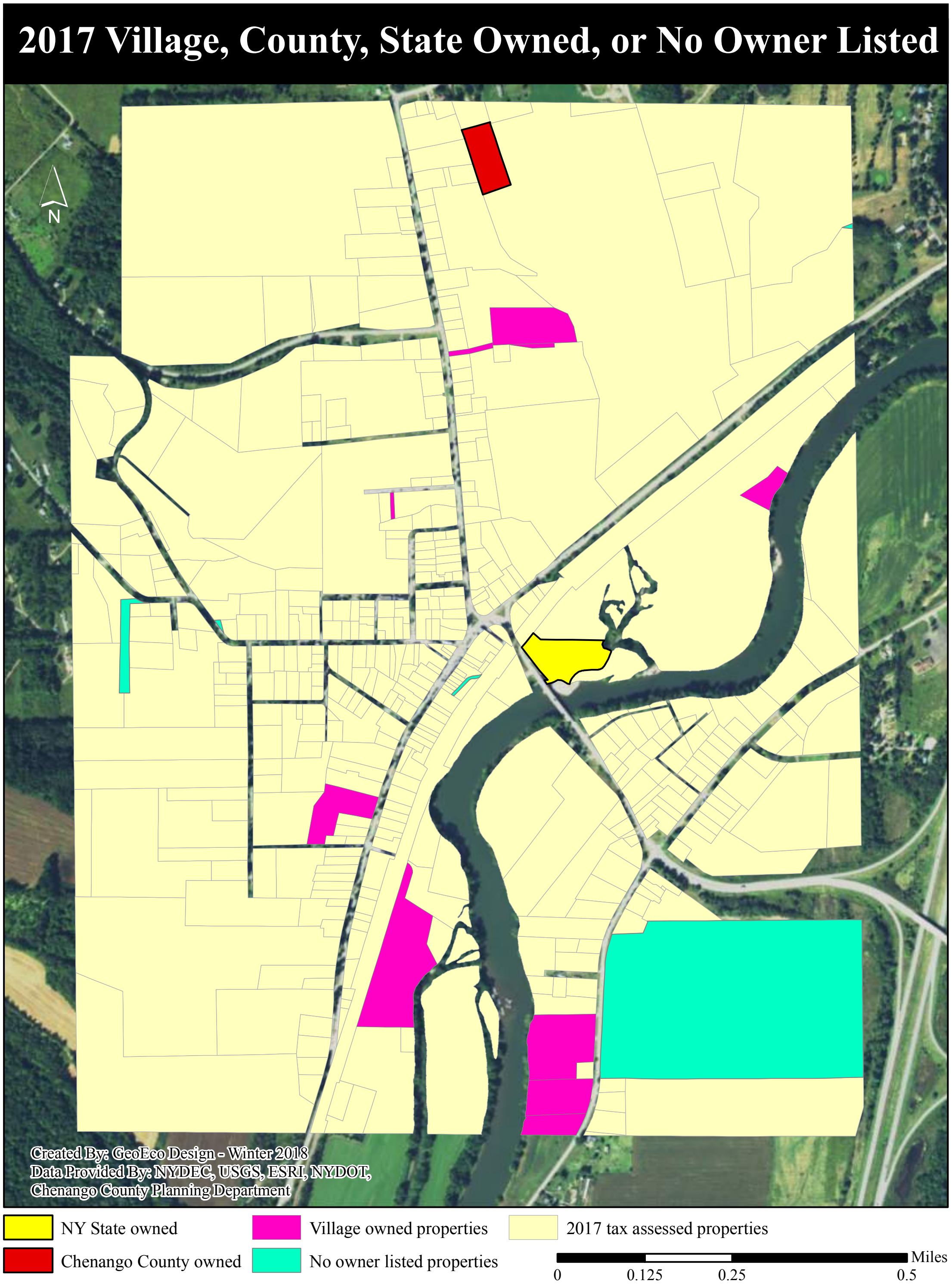


Figure 17. Map displaying government own and privately owned properties within the Village of Afton.

9. LIST OF APPENDICES

Appendix S1: NRCS Engineer Survey Diagram of 2011 High-Marks

Appendix S2: FEMA Flood Insurance Rate Map (1992)

Appendix S3: FEMA Flood Insurance Rate Map (2010)

Appendix S4: Table of 139 Flood-Unsafe Tax Property Assets

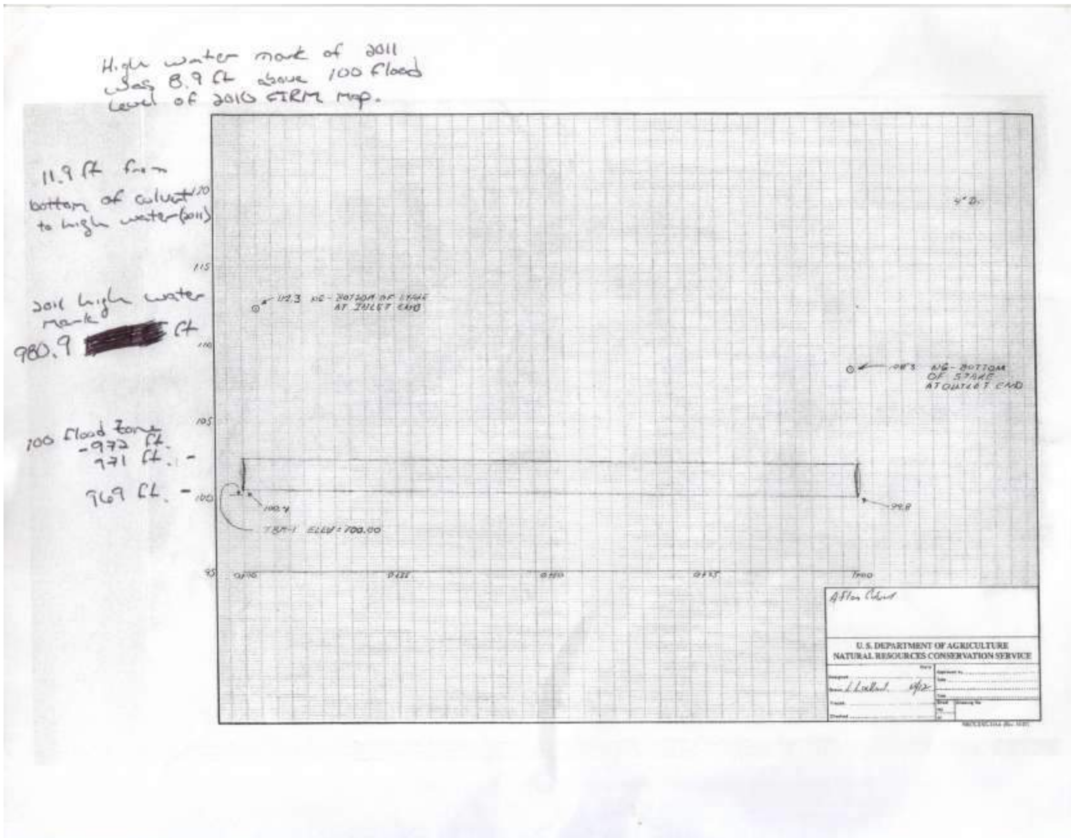
Appendix S5: 2015 Village of Afton Water Quality Report

Appendix S6: 2016 Village of Afton Water Quality Report

Appendix S7: Village of Afton Radiological Report

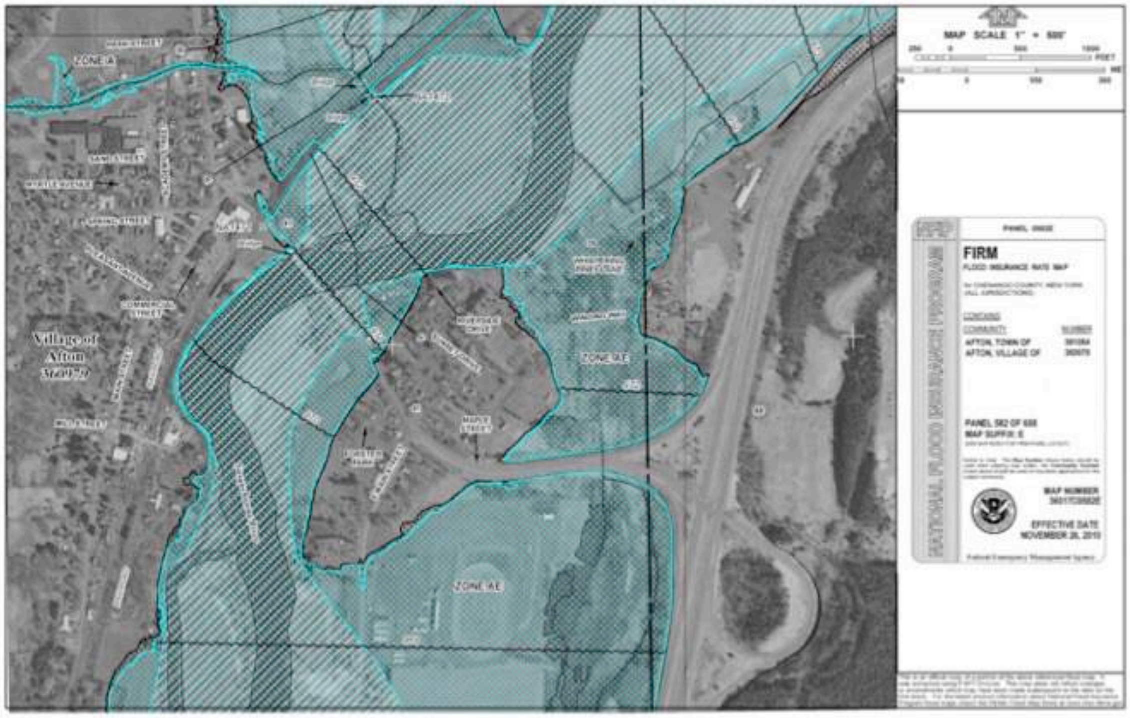
Appendix S8: Examples of Best Management Practices (BMPs) for Afton's Flood Management Park

Appendix S9: The Afton Village Residents Meeting – 23 April 2017 – Presentation



Appendix S1. Diagram illustrating survey results of high-water marks, above and below the culvert, from NRCS Engineer (L. Lockrel, 2012).

Appendix S2. 1992 Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM).



Appendix S3. 2010 Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM).

Appendix S4. Table of ownership information for the 139 Flood Not-Safe properties within the Village of Afton.

Street Address	Owner Name	Acres	Land Assess	Total Assess
2106 E Windsor Rd	Siewers, John	.00	6750.00	52500.00
5 Highland Ave	Craver, Philip B	.41	6500.00	55500.00
	Seco Realty & Development Corp	4.96	2000.00	2000.00
Main St	Village Of Afton	.20	1000.00	1000.00
100 Caswell St	Zablock, James M	8.70	9000.00	9000.00
208 Lewis Ln	Warrens Excavation and Stone	8.85	15000.00	15000.00
84 Caswell St	Dascano, Christian J Jr	.34	5000.00	51500.00
100 Caswell St	Zablocki, James	4.96	5750.00	5750.00
	Village Of Afton	3.92	3500.00	18500.00
4 Little League Rd	Howe, Patricia S	.36	5000.00	67500.00
150 Caswell St	Ricks, Leslie H	6.64	6300.00	6300.00
142 Caswell St	Henchy, Todd J	.64	750.00	750.00
148 Caswell St	Nelson, Jeffery S	.00	6000.00	52000.00
	Ricks, Leslie H	2.40	8500.00	69000.00
150 Caswell St	Ricks, Leslie H	.09	1000.00	1000.00
20 Highland Ave	Ramsey, Renee L	.52	7600.00	61600.00
	Lashway Michael	1.02	6500.00	43000.00
86 Theresa Blvd	T&N River Club, LLC	1.60	16000.00	16000.00
County Office Building	State, Of New York	3.73	5000.00	5000.00
501 Marquette Ave Ste 1410	Norfolk Southern Railway Comp	22.70	.00	643772.00
86 Theresa Blvd	T&N River Club, LLC	1.80	16000.00	208000.00
11 Mill St	McDowell & Walker Inc	1.62	20000.00	110000.00
80 Downing Dr	Quesada, Ruben G	10.00	10000.00	80000.00
37 Maple Ave	Stone, Doris B	10.00	10000.00	73500.00
9 Maple St	Browning, Peter C	3.62	7800.00	78000.00
26 Riverside Dr	Siewers, John P	.68	7500.00	19300.00
16 Riverside Dr	Mies, Robert J	1.00	7500.00	50500.00
10 Riverside Dr	Tucker, Patricia U	.43	6500.00	44100.00
38 Maple St	Williams, Robert E	.49	4500.00	4500.00
38 Maple St	Williams, Sadie L	.61	7000.00	39700.00
	Verona Family Partnership	.29	7000.00	110000.00
	Verona, Family Partnership	.30	3000.00	3000.00
28 Maple St	Decker, Tammy L	.21	5500.00	45000.00
24 Maple St	Cadden, Margaret D	.00	7000.00	44000.00
59 E Main St	Cutting, Michael P	2.30	9000.00	95000.00
16 Evelyn Ave	Burnett, Alice M	1.60	7500.00	57500.00
7 Evelyn Ave	Frisco, Mary Jo	.75	7000.00	56000.00
11 Evelyn Ave	Joslyn, Mary	.35	6000.00	25750.00
15 Evelyn Ave	Iaia, Tina M	.55	7500.00	23900.00
1260 County Rd 4	Buttner Brian J	1.49	8000.00	16000.00
	Village, Of Afton	5.23	14000.00	14000.00
30 Tyler St	Potts, Timothy	.36	5000.00	51900.00
14 E Main St	Briggs, Floyd	.47	6500.00	44500.00
	Village of Afton	3.00	9200.00	44100.00
	Village of Afton	1.58	7000.00	7000.00
540 State Hwy 41	Williams, Lawrence E Sr	.12	800.00	800.00
141 Pierce Ln	Page, Nikki L	1.08	7000.00	7000.00
9 Dyer Flat Rd	Schultz, Alfred	.72	6500.00	26400.00
	Fritzsch, Craig R	2.00	4500.00	5000.00
2906 Rt 79	A & G Realty Associates, LLC	21.60	10000.00	10000.00
	Royston, Joan	1.75	2950.00	2950.00
50 Main St	Affuso, Grace	.43	4000.00	44000.00
	Village of Afton	8.50	15000.00	20000.00
	McDowell & Walker Inc	2.50	25000.00	101000.00
214 Main St	Vance, James O	.45	11500.00	68000.00
22 Tarpon Ln	Cicero, Carol L	.40	6500.00	56000.00
	De Luca, Nicholas	.13	8000.00	8000.00
2383 State Hwy 41	Sherman, Christopher	.00	4000.00	30500.00
2 Merril St	Key Housing Dev Funding Corp	3.01	25000.00	1100000.00
30 Caswell St	First Baptist Church	1.00	8500.00	125000.00
215 Main St	Stafford, William L	.36	6500.00	70000.00
215 Main St	Stafford, William L	.25	5500.00	35000.00
30 Caswell St	First Baptist Church of Afton	.70	7500.00	44500.00
54 Caswell St	Joanne, Decker	1.61	8500.00	55000.00
54 Caswell St	Joanne, Decker	17.89	6800.00	6800.00
60 Caswell St	Wylubski, David M	.40	2500.00	2500.00
	Seco Realty & Development Corp	26.50	42250.00	42250.00
	Afton Village Dump	9.40	4160.00	4200.00
	Seco Realty & Development Corp	2.85	7500.00	7500.00
169 Main St	Town of Afton	5.83	6000.00	6000.00

	Higher Ground Christian Church	5.00	30000.00	545000.00
15 Winding Way	Vail Kenneth A	7.66	13000.00	73500.00
	Afton Glenwood Cemetery Assn	1.80	9500.00	9500.00
138 Winding Way	Johnson, Gayle E	4.00	5500.00	5500.00
9 Winding Way	Brown, William	.68	5500.00	46300.00
146 E Main St	Hosier, William L	1.01	7500.00	43300.00
146 E Main St	Hosier, William L	.45	7000.00	7000.00
148 E Main St	Nickerson, Janice	.49	5500.00	50100.00
	Palmatier, Bret	3.60	4500.00	9550.00
151 E Main St	Harris, Gerald W	1.30	5100.00	5100.00
155 E Main St	Mullin, Carolyn L	2.80	12000.00	125000.00
155 E Main St	Mullin, Carolyn L	1.78	1100.00	1100.00
125 Mountain Rd	Bagnall Properties LLC	.17	3000.00	3000.00
161 E Main St	Mewhorter, Jeffrey	3.78	8000.00	130000.00
29 Riverside Dr	Kimble, Martie J	.94	7500.00	59000.00
1649 Rita Rd	Whipple, Diane	1.93	9400.00	69600.00
491 Algerine St	Page, Nikki L	19.00	10000.00	10000.00
		.00	.00	.00
4030 State Hwy 79	Livermore, Russell	4.20	16000.00	87000.00
273 Clifton Pl Apt 4A	Patzak, Serge A	1.00	6000.00	51000.00
	Village of Afton	1.00	500.00	500.00
	Vail, Thomas C	40.90	28500.00	97500.00
2383 Route 41	Schuldt, William H	.24	1000.00	1000.00
2383 Route 41	Schuldt, William	9.70	8000.00	8000.00
151 E Main St	Harris, Gerald W	1.10	7000.00	118000.00
	Vail, Thomas C	40.90	28500.00	97500.00
	Vail, Thomas C	40.90	28500.00	97500.00
26 Riverside Dr	Siewers, John P	.68	7500.00	19300.00
2106 E Windsor Rd	Siewers, John	.00	6750.00	52500.00
16 Riverside Dr	Mies, Robert J	1.00	7500.00	50500.00
	Fritzsch, Craig R	2.00	4500.00	5000.00
	Fritzsch, Craig R	2.00	4500.00	5000.00
2906 Rt 79	A & G Realty Associates, LLC	21.60	10000.00	10000.00
2906 Rt 79	A & G Realty Associates, LLC	21.60	10000.00	10000.00
	Vail, Thomas C	40.90	28500.00	97500.00
208 Lewis Ln	County of Chenango	2.58	6200.00	21200.00
	KT Energy Services, LLC	2.00	12000.00	55800.00
544 Hall Rd	Gonzales, Ollie L	.51	7600.00	62600.00
501 Marquette Ave Ste 1410	Norfolk Southern Railway Comp	22.70	.00	643772.00
	James, Ryan	1.50	8000.00	105000.00
208 Lewis Ln	Warrens Excavation and Stone	8.85	15000.00	15000.00
66 Caswell St	Beams, Richard L	.65	7500.00	60000.00
82 Caswell St	Birch, Elizabeth A	.35	6000.00	63500.00
76 Caswell St	Cutting, Josephine T	.35	6000.00	39000.00
70 Caswell St	Cabey Robert E	.39	7000.00	35000.00
72 Caswell St	Neubauer, Roger E	.34	8400.00	18900.00
	Afton Central School District	1.64	2600.00	47600.00
	Village Garage	.40	7700.00	67000.00
Academy St	Afton Central School	17.80	252000.00	1500000.00
643 Melondy Hill Rd	Dougherty, John P	.50	3000.00	3000.00
	Dougherty, John P	.44	6000.00	61000.00
	Dougherty, John P	.71	7000.00	85000.00
2 Harpur Ln	Johnson, Jennifer	3.48	9600.00	49400.00
98 Spring St	Habberfield, Jeffrey	.60	4000.00	27500.00
5756 W 9600 N	Pixley, Edward G	4.00	5000.00	5000.00
	Lawrence, Michael J	3.00	16000.00	92300.00
Box 149	Crosby, Beryl	.95	3750.00	3750.00
703 Front St	Lesko , Charles Jr	2.79	3750.00	3750.00
Academy St	Afton Central School	7.50	6000.00	6000.00
84 Caswell St	Dascano, Christian J Jr	.34	5000.00	51500.00
Main St	Village Of Afton	.29	1000.00	10000.00
	Tryon, Richard I	.54	6500.00	73500.00
98 Caswell St	Egdorf, Lori A	.22	4500.00	40000.00
30 Caswell St	First Baptist Parsonage	.53	6500.00	46000.00
46 Caswell St	Weeks, Keith	.26	6000.00	45000.00
152 Afton Lake Rd	Smith, Donald	.19	5000.00	22000.00
60 Caswell St	Wylubski, David M	.49	7000.00	62500.00
64 Caswell St	Decker, Thomas V	.39	6500.00	45000.00
	Village of Afton	.13	2600.00	2600.00

Appendix S5. 2015 Village of Afton water quality report.

Annual Drinking Water Quality Report for 2015
Village of Afton
105 Main Street
Afton, NY 13730
(Public Water Supply ID# NY0801738)

Introduction

To comply with State regulations, the Village of Afton Water Department will be issuing an annual report describing the quality of your drinking water. The purpose of this report is to raise your understanding of drinking water and awareness of the need to protect our drinking water sources. Last year, your tap water met all State drinking water health standards. We are proud to report that our system did not violate a maximum contaminant level or any other water quality statement. This report provides an overview of last year's water quality. Included are details about where your water comes from, what it contains, and how it compares to State standards.

If you have any questions about this report or concerning your drinking water, please contact **Joshua Sweeney, Superintendent of Public Works, (607) 639-1903**. We want you to be informed about your drinking water. If you want to learn more, please attend any of our regularly scheduled village board meetings. The meetings are held the second Monday of each month at 7:00PM at the Afton Community Center.

Where does our water come from?

In general, the sources of drinking water (both tap water and bottled water) include rivers, lakes, streams, ponds, reservoirs, springs, and wells. As water travels over the surface of the land or through the ground, it dissolves naturally occurring minerals and, in some cases radioactive material and can pick up substances resulting from the presence of animals or from human activities. Contaminants that may be present in source water include: microbial contaminants; inorganic contaminants; pesticides and herbicides; organic chemical contaminants; and radioactive contaminants. In order to ensure that tap water is safe to drink, the State and the EPA prescribe regulations which limit the amount of certain contaminants in water provided by public water systems. The State Health Department's and the FDA's regulations establish limits for contaminants in bottled water which must provide the same protection for public health.

Our water system serves approximately 1000 people through 380 service connections. Our water sources are a groundwater well (with groundwater drawn from a single 133-foot deep drilled well) and six springs located off of NYS Route 41 on a protected 100-acre parcel of land owned by the village. Water flows from the springs via gravity to the Spring Water Treatment Plant where it is treated with a NSF approved liquid Sodium Hypochlorite solution (bleach) for disinfection. Water is pumped from the well into the Well Treatment Plant where it is treated with a NSF approved liquid Sodium Hypochlorite solution (bleach) for disinfection, and Polyphosphate for manganese removal. The treated water from the springs typically flows via gravity to the distribution system where it connects to the line carrying treated water from the well. This water then flows to the two storage facilities (210,000-gallon steel tank and 180,000-gallon covered reservoir).

Are there contaminants in our drinking water?

As the State regulations require, we routinely test your drinking water for numerous contaminants. These contaminants include: total coliform, turbidity, inorganic compounds, nitrate, nitrite, lead and copper, volatile organic compounds, total trihalomethanes, haloacetic acids, radiological and synthetic organic compounds. The table presented below depicts which compounds were detected in your drinking water. The State allows us to test for some contaminants less than once per year because the concentrations of these contaminants do not change frequently.

It should be noted that all drinking water, including bottled drinking water, may be reasonably expected to contain at least small amounts of some contaminants. The presence of contaminants does not necessarily indicate that water poses a health risk. More information about contaminants and potential health effects can be obtained by calling the EPA's Safe Drinking Water Hotline (800-426-4791) or the Chenango County Health Department at (607-337-1673).

Table of Detected Contaminants							
Contaminant	Violation Yes/No	Date of Sample	Level Detected (Range)	Unit Measure ment	MCLG	Regulatory Limit (MCL, TT or AL)	Likely Source of Contamination
Microbiological Contaminants							
Total Coliform	No	2 samples monthly	Absent	Present/ Absent	0	Any positive sample	Naturally occurring in the environment.
Inorganic Contaminants							
Nitrate- Spring	No	12/29/15	0.325	mg/L	10	10	Runoff from fertilizer use; Leaching from septic tanks, sewage; Erosion of natural deposits.
Nitrate - Well	No	12/29/15	<0.05	mg/L	10	10	Runoff from fertilizer use; Leaching from septic tanks, sewage; Erosion of natural deposits.
Lead	No	9/19/13	0.011[1] (0.0005-0.042)	mg/L	0	AL= 0.015	Corrosion of household plumbing systems; Erosion of natural deposits.
Copper	No	9/19/13	0.161	mg/L	1.3	AL= 1.3	Corrosion of household plumbing systems; Erosion of natural deposits; leaching from wood preservatives.
Barium- Spring	No	10/23/13	0.005	mg/L	2	2	Discharge of drilling wastes; Discharge from metal refineries; Erosion of natural deposits.
Barium - Well	No	10/23/13	0.130	mg/L	2	2	Discharge of drilling wastes; Discharge from metal refineries; Erosion of natural deposits.
Fluoride- Well	No	10/23/13	0.20	mg/L	N/A	2.2	Erosion of natural deposits. Discharge from fertilizer and aluminum factories.
Disinfection Byproducts							
Total Tri-Halomethanes Site 1(LRAA1)	No	8/27/15	2.98	ug/L	n/a	80	By-product of drinking water chlorination needed to kill harmful organisms. TTHMs are formed when source water contains large amounts of organic matter.
Total Tri-Halomethanes Site 2(LRAA2)	No	8/27/15	0.00	ug/L	n/a	80	
Haloacetic Acids Site 1(LRAA1)	No	8/27/15	0.00	ug/L	n/a	60	By-product of drinking water chlorination needed to kill harmful organisms.
Haloacetic Acids Site 2(LRAA2)	No	8/27/15	0.58	ug/L	n/a	60	

Table of Detected Contaminants							
Contaminant	Violation Yes/No	Date of Sample	Level Detected (Range)	Unit Measure ment	MCLG	Regulatory Limit (MCL, TT or AL)	Likely Source of Contamination

1-The level presented represents the 90th percentile of 10 tested sites. A percentile is a value on a scale of 100 that indicates the percent of a distribution that is equal to or below it. The 90th percentile is equal to or greater than 90% of the lead values detected at your water system. In this case, 10 samples were collected by your water system, ranging in concentrations from 0.0005 mg/L to 0.042 mg/L. The 90th percentile of collected samples is 0.011 mg/L for lead. The action level for lead was not exceeded at any of the test sites. For more information about Lead contact your local health department or www.epa.gov .

Definitions:

Maximum Contaminant Level (MCL): The highest level of a contaminant that is allowed in drinking water. MCLs are set as close to the MCLGs as feasible.
Maximum Contaminant Level Goal (MCLG): The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety.
Maximum Residual Disinfectant Level (MRDL): The highest level of a disinfectant allowed in drinking water. There is convincing evidence that addition of a disinfectant is necessary for control of microbial contaminants.
Maximum Residual Disinfectant Level Goal (MRDLG): The level of a drinking water disinfectant below which there is no known or expected risk to health. MRDLGs do not reflect the benefits of the use of disinfectants to control microbial contamination.
Action Level (AL): The concentration of a contaminant which, if exceeded, triggers treatment or other requirements which a water system must follow.
Treatment Technique (TT): A required process intended to reduce the level of a contaminant in drinking water.
Non-Detects (ND): Laboratory analysis indicates that the constituent is not present.
Nephelometric Turbidity Unit (NTU): A measure of the clarity of water. Turbidity in excess of 5 NTU is just noticeable to the average person.
Milligrams per liter (mg/l): Corresponds to one part of liquid in one million parts of liquid (parts per million - ppm).
Micrograms per liter (ug/l): Corresponds to one part of liquid in one billion parts of liquid (parts per billion - ppb).
Nanograms per liter (ng/l): Corresponds to one part of liquid to one trillion parts of liquid (parts per trillion - ppt).
Picograms per liter (pg/l): Corresponds to one part per of liquid to one quadrillion parts of liquid (parts per quadrillion – ppq).
Picocuries per liter (pCi/L): A measure of the radioactivity in water.
Millirems per year (mrem/yr): A measure of radiation absorbed by the body.
Million Fibers per Liter (MFL): A measure of the presence of asbestos fibers longer than 10 micrometers.

What does this information mean?

As you can see by the table, our system had no violations. We have learned through our testing that some contaminants have been detected; however, these contaminants were detected below the level allowed by the State.

Important Information Regarding Lead:

If present, elevated levels of lead can cause serious health problems, especially for pregnant women, infants, and young children. It is possible that lead levels at your home may be higher than at other homes in the community as a result of materials used in your home's plumbing. The Village of Afton is responsible for providing high quality drinking water, but cannot control the variety of materials used in plumbing components. When your water has been sitting for several hours, you can minimize the potential for lead exposure by flushing your tap for 30 seconds to 2 minutes before using water for drinking or cooking. If you are concerned about lead in your water, you may wish to have your water tested. Information on lead in drinking water, testing methods, and steps you can take to minimize exposure is available from the Safe Drinking Water Hotline (1-800-426-4791) or at http://www.epa.gov/safewater/lead.

Is our water system meeting other rules that govern operations?

During 2015, our system was in compliance with applicable State drinking water operating, monitoring and reporting requirements.

Do I Need to Take Special Precautions?

Although our drinking water met or exceeded state and federal regulations, some people may be more vulnerable to disease causing microorganisms or pathogens in drinking water than the general population. Immuno-compromised persons such as persons with cancer undergoing chemotherapy, persons who have undergone organ transplants, people with HIV/AIDS or other immune system disorders, some elderly, and infants can be particularly at risk from infections. These people should seek advice from their health care provider about their drinking water. EPA/CDC guidelines on appropriate means to lessen the risk of infection by Cryptosporidium, Giardia and other microbial pathogens are available from the Safe Drinking Water Hotline (800-426-4791).

Information for Non- English Speaking Residents

Spanish

Este informe contiene informacion muy importante sobre su agua beber. Traduzcalo o hable con alguien que lo entienda bien

French

Ce rapport contient des infromations importantes sur votre eau potable. Traduisez-le ou parlez en avec quelqu'un qui le comprend bien.

Why Save Water and How to Avoid Wasting It?

Although our system has an adequate amount of water to meet present and future demands, there are a number of reasons why it is important to conserve water:

- Saving water saves energy and some of the costs associated with both of these necessities of life;
- Saving water reduces the cost of energy required to pump water and the need to construct costly new wells, pumping systems and water towers; and
- Saving water lessens the strain on the water system during a dry spell or drought, helping to avoid severe water use restrictions so that essential fire fighting needs are met.

You can play a role in conserving water by becoming conscious of the amount of water your household is using, and by looking for ways to use less whenever you can. It is not hard to conserve water. Conservation tips include:

- Automatic dishwashers use 15 gallons for every cycle, regardless of how many dishes are loaded. So get a run for your money and load it to capacity.
- Turn off the tap when brushing your teeth.
- Check every faucet in your home for leaks. Just a slow drip can waste 15 to 20 gallons a day. Fix it up and you can save almost 6,000 gallons per year.
- Check your toilets for leaks by putting a few drops of food coloring in the tank, watch for a few minutes to see if the color shows up in the bowl. It is not uncommon to lose up to 100 gallons a day from one of these otherwise invisible toilet leaks. Fix it and you save more than 30,000 gallons a year.

Closing

Thank you for allowing us to continue to provide your family with quality drinking water this year. In order to maintain a safe and dependable water supply we sometimes need to make improvements that will benefit all of our customers. The costs of these improvements may be reflected in the rate structure. Rate adjustments may be necessary in order to address these improvements. We ask that all our customers help us protect our water sources, which are the heart of our community. Please call our office if you have questions.

Appendix S6. 2016 Village of Afton water quality report.

Annual Drinking Water Quality Report for 2016
Village of Afton
105 Main Street
Afton, NY 13730
(Public Water Supply ID# NY0801738)

Introduction

To comply with State regulations, the Village of Afton Water Department will be issuing an annual report describing the quality of your drinking water. The purpose of this report is to raise your understanding of drinking water and awareness of the need to protect our drinking water sources. Last year, your tap water met all State drinking water health standards. We are proud to report that our system did not violate a maximum contaminant level or any other water quality statement. This report provides an overview of last year's water quality. Included are details about where your water comes from, what it contains, and how it compares to State standards.

If you have any questions about this report or concerning your drinking water, please contact **Joshua Sweeney, Superintendent of Public Works, (607) 639-1903.** We want you to be informed about your drinking water. If you want to learn more, please attend any of our regularly scheduled village board meetings. The meetings are held the second Monday of each month at 7:00PM at the Afton Community Center.

Where does our water come from?

In general, the sources of drinking water (both tap water and bottled water) include rivers, lakes, streams, ponds, reservoirs, springs, and wells. As water travels over the surface of the land or through the ground, it dissolves naturally occurring minerals and, in some cases radioactive material and can pick up substances resulting from the presence of animals or from human activities. Contaminants that may be present in source water include: microbial contaminants; inorganic contaminants; pesticides and herbicides; organic chemical contaminants; and radioactive contaminants. In order to ensure that tap water is safe to drink, the State and the EPA prescribe regulations which limit the amount of certain contaminants in water provided by public water systems. The State Health Department's and the FDA's regulations establish limits for contaminants in bottled water which must provide the same protection for public health.

Our water system serves approximately 1000 people through 380 service connections. Our water sources are a groundwater well (with groundwater drawn from a single 133-foot deep drilled well) and six springs located off of NYS Route 41 on a protected 100-acre parcel of land owned by the village. Water flows from the springs via gravity to the Spring Water Treatment Plant where it is treated with a NSF approved liquid Sodium Hypochlorite solution (bleach) for disinfection. Water is pumped from the well into the Well Treatment Plant where it is treated with a NSF approved liquid Sodium Hypochlorite solution (bleach) for disinfection, and Polyphosphate for manganese removal. The treated water from the springs typically flows via gravity to the distribution system where it connects to the line carrying treated water from the well. This water then flows to the two storage facilities (210,000-gallon steel tank and 180,000-gallon covered reservoir).

Are there contaminants in our drinking water?

As the State regulations require, we routinely test your drinking water for numerous contaminants. These contaminants include: total coliform, turbidity, inorganic compounds, nitrate, nitrite, lead and copper, volatile organic compounds, total trihalomethanes, haloacetic acids, radiological and synthetic organic compounds. The table presented below depicts which compounds were detected in your drinking water. The State allows us to test for some contaminants less than once per year because the concentrations of these contaminants do not change frequently.

It should be noted that all drinking water, including bottled drinking water, may be reasonably expected to contain at least small amounts of some contaminants. The presence of contaminants does not necessarily indicate that water poses a health risk. More information about contaminants and potential health effects can be obtained by calling the EPA's Safe Drinking Water Hotline (800-426-4791) or the Chenango County Health Department at (607-337-1673).

Table of Detected Contaminants							
Contaminant	Violation Yes/No	Date of Sample	Level Detected (Range)	Unit Measurement	MCLG	Regulatory Limit (MCL, TT or AL)	Likely Source of Contamination
Inorganic Contaminants							
Nitrate- Spring	No	12/14/16	0.28	mg/L	10	MCL = 10	Runoff from fertilizer use; Leaching from septic tanks, sewage; Erosion of natural deposits.
Lead	No	9/14/16	0.0015[1] (<0.001-0.009)	mg/L	0	AL= 0.015	Corrosion of household plumbing systems; Erosion of natural deposits.
Copper	No	9/14/16	0.15[1] (0.0024-0.55)	mg/L	1.3	AL = 1.3	Corrosion of household plumbing systems; Erosion of natural deposits; leaching from wood preservatives.
Barium - Well	No	5/16/16	0.137	mg/L	2	MCL = 2	Discharge of drilling wastes; Discharge from metal refineries; Erosion of natural deposits.
Fluoride- Well	No	5/16/16	0.20	mg/L	N/A	MCL = 2.2	Erosion of natural deposits. Discharge from fertilizer and aluminum factories.
Disinfection Byproducts							
Total Tri-Halomethanes Site 1(LRAA1)	No	8/27/15	2.98	µg/L	n/a	MCL = 80	By-product of drinking water chlorination needed to kill harmful organisms. TTHMs are formed when source water contains large amounts of organic matter.

1-The level presented represents the 90th percentile of 10 tested sites. A percentile is a value on a scale of 100 that indicates the percent of a distribution that is equal to or below it. The 90th percentile is equal to or greater than 90% of the lead and copper values detected at your water system. The action level for lead and copper was not exceeded at any of the test sites. For more information about lead contact your local health department or www.epa.gov .

Definitions:

Maximum Contaminant Level (MCL): The highest level of a contaminant that is allowed in drinking water. MCLs are set as close to the MCLGs as feasible.
Maximum Contaminant Level Goal (MCLG): The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety.
Maximum Residual Disinfectant Level (MRDL): The highest level of a disinfectant allowed in drinking water. There is convincing evidence that addition of a disinfectant is necessary for control of microbial contaminants.
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Ce rapport contient des infromations importantes sur votre eau potable. Traduisez-le ou parlez en avec quelqu'un qui le comprend bien.

Closing

Thank you for allowing us to continue to provide your family with quality drinking water this year. In order to maintain a safe and dependable water supply we sometimes need to make improvements that will benefit all of our customers. The costs of these improvements may be reflected in the rate structure. Rate adjustments may be necessary in order to address these improvements. We ask that all our customers help us protect our water sources, which are the heart of our community. Please call our office if you have questions.

Appendix S7. Village of Afton radiological report.

LSL Life Science Laboratories, Inc.

Josh Sweeney
Afton, Village of
19 Court St.
Afton, NY 13730

Phone: (607) 343-4642
FAX: (607) 639-1903

Federal Water Supply ID: NY0801738

Laboratory Analysis Report

Prepared For

Afton, Village of

LSL Project ID: **1720393**

Receive Date/Time: 12/13/17 17:57

LSL Central Lab
5854 Butternut Drive
East Syracuse, NY 13057
Tel. (315) 445-1900
Fax (315) 445-1104
NYS DOH ELAP #10248
PA DEP #68-2556

LSL North Lab
131 St. Lawrence Avenue
Waddington, NY 13694
Tel. (315) 388-4476
Fax (315) 388-4061
NYS DOH ELAP #10900

LSL Finger Lakes Lab
16 N. Main St., PO Box 424
Wayland, NY 14572
Tel. (585) 728-3320
Fax (585) 728-2711
NYS DOH ELAP #11667

LSL Southern Tier Office
Cuba, NY
Tel. (585) 209-4032

LSL MidLakes Office
Canandaigua, NY
Tel. (585) 728-3320

This report was reviewed by: [signature] *Date:* 1/15/18

David J. Prichard, Director of Tech. Services

A copy of this report was sent to:

Page 1 of 2

Date Printed: 1/15/18

-- LABORATORY ANALYSIS REPORT --

Afton, Village of *Afton, NY*

Sample ID: Spring		**LSL Sample ID:**	1720393-001
Location:		**Federal Water Supply ID:**	NY0801738
Sampled: 12/13/17 8:00	**Sampled By:** DB	**Source Code:**	
Sample Matrix: PWS		**Reason Code:**	

Analytical Method / Analyte	Result	Units	Prep Method	Prep Date	Analysis Date & Time	Analyst Initials
EPA 900.0 Gross Alpha						
Gross Alpha	See Attached					
This analysis was performed by NYS DOH ELAP laboratory number 11777.						
EPA 903.0 Radium 226						
Radium 226	See Attached					
This analysis was performed by NYS DOH ELAP laboratory number 11777.						
EPA 904.0 Radium 228						
Radium 228	See Attached					
This analysis was performed by NYS DOH ELAP laboratory number 11777.						
Free Chlorine, (Client Provided)						
Free Available Chlorine	1.0	mg/l			12/13/17 08:00	DB

Sample ID: Well		**LSL Sample ID:**	1720393-002
Location:		**Federal Water Supply ID:**	NY0801738
Sampled: 12/13/17 7:45	**Sampled By:** DB	**Source Code:**	
Sample Matrix: PWS		**Reason Code:**	

Analytical Method / Analyte	Result	Units	Prep Method	Prep Date	Analysis Date & Time	Analyst Initials
EPA 900.0 Gross Alpha						
Gross Alpha	See Attached					
This analysis was performed by NYS DOH ELAP laboratory number 11777.						
EPA 903.0 Radium 226						
Radium 226	See Attached					
This analysis was performed by NYS DOH ELAP laboratory number 11777.						
EPA 904.0 Radium 228						
Radium 228	See Attached					
This analysis was performed by NYS DOH ELAP laboratory number 11777.						
Free Chlorine, (Client Provided)						
Free Available Chlorine	0.9	mg/l			12/13/17 07:45	DB

Analysis performed at: *(1) LSL Central Lab, (2) LSL North Lab, (3) LSL Finger Lakes Lab*

Summit Environmental Technologies, Inc.
3310 Win St.
Cuyahoga Falls, Ohio 44223
TEL: (330) 253-8211 FAX: (330) 253-4489
Website: http://www.settek.com

January 11, 2018

Greg Smith
Life Science Laboratories, Inc.
5854 Butternut Dr.
E. Syracuse, NY 13057
TEL: (315) 445-1105
FAX: (315) 445-1301

RE: 1720393

Dear Greg Smith: Order No.: 17120858

Summit Environmental Technologies, Inc. received 2 sample(s) on 12/18/2017 for the analyses presented in the following report.

Holly Florea
Project Manager
3310 Win St.
Cuyahoga Falls, Ohio 44223

Arkansas 88-0735, California 07256CA, Colorado, Connecticut PH-0108, Delaware, Florida NELAC E87688, Georgia E87688, Idaho OH00923, Illinois 200061, Indiana C-OH-13, Kansas E-10347, Kentucky (Underground Storage Tank) 3, Kentucky 90146, Louisiana 04061, Maryland 339, Minnesota 409711, New Hampshire 2996, New Jersey OH006, New York 11777, North Carolina 39705 and 631, North Dakota R-201, Oklahoma 9940, Oregon OH200001, Rhode Island LA000317, South Carolina 92016001, Texas T104704466-11-5, Utah OH009232011-1, Virginia 00440 and 1581, Washington C891

Summit Environmental Technologies, Inc.
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Cuyahoga Falls, Ohio 44223
TEL: (330) 253-8211 FAX: (330) 253-4489
Website: http://www.settek.com

Case Narrative

WO#: 17120858
Date: 1/11/2018

CLIENT: Life Science Laboratories, Inc.
Project: 1720393

WorkOrder Narrative:
This report in its entirety consists of the following documents: Cover Letter, Case Narrative, Analytical Results, QC Summary Report, Applicable Accreditation Information, Chain-of-Custody, Cooler Receipt Form, and other applicable forms as necessary. All documents contain the Summit Environmental Technologies, Inc., Work Order Number assigned to this report.

Summit Environmental Technologies, Inc., holds the accreditations/certifications listed at the bottom of the cover letter that may or may not pertain to this report. State Certificates and Scopes of Accreditation are attached as applicable. Results provided in this report for any parameter not listed on the Scope of Accreditation should be considered "not certified."

The information contained in this analytical report is the sole property of Summit Environmental Technologies, Inc. and that of the customer. It cannot be reproduced in any form without the consent of Summit Environmental Technologies, Inc. or the customer for which this report was issued. The results contained in this report are only representative of the samples received. Conditions can vary at different times and at different sampling conditions. Summit Environmental Technologies, Inc. is not responsible for use or interpretation of the data included herein.

All results for Solid Samples are reported on an "as received" or "wet weight" basis unless indicated as "dry weight" using the "-dry" designation on the reporting units.

This report is believed to meet all of the requirements of the accrediting agency, where applicable. Any comments or problems with the analytical events associated with this report are noted below.

Analytical Sequence QC Notes:
17120858-001aMS Radium-226_DW(903.0): MS out from acceptable range due to matrix effect.

Summit Environmental Technologies, Inc.
3310 Win S
Cuyahoga Falls, Ohio 4422
TEL: (330) 253-8211 FAX: (330) 253-448
Website: http://www.settek.co

Qualifiers and Acronyms

WO#: 17120858
Date: 1/11/2018

These commonly used Qualifiers and Acronyms may or may not be present in this report.

Qualifiers

U	The compound was analyzed for but was not detected.
J	The reported value is greater than the Method Detection Limit but less than the Reporting Limit.
H	The hold time for sample preparation and/or analysis was exceeded.
D	The result is reported from a dilution.
E	The result exceeded the linear range of the calibration or is estimated due to interference.
MC	The result is below the Minimum Compound Limit.
*	The result exceeds the Regulatory Limit or Maximum Contamination Limit.
m	Manual integration was used to determine the area response.
d	Manual integration in which peak was deleted
N	The result is presumptive based on a Mass Spectral library search assuming a 1:1 response.
P	The second column confirmation exceeded 25% difference.
C	The result has been confirmed by GC/MS.
X	The result was not confirmed when GC/MS Analysis was performed.
B/MB+	The analyte was detected in the associated blank.
G	The ICB or CCB contained reportable amounts of analyte.
QC-/+	The CCV recovery failed low (-) or high (+).
R/QDR	The RPD was outside of accepted recovery limits.
QL-/+	The LCS or LCSD recovery failed low (-) or high (+).
QLR	The LCS/LCSD RPD was outside of accepted recovery limits.
QM-/+	The MS or MSD recovery failed low (-) or high (+).
QMR	The MS/MSD RPD was outside of accepted recovery limits.
QV-/+	The ICV recovery failed low (-) or high (+).
S	The spike result was outside of accepted recovery limits.
Z	Deviation; A deviation from the method was performed; Please refer to the Case Narrative for additional information

Acronyms

ND	Not Detected	**RL**	Reporting Limit
QC	Quality Control	**MDL**	Method Detection Limit
MB	Method Blank	**LOD**	Level of Detection
LCS	Laboratory Control Sample	**LOQ**	Level of Quantitation
LCSD	Laboratory Control Sample Duplicate	**PQL**	Practical Quantitation Limit
QCS	Quality Control Sample	**CRQL**	Contract Required Quantitation Limit
DUP	Duplicate	**PL**	Permit Limit
MS	Matrix Spike	**RegLvl**	Regulatory Limit
MSD	Matrix Spike Duplicate	**MCL**	Maximum Contamination Limit
RPD	Relative Percent Different	**MinCL**	Minimum Compound Limit
ICV	Initial Calibration Verification	**RA**	Reanalysis
ICB	Initial Calibration Blank	**RE**	Reextraction
CCV	Continuing Calibration Verification	**TIC**	Tentatively Identified Compound
CCB	Continuing Calibration Blank	**RT**	Retention Time
RLC	Reporting Limit Check	**CF**	Calibration Factor
DF	Dilution Factor	**RF**	Response Factor

This list of Qualifiers and Acronyms reflects the most commonly utilized Qualifiers and Acronyms for reporting. Please refer to the Analytical Notes in the Case Narrative for any Qualifiers or Acronyms that do not appear in this list or for additional information regarding the use of these Qualifiers on reported data.

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Workorder Sample Summary

WO#: 17120858
11-Jan-18

CLIENT: Life Science Laboratories, Inc.
Project: 1720393

Lab SampleID	Client Sample ID	Tag No	Date Collected	Date Received	Matrix
17120858-001	1720393-001A,B		12/13/2017	12/18/2017 9:15:00 AM	Drinking Water
17120858-002	1720393-002A,B		12/13/2017	12/18/2017 9:15:00 AM	Drinking Water

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DATES REPORT

WO#: 17120858
11-Jan-18

Client: Life Science Laboratories, Inc.
Project: 1720393

Sample ID	Client Sample ID	Collection Date	Matrix	Test Name	Leachate Date	Prep Date	Analysis Date
17120858-001A	1720393-001A,B	12/13/2017	Drinking Water	Gross Alpha / Gross Beta Radioactivity (EPA 900.0)		12/28/2017 8:12:01 AM	1/4/2018 5:50:00 PM
				Radium-226 (903.0)		12/28/2017 7:23:36 AM	1/3/2018 11:17:00 AM
				Radium-226/228 (903.0/904.0)			1/11/2018
				Radium-228 (904.0)		12/28/2017 7:23:36 AM	1/2/2018 3:14:00 PM
17120858-002A	1720393-002A,B			Gross Alpha / Gross Beta Radioactivity (EPA 900.0)		12/28/2017 8:12:01 AM	1/2/2018 8:18:00 AM
				Radium-226 (903.0)		12/28/2017 7:23:36 AM	1/3/2018 11:17:00 AM
				Radium-226/228 (903.0/904.0)			1/11/2018
				Radium-228 (904.0)		12/28/2017 7:23:36 AM	1/2/2018 3:14:00 PM

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Analytical Report

(consolidated)

WO#: 17120858

Date Reported: 1/11/2018

CLIENT: Life Science Laboratories, Inc. **Collection Date:** 12/13/2017

Project: 1720393

Lab ID: 17120858-001 **Matrix:** DRINKING WATER

Client Sample ID 1720393-001A,B

Analyses	Result	PQL	Qual	Units	Uncertainty	DF	Date Analyzed
GROSS ALPHA / GROSS BETA RADIOACTIVITY (EPA 900.0)					**E900.0**	**E900**	Analyst: **BRD**
ALPHA, Gross	ND	3.00	U	pCi/L	± 1.43	1	1/4/2018 5:50:00 PM
COMBINED RADIUM-226/228 RADIUM-226/228 (903.0/904.0)					**MBDRA226RA22**		Analyst: **BRD**
Radium-226/Radium-228 Combined	ND	2.00	U	pCi/L	± 0.43	1	1/11/2018
COMBINED RADIUM-226/228 RADIUM-226 (903.0)					**E903.0**	**E903-904**	Analyst: **BRD**
Radium-226	ND	1.00	UQM+	pCi/L	± 0.07	1	1/3/2018 11:17:00 AM
Yield	1.00					1	1/3/2018 11:17:00 AM
COMBINED RADIUM-226/228 RADIUM-228 (904.0)					**E904.0**	**E903-904**	Analyst: **BRD**
Radium-228	ND	1.00	U	pCi/L	± 0.36	1	1/2/2018 3:14:00 PM
Yield	0.970					1	1/2/2018 3:14:00 PM

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	M	Manual Integration used to determine area response
MC	Value is below Minimum Compound Limit.	N	Tentatively identified compounds
ND	Not Detected	O	RSD is greater than RSDlimit
P	Second column confirmation exceeds	PL	Permit Limit

Summit Environmental Technologies, Inc.
3310 Win St.
Cuyahoga Falls, Ohio 44223
TEL: (330) 253-8211 FAX: (330) 253-4489
Website: http://www.settek.com

QC SUMMARY REPORT

WO#: 17120858
11-Jan-18

Client: Life Science Laboratories, Inc.
Project: 1720393
BatchID: 30233

Sample ID lcs-30233	SampType: LCS	TestCode: AlphaBeta_D Units: pCi/L			Prep Date: 12/28/2017				RunNo: 79014		
Client ID: LCSW	Batch ID: 30233	TestNo: E900.0 E900			Analysis Date: 12/29/2017				SeqNo: 1367360		
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
ALPHA, Gross	17.2	3.00	15.00	0	115	70	130				

Sample ID 17120855-001aMS	SampType: MS	TestCode: AlphaBeta_D Units: pCi/L			Prep Date: 12/28/2017				RunNo: 79014		
Client ID: BatchQC	Batch ID: 30233	TestNo: E900.0 E900			Analysis Date: 12/29/2017				SeqNo: 1367364		
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
ALPHA, Gross	17.3	3.00	15.00	0	115	70	130				

Sample ID 17120855-001aMSD	SampType: MSD	TestCode: AlphaBeta_D Units: pCi/L			Prep Date: 12/28/2017				RunNo: 79014		
Client ID: BatchQC	Batch ID: 30233	TestNo: E900.0 E900			Analysis Date: 12/29/2017				SeqNo: 1367365		
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
ALPHA, Gross	17.9	3.00	15.00	0	119	70	130	17.30	3.43	30	

Sample ID 17120856-001adup	SampType: DUP	TestCode: AlphaBeta_D Units: pCi/L			Prep Date: 12/28/2017				RunNo: 79014		
Client ID: BatchQC	Batch ID: 30233	TestNo: E900.0 E900			Analysis Date: 12/29/2017				SeqNo: 1367372		
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
ALPHA, Gross	ND	3.00						0	0	30	U

Qualifiers:
- * Value exceeds Maximum Contaminant Level.
- H Holding times for preparation or analysis exceeded
- MC Value is below Minimum Compound Limit.
- P Second column confirmation exceeds
- B Analyte detected in the associated Method Blank
- J Analyte detected below quantitation limits
- ND Not Detected
- PL Permit Limit
- E Value above quantitation range
- M Manual Integration used to determine
- O RSD is greater than RSDlimit
- R RPD outside accepted recovery limits

Original

Summit Environmental Technologies, Inc.
3310 Win St.
Cuyahoga Falls, Ohio 44223
TEL: (330) 253-8211 FAX: (330) 253-4489
Website: http://www.settek.com

QC SUMMARY REPORT

WO#: 17120858
11-Jan-18

Client: Life Science Laboratories, Inc.
Project: 1720393
BatchID: 30233

Sample ID 17120856-001adup	SampType: DUP	TestCode: AlphaBeta_D	Units: pCi/L		Prep Date: 12/28/2017				RunNo: 79014			
Client ID: BatchQC	Batch ID: 30233	TestNo: E900.0	E900		Analysis Date: 12/29/2017				SeqNo: 1367372			
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual	

Sample ID mb-30233	SampType: MBLK	TestCode: AlphaBeta_D	Units: pCi/L		Prep Date: 12/28/2017				RunNo: 79014		
Client ID: PBW	Batch ID: 30233	TestNo: E900.0	E900		Analysis Date: 1/2/2018				SeqNo: 1367388		
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
ALPHA, Gross	ND	3.00									U

Qualifiers:

- * Value exceeds Maximum Contaminant Level.
- H Holding times for preparation or analysis exceeded
- MC Value is below Minimum Compound Limit.
- P Second column confirmation exceeds
- B Analyte detected in the associated Method Blank
- J Analyte detected below quantitation limits
- ND Not Detected
- PL Permit Limit
- E Value above quantitation range
- M Manual Integration used to determine
- O RSD is greater than RSDlimit
- R RPD outside accepted recovery limits

Original

Summit Environmental Technologies, Inc.
3310 Win St.
Cuyahoga Falls, Ohio 44223
TEL: (330) 253-8211 FAX: (330) 253-4489
Website: http://www.settek.com

QC SUMMARY REPORT

WO#: 17120858

11-Jan-18

Client: Life Science Laboratories, Inc.

Project: 1720393 **BatchID:** 30255

Sample ID mb-30255	SampType: MBLK	TestCode: Radium-228_	Units: pCi/L	Prep Date: 12/28/2017		RunNo: 79061					
Client ID: PBW	Batch ID: 30255	TestNo: E904.0	E903-904	Analysis Date: 1/2/2018		SeqNo: 1368513					
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Radium-228	ND	1.00		0	0						U
Yield	0.690			0	0						

Sample ID lcs-30255	SampType: LCS	TestCode: Radium-228_	Units: pCi/L	Prep Date: 12/28/2017		RunNo: 79061					
Client ID: LCSW	Batch ID: 30255	TestNo: E904.0	E903-904	Analysis Date: 1/2/2018		SeqNo: 1368514					
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Radium-228	3.66	1.00	5.000	0	73.3	70	130				
Yield	0.820			0	0						

Sample ID lcsd-30255	SampType: LCSD	TestCode: Radium-228_	Units: pCi/L	Prep Date: 12/28/2017		RunNo: 79061					
Client ID: LCSS02	Batch ID: 30255	TestNo: E904.0	E903-904	Analysis Date: 1/2/2018		SeqNo: 1368515					
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Radium-228	3.98	1.00	5.000	0	79.6	70	130	3.664	8.26	20	
Yield	1.00			0	0			0.8200	19.8		

Qualifiers:

- * Value exceeds Maximum Contaminant Level.
- H Holding times for preparation or analysis exceeded
- MC Value is below Minimum Compound Limit.
- P Second column confirmation exceeds
- B Analyte detected in the associated Method Blank
- J Analyte detected below quantitation limits
- ND Not Detected
- PL Permit Limit
- E Value above quantitation range
- M Manual Integration used to determine
- O RSD is greater than RSDlimit
- R RPD outside accepted recovery limits

Original

Summit Environmental Technologies, Inc.
3310 Win St.
Cuyahoga Falls, Ohio 44223
TEL: (330) 253-8211 FAX: (330) 253-4489
Website: http://www.settek.com

QC SUMMARY REPORT

WO#: 17120858
11-Jan-18

Client: Life Science Laboratories, Inc.
Project: 1720393
BatchID: 30255

Sample ID: 17120858-001aMS | SampType: MS | TestCode: Radium-228_ | Units: pCi/L | Prep Date: 12/28/2017 | RunNo: 79061
Client ID: 1720393-001A,B | Batch ID: 30255 | TestNo: E904.0 | E903-904 | Analysis Date: 1/2/2018 | SeqNo: 1368518

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Radium-228	3.57	1.00	5.000	0	71.4	70	130				
Yield	0.610			0.9700	0						

Sample ID: 17120858-002adup | SampType: DUP | TestCode: Radium-228_ | Units: pCi/L | Prep Date: 12/28/2017 | RunNo: 79061
Client ID: 1720393-002A,B | Batch ID: 30255 | TestNo: E904.0 | E903-904 | Analysis Date: 1/2/2018 | SeqNo: 1368521

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Radium-228	0.681	1.00		0	0			0	200	20	JR
Yield	1.00			0	0			1.000	0		

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits	M	Manual Integration used to determine
MC	Value is below Minimum Compound Limit.	ND	Not Detected	O	RSD is greater than RSDlimit
P	Second column confirmation exceeds	PL	Permit Limit	R	RPD outside accepted recovery limits

Original

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3310 Win St.
Cuyahoga Falls, Ohio 44223
TEL: (330) 253-8211 FAX: (330) 253-4489
Website: http://www.settek.com

QC SUMMARY REPORT

WO#: 17120858
11-Jan-18

Client: Life Science Laboratories, Inc.
Project: 1720393
BatchID: 30255

Sample ID mb-30255 | SampType: MBLK | TestCode: Radium-226_ Units: pCi/L | Prep Date: 12/28/2017 | RunNo: 79088
Client ID: PBW | Batch ID: 30255 | TestNo: E903.0 E903-904 | Analysis Date: 1/3/2018 | SeqNo: 1369489

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Radium-226	ND	1.00									U
Yield	1.00										

Sample ID lcs-30255 | SampType: LCS | TestCode: Radium-226_ Units: pCi/L | Prep Date: 12/28/2017 | RunNo: 79088
Client ID: LCSW | Batch ID: 30255 | TestNo: E903.0 E903-904 | Analysis Date: 1/3/2018 | SeqNo: 1369490

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Radium-226	5.78	1.00	5.000	0	116	70	130				

Sample ID lcsd-30255 | SampType: LCSD | TestCode: Radium-226_ Units: pCi/L | Prep Date: 12/28/2017 | RunNo: 79088
Client ID: LCSS02 | Batch ID: 30255 | TestNo: E903.0 E903-904 | Analysis Date: 1/3/2018 | SeqNo: 1369491

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Radium-226	5.72	1.00	5.000	0	114	70	130	5.780	1.04	20	

Sample ID 17120858-001aMS | SampType: MS | TestCode: Radium-226_ Units: pCi/L | Prep Date: 12/28/2017 | RunNo: 79088
Client ID: 1720393-001A,B | Batch ID: 30255 | TestNo: E903.0 E903-904 | Analysis Date: 1/3/2018 | SeqNo: 1369494

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual

Qualifiers:
- * Value exceeds Maximum Contaminant Level.
- H Holding times for preparation or analysis exceeded
- MC Value is below Minimum Compound Limit.
- P Second column confirmation exceeds
- B Analyte detected in the associated Method Blank
- J Analyte detected below quantitation limits
- ND Not Detected
- PL Permit Limit
- E Value above quantitation range
- M Manual Integration used to determine
- O RSD is greater than RSDlimit
- R RPD outside accepted recovery limits

Original

Summit Environmental Technologies, Inc.
3310 Win St.
Cuyahoga Falls, Ohio 44223
TEL: (330) 253-8211 FAX: (330) 253-4489
Website: http://www.settek.com

QC SUMMARY REPORT

WO#: 17120858
11-Jan-18

Client: Life Science Laboratories, Inc.
Project: 1720393
BatchID: 30255

Sample ID 17120858-001aMS	SampType: MS	TestCode: Radium-226_	Units: pCi/L	Prep Date: 12/28/2017	RunNo: 79088
Client ID: 1720393-001A,B	Batch ID: 30255	TestNo: E903.0	E903-904	Analysis Date: 1/3/2018	SeqNo: 1369494

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Radium-226	6.55	1.00	5.000	0	131	70	130				S

NOTES:
MS out from acceptable range due to matrix effect.

Sample ID 17120858-002adup	SampType: DUP	TestCode: Radium-226_	Units: pCi/L	Prep Date: 12/28/2017	RunNo: 79088
Client ID: 1720393-002A,B	Batch ID: 30255	TestNo: E903.0	E903-904	Analysis Date: 1/3/2018	SeqNo: 1369497

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Radium-226	ND	1.00						0	0	20	U
Yield	1.00							1.000	0	0	

Sample ID 17121010-001adup	SampType: DUP	TestCode: Radium-226_	Units: pCi/L	Prep Date: 12/28/2017	RunNo: 79088
Client ID: BatchQC	Batch ID: 30255	TestNo: E903.0	E903-904	Analysis Date: 1/3/2018	SeqNo: 1369509

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Radium-226	ND	1.00						0	0	20	U
Yield	1.00							1.000	0	0	

Qualifiers:

- * Value exceeds Maximum Contaminant Level.
- H Holding times for preparation or analysis exceeded
- MC Value is below Minimum Compound Limit.
- P Second column confirmation exceeds
- B Analyte detected in the associated Method Blank
- J Analyte detected below quantitation limits
- ND Not Detected
- PL Permit Limit
- E Value above quantitation range
- M Manual Integration used to determine
- O RSD is greater than RSDlimit
- R RPD outside accepted recovery limits

Original
Page 13 of 13

Subcontractor Purchase Order / Chain of Custody

LSL

Life Science Laboratories, Inc.
5854 Butternut Dr., E. Syracuse, New York 130
Phone # (315) 445-1105 Fax # (315) 445-1301

Seller agrees to sell and deliver services as specified herein in accordance with the Subcontract Order. This order expressly limits acceptance to the terms of this order and any additional or different terms proposed by the seller are rejected unless expressly assented to in writing by Life Science Laboratories, Inc.

Samples sent to:	Report should be sent to:	Life Science Laboratories Project Number:	Special Instructions:
Summit Environmental Technologies Inc. 3310 Win Street Cuyahoga Falls, OH 44223 Phone: 330-253-8211 Fax: 330-253-4489	Life Science Laboratories, Inc. 5854 Butternut Drive East Syracuse, NY 13057 Sample Custody Department Contact Name: Greg Smith	1720393 Purchase Order Number (SO#): SO55992 Send invoice to: Accounting Department Results are required by this date: Standard	The Purchase Order Number must appear on all reports and invoices. *SAMPLES ARE FOR NEW YORK STATE COMPLIANCE.*

Life Science Labs Sample ID # / Client ID		Sample Date	Type grab	Type comp	Matrix	Preserv. Added	Containers size/type	#	Analysis Requested	Unit Price
1720393-001A,B	Spring	[illegible]	X		PW	HNO3	1/2 gal.	2	Comb. Radium 226/228, Alpha	[redacted]
1720393-002A,B	Well	[illegible]	X		PW	HNO3	1/2 gal.	2	Comb. Radium 226/228, Alpha	[redacted]
									Disposal fee	[redacted]
									Sub Total:	
									Surcharge:	
									Total:	[redacted]

1720858-001-002

Custody Transfers		Date	Time
Sampled By:	Received By:		
Relinquished By: [illegible]	Received By:	[illegible]	[illegible]
Relinquished By:	Received for Lab By: [illegible]	[illegible]	[illegible]
	Received Intact: Y N		°C

Copies: Original Purchasing Administration Accounting

Page 1 of 3

SOP: Sample Receipt

Summit Environmental Technologies
Cooler Receipt Form, Page 1

LSC

Initials of person inspecting cooler and samples: ANB

Order Number: [illegible]

Time Received: 915

N/A

Samples received within holding time: Y N N/A

Do any 40 mL vials contain bubbles?** Y N N/A
**Samples with bubbles ≤6mm are acceptable. Indicate bubble size if >6mm: ______

Was client contacted about samples: Y N

Will client send new samples: Y N

Client contact: ______

Date/Time: ______

Logged in by: ______

Comments: ______

Page 10 of 12

Figure 2 – Summit Environmental Technologies, Inc.
Cooler Receipt Form, Page 2

Sample pH Check, Chlorine Check and/or Radiological Scan

pH Strip SET (0-14)#: [illegible]	pH Strip (2.8-4.6) SET#: OES-01-0230
Total DPD packet SET#: OES-02-0232	Free DPD packet SET#: OES-01-0290
Disp. Pipette SET#:	

Sample ID	Test Method	pH	Chlorine (+ or -)	CPM	Comments

P = Permanganate interference
524.1, 525, 515.1, 525.2, 547, 548.1, 549.1, 531.2, 1613 methods checked for **Total** chlorine
552.2 checked for **Free** chlorine
531.2 pH is checked for ~3.8 (SET# OES-01-0149)
524.2 = pH and Chlorine checked by lab analyst

NEW YORK STATE DEPARTMENT OF HEALTH
WADSWORTH CENTER

Expires 12:01 AM April 01, 2018
Issued April 01, 2017
Revised August 31, 2017

CERTIFICATE OF APPROVAL FOR LABORATORY SERVICE

Issued in accordance with and pursuant to section 502 Public Health Law of New York State

MS. CECILIA MARKOVICH
SUMMIT ENVIRONMENTAL TECHNOLOGIES INC
3310 WIN STREET ASCOT INDUSTRIAL PARK
CUYAHOGA FALLS, OH 44223

NY Lab Id No: 11777

is hereby APPROVED as an Environmental Laboratory in conformance with the National Environmental Laboratory Accreditation Conference Standards (2003) for the category
ENVIRONMENTAL ANALYSES POTABLE WATER
All approved analytes are listed below:

Disinfection By-products	
Bromate	EPA 300.1 Rev. 1.0
Bromide	EPA 300.1 Rev. 1.0
	EPA 300.0 Rev. 2.1
Chlorate	EPA 300.1 Rev. 1.0
Chlorite	EPA 300.1 Rev. 1.0
Metals I	
Arsenic, Total	EPA 200.8 Rev. 5.4
Barium, Total	EPA 200.7 Rev. 4.4
	EPA 200.8 Rev. 5.4
Cadmium, Total	EPA 200.7 Rev. 4.4
	EPA 200.8 Rev. 5.4
Chromium, Total	EPA 200.7 Rev. 4.4
	EPA 200.8 Rev. 5.4
Copper, Total	EPA 200.7 Rev. 4.4
	EPA 200.8 Rev. 5.4
Iron, Total	EPA 200.7 Rev. 4.4
Lead, Total	EPA 200.8 Rev. 5.4
Manganese, Total	EPA 200.7 Rev. 4.4
	EPA 200.8 Rev. 5.4
Mercury, Total	EPA 245.1 Rev. 3.0
Selenium, Total	EPA 200.8 Rev. 5.4
Silver, Total	EPA 200.7 Rev. 4.4
	EPA 200.8 Rev. 5.4
Zinc, Total	EPA 200.7 Rev. 4.4
	EPA 200.8 Rev. 5.4

Metals II	
Aluminum, Total	EPA 200.7 Rev. 4.4
	EPA 200.8 Rev. 5.4
Antimony, Total	EPA 200.8 Rev. 5.4
Beryllium, Total	EPA 200.7 Rev. 4.4
	EPA 200.8 Rev. 5.4
Molybdenum, Total	EPA 200.7 Rev. 4.4
	EPA 200.8 Rev. 5.4
Nickel, Total	EPA 200.7 Rev. 4.4
	EPA 200.8 Rev. 5.4
Thallium, Total	EPA 200.8 Rev. 5.4
Vanadium, Total	EPA 200.7 Rev. 4.4
	EPA 200.8 Rev. 5.4
Metals III	
Boron, Total	EPA 200.7 Rev. 4.4
Calcium, Total	EPA 200.7 Rev. 4.4
Magnesium, Total	EPA 200.7 Rev. 4.4
Potassium, Total	EPA 200.7 Rev. 4.4
Sodium, Total	EPA 200.7 Rev. 4.4
Uranium (Mass)	EPA 200.8 Rev. 5.4
Miscellaneous	
2,3,7,8-Tetrachlorodibenzo-p-dioxin	EPA 1613B
Odor	SM 18-22 2150B (-97)
Organic Carbon, Total	SM 21-22 5310B (-00)
Perchlorate	EPA 314.0
Surfactant (MBAS)	SM 18-22 5540C (-00)

Serial No.: 56732

Property of the New York State Department of Health. Certificates are valid only at the address shown, must be conspicuously posted, and are printed on secure paper. Continued accreditation depends on successful ongoing participation in the Program. Consumers are urged to call (518) 485-5570 to verify the laboratory's accreditation status.

Page 1 of 2

NEW YORK STATE DEPARTMENT OF HEALTH
WADSWORTH CENTER

Expires 12:01 AM April 01, 2018
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Revised August 31, 2017

CERTIFICATE OF APPROVAL FOR LABORATORY SERVICE

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NY Lab Id No: 11777

is hereby APPROVED as an Environmental Laboratory in conformance with the National Environmental Laboratory Accreditation Conference Standards (2003) for the category ENVIRONMENTAL ANALYSES POTABLE WATER
All approved analytes are listed below:

Miscellaneous	
Turbidity	EPA 180.1 Rev. 2.0
Non-Metals	
Alkalinity	SM 18-22 2320B (-97)
Chloride	EPA 300.0 Rev. 2.1
Color	SM 18-22 2120B (-01)
Corrosivity	SM 18-22 2330
Cyanide	SM 18-22 4500-CN E (-99)
Fluoride, Total	EPA 300.1 Rev. 1.0
	EPA 300.0 Rev. 2.1
Nitrate (as N)	EPA 300.0 Rev. 2.1
Nitrite (as N)	EPA 300.0 Rev. 2.1
Orthophosphate (as P)	EPA 300.0 Rev. 2.1
Silica, Dissolved	EPA 200.7 Rev. 4.4
Solids, Total Dissolved	SM 18-22 2540C (-97)
Specific Conductance	SM 18-22 2510B (-97)
Sulfate (as SO4)	EPA 300.0 Rev. 2.1
Radiological Analytes	
Gross Alpha	EPA 900.0
Gross Beta	EPA 900.0
Radium-226	EPA 903.0
Radium-228	EPA 904.0
Uranium (Activity)	EPA 908.0

Serial No.: 56732

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Page 2 of 2

Life Science Laboratories, Inc.
5854 Butternut Drive
East Syracuse, NY 13057

Chain of Custody Record

1720393
AftonV/O
7616

Phone # (315) 445-1105 Telefax # (315) 445-1301

Client: Village OF AFTON WFP **Phone #** 607 343 9692
Address: 19 COURT ST **Fax #** 607-639-1903
AFTON, NY. 13730

Contact Person: DAVID H. BIRD
LSL Project #:
Client's Site I.D.:
Authorization:
Client's Project I.D.:

LSL Sample Number	Client's Sample Identifications	Sample Date	Sample Time	Type: grab	Type: comp.	Matrix	Preserv. Added	Containers #	Containers size/type	Analyses	Free Cl (mg/L)	Pres. Check
001	SPRING	12/13/17	8:00AM	X			HNO3	2	1/2 gal	Comb. Radium 226/228, Alpha	1.0	
002	Well	12/13/17	7:45AM					2	1/2 gal	" " " "	0.9	

Notes and Hazard identifications:

70°

Samples Received
On Ice

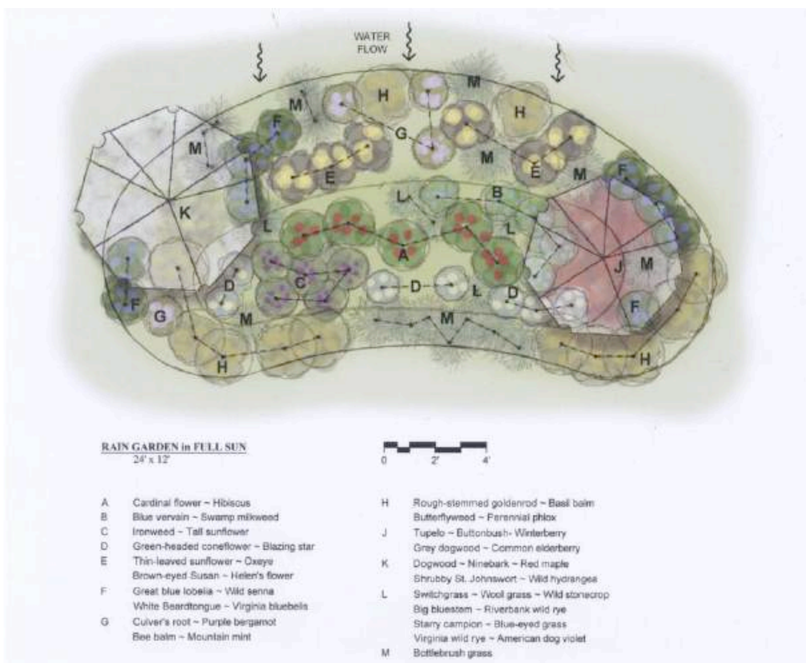
Custody Transfers	Date	Time
Sampled By: DAVID H. BIRD **Received By:**		
Relinquished By: DAVID H BIRD **Received By:** Bill Donaldson	12-13-17	1415
Relinquished By: Bill Donaldson **Received for Lab By:** R. [illegible]	12.13.17	17:51

Shipment Method: **Samples Received Intact:** Y N

Appendix S8. Examples of best management practices (BMPs) for the Village of Afton's waterfront flood management park.

Waterfront Park examples of natural solutions for flooding and stormwater management:

Raingarden*:* A raingarden is a shallow planted depression used to hold stormwater and runoff until it can infiltrate into the ground. Specific water loving plants are selected to be planted within the raingarden. There are many resources and examples available to assist with building a raingarden. Some raingardens include a drainpipe which leads to a retention basin, pond or holding tank. Plants can be specifically chosen to filter pollutants out of the stormwater or runoff.



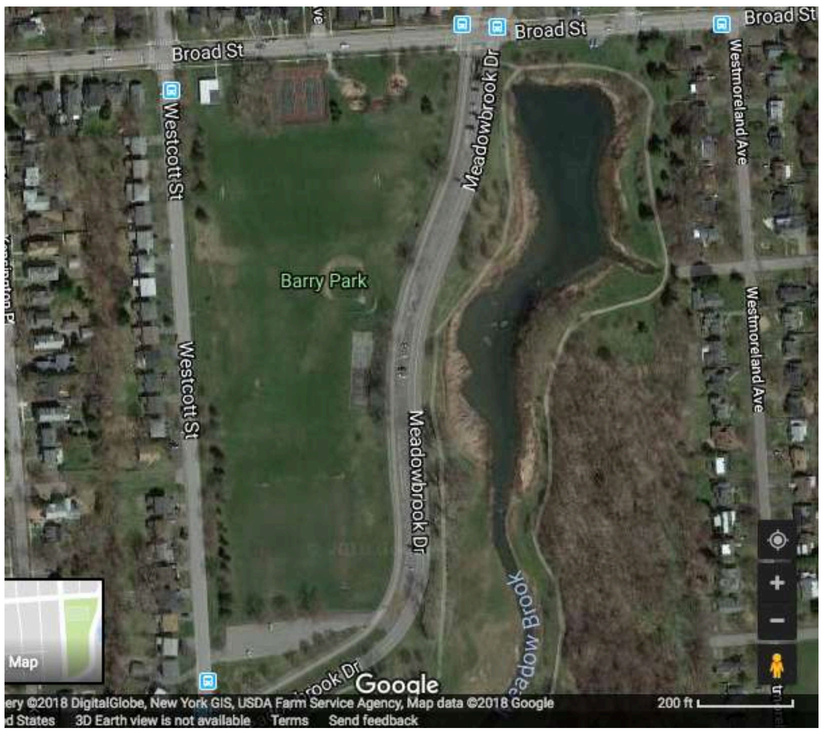
Picture credit: http://raingardenalliance.org/planting/design

Natural Floodplain*:* Restoring the Natural Flood plain is another option which could be demonstrated even in a small park. Much of the natural floodplain has been drained and filled or otherwise lost along the human habituated sections of the Susquehanna River. Floodplains are a natural part of a healthy River and floods are

Page 1 of 5

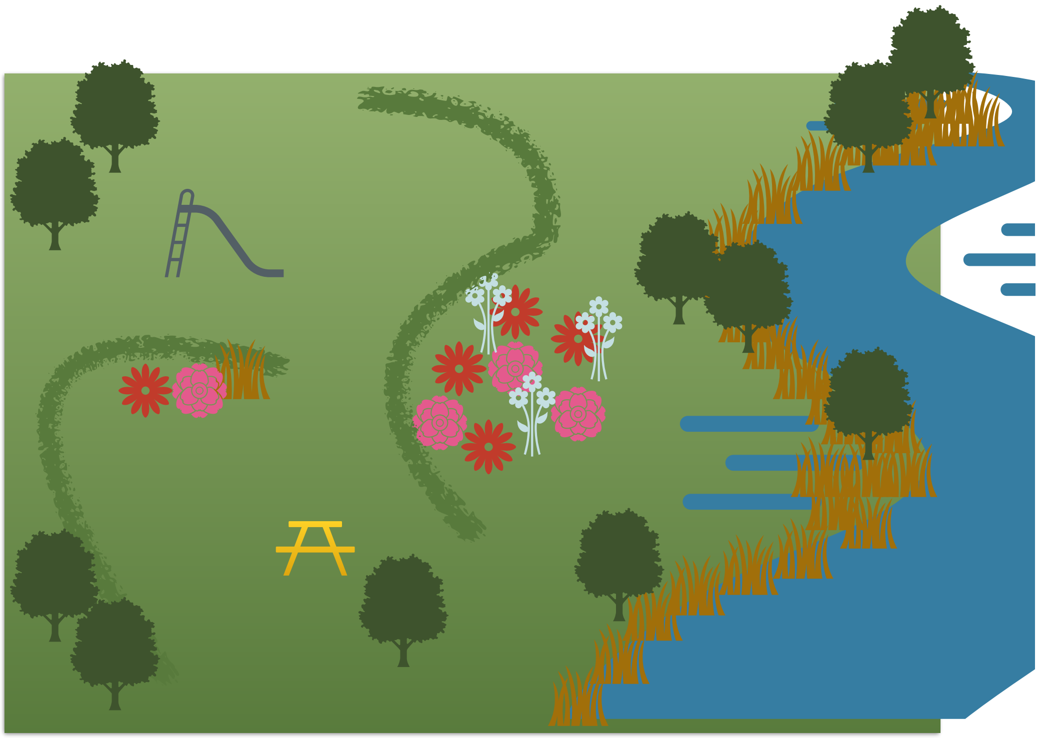
a natural occurrence. Restoring a part of the natural floodplain would include protecting and restoring the native habitat along the Susquehanna River.

Floodwater Detention and Retention Basin*:* An area that has been designed and designated to hold rain, floodwater and/or runoff. A detention pond is also known as a dry pond because the water is only held temporarily. The water in a detention pond is eventually released or infiltrated into the ground. The water in a retention pond is not temporary and only releases it's water if the pond level exceeds a specific level. The map below shows a retention pond in Syracuse, NY.



Bioswales*:* Bioswales are landscape design features built to direct and filter the flow of water such as runoff, stormwater, and floodwaters. A bioswale is also planted with vegetation which helps to filter and absorb water along the way. The picture below shows a bioswale in the foreground which is being build ans a completed bioswale on the opposite side of the road.

Photo credit: Duk at English Wikipedia - Transferred from en.wikipedia to Commons by Liftarn using CommonsHelper., Public Domain, https://commons.wikimedia.org/w/index.php?curid=11902676



Example of a general layout of a stormwater management park. Above the grass shows where the wetland could be expanded, large mature trees also are beneficial to uptake excess stormwater. A picnic area and playground help attract people to utilize the park. Grass covered berms help to guide the excess water back toward the river or into the rain gardens. A drain in the rain garden could also drain excess water into a retention or detention basin on the opposite side of the road. Parking could be sited along the road with the ditch being used as a bioswale which could drain to the same area as the rain garden. A walking trail with interpretive signage could also be added as an educational tool to teach about natural river processes as well as best management practices for stormwater.

Demonstration Stormwater Management Park

Prepared for: Village of Afton, NY

Prepared by: Stephanie Nick, MPS, Associate Project Manager GeoEco Design

March 11, 2018

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Appendix S9. The Afton Village Residents Meeting – 23 April 2017 – Presentation

Future Flood Risk in the Upper Susquehanna & Flood Dynamics in Afton, New York

The Afton Village Residents Meeting – 23 April 2017

Stephanie M. Nick, MPS
Associate Project Manager, GeoEco Design

Richard Ross Shaker, MSc., Ph.D.
Principal Investigator, GeoEco Design
Assistant Professor, Ryerson University

Future Flood Risk in the Upper Susquehanna & Flood Dynamics in Afton, New York

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Outline:

1. Climate Change & Hurricanes
2. Watersheds & Surface Hydrology
3. Flooding in the Northeast
4. Afton, NY: Flood Dynamics
5. Risk Prevention Options

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1. Climate Change & Hurricanes
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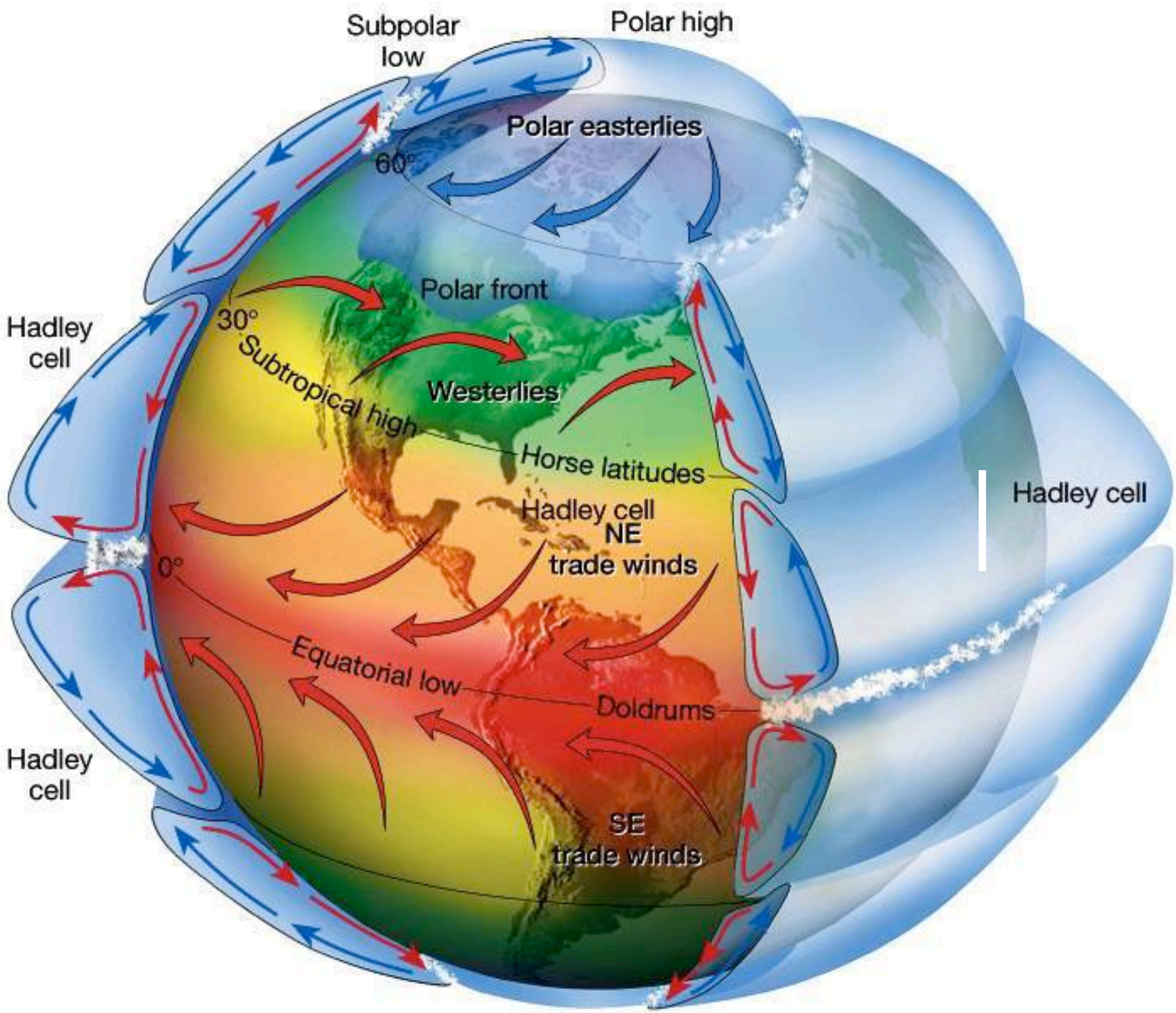
Afton, NY


Subpolar low
Polar high
Polar easterlies
60°
Polar front
Hadley cell
30°
Subtropical high
Westerlies
Horse latitudes
Hadley cell
NE trade winds
Hadley cell
0°
Equatorial low
Doldrums
Hadley cell
SE trade winds

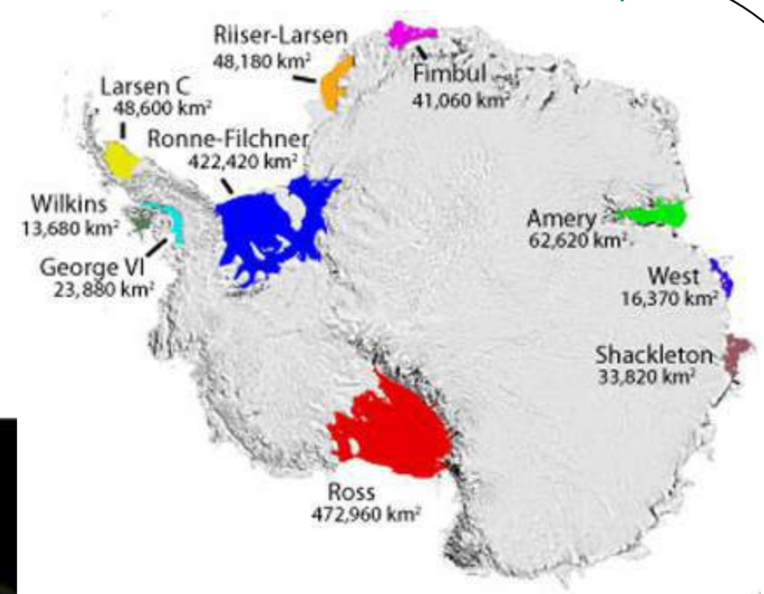
Warming Oceans

- Increase in atmospheric temperature has been **moderated** by oceans, which soak up more than 80% of warming
- Small warming of oceans contributes significantly to energy that drives storms
- **Water expands as it warms** – sea level rise
- Warmer temperatures will cause more evaporation from oceans → increasing atmospheric water vapor → increasing global warming

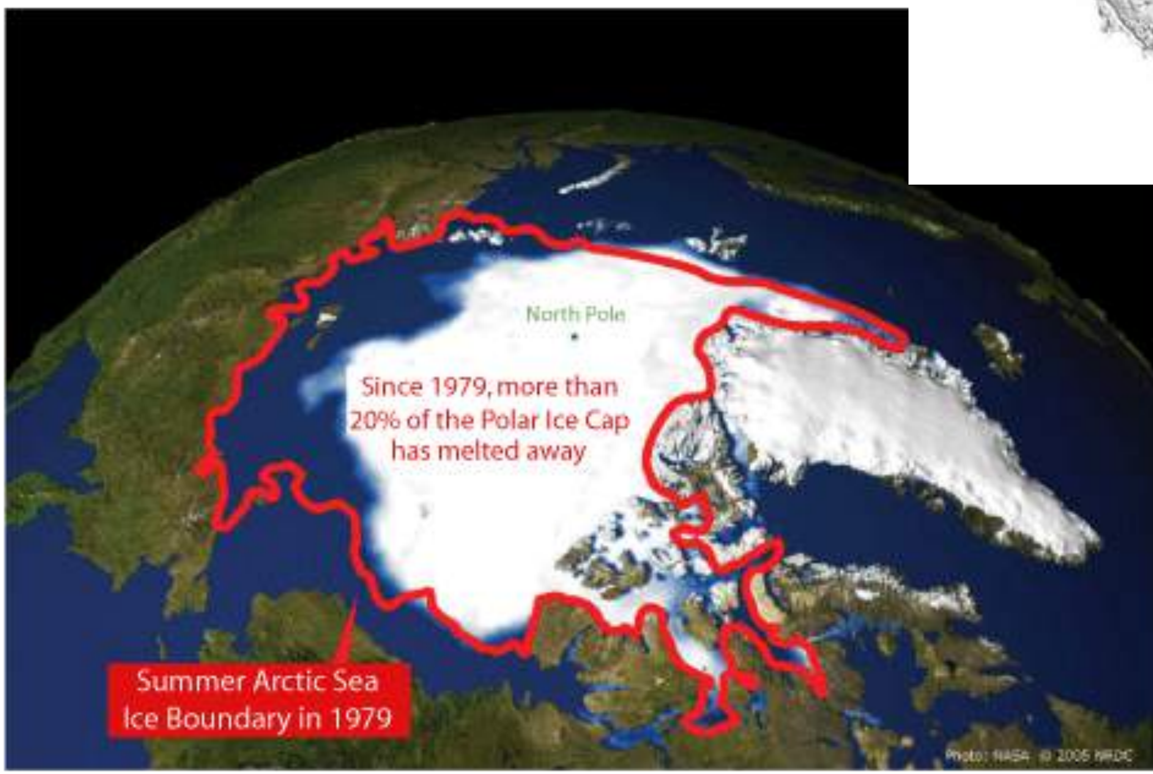
Sea-Level Rise

- Global warming leads to sea-level rise two ways:
  - **Water added from melting of ice on land**
  - **Heating and expansion of sea water**
- Melting **Arctic sea ice** does not raise sea-level (meltwater occupies same volume that ice did)
- Melting all **Greenland** ice would raise sea level by about 7 m
- Melting all **Antarctic** ice would raise sea level by about 66 m
  - Complete melting of both ice sheets is not likely in foreseeable future

Sea Ice: Arctic vs. Antarctic



Summer Arctic Sea Ice Decline



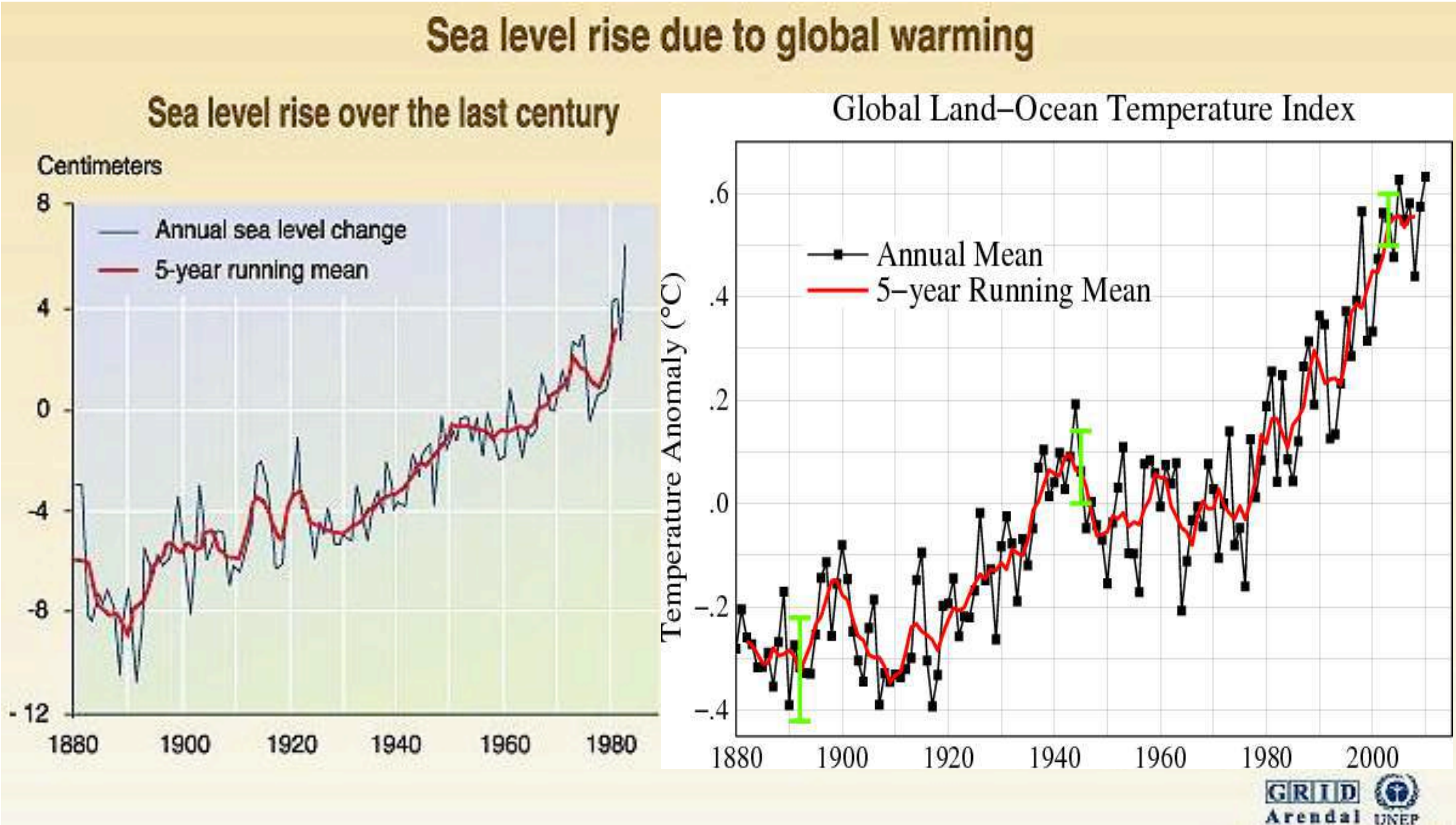
Source: NASA & Natural Resources Defense Council

Image Source: chriscolose. wordpress (above) global-greenhouse-warming.com (left)

Climate Change & Hurricane Damage

- Hurricane damage is amplified by:
  - Heavy or prolonged rain
  - Surge height and shape of coast
  - High winds and storm waves
  - Warm-water eddies to add energy
  - Storms stalled by other weather systems
- One-two punch could be **two or more large, back-to-back hurricanes**
- On average, five hurricanes develop in Atlantic Ocean every year, two of them major
- **Increases in sea-surface temperatures suggests more hurricanes in next few decades**

Ocean & Climate



***Global Surface Temperatures and Sea Level are rising**

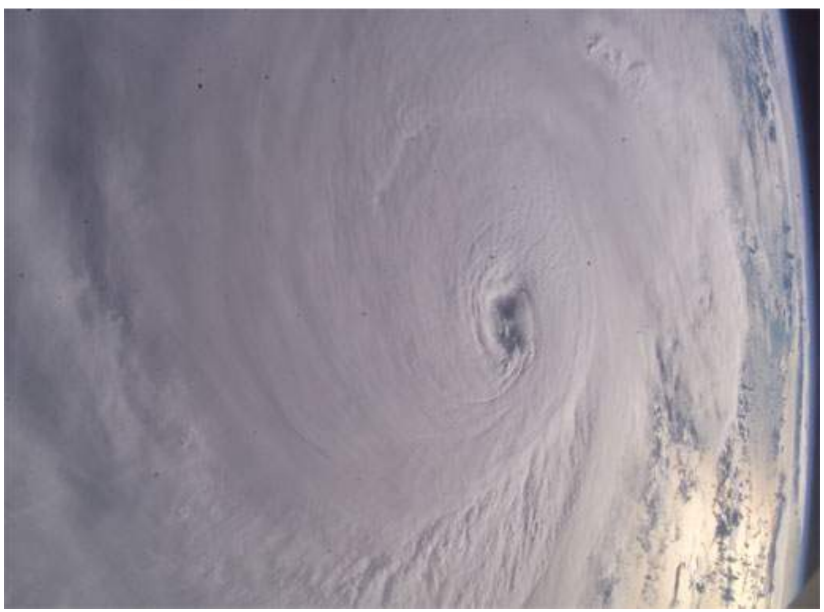
Ocean & Climate Hazards

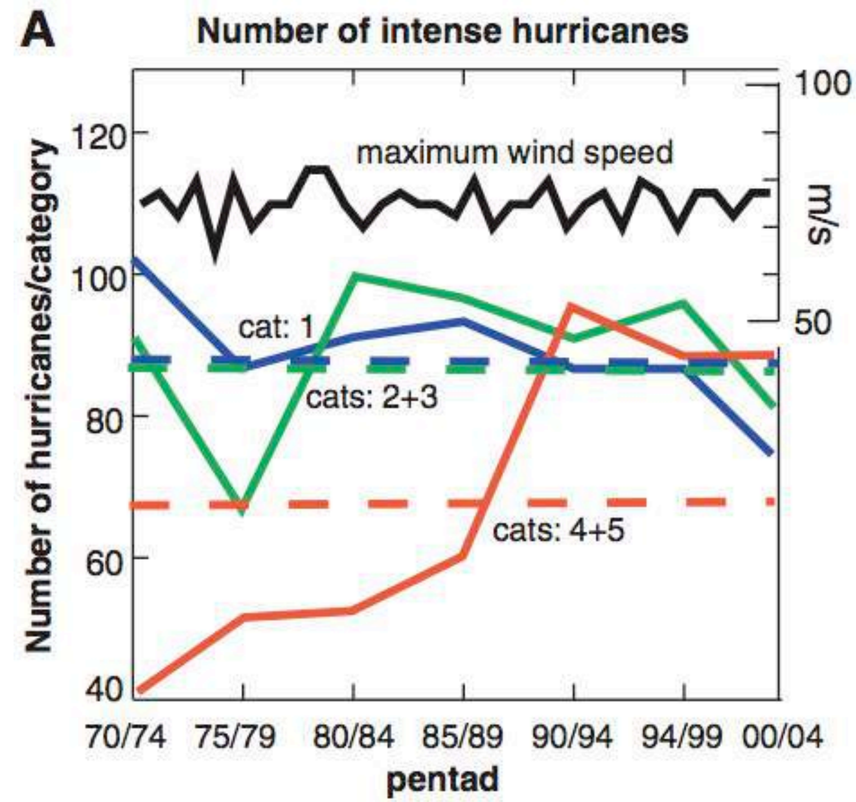
Sea surface temperature in the tropical oceans fuel hurricanes

Changes in Tropical Cyclone Number, Duration, and Intensity in a Warming Environment

P. J. Webster,[1] G. J. Holland,[2] J. A. Curry,[1] H.-R. Chang[1]

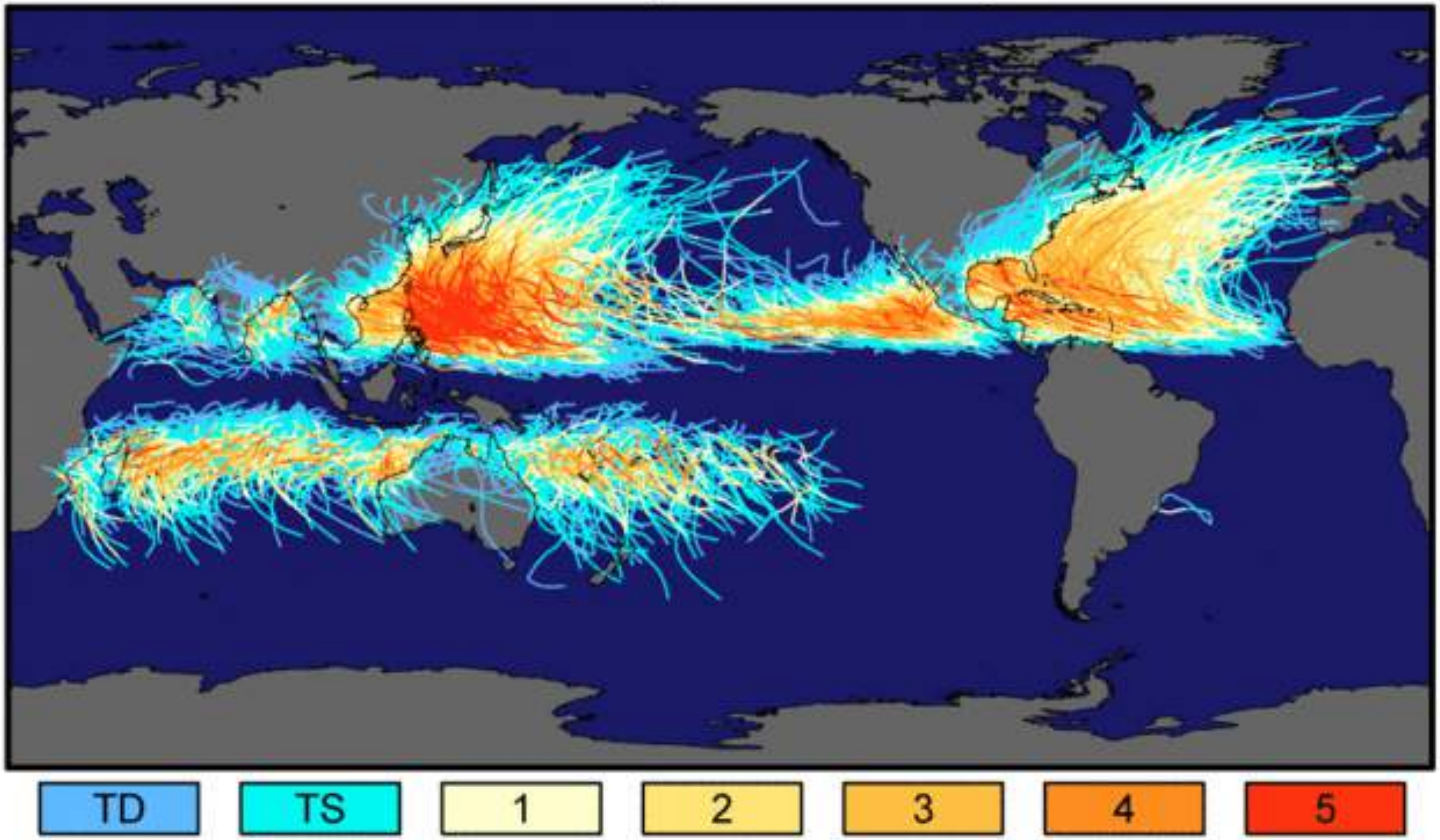
16 SEPTEMBER 2005 VOL 309 SCIENCE





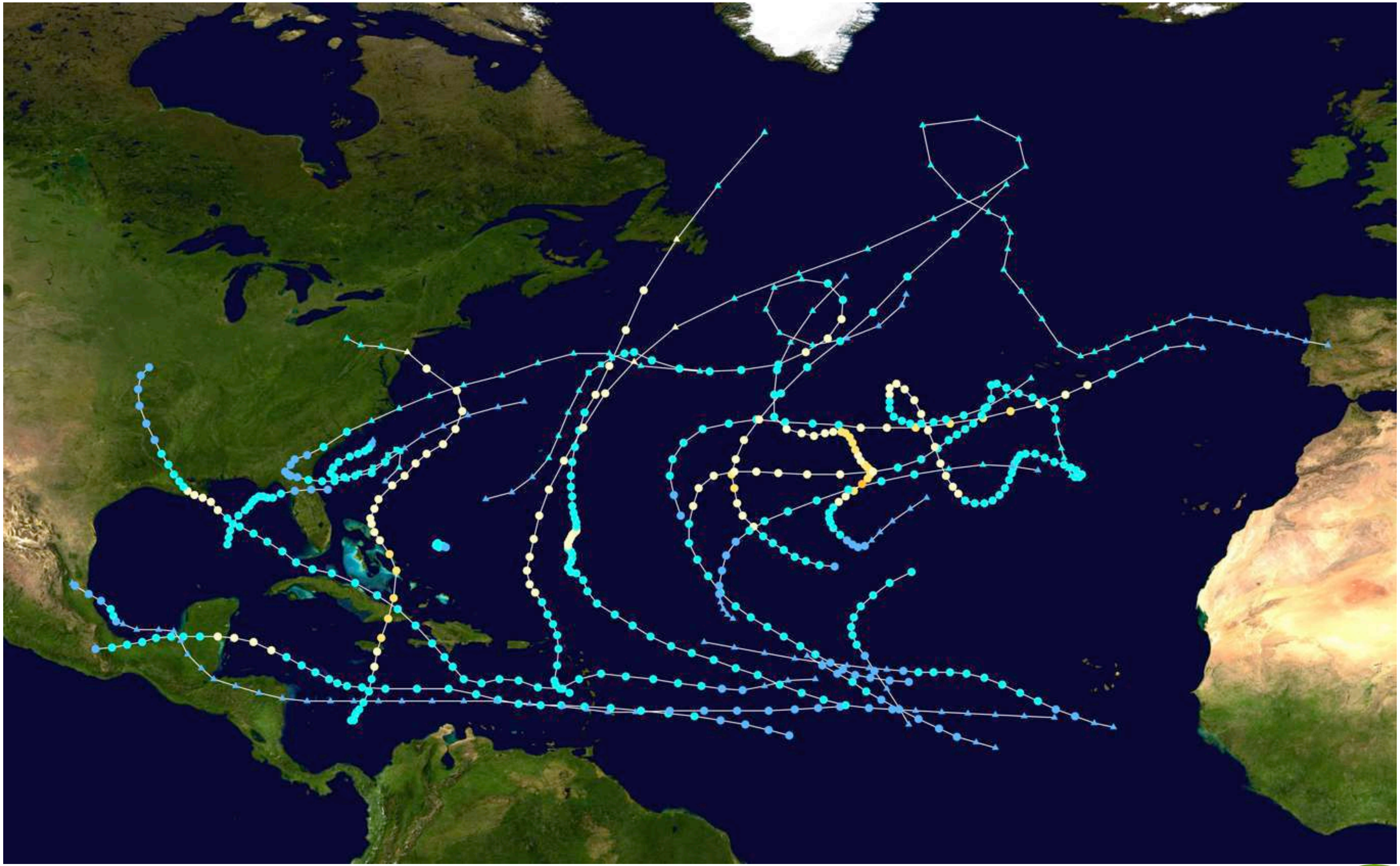
Hurricanes becoming more intense as ocean warms?

Tracks and Intensity of All Tropical Storms



Saffir-Simpson Hurricane Intensity Scale

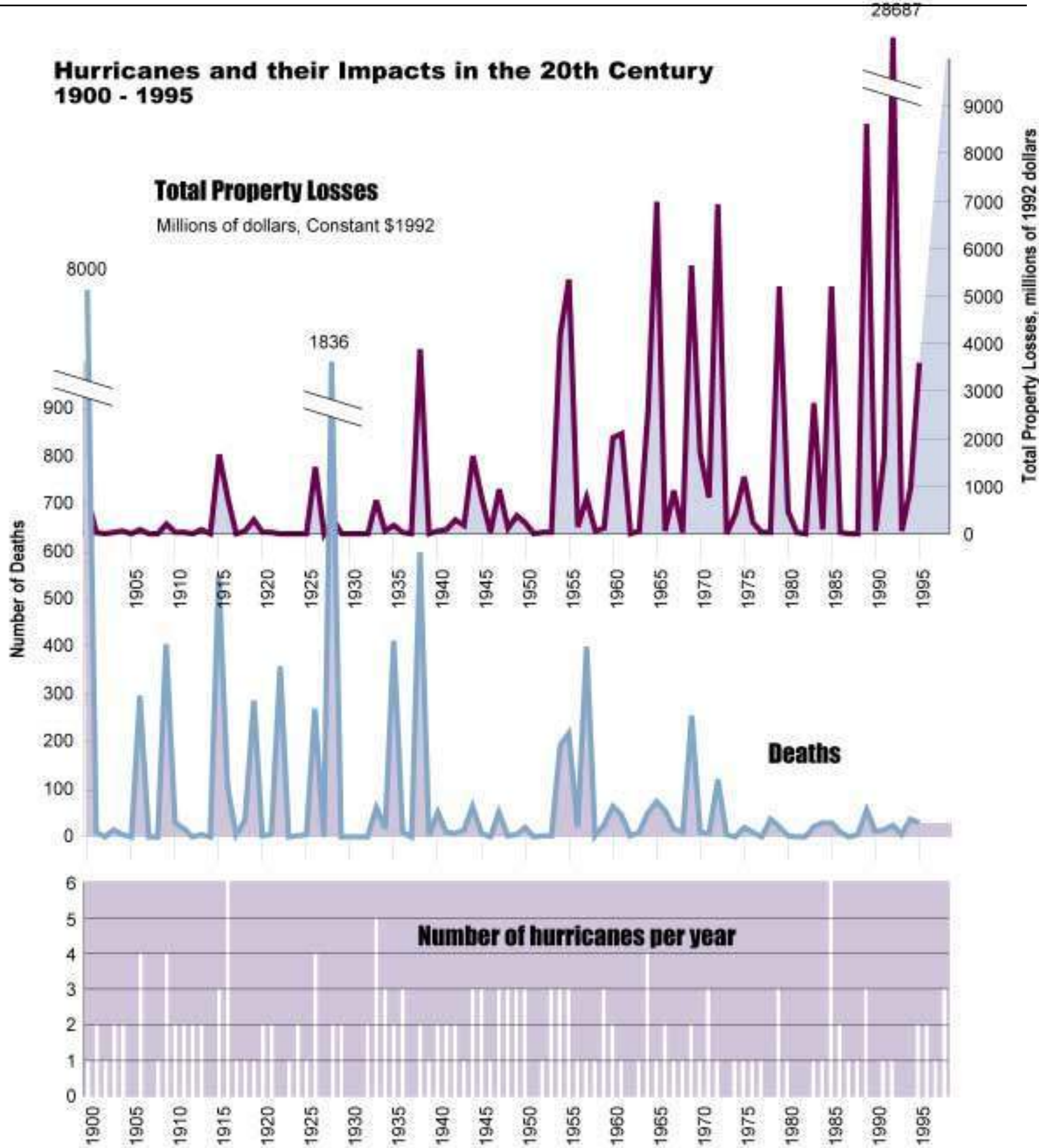
2012 Atlantic Hurricanes



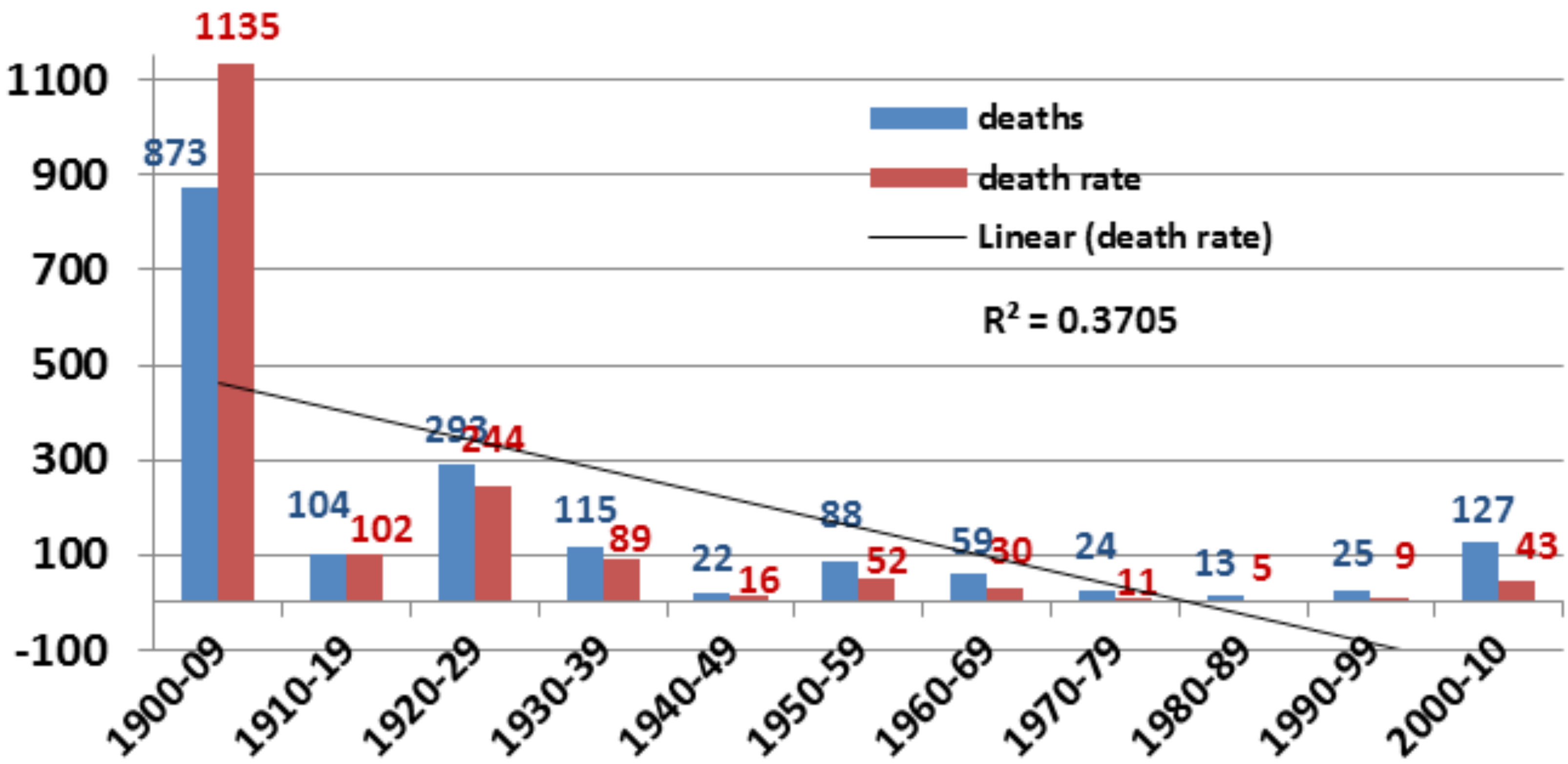
NOAA Historic
Hurricane Tracks: http://maps.csc.noaa.gov/hurricanes/#

Storm Damage

- Seven of top ten costliest hurricanes occurred in 2004, 2005, & 2012
- **Costs** related to hurricanes have dramatically increased
  - Rapidly growing populations along coast
  - More development in unsuitable locations
  - More expensive buildings
- Number of **deaths** has decreased
  - Improved ability to predict landfall locations
  - Coordinated ability to evacuate populations at risk

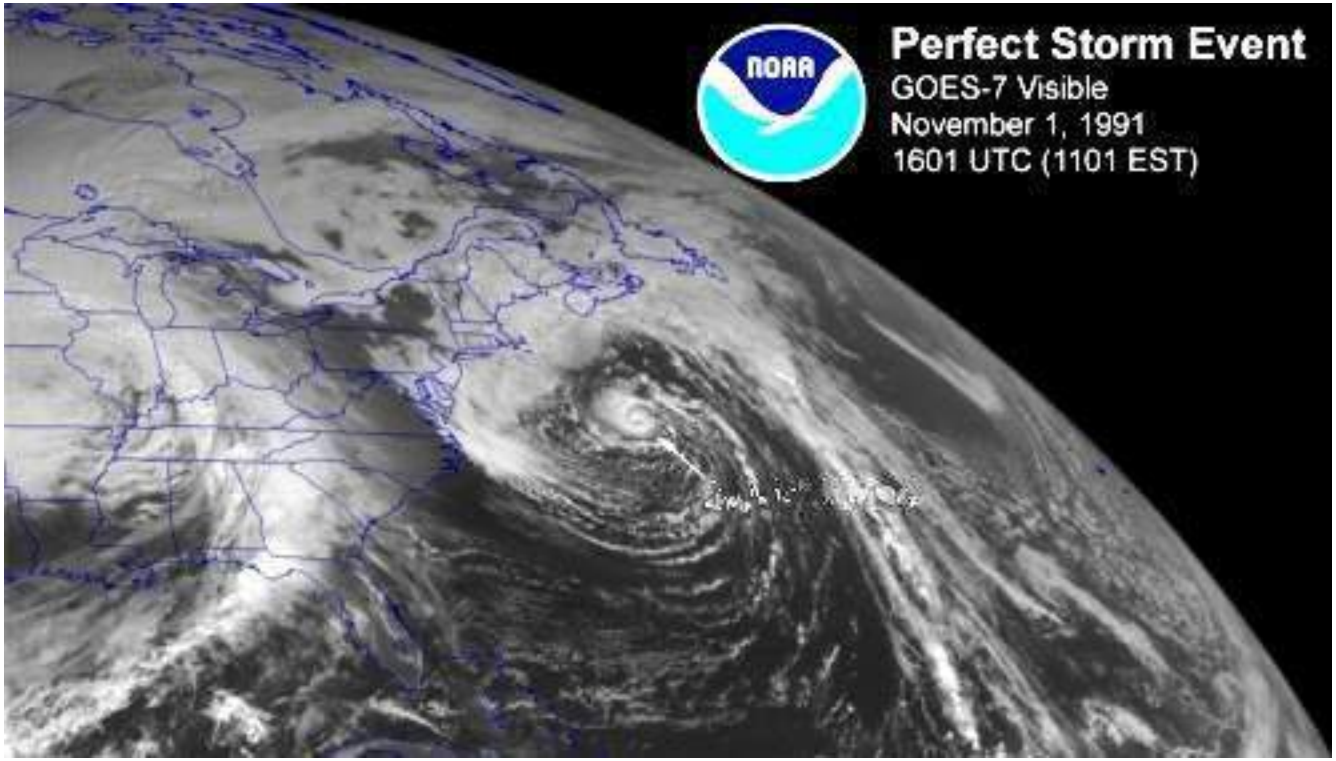

Hurricanes and their Impacts in the 20th Century
1900 - 1995
Total Property Losses
Millions of dollars, Constant $1992
8000
1836
28687
Total Property Losses, millions of 1992 dollars
Number of Deaths
Deaths
Number of hurricanes per year

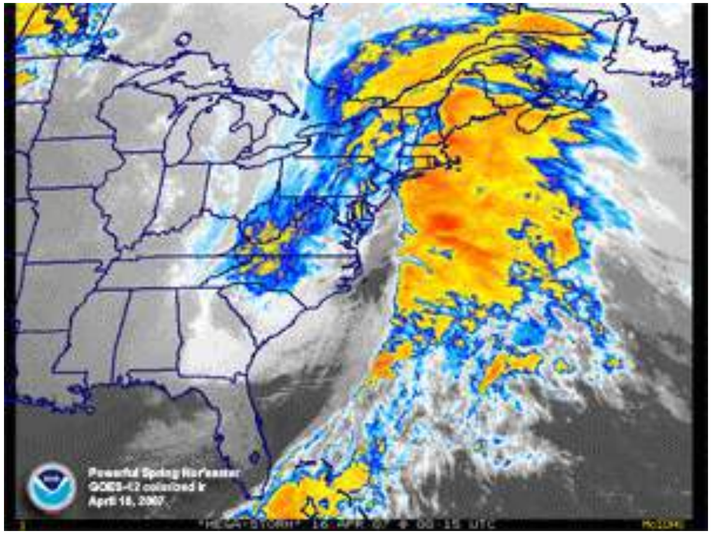
Hurricane deaths and death rates, 1900-2010



Source: Updated from Goklany (2009) using Blake et al. (2011) and USBC (2011).

Afton, NY


NOAA
Perfect Storm Event
GOES-7 Visible
November 1, 1991
1601 UTC (1101 EST)



Outline:

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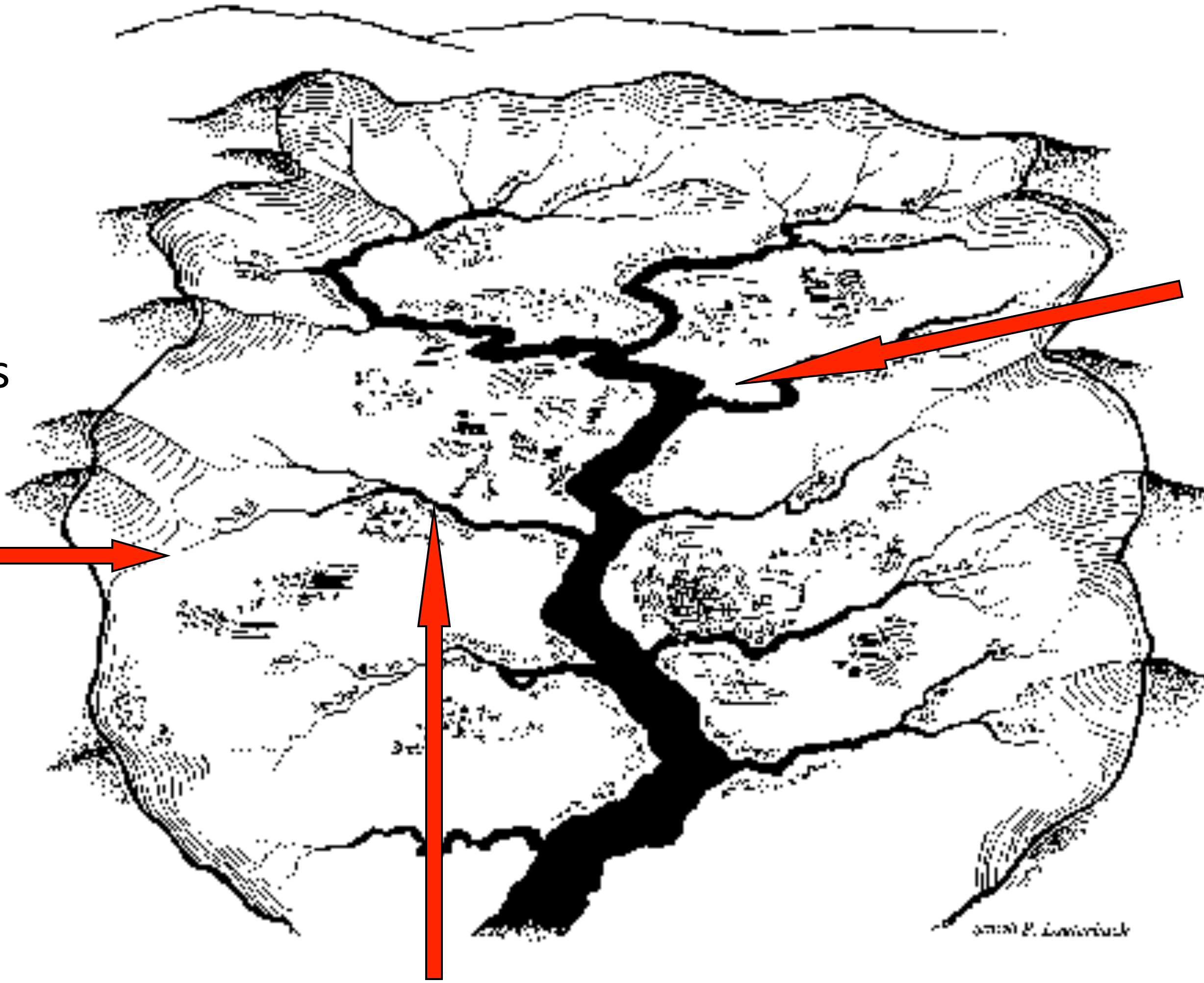
Typical River Drainage Basin

Source

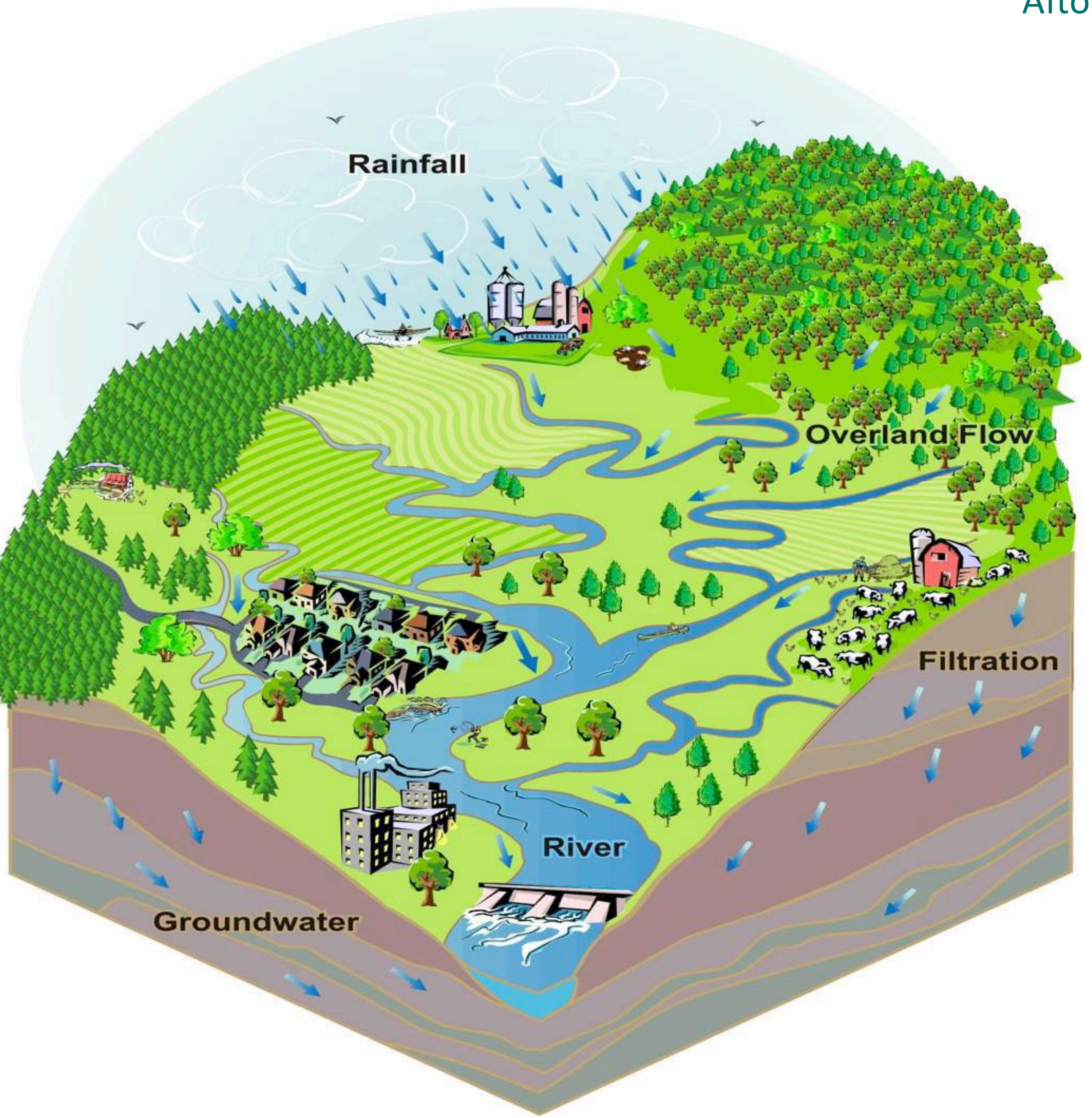
(the place where a river begins -a river system will have numerous sources, such as springs)



Confluence

(a place where two rivers meet)

Tributary stream (a smaller river that flows into a larger river)



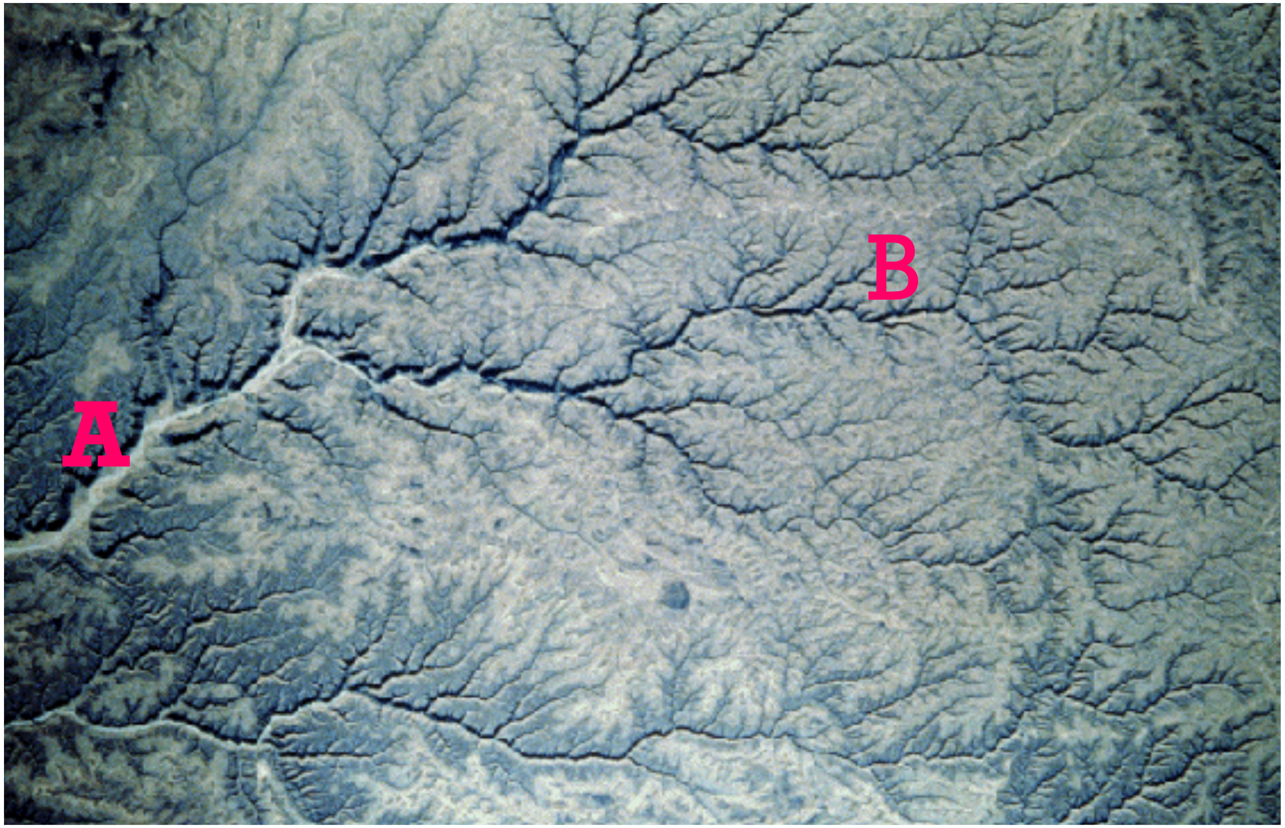
Rainfall
Overland Flow
Filtration
River
Groundwater

Drainage Basins/Watersheds

- All land on earth is a watershed.
- A watershed is often called a drainage basin.
- It is the land area drained by a network of channels, called <u>tributaries</u>, that increase in size as the amount of water and materials they must carry increases.

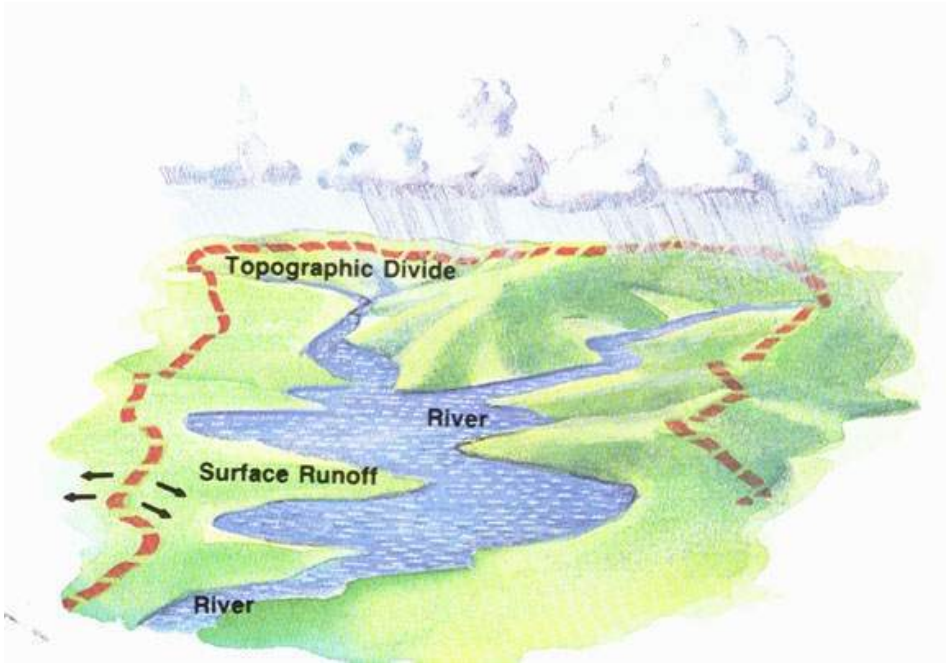
Remember.. Water Flows Downhill

- Water flows from HIGH elevation to LOW elevation.
- Water combines along the way– increasing size, volume, etc.



Where does water go?

- **Q**: During a precipitation event, where does water go once it hits the terrestrial surface of the Earth?



- **A**: Some gets absorbed into the ground (infiltration) some flows along the surface (runoff).

Areas of the Watershed

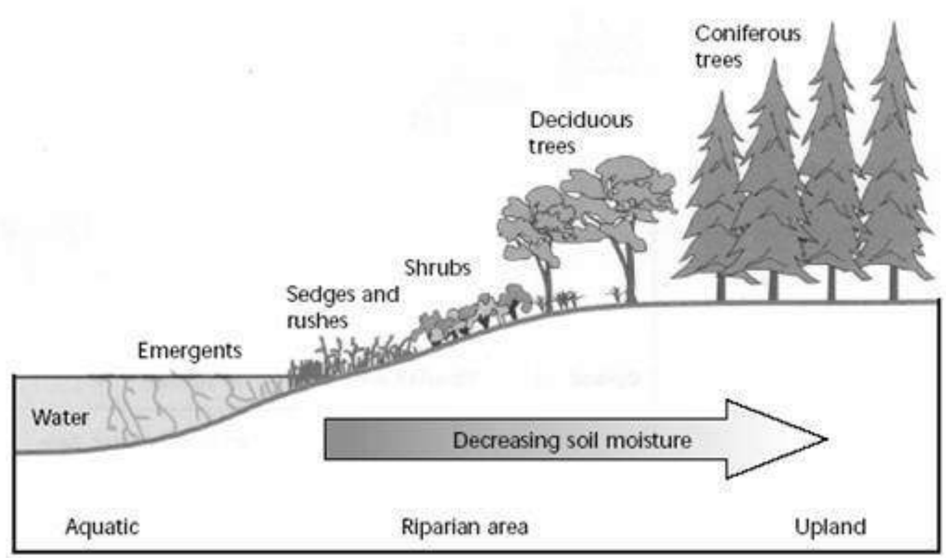


FIGURE 1 *Illustration of the moisture gradient in a typical riparian ecosystem (from Stevens et al. 1995:2).*

- Three Main Areas
  - 1) Aquatic (water)
  - 2) Riparian
  - 3) Upland

- Aquatic areas include standing water (e.g., ponds, lakes, wetlands, bogs, streams and rivers)

- Riparian areas are those corridors of vegetation next to and influencing the aquatic area.

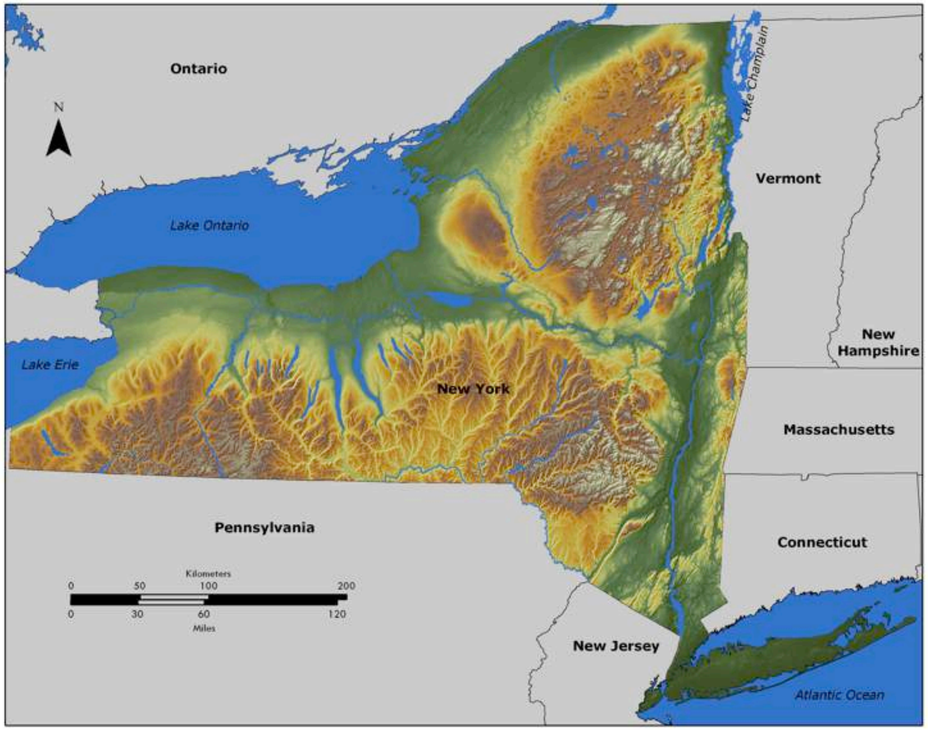
Watershed Area

- The catchment area of a watershed influences the amount of water that flows from the river or stream that drains it.

- **Generally, large watersheds receive more precipitation than small ones in like climates.**

- In moist climates, greater precipitation and runoff may occur in smaller watersheds than in larger watersheds with arid climates.

Watershed Shape and Slope



•Shape and slope of a watershed and its drainage pattern influence surface runoff and seepage in streams draining the watershed.

•Steeper the slope, the greater the possibility for rapid runoff and erosion.

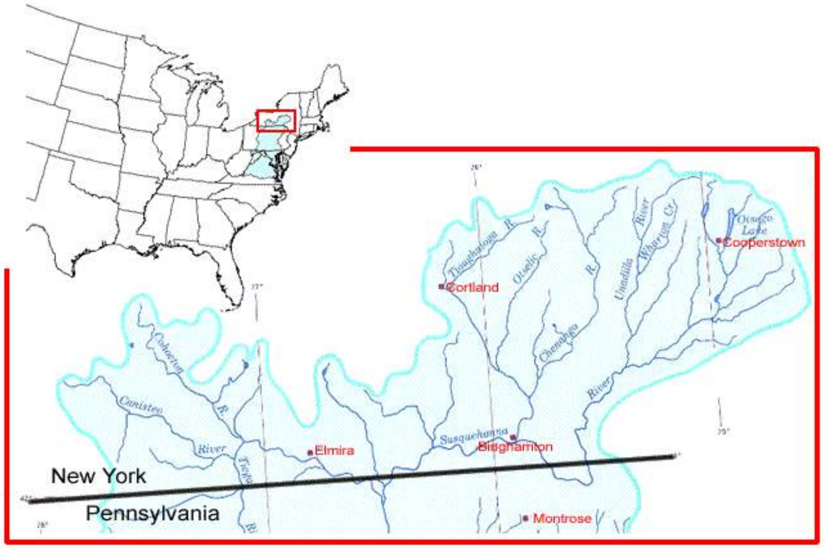
•Plant cover is more difficult to establish and infiltration of surface water is reduced on steep slopes.

Orientation

- Orientation of a watershed in relation to storm events impacts runoff and peak flows.

- A rainstorm moving up a watershed releases water in such a way that runoff from the lower section has passed its peak before runoff from the higher sections has arrived.

- A storm starting at the top of a watershed and moving down has an additive effect on runoff downstream.



Hydrologic Unit and Scale

- Hydrologic Unit Code (HUC) was created by the USGS to classify the nation’s watersheds and sub-watersheds.

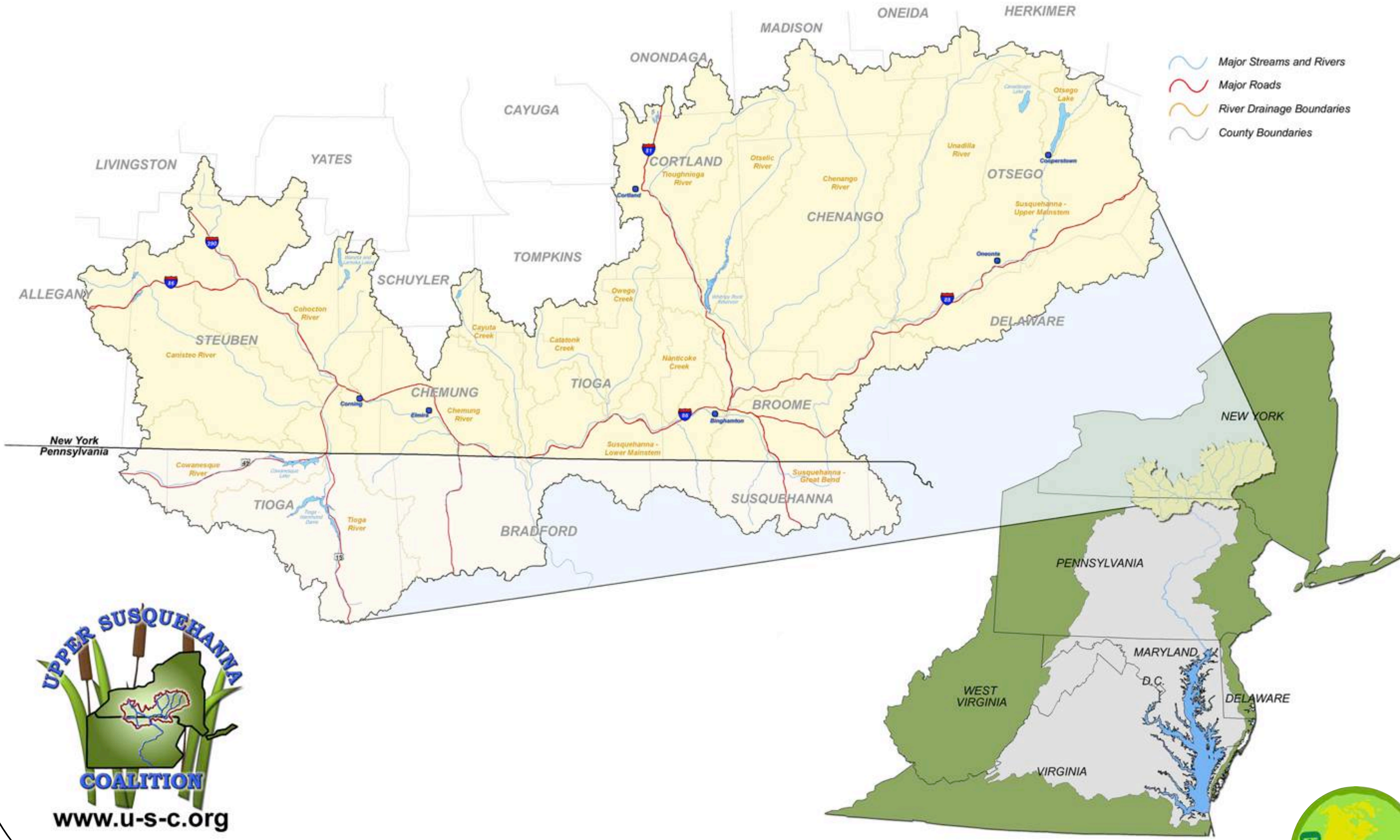
Info: http://water.usgs.gov/GIS/huc.html

GIS Data: http://datagateway.nrcs.usda.gov/

Chesapeake Bay Watershed

THE UPPER SUSQUEHANNA COALITION

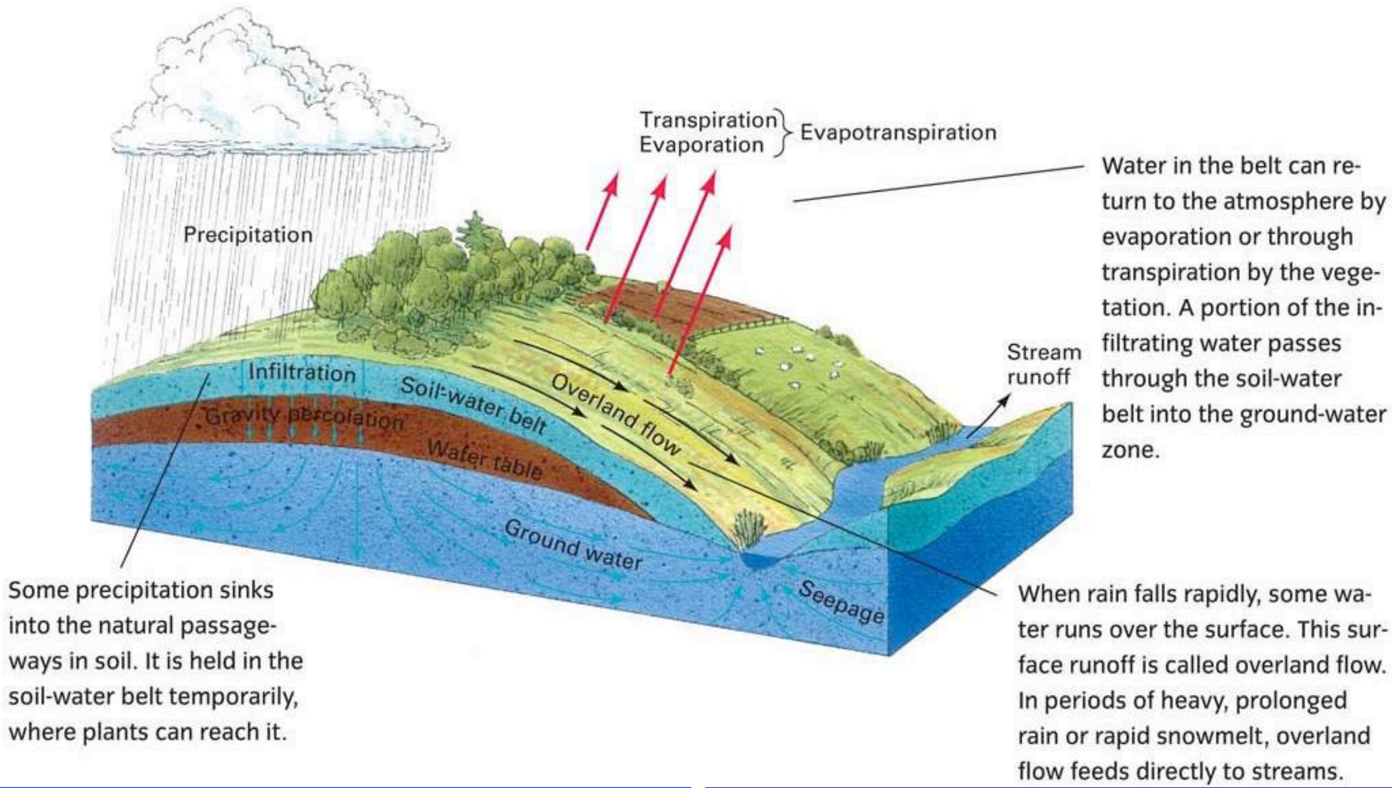
HEADWATERS OF THE CHESAPEAKE BAY



www.u-s-c.org

Hydrologic Cycle Revisited

Precipitation may infiltrate, run off, evaporate/transpire



Infiltration: absorption and downward movement of precipitation into the soil and regolith

Runoff: flow of water from continents to oceans through stream flow and shallow ground-water flow

Meteorological Factors Impacting Surface Runoff

- Type of precipitation
- Rainfall intensity
- Rainfall amount
- Rainfall duration
- Distribution of rainfall over the drainage basin
- Direction of storm movement
- Precipitation that occurred earlier and resulting soil moisture
- Meteorological conditions that affect evapotranspiration

Physical Characteristics Impacting Surface Runoff

Overland runoff from disturbed areas often contains excessive sediment in addition to water. (USGS)

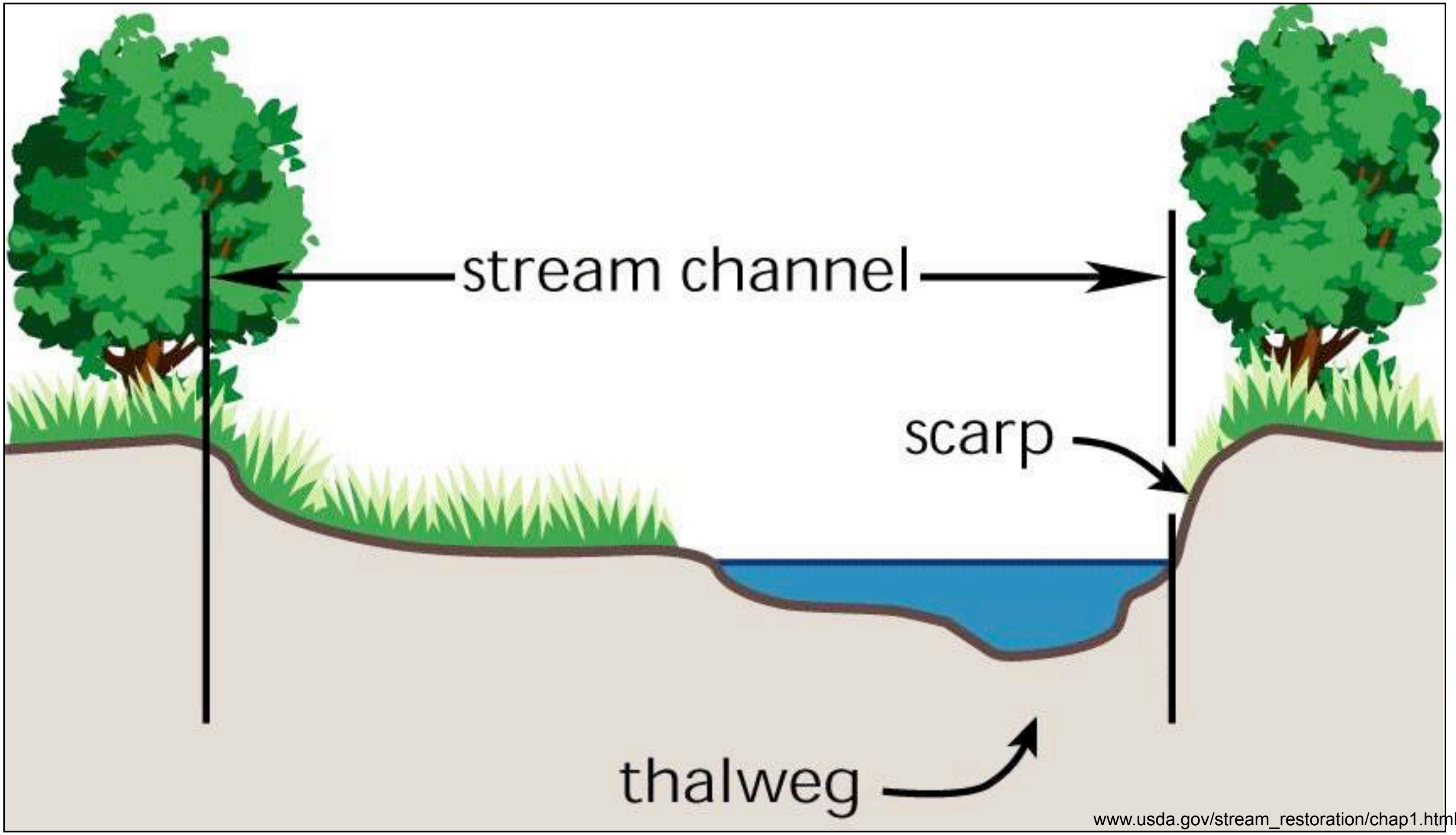
- Land use
- Vegetation
- Soil type
- Drainage area
- Basin shape
- Elevation
- Topography, especially the slope of the land
- Drainage network patterns
- Ponds, lakes, reservoirs, sinks, etc. in the basin, which prevent or delay runoff from continuing downstream

Human Factors Impacting Surface Runoff

- Urbanization -- more impervious surfaces reduce infiltration and accelerate water motion.

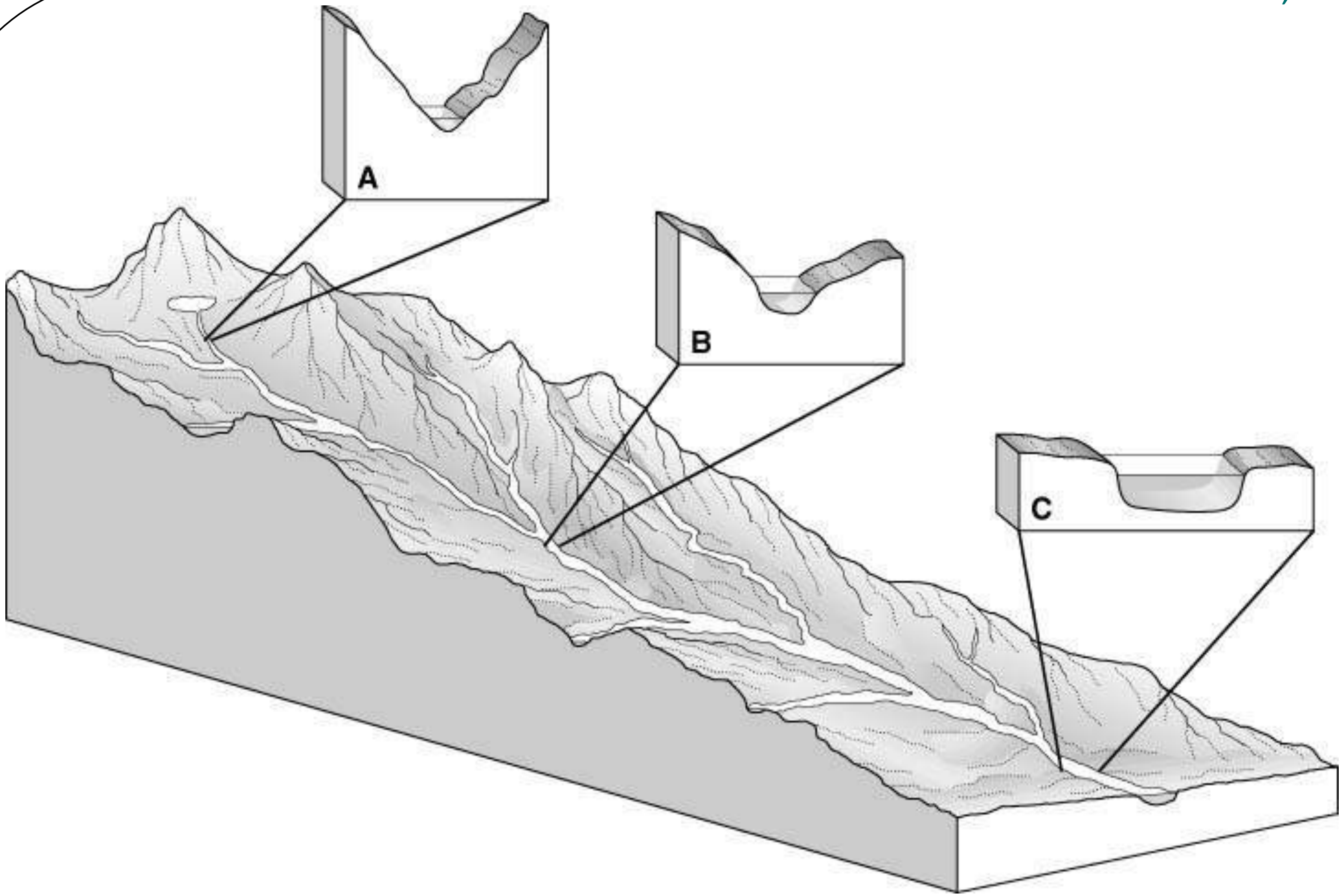
- Removal of vegetation and soil -- surface grading, artificial drainage networks increases volume of runoff and shortens runoff time to streams from rainfall and snowmelt.

Cross Section of a Channel



Rivers

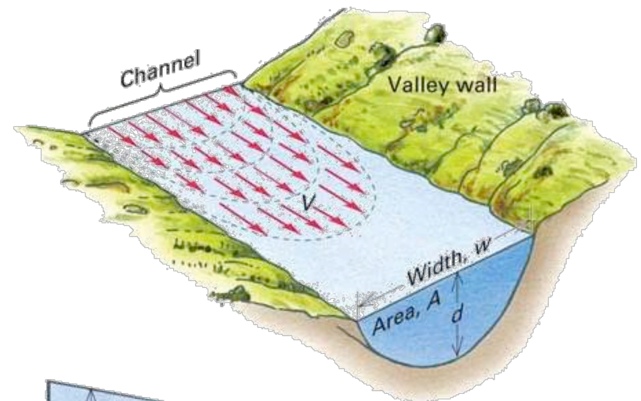
- River Morphology:
  - Young, “V” shaped valleys
  - Older, “U” shaped valleys
  - Oldest, *meandering* channels with *oxbow* lakes
  - Braided channels with lots of sediment
    - Channels are choked with sediments
    - Below glacial terrain
    - In wetlands where there is very low gradient (slope)

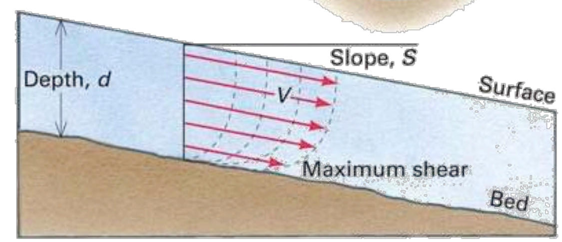


Changes in stream properties along a watershed.

Characteristics of Stream Flow

- Water slowed by friction with channel walls and bed.
- Velocity is greatest in the middle and top of the stream.
- The steeper the gradient, the faster the flow.
- <u>Discharge</u>: volume of the stream, cubic meters/second.



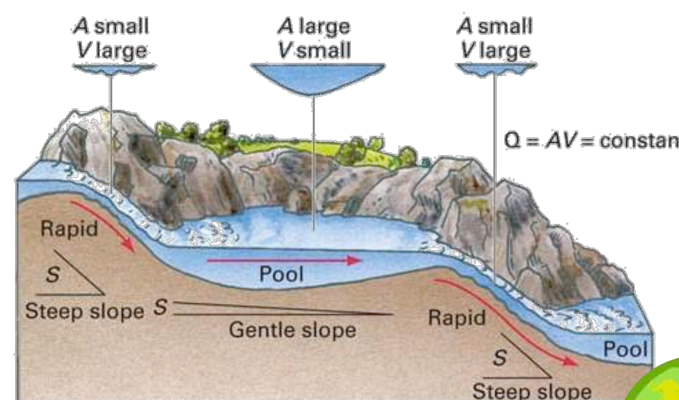


Q=AV=constant

Q: discharge

A: cross-sectional area

V: velocity

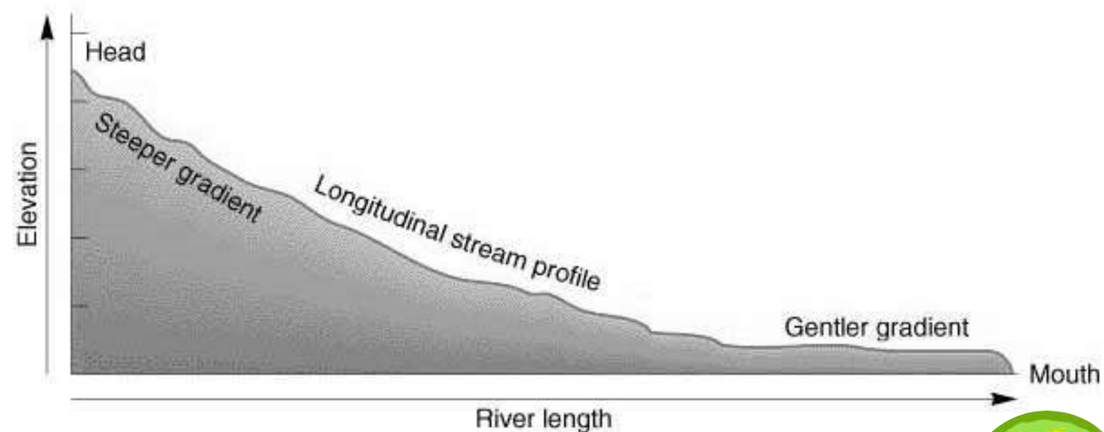


Stream Gradient

- Stream gradient is the drop in elevation over a given distance.

Slope = Rise/Run

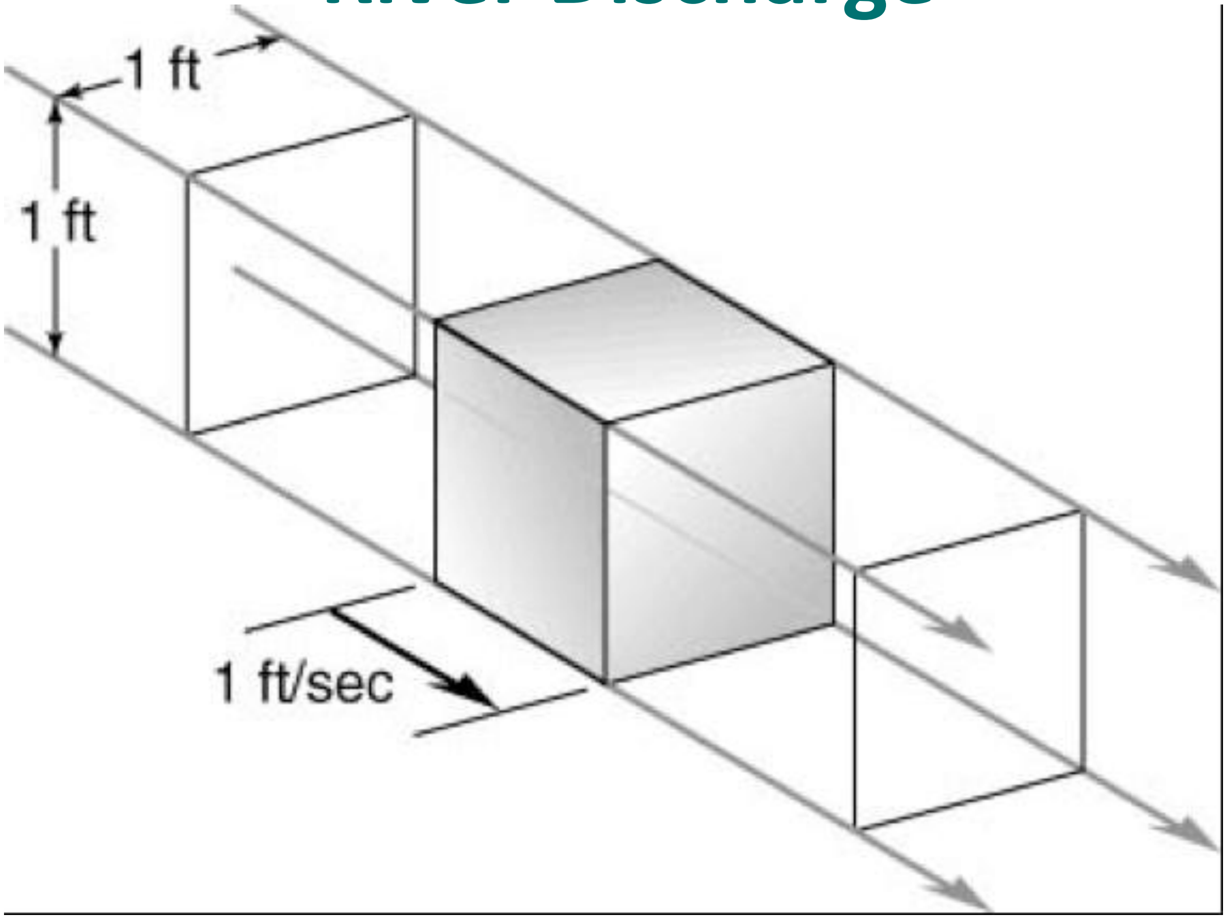
- Calculated by dividing the elevation drop by distance.



River Discharge

- Discharge is the flow of water
  - Measured in units of cubic feet per minute, or cfs
  - The metric equivalent is liters per second, or Lps
- We find the discharge, Q, by taking the product of the velocity, v, and the area, A:
  - Q = V A
  - Example, if the width of the channel is ten feet, the depth is one foot, and the velocity is two feet per second, then
    - $A = 10\ ft \times 1\ ft = 10\ ft^2$
    - $Q = 2\ ft/s \times 10\ ft^2 = 20\ cfs$

River Discharge



One cubic foot per second, or cfs (or one cubic meter per second, or cms) is equivalent to one cubic foot (or meter) of water flowing past a given point in a one-second time interval.

Flooding

- **Flooding** is the natural process of overbank flow.

- Most river flooding related to:
  - Amount of precipitation
  - Distribution of precipitation
  - Soil type & infiltration rate
  - Soil moisture
  - Basin size and shape
  - Slope
  - Land cover/Land use
  - Runoff

- Flooding is the most common of disastrous acts of nature among all catastrophes leading to economic losses and death (Sharma and Priya 2001).

- Caused by:
  - Summer thunderstorms
  - Tropical storms
  - Melting snow
  - Ice and debris jams in rivers
  - Seasonal changes (e.g., monsoons)

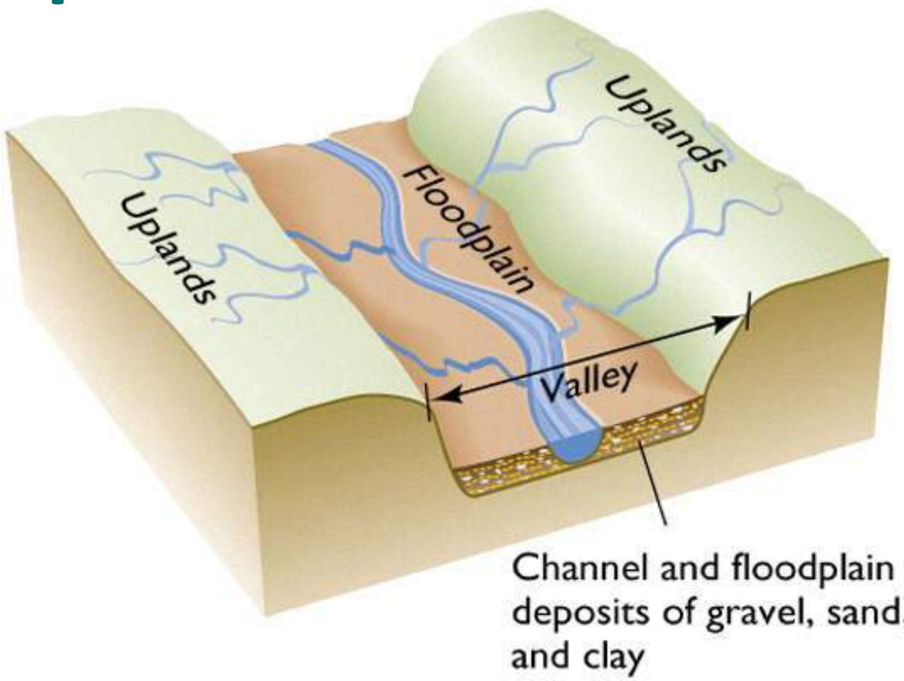
Flood Characterization

- Floods can be characterized in several ways.
  - **Flood discharge** is the discharge of the stream at the point where water overflows the channel banks.
  - **Stage** is defined as the height of water in the river.
- **Flood stage** is frequently used to indicate that the elevation of the water surface has reached a level likely to cause damage to personal property.
  - Based on human perception, so elevation that is considered flood stage depend on human use of the floodplain (Beyer 1974).

Floodplain

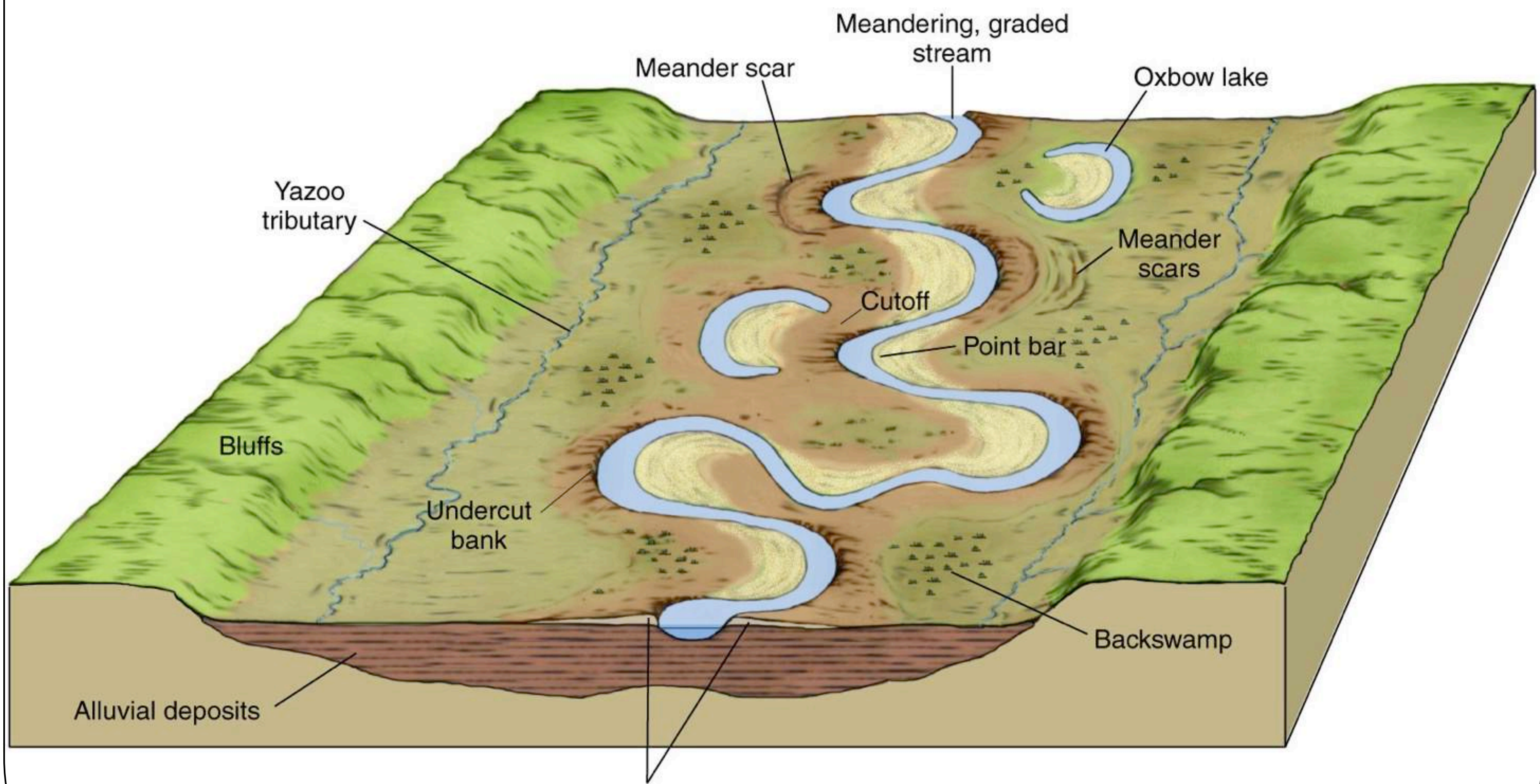
- **<u>Floodplain</u>** is the flat surface adjacent to the river channel that is periodically inundated by floodwater.

- Most floodplains have deposits that are finer grained than those found in, and immediately adjacent to, the channel.



<u>Illuvium</u> is material accumulated through illuviation (material transport).

Floodplain Landscape Features



Two Main Types: Flash Floods (1)

- **<u>Flash floods</u>** typically occur:
  - In upper parts of drainage basins
  - Small drainage basins of tributaries to large rivers
- Generally produced by:
  - Intense rainfall
  - Short time periods
  - Small areas
- Flash flooding most common in:
  - Arid and semiarid environments
  - In areas of steep topography
  - Less vegetation
  - Following breaks of:
    - Dams
    - Levees
    - Ice and debris jam

Two Main Types: Downstream Floods (2)

- Flash floods often contribute to downstream floods.

- **<u>Downstream floods</u>** are floods:
  - That cover wide areas
  - Found in low slope areas
  - Usually produced by storms of long duration that saturate soil and produce increased runoff

- Downstream floods are characterized by the downstream movement of the floodwaters with a large rise and fall of discharge at a particular location (ARS 1969).

Image: Mississippi River Flood -2011

National Trend in Flood Damage

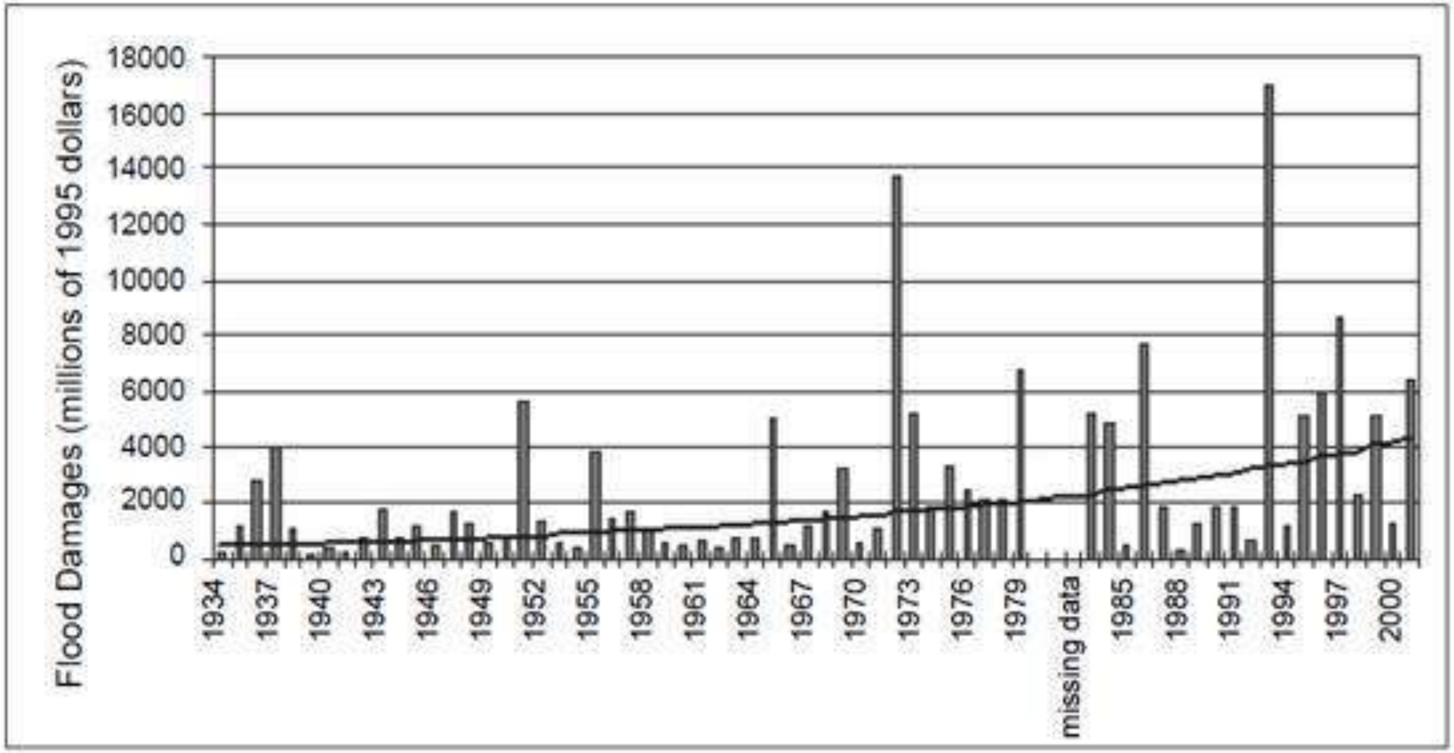
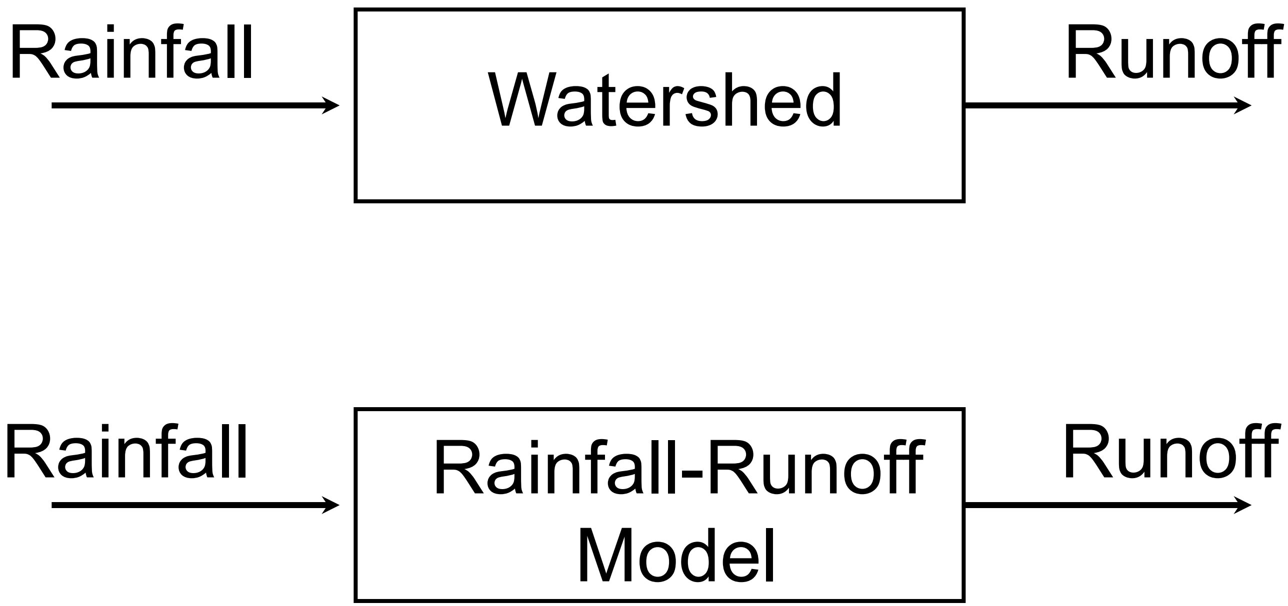
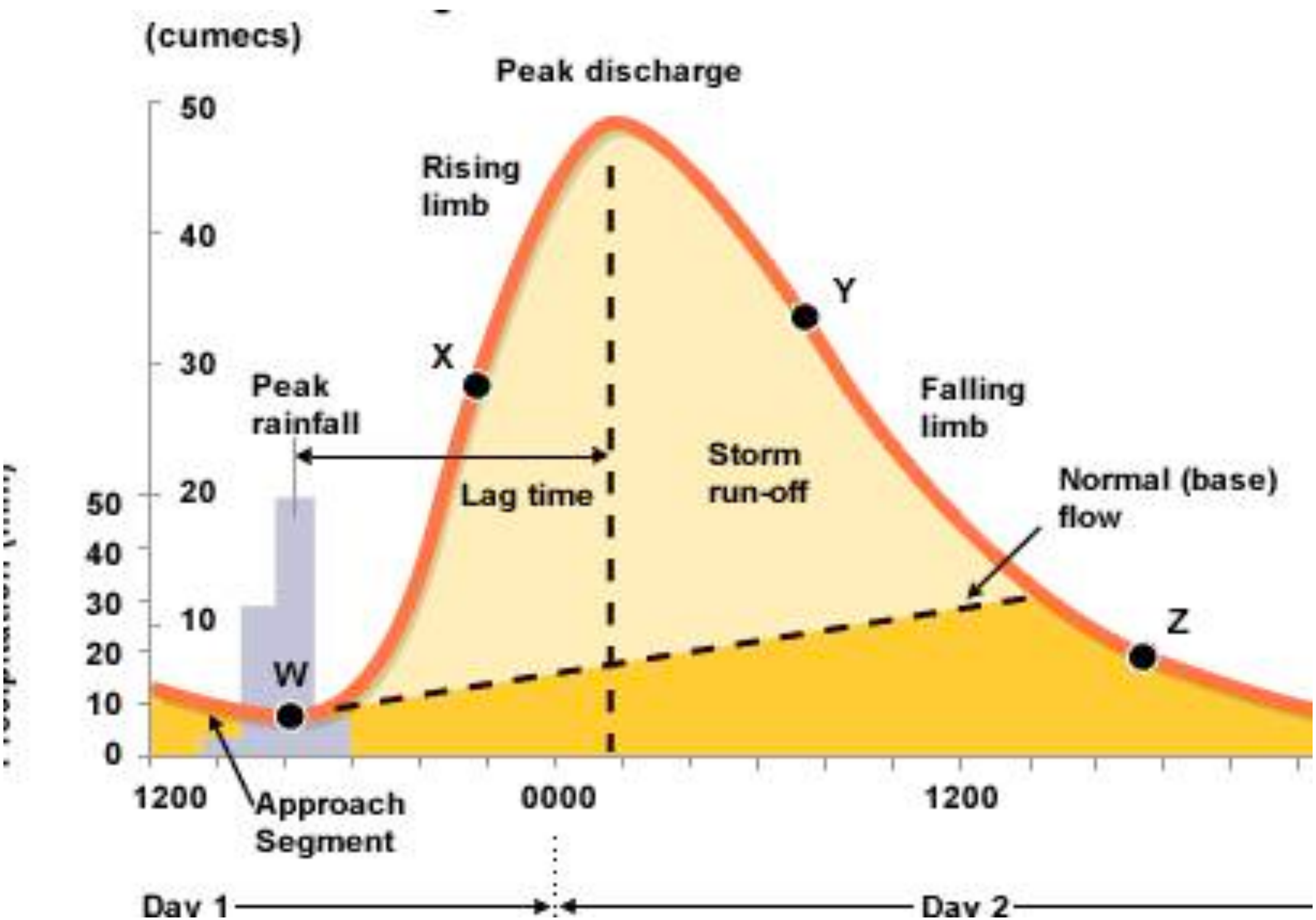


Figure 1. Real National Flood Damages 1934-2001 (NWS reanalyzed data)

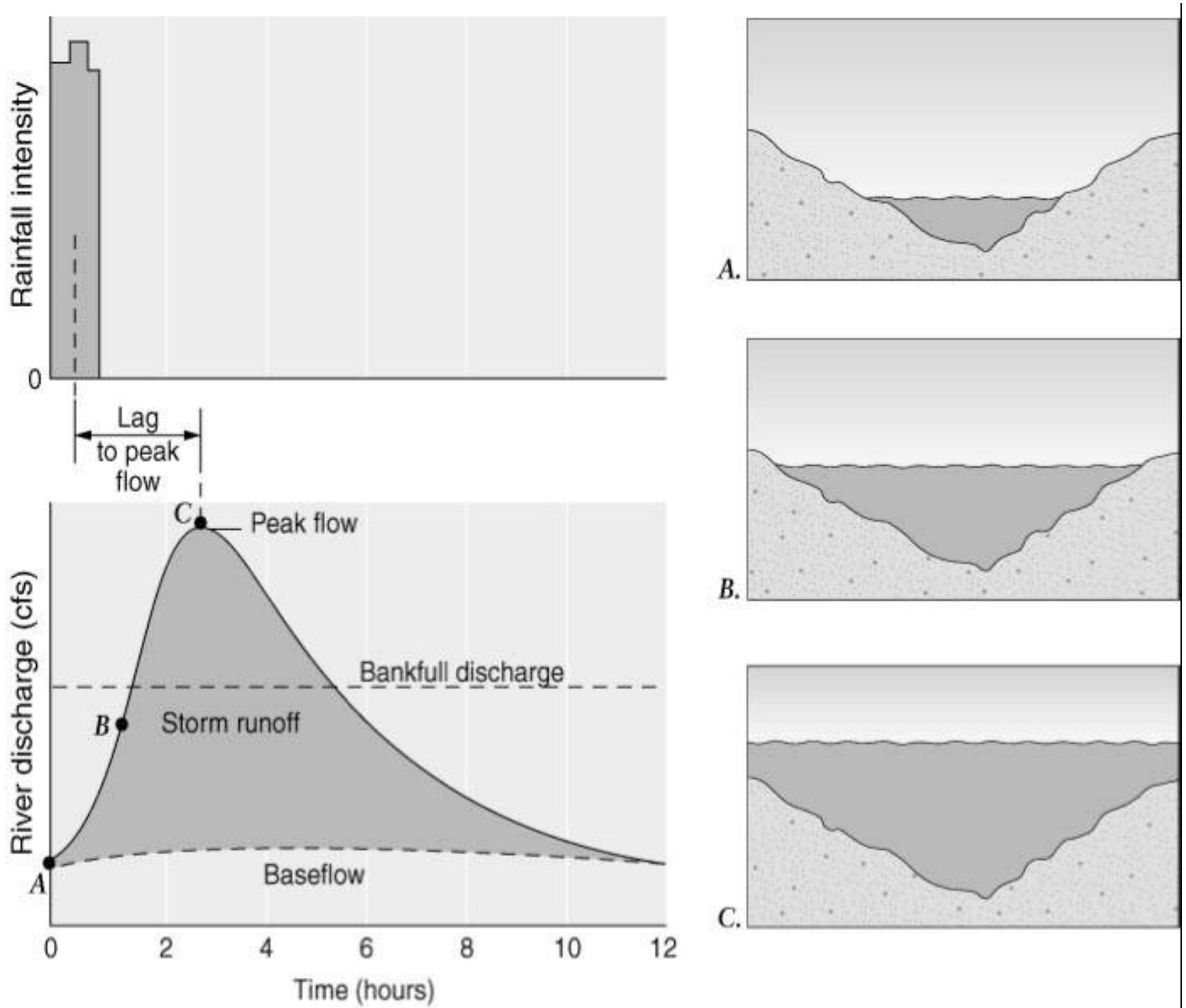
Rainfall – Runoff Modeling



Runoff Hydrograph (Recession Curve)



Afton, NY



The hydrograph of a river can look similar to this example after a brief but intense rainfall event.

Hydrograph Shape

- Main **<u>TWO</u>** factors influencing hydrograph shape are:

  - 1) <u>Drainage characteristics</u>: basin area, basin shape, basin slope, soil type, land use, drainage density, and drainage network topology.

    **Note: Most changes to land cover/land use tend to increase runoff.

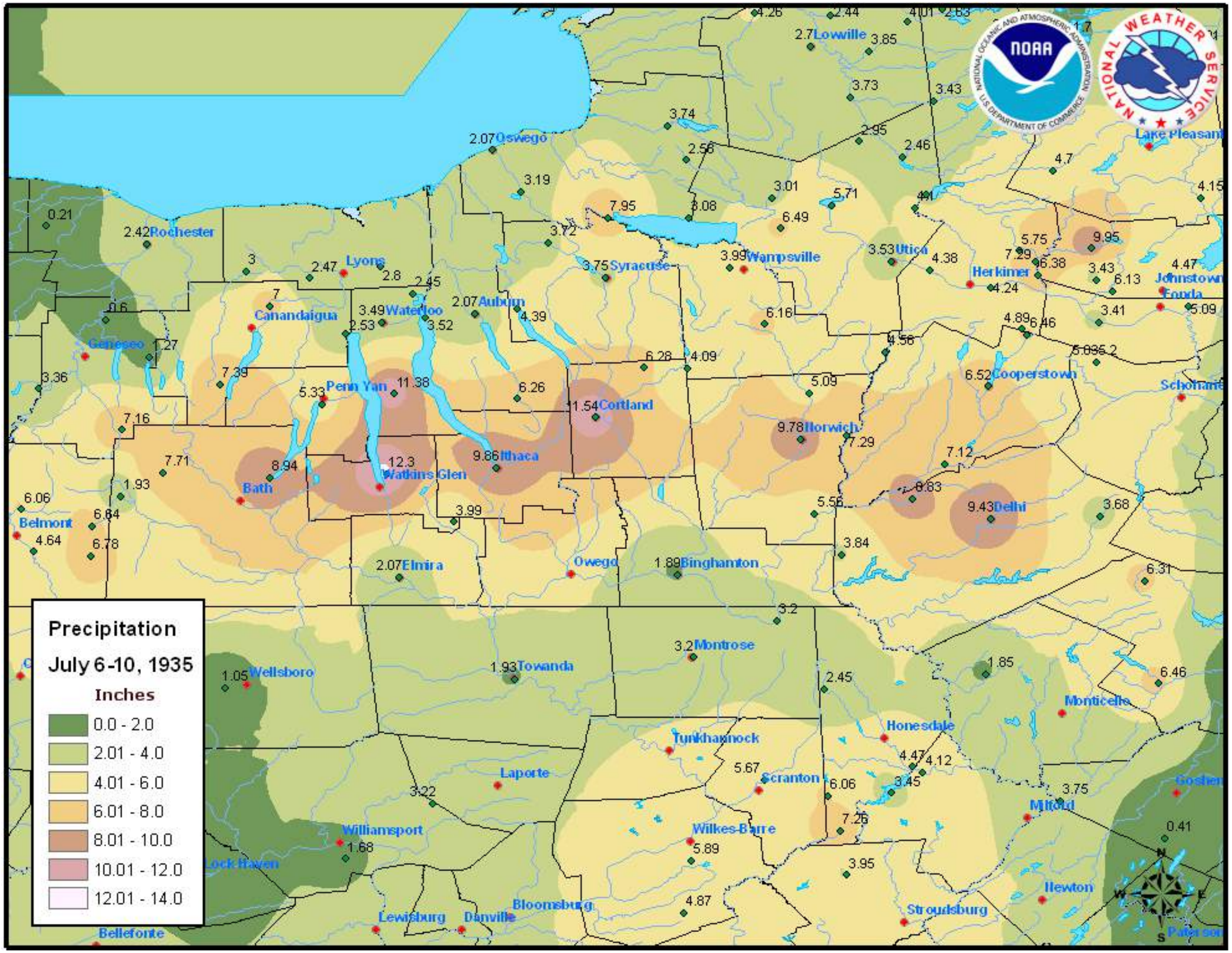
  - 2) <u>Rainfall characteristics</u>: rainfall intensity, duration, and their spatial and temporal distribution.

    **Note: Storms moving downstream tend to produce larger peak flows than storms moving upstream.

Outline:

1. Climate Change & Hurricanes
2. Watersheds & Surface Hydrology
3. Flooding in the Northeast
4. Afton, NY: Flood Dynamics
5. Risk Prevention Options

Flood of July 1935



Agnes Track: 1972

See WSKG documentary: “Agnes: The Flood ‘72”

Afton, NY

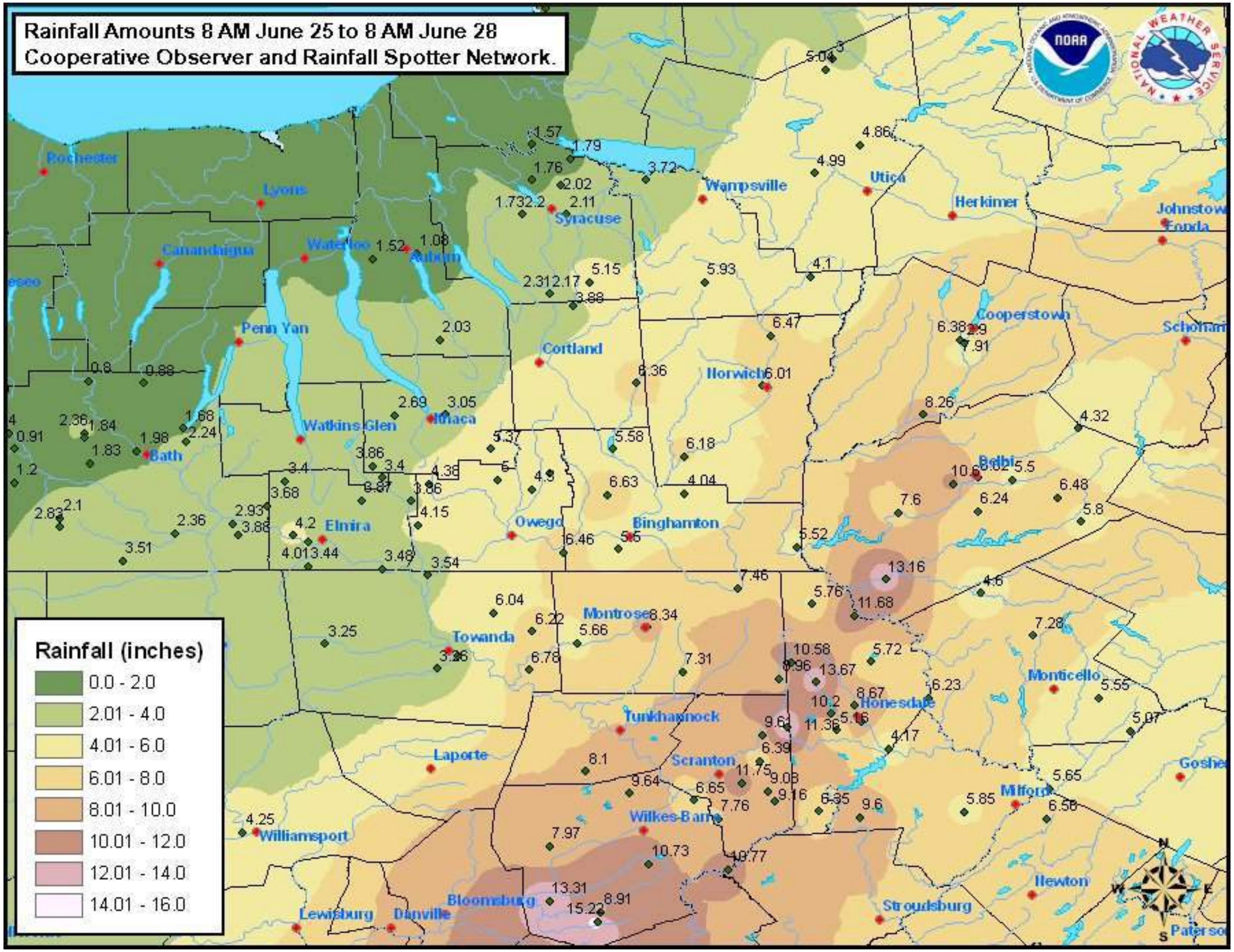
Rainfall Totals:

June 20-24

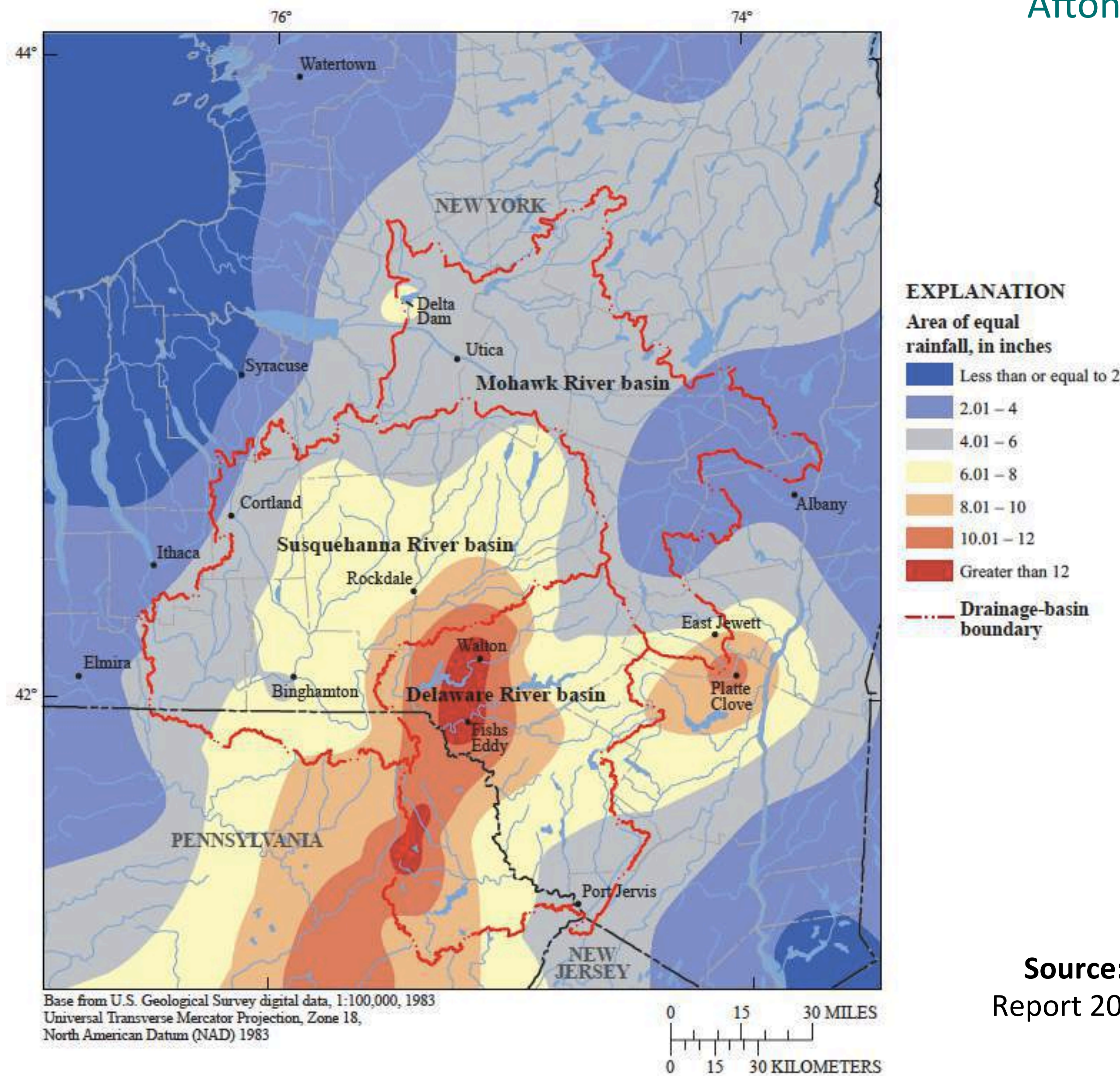
1972

See: http://www.erh.noaa.gov/ctp/features/historical/agnes.php

Flood of June 2006



Afton, NY



Source: USGS, Report 2009 - 1063

Figure 1A. Cumulative 4-day rainfall for the storm of June 26–29, 2006, and pertinent geographic features of New York.

How rare was the 2006 flood?

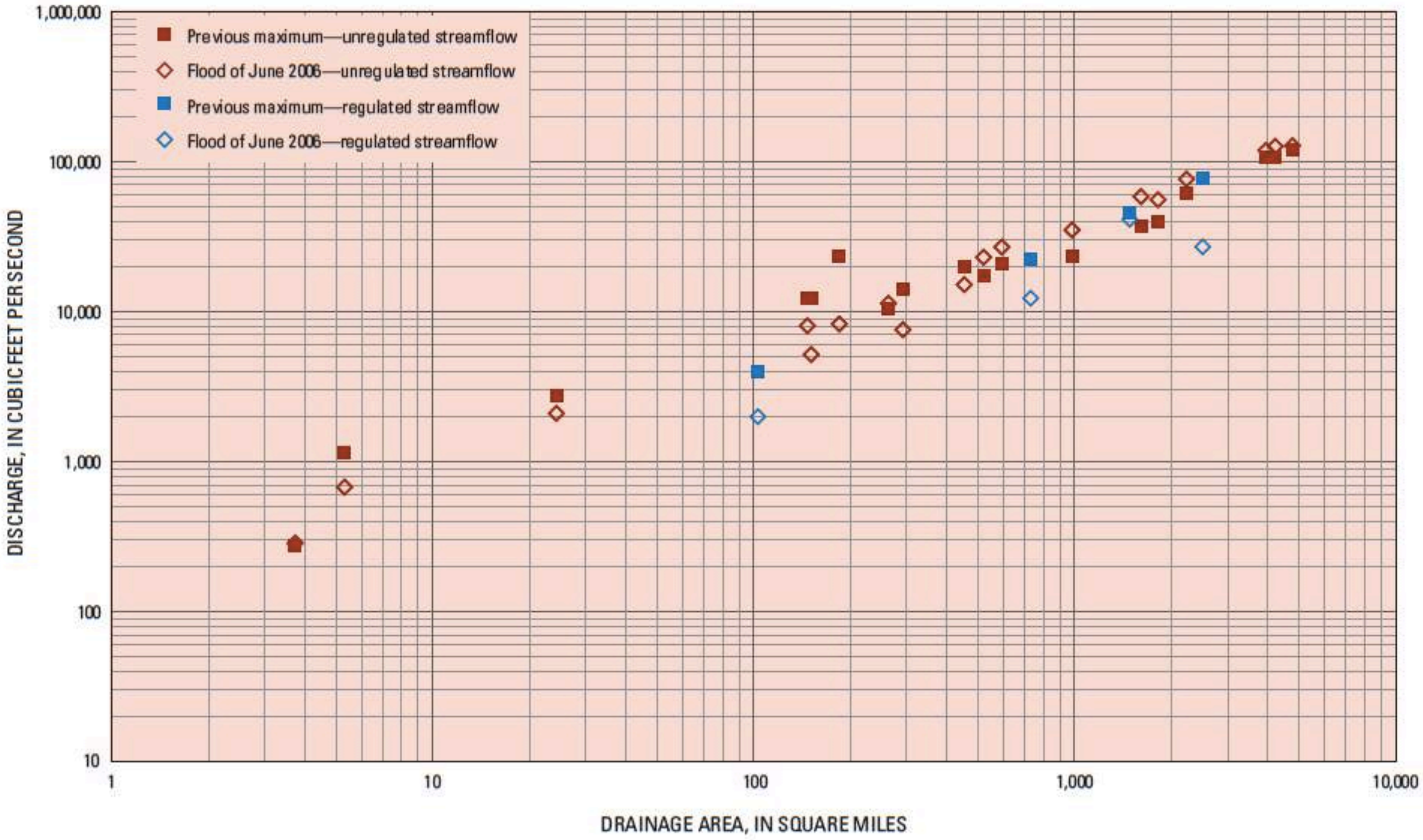
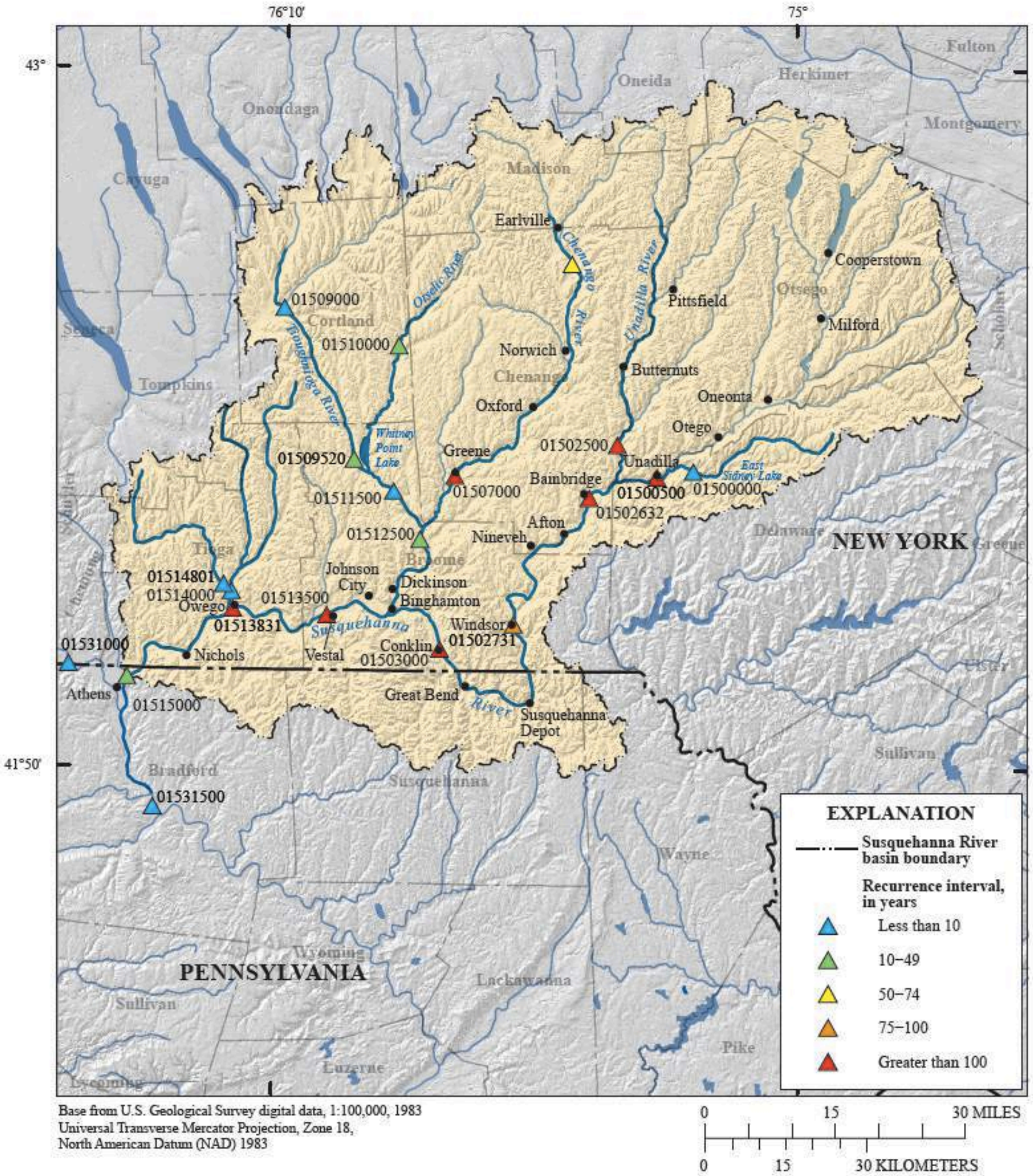


Figure 5C. Peak discharges for the flood of June 26–29, 2006, and previous maximum known discharge at selected stream-gaging stations in the Susquehanna River basin, NY, as a function of drainage area.

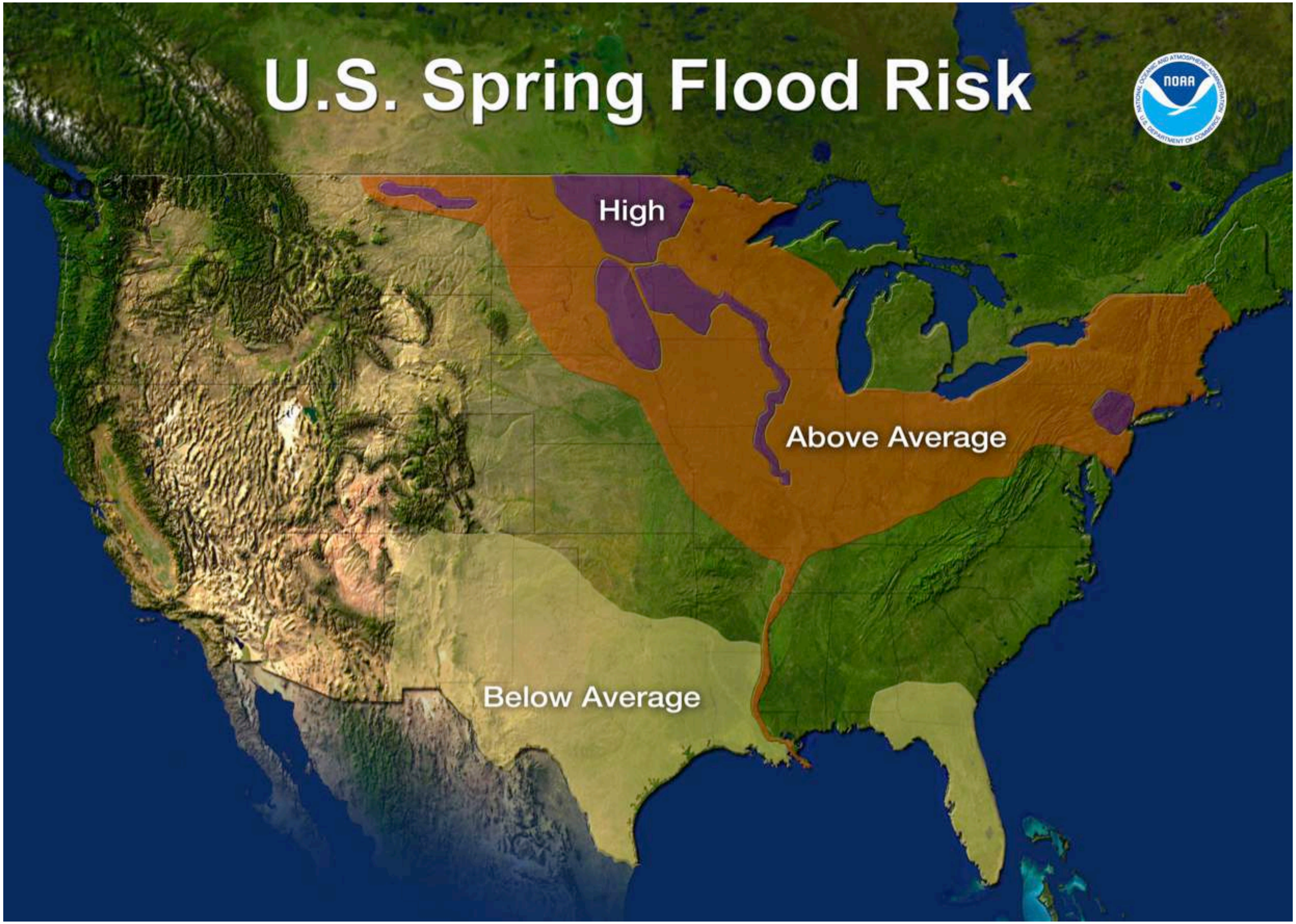
Source: USGS, Report 2009 - 1063



Source: USGS, Report 2009 - 1063

Source: USGS, Report 2009 - 1063

Figure 14A. Top–Collapse of Interstate Route 88 over Carrs Creek near Unadilla (Exit 10), NY, on June 28, 2006. Bottom–Carrs Creek and washed-out culvert at Interstate Route 88 near Unadilla (exit 10), NY, on June 28, 2006. Photos courtesy of The Daily Star, taken by staff photographer Julie Lewis.



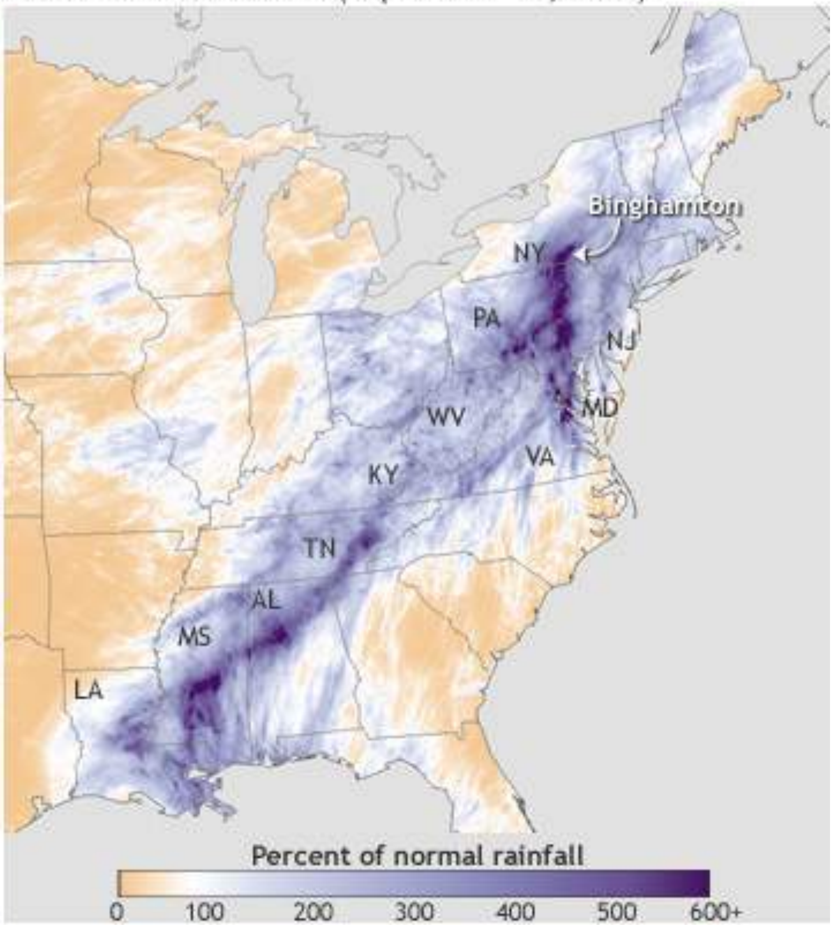
Source Date: 2011

Afton, NY

Record Rains & Floods in Northeast

Flooded road, Binghamton, NY

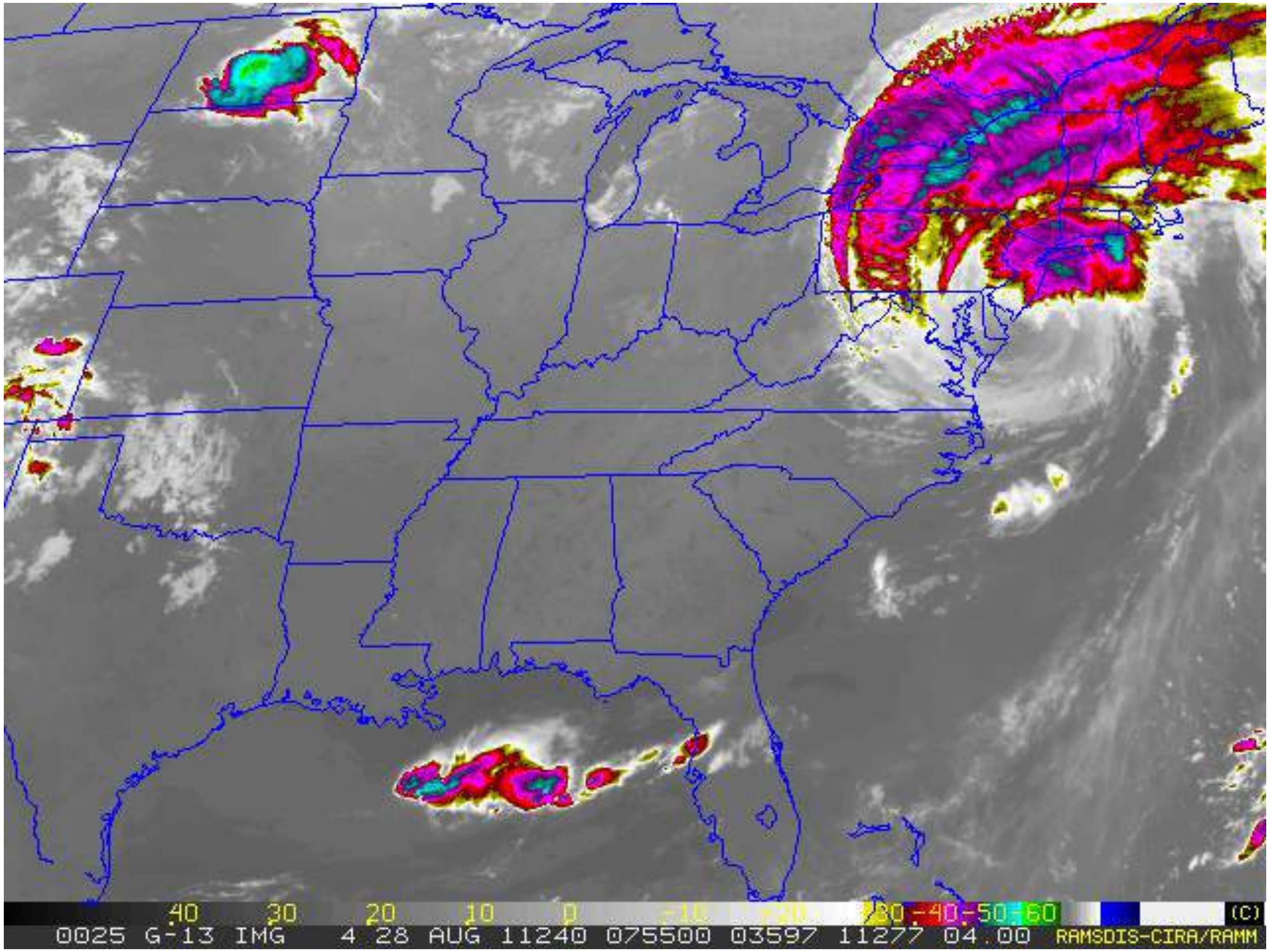
Month-to-date rainfall (September 14, 2011)



NOAA CLIMATE SERVICES
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

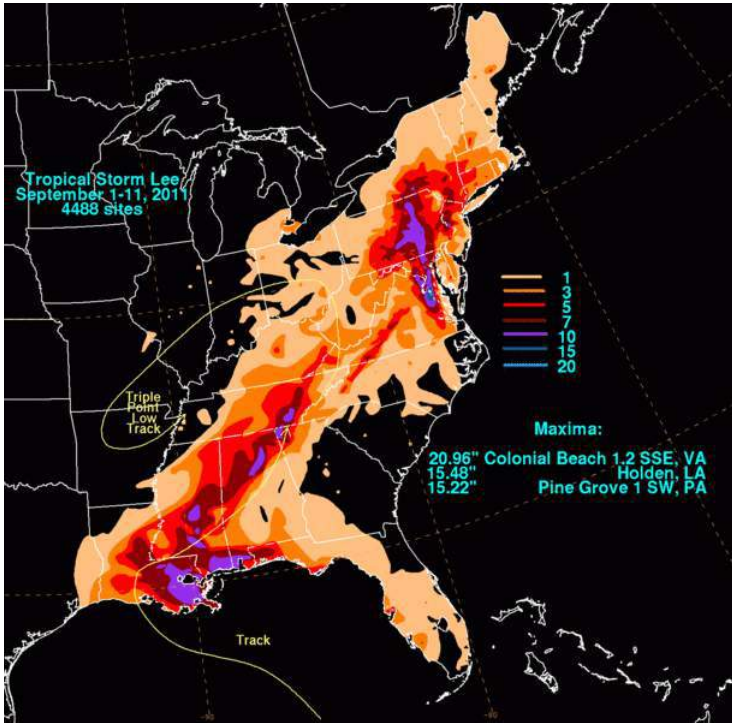
GeoEco

Hurricane/Tropical Storm Irene (2011)



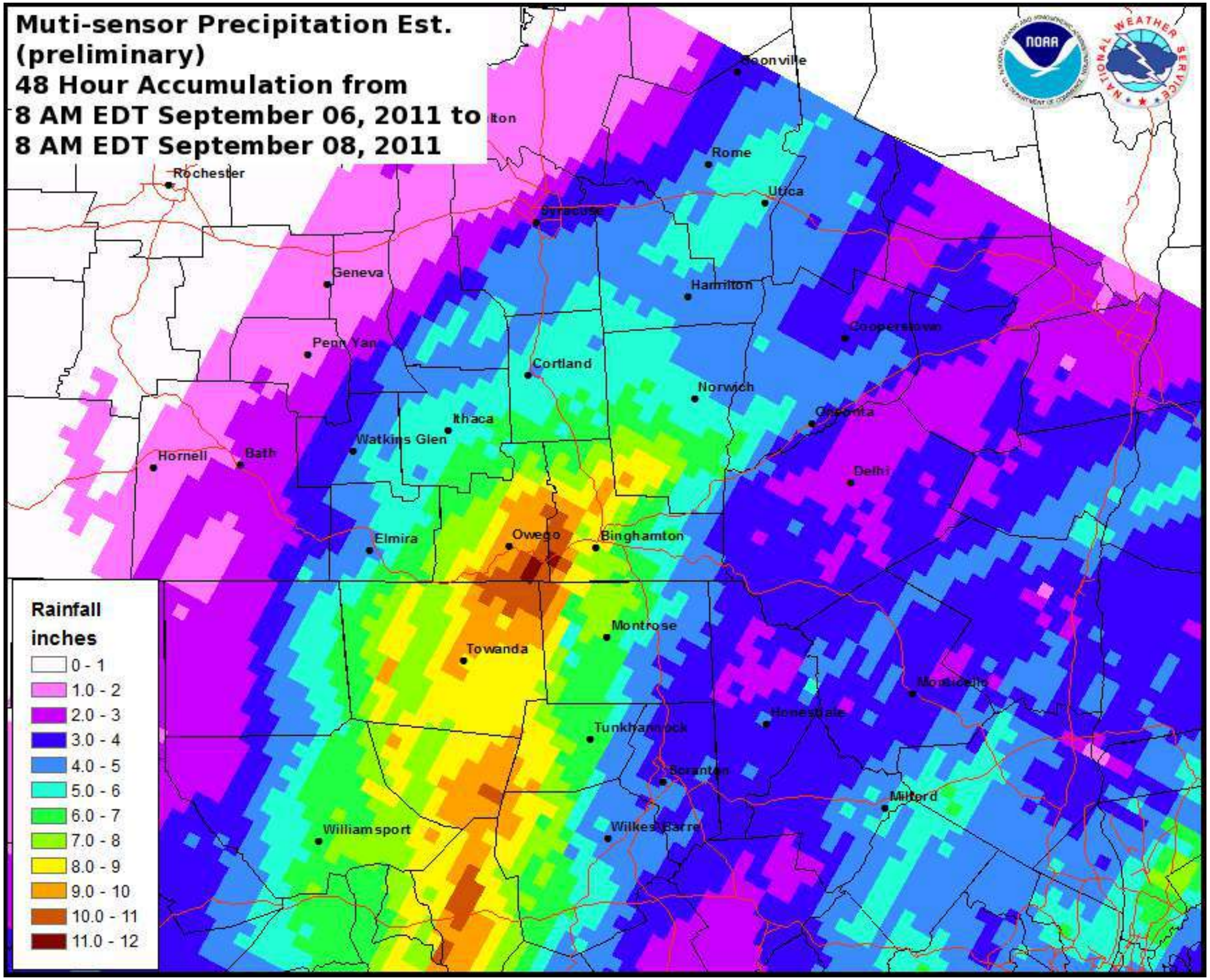
Link: http://www.erh.noaa.gov/bgm/WeatherEvents/Flood/august282011/satellite_regional_ir.shtml

Hurricane/Tropical Storm Lee (2011)



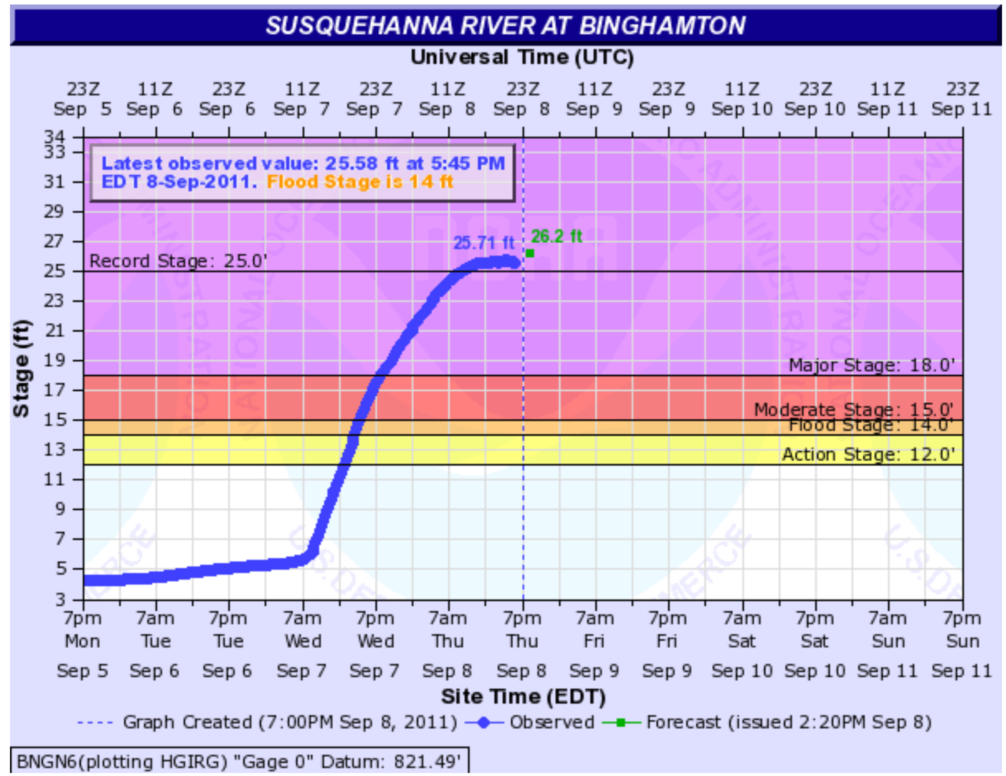
Formed: 1 September 2011
Dissipated: 5 September 2011

Hurricane/Tropical Storm Lee (2011)



Afton, NY

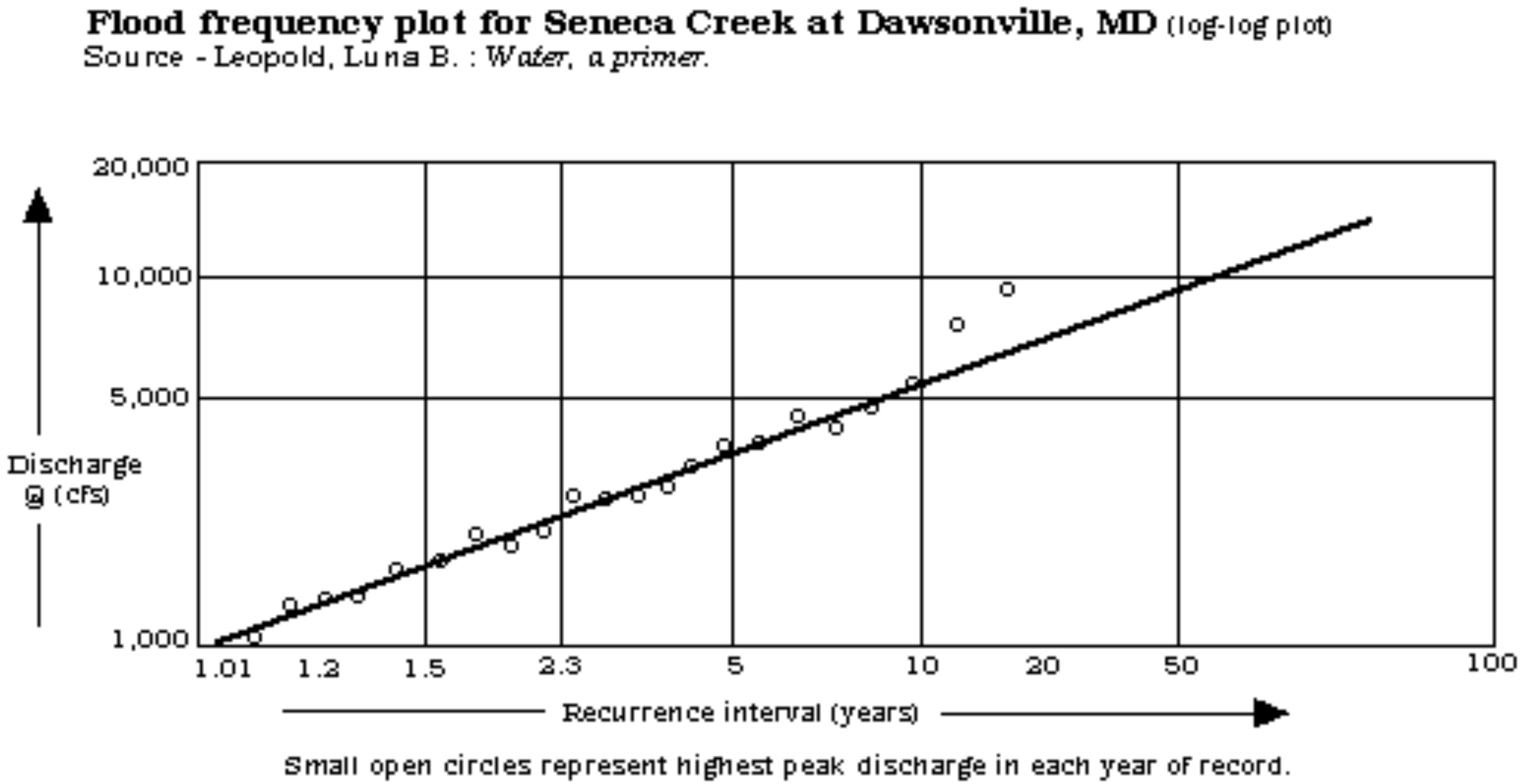
Great Binghamton Flood (2011)



*Advanced Hydrologic Prediction Service

NOAA NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
UNITED STATES DEPARTMENT OF COMMERCE

Flood Frequency



Flood frequency – how often will it happen?

Afton, NY

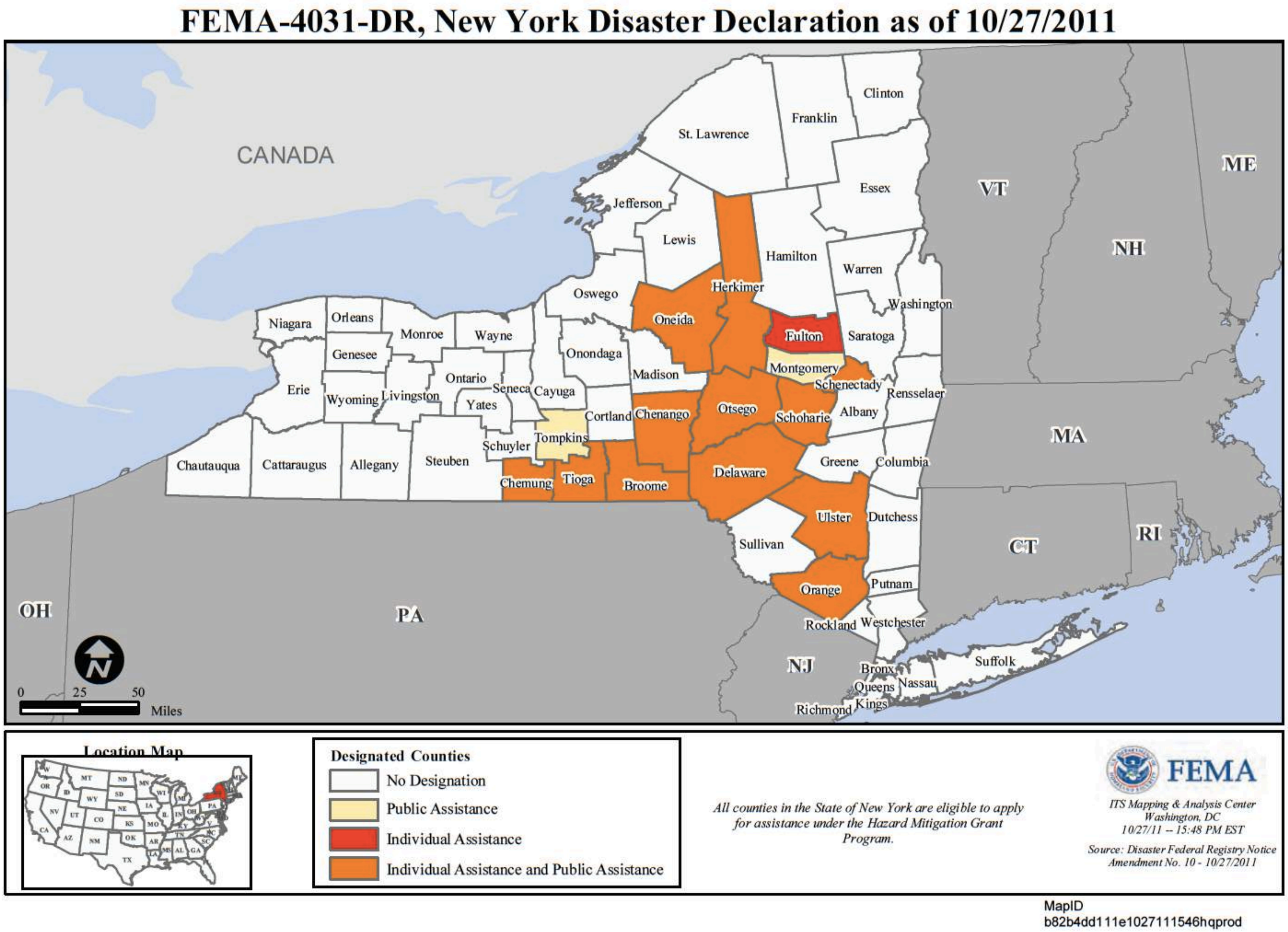
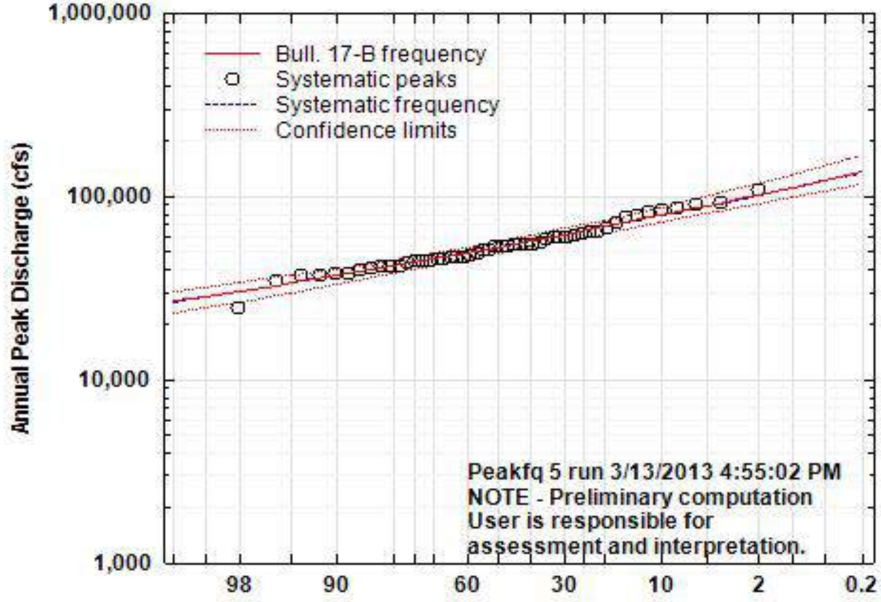
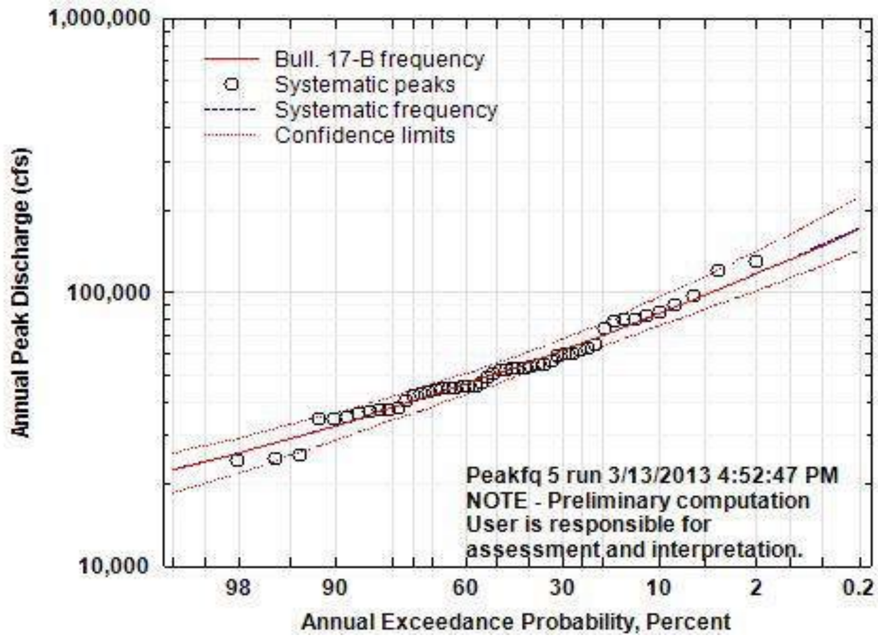


Figure 66. The counties of New York that were declared major disaster areas following the flooding of September 8–9, 2011. (From Federal Emergency Management Agency, 2011b)



Changes in flood frequency at the Vestal, NY gaging station, Susquehanna River

1935-1984



1962-2011

Analysis source: Peter Knuepfer, Ph.D.

KOPERNIK OBSERVATORY & SCIENCE CENTER
698 UNDERWOOD ROAD, VESTAL, NEW YORK 13850
PHONE (607) 748-3685 * FAX (607) 748-3222 * WWW.KOPERNIK.ORG

July 19, 2013

Afton Village Justice
PO Box 402
Afton, NY 13730-0402

I take this opportunity to invite you to our September 13th conference for Twin Tier municipal officials:
"Extreme Weather, Climate Change, Mitigation and Adaptation".

As you know, our region has experienced extreme weather over the past decade. The great floods of 2006 and 2011 of the Susquehanna River basin continue to remind us of the personal hardship and economic cost of extreme weather.

Climate projections from the New York State Energy Research and Development Authority (NYSERDA) suggest that the extreme weather of the past may be but a prelude to the climate of the future. By 2080, regional temperatures are expected to rise by 4.5 to 8.5°F and precipitation by more than 10%. The Susquehanna River basin will flood with increasing frequency.

Our featured speakers address these issues with a special understanding of the needs of regional officials to make our communities more resilient to the effects of extreme weather and climate change. Specifically:

- **Mark Wysocki. Department of Earth and Atmospheric Sciences, Cornell University: "Extreme Weather and Climate Change in the Northeast".**
- **Dave Nicosia. National Weather Service and Warning Coordination Meteorologist: "The Southern Tier: Extreme Weather and Climate Change—Perspectives on the Past, Present, and Future".**
- **Art DeGaetano. Department of Earth and Atmospheric Sciences, Cornell University: "Proactive Adaptation for Extreme Weather in the Southern Tier".**

Erik Miller, Executive Director, Southern Tier East Regional Planning and Development Board: "Mitigation: Reducing Greenhouse Gas Emissions and Achieving Sustainability".

Funded by NYSERDA, the City of Binghamton, and NYSEG, our conference is scheduled for September 13, 9:00 a.m. to 5:00 p.m., Kopernik Observatory & Science Center. Sponsors include Kopernik, WSKG Public Media, and Southern Tier East Regional Planning and Development Board. On-line registration is $25 at http://www.kopernik.org and includes lunch and refreshments. Preference given to the first 100 registrants. Registration is $30 at the day of the conference.

Cordially,

Drew Deskur
Director: Kopernik Observatory & Science Center

Outline:

1. Climate Change & Hurricanes

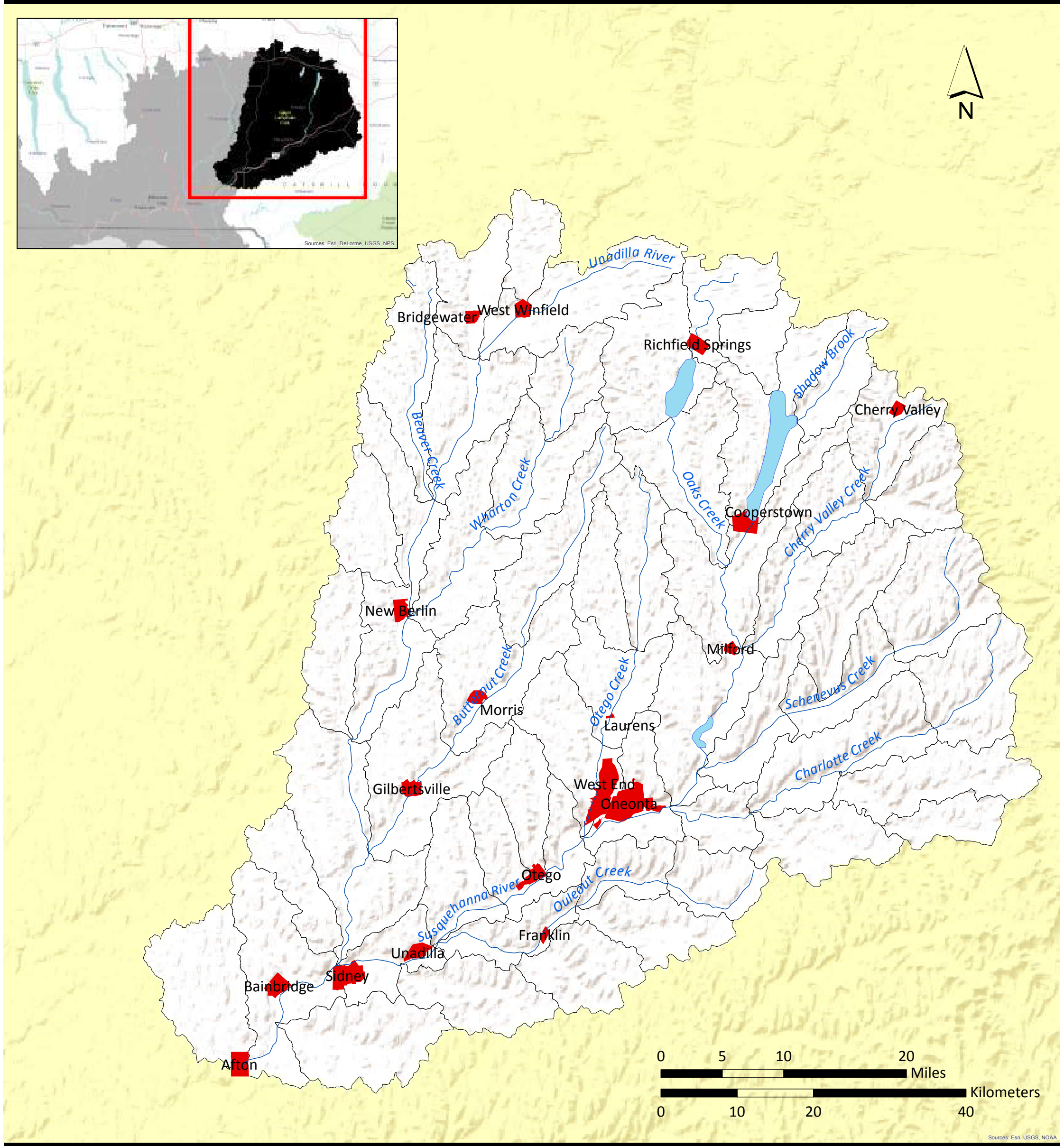
2. Watersheds & Surface Hydrology

3. Flooding in the Northeast

4. Afton, NY: Flood Dynamics

5. Risk Prevention Options

Drainage Basin: Afton, NY

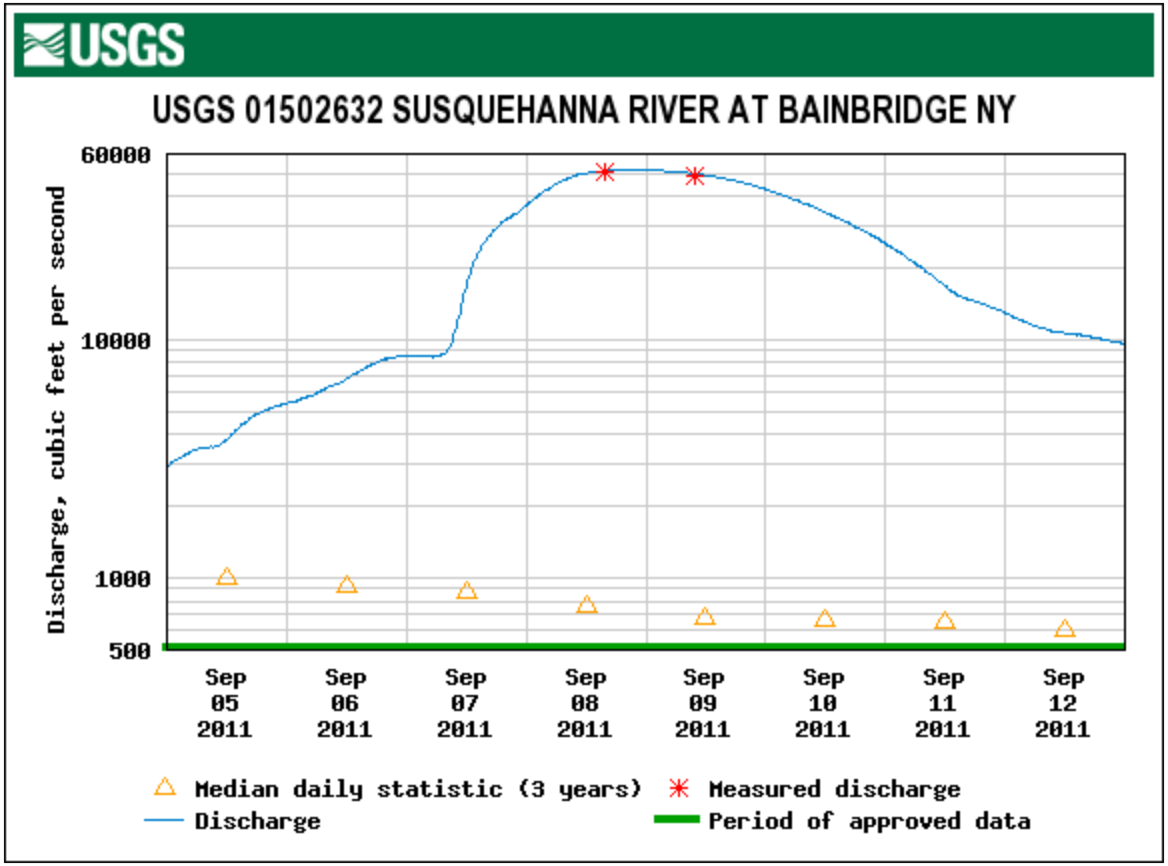


Created By: Richard R. Shaker, Ph.D.
Binghamton University, State University of New York

Data Sources: NYSDEC, USDA, USGS, ESRI
Projection: NAD 1983 UTM Zone 18N

Drainage area: 1,720 Mi Sq.

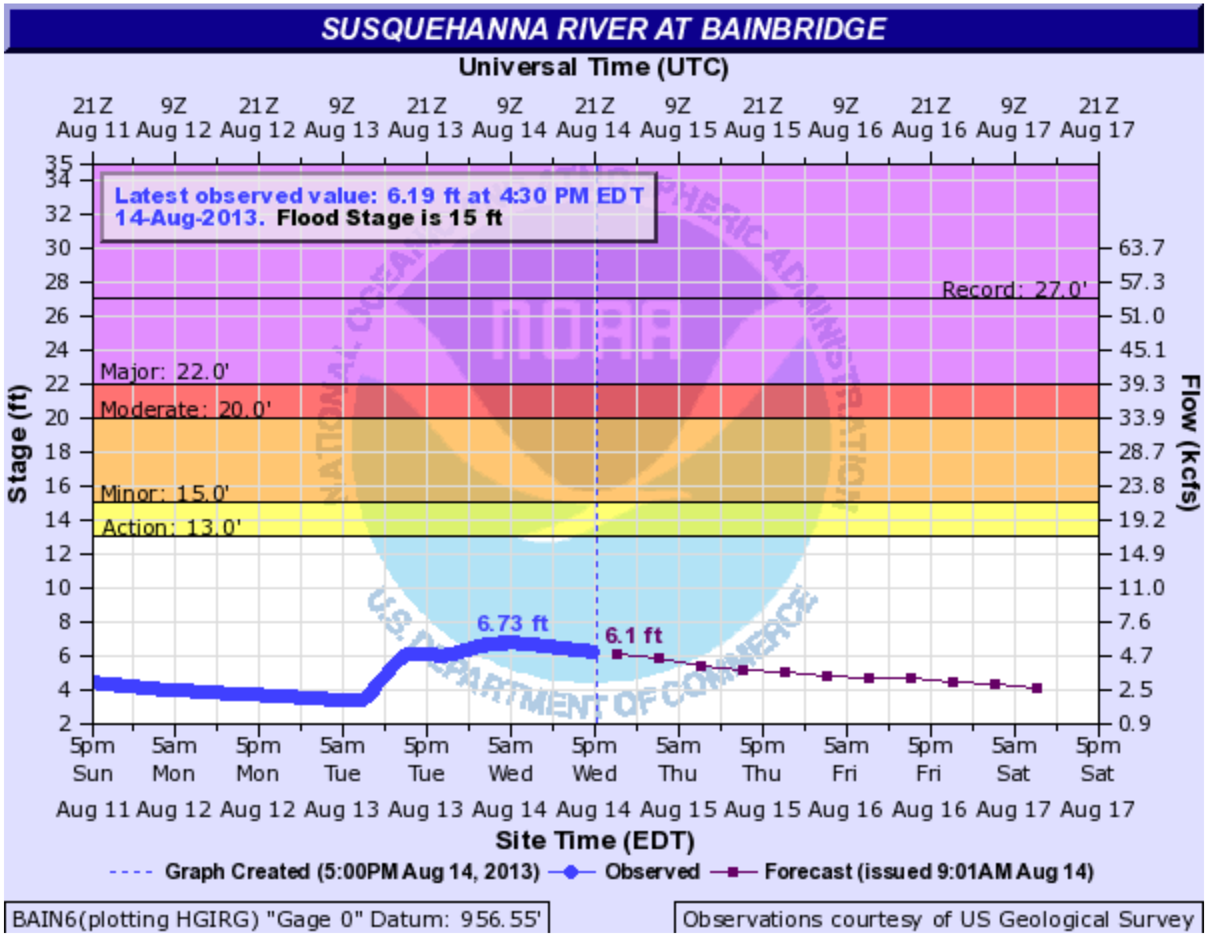
Nearest Gauging Station



Extreme records (June 29, 2006): Maximum discharge, 58,700 Cu. ft./sec.
Gage height, 27.05 ft.
(Sept. 9, 2011): Maximum discharge, 48,300 Cu. ft./sec.
Gage height, 26.2 ft.

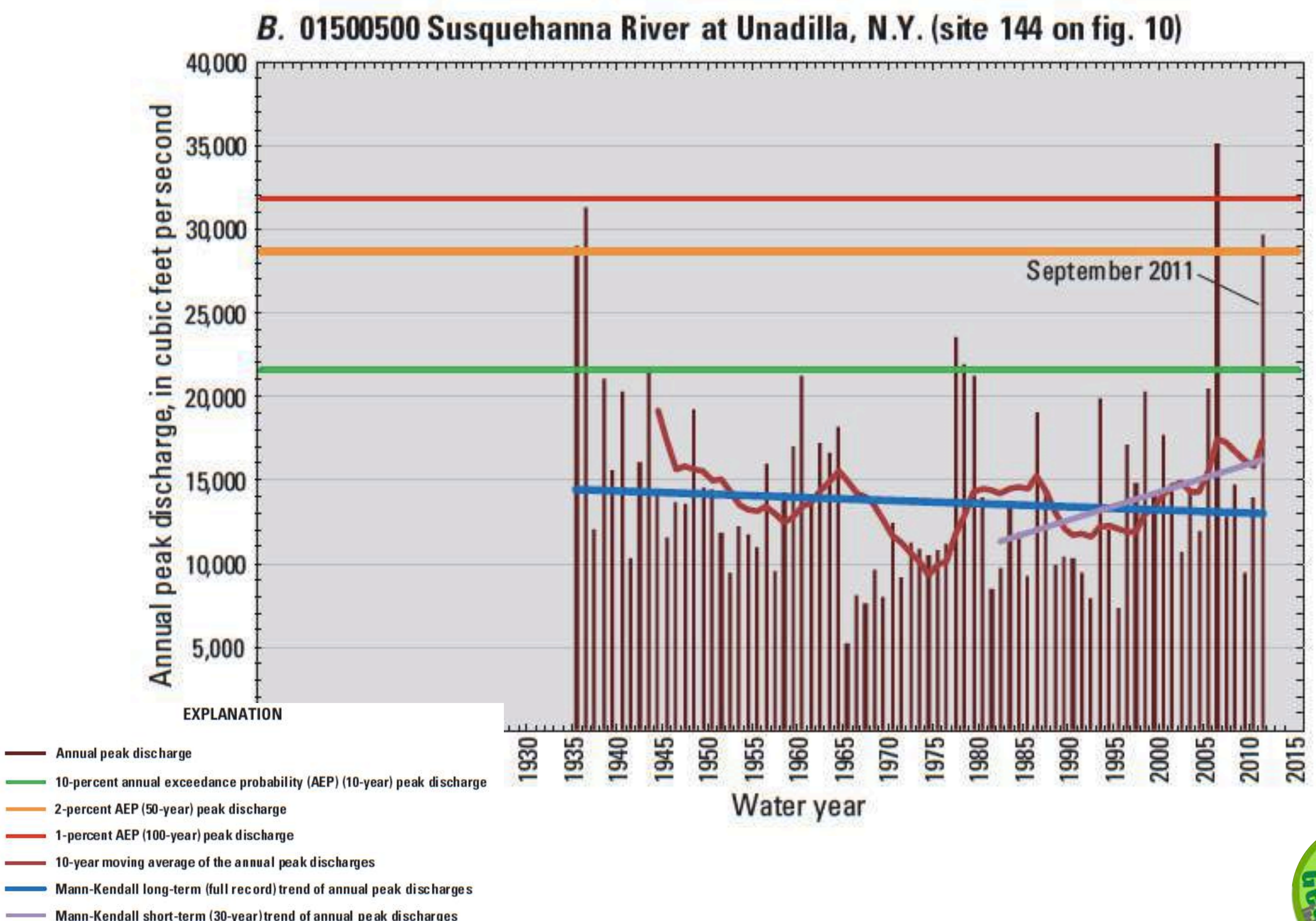
Afton, NY

Nearest Gauging Station



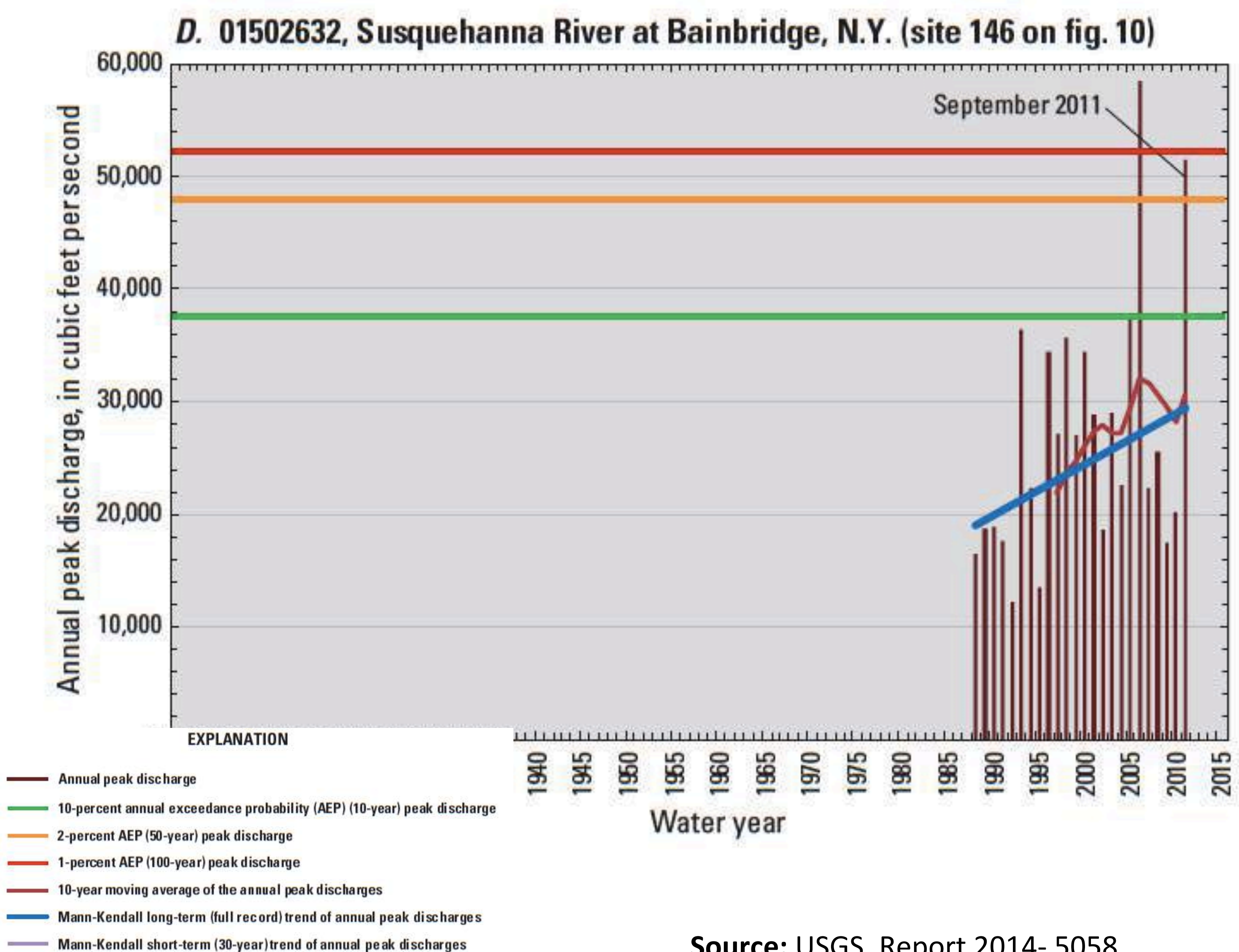
Top five stages: 6/29/2006 (27.05ft), 9/8/2011 (26.20ft), 3/29/1914 (23.10ft), 3/15/1977 (22.20ft), 3/1/1910 (22.10ft)

Flood Frequency



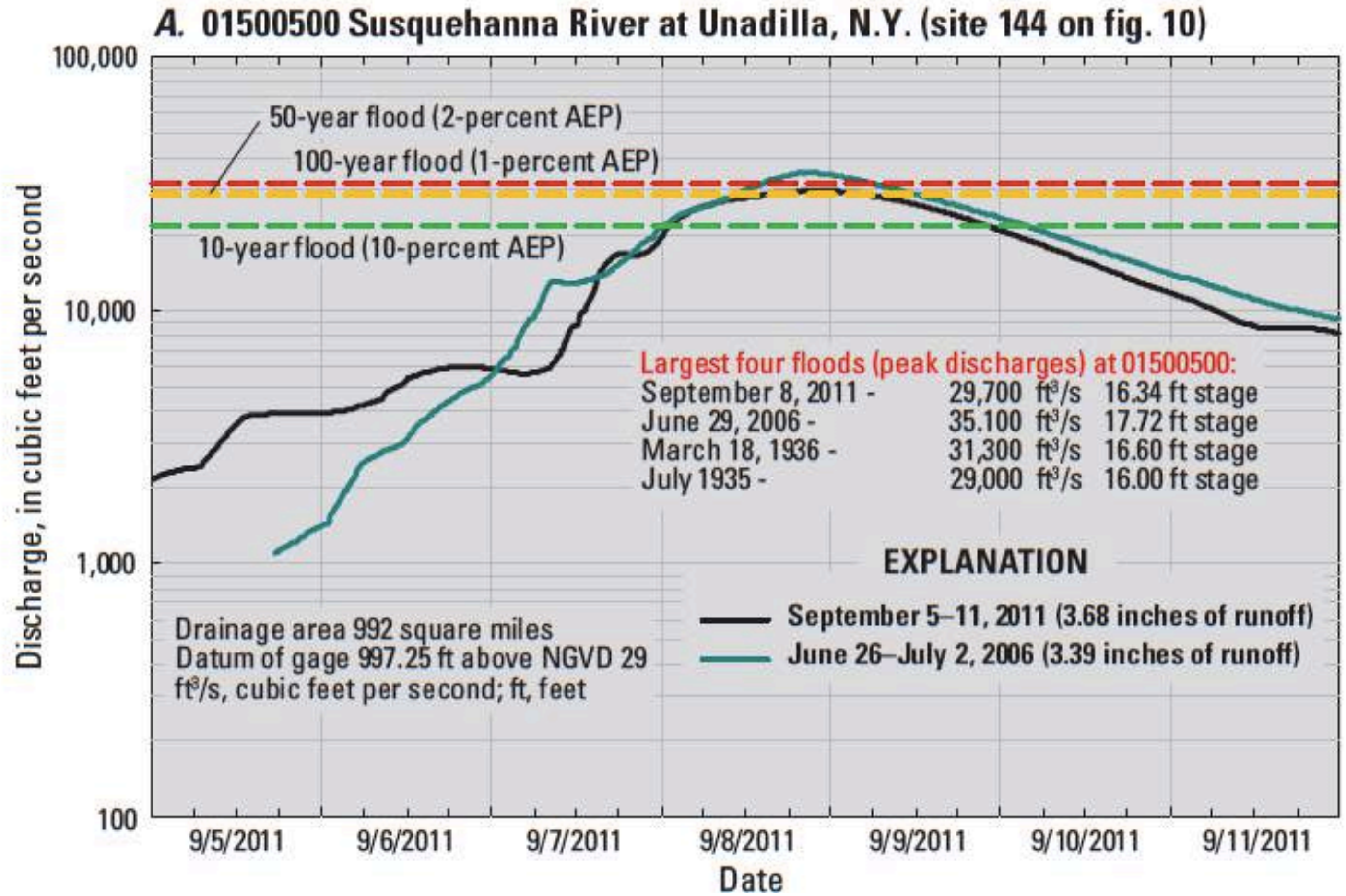
Source: USGS, Report 2014- 5058

Flood Frequency



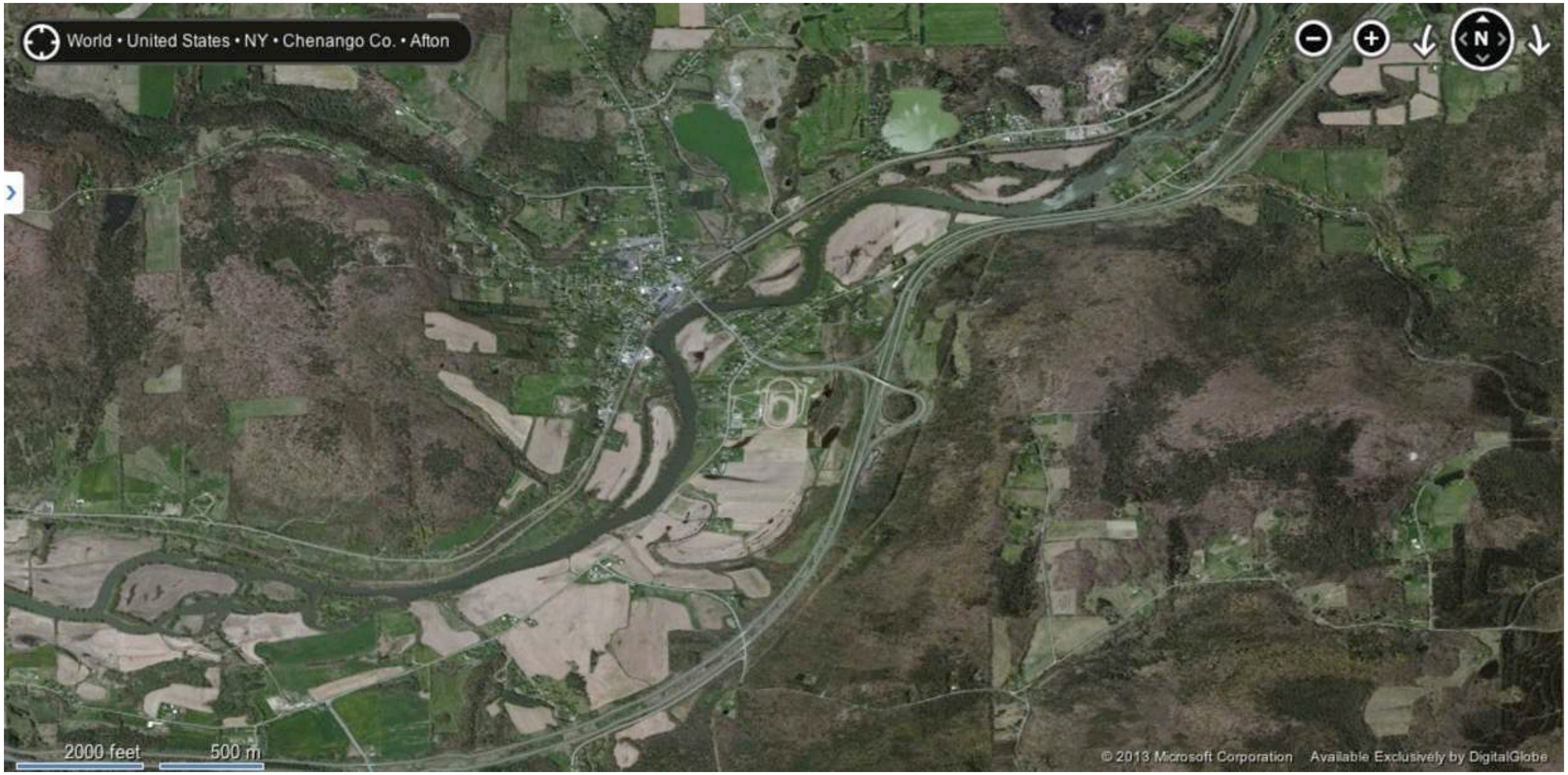
Source: USGS, Report 2014- 5058

Flood Frequency

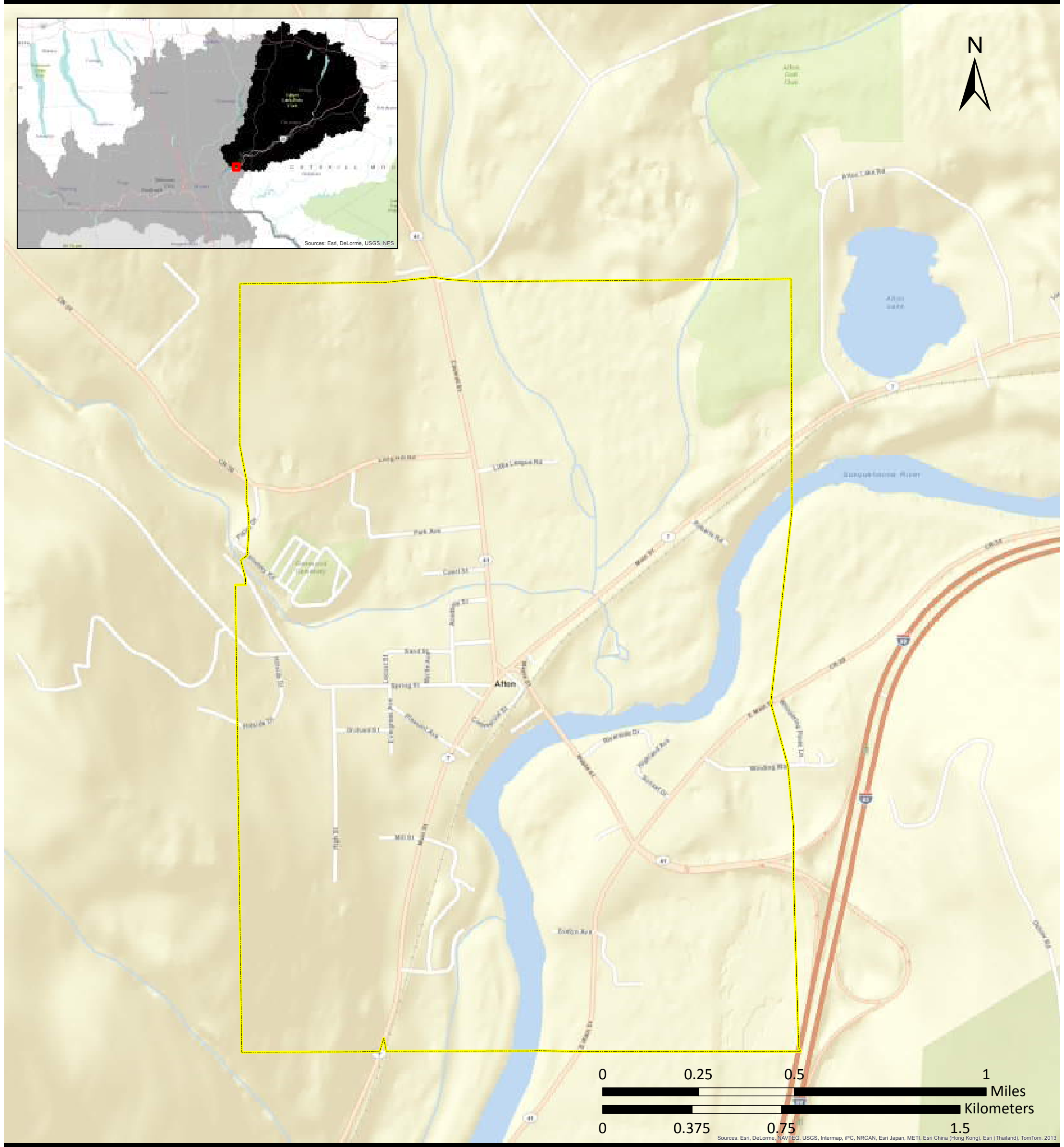


Source: USGS, Report 2014- 5058

Afton Aerial Photography



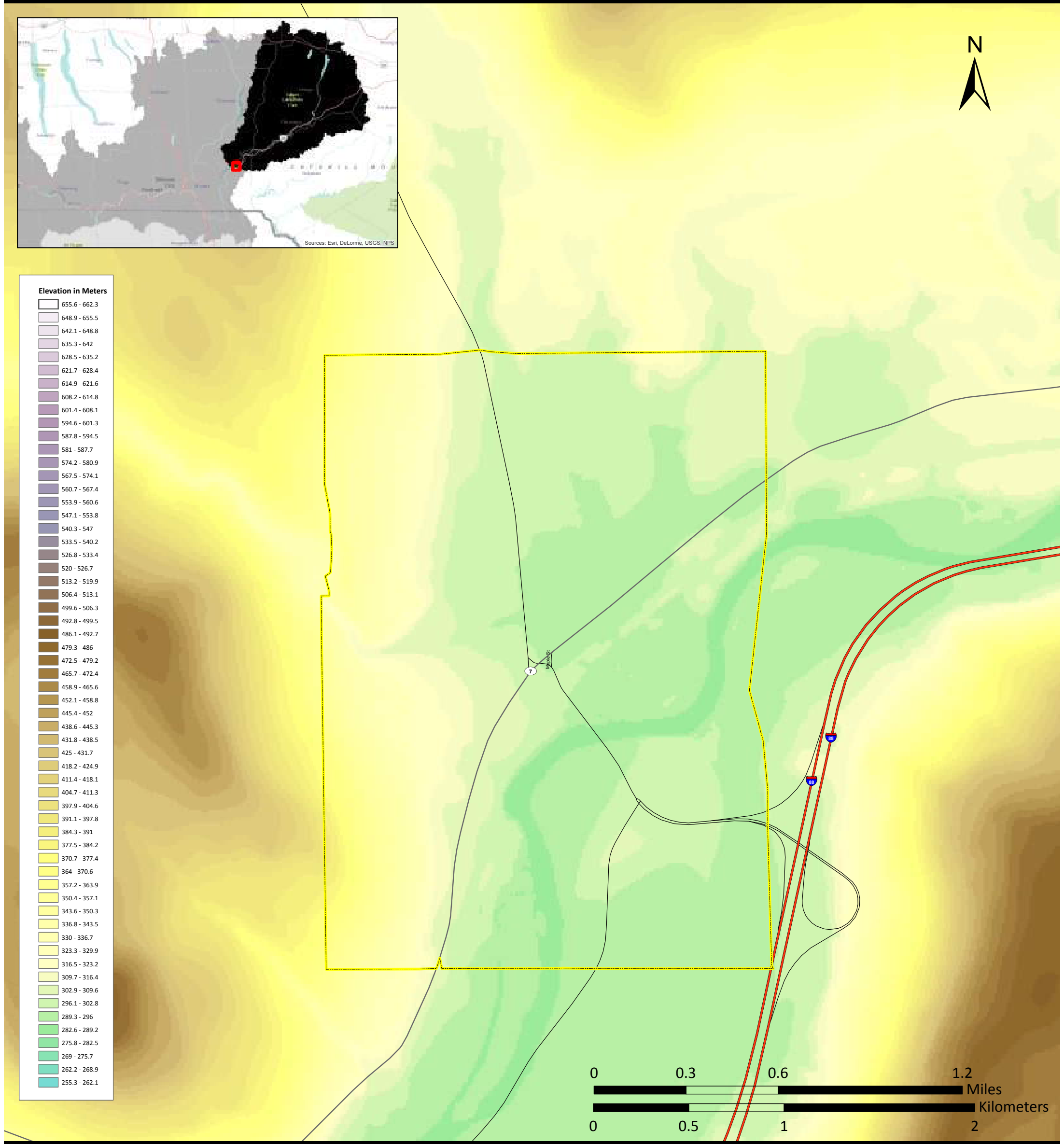
Street Map & Village Limits: Afton, NY



Created By: Richard R. Shaker, Ph.D.
Binghamton University, State University of New York

Data Sources: NYSDEC, USDA, USGS, ESRI
Projection: NAD 1983 UTM Zone 18N

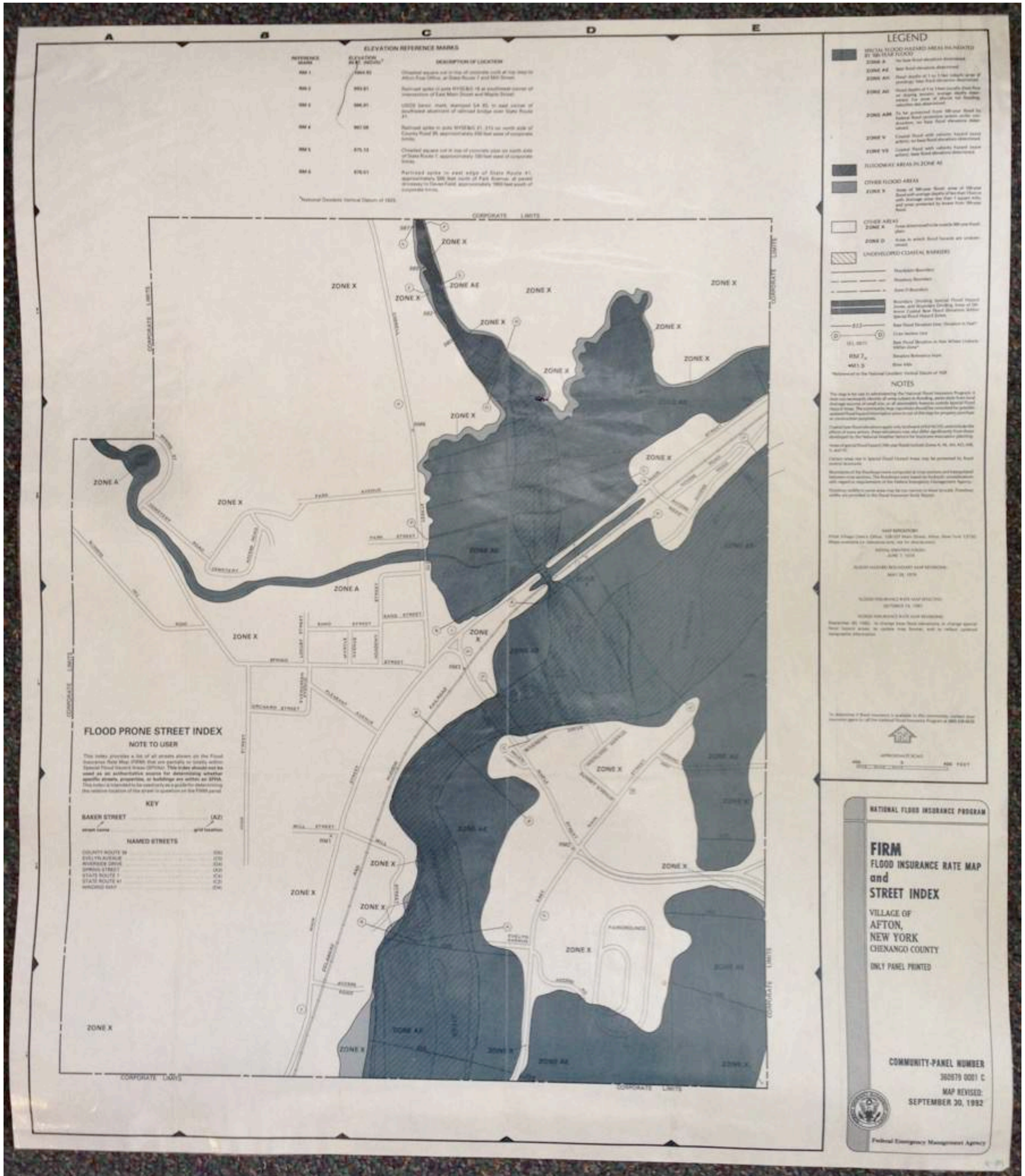
Digital Elevation (10 x 10m): Afton, NY



Created By: Richard R. Shaker, Ph.D.
Binghamton University, State University of New York

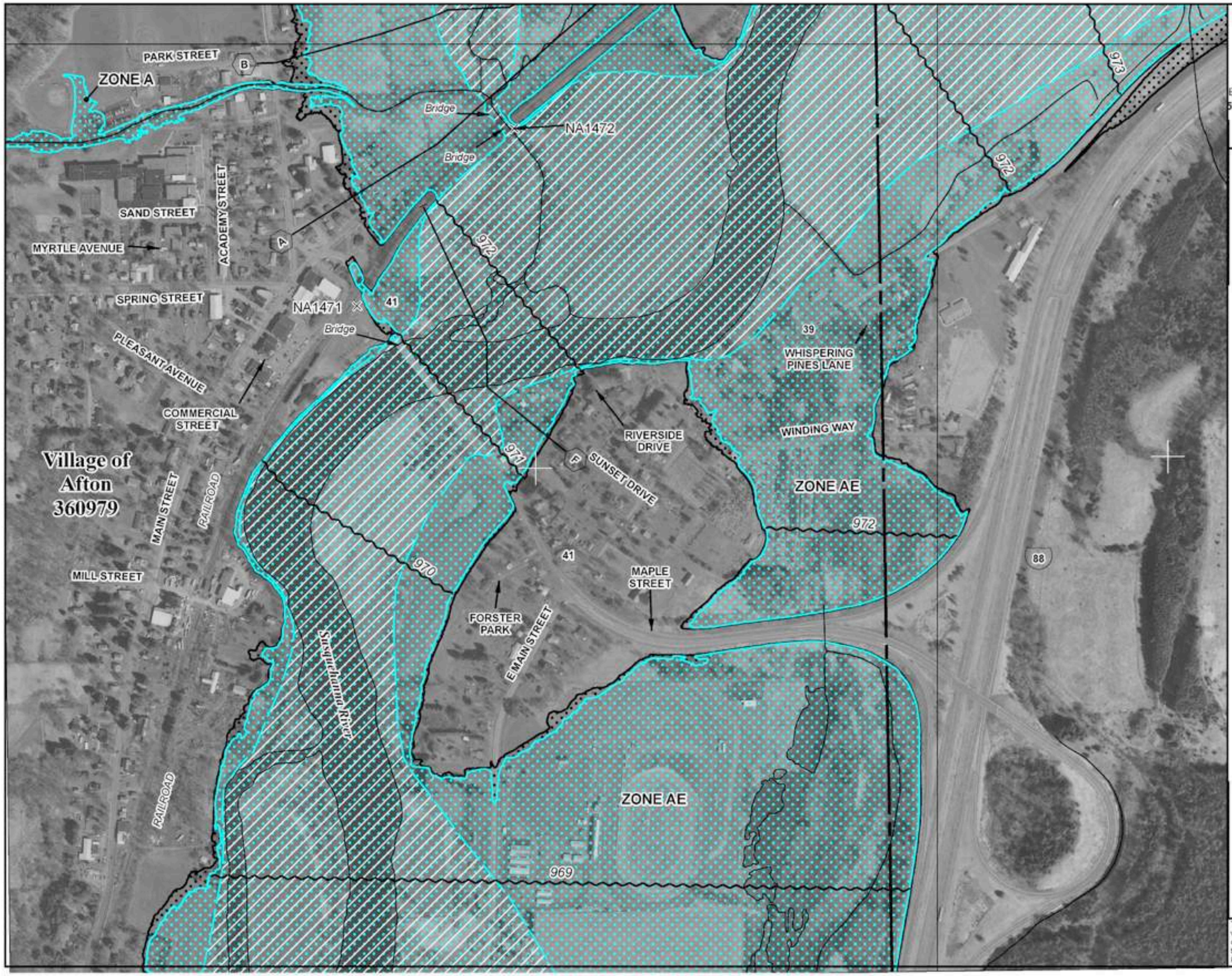
Data Sources: NYSDEC, USDA, USGS, ESRI
Projection: NAD 1983 UTM Zone 18N

Afton, NY



ELEVATION REFERENCE MARKS
LEGEND
NOTES
CORPORATE LIMITS
ZONE X
ZONE AE
ZONE A
FLOOD PRONE STREET INDEX
NOTE TO USER
KEY
NAMED STREETS
NATIONAL FLOOD INSURANCE PROGRAM
FIRM
FLOOD INSURANCE RATE MAP
and
STREET INDEX
VILLAGE OF
AFTON,
NEW YORK
CHENANGO COUNTY
ONLY PANEL PRINTED
COMMUNITY-PANEL NUMBER
MAP REVISED:
SEPTEMBER 30, 1992
Federal Emergency Management Agency

Afton, NY



MAP SCALE 1" = 500'

250 0 500 1000 FEET

50 0 150 300 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0582E

FIRM

FLOOD INSURANCE RATE MAP

for CHENANGO COUNTY, NEW YORK (ALL JURISDICTIONS)

CONTAINS:

COMMUNITY	NUMBER
AFTON, TOWN OF	361084
AFTON, VILLAGE OF	360979

PANEL 582 OF 608

MAP SUFFIX: E

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER 36017C0582E

EFFECTIVE DATE NOVEMBER 26, 2010

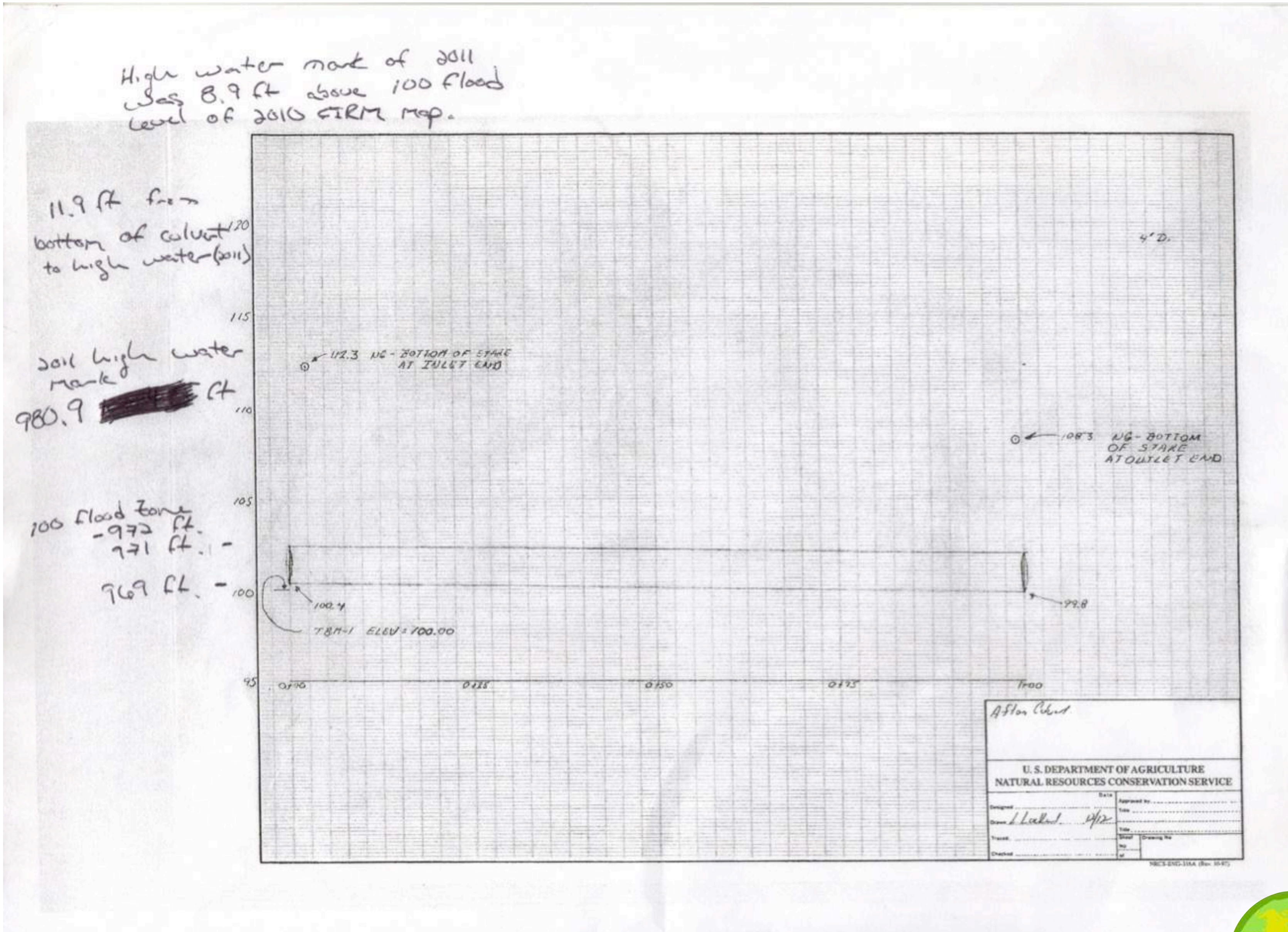
Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

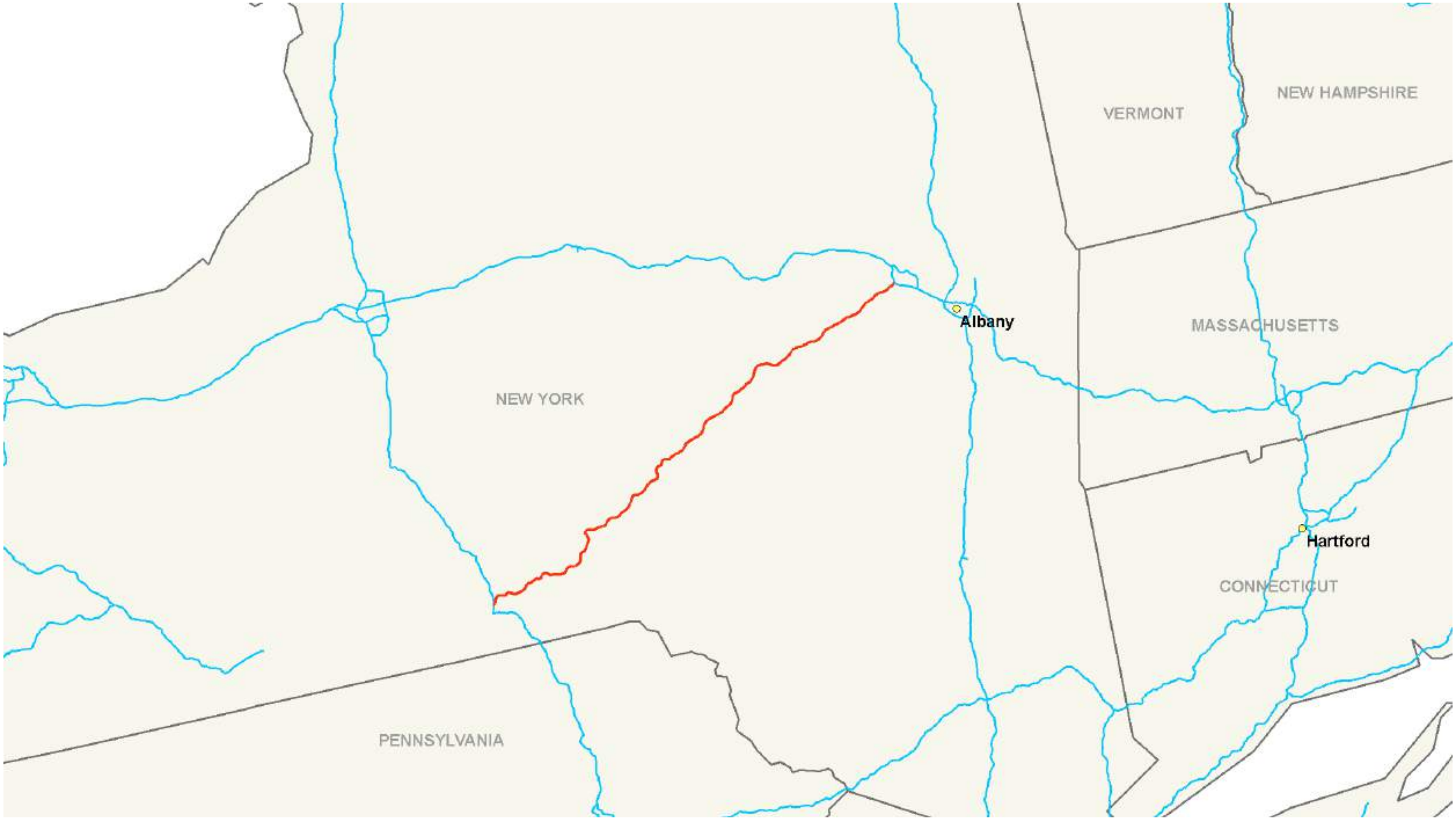
Afton, NY

N
© 2013 Google
Image Landsat
Image NOAA
Google earth
2006
Imagery Date: 4/9/2013 42°13'27.78" N 75°30'57.56" W elev 295 m eye alt 364 m

Afton, NY


High water mark of 2011
was 8.9 ft above 100 flood
level of 2010 FIRM map.
11.9 ft from
bottom of culvert
to high water (2011)
2011 high water
mark
980.9 [redacted] ft
100 flood zone
-972 ft.
971 ft.
969 ft.
120
115
110
105
100
95
112.3 NG - BOTTOM OF STAKE
AT INLET END
108.3 NG - BOTTOM
OF STAKE
AT OUTLET END
4' D.
100.4
99.8
TBM-1 ELEV = 100.00
0+00
0+25
0+50
0+75
1+00
Afton Culvert
U. S. DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE

I-88 (Assigned 1968 – Completed 1989)



Source: http://en.wikipedia.org/wiki/
Interstate_88_(New_York)#cite_note-20

NEPA (1970) & EIS

The National Environmental Policy Act (NEPA) requires federal agencies to integrate environmental values into their decision making processes by considering the environmental impacts of their proposed actions and reasonable alternatives to those actions.

To meet NEPA requirements federal agencies prepare a detailed statement known as an **Environmental Impact Statement (EIS)**. EPA reviews and comments on EISs prepared by other federal agencies, maintains a national filing system for all EISs, and assures that its own actions comply with NEPA.

Source: http://en.wikipedia.org/wiki/National_Environmental_Policy_Act

Outline:

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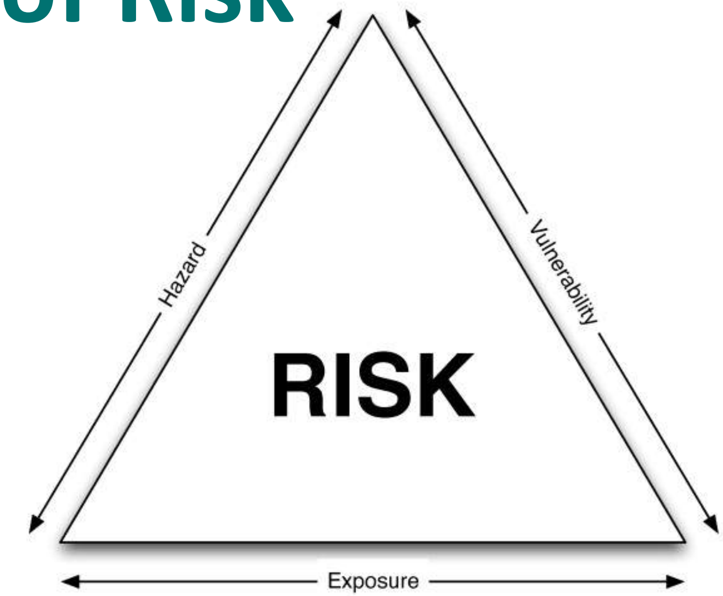
Vulnerability, Hazards, & Exposure as Elements of Risk

- **Risks** associated with natural hazards can be understood as an interaction of **hazards**, **exposure**, and **vulnerability** forming a 'risk triangle' (Crichton, 1999; 2007).



- Risk associated with some particular hazard lies in the consequences of that hazard, and increases through **probability**, **severity**, and **exposure**.

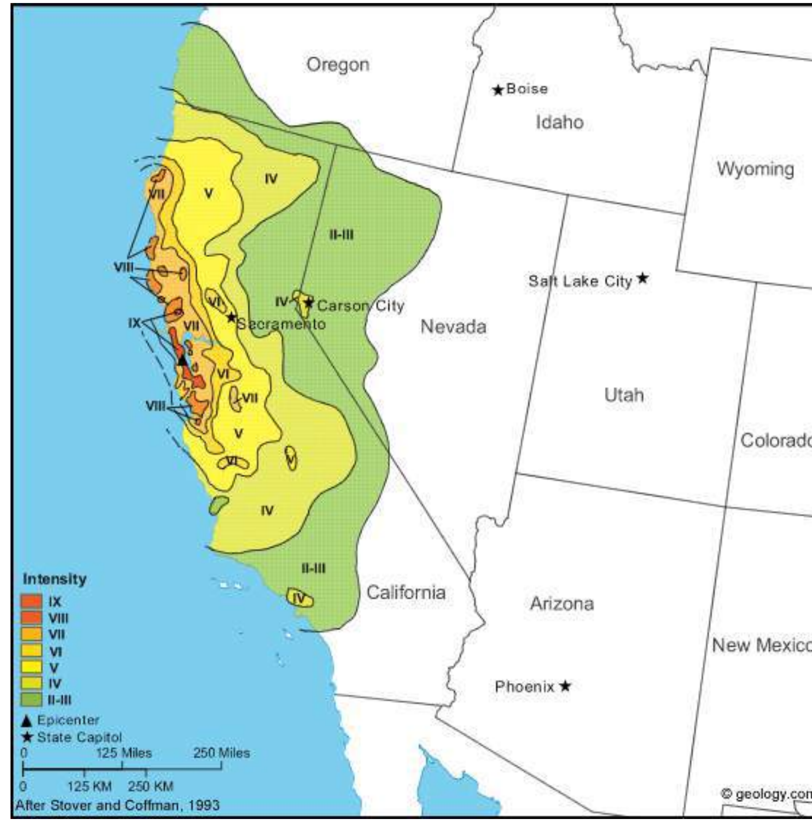
For further clarity this graphical Representation is also expressed as the following function:

Risk: [*F*]: {exposure, hazards, vulnerability}

Hazard

- **<u>Hazard</u>**: is the inherent danger associated with a potential environmental problem (e.g., heat, landslide, earthquake).

- It includes regional susceptibility as well as relative hazard of specific areas with the region.



San Francisco Earthquake
Magnitude 7.8
18 April 1906

Exposure

- **Exposure**: is the human population, ecological resources, or property exposed to the hazard.

Rikuzentakata, Japan (2011)

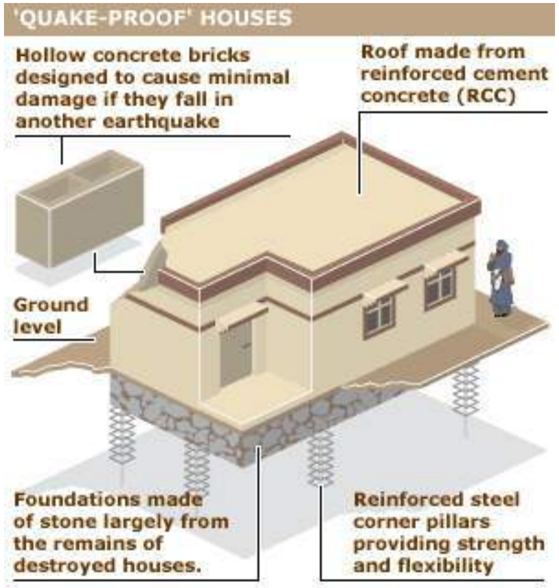
Marina Beach, Chennai, India (2004)

New Orleans (2005)

Vulnerability

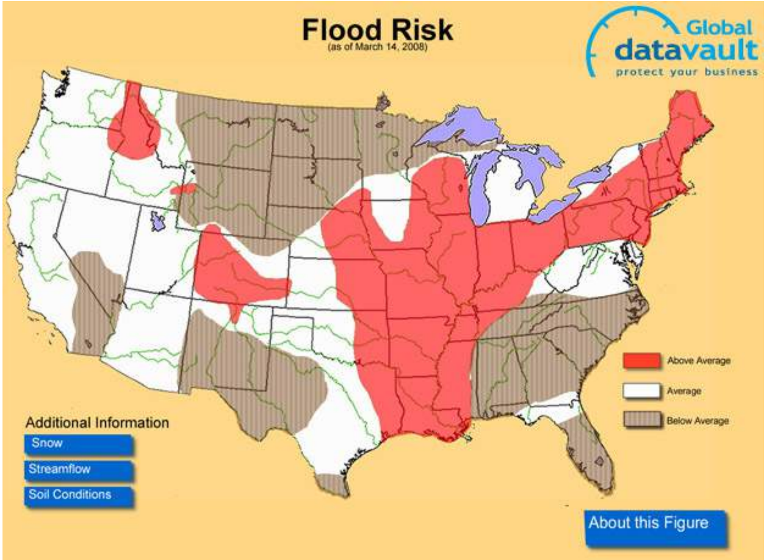
- **Vulnerability**: is the unprotected nature of the exposure.

- **Vulnerability**: can be reduced by engineering design (e.g., floodproofing, earthquake resistant design, heating and air conditioning systems to temper extreme heat and cold.



Risk

- **Risk**: is the probable degree of injury and damage likely to occur from exposure of people and property to the hazard over a specific time period.



- **Risk analysis**: involves combining (or overlaying as maps) assessment of relative hazard, exposure, and vulnerability, as well analyzing the probability of occurrence.

Mitigating Hazards

- **<u>Hazard mitigation</u>**: is the long-term reduction of the effects of natural hazard events.

- ***Mitigation*** is applied to many aspects of environmental planning and management.

- **Hierarchy of Environmental Impact Mitigation Strategies**
  - 1. **Avoid the impact** (move away altogether).
  - 2. **Lessen the impact by modifying location on site** (move away to lesser impact area).
  - 3. **Lessen the impact by modifying design** (apply engineering or design features).
  - 4. **Offset the impact** (compensate for the impact by monetary relief, reconstruction, re-creation).

Flood Hazard Mitigation

- **Structural Measures**
  - Guide floodwaters by building levees, floodwalls, channel enlargement (flood protection).
  - Flood abatement; lessen floodwaters (peak discharge) through upland runoff control measures, including detention (dams, reservoirs).
  - Adjust site characteristics by elevating sites with fill material.
  - Adjust building characteristics by elevating and floodproofing structures and related infrastructure.

Minimizing Flood Hazards

- 19th century humans have responded to floods by attempting to prevent them by modifying streams and rivers (e.g., dams, levees).
- Flood-control projects lure more people to the floodplain.
  - We have yet to build a dam or channel capable of controlling the heaviest runoff; when structure fails flooding is extensive (OEP 1972; Mount 1997).
- **Physical Barriers** include:
  - Earthen levees
  - Concrete flood walls
  - Reservoirs to store water for later release at safe rates
  - On-site storm water retention basins
- Potential benefits are often lost because of increased development in upper watersheds and floodplains.

"Hard-Path" Solutions

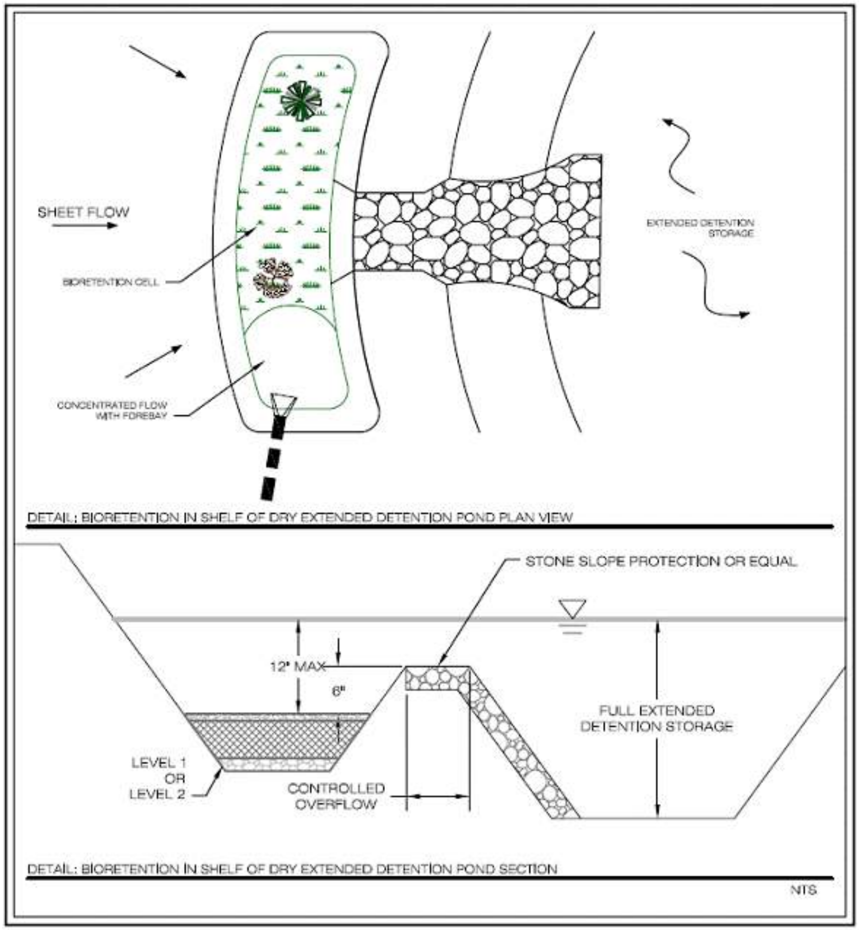
- "Hard-path" water management (Gleick 2003)- including structures for water supply, recreation, irrigation, power generation, and flood control- has also increased water scarcity throughout the world (Schneider 2010).

Culvert

- A ***culvert*** is a control structure that is normally constructed so channel flow can pass under a road.
  - Can act like:
    - Weir, flume, pipe, or channel

- Culverts often cause the flow upstream of structure to rise above normal ***stage***.
  - This phenomenon is called a ***backwater***.

Reservoirs & Spillways



Reservoirs & Spillways

- The "permanent" pool of water that is formed up to the ***principle spillway*** is usually sized based on:
  - Sediment inflow during the life of the impoundments;
  - Recreational needs;
  - Water supply requirements.

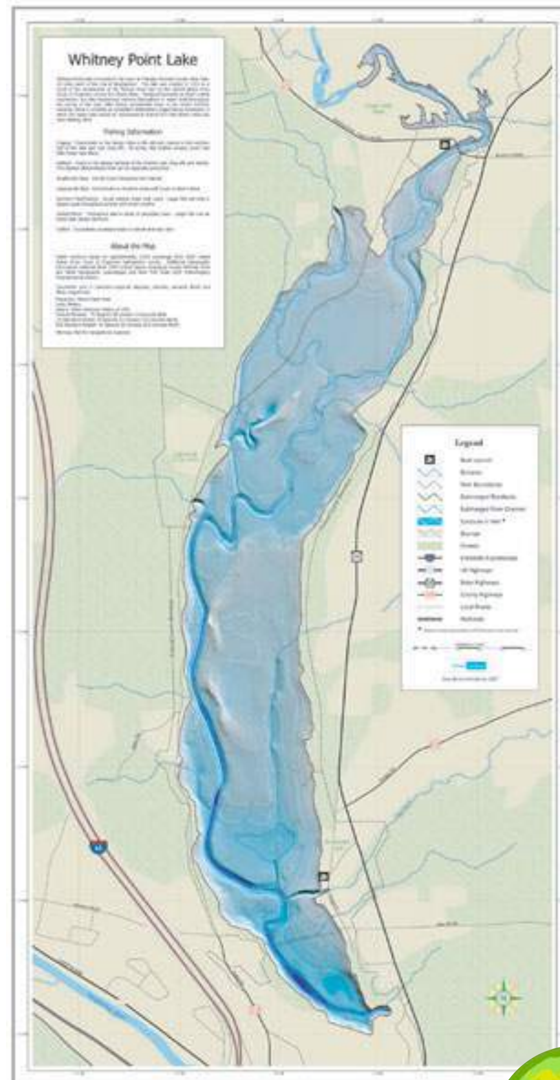
*Note: Water is lost due to:

-- Evaporation

-- Seepage

-- Pumped withdrawals

-- Storage lost from sediment inflows

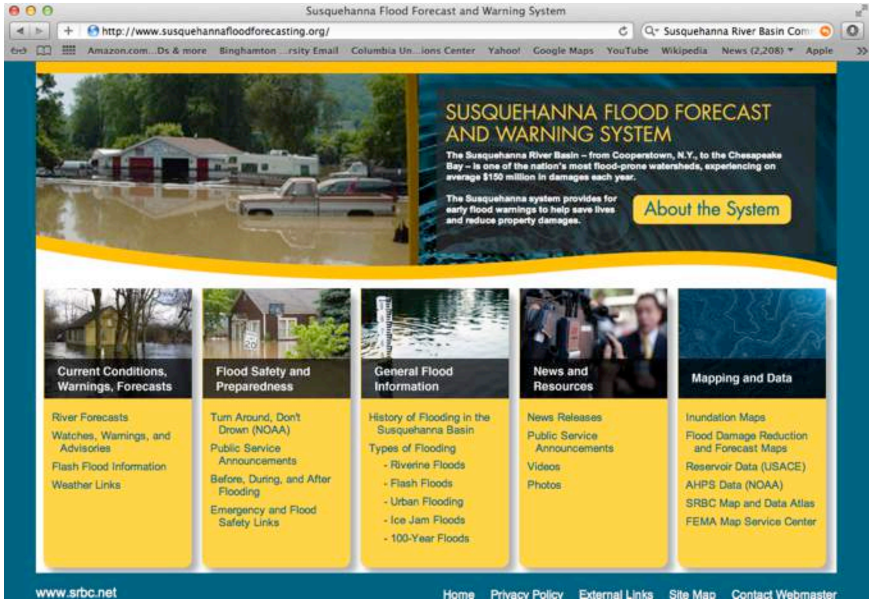


Flood Hazard Mitigation

- **Non-structural Measures**
  - Provide emergency preparedness measures, such as flood warnings.
  - Provide relief through private and federal disaster assistance.
  - Provide information; maps of flood plans and information about flood risks and safe floodplain building practices.
  - Adjust future land use by floodplain planning, vacant land acquisition, and regulatory zoning.
  - Adjust existing land use by acquiring and relocating buildings.
  - Provide affordable insurance for flood damages.

"Soft-Path" Solutions

- Typical "soft-path" flooding reduction approaches include:
  - altering upstream land management practices,
  - establishing zoning regulations to constrain floodplain development,
  - using Multi-Criteria Decision Support Systems (MCDSS) for flood management, emergency flood response, and recovery from flooding events (Levy et al. 2007).



Susquehanna Flood Forecast & Warning System

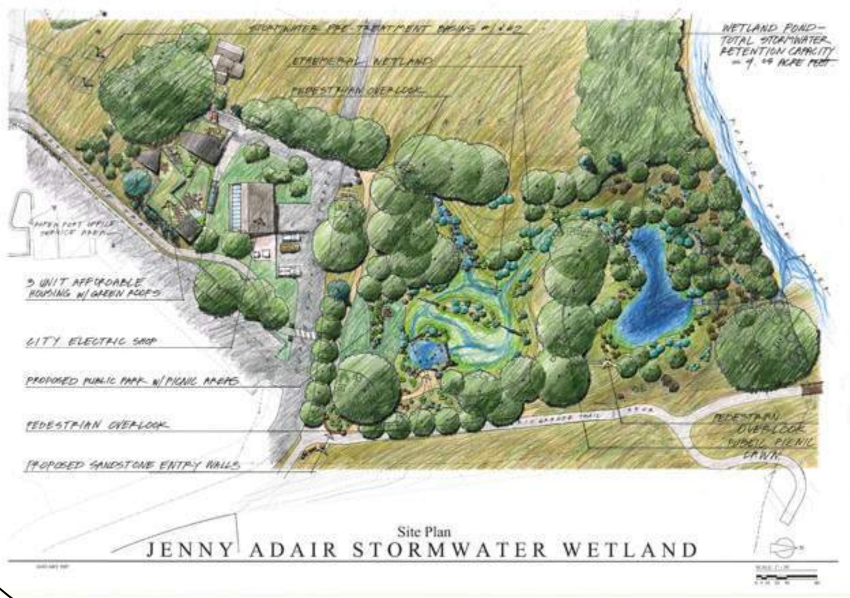
Best Management Practices (BMPs)

- **Best Management Practices** (**BMP**) are water pollution control mechanisms.
- To reduce stormwater runoff to municipal sewage centers; albeit BMPs may refer to principal control or treatment techniques.
- **BMPs** first appeared in CWA in 1987 for reducing Nonpoint Source Pollutants.
- Addendum to CWA in 2001 for reducing stormwater runoff with BMPs

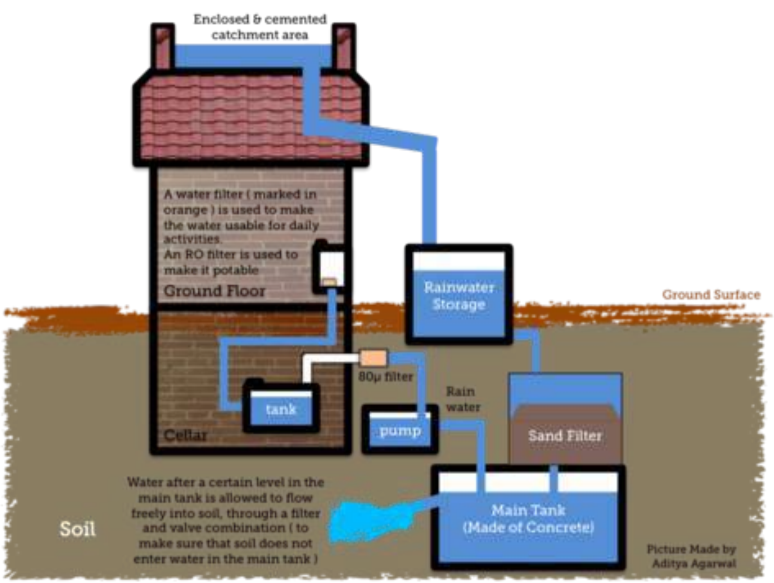
Downspout Disconnects

Rain gardens/barrels

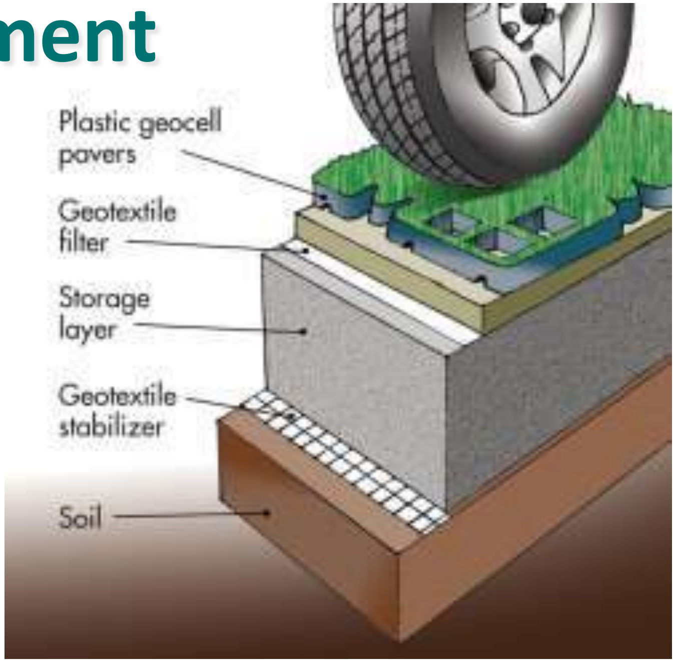
Bioretention Basins/Wetlands



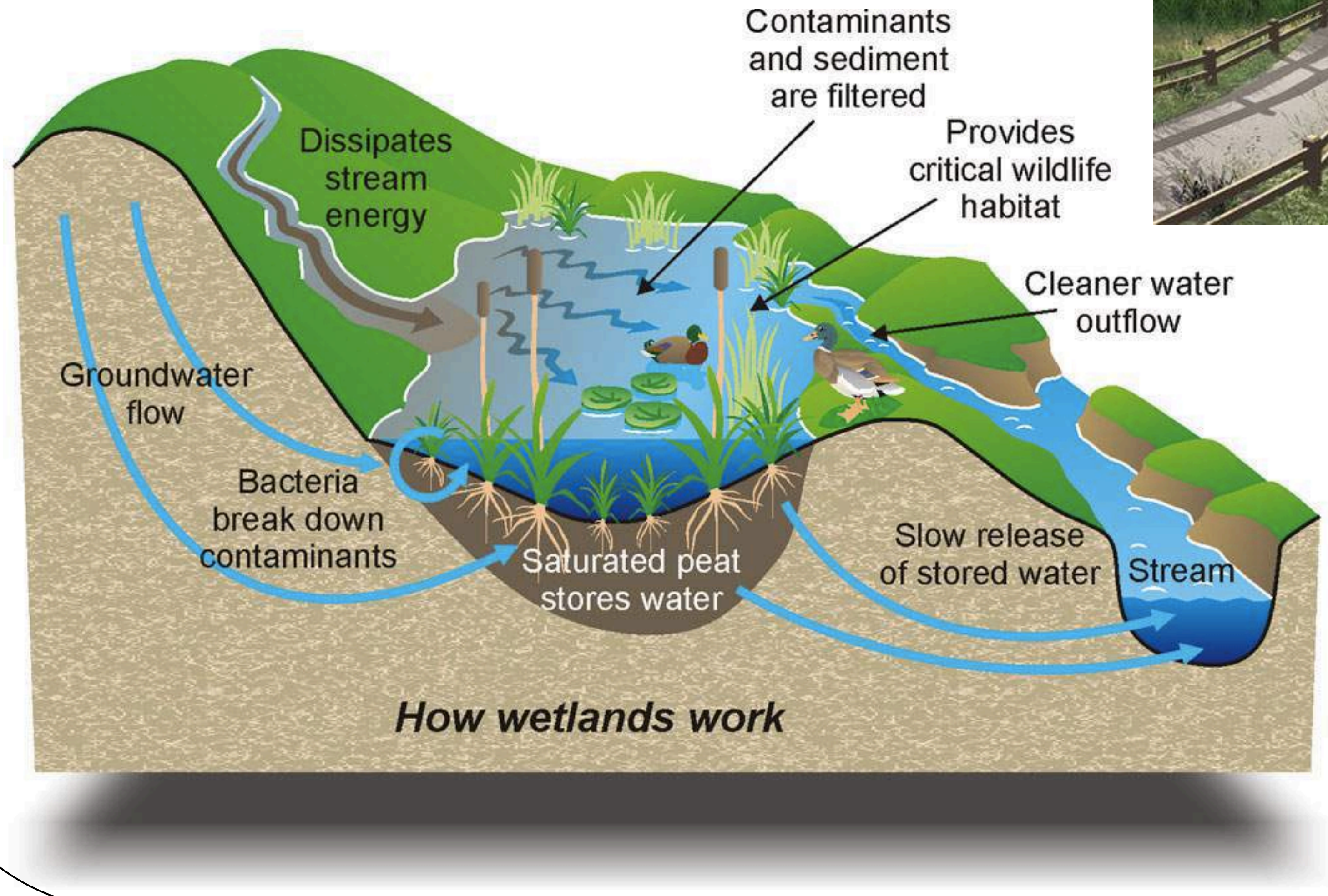
Rainwater Harvesting



Porous Pavement



Wetland Restoration



Relocate Flooded Properties

FEMA

Village Locals Reflect
Moving Was Best Flood Protection

Village of Soldiers Grove, WI – In August 2007, the biggest flood in the history of Soldiers Grove came roaring through the village. The Kickapoo River quickly topped the levees, and water didn't recede for about 10 days. Years earlier the center to the town had been moved.

Residents experienced floods in 1907, 1912, 1917, 1935, 1951, and the "big one" in 1978. From 1969 to 2007, the state had 25 nationally declared flood disasters in 38 years. The flood of record in 2007 inflicted the worst damage in the state just 10 miles downstream in Gays Mills.

"The Kickapoo can turn into a wild river. I don't know how we escaped all the floods without loss of life. We had a lot of good people, fire crews, and emergency management crews out there working evacuations and rescues," stated Jerry Moran, Crawford County Sheriff. "Each time there was very little advance warning. People woke up at night with three to four inches of water already in their homes."

Local debate about what to do about the flooding began to swell in the mid-60s when the U.S. Army Corps of Engineers proposed an upstream dam and a new levee for the village. The costs to the village exceeded their ability to pay. The unprecedented move of their downtown, surrounded on three sides by the river, to higher ground began to make financial sense.

Environmentalists were fighting against the Corps over the dam, and the maintenance of the levee was going to cost the village nearly all of their annual tax revenues. By 1975, a small Comprehensive Employment and Training Act grant paid for a relocation coordinator. By 1976 the village took the unprecedented move of passing a resolution that supported relocation to avoid future flood disasters.

The flood of July 1978 made things happen. On July 7, 1978 a federal disaster declaration made federal funds available to flood-proof the village. Local planners convinced state and federal officials moving the town was the best flood-proofing and eventually received their first federal grant of $900,000 from HUD's Community Development Block Grant to get the project moving – acquire flood prone properties, clear the area, demolish old properties, and rebuild the town uphill.

By 1983 the $6 million relocation project was done. According to Hirsch, in 1979 the village wanted to "help the US reduce its dependency on foreign oil" so the village incorporated solar heating in the new buildings, subsequently dubbed Solar Village.

"Since the buildings have solar heating they are insulated a lot better. If I get a good day of sun, I'll get three days of heat. It's clean. I've never had to paint because of dirt from the system," Young noted.

Locals have witnessed a moderate population growth to over 600 with new businesses and the expansion of older ones. "If Soldiers Grove stayed in the floodplain, it would have been a stagnant community; it would have still existed, but stagnant. All the new businesses would have not happened if we were still over there," Moran stated.

"The recent August 2007 flood devastation reinforced that we did the right thing. I don't ever want to go through another flood like 1978," added Young.

Crawford County, Wisconsin

Quick Facts

Year:
1978

Sector:
Public/Private Partnership

Cost:
$6,000,000.00 (Estimated)

Primary Activity/Project:
Flood-proofing

Primary Funding:
Local Sources