5.4.8 Wildfire

The following section provides the hazard profile (hazard description, location, extent, previous occurrences and losses, probability of future occurrences, and impact of climate change) and vulnerability assessment for the wildfire hazard in Dutchess County.

5.4.8.1 Profile

Hazard Description

According to the New York State Hazard Mitigation Plan (NYS HMP), wildfire is defined as an uncontrolled fire spreading through natural or unnatural vegetation that often has the potential to threaten lives and property if not contained. Wildfires that burn in or threaten to burn buildings and other structures are referred to as wildland urban interface fires. Wildfires include common terms such as forest fires, brush fires, grass fires, wildland urban interface fires, range fires or ground fires. Wildfires do not include those fires, either naturally or purposely ignited, that are controlled for a defined purpose of managing vegetation for one or more benefits (NYS DHSES, 2014).

Wildfire in New York State is based on the same science and environmental factors as any wildfire in the world. Fuels, weather, and topography are the primary factors that determine the natural spread and destruction of every wildfire. New York State, including Dutchess County, has large tracts of diverse forest lands, many of which are the result of historic destructive wildfires. Although destructive fires do not occur on an annual basis, the State's fire history shows a cycle of fire occurrence that result in human death, property loss, forest destruction, and air pollution (NYS DHSES, 2014).

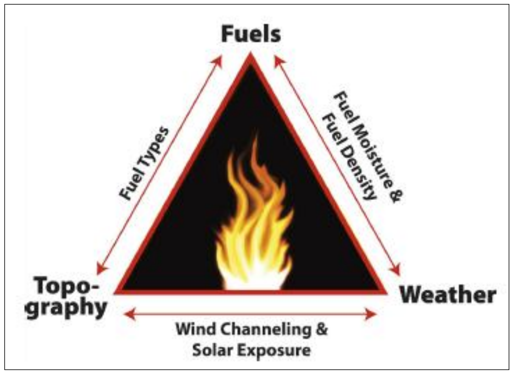
There are three different classes of wildfires: surface fires, ground fires, and crown fires. Surface fires are the most common type and burns along the forest floor, moving slowly and killing or damaging trees. Ground fires are usually started by lightning and burns on or below the forest floor. Crown fires spread rapidly by wind and move quickly by jumping along the tops of trees.

FEMA indicates that there are four categories of wildfires that are experienced throughout the U.S. These categories are defined as follows:

- <u>Wildland fires</u> – fueled almost exclusively by natural vegetation. They typically occur in national forests and parks, where Federal agencies are responsible for fire management and suppression.
- <u>Interface or intermix fires</u> – urban/wildland fires in which vegetation and the built-environment provide fuel
- <u>Firestorms</u> – events of such extreme intensity that effective suppression is virtually impossible. Firestorms occur during extreme weather and generally burn until conditions change or the available fuel is exhausted.
- <u>Prescribed fires and prescribed natural burns</u> – fires that are intentionally set or selected natural fires that are allowed to burn for beneficial purposes (FEMA, 1997).

Fire Ecology and Wildfire Behavior

The "wildfire behavior triangle" illustrates how three primary factors influence wildfire behavior: fuel, topography, and weather. Each point of the triangle represents one of the three factors; the sides represent the interplay between the factors. For example, drier and warmer weather combined with dense fuel loads and steeper slopes will cause more hazardous fires than light fuels on flat ground.



A fire needs all of the following three elements in the right combination to start and grow: a heat source, fuel, and oxygen. The growth of the fire primarily depends on the characteristics of available fuel, weather conditions, and terrain. Climate change is also considered a potential source of influence. These four factors are described below:

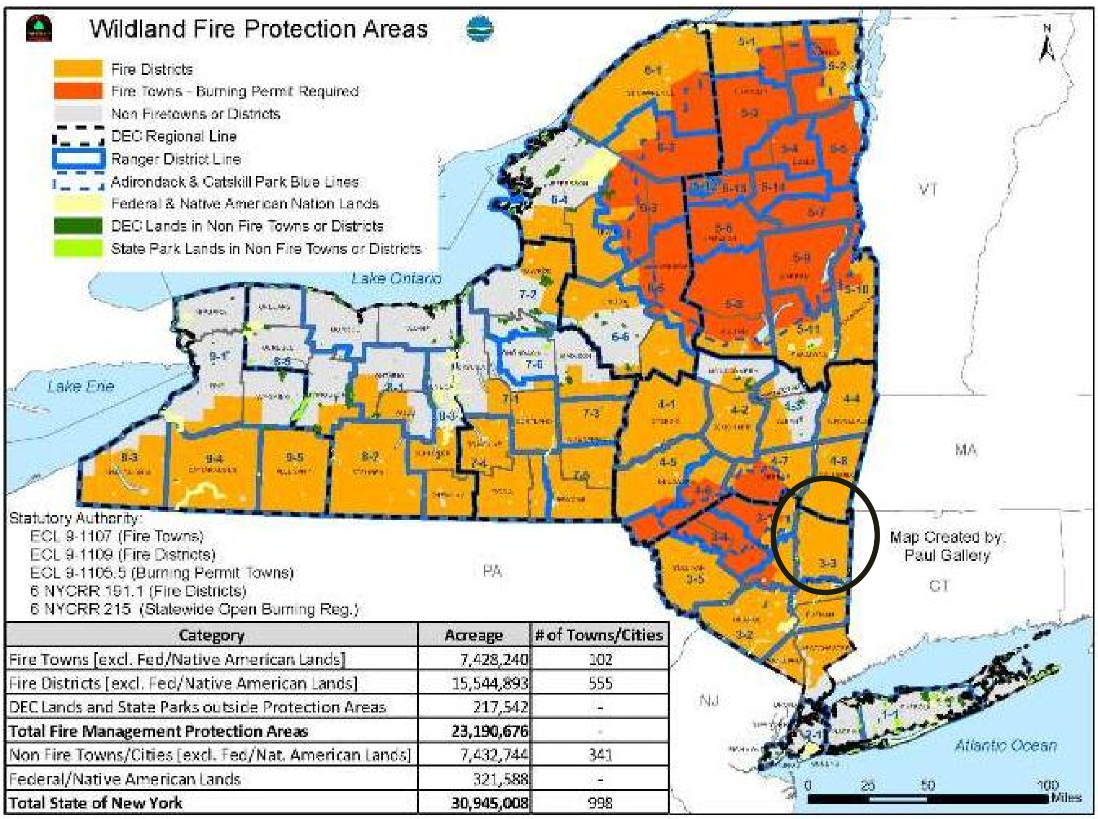
- Fuel
  - Lighter fuels such as grasses, leaves, and needles quickly expel moisture and burn rapidly, while heavier fuels such as tree branches, logs, and trunks take more time to warm and ignite.
  - Snags and hazard trees–especially those that are diseased, dying, or dead—are quickly engulfed and allow fires to spread quickly.
- Weather
  - Strong winds within the vicinity of the flames produce extreme fire conditions. Of particular concern are wind events that potentially persist for longer periods of time, or ones with significant wind speeds, which can sustain and quickly promote the spread of fire through movement of embers or exposure within tree crowns.
  - Spring and summer months, which can experience drought-like conditions extending beyond the normal season, also expand the average fire season. Likewise, the passage of a dry, cold front through the region can result in a sudden increase in wind speeds and a change in wind direction affecting fire spread.
  - Thunderstorm activity, which typically begins with wet storms, turns dry with little or no precipitation reaching the ground as the season's progress.
- Terrain
  - Regional and local topography influence the amount and moisture of fuel.
  - Barriers such as highways and lakes can affect the spread of fire.
  - Elevation and slope of landforms affect fire spread; flames move more easily uphill than downhill.
- Changes to Environment
  - Without an increase in summer precipitation (greater than any predicted by climate models), areas susceptible to future burning are very likely to increase.
  - Infestation from insects is also of concern as it may impact forest health. Potential insect populations may increase with warmer temperatures as a result of warmer temperatures. Infested, stressed trees increase the fuel load.
  - Tree species composition will change as species respond uniquely to a changing climate.
  - Wildfires cause both short-term and long-term losses. Short-term losses can include destruction of timber, wildlife habitat, scenic vistas, and watersheds. Long-term effects include smaller timber harvests, reduced access to affected recreational areas, and the destruction of cultural and economic resources and community infrastructure.

Location

According to the U.S. Fire Administration (USFA), the fire problem in the U.S. varies from region to region. This often is a result of climate, poverty, education, demographics, and other causal factors (USFA, 2013). Wildfires do occur in New York State. Many areas in the State, particularly those that are heavily forested or contain large tracts of brush and shrubs, are prone to fires. New York State has over 18 million acres of non-Federal forested land, along with an undetermined amount of open space and wetlands. The Adirondacks, Catskills, Hudson Highlands, Shawangunk Ridge, and Long Island Pine Barrens are examples of fire-prone areas (NYSDEC 2013).

In New York State, the NYSDEC's Division of Forest Protection (Forest Ranger Division) is designated as the State's lead agency for wildfire mitigation. The Forest Ranger Division has a statutory requirement to provide a forest fire protection system for 657 of the 932 jurisdictions throughout New York State. It includes cities and villages and cover 23.1 million acres of land, including all state-owned land outside of the jurisdictions. The Lake Ontario Plains and New York City-Long Island areas are the general areas not included in the statutory requirement. Figure 5.4.8-1 displays the fire protection areas in New York State. This figure indicates that, as of 2015, Dutchess County is located in Fire District 3-3.

Figure 5.4.8-1. Forest Ranger Division Wildfire Protection Areas



Category	Acreage	# of Towns/Cities
Fire Towns [excl. Fed/Native American Lands]	7,428,240	102
Fire Districts [excl. Fed/Native American Lands]	15,544,893	555
DEC Lands and State Parks outside Protection Areas	217,542	-
Total Fire Management Protection Areas	**23,190,676**	
Non Fire Towns/Cities [excl. Fed/Nat. American Lands]	7,432,744	341
Federal/Native American Lands	321,588	-
Total State of New York	**30,945,008**	998

Source: NYSDEC 2015
Note: Dutchess County is indicated by the black oval.

New York State is divided into 10 fire danger rating areas (FDRAs). FDRAs are defined by areas of similar vegetation, climate, and topography in conjunction with agency regional boundaries, National Weather Service (NWS) fire weather zones, political boundaries, fire occurrence history, and other influences. The Forest Ranger Division issues daily fire danger warnings when the fire danger rating is at high or above in one or more FDRAs.

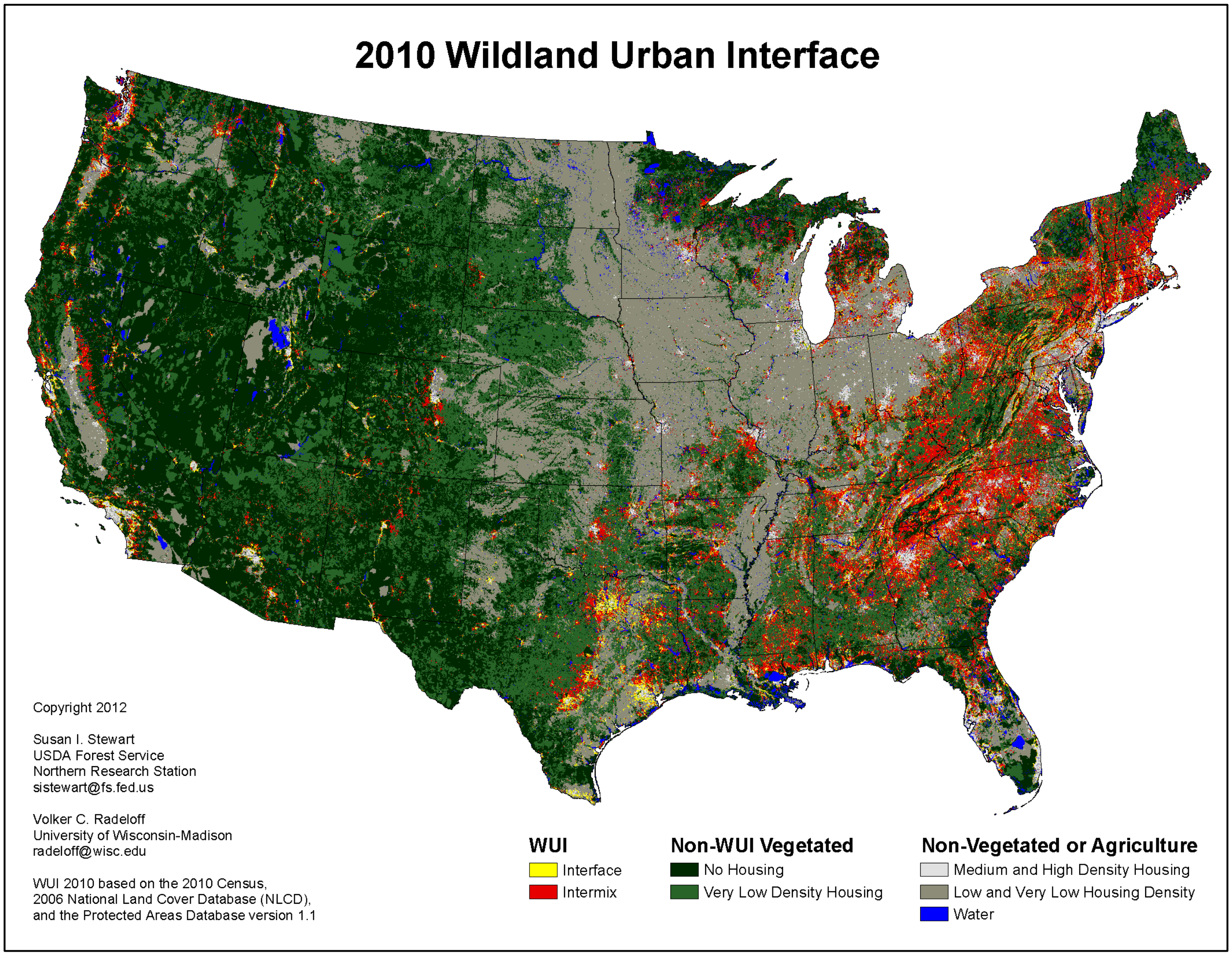
Wildfire/Urban Interface (WUI) in New York State/Dutchess County

Wildland/Urban Interface (WUI) is the area where houses and wildland vegetation coincide. Interface neighborhoods are found all across the U.S., and include many of the sprawling areas that grew during the 1990s. Housing developments alter the structure and function of forests and other wildland areas. The outcomes of the fire in the WUI are negative for residents; some may only experience smoke or evacuation, while others may lose their homes to a wildfire. All states have at least a small amount of land classified as WUI. To determine the WUI, structures per acre and population per square mile are used. Across the U.S., 9.3-percent of all land is classified as WUI. The WUI in the area is divided into two categories: intermix and interface. Intermix areas have more than one house per 40 acres and have more than 50-percent vegetation. Interface areas have more than one house per 40 acres, have less than 50-percent vegetation, and are within 1.5 miles of an area over 1,235 acres that is more than 75-percent vegetated (Stewart et al., 2006).

The NYS HMP indicates that New York State has all three types of WUI interfaces. The Adirondack and Catskill Mountains contain large tracts of forests with the mixed, and to a lesser extent, the classic interface occurring throughout. The remainder of the State contains classic and mixed interfaces with some major cities containing an occluded interface. The population migration from an urban to suburban and rural living will continue, increasing the possibility of loss and/or damage to structures in the WUI. Many property owners are unaware that a threat from a wildfire exists or that their homes are not defensible from it. Water supplies at the scene in the WUI are often inadequate. Access by firefighting equipment is often blocked or hindered by driveways that are either narrow, winding, dead-ended, have tight turning radii or have weight restrictions. Most wildland fire suppression personnel are inadequately prepared for fighting structural fires and local fire departments are not usually fully-trained or equipped for wildfire suppression. Further, the mix of structures, ornamental vegetation and wildland fuels may cause erratic fire behavior. These factors and others substantially increase the risk to life, property and economic welfare in the WUI. While there are many interface communities throughout New York and Dutchess County, an official list that details the location, type of interface and surrounding fuel make-up does not exist (NYS DHSES 2014).

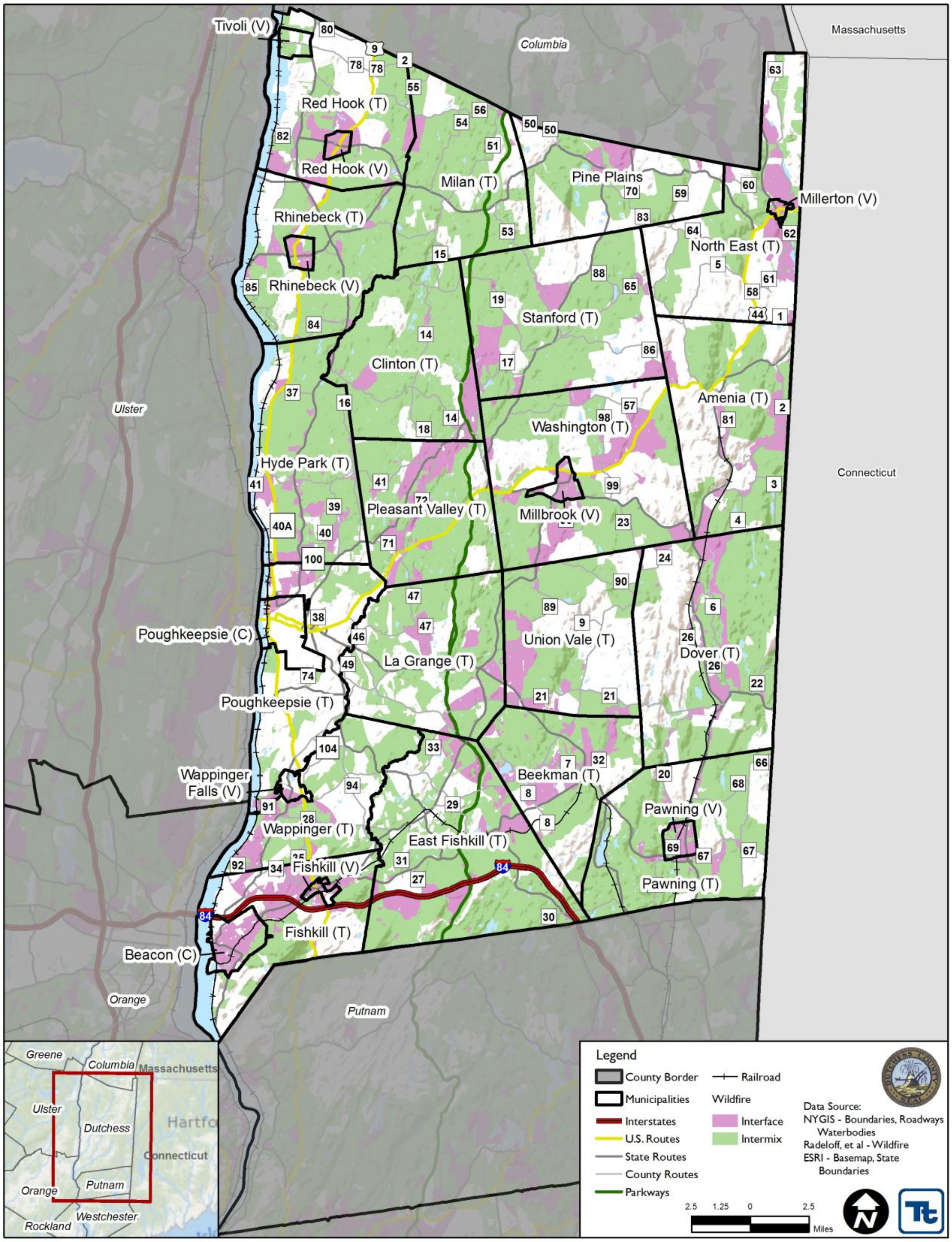
A detailed WUI (interface and intermix) was obtained through the SILVIS Lab, Department of Forest Ecology and Management, University of Wisconsin-Madison which also defines the wildfire hazard area. The California Fire Alliance determined that areas within 1.5 miles of wildland vegetation are the approximate distance that firebrands can be carried from a wildland fire to the roof of a house. Therefore, even structures not located within the forest are at risk to wildfire. This buffer distance, along with housing density and vegetation type were used to define the WUI illustrated in Figure 5.4.8-2 and Figure 5.4.8-3, below (Radeloff, et al, 2005).

Figure 5.4.8-2. SILVIS Wildland Urban Interface across the United States



Source: Radeloff et al, 2005

Figure 5.4.8-3. SILVIS Wildland Urban Interface and Intermix in Dutchess County



Source: Radeloff, et al. 2005

Extent

The extent (that is, magnitude or severity) of wildfires depends on weather and human activity. There are several tools available to estimate fire potential, extent, danger and growth including, but not limited to the following:

Wildland Fire Assessment System (WFAS) is an internet-based information system that provides a national view of weather and fire potential, including national fires danger, weather maps and satellite-derived "greenness" maps. It was developed by the Fire Behavior unit at the Fire Sciences Laboratory in Missoula, Montana and is currently supported and maintained at the National Interagency Fire Center (NIFC) in Boise, Idaho (USFS, Date Unknown).

Each day during the fire season, national maps of selected fire weather and fire danger components of the National Fire Danger Rating System (NFDRS) are produced by the WFAS (USFS, Date Unknown). Fire Danger Rating level takes into account current and antecedent weather, fuel types, and both live and dead fuel moisture. This information is provided by local station managers (USFS, Date Unknown). Table 5.4.7-1 shows the fire danger rating and color code, which is also used by the NYSDEC to update their fire danger rating maps, which is identified later in this section.

Table 5.4.8-1. Description of Fire Danger Ratings in New York State

Adjective Rating Class and Color Code	Class Description
Red Flag	A short-term, temporary warning, indicating the presence of a dangerous combination of temperature, wind, relative humidity, fuel or drought conditions which can contribute to new fires or rapid spread of existing fires. A Red Flag Warning can be issued at any Fire Danger level.
Extreme (Red)	Fires start quickly, spread furiously, and burn intensely. All fires are potentially serious. Development into high intensity burning will usually be faster and occur from smaller fires than in the very high fire danger class. Direct attack is rarely possible and may be dangerous except immediately after ignition. Fires that develop headway in heavy slash or in conifer stands may be unmanageable while the extreme burning condition lasts. Under these conditions the only effective and safe control action is on the flanks until the weather changes or the fuel supply lessens.
Very High (orange)	Fires start easily from all causes and, immediately after ignition, spread rapidly and increase quickly in intensity. Spot fires are a constant danger. Fires burning in light fuels may quickly develop high intensity characteristics such as long-distance spotting and fire whirlwinds when they burn into heavier fuels.
High (yellow)	All fine dead fuels ignite readily and fires start easily from most causes. Unattended brush and campfires are likely to escape. Fires spread rapidly and short-distance spotting is common. High-intensity burning may develop on slopes or in concentrations of fine fuels. Fires may become serious and their control difficult unless they are attacked successfully while small.
Moderate (blue)	Fires can start from most accidental causes but, with the exception of lightning fires in some areas, the number of starts is generally low. Fires in open cured grasslands will burn briskly and spread rapidly on windy days. Timber fires spread slowly to moderately fast. The average fire is of moderate intensity, although heavy concentrations of fuel, especially draped fuel, may burn hot. Short-distance spotting may occur, but is not persistent. Fires are not likely to become serious and control is relatively easy.
Low (green)	Fuels do not ignite readily from small firebrands although a more intense heat source, such as lightning, may start fires in duff or punky wood. Fires in open cured grasslands may burn freely a few hours after rain, but woods fires spread slowly by creeping or smoldering, and burn in irregular fingers. There is little danger of spotting.

Source: NYS DHSES 2014

The ***Fire Potential Index (FPI)*** is derived by combining daily weather and vegetation condition information and can identify the areas most susceptible to fire ignition. The combination of relative greenness and weather information identifies the moisture condition of the live and dead vegetation. The weather information also identifies areas of low humidity, high temperature, and no precipitation to identify areas most susceptible to fire ignition. The FPI enables local and regional fire planners to quantitatively measure fire ignition risk (USGS, 2005). FPI maps are provided on a daily basis by the U.S. Forest Service. The scale ranges from 0 (low) to 100 (high). The calculations used in the NFDRS are not part of the FPI, except for a 10-hour moisture content (Burgan et al, 2000).

Fuel Moisture (FM) content is the quantity of water in a fuel particle expressed as a percent of the oven-dry weight of the fuel particle. FM content is an expression of the cumulative effects of past and present weather events and must be considered in evaluating the effects of current or future weather on fire potential. FM is computed by dividing the weight of the "water" in the fuel by the oven-dry weight of the fuel and then multiplying by 100 to get the percent of moisture in a fuel (Burgan et al, 2000).

There are two kinds of FM: live and dead. Live fuel moistures are much slower to respond to environmental changes and are most influenced by things such as a long drought period, natural disease and insect infestation, annuals curing out early in the season, timber harvesting, and changes in the fuel models due to blow down from windstorms and ice storms (Burgan et al, 2000). Dead fuel moisture is the moisture in any cured or dead plant part, whether attached to a still-living plant or not. Dead fuels absorb moisture through physical contact with water (such as rain and dew) and absorb water vapor from the atmosphere. The drying of dead fuels is accomplished by evaporation. These drying and wetting processes of dead fuels are such that the moisture content of these fuels is strongly affected by fuel sizes, weather, topography, decay classes, fuel composition, surface coatings, fuel compactness and arrangement (Schroeder and Buck, 1970).

Fuels are classified into four categories which respond to changes in moisture. This response time is referred to as a time lag. A fuel's time lag is proportional to its diameter and is loosely defined as the time it takes a fuel particle to reach two-thirds of its way to equilibrium with its local environment. The four categories include:

- 1-hour fuels: up to ¼-inch diameter – fine, flashy fuels that respond quickly to weather changes. Computed from observation time, temperature, humidity, and cloudiness.
- 10-hour fuels: ¼-inch to one-inch in diameter - computed from observation time, temperature, humidity, and cloudiness or can be an observed value.
- 100-hour fuels: one-inch to three-inch in diameter - computed from 24-hour average boundary condition composed of day length (daylight hours), hours of rain, and daily temperature/humidity ranges.
- 1000-hour fuels: three-inch to eight-inch in diameter - computed from a seven-day average boundary condition composed of day length, hours of rain, and daily temperature/humidity ranges (National Park Service, Date Unknown).

The ***Keetch-Byram Drought Index (KBDI)*** is a drought index designed for fire potential assessment. It is a number representing the net effect of evapotranspiration and precipitation in producing cumulative moisture deficiency in deep duff and upper soil layers (USFS, Date Unknown). The index increases each day without rain and decreases when it rains. The scale ranges from 0 (no moisture deficit) to 800 (maximum drought possible). The range of the index is determined by assuming that there is eight inches of moisture in a saturated soil that is readily available to the vegetation. For different soil types, the depth of soil required to hold eight inches of moisture varies. A prolonged drought influences fire intensity, largely because more fuel is available for combustion. The drying of organic material in the soil can lead to increased difficulty in fire suppression (Florida Forest Service, Date Unknown).

The ***Haines Index***, also known as the Lower Atmosphere Stability Index, is a fire weather index based on stability and moisture content of the lower atmosphere that measures the potential for existing fires to become large fires. It is named after its developer, Donald Haines, a Forest Service research meteorologist, who did the initial work and published the scale in 1988 (Storm Prediction Center [SPC], Date Unknown).

The Haines Index can range between 2 and 6. The drier and more unstable the lower atmosphere is, the higher the index. It is calculated by combining the stability and moisture content to the lower atmosphere into a number that correlates well with large fire growth. The stability term is determined by the temperature difference between two atmospheric layers; the moisture term is determined by the temperature and dew point different. The index, as listed below, has shown to correlate with large fire growth on initiating and existing fires where surface winds do not dominate fire behavior (USFS, Date Unknown).

- Very Low Potential (2) – moist, stable lower atmosphere
- Very Low Potential (3)
- Low Potential (4)
- Moderate Potential (5)
- High Potential (6) – dry, unstable lower atmosphere (USFS, Date Unknown)

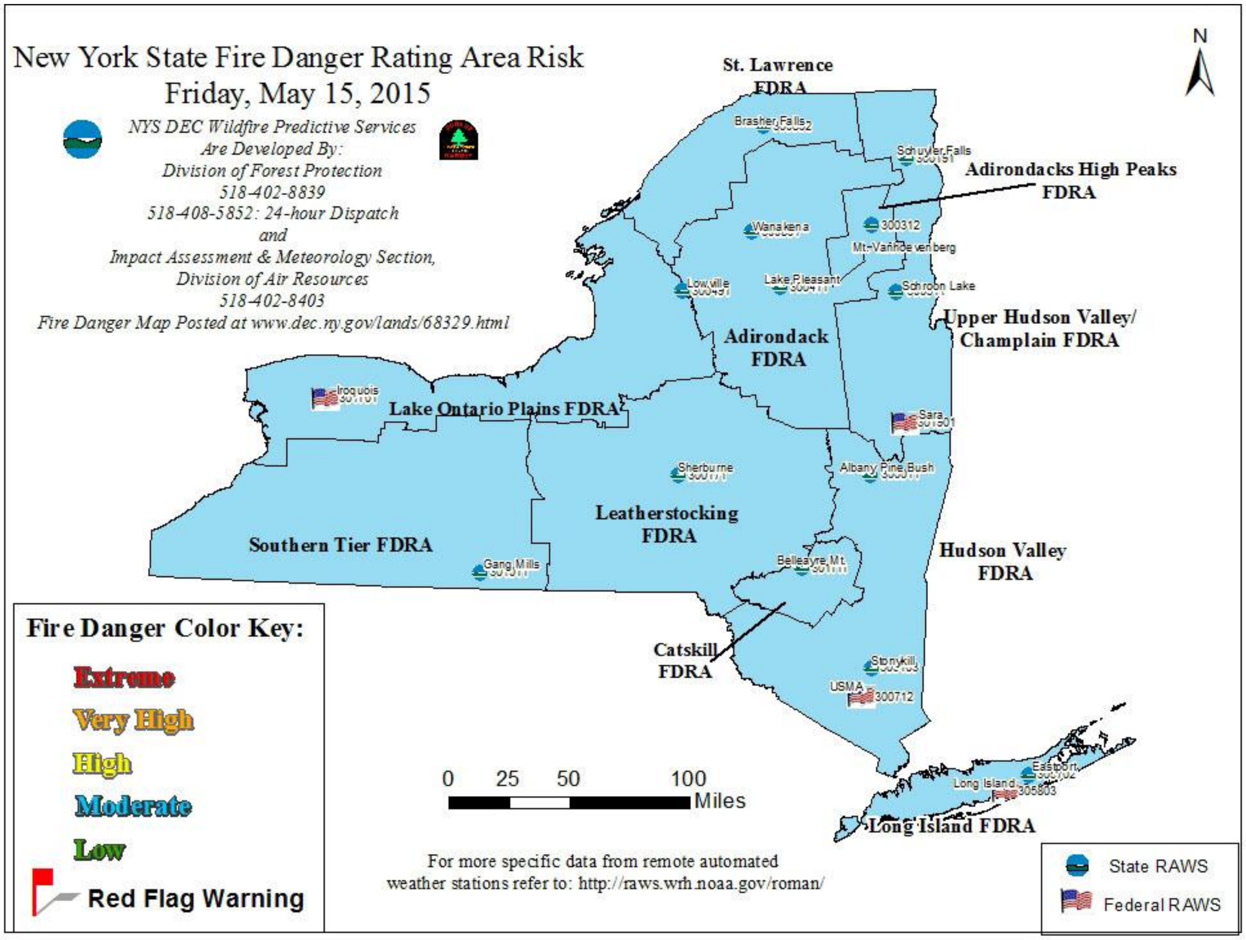
The Haines Index is intended to be used all over the U.S. It is adaptable for three elevation regimes: low elevation, middle elevation, and high elevation. Low elevation is for fires at or very near sea level. Middle elevation is for fires burning in the 1,000 to 3,000 feet in elevation range. High elevation is intended for fires burning above 3,000 feet in elevation (SPC, Date Unknown).

The ***Buildup Index (BUI)*** is a number that reflects the combined cumulative effects of daily drying and precipitation in fuels with a 10 day time lag constant. The BUI can represent three to four inches of compacted litter or can represent up to six inches or more of loose litter (North Carolina Forest Service, 2007).

NYSDEC Fire Danger Rating Map

A current fire danger rating map is updated daily on the NYSDEC website (http://www.dec.ny.gov/lands/68329.html). The map is developed by information obtained from the Division of Forest Protection and Division of Air Resources (impact assessment and meteorology section). Figure 5.4.8-4 shows the FDRAs in New York State and the current (as of May 14, 2015) fire danger risk for each of the areas. The figure is color coded and indicates where there are red flag warning areas. The table following the figure describes the fire danger ratings for New York State.

Figure 5.4.8-4. New York State Fire Danger Rating Areas



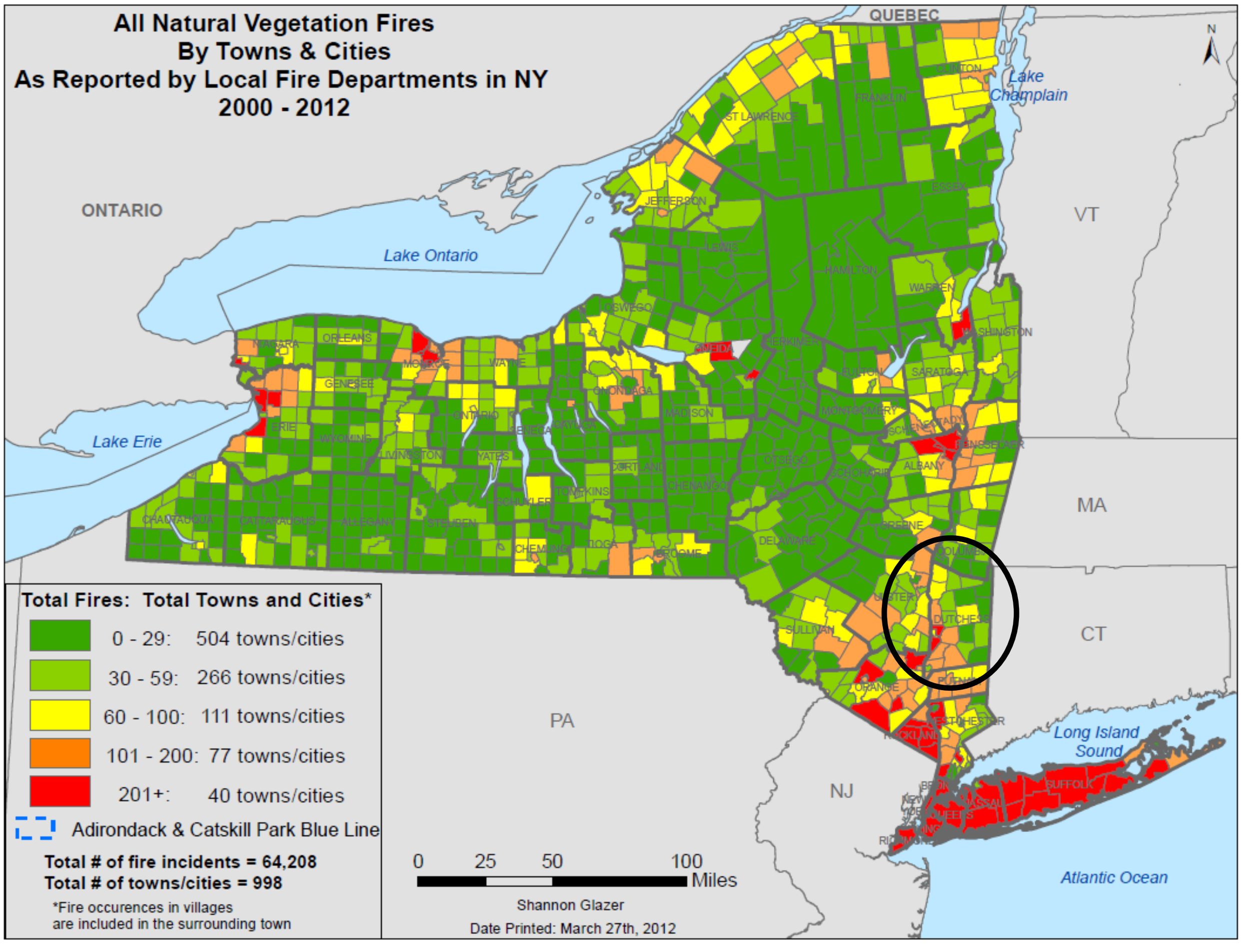
Source: *NYSDEC, 2015*

Previous Occurrences and Losses

Wildfire occurrence in New York State is based on two data sources – the New York State Forest Ranger force and the New York State Office of Fire Prevention and Control. The New York State Forest Ranger is a division of the NYSDEC. It has fought fires and retained records for over 125 years. Between 1989 and 2012, Ranger Division records indicate that rangers suppressed 6,971 wildfires that burned a total of 67,273 acres (NYSDEC 2013). New York State Office of Fire Prevention and Control (OFP&C) indicates that from 2002 through 2012, fire departments throughout New York responded to 64,208 wildfires, brush fires, grass fires or other outdoor fires (NYSDEC 2013).

According to the Ranger Division wildfire occurrence data from 1988 through 2012, 95-percent of wildfires in the State were human-caused. Debris burning accounted for 35-percent; arson accounted for 17-percent; campfires accounted for 13-persent; children accounted for 5-percent; smoking, equipment, and railroads accounted for 30-percent; and lightning accounted for 5-percent of all wildfires (NYSDEC 2013). Figure 5.4.8-5 illustrates the occurrences of wildfires in New York State, between 2000 and 2012.

Figure 5.4.8-5. Wildfire Occurrences in New York State, 2000-2012



Source: *NYSDEC 2013*
Note: *The black oval indicates the location of Dutchess County.*

Many sources provided wildfire information regarding previous occurrences and losses associated with wildfire throughout New York State and Dutchess County. With so many sources reviewed for the purpose of this HMP Update, loss and impact information for many events could vary depending on the source. Therefore, the accuracy of monetary figures discussed is based only on the available information identified during research for this HMP.

Between 1954 and 2015, New York State was included in two FEMA fire management assistance (FMA) declarations. Generally, these disasters cover a wide range of the State; therefore, the disaster may have impacted many counties. Dutchess County was not included in any FMA declarations. For this 2015 HMP, wildfire events were summarized from 1990 to 2015 are identified in Table 5.4.8-2. Please note that not all events that have occurred in Dutchess County are included due to the extent of documentation and the fact that not all sources may have been identified or researched. Loss and impact information could vary depending on the source. Therefore, the accuracy of monetary figures discussed is based only on the available information identified during research for this HMP.

Table 5.4.8-2. Wildfire Events in Dutchess County, 1990 to 2015

Dates of Event	Event Type	FEMA Declaration Number	Location / County Designated?	Losses / Impacts
July 5, 2002	Wildfire	N/A	N/A	No damages and/or losses were identified for the County.
March 26, 2012	Brush Fire	N/A	N/A	Brush fire at Bundy Hill in Pawling
April 15, 2015	Brush Fire	N/A	N/A	A brush fire in the Town of Wappinger occurred in the area of the rail trail between Diddell Road and Route 376. The fire encompassed approximately 40 acres. Ten mutual aid fire departments and the NYSDEC responded to the fire.
May 14, 2015	Brush Fire	N/A	N/A	A brush fire occurred in East Fishkill along I-84 (eastbound) near mile marker 52.8.
May 18, 2015	Brush Fire	N/A	N/A	Brush fire occurred in the Town of Beekman near Stagecoach passage.

Sources: NYSDEC
FEMA Federal Emergency Management Agency
NYSDEC New York State Department of Environmental Conservation
N/A Not Applicable

Probability of Future Occurrences

According to the New York State Forest Ranger Division, wildfire occurrence data from 1988 to 2012 have shown that New York State, including Dutchess County, will always be susceptible to wildfires. Ninety-five percent of wildfires in New York State are caused by humans, while lightning is responsible for only five percent. Beginning in 2010, New York State enacted revised open burning regulations that ban brush burning statewide from March 15th through May 15th. This time period is when 47% of all fire department-response wildfires occur. Forest ranger data indicates that this new statewide ban resulted in 74% fewer wildfires caused by debris burning in upstate New York from 2010 to 2012. Debris burning has been prohibited in New York City and Long Island for more than 40 years. Since compliance with this regulation, forest ranger and fire department historical fire occurrence data will serve as a benchmark for analysis of wildfire occurrence (NYS DHSES, 2014).

The State's large size, diverse topography, and variety of climates require the State be divided into distinct units for describing wildfire potential and risk. See the Location section of this profile for information regarding the risk areas.

Wildfire experts say there are four reasons why wildfire risks are increasing:

- Fuel, in the form of fallen leaves, branches and plant growth, have accumulated over time on the forest floor. Now this fuel has the potential to "feed" a wildfire.
- Increasingly hot, dry weather in the U.S.
- Changing weather patterns across the country.
- More homes built in the areas called the Wildland/Urban Interface, meaning homes are built closer to wildland areas where wildfires can occur (NYS DHSES, 2014).

It is likely that New York State will experience small wildfires throughout the state on a yearly basis (as the State has regularly experienced in the past). However, advanced methods of wildfire management and control and a better understanding of the fire ecosystems should reduce the number of devastating fires in the future (NYS DHSES, 2014).

Estimating the approximate number of wildfires to occur in Dutchess County is difficult to predict in a probabilistic manner. This is because a number of variable factors impact the potential for a fire to occur and because some conditions (for example, ongoing land use development patterns, location, fuel sources, and construction sites) exert increasing pressure on the WUI zone. Based on available data, wildfires will continue to present a risk to Dutchess County. Given the numerous factors that can impact urban fire and wildfire potential, the likelihood of a fire event starting and sustaining itself should be gauged by professional fire managers on a daily basis.

In Section 5.3, the identified hazards of concern for Dutchess County were ranked. The probability of occurrence, or likelihood of the event, is one parameter used for ranking hazards. Based on historical records and input from the Planning Committee, the probability of occurrence for wildfire in the County is considered 'frequent' (event likely to occur within 25 years, as presented in Section 5.3)

Climate Change Impacts

Climate change directly and indirectly affects the growth and productivity of forests: directly due to changes in atmospheric carbon dioxide and climate, and indirectly through complex interactions in forest ecosystems. Climate also affects the frequency and severity of many forest disturbances, such as infestations, invasive species, wildfires, and storm events. As temperatures increase, the suitability of a habitat for specific types of trees changes. There is also evidence that prolonged heat waves are likely to lead to a greater number of wildfire incidents. Stronger winds from larger storms may lead to more fallen branches for wildfires to consume. An increase in rain and snow events primes forests for fire by growing more fuel. Drought and warmer temperatures lead to drier forest fuels (NYS DHSES, 2014).

Climate change is beginning to affect both people and resources in New York State, and these impacts are projected to continue growing. Impacts related to increasing temperatures and sea level rise are already being felt in the State. ClimAID: the Integrated Assessment for Effective Climate Change in New York State (ClimAID) was undertaken to provide decision-makers with information on the State's vulnerability to climate change and to facilitate the development of adaptation strategies informed by both local experience and scientific knowledge (New York State Energy Research and Development Authority [NYSERDA], 2011).

Each region in New York State, as defined by ClimAID, has attributes that will be affected by climate change. Dutchess County is part of Region 5, East Hudson and Mohawk River Valleys. Some of the issues in this region, affected by climate change, include: more frequent heat waves and above 90°F days, more heat-related deaths, increased frequency of heavy precipitation and flooding, decline in air quality, etc. (NYSERDA, 2011).

Temperatures in New York State are warming, with an average rate of warming over the past century of 0.25° F per decade. Average annual temperatures are projected to increase across New York State by 2° F to 3.4° F by the 2020s, 4.1° F to 6.8° F by the 2050s, and 5.3° F to 10.1° F by the 2080s. By the end of the century, the greatest warming is projected to be in the northern section of the State (NYSERDA, 2014).

Regional precipitation across New York State is projected to increase by approximately one to eight-percent by the 2020s, three to 12-percent by the 2050s, and four to 15-percent by the 2080s. By the end of the century, the greatest increases in precipitation are projected to be in the northern areas of the State (NYSERDA, 2014).

In Region 5, it is estimated that temperatures will increase by 3.5ºF to 7.1ºF by the 2050s and 4.1ºF to 11.4ºF by the 2080s (baseline of 47.6ºF). Precipitation totals will increase between 2 and 15% by the 2050s and 3 to 17% by the 2080s (baseline of 38.6 inches). Table 5.4.8-3 displays the projected seasonal precipitation change for the East Hudson and Mohawk River Valleys ClimAID Region (NYSERDA, 2011).

Table 5.4.8-3. Projected Seasonal Precipitation Change in Region 5, 2050s (% change)

Winter	Spring	Summer	Fall
+5 to +15	-5 to +10	-5 to +5	-5 to +10

Source: NYSERDA, 2011

With the increase in temperatures, heat waves will become more frequent and intense, increasing heat-related illness and death and posing new challenges to the energy system, air quality and agriculture. Summer droughts are projected to increase, affecting water supply, agriculture, ecosystems, and energy projects (NYSERDA, 2011).

Fire is determined by climate variability, local topography, and human intervention. Climate change has the potential to affect multiple elements of the wildfire system: fire behavior, ignitions, fire management, and vegetation fuels. Hot dry spells create the highest fire risk. With the increasing temperatures occurring in New York State, wildfire danger may intensify by warming and drying out vegetation. When climate alters fuel loads and fuel moisture, forest susceptibility to wildfires changes. Climate change also may increase winds that spread fires. Faster fires are harder to contain, and thus are more likely to expand into residential neighborhoods.

5.4.8.2 Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed or vulnerable in the identified hazard area. For the wildfire hazard, the portions of Dutchess County in the Wildland/Urban Interface zones (Interface and Intermix) have been identified as the hazard area. Therefore, all assets in the county (population, structures, critical facilities and lifelines), as described in the County Profile (Section 4), located in the hazard area are exposed and potentially vulnerable to wildfire. The following text evaluates and estimates the potential impact of the wildfire hazard on the County including:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impact on: (1) life, health and safety of residents, (2) general building stock, (3) critical facilities, (4) economy, and (5) future growth and development
- Effect of climate change on vulnerability
- Change of vulnerability as compared to that presented in the 2006 Dutchess County HMP
- Further data collections that will assist understanding this hazard over time

Overview of Vulnerability

Wildfire hazards can impact significant areas of land, as evidenced by wildfires throughout the State and United States over the past several years. Fire in urban areas has the potential for great damage to infrastructure, loss of life, and strain on lifelines and emergency responders because of the high density of population and structures that can be impacted in these areas. Wildfire, however can spread quickly, become a huge fire complex consisting of thousands of acres, and present greater challenges for allocating resources, defending isolated structures, and coordinating multi-jurisdictional response. If a wildfire occurs at a WUI, it can also cause an urban fire and in this case has the potential for great damage to infrastructure, loss of life, and strain on lifelines and emergency responders because of the high density of population and structures that can be impacted in these areas.

Potential losses from wildfire include human life, structures and other improvements, and natural resources. Given the immediate response times to reported wildfires, the likelihood of injuries and casualties is minimal. Smoke and air pollution from wildfires can be a health hazard, especially for sensitive populations including children, the elderly, and those with respiratory and cardiovascular diseases. Wildfire may also threaten the health and safety of those fighting the fires. First responders are exposed to the dangers from the initial incident and after-effects from smoke inhalation and heat stroke. In addition, wildfire can lead to ancillary impacts such as landslides in steep ravine areas and flooding caused by the impacts of silt in local watersheds.

Data and Methodology

The WUI (interface and intermix) obtained through the SILVIS Lab, Department of Forest Ecology and Management, University of Wisconsin – Madison was referenced to define the wildfire hazard areas. The University of Wisconsin-Madison wildland fire hazard areas are based on the 2010 Census and 2006 National Land Cover Dataset and the Protected Areas Database. For the purposes of this risk assessment, the high-, medium-, and low-density interface areas were combined and used as the "interface" hazard area, and the high-, medium-, and low-density intermix areas were combined and used as the "intermix" hazard areas. Figure 5.4.8-2 and Figure 5.4.8-3 shown above display the 2010 Wildfire Urban Interface for the U.S. and Dutchess County, respectively, by 2010 U.S. Census block.

The asset data (population, building stock, and critical facilities) presented in the County Profile (Section 4) was used to support an evaluation of assets exposed and potential impacts and losses associated with this hazard. To determine what assets are exposed to wildfire, available and appropriate Geographic Information System (GIS) data were overlaid upon the hazard area. Limitations of this analysis are recognized, and as such, the analysis is used only to provide a general estimate.

Impact on Life, Health and Safety

As demonstrated by historic wildfire events in New York and other parts of the country, potential losses include human health and life of residents and responders, structures, infrastructure and natural resources. In addition, wildfire events can have major economic impacts on a community from the initial loss of structures and the subsequent loss of revenue from destroyed business and decrease in tourism. The most vulnerable populations include emergency responders and those within a short distance of the interface between the built environment and the wildland environment.

Wildfires can cost thousands of taxpayer dollars to suppress and control and involve hundreds of operating hours on fire apparatus and thousands of volunteer man hours from the volunteer firefighters. There are also many direct and indirect costs to local businesses that excuse volunteers from work to fight these fires.

As a way to estimate the county's population vulnerable to the wildfire hazard, the population located within the WUI was overlaid upon the 2010 Census population data (U.S. Census 2010). Census blocks with centers within the hazard area were used to calculate the estimated population exposed to the wildfire hazard. Table 5.4.8-4 summarizes the estimated population exposed by municipality.

Based on the analysis, 90,521 individuals, or 30.4% of the County's population, are exposed to the Intermix wildfire hazard, while 88,161, or 29.6% of the County's population, is exposed to the Interface wildfire hazard. Overall, the Boroughs of Fishkill, Millbrook, Millerton, and Pawling have the greatest number of individuals located in the hazard area.

Table 5.4.8-4. Estimated Vulnerable Population

Municipality	US. Census 2010 Population	Estimated Population Exposed			% of Total Exposed
		Intermix	Interface	Total	
Amenia (T)	4,436	2,080	1,051	3,131	70.6%
Beacon (C)	15,541	482	12,565	13,047	84.0%
Beekman (T)	14,621	7,735	4,395	12,130	83.0%
Clinton (T)	4,312	3,150	875	4,025	93.3%
Dover (T)	8,699	4,051	3,944	7,995	91.9%
East Fishkill (T)	29,029	15,700	4,210	19,910	68.6%
Fishkill (T)	19,936	2,874	8,741	11,615	58.3%
Fishkill (V)	2,171	0	2,171	2,171	100.0%
Hyde Park (T)	21,571	10,392	8,564	18,956	87.9%
LaGrange (T)	15,730	7,544	1,974	9,518	60.5%
Milan (T)	2,370	2,115	90	2,205	93.0%
Millbrook (V)	1,452	104	1,345	1,449	99.8%
Millerton (V)	958	42	916	958	100.0%
Northeast (T)	2,073	659	724	1,383	66.7%
Pawling (T)	6,116	4,281	1,553	5,834	95.4%
Pawling (V)	2,347	604	1,735	2,339	99.7%

Municipality	US. Census 2010 Population	Estimated Population Exposed			% of Total Exposed
		Intermix	Interface	Total	
Pine Plains (T)	2,473	984	940	1,924	77.8%
Pleasant Valley (T)	9,672	5,531	3,853	9,384	97.0%
Poughkeepsie (C)	32,736	0	5,093	5,093	15.6%
Poughkeepsie (T)	42,399	1,751	4,273	6,024	14.2%
Red Hook (T)	8,240	3,128	2,492	5,620	68.2%
Red Hook (V)	1,961	1	1,916	1,917	97.8%
Rhinebeck (T)	4,891	3,389	1,051	4,440	90.8%
Rhinebeck (V)	2,657	263	2,323	2,586	97.3%
Stanford (T)	3,823	2,677	813	3,490	91.3%
Tivoli (V)	1,118	369	0	369	33.0%
Union Vale (T)	4,877	2,687	1,807	4,494	92.1%
Wappinger (T)	22,468	6,137	5,266	11,403	50.8%
Wappinger Falls (V)	5,522	0	2,413	2,413	43.7%
Washington (T)	3,289	1,791	1,068	2,859	86.9%
Dutchess County (TOTAL)	**297,488**	**90,521**	**88,161**	**178,682**	**60.1%**

Sources: U.S. Census 2010, Radeloff et al. 2005

Impact on General Building Stock

The most vulnerable structures to wildfire events are those located within the WUI areas. Buildings constructed of wood or vinyl siding are generally more likely to be impacted by the fire hazard than buildings constructed of brick or concrete. To estimate the buildings exposed to the wildfire hazard, the hazard areas were overlaid upon the building inventory in the County (Census block). The replacement cost value of the structures with their center in the hazard area were totaled. Table 5.4.8-5 summarizes the estimated building stock inventory exposed by municipality. The limitations of this analysis are recognized, and as such the analysis is only used to provide a general estimate.

Table 5.4.8-5. Building Stock Replacement Value Located in WUI Hazard Area

Municipality	Total RV (Structure and Contents)	Building RV Exposed			% of Total Exposed
		Intermix	Interface	Total	
Amenia (T)	$1,943,434,588	$426,299,750	$890,373,883	$1,316,673,634	67.7%
Beacon (C)	$3,343,631,632	$2,594,485,854	$134,482,798	$2,728,968,652	81.6%
Beekman (T)	$3,824,624,378	$1,290,158,764	$2,181,803,082	$3,471,961,846	90.8%
Clinton (T)	$2,069,522,881	$359,424,160	$1,580,961,764	$1,940,385,924	93.8%
Dover (T)	$2,781,316,617	$818,542,835	$1,494,476,560	$2,313,019,395	83.2%
East Fishkill (T)	$10,141,818,207	$1,584,670,900	$5,045,295,333	$6,629,966,233	65.4%
Fishkill (T)	$6,611,883,715	$2,691,680,983	$1,356,252,991	$4,047,933,974	61.2%
Fishkill (V)	$684,424,401	$510,617,735	$718,679	$511,336,415	74.7%
Hyde Park (T)	$6,063,728,469	$2,179,192,534	$3,306,279,936	$5,485,472,470	90.5%

Municipality	Total RV (Structure and Contents)	Building RV Exposed			% of Total Exposed
		Intermix	Interface	Total	
LaGrange (T)	$5,916,908,642	$622,432,723	$2,786,875,250	$3,409,307,973	57.6%
Milan (T)	$1,230,195,126	$53,396,844	$1,039,901,791	$1,093,298,635	88.9%
Millbrook (V)	$729,406,405	$658,055,185	$41,684,233	$699,739,418	95.9%
Millerton (V)	$331,725,332	$288,517,579	$38,841,594	$327,359,173	98.7%
Northeast (T)	$1,427,398,702	$329,880,158	$428,651,502	$758,531,660	53.1%
Pawling (T)	$2,567,191,358	$463,872,766	$1,853,838,152	$2,317,710,919	90.3%
Pawling (V)	$776,997,342	$587,593,634	$189,403,708	$776,997,342	100.0%
Pine Plains (T)	$1,278,056,930	$398,160,598	$538,306,825	$936,467,423	73.3%
Pleasant Valley (T)	$3,111,800,909	$936,799,255	$1,926,303,164	$2,863,102,419	92.0%
Poughkeepsie (C)	$6,538,699,835	$546,052,412	$0	$546,052,412	8.4%
Poughkeepsie (T)	$15,283,939,811	$1,041,818,125	$732,260,828	$1,774,078,953	11.6%
Red Hook (T)	$3,159,628,647	$872,811,018	$1,386,209,159	$2,259,020,177	71.5%
Red Hook (V)	$774,900,418	$773,183,663	$1,716,755	$774,900,418	100.0%
Rhinebeck (T)	$2,464,483,474	$453,669,625	$1,768,452,550	$2,222,122,175	90.2%
Rhinebeck (V)	$1,157,909,263	$889,361,052	$132,929,642	$1,022,290,694	88.3%
Stanford (T)	$2,113,883,643	$388,784,125	$1,414,090,736	$1,802,874,861	85.3%
Tivoli (V)	$340,051,328	$0	$167,757,248	$167,757,248	49.3%
Union Vale (T)	$2,093,773,650	$756,769,471	$1,050,118,543	$1,806,888,014	86.3%
Wappinger (T)	$5,787,089,913	$1,110,867,829	$1,863,036,636	$2,973,904,465	51.4%
Wappinger Falls (V)	$1,153,456,878	$393,911,469	$0	$393,911,469	34.2%
Washington (T)	$2,223,473,555	$538,540,770	$1,158,788,507	$1,697,329,277	76.3%
Dutchess County (TOTAL)	**$97,925,356,049**	**$24,559,551,818**	**$34,509,811,849**	**$59,069,363,667**	**60.3%**

Sources: Dutchess County, Radeloff et al. 2005
RV Replacement value

Impact on Critical Facilities

It is recognized that a number of critical facilities are located in the wildfire hazard area, and are also vulnerable to the threat of wildfire. Many of these facilities are the locations for vulnerable populations (i.e., schools, senior facilities) and responding agencies to wildfire events (i.e., fire, police). Table 5.4.8-6 summarizes the critical facilities located within the wildfire hazard area by jurisdiction.

Table 5.4.8-6. Facilities in WUI (Interface and Intermix) Hazard Area

Municipality	Facility Types																		
	Accommodation	Air	Dam	DPW	Fire/EMS	Gas Station	Government	Library	Medical	Police	Post Office	Potable Pump	Rail Facility	School	Senior	Potable Storage	Town Hall	Well	Wastewater Pump	Wastewater Facility
Amenia (T)	1	1	4	2	2	2	0	1	0	0	2	2	1	0	1	1	1	0	0	0
Beacon (C)	1	0	2	0	4	4	4	1	0	1	1	0	0	4	3	0	1	0	0	1
Beekman (T)	3	1	4	2	1	3	0	1	0	1	1	0	0	1	0	1	1	2	0	3
Clinton (T)	1	0	11	2	3	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Dover (T)	3	0	5	1	2	4	0	1	0	1	1	1	1	4	1	1	1	0	1	2
East Fishkill (T)	2	1	10	2	6	6	0	0	0	3	1	3	0	3	0	2	0	1	0	1
Fishkill (T)	7	0	2	1	5	7	0	0	0	1	1	2	1	2	2	3	0	1	0	0
Fishkill (V)	1	0	0	0	1	1	0	1	0	1	1	0	0	1	0	0	1	0	0	1
Hyde Park (T)	12	1	9	1	7	11	0	2	0	1	2	7	0	8	2	5	1	0	0	1
LaGrange (T)	1	0	5	0	1	5	1	0	0	0	1	4	0	2	0	0	0	3	0	1
Milan (T)	2	0	10	0	2	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Millbrook (V)	2	0	5	1	1	0	0	1	0	1	1	0	0	4	0	0	2	0	0	0
Millerton (V)	1	0	1	1	1	0	0	1	0	1	1	0	0	1	1	1	2	0	0	0
Northeast (T)	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Pawling (T)	0	2	13	1	2	1	0	1	0	0	1	3	1	2	1	1	0	6	1	0
Pawling (V)	1	0	1	0	0	2	0	1	0	1	1	0	1	2	1	1	2	0	6	1
Pine Plains (T)	2	0	7	2	1	1	0	1	0	2	1	2	0	3	0	1	1	1	0	0
Pleasant Valley (T)	1	1	16	1	3	7	0	1	0	1	2	1	0	3	0	0	1	0	1	0
Poughkeepsie (C)	0	0	0	0	1	1	4	0	0	0	0	0	0	2	1	0	0	0	0	0
Poughkeepsie (T)	1	1	1	1	3	2	0	0	1	0	0	0	1	2	0	2	0	0	2	1
Red Hook (T)	2	2	5	2	0	1	0	0	0	0	1	4	0	0	0	1	1	0	0	0
Red Hook (V)	2	0	1	0	1	3	0	1	0	1	1	0	0	3	0	1	1	0	0	0
Rhinebeck (T)	9	1	7	2	3	0	0	1	0	2	1	1	1	0	3	1	0	0	0	1

	Facility Types																			
Municipality	**Accommodation**	**Air**	**Dam**	**DPW**	**Fire/EMS**	**Gas Station**	**Government**	**Library**	**Medical**	**Police**	**Post Office**	**Potable Pump**	**Rail Facility**	**School**	**Senior**	**Potable Storage**	**Town Hall**	**Well**	**Wastewater Pump**	**Wastewater Facility**
Rhinebeck (V)	6	0	3	0	1	3	1	1	1	1	1	0	0	5	2	0	2	0	2	1
Stanford (T)	2	1	16	1	1	1	0	0	0	0	2	0	0	2	0	0	1	0	0	0
Tivoli (V)	1	0	1	0	1	0	0	1	0	0	1	0	0	0	0	0	1	0	0	0
Union Vale (T)	1	1	8	0	2	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0
Wappinger (T)	0	0	3	1	4	4	0	0	0	1	2	0	0	3	1	2	1	1	1	4
Wappinger Falls (V)	0	0	0	1	1	1	0	0	0	0	0	0	0	1	1	1	1	0	0	0
Washington (T)	2	1	15	1	0	0	3	0	0	0	0	1	0	3	1	0	0	0	1	0
Dutchess County (TOTAL)	**67**	**14**	**165**	**26**	**60**	**73**	**13**	**17**	**2**	**20**	**29**	**32**	**7**	**62**	**22**	**26**	**22**	**15**	**15**	**18**

Source: Dutchess County, NYGIS
Note: DPW – Department of Public Works
EMS – Emergency Medical Services

Impact on Economy

Wildfire events can have major economic impacts on a community from the initial loss of structures and the subsequent loss of revenue from destroyed business and decrease in tourism. Wildfires can cost thousands of taxpayer dollars to suppress and control and involve hundreds of operating hours on fire apparatus and thousands of volunteer man hours from the volunteer firefighters. There are also many direct and indirect costs to local businesses that excuse volunteers from working to fight these fires.

Future Growth and Development

Areas targeted for potential future growth and development in the next five years have been identified across Dutchess County at the municipal level. Refer to the jurisdictional annexes in Volume II of this HMP. It is anticipated that any new development and new residents in the WUI areas will be exposed to the wildfire hazard.

Effect of Climate Change on Vulnerability

According to the U.S. Fire Service (USFS), climate change will likely alter the atmospheric patterns that affect fire weather. Changes in fire patterns will, in turn, impact carbon cycling, forest structure, and species composition. Climate change associated with elevated greenhouse gas concentrations may create an atmospheric and fuel environment that is more conductive to large, severe fires (USFS, 2011). Under a changing climate, wildfires are expected to increase by 50% across the U.S. (USFS, 2013).

Fire interacts with climate and vegetation (fuel) in predictable ways. Understanding the climate/fire/vegetation interactions is essential for addressing issues associated with climate change that include:

- Effects on regional circulation and other atmospheric patterns that affect fire weather
- Effects of changing fire regimes on the carbon cycle, forest structure, and species composition, and
- Complications from land use change, invasive species and an increasing wildland-urban interface (USFS, 2011).

It is projected that higher summer temperatures will likely increase the high fire risk by 10 to 30-percent. Fire occurrence and/or area burned could increase across the U.S. due to the increase of lightning activity, the frequency of surface pressure and associated circulation patterns conductive to surface drying, and fire-weather conditions, in general, which is conductive to severe wildfires. Warmer temperatures will also increase the effects of drought and increase the number of days each year with flammable fuels and extending fire seasons and areas burned (USFS, 2011).

Future changes in fire frequency and severity are difficult to predict. Global and regional climate changes associated with elevated greenhouse gas concentrations could alter large weather patterns, thereby affecting fire-weather conducive to extreme fire behavior (USFS, 2011).

Change of Vulnerability

A wildfire exposure analysis was not conducted as part of the 2006 HMP risk assessment. The updated vulnerability assessment provides a more current exposure analysis for the County.

Additional Data and Next Steps

As the custom building inventory is updated additional building attributes regarding the construction of structures, such as roofing material, fire detection equipment, structure age, etc. may be incorporated as available. As stated earlier, buildings constructed of wood or vinyl siding are generally more likely to be impacted by the fire hazard than buildings constructed of brick or concrete. The proximity of these building types to the fuel hazard areas should be identified for further evaluation. Development and availability of such data would permit a more detailed estimate of potential vulnerabilities, including loss of life and potential structural damages.