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 Rockland 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).

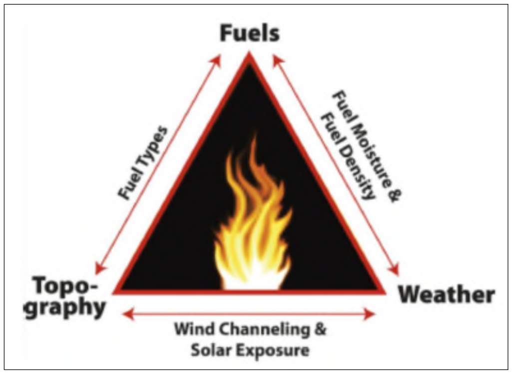
Wildfire in New York State is based on the same science and environmental factors as any wildfire in the world. Fuels, weather, and topography are the primary factors that determine the natural spread and destruction of every wildfire. New York State, including Rockland County, has large tracts of diverse 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:

- Wildland fires – fueled almost exclusively by natural vegetation. They typically occur in national forests and parks, where Federal agencies are responsible for fire management and suppression.
- Interface or intermix fires – urban/wildland fires in which vegetation and the built-environment provide fuel
- Firestorms – 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.
- Prescribed fires and prescribed natural burns – 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:

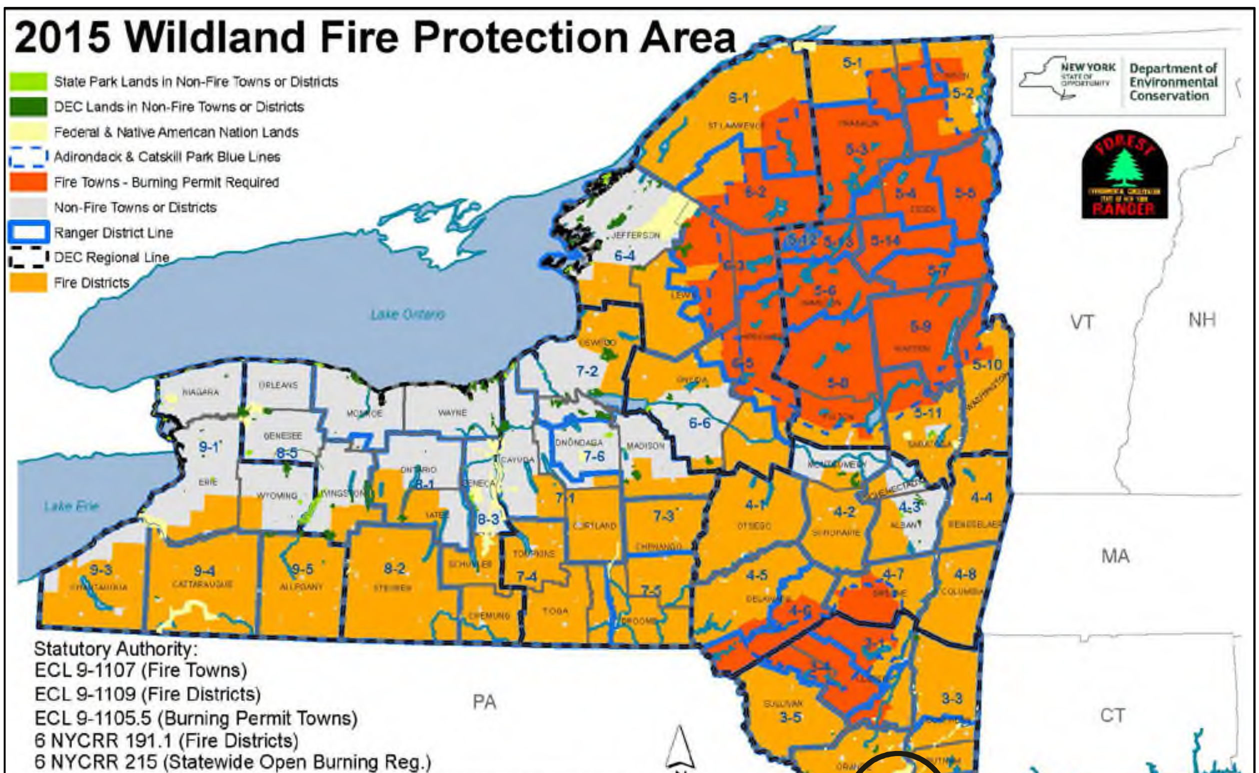
- Fuel
    - Lighter fuels such as grasses, leaves, and needles quickly expel moisture and burn rapidly, while heavier fuels such as tree branches, logs, and trunks take more time to warm and ignite.
    - Snags and hazard trees–especially those that are diseased, dying, or dead—are quickly engulfed 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, Rockland County is located in Fire District 3-2.

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: *Rockland 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. Rockland County is located in the Hudson Valley FDRA. This is discussed further in in the Extent section of this profile.

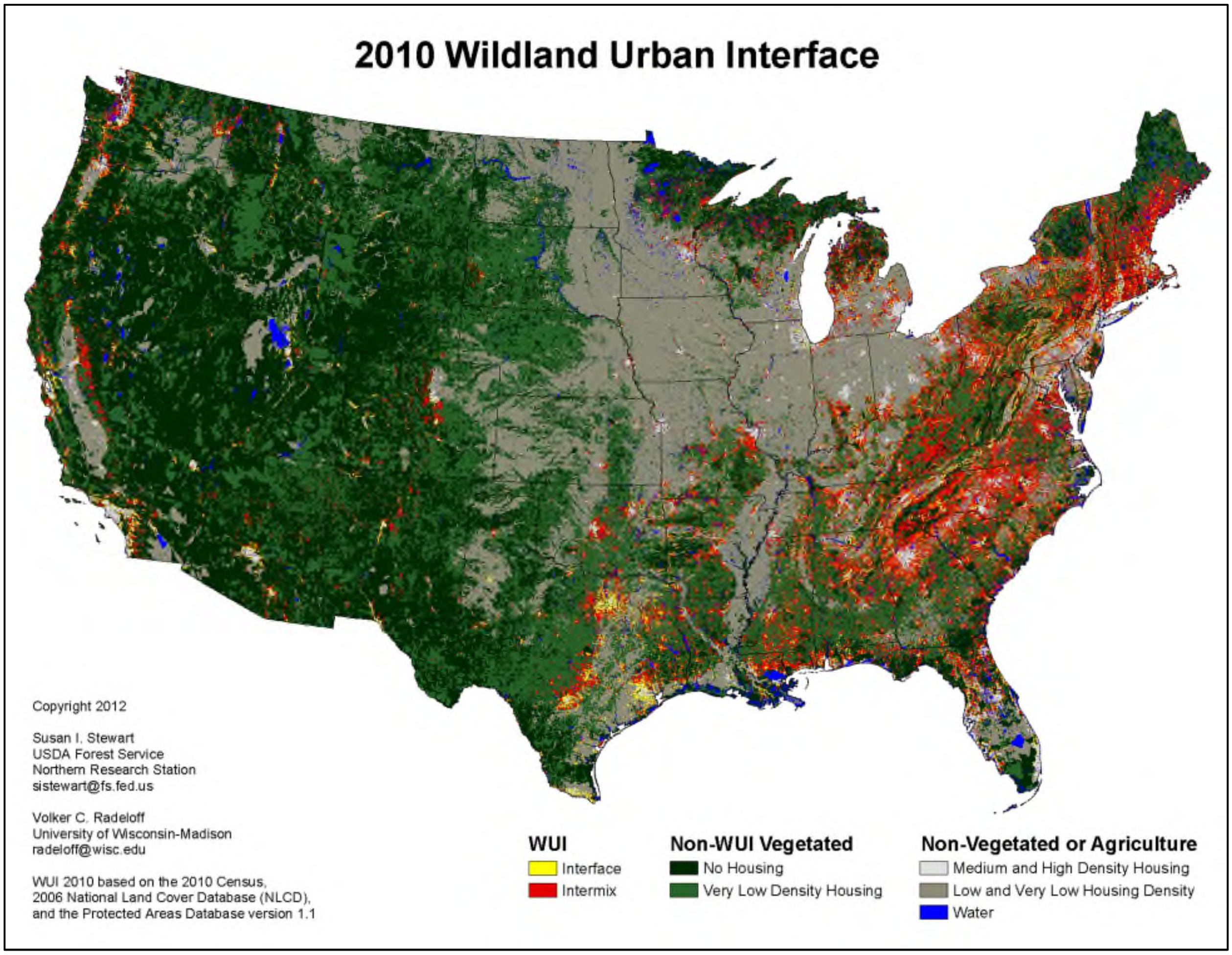
Wildfires in Rockland County typically occur in the forested areas in the northern and western portions of the County and in areas parallel to the Hudson River. Many of these areas at risk are popular with hikers and campers. Several major transportation routes (New York State Thruway and Palisades Parkway) traverse these areas, leaving them vulnerable to closure during wildfires due to smoke conditions (Rockland County HMP 2010).

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

Wildland urban interface (WUI) is the area where natural areas and development meet. Since 1990, 60% of new homes in the United States have been built in the WUI. These homes are at risk of structure loss, injury and death from a wildfire. All states have at least a small amount of land classified as WUI, approximately 9.9% of all land is classified as WUI. The WUI is divided into two categories: intermix and interface. Intermix WUI refers to areas where housing and wildland vegetation intermingle, while interface WUI refers to areas where housing is in the vicinity of a large area of dense wildland vegetation (Martinuzzi et al. 2015). Intermix areas have more than one house per 40 acres and have more than 50% vegetation. Interface areas have more than one house per 40 acres, have less than 50% vegetation, and are within 1.5 miles of an area over 1,235 acres that is more than 75% vegetated (Stewart et al., 2006). In New York State, 31% (15,240 square miles) is located in the WUI; with 6.3% (3,111 square miles) is located in the WUI interface and 24.7% (12,129 square miles) is located in the WUI intermix (Martinuzzi et al. 2015).

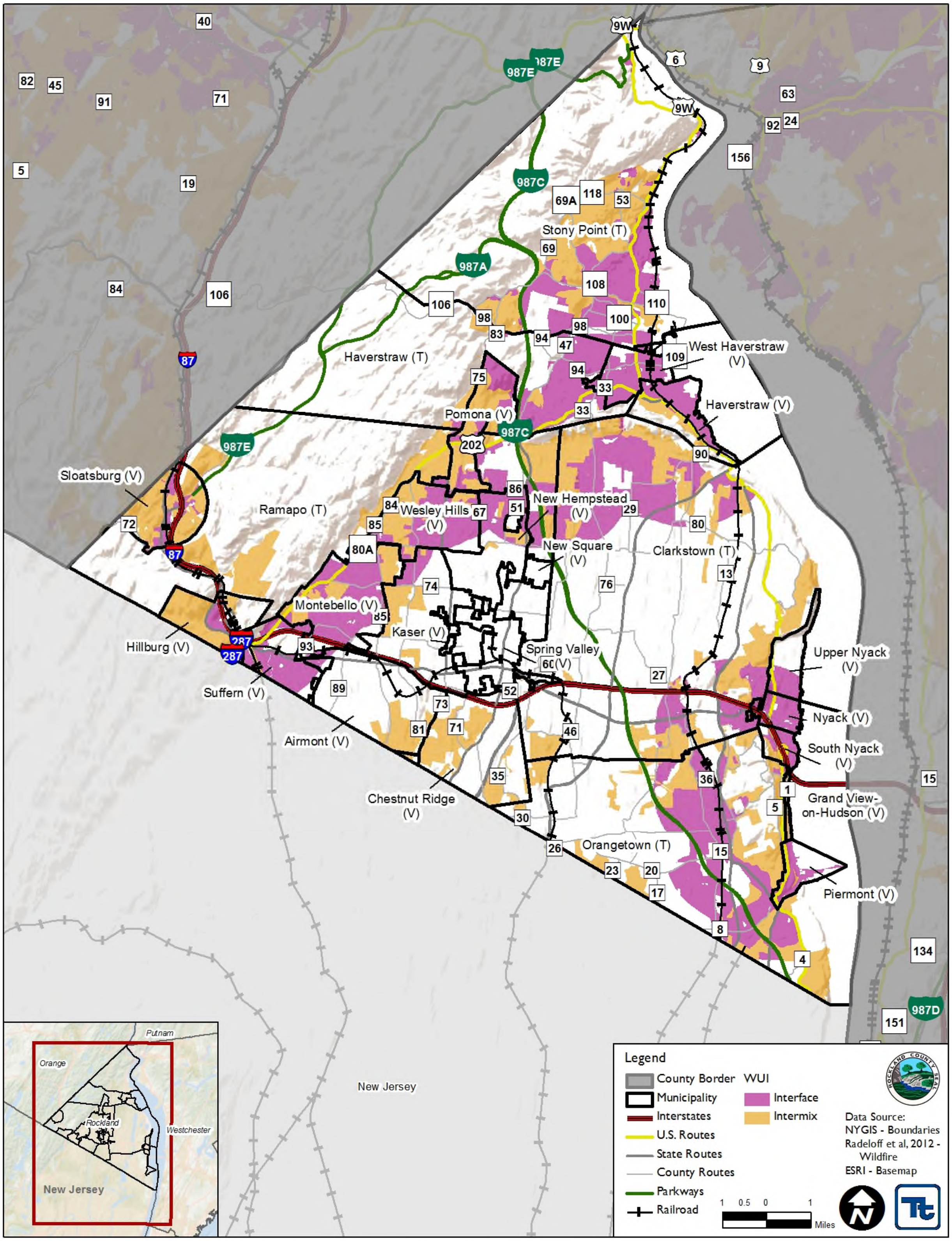
A detailed WUI (interface and intermix) was obtained through the SILVIS Lab, Department of Forest Ecology and Management, University of Wisconsin-Madison which also defines the wildfire hazard area. The California Fire Alliance determined that areas within 1.5 miles of wildland vegetation are the approximate 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 2012).

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



Source: Radeloff et al. 2012

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



Source: Radeloff et al. 2012

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. 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 2016). Table 5.4.8-1 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: NYSDEC 2016

The ***Fire Potential Index (FPI)*** is a moisture-based vegetation flammability indicator. The FPI indicates the estimated proportion (percentage) of the vegetation that is dry enough to burn, thus the FPI is highest when dead fuel moistures and vegetation greenness are low. The FPI is calculated once daily for the continental U.S. at a resolution of 1 square kilometer. Although these maps provide a relative measure of fuel flammability across the

U.S., on a scale of 0 to 100, they do not indicate the chance that a large fire will occur (USFS 2016). FPI maps are provided once daily by the U.S. Forest Service. The scale ranges from 0 (low) to 100 (high) (USGS 2016).

Fuel Moisture (FM) is a tool that is used to understand the fire potential for locations across the United States. It is a measure of the amount of water in a fuel (vegetation) available to a fire, and is expressed as a perfect of the dry weight of that specific fuel. When fuel moisture content is high, fires do not ignite readily, or at all, because heat energy has to be used to evaporate and drive water from the plant before it can burn. When the fuel moisture content is low, fires start easily and will spread. When the fuel moisture content is less than 30 percent, that fuel is essentially considered to be dead (known as dead fuels). Dead fuels respond solely to current environmental conditions and are critical in determining fire potential (USFS 2016; NCDC 2013).

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 based upon how long it would take for two-thirds of the dead fuel to respond to atmospheric moisture. 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 (NCDC 2013).

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. The KBDI attempts to measure the amount of precipitation necessary to return the soil to full field capacity. 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) (USFS 2016).

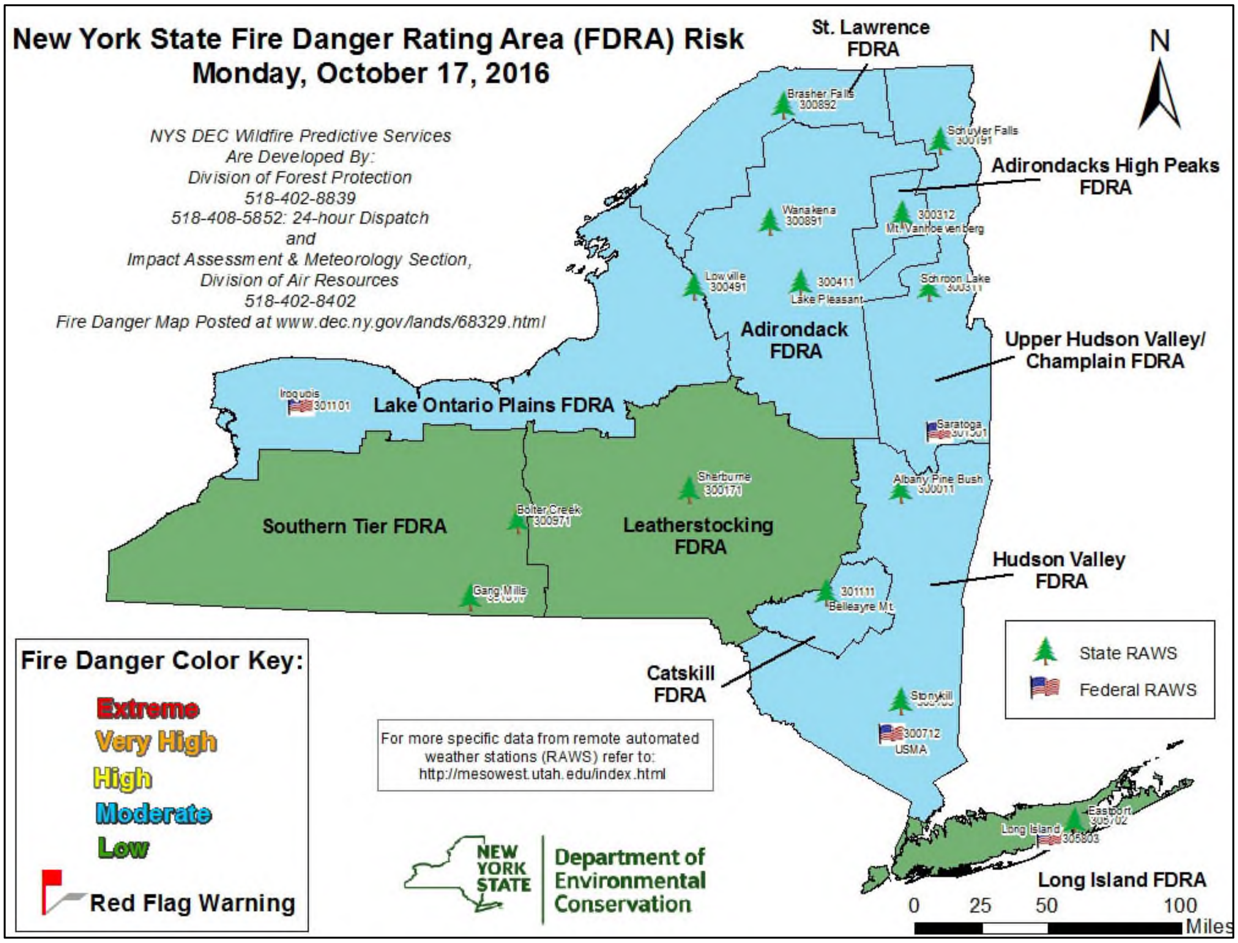
The ***Haines Index***, also known as the Lower Atmosphere Stability Index, was developed for fire use. It is used to indicate the potential for wildfire growth by measuring the stability and dryness of the air over a fire. It is calculated by combining the stability and moisture content of the lower 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 difference. This index has been shown to be correlated with large fire growth on initiating and existing fires where surface winds do not dominate fire behavior. The Haines Index can range between 2 and 6. The drier and more unstable the lower atmosphere is, the higher the index:

- 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 2016)

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 October 17, 2016) 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. The figure is showing Rockland County at moderate risk, as of October 17, 2016.

Figure 5.4.8-4. New York State FDRAs



Source: NYSDEC 2016

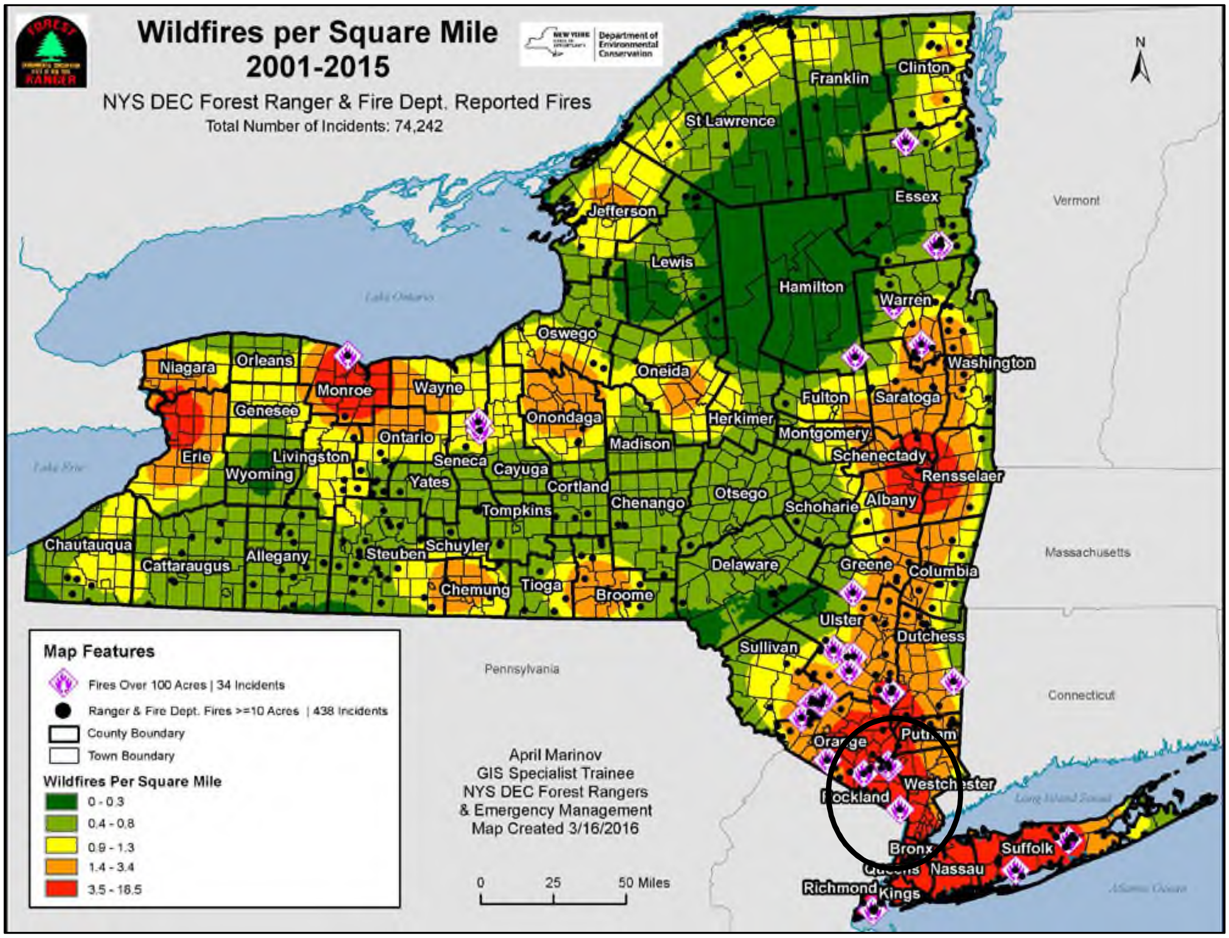
Previous Occurrences and Losses

Wildfire occurrence reporting in New York State is based on two data sources: New York State Forest Ranger Force and fire department data collected by the New York State Office of Fire Prevention and Control (OFP&C). Over the past 25 years, from 1991 to 2015, the Forest Ranger Division indicated that rangers suppressed 5,984 wildfires that burned a total of 53,896 acres. OFP&C indicated that from 2002 to 2012, fire departments across the State responded to 64,208 wildfires, brush fires, grass fire or other outdoor fires (NYSDEC 2016).

Between 1891 and 2015, there have been 97,475 wildfires in the State that burned over 2.5 million acres, as reported by the NYSDEC Division of Forest Protection (NYSDEC 2016).

According to the Ranger Division wildfire occurrence data from 1988 through 2012, 95% of wildfires in the State were human-caused while lightning was responsible for 5% of the fires. Debris burning accounted for 35%; arson accounted for 17%; campfires accounted for 13-persent; children accounted for 5%; smoking, equipment, and railroads accounted for 30%; and lightning accounted for 5% of all wildfires (NYSDEC 2016). Figure 5.4.8-5 illustrates the number of wildfires per square mile in New York State from 2001 to 2015, as reported by the Forest Ranger Division and local fire departments.

Figure 5.4.8-5. Wildfires per Square Mile in New York State, 2001-2015



Source: *NYSDEC 2016*
Note: *The black oval indicates the location of Rockland County.*

Many sources provided wildfire information regarding previous occurrences and losses associated with wildfire throughout New York State and Rockland 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 2016, 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. Rockland County was not included in any FMA declarations. For this HMP, wildfire events were summarized from 2010 to 2016 are identified in Table 5.4.8-2. For events prior to 2010, refer to the 2010 Rockland County Multi-Jurisdictional Hazard Mitigation Plan. Please note that not all events that have occurred in Rockland 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 Rockland County, 2010 to 2016

Dates of Event	Event Type	FEMA Declaration Number (if applicable)	Location / County Designated?	Losses / Impacts
November 14, 2013	Brush Fires	N/A	N/A	Brush fires burned 363 acres in Rockland County. More than 150 firefighters battled the brush fires in Clausland Mountain State Park in the Town of Orangetown. The fires spread quickly due to windy and dry conditions.
November 13-15, 2016	Brush Fires	N/A	N/A	Two brush fires broke out in Harriman State Park on November 13th. The first started around 2:30pm in the Pine Meadow section of the park and the second started at 11:45pm on Tom Jones Mountain across the Orange County line in Tuxedo. Approximately 500 acres of mainly brush and ground cover burned on Tom Jones Mountain in Orange County and about 180 acres in Rockland County's Pine Meadow section of the park. The dry weather combined with the fallen leaves helped fuel the fires. Plumes of smoke extended into Rockland County.

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 Rockland 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 Rockland 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 Rockland 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 Rockland 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).

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). According to the ClimAID report, it is likely that late-summer short-duration droughts will increase in New York State by the end of the century.

However, each region in New York State, as defined by ClimAID, has attributes that will be uniquely affected by the impacts of climate change. Rockland County is part of Region 2, Catskill Mountains and West Hudson River Valley (NYSERDA 2011). In Region 2, it is estimated that temperatures will increase by 3.1ºF to 6.9ºF by the 2050s and 4.0ºF to 10.7ºF by the 2080s (baseline of 50.0ºF). Precipitation totals will increase between 1 and 14% by the 2050s and 2 to 18% by the 2080s (baseline of 46.0 inches). Table 5.4.8-3 displays the projected seasonal precipitation change for the Catskill Mountains and West Hudson River Valley ClimAID Region (NYSERDA 2014).

Table 5.4.8-3. Projected Seasonal Precipitation Change in Region 2, 2050s (% change)

Winter	Spring	Summer	Fall
0 to +15	0 to +10	-5 to +10	-5 to +10

Source: NYSERDA 2011

With the increase in temperatures, heat waves will become more frequent and intense, posing new challenges to the energy system, air quality and agriculture, and potentially increasing the risk of wildfire. Summer droughts are also 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 Rockland 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 2010 Rockland 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 Rockland 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, 21,026 individuals, or 6.7% of the County's population, are exposed to the Intermix wildfire hazard, while 110,330, or 35.4% of the County's population, is exposed to the Interface wildfire hazard. Overall, the Towns of Clarkstown, Orangetown, Stony Point, and Haverstraw 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	
Airmont, Village of	8,628	527	212	739	8.6%
Chestnut Ridge, Village of	7,916	1,684	0	1,684	21.3%
Clarkstown, Town of	78,867	3,748	14,850	18,598	23.6%
Grand View on Hudson, Village of	285	235	50	285	100.0%
Haverstraw, Town of	12,808	292	12,244	12,536	97.9%
Haverstraw, Village of	11,910	811	10,919	11,730	98.5%
Hillburn, Village of	951	211	684	895	94.1%
Kaser, Village of	4,724	0	0	0	0.0%
Montebello, Village of	4,526	779	3,535	4,314	95.3%
New Hempstead, Village of	5,132	277	1,070	1,347	26.2%
New Square, Village of	6,944	0	0	0	0.0%
Nyack, Village of	6,765	0	6,765	6,765	100.0%
Orangetown, Town of	36,832	2,834	15,245	18,079	49.1%
Piermont, Village of	2,510	113	1,797	1,910	76.1%
Pomona, Village of	3,103	1,305	1,719	3,024	97.5%
Ramapo, Town of	38,252	2,087	2,214	4,301	11.2%
Sloatsburg, Village of	3,039	1,593	1,426	3,019	99.3%
South Nyack, Village of	3,510	542	2,617	3,159	90.0%
Spring Valley, Village of	31,347	0	0	0	0.0%
Stony Point, Town of	15,059	2,599	10,314	12,913	85.7%
Suffern, Village of	10,723	0	9,710	9,710	90.6%
Upper Nyack, Village of	2,063	0	1,288	1,288	62.4%
Wesley Hills, Village of	5,628	1,389	3,819	5,208	92.5%

Municipality	US. Census 2010 Population	Estimated Population Exposed			% of Total Exposed
		Intermix	Interface	Total	
West Haverstraw, Village of	10,165	0	9,852	9,852	96.9%
Rockland County	**311,687**	**21,026**	**110,330**	**131,356**	**42.1%**

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	
Airmont, Village of	$1,918,825,000	$95,782,000	$177,379,000	$273,161,000	14.2%
Chestnut Ridge, Village of	$2,012,432,000	$397,225,000	$0	$397,225,000	19.7%
Clarkstown, Town of	$17,738,436,000	$1,002,074,000	$3,228,819,000	$4,230,893,000	23.9%
Grand View on Hudson, Village of	$90,160,000	$72,663,000	$16,190,000	$88,853,000	98.6%
Haverstraw, Town of	$2,105,505,000	$66,901,000	$1,865,358,000	$1,932,259,000	91.8%
Haverstraw, Village of	$1,383,509,000	$125,635,000	$1,207,506,000	$1,333,141,000	96.4%
Hillburn, Village of	$274,003,000	$79,058,000	$137,329,000	$216,387,000	79.0%
Kaser, Village of	$905,538,000	$0	$0	$0	0.0%
Montebello, Village of	$1,087,531,000	$155,549,000	$619,394,000	$774,943,000	71.3%
New Hempstead, Village of	$761,317,000	$63,330,000	$153,446,000	$216,776,000	28.5%
New Square, Village of	$469,065,000	$0	$0	$0	0.0%
Nyack, Village of	$2,151,804,000	$0	$1,660,936,000	$1,660,936,000	77.2%
Orangetown, Town of	$9,753,484,000	$1,109,144,000	$3,874,568,000	$4,983,712,000	51.1%
Piermont, Village of	$607,070,000	$25,095,000	$384,351,000	$409,446,000	67.4%
Pomona, Village of	$751,081,000	$336,412,000	$402,982,000	$739,394,000	98.4%
Ramapo, Town of	$4,907,209,000	$316,498,000	$424,221,000	$740,719,000	15.1%
Sloatsburg, Village of	$560,532,000	$300,302,000	$255,907,000	$556,209,000	99.2%
South Nyack, Village of	$909,458,000	$83,485,000	$519,067,000	$602,552,000	66.3%
Spring Valley, Village of	$3,250,707,000	$0	$0	$0	0.0%
Stony Point, Town of	$3,203,457,000	$582,351,000	$2,071,267,000	$2,653,618,000	82.8%
Suffern, Village of	$2,003,083,000	$0	$1,799,427,000	$1,799,427,000	89.8%
Upper Nyack, Village of	$420,682,000	$0	$277,005,000	$277,005,000	65.8%

Municipality	Total RV (Structure and Contents)	Building RV Exposed			% of Total Exposed
		Intermix	Interface	Total	
Wesley Hills, Village of	$1,046,454,000	$277,596,000	$699,482,000	$977,078,000	93.4%
West Haverstraw, Village of	$1,607,273,000	$0	$1,560,579,000	$1,560,579,000	97.1%
Rockland County	**$59,918,615,000**	**$5,089,100,000**	**$21,335,213,000**	**$26,424,313,000**	**44.1%**

Sources: Hazus-MH 3.2, Radeloff et al. 2005

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

	Facility Types																				
Municipality	**Communication**	**County Building**	**Day Care**	**DPW**	**EMS**	**Fire Station**	**Hazmat**	**Medical**	**Military**	**Municipal Hall**	**Police Station**	**Post Office**	**Potable Water**	**Potable Pump**	**Rail Facility**	**School**	**Senior**	**Water Tower**	**Well**	**Wastewater Pump**	**Wastewater Facility**
Airmont, Village of	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0
Chestnut Ridge, Village of	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	1	1	0
Clarkstown, Town of	1	0	12	0	0	3	7	0	0	0	0	2	0	0	0	4	1	1	11	12	0
Grand View on Hudson, Village of	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Haverstraw, Town of	0	0	9	1	0	2	1	0	0	1	1	0	0	0	0	3	0	0	24	0	0
Haverstraw, Village of	0	0	9	1	1	5	1	0	0	1	0	1	1	0	0	2	6	0	0	0	0
Hillburn, Village of	0	0	0	2	0	1	1	0	0	1	0	1	0	0	0	0	0	0	1	0	1
Kaser, Village of	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Montebello, Village of	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	4	0	0	4	6	0
New Hempstead, Village of	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1	0
New Square, Village of	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nyack, Village of	0	0	13	1	1	6	0	0	0	1	0	1	0	0	0	0	3	0	0	0	0
Orangetown, Town of	1	0	17	0	1	4	13	0	1	0	0	4	0	0	0	7	5	0	5	1	0
Piermont, Village of	0	0	1	1	1	1	0	0	0	1	1	1	0	0	0	1	0	0	0	0	0
Pomona, Village of	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2	1	0
Ramapo, Town of	0	0	8	0	0	1	3	0	0	0	0	1	0	0	0	1	1	0	4	7	0
Sloatsburg, Village of	1	0	4	1	1	1	3	0	0	1	0	1	0	0	1	1	0	1	0	0	2
South Nyack, Village of	1	0	1	1	0	1	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0
Spring Valley, Village of	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stony Point, Town of	0	0	8	1	1	2	6	0	0	1	1	2	0	0	0	2	1	0	22	0	0
Suffern, Village of	0	0	4	1	0	3	4	1	0	1	1	1	0	0	1	1	2	0	2	0	1
Upper Nyack, Village of	0	0	1	1	0	1	0	0	0	1	0	0	0	0	0	2	0	0	0	0	0
Wesley Hills, Village of	0	0	1	0	0	0	1	0	0	1	0	0	0	2	0	2	0	0	1	1	0

Municipality	Facility Types																				
	Communication	County Building	Day Care	DPW	EMS	Fire Station	Hazmat	Medical	Military	Municipal Hall	Police Station	Post Office	Potable Water	Potable Pump	Rail Facility	School	Senior	Water Tower	Well	Wastewater Pump	Wastewater Facility
West Haverstraw, Village of	0	0	10	0	0	2	3	0	0	0	0	1	0	0	0	0	1	0	1	0	0
Rockland County	**5**	**2**	**103**	**11**	**6**	**33**	**45**	**1**	**1**	**14**	**5**	**16**	**1**	**2**	**2**	**34**	**21**	**2**	**81**	**31**	**4**

Source: Rockland County, Radeloff et al. 2005
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 Rockland 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%. 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 2010 HMP risk assessment. The updated vulnerability assessment provides a more current exposure analysis for the County.

Additional Data and Next Steps

Creating a custom building inventory including tax assessor data and 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.