

5.4.1 Drought

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 drought hazard in Rockland County.

5.4.1.1 Profile

Hazard Description

Drought is a period characterized by long durations of below normal precipitation. Drought is a temporary irregularity and differs from aridity since the latter is restricted to low rainfall regions and is a permanent feature of climate. Drought conditions occur in virtually all climatic zones yet its characteristics vary significantly from one region to another, since it is relative to the normal precipitation in that region. Drought can affect agriculture, water supply, aquatic ecology, wildlife, and plant life.

There are four different ways that drought can be defined or grouped:

- **Meteorological** drought is a measure of departure of precipitation from normal. It is defined solely on the relative degree of dryness. Due to climatic differences, what might be considered a drought in one location of the country may not be a drought in another location.
- **Agricultural** drought links various characteristics of meteorological (or hydrological) drought to agricultural impacts, focusing on precipitation shortages, differences between actual and potential evapotranspiration, soil water deficits, reduced ground water or reservoir levels, and other parameters. It occurs when there is not enough water available for a particular crop to grow at a particular time. Agricultural drought is defined in terms of soil moisture deficiencies relative to water demands of plant life, primarily crops.
- **Hydrological** drought is associated with the effects of periods of precipitation shortfalls (including snowfall) on surface or subsurface water supply. It occurs when these water supplies are below normal. It is related to the effects of precipitation shortfalls on stream flows and reservoir, lake, and groundwater levels.
- **Socioeconomic** drought is associated with the supply and demand of an economic good with elements of meteorological, hydrological, and agricultural drought. This differs from the aforementioned types of drought because its occurrence depends on the time and space processes of supply and demand to identify or classify droughts. The supply of many economic goods depends on weather (for example water, forage, food grains, fish, and hydroelectric power). Socioeconomic drought occurs when the demand for an economic good exceeds supply as a result of a weather-related shortfall in water supply (National Drought Mitigation Center 2014).

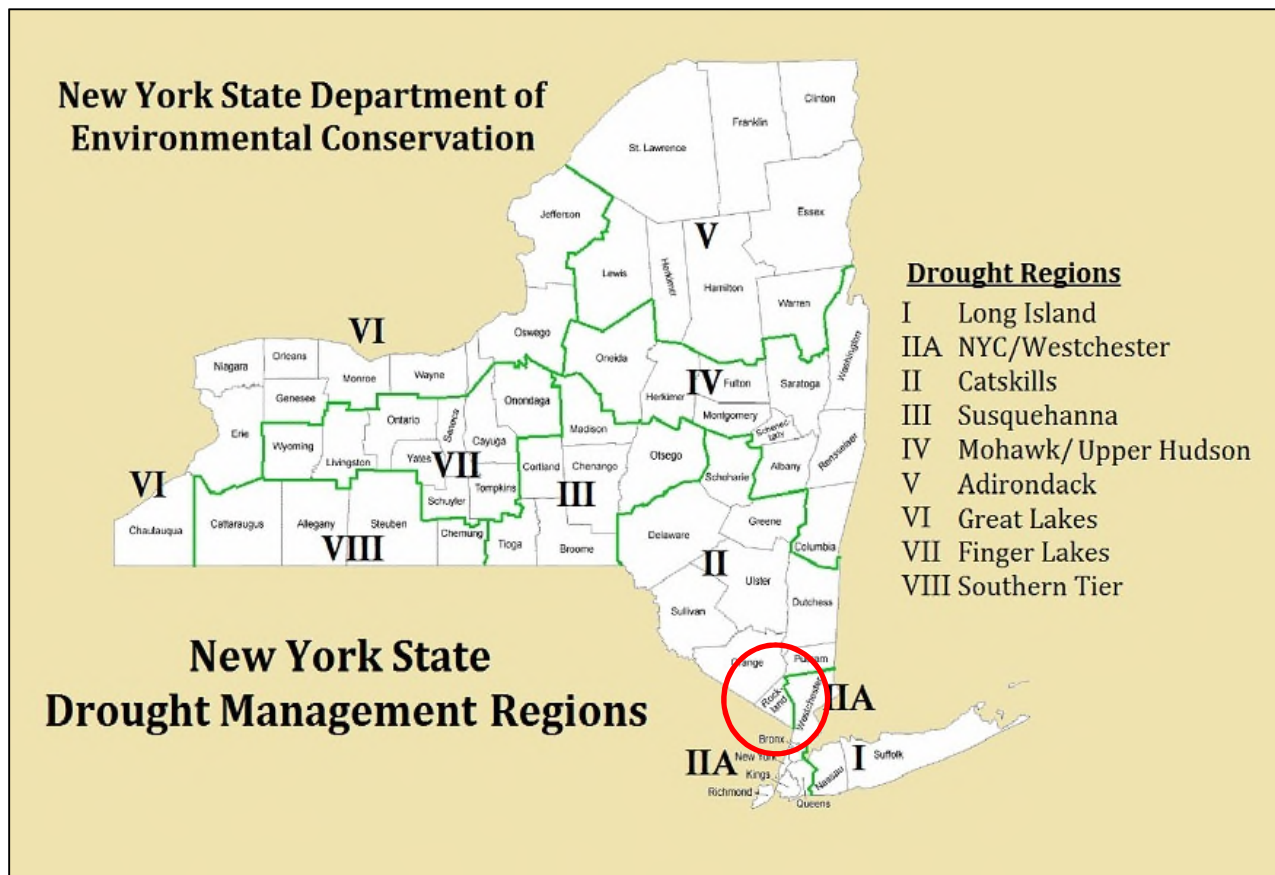
Location

Droughts can occur in all parts of the United States and any time of the year. Drier regions are more susceptible to long term or extreme drought conditions, while other areas tend to be more susceptible to short term, less severe droughts. In New York State, there is an abundant supply of water found throughout the State with streams, lakes, and coastal areas that have an average precipitation ranging from 60 inches in the Catskills to 28 inches in the Lake Champlain Valley. Variations in the normal amounts can lead to periods of dry weather and periods of drought (NYS DHSES 2014).

The National Oceanic and Atmospheric Administration (NOAA) has divided the United States into 344 climate divisions. According to NOAA, New York State is made up of 10 climate divisions: Western Plateau, Eastern Plateau, Northern Plateau, Coastal, Hudson Valley, Mohawk Valley, Champlain Valley, St. Lawrence Valley, Great Lakes, and Central Lakes (NOAA 2016a). Rockland County is located in the Hudson Valley Climate Division.

The New York State Department of Environmental Conservation (NYSDEC) has divided New York State into nine drought management regions based roughly on drainage basins and county lines. NYSDEC monitors precipitation, lake and reservoir levels, stream flow, and groundwater level at least monthly in each region and more frequently during periods of drought. NYSDEC uses this data to assess the condition of each region, which can range from "normal" to "drought disaster" (NYSDEC 2016a). Figure 5.4.1-1 shows the drought regions of New York State with Rockland County circled. Rockland County is located within the Catskills Drought Region (Region II).

Figure 5.4.1-1. Drought Regions of New York State



Source: NYSDEC 2016b

Note: The red circle indicates the location of Rockland County

Extent

The severity of a drought depends on the degree of moisture deficiency, the duration, and the size and location of the affected area. The longer the duration of the drought and the larger the area impacted, the more severe the potential impacts (NOAA 2000). The NYSDEC and the New York State Drought Management Task Force identifies droughts in the following four stages:

- **Normal** is considered the standard moisture soil levels found throughout New York State
- **Drought Watch** is the first stage of drought. This stage is declared by the NYSDEC and is intended to give advance notice of a developing drought. As this stage, the general public is urged to conserve water. Public water purveyors and industries are urged to update and begin to implement individual drought contingency plans.
- **Drought Warning** is the second stage of drought. This stage is also declared by the NYSDEC and is a notice of impending and imminent severe drought conditions. A warning declaration includes stepping up public awareness and increasing voluntary conservation. Public water supply purveyors and industries are urged to continue to implement local drought contingency plans. Federal, state and local water resources agencies are notified to prepare for emergency response measures.
- **Drought Emergency** is the third stage of drought. This stage is declared by the NYSDHSES, based upon recommendation of the Task Force. It is a notice of existing severe and persistent drought conditions. An emergency declaration is a notice for local water resources agencies to mandate conservation and implement other emergency response measures. A continuing and worsening drought emergency may result in the New York State governor declaring a drought disaster. It is a notice of the most severe and persistent drought conditions. At this stage, a significant proportion of communities in the impacted area likely are unable to respond adequately (NYSDHSES 2014).

New York State uses two methodologies to determine the various drought stages. The Palmer Drought Index (PDI) is a commonly used drought indicator and is primarily based on soil conditions. These are typically the first indicators that a moisture deficit is present. These values range from -5 to +5 with positive values indicating wetter conditions and negative values representing drier conditions (NYS DHSES 2014).

The second methodology used by New York State was developed by the NYSDEC and is referred to as the State Drought Index (SDI). The SDI evaluates drought conditions on a more comprehensive basis by measuring whether numerous indicators reach dire thresholds. The data collected is compared against critical threshold values to show a normal or changeable drought condition. The indicators are weighted on a regional basis to reflect the unique circumstances of each drought management region (NYS DHSES 2014).

Previous Occurrences and Losses

Between 1954 and 2016, New York State experienced one FEMA declared drought-related major declaration (DR) classified as a water shortage. Generally, these disasters cover a wide region of the State; therefore, they may have impacted many counties. Rockland County was included in this declaration (FEMA 2016).

Agriculture-related drought disasters are quite common. One-half to two-thirds of the counties in the U.S. have been designated as disaster areas in each of the past several years. The USDA Secretary of Agriculture is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in counties that are contiguous to a designated county. Between 2012 and mid-2016, New York State has been included in 41 USDA declarations. Of those 41 declarations, Rockland County has been included in seven of the declarations; however, only two of them were a result of drought conditions (S3427 in 2012 and S3759 in 2014).

For this 2016 Plan Update, known drought events, including FEMA and USDA disasters, that have impacted Rockland County between 2005 and 2016 are identified in Table 5.4.1-1. For events prior to 2005, refer to the 2010 Rockland County Multi-Jurisdictional Hazard Mitigation Plan. Please note that not all events that have occurred in the 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 Update.

Table 5.4.1-1. Drought Events Impacting Rockland County, 2005 to 2016

Dates of Event	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Losses / Impacts
July – December 2012	Drought	N/A	N/A	The Governor of New York State issued a statewide ban on outdoor residential brush burning due to dry weather and elevated fire danger. Emergency personnel were at a higher state of readiness for wildfire outbreaks. The lack of snowfall during the winter lead to an increase in the dryness. Some areas of New York State received only 25% of average rainfall during the spring and early summer. The heat and drought during July jeopardized second and third cuttings of hay in the State. Additionally, the dryer weather brought a higher incidence of mosquitoes with West Nile Virus to parts of New York State. There were 107 reported cases of West Nile Virus and nine deaths across the State. The USDA included Rockland in a disaster declaration for this event (S3427).
2014	Drought	N/A	N/A	The USDA included Rockland County in a disaster declaration for the 2014 drought (S3759).
2016	Drought	N/A	N/A	On August 3 rd , Governor Cuomo directed NYSDEC to issue a Drought Warning for Drought Regions VI, VII and VIII. A Drought Watch was issued for regions I, II, IIA, III, IV, and V (declared July 15th). Residents were encouraged to voluntarily conserve water. In Rockland County, on July 21 st , County Executive Ed Day and Commissioner of Health Dr. Ruppert declared a Stage II water Emergency which resulted in mandatory limitations on water used by residents and businesses.

Source(s): FEMA 2016; NYSDHSES 2014; NOAA-NCEI 2016b; USDA 2016; NYSDEC 2016c; Rockland County 2016

FEMA Federal Emergency Management Agency
 NCEI National Centers for Environmental Information
 NOAA National Oceanic and Atmospheric Administration
 NYSDEC New York State Department of Environmental Conservation
 NYSDHSES New York State Division of Homeland Security and Emergency Services
 USDA U.S. Department of Agriculture

Probability of Future Occurrences

Based upon risk factors for and past occurrences, it is likely that droughts will occur across New York State and Rockland County in the future. In addition, as temperatures increase (see climate change impacts), the probability for future droughts will likely increase as well. Therefore, it is likely that droughts will occur in the State and County of varied severity in the future.

According to the 2014 New York State Hazard Mitigation Plan Update, between 1960 and 2012, Rockland County had one drought event that resulted in over \$185,000 in crop damage. These statistics showed that the County had a 2% chance of droughts occurring in the future with a recurrence interval of 52 (NYS DHSES 2014). However, according to the NOAA National Centers for Environmental Information (NCEI) database, Rockland County experienced 10 drought events between 1950 and 2015. The table below shows these statistics, as well as the annual average number of events and the percent chance of these individual drought hazards occurring in Rockland County in future years (NOAA NCEI 2016b).

Table 5.4.1-2. Probability of Future Occurrence of Drought Events

Hazard Type	Number of Occurrences Between 1950 and 2015	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Probability of Event in any given year	% chance of occurrence in any given year
Drought	10	0.15	6.60	0.15	15.15

Source: NOAA NCEI 2016b

It is estimated that Rockland County will continue to experience direct and indirect impacts of drought and its impacts on occasion, with the secondary effects causing potential disruption or damage to agricultural activities and creating shortages in water supply within communities.

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 hazard rankings. Based on historical records and input from the Planning Committee, the probability of occurrence for drought in the County is considered ‘frequent’ (likely to occur within 25 years, as presented in Table 5.3-3).

Climate Change Impacts

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, which may experience declines in popular apple varieties and in winter recreation opportunities, among other issues, due to climate change (NYSERDA 2011). In Region 2, it is estimated that temperatures will increase by 3.1°F to 6.9°F by the 2050s and 4.0°F to 10.7°F by the 2080s (baseline of 50.0°F). Precipitation totals will increase between 1 and 14% by the 2050s and 2 to 18% by the 2080s (baseline of 46.0 inches). Table 5.4.1-3 displays the projected seasonal precipitation change for the Catskill Mountains and West Hudson River Valley ClimAID Region (NYSERDA 2014).

Table 5.4.1-3. 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

The frequency of heat waves and drought are also projected to increase in Region 2. 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). Table 5.4.1-4 displays the projected changes in these events and includes the minimum, central range and maximum days per year.

Table 5.4.1-4. Changes in Extreme Events in Region 3 – Heat Waves and Drought Conditions

Event Type	# Days Per Year	Baseline	2020s	2050s	2080s
Heat Waves	Number of Days per year with maximum temperature exceeding: minimum, (central range), and maximum				
	90°F	12 days	16 (19 to 25) 27	24 (31 to 47) 56	31 (38 to 77) 85
	Number of heat waves per year	1 event	2 (3 to 3) 4	3 (4 to 6) 8	4 (5 to 9) 9
	Average duration	4 days	4 (5 to 5) 5	5 (5 to 6) 6	5 (5 to 7) 8

Source: NYSERDA 2011

5.4.1.2 Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed or vulnerable in the identified hazard area. For the drought hazard, all of Rockland County has been identified as exposed. Therefore, all assets in the County (population, structures, critical facilities and lifelines), as described in the County Profile (Section 4), are exposed and potentially vulnerable to a drought. The following text evaluates and estimates the potential impact of the drought 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 Hazard Mitigation Plan
- Further data collections that will assist understanding this hazard over time

Overview of Vulnerability

The entire County is vulnerable to drought. However, areas at particular risk are areas used for agricultural purposes (farms and cropland), open/forested land vulnerable to the wildfire hazard, densely-populated areas where communities rely on surface water supplies (above ground reservoirs) for industrial, commercial, and domestic purposes, and certain areas where elderly, impoverished or otherwise vulnerable populations are located.

Vulnerable populations could be particularly susceptible to the drought hazard and cascading impacts due to age, health conditions, and limited ability to mobilize to shelter, cooling and medical resources.

Data and Methodology

Data was collected from USDA, NOAA-NCEI, Rockland County, and the Steering and Planning Committees. Insufficient data was available to model the long-term potential impacts of a drought on the County. Over time, additional data will be collected to allow better analysis for this hazard. Available information and a preliminary assessment are provided below.

Impact on Life, Health and Safety

Droughts may have devastating effects on communities and the surrounding environment. The amount of devastation depends on the strength and duration of a drought event. One impact of drought is its impact on water supply. When drought conditions persist with little to no relief, water restrictions may be put into place by local or state governments. These restrictions can include watering of lawns, washing cars, etc. In exceptional drought conditions, watering of lawns and crops may not be an option. If crops are not able to receive water, farmland will dry out and crops will die. This can lead to crop shortages, which, in turn, increases the price of food (North Carolina State University 2013).

Droughts also have the potential to lead to water pollution due to the lack of rain water to dilute any chemicals in water sources. Contaminated water supplies may be harmful to plants and animals. If water is not getting into the soils, the ground will dry up and become unstable. Unstable soils increase the risk of erosion and loss of top soil (North Carolina State University 2013).

The impacts on public health from drought can be severe which includes increase in heat-related illnesses, waterborne illnesses, recreational risks, limited food availability, and reduced living conditions. Those individuals who rely on water, such as farmers, may experience financial-related stress. Decreased amounts and quality of water during drought events have the potential to reduce the availability of electricity (hydropower, coal-burning and nuclear) (North Carolina State University 2013).

Drought conditions can affect people's health and safety including health problems related to low water flows and poor water quality; and health problems related to dust. Droughts also have the potential to lead to loss of human life (NDMC 2016). Other possible impacts to health due to drought include increased recreational risks; effects on air quality; diminished living conditions related to energy, air quality, and sanitation and hygiene; compromised food and nutrition; and increased incidence of illness and disease. Health implications of drought are numerous. Some drought-related health effects are short-term while others can be long-term (CDC 2012).

As previously stated, drought conditions can cause shortages in water for human consumption. Droughts can also lead to reduced local firefighting capabilities. The drought hazard is a concern for Rockland County because the County's water supply comes from both groundwater and surface water supplies. Additionally, some the County's water supplies communities in New Jersey (Rockland County Comprehensive Plan 2011). Nearly all the water supply for the County is derived from precipitation that falls within the County borders. Periods of below average precipitation can result in mandatory water restrictions. In the short-term, surface water supplies are affected more quickly during droughts than groundwater sources.

Impact on General Building Stock

No structures are anticipated to be directly affected by a drought event. However, droughts contribute to conditions conducive to wildfires and reduce fire-fighting capabilities. Risk to life and property is greatest in those areas where forested areas adjoin urbanized areas (high density residential, commercial and industrial) also known as the wildfire urban interface (WUI). Therefore, all assets in and adjacent to, the WUI zone, including

population, structures, critical facilities, lifelines, and businesses are considered vulnerable to wildfire. Refer Section 5.4.8 for the Wildfire risk assessment.

Impact on Critical Facilities

Water supply facilities may be affected by short supplies of water. As mentioned, drought events generally do not impact buildings; however, droughts have the potential to impact agriculture-related facilities and critical facilities that are associated with potable water supplies.

Impact on the Economy

When a drought occurs, the agricultural industry is most at risk in terms of economic impact and damage. During droughts, crops do not mature leading to a lessened crop yield, wildlife and livestock are undernourished, land values decrease, and ultimately there is financial loss to the farmer (FEMA 1997).

Based on the 2012 Census of Agriculture, there were 23 farms in Rockland County, with 526 acres of total land in farms. The average farm size was 23 acres. Rockland County farms had a total market value of products sold of over \$1.6 million in crop sales and \$60,000 in livestock sales), averaging \$75,390 per farm. The Census indicated that 15 of farm operators reported farming as their primary occupation (USDA 2012). Although the number of farms is small, it has been noted that agriculture is important to Rockland County and its municipalities (Rockland County HMP 2010). Table 5.4.2-4 shows the acreage of agricultural land exposed to the drought hazard.

Table 5.4.1-5. Agricultural Land in Rockland County in 2012

Number of Farms	Land in Farms (acres)	Total Cropland (acres)	Harvested Cropland (acres)	Irrigated Land (acres)
23	526	220	195	73

Source: USDA 2012

The 2012 Census of Agriculture for Rockland County indicated that the top crop items, by acres, in the County are apples (77 acres) and sweet corn (27 acres) (USDA 2012).

A prolonged drought can have a serious economic impact on a community. Increased demand for water and electricity may result in shortages and a higher cost for these resources (FEMA 2005). Industries that rely on water for business may be impacted the hardest (e.g., landscaping businesses). Even though most businesses will still be operational, they may be impacted aesthetically. These aesthetic impacts are most significant to the recreation and tourism industry. As stated above, if there are periods of lower than average precipitation in the County, mandatory water restrictions may be enforced. These water restrictions are viewed in the County as having a significant impact on commercial nurseries and the landscaping industry (Rockland County HMP 2010). In addition, droughts in another area could impact the food supply/price of food for residents in the County.

Future Growth and Development

As discussed in Section 4, areas targeted for future growth and development have been identified across Rockland County. Future growth could impact the amount of potable water available due to a drain on the available water resources. Other areas that could be impacted include agriculture and recreational facilities such as golf courses, farms, and nurseries. Areas targeted for potential future growth and development in the next five (5) years have been identified across the County at the municipal level. Refer to the jurisdictional annexes in Volume II of this HMP.

Effect of Climate Change on Vulnerability

Nearly every region in the country is facing some increased risk of seasonal drought. Climate change can significantly affect the sustainability of water supplies in the future. As parts of the United States get drier, the amount and quality of water available will likely decrease, impacting people's health and food supplies. With climate change, the entire country will likely face some level of drought. A report by the Natural Resources Defense Council (NRDC) found that 1,100 counties (one-third of all counties in the contiguous 48 states) face higher risks of water shortages by mid-century as a result of climate change. More than 400 of these counties will face extremely high risks of water shortages.

Change of Vulnerability

When examining the change in the County's vulnerability to drought events from the original HMP to this update, it is important to look at each entity that is exposed and vulnerable. The total population across the County has continued to increase over the past few years, which will place a greater stress on the water supply during a drought event. In terms of the agricultural industry for Rockland County, there has been a 10% increase in the total number of farms since 2007 (USDA 2012).

Additional Data and Next Steps

For the Plan Update, any additional information regarding localized concerns and past impacts will be collected and analyzed. This data will be developed to support future revisions to the plan. Mitigation efforts could include building on existing New York State, Rockland County, and local efforts.