5.4.4 Expansive Soils

This section provides a profile and vulnerability assessment for the expansive soils hazard.

Hazard Profile

This section provides profile information including description, extent, location, previous occurrences and losses and the probability of future occurrences.

Description

Soils and soft rock that tend to swell or shrink due to changes in moisture content are known as expansive soils. Expansive soils are often referred to as swelling clays because clay materials are most susceptible to swelling and shrinking. Changes in soil volume present a hazard primarily to structures built on expansive soils. The most extensive damage occurs to highways and streets (FEMA, 1997).

In the U.S., two major groups of rocks serve as parent materials of expansive soils and more common in the western portion of the country. The first group consists of ash, glass, and rocks of volcanic origin. The aluminum silicate minterals in these volcanic materials often decompose to form expansive clay minerals, known as montmorillonite. The second group consists of sedimentary rocks containing clay minerals, for example the shales of the semiarid west-central states (FEMA, 1997).

According to the New York State Hazard Mitigation Plan (NYS HMP) 2014 update, expansaive soils are any soil that expands when wet and shrinks when dry. Soils are tested using an accepted standard of measurement to determine swell potential. Expansive soils can exert pressures up to 14,000 pounds per foot, causing the breakdown of building foundations and structural integrity. Roadbeds may also be affected and could lead to avalanche and collapse when cutting into mountains and hillsides (NYS DHSES 2013).

Expansive soils contain minerals, such as smectite clays, that are capable of absorbing water. As these clays absorb water, they increase in volume. The more water absorbed the more their volume increases. Expansions of 10% or more are not uncommon. This change in volume can exert enough force on a building or other structure to cause damage. When dry, expansive soils shrink and can remove support from buildings or other structures and result in damaging subsidence. Fissures in the soil can also develop. Fissure can facilitate the deep penetration of water when moist conidtiosn or runoff occurs. This produces a cycle of shrinkage and swelling that places repetitive stress on structures (NYS DHSES 2013).

Issues associated with expansive soils include:

- Foundation cracks
- Heaving and cracking on floor slabs and walls
- Jammed doors and windows
- Ruptured pipelines
- Heaving and cracking of sidewalks and roads
- Damage to the upper floors of the building (when motion in the structure is significant) (NYS DHSES 2013)

Extent

The extent to which soil expansion is present in an area or site can be measured using the Soil Expansion Potential standard (ASTM D-4829). The expansion index (EI) provides an indication of swelling potential of a compacted soil. The EI test is not used to duplicate any particular field conditions such as soil density, water content, loading, in-place soil structure, or soil water chemistry.

Table 5.4.4-1. Soil Expansion Index

Expansion Index	Potential Expansion
0-20	Very Low
21-50	Low
51-90	Medium
91-130	High
>130	Very High

Source: ASTM 2013
Note: The Uniform Building Code (UBC) mandates that special foundation design consideration be employed if the EI is 20 or greater.

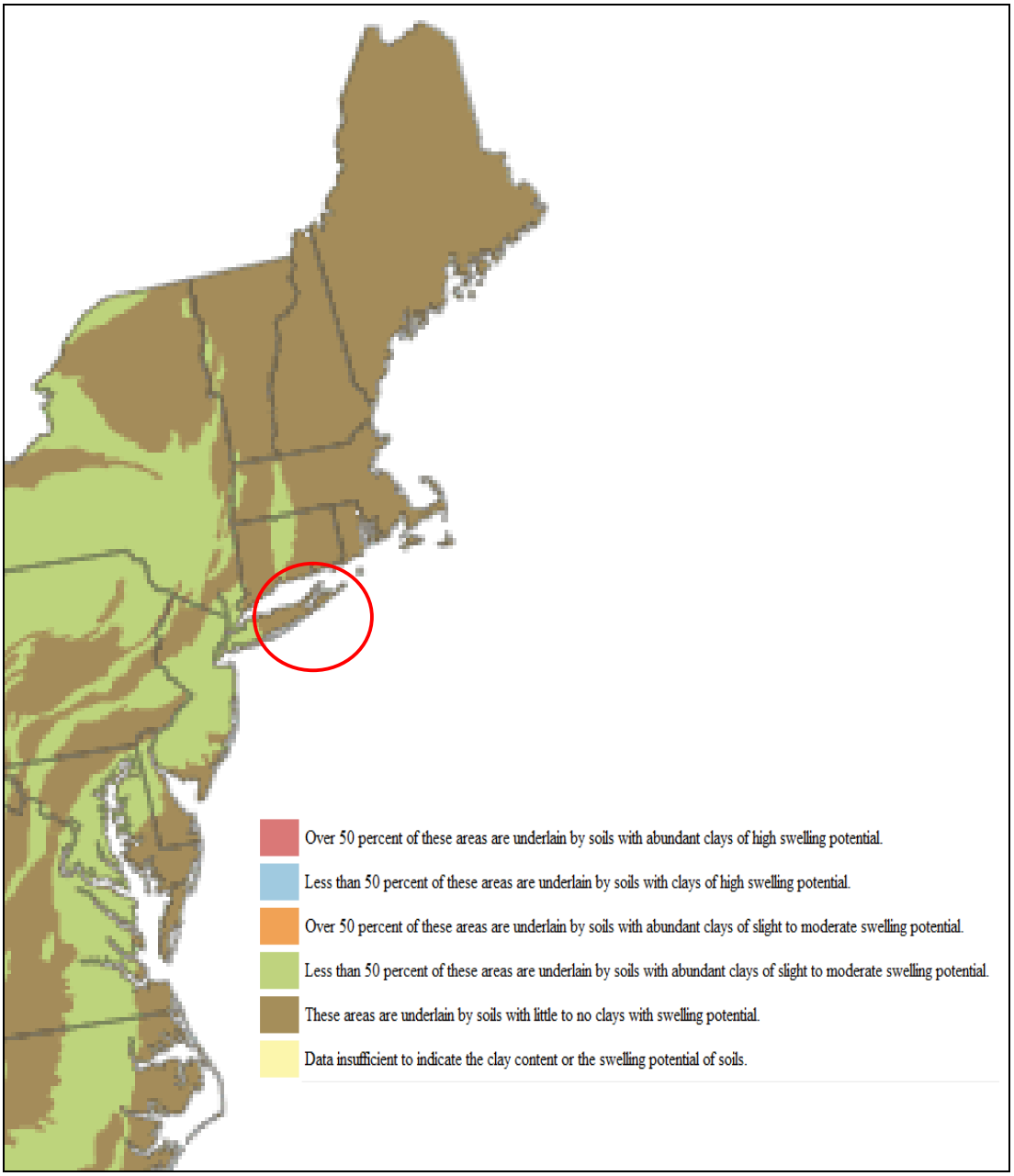
Based on the expansion potential rating, mitigation may be required for building construction or repairs. The UBC mandates that special foundation design consideration be employed if the EI is 20 or greater. The New York Residential Building Code (Section R403.1.8) addresses consideration of expansive soils. Construction dangers are reduced when engineers incorporate cement or lime or other salts into expansive soils. These help to lessen the effects of expansion. Other methods of reducing expansive soil danger include replacing the top three to four feet of expansive soil with non-expansive soils or compacting existing expansive soil.

Location

Expansive soils are present throughout the world and are found in every state in the U.S. It is estimated that one-quarter of all homes in the U.S. have some damage caused by expansive soils (NYS DHSES 2013). Figure 5.4.4-1 shows the geographic distribution of expansive soils in the eastern U.S. The figure includes soils that have a clay mineral composition which can potentially cause damage.

The figure shows that New York State's soils are determined to be of two types, either fairly low or swelling potential. Less than 50% of the northeast region (Adirondack Mountains) and the northwest region (Lake Plains along the south shore of Lake Ontario) are underlain by soils with clays of high swelling potential. The remainder of the State is underlain by soils with little to no clays with swelling potential (NYS DHSES 2013). The vast majority of Suffolk County is underlain by soils with little to no clays with swelling potential. The exception to this is the Town of Smithtown, in which less than 50 percent of the town is underlain by soils with abundant clays of slight to moderate swelling potential.

Figure 5.4.4-1. Expansive Soils of the U.S.



Source: *Geology.com, Date Unknown*
Notes: *The red circle indicates the approximate location of Sufolk County. The figure indicates that Suffolk County is underlain by soils with little to no clays with swelling potential.*

Previous Occurrences and Losses

There have been no federally-declard disasters for expansive. According to the New York State Geological Survey (NYSGS), historical records including scientific study data for land subsidence in the State is either sparse, not readily available, or does not exist in summary form. There may have been instances of expansive soils causing damage but have not been reported (NYS DHSES 2013).

In Suffolk County, only one reported occurrence was reported in Smithtown. On January 15, 2013, a water main broke creating a giant gaping sink hole that damaged a vehicle. There were no injuries reported and only 26 residences were without water for a few hours (NYS DHSES 2013).

Probability of Future Events

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 expansive soils in the Planning Area is considered 'rare' (hazard event that occurs from once in 100 years to once in 1,000 years). Although no reported incidences have occurred within the County, it is anticipated that Suffolk County will experience indirect impacts from expansive soils that may affect the general building stock, local economy and may induce secondary hazards such ignite fires and cause utility failure.

Climate Change Impacts

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. Suffolk County is part of Region 4, New York City and Long Island. Some of the issues in this region, affected by climate change, include: the area contains the highest population density in the State; sea level rise and storm surge increase coastal flooding, erosion, and wetland loss; challenges for water supply and wastewater treatment; increase in heat-related deaths; illnesses related to air quality increase; and higher summer energy demand stresses the energy system (NYSERDA, 2011).

Temperatures and precipitation amounts are expected to increase throughout the State, as well as in Region 4. It is anticipated that by the 2020s, the State's temperature will rise between 1.5 and 3ºF; 3 to 5.5ºF by the 2050s; and 4 to 9ºF by the 2080s. The lower ends of these ranges are for lower greenhouse gas emissions scenarios and the higher ends for higher emission scenarios (NYSERDA, 2011).

In Region 4, it is estimated that temperatures will increase by 3ºF to 5ºF by the 2050s and 4ºF to 7.5ºF by the 2080s (baseline of 53ºF). Precipitation totals will increase between 0 and 10% by the 2050s and 5 to 10% by the 2080s (baseline of 43 inches). Table 5.4.4-2 displays the projected seasonal precipitation change for the New York City and Long Island ClimAID Region (NYSERDA, 2011).

Table 5.4.4-2. Projected Seasonal Precipitation Change in Region 4, 2050s (% change)

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

Source: NYSERDA, 2011

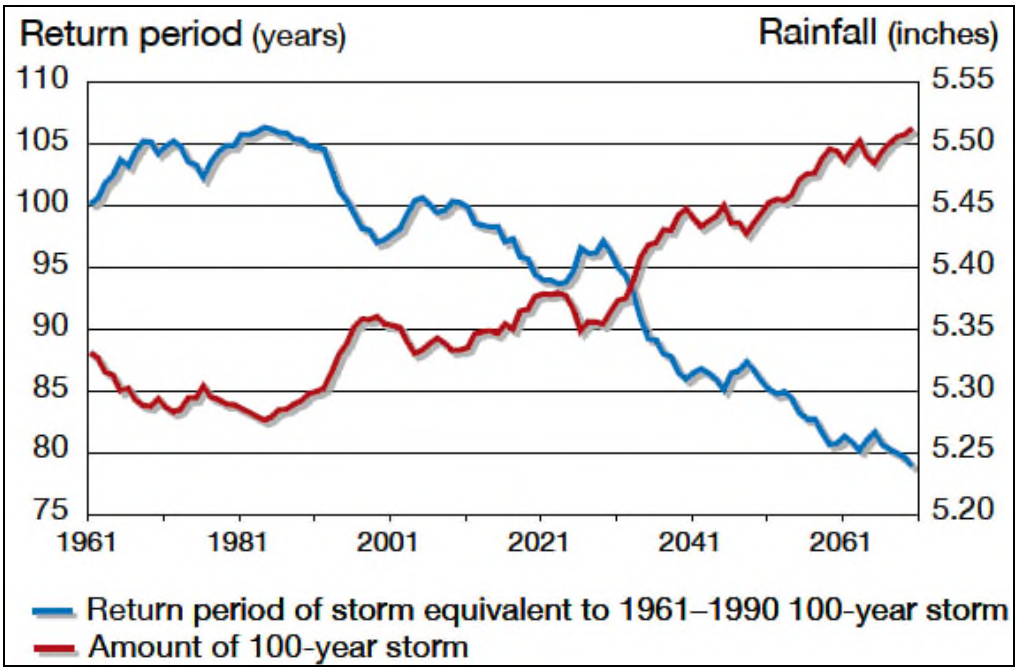
The projected increase in precipitation is expected to fall in heavy downpours and less in light rains. The increase in heavy downpours has the potential to affect drinking water; heighten the risk of riverine flooding; flood key rail lines, roadways and transportation hugs; and increase delays and hazards related to extreme weather events (NYSERDA, 2011).

Increasing air temperatures intensify the water cycle by increasing evaporation and precipitation. This can cause an increase in rain totals during events with longer dry periods in between those events. These changes can have a variety of effects on the State's water resources (NYSERDA, 2011).

Over the past 50 years, heavy downpours have increased and this trend is projected to continue. This can cause an increase in localized flash flooding in urban areas and hilly regions. Flooding has the potential to increase pollutants in the water supply and inundate wastewater treatment plants and other vulnerable facilities located within floodplains. Less frequent rainfall during the summer months may impact the ability of water supply systems. Increasing water temperatures in rivers and streams will affect aquatic health and reduce the capacity of streams to assimilate effluent wastewater treatment plants (NYSERDA, 2011).

Figure 5.4.4-2 displays the project rainfall and frequency of extreme storms in New York State. The amount of rain fall in a 100-year event is projected to increase, while the number of years between such storms (return period) is projected to decrease. Rainstorms will become more severe and more frequent (NYSERDA, 2011).

Figure 5.4.4-2. Projected Rainfall and Frequency of Extreme Storms



Source: NYSERDA, 2011

Total precipitation amounts have slightly increased in the Northeast U.S., by approximately 3.3 inches over the last 100 years. There has also been an increase in the number of two-inch rainfall events over a 48-hour period since the 1950s (a 67-percent increase). The number and intensity of extreme precipitation events are increasing in New York State as well. More rain heightens the danger of localized flash flooding, streambank erosion and storm damage (Cornell University College of Agriculture and Life Sciences, 2011).

As previously stated, as expansive soils absorb more water, they increase in volume, creating the potential to exert enough force on a building or other structure to cause damage. When expansive soils are dry, they shrink and can remove support from buildings or other structures, resulting in damaging subsidence. Temperatures and precipitation amounts are expected to increase throughout New York State; thus, increasing the risk of impacts from potential soils.

Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed or vulnerable in the identified hazard area. The following text evaluates and estimates the potential impact of expansive soils on Suffolk 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 2008 Suffolk County Hazard Mitigation Plan
- Further data collections that will assist understanding this hazard over time

Overview of Vulnerability

Soils and soft rock that tend to swell or shrink due to changes in moisture content are commonly known as expansive soils. Changes in soil volume present a hazard primarily to structures built on top of expansive soils. The most extensive damage occurs to highways and streets. Expansive soil hazards are slow to develop but can cause a range of structural impacts. Damage to residential homes, commercial buildings, highways, and streets can cause a financial drain on the local and regional economy. Suffolk County is underlain by nonexpansive materials and contains little to no swelling clay; therefore, occurrence of expansive materials is extremely limited and impacts are rare.

Data and Methodology

At the time of this HMP update, insufficient data was available to model the long-term potential impacts of expansive soils, if any, 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

Based on previous occurrences and severity, impacts to life, health and safety are minimal for expansive soils. Suffolk County identified expansive soils has a hazard of concern; however, the County is underlain by nonexpansive materials that poses very low to no risk to the population.

Impact on General Building Stock and Critical Facilities

Because of differences in building construction, residential structures and one-story commercial structures are more susceptible to damage by expansive soils compared to multi-story buildings. Multi-story buildings are heavier and can generally counter the swelling pressures. The exception is when multi-story buildings are built on wet clay, and may experience damage by shrinkage of the clay if moisture levels are substantially reduced (be evapotranspiration or by evaporation from under heated buildings) (FEMA, 1997).

Various types of structural damage to buildings include sticking doors; uneven flooring; and cracked foundations, floors, walls, ceilings and windows. Damage to small buildings is greatest when the structure is built on dry clay, such as during drought conditions, followed by rain which swells the soil. Human activities can also influence the moisture of the soils including an increase in moisture from broken or leaking water and sewer lines, watering the landscaping, and surface ponding (FEMA, 1997).

According to FEMA's *Multi Hazard Identification and Risk Assessment*, the best way to mitigate structural damage from expansive soils is to avoid building on them. However, when this is not possible, engineering practices can be applied including removal of the soil; application of heavy loads to offset the swelling pressure; preventing access to water; presetting and chemical stabilization (FEMA, 1997).

Property maintenance to prevent excessive moisture from entering the soil near foundations should be implemented for owners of buildings in areas of expansive soils. This would include proper grading and keeping gutters/downspouts clear of debris and not discharging adjacent to the foundation. In addition, inspection of the property after heavy rainfall to address drainage issues should also be put into practice.

Impact on the Economy

As summarized by FEMA, the greatest damage from expansive soils is to highways and roads. Damages result from differential vertical movement that occurs as clay moisture content adjusts to the changed environment. For pavement, differential movement of 0.4 inches with a horizontal distance of 20 feet can pose an engineering problem for fast travel (FEMA, 1997). Infrastructure damage is costly and can impact the local and regional economy.

Future Growth and Development

As discussed and illustrated in Section 4, areas targeted for future growth and development have been identified across the County. Any new development in terms of structures and infrastructure (i.e., highways and streets) on known expansive soils could be potentially impacted. Proper grading and building regulations/code including proper slab design and emplacement procedures can mitigate structural damage to new development in areas where expansive soils exist. In most cases, structural damage due to expansive soils is not covered by insurance (FEMA, 1997). Refer to the jurisdictional annexes in Volume II of this HMP.

Effects of Climate Change on Vulnerability

The potential effects of climate change on Suffolk County's vulnerability to expansive soil events needs to be considered as a greater understanding of regional climate change impacts develop.

Additional Data and Next Steps

For future plan updates, any additional information regarding localized concerns, identifying and mapping the extent of expansive soil areas, and past impacts will be collected and analyzed. The data will be developed to support future revisions to the plan. Mitigation efforts could include building on existing New York State, Suffolk County, and local efforts.