New York State Comptroller
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New York's Local Governments Adapting to Climate Change:

Challenges, Solutions and Costs

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Executive Summary

Rising global temperatures are fueling extreme weather, deadly heat waves, excessive drought, crop failure, and other economic and public health catastrophes.

In 2022, the Office of the New York State Comptroller (OSC) conducted a survey of the State's 353 Climate Smart Communities* to assess their actual spending over the prior five years and anticipated spending over the next five on changes to buildings, roads, bridges and other critical infrastructure associated with climate change. The Office of the State Deputy Comptroller (OSDC) separately worked with New York City to get a broad sense of its spending on similar projects.

Survey Results From 95 Climate Smart Communities

The 95 local governments responding to the survey reported a total of $1.34 billion in actual and anticipated expenditures between 2017 and 2026 on projects. They estimated that about 55 percent ($737 million) of this total was in response to climate change-related hazards, with flooding and increased storm activity far outweighing other hazards.

Respondents had funded or anticipated funding about 52 percent of these costs locally, with grants or other aid from State and federal sources accounting for the remainder.

OSC used this information to calculate the local cost of adapting to climate change in these communities. This totaled $384 million during the ten-year period, with State and federal taxpayers funding an additional $182 million and $171 million, respectively.

The survey asked for information on projects in ten action categories. The most commonly reported actions were:

- Planting trees or other vegetation (46 respondents reported projects in this category);
- Enlarging culverts (44);
- Rebuilding or retrofitting critical infrastructure other than buildings (42); and
- Retrofitting municipal buildings (41).

The most expensive category was rebuilding or retrofitting critical infrastructure other than buildings. This category included major changes to wastewater treatment facilities, which were especially expensive to address. This action category cost $632 million in total, $401 million (64 percent) of which was attributed to climate change adaptation. The local cost of these totaled $368 million, with $235 million attributed to climate change.

The second most expensive action category was dependent on what was being measured:

- Total cost: relocating or demolishing buildings ($136 million);
- Climate change-related cost: enlarging or replacing culverts ($59 million);
- Local cost: relocating or demolishing municipal buildings or other infrastructure ($62 million); and
- Local costs attributed to climate change: building protective structures ($35 million).

*Climate Smart Communities is a New York State program that supports local governments in leading their communities to reduce greenhouse gas emissions, adapt to the effects of climate change, and thrive in a green economy. At the time the survey was administered, there were 353 communities in the program. As of April 6, 2023, there were 376.

New York City Results

Unlike many other local governments participating in the survey, New York City is vulnerable to sea-level rise, nor'easters, post-tropical cyclones, and extreme heat and precipitation, and has been experiencing more frequent and intense storms and flooding.[1] Given its location on the coast, population, property values and extensive underground subway system, the City has a particularly well-established and long-standing interest in adaptation and resilience, with a more complex framework and significantly larger budget than the other local governments in the survey.

The Office of the State Deputy Comptroller for the City of New York consulted with local officials and arrived at estimates for planned capital commitments to cover projects that either fully or partially address adaptation or resilience needs, or have the potential to address such needs.[2] Planned commitments for projects that were not assigned to either of these categories were included in a fourth category, considered unlikely to include adaptation and resilience measures. While OSC used this approach of assigning planned commitments to one of four categories, the City is developing a strategic analysis to more precisely determine its resiliency spending.

The OSC analysis, which focused on the City's budget and did not include planned spending by other levels of government, showed that the City's capital commitment plan for FY 2023 alone included $829 million for projects that can be considered full adaptation and resilience and another $1.3 billion that was partially for these purposes. Furthermore, the plan showed commitments for adaptation and resilience (including those that are either fully or partially for this purpose) averaging $1.8 billion or 9.7 percent of average annual commitments for all capital projects for FY 2023 through FY 2026.

Among the projects considered either full or partial adaptation and resilience, the biggest cost drivers were sewer projects ($2.3 billion over the four years), water pollution control ($1.8 billion) and the broad category of resiliency, technology and equipment ($1.6 billion). Planned commitments for sewer to include storm and combined sewer projects as well as work on green infrastructure and bluebelts.[3]

Introduction

Climate change poses an existential threat to virtually every aspect of the living, built and natural world. Temperatures are rising at alarming rates, extending droughts. Shifting seasonal patterns are disrupting growing seasons and agricultural practices. More frequent and increasing powerful and destructive storms, flooding and rising sea levels are increasingly threatening coastal and inland communities, impacting lives, property, wildlife, natural resources and more. All are expected to accelerate in the years ahead.[4]

Global and national actions are needed to achieve the goals of the Paris Climate Agreement to reduce future climate change, but changes are already affecting communities around the world. A report prepared for the New York State Energy Research and Development Authority's (NYSERDA) "ClimAID" report *(Integrated Assessment for Effective Climate Change Adaptation Strategies in New York State)* estimated that climate change costs in New York State could approach $10 billion *annually* by midcentury.[5]

Adapting to these changes can take two major forms: increased maintenance or replacement of infrastructure and goods damaged by climate change-related events, or proactively changing the design of infrastructure to make it less susceptible to those events (including, in some cases, moving development to less susceptible areas). Both cost money, and it can be particularly difficult to find the funding for the latter type of spending. However, proactive adaptation costs substantially less over time: a recently updated FEMA study estimated that spending $1 on natural hazard mitigation up front saves between $4 and $7 (depending on the action measured) in future damages.[6]

New York State has taken important actions to tackle the challenges of climate change, both in terms of adapting to increasing natural hazards and helping with national and global efforts to reduce emissions:

- **2014 Community Risk and Resiliency Act (CRRA)** – Requires applicants for permits/ funding in a number of specified permitting and funding programs to demonstrate that future physical climate risks due to sea-level rise, storm surge and flooding have been considered in the project designs.[7]
- **2019 Climate Leadership and Community Protection Act (CLCPA)** – Requires New York to reduce economy-wide greenhouse gas emissions 40 percent by 2030, and no less than 85 percent by 2050, from 1990 levels. It also expands consideration of climate change resiliency measures to environmental justice issues. The CLCPA Scoping Plan (released December 2022) outlines key strategies for adaptation and resilience, such as planning, infrastructure resilience and natural systems protection. The plan recommends technical assistance to local governments from, among others, the New York State Department of Environmental Conservation (NYSDEC) and NYSERDA.[8]
- **2022 Clean Water, Clean Air and Green Jobs Environmental Bond Act** – Authorizes the sale of State bonds up to $4.2 billion to fund climate change mitigation, flood risk reduction, water quality improvement and open space land conservation.[9]

New York's local governments are also having to address the impacts and challenges of climate change and adapt their built environments. They are affected by these changes in several ways. First, they maintain important infrastructure, including 85 percent of the State's road network and the vast majority of its utilities, including drinking water systems, wastewater treatment plants, sewers and stormwater systems.[10] To the extent these are being affected by climate change, taxpayers face increasing costs and users may experience decreased quality of life. Second, local governments provide and/or maintain many of the services that must be at the ready in emergencies like storms and other extreme weather, including first responders, such as fire fighters and police.

Yet, until now, little has been done to assess the cost of either response to existing changes or to investments in resilience at the local government level. Even in the case of New York City, which has incorporated resiliency into its larger planning process for many years, spending specifically on climate change adaptation can be difficult to ascertain.

To rectify this lack of information, OSC surveyed a subset of local governments that are already focused on climate change issues, the State's 353 registered NYS Climate Smart Communities.[11] Of the 353 Climate Smart Communities that received surveys, 95 responded. These 95 local governments include 8 counties, 11 cities, 41 towns and 35 villages.[12] In addition, OSC's Office of the State Deputy Comptroller for New York City consulted with local officials and generated specific estimates for the City's investment in adaptation and resilience.

In the survey, each local government outside of New York City was asked about whether it had any projects to report in any of nine possible action areas. A copy of the survey form is available **here**.[13] These were based loosely on "hazard-specific actions" identified by the U.S. Federal Emergency Management Agency as critical to adapting to specific climate change hazards, with modifications to make the survey more pertinent to New York local governments, described in detail in the next section.[14] Within each action, local governments were asked to:

1. Describe specific projects undertaken in the past five years or planned in the next five years (roughly FYE 2017 to 2027, although respondents were given the opportunity to note if a project was started prior to this period or anticipated to continue after its end). These projects were described in a free-response field, and space was provided to show further details. OSC researchers then used these project descriptions to create broad categories within each action to facilitate discussion of the projects in more detail.
2. Pick the primary and, if relevant, secondary climate change hazards driving the need for the project (or adding costs to a project that would have been undertaken anyway).
3. Estimate the cost of the project and the percentage of that cost that is due specifically to climate change hazards.
4. Estimate the percentage of funding from local, State and federal sources.

The discussion in the report below follows these broad categories, describing what the 95 respondents across the State reported spending on projects to help them adapt to climate change, and the accompanying tables and charts (unless otherwise noted) are based on the survey's results. New York City's estimates were based on the City's planned commitments to cover awards for capital projects and are discussed separately in a New York City section.

Of course, the results reported in this report represent the efforts of only a small percentage of the local governments in the State outside of New York City. And they also likely represent a significant underestimate of even the adaptation costs of the respondents. Most (including New York City) did not estimate increased cost of operations and maintenance due to climate change. Nor did they estimate the trade-off cost of putting off other capital investments while adaptation projects were undertaken.

What Are Local Governments Outside NYC Doing to Adapt to Climate Change?

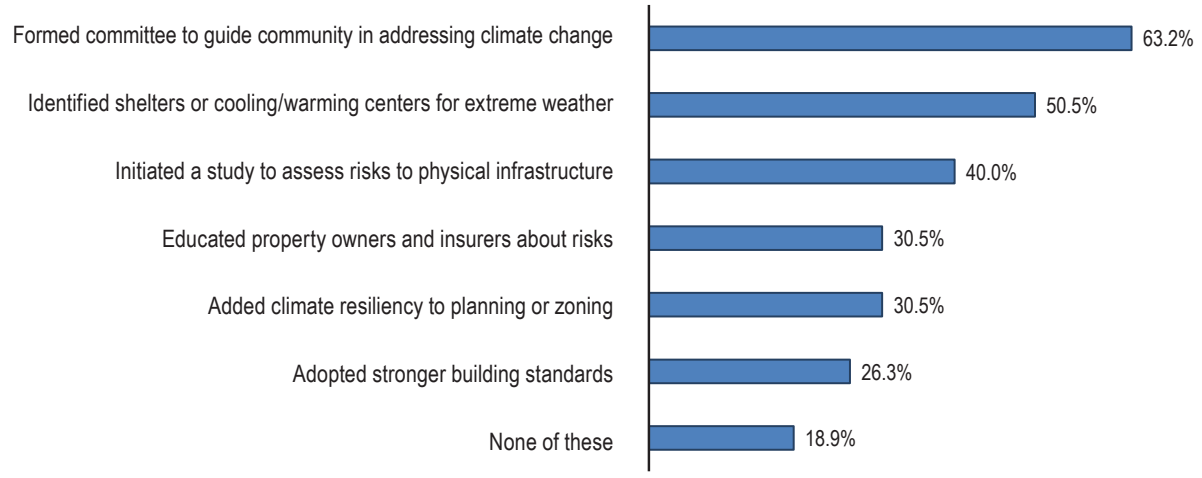
Although the survey was intended to identify the costs local governments have been incurring to adapt to climate change, it started with questions about measures that might not have a price tag but could improve climate resiliency for the community at large.

Of the 95 respondents, 77 reported taking at least one such measure, and six reported taking all of them. (See Appendix A for a list.) The most popular, by far, was forming (or participating in) a committee meant to guide efforts to address climate change. (See Figure 1.) About half reported identifying emergency shelters for residents to use in the event of extreme weather, and more than a third said they had initiated some type of study to assess climate change risks. (Some of these planning studies were also reported as actions, where they resulted in or estimated a future cost to the local governments.)

Least commonly reported were adopting building standards to address climate change, adopting climate change standards in planning or zoning regulation, and educating property owners on risk. These are among the most effective interventions. For example, FEMA estimates that every additional dollar spent on building to codes above the minimum standard saves at least $4 in avoided disaster costs.[15]

FIGURE 1

Percentage of Respondents That Reported Taking Systemic Actions to Plan and Adapt to Climate Hazards.

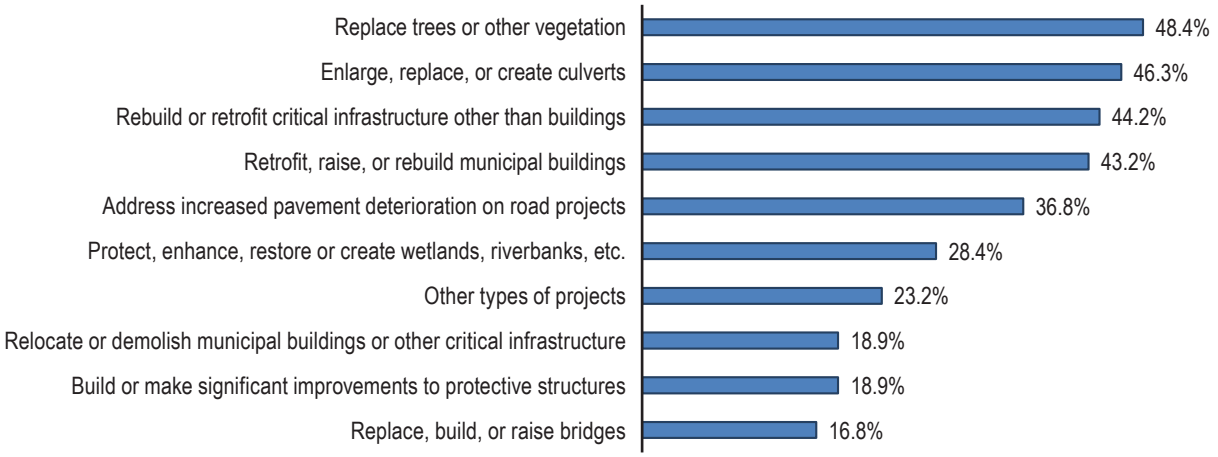


The bulk of the survey was devoted to determining what types of actions local governments were funding. Of the 95 local governments that responded completely to the survey, 77 (not all the same as the 77 above) reported that they had undertaken or planned projects to adapt their built environment, infrastructure, and natural systems to climate change. (For a list of which respondents reported each action, see Appendix B.)

Figure 2 shows the percentage of responding local governments that reported undertaking or planning adaptation projects in each action. The four most commonly reported actions (with more than 40 percent of the 95 respondents describing projects in each of these areas) were related to tree planting, culverts, and retrofitting critical infrastructure and municipal buildings in response to changing climate conditions. The least-reported actions (with less than 20 percent of respondents referencing each of these types of projects) were those related to bridges, enhancing "hard" protective structures such as dams and levees and relocating or demolishing municipal buildings. Nearly one quarter (23.2 percent) of local governments also reported "other types of projects," including flood management and longer-term planning, such as solar panel or electric vehicle infrastructure installation, among other things.

Within each action, the survey asked respondents to describe the project or set of projects they were specifically describing. The discussion below is based on OSC's use of these to further break each action results into project types. (For a summary of all the project types by action, see Appendix C.)

FIGURE 2
Percentage of Respondents Reporting Climate Change Adaptation Projects, by Type of Action

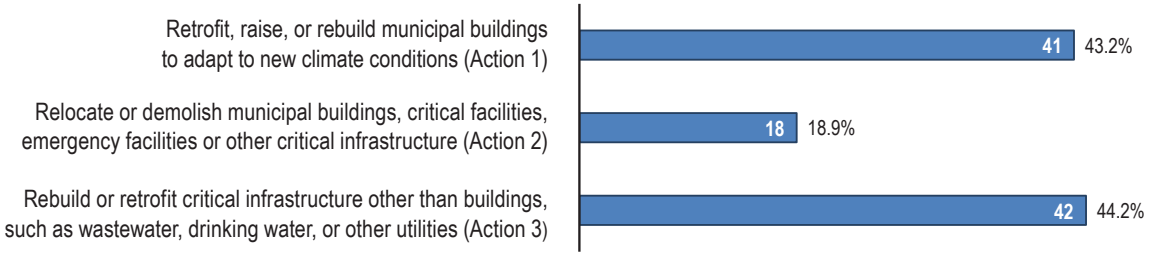


Adapting Municipal Buildings and Critical Facilities through Retrofitting, Rebuilding or Relocating

Actions 1-3 of the survey included retrofitting, or otherwise making changes to, municipal buildings (town halls, highway buildings, etc.) and critical infrastructure (such as water-related infrastructure, or emergency facilities like fire and police stations) to adapt to climate change. These first three actions also included the more drastic and less commonly reported relocation or demolition of any of those structures. (See Figure 3.)

FIGURE 3

Percentage of Respondents Reporting Climate Change Adaptation Projects, by Action (1-3)



Retrofit, Raise or Rebuild Municipal Buildings (Action 1)

Of the 95 survey respondents, 41 (43.2 percent) reported that they had undertaken projects to adapt municipal buildings to climate change. (See Figure 4 for more detail.)

The most common type of project reported was installing emergency power generators at a central business location (e.g., town or village hall) to combat power outages attributed to increasingly severe storms. Fifteen respondents reported installing at least one generator. These projects were some of the smallest in scope reported in response to the survey, as they were usually completed and paid for in one year.

FIGURE 4
Action 1: Retrofit, Raise or Rebuild Municipal Buildings (41)

Commonly reported projects (number of municipalities)	Selected descriptions from surveys
Multiple retrofits/other building enhancements (16)	Building envelope efficiencies such as windows, siding or insulation; or floodproofing. Raising up heating or cooling units to protect from flooding.
Build a new municipal structure or raise a building (7)	Rebuilding public works/highway facilities, town halls, etc., in lower-lying areas. Raising buildings above recommended flood elevations.
Roofs (5)	Enhancing or replacing flat roofs to accommodate increasingly extreme wind, ice, or heavy snowfalls. **Green roofs** absorb rainwater, reduce "heat island" effects, and can help save energy by regulating indoor building temperature.
Generators (15)	Designated **shelters, emergency centers, drinking- or wastewater-facilities**, and **municipal operations** can be maintained during power outages.

Note: Two projects were combination roof/generator projects and were counted in both categories in the table above. For the purpose of total project count (41), each is counted only once.

Seven local governments reported that they needed to build a new municipal structure or raise a building in response to climate change, including constructing several new town halls, highway facilities, and public works facilities, primarily because of flooding. The Village of Little Valley has rebuilt multiple buildings, including a drinking water well-house, and the City of Oneida reported that they are planning to elevate a historic fire service structure to protect it from flooding.

Five municipalities reported that climate change was at least partially responsible for the decisions around when and how to replace roofs. Some reported needing roofs that can withstand extreme weather, such as more frequent heavy rain events that cause leaking or snowstorms that result in higher accumulations than the roofs were designed to withstand. The cities of Binghamton and Rochester reported building green roofs to catch rainfall, diverting or slowing it before entering the stormwater drains for treatment during heavy precipitation events. These municipalities anticipate that the green roofs will also provide respite from the heat-island effect that leads to warmer temperatures in urban areas.[16]

Other reported building enhancements included multiyear investments, such as installing air-source heat pumps or geothermal heating, tightening the building envelope (weatherizing windows, adding insulation, etc.) and undertaking other energy efficiency projects, at least in part, to adapt to increasingly extreme temperatures.

Changing How We Think About Simple Building Retrofits

Increasingly extreme weather and temperatures have led to rising or unpredictably fluctuating energy costs for the **Village of Rhinebeck**. One way they are considering adapting is by retrofitting the Village Hall to create a more energy efficient building. If the Village decides to undertake the recent energy/HVAC study recommendations, they will update the lighting, tighten the envelope, replace the heating and cooling system and upgrade the HVAC. This is a much larger scale project than simply replacing an old furnace — which is what they might have done before climate change became a necessary consideration in capital planning.

Relocate or Demolish Municipal Buildings, Critical Facilities, Emergency Facilities or Other Infrastructure (Action 2)

Eighteen local governments described adapting to climate change by relocating or demolishing municipal buildings, critical facilities, emergency facilities or other infrastructure. (See Figure 5.) Where Action 1 projects mainly retrofitted existing structures, Action 2 projects show how adapting to climate change can require local governments to abandon and demolish structures – in some cases, entire buildings or plants – and move them to a new location.

FIGURE 5
Action 2: Relocate or Demolish Municipal Buildings or Other Critical Infrastructure (18)

Commonly reported projects (number of municipalities)	Descriptions, as reported
Water-related facilities (8)	Relocating structures with a history of flooding; protecting (by raising portions of, for example) new building sites so the infrastructure would not be impacted during future flood incidents.
Police and fire buildings (3)	Relocating buildings outside flood zones or other high-risk areas such as dam failure inundation zones or storm-surge areas.

Eight municipalities reported needing to demolish or relocate water or wastewater infrastructure, including one of the costliest and longest-term projects reported in the survey, in the Village of Saranac Lake (see page 34 for more detail). Most of these projects were undertaken to deal with flooding and erosion. Examples included moving intake pipes and installing pumps to clear floodwater, as well as relocating or demolishing entire water plants, filtration buildings or pump stations, which are essential to delivering drinking water or for moving wastewater to treatment plants.

Three projects involved fire and police buildings; two of these required completely relocating the units because of existing flooding and one moved the facility out of a potential dam failure inundation zone. The City of Binghamton decided to relocate its downtown fire department out of what has become a flood-prone area, after two major floods within five years “seriously impacted” the original headquarters.

Other reported projects included the relocation of highway garages, a salt shed and a waste transfer station out of flood zones. Another local government cited extreme weather as part of the reason to demolish an empty county jail building.

Rebuild or Retrofit Critical Infrastructure Other Than Buildings (Action 3)

Forty-two of the 95 respondents reported projects to rebuild or retrofit critical infrastructure other than buildings. (See Figure 6.)

Most of these projects impacted infrastructure for handling wastewater or drinking water. Although these facilities may require upgrades due to decay from age or the demands of economic development and population growth, the ones reported in the survey were at least partially due to the stresses of climate change, such as more frequent storms and increased water volume.

More than half of the municipalities in this category (27 of 42) reported expenditures on wastewater, stormwater and sewer facilities. One of these, the Binghamton-Johnson City Joint Sewage Treatment Plant Rehabilitation Project, reported that nearly the entire project was the direct result of storms and flooding exacerbated by climate change. (See Binghamton-Johnson City text box on page 13.) The City of Albany cited sea-level rise as a factor in the new design and increased construction costs of tide gates at their combined sewer outflow (CSO) on the Hudson River.

FIGURE 6
Action 3: Rebuild or Retrofit Critical Infrastructure Other Than Buildings (42)

Commonly reported projects (number of municipalities)	Descriptions, as reported
Wastewater, stormwater and sewer facilities (27)	Protecting combined sewer outflows (CSOs) from backing up into the sewer system during high-water-level events caused by storms or sea-level rise. Protecting sewage treatment structures from water infiltration through, for example, dry floodproofing (making a building watertight by applying a waterproof membrane to the outside below the floodline) or building floodwalls above known flood levels. Relining sanitary sewer pipes to reduce inflow and infiltration of water which will damage pipes. Protecting pump stations, which collect, store and lift wastewater or sewage for further distribution.
Drinking water infrastructure (8)	Protecting against contamination of drinking water wells by surface water in low-lying areas. Protecting drinking water pump stations and their controls from infiltration by use of drain plugs or other methods. Rebuilding after storm damage.

Eight projects were in the drinking water category, and included having to move intakes, relocate wells and pump stations in now flooded areas, construct new water tanks and even bring in water from new sources because of saltwater or surface-water contamination.

Finally, some municipalities used this category to report other large-scale projects. For example, the Village of Little Valley, which operates a municipal electric utility, reported plans to relocate an electrical substation as part of their climate hazard mitigation plan.

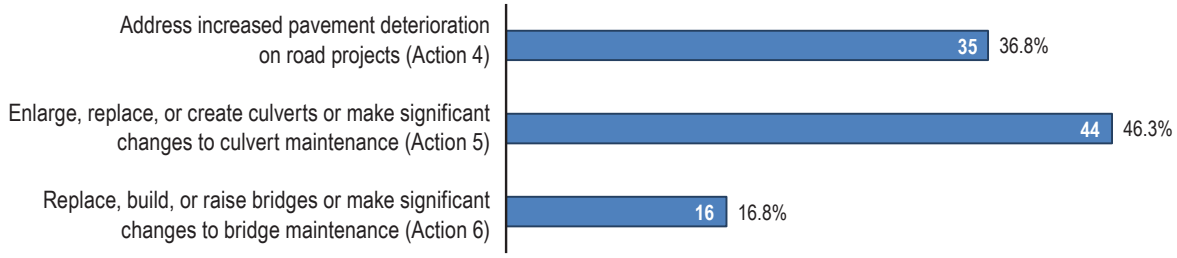
The Binghamton-Johnson City Joint Sewage Treatment Plant is a 60 million gallon-per-day wastewater treatment facility jointly owned by the City of Binghamton and the Village of Johnson City and managed by a joint sewage board. In September 2011, significant flooding from Tropical Storm Lee inundated the Plant, damaging key equipment and collapsing an external treatment wall, leaving much of the Plant inoperable or performing poorly. In 2014, planning for the rehabilitation project started and by May 2021 the project was nearly complete. The Plant is now fortified by flood walls built high enough to withstand a surge from a 500-year flood and equipped with hefty generators allowing it to continue to function in the event of a power failure.

Adapting Roads, Culverts and Bridges

These actions covered how local governments are adapting roads to climate change, including road surfaces, as well as road-related structures such as culverts and bridges. Figure 7 shows the three road-related hazard specific actions together.

FIGURE 7

Percentage of Respondents Reporting Climate Change Adaptation Projects, by Action (4-6)



Address Increased Pavement Deterioration on Roads (Action 4)

Of the 95 survey respondents, 35 reported that they have adapted to climate change by addressing increased pavement deterioration on roads. (See Figure 8.)

As with water infrastructure, roads are impacted by a combination of factors, including aging, normal wear and tear and pressures from development, alongside increasing climate change-related pressures. In this survey, however, many respondents attributed a significant percentage of their project costs to increased freezing and thawing, extreme temperatures, more intense storms and hurricanes, and increased flooding due to climate change.

FIGURE 8
Action 4: Address Increased Pavement Deterioration on Roads (35)

Commonly reported projects (number of municipalities)	**Descriptions, as reported**
Drainage-related road repair (18)	Stormwater systems impact road quality. Culverts are essential parts of many roadways and their deterioration or clogging can lead to water or erosion damage and result in poor road quality. Storm, hurricane or flood response. Increasingly common are "X-hundred year flood" events: these are floods of such large magnitude that they should have an extremely low chance of occurrence.
Annual assessment and resurfacing (17)	Respondents atrributed a portion of the routine maintenance and planned improvements (and costs) to climate adaptation.

Eighteen local governments reported drainage-related road repairs, which included stormwater management such as sewers and culverts and dealing with large swaths of impervious surface (like parking lots). The Village of East Nassau has been chip-sealing a few miles of dirt roads every other year to protect residents from heavy rainfalls, erosion, flooding and extreme weather events. Other municipalities reported repairs to road damage caused by flooding.

Enlarge, Replace, or Create Culverts, or Make Significant Changes to Culvert Maintenance (Action 5)

Forty-four of the 95 respondents said that they have had to adapt to climate change by enlarging, replacing or creating culverts, or by making significant changes to the way culverts are maintained. Culverts are a common drainage device used to channel water, generally under a roadway. They are often made of corrugated or smooth metal, and range in scale from large structures that mimic bridges to smaller pipes that help divert water into channels and ditches. Culverts are often considered part of the roadway, but can serve a dual function as a structure that connects stream habitats for fish and wildlife.

FIGURE 9
Action 5: Enlarge, Replace, or Create Culverts (44)

Commonly reported projects (number of municipalities)	**Descriptions, as reported**
Replace or enlarge culverts; or increased maintenance (35)	Enlarge existing culverts to increase hydraulic capacity, which should minimize flooding. More frequent extreme weather events shorten replacement schedule. New culverts in places where increased stormwater runoff overflows streams or creates ditches. Culverts more often need clearing because they are plugged with debris during the heaviest storms.
Planning (4), other related stormwater or CSO projects (4), or bridge culverts (1)	Includes water management plans, flood mitigation plans, "complete streets" plans that include water concerns, and municipal maintenance plans. Culverts as a component of the wastewater management system, whether it be separate storm sewers or a combined system (CSO). Roads that cross waterways may use a blend of culverts and bridges.

When increased storm activity, sea-level rise or other factors lead to increased flooding, existing culverts may be unable to handle the volume of water that must be diverted, becoming plugged with debris. If cleaning and/or dredging is no longer effective or becomes too frequently needed, they may have to be replaced with larger diameter passages. Of the 44 culvert projects reported, 35 were aimed at increasing capacity. (See Figure 9.)

The Town of Canandaigua, for example, is building culverts and drainage to prevent large storm events from depositing silt and sediment into Canandaigua Lake and along a main roadway.

Some municipalities used this action category to report planning or inventory projects that included culverts, or larger drainage projects that include stormwater and combined sewer improvements as well as culverts. One used it to report a bridge culvert reconstruction.

Replace, Build, or Raise Bridges (Action 6)

Sixteen of the 95 respondents reported replacing, building or raising bridges. (See Figure 10.) Local officials indicated that most of this work is being done to help them deal with increased flooding.

Entirely replacing bridges is a major investment, and there are far fewer bridges than roads or culverts throughout the State. Even so, eight local governments reported needing to replace bridges. In most cases, the replacements were necessary for a number of reasons, including age or damage from one specific storm. However, climate-related flooding or extreme weather were both cited as contributing factors to the need for the timing of the replacement and its new specifications.

FIGURE 10
Action 6: Replace, Build, or Raise Bridges (16)

Commonly reported projects (number of municipalities)	Descriptions, as reported
Replace bridges (8)	Timing for replacement is changed due to increasingly extreme weather or frequent floods. Replacing a culvert with a bridge, where enlargement or deepening of the crossing necessitates it. Hurricane or storm damage exacerbated deterioration.
Rehabilitate or raise bridges (8)	Damages caused by flooding or scouring of embankments or structural piers. Sea-level rise or high-level flooding on road or train bridges will require raising bridge elevations. Studies to determine extent of repair necessary.

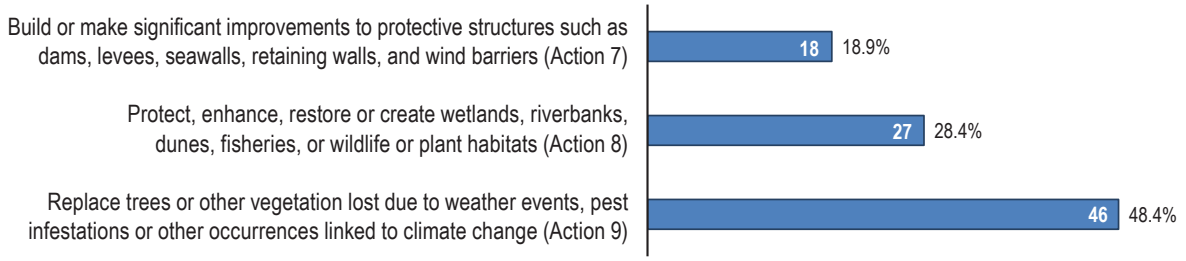
The other eight municipalities reported bridge rehabilitation projects. Most of these were being undertaken to fix erosion and scouring of the protective banks or the piers, footings or foundations of bridges. One of the largest projects, however, included raising the elevation of the Tarrytown H-Bridge “if and when” the Metro North Hudson Line railroad tracks under that bridge “need to be raised in elevation due to sea-level rise.”

Improving Protective Structures and Adapting Natural Systems to Climate Change

The next three sets of actions in the survey include a wide variety of projects to adapt natural systems to climate change, including both building or repairing protective structures (such as dams and seawalls) and making "softer" changes, such as tree plantings. (See Figure 11.) Most of these actions are intended to bolster the resiliency of structures or natural systems, such as protecting shorelines, redirecting water or attenuating erosion. Such projects could be undertaken for a number of reasons, including remediating pollution, beautification of an area, or to mitigate the impact of nearby development. However, only those that have been undertaken or modified at least partially in response to climate change-related causes (extreme weather, sea-level rise, etc.) would have been included in response to the survey.

FIGURE 11

Percentage of Respondents Reporting Climate Change Adaptation Projects, by Action (7-9)



Build or make significant improvements to protective structures (Action 7)

Eighteen of the 95 respondents reported making significant improvements to or building new protective structures, such as dams, levees, seawalls and retaining walls. (See Figure 12 for a list of these projects and Figure 13 for a glossary of some of the terms used.)

Several local governments described projects to protect houses, roads, buildings or critical infrastructure constructed along waterfronts from erosion over time. These protective structures include "hard" or structural streambank or shoreline stabilization measures, although some include a "living" portion in the form of plantings and naturalized buffers.

FIGURE 12
Action 7: Build or Make Significant Improvements to Protective Structures (18)

Commonly reported projects (number of municipalities)	**Descriptions, as reported** (See commonly cited terms in text box).
Streambank or shoreline revitalization (10)	Protect houses, roads, buildings or critical infrastructure constructed along waterfronts from extreme events through stabilization measures such as building structural controls and naturalized buffers. Increase shoreline resilience thorugh work on protective structures. Building earthen structures to impede flooded waterways from overtaking a fire house, a public works facility and a neighborhood school.
Dams (4), levees (1), bridges (1), or other (2)	Replacing, removing, or upgrading. Responding to federal flood guidelines.

For example, the Town of Bethlehem is planning a shoreline project designed to protect a local park and nearby infrastructure from the effects of sea-level rise along the Hudson River. (See text box.) On Long Island, the Town of Brookhaven and Suffolk County both reported undertaking projects to protect parts of their shorelines. Brookhaven reported implementing jetty improvements and the County has built up a living shoreline of plants and breakwaters over the last decade. Suffolk County is also developing a system of lowland detention basins and higher elevation impoundments to slow destructive surface waters from eroding the North Shore waterfront.

The Town of Bethlehem is working to modernize the 1/2-mile shoreline of Henry Hudson Park on the Hudson River Estuary to be more resilient to sea-level rise and erosion and to provide a better wildlife habitat than the collapsing shoreline structure currently in place. The design will accommodate major floods while improving the recreation experience for visitors and improving habitat for river wildlife. The scale of this project means the town is depending on continued technical and financial assistance from experts at the U.S. Army Corps of Engineers and the NYSDEC.

Other local governments reported that climate change was affecting spending on municipal dams. The Village of Rhinebeck, for example, is considering a project to automate the process of opening valves to release water from their dam, since increasingly frequent extreme weather events have begun to require them to release water multiple times a year.

FIGURE 13
Commonly Cited Terms in the Survey for Protective Structures (Action 7) or Projects to Protect Natural Systems (Action 8)

Riparian, littoral and coastal	Terms for the ecologically sensitive area of land along the shores of a river, stream, lake or ocean
Bulkhead or seawall	Hard structure permanently built along the water's edge
Jetty or groin	Hard structure permanently built perpendicular to the shore
Breakwater	Fixed or floating offshore barrier used to reduce wave energy and promote beach buildup
Riprap (or revetment)	A sloping pile of rocks along the water's edge used to reduce erosion
Dam	Structure built across a water body that holds water on both sides at different levels for regulating flow
Levee or berm	Often an earthen mound built to hold water on one side for flood protection of lower lying areas
Swale, retention or detention area	Depression in the landscape, often vegetated, created to slow the percolation of contaminated stormwaters or to detain water for flood protection
Beach nourishment	Addition of sediment to the coastline to address erosion and its negative effects

Protect Natural Systems (Action 8)

Of the 95 survey respondents, 27 said that they have had to change the way they protect natural systems within their purview because of changes in the climate. These projects differ slightly from the actions categorized in Action 7 (protective structures) in that these rely on softer technologies and plantings. (See Figure 14 for a list of these projects and Figure 13 for a glossary of some of the terms used.)

FIGURE 14
Action 8: Protect Natural Systems (27)

Commonly reported projects (number of municipalities)	Descriptions, as reported
Shoreline remediation using vegetation (12)	Remediating or restoring streambanks, riparian areas (river and stream banks) and shorelines using trees and plants. Managing invasive species to ensure the native species that protect against erosion and filter water can thrive. Nourishing coastal beach systems with plantings.
Wetlands (3)	Creating wetlands out of previously impermeable surfaces (such as parking lots). Creating flood storage that adapts the lansdcape to hold storm or floodwaters before they can reach sensitive areas.
Planning and comprehensive management (8)	Planning includes doing an inventory of natural resource assets, an assessment of climate risks, a visioning analysis, changes to zoning, planning for land purchase or sale, etc. Any of these can be components of a comprehensive plan as well. Land acquisition can give a municipality greater control over management, but working with private landowners directly may be effective.

Twelve municipalities reported working to remediate or restore streambanks, riverbanks and shorelines, using trees and plants to slow the impact of increased erosion and flooding. The Village of Rhinebeck participated in NYSDEC's "Trees for Tribs" (tributaries) program, which promotes planting trees along streambanks. Rochester described its participation in another State-organized effort (see the "Rochester – Projects in a Regional Context" text box on page 22).[17] Suffolk County reported using plantings to nourish coastal beach systems. Municipalities statewide reported planting trees, stabilizing banks with plantings or riprap (rocky materials) and otherwise trying to strengthen their stream- and riverbanks to better withstand increased storms and floods. Some described programs to manage invasive plant species, ensuring that the native species which are better at fighting erosion and filtering water for habitat thrive.

Three municipalities reported protecting naturalized areas through the creation of wetland areas, the upgrading of marsh edge zones or redirecting creek overflow during floods to wetlands and farmlands.

Other projects reported in this action category included more comprehensive projects, such as resiliency planning or inventories of how climate change is affecting the community. One lakeside village is proposing to acquire land to combat erosion and flooding; another village reported a demonstration project that highlights the capacity for intensive plantings to retain water and mitigate roadside flooding.

Rochester – Projects in a Regional Context

The City of Rochester reported projects for erosion control, flood protection and resiliency measures along both banks of the Genesee River near its confluence with Lake Ontario, which had major flooding due to high water levels in the Lake Ontario and St. Lawrence River System in 2017 and 2019.

These are being undertaken as part of the New York State Resiliency and Economic Development Initiative (REDI), established in 2019 to, among other things, "increase the resilience of shoreline communities…in the region." This multi-county initiative was established to "identify local priorities, at-risk infrastructure and other assets, and public safety concerns," and the State has committed up to $300 million to fund REDI projects.[18]

Plant or Replace Trees or Other Vegetation (Action 9)

Respondents to the survey were asked to separate out vegetative plantings intended to protect natural systems (Action 8) from those in this category (Action 9), which were related to tree plantings, removal or replanting linked to weather events, pest infestations or other climate change-related occurrences. Forty-six municipalities reported undertaking tree projects in this category, although eight of the municipalities reporting tree plantings in Action 9 appeared to be doing so for streambank stabilization. (See Figure 15.)

FIGURE 15
Action 9: Plant or Replace Trees or Vegetation (46)

Commonly reported projects (number of municipalities)	Descriptions, as reported
Streambank stabilization (8)	Planting projects that provide streambank and riparian buffer resiliency.
Invasive species (6)	Replacing street trees and plantings with more bio-diverse and climate-and-invasive adaptable species. Reacting to insect infestation by removing and replacing ash trees.
Planning (13)	Includes comprehensive tree plans, studies, inventories and program implementation.
Annual maintenance (19)	Includes comprehensive tree plans, studies, inventories and program implementation.

Some of the larger cities, towns and villages surveyed reported undertaking comprehensive tree inventory and management plans, including the cities of Albany and Syracuse and towns of Bethlehem and East Rockaway. A few municipalities have also established Tree Committees.

Six respondents reported removing and replacing invasive species of plants, and four municipalities specifically mentioned that they had to remove and replace trees because of the emerald ash borer (insect) infestation.

Other Projects (Action 10)

In addition to the nine adaptation action categories in the survey, 22 municipalities reported projects they undertook or plan to undertake due to climate change that they determined were not related to those actions. For example, the City of Binghamton is acquiring 12 flood-prone private properties to be demolished and the area turned into a greenspace that will buffer the remaining area from future floods. In addition to large-scale flood management projects, there were also some smaller projects, such as improvements to an emergency center to shelter residents from extreme heat and a project to prevent flooding from ice jams. (See Figure 16.)

FIGURE 16
Action 10: Other Projects (22)

Commonly reported projects (number of municipalities)	Descriptions, as reported
Planning and project management (9)	Includes funding flood mitigation studies, flood buyout studies, emergency management plans and natural resource inventories, as well as creating conservation advisory councils and attending conferences.
Various uncategorized (8)	Ranging from large-scale flood management projects to smaller-scale projects such as sponsoring emergency heat centers.
Greenhouse gas mitigation (5)	Among many other things, replacing fleets with electric vehicles, installing EV charging stations, solarizing municipal buildings, and replacing streetlights with LED bulbs.

Nine towns and villages also used this category to report planning and project management, including funding flood mitigation studies, flood buyout studies, emergency management plans and natural resource inventories, as well as creating conservation advisory councils and attending conferences.

Although this survey focused on physical adaptations to climate change, five units also included projects that are meant to mitigate future climate change (i.e., reduce greenhouse gases) and include municipal upgrades such as replacing the municipal fleet with electric vehicles (EV) and solarizing municipal buildings, as well as public efforts such as replacing streetlights with more efficient LED bulbs, installing EV charging stations and promoting a Community Solar Campaign.

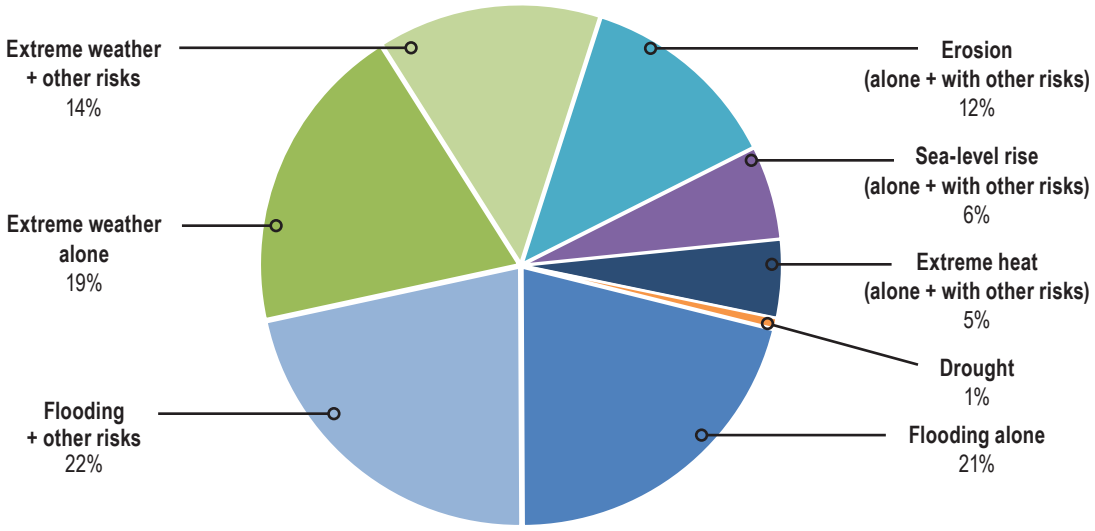
What Are Their Biggest Climate Hazards?

Survey respondents were asked to attribute each broad action taken (such as retrofitting municipal buildings) to a primary climate change hazard and, where relevant, to a secondary climate change hazard.

Figure 17 illustrates the breakdown of responses. Flooding and extreme weather were cited most often.

FIGURE 17

Flooding Dominates as the Primary Climate Hazard Addressed by Municipal Adaptation Projects.



Flooding (not related to sea-level rise)

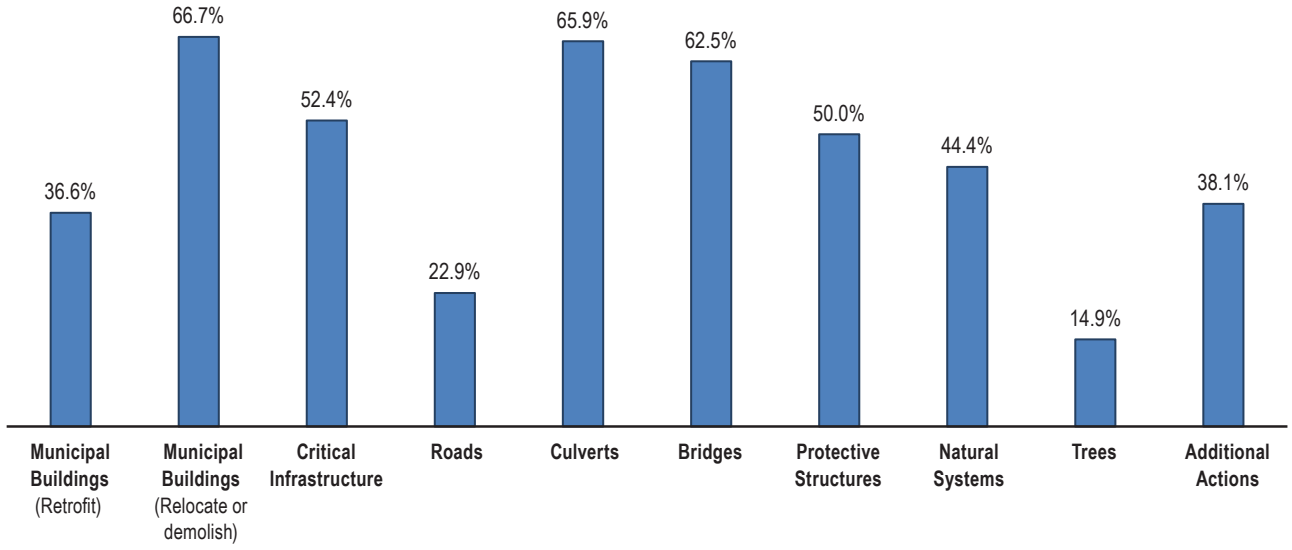
Climate change is linked to greater total rainfall and more frequent heavy precipitation events, making inland flooding a more common occurrence. Floods damage property, buildings and infrastructure, cause bridge and road closures, disrupt services and can lead to injuries and fatalities.

Survey respondents identified flooding (not related to sea-level rise) as the single most common primary climate risk addressed. Flooding was the primary motivation for 43 percent of all actions, and was either a primary or secondary reason for undertaking 60 percent of the actions reported.

Flooding was the most common reason for relocating or demolishing municipal buildings, undertaking culvert and bridge projects, and making changes to critical infrastructure. (See Figure 18.)

FIGURE 18

Percentage of Actions Where Respondents Cited Flooding as Primary Climate Hazard



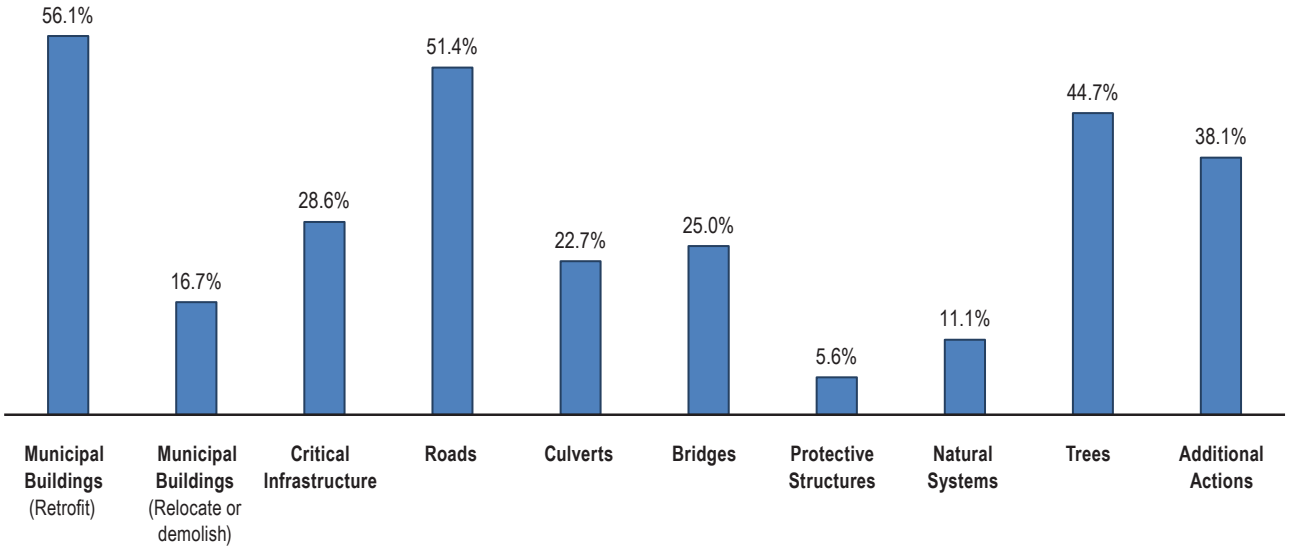
Extreme weather

Ice, snow, hail, wind and rainstorms are examples of extreme weather exacerbated by climate change. Fast moving storms can inundate storm sewers, culverts, bridges and dams or cause landslides, hail and wind frequently accompany thunderstorms, and heavy ice and snow can build up on rooftops and roads. All of these can cause substantial damage to vehicles, roofs and trees, pull down power lines or affect other critical services.

Extreme weather was cited as the primary reason for about a third of all actions. It was the most common reason given for retrofitting municipal buildings, such as roofing projects or purchasing generators to maintain services during more frequently occurring power outages, and was the primary climate change hazard cited for undertaking road projects or planning studies. (See Figure 19.)

FIGURE 19

Percentage of Actions Where Respondents Cited Extreme Weather as Primary Climate Hazard



Sea-level rise

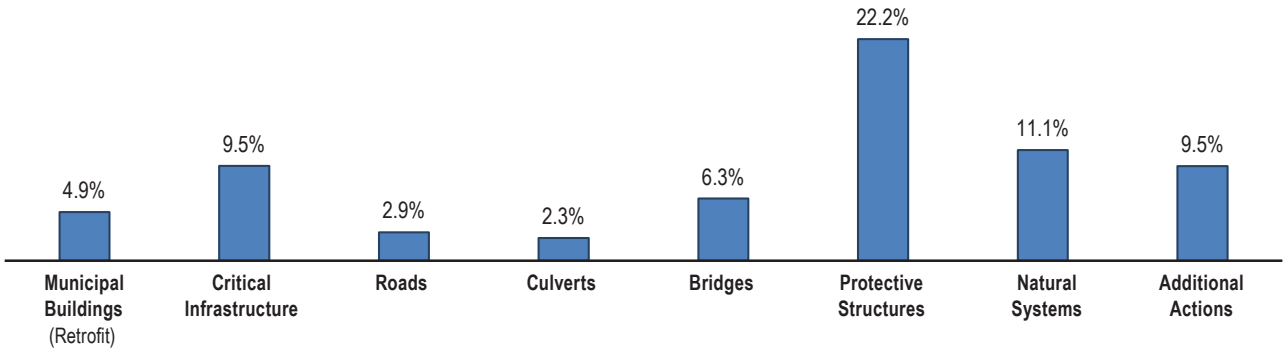
New York State has hundreds of linear miles of Atlantic coastline: New York City and three counties (Suffolk, Nassau and Westchester) are immediately subject to coastal concerns, as are many of their component cities, towns and villages. Add to them the municipalities along the Hudson River shoreline and the tributary rivers and streams that are subject to tidal movements from sea-level rise, and the impact of climate change-related sea-level rise on the State becomes apparent. As Figure 20 shows, respondents from the tip of Suffolk County to the City of Albany reported undertaking actions due to sea-level rise.

FIGURE 20
Survey Respondents Listing Actions Taken Due to Sea Level Rise

A 2010 report by New York's Sea Level Rise Task Force found that existing investment and land-use planning practices by the State and its local governments were encouraging development in areas of high risk of coastal flooding and erosion. It called for increased State involvement in predicting where these risks were greatest and mandating changes that would reduce vulnerability in these areas, as well as funding research into other adaptive strategies.[19]

Sea-level rise was given as the primary reason for nearly a quarter of actions to build or improve protective structures, such as levees and breakwaters, and for 11 percent of actions taken to protect natural systems. (See Figure 21.)

FIGURE 21
Percentage of Actions Where Respondents Cited Sea-level Rise as Primary Climate Hazard



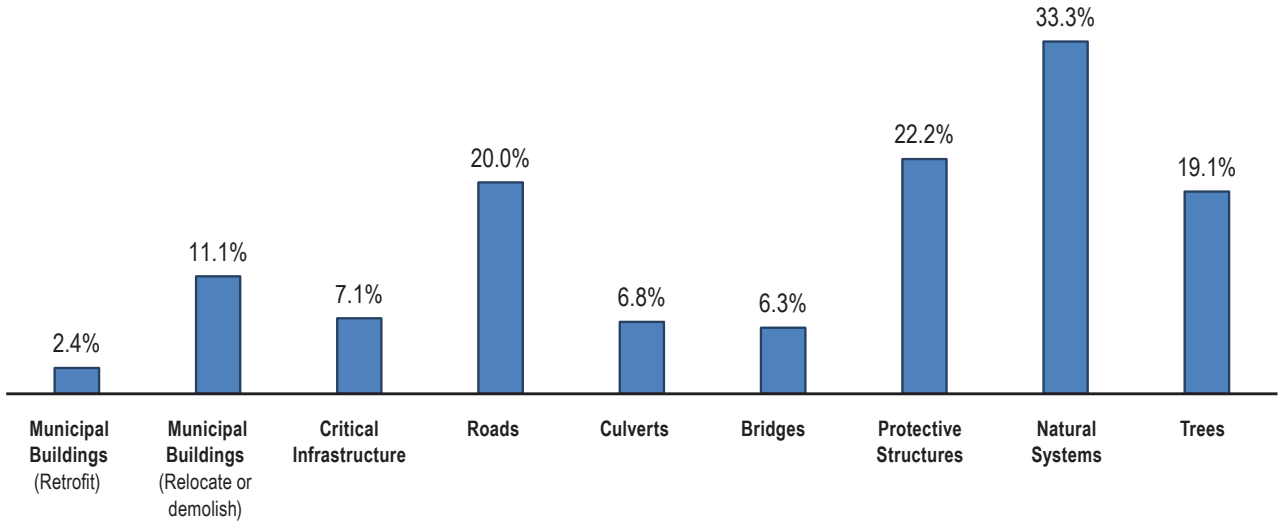
Erosion

Erosion is the wearing away of land, such as loss of riverbank, beach, shoreline, or dune material. Erosion is generally a secondary effect of things like repetitive flooding or sea-level rise and can also be caused or exacerbated by human activities such as infrastructure or building placement or construction. It typically appears in the form of subsidence (collapsing or sinking surface land), sediment loss or shifting coastlines.

Erosion was given as the primary reason for undertaking around 12 percent of all reported actions. However, it was responsible for about a third of natural systems actions, such as planting trees and other vegetation. These plantings slow the movement of water carrying silt and sediment away and provide roots to hold soil and rocks in place. It was the primary reason for 22.2 percent of protective structure projects, such as adding riprap (loose stone used to form a foundation for a breakwater), gabions (rocks in metal cages), or other coarse material to slow water and collect sediment. It was also the primary reason for 20 percent of all road projects. (See Figure 22.)

FIGURE 22

Percentage of Actions Where Respondents Cited Erosion as Primary Climate Hazard



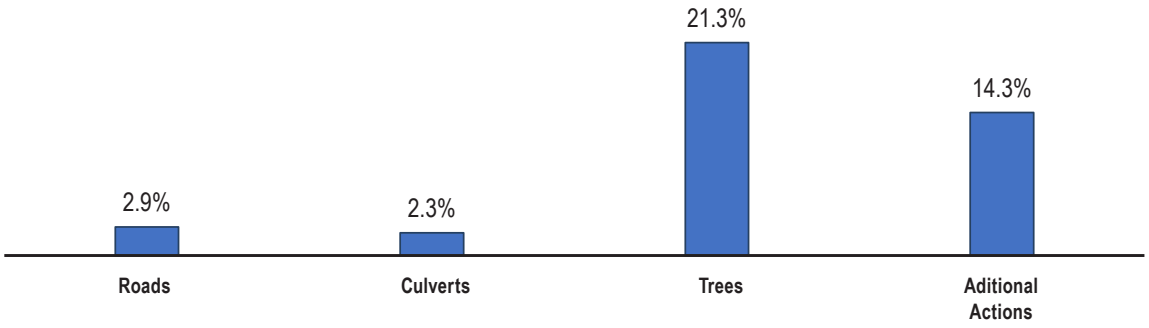
Extreme Heat

Extreme heat is typically recognized as the condition where temperatures consistently stay ten degrees or more above a region's average high temperature for an extended period. With climate change, heat waves have become hotter, more frequent, and longer lasting, and are occurring in locations unaccustomed to such extremes.

Only about 5 percent of actions were reported as primarily due to extreme heat, and nearly all of these were street tree projects. (See Figure 23.)

FIGURE 23

Percentage of Actions Where Respondents Cited Extreme Heat as Primary Climate Hazard



What Do These Adaptation Projects Cost?

Survey respondents were asked to report the total cost of each action taken (potentially including the cost of multiple projects), as well as an estimate of the percentage of that cost that they attributed to climate change-related hazards. For example, a municipality might need to replace a roof based on its age. However, increasingly strong storms might cause them to do so earlier than expected or to use more high wind-resistant materials. In such a case, the local government might attribute only a portion of the cost of the replacement to climate change. From these two figures (total cost and percentage attributable to climate change), OSC calculated the total costs attributed to climate change.

In total, the 95 local governments responding to the survey reported over $1.3 billion in costs, and attributed 54.9 percent of these costs to climate change, for a total of $737.2 million in climate change-related expenses.

As Figure 24 shows, the overall cost of reported projects varied quite a bit by action, as did the percentage attributed to climate change hazards. The largest total cost was for action 3 (rebuilding or retrofitting critical infrastructure other than buildings), which alone accounted for nearly half of the total costs reported in the survey. Respondents also attributed 63.5 percent of those costs to climate change, more than for most actions.

FIGURE 24
Cost of Adapting to Climate Change

	Total reported costs	Percentage of costs attributed to climate change	Costs attributed to climate change
Total for all reported actions (number of municipalities)	**$1,342,885,229**	**54.9%**	**$737,175,158**
Action 1: Retrofit, raise or rebuild municipal buildings (41)	$99,737,748	47.3%	$47,131,384
Action 2: Relocate or demolish municipal buildings or other critical infrastructure (18)	$136,268,000	24.4%	$33,281,500
Action 3: Rebuild or retrofit critical infrastructure other than buildings (42)	$631,930,504	63.5%	$401,312,365
Action 4: Address increased pavement deterioration on roads (35)	$95,304,876	41.1%	$39,178,793
Action 5: Enlarge, replace, or create culverts (44)	$104,524,890	56.9%	$59,492,554
Action 6: Replace, build, or raise bridges (16)	$109,487,160	49.4%	$54,118,580
Action 7: Build or make significant improvements to protective structures (18)	$86,315,894	63.2%	$54,539,430
Action 8: Protect natural systems (27)	$53,496,010	63.3%	$33,876,215
Action 9: Plant or replace trees or vegetation (46)	$20,207,646	45.5%	$9,185,789
Action 10: Other Projects (22)	$5,612,500	90.1%	$5,058,550

The next most expensive action overall, relocating or demolishing municipal buildings or other infrastructure, while costing $136 million, was also the least attributed to climate change, with just under a quarter of the cost attributed to climate hazards.

The least expensive projects appear to have been planting trees or vegetation, which accounted for only $20 million in total costs, just under half of which were attributed to climate change.

The following discussion gets into more detail by project type. (For a summary table by action and project type, see Appendix D.)

FIGURE 25
Action 1: Costs to Retrofit, Raise or Rebuild Municipal Buildings (41)

Commonly reported projects (number of municipalities)	Total reported costs	% attributed to climate change	Costs attributed to climate change
Multiple retrofits (16)	$56,725,000	60.8%	$34,497,150
New structure/raise building (7)	$34,970,833	26.7%	$9,354,375
Roofs (5)	$3,604,120	48.7%	$1,756,000
Generators (15)	$4,437,794	34.3%	$1,523,859
Action 1 Total	**$99,737,748**	**47.3%**	**$47,131,384**

Note: Two local governments described projects that included both generator and roof elements in this action. These were counted in both project types, but the costs were included in the roof projects only and the total of 41 reflects each project once.

Within Action 1, the cost of different project types varied widely as well. (See Figure 25.) Generators were the least expensive type of project, on average, but prices varied quite a bit. Most generator projects ranged from $40,000 to $500,000, but one project cost only $8,000 and the most expensive was reported as $2 million. Some of the variation had to do with whether local governments were merely adding a generator to an existing system or setting up a new system, or if more than one generator was involved. The $2 million project was a backup generator system in a city wastewater treatment plant (City of North Tonawanda). Respondents typically attributed between 20 and 70 percent of these costs to climate change, averaging 34.3 percent.

At the other end of the spectrum, the seven projects in the “new structure/raise existing buildings” grouping, while far less common than other project types, were also much more expensive, with one costing less than $1 million and several exceeding $4 million. However, on average, just over a quarter of the total cost of these projects was attributed to climate change response. Two of the five roof projects (the green roofs, described in more detail on page 9) cost over $1 million each.

“Other” projects were the most expensive in aggregate, as many respondents grouped multiple renovation or retrofitting projects within this action category.

Relocate or Demolish Municipal Buildings, Critical Facilities, Emergency Facilities or Other Infrastructure (Action 2)

FIGURE 26
Action 2: Costs to Relocate or Demolish Municipal Buildings or Other Critical Infrastructure (18)

Commonly reported projects (number of municipalities)	Total reported costs	% attributed to climate change	Costs attributed to climate change
Water-related facilities (8)	$102,648,000	16.0%	$16,401,500
Police and fire buildings (3)	$21,000,000	53.0%	$11,125,000
Other (7)	$12,620,000	45.6%	$5,755,000
Action 2 Total	**$136,268,000**	**24.4%**	**$33,281,500**

Overall, only 18 local governments reported projects in Action 2, but most of these relocation or demolition projects were fairly expensive, with only five reporting costs of less than $1 million and four reporting costs of $10 million or more. (See Figure 26.)

Water and wastewater facility projects tended to be the most expensive. Three of these projects cost at least $10 million, and three more cost between $3 million and $7.5 million. The Village of Saranac Lake's plan to move its water and wastewater treatment infrastructure was the most expensive, with an estimated cost of $65 million, although the Village also reported that only 5 percent of that cost ($3.25 million) would be in response to climate change. Similarly, the Village of Millerton ascribed only 8 percent of its $10 million wastewater/sewer project to climate change. In comparison, the Village of Aurora attributed over half of its $10 million cost for rebuilding and relocating water and wastewater infrastructure to climate change hazards.

The City of Binghamton's choice to move a fire station (described on page 11) due to repeated flooding reportedly cost $9.5 million, 75 percent of which was attributed to climate change. The City of Auburn also reported that it planned to spend around $10 million to relocate its public safety building outside the inundation zone of a nearby dam, although they only attributed about a quarter of that cost to climate change. In contrast, the Town of Olive attributed the full $1.5 million cost of relocating its Boiceville Firehouse to climate change.

FIGURE 27
Action 3: Costs to Rebuild or Retrofit Critical Infrastructure Other than Buildings (42)

Commonly reported projects (number of municipalities)	Total reported costs	% attributed to climate change	Costs attributed to climate change
Wastewater, stormwater, and sewer facilities (27)	$553,946,504	64.1%	$354,913,865
Drinking water infrastructure (8)	$55,254,000	51.9%	$28,692,500
Other (7)	$22,730,000	77.9%	$17,706,000
Action 3 Total	**$631,930,504**	**63.5%**	**$401,312,365**

Actions to rebuild or retrofit critical infrastructure other than buildings accounted for $631.9 million, or nearly half of the total costs reported in this survey. Municipalities reporting projects in Action 3 also attributed 63.5 percent of their costs to climate change, a higher percentage than almost any other action category. (See Figure 27.)

Structural adaptations to both drinking water and storm/wastewater treatment facilities were especially expensive, as they were both among the most common types of projects within the category and had some of the highest reported per-project costs. In fact, many of these projects had the highest costs in the entire survey, with 12 of them costing $10 million or more each, and all but 6 over $1 million apiece.

Fifteen of the 27 local governments that reported wastewater, stormwater and sewer facilities and equipment projects attributed between 50 and 100 percent of the costs to climate change. The largest of these, the Binghamton-Johnson City Joint Sewage Treatment Plant Rehabilitation Project, reported that 85 percent ($234 million) of the total $275 million in costs were directly related to storms and flooding exacerbated by climate change. (See text box on page 13 for description of the project.) Other particularly high-cost projects included rebuilding or upgrading wastewater treatment plants and separating storm and sanitary sewers to reduce combined sewer overflows.

Three of the eight drinking water projects were reported as costing $10 million or more. Dutchess County reported a project to import water from an external source to existing sources that have been contaminated, at an estimated cost of $20 million. They attributed 75 percent of the cost to climate change-related flooding.

Seven municipalities reported projects that did not involve either drinking, storm or wastewater facilities, including an $11 million dam project in the City of Oneida. The City attributed 85 percent of the cost of this project to climate change-related erosion.

FIGURE 28
Action 4: Costs to Address Increased Pavement Deterioration on Roads (35)

Commonly reported projects (number of municipalities)	Total reported costs	% attributed to climate change	Costs attributed to climate change
Drainage-related repair (18)	$60,217,876	33.5%	$20,170,243
Annual assessment and resurfacing (17)	$35,087,000	54.2%	$19,008,550
Action 4 Total	**$95,304,876**	**41.1%**	**$39,178,793**

Although 35 of the 95 survey respondents reported pavement-deterioration projects, with a total cost of $95.3 million, a relatively low percentage of this total – $39.2 million (41%) – was reported as being attributable to climate change. (See Figure 28.)

Drainage-related repair projects reported by 18 local governments accounted for over 60 percent of the total costs for this action category (about $60 million). Some of the largest projects reported having only a small percentage of costs attributed to climate change. Suffolk County, for instance, reported $26 million for several projects over many years in this category to improve water quality treatment through bioretention (i.e., capturing stormwater in a basin, allowing it to filter slowly through natural materials to increase the water quality before it drains to a water body) on county-owned roads. However, it only attributed 14 percent, or $3.6 million, of this to climate change, primarily flooding.

Routine road assessment and resurfacing projects cost 17 local governments $35.1 million, more than half of which could be attributed to climate change ($19 million). Some municipalities reported specific roads or projects where the majority of the cost was attributable to climate change. A project to elevate certain roadways to reduce the future need to frequently repave certain areas was the highest cost project in this category. Other municipalities estimated the percentage of their regular paving and maintenance that could be attributed to climate change, generally citing extreme weather as the primary hazard responsible.

Enlarge, Replace, or Create Culverts, or Make Significant Changes to Culvert Maintenance (Action 5)

FIGURE 29
Action 5: Costs to Enlarge, Replace, or Create Culverts (44)

Commonly reported projects (number of municipalities)	Total reported costs	% attributed to climate change	Costs attributed to climate change
Replace or enlarge culverts; or increased maintenance (35)	$46,544,890	57.5%	$26,778,304
Planning (4), other related storm sewer or CSO projects (4), or bridge culverts (1)	$57,980,000	56.4%	$32,714,250
Action 5 Total	**$104,524,890**	**56.9%**	**$59,492,554**

Nearly half of local governments reported costs for enlarging, replacing, or creating culverts, totaling $104.5 million. (See Figure 29.) Most of the individual projects were moderate in cost, with only two exceeding $10 million, and about half costing less than $1 million (often substantially less). However, the percentage of the cost attributable to climate change was relatively high – nearly 57 percent, totaling $59.5 million, making this the second most expensive action area in costs attributed to climate change.

Projects to enlarge, replace or create culverts or to make significant changes to the way culverts are maintained made up $46.5 million, or less than half, of the total costs in Action 5, despite accounting for nearly 80 percent of projects in this action category. Culvert projects in the Village of Aurora and the City of Syracuse were the most expensive projects in this category, at $5 million each.

At nearly 58 percent, culvert projects were, however, more heavily attributed to climate change (most commonly flooding or extreme weather) than average. Seven municipalities attributed 100 percent of their culvert-replacement costs to climate change-related flooding.

The nine projects in this action category that included culvert elements as part of a larger plan or set of improvements added up to nearly $58 million. Two such projects – a bridge culvert reconstruction in the City of Poughkeepsie and citywide storm sewer improvements in the City of Auburn – had reported costs of over $20 million each. Flooding was once again the primary hazard cited, with half of the cost in each case attributed to climate change.

FIGURE 30
Action 6: Cost to Replace, Build, or Raise Bridges (16)

Commonly reported projects (number of municipalities)	Total reported costs	% attributed to climate change	Costs attributed to climate change
Rehabilitate or raise bridges (8)	$74,250,000	47.1%	$34,984,000
Replace bridges (8)	$35,237,160	54.3%	$19,134,580
Action 6 Total	**$109,487,160**	**49.4%**	**$54,118,580**

Although only 16 local governments reported bridge rehabilitation and replacement actions – far fewer than the number reporting other actions – the total spent on these projects ($109.5 million) ranked third overall, and costs attributed to climate change ($54.1 million, or 49 percent) ranked fourth. (See Figure 30.)

Bridge rehabilitation projects tended to be more expensive than replacement projects, with four of the eight rehabilitation projects having costs of $10 million or more. Seven of the eight reported bridge replacement projects were under $10 million, totaling $35 million, of which $19.1 million (just over 54 percent) was attributed to climate change.

FIGURE 31
Action 7: Costs to Build or Make Significant Improvements to Protective Structures (18)

Commonly reported projects (number of municipalities)	Total reported costs	% attributed to climate change	Costs attributed to climate change
Streambank or shoreline revitalization (10)	$63,162,894	57.1%	$36,057,930
Dams (4), levees (1), bridges (1), or other (2)	$23,153,000	79.8%	$18,481,500
Action 7 Total	**$86,315,894**	**63.2%**	**$54,539,430**

Eighteen local governments reported total costs of $86.3 million to adapt to climate change by building new or making significant improvements to existing protective structures, with $54.5 million (63.2 percent) of these costs attributed to climate change hazards. (See Figure 31.)

Streambank or shoreline structure projects were the most expensive in total, accounting for $63.2 million of the total, with 57.1 percent ($36.1 million) of the costs attributable to climate change. The City of Rochester reported a planned set of river wall improvements and extensions totaling over $30 million, $8.6 million of which was for current improvements to the West River Wall in the Corn Hill neighborhood. Although the City noted that "the purpose of the projects was flood protection and is related to climate change," they also reported that some of the expenditures were due to the poor condition of the existing wall and for the improvement of waterfront amenities. In total, the City attributed 50 percent ($15 million) of total costs to climate change-related flooding.

The Town of Bethlehem attributed nearly 75 percent of its $9 million Hudson River shoreline project to sea-level rise (described on page 19). Local officials continue to seek federal and State assistance to continue the efforts, stating that the costs are too great for the Town to fund alone.

Other protective structure projects, such as dams, levees, bridges, berms or swales, were less expensive overall, totaling just over $23 million. (Defined in Figure 13 on page 20.) However, municipalities reporting these types of projects attributed most of their cost (nearly 80 percent) to climate change, with four attributing the full cost of their projects to climate change-related flooding or erosion. The Village of Montour Falls stated that 100 percent of the $850,000 cost to test and certify that its levee will protect the community from flooding is climate change-related.

FIGURE 32
Action 8: Costs to Protect Natural Systems (27)

Commonly reported projects (number of municipalities)	Total reported costs	% attributed to climate change	Costs attributed to climate change
Shoreline remediation using vegetation (12)	$30,188,835	65.8%	$19,865,527
Planning and comprehensive management (8)	$18,232,175	53.0%	$9,662,188
Wetlands (3)	$3,820,000	100.0%	$3,820,000
Other (4)	$1,255,000	42.1%	$528,500
Action 8 Total	**$53,496,010**	**63.3%**	**$33,876,215**

Twenty-seven local governments reported projects to protect natural systems using vegetation and softer technologies, for a total of $53.5 million, a relatively low total cost compared with other actions (in aggregate). However, municipalities attributed $33.9 million (63.3 percent) of their total costs to climate change adaptation. (See Figure 32.)

Twelve local governments reported a total of $30.2 million for projects to remediate or restore shorelines using vegetation, attributing nearly two thirds ($19.9 million) of this to various climate change hazards, including sea-level rise, flooding and erosion. The largest of these projects was Suffolk County's multi-year coastal resiliency and beach nourishment projects on county and state park lands, totaling roughly $15 million, with about $9 million attributed to climate change. Four other municipalities reported spending over $1 million each on projects, including Erie County, which is undertaking a habitat restoration along the Buffalo River costing $6 million, 34 percent of which they reported as being due to climate change-related erosion.

The costs of the three wetlands-only projects – totaling $3.8 million – were entirely ascribed to climate change. A single wetland-creation project in the Village of Piermont, undertaken due to sea-level rise, accounted for $3 million of this total.

Eight local governments reported another $18.2 million in costs for the management and planning for natural systems protection, with about half ($9.7 million) of those costs reported as climate change-related. The most expensive of these was in the City of Syracuse, which reported $8 million to study and potentially implement flood storage at a point along the Onondaga Creek that would protect property downstream in more populated areas. The City attributed about half of those costs to flooding from climate change.

Plant or Replace Trees or Other Vegetation (Action 9)

FIGURE 33
Action 9: Costs to Plant or Replace Trees or Vegetation (46)

Commonly reported projects (number of municipalities)	Total reported costs	% attributed to climate change	Costs attributed to climate change
Planning (13)	$10,501,000	49.8%	$5,227,800
Streambank stabilization (8)	$6,352,029	33.5%	$2,129,507
Annual maintenance (19)	$1,951,057	52.6%	$1,025,911
Invasive species (6)	$1,403,560	57.2%	$802,570
Action 9 Total	**$20,207,646**	**45.5%**	**$9,185,789**

Forty-six municipalities reported tree planting, removal or replanting linked to weather events, pest infestations or other climate change-related occurrences, with $20.2 million spent, lower than any other action. In addition, many local governments reported annual tree replanting and maintenance, but noted that 45.4 percent of their current costs, or $9.2 million, could be attributed to extreme weather, extreme heat or erosion. (See Figure 33.)

Some of the costliest projects in this action area were for planning projects, such as urban tree inventories and management plans. The cities of Albany, North Tonawanda and Syracuse reported planning projects costing over $2 million each.

The cost for the eight local governments that reported streambank stabilization tree planting projects in this action totaled more than $6 million. The Town of Brookhaven's "Trees for Tribs" program (described on page 21) accounted for $4.7 million of this total, a quarter of which ($1.2 million) was attributed to climate change, primarily extreme weather.

Many other local governments mentioned the climate change-related costs of replacing trees that were lost to the emerald ash borer, an invasive insect species that has threatened the existence of ash trees in North America. For example, the City of Oneida reported having to cut down over 200 trees in 2022, costing about $200,000 and attributed entirely to climate change.

Nineteen local governments reported a total of $1.9 million in tree planting costs without specifying a specific reason other than "annual tree planting" or similar wording. However, they attributed about half of these costs to climate change, usually citing extreme weather as the primary hazard.

Other Projects (Action 10)

FIGURE 34
Action 10: Other Projects (22)

Commonly reported projects (number of municipalities)	Total reported costs	% attributed to climate change	Costs attributed to climate change
Planning and project management (9)	$393,500	77.6%	$305,500
Greenhouse gas mitigation (5)	$205,000	90.9%	$186,250
Various uncategorized (8)	$5,014,000	91.1%	$4,566,800
Action 10 Total	**$5,612,500**	**90.1%**	**$5,058,550**

In addition to the nine adaptation action categories in the survey, 22 municipalities reported other projects they undertook or plan to undertake due to climate change. These costs were much more likely to be completely attributed to climate change (90.1 percent). The projects widely range in scale, from the City of Binghamton's $2.9 million in costs to acquire 12 flood-prone private properties to be demolished, to the $22,000 the Town of Campbell spent to deter ice jams. (See Figure 34.)

Who Pays the Bill?

Respondents were asked to estimate the share of funding by source (local, State or federal), for each action category. In aggregate, over half of project funds came from local sources, with State and federal grants each funding about 24 percent of the remaining costs. (See Figure 35.)

The funding source percentages differed by action category, as Figure 36 shows. Even within action categories, the percentage could vary quite a bit by project type. Overall, however, the action categories give insight into which types of projects received more State or more federal funding and, by extension, which ones tended to fall more on local taxpayers.

(For more detail on funding source by project type, see Appendix D, pages 61-68.)

FIGURE 35
Sources of Revenue for all Actions

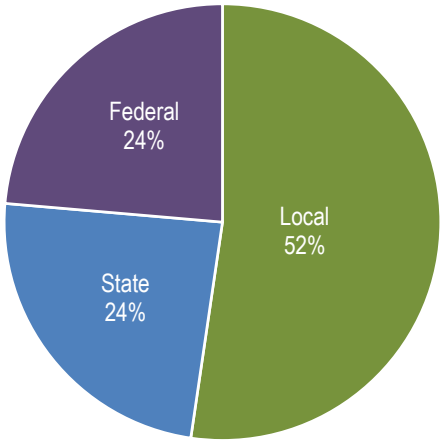
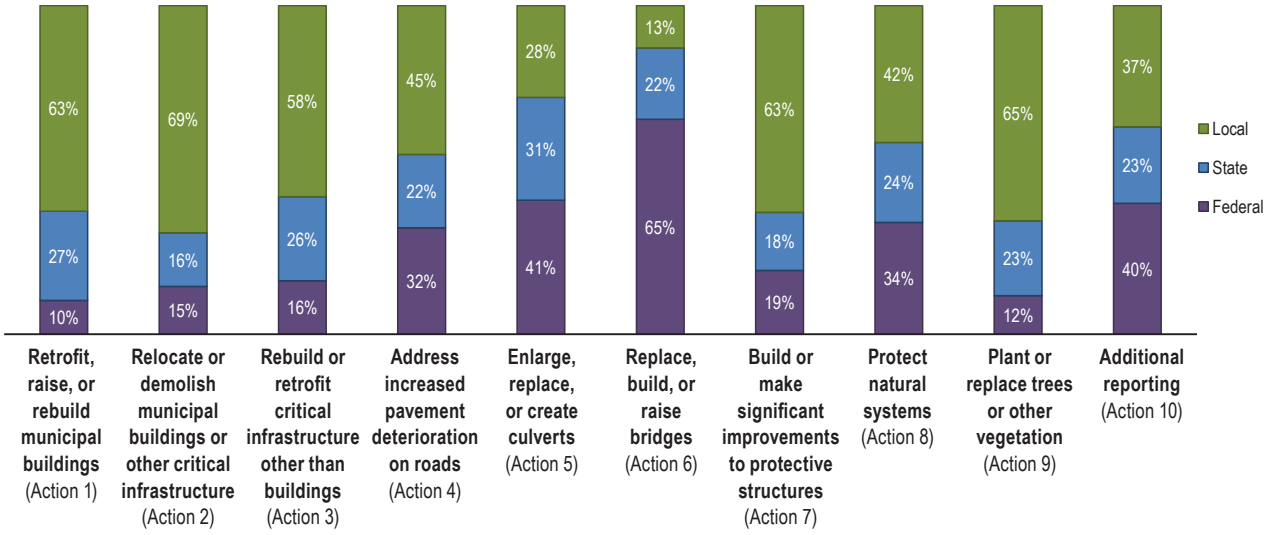


FIGURE 36
Sources of Revenue, by Adaptation Action



Local Funding

Local funding for adaptation projects is typically derived from property taxes, sales taxes and charges for services. Larger projects may be financed by debt issued by the municipality. For the purposes of this survey, respondents were asked to report debt-funded projects as "local source" funds. A few respondents also included proposed revenues from philanthropic entities or not-for-profits in the local funds section. For example, a private sponsor might purchase a conservation easement that would contribute to municipal efforts at resiliency along a waterfront.

Figure 37 shows local share costs in more detail. In aggregate, local governments reported that 52 percent ($703 million) of the costs reported in the survey were (or will be) funded locally. Local governments bore an especially large percentage (58 to 69 percent) of the costs involved in the expensive categories of retrofitting, demolishing or moving local buildings and other critical infrastructure (actions 1-3). Added together, these actions accounted for three-quarters of all local costs, driven largely by expensive wastewater infrastructure projects. They were also responsible for more than 60 percent of the cost of building protective structures (Action 7) and for planting trees (Action 9).

FIGURE 37
Local Cost of Adapting to Climate Change

	% of Total	Dollar amount	Amount attributed to climate change
Total for all reported actions (number of municipalities)	**52.3%**	**$702,610,018**	**$383,830,900**
Action 1: Retrofit, raise or rebuild municipal buildings (41)	62.6%	$62,415,729	$29,804,340
Action 2: Relocate or demolish municipal buildings or other critical infrastructure (18)	69.1%	$94,216,600	$23,968,820
Action 3: Rebuild or retrofit critical infrastructure other than buildings (42)	58.2%	$367,637,726	$234,639,213
Action 4: Address increased pavement deterioration on roads (35)	45.3%	$43,137,701	$16,043,842
Action 5: Enlarge, replace, or create culverts (44)	27.9%	$29,192,421	$16,638,569
Action 6: Replace, build, or raise bridges (16)	12.9%	$14,121,790	$7,030,356
Action 7: Build or make significant improvements to protective structures (18)	62.9%	$54,297,865	$34,656,060
Action 8: Protect natural systems (27)	41.7%	$22,289,341	$13,369,104
Action 9: Plant or replace trees or vegetation (46)	65.5%	$13,231,946	$5,846,682
Action 10: Other Projects (22)	36.9%	$2,068,900	$1,833,912

Multiplying the estimate of "cost attributed to climate change" by the "percentage of total cost from local sources" provides a broad estimate of the total additional cost that these local governments are facing due to climate change. In total, the 95 local governments replying to the survey reported local costs of $384 million due to climate change, over and above their normal capital expenditures.

In addition to representing only a small percentage of all local governments in the State, this is likely a significant underestimate of their own adaptation costs, as it is likely not inclusive of general day-to-day increases in operations and maintenance undertaken by local governments, nor of the cost of putting off other capital projects, such as roads, due to increasing adaptation needs.

State and Federal Funding

Local governments frequently seek financial assistance from the State and federal governments for climate adaptation projects. These grants can help spread the cost of expensive adaptations that communities might otherwise be unable to afford, such as those in environmentally sensitive areas or communities with a lower tax base. If designed correctly, State and federal funding streams can also incentivize appropriate responses. They can promote planning and implementing proactive adaptations that allow the community to be more resilient in the future. For example, a community might raise a roadway or otherwise improve its drainage, rather than spending ever-increasing amounts on frequent repaving due to flooding.

State and federal funds for climate change adaptation can come in various forms. A local government may seek a grant for a specific project, as the Town of Bethlehem is doing for its Henry Hudson Park project (page 19). Local governments may also use ongoing funding for certain purposes, such as road or bridge repair, to undertake projects that have a climate change element. Funds may also be provided as part of a larger State-coordinated project, such as Trees for Tribs or the Resiliency and Economic Development Initiative (described on pages 21 and 22). Low- or no-interest loans from these sources may be considered partly State or federal funds, to the extent that the local government is saving money on interest payments or bond insurance.

State Funding

Although State funding was not the largest component contributor to any broad overall action category, it is a significant source for many, averaging about 24 percent for all projects in the survey. (See Figure 38.)

State funding was especially significant for culvert projects, responsible for nearly one-third of the costs of those projects. It was also the largest non-local source of the funding for retrofits of both municipal buildings and other infrastructure.

Road projects (Action 4) also received a fair amount of State funding, with several respondents mentioning funding from the State's Consolidated Highway Improvement Program (CHIPS). Many projects reported in this action area list State funding as the largest source, despite the overall average being lower. Of course, since CHIPS funding is stable year-to-year and may be used for all types of major road projects, an increase in the amount of CHIPS funding going toward road improvements for adapting to climate change would effectively reduce the amount of ongoing funding available for other projects.

The State's cost for the projects in this survey was estimated at $323 million, of which approximately $182 million was attributed to climate change.

FIGURE 38
State Share of Costs of Adapting to Climate Change

	% of Total	Dollar amount	Amount attributed to climate change
Total for all reported actions (number of municipalities)	**24.0%**	**$322,943,498**	**$182,093,662**
Action 1: Retrofit, raise or rebuild municipal buildings (41)	27.1%	$27,069,266	$13,387,782
Action 2: Relocate or demolish municipal buildings or other critical infrastructure (18)	16.3%	$22,274,400	$5,854,618
Action 3: Rebuild or retrofit critical infrastructure other than buildings (42)	25.6%	$161,626,326	$102,316,270
Action 4: Address increased pavement deterioration on roads (35)	22.4%	$21,318,575	$8,152,625
Action 5: Enlarge, replace, or create culverts (44)	31.3%	$32,682,349	$18,636,893
Action 6: Replace, build, or raise bridges (16)	21.7%	$23,765,370	$11,757,568
Action 7: Build or make significant improvements to protective structures (18)	17.7%	$15,264,009	$9,107,131
Action 8: Protect natural systems (27)	24.4%	$13,026,403	$9,471,434
Action 9: Plant or replace trees or vegetation (46)	22.8%	$4,608,200	$2,220,226
Action 10: Other Projects (22)	23.3%	$1,308,600	$1,189,114

Federal Funding

Although federal funding amounts were almost as significant as those from State funding for the projects reported, the proportion of funding was varied, depending on the type of project. Federal funding was the largest reported funding source for bridge and culvert projects (Actions 5 and 6). It was a significant source for road projects as well, partly because the City of Kingston anticipated funding its entire "Weaving the Waterfront" project, which includes elevating two roads for a total of $20 million, using federal grant sources. However, federal sources accounted for very little of the funding for municipal retrofits or natural systems enhancement. (See Figure 39.)

For the projects identified in the survey, the federal government was reported as funding about $317 million, of which about $171 million was attributed to climate change adaptation.

FIGURE 39
Federal Share of Costs of Adapting to Climate Change

	% of Total	Dollar amount	Amount attributed to climate change
Total for all reported actions (number of municipalities)	**23.6%**	**$317,331,711**	**$171,250,597**
Action 1: Retrofit, raise or rebuild municipal buildings (41)	10.3%	$10,252,753	$3,939,261
Action 2: Relocate or demolish municipal buildings or other critical infrastructure (18)	14.5%	$19,777,000	$3,458,062
Action 3: Rebuild or retrofit critical infrastructure other than buildings (42)	16.2%	$102,666,452	$64,356,883
Action 4: Address increased pavement deterioration on roads (35)	32.4%	$30,848,600	$14,982,326
Action 5: Enlarge, replace, or create culverts (44)	40.8%	$42,650,120	$24,217,092
Action 6: Replace, build, or raise bridges (16)	65.4%	$71,600,000	$35,330,656
Action 7: Build or make significant improvements to protective structures (18)	19.4%	$16,754,020	$10,776,238
Action 8: Protect natural systems (27)	34.0%	$18,180,266	$11,035,676
Action 9: Plant or replace trees or vegetation (46)	11.7%	$2,367,500	$1,118,880
Action 10: Other Projects (22)	14.5%	$2,235,000	$2,035,523

Adaptation in New York City

Given its location on the northeast coast, New York City is vulnerable to sea-level rise, nor'easters and post-tropical cyclones, as well as extreme heat and precipitation. In eight of the past 11 years, at least one climate-related federal emergency disaster has been declared for one or more areas of New York City (see Figure 40).[20] The increasing frequency with which these hazards have impacted New York City over the past decade has led to significant planning and investments in climate adaptation and resilience.

FIGURE 40
New York City Area Climate Related Federal Emergency Disaster Declarations Since 2010

Years	Event	Bronx	Brooklyn	Manhattan	Queens	Staten Island
2010	Nor'easter/Flooding		X		X	X
	Severe Storms/Tornados/Straight Line Winds		X		X	X
2011	Hurricane Irene	X	X	X	X	X
	Winter Storm Alfred					X
2012	Hurricane Sandy	X	X	X	X	X
2013	Severe Storm/Tidal Surge	X				X
2016	Nor'easter/Winter Storm	X	X	X	X	X
2018	Winter Storm/Flooding		X		X	X
	Nor'easter/Flooding		X		X	X
2020	Tropical Storm Isaias				X	X
2021	Hurricane Ida/Pluvual Flooding	X	X	X	X	X

Source: Federal Emergency Management Agency; Rebuild by Design

Adaptation and Resilience Planning

New York City began including climate change adaptation and resilience in its overall planning strategy at least as early as 2007 when it launched PlaNYC 2030. The practice has continued through several plan updates over the years, including the OneNYC 2050 Plan, which was initiated in 2019 and has the stated intent to "confront our climate crisis, achieve equity and strengthen our democracy."[21] More recently the City initiated an AdaptNYC plan focusing on extreme heat and rainfall, and coastal flooding.[22] Over the years, the City adopted policies and legislation such as those in Appendix E to achieve the objectives of the plans, often informed by research and analyses (see examples in Appendix F).

Recent Adaptation and Resilience Activities

The OneNYC 2050 Plan has 30 strategic initiatives clustered around eight goals.[23] One initiative aims to "strengthen communities, buildings, infrastructure, and the waterfront to be more resilient," under the goal of a livable climate.[24] Many of the steps taken under this initiative and to achieve the stated goal involved new local laws, some of which amended the City's administrative code.

In keeping with a OneNYC commitment, the City is undertaking a five-year pilot program, to end in 2026, that is focused on using climate resiliency design guidelines (first introduced in 2017) for publicly funded capital projects. The pilot must include at least 35 projects, and no fewer than four are to be implemented in each of the five boroughs, and a total of 35 percent of them are to be located in environmental justice areas.[25] The OneNYC April 2022 progress report indicates that 40 projects have applied to participate in the pilot.

By the end of the pilot program, the Mayor's Office of Long Term Planning and Sustainability (OLTPS), which is now the Mayor's Office of Climate and Environmental Justice (MOCEJ), will need to have generated and established a climate resiliency score metric, which may differ by type of capital project (new construction, substantial improvements or infrastructure).[26] The resiliency score will consist of a system of points or metrics that assess the potential performance of resiliency features, such as elevation to reduce risk of flooding, heat mitigation, and on-site stormwater capture and management. After 2026, every City-funded capital project costing $10 million or more must meet or exceed the relevant minimum climate resiliency score, guided by a methodology, or otherwise receive approval from MOCEJ or other oversight entity to be named.

Commitments for Capital Investment in Adaptation and Resilience

New York City is currently developing a strategic analysis to more precisely capture its spending on resiliency. While this analysis is not yet complete, OSC has developed a conservative estimate of the City's planned adaptation and resilience spending using keyword searches of budget lines and capital project descriptions (see Figure 41).[27] Budget lines were then assigned depending on whether projects were considered fully for adaptation and resilience, partially for adaptation and resilience, had the potential to include adaptation and resilience measures, or other. Budget lines for full adaptation and resilience projects are those that cover storm sewers, green infrastructure (trees and shrubs), bluebelts (ecologically rich drainage systems) and resilience work on infrastructure across the City. Budget lines for part adaptation and resilience projects include all other sewer investments. Lines considered as potential for adaptation and resilience cover projects where there are opportunities to incorporate resiliency features during design and construction, reconstruction or improvement.

FIGURE 41
New York City's Planned Capital Commitments 2023 to 2026, With Percentage Distribution Per Year

Categories	2023		2024		2025		2026	
	Amount (in Millions)	Percentage of total	Amount (in Millions)	Percentage of total	Amount (in Millions)	Percentage of total	Amount (in Millions)	Percentage of total
Adaptation & Resilience	**$829**	**4.0%**	**$1,149**	**5.3%**	**$655**	**3.6%**	**$566**	**3.6%**
Education	$15	0.1%	$9	0.0%	$0	0.0%	$0	0.0%
Parks	$32	0.2%	$37	0.2%	$22	0.1%	$4	0.0%
Resiliency, Technology and Equipment.	$518	2.5%	$489	2.2%	$394	2.2%	$209	1.3%
Sewers	$265	1.3%	$614	2.8%	$239	1.3%	$353	2.3%
Part Adaptation & Resilience	**$1,306**	**6.3%**	**$1,270**	**5.8%**	**$1,008**	**5.6%**	**$598**	**3.9%**
Highways	$283	1.4%	$490	2.2%	$454	2.5%	$286	1.8%
Parks	$0	0.0%	$1	0.0%	$11	0.1%	$0	0.0%
Sewers	$197	0.9%	$396	1.8%	$105	0.6%	$153	1.0%
Water Pollution Control	$826	4.0%	$384	1.8%	$437	2.4%	$160	1.0%
Potential for Adaptation & Resilience	**$3,723**	**18.0%**	**$3,569**	**16.4%**	**$4,767**	**26.3%**	**$4,940**	**31.8%**
Other	**$14,882**	**71.8%**	**$15,820**	**72.5%**	**$11,727**	**64.6%**	**$9,414**	**60.7%**
Total	**$20,740**	**100.0%**	**$21,809**	**100.0%**	**$18,157**	**100.0%**	**$15,518**	**100.0%**

Sources: Office of Management and Budget; OSC analyses

Note: Data as published September 12, 2022; Dollar amounts are in millions and does not include funding from non-city sources. During the analysis period, the City updated its latest capital commitments data and total planned commitments may be different from that noted above.

The OSC method was applied to generate estimates of adaptation and resiliency spending based on the City's 2023 capital commitments plan (intended to cover projects awarded to contractors that are registered with the New York City Comptroller). The estimates generated (focused on the City's budget and not including spending in the City by other levels of government or where the City shares project costs with other entities) showed that for 2023 alone, $829 million was planned for commitments to cover projects that can be considered full adaptation and $1.3 billion to cover projects that can be considered partially adaptation and resilience, for a total of $2.1 billion (see Figure 41). Furthermore, planned commitments for these two categories account for $7.4 billion, or 9.7 percent of total commitments for all projects for FY 2023 through FY 2026. Planned commitments for the two categories average more than $1.8 billion per year over the period.

Under the OSC approach, full adaptation and resilience projects include those that cover investments in green infrastructure and bluebelts which slow rainfall run-off to the main sewers and reduce the risk of flash flooding. The New York City Department of Environmental Protection 2021 annual report on green infrastructure identifies projects for planting trees and shrubs along sidewalks, parking lanes, medians and roadways (right-of-way green infrastructure) in areas of the Bronx, Brooklyn and Queens (Westchester Creek, Bronx River, Newtown Creek, Flushing Creek and Jamaica Bay).[28] The Department also has a portal showing the progress of the bluebelt system in the Staten Island Bluebelt.[29]

Conclusion

In response to a survey in 2022, the 95 Climate Smart Communities around the State surveyed by OSC confirmed that local governments are having to adapt local infrastructure to new, harsher conditions caused by climate change. Of the 95, 77 reported having to take at least one action to adapt to hazards, with increased flooding and severe weather particularly commonly reported. Many local governments reported having to upgrade municipal buildings and replace drainage culverts, but some of the most expensive projects involved wastewater and, less commonly, drinking water infrastructure.

The 95 respondents represent only 6 percent of the State's 1,585 municipal governments (counties, cities, towns and villages). Even so, between them, they reported 10-year (five prior actual years plus five budgeted or planned years) costs of $1.34 billion, of which respondents attributed $737 million to climate change adaptation. They reported being responsible for just over half of these costs, or $384 million, with State or federal sources funding the rest. In addition, this is likely an understatement of the actual cost of adaptation because most respondents did not include increased maintenance and operational costs.

These all pale in comparison to the estimates provided separately by the State's largest city. Given its location on the coast, New York City has been experiencing cloudbursts, more frequent and intense post-tropical cyclones and nor'easters, and extreme heat resulting from a warming climate. Since 2007, the City's response to the losses and damages resulting from these extreme climate events has included adopting new policies and legislation and investing in infrastructure to improve resilience. OSC analysis shows an average of more than $1.8 billion is allocated for each of the years 2023 through 2026 to cover the City's planned commitments for capital infrastructure projects (such as storm sewers, combined sewers and green infrastructure) that can be considered either full or partial adaptation and resilience. This is 9.7 percent of the annual average of planned commitments for all New York City capital projects for those years, and more than two times the size of the 10-year adaptation and resilience expenditures (actual and planned) of the other 95 local governments that participated in the survey.

This survey shows that local governments are shouldering a significant burden of the costs of adapting to climate change. Since we have surveyed Climate Smart Communities, rather than the entire population of local governments, it is possible that these municipalities may be making more investments in resiliency measures compared to other communities. Effective capital planning moving forward requires all local officials to assess the need for additional climate actions, plan for these higher costs, and communicate these challenges to their stakeholders at both the State and local level, so that the infrastructure under their care is being adapted for this long-term challenge.

Appendix A: Reported Measures to Increase Resiliency

Reported Measures to Increase Resiliency

Muni Name	Formed or attended committees	Adopted building standards	Initiated planning studies	Educated Property Owners	Adopted zoning ordinances	Identified emergency shelters	None of these
City of Albany (Albany)	✓		✓			✓	
City of Auburn (Cayuga)			✓		✓	✓	
City of Binghamton (Broome)		✓	✓		✓	✓	
City of Hudson (Columbia)	✓					✓	
City of Ithaca (Tompkins)	✓	✓	✓	✓			
City of Kingston (Ulster)	✓	✓	✓	✓	✓	✓	
City of North Tonawanda (Niagara)	✓				✓	✓	
City of Oneida (Madison)						✓	
City of Poughkeepsie (Dutchess)	✓						
City of Rochester (Monroe)	✓			✓	✓	✓	
City of Syracuse (Onondaga)	✓	✓	✓	✓	✓		
County of Chenango			✓		✓		
County of Columbia	✓						
County of Dutchess	✓	✓	✓		✓	✓	
County of Erie	✓						
County of Schenectady	✓		✓			✓	
County of Suffolk	✓		✓	✓	✓	✓	
County of Sullivan	✓		✓	✓		✓	
County of Tompkins	✓						
Town of Amenia (Dutchess)						✓	
Town of Ancram (Columbia)	✓		✓	✓		✓	
Town of Babylon (Suffolk)	✓	✓	✓	✓	✓	✓	
Town of Bethlehem (Albany)	✓					✓	
Town of Bolton (Warren)							✓
Town of Brighton (Monroe)	✓			✓			
Town of Brookhaven (Suffolk)	✓	✓	✓	✓	✓	✓	
Town of Campbell (Steuben)							✓
Town of Canandaigua (Ontario)	✓		✓		✓		
Town of Chester (Warren)			✓			✓	
Town of Clarendon (Orleans)							✓
Town of Clinton (Dutchess)	✓		✓				
Town of Copake (Columbia)	✓		✓			✓	
Town of Dannemora (Clinton)						✓	
Town of Diana (Lewis)							✓
Town of Dryden (Tompkins)	✓	✓	✓	✓	✓		
Town of Fallsburg (Sullivan)							✓
Town of Ghent (Columbia)	✓	✓				✓	
Town of Highland (Sullivan)						✓	
Town of Hillsdale (Columbia)	✓		✓			✓	
Town of Hunter (Greene)					✓		
Town of Hurley (Ulster)	✓						
Town of Ithaca (Tompkins)	✓	✓			✓		
Town of Jay (Essex)							✓
Town of Lewis (Essex)						✓	
Town of Lodi (Seneca)	✓	✓	✓	✓		✓	
Town of Lyndon (Cattaraugus)							✓
Town of Mamaroneck (Westchester)	✓		✓	✓		✓	
Town of Naples (Ontario)	✓						
Town of New Lebanon (Columbia)	✓		✓			✓	
Town of New Lisbon (Otsego)	✓			✓			
Town of New Paltz (Ulster)	✓						

Appendix A: Reported Measures to Increase Resiliency

Reported Measures to Increase Resiliency

Muni Name	Formed or attended committees	Adopted building standards	Initiated planning studies	Educated Property Owners	Adopted zoning ordinances	Identified emergency shelters	None of these
Town of Olive (Ulster)	✓	✓	✓	✓		✓	
Town of Poughkeepsie (Dutchess)	✓		✓		✓	✓	
Town of Putnam Valley (Putnam)	✓		✓	✓	✓	✓	
Town of Rockland (Sullivan)					✓	✓	
Town of Seneca Falls (Seneca)		✓	✓		✓		
Town of Shawangunk (Ulster)							✓
Town of Sodus (Wayne)	✓						
Town of Somers (Westchester)	✓	✓		✓		✓	
Town of Stuyvesant (Columbia)	✓				✓	✓	
Village of Athens (Greene)	✓			✓		✓	
Village of Aurora (Cayuga)	✓	✓		✓		✓	
Village of Bath (Steuben)							✓
Village of Bronxville (Westchester)	✓		✓	✓		✓	
Village of Catskill (Greene)							✓
Village of Cayuga Heights (Tompkins)	✓	✓	✓	✓	✓	✓	
Village of Cherry Valley (Otsego)							✓
Village of Cooperstown (Otsego)	✓		✓				
Village of Cuba (Allegany)							✓
Village of Dansville (Livingston)							✓
Village of East Aurora (Erie)							✓
Village of East Nassau (Rensselaer)	✓		✓	✓		✓	
Village of East Rockaway (Nassau)		✓		✓		✓	
Village of Fayetteville (Onondaga)		✓					
Village of Great Neck Plaza (Nassau)	✓	✓		✓	✓		
Village of Greenport (Suffolk)						✓	
Village of Hamilton (Madison)	✓		✓	✓		✓	
Village of Lake George (Warren)*							✓
Village of Little Valley (Cattaraugus)	✓	✓		✓	✓	✓	
Village of Millerton (Dutchess)	✓				✓		
Village of Montour Falls (Schuyler)	✓	✓	✓		✓	✓	
Village of Naples (Ontario)	✓				✓	✓	
Village of Nelsonville (Putnam)							✓
Village of Piermont (Rockland)	✓	✓	✓	✓	✓	✓	
Village of Pulaski (Oswego)	✓				✓		
Village of Rhinebeck (Dutchess)	✓		✓	✓		✓	
Village of Rye Brook (Westchester)	✓					✓	
Village of Saranac Lake (Franklin)	✓	✓	✓				
Village of Sherburne (Chenango)	✓						
Village of Springville (Erie)	✓						
Village of Tarrytown (Westchester)	✓	✓	✓	✓	✓	✓	
Village of Tupper Lake (Franklin)			✓				
Village of Wesley Hills (Rockland)							✓
Village of Whitney Point (Broome)							✓
Village of Woodsburgh (Nassau)		✓					

*** Village of Lake George submitted two completed responses. Table reflects the response submitted by the CFO.**

Appendix B: Local Government Actions Taken

Local Government Actions Taken

Muni Name	Retrofit, raise or rebuild municipal buildings	Relocate or demolish municipal buildings or other critical infrastructure	Rebuild or retrofit critical infrastructure other than buildings	Address increased pavement deterioration on roads	Enlarge, replace, or create culverts	Replace, build, or raise bridges	Build or make significant improvements to protective structures	Protect natural systems	Plant or replace trees or vegetation	Other
City of Albany (Albany)			✓						✓	
City of Auburn (Cayuga)		✓	✓		✓	✓		✓	✓	
City of Binghamton (Broome)	✓	✓	✓						✓	✓
City of Hudson (Columbia)			✓					✓		
City of Ithaca (Tompkins)	✓		✓			✓				
City of Kingston (Ulster)	✓		✓	✓	✓		✓	✓	✓	✓
City of North Tonawanda (Niagara)	✓		✓	✓			✓	✓	✓	
City of Oneida (Madison)	✓		✓	✓					✓	
City of Poughkeepsie (Dutchess)	✓	✓	✓		✓	✓		✓	✓	
City of Rochester (Monroe)	✓						✓	✓	✓	
City of Syracuse (Onondaga)			✓		✓	✓		✓	✓	
County of Chenango										
County of Columbia	✓	✓	✓	✓	✓	✓				
County of Dutchess	✓	✓	✓	✓						
County of Erie		✓	✓					✓	✓	
County of Schenectady					✓				✓	
County of Suffolk	✓			✓	✓		✓	✓		
County of Sullivan	✓	✓			✓		✓			✓
County of Tompkins										
Town of Amenia (Dutchess)		✓	✓							
Town of Ancram (Columbia)					✓					
Town of Babylon (Suffolk)	✓		✓	✓	✓	✓	✓		✓	
Town of Bethlehem (Albany)			✓				✓	✓	✓	
Town of Bolton (Warren)										
Town of Brighton (Monroe)			✓	✓	✓				✓	
Town of Brookhaven (Suffolk)	✓		✓		✓		✓	✓	✓	✓
Town of Campbell (Steuben)	✓									✓
Town of Canandaigua (Ontario)	✓	✓	✓	✓	✓				✓	
Town of Chester (Warren)	✓				✓					✓
Town of Clarendon (Orleans)										
Town of Clinton (Dutchess)					✓				✓	
Town of Copake (Columbia)										
Town of Dannemora (Clinton)	✓		✓		✓			✓		
Town of Diana (Lewis)										
Town of Dryden (Tompkins)					✓					
Town of Fallsburg (Sullivan)										
Town of Ghent (Columbia)				✓	✓					
Town of Highland (Sullivan)										
Town of Hillsdale (Columbia)					✓	✓		✓	✓	
Town of Hunter (Greene)		✓		✓						
Town of Hurley (Ulster)					✓					
Town of Ithaca (Tompkins)				✓					✓	
Town of Jay (Essex)	✓		✓					✓		
Town of Lewis (Essex)										
Town of Lodi (Seneca)	✓	✓		✓	✓	✓	✓	✓	✓	
Town of Lyndon (Cattaraugus)	✓			✓	✓					
Town of Mamaroneck (Westchester)	✓		✓	✓	✓	✓			✓	✓

Appendix B: Local Government Actions Taken

Local Government Actions Taken

Muni Name	Retrofit, raise or rebuild municipal buildings	Relocate or demolish municipal buildings or other critical infrastructure	Rebuild or retrofit critical infrastructure other than buildings	Address increased pavement deterioration on roads	Enlarge, replace, or create culverts	Replace, build, or raise bridges	Build or make significant improvements to protective structures	Protect natural systems	Plant or replace trees or vegetation	Other
Town of Naples (Ontario)			✓		✓		✓	✓	✓	
Town of New Lebanon (Columbia)									✓	✓
Town of New Lisbon (Otsego)					✓					✓
Town of New Paltz (Ulster)										
Town of Olive (Ulster)	✓	✓		✓	✓			✓		✓
Town of Poughkeepsie (Dutchess)	✓		✓	✓	✓			✓		✓
Town of Putnam Valley (Putnam)	✓	✓	✓	✓	✓	✓	✓	✓		✓
Town of Rockland (Sullivan)	✓		✓					✓	✓	
Town of Seneca Falls (Seneca)	✓		✓		✓					
Town of Shawangunk (Ulster)					✓					
Town of Sodus (Wayne)										
Town of Somers (Westchester)	✓									
Town of Stuyvesant (Columbia)	✓									
Village of Athens (Greene)				✓	✓				✓	✓
Village of Aurora (Cayuga)		✓	✓	✓	✓		✓	✓	✓	✓
Village of Bath (Steuben)										
Village of Bronxville (Westchester)			✓				✓		✓	✓
Village of Catskill (Greene)					✓					
Village of Cayuga Heights (Tompkins)	✓			✓	✓				✓	
Village of Cherry Valley (Otsego)				✓						
Village of Cooperstown (Otsego)			✓		✓				✓	
Village of Cuba (Allegany)		✓	✓	✓		✓				
Village of Dansville (Livingston)										
Village of East Aurora (Erie)			✓	✓					✓	
Village of East Nassau (Rensselaer)				✓	✓	✓		✓	✓	✓
Village of East Rockaway (Nassau)	✓			✓					✓	
Village of Fayetteville (Onondaga)										
Village of Great Neck Plaza (Nassau)	✓		✓	✓					✓	✓
Village of Greenport (Suffolk)			✓	✓	✓				✓	
Village of Hamilton (Madison)	✓									
Village of Lake George (Warren)*										
Village of Little Valley (Cattaraugus)	✓	✓	✓		✓					
Village of Millerton (Dutchess)		✓		✓					✓	
Village of Montour Falls (Schuyler)	✓		✓	✓	✓	✓	✓		✓	✓
Village of Naples (Ontario)			✓	✓	✓			✓	✓	✓
Village of Nelsonville (Putnam)	✓			✓					✓	✓
Village of Piermont (Rockland)								✓	✓	
Village of Pulaski (Oswego)	✓		✓	✓			✓	✓	✓	✓
Village of Rhinebeck (Dutchess)	✓				✓	✓	✓	✓	✓	✓
Village of Rye Brook (Westchester)	✓		✓	✓	✓				✓	
Village of Saranac Lake (Franklin)	✓	✓					✓		✓	
Village of Sherburne (Chenango)			✓			✓			✓	
Village of Springville (Erie)	✓	✓	✓	✓					✓	
Village of Tarrytown (Westchester)	✓		✓		✓	✓	✓	✓	✓	
Village of Tupper Lake (Franklin)										
Village of Wesley Hills (Rockland)					✓					
Village of Whitney Point (Broome)										
Village of Woodsburgh (Nassau)										

*** Village of Lake George submitted two completed responses. Table reflects the response submitted by the CFO.**

Appendix C: Project Types by Action Category

Project Types by Action Category		
Action	**Commonly reported projects** (number of municipalities)	**Selected descriptions from surveys**
Action 1: Retrofit, raise or rebuild municipal buildings (41)	Multiple retrofits (16)	Building envelope efficiencies such as windows, siding or insulation; or floodproofing. Raising up heating or cooling units to protect from flooding.
	Build a new municipal structure or raise a building (7)	Rebuilding public works/highway facilities, town halls, etc., in lower-lying areas. Raising buildings above recommended flood elevations.
	Roofs (5)	Enhancing or replacing flat roofs to accommodate increasingly extreme wind, ice, or heavy snowfalls. Green roofs absorb rainwater, reduce "heat island" effects, and can help save energy by regulating indoor building temperature.
	Generators (15)	Designated shelters, emergency centers, drinking- or wastewater-facilities, and municipal operations can be maintained during power outages.
Action 2: Relocate or demolish municipal buildings or other critical infrastructure (18)	Water-related facilities (8)	Relocating structures with a history of flooding. Protecting (by raising portions of, for example) new building sites so the infrastructure would not be impacted during future flood incidents.
	Police and fire buildings (3)	Relocating buildings outside flood zones or other high-risk areas such as dam failure inundation zones or storm-surge areas.
Action 3: Rebuild or retrofit critical infrastructure other than buildings (42)	Wastewater, stormwater, and sewer facilities (27)	Protecting combined sewer outflows (CSOs) from backing up into the sewer system during high-water-level events caused by storms or sea-level rise. Protecting sewage treatment structures from water infiltration through, for example, dry floodproofing (making a building watertight by applying a waterproof membrane to the outside below the floodline) or building floodwalls above known flood levels. Relining sanitary sewer pipes to reduce inflow and infiltration of water which will damage pipes. Protecting pump stations, which collect, store and lift wastewater or sewage for further distribution.
	Drinking water infrastructure (8)	Protecting against contamination of drinking water wells by surface water in low-lying areas. Protecting drinking water pump stations and their controls from infiltration by use of drain plugs or other methods. Rebuilding after storm damage.

Appendix C: Project Types by Action Category

Project Types by Action Category		
Action	**Commonly reported projects** (number of municipalities)	**Selected descriptions from surveys**
Action 4: Address increased pavement deterioration on roads (35)	Drainage-related repair (18)	Stormwater systems impact road quality. Culverts are essential parts of many roadways and their deterioration or clogging can lead to water or erosion damage and result in poor road quality. Storm, hurricane or flood response. Increasingly common are "X-hundred year flood" events: these are floods of such large magnitude that they should have an extremely low chance of occurrence.
	Annual assessment and resurfacing (17)	Respondents atrributed a portion of the routine maintenance and planned improvements (and costs) to climate adaptation.
Action 5: Enlarge, replace, or create culverts (44)	Replace or enlarge culverts; or increased maintenance (35)	Enlarge existing culverts to increase hydraulic capacity, which should minimize flooding. More frequent extreme weather events shorten replacement schedule. New culverts in places where increased stormwater runoff overflows streams or creates ditches. Culverts more often need clearing because they are plugged with debris during the heaviest storms.
	Planning (4), other related storm sewer or CSO projects (4), or bridge culverts (1)	Includes water management plans, flood mitigation plans, "complete streets" plans that include water concerns, and municipal maintenance plans. Culverts as a component of the wastewater management system, whether it be separate storm sewers or a combined system (CSO). Roads that cross waterways may use a blend of culverts and bridges.
Action 6: Replace, build, or raise bridges (16)	Replace bridges (8)	Timing for replacement is changed due to increasingly extreme weather or frequent floods. Replacing a culvert with a bridge, where enlargement or deepening of the crossing necessitates it. Hurricane or storm damage exacerbated deterioration.
	Rehabilitate or raise bridges (8)	Damages caused by flooding or scouring of embankments or structural piers. Sea-level rise or high-level flooding on road or train bridges will require raising bridge elevations. Studies to determine extent of repair necessary.

Appendix C: Project Types by Action Category

Project Types by Action Category		
Action	**Commonly reported projects** (number of municipalities)	**Selected descriptions from surveys**
Action 7: Build or make significant improvements to protective structures (18)	Streambank or shoreline revitalization (10)	Protecting houses, roads, buildings or critical infrastructure constructed along waterfronts from extreme events through stabilization measures such as building structural controls and naturalized buffers. Increasing shoreline resilience thorugh work on protective structures. Building earthen structures to impede flooded waterways from overtaking a fire house, a public works facility or a neighborhood school.
	Dams (4), levees (1), bridges (1), other (2)	Replacing, removing, or upgrading. Responding to federal flood guidelines.
Action 8: Protect natural systems (27)	Shoreline remediation using vegetation (12)	Remediating or restoring streambanks, riparian areas (river and stream banks) and shorelines using trees and plants. Managing invasive species to ensure the native species that protect against erosion and filter water can thrive. Nourishing coastal beach systems with plantings.
	Wetlands (3)	Creating wetlands out of previously impermeable surfaces (such as parking lots). Flood storage adapts the lansdcape to hold storm or floodwaters before they can reach sensitive areas.
	Planning and comprehensive management (8)	Planning includes doing an inventory of natural resource assets, an assessment of climate risks, a visioning analysis, changes to zoning, planning for land purchase or sale, etc. Any of these can be components of a comprehensive plan as well. Land acquisition can give a municipality greater control over management, but working with private landowners directly may be effective.

Appendix C: Project Types by Action Category

Project Types by Action Category		
Action	**Commonly reported projects** (number of municipalities)	**Selected descriptions from surveys**
Action 9: Plant or replace trees or vegetation (46)	Streambank stabilization (8)	Planting projects provide streambank and riparian buffer resiliency.
	Invasive species (6)	Replacing street trees and plantings with more bio-diverse and climate-and-invasive adaptable species. Reacting to insect infestation by removing and replacing ash trees.
	Planning (13)	Includes comprehensive tree plans, studies, inventories and program implementation.
	Annual maintenance (19)	Planting trees annually to replace canopy lost to disease, infestation, storms and construction.
Action 10: Other Projects (22)	Planning and project management (9)	Includes funding flood mitigation studies, flood buyout studies, emergency management plans and natural resource inventories, as well as creating conservation advisory councils and attending conferences.
	Various uncategorized (8)	Ranging from large-scale flood management projects to smaller-scale projects such as sponsoring emergency heat centers.
	Greenhouse gas mitigation (5)	Municipalities are, among many other things, replacing fleets with electric vehicles, installing EV charging station, solarizing municipal buildings, and replacing streetlights with LED bulbs.

Note: Two projects were combination roof/generator projects and were counted in both categories in Action 1. For the purpose of total project count (41), each is counted only once.

Appendix D: Costs by Project Type and Action Category

Total Cost and Cost Attributed to Climate Change				
Action	**Commonly reported projects** (number of municipalities)	**Total reported costs**	**Percentage attributed to climate change**	**Costs attributed to climate change**
Action 1: Retrofit, raise or rebuild municipal buildings (41)	Multiple retrofits (16)	$56,725,000	60.8%	$34,497,150
	New structure/raise building (7)	$34,970,833	26.7%	$9,354,375
	Roofs (5)	$3,604,120	48.7%	$1,756,000
	Generators (15)	$4,437,794	34.3%	$1,523,859
Action 1 Total		**$99,737,748**	**47.3%**	**$47,131,384**
Action 2: Relocate or demolish municipal buildings or other critical infrastructure (18)	Water-related facilities (8)	$102,648,000	16.0%	$16,401,500
	Police and fire buildings (3)	$21,000,000	53.0%	$11,125,000
	Other (7)	$12,620,000	45.6%	$5,755,000
Action 2 Total		**$136,268,000**	**24.4%**	**$33,281,500**
Action 3: Rebuild or retrofit critical infrastructure other than buildings (42)	Wastewater, stormwater, and sewer facilities (27)	$553,946,504	64.1%	$354,913,865
	Drinking water infrastructure (8)	$55,254,000	51.9%	$28,692,500
	Other (7)	$22,730,000	77.9%	$17,706,000
Action 3 Total		**$631,930,504**	**63.5%**	**$401,312,365**
Action 4: Retrofit, raise or rebuild municipal buildings (41)	Drainage-related repair (18)	$60,217,876	33.5%	$20,170,243
	Annual assessment and resurfacing (17)	$35,087,000	54.2%	$19,008,550
Action 4 Total		**$95,304,876**	**41.1%**	**$39,178,793**
Action 5: Relocate or demolish municipal buildings or other critical infrastructure (18)	Replace or enlarge culverts; or increased maintenance (35)	$46,544,890	57.5%	$26,778,304
	Planning (4), other related storm sewer or CSO projects (4), or bridge culverts (1)	$57,980,000	56.4%	$32,714,250
Action 5 Total		**$104,524,890**	**56.9%**	**$59,492,554**

Note: Two local governments described projects that included both generator and roof elements in Action 1. These were counted in both project types, but the costs were included in the roof projects only and the total of 41 reflects each project once.

Appendix D: Costs by Project Type and Action Category

Total Cost and Cost Attributed to Climate Change				
Action	**Commonly reported projects** (number of municipalities)	**Total reported costs**	**Percentage attributed to climate change**	**Costs attributed to climate change**
Action 6: Replace, build, or raise bridges (16)	Rehabilitate or raise bridges (8)	$74,250,000	47.1%	$34,984,000
	Replace bridges (8)	$35,237,160	54.3%	$19,134,580
Action 6 Total		**$109,487,160**	**49.4%**	**$54,118,580**
Action 7: Build or make significant improvements to protective structures (18)	Streambank or shoreline revitalization (10)	$63,162,894	57.1%	$36,057,930
	Dams (4), levees (1), bridges (1), or other (2)	$23,153,000	79.8%	$18,481,500
Action 7 Total		**$86,315,894**	**63.2%**	**$54,539,430**
Action 8: Protect natural systems (27)	Shoreline remediation using vegetation (12)	$30,188,835	65.8%	$19,865,527
	Planning and comprehensive management (8)	$18,232,175	53.0%	$9,662,188
	Wetlands (3)	$3,820,000	100.0%	$3,820,000
	Other (4)	$1,255,000	42.1%	$528,500
Action 8 Total		**$53,496,010**	**63.3%**	**$33,876,215**
Action 9: Plant or replace trees or vegetation (46)	Planning (13)	$10,501,000	49.8%	$5,227,800
	Streambank stabilization (8)	$6,352,029	33.5%	$2,129,507
	Annual maintenance (19)	$1,951,057	52.6%	$1,025,911
	Invasive species (6)	$1,403,560	57.2%	$802,570
Action 9 Total		**$20,207,646**	**45.5%**	**$9,185,789**
Action 10: Other Projects (22)	Planning and project management (9)	$393,500	77.6%	$305,500
	Greenhouse gas mitigation (5)	$205,000	90.9%	$186,250
	Various uncategorized (8)	$5,014,000	91.1%	$4,566,800
Action 10 Total		**$5,612,500**	**90.1%**	**$5,058,550**
Total Cost		**$1,342,885,228**	**54.9%**	**$737,175,158**

Note: Two local governments described projects that included both generator and roof elements in Action 1. These were counted in both project types, but the costs were included in the roof projects only and the total of 41 reflects each project once.

Appendix D: Costs by Project Type and Action Category

Local Cost				
Action	**Commonly reported projects** (number of municipalities)	**Local funding as % of total**	**Total local funding**	**Local funding attributed to climate change**
Action 1: Retrofit, raise or rebuild municipal buildings (41)	Multiple retrofits (16)	66.4%	$37,685,000	$22,918,027
	New structure/raise building (7)	64.8%	$22,648,917	$6,058,376
	Roofs (5)	21.8%	$786,162	$383,034
	Generators (15)	29.2%	$1,295,650	$444,903
Action 1 Total		**62.6%**	**$62,415,729**	**$29,804,340**
Action 2: Relocate or demolish municipal buildings or other critical infrastructure (18)	Water-related facilities (8)	67.3%	$69,102,600	$11,041,484
	Police and fire buildings (3)	95.2%	$20,000,000	$10,595,238
	Other (7)	40.5%	$5,114,000	$2,332,097
Action 2 Total		**69.1%**	**$94,216,600**	**$23,968,820**
Action 3: Rebuild or retrofit critical infrastructure other than buildings (42)	Wastewater, stormwater, and sewer facilities (27)	59.1%	$327,415,926	$209,775,585
	Drinking water infrastructure (8)	45.1%	$24,906,800	$12,933,695
	Other (7)	67.4%	$15,315,000	$11,929,934
Action 3 Total		**58.2%**	**$367,637,726**	**$234,639,213**
Action 4: Retrofit, raise or rebuild municipal buildings (41)	Drainage-related repair (18)	58.8%	$35,426,501	$11,866,262
	Annual assessment and resurfacing (17)	22.0%	$7,711,200	$4,177,579
Action 4 Total		**45.3%**	**$43,137,701**	**$16,043,842**
Action 5: Relocate or demolish municipal buildings or other critical infrastructure (18)	Replace or enlarge culverts; or increased maintenance (35)	32.4%	$15,081,171	$8,676,531
	Planning (4), other related storm sewer or CSO projects (4), or bridge culverts (1)	24.3%	$14,111,250	$7,962,038
Action 5 Total		**27.9%**	**$29,192,421**	**$16,638,569**

Note: Two local governments described projects that included both generator and roof elements in Action 1. These were counted in both project types, but the costs were included in the roof projects only and the total of 41 reflects each project once.

Appendix D: Costs by Project Type and Action Category

Local Cost				
Action	**Commonly reported projects** (number of municipalities)	**Local funding as % of total**	**Total local funding**	**Local funding attributed to climate change**
Action 6: Replace, build, or raise bridges (16)	Rehabilitate or raise bridges (8)	12.0%	$8,880,000	$4,183,945
	Replace bridges (8)	14.9%	$5,241,790	$2,846,411
Action 6 Total		**12.9%**	**$14,121,790**	**$7,030,356**
Action 7: Build or make significant improvements to protective structures (18)	Streambank or shoreline revitalization (10)	60.5%	$38,204,865	$21,810,089
	Dams (4), levees (1), bridges (1), or other (2)	69.5%	$16,093,000	$12,845,972
Action 7 Total		**62.9%**	**$54,297,865**	**$34,656,060**
Action 8: Protect natural systems (27)	Shoreline remediation using vegetation (12)	39.5%	$11,932,801	$7,852,287
	Planning and comprehensive management (8)	54.7%	$9,976,040	$5,286,828
	Wetlands (3)	3.2%	$120,500	$120,500
	Other (4)	20.7%	$260,000	$109,490
Action 8 Total		**41.7%**	**$22,289,341**	**$13,369,104**
Action 9: Plant or replace trees or vegetation (46)	Planning (13)	46.0%	$4,832,600	$2,405,853
	Streambank stabilization (8)	85.5%	$5,429,729	$1,820,308
	Annual maintenance (19)	86.4%	$1,686,057	$886,568
	Invasive species (6)	91.5%	$1,283,560	$733,953
Action 9 Total		**65.5%**	**$13,231,946**	**$5,846,682**
Action 10: Other Projects (22)	Planning and project management (9)	95.3%	$375,000	$291,137
	Greenhouse gas mitigation (5)	9.8%	$20,000	$18,171
	Various uncategorized (8)	33.4%	$1,673,900	$1,524,604
Action 10 Total		**36.9%**	**$2,068,900**	**$1,833,912**
Total Cost		**52.3%**	**$702,610,018**	**$383,830,900**

Note: Two local governments described projects that included both generator and roof elements in Action 1. These were counted in both project types, but the costs were included in the roof projects only and the total of 41 reflects each project once.

Appendix D: Costs by Project Type and Action Category

State Assistance				
Action	**Commonly reported projects** (number of municipalities)	**State funding as % of total**	**Total State funding**	**State funding attributed to climate change**
Action 1: Retrofit, raise or rebuild municipal buildings (41)	Multiple retrofits (16)	28.1%	$15,968,000	$9,710,895
	New structure/raise building (7)	20.2%	$7,075,458	$1,892,620
	Roofs (5)	77.5%	$2,793,958	$1,361,273
	Generators (15)	27.8%	$1,231,850	$422,995
Action 1 Total		**27.1%**	**$27,069,266**	**$13,387,782**
Action 2: Relocate or demolish municipal buildings or other critical infrastructure (18)	Water-related facilities (8)	14.4%	$14,774,400	$2,360,712
	Police and fire buildings (3)	4.8%	$1,000,000	$529,762
	Other (7)	51.5%	$6,500,000	$2,964,144
Action 2 Total		**16.3%**	**$22,274,400**	**$5,854,618**
Action 3: Rebuild or retrofit critical infrastructure other than buildings (42)	Wastewater, stormwater, and sewer facilities (27)	26.3%	$145,785,126	$93,404,620
	Drinking water infrastructure (8)	23.9%	$13,201,200	$6,855,168
	Other (7)	11.6%	$2,640,000	$2,056,482
Action 3 Total		**25.6%**	**$161,626,326**	**$102,316,270**
Action 4: Retrofit, raise or rebuild municipal buildings (41)	Drainage-related repair (18)	27.3%	$16,425,575	$5,501,819
	Annual assessment and resurfacing (17)	13.9%	$4,893,000	$2,650,806
Action 4 Total		**22.4%**	**$21,318,575**	**$8,152,625**
Action 5: Relocate or demolish municipal buildings or other critical infrastructure (18)	Replace or enlarge culverts; or increased maintenance (35)	38.1%	$17,713,599	$10,191,025
	Planning (4), other related storm sewer or CSO projects (4), or bridge culverts (1)	25.8%	$14,968,750	$8,445,868
Action 5 Total		**31.3%**	**$32,682,349**	**$18,636,893**

Note: Two local governments described projects that included both generator and roof elements in Action 1. These were counted in both project types, but the costs were included in the roof projects only and the total of 41 reflects each project once.

Appendix D: Costs by Project Type and Action Category

State Assistance				
Action	**Commonly reported projects** (number of municipalities)	**Local funding as % of total**	**Total local funding**	**Local funding attributed to climate change**
Action 6: Replace, build, or raise bridges (16)	Rehabilitate or raise bridges (8)	21.5%	$15,970,000	$7,524,505
	Replace bridges (8)	22.1%	$7,795,370	$4,233,063
Action 6 Total		**21.7%**	**$23,765,370**	**$11,757,568**
Action 7: Build or make significant improvements to protective structures (18)	Streambank or shoreline revitalization (10)	21.4%	$13,534,009	$7,726,188
	Dams (4), levees (1), bridges (1), or other (2)	7.5%	$1,730,000	$1,380,944
Action 7 Total		**17.7%**	**$15,264,009**	**$9,107,131**
Action 8: Protect natural systems (27)	Shoreline remediation using vegetation (12)	23.3%	$7,046,500	$4,636,894
	Planning and comprehensive management (8)	8.8%	$1,605,403	$850,787
	Wetlands (3)	96.8%	$3,699,500	$3,699,500
	Other (4)	53.8%	$675,000	$284,253
Action 8 Total		**24.4%**	**$13,026,403**	**$9,471,434**
Action 9: Plant or replace trees or vegetation (46)	Planning (13)	34.9%	$3,668,400	$1,826,270
	Streambank stabilization (8)	8.7%	$554,800	$185,996
	Annual maintenance (19)	13.6%	$265,000	$139,343
	Invasive species (6)	8.3%	$120,000	$68,617
Action 9 Total		**22.8%**	**$4,608,200**	**$2,220,226**
Action 10: Other Projects (22)	Planning and project management (9)	4.7%	$18,500	$14,363
	Greenhouse gas mitigation (5)	61.0%	$125,000	$113,567
	Various uncategorized (8)	23.2%	$1,165,100	$1,061,184
Action 10 Total		**23.3%**	**$1,308,600**	**$1,189,114**
Total all Projects in all Actions		**24.0%**	**$322,943,498**	**$182,093,662**

Note: Two local governments described projects that included both generator and roof elements in Action 1. These were counted in both project types, but the costs were included in the roof projects only and the total of 41 reflects each project once.

Appendix D: Costs by Project Type and Action Category

Federal Assistance				
Action	**Commonly reported projects** (number of municipalities)	**Federal funding as % of total**	**Total Federal funding**	**Federal funding attributed to climate change**
Action 1: Retrofit, raise or rebuild municipal buildings (41)	Multiple retrofits (16)	5.4%	$3,072,000	$1,868,228
	New structure/raise building (7)	15.0%	$5,246,458	$1,403,379
	Roofs (5)	0.7%	$24,000	$11,693
	Generators (15)	43.0%	$1,910,294	$655,961
Action 1 Total		**10.3%**	**$10,252,753**	**$3,939,261**
Action 2: Relocate or demolish municipal buildings or other critical infrastructure (18)	Water-related facilities (8)	18.3%	$18,771,000	$2,999,304
	Police and fire buildings (3)	0.0%	$-	$-
	Other (7)	8.0%	$1,006,000	$458,758
Action 2 Total		**14.5%**	**$19,777,000**	**$3,458,062**
Action 3: Rebuild or retrofit critical infrastructure other than buildings (42)	Wastewater, stormwater, and sewer facilities (27)	14.6%	$80,745,452	$51,733,661
	Drinking water infrastructure (8)	31.0%	$17,146,000	$8,903,638
	Other (7)	21.0%	$4,775,000	$3,719,584
Action 3 Total		**16.2%**	**$102,666,452**	**$64,356,883**
Action 4: Retrofit, raise or rebuild municipal buildings (41)	Drainage-related repair (18)	13.9%	$8,365,800	$2,802,162
	Annual assessment and resurfacing (17)	64.1%	$22,482,800	$12,180,164
Action 4 Total		**32.4%**	**$30,848,600**	**$14,982,326**
Action 5: Relocate or demolish municipal buildings or other critical infrastructure (18)	Replace or enlarge culverts; or increased maintenance (35)	29.5%	$13,750,120	$7,910,748
	Planning (4), other related storm sewer or CSO projects (4), or bridge culverts (1)	49.8%	$28,900,000	$16,306,344
Action 5 Total		**40.8%**	**$42,650,120**	**$24,217,092**

Note: Two local governments described projects that included both generator and roof elements in Action 1. These were counted in both project types, but the costs were included in the roof projects only and the total of 41 reflects each project once.

Appendix D: Costs by Project Type and Action Category

Federal Assistance				
Action	**Commonly reported projects** (number of municipalities)	**Local funding as % of total**	**Total local funding**	**Local funding attributed to climate change**
Action 6: Replace, build, or raise bridges (16)	Rehabilitate or raise bridges (8)	66.5%	$49,400,000	$23,275,550
	Replace bridges (8)	63.0%	$22,200,000	$12,055,105
Action 6 Total		**65.4%**	**$71,600,000**	**$35,330,656**
Action 7: Build or make significant improvements to protective structures (18)	Streambank or shoreline revitalization (10)	18.1%	$11,424,020	$6,521,654
	Dams (4), levees (1), bridges (1), or other (2)	23.0%	$5,330,000	$4,254,585
Action 7 Total		**19.4%**	**$16,754,020**	**$10,776,238**
Action 8: Protect natural systems (27)	Shoreline remediation using vegetation (12)	37.1%	$11,209,534	$7,376,346
	Planning and comprehensive management (8)	36.5%	$6,650,733	$3,524,573
	Wetlands (3)	0.0%	$-	$-
	Other (4)	25.5%	$320,000	$134,757
Action 8 Total		**34.0%**	**$18,180,266**	**$11,035,676**
Action 9: Plant or replace trees or vegetation (46)	Planning (13)	19.0%	$2,000,000	$995,677
	Streambank stabilization (8)	5.8%	$367,500	$123,204
	Annual maintenance (19)	0.0%	$-	$-
	Invasive species (6)	0.0%	$-	$-
Action 9 Total		**11.7%**	**$2,367,500**	**$1,118,880**
Action 10: Other Projects (22)	Planning and project management (9)	0.0%	$-	$-
	Greenhouse gas mitigation (5)	29.3%	$60,000	$54,512
	Various uncategorized (8)	43.4%	$2,175,000	$1,981,011
Action 10 Total		**14.5%**	**$2,235,000**	**$2,035,523**
Total all Projects in All Actions		**23.6%**	**$317,331,711**	**$171,250,597**

Note: Two local governments described projects that included both generator and roof elements in Action 1. These were counted in both project types, but the costs were included in the roof projects only and the total of 41 reflects each project once.

Appendix E: New York City Climate Change Adaptation and Resilience Measures Taken Since 2012

Examples of New York City's efforts to form or participate in committees intended to guide efforts to address climate change and its fiscal impacts)

- **NYC Local Law 2017/064:** Establish of Environmental Justice Interagency Working Group (IWG) who will develop a comprehensive Environmental Justice Plan. Establish of the Environmental Justice Advisory Board who will make recommendations to the IWG to promote environmental justice.

- **NYC Local Law 2017/060:** Requires the Environmental Justice Interagency Working Group to conduct a study of environmental justice areas and establishs of an environmental justice portal. Also provides recommendations for legislation, policy, and budget initiatives.

- **NYC Local Law 2015/072:** Requires the Climate Adaptation Task Force to include resiliency recommendations for the protection of public and private telecommunications infrastructure relating to climate change.

- **NYC Local Law 2012/042:** Institutionalized the New York City Panel on Climate Change (NPCC) and New York City Climate Change Adaptation Task Force.

Examples of New York City's efforts to adopt building standards intended to address increasing risks related to climate change

- **NYC Local Law 2021/043:** Requires most structures located in the floodplain to provide additional floodproofing and be elevated an additional 1 to 2 feet, or by the 500-year flood elevation, based on structure type.

- **Local Law 2021/041:** Requires resilience design guidelines, pilot program, and resiliency score metrics. Incorporated as Title 3, Subchapter 2, 3-131, 3-132.

- **Local Law 94 of 2019:** Amends the administrative code of the City of New York and the New York City building code, in relation to requiring that the roofs of certain buildings be covered in green roofs or solar photovoltaic electricity generating systems.

- **Local Law 92 of 2019:** Amends the New York City building code, in relation to requiring that the roofs of certain buildings be partially covered in green roof or solar photovoltaic electricity generating systems.

Appendix E: New York City Climate Change Adaptation and Resilience Measures Taken Since 2012

Additional Local Laws Related to Climate Adaptation and Resilience

Local Law 122 of 2021: A Local Law to amend the administrative code of the City of New York, in relation to the creation of a citywide climate adaptation plan.

Zoning for Coastal Flood Resiliency: Text amendment adopted by the City Council on May 12, 2021 to allow homeowners, business owners, architects and others to design resilient buildings that are better protected from flood risk and reduce flood insurance costs.

Local Law 43 of 2021: A Local Law to amend the New York City building code, in relation to additional freeboard for structures in the floodplain.

Local Law 41 of 2021: A Local Law to amend the administrative code of the City of New York, in relation to climate resiliency design guidelines and resiliency scoring.

Local Law 91 of 2020: A Local Law to amend the administrative code of the City of New York, the New York City plumbing code and the New York City building code in relation to citywide stormwater management controls.

Local Law 84 of 2020: A Local Law to amend the administrative code of the City of New York, in relation to annual reporting of heat vulnerability and heat-related deaths.

Local Law 172 of 2018: A Local Law to amend the administrative code of the City of New York, in relation to requiring a map of areas in the City most vulnerable to increased flooding in the future and a plan to address such flooding.

Local Law 64 of 2017: A Local Law to amend the administrative code of the City of New York, in relation to identifying and addressing environmental justice issues.

Local Law 84 of 2013: A Local Law to amend the New York City Charter, in relation to planning for resiliency to climate change as a responsibility of the Office of Long-Term Planning and Sustainability.

Appendix F: New York City Climate Change Impact, Mitigation and Resilience Studies

Studies	Date	Lead Agency
State of Climate Knowledge	2021	NYC Mayor's Office of Climate Resiliency
Advancing Tools and Methods for Flexible Adaptation Pathways and Science Policy Integration	March 2019	New York City Panel on Climate Change
Neighborhood Coastal Flood Protection Project Planning Guidance	December 2021	NYC Mayor's Office of Climate Resiliency
Financial District and Seaport Climate Resilience Master Plan	December 2021	NYC Economic Development Corporation (NYCEDC); NYC Mayor's Office of Resiliency
Lower Manhattan Climate Resilience Study	March 2019	NYCEDC; Mayor's Office of Recovery and Resiliency
Cloudburst Resiliency Planning Study	January 2017	NYC Department of Environmental Protection
New York City Waterfront Revitalization Programs	June 2016	NYC Department of City Planning
Climate Risk Information 2013: Observations, Climate Change Projections, and Maps	June 2013	New York City Panel on Climate Change
Climate Change Adaptation in New York City: Building a Risk Management Response; NYC Panel on Climate Change 2010 Report	May 2010	New York City Panel on Climate Change
New York City Comprehensive Waterfront Plan	2021	NYC Department of City Planning
New Normal: Combating Storm-Related Extreme Weather in New York City	September 2021	NYC Extreme Weather Response Task Force
NYC Stormwater Resiliency Plan	May 2021	NYC Department of Environmental Protection
Vision Plan for a Resilient East Harlem	December 2019	NYC Department of Parks & Recreation; NYC Mayor's Office of Resiliency
NYC's Risk Landscape: A Guide to Hazard Mitigation	May 2019	NYC Office of Emergency Management
Zoning for Coastal Flood Resiliency: Planning for Resilient Neighborhoods	May 2019	NYC Department of City Planning
Resilient Industry: Mitigation and Preparedness in the City's Industrial Floodplain	2018	NYC Department of City Planning
Resilient Retail	July 2016	NYC Department of City Planning
Resilient Neighborhoods	2016-2017	NYC Department of City Planning
Cool Neighborhoods NYC	June 2017	NYC Mayor's Office of Recovery and Resiliency
Special Initiative for Rebuilding and Resiliency: A Stronger, More Resilient New York	June 2013	NYC Special Initiative for Rebuilding and Resiliency
Resilient Edgemere	March 2017	NYC Housing Preservation and Development

Notes

[1] U.S. Department of Homeland Security, Federal Emergency Management Agency (FEMA), **https://www.fema.gov/disaster/declarations** (search for New York); U.S. Department of Housing and Urban Development, Rebuild by Design, *Resilient Infrastructure for New York State*, **https://rebuildbydesign.org/wp-content/uploads/2021/12/1329.pdf**.

[2] Capital commitments are awarded contracts for capital works that are registered with the New York City Comptroller. This estimate was formulated using the New York City commitment plan which represents a mix of actual and projected commitments.

[3] While storm sewers drain stormwater, combined sewers accommodate both storm and wastewater and account for some 60 percent of the City's sewer system. See New York City Department of Environmental Protection at **https://www.nyc.gov/site/dep/water/sewer-system.page**, accessed 4/7/2023.

[4] For more on climate risks, see U.S. Global Change Research Program, *Fourth National Climate Assessment*, Chapter 2: Our Changing Climate, at **https://nca2018.globalchange.gov/downloads/NCA4_Ch02_Changing-Climate_Full.pdf** and Working Group I (WGI) contribution to the Intergovernmental Panel on Climate Change (IPCC), *Summary for Policymakers*, **www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM.pdf**, pages 5, 12 and 13).

[5] Robin Leichenko, et al., ClimAID Annex III, *An Economic Analysis of Climate Change Impacts and Adaptations in New York State*, 2014, Annex III, p3, at **https://www.nyserda.ny.gov/-/media/Project/Nyserda/Files/Publications/Research/Environmental/EMEP/climaid/ClimAID-Annex-III.pdf**.

[6] FEMA Federal Insurance and Mitigation Administration, "Natural Hazard Mitigation Saves Interim Report Fact Sheet," June 2018, at: **www.fema.gov/sites/default/files/2020-07/fema_mitsaves-factsheet_2018.pdf**.

[7] See NYSDEC, "Community Risk and Resiliency Act (CRRA) Provisions," at **https://www.dec.ny.gov/energy/104113.html**, accessed 3/20/2023.

[8] New York State Climate Action Council, *New York State Climate Action Council Scoping Plan*, December 2022, at **https://climate.ny.gov/-/media/project/climate/files/NYS-Climate-Action-Council-Final-Scoping-Plan-2022.pdf**, chapter 21, pages 404-420.

[9] See New York State, "Clean Water, Clean Air and Green Jobs Environmental Bond Act," at **https://www.ny.gov/programs/clean-water-clean-air-and-green-jobs-environmental-bond-act**, accessed 3/20/2023.

[10] For more on local infrastructure, see OSC reports, including: *Locally Owned Roads by the Numbers* (January 2022), *Dam Infrastructure: Understanding and Managing the Risks* (June 2018), *A Partially Treated Problem: Overflows From Combined Sewers* (May 2018), *Local Bridges by the Numbers* (October 2017), *Oversight and Monitoring of Municipal Water Systems* (October 2017), *Drinking Water Systems in New York: The Challenges of Aging Infrastructure* (February 2017), all available at: **www.osc.state.ny.us/local-government/publications**.

[11] For more on Climate Smart Communities, see New York State's website on the topic: "About the Climate Smart Communities Program," available at **www.climatesmart.ny.gov/about**. There were 353 as of 2/9/22.

[12] The respondents were found to be representative of the larger group of Climate Smart Communities surveyed. The sample (n=95) was reflective of the Climate Smart Communities (N=353) when examined by government class, region and population size. The 95 "respondents" were those that completed the survey; partial results were discarded.

[13] **https://www.osc.state.ny.us/files/local-government/publications/2023/pdf/NYSOSCClimateChangeAdaptationExpendituresSurvey.pdf**.

[14] OSC also consulted with experts at NYSDEC, the Energy Research and Development Agency (NYSERDA) and the Department of Health, as well as several academic institutions.

Notes

[15] FEMA, "Natural Hazard Mitigation Saves Interim Report Fact Sheet," June 2018.

[16] Urban areas, where buildings, roads, and other infrastructure are highly concentrated and greenery is limited, trap and store heat throughout the day. These become pockets of heat referred to as "heat islands" and have higher temperatures relative to outlying areas. See United States Environmental Protection Agency, "Learn About Heat Islands," at **www.epa.gov/heatislands/learn-about-heat-islands**, accessed October 17, 2022. New York State passed new legislation in September 2022 directing NYSDEC to study the impacts of disproportionate heat conditions in urban areas, particularly in disadvantaged communities. (Chapter 563 of the Laws of 2022)

[17] For more on the Trees for Tribs program, including its Hudson River Estuary activities, see NYSDEC, "Trees for Tribs," available at: **https://www.dec.ny.gov/animals/77710.html**, accessed 4/7/2023.

[18] New York State Lake Ontario Resiliency and Economic Development Initiative, available at: **www.governor.ny.gov/programs/lake-ontario-resiliency-and-economic-development-initiative-redi**.

[19] New York State Sea Level Rise Task Force, *New York State Sea Level Rise Task Force: Report to the Legislature*, p.p. 7-8, at: **www.dos.ny.gov/system/files/documents/2020/09/nys-sea-level-rise-task-force-report.pdf**.

[20] U.S. Department of Homeland Security, Federal Emergency Management Agency; U.S. Department of Housing and Urban Development, Rebuild by Design, *Resilient Infrastructure for New York State*.

[21] The City of New York, OneNYC 2050 webpage, at **https://onenyc.cityofnewyork.us/#:~:text=OneNYC%202050%20is%20a%20strategy,Join%20us**, accessed 4/7/2023.

[22] The Mayor's Office of Climate and Environmental Justice, **https://climate.cityofnewyork.us/initiatives/adaptnyc/**, accessed 4/7/2023. AdaptNYC meets the requirements of Local Law 2021/122, which calls for the City to publish a climate change adaptation plan by September 2022, and every 10 years thereafter.

[23] The City of New York, *OneNYC 2050 Progress Report*, April 2022, at **https://onenyc.cityofnewyork.us/wp-content/uploads/2022/05/OneNYC-2022-Progress-Report.pdf**; *OneNYC2050 Action Plan*, at **https://onenyc.cityofnewyork.us/wp-content/uploads/2019/05/OneNYC-2019-2050-Action-Plan.pdf**.

[24] This goal is for the City to "lead a just transition to achieve carbon neutrality and adapt the city to withstand and emerge stronger from the impacts of climate change." See The City of New York, *OneNYC 2050, A Livable Climate*, **https://onenyc.cityofnewyork.us/strategies/a-livable-climate/**, accessed 4/7/2023.

[25] An environmental justice area is defined in Section 3-1001 of Title 3, Chapter 10 of the New York Administrative Code as "a low-income community located in the city, or a minority community located in the city," **https://codelibrary.amlegal.com/codes/newyorkcity/latest/NYCadmin/0-0-0-1690**, accessed 4/7/2023.

[26] The metric is to include consideration of such design features as elevation to reduce risk of flooding, green infrastructure, on-site storm water capture and management, living walls or structures, pervious pavement, integration of natural shoreline, and incorporation or preservation of natural vegetation or habitat. These are to be applied to all capital projects except those managed by the New York City Housing Authority and the New York City School Construction Authority, which may both develop separate score metrics, to be approved by the OLTPS.

[27] The data used for these estimates was from NYC Open Data, *The Capital Commitment Plan*, Office of Management and Budget, **https://data.cityofnewyork.us/City-Government/Capital-Commitment-Plan/2cmn-uidm**, accessed 1/17/2023.

[28] New York City Department of Environmental Protection, *NYC Green Infrastructure, 2021 Annual Report*, p. 2, **https://www1.nyc.gov/assets/dep/downloads/pdf/water/stormwater/green-infrastructure/gi-annual-report-2021.pdf**.

[29] New York City Department of Environmental Protection, "The Bluebelt Program," **https://www1.nyc.gov/site/dep/water/the-bluebelt-program.page**, accessed 4/7/2023.

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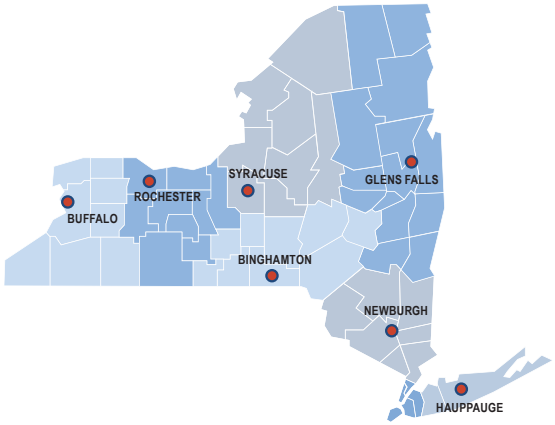

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