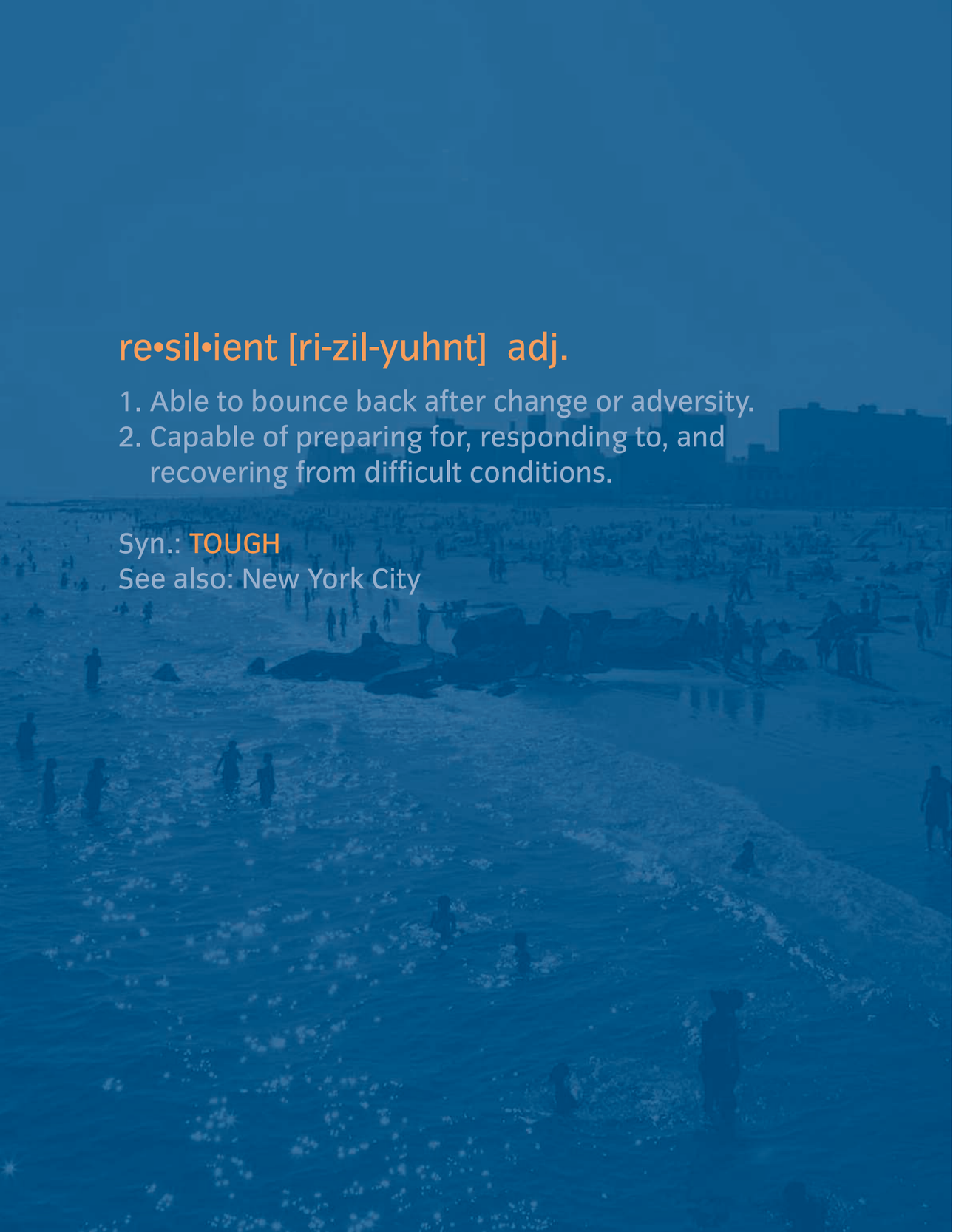
planYC
A STRONGER,
MORE RESILIENT
NEW YORK
The City of New York
Mayor Michael R. Bloomberg



This report is dedicated to the 43 New Yorkers who lost their lives during Sandy, and to the loved ones they left behind. It is also offered in recognition of those whose homes, businesses, and communities were damaged during the storm and who are working to rebuild. The City stands in solidarity with all of them as it makes plans to strengthen New York so that future climate events do not have the same devastating effects.

Foreword from the Mayor

June 11, 2013

CITY OF NEW YORK

Hurricane Sandy was the worst natural disaster ever to hit New York City. Forty-three New Yorkers lost their lives, many more lost homes or businesses, and entire communities were sent reeling by the storm's devastating impact.

Seven months later, we still have a lot of work to do to help the hardest-hit communities get back on their feet—but there's no question we've come a long way. During tough times, our city always pulls together, and our post-Sandy recovery has been an unprecedented team effort. Thousands of City workers and NYC Service volunteers have put in countless hours cleaning and rebuilding neighborhoods and helping families impacted by the storm, and our Administration has launched innovative new programs to expedite that work. We've also received tremendous help from partners in Federal and State government, from local community leaders, and from nonprofit groups. Private citizens and corporations, from both here in the five boroughs and across the world, have donated nearly $60 million to the Mayor's Fund to Advance New York City in support of hurricane relief and recovery. Together, we are doing everything possible to help communities rebound and rebuild for the long term.

As our recovery from Sandy continues, we must also look to the future—and prepare for it. The long-term sustainability plan we launched in 2007—PlaNYC—included forward-looking resiliency initiatives that provided important protections during Sandy. But the storm set the bar higher—and as the possibility of more severe weather increases with climate change, we must rise to the occasion.

In December 2012, we announced the formation of the Special Initiative for Rebuilding and Resiliency and charged it with producing a plan to provide additional protection for New York's infrastructure, buildings, and communities from the impacts of climate change. *A Stronger, More Resilient New York*—a roadmap for producing a truly sustainable 21st century New York—is the result of that effort.

It is impossible to know what the future holds for New York. But if this plan is brought to life in the years and decades ahead, a major storm that hits New York will find a much stronger, better protected city.

In our vision of a stronger, more resilient city, many vulnerable neighborhoods will sit behind an array of coastal defenses. Waves rushing toward the coastline will, in some places, be weakened by offshore breakwaters or wetlands, while waves that do reach the shore will find more nourished beaches and dunes that will shield inland communities. In other areas, permanent and temporary floodwalls will hold back rising waters, and storm surge will meet raised and reinforced bulkheads, tide gates, and other coastal protections.

Water that makes its way inland will find hardened and, in some cases, elevated homes, making it more difficult to knock buildings off their foundations or knock out mechanical and electrical systems. And it will be absorbed by expanded green infrastructure, or diverted into new high-level sewers. Meanwhile, power, liquid fuels, telecommunications, transportation, water and wastewater, healthcare, and other networks will operate largely without interruption, or will return to service quickly when preventative shutdowns or localized interruptions occur.

Of course, if this plan is implemented, New York City will not be "climate-change proof"—an impossible goal—but it will be far safer and more resilient than it is today. While no one can say with certainty exactly how much safer, the climate analysis in Chapter 2 shows that the investments recommended in this plan certainly will be worthwhile. Lives will be saved and many catastrophic losses avoided. For example, while Sandy caused about $19 billion in losses for our city, rising sea levels and ocean temperatures mean that by the 2050s, a storm like Sandy could cause an estimated $90 billion in losses (in current dollars)—almost five times as much.

However, if the first phase of coastal protection measures and major power and building protections recommended in this plan are taken into account, the economic outlook changes dramatically. Pursuing just these measures could reduce expected losses in the 2050s by up to 25 percent, or more than $22 billion. Implementing all of the measures in this plan would result in an even larger reduction, and smart investments by State-led transportation authorities and others could reduce losses further still.

This economic analysis only quantifies the value of losses avoided due to future coastal storms. Our plan will also help avoid losses as a result of other extreme weather events, such as the heavy downpours and heat waves that can cause damage and threaten public health, and which are predicted to grow in intensity as the climate changes.

Over time, implementation of this plan would address many of the risks that a coastal city like New York faces. By hardening our coastline, by making our building stock stronger, by creating a more durable power network and better stormwater infrastructure, and so much more, we can be better prepared for anything the future holds.

We are a coastal city—and we cannot, and will not, abandon our waterfront. Instead, we must build a stronger, more resilient city—and this plan puts us on a path to do just that. It will not be easy, and it will take time; but as New Yorkers we are more than up to the task.

Michael R. Bloomberg
Mayor

Credit: Alan Wu

A STRONGER, MORE RESILIENT NEW YORK

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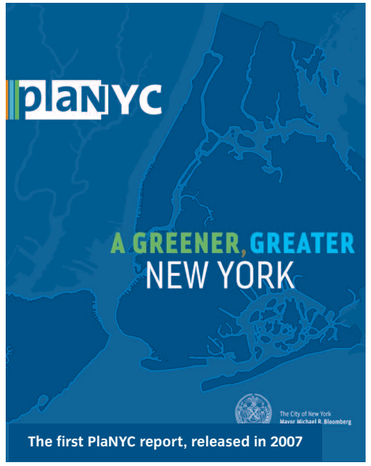
Preface



The first PlaNYC report, released in 2007

Well in advance of Sandy, the 2007 edition of *A Greener, Greater New York* raised the possibility of a catastrophic storm that might flood the Holland Tunnel, as shown in this illustrative depiction

When Michael R. Bloomberg launched PlaNYC back in 2007, combating climate change was not on the agenda of most municipal governments. Although scientists had shown that human activities were increasing the concentration of greenhouse gases in the earth's atmosphere—and those gases were raising temperatures and sea levels—many people still questioned the very idea of climate change. Besides, what could a single city do about such a global problem?

However, Mayor Bloomberg recognized that this global problem was also a local one. Sea levels around the city already had risen more than a foot during the previous century. Higher sea levels meant coastal storms were more likely to cause flooding, and as a waterfront city with low-lying areas, New York was especially vulnerable to the storms that climate change was expected to bring. Mayor Bloomberg also knew that because of New York City's prominence in the world, it was positioned to take a leadership role on these pressing matters.

The result was PlaNYC, Mayor Bloomberg's pioneering effort to accommodate a growing population, enhance the quality of life for all New Yorkers—and address climate change. A 2007 report entitled *A Greener, Greater New York* laid out PlaNYC's ambitious goals. These included reducing the city's greenhouse gas emissions by more than 30 percent by 2030, and 126 other initiatives that City agencies would undertake to reach these goals, including the establishment of a new Mayor's Office of Long-Term Planning and Sustainability (OLTPS) to lead the effort.

As part of PlaNYC, the Bloomberg Administration sought to understand New York's climate risks. For example, it established the New York City Panel on Climate Change (NPCC), a body of leading climate and social scientists charged with making climate projections for the city—the first group of its kind in the country. OLTPS began working with the Federal Emergency Management Agency to help produce updated Federal flood maps that would provide more accurate information about New York's risks from coastal storms. In 2011, the City updated *A Greener, Greater New York*, with new initiatives that placed an even greater emphasis on climate resiliency in response to changes in weather that already were taking place.

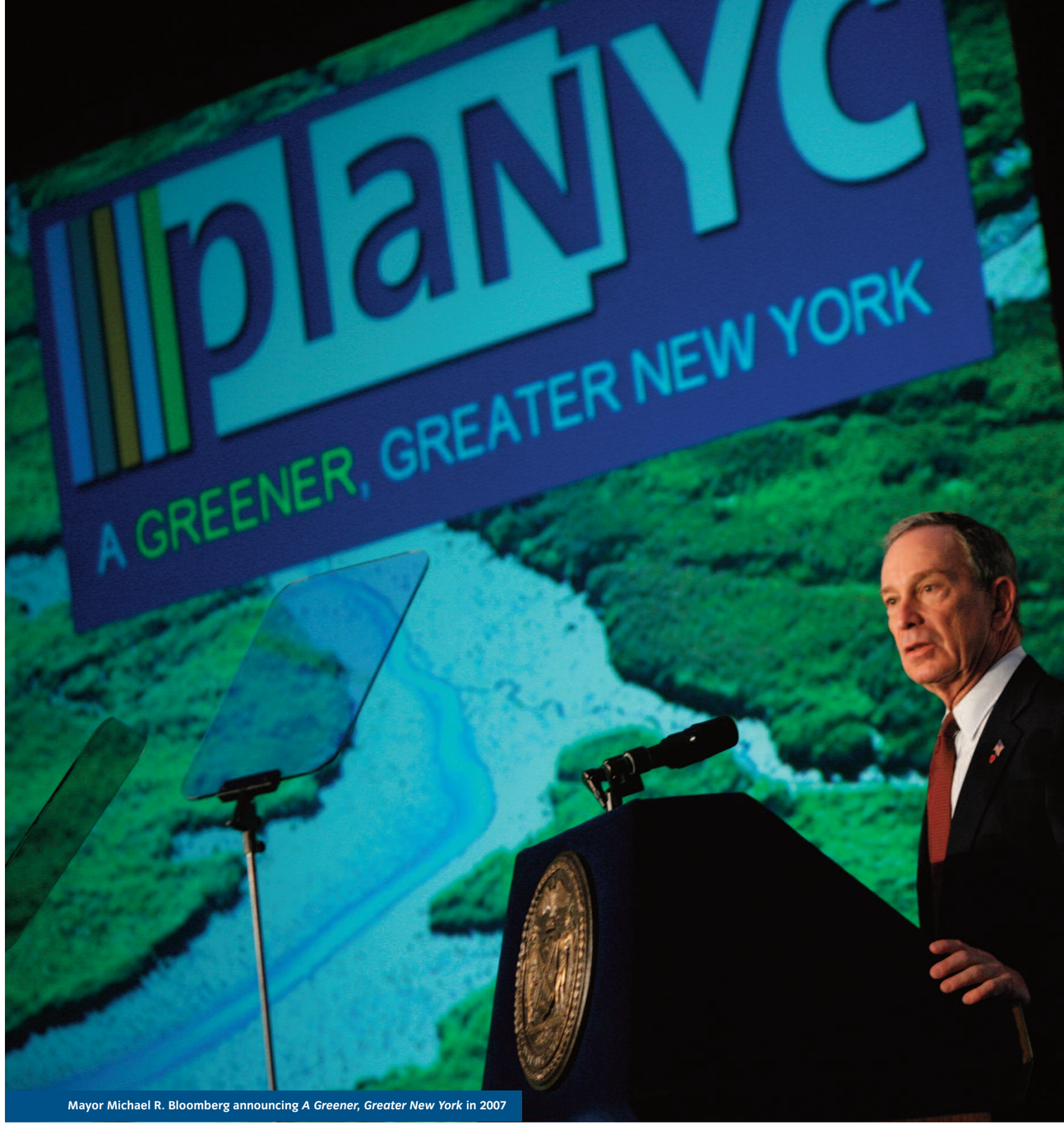
In ways good and bad, PlaNYC was prescient: Six years on, New York's population is growing rapidly, as is the demand for housing and City services. But PlaNYC also hypothesized storm surges that could overtop the Battery and flood critical infrastructure like the Holland Tunnel. Sandy did that and, tragically for many New Yorkers, much more.

By the time Sandy was forming in distant waters, progress on PlaNYC's resiliency efforts had advanced substantially. Greenhouse gas emissions in New York City were down 16 percent. The City was updating its Building Code to make new buildings more flood-resistant. The Department of Environmental Protection and the Department of Parks & Recreation were restoring and enhancing wetlands. These and many other efforts to prepare our city for a future with climate change were well underway.

On October 29, Sandy hit the city with a force that made two things devastatingly clear. First, New York City had been right to invest in protections against extreme weather. Our resiliency investments performed well during Sandy: recently restored wetlands helped to soak up floodwaters like sponges; new, elevated buildings in inundated areas emerged with significantly less damage; much of the sewer system continued to operate and was restored almost completely within five days of the storm. But Sandy's magnitude, its effects on so many parts of the city, and the threat of ever greater risks from climate change also taught a second lesson: we needed to redouble our efforts.

For this reason, even as the City organized unprecedented relief operations following Sandy, Mayor Bloomberg convened the Special Initiative for Rebuilding and Resiliency (SIRR) and charged it with analyzing the impacts of the storm on the city's buildings, infrastructure, and people; assessing the risks the city faces from climate change in the medium term (2020s) and long term (2050s); and outlining ambitious, comprehensive, but achievable strategies for increasing resiliency citywide. The Mayor also asked SIRR to develop proposals for rebuilding the areas hardest hit by Sandy—the Brooklyn-Queens Waterfront, the East and South Shores of Staten Island, South Queens, Southern Brooklyn, and Southern Manhattan—to help them to emerge safer, stronger, and better than before.

The result of this effort—and the latest incarnation of PlaNYC—is *A Stronger, More Resilient New York*. Let others endlessly debate the causes (or even the existence) of climate change. New York City has chosen, once again, to act—by continuing to reduce its contribution to climate change and, at the same time, taking decisive and comprehensive steps to prepare and adapt.



Mayor Michael R. Bloomberg announcing *A Greener, Greater New York* in 2007

Staten Island residents rescued during Sandy

Credit: Michael Kirby Smith/The New York Times

Introduction

After Sandy, volunteers helped out at Beach 41st Street Houses in Far Rockaway.

Public Engagement

"To succeed, the plans must include the input of the people who live and work in these communities—and they will. Members of the community will assist in shaping and implementing each community plan—and that will be just the beginning of our work."
– Mayor Michael Bloomberg, announcing the Special Initiative for Rebuilding and Resiliency on December 6, 2012

Public outreach has been a priority for the Special Initiative for Rebuilding and Resiliency (SIRR) throughout the formulation of *A Stronger, More Resilient New York*. SIRR consulted elected officials, community leaders, and the general public in areas impacted by Sandy, as well as citywide organizations with a stake in sustainability and resiliency. This outreach has been conducted with numerous stakeholders:

Government Partners Engaged	30+	City, State, and Federal Agencies
Public Officials Briefed	65+	Elected Offices
	19	Community Boards
Organizations Briefed	320+	Business, Civic, Community-Based, Environmental, Faith-Based, and Labor
General Public Engagement	11	Public Workshops
	1,000+	New Yorkers Briefed In Person

Building a more resilient New York in the face of long-term climate change is work that will take years beyond the publication of *A Stronger, More Resilient New York*. Ultimately it is the public who will carry forward this plan. SIRR offers sincere thanks to those who participated in the development of the report, which we hope will benefit generations to come.

When Hurricane Sandy roared into New York on October 29, it drove the waters around our city right up to, and then over, our doorstep. Forty-three people died in the deluge and untold numbers were injured. Along the shoreline the storm surge smashed buildings and engulfed entire communities. It flooded roads, subway stations, and electrical facilities, paralyzing transportation networks and causing power outages that plunged hundreds of thousands into darkness. Fires raged. Wind felled trees. Heartache and hardship—and at least $19 billion in damage—are the storm's legacy.

An unpredictable series of meteorological phenomena combined to create this disaster—Sandy arrived during a full moon, when the Atlantic tides were at their highest; the storm was enormous and when it collided with other weather fronts, it turned sharply and made landfall in New Jersey, subjecting the city to onshore winds that drove its devastating storm surge right into our coastal communities.

When the waters receded, New York was, in many ways, a changed city. Certainly the lives of many New Yorkers had changed. Friends and loved ones were lost. Homes that families had passed down for generations were gone. Businesses that New Yorkers had started from scratch were wiped out. New Yorkers looked around and saw beloved parks and beaches in ruins. Even residents of inland areas that escaped direct storm damage were affected when workplaces and schools could not open because of power outages. The subway system was shut down. In some places, the mail could not be delivered.

New Yorkers across all five boroughs felt more vulnerable. Sandy was a cruel reminder of how destructive coastal storms can be in our dense urban environment—storms that, with climate change, are expected to increase in intensity.

Under Mayor Bloomberg's leadership, relief and recovery efforts kicked in immediately. Teams from countless City agencies fanned out across New York, removing debris and beginning the process of restoring what had been lost. The Bloomberg Administration created the Mayor's Office of Housing Recovery Operations to work with the City's Department of Housing Preservation and Development and other agencies to rebuild and repair homes and return people who had been displaced to safe, sustainable housing. It established loan and grant programs to help businesses clean up and reopen their doors.

New Yorkers themselves also rose to the occasion. People from all boroughs streamed to the Rockaways and Red Hook, to Coney Island and Staten Island, and to other hard-hit communities, bringing with them food, fuel for generators, and ready hands to help in whatever way they could. Volunteers went door-to-door in high-rise buildings to assist the elderly or those with disabilities left stranded when elevators stopped functioning. They worked with the National Guard and the Red Cross to distribute emergency supplies.

But even as the people of the city focused on Sandy and the destruction it had wrought across the five boroughs, it became clear that relief and recovery efforts alone would not be a sufficient response to this disaster. It was critical for the City also to turn simultaneously to the future and to prepare—not just for "the next Sandy," and not just for hurricanes and storm surge. It was essential to redouble the broader preparations for climate change begun with PlaNYC.

In December 2012, Mayor Bloomberg delivered a speech announcing a major new effort to ready the city for the future. *A Stronger, More Resilient New York* is the response to the Mayor's call to action. The nearly $20 billion plan contained in this report (towards which the City will contribute up to $1 billion in new funding) includes over 250 initiatives. Together these initiatives will further protect the coastline—our first defense against storms and rising sea levels—as well as strengthen the buildings in which New Yorkers live and work, and all the vital systems that support the life of the city, including our energy grid, transportation systems, parks, telecommunications networks, healthcare system, and water and food supplies. Meanwhile, for the areas of New York that Sandy hit especially hard, this plan proposes local rebuilding initiatives that will help these communities emerge safer, stronger, and better than ever.

The underlying goal of this report is resiliency. That is, to adapt our city to the impacts of climate change and to seek to ensure that, when nature overwhelms our defenses from time to time, we are able to recover more quickly.

In short, we have to be tough.

And toughness, as we all know, is one of the defining traits of New Yorkers.

In just the first few years of this century, we have been through the September 11, 2001 terrorist attacks, financial crises and blackouts, and now, Sandy. With each challenge, we have become more united as a city.

We must come together again with an even stronger commitment to slow the progress of climate change while simultaneously preparing for the changes already evident around us—and those yet to come.

If we embrace this plan today, we will be positioned to meet the challenges that climate change may bring tomorrow, and almost certainly will bring in the years and decades ahead. If we take action now, we will make New York City stronger, safer, and more resilient—not only for our own benefit, but for the benefit of future generations of New Yorkers.

The time has come to make our city even tougher.

Volunteers in New Dorp Beach in Staten Island

Credit: Katie Orlinsky/The New York Times

What Resiliency Means

It was October 30, 2012, the immediate aftermath of Sandy. Homes and businesses across the Rockaways lay in ruins, devastated by the storm's surge. Yet a new oceanfront housing development named Arverne by the Sea stood as a stalwart survivor. While planning the development, the City had required the developer to install a wide, planted dune system on the beach in front of the site and to elevate homes, incorporating special drainage features. During Sandy, the dunes absorbed the storm's destructive waves. The site's elevation and drains kept water out of most homes. All of these measures protected property and possibly saved lives.

Arverne by the Sea was minimally affected by Sandy. Credit: Gerard Romski

Over in Southern Brooklyn, meanwhile, the Shorefront Center for Rehabilitation and Nursing Care was able to remain open, despite the area's widespread inundation. Constructed to City standards intended to protect against storms just like Sandy, the facility not only was a safe haven for its residents, it also sheltered members of the wider community whose own homes were flooded.

And in Lower Manhattan, Battery Park City, too, stood strong even though it fronts directly on the Hudson River. When built, its site had been raised, and its buildings were set back behind parks and an esplanade. As a result, residents and businesses emerged from Sandy largely unscathed.

The threats of climate change are significant and growing. Others have said that the only answer to these threats—rising sea levels, powerful storms, and other chronic and extreme events—is to wall the city in, or to retreat from the shore. But the success stories above—and many other examples across the five boroughs—make clear that it is possible to build a more resilient New York.

A resilient city is not one that is shielded from climate change all of the time—because, sadly, when it comes to nature's powerful forces, that is simply not possible. But a resilient city is one that is: first, protected by effective defenses and adapted to mitigate most climate impacts; and second, able to bounce back more quickly when those defenses are breached from time to time.

It is based on these convictions that we have formulated the following resiliency principles—principles that underlie all aspects of this report. These are the principles that should also guide our city in the years and decades ahead as we all work together to create a stronger, more resilient New York:

Dunes around Arverne By The Sea absorbed the storm's destructive waves. Credit: Gerard Romski

We *can* embrace our coastline. A strong coastline—with vibrant waterfront neighborhoods, critical infrastructure, and cherished natural and cultural resources—is essential to New York's present and future. We can fight for and rebuild what was lost, fortify the shoreline, and develop waterfront areas for the benefit of all New Yorkers. The city cannot, and will not, retreat.

We *must* plan ambitiously. Even with limited resources, we must make investments in smart, effective protections for our city, modifying and expanding strategies as we learn more about the threats we face and piloting projects that can be scaled up over time.

We *will* make New York a stronger, more resilient city. The city must be able to withstand the forces of climate change and bounce back quickly when extreme weather strikes. Climate change affects all New Yorkers. Not just those whose homes or businesses were flooded during Sandy, or those in the South Bronx or East Harlem or a hundred other neighborhoods that could be struck during a future storm, but every man, woman, and child who may not be able get to work or school because the subway is shut due to flooding, or whose health is at risk during a prolonged heat wave or power outage—that is, every man, woman, or child who calls New York City home.

Out of the heartbreaking catastrophe that was Sandy has come this *can*-do, *must*-do, *will*-do plan.

The time to act on this plan is now.

New Yorkers return to the Coney Island Boardwalk in full force on Memorial Day weekend 2013 Credit: Jim McDonnell

Sandy and Its Impacts

In the Lower Manhattan Financial District Post-Sandy

Credit: Alexius Tan

43 deaths… 6,500 patients evacuated from hospitals and nursing homes… Nearly 90,000 buildings in the inundation zone… 1.1 million New York City children unable to attend school for a week… close to 2 million people without power… 11 million travelers affected daily… $19 billion in damage…

By any measure, Sandy was an unprecedented event for New York City. Never in its recorded history had the city experienced a storm of this size. Never had a storm caused so much damage. Never had a storm affected so many lives. As of the writing of this report, individuals, families, businesses, institutions, and, in some ways, the city itself are still recovering from this devastating natural disaster and will continue to do so for years.

As it turns out, it took an improbable set of factors coming together in exactly the worst way to give rise to the catastrophic impacts of this storm. (*See sidebar: A Brief History of Sandy*)

There was, for example, the storm's timing. Its arrival on the evening of October 29 coincided almost exactly with high tide on the Atlantic Ocean and in New York Harbor (high tide arrived at the Battery in Lower Manhattan at 8:54 p.m., and the surge peaked there at 9:24 p.m.). This meant that water levels along much of the city's southern coastline already were elevated, with typical high tides about five feet higher than water levels at low tide. And, on the night of Sandy's arrival, it was not just a normal high tide but a "spring" tide, when the moon was full and the tide was at the very peak of its monthly cycle—generally up to half a foot higher than the average high tide. (*See maps: Water Levels Around New York City on October 29*)

Then there was the storm's size. When Sandy made landfall, its tropical-storm-force winds extended 1,000 miles from end to end, making it more than three times the size of Hurricane Katrina. Storm size—the area over which strong winds blow—correlates closely with storm surge, the rise in water level caused by the storm's low pressure and the force of its winds pushing against the water. (*See graphic: Sandy Size and Wind Speed; see graphic: Katrina Size and Wind Speed*)

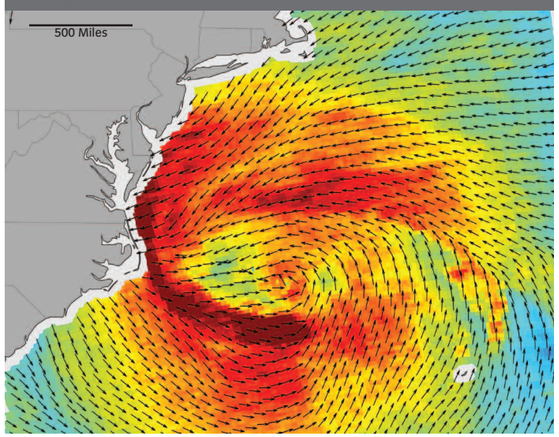
Because Sandy was such a massive storm, it generated a massive surge. And that surge, coming on top of the spring high tide, created a "storm tide" of over 14 feet above Mean Lower Low Water at the Battery, shattering the previous record of 10 feet, set when Hurricane Donna arrived in New York in 1960. (*See chart: High Water Events at Lower Manhattan*)

Finally, there was the unusual path Sandy took to the city's shores. Most hurricanes that approach the Northeast glance the coastline or curve east and head out to sea before they ever reach New York. But as Sandy came spinning north along the east coast of the United States, winds spiraling counterclockwise, the storm encountered weather systems that caused it to take a different course—one that would spell disaster for parts of the city. A high-pressure system to the north blocked the storm's advance. At the same time, a low-pressure system that was pushing eastward towards the Atlantic coast energized the storm and reeled it in. Steered between these two systems, Sandy made a westward turn—and headed straight for land just as it was increasing in intensity. At 7:30 p.m. on October 29, 2012, Sandy slammed into New Jersey head-on, seven miles north of Atlantic City, with maximum winds of 80 miles per hour.

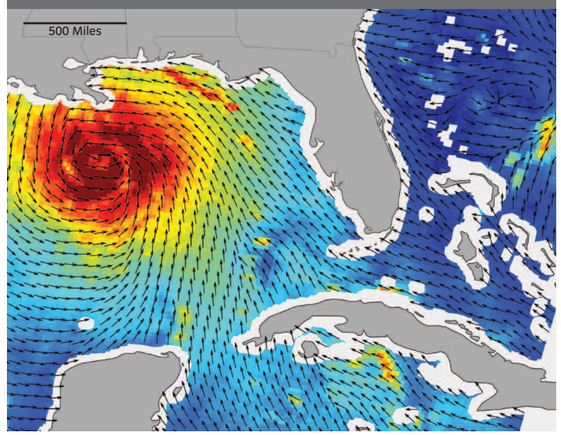
The storm's angle of approach put New York City in the path of the storm's onshore winds, the worst possible place to be. The winds earlier that day had been blowing in a generally southward direction in the New York area. However, as Sandy arrived, its winds shifted, instead moving in a generally northwesterly direction. It was this shift that helped push the storm's massive surge—and its large, battering waves—directly at the south-facing parts of the city.

As a result of all of these factors, Sandy hit New York with punishing force. Its surge and waves battered the city's coastline along the Atlantic Ocean and Lower New York Bay, striking with particular ferocity in neighborhoods across South Queens, Southern Brooklyn, and the East and South Shores of Staten Island, destroying homes and other buildings and damaging critical infrastructure. Meanwhile, the natural topography of the city's coastline channeled the storm surge that was arriving from

Sandy Size and Wind Speed



Katrina Size and Wind Speed



Wind Speed (miles per hour)
0 20 40 60

Source: NASA

A Brief History of Sandy

Sandy was no ordinary hurricane. It was a meteorological event of colossal size and impact. It was a convergence of a number of weather systems that came together in a way that was disastrous for the New York area.

Sandy, however, began innocently enough—far from New York and almost three weeks before its arrival on the area's shores. It was October 11, late in the Atlantic hurricane season, when a tropical wave formed off the west coast of Africa. By October 22, the wave had evolved into a weather system in the Caribbean called Tropical Storm Sandy, the 18th named storm of the 2012 hurricane season. (*See map: Sandy Storm Path*)

A tropical storm is a cyclone—a system of clouds and thunderstorms rotating around a central "eye"—that originates in tropical waters and gets its energy from those warm waters. Sandy gained wind speed as it curled north. By October 24, it was a hurricane—a storm with wind speeds of at least 74 miles per hour (mph)—with an eye visible on satellite images. Sandy made landfall on Jamaica on October 24 as a Category 1 hurricane then intensified to a Category 3 hurricane before hitting Cuba on October 25, according to the National Hurricane Center.

While the storm moved across the Bahamas, it weakened to a Category 1 hurricane—but began to grow significantly in size. It continued to grow as it traveled north of the islands. After passing the Bahamas, Sandy turned northeast, beginning its trek through the Atlantic Ocean, paralleling the eastern coast of the United States. Its winds whirled counterclockwise, raising water levels all the way from Florida to Maine.

Although most hurricanes on a northward track along the US coast continue to hug the coast or eventually curve east and out to sea before they reach New York, Sandy encountered two other weather systems that caused it to shift direction and abruptly intensify yet again. One was a high-pressure system to the north that blocked Sandy's northward advance. The other was a low-pressure system pushing eastward over the southeastern United States that reenergized Sandy. Steered between these two weather systems, Sandy turned sharply west just as it was reaching another peak of intensity.

When Sandy made landfall in Brigantine, New Jersey, just north of Atlantic City, at 7:30 p.m. on October 29 with 80-mph winds, it was technically no longer a hurricane. Two-and-a-half hours before it had made landfall, the National Hurricane Center had reclassified Sandy as a "post-tropical cyclone" because the storm had evolved in such a way that it no longer possessed the technical characteristics of a hurricane: It lacked strong thunderstorm activity near its center; its energy did not come from warm ocean waters but from the jet stream; and it had lost its eye.

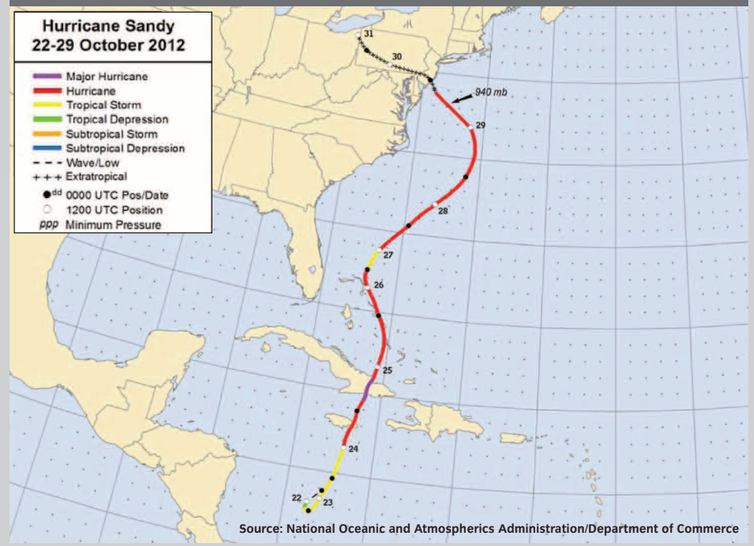
No matter what Sandy was called, though, the storm never lost its large wind field or its large radius of maximum wind (which is why weather experts still considered it a "hurricane strike" when it hit the New York region). In fact, when the storm made landfall, its tropical-storm-force winds extended 1,000 miles—three times that of a typical hurricane. It was those winds, as well as the storm's low pressure, that were responsible for its catastrophic storm surge.

The storm's angle of approach was also significant. Because Sandy came at the coast of New York at a perpendicular angle, its counterclockwise onshore winds drove the surge—and the surge's large, battering waves—directly into the city's coastline.

After landfall, Sandy slowed and weakened while moving through southern New Jersey, northern Delaware, and southern Pennsylvania. It finally lost its defined center while passing over northeastern Ohio late on October 31. For the next day or two, what remained of Sandy continued over Ontario, Canada before merging with a low-pressure area over eastern Canada and heading out to sea for good.

At that point, of course, New York still was reeling from the storm's effects—and was only beginning to cope with the extent of the damage.

Sandy Storm Path



Source: National Oceanic and Atmospherics Administration/Department of Commerce

Sandy by the Numbers

Sandy made landfall three times: at Bull Bay, Jamaica, on October 24; at Santiago de Cuba, Cuba, on October 25; and finally at Brigantine, New Jersey, on October 29

The storm's wind speed was 80 mph at landfall in New Jersey.

Its wind field extended for 1,000 miles.

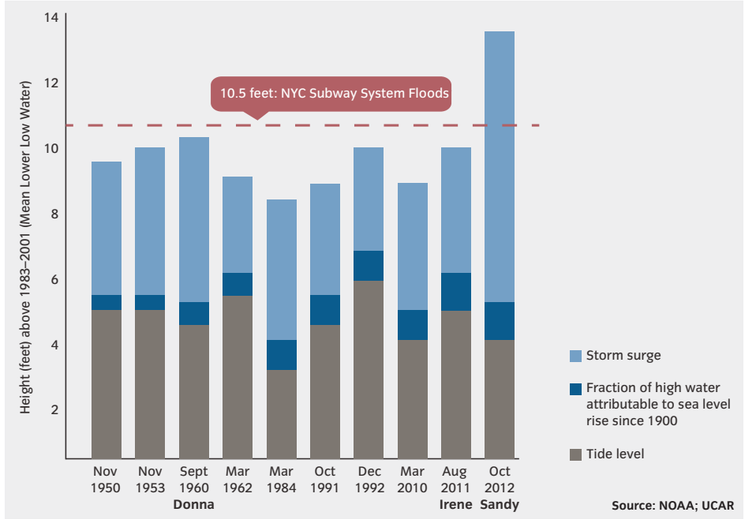
In the US, $50 billion in total damages have been attributed to the storm, making it more costly than any other storm except Hurricane Andrew in 1992 and Hurricane Katrina in 2005.

the ocean northward into New York Harbor, elevating water levels in Jamaica, Sheepshead, Gravesend, and Gowanus Bays, as well as in Upper New York Harbor and the East and Hudson Rivers. At the same time, the storm surge also was pushing water into Long Island Sound, and from there south.

In short, the ocean fed bays, the bays fed rivers, the rivers fed inlets and creeks. Water rose up over beaches, boardwalks, and bulkheads. It was an onslaught of water.

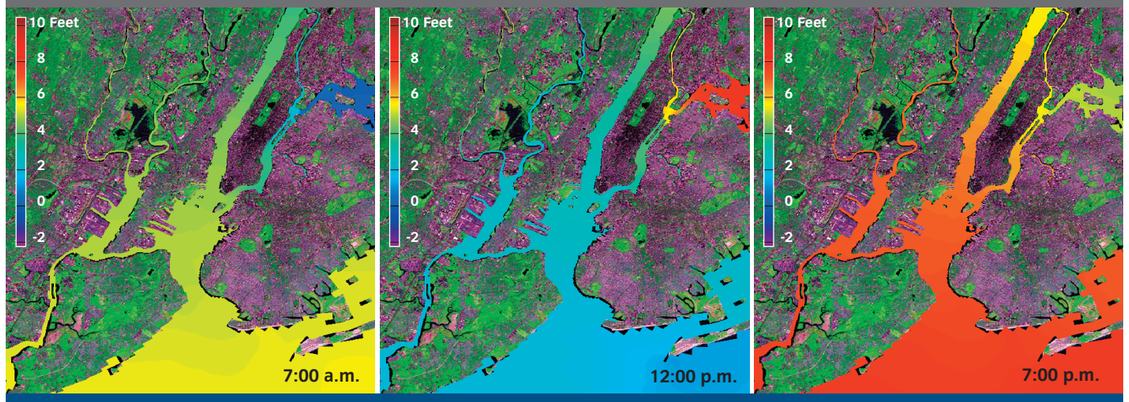
In total, a staggering 51 square miles of New York City flooded—17 percent of the city's total land mass. The floodplain boundaries on the flood maps from the Federal Emergency Management Agency (FEMA) in effect when Sandy hit had indicated that 33 square miles of New York City might be inundated during a so-called "100-year" flood, or the kind of flood estimated to have only a 1 percent chance of occurring in any given year. However, Sandy's storm tide caused flooding that exceeded the 100-year floodplain boundaries by 53 percent citywide. In Queens, the area Sandy flooded was almost twice as large as the floodplain area indicated on the maps. In Brooklyn, the area that flooded was more than twice as large as the floodplain. In certain communities, flooded areas were several times the size of the floodplains on FEMA maps. (*See map: Sandy Inundation*)

High-Water Events in Lower Manhattan



Source: NOAA; UCAR

Water Levels Around New York City on October 29



Tidal cycles are different in different parts of the Harbor—with lower water levels in Long Island Sound coinciding with higher levels in the Lower and Upper New York Bay and vice versa. On the evening of October 29th, just before the arrival of Sandy's surge, the tidal cycle was bringing higher tides to the City's south and lower tides to its north.

Source: CMS at Stevens Institute of Technology

The urban character of New York City magnified the impact of the flooding. More than 443,000 New Yorkers were living in the areas that Sandy flooded when the storm struck. In all, 88,700 buildings were in this inundation zone—buildings containing more than 300,000 homes and approximately 23,400 businesses. Much of the city's critical infrastructure also was within flooded areas—including hospitals and nursing homes, key power facilities, many elements of the city's transportation networks, and all of the city's wastewater treatment plants.

In many places, it was not only the extent of flooding that was significant; it was also the depth of floodwaters. Water heights of several feet above ground level were prevalent in many coastal areas. Near Sea Gate, on the Coney Island peninsula in Brooklyn, the water reached 11 feet above ground level, and at Tottenville on Staten Island, they rose to 14 feet.

Many storms have hit New York with higher winds than Sandy's 80-mile-per-hour peak wind gusts. Many storms have brought more rain than the half inch that Sandy dropped in parts of New York. However, Sandy's storm surge—and the devastation it caused—was unlike anything seen before. The surge, and the flooding and waves that came with it, had an enormous impact on the city.

Sandy's Impact on New York

Any catalogue of the woes that Sandy brought to New York City must start with the tragic deaths of 43 people, the vast majority of whom perished from drowning in areas where waters rose rapidly as a result of the surge. Of these deaths, 23 occurred in Staten Island (including 10 in the neighborhood of Midland Beach alone), with the remainder spread throughout Queens, Brooklyn, and Manhattan. The storm took an especially high toll on the young and old, with victims ranging from a 2-year-old boy to a man and a woman aged 90.

In other cases, the storm spared lives, but still turned them upside down. It destroyed homes that families had tended to over generations (of the hundreds destroyed or determined to be structurally unsound by the Department of Buildings (DOB), with over 60 percent in Queens and almost 30 percent in Staten Island). It impacted many businesses that New Yorkers had started from scratch (not just those in Sandy's inundation area, but 70,000 in areas that lost power during the storm). In some cases, it severely affected those with the fewest resources to draw on—residents of public housing developments, for example, since many of these developments are located on the coastline and were thus particularly vulnerable to extreme weather events. More than 400 New York City Housing Authority buildings containing approximately 35,000 housing units lost power, heat, or hot water during Sandy.

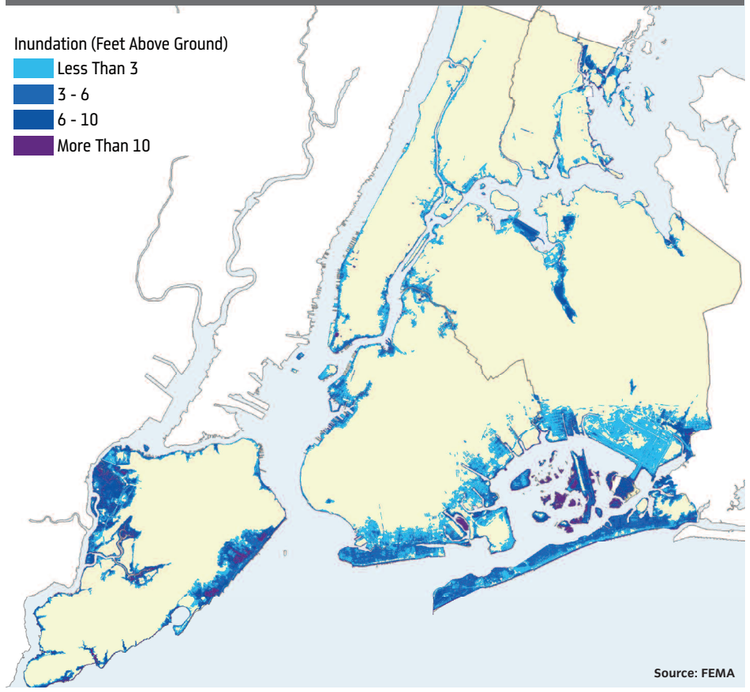
Meanwhile, facilities and services that are crucial to the well-being of all New Yorkers fully or partially shut down for the duration of the storm, and in some cases, for long periods afterwards. Disruptions to some systems (such as power) affected the functioning of others (healthcare, transportation, and telecommunications, among others). The trials of some communities (flooding and power outages in hubs like Southern Manhattan) created tribulations for others (those living elsewhere who could not work because their offices could not open). The storm was a reminder of how interconnected the city's systems are.

It also highlighted significant vulnerabilities in many of these systems and in certain geographic areas of the city. Below are brief summaries of some of the major impacts of the storm on the city's coastline, buildings, infrastructure, and selected neighborhoods. Further information, analysis, and initiatives can be found in the relevant chapters of the report.

Coastline and Waterfront Infrastructure

During Sandy, the coastline of the southern half of the city felt the full force of the storm. Ocean-facing areas generally experienced the destructive impact of waves reported to be 12 feet or more, along with flooding, while other coastal areas experienced only flooding, though the damage from that flooding was still serious and long-lasting.

Sandy Inundation



Source: FEMA

Although barges and other "floating" infrastructure played a key role in the city's recovery from Sandy, damage to "fixed" waterfront infrastructure was extensive. The storm damaged boardwalks, landings, and terminals. Waves and retreating waters caused coastal erosion, with New York's beaches losing up to 3 million cubic yards of sand or more citywide, including 1.5 million cubic yards on the Rockaway Peninsula alone.

Though the storm surge generally devastated areas that it touched, the city's nourished beaches, dunes, and bulkheads did help to mitigate its impact, particularly where these protections were combined to form multilayered defenses.

For more on coastal protection, see Chapter 3.

Buildings

Building damage from Sandy was widespread and in many cases severe. In some areas, storm surge and rising floodwaters pushed houses right off their foundations or caused walls to collapse. Elsewhere, floodwaters filled basements and ruined electrical and other building systems, as well as personal possessions. As of December 2012, DOB had tagged nearly 800 buildings as having been structurally damaged or destroyed across the five boroughs, with tens of thousands more impacted, including buildings containing nearly 70,000 housing units that were registered with FEMA and determined to have sustained some level of damage. Over 100 of the lost homes and businesses were destroyed by storm-related fires, which were often electrical in nature, caused largely by the interaction of electricity and seawater.

Overall, there were several predictors of how the storm impacted New York's building stock. Some of these predictors related to the characteristics of the inundation that buildings faced. Not surprisingly, shoreline areas that experienced the strong lateral forces of waves had many more damaged buildings than areas with still-water flooding only. Other predictors related to a building's physical characteristics (such as building height and construction type) as well as age, which, in turn, determined the regulations in force when the building was constructed. Overall, older, 1-story, light-frame buildings suffered the most severe structural damage—representing just 18 percent of the buildings in the areas inundated by Sandy, but 73 percent of all buildings tagged as structurally damaged or destroyed by DOB as of December 2012.

Although high-rise buildings did not generally experience as much structural damage, they

Boardwalk damage in the Rockaways

Credit: Daniel Avila/NYC Parks

often lost mechanical building equipment housed in basements, rendering buildings uninhabitable and leaving residents stranded on upper floors and businesses closed until repairs could be made.

For more on buildings, see Chapter 4.

Insurance

For many New Yorkers, insurance issues have compounded the problem of building damage from Sandy, with the extensive flood damage from the storm focusing attention on flood insurance. Most large commercial properties obtain insurance, including flood insurance, through the private market. Although most homeowners in New York City have homeowners insurance, these policies typically do not cover flood damage, and homeowners and small business owners seeking flood coverage generally purchase policies through the National Flood Insurance Program (NFIP), which is administered by FEMA.

When Sandy struck, however, most New York City property owners affected by the storm did not have adequate flood insurance—or any flood insurance at all. This was the case for a variety of reasons. For example, more than half of all buildings and about half of the residential units in the area flooded by Sandy were outside of FEMA's 100-year floodplain—so the owners of these buildings were probably unaware of the risks that they faced and, at any rate, were not required by the terms of their mortgages to have flood insurance (since Federally backed mortgages require such coverage only for buildings in the 100-year floodplain). Even among those in the floodplain, many were not insured for flood damage (less than 50 percent of residential buildings in the pre-Sandy 100-year floodplain had flood insurance). This was either because they did not comply with, and their mortgage lenders did not enforce, the terms of their mortgages (about one-third of residential buildings with Federally backed mortgages in New York when Sandy hit did not have flood insurance), or because they did not have mortgages in the first place. Meanwhile, in many cases, those who were insured discovered, after Sandy, that they were not covered for certain losses, such as damages in basements.

Going forward, premiums in the private insurance market may increase in the near term, particularly in flood-prone areas, but the private insurance market overall, despite large losses from Sandy, is expected to remain competitive, with signs, as of the writing of this report, that the market may already be stabilizing. Because of reforms to the NFIP enacted before Sandy, however, property owners insured by the NFIP are likely to see large and permanent increases in flood insurance premiums—unless changes to the NFIP are enacted.

For more on insurance, see Chapter 5.

Utilities

Sandy dealt a serious blow to the city's utilities—particularly its electric utilities, due in part to the fact that some of the most important utility infrastructure is on the waterfront. Close to 2 million people lost power at some point during the storm, with almost a third of these customers in Manhattan. In fact, parts of Lower Manhattan and Brooklyn even lost power prior to Sandy, when Con Edison preemptively disconnected them from the city's grid to protect equipment and reduce potential downtime. Almost all areas south of the Empire State Building followed when floodwaters inundated several of the city's substations in Southern Manhattan. On Staten Island and in the Rockaways, meanwhile, 120,000 customers lost power due to substation damage, while all around the city, strong winds took down overhead lines, affecting another 390,000 customers.

Generally, damaged substations were repaired quickly, with power restored to most customers in Manhattan, for example, within four to five days. Repairing damage to the whole overhead system, though, took almost two weeks, even with the help of thousands of utility workers from other states. Damage to electrical equipment within buildings took considerably longer in many cases, leaving some places in the Rockaways and other hard-hit areas without power or heat for weeks as crews of electricians and plumbers, many of them sent by the City free of charge as part of its Rapid Repairs program, went door-to-door to check and repair equipment.

Other utility systems experienced varying degrees of disruption. Con Edison's steam system, which services 1,700 large buildings in Manhattan, including major hospitals, was unable to supply steam to one-third of its customers when the storm inundated four of the system's six plants and flooded utility tunnels. It took nearly two weeks to restore service to these customers.

The natural gas system generally performed better, although 84,000 customers lost service, mostly in Brooklyn, where National Grid shut off gas valves close to the coast to isolate flooded pipes from the rest of its distribution system. Within hard-hit areas, each affected customer had to be checked by plumbers before service was restored, which took several weeks.

For more on utilities, see Chapter 6.

Liquid Fuels

For many New York City drivers, the post-storm period might have brought back memories of the oil crises of the 1970s. For days and weeks, long lines were the norm at gas stations that still had fuel. Although initial reports suggested that stations primarily closed because they did not have the power to pump gas, in fact over 90 percent of the city's gas stations were outside of the areas of the city that experienced widespread power outages. Instead, the real problem was that the stations had no gas to pump. This was due to severe breakdowns in the supply chain serving New York caused by storm damage to fragile infrastructure in New Jersey and on the New York City waterfront.

The storm shut down refineries for several weeks, stopped marine and pipeline deliveries for three to four days, and damaged storage terminals. As a result, for four days after the storm, the system received no new supply, and for almost a month after that, supply was limited. As soon as drivers returned to the roads, long lines at gas stations followed. Within one week of Sandy's landfall, less than 20 percent of stations were able to sell fuel at any given time.

Working with the Federal government and the State National Guard, the City set up a fueling program for critical and public service fleets including emergency responders, utility vehicles, ambulances, and school buses. Regular consumers had to wait several weeks for the system to recover fully, though license plate-based rationing did reduce lines and a host of regulatory waivers helped bring supply back into balance with demand.

For more on liquid fuels, see Chapter 7.

Healthcare

Sandy placed an unprecedented strain on the city's healthcare system as a whole, and disrupted services in affected communities across New York. Six hospitals closed—four in Manhattan, one in Brooklyn, and one on Staten Island—requiring City and State health officials, co-located at the City's Office of Emergency Management, to coordinate the evacuation of nearly 2,000 patients. Hospitals that remained open—frequently owing to the heroic efforts of staff, who pumped out or diverted water, repurposed lobbies to serve as inpatient rooms, and siphoned gasoline from vehicles to run generators—struggled to meet the needs of incoming patients.

Charging cell phones in the East Village

Credit: Matt Kane

Nursing homes and adult-care facilities were also affected by flooding and power outages. Twenty-six facilities closed and five partially closed, resulting in the evacuation of 4,500 patients. At the community level, flooding caused over 500 buildings with doctors' offices, clinics, and other outpatient facilities to close. Many patients who could not reach their normal providers had to postpone care or sought help at hospital emergency rooms, further straining the entire system.

For more on healthcare, see Chapter 8.

Telecommunications

Sandy caused outages across phone, wireless, cable, and Internet services. Short-term outages affected the greatest number of customers and were a direct result of power loss, which knocked out cable and Internet service in homes and businesses immediately. Wireless service was also affected when backup batteries powering cell sites ran down, generally four to eight hours after grid power was lost, reducing or eliminating service to over a million cell customers in New York City. Even customers with working cell networks found that charging mobile devices was a challenge in areas without power, though many businesses and cell companies set up charging stations in affected areas.

Meanwhile, flood damage at critical facilities in Southern Manhattan, Red Hook, and the Rockaways disrupted landline and Internet service throughout the neighborhoods they served for up to 11 days. Generally, providers with modern networks and hardened facilities were able to restore service faster, while those that had not adequately protected facilities from flooding faced longer and more extensive outages.

In coastal areas, flood damage to building telecommunications equipment and cabling caused long-term outages, with some providers using flood damage as an opportunity to swap in new, more resilient equipment rather than simply fixing in-place infrastructure—a benefit to customers over the long term, but frequently at the cost of considerable short-term inconvenience. For example, in commercial buildings in part of Southern Manhattan, Verizon opted to replace corroded copper cables with fiber. The result was that in a sample of 172 buildings, nearly 60 percent did not have service fully restored 60 days after Sandy, with 12 percent still out after 100 days.

For more on telecommunications, see Chapter 9.

A gas station line in Sunnyside, Queens

Credit: Brian Kingsley

Transportation
During Sandy, many highways, roads, railroads, and airports flooded. At the same time, all six East River subway tunnels connecting Brooklyn and Manhattan were knocked out of service by flooding, along with the Steinway Tunnel that carries the 7 train between Queens and Manhattan, the G train tunnel under Newtown Creek, the Long Island Railroad and Amtrak tunnels under the East River and the PATH and Amtrak tunnels under the Hudson River. Major damage occurred to the South Ferry subway station in Lower Manhattan, as well as to the subway viaduct connecting Howard Beach, Broad Channel, and the Rockaways. Service also was disrupted on the Staten Island Ferry, the East River Ferry, and private ferries. The loss of ferry service during and after Sandy stranded some 80,000 normal weekday riders, while the loss of subway service stranded another 5.4 million normal weekday riders.

Exacerbating flooding was the loss of electrical power, which made it difficult to pump out tunnels, clean up damaged subway stations, and begin restoring service. The difficulty in "dewatering" the tunnels further increased the damage from Sandy, as sensitive mechanical, electrical, and electronic equipment soaked in corrosive salt water. In addition to subway tunnels, flooding closed three vehicular tunnels into and out of Manhattan, interrupting the commutes of 217,000 vehicles.

Although major bridges reopened as soon as winds dissipated and portions of the transportation network not directly flooded experienced little damage, over 500 miles of roads suffered significant damage and the subway system remained out of service in the days after the storm, even as crews worked around the clock to restore service. This led to significant gridlock on roads and bridges into Manhattan as people tried to return to work by car. The commuting challenges led City and State officials to implement temporary measures to manage travel and congestion. These measures included restrictions on single-occupant vehicles using bridges and tunnels across the Hudson and East Rivers, increased East River ferry service, and the successful "bus bridges"—an above-ground replacement for the subways that sent hundreds of buses back and forth on the bridges between Brooklyn and Manhattan. These measures enabled over 226,000 commuters to cross the East River—almost triple the number able to cross before they were in place.

One week after Sandy struck, many subway lines had been fully or partially restored, but some elements of the system remained closed much longer, with repairs projected to take months and even years. However, the opening of A train service to Broad Channel and the Rockaways just prior to the release of this report shows the strong commitment of the region's transportation agencies to the restoration of service as quickly as possible.

For more on transportation, see Chapter 10.

Station out of service due to subway system shutdown
Credit: MTAPhotos

Parks
The Department of Parks & Recreation (DPR) closed all City parks the day before Sandy, and the parks remained closed after the storm while DPR worked continuously to complete park inspections, reopening many facilities within three days—aided by legions of volunteers who helped bag debris and gather fallen branches. However, nearly 400 parks were damaged significantly and remained closed for major repairs. Across the city approximately 20,000 street and park trees were damaged or downed. Beaches and waterfront park facilities were hard-hit by storm surge, erosion, and coastal flooding, with two miles of scenic boardwalk destroyed primarily in the Rockaways as well as in Coney Island and on the East Shore of Staten Island.

Notwithstanding this loss, many DPR facilities—including beaches, wetlands, and other natural areas—played a role in protecting adjacent communities, serving as a buffer for these areas. In addition, some newer parks, which designers had planned with extreme weather risks in mind, weathered the storm with comparatively little damage. For example, Brooklyn Bridge Park generally fared well because of its elevation and use of resilient coastal edges and plantings. Meanwhile, the new park being constructed at the center of Governors Island—on a site elevated with fill—also largely was protected from Sandy's surge.

For more on parks, see Chapter 11.

Water and Wastewater
High-quality drinking water continued to flow uninterrupted to New York City during and after Sandy. However, in areas with power outages, the pumping systems in high-rise buildings ceased to function, leaving residents on upper floors with empty taps and no way to flush toilets. Meanwhile, a fire in Breezy Point in Queens caused significant disruption to that neighborhood's private water distribution system.

By contrast, Sandy's storm surge had a major impact on the city's wastewater treatment system. Ten of 14 wastewater treatment plants operated by the Department of Environmental Protection (DEP) released partially treated or untreated sewage into local waterways (though water quality samples showed impacts to be minimal due to dilution from the enormous volume of water flowing through the Harbor from the surge). In addition, 42 of 96 pumping stations that keep stormwater, wastewater, or combined sewage moving through the system were temporarily out of service because they were damaged or lost power.

While many facilities in neighboring municipalities were impaired for several weeks, New York City was treating 99 percent of its wastewater within just four days of the storm's end, and 100 percent within 2 weeks.

As for the city's stormwater and combined sewers, though Sandy was not a major rain event and the sewers generally performed as designed during the storm, the unprecedented volume of the surge was beyond the capacity of the system to handle. As the surge finally receded, the system did help to drain floodwaters, though the sand and debris left by the surge did slow this process.

For more on water and wastewater, see Chapter 12.

Other Critical Networks
Thankfully, New York's food supply chain continued to function reasonably well during and following the storm. This supply chain is made up of wholesale distributors, which bring food to the city and often store it in warehouses, and retailers, which supply food directly to New Yorkers. The city's food distributors depend heavily on transportation networks to make deliveries and electricity for their refrigeration systems, so they experienced a slight strain when the area's bridges were temporarily closed and power outages were at their peak. Fortunately, though, Hunts Point, the city's largest food distribution center—and a key distribution point for much of the fresh food that comes into the city—largely was unaffected.

Location dictated Sandy's impact on food retailers. For example, when power went out in Southern Manhattan, many supermarkets and bodegas lost perishable food. Meanwhile, many food retailers in Coney Island and Brighton Beach (almost 30 supermarkets and 50 bodegas) and nearly all retailers in the Rockaways and Broad Channel were affected by storm surge or flooding. Unless they had generators, these retailers were also without power and also lost inventory. Many food pantries—an important source of nourishment for the city's vulnerable populations often located in the basements of churches and other buildings—similarly experienced flooding. This left some areas without access to food within a reasonable distance.

The City and FEMA stepped in and over a three-month period gave out almost 4 million meals from hot-food distribution sites in areas such as South Queens and Southern Brooklyn.

New York City's solid waste system, too, generally functioned well, despite some damage to its facilities, its vehicle fleet, and New York City's rail network. Truck-based collection resumed almost immediately after the storm, even though many Department of Sanitation workers themselves had homes damaged by the storm. In addition to diligently removing the regular daily volume of solid waste, these employees managed to cart away over 400,000 tons of excess debris from waterlogged homes and businesses—to widespread acclaim.

Blackout in Chelsea from Southern Manhattan power outage
Credit: Dan Nguyen

Because some facilities responsible for receiving New York City's solid waste were affected by the storm, the City made contingency plans for disposal—for instance, diverting over 10 percent of the city's residential and institutional solid waste from a waste-to-energy facility in New Jersey to other facilities. Rail transport of solid waste also experienced disruptions. Important lines were down for five days on Staten Island and in the Bronx, during which time solid waste was stored in containers or shipped out on transfer trailers.

For more on food supply and solid waste, see Chapter 13.

Communities
While Sandy affected neighborhoods all across New York City, the storm hit five coastal areas particularly hard—the Brooklyn-Queens Waterfront, the East and South Shores of Staten Island, South Queens, Southern Brooklyn, and Southern Manhattan. Three of the five areas (the East and South Shores of Staten Island, South Queens, and Southern Brooklyn) were directly exposed to storm surge and destructive waves along the shore, and all experienced widespread inundation. Across the five areas—which are home to 685,000 people—physical and economic damage was extensive and long-lasting.

Building damage in these areas was pervasive and in many cases devastating. Neighborhoods in South Queens, Southern Brooklyn, and along the East and South Shores of Staten Island accounted for over 90 percent of the buildings in Sandy-inundated areas citywide and over 70 percent of the buildings tagged by DOB as having been seriously damaged or destroyed citywide as of December 2012. Buildings along the Brooklyn/Queens Waterfront and in Southern Manhattan, meanwhile, often lost critical building systems, expensive mechanical equipment, and personal property and inventory located on ground floors. Residents of high-rise buildings—including elderly New Yorkers and those with physical limitations—found themselves, in many cases, stranded on upper floors when their buildings lost elevator service. Many of these impacts were felt particularly acutely by residents of public housing developments located on the waterfront.

Across these communities, there was also damage done to critical infrastructure, often affecting not just these communities, but the city as a whole. For example, many of Southern Manhattan's vehicular tunnels were inundated during the storm, resulting in their closure for up to three weeks following Sandy, eliminating key connections between New York City and New Jersey and between New York's boroughs. Southern Manhattan's subway tunnels flooded as well, and most subway lines were down between three and seven days, impairing the system citywide. Wastewater treatment plants in several neighborhoods also saw flooding and damage, and all five communities experienced power outages.

The recovery of these neighborhoods is vital not only to the people who live and work in them, but to the city as a whole. This report would not be complete without plans to address the vulnerabilities that Sandy exposed in these areas and that climate change likely will exacerbate in the future. The initiatives in this report aim to help these communities stand strong again.

For the Brooklyn-Queens Waterfront, see Chapter 14. For the East and South Shores of Staten Island, see Chapter 15. For South Queens, see Chapter 16. For Southern Brooklyn, see Chapter 17. For Southern Manhattan, see Chapter 18.

Climate Analysis

Near Bylot Island, Canada

Credit: Susan van Gelder

Flooding at West and Cortlandt Streets, Hurricane Donna, 1960 Credit: Allyn Baum/The New York Times

Although New York City has been hit by coastal storms before, Sandy was an historic event by many measures. Since 1900, 14 hurricanes and countless nor'easters have struck the area. Sandy, however, exceeded them all—not only in terms of storm surge height, but also in the scale and scope of the devastation it caused. *(See sidebar: Storms Through New York City History)*

Of course, Sandy was not just an historic storm. It was also idiosyncratic. As discussed in Chapter 1 (*Sandy and Its Impacts*), a set of circumstances—timing, size, and path—all came together to cause unprecedented impacts, primarily on the southern, coastal-facing areas of the city.

As devastating as Sandy was, however, not everything about the storm was unprecedented. Its 80- mile-per-hour (mph) peak wind gusts fell well short of other storms that have hit New York City, including Hurricane Carol in 1954 (up to 125-mph gusts) and Hurricane Belle in 1976 (up to 95-mph gusts). Previous storms also brought much more rain with them. Sandy dropped a scant inch in some parts of New York, far less than the 5 inches of rain dropped on the city during Hurricane Donna in 1960 or the 7.5 inches during the April 2007 nor'easter.

With greater winds and more rain, Sandy could have had an even more serious impact on the areas of Staten Island, Southern Brooklyn, and South Queens that experienced the most devastation during the storm. And while Sandy brought the full force of its impact at high tide for these southernmost areas of the city, it hit the area around western Long Island Sound almost exactly at low tide. As a consequence, parts of the Bronx, Northern Queens, and East Harlem were not as affected as they could have been.

In fact, the same storm, arriving at a slightly different time, likely would have had significant effects on New York's northernmost neighborhoods. According to modeling undertaken by the storm surge research team at the Stevens Institute of Technology, if Sandy had arrived earlier—near high tide in western Long Island Sound, rather than in New York Harbor and along the Atlantic Ocean—the peak water level in the western Sound, measured at the King's Point gauge, which hit more than 14 feet above Mean Lower Low Water, or MLLW (over 10 feet above datum NAVD88) during Sandy, instead could have reached almost 18 feet above MLLW (almost 14 feet above NAVD88). *(See maps: Sandy Inundation, Bronx and Northern Queens and Sandy Inundation Simulated 9 Hours Earlier, Bronx and Northern Queens; see sidebar: Defining Datums; see graph: Illustrative Shift in Tide Cycle)*

The result would have been devastating for infrastructure providing critical services to the rest of the city. Flooding could have overwhelmed parts of the Hunts Point Food Distribution Center in the Bronx, thereby threatening facilities that are responsible for handling as much as 60 percent of the city's produce. Meanwhile, the power plants in Astoria, Queens, which are responsible for almost one-third of the city's installed generation capacity, could have been inundated as well. At LaGuardia Airport, which was flooded to about 14 feet above MLLW (about 10 feet above NAVD88) during Sandy, this could have resulted in a water level of about 17 feet above MLLW (13 feet above NAVD88) or up to 12 feet of water above ground level. Additional, four wastewater treatments plants and 29 water pumping stations could also have been affected.

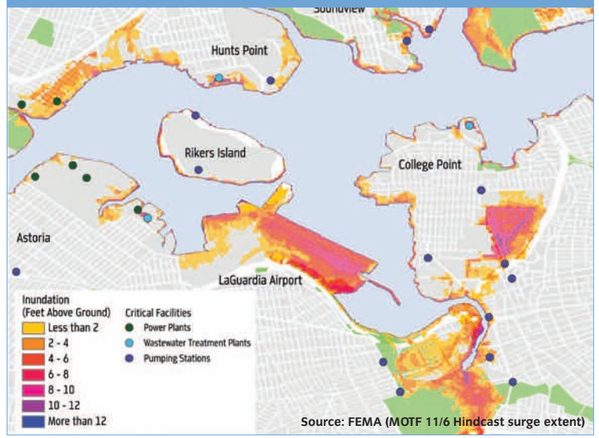
Clearly, while Sandy was historic, it was not, in fact, a worst-case scenario for all of New York

Storms Through New York City History

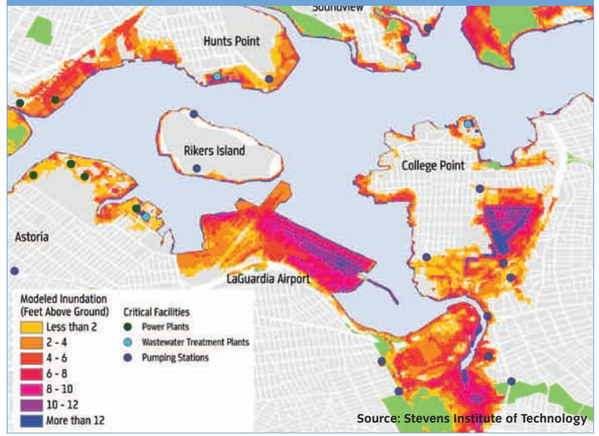
Sandy may have been the latest catastrophic storm to hit New York City, but it certainly was not the first. Throughout history, the city has suffered from hurricanes and other coastal storms, such as nor'easters. Hurricanes and tropical storms strike New York infrequently, relative to other types of coastal storms (generally arriving during hurricane season, June 1 to October 31), and can produce large surges, heavy rains, and high winds. Nor'easters, by contrast, are cold weather storms that have strong northeasterly winds blowing in from the ocean ahead of them. Compared to hurricanes, nor'easters generally bring smaller surges and weaker winds but can cause significant harm because they tend to last longer, resulting in extended periods of high winds and high water that can be sustained through one or more high tides.

In 1821, a hurricane made a direct strike on New York City, bringing winds of about 75 mph and a reported 13-foot storm surge that flooded Lower Manhattan as far north as Canal Street. In 1938, a storm known as the Long Island Express—because the fast-moving eye passed over Long Island—hit with no warning, leading to over 600 deaths, including 10 in New York City, while 100-mph wind gusts knocked out electricity north of 59th Street in Manhattan. In 1960, Hurricane Donna had wind gusts of up to 90 mph and a 10-foot (above MLLW) storm surge that caused extensive pier damage. Major storms have been showing up in the North Atlantic with greater frequency in the last few decades. Examples of recent storms having significant impacts to New York City include: Agnes in 1972, Belle in 1976, Gloria in 1985, a nor'easter in 1992, Bertha in 1996, Floyd in 1999, Isabel in 2003, Ernesto in 2006, a nor'easter in 2007, and Irene and Lee in 2011—which made back-to-back appearances just 14 months prior to Sandy.

Sandy Inundation, Bronx and Northern Queens



Sandy Inundation Simulated 9 Hrs. Earlier, Bronx and Northern Queens



Simulated estimate of flooding by the Stevens Institute of Technology's NYHOPS model. Note that these results are hypothetical.

Defining Datums

A vertical datum is a base reference point for determining heights or depths. Vertical datums set a consistent zero point so elevations can be compared with one another at different locations with different physical characteristics. For example, flood levels can be measured relative to mean sea level, or relative to ground levels that may be well above mean sea level.

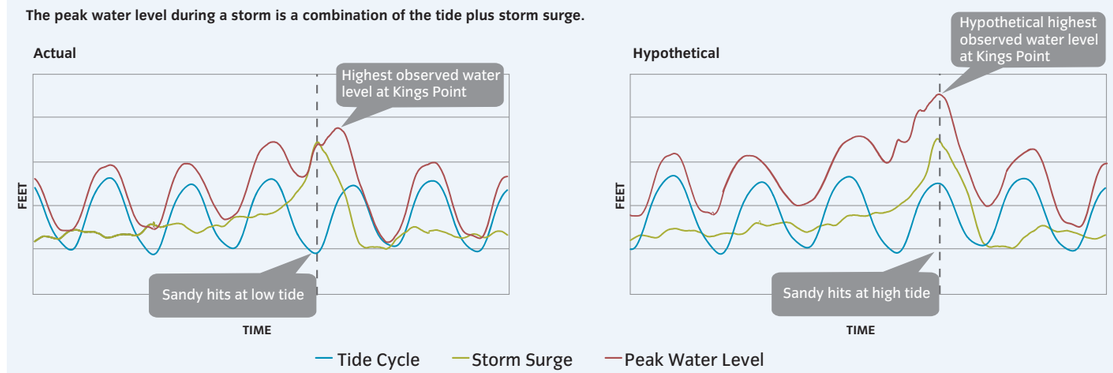
Tidal datums, such as Mean Lower Low Water (MLLW), are standard elevations defined by a certain phase of the tide. Tidal datums are used as references to measure local water levels and therefore vary over different areas. For example, the MLLW tidal datum is determined by averaging the lower of the two low waters of any tidal day for a particular tide gauge over a period of time. There are tide gauges in the New York City area at multiple locations, including at the Battery and Kings Point. MLLW is a useful datum for comparing water levels at a specific point to "normal" water levels, but is less helpful for comparing water elevations in different locations, since they may experience very different MLLW levels.

Gravity-based datums, such as the North American Vertical Datum of 1988 (NAVD88) are referenced to a fixed point in the ground. NAVD88 is the national standard, largely because it allows for comparisons of water levels across many locations that have different tidal characteristics.

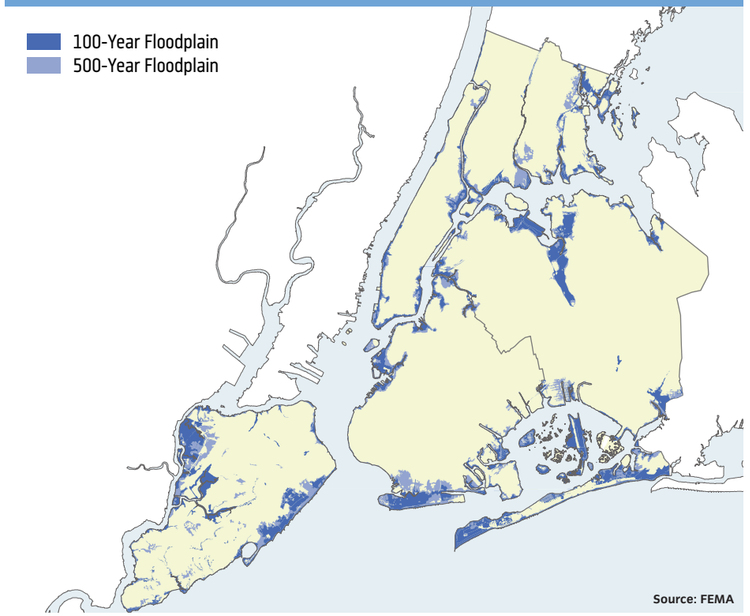
In order to facilitate comparisons across different locations, this report refers to all water elevations in NAVD88 unless otherwise specified. MLLW is used selectively to highlight location-specific water levels and typically shows higher values than NAVD88. Flood depths, which are measured from ground level and vary with terrain, also are used to describe the flooding experienced in different neighborhoods.

Illustrative Shift in Tide Cycle

The peak water level during a storm is a combination of the tide plus storm surge.



1983 FEMA Flood Insurance Rate Maps, FIRMs



City. And as the climate changes, raising the prospect of stronger storms coming more frequently, the risks that New York City faces will only intensify.

Of course storms are not the only climate threats New Yorkers face. The city is also vulnerable to other "extreme" events, such as heavy downpours, heat waves, droughts, and high winds. Chronic conditions, such as rising sea levels, higher average temperatures, and increased annual precipitation, also have direct impacts on the city and can make the effects of extreme events worse. That is why this report is not about preparing New York for the next Sandy or even the next coastal storm, but is instead about how New York can adapt to the full spectrum of future challenges posed by climate change—whatever they may be.

New York's Current Vulnerabilities

Since 1983, New York's vulnerability to coastal storms has been reflected in flood maps produced by the Federal Emergency Management Agency (FEMA), which describe the Federal government's assessment of flood risk. Called Flood Insurance Rate Maps (FIRMs) because they are used by the National Flood Insurance Program (NFIP) and trigger certain flood insurance requirements, the maps show how much land lies within the "100-year floodplain" (the area that has a 1 percent or greater chance of flooding in any given year) and the "500-year floodplain" (the area that has a 0.2 percent or greater chance of flooding any year). They also define different zones of vulnerability within the 100-year floodplain, including areas that are at risk of destructive wave action, and that generally require flood-protective construction standards (see Chapter 3, *Coastal Protection*; Chapter 4, *Buildings*; and Chapter 5, *Insurance*).

These 1983 FIRMs show that a full 33 square miles of New York City—almost half of Brooklyn—are within the equivalent of the 100-year floodplain. As of 2010, there were about 218,000 New Yorkers living in those areas. All 14 of the city's wastewater treatment plants and 12 out of 27 power plants, representing 37 percent of the city's generation capacity, are within the 100-year floodplain as reflected in the 1983 FIRMs, many of these critical facilities placed on the coast out of operational necessity. There are also vibrant neighborhoods and commercial districts in this area that contain approximately 35,500 buildings, 377 million square feet of floor area, and 214,000 jobs. *(See map: 1983 FEMA Flood Insurance Rate Maps, FIRMs)*

However, even before Sandy, the City and FEMA had known that the flood maps did not adequately reflect New York's risks. Although FEMA converted the maps to digital form in 2007, their content had not changed meaningfully since 1983. As such, this report refers to the maps as 1983 FIRMs. In the intervening three decades, many changes had been made to the city's shoreline and significant development had occurred on the waterfront. In addition, sea levels had continued to rise as they had since the beginning of the 20th century (over a foot since 1900), more accurate coastal modeling and mapping techniques had been developed, and 30 years of additional data on storms were available.

Recognizing the need for updated information on New York's flood risks, in 2007, the City formally requested that FEMA update its flood maps for New York—a multiyear process that FEMA kicked off in 2009. In 2010, to help inform FEMA's mapping process, the City acquired the most detailed elevation data ever gathered for New York, known as LiDAR (light detection and ranging) data. To collect these data, the City flew an airplane equipped with a laser scanner over the five boroughs to measure land elevations with tremendous precision. This allowed the City to create a detailed, three-dimensional picture of the shape and characteristics of New York's surface area—which in turn could be used by FEMA for substantially better flood mapping.

Hurricane Sandy demonstrated the importance of regular coastal updates to FEMA's maps. The area that flooded during the storm was more than one and a half times larger than the 100-year floodplain defined on FEMA's 1983 FIRMs. In certain communities, the areas that flooded were several times larger than the floodplains outlined on the maps. In Brooklyn and Queens, for example, the combined amount of land flooded was roughly equal to the amount of land in the entire citywide 100-year floodplain as mapped in 1983 (both about 33 square miles). Meanwhile, about 60 percent of all buildings and more than half of the residential units in areas that Sandy inundated were outside the 100-year floodplain, as were approximately 25 percent of the buildings tagged by the Department of Buildings (DOB) as having been seriously damaged or destroyed as of December 2012. In these areas, not only were residents unaware of the risks that they faced, but the buildings in which they lived and worked had not been subject to the flood-protective construction standards that generally apply within the floodplain (see Chapter 4). *(See map: 1983 FEMA FIRMs and Sandy Inundation Area Comparison)*

Just three months after Sandy, in January 2013, as part of an effort to give New Yorkers better information about their flood risks from coastal storms, FEMA issued interim maps for New York, just as it had done for other communities that did not have up-to-date maps following major storms (for example, it did so for Louisiana and Mississippi after Hurricane Katrina in 2005). These interim maps—called Advisory Base Flood Elevation maps, or ABFEs—together with a set of emergency measures enacted by Mayor Bloomberg to suspend certain zoning restrictions and modify certain building codes temporarily, allowed New Yorkers to begin rebuilding after the storm to standards that better reflected actual flood risks.

In June 2013, FEMA issued Preliminary Work Maps (PWMs) for New York City that incorporated even more accurate wave modeling. Though similar in many cases to the ABFEs released in January, the revised maps differed significantly in certain respects—they showed, for example, substantially smaller areas of the city at risk of destructive wave action. These PWMs will be considered best-available information until FEMA releases Preliminary FIRMs (by the end of 2013), the first official product of the FEMA map update process launched in 2009. After a public review and appeals period, the Preliminary FIRMs will be revised and released as new, final Effective FIRMs (replacing the 1983 maps) likely in 2015. The new FIRMs will inform a variety of flood-related requirements, including flood insurance and flood-protective construction standards. Though some adjustments may occur, it is currently believed that the new FIRMs will tell a similar story about the city's vulnerability to coastal storms as was told by the PWMs. *(See map: 2013 FEMA Preliminary Work Maps (PWMs)*

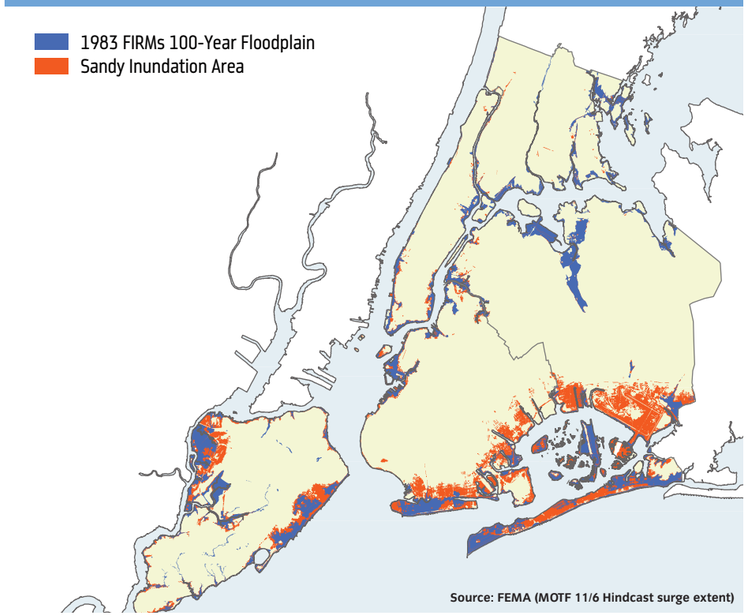
100-Year Flood

The term "100-year" flood can be misleading, and perhaps even provides a false sense of security. This report uses the term "100-year" flood or floodplain because it is the most commonly used phrase and one with which the public is familiar. Nevertheless it is important to understand what the term means. A 100-year flood is not the flood that happens once every 100 years. Rather, it is the flood that has a 1 percent chance of occurring in any given year. Experiencing a 100-year flood does not decrease the chance of a second 100-year flood occurring that same year or any year that follows.

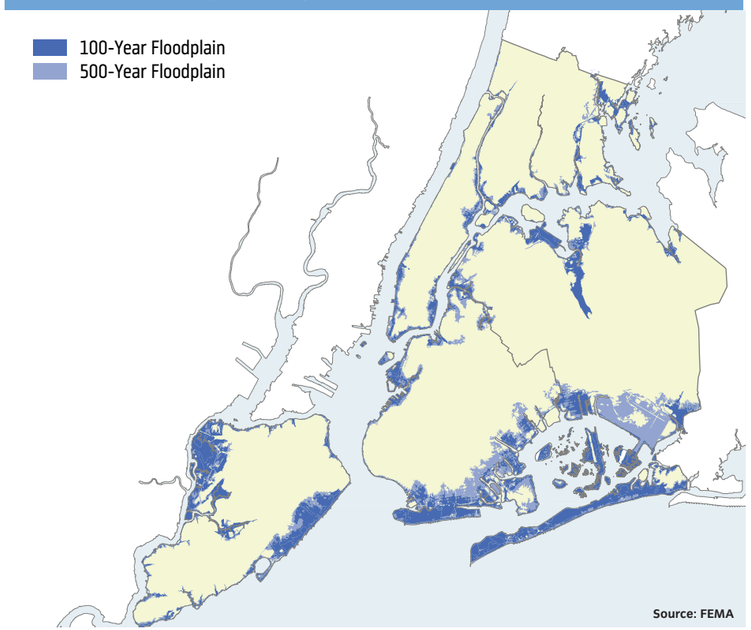
Even the 1 percent concept can be misleading—because when the years add up, so too does the probability. A 1 percent chance each year may not seem like much, but when the public or private sectors are making decisions, it matters. Determining whether to buy a particular house or where to build a power plant has long-term implications. For example, a 100-year flood today, without considering future impacts from sea level rise or climate change, has a 26 percent chance of occurring at least once over the life of a 30-year mortgage. Similarly, a 100-year flood today has a 45 percent chance of occurring over the 60-year life of a power substation.

Lest anyone think the probability of a so-called 100-year storm is too remote to worry about or plan for, consider what it means for the children of New York today. A child born today with the average life expectancy of a New Yorker (80.9 years) faces a 56 percent probability (without sea level rise) of witnessing today's 100-year flood within her lifetime.

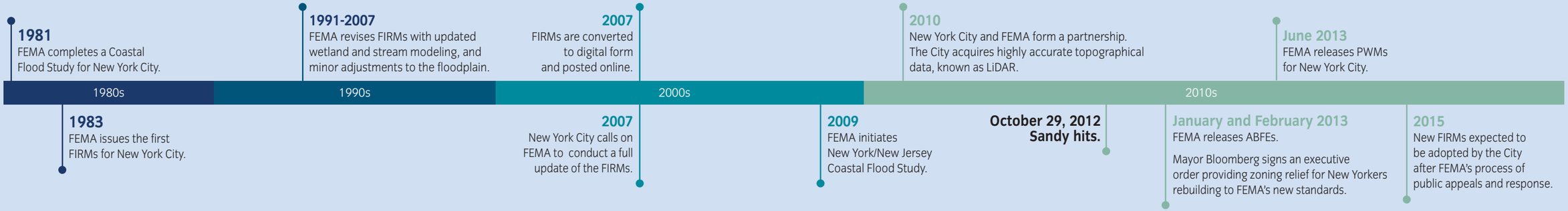
1983 FEMA FIRMs and Sandy Inundation Area Comparison



2013 FEMA Preliminary Work Maps (PWMs)



Updating FEMA FIRMs for New York City



Floodplain Comparison of Major American Cities

City	Population in the 100-Year Floodplain	Share of Total Population	Land Area of 100-Year Floodplain (Square Miles)	Population Density of 100-Year Floodplain (People per Square Mile)
New York	398,100	5%	48	8,300
Houston	296,400	14%	107	2,800
New Orleans	240,200	70%	183	1,300
Miami	144,500	36%	18	8,000
Fort Lauderdale	83,200	50%	21	4,000
San Francisco	9,600	1%	3	3,200

Source: NOAA's Spatial Trends in Coastal Socioeconomics, Demographic Trends (1970-2011); 2010 US Census Tiger Files, and population data; floodplain census data gathered from Miami's Chief of Community Planning, Houston's City Engineer, and Fort Lauderdale's Planning Department; New York population data was obtained from the Department of City Planning Population Division.

Overall, the story told by the PWMs is unsurprising but nonetheless troubling. The new 100-year floodplain, roughly corresponding to the areas flooded during Sandy, is larger than indicated on the 1983 maps by about 15 square miles, or 45 percent. The new floodplain includes larger portions of all five boroughs with significant expansion in Brooklyn and Queens. Citywide, there are now 67,700 buildings in the floodplain (an increase of 90 percent over the 1983 FIRMs) encompassing over 534 million square feet of floor area (up 42 percent). The number of residential units in the floodplain has increased to 196,700 (a jump of over 61 percent), with the majority of those residences in Brooklyn, Manhattan, and Queens. Almost 400,000 New Yorkers now live in the floodplain (up 83 percent)—more living in the floodplain than in any other American city (though some cities, such as New Orleans, have a much higher share of their populations in the 100-year floodplain). *(See timeline: Updating FEMA FIRMs for New York City; see table: Floodplain Comparison of Major American Cities)*

While the information contained in the PWMs has been critical for assessing current risks and informing rebuilding, the city's experience both before and after Sandy highlights areas for improvement in the current FEMA flood-mapping process. The lack of regular updates, the time involved in performing such updates, and the communication to stakeholders regarding those updates have made it challenging for governments, infrastructure operators, residents, and business owners to understand and address their coastal flood risks.

Storms are not the only weather challenges to New York City. Another is heavy downpours—which have increased over the last half-century across the Northeast. These heavy rains threaten the city's critical infrastructure, especially the water and transit systems. For example, in 2011, back-to-back Tropical Storms, Irene and Lee, produced elevated turbidity (murkiness resulting from stirred sediment) and high bacteria counts in several of the City's Upstate reservoirs that supply drinking water. During and immediately following the storms, turbidity levels remained high in the Catskill System and in the Catskill Aqueduct, which carries drinking water from the Ashokan Reservoir to the Kensico Reservoir before delivering it to the city. As a result, special treatment continued for almost nine months, the longest such treatment period ever recorded. With treatment and operational measures, the City ensured that the drinking water delivered to the public remained in compliance and safe for consumption.

Heavy downpours also present risks to the transit system. A single rainstorm in 2007 severely disrupted 19 major segments of New York City's subway system during morning rush hour, forcing much of the system to shut down and affecting as many as 2.3 million subway riders. Impacts to the subway system created further congestion and delays on flooded roadways and on the bus system, as subway riders tried to find a ways to get to work.

Meanwhile, heat waves—defined here as three or more consecutive days of temperatures at or above 90 degrees—are another extreme weather threat to New York. These events can be even more severe in New York due to the Urban Heat Island (UHI) effect that can cause the city's air temperature to be more than seven degrees warmer than in neighboring counties, particularly at night, disproportionately impacting certain neighborhoods. The UHI effect is caused in part by a greater concentration of buildings and paved areas, and affects energy use, comfort and quality of life, and exposure to heat stress. Heat waves strain the city's power grid and cause deaths from heat stroke and exacerbate chronic health conditions, particularly for vulnerable populations such as the elderly. In fact, heat waves kill more Americans each year than all other natural disasters combined. For example, a heat wave in New York in July 2006 resulted in 140 deaths. Going forward, a more severe and persistent heat wave, or one coupled with a major power outage, could cause even more deaths.

Another extreme event that impacts New York is drought. Droughts can lower reservoir levels and thus have an obvious and significant impact on the city's drinking water supply. Several droughts have occurred over the last 50 years, with the most intense lasting from 1963 to 1965, during which time residents and businesses significantly reduced water use through voluntary and mandatory restrictions. Since that

A September 2004 storm flooded 9th Street in Brooklyn. Credit: Seth Wenig/The New York Times

Patients being treated for heat exhaustion at the Maimonides Medical Center in Brooklyn during the July 2006 heat wave Credit: James Estrin/The New York Times

Wind damage from Sandy in Brooklyn

Credit: Earl Wilson/The New York Times

time, water demand has dropped, reducing the risk to New York from drought. However, the City continues to take steps to reduce water demand, such as identifying and repairing leaks, encouraging the use of more efficient "low flow" plumbing fixtures, and installing more than 830,000 automatic meter reading devices across the city to allow customers to manage their water use better. While these efforts have significantly increased drought resilience, the City continues to monitor and manage water demand.

Finally, New York also faces the threat of high winds—especially in connection with coastal storms. High winds can down trees and overhead utility lines, damaging property and causing power outages. At high enough speeds, winds can even damage buildings. Category 1 hurricanes come with sustained wind speeds of at least 74 mph, and Category 2 hurricanes bring sustained winds of 96 to 110 mph—far greater than Sandy's 80-mph wind speeds at landfall in New Jersey. In fact, in 1954, Hurricane Carol brought sustained wind speeds of up to 100 mph to the New York area, causing extensive damage.

New York's Vulnerabilities in the Future

Although New York clearly is at risk today, long-term changes in climate will make many extreme events and chronic conditions worse. These changes have, in fact, been underway for some time. As noted earlier, over the last century, sea levels around New York City have risen by more than a foot. Temperatures, too, are climbing. In fact, the National Weather Service and National Oceanic and Atmospheric Administration (NOAA) labeled 2012 the warmest year on record in New York City and in the contiguous United States, with average temperatures in the US 3.2 degrees Fahrenheit above normal and a full degree higher than the previous warmest year ever recorded.

Globally, all signs indicate that these changes will accelerate. Atmospheric concentrations of heat-trapping carbon dioxide have reached levels that have not been seen on earth for millions of years. Since the onset of the industrial revolution, combustion of fossil fuels and land use changes have led to a roughly 40 percent increase in carbon dioxide levels. Because the key greenhouse gas, carbon dioxide, stays in the atmosphere for 100 years or longer, the climate is essentially "locked in" to some additional warming. Meanwhile, since the late 1970s, global average temperatures have increased by approximately 1 degree Fahrenheit and the volume of sea ice in the Arctic during the month of September has declined by almost 80 percent. Ocean temperatures have also warmed and the vast majority of glaciers have retreated.

Long-term changes in climate mean that when extreme weather events strike, they are likely to be increasingly severe and damaging. As sea levels rise, coastal storms are likely to cause flooding over a larger area and to cause areas already at-risk to flood more frequently than today. As temperatures get warmer, heat waves are expected to become more frequent, last longer, and intensify—posing a serious threat to the city's power grid and New Yorkers' health.

Through PlaNYC, the City has been making a concerted effort to understand the effects that climate change will have on New York. A critical part of this effort began as far back as 2008, when Mayor Bloomberg convened the New York City Panel on Climate Change (NPCC)—one of the first American cities to create a body of leading climate and social scientists charged with developing local climate projections. With representatives from leading scientific institutions, such as the NASA Goddard Institute for Space Studies and Columbia University's Earth Institute, the NPCC brought to bear state-of-the-art global climate models and local observations to analyze future local vulnerabilities.

In 2009, the NPCC released its findings in a groundbreaking report that made predictions for a set of chronic hazards and extreme events likely to confront the city in the future. The report—entitled *Climate Risk Information 2009*—described a New York that would be far more exposed to climate-related impacts going forward than it is today. For example, the NPCC projected that by mid-century New York could experience sea levels (under a "middle range" scenario) that are up to a foot higher, causing flooding from what is today a 100-year storm to occur two to three times as often. The NPCC also projected that by the 2050s New York was likely to experience more frequent heavy downpours and many more days at or above 90 degrees.

To begin addressing these risks, in 2008 the Mayor convened more than 40 public and private infrastructure operators as part of the Climate Change Adaptation Task Force, another PlaNYC initiative. Task Force members used the NPCC projections to evaluate the risks to their infrastructure and identify strategies to address them. For instance, Con Edison assessed how changes in extreme heat would impact future peak electrical load demand, to determine when additional capacity might be required.

The City also took action to strengthen its built environment. For example, the City required new waterfront development to design for the future risk of sea level rise and coastal storms, and passed regulations allowing buildings to elevate electrical equipment to their roofs without special permits. The City also launched the NYC°Cool Roofs Program to paint rooftops white, thereby minimizing heat gain.

The work of the Climate Change Adaptation Task Force and City agencies demonstrates the power of accurate information to drive thoughtful planning and decision-making. That is why the City has continued to advocate for better and more current information on the risks New York faces. As mentioned earlier, the City pushed for an update to FEMA's flood maps for New York so the City and its residents and businesses could better understand the existing risks from flooding during coastal storms. However, the City also recognized that even updated FEMA flood maps, because they are based on historic data, will not provide information about the changes that are likely to threaten New York in the future.

NPCC 2013 Climate Projections

Chronic Hazards	Baseline (1971-2000)	2020s		2050s	
		Middle Range (25th - 75th percentile)	High End (90th percentile)	Middle Range (25th - 75th percentile)	High End (90th percentile)
Average Temperature	54 °F	+2.0 to 2.8 °F	+3.2 °F	+4.1 to 5.7 °F	6.6 °F
Precipitation	50.1 in.	+1 to 8%	+10%	+4 to 11%	+13%
Sea Level Rise[1]	0	+4 to 8 in.	+11 in.	+11 to 24 in.	+31 in.

Extreme Events		Baseline (1971-2000)	2020s		2050s	
			Middle Range (25th - 75th percentile)	High End (90th percentile)	Middle Range (25th - 75th percentile)	High End (90th percentile)
Heat Waves and Cold Events	Number of days per year at or above 90°F	18	26 to 31	33	39 to 52	57
	Number of heat waves per year	2	3 to 4	4	5 to 7	7
	Average duration (days)	4	5	5	5 to 6	6
	Number of days per year at or below 32°F	72	52 to 58	60	42 to 48	52
Intense Precipitation	Days per year with rainfall exceeding 2 inches	3	3 to 4	5	4	5
Coastal Floods at the Battery[1]	Future annual frequency of today's 100-year flood	1.0%	1.2% to 1.5%	1.7%	1.7% to 3.2%	5.0%
	Flood heights from a 100-year flood (feet above NAVD88)	15.0	15.3 to 15.7	15.8	15.9 to 17.0	17.6

Source: NPCC; for more details, see *Climate Risk Information 2013*.

[1] **Baseline period for sea level rise projections is 2000-2004.**

Like all projections, the NPCC climate projections have uncertainty embedded within them. Sources of uncertainty include data and modeling constraints, the random nature of some parts of the climate system, and limited understanding of some physical processes. The NPCC characterizes levels of uncertainty using state-of-the-art climate models, multiple scenarios of future greenhouse gas concentrations, and recent peer-reviewed literature. Even so, the projections are not true probabilities, and the potential for error should be acknowledged.

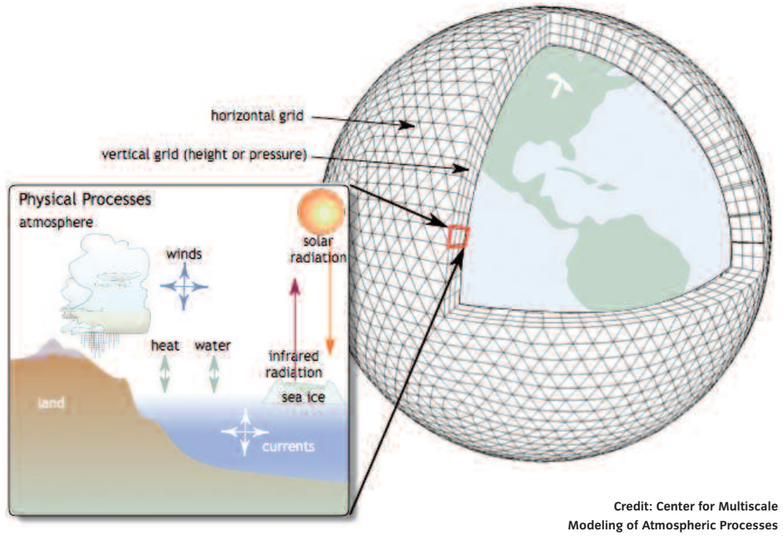
To ensure that the City would always have access to the latest information about future climate risks, in September 2012 New York City formally codified the NPCC and the Climate Change Adaptation Task Force when it wrote those two entities into law—the first bill passed by any local government in the country to institutionalize a process for updating local climate projections and identifying and implementing strategies to address climate risks. The new law requires that the NPCC meet twice a year, advise the City and the Climate Change Adaptation Task Force on the latest scientific developments, and update climate projections at least every three years, starting from March 2013.

Of course, in the wake of Sandy, waiting another three years would have been too long. That is why, in January 2013, the City reconvened the NPCC on an emergency basis to update its projections to inform planning for rebuilding and resiliency post-Sandy. NPCC members agreed to participate on an accelerated timetable, setting aside other important research to focus on updating the projections to help New York plan for the future.

Drawing on the latest climate models, recent observations about climate trends, and new information about greenhouse gas emissions, the NPCC updated its 2009 projections—in a document called *Climate Risk Information 2013*, which it has released concurrent with this report. These projections tell a dire story about New York's future. *(See table: NPCC 2013 Climate Projections; see sidebar: How New York's Climate Projections are Developed)*

The NPCC now projects that, by mid-century, sea levels could rise by more than 2.5 feet, especially if the polar ice sheets melt at a more rapid rate than previously anticipated. That magnitude of sea level rise would threaten

How New York's Climate Projections Are Developed



Credit: Center for Multiscale Modeling of Atmospheric Processes

The New York City Panel on Climate Change (NPCC) develops climate projections using global climate models. These models are mathematical representations of the earth's climate system (e.g., the interactions between the ocean, atmosphere, land, and ice). They use estimates of future greenhouse gas and pollutant concentrations to project changes in climate variables such as temperature and precipitation. Because future emissions are uncertain, scientists use a range of scenarios that can be linked to assumptions about future population and economic growth and technological change.

To develop the most recent set of climate projections, the NPCC used the latest climate models developed for the upcoming *Intergovernmental Panel on Climate Change Fifth Assessment Report*. The NPCC also used estimates of future atmospheric concentrations of greenhouse gases called Representative Concentration Pathways (RCPs), selecting two RCPs (4.5 and 8.5) for which the greatest number of climate model simulations were available and which span a range of potential future concentrations. To produce local temperature and precipitation projections, the NPCC used these two RCPs and 35 global climate models for the land-based grid box covering New York City. To generate sea level rise projections, the NPCC used 24 global climate models and the same two RCPs. For sea level rise, the NPCC also included additional global factors and local factors.

The results provide a range, or distribution, of outcomes. Local projections are presented for the "middle range" (the middle 50 percent of that distribution) and the "high end" (the 90th percentile of that distribution). The high end is presented as a more extreme outcome and would be appropriate for those with lower risk tolerances—such as critical infrastructure operators.

Source: NPCC; for more details, see *Climate Risk Information 2013*.

low-lying communities in New York with regular and highly disruptive tidal flooding, and make flooding as severe as today's 100-year storm at the Battery up to five times more likely. The NPCC also predicts it is more likely than not (more than 50 percent probability) that there will be an increase in the most intense hurricanes in the North Atlantic Basin.

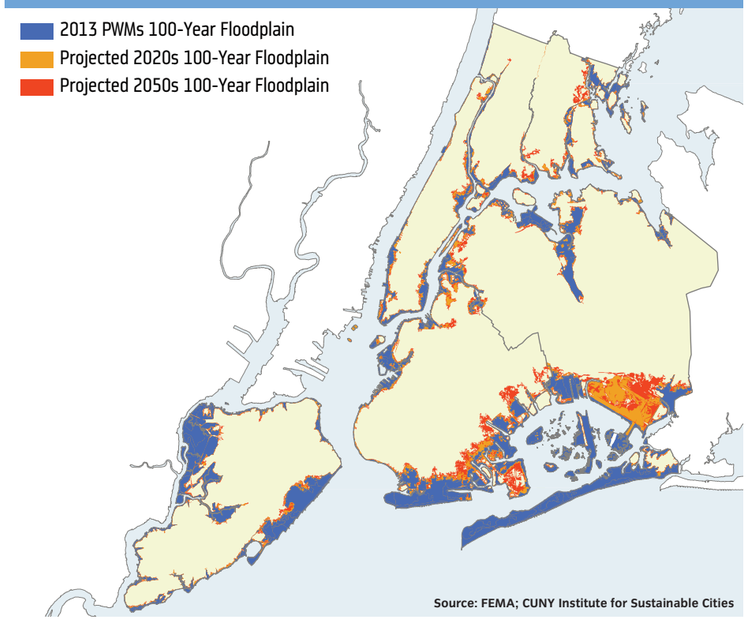
Meanwhile, the NPCC also predicts that, by the 2050s, the city could have as many days at or above 90 degrees annually as Birmingham, Alabama has today—a threefold increase over what New York currently experiences. Heat waves could more than triple in frequency, lasting on average one and a half times longer than they do today. Similarly, it is also very likely (more than 90 percent probability) that the New York City area will see an increase in heavy downpours over this time period.

These projections have been subjected to rigorous peer review, and represent the best-available climate science for New York City. However, they are not yet officially recognized by the State or Federal governments because there is no formal mechanism for them to do so. As planning for resiliency moves forward in New York, it will be necessary to make sure that all stakeholders addressing climate change in New York City are using common projections based on the work of the NPCC to avoid confusion or conflicting standards.

The City also has worked with the NPCC to develop a series of "future flood maps" for New York that will help guide the city's rebuilding and resiliency efforts. These forward-looking maps are created by using a simplified approach that combines the NPCC's "high end" sea level rise projections with FEMA's PWMs. The maps illustrate how the 100-year floodplain could increase over the next several decades with these high end projections. Because these maps were not developed using advanced coastal modeling, the accuracy of the flood projections is limited and they are not suitable for evaluating risks to individual properties. However, they are extremely useful for understanding the general extent of future flood risks. *(See map: Future Flood Maps for the 2020s and 2050s; see sidebar: Possible Links Between Sandy and Climate Change)*

The new maps show that the area that might be flooded in a 100-year storm in the 2020s could expand to 59 square miles (up 23 percent from the PWMs) and encompass approximately 88,800 buildings (up 31 percent). With more than 2.5 feet of sea level rise, New York City's 100-year floodplain in the 2050s could be 72 square miles—a staggering 24 percent or nearly a quarter of the city—an area that today contains approximately 114,000 buildings

Future Flood Maps for the 2020s and 2050s



Source: FEMA; CUNY Institute for Sustainable Cities

Like all environment-related projections and associated map products, the NPCC future flood maps have uncertainty embedded within them. In this case, uncertainty is derived from a set of data and modeling constraints. Application of state-of-the-art climate modeling, best mapping practices and techniques, and scientific peer review was used to minimize the level of uncertainty. Even so, the map product should be regarded as indicative of the general extent of future flood risks based on high end sea level rise projections and not of the actual spatial extent of future flooding.

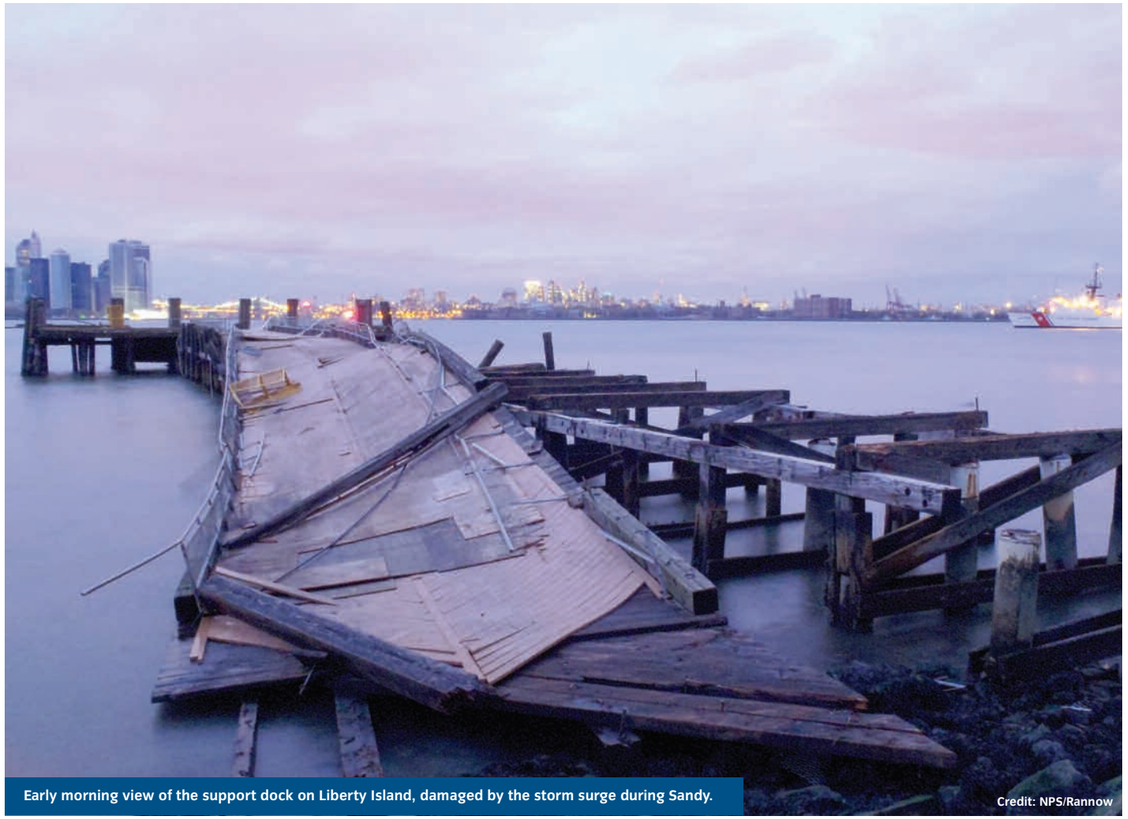
Possible Links Between Sandy and Climate Change

Sandy has brought public attention to the climate hazards of the New York area. But did climate change *cause* the storm? While it is impossible to attribute any one event such as Sandy entirely to climate change, higher sea levels certainly did increase the extent and magnitude of coastal flooding caused by the storm. Since 1900, sea levels have risen more than a foot in New York City, primarily due to climate change. As sea levels continue to rise, coastal storms will cause flooding over a larger area and at increased heights than they otherwise would have.

Sandy is also thought to have gained strength from unusually warm upper ocean temperatures in the North Atlantic. As the planet warms, upper ocean temperatures are expected to increase, which could fuel storms. Although hurricanes depend on a range of climate variables and it is not clear how these other variables will change, recent studies suggest that the most intense hurricanes may increase globally. And, it is more likely than not (greater than 50 percent probability) that such hurricanes also will increase in the North Atlantic Basin.

Loss of sea ice as the Arctic warms may possibly have influenced Sandy's path and intensity. The volume of sea ice in the early fall has decreased 80 percent since the late 1970s, and some researchers have linked this to changes in the atmospheric steering currents known as the jet stream—changes that may be increasing the frequency and intensity of extreme weather events. The dip in the jet stream that contributed to Sandy's "westward" turn that resulted in its striking New Jersey was unusual. Whether the reduction of sea ice played a role in that particular configuration remains unknown, but climate scientists believe it is worthy of further research.

Source: NPCC; for more details, see *Climate Risk Information 2013*



Early morning view of the support dock on Liberty Island, damaged by the storm surge during Sandy. Credit: NPS/Rannow

(almost twice as many as indicated by the PWMs). This area currently accounts for 97 percent of the city's power generation capacity, 20 percent of its hospital beds, and a large share of its public housing. Over 800,000 New Yorkers, or 10 percent of the city's current population, now live in the 100-year floodplain projected for the 2050s—a number of flood-vulnerable residents that is greater than the total number of people living in the entire city of Boston.

Building on the information contained in these future flood maps, the City also commissioned an analysis of the economic impacts of projected changes in the city's vulnerability to coastal storms. This work was completed by Swiss Re, one of the world's largest reinsurers (a company that, because it provides its clients with reinsurance and insurance protection against natural catastrophe risks, has developed expertise in projecting the probability of extreme weather and the resulting damage). Unlike the risk represented in FEMA's maps, Swiss Re took into account the potential damage caused by both flooding and high winds. Their analysis shows that the combination of rising sea levels and more intense storms is expected to come with significant costs—costs that will be measured in many billions of dollars. *(See sidebar: Expected Loss Modeling and Cost-Benefit Analysis)*

With analytical tools such as the Swiss Re model, the City has yet another way of assessing the likelihood and impact of coastal storms on New York. Still the model does not assess the impact of extreme events beyond coastal storms (which include both storm surge and wind), nor does it assess potential public health impacts of coastal storms and other extreme weather events such as heat waves.

The City, however, has been working to fill this gap in understanding the public health risks posed to New York by climate change. As part of the Climate-Ready Cities and States Initiative, the City's Department of Health and Mental Hygiene (DOHMH) has been estimating health risks, identifying vulnerable populations, and developing public health adaptation strategies for extreme heat and other climate hazards. For example, without mitigation, hotter summers predicted for the 2020s (based on the NPCC 2009 projections), could cause an estimated 30 to 70 percent increase in heat-related deaths, or about 110 to 260 additional heat-related deaths per year on average in New York City compared to the baseline period for the analysis (1998–2002). Additional work will be necessary to refine these projections and identify strategies with which to respond, but this analysis is an important starting point that illustrates, in yet another way, the stakes associated with climate change.

The remainder of this report outlines specific initiatives to address the current and future climate change-related vulnerabilities faced by New York as outlined above. But these initiatives will be most effective only if they continue to be informed by the best-available science. And while New York has been a global leader in this area, there is still more that the City can do—on its own and with the Federal government—to improve the quality of the data and tools available to it.

This chapter contains a series of initiatives that are designed to strengthen the City's ability to understand and prepare for the impacts of climate change. In many cases, these initiatives are both ready to proceed and have identified funding sources assigned to cover their costs. With respect to these initiatives, the City intends to proceed with them as quickly as practicable, upon the receipt of identified funding.

Meanwhile, in the case of certain other initiatives described in this chapter, though these initiatives may be ready to proceed, they still do not have specific sources of funding assigned to them. In Chapter 19 (*Funding*), the City describes additional funding sources, which, if secured, would be sufficient to fund the full first phase of projects and programs described in this document over a 10-year period. The City will work aggressively on securing this funding and any necessary third-party approvals required in connection therewith (i.e., from the Federal or State governments). However, until such time as these sources are secured, the City will proceed only with those initiatives for which it has adequate funding.

Initiative 1
Work with FEMA to improve the flood-mapping process

The nearly three-decade gap between the introduction of FIRMs for New York in 1983 and the launch of a map update process in 2009 meant that the City and other stakeholders had to rely upon outdated and inaccurate information to assess coastal flood risks. The City will work with FEMA to improve the flood map update process—seeking to require coastal analysis updates every 10 years. To ensure that FEMA's maps are not just more current but also more accurate and informative, the City will continue to work with FEMA to review the analysis leading to the production of Preliminary FIRMs by the end of 2013. The City also will call on FEMA to implement a series of technical and process improvements—including more appropriate application of wave modeling, thorough documentation of all work, and the use of an external quality assurance contractor to review completed work. This work is technically complicated and checks should be built into the process at every step. With participation from FEMA and the Office of Long-Term Planning and Sustainability (OLTPS), this joint work can begin immediately.

Initiative 2
Work with FEMA to improve the communication of current flood risks

Despite FEMA's best efforts, many residents and business owners in vulnerable areas have found both the flood-mapping process and the maps themselves to be confusing. In fact, even today, many New Yorkers in the floodplain are not aware of the existence of FEMA's maps. The City, through OLTPS, will call on FEMA to increase the transparency of its mapping process, to improve the user experience in accessing online flood maps, and to expand efforts to make all affected property owners aware of the maps. Subject to available funding, this may include joint development of a new interactive platform for communicating flood-related risk information, insurance availability, and steps New Yorkers can take to protect themselves from flood risks.

Initiative 3
Call on the State and Federal governments to coordinate with the City on local climate change projections

Using multiple sets of climate change projections for New York City across different levels of government would cause confusion among stakeholders and would potentially lead to conflicting standards for protecting against future risks. To address this concern, the City will work with State and Federal partners to agree on a uniform set of projections for New York City and a consistent approach for presenting those projections, based on the work of the NPCC. The City, through OLTPS, also will call on the Federal government to establish a policy that would recognize local climate projections if they meet rigorous scientific standards.

Initiative 4
Continue to refine local climate change projections to inform decision-making

Although the NPCC's 2013 work represents the most current view of the risks that New York faces, there remains more work to be done, as is always the case with such efforts. The City will work with the NPCC and key stakeholders in 2013 and beyond to develop additional climate change projections and to make these projections even more useful. For example, OLTPS will work with the NPCC to include additional extreme climate events and chronic hazards, such as high winds and humidity, in the scope of the NPCC's work. OLTPS and the NPCC also will work to identify a set of metrics that can help the City and others measure actual climate changes against predicted climate change, in order to adjust policies and investment decisions in the future.

Initiative 5
Explore improved approaches for mapping future flood risks, incorporating sea level rise

Although the City and the NPCC have developed future flood maps to show how sea level rise could change flood zones going forward, the methodologies for developing these maps can be improved with better science and intergovernmental coordination. To plan for future coastal risks more effectively, the City will work with the NPCC and Federal partners to evaluate alternative approaches to mapping future risks. OLTPS will continue to develop improved future flood maps and will work with FEMA to develop recommendations for how FEMA can incorporate the future impacts of sea level rise into its ongoing non-regulatory mapping efforts.

Initiative 6
Launch a pilot program to identify and test strategies for protecting vulnerable neighborhoods from extreme heat health impacts

On average, heat waves cause more deaths than any other type of extreme weather event. Going forward, more intense, longer, and more frequent heat waves will increase this risk, especially to seniors, those with chronic disease, and those without access to air conditioning. Subject to available funding, the City will: 1) develop updated UHI models and maps to measure air temperature and evaluate landscape-based strategies to mitigate UHI effects; 2) work in two high-risk neighborhoods to identify vulnerable populations, residential facilities, walking and transit routes, existing and potential locations of UHI mitigation measures, and air conditioned spaces that could be made accessible as cooling shelters; and 3) engage with community stakeholders and City agencies to develop and implement enhanced Heat-Health Warning Systems, targeted UHI mitigation measures, and expanded access to air conditioned spaces during heat waves. The project will produce a replicable model for heat illness prevention strategies to roll out to other high-risk neighborhoods, and to inform citywide cooling messages and strategies. The project will be led by DOHMH, building upon studies and communications strategies developed as part of a Centers for Disease Control-funded Climate-Ready Cities project. DOHMH will work in coordination with OLTPS and the Department of Parks & Recreation on the development of UHI models and maps. The goal is to launch the project in late 2013 and complete it by 2015.

Expected Loss Modeling and Cost-Benefit Analysis

Overview

In setting out to define plans for strengthening New York City's resiliency to climate change, it was critical to anchor the development of those strategies in the best possible understanding of the magnitude of the risks facing New York—including its infrastructure and its neighborhoods. Moreover, in a world of finite resources and competing priorities, a properly developed resiliency strategy should assess potential initiatives in part by relating the costs of those initiatives, including capital and operating costs, to the benefits of those initiatives—namely the reduction in risk.

Although it is impossible to quantify future risks to New York or the cost-benefit ratio of any specific intervention with precision, the insurance industry has developed probabilistic models that rely on analytical techniques to provide quantitative guidance on these topics. In order to ground its work in the best-available analysis, the City engaged Swiss Re, a reinsurance company. Swiss Re uses probabilistic models to assess both the frequency and severity of an event (such as a coastal storm) as well as the magnitude of loss likely to be suffered if such an event were to occur. Working with the City, the company applied the same models used for their internal underwriting and risk analysis activities to the assessment of the risks facing New York.

Approach

The City applied Swiss Re's natural catastrophe models to New York City to help understand the potential impacts of wind and storm surge on the city (FEMA's FIRMs do not model the impacts of wind), assuming a world of rising sea levels and more intense storms. In order to do so, the City and Swiss Re combined three sets of inputs:

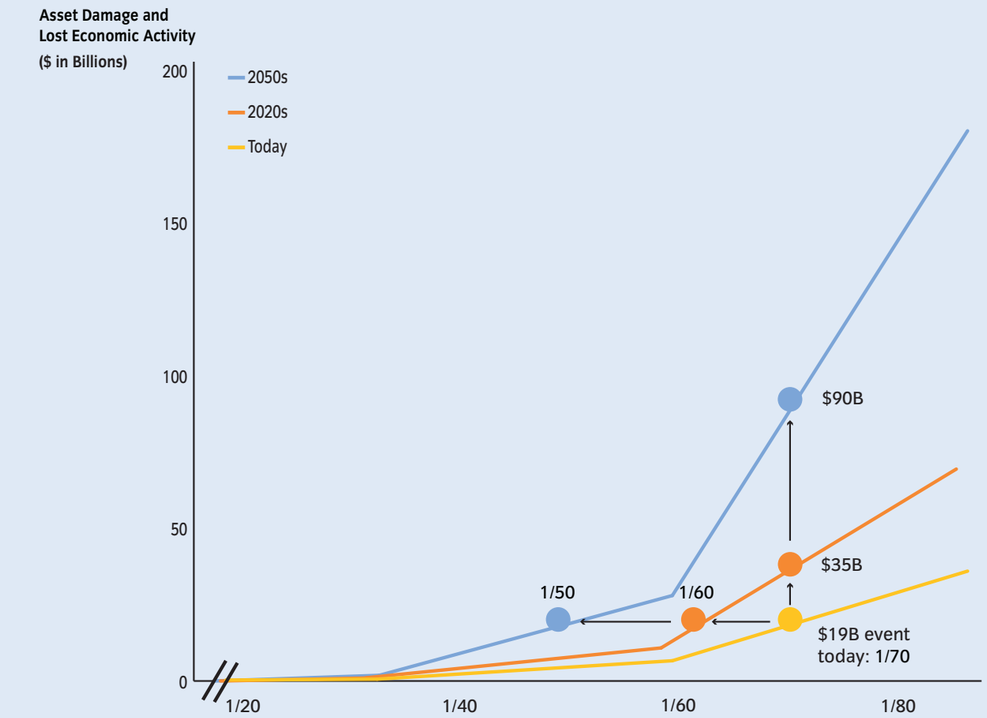
1. **Hurricane models:** As a seller of large-scale natural catastrophe reinsurance products, Swiss Re has built simulations of hurricanes based on robust historical data. Swiss Re uses data from the National Hurricane Center that includes nearly 1,200 observed tropical storms and hurricanes in the Atlantic Basin between 1851 and 2008. The Swiss Re model then "tweaks" each of these historical storms hundreds of times to create over 200,000 storms that could form in the area, and then uses established models for atmospheric pressure, speed, size, and angle of landfall to assess the resulting storm surge and wind fields.

2. **Climate change scenarios:** The City provided Swiss Re with guidance on projected sea level rise in the 2020s and 2050s, based on work of the New York Panel on Climate Change (NPCC). Specifically, the City instructed Swiss Re to assume of sea level rise by the 2020s, and the 2050s, based on the NPCC's climate projections. In addition, Swiss Re adjusted the future frequency of different categories of hurricanes (tropical storm through category 5) based on academic research.

3. **City-level asset and economic activity:** The consultants worked closely with City agencies to develop a working model of asset value divided into several categories, including, among other things, buildings, transportation, telecommunications, and utilities. These asset values were further broken down by zip code as was the city's economic activity (gross city product).

It is important to note several key limitations to this approach. First, while the Swiss Re models assess the potential impact of surge and wind resulting from coastal storms, they do not reflect the risk from other climate impacts—heat waves, drought, heavy downpours, and more. As a result, the analysis does not provide a holistic assessment of risk. Second, the analysis assumes the city as it exists today, not as it may change in the future. Thus, impacts to major new buildings or infrastructure that may exist in the 2020s or 2050s are not reflected in projected losses. Finally, and most importantly, the Swiss Re models only seek to estimate losses that can be readily measured in dollars—namely, physical damage to assets, such as buildings and tunnels, and reductions in income and loss of use due to physical damage (for example, if people in unimpacted areas could not travel to work due to transportation outages). Using this approach total losses caused by Sandy, an estimated $19 billion (according to the City's analysis provided to the Federal government), could be broken down into over $13 billion of physical damage and almost $6 billion of lost economic activity. But of course, not every potential impact can or should be quantified by such a simple metric. For example, the Swiss Re models do not predict loss of life or injury. Nor do they highlight potentially disproportionate impacts on disadvantaged populations such as the elderly or medically vulnerable. These and other non-financial impacts should be and have been critical inputs in the development of the initiatives in this report.

Loss Frequency Curves



Source: Team Analysis

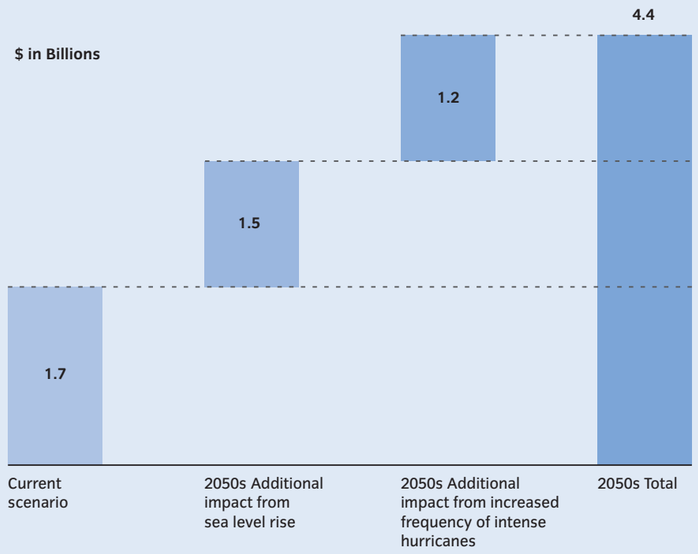
Based on these inputs, Swiss Re models produce a "loss frequency curve" for each of three scenarios: 2012, the 2020s, and the 2050s. Each curve indicates the probability that a given level of loss—in terms of both asset damage and lost economic activity, expressed in billions of current dollars—will be met or exceeded in any given year (known also as the "probability of exceedance"). As sea levels rise and hurricane patterns change, the loss curves move up, demonstrating both that the chance of experiencing a given level of loss grows over time and the amount of loss increases if the probability of occurrence is kept constant.

For example, according to the Swiss Re analysis, a storm today that causes the same magnitude of infrastructure and property damage and economic loss as Sandy ($19 billion) is considered a once-in-70-year "loss event" (or has a 1.4 percent chance of happening in any given year). This reflects a range of storms including those that, unlike Sandy, could result in very little damage due to flooding but major damage due to wind. With the impact of climate change (and assuming no additional development in the floodplain), the models suggest that this probability will grow—causing a $19 billion loss event (in current dollars) to become a once-in-60-year loss event by the 2020s (or an event with a 1.7 percent chance of happening in any given year), and a once-in-50-year loss event by the 2050s (or an event with a 2 percent chance of occurring in any given year).

In addition, by keeping the probability of occurrence constant, the Swiss Re analysis further shows that a once-in-70-year loss event today is expected to cause in the future significantly more damage than Sandy caused. The models suggest that a storm of this frequency would cause $35 billion (in current dollars) of damage by the 2020s, an increase of 1.8 times the actual damage caused by Sandy. Meanwhile, by the 2050s, with rising sea levels and more intense storms, a once-in-70-year loss event would cause an estimated $90 billion (in current dollars) of damage, or almost five times the asset damage and economic loss caused by Sandy, even if it is assumed that no additional development happens in the floodplain.

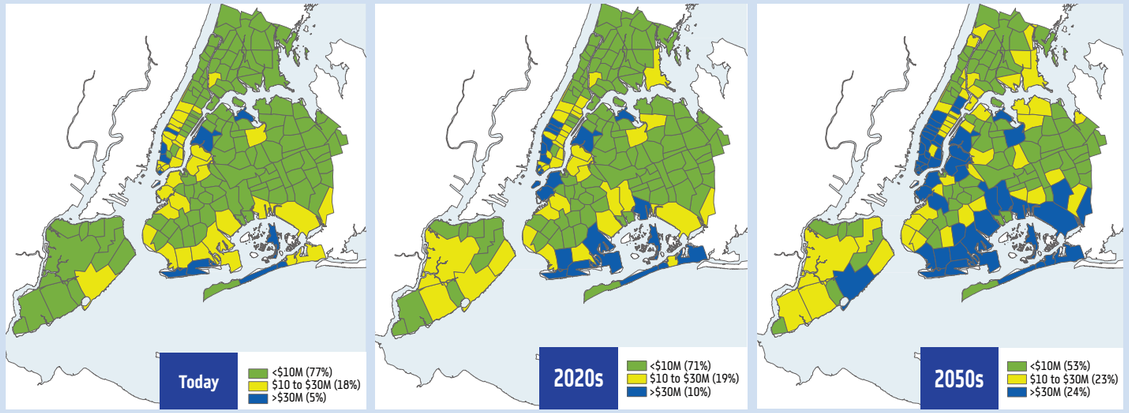
Expected Loss Modeling and Cost-Benefit Analysis (Continued)

Growth in Expected Annual Losses from Storm Surge and Wind



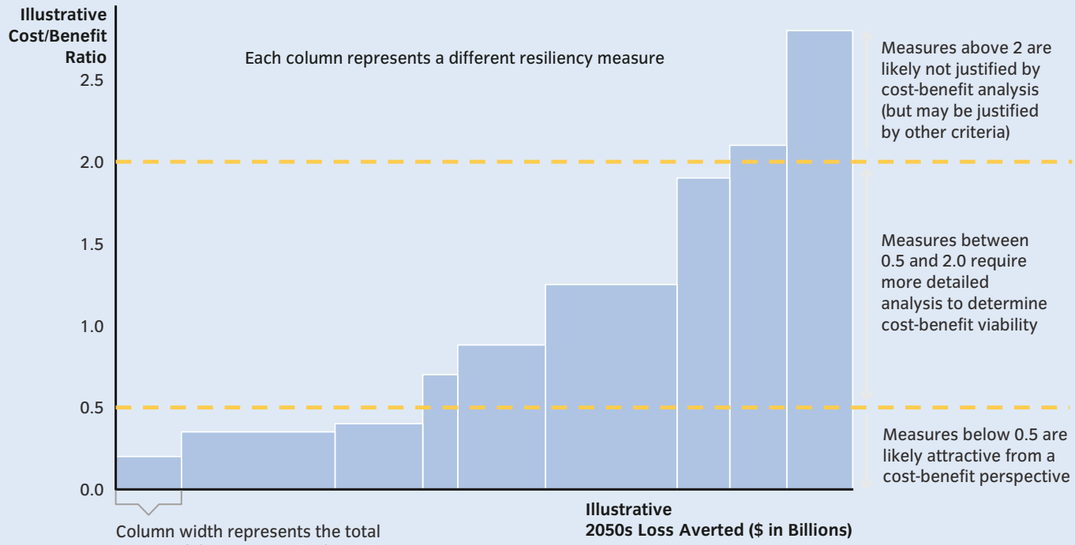
While the loss frequency curves map different levels of loss to their exceedance probabilities, another way to understand the risks to New York is to consider expected annual losses. This is generated by multiplying the different exceedance probabilities by the amounts of loss associated with them and adding up the results (or put differently, by calculating the area under the loss curve). The resulting number indicates the expected annual average impact to assets and economic activity, recognizing that in some years the actual losses may be zero (if no coastal storms strike New York) while in other years the losses may be significant (if, for example, a Sandy-level loss event were to strike). The Swiss Re models project that expected annual losses in New York City of $1.7 billion today will grow to $4.4 billion in current dollars by the 2050s. As the chart indicates, this growth in expected losses is attributable in roughly equal proportions to rising sea levels (which make flooding from coastal storms more damaging) and to the increased frequency of intense hurricanes.

Total Asset and Economic Activity Losses



Yet another way to understand the projected economic loss to the city due to sea level rise and the increased frequency of intense hurricanes is by conducting a geographical analysis, taking into account the physical locations of assets and economic activity. For example, the Swiss Re models break these losses down by zip code over time. Today, expected losses are concentrated in many of the same areas of the city that were impacted during Sandy (such as the East and South Shores of Staten Island, Southern Brooklyn, South Queens, the Brooklyn-Queens Waterfront, and Southern Manhattan), but also in other, less-impacted areas such as Northern Queens and the Bronx. In the future, the expected losses cover a significantly wider swath of the city. It is also important to note that while the maps divide the city by zip code (which may cover reasonably large areas, including inland areas), actual losses generally will be concentrated in the waterfront areas of those zip codes.

Cost-Benefit Analysis Output



In addition to calculating expected losses, the Swiss Re models also enable cost-benefit estimates of proposed interventions. Through analysis of the costs (including capital costs and ongoing operating costs) of specific interventions, the models estimate the benefit of these actions in terms of avoided (or mitigated) damage to assets and losses to economic activity. Although this model is not designed specifically to measure the costs and benefits of resiliency measures, it can provide helpful guidance. For example, in evaluating proposals, the City generally concluded that an intervention with a cost-benefit ratio of greater than two (projected costs twice as large as projected benefits) was unlikely to be attractive on a cost-benefit basis, even with refined assumptions.

By contrast, a measure with a cost-benefit ratio of less than 0.5 (projected benefits twice as large as projected costs) was considered highly likely to be an attractive investment. The chart above is an illustration of how general interventions were evaluated.

Of course, as noted earlier, certain interventions that perform well or poorly on a cost-benefit analysis might nonetheless be worthwhile public investments as a result of other, less easily quantifiable attributes (such as the protection or lack of protection provided to vulnerable populations). For this reason, cost-benefit analyses were an important tool, but not the only tool employed by the City in selecting among resiliency strategies for this report.

East Shore, Staten Island

Credit: Staten Island Borough President's Office

Coastal Protection

New York City's Coastline: Then and Now

Historic wetlands from "Nature's Estuary: The Historic Tidelands of New York New Jersey Estuary" Regional Plan Association, 2003. Historic data compiled by George Colbert and Guenter Vollath from 19th century U.S. Geological Survey, U.S. Coast and Geodetic Survey, New Jersey Geological Survey and the Ratzer Survey of 1776-1777.

When Henry Hudson sailed into what is now known as New York Harbor in 1609, the coastline he encountered was a wondrous place. Archipelagos of small islands dotted near-shore waters. Wetlands and oyster beds stretched for miles. Sloping beaches lay dazzling under the sun. The harbor coastline provided abundant food sources and natural protection from storms. It would prove essential to the survival and growth of the early settlement of New Amsterdam. (*See map: New York City's Coastline: Then and Now*)

This coastline is just as essential to New York City's survival and growth today.

Not surprisingly, New York City's coastline—which stretches a total of 520 miles and is longer than the coastlines of Miami, Boston, Los Angeles, and San Francisco combined—has changed dramatically since the 17th century. The inhabitants of New York City have altered its very topography in many ways, dredging waterways to ease the way for shipping, constructing piers and bulkheads, and even using fill to reshape the shoreline's contours. While some of the historic natural features that once protected what is today New York City have been lost in the process, the changes that were made have enabled commerce and industry to flourish, neighborhoods to thrive, and infrastructure to perform critical functions.

Notwithstanding the important role played by the city's waterfront through most of its history, during the last decades of the 20th century, large sections of the coastline fell into disuse and disrepair. In recent years, however, the city has begun to reconnect with this critical asset. These new connections have taken many forms, from investments in the working waterfront to new housing, parks, and ferry landings. As much as this renewed embrace of what Mayor Bloomberg has referred to as the "sixth borough" has benefitted its citizenry, New York's reengagement with its coastline has also occurred out of necessity—as the city has sought to meet the needs of a growing population and expanding economy.

However, even as the city has reconnected with its waterfront, New Yorkers have known that proximity to the water brings with it certain challenges, especially as global climate change advances—a threat discussed in detail in PlaNYC, the City's sustainability plan, in 2007. Thus, in 2011, building on PlaNYC, the City released *Vision 2020: The New York City Comprehensive Waterfront Plan*, the centerpiece of an effort known as the Waterfront Vision and Enhancement Strategy, or WAVES. This effort set forth broad goals for the shoreline of New York City, including, of course, increased climate resiliency. To this end, the report's accompanying WAVES Action Agenda put forth specific initiatives that already have helped to create a waterfront that is more productive and better prepared for the future.

In October 2012, with the arrival of Sandy, the case for increased climate resiliency—even beyond the initiatives set forth in the WAVES Action Agenda—was forcefully made to all New Yorkers. The storm scoured beaches along New York City's ocean-facing coastline, damaging buildings and infrastructure, flooding neighborhoods, causing dangerous erosion, and most seriously, killing 43 New Yorkers. Areas along the Hudson and East Rivers and the other waterways in the Upper Bay, meanwhile, experienced record-setting flooding, along with damage and destruction to building systems, business inventory, and personal property.

As the impacts of climate change accelerate over time, more damage, more flooding, and more erosion are likely in New York, with sea levels continuing to rise and more of the most intense storms expected. In response to these challenges, the City believes that it must bulk up its defenses, improving the coastline with protective measures. This will not eliminate all flooding from all conceivable storms—an impossible goal—but mitigate the effects of sea level rise where the risk is greatest and reduce the effects of storm waves and storm flooding significantly.

Reaching these resiliency goals—and protecting all of the waterfront assets along the coastline more effectively—requires a deliberate and coordinated approach. This chapter seeks to achieve this goal, presenting the City's new, comprehensive coastal protection plan.

The plan articulates a full menu of proposed coastal protection measures tailored to the specific geomorphology of (described below) and risks facing neighborhoods that are most exposed. These measures, though complementary, also can be implemented independently over time, based on available funding and relative priority. Though ultimately the city will be best served by implementing the entire suite of options, this report sets forth an initial set of projects that targets areas that have particularly large concentrations of businesses or residents (or both), areas that house critical infrastructure, and areas that shelter especially vulnerable populations. Though these projects still come at significant cost, they have been scaled in such a way that the City believes that they not only can but should get under way immediately.

Of course, the City cannot implement these new coastal protection measures alone. Implementing them will require partnerships with the Federal government, likely through the US Army Corps of Engineers (USACE), and other regional stakeholders and governmental entities. To make these new coastal measures as effective as possible, the City itself also will have to improve the way that it administers the shoreline that it controls, ensuring better management, design, and operation of its coastal assets—something that this chapter also addresses. Finally, this chapter also will call on the various regulatory bodies with responsibility for permitting along the waterfront in New York City—from the City, to the State, to the Federal government—to work together to clarify, simplify, and simultaneously make more effective the process of permitting, both in general and for critical flood-protection projects.

Over the centuries, the coastline of New York City has been a sparkling natural resource, a setting for commerce and industry, and a place for housing and recreation. Going forward, it also can reprise a role that it played ably in the early days of New Amsterdam and before. Namely, to provide protection to the people living along and behind this coastline.

The New York City Coastline

The city's 520-mile coastline—bordering the ocean, as well as rivers, bays, and inlets—is both diverse and complex. To understand this coastline, it is critical to understand its geomorphology—or the combination of its natural landforms, underlying geological conditions, and built condition. The geomorphology of today's city is largely the result of a colossal glacier that moved over what is now New York City over 20,000 years ago, combined with the coastal modifications that inhabitants have made in more recent times. This complexity is, in turn, amplified not just in the diverse uses and multiple property owners found today all along the water's edge across the city, but also by the many regulators with responsibility for the coastline's protection.

The Geomorphology of the New York City Coastline

New York City's southernmost waterfront areas—the Rockaway Peninsula, the Coney Island peninsula, and the East and South Shores of Staten Island—generally are characterized by gently sloping sandy beaches with some natural and built dunes, as well as discrete areas containing elevated bluffs. In places, groins (rock and timber structures perpendicular to beaches) and other reinforced structures have been installed to protect these beaches. Communities in these areas typically are less densely populated than other parts of New York City, though they also tend to be much more densely populated than other coastal areas along the eastern seaboard.

Within Jamaica Bay, one of the region's most important and largest natural features, there are many natural edges and marsh islands, some newly reconstituted. Here, portions of the shoreline have been filled in and hardened with bulkheads (vertical retaining walls) and revetments (shoreline protection constructed with armor stone). Many of the areas surrounding Jamaica Bay are particularly low-lying, a result of the glacial outwash plains that were formed at the end of the last Ice Age. Along and within Jamaica Bay and its tributaries, there are a wide array of neighborhoods, as well as several elements of critical city infrastructure, including transportation assets such as John F. Kennedy (JFK) Airport, marine terminals, and wastewater treatment plants.

Further north and within the Upper Bay—the areas along the Hudson and East River shorelines of Manhattan, Brooklyn, and Queens, as well as on the North Shore of Staten Island—the topography historically rose quickly to greater elevations along the coast. However, significant use of landfill to extend the coastline and the filling and development of former marshland have altered the waterfront significantly over the past three centuries, with large areas along these coasts now lying at or near the water level. Examples of these low-lying areas include the southern parts of Manhattan, East Harlem, Red Hook, and the areas adjacent to the Gowanus Canal and Newtown Creek in Brooklyn and Queens. Generally, in these areas, coastal edges have been hardened extensively over time with bulkheads, revetments, and piers supporting maritime, industrial, commercial, residential, and transportation uses.

In the northernmost waterfront areas of the city, the shorelines are quite varied. Some parts are naturally rocky, such as along City Island and Eastchester Bay. Other areas, by contrast, including Orchard Beach, have more gently sloping, sandy edges, some of which are man-made. Along the northern Queens waterfront as well as along large sections of the Harlem and Hudson Rivers in northern Manhattan and the Bronx, the topography is generally quite steep with high bluffs in some neighborhoods. Along parts of the east and south Bronx waterfront, meanwhile, land tends to slope more gently up from the water's edge. A variety of filled land and hardened edges, such as bulkheads and revetments, have been put in place throughout the area over time, with some natural areas reintroduced and restored, such as at Alley Creek in Queens. The land uses in the city's northern waterfront areas are quite diverse, ranging from key infrastructure such as LaGuardia Airport and the multiple power plants in Astoria, Queens, to the Hunts Point Food Distribution Center in the Bronx, to single-family homes on City Island and large, multi-family developments such as Co-Op City in the northeast Bronx.

Generally, New York City's coastline does not have purpose-built coastal defenses; many of the features that serve this function do so coincidentally, rather than by design. For example, recreational beaches—nourished (i.e., provided with additional sand to supplement and replace sand lost to erosion) and expanded over time in a partnership between the Department of Parks & Recreation (DPR) and the USACE—generally have been engineered with recreational goals in mind, though they also provide important protection for adjacent neighborhoods. The city's remaining wetlands and natural areas, which, until recently, often were viewed as underutilized property that could be filled and developed, also play an important protective role, serving to buffer inland areas. Meanwhile, though the coastline is dotted with many of the city's most beloved parks, it is only in recent years that the designs of these recreational areas, such as at Brooklyn Bridge Park and Governors Island, have deliberately incorporated discrete resiliency measures that could provide a model for other parks. Finally, the city's ubiquitous bulkheads also play a role in defending the city from harm, not only holding the land behind them in place—their intended purpose—but also breaking waves during storms.

Because of the uncoordinated fashion in which they were constructed over time, however, these various features, even where they do serve a defensive purpose, lack the robustness, comprehensiveness, and adaptability that the new era of climate change demands.

Regulatory Framework for the Coastline

Over a dozen City, State, and Federal agencies play a role in regulating New York City's waterfront and many waterways. In some cases, efforts by these agencies are not completely aligned. This lack of unified and coordinated regulatory oversight can lead to delayed and unpredictable waterfront activity, complicating the achievement of important public goals, including coastal resiliency.

On the City level, one organization with an important regulatory role is the City Planning Commission, which enacts zoning, reviews land use, and is the local administrator of the Waterfront Revitalization Program, a State program required under the Coastal Zone Management Act. The Department of Small Business Services (SBS), meanwhile, oversees waterfront construction activity through its dockmaster and waterfront permit units.

At the State level, a key role is played by the New York State Department of State, which monitors consistency of Federal actions against the State and City Coastal Management Program policies.

Previous Coastal Protection Studies of New York City

Although this report contains the City's first comprehensive coastal protection plan, many studies conducted in partnership with the US Army Corps of Engineers (USACE) and the State over the years have addressed the need for coastal protections. Some studies—such as those for the Rockaway Peninsula (initially authorized in 1965), Coney Island (1986), and Orchard Beach (1992)—led to beach nourishment projects that included popular recreational components. Other studies that were focused more directly on flood protection, such as the Hurricane and Storm Damage Reduction Project for the South Shore of Staten Island, authorized in 1993, were left uncompleted due to a lack of funding and consensus and have only recently been relaunched and fully funded.

By contrast, a study of Plumb Beach, Brooklyn is a notable success story. The study recommended a reconstituted beach, which was completed in 2012, just days before Sandy, providing significant protection to the Belt Parkway during the storm.

Another important study is the Hudson-Raritan Estuary Comprehensive Restoration Plan. This plan was released in May 2009 by the USACE and the Port Authority of New York & New Jersey, in partnership with the New York New Jersey Harbor Estuary Program. The plan is targeted at improving 11 ecosystem types within the estuary. Though the plan does not focus on flood protection, there is now an opportunity to leverage its findings to achieve ecosystem and flood protection benefits in the areas adjacent to the relevant ecosystems.

Notwithstanding all of the foregoing, a comprehensive flood protection study for the Upper New York Bay, one of the most densely populated and economically important waterways in the world, has never even been undertaken—let alone completed. The opportunity presented by the USACE's North Atlantic Coast Comprehensive Study, which was authorized by Congress in January 2013 and will evaluate flood risks of vulnerable coastal populations in areas affected by Sandy, must not be wasted.

At the same time, the State Department of Environmental Conservation regulates in-water activities, wetlands, and other coastal uses by issuing permits, including water quality certifications, and enforces the Coastal Erosion Hazard Area, pursuant to which the State regulates, and generally seeks to discourage, the construction of hardened structures in areas of high erosion risk like beaches.

Finally, the Federal government's regulatory reach is distributed among many agencies, with the USACE, which has broad authority over the waters of the United States, typically serving as the coordinating body for many Federal agencies, including the US Fish and Wildlife Service and the Environmental Protection Agency. Among the USACE's responsibilities in New York Harbor are regulating its navigable waterways, implementing local public works projects, and protecting against flood risks, all as authorized by Congress. The US Coast Guard also plays a vital role in New York Harbor, regulating vessel traffic and coordinating other waterway activities.

Prior to Sandy, the City had partnered with the USACE and the State on several studies to evaluate protections for vulnerable communities in New York City. These studies typically were initiated following major storms, and some led to important projects that have been completed or are underway. In other cases, though, studies languished due to a lack of consensus on solutions. Moreover, despite the existence of many vulnerable and densely populated coastal areas in New York City, no comprehensive flood protection studies have ever been undertaken for the Manhattan, Brooklyn, Queens, and Bronx riverfronts, or for other areas of the Upper Bay. (*See sidebar: Previous Coastal Protection Studies of New York City*)

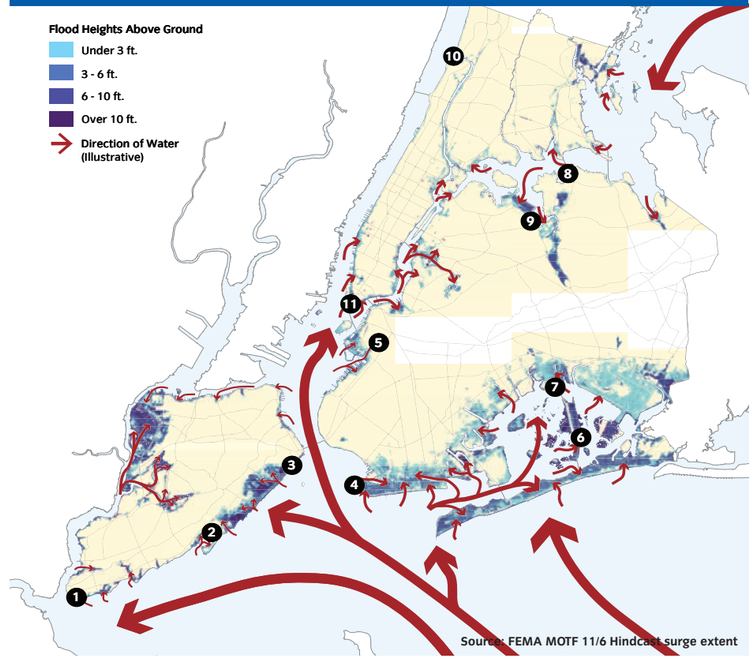
Until recently, the types of storms that have prompted studies on coastal protections have occurred infrequently. As a result, following these storms, interest in protection tended to wane, with impacted coastal communities often unable to secure the requisite funding needed to move forward with more effective protection measures. Sandy, however, has focused renewed attention on the need for such measures in New York City and brought into better focus the risks that extreme weather poses for the coast.

What Happened During Sandy

The Effects of the Storm Surge on the Coastline

Storm surge is the increase in water levels brought about by the low pressure and wind field of a coastal storm. When the surge comes into contact with a shoreline, it pushes additional water onto that shoreline, often inundating large inland areas. The impacts of surge are further amplified when entering water bodies that serve as funnels, such as New York Harbor. Overall, Sandy's surge had an incredibly

Sandy Inundation



Peak Storm Surge Elevations During Sandy

Location	Time Oct. 29, 2012	Water Level in Feet (NAVD88)
1. Tottenville, Staten Island	8:38 p.m.	+16.0
2. Great Kills Harbor, Staten Island	8:52 p.m.	+13.2
3. South Beach, Staten Island	8:23 p.m.	+15.0
4. Sea Gate, Brooklyn	8:23 p.m.	+13.3
5. Gowanus Canal, Brooklyn	9:04 p.m.	+11.1
6. Broad Channel, Queens	9:18 p.m.	+10.4
7. Howard Beach, Queens	9:23 p.m.	+11.2
8. Whitestone, Queens	10:06 p.m.	+10.6
9. World's Fair Marina, Queens	10:06 p.m.	+10.4
10. Inwood, Manhattan	10:06 p.m.	+9.5
11. The Battery, Manhattan	9:24 p.m.	+11.3*

*** Equivalent to 14 feet above Mean Lower Low Water (MLLW)** **Source: USGS, NOAA**

Note: This chart calculates all elevations using the national reference standard known as NAVD88, which establishes a consistent base measurement point from which elevations are determined, unlike other local references to sea level. Press accounts or other sources are known to be reported using many reference standards and require conversion (see Chapter 2, *Climate Analysis*).

destructive impact on the coastline of New York City, though different sections of the coastline experienced the storm differently and with different consequences. (*See map: Sandy Inundation*)

Generally, Sandy's coastal inundation took one of three forms. First, floodwaters came directly from the ocean, as water surged over beaches and bulkheads, flooding neighborhoods and critical infrastructure such as tunnels. Extreme water levels were seen citywide as the storm peaked in the evening of October 29, 2012. (*See chart: Peak Storm Surge Elevations During Sandy*)

In many cases, in ocean-facing areas such as Southern Brooklyn, South Queens, and the East and South Shores of Staten Island, from South Beach to Tottenville, the surge brought with it not just large volumes of water but also powerful waves that wreaked havoc on buildings and infrastructure alike. Record ocean waves of over 30 feet were measured in the ocean southeast of the Rockaway Peninsula.

Another impact of the wave action along the city's ocean-facing coastline was massive beach erosion. In fact, estimates indicate that up to 3 million cubic yards of sand, and maybe more, were lost citywide, with the Rockaway Peninsula alone losing about 1.5 million cubic yards of sand (a volume larger than the Empire State Building) and additional losses occurring in Coney Island, Orchard Beach, and the East and South Shores of Staten Island.

The second way Sandy's surge impacted the city was via less direct routes. In these cases, the city's many bays, inlets, and creeks functioned as "backdoor" channels, funneling ocean waters inland. For example, much of the flooding in Southern Brooklyn came not only over the area's beaches, but also via Coney Island Creek and Sheepshead Bay. Likewise, floodwaters from Jamaica Bay contributed to the inundation of the Rockaway Peninsula, where, as area residents explained, "the ocean met the bay." Newtown Creek, meanwhile, overflowed its banks, flooding Maspeth, Greenpoint, East Williamsburg, and Bushwick. Similarly, the Gowanus Canal overflowed its banks, flooding Red Hook and other adjacent neighborhoods.

The third way Sandy's surge impacted New York City was by overtopping the city's extensive shoreline drainage infrastructure, and in some cases infiltrating the roadway drainage and sewer system through catch basins, manholes, and storm drains in the streets, especially in low-lying areas such as in Midland Beach, Staten Island. This network of pipes and other features is designed to drain rainwater away from land and into the area's waterways and is not designed to protect against storm surge. Additionally, several tide gates and floodgates (devices that prevent water from flowing backwards through the drainage system)—including at Oakwood Beach, Staten Island—were damaged during the storm, while others, including at Flushing Meadows Corona Park, lost power and had to be operated manually during Sandy, amid the overwhelming volume of water that they were being asked to handle.

Performance of Existing Coastal Defenses

Though Sandy's surge generally devastated areas that it touched, some coastal features and strategies—such as beaches nourished with sand, dunes, wetlands, new and elevated drainage systems, site elevation, and bulkheads—did offer some protection. For example, many nourished beaches and dunes absorbed the destructive energy of waves and floodwaters, in many cases buffering adjacent neighborhoods. This was the case on the Coney Island peninsula, where the neighborhoods behind the nourished beaches of Coney Island and Brighton Beach suffered far less-destructive wave impact than did Sea Gate, where the beaches had not been nourished. In addition, areas of the Rockaway Peninsula with established dunes, such as Beach 56th Street, suffered substantially less damage and less sand migration into neighborhoods than areas without them, such as Beach 94th Street. (*See photos: Dune Protection on the Rockaway Peninsula*)

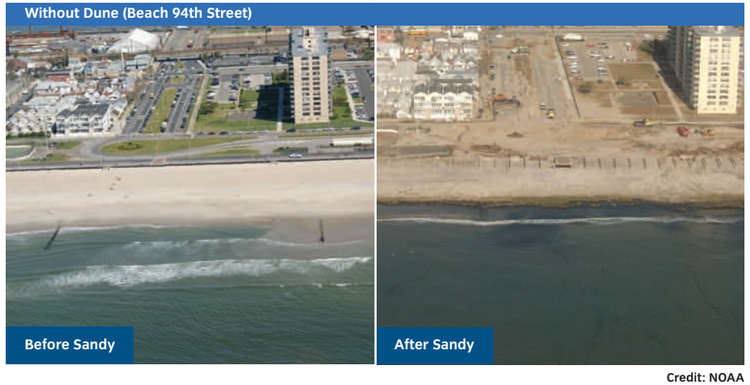
Site elevation, too, often proved effective in protecting buildings from destructive waves and flooding. Much of the city's development along the waterfront has occurred on land created by filling in historic wetlands and marshes *at-grade*, leaving them at risk of flooding. However, *elevated* developments—such as Battery Park City in Lower Manhattan and Arverne By The Sea on the Rockaway Peninsula—survived Sandy with minimal damage, particularly compared to other nearby locations that were not elevated.

Drainage systems that took advantage of local landscape and site characteristics also worked well. Though the volume of water that came with Sandy's surge was so massive that, in many cases, these systems were overwhelmed by peak water levels, areas with newer, elevated systems such as Arverne By The Sea were able to drain more quickly as floodwaters receded—sometimes immediately—allowing quicker recovery.

Dune Protection on the Rockaway Peninsula

With Dune (Beach 56th Street)

Without Dune (Beach 94th Street)



Credit: NOAA

Risk Assessment: Impact of Climate Change on Coastal Protection

Major Risk Moderate Risk Minor Risk

	Scale of Impact			
Hazard	Today	2020s	2050s	Comments
Gradual				
Sea level rise				Could cause daily or weekly tidal flooding in low-lying neighborhoods
Increased precipitation				Minimal impact
Higher average temperature				Minimal impact
Extreme Events				
Storm surge				Risk likely would increase as sea levels rise
Heavy downpour				Minimal impact
Heat wave				Minimal impact
High winds				Minimal impact

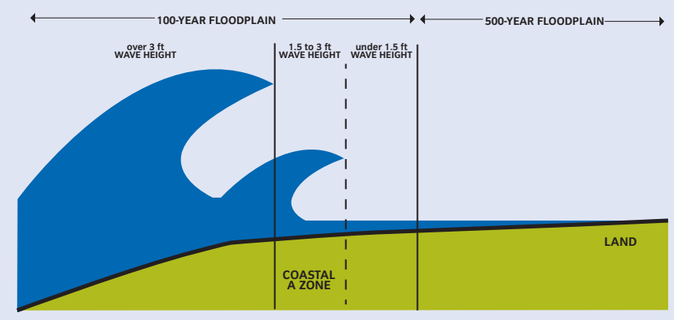
As for wetlands, their ability to reduce damage depended on their specific characteristics. Tidal wetlands on their own have little ability to stop the volume of water seen during Sandy. However, those that had been constructed with elevated edges proved capable of retaining some floodwaters in places such as Alley Creek, in Queens. In these cases, the elevated edges kept floodwaters from infiltrating neighborhoods and critical infrastructure while the wetlands attenuated waves, actually reducing the velocity and destructive force of incoming waves, a role that wetlands are well-suited to serve.

Finally, in some places, bulkheads also were able to break waves and reduce the destructive energy of the storm surge. Although the storm surge did sweep over bulkheads in many areas, those in Lower Manhattan, and along the Belt Parkway near Bay Ridge, helped to disperse wave energy and act as a "shock absorber" for adjacent areas.

What Could Happen in the Future

Going forward, New York City's coastline and waterfront infrastructure face significant climate risks, chief among them risks associated with storm surge and wave action. The New York City Panel on Climate Change (NPCC) projects that the frequency of the most intense storms by the 2050s will increase (see Chapter 2, *Climate Analysis*). Storms packing even the same or lesser power than Sandy, though, will pose greater risk to the area as sea levels raise the base level of water around the five boroughs. All of this is expected to result in inundation, destructive waves, and erosion of the coastline on a more regular basis. At the same time, as sea levels rise, this in and of itself could pose threats to low-lying areas of the city, even in the absence of storm conditions. (*See chart: Risk Assessment: Impact of Climate Change on Coastal Protection*)

Floodplain Zone Diagram



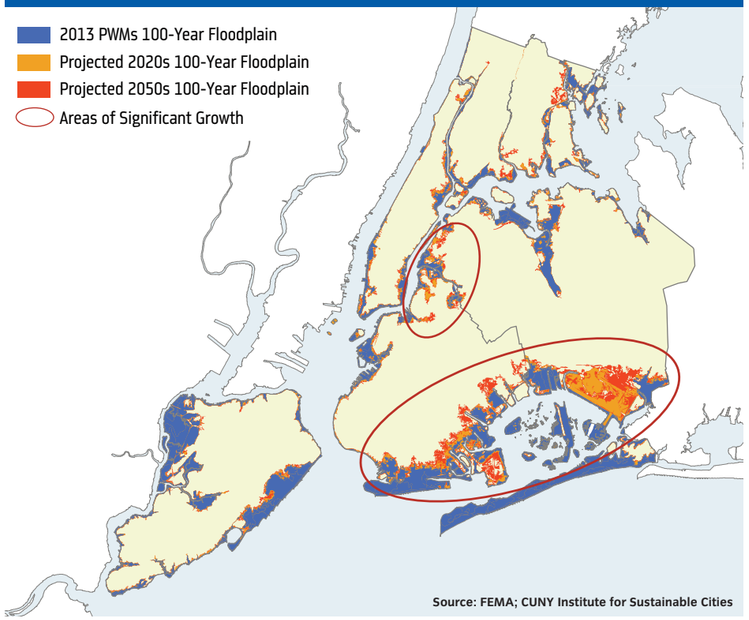
Source: FEMA

Major Risks

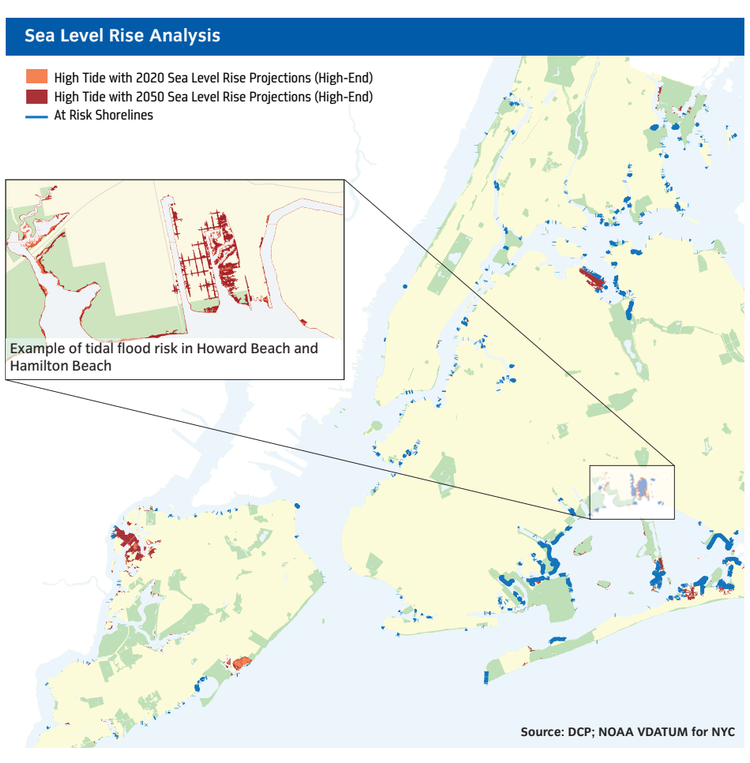
The greatest risk to coastal areas in New York City is storm surge.

To understand why and to what extent, it is first helpful to understand the Federal Emergency Management Agency's (FEMA) Flood Insurance Rate Maps (FIRMs). The FIRMs, which have not significantly changed for New York City since

Future Flood Maps for the 2020s and 2050s



Sea Level Rise Analysis



1983, represent the Federal government's assessment of coastal flood risk. They serve multiple purposes, including helping to determine premiums under the National Flood Insurance Program (NFIP) and triggering certain flood insurance requirements on Federally backed mortgages (See Chapter 5, *Insurance*). These maps divide coastal areas into several zones of vulnerability:

- **A Zones**: the 100-year floodplain—an area that has a 1 percent or greater chance of flooding in any given year;
- **V Zones**: the portion of the 100-year floodplain subject to high-velocity wave action (defined as a 3 foot or greater breaking wave);
- **Coastal A Zones**: the portion of the 100-year floodplain subject to breaking waves between 1.5 and 3 feet; and
- **Shaded X Zones**: the 500-year floodplain—an area that has a 0.2 percent or greater chance of flooding in any given year. (*See graphic: Floodplain Zone Diagram*)

The 1983 FIRMs indicate a 100-year floodplain in New York City of 33 square miles, or 11 percent of the city's land area. Prior to Sandy, FEMA had already begun the process of updating the 1983 FIRMs with new maps, intended to reflect current flood risks more accurately. In June 2013, new maps, known as Preliminary Work Maps (PWMs), were released by FEMA and reflect an expansion of the city's 100-year floodplain by 15 square miles, or 45 percent, over the 1983 FIRMs. The new floodplain consists of larger portions of all five boroughs, with significant expansion in Brooklyn and Queens. The new 100-year floodplain on the PWMs now includes 67,700 structures (an increase of 91 percent over the number of structures in the 100-year floodplain in the 1983 FIRMs). It is expected that the 100-year floodplain will continue to expand due to sea level rise at a steady pace over the course of the next decade and beyond, eventually reaching 72 square miles, or 24 percent of the city's land area, by the 2050s, with corresponding increases in wave zones. These future floodplains are illustrated on future flood maps that the City has created in collaboration with the NPCC for this report. (*See map: Future Flood Maps for the 2020s and 2050s*)

The V Zones on the PWMs include only slightly more buildings than the V Zones on the 1983 FIRMs. However, these zones are expected to grow further as sea level rise expands the floodplains in areas citywide, potentially including areas such as those south of and within Great Kills Harbor in Staten Island. Since stronger waves are projected to exert more destructive forces on the city's existing coastal edges, the wave action, in addition to being spread over a wider area, is also likely to cause greater damage and erosion.

The foregoing risks of flooding and wave action can be found in many parts of the five boroughs, but are most acute in certain coastal areas of New York City, as indicated in a comprehensive analysis of the coastline that the City undertook as part of the planning for this report. These especially vulnerable areas include exposed neighborhoods of the Rockaway Peninsula, the Coney Island peninsula, and the East Shore of Staten Island, which share a common geologic heritage and therefore a common flood profile. A similar profile is found in several Upper Bay neighborhoods, including Red Hook, East Harlem, Lower Manhattan, the Lower East Side, and the communities adjacent to Newtown Creek and the Gowanus Canal. Flooding is expected to pose a significant risk in these areas through the 2050s as sea levels rise. (*See sidebar: Analysis of Coastal Vulnerabilities and Resiliency Measures*)

Potential Sea Level Rise Impacts

Borough	Waterfront (miles)	At Risk of Tidal Flooding (miles)	(%)
Bronx	86.7	6.2	7%
Brooklyn	113.3	11.5	10%
Manhattan	44.8	1.3	3%
Queens	155.1	21.4	14%
Staten Island	120.1	2.6	2%
Total	**520**	**43**	**8%**

Source: DCP

Other Risks

Sea level rise in and of itself—even without the impact of coastal storms—is a growing risk that already affects certain low-lying neighborhoods. These include Broad Channel in Queens and other areas where homes and other structures in some cases are lower in elevation than corresponding roadway infrastructure, exacerbating flooding. These areas today experience flooding at the highest range of the regular tidal cycle. As sea levels continue to rise, these neighborhoods will flood more frequently, while other low-lying neighborhoods that do not flood regularly with the tides will start to do so. (*See map: Sea Level Rise Analysis; see chart: Potential Sea Level Rise Impacts*)

In fact, current projections indicate that, by the 2050s, approximately 43 miles of coastline—8 percent of the city's total excluding beaches and wetlands—could be at risk of daily or weekly tidal inundation during non-storm conditions. The risk of regular tidal flooding will be most pronounced in neighborhoods around Jamaica Bay in southeastern Queens, particularly Howard Beach and Broad Channel, and on portions of the Rockaway Peninsula, which has the lowest-lying topography in the city. It also will impact neighborhoods along the East River in Brooklyn and Queens. In addition to this regular flooding, sea level rise could also:

- damage buildings by weakening structural elements (particularly in wood-frame structures) and interfering with critical building systems (such as electrical panels, boilers, and hot water heaters);
- increase erosion on the city's beaches, reducing the level of protection provided by beach nourishment programs;
- damage coastal roads, eroding their base layers, leading to sinkholes, potholes, and other roadway failures;
- impair stormwater systems and raise groundwater levels, increasing flooding during heavy downpours;
- increase groundwater salinity, threatening native plant species and leading to a loss of vegetation in wetlands and on dunes, which, in turn, could impair the flood protection offered by these features; and
- exacerbate the effects of storms, particularly higher frequency events such as Nor'easters.

Although a less-significant risk to coastal areas than storm surge and sea level rise, heavy downpours and high winds also could minimally impact these areas in the future by eroding certain coastal protection elements, such as dunes or beaches.

Coastal Protection Strategies

As Sandy illustrated, the forces of nature can be significant, sometimes overwhelming even well-designed coastal defenses. That said, the future of the city lies along its coastline—something that has always been true, but is especially true given the nearly 535 million built square feet lying within the city's 100-year floodplain on the PWMs and the million more residents that will move to the already densely settled five boroughs in the coming decades. Given this reality, the City's plan for coastal protection focuses not on retreat—a strategy that may make sense in only very limited circumstances, but is neither possible nor desirable on a larger scale—and instead focuses on the following strategies:

Increase coastal edge elevations

Sea level rise threatens to inundate some neighborhoods with daily or weekly tidal flooding by the 2050s. To address this risk, the City will increase the height of vulnerable coastal edges with bulkheads, beach nourishment and other measures over time. This adaptive strategy allows for ongoing monitoring of sea level rise and investment as and where needs arise.

Minimize upland wave zones

Storm waves, which are projected to increase in size and strength over time, threaten to cause neighborhood damage, erosion, and the loss of beach sand in vulnerable areas. To address this risk, the City will work to provide significant attenuation of waves—that is, to knock down waves, or diminish their velocity—both off and onshore, before they reach neighborhoods. This approach will reduce potential damage to structures, reduce erosive forces on the shoreline, and protect infrastructure. Moreover, this approach should also influence the delineation of high-risk V and Coastal A Zones on FEMA's future FIRMs, especially if measures are built where possible, to the 100-year flood elevation with an additional allowance for future sea level rise. This, in turn, potentially could reduce the costs of flood insurance and mitigation within protected areas (See Chapter 5).

Protect against storm surge

To address the risk of storm flooding, the City will work to keep water from storm surge out of vulnerable neighborhoods and away from critical infrastructure. To do this, the City will use flood protection structures, such as floodwalls, levees, and local storm surge barriers built, where possible, to the 100-year flood elevation with an additional allowance for future sea level rise. Generally, the City will seek measures that minimize damage if overtopped.

Improve coastal design and governance

To ensure the successful implementation of the strategies outlined above, the City will make improvements to the design and governance of coastal areas. Specifically, the City will study how natural areas and open space can be used to protect adjacent neighborhoods and maintain neighborhood quality of life, and will work to manage its own waterfront assets more effectively, while also developing partnerships to improve permitting and study innovative coastal protections.

Analysis of Coastal Vulnerabilities and Resiliency Measures

The City's proposals for coastal protection measures are based on a multi-faceted analysis. This analysis considered factors ranging from the nature and likelihood of coastal hazards (such as destructive waves or flooding), to the possible impact of these hazards on the built environment and critical infrastructure, to the likely effectiveness of certain protective measures. The City also considered whether an area included high concentrations of particularly vulnerable populations, such as the elderly or those with disabilities, that would be at greater risk during a storm event.

Another important consideration was the underlying geomorphology of the regions examined, as well as the coastal features already in place. This analysis drew upon the work contained in the Department of City Planning's groundbreaking *Urban Waterfront Adaptive Strategies* (UWAS) study. The UWAS study, which was funded by a US Department of Housing and Urban Development Sustainable Communities Regional Planning grant and will be released shortly after this report, explores how the coastline was shaped by glacial processes, more recent coastline modifications, and other relevant coastal forces.

Among the elements of the UWAS study that proved most useful in the creation of this report were three discrete but related UWAS work streams. The first of these work streams involved extensive review of existing soil data, which allowed the UWAS study to map the underlying geology of the city's coast. Based on this survey, the UWAS study was able to demonstrate that certain low-lying land formations—such as Jamaica Bay and its surrounding neighborhoods, the East Shore of Staten Island, Lower Manhattan, East Harlem, and the areas adjacent to Newtown Creek—largely consist of outwash plains and post-glacial deposits, which makes them vulnerable to continued flooding and erosion. By contrast, the UWAS study also demonstrated that other areas consisting of harder soils and rock at steeper slopes are much less susceptible to flood hazards. Not surprisingly, during Sandy, the inundation area closely matched the lowest-lying areas with the softest soils. (*See map: Geologic Landforms of New York City*)

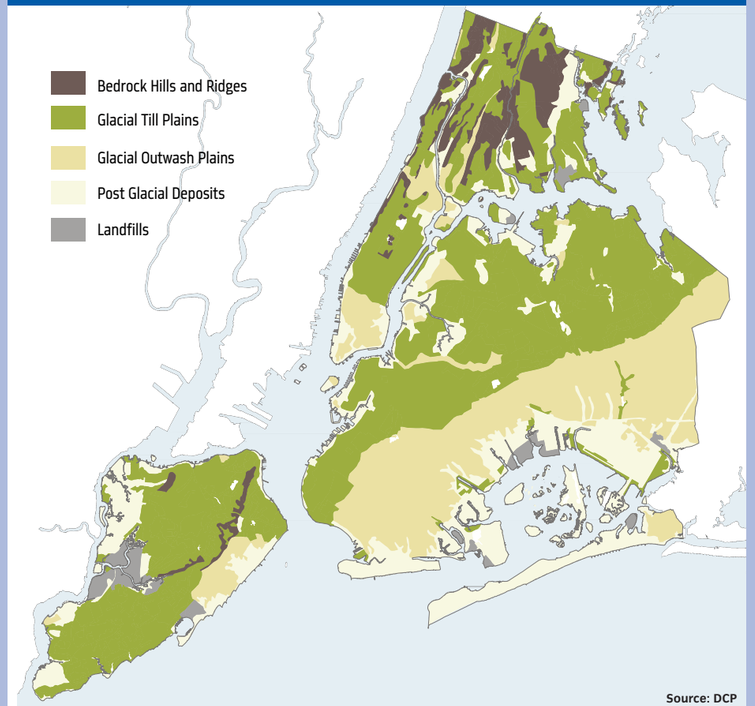
Additionally, the UWAS study evaluated the distance over which waves could develop due to the affects of wind ("fetch") to evaluate each area's susceptibility to wind-driven wave action.

A second important work stream of the UWAS study involved an examination of the entirety of the city's shoreline using aerial photography and other data sources to determine whether sections were reinforced with coastal structures—such as revetments, bulkheads, or piers—or were in a more natural state, with either rocky, sandy, or marshy edges. This work was particularly relevant to this report, given that areas that are not reinforced or vegetated tend to be more vulnerable to erosion (except in ocean-facing areas prone to wave action, where structures may actually increase erosion and interrupt natural sediment transport processes). This, together with the aforementioned study of the city's underlying geology, allowed the UWAS study to create a unique and useful map dividing the city's coastline into nine discrete geomorphology types. (*See map: Coastal Geomorphology*)

The third important work stream of the UWAS study involved an evaluation of the coastal resiliency measures suitable for the different types of areas observed. This work involved dividing the various types of defenses into several relevant reaches, or categories, including "upland," "coastline," and "in-water." It then assessed the applicability of these categories of defenses to various physical conditions, looking at factors such as the consistency of various defenses with adjacent land use; cost (both upfront and long-term); potential barriers to implementation; risk reduction and other cultural, social, or economic benefits; and potential unintended consequences such as environmental impacts. (*See chart: Typical Coastal Resiliency Measures*)

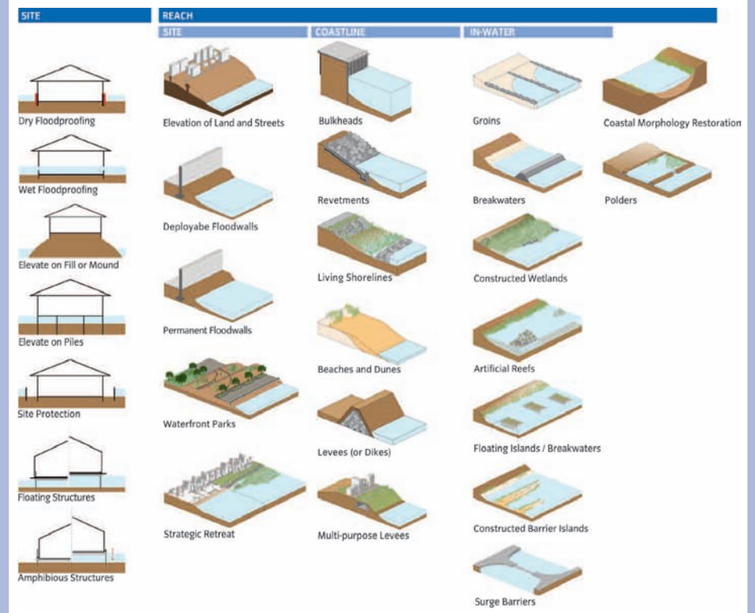
Thus, the work of the UWAS study provided an analytically rigorous and replicable approach for matching applicable coastal resiliency measures to vulnerable areas of the city, thereby informing the development and adoption of the goals, strategies, and initiatives in this report.

Geologic Landforms of New York City



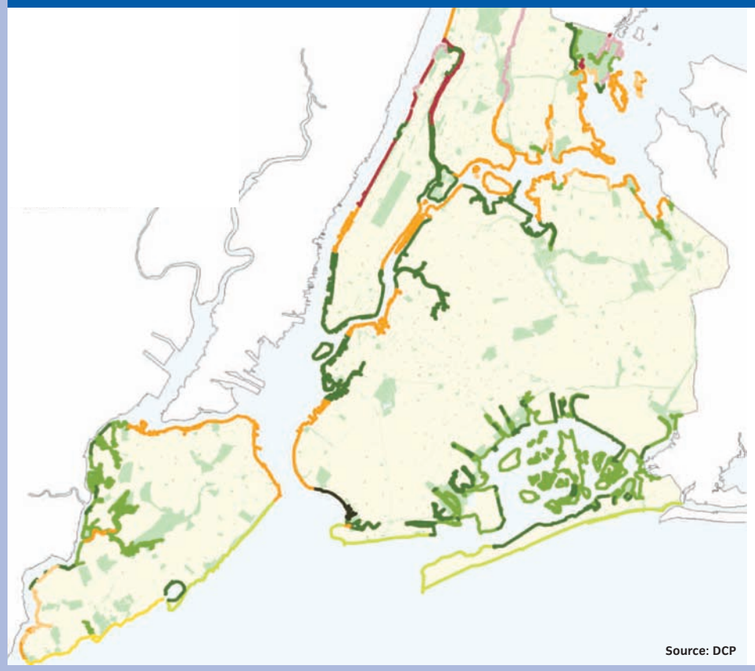
Source: DCP

Typical Coastal Resiliency Measures



Source: DCP

Coastal Geomorphology



Source: DCP

Geomorphology Type	Geology	Elevation	Fetch	Reinforced	Soils
Oceanfront Beaches	Glacial outwash plains	Low	High	No	Soft
Coastal Marshes	Glacial outwash plains	Low	Low	No	Soft
Hardened Sheltered Bay Plains	Glacial outwash plains	Low	Low	Yes	Soft
Hardened Oceanfront Plains	Glacial outwash plains	Low	High	Yes	Soft
Hardened Sheltered Bay Slopes	Glacial till plains & hills	Medium	Low	Yes	Mix of soft & dense
Rocky Sheltered Bay Slopes	Glacial till plains & hills	Medium	Low	No	Mix of soft & dense
Unreinforced Slopes	Glacial till plains & hills	Medium	High	No	Mix of soft & dense
Sheltered, Rocky Bluffs	Sheltered bedrock controlled hills & ridges	High	Low	No	Mix of soft & dense
Sheltered, Hardened Bluffs	Sheltered bedrock controlled hills & ridges	High	Low	Yes	Mix of soft & dense

Source: DCP

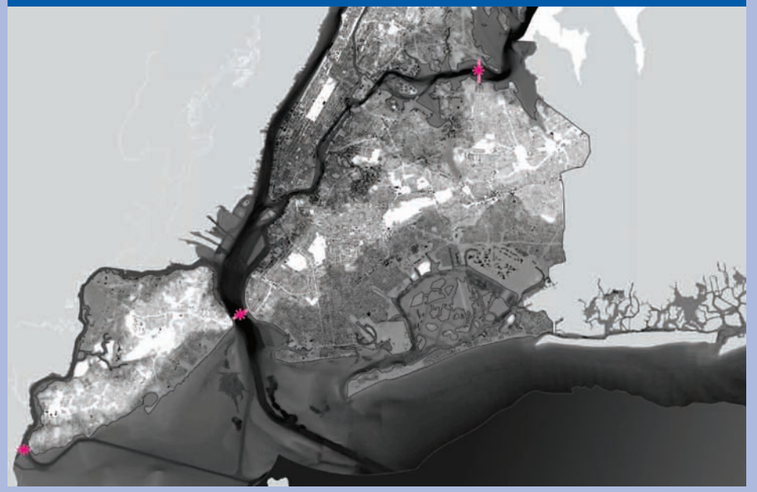
Harborwide Storm Surge Barriers

A variety of observers have raised the idea of harborwide storm surge barriers in response to the threat of coastal storms faced by New York City. One proposal that has been put forth, for example, calls for a three-part design, consisting of closure gates at the Narrows, the Arthur Kill, and the upper reaches of the East River. A second proposal would require two barriers, one at the upper reaches of the East River and one connecting Sandy Hook, NJ with the Rockaway Peninsula. In each case, the closure gates would be navigable channel openings, allowing ship traffic and water to flow through under ordinary circumstances. During storm events, however, the gates would be closed, in theory, blocking surge waters. To make either of these proposals work, a series of levees extending out from the closure gates would need to be constructed to ensure that displaced water is not simply pushed into low-lying areas adjacent to the closure gates. (*See map: Alternative 1: Three Barriers; See map: Alternative 2: Two Barriers*)

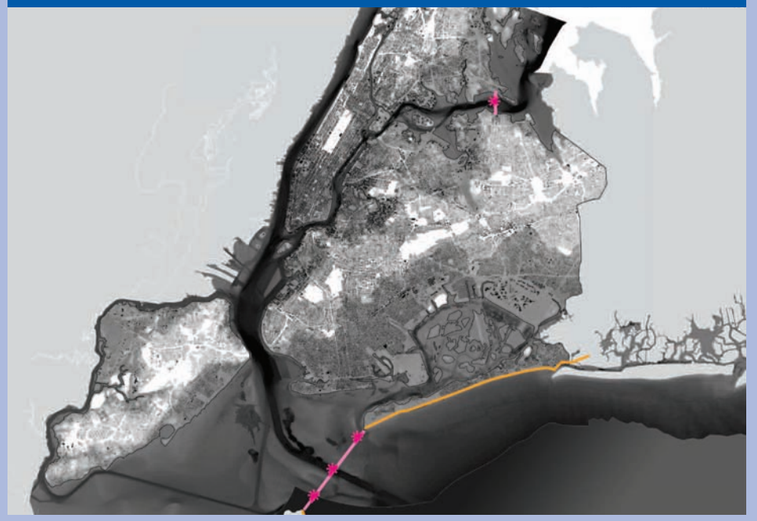
For some observers, the idea of constructing a single piece of engineering offers the appeal of seeming simplicity, as compared to a suite of a more targeted, localized protections. However, the construction of such harborwide storm surge barriers actually presents many complications:

- First, such a system of barriers would be extraordinarily expensive—perhaps costing $20 to $25 billion to build, with substantial operating and maintenance costs—substantially more than the City's proposed Phase 1 coastal protection initiatives and substantially more than any source of funding currently identified.
- Second, harborwide barriers would require a design, approval, and construction process that could, based on past experience with major in-water engineering projects in the New York City area and elsewhere around the globe, take two to three decades to complete.
- Third, the possible hydrodynamic and environmental impacts (on fish migration, siltation, river flow, and water quality) of harborwide barriers are likely to be substantial, are not yet known, and would require extensive study, potentially derailing or requiring substantial redesign of the project. These impacts also could be the subject of lawsuits—which have, in New York's relatively recent past, led to the cancellation of major in-water projects.
- Fourth, as mentioned above, to make a project such as this work, there likely would need to be massive levees (20 feet or more above grade) along adjacent coastal areas, including on the Rockaway Peninsula and possibly Coney Island and Staten Island, depending on which barrier option is chosen. These levees would have dramatic impacts on the character of the beaches and adjacent neighborhoods that may prove to be highly disruptive.
- Fifth, any barriers would create an "insiders/outsiders" dynamic, with only those behind the barriers receiving maximum protection, leaving densely developed communities along the South and North Shores of Long Island and the Jersey Shore outside the protected zone.
- Sixth, a harborwide barrier project may also cause additional flooding in areas outside the barriers (especially in tighter waterways, such as the Upper East River), thus making those communities more vulnerable than they would be without such barriers.
- Seventh, and finally, since the barriers would be open most of the time (to allow navigation), it would represent a major public investment that would end up doing nothing to address the growing problem of rising sea levels.

Alternative 1: Three Barriers



Alternative 2: Two Barriers



Comprehensive Coastal Protection Plan

In theory, one way to achieve the City's goals for its coastline may be the construction of massive protective infrastructure, such as harborwide storm surge barriers at the entrances to New York Harbor. As attractive as the concept of a single "silver bullet" solution may be, though, a closer examination of this strategy strongly suggests that relying on such a solution would pose significant risks to the city that far outweigh its theoretical benefits. (*See sidebar: Harborwide Storm Surge Barriers*)

Given this, the City believes that the right approach to coastal protection is an integrated system of discrete coastal projects, that together would constitute the elements of a multilayered approach also involving resiliency measures for buildings and protections for critical infrastructure. The advantage of this approach is three-fold. First, it diversifies the city's exposure to given technologies, reducing the chance of devastating failure, as occurred in New Orleans during Katrina, when the city's main defensive system, its levees, failed, leaving many parts of the city completely unprotected. Second, the City's proposed approach also has the advantage of being scalable to available resources, rather than requiring all resources to be secured before anything moves forward. Finally, certain elements of the City's plan can begin almost immediately, making New Yorkers safer today, rather than waiting years or perhaps even decades for a solution that may never be completed.

Therefore, to achieve its ambitious goals, the City is proposing a broad range of coastal protection measures. This breadth reflects the fact that different coastal areas in the city face different risks and therefore require protection that is specifically tailored to their needs.

Some of the proposed measures mimic existing coastal features that performed well during Sandy. Others have been proven to be successful elsewhere. Where possible, the City has derived inspiration from the historic natural features that once protected the coastline throughout the city. Elsewhere, both traditional and newly developed technologies have been considered.

Coastal protection measures first will be designed to match the risks facing a given area. For example, in areas where land is very low-lying and exposed to daily fluctuations in tide levels, the City will seek to increase edge elevations with bulkheads, revetments, and beach nourishment. Where wave action is expected, wave attenuation measures—such as dunes, offshore breakwaters, wetlands or oyster reefs, and groins—likely will be more suitable. Where stretches of very low-lying land are highly vulnerable to storm surge, protection measures—including higher floodwalls, levees, and local storm surge barriers—are proposed to increase coastline elevations and prevent inundation.

Measures also will consider the geomorphology and land use of neighborhoods. For ocean-facing beaches, beach nourishment and dune construction are viewed as most appropriate, because these areas already feature natural sand movement, sandy soils, and supporting topography. For locations along the Upper Bay with existing built edges (and space constraints), proposed measures include floodwalls and levees. Along the protected coves of the Upper East River and within Jamaica Bay, strengthened or new wetlands and other measures that break waves are likely to be effective. Finally, in areas where small inlets and other passages have served or could serve as "backdoors" for flooding of large inland areas, measures that address these passages, such as local storm surge barriers, are proposed.

In evaluating each risk-reduction measure, and groupings of measures, the City employed sophisticated storm surge modeling to explore the performance of coastal protection measures. The City used these digital hydrodynamic models to test the effectiveness of each measure in reducing wave heights and storm surge levels in Sandy-like storms, as well as in scenarios of future 100-year and 500-year storms assuming the sea level rise projections from NPCC. This analysis informed the location and configuration of each measure, including heights of proposed floodwalls and dunes.

After modeling the effectiveness of different coastal protection options, the next step in the City's analysis was an evaluation of the cost-effectiveness of the approach. Both upfront construction costs and long-term maintenance costs were estimated to calculate total lifecycle expenses. Benefits were then quantified based on each measure's ability to reduce risk, decrease damage, and increase resiliency, based on commonly accepted insurance industry models and predictions. When evaluated at specific locations, cost-benefit ratios were developed and used for comparison with other measures.

Finally, the City also evaluated measures in light of other important public considerations. These included waterfront access, navigation impacts, recreational benefits, environmental impact, contribution to ecosystem restoration, social and environmental justice, and impact on neighborhood character and quality of life for residents and businesses.

Full-Build Recommendations

The following measures will, at full build, form the city's comprehensive coastal protection system. Though, some of these measures can begin immediately, many will require partnerships with other governmental entities, including, perhaps most importantly, the USACE.

To ensure that this plan can be implemented as quickly as possible, the City is therefore calling on the USACE to place the measures that make up the City's proposed plan at the core of any subsequent evaluation or study of flood risk within the five boroughs of New York City that the USACE (or other agencies) undertake. For example, the USACE will complete a North Atlantic Coast Comprehensive Study, or NACCS, which is intended to address the flood risks of vulnerable coastal populations in areas affected by Sandy. The NACCS will guide future Federal investment in flood protection for the entire Northeast region of the United States. It is imperative that the NACCS build upon the work of this report to generate Federally funded projects and to ensure that projects are constructed in New York City on an expedited timeframe.

The City's recommended coastal protection measures are described below, grouped by strategy. (*See map: Comprehensive Coastal Protection Plan | Full-Build Recommendations*)

Strategy: Increase coastal edge elevations

Beach Nourishment

Beaches are an important recreational and economic resource for the city. They are also a critical part of the City's coastal defense network. Regular wave action and the natural sediment transport process (the ongoing movement of sand following the dominant wave direction) continue to erode beaches over time, however. Storms only accelerate this process. A regular program of beach nourishment—that is, adding large quantities of sand to widen and elevate beaches on a regular cycle, as well as after significant storm events—

Beach Nourishment

Comprehensive Coastal Protection Plan | Full-Build Recommendations

Phase 1 Initiatives

Additional Full-Build Recommendations

Increase Coastal Edge Elevations

Beach Nourishment
- 1 Coney Island, Brooklyn
- 2 Rockaway Peninsula, Queens
- 3 East and South Shores, Staten Island
- A Orchard Beach, Bronx

Armor Stone (Revetments)
- 4 Coney Island Creek, Brooklyn
- 5 Annadale, Staten Island
- B South Shore, Staten Island

Bulkheads
- 6 Citywide Program
- 7 Belt Parkway, Brooklyn
- 8 Beach Channel Drive, Queens

Tide Gates / Drainage Devices
- 9 Oakwood Beach, Staten Island
- 10 Flushing Meadows, Queens
- C Coney Island Creek, Brooklyn
- D Mill Creek, Staten Island

Minimize Upland Wave Zones

Dunes
- 11 Rockaway Peninsula, Queens
- 12 Breezy Point, Queens
- E Coney Island, Brooklyn

Offshore Breakwaters
- 13 Great Kills Harbor, Staten Island
- F South Shore, Staten Island
- G Rockaway Extension
- H City Island, Bronx

Wetlands, Living Shorelines and Reefs
- 14 Howard Beach, Queens
- 15 Tottenville, Staten Island
- 16 Plumb Beach, Brooklyn
- 17 Brant Point, Queens
- I Jamaica Bay
- J Bay Ridge Flats
- K Saw Mill Creek, Staten Island

Groins
- 18 Sea Gate, Brooklyn

Protect Against Storm Surge

Integrated Flood Protection System
- 19 Hunts Point, Bronx
- 20 East Harlem, Manhattan
- 21 Lower Manhattan / Lower East Side
- 22 Hospital Row, Manhattan
- 23 Red Hook, Brooklyn
- L Brooklyn-Queens Waterfront
- M West Midtown, Manhattan

Floodwalls / Levees
- 24 East Shore, Staten Island
- 25 Farragut Substation, Brooklyn
- N Astoria Generating Station, Queens

Local Storm Surge Barrier
- 26 Newtown Creek
- O Rockaway Inlet
- P Gowanus Canal, Brooklyn

Multi-purpose Levee
- Q Lower Manhattan

Note: Though all projects indicated on this map are recommended in the full-build scenario, not all are individually labeled in the key.

is critical to ensuring that city beaches continue to serve their vital coastal protection role.

Selected Locations: Rockaway Peninsula; Coney Island peninsula; East Shore and South Shore of Staten Island; and Orchard Beach in the Bronx. (*See photo: Beach Nourishment*)

Armor Stone (Revetments)

Hardening exposed shorelines with armor stone (various kinds of massive rocks, including granite), or revetments can protect against erosion caused by storms and rising sea levels. Revetments, also known as rip-rap, are a proven coastal protection technique in New York City and can also be used to raise edge elevations. Experience has demonstrated that revetments require minimal maintenance. In addition, the shallow slopes of revetments can provide near-shore habitat for marine organisms and vegetation.

Armor Stone (Revetments)

Selected Locations: South Shore of Staten Island and Coney Island Creek. (*See photo: Armor Stone (Revetments)*)

Bulkheads

Historically, bulkheads (or structures, usually made of stone or concrete, at the water's edge) have been installed to hold shorelines in place and provide land for commerce adjacent to the city's rivers. They are also used to protect exposed shorelines from erosion. Over time, these bulkheads have taken on an expanded role—supporting parks, esplanades, and highways. Raising bulkheads in targeted locations citywide would mitigate the effects of rising sea levels in low-lying areas shown to be prone to future tidal flooding.

Bulkheads

Selected Locations: Bay side of the Rockaway Peninsula, Broad Channel, and Howard Beach in Queens; West Midtown and Sherman Creek in Manhattan; Locust Point in the Bronx; Greenpoint in Brooklyn; and in the North Shore of Staten Island; as well as other locations that will be evaluated. (*See photo: Bulkheads*)

Tide Gates/Drainage Devices

Tide gates, "duckbill" valves, which seal a pipe end but still allow water to drain, and other backflow-prevention devices are used to ensure that water does not flow backwards through drainage infrastructure. These commonly used devices, although not universally applicable, can be used to improve the performance of the city's drainage network and reduce flood risk, though they must be evaluated on a site-specific basis so as not to impede the ability of upland areas to drain stormwater.

Tide Gates/Drainage Devices

Selected Locations: Oakwood Beach and Mill Creek in Staten Island; Coney Island Creek; Flushing Meadows Corona Park in Queens; and Beach Channel Drive on the Rockaway Peninsula. (*See photo: Tide Gates*)

Strategy: Minimize upland wave zones

Dunes

Dunes—reinforced sand mounds typically located along the back edge of a beach—help break waves and keep floodwaters from inundating neighborhoods. Dunes can be "sacrificial," designed to allow sand to wash away as storm waters recede. Generally, they require maintenance and sand replenishment from time to time, especially after storms. Dunes work well when planted (because plant roots help hold the sand in place) and reinforced (with a structural inner core of rock or geotextiles, on which the sand sits). In some locations, they work even better when there is enough land to allow for both primary and secondary dunes (a double-dune system), which also provide redundant coastal protection.

Selected Locations: Rockaway Peninsula and the Coney Island peninsula. (*See rendering: Primary and Secondary Dune System*)

Offshore Breakwaters

Offshore breakwaters—features typically composed of rock or other robust materials located in an ocean or bay—attenuate wave energy offshore, thereby absorbing the force of destructive waves before they reach the coast and adjacent neighborhoods. By calming nearby waters, these structures also can provide new habitat for in-water organisms such as oysters. Although expensive, offshore breakwaters can reduce risks significantly for areas exposed to significant wave action and erosion.

Selected Locations: Rockaway Extension; City Island in the Bronx; South Shore of Staten Island; and Upper Bay. (*See rendering: Offshore Breakwaters*)

Wetlands, Reefs, and Living Shorelines

Wetlands—swamps, marshes, and bogs—are areas that are inundated or saturated by surface or groundwater sufficiently frequently to support vegetation that thrives in wet soil conditions. Reefs are an offshore feature typically below sea level. Living shorelines are coastal edges that incorporate a combination of reefs, breakwaters, maritime or coastal forests, and tidal wetlands to reduce wave action and erosion. These natural features are known to offer significant ecosystem and water quality benefits, and also to aid in the retention of stormwater, sediment, nitrogen, and other nutrients.

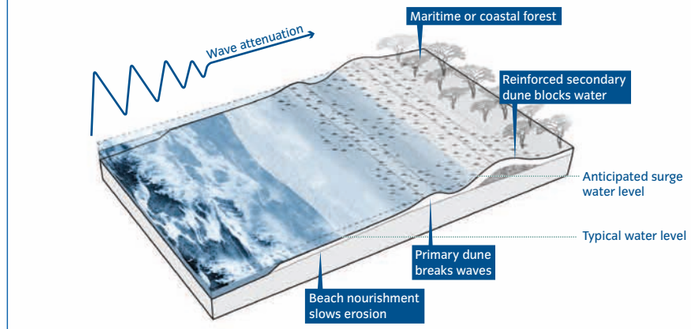
What is less well-understood is their ability to reduce waves during storms, although anecdotal evidence indicates that they can perform this function. More analytical research, including the City's storm surge modeling completed for this report, has shown that, when placed appropriately, wetlands, oyster reefs, and living shorelines, including coastal forests, possess effective wave-attenuation properties. Those properties may be improved even further by altering the depth at which these features are placed or modestly increasing the inclusion of hardened elements such as rock.

Selected Locations: Jamaica Bay; Tottenville in Staten Island; Bay Ridge Flats; along the Arthur Kill and Kill van Kull; and along Long Island Sound. (*See rendering: Wetlands with Wave Attenuation*)

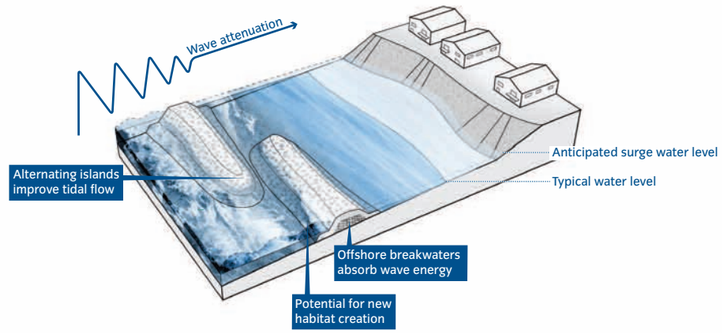
Groins

These installations of rocks or timber, perpendicular to the shoreline, are often referred to as jetties. They can help retain sand from beach nourishment projects on-site and also serve to break waves and absorb wave energy. Though groins must be carefully evaluated because they have the potential to disrupt natural sediment transport processes, with careful planning, they can serve a vital function in protecting oceanfront communities.

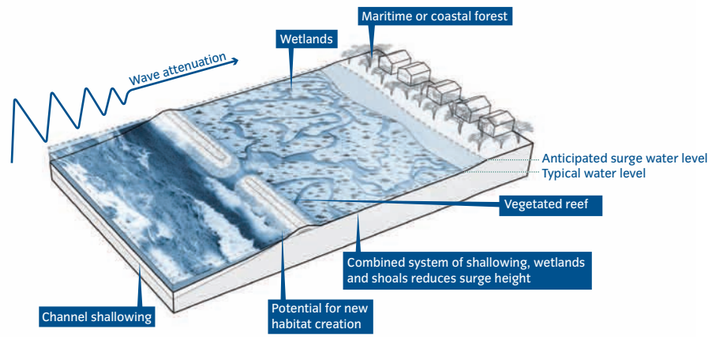
Primary and Secondary Dune System



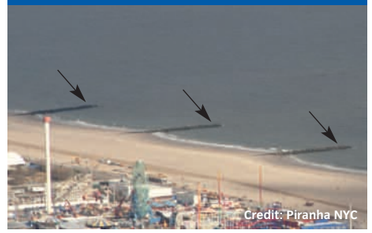
Offshore Breakwaters



Wetlands with Wave Attenuation



Groins



Selected Locations: Sea Gate in Brooklyn and the Rockaway Peninsula (*See photo: Groins*)

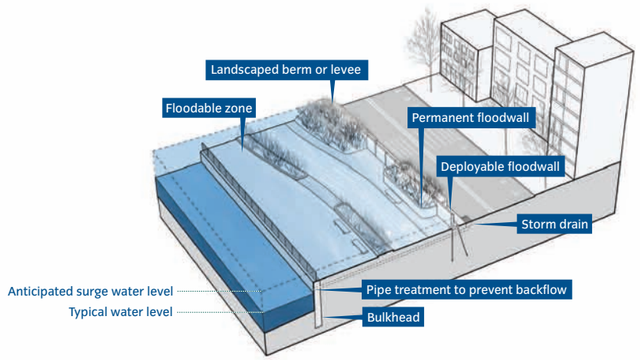
Strategy: Protect against storm surge

Integrated Flood Protection Systems

Flexible and adaptable, integrated flood protection systems are composed of a variety of elements that can be combined and customized in areas where critical infrastructure or vulnerable neighborhoods require a high level of flood protection. Such systems have evolved from traditional floodwalls and can include landscaping features, such as terraced berms at the back end of a waterfront park; benches, park walls, flood-proofed buildings or bridge abutments; drainage improvements, including valves and gates; and temporary features such as deployable floodwalls, which can be erected in advance of an extreme weather event. Passive elements that float into position during flood conditions by reacting to floodwaters can also be a part of an integrated flood protection system in discrete areas such as the entrances to underground parking garages.

In the case of areas that are subject to the risks posed by infrequent, but damaging, extreme weather events—but where permanent features are undesirable or infeasible–one solution is to rely more heavily on deployable floodwalls. These systems, which consist of moveable posts and panels which are, at times of vulnerability, affixed to permanent, in-ground foundations, can be removed immediately after a threat recedes. The advantage of deployable systems is, of course, the fact that they allow the waterfront to remain open and accessible at all times, except during weather events. However, the systems do pose maintenance and operating challenges (e.g., the deployable elements need to be stored, deployment often requires heavy equipment and a sizeable workforce, and regular drills are required to ensure readiness during storms). (*See photos: Deployable Floodwalls*)

Integrated Flood Protection System



Selected Locations: Red Hook in Brooklyn; East Harlem, Lower Manhattan, and the Lower East Side in Manhattan; Hospital Row in Manhattan; Hunts Point in the Bronx; Long Island City and Astoria in Queens; and Stapleton, Staten Island. (*See rendering: Integrated Flood Protection System*)

Floodwalls/Levees

Floodwalls, or permanent vertical barriers, are designed to provide a higher level of surge protection for vulnerable neighborhoods and critical infrastructure, attenuating waves and blocking surge.

Selected Location: Con Edison's Farragut substation on the East River in Brooklyn.

Meanwhile, levees, a traditional approach to flood management, are impervious earthen or rock embankments that also provide a greater degree of flood protection. However, unless intelligently integrated into the urban landscape, floodwalls and levees can cordon off communities from the water. Strategies designed to reduce obtrusiveness include incorporating walkways or esplanades along the top of levees.

Selected Locations: East Shore of Staten Island and Coney Island Creek. (*See photo: Levees*)

Storm waves at Rockaway Beach

Deployable Floodwalls

Credit: John Doman/St. Paul Pioneer Press

Installation of deployable floodwalls

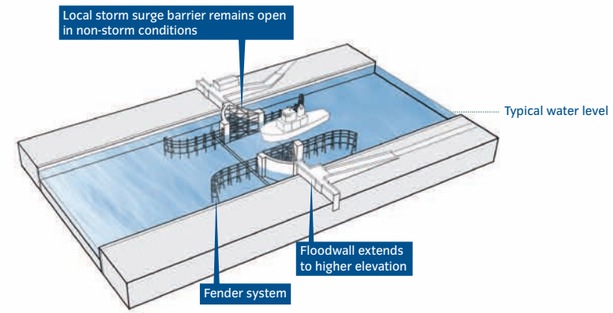
Credit: thegeographyofblackwoodgsce

Completed deployable floodwalls

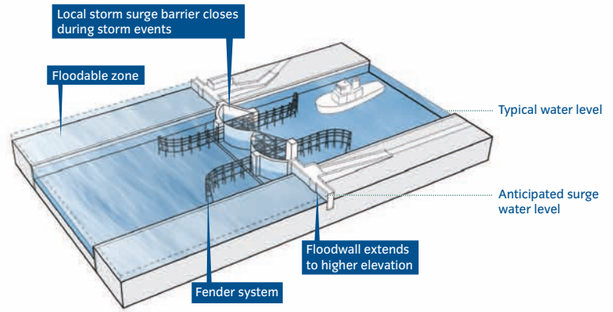
Levees

Credit: Mary Kimball/DCP

Local Storm Surge Barrier—Open



Local Storm Surge Barrier—Closed



Local Storm Surge Barriers

Local storm surge barriers consist of large movable in-water gates and connecting levees or floodwalls on adjacent shores. These barriers are constructed in navigable water bodies to allow for normal maritime commerce and boating in non-storm conditions. However, the barriers also can be closed in advance of an extreme weather event to protect the inland neighborhoods behind them. Although these installations are expensive, local storm surge barriers that are more modest in scope could enhance protection in significant parts of the city in a cost-effective manner.

Selected Locations: Newtown Creek; Rockaway Inlet; and the Gowanus Canal in Brooklyn. (*See rendering: Local Storm Surge Barrier—Open; See rendering: Local Storm Surge Barrier —Closed*)

Multi-Purpose Levees

Multi-purpose levees function much like a simple levee but play additional roles, serving, for example, as transportation infrastructure, providing parking, supporting residential, retail or commercial uses, or serving as open space. In certain high-density locations, multi-purpose levees can serve not only as flood protection for adjacent neighborhoods, but also can provide a cost-effective mechanism to pay for coastal protection by creating land for development, which is also elevated and thus itself not at risk of flooding.

Selected Location: Lower Manhattan.

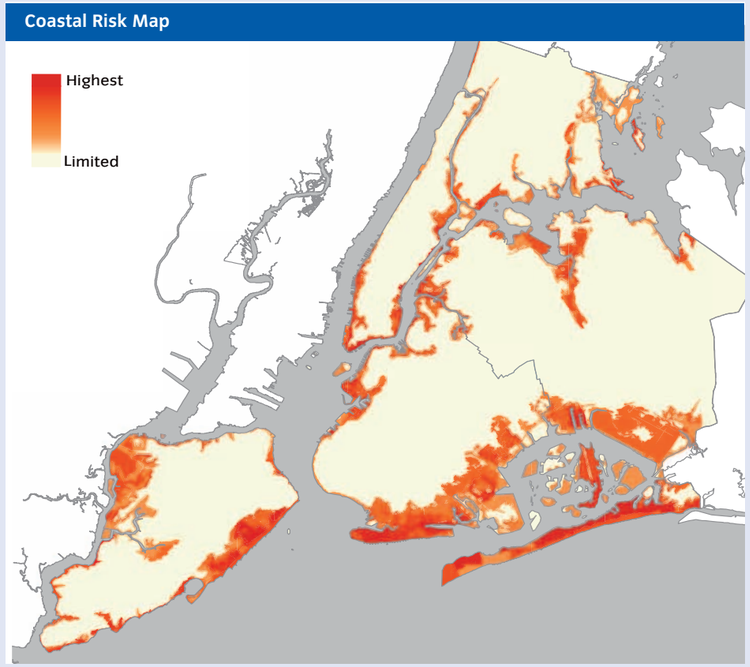
This chapter contains a series of initiatives that are designed to strengthen New York's coastal defenses. In many cases, these initiatives are both ready to proceed and have identified funding sources assigned to cover their costs. With respect to these initiatives, the City intends to proceed with them as quickly as practicable, upon the receipt of identified funding.

Meanwhile, in the case of certain other initiatives described in this chapter, though these initiatives may be ready to proceed, they still do not have specific sources of funding assigned to them. In Chapter 19 (*Funding*), the City describes additional funding sources, which, if secured, would be sufficient to fund the full first phase of projects and programs described in this document over a 10-year period. The City will work aggressively on securing this funding and any necessary third-party approvals required in connection therewith (i.e., from the Federal or State governments). However, until such time as these sources are secured, the City will only proceed with those initiatives for which it has adequate funding.

New York City's Collaboration with the USACE

The USACE, which has broad authority over the waters of the United States, including responsibility for executing Federal flood protection projects, has been an important partner for New York City in the past. The importance of this partnership will only grow as the City seeks to implement the coastal protection projects described in this report. To this end, it is imperative that the initiatives outlined in this report be incorporated into the USACE's overall strategy for the city (including as part of the North Atlantic Coast Comprehensive Study) and into the planning, design, and implementation of any USACE-constructed projects. The City looks forward to continuing to work collaboratively with the USACE to make New York a safer and more resilient city.

Coastal Risk Map



While the City's comprehensive plan for coastal protection includes all of the tactics described above and shown on the Full-Build Recommendations map, implementation of all of these tactics simultaneously would be an expensive proposition. Furthermore, in many cases, it may make sense to monitor the actual rising sea levels before making some of the aforementioned investments where associated risks may not be felt for several decades.

However, the risks faced today coupled with the expected increase in these risks in the years ahead, *do not* give the City the luxury of deferring investment indefinitely. Thus, while the resources available to the City today may be limited, it is incumbent upon—and possible for—the City to think ambitiously and make substantial improvements in its existing coastal defenses in the near-term.

To evaluate where to make its proposed initial set of investments, the City started by developing a Coastal Risk Map. This map analyzed the likelihood of flooding and wave action across all five boroughs and then layered onto this the density of current development, the presence of critical infrastructure and other factors, including the presence of vulnerable populations. (*See map: Coastal Risk Map*)

Based on the City's Coastal Risk Map, the feasibility of potential protective measures, and other considerations, the City is proposing a highly ambitious first phase of its comprehensive coastal protection plan, consisting of 37 projects drawn from its full-build recommendations.

These 37 initiatives include pre-Sandy USACE projects that are now fully funded as well as other projects, some of which will require cooperation with the USACE and other partners, and others that can be implemented by the City alone. Many will also require environmental review. Together, these initiatives will not only significantly reduce the vulnerability of hundreds of thousands of New Yorkers, but also will demonstrate the effectiveness of a wide range of coastal protection technologies that could be scaled up in the future. (*See map: Comprehensive Coastal Protection Plan | Phase 1 Initiatives*)

The City subjected these projects to a cost-benefit analysis to determine how effective they were at reducing future risks. Based on estimated lifecycle costs and using insurance industry-based predictive models, the City concluded that the package of Phase 1 Initiatives has an aggregate cost-benefit ratio that supports moving forward with its implementation.

Strategy: Increase coastal edge elevations

Beach Nourishment
In several parts of the city, beach sand served as a key line of defense when Sandy hit. During the storm, however, large quantities of this sand were washed away. To close the defensive breach created by this loss, the City will support the work of the USACE to complete emergency beach nourishments—replacing not only sand lost during Sandy, but also sand lost since earlier USACE nourishment of these beaches, in some cases many years ago. DPR will ensure that this work makes effective use of existing Federal appropriations and enhances protection during the 2013 hurricane season and beyond. The City also will work with the USACE to develop a plan for ongoing beach maintenance, so that a sand restoration plan is in place in anticipation of future storms.

Initiative 1
Continue to work with the USACE to complete emergency beach nourishment in Coney Island

The City will support the work of the USACE to complete emergency beach nourishment from Corbin Place to West 37th Street, expected to include 1 million cubic yards of sand. This project will start in July 2013, with completion targeted for December 2013.

Initiative 2
Continue to work with the USACE to complete emergency beach nourishment on the Rockaway Peninsula

The City will support the work of the USACE to complete emergency beach nourishment from Beach 19th Street to Beach 149th Street, expected to include 3.6 million cubic yards of sand. This project will start in June 2013, with completion targeted for December 2013.

Initiative 3
Complete short-term beach nourishment, dune construction, and shoreline protection on Staten Island

The loss of sand in Staten Island has left several neighborhoods exposed and vulnerable to future storms. The City, therefore, will complete interim beach nourishment and short-term dune improvements in Staten Island, including beach nourishment in South Beach, Crescent Beach, and Tottenville; dune construction from New Dorp Beach to Oakwood Beach; and shoreline stabilization to close the breach at Wolfe's Pond Park. DPR will ensure that this work, which began in May 2013 and will end by October 2013, makes effective use of existing Federal appropriations and enhances protection during the 2013 hurricane season and beyond.

Initiative 4
Install armor stone shoreline protection (revetments) in Coney Island

Coney Island Creek provides a pathway for the "backdoor flooding" of much of Southern Brooklyn. Subject to available funding, the City, therefore will raise the Creek's lowest edge elevations to a consistent grade with revetments to reduce the risk of flooding and erosion at low spots bordering the Creek. The Mayor's Office of Long-Term Planning and Sustainability (OLTPS) will work with the New York City Economic Development Corporation (NYCEDC) to complete this project. The goal is to begin design work in 2013 and complete the project in three years.

Initiative 5
Install armor stone shoreline protection (revetments) on Staten Island

The South Shore of Staten Island continues to be at risk for future erosion of its beaches and bluffs. Subject to available funding, the City, therefore will implement shoreline protection using revetments in vulnerable locations on the South Shore of Staten Island, such as Annadale. OLTPS will work with NYCEDC to complete this project. The goal is to begin design work in 2013, with completion within three years.

Initiative 6
Raise bulkheads in low-lying neighborhoods across the city to minimize inland tidal flooding

Eight percent of the city's shoreline will be at risk of daily tidal flooding by 2050. Subject to available funding, the City, therefore, will implement a program to raise bulkheads and other shoreline structures to minimize the risk of regular flooding in targeted neighborhoods, including the bayside of the Rockaway Peninsula, Broad Channel and Howard Beach in Queens, West Midtown in Manhattan, Locust Point in the Bronx, Greenpoint in Brooklyn, the North Shore of Staten Island, and other low-lying locations. OLTPS will work with NYCEDC and other agencies to implement this program in conjunction with a new citywide waterfront inspections program that will assess needs throughout the five boroughs. The goal is to begin the first phase of evaluations in 2013.

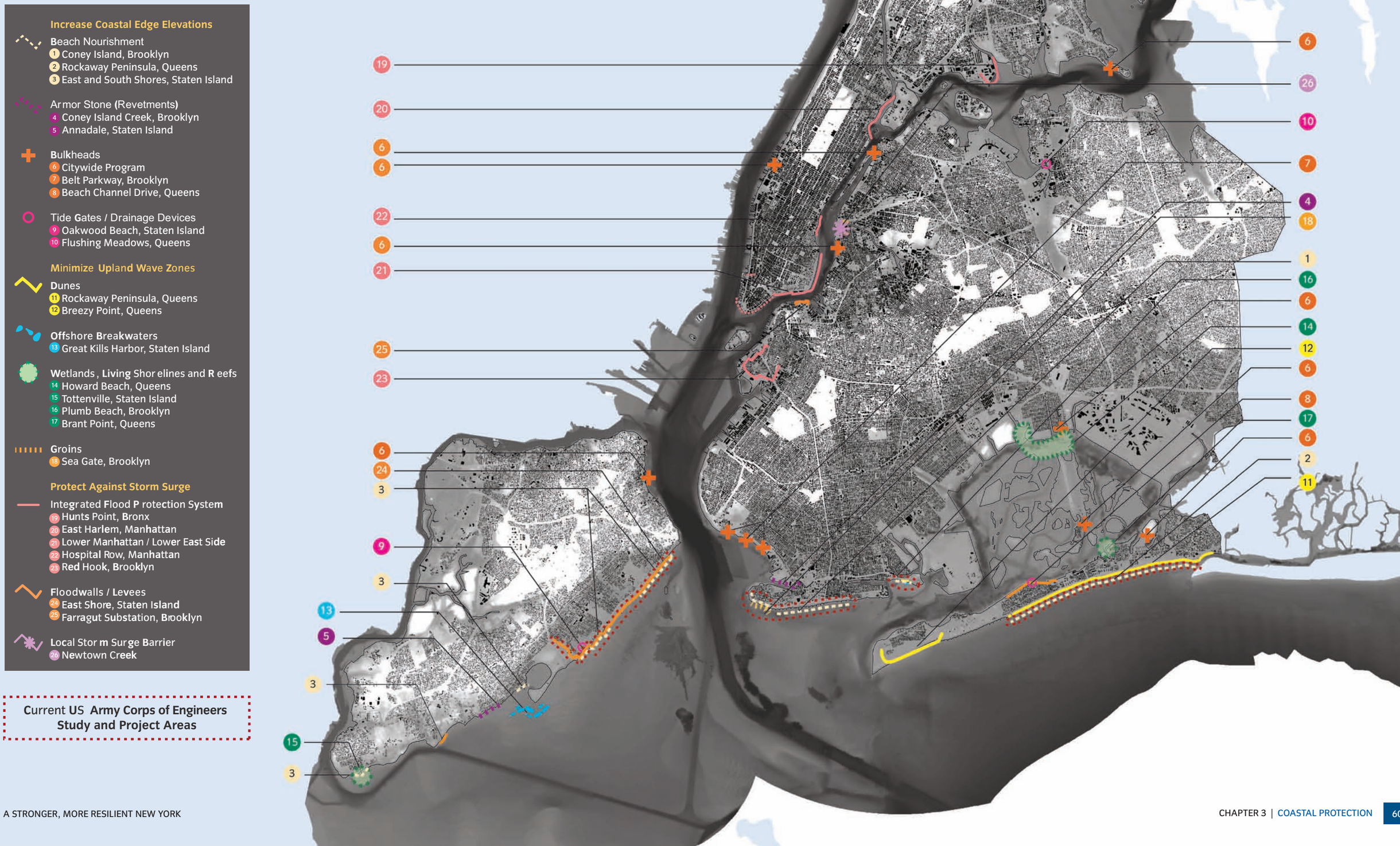
Initiative 7
Complete emergency bulkhead repairs adjacent to the Belt Parkway in Southern Brooklyn

The failure of bulkheads adjacent to the Belt Parkway has left several portions of this vital roadway exposed and vulnerable to future storms. The City, therefore, will complete bulkhead repairs in areas damaged during Sandy, including at 14th Avenue, 17th Avenue, and 95th Street. DPR will complete this work by December 2013, making effective use of existing Federal appropriations and enhancing protection during the 2013 hurricane season and beyond.

Beach Restoration for Summer 2013

Following Sandy, Mayor Bloomberg made a commitment to open New York City's eight public beaches in time for Memorial Day weekend 2013. However, several key facilities necessary to meet this goal—including bathrooms, lifeguard stations, maintenance and operations offices, and concessions—had been completely destroyed or significantly damaged in the storm. In a coordinated interagency effort led by the Department of Parks & Recreation, with the Department of Design and Construction and other City, State and Federal partners, the City invested over $270 million that not only removed debris, corrected hazardous conditions, restored beach access and renovated damaged buildings, but also replaced the key facilities that were destroyed with new facilities designed to withstand future storms. These 35 prefabricated modular buildings will be used as bathrooms and lifeguard stations on the Rockaway Peninsula, Coney Island, and Staten Island and were designed and constructed to a height ranging from 7 to 14 feet above the existing grade to ensure maximum resiliency. Having met the Memorial Day opening date, the City, State, and Federal governments are now working to restore sand and other protective elements on the beaches .

Comprehensive Coastal Protection Plan | Phase 1 Initiatives



Post-storm flooding and erosion along Coney Island Creek, Brooklyn

Credit: Charles Denson/Coney Island History Project

Initiative 8
Complete bulkhead repairs and roadway drainage improvements adjacent to Beach Channel Drive on the Rockaway Peninsula

The flooding of neighborhoods along Beach Channel Drive on the Rockaway Peninsula exposed additional vulnerabilities along several portions of this vital roadway. The City, therefore, will complete bulkhead repairs from Beach 143rd Street to Beach 116th Street and install duckbill tide gates within a portion of the roadway drainage network in that area, reducing the risk of "backdoor" flooding. NYCEDC will ensure that this work, which began in 2011 and will be completed in 2014, will make effective use of existing funding and enhance protection during the 2013 hurricane season and beyond.

Initiative 9
Continue to work with the USACE to complete emergency floodgate repairs at Oakwood Beach, Staten Island

The failure of a floodgate in Oakwood Beach on Staten Island has left this neighborhood vulnerable to future storms. OLTPS, therefore, will call upon the USACE to complete floodgate repairs at this location, ensuring that this work, which is expected to begin in June 2013 and end by December 2013, makes effective use of existing Federal appropriations and enhances protection during the 2013 hurricane season and beyond.

Initiative 10
Complete tide gate repair study at Flushing Meadows Corona Park, Queens

The malfunction of a tide gate system within Flushing Meadows Corona Park in Queens has left this important public asset vulnerable to future storms and impacts from sea level rise. Subject to available funding, the City, through DPR, therefore will complete a tide gate repair study at this location to identify options to reduce the risk of future flooding. The goal is to complete this study in 2014.

Strategy: Minimize upland wave zones

Initiative 11
Continue to work with the USACE to complete existing studies of the Rockaway Peninsula and implement coastal protection projects

The entire Rockaway Peninsula faces continued risk of floods and wave action. The City, therefore, will call on the USACE to complete the Rockaway reformulation study started in 2003. This authorized study offers an expedited path to rethinking and improving the current flood protections on the Rockaway Peninsula. DPR will ensure that this work makes effective use of existing Federal appropriations to advance meaningful flood protection projects. It is expected that the reformulation study will be completed by 2015. The goal is to complete this project within four years of completing the USACE study. Consistent with this study, the City also will call upon the USACE to implement further beach nourishment and dune construction projects in the area, working with DPR to complement its future boardwalk restoration plans. DPR also will work with the USACE to determine the feasibility and effectiveness of expanding or strengthening the existing groin fields on the Rockaway Peninsula. In the interim, DPR will complete short-term dune improvements on the Rockaway Peninsula from Beach 9th Street to Beach 149th Street in 2013, using low-cost and readily available solutions to mitigate the effects of storm waves on adjacent neighborhoods during the 2013 hurricane season and beyond.

Initiative 12
Call on and work with the USACE to study and install primary and secondary dune systems in vulnerable Rockaway peninsula neighborhoods (such as Breezy Point)

Neighborhoods such as Breezy Point suffered devastating damage from Sandy and remain exposed to extreme weather events, particularly along the ocean. Subject to available funding, the City, therefore will call on the USACE to study and construct a dune project to protect this neighborhood and to demonstrate the general effectiveness of primary and secondary dune systems as a defense against storm waves and flooding. OLTPS will oversee these efforts. The goal is to complete this project within four years of completing the USACE study.

Any such project would, if federal funding is involved, require public access to impacted areas. Accordingly, before this project could advance, the Breezy Point Cooperative would have to agree to that condition.

Initiative 13
Call on and work with the USACE to study and install offshore breakwaters adjacent to and south of Great Kills Harbor

The area of Staten Island adjacent to and south of Great Kills Harbor faces an increasing risk of wave action and erosion during extreme weather events that could undermine the shoreline bluffs and damage homes. Subject to available funding, the City, therefore will call on the USACE to study and construct a demonstration offshore wave attenuation project in this area, both to offer a first line of protection and to test the effectiveness of such a system. OLTPS will oversee these efforts. The goal is to complete this project within four years of completing the USACE study.

Initiative 14
Call on and work with the USACE to study and install wetlands for wave attenuation in Howard Beach and to study further flood protection improvements within Jamaica Bay

Howard Beach and Hamilton Beach, two Queens communities along the northern coastline of Jamaica Bay, are highly exposed, low-lying neighborhoods. Subject to available funding, the City, therefore will call on the USACE to implement a wetlands restoration project designed to attenuate waves. This project will build upon the existing work of the Hudson-Raritan Estuary Comprehensive Restoration Plan and leverage planning work done by the Nature Conservancy. It will not only protect the two aforementioned neighborhoods, but also will allow the effectiveness of such wetland restorations to be tested. DPR will oversee these efforts. The goal is to complete this project within four years of completing the USACE study.

Subject to available funding, the City also will call upon the USACE, simultaneous with the Howard Beach-Hamilton Beach wetlands restoration, to restart existing studies of the Rockaway Peninsula and of Jamaica Bay. These authorized studies offer an expedited path to project completion. Following completion of these studies, the USACE should implement coastal protection projects to provide flood protection and reconstitute some of the city's most important historic protective wetlands and marsh islands. DPR will ensure that this project makes effective use of existing Federal appropriations to advance combined flood protection and ecosystem restoration projects. If restarted now, this study should be completed by 2016 and would expedite restoration of Jamaica Bay wetlands, improvements to bulkheads in low-lying neighborhoods, and implementation of a local storm surge barrier for Rockaway Inlet.

Initiative 15
Call on and work with the USACE to study and install living shorelines for wave attenuation in Tottenville

Tottenville, the southernmost community in Staten Island, remains vulnerable to wave action in future extreme weather events. Subject to available funding, the City, through DPR, therefore will call on the USACE to develop and implement a living shoreline project, both to protect the neighborhood and to demonstrate the effectiveness of this approach to wave attenuation on the open Lower Bay. This living shoreline project, consisting of oyster reef breakwaters, beach nourishment, and maritime forest enhancements, will be located in an area adjacent to Conference House Park in Tottenville. The goal is to complete this project within four years of completing the USACE study.

Initiative 16
Continue to work with the USACE to complete its Plumb Beach breakwater and beach nourishment project in Southern Brooklyn

During Sandy, the first phase of the Plumb Beach nourishment project along the Belt Parkway in Southern Brooklyn likely prevented a breach of the adjacent highway, thus protecting a vital transportation link. The City will, therefore, call on the USACE to complete the second phase of this project, including the installation of offshore breakwater and additional beach nourishment components. DPR will ensure that this project makes use of existing Federal appropriations to provide meaningful protection to this critical asset. This project will be completed in 2014.

Initiative 17
Complete living shorelines and floating breakwaters for wave attenuation in Brant Point, Queens

Brant Point, on the eastern edge of the Rockaway Peninsula in Jamaica Bay, is a low-lying natural area that faces potential impacts from sea level rise and, during coastal storms, wave action. Subject to available funding, the City, through the Department of Environmental Protection (DEP), therefore will construct and evaluate living shorelines and floating breakwaters in Jamaica Bay. In addition to providing protection to Brant Point, this project will demonstrate that floating breakwaters can attenuate waves during non-storm conditions, protecting existing wetlands and marsh islands from the erosive forces of waves associated with sea level rise. The goal is to complete this project in 2014.

Initiative 18
Continue to work with the USACE to complete its Sea Gate project in Southern Brooklyn

The neighborhood of Sea Gate remains vulnerable to waves and flooding during extreme weather events. The City will, therefore, call upon the USACE to complete its existing groin project to protect this neighborhood. These groins, and associated beach nourishment, are primarily intended to protect the terminal groin at West 37th Street, but will also provide a first line of protection to the neighborhood against wave action. DPR will monitor this project so that it makes use of existing Federal appropriations to provide meaningful protection to an exposed neighborhood. This project will be completed in 2014.

Strategy: Protect against storm surge

Integrated Flood Protection Systems
In several parts of the city, flood risk associated with extreme weather events remains high. Yet, in these areas, existing conditions and land uses preclude the deployment of traditional measures such as levees or permanent floodwalls to reduce this risk. To address this challenge, the City proposes installing integrated flood protection systems.

These systems have been demonstrated to be effective at reducing flood risk around the world, including in the Netherlands, the United Kingdom, and parts of the Midwestern United States. To ensure that the systems constructed in New York City follow the best and latest practices and ideas, and subject to available funding, OLTPS will work with NYCEDC to conduct a global design competition that will seek partners to design these systems to be as efficient and cost-effective as possible. The goal is to launch the competition in 2013, and upon designation of winning ideas, will proceed into design and construction in 2014.

Initiative 19
Install an integrated flood protection system in Hunts Point

Hunts Point in the Bronx is home to the Hunts Point Food Distribution Center, an important part of the city's food supply chain, and is at risk of flooding during extreme weather events. Subject to available funding, the City, therefore will install an integrated flood protection system in Hunts Point. OLTPS will work with multiple agencies to design and construct this project. The expected alignment will be along the future Hunts Point greenway and along the water's edge between the New Fulton Fish Market and the Hunts Point Produce Market and may be designed to protect other adjacent city infrastructure, subject to available funding, include other adjacent City infrastructure. The goal is to complete design in 2014 with project completion by 2016.

Initiative 20
Install an integrated flood protection system in East Harlem

East Harlem is at risk for flooding during extreme weather events. Subject to available funding, the City, therefore will install an integrated flood protection system in East Harlem. OLTPS will work with multiple agencies to design and construct this project. The expected alignment will be along the Franklin D. Roosevelt East River (FDR) Drive esplanade between East 90th Street and East 127th Street, or could potentially follow the highway dividing wall. The goal is to complete design in 2014 with project completion by 2016.

Initiative 21
Install an integrated flood protection system in Lower Manhattan, including the Lower East Side

The Lower East Side includes not just a very large residential population, but also one that lives at among the highest densities in the United States. The area is also home to among the largest numbers of low and moderate income households in Southern Manhattan, with many housing NYCHA housing units alone located in the floodplain. This neighborhood, meanwhile, is the location of critical infrastructure that, if compromised, could have citywide impacts. These include support structures for the subway system, Con Edison substations, a DEP pumping station, and the FDR Drive. Subject to available funding, the City, therefore will install the first phase in the Lower East Side and Chinatown of what is intended eventually to be an integrated flood protection system for all of Southern Manhattan. The protection would be designed to produce only a minimal impact on, and generally support, neighborhood fabric during non-storm conditions. The expected alignment of this first phase would start north of the Brooklyn Bridge and continue north to approximately East 14th Street. The goal is for design work on this first phase to begin in 2014, with completion in 2016.

In addition to the foregoing, the City also will consider extending the first phase of this integrated flood protection system south from the alignment described above to Lower Manhattan, including the Financial District. This is because, though the area contains a smaller and less economically vulnerable residential population and is less densely-populated than the Lower East Side and Chinatown, it is a major hub of commercial activity for the region and, like the Lower East Side and Chinatown, contains vital infrastructure. Accordingly, the City will work with the local community, including the local business community and property owners, to explore alternative, private financing sources for the aforementioned southern extension that could be leveraged to secure new sources of public financing. By way of example, such private sources could include a modest per-square-foot assessment on commercial space that would be protected by this extension. When completed, the expected alignment of this extension would start at the southern end of the system proposed for the Lower East Side and Chinatown and would run south along South Street to Battery Park, with a small section running across West Street, north of Battery Park City. If funding were identified, the timing for the southern extension could be consistent with the schedule above.

Initiative 22
Install an integrated flood protection system at Hospital Row

Bellevue Hospital and its neighboring healthcare facilities flooded during Sandy and remain at risk of flooding during extreme weather events. Subject to available funding, the City, therefore will install an integrated flood protection system at Hospital Row north of 23rd Street in Manhattan. OLTPS will work with multiple agencies to design and construct this project. The expected alignment will be along the service road of the FDR Drive, utilizing floodwalls and other localized measures where appropriate to integrate the system. The system will specifically enhance protection to Bellevue Hospital, a critical trauma facility, and could potentially integrate with existing plans by neighboring facilities operated by New York University and the Veterans Administration. The goal is to complete design in 2014 with project completion by 2016.

Initiative 23
Install an integrated flood protection system in Red Hook

Red Hook is prone to coastal flooding and is home to vulnerable populations at risk during extreme weather events. Subject to available funding, the City, therefore will install an integrated flood protection system in Red Hook. OLTPS will work with multiple agencies to design and construct this project. The expected alignment will use a portion of the Brooklyn Waterfront Greenway and otherwise likely will follow the first mapped street inland of the waterfront. The goal is to complete design in 2014 with project completion by 2016.

Initiative 24
Continue to work with the USACE to complete existing studies on Staten Island and implement coastal protection projects

Sandy demonstrated the significant flood and wave risk on the East and South Shores of Staten Island, where much of the damage to structures and loss of life in the city occurred during the storm. Without additional protective action, those coastal communities remain vulnerable to future storms. The City will, therefore, call on the USACE to expedite the completion and implementation of its flood risk reduction study applicable to the East Shore of Staten Island, authorized by Congress in 1993. DEP and DPR will work with the USACE to ensure that this work will make effective use of existing Federal appropriations to advance meaningful flood protection and inland drainage projects. It is expected that the first phase of this study will be completed in 2014 and will recommend elements such as buried levees and floodwalls between Fort Wadsworth and Great Kills. The City will work with the USACE to determine the approach and specific location for these protections. As part of this initiative, the City will call on the USACE to develop a plan for ongoing beach nourishment to restore sand rapidly after extreme weather events. The second phase of this study is expected to be completed in 2016, recommending the installation of flood protection projects between Great Kills and Tottenville. The City will call upon the USACE to implement recommended projects along the South Shore of Staten Island. The goal is to complete these projects within four years of completing the USACE studies.

Initiative 25
Call on and work with Con Edison to protect the Farragut substation

Con Edison's Farragut substation came close to flooding during Sandy. This vital element of the city's power distribution network, serving almost 500,000 customers (or approximately 1.25 million people), sits in an area of growing risk from storm surge. The City, therefore, will call on Con Edison to protect this vital electrical substation from the impacts of storm surge. To accomplish this, Con Edison could consider floodwalls along the perimeter of the facility or other measures to meet a higher design standard for flood protection. This project could be incorporated into Con Edison's upcoming rate case at the State's Public Service Commission. OLTPS will monitor and support with technical assistance the rapid implementation of this project.

Initiative 26
Call on and work with the USACE to study and install local storm surge barriers at Newtown Creek

Newtown Creek was the source of extensive flooding during Sandy, providing a prime example of the significant "backdoor flooding" risk posed by inlets and waterways citywide. Subject to available funding, the City, through OLTPS, therefore will call on USACE to implement a project that will minimize damage within Newtown Creek during storm events through the installation of a local storm surge barrier with gates and connecting levees at the mouth of Newtown Creek. These gates will close in advance of an extreme weather event to keep flood waters from flowing into Newtown Creek and its adjacent neighborhoods. As Newtown Creek is a Superfund site, proper coordination with the Environmental Protection Agency and others will be required to ensure successful project implementation. DEP will assist in the evaluation of potential water quality impacts. The goal is to complete this project within six years of completing the USACE studies.

Strategy: Improve coastal design and governance

Initiative 27
Continue to work with the USACE to complete its comprehensive flood protection study of New York Harbor

The USACE is required by statute to conduct a comprehensive study to address the flood risks of vulnerable coastal populations in areas that were affected by Sandy. This study is a unique opportunity to guide Federal investment designed to reduce the future risks of climate change to the region. The recent experience in Louisiana has shown this type of study requires robust local partnership to ensure success. To this end, the City will call on the USACE to: expedite its comprehensive study of flood protection in New York City; adopt this report's goals, strategies, and initiatives for New York City as a key element of its own comprehensive study; and ensure that the comprehensive study translates into projects ready for Congressional authorization. To ensure that all of the foregoing measures are taken, OLTPS, working with DCP, DPR, NYCEDC, DEP, and the New York City Department of Transportation (NYCDOT), will lead the City's collaboration with the USACE in the development of its study. By statute, the USACE must deliver this comprehensive study to Congress by January 2015.

Initiative 28
Implement the WAVES Action Agenda

Although Sandy exposed vulnerabilities on the city's waterfront, the storm did not diminish the City's resolve to continue using this waterfront for a variety of recreational, commercial, and natural purposes. In fact, the City's prior policy objectives on the waterfront, highlighted in *Vision 2020: The NYC Comprehensive Waterfront Plan*, remain critical to the city's future, emphasizing and building upon the coastal resiliency elements contained in PlaNYC. The City will, therefore, redouble its commitment to implementing the entire WAVES Action Agenda, completing several particularly relevant projects in 2013, including the Urban Waterfront Adaptive Strategies study, and revisions to the City's Waterfront Revitalization Program to address sea level rise.

Initiative 29
Implement citywide waterfront inspections to better manage the City's waterfront and coastal assets

The City currently conducts waterfront inspections in a decentralized manner, and according to inconsistent standards. Subject to available funding, the City, therefore will implement a centralized waterfront inspection program for its entire portfolio of coastal and waterfront assets. This program, managed by NYCEDC, will improve safety for the public, apply a consistent set of standards for all inspections, and allow for more cost-effective procurement of inspection contracts. It also will lead to better understanding of the state-of-good-repair of City assets, more effectively maintained waterfront assets, and reduced life-cycle costs. As part of the program, NYCEDC will update the inventory of the City's coastal and waterfront assets and will also update the inspection guidelines manual to incorporate inspection procedures for new asset types, such as beaches, wetlands, integrated flood protection systems, and boardwalks. Funding for subsequent repair and rehabilitation work will be assessed based on the inspection program's findings. The goal is to begin the first round of inspections in 2014.

Initiative 30
Study design guidelines for waterfront and coastal assets to better mitigate the effects of flooding

While Sandy exposed many areas of vulnerability within the city, it also identified effective protections that should be incorporated elsewhere. Subject to available funding, the City, through DPR, therefore will study the cost-effectiveness of new waterfront and coastal asset design guidelines for open spaces and natural areas, assessing whether and how best to use these areas to protect adjacent neighborhoods, to improve landscaping to direct and store excess floodwaters, to ensure that new open space and park designs allow for maximum resiliency of parkland after an extreme weather event, and to build upon existing DPR high-performance landscape guidelines. These projects will improve the predictability of regulatory permitting and provide for better habitat considerations in future designs. The goal is to complete the study in 2014.

Initiative 31
Evaluate soft infrastructure as flood protection and study innovative coastal protection techniques

In the course of developing this comprehensive coastal protection plan, several new and innovative coastal protection ideas emerged that warrant further long-term study to determine whether they could be cost-effective and successful in New York City. Subject to available funding, the City, therefore will partner with academic institutions, the planned the Science and Jamaica Bay Science and Resilience Center, and other interested organizations to evaluate innovative coastal protection techniques, such as employing sand engines (a means of nourishing beaches and supplementing dunes by utilizing natural ocean currents) in areas such as the Rockaway Peninsula, and "shallowing" (reducing the depth of) bays, such as Jamaica Bay, for flood and wave risk reduction. These partnerships, led by OLTPS, working with DEP and DPR, will develop or identify appropriate scientific procedures to evaluate the effectiveness of these and other soft infrastructure investments for flood protection and wave attenuation and will advance other innovative coastal protection ideas. The goal is begin the study in 2013.

Initiative 32
Evaluate the city's vulnerability to drainage pipe flooding and identify appropriate solutions to minimize those risks

Many of the coastal protection measures proposed herein include barriers against storm surges. In connection with these initiatives, existing or proposed drainage infrastructure will be reviewed on a project-by-project basis to evaluate whether tide gates, valves, or other backflow prevention devices could help to reduce the possibility of flood exposure, without impeding stormwater drainage from upland areas. Subject to available funding, the City, through OLTPS and working with DEP, NYCEDC, and NYCDOT, therefore will study how those site-specific pipe networks are likely to perform during extreme surge events and will seek to identify a range of cost-effective proposals to address identified risks. Current plans to install "duckbill" tide gates on existing roadway drainage networks, such as along Beach Channel Drive on the Rockaway Peninsula, also will be monitored to evaluate their effectiveness as protection against storm surge. The goal is to complete these evaluations concurrent with the design of these coastal protection projects.

Initiative 33
Evaluate strategies to fund wetland restoration and explore the feasibility of wetland mitigation banking structures

As discussed earlier in this chapter, wetlands can act as a natural buffer to protect upland communities by retaining some floodwaters and attenuating waves during storm conditions. New York City has thousands of acres of degraded wetlands that could provide increased coastal resiliency if they were restored and expanded. Financing for such projects, however, has proved challenging. Subject to available funding, the City, therefore will work with State and Federal agencies to examine the feasibility of wetland mitigation banking in New York City—an approach to ecosystem restoration that offers greater ecologies and economies of scale than traditional approaches to mitigation. If feasible, the City will pilot a mitigation bank to help fund a restoration project at Saw Mill Creek in Staten Island. The goal is for the first pilot project to be implemented by NYCEDC in 2014.

Initiative 34
Work with agency partners to improve the in-water permitting process

The current waterfront permitting system in New York City requires those seeking permits to navigate an often-confusing series of requirements from multiple agencies. The process to obtain proper permits can stretch for years and is costly, leading, among other things, to delays in the repair and development of waterfront infrastructure necessary for flood protection. The City will, therefore, work with State agency partners to explore development of a one-stop waterfront permitting website that will help applicants better understand the process, answer specific application questions, and facilitate approval of worthy applications. NYCEDC will provide support in the technical development of the website, which is expected to be managed subsequently by the State. The site will launch in 2014.

Initiative 35
Enhance waterfront construction oversight by strengthening the City's waterfront permit and dockmaster units

The City's waterfront permit and dockmaster units oversee waterfront structures that, in addition to their other functions, play an important role in flood protection during both storm and non-storm conditions. The City will explore options to enhance waterfront permitting and strengthen this function. SBS will update its fee schedule in 2014 to offset some of the costs of providing these services. The City also will explore moving waterfront permitting and dockmaster responsibilities from SBS to another agency with a more closely aligned mission.

Initiative 36
Identify a lead entity for overseeing the collaboration on the USACE comprehensive study and for overseeing the implementation of coastal flood protection projects

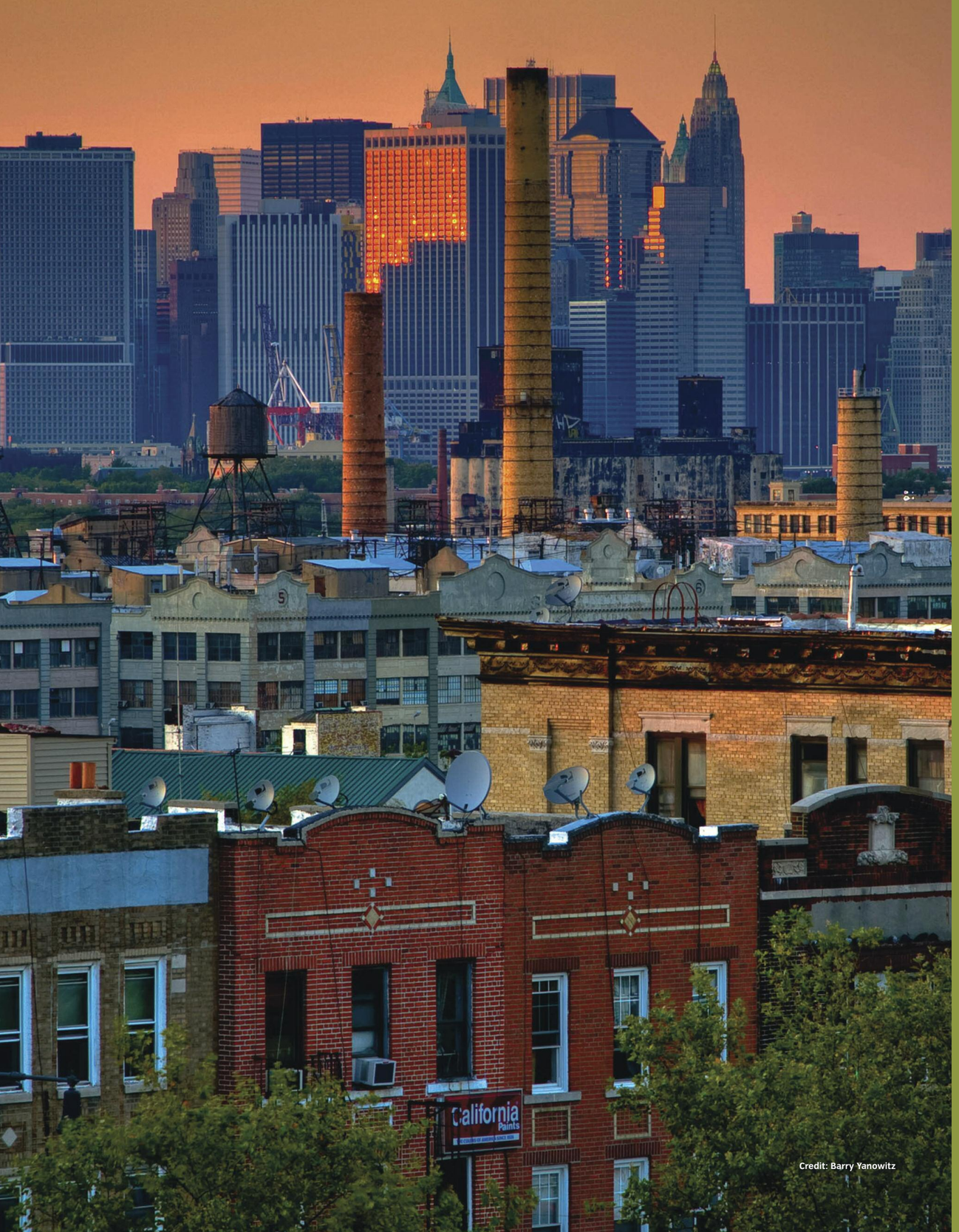
Without an appropriate investment in governance and oversight, the risk is high that coastal investments requiring long planning and implementation schedules will lose momentum and will not be completed on schedule or in concert with the City's resiliency goals. Therefore, OLTPS will assume the coordination role on coastal protection projects immediately.

Initiative 37
Call on and work with the USACE and FEMA to collaborate more closely on flood protection project standards

Federal investments in coastal protection typically are implemented by the USACE, while the National Flood Insurance Program is managed by FEMA. In certain instances, Federal investments in flood protection projects have not resulted in revised flood maps nor have they reduced the cost of flood insurance for property owners in newly protected areas. The City, therefore, will call on the USACE and FEMA to collaborate more closely on flood protection project standards to ensure that Federal investments that meet appropriate risk-reduction standards, produce a corresponding reduction in flood insurance rates in affected areas. OLTPS, working with DCP, will also call for closer project development coordination between these two Federal agencies to ensure improved project outcomes for those in affected areas. Additionally, OLTPS will call upon FEMA to recognize a variety of effective, yet temporary, deployable floodwall systems in future revisions to FIRMs.

Jamaica Bay

Credit: Ben Huff



Credit: Barry Yanowitz

Buildings

Bungalows in New Dorp Beach. Rowhouses in Sheepshead Bay. Office towers in Lower Manhattan. Industrial warehouses along the waterfront in Sunset Park. New York City has a diverse building stock encompassing approximately 1 million structures of almost every imaginable type and combination of uses. These buildings are New York City's homes, work places, museums, historic landmarks, community centers, and places of worship—and they are also critical contributors to the rich and varied character of communities across the city.

However, because New York is a coastal city, its buildings have long been subject to climate risks, particularly the flooding associated with storm surge and sea level rise. In fact, when the Federal Emergency Management Agency (FEMA) released its first Flood Insurance Rate Maps (FIRMs) for New York City in 1983, it defined the 100-year floodplain—the area that has a 1 percent or greater chance of flooding in any given year—as an expanse that today includes approximately 35,500 buildings with more than 376 million square feet of space. While these maps demonstrated the city's long-standing vulnerability to flooding, Sandy showed that New York's buildings are even more vulnerable than previously thought. Sandy's floodwaters inundated an area that included approximately 88,700 buildings, more than half of which were located outside the 1983 floodplain boundaries that were in effect when the storm arrived. These buildings encompassed roughly 662 million square feet of space and housed more than 443,000 residents and 245,000 jobs. *(See map: Comparison of 100-Year Floodplain in 1983 FIRMs and Sandy Inundation Area)*

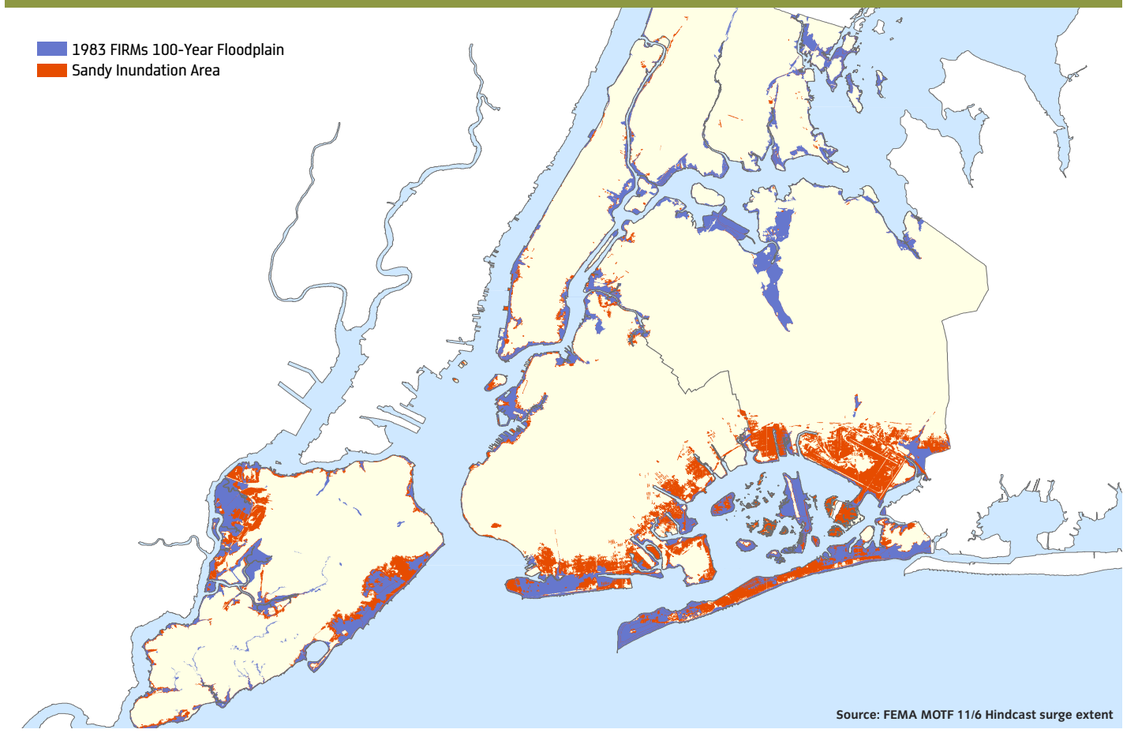
Sandy's impact is illustrative of the city's growing climate risks. For example, the 100-year floodplain, defined on recent Preliminary Work Maps (PWMs) created by FEMA, now encompasses more than 67,700 buildings, nearly twice the number of buildings in the 1983 FIRMs. In addition to the risks that the PWMs indicate these buildings now face, many of these properties also will be subject to significant new Federal flood insurance requirements.

However, even the revised FEMA flood maps do not reflect the full risk to New York City's building stock. That is because these maps are based on historical storm profiles and do not take into account potential changes in coastal storms or projected sea level rise, which, based on recent high end projections for sea level rise, could expand the size of the city's floodplain to include more than 88,000 buildings by the 2020s and more than 114,000 buildings by the 2050s (see Chapter 2, *Climate Analysis*). They also do not take into account other risks that climate change could exacerbate, including storm-related wind gusts.

Coastal protection measures are a significant and critical part of the City's efforts to protect buildings from current and future climate risks (see Chapter 3, *Coastal Protection*). While these measures should reduce the effects of storm surge, destructive waves, and sea level rise, they will not eliminate completely those impacts under all potential storm conditions, and they also will take time to design, fund, and build. Thus, they address only part of the challenge facing New York City's building stock. It is therefore equally important to supplement coastal protection measures by pursuing resiliency at the building level, offering multiple approaches to protect a wide range of the city's structures against the full spectrum of climate risks.

That is why this chapter proposes a two-part strategy for the city's building stock that is in keeping with the overarching goals of this report—to reduce the impacts of climate change, while also enabling the city to bounce back quickly when such impacts are felt. The two-part strategy seeks to strengthen new and rebuilt structures to meet the highest available standards and to facilitate the retrofitting of as many existing buildings as possible so that they become significantly more resilient than they are today. This approach will benefit a full range of buildings—those that are and may become vulnerable; those that are new and preexisting; those that are residential and non-residential; those that were impacted by Sandy and those that were not.

Comparison of 100-Year Floodplain in 1983 FIRMs and Sandy Inundation Area



Common Building Types Across New York City

Credit: DOB/Samantha Modell

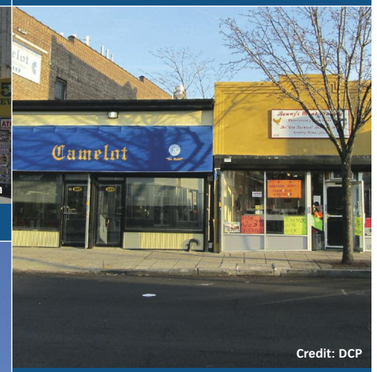
Detached 1- and 2-Family Home

Credit: Wikimedia/Jim Henderson

Attached 1- and 2-Family Home

Credit: Wikimedia/Beyond My Ken

Low- to Mid-Rise Mixed-Use Building



Credit: DCP

Low- to Mid-Rise Commercial Building

Credit: John Hans Lee

High-Rise Commercial Building

Credit: DOB/Samantha Modell

High-Rise Multi-Family Building

Credit: Alexandros Washburn

Low- to Mid-Rise Industrial Building

How the Building System Works

Any understanding of the vulnerabilities of New York's buildings must start with an understanding of the types of structures in the city and how they are regulated.

Structural Characteristics and Uses of New York City's Building Stock

New York City's buildings can be categorized by the following attributes, all of which are relevant for resiliency:

- physical characteristics;
- building use; and
- building age.

(See photos: Common Building Types Across New York City)

New York's buildings can be categorized by building height, construction type (as defined by the Building Code), and proximity to other structures. Building height ranges from low-rise (1 or 2 floors) to mid-rise (3 to 6 floors) to high-rise (7 floors and up). Meanwhile, there are two main construction types: so-called "combustible" buildings that are built using lighter stud-frame construction or wood joists on masonry bearing walls; and "non-combustible" buildings that use steel or masonry and concrete frames. Buildings in New York also can be characterized by their proximity to each other: they can be detached (freestanding); semi-attached (sharing a wall with another building); or attached (sharing walls on at least two sides with adjoining buildings). *(See table: Categorization of New York City Buildings by Physical Characteristics)*

Finally, buildings in New York also can be categorized by their age. This is a key factor because it correlates to the rules applicable at the time of the building's construction—and therefore the type of construction used.

Ever since Peter Stuyvesant instituted the first building regulations in New York in 1648 (appointing fire wardens to inspect buildings for fire hazards), the City's regulations governing the construction and the location of buildings have evolved, ensuring that new buildings meet

Categorization of New York City Buildings by Physical Characteristics

Building Height	• Low-rise: 1 or 2 floors • Mid-rise: 3 to 6 floors • High-rise: 7 floors and up
Construction Type (as defined by the Building Code)	• "Combustible" buildings: built using lighter, stud-frame construction; or wood joists on masonry bearing walls • "Non-combustible" buildings: built using steel, or masonry and concrete frames
Proximity	• Detached: freestanding • Semi-attached: sharing a wall with another building • Attached: sharing walls on both sides with adjoining buildings

increasingly high safety standards. While this approach has improved building safety over time, the corollary of this is that many older structures in the city were built according to codes that leave them more vulnerable to extreme weather events than buildings constructed to more modern standards.

Regulatory Framework for New York City's Building Stock

Buildings in New York City are governed by a wide variety of rules and regulations. Two City agencies share primary responsibility for overseeing New York's buildings: the Department of Buildings (DOB) and the Department of City Planning (DCP).

DOB regulates construction standards to ensure safe and lawful building use. DOB accomplishes its mission by enforcing several codes and regulations, including the City's Construction Codes (of which the Building Code is a part), the Electrical Code, and the Zoning Resolution. DOB also is responsible for enforcing the New York State Multiple Dwelling Law, which governs the habitability of multi-family buildings in New York City.

DCP, meanwhile, establishes citywide regulations for building use, density, and bulk through the Zoning Resolution. DCP also initiates planning and zoning changes for individual neighborhoods and business districts to promote the orderly growth and development of the city. Any changes to the Zoning Resolution initiated by DCP require the approval of the City Planning Commission and the City Council.

In addition to DOB and DCP, many other City agencies play critical roles in overseeing New York's building stock. These include the Fire Department of New York (FDNY), the Department of Housing Preservation and Development (HPD), and the Board of Standards and Appeals (BSA). *(See table: City Agencies That Regulate New York's Building Stock)*

Thanks to the efforts of these agencies and others, New York has a long history of working to improve the resiliency of its buildings. For example, the building codes and land use laws enacted in the 1960s (including a new Zoning Resolution passed in 1961 as well as critical building code revisions that culminated in a new Building Code in 1968) contained many measures that, while not explicitly designed to protect buildings from climate risks, did seek to make buildings generally safer, and thus also had the effect of improving flood protection.

As larger buildings continued to be constructed to accommodate the city's growing population, the City amended its Building Code to increase fire protection requirements in areas with high concentrations of residents. This resulted in heavier buildings that were constructed of non-combustible materials such as steel, concrete, and masonry—materials that also reduced vulnerability to structural damage during storm surge and flooding events. Over time, older, light-frame buildings in central portions of the city tended to be replaced by bigger, heavier buildings, while light-frame, low-density buildings remained more common on the edges of the city.

The City began actively and deliberately incorporating resiliency into its building regulations in 1983, when FEMA first released its FIRMs for New York City, which set the boundaries of the 100-year floodplain (see Chapter 2). In the FIRMs, the 100-year floodplain itself is divided into subzones that further delineate the level of risk, including V Zones, in which the physical impact of waves during flooding is expected to be greatest, and A Zones, where waves are expected to be less significant. These maps also show the associated Base Flood Elevations (BFEs), or the height to which floodwaters potentially could rise.

These maps are relevant to New York's building regulations because of the role they play in the National Flood Insurance Program (NFIP), which allows property owners to purchase flood insurance from the Federal government. First, properties in the 100-year floodplain are required to carry flood insurance, usually from the NFIP, if they are encumbered by Federally backed mortgages (see Chapter 5, *Insurance*). Additionally, under Federal law, if jurisdictions such as New York want their citizens to be able to purchase insurance from the NFIP, then these jurisdictions must incorporate nationally recognized flood-resistant construction standards into their own building codes. Generally, these standards apply to new and substantially improved buildings (i.e., buildings for which the cost of alteration is greater than 50 percent of their value, prior to improvement) in the floodplain. The City adopted these standards in 1983.

In addition to adhering to requirements established by the NFIP, New York City also is required to comply with a State regulation that mandates that New York City's local building codes be at least as protective as the State's own Building Code. This is relevant because, in 2010, New York State adopted an even higher elevation standard than was required under the NFIP, mandating that new and substantially improved buildings in the 100-year floodplain must include "freeboard"—an incremental elevation above the BFE to which a building must be flood-protected. Freeboard is one way to compensate for uncertainties relating to flood modeling and to future sea level rise. Pursuant to this State requirement, 1- and 2-family homes were required to add 2 feet of freeboard to the BFE, while most non-residential buildings were required to add one foot of freeboard. The applicable elevation, BFE plus freeboard, is referred to as the Design Flood Elevation (DFE). New York City adopted the State's standard as part of an Emergency Rule issued by DOB in January 2013. *(See graphic: Flood Protection Terms)*

In New York City, these Federal, State, and local standards are incorporated into Appendix G of the Building Code, which outlines the flood-resistant construction techniques that are required for new and substantially improved buildings in the 100-year floodplain. Appendix G is therefore a critical tool for protecting vulnerable buildings. *(See chart: Overview of Appendix G: Flood-Resistant Construction)*

Pursuant to Appendix G and consistent with the standards above, in residential buildings anywhere in the 100-year floodplain, living areas are not permitted below the DFE. Only parking, building access, and storage are permitted below such elevations. For residential buildings in A Zones, any area below the DFE must be "wet flood-proofed," a technique designed to allow floodwaters to enter and leave a structure through flood openings or vents. This approach allows hydrostatic forces—the pressure exerted by the sheer weight of water—to equalize on both sides of building walls and thus prevents structures from collapsing. Residential buildings in A Zones also may comply with Appendix G by elevating their lowest floor above the DFE. *(See graphic: Wet Flood-Proofing Method)*

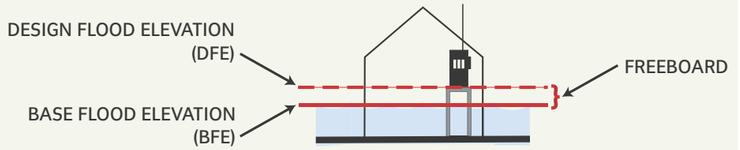
For a residential building in a V Zone, the entire structure must be elevated on piles to prevent the lateral force of waves from damaging the structure. In addition, areas below the DFE are required to be open or built with "breakaway" walls, such as non-supporting open-lattice walls, that can give way under water pressure without causing the building to collapse.

Requirements for commercial buildings differ from those of residential buildings. In A Zones, commercial buildings must have their lowest floor elevated above the DFE or be "dry flood-proofed" (made watertight) below the DFE. Dry flood-proofing techniques are designed to prevent water from entering a structure (using,

City Agencies That Regulate New York's Building Stock

Agency	Regulatory Role	Applicable Regulations
Department of Buildings (DOB)	• Regulates construction standards to ensure safe and lawful building use	• Construction Codes (of which the Building Code is a part) • Electrical Code • Zoning Resolution • New York State Multiple Dwelling Law
Department of City Planning (DCP)	• Regulates building uses, density, and bulk through the Zoning Resolution • Initiates planning and zoning changes for individual neighborhoods, as well as citywide changes, subject to the approval of the City Planning Commission and the City Council	• Zoning Resolution
Fire Department of New York (FDNY)	• Regulates the maintenance and safe use of buildings with regard to fire hazards	• Fire Code
Department of Housing Preservation and Development (HPD)	• Maintains and administers basic standards for the safety and habitability of housing	• Housing Maintenance Code
Board of Standards and Appeals (BSA)	• Adjudicates appeals of interpretations of the Zoning Resolution, as well as variances and certain special permits	• Zoning Resolution

Flood Protection Terms

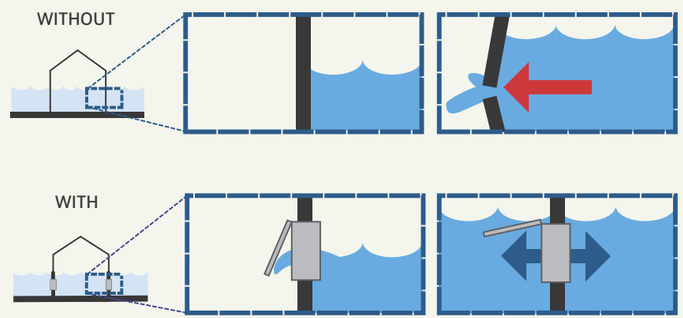


Overview of Appendix G: Flood-Resistant Construction

	A ZONE		V ZONE
FLOOD PROTECTION STRATEGY	DRY FLOOD-PROOFING WATERTIGHT STRUCTURE e.g., FLOOD SHIELDS	WET FLOOD-PROOFING WATER TO RUN-IN / RUN-OUT e.g., FLOOD VENTS	ELEVATED STRUCTURE VIRTUALLY OPEN STRUCTURE e.g., OPEN LATTICE BREAKAWAY WALLS
GROUND FLOOR CONFIGURATION	FLOOD SHIELDS PREVENT WATER FROM ENTERING; DFE; NON-RESIDENTIAL SPACE ONLY; LOWEST OCCUPIED FLOOR ALLOWED TO BE EXCAVATED BELOW GRADE; NOT PERMITTED FOR ENTIRELY RESIDENTIAL BUILDINGS	DFE; LOWEST OCCUPIED FLOOR TO BE AT OR ABOVE DESIGN FLOOD ELEVATION	OPEN LATTICE BREAKAWAY WALL; DFE; VERTICAL FOUNDATION MEMBER; BOTTOM OF LOWEST STRUCTURAL MEMBER TO BE AT OR ABOVE DESIGN FLOOD ELEVATION
PERMITTED USE BELOW DFE	✓ PARKING ✓ ACCESS ✓ STORAGE ✓ NON-RESIDENTIAL ✗ RESIDENTIAL	✓ PARKING ✓ ACCESS ✓ STORAGE ✗ NON-RESIDENTIAL ✗ RESIDENTIAL	✓ PARKING ✓ ACCESS ✓ STORAGE ✗ NON-RESIDENTIAL ✗ RESIDENTIAL

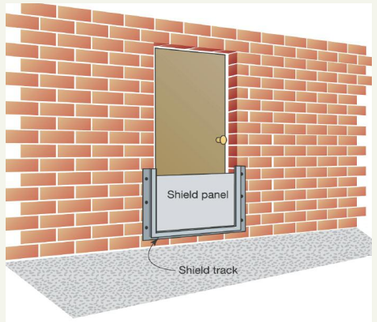
Source: DCP

Wet Flood-Proofing Method



Without wet flood-proofing, pressure from floodwaters builds up on one side of a building's walls, often causing structural damage. With wet flood-proofing, openings or vents permit floodwaters to enter an enclosed area, allowing this pressure to equalize on both sides of the building's walls thereby preventing the structural damage.

Dry Flood-Proofing Method Using Temporary Flood Shields



One method of dry flood-proofing is a temporary flood shield that can help prevent low-level flooding from entering through an opening such as a door or window.

Source: FEMA

for example, sealants, flood shields, or aquarium glass) and to strengthen structural components to resist hydrostatic forces from floodwaters. In V Zones, such dry flood-proofing of commercial uses is not permitted. Instead, as with residential buildings, the lowest occupied floor must be elevated above the DFE. *(See graphic: Dry Flood-Proofing Method Using Temporary Flood Shields)*

For all new and substantially improved buildings, Appendix G further requires that, regardless of intended use, flood damage-resistant materials must be used below the DFE. Such materials must be capable of withstanding direct and prolonged contact with floodwaters, without sustaining any damage that requires more than cosmetic repair. In addition, pursuant to Appendix G, mechanical equipment (electrical, heating, ventilation, plumbing, and air conditioning systems) either must be located above the DFE or, if located below the DFE, must be protected so as to prevent it from being inundated with water.

Under Mayor Bloomberg, the City has been even more aggressive about building resiliency, focusing not just on surge and flood but also on other climate risks. For example, in 2008, the Mayor and the City Council Speaker convened the Green Codes Task Force—an expert panel of architects, engineers, regulators, and other stakeholders—to recommend changes to the City's codes and regulations to make buildings more sustainable. The group's 111 recommendations included proposals to augment building standards in the 100-year floodplain to account for rising sea levels and to ensure "passive survivability"—providing residents with safe living conditions in the event of citywide utility failures. To date, 39 of the group's recommendations have been adopted by City agencies and the City Council. Meanwhile, in 2011, DCP released *Vision 2020: New York City Comprehensive Waterfront Plan*, a 10-year plan for the city's 520-mile waterfront that explicitly included increasing climate resiliency as one of eight overarching goals, addressing in detail the need to consider climate risks as a part of waterfront development.

In the immediate aftermath of Sandy, the City reexamined its existing flood-resistant construction rules so that rebuilding and new construction would reflect the best available data on coastal flood risk. As a result, on January 13, 2013, in collaboration with the City Council, Mayor Bloomberg issued Executive Order 230, "An Emergency Order to Suspend Zoning Provisions to Facilitate Reconstruction in Accordance with Enhanced Flood Resistant Construction Standards." This emergency order suspended height and other zoning restrictions so that buildings could meet new advisory flood elevation standards published by FEMA in February, without being penalized under the Zoning Resolution (for example, if elevation put a structure into conflict with zoning height limitations). This measure was designed as a temporary tool so that buildings being built or retrofitted post-Sandy would be constructed safely, according to the then-best available information.

In an effort to further promote resiliency, the Mayor and the City Council Speaker convened the Building Resiliency Task Force (BRTF), an expert panel of engineers, architects, developers, and property owners, along with representatives of City government. The BRTF, which worked closely with those involved in developing this report, was charged with undertaking a comprehensive review of current code standards and proposing changes with the goal of ensuring that, going forward, buildings would be constructed to the most modern standards of resiliency. Managed by the Urban Green Council, the local chapter of the US Green Building Council, the BRTF is developing proposals that will be released in 2013. These proposals will expand upon and complement the recommendations outlined in this chapter.

Credit: DOB/Dan Eschanasy

The effects of flooding and storm surge resulted in severe structural damage to many buildings during Sandy.

What Happened During Sandy

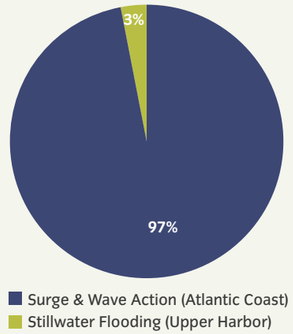
Building damage from storm surge and inundation during Sandy was widespread and in many cases severe. Sandy flooded an area that included approximately 88,700 buildings, or 9 percent of the city's building stock. These buildings encompassed 662 million square feet of space that included more than 300,000 housing units and 23,400 businesses. The storm completely destroyed or rendered structurally unsound hundreds of buildings and damaged thousands more. More than 100 of these impacted homes and businesses were destroyed by storm-related fires, which were predominantly electrical in nature and caused largely by the interaction of electricity and seawater.

Following Sandy, both the Federal government (through FEMA) and City government (through DOB) inspected the damage caused by the storm. At the Federal level, as of February 15, 2013, FEMA had completed inspections of nearly 70,000 housing units that registered with FEMA for disaster assistance. These inspections demonstrated that building damage varied widely, both in terms of the dollar value of losses and the level of flooding sustained. For example, of the approximately 47,000 owner-occupied housing units inspected by FEMA, 49 percent had sustained damage in excess of $10,000, with 12 percent sustaining damage in excess of $30,000. Of the approximately 22,000 rental housing units inspected, 26 percent sustained "substantial damage", the highest damage classification used by FEMA, indicating that damage was 50 percent or more of the pre-flood market value of the building.

The City's building-level damage assessments following Sandy were similarly comprehensive. These were led by DOB and represented the largest building inspection initiative in New York City history, teaming DOB inspectors and engineers with private-sector engineers who volunteered to serve the effort in Rapid Assessment Teams. The result of this initiative was a series of "tags" applied to buildings, ranging from "red" (indicating structural damage) to "yellow" (indicating that portions might be unsafe or might have significant non-structural damage) to "green" (indicating less serious damage or no damage at all).

The first set of these tags was issued by DOB Rapid Assessment Teams that were sent to the most impacted sections of the city immediately following Sandy (DOB Post-Storm Tags). Of the roughly 82,000 buildings receiving DOB Post-Storm Tags, approximately 73,000 of the buildings were tagged as green (or 89 percent of the total), 7,800 were tagged as yellow (or 10 percent of the total), and 930 were tagged as red (or 1 percent of the total). Of the red-tagged buildings, 220 were further categorized as destroyed.

Buildings Assigned Red or Destroyed Tags, Categorized by Flood Type



Source: DOB December Tags, DCP PLUTO

In December 2012, DOB conducted a follow-up assessment of the buildings that received DOB Post-Storm Tags, focusing on the roughly 8,700 buildings that had earlier been tagged yellow or red (including those tagged as destroyed). This assessment sought to standardize DOB's classification methodology across the boroughs. Generally, this assessment took a more conservative approach, for example, assigning yellow tags for damage to building systems only in larger buildings with elevators. As a result, a number of properties were reclassified (DOB December Tags). Of the roughly 8,700 buildings receiving DOB December Tags, approximately 1,300 were given yellow tags, and 780 were given red tags, of which 230 were further categorized as destroyed.

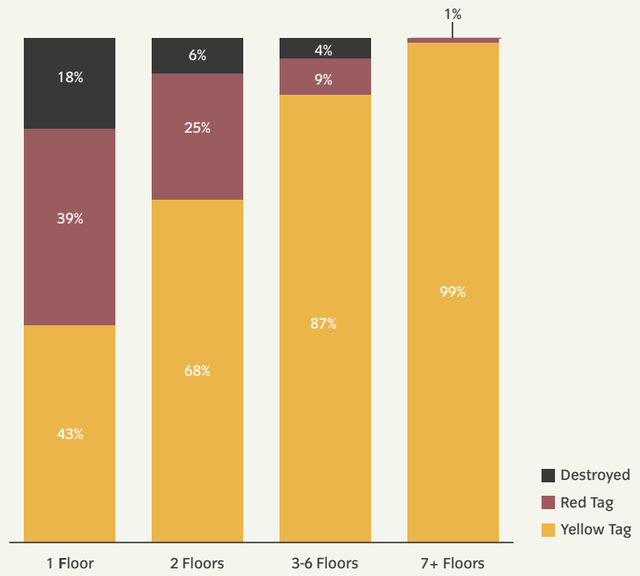
Though the figures diverge from one another, the story that they tell about the impact of Sandy on the city's building stock is relatively consistent. Namely that, with respect to the buildings that were seriously damaged by Sandy (those receiving either yellow or red tags, including those further classified as destroyed), the majority (between 63 percent and 91 percent) received yellow tags. This indicates that most Sandy-related damage was non-structural in nature, largely due to flooding of building systems and equipment (including electrical, sanitary, and life safety systems) located on ground floors or in basements—a conclusion that is buttressed by the fact that the aforementioned figures likely *understate* the number of buildings citywide that could have received yellow tags, given that DOB's focus was generally on areas of the city where structural damage to buildings was greatest.

Though the damage indicated by yellow tags, in most cases, did not structurally compromise buildings, it did, in many cases, have profound impacts on building occupants, displacing residents and businesses likely also to be contending with extensive damage to building contents. Some yellow tagged buildings also required significant and costly repairs, including work on ground floors and basements.

Two sets of factors proved to be strong predictors of how Sandy affected buildings. First, flood characteristics such as surge force and depth of inundation correlated strongly with the degree of damage suffered by a building. Thus, shoreline areas that experienced the strong lateral forces of waves had many more damaged buildings than areas with stillwater flooding. In fact, wave action along the Atlantic Coast (including Southern Brooklyn, South Queens, and the East and South Shores of Staten Island) accounted for the majority of damaged buildings, and for nearly all buildings tagged red or destroyed citywide, whether those tags were DOB Pre-Storm Tags or DOB December Tags. (*See chart: Buildings Assigned Red or Destroyed Tags, Categorized by Flood Type*)

Other, perhaps less intuitive, predictors of Sandy's impact on any given building included building age and physical characteristics. For example, buildings predating the 1961 Zoning Resolution and the 1983 FIRM standards fared much worse than newer buildings, more frequently sustaining significant damage. Moreover, where more recently constructed buildings did suffer damage, such damage tended to be moderate rather than severe.

Buildings Assigned Destroyed, Red, and Yellow Tags, Categorized by Building Height



Source: DOB December Tags, DCP PLUTO

Building height was another key predictor of the degree of building damage from Sandy. One-story buildings proved particularly susceptible to severe damage. Although such buildings accounted for less than 25 percent of the buildings in the area inundated by Sandy, they represented roughly 75 percent of the buildings that sustained the most severe damage according to the DOB December Tags (those receiving red tags, including those further tagged as destroyed). By contrast, high-rise buildings experiencing inundation generally did not sustain structural damage according to the DOB December Tags. They, however, often did experience damage to building systems that were housed in basements or otherwise insufficiently elevated. (*See chart: Buildings Assigned Destroyed, Red, and Yellow Tags, Categorized by Building Height*)

Construction type, which tends to correlate with building height, also served as a predictor of Sandy-related damage for buildings. As stated above, low-rise structures suffered the most severe damage. Though such structures are often of combustible construction, not all are. However, where low-rise structures were also of combustible construction, the damage tended to be even more severe. In fact, while 85 percent of the 1-story buildings in the area inundated by Sandy were combustible structures, 99 percent of 1-story buildings receiving red DOB December Tags (including those further tagged as destroyed) were of a combustible construction type. Conversely, high-rise structures, which often are of a non-combustible construction type, tended to experience less severe structural damage. (*See photos: Combustible Construction Type and Non-Combustible Construction Type*)

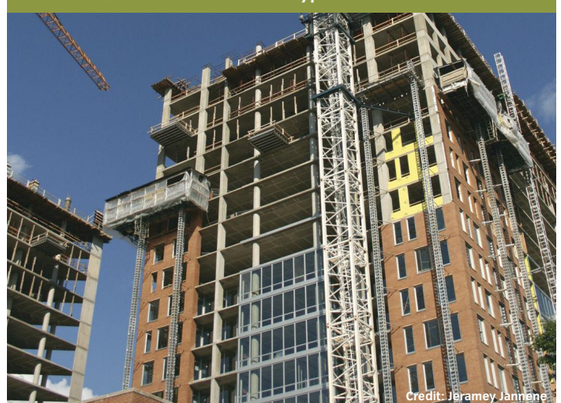
The building type most vulnerable to Sandy's effects turned out to be 1-story combustible buildings constructed before 1961—including bungalows found in many coastal areas of the city. Buildings matching these characteristics represented 18 percent of the buildings in the inundated areas of the city, but 73 percent of all structurally damaged or destroyed buildings in the city. Structures of this type were approximately four times more likely to sustain severe damage than their share in the inundation area would suggest. (*See chart: Share of Total Buildings in the Sandy Inundation Area Compared to Share of Building Damage, Categorized by Building Type*)

Combustible Construction Type

Credit: Devin Ford

Combustible structures, such as the wood stud-frame building above, tend to be lighter and shorter and suffered more severe structural damage during Sandy.

Non-Combustible Construction Type



Credit: Jeramey Jannene

Non-combustible structures, such as the reinforced concrete frame building above, tend to be heavier and bigger, and primarily suffered non-structural damage to building systems and equipment during Sandy.

Share of Total Buildings in the Sandy Inundation Area Compared to Share of Building Damage, Categorized by Building Type

		1 Floor		2 Floors		3 to 6 Floors		7 Floors or Higher		
	Year of Construction	Combustible	Non-Combustible	Combustible	Non-Combustible	Combustible	Non-Combustible	Combustible	Non-Combustible	
Buildings in the Sandy Inundation Area – Total Buildings	Pre-1961	18%	3%	37%	1%	11%	1%	0%	1%	100%
	Post-1961	2%	1%	16%	1%	6%	1%	0%	1%	
Buildings Assigned Red or Destroyed Tags	Pre-1961	73%	1%	16%	0%	5%	0%	0%	0%	100%
	Post-1961	1%	0%	3%	0%	1%	0%	0%	0%	

Percentages reflect the share of buildings in each category – either Total Buildings in the Sandy Inundation Area or Buildings with Red or Destroyed Tags– that have the characteristics defined in the chart. For example, 1-story buildings of a combustible construction type built pre-1961 represented 18 percent of the buildings in the Sandy Inundation Area, but 73 percent of the buildings tagged red or destroyed.

Source: DOB December Tags, DCP PLUTO

Although both size and construction type did play a role in the poor performance of many damaged and destroyed 1-story buildings, it is noteworthy that other 1-story structures and other combustible structures generally did not fare as poorly as 1-story combustible structures that also were built prior to the introduction of modern building codes. Thus the rules and regulations contained in these codes did appear to have played a particularly critical role in determining how well impacted structures fared.

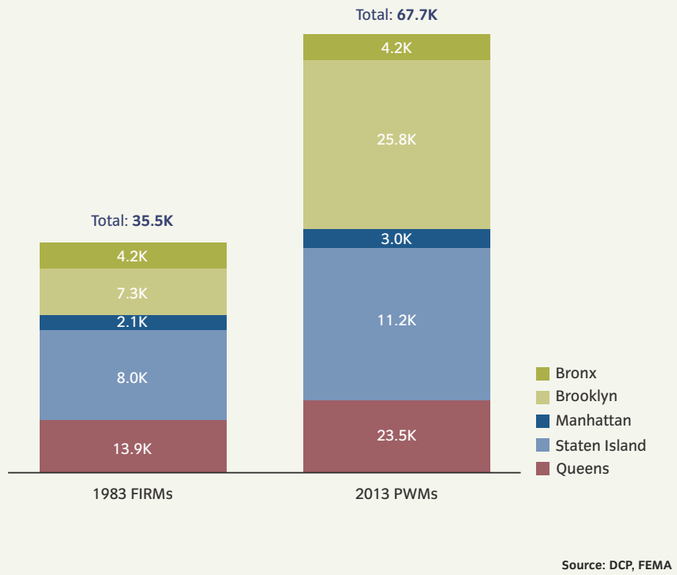
What Could Happen in the Future

New York City's buildings face a variety of risks related to climate change.

Major Risks

Now and into the future, the risk of storm surge combined with sea level rise is likely to present the greatest threat to New York City's building stock. Flood risk is illustrated by the recent PWMs created by FEMA, which show more than 67,700 buildings now to be in New York City's 100-year floodplain, up from the approximately 35,500 indicated in the 1983 FIRMs—an increase of roughly 90 percent. These 67,700 buildings, in turn, encompass nearly 535 million square feet of space and house approximately 398,000

Expansion of the Number of Buildings in the 100-Year Floodplain



Source: DCP, FEMA

Risk Assessment: Impact of Climate Change on Buildings

Major Risk Moderate Risk Minor Risk

	Scale of Impact			
Hazard	**Today**	**2020s**	**2050s**	**Comments**
Gradual				
Sea level rise				Increasing numbers of buildings face weekly and daily flooding
Increased precipitation				Minimal impact
Higher average temperature				Minimal impact
Extreme Events				
Storm surge				Large and growing number of buildings likely would face significant flooding risk
Heavy downpour				Minimal impact
Heat wave				INDIRECT: impact primarily relating to increased risk of power outages
High winds				Building codes are calibrated to anticipated wind speeds though in-place stock and equipment may be vulnerable

residents and 271,000 jobs. Though these figures are significant in many ways, they tell only part of the story of the city's vulnerability. *(See chart: Expansion of the Number of Buildings in the 100-Year Floodplain)*

As vulnerable as New York's building stock may be today, it is very likely to become even more vulnerable in the future. According to climate projections from the New York City Panel on Climate Change (NPCC) described in Chapter 2 (*Climate Analysis*), sea levels are forecast to rise through the 2020s and 2050s. During this period, the floodplain will expand, with a corresponding increase in the number of buildings in the 100-year floodplain—rising to more than 88,000 by the 2020s and more than 114,000 by the 2050s based on recent high end projections of sea level rise. In addition to exposing more New Yorkers to greater risk, an expansion of this scale also would have significant financial impacts on hundreds of thousands of New Yorkers, ranging from new requirements relating to flood insurance, to more expensive flood insurance premiums, to new requirements for property owners to alter ground-level and underground spaces to comply with national flood-resistant construction standards (see Chapter 5).

Other Risks

Going forward, high winds are projected to pose a moderate risk to the building stock of New York.

While the NPCC does not provide specific projections for wind speeds, their projections do suggest an overall increase in the frequency of the most intense hurricanes, which are accompanied by high winds. Though the Building Code already requires new and substantially improved buildings to protect against top winds associated with a Category 3 hurricane, older buildings that predate modern standards and have improperly installed and maintained external elements may be vulnerable. This is especially true in areas with open exposures—for instance, along the coast—and with respect to older 1- and 2-family homes. And all structures, including high-rise buildings, will continue to face potential damage to façades from airborne debris during the sorts of extreme wind events that could occur in the future.

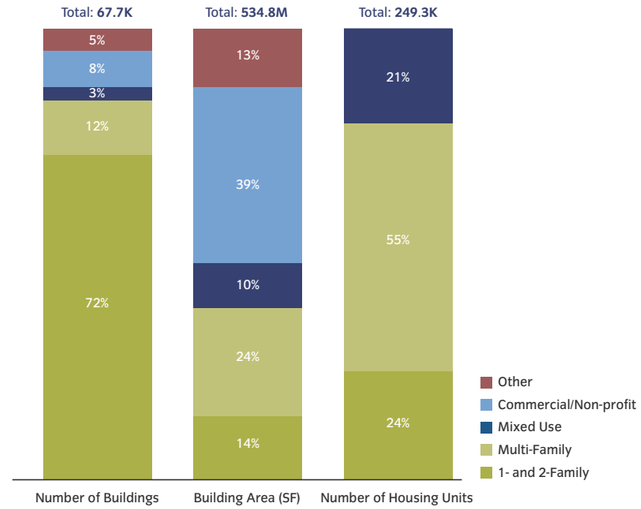
In addition, the city's future wind risk profile in the face of climate change is uncertain. While current Building Code requirements are based on data from area airports—John F. Kennedy International Airport, LaGuardia Airport and Newark Liberty International Airport—a detailed mapping of the city's wind profile could provide a much more accurate assessment of the risks that buildings face with potentially increased storm activity.

Meanwhile, heavy downpours, increased precipitation, and higher temperatures in the future are expected to have a minimal impact on buildings. Though increased precipitation may raise the possibility of flooding, the levels of flooding currently projected are not believed to present anywhere near the same threat to life and property that storm surge poses now and in the future. Similarly, currently forecasted increases in average temperatures should not affect significantly the resiliency of building structural elements or in-house mechanical and electrical systems. However, without resiliency investments, the power outages that may come with heat waves certainly would affect the occupants of the city's buildings (see Chapter 6, *Utilities*).

This chapter contains a series of initiatives that are designed to mitigate the impacts of climate change on New York's buildings. In many cases, these initiatives are both ready to proceed and have identified funding sources assigned to cover their costs. With respect to these initiatives, the City intends to proceed with them as quickly as practicable, upon the receipt of identified funding.

Meanwhile, in the case of certain other initiatives described in this chapter, though these initiatives may be ready to proceed, they still do not have specific sources of funding assigned to them. In Chapter 19 (*Funding*), the City describes additional funding sources, which, if secured, would be sufficient to fund the full first phase of projects and programs described in this document over a 10-year period. The City will work aggressively on securing this funding and any necessary third-party approvals required in connection therewith (i.e., from the Federal or State governments). However, until such time as these sources are secured, the City will only proceed with those initiatives for which it has adequate funding.

Buildings, Building Area, and Housing Units in the 2013 PWMs Broken Down by Land Use



Source: FEMA, DCP PLUTO

Overview and Approach

As the impact of Sandy demonstrated, buildings constructed in accordance with modern codes and standards tend to be better able to withstand extreme weather events—that is, they tend to be more resilient. Yet these codes and standards cannot remain static. They must evolve continually to incorporate the best available technologies and methodologies. The building initiatives to address climate risks, therefore, include a focus on enhancements to New York's building codes, with the goal of achieving two ends:

1. Strengthen new and substantially improved buildings to meet the highest possible standards;
2. Protect existing buildings—which remain the city's biggest challenge given their numbers—by encouraging targeted retrofits over time.

Strengthen new and rebuilt structures to meet the highest resiliency standards moving forward

For new and substantially improved buildings (that is, buildings for which the cost of alteration is greater than 50 percent of their previous value), the highest resiliency standards can be incorporated early in the design phase of construction in a manner that would effectively mitigate future losses. The City, through the Mayor's Office of Long-Term Planning and Sustainability (OLTPS), therefore will work with the City Council to enhance the Construction Codes so that these buildings are designed to reflect the best available information on climate risk and resiliency.

Retrofit as many existing buildings as possible to improve resiliency

Meanwhile, the City also must deal with its substantial in-place inventory of existing buildings that are or will be vulnerable to climate risks. In many ways, existing buildings represent a bigger challenge than new buildings. Most of the buildings in the city's 100-year floodplain are older, constructed to codes and standards that did not incorporate flood resistance. In fact, approximately 72 percent of the structures in the city's 100-year floodplain were erected before 1961, when the current Zoning Resolution was passed, and 85 percent before 1983, when the City adopted FEMA's flood maps and incorporated flood-resistant construction standards for new and substantially improved buildings in the 100-year floodplain.

New York City's buildings also, in many cases, can be found amid urban site conditions that make retrofits challenging. The city's building stock differs dramatically from that of communities in other coastal flood-prone areas, such as the Gulf Coast and the Southern Atlantic Coast, which have sought to incorporate flood resistance even into their preexisting building stock. While construction in these coastal areas consists primarily of lower-density homes, buildings in New York City's 100-year floodplain include substantial numbers of higher density, and often attached multi-family, and commercial/nonprofit buildings. Thus, while more than 70 percent of the 67,700 buildings in the 100-year floodplain of FEMA's PWMs are 1- and 2-family homes, a majority of the building area and housing units in the floodplain can be found in higher-density buildings. Specifically, approximately 34 percent of the 535 million square feet located in the 100-year floodplain can be found in multi-family buildings or mixed-use structures (which also tend to be multi-family), and roughly 39 percent can be found in commercial/nonprofit space. Similarly, while 1- and 2-family homes represent only 24 percent of the approximately 249,000 housing units in the 100-year floodplain, roughly 76 percent can be found in multi-family or mixed-use buildings. *(See chart: Buildings, Building Area, and Housing Units in the 2013 PWMs Broken Down by Land Use)*

The very nature of the city's structural inventory poses a challenge to using methodologies such as elevation to retrofit New York's building stock. For example, many property types common in New York City's neighborhoods have multiple stories and are constructed from materials such as masonry and concrete that make elevation difficult. Many also are attached or semi-attached, which means that elevation would require coordination with neighboring properties, and may be physically difficult and financially infeasible. Additionally, whereas in other jurisdictions, abandonment of ground floor and underground space may be a viable alternative to actual elevation, in many parts of New York, because of the high

value of usable real estate, doing so would result in significant financial loss to property owners.

Greater flood protection in developed areas also poses urban design challenges—both for retrofitting and new construction. Such protection can interfere with the visual connectivity between the first floor of a building and the public sidewalk, creating uninviting entranceways, and leading to architecture that fails to engage pedestrians. In New York, traditional flood-protection methods, therefore, have the potential to impact the neighborhood fabric in a negative way and could undermine the vitality of street life.

For example, if buildings in dense urban areas are elevated, spaces left unoccupied at the street level could pose security risks to area residents. Elevation also can make commercial corridors—which provide critical services and employment—untenable by inhibiting access to street-level retail. Visual and physical accessibility of retail from the sidewalk is more important in New York than elsewhere because New Yorkers walk to shopping and services more than anyone else in the United States. Elevating stores also can isolate them from the street environment. In addition, dry flood-proofing of retail or industrial structures can be technically difficult or costly. Meanwhile, even where elevation may be physically possible (as in the case of smaller, wood-framed structures), the narrow lots in New York City limit the space needed to stage construction and make post-elevation access challenging. *(See sidebar: Urban Site Conditions and Flood Protection Challenges)*

In short, these and other constraints make it prohibitively expensive, physically infeasible, or both, for owners of many properties in the floodplain to elevate their structures or to otherwise retrofit their buildings to meet national flood-resistant construction standards in full. In fact, as of the writing of this report, it is estimated that owners of approximately 39 percent of buildings in the 100-year floodplain of the PWMs (or roughly 26,300 buildings) would face significant challenges if they sought to retrofit in these ways due just to their challenging site conditions such as narrow lots or attached structures—without even taking into account issues such as cost and the ability to secure financing.

Given these obstacles, some policy advocates have suggested alternative approaches to improve the resiliency of New York's housing stock, such as government purchases of large numbers of vulnerable properties in the floodplain. Buyouts intended to turn exposed properties into natural or open spaces may make sense in limited circumstances in very high-risk areas where vulnerability is a function of the land itself, and not of shortcomings in the buildings that exist there as of the writing of this report. However, such buyouts raise many issues. They would need to result in an open space or buffer area that serves a useful purpose, and to do so, would require near-unanimous participation of area residents to be effective—a challenge in many circumstances. Additionally, even if unanimity (or near-unanimity were achieved), the approach can be expensive—diverting limited resources from other investments that may be more cost-effective or have a more widespread impact. Given the scale of New York's building stock in the coastal area, the fact that buildings can be constructed to address the flood risks faced in the vast majority of coastal neighborhoods, and the limited alternative options for a growing population in New York City and the region, wholesale abandonment of or retreat from the city's waterfront is simply not a practical option.

The City, therefore, proposes an approach pursuant to which buyouts would be a tool in the City's tool kit, but one that would be used sparingly and, where used, would most commonly be used with the goal of redeveloping acquired properties in a more resilient fashion. In most cases, the City will prioritize the use of limited resources to retrofit the largest number of existing buildings to a significantly higher standard of resiliency. This strategy focuses on avoiding catastrophic loss in building types that proved most vulnerable during Sandy and otherwise seeks to allow inhabitants to reoccupy buildings quickly—after complying with all City evacuation orders and once reentry is deemed to be safe—by focusing efforts on elevating or otherwise protecting critical building systems. As with all retrofits, these building improvements would be completed in compliance with existing City construction rules, including the requirement that alterations greater than 50 percent of building value, prior to improvement, be considered "substantial improvements." Substantially improved buildings must comply with the same flood-resistant construction standards as new buildings.

Strategy: Strengthen new and substantially rebuilt structures to meet the highest resiliency standards moving forward

Initiative 1

Improve regulations for flood resiliency of new and substantially improved buildings in the 100-year floodplain

As described above, the current rules for flood-resistant construction incorporate elevations from the most recently adopted FEMA FIRMs, which have not been significantly updated since 1983. In 2010, FEMA began working with the City to update these maps to reflect better information on current flood risk. As part of this effort, FEMA released PWMs in June 2013. These maps provide an updated approximation of the final boundaries of the floodplain and BFEs that will be found in the final FIRMs that are expected to be issued by FEMA in 2015, with City adoption thereafter.

To enable new and substantially improved buildings, as well as existing buildings that retrofit voluntarily, to withstand appropriate flood risk, the City has proposed an amendment to the Zoning Resolution to allow these buildings to be elevated, without being penalized by zoning height limitations, to the higher of the BFE in the current effective FIRMs or the best available flood maps (currently the PWMs), in each case, plus 1 to 2 feet of freeboard. The proposed changes would also allow additional flexibility for other resiliency measures, including the elevation of mechanical equipment and relocation of existing underground parking.

When the new FIRMs are finalized, the City will further update the Building Code to reference the elevations contained therein and to require freeboard of 1 to 2 feet above these elevations.

Looking to a future where sea level rise could result in flood elevations even beyond the mandated freeboard, the City also will conduct a study of the implications of permitting zoning relief for up to 3 feet of freeboard. This analysis will serve as a necessary first step towards potential future adoption of corresponding zoning changes.

Towards a similar end, the City and the NPCC will establish a set of interim metrics to be measured in 2025 that will indicate whether sea levels around New York appear to be rising at expected rates. Every six years—in conjunction with every second Construction Codes review cycle—the NPCC and the City will review observed sea level rise. If, by 2025, sea level rise surpasses the metrics put forth by the City and the NPCC, the Building Code will be amended at that time, with corresponding zoning relief, to require 3 feet of freeboard above the BFE in FEMA's FIRMs (rather than the proposed 1 to 2 feet).

The Construction Codes (of which the Building Code is a part) will be amended in yet other ways, including additional changes that will help protect building systems and enable continued building operation in the event of utility failures during a flooding event. For example, new and substantially improved buildings in the 100-year floodplain will be required to install backflow preventers for sewer connections, to seal points of entry further from floodwaters, and will be required to safeguard toxic materials.

The Construction Codes also will be amended to reduce restrictions on the length of cables that carry telecommunications service, allowing these cables to reach elevations above the DFE.

In addition, the City will revise existing provisions that restrict options for elevating critical equipment. For example, to encourage building owners to protect fuel tanks from flood damage, the current limits on the size of fuel tanks located above grade will be revised to allow for more flexibility. Also, DOB will issue a clarification on how mechanical equipment rooms contribute to floor area in a building.

In 2013, the City, through OLTPS, will seek to implement the foregoing changes to the Construction Codes. Also in 2013, DCP will continue to take the foregoing zoning changes through the public review process, with the goal of adoption before the end of the year. By 2015, DCP also will launch an analysis of the implications of allowing up to 3 feet of freeboard above the BFE, pending the scheduled release of the final FIRMs.

Initiative 2

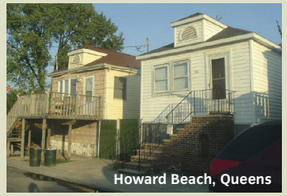
Rebuild and repair housing units destroyed and substantially damaged by Sandy

Roughly 23,000 private residential buildings encompassing nearly 70,000 housing units sustained some level of damage during Sandy. More than 2,000 of these buildings were significantly damaged and must be completely rebuilt or substantially improved, incorporating the highest resiliency standards. To address the damages sustained and to more effectively prepare these significantly damaged buildings for future storm events, the City either will assist owners or, in limited cases meeting City criteria, will facilitate the acquisition of properties by new owners whom it will assist, in rebuilding and substantially improving these properties based on the best floodplain data available over time. Additionally, the City will seek to incorporate resiliency measures into approximately 500 to 600 multi-family properties that sustained minor damage, including those developed under the City's Mitchell Lama Program and other affordable housing programs.

The Mayor's Office of Housing Recovery Operations (HRO) and HPD will lead these efforts. Federal Community Development Block Grant (CDBG) funding in the amount of approximately $530 million has been allocated to the first phase of these programs. HRO and HPD plan to

Urban Site Conditions and Flood Protection Challenges

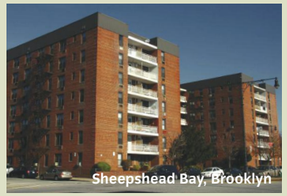
As described previously, site conditions in New York City make it both physically and financially difficult for the owners of many buildings in the 100-year floodplain to retrofit their buildings to current Federal flood-resistant construction standards. These challenges come into sharp focus when common building types in neighborhoods across New York City are examined.


Howard Beach, Queens

1- AND 2- FAMILY HOMES ON NARROW LOTS
Narrow lots lack space needed to stage construction when elevating a building.

Bayside, Queens

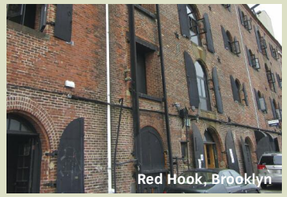
ATTACHED AND SEMI-ATTACHED HOMES
Reconfiguration of one building affects adjoining ones, and, with multi-story buildings, elevation requires removing floors and front and rear facades, in effect demolishing and rebuilding.


Sheepshead Bay, Brooklyn

MULTI-STORY BUILDINGS
These buildings would, under current Federal flood-resistant construction standards, either have to eliminate all ground-floor and basement units, displacing families and forfeiting rental income, or elevate, which is highly impractical.

South Street Seaport, Manhattan

BUILDINGS WITH COMMERCIAL GROUND FLOORS
Commercial spaces thrive on ground-floor access. Raising the lowest floor to higher base flood elevations hampers commerce and complicates accessibility.


Red Hook, Brooklyn

INDUSTRIAL BUILDINGS
Though Federal flood-resistant construction standards allow dry flood-proofing of industrial spaces, this approach is costly and less reliable for flood levels higher than 3 feet.

Credit from top to bottom: Tim F via Flickr, WikiMedia, mercurialn via Flickr, Gryffindor via WikiMedia, Adam Elmquist via Panoramio

use a portion of these funds to repair and rebuild a subset of properties that were damaged significantly and, therefore, must be rebuilt or substantially improved.

Initiative 3
Study and implement zoning changes to encourage retrofits of existing buildings and construction of new resilient buildings in the 100-year floodplain

The City, through DCP, will undertake a series of citywide and neighborhood-specific land use studies to address key planning issues in severely affected and vulnerable communities. As part of these studies, the City will identify ways to facilitate the voluntary construction of new, more resilient building stock and to encourage voluntary retrofits of existing vulnerable buildings over time. To be undertaken in close consultation with local residents, elected officials, and other community stakeholders, these land use studies will focus in particular on the challenges posed by the combination of flood exposure of the applicable neighborhoods, the vulnerability of the building types that are found in these neighborhoods (e.g., older, 1-story bungalows) and site conditions in these areas, such as the narrow lots in Midland Beach that can make replacement or retrofit of vulnerable buildings expensive or complicated.

Both citywide zoning changes and detailed neighborhood studies will promote the voluntary development of new, resilient buildings through strategies such as:
- allowing more flexibility in the measurement of height of elevated buildings and allowing parking to be placed underneath, provided steps such as landscaping are taken to address the quality of the streetscape; and
- enabling or even encouraging construction of new buildings that meet modern standards on existing small lots, either individually or in combination with other lots to be rebuilt.

Zoning changes to encourage the voluntary retrofit of existing buildings could include:
- permitting building owners to construct an additional floor above existing top floors to replace space below the DFE that is limited in use to meet flood protection standards;
- promoting best practices for the alternative use of ground floor space below the DFE, where Federal flood-resistant construction standards do not permit residential uses and may not permit commercial or other uses;
- increasing the building space allowed for mechanical systems, enabling property owners to more easily elevate building systems; and
- permitting greater flexibility in the design of stairs, ramps, and other accessibility features where elevation is required for flood-protection purposes.

DCP's proposed Flood Resilience text amendment addresses some of these issues on a citywide basis. Subject to available funding, the goal is for DCP to commence additional studies in 2013. Thereafter, DCP would move to implement any changes deemed to be appropriate based on the results of its study.

To supplement these studies as well as post-Sandy housing recovery efforts more broadly, DCP also has worked with representatives of the local design community to develop a set of urban design principles to consider while designing flood-resilient buildings. These principles—included in DCP's *Designing for Flood Risk* study to be released in June 2013—can help mitigate the negative impacts of building elevation on streetscape, building access, ground floor activity, architectural quality, and neighborhood character. *(See sidebar: Designing for Flood Risk: Urban Design Principles)*

Initiative 4
Launch a competition to encourage development of new, cost-effective housing types to replace vulnerable stock

Many property owners are facing the reality that their homes are not only vulnerable to risks such as coastal flooding, but shortly they also may be facing substantial increases in their insurance premiums. In some cases, elevation of existing structures may be possible; in other cases, however, such elevation may be difficult or even impossible.

Subject to available funding, the City, through HPD, will launch an international competition called the Resilient Housing Design Competition. This competition will award prizes to private sector developers who design and develop new, high-quality housing prototypes that offer owners of vulnerable building types (e.g., older, 1-story bungalows) a cost-effective path that is consistent with City building and zoning requirements to replacing these structures. The winners of this competition will be given the opportunity to place these structures into service in connection with a City-sponsored development project. Prototypes will have applicability throughout the five boroughs. The goal is for HPD to launch this competition in 2013. Phase 1 of the competition will be an open international call for the creation of these prototypes, with a focus, in particular, on prototypes that address site conditions that are particularly challenging. Up to 10 winners will be selected for total cash prizes of up to $2 million, awarded by a panel of judges, which, among other considerations, will evaluate the likelihood that the prototypes actually will be deployed by New York City property owners.

Initiative 5
Work with New York State to identify eligible communities for the New York Smart Home Buyout Program

In February 2013, New York State announced a program pursuant to which the State would purchase highly vulnerable properties, tear down existing structures, and convert such properties into permanent open space. The City—through multiple agencies and departments including HRO, HPD, DCP, the Department of Environment Protection (DEP), and the Department of Parks & Recreation (DPR)—will evaluate opportunities for collaboration with the State in connection with this program based on an objective set of criteria developed by the City, including extreme vulnerability, consensus among a critical mass of contiguous local residents, and other relevant factors. It is anticipated that the eligibility criteria will be met in a relatively limited number of New York City areas. Funds allocated for this program statewide include $171 million in CDBG funding from New York State, together with other State sources.

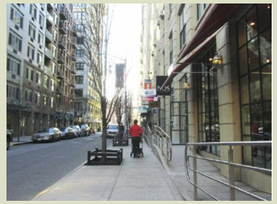
Initiative 6
Amend the Building Code and complete studies to improve wind resiliency for new and substantially improved buildings

In recent memory, New York City has not been struck by a regional wind event. However, though current Building Code requirements are calibrated to withstand a Category 3 hurricane, as the climate changes, the frequency of extreme wind events is likely to increase.

To address this uncertainty and improve the City's approach to protecting buildings from wind risks, the City will take the precautionary measure of amending the Building Code to clarify current wind-resistance specifications for façade elements and will restrict the use of pea gravel and small dimension stone as ballast on roofs. The City, through OLTPS, will implement these Building Code changes in 2013. Subject to available funding, DOB also will initiate a study to help the City more accurately map the wind profiles facing New York City's buildings across all five boroughs, identifying sites that face the greatest risk. The goal is to commence this study in 2013, with completion expected in 2015.

Designing for Flood Risk: Urban Design Principles

FEMA and Building Code standards for flood-resistant construction require new or substantially improved buildings in flood zones to be flood-proofed or elevated above projected flood levels. However, elevating buildings more than a few feet above the sidewalk can have negative effects on streetscape, building access, public safety, ground floor activity, architectural quality, and neighborhood character. DCP has worked with representatives of the local design community to develop a set of urban design principles to guide the design of flood-resilient buildings.



VISUAL CONNECTIVITY
Having the windows and front door of a building face the public street can create a sense of security and comfort for pedestrians. These architectural elements also provide visual interest, which in turn promotes a walkable neighborhood. Elevating the first floor of a building can limit this visual connectivity. In residential neighborhoods, porches, stoops, and generous access elements can be designed in order to help to mitigate this disconnection. On commercial streets, this visual connectivity is important to the viability of local retail. A common best practice would be to dry flood-proof the commercial space so that it can be closer to sidewalk level and therefore maximize visual and physical connectivity.

FACADE ARTICULATION
Buildings often contribute to the character of a place by offering human-scale architectural elements, particularly on first floors. Elevated buildings with crawl spaces, parking, or storage can create blank walls at grade. Setting a building back from the property line slightly and using landscaping and/or other creative design solutions could help to buffer these voids in an active streetscape. If ground-level parking is the only feasible option, then garage doors and curb cuts should be designed to minimize their impact on the pedestrian realm.

INVITING ACCESS
Elevated buildings pose challenges for accessibility. Ramps can be difficult to accommodate, particularly on smaller lots. Even smaller buildings that are not required to meet Americans with Disabilities Act (ADA) standards have the challenge of integrating longer runs of stairs into building or landscape design. Introducing a 90-degree turn or landing, and paying careful attention to overall stair design could make a long run of stairs easier to climb and appear more inviting for pedestrians.

NEIGHBORHOOD CHARACTER
Some neighborhoods exhibit a relative uniformity of building form. Elevating buildings will necessarily produce variations in building height and, in some cases, placement on the lot. Designers should respect a neighborhood's character by taking cues from existing context in building massing, fenestration, rooflines, and other architectural elements.

Adapting to higher standards of flood resistance is both a challenge and an opportunity for architects to achieve higher standards of design. The opportunity exists to innovate and produce buildings that contribute to the public realm and have a positive long-term effect on those neighborhoods recovering from Sandy.

Source: DCP

Strategy: Retrofit as many buildings as possible so that they will be significantly more resilient than they are today

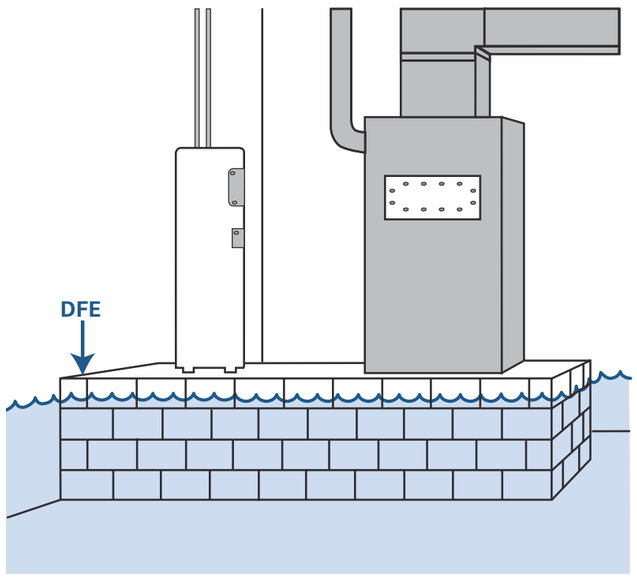
Initiative 7

Encourage existing buildings in the 100-year floodplain to adopt flood resiliency measures through an incentive program and targeted requirements

The City will propose a program that will encourage and, in some limited cases, require property owners to adopt targeted flood protection measures that are tailored to New York's dense urban environment and that will offer meaningfully greater protection than the status quo.

This program consists of two elements:
- an incentive program, which will fund a portion of eligible flood-protection costs for existing building stock, subject to available funding; and
- a requirement for large buildings—those with 7 or more stories that are more than 300,000 square feet in size—to undertake flood-protection measures by 2030.

Flood Protection of Building Systems



Example of a building hot water heater and furnace elevated above the minimum flood protection level via a platform.

Incentive Program

With the goal of ensuring that the vast majority of the built square footage currently in the 100-year floodplain is significantly better protected from flood risk going forward than prior to Sandy, the City will create, subject to available funds, a $1.2 billion program that will offer grants or, where appropriate, loans to building owners to help fund a percentage of the eligible costs of completing all or some of the Core Flood Resiliency Measures (as defined below).

The actual percentage of costs covered by this program will be based on a sliding scale, taking into account the uses of the applicable building (as defined by Department of Finance (DOF) tax class), the applicable building's size, and building value (using assessed value as a proxy). Prior to implementation of this program, the City will publish for public comment a proposed methodology for calculating the aforementioned sliding scale. Subject to the discretion of the City in cases of great need, the City will cap awards at $2 million per building.

Core Flood Resiliency Measures: As Sandy demonstrated, during an inundation event, damage to systems and equipment is the most common type of damage experienced by buildings. In addition to imposing costly repairs, damage to systems and equipment also delays recovery, preventing people from reoccupying their homes and getting their businesses up and running quickly after a storm.

The Core Flood Resiliency Measures will therefore include elevation or other flood protection of the following critical building equipment and utilities: fire protection equipment (including alarms and pumps); electrical equipment (including panels, switch gear, and transformers); heating, ventilation, and air conditioning (HVAC) equipment (including boilers, furnaces, and burners); plumbing equipment (including domestic water equipment and sump pump power feeds); telecommunications equipment; elevator equipment; and emergency generators and associated fuel tanks and pumps (subject to the approval of the Code amendments described above). (*See graphic: Flood Protection of Building Systems*)

Elevation or flood-proofing of this equipment will be required to meet the standard of the higher of the BFE, as set forth in the PWMs, or the FIRMs in effect as of the writing of this report, in each case, plus 1 to 2 feet of freeboard (as applicable). Upon adoption of the new FIRMs, elevation will be required to meet the standard of the BFE, as set forth in the new FIRMs, plus 1 to 2 feet of freeboard (as applicable).

For owners of 1- to 2-story buildings of a combustible type—those buildings most at risk of severe structural damage during a flood—Core Flood Resiliency Measures also will include structural reinforcement to prevent collapse in the event of inundation, including:
- upgrades to the foundation;
- reinforcement of exterior walls; and
- wet flood-proofing (see above).

These measures do not suggest that inhabitants should remain in their buildings during a flood or storm surge event. Regardless of the interventions completed, all residents and businesses should, of course, comply with any City evacuation orders to promote their safety. However, the goal is for the retrofits proposed above to allow residents and businesses to recover more quickly after a storm, once reentry is deemed to be safe.

Disbursement of Funds: For the first one to two years of the program, funds will be allocated to specific categories of uses to enable an equitable distribution of such funds across building types and geographies. Categories for which funds will be set aside during this one to two year period will be the following:
- $100 million reserved for 1- to 3-family homes (DOF tax class 1);
- $500 million to be divided among the boroughs based on their share of buildings in the 100-year floodplain; and
- $100 million reserved for affordable housing projects (i.e., projects where at least 50 percent of units have income restrictions pursuant to a regulatory agreement, or projects otherwise designated as "affordable" by the HPD Commissioner).

At the end of the initial one to two year period of the program, any reserved funds that remain unused will be made available to all eligible applicants.

The Core Flood Resiliency Measures incorporate lessons learned from FEMA's work in assessing the damage from Sandy, as well as guidance from FEMA's extensive experience with building mitigation. Yet existing NFIP rules do not offer insurance rate reductions for buildings that become materially less vulnerable with these retrofits. To address this challenge, the City will continue to work with FEMA to develop a system of mitigation premium credits that reduce the cost of insurance for property owners who invest in these and other alternative approaches (see Chapter 5).

New York City Economic Development Corporation (NYCEDC) and HPD will administer this program beginning in 2013. The City will pursue CDBG funds as well as Federal Hazard Mitigation Grant Program (HMGP) funding, and other new sources, for the required funding for the program (see Chapter 19, *Funding*).

Mandate for Large Buildings

In addition to the incentive program outlined above, the City also will require buildings in the 100-year floodplain that are 7 stories or taller and greater than 300,000 square feet in size to complete Core Flood Resiliency Measures by 2030, so that the City's largest buildings are not knocked out of service by future flood events.

Given the structural stability of buildings of this size, this mandate will apply to elevation or flood-protection of building equipment and utilities as described above, but will not require structural reinforcements. This mandate will be implemented via a change to the City's Building Code and will be administered by DOB.

This mandate will not apply to public housing developments—which are pursuing a parallel resiliency program—or hospitals, nursing homes, and adult care facilities—which will be subject to a different mandate (see Initiative 9, below, and Chapter 8, *Healthcare*). The mandate will apply to affordable housing projects. However, because of the sometimes precarious financial position of such projects, they will be entitled to apply for a hardship waiver from the HPD Commissioner. Buildings subject to the mandate will be eligible to apply for funds through the incentive program described above.

With respect to buildings subject to this mandate, there will be two ways to achieve compliance. One will be a more traditional compliance track, pursuant to which building owners will complete one of the following approved flood-protection strategies:
- elevation of applicable equipment and utilities at or above the applicable DFE;
- dry flood-proofing of equipment and utilities below and up to the applicable DFE; and
- dry flood-proofing of the building itself below and up to the applicable DFE.

Buildings subject to the mandate also will be offered an alternative compliance track, pursuant to which building owners will be deemed to have satisfied the mandate, provided that they have taken one of the following steps:
- put in place alternative building-based measures (for example, temporary barriers coupled with an action plan; regular drills by trained staff; and renewal certificates) that provide an equivalent level of protection to the traditional path, as certified by a structural engineer and approved by DOB; or
- achieved protection via a coastal defense system that protects the applicable building up to the applicable DFE, as certified by a structural engineer and approved by DOB.

Notwithstanding the foregoing, the alternative compliance track will not be available for the following life safety systems: emergency generators and associated fuel tanks and pumps (subject to the approval of the Code amendments described above); fire alarm system components; fire pumps (to the extent that such components are not submersible); domestic water systems (to the extent that components are not submersible); and sump pump power feed equipment.

In addition, property owners may appeal to DOB for a variance from the mandate if site constraints or other engineering factors render compliance impossible. The BSA also will be authorized to grant such variances.

The City will seek City Council approval for this mandate—through a Building Code change—by the end of 2013. When first implemented, DFEs will be as set forth in the PWMs. Upon adoption of the new FIRMs in 2015, DFEs will be as set forth therein.

Compliance with the mandate will be monitored by the City in two ways. First, by the end of 2020, subject buildings owners will be required to submit an interim report certifying that they have complied with the mandate, or to submit an affidavit describing a plan to achieve such compliance by 2030. Any buildings that become subject to this mandate in the future as flood maps are revised will have 15 years from the date that the applicable map is adopted to comply with the mandate.

Initiative 8

Establish Community Design Centers to assist property owners in developing design solutions for reconstruction and retrofitting, and connect them to available City programs

Property owners in neighborhoods affected by Sandy, or other potentially vulnerable areas in the 100-year floodplain, are working to understand how to rebuild or retrofit their buildings to be prepared for future extreme weather. The City, through HRO, will work with local partners and advocates to establish a physical presence in affected neighborhoods across the city in so-called Community Design Centers, in which a mix of professional and volunteer design staff would be on-call to help residents with reconstruction questions. The staff of each Community Design Center will also direct property owners to City programs that facilitate building repair and resiliency. The Centers could be managed by the City with support from local partners.

Initiative 9

Retrofit public housing units damaged by Sandy and increase future resiliency

New York City Housing Authority (NYCHA) developments across the city sustained significant damage during Sandy, including damage to electrical systems in approximately 250 NYCHA buildings. To address this issue, the City will implement targeted efforts to strengthen building resiliency against future extreme weather events by designing and constructing improvements to public housing directly impacted by Sandy.

Federal CDBG funding in the amount of $108 million has been allocated to this initiative. The first phase of this program will include the installation of permanent emergency generators or alternate measures to enhance power resiliency at NYCHA's most vulnerable impacted buildings. In addition, a combination of payments from NFIP policies, commercial insurance policies, and FEMA's Public Assistance Program may be available to provide funds to cover the cost of repairing damaged structures and making resiliency improvements on these damaged buildings. Subject to available funding, NYCHA will begin this

work in 2013. By September 2013, NYCHA will also begin a planning process to identify targeted resiliency measures (for example, raised boilers and electrical switch gear) to address vulnerability throughout buildings in its portfolio in the 100-year floodplain. *(See sidebar: New York City Housing Authority Resiliency Planning)*

Initiative 10
Launch a sales tax abatement program for flood resiliency in industrial buildings

Industrial properties are particularly vulnerable to flood damage, because they tend to be concentrated in coastal areas of the city. This vulnerability is heightened since many industrial businesses are located in 1- to 2-story structures and ordinarily store expensive equipment and inventory at ground level. Industrial businesses also frequently operate on thin profit margins.

Given this, the City will launch a sales tax abatement program directed at industrial businesses to help subsidize the cost of making flood resiliency improvements. The program will prioritize 1- to 2-story buildings with more than 4 feet between their actual ground elevation and the applicable BFE.

The New York City Industrial Development Agency (NYCIDA) will implement this program beginning in 2013, with total benefits pursuant to the program to be capped at $10 million.

Initiative 11
Launch a competition to increase flood resiliency in building systems

Approximately 88,700 buildings were located in areas impacted by Sandy. The number of properties at risk of coastal flooding, meanwhile, is likely to increase through the 2020s and 2050s, as sea levels rise and the floodplain expands.

To address this challenge, the City will launch a Resiliency Technologies Competition to allocate grants on a competitive basis to improve building resiliency. The competition will seek to fund demonstration projects that use innovative technologies to make building systems more resilient. NYCEDC will launch this competition in 2013 and expects to select winners in 2014. Approximately $40 million in Federal CDBG funding has been allocated to the competition.

Initiative 12
Clarify regulations relating to the retrofit of landmarked structures in the 100-year floodplain

A number of vulnerable structures in the city's 100-year floodplain are designated as historic landmarks. Landmarks have restrictions applicable to them that may make it challenging for the owners of those structures to undertake resiliency retrofits. Consistent with its underlying mission and legislation, the Landmarks Preservation Commission (LPC), therefore, will clarify its regulations, with the goal of assisting owners of landmarked buildings and properties in landmarked districts in the 100-year floodplain who are contemplating retrofit projects.

Initiative 13
Amend the Building Code to improve wind resiliency for existing buildings and complete studies of potential retrofits

As indicated above, while the NPCC does not provide specific projections for wind speeds, its projections do suggest an overall increase in the frequency of the most intense storm events that have wind effects. Older buildings that predate modern standards are particularly vulnerable, especially in coastal areas with open exposures. In addition, all structures, including high-rise buildings, will continue to face potential damage to façades from airborne debris during the sorts of extreme wind events that could occur in the future.

To address these risks, in 2013, the City—through OLTPS—will amend the Building Code to expand the existing DOB Façade Inspection Safety Program for high-rise buildings to include rooftop structures and equipment. Subject to available funding, DOB also will initiate a study of potential wind resiliency retrofits and their potential costs and benefits, consulting with a committee of industry experts. The goal is to complete the study by 2016.

New York City Housing Authority Resiliency Planning

The New York City Housing Authority (NYCHA) operates 2,596 buildings in 334 developments throughout New York City. These developments are home to over 400,000 residents—approximately the size of the entire population of Miami, Florida. Residents include working families, low-income households, seniors, and other vulnerable populations. While these developments are located in all five boroughs, there are significant concentrations of public housing on the waterfront far from the urban core, as in the Rockaways in Queens, or in locations with limited public transportation, such as in Red Hook in Brooklyn.

In preparation for Sandy's arrival, therefore, NYCHA was required to take important steps to protect its residents and assets—including implementing evacuation plans in the City's evacuation zones. Despite these orders to evacuate, many NYCHA residents, like others throughout the city, chose to shelter in place.

Due to the large size and heavy construction of NYCHA buildings, the developments suffered little structural damage. However, in many cases, building mechanical and electrical equipment in basements was inundated. A total of 402 buildings housing 80,000 residents lost power as a result of the flooding of these building systems. Though NYCHA and community-based organizations worked to address the needs of these residents, the impact of the storm damage and the difficulty repairing it demonstrated the importance of making resiliency investments going forward.

As part of the recovery and rebuilding process, therefore, NYCHA is working to strengthen its buildings portfolio and incorporate measures such as the flood-proofing of critical building systems in areas impacted by Sandy. In addition, NYCHA is analyzing options for increasing the safety of buildings not impacted by Sandy but at risk of future flooding and other extreme weather damage. Over the next few months, NYCHA will begin a planning process to identify the best methods for increasing resiliency in vulnerable NYCHA buildings across the city, a process that will engage resiliency engineering experts and elicit input from NYCHA residents.

Example of large backup HVAC equipment on street

Credit: FEMA/Ashley Andujar

Initiative 14
Amend the Construction Codes and develop best practices to protect against utility service interruptions

Disruptions to building services—due either to the failure of in-building systems or of the utility networks on which they rely—can render a building unusable during a range of climate events, such as storms and heat waves. To begin to address these risks, the City—through OLTPS—will develop a list of relevant best practices and, in certain cases outlined below, will amend existing regulations.

The first step that the City will take will be to require, by 2014, common access to potable water in high-rise multi-family buildings during emergency situations. This will be done to help upper-floor residents who may lose access to such water in their units in the event of the failure of building electric pumps. The City also will develop requirements, beginning in 2013, to enable exit lighting to continue to function during an extended blackout.

Additionally, by 2013, the City will develop best practices relating to voluntary backup power generation and, will amend relevant codes to allow buildings to comply with these best practices. Proposed code changes will allow for reliable, safe, and resilient alternative fuel sources and cogeneration systems for emergency power, as well as building-mounted solar power. New guidelines for "quick-connect utility hook-ups" also will be promulgated, facilitating the rapid restoration of electricity and heat during utility outages.

The City will further develop, by 2014, best practices for emergency planning relating to longer-term survivability and will create model "building emergency plans" available to building owners. Among other provisions, the model plans will encourage large commercial buildings to pre-negotiate disaster recovery agreements with service providers and will encourage multi-family residential buildings to provide clear communication protocols for essential personnel.

The City also will study, by 2015, strategies to limit heating and cooling losses through building exterior walls, windows, and roofs. The purpose of this study will be to determine how to extend the length of time during which homes and businesses can continue to operate after the loss of electrical power.

Community and Economic Recovery

Business recovery efforts in Red Hook, Brooklyn

Credit: Michael Fleshman

Over 23,000 businesses and nonprofits employing 245,000 people were located in areas flooded by Sandy. Nearly 95 percent of these impacted enterprises were small- and medium-sized (employing 50 or fewer people), with many concentrated in the retail and service sectors. However, a number of very large enterprises also were impacted by Sandy's storm surge, including major corporations in Lower Manhattan; healthcare institutions on Hospital Row and spread throughout the Rockaways and Coney Island; and manufacturers across a wide swath of Brooklyn, Queens, and Staten Island. Meanwhile, outside of Sandy's inundation area, tens of thousands of additional businesses and nonprofit institutions, employing many thousands more New Yorkers, were impacted indirectly by Sandy, losing heat and power for, in some cases days unable to access customers and employees due to transportation outages.

With local retailers, institutions, and service providers temporarily inaccessible or offline, the immediate aftermath of Sandy reinforced the importance of having community services and facilities in times of crisis. It also demonstrated the critical role that local commercial corridors play throughout the city as centers of employment and economic activity.

Overall, impacted businesses and nonprofits—whether large, small, or in-between—faced extensive damage to inventory and equipment, damage to the interiors of their spaces, and/or structural damage to their buildings. In fact, according to estimates released by the Mayor's Office, the direct private losses in New York City due to Sandy totaled approximately $8.6 billion, of which up to $4.8 billion were uninsured.

A significant percentage (70 percent) of the businesses and nonprofits that were most seriously impacted were concentrated in five distinct areas of the city. These areas were: the Brooklyn-Queens Waterfront, the East and South Shores of Staten Island, South Queens, Southern Brooklyn, and Southern Manhattan. In recognition of this disproportionate impact, on December 5, 2012, Mayor Bloomberg announced the creation of new Business Recovery Zones (BRZs) to align the City's recovery efforts to the specific needs of these most impacted areas. Each BRZ was assigned a point person to identify and begin to develop solutions to the issues facing these areas. BRZ leaders conducted outreach events, worked with more than 1,000 businesses to connect them to government resources, and ensured that basic services—such as grocery stores—were restored quickly.

In addition to forming and staffing the BRZs, the City also quickly undertook a number of other activities to assist businesses in the immediate aftermath of Sandy, including:

- Coordinating efforts between the Department of Small Business Services' (SBS) Business Outreach Emergency Response Unit and the Office of Emergency Management to help address time-sensitive business and nonprofit issues, including power restoration and large debris removal;
- Launching nine NYC Restoration Centers;
- Tasking NYC Business Solution Centers to provide local services to businesses, nonprofits, and residents;
- Launching a loan and matching grant fund for impacted businesses and nonprofits, capitalized with over $25 million, in partnership with Goldman Sachs, the New York Bankers Association, the Mayor's Fund to Advance New York City, and the Partnership for New York City;
- Structuring, through the New York City Industrial Development Agency, a sales tax waiver program to reduce the cost of reconstruction with $25 million in total capacity;
- Working with New York State to administer National Emergency Grant funds, which the City used to hire more than 1,100 individuals to help with recovery and cleanup in parks and public housing;
- Launching a $1 million Small Business Assistance Grant in partnership with Barclays, Citi, and UBS for businesses that had reopened but needed help with repairs;
- Establishing the NYC Restoration Business Acceleration Team to coordinate City services, such as permitting and inspections, in order to expedite business and nonprofit reopenings; and
- Launching the Support NYC Small Business campaign to spotlight open businesses and their recovery stories through radio, subway, bus shelter, and print advertisements, as well as an interactive website that, as of the writing of this report, has been viewed more than 20,000 times.

In total, these programs—launched almost entirely with City resources while Congress debated the scale of Sandy-related supplemental appropriations—are believed, as of the date of this report, to have assisted more than 2,500 companies, employing over 6,800 New Yorkers in all five boroughs.

Building on the positive momentum generated by the aforementioned programs, the City's Partial Action Plan, which outlines the uses of the City's initial $1.8 billion allocation of Federal disaster recovery funding under the Community Development Block Grant (CDBG) program, proposed the dedication of $300 million of this funding, including planning and administrative costs, to targeted business, nonprofit, and community recovery programs. The plan was approved on May 10, 2013 by the US Department of Housing and Urban Development.

Using these and other resources in order to support recovery in the impacted areas, the City will pursue a five-borough community and economic recovery plan to help build grassroots capacity and foster community leadership; to help businesses and nonprofits impacted by Sandy to recover; to help businesses and nonprofits in vulnerable locations to make resiliency investments that will prepare them better for future extreme weather; and to bring new economic activity to neighborhoods recovering from the impacts of Sandy to enable these neighborhoods to come back even stronger than they were before.

HireNYC

There is the opportunity to use Sandy rebuilding efforts to put people in devastated communities back to work. This is especially important in hard-hit areas that had high rates of unemployment prior to the storm. The City is dedicated to taking advantage of this opportunity and will use its HireNYC and Workforce One Career Centers to do so. Immediately after Sandy, the City's Workforce One Career Centers helped to locate more than 1,000 workers to help with cleanup efforts in impacted communities.

HireNYC is a free program that connects low-income individuals to economic development projects sponsored by the City, taking advantage of the City's workforce development services. Among other things, the program provides free applicant screening services to project developers. This program, along with the City's Workforce One Centers (including a new center to be opened in Far Rockaway), will help to ensure that vulnerable populations in impacted communities are positioned to take advantage of post-Sandy rebuilding efforts.

Local advertising supporting businesses recovering from Sandy

Initiative 1
Launch Business Recovery and Resiliency Programs

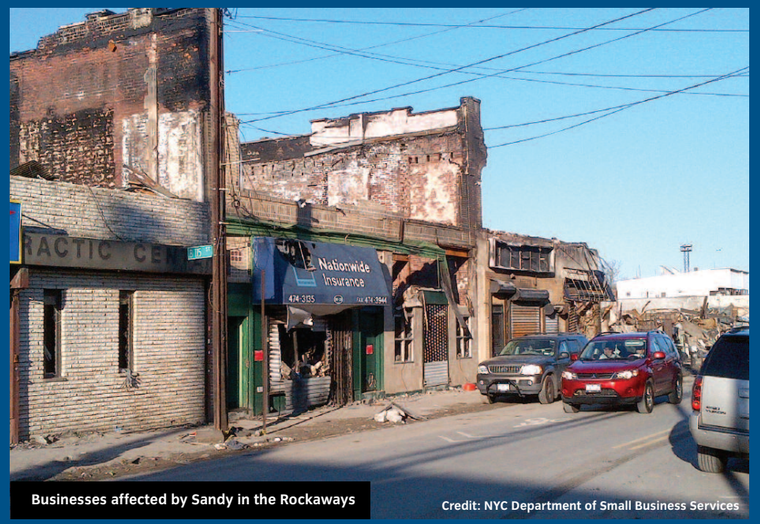
During Sandy, over 23,000 businesses citywide were inundated by the storm. For many, recovery has been challenging. To assist with this recovery, immediately after the storm, the City launched the series of programs previously described, including a $25 million loan and grant program and a $25 million sales tax waiver program designed to help businesses get back on their feet. Building on the momentum of these programs, which have assisted more than 2,500 businesses as of the writing of this report, the City, through New York City Economic Development Corporation (NYCEDC), will launch the CDBG-funded Business Resiliency Investment Program of up to $100 million, including planning and administrative costs, to help vulnerable businesses throughout the city make resiliency investments in their buildings and equipment and the Business Loan and Grant Program of up to $80 million, to assist businesses with recovery and rebuilding efforts.

Initiative 2
Launch the Neighborhood Game Changer Competition

In many of the communities impacted by Sandy, lack of opportunities for economic advancement among significant impacted populations has hampered recovery. In many cases, this situation existed even before Sandy but has been exacerbated by the impacts of the storm. To address this, the City, through NYCEDC, will launch the CDBG-funded Neighborhood Game Changer program to invest up to $20 million in public money, including planning and administrative costs, in each of the five communities on which this report focuses. This funding will be available on a competitive basis to help finance transformational projects. Such projects could include those that:

- Bring transformative uses to an area's waterfront and beaches;
- Establish new anchor institutions, businesses, and critical services on commercial corridors;
- Improve transportation access and tourism infrastructure; and
- Attract new uses to and result in improved resiliency of public facilities.

To win the competition, projects will have to spur incremental economic activity and match public funding with significant private funding. This program will be administered by NYCEDC through a competitive Request for Proposals (RFP) process in 2013.



Businesses affected by Sandy in the Rockaways

Credit: NYC Department of Small Business Services

Initiative 3
Launch Neighborhood Retail Recovery Program

The cores of many Sandy-impacted neighborhoods are the local commercial corridors that provide employment opportunities and services to those who live and work around them. They include local retailers, institutions, and service providers—including food markets, pharmacies, social service organizations, laundromats, and others. In many cases, though, these corridors were devastated by the storm. To address this, the City will call on the Public Service Commission (PSC) and Con Edison to amend the preferential Business Incentive Rate (BIR) program, which offers a discount on Con Edison's electric delivery charges, and will call on the Long Island Power Authority (LIPA) to create such a program in the Rockaways, to allow it to be extended to impacted small businesses in the five communities on which this report focuses. Businesses and nonprofits with 10 or fewer employees that have received support from City-sponsored loan and grant programs will be eligible for the discount for five years up to a maximum discount of $50,000 per business or nonprofit. The maximum aggregate benefit available for each impacted community area will be $1 million, for a total benefit of $5 million. The program will focus on key priority corridors to enable resilient recovery in the most critical portions of each neighborhood.

Initiative 4
Support local merchants in improving and promoting local commercial corridors

As mentioned above, Sandy highlighted the important role played by local commercial corridors in many of the impacted communities. The City, through the SBS, will continue to provide financial and/or technical assistance to area business improvement districts (BIDs), merchant associations, and other groups that work to improve, market, maintain, and otherwise promote primary commercial corridors. Subject to review of applications received, SBS will prioritize allocating its resources, including its CDBG funding, to impacted commercial corridors. SBS programs, which, in addition to being funded by CDBG, also will be funded by private partners and the Mayor's Fund to Advance New York City, will seek to jump-start business activity in hard-hit areas by providing both capital and technical assistance for:

- Capacity building for existing and new BIDs, merchant associations, and chambers of commerce. Many of the key commercial corridors in the impacted areas lack organized efforts in retail corridors, and SBS will help to form these entities and give them the tools to market local businesses, hold promotional events and programming, and coordinate cleanliness and safety efforts. In addition to using upcoming allocations of CDBG funds, SBS has committed to providing seed money to create new merchant organizations for hard-hit areas in the Rockaways, and in and around the South Street Seaport.

- Retail façade and streetscape improvements that enliven the character and vibrancy of commercial corridors. Storefront improvements such as neighborhood-sensitive signage and façades, mesh security gates, and engaging awnings help to create a sense of place and attract residents and visitors. Those areas most impacted by Sandy have the opportunity to recreate their commercial centers to reflect their neighborhood's character positively. By making these and other streetscape improvements—such as upgrading light poles, benches, and tree and flower beds—the City will work with local businesses and nonprofits to make these commercial corridors destinations again.

- Marketing and business attraction activities to advertise commercial districts and the neighborhoods they serve. Local events that attract people to commercial districts help enliven these districts, which can be critical after a disaster. Marketing materials such as brochures or promotional maps, meanwhile, can complement these efforts, serving as a way for retail businesses to advertise that they remain open for business. The City, therefore, will support efforts such as these in Sandy-impacted commercial districts.

Initiative 5
Continue to support the FRESH program to increase the number of full-line grocers in underserved neighborhoods

Even before Sandy, the residents of many communities impacted by Sandy lacked adequate access to fresh fruits and vegetables and other healthy food options. Noting this challenge, especially in underprivileged areas of the city, in 2009, the City launched the FRESH (Food Retail Expansion to Support Health) program, a series of zoning and financial incentives available to supermarkets that fill this gap in neighborhoods underserved by grocery retail. To promote the recovery of commercial corridors in these areas, the City will continue to support the FRESH program, with a particular focus on Sandy-impacted neighborhoods.

Initiative 6
Reassess commercial properties citywide to reflect post-Sandy market values

After Sandy, many commercial properties were worth less than before the storm. To reflect this fact and to help with recovery from the storm, the City has reassessed more than 88,000 properties impacted by the storm citywide. Overall, these reassessments have lowered the tax burden on Sandy-impacted properties—including both commercial and residential properties—by over $90 million, with commercial properties in neighborhoods impacted by Sandy receiving a reduction, on average, of approximately 10 percent of their pre-storm assessed values. The City, through the Department of Finance, will continue making these reassessments.

Minority and Women-owned Business Enterprises

A Long Island City construction project

Sandy was a challenging event for businesses throughout New York City. As recovery continues across the five boroughs, the City likely will tap private sector expertise, ranging from professional services firms to construction contractors and sub-contractors. Where it does so, the City has the opportunity not just to rebuild devastated communities, but to do so in a way that helps traditionally disadvantaged businesses, including Minority-and Women-owned Business Enterprises (MWBEs).

The City's passage of Local Law 129 in 2005 sought to connect certified MWBEs with opportunities to sell their products and services to agencies on contracts under $1 million. Certified businesses obtained greater access to, and information about, contracting opportunities through classes, networking events, and targeted solicitations. They also received technical assistance to compete for those contracts more effectively and benefited from inclusion in the City's Online Directory of Certified Businesses. Local Law 129,set goals for City agencies to meet for MWBE participation on program-eligible contracts.

In the years since the passage of Local Law 129, the number of MWBEs certified to do business with the City has grown from 700 to more than 3,500, with firms receiving more than $3 billion in City contracts. In fiscal year 2012 alone, MWBEs won almost $530 million worth of City prime contracts and sub-contracts.

Building on this success, in February 2012, the City launched Compete to Win, five initiatives to help facilitate teaming opportunities, provide technical assistance, match MWBE owners with mentors, and secure loans and surety bonds for MWBEs. These initiatives will be of particular value to MWBEs in the construction industry as they pursue Sandy-related work.

In January of 2013, building further on the City's MWBE successes, the Mayor signed into law Local Law 1, which, among other things, eliminates the $1 million cap on contracts targeted to MWBEs, thereby increasing the overall value of program-eligible contracts from $400 million to $2.2 billion. Local Law 1 also increases accountability for City agencies relative to their contracting participation goals.

Since Sandy, many MWBEs have found new opportunities in connection with the recovery effort. For example, the City's Rapid Repairs program employed 10 prime contractors and approximately 185 subcontractors, including 37 MWBEs. The City will continue to use opportunities such as this throughout the post-Sandy recovery effort to promote the growth of MWBEs.

Insurance

Rebuilding the Rockaways restaurant Thai Rock, Queens

Credit: Trista Sordillo

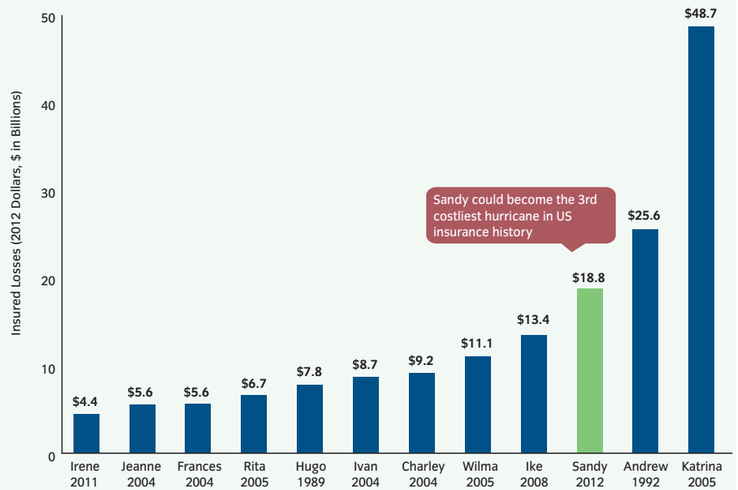
We are all moved by natural disasters. We sympathize with those who fall victim to these dreaded events, we reach out with help and donations—and we hope that such catastrophes will not touch us directly. When they do, as New Yorkers recently learned with Sandy, these events can be devastating. Insurance can help provide people and businesses with financial protection against such catastrophes. Insurance also can benefit the city as a whole, reducing the need for government disaster assistance and minimizing the impact of shocks that otherwise could undermine the stability of communities and the local economy.

Beyond the hardships that these catastrophes inflict, there are very real economic costs. Nationally, these costs have risen dramatically in recent years. In fact, 10 of the 12 most costly hurricanes in US insurance history occurred during the past decade—with uninsured losses even greater than insured losses for many of these disasters. Several factors have contributed to these rising costs. One is the increase in the frequency and severity of extreme weather. Another is the growth of metropolitan centers; with more Americans living close together, when a disaster strikes, it affects more people. The increased costs of natural disasters are also due to the rise in the sheer number and value of properties in vulnerable areas.

Blackout in Manhattan

Credit: Dan Nguyen

Hurricanes With Highest Insured Losses in US History



Source: Insurance Information Institute

Sandy likely will become the third most expensive hurricane in United States history in terms of losses covered by insurance (after Katrina in 2005 and Andrew in 1992). The storm is estimated to have caused a total of approximately $19 billion in insured losses covered by private insurers and between $12 and $15 billion in insured losses covered by the National Flood Insurance Program (NFIP), a program managed by the Federal Emergency Management Agency (FEMA). *(See chart: Hurricanes With Highest Insured Losses in US History)*

Notwithstanding the high insured losses incurred during Sandy, in fact, thousands of New Yorkers whose homes and businesses were inundated by the storm did not have adequate flood coverage—or any coverage at all. In part, this was because many New Yorkers did not know they needed a separate policy for flood insurance, or simply chose not to insure against flood risks. For other owners, the problem was that they did not know that their properties were at risk. This was attributable to the fact that the Flood Insurance Rate Maps (FIRMs) in effect when Sandy struck (i.e., the maps created by FEMA to delineate areas at risk of flooding) were outdated. They not only had not been meaningfully revised since 1983, but they also significantly understated the flood risks in New York. In fact, more than half of all buildings in areas inundated by Sandy were outside of the 100-year floodplain—the area that has 1 percent or greater chance of flooding in any given year—indicated on these maps.

In addition to highlighting the importance of flood insurance, Sandy also brought to the forefront the impact that recent reforms to the NFIP will have on New Yorkers. These reforms, enacted by the Biggert-Waters Flood Insurance Reform Act of 2012 (Biggert-Waters), require changes to the NFIP that will strengthen the financial solvency of the program, which had been $18 billion in debt to the US Treasury prior to Sandy. These changes will phase out the program's policyholder subsidies, which, in many cases, had kept premiums well below actuarial rates. As a result, rates will be rising for many policyholders throughout New York—something that would have occurred even without Sandy.

Compounding this is the fact that, after Sandy, FEMA released Preliminary Work Maps (PWMs) to provide more updated information on flood risk in New York City. The new maps show a significantly expanded 100-year floodplain compared with the 1983 maps, with approximately 32,000 more buildings in the floodplain (an increase of 91 percent). As these PWMs are turned into regulatory maps, it is likely that many more New Yorkers will be deemed to be exposed to flood risk, and, if they have Federally backed mortgages, they will be required to buy flood insurance—just as rates are increasing dramatically.

In keeping with the overarching goals of this report—which are to minimize loss and disruption from climate hazards and enable the city to bounce back quickly if damage is sustained—the City will propose several ways to address the insurance challenges described above. In doing so, the City will avoid falling into a common post-disaster trap: namely, calling for subsidized coverage, which may provide short-term benefits to the insured, but contributes to other adverse long-term consequences, including encouraging high-risk behavior. Instead, the City will propose a series of reforms to the NFIP that will encourage flood mitigation by, and offer commensurately lower premiums to, those who obtain flood insurance; create lower-cost flood insurance products for those who are vulnerable to flooding but are not required to obtain insurance; and advocate for the creation of premium assistance measures to help low-income New Yorkers afford flood insurance.

Sandy's Impacts Outside of the NFIP

Sandy is likely to have impacts on insurance coverage in New York beyond the National Flood Insurance Program (NFIP). However, those impacts are not expected to be nearly as dramatic as impacts to those who have, or soon will be required to have, policies through the NFIP. Accordingly, this chapter focuses primarily on the NFIP. The private insurance market is generally expected to remain stable for two reasons. First, while homeowners insurance rates may rise post-Sandy, rate increases in this market generally must be approved by State government insurance regulators, who work to ensure fair and reasonable pricing.

Second, in the commercial property insurance market, early analysis indicates that Sandy's impact is likely to be modest overall. A May 2013 report by the insurance brokerage firm Marsh found that rates in this market have remained relatively stable and competitive through the first quarter of 2013—even if providers were tightening some policy terms and conditions. According to early indications from Marsh, this stability generally continued through the second quarter of 2013. These observations are largely backed up by a recent study by Advisen, a global insurance data and analytics provider, which found that even though insured losses from Sandy were high, they were unlikely to lead to sharply higher premiums for a sustained period of time. According to Advisen, though it was possible that premiums would increase in the short term—especially for properties in flood-prone regions—the property-casualty insurance market remained abundantly capitalized, which likely would soften the future financial impact of Sandy over time.

Notwithstanding the foregoing, changes in the insurance market bear continued monitoring by the City. If, in the future, Sandy's impacts on this market appear to be more substantial than projected, the City should develop initiatives to address these impacts for the benefit of policyholders in the five boroughs.

How the Insurance System Works

Insurance transfers risk from an individual policyholder to a larger risk-sharing pool. The insurance system is based on the principle of risk-based premiums: those with greater risk (i.e., those more likely to suffer damage and require a claims payment from an insurance provider) should pay higher premiums than those with less risk. Thus, an owner of a property in an area prone to floods and hurricanes should pay more for insurance than the owner of a property in an area with less risk. The reason insurance providers must charge risk-based rates is that these rates are necessary for providers to remain financially solvent and have sufficient resources to pay policyholder claims in the event of losses.

Because of the delicate balance that providers must strike, regulators oversee the licensing of insurance companies, monitor insurers' financial health and reporting, and review their market conduct. State governments are the primary regulators of insurance companies. In New York State, the Department of Financial Services is the primary regulatory body that oversees the insurance market, reviewing and approving rates for homeowners policies, for example. Under State law, New York City does not have the authority to regulate insurance companies.

Property insurance can provide protection for individuals and businesses against losses due to climate risks and other types of risks. Coverage generally is provided through package policies such as standard homeowners and commercial property policies, which include coverage for a variety of perils, or causes of loss, such as hailstorms, fire, and theft. However, coverage for flooding, like most other natural catastrophes, is generally excluded and must be purchased through a separate policy.

This is because catastrophic risk is different from other insured risks. First, catastrophic risk is low probability, or infrequent in occurrence. As a result, individuals and businesses generally choose not to purchase insurance for these risks. One of the reasons for this is that individuals tend to underestimate their vulnerability to catastrophic risks. In fact, while greater numbers of homeowners tend to buy catastrophic coverage such as flood insurance after a natural disaster—because of their heightened awareness of risk—many of these same homeowners later let their policies lapse if they have not made a claim. This is even true for those who are required by law to have coverage, such as those with Federally backed mortgages. Whereas lenders rigorously enforce purchase requirements for homeowners insurance, many have been less vigilant about enforcing requirements for catastrophic risks like floods. *(See sidebar: Risk Perception and Demand for Catastrophic Insurance)*

Risk Perception and Demand for Catastrophic Insurance

Recent studies by the Wharton Risk Management and Decision Processes Center at the University of Pennsylvania find that many residents in hazard-prone areas perceive the likelihood of suffering losses from natural hazards in a given year to be so low that they do not purchase insurance or take measures to protect their homes. After experiencing severe damage—at the point when they have a heightened awareness of the consequences of a disaster—they often purchase insurance. However, many let their policies lapse a few years later if they have not made a claim on their policy.

Rather than viewing insurance as a form of protection, there is a tendency to regard it as an investment. If one pays premiums for a few years and does not make a claim, the money spent on premiums is viewed as being a bad investment. In fact, not suffering a loss should be viewed as the most desirable outcome. The best return on an insurance policy is no return at all.

Catastrophic risk is different from other risks in yet another way: its impact is correlated with a geographic area. That is, when one policyholder is affected, it usually means others are too, since natural disasters tend to affect a large number of people in close proximity. Due to the extraordinarily high losses that can occur when disasters strike, insurers require high premiums for catastrophe insurance, further dissuading potential policyholders. Consequently, premiums for a flood insurance policy can, in some cases, cost more than a homeowners policy that covers a whole range of perils.

Government-Provided Catastrophe Insurance

To promote broader catastrophe coverage at lower rates, the government often steps in to provide insurance directly. Several states that face hurricane risks, for example, have established their own catastrophe insurance programs. In most cases, these programs are designed to be "insurers of last resort"—to offer coverage to those unable to obtain policies in the private market. Many of these state-run pools are established after a disaster, as demand for coverage grows and as private coverage becomes less available or more expensive.

This was true in Florida in 1992 after Hurricane Andrew led to an unprecedented volume of claims. In response, many insurance companies raised rates sharply, canceled, or declined to renew policies, or simply withdrew from the Florida market altogether. A state-run insurer of last resort, which evolved to become Citizens Property Insurance Corporation, eventually was established to provide affordable coverage to homeowners and businesses. After years of offering subsidized rates, Citizens is now the largest property insurer in Florida, with reserves that many experts believe to be insufficient to pay claims in the event of another disaster.

The Texas Windstorm Insurance Underwriting Association, created in the 1970s, is another state program that did not collect adequate premiums to cover the actual risk of damage. After two hurricanes in 2008, it has liabilities that exceed assets by nearly $200 million, as of the writing of this report—and its board recently considered placing the program into receivership.

As demonstrated above, government insurance programs are frequently under intense pressure to offer subsidized premiums, which often leads to financial insolvency. These subsidized programs also have created other undesirable consequences. For example, government-sponsored insurers with inadequate capital resources must, when disaster strikes, seek state backing, which diverts funds from other priorities such as education and public safety. This need to tap public coffers is common among state-run programs, which often insure properties that cannot get coverage elsewhere—since they generally are forbidden to deny coverage to high-risk properties. As a result, their overall insurance pools are comprised of policyholders with both higher risk and higher probability of loss.

These programs also have had another unfortunate consequence. Namely, by subsidizing the cost of insurance, they have, in effect, encouraged people—who do not have to bear the true costs of the risks they choose to take—to build and live in areas susceptible to natural catastrophes.

National Flood Insurance Program

Prior to the creation of the NFIP in 1968, the Federal government's involvement in flood protection focused on making investments in structural flood-control projects, such as dams and levees, and providing post-disaster assistance to flood victims. Eventually, in recognition of increasing flood losses and Federal disaster-relief costs, and because private insurers were unwilling to offer coverage, Congress created the NFIP.

Flood damage in New Dorp Beach, Staten Island

Credit: John De Guzman

In establishing the NFIP, Congress reasoned that the Federal government was a suitable insurance provider because it could pool risk broadly across the entire country. At the same time, Congress believed that the NFIP could be used to reduce future flood damages through state and community floodplain-management regulations, thus eventually reducing Federal spending on disaster assistance.

Today, FEMA, through its administration of the NFIP, sets insurance premiums and establishes minimum building standards on the basis of the Flood Insurance Rate Maps (FIRMs) that it produces. These maps delineate the geographic boundary of the floodplain in different regions, including the 100-year floodplain (the area with a 1 percent or greater chance of flooding in any given year) and the 500-year floodplain (the area with a 0.2 percent or greater chance of flooding each year). The FIRMs also show the height to which the floodwaters from a 100-year storm could rise, which is known as the Base Flood Elevation (BFE).

NFIP policies are available to property owners in participating communities. As a condition of participation, these communities must adopt FEMA's flood-resistant construction requirements or more stringent local standards as part of their local building codes (see Chapter 4, *Buildings*). As a participating community, New York City incorporated FEMA's required construction standards into its building code in 1983. Pursuant to this, new buildings in the 100-year floodplain must be built at or above the BFE in the five boroughs.

Residential policyholders can obtain coverage through the NFIP for up to $250,000 for their homes, with separate policies for contents available for up to $100,000. Policies for non-residential policyholders cover up to $500,000 for buildings and up to $500,000 for contents. In both cases, although policies cover basic electrical and mechanical equipment, such as central air conditioners, furnaces, and hot water heaters located in basements, NFIP policies generally do not cover personal property that is located in basements. *(See chart: National Flood Insurance Program Coverage Limits)*

Because of the limited coverage the NFIP provides, the program primarily attracts homeowners and some small businesses. Larger businesses, by contrast, tend to buy insurance through the private market. These companies typically have comprehensive insurance policies that bundle together property, business interruption, liability, and other coverage into a single policy, which, in areas at risk of flooding, typically includes flood coverage.

National Flood Insurance Program Coverage Limits

Policy Type	Maximum Coverage
Building Coverage	
Single-family dwelling	$250,000
Two- to four-family dwelling	$250,000
Multi-family ("Other Residential")	$250,000
Commercial ("Non-Residential")	$500,000
Contents Coverage	
Residential	$100,000
Commercial	$500,000

Source: FEMA

Historically, the NFIP has offered subsidized premiums to many policyholders. For example, for properties built before the issuance of FIRMs, a subsidized "pre-FIRM" rate was originally created to encourage broader participation in the NFIP. The program also allowed "grandfathering" provisions so that properties that were mapped into higher risk areas on subsequent flood maps were able to keep their former, subsidized rates. FEMA estimates that roughly 20 percent of all policyholders in the program pay subsidized rates today. For some properties, these rates may be only half of the actuarial rates.

Reform of the National Flood Insurance Program

While serving the important policy goals of providing flood insurance and encouraging safer construction in floodplains, the NFIP faces some of the same challenges that many other government-sponsored catastrophe insurance programs face. For example, originally intended to be self-supporting, the NFIP has required multiple infusions of tax dollars to stay afloat, in part due to the program's subsidized premiums. It also, though, has suffered from the significant cost of paying claims time and again on properties with repetitive flooding. These properties represent only 1 percent of NFIP policies but account for 25 to 30 percent of claims historically paid by the program. Unlike private insurers, however, by law, the NFIP generally has not been allowed to deny insurance to these high-risk properties, despite the significant drain on resources that they represent.

In 2012, because of the financial difficulties of the NFIP, Congress passed the Biggert-Waters Flood Insurance Reform Act, renewing the program through 2017 but requiring significant changes to it. These changes include an elimination of subsidies on new or lapsed policies and a phase-out for subsidies on other polices. The biggest rate increases may occur in areas affected by changes in FEMA flood maps. In areas where FIRMs are not changed, rates on existing policies for second homes, businesses, and properties suffering repetitive losses will increase by 25 percent per year until they reach their full actuarial rates. For all other properties, the rate of increase will be capped at 20 percent per year. Meanwhile, in areas where new FIRMs are put in place by FEMA, subsidies will be phased out over five years. Under Biggert-Waters, penalties on banks also will be raised to increase the likelihood that they will enforce mandatory purchase requirements associated with Federally backed mortgages. *(See chart: Summary of Changes to NFIP Premiums Required by Biggert-Waters)*

Looking to the future, the impact of Biggert-Waters will be particularly severe for policyholders in New York who live in buildings constructed before the City first adopted FEMA's FIRMs in 1983 and who, therefore, were entitled to heavily subsidized premiums. Approximately 75 percent of the nearly 26,000 NFIP policies in effect during Sandy were eligible for these lower rates. Subsidies will phase out for these policyholders over five years after FEMA's new FIRMs become effective, likely in 2015. Starting in 2015, new policyholders likely will have to pay full-risk rates immediately.

What Happened During Sandy

Sandy highlighted New York City's vulnerability to flooding. However, the storm also served as a reminder of the importance of flood insurance for homeowners and businesses alike.

Summary of Changes to NFIP Premiums Required by Biggert-Waters

Date of Implementation	What Will Happen	Who is Affected
January 1, 2013	• 25% premium increase per year until premiums reflect full-risk rates	• Homeowners with subsidized insurance rates on second homes or other non-primary residences
October 1, 2013	• 25% premium increase per year until premiums reflect full-risk rates	• Owners of business properties with subsidized premiums • Owners of properties with severe repetitive loss (cumulative NFIP claims payments exceeding the fair market value of the property)
October 1, 2013	• Up to 20% premium increase per year	• All policyholders not subject to other phase-outs
Late 2014	• 5 year phase-out of subsidies on existing policies • Immediate requirement to pay full-risk rate for new or lapsed policies	• All policyholders affected by map changes (FEMA's revised Flood Insurance Rate Maps are expected for New York City in 2015)

Source: FEMA

While approximately 95 percent of New York City homeowners have homeowners insurance, the majority did not have separate flood policies when Sandy struck. Thousands of insured property owners thus were faced with the sobering fact that they had no coverage for the flood damage their properties sustained. In fact, the City estimates that less than 20 percent of residential buildings in areas inundated by Sandy had coverage through the NFIP. The numbers are believed to have been even lower for businesses; approximately 26,400 businesses with fewer than 50 employees were in the Sandy inundation zone in New York, but only 1,400 commercial NFIP policies were in effect when Sandy hit.

Even for property owners with NFIP policies, in many cases, those policies covered only a portion of what homeowners needed to pay for repairs. For example, for many property owners, most of their damage occurred in basements, for which NFIP policies provide only minimal coverage.

Another insurance complication for many New Yorkers post-Sandy was that they were required to hold multiple policies covering multiple risks, including general property and casualty policies, along with their NFIP policies. After the storm, claims adjusters had to determine the cause of—and thus the policy that would pay for—each policyholder's losses, a process that was frequently time-consuming.

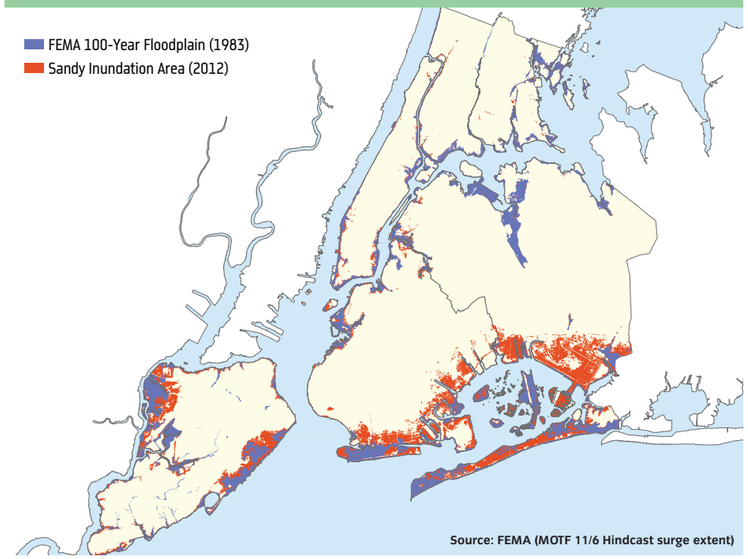
Additionally, once claims were adjusted, policyholders did not always receive immediate payment, primarily because many policies had standard clauses directing insurers to issue payments to mortgage lenders, rather than to policyholders directly. Banks then needed to endorse checks before funds could be released to policyholders, often requiring proof that repairs had been made before doing so. Following Sandy, State regulators intervened in many cases to expedite the release of claims payments by banks to policyholders.

Sandy exposed other insurance-related issues in New York. For example, many businesses experienced losses from business interruption relating to power and transit outages. However, in most cases, even if they had business interruption policies, they were not covered unless they had flood insurance policies as well.

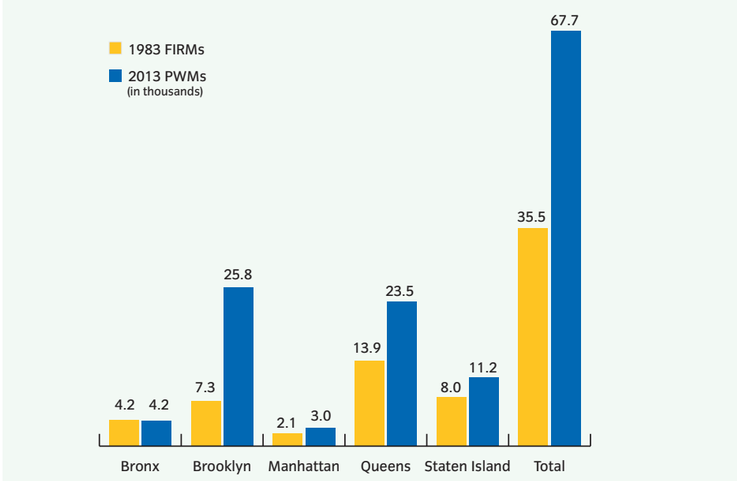
Yet another issue was that many of those who experienced flood-related losses were required to have flood insurance, but did not actually have policies. In fact, the City estimates that approximately one-third of homeowners in the 1983 floodplain who had Federally backed mortgages, and thus were supposed to have flood insurance, did not have policies in force when Sandy hit, reflecting a combination of lax compliance by homeowners and lax enforcement by many banks.

These figures, while daunting, may somewhat misstate the problem in New York. This is because the mandatory purchase requirement can apply differently to multifamily buildings. Generally, for condominiums and cooperatives, individual unit or apartment owners may not be required to hold a separate flood insurance policy if the building association has purchased a policy with sufficient coverage. The required level of coverage for a building depends upon factors including the outstanding balance of the building's mortgage, the replacement value of the building, and the number of units. If the building has met the required coverage levels, individual unit owners are, in most cases, considered in compliance with the purchase requirement. Accordingly, some of the low flood insurance penetration in New York may be attributable to this aspect of the NFIP.

Comparison of 100-Year Floodplain in 1983 FIRMs and Sandy Inundation Area



Number of Buildings in the 100-Year Floodplain by Borough



There are multiple reasons for the low penetration of flood insurance in New York. In some cases, New Yorkers simply chose not to buy flood insurance because, as noted earlier, people tend to underestimate the risk of low-probability events. They also typically misjudge the economic impact of suffering flood damage. When faced with a bill of approximately $1,000 per year for a flood policy—the average NFIP premium paid on 1- to 4-family residential policies in New York City pre-Sandy—many New Yorkers ended up choosing to spend their money elsewhere.

Other policyholders, meanwhile, previously had coverage, but then allowed their insurance policies to lapse. This can happen easily, since NFIP policies, like homeowners policies, are one-year contracts. A recent study found that new NFIP policies are typically held for just two to four years, with 20 to 30 percent of policies dropped after only one year. This, again, is at least in part attributable to lax mortgage enforcement by banks, which seem to have enforced mandatory flood insurance purchase requirements at the time mortgages were issued, but then did not monitor compliance thereafter.

The final reason for New York's low penetration rate is that many impacted New Yorkers were neither aware of their risks nor required to buy flood insurance because they lived in areas outside the boundaries of the floodplain on FEMA's 1983 maps. This was true for half of all buildings and half of all residential units in areas inundated by Sandy. *(See map: Comparison of 100-Year Floodplain in 1983 FIRMs and Sandy Inundation Area)*

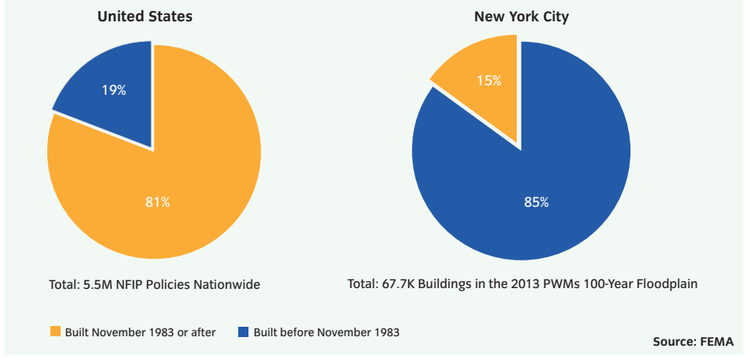
What Could Happen in the Future

After Sandy, FEMA released advisory maps to portray current flood risks more accurately. Those maps have been replaced by the recently released PWMs. These new maps do not have an immediate impact on flood insurance requirements. However, the final Flood Insurance Rate Maps, likely to go into effect in 2015, are expected to be consistent with the PWMs and will trigger insurance purchase requirements for many New Yorkers.

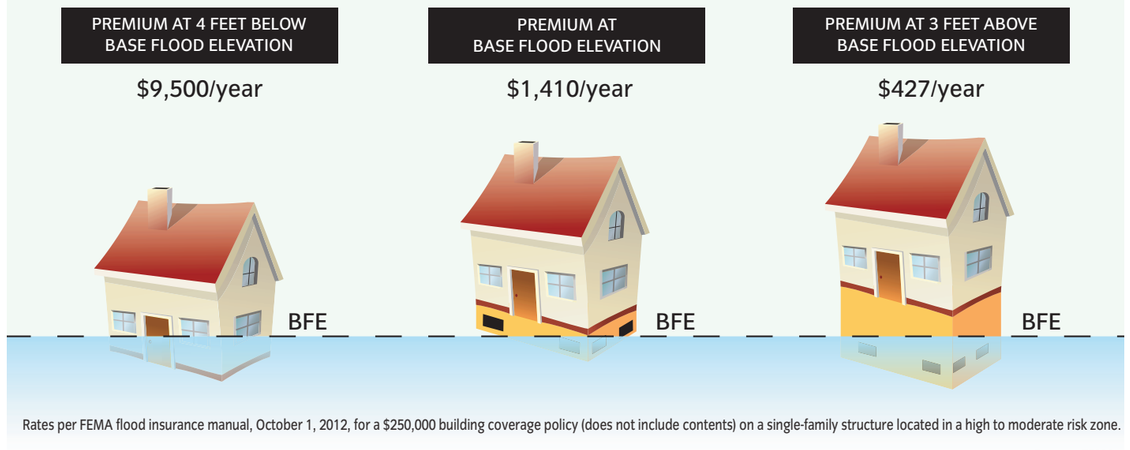
According to the PWMs, the number of buildings in New York City's 100-year floodplain is nearly double the number in the 1983 FIRMs. An estimated 85 percent of these buildings are "pre-FIRM"—i.e., constructed before November 1983—and thus pre-date the building code requirements that mandate construction at or above the Base Flood Elevation. In comparison, only 19 percent of the 5.5 million properties insured by the NFIP policies nationwide are "pre-FIRM." This contrast highlights one of the ways in which the urban character and older building stock of New York City differs dramatically from most other regions that participate in the NFIP—to the detriment of New York policyholders (see Chapter 4). *(See chart: Number of Buildings in the 100-Year Floodplain by Borough; See chart: National Flood Insurance Program Coverage by Age of Buildings)*

Though owners of these properties are, as of the writing of this report, still eligible to buy subsidized NFIP policies, as a result of Biggert-Waters, their rates will begin to increase. Once

National Flood Insurance Program Coverage by Age of Buildings



Insurance Premiums Under the National Flood Insurance Program



Rates per FEMA flood insurance manual, October 1, 2012, for a $250,000 building coverage policy (does not include contents) on a single-family structure located in a high to moderate risk zone.

Source: FEMA

the final FIRMs are in effect, all policies will be charged risk-based rates, either immediately or through a phasing-out of subsidies, which could result in a steep rise in insurance premiums on these properties.

Under the NFIP, FEMA traditionally has set risk-based rates by evaluating the distance between a property's lowest floor and the BFE. This is because a building below expected flood levels is generally assumed to be at greater risk. Rates rise steeply for buildings the farther the lowest occupied floor is below the BFE. *(See graphic: Insurance Premiums Under the National Flood Insurance Program)*

The PWMs show Base Flood Elevations throughout the five boroughs to be increasing by one to four feet in most areas, with variation from neighborhood to neighborhood. Accordingly, even many properties that comply with today's BFE will soon be one to four feet below the revised BFE. An illustration of how these changes will impact different areas can be seen in the estimated changes in the five communities on which this report focuses. *(See table: Estimated Range of Base Flood Elevation Increases: SIRR Communities)*

Looking at an individual case highlights the full impact of all of the changes relating to NFIP that New Yorkers soon will be facing. Consider the owner of a single-family home in Tottenville in Staten Island that has its lowest floor at the same level as the current Base Flood Elevation. As of the writing of this report, this homeowner would pay about $1,400 per year for the maximum $250,000 coverage. However, if the information in the Preliminary Work Maps, showing the BFE increasing by almost four feet for this area, carries through to the final Flood Insurance Rate Maps, then the premium on that property likely will jump to $9,500 once the new FIRMs are in effect. The same would be true for an owner of a similar property in Breezy Point in Queens, for which the PWMs also show a four foot increase in the BFE. To put this in perspective, if the owner of the home in the Tottenville example were earning the median annual household income in this area—which, at $80,000 is significantly higher than the median household income for New York City as a whole—once the new rates go into effect, the owner would be required to spend a staggering 12 percent of his or her household income on flood insurance.

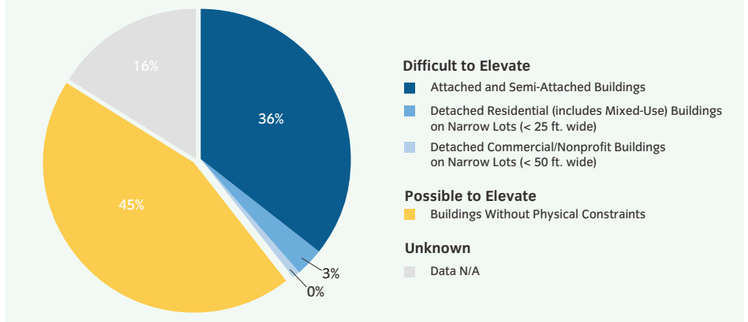
Overall, the projected added costs in flood insurance likely will decrease the value of properties in the floodplain citywide, since prospective buyers presumably will factor future insurance costs into the price they are willing to pay for these properties. In addition, as a result of these added insurance costs, property owners who are not required by law to carry flood insurance likely will opt out of coverage altogether.

In theory, it should be possible to construct or retrofit buildings in ways that reduce the risk of damage and, in turn, to reduce the cost of insurance under the NFIP. However, in practice, the NFIP provides few incentives for property owners to protect their buildings from flood damage and reduce their premiums, other than by elevating their buildings—actually lifting structures above the BFE. While that option may be possible for some structures—such as small wood-frame structures common in other parts of the country—it simply is not feasible in many areas of New York City, especially where much of the building stock consists of attached and semi-attached buildings and multi-story structures. Other features such as narrow lots and the use of construction materials such as masonry and concrete can also make elevation of buildings difficult (see Chapter 4). In New York, approximately 26,300 buildings in the

Estimated Range of Base Flood Elevation Increases: SIRR Communities

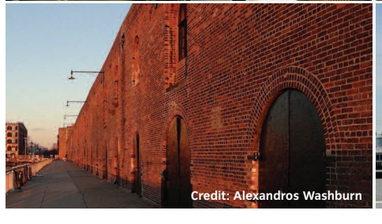
Community	Range of BFE Increase (in feet)
Brooklyn-Queens Waterfront	1.0 - 3.0
East and South Shore, Staten Island	2.0 - 4.0
South Queens	1.0 - 4.0
Southern Manhattan	1.0 - 3.0
Southern Brooklyn	2.0 - 3.0

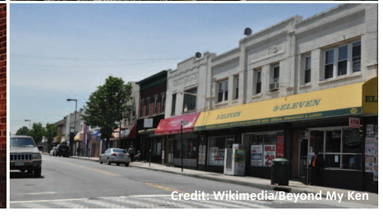
Physical Constraints to Elevating New York City Buildings



Credit: Wikimedia/Jim Henderson

Credit: DOB/Samantha Modell


Credit: Alexandros Washburn


Credit: Wikimedia/Beyond My Ken

Residential home in New Jersey, compliant with FEMA standards
Credit: Wendell A. Davis, Jr./FEMA

Policy Options to Address Insurance Affordability

With premiums in some areas likely to increase significantly as a result of the Biggert-Waters Act, low-income residents may not be able to afford insurance. Two approaches to addressing this issue are described below.

One approach would be a national voucher program. This would be consistent with Biggert-Waters, which specifically authorizes a FEMA-National Academy of Sciences study of affordability that is to explore, among other approaches, a means-tested flood insurance voucher program for low-income residents currently residing in flood-prone areas. A voucher program could work as follows: A low-income homeowner would receive a voucher worth, for example, $200. That homeowner then would be required to use this voucher to purchase flood insurance. If the homeowner's risk-based premium were $1,000, the homeowner could use his or her voucher to pay for $200 of this premium, resulting in out-of-pocket expenses of $800 ($1,000 minus $200).

A second, complementary tool for reducing the cost of insurance is mitigation. If a homeowner invests in a mitigation measure that reduces annual expected losses by, for example, $300, then his or her premium should, in theory, decrease by this amount, whether or not the homeowner received a voucher. The decrease in premium would be based on the expected lower claim payments from future flood damage as a result of the mitigation measure implemented. In the homeowner in the first example receives a $200 voucher and invests in mitigation, that individual would pay a premium of $500 ($800 minus $300). If the applicable house were sold, the property should command a higher price as a result of this improvement, and the new owner would benefit from a more resilient structure.

A challenge to the latter strategy of premium reduction (i.e., mitigation) is how to finance the required upfront cost of this mitigation. This could be addressed by a home-improvement loan to cover the costs of mitigation investments. In many cases, the reduction in premiums resulting from mitigation investments should be greater than the costs of home improvement loans that would help pay for them. For example, returning to the aforementioned homeowner, if he or she were to obtain a home-improvement loan to cover the cost of a mitigation investment and debt service on that loan were to cost $100, then the homeowner's net cost would be $800 (i.e., the $1,000 base premium, minus $300 in premium reduction due to the mitigation investment, plus $100 to cover the cost of the home-improvement loan).

Source: Wharton Risk Management and Decision Processes Center

newly expanded floodplain have characteristics or site conditions that would make elevation enormously challenging, or even impossible. *(See chart: Physical Constraints to Elevating New York City Buildings)*

On top of this, elevation as a mitigation strategy creates another set of problems in an urban environment such as New York that it does not present elsewhere. By eliminating ground flood uses such as retail stores, elevation disrupts the fabric of neighborhoods, impedes important economic activity, makes services less accessible to residents, and potentially takes "eyes off the streets," posing possible public safety challenges as well.

New York City faces a range of climate risks as of the writing of this report and over the next several decades. These risks are expected to have impacts on buildings, and thus have implications for insurance coverage.

According to projections from the New York City Panel on Climate Change (NPCC), described in Chapter 2 *(Climate Analysis)*, sea levels are forecast to rise through the 2020s and 2050s. During this period, the 100-year floodplain will expand and BFEs could increase. The number of buildings in the 100-year floodplain is forecast to rise to 88,700 by the 2020s and 114,000 buildings by the 2050s. If property owners in the new floodplain buy flood insurance in the same proportion as property owners in the current floodplain do, nearly 45,000 buildings would be uninsured in the 2020s and 60,000 would be uninsured in the 2050s.

While other types of climate risks could affect various types of insurance coverage in New York, the impact of sea level rise and greater frequency of the most intense coastal storms are expected to have the greatest impact on NFIP rates.

This chapter contains a series of initiatives that are designed to address important issues related to insurance. In many cases, these initiatives are both ready to proceed and have identified funding sources assigned to cover their costs. With respect to these initiatives, the City intends to proceed with them as quickly as practicable, upon the receipt of identified funding.

Meanwhile, in the case of certain other initiatives described in this chapter, though these initiatives may be ready to proceed, they still do not have specific sources of funding assigned to them. In Chapter 19 (*Funding*), the City describes additional funding sources, which, if secured, would be sufficient to fund the full first phase of projects and programs described in this document over a 10-year period. The City will work aggressively on securing this funding and any necessary third-party approvals required in connection therewith (i.e., from the Federal or State governments). However, until such time as these sources are secured, the City will only proceed with those initiatives for which it has adequate funding.

Strategy: Target affordability solutions to low-income policyholders

The combined impact of Biggert-Waters and the remapping of New York City's floodplain will result in significant increases in flood insurance premiums, which many New Yorkers, especially the city's most vulnerable populations—including those with low, or on fixed, incomes—will not be able to afford. These increases will pose serious challenges to the economic stability not only of neighborhoods in New York City but also of neighborhoods nationwide.

Initiative 1
Support Federal efforts to address affordability issues related to reform of the NFIP

Biggert-Waters requires FEMA and the National Academy of Sciences (NAS) to conduct a study of methods to help individuals to be able to afford risk-based premiums under the NFIP. According to the law, FEMA and NAS are to focus this study on targeted assistance, including means-tested vouchers, rather than generally subsidized rates.

The City will support these goals actively and will urge its Federal government partners to take swift action to comply with these Biggert-Waters provisions. The study was slated for completion within 270 days of the enactment of Biggert-Waters, but that deadline has passed. FEMA and the NAS should, therefore, initiate the study immediately for completion no later than the first half of 2014, enacting the recommendations as quickly as possible thereafter.

The City will especially support Federal action aimed at addressing affordability for the city's (and country's) most vulnerable populations, such as low-income, owner-occupied households.

If no progress is made on addressing insurance affordability for vulnerable households by the time the new FIRMs are in effect, the City will consider taking its own actions to support these households. These actions might include establishing a fund to cost-share insurance premiums or policyholders' deductibles in the event of a loss. However, the City, unlike the Federal government, does not have the capacity to take broad action on this issue, and therefore strongly urges FEMA and NAS to take the necessary steps immediately.

Strategy: Define resiliency standards for existing buildings

Sandy highlighted the limited information currently available on risk-reduction techniques short of elevation, which is impractical, financially infeasible or physically impossible for building types common in New York City and other dense urban areas. This dearth of information complicates efforts by property owners seeking to invest in mitigation.

Initiative 2
Develop FEMA-endorsed flood protection standards and certifications for existing urban buildings

The City has developed a retrofit standard, referred to as the "Core Flood Resiliency Measures" (see Chapter 4). The City proposes that these measures be rolled out citywide. These measures incorporate building mitigation options that are physically and financially feasible for a wide range of urban building types. This standard focuses on resiliency measures that protect building systems and structural integrity and was developed, in part, based on post-Sandy damage assessments by FEMA.

The City will work with FEMA to develop a national flood-protection standard for urban buildings, to complement and augment the Core Flood Resiliency Measures and to supplement FEMA's preferred elevation approach. Because many of New York City's building types and urban site conditions can be found in other dense, urban areas throughout the country, especially in the Northeast, this work will be widely applicable across the country. To this end, the Office of Long-Term Planning and Sustainability (OLTPS) will continue discussions that are already underway with FEMA, with the goal of achieving agreement on new standards by 2014.

Initiative 3
Call on FEMA to recognize mixed-use buildings as a distinct building category

Mixed-use buildings do not, as of the writing of this report, exist as a separate building class under the NFIP; if occupancy in a given building is more than 75 percent residential, it is considered a residential building. At less than 75 percent residential occupancy, the building is considered non-residential.

Under current FEMA regulations for the NFIP, non-residential buildings located in the 100-year floodplain are permitted to certify qualifying flood-proofing designs as an alternative to elevation to, or above, the BFE. Properties with approved flood-proofing certifications pay considerably lower insurance premiums than properties below the BFE. Because of FEMA's categorization, a building with ground floor retail and no residential units below the BFE that has more than 75 percent of its floor area above the ground floor would be classified as a residential building and, therefore, would not be eligible for a flood-proofing certification.

The City will work with FEMA to create a separate mixed-use building category, allowing these structures to be eligible for flood-proofing certifications, provided they do not have residential occupancy below the applicable BFE. OLTPS will continue discussions already underway with FEMA, with the goal of achieving agreement by 2014. In the PWMs, there are approximately 2,300 mixed-use buildings in New York City that would benefit from this change.

Strategy: Incorporate resiliency standards in insurance underwriting

Consistent with the principle of risk-based premiums, measures that reduce a property's risk of damage should be reflected in a commensurate reduction in the cost of insurance; this is because investments in mitigation have many long-term benefits, including protecting lives and reducing the risk of property losses. Insurers and lenders also benefit when policyholders invest in mitigation by reducing their potential exposure to loss. However, based on the current NFIP rating system, insurance costs can be reduced significantly when a building is elevated above the BFE, but not if other mitigation measures are taken. Alternative mitigation methods that demonstrably reduce the risk of flood damage should also be integrated into the NFIP's insurance rating system.

Initiative 4
Call on FEMA to develop mitigation credits for resiliency measures

Mitigation is critical to strengthening the resiliency of the existing built environment. As previously discussed, for many building types in New York City and urban areas nationally, structural characteristics, site conditions, and cost pose a challenge to elevation. Fortunately, other mitigation options are available. The NFIP should encourage property owners to take effective and realistic actions to reduce risks. The City, therefore, will call on FEMA to develop a system of insurance premium credits under the NFIP, to offer risk-based incentives for investing in a range of mitigation measures.

OLTPS will work with FEMA to commission a study of mitigation measures to be considered for this program. The study, to include measures developed through Initiative 2, will analyze these measures and their impact on risk, assessing these impacts for a range of building types.

Working in partnership with FEMA, OLTPS will initiate the study in 2013 and oversee this effort; the study is expected to be completed by 2014. The City will call on FEMA to review and incorporate the study's findings into the underwriting of flood insurance as soon thereafter as possible.

Initiative 5
Study approaches for New York City to join FEMA's Community Rating System program

The National Flood Insurance Program's Community Rating System (CRS) is a voluntary incentive program that encourages community floodplain management activities that exceed the minimum NFIP requirements. For communities that are admitted into the CRS program, flood insurance premiums are discounted for all policyholders in these communities by at least 5 percent to reflect the overall reduced flood risk profile.

The City will evaluate New York's ability to gain admission to the CRS program, and the costs and benefits of doing so. While the opportunity for discounted premiums for New Yorkers is compelling, joining the program may require the City to take legal or other remedial actions against property owners found to be in violation of building codes in the floodplain. A measured approach to understanding the City's potential obligations, and practical solutions to meeting those obligations, is therefore required. OLTPS and the Department of Buildings will complete this evaluation by the first half of 2014.

Strategy: Expand pricing options for policyholders

Flexible pricing options can encourage more people, especially those not required to carry insurance, to purchase coverage that suits their needs. A higher-deductible option is a commonly used tool in insurance pricing for reducing premium costs to policyholders while protecting against catastrophic losses. Higher deductibles are consistent with the principle of risk-based pricing and provide significant cost savings to policyholders who choose them. This approach is a common feature of catastrophe insurance policies, with, for example, most homeowners insurance policies in New York State including mandatory hurricane deductibles, often up to 5 percent of the insured value of a home.

Initiative 6
Call on FEMA to allow residential policyholders to select higher deductibles

Currently under the NFIP, deductibles up to $50,000 are allowed for commercial policies, but residential policies are limited to a maximum deductible of $5,000. Initial analyses indicate that if a $10,000 deductible were available on residential policies, flood insurance premiums could be reduced by more than 30 percent, while a $25,000 deductible could cut premiums in half. This option likely would be available only to property owners who do not have Federally backed mortgages, as these individuals are not subject to the regulatory regime applicable to such mortgages and thus have more flexibility. Even so, there is a potentially significant market for this product.

The City will work with FEMA to evaluate the higher-deductible option in order to understand precisely how deductibles would translate into premium reductions for various property types and to determine which property owners would be best served by higher deductibles.

In connection with the introduction of higher-deductible policies, the City will call for FEMA to initiate a comprehensive policyholder education initiative that helps consumers choose a deductible level that they can afford while avoiding the potential for underinsurance in the event of a loss. OLTPS will continue discussions already underway with FEMA, with the goal of reaching agreement on new policy options with by 2014.

Strategy: Improve awareness and education about insurance

For insurance to play the appropriate role in providing individuals and businesses with financial protection from climate risks, consumers must be aware of both their risks and the coverage their insurance policies include or exclude. Issues of consumer awareness and education should be addressed at the points of sale and renewal, and throughout the life of an insurance contract. Insurers also should be aware of the extensive efforts the City is taking to minimize loss and disruption from climate hazards through the initiatives in this report. Doing so will foster a more robust insurance market for the benefit of all participants.

Initiative 7
Support the goals of the NYS 2100 Commission to protect New York State, consumers, and businesses

The NYS 2100 Commission was convened by Governor Cuomo in response to recent severe weather events experienced by New York State, including Sandy. The Commission's Insurance committee outlined a series of goals and strategies protecting consumers and businesses. The City will support the State in pursuing the Commission's goals, which include:

- promoting investments in mitigation;
- improving consumer awareness and education;
- preventing underinsurance for flood risk and covered perils;
- expanding coverage for business interruption;
- promoting a comprehensive insurance emergency measures act; and
- providing catastrophe response services.

Initiative 8
Call on New York State to improve policyholder awareness at the point of sale or renewal

Sandy demonstrated the importance of policyholder awareness, particularly relating to flood insurance, as well as the importance of easily understood insurance contracts. These issues should be addressed by New York State as the primary regulator of the insurance industry in

New York. The City, working through OLTPS, will collaborate with the New York State Department of Financial Services to evaluate opportunities to improve policyholder awareness, including through more meaningful disclosure at the points of sale and renewal. Among other things, the City and State should review the role that a variety of actors—including policyholders, insurers, brokers, and agents—can play in achieving this goal.

Initiative 9
Launch a consumer education campaign on flood insurance

The Preliminary Work Maps show an increase of approximately 32,000 buildings in the 100-year floodplain. Therefore, it is critically important that owners of these properties in particular understand their obligations and be aware that their standard homeowners policies do not generally provide flood coverage. The City will launch a consumer education campaign to achieve these ends. Communication channels may include subway advertisements, radio spots, and social media. The Department of Consumer Affairs will develop and launch this citywide campaign in 2014.

Initiative 10
Launch an engagement campaign targeting insurers

Insurers' perceptions of climate risks in New York City and their confidence in the City's adaptation strategies can influence the availability and pricing of insurance. The City will, therefore, launch an insurer engagement campaign to inform insurance providers about the comprehensive measures the City is taking both pursuant to this report and more generally to minimize loss and disruption from climate risks.

This campaign, which will be launched by OLTPS, will include information on coastal protection investments, building code changes, and initiatives that impact business continuity like infrastructure hardening and transportation resiliency. The target audience will include insurance company executives and underwriters, catastrophe modeling experts, and other stakeholders from leading commercial and homeowner insurance providers in New York. The objective of this campaign will be to convince these individuals and their companies to consider the City's strategies as they set rates in New York. OLTPS will hold the first forum with insurers in 2013 and continue industry engagement on an annual basis.

Volunteer working to rebuild property after Sandy in Red Hook, Brooklyn

Credit: Damon Winter/The New York Times

Ravenswood Generating Station, on the East River waterfront, is the largest power plant in New York City.

Credit: Lawrence Chernin

Utilities

A steam vent in Midtown

Credit: Jorge Royan

At night, the city is aglow: Times Square dazzles visitors with all shades of neon; lights trace the spans of bridges from the Verrazano to the Whitestone; and street lights illuminate the clouds of steam that rise from the streets of Manhattan. Energy—electricity, natural gas, and steam—makes so much that is iconic about New York City possible. Utility networks not only bring the city's famous skyline to life, they also run the subways, keep the city cool in summer and warm in winter, and support every aspect of the economy.

Under the surface of the streets and out of sight, layers of critical energy infrastructure power the city. Pipelines bring natural gas from across the country. Power lines link the city to the larger regional grid. Generators burn gas to produce electricity. Steam travels from large boiler and cogeneration facilities to buildings through miles of underground conduits. These systems are complex and, in many cases, old—yet most New Yorkers do not think about them until they fail. However, these critical systems deserve careful consideration because they are vulnerable to extreme weather events—and likely will become more vulnerable as the climate changes.

Extreme weather has always been an issue for utility networks, including in the last decade. In 2006, a heat wave caused an extended blackout that affected approximately 250,000 Queens residents. In 2011, Hurricane Irene's floodwaters came close to leaving parts of Lower Manhattan in the dark. And in the summer of the same year, another heat wave led to an all-time record for city electricity demand.

But Sandy was different. Never before had the city experienced a weather event on this scale (the citywide blackout in the summer of 2003 was a result of a software error several states away). During and after the storm, one-third of the city's electric generating capacity was temporarily lost. Five major electric transmission substations in the city flooded and shut down. Parts of the natural gas distribution network were inundated. And four of six steam plants in the city were knocked out of service.

By the time the storm passed, more than 800,000 customers (representing over 2 million New Yorkers) were without power and 80,000 customers were without natural gas service. A third of the buildings served by the city's steam system—including several major hospitals—were without heat and hot water.

Within a few days of Sandy's departure from New York, much of the city had regained service. In some neighborhoods, however, including large parts of the Rockaways and Staten Island, outages lasted for weeks, as crews of electricians and plumbers went door-to-door to repair flooded equipment.

As serious as the damage to the city's energy infrastructure was, in many ways, the impact that this damage had on people and businesses was even worse. Hospitals had to be evacuated under emergency conditions when primary power was lost and backup generators failed. In high-rise buildings, elevators did not run and most taps above the seventh floor went dry because water pumps had no power. Many offices were left in the dark and without heat. The power outage caused transit shutdowns that prevented employees from going to work, even if their offices were unaffected. The real cost of the hurricane was measured less in repairs to energy infrastructure than in the profound disruption to the existing patterns of city life and commerce.

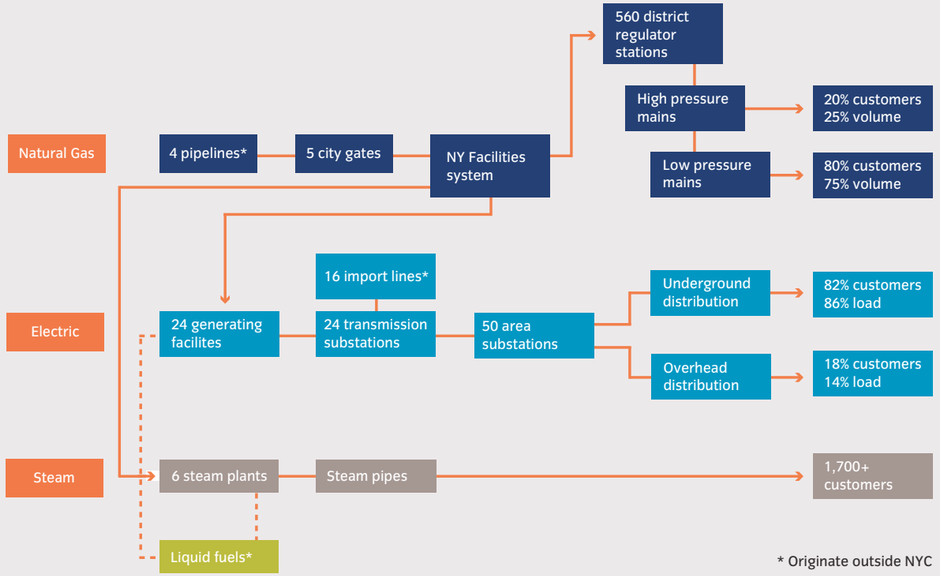
In the future, stronger storms and longer and more intense heat waves will likely pose new challenges to energy infrastructure. The city's energy systems—although reliable during ordinary weather events—need to be upgraded.

In keeping with the overarching goals of this report—which are to limit the impacts of climate change while enabling New York to bounce back quickly when impacts cannot be avoided—the City will work with utility companies and regulatory bodies to improve the current approach to utility regulation and investment. The City will advocate for incorporating risk-based preparation for low-probability but high-impact events, spending capital dollars to harden energy infrastructure and make utility systems more flexible, and diversifying energy sources. Collectively these strategies will reduce the frequency and severity of service disruptions, while allowing for more rapid restoration of service when these disruptions do occur.

How the System Works

New Yorkers spend roughly $19 billion per year on the energy to power, heat, and cool their city. The city's highly interdependent electricity, natural gas, and steam networks are among the oldest and most concentrated in the nation. Yet they are also still among its most reliable. These systems bring energy in bulk into the region and then transport it through layers of infrastructure, reducing levels of voltage (for power) or pressure (for gas) along the way and ultimately delivering energy to consumers. To understand how this system works as a whole, it is first necessary to understand its constituent parts. (*See graphic: Diagram of the Utility Systems*)

Diagram of the Utility Systems



Source: OLTPS

Electric System

The world's first centralized electric generation and distribution system was developed in New York City in the 1880s, by Thomas Edison. As of the writing of this report, New York's electricity system has since grown to serve 3 million customers—including 8.3 million people and 250,000 businesses —who consume roughly 1.4 percent of all electricity produced in the United States. In summer, the grid handles peak loads of over 11,000 megawatts (MW)—almost twice as much as the next largest city, Los Angeles.

The electric system consists of three major elements: generation, which produces electricity; the transmission system, which transports electricity at high voltages to large substations; and the distribution system, which carries electricity from large substations to smaller ones and ultimately to homes, businesses, and other customers. This system is owned, operated, and regulated by a wide array of private and public entities. *(See graphic: Overview of Electric Industry Participants)*

Generation

Multiple private companies and a public authority own and operate 24 plants within or directly connected to New York City (the "in-city fleet"). These plants can generate up to 9,600 MW of power, which is more than 80 percent of New York City's peak demand (defined as the peak level of electricity demand required on the most power-intensive days each year). Usually, only a subset of the in-city fleet will be running at any given time, with roughly 50 percent of the city's needs met with cheaper electricity imported from Upstate New York and New Jersey. The entire in-city fleet operates only during periods of peak electricity usage, such as during summer heat waves, when the use of air conditioning soars. New York City reached an historic peak of over 11,500 MW during a heat wave in July 2011, when temperatures reached over 100 degrees Fahrenheit for three consecutive days.

The in-city generation fleet is fueled predominantly by natural gas, with many plants also able to burn fuel oil. All of the in-city plants are located along the waterfront, with more than half concentrated in Astoria and Long Island City in Queens. Almost two-thirds of the fleet is more than 40 years old, equipped with technology that has lower efficiency and higher air emissions than modern plants.

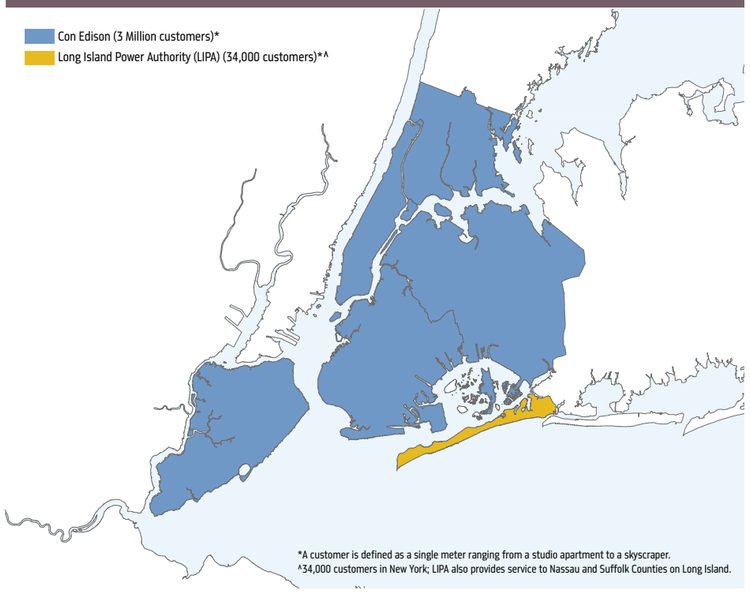
In addition to the in-city generating fleet, another small but growing source of energy in the New York market is customer-sited distributed generation (DG). Much of the 160 MW of DG capacity in New York consists of combined heat and power (CHP) installations, with smaller installations of renewable generation, including solar photovoltaic panels and fuel cells. CHP installations typically are found at large residential complexes, hospitals, and universities. These systems are usually in operation most of the time, replacing or supplementing electric power received from the grid. Some of these installations also are configured so they can operate independently of the grid during blackouts.

Transmission

Long-distance transmission lines connect the city with up to 6,000 MW of supply from areas as near as Northern New Jersey, Long Island, and the Hudson Valley, and as far as Northern and Western New York State. Both in-city-generated and imported electricity feed into Con Edison's electric grid at 24 high-voltage facilities housing switching and transformer equipment—known as transmission substations. Each of these substations routes the electricity that powers a large number of customers or clusters of critical infrastructure. In fact, a single substation in New York may support hundreds of thousands of customers—numbers that make New York's transmission system rare among other US systems.

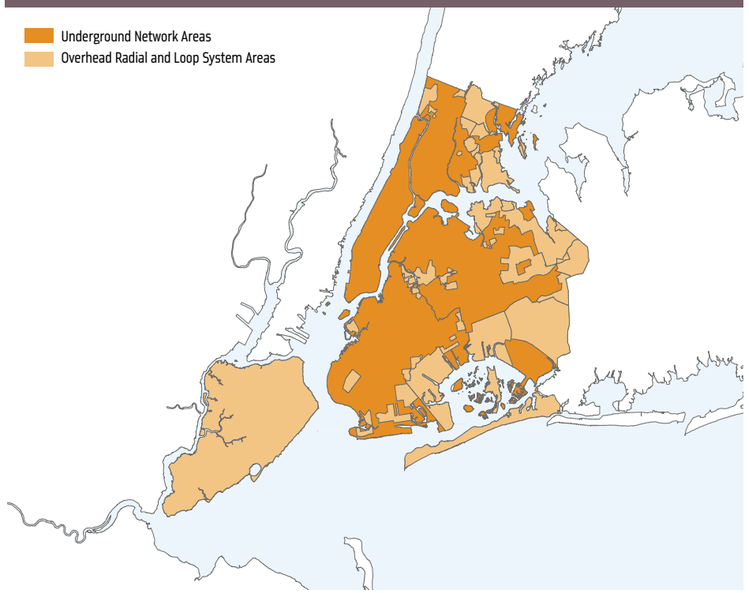
At the city's transmission substations, transformer equipment decreases electrical voltages. Electricity is then sent at these lower voltages through sub-transmission lines to area substations. There, smaller transformers decrease voltage once again and feed the

Electric Service Territories



Source: Con Edison, LIPA

Electric Distribution Systems



Source: Con Edison, LIPA

distribution system. The New York Independent System Operator (NYISO) coordinates the flow of electricity on the transmission system across the state, while Con Edison operates the transmission facilities it owns in the city.

Distribution

Con Edison is the primary electric utility in the city, providing electric distribution services to all five boroughs. The one exception is the Rockaways, which are served by the Long Island Power Authority (LIPA), a public authority controlled by New York State. LIPA does not operate and maintain its distribution system directly. Rather, it contracts for the operation and maintenance of this system to National Grid. This arrangement is set to expire at the end of 2013, when a subsidiary of Public Service Enterprise Group (PSEG) is scheduled to take over for National Grid for a 10-year period thereafter. (*See map: Electric Service Territories*)

The utilities' distribution systems consist of feeder lines that originate from "area substations," which are smaller than the transmission substations described above, but are nonetheless critical. Area substations typically serve one or two neighborhood-level "networks" or "load areas" of customer demand, each of which includes tens of thousands of customers.

In densely populated areas, such as Manhattan and certain portions of the other boroughs, the distribution system that carries power from area substations to end users consists of underground network systems—that is, systems that operate as a grid that can serve customers via multiple paths. In the rest of the city, the distribution system consists of a combination of underground and overhead loop systems and radial lines—that is, systems with simpler architecture, though also with fewer redundancies. These loop systems and radial lines account for about 14 percent of load on Con Edison's distribution system. LIPA's system in the Rockaways is made up exclusively of loop and radial systems. (*See map: Electric Distribution Systems*)

Customers ultimately receive electric power through service lines that are connected to their buildings' electrical equipment. In many cases, high-rise buildings or campus-style complexes have dedicated transformer equipment that serves these individual customers. This equipment is typically located in vaults beneath area sidewalks.

Natural Gas System

Natural gas fuels approximately 65 percent of heating and a significant percentage of cooking needs in buildings throughout New York. It also fuels more than 98 percent of in-city electricity production by power plants. A system of four privately-owned interstate pipelines transports natural gas from the Gulf Coast, Western Canada, and other production areas into the city at interconnection points called "city gates."

From the various city gates, high-pressure gas flows through an intra-city transmission system known as the New York Facilities. Gas that is destined for New York City's power plants generally is drawn at high pressure directly from the New York Facilities. To reach most other customers, gas is delivered through a set of regulator stations that reduce the pressure of the gas and send it into a vast network of underground distribution mains. In the city, these distribution mains come in two varieties: high-pressure and low-pressure. The low-pressure system is composed of cast iron and bare steel mains—outdated infrastructure that gradually is being replaced by the system's operators. This system is located mostly in the oldest parts of the city. Newer, high-pressure mains tend to be made of coated steel and plastic.

In New York City, Con Edison owns and operates the gas distribution system in Manhattan, the Bronx, and parts of Northern Queens. National Grid owns and operates the system in the rest of the city. (*See map: Natural Gas Service Territories*)

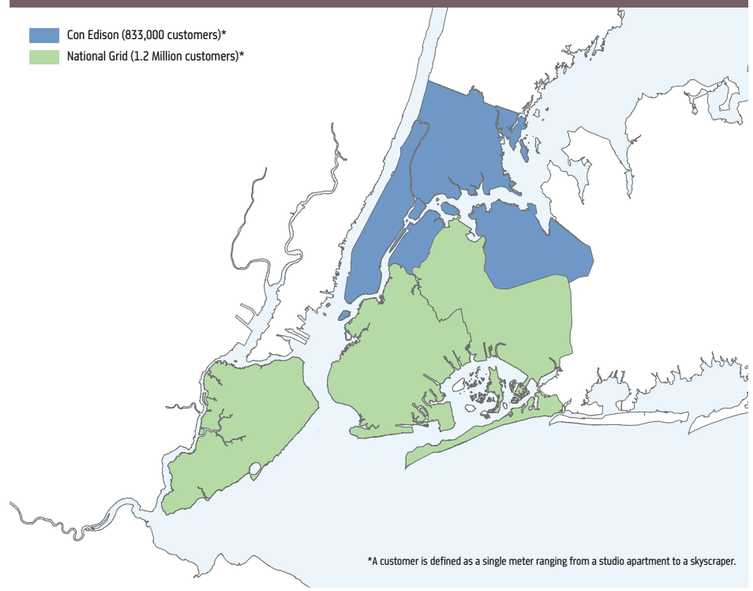
The city's natural gas demand usually peaks on cold winter days, when it can exceed the capacity of the four interstate pipeline connections. On those days, utilities ask electric generating plants and other large users to switch to liquid fuels. In the next three years, pipeline capacity will expand as private companies complete two new pipeline connections to serve the city, a significant advance in the City's cleaner burning fuels initiatives.

Steam System

The Con Edison steam system, one of the largest district steam systems in the world, provides over 1,700 buildings in Manhattan—including 10 hospitals and many of the city's largest institutions—with energy for heat, hot water, and, in some cases, air conditioning. The advantage of the steam system to customers is that it allows them to avoid owning and maintaining their own boiler systems. Instead, these customers are responsible for the easier task of maintaining on-site steam traps and condensate pumps. (*See map: Steam Service Territory*)

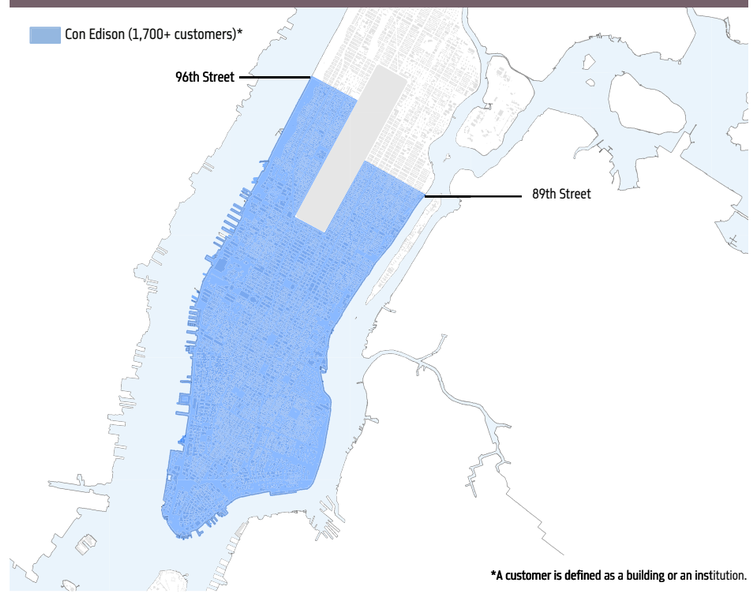
Six natural gas- and fuel oil-fired steam generating facilities in Manhattan, Brooklyn, and Queens can collectively produce over 10 million pounds of steam per hour, either cogenerating this steam along with electricity, or producing steam alone in massive boilers. A network of 105 miles of underground pipes transports this steam to customers.

Natural Gas Service Territories



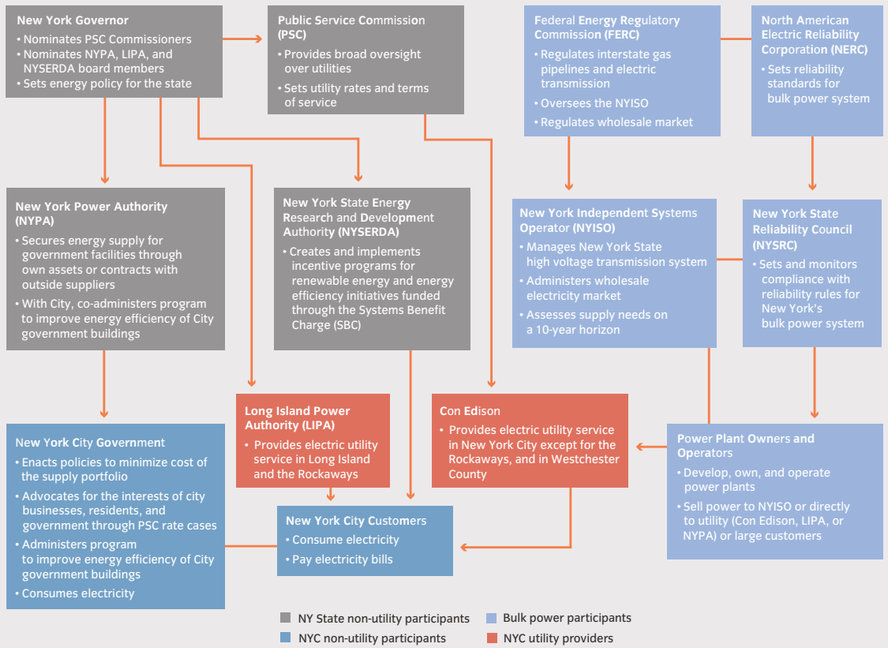
Source: Con Edison, National Grid

Steam Service Territory



Source: Con Edison

Overview of Electric Industry Participants



Source: OLTPS

Utility Regulation

A combination of private companies and public authorities own and operate New York's energy system, which is subject to a complex system of Federal and State oversight. Within this regulatory system, different entities are responsible for setting reliability expectations and standards, providing regulatory oversight, and for monitoring compliance with performance standards. The overall goal is to ensure safe, reliable, and affordable delivery of electricity, natural gas, and steam. (*See graphic: Utility Regulation*)

In the electric sector, the Federal Energy Regulatory Commission (FERC) oversees interstate transmission rates and wholesale electricity sales, while the New York State Reliability Council (NYSRC) establishes the State's electric reliability standards for the bulk power and bulk transmission systems. Subject to these standards, the NYISO operates the state's wholesale electricity market and high-voltage transmission system, and monitors the reliability of the state-wide transmission system. The New York State Public Service Commission (PSC) oversees all aspects of retail electric service, including the utilities' rates, terms, and conditions of service, as well as the safety, adequacy, and reliability of the service they provide.

Reliability expectations set by regulators govern the design and operation of the electric system. In the generation and transmission system, the reliability standards are set by the NYSRC, which requires that the bulk power and transmission system be designed so as to have an unplanned outage no more than once in 10 years.

Con Edison, in turn, designs and operates its electric system so that its network system, the portion of its system that serves the city's more densely-populated areas, is able to withstand the loss of two components within a distribution network and still maintain service. In less densely-populated areas, the system is designed to withstand the loss of one component.

Oversight of the rates, terms, and conditions of electric service is the domain of the PSC. One mechanism used by the PSC towards this end is the "rate case" process, in which the PSC determines the conditions for utility rate increases. During this process, a utility submits a filing that contains a justification for a rate increase, including details on capital investments that it proposes to make. The City and a variety of other stakeholders offer comments, testimony, and recommendations on the rate request and other related issues. The PSC then makes a decision about the proposed increase based on factors including whether the rates adopted will maintain safe and adequate service for customers. The same process applies to gas and steam utilities.

To measure how well the electric utilities are performing, the PSC uses quantitative metrics. The two main metrics are the System Average Interruption Frequency Index (SAIFI) and the Customer Average Interruption Duration Index (CAIDI). SAIFI measures the average number of interruptions per customer per year, while CAIDI measures the average length of each interruption. Con Edison's SAIFI is the lowest in the nation among large investor-owned utilities; its CAIDI, however, is above the national average. This generally reflects the fact that Con Edison's underground network systems are quite robust, suffering outages less frequently than typical above-ground systems – but when outages do occur, they can take longer to address and repair than overhead disruptions. (*See chart: Reliability Performance Comparison Among Selected US Utilities*)

For the natural gas and steam utilities, regulation of system design and operations is focused on safety. Oversight on rates and conditions of services is regulated similarly to the electric sector. In the case of the natural gas system, the FERC regulates interstate pipelines and the PSC regulates local distribution companies and the provision of retail gas service. Gas pipeline safety is regulated by the United States Department of Transportation (US DOT), though in New York State, the PSC is the US DOT's designee for this purpose. The steam system, on the other hand, is regulated solely by the PSC. For both systems, performance metrics used by the PSC measure how well utilities manage leaks and how quickly they respond to reports of them (and, in the case of the natural gas utilities, odors).

Across all of the city's energy systems, the PSC also establishes financial incentives for each utility. These incentives impose revenue adjustments for failure to achieve specified thresholds or target levels of performance.

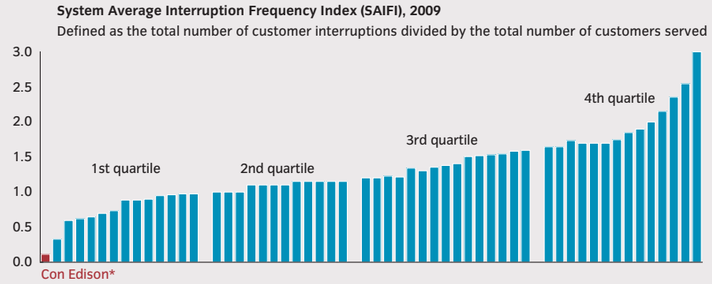
Climate change and its associated risks are not considered with respect to virtually any aspect of the regulatory framework applicable to New York's energy system. For example, the models that the NYISO runs to test whether the electric system will be able to meet future standards factor in the possibility of future heat waves, but do not yet consider the fact that in the future, heat waves are likely to be more frequent, more intense, and longer lasting than today, impacting electric demand. Similarly, when the utilities design their equipment, they tend to do so with a certain level of storm surge in mind. The regula-

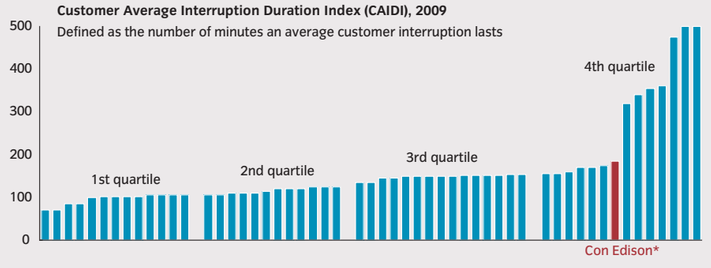
Utility Regulation

UTILITY SERVICE	RELIABILITY EXPECTATIONS	REGULATORY OVERSIGHT	PERFORMANCE MONITORING
Electric generation and transmission	• NYSRC requires that the probability of the loss of firm load due to system wide resource deficiencies be no more than 1 day per 10 years in accordance with Federal standards set by NERC	• FERC oversees NERC and NYISO, which manages bulk electricity generation and transmission in New York • NYSRC sets reliability standards (with FERC and PSC oversight)	• Compliance with NERC and NYSRC standards is monitored by the NYSRC and NYISO through reporting, audits, and investigations
Electric distribution	• Con Edison designs network system to withstand the loss of two components; parts of the overhead system are designed to withstand the loss of one component (depending on location and population density)	• PSC regulates rates, terms, and conditions of service	• PSC measures performance using SAIFI, CAIDI, and major outage events • PSC also tracks use of remote monitoring systems and restoration times following outages
Natural Gas transmission	• N/A, focus is on safety	• FERC regulates rates, terms, and conditions of service • USDOT regulates pipeline safety	• N/A
Natural Gas transmission	• N/A, focus is on safety	• PSC regulates rates, terms, and conditions of service • PSC regulates pipeline safety as USDOT's delegate	• PSC measures emergency response time to leaks, leak repair backlog, damages to gas facilities, and replacement of leak-prone gas mains
Steam	• N/A, focus is on safety	• PSC regulates rates, terms, and conditions of service	• PSC measures response time to leaks and leak repair backlog

Source: OLTPS

Reliability Performance Comparison Among Selected US Utilities





* Con Edison numbers include the underground network system, which is unique among compared utilities
Note: Chart values include major storm events

Source: Edison Electric Institute, NYS PSC, Team Analysis

The Arverne Substation in the Rockaways was severely damaged by Sandy.

Credit: LIPA

tors, however, do not yet require these utilities to consider a full range of present and future storm surge risks. When it comes to measuring performance, some versions SAIDI and CAIFI metrics that are used for the purpose actually exclude outages that are caused by major weather events.

What Happened During Sandy

Sandy caused unprecedented damage to New York's electricity and steam systems, while the city's gas system experienced damage that was smaller in scale and impact. In all three systems, however, damage occurred to infrastructure and customer equipment alike, leaving hundreds of thousands of customers without electricity, tens of thousands of customers without natural gas, and hundreds of the city's largest buildings without steam for heat and hot water.

Most of the city's energy systems ultimately recovered within a week of Sandy's departure. However, in parts of the city where floodwaters inundated basements and sub-basements, it took additional weeks to make the extensive repairs to homes and businesses that were necessary for utility service to be restored.

Electric System

The total number of New York customers left without power as a result of Sandy ultimately came to 800,000, which, given that utilities define a customer as a single electric meter, is equal to more than 2 million people. This is five times as high as the number that lost power during Hurricane Irene, the second most-disruptive storm in recent history. Despite actions by the utilities to protect their assets, the storm caused serious damage to generation, transmission, and distribution systems, as well as to customer-owned equipment. While utilities sought to restore services as quickly as possible, the extent of the damage led to a complex and lengthy restoration process. Service to most Con Edison customers was restored within four days. However, some customers' service was not restored for almost two weeks, making this event the longest-duration outage in Con Edison's history. LIPA's electric service restoration in the Rockaways took an average of almost 14 days—with some customers enduring outages over a much longer period.

In the days leading up to Sandy, the utilities took preemptive actions to minimize potential downtime by protecting and preserving their infrastructure. For example, to mitigate the impact of a surge (which, based on the best available forecasts, would top 11 feet at the Battery in Manhattan), the utilities protected critical facilities with sandbags, plywood and other temporary barriers. Then, as the storm arrived on the night of October 29, Con Edison shut down three entire networks preemptively—its Bowling Green and Fulton networks in Lower Manhattan, and its Brighton Beach network in Brooklyn—to prevent catastrophic flood damage to several clusters of underground distribution equipment as well as to customer equipment. Elsewhere, Con Edison prepared to de-energize feeders when flooding appeared imminent at key underground transformer vaults. Because of the configuration of the network distribution system, many of these preemptive moves caused the loss of electricity not only to customers in areas that were anticipated to be in Sandy's inundation zones but also to many customers that were expected to be outside of those zones.

When the storm arrived, the surge exceeded projections, topping out not at 11 feet but at 14 feet (MLLW) at the Battery and overwhelming many pre-storm preparations. Flooding forced several power plants and several transmission lines that import electricity from New Jersey to shut down, leaving New York City more dependent on a subset of its in-city generation capacity and on the electricity supply from Upstate New York. Some facilities also were damaged severely by Sandy's surge. This was true, for example, at the Brooklyn Navy Yard Cogeneration plant and the Linden Cogeneration plant. Other facilities, meanwhile, were disconnected temporarily because of impacts to the transmission system. While the impacts to electricity supply were significant, Sandy, ultimately, did not have the impact it might have had, had the storm arrived during the summer. (*See sidebar: Summer Demand Scenario*)

Perhaps the most significant (and dramatic) impact that Sandy had on the operation of the transmission and distribution systems occurred when the storm's surge came into contact with several key substations—including substations that, based on earlier surge forecasts, were not expected to be impacted. For example, in the Rockaways, all four LIPA substations were knocked out by floodwaters, resulting in widespread power failures throughout the peninsula. In Manhattan, Sandy's surge overtopped temporary protective barriers at Con Edison's East 13th Street complex, flooding two transmission substations and leading to an intense electric arc that could be seen from across the East River. Storm surge also impacted a Con Edison area substation in Lower Manhattan. Across these facilities, critical control equipment was submerged in saltwater. The damaged systems made the substations inoperable, knocking out power to most of Manhattan south of 34th Street (with one notable exception being Battery Park City, which is supplied with electricity from a transmission substation in Brooklyn). Finally, flooding of a transmission substation in Staten Island caused a grid-level shutdown in the western part of the borough.

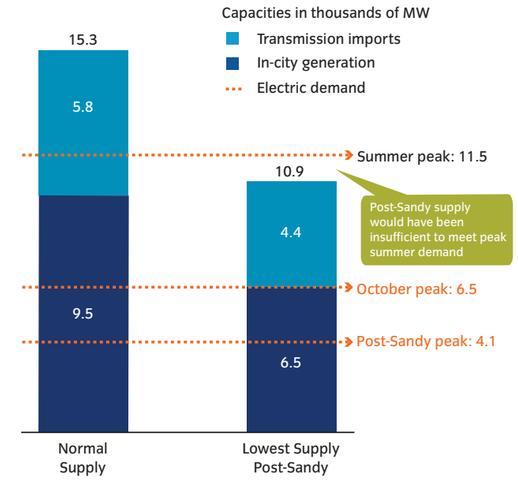
Each of these substation losses impacted tens or hundreds of thousands of customers. In all, approximately 370,000 electric customers in New York City lost power due to network shutdowns and substation flooding in Manhattan, Brooklyn, Queens, and Staten Island. (*See map: Electric Network Shutdowns During Sandy by Cause*)

Summer Demand Scenario

After Sandy, New Yorkers generally focused on the impact of the storm on the city's electricity consumers. By damaging distribution systems and customer equipment and disrupting activity across New York, the storm temporarily reduced demand for electricity in the city by some 40 percent. What has received less attention, however, is the fact that Sandy also disrupted a large number of in-city generators (directly and indirectly), leaving the city short of 3,000 MW of capacity upon which it normally could depend (almost one-third of normal in-city capacity). In addition, due to impacts to low-lying sections of the transmission infrastructure between New York and New Jersey, Sandy also left the city temporarily unable to access more than 1,400 MW of import capacity from New Jersey.

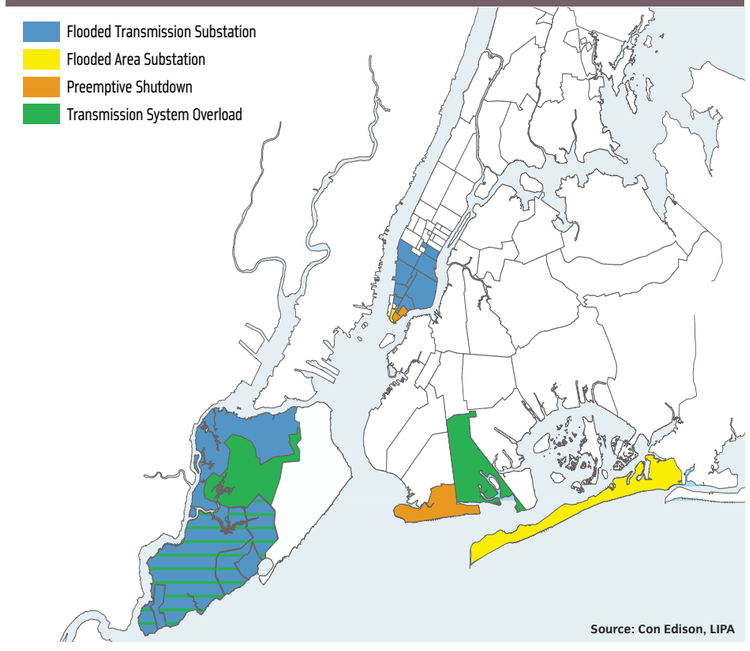
Because of the timing of Sandy's arrival in late October, when electricity usage tends to be relatively low, the remaining supply available to the city after Sandy ended up being sufficient to support the city's demand at the time. However, if Sandy had come during the peak summer demand period, it is possible that—once the storm had passed and peak load had recovered—the remaining in-city generation capacity would have been inadequate to meet the city's demand. This, in turn, could have resulted in severe outages on a much wider scale than those actually caused by Sandy. This disruptive outcome is one that the city may not avoid during future extreme weather events, particularly if hardening measures are implemented to protect distribution infrastructure and customer equipment without also protecting generating assets.

Electricity Supply and Demand Balance



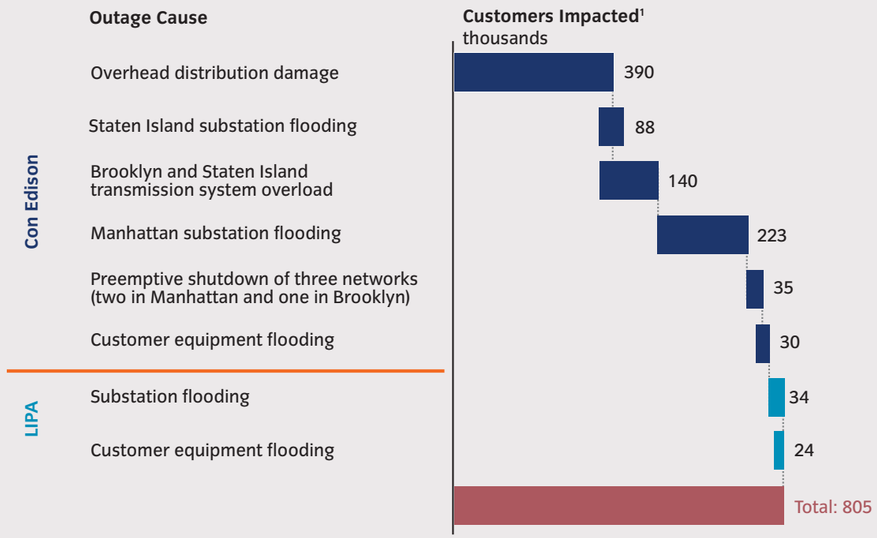
Source: NYISO

Electric Network Shutdowns During Sandy by Cause



Source: Con Edison, LIPA

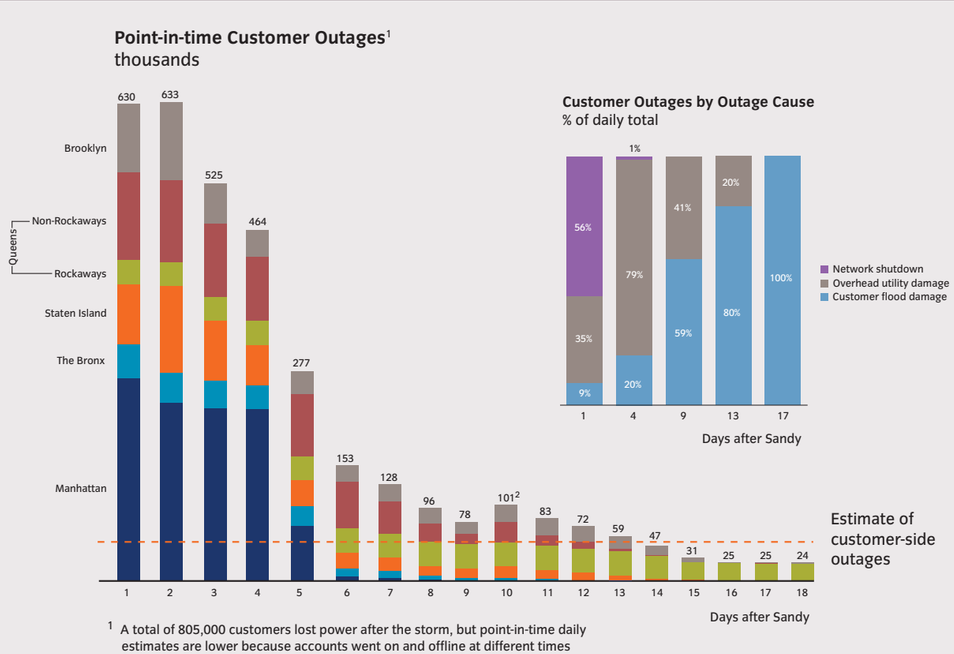
Causes of Electric System Outages and Customer Impacts



[1] Overlaps of customer counts exist between categories

Source: Con Edison, LIPA

Electrical Outage Restoration

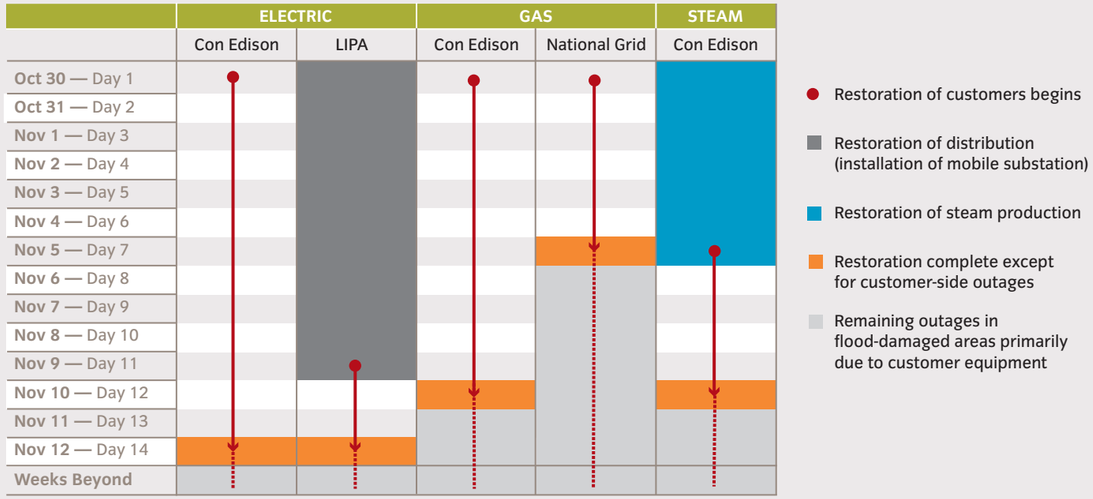


[1] A total of 805,000 customers lost power after the storm, but point-in-time daily estimates are lower because accounts went on and offline at different times

[2] Increase in customer outages due to the impact of nor'easter on Nov. 7

Source: Con Edison, LIPA

Electric, Gas, and Steam System Restoration Milestones



Source: Con Edison, LIPA, National Grid

Substation disruptions also led to stresses within the city's bulk transmission system, which became another cause of power outages. For example, a day after Sandy's departure, a transmission system overload resulted from flood impacts at two transmission substations in Brooklyn and Staten Island. The combination of these factors and the loss of all import capacity from New Jersey meant that the remaining transmission line capacity from northern parts of the city to parts of Brooklyn and Staten Island was inadequate to support the load. As a result, Con Edison was forced to terminate service to 140,000 customers, including some customers which had lost and regained power just the day before. This situation persisted for two and half hours, until additional generation (340MW from the Arthur Kill Generating Station that had been undergoing scheduled maintenance) could be brought online.

In addition to the outages caused by substation disruptions, Sandy caused localized outages in the city's overhead distribution system. Intense periods of sustained winds as well as wind gusts reaching 90 miles per hour toppled trees and pushed branches into power lines. Ultimately, 140 miles of overhead lines, 1,000 poles, and 900 transformers were damaged in Con Edison's system and had to be replaced or repaired. As a result approximately two-thirds of the city's customers served by the overhead system, or 390,000 customers, lost power at some point.

Within heavily flooded areas, approximately 55,000 customers primarily lost power not only because of damage to the utility system serving them but because of damage to electrical equipment in their buildings. In many cases, these customers suffered much longer outages due to the extensive repairs needed on their own equipment. Customers that were impacted by flooding in their basements included three hospitals. These hospitals eventually were forced to evacuate patients because they were unable to rely on their backup power systems. (*See chart: Causes of Electric System Outages and Customer Impacts*)

As Sandy's floodwaters receded, the utilities were faced with the massive task of restoring electricity to those who had lost it. The efforts to restore electric service were centered around repairs to damaged transmission infrastructure and local distribution system equipment. Of course, before restoration could occur, it was necessary for the utilities to determine where the need for restoration existed. The identification of system outages generally relies on a combination of grid monitoring technology, customer complaints, and, in areas of heavy damage, special assessment teams sent out by the utilities. Following Sandy, once the utilities assessed the location and extent of damage, restoration of service was prioritized to the extent possible for facilities necessary for critical care and public safety, City infrastructure, and individual customers. *(See charts: Electric Outage Restoration* and *Electric, Gas and Steam System Restoration Milestones*)

Electric service restoration to customers connected to the underground distribution system depended on the utilities' ability to reenergize inundated substations. In most cases, during Sandy, the major electricity-carrying equipment in these substations escaped catastrophic damage. In fact, most of the portions of the system that were damaged were restored in a matter of days. Once each substation was restored, service to the tens of thousands of customers could be turned on almost instantaneously.

Much work remained even after the restoration of substations. While Con Edison's decision to deenergize portions of the underground distribution system in Lower Manhattan and low-lying areas in Brooklyn and Queens preemptively reduced the extent of damage, localized areas of flooding required hundreds of underground vaults to be pumped dry. The combination of dewatering, the replacement of the many components that were damaged by inundation, and the inspections that were required prior to reenergizing turned out to be a significant undertaking for Con Edison.

Utilities from around the country sent "mutual assistance crews" to assist in this restoration effort. For example, Con Edison brought in nearly 3,400 overhead line workers (as well as over 400 underground workers) from as far away as California. As a result of these efforts, service to the majority of overhead and underground system customers was restored within a week. Due to the sheer volume of damage across the system, it took another week to restore power to all of Con Edison's customers who could accept it.

Utility workers pumping water out of underground electric vaults post-Sandy

Credit: Con Edison

The situation in LIPA's territory in the Rockaways was worse. There, several substations were so badly damaged that a mobile substation unit had to be put in place while longer-term repairs were conducted. As a result, it took 11 days after Sandy passed before LIPA could begin to reenergize its grid. Three days later, LIPA was able to restore power to 10,000 customers, predominantly in portions of Far Rockaway, whose homes were built on higher ground. The majority of customers in Rockaway neighborhoods such as Belle Harbor, Rockaway Beach, and Arverne, had significant flood damage to electrical equipment in their homes and businesses, which further delayed service restorations.

As indicated, even when power was restored to different parts of the city's electrical grid, customers were not able necessarily to use that power in their homes and businesses; this was due, in many cases, to significant damage to customer-side equipment caused by the flooding. In these cases, the City worked with Con Edison, LIPA, and National Grid to create an innovative program for impacted homeowners called Rapid Repairs. This program, funded by FEMA, made licensed electricians available to repair customer-side electrical damage. By the time it ended, five months after Sandy, the Rapid Repairs program had helped restore service to some 20,000 homes.

It is worth noting that, amidst the widespread electric outages, there were some cases where facilities performed well on either backup generators or CHP systems. For example, at least five hospitals relied on backup generator systems in order to stay in operation during the storm and its aftermath. Meanwhile, New York University had success keeping key buildings on its Washington Square campus lit and heated thanks to a newly installed gas-fired CHP system, which it was able to operate seamlessly in isolation from the grid when the grid failed.

Natural Gas System

Overall, the city's natural gas system fared better than its electric grid. However, even this generally resilient system did not escape damage, with approximately 80,000 National Grid and 4,000 Con Edison customers ultimately losing service.

As was the case for the electric grid, Sandy's impact on the city's natural gas system began with a series of preemptive steps that were taken by Con Edison and National Grid. For example, as Sandy approached, the two utilities isolated some low-lying parts of their networks to ensure that any intrusion of water would be limited, rather than spreading system-wide. Both Con Edison and National Grid also shut down several regulator stations in anticipation of the storm.

As Sandy's surge peaked, Con Edison and National Grid needed to take immediate action, resulting in the shutdown of still more sections of their respective distribution systems. In some parts of the low-pressure distribution system, the pressure of floodwaters quickly exceeded the pressure inside the gas mains, resulting in water intrusion through cracks, holes and other weak points. Meanwhile, in the high-pressure distribution system, floodwaters entered some customer service lines. The net effect of the preemptive actions and the inundation damage was loss of gas service in a number of city neighborhoods, including Coney Island, Howard Beach, the Rockaways, Edgewater Park, Locust Point, City Island, and portions of the East Village and South Street Seaport. Additionally, some of Con Edison's gas control and monitoring equipment stopped functioning, due to the loss of power and telecommunications services.

As Sandy's floodwaters receded, restoration primarily depended on the removal of water from distribution mains, equipment and pipe inspections, and the re-lighting of customers' appliances. Though this work began almost immediately, damage to some system components was extensive. For example, in the weeks following the storm, National Grid had to rebuild 13 miles of gas mains serving Breezy Point (which had also been damaged by fire) and New Dorp.

Similar to the electric grid, restoration of the gas distribution system was still, in some cases, insufficient to re-light appliances in homes and businesses that were damaged by floodwaters. Here again, the City's Rapid Repairs program was instrumental in assisting homeowners with making repairs to damaged boilers and heating systems.

Steam System

During Sandy, one-third of the city's steam customers, including five acute care hospitals, experienced outages. As was the case for the electric grid and gas distribution system, Sandy's impact on the city's steam distribution system began with a series of preemptive steps that were taken by Con Edison. These included the closing of low-lying segments of the system, in order to avoid a damaging and potentially explosive effect called "water hammer" that occurs when cold floodwaters meet hot steam pipes. Con Edison also shut down two generating stations that were potentially vulnerable to inundation: East River and Brooklyn Navy Yard.

The storm surge from Sandy forced Con Edison to shut down two more generating stations, one at 59th Street and one at 74th Street in Manhattan. In total, during Sandy, the city's steam system lost nearly 90 percent of its generating capacity, resulting in a complete shutdown of the system below 14th Street. Other customers lost steam service when parts of the First Avenue distribution tunnel, which steam mains, gas mains, and electric lines traverse, were flooded with 500,000 gallons of water. Moreover, some customers' steam services were shut down when the electric grid failed in Southern Manhattan, and they were unable to power their buildings' systems.

Following Sandy, restoration of the steam system took approximately 12 days. This was not only because of the significant damage that had occurred but also because of the careful timing and sequencing required for restoration, including the repair of production capacity and dewatering of pipes, which are both necessary preconditions for the warming and pressurization of mains.

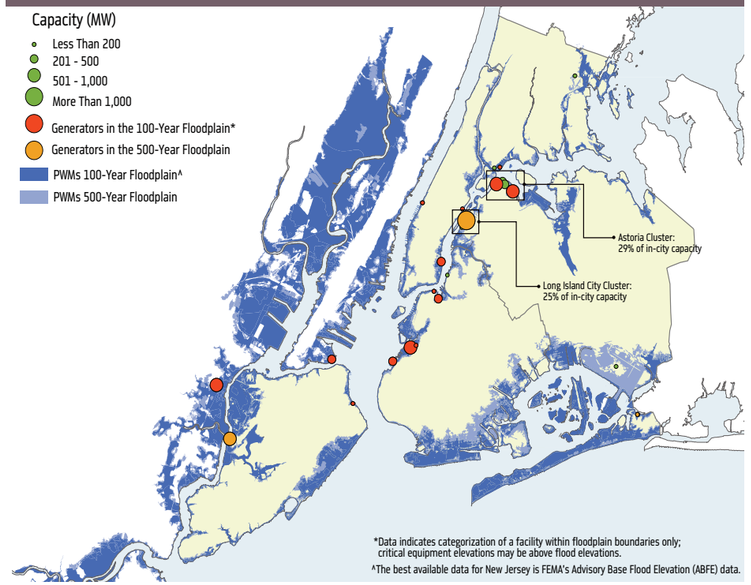
What Could Happen in the Future

Going forward, impacts from several types of extreme weather events could cause major failures in the city's utility systems, which could take multiple days to weeks to repair. The electric and steam systems face the greatest risks, with storm surge, paired with sea level rise, representing the most significant challenge. The electric system also could be impacted seriously by more frequent, longer, and intense heat waves. The natural gas system is fairly resilient overall, but storm surge could still pose a localized risk.

Major Risks

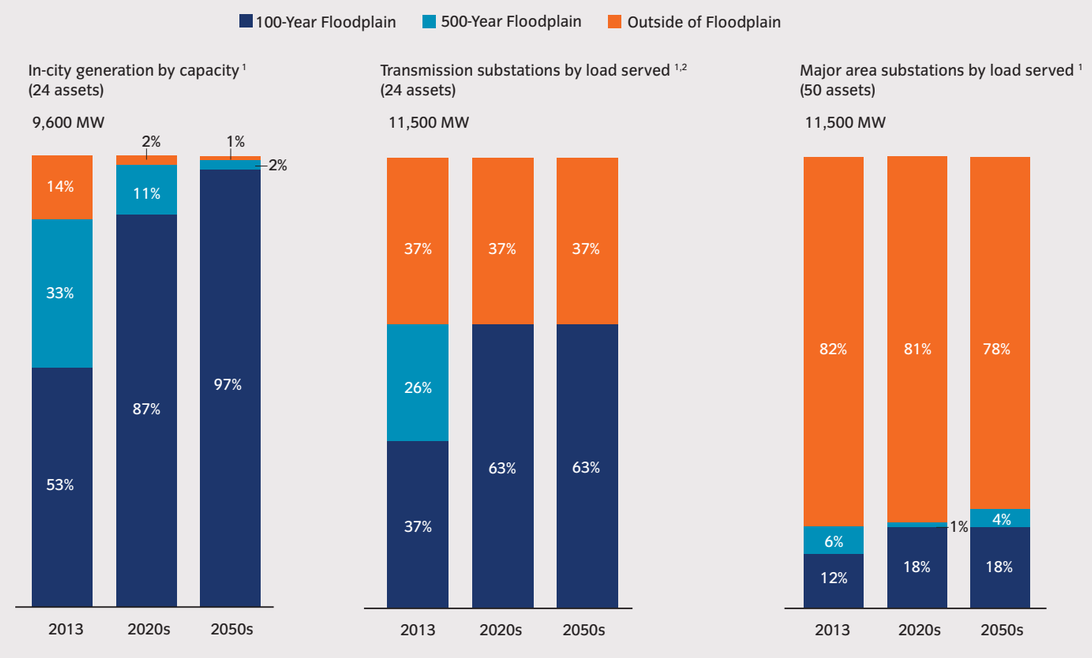
As Sandy demonstrated, storm surge could cause major loss of electric and steam service. The city's underground electric and steam distribution systems are vulnerable to floodwaters, as are electric and steam generating facilities. Today, 88 percent of the city's steam generating capacity already lies within the 100-year floodplain. In the electric system, 53 percent of in-city electric generation capacity, 37 percent of transmission substation capacity, and 12 percent of large distribution substation capacity lie

In-City Electric Generating Facilities in the Floodplain



Source: FEMA, OLTPS

Electric Assets in Current and Future Floodplains



[1] Data indicates categorization of a facility within floodplain boundaries only; critical equipment elevations may be above flood elevations

[2] Does not include transmission substations that do not serve load directly

Source: FEMA, CUNY Institute for Sustainable Cities, OLTPS

Risk Assessment: Impact of Climate Change on Utilities—Electric System

Major Risk Moderate Risk Minor Risk

	Scale of Impact			
Hazard	Today	2020s	2050s	Comments
Gradual				
Sea level rise				Minimal impact
Increased precipitation				Minimal impact
Higher average temperature				Minimal impact
Extreme Events				
Storm surge				Much of the critical infrastructure is in floodplains; flood risks will become worse over time
Heavy downpour				Minimal impact
Heat wave				Increased risk of outages due to the impact of heat waves on peak demand and on electric infrastructure
High winds				Risk of damage to overhead power lines

Risk Assessment: Impact of Climate Change on Utilities—Steam System

Major Risk Moderate Risk Minor Risk

	Scale of Impact			
Hazard	Today	2020s	2050s	Comments
Gradual				
Sea level rise				Minimal impact
Increased precipitation				Minimal impact
Higher average temperature				Minimal impact
Extreme Events				
Storm surge				Most steam generation assets and parts of the distribution system are in floodplains; flood risks will become worse over time
Heavy downpour				Localized outages are possible
Heat wave				Minimal impact
High winds				Minimal impact

Risk Assessment: Impact of Climate Change on Utilities—Natural Gas System

Major Risk Moderate Risk Minor Risk

	Scale of Impact			
Hazard	Today	2020s	2050s	Comments
Gradual				
Sea level rise				Minimal impact
Increased precipitation				Minimal impact
Higher average temperature				Minimal impact
Extreme Events				
Storm surge				City gates could lose monitoring/control systems; low-pressure distribution pipes could experience water infiltration
Heavy downpour				Minimal impact
Heat wave				Minimal impact
High winds				Minimal impact

within the 100-year floodplain. Based on the best available sea level rise projections, these figures are forecast to grow by the 2050s to 97 percent, 63 percent, and 18 percent, respectively. *(See map: In-City Electric Generating Facilities in the Floodplain; see chart: Electric Assets in Current and Future Floodplains)*

For the natural gas system, the biggest risk that storm surge poses (both today and in the future) is to the distribution infrastructure. Although flooding in and of itself usually will not stop the flow of gas, if water enters pipes, service can be compromised. The low pressure system is particularly vulnerable to this type of infiltration. Further upstream, the risks are lower, since gas can continue to flow if water inundates a city gate or regulator station (though controls and metering equipment are not always impervious to flooding).

Another significant risk to the city's energy systems—primarily its electric grid—comes from heat waves. Historically, heat waves impacted the city's electric grid more frequently and more significantly than any other type of weather event. For example, in 2006 a heat wave-related electrical outage in Long Island City, Queens resulted in the loss of power to approximately 115,000 customers (or 25,000 residents)—some for more than a week. In the future, New York is likely to face longer, more frequent, and more intense heat waves.

Heat waves create issues for the electric grid in two ways. First, they typically lead to a significant increase in demand as the use of air conditioning soars. This risks an imbalance between demand and supply, which can lead to outages. Second, the very temperatures that cause increases in demand simultaneously strain the electric generating and distribution equipment itself. For example, a prolonged heat wave makes it difficult for electricity-carrying equipment (such as transformers) to dissipate heat, while urban heat island effects (where heat absorbed during the day is retained near asphalt surfaces) put particular strain on distribution equipment located underground. These factors can lead to equipment failures and cascading disturbances in the electric system.

These two risks caused by heat waves can be mitigated, to an extent, if the NYISO or utilities ask certain customers to reduce electricity usage (and pay them for doing so) as part of demand response programs. Additionally, utilities can implement network-wide voltage reductions (between 5 and 8 percent) to relieve stress on equipment in strained networks. Con Edison employed this strategy in the summer of 2012, reducing voltage in 28 networks for a half day to 3 days at a time. However, if these measures do not sufficiently reduce demand and equipment stress, more significant impacts could occur, including the disconnection of entire neighborhoods or—when all strategies fail—cascading blackouts. *(See map: Heat Wave Impact: Voltage Reduction in Con Edison Networks)*

Finally, in addition to storm surge and heat waves, the vulnerabilities of the various energy systems present a significant risk to their sister systems, due to their interconnectivity. For example, natural gas and liquid fuels are necessary for the generation of much of the city's electricity and steam. Thus, disruptions to the fuel supply chain may in turn disrupt power and steam production. The steam system is also vulnerable to large-scale power outages: All of the city's steam generating plants rely on electric equipment, and although backup

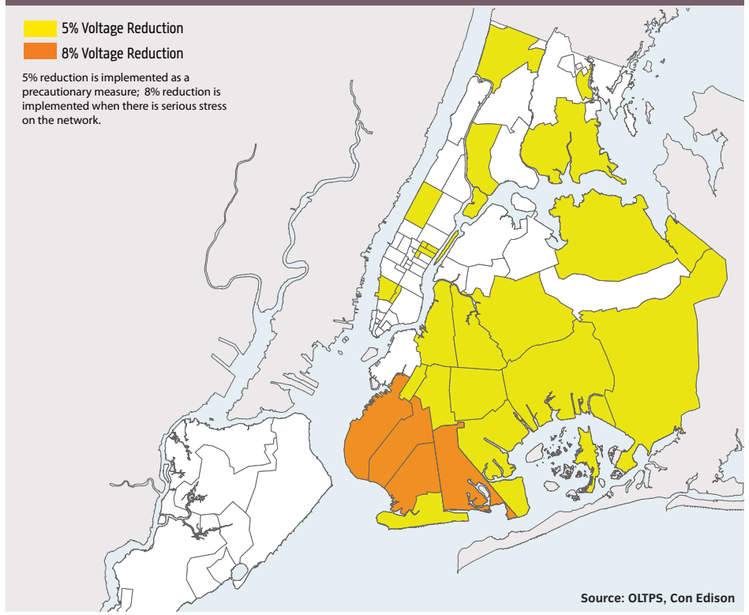
generation is often available, switching to it requires time, meaning that the steam system is vulnerable to depressurization during the downtime. This is what happened during the citywide power outage of 2003, when the entire steam system was shut down for more than five days.

Other Risks

High winds will continue to pose a serious risk to the electric system looking forward. Since most wind-related damage occurs when winds topple trees and branches into power lines, the damage tends to cause more localized outages, rather than system-wide issues. That said, hurricanes and other large storms with significant wind can lead to damage that is more widespread.

Meanwhile, for the steam system, tropical storms or hurricanes that bring heavy downpours may present some of the same challenges that surge does, though likely on a much more localized basis. Large volumes of water around steam mains prevent condensate traps from functioning properly, potentially leaving piping vulnerable to water hammer effects that can shut down steam mains.

Heat Wave Impact: Voltage Reduction in Con Edison Networks



Source: OLTPS, Con Edison

Credit: Seth Pinsky

This chapter contains a series of initiatives that are designed to mitigate the impacts of climate change on New York's utility systems. In many cases, these initiatives are ready to proceed and have identified funding sources assigned to cover their costs. With respect to these initiatives, the City intends to proceed with them as quickly as practicable.

Certain other initiatives described in this chapter may be ready to proceed, but still do not have specific sources of funding assigned to them. In Chapter 19 (*Funding*), the City describes additional funding sources, which, if secured, would be sufficient to fund the full first phase of projects and programs described in this document over a 10-year period. The City will work aggressively on securing this funding and any necessary third-party approvals required in connection therewith (i.e., from the Federal or State governments). However, until such time as these sources are secured, the City will proceed only with those initiatives for which it has adequate funding.

From the 19th century to today, New York's energy systems have evolved along with the city that they serve. However, emerging climate threats will necessitate a rethinking of important aspects of the systems' architectures. At the same time, new technologies present an opportunity to modernize these systems in ways that could increase their resiliency significantly.

To this end, the City will advance a series of proposals designed to enable electricity, gas, and steam to be delivered reliably to New Yorkers, even during the extreme weather events that are expected in the coming decades. These proposals will address gaps in the regulatory framework applicable to these systems, as well as the infrastructure that supports them. Collectively, even as the climate changes, these proposals will reduce the frequency and severity of service disruptions, while allowing for more rapid restoration of service when disruptions do occur.

Strategy: Redesign the regulatory framework to support resiliency

The first set of proposals is designed to address gaps in the regulatory framework that governs the city's energy systems. This will assist utilities and regulators with identifying and appropriately funding long-term capital projects that will make the electric, gas, and steam systems more resilient.

Initiative 1

Work with utilities and regulators to develop a cost-effective system upgrade plan to address climate risks

Utilities and regulators long have employed analytical techniques to ensure adequate energy supply in the event of heat waves or failure of individual pieces of equipment. However, regulators generally do not require utilities to prepare for the possibility of losing entire facilities to weather events such as storm surge, nor do they consider the indirect economic and societal impact of such events. This is primarily because current guidelines instruct utilities, in designing their systems, to consider what is known and measurable—an approach that does not address low-probability but high-impact events such as Sandy.

The City, through the Mayor's Office of Long-Term Planning and Sustainability (OLTPS), will work with utilities, regulators, and climate scientists to adjust the existing regulatory framework to address these shortcomings. These changes will seek to require utilities to analyze costs, benefits, and risks, and to upgrade their systems as appropriate to withstand the sorts of high-impact risks that they face not only today, but also are likely to face with increasing frequency in the future. At the same time, the City will seek modifications in the ratemaking process to ensure that resiliency-related investments are given due consideration and that the utilities have a reasonable opportunity to recover those investments, just as they now recover their investments related to reliability.

Underlying all decisions on infrastructure upgrades that address extreme weather and climate change resiliency (including the type of investments that the City will seek to encourage utilities to make through the aforementioned regulatory changes) is an accurate assessment of risks. This is because not all assets need to be protected to the same standard, given that some are more vulnerable or important than others. To avoid unnecessary rigidity, the City will advocate for the use of probabilistic risk assessments by regulators and utilities to help guide the most efficient use of the utilities' capital budgets.

OLTPS has taken the first steps towards developing a risk assessment model that takes into account storm probabilities and future surge heights, quantifying possible customer outages and economic losses, and thereby beginning to identify the system assets that should be prioritized for protection. OLTPS will work with the utilities and climate scientists to continue to refine this model, with the goal of building a cost-benefit tool upon which to base storm hardening investment decisions that the PSC could incorporate into its utility regulation framework. (*See sidebar: Climate Risk Model for the Electric Sector*)

Initiative 2

Work with utilities and regulators to reflect climate risks in system design and equipment standards

To date, the system planning approaches and design standards used by New York's utilities and regulators have ensured highly reliable systems in New York. However, they have not been established with the goal of optimizing system resiliency. Ultimately, the city's systems should be capable not only of reliable day-to-day operation, but also of remaining operational during extreme weather events (such as hurricanes, tropical storms, and heat waves), and recovering quickly when parts of the system fail.

This can be achieved in part by considering climate change impacts in system planning

Climate Risk Model for the Electric Sector

Extreme climate events may be difficult to predict more than a few days in advance—but their general patterns of occurrence are measurable. In the electric sector, these measurements can support analytical techniques that reveal the extent of existing and future risks and support better decision-making as utilities and regulators decide how much and how quickly to invest to prepare for heat waves, storm surges, and high wind events.

OLTPS, with support from the Analytics Division of the Mayor's Office of Policy and Strategic Planning, has taken the first steps towards a more quantitative approach to addressing the climate-related risks to New York City's electric systems. The Electric Sector Storm Surge Risk Model (ESRM), which the City is developing, contains three main modules:

1. The storm surge module, which builds on third-party storm models and climate change projections from the NPCC to generate hundreds of inundation scenarios and associated probabilities of occurrence for critical electric infrastructure locations, looking at 2013, the 2020s, and the 2050s;
2. The network structure module, which maps out the dependencies between individual substations and the networks they serve and compares the design elevation of each substation with the surge height in each individual storm to determine whether or not it would remain functional; and
3. The customer module, which uses the wealth of data available to the City to move past the simple number of customers that a network serves towards a more nuanced understanding of the network's importance—including the critical customers that depend on it, the amount of economic activity it supports, and, for example, the number of high-rise housing units that it serves that contain vulnerable populations.

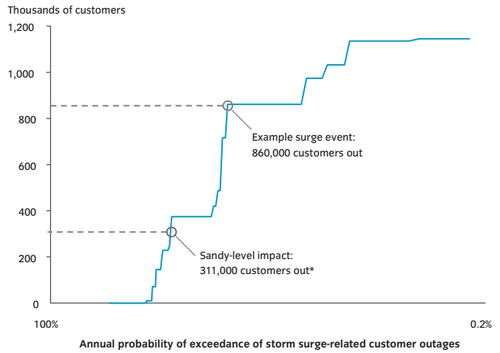
The model is still in the early phases of development; the examples shown here illustrate how the three modules, taken together, make it possible to develop a preliminary quantitative baseline of risks that the electric system faces. For example, Chart A demonstrates the relationship between a given level of customer losses and the probability that this level will be met or exceeded in any one year. This analysis shows that, from this perspective, Sandy is not the "worst storm" that could hit the city. In fact, storms at the tail-end of the distribution, though unlikely, could result in customer losses almost four times as high as those suffered during Sandy. The model can also guide investment decisions. Again, by way of example, Chart B demonstrates that only five substations are likely to be responsible for 80 percent of annual expected customer losses. This would suggest that resiliency investments in these substations should be prioritized. If the outcomes are measured in terms of Gross City Product (GCP) losses resulting from outages, the order of priority among the five substations changes but the overall list remains the same.

The next step in the development of the model is to move beyond estimating baseline losses towards calculating the cost-effectiveness of various protection strategies and also guiding the standards to which critical assets should be protected. Further on, strategies to address heat and wind risks could be included as well, though the proper development of these elements would require a significant commitment of engineering resources. As an example, an early estimate developed as a proof of concept, shown in Chart C, suggests that hardening substations against surge may be a more effective use of funds than burying overhead power lines to protect them against wind.

The City has already been working closely with utilities and regulators to discuss these new quantitative approaches and to explore ways to incorporate them into utility decision-making and regulation—but much more work remains to be done. OLTPS will continue to refine the ESRM, and will work with utilities and regulators to expand the approach to include costs of protection strategies and to incorporate heat and wind risks within a common framework.

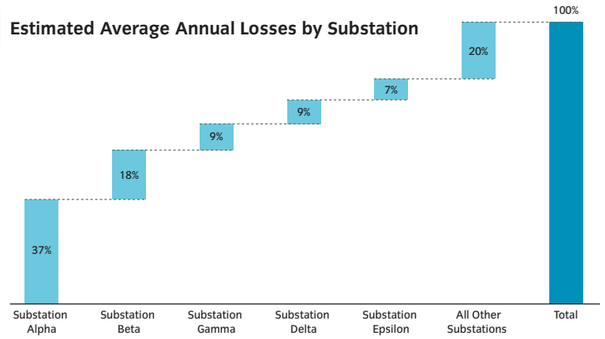
Customer Losses Due to Storm Surge-Related Substation Outages

A. Estimated Total Losses by Event Probability



*Outages associated with direct substation outage
Note: Preliminary analysis

B. Estimated Average Annual Losses by Substation

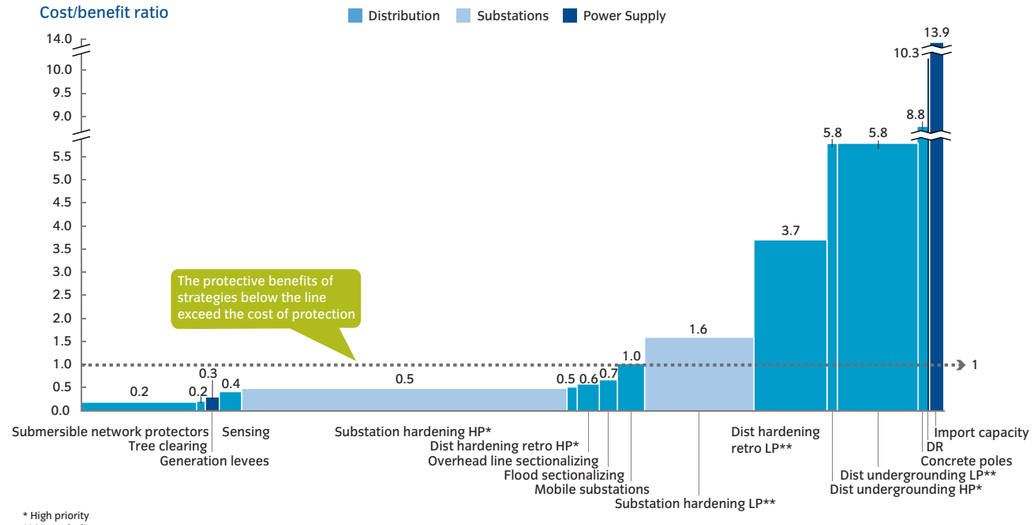


2013 climate risk
Note: Preliminary analysis

Source: OLTPS

Estimated Risk Reduction Potential of Protection Strategies

C.



* High priority
** Low priority
Note: Preliminary analysis for illustrative purposes only

Source: Team Analysis

Credit: Stefan Klaas

decisions. With regard to heat waves, for example, the City has worked with the New York City Panel on Climate Change (NPCC) and Con Edison to establish that an increase in average temperatures of just 1 degree Fahrenheit in New York in the years ahead could increase peak demand in the city by as much as 175 MW—a likely underestimate given that it does not include the impact of changes in average humidity (which could increase air conditioner use and therefore peak demand even further). The City's goal is for the NYISO to incorporate temperature and humidity forecasts into the Reliability Needs Assessment used in bulk power system planning. This would allow system planners to make adjustments to long-term plans for resource adequacy and transmission reliability to ensure supply will be adequate even as the climate changes.

Design of a more resilient system will also be accomplished in parallel by updating system and equipment design standards. The City, therefore, will call on utilities to work with it and the PSC to examine system designs and consider changes to design standards in light of the likelihood of higher ambient peak temperatures, longer heat waves, extended exposure to flooding and saltwater, and stronger and more sustained winds.

With regard to heat waves, a specific focus must be on Con Edison's underground networks. As part of this evaluation, the City will ask Con Edison and the PSC to reexamine and evaluate the strategy employed in recent years by which peak system demand during heat waves has been met by reducing voltage. In particular, the City will ask the utility and the regulator to assess the propriety of the use of voltage reductions in lieu of system reinforcements and upgrades, as well as the potential implications of relying on voltage reductions during more frequent and longer duration heat waves.

Initiative 3

Work with utilities and regulators to establish performance metrics for climate risk response

Regulators exclude performance during extreme weather events when evaluating utility performance and structuring the financial incentives associated with such evaluations. However, given the likely increases in frequency of these weather events, the time has come for utilities to be held accountable for their performance before, during and after such events.

The City will work with the utilities and the PSC to develop updated resiliency metrics and realistic performance standards, including appropriate incentives. Examples of performance metrics could include, among other things, minimum times to reach a 90 percent restoration threshold for customers following different classes of weather events. The City's expectation is that these metrics and standards would evolve over time as climate-related threats increase.

In connection with the metrics and standards above, the City also will call upon the PSC to require utilities to publish annual progress reports describing their preparedness for climate risks. Among the indicators described in the annual reports could be recent and projected climate-related capital investments, including replacements of unprotected conductors in overhead networks with extensive tree coverage, replacement of cast iron and bare steel gas mains in flood-prone areas, and installation of submersible underground equipment.

Strategy: Harden existing infrastructure to withstand climate events

Sandy demonstrated how the failure of key nodes in the energy distribution system can have widespread impacts on the city's energy systems, with significant repercussions for people, businesses, and communities. To address this, the City will call upon the utilities to identify high-priority infrastructure that is vulnerable to increasingly common climate risks, such as floods and heat waves, and to make the investments necessary to harden that infrastructure.

Initiative 4

Work with power suppliers and regulators to harden key power generators against flooding

As described above, 53 percent of New York City's power plants are in the 100-year floodplain. By the 2050s, 97 percent will be. Despite this, regulators do not yet require the owners of these plants to invest in flood-protection measures.

The City, working through OLTPS, will convene plant owners, utilities, and regulators to work together to prioritize, plan, and budget for the hardening of key in-city assets. For existing plants, the City will call upon the NYSRC to develop reliability rules that would be administered and enforced by the NYISO and that would require select plant owners to upgrade their facilities to withstand at least a so-called "100-year flood" (a flood level that has a 1 percent chance of being met or exceeded in any given year). The City will work with the facility owners, the NYSRC, NYISO, PSC, and Con Edison to identify the selected plants based on a cost-benefit analysis developed by all of the parties, and to determine the measures that should be undertaken, the timeframe for completing the measures, and a method by which the owners could recover the costs of such projects.

For new generating facilities and those undergoing substantial upgrades (such as repowering) that will be sited in the city's 500-year floodplain, the City further will call upon the PSC to require hardening to a 500-year flood elevation, or demonstration of other measures to be able to remain operational during, or recover quickly from, a 500-year flood event.

Initiative 5

Work with utilities and the PSC to harden key electric transmission and distribution infrastructure against flooding

Transmission substations, distribution substations, utility tunnels, and underground equipment are all at risk of flooding. For example, 37 percent of transmission substations are in the 100-year floodplain today and 63 percent are likely to be in the 100-year floodplain by the 2050s.

The City will work with utilities and regulators to protect these assets from future flood events. In the case of substations, the City, working with Con Edison, LIPA, and the PSC, will prioritize investments by evaluating the role that each such substation plays in system reliability, the number and criticality of customers that it serves (e.g., giving priority to hospitals), and the projected economic impact of its failure. The City's initial modeling suggests that 20 percent of transmission-level substations are responsible for 80 percent of annual expected customer losses.

Storm hardening measures to be implemented at the selected substations will be site-specific. In some cases, depending on the substation's configuration, selected assets within a substation could be elevated; in other cases, a combination of strategies, including protecting the perimeter of the facility, could be implemented.

In the case of utility tunnels, the City will support Con Edison's proposed plans to protect each from flooding. Finally, in the case of underground transformers and switches in the floodplains—of which 52 percent are currently submersible or water-resistant—the City will work with utilities and regulators to advance the goal of replacing, over time, all underground equipment in the 100-year floodplain with equipment that is submersible and unaffected by saltwater.

Initiative 6

Work with utilities and the PSC to harden vulnerable overhead lines against winds

During storms, high winds and downed trees threaten overhead electric poles, transformers, and cables. The City will work with Con Edison and LIPA to manage these risks through tree maintenance, line strengthening, and a line relocation program.

In some cases, rerouting lines underground may also be warranted, depending on the number of customers impacted and cost involved. In most cases, however, this option will be complicated and very expensive. On February 25, 2013, the City passed Local Law 13, directing OLTPS to conduct a study examining the "undergrounding" of overhead power lines in the city. Findings are to be submitted to the Mayor and City Council. The study is being conducted in partnership with Con Edison and will include an analysis of both projected costs and the expected effects on grid reliability of more extensive "undergrounding." It also will lay the foundations for including wind risks in the overall regulatory framework governing system reliability. If appropriate, the study will further identify the areas of the city, if any, where "undergrounding" could be of particular benefit, as well as those areas where it is viewed to be impracticable or subject to greater reliability risk.

Initiative 7

Work with utilities, regulators, and gas pipeline operators to harden the natural gas system against flooding

Although the city's gas system performed relatively well during Sandy, there were instances where remote operation of parts of the system failed. Additionally, the distribution system had localized outages due to water infiltration.

To ensure that future floods do not extensively compromise the gas system or reduce the ability of Con Edison or National Grid to control and monitor their systems, the City will work with the PSC, pipeline companies, and utilities to develop plans to harden all city-gates, interface regulator stations, and control equipment against flooding. To protect the distribution system, the City will work with the PSC, Con Edison, and National Grid to take steps to prevent water from infiltrating into gas pipes. In the low pressure system this will be achieved by expanding existing programs to replace the bare steel and cast iron pipes that are prone to corrosion, leaks, and cracks. In the high pressure system this will be achieved by installing backflow prevention devices on vent lines.

Initiative 8

Work with steam plant operators and the PSC to harden steam plants against flooding

Five out of six of the city's steam plants are in the floodplain today. Relocating these plants is neither practical nor cost-effective. The City, therefore, will call upon Con Edison and the PSC to increase the resiliency of these plants by taking flood-protection measures, including adding floodwalls, sealing building perimeters, raising equipment, and installing flood-protected, natural gas-fired back-up generators as appropriate (allowing Con Edison to deliver steam even during widespread power outages).

Strategy: Reconfigure utility networks to be redundant and resilient

Hardening existing infrastructure is only the first step in making the city's energy networks stronger. In the coming years, regulated utilities and private companies alike should rethink the entire architecture of their systems to help the City meet its twin goals of reducing the likelihood of failure and ensuring that service restoration can happen more quickly when failures do occur.

Initiative 9

Work with industry partners, New York State, and regulators to strengthen New York City's power supply

New York City's 9,600 MW of power generation can satisfy over 80 percent of peak demand, but the majority of these in-city power plants are located in the 100-year floodplain, all depend on natural gas and liquid fuel supplies (which themselves are subject to supply interruptions during extreme weather events), and almost two-thirds are more than 40 years old. The City will take steps to diversify and improve the sources of the city's power supply, and to do so in a way that will connect the city directly to new, low-carbon generation sources (which address some of the causes of climate change).

First, the City will continue to work with the NYISO to change wholesale energy rules to encourage generation owners to repower their older, less efficient, and higher polluting in-city power plants. The City already has facilitated the repowering of a 500 MW power plant operated by NYPA in Astoria.

Second, the City will encourage the development of new transmission lines connecting the city to other markets and sources of supply. The Hudson Transmission Project, which recently commenced operation, provides a new 660 MW connection between the city and the transmission system in the Mid-Atlantic and Midwestern regions. Additionally, the City actively supported the issuance of a State permit to construct and operate a 343-mile transmission line from Quebec that would allow for the importation of 1,000 MW of clean, low carbon Canadian hydropower directly to New York City.

Third, the City will continue to explore opportunities to expand low-carbon electricity generation sources in the area—working, for example, with NYPA and Con Edison on the potential development of up to 700 MW of offshore wind turbines in the waters south of the Rockaway peninsula. The Federal government currently is reviewing a NYPA lease application for use of underwater lands for such purposes.

Initiative 10

Require more in-city plants to be able to restart quickly in the event of blackout

Many New York City power plants, including some of the newest ones, cannot be restarted without external power sources (i.e., they cannot "black-start") after grid-scale outages. This slows the grid's ability to recover. State regulators only recently adopted a requirement that all new plants proposed to be built in New York either be able to provide for "black-start" capacity or to justify why such capacity is not included. This requirement did not exist when the city's newest plants received siting approval, while older in-city plants that do have such capacity are approaching the end of their useful lives. The City, through OLTPS, therefore, will work with generators, the PSC, the NYISO, FERC, and Con Edison to expand "black-start" capabilities within the existing generation fleet.

Initiative 11

Work with Con Edison and the PSC to develop a long-term resiliency plan for the electric distribution system

While hardening existing power assets is an important strategy, utilities also need to incorporate resilience into their long-term expansion plans, factoring in changing patterns of load growth. The City will call on Con Edison and the PSC to develop a long-term system resiliency strategy for the in-city electric system that will seek to divest load from coastal, "too-big-to-fail" nodes, with a strong bias towards building inland, so as to diversify geographic exposure. The strategy will also seek to relieve transmission limitations to large load pockets in Brook-

lyn and Manhattan.
Additionally, the strategy will provide for the system to evolve to contend with heavy blows from extreme weather events, such as storms and heat waves. Examples of potential projects that could emerge from the development of such a strategy could include: the creation of a new 345 kV link between Queens and the Bronx to strengthen the connection to Upstate electrical supplies and reduce reliance on the Astoria generation cluster; load divestment from substations to reduce congestion in the Brooklyn load pocket; and a new transmission corridor running inland between Staten Island and Queens. OLTPS will work with Con Edison, the NYISO, and the PSC to develop this strategy, outlining potential options, analyzing costs, and developing a roadmap for implementation.

Initiative 12
Work with utilities and regulators to minimize electric outages in areas not directly affected by climate impacts

Coastal flooding typically requires the shutdown of electrical feeders that could be exposed to floodwaters. In extremely dense areas of Lower Manhattan and Brooklyn, this can mean preemptive shutdowns of entire networks, with large swaths of customers losing service even if they are not directly affected by flooding.

To reduce the incidence of these so-called "sympathetic outages", the City will work with the utilities to design and implement new network boundaries. In the Fulton network, for example, a reconfiguration of the network would allow New York Downtown Hospital, which lies outside the 100-year floodplain, to continue to receive electricity during a coastal flood (rather than losing power as occurred during Sandy). Elsewhere in coastal areas served by the underground system, utilities should take measures like installing sectionalizing switches to allow more precise control over feeder shutdowns and isolations, reducing the number of customers impacted by a shutdown. Similar principles should be applied to the overhead system. For example, estimates by Con Edison indicate that 650 or more automatic reclosers or switches could be installed on overhead loop and radial systems citywide, each of which could locally have the effect of reducing by 50 percent the number of customers affected by a problem like tree branch damage to an overhead line. The City will work with Con Edison and LIPA to identify areas for priority attention.

Initiative 13
Work with utilities and regulators to implement smart grid technology to assess system conditions in real time

After an extreme weather event, the first task of any utility is to identify the location and extent of damage. Utilities usually rely on customer reports of power outages, together with on-site inspections by crews. Gathering information in this way, though, takes time and can be delayed by problems on the ground, such as impassable roads.

The City will call on Con Edison and LIPA to work with the New York State Smart Grid Consortium and stakeholders such as the USDOE to develop, demonstrate, and deploy low-cost sensor technologies, along with system integration, automated control, and decision-aided tools, that would allow the two utilities to assess system conditions in real time and facilitate timely dispatch of crews and equipment to the highest priority problem locations. To minimize costs, utilities could prioritize coverage of a statistically significant number of customers with smart meters, focusing, for example, on the 34,000 residential high-rise buildings in the city, or could prioritize coverage of key grid locations, such as at distribution sectionalizing switches, which could be monitored with advanced voltage sensors.

Initiative 14
Work with utilities and regulators to speed up service restoration for critical customers via system configuration

After extreme weather events, electric utilities may not be able to restore electric service to individual customers until damaged customer equipment is repaired or replaced.

The City will work with Con Edison and LIPA to identify cost-effective ways to isolate critical customers, including through installing switches and other equipment along feeders that supply them. In some cases, this could allow utilities to restore service to these customers more quickly than they are able to restore service to others on the same circuit—or even to avoid service interruption in the first place. The City also will evaluate whether other options, such as on-site backup power for these critical customers, would be more cost-effective.

Initiative 15
Work with utilities and regulators to speed up service restoration via pre-connections for mobile substations

Mobile substation units can restore partial functionality of electrical distribution circuits while utilities undertake permanent repairs to damaged substations. This technology could potentially be effective at substations that support Con Edison's 4kV distribution grids or at LIPA's substations in the Rockaways. However, for these units to be effective, the utilities must pre-install the necessary connections in the system and have a way to source the mobile substations quickly.

The City will work with Con Edison, LIPA, and the PSC to complete technical evaluations of the use of mobile units as a strategy for high-priority substations, and, where this strategy is believed to be cost-effective, will advocate for its implementation. As part of this analysis, the City will work with the utilities to explore strategies for reducing the cost of these mobile units by, for example, sharing mobile units with neighboring regions.

Initiative 16
Work with pipeline operators to expand and diversify natural gas supply

The natural gas connections to New York City generally have sufficient capacity to provide the city's customers with gas, but on days when demand is high, all five city-gate connections are needed to prevent forced shutdowns.

The City will continue to support ongoing projects by gas pipeline operators to install additional city-gate capacity linking New York City to new natural gas pipelines. These projects include the Spectra pipeline, which will connect to Con Edison's gas system. The City supported the Federal approval of the Spectra pipeline and has continued to support its completion; it is now under construction. The City also has supported and will continue to support the issuance of a FERC permit for the Williams Rockaways Lateral, which will serve National Grid's gas network and is now seeking approval from regulators.

Initiative 17
Work with utilities and regulators to strengthen the in-city gas transmission and distribution system

Even when adequately supplied from the outside, New York's natural gas system has limited capacity to move gas within the city. If one city gate were to shut down on a high demand day, the New York Facilities may be unable to supply the area that the city gate serves from elsewhere, which could cause significant outages. The City, working through OLTPS, will collaborate with pipeline companies, Con Edison, and National Grid to assess this risk and develop plans to strengthen the in-city transmission system.

Initiative 18
Launch energy infrastructure resiliency competition

Many resiliency solutions for the city's energy systems are available today, including building floodwalls or elevating equipment. However, new approaches—especially more cost-effective ones—could play a critical role in protecting these systems in the future.

To this end, the City will launch a Resiliency Technologies Competition that will allocate competitive grants to projects that use innovative technologies to further (1) building resiliency and (2) infrastructure resiliency. New York City Economic Development Corporation (NYCEDC) and the Mayor's Office will launch the competition in the summer of 2013 and expect to select winners in 2014. The City allocated $45 million in Federal CDBG funding to the competition.

Strategy: Reduce energy demand

In the years to come, rising temperatures will lead to higher peak demand. One strategy to accommodate it involves increasing the supply of energy available to the city. However, an equally (or more) effective—and far less expensive—strategy is to manage demand itself, both during peak periods, and more broadly. Programs are already in place to encourage both kinds of demand reduction. The City will continue to advance them, as well as develop new ones.

Initiative 19
Work with utilities and regulators to expand citywide demand response programs

In recent years, Con Edison and the NYISO have built up approximately 500 MW of demand response (DR) capacity to manage the brief periods of peak electrical demand that would otherwise require costly system expansions. The City will call on Con Edison, LIPA, PSC and the NYISO to increase this capacity and will support two strategies to accomplish this goal.

First, to create additional incentives for DR participation, the City will continue to support full implementation of a recent FERC ruling that brings DR pricing closer to the pricing of traditional generation. Second, to expand DR beyond its existing base of large customers, the City will work with the NYISO, Con Edison and LIPA to update participation standards and increase the role of private companies that aggregate DR potential across multiple small users.

City government also will play a role in decreasing in-city peak demand. It will do this directly, acting through the Department of Citywide Administrative Services (DCAS) to scale up its DR capacity with the goal of reaching 50 MW by 2018—including through expanding DR capacity at City facilities like wastewater treatment plants and City University of New York campuses.

Initiative 20
Work with government and private sector partners to expand the energy efficiency of buildings

Energy efficiency programs save owners money and reduce carbon emissions. These programs also have resiliency benefits, both because they reduce the chance of peak season outages by lowering demand and because they allow buildings themselves to remain habitable longer if outages do occur.

Expanding on the ambitious building energy efficiency programs put in place in PlaNYC in 2007, the City will scale up its energy efficiency efforts by focusing on energy use benchmarking, audit and retro-commissioning requirements, upgrades to lighting, and new financing approaches that would be available to a wider segment of New York City's one million buildings. In one example, the City will launch Green Light New York, a new energy efficiency and lighting center to educate designers, engineers, and the real estate community on effective technologies and best practices for lighting and building systems integration. In another example, the New York City Energy Efficiency Corporation (NYCEEC) will work with government partners including the New York State Energy Research and Development Authority (NYSERDA) and private lenders to identify and finance energy efficiency projects in the city.

Cost Impact and Recovery

Most of the initiatives described in this chapter carry a cost. Utility infrastructure costs of this type are typically included in the rates charged by utilities, subject to PSC authorization. Non-utility transmission providers and owners of electric generation facilities recover their infrastructure costs from the revenues they receive in the wholesale electric markets, and sometimes through rate surcharges authorized by the FERC.

Increases in infrastructure investments do not necessarily lead to higher rates because the utilities may be able to net the incremental costs against credits or savings produced from other program and project changes. Here, the City anticipates that most, if not all, of the infrastructure improvements related to the initiatives can be undertaken as part of the utilities' ongoing capital programs, thereby avoiding any rate increases. To the extent the resiliency investments are additive to rates, the increases are expected to be relatively small, perhaps no more than a fraction of one percent each year. While any increase in rates could have an impact on customers, businesses and residents expect and depend on reliable utility service, and the economic costs of utility outages can be enormous—a single day without electricity can mean more than $1 billion in lost economic output for New York City.

Worker repairing electrical infrastructure after Sandy

Credit: Con Edison

Strategy: Diversify customer options in case of utility outage

Even the most reliable utility networks occasionally will fail, and when they do, alternatives become important. Appropriately configured solar panels can provide electricity for individual customers and their local communities. Pre-installed connections to mobile boilers can expedite emergency provision of heat and hot water. CHP installations can supply all three. The City will explore both customer-level and district-wide options for power redundancy.

Initiative 21

Work with public and private partners to scale up distributed generation (DG) and micro-grids

There exists the potential for significant expansion of DG systems in New York. However, regulatory structures, financing challenges, and lack of information constrain further growth. The City, acting through OLTPS and the New York City Distributed Generation Collaborative (DG Collaborative)—a stakeholder group convened by the City in 2012, and consisting of utilities, regulators, the USDOE Northeast Clean Energy Application Center at Pace University, developers, and other industry representatives has been working to address barriers to DG and micro-grid penetration, with a goal of bringing citywide capacity to the original PlaNYC goal of 800 MW by 2030.

To promote DG, the City will work with the DG Collaborative to employ four main strategies. First, to address regulatory barriers, the City will call on the PSC to reevaluate the existing tariff structures and interconnection standards relating to DG in New York City. Second, to address the financing barriers to DG, the City will work with NYCEEC and New York State to increase access to low-cost financing for DG systems, and with NYSERDA to revise DG incentives, especially at critical facilities such as hospitals. Third, to address information barriers, the City will work with the DG Collaborative to provide technical assistance to property owners and developers, sharing best practices on DG projects and applying lessons learned from municipal buildings to privately-owned facilities. For example, the City has screened over 340 municipal buildings for technical compatibility with cogeneration, resulting in a 15 MW project under construction at Rikers Island and a 12 MW project at North River Waste Water Treatment Plant. The City will expand its screening analysis to include other DG technologies, such as fuel cells and renewables, working to expand DG in City buildings to 55 MW by 2017. Fourth, the DG Collaborative will work with City agencies to streamline administrative processes to promote prompt one-stop regulatory review of potential DG projects.

For solar photovoltaic systems (PV), in particular, the City will call on the Smart DG Hub—a stakeholder group convened by CUNY—to examine the applications of solar PV during outages and the technical and regulatory solutions for enabling cost effective and safe deployment of PV during outages.

Meanwhile, micro-grids, or neighborhood-scale networks of DG installations, have the potential to provide resiliency benefits, but require study. To encourage micro-grid adoption, the City will focus on four actions. First, the City will call on the PSC to clarify the rules governing the export of energy to multiple property owners and across roadways, so as to reduce uncertainty for private investors. Second, the City will evaluate the potential for a micro-grid pilot in clusters of City-owned buildings. Third, the City will work with USDOE, NYS Smart Grid Consortium, the DG Collaborative, and NYSERDA to examine the feasibility of micro-grid pilots throughout the city, including in areas like the Rockaways. Fourth, the City will work with NYSERDA and academic institutions to study the technical and economic effects of higher penetration of micro-grid systems on New York City's energy networks. Finally, utilities should incorporate micro-grid expansion into their planning.

Initiative 22

Incorporate resiliency into the design of City electric vehicle initiatives and pilot storage technologies

Electric vehicles (EVs) can emit 70 percent less carbon than average cars, one reason the City has one of the largest public sector EV fleets in the nation. With future enhancements, they also could have resiliency benefits. For example, during a power outage, an EV potentially could be used as an energy source to power a small home for a day.

The City, acting through OLTPS, will build on its work to accelerate EV adoption in the city, incorporating resiliency features into electric vehicle infrastructure. The biggest barrier to doing this is that the standards for two-way power flow between vehicles and chargers do not exist yet; even though the technologies have been tested in the US, national standards organizations have not yet codified the necessary protocols. The standards may not arrive for several years, but the City will work to ensure that the EV infrastructure being built today is sufficiently robust to accommodate two-way power flow in the future.

In addition, the City will pilot new battery storage applications and streamline regulation to enable private sector adoption. For example, NYCEDC is piloting a large battery storage system at the Brooklyn Army Terminal that will pave the way for adoption of distributed storage applications that could improve grid reliability, provide emergency power to critical systems, and manage peak loads. The City will continue to work with technology developers to determine how batteries can be safely and efficiently added to buildings.

Initiative 23

Improve backup generation for critical customers

During a power outage, it would be advantageous for the city if critical customers had backup generation in-place. It would also be advantageous for less critical users to be able to connect to backup generation.

The City, acting through the Office of Emergency Management (OEM), will expand its capacity to supplement the backup generation needs of critical and public interest customers, focusing separately on two tiers of need. The first tier—hospitals, nursing homes, police and fire stations, and wastewater treatment plants—already tend to have backup generation installed. Sometimes, though, this generation fails. OEM, therefore, maintains a fleet of mobile generators that it can deploy on short notice.

Facilities in the second tier—gas stations, pharmacies, food supply stores and other private customers that provide critical services that can be interrupted by extreme weather events—generally do not have backup generation, but may need it in the event of a widespread power outage. OEM, therefore, will coordinate with NYSERDA and Federal partners to develop a generator plan that uses a combination of incentives and regulations to pre-wire a subset of these facilities to accept generators and encourages these customers to rely on a combination of purchases of generators and generator supply contracts to enable availability in case of need.

In a separate but related effort, in the city's public housing developments, the City, acting through NYCHA, will install more than 100 natural gas-fired generators in buildings in the 100-year floodplain that have the greatest share of vulnerable residents.

Credit: Seth Pinsky

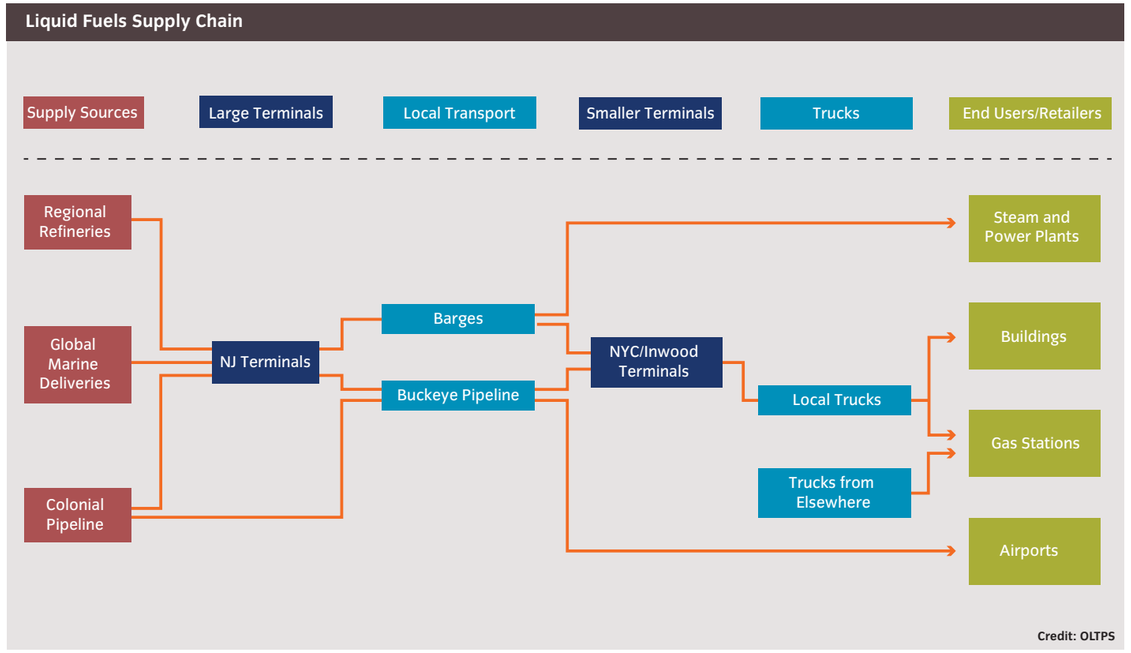
Liquid Fuels

Liquid fuels infrastructure in northern New Jersey

Credit: Keith Meyers/The New York Times

Lines form outside of a gas station in Sunnyside, Queens after Sandy.

Credit: Brian Kingsley



Liquid fuels keep New York City on the move. Every day, approximately 3.4 million gallons of gasoline and diesel fuel course through engines as vehicles move through the streets of the city, logging over 22 million miles and transporting passengers, consumer goods, supplies, equipment, and personnel to their various destinations. This potent energy source powers the 57,000 taxis, limos, liveries, and other "for-hire" vehicles that provide up to 650,000 rides per day. It fuels most of the 5,600 MTA busses serving over 2.1 million riders daily, along with the 26,000 vehicles of the Police, Fire, Sanitation, and other departments. And it ensures that the private cars among the 2 million vehicles registered in New York City stand at the ready to get New Yorkers across the five boroughs to where they need to go.

Liquid fuels do more, though, than just power vehicles. Over 10,000 buildings in the city use heating oil to keep homes warm and showers hot, consuming up to 6.6 million gallons on the coldest days. The three major airports serving New York fill planes with 6 million gallons of jet fuel daily. Moreover, although natural gas fires most of the city's power and steam generators, almost all of these facilities are also capable of switching to liquid fuels during shortages of natural gas. Because liquid fuels are both energy dense (meaning they produce a large amount of energy from a relatively small amount of volume) and easily portable on ships, through pipelines, in trucks, and even in hand canisters, they provide the flexibility needed during disruptions to other energy sources.

And yet, for all of the flexibility of liquid fuels, during Sandy, failures occurred across the supply chain that brings this precious resource to New York and the larger metropolitan region. Refineries and terminals lost power and were damaged, and pipelines shut down—all of which led to the widespread gas station closures that, for many New York drivers, have become among the most vivid memories of the post-storm period. Despite the early conclusion many reached that these closures were due primarily to power outages that prevented stations from pumping gas, the larger problem turned out to be that stations simply had no gas to pump. The station closures, and the long lines at the stations that did have gas, not only frustrated drivers, limited mobility, and slowed economic activity, they also hampered recovery efforts. Lack of fuel made it more challenging for ambulances to respond to emergencies. It made it harder for utility workers to restore electricity. It delayed doctors and nurses who were trying to treat patients. It interfered with the ability of relief workers to reach the hardest hit areas of the city. In short, the storm and its aftermath highlighted just how dependent New York City is on gasoline, diesel fuel and heating oil—and underscored the vulnerabilities in the fuel supply infrastructure.

In keeping with the overarching goals of this report, which are to limit the impacts of climate change and enable New York to bounce back after extreme weather events, the City will seek to strengthen the liquid fuels supply chain so that fuel networks can quickly recover after disruption. To do so, the City is proposing ways to harden infrastructure along this supply chain, to increase redundancy and fuel supply flexibility, and to ensure that supply is always available for vehicles critical to the city's infrastructure, safety, and recovery after extreme weather events.

How the Liquid Fuels System Works

The New York metropolitan area is the largest liquid fuels hub on the East Coast and one of the largest in the country. Liquid fuels reach New York City after traveling through a supply chain via assets spread across many owners. There is little regulatory oversight with respect to infrastructure climate resilience, and almost no operational information is shared by owners, either with each other or third parties.

Liquid fuels generally enter the New York City market from three major sources: regional refineries, pipelines that originate at refineries in the Gulf Coast region, and marine fuel tankers that arrive from refineries all over the world. Regional refineries and pipelines each provide 35 to 40 percent of New York City's supply. Marine tankers supply the balance.

Refineries separate crude petroleum into finished liquid fuels for consumer use. Currently one refinery in northern New Jersey and four refineries in the Philadelphia area provide over 42 million gallons per day of regional refining capacity serving the Northeast market. These refineries require large amounts of electricity to operate, mostly relying on power delivered by utilities.

The Colonial pipeline is a major conduit for New York City and the Northeast with a maximum capacity of 37 million gallons per day. This pipeline transports fuels from refineries as far away as the Gulf Coast region to a major hub in Linden, New Jersey. The Buckeye pipeline then brings fuels from the Colonial line, refineries, and terminals in the Linden area to New York City and Long Island terminals, as well as directly to JFK and LaGuardia airports. Fuel is propelled through these pipelines by pumping stations, which are powered by electricity delivered by utilities.

As for the marine tanker network, these vessels deliver fuels to and ship fuels via New York Harbor. In 2010, 8.7 billion gallons were imported from other countries, while over 12.6 billion gallons were exported abroad. In the New York area, the movement of these marine tankers occurs mainly along the waterways between Staten Island and New Jersey.

Once liquid fuels arrive in the New York area via pipeline, regional refineries, or marine tankers, they are stored and sold from terminals mainly concentrated in a few waterfront areas in New Jersey and around the city. Large terminals, which receive shipments from pipelines and tanker ships, supply small- and medium-sized terminals via barge or pipeline. The small- and medium-sized terminals blend in mandated additives, such as ethanol, or performance- and brand-based additives. Truck racks then are used to load liquid fuels from terminal storage tanks onto trucks, which then supply gas stations and buildings.

Approximately 800 gas stations are located throughout New York City. These stations have an estimated 14.6 million gallons of storage capacity in underground storage tanks—enough capacity to satisfy approximately four days' worth of demand. However, since not all stations' storage tanks are full at all times, the city generally has much less than four days' worth of fuel supply on hand.

Over 500 of the gas stations in New York City are associated with seven major brands. Most of these stations are franchised. Under traditional retail fuel franchise agreements, these stations are obligated to source fuel from designated suppliers and to sell only specific formulations of gasoline and diesel. By contrast, the retail fueling stations selling fuel under the Hess brand are corporate-owned. However, as of the writing of this report, Hess has announced that it intends to sell its retail network to focus on other aspects of its business. Regardless of ownership structure, gas stations traditionally operate on thin profit margins from their core business of selling gasoline and diesel fuel.

The City has its own transportation fueling sites for government use. Of its 414 total sites, 16 are located Upstate and serve the Department of Environmental Protection (DEP) vehicles in the City's watershed areas. The majority (240) of the City's sites are at Fire Department of New York (FDNY) facilities. Overall, the City has storage capacity for 1.2 million gallons of fuel—a two weeks' supply for City vehicles—though, again, not all tanks are always full.

Given the Northeast's dependence on heating fuels, the US Department of Energy (DOE) maintains a home heating fuel reserve in case of major supply disruptions. This reserve is stored in fuel terminals in Connecticut, Massachusetts, and New Jersey, and contains over 42 million gallons of ultra-low sulfur diesel

meant to be used in buildings, but able to be used in diesel-fueled vehicles.

With respect to other sectors in New York, each of these acquires and stores fuel in a different way. For example, as mentioned above, airports generally receive jet fuel directly via pipelines that feed large on-site tanks. Buildings accept truck deliveries of heating oil, pumped directly into their fuel storage tanks. For the most part, power and steam generators receive liquid fuel shipments via barges, which replenish large tanks used for on-site storage.

Regulation of the Liquid Fuel Supply

Responsibility for the regulation of the fuel supply infrastructure, and the transportation and consumption of fuel, is divided among Federal, State, and City agencies. These agencies have promulgated a variety of rules affecting supply in New York City. For example, regulations from the US, New York State, and New York City Departments of Transportation determine how fuel is transported into and around the city. Meanwhile, the US Environmental Protection Agency (EPA), NYS Department of Environmental Conservation (NYSDEC), and DEP all regulate the chemical composition of fuels sold and consumed within the city. In addition, the Jones Act, originally passed in 1920, restricts foreign-flagged vessels from delivering fuel supply from domestic sources. Of note, none of these entities set regulations that are expressly designed to address the threats to the fuel supply chain by climate-related risks, such as storm surge. *(See chart: Transportation and Consumption Regulations Affecting Liquid Fuels)*

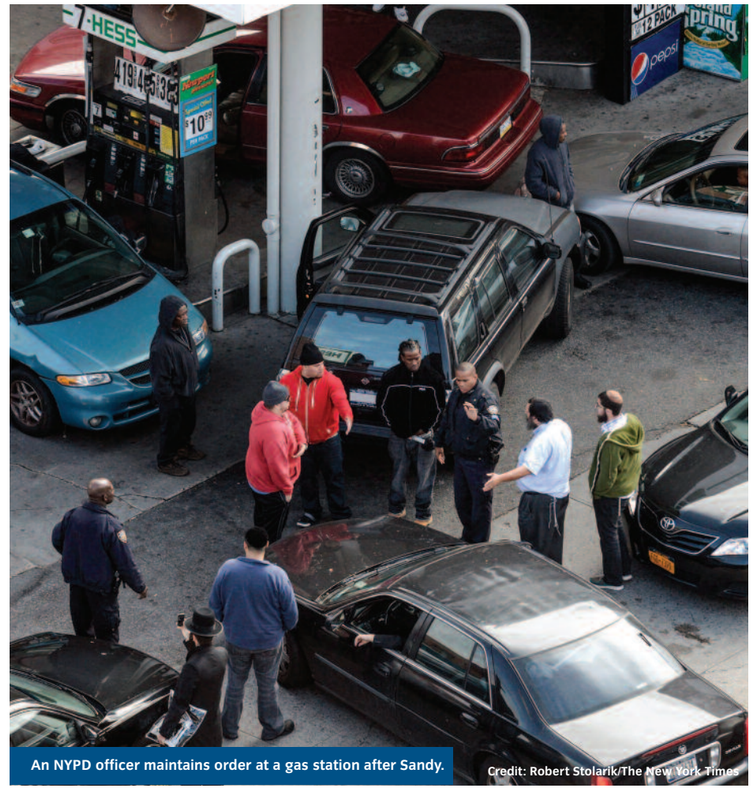
Transportation and Consumption Regulations Affecting Liquid Fuels

Law or Regulation	Administered by	Description
NYC biodiesel requirement	DEP	Requires a minimum of 2% biodiesel in all heating fuels used in buildings.
NYC heating oil sulfur regulation	DEP	Requires #4 and #6 heating oils in buildings to have lower sulfur content.
Transportation height and weight restrictions	NYSDOT, NYCDOT	Restricts vehicles above certain heights, weights, and lengths on designated roadways and bridges.
Truck route regulations	NYCDOT	Restricts freight truck vehicle traffic through certain roadways.
Transportation of flammables through tunnels	Port Authority, the MTA, FDNY	Restricts transportation of flammable liquids through tunnels.
On-road vs. off-road diesel requirement	NYSDOT	Treats fuels that are used for on-road (transportation) use and off-road (heating) use differently for tax purposes, even if they are chemically the same. Off-road fuel is tinted red and is prohibited for on-road use.
NYS heating oil sulfur regulation for NYC	NYSDEC	Requires #2 heating oil to have no more than 15 ppm sulfur content in New York City.
Local formulation requirements	EPA	Requires the use of reformulated gasoline blendstock for oxygenate blending (RBOB) in NYC, LI, Westchester, Orange, Putnam, and Rockland Counties to improve air quality by reducing ground level ozone.
Vapor pressure requirement	EPA	Requires the reduction of the vapor pressure of gasoline in summer months, thus reducing volatile organic compounds (VOCs) that lead to ground level ozone.
Federal sulfur requirement	EPA	Requires ultra low sulfur diesel (ULSD), with less than 15 parts per million (ppm) sulfur specification, for highway diesel fuel. Requires low sulfur (500 ppm) and ULSD fuel to be phased in for non-road, locomotive, and marine engines from 2007–2014.
Vapor recovery systems requirement for fuel loading/unloading	EPA	Requires bulk gasoline and marine loading terminals and associated truck racks to use vapor recovery or vapor combustion devices during fuel loading and unloading for both emissions and safety.
Jones Act (Merchant Marine Act of 1920)	US DHS	Requires that all goods transported by water (including fuels) between US ports be carried in US-flagged ships, constructed in the United States, owned by US citizens, and crewed by US citizens and US permanent residents.
Driver hours-of-service (HOS) regulations	US DOT	Allows delivery truck drivers to drive a maximum of 11 hours after 10 consecutive hours off duty.

What Happened During Sandy

Disruptions occurred at nearly every level of the fuel supply chain, reducing all fuel flow into and within the New York metropolitan area. Most of the infrastructure affected was located in New Jersey, where a combination of extended power outages and direct damage from storm surge, for a time, nearly dried up New York City's fuel supply.

Despite widespread failures throughout the supply chain during and after Sandy, a lack of available information on the operational status of terminals, pipelines, refineries, and other key infrastructure delayed situational awareness for several days. Duplicative efforts among different governmental entities to secure information further delayed diagnosis of the cause of the supply disruptions and resulted in conflicting reports and, at least initially, responses that did not properly address the underlying issues.



An NYPD officer maintains order at a gas station after Sandy. Credit: Robert Stolarik/The New York Times

Regional Refineries, Operational Status After Sandy

Refinery	Location	Operating Capacity (thousand bbl/day)	Operational Status, Days After Sandy								
			0	+1	+2	+3	+4	+5	+6	+7	+8	+9
Hess	Port Reading, NJ	70										
Phillips 66	Linden, NJ	238										
Sunoco	Philadelphia, PA	335										
PBF	Delaware City, DE	182										
PBF	Paulsboro, NJ	160										
Monroe Energy	Trainer, PA	185										

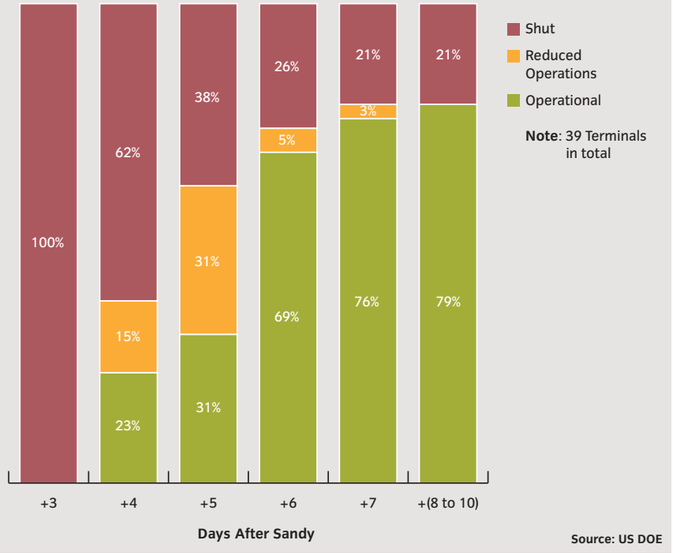
Pipelines, Operational Status After Sandy

Pipeline	Operational Status, Days After Sandy									
	0	+1	+2	+3	+4	+5	+6	+7	+8	+9
Colonial										
Buckeye										

Shut Reduced operations Operational

Source: US DOE

New York Metropolitan Area Fuel Terminals, Operational Status After Sandy



Source: US DOE

Hurricane Sandy dramatically reduced output at refineries that supply New York City. While Philadelphia refineries were not greatly affected by the storm and reopened fairly quickly, two northern New Jersey refineries were closed for extended periods. The owners of these regional refineries partially shut down their facilities before the storm to minimize damage to equipment, eliminating 35 to 40 percent of the region's total supply capacity preemptively. Despite this prudent preparation, storm surge damage to electrical equipment at two of the six refineries delayed their restarting, reducing regional refining capacity by 26 percent. Although both refineries eventually reopened several weeks later, one of the two subsequently was permanently closed, due to market conditions. *(See chart: Regional Refineries, Operational Status After Sandy)*

The Colonial and Buckeye pipelines also were impacted by Sandy, shutting down for four days due to extensive power outages in New Jersey. This reduced total supply in the region by another 35 to 40 percent. Even after backup power generators were deployed and utility power was restored, it is likely that the flow of fuel through these pipelines still did not reach pre-storm levels for several days because of bottlenecks at the terminals that they supplied. *(See chart: Pipelines, Operational Status After Sandy)*

Of all of the ways in which Sandy interfered with the liquid fuel supply chain in the New York region, perhaps the most significant was the damage to the area's terminals. This damage took multiple forms. For example, docks at some terminals were destroyed, making it impossible for those terminals to ship or receive fuel. In many cases, damage to electrical equipment reduced the capacity of impacted terminals to dispense fuel to delivery trucks that service gas stations. Additionally, damage to storage tanks at several terminals resulted in spills into area waterways totaling some 460,000 gallons of fuel around the city. And, as a result of the large amount of storm-related debris in the harbor immediately following Sandy, the US Coast Guard placed restrictions on port traffic for days until the waterways were deemed safe for use. As a result, even if a terminal were otherwise able to operate, many were still, for a period, unable to dispense or receive tanker and barge shipments, reducing supply capacity by an additional 20 to 25 percent. Overall, for three days after Sandy, all fuel terminals in the New York metropolitan region were completely out of service. Even 10 days after the storm, only 79 percent were operational. *(See chart: New York Metropolitan Area Fuel Terminals, Operational Status after Sandy)*

The closures of terminals meant that many gas stations had no supply. However, supply agreements required franchised gas stations to source their fuel only from those facilities. Accordingly, even where alternative sources of fuel may have been available, these stations could not take advantage of them. One significant exception to this during Sandy was gas stations owned by Hess, which had the ability to source fuel from corporate-owned terminals outside of the region. As a result, Hess stations received more frequent fuel shipments and remained open on average twice as long daily as other gas stations.

Another barrier to the restoration of fuel availability was local, State, and Federal regulations relating to the transportation and consumption of liquid fuels, which restricted supply from entering the city. For example, New York State's price-gouging law, which was meant to prevent predatory price increases during emergencies, may actually have had the perverse effect of constraining fuel supply due to its lack of clarity. This is because this law, prohibiting an "unconscionably excessive" price increase, made it unclear to retailers how much of a price increase would be considered price gouging, preventing them from temporarily raising prices at the pump. This would have allowed retailers, in turn, to pay the additional transportation costs associated with sourcing fuel from other regions.

With little or no fuel to sell to customers, stations all across New York City were forced to close—even though, unlike in New Jersey and on Long Island, 90 percent of the stations in the city were outside of the areas that experienced widespread power outages. In fact, most drivers in New York City were able to find a station that had access to adequate power within a five mile radius after the storm, except those in the Rockaways. *(See map: Retail Gas Stations, Electrical Network Shutdowns, and Sandy Inundation Area)*

Because of the post-Sandy fuel shortage, however, within one week of Sandy's landfall, less than 20 percent of stations were able to sell fuel at any given time. During that time, even after receiving fuel shipments, in many cases, stations would end up selling out in short order. For many drivers, this meant spending hours searching around the region for stations with gas, often waiting in long lines at the few that remained open—only, in some cases, to have those stations run out before every customer had a chance at the pump. Because demand was concentrated at fewer stations, the presence of New York City police officers was required at gas stations to maintain order and direct traffic. *(See chart: New York City Gas Stations by Point-in-Time Operational Status)*

As significant as the impact of the fuel shortage was on the general population, even more seriously, personnel and entire fleets that were critical to storm response had difficulties refueling. This was true of utility technicians essential to power-restoration efforts, hospital staff, nonprofit relief workers, and other critical personnel. In each case, these important individuals were also forced to spend hours either searching for open gas stations or waiting in line, delaying emergency response and restoration efforts citywide.

The fuel supply disruption also affected power and steam plants in and around the city. As the storm approached, Con Edison called upon power plants within the city to switch to liquid fuels preemptively in case of a natural gas disruption. Eventually, as the area's fuel supply issues emerged, some power and steam plants actually had difficulty obtaining adequate fuel shipments, in some cases, coming close to depleting their fuel supplies.

In response to the fuel shortage, the City worked with the State and Federal governments and with private industry to put in place a variety of measures to restore supply, with a goal of prioritizing fuel for emergency responders, then for private fleets critical for infrastructure restoration and relief, and finally for the general public.

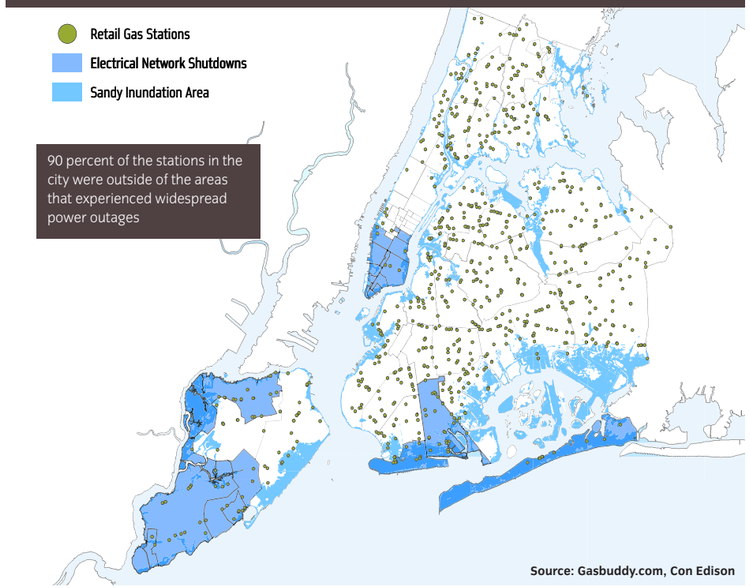
One example of the steps that the City took to bring supply and demand back into balance was a waiver of regulations on the transportation and consumption of fuels within New York City. The City, State, and Federal governments also worked together to secure a waiver of a series of relevant restrictions, including the Jones Act, local gasoline formulation requirements, gasoline vapor pressure requirements, on-road diesel requirements, diesel sulfur requirements, biodiesel requirements, and certain transportation restrictions. While these actions all took place within a few days of the storm and led to additional supply entering the system, the depletion of service station inventories continued to occur too quickly for the supply chain to "catch up," resulting in continued shortages.

Therefore, 11 days after the storm and consistent with steps taken in New Jersey and Long Island, Mayor Bloomberg issued an Executive Order for the rationing of gasoline—the first in New York City since the 1970s. Pursuant to the Executive Order, drivers of vehicles with license plates ending in odd numbers were permitted only to fuel on odd-numbered days, while those with plates ending with even numbers or letters were permitted to fuel only on even-numbered days.

The US Department of Energy also began releasing supply from the Northeast Home Heating Oil Reserve. The ultra-low sulfur diesel contained in the reserve, which was meant to be used in buildings for heating, was made available for use in vehicles, helping to reduce the area's diesel shortage.

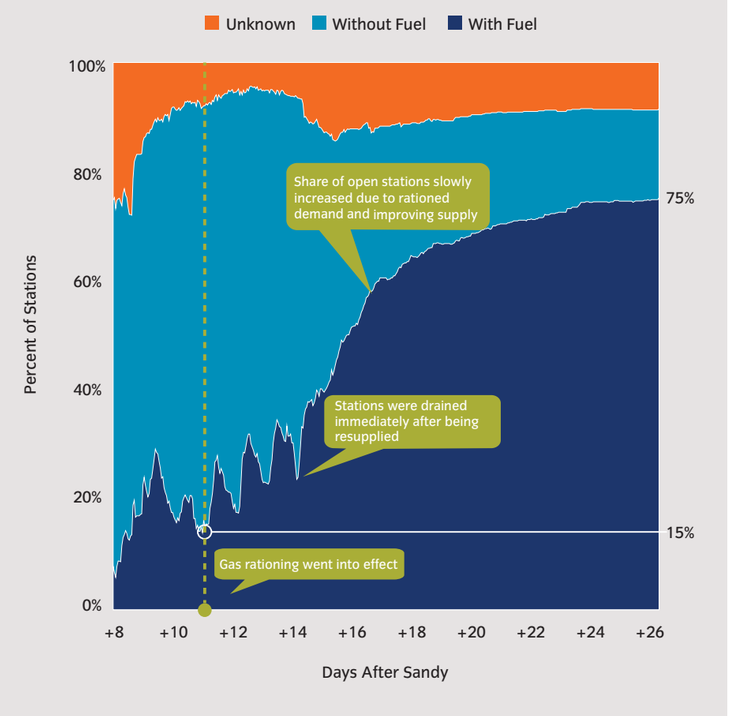
The City also identified groups deemed critical to storm response and in need of fueling assistance. These groups included City staff from uniformed

Retail Gas Stations, Electrical Network Shutdowns, and Sandy Inundation Area



Source: Gasbuddy.com, Con Edison

New York City Gas Stations by Point-in-Time Operational Status



Source: Gasbuddy.com

Risk Assessment: Impact of Climate Change on Liquid Fuels

Major Risk Moderate Risk Minor Risk

	Scale of Impact			
Hazard	Today	2020s	2050s	Comments
Gradual				
Sea level rise				Low-lying infrastructure could be vulnerable to minor damage with significant sea level rise
Increased precipitation				Minimal impact
Higher average temperature				Minimal impact
Extreme Events				
Storm surge				Most terminals and refineries are in floodplains; flood risks will become worse over time
Heavy downpour				Minimal impact
Heat wave				INDIRECT: Increased likelihood of power outages could disrupt operations of supply infrastructure
High winds				INDIRECT: Increased likelihood of power outages could disrupt operations of supply infrastructure served by above-ground lines

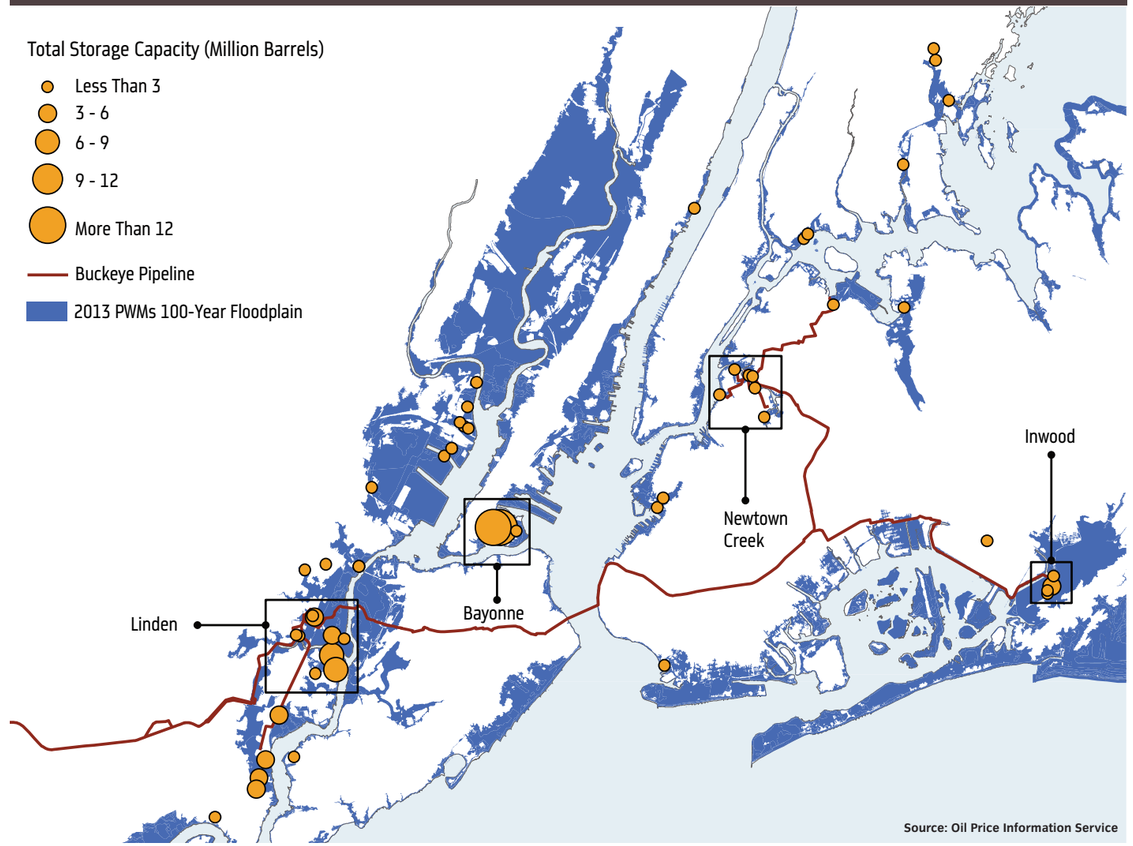
Fuel terminals between Newark Liberty International Airport and Port Elizabeth in northern New Jersey

Credit: Keith Meyers/The New York Times

agencies, doctors and nurses, and electricians and other skilled tradespeople. To fuel their vehicles and the vehicles of others, the City worked with the New York National Guard, the US Defense Logistics Agency, the US Department of Energy, the National Park Service, and the City's fuel vendors to set up an emergency fueling station at Floyd Bennett Field in Brooklyn. A total of 450,000 gallons of fuel were supplied to over 25,000 vehicles from this station. The assisted vehicles included private ambulances, Access-a-Ride vehicles, food trucks supporting storm response efforts, and utility trucks. In a complementary effort, the New York National Guard and the Department of Citywide Administrative Services (DCAS) also conducted fuel missions to fill gas cans to supply emergency electrical generators.

Another fuel-related effort in the aftermath of Sandy was one undertaken by the City, which involved working with the fuel vendors to increase fuel deliveries for City fleets. As a result of these efforts, the City's two primary vendors ended up delivering supplies that exceeded normal fuel deliveries by 65 percent. The City also made arrangements to fuel emergency and critical storm response vehicles at 10 Hess retail stations across the city. The NYPD monitored the Hess sites, ensuring that critical vehicles were able to access fuel without having to wait in line.

Regional Liquid Fuel Terminals



Source: Oil Price Information Service

What Could Happen in the Future

The risks that extreme weather events pose to the liquid fuels supply chain are, as Sandy showed, serious if not addressed. The systematic failure that occurred as a result of Sandy's storm surge revealed that there are already significant challenges today. These challenges will only be exacerbated by climate change in the future.

Major Risks

Given the existing locations of key terminals, pipelines, and refineries, and the importance of waterfront access for the movement of fuels into New York City, the greatest risk to the liquid fuel supply is storm surge. Of the 39 fuel terminals in the New York metropolitan area, nearly all lie within FEMA's 100-year floodplain. The same is also true of the refinery in northern New Jersey as of the writing of this report. As the climate changes, the frequency of the most intense hurricanes is likely to increase, potentially increasing the risk to these facilities. *(See map: Regional Liquid Fuel Terminals.)*

Not only do extreme weather events cause direct damage to key liquid fuel assets in the region, they also disrupt the power infrastructure critical to the functioning of terminals, refineries, and pipelines. Although utilities must meet current reliability standards, the increased frequency and severity of heat waves and storm surges associated with the most intense coastal storms are likely to increase the frequency of power disruptions throughout the region that would, in turn, render key refineries, pipelines, and terminals inoperable (see Chapter 6, *Utilities*). Given the high energy requirements of pipelines and refineries, backup generation may only provide limited operability during utility power outages. Additionally, if power were out for more than a few hours, refineries would quickly shut down, after which it would take weeks to restart them. Gas stations and terminals, which generally do not have on-site backup generation, also are fully reliant on utility power.

Other Risks

High winds present moderate risks to the liquid fuels supply chain. Wind events could result in direct damage to refineries, which have tall distillation columns that are critical to the processing of crude oil. In addition, if wind events affect the availability of utility-supplied electric power, they will also impact terminals, refineries, pipelines, and gas stations.

This chapter contains a series of initiatives that are designed to mitigate the impacts of climate change on New York's liquid fuel supply. In many cases, these initiatives are both ready to proceed and have identified funding sources assigned to cover their costs. With respect to these initiatives, the City intends to proceed with them as quickly as practicable, upon the receipt of identified funding.

Meanwhile, in the case of certain other initiatives described in this chapter, though these initiatives may be ready to proceed, they still do not have specific sources of funding assigned to them. In Chapter 19 (*Funding*), the City describes additional funding sources, which, if secured, would be sufficient to fund the full first phase of projects and programs described in this document over a 10-year period. The City will work aggressively on securing this funding and any necessary third-party approvals required in connection therewith (i.e., from the Federal or State governments). However, until such time as these sources are secured, the City will proceed only with those initiatives for which it has adequate funding.

Storm surge, storm- or heat wave-driven power outages, and other natural or manmade disasters can cause disruptions in the supply of liquid fuels. The City will seek to minimize the frequency and severity of disruptions by increasing the resiliency of key infrastructure. However, in recognition of the fact that it is not possible to prevent all disruptions, the City also will seek to minimize the impacts of such disruptions by improving restoration times. Finally, in the event of a significant, lengthy and widespread fuel supply disruption, the City will prepare for a work-around of the normal supply chain to maintain operations that are necessary to restoration and relief while the normal chain is being restored.

Strategy: Seek to harden the liquid fuels supply infrastructure

The fuel supply infrastructure is vulnerable to extreme weather events, which are likely to become more frequent and more severe in the future. Hardening of key assets would decrease disruptions and allow for faster restoration of operations.

Initiative 1
Call on the Federal government to convene a regional working group to develop a fuel infrastructure hardening strategy

The fuel supply shortage after Sandy was caused mainly by damage to infrastructure in New Jersey, where the City and State of New York have no regulatory or legislative authority. Owners are not required by any existing regulations to harden infrastructure against climate change impacts. In fact, due to the highly dynamic and competitive nature of the fuel industry, suppliers often do not have the resources and long-term outlook necessary to make their waterfront assets more resilient against threats such as storm surge and power loss.

The City, therefore, will call on the Federal Hurricane Sandy Rebuilding Task Force and the US Department of Energy to convene the necessary stakeholders to ensure that key infrastructure is hardened. The City also will call on the Columbia University Center on Global Energy Policy to join this effort. In addition to the City, participants in this effort should include the State of New York, the State of New Jersey, and private owners of key assets. The Office of Long-Term Planning and Sustainability (OLTPS) will begin working with these parties immediately to develop a strategy that will achieve the goal of hardening pipelines, refineries, and terminals critical to maintaining fuel supplies in the region.

Initiative 2
Develop a reporting framework for fuel infrastructure operators to support post-emergency restoration

There currently are no requirements to report information on the operational status of terminals, pipelines, refineries and gas stations. In an emergency, not being able to access the information needed to gain a comprehensive understanding of the regional challenges will hamper recovery and restoration. The City will call on and work with the Federal government and private industry to develop streamlined reporting protocols for operators, as well as automated sensors and other information technology (IT) systems that will monitor the operational status of these facilities. OLTPS and the New York City Economic Development Corporation will begin working immediately with the US DOE to develop these systems and an information-reporting framework for these facilities, in a manner that is sensitive to the industry's need for security and confidentiality.

Initiative 3
Work with Buckeye and New York State to safely build pipeline booster stations in New York City to increase supply and withstand extreme weather events

Many existing pumping stations along pipelines are not hardened against extreme weather. Before Sandy, Buckeye had proposed the installation of a booster station to increase flow into New York City for economic reasons. This booster station also would help bring additional supply to New York City in emergency situations. New York State has advocated for the building of a booster station to increase supply during shortages. The City also will advocate for the building of a new booster station if design specifications meet the necessary legal, safety, and resiliency standards, and all necessary commercial terms could be secured. OLTPS will begin working immediately with Buckeye and New York State to ensure that a booster station, once installed, will be designed to withstand climate change impacts to the greatest extent possible.

Initiative 4
Work with New York State to provide incentives for the hardening of gas stations to withstand extreme weather events

Although lack of power supply at gas stations was not the primary cause of fuel shortages after Sandy, a widespread power outage in the city would cripple gas station operations, making gasoline and diesel unavailable. New York State's 2013–2014 budget requires retail fuel stations within a half-mile of controlled access roads and designated evacuation routes to invest in equipment that would allow them to connect generators quickly in the event of a power loss, and to enter into supply contracts for emergency generators.

The City will support the State in the design and implementation of the generator connection program, an effort that will include working with the New York State Energy Research and Development Authority (NYSERDA), which was directed to develop an incentive program to minimize the financial impact of the budget requirements. In addition the City will work with the State to assess the vulnerability of gas stations on the Rockaway Peninsula, an area of the City in which gas stations are not required to comply with the State budget requirements, but should, due to its geographic isolation.

Because the aforementioned program does not require any other hardening measures against flooding or other climate-related risks, OLTPS will work with NYSERDA, retail gas stations, and the State legislature to seek to develop effective hardening incentive programs for key retail fueling stations in vulnerable areas, including the Rockaways, by 2014.

Initiative 5
Ensure that a subset of gas stations and terminals have access to backup generators in case of widespread power outages

As previously mentioned, gas stations are vulnerable to widespread power outages, which could prevent them from operating. In New York State's 2013–2014 budget, NYSERDA was directed to develop a generator pool program for gas stations. The Office of Emergency Management (OEM) will assist NYSERDA, the Federal Emergency Management Agency, and the US Army Corps of Engineers (the USACE) in developing such a pool and in creating a pre-event positioning plan to enable the ready deployment of generators to impacted areas immediately in the wake of a disaster.

Strategy: Enhance the ability of the supply chain to respond to disruptions

One reason restoration of fuel supply was so slow after Sandy was the lack of redundancies and market flexibility needed to respond to such disruptions. As Sandy also showed, the impacts of a supply disruption can be blunted through market and regulatory changes.

Initiative 6
Explore the creation of a transportation fuel reserve to temporarily supply the private market during disruptions

Even if the fuel supply chain is hardened, the possibility of widespread disruption to supply still exists. In the event of such a disruption for an extended period of time in and around the city, a transportation fuel reserve for the City, State, or region would assist in restoration and relief efforts. The City will work with Federal and State governments, and the Columbia University Center on Global Energy Policy to evaluate the feasibility and cost of such a program. Such a program would complement the already existing Northeast Home Heating Oil Reserve, managed by the US DOE in Connecticut. In 2013 and 2014, OLTPS will work with the US DOE, New York State, and surrounding state governments on this effort.

Initiative 7
Call on New York State to modify price-gouging laws and allow flexibility of gas station supply contracts to increase fuel availability during disruptions

There is a lack of clarity in New York State's price-gouging laws during the very limited circumstances of a widespread disruption of fuel supplies in the New York region. This uncertainty results in retail fuel station owners' unwillingness to raise prices after such a disruption to pay for supply from outside of the region. The City estimates that a $0.33 increase in fuel prices after Sandy (a premium of approximately 10 percent) would have allowed stations to cover the additional transportation costs to bring fuel into the city from as far as Charlotte, North Carolina. Another challenge during Sandy was that many retail fuel stations were bound by franchise agreements to source fuel only from certain suppliers, which were either not operational or had insufficient supplies after the storm. These contractual obligations prevented station owners from temporarily sourcing fuel from different suppliers.

A solution to the problem posed by the State's price-gouging laws would be to allow a controlled increase in prices during fuel supply emergencies, while still ensuring fair pricing. A solution to the problem posed by retailers' franchise agreements, meanwhile, would be the inclusion of a "force majeure" clause in fuel supply contracts that would allow franchised stations to source fuel on a temporary basis from any wholesaler if a retailer's usual suppliers are unable to deliver.

OLTPS will, therefore, work with New York State to seek legislation in 2013 and 2014 that would permit controlled increases in fuel prices during and after extraordinary weather events, and that would mandate a "force majeure" clause in all fuel supply contracts and franchise agreements, in each case, to be exercised only during a liquid fuels shortage, as declared by the Governor.

Initiative 8
Develop a package of City, State, and Federal regulatory actions to address liquid fuel shortages during emergencies

Various regulations relating to the transportation and consumption of fuels in New York City limit the flexibility of the market to respond to disruptions. The City will work with the State and Federal governments to prepare an "off-the-shelf" package of regulatory measures for use in the event of a liquid fuels shortage. A list of such waivers that would be issued rapidly across different levels of government would allow supply-demand imbalances in the fuel supply to be mitigated more quickly. The waiver of the Jones Act, for example, would allow foreign-flagged ships to deliver fuel into the region. Waivers of the City's fuel sulfur requirements and the local formulation requirements would allow fuel that is normally consumed upstate and elsewhere to be shipped into and sold within New York City. A waiver of the on-road diesel fuel requirement would allow heating fuel to be used in vehicles. The imposition of fuel rationing would further allow the retail fuel supply to stabilize.

OEM and DCAS will, therefore, develop and regularly maintain a fuel-rationing plan and package of regulatory waivers and modifications that would be put in place immediately after the declaration of a liquid fuels shortage, as declared by the Mayor. OEM will further work with the State and Federal governments to develop complementary measures. OEM will update the City's plan and package on an annual basis.

Strategy: Improve the City's ability to fuel first responders and private critical fleets

The City must be able to respond quickly to a fuel supply disruption, providing continuous fueling to vehicles that are critical for emergency response, infrastructure rebuilding, and disaster relief. These vehicles include emergency responders, utility restoration fleets, medical personnel vehicles, electricians and other skilled trades workers, construction vendors, private ambulances, wheelchair accessible transportation vehicles, food supply trucks supporting relief efforts, and City government staff from uniformed agencies.

Initiative 9
Harden municipal fueling stations and enhance mobile fueling capability to support both City government and critical fleets

During a widespread disruption to the retail liquid fuels market, the City must be able to bypass the supply chain by using its own network of gas stations and mobile fueling trucks. This will ensure continued service at City-owned fueling sites and mobile fueling operations for City-owned fleets, as well as select critical fleets that are privately owned. The City, through DCAS, will procure additional mobile fueling trucks, generators, light towers, forklifts, and water pumps to permit the City to harden its own fuel supply infrastructure and put in place emergency fueling operations immediately following a disruption in the supply chain.

In the event of a prolonged disruption, the City must ensure that it does not deplete its own fuel supply for first responders and critical fleets. Currently, the City owns almost two weeks of fuel storage capacity for its own normal usage, and much less when fueling privately-owned vehicles. Therefore, DCAS also will also issue a request for expressions of interest in 2014 in order to evaluate the different options for sourcing fuel during emergencies.

Credit: HHC

Healthcare

Kings County Hospital Center in Brooklyn illustrates the size and complexity of hospital campuses. Credit: HHC

New York City's population of 8.2 million includes people with a wide range of health needs. Many—in relatively good health—see their doctors infrequently, but all count on them to be available if they get injured or become sick.

Over 1 million New Yorkers, on the other hand, are in poor health—which could include those who have chronic conditions such as diabetes and high blood pressure—and these individuals depend on regular, ongoing medical care. Furthermore, there are 800,000 New Yorkers under the age of five or over the age of 80 who are more vulnerable to illness and injury and more likely to need life-saving medical care.

A vast, complex healthcare system has evolved to meet the needs of New York's diverse population, and Sandy caused disruptions across that system. The storm completely shut down six hospitals and 26 residential-care facilities. More than 6,400 patients were evacuated through efforts coordinated by the Healthcare Evacuation Center (HEC). Providers who remained open strained to fill the healthcare void—hospitals repurposed lobbies as inpatient rooms, adult care facilities siphoned gas from vehicles to run emergency power generators, and nursing home staff lived on-site for four or more days until their replacements arrived. Flooding and power outages forced community clinics, doctors' offices, pharmacies, and other outpatient facilities to close or reduce services in the areas most impacted by the storm.

Sandy not only put unprecedented stress on the provider system; it placed the health of medically fragile individuals at risk. There were an estimated 75,000 people in poor health living in areas that were inundated by floodwaters and an estimated 54,000 more in communities that lost power. These groups faced additional health risks during the storm and were less capable of gaining access to appropriate care. For example, lack of heating in their buildings could have caused new health conditions, and those who lived in high-rise buildings might have been unable to leave their homes if elevators were not functioning. Furthermore, the unpredictable storm conditions increased the risk that any New Yorker could require life-saving medical care.

In keeping with the overarching goals of the Special Initiative for Rebuilding and Resiliency—to minimize the impacts of climate change and enable quick recovery after extreme weather events—the City will make the healthcare system more resilient. To ensure that hospitals, nursing homes, and adult care facilities can operate continuously during extreme weather, the City will require that new facilities be built to higher resiliency standards and existing providers are hardened to protect critical systems. To reduce barriers to care in impacted communities, the City will seek to keep the lines of communication open between patients and their providers and enable affected community-based providers to reopen quickly after a disaster. Making our healthcare system more resilient will benefit our most fragile populations—and all New Yorkers.

How the Healthcare System Works

New York City's healthcare system is a web of interdependent providers, each supplying specific medical services and care to patients. Providers can be grouped into four broad categories: hospitals, residential providers, community-based providers, and home-based providers. Patients typically enter the healthcare system through community-based providers (such as doctors' offices) or hospital emergency departments. Depending on their medical needs, patients may then be directed to other providers for appropriate care.

Hospitals

Hospitals play a crucial role in the healthcare system, caring for those with the most acute medical conditions—patients for whom a delay in care can be life-threatening—as well as performing hundreds of elective surgeries and procedures every day. There are 70 acute care and psychiatric hospitals in New York City, providing both inpatient and outpatient services. Some hospitals specialize in particular medical conditions (such as cancer, orthopedics, or pediatrics) or are devoted to specific groups of the population, such as veterans.

Most hospitals have emergency departments (EDs) where people can seek care as walk-in patients or arrive by ambulance. Some EDs play a unique role in the 911 system, serving as designated regional trauma and/or burn centers. These EDs are staffed around the clock with multiple specialists, allowing them to handle a variety of serious trauma cases, such as a brain injury sustained in a car accident. In all, New York City hospital EDs see on average over 8,000 patients every day.

Many patients enter hospitals' inpatient care units through either the ED or referrals from their outpatient providers. After treatment, if intensive rehabilitation is needed, patients may be transferred to nursing homes or discharged with referrals to visiting nurse or aide services for home-based supportive care. Over time, as their conditions stabilize, some patients may no longer need the same level of services, while others may continue to require long-term care at home or in a facility.

Hospitals can be very large institutions, with up to 1,000 inpatient beds. While some hospitals occupy a single building, many have multiple buildings on a campus. Whatever their specialization or physical configuration, hospitals are required, under New York State Department of Health (NYSDOH) regulations, to take steps to ensure patient safety under normal conditions as well as during emergencies. For example, emergency generators must be able to switch on in less than 10 seconds. This ensures that power is not interrupted for essential services, such as life-sustaining equipment for babies in neonatal units or those relying on ventilators to breathe during surgery.

Residential Providers

New York City's 1,400 residential-based providers care for over 80,000 patients at any given time. Included in this category are nursing homes, which offer skilled nursing for the elderly and very frail in need of ongoing medical attention, and adult care facilities, which primarily support residents who require help with basic daily tasks such as meals or bathing. Other residential providers offer treatment, care, and supportive housing for individuals with substance abuse problems, developmental disabilities, or other behavioral or mental health challenges.

Some patients are admitted from hospitals and other healthcare providers for short-term rehabilitation and only stay with a residential provider until they are able to return to their own homes. These include stroke patients learning to speak again, hip replacement patients taking their first steps after surgery, and people with drug addictions participating in rehabilitation programs. Others, such as those who are frail or have severe lifelong disabilities, live in residential facilities on a long-term basis. If patients develop acute medical conditions while in residence, they are often transferred to hospitals for short-term care.

Residential facilities vary in size and configuration. Some nursing homes and adult care facilities resemble large homes or apartment buildings, while some look more like hospitals. Other residential facilities—including those for substance abuse treatment and developmental disabilities—tend to be much smaller in size. Citywide, other residential providers have four times the number of buildings as nursing homes and adult care facilities. However, in total these providers care for only half as many residents. No matter the size of the facility, all providers must look after the health, safety, and well-being of their residents.

Community-Based Providers

The healthcare services that keep most New Yorkers well on a day-to-day basis—screening for illness, managing chronic disease, and dispensing medication—are delivered primarily through community-based providers. These providers offer services from over 10,000 buildings across the five boroughs and are the most common entry point into the healthcare system. In the majority of cases, these providers are the ones with which patients interact most frequently.

Included in this broad group are large community clinics that provide primary care, mental and behavioral health services, and other outpatient services to hundreds of people every week. Other community-based providers include private doctors' practices for primary and specialty care, dialysis centers, hospital-affiliated outpatient providers, independent clinics and treatment centers, and retail pharmacies. New Yorkers collectively make 15 million visits to primary care doctors annually as well as millions more visits to specialists and pharmacies. Though the space arrangements of these providers vary widely, many providers are tenants occupying commercial buildings or first-floor retail spaces.

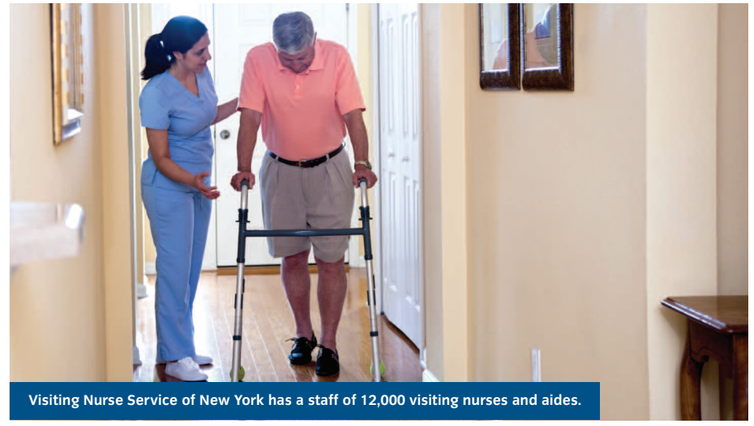
Home-Based Providers

Home-based providers make up a small—but growing—segment of the healthcare system. Visiting nurses and aides provide care and assistance to over 100,000 New Yorkers in their own homes. These providers dispense medication, dress wounds, monitor medical conditions, and help with meals and bathing. Most patients are visited a few times a week, but some are visited daily and rely on their nurses and aides for the same type of life-sustaining care that is provided in a nursing home. Many patients start receiving home-based care after being discharged from a hospital or upon referrals from their community-based providers.

Regulatory Framework of the Healthcare System

Healthcare providers are primarily regulated by the New York State Department of Health, the New York State Office of Mental Health, or the New York State Office of Alcoholism and Substance Abuse Services. These agencies regulate providers' facilities and the provision of care, including licensing and construction of new facilities, the addition of inpatient beds, the creation of discharge procedures, and the approval of emergency changes to standard medical protocols.

Though New York State laws are comprehensive, New York City healthcare providers must also adhere to other regulations. For example, to receive reimbursement from Medicare, the primary payer for patients over 65, providers must follow the Centers for Medicare & Medicaid Service's regulations. In addition, New York City requires that provider buildings meet local fire safety and building codes, and that their kitchens meet the food safety standards of the New York City Department of Health and Mental Hygiene (DOHMH). Healthcare providers are regularly inspected by State and City inspectors to ensure compliance. Furthermore, many providers subject themselves to stricter operational or building standards to gain accreditations from external associations such as The Joint Commission, a nonprofit organization that accredits healthcare institutions nationwide. All hospitals in New York City are accredited by The Joint Commission, which requires additional contingency measures to address temporary failures of critical systems.



Visiting Nurse Service of New York has a staff of 12,000 visiting nurses and aides.

Coney Island Hospital staff survey the flood-damaged basement after Sandy. Credit: HHC

Coney Island Hospital During Sandy

Coney Island Hospital in Southern Brooklyn serves a community of nearly 750,000 people. It has 371 beds for comprehensive inpatient medical services, and its emergency department (ED) sees an average of 1,500 patients every week. The facility is operated by the New York City Health and Hospitals Corporation (HHC). Due to its location, the hospital is vulnerable to extreme coastal storms. Therefore, hospital staff always monitor the weather and have extensive plans in place for emergencies.

On Saturday, October 27, two days before Sandy hit, the hospital's Incident Command and Emergency Operations Center was fully activated. The hospital began a rapid patient discharge process and pre-evacuated 33 patients on ventilators and life support to other hospitals outside the floodplain. The patients in the older Main Building, which is less than a mile from the ocean, were relocated to upper floors in the newer Tower Building.

At around 9:30 p.m. on October 29, the hospital and surrounding community lost power. However, the hospital's lights remained on as emergency generators kicked in. The storm surge pushed water from the ocean, Sheepshead Bay, and Coney Island Creek inland, flooding the ED with five inches of water within minutes. Acting quickly, hospital staff safely moved 25 stretcher patients from the ED to higher floors.

With the inundation of the entire hospital campus, the generator room began to flood. To save the hospital's generator from irreparable damage, engineers shut it off, plunging the hospital into total darkness for more than four hours. During the peak of the storm, there was no communication with the outside world, but the staff valiantly cared for patients using flashlights and battery-powered medical devices.

Meanwhile, many residents of the surrounding community who had not evacuated turned to the hospital for shelter, including four adults and two dogs delivered by a police boat. A total of 60 displaced residents were housed in the hospital auditorium.

After the storm passed and the water receded, hospital staff switched the emergency generator back on. Over the following 12 hours, the hospital evacuated all remaining patients—more than 220—to other facilities. During this process, staff relied on point-to-point radio communication with the nearest HHC facility, Kings County Hospital, which then relayed messages to other facilities.

It took almost five days to pump out over 10 million gallons of water from flooded basement areas. Nevertheless, hospital personnel instituted emergency repairs and clean-up, which allowed the hospital to reopen with limited outpatient clinical services two days after the storm. Comprehensive inpatient care services were partially restored by mid-January.

What Happened During Sandy

New York City's healthcare system is designed to handle fluctuations in demand as healthcare needs vary seasonally. However, the cascading closures of providers during and after Sandy strained the system citywide. Because of the closures, providers that remained open had to operate beyond normal capacity, which was difficult to sustain for extended periods. To ensure they were able to address the most acute medical needs, some providers that remained open reduced certain services they offered—for example, postponing non-emergency surgeries or suspending outpatient procedures.

Disruptions in citywide systems—transportation, fuel, telecommunication, and power—had a noticeable but short-term impact on the healthcare system. Transportation outages and restrictions, as well as fuel restrictions, made it difficult for healthcare staff to travel to workplaces in the first week after the storm. Telecommunication breakdowns meant that impacted providers were unable to communicate with patients, and also made coordination with City and State officials for response efforts more challenging. Power outages closed some community-based providers for up to a week, while flood damage closed a limited number of providers for much longer, necessitating repairs and the replacement of destroyed equipment.

Across the city, five acute care hospitals and one psychiatric hospital closed. This resulted in the emergency evacuation of nearly 2,000 patients coordinated by the HEC, in addition to an unknown number of patients who were transferred within provider networks or were discharged before or after Sandy. Of these, three hospitals closed in advance of the storm: New York Downtown (Manhattan) closed after notice of a potential pre-emptive utility shutdown, while the Veterans Affairs New York Harbor Hospital (Manhattan) and South Beach Psychiatric Center (Staten Island) closed due to concerns about flooding. Three other hospitals—New York University's Langone Medical Center (Manhattan), Bellevue Hospital (Manhattan), and Coney Island Hospital (Brooklyn)—evacuated during or after Sandy due to the failure of multiple electrical and mechanical systems including emergency power systems. In the immediate aftermath of Sandy, hospital bed capacity was down eight percent citywide. *(See sidebar: Coney Island Hospital during Sandy)*

Meanwhile, 10 hospitals remained open despite power outages and/or limited flooding in basement areas. In the week after the storm, Beth Israel in Manhattan—powered only by back-up generators due to the area-wide power outage—saw a 13 percent increase in ED use. To meet patient demand, the hospital suspended elective procedures and surgeries. Other hospitals used workarounds in response to communication and information technology (IT) failures. For example, runners on each floor conveyed doctors' orders, paper charts replaced electronic records, and two-way radios were used to communicate with other providers. To handle the influx of patient evacuees, some receiving hospitals turned lobbies into inpatient wards and gave emergency permission for OB/GYNs displaced from other hospitals to deliver babies in their facilities.

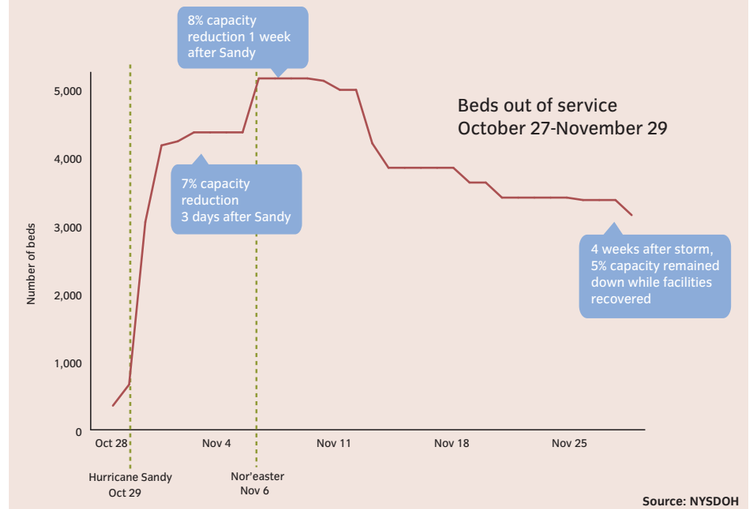
Some hospitals narrowly escaped flood damage. For example, Metropolitan Hospital in upper Manhattan just missed having its critical electrical systems flooded, and on Staten Island University Hospital's North Campus, floodwaters came within inches of the hospital entrance.

New York City hospitals incurred an estimated $1 billion in costs associated with emergency response measures taken during and immediately after Sandy, including the costs of staff overtime, patient evacuations, and emergency repairs of equipment. To return to normal operations, as of the writing of this report, it is projected that damaged hospitals will spend at least another $1 billion on repairs and mitigation. In addition, permanent revenue loss for hospitals citywide is estimated to have been nearly $70 million per week in the immediate aftermath of the storm. Hospitals that were closed due to serious damage experienced revenue losses over many months.

Sandy's impact on residential providers was also significant. Sixty-one nursing homes and adult care facilities were in areas impacted by power outages and/or flooding. Half of these providers continued to operate—some because they sustained minimal or no damage, others because they had effective emergency plans. But within a week of the storm, 26 facilities had to shut down, and another five partially evacuated, reducing citywide residential capacity by 4,600 beds and leading to the evacuation of 4,500 residents who had to be transported to other facilities or Special Medical Needs Shelters, which were staffed by personnel from the New York City Health and Hospitals Corporation (HHC) and Disaster Medical Assistance Teams (DMAT). These closures impacted hospitals as well, preventing them from discharging patients to nursing homes, as they normally would have done. Instead, hospital beds that could have been available for new patients remained occupied by existing patients who had nowhere else to recover after treatment. *(See chart: Citywide Bed Capacity Reductions in Nursing Homes and Adult Care Facilities)*

Over 700 patients were evacuated from Bellevue Hospital in Manhattan the day after Sandy. Credit: HHC

Citywide Bed Capacity Reductions in Nursing Homes and Adult Care Facilities



Source: NYSDOH

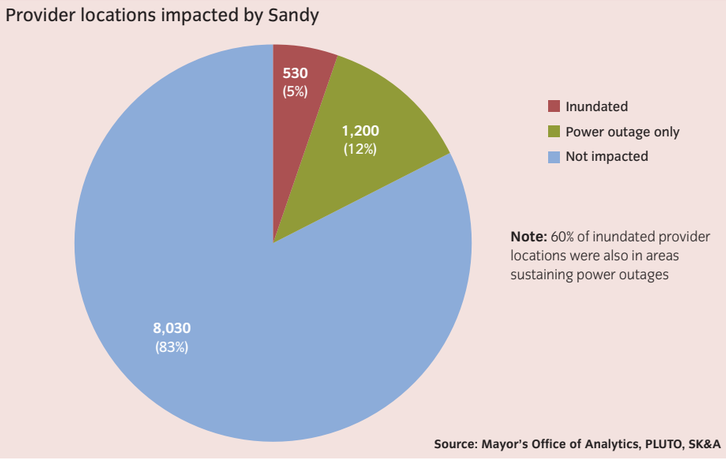
Power loss was the primary cause of post-Sandy evacuations from nursing homes and adult care facilities, and many providers experienced both utility outages and damage to building electrical equipment. Even providers with generators had difficulties if those generators were located in parts of buildings that flooded or if providers had failed to secure fuel in advance. Without power, other critical systems—lights, heating, elevators, kitchens, and medical equipment—could not function.

Although two nursing homes and one adult care facility evacuated patients in advance of the storm, 28 others evacuated under emergency conditions. These stressful emergency scenarios added significantly to patient risk (though, fortunately, there was no loss of life during any Sandy-related evacuations in the city). Some evacuees were transported without medical records or proper identification, making it difficult for receiving providers to administer appropriate care or notify evacuees' families and caretakers.

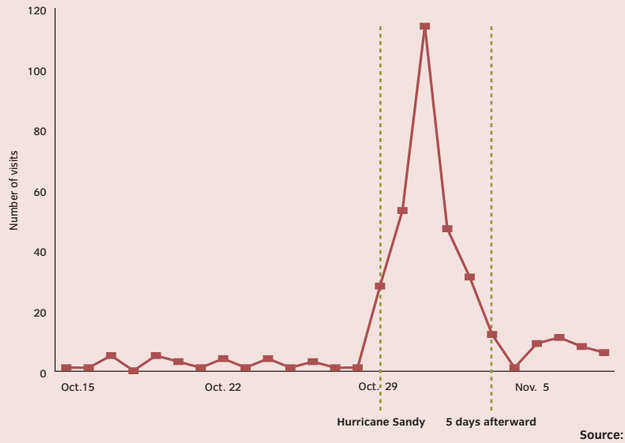
Among other residential providers, the majority with fewer than 10 beds, approximately 5 percent of facilities were located in inundated areas, and another 10 percent were in areas impacted by power outages. These disruptions caused some facilities to evacuate patients while others remained safely sheltered in place. Overall, however, these evacuations did not significantly impact the broader healthcare system because many evacuees were safely transferred to other providers.

Community-based providers in over 500 buildings across the city (5 percent of total community-based provider buildings) were

Impact of Sandy on Buildings Housing Community-Based Providers



Citywide Emergency Department Visits Needing Dialysis



located in inundated areas, including 300 buildings with doctors' offices, 100 retail pharmacies, and at least 70 outpatient and ambulatory care centers. Flooding in facilities in low-rise buildings or on the lower levels of taller buildings resulted in damage that often took weeks or even months to repair. Providers on higher floors could not reopen until damaged electrical systems, boilers, elevators, and other building systems were repaired. *(See chart: Impact of Sandy on Buildings Housing Community-Based Providers)*

An additional 12 percent of community-based providers' buildings were in areas that experienced power outages only. Since most community-based providers occupy buildings without generators, these providers typically remained closed until utilities were restored.

The impact of community-based provider closures was felt most in the areas hardest hit by the storm. In South Queens, for example, 60 percent of provider buildings were in inundated areas, while in Southern Manhattan, 95 percent of providers experienced power outages. Elsewhere in the city, community-based care was only affected if doctors and staff could not travel to their offices. Most providers opened as soon as transportation was restored.

New Yorkers whose providers' facilities closed often were left without a way to see or communicate with their providers. For many without immediate medical concerns, the temporary closures may have had limited impact. However, others with pressing healthcare needs—dialysis patients or those on methadone, for instance—had to seek alternative care immediately, often from hospital emergency departments or mobile medical vans staffed by doctors and nurses from community clinics and other healthcare workers. The longer providers remained closed, the greater the numbers of individuals who had to look elsewhere for care. *(See chart: Citywide Emergency Department Visits Needing Dialysis)*

Home-based care was impacted primarily by disruptions in the transportation system. The public transportation shutdown, travel restrictions on single-occupancy cars, and gasoline shortages all made it difficult for nurses and aides to reach the homes of patients scattered across the five boroughs. If and when providers finally did reach their destinations, elevators that were out of service—due to power outages or flood damage—often made it challenging for staff to reach patients on upper floors in high-rise buildings. The power, water, and heat outages within patients' homes were also problematic, increasing the likelihood that existing medical conditions would worsen or new ones would develop.

What Could Happen in the Future

Now and over the next 40 years, the primary climate risks facing the healthcare system are expected to be storm surge and heat waves.

Major Risks

Newly released Preliminary Work Maps (PWMs) from the Federal Emergency Management Agency (FEMA) place at least 300 more buildings housing healthcare providers in the 100-year floodplain than were in the floodplain in the 1983 Flood Insurance Rate Maps (FIRMs). Based on high-end projections for sea level rise from the New York City Panel on Climate Change (NPCC), another 200 facilities will be in the 100-year floodplain by the 2020s, and a total of 1,000 healthcare facilities will be in the 100 year floodplain by the 2050s. If the vulnerabilities of healthcare providers to flooding are not addressed, 10 percent of New York City's healthcare buildings will be at risk of damage and closure in the event of a major flood event under this scenario.

Among the vulnerable healthcare facilities are hospitals with 10 facilities—representing 16 percent of hospital beds citywide—in the 100-year floodplain, as indicated by the PWMs, and one more is in the 500-year floodplain. This one facility is expected to be added to the 100-year floodplain by the 2020s, with two more likely to be added by the 2050s. By mid-century, hospitals in the 100-year floodplain are expected to include three psychiatric hospitals and four regional trauma centers. *(See map: Hospitals in the Floodplain)*

Risk Assessment: Impact of Climate Change on the Healthcare System

Major Risk Moderate Risk Minor Risk

	Scale of Impact			
Hazard	Today	2020s	2050s	Comments
Gradual				
Sea level rise				Minimal Impact
Increased precipitation				Minimal Impact
Higher average temperature				Minimal Impact
Extreme Events				
Storm surge				Risk to facilities will increase as sea level rises
Heavy downpour				Minimal Impact
Heat wave				Increased patient demand can likely be handled by normal operations INDIRECT: Power outages could lead to evacuation because HVAC systems are required for operation, yet many are not connected to backup power
High winds				Minimal Impact

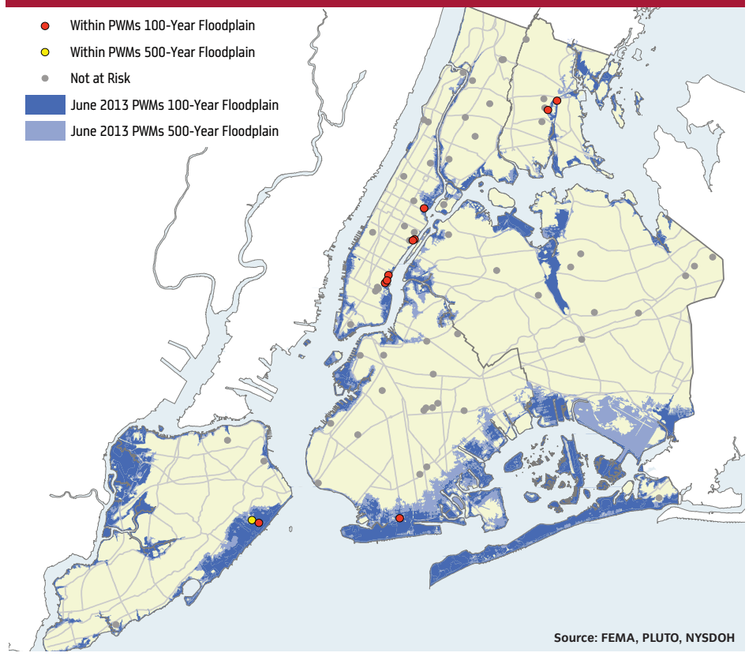
Meanwhile, 37 nursing homes and adult care facilities, representing 14 percent of citywide bed capacity, are in the 100-year floodplain, as indicated by the PWMs, with seven more likely to be in the floodplain by the 2020s. By the 2050s, 33 nursing homes and 25 adult care facilities are likely to be in the 100-year floodplain, many of these (approximately 60 percent) in Southern Brooklyn and South Queens. Among other residential care facilities, approximately 70 are in the floodplain, (7 percent of citywide bed capacity), with another 50 (an additional 5 percent of citywide bed capacity) likely to be added by the 2050s. *(See map: Nursing Homes and Adult Care Facilities at Risk in Southern Brooklyn and South Queens)*

Among community-based providers, approximately 5 percent of buildings with providers are in the 100-year floodplain, as indicated by the PWMs. There are approximately 550 buildings with community clinics, doctors' offices, pharmacies, and other outpatient and ambulatory care centers in the 100-year floodplain and nearly 400 more buildings are expected to be in the floodplain by the 2050s. *(See chart: Projected Growth in Flood Risk of Buildings Housing Community-Based Providers)*

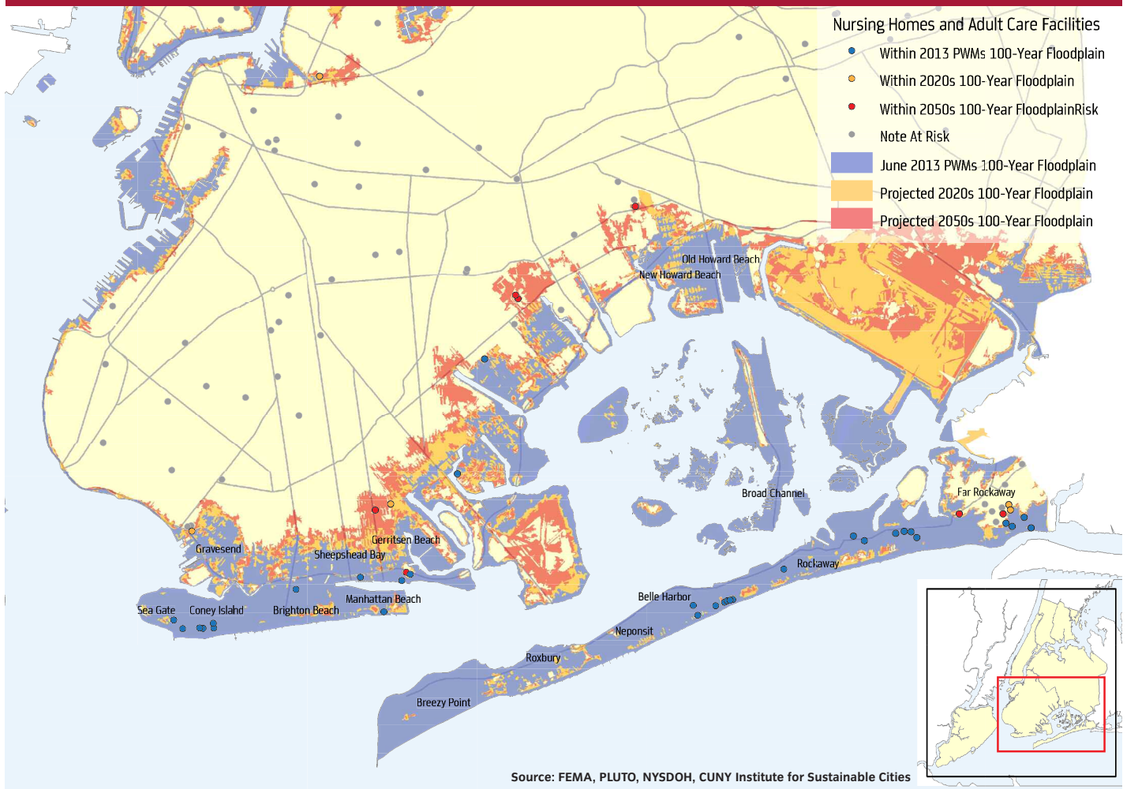
Other Risks

In addition to storm surge, heat waves pose a serious health risk to New Yorkers. They can cause

Hospitals in the Floodplain

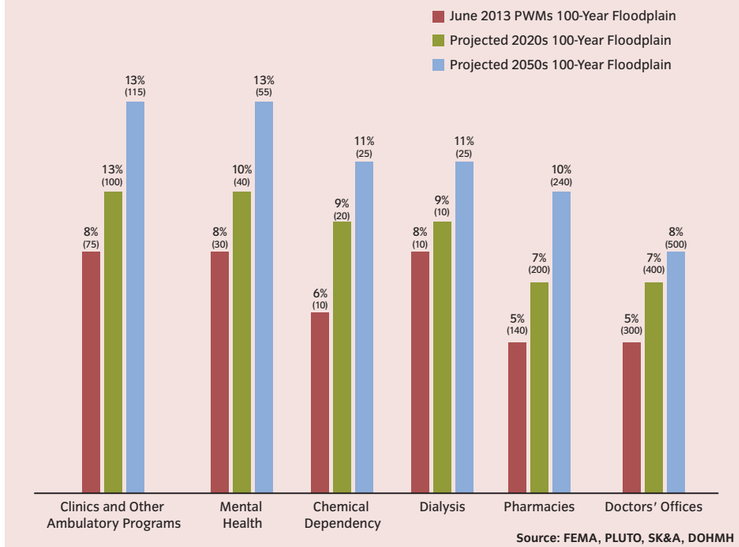


Nursing Homes and Adult Care Facilities in Southern Brooklyn and South Queens



Source: FEMA, PLUTO, NYSDOH, CUNY Institute for Sustainable Cities

Projected Growth in Flood Risk of Buildings Housing Community-Based Providers



Source: FEMA, PLUTO, SK&A, DOHMH

deaths by exacerbating chronic conditions and inducing heat-related medical conditions, such as heat stroke. Heat waves are particularly life-threatening to elderly and medically fragile individuals who do not have air conditioning in their homes. Even New Yorkers who do have air conditioning will be impacted if heat waves lead to widespread power outages. In addition, power outages from heat waves cause disruptions in the healthcare system citywide. Community-based providers would likely have to shut down until power is restored. Hospitals, nursing homes, and adult care facilities would not need necessarily to evacuate immediately, provided they had backup generators to maintain adequate cooling capacity. However, today the vast majority of these facilities do not have backup power for cooling of their inpatient units.

Sudden downpours and wind are unlikely to have a significant impact on healthcare providers, particularly as facilities with the most vulnerable patients (for example, hospitals) are required to have greater structural resiliency than regular commercial buildings. However, specific facilities may be at risk depending on their site drainage capacity for heavy rains and their façade, window, and rooftop conditions.

This chapter contains a series of initiatives that are designed to mitigate the impacts of climate change on New York's healthcare system. In many cases, these initiatives are both ready to proceed and have identified funding sources assigned to cover their costs. With respect to these initiatives, the City intends to proceed with them as quickly as practicable, upon the receipt of identified funding.

Meanwhile, in the case of certain other initiatives described in this chapter, though these initiatives may be ready to proceed, they still do not have specific sources of funding assigned to them. In Chapter 19 (*Funding*), the City describes additional funding sources, which, if secured, would be sufficient to fund the full first phase of projects and programs described in this document over a 10-year period. The City will work aggressively on securing this funding and any necessary third-party approvals required in connection therewith (i.e., from the Federal or State governments). However, until such time as these sources are secured, the City will proceed only with those initiatives for which it has adequate funding.

In the aftermath of Sandy, temporary boilers were used at NYU Langone Medical Center. Credit: FEMA

To preserve the health and well-being of all New Yorkers, the City's healthcare system must maintain sufficient capacity to meet patients' needs during disasters and be prepared to resume normal services as quickly as possible. To this end, the City will require flood-prone hospitals, nursing homes, and adult care facilities to provide redundancies for critical systems and prevent physical damage to equipment. These facilities account for almost 90 percent of all inpatient and residential bed capacity at risk of flooding. If successfully mitigated, they can stay open and ensure that system capacity is not heavily strained during disasters. The remaining residential bed capacity at risk of flooding is spread across many smaller providers citywide. The vulnerability of these providers to climate risks is typically best addressed through emergency planning and other operational solutions, especially because physical protection of these facilities may be too difficult and not cost-effective given building and physical constraints.

Since community-based providers are located citywide, most will not be affected by flooding from extreme weather events. However, those impacted will be highly concentrated in hard-hit communities. The City will, therefore, work with clinics and pharmacies to implement targeted mitigation in areas where services may be most needed after a disaster. To further reduce barriers to the restoration of community-based care, the City will also call upon outpatient providers to consider technology-based mitigation strategies that are appropriate to their scale and allow for faster recovery.

Furthermore, measures to increase the resiliency of citywide power, transportation, and water systems will ensure that community-based and home-based providers can recover the resources that they depend on most as quickly as possible. (See Chapter 6, *Utilities*; Chapter 10, *Transportation*; and Chapter 12, *Water and Wastewater*)

Strategy: Ensure critical providers' operability through redundancy and the prevention of physical damage

Hospitals, nursing homes, and adult care facilities rely on extensive equipment and utility services to diagnose, treat, and care for patients. Basic utilities (such as power and water supply); building equipment (heating, ventilation, air conditioning, and elevator systems); medical equipment (diagnostic labs, X-ray machines, and medical gas tanks); and other services (such as kitchens and laundry rooms) are all integral to normal patient care. Much of this equipment is located in the facilities' lower levels, which are at risk of flooding during extreme weather events. Fortunately, providers have operational plans and workarounds for many of these systems in case of disruptions.

However, some systems—power, water, heating, and air conditioning—require both operational planning and physical hardening to be made more resilient. These systems are the foundation of a facility's medical infrastructure and are essential for the operation of all other services and equipment, including emergency operations. Without these critical systems, providers cannot ensure safe patient care and may be forced to evacuate. Furthermore, severe damage to these systems can result in long-term closures as repairs can often take several months.

Therefore, the City will amend its Construction Codes to require new and existing healthcare providers to take actions that ensure critical building systems are physically protected from the impacts of extreme weather, and—to address outages—are supplied with backup systems. The City also will provide financial assistance to support the mitigation projects of providers who have limited funding sources. These new resiliency measures will minimize the risk of evacuating patients and keep important healthcare facilities open for the benefit of all New Yorkers.

Initiative 1
Improve the design and construction of new hospitals

New hospitals that are constructed in the floodplain could experience critical system failures due to storm surge and may be at risk of evacuating patients. To improve the resiliency of any new hospital that is built in the 500-year floodplain, the City will, therefore, amend its Construction Codes to require a higher level of protection and critical systems redundancy.

For example, new hospital buildings will be required to meet construction code standards for flood-resistant construction to the 500-year flood elevation, which is a higher than the 100-year flood elevation to which protection is required today. Protecting utilities and mechanical equipment to this higher flood level will ensure that new hospitals—which are expected to serve the city for many decades—will be protected even as climate change increases flood risk.

Credit: FEMA

Submarine doors can be used to protect building equipment in lower floors.

In addition, the City will institute new resiliency requirements related to electronic data and communications technologies, which play an increasingly central role in patient care. New hospitals in the 500-year floodplain will be required to increase their IT and telecommunications resiliency by installing two independent points-of-entry for telecom and communication to reduce the risk of outages from a single supplier.

Backup options are crucial to ensure that critical systems can function and long-term closures can be avoided. New hospitals will, therefore, also be required to be built with pre-wired electrical connections for external emergency power generators as well as for temporary boiler and chiller connections if the primary equipment is below the 500-year flood elevation. In addition, new hospitals in the 500-year floodplain will be required to ensure that air conditioning services to their inpatient care areas are available when utility power is disrupted (for example, by placing chiller systems on emergency power). Having an air conditioning solution that is not dependent solely on primary utility power will help avert evacuations. These measures will ensure that providers do not incur high costs later for damages, repairs, or retrofits. The Office of Long-Term Planning and Sustainability (OLTPS) will include the proposed amendments to the New York City Construction Codes in its broader proposal to the New York City Council in the latter half of 2013.

Initiative 2

Require the retrofitting of existing hospitals in the 500-year floodplain

Many existing hospital buildings in the floodplain remain vulnerable to the impact of storm surge. To improve the resiliency of these buildings, the City will require existing hospital buildings in today's 500-year floodplain to meet, by 2030, a subset of the amended New York City Construction Codes standards through building retrofits.

This mandate will apply to the eleven hospitals that are, as indicated by the PWMs, in the floodplain. They will be mandated to protect their electrical equipment, emergency power systems, and domestic water pumps to the 500-year flood elevation by elevating the equipment, hardening equipment in place (for example, through the use of submarine doors), or dry flood-proofing basements and lower floors. They will also be required to ensure that emergency power systems—generators and fuel pumps—are accessible to building staff at all times, so that emergency power can be maintained continuously, even during flood conditions.

As with new hospitals, existing hospitals will also be required to install by 2030: Backup air conditioning service for inpatient care areas in case of utility outages (for example, chillers on emergency power); pre-connections for temporary boilers and chillers if primary equipment is not elevated; and pre-connections for external generators as a backup power source in case the hospital must run on emergency power for extended periods. These redundancies will provide an additional level of protection for hospitals' most critical services, and thus, will help avert evacuation in the event that primary equipment is breached or permanently damaged.

Many providers have already met several of these requirements. For example, many hospital generators are elevated today. In addition, providers generally acknowledge that power, emergency power, and water are necessary for them to remain operational, and investments in flood mitigation are needed to minimize future evacuation risk. Accordingly, many providers already have made plans to address these risks. To avoid placing an undue financial burden on providers, hospitals will not be mandated to retroactively protect other critical systems and services (such as emergency departments, elevators, lab equipment, telecommunications, IT, and medical equipment) for which other workarounds can be implemented. Never the less, protection for these systems still will be encouraged as a best practice especially since they could be essential for some facilities to remain in operation, depending on their layout and unique risks.

OLTPS will include these retrofit requirements in its broader proposal to the New York City Council in 2013. The City will enforce compliance with this mandate by 2030 (recognizing compliance to be voluntary for hospitals owned by the State or Federal government). As part of this process, by the end of 2020, hospitals will be required to submit an interim report certifying that they have complied with the requirements or to submit an affidavit describing a plan to achieve such compliance by 2030. Hospitals added to the floodplain in future versions of flood maps will have 15 years from the release of such new maps to implement retrofits.

Initiative 3

Support the Health and Hospitals Corporation's (HHC) effort to protect public hospital emergency departments from flooding

Emergency departments (EDs) are critical access points for patients in need of hospital services. Three public hospitals' EDs are at risk of flooding due to storm surge. Subject to available funding, the City will aim to ensure these EDs are protected and available to care for New Yorkers. Bellevue Hospital (Manhattan), Metropolitan Hospital (Manhattan), and Coney Island Hospital (Brooklyn) are operated by the New York City HHC, which serves all New Yorkers, regardless of their ability to pay. With EDs located below the 500-year flood elevation, direct flood damage would cause the EDs to be closed for months, as equipment, walls, and floors would need to be replaced. Extended closures would require patients to travel longer distances to receive care, and other providers to accommodate additional volume.

Bellevue Hospital has the only designated regional trauma center below 68th Street in Manhattan. The City will pursue a coastal protection pilot project, subject to available funding, which includes measures to address the flood risk to Bellevue's ED. Mitigation options under consideration include floodwalls and ramps. The City will also support HHC's on-going efforts to work with the State and Federal governments to identify mitigation solutions and funding sources that allow its other EDs to be protected from flooding. Current options being explored include elevating Coney Island Hospital's ED and other critical building systems above the 500-year flood elevation and installing temporary or permanent floodwalls around Metropolitan Hospital's ED and campus *(see* Chapter 3, *Coastal Protection)*.

Initiative 4

Improve the design and construction of new nursing homes and adult care facilities

New nursing homes and adult care facilities are at risk of power service failures due to storm surge, which could result in patient evacuations. To address this risk, the City will amend its Construction Codes to require that new facilities be constructed with additional resiliency measures for their emergency power systems, which are essential to allow staff and patients to shelter in place safely during a disaster. Power in these residential facilities is needed not only for standard operational requirements—such as lighting, elevators, use of medical equipment, and communications—but also for essential emergency operations such as pumping floodwater out of basements if flood protection fails.

New nursing homes are already required to have emergency generators, but because generators can fail when used for an extended period of time, facilities will now be required to have in place an electrical pre-connection for an external stand-by generator. The ability to switch electrical systems over quickly to a stand-by generator can reduce significantly the likelihood of emergency evacuations during or after a disaster.

Meanwhile with respect to adult care facilities, they are not currently required by the State or City to have any emergency power systems. Their residents are more ambulatory and less fragile than nursing home patients but, nevertheless, require care and living assistance that is dependent on working electricity. For this reason, the City will require new facilities to install either an emergency generator that is adequately protected or pre-connection to an external stand-by generator. OLTPS will propose these requirements for new nursing homes and adult care facilities to the City Council in the latter half of 2013.

Initiative 5

Require the retrofitting of existing nursing homes in the 100-year floodplain

Among all the critical systems that nursing homes rely on for normal operations, power and water are the most essential during emergency conditions because they are required for so many other services such as heating, air conditioning, sanitation, and elevator services.

The City will therefore require existing nursing homes in the 100-year floodplain which, as indicated by the PWMs, includes 18 facilities (11 percent of the citywide bed capacity), to meet standards by 2030 for the protection of electrical equipment, emergency power systems, and domestic water pumps (if applicable) retroactively pursuant to changes in the City's Construction Code. These systems will be protected to the 100-year flood elevation, in accordance with specifications already in the New York City Construction Codes.

OLTPS will propose these requirements to the City Council in the latter half of 2013. The City will enforce compliance with this mandate. As part of this process, by the end of 2020, nursing homes will be required to submit an interim report certifying that they have complied with the retrofit requirements or to submit an affidavit describing a plan to achieve such compliance by 2030.

Because it may be difficult for some nursing homes to secure the financial capital needed for retrofit projects, a financial assistance program will be launched by the City, subject to available funding (see Initiative 7). Nursing homes that are added to the floodplain with the release of future flood maps will be required to comply within 15 years of such new flood maps going into effect.

The Shorefront Center in Southern Brooklyn was constructed nearly 30 feet above ground. Credit: MJHS

Shorefront Center During Sandy

Built in 1994, the Shorefront Center for Rehabilitation and Nursing Care, in Southern Brooklyn, was designed to comply with building code requirements for flood-resistant construction due to its proximity to the ocean. Having been built to exceed the 500-year flood elevation by three feet, the entire facility is elevated nearly 30 feet above ground, with parking spaces below. All of the building's systems and equipment are also elevated and thus protected from floodwaters. The emergency power supply is furnished with enough capacity to run medical equipment, elevators, and heating, ventilation, and air conditioning (HVAC) systems to ensure the facility can continue to operate during power outages. Furthermore, the elevated first floor houses only the lobby and other support services. Community and administrative space is located on the second floor, while residents' and patients' rooms start on the third.

During Sandy, the building functioned as planned. At the peak of the storm, floodwaters filled the parking area and reached the lobby door, but did not enter the building. Emergency power generators remained safe and supplied backup power for four days while area-wide power was out. The nursing home's emergency plans for food and medical supplies allowed staff and patients to shelter in place despite limited transportation for incoming supplies. Shorefront was not only able to provide continuous care to its residents during and after Sandy, but it also assisted people from the local community who sought food and shelter.

Initiative 6

Require the retrofitting of existing adult care facilities in the 100-year floodplain

Over 25 percent of citywide adult care facility bed capacity is in the 100-year floodplain (within 19 facilities) and is at risk of power outages due to storm surge. Many of these facilities have their electrical equipment in lower levels where it is vulnerable to flooding. Furthermore, these facilties are also at risk of power outages during heatwaves. In either case, power outages would increase the risk of emergency evacuations. The City will, therefore, require existing adult care facilities located in the 100-year floodplain to elevate or protect their electrical equipment to the 100-year flood elevation, in accordance with the specifications applicable to new buildings in the New York City Construction Codes. In addition, these providers will be required to install an emergency generator that is adequately protected in their facilities. Alternatively, they may install an electrical pre-connection to an external generator,

At Shore View Nursing Home in Brighton Beach, an emergency generator was moved from the basement and elevated on a raised platform. Credit: Shore View Nursing Home

provided they have an operational plan in place that allows them to access an external generator quickly during an emergency (through, for example, regular contracts with suppliers).

OLTPS will propose these requirements to the City Council in the latter half of 2013. The City will enforce compliance with this mandate. As part of this process, by end of 2020, adult care facilities will be required to submit an interim report certifying that they have complied with the retrofit requirements or an affidavit describing a plan to achieve such compliance by 2030. As with nursing homes, adult care facilities will be eligible for financial support, subject to available funding, to comply with the mandate (see Initiative 7). Moving forward, facilities that are added to the floodplain with the release of future flood maps will be required to comply within 15 years of the new flood maps going into effect.

Initiative 7
Support nursing homes and adult care facilities with mitigation grants and loans

The primary obstacle for most nursing homes and adult care facilities in implementing mitigation measures is financing the investment.

Subject to available funding, the City, through DOHMH and the New York City Economic Development Corporation (NYCEDC), will, therefore, administer competitive grants and subsidized loans to assist providers with the upfront costs of certain mandated retrofit projects.

Most nursing homes and adult care facilities receive the majority of their revenue from publicly funded programs such as Medicaid, Supplemental Security Income, or Safety Net Assistance. Typically, reimbursement rates from these programs are not sufficient to enable nursing homes and adult care facilities to invest in costly mitigation projects that do not impact day-to-day care directly. If any capital investments are made, some nursing homes may receive Medicaid reimbursements for a portion of their mitigation costs; while other providers may not be reimbursed.

To qualify for the program, nursing homes and adult care facilities will be required to demonstrate financial need, emergency preparedness planning, and an operational commitment to remain safely open during disasters or reopen quickly thereafter. Eligible mitigation will include retrofits to meet amended building codes (see Initiatives 5 and 6) and wet flood-proofing of walls and floors below the 100-year flood elevation to limit damage from mold. The goal is for NYCEDC and DOHMH to launch the program, capped at $50 million citywide, when the proposed building code amendments for nursing homes and adult care facilities go into effect.

Initiative 8
Increase the air conditioning capacity of nursing homes and adult care facilities

Nursing homes and adult care facilities today typically do not have enough emergency power capacity to run their air conditioning systems. Thus, some providers could be forced to evacuate during power outages that occur in hot summer months. To reduce this risk, the City will seek a sales tax waiver for 100 nursing homes and adult care facilities citywide to install emergency power solutions for their air conditioning systems. This benefit, which will be capped at $3 million citywide, will only be available to those facilities eligible for such benefits under state law. Eligibility criteria for this program will be announced over the next year and will, among other things, include demonstrated financial need.

At Shore View Nursing Home in Brighton Beach, a cement wall protects vents for boilers and chillers from over 5 feet of storm surge. Credit: Shore View Nursing Home

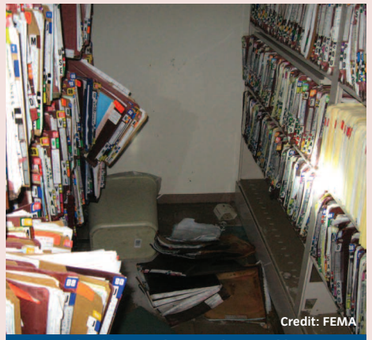
Strategy: Reduce barriers to care during and after emergencies

Additional initiatives, spearheaded by the City in collaboration with healthcare associations and providers, will ensure that community-based providers in the healthcare system can provide limited but critical services under emergency conditions and restore normal services as quickly as possible after a disaster. The City's goal is to improve the resiliency of the community-based provider network so that even in the hours and days immediately after a disaster, when other local businesses are still recovering, healthcare providers can offer essential services to New Yorkers with the greatest need for care.

Initiative 9
Harden primary care and mental health clinics

In communities that are at risk of extensive flooding, the accessibility of primary care and mental health services may be compromised for weeks after a disaster due to extended facility closures. Ensuring that local clinics can reopen quickly to provide primary care, mental health counseling, and other medical services in high-need communities is important for the health and safety of residents and will address the concentrated impact of storm surge.

Subject to available funding, the City, through DOHMH and a fiscal intermediary, will therefore disburse grants and interest-free loans to five to six providers that serve large outpatient populations in communities where medical services may be reduced significantly because of extreme weather events. These capital investments will enable faster recovery of services—for example, via installation of emergency power systems, protection of other critical building systems, and wet floodproofing of facilities. The goal is to launch an application process during the next year. The selection process will prioritize clinics that offer a broad scope of medical services, and demonstrate adequate emergency operations plans.



Patient health records were damaged by floodwaters. Credit: FEMA

Initiative 10
Improve pharmacies' power resiliency

Pharmacies dispense life-saving drugs. However, without power, pharmacists cannot access the necessary patient records or insurance information to dispense these drugs. For retail pharmacies that do not sustain structural building damage, generators allow providers to restore the most critical building services they need to reopen. With an emergency power supply, pharmacies can access patient records, receive calls from doctors about new prescriptions or refills, and communicate with insurers and payers for billing purposes. To reopen with emergency power, pharmacies also will need to have robust emergency operations plans ensuring staff transportation and the delivery of supplies to the facility. For New Yorkers who depend on regular prescriptions, quick restoration of pharmacy services is critical.

DOHMH will, therefore, work with other agencies, including Office of Long-Term Planning and Sustainability, the Office of Emergency Management, the Department of Transportation, the Department of Buildings, the Department of Environmental Protection, and pharmacies to assist pharmacies to reopen quickly after a disaster. DOHMH will explore issues such as installing pre-connections for external generators, identifying a central emergency point of contact, permitting, and emergency operations planning. By the end of 2013, DOHMH will launch an emergency preparedness website for pharmacies.

Initiative 11
Encourage telecommunications resiliency

In the aftermath of a disaster, it is important that New Yorkers be able to speak to their doctors for guidance on needed medical care. While in-person visits are ideal for diagnosing and treating health concerns, a phone consultation can be extremely valuable in addressing many patients' needs after a disaster.

For example, a telephone conversation allows a trusted doctor who is familiar with a patient's medical history and specific health conditions to help with post-disaster anxiety, answer health-related questions, perform initial triage of medical concerns, refill prescriptions, or direct patients to alternative providers and medical resources. Telecommunications resiliency is especially important for mental health providers who may need to support patients during the extremely stressful period after a disaster.

To this end, DOHMH is developing a best practice guide and outreach plan to help community-based providers understand the importance of telecommunications resiliency as well as the options they might consider and questions to ask when evaluating solutions. Resiliency solutions could include using backup phone systems (such as a remote answering service that would not be affected by local weather hazards), Voice over Internet Protocol (VoIP) technology that allows office phone lines to be used off-site, and pre-disaster planning to inform patients of available emergency phone numbers. DOHMH will continue to develop the informational materials through the remainder of 2013.

Initiative 12
Encourage electronic health record-keeping

Doctors rely on patients' medical records to provide and track care, but these important records may be compromised or destroyed due to flooding. Damage to paper records results in the loss of valuable patient information, which may impact care. In addition, the specialized disposal of this sensitive material once damaged can result in high waste removal costs.

Electronic Health Records can help prevent the permanent loss of data and allow for quick restoration of services after a disaster. However, even EHR systems need to be implemented with operational resiliency in mind. For example, providers might want to ensure that they can still access patient information even if they cannot occupy their offices. In addition, providers must ensure that computers and servers are not located on floors where they may be flooded. Their vendors' servers must also be protected from flood risk.

DOHMH's Primary Care Information Project (PCIP) sponsors numerous initiatives to help primary care and mental health providers citywide with EHR technical assistance for their practices. Moving forward, PCIP programs will highlight the ways in which EHR can be used to prevent permanent loss of data and quickly restore services after a disaster. PCIP will target providers, in the floodplain, that can benefit significantly from transitioning to EHR, with specific guidance on how EHR should be implemented for maximum effectiveness in flood hazard mitigation.

Running on generator power, a temporary pharmacy in a double-wide trailer served customers in Sheepshead Bay, Southern Brooklyn. Credit: DuaneReade

Community Preparedness and Response

City employees from a variety of agencies coordinated with communities and volunteers.

Credit: Dave Seliger/OEM

Friends and family, neighbors down the block, and even strangers living in another borough—thousands of New Yorkers stepped up to help others during and after Sandy. This response was not only impressive; it has been critical to the recovery and rebuilding of hard-hit neighborhoods. The collaboration amplified the City's ability to address community needs.

Of course, community involvement should not be limited to disaster response. It also must extend to disaster preparedness, including efforts to improve communications in advance of an event that is reasonably foreseeable, such as extreme weather. During Sandy, the City launched an unprecedented campaign to warn New Yorkers of the impending storm. The City's Office of Emergency Management (OEM) sent electronic alerts to more than 165,000 residents, and NYC.gov provided information to four million unique visitors.

During Sandy, community leaders helped by reinforcing or tailoring messages to local populations, including both residents and business owners. For example, these leaders supported evacuation orders and encouraged companies to elevate valuable inventory and equipment.

But of course, community preparedness and response is most effective when it is coordinated closely with City activities, as facilitated by NYC Service and other City agencies. This requires the best possible information flows—from communities to the City, and from the City to communities.

Nowhere is information flow from communities to the City more important than with regard to vulnerable populations such as the elderly, sick, and disabled who may have a limited ability to help themselves or even to seek help from others. That is why, prior to the arrival of Sandy, representatives of the City's Human Resources Administration (HRA), the Department for the Aging (DFTA), and the Administration for Children's Services (ACS) worked around-the-clock with their partner service providers to contact clients to advise them of safety protocols.

After the storm, however, these and other agencies found it challenging to confirm that known vulnerable clients were well, due to displacement, telecommunications failures, and other reasons. Although certain agencies had access to databases with client information, in some cases, legal and technical barriers prevented the sharing of lists across agencies. Although, ultimately, City agencies and community-based organizations conducted outreach that located and served thousands of vulnerable individuals, the lack of a consolidated and accessible information source made this task both slower and more difficult than it should have been. In recognition of these issues, the City's *Hurricane Sandy After Action Report*, released in May 2013, called for "better integration of the City's data across all platforms and agencies to increase situation awareness and allow for more targeted, efficient response and recovery operations."

Delivery of emergency relief supplies

Credit: OEM

Although improving the City's access to information would be an important start, the City also needs the ability to push information out in a targeted fashion to threatened or impacted communities. Today, the City's Housing Maintenance Code authorizes the Department of Housing, Preservation, and Development (HPD) to require the registration of tenant-occupied residential properties, including basic contact information such as emergency telephone numbers. However, during Sandy, several deficiencies emerged. For example, HPD does not have the legal authority to require 1- and 2-family owner-occupied homes to provide emergency contact information. Moreover, existing law prohibits HPD from sharing emergency contact information with any other entity, including other City agencies engaged in emergency preparedness and response. These and other issues hampered the City's ability to communicate information in a targeted fashion.

As the City strives to become more resilient through investments in its buildings and infrastructure, it also must continue to call upon communities to play a key role in emergency preparedness and response. The *After Action Report* outlines a series of strategies for accomplishing this goal. In addition to these robust strategies, in this report, the City also proposes two more ways of engaging communities: the development of a pilot community needs assessment and action plan for increasing local capacity, and an expansion of OEM's existing Community Emergency Response Teams (CERT). In addition, the City will pursue two measures to improve agencies' abilities to gather data from and disseminate information to communities on a real-time basis prior to, during, and after extreme weather events and other disasters.

Initiative 1

Launch a pilot program to identify and address gaps in community capacity

The local capacity to organize and support residents and businesses varies greatly from neighborhood to neighborhood. The City learned from Sandy that neighborhoods with higher community capacity tended to prove more resilient. Subject to available funding, the City will conduct a pilot community needs assessment in one to-be-identified Sandy-impacted community. Upon selection of the applicable community, OEM and the City's Center for Economic Opportunity (CEO) will work with local residents to identify community strengths and needs and develop a set of recommendations for improving local preparedness and response capacity before, during, and after an extreme weather event. Following this "gap identification process," the City and the community subsequently will develop and implement a plan—as well as seek philanthropic and other potential funding sources—to address identified needs. The goal is to launch this pilot in 2013, and subsequently to explore expanding it to other neighborhoods if additional funding becomes available.

Initiative 2

Continue and expand OEM's Community Emergency Response Teams

OEM currently oversees the CERT program, comprised of well-trained volunteers that support individuals, families, and local organizations in their communities with emergency education, preparedness, and response, including assisting first responders. Several vulnerable neighborhoods, however, are underrepresented—with small CERT teams or none at all. In the wake of Sandy, the City will expand CERT, with an initial focus on Red Hook and the New York City Housing Authority's Red Hook Houses. In addition, as referenced in the *After Action Report*, the City will expand EmergeNYC, a volunteer program run by NYC Service. This program prepares large numbers of local volunteers to support impacted communities with high-impact tasks such as food distribution following a disaster. In addition, OEM and NYC Service, working with CEO, will pursue opportunities for low-income young adults to become engaged in the City's disaster-

Relief kits awaiting distribution to families in Red Hook

Credit: RDeLetto/Flickr

preparedness efforts. This will be done as part of a subsidized jobs program, such as NYC Recovers, and will provide participating young adults with a formal leadership role in their communities. Finally, OEM currently is piloting a simplified disaster response workshop for participants in the Neighborhood Leadership Institute, a program run by the Mayor's Office of Immigrant Affairs and the New York City Community Trust in partnership with the Citizens Committee for New York City, to provide skill-building sessions for emerging immigrant leaders. If successful, the City will seek additional funding to replicate this training.

Initiative 3

Expand the Worker Connect information technology tool to serve as an Emergency Services Portal

Existing technical and legal barriers to information sharing limit the ability of City agencies to access limited but critical information about vulnerable populations, including the name, address, age, and medical condition of these individuals. Improving access even to this limited set of information could result in dramatic improvements to the City's ability to identify and respond to urgent needs during extreme weather events. Subject to available funding, the City, acting through the Office of the Deputy Mayor for Health and Human Services, will seek to expand the existing Worker Connect information technology tool to perform this critical function. Worker Connect currently provides access to select client information from data sources across five City agencies: HRA, ACS, the Department of Finance, the Department of Homeless Services, and the New York City Housing Authority. The City will seek to enhance Worker Connect with a new Emergency Services Portal, with access to a number of additional agency, nonprofit, and private data sources, subject to a review of legal and privacy considerations. The City also will seek to strengthen the functionality of Worker Connect's Emergency Services Portal by adding new reporting capabilities. Finally, the use of unique identifiers such as a Building Identification Number will allow this system to interrelate to other datasets or programs, as appropriate based on a legal and technical review of the desirability and feasibility of such connectivity. The goal would be to launch the effort in 2013, with full development expected to last up to four years.

Initiative 4

Explore the creation of a new online Emergency Notification Contact System

Although HPD's existing tenant contact data collection system is a useful tool, with certain improvements it could expand into a far more robust preparedness and response communication system. Subject to available funding, the City, through HPD, will explore the creation of an online Emergency Notification Contact System (ENCS) that would be distinct from, but complementary to, the existing mandatory housing registration system. Although a local law would be required to make participation in the ENCS mandatory, in the interim, HPD will pursue the creation of a voluntary database. This database would include not only basic and emergency contact information (including for 1- and 2-family homeowners), but also supplementary details where possible—including, for example, the availability of emergency generators, the type of building heating system, information regarding vulnerable populations, and other relevant information. The ENCS also could include the ability to receive electronic updates from registrants and to push messaging to targeted subsets of registrants. The system should have the capability to integrate not only with other HPD systems but also with other City databases for emergency purposes. Upon receipt of the necessary funding, HPD would manage the system's development, implementation, and maintenance, while working with other agencies to identify the requisite data and to provide access to those other agencies where appropriate and permissible. HPD also would work with the City Council to consider mandating participation in the ENCS.

NYC Service volunteers participating in beach cleanup

Telecommunications

Someone makes a call from a cell phone in Manhattan to a house on Staten Island. That call follows a circuitous path. The call connects to a cell site atop a private building, runs through cables under the street, navigates three separate telecommunications switching facilities, and continues through miles of underground and overhead cables. When the call finally reaches the house on Staten Island, it has been controlled by at least two phone providers, it has operated under the authority of at least three government regulators, and it has relied on the seamless operation of a vast network of equipment.

Clearly, telecommunications in New York City, as elsewhere, are complex. And, of course, they cover more than phone calls, encompassing Internet and cable television services as well. All of these telecommunications services rest on a vast infrastructure of over 50 thousand miles of cabling, thousands of cell sites, and nearly 100 critical facilities. This telecommunications infrastructure not only serves New York's population of 8.3 million residents, it also serves the city's 3.9 million workers, 250,000 businesses, and 50 million annual visitors. The city's telecommunications infrastructure plays a critical global role: it is estimated that New York City accounts for approximately 3 percent of the world's web traffic—even as the city serves as home to only 0.1 percent of the world's population.

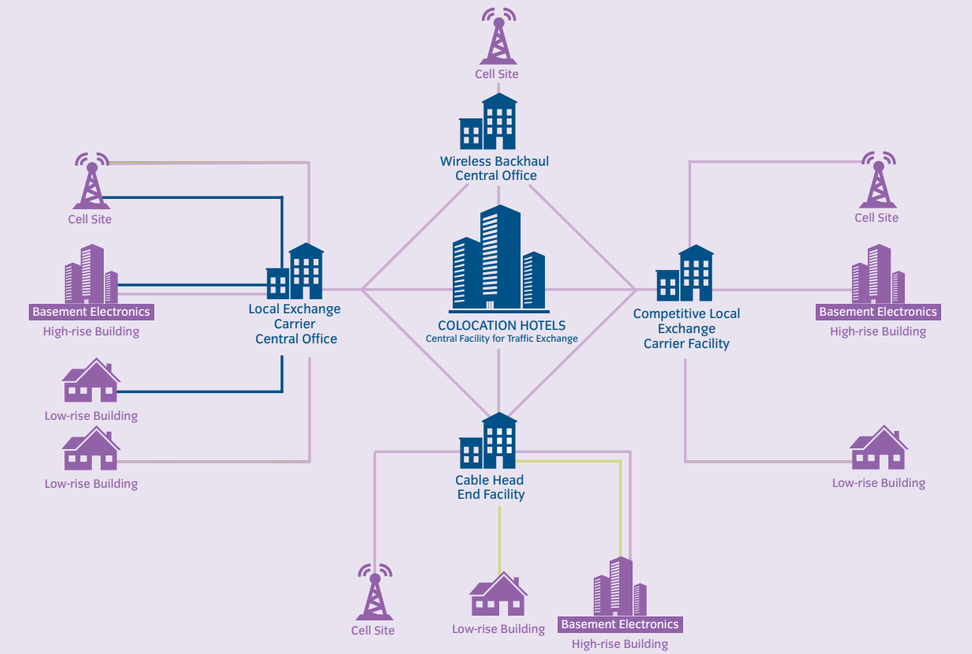
In the city's increasingly information-based economy—which depends on quickly accessing and exchanging information—telecommunications keep our city running. The finance industry depends on these services to process transactions. Small businesses rely on them to receive orders and contact customers. New Yorkers use them for everything from getting news to communicating with friends to buying food—whether ordering from favorite neighborhood takeout restaurants or paying for groceries through food assistance programs such as Electronic Benefits Transfer (EBT).

Telecommunications also are increasingly important to New Yorkers' health and public safety. Particularly for vulnerable populations during emergencies, being able to send a text to a family member or make a 911 call can be the difference between getting help and being stranded or worse. As hospitals and other healthcare providers transition to electronic medical records, connectivity is becoming even more essential to our healthcare system.

Competition across New York City's telecommunications market is robust, with multiple providers delivering overlapping services. New York City is served by four cable TV providers, the four major national wireless providers (Verizon, AT&T, T-Mobile, and Sprint), and over a dozen competitive local exchange carriers providing telephone and other services.

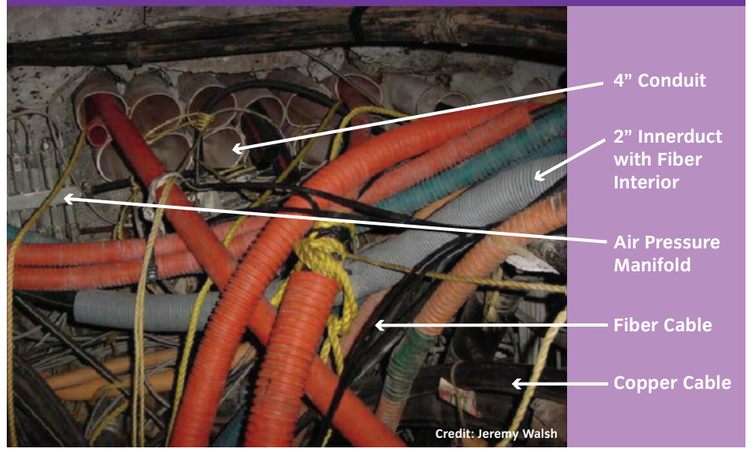
Nonetheless, improvements are needed. Sandy exposed weaknesses in the city's telecommunications infrastructure—including the location of critical facilities in areas that are susceptible to flooding. In Southern Manhattan and the Rockaways, the storm caused

Components of the Telecommunications System



CABLE TYPE	PERIOD IN USE	LAST INSTALLED	RESILIENCY
Copper Cables	1910s to present	Lead sheath cable until 1970s; plastic sheath still being installed	Vulnerable to flooding
Coaxial Cables	1950s to present	Still being installed	Difficult to troubleshoot; more resilient than copper
Fiber Cables	1970s to present	Still being installed	Most resilient cable; slowly replacing others

Underground Cable and Conduit



neighborhood-wide outages that lasted up to 11 days—and for those buildings that suffered inundation, restoration of service took well over three months in some places.

In keeping with the broad goals of this report—which are to minimize disruptions from climate hazards and to increase the New York's capacity to bounce back quickly if damage is sustained—the City's plan should enhance the resiliency of the telecommunications system. The City will advocate that a base level of telecommunications service is available and accessible throughout New York at all times for emergency communication, and will work toward quick restoration of full telecommunications services when disruptions do occur. The City will do this by increasing the accountability of telecommunications providers to invest in resiliency and by using new regulatory authority to enable rapid recovery after extreme weather events, to harden facilities so as to reduce weather-related impacts and to create redundancy to reduce the risk of outages. While competition may drive better service and resiliency in some areas, the City must take an active role in making the telecommunications infrastructure more resilient in all parts of New York.

How the Telecommunications System Works

Telecommunications services—telephone, wireless, Internet, and cable—are delivered from interconnected central facilities that transfer data among one another and then send that data back out over a network of cables to end users in their homes and offices or on mobile devices. All components of this infrastructure need to be functioning along the entire route for a call, text message, email, or other type of data to be sent successfully from one point to another.

Components of the Telecommunications System

The telecommunications system is comprised of four main components: critical facilities, cabling, cell sites, and equipment in individual buildings. *(See graphic: Components of the Telecommunications System)*

Critical telecommunications facilities are larger distribution and switching centers. They provide connectivity across all major services and each supports tens of thousands of customers. These critical facilities include telephone central offices; "colocation" hotels, which are secure physical sites or buildings where data are transferred from one provider to another; and cable "head ends," the facilities that distribute cable TV and Internet services to subscribers. Providing round-the-clock services, these critical facilities have back up batteries and fuel-powered generators, and they are environmentally controlled to keep electrical equipment safe from excessive humidity and overheating.

Cabling provides the connections essential to telecommunications and can be strung overhead via utility poles or can run underground. New York's oldest cabling is lead-encased copper, with sections ranging from 10 to 90 years old. The copper network is in poor condition due to its age. Many cables have leaks, compromising the pressurized air system designed to keep water away from copper wiring. Coaxial cable is a newer material that is somewhat resistant to water and is primarily used for cable TV and Internet services. Fiber cable is the newest and most resilient type of cable, being both fully water-resistant and able to carry all types of service.

Conduit, an underground pipe through which cable is threaded, is the way most cable snakes beneath New York City. While it is more expensive to construct than overhead wires, it is also more protected and less intrusive. Conduit is used in the densest areas of the city—Manhattan, the Bronx, and parts of Brooklyn, Queens, and Staten Island. Manhattan and the Bronx have a shared conduit network run by Empire City Subway, a private company that is responsible for providing conduit infrastructure for providers in all areas of those boroughs. In the other boroughs, Verizon, Time Warner Cable, and Cablevision have the most extensive conduit infrastructure, some of which is rented to other providers. *(See graphic: Underground Cable and Conduit)*

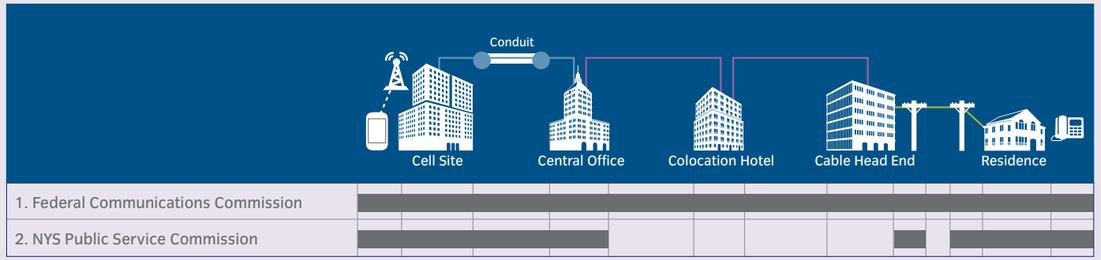
Cell sites are also key components of the telecommunications infrastructure. Unlike in rural areas, where cell sites often sit atop freestanding towers, cell sites in New York City are typically placed on the rooftops of buildings. Cell sites have three components: an antenna, electronics, and backhaul circuits—cables that connect the cell site to the larger telecommunications network. Backhaul circuits are generally copper or fiber optic cable, most frequently taking a single path back to central switching facilities. Most cell sites rely on power supplied by a utility, and have four to eight hours of battery backup.

The final piece of the telecommunications puzzle is the equipment in homes, offices, and other buildings that distributes signals transmitted via cabling from critical facilities to individual customers. This equipment ranges from electronic multiplexers in large buildings (usually found in basements) to terminals attached to the exterior of small residential buildings (positioned a few feet off the ground), to individual customers' modems.

Regulatory Framework for the Telecommunications System

Federal, State, and City agencies are involved in the regulation of the telecommunications industry. However, none currently has comprehensive responsibility for the entire system, and none is charged with ensuring that required service is available in emergencies. While the Federal Communications Commission (FCC) has a Communications Security, Reliability, and Interoperability Council that promotes best practices for resiliency, it does not require compliance with these standards.

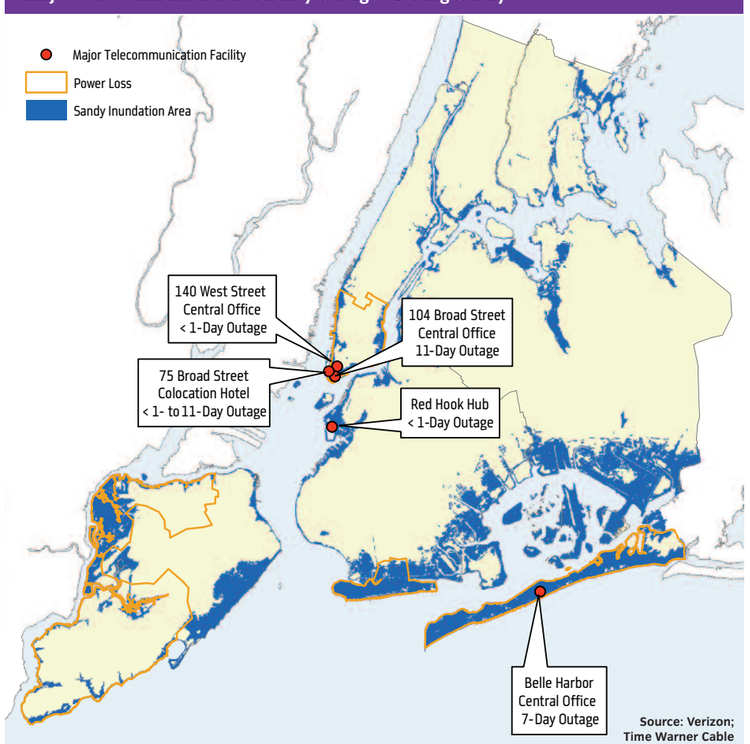
State and Federal Regulatory Authority Over a Call in New York City



The FCC has significant authority over wireless, long-distance phone, and Internet (including at least some aspects of "Voice over Internet Protocol," or VoIP) services. The New York State Public Service Commission (PSC) has significant authority regarding local traditional landline telephone service. Finally, the FCC, the PSC, and the City all share regulatory authority over cable TV service.

Three City agencies are involved in overseeing various aspects of the telecommunications infrastructure in New York City. Founded in 1994 to consolidate the City's information technology functions with its cable and telecommunications activities, the Department of Information Technology and Telecommunications (DoITT) is responsible, among other things, for purchasing and administering internal communications services for City agencies; for administering the franchises that allow communications companies to access public rights of way for their infrastructure—above and below the city's streets—and for collecting fees and other compensation for such access. The Department of Transportation (NYCDOT) also plays a role as manager of street access through its control of permitting for street construction. Finally, the Department of Buildings (DOB) is the custodian of the Building Code, which determines, among other things, the placement of electrical equipment, backup power, and fuel storage at critical telecommunications facilities. *(See graphic: State and Federal Regulatory Authority Over a Call in New York City)*

Major Telecommunications Facility Outages During Sandy

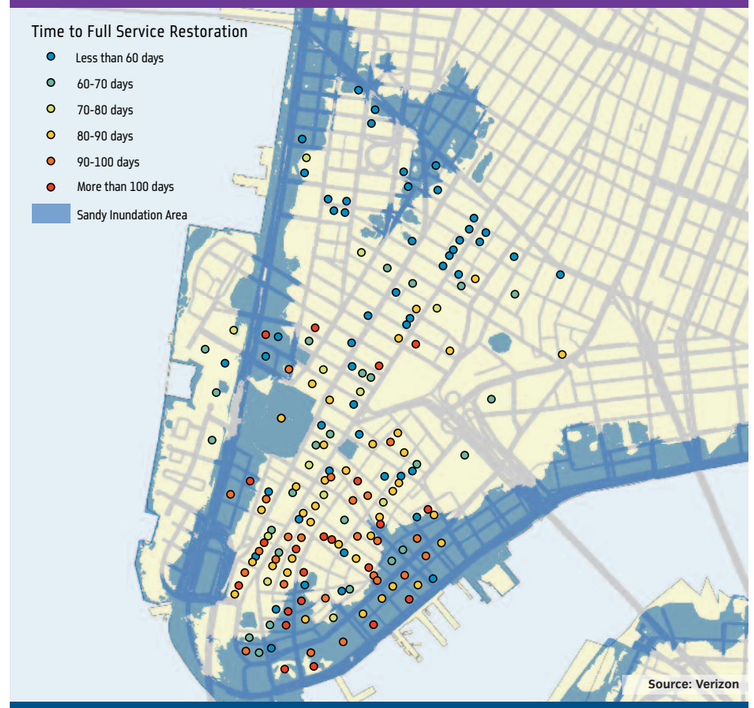


Source: Verizon; Time Warner Cable

In recent decades, evolving technology has led to shifting regulatory authority, as some services move out of one regulator's domain and into that of another. The transition from traditional wire-line phone service to phone service via fiber optic cable or Internet (VoIP) is a prime example. Consumers who make the switch from a landline phone service to VoIP move from a service that is regulated by the State to a service that is at least in part regulated at the Federal level. Not surprisingly, the popular bundled services offered by many providers have a particularly complex regulatory structure. A bundled voice, Internet, and cable package, for example, is regulated on both the local (cable) and Federal (Internet and VoIP) levels.

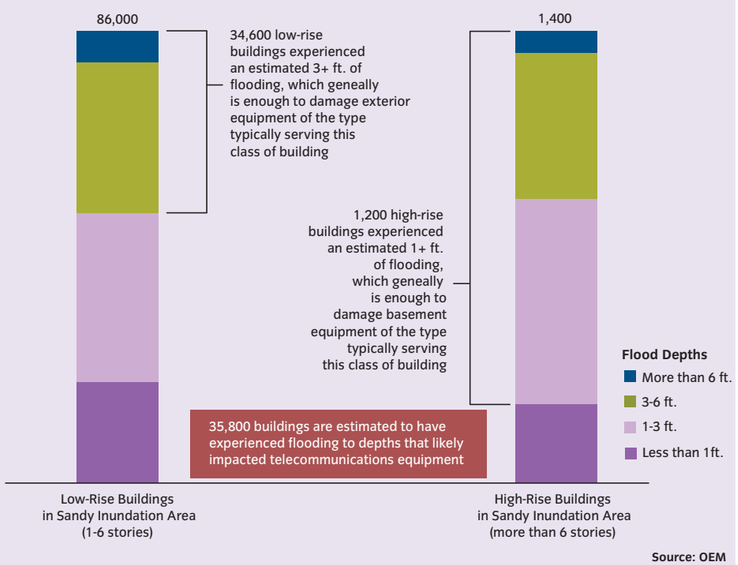
As a result of these overlapping jurisdictions, there is currently no single entity that is prioritizing or enforcing resiliency across the entire system. To ensure that changes in technology do not compromise public access and safety, a focus on creating a more resilient telecommunications system is crucial—especially as the effects of climate change are felt in New York City.

Sample of Telecommunications Service Restoration Times of Commercial Buildings in Southern Manhattan



High-rise commercial buildings that lost telecommunications service during Sandy took weeks or months to restore service because of damage to copper cables, and difficulties in restoring power and replacing flood-damaged equipment in individual buildings.

Estimated Flood Damage to Telecommunications Equipment in Buildings



Source: OEM

What Happened During Sandy

During Sandy, telecommunications outages followed the pattern of utility power outages and flooding. When utility power went out, it knocked out cable and Internet services in homes and businesses immediately. These power-driven telecommunications outages affected the greatest number of customers and were generally short-term. However, flood damage at critical facilities, in individual buildings, and to cable infrastructure led to longer-term outages.

The storm affected several critical facilities immediately. The loss of utility power required the use of backup power at central offices in Southern Manhattan, Staten Island, Southern Brooklyn, and the Rockaways.

At critical facilities in Southern Manhattan, Red Hook, and the Rockaways, flood damage to equipment and backup power systems caused service to go out in the areas they served. Flooding caused damage to electrical switchgear, backup generators, and fuel storage containers, particularly if they were housed in basements or sub-basements. The pumps in many of these facilities were not designed for the volume of corrosive salt water that inundated them—up to one million gallons of water at some sites. As a result, it took up to five days just to get the water out of some central offices, prompting some companies not just to repair but to redesign their facilities entirely. *(See graphic: Major Telecommunications Facility Outages During Sandy)*

Cable infrastructure experienced light outages as a result of wind damage to overhead wiring in Brooklyn, the Bronx, Queens, and Staten Island. In Southern Manhattan, the failure of the aging air pressure system caused widespread copper cable damage. The most impacted part of the city's cable infrastructure was the legacy copper network. When power failed in Verizon's central office at 104 Broad Street, the air pressure system that kept water out of its cables shut down, and the copper cables were infiltrated with salt water. Using the damage as an opportunity, Verizon swapped out its copper network for a more resilient fiber optic network. Though clearly a benefit to customers over the long term, the process required replacing equipment at all buildings served by the affected copper—even where flooding had not directly damaged a building's telecommunications equipment. This led to a loss of phone service over a wide swath of Verizon's service territory in Southern Manhattan, causing significant short-term disruption. *(See sidebar: A Tale of Two Central Offices)*

A Tale of Two Central Offices

140 West Street and 104 Broad Street

Central offices that "hardened," or protected, their equipment before the storm had shorter downtimes than central offices where equipment was left vulnerable to flooding. Two Verizon central offices in Southern Manhattan that flooded during Sandy illustrate this point. One office (at 140 West Street) had raised generators and electrical equipment after September 11 and as a result was able to restore service within one day of the storm. The other (at 104 Broad Street) had basement electrical equipment and generators that were completely flooded, knocking out service there for 11 days. Restoration of service to other buildings took significantly longer, with some buildings not restored even six months after the storm. The lesson learned: investment in resiliency works.

140 West Street Central Office	104 Broad Street
Pre-Sandy Condition • Raised generators • Raised electrical switchgear • Newer copper infrastructure (plastic casing) • Extensive fiber deployment • Standby pumps to protect against flooding	**Pre-Sandy Condition** • Generators at or below grade • Electrical switchgear at or below grade • Older copper infrastructure (lead casing)
Sandy Effects • Raised generators and electrical switchgear were not impacted by flooding • Newer copper infrastructure was not inundated with water for an extended period • Fiber infrastructure was undamaged • Fuel tanks were disabled and fuel was compromised	**Sandy Effects** • Generators; electrical switchgear; and heating, ventilation, and air conditioning (HVAC) systems were inundated with salt water • Water remained in the basement vault for five days • Copper infrastructure was submerged for five days until vaults could be pumped out
Post-Sandy Restoration • Operational within 24 hours, after temporary fuel tanks were put in place and temporary power cables were run to the switchgear	**Post-Sandy Restoration** • Operational after 11 days, with delays caused by need to find locations for replacement generators, electrical switchgear, and HVAC, and to connect these to the building

Post-9/11, Verizon hardened 140 West Street.

140 West Street cable vault contained relatively fewer copper wires and saw less inundation post-Sandy than 104 Broad Street.

104 Broad Street contained a large number of copper wires pre-Sandy.

Cable vault of 104 Broad Street had to be stripped of copper wire post-Sandy.

140 West Street and 104 Broad Street Central Office Resiliency

Although 140 West Street fared much better during Sandy, both buildings incurred damage. Verizon currently is hardening both offices to prevent future inundation: all electrical switchgear will be raised to the second floor or higher, fuel tanks are being redesigned to withstand submersion, generators are being raised above expected flood heights, and external flood barriers are being considered by Verizon. Most of these hardening measures are expected to be in place by August 2013.

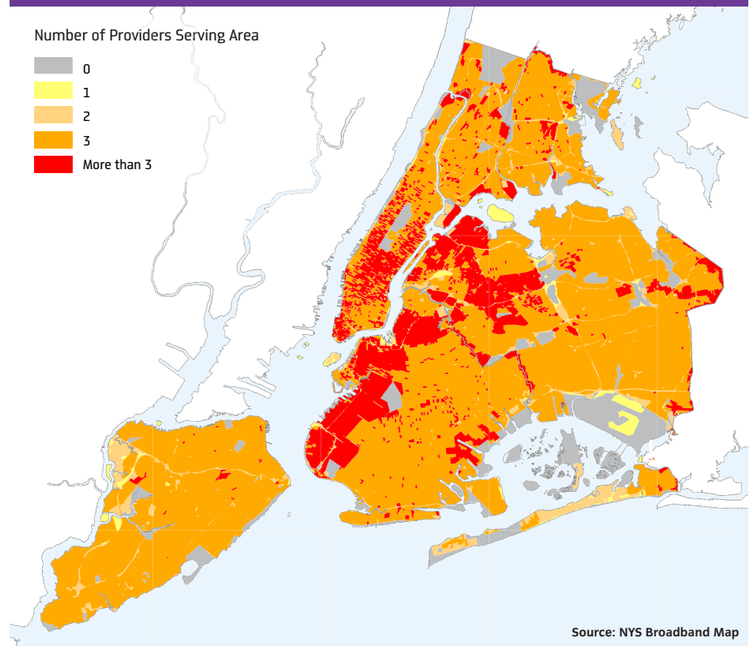
Generally, new coaxial and fiber optic cable fared better than copper cable. The coaxial and fiber cables remained in good condition throughout the storm, though wind and tree damage to overhead wires caused limited outages in areas of Staten Island, Brooklyn, and Queens. Flooding usually only interrupted service provided by coaxial and fiber cables when the electrical equipment to which they were connected lost power.

Longer-term telecommunications outages in the city were primarily caused by flood damage to commercial and residential buildings. Flooding of one to three feet or more usually resulted in damage to basement and exterior telecommunications equipment, affecting an estimated 35,800 buildings across the city. In high-rise buildings, flooding often destroyed telecommunications equipment including electronics and copper distribution frames, along with electrical switchgear that distributed power. To restore telecommunications service, buildings frequently looked for access to power and space at higher elevations for new equipment—a process that, in some cases, created delays in service restoration. *(See map: Sample of Telecommunications Service Restoration Times of Commercial Buildings in Southern Manhattan; see chart: Estimated Flood Damage to Telecommunications Equipment in Buildings)*

Cell service outages were largely caused by loss of power, loss of backhaul service, and/or physical damage to antennas, with power loss being the most significant factor. Cell providers rushed to respond to network outages by connecting generators to existing cell sites, where possible. In areas where the existing cell sites could not be quickly restored, providers used Cells On Wheels (COWs), mobile cell sites that can be deployed after a disaster. Because many cell sites in New York are affixed to private buildings, in many cases, cell sites could not be restored until power to the relevant buildings and connection to backhaul circuits were fully restored. After power was restored, providers then could work on restoring the landline connections to the cell sites. These landline reconnections caused the longest delays in restoring full cell service.

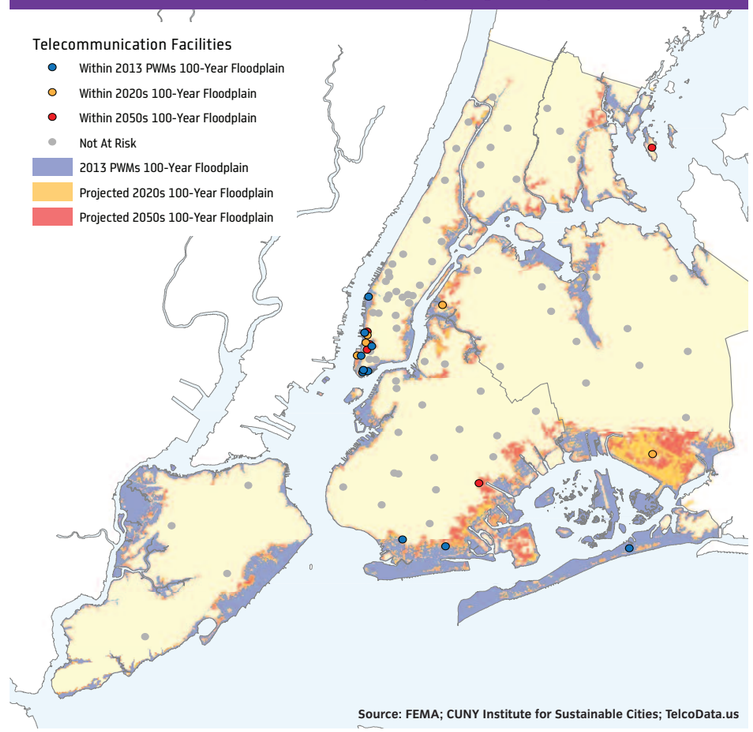
Clearly, the reasons for and duration of telecommunications outages varied, but some generalizations can be made. First, although some telecommunications equipment and facilities had been designed for power outages and flooding, many were not. Many critical facilities were not hardened to best practice standards, leaving equipment—most notably backup generators—below anticipated flood heights. In high- and low-rise buildings, telecommunications equipment in basements was flooded too easily, causing significant damage even at relatively low floodwater heights.

Wire-Line Provider Redundancy



Source: NYS Broadband Map

Critical Telecommunications Facilities in the Expanding Floodplain



Source: FEMA; CUNY Institute for Sustainable Cities; TelcoData.us

Risk Assessment: Impact of Climate Change on Telecommunications

Major Risk Moderate Risk Minor Risk

	Scale of Impact			
Hazard	Today	2020s	2050s	Comments
Gradual				
Sea level rise				Minimal impact
Increased precipitation				Minimal impact
Higher average temperature				Minimal impact
Extreme Events				
Storm surge				Facilities face significant and increasing risk of flooding
Heavy downpour				Minimal impact
Heat wave				Extreme heat for an extended period may shorten life span of electronic gear if spaces are not properly air-conditioned INDIRECT: Power outages could lead to telecommunications outages
High winds				Minimal impact

Another problem that emerged during Sandy was that most cell sites did not have adequate backup power. Standard battery backup for cell towers of four to eight hours simply proved insufficient during the extended outages Sandy caused.

Further, single points of vulnerability in the telecommunications network posed another challenge to maintaining and restoring service post-Sandy. Though some networks were built with redundancy—for instance, cabling taking two separate routes from a cell tower back to a central switching facility—many parts of the network were not. Where these vulnerabilities exist, one cut cable or flooded facility could result in an outage for a few or a few thousand customers. The same was true for buildings, some of which had multiple telecommunications providers—in which case, residents and businesses were able to switch service to the providers that restored service fastest—but many of which, especially on the residential side, had limited or no secondary provider options. *(See map: Wire-Line Provider Redundancy)*

During and after Sandy, carriers required varying degrees of City assistance and coordination. Providers were in regular communication with City officials and elected officials at all levels about immediate recovery needs, but there were some conflicting requests. The City also had difficulty in getting accurate data from providers in consistent, usable formats on immediate outages and recovery work. In addition, some providers had trouble getting their recovery personnel access to restricted bridges because they had not been designated as critical to recovery.

Finally, the City had limited ability to gather data from or enforce standards on providers. For example, while the FCC collects information on outages, it does not do so in real-time, and does not always share it with the City. Meanwhile, the main regulators of the telecommunications network, the FCC and PSC, are exploring ways to improve communications network resiliency.

What Could Happen in the Future

Looking to the future, climate change poses several risks to the telecommunications system.

Major Risks

Storm surge poses a significant and increasing risk to the power grid upon which telecommunications infrastructure depends. Though telecommunications facilities are generally farther from the floodplain than power facilities, 13 percent of critical telecommunications facilities lie in the 100-year floodplain on Preliminery FEMAs Work Maps (PWMs), meaning that they face a risk of flooding from storm surge. By the 2020s, the number of critical facilities in the 100-year floodplain will grow to approximately 18 percent. By the 2050s, that number is expected to climb to 24 percent. With up to 31 inches of sea level rise expected by the 2050s, the risk to critical central offices, including the two largest central offices serving Southern Manhattan, is likely to increase. *(See map: Critical Telecommunications Facilities in the Expanding Floodplain)*

Other Risks

Heat waves pose a threat to the power grid, which is crucial to the operations of the telecommunications system. Extreme heat for an extended duration also may shorten the life span of electronic telecommunications equipment in buildings if the spaces housing this equipment do not have proper cooling.

High winds present a risk of damage to overhead wires in the parts of the Bronx, Brooklyn, Queens, and Staten Island where they exist. Outages due to overhead wire damage, however, do not result in system-wide failures but, rather, only affect a few buildings or blocks at a time, and they are generally able to be repaired quickly, relative to damaged underground cables.

Credit: Karsten Moran/The New York Times

People without power after Sandy had to use their electronic devices at a Chase Bank

This chapter contains a series of initiatives that are designed to mitigate the impact of climate change on New York's telecommunications system. In many cases, these initiatives are both ready to proceed and have identified funding sources assigned to cover their costs. With respect to these initiatives, the City intends to proceed with them as quickly as practicable, upon the receipt of identified funding.

Meanwhile, in the case of certain other initiatives described in this chapter, though these initiatives may be ready to proceed, they still do not have specific sources of funding assigned to them. In Chapter 19 (*Funding*), the City describes additional funding sources, which, if secured, would be sufficient to fund the full first phase of projects and programs described in this document over a 10-year period. The City will work aggressively on securing this funding and any necessary third-party approvals required in connection therewith (i.e., from the Federal or State governments). However, until such time as these sources are secured, the City will only proceed with those initiatives for which it has adequate funding.

The City will pursue a set of initiatives to ensure that all New Yorkers have access to robust telecommunications services backed by resilient networks and infrastructure. These initiatives address the telecommunications system's vulnerabilities that Sandy exposed and that climate change will exacerbate—in particular, the risk of likely service outages due to loss of power from damage caused to facilities by storm surges and heat waves. They do so by addressing a central challenge for New York—the distributed regulatory environment for telecommunications that historically has given the City little authority.

The City's initiatives can be grouped as follows: those seeking to increase accountability to promote resiliency; those seeking to enable rapid recovery after extreme weather events; those seeking to harden facilities to reduce weather-related impacts; and those seeking to create redundancy to reduce the risk of outages.

Strategy: Increase accountability to promote resiliency

The 21st century has witnessed the convergence of telecommunications service across wired voice, cable TV, and broadband, and the increasing centrality of communications networks in the daily lives, jobs, and safety of the city's people. The rapid shift in communications technology has revealed significant gaps in the regulatory framework—gaps that leave the network exposed.

To address these gaps, the City will work to strengthen its regulatory powers while also developing a stronger relationship with telecommunications providers to facilitate more consistent coordination of resiliency measures and disaster preparedness efforts.

Initiative 1
Establish an office within DoITT to focus on telecommunications regulation and resiliency planning

While the City has regulatory authority over some aspects of telecommunications service, it has no entity focused on ensuring the resiliency of public communications networks. Subject to available funding, the City, therefore, will form within DoITT a new Planning and Resiliency Office (PRO) that will have the resources needed to maintain more strategic communication with providers and provide additional monitoring of franchisee compliance with requirements.

DoITT PRO will work to better understand the way providers operate in order to promote and enforce resiliency for telecommunications providers through the franchise renewal process and through other agreements into which such providers enter with the City. Additionally, DoITT PRO will assist providers in navigating City processes, and will explore options to increase conduit infrastructure and resiliency. Furthermore, the office will standardize the formats and frequency of performance data reporting about significant outages across providers, publish service data where appropriate, and tighten service and restoration standards.

Finally, the new office will advocate for State and Federal regulatory changes, encouraging better alignment in Federal, State, and local approaches to regulation, and will push for reporting and resiliency requirements that would lead to better preparation, awareness, and response in the event of extreme weather events. DoITT will launch the new office in 2013.

Initiative 2
Establish new resiliency requirements for providers using scheduled renewals of the City's franchise agreements

Flooding caused outages during Sandy in facilities that were not following the FCC's recommended best practices for resiliency, including flood protection measures. DoITT will promulgate and enforce resiliency standards through the franchise renewal process. Franchise agreements with cable TV service providers are renewed periodically, with most up for renewal in 2020.

Within such new franchise agreements, the City may establish, for example, standards for issues such as repair timelines (called "Mean Time to Repair") in the event of individual outages, including as a result of extreme weather events. The City also will seek to standardize data reporting and publishing requirements to support quicker data analysis in the event of limited or widespread service disruption. Planning for the 2020 renewals will start in 2014 because of the long negotiation period that has been standard in previous renewals.

Strategy: Enable rapid recovery after extreme weather events

While hardening facilities and preventing damage is critical, it is not always possible to avoid every emergency. Anticipating and responding efficiently to disasters is a key feature of resilient infrastructure. The Office of Emergency Management (OEM) leads the City's efforts to prepare for emergencies and coordinates response and recovery, relying on other City agencies within each of their particular areas of expertise. For telecommunications, DoITT PRO will expand resiliency planning efforts and will liaise with franchisees to ensure restoration and resiliency.

Initiative 3
Request business continuity plans from current City franchisees as permitted under existing franchise agreements

All telecommunications providers conduct business continuity planning, but that planning has not traditionally been coordinated with the City. DoITT PRO, through the City's cable TV service franchise agreements, will encourage providers to increase disaster preparedness. Using applicable provisions in existing franchise agreements, DoITT PRO will require that providers share business continuity plans with the City and update and publish them on a regular basis. The office also will assist with preparing for providers' operational needs during emergencies such as access to the city via bridges and tunnels and deployment of equipment to critical facilities. The office also will encourage providers to take additional preparedness measures such as putting in place agreements for sharing cell networks in emergencies. Beginning in 2013, DoITT PRO will meet with providers to coordinate business continuity plans and meet regularly thereafter to update plans and address barriers to effective plan implementation with other City agencies.

Strategy: Harden facilities to reduce weather-related impacts

Short of removing equipment from the floodplain entirely—an impractical option for many buildings—the best way to protect telecommunications equipment in buildings from storm surge is to harden buildings and building systems. The City will develop new flood protection standards and encourage retrofitting of existing buildings through a combination of mandates and incentive programs. DoITT PRO also will work with cell providers to encourage hardening of cell sites. The office will request equipment hardening and upgrades in connection with the City's cable TV service franchise agreements.

Initiative 4
Develop flood protection standards for placement of telecommunications equipment in buildings

The City will develop flood protection standards for new buildings, together with programs to encourage retrofitting of existing buildings to ensure protection of utility equipment, including telecommunications equipment (see Chapter 4, *Buildings*).

Initiative 5
Use the DoITT franchise agreements to ensure hardening of all critical facilities

Damage to critical facilities caused neighborhood-wide outages during Sandy, in turn resulting in significant disruption to business and personal communications. The City will work with providers to strengthen the resiliency of these critical facilities. Specifically, through its franchise agreements with cable TV providers, DoITT has a number of tools already at its disposal that it will put to use, including requesting reports on the state of technology at provider facilities and potentially establishing requirements for facilities and equipment. DoITT already has requested from its cable TV franchisees plans to minimize the occurrence of significant outages due to future climate events. DoITT PRO will seek to expand this authority through future cable TV service franchise agreements.

Initiative 6
Work with cell providers to encourage hardening of cell sites

Wireless service went down in large sections of the city during Sandy as a result of the loss of power or connections to the larger telecommunications network at cell sites. The City will work with providers locally to encourage measures that will keep the cell networks functioning in emergencies. Although the wireless industry is regulated primarily at the Federal level, DoITT PRO will work with providers to encourage the creation of plans to pilot the hardening of some existing cell sites, including 48-hour backup power from batteries, generators, or a combination of both; raising key equipment out of the floodplain; and providing multiple wire-line paths from the sites to central facilities to provide backup network connections in the event of cable damage. DoITT PRO also will seek to meet with cell providers regularly beginning in 2013 to develop these hardening measures and clear barriers to implementation within the city.

Strategy: Create redundancy to reduce risk of outages

Beyond strengthening existing systems, ensuring system redundancy may be the best way to protect critical infrastructure from outages. Accordingly, the City will explore options for creating a redundant and resilient conduit infrastructure. The City also will implement programs to encourage redundancy among telecommunications providers in individual buildings and to disseminate information about provider redundancy and resiliency in buildings to the general public.

Initiative 7
Study options to increase conduit infrastructure redundancy and resiliency

After the significant telecommunications outages during Sandy, some areas with damaged cable did not have service for days or weeks. To avoid this in the future, the City will seek to encourage provider redundancy throughout New York through expanded spare conduit capacity and new approaches to laying cable. DoITT PRO, in consultation with NYCDOT, will explore tracking and managing providers' conduit requests to Empire City Subway in Manhattan and the Bronx, ensuring that Empire City makes spare conduit available. DoITT PRO also will work with providers to develop and test inexpensive alternatives to delivering telecommunications service, such as "micro-trenching," which provides a cheaper and faster method of conduit installation in certain areas of the city. DoITT PRO will explore further options for improving the availability and redundancy of conduit in Queens, Brooklyn, and Staten Island, including options such as a "shadow conduit policy" modeled after the current micro-trenching pilot. The office also will investigate a system to produce accurate conduit maps to manage more effectively shared infrastructure and monitor more effectively spare capacity. DoITT PRO will work to identify areas both within the Empire City Subway system and in Brooklyn, Queens, and Staten Island for potential conduit expansion initiatives. Planned ongoing engagement will include regular meetings with providers and with Empire City Subway.

Initiative 8
Continue implementation of ConnectNYC Fiber Access to create broadband redundancy

During Sandy, some providers restored service more quickly than others. Customers in buildings with multiple providers were able to switch to the service that was operational, while those without choice were left without options. Increasing broadband connections to buildings is another way to create redundancy. Through ConnectNYC, the City is partnering with providers to connect commercial and industrial businesses across the city with fiber. As required by their franchise agreements negotiated with DoITT, Time Warner Cable and Cablevision have allocated $12 million from their capital budgets to connect new businesses to their fiber networks. The New York City Economic Development Corporation (NYCEDC) is soliciting interest from businesses and will allocate these connections free of charge on a competitive basis. The first round of applications was received in December 2012, and the second round of applications is launching in June 2013.

Initiative 9
Add telecommunications provider quality and resiliency to the WiredNYC and NYC Broadband Map ratings

A significant challenge to broadband deployment throughout the city—and telecommunications service more broadly—is the lack of accessible data about the availability of providers, the service quality, and the resiliency of providers' systems. Without this information, companies looking for new space are unable to make informed decisions, reducing the incentive for providers to ensure that their networks are sufficiently resilient. Through the WiredNYC and NYC Broadband Connect Map programs, the City will publish information about broadband service at buildings around the city, rating the quality and resiliency, among other factors. NYCEDC will manage these programs. The WiredNYC certification system website will launch in June 2013, and the NYC Broadband Map website will launch in fall 2013.

Credit: NYCDOT

Transportation

Stillwell Avenue subway station in Coney Island

Credit: Zev Starr-Tambor

It carries one-third of all transit riders and two-thirds of all rail riders in the nation. It includes the nation's busiest rail hub and the largest bus and rail car fleets. It encompasses 6,000 miles of streets, 12,000 traffic signals, and nearly 800 bridges (including more than a couple of famous ones).

And, of course, it boasts the one and only Staten Island Ferry.

This complex behemoth is the New York region's transportation network. It encompasses the largest public transportation system in America, made up of subway networks, bus networks, commuter railroad networks, and ferry networks. And each of these networks is, in and of itself, staggeringly large.

Under normal conditions, the interconnected networks work together, adding up to an extraordinary supersystem, upon which New Yorkers—and the economy of the city, region, and nation—all depend. Day and night, millions of New Yorkers and visitors use this system to travel to and from work, school, shops, and cultural events, while goods move around the region by road, rail, and water. The city that never sleeps fittingly has a transportation system that never sleeps—until, with Sandy, nearly every element of New York's transportation system shut down.

Sandy's storm surge flooded vehicular tunnels, subway stations, roads, and airports. Transportation outages followed, impairing mobility and access to, from, and within the city and the region, and affecting 8.5 million public transit riders, 4.2 million drivers, and 1 million fliers.

Even after Sandy had departed, damage and power outages prevented restoration of the subway system for several days, with key sections shut for a week or longer. Responding quickly, City and State officials instituted a series of interim solutions to fill the transportation gap—including sending hundreds of buses to carry commuters back and forth across East River bridges and adding ferry service. However, damage to various elements of the system was severe—totaling many billions of dollars. In fact, as of the writing of this report, some elements still are not fully functional and will not be for months or even years.

The storm not only caused disruption; it demonstrated the centrality of the transportation system to the city's economy and overall ability to function. It also laid bare the vulnerabilities of various parts of the system to extreme weather and pointed to challenges that the region faces in increasing resiliency, given the size and complexity of its transportation system.

But these challenges must be tackled. In keeping with the broad goals of this report—which are to minimize disruptions caused by climate change and to enable New York City to bounce back when extreme weather events strike—the City will work to make the transportation system more resilient. It will seek to protect critical elements of the system from damage, maintain system operations during extreme events, and put in place plans for backup transportation options to increase mobility until regular services can be restored.

How the Transportation System Works

Transportation in New York City is complex due to the many different modes of travel, the ways they interact, and the grand scale of it all. And New Yorkers use this system in overwhelmingly large numbers, with 7.6 million daily subway and bus riders, close to 850,000 daily commuter rail riders, and almost 2 million people crossing the region's major bridges and tunnels every day. This network is busy for much of the day and night—not just during traditional commuting hours—with freight moving around the region by truck, hospital workers going to and from their shifts, and local residents and tourists visiting the city's many attractions.

The area of Manhattan south of 60th Street—the business center of the region and the nation—draws commuters to jobs from all over the New York area and beyond. Over 3.6 million travelers enter this district every weekday, with 1.4 million of those entering during the three-hour morning peak. Public transportation is absolutely critical to this travel, since 75 percent of those trips into the central business districts are made by public transit. Of those who do drive into this area, the majority depend on crossing a bridge or tunnel to do so, including 220,000 entering from Brooklyn, 175,000 entering from Queens, and 115,000 entering from New Jersey.

Travel within and among the outer boroughs is more varied. The use of buses is significant outside of Manhattan—with 2.1 million daily bus users in the other boroughs—as is the use of private vehicles, particularly for longer trips between the outer boroughs, where driving is generally faster and more direct. Many outer borough trips also require a major bridge crossing, and trips to and from Nassau and Suffolk Counties must pass through New York City. Close to a million trips pass between Nassau County and Queens every day, and over 500,000 trips cross the major bridges that connect between the outer boroughs every day.

While the city's transportation system is highly interconnected, it also does not exist in isolation. Instead, it is one network among the many that keep New York running. For example, the transportation network in the city depends on the power network to function; electricity is needed to run subways and trains, to switch on traffic signals, and to light tunnels, stations, and terminals. And, in turn, many of the city's other critical networks rely, wholly or in part, on the transportation network to run properly; this is especially true in times of emergency, when first responders and those bringing key supplies (such as food and fuel) must be able to reach individuals and communities that are in desperate need.

However, due to historical development patterns and operational needs, many parts of the city's transportation infrastructure are located near the waterfront or in low-lying areas, making them particularly vulnerable to the effects of climate change. This is true for many rail yards, which require large, flat expanses of land of the type frequently found near rivers and the shoreline. Similarly, by definition, ferry terminals must be at water's edge and close to the level of the water. Other assets are on the waterfront because that is where land was available or could be created through fill—this is how, for example, New York's airports were sited.

Some transportation assets, meanwhile, are not just at sea level, but are actually built below sea level. This is the case for the large segments of the city's transportation network that were built underground (including tunnels for vehicles and trains), designed both to span water bodies and to provide higher speed and greater capacity connections through dense and congested areas.

Transportation Networks

The first formal transportation elements to develop in New York City were its roads, which, under the Dutch and later the English, evolved from a network of Native American trading paths. In fact, Broadway, the oldest north-south thoroughfare in the city, was designed to connect the street network in Lower Manhattan (initially used by people on foot and on horse) to the northern reaches of the borough—and on into the Bronx and beyond. The Commissioners' Plan of 1811 laid out what is today perhaps the most distinctive aspect of New York's City's street network: Manhattan's modern street grid.

New York's ferry system, too, has a long pedigree. New Yorkers always have used the waterways to get around. Since the city's earliest days—especially before the development of long-span bridges—ferries have provided key water crossings, connecting Brooklyn, Queens, Staten Island, and New Jersey to Manhattan, both as stand-alone services and as links from rail terminals.

Over time, as New York City grew, it became increasingly important to link the soon-to-be consolidated boroughs effectively. Accordingly, in the late 19th and early 20th centuries, the City undertook a major program of bridge-building, completing some of the city's most iconic spans, including the Brooklyn and Manhattan Bridges over the East River. With the same goal in mind, New York City also worked with the Interborough Rapid Transit (IRT) Company to create its initial underground connections, opening the first subway line in 1904. The subway system has since expanded to become the largest in the world, with 659 miles of track and 468 stations, playing a critical role in making New York the global city it is today.

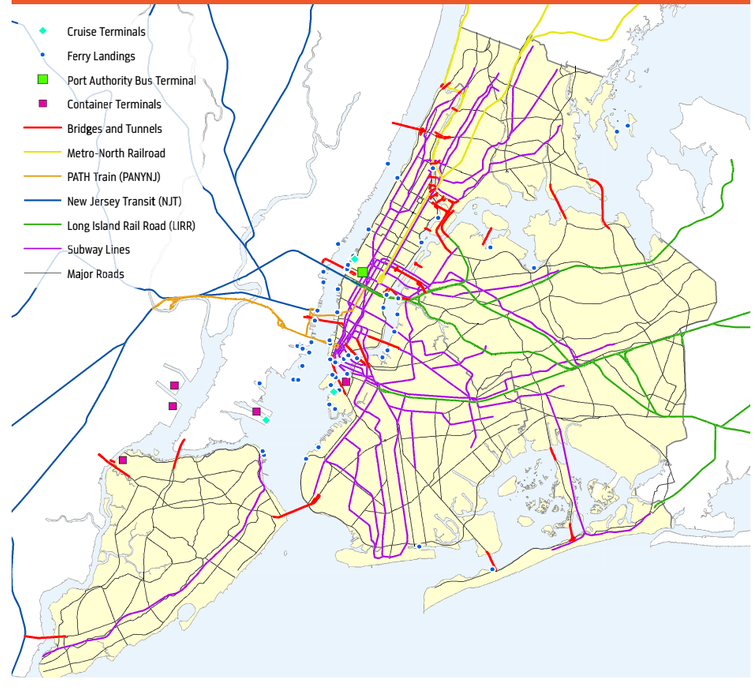
As the city continued to expand through the 20th century, New York's water-spanning tradition was picked up by the Port Authority of New York and New Jersey (the Port Authority) and the Triborough Bridge and Tunnel Authority (which subsequently became part of the Metropolitan Transportation Authority, or MTA). These two agencies built four bridges, and two tunnels connecting New Jersey to New York City, and seven bridges and two tunnels within the city. Meanwhile, in the latter half of the 20th century, the region's three major airports, including Kennedy and LaGuardia in Queens, became international gateways that, together, host more passenger traffic each year than the airports in any other metropolitan area outside of London.

In recent years, the City has expanded its transportation network by promoting a range of alternatives to driving, thus increasing the flexibility and efficiency of the system. For example, the City has expanded its pedestrian and bicycle networks. Walking has always played an important role for all manner of local trips and to gain access to the transit network, and cycling volumes in the city continue to grow. In addition, the City has maximized inter-modal connections and added several Bus Rapid Transit (BRT) routes (known in New York as Select Bus Service), or dedicated bus corridors that improve the speed, reliability, and attractiveness of bus service. Additionally, after many years during which the use of private ferries waned as new bridges and tunnels were built, the City, over the last 15 years, has helped bring about a renaissance in this transit mode, spurred by rising congestion on other networks and redevelopment of the waterfront neighborhoods of New York City and New Jersey. (*See map: Regional Transportation Network*)

Transportation Operators

All of New York's various transportation networks and services are linked in many ways, allowing a New Yorker or a visitor to the city to connect easily from one mode to another. So, for example, a marketing executive from Philadelphia might take an Amtrak train to Penn Station, then transfer to a subway, only to get off several stops later to hustle through the

Regional Transportation Network



busy streets of Lower Manhattan to her destination. In addition to shifting from one locale to another and from one transportation network to another, in making this trip, this visitor is also passing through multiple jurisdictions, from a system run by a Federal corporation, to one that is run by an authority under the control of the State, to one that is run by the City.

As illustrated in this example, many agencies manage different elements of New York's transportation system. For example, the New York City Department of Transportation (NYCDOT) has responsibility for roads and certain highways in the five boroughs, as well as over 12,000 traffic signals and 787 bridges. These bridges include the famous East River spans and 25 movable bridges that open and close to allow marine traffic to pass. NYCDOT also runs the Staten Island Ferry (SIF) and regulates all construction work on roadways and sidewalks, including work related to underground utilities. Additionally, since the launch of PlaNYC in 2007, NYCDOT has successfully expanded the city's bicycle network. It also has played a critical role, in partnership with the MTA, in creating multiple Select Bus Service (SBS) routes that make bus service faster and more reliable around the city.

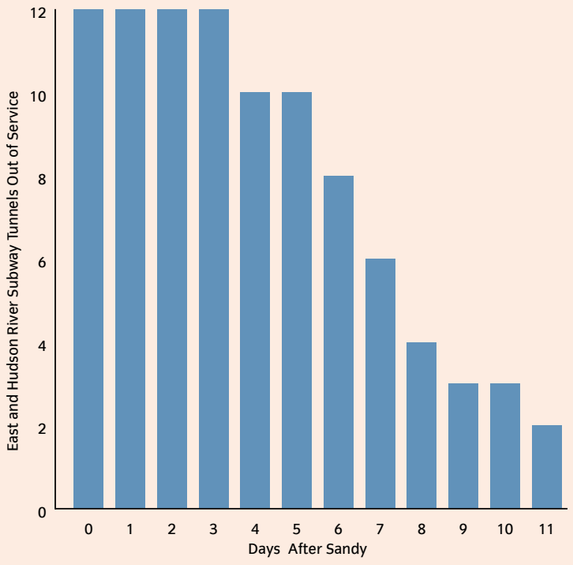
Two other important transportation agencies in New York City are the MTA and Port Authority. The MTA, a State authority, operates the nation's largest transit network and is responsible for the city's subway system, most of its buses, the Long Island Rail Road and Metro-North Railroad, and the tolled bridges and tunnels within New York City. Meanwhile, the Port Authority—an entity controlled jointly by the States of New Jersey and New York—is responsible for the city's airports, the bridges and tunnels connecting New York City to New Jersey, regional bus terminals, the Port Authority Trans-Hudson (PATH) rail system, and major parts of the region's ports infrastructure.

Other agencies that play central roles in transportation in New York City include the following:

- New York City Economic Development Corporation (NYCEDC), which is responsible for the East River Ferry, certain private ferry terminals, the City's cruise ship terminals, two heliports, parts of the region's port infrastructure, and portions of the city's freight railroad lines;
- New York State Department of Transportation, (NYSDOT) which is responsible for certain highways within the city and manages major highway construction improvements;
- New Jersey Transit (NJ TRANSIT), which operates rail and bus service between the city and New Jersey;
- Amtrak, which operates intercity rail service to and from New York City, the non-subway rail tunnels under the Hudson River and the East River, as well as Pennsylvania Station, the busiest transit hub in the country; and
- the Federal government—which, through various agencies, including the Department of Transportation—provides major capital funding for many of the region's transportation systems.

Finally, a variety of private entities play roles, both large and small, in the city's transportation system. These include the operators of taxi and black-car fleets, private ferries, commuter vans, local and intercity buses, maritime freight terminals and vessels, and airlines.

Subway Tunnel Closures After Sandy



Source: NYCDOT, MTA, and Port Authority of NY & NJ

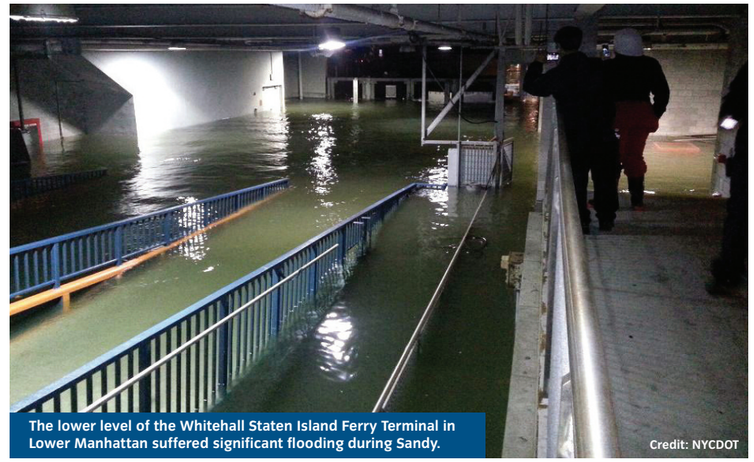
What Happened During Sandy

Sandy had a massive impact on the transportation system within New York City and the surrounding region, with the greatest impact felt on those elements located underground and close to the shoreline. The storm caused extensive damage and impaired the ability of the system to move people in and around the city and region.

The storm had an impact on transportation in New York City even before it arrived. Starting the day before Sandy hit, most public transportation agencies made the decision to initiate an orderly shutdown of their systems to protect transit vehicles (often referred to as rolling stock) and critical infrastructure, and to ensure public safety. So, for example, the MTA installed plywood and sandbag barriers at critical station entrances and ventilation grates, while it also moved subway cars, buses, and trains to higher ground. At ferry landings and terminals around the city, gangways were removed to allow floating elements to move with the tide and expected storm surge without damaging buildings and facilities. SIF and private ferry service was halted. All seven active SIF vessels were then docked at the St. George Ferry Terminal on Staten Island, with more than 100 dedicated employees remaining on duty to protect the fleet.

Due to concerns about high winds and flooding, the Port Authority, MTA, and NYCDOT closed the city's major bridges and tunnels crossings, with the exception of the Lincoln Tunnel, the entrances to which were deemed to be high enough above the Hudson River to be at low risk of flooding. Meanwhile, airlines flew their planes out of harm's way, sheltering them at airports out of Sandy's path.

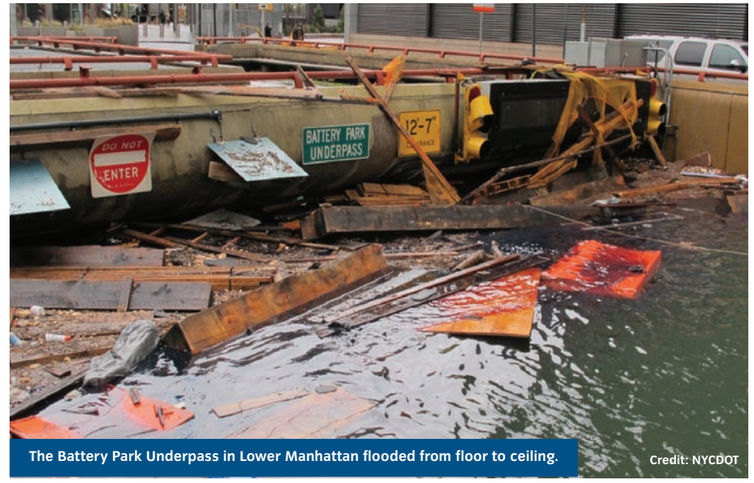
However, once Sandy arrived, its storm surge severely impacted many elements of the transportation system, including subway, railroad, and vehicular tunnels. Stormwaters flooded tunnel entrances and ventilation structures in Southern Manhattan, Long Island City, Red Hook, Hoboken, and Jersey City. Vehicular tunnels that were knocked out of service were NYCDOT's Battery Park Underpass and West Street Underpass, the MTA's Queens Midtown and Hugh L. Carey (formerly Brooklyn-Battery) Tunnels, and the Port Authority's Holland Tunnel. Also inundated were all six of the subway tunnels connecting Brooklyn to Manhattan, the Steinway Tunnel that carries the 7 train from Queens to Manhattan, and the G train tunnel between Long Island City and Greenpoint. The PATH tunnels under the Hudson River also were flooded, with water entering via various entrances on both the New York and New Jersey sides, as were the railroad tunnels under the East River and the Hudson River. *(See chart: Subway Tunnel Closures After Sandy)*



The lower level of the Whitehall Staten Island Ferry Terminal in Lower Manhattan suffered significant flooding during Sandy. Credit: NYCDOT

Other elements of the subway system were impacted as well. For example, the A train viaduct connecting Howard Beach, Broad Channel, and the Rockaways was washed away in two locations, while the South Ferry subway station in Lower Manhattan was fully flooded to the mezzanine level.

In areas inundated by Sandy, roads similarly were affected, although these floodwaters typically receded within 12 hours. While 60 lane-miles of roadways were damaged severely and 500 lane-miles of roadways sustained minor damage, most roadways in inundated areas were undamaged. However, flooding did damage traffic signals controlling nearly 700 intersections when signal control boxes and underground conduits and cables were exposed to the corrosive effects of salt water.



The Battery Park Underpass in Lower Manhattan flooded from floor to ceiling. Credit: NYCDOT

Sandy's surge also affected maritime transportation, damaging landings and docks and inundating facilities on land (including both cruise terminals and both SIF terminals). The storm's winds and rising waters battered the SIF vessels, breaking mooring lines and submerging the docks. To prevent the ships from crashing into the shore, the captains of six ferries remained at the helm and successfully maneuvered the propulsion systems against the force of the storm. When the unmanned Alice Austen broke free of its moorings and lurched towards the Sen. John J. Marchi, crews developed improvised fenders, protecting both ships from damage.

Surge waters inundated rail yards and airports. Several low-lying rail yards were flooded, including the MTA's Coney Island Yard complex in Brooklyn and the LIRR's John D. Caemmerer West Side Yard in Manhattan. Meanwhile, the city's airports were flooded by waters from Jamaica Bay and Long Island Sound, but these waters did not reach the terminals, where the most sensitive and highest value equipment is located.

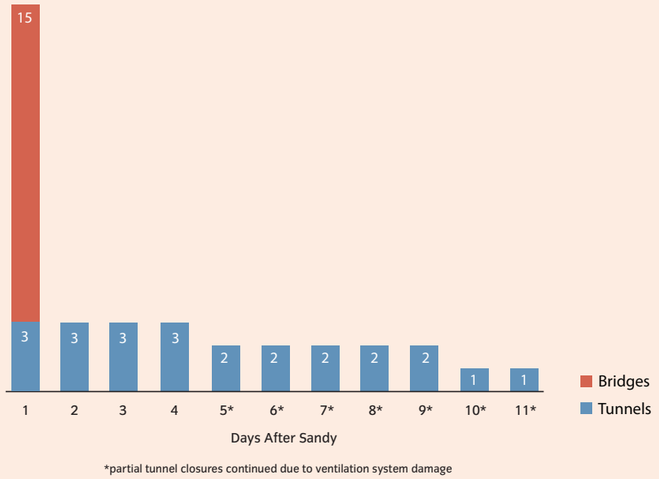
Sandy's surge thrust debris from the shore into the region's waterways, thereby necessitating a US Coast Guard shutdown of portions of the Harbor for five days. This decision hampered the movement of people and goods, including fuel as well as other supplies critical to recovery. Beyond the immediate impact of flooding, power outages from Sandy severely affected the transportation system. Lack of power meant that key equipment could not operate (e.g., train lines and tunnel ventilation equipment dependent on electricity). It also was a major impediment to the dewatering of the major tunnel infrastructure. Eventually, as power was restored, personnel from local agencies worked with crews from the US Army Corps of Engineers, Federal Emergency Management Agency (FEMA), US Navy, US Coast Guard, and National Guard to pump several hundred million gallons of water from these tunnels.

However, the fact that many tunnels were inundated for days exacerbated the impact of flooding and led to significantly greater water and corrosion damage to delicate equipment. For example, during the months following Sandy, this lingering damage resulted in more than 100 signal failures on the subway system, as well as ongoing problems with switches, power cables, and other infrastructure in the subways. Given the age and complexity of much of this equipment, obtaining replacement equipment proved both difficult and expensive. Despite the major disruptions and damage, much of the transportation system fared relatively well. For example, Sandy had a minor impact on the MTA's vehicles, thanks to the

agency's successful relocation of this rolling stock out of harm's way. Meanwhile, the region's freight rail infrastructure also emerged from the storm with minimal damage, although some service disruptions did occur due to flooding and debris on tracks. Because wind speeds during Sandy were lower than earlier storms, the major bridges were able to reopen within 12 hours of the storm's conclusion, following safety inspections by engineers. *(See chart: Major Vehicular Bridge and Tunnel Closures After Sandy)*

However, the overall transportation system struggled to reopen, affecting millions of commuters. In the first two days following Sandy, for a variety of reasons, many people stayed at home and most businesses in impacted areas remained shuttered. However, by the third day after the storm, people started to attempt to return to their normal routines. With the subway and other major systems still partially out of service, New Yorkers were forced to improvise. In some cases, this improvisation turned mass transit users into bikers or walkers. In many other cases, however, these mass transit users turned to automobiles. The result was gridlock, especially on roads and bridges leading into Manhattan. In fact, during this period, average highway speeds dropped by as much as 71 percent, relative to speeds on normal weekdays. *(See chart: Highway Travel Speeds at Selected Locations)*

Major Vehicular Bridge and Tunnel Closures After Sandy



*partial tunnel closures continued due to ventilation system damage

Source: NYCDOT, MTA, and Port Authority of NY & NJ

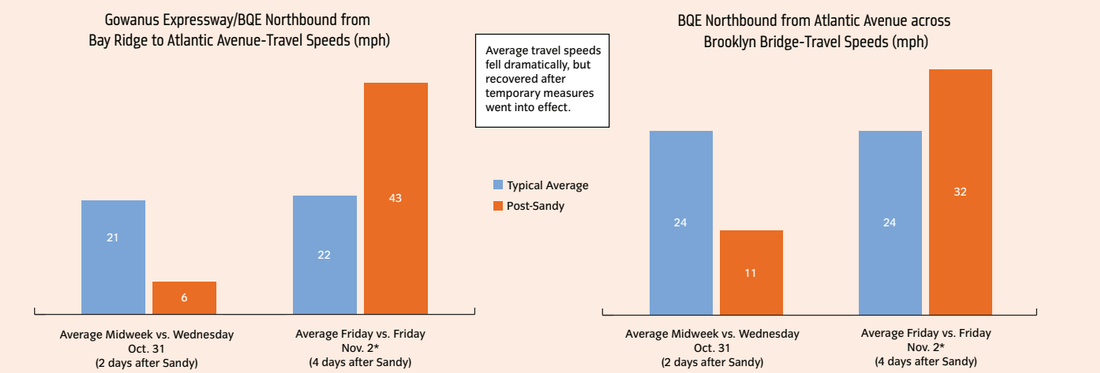
To maintain critical routes, City and State officials quickly implemented a series of temporary measures. Many of these measures were conceived on the spot immediately after Sandy hit. However, from temporary ferry routes, to bus bridges, to carpool requirements, together, they proved to be hugely successful in getting people moving again. *(See chart: East River Crossings Before and After Sandy; see sidebar: Temporary Services Help Restore Mobility After the Storm)*

As time progressed, much of the city's transportation network was brought back online. The ferry and marine transportation networks, for example, took between two days and a week to restore, while airports were back in operation within three days of the storm. The subways mostly were restored a week after Sandy, with vehicular tunnels taking closer to a week and a half to return to partial service due to damage to the ventilation equipment. By two weeks after Sandy, most of the city's transit network was functioning at or near normal capacity.

Certain elements took longer and in some cases, are still out of service as of the writing of this report, including portions of the subway system. For example, the Montague Street Tunnel used by the R train was restored eight weeks after Sandy (but will be taken out of service again for longer-term repairs), and the causeway that carries the A train connecting Howard Beach to the Rockaways was restored at the end of May 2013. Full restoration of South Ferry subway station in Lower Manhattan is expected to take several years.

In response to these longer-term transit outages post-Sandy–and generally to provide expanded mobility and access options—the following new and enhanced services were added:

Highway Travel Speeds at Selected Locations



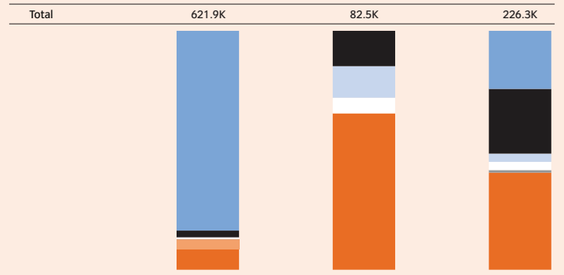
*Note: Bus bridges and HOV requirements were in effect on Nov. 2

Source: NYCDOT

- new ferry services from both the Rockaways and Staten Island to Lower Manhattan and Midtown to compensate for lost or constrained transit service;
- an H shuttle subway train, with an accompanying shuttle bus to the Howard Beach subway station through the Rockaways, to compensate for the loss of A train service across Jamaica Bay; and
- the reopening of the former South Ferry Terminal below the Whitehall Ferry Terminal, to allow 1 train service to the southern tip of Manhattan while the damaged South Ferry Terminal was being repaired.

Even as the city's transit system resumed most service, however, it was clear that Sandy's damage had been done. In total, close to 8.6 million daily public transit riders, 4.2 million drivers, and 1 million airport passengers were impacted by the shutdown of various systems. In addition, it is estimated that Sandy has resulted in a staggering $8 billion in physical damage to the region's transportation infrastructure, including $700 million in damage to NYCDOT's facilities and equipment.

East River Crossings Before and After Sandy



	Typical Weekday	Oct. 31 (2 days after Sandy)	Nov. 2* (4 days after Sandy)
Subways	520,000	0	55,000
Buses	17,400	12,200	61,300
Pedestrian	1,100	10,900	7,800
Bicycle	3,500	5,400	7,800
Ferries	900	0	2,400
Tunnels-Private Vehicles	25,000	0	0
Bridges-Private Vehicles	54,000	54,000	92,000

*Note: Bus bridges and HOV requirements were in effect on Nov. 2

Source: NYCDOT

What Could Happen in the Future

Looking to the future, the city's transportation system faces significant climate risks, including the risk of storm surge and flooding from coastal storms, heavy downpours, and sea level rise.

Major Risks

The greatest future risk to the city's transportation network is storm surge—a risk that, as Sandy illustrated, is significant even today primarily because so many critical pieces of transit infrastructure are located within the 100-year floodplain, the area that has a 1 percent or greater chance of flooding in any given year. The recently released Preliminary Work Maps (PWMs) from the Federal Emergency Management Agency (FEMA) define the 100-year floodplain as an area that already includes approximately 12 percent of the roadway network, all of the major tunnel portals other than the Lincoln Tunnel, portions of both airports, a variety of commuter rail assets, all three heliports, and a number of subway entrances and vent structures, principally in Lower Manhattan. *(See map: Transportation Network in the 2013 PWMs 100-Year Floodplain)*

Going forward, the risks associated with storm surge will grow more severe, as rising sea levels increase the impact of those surges and turn minor surges into major events. According to projections from the New York City Panel on Climate Change (NPCC), described in Chapter 2 (*Climate Analysis*), sea levels are forecast to rise through the 2020s and 2050s. During this period, the floodplain will expand. By the 2020s, the floodplain is estimated to encompass 15 percent of the city's roadway network, and by the 2050s, it is expected to encompass 19 percent of that network. More and more of the City's airport infrastructure will be at risk as storm surges will move from

Temporary Services Help Restore Mobility After the Storm

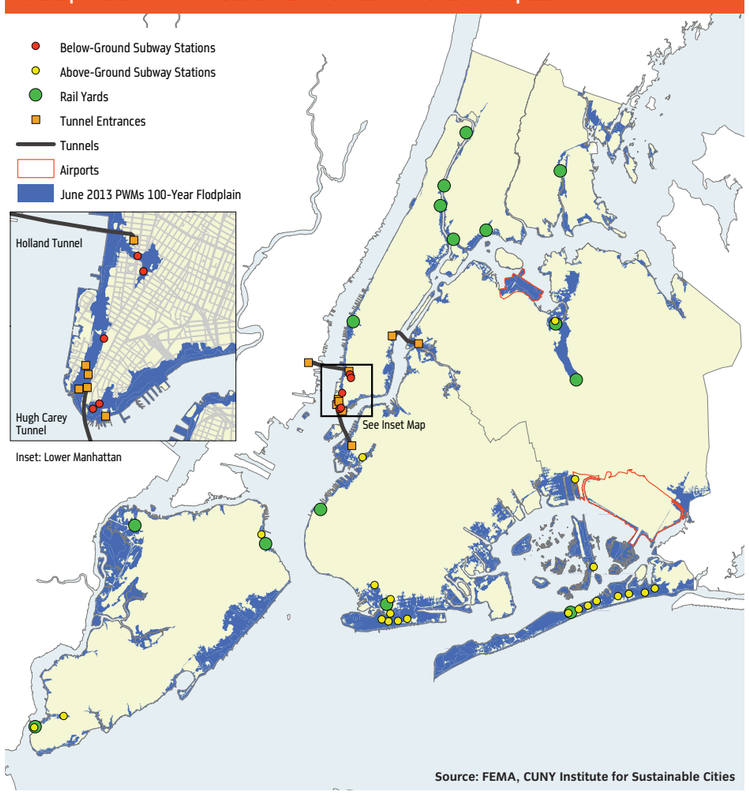
On a normal day, the subway carries about 80 percent of the people crossing the East River into Manhattan. Following Sandy, however, with subway service across the river entirely shut down for a number of days, many people tried to commute by car. Gridlock ensued. It quickly became clear that the transportation network simply was not designed to handle the spike in drivers attempting to enter the central business district south of 60th Street.

In response, the New York City Department of Transportation (NYCDOT), the New York City Police Department (NYPD), and the Metropolitan Transportation Authority (MTA) instituted a series of measures to limit the number of cars coming into Manhattan but still get people across the river. First, cars entering Manhattan's central business district were required to have three or more occupants. Second, the NYPD, NYCDOT, and the MTA implemented three new temporary, high-capacity, point-to-point bus routes (which quickly became known as "bus bridges"), connecting Downtown Brooklyn and Williamsburg with Midtown Manhattan, using 300 buses that the MTA diverted from other routes. Third, the East River Ferry service pattern was modified to increase capacity and provide faster service along routes with the highest demand, taking advantage of the infrastructure already in place and the vessels on hand.

The challenges inherent in communicating information about these temporary measures in the immediate post-Sandy environment initially led to some confusion among travelers—particularly those drivers who had to be turned away as they tried to enter Manhattan because they did not meet the occupancy requirements. However, these measures accomplished their desired goal, together enabling over 226,000 commuters to cross the East River—almost triple the number able to cross before these measures were in place.

The South Ferry Station in Lower Manhattan was flooded to the mezzanine level. Credit: MTAPhotos

Transportation Network in the 2013 PWMs 100-Year Floodplain



Source: FEMA, CUNY Institute for Sustainable Cities

flooding outlying runways to threatening the terminal buildings, while additional subway stations will be at risk.

More intense downpours expected with climate change also pose a major risk to the transportation system. As with storm surge, heavy downpours pose the most significant challenge to subway and vehicular tunnels throughout the city, particularly in locations where tunnel entrances are located in low-lying areas or in areas with poor subsurface drainage. Examples of infrastructure matching this flood profile include the F train on Hillside Avenue in Queens and several subway lines in Lower Manhattan. Generally, heavy downpours are expected to pose only a moderate risk to roads and bridges, which may experience more frequent temporary flooding, but not more lasting damage.

Other Risks

High winds are likely to represent a moderate risk to the above-ground portions of the city's transportation infrastructure, such as traffic signals, signs, bridges, and street lights. They also could pose challenges to the aviation system, interfering with flight operations and, in the worst cases, creating safety hazards. Although high winds can cause power outages, which have serious impacts on the transportation network as a whole, it is not believed that these impacts will be greater than those facing the city today.

Heat waves, meanwhile, present a moderate threat to the city's ground transportation infrastructure, though it is not expected to become materially greater until the 2050s. Heat waves could create problems with opening and closing movable bridges and cause softening of asphalt roads. Heat waves also could become an issue for the subway system, increasing temperatures on platforms to levels that could turn what, today, is only a passenger comfort issue into a passenger safety issue. Moreover, heat waves could increase the potential for power outages, which affect transportation networks across the board.

Finally, sea level rise in and of itself is expected to pose a low risk to the city's transportation infrastructure for the next three decades. However, by the 2050s tidal flooding—already an issue for some low-lying areas—could become more widespread along the waterfront, including areas such as Southern Brooklyn and South Queens. Waterfront assets including the city's airports and ferry terminals could be placed at risk by this periodic flooding threat.

Risk Assessment: Impact of Climate Change on Transportation

Major Risk Moderate Risk Minor Risk

	Scale of Impact			
Hazard	**Today**	**2020s**	**2050s**	**Comments**
Gradual				
Sea level rise				Some protection required, but most infrastructure is above future sea level
Increased precipitation				Minimal impact
Higher average temperature				Minimal impact
Extreme Events				
Storm surge				Increased flooding of key at-grade and underground infrastructure as storms worsen
Heavy downpour				Flooding of underground infrastructure possible during heaviest downpours
Heat wave				Movable infrastructure (bridges, switches) could be impacted, as well as safety/comfort on subway platforms INDIRECT: reduced electrical supply reliability impacts many aspects of infrastructure
High winds				General damage to infrastructure possible, as well as impact on aviation

Risk Assessment: Impact of Climate Change by Category of Transportation Asset

Major Risk Moderate Risk Minor Risk

	Asset Impacts				
Hazard	**Roads, Bridges, and Vehicular Transportation**	**Ferries and Marine Transport**	**Tunnels and Subways**	**Rail** (includes above-ground subways)	**Airports**
Gradual					
Sea level rise					
Extreme Events					
Storm surge					
Heavy downpour					
Heat wave					
High winds					

Note: This chart excludes increased precipitation and higher average temperature because these are expected to have minimal impact on the transportation system

This chapter contains a series of initiatives that are designed to mitigate the impacts of climate change on New York's transportation system. In many cases, these initiatives are both ready to proceed and have identified funding sources assigned to cover their costs. With respect to these initiatives, the City intends to proceed with them as quickly as practicable, upon the receipt of identified funding.

Meanwhile, in the case of certain other initiatives described in this chapter, though these initiatives may be ready to proceed, they still do not have specific sources of funding assigned to them. In Chapter 19 (*Funding*), the City describes additional funding sources which, if secured, would be sufficient to fund the full first phase of projects and programs described in this document over a 10-year period. The City will work aggressively on securing this funding and any necessary third-party approvals required in connection therewith (i.e., from the Federal or State governments). However, until such time as these sources are secured, the City will only proceed with those initiatives for which it has adequate funding.

As outlined above, climate change could have a significant impact on the city's transportation infrastructure, ranging from short-term outages to direct damage—or even destruction of critical assets, in some cases. These impacts may make it difficult for commuters to travel to work and school and will hinder the economic and social life of the city.

To mitigate these impacts, the City and other transportation system operators will have to protect their critical assets—particularly those most vulnerable to damage and with the greatest economic and mobility value. However, they also will have to ensure both maximum system redundancy (offering transit users as many different routes as possible to their intended destinations) and that they are well-prepared to restore transportation services quickly, if and when extreme events breach defenses.

Strategy: Protect assets to maintain system operations

Given the range of potential climate change impacts on the transportation network and the criticality of the transportation network, the City will implement initiatives to protect the infrastructure that it controls from damage and loss of service and will call on other agencies to protect other transportation infrastructure critical to the city.

Sandy damaged many miles of City streets. Credit: NYCDOT

Initiative 1
Reconstruct and resurface key streets damaged by Sandy

Sandy's waves and flooding caused significant damage to roadways. To address this damage, subject to available funding, the City, through NYCDOT, will reconstruct 60 lane-miles of streets that were severely damaged and conduct both subsurface and surface repairs. These newly-reconstructed streets also will include upgraded resiliency features to prevent future damage. In addition, NYCDOT will resurface 500 lane-miles of streets with damaged pavement but underlying structures that are in good condition. This initiative is already underway, with funding from Federal and City sources supporting rapid restoration of transportation services.

Initiative 2
Integrate climate resiliency features into future capital projects

The city's roadways are vulnerable to climate change threats in a variety of ways, including surface flooding from heavy downpours, wave action from storm surge, and asphalt damage from heat waves. These threats can have downstream impacts on other systems (including subways and utilities) and on private property. To mitigate the impact of these threats on streets and other infrastructure, subject to available funding, the City, through NYCDOT, will integrate a variety of climate resiliency features into future street reconstruction projects. This will include integrating storm water management best practices and tools. These features allow water captured on streets to soak into the ground rather than flow into the sewer system, resulting in lower drainage loads on both sewers and wastewater treatment plants. (see Chapter 12, *Water and Wastewater*)

While specific climate resiliency features will be designed for each location on a case-by-case basis, the range of tools could include raising street grades, installing bioswales (planted areas in the sidewalk designed to capture stormwater from the adjacent roadway) and/or pre-cast permeable concrete gutters, and adding or raising bulkheads. These features are already being integrated into active capital projects and this will continue in the future.

Initiative 3
Elevate traffic signals and provide backup electrical power

New York's traffic signals are vulnerable to damage from flooding, as well as to power loss from various extreme weather events. Either impact would reduce roadway network operational efficiency and could require the placement of New York City Police Department (NYPD) traffic agents to control traffic. The most vulnerable elements of the city's traffic signals are the signal controllers housing the electrical equipment that operates the traffic signal and communicate with the NYCDOT Traffic Management Center. Accordingly, subject to available funding, the City, through NYCDOT, will raise controllers at approximately 500 intersections in flood-vulnerable locations, placing the electrical hardware above the 100-year flood elevation. In tandem with this effort, the City also will install power inverters in approximately 500 NYPD vehicles, which will allow these vehicles to provide backup electrical power to critical traffic signals in the event that grid power is lost. These improvements will take place over the next three years and will increase the resiliency of this critical component of the transportation network.

Various technologies are available to seal tunnel entrances in the event of flooding such as the closeable flood doors on the Elizabeth River Tunnels in Portsmouth, VA. Credit: The Elizabeth River Tunnel Project, Portsmouth, VA

Initiative 4
Protect NYCDOT tunnels in Lower Manhattan from flooding

The two tunnels owned by NYCDOT in Lower Manhattan—the Battery Park Underpass and the West Street Underpass—are vulnerable to flooding from both storm surge and heavy downpours, which would significantly disrupt Lower Manhattan's transportation network. NYCDOT, therefore, has evaluated a series of potential flood protection strategies, including installing floodgates and raising tunnel entrances and ventilation structures above flood elevations to provide specific protection for sensitive mechanical and electrical equipment, including ventilation, lighting, and safety systems. Subject to available funding, the City, through NYCDOT, will implement the most promising and cost effective strategies to provide this protection from water infiltration and damage. The goal is to begin work in 2014 and complete it within five years.

Initiative 5
Install watertight barriers to protect movable bridge machinery

The mechanical equipment that allows 25 of the city's bridges to move to provide a clear path for marine traffic is vulnerable to flooding. Damage to this equipment could impact marine and roadway traffic, if bridges were locked either open or closed. Subject to available funding, the City, through NYCDOT, will install watertight barriers to protect the bridges' mechanical equipment from flood damage to ensure that these critical crossings function properly.

Initiative 6
Protect Staten Island Ferry and private ferry terminals from climate change-related threats

New York City's ferry services are vulnerable to disruption and damage from flooding and wind that could lead to extended service suspensions and reduced mobility. To maintain service and allow for quicker service restoration, the City, through NYCDOT and NYCEDC, will continue to use Federal Transit Administration Emergency Relief funds to construct physical improvements to the floating infrastructure, loading bridges/gangways, pilings, and piers at both the Whitehall and Saint George SIF terminals and at additional ferry landings around the city. Within the next four years, NYCDOT and NYCEDC will protect critical aspects of these facilities by water-proofing certain equipment, relocating other equipment out of harm's way, and otherwise protecting electrical equipment from damage.

Initiative 7
Integrate resiliency into planning and project development

Climate adaptation and resiliency have not been critical considerations in prioritizing capital projects for either Federal or City funds, making it more challenging to fund projects that address critical climate change-related vulnerabilities in the city's transportation network. The City, however, already has begun working with other member agencies of the New York Metropolitan Transportation Council, which is responsible for prioritizing federal transportation funding in the New York region, to ensure that resiliency is a factor in such prioritization. Going forward, the City will advocate for similar changes in the planning and evaluation factors that are included in the next Federal legislation funding surface transportation.

At the same time, the City will call upon the various transportation agencies in the region to plan jointly for resiliency and adaptation, thus avoiding duplicative investment and unintended consequences.

Initiative 8
Call on non-City agencies to implement strategies to address climate change threats

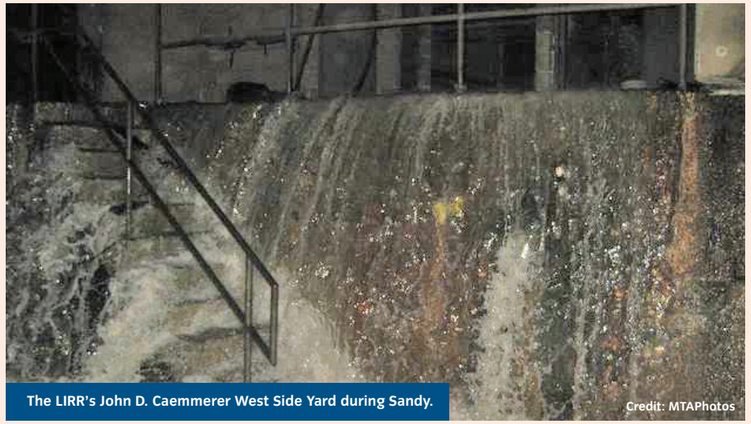
Many non-City agencies that own and operate critical portions of New York City's transportation system already have called for increased investment in resiliency and protection strategies appropriate for their

Adding System Flexibility

A number of projects that improve the flexibility of the transportation system and create redundant connections along critical corridors are currently in various phases of development:

- Amtrak's Gateway Project which seeks to add intercity rail capacity into New York City;
- extension of the MTA New York City Transit's 7 subway line to New Jersey or alternatives that would significantly expand cross-Hudson commuting capacity;
- transit improvements along the North Shore of Staten Island; and
- extension of Metro-North Railroad service to Penn Station.

LaGuardia Airport closed due to flooding on its runways. Credit: Port Authority of NY & NJ



The LIRR's John D. Caemmerer West Side Yard during Sandy. Credit: MTAPhotos

Temporary "Bus Bridges" (Non-Stop Bus Service) After Sandy

systems. Without comprehensive implementation of such actions across all transportation systems, critical assets could remain vulnerable to damage and disruption from future climate change-related events. Seeking to ensure that the city's entire transportation system is protected from climate change threats and is prepared for quick restoration following an extreme climate event, the City will call on these agencies to implement hardening and preparation measures, including those already outlined in plans such as the NYS2100 Commission Report. Infrastructure protection should include the following system elements:

- vehicular and rail tunnels, including the subway system;
- bus depots and terminals, and other facilities that are critical to providing bus service;
- rail and subway yards, and other facilities that are critical to providing rail service;
- airport facilities, including runways, lighting systems, navigation systems, and terminal buildings; and
- port and marine facilities, particularly those that handle critical supplies such as food, fuel, and building materials.

In addition, the City will continue to collaborate with Federal and State transportation agencies to support projects that expand the flexibility and redundancy of the transportation network. *(see sidebar: Adding System Flexibility)*

Strategy: Prepare the transportation system to restore service after extreme climate events

The city's transportation system is too large, too complex, and too old for it to be entirely "climate-change-proofed." In this vein, New York's experience after Sandy demonstrated the importance of maximizing modal redundancy within the system, of ensuring that—when systems are overwhelmed by extreme weather events—they are quickly brought back to regular service, and of being prepared to add temporary services to restore mobility while outages continue.

Therefore the City will implement the initiatives below.

Initiative 9

Plan for temporary transit services in the event of subway system suspensions

When major portions of the subway system are out of service, there simply is not sufficient capacity in the rest of transit network or the roadway system to carry the increased volume

Protected ferry landings can ensure rapid resumption of service.

of commuters and other travelers. To address this situation, the City, through NYCDOT, will continue to work with its transportation partners to develop and regularly update formal plans to provide temporary transportation services. These services could include temporary, high-capacity "bus bridges" of the type implemented during Sandy, temporary point-to-point ferry services, and dedicated bus lanes and necessary enforcement, among others. Identifying the range of potential threats to the transit network and the potential impacts of these threats will be critical to this effort, enabling agencies to determine the types of temporary services that may be necessary. Detailed strategies already have been developed and will continue to be refined and expanded by NYCDOT, the MTA, and other regional agencies. NYCDOT subsequently will acquire and store the traffic control, public information, and other ancillary materials necessary to implement these temporary services. *(See map: Temporary "Bus Bridges" (Non-Stop Bus Service) After Sandy)*

NYCDOT and NYCEDC will work with private ferry fleet operators, and with the MTA and private bus fleet operators, to investigate the level and type of support these companies could provide in the event of a public transit outage

Finally, NYCDOT will work with the MTA to investigate providing city residents with greater access to LIRR and Metro-North services during significant emergency events that lead to major transit disruptions, at fares comparable to those of the subway. This access would be limited to the periods of major disruption, providing an alternative mobility option similar to the type of "cross-honoring" of tickets that is often put in place on NJ TRANSIT buses, PATH, and NJ TRANSIT commuter rail following major disruptions of one of those services.

Initiative 10

Identify critical transportation network elements and improve transportation responses to major events through regular resiliency planning exercises

Many of the facilities critical to the City's ability to respond effectively to a disaster are vulnerable to disruption and damage, potentially impairing delivery of emergency services and supplies of food, fuel, and medicine, as well as impairing the restoration of critical non-transportation infrastructure and economic activity. To respond better to a variety of different possible transportation outage and restoration scenarios, the City, through NYCDOT, will begin immediately to work with a wide range of transportation agencies and other stakeholders around the region to identify the critical elements of the surface transportation network that need to be available quickly following different types of events. The key tool to identify these networks will be an ongoing series of detailed and multi-disciplinary resiliency planning exercises—and potentially even live drills—that will allow these agencies to understand where resources need to be focused before, during, and after an event. This will provide a basis for prioritizing resiliency investments, improving operational response, and disseminating guidance to transportation stakeholders about the routes that they can expect will be available following an event.

Initiative 11

Develop standard plans for implementing High-Occupancy Vehicle (HOV) requirements

During a number of different events—both natural and manmade—that have led to significant interruptions of subway service into and out of Manhattan, the volume of private vehicles trying to cross into Manhattan has overwhelmed available capacity and created gridlock in locations around the city. In response, the City has implemented requirements that vehicles entering the Manhattan central business district have three or more occupants. To improve the future implementation of these measures, the City, through NYCDOT and NYPD, is working to develop standard protocols for implementing HOV requirements, including the conditions under which these requirements will be implemented, and the tools that will be used to communicate this information to the public. NYCDOT, NYPD, and the City's Office of Emergency Management are working together to formalize any exemptions to the HOV requirements, including emergency response vehicles and potentially vehicles carrying key supplies such as food or fuel or emergency response personnel for private businesses. Detailed planning for this eventuality will be completed by the relevant agencies by the end of 2013.

Initiative 12

Plan for and install new pedestrian and bicycle facilities to improve connectivity to key transportation hubs

Subway service interruptions can cause New Yorkers to turn to walking and biking in large numbers, overwhelming the current capacity of pedestrian and bicycle paths, particularly those crossing the East River. To provide additional capacity in these situations, subject to available funding, the City, through NYCDOT and NYPD, will plan for the deployment of temporary pedestrian and bicycle capacity in the event of an emergency situation. This capacity could include special lanes on East River Bridges and their approaches, and lanes that provide access to ferry landings. These agencies will procure

and store the materials necessary to implement these facilities quickly in the event of an emergency, with such materials likely including static signs, temporary traffic control devices, and electronic message signs. Planning for this effort will begin in 2013, with the goal to fully develop these capacity enhancements by the end of 2014.

The City, through NYCDOT, also will work with CitiBike/NYC Bike Share, which provides a transportation option that does not require grid electrical power, to explore future expansion of the bike share network to areas that are vulnerable to weather-related transportation interruptions and that are also adjacent to CitiBike's initial service area, including neighborhoods such as Red Hook, Greenpoint, and Long Island City. This process will begin after the full Citibike deployment is complete.

Initiative 13
Construct new ferry landings to support private ferry services

Emergencies and other events that disrupt subway or transportation service can create serious challenges to mobility within the city, with resulting economic, community, and social impact. To increase the availability of interim transportation services—particularly between the boroughs—subject to available funding, the City, through NYCEDC, will work to expand the network of ferry landings available for both regular and emergency use. To support the establishment of emergency ferry services, NYCEDC will design and procure two new ferry landing barges that are outfitted with the required equipment for providing basic ferry service, with a goal of completing these within three years. These barges will be stored in a secure and protected location. When the need arises, they will be deployed within 24 to 48 hours as temporary landings, allowing for the rapid establishment of interim service. As part of this exercise, NYCEDC will work with the New York State Department of Environmental Conservation to identify potential locations where these barges quickly could be deployed adjacent to neighborhoods that are vulnerable to climate-related transportation interruptions, in a manner that minimizes the impact on the natural environment.

In addition, subject to available funding, the City, through NYCEDC and NYCDOT, will work together to deploy four new permanent ferry landings. These strategic locations will be selected based on the results of the ongoing Comprehensive Citywide Ferry Study in (see Initiative 18 for details on the study). The landings will be designed to be mobile so that, in an extreme situation, they can be temporarily relocated to provide alternative transit services where needed. The goal is to begin design of these landings later in 2013, with deployment based on the results of the ferry study.

Initiative 14
Deploy the Staten Island Ferry's Austen Class vessels on the East River Ferry and during transportation disruptions

During transit service disruptions that cause large numbers of commuters to use ferry services, the increased demand can outstrip the capacity of typical private ferry vessels. To supplement East River Ferry capacity during such times, NYCDOT will be prepared to deploy the SIF's Austen Class vessels for service along these routes, developing specific operational plans for different scenarios. The Austen Class ferries, due to their size and maneuverability, have been used on a number of occasions over the years to assist in emergencies. Each of the two vessels can carry 10 times the passenger volume of a typical East River Ferry and could, therefore, during major transportation disruptions, help meet sudden increases in ridership on the East River and potentially in other locations.

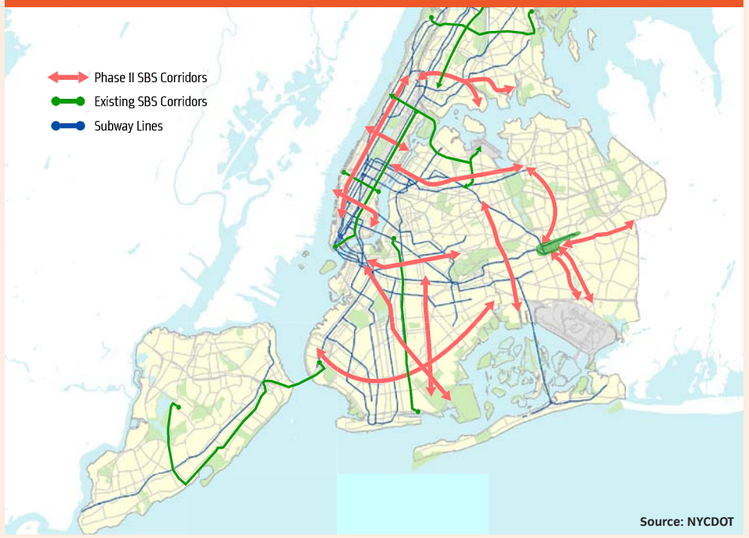
Initiative 15
Improve at all levels communications about the restoration of transportation services

During and immediately following an emergency situation, communication among agencies and with the general public can suffer from a lack of reliable information and clear communication channels, leading to considerable confusion. To improve the flow of accurate and reliable information, the City will use existing interagency working groups to develop standardized communications protocols for use during transportation disruptions. The plan will include a standard "playbook" for outreach to agency stakeholders and the public regarding system status and interim measures. Truck routes will be a particular focus, in order to provide accurate information to truck companies and drivers during emergencies, minimize the impact of trucks on the City's sensitive infrastructure, and facilitate the safe, fast, and efficient delivery of relief supplies.

Strategy: Implement new and expanded services to increase system flexibility and redundancy

During an emergency situation when subway service is disrupted, other transportation modes often are overwhelmed, crippling the city's mobility and economy. Greater system redundancy that adds flexibility to adapt to unexpected events would add to the resiliency of the transportation network. Beyond creating additional capacity and responsiveness on a daily basis, these investments will be particularly valuable during a variety of weather events and other emergency situations.

Existing and Proposed Select Bus Service Corridors



Source: NYCDOT

The City, therefore, will work with its transportation partners to develop and implement the new or expanded transit services described below.

Initiative 16
Expand the city's Select Bus Service network

Subway disruptions or outages can create serious mobility challenges for many New Yorkers. As described above, since 2008 the City and the MTA have implemented four SBS Bus Rapid Transit routes to address general mobility challenges. These routes also can form the backbone of high-capacity bus service in the event of major subway outages. NYCDOT is working with the MTA to expand the city's SBS network significantly, building on a plan developed jointly in 2010 and reinforced in the New York State 2100 Report issued in January. Implementation of this plan has already begun, with three new SBS routes ready to launch shortly in Brooklyn, the Bronx, and Queens. Planning is underway for the Woodhaven Boulevard corridor in 2013, benefiting some of the Southern Queens neighborhoods impacted by Sandy. Subject to available funding, over the next five years NYCDOT will work with the MTA to implement four additional SBS routes. Also subject to available funding, the additional 12 routes included in the plan will be launched subsequently. *(See map: Existing and Proposed Select Bus Service Corridors)*

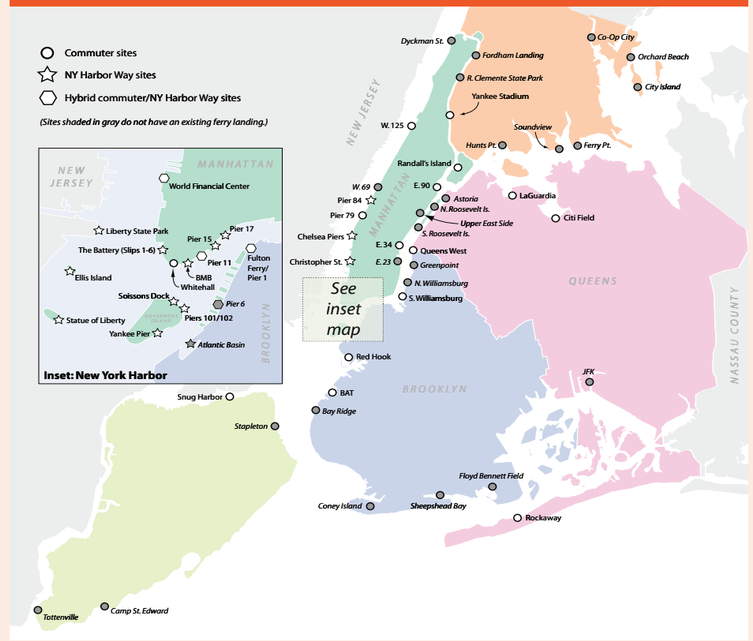
Initiative 17
Expand the network of bus priority strategies on arterial highways

During both normal and emergency situations, congestion on the region's highways can inhibit mobility and slow the city's recovery. As with the SBS routes, bus priority strategies for express, local, and intercity buses can improve this situation for both standard and emergency operations. Therefore, subject to available funding, the City, through NYCDOT, will work to expand its network of bus priority strategies. Over the next several years, the intention is to include 15 miles of bus priority corridors on major limited-access arterial highways, as these highways are improved or reconstructed in partnership with NYSDOT. This effort will focus on highways on which a variety of buses normally travel. Building on the State's Managed Use Lanes Study, these priority corridors will consist of lanes designed to help the impacted buses move through congested areas quickly and reliably. Types of treatments could include median bus lanes (similar to those on the Staten Island Expressway), contraflow bus lanes (such as contraflow lanes on the Gowanus Expressway and the Long Island Expressway), and use of shoulders for bus traffic (a technique that has been used successfully in other locations). The goal is to implement at least one new or expanded bus priority strategy within five years, with additional facilities added as opportunities arise.

Initiative 18
Expand ferry services in locations citywide

The city's waterways present barriers to movement when key crossings are disrupted by a storm or other events. Ferry services provide a critical transportation option for connecting the city across these obstacles under a variety of conditions, including transit disruptions. To plan these services better, the City, through NYCEDC, is currently updating the Comprehensive Citywide Ferry Study (first published in 2011) to explore opportunities for expanding ferry service beyond the existing routes. Based on the results of this study, the City, subject to available funding, will work with its private-sector partners to provide additional service in appropriate locations throughout the city. Chapter 14 (*Brooklyn-Queens Waterfront)*, Chapter 15 (*East and South Shores of Staten Island*), and Chapter 16 (*South Queens*) provide additional details on potential new or expanded ferry services in these respective neighborhoods. In addition, NYCEDC will use a Request for Expressions of Interest process to identify and validate the most promising opportunities for new ferry service. *(See map: Citywide Ferry Study)*.

Citywide Ferry Study



Staten Island Ferry Resiliency Upgrades

As was proved during Sandy, ferries are a critical lifeline during and after extreme weather events. This is, of course, true for the Staten Island Ferry, which provides a service that is directly threatened by climate change. Even as the City invests in waterfront and terminal infrastructure protections, ferry boats themselves face operational challenges and vulnerabilities during extreme weather events. Since three existing Barberi-class Staten Island Ferry boats are nearing the end of their useful lives, NYCDOT is preparing to replace these boats with new ferries with cycloidal propulsion systems. Cycloidal propulsion will improve ferry boat maneuverability and safety in high winds, rough waters, and during storm surges. NYCDOT has completed design of these boats and is seeking $300 million in federal funding to procure them. Accelerating these purchases will allow the ferries to be in operation by 2015, providing a resiliency benefit to the people of Staten Island and the city as a whole.

Parks

Manhattan's Fort Washington Park and its famous Little Red Lighthouse

Credit: NYC Parks

New York City boasts some of the most magnificent public parks in the world. From wild to manicured, from shoreline to inland, these parks run the gamut in program and design. Large or small, they offer New Yorkers and visitors alike seemingly endless opportunities for recreation. Playgrounds, waterfront esplanades, wetlands, hiking trails, dog runs, boating and kayaking areas, athletic courts and fields, beaches and swimming pools, monuments and historic buildings—all these can be found in the city's parks.

This system of parks and open spaces spans over 29,000 acres, covering 14 percent of the city and encompassing 1,942 sites across all five boroughs. Not surprisingly, because of the vast extent of the city's parks system, when Sandy hit, the impact felt across New York was also felt in parks citywide. From trees downed by Sandy's winds to large stretches of boardwalk and beaches overwhelmed by Sandy's surge, the storm not only wrought hundreds of millions of dollars in damage, but also disabled spaces that, in many cases, were the heart and soul of the neighborhoods they served. With centers for distributing food and other needed supplies, parks were the places where communities came together to begin the road to recovery.

Credit: NYC Parks

Jamaica Bay

Jamaica Bay is one of New York's largest natural features, covering over 10,000 acres of parkland in Brooklyn and Queens managed by both the City and the Federal governments. The Bay contains rare native habitats such as salt marshes, forests, and freshwater ponds. The Bay also is home to a stunning array of wildlife, including over 50 species of butterflies, and a bird sanctuary visited by 330 different species.

The accelerated loss of marshland within Jamaica Bay over the 20th century prompted many governmental initiatives to preserve and restore the Bay's ecology. With the goal of better aligning their Jamaica Bay-area holdings and to foster greater collaboration, in July 2012, then-Secretary of the Interior Ken Salazar and Mayor Bloomberg signed a landmark Cooperative Management Agreement governing Jamaica Bay-Rockaway Parks.

As part of this Agreement, the City is embarking on several initiatives with leadership support from the Rockefeller Foundation and additional support from Bloomberg Philanthropies, Moore Charitable Trust, National Grid, and the Secunda Family Foundation. First, the City aims to expand wetland restoration that it had begun around Jamaica Bay, guided by the Comprehensive Restoration Plan developed under the United States Army Corps of Engineers with support from the National Park Service, the City, and many other regional entities. These efforts are also guided by the Department of Environmental Protection's Jamaica Bay Watershed Protection Plan. Second, the City will establish interagency working groups to explore the feasibility of restoring the historic shallow basin profile of Jamaica Bay to benefit both habitat and the environment while reducing storm surge-related flood risks in areas surrounding the Bay. Third, the City, in partnership with the National Park Service, will establish the Jamaica Bay-Rockaway Parks Conservancy to promote visitation, education programs, scientific research and recreational opportunities. Finally, the Agreement also seeks to establish a Science and Resilience Center at Jamaica Bay to catalyze research and fieldwork in the Bay. Among other things, the new Center will facilitate an exchange of information among policymakers and academics on issues of coastal and urban resiliency that are relevant to cities around the world. The Center also will address local issues facing the Bay, including opportunities to improve water quality and continue to restore degraded natural areas.

As devastating as Sandy was to the parks system, the storm also taught two important lessons: First, with certain exceptions, much of the parkland emerged with only moderate damage; this showed that, where properly designed, parks and other open spaces actually can withstand the blow of a severe storm. Moreover, in many cases, they acted as the first line of defense for the neighborhoods and infrastructure that they fronted, revealing that parks serve an important protective purpose.

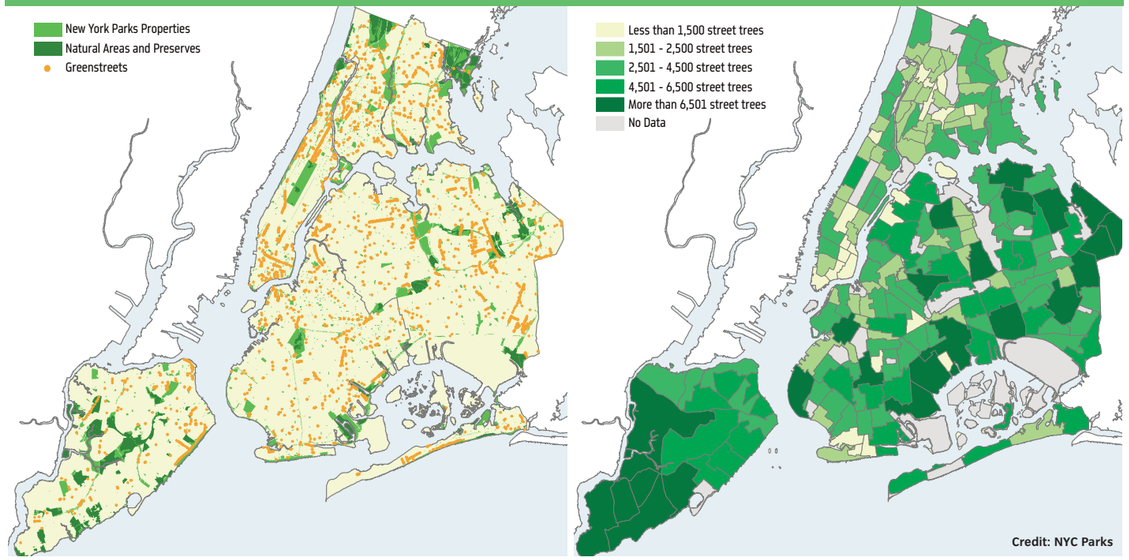
These lessons are critical because New York's parks are not only vulnerable to today's climate-related threats, but are likely to become more so as climate change continues. This is true not only with respect to acute conditions such as storm surge, but also with respect to chronic conditions such as increased temperatures and rainfall. Even modest changes can wreak havoc on the many species of plants and animals found in the city's parks—species that, in many cases, have evolved over eons to thrive in a climate that now is changing rapidly. Indeed, climate change not only threatens the natural landscape of the city's parks but actually threatens the city itself, putting at risk plants that help retain stormwater, provide shade, and make the city livable.

Given the many important roles played by the city's park system, it is critical that New York take steps today to improve the system's resiliency. In keeping with the overarching goals of this report—to minimize the impacts of climate change and enable quick recovery after extreme weather events—the City will pursue strategies that will strengthen parks themselves so they, in turn, can act as stronger buffers for adjacent communities. The City also will develop the tools to analyze and modify its park system for these many roles in an era of increasing change.

How the Parks System Works

New York is fortunate to host parks owned and operated by the City, State, and Federal governments, as well as several that are managed jointly. For example, Hudson River Park along the west side of Manhattan is managed by a trust that is jointly controlled by the City and the State. The National Park Service, meanwhile, manages a 22-acre national monument on Governors Island, while the Trust for Governors Island, a not-for-profit created by the City, manages the other 150 acres. The planned transformation of Jamaica Bay into a world-class site for recreation, ecological restoration, wildlife protection, and scientific research is an expansive example of City-Federal cooperation. (*See sidebar: Jamaica Bay*)

New York City's Parks System



Credit: NYC Parks

The City also partners with non-governmental bodies in the management of parks. For example, Central Park, Forest Park in Queens, the Staten Island Greenbelt, and Prospect Park are supported in part by independent conservancies, which raise funds for the operation and maintenance of those parks. *(See sidebar: Public-Private Partnerships)*

For the most part, however, when New Yorkers visit parkland in the five boroughs, they are visiting recreational assets that are both owned and managed by the City through the Department of Parks & Recreation (DPR). These properties, therefore, are the primary focus of this report. *(See map: New York City's Parks System)*

The City's parks system can be categorized into four main types of properties: beaches and waterfront parks, inland parks, natural areas and preserves, and Greenstreets infrastructure.

Beaches and Waterfront Parks
Among DPR's assets, its beaches, boardwalks, and waterfront parks constitute by far its most expansive category, covering over 7,300 acres or 30 percent of its total land area. This parkland connects millions of city residents and visitors to the water. In fact, in 2012 alone, the city's beaches welcomed over 21 million people, providing them with a wide range of recreational opportunities and amenities. Especially in recent years, the city's waterfront parks also have spurred the development of residences and businesses along their peripheries. Examples of waterfront parks include Rockaway Beach in Queens, Coney Island in Brooklyn, Orchard Beach in the Bronx, Battery and Riverside Parks in Manhattan, and Midland Beach in Staten Island. Waterfront parks can be found along 150 miles—or almost 30 percent—of the city's total coastline.

Inland Parks
New York's 1,942 parks are home to more than 1,000 playgrounds, 800 athletic fields, 550 tennis courts, 60 public pools, and 30 recreation centers, as well as many other active and passive assets. Connecting these parks to one another and to the city's waterfront and beaches are over 100 miles of Greenways that provide residents and visitors alike with pedestrian- and cyclist-friendly corridors.

Natural Areas and Preserves
The city's 9,900 acres of natural areas include forests, grasslands, and wetlands—representing over a third of the acreage in DPR's system. Natural areas provide many benefits, including air quality improvements, carbon sequestration, enhanced wildlife habitats, stormwater retention, shoreline protection, and native plant life preservation. The city's wetlands, for example, shelter a wide variety of plants and animals. These areas protect the quality of waterways by absorbing nutrients and filtering sediment and contaminants.

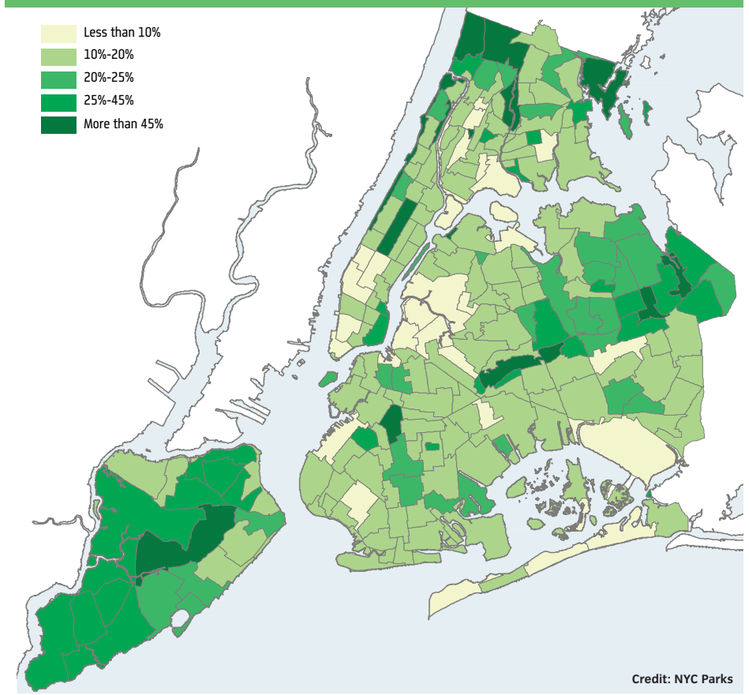
Freshwater streams play an important role in New York city's ecosystem as well as manage stormwater runoff. Today, however, there are few natural streams remaining in New York City, with many now piped underground. Some, such as Tibbetts Brook in the Bronx, also are connected to the City's combined sewer infrastructure and flow directly into the local wastewater treatment plant.

Public-Private Partnerships

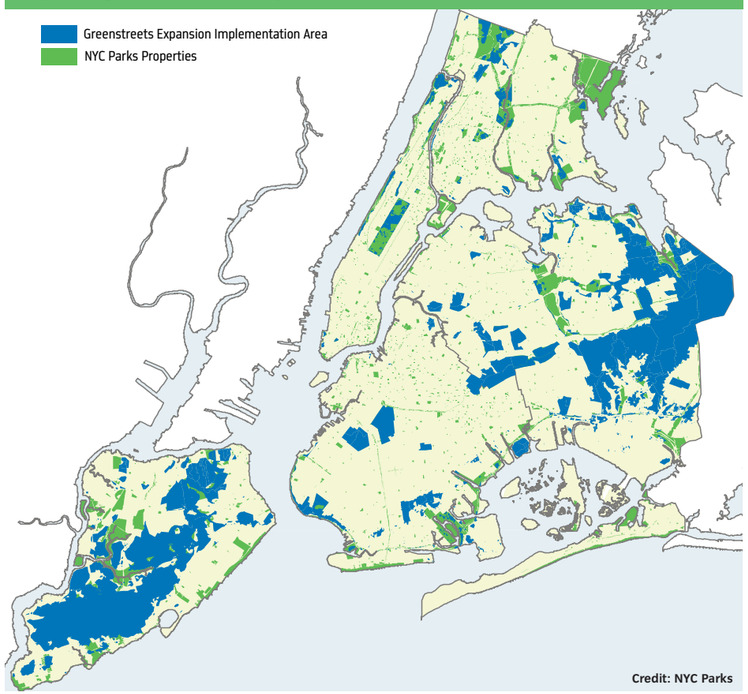
New York City's parks system has experienced an incredible transformation over the past 30 years with the assistance of many partner organizations. This wide network of innovative partnerships has brought countless volunteers, much needed resources, and a shared advocacy for the city's green spaces. Hundreds of neighborhood Friends of Parks groups, many supported by Partnerships for Parks, have galvanized local interest and stewardship across the five boroughs.

Organizations like the Central Park Conservancy, the Forest Park Trust, Prospect Park Alliance, the Greenbelt Conservancy, and the Bronx River Alliance have absorbed significant maintenance responsibility in specific parks and also raise millions of dollars for capital improvements. Other partners cast a citywide focus, such as the City Parks Foundation, with its commitment to expanding opportunities for cultural and recreational programming, and the Natural Areas Conservancy, a new organization developing a innovative model to manage natural areas in parks as one ecosystem.

Tree Canopy by Neighborhood



Expanding the Greenstreets System



Also found in the city's natural areas—as well as in inland parks, along waterfront parks and beaches, and along streets—are trees, many of which are managed by DPR. These trees not only moderate temperatures; they also remove carbon dioxide and pollutants from the air, among other important functions. DPR's trees range from large canopy trees to street trees, which both enhance sidewalk environments and protect waterways by reducing stormwater runoff. DPR staff manage this urban forest by planting new trees and pruning existing trees to remove dead branches and increase light and air penetration. Since it was announced in PlaNYC in 2007, the City has planted nearly 760,000 trees as part of the Million-TreesNYC initiative. *(See map: Tree Canopy by Neighborhood)*

Greenstreets

DPR's green infrastructure includes natural areas that absorb stormwater and 2,500 Greenstreets, which transform parts of the city's asphalt areas into green landscapes. First constructed in 1996 as a joint project between DPR and the City's Department of Transportation (NYCDOT), Greenstreets have been built throughout the five boroughs in unused road areas, traffic islands, and industrial areas. Greenstreets beautify communities, improve air quality, reduce air temperatures, and enhance safety by shortening street-crossing distances and slowing traffic. (*See map: Expanding the Greenstreets System*)

In 2010, the unit that managed DPR's Greenstreets program became the Green Infrastructure Unit, solidifying its focus on active stormwater capture and using soil beds and other natural features to divert water. By using specially designed soils and plants in these areas, Greenstreets projects absorb runoff from an area 10 or more times their size. Created in partnership with the Department of Environmental Protection (DEP), new stormwater Greenstreet designs enhance cost-effective rainwater capture practices in priority areas of the city, as part of the NYC Green Infrastructure Plan. This work prevents runoff from entering the City's combined sewer system, which, in turn, lessens the frequency of combined sewer overflows (CSOs).

To manage these four categories of parks assets, DPR has a variety of administrative buildings from which staff run, build, and maintain this one-of-a-kind park system. These buildings include the agency's headquarters at the Arsenal in Central Park and other operations centers citywide. In addition to its administrative facilities, DPR also operates other facilities that support its operations and research activities. For example, the Greenbelt Native Plant Center, a 13-acre greenhouse and seed bank, provides plant material for natural area restoration projects in the city.

Finally, across the city, DPR supports its efforts through a wide variety of recreational, cultural, scientific, and educational programming. In 2013, DPR launched a Parks Fellowship and Conservation Corps, a new public service program that will expose and attract participants to career opportunities in DPR and the environmental field. The Conservation Corps will support DPR priority projects, provide valuable work experience across DPR divisions, and foster the next generation of leaders dedicated to protecting and enhancing the City's parks and natural resources.

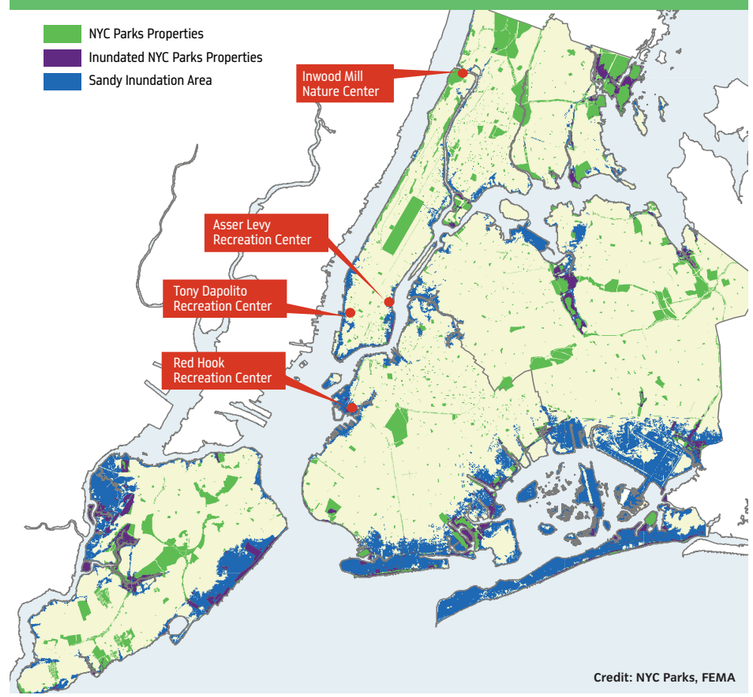
What Happened During Sandy

Sandy inundated over 5,700 acres of New York's park system and caused nearly $800 million in damage. (*See map: Parks Assets Affected by Sandy)*

As described in Chapter 3 *(Coastal Protection)*, the city's beaches bore the brunt of the storm's wave action, with significant impacts on the Rockaway Peninsula, Coney Island and adjacent areas of Southern Brooklyn, and along the East and South Shores of Staten Island. On the Rockaway Peninsula, storm surge pounded whole sections of the boardwalk, scattering them into the neighboring communities. Meanwhile, erosion displaced up to 3 million cubic yards of sand and maybe more. In some places, beachfronts retreated by as much as 70 feet. Sandy also pushed water over bulkheads on DPR-managed waterfront sites, damaging these critical coastal defenses and allowing waters to flood parts of the Belt Parkway in Brooklyn. In addition, Sandy damaged DPR's beachfront infrastructure and facilities, including public restrooms.

However, earlier beach nourishment projects (where sand was deposited on existing beaches to both elevate and widen them) also proved successful at city beaches. As a result, for example, the portion of Rockaway Beach at Beach 56th Street, which had well-maintained planted dunes, not only was able to partially resist Sandy's force but also was instrumental in protecting neighborhoods. By contrast, at Beach 94th Street, which had limited beach nourishment and dune maintenance, storm surge destroyed the wooden boardwalk and swept significant volumes of sand into the surrounding neighborhoods. Another successful nourishment project could be found at Plumb Beach in Southern Brooklyn, where, just before Sandy hit, the United States Army Corps of Engineers (USACE) had finished adding 120,000 cubic yards of clean, dredged sand. This intervention

Parks Assets Affected by Sandy



kept Sandy's surge from potentially breaching a vulnerable section of the Belt Parkway.

Interestingly, not all waterfront parks in Sandy's path were impacted equally. The use of resilient materials and terraced grading helped protect Battery Park and Riverside Park. Revetments, armor stone edges that absorb and deflect waves, and salt-tolerant plantings helped Brooklyn Bridge Park escape with less damage than much of the area surrounding it. At Governors Island, meanwhile, thanks to elevation and other flood-protective strategies, the site of a future park escaped largely unharmed.

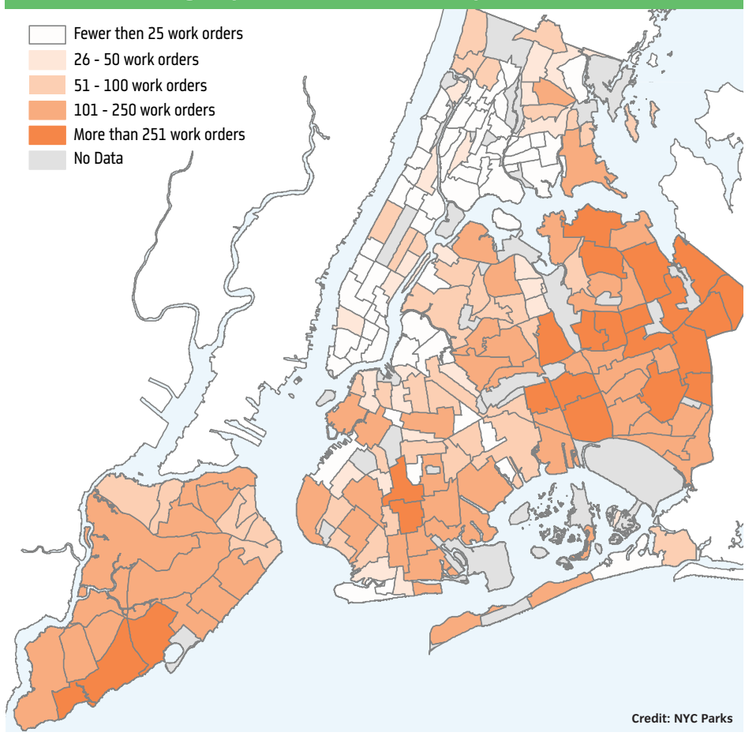
However, flooding from storm surge did affect city marinas and piers, including the 79th Street Boat Basin in Manhattan, the World's Fair Marina in Queens, the Sheepshead Bay Piers in Brooklyn, and the Lemon Creek Marina on Staten Island. Docks, pilings, and piers were damaged, and buildings supporting these marinas were inundated, causing damage to equipment and electrical and plumbing systems.

While the waterfront parks faced the most direct impacts, certain inland neighborhood recreational facilities sustained damage as well. In inundated areas, facilities such as the Asser Levy Recreation Center, the Tony Dapolito Recreation Center, the Inwood Nature Center, and the Red Hook Recreation Center suffered significant water damage to structural and mechanical systems, affecting in some cases the massive filtration plants supporting attached outdoor pools. As a result of this inundation, these centers were shut for four weeks.

Though Sandy flooded over 3,000 acres of natural areas, New York City's wetlands fared relatively well. For example, the salt marshes located in Jamaica Bay and its tributary systems remained largely clear of floating debris, with much of their vegetation surviving. By contrast, across the city, approximately 20,000 street and park trees were downed by Sandy's winds, resulting in weeks of emergency forestry work. In some areas, downed trees and limbs took down nearby utility lines, which disrupted power and telecommunications services. *(See map: Street Tree Emergency Work Orders Post-Sandy)*

With respect to Greenstreets, many performed well during Sandy. For example, the stormwater Greenstreet at Nashville Boulevard and Colfax Street in Queens absorbed water equivalent to 31 times its own area, including 1,300 gallons of rainwater falling directly on it and 39,000 gallons of runoff flowing in from surrounding streets—an amount estimated to represent 3,000 percent more water than a non-stormwater Greenstreet typically would hold. In the stormwater sites, little erosion or ponding was seen. While surge inundation killed some vegetation, generally, Greenstreets emerged from Sandy with minimal damage and plant loss.

Street Tree Emergency Work Orders Post-Sandy



Credit: NYC Parks

Parks Assets Inundated and at Risk

NYC Parks	Citywide Total	Inundated by Sandy		2013 PWMs 100-Year Floodplain		Projected 2020s 100-Year Floodplain		Projected 2050s 100-Year Floodplain	
Park Properties (acres)*	24,200	5,700	24%	5,800	24%	6,600	27%	7,400	31%
Street Trees**	592,400	41,600	7%	35,990	6%	46,400	8%	61,100	10%
Natural Areas (acres)	9,900	3,000	30%	3,117	31%	3,300	33%	3,500	35%
Greenstreets (acres)	173	26	15%	26	15%	30	17%	40	23%

* not including areas located beyond NYC shoreline
** based on 2005-2006 Street Tree Census data

Risk Assessment: Impact of Climate Change on Parks

Major Risk Moderate Risk Minor Risk

	Scale of Impact			
Hazard	Today	2020s	2050s	Comments
Gradual				
Sea level rise				Risk in coastal areas for parks, Greenstreets, street trees, and natural areas
Increased precipitation				Could increase flooding in inland parks, natural areas and preserves, and roadways
Higher average temperature				Could increase stress on plantings, especially if coinciding with drought
Extreme Events				
Storm surge				Risk primarily for coastal parks (significant expansion in parks acreage in the floodplain by the 2050s), but could produce flooding in inland areas
Heavy downpour				Resulting flooding could cause street tree and forestry damage
Heat wave				Could increase stress on plantings
High winds				Street trees and forestry at risk, with indirect impacts on power lines and transportation

Key DPR operations and administrative facilities both within and beyond the inundation zone were impacted by Sandy. In Flushing Meadows Corona Park, areas of the park at lower elevations and closer to Flushing Bay were flooded, including the Olmsted Center, causing damage to office spaces, archived documents, and the computer network. On the other hand, a facility within Sara D. Roosevelt Park in Manhattan, which assists in dispatching needed Parks resources in emergency situations, was equipped with a generator and continued operation despite widespread power loss in surrounding areas. *(See table: Parks Assets Inundated and at Risk)*

Crescent Beach Park on Staten Island post-Sandy

Credit: NYC Parks

What Could Happen in the Future

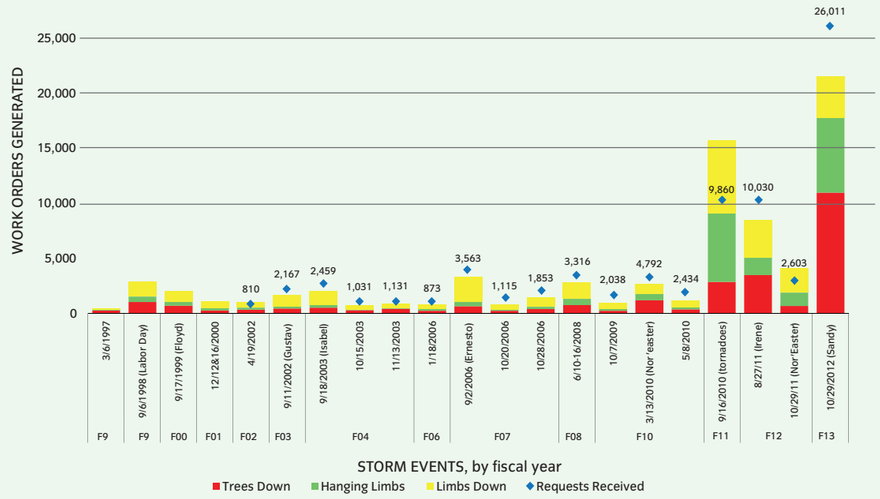
Going forward, the city's parks face a variety of risks related to climate change.

Major Risks

The most significant risk to the parks system is flooding from coastal storms, which is likely to be exacerbated by projected sea level rise. This risk is significant even today, as illustrated by recently released flood maps from the Federal Emergency Management Agency (FEMA). According to these maps, called Preliminary Work maps (PWMs), over 5,800 acres (or 24 percent) of the city's parkland are in the 100-year floodplain, an area that has a 1 percent or greater chance of flooding in any given year. Over 230 DPR buildings are within the floodplain, including several key facilities such as the Greenbelt Native Plant Center and the Lyons Recreation Center on Staten Island.

According to the New York City Panel on Climate Change (NPCC), sea levels are expected to rise around New York City. By the 2020s, under high-end sea level rise projections, 6,600 acres (27 percent) of the city's parkland could lie in the 100-year floodplain, increasing to over 7,400 acres (or 31 percent) by the 2050s. An even more disturbing pattern

Forestry Storm Events



Credit: NYC Parks

holds true for DPR buildings, with the number in the floodplain forecast to grow even faster, rising to 301 buildings (an increase of 30 percent) by the 2020s and to almost 350 buildings (a 50 percent increase) by the 2050s. This increasing vulnerability to storm surge can be seen across DPR's portfolio, from its natural areas to its street trees to its Greenstreets—putting all these assets and the surrounding communities they protect at risk. *(See map: Parks Assets in the Floodplain)*

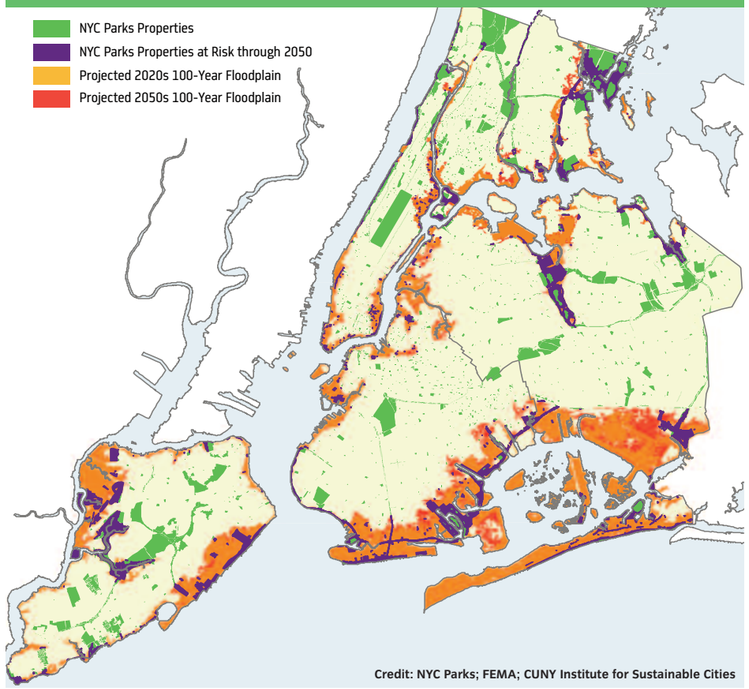
Other Risks

While surge from coastal storms poses the most significant climate-related risk to New York's parks in coming years, other extreme weather events also could impact DPR's system. With an estimated 2.5 million trees under DPR's jurisdiction, the city's urban forest is at great risk with the increasing frequency of the most intense storms with high winds, potentially impacting vital utility networks. Similarly, more frequent heavy downpours in New York could damage play surfaces and cause water quality impacts. (*See graph: Foresty Storm Events*)

Even without extreme weather events, chronic hazards also could impact New York's parks. For example, gradual sea level rise over time could lead to the loss of salt marsh habitats along the city's coastline, endangering plants and animals—a threat also posed by expected higher average temperatures and increased variability in precipitation. Additionally, sea level rise could lead to regular tidal flooding around New York City, especially in parks in South Queens, Alley Pond Park in northern Queens, and Pelham Bay Park in the Bronx.

Meanwhile, associated changes in ocean temperature may affect the distribution of oysters and other aquatic life in New York Harbor, and also could affect commercial and recreational fisheries in and around the city. Sea level rise and other chronic changes also could impact the water levels and chemistry of area freshwater ponds, harming the local ecology.

Parks Assets in the Floodplain



Credit: NYC Parks; FEMA; CUNY Institute for Sustainable Cities

This chapter contains a series of initiatives that are designed to mitigate the impacts of climate change on New York's parks system. In many cases, these initiatives are both ready to proceed and have identified funding sources assigned to cover their costs. With respect to these initiatives, the City intends to proceed with them as quickly as practicable, upon the receipt of identified funding.

Meanwhile, in the case of certain other initiatives described in this chapter, though these initiatives may be ready to proceed, they still do not have specific sources of funding assigned to them. In Chapter 19 *(Funding)*, the City describes additional funding sources, which, if secured, would be sufficient to fund the full first phase of projects and programs described in this document over a 10-year period. The City will work aggressively on securing this funding and any necessary third-party approvals required in connection therewith (i.e., from the Federal or State governments). However, until such time as these sources are secured, the City will only proceed with those initiatives for which it has adequate funding.

To protect parks and their surrounding neighborhoods, the City will work to upgrade and better prepare these parks—and related facilities—to withstand future extreme weather events as well as the chronic impacts of climate change. To this end, the City will seek to make parks more effective at absorbing and buffering the impacts of extreme events; will work to retrofit or harden parks and facilities, as well as wetlands and other natural areas; and will develop tools for comprehensive climate adaptation planning and design.

Strategy: Adapt parks and expand green infrastructure to shield adjacent communities from the impacts of extreme weather events

To protect parks themselves, together with surrounding neighborhoods, the City will seek to increase the capacity of its parks to absorb floodwaters (from storm surge and heavy precipitation) and to absorb the driving impact of surge-related wave action. The City also will seek to expand its green infrastructure citywide.

Initiative 1
Restore city beaches

Beaches play an important recreational role and also are an important component in the city's coastal defenses, but they cannot protect adjacent areas without being "nourished" (replenished with new sand to replace that lost to erosion) from time to time. Subject to available funding, the City, through DPR, will collaborate with Federal and State partners—including the USACE—to implement plans quickly to restore sand lost after extreme storm events and to conduct regular nourishment of beaches and regular monitoring to detect the early signs of erosion. The goal is launch this effort at city beaches such as Plumb Beach in Brooklyn and Orchard Beach in the Bronx by 2015 (see Chapter 3*)*.

To restore the city's beaches following Sandy, DPR and the Department of Design and Construction, in cooperation with many other City, State, and Federal partners, conducted an expedited program of projects to provide new and elevated lifeguard stations and public bathrooms and improvements to other beachfront amenities in advance of Memorial Day 2013. DPR constructed 35 prefabricated modular buildings, to be used as comfort stations and lifeguard stations, in Rockaway, Coney Island, and Staten Island, informed by storm surge projections for the 500-year floodplain at a height ranging from 7 to 14 feet above the existing grade to reduce the risk of flood damage and give a greater level of protection to these facilities. This impressive achievement comprised the first phase of restoring the city's beaches. In the coming months and years, DPR will continue its efforts to provide emergency sand nourishment and to expedite planning, evaluation, and design work for long-term plans to restore the city's beaches, boardwalks, and other beachfront amenities.

Credit: Sage and Coombe Architects

Phase 1 Restoration, Rockaway Beach

Initiative 2
Harden or otherwise modify shoreline parks and adjacent roadways to protect adjacent communities *(See Coastal Protection Initiative 30)*

Approximately 24 percent of DPR parks and other open spaces are in the 100-year floodplain on the PWMs, which is expected to expand as sea levels rise—including in areas where parks front residential and commercial districts. Subject to available funding, the City, through DPR, will study and identify mitigation strategies, including cost-effective ways to use its parks system to protect adjacent neighborhoods and the parks themselves. Strategies could include hardening or elevating park infrastructure, construction of levees or floodwalls to minimize flooding and attenuate waves, and using flood-tolerant materials in the construction of parks. The goal is to complete this study in 2014.

Initiative 3
Reinforce or redesign bulkheads in coastal parks *(See Coastal Protection Initiative 6; see Coastal Protection Initiative 29)*

The current portfolio of bulkheads and other waterfront structures in the city includes many aging or damaged assets that are at risk of failure, particularly during a major storm event. Many of these at-risk bulkheads can be found on DPR properties. Subject to available funding, the City, will inspect—as part of a new citywide waterfront inspection program—damaged bulkheads on parkland to develop a plan that will allow, over time, for their reconstruction, elevation, or replacement with living shorelines, where appropriate, that are both more resistant to storm damage and more accommodating of marine life. The goal is to launch this program in 2013. See Chapter 3 for more information on the City's plans for inspecting bulkheads and improving the resiliency of the coastline.

Initiative 4
Expand the City's Greenstreets, including for Jamaica Bay

Increased localized flooding is likely from more frequent heavy downpours in the future.

Subject to available funding, the City, through DPR and in partnership with DEP, will expand its efforts to build more and larger Greenstreets to absorb stormwater, mitigate local flooding, decrease urban heat island effect, increase pedestrian and traffic safety, and beautify neighborhoods. This will expand the installation of green infrastructure at appropriate locations in the City's streets, with approach modeled upon the NYC Green Infrastructure Plan, which improves water quality in combined sewer areas.

The first phase of this expansion would focus on fourteen neighborhoods with the greatest potential for improvement, areas that are not slated for CSO improvements through the NYC Green Infrastructure Plan, but could be well-suited for Greenstreets based on best available data showing low bedrock and ground water. The goal is to construct and maintain 1,600 Greenstreets at a high density to amplify impacts such as cooling and ecological health. This expansion would capture approximately 32 million cubic feet of stormwater per year by 2015, with a footprint of over 50 acres of increased green space. Thereafter, DPR will consider expansion of this strategy over a 10-year period, focusing on the remaining 20 percent of the city where new Greenstreets could provide myriad benefits.

An early priority for this effort will be the area surrounding Jamaica Bay, where DPR will collaborate with DEP and NYCDOT to reduce localized flooding and stormwater runoff, directly improving the health of the Bay. The goal is to begin pilot projects in and around Coney Island, Marine Park, the Rockaways, and Canarsie Park, including Greenstreets and parkland installations by 2014.

Strategy: Retrofit or harden park facilities to withstand the impacts of climate change

Even where parks-related facilities do not serve a protective function, they nonetheless offer vitally important amenities for the communities they serve. The City, therefore, will seek to protect these facilities from the impacts of climate change where possible and to enable them to bounce back quickly when impacts do occur.

Initiative 5:
Fortify marinas and piers

Marinas and piers are valuable water-dependent facilities that are vulnerable to extreme weather events. Subject to available funding, the City, through DPR, will begin to address this vulnerability by increasing the resiliency of its fixed and floating structures at the 79th Street Boat Basin in Manhattan, the World's Fair Marina in Queens, Lemon Creek Marina in Staten Island, and the Sheepshead Bay Piers in Brooklyn in 2013. This work will include increasing piling count and height, replacing deteriorated pilings, and installing steel hurricane straps on piers. Additionally, lighter floating docks will be replaced with heavy-duty, modular articulating docks, more robust wave screens, and icebreaker systems. Contingency plans also will be developed to accommodate bow-loading passenger ferries, in the event that these sites can aid in emergency transportation measures *(see* Chapter 10, *Transportation)*. The goal is to complete these improvements by 2016.

Initiative 6
Relocate or increase the resiliency of playgrounds and athletic fields

The City's park network includes over 1,000 playgrounds and 800 athletic fields—over 256 acres of which were inundated during Sandy. Subject to available funding, the City, through DPR, will continue to assess whether facilities impacted by Sandy or otherwise impacted should be relocated or otherwise protected from future inundation. Based on these findings and subject to available funding, DPR then will adopt flood-mitigation tactics at these facilities (such as carpet-style synthetic turf and tiled safety surfacing) to allow for easier post-flood repair and cleanup. DPR also will install rain gardens and water collection systems around these facilities to reduce flooding in parks and the burden on stormwater systems during these extreme events. The goal is to complete the analysis of all sites by 2015.

Initiative 7
Protect mechanical systems at major park facilities and buildings

As with buildings citywide, many park facilities in flood-prone areas have mechanical systems that are vulnerable to inundation. Damage to these systems can, in turn, result in extended facility closures and costly repairs. Subject to available funding, the City, through DPR, therefore will begin the process of flood-proofing all of its mechanical, electrical, irrigation and critical systems in parks that are located in the 100-year floodplain. These protective measures could include elevating mechanical systems, or flood-proofing their enclosures—all consistent with strategies outlined in Chapter 4 *(Buildings)*. Subject to available funding, this effort will begin with a DPR-led pilot program to test flood-proofing technologies to achieve maximum effectiveness in future capital projects. The goal is to commence this pilot program by 2015, at which time DPR will identify and implement design strategies for five different facilities, targeting boilers; heating, ventilation, and air conditioning systems; pool filtration plants; and irrigation systems.

Initiative 8
Move or protect critical operations centers

Many DPR buildings, including operations centers and administrative buildings, are located in the 100-year floodplain and are, therefore, at risk of flooding. Subject to available funding, the City, through DPR, therefore, will strive to maintain critical operations at these centers during and immediately after extreme weather events. To this end, DPR will construct waterproof walls, berms, and pump systems powered with dual fuel generators, where possible, to protect these centers from flooding. DPR also will upgrade applicable telecommunication, utility, and computer systems in these centers so they can function as temporary reporting sites. These upgrades will occur pursuant to the availability of funding. The goal is to complete this project in five years.

Strategy: Protect wetlands, other natural areas, and the urban forest

Wetlands, streams, forests and other natural areas offer substantial sustainability and resiliency benefits. The protection and restoration of these natural areas is, therefore, of critical importance.

Initiative 9
Work with the Federal government to transform Jamaica Bay

One of the most significant opportunities in New York's history for the development, management, maintenance, and programming of an integrated set of wetlands and other natural areas for natural habitat and recreational use exists in and around Jamaica Bay. Through its groundbreaking partnership with the National Park Service, the City, through DPR, will seek to promote habitat preservation and flood protection as well as a variety of programs in the 10,000 acres of Federally and City-owned parks in and around Jamaica Bay. This program will offer educational, scientific, recreational, and other opportunities to visitors. The goal for this partnership is to lead large-scale bay restoration and green infrastructure projects, which, in addition to improving the Bay itself, also will protect the many adjacent neighborhoods in Brooklyn and Queens.

Initiative 10
Increase the health and resiliency of natural areas, including Tibbetts Brook

Increased stormwater runoff mixed with sewage outflows poses a risk not just to the developed areas of the city but also to its natural areas. Subject to available funds, the City, through DPR and DEP, will restore freshwater streams and restore or construct wetlands to manage runoff and reduce the impacts of extreme weather events.

In particular, DPR will collaborate with DEP to make near-term progress toward the separation of Tibbetts Brook from the city's combined sewer system. This will reduce stormwater flow into the combined sewer system and provide wetland restoration in a cost-efficient manner. This effort will include property acquisition, conceptual design, and eventual construction. Successful separation would reduce CSO volumes into the Brook and the Harlem River by an estimated 140 million gallons per year, improving river water quality and freeing capacity at the Wards Island Wastewater Treatment Plant.

The goal is to develop conceptual designs and complete construction documents by 2015.

Initiative 11
Improve the health and resiliency of the city's urban forest

The city's forests and trees provide an array of health and environmental benefits. They are, though, vulnerable to a variety of climate change-related impacts, including storm surge, wind, and changes in average temperatures. Subject to available funding, the City, through DPR, will undertake a variety of efforts to protect trees—whether located in natural areas and parks, or along streets. Specifically, DPR will undertake three parallel efforts, all subject to available funding.

First, DPR will add to its forest management crews. Just one additional six-person crew would allow DPR, in partnership with the Natural Areas Conservancy, to expand active management of forests by 200 acres. Second, DPR will identify locations to expand tree beds, thereby giving tree roots more room to grow and reducing the high rate of tree mortality and failure during storms. Initially, DPR will target 5 percent of all planting locations for such expansion in connection with the City's existing MillionTreesNYC initiative. Finally, DPR will modify its regular tree inspection and pruning efforts to prioritize trees in areas vulnerable to extreme weather events. These pruning efforts will cover 80,000 street trees, 10,000 young trees, and 20,000 park trees annually—a rate that will enable DPR to cycle through the entire citywide tree population every seven years. To launch this program, DPR will use existing funding to hire and train 10 foresters to perform tree risk assessment inspections and supervise pruning efforts. The goal is to launch this program in 2013.

Initiative 12
Increase growth of local plant material for restoration work

Nearly every landscape restoration project undertaken by DPR around the city requires locally sourced or native plant materials. Subject to available funding, the City, through DPR, therefore will make capital improvements and add additional staff to its Greenbelt Native Plant Center. The unprecedented volume of plants needed for post-Sandy restoration projects requires the timely production of a sufficient supply of the right local genetic stock of such plants. This program was launched in 2013.

Strategy: Develop tools for comprehensive climate adaptation planning and design

As weather experts expect conditions to evolve over a long period of time, the City aims to respond appropriately with resiliency measures for its park network. To that end, the City and its partners will seek to secure appropriate tools to monitor and measure conditions in the environment and the success of investments that it is making.

Initiative 13
Establish a center for resiliency and restoration efforts in the Jamaica Bay-Rockaway Parks

The joint City-Federal effort to transform Jamaica Bay into a national model has, as one of its centerpieces, a plan to create a new Science and Resilience Center at Jamaica Bay. The City, through DPR and in close collaboration with the National Park Service, will work with leading academic institutions to make this center a reality, with initial operations to begin in the fall of 2013.

The Science and Resilience Center at Jamaica Bay will serve a variety of key functions. First, the Center will facilitate decision-making by policy makers based on the latest scientific information developed by academic institutions. Second, the Center will address Jamaica Bay issues, such as water quality and ecological restoration. Third, the Center will seek to ensure the broad dissemination of resiliency-related research and policymaking to governments and scientific institutions around the world. The goal is to launch the Center in 2013.

Initiative 14
Quantify the benefits of the city's ecosystems and green infrastructure

A lack of high-quality performance data could hamper the City's ability to make smart decisions about its green infrastructure. Subject to available funding, the City, through DPR and DEP, will commission studies on the impact of the city's green infrastructure and natural areas, seeking to quantify the program's impacts on air pollution, stormwater capture and flood control, the urban heat island effect, public health, and biodiversity. The City will adapt and employ tools developed by the US Forest Service for these studies, and will use the information to prioritize future projects. The goal is to launch this program in 2013.

Initiative 15
Create climate adaptation plans for all parks in the 100-year floodplain

Costly infrastructure and important natural elements throughout DPR's park system face significant risk due to future climate change. Subject to available funding, the City, through DPR, will map and catalogue all of the facilities, infrastructure, and plant communities in DPR's system within the city's 100-year floodplain, with the goal of developing adaptation plans. These plans will include detailed elevation information to understand how different parks may be impacted by extreme weather events. This information will inform DPR flood mitigation measures, including updates of DPR's 2010 report *High Performance Landscape Guidelines: 21st Century Parks for NYC*. The goal is to launch this program in 2013.

Initiative 16
Map the city's overhead utilities and street trees

The city's many street trees pose a risk to utility lines and other infrastructure. Better information, however, could help to manage this risk. Subject to available funding, the City, through DPR, will collaborate with local utilities to map the city's trees against its overhead utility networks by 2015. This mapping exercise is intended to help DPR and the owners of utility infrastructure to develop an effective vegetation management plan for those street trees. The goal is to launch this program in 2013.

Environmental Protection and Remediation

Building under development at a completed cleanup site in the NYC Brownfield Cleanup Program

Credit: NYC Mayor's Office of Environmental Remediation

New York City's waterfront has long been a working waterfront, home to a diverse array of businesses large and small. From the South Bronx to Sunset Park in Brooklyn, and from the Kill Van Kull along Staten Island's North Shore to the Newtown Creek area in Queens, the working waterfront continues to thrive in many areas, home to growing companies and the strong employment opportunities they create.

Some of these businesses, however, rely upon hazardous substances to produce their goods and services. Whether on unenclosed or "open" industrial sites housing scrap metal yards or recycling centers, or at indoor or "enclosed" industrial sites housing factories and print shops, these industrial uses often depend upon chemicals and other compounds that can have harmful impacts if not used and protected properly.

Though industrial users can be found in many waterfront locations throughout the city, there are significant concentrations in several neighborhoods, including those noted above plus Red Hook and the Brooklyn Navy Yard. These working waterfront areas are not only important clusters of commercial activity, but are also vulnerable to storm surge.

Following Hurricane Sandy, the Department of Environmental Protection (DEP) undertook an effort to understand the impact of the storm on sites that store hazardous substances. This effort was in accordance with Local Law 26 of 1988, more commonly known as the NYC Right-to-Know Law. This law generally requires businesses that store specified quantities of hazardous substances to report the presence of these substances to DEP, in order to enable monitoring—including in the event of extreme weather.

In the wake of Hurricane Sandy, DEP determined that there were 367 facilities that had, in recent years, filed reports under Local Law 26 and that were located within areas impacted by the storm. According to DEP's field research, out of these 367 facilities, 263 reported no impacts whatsoever from Sandy. Meanwhile, 46 facilities, were severely affected by Sandy, but reported no spills and showed no evidence of spills. Another 40 facilities, upon inspection by DEP proved to have closed or relocated. Of the remaining 18 facilities inspected by DEP, 11 facilities reported spills but had conducted clean-ups prior to inspection, and seven were completely washed out by the storm.

With this information in-hand, DEP conducted extensive inspections of the impacted sites. These inspections did not indicate the presence of any spilled chemicals regulated by DEP at any of the applicable sites. Though the lack of evidence of contamination may indicate that the impacted businesses had secured these chemicals sufficiently prior to Sandy or adequately remediated their sites post-storm, it also may reflect the particular reality of Sandy, as the high volume of water may have diluted and washed away any spills that occurred.

For sites that continue to host industrial businesses involving hazardous substances—whether open or enclosed—continued identification and monitoring remain critical in anticipation and in the wake of extreme weather. That is why DEP continues to work closely with the City's Office of Emergency Management, ensuring, for example, that its list of vulnerable facilities takes into account the floodplain identified in the most recently produced Federal Emergency Management Agency (FEMA) maps. The City also is continuing to identify ways for these important employers to protect their business, their employees, and their neighbors.

As important as the monitoring of active industrial sites is, another significant challenge faced by the City is how to deal with the many previously industrial sites located throughout the five boroughs that have ceased to be used for such purposes, but nonetheless remain encumbered by the hazardous remnants of their industrial past. These so-called "brownfields" present risks to adjacent communities, but they also represent an opportunity—for new development and new employment. That is why the 2007 PlaNYC report set a goal of cleaning up all contaminated land in New York City.

As an outgrowth of that report—and with that goal in focus—the City created the Mayor's Office of Environmental Remediation (OER) to coordinate public and private efforts, including those targeting the many brownfields located along or near the waterfront. For example, in 2011, OER initiated the New York City Brownfield Cleanup Program (BCP) to help landowners and developers clean up contaminated property and facilitate redevelopment of these abandoned properties. The first municipal brownfield cleanup program in the nation, the BCP ensures that brownfield sites with light-to-moderate levels of contamination are properly cleaned, thus spurring neighborhood revitalization, job creation, and an increase in local amenities. In administering the BCP, OER utilizes NYS Department of Environmental Conservation (NYSDEC) standards, achieving high-quality remediation that involves removal of highly concentrated pollutants and placement of thick and often hardened layers of clean materials on the surface of remediated brownfield sites. Upon successful completion of cleanup in the BCP, program participants receive liability protection against future environmental enforcement on the property, providing lenders and occupants with assurances that these properties have been cleaned up under government oversight to a standard that is protective of human health and the environment.

Mayor Bloomberg announcing new brownfield project

Credit: NYC Mayor's Office

Another program established by OER is the NYC Brownfield Incentive Grant (BIG) program, which provides funding for brownfield investigation and cleanup, including grants to community brownfield planners under the Brownfield Opportunity Area (BOA) program, and special grants and resources to facilitate nonprofit and local community development on brownfields. OER also has developed the Searchable Property Environmental Electronic Database (SPEED), a one-of-a-kind GIS-based web application designed to facilitate property environmental research.

Since its inception in 2011, the BCP and associated OER programs have proven to be strong drivers of remediation that have made the environment cleaner and spurred economic activity. The BCP has enrolled and approved for cleanup over 95 projects—including 70 percent in historically disadvantaged communities—representing approximately $3 billion in new investment in over 8 million square feet of new development. This new investment is expected to generate over 3,100 permanent jobs, over 8,000 construction jobs and approximately $600 million in new City tax revenues over the next 30 years—all as a result of just the first two years of operation of the BCP. (*See map: Brownfield Cleanup Program Sites; see chart: New Development Resulting from Brownfield Cleanup Program)*

In the first 48 hours after Sandy, OER undertook inspections of over 80 brownfield cleanup projects in inundated areas. These inspections indicated that the cleanup methods promoted by OER had proven very effective in preventing pollutant release from brownfield sites and associated impacts in surrounding communities. These findings, supplemented by outreach to the scientific community and inspection of almost 25 miles of waterfront in different parts of the city, strongly support the efficacy of existing cleanup approaches and suggest that the most important thing the City can do to make its brownfield sites more resilient to the effects of future climate change is to accelerate the pace of brownfield cleanup in the floodplain. These findings also support the development of several improvements in remedial procedures that can make these sites even more resilient, including development of extreme weather preparedness plans and adoption of brownfield resiliency best management practices.

To protect operating open and enclosed industrial sites with hazardous substances in an economically feasible way, and to encourage the remediation and redevelopment of brownfields in a resilient fashion, the City will pursue the following initiatives:

Initiative 1

Identify cost-effective measures to safeguard exposed substances in the 100-year floodplain

Given the large number of open industrial properties in the 100-year floodplain as

Brownfield Cleanup Program Sites

Source: NYC Mayor's Office of Environmental Remediation

Brownfield site after Sandy

Credit: NYC Mayor's Office of Environmental Remediation

delineated by FEMA, it is important to minimize the negative effects these uses have on adjacent properties, residents, and water bodies. To this end, the City will complete the Open Industrial Uses Study. The study, led by the Department of City Planning (DCP) in cooperation with DEP and the New York City Economic Development Corporation, will generate recommendations by the end of 2013 for zoning text amendments or other legislation, and assess incentives that may assist in the implementation of such controls. Recommendations for cost-effective measures will seek to improve the business climate and natural environment in industrial areas, retain important industrial businesses, and foster new businesses and jobs in areas near open industrial uses. The study, and subsequent actions to implement recommendations, will support the working waterfront and protect communities while making industrial areas stronger, safer, and more resilient to climate change.

Initiative 2

Develop a catalogue of best practices for storing enclosed hazardous substances in the 100-year floodplain

Without the appropriate precautions, even enclosed hazardous substances in the city's 100-year floodplain could be disturbed by storm surge, resulting in undesirable impacts. As a complement to the preceding study on open industrial uses, the City, subject to available funding, will develop a catalogue of cost-effective best practices for the prevention of contamination caused by the storage of hazardous substances in the floodplain. The development of the catalogue will include outreach to community groups and businesses. Federal funding may be available to implement best practices in certain instances through the City's Business Resiliency Investment Program, funded by Community Development Block Grants. The development of these best practices will help vulnerable businesses to protect themselves through a variety of preapproved measures, including resiliency investments, which will seek to protect adjacent communities from hazardous substances that otherwise could be released. The goal is for the Mayor's Office of Long-Term Planning and Sustainability to begin the process of developing the catalogue of best practices in 2013, with participation by other City agencies.

Initiative 3

Accelerate brownfield cleanup in the 100-year floodplain to prevent release of pollutants

Brownfields pose potential risks to surrounding areas during coastal storms, as the pollutants embedded in these sites may be released and redistributed by floodwaters. Subject to available funding, the City will expand its existing BIG cleanup program to provide bonus grants to accelerate cleanup of brownfields in the floodplain in order to mitigate the impact of extreme weather events. In the next two years, this program is expected to provide bonus grants for approximately 30 BCP sites located in the 100-year floodplain. In addition, the City will focus its use of existing State and Federal brownfield grants toward the study and cleanup of brownfields that can become parks and open spaces in the floodplain.

These grants will help to fund remedial actions that will remove concentrated pollutants and cap sites with thick or hardened clean surface layers, reducing contamination risks and providing more open space for storm surge dissipation. By focusing on shovel-ready cleanup and development projects, the program will help jump-start near-term economic recovery in waterfront neighborhoods—including investment in approximately 2.4 million square feet of development. The goal is to launch the expanded program in 2013.

Initiative 4

Explore strengthened cleanup standards on industrial waterfront brownfields

Existing State brownfield soil cleanup standards are more lenient for sites that are to remain industrial than those for which other uses are contemplated. Where these industrial properties are located in waterfront areas that are vulnerable to erosion from future storm surges, these standards may not provide sufficient protection for surrounding communities. The City will examine the existing soil cleanup standards for industrial waterfront sites and evaluate whether such protections can be strengthened in a way that also is financially feasible for industrial development.

Initiative 5

Launch brownfield climate change resiliency audits and improve storm preparedness

Brownfield developers can make significant progress towards improving the climate change resiliency of remediated land and the new buildings constructed on them by adopting simple best management practices during the project planning stage. However, many developers do not yet understand these practices. The City will establish a pilot program to provide free reviews of brownfield cleanup and development plans by a resiliency expert and will provide developers with a report of best management practices that could be implemented to improve the resiliency of their projects. These assessments, called Brownfield Climate Change Resiliency Audits, will be conducted by City contractors and will be provided free of charge. OER also is performing brownfield storm preparedness training for the environmental and development industry. Going forward, OER will require an extreme storm contingency plan in every brownfield cleanup plan it approves. Developers also will have access to pro bono brownfield resiliency consultations with local industry experts through a program developed by OER and the nonprofit NYC Brownfield Partnership. OER will begin audits immediately and will publish a report of findings by the end of 2013. Subject to available funding, OER will continue and expand this program in 2014.

Initiative 6

Launch full operation of the NYC Clean Soil Bank

After remedial action is completed at brownfield sites, it is common for developers to continue excavations deep into clean native soils in order to make room for basements or underground parking garages. Developers typically are not able to use this clean soil and must pay to have it removed. At the same time, at other locations, such as City-sponsored construction sites, clean soil is needed and must be purchased at substantial cost. With approval from NYSDEC now in hand, the City will establish full operation of the NYC Clean Soil Bank, a landmark recycling program for clean native soil from deep development excavations on remediated brownfield sites, which will allow this soil to be reused, free of charge, on city construction projects or brownfield properties. This soil may be used for projects such as the elevation of grades or the creation of natural barriers to mitigate the impacts of sea level rise and storm surge. OER will launch this program in 2013.

Initiative 7

Perform update of SPEED, the City's online environmental research engine

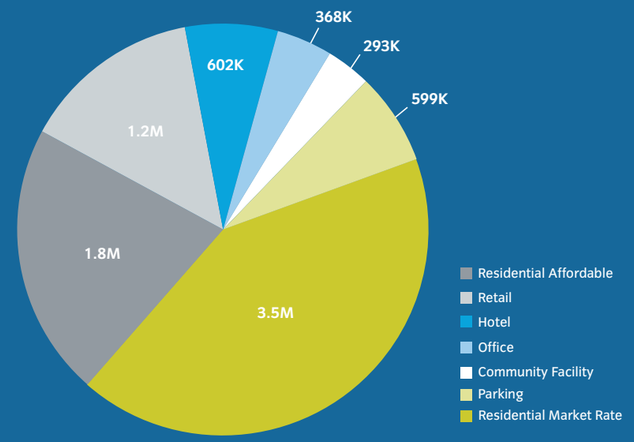
The SPEED application described previously, though useful, lacks certain information that would help inform resiliency strategies, including information from the latest FEMA flood maps. Subject to available funding, the City will expand the information available in SPEED to enable climate change resiliency analyses, and to improve the efficacy of its use before, during, and after future extreme weather. Using an existing State grant, OER also will establish an innovative application for use by community brownfield planners working to improve local brownfield cleanup, development, and resiliency efforts. The goal is to complete an update to the SPEED database by the end of 2013.

Brownfield cleanup site

Credit: NYC Mayor's Office of Environmental Remediation

New Development Resulting from Brownfield Cleanup Program

Square Feet, as of April 2013



Total = 8.3M Square Feet

Source: NYC Mayor's Office of Environmental Remediation

Paerdegat Basin, Jamaica Bay

Credit: Mylan Cannon/The New York Times

Water and Wastewater

Newtown Creek Wastewater Treatment Plant in Greenpoint, Brooklyn

Credit: DEP

New York's water and wastewater system is an engineering marvel of massive scale. Every drop of water that comes out of the city's taps has traveled through a complex network of aqueducts and tunnels, some dating back more than 150 years, from sources that extend more than 125 miles from the city and across a 2,000-square-mile watershed. Water that enters the city's drains is conveyed through 7,500 miles of sewers and returned to New York City waterways.

With more than 8 million residents and many more daily commuters and visitors in New York City, merely ensuring that they all have the essentials—including uninterrupted water and wastewater services—requires a constant choreography that is as complex as it is invisible to its users. Whether turning on a tap to get a drink, running a bath, watering a lawn, flushing a toilet, or fighting a fire, New Yorkers rightly expect their water and wastewater system to work for them—all the time, no matter the conditions.

But the Department of Environmental Protection (DEP) and the water and wastewater system it manages accomplish much more than just supplying the essentials. DEP does not just provide drinking water; it provides clean, mostly unfiltered water from distant, carefully protected and managed watersheds—thereby eliminating the need for billions of dollars in filtration plant investments that would otherwise be required. DEP does not just carry and treat wastewater; it helps to protect a harbor and waterways that are cleaner than they have been in over a century.

Moreover, DEP's system is able to function even under extraordinary conditions. In the wake of storms that cause disruptions to one or several of its reservoirs, system operators are able to draw from other parts of the system, thereby maintaining an uninterrupted flow. While on average, New York's wastewater facilities treat about 1.3 billion gallons of wastewater per day, on a wet day they can treat twice as much as they do on a dry day.

Of course, even a system as effective as this one has its limits. Sandy, though it was not a significant rain event, came with a surge that affected some of DEP's assets in low-lying areas, knocking out electrical grid power and critical equipment at key wastewater facilities located along the waterfront. As a result, DEP resorted to its onsite and portable backup power systems and mobilized portable pumps.

As Sandy demonstrated, the city's water and wastewater system has vulnerabilities to extreme weather that must be addressed, particularly as climate change increases the likelihood of storm surges and heavy rains that can result in overflow of untreated sewage into the city's waterways. To prepare for the future, DEP began implementing climate change resiliency measures early, in 2008, when it issued the Climate Change Assessment and Action Plan. Prior to Sandy, DEP was already in the process of performing a detailed climate change study for representative wastewater treatment plants, pumping stations, and drainage areas to determine the potential likelihood and severity of various risks, including storm surge. After Sandy, DEP expanded that study to include all of its wastewater infrastructure across the city to systematically determine risks and resiliency measures to help prevent future disruptions.

Beyond this, DEP invests billions of dollars—from revenues generated by the water and sewer assessment charged to every New York building—to upgrade and maintain the system, thereby safeguarding efficient performance during all conditions.

However, some extreme weather events are likely to become more severe and, in some cases, more frequent. In keeping with the goals of this report, where possible and reasonable, the City will work to mitigate the impacts of climate change to the water and wastewater system. Meanwhile, for those times when impacts do occur, the City will enable rapid recovery by building resiliency into this system. To that end, the City will protect wastewater treatment facilities from storm surge, improve and expand drainage infrastructure, and invest in projects that increase the redundancy and flexibility of the water supply system.

How The Water and Wastewater System Works

DEP manages a complex system that begins with reservoirs located over 125 miles away from the city and ends at the city's 14 wastewater treatment plants with the release of treated effluent into New York Harbor. Although the system is integrated, it is best explained by separating it into two primary components: the city's water supply and distribution system, and its collections and treatment system. (*See chart: The Water and Wastewater System in New York City*)

Water Supply and Distribution

The New York City water supply system provides drinking water to almost half the population of the State of New York—8 million people in New York City and 1 million people in Westchester, Putnam, Orange, and Ulster Counties—plus the tens of millions of commuters and tourists who visit the city throughout the year. Overall, the system has a total storage capacity of 580 billion gallons, and consumption is more than 1 billion gallons each day.

The Croton watershed was the city's first Upstate water supply and is located entirely east of the Hudson River in Westchester, Putnam, and Dutchess Counties, with a small portion in the State of Connecticut. Historically, 10 percent of the city's average daily water demand has been provided by the Croton system, although in times of drought, it may supply significantly more water. As of the writing of this report, the system is offline temporarily while the City constructs a water treatment plant to filter the Croton water supply. Once completed, Croton water will be filtered and disinfected before flowing into Jerome Park Reservoir in the Bronx.

The Catskill system consists of two reservoirs—Schoharie and Ashokan—located west of the Hudson River in Ulster, Schoharie, Delaware, and Greene Counties. Water leaves Schoharie Reservoir via the 18-mile Shandaken Tunnel, which empties into the Esopus Creek and then travels 22 miles through the Esopus to Ashokan Reservoir. Water leaves Ashokan Reservoir via the 75-mile-long Catskill Aqueduct, which travels to Kensico Reservoir in Westchester County. The Catskill system provides, on average, 40 percent of the city's daily water supply.

The Delaware system consists of four reservoirs west of the Hudson River: Cannonsville, Pepacton, and Neversink in the Delaware River basin, and Rondout in the Hudson River basin. The outflow from the first three reservoirs arrives in Rondout via three separate tunnels. Water then leaves Rondout and travels to West Branch Reservoir in Putnam County via the 90-mile Rondout/West Branch Tunnel. Water from West Branch subsequently flows through the Delaware Aqueduct to Kensico Reservoir. The Delaware system provides, on average, 50 percent of the city's daily demand.

Because waters from the Catskill and Delaware watersheds mix at Kensico Reservoir, they are frequently referred to as one system: the Catskill/ Delaware system. DEP has completed construction of an Ultraviolet Disinfection Facility to improve and ensure high-quality water for the Catskill/ Delaware system. This facility provides secondary disinfection for Catskill and Delaware water before it flows to Hillview Reservoir in Yonkers.

Water is distributed from Hillview Reservoir and Jerome Park Reservoir to end users throughout the city via more than 7,000 miles of water mains and pipes at pressures that, in most cases, only require privately owned electric pumps for buildings taller than six stories. The 7,000 miles of water mains and pipes that distribute water throughout the five boroughs are buried and pressurized, preventing water from infiltrating. Furthermore, there is necessary redundancy built into the system so that water supply can be diverted to different pipes within the system to ensure the constant flow of water.

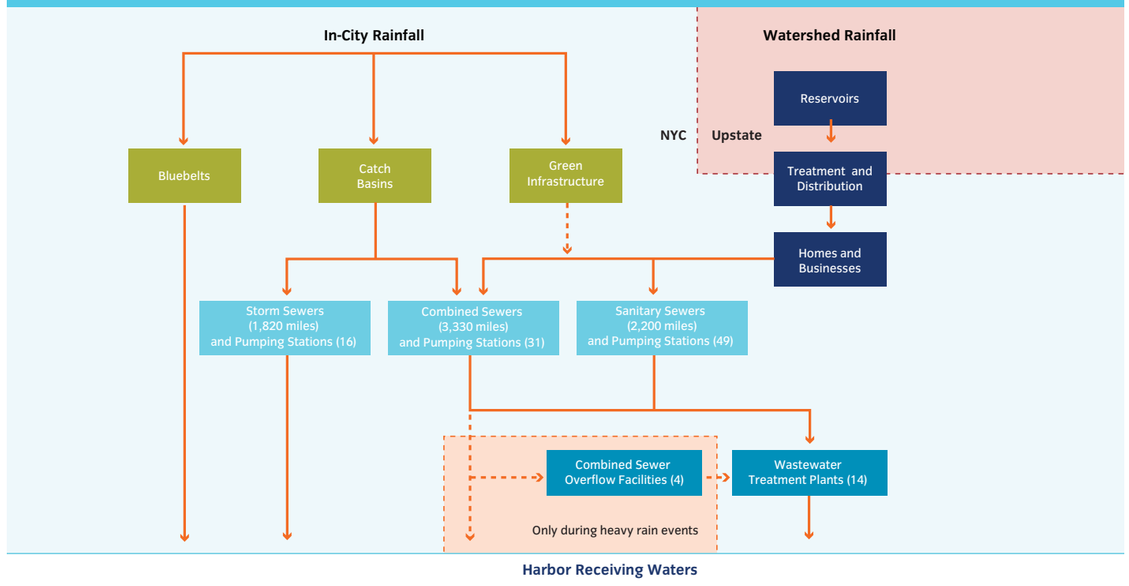
Despite this flexibility, the water supply remains vulnerable to heavy rain events. The events of the summer of 2011 illustrate this vulnerability. In late August, Hurricane Irene arrived in the Northeast, bringing with it wind and heavy rain. Although Irene weakened to a tropical storm as it moved over New York City, it nonetheless brought torrential rains, particularly Upstate, which saw more than 16 inches fall in parts of the Catskill System, and up to 10 inches in a 12-hour period in many other areas of the watershed. Twenty-three US Geological Survey stream gauges in the Catskill and Delaware watersheds recorded new maximum flow readings, and the flooding caused catastrophic damage to watershed communities, washing out many roads and bridges, damaging many homes, and causing widespread power outages. DEP responded to the resulting elevated levels of turbidity (murkiness resulting from stirred sediment) in reservoirs through various operational measures, including daily treatment and reduction of the flow of water from the Catskill system.

Just 10 days later, Tropical Storm Lee affected the same area, bringing with it more heavy rain and further affecting water quality conditions in several reservoirs. Once again, DEP responded with operational measures and maintained an adequate supply of high-quality drinking water for the city. The combination of two heavy rain events in a 10-day period led to unprecedented operational measures—including a record 260-day treatment regime for the Catskill system.

Wastewater Collection and Treatment

Every day, the City treats 1.3 billion gallons of wastewater and helps restore and maintain water quality in New York Harbor. Although the city uses a sanitary sewer system that carries only sewage, it, like other older urban centers, largely is served by a combined sewer system where stormwater and sanitary waste are carried through a single pipe. Stormwater enters the collections and treatment system from catch basins that direct flow to the city's sewer system. Sanitary waste enters the sewer system through direct connections from buildings. From there, wastewater flows by gravity through sewers, about 60 percent of which are combined sewers. In low-lying areas, the city has 96 pumping stations that lift wastewater and stormwater to a higher elevation and help continue its journey.

The Water and Wastewater System in New York City



Kensico Reservoir in Westchester County, NY

Credit: DEP

The combined sewer and sanitary sewer systems convey wastewater to the City's 14 wastewater treatment plants. At these plants, wastewater undergoes five major processes: preliminary treatment; primary treatment; secondary treatment; disinfection; and, finally, sludge treatment. Preliminary treatment screens debris and litter to protect the main sewage pumps and other equipment. The main sewage pumps then lift the wastewater to the surface level for primary and secondary treatment. Primary and secondary treatments remove on average between 85 and 95 percent of all pollutants from wastewater (up to 40 percent removed in primary treatment and up to another 60 percent in secondary treatment). Once the treated water is disinfected, it is returned to the city's waterways. Meanwhile, the remaining sludge is treated, with the resulting material, known as biosolids, frequently shipped elsewhere for disposal in landfills, or for use as compost or fertilizer.

All of the city's 14 wastewater treatment plants are located along the waterfront at relatively low elevations. Waterfront locations significantly reduce the cost and environmental impact of treating wastewater in New York City, making it easier for flow to arrive by gravity and providing nearby waterways to discharge treated effluent. Secondarily, but also importantly, the waterfront location further allows sludge to be transported efficiently by boat to DEP facilities for additional treatment.

Under normal conditions, system capacity is adequate to perform full treatment for the combined volume of sewage. During periods of rainfall when flow exceeds two times dry weather capacity, the combined volume of sewage and stormwater quickly can exceed the capacity of the wastewater treatment plants. The system is designed to discharge a mix of stormwater and wastewater—called combined sewer overflow or CSO—into nearby waterways to drain the city quickly and prevent the biological processes at the wastewater treatment plants from becoming compromised, which could lead to extended service outages.

In response to these CSO events, the City has invested billions of dollars. Recently, however, the City restructured its approach to implement innovative strategies to absorb rain before it can enter sewers, and, in the process, create systems of greenery that shade and beautify the city. In September 2010, Mayor Bloomberg launched the NYC Green Infrastructure Plan, a comprehensive 20-year effort to meet water quality standards, and in March 2012, the plan was incorporated into a consent order with the State that will eliminate or defer $3.4 billion in traditional investments and result in approximately 1.5 billion gallons of CSO reductions annually by 2030.

The City's Bluebelt program complements its Green Infrastructure program. Bluebelts are natural areas that often enhance existing drainage corridors (such as streams, ponds, and other wetland areas) and convey, treat, and retain stormwater in place of traditional "grey" infrastructure. Bluebelts engineer these natural elements to slow the flow of water and use vegetation and other elements to absorb and filter impurities. DEP's Bluebelt program started in Staten Island (with almost 10,000 acres now in place) and is now expanding in Staten Island and into other parts of the city, including Southeast Queens.

What Happened During Sandy

While Sandy's impact on the water supply was minimal, impacts on the wastewater system were more significant—predominantly as a result of storm surge and the loss of electrical power.

Sandy passed to the south of the Catskill/Delaware watershed and, therefore, brought minimal rainfall and did not affect the city's water supply substantially. All of New York City's drinking water treatment and distribution facilities remained operational and supplied potable water throughout the storm. Kensico Reservoir in Westchester County, part of the Catskill/Delaware System, did experience a spike in turbidity. The turbidity at Kensico was the result of high winds that caused erosion on the reservoir's edge, sending natural materials into the reservoir. However, DEP was able to adjust water supply operations at Kensico so that water supply distribution and quality in the city were not affected. The city's robust water quality testing system, which takes more than 500,000 samples per year, sampled locations in the watershed and nearly 1,000 stations across the five boroughs during and after Sandy, and confirmed water quality.

Although the system fared well overall and drinking water remained safe during Sandy, there were some localized impacts on water supply. Many high-rise buildings throughout the city were unable to pump water to residents on upper floors due to the loss of power to their pumping systems. Meanwhile, in Breezy Point, a private community on the Rockaway Peninsula in Queens, fires caused significant disruption to the neighborhood's private water distribution system, which draws its supply from City-owned mains. Finally, while some City-owned water main breaks were reported, there was no significant spike citywide, and in these individual cases it took DEP an average of five hours to restore water service.

However, Sandy did impact the city's wastewater treatment plants, which are along the waterfront and at low elevations, and are thus particularly vulnerable to storm surge. To address these impacts, DEP worked tirelessly to ensure that the system would perform its core functions without significant disruption.

During Sandy, 10 of DEP's 14 wastewater treatment plants were damaged or lost power, and released untreated or partially treated wastewater into local waterways. Three of these facilities were non-operational for some time as a result of the storm: Coney Island for two hours, North River for seven hours, and Rockaway for three days. The other facilities maintained at least partial treatment, including removal of pollutants and disinfection of effluent before water from these plants was discharged into waterways. Although, collectively, wastewater treatment plants operated at more than twice their normal flow rate at the height of the storm, approximately 560 million gallons of untreated sewage mixed with stormwater and seawater was released into local waterways, equivalent to approximately half a day's worth of normal wastewater treatment. (*See chart: Volume of Wastewater Treated During Sandy*)

Most of the damage to wastewater facilities involved electrical systems and equipment, including substations, motors, control panels, junction boxes, and instrumentation. Sandy's floodwaters inundated the lower levels of facilities, where much of this equipment is located. Even where electrical systems were not damaged during Sandy, utility power outages forced many facilities to operate on emergency generators for up to two weeks.

Where shutdowns occurred, DEP worked quickly to mitigate impacts. For example, the Rockaway Wastewater Treatment Plant (WWTP), which treats approximately 1 percent of the city's wastewater, suffered severe flooding—as did the upstream sewers and the surrounding community—and was shut down during and immediately after the storm; just three days later it was providing partial treatment, and two weeks later, it was fully back online.

Many of DEP's wastewater treatment plants, however, performed well throughout the storm. For example, the Oakwood Beach plant in Staten Island was able to treat 80 million gallons of wastewater during the storm—twice its normal level—despite being surrounded by Sandy's surge and incurring some damage. This performance is attributable at least in part to the elevation of critical systems during a facility upgrade that took place more than three decades ago—and the dedication of the workers who stayed and continued operations even while the plant was surrounded by water.

In addition to affecting treatment facilities, Sandy also affected pumping stations. Forty-two of 96 such stations were damaged or lost power. Power outages were responsible for roughly half of the impacts, with storm surge inundation responsible for the other half—primarily in coastal communities in Staten Island, Brooklyn, and Queens. At inundated pumping stations, many of which are underground, recovery required not just pumping floodwaters out of the stations, but also repairing damage caused by the corrosive impact of seawater on electrical equipment. (*See map: Pumping Stations Affected By Sandy*)

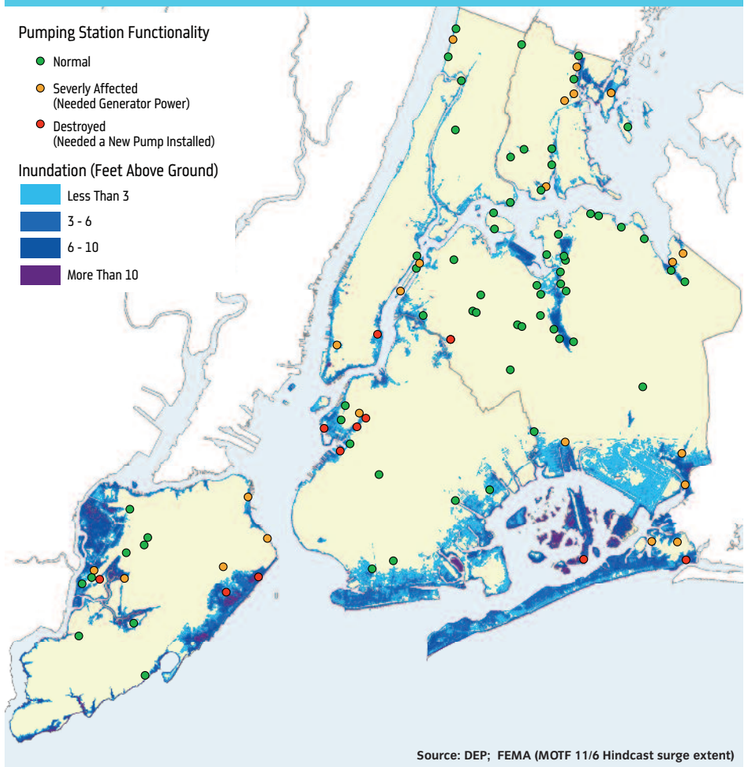
Thanks to an immediate response by DEP employees, most affected treatment plants and pumping stations were running again shortly after Sandy's floodwaters receded. Within four days of Sandy, 13 of 14 wastewater treatment plants and most pumping stations were fully operational, treating 99 percent of New York City's wastewater.

Despite the rapid response, Sandy's surge led to the release of wastewater into New York's waterways. As DEP reported, approximately 560 million gallons of untreated combined sewage, stormwater, and seawater from

Volume of Wastewater Treated During Sandy

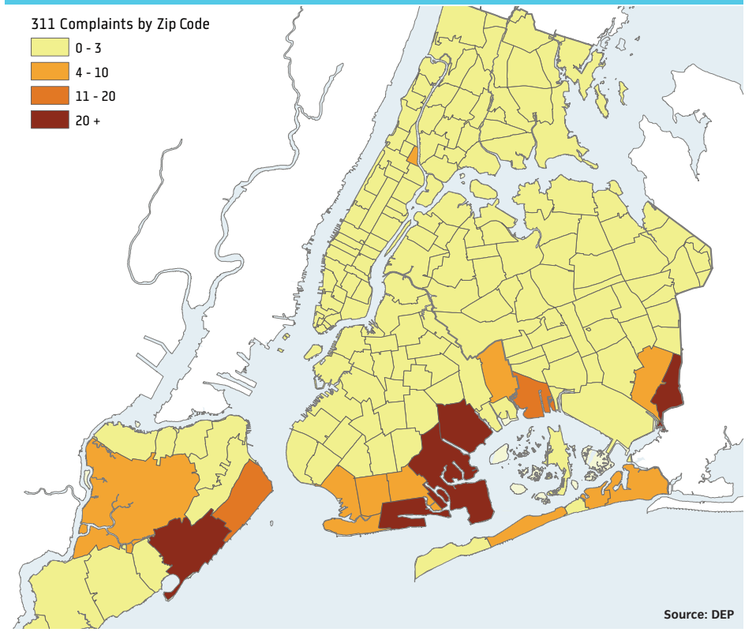
Source: DEP

Pumping Stations Affected By Sandy



Source: DEP; FEMA (MOTF 11/6 Hindcast surge extent)

Confirmed Sewer Backup and Street Flooding Complaints Oct. 30 - Nov. 1, 2012



sewers, and another approximately 800 million gallons of partially treated and disinfected wastewater, were released into waterways. After Sandy, DEP collected samples of water quality throughout the harbor. Data from these samples showed that water quality in New York Harbor was not affected significantly by the storm. Some localized and limited exceptions were attributable, at least in part, to damage at wastewater treatment facilities in other regional municipalities outside of DEP's jurisdiction. These third-party impacts were concentrated in waterways near Raritan Bay and the Narrows.

Part of the reason that Sandy's impact on water quality was so limited was likely Sandy itself. The same high volume of seawater that affected some DEP assets also helped to dilute the discharge of untreated or partially-treated sewage. Nonetheless, as a precautionary measure, two days after Sandy, the City issued a recreational water body advisory for the Hudson and East Rivers, New York Harbor, Jamaica Bay, and the Kill Van Kull. The advisory remained in place for 30 days and was lifted after DEP testing confirmed that the waterways were safe.

Another impact of Sandy was sewer backups, which occurred in some coastal areas. Sandy's surge inundated properties and the sewer system through catch basins, manholes, and storm drains in the streets. While ultimately, the city's drainage systems helped to drain floodwater after the storm surge receded, the surge also deposited sand and debris in and around drainage systems, which slowed the drainage process. Recorded complaints for sewer backups and flooding, received through the City's 311 service, were concentrated in highly developed areas near the waterfront. DEP inspected the areas of all recorded complaints and performed any necessary work. DEP crews cleaned more than 3,500 catch basins and flushed more than 190,000 linear feet of sewer lines in the three weeks following the storm, and accompanied other City agencies in additional cleanup efforts. *(See map: Confirmed Sewer Backup and Street Flooding Complaints Oct. 30 - Nov. 1, 2012)*

What Could Happen in the Future

The greatest climate change-related risk to the city's water supply is runoff from heavy downpours affecting water quality in reservoirs. By contrast, the greatest risk faced by the city's wastewater system is storm surge inundation of critical assets, potentially leading to release of untreated or partially treated wastewater.

Major Risks

Heavy downpours pose a significant risk to the city's water supply system. They produce increased runoff, which causes high pathogen and contaminant levels in reservoirs, increases turbidity due to the underlying geology of land near the reservoirs, and affects the drinking water disinfection process. These conditions are particularly challenging if extreme rainfall events happen one right after another, before the impacts of a previous event have been controlled fully. This vulnerability of the water system, particularly the Catskill system, is expected to be tested with greater frequency through the 2050s with increases in heavy downpours in the New York region.

Storm surge, on the other hand, poses a major risk for the city's wastewater treatment plants and pumping stations, as Sandy demonstrated. Floodwaters from the surge can damage equipment and disrupt the power supply at these facilities; consequently, partially treated or untreated sewage can spill into waterways around New York City.

This vulnerability only will increase as the climate changes. Given their waterfront locations, according to a recent DEP study, by the 2050s, all of the city's 14 wastewater treatment plants will have at least some of their equipment located below the Base Flood Elevation (BFE), or the height to which floodwaters are expected to rise during a "100-year flood" (a flood with a 1 percent or greater chance of occurring in any given year). As sea levels rise, expected flood heights will also increase, putting a greater percentage of treatment facility equipment at risk of flooding and increasing the likelihood that surge from a coastal storm would disrupt or even shut down DEP facilities. The percentage of critical equipment that is estimated to be below expected flood heights, based on New York City Panel on Climate Change "high end" sea level rise projections for the 2050s, varies by facility from as little as less than 1 percent at Jamaica WWTP to potentially as much as 70 percent at Hunts Point WWTP.

Meanwhile, of the city's 96 pumping stations, 37 are located in the 100-year floodplain indicated in the Federal Emergency Management Agency (FEMA) 2013 Preliminary Work Maps. That number is expected to grow over time—to 48 by the 2020s and 58 by the 2050s. (*See sidebar: Reducing Flood Risk to Key Wastewater Infrastructure*)

Other Risks

The city's wastewater system is also at risk from gradual sea level rise—without storm surge. Sea level rise itself may cause flow to back up during heavy rain and limit the ability of some wastewater treatment plants to operate at full capacity, leading to CSO events and release of partially treated sewage into area waterways.

Increased precipitation and heavy downpours alone, regardless of sea levels, also could lead to CSO events. Furthermore, heavy downpours can overwhelm the sewer system and cause

Risk Assessment: Impact of Climate Change on Wastewater

Major Risk Moderate Risk Minor Risk

	Scale of Impact			
Hazard	**Today**	**2020s**	**2050s**	**Comments**
Gradual				
Sea level rise				At higher water levels, wastewater treatment plants may not be able to operate at full capacity during heavy rain events, leading to releases of untreated or partially treated sewage into waterways
Increased precipitation				Combined sewage and stormwater could exceed the capacity of wastewater treatment plants, leading to releases of untreated or partially treated sewage into waterways
Higher average temperature				Minimal impact
Extreme Events				
Storm surge				Asset damage and power disruption could lead to releases of untreated or partially treated sewage into waterways
Heavy downpour				Combined sewage and stormwater could exceed the capacity of wastewater treatment plants, leading to releases of untreated or partially treated sewage into waterways Sewer system capacity may be exceeded more frequently, leading to street flooding and sewer backups
Heat wave				INDIRECT: Utility power outages could lead to reduced treatment levels and sewage bypass
High winds				Minimal impact

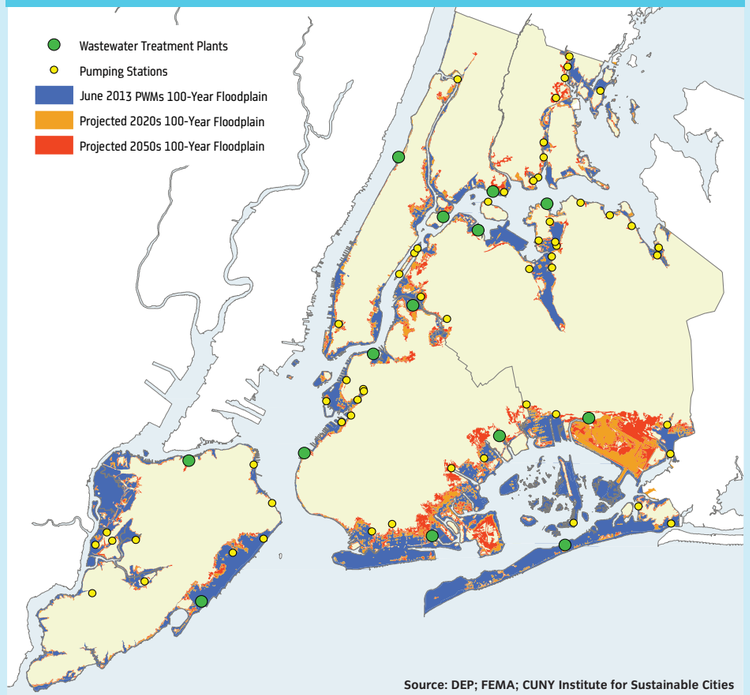
Risk Assessment: Impact of Climate Change on Water Supply

Major Risk Moderate Risk Minor Risk

	Scale of Impact			
Hazard	**Today**	**2020s**	**2050s**	**Comments**
Gradual				
Sea level rise				Minimal Impact
Increased precipitation				Increased turbidity, pathogen, and contaminant levels could require treatment and challenge disinfection process
Higher average temperature				Reduced snowpack, drought, and higher demand could stress water supply Increased algae growth could affect water color and taste and challenge the disinfection process
Extreme Events				
Storm surge				Minimal Impact
Heavy downpour				Increased turbidity, pathogen, and contaminant levels could require treatment and challenge disinfection process
Heat wave				Reduced snowpack, drought, and higher demand could stress water supply Increased algae growth could affect water color and taste and challenge the disinfection process
High winds				Minimal impact

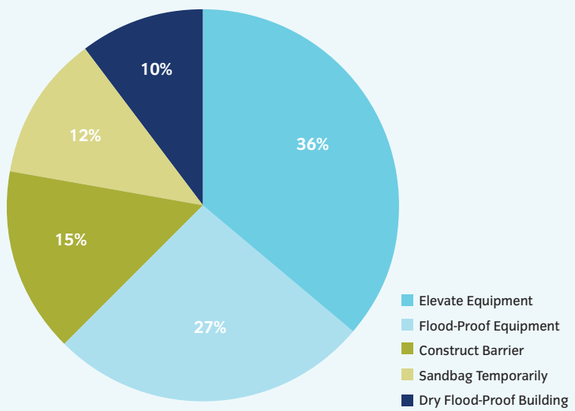
Reducing Flood Risk to Key Wastewater Infrastructure

Wastewater Facilities at Risk of Storm Surge Inundation



Source: DEP; FEMA; CUNY Institute for Sustainable Cities

Recommended Adaptation Strategy Allocations for Wastewater Facilities



Source: DEP

Many of New York City's 14 wastewater treatment plants and 96 pumping stations are susceptible to flood damage from storm surge, as seen during Sandy. With climate change, the vulnerability of these facilities likely will increase in the future. Accordingly, DEP has undertaken a detailed facility risk assessment and adaptation study to identify which wastewater infrastructure is and will be most at risk of flooding during extreme weather events, and to recommend adaptation strategies to address these risks.

To make its determination of vulnerability, DEP undertook site visits, engineering analyses and interviews with facility personnel. Common flood pathways that DEP examined included doorways, outfall pipes, bulkheads, windows, vents, conduits, and facility tunnel systems. Facility assets were determined to be at risk if they fell below expected flood heights based on "high end" sea level rise projections for the 2050s developed by the New York City Panel on Climate Change.

According to the study, all 14 wastewater treatment plants have assets that are at some level of risk. In fact, of the almost 47,700 total assets at these facilities, about 4,000 that are necessary for primary treatment and 10,600 other facility assets were shown to be vulnerable. Meanwhile, 58 of the 96 pumping stations were shown to be vulnerable.

DEP also analyzed a projection of its financial exposure to the aforementioned vulnerability. Again assuming high end sea level rise projections, the City's potential exposure was estimated to be $900 million at wastewater treatment plants and $220 million at pumping stations. This exposure excluded any costs associated with loss of service or environmental impacts. Based on the potential costs alone, DEP has concluded that there is a clear need for a robust set of protective measures.

To determine which protective measures to prioritize, DEP looked at a portfolio of strategies, including dry flood-proofing buildings with watertight windows and doors, elevating equipment, making pumps submersible and protecting electrical equipment with watertight casings, constructing external flood barriers, installing temporary sandbagging, and providing backup power generation to pumping stations (wastewater treatment plants are already so equipped).

DEP also looked at operational, environmental, social, and financial metrics in deciding how to prioritize its investments. These metrics included historical flooding frequency, proximity to beaches and sensitive water bodies, population served, number of critical facilities such as hospitals affected, and scheduled improvements in DEP's 10-year capital plan.

Based on the foregoing (as well as studies of site feasibility and cost-benefit analyses) a combination of recommended strategies was selected for each facility. Generally, for assets critical to meeting a minimum required level of service, strategies that would result in the highest resiliency levels were selected, while, for other assets, DEP sought to strike a balance between resiliency and return on investment.

The bottom line of the study is that a strategic mix of protective strategies could avoid almost 90 percent of risk citywide to wastewater treatment plants and ensure continuous service at pumping stations. In this way, the study set forth a cost-effective strategy for reducing damage to infrastructure and safeguarding public health.

Turbid water spilling from the Cannonsville Reservoir, Delaware County, NY, June 2006 Credit: DEP

Drought conditions at the Cannonsville Reservoir, Delaware County, NY, Dec. 2001 Credit: DEP

flooding and backups. The city's drainage systems, however, are designed to handle heavy rainfall, with capacity for rainfall intensity of 1.5 inches per hour in most areas of the city, where sewers were built prior to 1960, and 1.75 inches per hour in locations with sewers built after 1960.

While increases in temperature can have an effect on water quality in reservoirs, such as increased algae growth which can lead to changes in water color and taste and challenge the disinfection process, it can also lead to more severe water quantity impacts, including droughts. As of the writing of this report, New York City designates the 1963–1965 drought as the "drought of record," or the city's anticipated worst-case scenario. Though precipitation in the New York City area generally is expected to increase going forward, the City does need to monitor drought patterns, and changes in winter snowpack which may limit the ability of reservoirs to refill sufficiently to meet summer demand.

Finally, potential disruptions to power supply resulting from heat waves are another challenge that the city's water and wastewater systems may face going forward as the climate changes. However, many facilities have backup generators. Wastewater treatment plants, for instance, are required to have backup generators and maintain partial treatment during a blackout or brownout, thereby limiting the net impact of this risk.

This chapter contains a series of initiatives that are designed to mitigate the impacts of climate change on New York's water and wastewater system. In many cases, these initiatives are both ready to proceed and have identified funding sources assigned to cover their costs. With respect to these initiatives, the City intends to proceed with them as quickly as practicable, upon the receipt of identified funding.

Meanwhile, in the case of certain other initiatives described in this chapter, though these initiatives may be ready to proceed, they still do not have specific sources of funding assigned to them. In Chapter 19 (*Funding*), the City describes additional funding sources, which, if secured, would be sufficient to fund the full first phase of projects and programs described in this document over a 10-year period. The City will work aggressively on securing this funding and any necessary third-party approvals required in connection therewith (i.e., from the Federal or State governments). However, until such time as these sources are secured, the City will proceed only with those initiatives for which it has adequate funding.

Uninterrupted access to high-quality drinking water and continuous treatment of wastewater are critical to the viability of New York City as the climate continues to change. Though, as Sandy demonstrated, the city's water and wastewater systems are already highly resilient due to investments over many decades, the city cannot function without either system. DEP, therefore, will accelerate its resiliency efforts across a range of initiatives, including both existing and new efforts. DEP's strategies will include protecting wastewater treatment facilities from storm surge, improving and expanding drainage infrastructure, and investing in the projects which increase the redundancy and flexibility of the water system.

Strategy: Protect wastewater treatment facilities from storm surge

The City's investments in wastewater treatment over many years have resulted in dramatic improvements in the waterfront's ecological conditions, making the area a safer place to live and enhancing opportunities for public recreation. However, a substantial number of critical wastewater treatment assets are located, by design, in low-lying areas at risk of flooding in an extreme weather event. To minimize disruptions to its wastewater systems and protect its waterfront, the City must protect its vulnerable facilities from flooding impacts that may occur from future storms. Owners of other such facilities along area waterways also must undertake similar protective measures.

Initiative 1
Adopt a wastewater facility design standard for storm surge and sea level rise

Sandy damaged wastewater treatment plants and pumping stations even though the design of City wastewater facilities has taken into account the highest historically recorded water height of nearby water bodies or the BFEs identified in FEMA maps. The City, therefore, will adopt an increased level of protection for design and construction of all wastewater facilities based on the latest FEMA maps, modified to reflect sea level rise projections for the 2050s. The design for upgrades to DEP's Gowanus Canal facility, for instance, will protect any critical equipment that is located at or lower than 2.5 feet above the best-available BFE. DEP will adopt the new design guidelines in 2013.

Initiative 2
Harden pumping stations

Many of the city's pumping stations are located in low-lying areas and are necessary to convey wastewater and stormwater out of communities; however, their location also increases their vulnerability to storm surge. Therefore, subject to available funding, the City will retrofit these pumping stations for resiliency. These protective measures include raising or flood-proofing critical equipment, constructing barriers, and installing backup power supplies. Preliminary estimates indicate that there are currently 58 at-risk pumping stations, of which several already are scheduled for capital improvements. DEP will pursue implementation of resiliency projects at these pumping stations in conjunction with repairs and planned capital work, and as appropriate based on the level of risk, historical flooding, and potential community impacts, among other criteria. The goal is to begin implementation in 2014.

Initiative 3
Harden wastewater treatment plants

All 14 of the city's wastewater treatment facilities are located along the waterfront and are therefore at risk in the event of a coastal storm. Subject to available funding, the City will protect these critical treatment facilities by raising or flood-proofing assets that are critical to the treatment process, constructing barriers, improving waterfront infrastructure, or implementing redundancy measures to avoid failure of these critical treatment systems. DEP will target initially facilities that have been identified as either most at risk or as having the largest implications for adjacent communities and waterways, based on the findings of DEP's in-depth study. These facilities include the Oakwood Beach, Coney Island, 26th Ward, Hunts Point, Rockaway, and Jamaica WWTPs. The goal is to begin implementation of adaptation measures for these and other facilities in 2014 as part of repairs and other planned capital projects.

Initiative 4
Explore alternatives for the Rockaway Wastewater Treatment Plant

The Rockaway WWTP was one of the most heavily damaged wastewater facilities during Sandy. However, prior to investing significant funds to protect the plant from future storms, the City will consider converting it to a pumping station, which would be less expensive to protect, and potentially transferring its treatment responsibilities to a less vulnerable wastewater treatment facility elsewhere in the city. The City will conduct a feasibility study to consider all options. In addition to potentially decreasing future operations and maintenance needs, the conversion of this treatment plant would provide the opportunity to incorporate protective measures that would help avoid the failure of critical systems in future extreme weather events, and the potential impacts to water quality that could come with such failure. DEP will initiate the feasibility study in 2014 and, based on the results and subject to available funding, will consider moving forward with the conversion while incorporating additional resiliency measures.

Rendering of cogeneration facilities at North River Wastewater Treatment Plant in Manhattan

Credit: DEP

Initiative 5
Develop cogeneration facilities at North River Wastewater Treatment Plant

The North River WWTP, in Upper Manhattan, had to cut off its electrical power supply when waters threatened the plant's internal substation. While, like other wastewater treatment plants, the facility was able to run on generators, it did have to power down for several hours. The City will continue to enhance the reliability of this critical facility by installing cogeneration equipment there while hardening electrical assets. Using methane generated by the wastewater treatment process itself, cogeneration will produce electric power to keep wastewater treatment processes at North River online during power outages or during peak summer load periods, when Con Edison may request that the facility reduce its power usage. The project will replace the existing engines at the treatment plant with new, efficient motors and a cogeneration system that will generate electricity sufficient to meet base electrical demand and recover heat for the treatment plant's entire process and building needs. DEP projects that design of the cogeneration project at North River WWTP will be completed by 2015, with construction timeline pending design specifications.

Initiative 6
Explore opportunities to expand cogeneration and other energy measures

Although all city wastewater treatment plants maintain backup power supplies, there are other measures that will improve the ability of wastewater treatment plants to operate reliably during disruptions to the electrical grid. The City will explore the feasibility of expanding cogeneration and other energy-related reliability measures to other wastewater treatment plants in the city besides North River, including the Wards Island WWTP. These measures, which could include energy efficiency, increased generation and use of renewable energy supplies such as methane gas and solar energy, and cogeneration, would improve the ability of wastewater treatment plants to operate reliably during disruptions to the electrical grid while also enabling significant reductions in DEP greenhouse gas emissions. Over the long term, DEP will continue to plan and design new and improved wastewater treatment facilities with the ultimate goal of recovering and producing all energy on site, where feasible. DEP will begin a feasibility study for cogeneration at Wards Island in 2013, with implementation and other efforts to follow based on results and subject to available funding.

Stormwater running into a green infrastructure bioswale

Credit: DEP

Initiative 7
Encourage regional resiliency planning

Even if the City protects its wastewater treatment assets, the water quality at certain locations in New York Harbor may still be at risk should non-City facilities discharge sewage at a large scale—as happened during Sandy. The City, therefore, immediately will call upon nearby utilities in New York and New Jersey to take measures to protect their wastewater facilities from storm surge and sea level rise. Through regional resiliency planning, the City and neighboring municipalities alike can protect our shared Harbor.

Strategy: Improve and expand drainage infrastructure

Increased rainfall and heavy downpours may contribute to increases in street flooding, sewer backups, and combined sewer overflows. Improving the city's sewer systems will enhance the ability of the existing infrastructure to cope with environmental changes. To this end, DEP will continue to implement a number of its programs that are already under way and, where opportunities exist, will seek to expand these programs.

Initiative 8
Reduce combined sewer overflows with Green Infrastructure

As climate change brings increasing rainfall volume to the New York area, the city may also experience shifts in the frequency and volume of CSOs. The City will continue to implement its Green Infrastructure Plan and CSO Long-Term Control Plans (LTCPs) to reduce such CSOs. For this purpose, DEP, working with the Department of Parks & Recreation and Department of Transportation (NYCDOT), will continue to pursue its plan to capture the first inch of runoff in 10 percent of impervious surfaces citywide in areas within the combined sewer system by 2030. At the same time, DEP also will continue to develop LTCPs to evaluate long-term

solutions to reduce CSOs and improve water quality in New York City's waterways. DEP will issue an LTCP for Alley Creek in Queens in 2013, with nine additional water body-specific LTCPs and one citywide LTCP to follow by 2017—including plans for Coney Island Creek, the Gowanus Canal, Newtown Creek, and Jamaica Bay.

Initiative 9
Reduce combined sewer overflows with high-level storm sewers citywide

While the construction of new, green infrastructure is an effective solution to manage rainfall and reduce CSOs in some locations, in other areas, it will be more cost-effective to enhance the city's existing sewer system. The City will augment existing combined sewers with high-level storm sewers in certain areas near the water's edge around the city. These high-level storm sewers sit on top of the combined sewer and accept stormwater from the street before diverting it to a nearby waterway, with the combined sewer below it sending wastewater and a reduced amount of stormwater to a treatment plant. Such high-level storm sewers are able to capture 50 percent of rainfall before it enters combined sewers. Among the benefits of high-level storm sewers are mitigation of CSOs and the potential to reduce street flooding. To this end, DEP will continue to pursue approximately 15 high-level storm sewer projects that will be completed by 2023, and will continue to seek additional opportunities near the water's edge for additional high-level storm projects that are deemed to be most cost-effective and can be implemented in conjunction with NYCDOT street improvements and other community infrastructure projects.

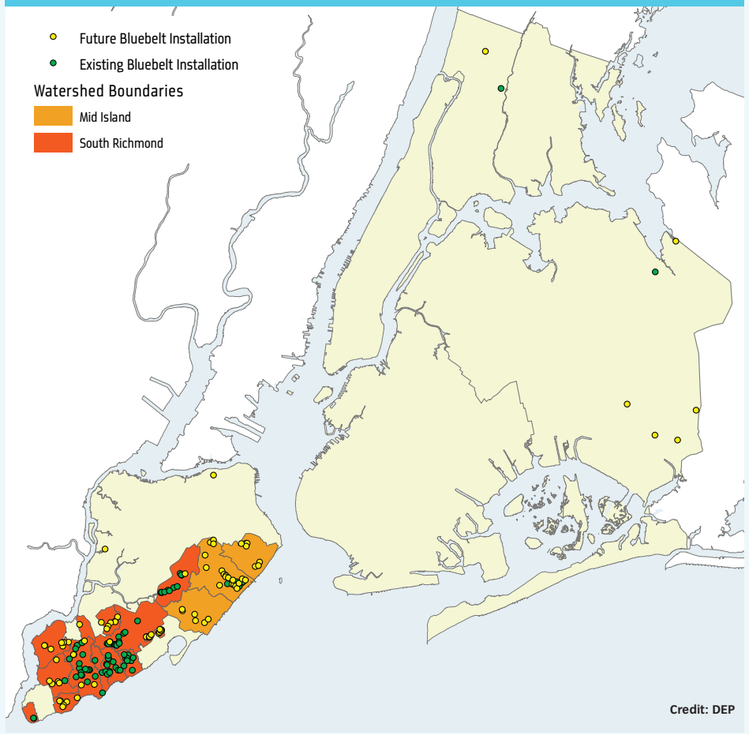
Initiative 10
Continue to implement and accelerate investments in Bluebelts across the city

Some areas of the city lack a fully built-out storm sewer system, and street flooding can occur even during minimal rain events. The City will, in addition to implementing new sewer build-outs and upgrades, continue to implement and accelerate its innovative Bluebelt drainage program. It will do so in several of these areas where opportunities exist to preserve and enhance natural areas, including streams, ponds, and other wetlands that remove pollutants before stormwater enters waterways. Through the next decade, DEP will complete substantially the South Richmond Bluebelt in Staten Island and additional Bluebelts in Twin Ponds, Queens. DEP also will begin to construct the Mid-Island Bluebelt on the East Shore of Staten Island. DEP will also accelerate planning and design of some Bluebelt systems including in Van Cortlandt Park in the Bronx and at Last Chance Pond in Staten Island, subject to available funding and environmental review.

Bluebelt installation under normal conditions

Credit: DEP

Citywide Bluebelt Map



Credit: DEP

Initiative 11
Build out stormwater sewers in areas of Queens with limited drainage systems

Large areas of South Queens, including portions of Broad Channel, Edgemere, Bayswater, Far Rockaway, Rockaway Beach and Arverne, as well as surrounding neighborhoods in Southeast Queens, such as Rosedale and Jamaica, do not have fully built-out storm sewer systems and currently experience street flooding, which may be exacerbated if rainfall increases with climate change. DEP, therefore, will continue to build out the storm sewer systems in these locations along with sanitary sewer upgrades and high-level storm sewers, undertaking approximately 30 projects through 2023. DEP will seek additional sewer build-out, improvement, or upgrade opportunities in conjunction with NYCDOT street improvements and other community infrastructure projects, including in areas with street flooding.

Initiative 12
Periodically review rainfall trends and implications for stormwater infrastructure

Future changes in rainfall intensity may warrant reconsideration of sewer design to decrease street flooding. DEP recently completed an assessment of historical rainfall data which revealed no changes in hourly and sub-hourly rainfall intensity. However, in order to recognize any emerging trends in precipitation intensity, DEP will work with the Mayor's Office of Long-Term Planning and Sustainability and the New York City Panel on Climate Change to create a process to reassess precipitation data periodically and incorporate any advances in climate modeling. Based on material emerging trends indicated by the foregoing, DEP will assess implications for the sizing of stormwater detention systems, sewer site connections, and green infrastructure, as appropriate. These assessments will occur approximately every eight years, with the next reassessment in 2021.

Strategy: Promote redundancy and flexibility to ensure constant supply of high-quality water

The City owns and operates an extensive water supply network that may increasingly be affected by climate change. However, redundancy and flexibility, which are already built into the system, allow the City to draw upon the largest quantity of water from the highest-quality sources in varying weather conditions. Building on this redundancy and flexibility, the City will protect critical infrastructure and watershed lands and improve upon the physical connections between different parts of the system to enable the use of the most appropriate source of water at any given moment in time.

Initiative 13
Repair the leak in the Delaware Aqueduct

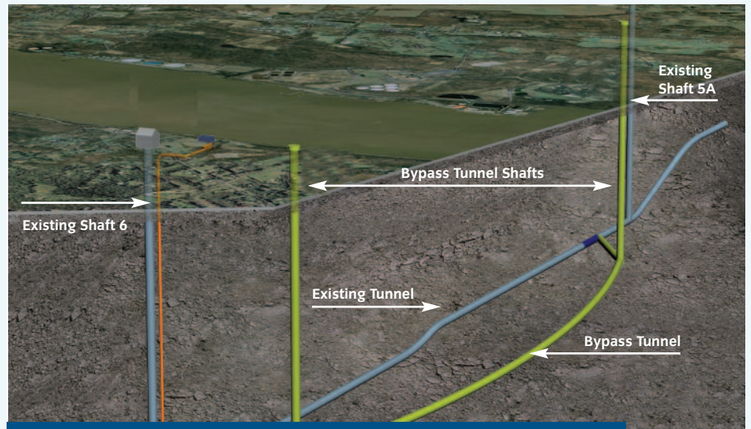
Every drop of clean water counts, particularly in times of drought and other extreme weather events that affect supply. The City will implement planned repairs to the Delaware Aqueduct, which conveys, on average, 50 percent of the city's water from Upstate sources. This aqueduct has been leaking between 15 and 35 million gallons of water a day for many years. In 2013, DEP will begin construction of a three-mile bypass tunnel around the section which has the largest leak. While the bypass is connected and the aqueduct is out of service, DEP will repair other sections of the tunnel. These repairs will enhance the reliability of the city's water supply and maintain flexibility during normal operations, as well as during periods when the water system is depleted, or when water quality in other parts of the system is affected by heavy rain or heat waves. Since the Delaware Aqueduct will need to be shut down in order to connect the new bypass tunnel, this will result in a temporary decrease in water supply. Accordingly, in preparation for the shutdown, DEP will increase the capacity and use of the Catskill and Croton systems; reactivate a groundwater system in Southeast Queens; and adopt both a new Water Demand Management Plan that will conserve water citywide, and water shortage rules to impose use restrictions during droughts and infrastructure repairs. The tunnel shutdown, repairs, and reactivation are expected to be completed in 2022.

Initiative 14
Improve interconnection between the Catskill and Delaware aqueducts and maximize capacity to deliver water from the Catskill/Delaware system

The impacts of climate change on the city's three water supply systems—the Catskill, Delaware, and Croton systems—are likely to vary. For example, while the Catskill system is prone to elevated turbidity, the Delaware system is less so. This variability is one of the strengths of the city's water supply system. However, tapping into that strength requires the right infrastructure. The City, therefore, will complete several planned infrastructure projects, including a new connection between the Catskill and Delaware water supply systems. The City also will consider a project to pressurize the Catskill Aqueduct between Kensico Reservoir and DEP's Ultraviolet Disinfection Facility, in order to give DEP the ability to maximize use of water from Kensico Reservoir and maximize flow to Hillview Reservoir. DEP will begin construction of the interconnection between the Catskill and Delaware system in 2013 and, subject to pending analysis, would commence construction of the pressurized Catskill Aqueduct after the repair of the Delaware Aqueduct is completed in 2022.

Initiative 15
Continue the Watershed Protection Program to maintain drinking water quality

The City will maintain its commitment to protect its reservoirs and the watersheds that surround them while considering the challenges of climate change. DEP will continue to implement its Long-Term Watershed Protection Program to protect water quality in the streams and other water bodies that feed its reservoirs, and in the reservoirs themselves. The City will continue to acquire land strategically in the watershed and manage that land. DEP also will continue its stream, farm, and forestry programs. These and other watershed protection efforts help maintain water quality, promote environmentally compatible economic development, and enable the City to avoid building a water filtration facility for the Catskill/Delaware systems. DEP's support of these programs in the watershed also helps to reduce the high levels of nutrients associated with stormwater, which can otherwise cause increased algae levels in reservoirs. In 2013, DEP expects that the filtration waiver applicable to the Delaware and Catskill systems will be revised and will incorporate updates to its Long-Term Watershed Protection Program, as outlined above.



Rendering of the bypass tunnel around the leaking section of the Delaware Aqueduct

Credit: DEP

Hunts Point Food Distribution Center, Bronx, NY

Other Critical Networks

Food Supply

One of the least-known but most important rituals in New York takes place every night in the South Bronx at the Hunts Point Food Distribution Center (FDC). There, in striking abundance, delicacies from around the state, country, and the world are bought and sold—cabbage from New York, oranges from California, blueberries from Chile, bell peppers from the Netherlands, beef from Australia, and fish from Nova Scotia. All around the Hunts Point FDC, and in dozens and dozens of nearby buildings, everything from international food to alcoholic beverages is packaged, warehoused, and sold—sold to supermarkets, sold to bodegas, sold to street vendors, sold to restaurants. Its customer base also includes schools as well as the food banks, soup kitchens, and pantries that serve New York's most vulnerable populations.

Unfortunately, the Hunts Point neighborhood is not just critically important, it is also vulnerable. It sits on a peninsula with the East River on two sides, and the Bronx River on the third. Meanwhile, close to 28 percent of the site is at risk of flooding, meaning that approximately 93 acres of the 329-acre site lies within the 100-year floodplain (the area that has a 1 percent or greater chance of flooding in any given year) as set forth in the Preliminary Work Maps (PWMs) produced by the Federal Emergency Management Agency (FEMA).

Sandy spared Hunts Point the worst of its impacts largely because it hit New York at low tide in the Long Island Sound. However, complacency in the wake of Sandy would be a mistake, as the food supply system may not escape significant impacts in the next extreme weather event. That is why this plan seeks to protect the Hunts Point neighborhood and the various elements of the food supply system found across the city and its surrounding region from climate change-related impacts, while seeking to strengthen the ability of that system to bounce back when, from time to time, impacts do occur.

Although initiatives outlined in several other chapters of this report are important contributors to the overall resiliency of the food supply network (see Chapter 6, *Utilities*; Chapter 7, *Liquid Fuels*; and Chapter 10, *Transportation*), the City also will pursue a series of food-specific efforts, targeting the most significant concentrations of both wholesale distribution and retail access.

How the Food Supply System Works

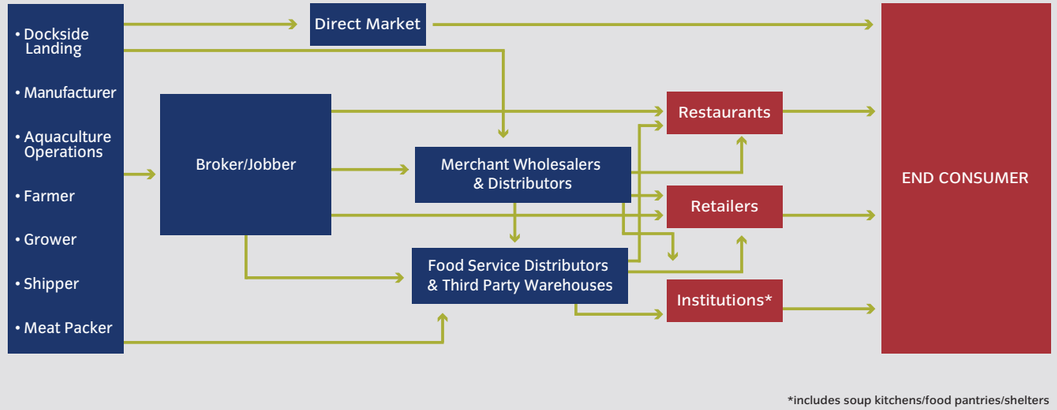
Each year, more than 5.7 million tons of both domestic and international food shipments flow into New York City, snaking their way over sea, rail, and road from farms, fisheries, and factories to the city's retailers and restaurants. The system that has developed to carry this bounty to consumers is multilayered and interdependent. It begins, for the purposes of this analysis, in the city and the surrounding region, with wholesalers that take in shipments from around the world and then repackage and distribute them for retail sale.

Large, national distributors such as Sysco, General Trading, White Rose, and C&S stock a wide variety of products and distribute them via trucks primarily to large retailers, such as grocery stores, and institutions, such as hospitals and universities. Their warehouses generally are dispersed outside of the city's boundaries—including a large concentration in New Jersey and smaller concentrations in Connecticut and Upstate New York—though some facilities are located within the Bronx and other parts of the five boroughs.

Certain large retailers such as Whole Foods, meanwhile, rely upon in-house distribution facilities and trucks. Regardless of whether retailers are serviced by third-party distributors or their own distribution systems, virtually all also receive certain specialty products (such as branded snacks and soft drinks) from vendors via direct store delivery. (*See diagram: Food Supply Chain*)

When it comes to smaller stores, restaurants and other retail outlets, many rely heavily on the markets in Hunts Point—especially the public wholesale markets. In fact, about 60 percent of the city's produce and about half of the city's meat and fish passes through Hunts Point for sale and distribution to retailers and consumers. Additional major meat markets exist in Sunset Park, Brooklyn and in Manhattan's Meat Packing District, with smaller, wholesale clusters for the distribution of specialized foods found in Maspeth, Queens and the Lower East Side and Chinatown in Lower Manhattan.

Food Supply Chain



Hunts Point Food Distribution Center

Karsten Moran/The New York Times

From wholesalers and distributors, much of the city's food supply makes its way to retailers such as grocery stores—including both smaller stores and "full-line" grocers, which, in New York City, generally are greater than 6,000 square feet, as defined by the City's Food Retail Expansion to Support Health (FRESH) program. About a quarter of food retail outlets are full-line grocery stores, while close to three-quarters are smaller markets and convenience stores such as bodegas. The New York State Department of Agriculture and Markets (NYSDAM) licenses these food retail outlets (those with less than 50 percent of space dedicated to selling prepared foods).

Despite the presence of approximately 10,000 stores in New York City that sell perishable food, there are many underserved neighborhoods that lack sufficient access to full-line grocers, which provide the most diverse range of products, including fresh produce and proteins (meat, fish, and dairy). These areas often are served by smaller stores that provide only basic staples and lack nutritious, affordable fresh food. In many of these neighborhoods, there are higher rates of diet-related diseases and obesity.

Since 2009, the City has used financial incentives and its zoning authority to encourage the development of full-line grocers in underserved areas, through the FRESH program. To date, 13 FRESH-supported projects will lead to the creation of 340,000 square feet of new, renovated or expanded retail space in previously retail-deficient neighborhoods.

Besides shopping at grocery stores, New Yorkers also purchase food from a variety of other retailers, including delivery services, farmers markets, and food carts—in addition, of course, to the city's dizzying array of more than 24,000 restaurants.

However, individual residents are not the only purchasers of food. Elderly and disabled populations may rely upon meal delivery services provided by nonprofits, many of which receive government funding. Furthermore, a variety of other private, nonprofit, and public institutions—including hospitals, schools, and senior centers—are huge buyers of food. The Department of Citywide Administrative Services (DCAS) purchases food on behalf several City agencies, including the Department of Corrections (DOC), the Human Resources Administration (HRA), and the Division of Youth and Family Justice (DYFJ). The Department of Education (DOE) serves about 180 million meals and snacks per year, while the Health and Hospitals Corporation (HHC), responsible for managing all City-owned health facilities, provides 10 million meals and snacks annually. Additionally, non-governmental hospitals and universities supply meals to various populations.

The food supply system is not only highly complex. It is also highly dependent on other networks such as power, transportation, liquid fuels, and—to a lesser degree—telecommunications.

Electricity is vital for the food supply system, particularly because it enables the refrigeration necessary to keep perishable food—especially produce, meat, and fish—fresh and edible for longer periods. Refrigeration is power-intensive, typically responsible for about 43 percent of electricity use at a full-line grocer. Power supports other functions as well—including lights, air conditioning, information technology (for tracking inventory), and cash registers. Consumers also rely on power to store and prepare their in-home food supplies since, for example, unrefrigerated raw chicken spoils within two hours at room temperature.

The transportation network is similarly, if not even more, important. Approximately 95 percent of the city's food travels into New York City by truck, via a limited number of access points (mainly bridges). In fact, nearly 30 percent of the truck traffic over the George Washington Bridge on any given day is believed to be carrying food. Every day, almost 13,000 trucks travel into and out of the Hunts Point FDC alone—and, of course, those trucks are wholly reliant on the availability of liquid fuels.

Risk Assessment: Impact of Climate Change on Food Supply

Major Risk Moderate Risk Minor Risk

	Scale of Impact			
Hazard	Today	2020s	2050s	Comments
Gradual				
Sea level rise				Minimal impact
Increased precipitation				Minimal impact
Higher average temperature				Minimal impact
Extreme Events				
Storm surge				Direct damage possible to Hunts Point and retailers in the floodplain; possible interruptions to supporting systems (e.g., utilities, liquid fuels, and transportation) Power outages could lead to failures across supply chain
Heavy downpour				Minimal impact
Heat wave				Power outages could lead to failures at both distributors and retailers
High winds				Minimal impact

Telecommunications capabilities, meanwhile, enable the continued operation of payment systems at retailers—including credit card transactions as well as transactions using Electronic Benefit Transfer (EBT) cards, through which the City distributes funds for purchasing food to low-income residents, as part of the Supplemental Nutrition Assistance Program (SNAP, formerly called food stamps). The United States Department of Agriculture (USDA) oversees SNAP, while the City and its Human Resources Administration (HRA) are responsible for administering these Federal benefits to New Yorkers. Retailers also use the telecommunications network to communicate with distributors and wholesalers to help keep them adequately stocked.

Finally, in the event of a disruption in the food supply system, the City's Office of Emergency Management (OEM) has in place response procedures that include emergency feeding plans, commodity distribution plans, and coordination of emergency food programs for vulnerable populations. OEM works with nonprofits, private organizations, and other governmental agencies in developing its emergency preparations.

What Happened During Sandy

During Sandy, wholesale warehouses and distribution facilities in the city and in surrounding areas were largely unaffected, with the exception of wholesalers located in directly impacted areas such as the Gansevoort Meat Market in Southern Manhattan and the in-house distribution fleets of Fresh Direct and City Harvest in Long Island City, Queens. Facilities owned by the largest wholesalers proved to be highly resilient, thanks to redundant power systems as well as multiple locations. For example, the American Red Cross, which is responsible for certain emergency feeding operations under contract with the City, was able to rely on uninterrupted supply from US Foods, thanks to the company's diffuse sites and backup power systems.

Distribution impacts did occur, however, largely due to delays in truck-based freight. Incoming trucks to Hunts Point and elsewhere, for example, encountered restrictions or delays at major bridge crossings due to single-occupancy vehicle restrictions, since most freight trucks have just a driver and no passengers. Distributors also faced challenges sourcing fuel for their fleets due to supply shortages (see Chapter 7).

In impacted neighborhoods, retailers were hit harder than expected. The maps used to predict where floodwaters would hit, the 1983 Flood Insurance Rate Maps (FIRMs), proved to fall short of much of the Sandy Inundation Zone. Retailers suffered both direct damage from flooding and indirect losses due to power outage. Floodwaters damaged building systems and fixtures, and destroyed significant quantities of inventory—including nonperishable or shelf-stable goods that were left close to the ground. Power outages resulted in additional inventory loss due to spoilage of perishables and also prevented stores from conducting credit card or EBT transactions (even where the telecommunications network was working). Because these impacts were concentrated within inundation areas, whole neighborhoods found themselves with limited or no retail food access. Transportation breakdowns meant that the problems of residents of these neighborhoods were compounded, because they frequently had limited ability to travel to other areas to find functioning retailers. However, in many areas, unimpacted retailers were sufficiently close that physically able residents could walk to alternative locations.

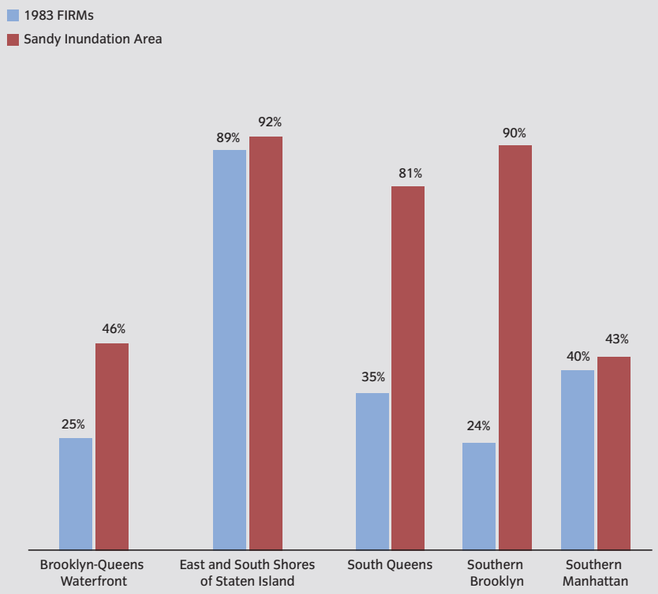
Another impact resulted from the fact that families without electricity were unable to keep perishable foods or cook (for those with electric stoves). Some emergency food providers such

as food pantries and soup kitchens—the very entities that often are called up to provide emergency food assistance—were inundated and so, in some cases, were unable to provide service in the days and weeks immediately following Sandy. While there were sustained power outages affecting entire neighborhoods, retailers big and small eventually found ways to recover. This included pumping out water or waiting for waters to recede, sourcing backup power, cleaning, rebuilding, and restocking. For example, one retailer in Coney Island used dry ice to provide temporary refrigeration for produce, while another in East Harlem hired a bus service to bring in stranded employees.

Despite these and other efforts by local retailers, some communities were forced to rely upon emergency food distribution measures In a matter of days, the City and its partners in the State and Federal governments and the nonprofit sector developed and implemented the largest emergency feeding operation in New York history. Thanks to both in-place and emergency contracts and with support from the National Guard and others, through January 31, the City and others distributed over 2.1 million shelf-stable meals, over 700,000 prepared meals, and almost 280,000 meals from food trucks. Many of these meals were served through 17 City-run "pop-up" sites across the impacted areas.

In addition, by the first week of November, HRA had worked with the State and Federal government to replace SNAP benefits equaling 50 percent of a recipient's October benefit, as well as manually processed requests for full reimbursement. These two efforts alone ensured that more than $66 million in purchasing power was available to particularly vulnerable populations affected by the storm. Combined with almost $6 million in additional benefits provided in December 2012 through the Disaster Food Stamp program, a total of more than $72 million in additional SNAP benefits reached impacted communities. The Mayor's Fund to Advance New York City provided additional support, while the DOE received Federal approval to provide additional free school meals in Sandy-impacted areas through March. Nonprofit feeding operations continued in some neighborhoods into the spring. For example, City Harvest delivered over 7 million pounds more food than during the same October-to-March period the previous year.

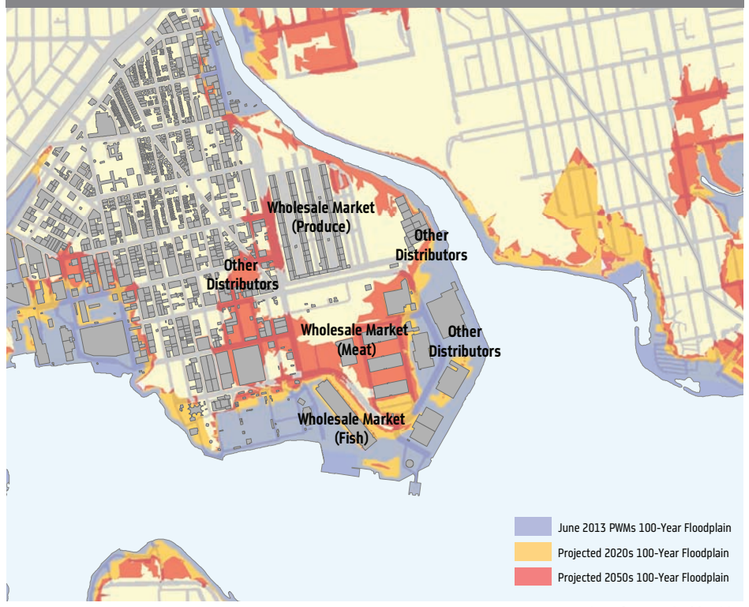
Food Retail Area in Sandy-Impacted Communities



Note: Data represents percentage of food retail square footage within impacted communities in 1983 FIRMS or Sandy Inundation areas

Source: FEMA and Hoovers

Hunts Point Peninsula and Food Distribution Center Vulnerability



Source: FEMA, CUNY Institute for Sustainable Cities

What Could Happen in the Future

As a diffuse system reliant on many different facilities, the city's food supply system is generally quite resilient. However, the Hunts Point FDC, a major link in the city's food supply chain, presents a major vulnerability to storm surge. Additionally, neighborhood-level retail impacts could be significant across the five boroughs. *(See chart: Food Retail Area in Sandy-Impacted Communities*)

Major Risks

The most significant risk to the food supply system is the threat of storm surge, particularly as rising sea levels increase the City's 100-year floodplain. Much of this risk is attributable to the vulnerability of the Hunts Point area, which lies within the 100-year floodplain as mapped on FEMA's Preliminary Work Maps (PWMs). As mentioned earlier, the vulnerability at Hunts Point includes public markets, as well as a variety of major private distributors. As described in Chapter 2 (*Climate Analysis*), if Sandy had taken a different path or arrived at a slightly different time (i.e., high tide in Long Island Sound), the Hunts Point area might have flooded, lost power and significant inventory, and suffered from major operational interruptions. Also, because Hunts Point supplies a disproportionate share of the food wholesaling needs of low-income neighborhoods in New York, the impacts of damage in that area would be felt most dramatically in the communities with the fewest retail food alternatives. (*See map: Hunts Point Peninsula and Food Distribution Center Vulnerability*)

Storm surge is also a significant threat to neighborhood-level retail access in coastal communities, as Sandy demonstrated. There are almost 700 food retail markets in the PWM-defined 100-year floodplain, representing over 10 percent of the city's food retail space. By the 2020s, the projected 100-year floodplain will have expanded to include nearly 155 more existing food stores, the majority of which are smaller markets which almost exclusively serve low-income and vulnerable neighborhoods. By the 2050s, almost 200 additional existing stores will be found in the projected 100-year floodplain— bringing the total of at-risk retail floor area to over 15 percent of the city's total food retail space, and close to 1030 total stores. *(See chart: Food Retail Area in the 100-Year Floodplain in Sandy-Impacted Communities*)

While most of New York's food retail square footage will not be at risk of surge, the buildings that are at risk are concentrated in low-income communities. Indeed, the top four at-risk community districts—which are projected to have more than 75 percent of their food retail floor area in a floodplain by the 2050s—are all areas with high levels of low-income populations. This includes Coney Island, the Rockaways, Throgs Neck/Co-Op City, and East Harlem.

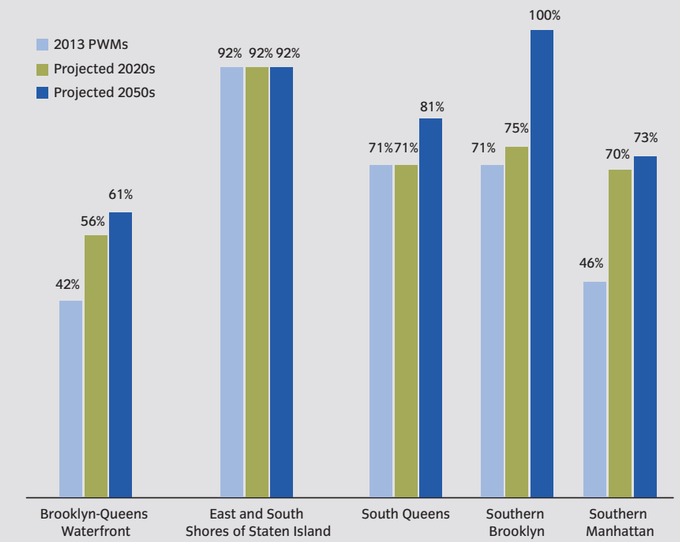
Certain City government food programs also will be at risk of storm surge-related impacts. This is because some of the City's food procurement, which is managed by DCAS, is made through smaller, less-resilient distributors with fewer resources to invest in resiliency measures. In fact, it is believed that relatively less-resilient distributors currently constitute most of the contracted suppliers for DCAS procurements on behalf of agencies such as the Administration for Children's Services, HRA, DOC, and OEM.

Storm surge creates additional risks for the food supply system to the extent that it threatens the city's power, liquid fuels, and transportation networks. Power network dependency for food storage and business operations means that basic continued business operations could be at risk in the event of a significant disruption to the power grid. Many functions of the food supply system also depend on access to fuel needed for food transport or to power backup generators. Additionally, the food supply system's dependence on truck-carried freight means that transportation impacts from storm surge could have a cascading effect on food availability.

Other Risks

Heat waves that result in power losses threaten the operations of wholesale and retail facilities, where backup power is not available. The loss of refrigeration capabilities may result in the spoilage of large amounts of perishable goods, while retailers also could lose the ability to process electronic payments, including the EBT purchases that are so critical to low-income populations. Power losses also impact consumer access to food by interrupting in-home refrigeration and cooking. The initiatives outlined in Chapter 6 are meant to address these challenges. Chronic sea level rise (when no coastal storms are present) is unlikely to impact the food supply system as a whole, since it is spread broadly across a diverse geographic area. Similarly, heavy downpours and high winds should not cause impacts on the broader network or consumer access, though isolated distribution or retail sites could suffer localized impacts.

Food Retail Area in the 100-Year Floodplain in Sandy-Impacted Communities



Note: Data represents percentage of food retail square footage within impacted communities in each 100-Year floodplain scenario.

Source: FEMA, CUNY Institute for Sustainable Cities and Hoovers

This chapter contains a series of initiatives that are designed to mitigate the impacts of climate change on New York's food supply system. In many cases, these initiatives are ready to proceed and have identified funding sources assigned to cover their costs. With respect to these initiatives, the City intends to proceed with them as quickly as practicable, upon the receipt of identified funding.

Meanwhile, in the case of certain other initiatives described in this chapter, though these initiatives may be ready to proceed, they still do not have specific sources of funding assigned to them. In Chapter 19 (*Funding*), the City describes additional funding sources, which, if secured, would be sufficient to fund the full first phase of projects and programs described in this document over a 10-year period. The City will work aggressively on securing this funding and any necessary third-party approvals required in connection therewith (i.e., from the Federal or State governments). However, until such time as these sources are secured, the City will proceed only with those initiatives for which it has adequate funding.

Careful implementation of the utility, liquid fuels, and transportation recommendations in Chapters 6, 7, and 10 of this plan will help to protect the food supply network by increasing access to the energy and freight capabilities needed to maintain operations. Additional measures will identify and address vulnerabilities at the wholesale and retail levels.

Strategy: Enable continued operations of supporting systems upon which the food system depends

Recognizing that the food system depends on power, liquid fuel, and transportation networks, the City's food supply efforts inextricably are linked to initiatives described in detail elsewhere in this report. For example, the food supply network will benefit from a variety of initiatives that seek to encourage utility-led, cost-effective resiliency measures to protect the power grid and enable it to recover quickly in the event of impacts (see Chapter 6).

Similarly, the City will work towards maintaining a sufficient fuel supply to meet the needs of the truck fleets on which the food system depends. As part of its fuel supply resiliency efforts, the City will work with government and private entities to harden liquid fuel supply infrastructure and improve the system, and to prepare it to bounce back quickly from supply chain breaks with both off-the-shelf regulatory waivers and emergency fueling capabilities. For more information on these strategies, see Chapter 7.

Finally, the City will implement measures so that the critical road networks identified in Chapter 10 include critical food supply corridors that would benefit from additional resiliency investments. As part of its transportation resiliency efforts, the City also may prioritize certain categories of food supply trucks during periods of restricted access (for example, during periods when single-occupant vehicles are not permitted to use river crossings). Building on initiatives outlined in Chapter 10 and as part of the food distribution study outlined below, the City will work with large wholesalers to identify alternative modes—such as rail or barge— of bringing in large-scale food supply in the event that truck-based routes become wholly or partially unavailable.

Strategy: Identify and harden critical food distribution assets

To help the food system to withstand direct and indirect risks, the City will study the system for prospective vulnerabilities and develop a more refined plan for long-term protections. In the short term, the City has identified critical vulnerabilities that it will seek to address. Most notably, in Chapter 3 *(Coastal Protection)*, the City proposes the construction of an integrated flood protection system to enhance protection of the Hunts Point peninsula, including the Hunts Point FDC, as part of the proposed Phase I Initiatives. Additional food supply-specific initiatives can help to implement multilayered defenses to protect the system.

Initiative 1

Study the food distribution system to identify other prospective vulnerabilities

Sandy showed New York's food supply system to be highly resilient, but a deeper analysis of the interactions between the different segments of the supply chain is necessary to refine this understanding. Subject to available funding, the City will commission a study of New York's food distribution system, to identify vulnerabilities and develop a plan to protect the system from those vulnerabilities in the long term. As an outgrowth of this study and building upon the 2011 update to PlaNYC, the Office of Long-Term Planning and Sustainability (OLTPS) will identify key distribution assets in surrounding jurisdictions (including major wholesale distributors that supply the New York market), and will work with those jurisdictions and the owners of those assets to identify and address risks. The study also would seek to improve food-related disaster preparedness at the community level in order to augment and inform efforts already underway at OEM. Through the study, the City would create a comprehensive plan to identify and integrate City resources, alternative food providers, community-based organizations, and other providers into its emergency feeding response plans. The goal is to begin this study in the next six months.

Initiative 2

Expand upon prior energy studies to explore options for cost-effective, continuous power for the Hunts Point Food Distribution Center

In order to enable continued operation, refrigerated storage capacity, and an uninterrupted supply chain to most of the city, strengthening the resiliency of the power supply at the Hunts Point FDC is critical. The City will work with tenants at the Hunts Point FDC to put in place options to enable such a continuous power supply. The options could include expanding existing tenant-led efforts to procure and install backup generators, or raising power lines and utility infrastructure in place. New York City Economic Development Corporation (NYCEDC) will lead this cooperative effort in 2013, leveraging a prior City study that examined the feasibility of installing a combined heat and power system for the entire Hunts Point FDC.

Strategy: Improve the resiliency of consumer access

Sandy exposed the vulnerabilities consumers face in accessing food through normal channels after a major storm. Initiatives to harden retail access points and diversify City procurement of food will improve the resiliency of this segment of the supply chain. These efforts will draw on the recommended Core Flood Resiliency Measures outlined in Chapter 4 (*Buildings*), as well as a buildings incentive program that seeks to help 70 percent of New York's floor area—including retail—to become more resilient by 2030.

Initiative 3

Call on New York State to issue preparedness guidelines to retailers in anticipation of extreme weather events

Proper preparedness can enable retailers to protect more of their inventory, even during significant flooding events. The City will call on New York State Department of Agriculture and Markets, the regulatory authority that licenses food retail establishments, to develop and issue preparedness guidelines for retailers at-risk of climate impacts, such as flooding and storm surges. These guidelines would help retailers protect packaged foods, maintain ample stocks, and protect retail space, allowing for rapid reopening of retail outlets following an extreme weather event. OLTPS and OEM will work with NYSDAM to disseminate these State-issued preparedness guidelines to New York City retailers in 2013.

Initiative 4

Call on the State Legislature to pass City-sponsored legislation mandating electric generators for food retailers

Even retailers with shelf-stable inventory need electrical power to operate lights and cash registers and to process credit, debit, and EBT cards. The City will call on the State legislature to pass a law to require certain retailers to either install a transfer switch to enable quick connection to a generator, or to maintain a backup generator on site. The proposed legislation will aim to require that back-up power be capable of powering retailers' basic systems necessary for operations. The legislation, would not, however, require capacity to power refrigeration equipment, which is extremely power-intensive. The proposed legislation will aim to require stores to initiate backup power systems within 24 hours of power outages and would apply to stores of 20,000 square feet or more of floor space, or those having 60 or more employees (full- or part-time). OEM will work with the City's State Legislative Affairs Office to advance this legislation.

Initiative 5

Continue to support the FRESH program to increase the number of full-line grocers in underserved neighborhoods

Low-income neighborhoods are particularly vulnerable to retail outages as many are in vulnerable locations and, even without extreme weather conditions, lack adequate retail access options. As part of its continuing efforts to encourage the development of full-line grocery stores in underserved neighborhoods, the City, through NYCEDC and the Department of City Planning, will continue to support the FRESH program to provide multilayered benefits to encourage full-line grocery developers to locate in these underserved neighborhoods.

In parallel to the FRESH program, the New York Healthy Food & Healthy Communities Fund and New York State will work to facilitate the development of healthy food markets in underserved communities throughout New York State. This partnership will immediately provide pre-development grants and loans to new full-line grocery store projects in these communities.

Food Supply Initiative 6

Expand DCAS food procurement pilots towards contracts with larger, more resilient distributors that have active New York operations

The City currently procures food for several key agencies using a number of single-supplier, item-specific contracts that provide no alternative sources when a designated supplier is unable to deliver needed product. The City will expand current pilots to backstop DCAS food procurement to strengthen resiliency and redundancy in case of future climate hazards. DCAS will work so that its supplier contracts for DOC, DYFJ, and HRA (food pantries and soup kitchens) have backstops in place by the end of 2013.

Initiative 7

Implement preparedness measures for continued availability of SNAP benefits for vulnerable consumers following large-scale power outages

Power outages can affect the ability of consumers to store fresh food and produce, and can spoil food already in the refrigerators of households. Consumers who depend on SNAP benefits depend on the availability of these funds to replenish their food supply. The City, through HRA, will prepare waiver requests for immediate submittal to the Federal government, specifically the USDA, for the automatic mass replacement of benefits in the event of a large-scale power disruption. This is the fastest way to get food purchasing power back into the hands of low-income New Yorkers, and it will free up critical City resources and reduce administrative burden on City agencies, when these resources are needed most. HRA, as administrator of Federal SNAP benefits for New Yorkers, will initiate these preparations in 2013.

Key Food, Coney Island

Solid Waste

Every morning before dawn, nearly a thousand Department of Sanitation (DSNY) collection trucks roll out of garages located around the city to begin their daily rounds. By the time most people wake up, DSNY employees—"New York's Strongest"—already are well on their way to collecting their daily haul of over 12,000 tons of waste and recyclables from residential buildings, schools, hospitals, and other institutions. The remainder of the city's daily intake of 50,000 tons is generated by businesses or construction sites and is collected by private haulers.

In ordinary times, garbage collection fades into the background of the city's life. The collection of solid waste, though critical to the functioning of the city, is so orderly and predictable that it becomes almost invisible to most New Yorkers.

In extraordinary times, however, DSNY's fleet of more than 2,000 collection vehicles and more than 9,000-person army of sanitation workers and support employees suddenly attract the spotlight. Never was this truer than in the aftermath of Sandy. Under the direction of the City-activated Debris Removal Task Force and with the participation of other City, State, and Federal agencies, DSNY employees worked 12-hour shifts around the clock, seven days a week, to collect more than 400,000 tons of Sandy-related debris, including downed trees.

The massive debris clean-up after Sandy demonstrated the resiliency of the City's solid waste capabilities. But the next time could be different. A storm pattern different from that of Sandy could affect more DSNY facilities more seriously. As the City's solid waste collection network shifts towards more environmentally friendly marine routes, it will rely increasingly on waterfront facilities that must be protected. And since the City's solid waste disposal network extends well beyond the five boroughs and the City's control, it will require coordination among multiple parties.

The commercial solid waste collection system served by private haulers is closely intertwined with the DSNY system, which is the focus of this chapter. Although the commercial system may suffer some unique climate impacts, it is expected that DSNY will be capable of collecting excess debris in the wake of an extreme weather event—as was demonstrated after Sandy.

In keeping with the broad goals of this report—to minimize disruptions from climate hazards and ensure New York can bounce back quickly if damage is sustained—the City will enhance the resiliency of the solid waste system. This will include hardening critical City-owned solid waste assets to protect them from storm impacts while also seeking to ensure that the broader solid waste network—both City- and third-party owned—is sufficiently resilient to enable the system to resume operations quickly should disruptions occur.

DSNY workers and collection truck

Credit: Emilee McGovern

How the Solid Waste System Works

DSNY's distinctive white collection trucks are the most visible component of a vast, multimodal system that must not only collect garbage from streets but also dispose of it safely. It involves City employees, garages, and specialized vehicles, as well as a far-flung network of private haulers, transfer stations, rail lines, and disposal companies that extends well beyond the borders of the five boroughs. Significant changes are underway to make the system more efficient and environmentally friendly.

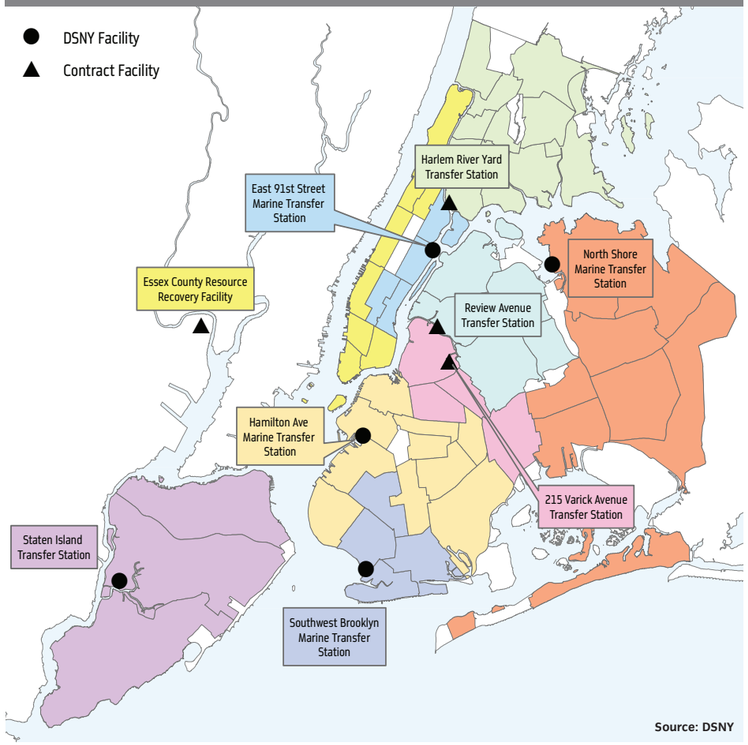
Today, collection trucks from garages in 59 separate sanitation districts carry approximately 90 percent of the city's residential and institutional waste to one of over 30 transfer stations. Then waste is moved to larger commercial tractor-trailers, also called "transfer trailers" (responsible for about 50 percent of the total), or railcars (responsible for about 40 percent of the total). Via truck or rail, the waste is then transported to disposal sites outside the city—as far afield as Pennsylvania, Ohio, and South Carolina. The approximately 10 percent remaining is carried directly by collection trucks to the Essex County Resource Recovery Facility in New Jersey, a privately operated waste-to-energy facility that combusts more than 1,000 tons per day of municipal solid waste from the city to generate electricity.

Private haulers collect commercially-generated waste, construction and demolition waste (sheetrock, wood, tiles), and fill material (dirt, rock). Most solid waste collected by DSNY and private haulers is processed at the same network of private transfer stations located in the city. Private solid waste haulers rely primarily on trucks to remove solid waste for transport to landfills and incinerators.

The closure of the Fresh Kills Landfill in Staten Island in 2001 created the need for this primarily truck-based system to begin exporting solid waste. In 2006, however, the City released the Comprehensive Solid Waste Management Plan (SWMP), a framework designed to eliminate New York's reliance on a network of land-based transfer stations and long-haul trucking to export residential waste. Once fully implemented, the SWMP will achieve a dramatic reduction in DSNY's number of truck trips and miles driven—and therefore the environmental and health impacts—in connection with the disposal of New York City's waste.

The SWMP outlined a plan to create four marine transfer stations that will be operational by 2018. Together, the four facilities—to be located on Gravesend Bay in Southwest Brooklyn; on the North Shore in Flushing Bay; along the East River in Manhattan; and along the Gowanus Canal—will enable DSNY to move approximately 50 percent of New York's non-commercial solid waste via barge and then onto rail. In so doing, the plan is expected to reduce annual DSNY collection truck travel by 2.8 million miles and reduce commercial tractor-trailer miles driven within the city by another 2.8 million vehicle miles. (*See map: DSNY Facilities and Sanitation Districts*)

DSNY Facilities and Sanitation Districts



Source: DSNY

What Happened During Sandy

Despite the scale of Sandy's impact, New York's solid waste collection and disposal system generally proved to be quite resilient, though some issues did materialize. Sandy strained the solid waste disposal network, exceeding storage capacity, disabling transportation, and requiring emergency resources such as containers and vehicles.

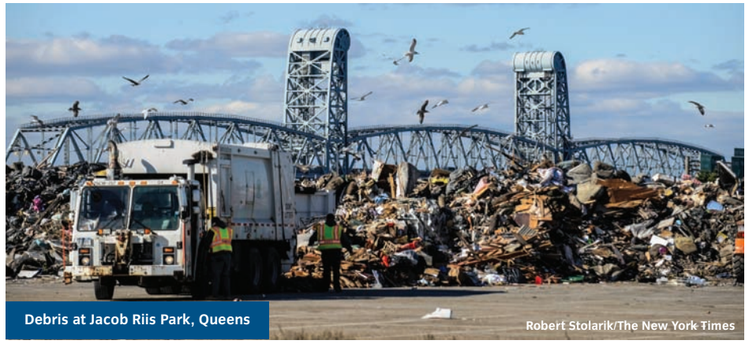
Amazingly, DSNY's normal collection services were affected only minimally, and neighborhoods typically missed at most just one regularly scheduled pickup, with curbside recycling resuming less than two weeks after Sandy. Although more than 60 DSNY facilities sustained some damage, including almost 50 garages, the impact was minor due in part to the fact that the facilities housed vehicles that were, in most cases, moved out of the storm surge inundation area. Nonetheless, 44 heavy-duty and 31 light- and medium-duty vehicles were damaged or destroyed by floodwaters. This damage did not prevent DSNY from carrying out its regular tasks—or from completing its massive post-Sandy cleanup efforts.

The larger waste disposal system, however, was affected by Sandy. Most significantly, one day before the storm, the Essex County Resource Recovery Facility preemptively shut down its boilers. The facility then experienced significant inundation which knocked it out of operation for a subsequent two weeks. With the loss of over 10 percent of its disposal capacity, DSNY was forced to enter into emergency disposal contracts with vendors.

The rail transport network used for waste disposal also was affected by Sandy, with operations halted in Staten Island and the Bronx for five days as vendors inspected flooded railcars and restored them to service. During that time, DSNY safely stored excess waste in containers to await restored rail service or shipped it via transfer trailer.

Although none of the four new marine transfer stations is yet operational, one of the two sites that are under construction—at Hamilton Avenue in Brooklyn—did see water levels exceed the pier elevation, though the waters remained well below the height at which solid waste will be stored once the station is completed.

Overall, DSNY found no indication that solid waste from any of its facilities was washed into the city's waterways. While the former Fresh Kills Landfill sustained light damage to its pollution control infrastructure, it appears there were minimal environmental impacts.



Debris at Jacob Riis Park, Queens

Robert Stolarik/The New York Times

What Could Happen in the Future

Although the solid waste system showed itself to be relatively resilient during Sandy, it nonetheless faces risks associated with climate change.

Major Risks

Given the dispersed nature of the city's solid waste network, its reliance on largely movable equipment, and the resiliency measures built into the new marine transfer stations, it is not expected that climate changes will present major risks to that network in the foreseeable future.

Other Risks

With a number of facilities such as garages located along the waterfront as well as four new marine transfer stations scheduled to begin operations in the next four years, the solid waste system is most vulnerable to storm surge (particularly as sea levels rise), although only moderately so. Many of DSNY's facilities and that of its third-party providers are critical to the degree they house vehicles, but those vehicles can easily be moved out of the floodplain to other facilities and locations, as needed.

The four planned marine transfer stations are designed not only to be environmentally friendly, but also highly resilient and, therefore, are not expected to be at significant risk. Marine transfer stations will have three levels. The uppermost level will be a so-called "tipping floor," from which collection vehicles will discharge solid waste onto the middle level or loading floor. On the loading floor, front-end loaders will manage the waste and push it through slots in the floor into waterproof sealable containers. These containers then will be placed onto barges for waterborne export. The loading floors, where loose waste will be found, generally will be located approximately 16 feet above the Base Flood Elevation, or the height to which floodwaters are expected to rise during a 100-year flood (i.e., a flood with a 1 percent or greater chance of occurring in any given year). This means that the risk of loose waste being washed away by inundation—even in an extreme weather event—will be extremely limited. (*See image: Marine Transfer Station Cross-Section*)

Meanwhile, disruptions to vendor operations, including rail networks, might affect the capacity to remove bulk waste from the city both today and in the future. However, as Sandy showed, DSNY has a number of alternatives for redirecting waste, including a network of vendors and backup equipment such as storage containers.

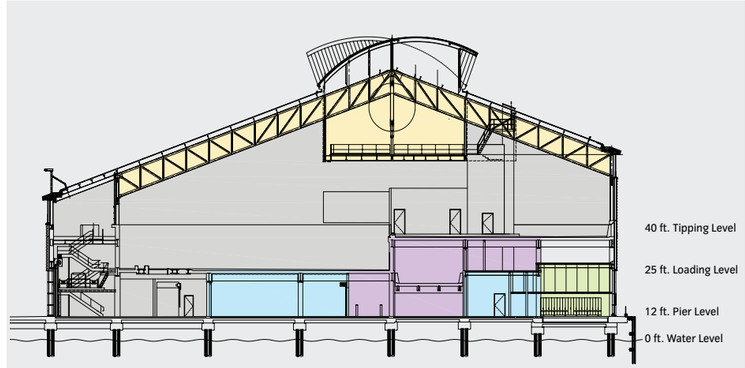
None of the other identified extreme risks (such as heavy downpour, heat wave, and high winds) or chronic impacts (such as sea level rise, increased precipitation, or higher average temperatures) is expected to create any direct risk to the city's solid waste network. However, the solid waste system is exposed to indirect impacts of climate change to the extent that, for example, the city's liquid fuel supply is threatened. This risk and proposed strategies are addressed in Chapter 7 (*Liquid Fuels*).

Risk Assessment: Impact of Climate Change on Solid Waste

Major Risk Moderate Risk Minor Risk

	Scale of Impact			
Hazard	Today	2020s	2050s	Comments
Gradual				
Sea level rise				Minimal impact
Increased precipitation				Minimal impact
Higher average temperature				Minimal impact
Extreme Events				
Storm surge				Disruptions to garbage collection could result from flooding of transportation networks Marine transfer stations could experience limited damage Excess debris could be generated due to property damage
Heavy downpour				Minimal impact
Heat wave				Minimal impact
High winds				Minimal impact

Marine Transfer Station Cross-Section



Source: DSNY

This chapter contains a series of initiatives that are designed to mitigate the impacts of climate change on the solid waste disposal system. In many cases, these initiatives are both ready to proceed and have identified funding sources assigned to cover their costs. With respect to these initiatives, the City intends to proceed with them as quickly as practicable, upon the receipt of identified funding.

Meanwhile, in the case of certain other initiatives described in this chapter, though these initiatives may be ready to proceed, they still do not have specific sources of funding assigned to them. In Chapter 19 (*Funding*), the City describes additional funding sources, which, if secured, would be sufficient to fund the full first phase of projects and programs described in this document over a 10-year period. The City will work aggressively on securing this funding and any necessary third-party approvals required in connection therewith (i.e., from the Federal or State governments). However, until such time as these sources are secured, the City will only proceed with those initiatives for which it has adequate funding.

New York City's solid waste disposal system—inside and outside of the city, public and private—is designed to collect waste and recyclables and dispose of both safely through continuous operation when possible or through fast restoration.

Strategy: Protect solid waste facilities and disposal networks

Fixed solid waste collection and disposal assets, including critical facilities, roads, and railways, typically were not built with flood protection or other climate change risks in mind. To address the potential risks to the solid waste network, the City will harden its waste collection and disposal facilities and work within its extended third-party-owned solid waste network to ensure that practical resiliency measures are in place for future extreme weather events.

Initiative 1
Harden critical City-owned facilities

Although storm surge is not a major risk to the solid waste system, selected key assets could suffer limited impacts in the event of a significant storm. Subject to available funding, the City will harden equipment at four marine transfer stations, garages, and other vulnerable facilities to prepare for the impacts of future storm surge and to minimize future service disruptions. These efforts will include resiliency projects such as raising and flood-proofing equipment at nearly 70 facilities that will be prioritized based on their flood risk. In addition to physical measures such as raising elevation levels of switches and pumps to keep them out of harm's way and installing bulkhead doors to keep water out, DSNY will develop operational protocols to prepare its facilities and equipment for extreme weather more effectively.

In so doing, the City not only will ensure continued waste collection and disposal during future events, but also will minimize impacts that might otherwise result from flooding of facilities that store loose waste. Additionally, by ensuring the continued operation of marine transfer stations, the City also will ensure that additional trucks are not needed on New York's roads during storm recovery, thereby easing congestion and minimizing impacts to transportation and fuel networks. DSNY will complete a detailed assessment of protection measures for at-risk facilities by the end of 2013. The goal is to implement these measures as part of Sandy reconstruction and other planned construction and capital projects through 2018.

Initiative 2
Work with third-party owners to protect critical assets and networks

Many of the disruptions to the solid waste disposal process that occurred during Sandy—and that could occur in the future—were due to affected assets owned by third parties. These assets are essential to DSNY waste disposal efforts and to the removal of commercial waste by private haulers. The City will work with its network of vendors and rail operators to identify priority resiliency measures and to encourage them to provide redundant and alternative capacity. For instance, DSNY will request or require, as appropriate, that its vendors maintain additional railcars and storage containers in safe, accessible locations in advance of storm events. DSNY also will direct its vendors to secure agreements for additional tractor-trailer capacity in the event that a rail disruption exceeds storage capacity and to provide dumping capacity at alternate company-owned transfer stations.

DSNY further will work to ensure that critical solid waste facilities that are not under its jurisdiction are incorporating storm surge risk and sea level rise projections into their design. This includes developing an inventory of critical system vulnerabilities and working with vendors, rail operators, and private transfer stations to catalogue known risks and develop contingency plans. These measures will limit the potential for disruptions to solid waste collection and disposal. DSNY's coordination and planning efforts are anticipated to occur within the next year, with implementation expected to commence immediately thereafter.

The future Sims Municipal Recycling Facility, located at the South Brooklyn Marine Terminal, will be elevated above the Base Flood Elevation

Credit: Kirsten Luce/The New York Times

The Sims Municipal Recycling Facility under construction in November 2012

Community Rebuilding and Resiliency Plans

New York is a city of neighborhoods—hundreds of them, all different but all treasured both by those who know them intimately and by the city as a whole. These neighborhoods are where New Yorkers live and raise families and where they work and run businesses. Whether these communities have peaceful parks or lively beaches, historic buildings or hip shops, these are the places New Yorkers return to again and again—and visitors search out for a taste of the city's famed diversity.

The city cherishes its neighborhoods, and the strategies and initiatives detailed in previous chapters are designed to benefit all of them. For example, strengthening the electric grid will help minimize power outages in all neighborhoods. Protecting the transportation network will help keep roads open and mass transit running. Making the healthcare system more resilient will help hospitals to remain operational for residents throughout the city.

Yet even as the city plans for the future and seeks to make neighborhoods in all five boroughs more resilient in the face of climate change, it also recognizes that Sandy affected people in certain neighborhoods more than those in the rest of the city. As of the writing of this report, many of these people still are struggling to get back on their feet. They still are trying to repair homes, replace lost inventory, and generally put lives back together in places that have not yet returned to "normal."

Though these people can be found in many corners of the city, the neighborhoods that ultimately suffered the greatest lingering physical damage—the neighborhoods where "normal" continues to feel farthest away—are clustered in five areas of the city. These five areas, which together are home to 683,000 people and nearly 42,000 businesses, are the Brooklyn-Queens Waterfront, the East and South Shores of Staten Island, South Queens, Southern Brooklyn, and Southern Manhattan.

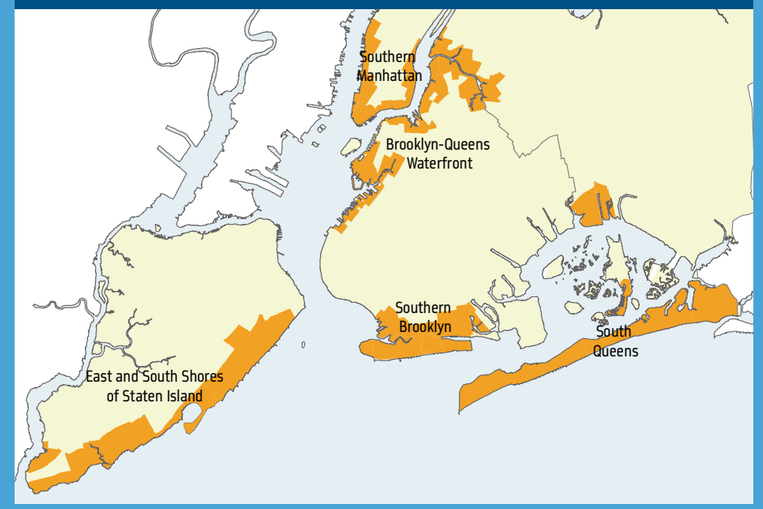
While these areas of the city generally share a number of traits since Sandy—including widespread damage, significant business interruption, and lost infrastructure—they also have in common yet another attribute. Namely, in each there is a fierce attachment to home and community—an unwavering determination to recover. The Community Rebuilding and Resiliency Plans for these five communities are offered in recognition—and celebration—of that resilient spirit.

The chapters on the following pages tell these communities' stories: They describe the vulnerabilities these areas possessed before Sandy. They explain what happened during the storm. They suggest what a future of increased climate risks may bring. Finally, they describe dozens of citywide and community-specific initiatives that will help these communities stand strong again.

Some have said that following Sandy the only answer is to "retreat" from the shore. But in New York City, as a general matter, that is simply not possible. The city's waterfront areas are dense, urban places containing hundreds of thousands of people and hundreds of millions of square feet of built space that simply cannot be picked up and relocated elsewhere. Furthermore, New York's experience during Sandy shows that with the right mix of defenses, built up in layers—defenses at the coastal level, at the building level, and at the infrastructure level—it is possible to live on the waterfront in a more resilient fashion. While it is not possible to "climate change-proof" these communities, it is possible to continue to enjoy their many virtues while addressing many of the threats that exist today and that are likely to increase with changes in the climate.

So New York City will not retreat, and it will not abandon. New York City, instead, will stand with its waterfront neighborhoods. The City will fight for these neighborhoods and for all neighborhoods across the five boroughs.

Areas of Focus for Community Rebuilding and Resiliency Plans



Brooklyn-Queens Waterfront

Brooklyn Waterfront

Credit: Wally Gobetz

The manager of a family-owned scrap-metal salvage company along the Queens side of Newtown Creek watches as backhoes lift mounds of shredded metal and deposit them into barges. Over in Williamsburg, a young couple hops off of the East River Ferry, walks past gleaming new high-rises along the waterfront and heads over to Bedford Avenue to meet friends at a coffee house. Meanwhile, in DUMBO, inside a loft space in a 19th-century factory building, a software developer creates a cutting-edge application that will be downloaded by users around the world. And outside of a 14-story brick building that is part of Red Hook Houses West, a resident who has lived in the complex since it first opened in the 1950s chats with neighbors she has known for decades.

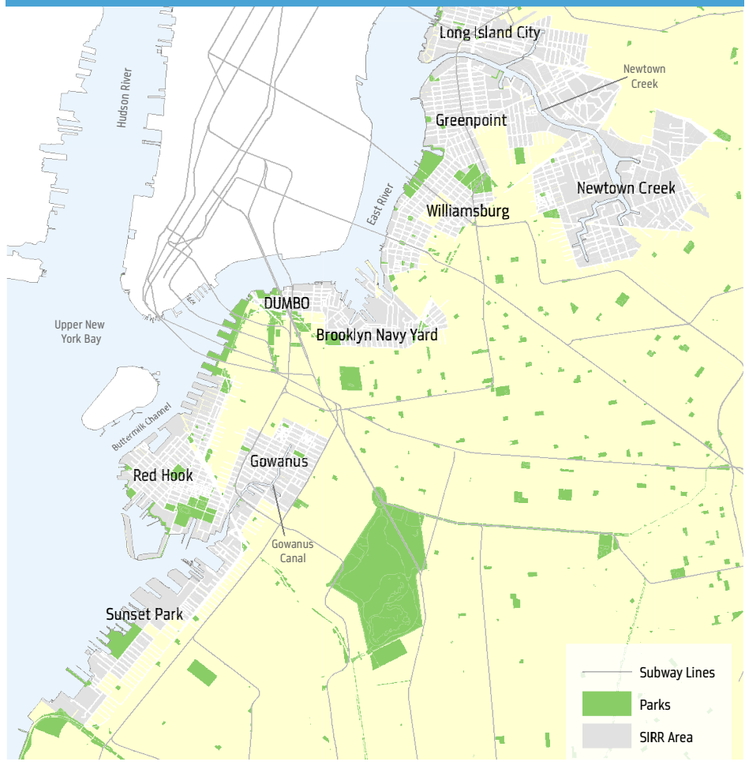
This is the Brooklyn-Queens waterfront, where old and new, past and present, historic industry and a burgeoning creative economy, all converge in a bracing, up-to-the-minute mix.

The "Waterfront," as it will be referred to in this chapter, stretches approximately 33 miles along the western edges of Brooklyn and Queens, bordering Upper New York Bay, Gowanus Bay, Buttermilk Channel, and the East River. The Waterfront includes major neighborhoods from Sunset Park, Gowanus, and Red Hook in the south, up through DUMBO and the Brooklyn Navy Yard, then north to Williamsburg, Greenpoint, and Long Island City. The area also encompasses scores of smaller neighborhoods as well as the areas along Newtown Creek. (*See map: Neighborhoods of Brooklyn-Queens Waterfront*)

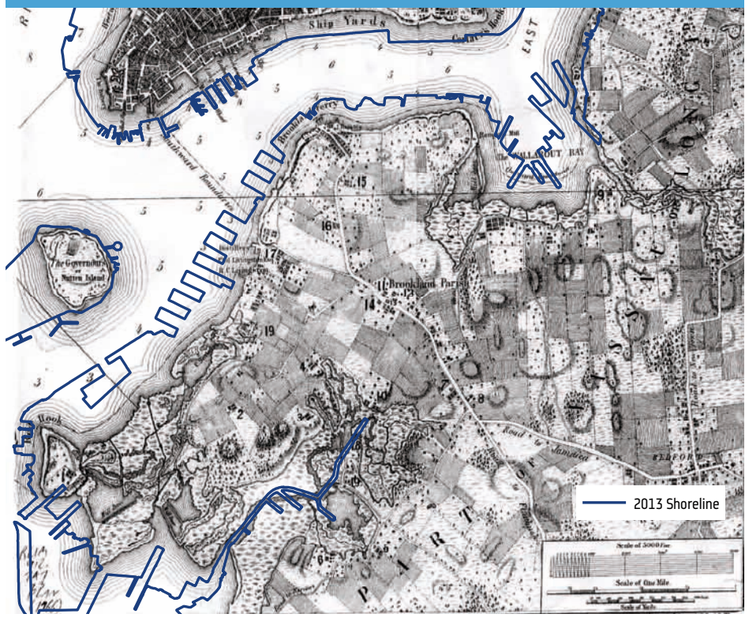
European settlers purchased much of this sprawling land from the Lenape people in the 1630s. At that time, the Waterfront largely consisted of marshlands, marked by navigable creeks and small islands. Eventually property owners and government filled in the marshes and extended and regularized the area's coastline, paving the way—literally—for development, which began in earnest in the 19th century, when the area became a center of shipbuilding, manufacturing, and waterborne commerce. Through this industrial boom, thousands of homes—mostly attached row houses—were built along or near the water to provide shelter to those whose labor was powering the businesses that dotted the area. (*See map: The Shoreline: Then and Now*)

Since the 19th century, use of this waterfront has changed greatly, with shifts in the types and amounts of waterborne activity, and the arrival of new businesses, nonprofits, and residents. In a number of areas, the City has played an active role in shaping the Waterfront, managing properties, pursuing programs to support

Neighborhoods of Brooklyn-Queens Waterfront



The Shoreline: Then and Now



industrial businesses and arts organizations, encouraging the redevelopment of underused lots for housing and open space, and increasing public access to the waterfront for recreational use and waterborne transportation.

As treasured as the neighborhoods of the Waterfront are to visitors and residents alike, the area always has been vulnerable to extreme weather—a vulnerability that is likely to increase as the climate changes in the coming years and decades. This vulnerability is due to the fact that significant sections of the Waterfront are low-lying and prone to flooding during coastal storms, placing buildings and infrastructure located there at risk. Many of these buildings are low-rise and attached, dating to the 19th century—and thus not easy candidates for flood-mitigation measures such as elevation.

The area's vulnerabilities were highlighted by Sandy. Although the Waterfront's sheltered location in New York Harbor largely protected the area from destructive waves, the storm's surge did cause extensive flooding throughout the area—in many places over 6 feet deep. Not surprisingly, flooding occurred along the Harbor and River-facing western edge of the Waterfront, inundating neighborhoods, industrial properties, and retail corridors. The surge also made its way up the Gowanus Canal and Newtown Creek, flooding areas much farther inland. The result of this deluge was damage to building systems and contents, loss of power, displacement of residents, and weeks to months of lost revenue for businesses and nonprofits.

Fortunately, as of the writing of this report, most residents of the Waterfront are back in their homes, most businesses have reopened, and key infrastructure is once again functioning. However, as extreme weather events become more severe and, in some cases, more frequent, challenges like those experienced during and after Sandy likely will increase along the Waterfront.

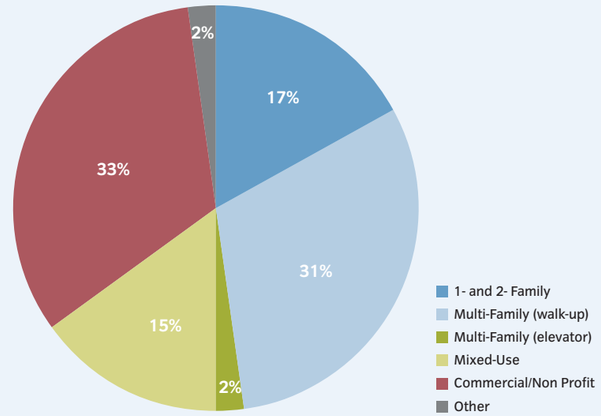
To help the Waterfront continue its post-Sandy recovery and face the challenges ahead, the City has developed a plan that reflects the overarching goals of this report—to seek to limit the impacts of climate change going forward, while enabling New York and its neighborhoods to bounce back quickly when those impacts cannot be averted. The plan for the Waterfront outlined in this chapter will address the area's most significant risk—its vulnerability to storm surge, particularly as sea levels rise—by adapting its coastline and addressing its exposures from inland water bodies, by facilitating retrofits of existing buildings and resiliency in new construction, and by protecting vital infrastructure. The plan also will address other risks the area faces, including heavy downpours, heat waves, and high winds, drawing upon citywide and locally tailored initiatives. Finally, the plan will build on the area's natural assets and local economic strengths to encourage reinvestment and growth in the many neighborhoods. Overall, the plan seeks to make the residents, businesses, nonprofits, buildings, and infrastructure of the Waterfront stronger and safer than they were before Sandy while simultaneously maintaining the area's unique character.

Area Characteristics

The Waterfront has been for centuries, and still is, home to a great diversity of people, a vital economic engine for New York City, and the site of critical infrastructure serving the entire city. Though the neighborhoods that line the Waterfront are distinct, many share important characteristics.

These common characteristics include large numbers of attached residential buildings; important industrial and water-dependent businesses; along with newer start-ups in the creative economy; communities with

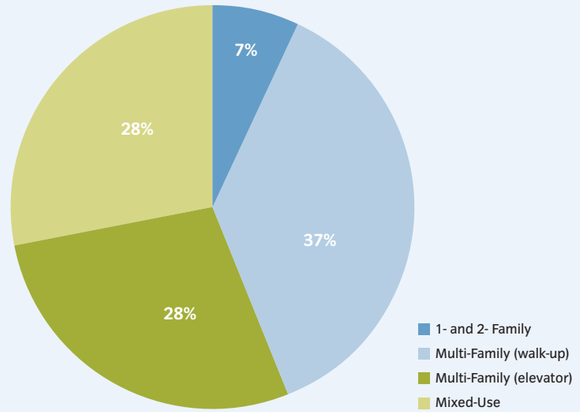
Area Buildings by Type



Total: 12,600 Buildings

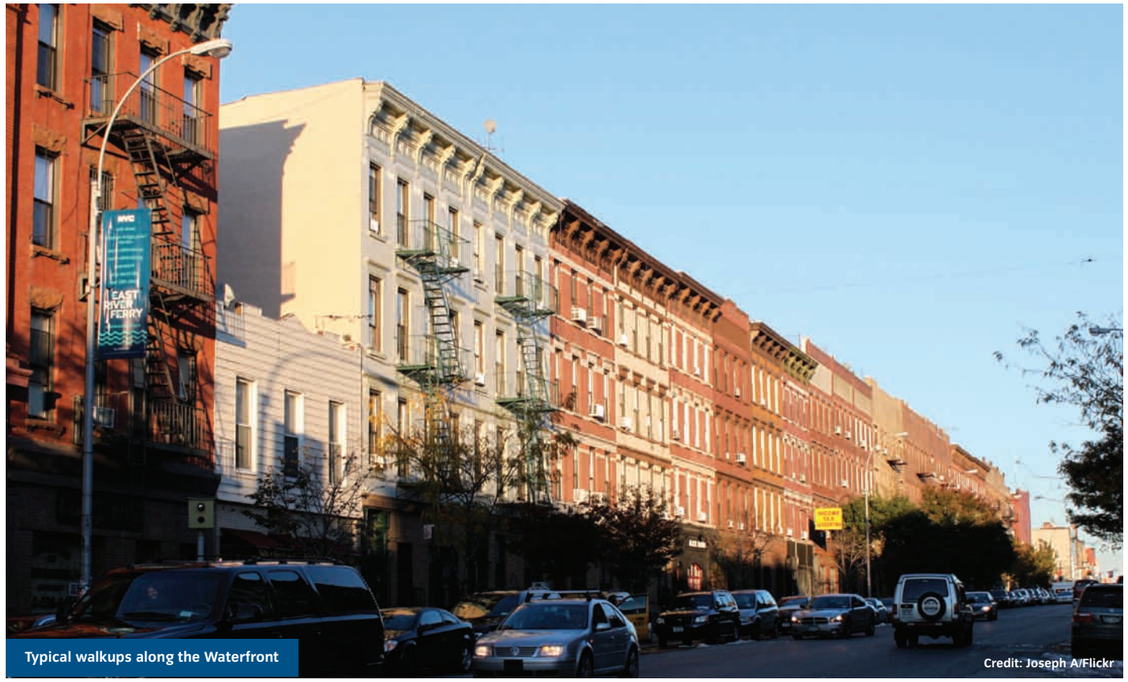
Source: DCP PLUTO

Area Housing Units by Building Type



Total: 50,900 Housing Units

Source: DCP PLUTO



Typical walkups along the Waterfront

Credit: Joseph A/Flickr

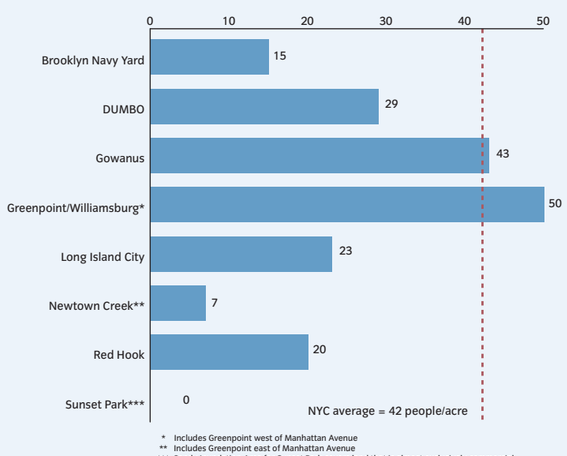
large concentrations of immigrants; and, in recent years, increasing access to the water for recreational use by both residents and visitors alike.

Also, many neighborhoods along the Waterfront have a pronounced historic flavor. With the shared past of a booming industrial sector, various neighborhoods have abandoned sites that were used formerly for industrial purposes but now are designated as brownfields (see *Environmental Protection and Remediation*). Also contributing to the historic feel is the area's building stock: only 9 percent of the area's buildings were constructed after 1983, when flood-protection standards were added to the New York City Building Code. In fact, along the Waterfront, 20 percent of all buildings and 27 percent of all residential buildings were built before 1900.

Neighborhoods and Residential Development

Residential buildings along the Waterfront, which house almost 100,000 area residents, come in a variety of shapes and sizes. There are 1- and 2-family homes, multi-family walkups, multi-family elevator buildings, and larger mixed-use buildings. Generally, low- and mid-rise buildings from the 19th and 20th centuries predominate, with the notable exception of the new high-rise development that has taken place in Williamsburg, Long Island City, and DUMBO over the last decade or so. (*See chart: Area Buildings by Type; See chart: Area Housing Units by Building Type*)

Area Population Density



* Includes Greenpoint west of Manhattan Avenue
** Includes Greenpoint east of Manhattan Avenue
*** Sandy Inundation Area for Sunset Park covers land that is almost exclusively commercial

Source: 2010 US Census

Because of the significant amount of area occupied by industry, the Waterfront area has a relatively low population density (20 people per acre) as compared to the citywide average (42 people per acre). The only exceptions are Greenpoint/Williamsburg (50 people per acre) and Gowanus (43 people per acre), which have more concentrated residential areas. (*See chart: Area Population Density*)

Even with their shared traits, as discussed above, each of the major neighborhoods along the Waterfront has its own character. For example, the waterfront in Sunset Park—roughly stretching from the Upper New York Bay to 3rd Avenue—remains very much a "working waterfront." Much of the property in this area is owned by the City and managed by New York City Economic Development Corporation (NYCEDC), including the Brooklyn Army Terminal, Bush Terminal, and the South Brooklyn Marine Terminal. Together, these NYCEDC-managed properties house companies that employ nearly 4,500 people, and, as of the writing of this report, occupancy at one of them, the Brooklyn Army Terminal, standing at 98 percent. Most of Sunset Park's nearly 2,100 residents, including a large immigrant population, live uphill of this waterfront area, and work on the waterfront.

Just north of Sunset Park lies the neighborhood of Gowanus, home to nearly 18,000 residents. Gowanus has a long industrial history centered on the 1.8-mile Gowanus Canal, which extends inland from Gowanus Bay. The Canal was once among the busiest industrial and commercial inland waterways in the United States. As a result, during its earlier history, the Canal suffered significant pollution. As of the writing of this report, it is in the early stages of the Environmental Protection Agency's (EPA) Superfund cleanup process. Though the Canal now is the site of much less maritime activity than in the past, the activity that does occur along the Canal is facilitated by the five New York City Department of Transportation (NYCDOT) movable bridges that cross the water body. Residents of Gowanus tend to live in attached walkup apartment buildings (many of which were built for industrial workers) or 1- and 2-family homes. Additionally, Gowanus Houses and Wyckoff Gardens, New York City Housing Authority (NYCHA) developments, together contain over 1,600 housing units. In recent years, Gowanus has seen the construction of some new low- and mid-rise residential buildings. More such buildings have been proposed for the future.

West of Gowanus is the peninsula of Red Hook, surrounded by Gowanus Bay, the Upper Bay, and Buttermilk Channel. A true mixed-use neighborhood, Red Hook contains residential and large- and small-scale commercial and industrial uses. The neighborhood was once one of the most active freight ports in the world. As of the writing of this report, significant maritime industrial uses remain. These include the Port Authority of New York and New Jersey's (the Port Authority) Red Hook Container Terminal, home to large businesses such as Phoenix Beverages, and Atlantic Basin and the Brooklyn Cruise Terminal, managed by NYCEDC. Elsewhere in the neighborhood, Red Hook contains a wide range of other industrial businesses, including a growing group of artisanal food and drink manufacturers. Van Brunt Street, the primary commercial corridor, is lined by restaurants and small businesses, as is Columbia Street, a burgeoning sub-neighborhood along the waterfront, just north of Red Hook. Larger retailers in the area, including IKEA and the Fairway supermarket, have also opened in Red Hook in recent years.

Meanwhile, Red Hook's 14,000 residents reside in a variety of buildings, though the majority live in NYCHA's Red Hook Houses, the largest public housing development in Brooklyn. An important piece of infrastructure, the Gowanus Expressway, under which runs Hamilton Avenue, forms the northern boundary of Red Hook, with the entrance to the Hugh L. Carey Tunnel (formerly Brooklyn-Battery) also on the neighborhood's northern end. (*See sidebar: Red Hook Past and Present*)

Farther north along the Waterfront lies DUMBO, short for "Down Under the Manhattan Bridge Overpass." This area is characterized by a wide range of building types, including multi-story 19th- and 20th-century industrial lofts, glass-and-steel towers, and mixed-use walkups, many on cobblestone streets. In 2007, much of the area was designated an historic district by the Landmarks Preservation Commission (LPC), which described the neighborhood as "essential to Brooklyn's rise as a major American industrial center." In recent years, the area has grown, attracting new development and residents and supporting an active arts community as well as a growing technology sector. The area also has seen significant public and private investment, such as the opening of the first phases of Brooklyn Bridge Park beginning in 2010. As of the writing of this report, DUMBO, including the small Vinegar Hill neighborhood on its northern edge, has a population of 3,600.

Northeast of DUMBO is the Brooklyn Navy Yard, an industrial facility that first opened in 1801. The Navy Yard was one of the nation's preeminent Naval ship building facilities until its closure in 1966. Decommissioned and sold to the City in 1968, the 300-acre industrial park is operated by the Brooklyn Navy Yard Development Corporation (BNYDC) and is home to over 300 industrial businesses that employ

Red Hook Past and Present

Red Hook remained largely rural and undeveloped from the mid-17th century through the mid-19th century, when the construction of sheltered ports at Atlantic Basin and Erie Basin on Red Hook's waterfront turned the area into one of the busiest shipping centers in the United States. From the beginning of the Civil War to the 1940s, ships from all over the world docked at Red Hook to load and unload cargo and for repairs and maintenance. This, in turn, attracted generations of immigrants and others to the area. To house the families of area dockworkers, in 1938, NYCHA's Red Hook Houses opened—among the first public housing complexes in the city and a model that would be replicated widely elsewhere.

In the second half of the 20th century, Red Hook's fortunes began to change. With the introduction of container shipping, many of Red Hook's dock facilities suddenly became obsolete. Rapidly, businesses—and the jobs they created—left. With the decline of the maritime industry, the local economy weakened, a trend that was exacerbated by the construction of the Gowanus Expressway in 1946, which cut the neighborhood off from the rest of Brooklyn. At the same time, the area saw crime rates soar.

Over the past two decades, however, Red Hook has begun to turn around. Several factors, including community and government initiatives such as the Red Hook Community Justice Center, helped to contribute to the area's renaissance. As crime plummeted and community-based organizations increased their presence in the neighborhood, public and private investment followed. Businesses, including larger retailers, opened on and near Van Brunt Street, bringing new visitors and economic activity to the area.

However, transportation options to and through Red Hook remain limited. Red Hook lacks a subway stop, with the closest one requiring crossing heavily trafficked Hamilton Avenue. This is a particular issue for area residents who face long commutes to work. In many cases, schools, healthcare, and other key services are also not easily accessible. The limited availability of public transit also has affected a number of the local businesses that have opened in recent years, making it difficult for them to attract a large customer base.

Transit access is not the only challenge Red Hook faces. The area is also vulnerable to weather-related events. This is because much of the neighborhood rests on low-lying former marshland, leaving it flood-prone. As demonstrated during Sandy, such flooding can damage the mechanical systems of buildings, the possessions of those living in ground-floor residential units, the inventory of ground-floor retailers, and the heavy equipment and products of industrial businesses.

Socioeconomic Characteristics

Area	Population	Poverty Rate	Median Household Income	Households	Owner-Occupied Housing Units	% Homeowners	% Owner-Occupied Housing Units with Mortgage	Median Owner-Occupied Unit Value
Brooklyn Navy Yard	5,100	36%	$37,900	1,300	350	27%	60%	$506,800
DUMBO	3,600	5%	$167,700	1,300	600	46%	95%	$1,000,000+
Gowanus	17,800	18%	$68,500	8,000	2,000	25%	64%	$854,100
Greenpoint/ Williamsburg *	35,800	20%	$60,400	15,300	2,700	18%	65%	$705,800
Long Island City	9,700	7%	$92,100	4,200	1,000	23%	81%	$619,300
Newtown Creek**	12,400	19%	$52,000	4,500	700	16%	59%	$678,400
Red Hook	13,800	33%	$47,700	5,900	870	15%	81%	$615,600
Sunset Park ***	N/A	N/A	N/A	N/A	N/A	N/A	N/A	NA
Citywide Total/ Average	**8,175,000**	**19%**	**$51,300**	**3,050,000**	**993,500**	**33%**	**64%**	**$514,900**

Source: 2010 US Census, 2011 American Community Survey, 5-Year estimate

* Includes Greenpoint, west of Manhattan Avenue
** Includes Greenpoint,east of Manhattan Avenue
*** Sandy Inundation Area for Sunset Park covers land that is almost exclusively commercial

6,400 workers. A residential community just east of the Navy Yard is compromised primarily of multi-family walk-ups.

Extending along the East River from the edge of the Brooklyn Navy Yard is Williamsburg. This neighborhood, too, has a storied industrial past. Today, it still retains significant industrial pockets. However, in recent years it has grown more residential, with a very diverse population. Some of the changes in Williamsburg have come about as a result of a rezoning that occurred in 2005. At that time, in an effort to reactivate vast stretches of Williamsburg's industrial waterfront, which had fallen into disuse, and to build on the momentum that the neighborhood was experiencing as young artists and others moved into older industrial loft buildings, the City rezoned much of the northern part of the neighborhood. This rezoning allowed the construction of much-needed new housing, including significant numbers of affordable housing units. It also created a blueprint for developing new public open space. After the rezoning, high-density waterfront development and mid-rise development farther inland took place. This development has resulted in some of the few buildings along the waterfront that were built to modern resiliency standards. As a result of this new development, the continuing appeal of the area to young people, and growth in existing communities south of the Williamsburg Bridge, the area's population doubled in the first decade of the 21st century, now totaling 35,800, including the population in western Greenpoint.

The same 2005 rezoning that has been helping to revitalize Williamsburg also applied to Williamsburg's northern neighbor, Greenpoint, the northernmost part of Brooklyn. Though this area has seen less residential development following the rezoning than Williamsburg, substantial development is expected. Meanwhile, east of McGuinness Boulevard, Greenpoint retains an active industrial area. Its population is largely working-class and multi-generational, with concentrations of immigrant communities.

Bordering Greenpoint, and separating Brooklyn from Queens, is Newtown Creek, a 3.5-mile channel that extends deep into both boroughs. The area surrounding Newtown Creek includes portions of the Brooklyn neighborhoods of Greenpoint, East Williamsburg, and Bushwick, and the Queens neighborhoods of Long Island City and Maspeth. Newtown Creek remains an active industrial waterway, spanned by six movable bridges managed by NYCDOT and bordered by bulkheads suited to maritime use. As happened on the Gowanus Canal, past industrial uses along the Creek were responsible for significant contamination. In 2010, therefore, the EPA designated the Creek as a Superfund site. Cleanup efforts pursuant to the Superfund program are expected to start in a decade, following a study of the waterway's contamination, which will be completed in 2015. There are over 2,700 buildings along the Creek, housing 12,400 people and 1,800 businesses. Though over half of the surrounding buildings are occupied by maritime and other industrial uses, nearly 40 percent are residential walkups and 1- to 2-family homes.

The northernmost area of the Waterfront is Long Island City, located at the intersection of the East River and Newtown Creek. It is a transportation hub, with easy access to Manhattan. Long Island City is also a flourishing arts center and an important business center, with large commercial buildings, housing, and, among other things, back offices for Citigroup and the headquarters for JetBlue. A 2001 rezoning led to the development of new waterfront residential buildings that are complemented by other large projects such as Queens West and Hunter's Point South, the largest middle-income housing development in the city since Starrett City. Large new buildings are under construction at both sites.

Socioeconomic Characteristics

In aggregate, the socioeconomic profile of the Waterfront approximates the profile of the city as a whole. However, there are wide variations from neighborhood to neighborhood. For example, the median household income in Red Hook is $47,700, and the poverty rate in the area stands at approximately 33 percent. Meanwhile, in DUMBO the equivalent figures are $167,700 and 5 percent, respectively. Great socioeconomic diversity can be found even within several of these neighborhoods. For example, according to a New York Times census analysis, in Williamsburg, in one census tract nearly 45 percent of households have a median income of $100,000 or more, while in the census tract just to its south, 46 percent of the population makes under $30,000. (*See table: Socioeconomic Characteristics*)

Businesses, Nonprofits, and the Local Economy

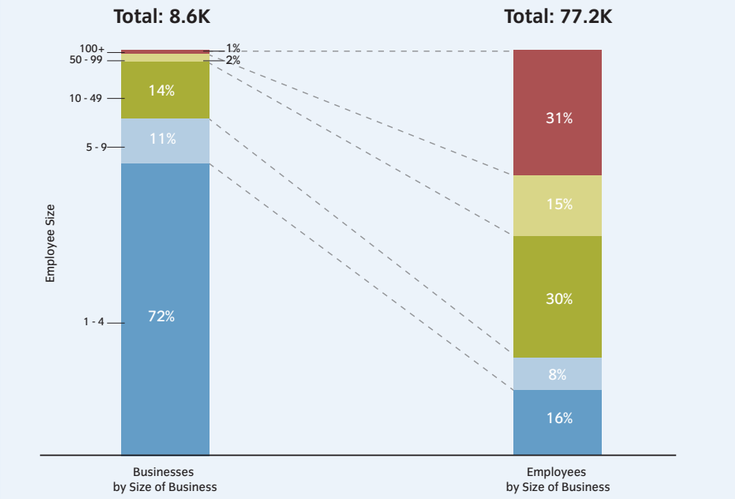
While the neighborhoods along the Waterfront contain a wide variety of businesses—totaling approximately 8,600 companies employing over 77,200 people—the most significant sector in the area remains the industrial sector, as was the case years ago. As of the writing of this report, industrial businesses make up nearly 40% of all businesses and nearly all of the area's large employers (those with 100 or more employees). These businesses range from food and equipment manufacturers to civil engineering firms. *(See chart: Profile of Area Businesses by Industry)*

Approximately 22 percent of buildings along the Waterfront have industrial uses in them. However, because they tend to be among the area's larger buildings, they account for about 40 percent of the total built square footage. Many of these industrial businesses perform important operations out in the open, including those involved in auto dismantling, recycling, and asphalt and cement manufacturing.

Retail businesses are also an important part of the economy along the Waterfront. They not only contribute to the active street life serving area residents but attract visitors from across the city and beyond. Some of the Waterfront's most vibrant commercial corridors include Van Brunt Street and the Columbia Street Waterfront District in Red Hook, as well as Manhattan and Bedford Avenues in Greenpoint/Williamsburg, and Vernon Boulevard and Jackson Avenue in Long Island City.

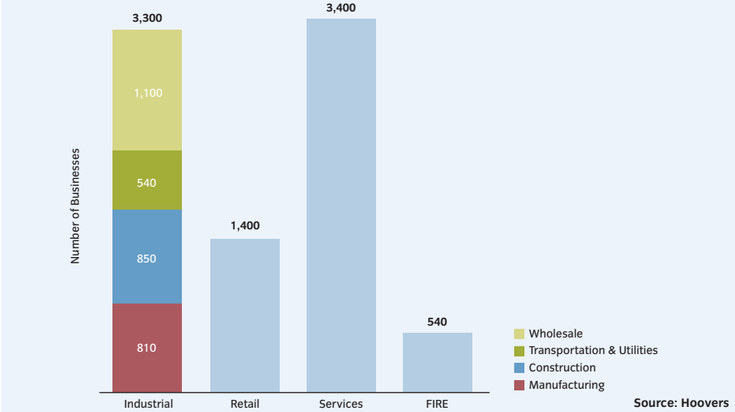
The arts community is another important economic engine along the Waterfront. There are galleries, event spaces, and theaters throughout the area. The area is also home to social service organizations that provide essential services to the area's low-income population, strengthen economic development, and offer employment opportunities.

Profile of Area Businesses



Source: Hoovers

Profile of Area Businesses by Industry



Source: Hoovers

Overall, the Waterfront is dominated by small businesses (those employing fewer than five people), which represent about 72 percent of area businesses. Large businesses also play an important role, though, with approximately 31 percent of all people employed along the Waterfront working for businesses with over 100 employees. (*See chart: Profile of Area Businesses*)

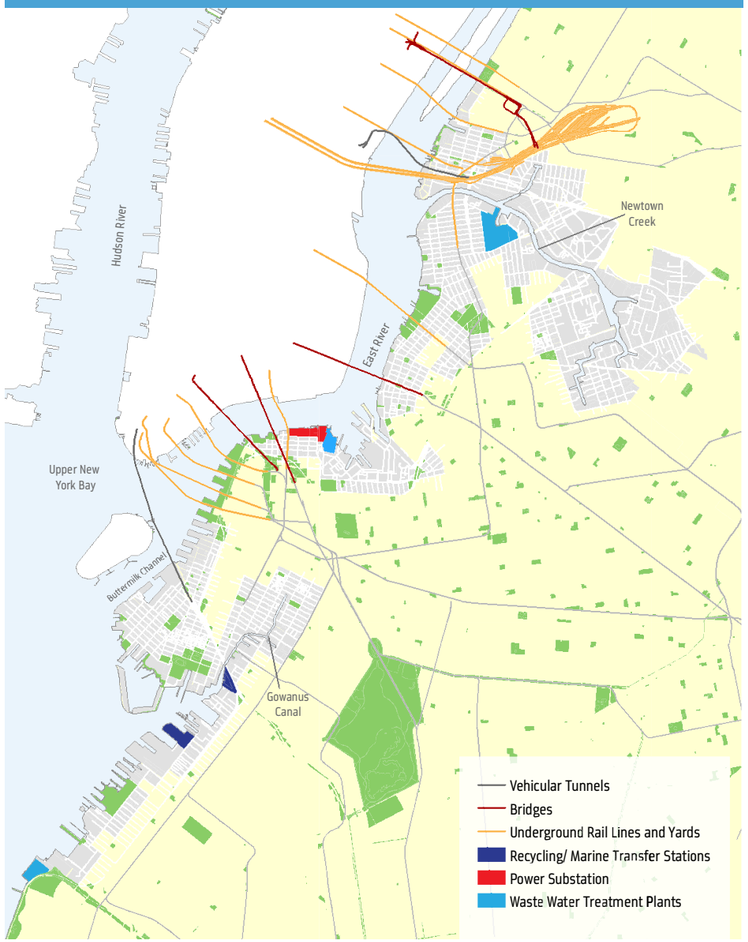
Critical Infrastructure

The Waterfront contains critical infrastructure that serves the entire region. For example, the Waterfront is host to a variety of important transportation assets. These include the eastern terminuses of two vehicular tunnels, the Hugh L. Carey Tunnel in Red Hook and the Queens Midtown Tunnel in Long Island City. Together, these two tunnels transport nearly 140,000 commuters on an average workday. The Williamsburg, Manhattan, Brooklyn, and Ed Koch Queensboro Bridges spanning the East River, meanwhile, link the neighborhoods of the Waterfront to Manhattan. Together, these bridges transport over 600,000 commuters on an average workday. Six subway tunnels connect Brooklyn and Manhattan via the Waterfront, while four connect Queens and Manhattan, and one connects Brooklyn and Queens. Four tunnels carrying commuter and Amtrak train service between Manhattan and Long Island and New England also route

The newly renovated Smith and 9th Street subway station

Credit: Julian Dunn

Area Critical Infrastructure



through Long Island City. The Waterfront is also home to one of two NYCDOT asphalt plants (located on Hamilton Avenue), as well as Sunnyside Yards, one of the most active rail yards in the United States, in Long Island City.

Several Department of Environmental Protection (DEP) facilities are found along the Waterfront. These include the Owls Head Wastewater Treatment Plant (WWTP) in Sunset Park, the Red Hook WWTP near the Navy Yard, and the Newtown Creek WWTP in Greenpoint, which together serve over 2 million people and handle nearly 500 million gallons of wastewater per day. Ten pumping stations in the area help convey sewage and stormwater to these plants.

The Hamilton Avenue Marine Transfer Station, currently under construction, is one of four marine transfer stations citywide that will reduce truck traffic by shifting the transportation of solid waste to barges for transfer to landfills. Meanwhile, a major recycling facility is being developed by Sims at the South Brooklyn Marine Terminal in Sunset Park and is expected to be operational by 2015 (see Chapter 13, *Other Critical Networks*).

Important power assets along the Waterfront include Con Edison's Farragut Substation. Located between DUMBO and the Brooklyn Navy Yard, this substation is a vital piece of the electrical infrastructure that ensures the flow of power to Lower Manhattan and much of northern Brooklyn. (*See map: Area Critical Infrastructure*)

What Happened During Sandy

Given their locations in the Harbor, Waterfront neighborhoods generally were protected from Sandy's most destructive "wave action." However, storm surge coming directly off the Harbor and East River as well as the inland water bodies—the Gowanus Canal and Newtown Creek—did substantial damage in many areas. Flooding in some places exceeded 6 feet, overwhelming low-lying areas and inundating basements and ground floors. The flooding also overwhelmed the city's sewers in many places, resulting in sewage backing up into homes and businesses, as well as combined sewer overflows (CSOs). Not surprisingly, however, the extent and type of damage along the Waterfront varied greatly from neighborhood to neighborhood. (*See map: Area Inundation and Surge Height*)

For example, in Sunset Park, surge waters overtopped the banks of the East River from around 17th Street to 63rd Street. The floodwaters pushed as far east as 3rd Avenue, between approximately 24th and 39th Streets. Generally, though, thanks to the steep elevation change between the largely industrial waterfront area and the residential areas to the east, Sandy resulted in very little impact on the area's residential population.

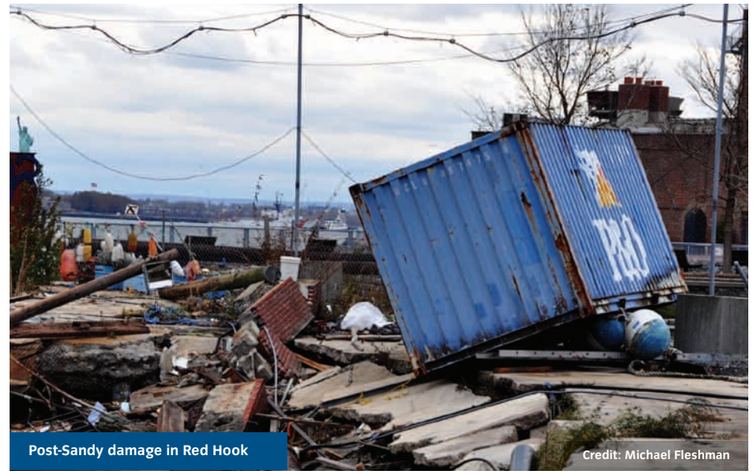
In Red Hook, water flooded the neighborhood from all three of its coasts–from the Upper Bay, Buttermilk Channel, and Gowanus Bay. This inundation impacted much of the neighborhood, including NYCHA's Red Hook Houses, save for a small elevated section around Coffey Street and a few streets in northern Red Hook close to Hamilton Avenue. Properties along the Columbia Street Waterfront District also experienced significant flooding.

In Gowanus, the impacts from Sandy came mainly from Gowanus Bay, which, as it filled with Sandy's surge, elevated water levels in the Gowanus Canal. Sandy's floodwaters eventually overtopped the Canal's bulkheads, inundating industrial and residential buildings surrounding the Canal. Although a significant community concern in the wake of the storm was whether the floodwaters from this Superfund site had contaminated the area, EPA testing showed that the toxic sediment at the bottom of the Canal remained largely undisturbed, and that bacteria levels in the floodwaters did not pose a significant health risk.

In DUMBO, meanwhile, waters from the East River flooded buildings along several streets, including Main Street and Water Street. And in the Brooklyn Navy Yard, approximately 20 of the Navy Yard's 45 buildings, mostly in the southwest section of the Yard, were flooded with between 4 and 6 feet of water.

In contrast, flooding and damage in Williamsburg was minimal, with waters rarely going far inland. The limited damage was due in part to the higher elevation of some of the new buildings in the area, as well as the buildings' esplanades, which served as an effective buffer for floodwaters.

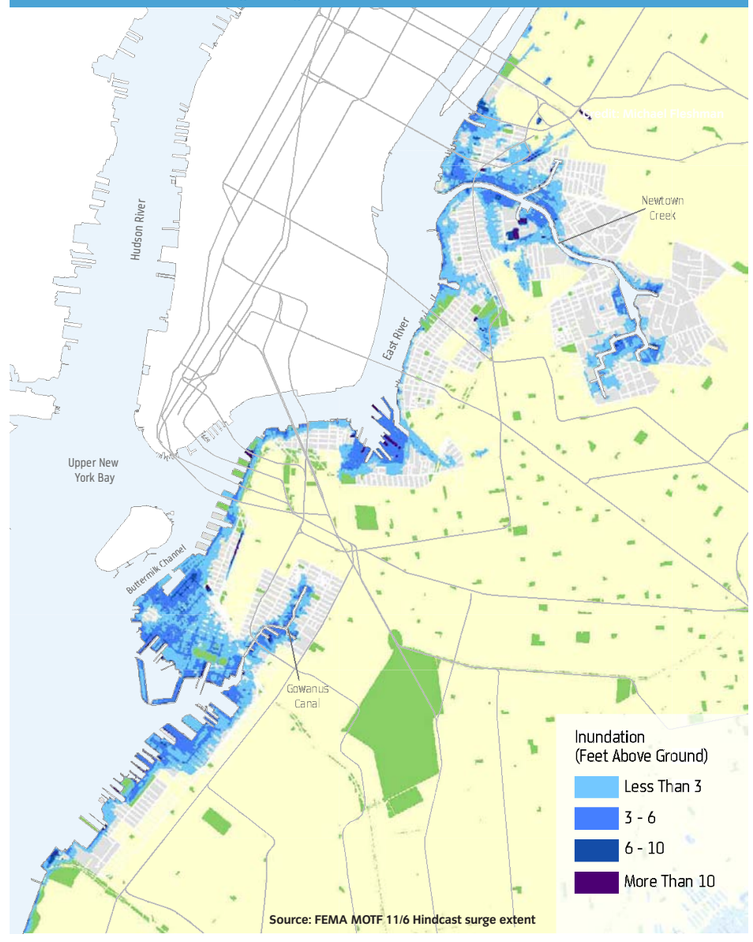
In Greenpoint, though, water from the East River and Newtown Creek caused flooding of streets and properties all along the neighborhood's perimeters. Floodwaters, for example, came significantly inland in the neighborhood's northeast, entering largely along Greenpoint Avenue and McGuinness Boulevard. The area also experienced flooding in its southwest section, close to the border it shares with Williamsburg.



Post-Sandy damage in Red Hook

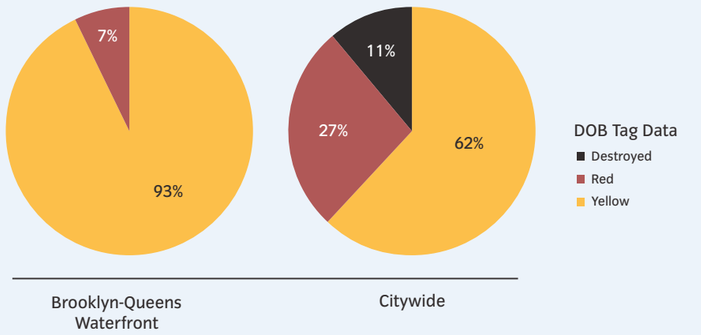
Credit: Michael Fleshman

Area Inundation and Surge Height



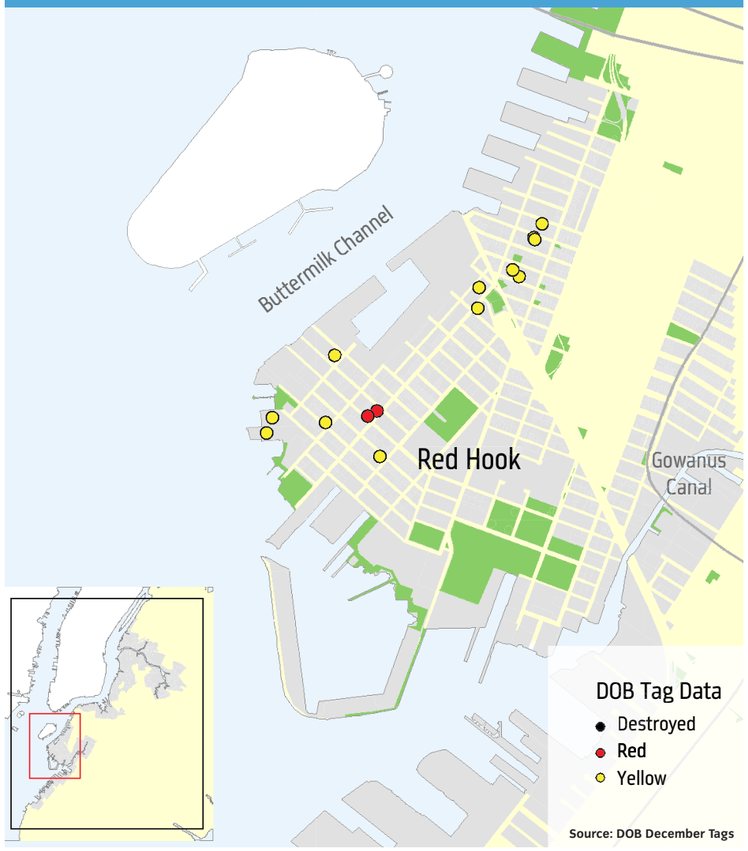
Source: FEMA MOTF 11/6 Hindcast surge extent

Level of Building Damage



Source: DOB December Tags

Location and Level of Building Damage – Red Hook



Source: DOB December Tags

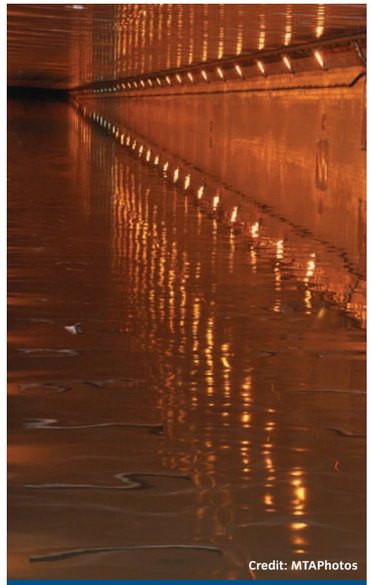
As Sandy's surge pushed into Newtown Creek from the East River, the Creek carried those waters inland, including to parts of Maspeth, Bushwick, and East Williamsburg. As with floodwaters off of the Gowanus Canal, floodwaters off of Newtown Creek also raised health concerns in surrounding communities. However, EPA testing here also showed that bacteria levels did not appear to pose a danger to area residents. The EPA also found that, post-Sandy, the various chemicals for which it tested were all below levels that should cause concern for area residents.

In Long Island City, inundation came from Newtown Creek as well as the East River, primarily via Anable Basin. While much of the neighborhood was unaffected, many buildings —such as those along 2nd Street, 5th Street, 51st Avenue, and Borden Avenue—experienced up to 6 feet of flooding, with important public infrastructure, such as Gantry Plaza State Park, also affected.

As a result of Sandy, a large number of buildings along the Waterfront suffered damage. After the storm, the New York City Department of Buildings (DOB) sent out inspectors to assess damages in buildings along the Waterfront and in other inundated areas of the City. These inspectors were asked to assign "tags" to buildings based on the observed condition of each structure. "Green" tags indicated less serious damage or no damage at all. "Yellow" tags indicated that portions of a building might be unsafe or might have significant non-structural damage. "Red" tags indicated structural damage. And a subcategory of "red" tags was further categorized as "destroyed."

The most methodologically rigorous building damage assessment undertaken by DOB was completed in December 2012. According to this assessment, of those buildings citywide that were tagged either yellow or red (including those further classified as destroyed), a relatively small percentage were located along the Brooklyn-Queens Waterfront. This is likely less a reflection of the relative damage in the area and more a reflection of the fact that, in doing these assessments, DOB was primarily focused on ocean-facing parts of the city, where a higher incidence of structural damage occurred. Regardless, to the extent that DOB did tag damaged buildings along the Waterfront, these buildings tended to be clustered in the Red Hook and Greenpoint neighborhoods.

Overall, along the Waterfront, the percentage of red and yellow tagged buildings that were tagged yellow (93 percent) was higher than the percentage citywide (62 percent). This largely was a result of the nature of the area's flooding



Flooded Queens Midtown Tunnel

(stillwater inundation, as opposed to destructive wave action), which tended to cause less structural damage and instead caused damage to building systems and contents. (*See map: Location and Level of Building Damage*)

Overall, along the Waterfront, over 1,300 residential buildings were within the inundation area, and these buildings contained nearly 16,200 residential units. In many cases, Sandy's inundation forced people out of their homes for days, weeks, and even months. In some cases, this was because they lived in flooded ground-floor or basement apartments that were destroyed by flooding. In others, such as along Pioneer Street in Red Hook, it was because vital building mechanical systems supporting their living spaces were knocked out of service.

Among the residential inventory impacted by Sandy were units in NYCHA developments along the Waterfront. The flooding of mechanical systems in the Gowanus Houses, for example, shut down the development's power, while residents of Red Hook Houses faced the challenges of weeks without power, heat, and, sometimes, running water. This was particularly difficult for residents who were elderly and/or had disabilities. In response, a massive volunteer effort in Red Hook coalesced to help these vulnerable residents, coordinated by existing community-based organizations (including Red Hook Initiative, Added Value, and the Red Hook Community Justice Center), as well as groups formed in response to Sandy (including Red Hook Coalition and Restore Red Hook). At the same time, NYCHA staff, dealing with similar challenges in multiple locations, worked night and day to make necessary repairs and secure generators and temporary boilers to get these buildings back online.

Location and Level of Building Damage – Greenpoint

Source: DOB December Tags

Also impacted by Sandy were Waterfront businesses, which were impacted significantly by the storm, particularly as floodwaters filled ground floors and basements, damaging building systems and contents. In total, approximately 3,100 businesses employing some 34,600 people were impacted by Sandy. A number of retail businesses both large and small were also severely affected, including stores and restaurants along Van Brunt Street in Red Hook. Nearby, Fairway Market, an important area anchor, had to gut its Red Hook store, though it reopened after four months.

Some industrial structures, such as the Brooklyn Army Terminal, which was built at a relatively higher elevation and with a hardened exterior, were impacted only minimally. The Terminal also benefitted from the foresight of NYCEDC property managers who brought in a backup generator from out-of-state as Sandy arrived .

Other industrial buildings, however, experienced greater challenges. At Bush Terminal, flooding of mechanical and electrical equipment resulted in the loss of Con Edison power for days, though NYCEDC property managers were able to restore power in eight buildings within 10 days and all buildings within 15 days, by sourcing generators from around the region. At the South Brooklyn Marine Terminal, a tenant storing new cars lost over 100 vehicles to a combination of inundation and fire. Meanwhile, at the Brooklyn Navy Yard, electric substations, boilers and dry docks, as well as bulkheads, were damaged significantly. Navy Yard tenants are estimated to have lost over $75 million worth of equipment and inventory. Though the Navy Yard was able to help tenants reopen quickly, repairs continue as of the writing of this report. Generally speaking, maritime businesses along the Waterfront largely were able to protect

Risk Assessment: Impact of Climate Change

Major Risk Moderate Risk Minor Risk

	Scale of Impact			
Hazard	Today	2020s	2050s	Comments
Gradual				
Sea level rise				Some areas already experience occasional flooding from creeks; sea level rise likely would result in increases in localized flooding
Increased precipitation				Combined sewage and stormwater could exceed the capacity of wastewater treatment plants, leading to releases of untreated or partially treated sewage into waterways
Higher average temperature				Minimal impact
Extreme Events				
Storm surge				Significant risk of flooding from both coastal and inland water bodies (e.g., runoff, sewer back-ups), as evidenced by Sandy; risk primarily to building systems
Heavy downpour				Sewer system capacity may be exceeded more frequently, leading to street flooding, sewer backup and combined sewer overflow
Heat wave				Greater strain on power system with potential for more failures; most significant impact on high-rise buildings
High winds				Minimal impact

their vessels from Sandy, with professional mariners manning these ships during the storm to keep them safe. However, many of these businesses did experience significant damage to their landside operations.

Along the Waterfront, Sandy's floodwaters disturbed hazardous substances on a number of existing and former industrial sites. However, after Sandy's departure, DEP conducted extensive inspections of sites that had been known to contain hazardous materials in the floodplain, and generally found conditions to be safe (see *Environmental Protection and Remediation*).

Sandy also had a major impact on infrastructure along the Waterfront. For example, after Sandy, the Queens Midtown Tunnel was closed for a week and a half due to extensive flooding. Meanwhile, the Hugh L. Carey Tunnel, took nearly three weeks to be reopened fully to the public. Together, the two tunnels were flooded with approximately 72 million of gallons of water. Subway service across the area was knocked out, as it was throughout the city. The Montague Subway Tunnel, which connects Brooklyn and Manhattan along the R line, experienced the worst flooding, shuttering R train service for nearly two months. Other lines, however, were generally back in service within a week. While the subways were out of service, the City's East River Ferry service ran modified routes that helped connect Brooklyn, Queens, and Manhattan, carrying double the number of passengers than would be carried on an ordinary weekday, during the first three days following the storm.

Sandy also impacted two major wastewater treatment plants. The Owls Head plant was partially impaired, due to the loss of its primary electrical systems. However, the plant was able to continue all treatment processes throughout the storm, though some loss of capacity resulted in the release of only partially treated sewage. The Newtown Creek facility, meanwhile, lost approximately half of its flow after the Manhattan Pumping Station shut down due to significant flooding. This plant, too, however, continued to treat sewage throughout the storm.

Other infrastructure along the Waterfront also sustained damage. Brooklyn Bridge Park suffered damage to electrical systems, but in general proved to be flood-resilient, as designed, allowing the park to reopen within days. Additionally, three public schools in the neighborhoods along the Waterfront were impacted by Sandy, including P.S. 15, P.S. 78, and the PAVE Academy Charter School. These schools were closed for up to 21 days, during which time students were sent to other locations.

What Could Happen in the Future

Going forward, the neighborhoods along the Waterfront face a variety of challenges as the climate changes.

Major Risks

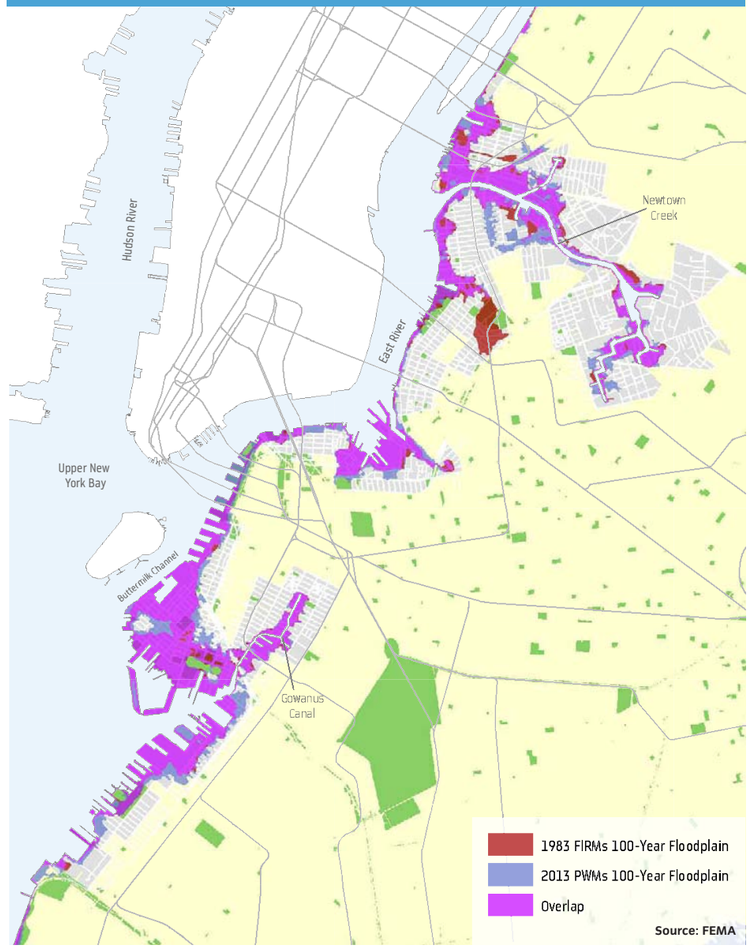
Given the Waterfront's coastal exposure, the most significant climate change-related risks for its neighborhoods are storm surge and flooding from coastal storms, which is likely to be exacerbated by projected sea level rise. This risk is significant even today along the Waterfront, as illustrated by flood maps released in June 2013 by the Federal Emergency Management Authority (FEMA). According to these Preliminary Work Maps (PWMs), the 100-year floodplain, the area with a 1 percent or greater chance of flooding in any given year, has expanded beyond that shown on the 1983 maps that were in effect when Sandy hit. In the new maps, the growth in the floodplain is most pronounced in Red Hook, Greenpoint, and Long Island City. The new maps show an expanded V Zone, the area where waves could exceed 3 feet in height, along the length of the Waterfront's coastline, including along piers containing buildings and equipment. (*See map: Comparison of 1983 FIRMs and Preliminary Work Maps*)

As the 100-year floodplain has expanded in size, there has been also an increase in the number of buildings in the floodplain—a 6 percent rise in residential buildings (from approximately 850 to 900 buildings) and a 15 percent increase in commercial buildings (from almost 1,350 to nearly 1,550 buildings). In addition, approximately 100 buildings—all commercial—are now located in a V Zone. Base Flood Elevations (BFE)—the height to which floodwaters could rise during a storm—have increased 1 to 3 feet throughout the area.

Critical infrastructure assets also are in the PWM 100-year floodplain, including the Owls Head, Red Hook, and Newtown Creek WWTPs, as well as Con Edison's Farragut Substation. Significant transportation infrastructure, such as the entrances to the Queens Midtown and the Hugh L. Carey Tunnels, also remain in the floodplain.

According to projections from the New York City Panel on Climate Change (NPCC), described in Chapter 2 (*Climate Analysis*), sea levels are forecast to rise through the 2020s and 2050s. During this period, the floodplain will expand, and throughout the area, BFEs could increase, resulting in a risk of even higher floodwaters during storms. (*See table: Buildings in the 100-Year Floodplain*)

Comparison of 1983 FIRMs and Preliminary Work Maps



Buildings in the 100-Year Floodplain

Buildings & Units	100-Year Floodplain			
	1983 FIRMs	2013 PWMs	Projected 2020s	Projected 2050s
Residential Buildings	850	890	2,130	2,960
Residential Units	12,100	10,800	19,600	23,900
Commercial and Other Buildings	1,430	1,650	2,500	2,740

Note: From the 1983 FIRMs to the PWMs the floodplain retracts in parts of Long Island City and Greenpoint, leading to the decrease in residential units in the floodplain.

Source: DCP Pluto, FEMA, CUNY Institute for Sustainable Cities

The additional growth in the floodplain into Williamsburg and Greenpoint is expected primarily east of the Navy Yard, and farther north in Long Island City. The floodplain also extends farther from Newtown Creek on both the Brooklyn and Queens sides. Along with this expansion, according to NPCC's high end projections, the number of buildings in the 100-year floodplain could rise to over 4,500 by the 2020s (a 71 percent increase over PWMs) and to over 5,700 by the 2050s (an additional 44 percent increase over the PWMs). (*See map: Comparison of Preliminary Work Maps and Future Floodplains*)

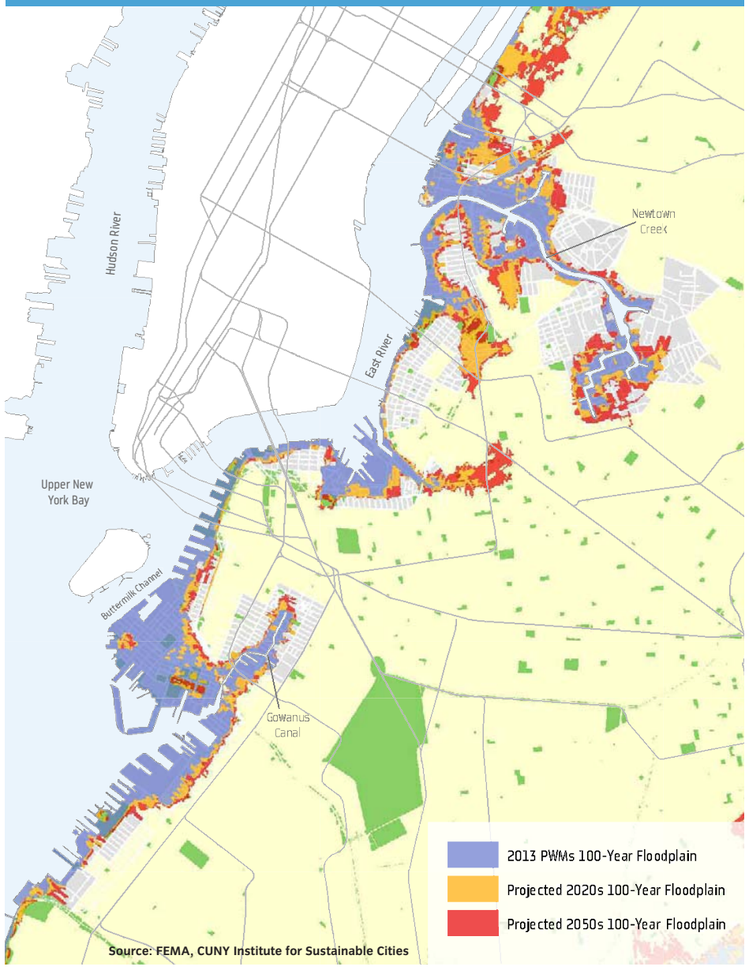
Other Risks

Though coastal inundation poses the greatest threat to the neighborhoods along the Waterfront, these neighborhoods face other climate risks as well. For example, sea level rise—even without extreme weather events such as hurricanes—could lead to increased frequency and severity of street, basement, and sewer flooding in some communities by the 2050s.

Increased precipitation and more and heavier downpours also could overwhelm sewer systems, resulting in more flooding, as well as result in increased numbers of CSO events. While future projections for changes in wind speeds are not available from the NPCC, a greater frequency of intense coastal storms by the 2050s could present a greater risk of high winds in the New York area, which could result in downed overhead power lines and trees, and potentially damage older buildings not constructed to modern wind standards.

Finally, higher average temperatures outside of heat waves are not expected to cause meaningful impacts on the neighborhoods along the Waterfront. However, heat waves could lead to more frequent power outages and may strain industrial equipment and machinery. (*See chart: Risk Assessment: Impact of Climate Change*)

Comparison of Preliminary Work Maps and Future Floodplains



Source: FEMA, CUNY Institute for Sustainable Cities

Brooklyn-Queens Waterfront community outreach workshop

Priorities from Public Engagement Along the Brooklyn-Queens Waterfront

Since the Special Initiative for Rebuilding and Resiliency (SIRR) was launched in December 2012, the input of local stakeholders has helped shape an understanding of what happened during Sandy, what risks the Brooklyn-Queens Waterfront faces in relation to climate change, and what approaches make sense to address these risks.

The area along the Waterfront is represented by a wide-array of elected officials at the Federal, State, and local levels. It also is represented by five community boards. The area is further served by a large number of community-based organizations, civic groups, faith-based organizations, and other neighborhood stakeholders. All played an important role in relief and recovery efforts after Sandy. Throughout the process of developing this plan, SIRR staff benefited from numerous conversations—both formal and informal—with these groups and individuals, including, along the Waterfront, two task forces that met regularly.

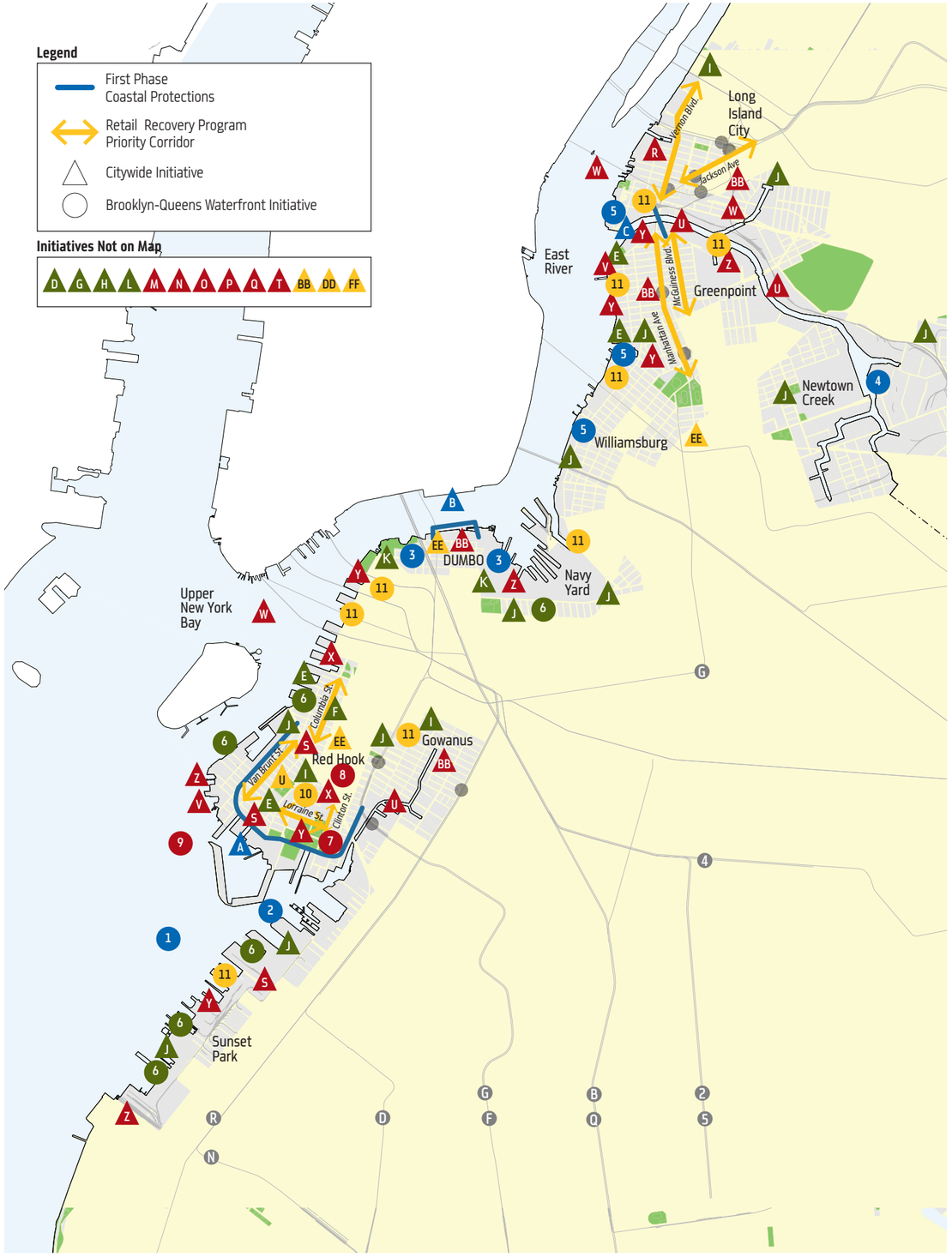
Task Force	Briefing Frequency	# of Stakeholders from the Brooklyn-Queens Waterfront
Elected Officials	Monthly	~20 City, State, Federal elected officials
Community-Based Organizations	4 -6 weeks	5 community boards 40+ faith-based, business, and community organizations

SIRR also held three public workshops in March and April of 2013 along the Waterfront, part of a series of such workshops held citywide in which over 1,000 New Yorkers participated to discuss issues affecting their neighborhoods and communicate their priorities for the future of their homes and communities. Generally, the on-the-ground insights provided at these public workshops helped SIRR staff to develop a deeper understanding of the specific priorities of, and challenges facing, the communities of the Waterfront.

Overall, out of the various task force and other meetings and public workshops attended by SIRR staff since January, several priorities for the Waterfront and the SIRR effort clearly emerged:

- address the major expense of repairs and resiliency for low-rise buildings;
- understand the tremendous hurdles attached properties face in meeting FEMA guidelines;
- provide flood protection from inland water bodies;
- mitigate street and property flooding, combined sewer overflow events;
- address the particular risks of industrial properties; and
- increase transportation redundancy.

BROOKLYN-QUEENS WATERFRONT | Initiative Summary



Coastal Protection

Selected Citywide Measures

- A Install integrated flood protection system in Red Hook
- B Call on and work with Con Edison to protect the Farragut substation
- C Call on and work with the (USACE) to study and install local storm surge barriers at Newtown Creek

* For additional Coastal Protection initiatives, see Coastal Protection section of Community Plan

1. Work with Port Authority of New York and New Jersey to continue a study of innovative coastal protection measures using clean dredge material in Southwest Brooklyn
2. Call on and work with the USACE to develop an implementation plan and preliminary designs for a local storm surge barrier along the Gowanus Canal
3. Implement strategies to protect Brooklyn Bridge Park and DUMBO
4. Support private investments that reduce flood risk along Newtown Creek
5. Create an implementation plan for comprehensive flood-protection improvements on public and private property along the Williamsburg, Greenpoint and Long Island City coastlines

Buildings

Selected Citywide Measures

- D Improve regulations for flood resiliency of new and substantially improved buildings in the 100-year floodplain
- E Rebuild and repair housing units destroyed and substantially damaged by Sandy
- F Study and implement zoning changes to encourage retrofits of existing buildings and construction of new resilient buildings in the 100-year floodplain
- G Amend the Building Code and complete studies to strengthen wind resiliency for new and substantially improved buildings
- H Encourage existing buildings in the 100-year floodplain to adopt flood resiliency measures through an incentive program and targeted mandate
- I Retrofit public housing units damaged by Sandy and increase future resiliency of public housing
- J Launch a sales tax abatement program for flood resiliency in industrial buildings
- K Clarify regulations relating to the retrofit of landmarked structures in the 100-year floodplain
- L Amend the Building Code and complete studies to improve wind resiliency for existing buildings

* For additional Buildings initiatives, see Buildings section of Community Plan

6. Implement planned upgrades to vulnerable City-owned, industrial properties

Critical Infrastructure

Selected Citywide Measures

- M Work with utilities and the Public Service Commission (PSC) to harden key electric transmission and distribution infrastructure against flooding
- N Work with utilituies and the PSC to harden vulnerable overhead lines against winds
- O Work with utilities, regulators, and gas pipeline operators to harden the natural gas system against flooding
- P Require retrofitting of existing hospitals in 100-year floodplain
- Q Require retrofitting of nursing homes in 100-year floodplain
- R Require retrofitting of adult care facilities in 100-year floodplain
- S Reconstruct and resurface key streets damaged by Sandy
- T Elevate traffic signals and provide backup electrical power
- U Install watertight barriers to protect movable bridge machinery
- V Protect Staten Island Ferry and private ferry terminals from climate change-related threats
- W Call on non-City transportation agencies to implement strategies to address climate change threats
- X Expand the network of bus priority lanes on arterial highways
- Y Harden or otherwise modify shoreline parks to protect adjacent communities
- Z Harden pumping stations
- AA Harden wastewater treatment plants
- BB Reduce combined sewer overflow with high-level storm sewers

* For additional Critical Infrastructure initiatives, see Critical Infrastructure sections of Community Plan

7. Improve connections between Red Hook and the rest of Brooklyn
8. Call for the MTA to explore Red Hook-Lower Manhattan bus connections
9. Implement expanded free summer weekend ferry from Manhattan to Red Hook in 2013

Community & Economic Recovery

Selected Citywide Measures

- CC Launch business recovery and resiliency programs
- DD Launch the Neighborhood Game Changer Competition
- ⟷ Call for Neighborhood Retail Recovery Program
  - Columbia Street Waterfront District (Hamilton Ave. to Atlantic Ave.)
  - Jackson Ave. (52nd Ave. to 23rd St.)
  - Manhattan Ave. (Ash St. to Driggs Ave.)
  - McGuinness Blvd. (Ash St. to Calyer St.)
  - Van Brunt St. (Reed St. to Bowne St.)
  - Lorraine St. (Dwight St. to Hicks St.)
  - Clinton St. (Hamilton Ave. to Centre St.)
  - Vernon Blvd. (54th Ave. to Queensboro Bridge)
- EE Support local merchants in improving and promoting local commercial corridors
- FF Continue to support the FRESH program to increase the number of full-time grocers in underserved neighborhoods

10. Create and implement a revitalization strategy for targeted retail and community spaces within Red Hook Houses
11. Implement planned and ongoing investments by the City and private partners
    - Bush Terminal Piers Park
    - Brooklyn Bridge Park
    - Bushwick Inlet Park
    - Box Street Park
    - Newtown Barge Park Expansion
    - Hunter's Point South
    - Redevelopment of Brooklyn Navy Yard

This chapter contains a series of initiatives that are designed to mitigate the impacts of climate change on the Brooklyn-Queens Waterfront. In many cases, these initiatives are both ready to proceed and have identified funding sources assigned to cover their costs. With respect to these initiatives, the City intends to proceed with them as quickly as practicable, upon the receipt of identified funding.

Meanwhile, in the case of certain other initiatives described in this chapter, though these initiatives may be ready to proceed, they still do not have specific sources of funding assigned to them. In Chapter 19 (*Funding*), the City describes additional funding sources, which, if secured, would be sufficient to fund the full first phase of projects and programs described in this document over a 10-year period. The City will work aggressively on securing this funding and any necessary third-party approvals required in connection there with (i.e., from the Federal or State governments). However, until such time as these sources are secured, the City will only proceed with those initiatives for which it has adequate funding.

Brooklyn-Queens Waterfront Community Rebuilding and Resiliency Plan

The Brooklyn-Queens Waterfront is an area treasured for its diversity of people, cultures, and industries. The area benefits from a long waterfront that has been a source of jobs and economic activity for centuries, and increasingly is becoming a place for residences and public open space.

The following is a multilayered plan that not only applies citywide strategies to the neighborhoods along the Waterfront but also provides strategies designed to address the area's specific needs and particular vulnerabilities. In anticipation of future climate change-related risks, this plan proposes ways that Waterfront neighborhoods can adapt by: Addressing storm surge along the entire coastline; providing opportunities to retrofit the area's most vulnerable building stock; protecting and improving critical infrastructure; and focusing investments in strategic areas such as Red Hook to advance a long-term and sustainable recovery.

Coastal Protection

As Sandy illustrated, the greatest extreme weather-related risk faced by New York City is storm surge, the effects of which are likely to increase given current projections of sea level rise. Going forward, it is anticipated that climate change will render coastal regions of the city, including the neighborhoods of the Waterfront, even more vulnerable to these risks.

While it is impossible to *eliminate* the chance of flooding in coastal areas, the City will seek to *reduce* its frequency and effects—mitigating the impacts of sea level rise, storm waves including erosion, and inundation on the coastline of the city generally and the neighborhoods of the Waterfront in particular. Among the strategies that the City will use to achieve these goals will be the following: Increasing coastal edge elevations; minimizing upland wave zones; protecting against storm surge; and improving coastal design and governance. When evaluating coastal protection, other priorities including navigation and ongoing efforts to improve water quality and natural habitats also will be considered prior to implementation, where appropriate.

The initiatives described below provide important examples of how the City intends to advance its coastal protection agenda citywide. These initiatives will have a significant impact on the residents, businesses, and nonprofits along the Waterfront. Taken together, when completed, the first four coastal protection initiatives described below would provide enhanced protection for over 1,600 buildings, representing over 8,700 housing units as well as many businesses and much of the critical infrastructure along the Waterfront.

For a full explanation of the following initiatives and a complete description of the City's comprehensive coastal protection plan, please refer to Chapter 3 (*Coastal Protection*).

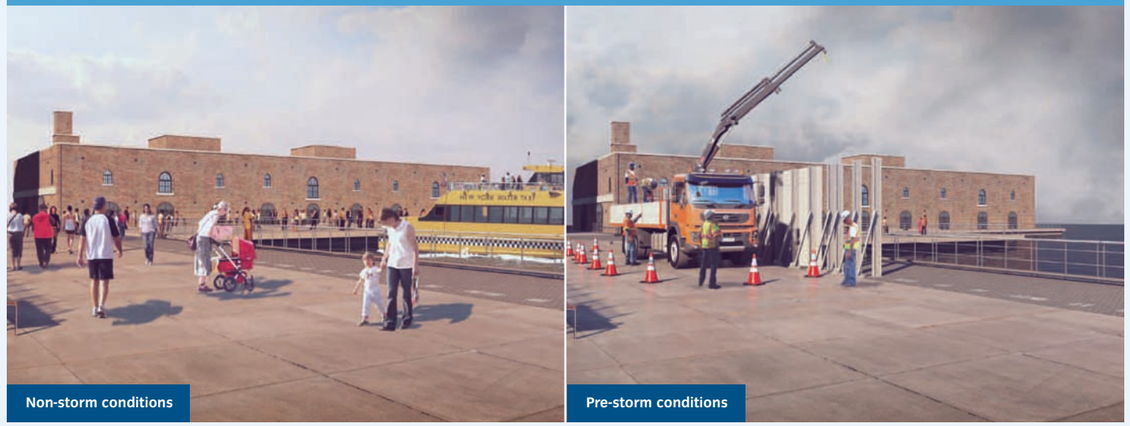
Coastal Protection Initiative 6
Raise bulkheads in low-lying neighborhoods to minimize inland tidal flooding

Bulkheads provide the first line of defense against flooding in many neighborhoods, including the Waterfront, but throughout the city many bulkheads are built to an elevation that may be insufficient given the latest projections of sea level rise by 2050. Subject to available funding, the City, therefore, will launch a program to raise bulkheads and other shoreline structures across the five boroughs in low-lying areas most at risk of daily or weekly tidal flooding, a phenomenon that could impact as much as 3 miles of the Waterfront's shoreline by the 2050s. The Mayor's Office of Long-Term Planning and Sustainability (OLTPS) will work with NYCEDC to manage this program, to begin implementation in 2013, in conjunction with the new citywide waterfront inspections program described in Chapter 3.

Coastal Protection Initiative 23
Install integrated flood protection system in Red Hook

Red Hook faces a number of challenges from climate change: A low-lying topography; older, often-attached buildings; a significant number of industrial businesses with valuable, ground-floor equipment and inventory that are difficult to elevate; vulnerable commercial corridors; and a significant population that lacks the means to make resiliency investments. These conditions make site-specific flood protection measures a challenge, likely leaving many residents, businesses, and infrastructure assets exposed. Subject to available funding, the City, therefore, will install an integrated flood protection system in Red Hook, composed of permanent features, temporary features, and landscaping and drainage improvements. This approach would protect much of the neighborhood but, at the same time, would not interfere with the neighborhood fabric during non-storm conditions. The design will be selected following an international competition and may include elevation of portions of the Brooklyn Waterfront Greenway. Other elements likely would run along the first mapped street inland of the waterfront throughout the neighborhood. The goal is to commence design in 2014 with completion expected by 2016. (*See rendering: Red Hook Flood Protection System*)

Conceptual Rendering of Red Hook Flood Protection System



Non-storm conditions

Pre-storm conditions

Coastal Protection Initiative 25
Call on and work with Con Edison to protect the Farragut substation

Con Edison's Farragut substation came close to flooding during Sandy. This vital element of the city's power distribution network, serving almost 500,000 customers (or approximately 1.25 million people), sits in an area of growing risk from storm surge. The City therefore, will, call on Con Edison to protect this vital electrical substation from the impacts of storm surge. To accomplish this, Con Edison could consider floodwalls along the perimeter of the facility or other measures to meet a higher design standard for flood protection. This project could be incorporated into Con Edison's upcoming rate case at the State's Public Service Commission (PSC). OLTPS will monitor and support with technical assistance the rapid implementation of this project.

Coastal Protection Initiative 26
Call on and work with the United States Army Corps of Engineers (USACE) to study and install local storm surge barriers at Newtown Creek

Newtown Creek was the source of extensive flooding during Sandy, carrying its surge miles inland. The risk of such flooding in the future is expected to grow as the climate changes. The City, through OLTPS, therefore, will call on the USACE to develop an implementation plan for, and construct, a storm surge barrier and associated levees at the mouth of Newtown Creek. Such a barrier would be navigable during non-storm periods and would close in advance of storm activity to protect the areas inland of the barrier. As Newtown Creek is a Superfund site, proper coordination with the EPA and others will be required to implement the project successfully. Water quality impacts also will be considered in the study of this project. OLTPS will seek to have the USACE complete this project, subject to available funding, within six years following the completion of the development by USACE of its study. (*See rendering: Newtown Creek Surge Barrier*)

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Beyond the priority coastal protection projects described in Chapter 3, including those summarized briefly above, the City is proposing additional coastal protection initiatives specific to the Waterfront's vulnerabilities. These initiatives are described below.

Conceptual Rendering of Newtown Creek Surge Barrier

Brooklyn-Queens Waterfront Initiative 1
Work with the Port Authority to continue a study of innovative coastal protection measures using clean dredge material in Southwest Brooklyn

Many pier-based businesses along the Waterfront, including some in Southwest Brooklyn, lie within a V Zone and, thus, may be subject to damaging waves during a storm. This risk is expected to grow in the future as the climate changes. The City, acting through NYCEDC, will work with the Port Authority to explore in-water protection measures, including a breakwater constructed from clean dredge material, and the creation of an oyster habitat

and wetlands within Bay Ridge Flats, a shallow area offshore of Red Hook and Sunset Park and adjacent to Bay Ridge Channel. This combination of strategies could decrease the strength of surge impacting Southwest Brooklyn during extreme weather events. As part of the study, the City and the Port Authority will work with the New York State Department of Environmental Conservation and the United States Coast Guard to explore how construction activities could be staged so as to minimize impacts on shipping and anchoring. NYCEDC will pursue this effort in 2013.

Brooklyn-Queens Waterfront Initiative 2
Call on and work with the USACE to develop an implementation plan and preliminary designs for a local storm surge barrier along the Gowanus Canal

Much of the area surrounding the Gowanus Canal lies within FEMA's 100-year floodplain, even without accounting for climate change. The land surrounding the Canal supports a variety of land uses and densities, with all structures in the area at risk of flooding. Because flood protection along the length of the coastal edges of the Canal may be extremely expensive, disruptive, and in some cases nearly impossible, the City, through OLTPS, will call for the USACE to create an implementation plan and complete preliminary designs for a local storm surge barrier at the mouth of the Gowanus Canal. Such a barrier could provide comprehensive protection for the entire area. As the Gowanus Canal is a Superfund site, proper coordination with the EPA and others would be required to implement the project successfully. One potential location for the proposed barrier is across the Gowanus Bay from Erie Basin to 29th Street in Sunset Park. Such a barrier would be supported by a raised levee along both piers connected to natural high points, preventing flooding to properties near the barrier. The barrier would have the added benefit of creating a new stormwater basin that could be used to facilitate drainage. The barrier would be navigable to allow for continued shipping traffic along this working waterfront.

Brooklyn-Queens Waterfront Initiative 3
Implement strategies to protect Brooklyn Bridge Park and DUMBO

Parts of Brooklyn Bridge Park sit below FEMA's base flood elevations (BFEs) and, therefore, are exposed to storm surge, even without accounting for climate change. To mitigate this risk, the City, through the Brooklyn Bridge Park Corporation, will make investments to increase park elevation along its waterfront, will create additional "rip rap" edges to reduce the impact of wave action, will select soils and plant material for future park phases that will increase resiliency and will work with the future developer of the John Street development site in DUMBO to elevate the new building and its coastal edges. These investments will begin in 2014.

Sandy also showed that the entire DUMBO waterfront is vulnerable to coastal flooding. This vulnerability is expected to increase as the climate changes. Subject to available funding, OLTPS will create a long-term implementation plan for an integrated flood protection system to protect the DUMBO neighborhood. The goal is to commence the plan in 2014.

Brooklyn-Queens Waterfront Initiative 4
Support private investments that reduce flood risk along Newtown Creek

Although the storm surge barrier at Newtown Creek described above would provide comprehensive protection for nearby properties, it could take time to build, leaving industrial and residential properties at risk in the near-term. A barrier also would not protect against the impacts of sea level rise outside of extreme weather events. The City, therefore, will offer technical assistance to businesses interested in obtaining relevant permits and investing private capital in restoring and upgrading bulkheads and making additional improvements that provide protection against flooding and sea level rise. NYCEDC will work with individual businesses, as well as local business improvement districts (BIDs) and local development corporations, to identify and advance these private investments, focusing, in particular, on the complicated permitting process that often accompanies them. The goal is that by the end of 2013, NYCEDC will advertise its support to businesses through local stakeholder groups.

Brooklyn-Queens Waterfront Initiative 5
Create an implementation plan for comprehensive flood-protection improvements on public and private property along the Williamsburg, Greenpoint, and Long Island City coastlines

Along the length of Williamsburg, Greenpoint, and Long Island City, significant new development is expected, presenting an opportunity to create a more resilient coastline. Subject to available funding, the City, through OLTPS in coordination with the Department of City Planning (DCP), the New York City Department of Parks and Recreation (DPR), and NYCDOT, will investigate resiliency strategies that rely on public and private solutions for these portions of the Waterfront, and can be implemented incrementally over time. Measures may include protections on private property that increase flood resiliency for new development projects and the neighborhoods that they front, such as as well as edge elevations along esplanades and open spaces that provide flood protection and could be integrated into zoning regulations, and protections on public property, such as, increased street elevations and resiliency measures incorporated into park designs. These measures would ultimately be integrated into other proposed protection measures such as the proposed Newtown Creek surge barrier (see Coastal Protection Initiative 26), and the proposed program for raising bulkheads in low-lying areas (see Coastal Protection Initiative 6). The goal is to complete this study by 2015.

Buildings

The city's buildings give physical form to New York. As Sandy demonstrated, however, the building stock citywide, including along the Waterfront, is highly vulnerable to extreme weather events—a vulnerability that is expected to increase in the future. While the coastal protection measures outlined above are designed to reduce the effects of sea level rise, storm surge, and wave action on the city and the neighborhoods of the Waterfront, these measures will not completely eliminate those risks. They also will take time to design, fund, and build. It is equally important, therefore, to supplement these measures by pursuing resiliency at the *building* level.

To achieve building-level resiliency, the City will seek to protect structures along the Waterfront and throughout the five boroughs against a spectrum of climate risks, including not only flooding but also high winds and other extreme events. Among the strategies that the City will use to achieve these goals will be to construct new buildings to the highest resiliency standards and retrofit as many existing buildings as possible so that they will be significantly better prepared to handle the impacts of extreme weather events.

The initiatives described below provide important examples of how the City intends to advance building resiliency citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits along the Waterfront. For a full explanation of the following initiatives and a complete description of the City's five-borough building resiliency plan, please refer to Chapter 4 (*Buildings*).

Buildings Initiative 1
Improve regulations for flood resiliency of new and substantially improved buildings in the 100-year floodplain

Though buildings constructed to modern Construction Codes generally performed well during Sandy, given the increasing risk of flooding that is likely with climate change, modifications are warranted. The City, therefore, will seek to amend the Construction Codes and Zoning Resolution to provide for strengthened requirements that will, among other things, improve the design of new buildings through the application of appropriate resiliency measures that are calibrated to the best floodplain data available over time and that critical building systems are better-protected from flood risks. In 2013, the City, through OLTPS, will seek to implement these code changes and DCP will continue to take zoning changes through the public review process, with the goal of adoption before the end of the year. If adopted, they will improve resiliency for developments along the Waterfront, including thousands of units of new housing that are permitted to be constructed both in Greenpoint and Williamsburg, following the rezoning of that neighborhood approved by the City Council and City Planning Commission in 2005, and in Long Island City at Hunter's Point South and Queens West.

Buildings Initiative 2
Rebuild and repair housing units destroyed and substantially damaged by Sandy

Roughly 23,000 private residential buildings encompassing nearly 70,000 housing units were damaged or destroyed during Sandy. Subject to available funding, the City, therefore, through the Mayor's Office of Housing Recovery Operations (HRO), will provide financial and other assistance to owners of residential properties that were destroyed or substantially damaged during Sandy, including approximately 30 residential buildings encompassing approximately 80 housing units in the Waterfront neighborhoods. To address the damages sustained and to more effectively prepare these significantly damaged buildings for future storm events, the City either will assist owners or, in limited cases meeting City criteria, will facilitate the acquisition of properties by new owners whom it will assist, in rebuilding and substantially improving these properties based on the best floodplain data available over time. Additionally, the City is seeking to incorporate resiliency measures into approximately 500 to 600 multifamily properties that sustained minor damage including many publicly assisted properties such as those developed pursuant to the Mitchell-Lama program and other affordable housing programs. The City, therefore, will support the retrofit of these publicly-assisted buildings, such as those developed pursuant to Mitchell-Lama and other affordable housing programs.

Buildings Initiative 3
Study and implement zoning changes to encourage retrofits of existing buildings and construction of new resilient buildings in the 100-year floodplain

The City, through DCP, will undertake a series of citywide and neighborhood-specific land use studies to address key planning issues in severely affected and vulnerable communities. As part of these studies, the City will identify ways to facilitate the voluntary construction of new, more resilient building stock, and to encourage voluntary retrofits of existing vulnerable buildings over time. To be undertaken in close consultation with local residents, elected officials, and other community stakeholders, these land use studies will focus on the challenges posed by the combination of flood exposure of the applicable neighborhoods and the vulnerability of the building types that are found in these neighborhoods (e.g., older, attached buildings that cannot easily or cost-effectively be elevated out of floodplains). Along the Waterfront, DCP will examine neighborhoods including the Columbia Street Waterfront District. Subject to available funding, the goal would be for DCP to commence this study in 2013. Thereafter, DCP would move to implement changes, if any, that it deems to be appropriate based on the results.

Buildings Initiative 5
Work with New York State to identify eligible communities for the New York Smart Home Buyout Program

The City will evaluate opportunities for collaboration with the State in connection with its home buyout program, using an objective set of criteria developed by the City, including extreme vulnerability, consensus among a critical mass of contiguous local residents, and other relevant factors. It is anticipated that these criteria will be met in a limited number of areas citywide. As of the writing of this report, no areas have been identified for this program along the Waterfront.

Buildings Initiative 6
Amend the Building Code and complete studies to strengthen wind resiliency for new and substantially improved buildings

As noted above, buildings constructed to modern Building Code standards generally performed well during Sandy. Sandy, however, brought relatively weak winds, compared to other hurricanes. Given the possibility of more frequent or intense wind events in the future, modifications to the Building Code are warranted. The City, therefore, through OLTPS, will seek to amend the Building Code to provide for strengthened requirements so that new buildings citywide can meet enhanced standards for wind resiliency. The City will further study whether additional wind resiliency standards should be required going forward. The amendments will be submitted to the City Council for adoption, and the study will commence, in 2013.

Buildings Initiative 7
Encourage existing buildings in the 100-year floodplain to adopt flood resiliency measures through an incentive program and targeted mandate

Even if every structure destroyed or damaged by Sandy were rebuilt to the highest resiliency standards, this would still leave tens of thousands of existing structures in the 100-year floodplain vulnerable—with more becoming vulnerable as the climate changes. Subject to available funding, the City, therefore, will launch a $1.2 billion program to provide incentives to owners of existing buildings in the 100-year floodplain to encourage them to make resiliency investments in those buildings. Of the up to $1.2 billion available through the program, the City will reserve up to $100 million for 1- to 3-family homes, up to $500 million for distribution across the five boroughs based on each borough's share of vulnerable buildings citywide, and $100 million for affordable housing developments. The City also will mandate that large buildings (those with seven or more stories that are more than 300,000 square feet in size) undertake certain flood resiliency investments by 2030. If the City consistently achieves its stated goal of encouraging significant resiliency retrofit investments for the vast majority of the built floor area in the 100-year floodplain in the five boroughs, over 8,000 housing units encompassing approximately 45 million square feet of built space along the Waterfront would, over time, be made meaningfully less vulnerable. The goal is to launch these programs in 2013.

Buildings Initiative 8
Establish Community Design Centers to assist property owners in developing design solutions for reconstruction and retrofitting, and connect them to available City programs

The City, through HRO, will establish Community Design Centers in neighborhoods across the city, potentially including the Waterfront, to assist property owners in developing design solutions for reconstruction and retrofitting, and connect them to available City programs. The Centers would be managed by the City—through agencies such as HRO, the Department of Housing Preservation and Development (HPD), DOB, DCP, and NYCEDC—with support from local partners.

Buildings Initiative 9
Retrofit public housing units damaged by Sandy and increase future resiliency of public housing

During Sandy, public housing developments owned and operated by NYCHA suffered significant damage throughout the city. Still more were not impacted by Sandy but remain vulnerable to extreme weather, with even more likely to become vulnerable as the climate changes. The City, therefore, through NYCHA, will repair public housing developments across the City that were damaged by Sandy, incorporating new flood resiliency measures. Along the Waterfront, 28 buildings containing nearly 3,000 units will be repaired. NYCHA also will undertake a planning process to identify additional resiliency investments in developments that are vulnerable to weather-related events, even if they were unaffected by Sandy. Along the Waterfront, NYCHA, subject to available funding, is evaluating resiliency investments in 36 buildings containing nearly 3,000 additional units.

Buildings Initiative 10
Launch a sales tax abatement program for flood resiliency in industrial buildings

As Sandy demonstrated, many industrial buildings are vulnerable to extreme weather, with more likely to become vulnerable as the climate changes. However, many industrial buildings margins, making it challenging to invest in resiliency. The city, through the New York City Industrial Development Agency (NYCIDA), therefore, will launch a $10 million program to provide incentives to owners of industrial buildings to encourage them to make resiliency investments in those buildings. The program will prioritize 1- to 2-story buildings with more than 4 feet between their actual ground elevation and the applicable BFEs. Along the Waterfront, approximately 1,250 industrial buildings with over 29 million square feet of floor area will be eligible for this program. The program will be launched in 2013.

Buildings Initiative 11
Launch a competition to increase flood resiliency in building systems

Many existing strategies for improving resiliency in buildings are either imperfect, expensive, or a combination of both. The City, through NYCEDC, therefore, will launch an approximately $40 million Resiliency Technologies Competition using allocated Community Development Block Grant (CDBG) funding to encourage the development, deployment, and testing of new resiliency technologies for building systems. Along the Waterfront, 2,540 buildings will be eligible to benefit from this competition. The program will be launched in 2013.

Buildings Initiative 12
Clarify regulations relating to the retrofit of landmarked structures in the 100-year floodplain

The City, through LPC, will clarify the Commission's regulations to assist owners of landmarked buildings and properties in landmarked districts in the 100-year floodplain who are contemplating retrofit projects. Along the Waterfront, there are 9 landmarked buildings in the floodplain, including buildings in the DUMBO Historic District and Fulton Ferry Historic District. The Commission will issue its clarifying regulations in 2013.

Buildings Initiative 13
Amend the Building Code to improve wind resiliency for existing buildings and complete studies of potential retrofits

As noted above, given the possibility for more frequent intense wind events in the future, modifications to the Building Code are warranted. The City, therefore, through OLTPS, will seek to amend the Building Code and expand the existing DOB Façade Inspection Safety Program for high-rise buildings to include rooftop structures and equipment. The City will further study whether additional wind resiliency standards are required going forward. These amendments will be submitted to the City Council for adoption and the study will commence in 2013.

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Beyond the priority building resiliency projects described in Chapter 4, including those summarized briefly above, the City is proposing an additional building resiliency initiative specific to the Waterfront's vulnerabilities.

Brooklyn-Queens Waterfront Initiative 6
Implement planned upgrades to vulnerable City-owned, industrial properties

As Sandy showed, numerous properties managed by City-affiliated entities, including the BNYDC and NYCEDC, lie within the 100-year floodplain and, therefore, are vulnerable to extreme weather events. To address the flood risks at these sites, the City will invest in upgrading these properties. Subject to available funding, upgrades, most of which will be completed by summer 2014, will include:

- Bush Terminal: Elevating electrical, mechanical, and safety systems; and installing watertight conduits.
- Brooklyn Navy Yard: Raising electrical substations; installing waterproof doors to the pump wells serving the dry docks; strengthening bulkheads; and evaluating building-specific protections.
- Brooklyn Army Terminal: Installing flood-proof doors; and moving backup generators out of the 500-year floodplain.
- Brooklyn Cruise Terminal: Raising electrical equipment to newly created mezzanines; and installing water-resistant floor materials.
- South Brooklyn Marine Terminal and Bush Terminal: Studying installation of in-water flood protections and developing operational plans to move valuable equipment out of vulnerable areas.

Insurance

Insurance can help provide residents and businesses with financial protection against losses from climate change and other types of risks. Sandy not only highlighted the importance of insurance, it also revealed that many New Yorkers are exposed to flood losses, which are not covered in standard homeowners or small business property insurance policies. Citywide, 95 percent of homeowners carry homeowners insurance, but when Sandy struck, less than 50 percent of residential buildings in the effective 100-year floodplain had coverage through the National Flood Insurance Program (NFIP), a Federal program, administered by FEMA that provides flood insurance to properties in participating communities like New York City. While larger properties, in particular large commercial properties, tend to purchase flood insurance through the private market, NFIP is the primary source of flood insurance for homeowners throughout the country. The City estimates that, in areas of the Waterfront inundated by Sandy, less than 16 percent of residential properties are typically insured under the NFIP, including 1- to 2- family homes, amongst others, actually had policies in force during Sandy. Furthermore, Sandy drew attention to the significant cost increases in flood insurance that many New Yorkers will soon face, resulting from recent reforms to the NFIP as required by the Biggert-Waters Flood Insurance Reform Act.

The City will use several strategies to encourage more New Yorkers to seek coverage and to ensure the NFIP meets the needs of policyholders citywide. Specifically, the City will work to: Address affordability issues for the most financially vulnerable policyholders; define mitigation measures that are feasible in an urban environment such as the Waterfront communities and create commensurate premium credits to lower the cost of insurance for property owners who invest in these measures; encourage the NFIP to expand pricing options (including options for higher deductibles) to give potential policyholders more flexibility to make choices about coverage; and launch efforts to improve consumer awareness, to help policyholders make informed choices. The initiatives described below are important examples of how the City will advance these strategies. These initiatives will have a major impact on the residents, small businesses, and nonprofits in this community. For a full explanation of the following initiatives and a complete description of the City's five-borough insurance reform plan, please refer to Chapter 5 (*Insurance*).

Insurance Initiative 1
Support Federal efforts to address affordability issues related to reform of the NFIP

The City will call on FEMA to work with the National Academy of Sciences to complete the study of flood insurance affordability, as required under the Biggert-Waters Act. The City will urge its Federal government partners to comply with this provision of the Act and take swift action to enact the recommendations.

Insurance Initiative 4
Call on FEMA to develop mitigation credits for resiliency measures

The NFIP provides few incentives for property owners to protect their buildings from flood damage and reduce their premiums, other than by elevating their buildings—actually lifting structures above flood elevation levels. In an urban environment such as the neighborhoods of the Waterfront, for a variety of reasons, elevation can be impractical, undesirable, and/or economically infeasible. Fortunately, other mitigation options are available. The City, therefore, will call upon FEMA to provide appropriate premium credits for mitigation measures other than elevation.

Insurance Initiative 6
Call on FEMA to allow residential policyholders to select higher deductibles

Flexible pricing options can encourage more people, especially those not required to carry insurance, to purchase insurance coverage that suits their needs. A higher-deductible option can substantially reduce premium costs to policyholders while remaining truly risk-based. Currently under the NFIP, deductibles up to $50,000 are allowed for commercial policies, but residential policies are limited to a maximum deductible of $5,000. The City, therefore, will call upon FEMA to allow homeowners who are not required to carry NFIP policies to purchase high-deductible policies, protecting them from catastrophic loss; initial estimates indicate that doing so could reduce insurance premiums by about half.

Critical Infrastructure

A resilient New York requires protection of its critical services and systems from extreme weather events and the impacts of climate change. This infrastructure includes the city's utilities and liquid fuel system, its hospitals and other healthcare facilities, telecommunications network, transportation system, parks, wastewater treatment and drainage systems, as well as other critical networks—all vital to keeping the city, including the neighborhoods along the Waterfront.

Utilities

The city's electric, natural gas, and steam systems are essential to everyday life in areas throughout the five boroughs, including the Waterfront. As Sandy proved, however, these systems are highly vulnerable to extreme weather events, with 800,000 customers losing electricity and 80,000 customers losing natural gas service during Sandy across the city, including approximately 160,000 lost electricity service in the borough of Brooklyn, and over 160,000 in Queens. This vulnerability likely will grow as the climate changes.

Among the strategies that the City will use to address these challenges for residents along the Waterfront and in other parts of the city will be to: Call for risk-based analysis of low-probability but high-impact weather events to be incorporated into utility regulation and investment decision-making; call for capital investments that harden energy infrastructure and make systems more flexible in responding to disruptions and managing demand; and better diversify the city's sources of energy. The initiatives described below provide important examples of how the City intends to advance utilities resiliency citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits along the Waterfront. For a full explanation of the following initiatives and a complete description of the City's five-borough utilities resiliency plan, please refer to Chapter 6 (*Utilities*).

Utilities Initiative 5
Work with utilities and the Public Service Commission (PSC) to harden key electric transmission and distribution infrastructure against flooding

Various transmission substations, distribution substations, utility tunnels, and underground equipment in the city are at risk of flooding during extreme weather. For example, 40 percent of transmission substations are in the 100-year floodplain today, and 67 percent are likely to be in the 100-year floodplain by the 2050s. The City, through the OLTPS, will work with Con Edison and the Long Island Power Authority (LIPA) to prioritize these assets based on their roles in system reliability, and to harden them as appropriate. This effort will begin in 2013.

Utilities Initiative 6
Work with utilities and the PSC to harden vulnerable overhead lines against winds

During extreme weather events, high winds and downed trees threaten overhead electric poles, transformers, and cables. The City, through OLTPS, will work with Con Edison and LIPA to manage the risk of wind and downed-tree damage through tree maintenance, line strengthening, and a line-relocation program. In some limited cases, rerouting lines underground may also be warranted, depending on the outcome of a cost-benefit analysis to be performed in partnership with the utilities. This effort will begin in 2013.

Utilities Initiative 7
Work with utilities, regulators, and gas pipeline operators to harden the natural gas system against flooding

Although the city's high-pressure gas transmission system performed relatively well during Sandy, there were instances where remote operation of parts of the system failed. Additionally, the distribution system had localized outages due to water infiltration. Seeking to limit the compromising effects of future floods on both the system's backbone and the ability

of Con Edison and National Grid to control and monitor the system, the City, through OLTPS, will work with the PSC, Con Edison, and National Grid to harden control equipment against flooding. In addition, the City will call upon Con Edison and National Grid to take steps to prevent water from infiltrating its gas pipes. This effort will begin in 2013.

Utilities Initiative 21
Work with public and private partners to scale up distributed generation (DG), including microgrids

The city's DG systems, including microgrids, have the potential for significant expansion—but are constrained by regulations, financing challenges, and lack of information. The City, through OLTPS and the New York City Distributed Generation Collaborative—a stakeholder group convened by the City in 2012—will continue efforts to achieve a PlaNYC goal of installing 800 megawatts of DG citywide by 2030. These efforts will include reform of PSC tariffs and other regulatory changes, expansion of low-cost financing, and provision of technical assistance to property owners and developers. This ongoing effort will continue in 2013.

Liquid Fuels

The liquid fuels supply chain is essential for everyday life throughout the five boroughs, including along the Waterfront. Sandy demonstrated the vulnerability of this system to extreme weather events. In the aftermath of Sandy, citywide—and particularly along the Waterfront—there were long lines at gas stations and other challenges for drivers, including emergency responders. The vulnerability of this system will only grow as the climate changes.

Among the strategies that the City will use to address these challenges for residents of the Waterfront and other parts of the city will be to: develop a strategy for hardening of liquid fuels infrastructure along the supply chain; increase redundancy and fuel supply flexibility; and increase supply availability for vehicles critical to the City's infrastructure, safety, and recovery from significant weather events. The initiatives described below provide important examples of how the City intends to advance its liquid fuels resiliency agenda citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits along the Waterfront. For a full explanation of the following initiatives and a complete description of the city's five-borough liquid fuels resiliency plan, please refer to Chapter 7 (*Liquid Fuels*).

Liquid Fuels Initiative 1
Call on the Federal government to convene a regional working group to develop a fuel infrastructure hardening strategy

The fuel supply shortage after Sandy was caused mainly by damage to infrastructure in New Jersey and other states, where the City and State of New York have no regulatory or legislative authority or oversight. The City, through OLTPS, will call on the Federal Hurricane Sandy Rebuilding Task Force and the United States Department of Energy to convene regional stakeholders to develop a strategy for hardening key infrastructure against future extreme weather. This effort will be launched in 2013.

Liquid Fuels Initiative 4
Work with New York State to provide incentives for the hardening of gas stations to withstand extreme weather events

New York State's 2013–2014 budget required that certain retail fuel stations will be required to invest in equipment that would allow them to connect generators quickly in the event of a power loss, and enter into supply contracts for emergency generators. The City, through OLTPS, will support the State in the design and implementation of this generator program, an effort that will include working with the New York State Energy Research and Development Authority (NYSERDA) to develop an incentive program to minimize the financial impact of the requirements on the businesses involved. In addition, OLTPS will work with the State to develop incentives to encourage retail fuel stations to implement resiliency measures other than backup power capability. This effort will be launched in 2013.

Liquid Fuels Initiative 5
Enable a subset of gas stations and terminals to have access to backup generators in case of widespread power outages

Gas stations are vulnerable to widespread power outages resulting from extreme weather events, which could prevent them from dispensing fuel. In New York State's 2013–2014 budget, NYSERDA was directed to develop a generator pool program for gas stations. The City, through its Office of Emergency Management (OEM), will work with NYSERDA, FEMA, and the USACE in 2013 and beyond to develop such a pool and to create a pre-event positioning plan to enable the ready deployment of generators to impacted areas in the wake of a disaster.

Liquid Fuels Initiative 8
Develop a package of City, State, and Federal regulatory actions to address liquid fuel shortages during emergencies

Various regulations relating to the transportation and consumption of fuels in New York City limit the flexibility of the market to respond to disruptions, including following extreme weather. The City, through OEM, will work with the State and Federal governments to prepare an "off-the-shelf" package of regulatory measures for use in the event of a liquid fuels shortage to allow supply-demand imbalances in the fuel supply to be mitigated more quickly. This effort will be launched in 2013.

Liquid Fuels Initiative 9
Harden municipal fueling stations and enhance mobile fueling capability to support both City government and critical fleets

The City must be able to respond quickly to a fuel supply disruption, providing continuous fueling to vehicles that are critical for emergency response, infrastructure rebuilding, and disaster relief. The City, through the Department of Citywide Administrative Services (DCAS), will procure fuel trucks, generators, light towers, forklifts, and water pumps to permit the City to put in place emergency fueling operations immediately following a disruption in the fuel supply chain. DCAS also will issue a Request for Expressions of Interest (RFEI) to potential suppliers of liquid fuels to evaluate options for sourcing such fuel during emergencies. The procurement effort will be launched in 2013, with the RFEI to follow in 2014.

Healthcare

The city's healthcare system is critical to the well-being of New Yorkers throughout the five boroughs, including throughout the neighborhoods along the Waterfront. This system is also a major economic engine for the city as a whole. Sandy exposed this system's vulnerabilities, which are expected to grow as the climate changes.

Among the strategies that the City will use to address these challenges for residents along the Waterfront and other parts of the city will be to: Build new hospitals, nursing homes, and adult care facilities to higher resiliency standards and harden existing facilities to protect critical systems; seek to keep lines of communication open between patients and providers, even during extreme weather events; and enable community-based providers to reopen quickly after a disaster. The initiatives described below provide important examples of how the City intends to advance its healthcare resiliency agenda citywide. These initiatives will have a positive impact on the residents and healthcare providers along the Waterfront. For a full explanation of the following initiatives and a complete description of the City's five-borough healthcare resiliency plan, please refer to Chapter 8 (*Healthcare*).

Healthcare Initiative 2
Require the retrofitting of existing hospitals in floodplains

Many existing hospital buildings in the floodplain remain vulnerable to the impact of storm surge, with more likely to become vulnerable the climate changes. The City, through OLTPS, therefore, will seek to amend the Construction Code to require existing hospital buildings in the 500-year floodplain to meet by 2030 a subset of the amended Construction Code standards for flood-resistant design. To minimize the risk of emergency evacuations and extended closures, these hospitals will be required to protect their electrical equipment, emergency power system, and domestic water pumps to the 500-year flood elevation. These hospitals also will be required to install backup air-conditioning service for inpatient care areas in case of utility outages, pre-connections for temporary boilers and chillers if primary equipment is not elevated, and pre-connections for external generators as a backup power source. OLTPS will propose these requirements to the City Council in 2013.

Healthcare Initiative 3
Support the Health and Hospitals Corporation's (HHC) efforts to protect public hospital emergency departments from flooding

Emergency departments (EDs) are critical access points for patients in need of hospital services, and at three public hospitals citywide—EDs are at risk of flooding due to storm surge Subject to available funding, therefore, the City through HHC, will invest in measures to flood-protect vulnerable EDs so they can remain available to provide care during extreme weather events. HHC already has begun exploring strategies to protect their EDs and will continue to develop their mitigation plans through 2013.

Healthcare Initiative 4
Improve design and construction of new nursing homes and adult care facilities

New nursing homes and adult care facilities are at risk of power failures due to storm surge, which could result in patient evacuations. The City, through OLTPS, therefore, will seek to amend the Construction Codes to require that new facilities are constructed with additional resiliency measures for their emergency power systems. New nursing homes also will be required to have emergency generators and electrical pre-connections for external stand-by generators. Adult care facilities will be required to install either emergency generators that are adequately protected or pre-connections to external stand-by generators. OLTPS will propose these requirements to the City Council in 2013.

Healthcare Initiative 5
Require retrofitting of nursing homes in floodplains.

Many existing nursing home facilities in the five boroughs are vulnerable to storm surge—a vulnerability that will only grow as the climate changes. The City, through OLTPS, therefore, will seek to amend the Construction Codes to require nursing homes in the 100-year floodplain retroactively to meet retroactive standards for the protection of electrical equipment, emergency power systems, and domestic water pumps (if applicable) by 2030. These systems will be protected to the 100-year flood elevation, in accordance with specifications already in the Construction Codes, and will help enable that patients can shelter in place safely or reoccupy quickly after a storm. OLTPS will propose these requirements to the City Council in 2013.

Healthcare Initiative 6
Require retrofitting of adult care facilities in floodplains

Nineteen adult care facilities in the city are vulnerable to storm surge, including one along the Waterfront. The City, through OLTPS, will seek to amend the Construction Code to require existing adult care facilities located in the floodplain to elevate or protect their electrical equipment to the 100-year flood elevation by 2030, in accordance with the specifications in the Construction Codes. In addition, the City will seek to require these providers to have either emergency generators that are adequately protected or electrical pre-connections to external generators. OLTPS will propose these requirements to the City Council in 2013.

Healthcare Initiative 7
Support nursing homes and adult care facilities with mitigation grants and loans

The primary challenge for most nursing homes and adult care facilities in implementing mitigation measures is obtaining financing. Subject to available funding, the City, through NYCEDC and the New York City Department of Health and Mental Hygiene (DOHMH), therefore, will administer competitive grants and subsidized loans to assist providers with mandated retrofit projects. The goal is for NYCEDC and DOHMH to launch the program when the proposed Construction Codes amendments applicable to nursing homes and adult care facilities proposed in this report go into effect, likely in 2013.

Healthcare Initiative 8
Increase the air-conditioning capacity of nursing homes and adult care facilities

Nursing homes and adult care facilities typically do not have enough emergency power capacity to run their air conditioning systems following the loss of power. This could cause some providers to evacuate during power outages that occur during hot summer months. The City will offer sales tax waivers totaling $3 million citywide to assist eligible nursing homes and adult care facilities that install emergency power solutions for air conditioning systems.

Healthcare Initiative 9
Harden primary care and mental health clinics

In communities such as those along the Waterfront that are at risk of extensive flooding during extreme weather events, primary care and mental health services may be compromised for weeks after a disaster due to extended facility closures. Subject to available funding, the City, through DOHMH and a fiscal intermediary, therefore, will administer a competitive financing program to harden large clinics providing primary care and mental health services in neighborhoods along the Waterfront and other high-need communities. The program will include grants and interest-free loans for capital investments that enable faster recovery of services—for example, installation of emergency power systems, protection of other critical building systems, and wet flood-proofing of facilities. The goal is for this effort to be launched in late 2013 or early 2014.

Healthcare Initiative 10
Improve pharmacies' power resiliency.

Pharmacies dispense life-saving medicines essential for those with chronic conditions. However, without power, pharmacists cannot access the necessary patient records or insurance information to dispense these medicines. The City, through DOHMH, will work with pharmacies to improve their ability to leverage generators for power resiliency and address their other emergency preparedness needs—including the launch of an emergency preparedness website for pharmacies. This effort already has begun and will continue throughout 2013.

Healthcare Initiative 11
Encourage telecommunications resiliency in the healthcare system

In the aftermath of a disaster, it is important that New Yorkers be able to speak to their doctors for guidance on needed medical care. The City, through DOHMH, therefore, will develop a best practice guide and outreach plan to help community-based providers understand the importance of telecommunications resiliency. Resiliency solutions could include using backup phone systems (such as a remote answering service that would not be affected by local weather hazards), Voice over Internet Protocol (VoIP) technology that allows office phone lines to be used off-site, and pre-disaster planning to inform patients of available emergency phone numbers. This effort will begin in 2013.

Healthcare Initiative 12
Encourage electronic health record-keeping

Doctors rely on patients' medical records to provide and track care, but paper records may be compromised or destroyed due to extreme weather events. The City, through existing DOHMH programs, therefore, will call upon community-based providers located in the 100-year floodplain and other disaster-prone areas to implement electronic health records (EHR) systems for resiliency. DOHMH's Primary Care Information Project will sponsor initiatives to provide primary care and mental health providers citywide with EHR technical assistance. This effort will begin in 2013.

Telecommunications

The city's telecommunications system is essential to individuals and businesses throughout the five boroughs, including throughout the neighborhoods along the Waterfront. While this is true at all times, it is especially true during emergencies. As Sandy demonstrated, however, this system is highly vulnerable to extreme weather events—precisely when telecommunications are most needed. Citywide and along the Waterfront, Sandy resulted in outages to landlines and mobile service, as well as to data service. The vulnerability of this system likely will grow as the climate changes.

Among the strategies that the City will use to address these challenges for residents, businesses, and nonprofits of the neighborhoods along the Waterfront and other parts of the city will be to: increase accountability among providers to promote resiliency; use strengthened City regulatory powers and stronger relationships with providers to enable rapid recovery after extreme weather events; encourage hardening of facilities to reduce weather-related impacts; and increase redundancy to reduce the impact of outages. The initiatives described below provide important examples of how the City intends to advance its telecommunications resiliency agenda citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits of the neighborhoods along the Waterfront. For a full explanation of the following initiatives and a complete description of the City's five-borough telecommunications resiliency plan, please refer to Chapter 9 (*Telecommunications*).

Telecommunications Initiative 1
Establish an office within the Department of Information Technology and Telecommunications (DoITT) to focus on telecommunications regulation and resiliency planning

While the City has regulatory authority over some aspects of telecommunications service, it has no entity focused broadly on ensuring the resiliency of the public communications networks. The City, therefore, will form within DoITT, a new Planning and Resiliency Office (PRO) that will have the resources needed to develop, monitor, and enforce resiliency standards, in close cooperation with State and Federal regulators and providers. DoITT will launch the new office in 2013.

Telecommunications Initiative 2
Establish new resiliency requirements for providers using scheduled renewals of the City's franchise agreements

Flooding caused outages during Sandy in facilities that did not follow the Federal Communication Commission's recommended best practices for resiliency, including flood protection measures. The City, through DoITT, therefore, will encourage and enforce resiliency standards for telecommunications providers through the franchise renewal process, and through other agreements into which such provides enter with the City. The City also will seek to require standardized outage reporting and publishing. DoITT will launch this effort in 2014, in advance of 2020 franchise renewals.

Transportation

Without the city's expansive transportation system, New York would grind to a halt. This was illustrated starkly during Sandy when outages occurred across the system during and immediately following the storm. These outages severely impacted the neighborhoods along the Waterfront, which found itself isolated by the shutdown of subway and other public transit systems, as well as flooding on arterial and secondary roads. The vulnerability of this system likely will grow as the climate changes.

Among the strategies that the City will use to address these challenges for residents of the neighborhoods along the Waterfront and other parts of the city will be to: Make the system more flexible and more resilient; protect critical elements of the system from damage; seek to maintain system operations during extreme weather events and, following extreme events, to enable quick recovery, while also putting in place plans for backup transportation options until regular service can be restored. The initiatives described below provide important examples of how the City intends to advance its transportation resiliency agenda citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits along the Waterfront. For a full explanation of the following initiatives and a complete description of the City's five-borough transportation resiliency plan, please refer to Chapter 10 (*Transportation*).

Transportation Initiative 1
Reconstruct and resurface key streets damaged by Sandy

Sandy's waves and flooding caused significant damage to area roadways. The City, through NYCDOT, will reconstruct 60 lane-miles of streets that were damaged severely, and will repave approximately 500 lane-miles of streets with damaged surfaces. Along the Waterfront, this will include 1.4 linear miles of reconstructed streets. Wherever feasible, the reconstructed streets also will include resiliency features to prevent future damage. NYCDOT will launch this initiative in 2013 with funding from Federal and City sources.

Transportation Initiative 3
Elevate traffic signals and provide backup electrical power

New York's traffic signals—and particularly the controllers that operates these signals and communicate with the NYCDOT Traffic Management Center—are vulnerable to damage from flooding, as well as to power loss from various extreme weather events. Accordingly, the City, through NYCDOT, will raise controllers at approximately 500 intersections in flood-vulnerable locations across the city, including along the Waterfront. In tandem with this effort to place electrical hardware above the 100-year floodplain elevation, NYCDOT also will install power inverters in approximately 500 NYPD vehicles to allow these vehicles to provide backup electrical power to critical traffic signals. This effort will begin in 2013.

Transportation Initiative 5
Install watertight barriers to protect movable bridge machinery

The mechanical equipment that moves 25 of the city's bridges—including five over the Gowanus Canal and six over Newtown Creek and its tributaries—is vulnerable to flooding. Damage to this equipment could, if it were to lock bridges in either an open or closed position, disrupt marine and roadway traffic. Therefore, over the next three years and subject to available funding, NYCDOT will install watertight barriers to protect the bridges' mechanical equipment.

Transportation Initiative 6
Protect Staten Island Ferry and private ferry service from climate change-related threats

To allow for quicker restoration of service on the Staten Island Ferry, the East River Ferry, and other ferry services, the City will use Federal Transit Administration Emergency Relief funds to construct physical improvements to the floating infrastructure, loading bridges/gangways, pilings, and piers at both the Whitehall and Saint George Ferry Terminals and at additional ferry landings around the city, including along the Waterfront. NYCDOT will launch this investment immediately.

Transportation Initiative 8
Call on non-City transportation agencies to implement strategies to address climate change threats

Many non-City agencies that own and operate critical portions of New York City's transportation system have already announced resiliency and protection initiatives appropriate to their systems. Without such action, the critical facilities managed by these agencies remain vulnerable to damage and disruption from future weather-related events. The City therefore, will call on these agencies to implement the initiatives that they have announced and take additional steps to protect their major transportation assets from climate change threats and prepare for quick restoration following an extreme weather event. Assets that may require hardening and/or preparation measures along the Waterfront include: the Hugh L. Carey Tunnel, the Queens Midtown Tunnel, underground subway tunnels, and Sunnyside Yard. The City will work with these agencies to advance these plans.

Transportation Initiative 9
Plan for temporary transit services in the event of subway system suspensions

When major portions of the subway system are out of service, there simply is not sufficient capacity in the rest of the transit network or the roadway system to carry the increased volume of commuters and other travelers. The City, through NYCDOT, therefore, will work with the MTA and other transportation partners to develop and regularly update formal plans to provide temporary transportation services in such an event, including following extreme weather. These services could take the form of temporary, high-capacity "bus bridges" of the type implemented during Sandy, linking, for example, Long Island City to Midtown Manhattan (see Initiative 16, below) or temporary point-to-point ferry services, for example connecting Sunset Park and Lower Manhattan. This planning effort will begin in 2013.

Transportation Initiative 10
Identify critical transportation network elements and improve transportation responses to major events through regular resiliency planning exercises

Many of the facilities critical to the City's ability to respond effectively to a disaster are vulnerable to disruption and damage during extreme weather events, potentially impairing delivery of emergency services and supplies, as well as impairing the restoration of critical non-transportation infrastructure and economic activity. This vulnerability is expected to increase as the climate changes. To respond better to a variety of different possible transportation outage and restoration scenarios, the City, through NYCDOT, will work with transportation agencies around the region to identify the critical elements of the surface transportation network that need to be available quickly following different types of events. The key tool to identify these networks will be an ongoing series of detailed and multidisciplinary resiliency planning exercises that will allow NYCDOT and its partners to understand where resources need to be focused before, during, and after an event. This effort will begin in 2013.

Transportation Initiative 16
Expand the city's Select Bus Service (SBS) network

Parts of the city lack subway access or have slow and unreliable public transportation. In these areas, the City and the MTA have been deploying SBS routes to improve general mobility. These routes can form the backbone of high-capacity bus service in the event of major subway outages, including following extreme weather events. The City, through NYCDOT, will work with the MTA to expand the SBS network significantly, building on a plan developed jointly in 2010 and reinforced in the NYS 2100 Report issued in January 2013. Implementation of this plan already has begun.

Transportation Initiative 17
Expand the network of bus priority lanes on arterial highways

Bus priority lanes for express and local buses can significantly improve mobility during periods of highway congestion. Accordingly, the City, through NYCDOT, will work with the New York State Department of Transportation and the MTA to implement 15 miles of bus priority corridors on major limited-access arterial highways, including those serving the Waterfront, such as the Brooklyn-Queens Expressway (BQE) and the Gowanus Expressway, as these highways are improved or reconstructed over the next several years. Under the right conditions, these lanes also could be open to high-occupancy vehicles, further improving the efficiency of the roadway system in coordination with single-occupancy vehicle restrictions that may be in place following an emergency. This effort will move forward in 2013.

Beyond the priority transportation resiliency projects described in Chapter 10, including those summarized briefly above, the City is proposing additional transportation resiliency initiatives specific to the Waterfront's vulnerabilities. These initiatives are described below.

Brooklyn-Queens Waterfront Initiative 7
Improve connections between Red Hook and the rest of Brooklyn

As Sandy showed, the lack of transportation options in Red Hook made it more challenging for Red Hook residents to access services during and after the storm, as it does in non-storm conditions. Hamilton Avenue's current configuration further exacerbates the area's isolation by impeding direct, safe access to and from the neighborhood by pedestrians and public transit users. The City, therefore, will invest in improvements to provide residents and visitors alike with quicker, safer, and more reliable transportation options, available during both emergencies and under normal conditions. To this end, NYCDOT will create a new connection between Red Hook and the rest of Brooklyn at Mill Street and will install an Urban Art Design Project and enhanced lighting under the Brooklyn-Queens Expressway at Hamilton Avenue and West 9th Street during the summer of 2013.

These actions will shorten the bus trip between Red Hook Houses and the closest subway stop by 50 percent during the morning rush hour and 25 percent during afternoon rush hour. They also will provide safer and more direct pedestrian and bicycle access to Red Hook from the rest of Brooklyn. This effort will move forward in 2013.

Brooklyn-Queens Waterfront Initiative 8
Call for the MTA to explore Red Hook-Lower Manhattan bus connections

As noted above, the lack of transit options in Red Hook made it more challenging for Red Hook residents to access services during and after the storm, as it does in non-storm conditions. To address this, the City, through the NYCEDC, will call on the MTA to study bus routes from Red Hook to Lower Manhattan via the Hugh L. Carey Tunnel. Such service would support the more than 25 percent of Red Hook residents who work in Manhattan while also bringing new potential customers and workers to Red Hook's businesses. This will be advanced in 2013.

Brooklyn-Queens Waterfront Initiative 9
Implement expanded free summer weekend ferry service from Manhattan to Red Hook in 2013

As noted above, the lack of transit options in Red Hook made it more challenging for Red Hook residents to access services during and after the storm, as it does in non-storm conditions. To help with the recovery of area businesses and to assess the viability of such service on a long-term basis, the City, through NYCEDC has launched a weekend ferry service, in partnership with IKEA, Fairway Market, New York Water Taxi, and Billybey Ferry Company, that will run from Memorial Day weekend through Labor Day during 2013. The free service will make two stops in Red Hook (at IKEA and Van Brunt Street) and one stop in Manhattan. The service will be coordinated with the East River Ferry, allowing for a free transfer at Wall Street/Pier 11.

Building on this pilot ferry service, the City will explore expanded ferry service to areas citywide, including Red Hook, on a permanent basis, through a Comprehensive Ferry Study. The study will be led by NYCEDC and will be launched during 2013.

Parks

During Sandy, it became clear that, in addition to serving as neighborhood front yards and recreation centers, in many places (including along the Waterfront), the city's parks serve as the city's front line of defense when extreme weather events hit, buffering adjacent neighborhoods. As the climate changes, it will be even more critical that the city's parks be able to play all of these roles.

Among the strategies that the City will use to address these challenges for residents of the neighborhoods along the Waterfront and elsewhere in the City will be to: strengthen the city's parks so that they can survive weather-related events more effectively and can act as stronger buffers for adjacent communities; and pursue technologies and approaches that will enable the City to monitor, analyze, and prepare the park system for its many roles in an era of increasing change. The initiatives described below provide important examples of how the City intends to advance its parks resiliency agenda citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits of the Waterfront. For a full explanation of the following initiatives and a complete description of the City's five-borough parks resiliency plan, please refer to Chapter 11 (*Parks*).

Parks Initiative 2
Harden or otherwise modify shoreline parks to protect adjacent communities

About 24 percent of DPR properties (by acreage) are today in the city's 100-year floodplain, and that percentage is expected to grow as sea levels rise—including in areas where the city's parks front residential and commercial districts. Subject to available funding, the City, through DPR, therefore, will study cost-effective ways to use its park system to protect particularly vulnerable adjacent neighborhoods, ideally identifying mitigation strategies that also protect the parks themselves. Target sites along the Waterfront include Bush Terminal Piers Park, Bushwick Inlet Park, Brooklyn Bridge Park, Box Street Park, and the Red Hook Recreational Area. The goal is for DPR to complete this study in 2014.

Parks Initiative 11
Improve the health and resiliency of the city's urban forest

The city's forests and trees provide an array of health and environmental benefits, but are vulnerable to a variety of climate change-related impacts, including storm surge, wind, and even changes in average temperatures. Subject to available funding, the City, through DPR, will undertake a variety of efforts to protect trees—whether located in natural areas and parks, or along streets. This would include adding forest management crews, identifying locations in which to expand tree beds, and modifying regular tree inspection and pruning efforts to prioritize trees in areas vulnerable to extreme weather events. The goal is for DPR to launch this effort in 2013.

Water and Wastewater

The city's water and wastewater system is one of the most complex in the world, not only supplying millions of New Yorkers with safe drinking water in all conditions, but also treating wastewater to enable the area's waterways to remain clean, while draining rainwater to minimize flooding. Sandy demonstrated the system's vulnerability to a whole host of weather-related threats, ranging from surge and sea level rise, to heavy downpours—threats that are expected to worsen as the climate changes.

Among the strategies that the City will use to address these challenges for residents of the neighborhoods along the Waterfront and other parts of the city will be to: protect wastewater facilities from storm surge; improve and expand drainage infrastructure; and promote redundancy and flexibility to make available a constant supply of high-quality drinking water. The initiatives described below provide important examples of how the City intends to advance its water and wastewater resiliency agenda citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits along the Waterfront. For a full explanation of the following initiatives and a complete description of the City's five-borough water and wastewater resiliency plan, please refer to Chapter 12 (*Water and Wastewater*).

Water and Wastewater Initiative 1
Adopt a wastewater facility design standard for storm surge and sea level rise

Sandy damaged wastewater treatment plants and pumping stations even though the design of City wastewater facilities typically has taken into account the highest historically recorded water height of nearby water bodies or the BFEs identified in FEMA maps. The City, therefore, will adopt an increased level of protection for design and construction of all wastewater facilities based on the latest FEMA maps, modified to reflect sea level rise projections for the 2050s. The design for upgrades to DEP's Gowanus Canal facility, for instance, will protect critical equipment that is located at or lower than 2.5 feet above the best-available BFE. DEP will adopt the new design guidelines in 2013.

Water and Wastewater Initiative 2
Harden pumping stations

Many of the city's pumping stations are located in low-lying areas and are necessary to convey wastewater and stormwater out of communities; however, their location also increases their vulnerability to storm surge. Therefore, subject to available funding, the City, through DEP, will retrofit these pumping stations to improve their resiliency. These retrofits will include raising or flood-proofing critical equipment, constructing barriers, and installing backup power supplies. Preliminary estimates indicate that there are currently 58 at-risk pumping stations, of which several are already scheduled for capital improvements. Subject to available funding, DEP will pursue implementation of resiliency projects in conjunction with repairs and planned capital work, and as appropriate based on the level of risk, historical flooding, and potential community impacts, among other criteria. Among the pumping stations to be considered for hardening are 10 along the Waterfront. The goal is to begin implementation in 2014.

Water and Wastewater Initiative 3
Harden wastewater treatment plants

All 14 of the City's wastewater treatment facilities are located along the waterfront and are therefore at risk in the event of a coastal storm. Subject to available funding, the City, through DEP, will protect these critical treatment facilities by raising or flood-proofing assets that are critical to the treatment process, constructing barriers, improving waterfront infrastructure, or implementing redundancy measures to avoid failure of these critical treatment systems. DEP will initially target facilities that have been identified as either most at-risk, or most likely to create issues for adjacent communities and waterways, based on the findings of an in-depth study by DEP. The goal is for DEP to begin implementation of adaptation measures for these and other facilities in 2014 as part of repairs and other planned capital projects.

Water and Wastewater Initiative 8
Reduce combined sewer overflows (CSOs) with Green Infrastructure

As climate change brings increasing rainfall volume to the New York area, the city may also experience shifts in the frequency and volume of CSOs. The City will continue to implement its Green Infrastructure Plan and CSO Long-Term Control Plans (LTCPs) to reduce such CSOs. For this purpose, DEP, working with the DPR and NYCDOT, will continue to pursue its plan to capture the first inch of runoff in 10 percent of impervious surfaces citywide by 2030. At the same time, DEP also will continue to develop LTCPs to evaluate long-term solutions to reduce CSOs and improve water quality in New York City's waterways. DEP will issue an LTCP for Alley Creek in Queens in 2013, with nine additional water body-specific LTCPs and one citywide LTCP to follow through 2017—including for Coney Island Creek, the Gowanus Canal, Newtown Creek, and Jamaica Bay. DEP will continue to implement this program in 2013, with the Gowanus Canal LTCP targeted for issuance in 2015 and Newtown Creek LTCP in 2017.

Water and Wastewater Initiative 9
Reduce combined sewer overflows with high-level storm sewers

While the construction of new, green infrastructure is an effective solution for managing rainfall and reducing CSOs in some locations, in other areas, it will be more cost-effective to enhance the city's existing sewer system. The City, through DEP, will augment existing combined sewers with so-called "high-level storm sewers" in certain areas, including along the Waterfront. These high-level storm sewers sit on top of a combined sewer and accept stormwater from the street before diverting it to a nearby waterway, capturing up to 50 percent of rainfall before it enters combined sewers. DEP, therefore, will continue to pursue high-level storm sewer projects along the Waterfront, including at 3rd Avenue in Gowanus; West Street in Greenpoint; and at multiple locations in DUMBO. These projects are to be completed by 2023. DEP will continue to seek additional opportunities for similar projects near the water's edge along the Waterfront, including a project in the Hunter's Point section of Long Island City that, as of the writing of this report, is in the design phase. Finally, the City also is making sewer investments in connection with new developments along the Waterfront, including at Hunter's Point South in Long Island City.

Other Critical Networks: Food Supply

Though the food supply chain generally emerged intact following Sandy, in certain local areas (including parts of the Waterfront), residents found themselves without access to basic sustenance after the storm. In addition, had Sandy played out just a little differently, it is possible that significant links in the food supply chain–including the food distribution center in Hunts Point in the Bronx—could have been seriously threatened. As the climate changes, it is likely that risks such as these will grow.

Although initiatives outlined in several other sections above are important contributors to the overall resiliency of the food supply network (including especially those addressing utilities, liquid fuels, and transportation), the City also will pursue food-specific strategies to meet this goal for the benefit of residents of the neighborhoods along the Waterfront and other parts of the city. These strategies will involve calling for resiliency investments at the most significant food wholesaling and distribution centers in the city and addressing issues relating to retail access in the event of extreme weather. The initiatives in Chapter 13 describe how the City intends to advance its food supply resiliency agenda citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits along the Waterfront. For a complete description of the City's five-borough food supply resiliency plan, please refer to Chapter 13 (*Other Critical Networks*).

Other Critical Networks: Solid Waste

On a daily basis, the solid waste collection system in New York disposes of more than 12,000 tons of waste and recycling in a safe and sanitary fashion. Unlike many other critical City systems, during Sandy this one proved remarkably resilient, resuming many of its normal functions almost immediately after the storm. In fact, thanks to the efforts of the City's Department of Sanitation, even as the agency was dealing with its own storm-related challenges, it was able to assist with the recovery of the neighborhoods along the Waterfront and the larger city by collecting the debris left by the storm in an organized and efficient manner.

However, the system does face real issues. For example, during Sandy, the city's solid waste disposal system experienced interruptions that interfered with its ability to convey refuse out of the city to its ultimate destination. Additionally, as the climate changes, it is likely that this system will become more vulnerable to extreme weather.

Among the strategies that the City will use to address these challenges for residents of the neighborhoods along the Waterfront and other parts of the city will be to: harden critical City-owned solid waste assets to protect them from extreme weather-related impacts; and seek to improve the resiliency of the broader solid waste network—both City- and third-party owned—enabling it to resume operation quickly should disruptions occur. The initiatives in Chapter 13 describe how the City intends to advance its solid waste resiliency agenda citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits along the Waterfront. For a complete description of the City's five-borough solid waste resiliency plan, please refer to Chapter 13 (*Other Critical Networks*).

Environmental Protection and Remediation

Sandy showed that extreme weather events—which are likely to increase in severity with climate change—not only have the potential to impact the city's people, built environment, and critical systems; they can have a deleterious impact on the natural environment. To help minimize the impact of future extreme weather on the environment is minimized, the City will advance a range of initiatives to protect open and enclosed industrial sites containing hazardous substances in an economically feasible way, and to encourage the cost-effective remediation and redevelopment of brownfields in a resilient fashion. These initiatives will have a positive impact on the residents, businesses, and nonprofits along the Waterfront, which is home to approximately 3,330 industrial companies and approximately 13 sites designated under the New York City Brownfield Cleanup Program. For a complete description of the City's five-borough environmental protection and remediation plan, please refer to *Environmental Protection and Remediation*.

Community and Economic Recovery

New York is a city of neighborhoods, and these neighborhoods vary widely in size and nature. Notwithstanding this variety, successful neighborhoods across the city tend to share certain traits. Two of these are: A formal and informal network of community members who help and support one another in good times and bad; and vibrant commercial and nonprofit sectors that employ and provide goods and services to the people of the community.

As Sandy demonstrated, however, both the network of community-based organizations and the commercial and nonprofit sectors in New York's neighborhoods can be sorely tested when extreme weather hits. During these times (when contributions from these networks and sectors are desperately needed) these organizations and businesses *themselves* are frequently coping with the same set of challenges that the community at large is–a circumstance that can push even the most well-run organization or business to the breaking point. Even with these pressures, during and in the immediate aftermath of Sandy, New York's commercial and nonprofit sectors overcame many of their own difficulties, playing a critical role in the recovery of neighborhoods across the city, including those along the Waterfront. However, as the climate changes, difficulties such as these will likely arise more frequently, testing these institutions mightily.

Among the strategies that the City will use to achieve the goal of making its neighborhoods and their critical institutions more resilient will be to: help build grassroots capacity and foster community leadership; help businesses and nonprofits impacted by Sandy to recover; help businesses and nonprofits in vulnerable locations to make resiliency investments that will better prepare them for future extreme weather; and bring new economic activity to neighborhoods recovering from the impacts of Sandy to enable these neighborhoods to come back even stronger than before.

The initiatives described below provide important examples of how the City intends to advance its community and economic recovery agenda citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits along the Waterfront. For a full explanation of the following initiatives and a complete description of the City's five-borough community and economic recovery plan, please refer to *Community and Economic Recovery*.

Community Disaster Preparedness Initiative 1
Identify and address gaps in community capacity

The capacity of a community to organize to aid businesses and residents after an extreme weather event or other disaster is a strong predictor of the success of that community's recovery. To improve this capacity of vulnerable communities, OEM, working with the NYC Center for Economic Opportunity (CEO), will undertake a pilot assessment of the strengths and weaknesses of a Sandy-impacted community—which could be a neighborhood along the Waterfront—to inform the creation of a plan to address needs uncovered by the assessment. Subject to available funding, the City, through OEM and CEO, will choose a pilot community and begin their study in 2013.

Community Disaster Preparedness Initiative 2
Continue and expand OEM's Community Emergency Response Teams

OEM currently trains 54 teams of 1,500 volunteers across the city, which staff Community Emergency Response Teams (CERTs). Before, during, and after disasters, including extreme weather events, members of these teams help to organize community disaster preparedness and participate in emergency response and recovery. Going forward, OEM will work with communities to create additional teams, ensuring that the volunteers that staff them are as representative as possible of the communities that they serve. Towards the same end, OEM, working with CEO, will also identify low-income young adults to be trained to lead their communities in disaster preparedness. OEM and CEO will launch this program by 2014.

Economic Recovery Initiative 1
Launch business recovery and resiliency programs

During Sandy, over 27,000 businesses citywide, including 3,130 along the Waterfront, were inundated by the storm. For many, recovery has been challenging. To assist with this recovery, immediately after the storm, the City launched the series of programs previously described in *Community and Economic Recovery*, including a $25 million loan and grant program and a $25 million sales tax waiver program designed to help businesses get back on their feet. Building on the momentum of these programs, which have assisted over 2,500 businesses as of the writing of this report, the City, through NYCEDC, will launch the CDBG-funded Business Resiliency Investment Program of up to $100 million to help vulnerable businesses throughout the city make resiliency investments in their buildings and equipment, and the Business Loan and Grant Program of up to $80 million will assist businesses with recovery and rebuilding efforts. NYCEDC will launch these programs in 2013.

Economic Recovery Initiative 2
Launch the Neighborhood Game Changer Competition

The recovery of many of the communities impacted by Sandy, including those along the Waterfront, has been hampered by a lack of opportunities for economic advancement and employment among significant populations that were impacted by the storm. In many cases, these challenges existed even before Sandy, but have been exacerbated by the impacts of the storm. To address this, the City, through NYCEDC, will launch the CDBG-funded Neighborhood Game Changer Competition to invest up to $20 million in public money in each of the five communities on which this report focuses, including those along the Waterfront. This funding will be available on a competitive basis to help finance transformational projects. To win the competition, a project will have to spur incremental economic activity, generate new employment opportunities, and match public funding with significant private capital. Projects that would be eligible to be funded along the Waterfront through this competition could include new attractions bringing new—visitors, significant new operations of a major business or nonprofit, the revitalization of important commercial corridors, the expansion of an existing neighborhood institution or a major new transportation option. NYCEDC will launch this program in 2013.

Economic Recovery Initiative 3
Launch Neighborhood Retail Recovery Program

At the core of many Sandy-impacted neighborhoods are the local commercial corridors that provide employment opportunities and services to those who live and work around them. They include local retailers, institutions, and service providers—such as food markets, pharmacies, social service organizations, laundromats, and others. In many cases, though, these corridors were devastated by the storm. To address this, the City will call on the PSC and Con Edison to amend the preferential Business Incentive Rate program, which offers a discount on Con Edison's electric delivery charges, to allow it to be extended to impacted small businesses in the five communities on which this report focuses, including the Waterfront. Businesses and nonprofits with 10 or fewer employees that have received support from City-sponsored loan and grant programs will be eligible for the discount for five years up to a maximum discount of $50,000 per business or nonprofit. The maximum aggregate benefit available along the Waterfront will be $1 million. The goal is for NYCEDC to launch this effort in 2013. Among the corridors where the benefit will be available along the Waterfront include:

- Columbia Street Waterfront District (Hamilton Ave. to Atlantic Ave.)
- Jackson Ave. (52nd Ave. to 23rd St.)
- Manhattan Ave. (Ash St. to Driggs Ave.)
- McGuiness Blvd. (Ash St. to Calyer St.)
- Van Brunt St. (Reed St. to Bowne St.)
- Lorraine St. (Dwight St. to Hicks St.)
- Clinton St. (Hamilton Ave. to Centre St.)
- Vernon Blvd. (54th Ave. to the Queensboro Bridge)

Economic Recovery Initiative 4
Support local merchants in improving and promoting local commercial corridors

As mentioned above, Sandy highlighted the important role played by local commercial corridors in many of the communities impacted by the storm The City, through the Department of Small Business Services (SBS), will provide financial and/or technical assistance to area BIDs, merchant associations, and other groups that work to improve, market, maintain, and otherwise promote primary commercial corridors. Subject to review of applications received, SBS will prioritize Sandy impacted commercial corridors in allocating its resources, including its CDBG funding. Such funding could be used for a variety of purposes, including capacity building, façade improvement programs, streetscape improvements, and business recruitment and marketing efforts. Along the Waterfront, corridors that could receive this additional assistance include corridors in Red Hook, East Williamsburg, and DUMBO. SBS will provide this assistance beginning in 2013.

Economic Recovery Initiative 5
Continue to support the FRESH program to increase the number of full-line grocers in underserved neighborhoods

Even before Sandy, the residents of many communities impacted by Sandy, including parts of the Waterfront, lacked adequate access to fresh fruits, vegetables, and other healthy foods. Noting this challenge, especially in underprivileged areas of the city, in 2009, the City launched the FRESH (Food Retail Expansion to Support Health) program, a series of zoning and financial incentives available to supermarkets to fill this gap in neighborhoods underserved by grocery retail. To promote the recovery of commercial corridors in these areas, the City will continue to support the FRESH program, with a particular focus on Sandy-impacted neighborhoods, including those along the Waterfront.

Economic Recovery Initiative 6
Reassess commercial properties citywide to reflect post-Sandy market values

After Sandy, many commercial properties were worth less than before the storm. To reflect this fact and to help with recovery from the storm, the City has reassessed more than 88,000 properties impacted by the storm citywide. Overall, these reassessments have lowered the tax burden on Sandy-impacted properties—including both commercial and residential properties—by over $90 million, with commercial properties in neighborhoods impacted by Sandy receiving a reduction, on average, of approximately 10 percent off of their pre-storm assessed values.

In addition to the measures described above, the City will advance the following initiatives to address the Waterfront's community and economic recovery needs:

Brooklyn-Queens Waterfront Initiative 10
Create and implement a revitalization strategy for targeted retail and community spaces within Red Hook Houses

The residents of NYCHA's Red Hook Houses experienced significant disruption during Sandy. To help these residents recover and to provide new services and economic opportunities, subject to available funding, the City, though a partnership between NYCHA and NYCEDC, will make capital improvements to NYCHA-controlled retail and community spaces. Among the facilities that could benefit from these investments are a currently vacant former retail structure located at the corner of West 9th and Columbia Streets. These improvements will seek to attract new retailers, offering better goods and services to area residents, creating job opportunities for residents, and generating additional revenue opportunities for NYCHA. These investments will also improve and/or expand facilities available to community organizations. The goal will be to launch this initiative in 2013.

Brooklyn-Queens Waterfront Initiative 11
Implement planned and ongoing investments by the City and private partners

Preservation and revitalization of neighborhoods most significantly impacted by Sandy will be hampered if the momentum of planned investments is lost. The City will continue to pursue and execute public and private investments that had been planned prior to Sandy along the Waterfront. Such projects include but are not limited to:

Parks and Open Space Projects

- *Bush Terminal Piers Park*, a new waterfront park between 43rd and 51st Streets in Sunset Park, with a first phase set to open in 2013.
- *Brooklyn Bridge Park*, an 85–acre sustainable waterfront park stretching 1.3 miles along Brooklyn's East River shoreline, with additional segments currently under construction.
- *Bushwick Inlet Park*, city parkland planned on the Williamsburg and Greenpoint waterfronts adjoining an existing State Park.
- *Box Street Park*, a planned new park at Box and Commercial Streets on the Greenpoint waterfront.
- *Newtown Barge Park Expansion*, an expansion of existing park onto adjacent City-owned property.

Residential and Economic Development

- *Hunter's Point South*, the largest City-sponsored, middle-income housing development in New York since the 1960s, situated on approximately 30 acres of prime waterfront property in Long Island City, with an adjoining public park and esplanade, with the first two towers under construction.
- *Redevelopment of the Brooklyn Navy Yard*, including adding over two million square feet of new industrial space, through the development of Admirals Row, Building 77, the Green Manufacturing Center, and the expansion of Steiner Studios.

Credit: Adrian Relingado

East and South Shores of Staten Island

The massive glacier that covered all of New York City 22,000 years ago left behind certain indelible marks. As the ice sheet melted, it deposited rocks, gravel, and sand that it had amassed in its journey, forming the varied topography of what is now known as Staten Island. The area that would one day be known as the East Shore became a vast swath of marshes and swamps that sloped roughly from where Hylan Boulevard lies today down to the Atlantic Ocean. The South Shore, farther down the coast and surrounded on three sides by water, contained belts of hillier ground and was separated from the ocean in places by red clay bluffs.

When Staten Island officially became part of New York City in 1898, the low-lying East Shore consisted mostly of small towns and, near the coastline, clusters of seasonal bungalows and beachfront resorts. The South Shore was also lightly populated, with small towns along upland roads and an early railway terminus in the southernmost town of Tottenville. *(See map: The East and South Shores: 1900 vs. 2000)*

By the late 1960s, however, Staten Island's population started to grow rapidly, due largely to the opening of the Verrazano-Narrows Bridge. Residential development began to spread southward through the borough, including on the East and South Shores. On the East Shore, some development occurred on land in close proximity to, and sometimes within, wetland areas. On the South Shore, development also moved closer to the coastline.

Whether they live in the East Shore or South Shore, the residents of these areas, in many ways, live a unique lifestyle. They are part of the nation's largest city, yet many own detached houses, and, within minutes of returning from work, can stroll along beaches or wooded paths. However, this independence, these homeownership opportunities, and the proximity to nature have always come with some significant downsides.

For example, the East Shore's low-lying topography makes some parts of the area prone to coastal flooding. In addition, a tall, invasive reed called *Phragmites* has flourished in former wetlands. Because its dry stalks are highly flammable, the reed has, from time to time, brought wildfires to the area.

On the South Shore, meanwhile, ocean waves have, over time, eroded the area's bluffs, threatening homes and businesses in some locations. Furthermore, low-lying areas around creeks and tributaries are subject to flooding during storms.

Perhaps of greatest concern, both the East and South Shores occupy a place in New York Harbor that leaves them particularly exposed to storm waves and surge during extreme weather events. This is because the coastlines of Long Island and New Jersey are angled such that, in certain circumstances, they can channel flood waters directly into these areas.

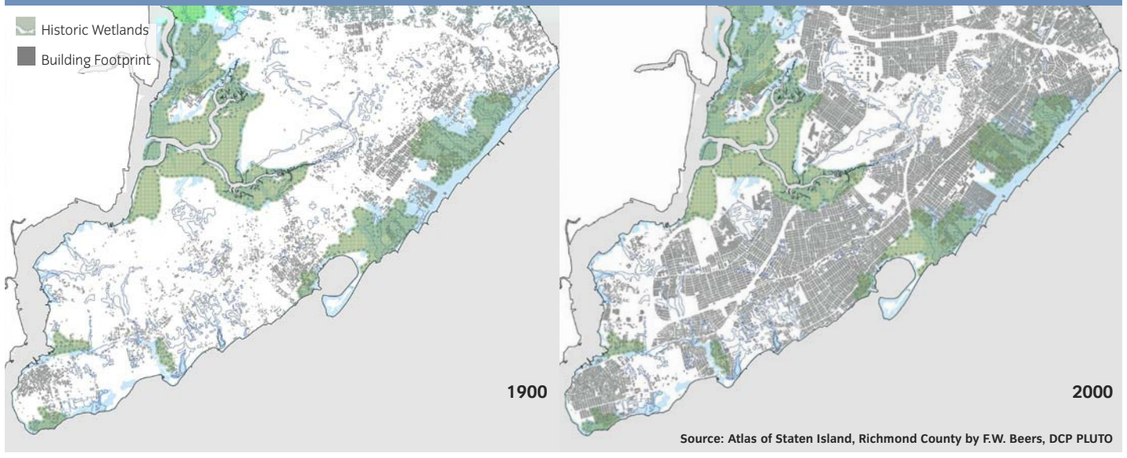
Sadly, many of these vulnerabilities came into play during Sandy. The storm's waves rose up over the East Shore's beaches, battering homes and sweeping some completely off their foundations. Waves also scoured the South Shore's bluffs and smashed ocean-facing houses, in some cases leaving behind only foundations and stairs. In both areas, water muscled its way inland, overwhelming residential communities, business strips, marinas, and roads. Of the 23 storm-related deaths on Staten Island—more than in any other borough—all but one occurred on the East and South Shores.

To help the East and South Shores recover from the tragedy of Sandy and prepare for a future of greater climate risks, the City has developed a plan that reflects the overarching goals of this report: To limit the impacts of climate change while enabling New York and its neighborhoods to bounce back quickly when those impacts cannot be avoided. The plan will address the area's most significant climate risk—its vulnerability to wave action and storm surge, particularly as sea levels rise—by protecting oceanfront and inland exposures, facilitating retrofits and resiliency in new and existing buildings, and safeguarding vital infrastructure. The plan also will address other significant risks—such as more heavy downpours, heat waves, and high winds—by drawing on both citywide and locally tailored initiatives. Finally, the plan will build on the natural assets of the East and South Shores and the powerful attachment residents have to their homes and neighborhoods to make the whole area even more vibrant and economically dynamic than it was before the storm.

Area Characteristics

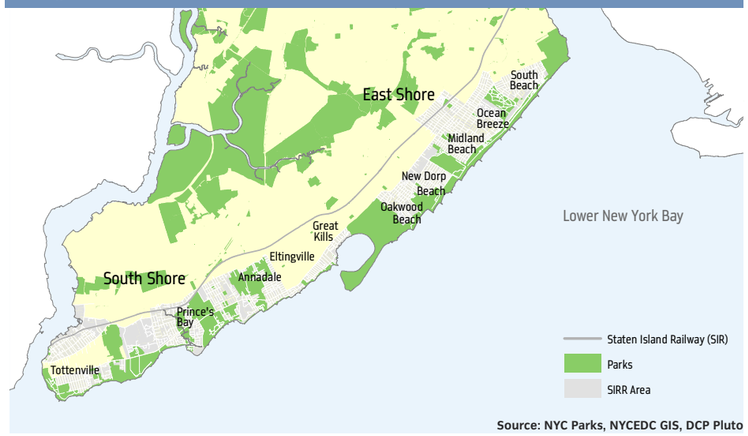
The East and South Shores, as defined in the report, are predominantly low-density residential communities, with small business corridors primarily serving local residents. Each community encompasses many smaller neighborhoods. *(See map: Neighborhoods of the East and South Shores)*

The East and South Shores: 1900 vs. 2000



Source: Atlas of Staten Island, Richmond County by F.W. Beers, DCP PLUTO

Neighborhoods of the East and South Shores



Source: NYC Parks, NYCEDC GIS, DCP Pluto

The East Shore—which stretches approximately three miles, from Fort Wadsworth to Great Kills Park—includes the neighborhoods of South Beach, Midland Beach, New Dorp Beach, and Oakwood Beach. The South Shore extends from Great Kills Park to the southernmost point in New York State and includes neighborhoods such as Great Kills, Eltingville, Annadale, Prince's Bay, and Tottenville. While residents are attached to their individual neighborhoods, they also tend to identify with the broader geographies of the East Shore and South Shore.

Both areas have abundant parkland and open space. The East Shore's 2.5-mile beach, boardwalk and promenade—along South Beach, Midland Beach, and Cedar Grove Beach—are City parks managed by the Department of Parks & Recreation (DPR), as well as important economic drivers for the area. Within the South Shore neighborhood of Prince's Bay sits Wolfe's Pond Park, one of several major waterfront open spaces that are managed by DPR. Other South Shore waterfront parks include Crescent Beach Park, Lemon Creek Park, and Conference House Park.

Between the East Shore and the South Shore is Great Kills Harbor, surrounded by Great Kills Park, one of three Federal parks (along with Forth Wadsworth and Miller Field) that form the Gateway National Recreation Area. Great Kills Park was built by the City, mostly on fill that dates to the 1930s. It was transferred to the National Parks Service in 1972. Ringed by private and public marinas, Great Kills Harbor is an economic hub and an important recreational amenity for the area.

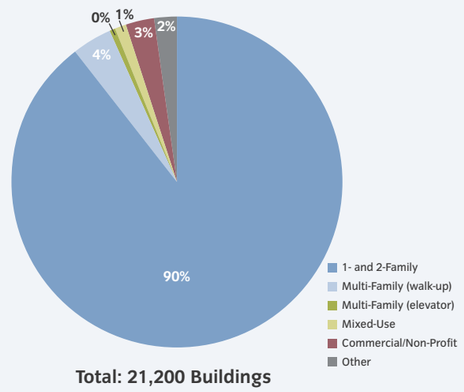
Beyond the beaches, parks, and marinas—which draw residents from across the borough—the East and South Shores contain other important Staten Island assets. For example, the historic houses of Conference House Park, in Tottenville, serve as area attractions, while other historic properties, such as the Olmsted-Beil House and Seguine Mansion, have the potential to play a similar role in the future. Critical wastewater treatment and stormwater management infrastructure for the East and South Shores, and transportation assets for the entire borough, can also be found in the area. Finally, important institutions, such as Staten Island University Hospital (SIUH), are both major employers and providers of critical local and borough-wide services.

Residential Development

The population of the East and South Shores today totals approximately 70,000 residents. Between 2000 and 2010, the areas together saw population growth of 11 percent. Families of all incomes have been drawn to the areas by the chance to own homes in what many consider an idyllic setting.

Generally, housing on the East and South Shores is freestanding, or detached, with pockets of semi-attached or attached houses. This stock consists predominantly of 1- and 2-family homes, which account for 90 percent of all area buildings, 93 percent of all residential buildings, and 84 percent of all housing units. Area homes also tend to be of a "combustible" construction type (e.g., wood-frame construction). Over one-half (59 percent) of 1- and 2-family homes were built before 1983, and thus constructed before current flood-protection standards were in place. *(See chart: Area Buildings Characterized by Type; see chart: Area Housing Units Characterized by Building Type)*

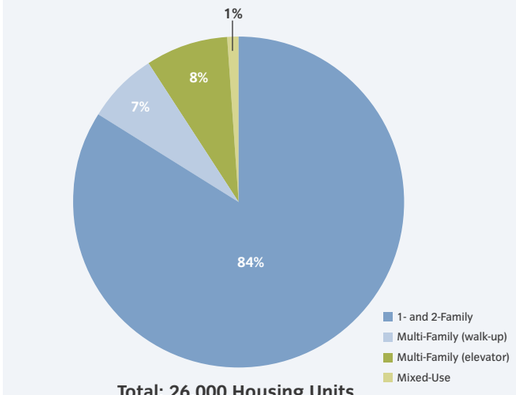
Area Buildings Characterized by Type



Total: 21,200 Buildings

Source: DCP PLUTO

Area Housing Units Characterized by Building Type



Total: 26,000 Housing Units

Source: DCP PLUTO

Bungalow housing in Midland Beach

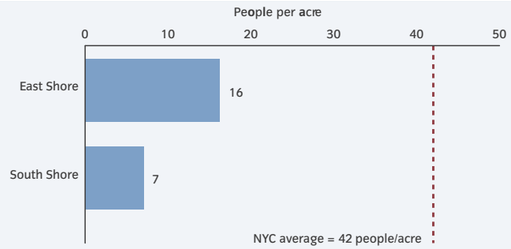
Credit: Sunghwan Yoon

Both the East and South Shores have population densities well below the citywide average of 42 people per acre, reflecting the area's single-family-home character as well its ample open space. The East Shore, however, is slightly more densely settled (16 people per acre) than the South Shore (7 people per acre) and Staten Island as a whole (11 people per acre). The East Shore's greater density reflects the fact that many homes in the neighborhoods of Midland Beach, South Beach, and New Dorp Beach are built on small lots and in close proximity to one another. *(See chart: Area Population Density)*

On the East Shore, many of the area's homes were built as seasonal cottages during the beachfront's heyday in the early 20th century, when it was lined with amusements and hotels. Beginning in the 1950s, though, as those uses and some cottages were cleared by the State for the South Beach Psychiatric Center in Ocean Breeze and by Robert Moses for planned roadways and public beaches, families began turning their cottages into year-round residences, often passing these homes down from generation to generation. However, since the houses were not built to modern standards and many have not been upgraded since they were constructed, they remain vulnerable to extreme weather.

By contrast, in recent years the South Shore has witnessed the construction of more sizable homes on larger lots, with much of the recent building occurring between Hylan Boulevard and the coastline. Some of these residences have been built near the South Shore's bluffs and beaches. Because of underwater topography, tides, and the natural movement of sediment, ocean waves can hit the South Shore nearly parallel to the coastline, carving away at the bluffs and making homes near the bluffs more vulnerable to flooding. Development also has occurred adjacent to many of the South Shore's creeks and inlets, including Lemon Creek. Though the South Shore community of Tottenville was not reached by the growth in construction after the opening of the Verrazano-Narrows Bridge, since the early 1990s, this area has seen more development, including along the shoreline below Hylan Boulevard, where rows of summer bungalows have been replaced by larger homes.

Area Population Density



Source: 2010 US Census

Socioeconomic Characteristics

Socioeconomic Characteristics

Taken together, the East and South Shores are relatively prosperous with a higher combined median household income ($76,800), higher combined homeownership rate (73 percent) and lower combined poverty rate (7 percent) than city averages. (*See table: Socioeconomic Characteristics*)

However, there are important socioeconomic differences between the East Shore and South Shore. As a whole, the East Shore has a lower median household income ($68,600) than the South Shore ($92,800). The median value of a housing unit in the East Shore before Sandy ($445,300) was slightly lower than the citywide median average ($514,900). This was in contrast to the median price of a housing unit in the South Shore, which was higher ($588,100). The East Shore also has a lower homeownership rate (68 percent) than that of the South Shore (83 percent).

Area	Population	Poverty Rate	Median Household Income	Households	Owner-Occupied Housing Units	% Homeowners	% Owner-Occupied Units with Mortgage	Median Owner-Occupied Unit Value
East Shore	45,300	8%	$68,600	16,150	11,000	68%	72%	$445,300
South Shore	24,400	4%	$92,800	8,300	6,900	83%	74%	$588,100
Total Staten Island SIRR Area	**69,700**	**7%**	**$76,800**	**24,450**	**17,900**	**73%**	**73%**	**$500,000**
Citywide Total/ Average	**8,175,000**	**19%**	**$51,300**	**3,050,000**	**993,500**	**33%**	**64%**	**$514,900**

Source: 2010 US Census, 2011 American Community Survey, 5-Year estimate

Finally, there are 5,100 households that rent on the East Shore and 47 percent are classified as "cost burdened," defined by the Federal government as households that pay 30 percent or more of their annual income for housing. In the South Shore, there are only 1,400 households that rent, but the percentage of those that are cost burdened is similar to the East Shore (51 percent).

Business, Nonprofits, and the Local Economy

Before Sandy, there were approximately 2,800 businesses employing over 17,100 people in the East and South Shores. The majority of those businesses (82 percent) were small, employing fewer than five people. However, 40 percent of area employees worked for larger businesses (those with more than 100 employees). *(See chart: Profile of Area Businesses)*

On the East and South Shores, the retail and service sectors are major employers, with the healthcare industry offering the highest wages. In fact, SIUH, an approximately 700-bed teaching hospital, is the largest Staten Island-based employer, with 82 percent of its workforce consisting of Staten Island residents (5,104 residents employed as of 2012). SIUH has two campuses: a North Campus on the East Shore (in Ocean Breeze), that has Staten Island's only regional trauma and burn center, Staten Island's largest emergency room, and over one-third of the borough's inpatient beds; and a South Campus on the South Shore in the Prince's Bay neighborhood. Adjacent to the SIUH North Campus is a State hospital for the mentally ill, the South Beach Psychiatric Center, which has approximately 200 full- and part-time employees.

The area's marinas—many with repair facilities and restaurants—are also important to the local economy. Six (five private and one public) are located within Great Kills Harbor, with four more in the South Shore, such as Lemon Creek Marina, located along or in close proximity to inland waterways.

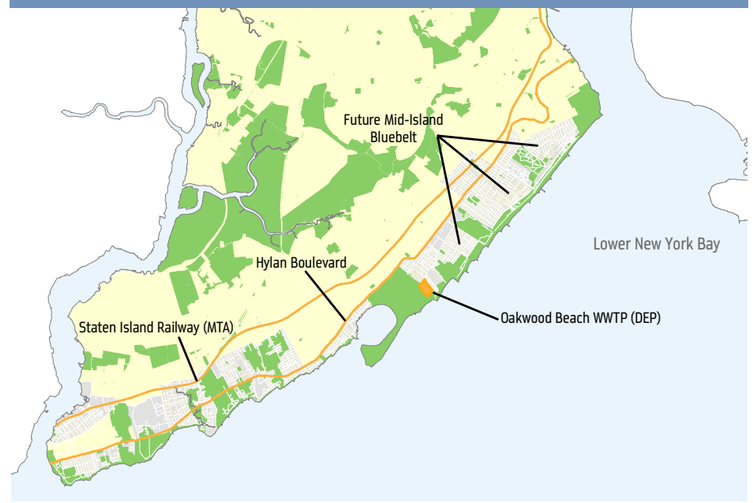
A primary commercial corridor for both the East and South Shores is Hylan Boulevard, a major north-south artery. In addition, the East Shore has small retail and commercial strips that serve local residents and summer visitors to beach areas. These include Midland Avenue, Sand Lane, Seaview Avenue (where a number of medical offices are clustered), and small strips along Father Capodanno Boulevard, which runs parallel to the beachfront.

In the South Shore, many neighborhoods have historic town centers, such as the commercial stretch of Main Street in Tottenville. Additional commercial thoroughfares include Page Avenue as well as small commercial districts along Annadale Road in Annadale and around the Staten Island Railway (SIR) stations in Eltingville and Great Kills. The Bricktown Centre and South Shore Commons shopping centers, located in Charleston, just north of Tottenville, house stores that draw customers from other sections of Staten Island and from New Jersey.

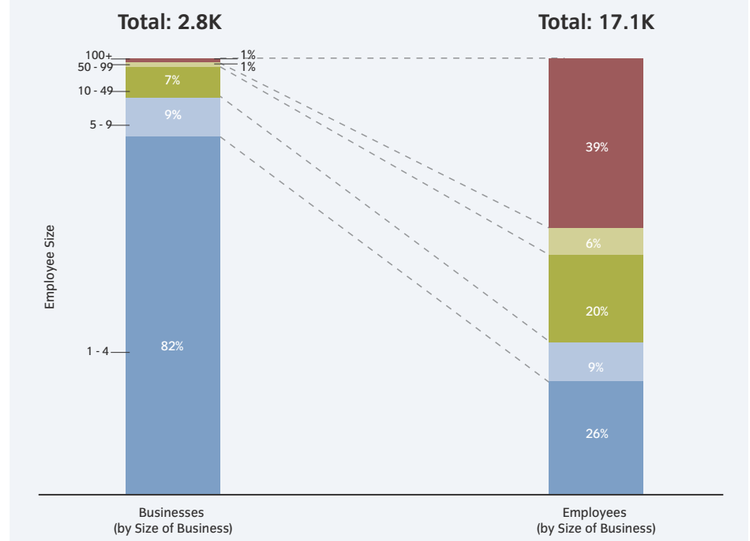
Critical Infrastructure

The East and South Shores contain critical wastewater treatment, stormwater

Area Critical Infrastructure



Profile of Area Businesses



Source: Hoovers

management, and transportation systems. *(See map: Area Critical Infrastructure)*

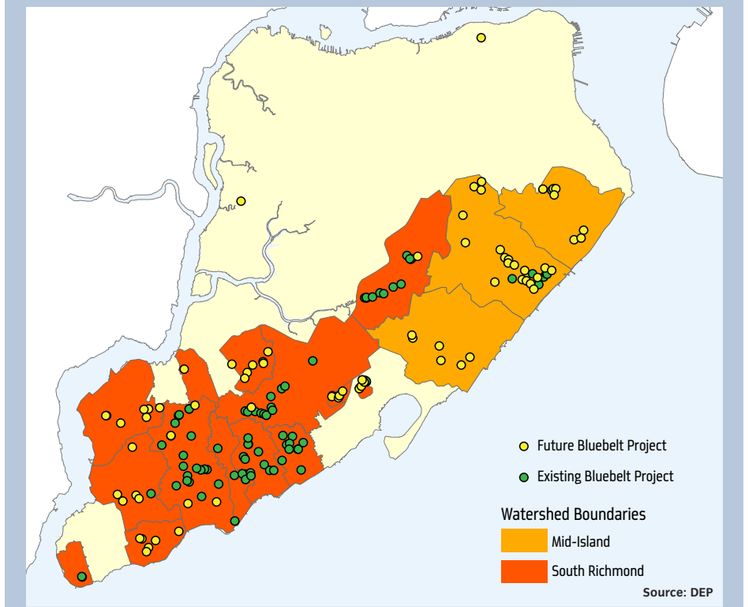
In the East Shore, the Oakwood Beach Wastewater Treatment Plant has been in operation since 1956 and serves nearly a quarter of a million people (roughly half of the population of Staten Island) in an 11,000-acre drainage area. On an average day, the facility, operated by the New York City Department of Environmental Protection (DEP), treats 30 million gallons of wastewater.

DEP also manages the Staten Island Bluebelt, an innovative system that uses open space to control stormwater while preserving Staten Island's wetlands—the last great stand of freshwater wetlands in New York City. Currently, the Bluebelt system drains 15 watersheds on the South Shore plus the Richmond Creek watershed, a combined area of approximately 10,000 acres. Property acquisition for the Bluebelt system on the South Shore is complete and DEP is now building out the drainage system for the area. *(See sidebar: What is the Bluebelt?)*

Building on the success of the South Shore system, DEP has proposed a comprehensive Mid-Island Bluebelt, which, would address street and property flooding in East Shore neighborhoods. When fully developed, the Mid-Island Bluebelt will drain a 5,000-acre area encompassing the South Beach, New Creek (Midland Beach), and Oakwood Beach watersheds. A little over half of the area needed for the Mid-Island Bluebelt has been acquired, though completion of the system is not expected until the 2040s.

What is the Bluebelt?

The Staten Island Bluebelt is an award-winning, ecologically sound, and cost-effective stormwater management system, which is also one of the most ambitious stormwater management efforts in the northeastern United States. Initiated in the late 1980s by DEP, the system makes use of natural drainage corridors—including streams, ponds, and other wetland areas—to convey, store, and filter stormwater, thus preserving these natural areas and minimizing the need to construct traditional underground stormwater systems. It works as follows: The Bluebelt natural drainage corridors, acquired by the City, convey stormwater from conventional storm sewers to the Raritan Bay or the Arthur Kill via concrete pipes that are located across beaches or open channels. At each point where storm sewers drain into the Bluebelt, a "best management practice" project, such as a detention basin or pond, is constructed to manage stormwater and enhance water quality. In sum, the Bluebelt program preserves open space, maintains natural floodplains, and provides flexible infrastructure—allowing for an adaptive and sustainable response to climate change.



The area's transportation assets include Hylan Boulevard. Running the length of the shoreline—approximately 14 miles, from the North Shore neighborhood of Rosebank to the South Shore neighborhood of Tottenville—the roadway is highly trafficked, with 44,000 vehicles and 32,000 bus riders traveling it on a typical weekday. Select Bus Service (SBS), started in September 2012, connects Hylan Boulevard and Bay Ridge, Brooklyn. Many sections of Hylan Boulevard are low-lying and flood during even normal rainfall.

Another transportation asset on the East and South Shores is the SIR, a 14-mile commuter rail line operated by the Metropolitan Transportation Authority (MTA). The only rapid transit line on Staten Island, the SIR provides service along the east side of the borough between St. George and Tottenville. Many residents from the East and South Shores use the SIR to reach the St. George Ferry Terminal, from which they take the Staten Island Ferry to Manhattan, where more than one-quarter of working Staten Island residents are employed. Several South Shore SIR stations, including the Richmond Valley Station, are in low-lying areas that flood during heavy rains.

Yet another transportation corridor in the area is Father Capodanno Boulevard. The Boulevard, part of a Robert Moses-planned roadway that was never fully realized, was built at a higher elevation than the neighborhoods through which it runs. As a result, during extreme weather events and even smaller storms, the Boulevard has prevented floodwaters in neighborhoods farther inland from draining back into the Harbor.

What Happened During Sandy

Sandy's arrival at high tide on the Atlantic, its massive surge, and its wind-whipped waves all spelled disaster for the East and South Shores. Peak storm tides reached 16 feet—almost five feet higher in Tottenville than at the Battery in Manhattan. Along the Staten Island coastline, monitors indicated storm tide fluctuations of 5 to 6 feet every 30 seconds, as large waves repeatedly slammed into the coast at the height of the storm.

On the East Shore, storm waves came across the beaches and battered homes. The surge was devastating for the neighborhoods of Oakwood Beach, South Beach, Midland Beach, and New Dorp Beach. In Oakwood Beach, for example, the surge swept some homes off of their foundations and deposited them in marshes. It flattened half of the houses on Kissam Avenue, inflicted extensive water

Devastation on Kissam Avenue/Oakwood Beach

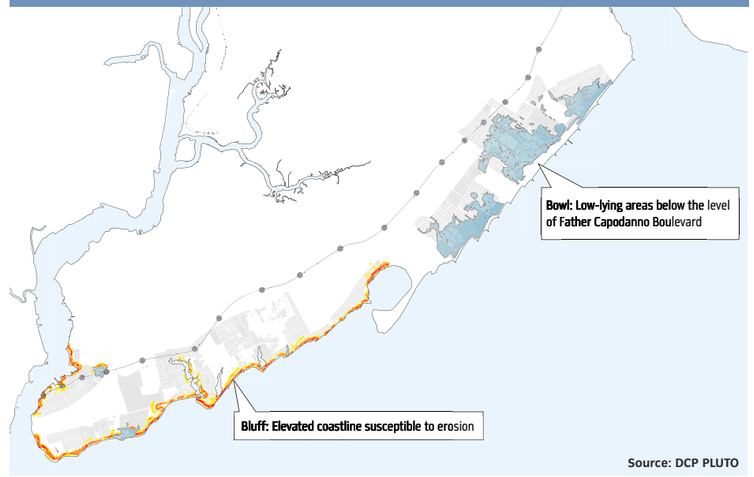
damage on the others, and forced all of the street's residents to seek temporary housing. On the beaches in front of South Beach and New Dorp Beach, much of the sand was washed away. *(See photo: Devastation on Kissam Avenue/Oakwood Beach)*

Many areas on the East Shore flooded due to their low elevation. The "bowl" topography of the East Shore, created by the higher elevation of Father Capodanno Boulevard, exacerbated damage to homes and businesses. When the storm surge topped this elevation, the "bowl" in which the communities inland of the Boulevard are built filled and floodwaters rose rapidly, following the natural contours of the land. With the ground saturated, this low topography trapped water in some neighborhoods at significant depths—in some places for several days. *(See map: Bowls and Bluffs; see map: Area Inundation and Surge Height)*

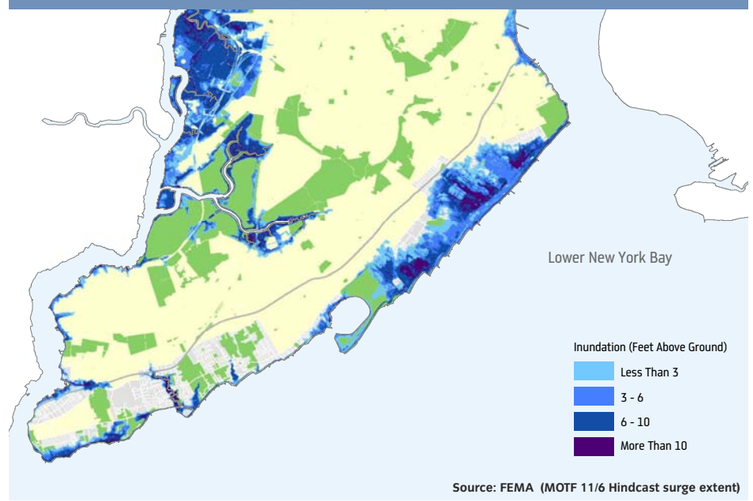
Sandy's surge also overwhelmed the area's drainage infrastructure, which is designed to drain rainwater and not to handle the massive volumes of water associated with a coastal surge. In some cases, floodwaters infiltrated roadway drainage and sewer systems through catch basins, manholes, and storm drains. Additionally, several tide and floodgates, devices that prevent water from flowing backwards through the drainage system—such as at Oakwood Beach—were damaged during the storm.

On the South Shore, early winds out of the northeast drove powerful waves almost parallel to the coastline. These waves carved away at the area's protective bluffs, causing significant erosion. Although the direction of the waves and the presence of the bluffs meant that generally only the first few rows of homes in most South Shore communities were exposed to the force of these waves, many homes that were hit, such as those around Tottenville Beach and Yetman Avenue, were smashed.

Bowls and Bluffs



Area Inundation and Surge Height



New Dorp Beach

Credit: John de Guzman

Erosion of South Shore bluffs

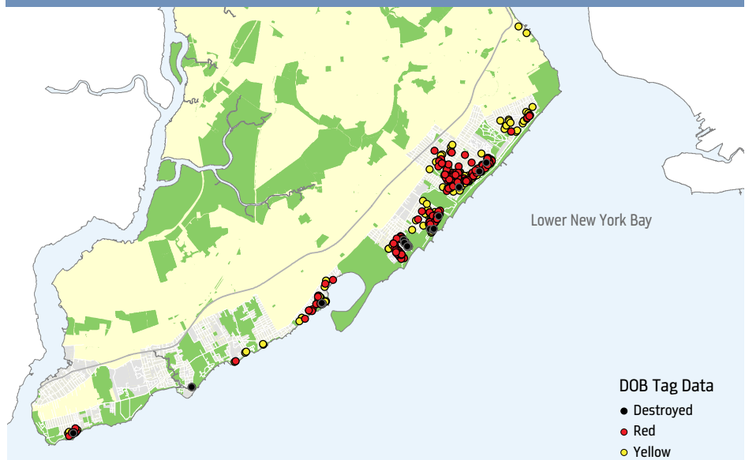
Credit: Bill Lyons/Advance

Meanwhile, in some neighborhoods along the South Shore, waterfront parks such as Wolfe's Pond Park took direct hits from the surge, likely buffering inland areas from further storm damage. However, many of these parks themselves sustained considerable damage that caused them to remain closed for months. Storm surge also traveled far inland on the South Shore into low-lying areas along creeks and tributaries, including Mill and Lemon Creeks. *(See photo: Erosion of South Shore Bluffs)*

As a result of Sandy, a large number of buildings in the East and South Shores suffered damage. After the storm, the New York City Department of Buildings (DOB) sent out inspectors to assess damages in the East and South Shores and other inundated areas of the City. These inspectors were asked to assign "tags" to buildings based on the observed condition of each structure. "Green" tags indicated less serious damage or no damage. "Yellow" tags indicated that portions of a building might be unsafe or might have significant non-structural damage. "Red" tags indicated structural damage. And a subcategory of "red" tags were further categorized as "destroyed". *(See map: Location and Level of Building Damage; See chart: Level of Building Damage)*

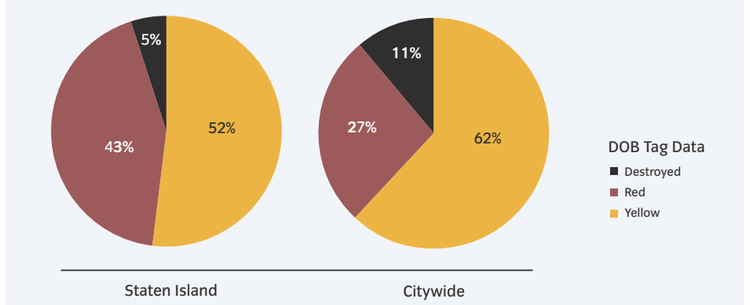
The most methodologically rigorous building damage assessment undertaken by DOB was completed in December 2012. According to this assessment, of those buildings citywide that were tagged, either yellow or red (including those further classified as destroyed), 23 percent were located in the East and South Shores. The yellow and red tagged buildings tended to be clustered in the East Shore neighborhoods of South Beach, Midland Beach, New Dorp Beach and Oakwood Beach and the South Shore neighborhoods of Great Kills,

Location and Level of Building Damage



Source: DOB December Tags

Level of Building Damage



Source: DOB December Tags

Damage to bungalow in New Dorp Beach

Credit: John de Guzman

Annadale and Tottenville. In the East and South Shores, consistent with other ocean-facing areas of the city, the percentage of red and yellow tagged buildings that were tagged red (48 percent) was higher than the percentage citywide (38 percent). This overrepresentation was reflective of the destructive impact that powerful waves coming off of the ocean had on the area's building stock.

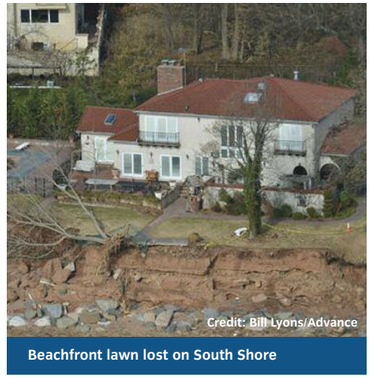
The structural characteristics of the area's building stock contributed to the scale of damage and destruction. As described in Chapter 4 (*Buildings*), throughout the city's inundation area, low-rise buildings of combustible construction predating 1983, when the City adopted FEMA's flood maps and incorporated flood-resistant construction standards, proved to be some of the most vulnerable building types during Sandy. This building type represented over half (61 percent) of the approximately 11,700 buildings in the inundated areas of the East and South Shores.

The damage from destructive waves during Sandy was especially severe for low-rise residential buildings in neighborhoods such as Midland Beach, South Beach, New Dorp Beach, and in East Shore communities along Father Capodanno Boulevard. In particular, a number of winterized bungalows in the area that were not properly anchored were washed off of their foundations during the storm. In these neighborhoods, post-storm demolitions have resulted in "missing tooth" residential blocks, where habitable homes stand next to empty lots previously occupied by neighboring houses.

SIUH also was impacted by the storm. Prior to Sandy's arrival, the hospital transferred especially vulnerable patients, such as those dependent on ventilators, to other facilities. Once Sandy hit, storm surge caused roads leading to the North and South campuses to be flooded, and some of the hospital's administrative and clinical support facilities to sustain damage. During and after the storm, the SIUH heliport was used as a landing site for relief helicopters, while the South campus lost power for days.

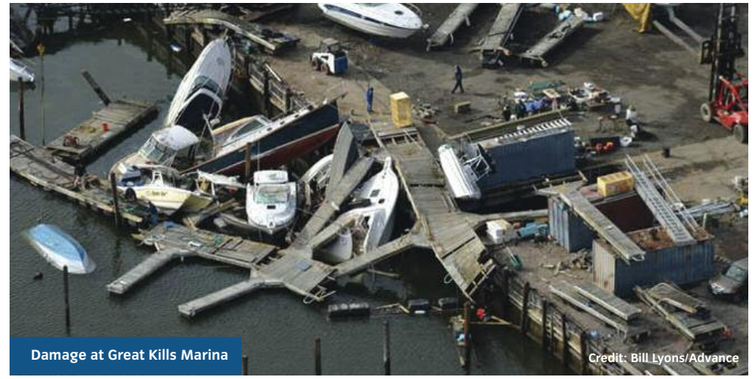
Meanwhile, marinas across the area were damaged severely. As of the writing of this report, all six marinas in Great Kills Harbor are still making repairs and have not reopened. At the publicly owned Nichols Marina in Great Kills Park, 350 floating wooden slips were swept away by Sandy. Repairs coupled with debris removal will effectively take this marina out of commission for the entire 2013 boating season.

A similar tale of damage and destruction played out for retail stores and commercial structures near the area's beaches. Businesses lost equipment, personal property, and building systems. In the East Shore, the small commercial corridor along Midland Avenue was devastated by flooding, winds, and power loss. Nearly four months after the storm, 51 of 72 Midland Avenue retailers remained closed. Businesses in Midland Beach along Father Capodanno Boulevard were similarly affected. In South Beach, professional offices along Seaview Avenue and retailers along Sand Lane suffered extensive damage. The Hylan Boulevard commercial corridor, roughly between Seaver Avenue and New Dorp Lane in the East Shore, was flooded with many businesses, including large-format retailers, forced to close for days. Businesses on and near Main Street in Tottenville sustained structural damage, with first floors often obliterated, leaving only wall studs.



Beachfront lawn lost on South Shore

Credit: Bill Lyons/Advance



Damage at Great Kills Marina

Credit: Bill Lyons/Advance

The storm also damaged critical infrastructure. The Oakwood Beach Wastewater Treatment Plant was completely surrounded by surge waters during Sandy, and the tremendous flow of seawater, sand, and other debris around the plant damaged some of the facility's pumps. DEP employees kept the plant running through the night of the storm, despite the fact that the facility lost some of its electrical power and had to run some functions on generators. Because of these efforts, the plant was able to treat over 80 million gallons of wastewater—more than 2.5 times the amount treated on a normal day—that otherwise would have backed up into homes and businesses.

As for the area's transportation assets, Hylan Boulevard was inundated in many areas during Sandy, causing severe delays in express and local bus service. Major damage also occurred at the SIR's operations and maintenance facilities, limiting service in the days after the storm (ultimately, full service was only restored in mid-December).

The Staten Island Ferry was also knocked out of service for five days after Sandy, mostly due to damage at the Whitehall Ferry Terminal in Lower Manhattan. This left many residents without transportation options to and from Manhattan, while also affecting those who travel by ferry to Staten Island for work and school. In response, approximately one month after the storm, additional ferry service to Manhattan (to Pier 11, continuing on to Midtown) was launched on a temporary basis from a newly installed, temporary landing in Great Kills Harbor.

Meanwhile, four schools were impacted in the area, with two—I.S. R002 George L Ebert and P.S. 052 John C. Thompson—remaining closed for almost a month following the storm. P.S. 003, The Margaret Gioiosa School, lost power during the storm, and Tottenville High School was closed while operating as a temporary shelter for area residents. During these temporary closures, students at these schools were sent to alternative locations.

Following the storm, many homeowner and civic associations in Midland Beach, Ocean Breeze, New Dorp Beach, and other neighborhoods played an essential role in recovery efforts, even as their own members and leadership dealt with personal challenges and tragedies. Several organizations, including many faith-based organizations, allowed their buildings to serve as distribution centers and temporary shelters, despite the fact that, in a number of cases, these facilities also suffered damage.

What Could Happen in the Future

Given the area's coastal exposure and low-lying topography, the most significant climate risk to the East and South Shores is the increased frequency of the most intense coastal storms. This risk likely will be exacerbated by sea level rise. *(See chart: Risk Assessment: Impact of Climate Change)*

Major Risks

Preliminary Work Maps (PWMs) were released in June 2013 by the Federal Emergency Management Agency (FEMA). These PWMs will be considered the best available information until FEMA releases Preliminary Flood Insurance Rate Maps (FIRMs), by the end of 2013. The PWMs show increased flood risk throughout the East and South Shores. On Staten Island, the 100-year floodplain, the area that has a 1 percent or greater chance of flooding in any given year, has expanded 37 percent in land area since the FEMA flood maps that were in effect during Sandy were released in 1983.

In the East Shore, the floodplain has expanded to encompass most of Midland Beach and extends as much as a mile inland in locations, beyond Hylan Boulevard towards the SIR tracks. In addition, the area surrounding Ocean Breeze Park, and certain residential blocks in New Dorp Beach and Oakwood Beach, have been added to the floodplain. In the South Shore, the new floodplain reaches additional residential blocks along the coastline in Annadale, Prince's Bay, and Tottenville, and extends inland along waterways, such as Mill Creek and Lemon Creek. (*See map: Comparison of 1983 FIRMs and Preliminary Work Maps*)

All beaches along the East and South Shore coastlines, and the northern edge of Great Kills Harbor, are now within a V Zone, which is a coastal area at risk of storm waves of three feet or more. In some limited instances, V Zones even encompasses residential properties, including the first inland rows of homes in certain South Shore neighborhoods such as Great Kills, Prince's Bay, and Annadale.

Overall, Base Flood Elevations (BFEs), or the height to which floodwaters could rise during a storm, have increased by two to four feet, in large swaths of the area.

In addition to expanding in area, according to the PWMs, the 100-year floodplain along the East and South Shores also now encompasses significantly more buildings (approximately 9,700 buildings total, a 46 percent increase). This includes an approximate 50 percent increase in residential units in the floodplain, a 32 percent increase in commercial buildings in the floodplain and, perhaps most significantly, a 49 percent increase in the area's 1- and 2-family homes—a housing type that is, as noted earlier, particularly vulnerable to storm surge. (*See chart: Buildings in the Floodplain*)

The PWMs also show critical facilities and infrastructure within the 100-year floodplain. Examples range from stretches of Hylan Boulevard in both the East and South Shores, to the areas surrounding the Oakwood Beach Wastewater Treatment Facility and the North Campus of the Staten Island University Hospital.

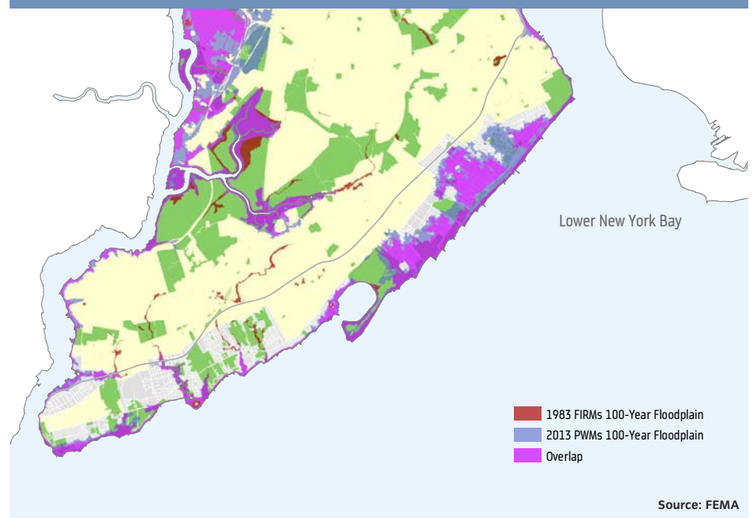
Looking forward, according to projections from the New York City Panel on Climate Change (NPCC), sea levels are likely to rise through the 2020s and 2050s (see Chapter 2). As sea levels rise, the floodplain will likely expand,

Risk Assessment: Impact of Climate Change

Major Risk Moderate Risk Minor Risk

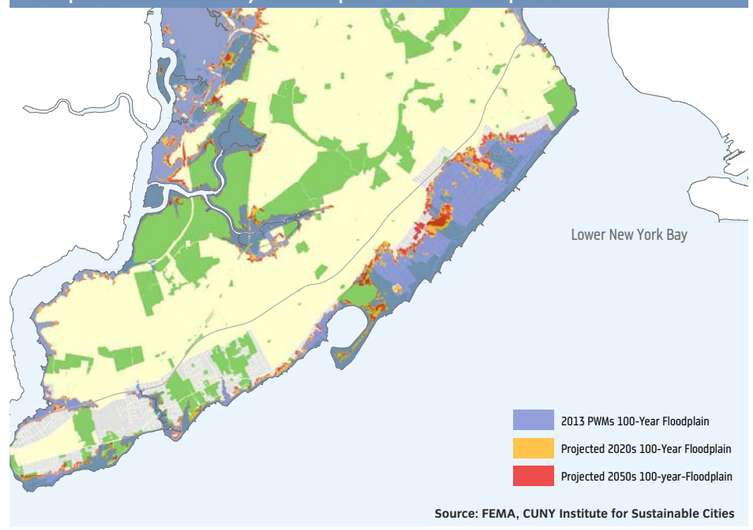
Hazard	Scale of Impact: Today	2020s	2050s	Comments
Gradual				
Sea level rise				Expected to make low-lying areas more vulnerable to coastal flooding; will also likely cause further erosion of beach and bluffs
Increased precipitation				Likely would cause additional flooding of low-lying areas, particularly in areas where the storm sewer system is not fully built out
Higher average temperature				Minimal impact
Extreme Events				
Storm surge				Significant risk of both wave action and coastal flooding, as evidenced by Sandy; risk likely would grow as V Zone and Coastal A Zone expand; increased storm frequency would leave less time to restore coastal protections
Heavy downpour				Will raise likelihood that the capacity of stormwater management systems may be exceeded more frequently, resulting in localized flooding
Heat wave				Will place greater strain on the area's power system, increasing the potential for failures
High winds				Would likely affect overhead power lines, the mode of power delivery to the majority of the area

Comparison of 1983 FIRMs and Preliminary Work Maps



Source: FEMA

Comparison of Preliminary Work Maps and Future Floodplains



Source: FEMA, CUNY Institute for Sustainable Cities

Buildings in the Floodplain

	100-Year Floodplain			
	1983 FIRMs	2013 PWMs	Projected 2020s	Projected 2050s
Residential Buildings	6,300	9,240	10,730	12,100
Residential Units	7,000	10,500	12, 300	14,700
Commercial and Other Buildings	380	490	550	600

Source: DCP PLUTO, FEMA

Staten Island's Historic North Shore

The neighborhoods on Staten Island's historic North Shore experienced Sandy in some ways that were similar to the neighborhoods on which this report focuses and in some ways that were different. However, each was impacted in ways that continue to affect the residents and businesses of these neighborhoods.

During Sandy, floodwaters reached beyond Bay Street in Clifton, Stapleton, and Tompkinsville, causing property damage and business disruption. The John B. Caddell tanker ran ashore in Stapleton during the storm, closing down Front Street. Piers driven ashore by Sandy blocked the Bay Street Landing in St. George. Along the Kill Van Kull, many docking and landside facilities were damaged. Inundation went beyond Richmond Terrace in parts of West Brighton, Port Richmond, and Mariners Harbor. At the Snug Harbor Cultural Center, volunteers and maintenance workers spent days clearing debris.

Looking to the future, the risks faced by the North Shore from extreme weather events are likely to increase due to climate change. The initiatives described in this report are designed to help address these risks through a range of strategies. Among these are: a program to raise bulkheads and other shoreline structures in low-lying areas most at risk of flooding, including, potentially, areas of the North Shore (see Coastal Protection Initiative 6); investments to harden the St. George Ferry Terminal (see Transportation Initiative 6); loans and grants to help thousands of New Yorkers repair and rebuild housing and reopen businesses (see Buildings Initiatives 2 and Economic Recovery Initiative 1); loans and grants to help thousands of New Yorkers make resiliency investments in their businesses, including a sales tax abatement program for owners of industrial buildings in the 100-year floodplain (see Buildings Initiative 7 and Buildings Initiative 10); and investments to promote community and economic recovery, including planned and on-going investments along the St. George Waterfront and at Stapleton.

Bay Street Landing

Credit: Bill Lyons/Advance

potentially resulting in even higher floodwaters due to storm surge. *(See map: Comparison of Preliminary Work Maps and Future Floodplains)*

Using the high end projections from the NPCC the City projects that the number of buildings in the future floodplain along the East and South Shores could rise to over 11,200 buildings by the 2020s (an approximate 16 percent increase of over what is shown by the PWMs) and to approximately 12,700 buildings by the 2050s (a further 15 percent increase over what is shown in the PWMs). Most of these will be 1- and 2-family homes. During this period, Coastal A Zones—area landward of a V Zone, at risk of storm waves of between 1.5 feet and 3 feet—are also likely to expand westward into East Shore communities and farther inland along the coastline and creeks in the South Shore. It is also possible that sea level rise, even without extreme weather events, could place further strain on low-lying areas and contribute to greater erosion of beaches and bluffs.

Other Risks

Though coastal inundation poses the greatest threat to the neighborhoods along the waterfront, these areas face other climate risks, as well. For example, going forward, increased precipitation and heavy downpours could lead to localized flooding of low-lying areas, particularly areas in the East Shore where the storm sewer system is not fully built out. Heavy downpours may also exceed the capacity of stormwater management systems more frequently, leading to localized street flooding in other low-lying areas of the East and South Shores.

While future projections for changes in wind speeds are not available from the NPCC, a greater frequency of intense coastal storms by the 2050s could present a greater risk of high winds in the New York area, which could result in downed overhead power lines and trees, and potentially damage older buildings not constructed to modern wind standards.

Heat waves may strain electric systems, resulting in power failures that can impact homes and businesses and the functioning of infrastructure. Finally, drought may increase the threat of wildfires in the area, especially in the East Shore, where the pervasiveness of *Phragmites* has resulted in more than 100 serious brush fires in the last 15 years. Many homes in the East Shore are within a designated Wildland-Urban Interface (WUI) zone, which is a zone where homes are built near or among lands prone to wildfire—a rarity in major cities such as New York.

Priorities from Public Engagement in the East and South Shores of Staten Island

Since the Special Initiative for Rebuilding and Resiliency (SIRR) was launched in December 2012, the input of local stakeholders has helped shape an understanding of what happened during Sandy, what risks the East and South Shores face in relation to climate change and what approaches make sense to address these risks.

The East and South Shores are represented by a wide array of elected officials at the Federal, State, and local levels. They also are represented by three Community Boards. The area is served further by a large number of community-based organizations, civic groups, faith-based organizations, and other neighborhood stakeholders. All played an important role in relief and recovery efforts after Sandy. Throughout the process of developing this plan, SIRR staff benefited from numerous working sessions—both formal and informal—with these groups and individuals, including, in the East and South Shores, two task forces that met regularly.

SIRR also held two public workshops in March of 2013 in Staten Island, part of a series of such workshops held citywide in which over 1,000 New Yorkers participated to discuss issues affecting their neighborhoods and communicate their priorities for the future of their homes and communities. On the East and South Shores, attendees expressed concern that programs designed to work in other boroughs of the city may not work in these communities. Generally, the on-the-ground insights provided at these public workshops helped SIRR staff to develop a deeper understanding of the specific priorities of, and challenges facing, the communities of the East and South Shors.

East and South Shores of Staten Island community outreach workshop

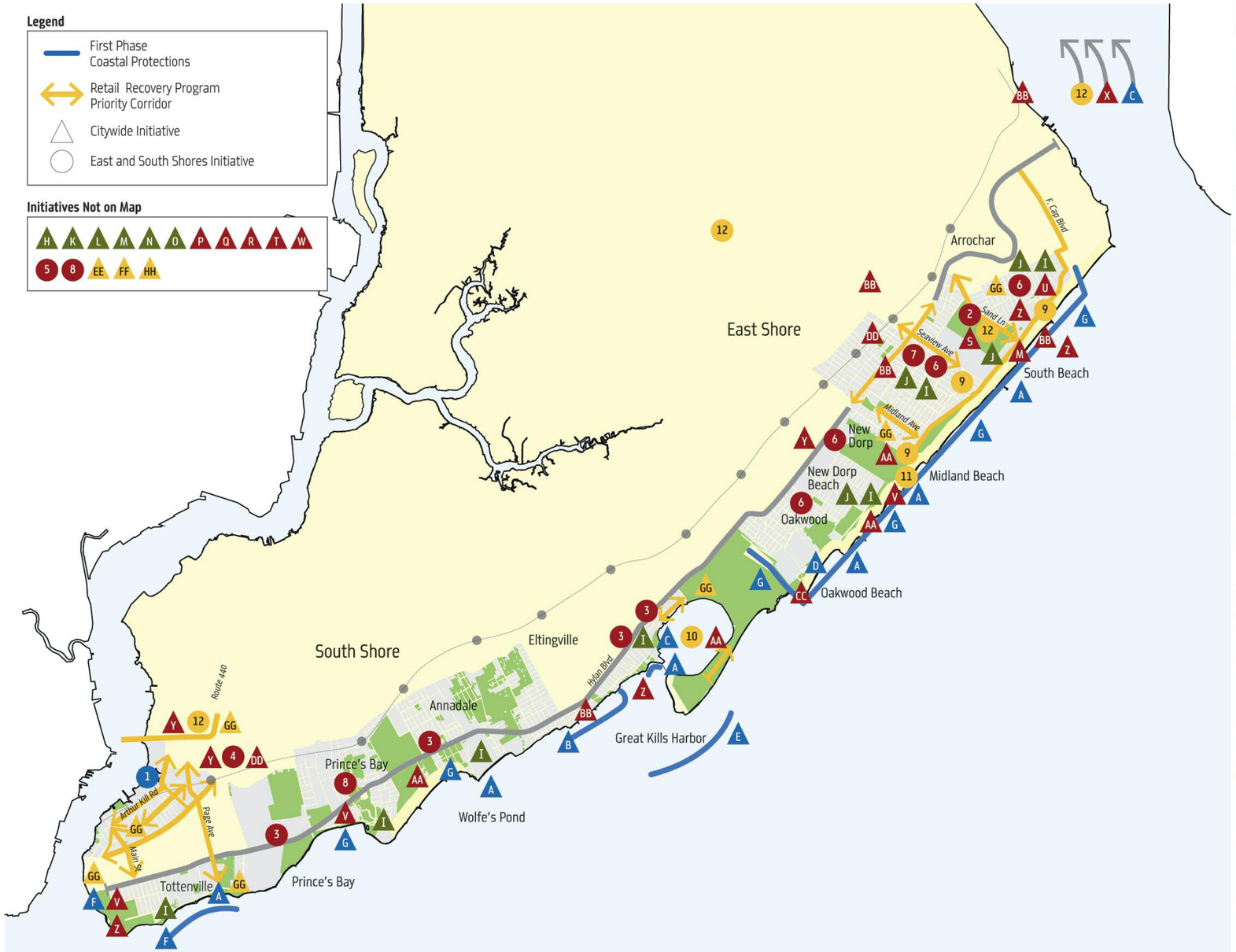
Task Force	Briefing Frequency	# of Stakeholders from the East and South Shores
Elected Officials	Monthly	• ~13 City, State, Federal elected officials
Community-based Organizations	4 - 6 weeks	• 3 community boards • 20+ faith-based, business, and community organizations

Overall, out of the various task force and other meetings and public workshops attended by SIRR staff since January, several priorities for the East and South Shores and the SIRR effort at large clearly emerged:

- Developing coastal/shoreline protections, while still ensuring public access to the waterfront;
- Protecting low-lying areas, by exploring more effective drainage systems, including the accelerated build-out and ultimate completion of Bluebelts;
- Developing programs to address the financial and physical challenges of rebuilding homes;
- Revitalizing local business corridors and waterfronts and marinas; and
- Preserving neighborhood character and affordability during neighborhood recovery and rebuilding.

East and South Shores of Staten Island community outreach workshop

EAST AND SOUTH SHORES STATEN ISLAND | Initiative Summary



Coastal Protection

Selected Citywide Measures

- A — Complete short-term beach nourishment, dune construction, and shoreline protection on Staten Island
- B — Install armor stone shoreline protection (revetments) on Staten Island
- C — Raise bulkheads in low-lying neighborhoods to minimize inland tidal flooding
- D — Call on and work with the USACE to complete emergency floodgate repairs at Oakwood Beach
- E — Call on and work with the USACE to develop an implementation plan for the installation of offshore breakwaters adjacent to and south of Great Kills Harbor
- F — Call on and work with the USACE to develop an implementation plan for, and install, living shorelines for wave attenuation in Tottenville.
- G — Call on and work with the USACE to complete existing studies on Staten Island and implement coastal protection projects

* For additional Coastal Protection initiatives, see Coastal Protection section of Community Plan

- 1 — Call on and work with the USACE to study the construction of a floodgate at Mill Creek

Buildings

Selected Citywide Measures

- H — Improve regulations for flood resiliency of new and substantially improved buildings in the 100-year floodplain
- I — Rebuild and repair housing units destroyed and substantially damaged by Sandy
- J — Study and implement zoning changes to encourage retrofits of existing buildings and construction of new resilient buildings in the 100-year floodplain
- K — Amend Building Code and complete studies to strengthen wind resiliency for new and substantially improved buildings
- L — Encourage existing buildings in the 100-year floodplain to adopt flood resiliency measures through an incentive program and targeted mandate
- M — Launch a sales tax abatement program for flood resiliency in industrial buildings
- N — Clarify regulations relating to the retrofit of landmarked structures in the 100-year floodplain
- O — Amend the building code to improve wind resiliency for existing buildings and complete studies of potential retrofits

* For additional Buildings initiatives, see Buildings section of Community Plan

Critical Infrastructure

Selected Citywide Measures

- P — Work with utilities and the Public Service Commission (PSC) to harden key electric transmission and distribution infrastructure against flooding
- Q — Work with utilities and the PSC to harden vulnerable overhead lines against winds
- R — Work with utilities, regulators, and gas pipeline operators to harden the natural gas system against flooding
- S — Require the retrofitting of existing hospitals in floodplains
- T — Require retrofitting of nursing homes in floodplains
- U — Require retrofitting of adult care facilities in floodplains
- V — Reconstruct and resurface streets damaged by Sandy
- W — Elevate traffic signals and provide backup electrical power
- X — Protect Staten Island Ferry and private ferry terminals from climate change-related threats
- Y — Call on non-City agencies to implement strategies to address climate change threats
- Z — Restore city beaches
- AA — Harden or otherwise modify shoreline parks to protect adjacent communities
- BB — Harden pumping stations
- CC — Harden wastewater treatment plants
- DD — Continue to implement and accelerate investments in Bluebelts across the city

* For additional Critical Infrastructure initiatives, see Critical Infrastructure sections of Community Plan

- 2 — Assist Staten Island University Hospital in applying for hazard mitigation funding
- 3 — Implement and expedite roadway and sewer capital projects along Hylan Boulevard, especially in vulnerable South Shore areas
- 4 — Call on and work with the MTA to create an implementation plan for the relocation of Richmond Valley SIR station to Page Avenue
- 5 — Study potential new ferry routes serving Staten Island and issue Request for Expression of Interest to gauge market interest
- 6 — Secure available Federal funding to implement the Community Wildfire Protection Plan for fire-prone areas on the East Shore
- 7 — Launch the first capital project for the Mid-Island Bluebelt in Midland Beach
- 8 — Explore expansion of the City's mitigation banking pilot as a funding mechanism to facilitate the construction of the Mid-Island and South Shore Bluebelts

Community & Economic Recovery

Selected Citywide Measures

- EE — Launch business recovery and resiliency programs
- FF — Launch the Neighborhood Game-Changer Competition
- Call for Neighborhood Retail Recovery Program
  - Great Kills Harbor (Full length of Mansion Avenue; portion of Buffalo Street adjoining Nichols Marina)
  - Hylan Boulevard (between Seaver Ave and New Dorp Lane); Main Street Tottenville (between Ellis Street and Amboy Road)
  - Main Street Tottenville (betweem Ellis Street and Amboy Road)
  - Midland Avenue (between Mason Avenue and Father Capodanno Blvd.)
  - Page Avenue Corridor (all streets between Arthur Kill Road, Nassau Place/Bethel Avenue, Amboy Road, Page Avenue, and Route 440)
  - Sand Lane (Sand Lane, between McClean Avenue and Father Capodanno Blvd., and Robin Road, between Arthur Avenue and Sand Lane)
  - Seaview Avenue (between Hylan Boulevard and Patterson Avenue)
- GG — Support local merchants in improving and promoting local commercial corridors
- HH — Continue to support the FRESH program to increase the number of full-line grocers in underserved neighborhoods

- 9 — Issue a Request for Expression of Interest (RFEI) for new concessions and services at City-controlled beaches in the East Shore
- 10 — Create a comprehensive revitalization plan for Great Kills Harbor to increase resiliency and to draw additional investment
- 11 — Create a strategic plan for public recreational land, including the beachfront recreation areas and open space
- 12 — Implement planned and on-going investments by the City and private partners
  - Ocean Breeze Track and Field Athletic Complex
  - Charleston Mixed-Use Development
  - New Stapleton Waterfront (Homeport) Redevelopment
  - St. George Waterfront Redevelopment
  - Former Coast Guard Site Development
  - Brielle Avenue Municipal Site

This chapter contains a series of initiatives that are designed to mitigate the impacts of climate change on the East and South Shores of Staten Island. In many cases, these initiatives are both ready to proceed and have identified funding sources assigned to cover their costs. With respect to these initiatives, the City intends to proceed with them as quickly as practicable, upon the receipt of identified funding.

Meanwhile, in the case of certain other initiatives described in this chapter, though these initiatives may be ready to proceed, they still do not have specific sources of funding assigned to them. In Chapter 19 (*Funding*), the City describes additional funding sources, which, if secured, would be sufficient to fund the full first phase of projects and programs described in this document over a 10-year period. The City will work aggressively on securing this funding and any necessary third-party approvals required in connection therewith (i.e., from the Federal or State governments). However, until such time as these sources are secured, the City will only proceed with those initiatives for which it has adequate funding.

East and South Shores Community Rebuilding and Resiliency Plan

The East and South Shores offer unparalleled access to beautiful beaches, the waterfront, and a network of public parks. Not surprisingly, this area inspires deep feelings of pride, community, and identity among area residents.

The following is a multilayered plan for the East and South Shores that not only applies citywide strategies to the area but also provides strategies designed to address specific local needs and vulnerabilities. In anticipation of future climate change-related risks, this plan proposes ways that East and South Shore neighborhoods can adapt by: Addressing inundation along the entire coastline; providing opportunities to retrofit the area's most vulnerable housing stock; protecting and improving critical infrastructure; and focusing investments in strategic areas, such as the beachfront, to advance a long-term and sustainable recovery.

Coastal Protection

As Sandy illustrated, the greatest extreme weather-related risks faced by New York City is storm surge, the effects of which are likely to increase given current projections of sea level rise. Going forward, it is anticipated that climate change will render coastal regions of the city, including the East and South Shores, even more vulnerable to these risks.

While it is impossible to eliminate the chance of flooding in coastal areas, the City will seek to reduce its frequency and effects—mitigating the impacts of sea level rise, storm waves and erosion, and inundation on the coastline of the city generally and the East and South Shores in particular. Among the strategies that the City will use to achieve these goals will be the following: Increasing coastal edge elevations; minimizing upland wave zones; protecting against storm surge; and improving coastal design and governance. When evaluating coastal protection, other priorities including navigation, ongoing efforts to improve water quality and natural habitats, will also be considered prior to implementation, where appropriate.

The initiatives described below provide important examples of how the City intends to advance its coastal protection agenda citywide. These initiatives will have a significant impact on the residents, businesses, and nonprofits of the East and South Shores. Taken together, when completed, the first seven coastal protection initiatives described below would provide enhanced protection for over 9,300 buildings representing over 10,000 housing units as well as many businesses and much of the critical infrastructure in the East and South Shores. For a full explanation of the following initiatives and a complete description of the City's comprehensive coastal protection plan, please refer to Chapter 3 (*Coastal Protection*).

Coastal Protection Initiative 3
Complete short-term beach nourishment, dune construction, and shoreline protection on Staten Island

The loss of sand from Staten Island's beaches has left several neighborhoods exposed and vulnerable to future storms. The City, therefore, will complete beach nourishment and short-term dune improvements along these beaches, including a beach nourishment project encompassing South Beach, Crescent Beach, and Tottenville; dune construction from New Dorp Beach to Oakwood Beach; and shoreline stabilization to close the breach at Wolfe's Pond Park. This work will make effective use of existing Federal appropriations and will enhance protection concurrent with the upcoming hurricane season and beyond. DPR will oversee these efforts.

Coastal Protection Initiative 5
Install armor stone shoreline protection (revetments) on Staten Island

As a result of erosion that occurred during Sandy, the South Shore's beaches and bluffs are more exposed to erosion and damage. To address this risk, subject to available funding, the City will install a first phase of revetments (shoreline protection constructed with armor stone) in vulnerable locations along the coastline of neighborhoods such as Annadale, south of Great Kills Harbor. This project will increase the area's resiliency and demonstrate the effectiveness of such shoreline erosion control. The Mayor's Office of Long Term Planning and Sustainability (OLTPS), working with NYCEDC, will design this shoreline protection to mitigate erosion of vulnerable coastal edges and flooding in low-lying areas during lesser storms. The goal is to begin design work in 2013 and complete within three years.

Coastal Protection Initiative 6
Raise bulkheads in low-lying neighborhoods to minimize inland tidal flooding

Bulkheads provide the first line of defense against flooding in many neighborhoods, including Great Kills, and in North Shore neighborhoods such as Stapleton and St. George, but throughout the city many bulkheads are built to an elevation that may be insufficient given the latest projections of sea level rise by 2050. Subject to available funding, the City, therefore, will launch a program to raise bulkheads and other shoreline structures across the five boroughs in low-lying areas most at risk of daily or weekly tidal flooding, a phenomenon that could impact approximately 2 miles of the East and South Shores' coastlines by the 2050s. OLTPS will work with NYCEDC to manage this program, to begin implementation in 2013, in conjunction with the new citywide waterfront inspections program described in Chapter 3.

Buried Levee at South Beach

Non-storm conditions

During storm conditions

Coastal Protection Initiative 9
Continue to work with the USACE to complete emergency floodgate repairs at Oakwood Beach

The failure of a floodgate in Oakwood Beach has left the neighborhood and surrounding areas vulnerable to future storms. The City, therefore, will call upon the US Army Corps of Engineers (USACE) to complete floodgate repairs at this location. This work will begin in June 2013 and end by December 2013, providing protection during the 2013 hurricane season and beyond.

Coastal Protection Initiative 13
Call on and work with the USACE to study and install offshore breakwaters adjacent to and south of Great Kills Harbor

Marinas, businesses, and multiple residential communities adjacent to and south of Great Kills Harbor face an increasing risk of wave action and erosion during extreme weather events that could undermind shoreline bluffs and damage homes. To address this risk, subject to available funding, the City will call on the USACE to develop an implementation plan for off-shore breakwaters that provide cost-effective wave attenuation. This offshore breakwater project will be designed to mitigate waves before they act upon the shoreline, minimizing their destructive forces in vulnerable neighborhoods. The goal is to complete this project within four years of completing a USACE study.

Coastal Protection Initiative 15
Call on and work with the USACE to study and install living shorelines for wave attenuation in Tottenville

Tottenville, the southernmost community in Staten Island, was hard-hit by Sandy's flooding and wave action. To address this community's vulnerability, the City will call on the USACE to develop and implement a living shoreline project to protect the neighborhood and to demonstrate the effectiveness of this approach to wave attenuation on the open Lower Bay. Based on this plan, DPR will design and install this living shoreline project—likely to consist of oyster reef breakwaters, beach nourishment, and maritime forest enhancements—in areas adjacent to Conference House Park in

Tottenville. If this project is demonstrated to be effective, other neighborhoods along the South Shore could be protected by future phases of work. The goal is to complete this project within four years of completing a USACE study.

Coastal Protection Initiative 24

Continue to work with the USACE to complete existing studies on Staten Island and implement coastal protection projects

Without additional protection, the East and South Shores remain vulnerable to storm surge and flooding. The City will, therefore, call upon the USACE to complete a longstanding study of flood risk reduction on the East and South Shores on an expedited basis and then to implement the recommended actions, as soon as practicable. This work will make effective use of existing Federal appropriations to advance meaningful flood protection projects. It is expected that the first phase of this study will be completed in 2014, which should lead to the construction of robust protections such as floodwalls and levees in front of the existing boardwalk on the East Shore from Fort Wadsworth to Great Kills. The City will work with the USACE to determine the approach and specific locations for these protections. If a local match for Phase 1 measures is required by the USACE, the City will work to secure the necessary resources. As part of this initiative, the City and the USACE will develop a plan for ongoing beach nourishment to restore sand rapidly after extreme weather events. The second phase of this study is expected to be completed in 2016. This should lead to additional flood protection projects between Great Kills and Tottenville on the South Shore. Two City agencies, DEP and DPR, will oversee these efforts. *(See renderings: Buried Levee at South Beach)*

Beyond the priority coastal protection projects described in Chapter 3, including those summarized briefly above, the City is proposing an additional coastal protection initiative specific to the vulnerabilities of the East and South Shores.

East and South Shore Initiative 1

Call on and work with the USACE to study the construction of a floodgate at Mill Creek

The South Shore's creeks and tributaries are vulnerable to inundation and flooding and will become more so in the future. To address this vulnerability, the City will call for the study of a floodgate at the mouth of Mill Creek, an effort that potentially could be incorporated into the existing USACE study of the South Shore's coastline. Floodgates allow storm water to flow out of waterways while preventing seawater backflow from inundating these waterways in reverse. Such an investment would provide protection against the potential flooding of important assets such as the SIR. It also could serve to demonstrate the viability of a potential mitigation strategy for other vulnerable waterways along the South Shore, including Lemon Creek.

Buildings

The city's buildings give physical form to New York. As Sandy demonstrated, however, the building stock citywide, including in the East and South Shores, is highly vulnerable to extreme weather events—a vulnerability that is expected to increase in the future. While the coastal protection measures outlined above are designed to reduce the effects of sea level rise, storm surge, and wave action on the city and the East and South Shores, these measures will not completely eliminate those risks. They also will take time to design, fund, and build. It is equally important, therefore, to supplement these measures by pursuing resiliency at the building level.

To achieve building-level resiliency, the City will seek to protect structures in the East and South Shores and throughout the five boroughs against a spectrum of climate risks, including not only flooding but also high winds and other extreme events. Among the strategies that the City will use to achieve these goals will be to construct new buildings to the highest resiliency standards and retrofit as many existing buildings as possible so that they will be significantly better prepared to handle the impacts of extreme weather events.

The initiatives described below provide important examples of how the City intends to advance building resiliency citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits of the East and South Shores. For a full explanation of the following initiatives and a complete description of the City's five-borough building resiliency plan, please refer to Chapter 4 (*Buildings*).

Buildings Initiative 1

Improve regulations for flood resiliency of new and substantially improved buildings in the 100-year floodplain

Though buildings constructed to modern Construction Codes generally performed well during Sandy, given the increasing risk of flooding that is likely with climate change, modifications are warranted. The City, therefore, will seek to amend the Construction Codes and Zoning Resolution to provide for strengthened requirements that will, among other things, improve the design of new buildings through the application of appropriate resiliency measures that are calibrated to the best floodplain data available over time and help ensure that critical building systems are better-protected from flood risks. In 2013, the City, through OLTPS, will seek to implement these code changes and the Department of City Planning (DCP) will continue to take zoning changes through the public review process, with the goal of adoption before the end of the year. If adopted, they will improve resiliency for the significant amount of mixed-use development likely to take place within the 100-year floodplain over time throughout the East and South Shores.

Buildings Initiative 2

Rebuild and repair housing units destroyed and substantially damaged by Sandy

Roughly 23,000 private residential buildings encompassing nearly 70,000 housing units were damaged or destroyed during Sandy. Subject to available funding, the City, therefore, through the Mayor's Office of Housing Recovery Operations (HRO), will provide financial and other assistance to owners of residential properties that were destroyed or substantially damaged during Sandy, including to approximately 380 residential buildings encompassing approximately 500 housing units in the East and South Shores. To address the damages sustained and to more effectively prepare these significantly damaged buildings for future storm events, the City either will assist owners or, in limited cases meeting City criteria, will facilitate the acquisition of properties by new owners whom it will assist, in rebuilding and substantially improving these properties based on the best floodplain data available over time. Additionally, the City is seeking to incorporate resiliency measures into approximately 500 to 600 multifamily properties that sustained minor damage including many publicly assisted properties such as those developed pursuant to the Mitchell-Lama program and other affordable housing programs. The City, therefore, will support the retrofit of these publicly-assisted buildings, such as those developed pursuant to Mitchell-Lama and other affordable housing programs.

Buildings Initiative 3

Study and implement zoning changes to encourage retrofits of existing buildings and construction of new resilient buildings in the 100-year floodplain

The City, through DCP, will undertake a series of citywide and neighborhood-specific land use studies to address key planning issues in severely affected and vulnerable communities. As part of these studies, the City will identify ways to facilitate the voluntary construction of new, more resilient building stock, and to encourage voluntary retrofits of existing vulnerable buildings over time. To be undertaken in close consultation with local residents, elected officials, and other community stakeholders, these land use studies will focus on the challenges posed by the combination of flood exposure of the applicable neighborhoods; the vulnerability of the building types that are found in these neighborhoods (e.g., older, 1-story bungalows); and site conditions in these areas (e.g., narrow lots) that can make elevation or retrofit of vulnerable buildings expensive or complicated. These studies will be coordinated with other area studies, including those examining beachfront revitalization, Bluebelt expansion and open space and transportation.

DCP will examine neighborhoods including East Shore communities that were severely damaged during Sandy and previous storms. In neighborhoods like Midland Beach, zoning changes may include mechanisms to accommodate or even encourage retrofits of buildings on existing lots, and the voluntary construction of resilient housing through the combination of smaller lots. Any new development in these neighborhoods would be consistent with the area's low density character and would be required to include resiliency measures. Other communities that may also be studied include South Beach and New Dorp Beach.

Subject to consultation with local elected officials and community members, DCP will also examine the need for resilient housing and measures in the beachfront communities of the East Shore, along Father Capodanno Boulevard. Oceanfront developments that performed well during Sandy and other extreme weather events, such as Arverne By The Sea in the Rockaways, and new coastal designs on Staten Island, such as the proposed Homeport development in Stapleton, would be studied as best practice. All studies will also analyze ways in which retrofits and rebuilding can help to revitalize local commercial corridors and the beachfront as a whole, along the East Shore.

Subject to available funding, the goal is for DCP to commence study in 2013. Thereafter, DCP would move to implement changes, if any, that it deems to be appropriate based on the results.

Buildings Initiative 4

Launch a competition to encourage development of new, cost-effective housing types to replace vulnerable stock

Subject to available funding, the City, through the Department of Housing Preservation and Development (HPD), will launch an international competition called the Resilient Housing Design Competition. This competition will offer prizes to private-sector developers who design and develop new, high-quality housing prototypes that offer owners of vulnerable building types (e.g., older, 1-story bungalows) a cost-effective path that is consistent with city building and zoning requirements and meets the highest resiliency standards. In addition to cash prizes, the winners of this competition will be given the opportunity to put these structures into service in connection with a City-sponsored development project. Prototypes will have applicability throughout the five boroughs, including in sections of the East and South Shores, such as Midland Beach and other vulnerable low-density communities. The goal is for HPD to launch this competition in 2013.

Buildings Initiative 5

Work with New York State to identify eligible communities for the New York Smart Home Buyout Program

The City will evaluate opportunities for collaboration with the State in connection with its home buyout program, using an objective set of criteria developed by the City, including extreme vulnerability, consensus among a critical mass of contiguous local residents, and other relevant factors. It is anticipated that these criteria will be met in a limited number of areas citywide. As of the writing of this report, the City had expressed support for buyout negotiations under this program that were ongoing between a group of Oakwood Beach homeowners and the staff of New York State Homes and Community Renewal.

Buildings Initiative 6

Amend the Building Code and complete studies to strengthen wind resiliency for new and substantially improved buildings

As noted above, buildings constructed to modern Building Code standards generally performed well during Sandy. Sandy, however, brought relatively weak winds, compared to other hurricanes. Given the possibility of more frequent or intense wind events in the future, modifications to the Building Code are warranted. The City, therefore, through OLTPS will seek to amend the Building Code to provide for strengthened requirements so that new buildings citywide can meet enhanced standards for wind resiliency. The City will further study whether additional wind resiliency standards should be required going forward. The amendments will be submitted to the City Council for adoption, and the study will commence, in 2013.

Buildings Initiative 7

Encourage existing buildings in the 100-year floodplain to adopt flood resiliency measures through an incentive program and targeted mandate

Even if every structure destroyed or damaged by Sandy were rebuilt to the highest resiliency standards, this would still leave tens of thousands of existing structures in the 100-year floodplain vulnerable—with more becoming vulnerable as the climate changes. Subject to available funding, the City, therefore, will launch a $1.2 billion program to provide incentives to owners of existing buildings in the 100-year floodplain to encourage them to make resiliency investments in those buildings. Of the up to $1.2 billion available through the program, the City will reserve up to $100 million for 1- to 3-family homes, up to $500 million for distribution across the five boroughs based on each borough's share of vulnerable buildings citywide, and $100 million for affordable housing developments.

The City also will mandate that large buildings (those with seven or more stories that are more than 300,000 square feet in size) undertake certain flood resiliency investments by 2030. If the City consistently achieves its stated goal of encouraging significant resiliency retrofit investments for the vast majority of the built floor area in the 100-year floodplain in the five boroughs, nearly 7,500 housing units encompassing approximately 12 million square feet of built space in the East and South Shores would, over time, be made meaningfully less vulnerable. The goal is to launch these programs in 2013.

Buildings Initiative 8

Establish Community Design Centers to assist property owners in developing design solutions for reconstruction and retrofitting, and connect them to available City programs

The City, through HRO, will establish Community Design Centers in neighborhoods across the city, potentially including the East and South Shores, to assist property owners in developing design solutions for reconstruction and retrofitting, and connect them to available City

programs. The Centers would be managed by the City—through agencies such as HRO, HPD, DOB, DCP, and NYCEDC—with support from local partners.

Buildings Initiative 10
Launch a sales tax abatement program for flood resiliency in industrial buildings

As Sandy demonstrated, many industrial buildings are vulnerable to extreme weather, with more likely to become vulnerable as the climate changes. However, many industrial buildings operate on thin margins making it challenging to invest in resiliency. The City, through the New York City Industrial Development Agency (NYCIDA), therefore, will launch a $10 million program to provide incentives to owners of industrial buildings to encourage them to make resiliency investments in those buildings. The program will prioritize 1- to 2-story buildings with more than four feet between their actual ground elevation and the applicable BFE. In the East and South Shores, seven industrial buildings with over 68,000 square feet of floor area will be eligible for this program. This program will be launched in 2013.

Buildings Initiative 11
Launch a competition to increase flood resiliency in building systems

Many existing strategies for improving resiliency in buildings are either imperfect, expensive, or a combination of both. The City, through NYCEDC, therefore, will launch an approximately $40 million Resiliency Technologies Competition using allocated Community Development Block Grant (CDBG) funding to encourage the development, deployment, and testing of new resiliency technologies for building systems. In the East and South Shores, approximately 9,730 buildings will be eligible to benefit from this competition. The program will be launched in 2013.

Buildings Initiative 12
Clarify regulations relating to the retrofit of landmarked structures in the 100-year floodplain

The City, through the Landmarks Preservation Commission (LPC) will clarify the Commission's regulations to assist owners of landmarked buildings and properties in landmarked districts in the 100-year floodplain who are contemplating retrofit projects. Currently in the East and South Shores, there are a total of seven landmarked buildings, with two in the floodplain shown in FEMA's PWMs. The Commission will issue its clarifying regulations in 2013.

Buildings Initiative 13
Amend the building code to improve wind resiliency for existing buildings and complete studies of potential retrofits

As noted above, given the possibility for more frequent intense wind events in the future, modifications to the Building Code are warranted. The City therefore, through OLTPS, will seek to amend the Building Code and expand the existing DOB Façade Inspection Safety Program for high-rise buildings to include rooftop structures and equipment. The City will further study whether additional wind resiliency standards are required going forward. These amendments will be submitted to the City Council for adoption, and the study will commence, in 2013.

Insurance

Insurance can help provide residents and businesses with financial protection against losses from climate change and other types of risks. Sandy not only highlighted the importance of insurance, it also revealed that many New Yorkers are exposed to flood losses, which are not covered in standard homeowners or small business property insurance policies. Citywide, 95 percent of homeowners carry homeowners insurance, but when Sandy struck less than 50 percent of residential buildings in the effective 100-year floodplain had coverage through the National Flood Insurance Program (NFIP), a federal program administered by FEMA that provides flood insurance to properties in participating communities like New York City. While larger properties, in particular large commercial properties, tend to purchase flood insurance through the private market, NFIP is the primary source of flood insurance for homeowners throughout the country. The City estimates that, in areas of the East and South Shores inundated by Sandy, less than 35 percent of residential properties typically insured under the NFIP, including 1- and 2-family homes, amongst others, actually had policies in force during Sandy. Furthermore, Sandy drew attention to the significant cost increases in flood insurance that many New Yorkers will soon face, resulting from recent reforms to the NFIP as required by the Biggert-Waters Flood Insurance Reform Act.

The City will use several strategies to encourage more New Yorkers to seek coverage and to help ensure the NFIP meets the needs of policyholders citywide. Specifically, the City will work to: Address affordability issues for the most financially vulnerable policyholders; define mitigation measures that are feasible in an urban environment, such as East and South Shore communities, and create commensurate premium credits to lower the cost of insurance for property owners who invest in these measures; encourage the NFIP to expand pricing options (including options for higher deductibles) to give potential policyholders more flexibility to make choices about coverage; and launch efforts to improve consumer awareness, to help policyholders make informed choices. The initiatives described below are important examples of how the City will advance these strategies. These initiatives will have a major impact on the residents, small businesses and nonprofits in the East and South Shores. For a full explanation of the following initiatives and a complete description of the City's five-borough insurance reform plan, please refer to Chapter 5 (*Insurance*).

Insurance Initiative 1
Support Federal efforts to address affordability issues related to reform of the NFIP

The City will call on FEMA to work with the National Academy of Sciences to complete the study of flood insurance affordability, as required under the Biggert-Waters Act. The City will urge its Federal government partners to comply with this provision of the Act and take swift action to enact the recommendations.

Insurance Initiative 4
Call on FEMA to develop mitigation credits for resiliency measures

The NFIP provides few incentives for property owners to protect their buildings from flood damage and reduce their premiums, other than by elevating their buildings—actually lifting structures above flood elevation levels. In an urban environment such as the East and South Shores, for a variety of reasons, elevation can be impractical, undesirable, and/or economically infeasible. Fortunately, other mitigation options are available. The City, therefore, will call upon FEMA to provide appropriate premium credits for mitigation measures other than elevation.

Insurance Initiative 6
Call on FEMA to allow residential policyholders to select higher deductibles

Flexible pricing options can encourage more people, especially those not required to carry insurance, to purchase insurance coverage that suits their needs. A higher-deductible option can substantially reduce premium costs to policyholders while remaining truly risk-based. Currently under the NFIP, deductibles up to $50,000 are allowed for commercial policies, but residential policies are limited to a maximum deductible of $5,000. The City, therefore, will call upon FEMA to allow homeowners that are not required to carry NFIP policies to purchase high-deductible policies, protecting them from catastrophic loss. Initial estimates indicate that doing so could reduce insurance premiums by about half.

Critical Infrastructure

A resilient New York requires protection of its critical services and systems from extreme weather events and the impacts of climate change. This infrastructure includes the city's utilities and liquid fuel system, its hospitals and other healthcare facilities, telecommunications network, transportation system, parks, wastewater treatment and drainage systems, as well as other critical networks—all vital to keeping the city, including the East and South Shores, running.

Utilities

The city's electric, natural gas, and steam systems are essential to everyday life in areas throughout the five boroughs, including the East and South Shores. As Sandy proved, however, these systems are highly vulnerable to extreme weather events, with 800,000 customers losing electricity and 80,000 customers losing natural gas service during Sandy across the city, including approximately 180,000 that lost electricity in the borough of Staten Island. This vulnerability will only grow as the climate changes.

Among the strategies that the City will use to address these challenges for residents of the East and South Shores and other parts of the city will be to: Call for risk-based analysis of low-probability but high-impact weather events to be incorporated into utility regulation and investment decision-making; call for capital investments that harden energy infrastructure and make systems more flexible in responding to disruptions and managing demand; and better diversify the city's sources of energy. The initiatives described below provide important examples of how the City intends to advance utilities resiliency citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits of the East and South Shores. For a full explanation of the following initiatives and a complete description of the City's five-borough utilities resiliency plan, please refer to Chapter 6 (*Utilities*).

Utilities Initiative 5
Work with utilities and the Public Service Commission (PSC) to harden key electric transmission and distribution infrastructure against flooding

Various transmission substations, distribution substations, utility tunnels, and underground equipment in the city are at risk of flooding during extreme weather. For example, 40 percent of transmission substations are in the 100-year floodplain today, and 67 percent are likely to be in the 100-year floodplain by the 2050s. The City, through OLTPS, will work with Con Edison and the Long Island Power Authority (LIPA) to prioritize these assets based on their roles in system reliability and to harden them as appropriate. This effort will begin in 2013.

Utilities Initiative 6
Work with utilities and the PSC to harden vulnerable overhead lines against winds

During extreme weather events, high winds and downed trees threaten overhead electric poles, transformers, and cables. The City, through OLTPS, will work with Con Edison and LIPA to manage the risk of wind and downed-tree damage through tree maintenance, line strengthening, and a line-relocation program. In some limited cases, rerouting lines underground may also be warranted, depending on the outcome of a cost-benefit analysis to be performed in partnership with the utilities. This effort will begin in 2013.

Utilities Initiative 7
Work with utilities, regulators, and gas pipeline operators to harden the natural gas system against flooding

Although the city's high-pressure gas transmission system performed relatively well during Sandy, there were instances where remote operation of parts of the system failed. Additionally, the distribution system had localized outages due to water infiltration. Seeking to limit the compromising effects of future floods on both the system's backbone and the ability of Con Edison and National Grid to control and monitor the system, the City, through OLTPS, will work with the PSC, Con Edison, and National Grid to harden control equipment against flooding. In addition, the City will call upon Con Edison and National Grid to take steps to prevent water from infiltrating its gas pipes. This effort will begin in 2013.

Utilities Initiative 21
Work with public and private partners to scale up distributed generation (DG), including microgrids

The city's DG systems, including microgrids, have the potential for significant expansion—but are constrained by regulations, financing challenges, and lack of information. The City, through OLTPS and the New York City Distributed Generation Collaborative—a stakeholder group convened by the City in 2012—will continue efforts to achieve a PlaNYC goal of installing 800 megawatts of DG citywide by 2030. These efforts will include reform of PSC tariffs and other regulatory changes, expansion of low-cost financing, and provision of technical assistance to property owners and developers. This ongoing effort will continue in 2013.

Liquid Fuels

The liquid fuels supply chain is essential for everyday life throughout the five boroughs, including in the East and South Shores. Sandy demonstrated the vulnerability of this system to extreme weather events. In the aftermath of Sandy, citywide—and particularly in the East and South Shores—there were long lines at gas stations and other challenges for drivers, including emergency responders. The vulnerability of this system will only grow as the climate changes.

Among the strategies that the City will use to address these challenges for residents of the East and South Shores and other parts of the city will be to: Develop a strategy for the hardening of liquid fuel infrastructure along the supply chain; increase redundancy and fuel supply flexibility; and increase supply availability for vehicles critical to the city's infrastructure, safety, and recovery from significant weather events. The initiatives described below provide important examples of how the City intends to advance its liquid fuel resiliency agenda citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits of the East and South Shores. For a full explanation of the following initiatives and a complete description of the City's five-borough liquid fuels resiliency plan, please refer to Chapter 7 (*Liquid Fuels*).

Liquid Fuels Initiative 1
Call on the Federal government to convene a regional working group to develop a fuel infrastructure hardening strategy

The fuel supply shortage after Sandy was caused mainly by damage to infrastructure in New Jersey, where the City and State of New

York have no regulatory or legislative authority or oversight. The City, through OLTPS, will call on the Federal Hurricane Sandy Rebuilding Task Force and the United States Department of Energy to convene regional stakeholders to develop a strategy for hardening key infrastructure against future extreme weather. This effort will be launched in 2013.

Liquid Fuels Initiative 4
Work with New York State to provide incentives for the hardening of gas stations to withstand extreme weather events

New York State's 2013-2014 budget required that certain retail fuel stations invest in equipment that would allow them to connect generators quickly in the event of a power loss, and enter into supply contracts for emergency generators. The City, through OLTPS, will support the State in the design and implementation of this generator program, an effort that will include working with the New York State Energy Research and Development Authority (NYSERDA) to develop an incentive program to minimize the financial impact of the requirements on the businesses involved. In addition, OLTPS will work with the State to develop incentives to encourage retail fuel stations to implement resiliency measures other than backup power capability. This effort will be launched in 2013.

Liquid Fuels Initiative 5
Enable a subset of gas stations and terminals to have access to backup generators in case of widespread power outages

Gas stations are vulnerable to widespread power outages resulting from extreme weather events, which could prevent them from dispensing fuel. In New York State's 2013-2014 budget, NYSERDA was directed to develop a generator pool program for gas stations. The City, through its Office of Emergency Management (OEM), will work with NYSERDA, FEMA, and the USACE in 2013 and beyond to develop such a pool and to create a pre-event positioning plan to enable the ready deployment of generators to impacted areas in the wake of a disaster.

Liquid Fuels Initiative 8
Develop a package of City, State, and Federal regulatory actions to address liquid fuel shortages during emergencies

Various regulations relating to the transportation and consumption of fuels in New York City limit the flexibility of the market to respond to disruptions, including following extreme weather events. The City, through OEM, will work with the State and Federal governments to prepare an "off-the-shelf" package of regulatory measures for use in the event of a liquid fuels shortage to allow supply-demand imbalances in the fuel supply to be mitigated more quickly. This effort will be launched in 2013.

Liquid Fuels Initiative 9
Harden municipal fueling stations and enhance mobile fueling capability to support both City government and critical fleets

The City must be able to respond quickly to a fuel supply disruption, providing continuous fueling to vehicles that are critical for emergency response, infrastructure rebuilding, and disaster relief. The City, through the Department of Citywide Administrative Services (DCAS), will procure fuel trucks, generators, light towers, forklifts, and water pumps to permit the City to put in place emergency fueling operations immediately following a disruption in the fuel supply chain. DCAS also will issue a Request for Expressions of Interest (RFEI) to potential suppliers of liquid fuels to evaluate options for sourcing such fuel during emergencies. The procurement effort will be launched in 2013, with the RFEI to follow in 2014.

Healthcare

The city's healthcare sector is critical to the well-being of New Yorkers throughout the five boroughs, including in the East and South Shores. It is also a major economic engine for the city as a whole. The East and South Shores feature a network of outpatient and community healthcare providers, thousands of residents employed in the healthcare sector, and SIUH, the largest Staten Island-based employer. Sandy exposed this system's vulnerabilities, which are expected to grow as the climate changes.

Among the strategies that the City will use to address these challenges for residents of the East and South Shores and other parts of the city will be to: Build new hospitals, nursing homes, and adult care facilities to higher resiliency standards and harden existing facilities to protect critical systems; seek to keep lines of communication open between patients and providers, even during extreme weather events; and enable community-based providers to reopen quickly after a disaster. The initiatives described below provide important examples of how the City intends to advance its healthcare resiliency agenda citywide. These initiatives will have a positive impact on the residents and healthcare providers of the East and South Shores. For a full explanation of the following initiatives and a complete description of the City's five-borough healthcare resiliency plan, please refer to Chapter 8 (*Healthcare*).

Healthcare Initiative 2
Require the retrofitting of existing hospitals in floodplains

Many existing hospital buildings in the floodplain remain vulnerable to the impact of storm surge, with more likely to become vulnerable as the climate changes. The City, through OLTPS, therefore, will seek to amend the Construction Code to require existing hospital buildings in the 500-year floodplain—including SIUH—to meet by 2030 a subset of the Construction Code standards for flood-resistant design. To minimize the risk of emergency evacuations and extended closures, these hospitals will be required to protect their electrical equipment, emergency power system, and domestic water pumps to the 500-year flood elevation. These hospitals also will be required to install backup air-conditioning service for inpatient care areas in case of utility outages, pre-connections for temporary boilers and chillers if primary equipment is not elevated, and pre-connections for external generators as a backup power source. SIUH already has begun exploring a number of these and other flood mitigation measures as part of its post-Sandy rebuilding process. OLTPS will propose these requirements to the City Council in 2013.

Healthcare Initiative 4
Improve design and construction of new nursing homes and adult care facilities

New nursing homes and adult care facilities are at risk of power failures due to storm surge, which could result in patient evacuations. The City, through OLTPS, therefore, will seek to amend the Construction Codes to require that new facilities are constructed with additional resiliency measures for their emergency power systems. New nursing homes also will be required to have emergency generators and electrical pre-connections for external stand-by generators. Adult care facilities will be required to install either emergency generators that are adequately protected or pre-connections to external stand-by generators. OLTPS will propose these requirements to the City Council in 2013.

Healthcare Initiative 5
Require retrofitting of nursing homes in floodplains

Many existing nursing home facilities in the five boroughs are vulnerable to storm surge—a vulnerability that will only grow as the climate changes. The City, through OLTPS, therefore, will seek to amend the Construction Codes to require nursing homes in the 100-year floodplain to meet standards for the protection of electrical equipment, emergency power systems, and domestic water pumps (if applicable) by 2030. These systems will be protected to the 100-year flood elevation, in accordance with specifications already in the Construction Codes, and will help enable patients to shelter in place safely or reoccupy quickly after a storm. OLTPS will propose these requirements to the City Council in 2013.

Healthcare Initiative 6
Require retrofitting of adult care facilities in floodplains

Nineteen adult care facilities in the city are vulnerable to storm surge, including one in the East Shore (New Broadview Manor Home for Adults). The City, through OLTPS, will seek to amend the Construction Codes to require existing adult care facilities located in the floodplain to elevate or protect their electrical equipment to the 100-year flood elevation by 2030, in accordance with the specifications in the Construction Codes. In addition, the City will seek to require these providers to have either emergency generators that are adequately protected or electrical pre-connections to external generators. OLTPS will propose these requirements to the City Council in 2013.

Healthcare Initiative 7
Support nursing homes and adult care facilities with mitigation grants and loans

The primary challenge for most nursing homes and adult care facilities in implementing mitigation measures is obtaining financing. Subject to available funding, the City, through NYCEDC and the New York City Department of Health and Mental Hygiene (DOHMH), therefore, will administer competitive grants and subsidized loans to assist providers with mandated retrofit projects. The goal is to launch the program when proposed Construction Code amendments applicable to nursing homes and adult care facilities proposed in this report go into effect, likely in 2013.

Healthcare Initiative 8
Increase the air conditioning capacity of nursing homes and adult care facilities

Nursing homes and adult care facilities typically do not have enough emergency power capacity to run their air conditioning systems following the loss of power. This could cause some providers to evacuate during power outages that occur during hot summer months. The City will offer sales tax waivers totaling $3 million citywide to assist eligible nursing homes and adult care facilities that install emergency power solutions for air conditioning systems.

Healthcare Initiative 9
Harden primary care and mental health clinics

In communities such as the East and South Shores that are at risk of extensive flooding during extreme weather events, primary care and mental health services may be compromised for weeks after a disaster due to extended facility closures. Subject to available funding, the City, through DOHMH and a fiscal intermediary, therefore, will administer a competitive financing program to harden large clinics providing primary care and mental health services in the East and South Shores and other high-need communities. The program will include grants and interest-free loans for capital investments that enable faster recovery of services—for example, installation of emergency power systems, protection of other critical building systems, and wet flood-proofing of facilities. The goal would be for this effort to be launched in late 2013 or early 2014.

Healthcare Initiative 10
Improve pharmacies' power resiliency

Pharmacies dispense life-saving medicines essential for those with chronic conditions. However, without power, pharmacists cannot access the necessary patient records or insurance information to dispense these medicines. The City, through DOHMH, will work with pharmacies to improve their ability to leverage generators for power resiliency and address their other emergency preparedness needs including the launch of an emergency preparedness website for pharmacies. This effort already has begun and will continue throughout 2013.

Healthcare Initiative 11
Encourage telecommunications resiliency in the healthcare system

In the aftermath of a disaster, it is important that New Yorkers be able to speak to their doctors for guidance on needed medical care. The City, through DOHMH, therefore, will develop a best practice guide and outreach plan to help community-based providers understand the importance of telecommunications resiliency. Resiliency solutions could include using backup phone systems (such as a remote answering service that would not be affected by local weather hazards), Voice over Internet Protocol (VoIP) technology that allows office phone lines to be used off-site, and pre-disaster planning to inform patients of available emergency phone numbers. This effort will begin in 2013.

Healthcare Initiative 12
Encourage electronic health record-keeping

Doctors rely on patients' medical records to provide and track care, but paper records may be compromised or destroyed due to extreme weather events. The City, through existing DOHMH programs, therefore, will call upon community-based providers located in the 100-year floodplain and other disaster-prone areas to implement electronic health records (EHR) systems for resiliency. DOHMH's Primary Care Information Project will sponsor initiatives to provide primary care and mental health providers citywide with EHR technical assistance. This effort will begin in 2013.

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Beyond the priority healthcare resiliency projects described in Chapter 8, including those summarized briefly above, the City is proposing an additional healthcare resiliency initiative that is specific to the vulnerabilities of the East and South Shores. This initiative is described below.

East and South Shore Initiative 2
Assist Staten Island University Hospital in applying for hazard mitigation funding

SIUH, which is home to the largest emergency room in Staten Island and accounts for over one-third of the borough's in-patient beds, has two campuses that are located in areas that are vulnerable to flooding. The City will, therefore, provide technical and other support to SIUH as it seeks to secure FEMA Hazard Mitigation Grant Program funding through the State-administered allocation process. This funding would allow SIUH to implement important flood resiliency measures, as described, in-part, in a needs assessment released by the Staten Island Borough President's Office. The City will consider providing similar assistance to other regional hospitals, as well.

Telecommunications

The city's telecommunications system is essential to individuals and businesses throughout the five boroughs, including in the East and South Shores. While this is true at all times, it is especially true during emergencies. As Sandy demonstrated, however, this system is highly vulnerable to extreme weather events—precisely when telecommunications are most needed. Citywide and in the East and South Shores, Sandy resulted in outages to landlines and mobile service, as well as to data service. The vulnerability of this system likely will grow as the climate changes.

Among the strategies that the City will use to address these challenges for residents, businesses and nonprofits of the East and South Shores and other parts of the city will be to: Increase accountability among providers to promote resiliency; use strengthened City regulatory powers and stronger relationships with providers to enable rapid recovery after extreme weather events; encourage hardening of facilities to reduce weather-related impacts; and increase redundancy to reduce the impact of outages. The initiatives described below provide important examples of how the City intends to advance its telecommunications resiliency agenda citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits of the East and South Shores. For a full explanation of the following initiatives and a complete description of the City's five-borough telecommunications resiliency plan, please refer to Chapter 9 (*Telecommunications*).

Telecommunications Initiative 1
Establish an office within the Department of Information Technology and Telecommunications (DoITT) to focus on telecommunications regulation and resiliency planning

While the City has regulatory authority over some aspects of telecommunications service, it has no entity focused broadly on ensuring the resiliency of the public communications networks. The City, therefore, will form within DoITT a new Planning and Resiliency Office (PRO) that will have the resources needed to develop, monitor, and enforce resiliency standards, in close cooperation with State and Federal regulators and providers. DoITT will launch the new office in 2013.

Telecommunications Initiative 2
Establish new resiliency requirements for providers using scheduled renewals of the City's franchise agreements

Flooding caused outages during Sandy in facilities that did not follow the Federal Communication Commission's recommended best practices for resiliency, including flood protection measures. The City, through DoITT, therefore, will encourage and enforce resiliency standards for cable TV providers through the franchise renewal process, and explore options to increase conduit infrastructure redundancy and resiliency. The City will also seek to require standardized outage reporting and publishing. DoITT will launch this effort in 2014, in advance of 2020 franchise renewals.

Transportation

Without the city's expansive transportation system, New York would grind to a halt. This was illustrated starkly during Sandy when outages occurred across the system during and immediately following the storm. These outages severely impacted the residents of the East and South Shores, who found themselves isolated by the shutdown of the Staten Island Ferry, other public transit systems and all Staten Island bridges, as well as by flooding on arterial and secondary roads. The vulnerability of this system will only grow as the climate changes.

Among the strategies that the City will use to address these challenges for residents of the East and South Shores and other parts of the city will be to: Make the system more flexible and more resilient; protect critical elements of the system from damage; and seek to maintain system operations during extreme weather events; and, following extreme events, to enable quick recovery, while also putting in place plans for backup transportation options until regular service can be restored. The initiatives described below provide important examples of how the City intends to advance its transportation resiliency agenda citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits of the East and South Shores. For a full explanation of the following initiatives and a complete description of the City's five-borough transportation resiliency plan, please refer to Chapter 10 (*Transportation*).

Transportation Initiative 1
Reconstruct and resurface key streets damaged by Sandy

Sandy's waves and flooding caused significant damage to area roadways. The City, through NYCDOT will reconstruct 60 lane-miles of streets that were damaged severely, and will repave approximately 500 lane-miles of streets with damaged surfaces. In the East and South Shores, this will include approximately 3 linear-miles of reconstructed streets, including Father Capodanno Boulevard from Sand Lane to Seaview Avenue, and 12 linear-miles resurfaced, including multiple east-west streets in the South Shore, such as Holton and Page Avenues, south of Hylan Boulevard. Wherever feasible, the reconstructed streets also will include resiliency features to prevent future damage. NYCDOT will launch this initiative in 2013 with funding from Federal and City sources.

Transportation Initiative 3
Elevate traffic signals and provide backup electrical power

New York's traffic signals—and particularly the controllers that operate these signals and communicate with the NYCDOT Traffic Management Center—are vulnerable to damage from flooding, as well as to power loss from various extreme weather events. Accordingly, the City, through NYCDOT, will raise controllers at approximately 500 intersections in flood-vulnerable locations across the city, including in the East and South Shores. In tandem with this effort to place electrical hardware above the 100-year floodplain elevation, NYCDOT also will install power inverters in approximately 500 NYPD vehicles to allow these vehicles to provide backup electrical power to critical traffic signals. This effort will begin in 2013.

Transportation Initiative 6
Protect Staten Island Ferry and private ferry terminals from climate change-related threats

To allow for quicker restoration of service on the Staten Island Ferry, the East River Ferry, and other ferry services, the City will use Federal Transit Administration Emergency Relief funds to construct physical improvements to the floating infrastructure, loading bridges/gangways, pilings, and piers at both the Whitehall and St. George ferry terminals and at additional ferry landings around the city. NYCDOT will launch this investment immediately.

Transportation Initiative 8
Call on non-City transportation agencies to implement strategies to address climate change threats

Many non-City agencies that own and operate critical portions of New York City's transportation system have already announced resiliency and protection initiatives appropriate to their system. Without such action, the critical facilities managed by these agencies will remain vulnerable to damage and disruption from future weather-related events. The City, therefore, will call on these agencies to implement the initiatives they announced and take additional steps to protect their major transportation assets from climate change threats and prepare for quick restoration following an extreme weather event. Assets that may require hardening and/or preparation measures in the East and South Shores include: Maintenance and operations facilities of the SIR, SIR stations in current or potentially future flood zones, park-and-ride facilities, and approaches to Staten Island bridges. The City will work with these agencies to advance these plans in 2013.

Transportation Initiative 9
Plan for temporary transit services in the event of subway system suspensions

When major portions of the subway system are out of service, there simply is not sufficient capacity in the rest of the transit network or the roadway system to carry the increased volume of commuters and other travelers. The City, through NYCDOT, therefore, will work with the MTA and other transportation partners to develop and regularly update formal plans to provide temporary transportation services in such an event, including following extreme weather. These services could take the form of temporary point-to-point ferry service, as, for example, the City put in place following Sandy, connecting Great Kills Harbor and Lower Manhattan. This planning effort will begin in 2013.

Transportation Initiative 10
Identify critical transportation network elements and improve transportation responses to major events through regular resiliency planning exercises

Many of the facilities critical to the City's ability to respond effectively to a disaster are vulnerable to disruption and damage during extreme weather events, potentially impairing delivery of emergency services and supplies, as well as impairing the restoration of critical non-transportation infrastructure and economic activity. This vulnerability is expected to increase as the climate changes. To respond better to a variety of different possible transportation outage and restoration scenarios, the City, through NYCDOT, will work with transportation agencies around the region to identify the critical elements of the surface transportation network that need to be available quickly following different types of events. The key tool to identify these networks will be an ongoing series of detailed and multi-disciplinary resiliency planning exercises that will allow NYCDOT and its partners to understand where resources need to be focused before, during, and after an event. This effort will begin in 2013.

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Beyond the priority transportation resiliency projects described in Chapter 10, including those summarized briefly above, the City is proposing additional transportation resiliency initiatives specific to the vulnerabilities of the East and South Shores. These initiatives are described below.

East and South Shore Initiative 3
Implement and expedite roadway and sewer capital projects along Hylan Boulevard, especially in vulnerable South Shore areas

Hylan Boulevard, a critical transit and roadway asset for East and South Shore communities, will remain flood-prone in low-lying areas even after proposed coastal protection measures are put in-place. The City, therefore, will move forward with capital projects to improve stormwater management and traffic-flow along Hylan Boulevard and in close proximity to the corridor. These projects will include: Three roadway projects paired with the installation of sewers and catch basins by DEP (planned from Butler Boulevard to Mount Loretto, from Cornelia Avenue to Poillon Avenue and from Robinson Avenue to Wiman Avenue); intersection improvement projects at Cleveland and Armstrong Avenues that will bring new paving and sewer and bus pad upgrades; and NYCDOT paving projects in the South Shore, encompassing, among other areas, locations around Great Kills Harbor. The three roadway projects are anticipated to begin between November 2014 and January 2016, the Cleveland-Armstrong project is anticipated to be completed by the end of 2013 and the South Shore projects are anticipated to begin in the summer of 2014.

East and South Shore Initiative 4
Call on and work with the MTA to create an implementation plan for the relocation of Richmond Valley SIR station to Page Avenue

The Richmond Valley SIR Station already experiences chronic flooding and lacks sufficient commuter parking. Meanwhile, the closing of the Atlantic and Nassau stations in Tottenville left the Page Avenue commercial area without direct SIR service. To aid recovery on the South Shore, subject to available funding, the City will work with the MTA to study the relocation of the Richmond Valley SIR station to Page Avenue to create a rail and bus hub. The study also will assess the feasibility of a park-and-ride facility at the new location. The City, acting through NYCEDC, will work with the MTA to identify funding for the study and, depending on the study's outcome, any proposals resulting therefrom. The goals of the study will be: To create a more resilient SIR station at higher elevation; to support retail recovery along the Page Avenue commercial corridor; to maximize access to public transportation on the South Shore; and to encourage transit ridership more broadly. The study will take approximately six months to complete after funding is secured.

East and South Shore Initiative 5
Study potential new ferry routes serving Staten Island and issue a Request for Expressions of Interest (RFEI) to gauge market interest

Many neighborhoods on the East and South Shores lack fast public transit access to Manhattan. In addition, during extreme weather events, the public and other transit options to which these areas do have access is subject to disruption. As part of its update of its Comprehensive Citywide Ferry Study, which is to provide analyses of options for inter-borough commuter and recreational ferry service citywide, the City will assess the feasibility of additional service on Staten Island. The update, which is fully funded, will analyze possible future service corridors, review possible funding sources, and assess issues of governance and oversight. A public outreach process will aid in the determination of which potential Staten Island landing sites to include in the study. NYCEDC will, in partnership with NYCDOT, lead this study, which is expected to take six to nine months to complete.

Parks

During Sandy, it became clear was that, in addition to serving as neighborhood front yards and recreation centers, in many places, including the East and South Shores, the City's parks literally serve as the city's front line of defense when extreme weather events hit, buffering adjacent neighborhoods. As the climate changes, it will be even more critical that the City's parks be able to play all of these roles.

Among the strategies that the City will use to address these challenges for residents of the East and South Shores and elsewhere in the city will be to: Strengthen the city's parks so that they are able to survive weather-related events more effectively and can act as stronger buffers for adjacent communities; and pursue technologies and approaches that will enable the City to monitor, analyze, and prepare the parks system for its many roles in an era of increasing change. The initiatives described below provide important examples of how the City intends to advance its parks resiliency agenda citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits of the East and South Shores. For a full explanation of the following initiatives and a complete description of the City's five-borough parks resiliency plan, please refer to Chapter 11 (*Parks*).

Parks Initiative 1
Restore city beaches

Beaches play an important recreational role in the East and South Shores and also are a vital component of the area's coastal defenses, but they cannot protect adjacent areas without being "renourished" (replenished with new sand to replace that lost to erosion) from time to time. Subject to available funding, the City, through DPR, will collaborate with Federal and State partners—including the USACE—to implement plans quickly to restore sand lost after extreme storm events and to conduct regular nourishment of beaches and regular monitoring to detect the early signs of erosion. This effort will focus on key beaches, including those on the East and South Shores, such as South Beach, Crescent Beach, and in Tottenville. The goal is to begin this effort in 2013.

To restore the beaches following Sandy, the City, in cooperation with many other City, State and Federal partners, conducted an expedited program of projects to provide new and elevated lifeguard stations and public bathrooms and improvements to other beachfront amenities in advance of Memorial Day 2013. This impressive achievement comprised the first phase of restoring the city's beaches. In the coming months and years, DPR will continue its efforts to provide emergency sand nourishment and to expedite planning, evaluation, and design work for long-term plans to restore the beaches, boardwalks, and other beachfront amenities of the East and South Shores.

Parks Initiative 2
Harden or otherwise modify shoreline parks to protect adjacent communities

About 24 percent of DPR properties (by acreage) are today in the city's 100-year floodplain, and that percentage is expected to grow as sea levels rise—including in areas where the city's parks front residential and commercial districts. Subject to available funding, the City, through DPR, therefore, will study cost-effective ways to use its parks system to protect particularly vulnerable adjacent neighborhoods, ideally identifying mitigation strategies that also protect the parks themselves. Immediate target sites in the East and South Shores include the beaches from New Dorp Beach to Oakwood Beach, as well as at Wolfe's Pond Park, as outlined above under Coastal Protections. The goal is to complete this study in 2014.

Parks Initiative 11
Improve the health and resiliency of the city's urban forest

The city's forests and trees provide an array of health and environmental benefits, but are vulnerable to a variety of climate change-related impacts, including storm surge, wind, and even changes in average temperatures. Subject to available funding, the City, through DPR, will undertake a variety of efforts to protect trees—whether located in natural areas and parks, or along streets. This would include adding forest management crews, identifying locations in which to expand tree beds, and modifying regular tree inspection and pruning efforts to prioritize trees in areas vulnerable to extreme weather events. The goal is for DPR to launch this effort in 2013.

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Beyond the priority parks resiliency projects described in Chapter 10, including those summarized briefly above, the City is proposing an additional parks resiliency initiative that is specific to the vulnerabilities of the East and South Shores. This initiative is described below.

East and South Shore Initiative 6
Secure available Federal funding to implement the Community Wildfire Protection Plan for fire-prone areas on the East Shore

Homes, essential infrastructure and the area's residents themselves are at substantial risk of catastrophic wildfires within an area of the East Shore that has been designed as a Wildlife Urban Interface Zone by the federal government. This zone covers the majority of the East Shore, including sections of Oakwood Beach, New Dorp Beach, Midland Beach, and South Beach.

To address this risk, the City, through DPR, will pursue funding for priority wildfire management measures within the Community Wildfire Protection Plan that was created and approved by a variety of City agencies, the National Park Service (NPS), and New York State Department of Environmental Conservation (NYSDEC) in 2012. This approval makes the City eligible to receive Federal funding for certain anti-wildfire pilot initiatives associated with the plan. Pilot initiatives will include: A program to control the population of the invasive and flammable reed *Phragmites*; and a program to create or maintain necessary buffer areas between fire hazard areas and existing residential areas. If the pilot initiatives prove successful, these techniques could be deployed throughout high-risk zones in the East Shore, subject to the identification of additional funding. Implementation of the pilot measures would begin immediately upon the securing of funding.

Water and Wastewater

The city's water and wastewater system is one of the most complex in the world, not only supplying millions of New Yorkers with safe drinking water in all conditions, but also treating wastewater to enable the area's waterways to remain clean, while draining rainwater to minimize flooding. What happened during Sandy demonstrated the system's vulnerability to a whole host of weather-related threats, ranging from surge and sea level rise, to heavy downpours—threats that are expected to worsen as the climate changes.

Among the strategies that the City will use to address these challenges for residents of the East and South Shores and other parts of the city will be to: Protect wastewater treatment facilities from storm surge; improve and expand drainage infrastructure; and promote redundancy and flexibility to make available a constant supply of high-quality drinking water. The initiatives described below provide important examples of how the City intends to advance its water and wastewater resiliency agenda citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits of the East and South Shores. For a full explanation of the following initiatives and a complete description of the City's five-borough water and wastewater resiliency plan, please refer to Chapter 12 (*Water and Wastewater*).

Water and Wastewater Initiative 1
Adopt a wastewater facility design standard for storm surge and sea level rise

Sandy damaged wastewater treatment plants and pumping stations even though the design of City wastewater facilities typically has taken into account the highest historically recorded water height of nearby water bodies or the BFEs identified in FEMA maps. The City, therefore, will adopt an increased level of protection for design and construction of all wastewater facilities based on the latest FEMA maps, modified to reflect sea level rise projections for the 2050s. DEP will adopt the new design guidelines in 2013.

Water and Wastewater Initiative 2
Harden pumping stations

Many of the city's pumping stations are located in low-lying areas and are necessary to convey wastewater and stormwater out of communities; however, their location also increases their vulnerability to storm surge. Therefore, subject to available funding, the City, through DEP, will retrofit these pumping stations to improve their resiliency. These retrofits will include raising or flood-proofing critical equipment, constructing barriers, and installing backup power supplies. Preliminary estimates indicate that there are currently 58 at-risk pumping stations, of which several are already scheduled for capital improvements. Subject to available funding, DEP will pursue implementation of resiliency projects in conjunction with repairs and planned capital work, and as appropriate based on the level of risk, historical flooding, and potential community impacts, among other criteria. Among the pumping stations to be considered are 3 in the East and South Shores. The goal is to begin implementation in 2014.

Water and Wastewater Initiative 3
Harden wastewater treatment plants

All 14 of the City's wastewater treatment facilities are located along the waterfront and are therefore at risk in the event of a coastal storm. Subject to available funding, the City, through DEP, will protect these critical treatment facilities by raising or flood-proofing assets that are critical to the treatment process, constructing barriers, improving waterfront infrastructure, or implementing redundancy measures to avoid failure of these critical treatment systems. DEP will initially target facilities that have been identified as either most at-risk, or most likely to have impact on adjacent communities and waterways, based on the findings of an in-depth study by DEP. These facilities include the Oakwood Beach Wastewater Treatment Plant. The goal is for DEP to begin implementation of adaptation measures for these and other facilities in 2014 as part of repairs and other planned capital projects.

Water and Wastewater Initiative 8
Reduce combined sewer overflows (CSOs) with Green Infrastructure

As climate change brings increasing rainfall volume to the New York area, the city may also experience shifts in the frequency and volume of CSOs. The City will continue to implement its Green Infrastructure Plan and CSO Long-Term Control Plans (LTCPs) to reduce such CSOs. For this purpose, DEP, working with DPR and NYCDOT, will continue to pursue its plan to capture the first inch of runoff in 10 percent of impervious surfaces citywide by 2030. At the same time, DEP also will continue to develop LTCPs to evaluate long-term solutions to reduce CSOs and improve water quality in New York City's waterways. DEP will issue an LTCP for Alley Creek in Queens in 2013, with nine additional waterbody-specific LTCPs and one citywide LTCP to follow through 2017.

Water and Wastewater Initiative 10
Continue to implement and accelerate investments in Bluebelts across the city

Some areas of the city—including parts of the East and South Shores—lack a fully built-out storm sewer system. Street flooding can occur, therefore, even during minimal rain events in these areas. The City, through DEP, will, therefore, continue to implement and accelerate its innovative Bluebelt drainage program in areas where opportunities exist to preserve and enhance natural areas including streams, ponds, and other wetlands that remove pollutants before stormwater enters waterways. Through the next decade, DEP will substantially complete the South Richmond Bluebelt in Staten Island and begin to construct a new Bluebelt system on the East Shore of Staten Island. Subject to available funding and environmental review, DEP will also accelerate planning of improvements to Last Chance Pond on the East Shore.

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Beyond the priority water and wastewater resiliency projects described in Chapter 12, including those summarized briefly above, the City is proposing additional water and wastewater resiliency initiatives that are specific to the vulnerabilities of the East and South Shores. These initiatives are described below.

East and South Shore Initiative 7
Launch the first capital project for the Mid-Island Bluebelt in Midland Beach

Low-lying East Shore communities regularly experience flooding of streets and private property, a challenge that likely will become greater with climate change. A drainage system for these areas, which would include a Bluebelt, would help with recovery from extreme weather events, as well as general stormwater management. The City, therefore, will launch the first capital project relating to the creation of a new Mid-Island Bluebelt, which is planned for the New Creek West Branch, located in the Midland Beach neighborhood—a neighborhood that was impacted severely by Sandy and has been impacted previously by other extreme weather events. To allow this project to commence in 2013, the City will work with non-city agencies to finalize the applicable Environmental Impact Statement, obtain all necessary permits, and begin proceedings and explore additional programs to acquire necessary property.

East and South Shore Initiative 8
Explore expansion of the City's mitigation banking pilot as a funding mechanism to facilitate the construction of the Mid-Island and South Shore Bluebelts

As described above, Bluebelts have been proven to help mitigate a variety of climate change-related risks. However, their construction is also expensive. To facilitate and accelerate the launch of Bluebelt initiatives citywide, including in the East and South Shores, the City will explore opportunities to develop a freshwater wetland mitigation banking program. Since the early 1990s, more than 900 mitigation banks have been created in 28 states across the country. A mitigation bank in New York could help fund an estimated 50 acres of planned wetland enhancement projects in the Mid-Island Bluebelt and another 11 acres of wetland restoration associated with the South Shore Bluebelt. The development of a pilot mitigation bank will be advanced by NYCEDC in 2014.

Other Critical Networks: Food Supply

Though the food supply chain generally emerged intact following Sandy, in certain local areas, residents found themselves without access to basic sustenance after the storm. In addition, had Sandy played out just a little differently, it is possible that significant links in the food supply chain—including the food distribution center in Hunts Point in the Bronx—could have been seriously threatened. As the climate changes, it is likely that risks such as these will grow.

Although initiatives outlined in several other sections above are important contributors to the overall resiliency of the food supply network (including especially those addressing utilities, liquid fuels, and transportation), the City also will pursue food-specific strategies to meet this goal for the benefit of residents of the East and South Shores and other parts of the city. These strategies will involve calling for resiliency investments at the most significant food wholesaling and distribution centers in the city and addressing issues relating to retail access in the event of extreme weather. The initiatives in Chapter 13 describe how the City intends to advance its food supply resiliency agenda citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits of the East and South Shores. For a complete description of the City's five-borough food supply resiliency plan, please refer to Chapter 13 (*Other Critical Networks*).

Other Critical Networks: Solid Waste

On a daily basis, the solid waste collection system in New York disposes of more than 12,000 tons of waste and recycling in a safe and sanitary fashion. Unlike many other critical City systems, during Sandy this one proved remarkably resilient, resuming many of its normal functions almost immediately after the storm. In fact, thanks to the efforts of the City's Department of Sanitation, even as the agency was dealing with its own storm-related challenges, it was able to assist with the recovery of the East and South Shores and the larger city by collecting the debris left by the storm in an organized and efficient manner.

However, the system does face real issues. For example, during Sandy, the city's solid waste disposal system experienced interruptions that interfered with its ability to convey refuse out of the city to its ultimate destination. Additionally, as the climate changes, it is likely that this system will become more vulnerable to extreme weather.

Among the strategies that the City will use to address these challenges for residents of the East and South Shores and other parts of the city will be to: Harden critical City-owned solid waste assets to protect them from extreme weather-related impacts; and seek to improve the resiliency of the broader solid waste network—both City- and third-party-owned—enabling it to resume operation quickly should disruptions occur. The initiatives in Chapter 13 describe how the City intends to advance its solid waste resiliency agenda citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits of the East and South Shores. For a complete description of the City's five-borough solid waste resiliency plan, please refer to Chapter 13 (*Other Critical Networks*).

Environmental Protection and Remediation

Sandy showed that extreme weather events — which are likely to increase in severity with climate change—not only have the potential to impact the city's people, built environment, and critical systems, they also can have a deleterious impact on the natural environment. To help minimize the impact of future extreme weather on the environment, the City will advance a range of initiatives to protect open and enclosed industrial sites containing hazardous substances in an economically feasible way, and to encourage the cost effective remediation and redevelopment of brownfields in a resilient fashion. These initiatives will have a positive impact on the residents, businesses, and nonprofits of the East and South Shores, which is home to 674 industrial businesses, and on the city as a whole. For a complete description of the City's five-borough environmental protection and remediation plan, please refer to *Environmental Protection and Remediation*.

Community and Economic Recovery

New York is a city of neighborhoods, and these neighborhoods vary widely in size and nature. Notwithstanding this variety, successful neighborhoods across the city tend to share certain traits. Two of these are: a formal and informal network of community members who help and support one another in good times and bad; and vibrant commercial and nonprofit sectors that employ and provide goods and services to the people of the community.

As Sandy demonstrated, however, both the network of community-based organizations and the commercial and nonprofit sectors in New York's neighborhoods can be sorely tested when extreme weather hits. During these times (when contributions from these networks and sectors are desperately needed) these organizations and businesses themselves are frequently coping with the same set of challenges that the community at large is—a circumstance that can push even the most well-run organization or business to the breaking point. Even with these pressures, during and in the immediate aftermath of Sandy, New York's commercial and nonprofit sectors overcame many of their own difficulties, playing a critical role in the recovery of neighborhoods across the city, including the East and South Shores. However, as the climate changes, difficulties such as these will likely arise more frequently, testing institutions mightily.

Among the strategies that the City will use to achieve the goal of making its neighborhoods and their critical institutions more resilient will be to: Help build grassroots capacity and foster community leadership; help businesses and nonprofits impacted by Sandy to recover; help businesses and nonprofits in vulnerable locations to make resiliency investments that will better prepare them for future extreme weather; and bring new economic activity to neighborhoods recovering from the impacts of Sandy to enable these neighborhoods to come back even stronger than before.

The initiatives described below provide important examples of how the City intends to advance its community and economic recovery agenda citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits of the East and South Shores. For a full explanation of the following initiatives and a complete description of the City's five-borough community and economic recovery plan, please refer to *Community and Economic Recovery*.

Community Preparedness Initiative 1
Identify and address gaps in community capacity

The capacity of a community to organize to aid businesses and residents after an extreme weather event or other disaster is a strong predictor of the success of that community's recovery. To improve the capacity of vulnerable communities OEM, working with the NYC Center for Economic Opportunity (CEO), will undertake a pilot assessment of the strengths and weaknesses of a Sandy-impacted community—which could be neighborhoods in the East and South Shores—to inform the creation of a plan to address needs uncovered by the assessment. Subject to available funding, OEM and CEO will choose a pilot community and begin their study in 2013.

Community Preparedness Initiative 2
Continue and expand OEM's Community Emergency Response Teams

OEM currently trains 54 teams of 1,500 volunteers across the city, which staff Community Emergency Response Teams (CERTs). Before, during, and after disasters, including extreme weather events, members of these teams help to organize community disaster preparedness and participate in emergency response and recovery. Going forward, OEM will work with communities to create additional teams, ensuring that these volunteers are as representative as possible of the communities that they serve. OEM, working with CEO, will identify low-income young adults to be trained to lead their communities in disaster preparedness. OEM and CEO will launch this program by 2014.

Economic Recovery Initiative 1
Launch business recovery and resiliency programs

During Sandy, over 27,000 businesses citywide, including approximately 1,300 in the East and South Shores, were inundated by the storm. For many, recovery has been challenging. To assist with this recovery, immediately after the storm, the City launched the series of programs (described in *Community and Economic Recovery*), including a $25 million loan and grant program and a $25 million sales tax waiver program designed to help businesses get back on their feet. Building on the momentum of these programs, which have assisted over 2,500 businesses as of the writing of this report, the City, through NYCEDC, will launch the CDBG-funded Business Resiliency Investment Program of up to $100 million to help vulnerable businesses throughout the city make resiliency investments in their buildings and equipment, and the Business Loan and Grant Program of up to $80 million will assist businesses with recovery and rebuilding efforts. NYCEDC will launch these programs in 2013.

Economic Recovery Initiative 2
Launch the Neighborhood Game Changer Competition

The recovery of many of the communities impacted by Sandy, including the East and South Shores, has been hampered by a lack of opportunities for economic advancement and employment among significant populations that were impacted by the storm. In many cases, these challenges existed even before Sandy, but have been exacerbated by the impacts of the storm. To address this, the City, through NYCEDC, will launch the CDBG-funded Neighborhood Game Changer Competition to invest up to $20 million in public money in each of the five communities on which this report focuses, including the East and South Shores. This funding will be available on a competitive basis to help finance transformational projects. To win the competition, a project will have to spur incremental economic activity, generate new employment opportunities, and match public funding with significant private capital. Projects that would be eligible to be funded in the East and South Shores through this competition could include new attractions bringing new visitors, significant new operations of a major business or nonprofit, the revitalization of important commercial corridors, the expansion of an existing neighborhood institution, or a major new transportation option. NYCEDC will launch this program in 2013.

Economic Recovery Initiative 3
Launch Neighborhood Retail Recovery Program

At the core of many Sandy-impacted neighborhoods are the local commercial corridors that provide employment opportunities and services to those who live and work around them. They include local retailers, institutions, and service providers—such as food markets, pharmacies, social service organizations, laundromats, and others. In many cases, though, these corridors were devastated by the storm. To address this, the City will call on the PSC and Con Edison to amend the preferential Business Incentive Rate (BIR) program, which offers a discount on Con Edison's electric delivery charges, to allow it to be extended to impacted small businesses in the five communities on which this report focuses, including the East and South Shores. Businesses and nonprofits with 10 or fewer employees that have received support from City-sponsored loan and grant programs will be eligible for the discount for five years up to a maximum discount of $50,000 per business or nonprofit. The goal is for NYCEDC to launch this effort in 2013. The maximum aggregate benefit available across the East and South Shores will be $1 million. Among the corridors where the benefit will be available in the East and South Shores include:

- Great Kills Harbor (full length of Mansion Avenue; portion of Buffalo Street, adjoining Nichols Marina);
- Hylan Boulevard (between Seaver Ave and New Dorp Lane);
- Main Street Tottenville (between Ellis Street and Amboy Road);
- Midland Avenue (between Mason Avenue and Father Capodanno Boulevard);
- Page Avenue Corridor (all streets between Arthur Kill Road, Nassau Place/Bethel Avenue, Amboy Road, Page Avenue, and Route 440);
- Sand Lane (between McClean Avenue and Father Capodanno Boulevard) and Robin Road (between Arthur Avenue and Sand Lane); and
- Seaview Avenue (between Hylan Boulevard and Patterson Avenue).

Economic Recovery Initiative 4
Support local merchants in improving and promoting local commercial corridors

As mentioned above, Sandy highlighted the important role played by local commercial corridors in many communities impacted by the storm. The City, through the Department of Small Business Services (SBS), will provide financial and/or technical assistance to area business improvement districts (BIDs), merchant associations, and other groups that work to improve, market, maintain, and otherwise promote primary commercial corridors. Subject to review of applications received, SBS will prioritize Sandy-impacted commercial corridors in allocating its resources, including its CDBG funding. Such funding could be used for a variety of purposes, including capacity building, façade improvement programs, streetscape improvements, and business recruitment and marketing efforts. In the East and South Shores, corridors that could receive this additional assistance include corridors in South Beach, Midland Beach, and Tottenville. SBS will provide this assistance beginning in 2013.

Economic Recovery Initiative 5
Continue to support the FRESH program to increase the number of full-line grocers in underserved neighborhoods

Even before Sandy, the residents of many communities impacted by Sandy, including parts of the East and South Shores, lacked adequate access to fresh fruits, vegetables, and other healthy foods. Noting this challenge, especially in underprivileged areas of the city, in 2009, the City launched the FRESH (Food Retail Expansion to Support Health) program, a series of zoning and financial incentives available to supermarkets to fill this gap in neighborhoods underserved by grocery retail. To promote the recovery of commercial corridors in these areas, the City will continue to support the FRESH program, with a particular focus on Sandy-impacted neighborhoods, including those in the East and South Shores.

Economic Recovery Initiative 6
Reassess commercial properties citywide to reflect post-Sandy market values

After Sandy, many commercial properties were worth less than before the storm. To reflect this fact and to help with recovery from the storm, the City has reassessed more than 88,000 properties impacted by the storm citywide. Overall, these reassessments have lowered the tax burden on Sandy-impacted properties—including both commercial and residential properties—by over $90 million, with commercial properties in neighborhoods impacted by Sandy receiving a reduction, on average, of approximately 10 percent off of their pre-storm assessed values.

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In addition to the measures described above, the City will advance the following initiatives to address the community and economic recovery needs of the East and South Shores.

East and South Shore Initiative 9
Issue a Request for Expressions of Interest (RFEI) for new concessions and services at City-controlled beaches in the East Shore

Damage inflicted by Sandy was particularly devastating to the East Shore's public beachfront, affecting the economic recovery of nearby commercial corridors and communities. In response, the City will issue an RFEI to help these public areas reemerge as resident and visitor destinations. The RFEI will call for ideas to activate select, strategic locations within publicly-owned lands between the FDR Boardwalk , the promenade, and Father Capodanno Boulevard.

This could include locations across from Ocean Breeze Park, at the Midland Beach Entrance Plaza, on the southern end of Midland Beach, and at New Dorp Beach. An activated beachfront would help to support local retail and business recovery, encourage private investment and development in nearby communities, provide jobs and services for local residents, and support current and planned DPR investments in the beachfront and adjacent areas. A wide range of amenities and services will be considered, including but not limited to: Eating and drinking establishments; concessions; and recreational facilities (such as bicycle rental facilities; kayak rental facilities; beach volleyball facilities; and outdoor fitness facilities). NYCEDC and DPR will issue this RFEI in 2013.

East and South Shore Initiative 10

Create a comprehensive revitalization plan for Great Kills Harbor to increase resiliency and to draw additional investment

Most of the six marinas and waterfront restaurants along Great Kills Harbor suffered significant damage from Sandy. Subject to available funding, the City, therefore, will launch a study that will seek to improve both the resiliency of the Harbor and the quality of life for the surrounding community. Even before Sandy, the Harbor held untapped economic and recreational potential. With the help of residents, business owners and other stakeholders, the City, through NYCEDC, will generate strategies to: Help Great Kills Harbor to rebuild; identify design improvements to protect the surrounding residential neighborhoods in future storms; explore partnerships between Federal, City and private recreation organizations; attract new commercial activity; and identify physical, circulation, parking, and design improvements for the area. The strategies developed as part of this plan could also be applicable to other marinas on the South Shore, such as Lemon Creek Marina. The goal is to complete this study within approximately six months after funding is secured.

East and South Shore Initiative 11

Create a strategic plan for public recreational land, including the beachfront recreation areas and open space

In many parts of the East and South Shores, there is poor access to and connections between national parkland, City parkland, and the beachfront on the East and South Shores, handicapping the potential of these assets to improve quality of life and contribute to the recovery of local communities. Subject to available funding, the City, through NYCEDC and DPR, therefore, will study the feasibility of ameliorating this situation, through investments that could include: a completed and improved greenway (that may incorporate the Amundsen Trailway) along the beachfront with a link to Great Kills Park; improved coordination between the City and the National Park Service; the creation of view corridors in natural areas; and the creation of public/private partnerships to operate and maintain these connections. The goal would be to complete this effort within approximately six months after funding is secured.

East and South Shore Initiative 12

Implement planned and ongoing investments by the City and private partners

Preservation and revitalization of neighborhoods most significantly impacted by Sandy will be hampered if the momentum of planned investments is lost. The City, therefore, will continue to pursue and execute on public and private investments that had been planned prior to Sandy in the East and South Shores and adjacent communities. Such projects include but are not limited to:

Parks and Open Space Projects

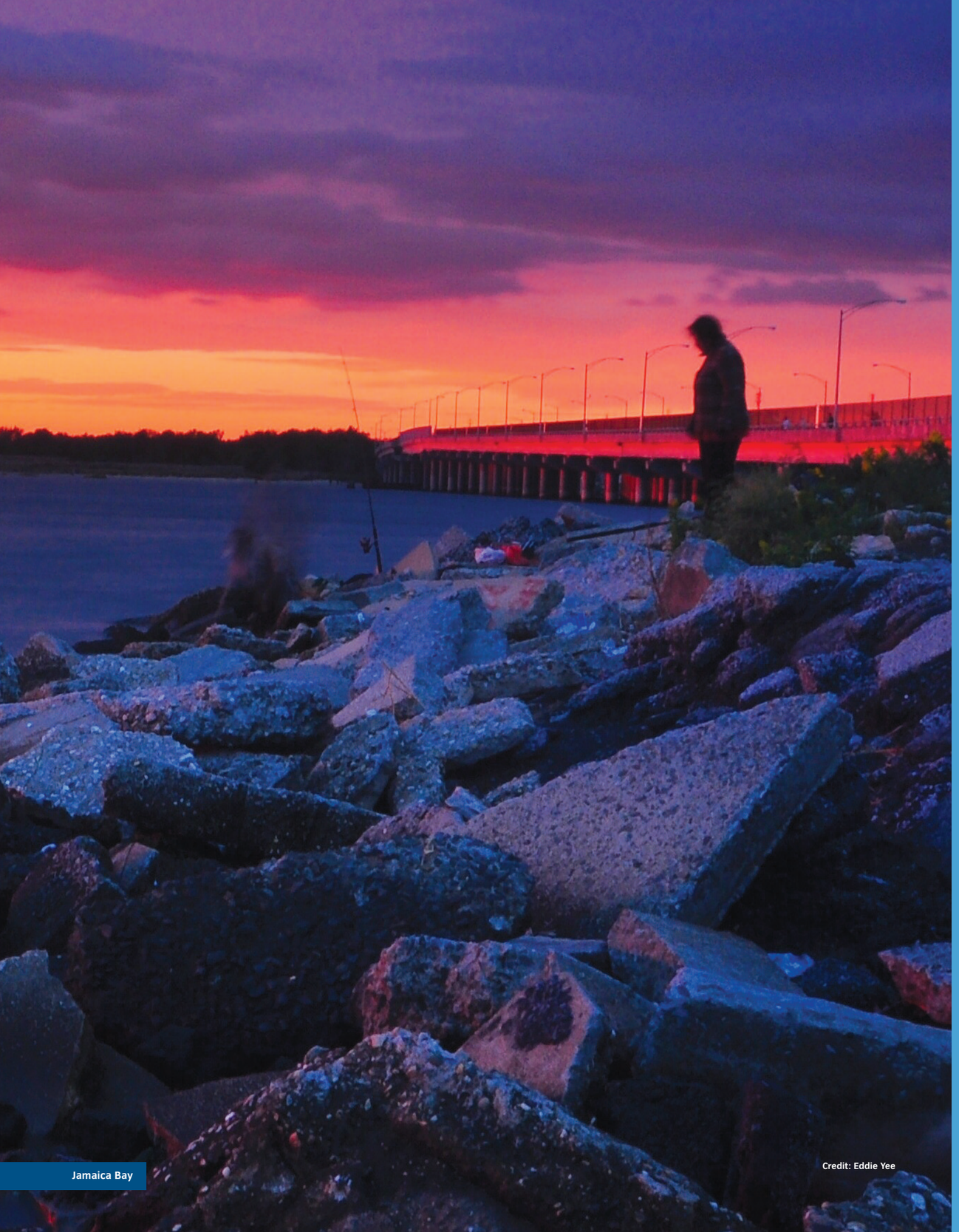
- *Ocean Breeze Track and Field Athletic Complex*, a 2,500-seat, state-of-the-art indoor track and field facility, funded with $72.7 million in City capital.

Community Facility Projects

- *Charleston Mixed-Use Development*, an approximately 60-acre City-owned property that is to be redeveloped into a new park, senior housing, a public school, a public library branch, and new retail space.

Economic Development

- *New Stapleton Waterfront (Homeport) Redevelopment*, a 35-acre decommissioned naval base that is to be transformed into a vibrant waterfront community, the first $140 million phase of which transformation is expected to break ground in summer 2013 and is to include two new residential buildings with 27,000 square feet of retail space and $33 million in City-funded infrastructure and open space improvements.
- *St. George Waterfront Redevelopment*, which is to include the world's tallest Observation Wheel and a high-end outlet retail complex and hotel that, together, will attract $480 million in private investment to St. George.
- *Former Coast Guard Site Development*, a $250 million development plan for an abandoned Coast Guard site in St. George, with a first phase that is to consist of 53,000 square feet of retail space.
- *Brielle Avenue Municipal Site*, a 46-acre, City-owned site, formerly known as Farm Colony, in connection with which the City is, as of the date of this report, reviewing RFP responses for redevelopment.



Jamaica Bay

Credit: Eddie Yee

South Queens

Neighborhoods of South Queens

At the southernmost point of Queens lies the only unobstructed coastline in all of New York City, the11-mile-long Rockaway Peninsula. Behind it are the 31 square miles of water that comprise Jamaica Bay. On the Peninsula and around the Bay are many neighborhoods that, at first glance, may seem to have little in common.

Far Rockaway, for example, sits at the eastern end of the Rockaway Peninsula, with sturdy brick high rises and tiny bungalows along the Atlantic Ocean and the A train rumbling on elevated tracks.

By contrast, Belle Harbor, which is farther west along the Peninsula, contains many large single-family houses dating from the 1920s, with tidy lawns, lining quiet streets.

Broad Channel's residents, meanwhile, occupy a skinny, mile-long island right in the middle of Jamaica Bay—an island they share with hundreds of species of birds that inhabit the Jamaica Bay Wildlife Refuge, which is also found there.

Yet, despite their differences, these three communities, along with the other neighborhoods on the Peninsula and ringing Jamaica Bay—including New Howard Beach, Old Howard Beach, and Hamilton Beach on the Bay's north side—are alike in certain very profound ways.

All of these neighborhoods—collectively referred to in this chapter as "South Queens"—share a common geomorphology. This entire area was once comprised of barrier islands and marshland, all made of the soft soil left behind by the glacier that covered, and helped form, New York City some 22,000 years ago. The area has the lowest elevation of any in the city—in places almost at sea level—making parts of it susceptible to flooding from even the regular movement of the tides.

And the area continues to evolve. In fact, the natural movement of sediment from east to west along the Rockaway Peninsula over the course of the 20th century formed what is today the community of Breezy Point—an area built on land that literally did not exist just a short time ago. As these changes in the Rockaway Peninsula have added land, they also have taken land away. The Peninsula, which acts as a barrier shielding the areas lying inland from it, once itself was partially shielded by smaller barrier islands to the south. Over time, though, those smaller islands disappeared, leaving the Peninsula completely exposed to the ocean and making its coastline significantly more vulnerable. (*See map: The Shoreline: Then and Now*)

Rockaway Beach

Credit: Daniel Avila/NYC Parks

Just as the neighborhoods of South Queens possess a common geomorphology, they also share a history of development. Generally, they first sprang up in the 19th century as seasonal recreational destinations, with pockets of small summer homes and bungalows spread throughout the Peninsula, New Howard Beach, Old Howard Beach, and Hamilton Beach, and more stately homes and hotels lining the Peninsula's oceanfront. This early development was spurred by the advent of a rail line to the Rockaways—the forerunner of the right-of-way that today carries the A train across Jamaica Bay.

After the construction of Cross Bay Boulevard in 1923, the area's neighborhoods began to attract year-round residents. This accelerated with the end of World War II, when property owners and government entities began paving over marshland, hardening shorelines with bulkheads and seawalls, and building new houses, some on landfill.

In the 1950s, a new wave of development began, this time focused primarily on the Peninsula. There, the public sector and private developers began constructing nursing homes, public housing developments, and affordable housing projects under the Mitchell-Lama program. This trend continued through the 1960s and 1970s, resulting in high concentrations of disadvantaged populations in certain parts of South Queens.

In recent decades, the neighborhoods of South Queens have continued to develop and flourish, with new residents, attracted by the desirability of living at or near the city's oceanfront, joining those who have lived in these areas for generations. Both newcomers and long-standing area residents value the area's tranquil atmosphere, scenic locale, and strong sense of community.

On October 29, 2012, a new chapter in the common history of South Queens was written with the arrival of Sandy. Waves struck the Peninsula's coastline, smashing houses, splintering large sections of boardwalk, causing widespread flooding, and washing away or thrusting onto neighborhood streets and properties at least 1.5 million cubic yards of beach sand. The storm surge pushed through Rockaway Inlet, overtopping bulkheads and seawalls throughout the Bay and bringing significant inundation to many Bay-lining neighborhoods. Though the storm brought hardship to many parts of New York, it was particularly devastating for this area.

The Shoreline: Then and Now

Source: Coast and Geodetic Survey, October 1903

Compounding the destruction caused by floodwaters, serious fires also broke out along the Peninsula in Breezy Point, Belle Harbor, and Rockaway Park. In most cases, these fires were caused by the interaction of salt water and electrical equipment. Due to the severe flooding in these areas, fire trucks were simply unable to reach affected homes and businesses. As a result, flames spread and fires burned uncontrolled for significant periods. In total, some 175 homes and businesses were destroyed.

Although rebuilding in South Queens is well underway as of the writing of this report, it is clear that simply restoring what existed in these neighborhoods before Sandy's arrival is not enough. As the climate changes, this area's vulnerabilities will only grow.

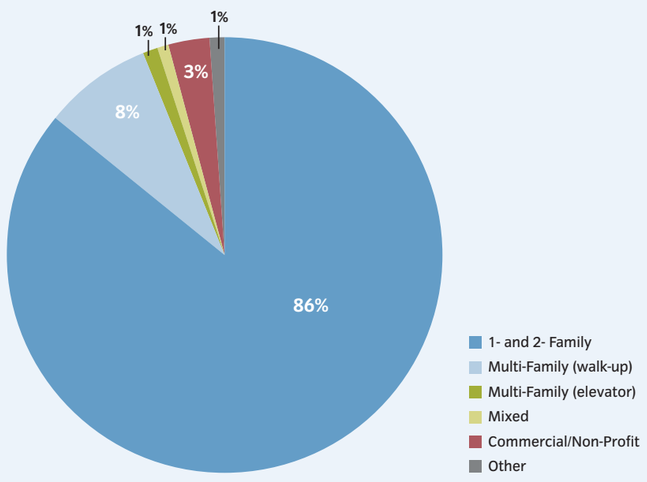
Entirely new layers of protection are needed for South Queens. This plan—which reflects the overarching goals of this report, namely to limit the effects of extreme weather, while enabling

Hamilton Beach

Credit: Nate Dorr

New York and its neighborhoods to bounce back quickly when those impacts cannot be prevented—proposes such protections. It addresses the area's most significant risks—its vulnerability to storm surge and rising sea levels—seeking to limit oceanfront and bayside exposures to floodwaters, facilitate the rebuilding and retrofitting of buildings in a more resilient fashion, and protect vital infrastructure more effectively. It also addresses other threats, including the increasing frequency of heavy downpours, heat waves, and high winds, by drawing on both citywide and locally tailored initiatives. Finally, the plan will build on the area's natural assets, local economic strengths, and community spirit to encourage reinvestment in its waterfront neighborhoods. This plan will ensure that South Queens is able to come back stronger after Sandy, and better prepared to confront a future of growing risks.

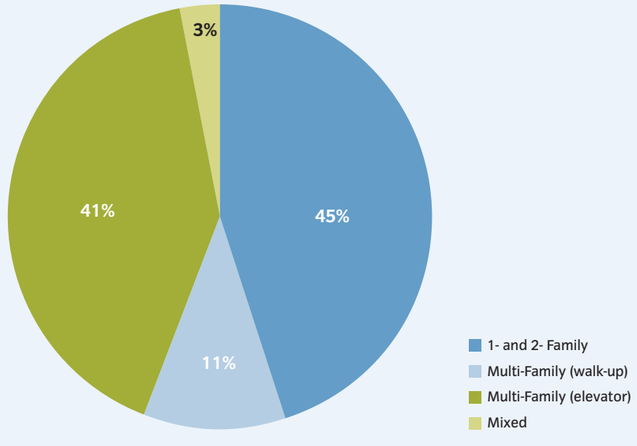
Area Buildings Characterized by Building Type



Total = 24,200 Buildings

Source: DCP PLUTO

Area Housing Units Characterized by Building Type



Total = 53,000 Housing Units

Source: DCP PLUTO

Area Characteristics

South Queens is predominantly residential, home to 130,000 people who inhabit some 15 different neighborhoods. Most businesses and nonprofits in the area are small, occupying commercial corridors that cater to local residents and summer visitors. However, there are some major employers in the area, especially in the healthcare sector. There is also significant infrastructure underpinning the everyday activities of those who live, work, and play in the area.

However, what truly sets South Queens apart is its unmatched recreational resources that serve not only the local communities, but the entire city. South Queens is one of New York's great summertime playgrounds.

Public beaches line nearly the entire stretch of the Rockaway Peninsula—adding up to the largest urban beach in America, lined, along five miles, with a boardwalk. While the Department of Parks & Recreation (DPR) manages approximately seven miles of beachfront in the Rockaways, an additional four miles, curving around the western end of the Peninsula, are under the jurisdiction of the National Park Service (NPS), part of the Gateway National Recreation Area.

In the Rockaways, the properties managed by NPS include the Robert Moses-designed Jacob Riis Park, which attracts visitors who mostly arrive by car or bus, lured not only by the beach but also by the famous Art Deco bathhouse that hosts ranger-led programs and history exhibits. Next door at Fort Tilden, a decommissioned military base, NPS maintains natural areas such as a maritime forest and freshwater ponds. Finally, there is Breezy Point Tip, an isolated NPS beach fronting Jamaica Bay.

Jamaica Bay itself is another precious natural resource in the area, containing a variety of native habitats including the city's largest remaining natural marshlands. Based on concerns about the accelerated loss of marshland within the Bay over the last century, governmental efforts were put in place to preserve and restore the Bay's ecology. As a result, today much of the Bay is surrounded by parkland, some controlled by NPS and some by the City. After working independently for decades, in 2012, the City formalized a partnership with NPS to allow coordinated management of a total of 10,000 acres of parkland, with a focus on enhancing recreational amenities and the resiliency of the Bay and its surrounding neighborhoods.

Neighborhoods and Residential Development

Despite their bountiful amenities, as mentioned previously, the neighborhoods of South Queens are, first and foremost, residential, containing a mix of housing types that range from bungalows to multi-family elevator buildings. Most residential buildings (86 percent) are 1- or 2-family homes, and 78 percent of the residential buildings in the area were constructed prior to 1961, when modern construction standards were adopted. These buildings ("combustible structures," in the City's nomenclature) tend to be constructed of lighter structural components such as wood. Though most buildings in South Queens are 1- or 2-family homes, more than half of all housing units (55 percent) are located in multi-family buildings. These multi-family buildings include six public housing developments operated by the New York City Housing Authority (NYCHA) and seven Mitchell-Lama developments. (*See chart: Area Buildings Characterized by Building Type; see chart: Area Housing Units characterized by Building Type*)

Rockaway Peninsula Neighborhoods:

On the easternmost end of the Rockaway Peninsula are found the neighborhoods of Bayswater and Far Rockaway, jointly referred to in this chapter as "Far Rockaway." Much denser than the other neighborhoods on the Peninsula, Far Rockaway is home to 54,000 residents—42 percent of South Queens's total population. Unlike the other neighborhoods of South Queens, Far Rockaway is built on land that is slightly elevated, making it less prone to flooding. This part of the Peninsula is also partially protected by groins and a portion of the Long Beach barrier island that is a part of Nassau County.

To the west of Far Rockaway are five neighborhoods that together are referred to here as "Rockaway." These neighborhoods are Arverne, Somerville, Edgemere, Rockaway Park, and Rockaway Beach. This area, with a population of 49,100, is the second most densely populated part of South Queens, owing in part to five NYCHA developments containing over 3,400 units and seven Mitchell-Lama buildings.

Particularly noteworthy in the Rockaway area is the neighborhood of Arverne. This community historically consisted of bungalow housing that was cleared as part of an urban renewal project in the 1960's. After laying fallow for many decades, the area began to spring back to life in recent decades with the construction of Arverne By The Sea, a 117-acre mixed-use development between Beach 62nd and 80th Streets, which opened in 2008. The City not only required that the new development be constructed on an elevated site, it also called for a wide planted dune system facing the ocean—design features that would serve the community well during Sandy. Additional urban renewal land east of Arverne By The Sea remains undeveloped.

North of Arverne, fronting Jamaica Bay, are the neighborhoods of Somerville and Edgemere. There, older bungalows and single-family homes built of "combustible" materials predominate. The area also contains newer affordable homeownership and rental units developed by the Housing Partnership, the primary City-sponsored developer of affordable housing units in the five boroughs. Between Somerville and Jamaica Bay lies Brant Point Wildlife Sanctuary, which is mostly undeveloped marshland that preserves natural habitat and helps protect neighboring areas from floodwaters.

To the west of Arverne, Somerville and Edgemere are Rockaway Park and Rockaway Beach. These areas have a mix of high- and low-rise buildings, ranging from multi-family complexes to clusters of bungalows. Fronting Rockaway Beach (as well as Arverne) are the first legal surfing beaches in New York City, which increasingly attract surfers from all five boroughs.

Farther west are Neponsit and Belle Harbor, neighborhoods that together have 5,500 residents who primarily inhabit larger single-family homes. They sit directly next to Jacob Riis and Fort Tilden National Parks.

At the westernmost tip of the Peninsula, lies a distinct area composed of the private communities of Roxbury and Breezy Point. Part of Breezy Point faces the ocean and another part, like Roxbury, fronts Rockaway Inlet. Nearly 4,100 residents live in 3,400 single-family homes and bungalows in these communities on land owned by the Breezy Point Cooperative. The Cooperative maintains its own infrastructure, controls access to its beachfront, and sets its own rules governing the construction and maintenance of properties.

Homes of South Queens

Credit: Uli Seit/New York Times

Broad Channel

Credit: Chester Higgins, Jr./New York Times

Neponsit

Credit: Municipal Art Society

Far Rockaway

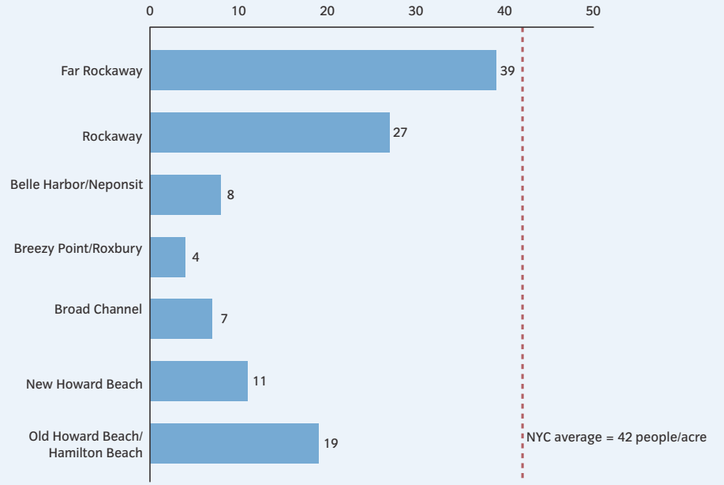
Credit: Quiggty4/Flickr

Rockaway Beach

Jamaica Bay Neighborhoods:
On the Jamaica Bay island of Broad Channel, residents live on the southern portion of the island while the Jamaica Bay Wildlife Refuge occupies the northern end. The community's 2,400 residents dwell in approximately 1,000 single-family homes, some on stilts—with many lining narrow channels on the island's western shore.

Finally, on the far side of the Bay, north of Broad Channel are New Howard Beach, Old Howard Beach, and Hamilton Beach. Together these areas have a population of 14,700. Old Howard and Hamilton Beaches generally contain smaller "combustible" single-family houses, including bungalows dating to the early twentieth century. New Howard Beach, meanwhile, tends to contain homes that are larger and newer, most sitting at slightly higher elevations. These neighborhoods contain numerous narrow basins providing access to small docks for recreational boating.

Population Density of South Queens



Source: 2010 US Census

Socioeconomic Characteristics

Socioeconomic Characteristics
The socioeconomic makeup of South Queens as a whole is roughly comparable to the city as a whole, with, for example, an average poverty rate of 18 percent in South Queens, that mirrors the rate across the five boroughs. Median household income across South Queens, meanwhile, is slightly higher ($55,000) than the citywide average ($51,300). The same is true of the rate of home ownership, which is about one third higher than the citywide average of 33 percent.

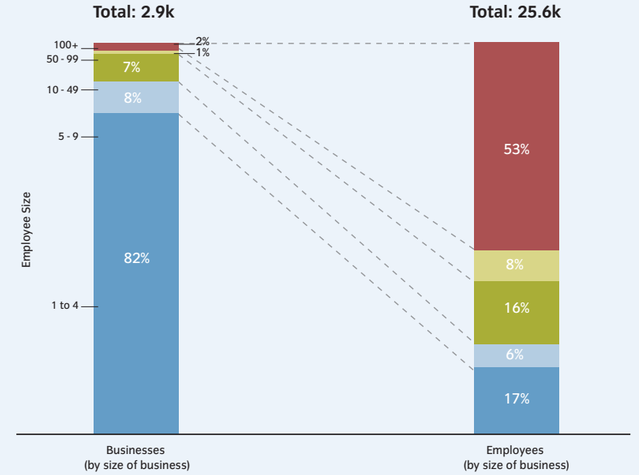
However, there are dramatic socioeconomic differences from neighborhood to neighborhood in South Queens. For example, in Broad Channel the poverty rate is only 1 percent, while the rates for Rockaway and Far Rockaway are 21 percent and 22 percent, respectively. Similarly, whereas the rate of homeownership in New Howard Beach and Breezy Point are both at 95 percent, the average rate for Rockaway and Far Rockaway is around 32 percent. (*See table: Socioeconomic Characteristics*)

Area	Population	Poverty Rate	Median Household Income	Households	Owner-Occupied Housing Units	% Homeowners	% Owner-Occupied Housing Units with Mortgage	Median Owner-Occupied Unit Value
Far Rockaway	54,000	22%	$39,800	17,100	4,400	26%	76%	$474,200
Rockaway	49,100	21%	$49,200	17,600	6,700	38%	59%	$384,100
Belle Harbor/ Neponsit	5,500	2%	$117,200	2,100	1,900	90%	50%	$810,700
Breezy Point/ Roxbury	4,100	2%	$86,900	1,800	1,700	95%	44%	$557,300
Broad Channel	2,400	1%	$78,200	850	700	78%	78%	$424,000
New Howard Beach	7,400	9%	$92,700	2,900	2,800	95%	53%	$673,000
Old Howard Beach/ Hamilton Beach	7,300	7%	$72,000	2,700	2,000	75%	50%	$550,400
Citywide Total/ Average	**8,175,000**	**19%**	**$51,300**	**3,050,000**	**993,500**	**33%**	**64%**	**$514,900**

Source: 2010 US Census, 2011 American Community Survey, 5-Year estimate

Businesses, Nonprofits, and the Local Economy
Generally speaking, businesses and nonprofits in South Queens tend to be small enterprises, with over 80 percent of businesses in the area employing fewer than 10 people. Though by number, the area's small businesses predominate, there are some larger enterprises in South Queens that account for a substantial portion of area employment. In fact, approximately one-half of the employees of South Queens businesses work for companies and institutions that employ over 100 people. (*See chart: Profile of Area Businesses*)

Profile of Area Businesses



Source: Hoovers

Among the important industries in South Queens, perhaps the most significant is healthcare. This sector includes most of the area's larger employers, ranging from local medical offices, to nursing homes, adult care facilities, and a hospital. Two of the major healthcare providers in South Queens are Peninsula General Nursing Home Corporation and St. John's Episcopal Hospital. Since the closure of Peninsula Hospital Center in 2012, St. John's, with an inpatient bed capacity of approximately 400, has been the sole hospital in all of South Queens.

Though the manufacturing sector does not play a significant role in South Queens, one major employer in the area is a manufacturer: Madelaine Chocolates. This company, located in Rockaway Beach, is, in fact, one of South Queens's larger employers. Located in its current location since 1967, before Sandy, the company employed 450 people and, on a typical day, turned 100,000 pounds of chocolate into Easter eggs, Chanukah gelt, and other confections.

Retail is another important sector of the South Queens economy. Generally, businesses in this sector can be found in the area's many commercial corridors that traditionally serve local residents and seasonal visitors. Commercial corridors include:

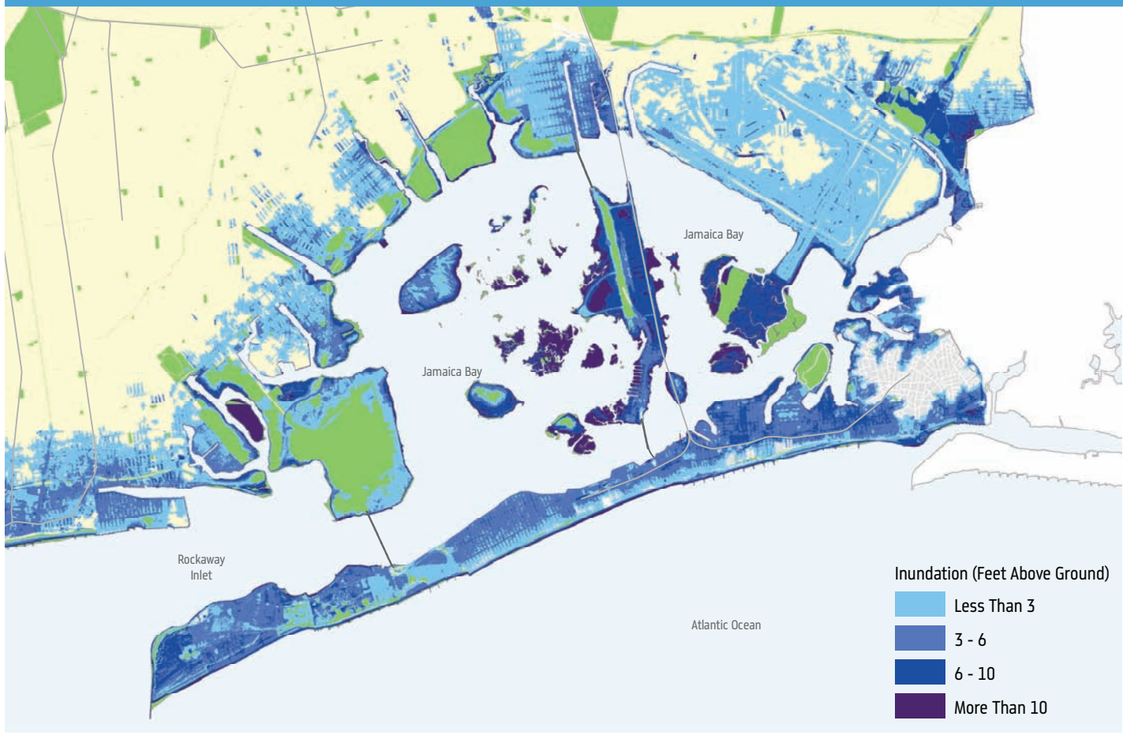
- Mott Avenue: Far Rockaway's main commercial corridor, this area is anchored by governmental and educational institutions. It is also served by multiple modes of public transit. The area includes a mix of small businesses and nonprofits as well as larger chain supermarkets and retailers. The area is the only commercial corridor in South Queens served by a local economic development organization, the Rockaway Development & Revitalization Corporation.
- Beach 116th Street: This commercial corridor runs from Jamaica Bay to the beach and is lined with small businesses. It intersects with another retail strip for a few blocks along Rockaway Beach Boulevard. Though the location has many advantages, including the terminus of the A line and access to both the beach and the Bay, the area has, struggled in recent years with the impact of vacant or underutilized buildings.
- Beach 129th Street: A smaller strip of retail, service, and dining establishments, this corridor primarily serves residents of Neponsit and Belle Harbor.
- Cross Bay Boulevard: This thoroughfare, running from the northern end of Jamaica Bay to the Rockaways, serves as the main commercial corridor of Howard Beach. It contains an auto-oriented retail strip, big-box retail, and, facing the water, restaurants and bars that are popular during the summer.
- Broad Channel: About a dozen retailers serving this community are scattered throughout the island.

Critical Infrastructure

In addition to the foregoing businesses and nonprofits that provide year-round employment and economic activity throughout South Queens, the Peninsula's beachfront and boardwalk also support a significant seasonal workforce. For example, during summer months, DPR hires lifeguards for the City's beaches, and restaurants and vendors, including Rockaway Park's popular Rockaway Taco, hire extra wait staff.

Notwithstanding this diversity of economic activity and the positive momentum from recent growth in the year-round surfing community

South Queens Surge Heights



Source: FEMA (MOTF 11/6 Hindcast surge extent)

and revitalized concessions around Rockaway Beach and Arverne, many businesses and nonprofits in South Queens had been struggling even before Sandy. This was due to a combination of factors, including the impact of the severe economic downturn that began in 2008.

Critical Infrastructure

South Queens contains a number of key infrastructure assets that serve the area and the larger city beyond. These include assets that are a part of the region's transportation network, process area wastewater, and act as vital coastal protections.*(See map: Critical Infrastructure)*

Among the transportation assets that can be found in the neighborhoods of South Queens, several serve as a critical link between this geographically isolated area and the rest of the city. For example, Cross Bay Boulevard and the Gil Hodges Memorial Bridge, both north-south arteries, provide vehicular access to the Rockaway Peninsula (and, in the case of Cross Bay Boulevard, to Broad Channel) from South Queens and Southern Brooklyn. The Metropolitan Transportation Authority's (MTA) A train and shuttle services that run on its lines, meanwhile, link the Rockaway Peninsula, Broad Channel, and Howard Beach via a causeway that traverses Jamaica Bay. On a typical weekday, thousands of daily commuters ride the A train, along with the Long Island Railroad, which stops in Far Rockaway, and the many bus lines serving the area.

South Queens is home to the Rockaway Wastewater Treatment Plant. The plant has been in operation since 1952 and treats 45 million gallons of wastewater per day while also receiving stormwater runoff. The facility, operated by the New York City Department of Environmental Protection (DEP), sits on low-lying land immediately adjacent to Jamaica Bay and is, therefore, one of the most vulnerable facilities in DEP's network to flooding and other weather-related events.

The Rockaway Wastewater Treatment Plant receives flow from the area's sanitary sewer system. Much of the Rockaways have been undergoing storm sewer build-out for years. Projects have included the extension, replacement, and installation of various water mains and sanitary and storm sewers throughout the Peninsula. However, the required build-out in the area is extensive, and in some neighborhoods, such as Far Rockaway, Edgemere, and Broad Channel, the storm sewer system has not been completed. As a result of this and their low elevation, these neighborhoods tend to be more susceptible to flooding.

Another important piece of infrastructure in South Queens is one that provides a coastal protection function: the area's beaches—especially those, along the Rockaway Peninsula, facing the Atlantic Ocean. However, in most places, these beaches lack dunes, groins and other forms of coastal protection. As a result, they experience regular erosion.

In response to this erosion, starting in 1977, the US Army Corps of Engineers (USACE) designed and implemented two major beach nourishment projects extending from Neponsit through Far Rockaway. However, in 2004, due to the high costs associated with these projects, the USACE deferred further nourishment and other planned projects, with a goal of finding more cost-effective solutions. In the interim, though, the area's beaches have continued to erode, reducing their ability to protect the neighborhoods along the Peninsula.

What Happened During Sandy

Arriving almost exactly at the moment of high tide in South Queens, Sandy brought a massive storm surge and battering waves to the neighborhoods of South Queens, wreaking havoc on the area. Most of the destruction brought by Sandy to these neighborhoods was, directly or indirectly, attributable to the huge volumes of water that inundated the area. This inundation followed three paths. First, areas flooded when waves rose directly up over beaches and broke against the neighborhoods behind them. Second, floodwaters were funneled through the Rockaway Inlet, throughout Jamaica Bay, and then into the tributaries and channels around the circumference of the Bay. Finally, in some places, inundation entered areas through low-lying drainage infrastructure that never was intended to face flooding of this magnitude. (*See map: South Queens Surge Heights*)

The result of all of this was widespread loss—building damage, power and transportation outages, disruptions in other services, displacement, and financial hardship for many residents, businesses, and nonprofits. Throughout South Queens, though few areas escaped harm altogether, different neighborhoods did experience the storm in different ways.

Compared to other neighborhoods in South Queens, generally speaking, Far Rockaway experienced minimal flooding associated with Sandy's surge due to its higher elevation and the fact that a portion of the coastline is protected by Long Beach. However, some pockets of Bayswater and the southern portions of Far Rockaway experienced more flooding than adjacent areas.

In Arverne, meanwhile, Sandy's surge breached the coastline, damaging beach-facing homes. However, damage was mitigated in large sections of Arverne By The Sea, where the dune system on the beach in front of the new development absorbed the impact of waves, while the elevated site and special drainage features in the development kept most housing units free of water.

Farther to the west, in Rockaway Park and Rockaway Beach, as in other sections of the Peninsula, Sandy's surge waters spread throughout the area. The net result in these communities was significant damage to building systems in high-rise structures (knocking out critical services like electricity and water), as well as flooding and structural damage to many of the area's low-rise buildings.

Even farther to the west on the Peninsula, damage generally increased. In these areas, high-velocity waves struck unprotected Belle Harbor, Neponsit, Roxbury, and Breezy Point, smashing structures facing the ocean and sending floodwaters down streets, onto properties, and into basements and ground floors. Vast amounts of sand also were pushed onto neighborhood streets, sidewalks, and private land.

At Riis Park, the parking lot and Art Deco bathhouse experienced significant damage, though it was not impacted structurally. At Fort Tilden, the entire network of protective dunes was lost, with the storm uncovering an old seawall with metal rebar and jagged debris. Fort Tilden remains closed as of the writing of this report.

Even as Sandy's surge attacked the Rockaway Peninsula from the ocean, it was also pushing through Rockaway Inlet. As it raised water levels in the area, it inundated Roxbury, damaging Bay-facing homes in the neighborhood.

From the Rockaway Inlet, the surge spread throughout Jamaica Bay, overtopping deteriorated seawalls along Belle Harbor and Neponsit and bringing floodwaters into these neighborhoods from that direction as well. As a result, at these and other points along the Peninsula the "ocean met the bay," with flood heights reaching as high as 10 feet.

Other Bay-facing Peninsula neighborhoods were deluged as well, including Somerville and Edgemere. There, low-lying land and soft soil conditions, together with already eroded

Fire damage in Breezy Point

Credit: Kirsten Luce/The New York Times

The Fires in the Rockaways

During and after Sandy, 94 storm-related fires broke out across New York City. About 80 percent of these fires were electrical in nature, caused by the interaction of electricity and seawater, though some were also caused by open flames or even faulty generators. In total, these fires destroyed over 200 homes and businesses across the five boroughs. As devastating as they were wherever they hit, the fires were particularly disastrous across the Rockaway Peninsula, where 175 of the destroyed homes and businesses were located.

Breezy Point

A 6-alarm fire broke out in Breezy Point when seawater brought by Sandy's surge came into contact with the electrical system of a single-family home in the community. Fueled by Sandy's high winds, the fire, which firefighters were unable to reach for some time due to flooding, spread quickly in this densely packed neighborhood, ultimately destroying 126 homes and damaging 22 more. It took 10 hours to bring the fire under control.

Belle Harbor

On Beach 129th Street in Belle Harbor, a major conflagration broke out after utility wires, compromised by the storm, came into contact with a 2-story home. The ensuing fire spread to 31 additional structures, completely destroying all of them.

Rockaway Beach Boulevard

On Rockaway Beach Boulevard and Beach 113th Street, utility wires came into contact with a 3-story, mixed-use building during the storm. The downed wires started a fire that eventually spread to 16 additional structures, destroying them all.

coastal conditions, allowed Sandy to undermine existing bulkheads, leaving homes virtually unprotected from the storm's waters.

Broad Channel, sitting at a low elevation in the middle of Jamaica Bay, also suffered from Sandy's surge, which spread large volumes of water throughout the neighborhood. Salt water contaminated the Jamaica Bay Wildlife Refuge's West Pond on the northern end of the island. In New Howard Beach, Old Howard Beach, and Hamilton Beach, inundation similarly caused significant devastation. Floodwaters largely entered these neighborhoods from the Bay via the narrow creeks and basins that wind through and among these neighborhoods.

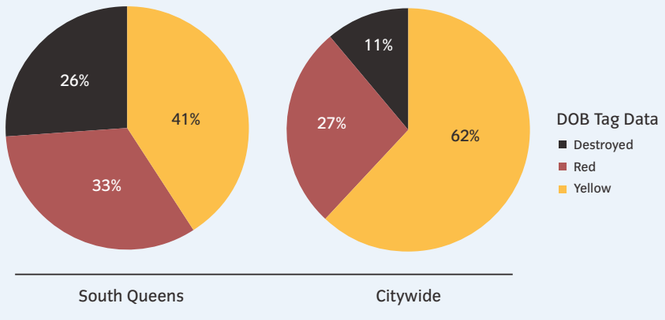
Another way in which Sandy wreaked havoc on South Queens was via its winds, which spread fires that broke out in several South Queens areas, including Breezy Point, Belle Harbor, and Rockaway, spreading them, in some cases, over large areas. (*See sidebar: The Fires in the Rockaways*)

As a result of Sandy, a large number of buildings in South Queens suffered damage. After the storm, the New York City Department of Buildings (DOB) sent out inspectors to assess damages in South Queens and other inundated areas of the City. These inspectors were asked to assign "tags" to buildings based on the observed condition of each structure. "Green" tags indicated less serious damage or no damage. "Yellow" tags indicated that portions of a building might be unsafe or might have significant non-structural damage. "Red" tags indicated structural damage. And a subcategory of "red" tags was further categorized as "destroyed".

Location and Level of Building Damage

Source: DOB December Tags

Level of Building Damage



Source: DOB December Tags

The most methodologically rigorous building damage assessment undertaken by DOB was completed in December 2012. According to this assessment, of those buildings citywide that were tagged, either yellow or red (including those further classified as destroyed), 37 percent were located in South Queens. This was well in excess of the percentage of all buildings in the citywide inundation zone that were located in South Queens (24 percent). The yellow and red tagged buildings in South Queens tended to be clustered in Edgemere, Somerville, Rockaway Beach, Rockaway Park, Belle Harbor, Neponsit, Roxbury, Breezy Point, Broad Channel and Hamilton Beach. Consistent with other ocean-facing areas of the city, in South Queens, the percentage of red and yellow tagged buildings that were tagged red (59 percent) was higher than the percentage citywide (38 percent). This overrepresentation was reflective of the destructive impact that powerful waves coming off of the ocean had on the area's building stock.

Like residents, businesses and nonprofits in South Queens were hit hard by Sandy, with over 2,275 businesses and nonprofits, employing nearly 15,000 people, impacted. These ranged from large to small.

For example, in Rockaway Beach, Madelaine Chocolates was inundated completely. This resulted not just in the loss of inventory and valuable equipment but also missed production during critical holiday seasons, from Thanksgiving through Easter.

Many neighborhood retail corridors, service-providers, and beach-related concession operators also were devastated. This devastation resulted primarily from inundation, though, in some cases, also was caused by fire. To add insult to injury, as these businesses and nonprofits began slowly to reopen after the storm, many found that they had fewer customers, owing to the large numbers of area residents who the storm had displaced. This was even true in Far Rockaway, where storm damage was less severe than elsewhere in South Queens,

Power Outages in South Queens

Although many parts of the city were affected by power outages, few were as significantly impacted as the neighborhoods of South Queens. Not only did the entire area lose power—caused by damage to substations, power lines, and customer equipment—but, in many cases, these power outages lasted longer than anywhere else in the city. To understand why this occurred, it is first necessary to understand how power is supplied to the area.

In the Rockaways, the Long Island Power Authority (LIPA), a public authority controlled by New York State, is responsible for delivering electric power. Meanwhile, as is the case in the rest of the city, Con Edison, a private utility company, is responsible for providing electric power to Broad Channel, New Howard Beach, Old Howard Beach, and Hamilton Beach.

During Sandy, all four LIPA substations serving the Rockaway Peninsula were knocked out of service by floodwaters, resulting in widespread power failures, impacting some 34,000 customers. Because of the extent of the damage to its system, after Sandy, LIPA was unable to reenergize its grid for some 11 days. Thereafter, LIPA was able to restore power relatively quickly to approximately 10,000 customers, predominantly in portions of Far Rockaway that did not suffer extensive flood damage. However, for the majority of areas that experienced significant flooding, and resulting physical damage to buildings, for safety reasons, it was necessary to repair this damage before power could be restored. As a result, around 24,000 customers remained without power returning one by one over months until each building received certified inspections or repairs to their equipment.

In Con Edison's territory, meanwhile, power outages were also extensive, impacting approximately 2,800 customers in New Howard Beach, Old Howard Beach, and Hamilton Beach and 950 customers in Broad Channel. This was, in large part, due to flooding, which, in turn, made it unsafe to restore electric service to customers until their in-building equipment could be inspected and, if damaged, repaired. According to Con Edison, eight days after Sandy's departure, half of the customers in New Howard Beach, Hamilton Beach, and Broad Channel had had their power restored, with about a quarter of customers restored in Old Howard Beach. The City's groundbreaking Rapid Repairs program dramatically accelerated the pace of power restoration in South Queens and other impacted areas, by dispatching contractors and skilled construction workers to make emergency repairs on residential properties affected by Sandy. In total, as of the writing of this report, Rapid Repairs has assisted more than 20,000 families – including thousands in South Queens.

Overall, extended power outages created hardships for many in South Queens, including the elderly and disabled. This was especially true for those living in multi-story facilities that had lost critical building systems, as occurred at numerous Mitchell-Lama developments, NYCHA developments, nursing homes, and adult care facilities.

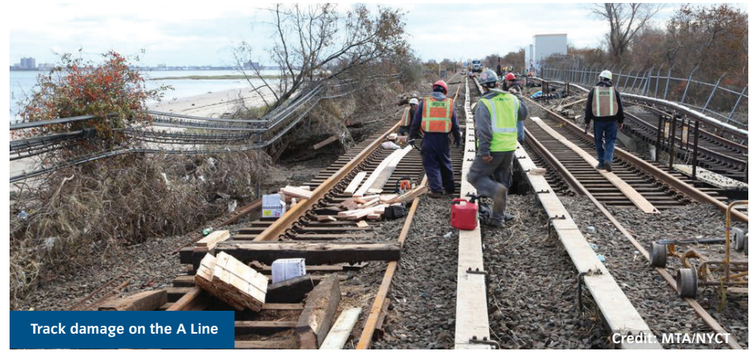
but where, three weeks after the storm, only 40 to 50 percent of area businesses had reopened. Businesses in South Queens suffered many losses, including lost inventory, damaged interiors, and compromised building systems.

Yet another impact that Sandy had on the neighborhoods of South Queens was extensive damage to the area's critical infrastructure. For example, Cross Bay Boulevard was fully submerged during the storm. After the storm, the thoroughfare was littered not just with damaged cars and trucks but also with boats that Sandy's surge had deposited well inland.

Mass transit serving South Queens also was significantly impaired by Sandy. For example, portions of the A train rail connection between Howard Beach and the Rockaway Peninsula were washed away, leaving 35,000 daily riders without a direct rail link to Queens, Brooklyn, and Manhattan. Subway tracks south of Howard Beach were also inundated with up to ten feet of water, washing these tracks out in many places and, in two locations, washing out the land on which the tracks ran. Other railroad equipment was seriously damaged or destroyed, including important signal systems. Though the MTA was able to put shuttle bus and train service in place in the interim, full service along the A line was not restored for some seven months, significantly increasing commuting times for those who normally relied on the subway.

Rockaway Boardwalk

Credit: Chang W. Lee/The New York Times



Track damage on the A Line

Credit: MTA/NYCT

Rockaway Beach, 1902

Restoration of the Rockaways Beachfront

Following Sandy, a top priority for the City was the reopening of the beaches of the Rockaway Peninsula in time for the summer of 2013. To this end, the Department of Parks and Recreation (DPR) repaired portions of the boardwalk that had sustained only minor or moderate damage to pre-Sandy designs, repaired and replaced damaged lifeguard stations and restrooms, and created resilient "boardwalk islands" in several compromised locations to provide access to beach facilities and amenities. Looking to the future, DPR intends not only to restore the boardwalk in full but also to continue to support beach restoration projects that will protect the neighborhoods that it fronts. DPR also is prioritizing opportunities for beach-fueled economic development in both the near- and long-terms that could contribute to the wider recovery of the Rockaway Peninsula, South Queens, and the city as a whole (See South Queens Initiatives 7 & 8).

To address the transit challenges posed by the closure of the A train, in November 2012, the City launched temporary ferry service between the Rockaways and Manhattan. Paid for in part with Federal money and using a landing site provided by National Grid, the service cost riders $2 per trip.

Another important piece of infrastructure in South Queens impacted by Sandy was the Rockaway Wastewater Treatment Plant. This facility suffered severe flooding and was out of service during the storm, leaving wastewater untreated for three days, although chlorine was applied to untreated effluent. Notwithstanding these releases, water quality samples taken by DEP following the storm showed minimal water quality impacts, due in part to dilution of effluent that resulted from the high volumes of water that Sandy brought with it. The Rockaway Wastewater Treatment Plant finally regained full treatment capacity approximately two weeks after the storm.

Sandy caused significant erosion along the beaches of South Queens. In fact, the USACE estimated that Rockaway Beach alone lost 1.5 million cubic yards of sand, much of it pushed up into neighborhood streets or washed into the Atlantic. Segments of the area's boardwalk were also destroyed, although the portions built of concrete tended to emerge unscathed or to sustain only minor to moderate damage.

Schools in the area were also damaged. In total, 37 schools in South Queens were closed for up to two months. Until repairs could be completed. Students at these schools were relocated to school facilities that had not been damaged to ensure that instructional disruption was kept to a minimum.

As significant as Sandy's impacts were on the many neighborhoods of South Queens, they also inspired acts of heroism. These efforts ranged from the relief operations undertaken by community-based organizations, other non-profits, local residents, and outside volunteers. The outpouring of financial and on-the-ground support helped many to begin addressing the damage done to their homes, supported efforts to clean up the area and assisted residents who were displaced or remained in the area but whose access to goods and services were impaired. In fact, the experience of Sandy inspired 40 local organizations to form a new coalition called Rockaway United. This group was established to coordinate services post-Sandy more effectively and to put mechanisms in place for future disasters. Efforts such as these were, in many ways, the silver linings that emerged from an otherwise grave situation, providing a ray of hope that, out of the tragedy of Sandy, the neighborhoods of South Queens will emerge with strengthened community networks that will be critical to resiliency in the future.

What Could Happen in the Future

Going forward, the neighborhoods of South Queens face a variety of risks relating to climate change. *(See chart: Risk Assessment: Impact of Climate Change)*

Major Risks

Given the area's coastal exposure, the most significant climate change-related risk posed to the neighborhoods of South Queens is flooding from coastal storms, which is likely to be exacerbated by projected sea level rise. This risk is significant even today, as illustrated by recently released Preliminary Work Maps (PWMs) from the Federal Emergency Management Agency (FEMA). According to these maps, the 100-year floodplain—the area with a 1 percent or greater chance of flooding in any given year—has expanded in the borough of Queens by 40 percent over that shown on the 1983 FEMA maps that were in effect when Sandy hit. In the new maps, the growth in the floodplain is profound for South Queens—with the exception of isolated sections of Far Rockaway, virtually the entirety of the South Queens area now lies within the 100-year floodplain. Additionally, portions of Broad Channel, Roxbury and Bayswater are now within a V Zone, which is a coastal area at risk of storm waves of three feet or more. In some limited instances zones encroach on residential property. (See Chapter 2, *Climate Analysis*; see map: *Comparison of 1983 FIRMs and Preliminary Work Maps*)

As the 100-year floodplain has expanded in size, there has also been an increase in the number of buildings in the floodplain—an increase of over 70 percent (from just over 11,000 to more than 19,000 buildings). Base Flood Elevations—the elevation to which floodwaters could rise during a storm—have increased 1 to 4 feet throughout the area.

According to projections from the New York City Panel on Climate Change (NPCC), described in Chapter 2 (*Climate Analysis*), sea levels are forecast to rise through the 2020s and 2050s. Though already in the 100-year floodplain, many neighborhoods in South Queens will experience more frequent flooding and even greater flood heights. *(See map: Comparison of Preliminary Work Maps and Future Floodplains)*

Although most of South Queens is already in the 100-year floodplain, flooding in these neighborhoods are likely to be at a greater height and occur more frequently. (*See table: Buildings in the Floodplain*)

Other Risks

Though coastal inundation poses the greatest threat to the neighborhoods along the waterfront, these areas face other climate risks, as well. Sea level rise, for example, even without extreme weather events like hurricanes, could, in some communities, lead to increased frequency and severity of street and basement flooding on a chronic basis by the 2050s. This risk, which already exists in areas like Edgemere, Broad Channel, Howard Beach and Hamilton Beach, is expected to impact as much as 12 miles of shoreline in the decades to come. (*See map: Sea Level Rise Analysis in Howard Beach and Hamilton Beach*)

Comparison of 1983 FIRMs and Preliminary Work Maps

Source: FEMA

Risk Assessment: Impact of Climate Change

Major Risk Moderate Risk Minor Risk

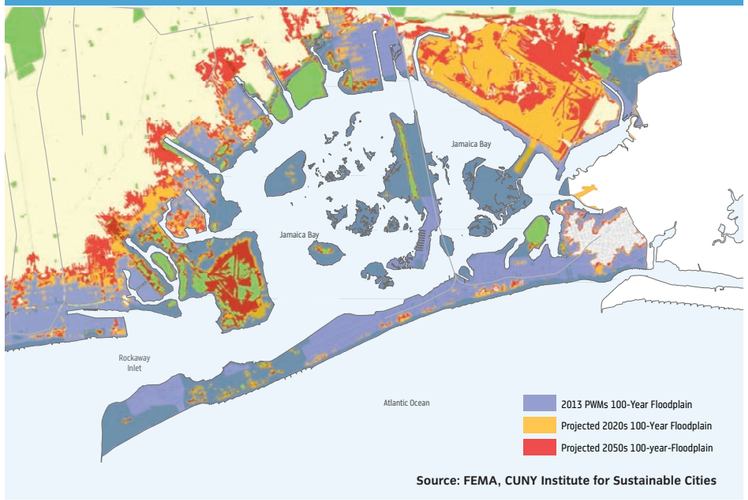
	Scale of Impact			
HAZARD	Today	2020s	2050s	Comments
GRADUAL				
Sea level rise				Some bay-facing, low-lying areas already experience regular tidal flooding; sea level rise likely would result in increases in localized flooding
Increased precipitation				Minimal impact
Higher average temperature				Minimal impact
EXTREME EVENTS				
Storm surge				Significant risk of both flooding and wave action, as evidenced by Sandy; risk likely would grow as V Zone expands; increased storm frequency would leave less time to restore coastal protections
Heavy downpour				May exceed capacity of sewer systems more frequently, resulting in localized flooding
Heat wave				Greater strain on power system with potential for more failures; most significant impact on high-rise buildings
High winds				Overhead power lines are at risk of failure

Buildings in the Floodplain

Buildings & Units	100-Year Floodplain			
	1983 FIRMs	2013 PWMs	Projected 2020s	Projected 2050s
Residential Buildings	10,810	18,790	20,030	20,560
Residential Units	25,400	42,600	45,000	46,500
Commercial and Other Buildings	350	640	690	700

Source: DCP PLUTO, FEMA

Comparison of Preliminary Work Maps and Future Floodplain



Source: FEMA, CUNY Institute for Sustainable Cities

Increased precipitation and more frequent and heavier downpours also could overwhelm sewer systems going forward, resulting in more flooding. Based on current forecasts, however, this risk is likely to be fairly localized.

While future projections for changes in wind speeds are not available from the NPCC, a greater frequency of intense coastal storms by the 2050s could present a greater risk of high winds in the New York area. This could cause issues for materials that are exposed and for buildings built before modern building codes—of which South Queens has many.

Sea Level Rise Analysis in Howard Beach and Hamilton Beach

Priorities from Public Engagement in South Queens

Since the Special Initiative for Rebuilding and Resiliency (SIRR) was launched in December 2012, the input of local stakeholders has helped shape an understanding of what happened during Sandy, what risks South Queens faces in relation to climate change and what approaches make sense to address these risks.

South Queens is represented by a wide array of elected officials at the Federal, State, and local levels. It is also represented by two community boards. The area is further served by a large number of community-based organizations, civic groups, faith-based organizations, and other neighborhood stakeholders. All played an important role in relief and recovery efforts after Sandy. Throughout the process of developing this plan, SIRR staff benefited from numerous conversations—both formal and informal—with these groups and individuals, including, in South Queens, two task forces that met regularly.

SIRR also held three public workshops in March of 2013 in South Queens, part of a series of such workshops held citywide in which over 1,000 New Yorkers participated to discuss issues affecting their neighborhoods and communicate their priorities for the future of their homes and communities. Generally, the on-the-ground insights provided at these public workshops helped SIRR staff to develop a deeper understanding of the specific priorities of, and challenges facing the communities of South Queens.

South Queens community outreach workshop

Task Force	Briefing Frequency	# of Stakeholders from South Queens
Elected officials	Monthly	• ~14 City, State, Federal elected officials
Community-based organizations	4 – 6 weeks	• 2 community boards • 55+ faith-based, business, and community organizations

Overall, out of the various task force and other meetings and public workshops attended by SIRR staff since January, several priorities for SIRR clearly emerged:

- Providing coastal protection measures on the ocean and bay;
- Clarifying available resources to retrofit, repair, and rebuild homes;
- Addressing concern over future flood insurance rates;
- Providing support to small businesses;
- Expanding transit options; and
- Creating jobs and access to job training and educational opportunities for local community members.

South Queens community outreach workshop

SOUTH QUEENS | Initiative Summary

Coastal Protection

Selected Citywide Measures

- **A** Call on and work with the USACE to complete emergency beach nourishment on the Rockaway Peninsula
- **B** Complete bulkhead repairs and roadway drainage improvements adjacent to Beach Channel Drive on the Rockaway Peninsula
- **C** Call on and work with the USACE to complete existing studies of the Rockaway Peninsula and implement coastal protection projects
- **D** Call on and work with the USACE to study primary and secondary dune systems in vulnerable Rockaway Peninsula neighborhoods and install such system on Breezy Point
- **E** Call on and work with the USACE to study and install wetlands for wave attenuation in Howard Beach and to study further flood protection improvements within Jamaica Bay
- **F** Complete living shorelines and floating breakwaters for wave attenuation in Brant Point

* For additional Coastal Protection initiatives, see Coastal Protection section of Community Plan

- **1** Call for USACE to develop an implementation plan to mitigate inundation risks through Rockaway Inlet, exploring a surge barrier and alternative measures
- **2** Develop an implementation plan to address frequent tidal inundation in Broad Channel and Hamilton Beach, incorporating international best practices
- **3** Complete short-term dune improvements on the Rockaway Peninsula

Buildings

Selected Citywide Measures

- **G** Improve regulations for flood resiliency of new and substantially improved buildings in the 100-year floodplain
- **H** Rebuild and repair housing units destroyed and substantially damaged by Sandy
- **I** Study and implement zoning changes to encourage retrofits of existing buildings and construction of new resilient buildings in the 100-year floodplain

Buildings

Selected Citywide Measures

- **J** Amend the Building Code and complete studies to strengthen wind resiliency for new and substantially improved buildings
- **K** Encourage existing buildings in the 100-year floodplain to adopt flood resiliency measures through an incentive program and targeted mandate
- **L** Retrofit public housing units damaged by Sandy and increase future resiliency of public housing
- **M** Launch a sales tax abatement program for flood resiliency in industrial buildings
- **N** Clarify regulations relating to the retrofit of landmarked structures in the 100-year floodplain
- **O** Amend the building code to improve wind resiliency for existing buildings and complete studies of potential retrofit

* For additional Buildings initiatives, see Buildings section of Community Plan

- **4** Complete design competition to enhance resiliency of planned Arverne East Project

Critical Infrastructure

Selected Citywide Measures

- **P** Work with utilities and the Public Service Commission (PSC) to harden key electric transmission and distribution infrastructure against flooding
- **Q** Work with utilities and the PSC to harden vulnerable overhead lines against winds
- **R** Work with utilities, regulators, and gas pipeline operators to harden the natural gas system against flooding
- **S** Require the retrofitting of existing hospitals in floodplains
- **T** Require retrofitting of nursing homes in floodplains
- **U** Require retrofitting of adult care facilities in floodplains
- **V** Reconstruct and resurface streets damaged by Sandy
- **W** Elevate traffic signals and provide backup electrical power
- **X** Call on non-City transportation agencies to implement strategies to address climate change threats
- **Y** Expand the city's Select Bus Service (SBS) network
- **Z** Restore city beaches
- **AA** Harden or otherwise modify shoreline parks to protect adjacent communities
- **BB** Work with the Federal government to transform Jamaica Bay
- **CC** Harden pumping stations
- **DD** Harden wastewater treatment plants
- **EE** Explore alternatives for the Rockaway Wastewater Treatment Plant

* For additional Critical Infrastructure initiatives, see Critical Infrastructure sections of Community Plan

- **5** Build a new multi-specialty ambulatory surgical center in the Rockaways
- **6** Expand ferry service to the Rockaway Peninsula

Community & Economic Recovery

Selected Citywide Measures

- **FF** Launch business recovery and resiliency programs
- **GG** Launch the Neighborhood Game-Changer Competition

↔ Call for Neighborhood Retail Recovery Program

- Cross-Bay Blvd. (between Belt Parkway and 165th Ave.)
- Broad Channel
- Beach 116th St.
- Beach 108th St.
- Rockaway Beach Blvd. (between Beach 113th and Beach 116th Sts.)
- Beach 129th St.
- Mott Ave. (between Cornaga and Beach Channel Dr.)
- All streets from Beach 90th to Beach 100th Sts
- Breezy Point

- **HH** Support local merchants in improving and promoting local commercial corridors
- **II** Continue to support the FRESH program to increase the number of full-line grocers in underserved neighborhoods

- **7** Get New Yorkers "Back to the Beach" for summer 2013
- **8** Explore opportunities for long-term activation of the beachfront
- **9** Develop a revitalization strategy for the Beach 108th Street corridor
- **10** Develop a comprehensive commercial revitalization plan for Beach 116th Street
- **11** Develop an implementation plan for redevelopment of Far Rockaway, potentially involving repositioning of City- and MTA-controlled sites
- **12** Launch a satellite Workforce 1 career center in Far Rockaways
- **13** Implement planned and ongoing investments by the City and private partners
  - Jamaica Bay/Rockaway Restoration Corps
  - Rockaway Institute for a Sustainable Environment (RISE)
  - Beach 73rd St. YMCA

This chapter contains a series of initiatives that are designed to mitigate the impacts of climate change on South Queens. In many cases, these initiatives are both ready to proceed and have identified funding sources assigned to cover their costs. With respect to these initiatives, the City intends to proceed with them as quickly as practicable, upon the receipt of identified funding.

Meanwhile, in the case of certain other initiatives described in this chapter, though these initiatives may be ready to proceed, they still do not have specific sources of funding assigned to them. In Chapter 19 (Funding), the City describes additional funding sources, which, if secured, would be sufficient to fund the full first phase of projects and programs described in this document over a 10-year period. The City will work aggressively on securing this funding and any necessary third-party approvals required in connection therewith (i.e., from the Federal or State governments). However, until such time as these sources are secured, the City will only proceed with those initiatives for which it has adequate funding.

South Queens Community Rebuilding and Resiliency Plan

South Queens is a section of New York City with scenic vistas and a relaxed pace, a rare find for urban New Yorkers. The area is characterized by tight-knit communities and rich natural and recreational assets, which include miles of open beaches and the majestic waters of Jamaica Bay.

The following is a multilayered plan that not only applies citywide strategies to South Queens, but also provides strategies designed to address the area's specific needs and particular vulnerabilities. In anticipation of future climate change-related risks, this plan proposes ways that South Queens neighborhoods can adapt by: addressing wave action and inundation along the entire coastline and within Jamaica Bay; providing opportunities to retrofit the area's most vulnerable building stock; protecting and improving critical infrastructure; and focusing investments in strategic areas, such as the beachfront, to advance a long-term and sustainable recovery.

Coastal Protection

As Sandy illustrated, the greatest extreme weather-related risk faced by New York City is storm surge, the effects of which are likely to increase given current projections of sea level rise. Going forward, it is anticipated that climate change will render coastal regions of the city, including South Queens, even more vulnerable to these risks.

While it is impossible to eliminate the chance of flooding in coastal areas, the City will seek to reduce its frequency and effects—mitigating the impacts of sea level rise, storm waves including erosion, and inundation on the coastline of the city generally and South Queens in particular. Among the strategies that the City will use to achieve these goals will be the following: increasing coastal edge elevations; minimizing upland wave zones; protecting against storm surge; and improving coastal design and governance.

In the development of cost-effective coastal protections measures that fit these strategies, a range of considerations, particularly the area's exposure to coastal risks, its geomorphology, and land use, must be taken into account. Other considerations, such as impacts to waterfront access, water quality and the environment, navigation, and neighborhood character and quality of life for residents and businesses, will be evaluated, where appropriate. For a full explanation of the following initiatives and a complete description of the City's comprehensive coastal protection plan, please refer to Chapter 3 (*Coastal Protection*).

The initiatives described below provide important examples of how the City intends to advance its coastal protection agenda citywide. These initiatives will have a significant impact on the residents, businesses, and nonprofits of South Queens. Taken together, when completed, the first seven coastal protection initiatives described below, would provide enhanced protection for nearly 18,000 buildings in South Queens, representing around 35,000 housing units as well as many businesses and much of the critical infrastructure.

Coastal Protection Initiative 2
Call on and work with the USACE to complete emergency beach nourishment on the Rockaway Peninsula

Beach replenishment in the Rockaways was suspended in 2004, and in the intervening years they have continued to erode. This erosion, coupled with the 1.5 million cubic yards of sand lost during Sandy, has created a breach that threatens adjacent neighborhoods. The City, therefore, will support emergency beach nourishment work from Beach 19th Street to Beach 149th Street. The initiative will replace approximately 3.6 million cubic yards of sand. This project is expected to start in July 2013, with completion targeted for December 2013. As part of this initiative, the City will continue to work with the USACE will develop a plan for ongoing beach maintenance so that future extreme weather events can be followed quickly by restoration of lost sand.

Coastal Protection Initiative 6
Raise bulkheads in low-lying neighborhoods to minimize inland tidal flooding

Bulkheads provide the first line of defense against flooding in many South Queens neighborhoods, including Old Howard Beach, Hamilton Beach, Broad Channel and Edgemere, but throughout the city, many bulkheads are built to an elevation that may be insufficient given the latest projections of sea level rise by 2050. Subject to available funding, the City, therefore, will launch a program to raise bulkheads and other shoreline structures across the five boroughs in low-lying areas most at risk of daily or weekly tidal flooding, a phenomenon that could impact as much as 12 miles of shoreline by the 2050s. The Mayor's Office of Long Term Planning and Sustainability (OLTPS) will work with the New York City Economic Development Corporation (NYCEDC) to manage this program, to begin implementation in 2013, in conjunction with the new citywide waterfront inspections program described in Chapter 3.

Coastal Protection Initiative 8
Complete bulkhead repairs and roadway drainage improvements adjacent to Beach Channel Drive on the Rockaway Peninsula

Belle Harbor is lined by about two miles of City-owned seawall on its bay side. This floodwall, however, is in deteriorated condition that could allow surge waters to inundate the neighborhood during extreme weather events. Complementing the bulkhead work described above (see Coastal Protection Initiative 6), the City, through NYCEDC, therefore will continue its ongoing work to restore segments of the floodwall that are in poor condition. NYCEDC recently completed the first of three segments between Beach 125th and Beach 130th Streets, and will restore the remaining sections by early 2014. The City also will equip a portion of the roadway drainage network from approximately Beach 116th Street to Beach 143rd Streets with new duckbill tide gates, or valves that block waters from entering pipes from the drainage end, while still allowing stormwater to drain out. This work will make use of existing funding and provide protection concurrent with and subsequent to the upcoming hurricane season. After work is completed, the City will evaluate the elevation of the floodwall generally and whether changes to this elevation should be made over time.

Coastal Protection Initiative 11
Call on and work with the USACE to complete existing studies of the Rockaway Peninsula and implement coastal protection projects

The entire Rockaway peninsula faces continued risk of flood and wave action. The City will, therefore, call on the USACE to complete the Rockaway reformulation study started in 2003. This authorized study offers an expedited path to rethink and improve the current flood protections on the Rockaway Peninsula. DPR will ensure that this work makes effective use of existing Federal appropriations to advance meaningful flood protection projects. It is expected that the reformulation study will be completed by 2015. Consistent with this study, the City also will call upon the USACE to implement further beach nourishment and dune construction projects in the area, and working with DPR to complement its future boardwalk restoration plans.

DPR also will work with the USACE to determine the feasibility and effectiveness of expanding or strengthening the existing groin fields on the Rockaway peninsula. In the interim, DPR will complete short-term dune improvements on the Rockaway peninsula from Beach 9th Street to Beach 149th Street, using low-cost and readily available solutions to mitigate the effects of storm waves on adjacent neighborhoods during this year's hurricane season.

Coastal Protection Initiative 12
Call on and work with the USACE to study primary and secondary dune systems in vulnerable Rockaway Peninsula neighborhoods and install such a system in Breezy Point

Neighborhoods such as Breezy Point suffered devastating damage from Sandy and are likely to become more exposed to extreme weather events as the climate changes. This vulnerability is particularly great on the ocean-facing side of Breezy Point, where wave action during extreme weather events brings not just inundation, but destructive force, as well. Subject to available funding, the City, working through OLTPS, therefore, will call on and work with the USACE to study and construct a project to protect this neighborhood first on its ocean-facing side. The City believes that such protection should take the form of a primary and secondary dune system, which not only will protect residents and their property but also will demonstrate the viability of these systems. It should be noted that, to obtain federal funding for these or other protective measures, the Breezy Point Cooperative, which is the owner of the oceanfront property in the area, will likely be required to provide public access to the community's beaches. The goal is that, following the completion of the USACE study, the resulting project would be implemented within four years.

Coastal Protection Initiative 14
Call on and work with the USACE to study and install wetlands for wave attenuation in Howard Beach and to study further flood-protection improvements within Jamaica Bay

Howard Beach and Hamilton Beach, two Queens communities along the northern coastline of Jamaica Bay, are highly exposed, low-lying neighborhoods. To address this vulnerability, subject to available funding, the City will call on the USACE to study and implement a wetlands restoration project designed to attenuate waves. This project will build upon the existing work contained in the Hudson-Raritan Estuary Comprehensive Restoration Plan and will leverage planning work done by the Nature Conservancy. This project will not only protect the two aforementioned neighborhoods, but also will allow the effectiveness of such wetland restorations to be tested. DPR will oversee these efforts. Following a USACE study, this project should, be implemented within four years.

The City also will call upon the USACE, simultaneous with the Howard Beach-Hamilton Beach wetlands restoration, to restart existing studies of the Rockaway Peninsula and of Jamaica Bay. These authorized studies offer an expedited path to project completion. Following completion of these studies, the USACE should, subject to available funding, implement coastal protection projects recommended by the studies to provide flood protection and reconstitute some of the city's most important historic

Wetlands Restoration Project, Jamaica Bay

Credit: Courtesy of US Army Corps of Engineers/Great Lakes Dredge & Dock, LCC: Stefan Turner Aerial Photography

protective wetlands and marsh islands. DPR will ensure that these projects make effective use of existing Federal appropriations. If restarted now, these studies should be completed by 2016. Improvements of bulkheads in low-lying neighborhoods, and implementation of a local storm surge barrier for Rockaway Inlet.

Coastal Protection Initiative 17
Complete living shorelines and floating breakwaters for wave attenuation in Brant Point, Queens

The Brant Point Wildlife Sanctuary is a low-lying natural area that, even today, is vulnerable to the potential impacts of extreme weather events. This threatens the Wildlife Sanctuary and the neighborhoods that it fronts. This vulnerability, moreover, is expected to grow as the climate changes. Therefore, the City, working through the Department of Environmental Protection (DEP) and subject to available funding, will construct and monitor new living shorelines and floating breakwaters in this area. These improvements not only will protect the Wildlife Sanctuary and the residents of the communities abutting the Sanctuary but also will demonstrate the viability of these protection systems, especially in areas with existing wetlands and marsh islands. If effective, living shoreline and floating breakwater projects could be replicated elsewhere in the city. The goal is that the project would be implemented during 2014.

Beyond the priority coastal protection projects described in Chapter 3, including those summarized briefly above, the City is proposing additional coastal protection initiatives specific to South Queens's vulnerabilities. These initiatives are described below.

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South Queens Initiative 1
Call for USACE to develop an implementation plan to mitigate inundation risks through Rockaway Inlet, exploring a surge barrier and alternative measures

Much of the flood damage from Sandy in the neighborhoods of Brooklyn and Queens that face Jamaica Bay came from water that flowed through Rockaway Inlet into the Bay. The extensive shoreline that surrounds Jamaica Bay supports a variety of land uses and densities, all of which are at risk of flooding. Because flood protection along the existing shoreline of Jamaica Bay would be extremely expensive, and disruptive, and in some cases nearly impossible, the City will call on and work with the USACE to develop an implementation plan for a local storm surge barrier to be constructed across Rockaway Inlet approximately between Manhattan Beach in Brooklyn and Breezy Point in Queens. A Rockaway Inlet local storm surge barrier at this location could protect against significant inland flooding and wave risk in neighborhoods from Sheepshead Bay to Howard Beach, as well as JFK Airport, Broad Channel, and the entire bayside of the Rockaway peninsula (provided that the barrier was completed in conjunction with dune enhancements along the oceanside of the Rockaway peninsula and mitigation measures along Coney Island Creek). This project, in turn, would obviate the need for extensive localized coastal protections spread around the shoreline of the Bay. A preliminary feasibility assessment, to be performed by OLTPS in coordination with DEP, would examine impacts on water quality, habitat, hydrodynamics, and navigation, and would identify potential secondary coastline reinforcements.

The goal is for USACE to begin work on this plan as part of its comprehensive study of flood risk reduction in New York City, based on the recommendations of this report.

South Queens Initiative 2
Develop an implementation plan to address frequent tidal inundation in Broad Channel and Hamilton Beach, incorporating international best practices

Already experiencing more frequent tidal flooding (even without extreme weather events) than other neighborhoods in South Queens, Broad Channel and Hamilton Beach face acute risk from projected sea level rise as described in Chapter 2 (*Climate Change*). To address this risk, the City, working through OLTPS and NYCEDC and subject to available funding, will develop cost-effective protection and adaptation strategies to address the vulnerability of buildings, land, and critical infrastructure in these communities in a manner that also addresses neighborhood character. Prior to launching the plan, the City will issue a Request for Qualifications for a technical support team of experts, including architects, engineers, urban and landscape designers, scientists and others who have international experience working in areas vulnerable to comparable flood risks and have experience generating innovative solutions. These experts will be tasked by the City with developing viable designs to address the challenges in these communities. The goal is to launch the planning process in 2013.

Simultaneously with launching this initiative, the City also will evaluate the flood protection impact of a joint DEP/Department of Transportation (NYCDOT) project on Broad Channel that is slated to commence by 2014. The project involves three local roadways and includes raising these roadways 3 feet, upgrading drainage systems, and installing bulkheads. If effective, the project could be replicated in other vulnerable areas of Jamaica Bay.

South Queens Initiative 3
Complete short-term dune improvements on the Rockaway Peninsula

In the event of a storm, the entire Rockaway Peninsula—without additional protection—is vulnerable to storm surge and flooding. While awaiting the completion of the Rockaway Reformulation Study described above (see Coastal Protection Initiative 11), the City will, through DPR, will complete short-term dune improvements on the Peninsula from Beach 9th Street to Beach 149th Street. These improvements will utilize low-cost solutions to mitigate the effects of extreme weather events on adjacent neighborhoods during the upcoming hurricane season.

Buildings

The city's buildings give physical form to New York. As Sandy demonstrated, however, the building stock citywide, including in South Queens, is highly vulnerable to extreme weather events—a vulnerability that is expected to increase in the future. While the coastal protection measures outlined above are designed to reduce the effects of sea level rise, storm surge, and wave action on the city and South Queens, these measures will not completely eliminate those risks. They also will take time to design, fund, and build. It is equally important, therefore, to supplement these measures by pursuing resiliency at the building level.

To achieve building-level resiliency, the City will seek to protect structures in South Queens and throughout the five boroughs against a spectrum of climate risks, including not only flooding but also high winds and other extreme events. Among the strategies that the City will use to achieve these goals will be to construct new buildings to the highest resiliency standards and retrofit as many existing buildings as possible so that they will be significantly better prepared to handle the impacts of extreme weather events. The initiatives described below provide important examples of how the City intends to advance building resiliency citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits of South Queens. For a full explanation of the following initiatives and a complete description of the City's five-borough building resiliency plan, please refer to Chapter 4 (*Buildings*).

Buildings Initiative 1
Improve regulations for flood resiliency of new and substantially improved buildings in the 100-year floodplain

Though buildings constructed to modern Construction Codes generally performed well during Sandy, given the increasing risk of flooding that is likely with climate change, modifications are warranted. The City, therefore, will seek to amend the Construction Codes, and Zoning Resolution to provide for strengthened requirements that will, among other things, improve the design of new buildings through the application of appropriate resiliency measures that are calibrated to the best floodplain data available over time and provide that critical building systems are better-protected from flood risks. In 2013, the City, through the OLTPS, will seek to implement these code changes and the Department of City Planning (DCP) will continue to take zoning changes through the public review process, with the goal of adoption before the end of the year. If adopted, they will improve resiliency for developments throughout South Queens.

Buildings Initiative 2
Rebuild and repair housing units destroyed and substantially damaged by Sandy

Roughly 23,000 private residential buildings encompassing nearly 70,000 housing units were damaged or destroyed during Sandy. Subject to available funding, the City, therefore, through the Mayor's Office of Housing Recovery Operations (HRO), will provide financial and other assistance to owners of residential properties that were destroyed or substantially damaged during Sandy, including to approximately 7,000 residential buildings encompassing approximately 8,000 housing units in South Queens. This program will help homes to be rebuilt or repaired to the highest resiliency standards based on the best floodplain data available over time. In limited circumstances, the City will explore acquisition of homes that were destroyed or damaged with the goal of subsequently disposing of such sites for redevelopment consistent with zoning. Additionally, the City is seeking to incorporate resiliency measures into approximately 500–600 multifamily properties that sustained minor damage including many publicly assisted buildings properties such as those developed pursuant to the Mitchell-Lama program and other affordable housing. The City, therefore, will support the retrofit of these publicly-assisted buildings, such as those developed pursuant to Mitchell-Lama and other affordable housing programs.

Buildings Initiative 3
Study and implement zoning changes to encourage retrofits of existing buildings and construction of new resilient buildings in the 100-year floodplain

The City, through DCP, will undertake a series of citywide and neighborhood-specific land use studies to address key planning issues in severely affected and vulnerable communities. As part of these studies, the City will identify ways to facilitate the voluntary construction of new, more resilient building stock, and to encourage voluntary retrofits of existing vulnerable buildings over time. To be undertaken in close consultation with local residents, elected officials, and other community stakeholders, these land use studies will focus on the challenges posed by flood exposure of the applicable neighborhoods; the vulnerability of the building types that are found in these neighborhoods (e.g., older, one-story bungalows); and site conditions in these areas (e.g. narrow lots and streets) in Hamilton Beach that can make elevation or retrofit of vulnerable buildings expensive or complicated.

In South Queens, DCP will examine neighborhoods including Old Howard Beach, Hamilton Beach and Broad Channel, exploring zoning and other land use changes that, in the future, could encourage residents, if they so choose, to make changes with respect to existing homes or build new homes that would result in significantly greater resiliency. Subject to available funding, the goal is for DCP to commence this study in 2013. Thereafter, DCP would move to implement changes, if any, that it deems to be appropriate, based on the results of its study.

Buildings Initiative 4
Launch a competition to encourage development of new, cost-effective housing types to replace vulnerable stock

Subject to available funding, the City, through the Department of Housing Preservation and Development (HPD), will launch an international Resilient Housing Design Competition. This competition will offer prizes to private-sector developers who design and develop new, high-quality housing prototypes that offer owners of vulnerable building types (e.g., older, one-story bungalows), a cost-effective path that is consistent with city building and zoning requirements to replacing these structures with structures that meet the highest resiliency standards. In addition to cash prizes, the winners of this competition will be given the opportunity to put these structures into service in connection with a City-sponsored development project. Prototypes will have applicability throughout the five boroughs, including in sections of South Queens such as Broad Channel and Hamilton Beach and other vulnerable bungalow communities. The goal is for HPD to launch this competition in 2013.

Buildings Initiative 5
Work with New York State to identify eligible communities for the New York Smart Home Buyout Program

The City will evaluate opportunities for collaboration with the State in connection with its home buyout program, using an objective set of criteria developed by the City, including extreme vulnerability, consensus among a critical mass of contiguous local residents, and other relevant factors. It is anticipated that these criteria will be met in a limited number of areas citywide. As of the writing of this report, no areas have been identified for this program in South Queens.

Buildings Initiative 6
Amend the Building Code and complete studies to strengthen wind resiliency for new and substantially improved buildings

As noted above, buildings constructed to modern Building Code standards generally performed well during Sandy. Sandy, however, brought relatively weak winds, compared to other hurricanes. Given the possibility of more frequent or intense wind events in the future, modifications to the Building Code are warranted. The City, therefore, through DOB will seek to amend the Building Code to provide for strengthened requirements so that new buildings citywide can meet enhanced standards for wind resiliency. The City will further study whether additional wind resiliency standards should be required going forward. The amendments will be submitted to the City Council for adoption, and the study will commence, in 2013.

Buildings Initiative 7
Encourage existing buildings in the 100-year floodplain to adopt flood resiliency measures through an incentive program and targeted mandate

Even if every structure destroyed or damaged by Sandy were rebuilt to the highest resiliency standards, this would still leave tens of thousands of existing structures in the 100-year floodplain vulnerable—with more becoming vulnerable as the climate changes. Subject to available funding, the City, therefore, will launch a $1.2 billion program to provide incentives to owners of existing buildings in the 100-year floodplain to encourage them to make resiliency investments in those buildings. Of the up to $1.2

billion available through the program, the City will reserve up to $100 million for 1- to 3-family homes, up to $500 million for distribution across the five boroughs based on each borough's share of vulnerable buildings, citywide, up to $90 million for small businesses, and $100 million for affordable housing developments. The City also will mandate that large buildings (i.e., those with seven or more stories that are more than 300,000 square feet in size) undertake certain flood resiliency investments by 2030. If the City consistently achieves its stated goal of encouraging significant resiliency retrofit investments for the vast majority of the built floor area in the 100-year floodplain in the five boroughs, as many as 13,500 buildings in South Queens, encompassing over 25,000 housing units and over 40 million square feet of built space would, over time, be made meaningfully less vulnerable. The goal would be to launch these programs in 2013.

Buildings Initiative 8
Establish Community Design Centers to assist property owners in developing design solutions for reconstruction and retrofitting and connect them to available City programs

The City, through HRO will establish Community Design Centers in neighborhoods affected by Sandy, potentially including South Queens, to assist property owners in developing design solutions for reconstruction and retrofitting, and connect them to available City programs. The Centers would be managed by the City—through agencies such as HRO, HPD, DOB, DCP, and NYCEDC—with support from local partners.

Buildings Initiative 9
Retrofit public housing units damaged by Sandy and increase future resiliency of public housing

During Sandy, public housing developments owned and operated by NYCHA suffered significant damage throughout the city. Still more were not impacted by Sandy but remain vulnerable to extreme weather, with even more likely to become vulnerable as the climate changes. The City, therefore, through NYCHA, will repair public housing developments across the City that were damaged by Sandy, incorporating new flood resiliency measures. In South Queens, 59 buildings containing over 4,000 units will be repaired incorporating resiliency investments.

Buildings Initiative 10
Launch a sales tax abatement program for flood resiliency in industrial buildings

As Sandy demonstrated, many industrial buildings are vulnerable to extreme weather, with more likely to become vulnerable as the climate changes. However, many industrial buildings operate on thin margins, making it challenging to invest in resiliency. The City, through the New York City Industrial Development Agency (NYCIDA), therefore, will launch a $10 million program to provide incentives to owners of industrial buildings to encourage them to make resiliency investments in those buildings. The program will prioritize 1- to 2- story building with more than 4 feet between their actual ground elevation and the applicable Base Flood Elevation (BFE). In South Queens, 16 industrial buildings with over 300,000 square feet of floor area will be eligible for this program. This program will be launched in 2013.

Buildings Initiative 11
Launch a competition to increase flood resiliency in building systems

Many existing strategies for improving resiliency in buildings are either imperfect, expensive, or a combination of both. The City, through NYCEDC, therefore, will launch an approximately $40 million Resiliency Technologies Competition using allocated Community Development Block Grant (CDBG) funding to encourage the development, deployment, and testing of new resiliency technologies for building systems. In South Queens, 19,400 buildings will be eligible to benefit from this competition. The program will be launched in 2013.

Buildings Initiative 12
Clarify regulations relating to the retrofit of landmarked structures in the 100-year floodplain

The City, through the Landmarks Preservation Commission, will clarify the Commission's regulations to assist owners of landmarked buildings and properties in landmarked districts in the 100-year floodplain who are contemplating retrofit projects. In South Queens, there is one landmarked building in the floodplain. The Commission will issue its clarifying regulations in 2013.

Buildings Initiative 13
Amend the building code to improve wind resiliency for existing buildings and complete studies of potential retrofit

As noted above, given the possibility for more frequent intense wind events in the future, modifications to the Building Code are warranted. The City, therefore, through OLTPS, will seek to amend the Building Code and expand the existing DOB Façade Inspection Safety Program for high-rise buildings to include rooftop structures and equipment. The City will further study whether additional wind resiliency standards are required going forward. These amendments will be submitted to the City Council for adoption and the study will commence in 2013.

Beyond the priority building resiliency projects described in Chapter 4, including those summarized briefly above, the City is proposing an additional building resiliency initiative specific to South Queens' vulnerabilities. This initiative is described below.

South Queens Initiative 4
Complete design competition to enhance resiliency of planned Arverne East Project

The Arverne East Urban Renewal Area in the Arverne section of the Rockaway Peninsula was planned for approximately 1,700 housing units, 500,000 square feet of retail and commercial space, together with a significant amount of open space, including a large nature preserve. As Sandy demonstrated, however, without resiliency investments, this area will be highly vulnerable to future extreme weather events. This vulnerability is expected to expand as the climate changes. Given this, HPD and its designated private development partner have launched a new design competition to solicit revised ideas for the development that would incorporate resiliency elements. Among the resiliency elements that will be considered will be the placement of open space and built elements to provide protection from extreme weather events. It is anticipated that competition winners will be announced in the fall of 2013.

Insurance

Insurance can help provide residents and businesses with financial protection against losses from climate change and other types of risks. Sandy not only highlighted the importance of insurance, it also revealed that many New Yorkers are exposed to flood losses, which are not covered in standard homeowners or small business property insurance policies. Citywide, 95 percent of homeowners carry homeowners insurance, but when Sandy struck less than 50 percent of residential buildings in the effective 100-year floodplain had coverage through the National Flood Insurance Program (NFIP), a federal program administered by FEMA that provides flood insurance to properties in participating communities like New York City. While larger properties, in particular large commercial properties, tend to purchase flood insurance through the private market, NFIP is the primary source of flood insurance for homeowners throughout the country. The City estimates that in areas of South Queens inundated by Sandy, less than 31 percent of residential properties typically insured under the NFIP, including 1- to 2- family homes, amongst others, actually had policies in force during Sandy. Furthermore, Sandy drew attention to the significant cost increases in flood insurance that many New Yorkers will soon face, resulting from recent reforms to the NFIP as required by the Biggert-Waters Flood Insurance Reform Act.

The City will use several strategies to encourage more New Yorkers to seek coverage and to help the NFIP meet the needs of policyholders citywide. Specifically, the City will work to: address affordability issues for the most financially vulnerable policyholders; define mitigation measures that are feasible in an urban environment such as South Queens and create commensurate premium credits to lower the cost of insurance for property owners who invest in these measures; encourage the NFIP to expand pricing options (including options for higher deductibles) to give potential policyholders more flexibility to make choices about coverage; and launch efforts to improve consumer awareness, to help policyholders make informed choices. The initiatives described below are important examples of how the City will advance these strategies. These initiatives will have a major impact on the residents, small businesses and nonprofits in this community. For a full explanation of the following initiatives and a complete description of the City's five-borough insurance reform plan, please refer to Chapter 5 (*Insurance*).

Insurance Initiative 1
Support Federal efforts to address affordability issues related to reform of the NFIP

The City will call on FEMA to work with the National Academy of Sciences to complete the study of flood insurance affordability, as required under the Biggert-Waters Act. The City will urge its Federal government partners to comply with this provision of the Act and take swift action to enact the recommendations.

Insurance Initiative 4
Call on FEMA to develop mitigation credits for resiliency measures

The NFIP provides few incentives for property owners to protect their buildings from flood damage and reduce their premiums, other than by elevating their buildings—actually lifting structures above flood elevation levels. In an urban environment such as South Queens, for a variety of reasons, elevation can be impractical, undesirable, and/or economically infeasible. Fortunately, other mitigation options are available. The City, therefore, will call upon FEMA to provide appropriate premium credits for mitigation measures other than elevation.

Insurance Initiative 6
Call on FEMA to allow residential policyholders to select higher deductibles

Flexible pricing options can encourage more people, especially those not required to carry insurance, to purchase insurance coverage that suits their needs. A higher-deductible option can substantially reduce premium costs to policyholders while remaining truly risk-based. Currently under the NFIP, deductibles up to $50,000 are allowed for commercial policies, but residential policies are limited to a maximum deductible of $5,000. The City, therefore, will call upon FEMA to allow homeowners that are not required to carry NFIP policies to purchase high-deductible policies, protecting them from catastrophic loss; initial estimates indicate that doing so could reduce insurance premiums by about half.

Critical Infrastructure

A resilient New York requires protection of its critical services and systems from extreme weather events and the impacts of climate change. This infrastructure includes the city's utilities and liquid fuel system, its hospitals and other healthcare facilities, telecommunications network, transportation system, parks, wastewater treatment and drainage systems, as well as other critical networks—all vital to keeping the city, including South Queens, running.

Utilities

The city's electric, natural gas, and steam systems are essential for everyday life in areas throughout the five boroughs, including South Queens. As Sandy proved, however, these systems are highly vulnerable to extreme weather events, with 800,000 customers losing electricity and 80,000 customers losing natural gas service during Sandy across the city, including approximately 131,000 in the borough of Queens that lost electricity service in the borough of Queens. This vulnerability likely will grow as the climate changes.

Among the strategies that the City will use to address these challenges for residents of South Queens and other parts of the city will be to: call for risk-based analysis of low-probability but high-impact weather events to be incorporated into utility regulation and investment decision-making; call for capital investments that harden energy infrastructure and make systems more flexible in responding to disruptions and managing demand; and better diversify the city's sources of energy. The initiatives described below provide important examples of how the City intends to advance utilities resiliency citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits of South Queens. For a full explanation of the following initiatives and a complete description of the City's five-borough utilities resiliency plan, please refer to Chapter 6 (*Utilities*).

Utilities Initiative 5
Work with utilities and the Public Service Commission (PSC) to harden key electric transmission and distribution infrastructure against flooding

Various transmission substations, distribution substations, utility tunnels, and underground equipment in the city are at risk of flooding during extreme weather. For example, 40 percent of transmission substations are in the 100-year floodplain today, and 67 percent are likely to be in the 100-year floodplain by the 2050s. The City, through the OLTPS, will work with Con Edison and LIPA to prioritize these assets based on their roles in system reliability, and to harden them as appropriate. This effort will begin in 2013.

Utilities Initiative 6
Work with utilities and the PSC to harden vulnerable overhead lines against winds

During extreme weather events, high winds and downed trees threaten overhead electric poles, transformers, and cables. The City, through OLTPS, will work with Con Edison and LIPA to manage the risk of wind and downed-tree damage through tree maintenance, line strengthening, and a line-relocation program. In some limited cases, rerouting lines underground may also be warranted, depending on the outcome of a cost-benefit analysis to be performed in partnership with the utilities. This effort will begin in 2013.

Utilities Initiative 7
Work with utilities, regulators, and gas pipeline operators to harden the natural gas system against flooding

Although the city's high-pressure gas transmission system performed relatively well during Sandy, there were instances where remote operation of parts of the system failed. Additionally, the distribution system had localized outages due to water infiltration. Seeking to limit the compromising effects of future floods on both the system's backbone and the ability of Con Edison and National Grid to control and monitor the system, the City, through OLTPS, will work with the PSC, Con Edison, and National Grid to harden control equipment against

flooding. In addition, the City will call upon Con Edison and National Grid to take steps to prevent water from infiltrating its gas pipes. This effort will begin in 2013.

Utilities Initiative 12
Work with public and private partners to scale up distributed generation (DG), including microgrids

The city's DG systems, including microgrids, have the potential for significant expansion—but are constrained by regulations, financing challenges, and lack of information. The City—through OLTPS and the New York City Distributed Generation Collaborative—a stakeholder group convened by the City in 2012—will continue efforts to achieve a PlaNYC goal of installing 800 megawatts of DG citywide by 2030.These efforts will include reform of PSC tariffs and other regulatory changes, expansion of low-cost financing, and provision of technical assistance to property owners and developers. This ongoing effort will continue in 2013.

Liquid Fuels

The liquid fuel supply chain is essential for everyday life throughout the five boroughs, including in South Queens. Sandy demonstrated the vulnerability of this system to extreme weather events. In the aftermath of Sandy, citywide—and particularly in South Queens—there were long lines at gas stations and other challenges for drivers, including emergency responders. The vulnerability of this system likely will grow as the climate changes.

Among the strategies that the City will use to address these challenges for residents of South Queens and other parts of the city will be to: develop a strategy for the hardening of liquid fuel infrastructure along the supply chain; increase redundancy and fuel supply flexibility; and increase supply availability for vehicles critical to the city's infrastructure, safety, and recovery from significant weather events. The initiatives described below provide important examples of how the City intends to advance its liquid fuel resiliency agenda citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits of South Queens. For a full explanation of the city's five-borough liquid fuels resiliency plan, please refer to Chapter 7 (*Liquid Fuels*).

Liquid Fuels Initiative 1
Call on the Federal government to convene a regional working group to develop a fuel infrastructure hardening strategy

The fuel supply shortage after Sandy was caused mainly by damage to infrastructure in New Jersey and other states, where the City and State of New York have no regulatory or legislative authority or oversight. The City, through OLTPS, will call on the Federal Hurricane Sandy Rebuilding Task Force and the United States Department of Energy to convene regional stakeholders to develop a strategy for hardening key infrastructure against future extreme weather. This effort will be launched in 2013.

Liquid Fuels Initiative 4
Work with New York State to provide incentives for the hardening of gas stations to withstand extreme weather events

Work with New York State to provide incentives for the hardening of gas stations to withstand extreme weather events New York State's 2013–2014 budget required that certain retail fuel stations invest in equipment that would allow them to connect generators quickly in the event of a power loss, and to enter into supply contracts for emergency generators. The City, through OLTPS, will support the State in the design and implementation of this generator program, an effort that will include working with the New York State Energy Research and Development Authority (NYSERDA) to develop an incentive program to minimize the financial impact of the requirements on the businesses involved. In addition, OLTPS will work with the State to develop incentives to encourage retail fuel stations to implement resiliency measures other than back-up power capability. This effort will be launched in 2013.

Liquid Fuels Initiative 5
Enable a subset of gas stations and terminals to have access to backup generators in case of widespread power outages

Gas stations are vulnerable to widespread power outages resulting from extreme weather events, which could prevent them from dispensing fuel. In New York State's 2013–2014 budgets, NYSERDA was directed to develop a generator pool program for gas stations. The City, through its Office of Emergency Management (OEM), will work with NYSERDA, FEMA, and the USACE tin 2013 and beyond to develop such a pool and to create a pre-event positioning plan to enable the ready deployment of generators to impacted areas in the wake of a disaster.

Liquid Fuels Initiative 8
Develop a package of City, State, and Federal regulatory actions to address liquid fuel shortages during emergencies

Various regulations relating to the transportation and consumption of fuels in New York City limit the flexibility of the market to respond to disruptions, including following extreme weather. The City, through OEM, will work with the State and Federal governments to prepare an "off-the-shelf" package of regulatory measures for use in the event of a liquid fuels shortage to allow supply-demand imbalances in the fuel supply to be mitigated more quickly. This effort will be launched in 2013.

Liquid Fuels Initiative 9
Harden municipal fueling stations and enhance mobile fueling capability to support both City government and critical fleets

The City must be able to respond quickly to a fuel supply disruption, providing continuous fueling to vehicles that are critical for emergency response, infrastructure rebuilding, and disaster relief. The City, through the Department of Citywide Administrative Services (DCAS), will procure fuel trucks, generators, light towers, forklifts, and water pumps to permit the City to put in place emergency fueling operations immediately following a disruption in the fuel supply chain. DCAS also will issue a request for expressions of interest (RFEI) to potential suppliers of liquid fuels to evaluate options for sourcing such fuel during emergencies. The procurement effort will be launched in 2013, with the RFEI to follow in 2014.

Healthcare

The city's healthcare system is critical to the well-being of New Yorkers throughout the five boroughs, including in South Queens. This system is also a major economic engine for the city as a whole. This is especially true for South Queens, where numerous nursing homes and adult care facilities, and a network of community-based facilities, doctors' offices, and pharmacies support the local area. Sandy demonstrated this system's vulnerabilities, which are expected to grow as the climate changes.

Among the strategies that the City will use to address these challenges for residents of South Queens and other parts of the city will be to: build new hospitals, nursing homes, and adult care facilities to higher resiliency standards and harden existing facilities to protect critical systems; seek to keep lines of communication open between patients and providers, even during extreme weather events; and enable community-based providers to reopen quickly after a disaster. The initiatives described below provide important examples of how the City intends to advance its healthcare resiliency agenda citywide. These initiatives will have a positive impact on the residents, and healthcare providers of South Queens. For a full explanation of the following initiatives and a complete description of the City's five-borough healthcare resiliency plan, please refer to Chapter 8 (*Healthcare*).

Healthcare Initiative 2
Require the retrofitting of existing hospitals in floodplains

Many existing hospital buildings in the floodplain remain vulnerable to the impact of storm surge, with more likely as the climate changes. The City, through OLTPS, therefore, will seek to amend the Construction Code to require existing hospital buildings in the 500-year floodplain to meet, by 2030, a subset of the amended New York City Construction Code standards for flood-resistant design. To minimize the risk of emergency evacuations and extended closures, these hospitals will be required to protect their electrical equipment, emergency power system, and domestic water pumps to the 500-year flood elevation. These hospitals also will be required to install backup air-conditioning service for inpatient care areas in case of utility outages, pre-connections for temporary boilers and chillers if primary equipment is not elevated, and pre-connections for external generators as a backup power source. OLTPS will propose these requirements to the City Council in 2013.

Healthcare Initiative 3
Support the HHC's efforts to protect public hospital emergency departments from flooding

Emergency departments (EDs) are critical access points for patients in need of hospital services, and three public hospitals in Manhattan and Brooklyn are at risk of flooding due to storm surge. The City will support HHC's ongoing efforts to invest in measures to flood-protect these vulnerable EDs so they can remain available to provide care during extreme weather events. The goal is for this effort to begin in 2013.

Healthcare Initiative 4
Improve design and construction of new nursing homes and adult care facilities

New nursing homes and adult care facilities are at risk of power failures due to storm surge, which could result in patient evacuations. The City, through OLTPS, therefore, will seek to amend the Construction Codes to require that new facilities are constructed with additional resiliency measures for their emergency power systems. New nursing homes also will be required to have emergency generators and electrical pre-connections for external stand-by generators. Adult care facilities will be required to install either emergency generators that are adequately protected or pre-connections to external stand-by generators. OLTPS will propose these requirements to the City Council in 2013.

Healthcare Initiative 5
Require retrofitting of nursing homes in floodplains

Many existing nursing home facilities in the five boroughs are vulnerable to storm surge, including 9 in South Queens—a vulnerability that likely will grow as the climate changes. The City, through OLTPS, therefore, will seek to amend the Construction Codes to require nursing homes in the 100-year floodplain—including five facilities in South Queens—to meet standards for the protection of electrical equipment, emergency power systems, and domestic water pumps (if applicable) by 2030. These systems will be protected to the 100-year BFE, in accordance with specifications already in the Construction Codes, and will help enable patients to shelter in place safely or re-occupy quickly after a storm. OLTPS will propose these requirements to the City Council in 2013.

Healthcare Initiative 6
Require retrofitting of adult care facilities in floodplains

Nineteen adult care facilities in the city are vulnerable to storm surge, including seven in South Queens alone. The City, through OLTPS, will seek to amend the Construction Codes to require existing adult care facilities located in the floodplain to elevate or protect their electrical equipment to the 100-year flood elevation by 2030, in accordance with the specifications in the Construction Codes. In addition, the City will seek to require these providers to have either emergency generators that are adequately protected or electrical pre-connections for external generators. OLTPS will propose these requirements to the City Council in 2013.

Healthcare Initiative 7
Support nursing homes and adult care facilities with mitigation grants and loans

The primary challenge for most nursing homes and adult care facilities in implementing mitigation measures is obtaining financing. Subject to available funding, the City, through NYCEDC and the New York City Department of Health and Mental Hygiene (DOHMH), therefore, will administer competitive grants and subsidized loans to assist providers with mandated retrofit projects. The goal is for NYCEDC and DOHMH to launch the program when proposed Construction Code amendments applicable to nursing homes and adult care facilities proposed in this report go into effect, likely in 2013.

Healthcare Initiative 8
Increase the air conditioning capacity of nursing homes and adult care facilities

Nursing homes and adult care facilities typically do not have enough emergency power capacity to run their air conditioning systems following the loss of power. This could cause some providers to evacuate during power outages that occur during hot summer months. The City will offer a sales tax waiver, totaling $3 million citywide, to assist eligible nursing homes and adult care facilities to install emergency power solutions for air conditioning systems.

Healthcare Initiative 9
Harden primary care and mental health clinics

In communities such as South Queens that are at risk of extensive flooding during extreme weather events, primary care and mental health services may be compromised for weeks after a disaster due to extended facility closures. Subject to available funding, the City, through DOHMH and a fiscal intermediary, therefore, will administer a competitive financing program to harden large clinics providing primary care and mental health services in South Queens and other high-need communities. The program will include grants and interest-free loans for capital investments that enable faster recovery of services—for example, installation of emergency power systems, protection of other critical building systems, and wet flood-proofing of facilities. The goal is for this effort to be launched in late 2013 or early 2014.

Healthcare Initiative 10
Improve pharmacies' power resiliency

Pharmacies dispense life-saving medicines essential for those with chronic conditions. However, without power, pharmacists cannot access the necessary patient records or insurance information to dispense these medicines. The City, through DOHMH, will work with pharmacies to improve their ability to leverage generators for power resiliency and address their other emergency preparedness needs–including the launch of an emergency preparedness website for pharmacies. This effort already has begun and will continue throughout 2013.

Healthcare Initiative 11
Encourage telecommunications resiliency in the healthcare system

In the aftermath of a disaster, it is important that New Yorkers be able to speak to their doctors for guidance on needed medical care. The City, through DOHMH, therefore, will develop a best practice guide and outreach plan to help community-based providers understand the importance of telecommunications resiliency. Resiliency solutions could include using back-up phone systems (such as a remote answering service that would not be affected by local weather hazards), Voice over Internet Protocol (VoIP) technology that allows office phone lines to be used off-site, and pre-disaster planning to inform patients of available emergency phone numbers. This effort will begin in 2013.

Healthcare Initiative 12
Encourage electronic health record-keeping

Doctors rely on patients' medical records to provide and track care, but paper records may be compromised or destroyed due to extreme weather events. The City, through existing DOHMH programs, therefore, will call upon community-based providers located in the 100-year floodplain and other disaster-prone areas to implement electronic health records (EHR) systems for resiliency. DOHMH's Primary Care Information Project will sponsor initiatives to provide primary care and mental health providers citywide with EHR technical assistance. This effort will begin in 2013.

Beyond the priority healthcare resiliency projects described in Chapter 8, including those summarized briefly above, the City is proposing an additional healthcare resiliency initiative specific to South Queens' vulnerabilities. This initiative is described below.

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South Queens Initiative 5
Build a new multi-specialty ambulatory surgical center on the Rockaway Peninsula

The closure of the Peninsula Hospital Center in 2012 left the entire Rockaway Peninsula with only one full-service hospital, St. John's Episcopal Hospital. To help fill the service gap and improve access to medical services for the entirety of the Peninsula, including during extreme weather events, the City, working through NYCEDC, has selected a private development partner to renovate the historic Rockaway Courthouse building in 2013. Following its renovation, the Courthouse will be turned into a new multi-specialty ambulatory surgical center and will also house medical tenants, providing outpatient surgical services in specialties that include ophthalmology, urology, obstetrics, gynecology, and orthopedics. It is anticipated that this renovation will be completed by 2015.

Telecommunications

The city's telecommunications system is essential to individuals and businesses throughout the five boroughs, including in South Queens. While this is true at all times, it is especially true during emergencies. As Sandy demonstrated, however, this system is highly vulnerable to extreme weather events—precisely when it is most needed. Citywide and in South Queens, Sandy resulted in outages to landlines and mobile service, as well as to data service. The vulnerability of this system likely will grow as the climate changes.

Among the strategies that the City will use to address these challenges for residents of South Queens and other parts of the city will be to: increase accountability among providers to promote resiliency; use strengthened City regulatory powers and stronger relationships with providers to enable rapid recovery after extreme weather events; encourage hardening of facilities to reduce weather-related impacts; and increase redundancy to reduce the impact of outages. The initiatives described below provide important examples of how the City intends to advance its telecommunications resiliency agenda citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits of South Queens. For a full explanation of the following initiatives and a complete description of the City's five-borough telecommunications resiliency plan, please refer to Chapter 9 (*Telecommunications*).

Telecommunications Initiative 1
Establish an office within the Department of Information Technology and Telecommunications (DoITT) to focus on telecommunications regulation and resiliency planning

While the City has regulatory authority over some aspects of telecommunications service, it has no entity focused broadly on ensuring the resiliency of the public communications networks. The City, therefore, will form within DoITT a new Planning and Resiliency Office (PRO) that will have the resources needed to develop, monitor, and enforce resiliency standards, in close cooperation with State and Federal regulators and providers. DoITT will launch the new office in 2013.

Telecommunications Initiative 2
Establish new resiliency requirements for providers using scheduled renewals of the City's franchise agreements

Flooding caused outages during Sandy in facilities that did not follow the Federal Communication Commission's recommended best practices for resiliency, including flood protection measures. The City, through DoITT, will, therefore, encourage and enforce resiliency standards for telecommunications providers through the franchise renewal process and through other agreements into which such providers enter with the City. The City will also seek to require standardized outage reporting and publishing. This effort will be launched in 2014, in advance of 2020 franchise renewals.

Transportation

Without the city's expansive transportation system, New York would grind to a halt. This was illustrated starkly during Sandy when outages occurred across the system during and immediately following the storm. These outages severely impacted South Queens, which found itself isolated by the shutdown of its only subway line for over six months and other public transit systems, as well as by flooding on arterial and secondary roads. The vulnerability of this system likely will grow as the climate changes.

Among the strategies that the City will use to address these challenges for residents of South Queens and other parts of the city will be to: make the system more flexible and more resilient; protect critical elements of the system from damage; and seek to maintain system operations during extreme weather events; and, following extreme events, to enable quick recovery, while also putting in place plans for back-up transportation options until regular service can be restored. The initiatives described below provide important examples of how the City intends to advance its transportation resiliency agenda citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits of South Queens. For a full explanation of the following initiatives and a complete description of the City's five-borough transportation resiliency plan, please refer to Chapter 10 (*Transportation*).

Transportation Initiative 1
Reconstruct and resurface key streets damaged by Sandy

Sandy's waves and flooding caused significant damage to area roadways. The City, through New York City Department of Transportation (NYCDOT) will reconstruct 60 lane- miles of streets that were damaged severely, and will repave approximately 500 lane-miles of streets with damaged surfaces. In South Queens, this will include 4 linear miles of reconstructed street and 23 lane miles resurfaced along the Joseph P. Addabbo Memorial Bridge, Cross Bay Boulevard, and in Hamilton Beach, Broad Channel, Neponsit, Belle Harbor, Rockaway and Far Rockaway. Wherever feasible, the reconstructed streets also will include upgraded resiliency features to prevent future damage. NYCDOT will launch this initiative in 2013 with funding from Federal and City sources.

Transportation Initiative 3
Elevate traffic signals and provide backup electrical power

New York's traffic signals—and particularly the controllers that operates these signals and communicate with the NYCDOT Traffic Management Center—are vulnerable to damage from flooding as well as to power loss from various extreme weather events. Accordingly, the City, through NYCDOT, will raise controllers at approximately 500 intersections in flood-vulnerable locations across the city, including in South Queens. In tandem with this effort to place electrical hardware above the 100-year flood elevation, NYCDOT also will install power inverters in approximately 500 NYPD vehicles to allow these vehicles to provide backup electrical power to critical traffic signals. This effort will begin in 2013.

Transportation Initiative 8
Call on non-City transportation agencies to implement strategies to address climate change threats

Many non-City agencies that own and operate critical portions of New York City's transportation system already announced resiliency and protection initiatives appropriate to their system. Without such action, the critical facilities, managed by these agencies, will remain vulnerable to damage and disruption from future weather-related events. The City, therefore, will call on these agencies to implement the initiatives that they announced and take additional steps to protect their major transportation assets from climate change threats and prepare for quick restoration following an extreme weather event. Assets that may require hardening and/or preparation measures in South Queens include the A train viaduct between the Rockaway Peninsula and Howard Beach. The City will work with these agencies to advance these plans in 2013.

Transportation Initiative 9
Plan for temporary transit services in the event of subway system suspensions

When major portions of the subway system are out of service, there simply is not sufficient capacity in the rest of the transit network or the roadway system to carry the increased volume of commuters and other travelers. The City, through NYCDOT, therefore, will work with the MTA and other transportation partners to develop and regularly update formal plans to provide temporary transportation services in such an event, including following extreme weather. This planning effort will begin in 2013.

Transportation Initiative 10
Identify critical transportation network elements and improve transportation responses to major events through regular resiliency planning exercises

Many of the facilities critical to the City's ability to respond effectively to a disaster are vulnerable to disruption and damage during extreme weather events, potentially impairing delivery of emergency services and supplies, as well as impairing the restoration of critical non-transportation infrastructure and economic activity. This vulnerability is expected to increase as the climate changes. To respond better to a variety of different possible transportation outage and restoration scenarios, the City, through NYCDOT, will work with transportation agencies around the region to identify the critical elements of the transportation network that need to be available quickly following different types of events. The key tool to identify these networks will be an ongoing series of detailed and multi-disciplinary resiliency planning exercises—and potentially even live drills—that will allow NYCDOT and its partners to understand where resources need to be focused before, during, and after an event. This effort will begin in 2013.

Transportation Initiative 16
Expand the city's Select Bus Service (SBS) network

Parts of the city lack subway access or have slow and unreliable public transportation. In these areas, the City and the MTA have been deploying SBS routes to improve general mobility. These routes can form the backbone of high-capacity bus service in the event of major subway outages, including following extreme weather events. The City, through NYCDOT, will work with the MTA to expand the SBS network significantly, building on a plan developed jointly in 2010. Implementation of this plan has already begun, with a new BRT route planned for Woodhaven Boulevard. In 2013, the City, working through NYCDOT, will commence the public outreach process to solicit feedback on a proposed SBS route along Woodhaven Boulevard and Cross Bay Boulevard, serving Howard Beach, Broad Channel and the Rockaway Peninsula.

Beyond the priority transportation resiliency projects described in Chapter 10, including those summarized briefly above, the City is proposing an additional transportation resiliency initiative specific to South Queens's vulnerabilities.

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South Queens Initiative 6
Expand ferry service to the Rockaway Peninsula

The vulnerability of the Rockaway Peninsula and Broad Channel to a prolonged outage of A train service was demonstrated immediately following Sandy, when the subway viaduct on which that service crosses Jamaica Bay was compromised. To provide transit alternatives while the viaduct was repaired after Sandy, the City, working with Seastreak LLC, launched an emergency ferry service running on weekdays between Beach 108th Street on the Rockaway Peninsula, Lower Manhattan and 34th Street, supported by federal funding provided by FEMA. At the same time, the MTA put in place shuttle train service along the Rockaway Peninsula and temporary bus service connecting the Peninsula, Broad Channel and subway service elsewhere in Queens. With the restoration of regular subway service to Broad Channel and the Rockaway Peninsula, the foregoing stop-gap measures were scheduled to end. However, to help with the recovery of area businesses and to assess the viability of such service on a long-term basis, the City has both extended the weekday ferry service that was instituted post-Sandy through Labor Day 2013 (subject to certain ridership thresholds) and is subsidizing through Labor Day 2013 expanded weekend ferry service to the Rockaways from Manhattan, in partnership with Seastreak LLC and TWFM Ferry, Inc. The weekday service will continue to stop at Beach 108th Street on the Peninsula and Wall Street/Pier 11 and East 34th Street in Manhattan. The weekend service will stop at both Riis Landing and Beach 108th Street on the Peninsula and Wall Street/Pier 11 in Manhattan.

Building on this pilot ferry service, the City will take two other ferry-related steps. First, the City will, working through NYCEDC, seek to secure existing Federal transportation funding designated for the Rockaway Peninsula to allow it to purchase and construct a flexible ferry landing that will enable the City to deploy future ferry service (whether for emergency, seasonal, or

commuter use) in a rapid and cost-effective way. Second, the City will also explore expanded ferry service to areas citywide, including the Rockaway Peninsula, on a permanent basis, through a Comprehensive Ferry Study. The study will be led by NYCEDC and will be launched during 2013.

Parks

During Sandy, it became clear that, in addition to serving as neighborhood front yards and recreation centers, in many places (including South Queens), the City's parks serve as the city's front line of defense when extreme weather events hit, buffering adjacent neighborhoods. As the climate changes, it will be even more critical that the city's parks are able to play all of these roles.

Among the strategies that the City will use to address these challenges for residents of South Queens and elsewhere in the City will be to: strengthen the city's parks so that they are able to survive weather-related events more effectively and can act as stronger buffers for adjacent communities; and pursue technologies and approaches that will enable the City to monitor, analyze, and prepare the park system for its many roles in an era of increasing change. The initiatives described below provide important examples of how the City intends to advance its parks resiliency agenda citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits of South Queens. For a full explanation of the following initiatives and a complete description of the City's five-borough parks resiliency plan, please refer to Chapter 11 (*Parks*).

Parks Initiative 1
Restore city beaches

Beaches play an important recreational role and also are an important component in the city's coastal defenses, but they cannot protect adjacent areas without being "nourished" (replenished with new sand to replace that lost to erosion) from time to time. Subject to available funding, the City, through DPR, will collaborate with Federal and State partners—including the USACE—to implement plans quickly to restore sand lost after extreme storm events and to conduct regular nourishment of beaches and regular monitoring to detect the early signs of erosion. The goal is launch this effort at city beaches such as Plumb Beach in Brooklyn and Orchard Beach in the Bronx by 2015 (see Chapter 3). To restore the city's beaches following Sandy, DPR and the Department of Design and Construction, in cooperation with many other City, State, and Federal partners, conducted an expedited program of projects to provide new and elevated lifeguard stations and public bathrooms and improvements to other beachfront amenities in advance of Memorial Day 2013. DPR constructed 35 prefabricated modular buildings, to be used as comfort stations and lifeguard stations, in Rockaway, Coney Island, and Staten Island, informed by storm surge projections for the 500-year floodplain at a height ranging from 7 to 14 feet above the existing grade to reduce the risk of flood damage and give a greater level of protection to these facilities. This impressive achievement comprised the first phase of restoring the city's beaches. In the coming months and years, DPR will continue its efforts to provide emergency sand nourishment and to expedite planning, evaluation, and design work for long-term plans to restore the city's beaches, boardwalks, and other beachfront amenities.

Parks Initiative 2
Harden or otherwise modify shoreline parks and adjacent roadways to protect adjacent communities

Approximately 24 percent of DPR parks and other open spaces are in the 100-year floodplain on the PWMs, which is expected to expand as sea levels rise—including in areas where parks front residential and commercial districts. Subject to available funding, the City, through DPR, will study and identify mitigation strategies, including cost-effective ways to use its parks system to protect adjacent neighborhoods and the parks themselves. Strategies could include hardening or elevating park infrastructure, construction of levees or floodwalls to minimize flooding and attenuate waves, and using flood-tolerant materials in the construction of parks. The goal is to complete this study in 2014.

Parks Initiative 4
Expand the City's Greenstreets, including for Jamaica Bay

Increased localized flooding is likely from more frequent heavy downpours in the future. Subject to available funding, the City, through DPR and in partnership with DEP, will expand its efforts to build more and larger Greenstreets to absorb stormwater, mitigate local flooding, decrease urban heat island effect, increase pedestrian and traffic safety, and beautify neighborhoods. This will expand the installation of green infrastructure at appropriate locations in the City's streets, with approach modeled upon the NYC Green Infrastructure Plan, which improves water quality in combined sewer areas.

The first phase of this expansion would focus on fourteen neighborhoods with the greatest potential for improvement, areas that are not slated for CSO improvements through the NYC Green Infrastructure Plan, but could be well-suited for Greenstreets based on best available data showing low bedrock and ground water. The goal is to construct and maintain 1,600 Greenstreets at a high density to amplify impacts such as cooling and ecological health. This expansion would capture approximately 32 million cubic feet of stormwater per year by 2015, with a footprint of over 50 acres of increased green space. Thereafter, DPR will consider expansion of this strategy over a 10-year period, focusing on the remaining 20 percent of the city where new Greenstreets could provide myriad benefits. An early priority for this effort will be the area surrounding Jamaica Bay, where DPR will collaborate with DEP and NYCDOT to reduce localized flooding and stormwater runoff, directly improving the health of the Bay. The goal is to begin pilot projects in and around Coney Island, Marine Park, the Rockaways, and Canarsie, including Greenstreets and parkland installations by 2014.

Parks Initiative 9
Work with the Federal government to transform Jamaica Bay

One of the most significant opportunities in New York's history for the development, management, maintenance, and programming of an integrated set of wetlands and other natural areas for natural habitat and recreational use exists in and around Jamaica Bay. Through its groundbreaking partnership with the National Park Service, the City, through DPR, will seek to promote habitat preservation and flood protection as well as a variety of programs in the 10,000 acres of Federally and City-owned parks in and around Jamaica Bay. This program will offer educational, scientific, recreational, and other opportunities to visitors. The goal for this partnership is to lead large-scale bay restoration and green infrastructure projects, which, in addition to improving the Bay itself, also will protect the many adjacent neighborhoods in Brooklyn and Queens.

Parks Initiative 11
Improve the health and resiliency of the city's urban forests

The city's forests and trees provide an array of health and environmental benefits. They are, though, vulnerable to a variety of climate-change-related impacts, including storm surge, wind, and changes in average temperatures. Subject to available funding, the City, through DPR, therefore, will undertake a variety of efforts to protect trees—whether located in natural areas and parks, or along streets. This would include adding forest management crews, identifying locations in which to expand tree beds, and modifying regular tree inspection and pruning efforts to prioritize trees in areas vulnerable to extreme weather events. The goal is for DPR to launch this effort in 2013.

Parks Initiative 13
Establish a center for resiliency and restoration efforts in the Jamaica Bay Rockaway Parks

The joint City-Federal effort to transform Jamaica Bay into a national model has, as one of its centerpieces, a plan to create a new Science and Resilience Center at Jamaica Bay. The City, through DPR and in close collaboration with the NPS, will work with leading academic institutions to make this center a reality, with initial operations to begin in the fall of 2013. The Science and Resilience Center at Jamaica Bay will serve a variety of key functions. First, the Center will facilitate decision-making by policy makers based on the latest scientific information developed by academic institutions. Second, the Center will address Jamaica Bay issues, such as water quality and ecological restoration. Third, the Center will seek to ensure the broad dissemination of resiliency-related research and policymaking to governments and scientific institutions around the world. The goal is to launch the Center in 2013.

Water and Wastewater

The city's water and wastewater system is one of the most complex in the world, not only supplying millions of New Yorkers with safe drinking water, but also treating wastewater to enable the area's waterways to remain clean while draining rainwater to minimize flooding. Sandy demonstrated vulnerability to this system to a whole host of weather-related threats, ranging from surge and sea level rise, to heavy downpours—threats that are expected to worsen as the climate changes.

Among the strategies that the City will use to address these challenges for residents of South Queens and parts of the city will be to: protect wastewater facilities from storm surge; improve and expand drainage infrastructure; and promote redundancy and flexibility to make available a constant supply of high-quality drinking water. The initiatives described below provide important examples of how the City intends to advance its water and wastewater resiliency agenda citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits of South Queens. For a full explanation of the following initiatives and a complete description of the City's five-borough water and wastewater resiliency plan, please refer to Chapter 12 (*Water and Wastewater*).

Water and Wastewater Initiative 1
Adopt a wastewater facility design standard for storm surge and sea level rise

Sandy damaged wastewater treatment plants and pumping stations even though the design of City wastewater facilities typically has taken into account the highest historically recorded water height of nearby water bodies or the BFEs identified in FEMA maps. The City, therefore, will adopt an increased level of protection for design and construction of all wastewater facilities based on the latest FEMA maps, modified to reflect sea level rise projections for the 2050s. DEP will adopt the new design guidelines in 2013.

Water and Wastewater Initiative 2
Harden pumping stations

Many of the city's pumping stations are located in low-lying areas and are necessary to convey wastewater and stormwater out of communities; however, their location also increases their vulnerability to storm surge. Therefore, subject to available funding, the City, through DEP, will retrofit these pumping stations to improve their resiliency. These retrofits will include raising or flood-proofing critical equipment, constructing barriers, and installing backup power supplies. Preliminary estimates indicate that there are currently 58 at-risk pumping stations, of which several are already scheduled for capital improvements. DEP will pursue implementation of resiliency projects, in conjunction with repairs and planned capital work, and as appropriate based on the level of risk, historical flooding, and potential community impacts, among other criteria. Among the pumping stations to be considered for hardening are five in South Queens. The goal is to begin implementation in 2014.

Water and Wastewater Initiative 3
Harden wastewater treatment plants

All 14 of the City's wastewater treatment facilities are located along the waterfront and are therefore at risk in the event of a coastal storm. Subject to available funding, the City, through DEP, will protect these critical treatment facilities by raising or flood-proofing assets that are critical to the treatment process, or constructing barriers to avoid failure of these critical treatment systems. DEP will target initially facilities that have been identified as either most at-risk, or most likely to create issues for adjacent communities and waterways, based on the findings of an in-depth study by DEP. These facilities include the Rockaway and Jamaica Wastewater Treatment Plants, which serve the Peninsula, Broad Channel, Howard Beach and Hamilton Beach. The goal is for DEP to begin implementation of adaptation measures for these and other facilities in 2014 as part of repairs and other planned capital projects.

Water and Wastewater Initiative 4
Explore alternatives for the Rockaway Wastewater Treatment Plant

The Rockaway Wastewater Treatment Plant was one of the most heavily damaged wastewater facilities during Sandy. However, prior to investing significant funds to protect the plant from future storms, the City, through DEP, will conduct a feasibility study to consider converting it to a pumping station, and potentially transferring its treatment responsibilities to a less vulnerable wastewater treatment facility elsewhere in the city. The conversion of this treatment plant would provide the opportunity to incorporate protective measures that would help avoid the failure of critical systems in future extreme weather events and the potential impacts to water quality that could come with such failure. DEP will initiate this feasibility study in 2014.

Water and Wastewater Initiative 11
Build out stormwater sewers in areas of South Queens with limited drainage systems

Large areas of South Queens, including portions of Broad Channel, Edgemere, Bayswater, Far Rockaway, Rockaway Beach and Arverne, as well as surrounding neighborhoods in Southeast Queens, such as Rosedale and Jamaica, do not have fully built-out storm sewer systems and currently experience regular street flooding, which may be exacerbated if rainfall increases with climate change. DEP will, therefore, continue to build out the storm sewer systems in these locations along with sanitary sewer upgrades and high-level storm sewers, undertaking 30 projects through 2023. DEP will seek additional sewer build-out, improvement, or upgrade opportunities in conjunction with NYCDOT street improvements and other community infrastructure projects, including areas with chronic street flooding.

Other Critical Networks: Food Supply

Though the food supply chain generally emerged intact following Sandy, in certain local areas (including parts of South Queens), residents found themselves without access to basic sustenance after the storm. In addition, had Sandy played out just a little differently, it is possible that significant links in the food supply chain—including the food distribution center in Hunts Point in the Bronx—could have been seriously threatened. As the climate changes, it is likely that risks such as these will grow.

Although initiatives outlined in several other sections above are important contributors to the overall resiliency of the food supply network (including especially those addressing utilities, liquid fuels, and transportation), the City also will pursue food-specific strategies to meet this goal for the benefit of residents of South Queens and other parts of the city. These strategies will involve calling for resiliency investments at the most significant food wholesaling and distribution centers in the city and addressing issues relating to retail access in the event of extreme weather. The initiatives in Chapter 13 describe how the City intends to advance its food supply resiliency agenda citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits of South Queens. For a complete description of the City's five-borough food supply resiliency plan, please refer to Chapter 13 (*Other Critical Networks*).

Other Critical Networks: Solid Waste

On a daily basis, the solid waste collection system in New York disposes of more than 12,000 tons of waste and recycling in a safe and sanitary fashion. Unlike many other critical City systems, during Sandy this one proved remarkably resilient, resuming many of its normal functions almost immediately after the storm. In fact, thanks to the efforts of the City's Department of Sanitation, even as the agency was dealing with its own storm-related challenges, it was able to assist with the recovery of South Queens and the larger city by collecting the debris left by the storm in an organized and efficient manner.

However, the system does face real issues. For example, during Sandy, the city's solid waste disposal system did experience interruptions that interfered with its ability to convey refuse out of the city to its ultimate destination. Additionally, as the climate changes, it is likely that this system will become more vulnerable to extreme weather.

Among the strategies that the City will use to address these challenges for residents of South Queens and other parts of the city will be to: harden critical City-owned solid waste assets to protect them from extreme weather-related impacts; and seek to improve the resiliency of the broader solid waste network—both City- and third-party owned—enabling it to resume operation quickly should disruptions occur. The initiatives in Chapter 13 describe how the City intends to advance its solid waste resiliency agenda citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits of South Queens. For a complete description of the City's five-borough solid waste resiliency plan, please refer to Chapter 13 (*Other Critical Networks*).

Environmental Protection and Remediation

Sandy showed that extreme weather events—which are likely to increase in severity with climate change—not only have the potential to impact the city's people, built environment, and critical systems; they also can have a deleterious impact on the natural environment. To help minimize the impact of future extreme weather on the environment, the City will advance a range of initiatives to protect open and enclosed industrial sites containing hazardous substances in an economically feasible way, and to encourage the cost-effective remediation and redevelopment of brownfields in a resilient fashion. These initiatives will have a positive impact on the residents, businesses, and nonprofits of South Queens, which is home to approximately 16 industrial companies. For a complete description of the City's five-borough environmental protection and remediation plan, please refer to Environmental Protection and Remediation.

Community and Economic Recovery

New York is a city of neighborhoods, and these neighborhoods vary widely in size and nature. Notwithstanding this variety, successful neighborhoods across the city tend to share certain traits. Two of these are: a formal and informal network of community members who help and support one another in good times and bad; and vibrant commercial and nonprofit sectors that employ and provide goods and services to the people of the community.

As Sandy demonstrated, however, both the network of community-based organizations and the commercial and nonprofit sectors in New York's neighborhoods can be sorely tested when extreme weather hits. During these times (when contributions from these networks and sectors are desperately needed) these organizations and businesses themselves are frequently coping with the same set of challenges that the community at large is—a circumstance that can push even the most well-run organization or business to the breaking point. Even with these pressures, during and in the immediate aftermath of Sandy, New York's commercial and nonprofit sectors overcame many of their own difficulties, playing a critical role in the recovery of neighborhoods across the city, including South Queens. However, as the climate changes, difficulties such as these will likely arise more frequently, testing institutions mightily.

Among the strategies that the City will use to achieve the goal of making its neighborhoods and their critical institutions more resilient will be to: help build grassroots capacity and foster community leadership; help businesses and nonprofits impacted by Sandy to recover; help businesses and nonprofits in vulnerable locations to make resiliency investments that will better prepare them for future extreme weather; and bring new economic activity to neighborhoods recovering from the impacts of Sandy to enable these neighborhoods to come back even stronger than before.

The initiatives described below provide important examples of how the City intends to advance its community and economic recovery agenda citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits of South Queens. For a full explanation of the following initiatives and a complete description of the City's five-borough community and economic recovery plan, please refer to *Community and Economic Recovery.*

The initiatives described below provide important examples of how the City intends to advance its community and economic recovery agenda citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits of South Queens. For a full explanation of the following initiatives and a complete description of the City's five-borough community and economic recovery plan, please refer to *Community and Economic Recovery*.

Community Disaster Preparedness Initiative 1

Identify and address gaps in community capacity

The capacity of a community to organize to aid businesses and residents after an extreme weather event or other disaster is a strong predictor of the success of that community's recovery. To improve the capacity of vulnerable communities, OEM, working with the NYC Center for Economic Opportunity (CEO), will undertake a pilot assessment of the strengths and weaknesses of a Sandy-impacted community, —which could be in South Queens—to inform the creation of a plan to address needs uncovered by the assessment. Subject to funding, OEM and CEO will choose a pilot community and begin their study by 2013.

Community Disaster Preparedness Initiative 2

Continue and expand OEM's Community Emergency Response Teams

OEM currently trains 54 teams of 1,500 volunteers across the city, which staff Community Emergency Response Teams (CERTs). Before, during, and after disasters, including extreme weather events, members of these teams help to organize community disaster preparedness and participate in emergency response and recovery. Going forward, OEM will work with communities to create additional teams, ensuring that the volunteers that staff them are as representative as possible of the communities that they serve. Towards the same end, OEM, working with the NYC Center for Economic Opportunity (CEO), will also identify low-income young adults to be trained to lead their communities in disaster preparedness. OEM and CEO will launch this program by 2014.

Economic Recovery Initiative 1

Launch business recovery and resiliency programs

Over 27,000 businesses citywide, including nearly 2,300 in South Queens, were inundated by the storm. For many, recovery has been challenging. To assist with this recovery, immediately after the storm, the City launched the series of programs, described in Community and Economic Recovery, including a $25 million loan and grant program and a $25 million sales tax waiver program designed to help businesses get back on their feet. Building on the momentum of these programs, which have assisted over 2,500 businesses as of the writing of this report, the City, through NYCEDC, will launch the CDBG-funded Business Resiliency Investment Program of up to $90 million to help vulnerable businesses throughout the city make resiliency investments in their buildings and equipment, and the up to $80 million will assist businesses with recovery and rebuilding efforts. NYCEDC will launch these programs in 2013.

Economic Recovery Initiative 2

Launch the Neighborhood Game-Changer Competition

The recovery of many of the communities impacted by Sandy, including South Queens, has been hampered by a lack of opportunities for economic advancement and employment among significant populations that were impacted by the storm. In many cases, these challenges existed even before Sandy, but have been exacerbated by the impacts of the storm. To address this, the City, through NYCEDC, will launch the CDBG-funded Neighborhood Game Changer Competition to invest up to $20 million in public money in each of the five communities on which this report focuses, including South Queens. This funding will be available on a competitive basis to help finance transformational projects. To win the competition, a project will have to spur incremental economic activity, and match public funding with significant private capital. Projects that would be eligible to be funded in South Queens through this competition could include new attractions bringing new visitors, significant new operations of a major business or non-profit, the revitalization of important commercial corridors, the expansion of an existing neighborhood institution, or a major new transportation option. NYCEDC will launch this program in 2013.

Economic Recovery Initiative 3

Launch Neighborhood Retail Recovery Program

At the core of many Sandy-impacted neighborhoods are the local commercial corridors that provide employment opportunities and services to those who live and work around them. They include local retailers, institutions, and service providers—including food markets, pharmacies, social service organizations, laundromats, and others. In many cases, though, these corridors were devastated by the storm. To address this, the City will call on the PSC and Con Edison to amend the preferential Business Incentive Rate (BIR) program, which offers a discount on Con Edison's electric delivery charges, and will work with call on LIPA to create such a program in the Rockaways to allow it to be extended to impacted small businesses in the five communities on which this report focuses. Businesses and nonprofits with 10 or fewer employees that have received support from City-sponsored loan and grant programs will be eligible for the discount for five years up to a maximum discount of $50,000 per business or nonprofit. The maximum aggregate benefit available across the impacted community areas will be $1 million, for a total benefit of $5 million. The goal is for NYCEDC to launch this effort in 2013. Among the corridors where the benefit would be available in South Queens include:

- Cross-Bay Blvd. (between Belt Pkwy and 165th Ave.)
- Broad Channel
- Beach 116th St.
- Rockaway Beach Blvd. (between Beach 113th and Beach 116th Sts.)
- Beach 129th St.
- Mott Ave. (between Cornaga and Beach Channel Dr.)
- All streets from Beach 90th to Beach 100th Sts.
- Breezy Point

Economic Recovery Initiative 4

Support local merchants in improving and promoting local commercial corridors

As mentioned above, Sandy highlighted the important role played by local commercial corridors in many impacted communities. The City, through the Department of Small Business Services (SBS), will provide financial and/or technical assistance to area business improvement districts (BIDs), merchant associations, and other groups that work to improve market, maintain, and otherwise promote primarily commercial corridors. Subject to review of applications received, SBS will prioritize allocating its resources, including its CDBG funding, to impacted commercial corridors. Such funding could be used for a variety of purposes, including capacity building, façade improvement programs, streetscape improvements, and business recruitment and marketing efforts. In South Queens, corridors that could receive this additional assistance include Beach 116th Street, Beach 129th Street, Mott Avenue in Far Rockaway, and Cross Bay Boulevard in Howard Beach and Broad Channel. SBS will provide this assistance beginning in 2013.

Economic Recovery Initiative 5

Continue to support the FRESH program to increase the number of full-line grocers in underserved neighborhoods

Even before Sandy, the residents of many communities impacted by Sandy, including parts of South Queens, lacked adequate access to fresh fruits, vegetables, and other healthy foods. To address this challenge, especially in underprivileged areas of the city, in 2009, the City launched the FRESH program (Food Retail Expansion to Support Health), a series of zoning and financial incentives available to supermarkets that fill this gap in underserved neighborhoods. To promote the recovery of commercial corridors in these areas, the City will continue to promote the FRESH program, with a particular focus on Sandy-impacted neighborhoods, including all areas east of Beach 116th Street on the Rockaway Peninsula.

In addition to the measures described above, the City will advance the following initiatives to address South Queens's community and economic recovery needs:

– – –

South Queens Initiative 7

Get New Yorkers "Back to the Beach" for summer 2013

Sandy caused extensive damage to the beaches of the Rockaway Peninsula. Thanks to substan-

Conceptual rendering of Beach 116th Street revitalization

tial efforts by DPR, all beaches in the area were able to reopen by Memorial Day 2013, the traditional start of the summer season, with ongoing boardwalk restoration continuing for parts of the boardwalk that sustained minor to moderate damage during Sandy. However, to restore these beaches fully to provide recreational and protective value to the neighborhoods they front, will require significant planning and construction. While this work will take time, it is critical to the local economy that the beaches continue to attract visitors from all over South Queens, the wider city and beyond. To this end, in addition to reopening the beaches with interim repairs to beach-related infrastructure and portion of the boardwalk, the City, along with the local community, is also bringing back popular recreational and entertainment events from previous years, including the Art in the Parks Program, yoga and zumba outdoor fitness classes, movie nights and the annual Rockstock and Barrels festival. The City also is exploring additional opportunities to revitalize the beachfront at key locations through the deployment of additional food and beverage concessions. As noted above, these efforts will be bolstered further by the extended and expanded ferry service being supported by the City during the summer of 2013.

South Queens Initiative 8
Explore opportunities for long-term activation of the beachfront

Building on the beach restoration work described above, the City will explore new opportunities to activate the beach and boardwalk along the Rockaway Peninsula that are more long-term and ambitious in nature. As a first step, the City, working through DPR, will continue to address those sections of the boardwalk that were more substantially damaged during Sandy and that, therefore, cannot be restored in near-term. This process will include a full consideration of ideas received from the community in numerous public forums since Sandy and the completion of a detailed analysis of resilient rebuilding options. This work is already underway, with plans expected to be released to the public for discussion by fall 2013.

In addition to the physical restoration of the boardwalk, the City also will explore several options to create new beachfront destinations at key nodes along the Rockaway Peninsula. The City, through DPR, will create a plan for recreational and community amenities on the beachfront in consultation with the community, and release it publicly for discussion by fall 2013.These amenities could include new recreational amenities such as a state-of-the-art skate park, new playgrounds with water features, volleyball and basketball courts and shade structures, as well as appropriate commercial amenities consistent with a boardwalk environment. The commercial components that will be included within this plan, as appropriate, could receive City capital support, subject to available funding, in conjunction with private investment, and will be implemented by DPR and NYCEDC.

As part of this effort, the City will further explore a partial reconfiguration of portions of Shorefront Parkway to provide additional space for activities as well as improved parking and bike access. It also will pursue opportunities for permanent cultural attractions such as public art installations, and music and performing arts venues along the beach. The City, through DPR and NYCEDC, will issue an RFEI in 2013 to seek partners to bring cultural programming, as a first phase, either to the Beach 108th Street roller hockey rink or in a new "pop up venue" at Beach 96th Street, starting in 2014.

South Queens Initiative 9
Develop a revitalization strategy for the Beach 108th Street corridor

As the City explores opportunities for long-term activation of the beachfront, it also will create a detailed revitalization strategy for the Beach 108th Street corridor, running from Jamaica Bay to the beach, exploring opportunities for potential ferry service on the Bay-side, potential redevelopment of underused parcels, potential public realm improvements along the length of the corridor including adjacent to the Rockaway Wastewater Treatment Plant, and retail improvements. Development of this plan will be started by NYCEDC and DCP in 2013, with completion expected in 2014. Thereafter, the City would move to implement land use and other changes that it deems to be appropriate, if any, based on the results of its study.

South Queens Initiative 10
Develop a comprehensive commercial revitalization plan for Beach 116th Street

Beach 116th Street is centrally located on the Rockaway Peninsula and provides easy access to mass transit and Cross Bay Boulevard. By some measures, it faced challenges even before Sandy, with store vacancies and underused or vacant buildings and lots. As a result of Sandy, however, the corridor suffered extensive damage, with many businesses destroyed and area infrastructure, including the subway terminus, knocked out of service. To help in the post-Sandy revival of Beach 116th Street, both for year-round residents and seasonal visitors, the City will create a detailed and comprehensive commercial revitalization plan for Beach 116th Street. This plan will set forth City-sponsored strategies (including, potentially, incentive programs and land use changes) that

Rendering of Beach 20th Street Plaza, Far Rockaway

will encourage the rebuilding of retail that was destroyed by Sandy along Rockaway Beach Boulevard, as well as the attraction of new development to underutilized lots (such as a possible "anchor block" at the corner of Beach 116th Street and the beach). Development of this plan will be started by NYCEDC and DCP in 2013, with completion expected in 2014.

Meanwhile, in the nearer-term, the City, through the Department of Small Business Services (SBS), will simultaneously continue to support small business-owners and the larger community with a retail facade improvement program and local merchant association capacity building program, using donated funds from private partners and the Mayor's Fund to Advance New York City. Applications for funding have already begun to be processed. Also, in the nearer-term, the City, through multiple agencies, will work to enhance the image of Beach 116th Street through streetscape improvements, including new shrubbery, planters, benches, better lighting, an art installation, and cleaner and safer streets.

South Queens Initiative 11
Develop a commercial revitalization plan for Far Rockaway, potentially involving repositioning of City- and MTA-controlled sites

Far Rockaway's downtown, surrounding Mott Avenue, is the commercial center and transit hub for the dense Far Rockaway neighborhood. However, the area contains strategically placed properties with unrealized or under-realized potential. The challenges faced by the area were exacerbated by the events surrounding Sandy, when many area residents who support the area's businesses were displaced and critical infrastructure, including subway service to Manhattan, was lost. To help in the post-Sandy revival of Far Rockaway's downtown, the City will create a detailed and comprehensive commercial revitalization plan for the area. This plan will set forth City-sponsored strategies (including, potentially, incentive programs and land use changes) that will help create a vibrant, multi-modal hub serving the Rockaway Peninsula and beyond, including by encouraging the development of currently vacant, privately owned sites in the area. In conjunction with the development of this plan, NYCEDC and the MTA will also issue a request for proposals to private developers seeking new development on the publicly-controlled parking and bus depot sites adjacent to the A train station. Finally, in the near-term, NYCEDC and NYCDOT, in partnership with the Rockaway Development & Revitalization Corporation, are working on a beautification project in the area that is expected to result in the construction of a new pedestrian plaza south of Mott Avenue, linking the Beach 20th and Beach 21st Streets. In May, the project received preliminary approval from the City's Public Design Commission, once formalized, construction will commence.

South Queens Initiative 12
Launch a satellite Workforce1 Career Center in Far Rockaway

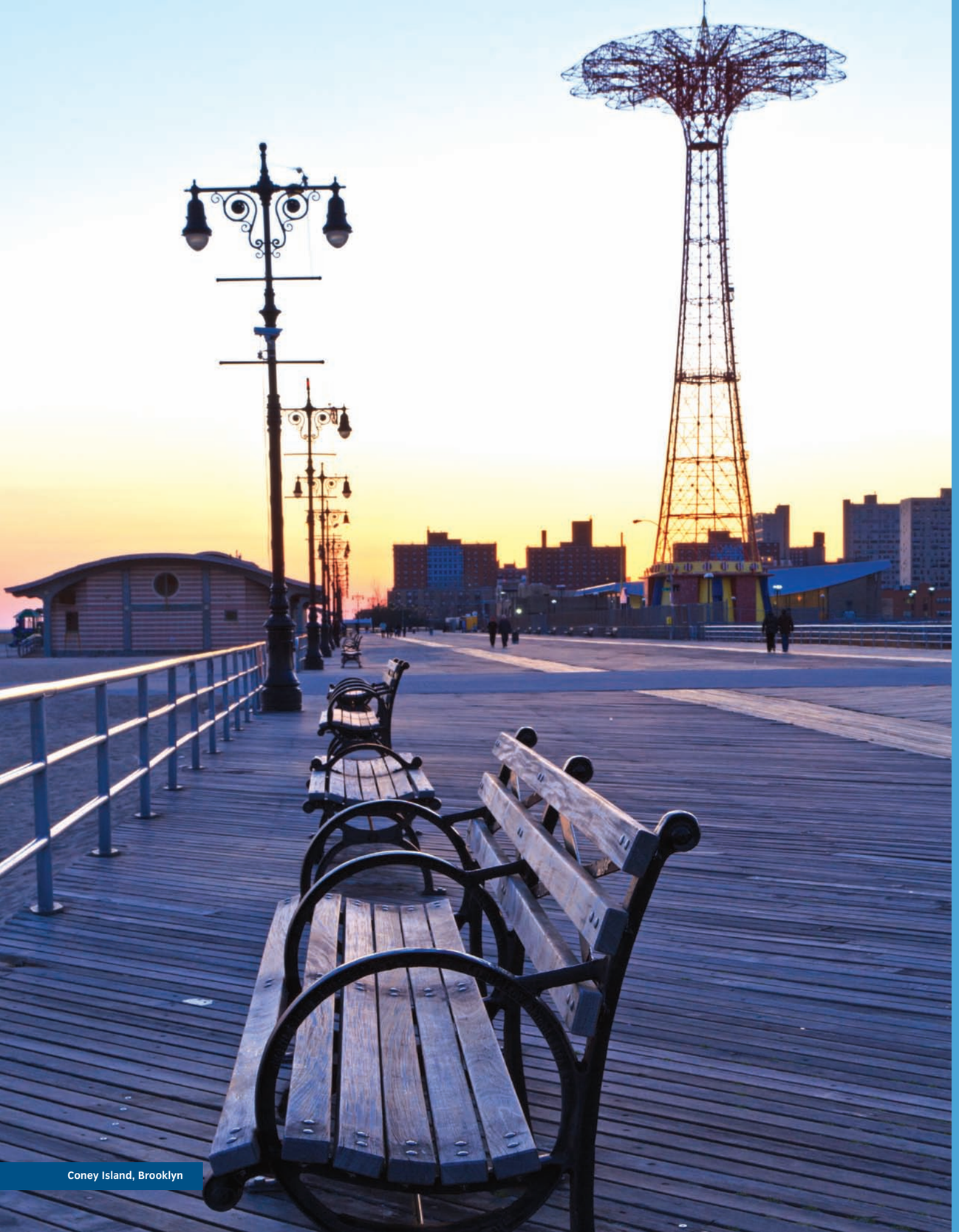
Far Rockaway suffers from a high unemployment rate, relative to others in South Queens. SBS will, therefore, work with local elected officials and institutions to launch a satellite Workforce1 Career Center in Far Rockaway, serving its population as well as residents of surrounding areas. Staff members will connect qualified candidates to job opportunities and work with local businesses to help recruit for their needs. The Center also will provide workshops and trainings to build skills and place individuals in positions throughout New York City. The new Workforce1 Career Center will open by late summer 2013.

South Queens Initiative 13
Implement planned and ongoing investments by the City and private partners

Preservation and revitalization of neighborhoods most significantly impacted by Sandy will be hampered if the momentum of planned investments is lost. The City, therefore, will continue to pursue and execute on public and private investments that had been planned prior to Sandy in South Queens. Such projects include but are not limited to:

Parks and Open Space
- Jamaica Bay/Rockaway Restoration Corps, a partnership with NPS launched in May that employs 200 workers to assist in the cleanup of Jamaica Bay and Rockaway Parks, restoring woodlands, wetlands and parkland damaged by Sandy.

Community Facilities
- Rockaway Institute for a Sustainable Environment (RISE), a visitor's center for community-based programs and cultural activities focused on environmental issues in a former Arverne firehouse converted by the Rockaway Waterfront Alliance with City support that is to open in 2015.
- Beach 73rd Street YMCA, a new 44,000 square-foot facility, the Peninsula's first, being built on 2.2 acres at Beach 73rd Street and Rockaway Beach Boulevard that is to open in fall 2013.



Coney Island, Brooklyn

Southern Brooklyn

The D, F, N, and Q trains converge at Stillwell Avenue in Coney Island, one of the most vibrant centers of residential and commercial life in Southern Brooklyn. Each year millions of visitors stream onto the boardwalk here overlooking the beach and Atlantic Ocean. Many move on to ogle the sea lions at the New York Aquarium or race down the famed wooden Cyclone, one of dozens of rides on offer.

Coney Island was not always so lively—or so accessible. The peninsula that now contains Coney Island and three other Southern Brooklyn neighborhoods was once an actual island, separated from the mainland by Coney Island Creek and reachable only at low tide. The entire area was a collection of wetlands, tidal marshlands, bays, inlets, creeks, and barrier islands—first the fishing grounds of the Lenape people and then part of a quiet farming community. *(See map: The Shoreline: Then and Now)*

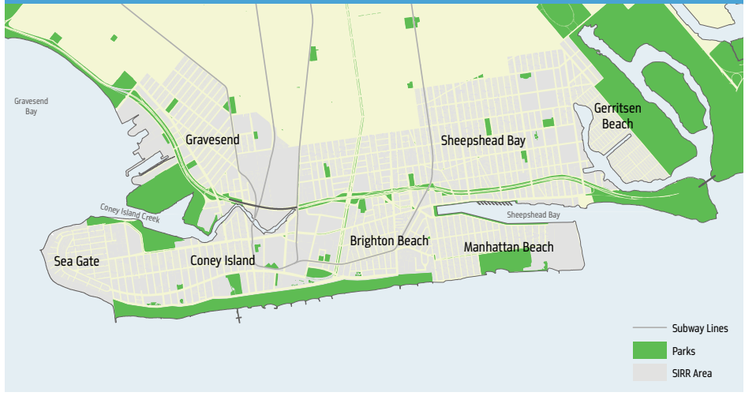
The Shoreline: Then and Now

Over time, as the area evolved into a summer resort and further development took place, property owners (and later, the City) filled in the middle of Coney Island Creek, connecting the island to the mainland. Throughout the area, marshlands and waterways were also filled to yield new land for development. The coastline was extended into the ocean and Sheepshead and Gravesend Bays, subsuming smaller barrier islands. By the mid-20th century, summer bungalow communities had largely become year-round neighborhoods: Sea Gate, Coney Island, Brighton Beach, Manhattan Beach, Gravesend, Sheepshead Bay, and Gerritsen Beach. Home to an economically and ethnically diverse array of residents—some with roots that go back generations—these neighborhoods offer a range of housing types, along with access to beautiful beaches, bays, and a network of public parks. *(See map: Neighborhoods of Southern Brooklyn)*

But because of Southern Brooklyn's location, low-lying topography, and pattern of development, the area has long been vulnerable to damage from storm waves and flooding. While the Rockaway Peninsula provides some protection to eastern portions of Southern Brooklyn, the smaller barrier islands that once helped attenuate (or break up) waves elsewhere are gone, and some of the area's building stock, including bungalows built in the early 20th century for summer use, are particularly susceptible to damage. Portions of the shoreline have experienced continuous erosion—in fact, the first documented beach nourishment project in the United States was at Coney Island in the 1920s, and there have been many such projects in the area since then, including a major United States Army Corps of Engineers (USACE) effort in the mid-1990s along the oceanfront in Coney Island and Brighton Beach.

During Sandy, the beach that had been nourished by the USACE did indeed help buffer those two neighborhoods. However, storm waves battered buildings in areas without coastal protections, including Sea Gate and Manhattan Beach, and inundation in Southern Brooklyn was widespread, much of it caused by flooding originating not from the ocean but from the area's bays, creeks, and inlets. As of the writing of this report, local businesses remain slow to recover. Although the USACE plans to restore the beach along Coney Island and Brighton Beach to its pre-storm condition—replenishing the roughly 272,000 cubic yards of sand that were washed away or pushed inland during Sandy—all of Southern Brooklyn is expected to be subject to future risks from storm surge, rising sea levels, and increased storms and precipitation resulting from climate change.

Neighborhoods of Southern Brooklyn



Brighton Beach Boardwalk

Credit: Tom Geibel

To help Southern Brooklyn recover from Sandy and move forward on firmer footing, the City has developed a strategy that reflects the overarching goals of this report, which are to seek to limit the impacts of climate change, while enabling New York and its neighborhoods to bounce back quickly when those impacts cannot be averted. The plan will address Southern Brooklyn's most significant risk—its vulnerability to storm surge, particularly as sea levels rise—by strengthening oceanfront and backdoor exposures, by facilitating retrofits and resiliency in new construction and existing buildings, and by protecting vital infrastructure. The plan will also address other significant risks such as more frequent heavy downpours, heat waves, and high wind events by drawing on both citywide and locally tailored initiatives. Finally, the plan will build on the area's natural assets and local economic strengths to encourage reinvestment in its many neighborhoods.

Area Characteristics

Southern Brooklyn is largely residential, encompassing a range of housing types, from small bungalows to large single-family homes to multi-family elevator buildings. While the vast majority of the area's residential buildings are private homes, most Southern Brooklyn households (76 percent) live in multi-family structures, each of which may contain scores or even hundreds of individual units. Small businesses on local commercial corridors primarily serve local residents, but Southern Brooklyn also has, of course, the destination entertainment attractions that draw people from all across the city and beyond, as well as large institutions and critical infrastructure. *(See charts: Area Buildings Characterized by Type; Area Housing Units Characterized by Building Type)*

Neighborhoods and Residential Development

Seven major neighborhoods make up Southern Brooklyn. Though several share a number of characteristics, in some cases they are quite distinct from one another.

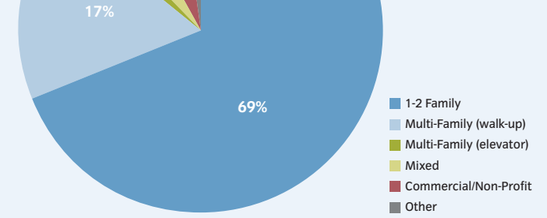
There are four primary neighborhoods on the Coney Island peninsula. On the western tip of the peninsula is Sea Gate, a private enclave developed as a planned community in the late 1890s and today operated by the Sea Gate Association. Sea Gate's 4,800 mixed-income residents live mostly in single-family homes on quiet streets near community-maintained private beaches and the waterfront Lindy Park.

Next to Sea Gate, at the center of the Coney Island peninsula is the neighborhood of Coney Island itself. Coney Island has a mix of multi-

Coney Island Beach

Credit: Ian Spanier

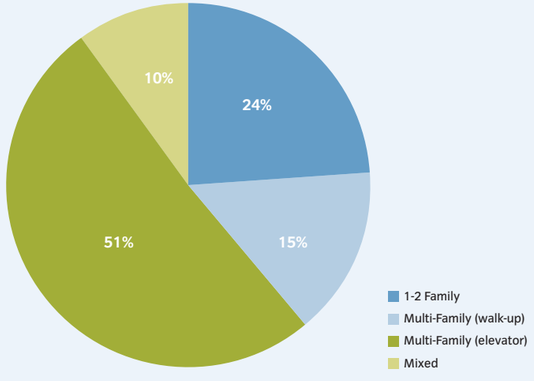
Area Buildings Characterized by Type



Total = 21,000 Buildings

Source: DCP PLUTO

Area Housing Units Characterized by Building Type



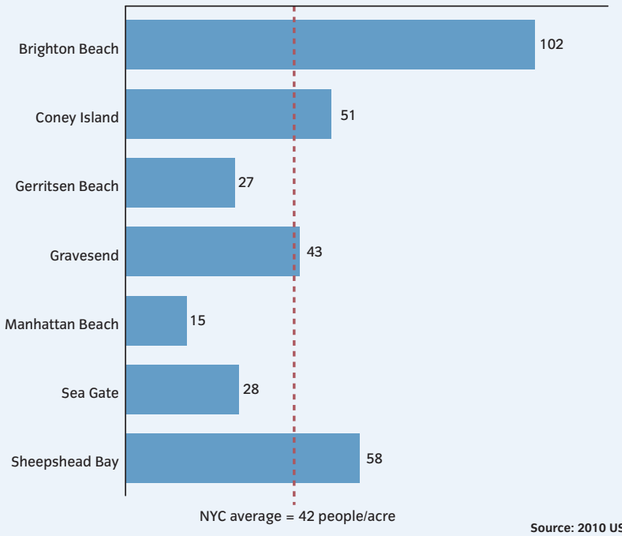
Total = 81,000 Housing Units

Source: DCP PLUTO

family buildings and single-family homes, with a high concentration of public housing and publicly- supported housing, including 37 buildings managed by the New York City Housing Authority (NYCHA) and approximately 6,300 units in the Mitchell-Lama program. Coney Island's main retail corridor is is Mermaid Avenue; meanwhile, an entertainment district stretches along Surf Avenue and the Coney Island Boardwalk. On the north side of Coney Island is Kaiser Park, bordering Coney Island Creek.

To the east of Coney Island and sharing its broad beach is Brighton Beach, the most densely developed Southern Brooklyn neighborhood, at 102 residents per acre (more than twice the city average). Most of its 31,500 residents live in multi-family buildings, though some bungalows remain from the 1920s, and have now have been adapted to year-round occupancy. An elevated train runs over Brighton Beach Avenue, the principal commercial corridor in the area. *(See chart: Area Population Density)*

Area Population Density



Source: 2010 US Census

Typical residences in Gerritsen Beach

Credit: gerritsenbeach.net

Manhattan Beach is the easternmost neighborhood on the peninsula. Its 4,600 residents primarily occupy large single-family homes in an oceanfront setting. The neighborhood encompasses Manhattan Beach Park—dotted with playgrounds, baseball diamonds, and tennis courts—and Kingsborough Community College, which sits on a former Coast Guard base along the shoreline.

Farther inland are three other major Southern Brooklyn neighborhoods. Gravesend, one of the area's larger neighborhoods, has a population of 38,300 people primarily occupying single-family row houses and multi-family elevator buildings. The MTA's Coney Island Yards, Coney Island Hospital, and Calvert Vaux Park also lie within Gravesend's boundaries.

The neighborhood of Sheepshead Bay, fronting the water body of the same name, has 62,000 residents, most of whom live in single-family homes and newer multi-family buildings. Rows of bungalows, however, remain along pedestrian walks on the north and south sides of Emmons Avenue, one of Sheepshead Bay's main commercial corridors. Some of these bungalows are as much as 5 feet below the street grade (which has been raised over time), making them particularly susceptible to flooding.

Gerritsen Beach—located on Plumb Beach Channel and Shell Bank Creek, off Gerritsen Inlet—today is a tight-knit neighborhood of 5,200 residents who reside mostly in single-family homes. Developed in the 1920s as a planned community, Gerritsen Beach still has hundreds of bungalows. Despite renovations, alterations, and expansions over the decades, many of these structures not only were erected without the benefit of modern construction codes; they also were built at low elevations and today are at risk of flooding.

Socioeconomic Characteristics

Just as there are differences in population density and housing types among Southern Brooklyn's neighborhoods, so too do these neighborhoods differ in their socioeconomic makeup. Southern Brooklyn encompasses both wealthier and economically distressed neighborhoods. For example, in Manhattan Beach, where unemployment is 5 percent and the poverty rate 16 percent, the majority (over 75 percent) of residents owns their homes and the average property value is close to $1 million. At the other end of the socioeconomic spectrum is Coney Island, where the unemployment rate is 13 percent and the poverty rate is 23 percent. Only one-fifth of Coney Island residents own homes. *(See table: Socioeconomic Characteristics)*

Socioeconomic Characteristics

Area	Population	Poverty Rate	Median Household Income	Households	Owner-Occupied Housing Units	% Homeowners	% Owner-Occupied Housing Units with Mortgage	Median Owner-Occupied Unit Value
Brighton Beach	31,500	24%	$31,700	12,100	2,700	22%	58%	$487,000
Coney Island	45,000	23%	$32,100	18,000	3,800	21%	38%	$320,800
Gerritsen Beach	5,200	7%	$62,500	1,900	1,400	75%	78%	$446,000
Gravesend	38,300	16%	$38,900	13,800	4,700	34%	44%	$546,200
Manhattan Beach	4,600	16%	$84,800	1,600	1,200	77%	52%	$922,300
Sea Gate	4,800	14%	$61,500	1,500	730	48%	66%	$614,600
Sheepshead Bay	62,000	14%	$49,900	24,000	11,200	47%	55%	$460,500
Citywide Total/ Average	**8,175,000**	**19%**	**$51,300**	**3,050,000**	**993,500**	**33%**	**64%**	**$514,900**

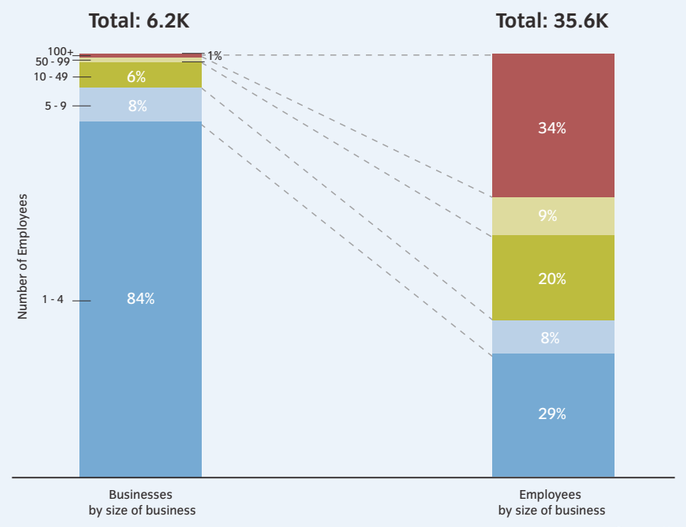
Source: 2010 US Census, 2011 American Community Survey, 5-Year estimate

Vulnerable populations also reside in Southern Brooklyn. There are over 18,000 residents of NYCHA developments, including significant numbers of individuals who have impaired mobility or are on life-support equipment. The nine nursing homes in the area have capacity for approximately 2,400 inpatients; meanwhile, the area's seven adult care facilities house over 1,300 residents. Coney Island Hospital has 371 beds.

Business and the Local Economy

Most businesses in Southern Brooklyn (nearly 85 percent) are small enterprises employing fewer than five people, with many occupying neighborhood commercial corridors that serve local residents. However, over one-third of the area's employees work for larger businesses or institutions, each of which may employ hundreds or even thousands of workers. For example, Coney Island Hospital, the biggest employer in the area and the largest medical facility in Southern Brooklyn, employs over 2,000 people. Coney Island Hospital is but one part of the area's healthcare sector, which plays a significant role in the local economy. The nursing homes, adult-care facilities, and other medical businesses serving Southern Brooklyn—including larger employers such as Shorefront Geriatric and the Shore View Nursing Home—offer not only critical services but also valuable employment. Nonprofit organizations also provide significant local employment, in addition to valuable social services. *(See graphic: Profile of Area Businesses)*

Profile of Area Businesses



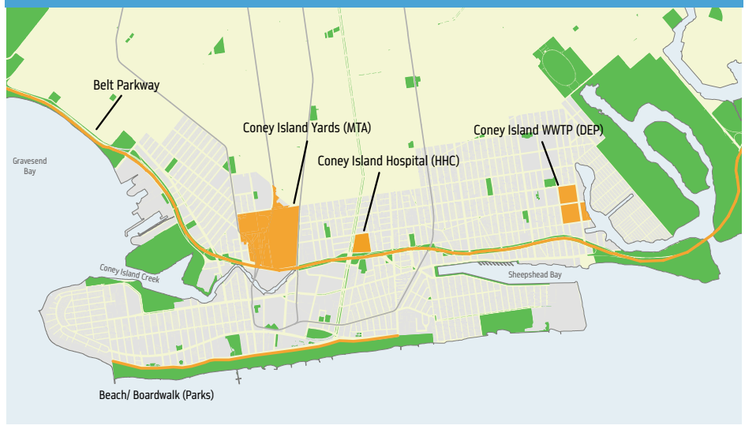
Source: Hoovers

The amusement area, including the Coney Island Boardwalk, is a significant economic engine, supported by seasonal visitation. The amusement area stretches from the New York Aquarium, a 14-acre campus at West 8th Street that draws 750,000 visitors annually, to MCU Park, home of the Brooklyn Cyclones, at West 17th Street. First developed in the late 19th century, the district has been undergoing a renaissance that started in the 1990s with the Cyclones and the renovation of the Stillwell Avenue subway station. Revitalization accelerated with the passage in 2009 of a comprehensive rezoning plan that has led to the opening of three new amusement areas, together with other year-round development in and around the amusement area.

Critical Infrastructure

Southern Brooklyn contains important infrastructure assets. While the 2.5-mile beach bordering Coney Island and Brighton Beach, maintained by the Department of Parks and Recreation (DPR), is a major recreational amenity, it is also critical for storm protection for the entire peninsula. The mid-1990s replenishment project by the USACE raised the beach by as much as 11 feet from Corbin Place in Manhattan Beach to West 37th Street at the edge of Sea Gate, to attenuate waves and protect adjacent flood-prone neighborhoods and shoreline buildings.

Area Critical Infrastructure



Credit: Fred R. Conrad/The New York Times

Damage in Sea Gate

Meanwhile, the Belt Parkway, an integral part of the regional highway network, extends 25 miles from the Gowanus Expressway in Brooklyn to the Cross Island Parkway in Queens. Built beginning in the 1930s, this major roadway has adjacent parks and esplanades maintained by DPR. Many sections of the Belt Parkway have oceanfront exposures and flood during rain or storm surge events, although a seawall or bulkhead exists along portions of the roadway. On Plumb Beach, a former barrier island east of Sheepshead Bay, the USACE has advanced renourishment projects to protect the roadway from erosion, including a recent project that involved the installation of geotubes (large, long textile tubes filled with sand).

Run by the Metropolitan Transportation Authority (MTA), Coney Island Yards facility is another integral part of the transportation infrastructure. The 75-acre facility—the largest rapid transit complex of its type in the world—includes workshops where maintenance and overhauls are performed on the subway fleet. The facility was constructed on former marshlands and near sea level, however, making the yard vulnerable to inundation.

The Coney Island Wastewater Treatment Plant (WWTP) is also a critical infrastructure asset. Located on Shell Bank Creek within Gerritsen Inlet, this Department of Environmental Protection (DEP) facility has the capacity to process 110 million gallons per day. It serves most of Southern Brooklyn and areas to the north and east. *(See map: Area Critical Infrastructure)*

What Happened During Sandy

Sandy's storm surge struck Southern Brooklyn in two ways. The storm brought direct wave impacts along ocean-facing areas, particularly in areas where coastal protections were lacking or inadequate, such as in Sea Gate and Manhattan Beach. Even more significant, though, was the inundation that occurred via inland waterways, and historic creeks and marshland that had been paved over decades before. Generally, waters that entered Southern Brooklyn through these routes resulted in "stillwater flooding," where the water rose steadily through the peak of the storm, and then receded quickly after the surge and high tide had passed. At Sandy's peak, floodwaters reached a height of 10 feet in some places, including, for example, along Neptune Avenue in Coney Island. *(See map: Area Inundation and Surge Height)*

In Sea Gate, powerful waves struck buildings along the waterfront, knocking out the first floors of a number of structures. Where owners had built bulkheads at the edges of their properties, damage generally was mitigated. However, areas without bulkheads both were themselves vulnerable and allowed waves to scour and undermine neighboring seawalls and bulkheads. For example, the substandard bulkhead at Lindy Park collapsed as a result of severe wave impacts.

Along Coney Island and Brighton Beach, by contrast, the USACE nourishment project generally performed as intended, breaking waves before they made contact with buildings. However, the beach lost approximately 272,000 cubic yards of sand, according to USACE estimates, and some areas along the beach that were nourished to lower elevations experienced breaches, with waves pushing sand and water into adjacent neighborhoods. At Ocean Parkway, for instance, waves pushed thousands of tons of sand northward, with water traveling 1.5 miles north to Avenue W, joining floodwaters from Sheepshead Bay and Coney Island Creek.

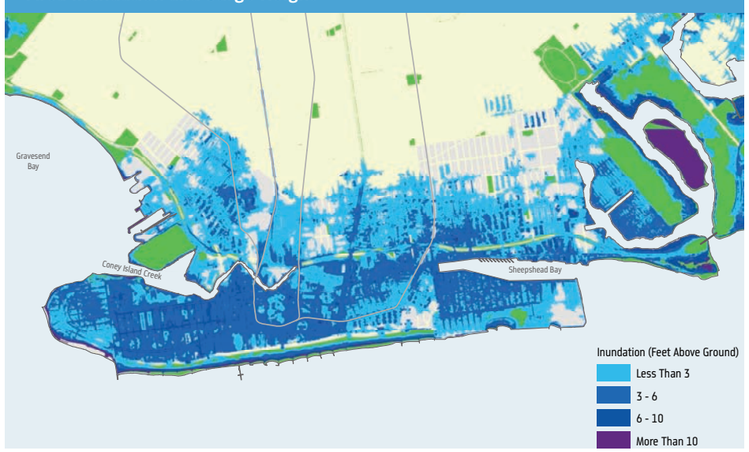
Meanwhile, in Manhattan Beach and at Kingsborough Community College, the elevation of the area helped mitigate flooding. Waves, though, damaged esplanades, docks, and other structures at the water's edge, particularly along the Manhattan Beach waterfront, from Corbin Place to the college campus at the eastern tip of the peninsula.

Sheepshead Bay was a major source of the floodwaters that impacted the neighborhoods of Sheepshead Bay and Manhattan Beach. The swelling of Coney Island Creek, too, led to inundation in Coney Island and Gravesend. The surge overtopped the creek's low edges (in fact, there was flooding along Neptune Avenue, adjacent to Coney Island Creek, a full 12 hours before the surge's peak). Even in the ocean-facing neighborhoods of Coney Island, Brighton Beach, and Manhattan Beach, floodwaters came primarily from their "backdoors" until the peak of the storm when, in many areas, waters from the ocean met waters from the north side of the peninsula on land.

Elsewhere, storm surge pushed into Gerritsen Inlet, which then overflowed into the neighborhood of Gerritsen Beach (although floodwaters also came over Plumb Beach and the Belt Parkway). This water then flowed to Shell Bank Creek and up and over the creek's edges into adjacent homes.

The most methodologically rigorous building damage assessment undertaken by New York City of Buildings (DOB) was completed in December 2012. According to this assessment, of those buildings citywide that were tagged, either yellow or red (including those further classified as destroyed), 10 percent were located in Southern Brooklyn. The yellow and red tagged buildings in Southern Brooklyn tended to be clustered along Atlantic Avenue in Sea Gate, in Sheepshead Bay and Gerritsen Beach. Southern Brooklyn was unusual among ocean-facing parts of the city, with a larger percentage of red and yellow tagged buildings that were tagged yellow (78 percent) than neighborhoods such as South Queens (41 percent) and the East and South Shores (52 percent). This was reflective of the fact that, in Southern Brooklyn, although a significant number of buildings were damaged by powerful waves coming off of the ocean, the area also experienced significant "backdoor" (stillwater) inundation in its northern regions. (*See map: Location and Level of Building Damage*)

Area Inundation and Surge Height

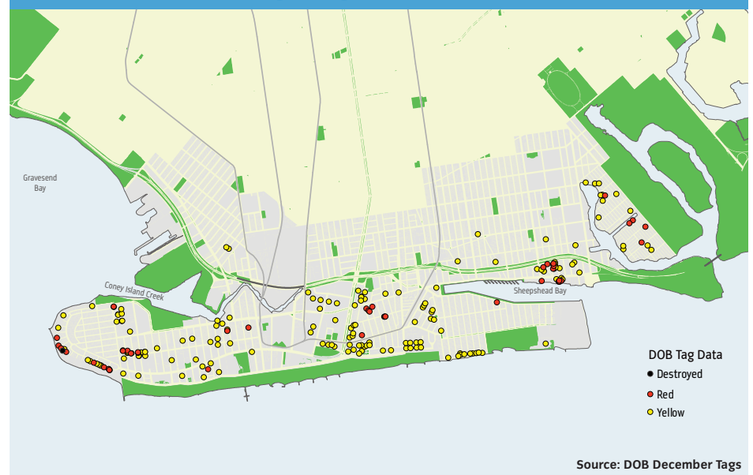


Source: FEMA MOTF 11/6 Hindcast surge extent

Credit: Nate Bliss

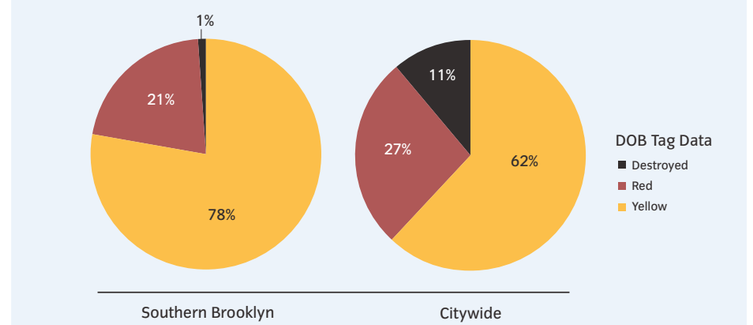
Damage at Manhattan Beach

Location and Level of Building Damage



Source: DOB December Tags

Level of Building Damage



Source: DOB December Tags

Damage at the W. 37th Street jetty

Credit: Nate Bliss

Overall, the storm's impact on buildings in Southern Brooklyn was primarily from stillwater flooding. Inundation damaged ground-floor and basement spaces, destroying electrical equipment and other building systems, and disrupting power service. Thousands of commercial spaces were inundated, resulting in the loss of inventory and valuable equipment that was not elevated, as well as the destruction of interior finishes.

Flooding had a huge impact on the homes and residents of Southern Brooklyn. Flooding of ground-floor residential units, single-family homes, and bungalows throughout the area resulted in temporary displacement of residents. Repairs to electrical, heat, and elevator systems in high-rise buildings—including public housing and Mitchell-Lama buildings—took two to four weeks and, in some cases, even longer. Meanwhile, 10 Department of Education buildings had major damage, which impacted fifteen schools. In Coney Island, it was nearly two and half months before students could return to P.S. 288 (the Shirley Tanyhill School). In the interim, these students were sent to other schools.

Local businesses were also hit hard, with over 5,000 businesses employing over 30,000 people affected by the storm. Along neighborhood retail corridors, local grocery stores were closed, making it difficult for residents in Coney Island to access food following the storm. In turn, many businesses that managed to reopen found themselves with fewer customers because so many Southern Brooklyn residents had been displaced.

There were significant losses within the entertainment area as well. At the New York Aquarium, operated by the Wildlife Conservation Society, floodwaters poured into buildings, causing an estimated $65 million in damage to life-support systems for fish and marine mammals and exhibit infrastructure. Sandy also destroyed the MCU Park front office, locker rooms, and field, and did millions of dollars of damage to rides and electrical systems at the area's amusement parks.

Southern Brooklyn's Jamaica Bay Neighborhoods

The neighborhoods of Southern Brooklyn that front on Jamaica Bay, including Marine Park, Bergen Beach, Mill Basin, Canarsie, and East New York, experienced Sandy in some ways that were similar to the neighborhoods on which this report focuses and in some ways that were different. However each was impacted in ways that continue to affect the residents and businesses of these neighborhoods.

During Sandy, most of the damage done to these neighborhoods was the result of inundation from Jamaica Bay. Sandy's floodwaters arrived with the storm, were pushed through Rockaway Inlet into the Bay and then made their way into creeks, basins, and inlets, overflowing sandy beaches and wetlands and overwhelming bulkheads. In the case of Canarsie, this neighborhood was flooded on multiple fronts, with waters coming both from Paerdegat Basin and Fresh Creek, impacting hundreds of structures.

Credit: Nate Bliss

Looking to the future, low-lying areas such as these neighborhoods are particularly at risk from rising sea levels that could exacerbate storm surges like that brought by Sandy. The initiatives described in this report are designed to help address these risks through a range of strategies. Among these are: new coastal protections (studying, for example, a potential storm surge barrier across Rockaway Inlet; *see Southern Brooklyn Initiative 4*); a program to raise bulkheads and other shoreline structures in low-lying most at risk of flooding, including potentially these Bay-facing Brooklyn neighborhoods (*see Coastal Protection Initiative 6*); and wetland restoration measures in and around Jamaica Bay. At the same time, this report proposes other measures that will help with recovery in these neighborhoods by supporting housing and commercial rebuilding, building-level resiliency investments, and investments in critical infrastructure.

Risk Assessment: Impact of Climate Change

Major Risk Moderate Risk Minor Risk

	Scale of Impact			
Hazard	Today	2020s	2050s	Comments
Gradual				
Sea level rise				Minimal impact
Increased precipitation				Could result in combined sewer overflows and flooding of low-lying areas
Higher average temperature				Minimal impact
Extreme Events				
Storm surge				Significant risk of both flooding and wave action, as evidenced by Sandy; risk will grow as V Zone expands; increased storm frequency will leave less time to restore coastal protections
Heavy downpour				As with increased precipitation, likely to result in more combined sewer overflows and flooding
Heat wave				Greater strain on power system with potential for more failures; most significant impact on high-rise buildings
High winds				Overhead power lines are at risk of failure

Meanwhile, Coney Island Hospital and many area nursing homes, adult-care residences, and other outpatient medical facilities experienced flooding and power loss, resulting in evacuations in the days after the storm. In fact, Coney Island Hospital, which lost power and suffered significant damage to its mechanical and electrical systems, had to close the day after the storm—evacuating more than 220 patients—and it was months before the hospital could begin providing inpatient care *(see Chapter 8, Healthcare)*.

Sandy also had a significant impact on key infrastructure in the area, resulting in damage and disruption to critical services. The Belt Parkway was inundated in sections, with damage to its seawall and bulkhead. At Coney Island Yards, there was flooding and significant damage to track switches. Transit service was down for nine days following the storm. The Coney Island WWTP lost power during the storm for two hours, and inundation inflicted modest damage on the facility. DEP workers heroically labored to get the plant back online quickly, which helped minimize the discharge of untreated wastewater following the storm.

What Could Happen in the Future

Going forward, given the area's coastal exposure and low topography, and as evidenced by Sandy's destructive impacts, the most significant risk to Southern Brooklyn is from flooding resulting from coastal storms, exacerbated by projected sea level rise.

Major Risks

Preliminary Work Maps (PWMs) were released in June 2013 by the Federal Emergency Management Agency (FEMA). According to these new PWMs, the boundaries for the 100-year floodplain—the area that has a 1 percent or greater chance of flooding in any given year—have expanded to include most portions of the area that were once marshlands. *(See map: Comparison 1983 FIRMs and Preliminary Work Maps)*

There is also a dramatic increase—215 percent—in buildings of all types in the 100-year floodplain of the PWMs compared to that of the 1983 FIRMs. Base Flood Elevations (BFE)—the height to which floodwaters could rise during a storm—shown on the maps have increased two to three feet in large swaths of the area. Meanwhile, V Zones, the areas of the 100-year floodplain where waves could exceed three feet in height, have increased along the oceanfront and, in some cases, they even extend into residential areas. Sensitive facilities, such as Coney Island Hospital and Coney Island Yards, are now within the 100-year floodplain. *(See table: Buildings in the Floodplain)*

According to projections from the New York City Panel on Climate Change (NPCC), described in Chapter 2, sea levels are projected to rise through the 2020s and 2050s. During this period, the floodplain will likely expand, and throughout the area, the BFE will likely continue to rise, reflecting the risk of ever-higher floodwaters during storms. According to the NPCC's high-end projections, the 2050s, in Southern Brooklyn, approximately 20,000 buildings are expected to be in the floodplain (an increase of 30 percent over the PWMs), V Zones are also expected to expand, and BFEs are expected to increase. *(See map: Comparison of Preliminary Work Maps and Future Floodplains)*

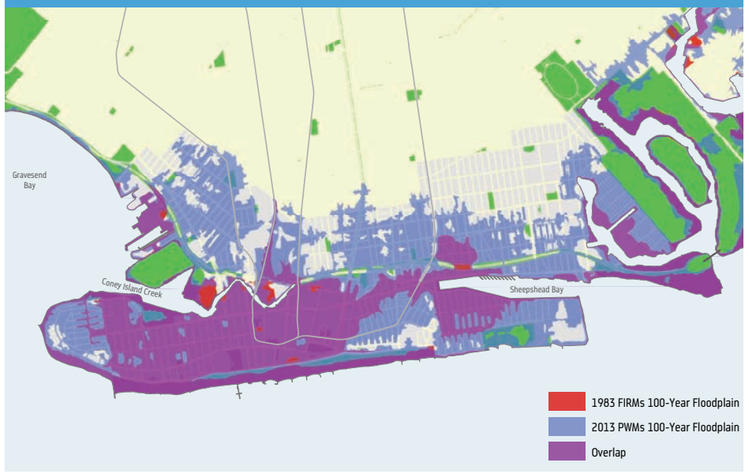
Taking into account the combination of sea level rise and increased storm severity, existing coastal protections may prove no

Buildings in the Floodplain

Buildings & Units	100-Year Floodplain			
	1983 FIRMs	2013 PWMs	Projected 2020s	Projected 2050s
Residential Buildings	4,240	14,220	16,880	18,560
Residential Units	28,100	61,400	73,700	78,800
Commercial and Other Buildings	700	1,340	1,540	1,650

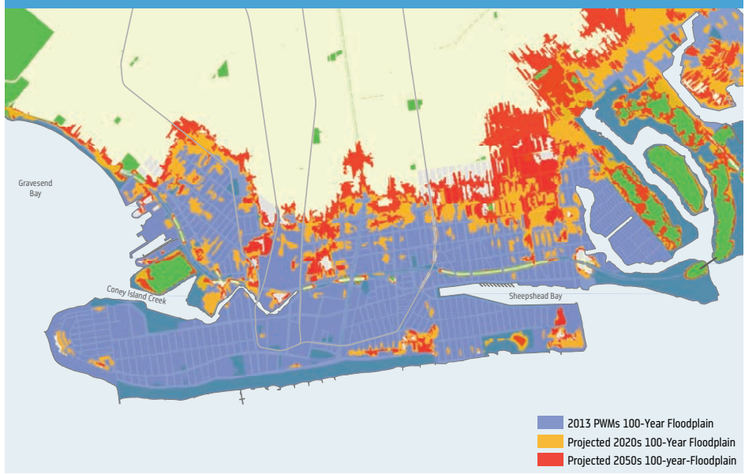
Source: DCP PLUTO, FEMA, CUNY Institute for Sustainable Cities

Comparison of 1983 FIRMs and Preliminary Work Maps



Source: FEMA

Comparison of Preliminary Work Maps and Future Flooplains



Source: FEMA, CUNY Institute for Sustainable Cities

longer adequate. Additionally, increased storm frequency will make it challenging to restore coastal protections between extreme weather events.

Other Risks

Though considerably less significant than the risk from storm surge, other moderate climate change risks do exist going forward for Southern Brooklyn. For example, increased precipitation and heavy downpours may overwhelm sewer systems, a phenomenon that already occurs today in some areas. Heavy rain events also could result in additional localized flooding.

While future projections for changes in wind speeds are not available from the NPCC, a greater frequency of intense hurricanes by the 2050s could present a greater risk of high winds in the New York area, which could result in downed overhead powerlines and trees, and potentially damage older buildings not constructed to modern wind standards. Heat waves may also strain power systems.

Because much of its land lies at least several feet above sea level, most of Southern Brooklyn is not expected to be threatened by sea level rise alone, under typical conditions, and in the absence of extreme weather events. However, isolated low-lying areas may experience increased regular tidal flooding. Higher average temperatures outside of the increase in the number of heat waves are not expected to have meaningful impacts on the area.

Coney Island Creek

Credit: Charles Denson/ Coney Island History Project

Priorities from Public Engagement in Southern Brooklyn

Southern Brooklyn community outreach workshop

Since the Special Initiative for Rebuilding and Resiliency (SIRR) was launched in December 2012, the input of local stakeholders has helped shape an understanding of what happened during Sandy, what risks Southern Brooklyn faces in relation to climate change, and what approaches make sense to address these risks.

Southern Brooklyn is represented by a wide array of elected officials at the Federal, State, and local levels. It is also represented by three community boards. The area is further served by a large number of community-based organizations, civic groups, faith-based organizations, and other neighborhood stakeholders. All played an important role in relief and recovery efforts after Sandy. Throughout the process of developing this plan, SIRR staff benefited from numerous conversations—both formal and informal—with these groups and individuals, including, in Southern Brooklyn, two task forces that met regularly.

SIRR also held two public workshops in March of 2013 in Southern Brooklyn, part of a series of such workshops held citywide in which over 1,000 New Yorkers participated to discuss issues affecting their neighborhoods and communicate their priorities for the future of their homes and communities. Generally, the on-the-ground insights provided at these public workshops helped SIRR staff to develop a deeper understanding of the specific priorities of, and challenges facing, the communities of Southern Brooklyn.

Overall, out of the various task force and other meetings and public workshops attended by SIRR staff since January, several priorities for SIRR clearly emerged:

Task Force	Briefing Frequency	# of stakeholders from Southern Brooklyn
Elected Officials	Monthly	• 11 City, State, Federal elected officials
Community-Based Organizations	4 - 6 weeks	• 3 community boards • 40+ faith-based, business, and community organizations

- Providing additional coastal/shoreline protection from wave action, beach erosion, and oceanfront vulnerabilities
- Adding protection from "back-door" inundation that can lead to flooding of inland areas.
- Focusing on infrastructure inadequacy, particularly drainage
- Improving communication, which was hindered after the storm
- Addressing the lagging recovery of some neighborhood services and commercial corridors

Coastal Protection

Selected Citywide Measures

- **A** Continue to work with the USACE to complete emergency beach nourishment in Coney Island
- **B** Install armored stone shoreline protection (revetments) in Coney Island
- **C** Complete emergency bulkhead repairs adjacent to the Belt Parkway in Southern Brooklyn
- **D** Continue to work with the USACE to complete its Plumb Beach breakwater and beach nourishment project in Southern Brooklyn
- **E** Continue to work with the USACE to complete its Sea Gate project in Southern Brooklyn

* For additional Coastal Protection initiatives, see Coastal Protection section of Community Plan

- **1** Call on and work with the USACE to study additional Sea Gate oceanfront protection
- **2** Continue to work with the USACE to study strengthening the Coney Island/Brighton Beach nourishment
- **3** Call on and work with the USACE to study Manhattan Beach oceanfront protections
- **4** Call on and work with the USACE to study mitigating inundation risks through Rockaway Inlet, exploring a surge barrier and alternative measures
- **5** Develop an implementation plan and preliminary designs for new Coney Island Creek wetlands and tidal barrier

Buildings

Selected Citywide Measures

- **F** Improve regulations for flood resiliency of new and substantially improved buildings in the 100-year floodplain
- **G** Rebuild and repair housing units destroyed and substantially damaged by Sandy
- **H** Study and implement zoning changes to encourage retrofits of existing buildings and construction of new resilient buildings in the 100-year floodplain
- **I** Amend the Building Code and complete studies to strengthen wind resiliency for new and substantially improved buildings
- **J** Encourage existing buildings in the 100-year floodplain to adopt flood resiliency measures through an incentive program and targeted mandate
- **K** Retrofit public housing units damaged by Sandy and increase future resiliency of public housing
- **L** Launch a sales tax abatement program for flood resiliency in industrial buildings
- **M** Clarify regulations relating to the retrofit of landmarked structures in the 100-year floodplain
- **N** Amend the Building Code to improve wind resiliency for existing buildings and complete studies of potential retrofits

* For additional Buildings initiatives, see Buildings section of Community Plan

- **6** Study additional resiliency initiatives for ground-floor housing within NYCHA buildings

Critical Infrastructure

Selected Citywide Measures

- **O** Work with utilities and the Public Service Commission (PSC) to harden key electric transmission and distribution infrastructure against flooding
- **P** Work with utilities and the PSC to harden vulnerable overhead lines against winds
- **Q** Work with utilities, regulators, and gas pipeline operators to harden the natural gas system against flooding
- **R** Require the retrofitting of existing hospitals in floodplains
- **S** Support the HHC's efforts to protect public hospital emergency departments from flooding
- **T** Require retrofitting of nursing homes in floodplains
- **U** Require retrofitting of adult care facilities in floodplains
- **V** Reconstruct and resurface key streets damaged by Sandy
- **W** Elevate traffic signals and provide backup electrical power
- **X** Call on non-City transportation agencies to implement strategies to address climate change threats
- **Y** Expand the city's Select Bus Service (SBS) network
- **Z** Restore city beaches
- **AA** Harden or otherwise modify shoreline parks to protect adjacent communities
- **BB** Harden wastewater treatment plants
- **CC** Reduce combined sewer overflow with Green Infrastructure

* For additional Critical Infrastructure initiatives, see Critical Infrastructure sections of Community Plan

- **7** Support CUNY launch of study and pilot of new technologies for high-rise buildings
- **8** Study options to ensure resiliency of private cogeneration facilities in the area
- **9** Construct new Coney Island Hospital outpatient clinic to replace the destroyed Ida G. Israel facility
- **10** Call for the USACE to develop an implementation plan for the reinforcement of existing Belt Parkway edge protections
- **11** Restore recreational infrastructure along Southern Brooklyn beaches
- **12** Complete planned drainage improvements in Coney Island to mitigate flooding
- **13** Provide technical assistance to support Sea Gate in repairing Sandy-damaged infrastructure

Community & Economic Recovery

Selected Citywide Measures

- **DD** Launch business recovery and resiliency programs
- **EE** Launch Neighborhood Game-Changer Competition
- ↔ Call for Neighborhood Retail Recovery Program
  - Brighton Beach Ave.
  - Coney Island, including Neptune, Mermaid, and Surf Avenues
  - Coney Island Ave.
  - Emmons Ave.
  - Gerritsen Ave.
  - Nostrand Ave.
  - Ocean Ave.
  - Sheepshead Bay Rd.
- **FF** Support local merchants in improving and promoting local commercial corridors
- **GG** Continue to support the FRESH program to increase the number of full-line grocers in underserved neighborhoods

- **14** Work with Brooklyn Chamber of Commerce to assist in organizing Sheepshead Bay businesses
- **15** Support area recovery through the rebuilding and expansion of the entertainment district
- **16** Study opportunities along Coney Island Creek to generate economic activity and facilitate resiliency investments
- **17** Implement planned and ongoing investments by the City and private partners
  - Calvert Vaux Park
  - The West 8th Street Access Project
  - Coney Island Commons and YMCA
  - Coney Island Comprehensive Plan

This chapter contains a series of initiatives that are designed to mitigate the impacts of climate change on Southern Brooklyn. In many cases, these initiatives are both ready to proceed and have identified funding sources assigned to cover their costs. With respect to these initiatives, the City intends to proceed with them as quickly as practicable, upon the receipt of identified funding.

Meanwhile, in the case of certain other initiatives described in this chapter, though these initiatives may be ready to proceed, they still do not have specific sources of funding assigned to them. In Chapter 19 (*Funding*), the City describes additional funding sources, which, if secured, would be sufficient to fund the full first phase of projects and programs described in this document over a 10-year period. The City will work aggressively on securing this funding and any necessary third-party approvals required in connection therewith (i.e., from the Federal or State governments). However, until such time as these sources are secured, the City will only proceed with those initiatives for which it has adequate funding.

Southern Brooklyn Community Rebuilding and Resiliency Plan

Southern Brooklyn is an historic area containing some of New York City's most iconic attractions and unique neighborhoods. The area benefits from unparalleled access to a beautiful beach, the waterfront, and a network of public parks.

The following is a multilayered plan that not only applies citywide strategies to Southern Brooklyn, but also provides strategies designed to address the area's specific needs and particular vulnerabilities. In anticipation of future climate change-related risks, this plan proposes ways that Southern Brooklyn neighborhoods can adapt by: addressing wave action and inundation along the entire coastline; providing opportunities to retrofit the area's most vulnerable building stock while exploring potential redevelopment over time in certain neighborhoods; protecting and improving critical infrastructure; and focusing investments in strategic areas, such as the beachfront, to advance a long-term and sustainable recovery.

Coastal Protection

As Sandy illustrated, the greatest extreme weather-related risk faced by New York City is storm surge, the effects of which are likely to increase given current projections of sea level rise. Going forward, it is anticipated that climate change will render coastal regions of the city, including Southern Brooklyn, even more vulnerable to these risks.

While it is impossible to eliminate the chance of flooding in coastal areas, the City will seek to reduce its frequency and effects—mitigating the impacts of sea level rise, storm waves including erosion, and inundation on the coastline of the city generally and Southern Brooklyn in particular. Among the strategies that the City will use to achieve these goals will be the following: increasing coastal edge elevations; minimizing upland wave zones; protecting against storm surge; and improving coastal design and governance. When evaluating coastal protection, other priorities including navigation and ongoing efforts to improve water quality and natural habitats, also will be considered prior to implementation, where appropriate.

The initiatives described below provide important examples of how the City intends to advance its coastal protection agenda citywide. These initiatives will have a significant impact on the residents, businesses, and nonprofits of Southern Brooklyn. Taken together, when completed, the first six coastal protection initiatives described below would provide enhanced protection for nearly 1,000 buildings in Southern Brooklyn, representing nearly 12,000 housing units as well as many businesses and much of the critical infrastructure in Southern Brooklyn. For a full explanation of the following initiatives and a complete description of the City's comprehensive coastal protection plan, please refer to Chapter 3 (*Coastal Protection*).

Coastal Protection Initiative 1
Continue to work with the USACE to complete emergency beach nourishment in Coney Island

Though the beach at Coney Island helped to protect adjacent neighborhoods from some of the impacts of Sandy's surge, doing so came at the cost of significant beach erosion. The City, therefore, will support emergency beach nourishment work from Corbin Place to West 37th Street. The initiative will replace approximately 1 million cubic yards of sand, which replaces sand lost during Sandy and will restore the beach to its original design profile. As part of this initiative, the City and USACE will develop a plan for ongoing beach maintenance to ensure future events can be followed quickly by restoration of lost sand. The project will begin in July with completion expected by the end of 2013.

Coastal Protection Initiative 4
Install armored stone shoreline protection (revetments) in Coney Island

During Sandy, Coney Island Creek was the source of much of the "backdoor" flooding in Southern Brooklyn. Subject to available funding, the City, therefore, will raise the lowest edge elevations with revetments along Coney Island Creek to a consistent grade. The City, through the Office of Long-Term Planning and Sustainability (OLTPS) and the New York City Economic Development Corporation (NYCEDC), will begin design in 2013 with completion expected within three years.

Coastal Protection Initiative 6
Raise bulkheads in low-lying neighborhoods to minimize inland tidal flooding

Bulkheads provide the first line of defense against flooding in many neighborhoods, including Southern Brooklyn, but throughout the city many bulkheads are built to an elevation that may be insufficient given the latest projections of sea level rise by 2050. Subject to available funding, the City, therefore, will launch a program to raise bulkheads and other shoreline structures across the five boroughs in low-lying areas most at risk of daily or weekly tidal flooding, a phenomenon that could impact over one mile of Southern Brooklyn's shoreline by the 2050s. OLTPS will work with NYCEDC to manage this program, to begin implementation in 2013, in conjunction with the new citywide waterfront inspections program described in Chapter 3.

Coastal Protection Initiative 7
Complete emergency bulkhead repairs adjacent to the Belt Parkway in Southern Brooklyn

Several critical bulkheads along the Belt Parkway failed during Sandy, leaving several portions of the roadway exposed and vulnerable to future extreme weather. The City, through DPR, therefore will complete bulkhead repairs in areas damaged during Sandy, including at 14th Avenue, 17th Avenue and 95th Street. These repairs will enhance protection during this year's hurricane season. These repairs are expected to be completed in 2013.

Coastal Protection Initiative 16
Continue to work with the USACE to complete its Plumb Beach breakwater and beach nourishment project in Southern Brooklyn

Shortly before Sandy's arrival, the USACE completed the first phase of a beach nourishment project at Plumb Beach, along the Belt Parkway. The project provided critical protection to the Parkway during the storm. The City, therefore, will support completion of the second phase of this existing project. The second phase will include additional nourishment and construction of an offshore breakwater. It is expected to be completed in 2014.

Coastal Protection Initiative 18
Continue to work with the USACE to complete its Sea Gate project in Southern Brooklyn

Sea Gate has very little coastal protection. As a result, during Sandy, the neighborhood sustained significant damage. The City, therefore, will support construction of groins in this neighborhood. These offshore structures are primarily intended to protect the terminal groin at West 37th Street, but also will provide a first line of protection to the neighborhood against some of the impacts of inundation and destructive wave action. This project is expected to be completed by 2014.

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Beyond the priority coastal protection projects described in Chapter 3, including those summarized briefly above, the City is proposing additional coastal protection initiatives specific to Southern Brooklyn's vulnerabilities. These initiatives are described below.

Southern Brooklyn Initiative 1
Call on and work with the USACE to study additional Sea Gate oceanfront protection

As described above, Sea Gate is highly vulnerable to wave action risks. This is due in part to the neighborhood's decision not to participate in the USACE replenishment project of the mid-1990s as a result of concerns relating to public access required in connection with the receipt of Federal funding. The City will call for the USACE to develop an implementation plan for additional protection measures at Sea Gate to address these lingering vulnerabilities. While the groin project referenced above will provide needed shoreline protection in the near-term, in developing its implementation plan, the USACE should investigate whether additional beach nourishment extending west of the existing West 37th Street jetty to Norton's Point and development of a reinforced sea wall or dune system on the coastal edge of Gravesend Bay may be appropriate. To obtain Federal funding for protective measures, the Sea Gate Association, which is the predominant owner of oceanfront property in the area, will likely be required to provide public access to the community's beaches. The goal is for USACE to begin work on this plan as part of its continuing studies of flood risk reduction in New York City, based on the recommendations of this report.

Southern Brooklyn Initiative 2
Continue to work with the USACE to study strengthening the Coney Island/Brighton Beach nourishment

While immediate restoration of these beaches to pre-storm conditions with sand replacement and reshaping is critical, rising sea levels and more frequent storm surge demands more protection, focused first on areas of the beach (such as that at the end of Ocean Parkway) that were breached in the recent storm. The City will call on the USACE to develop an implementation plan containing options for strengthening the protections offered by these beaches. Additional measures could include structured dune systems, seasonal installation of "snow-fencing" to control sand and sediment migration, and potential reinforcement or extension of existing groins. Working with DPR, the USACE should also explore such protective measures as part of its current comprehensive study. Certain low-cost interventions—such as temporary fencing—may be pursued or piloted by DPR in the near-term. The goal is for the USACE to begin work on this plan as part of its continuing studies of flood risk reduction in New York City, based on the recommendations of this report.

Southern Brooklyn Initiative 3
Call on and work with the USACE to study Manhattan Beach oceanfront protections

In Manhattan Beach, an historic esplanade has been the subject of an ownership dispute and was not repaired following a 1993 nor'easter, leaving waterfront properties and the neighborhood behind them vulnerable, therefore, to Sandy's pounding waves. The City will call on the USACE to develop an implementation plan containing options for reinforcing protections along the Manhattan Beach waterfront from Corbin Place to Kingsborough Community College at the eastern tip of the Coney Island peninsula. The City will encourage private waterfront property owners to engage with the USACE and consider participating in the implementation of such protections. New or reinforced ocean-facing protections—such as sea walls, bulkheads and revetments—would serve to protect ocean-facing structures and homes from waves and upland areas from inundation. The Federal government would likely require public waterfront access in order to support additional oceanfront protections. The goal is for the USACE to begin work on this plan as part of its comprehensive study of flood risk reduction in New York City, based on the recommendations of this report.

Southern Brooklyn Initiative 4
Call on and work with the USACE to study mitigating inundation risks through Rockaway Inlet, exploring a surge barrier and alternative measures

Much of the flood damage from Sandy in the neighborhoods of Brooklyn and Queens that face Jamaica Bay came from water that flowed through Rockaway Inlet into the Bay. The extensive shoreline that surrounds Jamaica Bay supports a variety of land uses and densities, all of which are at risk of flooding. Because flood protection along the existing shoreline of Jamaica Bay would be extremely expensive and disruptive, and in some cases nearly impossible, the City will call on and work with the USACE to develop an implementation plan for a local storm surge barrier to be constructed across Rockaway Inlet approximately between Manhattan Beach in Brooklyn and Breezy Point in Queens. A Rockaway Inlet local storm surge barrier at this location could protect against significant inland flooding and wave risk in neighborhoods from Sheepshead Bay to Howard Beach, as well as JFK Airport, Broad Channel and the entire bayside of the Rockaway peninsula (provided that the barrier were completed in conjunction with dune enhancements along the oceanside of the

Rockaway peninsula and mitigation measures along Coney Island Creek). This project, in turn, would obviate the need for extensive localized coastal protections spread around the shoreline of the Bay. A preliminary feasibility assessment, to be performed by OLTPS in coordination with DEP, would examine impacts on water quality, habitat, hydrodynamics, and navigation, and would identify potential secondary coastline reinforcements.

The aforementioned study should also examine alternative approaches to coastal protection of the vulnerable areas behind this potential surge barrier, including localized options for protecting areas adjacent to Sheepshead Bay. Examples of alternative approaches could be the use of the elevated Belt Parkway as a levee with passive floodwalls at roadway underpasses; permanent levees along the perimeter of the Bay; and the "shallowing" of Jamaica Bay. As another alternative, the study should also examine the feasibility of a navigable or non-navigable surge barrier at Gerritsen Inlet, exploring costs and potential impacts to navigation and water quality.

The goal is for the USACE to begin work on this plan as part of its comprehensive study of flood risk reduction in New York City, based on the recommendations of this report.

Southern Brooklyn Initiative 5

Develop an implementation plan and preliminary designs for new Coney Island Creek wetlands and tidal barrier

Coney Island Creek presents a significant flood risk to Coney Island and Gravesend. Therefore, the City will develop an implementation plan and preliminary designs for a significant rethinking of the Creek that goes beyond the revetment project described above. This rethinking will include consideration of further protections, including edge-strengthening and edge-softening measures, such as wetland construction, and a potential up-creek tidal barrier or dam across the Creek to control tidal surge and improve water quality. A new levee and tide gate system could connect Calvert Vaux and Kaiser Parks. New culverts (pipes) that generally would allow normal tidal flow could be closed at low-tide in anticipation of a storm, converting the Coney Island Creek bed into a water detention basin for the surrounding neighborhoods and holding back surge. Following a weather event, the culverts could be reopened and water could drain, flushing the Creek. *(See graphic: Conceptual Coney Island Creek culvert)*

While these changes would impede future navigation of the Creek, they would also present an unprecedented opportunity to mitigate flood risks for the entire Coney Island neighborhood, for much of the Gravesend neighborhood, and for sensitive infrastructure such as the MTA's Coney Island Yards, all of which were damaged by Sandy. Additionally, the Creek protections could serve to expand recreation options and public access, potentially transforming this ill-used waterway into a major public open space amenity for Southern Brooklyn. *(See rendering: Coney Island Creek)*

The implementation plan and preliminary designs, to be advanced by OLTPS and by the USACE subject to available funding, would investigate environmental impacts and benefits, hydrology, water quality issues, permitting issues, and operational considerations. The goal is for the USACE to begin work on this plan as part of its comprehensive study of flood risk reduction in New York City, based on the recommendations of this report.

Coney Island Creek

Conceptual rendering of Coney Island Creek wetlands and tidal barrier, with Rockaway inlet barrier

Buildings

The city's buildings give physical form to New York. As Sandy demonstrated, however, the building stock citywide, including in Southern Brooklyn, is highly vulnerable to extreme weather events—a vulnerability that is expected to increase in the future. While the coastal protection measures outlined above are designed to reduce the effects of sea level rise, storm surge, and wave action on the city and Southern Brooklyn, these measures will not completely eliminate those risks. They also will take time to design, fund, and build. It is equally important, therefore, to supplement these measures by pursuing resiliency at the building level.

To achieve building-level resiliency, the City will seek to protect structures in Southern Brooklyn and throughout the five boroughs against a spectrum of climate risks, including not only flooding but also high winds and other extreme events. Among the strategies that the City will use to achieve these goals will be to construct new buildings to the highest resiliency standards and retrofit as many existing buildings as possible so that they will be significantly better prepared to handle the impacts of extreme weather events.

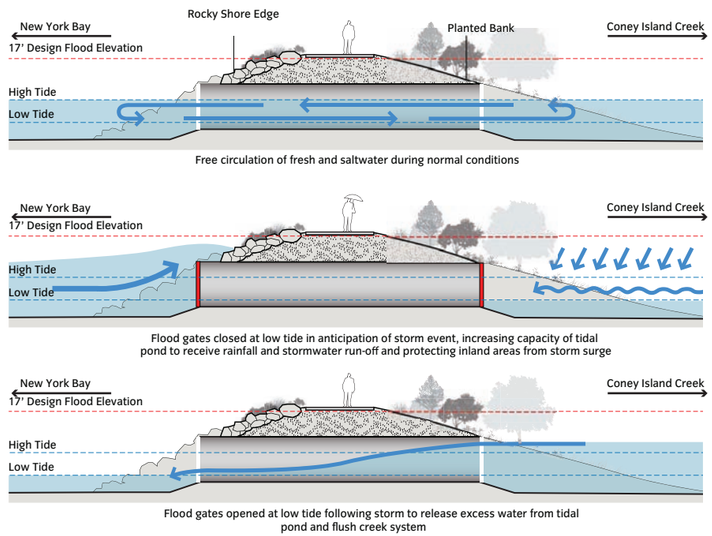
The initiatives described below provide important examples of how the City intends to advance building resiliency citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits of Southern Brooklyn. For a full explanation of the following initiatives and a complete description of the City's five-borough building resiliency plan, please refer to Chapter 4 *(Buildings)*.

Buildings Initiative 1

Improve regulations for flood resiliency of new and substantially improved buildings in the 100-year floodplain

Though buildings constructed to modern Construction Codes generally performed well during Sandy, given the increasing risk of flooding that is likely with climate change, modifications are warranted. The City, therefore, will seek to amend the Construction Codes and Zoning Resolution to provide for strengthened requirements that will, among other things, improve the design of new buildings through the application of appropriate resiliency measures that are calibrated to the best floodplain data available over time and provide that critical building systems are better-protected from flood risks. In 2013, the City, through OLTPS, will seek to implement these code changes and the Department of City Planning (DCP) will continue to take zoning changes through the public review process, with the goal of adoption before the end of the year. If adopted, they will improve resiliency for developments throughout Southern Brooklyn, including as many as 4,500 units of new housing that are permitted to be constructed in the Coney Island neighborhood pursuant to the rezoning of that neighborhood approved by the City Council and City Planning Commission in 2009.

Conceptual Coney Island Creek culvert



Buildings Initiative 2

Rebuild and repair housing units destroyed and substantially damaged by Sandy

Roughly 23,000 private residential buildings encompassing nearly 70,000 housing units were damaged or destroyed during Sandy. Subject to available funding, the City, therefore, through the Mayor's Office of Housing Recovery Operations (HRO), will provide financial and other assistance to owners of residential properties that were destroyed or substantially damaged during Sandy, including approximately 380 residential buildings encompassing approximately 1,500 housing units in Southern Brooklyn. To address the damages sustained and to more effectively prepare these significantly damaged buildings for future storm events, the City either will assist owners or, in limited cases meeting City criteria, will facilitate the acquisition of properties by new owners whom it will assist, in rebuilding and substantially improving these properties based on the best floodplain data available over time. Additionally, the City is seeking to incorporate resiliency measures into approximately 500 to 600 multifamily properties that sustained minor damage including many publicly-assisted properties such as those developed pursuant to the Mitchell-Lama program and other affordable housing programs. The City, therefore, will support the retrofit of these publicly-assisted buildings.

Buildings Initiative 3

Study and implement zoning changes to encourage retrofits of existing buildings and construction of new resilient buildings in the 100-year floodplain

The City, through DCP, will undertake a series of citywide and neighborhood-specific land use studies to address key planning issues in severely affected and vulnerable communities. As part of these studies, the City will identify ways to facilitate the voluntary construction of new, more resilient building stock, and to encourage voluntary retrofits of existing vulnerable buildings over time. To be undertaken in close consultation with local residents, elected officials, and other community stakeholders, these land use studies will focus on the challenges posed by the flood exposure of the applicable neighborhoods; the vulnerability

of the building types that are found in these neighborhoods (e.g., older, 1-story bungalows); and site conditions in these areas (e.g., narrow lots) that can make elevation or retrofit of vulnerable buildings expensive or complicated. In Southern Brooklyn, DCP will examine neighborhoods including Gerritsen Beach, exploring zoning and other land use changes that, in the future, could encourage residents, if they so choose, to make changes with respect to existing homes or build new homes that would result in significantly greater resiliency. Subject to available funding, the goal is for DCP to commence this study in 2013. Thereafter, DCP would move to implement changes, if any, that it deems to be appropriate based on the results.

Buildings Initiative 4
Launch a competition to encourage development of new, cost-effective housing types to replace vulnerable stock

Subject to available funding, the City, through the Department of Housing Preservation and Development (HPD), will launch an international Resilient Housing Design Competition. This competition will offer prizes to private-sector developers who design and develop new, high-quality housing prototypes that offer owners of vulnerable building types (e.g., older, 1-story bungalows), a cost-effective path that is consistent with city building and zoning requirements, and meet the highest resiliency standards. In addition to cash prizes, the winners of this competition will be given the opportunity to put these structures into service in connection with a City-sponsored development project. Prototypes will have applicability throughout the five boroughs, including in sections of Southern Brooklyn such as Gerritsen Beach and other vulnerable bungalow communities. The goal is for HPD to launch this competition in 2013.

Buildings Initiative 5
Work with New York State to identify eligible communities for the New York Smart Home Buyout Program

The City will evaluate opportunities for collaboration with the State in connection with its home buyout program, using an objective set of criteria developed by the City, including extreme vulnerability, consensus among a critical mass of contiguous local residents, and other relevant factors. It is anticipated that these criteria will be met in a limited number of areas citywide. As of the writing of this report, no areas have been identified for this program in Southern Brooklyn.

Buildings Initiative 6
Amend the Building Code and complete studies to strengthen wind resiliency for new and substantially improved buildings

As noted above, buildings constructed to modern Building Code standards generally performed well during Sandy. Sandy, however, brought relatively weak winds, compared to other hurricanes. Given the possibility of more frequent or intense wind events in the future, modifications to the Building Code are warranted. The City, therefore, through OLTPS, will seek to amend the Building Code to provide for strengthened requirements so that new buildings citywide can meet enhanced standards for wind resiliency. The City will further study whether additional wind resiliency standards should be required going forward. The amendments will be submitted to the City Council for adoption, and the study will commence, in 2013.

Buildings Initiative 7
Encourage existing buildings in the 100-year floodplain to adopt flood resiliency measures through an incentive program and targeted mandate

Even if every structure destroyed or damaged by Sandy were rebuilt to the highest resiliency standards, this would still leave tens of thousands of existing structures in the 100-year floodplain vulnerable—with more becoming vulnerable as the climate changes. Subject to available funding, the City, therefore, will launch a $1.2 billion program to provide incentives to owners of existing buildings in the 100-year floodplain to encourage them to make resiliency investments in those buildings. Of the up to $1.2 billion available through the program, the City will reserve up to $100 million for 1- and 2- family homes, up to $500 million for distribution to the five boroughs based on each borough's share of vulnerable buildings citywide, and $100 million for affordable housing developments. The City also will mandate that large buildings (those with seven or more stories that are more than 300,000 square feet in size) undertake certain flood resiliency investments by 2030. If the City consistently achieves its stated goal of encouraging significant resiliency retrofit investments for the vast majority of the vulnerable built floor area in the five boroughs, nearly 45,000 units encompassing approximately 55 million square feet of built space in Southern Brooklyn would, over time, be made meaningfully less vulnerable. The goal is to launch these programs in 2013.

Buildings Initiative 8
Establish Community Design Centers to assist property owners in developing design solutions for reconstruction and retrofitting, and connect them to available City programs

The City, through HRO, will establish Community Design Centers in neighborhoods across the City, potentially including Southern Brooklyn, to assist property owners in developing design solutions for reconstruction and retrofitting, and connect them to available City programs. The Centers would be managed by the City—through agencies such as HRO, HPD, DOB, DCP, and NYCEDC—with support from local partners.

Buildings Initiative 9
Retrofit public housing units damaged by Sandy and increase future resiliency of public housing

During Sandy, public housing developments owned and operated by NYCHA suffered significant damage throughout the city. Still more were not impacted by Sandy but remain vulnerable to extreme weather, with even more likely to become vulnerable as the climate changes. The City, therefore, through NYCHA, will repair public housing developments across the city that were damaged by Sandy, incorporating new flood resiliency measures. In Southern Brooklyn, 40 buildings containing over 4,000 units will be repaired. NYCHA also will undertake a planning process to identify additional resiliency investments in developments that are vulnerable to weather-related events, even if they were unaffected by Sandy. In Southern Brooklyn, NYCHA is, subject to available funding, evaluating resiliency investments in 47 buildings containing nearly 3,000 additional units.

Buildings Initiative 10
Launch a sales tax abatement program for flood resiliency in industrial buildings

As Sandy demonstrated, many industrial buildings are vulnerable to extreme weather, with more likely to become vulnerable as the climate changes. However, many industrial buildings operate on thin margins, making it challenging to invest in resiliency. The City, through the New York City Industrial Development Agency (NYCIDA), therefore, will launch a $10 million program to provide incentives to owners of industrial buildings to encourage them to make resiliency investments in those buildings. The program will prioritize 1- to 2-story buildings with more than four feet between their actual ground elevation and the applicable BFE. In Southern Brooklyn, approximately 25 industrial buildings with over 200,000 square feet of floor area will be eligible for this program. This program will be launched in 2013.

Buildings Initiative 11
Launch a competition to increase flood resiliency in building systems

Many existing strategies for improving resiliency in buildings are either imperfect, expensive, or a combination of both. The City, through NYCEDC, therefore, will launch an approximately $40 million Resiliency Technologies Competition using allocated Community Development Block Grant (CDBG) funding to encourage the development, deployment, and testing of new resiliency technologies for building systems. In Southern Brooklyn, 15,570 buildings will be eligible to benefit from this competition. The program will be launched in 2013.

Buildings Initiative 12
Clarify regulations relating to the retrofit of landmarked structures in the 100-year floodplain

The City, through the Landmarks Preservation Commission, will clarify the Commission's regulations to assist owners of landmarked buildings and properties in landmarked districts in the 100-year floodplain who are contemplating retrofit projects. In Southern Brooklyn, there are seven landmarked buildings or structures in the floodplain. The Commission will issue its clarifying regulations in 2013.

Buildings Initiative 13
Amend the Building Code to improve wind resiliency for existing buildings and complete studies of potential retrofits

As noted above, given the possibility for more frequent intense wind events in the future, modifications to the Building Code are warranted. The City, therefore, through OLTPS, will seek to amend the Building Code and expand the existing DOB Façade Inspection Safety Program for high-rise buildings to include rooftop structures and equipment. The City will further study whether additional wind resiliency standards are required going forward. These amendments will be submitted to the City Council for adoption and the study will commence in 2013.

Beyond the priority building resiliency projects described in Chapter 4, including those summarized briefly above, the City is proposing an additional building resiliency initiative that is specific to Southern Brooklyn's vulnerabilities. The initiative is described below.

Southern Brooklyn Initiative 6
Study additional resiliency initiatives for ground-floor housing within NYCHA buildings

NYCHA developments are a significant feature in Southern Brooklyn. One challenge in NYCHA's facilities is the presence of ground-floor residential units that are below the BFE, and are vulnerable to flooding. There are approximately 115 ground-floor units located in 37 NYCHA buildings in the Coney Island area.

To address this challenge, the City will explore the construction of new, resilient units in the Coney Island area to replace at-risk units. These units would be reserved for tenants of existing ground-floor units in public housing developments in Southern Brooklyn. Such a project, provided it were determined to be feasible and were funded, would include rent and occupancy protections for NYCHA residents and would allow residents to relocate into new, modern, and resilient units in their community. The study also will assess how NYCHA could best repurpose vacated ground floor units in current NYCHA buildings—exploring, for example, community or public-serving commercial uses.

The City's study will be undertaken in close consultation with the NYCHA resident community and will seek to identify new sources of capital funding and new operating resources. Such new sources of capital funding and operating resources are a necessary precondition for any project to proceed. The study will be completed by early 2014.

Insurance

Insurance can help provide residents and businesses with financial protection against losses from climate change and other types of risks. Sandy not only highlighted the importance of insurance, it also revealed that many New Yorkers are exposed to flood losses, which are not covered in standard homeowners or small business property insurance policies. Citywide, 95 percent of homeowners carry homeowners insurance, but when Sandy struck less than 50 percent of residential buildings in the effective 100-year floodplain had coverage through the National Flood Insurance Program (NFIP), a Federal program administered by FEMA that provides flood insurance to properties in participating communities like New York City. While larger properties, in particular large commercial properties, tend to purchase flood insurance through the private market, NFIP is the primary source of flood insurance for homeowners throughout the country. The City estimates that in areas of Southern Brooklyn inundated by Sandy, less than 17 percent of residential properties typically insured under the NFIP, including 1- to 2-family homes, amongst others, actually had policies in force during Sandy. Furthermore, Sandy drew attention to the significant cost increases in flood insurance that many New Yorkers will soon face, resulting from recent reforms to the NFIP as required by the Biggert-Waters Flood Insurance Reform Act.

The City will use several strategies to encourage more New Yorkers to seek coverage and to help the NFIP meet the needs of policyholders citywide. Specifically, the City will work to: address affordability issues for the most financially vulnerable policyholders; define mitigation measures that are feasible in an urban environment such as Southern Brooklyn and create commensurate premium credits to lower the cost of insurance for property owners who invest in these measures; encourage the NFIP to expand pricing options (including options for higher deductibles) to give potential policyholders more flexibility to make choices about coverage; and launch efforts to improve consumer awareness, to help policyholders make informed choices. The initiatives described below are important examples of how the City will advance these strategies. These initiatives will have a major impact on the residents, small businesses and nonprofits in this community. For a full explanation of the following initiatives and a complete description of the City's five-borough insurance reform plan, please refer to Chapter 5 (*Insurance*).

Insurance Initiative 1
Support Federal efforts to address affordability issues related to reform of the NFIP

The City will call on FEMA to work with the National Academy of Sciences to complete the study of flood insurance affordability, as required under the Biggert-Waters Act. The City will urge its Federal government partners to comply with this provision of the Act and take swift action to enact the recommendations.

Insurance Initiative 4
Call on FEMA to develop mitigation credits for resiliency measures

The NFIP provides few incentives for property owners to protect their buildings from flood damage and reduce their premiums, other than by elevating their buildings—actually lifting structures above flood elevation levels. In an urban environment such as Southern Brooklyn, for a variety of reasons, elevation can be impractical, undesirable, and/or economically

infeasible. Fortunately, other mitigation options are available. The City, therefore, will call upon FEMA to provide appropriate premium credits for mitigation measures other than elevation.

Insurance Initiative 6
Call on FEMA to allow residential policyholders to select higher deductibles

Flexible pricing options can encourage more people, especially those not required to carry insurance, to purchase insurance coverage that suits their needs. A higher-deductible option can substantially reduce premium costs to policyholders while remaining truly risk-based. Currently under the NFIP, deductibles up to $50,000 are allowed for commercial policies, but residential policies are limited to a maximum deductible of $5,000. The City, therefore, will call upon FEMA to allow homeowners that are not required to carry NFIP policies to purchase high-deductible policies, protecting them from catastrophic loss; initial estimates indicate that doing so could reduce insurance premiums by about half.

Critical Infrastructure

A resilient New York requires protection of its critical services and systems from extreme weather events and the impacts of climate change. This infrastructure includes the city's utilities and liquid fuel system, its hospitals and other healthcare facilities, telecommunications network, transportation system, parks, wastewater treatment and drainage systems, as well as other critical networks—all vital to keeping the city, including Southern Brooklyn, running.

Utilities

The city's electric, natural gas, and steam systems are essential to everyday life in areas throughout the five boroughs, including Southern Brooklyn. As Sandy proved, however, these systems are highly vulnerable to extreme weather events with 800,000 customers losing electricity and 80,000 customers losing natural gas service during Sandy across the city, including approximately 160,000 that lost electricity service in the borough of Brooklyn. This vulnerability will only grow as the climate changes.

Among the strategies that the City will use to address these challenges for residents of Southern Brooklyn and other parts of the city will be to: call for risk-based analysis of low-probability but high-impact weather events to be incorporated into utility regulation and investment decision-making; call for capital investments that harden energy infrastructure and make systems more flexible in responding to disruptions and managing demand; and better diversify the city's sources of energy. The initiatives described below provide important examples of how the City intends to advance utilities resiliency citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits of Southern Brooklyn. For a full explanation of the following initiatives and a complete description of the City's five-borough utilities resiliency plan, please refer to Chapter 6 (*Utilities*).

Utilities Initiative 5
Work with utilities and the Public Service Commission (PSC) to harden key electric transmission and distribution infrastructure against flooding

Various transmission substations, distribution substations, utility tunnels, and underground equipment in the city are at risk of flooding during extreme weather. For example, 40 percent of transmission substations are in the 100-year floodplain today, and 67 percent are likely to be in the 100-year floodplain by the 2050s. The City, through OLTPS, will work with Con Edison and the Long Island Power Authority (LIPA) to prioritize these assets based on their roles in system reliability and to harden them as appropriate. This effort will begin in 2013.

Utilities Initiative 6
Work with utilities and the PSC to harden vulnerable overhead lines against winds

During extreme weather events, high winds and downed trees threaten overhead electric poles, transformers, and cables. The City, through OLTPS, will work with Con Edison and LIPA to manage the risk of wind and downed-tree damage through tree maintenance, line strengthening, and a line-relocation program. In some limited cases, rerouting lines underground may also be warranted, depending on the outcome of a cost-benefit analysis to be performed in partnership with the utilities. This effort will begin in 2013.

Utilities Initiative 7
Work with utilities, regulators, and gas pipeline operators to harden the natural gas system against flooding

Although the city's high-pressure gas transmission system performed relatively well during Sandy, there were instances where remote operation of parts of the system failed. Additionally, the distribution system had localized outages due to water infiltration. Seeking to limit the compromising effects of future floods on both the system's backbone and the ability of Con Edison and National Grid to control and monitor the system, the City, through OLTPS, will work with the PSC, Con Edison, and National Grid to harden control equipment against flooding. In addition, the City will call upon Con Edison and National Grid to take steps to prevent water from infiltrating its gas pipes. This effort will begin in 2013.

Utilities Initiative 21
Work with public and private partners to scale up distributed generation (DG), including microgrids

The city's DG systems, including microgrids, have the potential for significant expansion—but are constrained by regulations, financing challenges, and lack of information. The City, through OLTPS and the New York City Distributed Generation Collaborative—a stakeholder group convened by the City in 2012—will continue efforts to achieve a PlaNYC goal of installing 800 megawatts of DG citywide by 2030. These efforts will include reform of PSC tariffs and other regulatory changes, expansion of low-cost financing, and provision of technical assistance to property owners and developers. This ongoing effort will continue in 2013.

Beyond the priority utilities resiliency projects described in Chapter 6, including those summarized briefly above, the City is proposing additional utilities resiliency initiatives that are specific to Southern Brooklyn's vulnerabilities. These initiatives are described below.

Southern Brooklyn Initiative 7
Support CUNY launch of study and pilot of new technologies for high-rise buildings

The City University of New York's Building Performance Lab intends to launch a study and pilot program in Southern Brooklyn to place backup renewable energy systems and on-site renewable energy generation at high-rise residential buildings, in part to aid resiliency. The City will provide technical assistance, as needed, for CUNY's study and the eventual launch. Such technologies may provide building-specific solutions for energy resiliency and help ease pressures on the grid in times of peak demand, while also producing cost savings for the relevant consumers. The CUNY Building Performance Lab will advance this study and pilot in the next two years.

Southern Brooklyn Initiative 8
Study options to ensure resiliency of private cogeneration facilities in the area

Several residential and commercial developments in Southern Brooklyn have on-site private cogeneration facilities that supply energy to certain buildings. Many of these facilities were damaged during the recent storm, and are vulnerable to future extreme weather events. The City, through OLTPS, will explore changes to the Construction Codes or other regulations to ensure proper protection measures are in-place at these facilities. This effort will begin with a study of cogeneration facilities and their vulnerabilities.

Liquid Fuels

The liquid fuel supply chain is essential for everyday life throughout the five boroughs, including in Southern Brooklyn. Sandy demonstrated the vulnerability of this system to extreme weather events. In the aftermath of Sandy, citywide—and particularly in Southern Brooklyn—there were long lines at gas stations and other challenges for drivers, including emergency responders. The vulnerability of this system will only grow as the climate changes.

Among the strategies that the City will use to address these challenges for residents of Southern Brooklyn and other parts of the city will be to: develop a strategy for the hardening of liquid fuels infrastructure along the supply chain; increase redundancy and fuel supply flexibility; and increase supply availability for vehicles critical to the city's infrastructure, safety, and recovery from significant weather events. The initiatives described below provide important examples of how the City intends to advance its liquid fuel resiliency agenda citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits of Southern Brooklyn. For a full explanation of the following initiatives and a complete description of the City's five-borough liquid fuels resiliency plan, please refer to Chapter 7 (*Liquid Fuels*).

Liquid Fuels Initiative 1
Call on the Federal government to convene a regional working group to develop a fuel infrastructure hardening strategy

The fuel supply shortage after Sandy was caused mainly by damage to infrastructure in New Jersey and other states, where the City and State of New York have no regulatory or legislative authority or oversight. The City, through OLTPS, will call on the Federal Hurricane Sandy Rebuilding Task Force and the United States Department of Energy to convene regional stakeholders to develop a strategy for hardening key infrastructure against future extreme weather. This effort will be launched in 2013.

Liquid Fuels Initiative 4
Work with New York State to provide incentives for the hardening of gas stations to withstand extreme weather events

New York State's 2013–2014 budget required that certain retail fuel stations invest in equipment that would allow them to connect generators quickly in the event of a power loss, and enter into supply contracts for emergency generators. The City, through OLTPS, will support the State in the design and implementation of this generator program, an effort that will include working with the New York State Energy Research and Development Authority (NYSERDA) to develop an incentive program to minimize the financial impact of the requirements on the businesses involved. In addition, OLTPS will work with the State to develop incentives to encourage retail fuel stations to implement resiliency measures other than backup power capability. This effort will be launched in 2013.

Liquid Fuels Initiative 5
Enable a subset of gas stations and terminals have access to backup generators in case of widespread power outages

Gas stations are vulnerable to widespread power outages resulting from extreme weather events, which could prevent them from dispensing fuel. In New York State's 2013–2014 budget, NYSERDA was directed to develop a generator pool program for gas stations. The City, through its Office of Emergency Management (OEM), will work with NYSERDA, FEMA, and the USACE in 2013 and beyond to develop such a pool and to create a pre-event positioning plan to enable the ready deployment of generators to impacted areas in the wake of a disaster.

Liquid Fuels Initiative 8
Develop a package of City, State, and Federal regulatory actions to address liquid fuel shortages during emergencies

Various regulations relating to the transportation and consumption of fuels in New York City limit the flexibility of the market to respond to disruptions, including following extreme weather events. The City, through OEM, will work with the State and Federal governments to prepare an "off-the-shelf" package of regulatory measures for use in the event of a liquid fuels shortage to allow supply-demand imbalances in the fuel supply to be mitigated more quickly. This effort will be launched in 2013.

Liquid Fuels Initiative 9
Harden municipal fueling stations and enhance mobile fueling capability to support both City government and critical fleets

The City must be able to respond quickly to a fuel supply disruption, providing continuous fueling to vehicles that are critical for emergency response, infrastructure rebuilding, and disaster relief. The City, through the Department of Citywide Administrative Services (DCAS), will procure fuel trucks, generators, light towers, forklifts, and water pumps to permit the City to put in place emergency fueling operations immediately following a disruption in the fuel supply chain. DCAS also will issue a Request for Expressions of Interest (RFEI) to potential suppliers of liquid fuels to evaluate options for sourcing such fuel during emergencies. The procurement effort will be launched in 2013, with the RFEI to follow in 2014.

Healthcare

The city's healthcare system is critical to the well-being of New Yorkers throughout the five boroughs, including in Southern Brooklyn. This system is also a major economic engine for the city as a whole. This is especially true for Southern Brooklyn, where a major New York City Health and Hospitals Corporation (HHC) hospital, numerous nursing homes and adult care facilities, and a network of community-based facilities, doctors' offices, and pharmacies support the local area. Sandy exposed this system's vulnerabilities, which are expected to grow as the climate changes.

Among the strategies that the City will use to address these challenges for residents of Southern Brooklyn and other parts of the city will be to: build new hospitals, nursing homes, and adult care facilities to higher resiliency standards and harden existing facilities to protect critical systems; seek to keep lines of communication open between patients and providers, even during extreme weather events; and enable community-based providers to reopen quickly after a disaster. The initiatives described below provide important examples of how the City intends to advance its healthcare resiliency agenda citywide. These initiatives will have a positive impact on the residents and healthcare providers of Southern Brooklyn. For a full explanation of the following initiatives and a complete description of the City's five-borough healthcare resiliency plan, please refer to Chapter 8 (*Healthcare*).

Healthcare Initiative 2
Require the retrofitting of existing hospitals in floodplains

Many existing hospital buildings in the floodplain remain vulnerable to the impact of storm surge, with more likely to become vulnerable as the climate changes. The City, through OLTPS, therefore, will seek to amend the Construction Code to require existing hospital buildings in the 500-year floodplain—including Coney Island Hospital—to meet by 2030 a subset of the amended Construction Code standards for flood-resistant design. To minimize the risk of emergency evacuations and extended closures, these hospitals will be required to protect their electrical equipment, emergency power system, and domestic water pumps to the 500-year flood elevation. These hospitals also will be required to install backup air-conditioning service for inpatient care areas in case of utility outages, pre-connections for temporary boilers and chillers if primary equipment is not elevated, and pre-connections for external generators as a backup power source. Coney Island Hospital already has begun exploring a number of these and other flood mitigation measures as part of its post-Sandy rebuilding process. OLTPS will propose these requirements to the City Council in 2013.

Healthcare Initiative 3
Support the HHC's efforts to protect public hospital emergency departments from flooding

Emergency departments (EDs) are critical access points for patients in need of hospital services, and at three public hospitals citywide—including Coney Island Hospital—EDs are at risk of flooding due to storm surge. Subject to available funding, the City, therefore, through HHC, will invest in measures to flood-protect these vulnerable EDs so they can remain available to provide care during extreme weather events. HHC has already begun exploring strategies to protect their EDs and will continue to develop their mitigation plans through 2013.

Healthcare Initiative 4
Improve design and construction of new nursing homes and adult care facilities

New nursing homes and adult care facilities are at risk of power failures due to storm surge, which could result in patient evacuations. The City, through OLTPS, therefore, will seek to amend the Construction Codes to require that new facilities are constructed with additional resiliency measures for their emergency power systems. New nursing homes also will be required to have emergency generators and electrical pre-connections for external stand-by generators. Adult care facilities will be required to install either emergency generators that are adequately protected or pre-connections to external stand-by generators. OLTPS will propose these requirements to the City Council in 2013.

Healthcare Initiative 5
Require retrofitting of nursing homes in floodplains

Many existing nursing home facilities in the five boroughs are vulnerable to storm surge—a vulnerability that will only grow as the climate changes. The City, through OLTPS, therefore, will seek to amend the Construction Codes to require nursing homes in the 100-year floodplain—including five facilities in Southern Brooklyn—to meet standards for the protection of electrical equipment, emergency power systems, and domestic water pumps (if applicable) by 2030. These systems will be protected to the 100-year flood elevation, in accordance with specifications already in the Construction Codes, and will help enable patients to shelter in place safely or reoccupy quickly after a storm. OLTPS will propose these requirements to the City Council in 2013.

Healthcare Initiative 6
Require retrofitting of adult care facilities in floodplains

Nineteen adult care facilities in the city are vulnerable to storm surge, including six in Southern Brooklyn alone. The City, through OLTPS, will seek to amend the Construction Codes to require existing adult care facilities located in the floodplain to elevate or protect their electrical equipment to the 100-year flood elevation by 2030, in accordance with the specifications in the Construction Codes. In addition, the City will seek to require these providers to have either emergency generators that are adequately protected or electrical pre-connections to external generators. OLTPS will propose these requirements to the City Council in 2013.

Healthcare Initiative 7
Support nursing homes and adult care facilities with mitigation grants and loans

The primary challenge for most nursing homes and adult care facilities in implementing mitigation measures is obtaining financing. Subject to available funding, the City, through NYCEDC and the New York City Department of Health and Mental Hygiene (DOHMH), therefore, will administer competitive grants and subsidized loans to assist providers with mandated retrofit projects. The goal is for NYCEDC and DOHMH to launch the program when proposed Construction Code amendments applicable to nursing homes and adult care facilities proposed in this report go into effect, likely in 2013.

Healthcare Initiative 8
Increase the air conditioning capacity of nursing homes and adult care facilities

Nursing homes and adult care facilities typically do not have enough emergency power capacity to run their air conditioning systems following the loss of power. This could cause some providers to evacuate during power outages that occur during hot summer months. The City will offer sales tax waivers totaling $3 million citywide to assist eligible nursing homes and adult care facilities that install emergency power solutions for air conditioning systems.

Healthcare Initiative 9
Harden primary care and mental health clinics

In communities such as Southern Brooklyn that are at risk of extensive flooding during extreme weather events, primary care and mental health services may be compromised for weeks after a disaster due to extended facility closures. Subject to available funding, the City, through DOHMH and a fiscal intermediary, therefore, will administer a competitive financing program to harden large clinics providing primary care and mental health services in Southern Brooklyn and other high-need communities. The program will include grants and interest-free loans for capital investments that enable faster recovery of services—for example, installation of emergency power systems, protection of other critical building systems, and wet flood-proofing of facilities. The goal is for this effort to be launched in late 2013 or early 2014.

Healthcare Initiative 10
Improve pharmacies' power resiliency

Pharmacies dispense life-saving medicines essential for those with chronic conditions. However, without power, pharmacists cannot access the necessary patient records or insurance information to dispense these medicines. The City, through DOHMH, will work with pharmacies to improve their ability to leverage generators for power resiliency and address their other emergency preparedness needs—including the launch of an emergency preparedness website for pharmacies. This effort already has begun and will continue throughout 2013.

Healthcare Initiative 11
Encourage telecommunications resiliency in the healthcare system

In the aftermath of a disaster, it is important that New Yorkers be able to speak to their doctors for guidance on needed medical care. The City, through DOHMH, therefore, will develop a best practice guide and outreach plan to help community-based providers understand the importance of telecommunications resiliency. Resiliency solutions could include using backup phone systems (such as a remote answering service that would not be affected by local weather hazards), Voice over Internet Protocol (VoIP) technology that allows office phone lines to be used off-site, and pre-disaster planning to inform patients of available emergency phone numbers. This effort will begin in 2013.

Healthcare Initiative 12
Encourage electronic health record-keeping

Doctors rely on patients' medical records to provide and track care, but paper records may be compromised or destroyed due to extreme weather events. The City, through existing DOHMH programs, therefore, will call upon community-based providers located in the 100-year floodplain and other disaster-prone areas to implement electronic health records (EHR) systems for resiliency. DOHMH's Primary Care Information Project will sponsor initiatives to provide primary care and mental health providers citywide with EHR technical assistance. This effort will begin in 2013.

Beyond the priority healthcare resiliency projects described in Chapter 8, including those summarized briefly above, the City is proposing an additional healthcare resiliency initiative that is specific to Southern Brooklyn's vulnerabilities. This initiative is described below.

Southern Brooklyn Initiative 9
Construct new Coney Island Hospital outpatient clinic to replace the destroyed Ida G. Israel facility

Hurricane Sandy wreaked havoc on Coney Island Hospital's outpatient facility, the Ida G. Israel Clinic, which was located north of Neptune Avenue along Coney Island Creek. Instead of rebuilding the clinic in its existing flood-prone location, HHC has identified a likely permanent site at a higher elevation. In order to restore these vital outpatient services as soon as possible, the City, through HHC, will construct an interim clinic on City-owned property located on Surf Avenue in Coney Island. This interim facility could be completed before the end of 2013.

Telecommunications

The city's telecommunications system is essential to individuals and businesses throughout the five boroughs, including in Southern Brooklyn. While this is true at all times, it is especially true during emergencies. As Sandy demonstrated, however, this system is highly vulnerable to extreme weather events—precisely when telecommunications are most needed. Citywide and in Southern Brooklyn, Sandy resulted in outages to landlines and mobile service, as well as to data service. The vulnerability of this system likely will grow as the climate changes.

Among the strategies that the City will use to address these challenges for residents, businesses, and nonprofits of Southern Brooklyn and other parts of the city will be to: increase accountability among providers to promote resiliency; use strengthened City regulatory powers and stronger relationships with providers to ensure rapid recovery after extreme weather events; encourage hardening of facilities to reduce weather-related impacts; and increase redundancy to reduce the impact of outages. The initiatives described below provide important examples of how the City intends to advance its telecommunications resiliency agenda citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits of Southern Brooklyn. For a full explanation of the following initiatives and a complete description of the City's five-borough telecommunications resiliency plan, please refer to Chapter 9 (*Telecommunications*).

Telecommunications Initiative 1
Establish an office within the Department of Information Technology and Telecommunications (DoITT) to focus on telecommunications regulation and resiliency planning

While the City has regulatory authority over some aspects of telecommunications service, it has no entity focused broadly on ensuring the resiliency of the public communications networks. The City, therefore, will form within DoITT a new Planning and Resiliency Office (PRO) that will have the resources needed to develop, monitor, and enforce resiliency standards, in close cooperation with State and Federal regulators and providers. DoITT will launch the new office in 2013.

Telecommunications Initiative 2
Establish new resiliency requirements for providers using scheduled renewals of the City's franchise agreements

Flooding caused outages during Sandy in facilities that did not follow the Federal Communication Commission's recommended best practices for resiliency, including flood protection measures. The City, through DoITT, therefore, will encourage and enforce resiliency standards for telecommunications providers through the franchise renewal process and, through other agreements into which such providers enter with the City, explore options to increase conduit infrastructure redundancy and resiliency. The City will also seek to require standardized outage reporting and publishing. DoITT will launch this effort in 2014, in advance of 2020 franchise renewals.

Transportation

Without the city's expansive transportation system, New York would grind to a halt. This was illustrated starkly during Sandy when outages occurred across the system during and immediately following the storm. These outages severely impacted Southern Brooklyn, which found itself isolated by the shutdown of subway and other public transit systems, as well as by flooding on arterial and secondary roads. The vulnerability of this system will only grow as the climate changes.

Among the strategies that the City will use to address these challenges for residents of Southern Brooklyn and other parts of the city will be to: make the system more flexible and more resilient; protect critical elements of the system from damage; and seek to maintain system operations during extreme weather events; and, following extreme events, to enable quick recovery, while also putting in place plans for backup transportation options until regular service can be restored. The initiatives described below provide important examples of how the City intends to advance its transportation resiliency agenda citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits of Southern Brooklyn. For a full explanation of the following initiatives and a complete description of the City's five-borough transportation resiliency plan, please refer to Chapter 10 (*Transportation*).

Transportation Initiative 1
Reconstruct and resurface key streets damaged by Sandy

Sandy's waves and flooding caused significant damage to area roadways. The City, through the Department of Transportation (NYCDOT), will reconstruct 60 lane-miles of streets that were damaged severely, and will repave approximately 500 lane-miles of streets with damaged surfaces. In Southern Brooklyn, this will include over a linear mile of reconstructed streets and over six linear miles resurfaced throughout the area. Wherever feasible, the reconstructed streets also will include resiliency features to prevent future damage. NYCDOT will launch this initiative in 2013 with funding from Federal and City sources.

Transportation Initiative 3
Elevate traffic signals and provide backup electrical power

New York's traffic signals—and particularly the controllers that operates these signals and communicate with the NYCDOT Traffic Management Center—are vulnerable to damage from flooding as well as to power loss from various extreme weather events. Accordingly, the City, through NYCDOT, will raise controllers at approximately 500 intersections in flood-vulnerable locations across the city, including in Southern Brooklyn. In tandem with this effort to place electrical hardware above the 100-year floodplain elevation, NYCDOT also will install power inverters in approximately 500 NYPD vehicles to allow these vehicles to provide backup electrical power to critical traffic signals. This effort will begin in 2013.

Transportation Initiative 8
Call on non-City transportation agencies to implement strategies to address climate change threats

Many non-City agencies that own and operate critical portions of New York City's transportation system have already announced resiliency and protection initiatives appropriate to their system. Without such action, the critical facilities managed by these agencies will remain vulnerable to damage and disruption from future weather-related events. The City, therefore, will call on these agencies to implement the initiatives that they have announced and take additional steps to protect their major transportation assets from climate change threats and prepare for quick restoration following an extreme weather event. Assets that may require hardening and/or preparation measures in Southern Brooklyn include: Coney Island Yard, the lower level of the Stillwell Avenue station, and the limited portions of the subway infrastructure located at grade in the area. The City will work with these agencies to advance these plans in 2013.

Transportation Initiative 9
Plan for temporary transit services in the event of subway system suspensions

When major portions of the subway system are out of service, there simply is not sufficient capacity in the rest of the transit network or the roadway system to carry the increased volume of commuters and other travelers. The City, through NYCDOT, therefore, will work with the MTA and other transportation partners to develop and regularly update formal plans to provide temporary transportation services in such an event, including following extreme weather. These services could take the form of temporary, high-capacity "bus bridges" of the type implemented during Sandy, linking, for example, Southern Brooklyn to Midtown Manhattan via the Nostrand Avenue Select Bus Service route (see Initiative 16, below) or temporary point-to-point ferry services, for example connecting Coney Island and Lower Manhattan. This planning effort will begin in 2013.

Transportation Initiative 10
Identify critical transportation network elements and improve transportation responses to major events through regular resiliency planning exercises

Many of the facilities critical to the City's ability to respond effectively to a disaster are vulnerable to disruption and damage during extreme weather events, potentially impairing delivery of emergency services and supplies, as well as impairing the restoration of critical non-transportation infrastructure and economic activity. This vulnerability is expected to increase as the climate changes. To respond better to a variety of different possible transportation outage and restoration scenarios, the City, through NYCDOT, will work with transportation agencies around the region to identify the critical elements of the surface transportation network that need to be available quickly following different types of events. The key tool to identify these networks will be an ongoing series of detailed and multi-disciplinary resiliency planning exercises that will allow NYCDOT and its partners to understand where resources need to be focused before, during, and after an event. This effort will begin in 2013.

Transportation Initiative 16
Expand the city's Select Bus Service (SBS) network

Parts of the city lack subway access or have slow and unreliable public transportation. In these areas, the City and the MTA have been deploying SBS routes to improve general mobility. These routes can form the backbone of high-capacity bus service in the event of major subway outages, including following extreme weather events. The City, through NYCDOT, will work with the MTA to expand the SBS network significantly, building on a plan developed jointly in 2010. Implementation of this plan has already begun, with a new SBS route that will go into effect this year on Nostrand Avenue in Brooklyn.

Beyond the priority transportation resiliency projects described in Chapter 10, including those summarized briefly above, the City is proposing an additional transportation resiliency initiative that is specific to Southern Brooklyn's vulnerabilities. This initiative is described below.

Southern Brooklyn Initiative 10
Call for the USACE to develop an implementation plan for the reinforcement of existing Belt Parkway edge protections

The coastal edges along portions of the Belt Parkway not only protect this key piece of transportation infrastructure, but also have the potential to provide additional flood protection to mainland neighborhoods throughout Southern Brooklyn. The City and State have an opportunity to incorporate resiliency design measures into future roadway and bridge reconstruction projects along the highway. The City, therefore, will call on the USACE to develop an implementation plan containing various options for reinforcing and strengthening existing edge protections along the Belt Parkway beyond the immediate repairs underway. The Belt Parkway is maintained by the NYCDOT, but its coastal edges are generally maintained by the Parks Department, as is the surrounding parkland. The New York State Department of Transportation is also involved in certain capital work. The goal is for USACE to begin work on this plan by 2015.

Parks

During Sandy, it became clear that, in addition to serving as neighborhood front yards and recreation centers, in many places (including Southern Brooklyn), the City's parks serve as the city's front line of defense when extreme weather events hit, buffering adjacent neighborhoods. As the climate changes, it will be even more critical that the city's parks are able to play all of these roles.

Among the strategies that the City will use to address these challenges for residents of Southern Brooklyn and elsewhere in the City will be to: strengthen the city's parks so that they are able to survive weather-related events more effectively and can act as stronger buffers for adjacent communities; and pursue technologies and approaches that will enable the City to monitor, analyze, and prepare the park system for its many roles in an era of increasing change. The initiatives described below provide important examples of how the City intends to advance its parks resiliency agenda citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits of Southern Brooklyn. For a full explanation of the following initiatives and a complete description of the City's five-borough parks resiliency plan, please refer to Chapter 11 (*Parks*).

Parks Initiative 1
Restore city beaches

Beaches play an important recreational role in Southern Brooklyn and also are a vital component of the area's coastal defenses, but they cannot protect adjacent areas without being "renourished" (replenished with new sand to replace that lost to erosion) from time to time. Subject to available funding, the City, through DPR, will collaborate with Federal and State partners—including the USACE—to implement plans quickly to restore sand lost after extreme storm events and to conduct regular nourishment of beach and regular monitoring to detect the early signs of erosion. This will focus on key beaches, including Southern Brooklyn beaches such as Plumb Beach, Manhattan Beach, Brighton Beach and Coney Island. The goal is to begin this effort in 2013.
To restore the beaches following Sandy, the City, in cooperation with many other City, State and Federal partners, conducted an expedited program of projects to provide new and elevated lifeguard stations and public bathrooms and improvements to other beachfront amenities in advance of Memorial Day 2013. This impressive achievement comprised the first phase of restoring the city's beaches. In the coming months and years, DPR will continue its efforts to provide emergency sand nourishment and to expedite planning, evaluation, and design work for long-term plans to restore the beaches, boardwalks, and other beachfront amenities of Southern Brooklyn.

Parks Initiative 2
Harden or otherwise modify shoreline parks and adjacent roadways to protect adjacent communities.

Approximately 24 percent of DPR parks and other open spaces are in the 100-year floodplain, which is expected to expand as sea levels rise—including in areas where parks front residential and commercial districts. Subject to available funding, the City, through DPR, will study and identify mitigation strategies, including cost-effective ways to use its park system to protect adjacent neighborhoods and the parks themselves. Strategies could include hardening or elevating park infrastructure, construction of levees or floodwalls to minimize flooding and attenuate waves, and using flood-tolerant materials in the construction of parks. Target sites in Southern Brooklyn include especially Marine Park, Manhattan Beach, Calvert Vaux Park, Kaiser Park, and other shoreline parks in the area. The goal is to complete this study in 2014

Parks Initiative 4
Expand the City's Greenstreets, including for Jamaica Bay

Increased localized flooding is likely from more frequent heavy downpours in the future. Subject to available funding, the City, through DPR and in partnership with DEP, will expand its efforts to build more and larger Greenstreets to absorb stormwater, mitigate local flooding, improve urban heat island effects, increase pedestrian and traffic safety, and beautify neighborhoods. This will expand the installation of green infrastructure at appropriate locations in the City's streets, with technology similar to the NYC Green Infrastructure Plan, which improves water quality in combined sewer areas. The first phase of this expansion would focus on fourteen neighborhoods with the greatest potential for improvement, areas that are not slated for CSO improvements through the City's Green Infrastructure Plan, but could be well suited for greenstreets based on best available data showing low bedrock and ground water. An early priority for this effort will be the area surrounding Jamaica Bay, where DPR will collaborate with DEP and NYCDOT to reduce localized flooding and stormwater runoff, directly improving the health of the Bay. The goal is to begin with pilot projects in and around Coney Island, Marine Park, the Rockaways, and Canarsie Park, including greenstreets and parkland installations by 2014.

Parks Initiative 11
Improve the health and resiliency of the city's urban forest

The city's forests and trees provide an array of health and environmental benefits but are vulnerable to a variety of climate change-related impacts, including storm surge, wind, and even changes in average temperatures. Subject to available funding, the City, through DPR, will undertake a variety of efforts to protect trees—whether located in natural areas and parks, or along streets. This would include adding forest management crews, identifying locations in which to expand tree beds, and modifying regular tree inspection and pruning efforts to prioritize trees in areas vulnerable to extreme weather events. The goal is for DPR to launch this effort in 2013.

Beyond the priority park resiliency projects described in Chapter 11, including those summarized briefly above, the City is proposing an additional parks resiliency initiative that is specific to Southern Brooklyn's vulnerabilities. This initiative is described below.

Southern Brooklyn Initiative 11
Restore recreational infrastructure along Southern Brooklyn beaches

DPR will work to restore recreational infrastructure along Southern Brooklyn beaches, including facilities (comfort stations, lifeguard stations, and administrative buildings) at Plumb Beach, Manhattan Beach, Brighton Beach, and Coney Island. In each case, these replacement facilities will be more resilient than the structures that preceded them. DPR has also already begun the reconstruction of damaged playgrounds, ball fields, courts, neighborhood parks, and other park facilities. DPR will complete this restoration and reconstruction work by 2014.

Water and Wastewater

The city's water and wastewater system is one of the most complex in the world, not only supplying millions of New Yorkers with safe drinking water in all conditions, but also treating wastewater to ensure that the area's waterways remain clean, while draining rainwater to minimize flooding. Sandy demonstrated the system's vulnerability to a whole host of weather-related threats, ranging from surge and sea level rise, to heavy downpours—threats that are expected to worsen as the climate changes.

Among the strategies that the City will use to address these challenges for residents of Southern Brooklyn and other parts of the city will be to: protect wastewater facilities from storm surge; improve and expand drainage infrastructure; and promote redundancy and flexibility to make available a constant supply of high-quality drinking water. The initiatives described below provide important examples of how the City intends to advance its water and wastewater resiliency agenda citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits of Southern Brooklyn. For a full explanation of the following initiatives and a complete description of the City's five-borough water and wastewater resiliency plan, please refer to Chapter 12 (*Water and Wastewater*).

Water and Wastewater Initiative 1
Adopt a wastewater facility design standard for storm surge and sea level rise

Sandy damaged wastewater treatment plants and pumping stations even though the design of City wastewater facilities has taken into account the highest historically recorded water height of nearby water bodies or the BFEs identified in FEMA maps. The City, therefore, will adopt an increased level of protection for design and construction of all wastewater facilities based on the latest FEMA maps, modified to reflect sea level rise projections for the 2050s. DEP will adopt the new design guidelines in 2013.

Water and Wastewater Initiative 2
Harden pumping stations

Many of the city's pumping stations are located in low-lying areas and are necessary to convey wastewater and stormwater out of communities; however, their location also increases their vulnerability to storm surge. Therefore, subject to available funding, the City, through DEP, will retrofit these pumping stations to improve their resiliency. These retrofits will include raising or flood-proofing critical equipment, constructing barriers, and installing backup power supplies. Preliminary estimates indicate that there are currently 58 at-risk pumping stations, of which several are already scheduled for capital improvements. Subject to available funding, DEP will pursue implementation of resiliency projects in conjunction with repairs and planned capital work, and as appropriate based on the level of risk, historical flooding, and potential community impacts, among other criteria. The goal is to begin implementation in 2014.

Water and Wastewater Initiative 3
Harden wastewater treatment plants

All 14 of the City's wastewater treatment facilities are located along the waterfront and are therefore at risk in the event of a coastal storm. Subject to available funding, the City, through DEP, will protect these critical treatment facilities by raising or flood-proofing assets that are critical to the treatment process, constructing barriers, improving waterfront infrastructure, or implementing redundancy measures to avoid failure of these critical treatment systems. DEP will initially target facilities that have been identified as either most at-risk, or most likely to create issues for adjacent communities and waterways, based on the findings of an in-depth study by DEP. These facilities include the Coney Island Wastewater Treatment Plant. The goal is for DEP to begin implementation of adaptation measures for these and other facilities in 2014 as part of repairs and other planned capital projects.

Water and Wastewater Initiative 8
Reduce combined sewer overflow (CSO) with Green Infrastructure

As climate change brings increasing rainfall volume to the New York area, the city may also experience shifts in the frequency and volume of CSOs. The City will continue to implement its Green Infrastructure Plan and CSO Long-Term Control Plans (LTCPs) to reduce such CSOs. For this purpose, DEP, working with DPR and NYCDOT, will continue to pursue its plan to capture the first inch of runoff in 10 percent of impervious surfaces citywide by 2030. At the same time, DEP also will continue to develop LTCPs to evaluate long-term solutions to reduce CSOs and improve water quality in New York City's waterways. DEP will issue an LTCP for Alley Creek in Queens in 2013, with nine additional waterbody-specific LTCPs and one citywide LTCP to follow through 2017—including for Coney Island Creek, the Gowanus Canal, Newtown Creek, and Jamaica Bay.

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Beyond the priority water and wastewater resiliency projects described in Chapter 12, including those summarized briefly above, the City is proposing additional water and wastewater resiliency initiatives that are specific to Southern Brooklyn's vulnerabilities. These initiatives are described below.

Southern Brooklyn Initiative 12
Complete planned drainage improvements in Coney Island to mitigate flooding

DEP has identified Coney Island as an area where existing stormwater and other related infrastructure systems require upgrades based, in part, on anticipated new development in the area. In conjunction with robust coastal defenses, expanded drainage infrastructure may assist in protecting against damage from weather-related flooding. In Coney Island, the City, therefore, will complete approximately $137 million in planned upgrades to stormwater and sewer infrastructure, including enlarging pipes and outfalls to handle additional flow. These projects are now being undertaken by DEP and the Department of Design and Construction (DDC), and are scheduled for phased completion over the next six years.

Southern Brooklyn Initiative 13
Provide technical assistance to support Sea Gate in repairing Sandy-damaged infrastructure

The Sea Gate community, where a private housing association owns and maintains the streets, parks, and sewer infrastructure, is outside of DEP's jurisdiction and thus faces unique challenge in the aftermath of Sandy. The neighborhood's Sandy-damaged infrastructure, which eventually ties into the City's sewer system, impacts not only Sea Gate but also poses downstream risks from clogs and back-ups. The City, through DDC, therefore, will work with the Sea Gate Association to assist it in obtaining all Federal funding for repairs for which it is eligible. The Sea Gate Association has engaged an engineering firm to study the condition of the area's infrastructure and suggest a scope for repairs, and the City will provide technical assistance in connection with that effort.

Other Critical Networks: Solid Waste

On a daily basis, the solid waste collection system in New York disposes of more than 12,000 tons of waste and recycling in a safe and sanitary fashion. Unlike many other critical City systems, during Sandy this one proved remarkably resilient, resuming many of its normal functions almost immediately after the storm. In fact, thanks to the efforts of the City's Department of Sanitation, even as the agency was dealing with its own storm-related challenges, it was able to assist with the recovery of Southern Brooklyn and the larger city by collecting the debris left by the storm in an organized and efficient manner.

However, the system does face real issues. For example, during Sandy, the city's solid waste disposal system experienced interruptions that interfered with its ability to convey refuse out of the city to its ultimate destination. Additionally, as the climate changes, it is likely that this system will become more vulnerable to extreme weather.

Among the strategies that the City will use to address these challenges for residents of Southern Brooklyn and other parts of the city will be to: harden critical City-owned solid waste assets to protect them from extreme weather-related impacts; and seek to improve the resiliency of the broader solid waste network—both City- and third-party owned—enabling it to resume operation quickly should disruptions occur. The initiatives in Chapter 13 describe how the City intends to advance its solid waste resiliency agenda citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits of Southern Brooklyn. For a complete description of the City's five-borough solid waste resiliency plan, please refer to Chapter 13 (*Other Critical Networks*).

Other Critical Networks: Food Supply

Though the food supply chain generally emerged intact following Sandy, in certain local areas (including parts of Southern Brooklyn), residents found themselves without access to basic sustenance after the storm. In addition, had Sandy played out just a little differently, it is possible that significant links in the food supply chain—including the food distribution center in Hunts Point in the Bronx—could have been seriously threatened. As the climate changes, it is likely that risks such as these will grow.

Although initiatives outlined in several other sections above are important contributors to the overall resiliency of the food supply network (including especially those addressing utilities, liquid fuels, and transportation), the City also will pursue food-specific strategies to meet this goal for the benefit of residents of Southern Brooklyn and other parts of the city. These strategies will involve calling for resiliency investments at the most significant food wholesaling and distribution centers in the city and addressing issues relating to retail access in the event of extreme weather. The initiatives in Chapter 13 describe how the City intends to advance its food supply resiliency agenda citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits of Southern Brooklyn. For a complete description of the City's five-borough food supply resiliency plan, please refer to Chapter 13 (*Other Critical Networks*).

Environmental Protection and Remediation

Sandy showed that extreme weather events—which are likely to increase in severity with climate change—not only have the potential to impact the city's people, built environment, and critical systems; they also can have a deleterious impact on the natural environment. To help minimize the impact of future extreme weather on the environment, the City will advance a range of initiatives to protect open and enclosed industrial sites containing hazardous substances in an economically feasible way, and to encourage the cost-effective remediation and redevelopment of brownfields in a resilient fashion. These initiatives will have a positive impact on the residents, businesses, and nonprofits of Southern Brooklyn, which is home to approximately 130 industrial companies and one site designated under the New York City Brownfield Cleanup Program. For a complete description of the City's five-borough environmental protection and remediation plan, please refer to *Environmental Protection and Remediation*.

Community and Economic Recovery

New York is a city of neighborhoods, and these neighborhoods vary widely in size and nature. Notwithstanding this variety, successful neighborhoods across the city tend to share certain traits. Two of these are: a formal and informal network of community members who help and support one another in good times and bad; and vibrant commercial and nonprofit sectors that employ and provide goods and services to the people of the community.

As Sandy demonstrated, however, both the network of community-based organizations and the commercial and nonprofit sectors in New York's neighborhoods can be sorely tested when extreme weather hits. During these times (when contributions from these networks and sectors are desperately needed) these organizations and businesses themselves are frequently coping with the same set of challenges that the community at large is—a circumstance that can push even the most well-run organization or business to the breaking point. Even with these pressures, during and in the immediate aftermath of Sandy, New York's commercial and nonprofit sectors overcame many of their own difficulties, playing a critical role in the recovery of neighborhoods across the city, including Southern Brooklyn. However, as the climate changes, difficulties such as these will likely arise more frequently, testing institutions mightily.

Among the strategies that the City will use to achieve the goal of making its neighborhoods and their critical institutions more resilient will be to: help build grassroots capacity and foster community leadership; help businesses and nonprofits impacted by Sandy to recover; help businesses and nonprofits in vulnerable locations to make resiliency investments that will better prepare them for future extreme weather; and bring new economic activity to neighborhoods recovering from the impacts of Sandy to enable these neighborhoods to come back even stronger than before.

The initiatives described below provide important examples of how the City intends to advance its community and economic recovery agenda citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits of Southern Brooklyn. For a full explanation of the following initiatives and a complete description of the City's five-borough community and economic recovery plan, please refer to *Community and Economic Recovery*.

Community Disaster Preparedness Initiative 1
Identify and address gaps in community capacity

The capacity of a community to organize to aid businesses and residents after an extreme weather event or other disaster is a strong predictor of the success of that community's recovery. To improve the capacity of vulnerable communities, OEM, working with the NYC Center for Economic Opportunity (CEO), will undertake a pilot assessment of the strengths and weaknesses of a Sandy-impacted community—which could be a neighborhood in Southern Brooklyn—to inform the creation of a plan to address needs uncovered by the assessment. Subject to available funding, the City, through OEM and CEO, will choose a pilot community and begin their study in 2013.

Community Disaster Preparedness Initiative 2
Continue and expand OEM's Community Emergency Response Teams

OEM currently trains 54 teams of 1,500 volunteers across the city, which staff Community Emergency Response Teams (CERTs). Before, during, and after disasters, including extreme weather events, members of these teams help to organize community disaster preparedness and participate in emergency response and recovery. In light of Sandy, OEM will work with

Coney Island Boardwalk

Coney Island Boardwalk today

Coney Island Boardwalk conceptual rendering including new protective dune and amusements

communities to create additional teams, ensuring that the volunteers are as representative as possible of the communities that they serve. Towards the same end, OEM, working with CEO, will identify low-income young adults to be trained to lead their communities in disaster preparedness. OEM and CEO will launch this program by 2014.

Economic Recovery Initiative 1
Launch business recovery and resiliency programs

During Sandy, over 27,000 businesses citywide, including over 5,500 in Southern Brooklyn, were impacted by the storm. For many, recovery has been challenging. To assist with this recovery, immediately after the storm, the City launched a series of programs described in *Community and Economic Recovery* including a $25 million loan and grant program and a $25 million sales tax waiver program designed to help businesses get back on their feet. Building on the momentum of these programs, which have assisted over 2,500 businesses as of the writing of this report, the City, through NYCEDC, will launch the CDBG-funded Business Resiliency Investment Program of up to $100 million to help vulnerable businesses throughout the city make resiliency investments in their buildings and equipment, and the Business Loan and Grant Program of up to $80 million will assist businesses with recovery and rebuilding efforts. NYCEDC will launch these programs in 2013.

Economic Recovery Initiative 2
Launch the Neighborhood Game-Changer Competition

The recovery of many of the communities impacted by Sandy, including Southern Brooklyn, has been hampered by a lack of opportunities for economic advancement and employment among significant populations that were impacted by the storm. In many cases, these challenges existed even before Sandy, but have been exacerbated by the impacts of the storm. To address this, the City, through NYCEDC, will launch the CDBG-funded Neighborhood Game Changer Competition to invest up to $20 million in public money in each of the five communities on which this report focuses, including Southern Brooklyn. This funding will be available on a competitive basis to help finance transformational projects. To win the competition, a project will have to spur incremental economic activity, generate new employment opportunities, and match public funding with significant private capital. Projects that would be eligible to be funded in Southern Brooklyn through this competition could include new attractions bringing new visitors, significant new operations of a major business or non-profit, the revitalization of important commercial corridors, the expansion of an existing neighborhood institution, or a major new transportation option. NYCEDC will launch this program in 2013.

Economic Recovery Initiative 3
Launch Neighborhood Retail Recovery Program

At the core of many Sandy-impacted neighborhoods are the local commercial corridors that provide employment opportunities and services to those who live and work around them. They include local retailers, institutions, and service providers—such as food markets, pharmacies, social service organizations, laundromats, and others. In many cases, though, these corridors were devastated by the storm. To address this, the City will call on the PSC and Con Edison to amend the preferential Business Incentive Rate (BIR) program, which offers a discount on Con Edison's electric delivery charges, to allow it to be extended to impacted small businesses in the five communities on which this report focuses, including Southern Brooklyn. Businesses and nonprofits with 10 or fewer employees that have received support from City-sponsored loan and grant programs will be eligible for the discount for five years up to a maximum discount of $50,000 per business or nonprofit. The maximum aggregate benefit available across Southern Brooklyn will be $1 million. The goal is for NYCEDC to launch this effort in 2013. Among the corridors where the benefit could be available in Southern Brooklyn include:

- Brighton Beach Avenue (between Ocean Parkway and West End Avenue)
- Coney Island, including Neptune, Mermaid, and Surf Avenues
- Coney Island Avenue (between Avenue X and Brighton Beach Avenue)
- Emmons Ave. (between West End Avenue and Knapp Street)
- Gerritsen Avenue (between Ave. U and Seba Avenue)
- Nostrand Avenue (between Avenue Z and Avenue U)
- Ocean Avenue (between Avenue W and Emmons Avenue)
- Sheepshead Bay Rd. (between Avenue Z and Emmons Avenue)

Economic Recovery Initiative 4
Support local merchants in improving and promoting local commercial corridors

As mentioned above, Sandy highlighted the important role played by local commercial corridors in many communities impacted by the storm. The City, through the Department of Small Business Services (SBS), will provide financial and/or technical assistance to area business improvement districts (BIDs), merchant associations, and other groups that work to improve, market, maintain, and otherwise promote primarily commercial corridors. Subject to review of applications received, SBS will prioritize allocating its resources, including its CDBG funding, to Sandy-impacted commercial corridors. Such funding could be used for a variety of purposes, including capacity building, façade improvement programs, streetscape improvements, and business recruitment and marketing efforts. In Southern Brooklyn, corridors that could receive this additional assistance include corridors in Brighton Beach, Sheepshead Bay, Gerritsen Beach, Coney Island, and Gravesend. SBS will provide this assistance beginning in 2013.

Economic Recovery Initiative 5
Continue to support the FRESH program to increase the number of full-line grocers in underserved neighborhoods

Even before Sandy, the residents of many communities impacted by Sandy, including parts of Southern Brooklyn, lacked adequate access to fresh fruits, vegetables, and other healthy foods. Noting this challenge, especially in underprivileged areas of the city, in 2009, the City launched the FRESH (Food Retail Expansion to Support Health) program, a series of zoning and financial incentives available to supermarkets to fill this gap in neighborhoods underserved by grocery retail. To promote the recovery of commercial corridors in these areas, the City will continue to support the FRESH program, with a particular focus on Sandy-impacted neighborhoods, including those in Southern Brooklyn.

Economic Recovery Initiative 6
Reassess commercial properties citywide to reflect post-Sandy market values

After Sandy, many commercial properties were worth less than before the storm. To reflect this fact and to help with recovery from the storm, the City has reassessed more than 88,000 properties impacted by the storm citywide. Overall, these reassessments have lowered the tax burden on Sandy-impacted properties—including both commercial and residential properties—by over $90 million, with commercial properties in neighborhoods impacted by Sandy receiving a reduction, on average, of approximately 10 percent off of their pre-storm assessed values.

In addition to the measures described above, the City will advance the following initiatives to address Southern Brooklyn's community and economic recovery needs:

Southern Brooklyn Initiative 14
Work with Brooklyn Chamber of Commerce to assist in organizing Sheepshead Bay businesses

Strengthened local civic infrastructure can prepare communities for disaster response. In Sheepshead Bay, where no existing merchant group exists, increased cooperation among area merchants and stakeholders would result in multiple benefits. Since early 2013, the Brooklyn Chamber of Commerce has been working to convene local merchants and support the potential establishment of a new merchant association. Additionally, the FEMA Community Planning and Capacity Building program has identified the area as a potential recipient of technical assistance in connection with the development of a tailored revitalization strategy. The City will support this effort by providing technical assistance of its own and, through existing programs, potential financial support coordinated by the SBS to match local business investments.

Southern Brooklyn Initiative 15
Support area recovery through the rebuilding and expansion of the entertainment district

The entertainment attractions in Southern Brooklyn are an important symbol of the area. More significantly, they contribute to area business activity, enhance local quality of life, and drive visitor activity that benefits the local economy. The entertainment areas have witnessed growth in recent years, and this momentum must be sustained to anchor area recovery.

The City will support enhancement of key area attractions to anchor recovery and growth, including construction of major new amusements, construction of a new seasonal amphitheater and community arts center, and expansion of the New York Aquarium, the most-visited attraction in Brooklyn and a year-round asset in the entertainment district. The City also will support enhanced programming, marketing, and district improvements to set the stage for economic growth, and will continue to support programs to link this growth to the local residential neighborhood through workforce development and other initiatives.

Costs to enhance and expand the entertainment district—including the construction of a new state-of-the-art steel rollercoaster between West 15th and West 16th Streets on the Boardwalk—will be borne primarily by private operators. For the New York Aquarium, the repair of damages from Sandy and the planned expansion of the campus including the Ocean Wonders project will be a joint effort of the Department of Cultural Affairs, the Wildlife Conservation Society, and FEMA. *(See rendering: Coney Island Boardwalk)*

Southern Brooklyn Initiative 16
Study opportunities along Coney Island Creek to generate economic activity and facilitate resiliency investments

In areas that contain particularly vulnerable buildings, vacant or underutilized properties, or unprotected privately owned waterfront edges, encouraging new construction can help to spur economic activity and achieve resiliency goals. The City will work to identify waterfront redevelopment and edge improvement opportunities along Coney Island Creek. Focusing on sites where existing utility and road infrastructure may be able to accommodate new development, the City will study opportunities to generate economic activity through resilient new construction, which could house a range of potential commercial and residential uses. By 2014, NYCEDC will launch and complete an economic development study of these potential sites along Coney Island Creek that will examine specific sites, regulatory constraints and infrastructure capacity.

Southern Brooklyn Initiative 17
Implement planned and ongoing investments by the City and private partners

Preservation and revitalization of neighborhoods most impacted by Sandy will be furthered by keeping planned development projects on-track. Among the development projects that the City will continue to pursue are the following:

Parks and Open Space

- *Calvert Vaux Park*, an enhancement project that incudes new artificial turf fields, new coastal habitat along the shoreline, and other park improvements.
- *The West 8th Street Access Project*, a project to improve access from the W. 8th Street subway station by demolishing an extant pedestrian bridge and creating a new boardwalk entry at W. 10th Street.

Economic Development

- *Coney Island Commons and YMCA*, a mixed-use development project that will create over 190 units of affordable housing and Southern Brooklyn's first YMCA, opening in 2013.
- *Coney Island Comprehensive Plan*, including the development of the Coney Island amusement and entertainment district, including the new Luna Park, Scream Zone, and Steeplechase Plaza, the re-lighting of the iconic Parachute Jump, and the construction of a new seasonal amphitheater, as well as new housing and neighborhood amenities.

Credit: Michael Brunet

Southern Manhattan

Since the Dutch sailed into New York Harbor, the area now known as Lower Manhattan has been at the center of things. Lower Manhattan is where George Washington was inaugurated, where Thomas Edison first installed electric streetlights, and where what would become the world's largest stock exchange was founded. Even New York City's sprawling subway system got its start here. To this day, the more than 500 acres south of Chambers Street hold a place of disproportionate importance for the entire city, region, nation, and world.

As defined in this report, Southern Manhattan, though, is more than just the tip of the borough. It includes the areas along the coastal edges of Manhattan north to 42nd Street, encompassing portions of the neighborhoods of Chinatown, the Lower East Side, Stuyvesant Town, and Kips Bay on the east, and Tribeca, the West Village, Chelsea, and Hudson Yards on the west. (*See map: Neighborhoods of Southern Manhattan*)

These neighborhoods, together with Lower Manhattan, are critical to the city and region. Southern Manhattan contains the fourth-largest business district in the United States. It lies at the heart of New York's transportation networks. It is a mass-transit hub, with 19 subway lines pulsing underfoot carrying millions of riders a day. It has heliports, ferry landings, and contains other key facilities on which all New York City depends, from power substations to healthcare institutions. And, not incidentally, it is home to nearly 200,000 people and approximately 300,000 workers—all while playing host to tens of millions of tourists each year.

The Shoreline: Then and Now

Source: Map: Colton 1836 Map; 1609 Shoreline: Welikia Project; 2013 Shoreline: NYCDCP

Yet, astonishingly, nearly 40 percent of the land on which Southern Manhattan sits *did not even exist* when the Dutch first arrived.

As the colony, initially called Nieuw Amsterdam and later named New York, grew and prospered, it became a magnet for people from all over the world, creating constant pressure for expansion. Residents moved northward, filling in streams and marshes to make way for roads and houses. From the earliest days, they also expanded outward, seeking access to the water. In the beginning, piers, wharves, and docks were built to facilitate maritime activity. In time, though, the people of the colony added land as well, held in place by stone or concrete "bulkheads," or retaining walls, and always at a low elevation. From the time of the Dutch, to the time of the British, through the modern age, approximately 900 acres would be added to the coasts of Southern Manhattan. (*See map: The Shoreline: Then and Now*)

Whether natural or manmade, the coastal areas of Southern Manhattan have been crucial to New York's evolution from trading post, to major port, to global city—even as the uses of these coastal areas constantly evolved. Through the beginning of the 20th century, industry and maritime interests dominated. Eventually, with the rise of the automobile, major arterial highways were paved along the waterfront. As maritime activity along the Manhattan shoreline declined, especially after World War II, waterfront buildings and piers fell into disrepair, as did many adjacent inland areas, which were occupied by dilapidated commercial buildings, vacant warehouses, and rundown tenement buildings.

In time, the Southern Manhattan shoreline entered an area of transition. Civic leaders recognized that the waterfront could once again become a valuable asset, as a home for parks and new residential and commercial office development. However, through it all, Southern Manhattan's low-lying coastal edges remained vulnerable to extreme weather—a fact that Sandy made painfully clearly.

As Sandy's surge entered New York Harbor, it breached the bulkheads all around Southern Manhattan, bringing floodwaters one and two blocks inland and in some cases even farther. Those who lived in, worked in, or owned businesses in Southern Manhattan were, of course, directly affected. The waters that coursed into residential buildings, stores, and office buildings compromised building systems, damaged interiors, and destroyed personal property.

However, Sandy's floodwaters also disabled critical infrastructure arrayed all along the coast—infrastructure that served citywide networks—and this had widespread repercussions.

In short order, workplaces, schools, and institutions that served all New Yorkers were closed. Even mail delivery was disrupted. Put simply, the crippling of Southern Manhattan during Sandy impaired the entire city.

Though many parts of Southern Manhattan have recovered as of the writing of this report, work remains in certain areas. Additionally, based on recently released flood maps from the Federal Emergency Management Agency (FEMA) and the latest climate projections, it is likely that the threats to Southern Manhattan will increase—with particular vulnerability along the east side and in Lower Manhattan, which is surrounded on three sides by water.

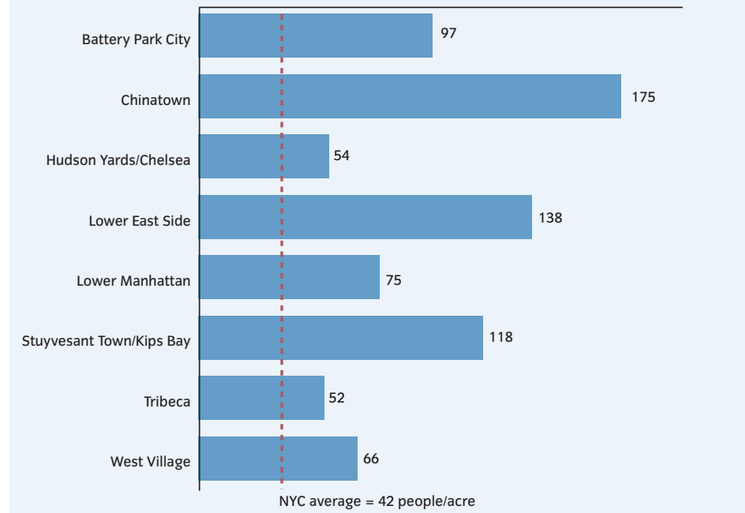
To address these threats, the City has developed a plan for Southern Manhattan that reflects the overarching goals of this report—to limit the effects of extreme weather while enabling New York and its neighborhoods to bounce back quickly when those impacts cannot be avoided. The plan addresses Southern Manhattan's most significant risk—its vulnerability to storm surge and rising sea levels—seeking to limit exposures to floodwaters, make buildings more resilient, and protect vital infrastructure more effectively. The plan also addresses other risks that the area faces—including more frequent and intense heat waves and an increase in the most intense hurricanes and associated winds—by drawing on both citywide and locally tailored initiatives. Finally the plan will help strengthen Southern Manhattan's commercial districts and enhance the area's vibrancy as a destination for visitors and a home for residents—all of which will ensure that, going forward, Southern Manhattan is able to continue to play its traditional role as a center for the entire city and region.

Area Characteristics

Manhattan (New York County) is the most densely populated county in the United States, and the neighborhoods of Southern Manhattan reflect this, all having population densities greater than the citywide average. These densely developed areas contain a total of 285 million built square feet, including 180 million square feet of commercial space and 105 million square feet of residential space. Southern Manhattan is, moreover, a hub of multiple infrastructure systems that serve the wider city and region. *(See chart: Area Population Density)*

Neighborhoods of Southern Manhattan

Area Population Density



Note: Peter Cooper Village included in Stuyvesant Town/Kips Bay

Source: 2010 US Census

At the water's edge, Southern Manhattan is rimmed by a bulkhead wall, which generally fronts on public space. These spaces range from the East River Park and East River Esplanade on the East Side, to Battery Park in the south, to the public spaces of Battery Park City and Hudson River Park on the West Side. On both the East Side and West Side, the area's public open spaces are bordered by major roadways—the FDR Drive and West Street (also known as Route 9A), respectively.

Neighborhoods and Residential Development

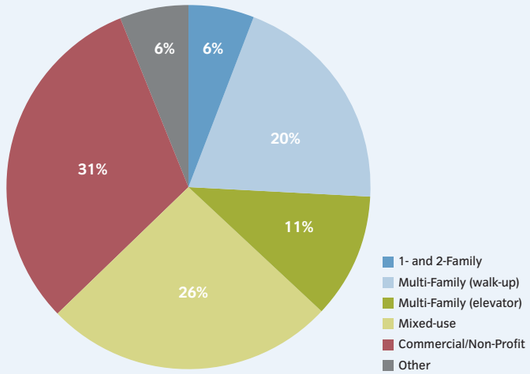
Though they share geographic proximity, the neighborhoods of Southern Manhattan—which together contain a population of nearly 200,000—are distinct. Even with this variety, the neighborhoods of Southern Manhattan generally can be grouped into three categories: those that are primarily residential, save for local retail and scattered commercial space; those that are primarily residential, with significant commercial space and other attractions that draw people

from outside of the area; and those that are primarily commercial but increasingly have residential populations. Generally speaking, the first category applies to the neighborhoods that line the East River, the second category applies to the neighborhoods along the Hudson River, and the third category applies to the neighborhoods of Lower Manhattan.

Since development in Southern Manhattan has been unfolding over centuries, the area contains a rich array of building types, ranging from walk-ups of five and six stories to high-rise residential towers, and from industrial buildings to commercial skyscrapers. Though 90 percent of the buildings in the area were erected before 1983, when modern flood-protection standards were incorporated into the City's Building Code, these buildings are primarily constructed of robust materials including steel, masonry, and concrete. This is generally true even of the over 1,700 buildings in Southern Manhattan that are within the area's 19 historic districts. *(See chart: Area Buildings Characterized by Type)*

Not surprisingly, given the area's density, nearly all (99 percent) of the 102,000 residential units in Southern Manhattan can be found in multi-story buildings. These include the buildings of the 24 public housing developments operated by the New York City Housing Authority (NYCHA), containing over 15,000 housing units. (*See chart: Area Housing Units Characterized by Building Type*)

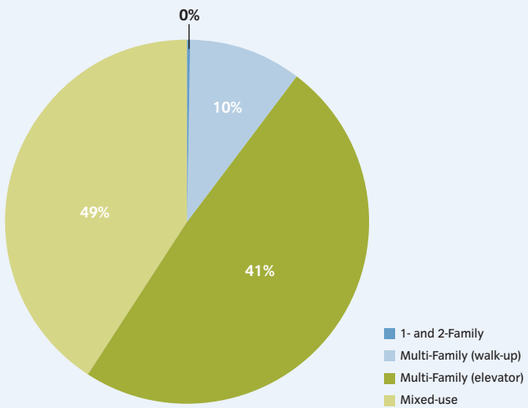
Area Buildings Characterized by Type



Total: 4,900 Buildings

Source: DCP PLUTO

Area Housing Units Characterized by Building Type



Total: 102,000 Housing Units

Source: DCP PLUTO

As described above, the neighborhoods lining the East River—Chinatown, the Lower East Side, Stuyvesant Town, and Kips Bay—generally can be characterized as residential areas with local retail stores, though there are exceptions to this characterization, including larger commercial establishments in Chinatown and the hospitals in Kips Bay. In most cases, the 98,500 people who live in these four neighborhoods reside in multi-story attached buildings or in developments comprised of high-rise towers in park-like settings.

Of these neighborhoods, the Lower East Side and Chinatown (including the so-called Two Bridges area) are the most densely populated (and, in fact, are the most densely populated neighborhoods in all of Southern Manhattan), with population densities of 138 and 175 residents per acre, respectively. Together these two neighborhoods alone are home to 70,400 residents, accounting for nearly 36 percent of all Southern Manhattan residents. Starting in the 1940s, large portions of these neighborhoods were developed through urban renewal, which led to concentrations of affordable housing of various kinds. As a result, the Lower East Side and Chinatown contain over 13,000 units of NYCHA housing, for example.

Kips Bay and Stuyvesant Town, which together have a population of 28,100, are slightly less densely populated than the Lower East Side and Chinatown, with 118 residents per acre. Stuyvesant Town (including neighboring Peter Cooper Village) is a planned community built after World War II by the Metropolitan Life Insurance Company, containing 20,000 units in a "tower in the park" setting. Kips Bay, meanwhile, is an older neighborhood with a mix of high-rise residential buildings and walk-ups.

By contrast, the neighborhoods along the Hudson River, while also possessing a strong residential base, contain more significant commercial and retail space. Together, these neighborhoods—Tribeca, the West Village, Chelsea, and Hudson Yards—have 47,900 residents and population densities of 52 to 66 residents per acre. They also attract sizable numbers of workers and visitors from outside of the neighborhoods, working in offices in Hudson Square, browsing at galleries in Chelsea or visiting the High Line. Generally, these areas are characterized by multi-story attached residential buildings as well as multi-story former industrial buildings that have been converted to commercial and residential uses. In many parts of these neighborhoods, shops and restaurants at the street level add liveliness and character to these areas.

Socioeconomic Characteristics

Area	Population	Poverty Rate	Median Household Income	Households	Owner-Occupied Housing Units	% Homeowners	% Owner-Occupied Housing Units with Mortgage	Median Owner-Occupied Unit Value
Battery Park City	13,400	5%	$170,900	6,200	1,200	19%	66%	$764,000
Chinatown	15,200	43%	$26,100	6,100	170	3%	63%	$673,600
Hudson Yards/ Chelsea	20,500	17%	$76,900	11,600	3,550	31%	59%	$766,600
Lower East Side	55,200	31%	$29,900	21,700	2,360	11%	45%	$537,000
Lower Manhattan	32,400	7%	$124,000	13,700	3,000	22%	62%	$785,800
Stuyvesant Town/ Kips Bay	28,100	12%	$93,000	13,000	400	3%	53%	$714,600
Tribeca	16,000	6%	$105,900	7,000	2,400	35%	57%	$867,800
West Village	11,400	6%	$127,400	6,200	2,100	34%	67%	$938,600
Citywide Total/ Average	**8,175,000**	**19%**	**$51,300**	**3,050,000**	**993,500**	**33%**	**64%**	**$514,900**

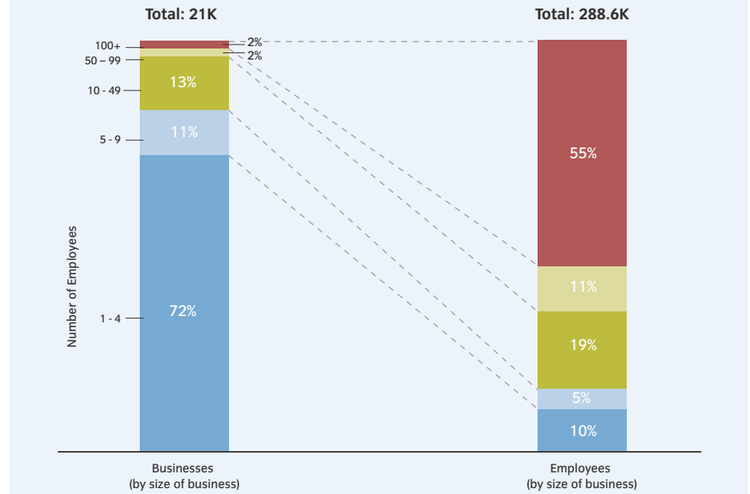
Note: Peter Cooper Village included in Stuyvesant Town/Kips Bay

Source: 2010 US Census, 2011 American Community Survey, 5-Year estimate

Finally, there is Lower Manhattan, a neighborhood unlike any other in Southern Manhattan. This is, first and foremost, because it is a regional commercial center, attracting 165,000 workers to the area on a daily basis. Here high-rise buildings predominate, although Lower Manhattan has low-scale sections, including the historic South Street Seaport area, with its brick buildings from the 19th century. The area also includes Battery Park City—with its generous parks and open spaces—constructed on landfill put in place in the 1970s along the southwest coast of Manhattan. In all, Lower Manhattan contains over 130 million square feet of commercial space (representing 72 percent of commercial space in Southern Manhattan), which serves both the city and the region.

While Lower Manhattan has primarily been a commercial district, in recent years the area's residential population has grown rapidly, doubling in the last decade to about 45,800 residents. Lower Manhattan also serves as a major tourist destination with over 4,100 hotel rooms, significant retailers, and many historic and cultural attractions, including the National September 11 Memorial & Museum.

Profile of Area Businesses



Source: Hoovers

Socioeconomic Characteristics

On average, the poverty rate in Southern Manhattan is consistent with the citywide average of 19 percent, though median household income in the area is much greater than the citywide median of $51,300. However, these averages mask large socioeconomic differences among the neighborhoods. (*See table: Socioeconomic Characteristics*)

For example, in the Lower East Side, the poverty rate is above 30 percent and in Chinatown it is over 40 percent. At the same time, median household income in the Lower East Side is $29,900, and in Chinatown it is $26,100—both of which are less than the citywide average. In Lower Manhattan, Battery Park City, Tribeca, and the West Village, by contrast, the most affluent neighborhoods in all of Southern Manhattan, poverty rates are less than half of the citywide average, while median household incomes in these areas are over $105,000—ranging from two to three times the citywide median.

Business, Nonprofits, and the Local Economy

Each of Southern Manhattan's neighborhoods has its own economic engines, ranging from neighborhood retailers to small-scale manufacturers to arts and cultural organizations to Fortune 500 companies and nonprofits. Together, these neighborhoods are home to over 21,000 businesses and nonprofits, employing nearly 300,000 people. Though the vast majority (83 percent) of area businesses and nonprofits are small, with fewer

South Ferry subway station (prior to Sandy)

Credit: bebolgood1/wikimedia

than 10 employees, the majority of workers (55 percent) are employed by larger businesses, with over 100 employees. (*See chart: Profile of Area Businesses*)

By far the most significant concentration of commercial activity in Southern Manhattan is in Lower Manhattan. In fact, Lower Manhattan accounts for some 52 percent of the businesses and 57 percent of the workers in all of Southern Manhattan. Lower Manhattan, historically home to businesses in the financial sector, has seen its economy increasingly diversify in recent years, with more and more service and new media and technology firms moving into the area.

Despite being severely impacted by the 9/11 terrorist attacks and the financial crisis of 2008, Lower Manhattan has remained characteristically resilient as an economic hub, boasting more companies as of the writing of this report than were in the area prior to 9/11. With major new developments rising or nearing completion—including 1 and 4 World Trade Center, the National September 11 Memorial & Museum, and the Fulton Transit Center—the area west of Broadway is increasingly becoming a focal point of business activity.

By contrast, the eastern edge of Southern Manhattan, including the Water Street and South Street Seaport district, while still a major commercial area and tourist destination, has faced challenges in recent years. Many financial services firms have moved so-called back-office operations out of this area, while the Seaport has, in recent years, lacked the dynamism of some of Lower Manhattan's other popular destinations. Of particular concern even before Sandy is the fact that leases for over 3 million square feet of office space in the Water Street corridor are set to expire over the next two years.

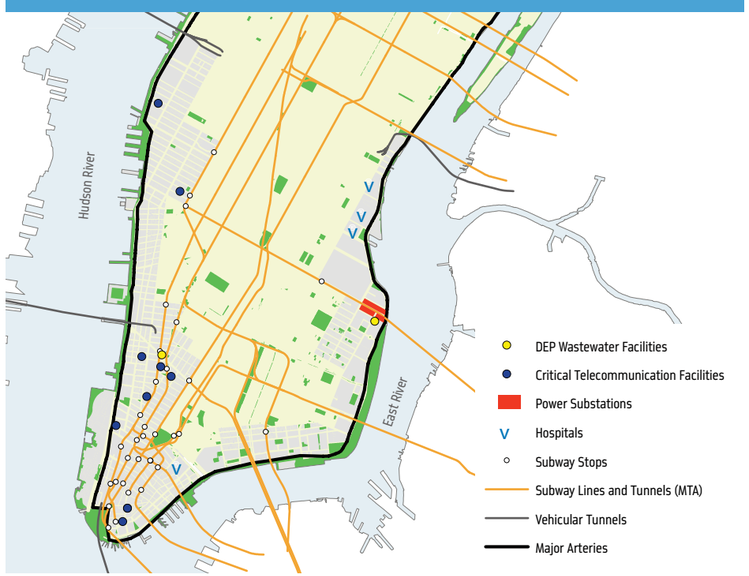
Critical Infrastructure

The high concentration of infrastructure assets in Southern Manhattan serves not only the area itself but other parts of Manhattan and, in many cases, the entire city and even the larger New York region. (*See map: Area Critical Infrastructure*)

For example, Southern Manhattan is home to several critical facilities in the electric system. These facilities are key elements of the city's electric system, which other city infrastructure systems depend on to function. Two substations at Con Edison's East 13th Street complex, which is located in the floodplain near the FDR Drive, send power to distribution networks south of 39th Street and north of the World Trade Center. Additionally, three other distribution substations in Southern Manhattan are in the floodplain. These transmission and distribution substations are critical for the delivery of electrical service to large swaths of the borough.

Healthcare facilities, too, are concentrated in Southern Manhattan, including four hospitals

Area Critical Infrastructure



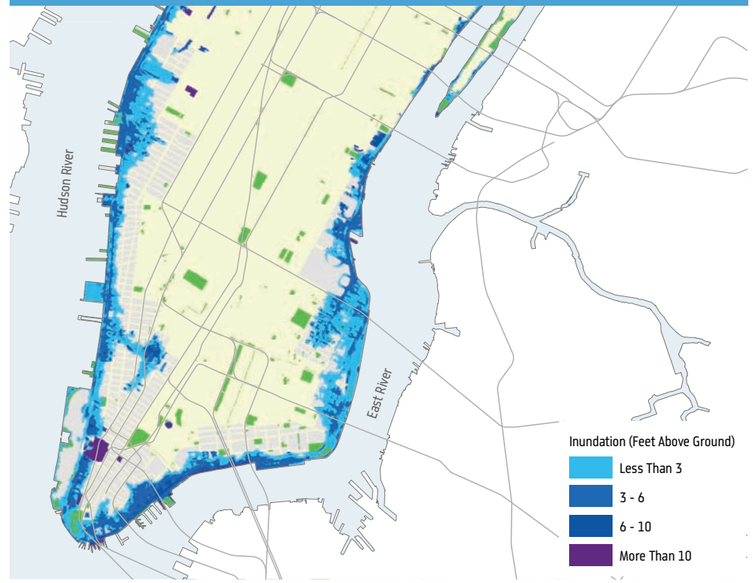
with 2,200 beds—20 percent of the Manhattan total. Three of these four hospitals are located on what is known as "Hospital Row," between East 23rd and East 34th Streets, along First Avenue. These include New York University's Langone Medical Center, a large nonprofit hospital; Bellevue Hospital, a public hospital managed by the Health and Hospitals Corporation (HHC) with the only State-designated regional trauma center in Southern Manhattan; and the Veterans Affairs New York Harbor Hospital, a public hospital managed by the US Department of Veterans Affairs. New York Downtown Hospital, located in Lower Manhattan, is the only hospital south of Canal Street. There are three additional hospital facilities south of 42nd Street including Beth Israel, just outside of the Southern Manhattan area on First Avenue.

Southern Manhattan's telecommunications facilities, too, are indispensable for the residents and businesses of the entire borough. These include two central offices and seven other critical facilities, primarily located on the West Side. Further, important data and land lines made of copper and fiber serving the area and other parts of Manhattan snake below the streets of Southern Manhattan via underground conduit.

Southern Manhattan also hosts important transportation assets. For example, its roadways are key links in the regional transportation network. These include the FDR Drive and West Street, which move vehicular traffic between Lower Manhattan and points north and beyond. On the West Side, the Lincoln and Holland Tunnels, operated by the Port Authority of New York and New Jersey (the Port Authority), connect Manhattan to New Jersey and serve over 175,000 vehicles a day. On the East Side, the Queens Midtown Tunnel and Hugh L. Carey Tunnel (formerly Brooklyn-Battery Tunnel), which are operated by the Metropolitan Transportation Authority (MTA), connect Manhattan with other New York City boroughs, serving approximately 140,000 vehicles per day. An additional two tunnels in Lower Manhattan, the Battery Park and West Street Underpasses, operated by the New York City Department of Transportation (NYCDOT), connect the FDR Drive to West Street and also provide access to the Hugh L. Carey Tunnel.

Of course, the heart of the transportation network in Southern Manhattan (and the entire city) is the subway system. Run by the MTA, this system serves 5.4 million riders per day and has 22 major lines, all but one of which pass through Manhattan. A total of seven tunnels connect Southern Manhattan and Queens and Brooklyn via the East River and have stations and/or ventilation and mechanical components

Area Inundation and Surge Height



Note: Inundation more than 10 feet includes below grade areas.

Source: FEMA (MOTF 11/6 Hindcast surge extent)

Flooding in the Lower East Side during Sandy

Credit: Michael Appleton/The New York Times

in the area. While Southern Manhattan generally is well-served by subways, Lower Manhattan is by far the best-served neighborhood, with 12 lines stopping at 17 stations.

Southern Manhattan is also home to two major Department of Environmental Protection (DEP) wastewater facilities. One, known as the Manhattan Pumping Station, is located at 13th Street, and the other, the Canal Street Pumping Station, is on Canal Street. Both facilitate the flow of wastewater to the Newtown Creek Wastewater Treatment Plant in Greenpoint, Brooklyn.

What Happened During Sandy

Though Southern Manhattan's location within New York Harbor protected it from the destructive wave impacts felt in areas along the open Atlantic coast, Sandy's surge arrived in the area with great force and height. In fact, at the peak of Sandy's surge, the tide gauge at the Battery registered water heights of more than 14 feet above Mean Lower Low Water (MLLW), the average of the lower low water height of each tidal day, or 11 feet above North American

Battery Park City: Construction of a New Coastal Edge

Battery Park City landfill before start of development, circa 1974

Credit: The New York Times

Since the 1600s, the inhabitants of Manhattan have been expanding their island out into the water surrounding it. This has particularly been true in Lower Manhattan. There, the last major expansion occurred in the 1970s, with the creation of Battery Park City, a 92-acre housing and commercial development built on landfill along the western edge of Lower Manhattan in the Hudson River.

As a general matter, during Sandy, the parts of Lower Manhattan built on landfill proved to be among the most vulnerable to flooding. Battery Park City was one significant exception to this rule, escaping the storm with almost no building damage. This was a direct result of the elevation of the landfill site and the location of the buildings.

Around Lower Manhattan, most historic landfill was created to expand maritime activity. Though well-suited for their original purposes, as these areas transitioned from maritime to other uses, the land never was raised to higher elevations. By contrast, Battery Park City was planned for housing and commercial space from the start—one of the first examples of landfill being added to Manhattan for a non-maritime purpose. Therefore, the elevation of the site was not dictated by the need to access the water.

Though FEMA's 1983 Flood Insurance Rate Maps (FIRMs) for New York City did not exist when the landfill for Battery Park City was constructed, the engineers who designed the development relied on then-existing flood hazard information to inform their planning. As a result, the buildings at Battery Park City generally sit approximately seven feet higher than the elevation of the former island edge (now West Street) and generally at the highest points on the development. From the building sites, Battery Park City gently steps down two to three feet to a generous riverfront esplanade and park area along most of its waterfront edge. Even this edge, though, is approximately three feet higher than other bulkheads in Lower Manhattan.

During Sandy, the bulkhead and elevation of Battery Park City served the neighborhood well. The bulkhead absorbed wave impacts, and, though water eventually did flood the area's esplanade and parks, the buildings, set back from the water's edge and on higher ground, hardly were affected. In fact, the greatest danger many of the buildings at Battery Park City faced during Sandy came, ironically, from West Street, on the site's inland side. This is because Sandy's surge was able to inundate the roadway from the north and the south—primarily because it had been constructed on landfill at a lower elevation for the purposes of maritime activities.

Vertical Datum of 1988 (NAVD88)—eclipsing the previous high-water mark from Hurricane Donna in 1960 by nearly four feet.

The surge overtopped bulkheads all around Southern Manhattan, sending floodwaters racing inland. Across the area, flooding typically reached one to two blocks from the coastline at depths of two to three feet. In certain areas, though, the waters extended farther inland and to far greater depths. The areas that generally experienced the worst inundation were those that were built on landfill along the coast, and, farther inland, where there had once been marshes and streams that had been built upon centuries ago. (*See map: Area Inundation and Surge Height*)

In Southern Manhattan, the greatest extent of inland flooding was along the area's eastern edge. There, the surge from the East River breached the bulkhead running from Kips Bay to Chinatown. Floodwaters not only inundated the East River Park esplanade, ball fields, and plantings, they traversed the FDR Drive, covering streets and encompassing buildings. In parts of the Lower East Side, much of which is built on landfill, the water traveled nearly 2,000 feet inland, almost reaching Avenue B, with floodwaters up to two feet deep along portions of Avenue C.

Along Southern Manhattan's western edge, the surge rose from the Hudson River, overtopping its bulkhead. Floodwaters inundated Hudson River Park, including piers and playgrounds, traversed West Street, and flowed into inland streets. In most of the neighborhoods on the West Side floodwaters reached one or two blocks inland at depths of two to three feet, but along Canal Street, a former waterway that was filled in during the city's northward expansion, water traveled nearly a half-mile inland.

In Lower Manhattan, meanwhile, the surge also overtopped bulkheads, though here the waterfront edge conditions and inland topography played a significant role in determining the extent of flooding. For example, on the eastern portion of Lower Manhattan, which is generally separated from the water only by an esplanade and local streets—with few inland barriers to slow and contain storm surge—waters flowed directly off of the East River and into the South Street Seaport area and the buildings along South Street, rising in some areas to eight feet in depth. In this section of Lower Manhattan, the locations with the highest floodwaters corresponded to areas of low-lying fill that had been added to Manhattan in some of the earliest years of the city's history.

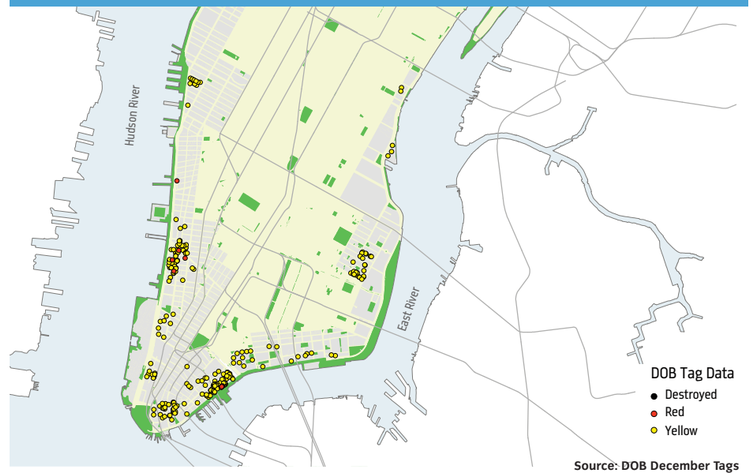
On the west side of Lower Manhattan, it was quite a different story for Battery Park City, because this neighborhood was built to a higher elevation. While Sandy's surge overtopped Battery Park City's bulkhead—and flooded the development's esplanade, playgrounds, fields, and plantings—the buildings in the development, which were constructed on the site's highest points, for the most part emerged from Sandy unscathed. (*See sidebar: Battery Park City: Construction of a New Coastal Edge*)

In other parts of the west side of Lower Manhattan, Sandy brought devastation. Sandy's surge easily flowed over the lower bulkheads to the north and south of Battery Park City, rushing farther inland and flooding the low-lying areas of West Street to depths of over four feet. Waters also spread onto the World Trade Center construction site, flooding below-grade areas, including the National September 11 Memorial & Museum.

The number of buildings in the area inundated by Sandy was substantial. In total, over 950 residential buildings (containing 46 million square feet of space and more than 40,000 units) and over 700 commercial and non-residential buildings (containing 85 million square feet of space) were affected by floodwaters. Of this total, 24 percent of the impacted floor area was in the neighborhoods of the East Side, 28 percent in the neighborhoods of the West Side, and 48 percent in Lower Manhattan. Perhaps most importantly, 58 percent of all impacted residential units were in the neighborhoods of the East Side.

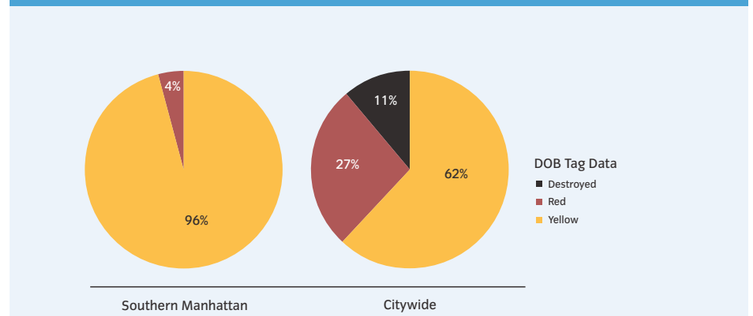
Buildings impacted by flooding generally sustained damage that was not of a structural nature. This was primarily because most of the buildings in the area are multi-story and constructed of steel, masonry, or concrete frames—unlike the lighter-frame buildings in many other areas Sandy inundated. Instead, most building damage in Southern Manhattan was to critical building systems, business inventory, and personal property. Since so many of these buildings' systems were located in basements or sub-basements, even in areas where floodwaters reached only one to two feet, elevators, water pumps, fire- and life-safety systems, heating and cooling systems, and lighting were compromised, making conditions for those in the floors above challenging or untenable.

Location and Level of Building Damage



Source: DOB December Tags

Classification of Building Damage

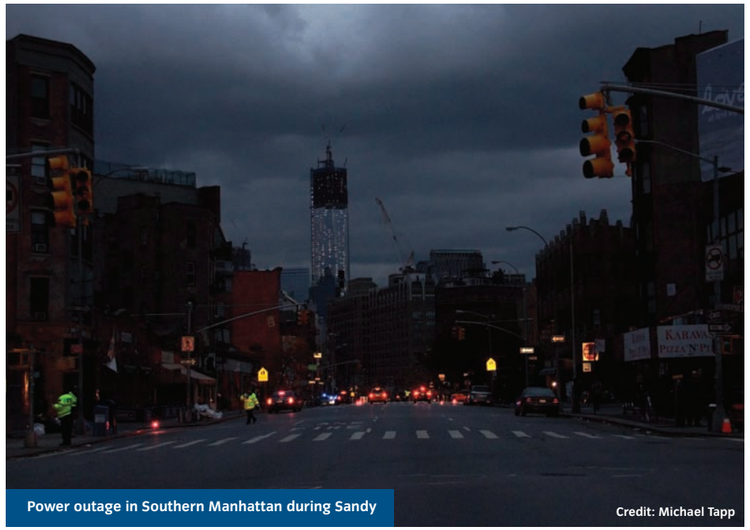


Source: DOB December Tags

As a result of Sandy, a large number of buildings in Southern Manhattan suffered damage. After the storm, the New York City Department of Buildings (DOB) sent out inspectors to assess damages in Southern Manhattan and other inundated areas of the city. These inspectors were asked to assign "tags" to buildings based on the observed condition of each structure. "Green" tags indicated less serious damage or no damage at all. "Yellow" tags indicated that portions of a building might be unsafe or might have significant non-structural damage. "Red" tags indicated structural damage. And a subcategory of "red" tags was further categorized as "destroyed." (*See table: Classification of Building Damage)*

The most methodologically rigorous building damage assessment undertaken by DOB was completed in December 2012. According to this assessment, of those buildings citywide that were tagged either yellow or red (including those further classified as destroyed), 13 percent were located in Southern Manhattan. The yellow and red tagged buildings in Southern Manhattan tended to be clustered on the eastern edge of Lower Manhattan with other clusters in Tribeca around Canal Street and in parts of Chinatown and the Lower East Side. In Southern Manhattan, the percentage of red and yellow tagged buildings that were tagged yellow (96 percent) was higher than the percentage citywide (62 percent). This largely was a result of the nature of the area's flooding (still-water inundation, as opposed to destructive wave action), which tended to cause less structural damage and instead caused damage to building systems and contents. (*See map: Location and Level of Building Damage*)

Though inundation caused a significant amount of damage to Southern Manhattan's building



Power outage in Southern Manhattan during Sandy

Credit: Michael Tapp

Flooding in South Ferry Station

Credit: MTAPhotos

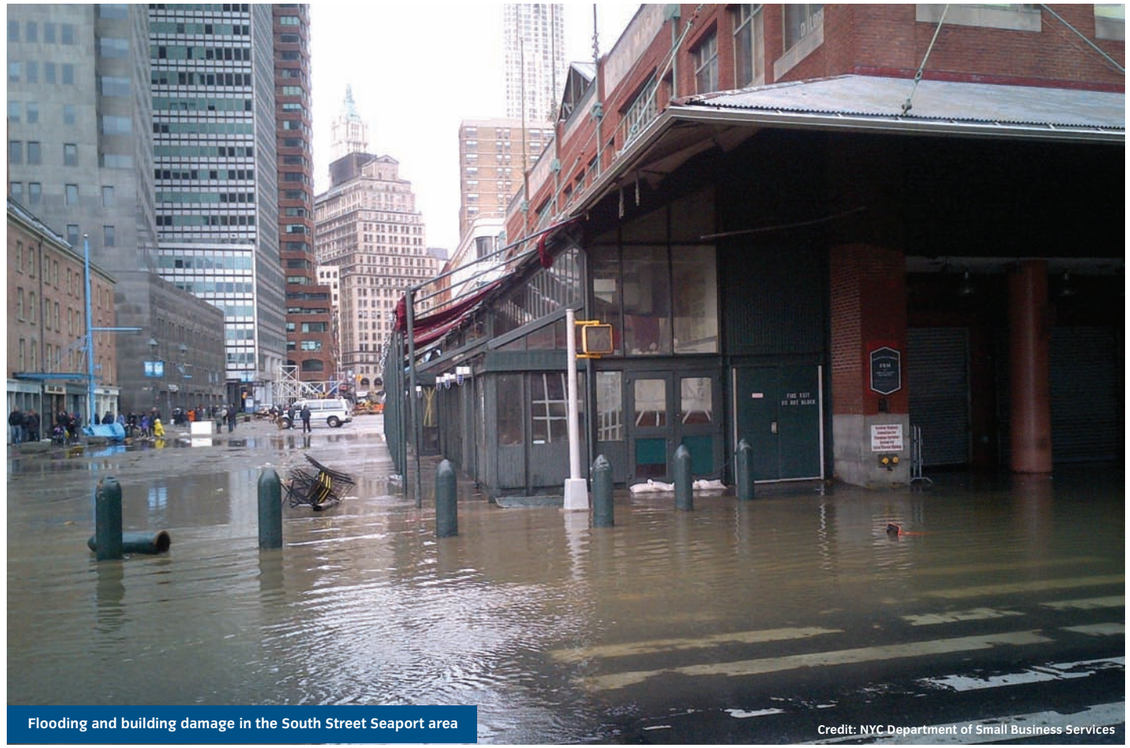
stock, perhaps the most significant impact that Sandy had on the area resulted from power outages that occurred across most of Manhattan south of 34th Street. As a result of these outages, even the many residents of buildings that were not flooded or had minimal damage were left without light, heat, refrigeration, or water for drinking, cooking, flushing toilets, or bathing. In high-rise buildings, elevators also ceased to function. As a result, many older or infirm residents who lived on higher floors were trapped in their apartments—in some cases unable to communicate or gain access to information through television or the Internet.

The storm also directly or indirectly affected businesses and nonprofits large and small. For example, the flooding itself wreaked havoc on ground-floor retailers, cultural institutions, nonprofits, and, especially in Chelsea, art galleries, destroying merchandise and inventory as well as equipment. In hard-hit areas, such as the South Street Seaport district, ground-floor businesses were still closed months after the storm, with some still not reopened as of the writing of this report. Many small businesses, even outside of the inundation area in Southern Manhattan, like their residential counterparts, also were impacted by the extended power outage. This destroyed inventory for food-related businesses, which rely on electricity for refrigeration, and interrupted business for various types of firms for up to five days, costing many of them important revenue. The power outage also disrupted transit, which deprived businesses of customers and made it difficult for employees to get to work.

Even after the waters receded and the power was restored, many small businesses and nonprofits in Southern Manhattan continued to suffer. This was especially true in the hardest-hit areas like Lower Manhattan, where telecommunications disruptions continued for some months, keeping many businesses and nonprofits from returning to normal business operations. In addition, since many high-rise buildings were unoccupied for weeks or even months after Sandy, retailers and others continued to suffer due to a loss of much of their customer base.

On the whole, larger businesses in Southern Manhattan were not impacted directly by Sandy's floodwaters, because most of these businesses occupied offices on upper floors in multi-story buildings. However, these office-oriented businesses were greatly impacted by flooding that impaired their buildings' systems. As with residents, small businesses, and nonprofits, large businesses located inland also were affected by power outages and transit disruptions, which prevented them from operating. In total, throughout Southern Manhattan, over 88 million square feet of commercial space and 6,500 businesses were in areas affected by flooding. An additional 260 million square feet and 68,000 businesses were in areas affected by power outages. Even as large businesses in Southern Manhattan began to resume operations when power and transit were restored, a significant number of those in Lower Manhattan were not able to do so for weeks or months because of various issues including those relating to telecommunications.

Sandy's impact on the Southern Manhattan electric system began before Sandy rolled in, when Con Edison shut down two of its electrical networks in the area preemptively to prevent severe damage and minimize potential downtime to underground distribution equipment (located in vaults beneath sidewalks), plunging over 6,500 hundred "customers" (and many more individuals) on the East Side of Lower Manhattan into darkness. Once the storm arrived, Sandy's surge caused damage to the substations at the East 13th Street complex and at the Seaport, shutting down 11 additional distribution networks and leaving another 225,000 customers without electricity—nearly all of Southern Manhattan south of 34th Street as well as certain areas north to 39th Street. Everything from traffic lights and street lights to cellular antennas was affected. Power to the whole area was not restored fully until about four days after the storm, only after substation



Flooding and building damage in the South Street Seaport area

Credit: NYC Department of Small Business Services

equipment was finally restored. Since many area buildings suffered damage to their electrical systems, building-level power outages would continue in many cases for several days.

The storm also affected Southern Manhattan's hospitals and their patients. New York Downtown Hospital, for example, evacuated patients before the storm once it was told that its power would be preemptively shut off, reopening, when power returned to the area. The Veterans Affairs New York Harbor Hospital also evacuated prior to the storm due to its proximity to the East River. New York University's Langone Medical Center and Bellevue Hospitals, though also near the East River, remained open as Sandy approached. Eventually, Sandy's surge sent floodwaters into the lower levels of these two hospitals (as well as the Veterans Affairs New York Harbor Hospital). This eventually forced New York University's Langone Medical Center and Bellevue to evacuate, during the storm in the case of the former, as its critical building systems failed, and, in the case of the latter, shortly after the storm. All three damaged hospitals remained partially or fully closed for months following the storm, reducing Manhattan's capacity by 2,100 beds or nearly 65 percent of the bed capacity below 42nd Street.

Critical telecommunications facilities and below-grade network cabling in Southern Manhattan also were impacted significantly by Sandy. Two central offices experienced serious damage from floodwaters, disconnecting businesses and residents who depended on these locations to relay phone and cable signals. Although one central office was functional within a day, the other remained closed for 11 days. Even more significantly, in Lower Manhattan, 95 percent of the copper wires in the neighborhood were destroyed by the corrosive floodwaters they soaked in during and after the storm. Significant parts of the network in Lower Manhattan were down for months after the storm as Verizon opted to replace damaged copper wiring with fiber, an upgrade that, over the long run, would benefit customers, but caused significant disruption for them in the post-storm period.

The cell network also experienced failure as cell antennas in Southern Manhattan, which tend to be located on building roofs and to use the electrical supplies of these buildings, stopped working shortly after power went out in the area. As a result, there was limited or no cell service below 34th Street for the duration of the power outage.

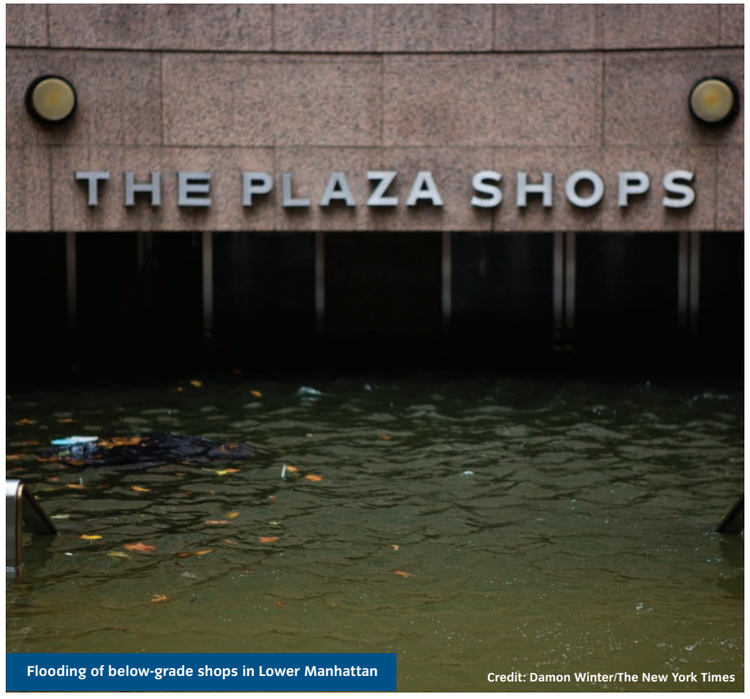
Sandy, meanwhile, had a huge impact on Southern Manhattan's transportation infrastructure. The power outage impacted the entire street network south of 34th Street as traffic signals and street lights were knocked out. The surge overwhelmed both of the major Manhattan highways encircling the coastline, inundating them with two to four feet of water which stayed several hours after the storm. Tunnels were flooded including the Holland and Queens Midtown tunnels, which remained closed for over a week. The Battery Park and West Street Underpasses, meanwhile, closed for two weeks, and the Hugh L. Carey Tunnel was closed for nearly three weeks as tens of millions of gallons of water were pumped from its depths.

Though the subway system was shut down preemptively as the storm approached, it still was severely impacted by Sandy, experiencing the worst flooding in its history. Floodwaters entered subway stations and tunnels through numerous low-lying entry points. Seven East River subway tunnels flooded, two of which were immersed in seawater from floor to ceiling. While some subway service was restored in Southern Manhattan and other areas of the city within two days of the storm, the cross-river tunnels were out of service longer, with

Risk Assessment: Impact of Climate Change

Major Risk Moderate Risk Minor Risk

	Scale of Impact			
Hazard	Today	2020s	2050s	Comments
Gradual				
Sea level rise				Future sea level rise likely would overtop some bulkheads on a regular basis, resulting in localized flooding
Increased precipitation				Minimal impact
Higher average temperature				Minimal impact
Extreme Events				
Storm surge				Significant risk of flooding in addition to limited wave action
Heavy downpour				Minimal impact
Heat wave				Greater strain on power system with potential for more failures; most significant impact on high-rise buildings
High winds				Building codes are calibrated to anticipated wind speeds, though existing building stock and equipment may be vulnerable



Flooding of below-grade shops in Lower Manhattan

Credit: Damon Winter/The New York Times

some closed for over a week. The South Ferry Station, which had only recently been completed and was the southern terminus of the 1 train, meanwhile, was damaged so badly that its predecessor had to be reopened while repairs were made, a process expected to take years as of the writing of this report.

Sandy also impacted Southern Manhattan's two DEP wastewater facilities. Both experienced service outages due to flooding, with the Manhattan Pumping Station down for 25 hours, and the Canal Street Pumping Station down for 42 hours. Though the shutdowns caused seawater mixed with runoff and sewage to be released into surrounding drainage areas, subsequent testing by DEP showed no significant water quality impacts.

What Could Happen in the Future

Going forward, the neighborhoods of Southern Manhattan face a variety of risks related to climate change, chief among them surge and flooding from coastal storms, which is likely to be exacerbated by sea level rise. *(See chart: Risk Assessment: Impact of Climate Change)*

Major Risks

Given the area's coastal exposure, the risk of flooding from storms is significant even today, as illustrated by the Preliminary Work Maps (PWMs) released in June 2013 by FEMA. According to the PWMs, the 100-year floodplain—the area with a 1 percent or greater chance of flooding in any given year—has expanded beyond the 100-year floodplain shown on the 1983 maps that were in effect when Sandy hit. *(See map: Comparison of 1983 FIRMs and Preliminary Work Maps)*

The PWMs reflect expansions of the floodplain typically of one block or less in almost all neighborhoods, with more pronounced expansions in the Lower East Side, Kips Bay, and in Chelsea. Like the 1983 maps, the new maps identify a V Zone, an area where waves are most forceful and could exceed three feet in height, all along the coastal edge of Southern Manhattan. This V Zone generally does not extend inland past the bulkhead.

Though the 100-year floodplain has expanded relatively modestly in terms of total area in Southern Manhattan, because of the high density of the area, even this modest expansion has resulted in a significant increase in the number of buildings in the floodplain. The number of buildings at risk has increased 73 percent (from 930 to 1,610 buildings, encompassing an additional 10,000 residential units).

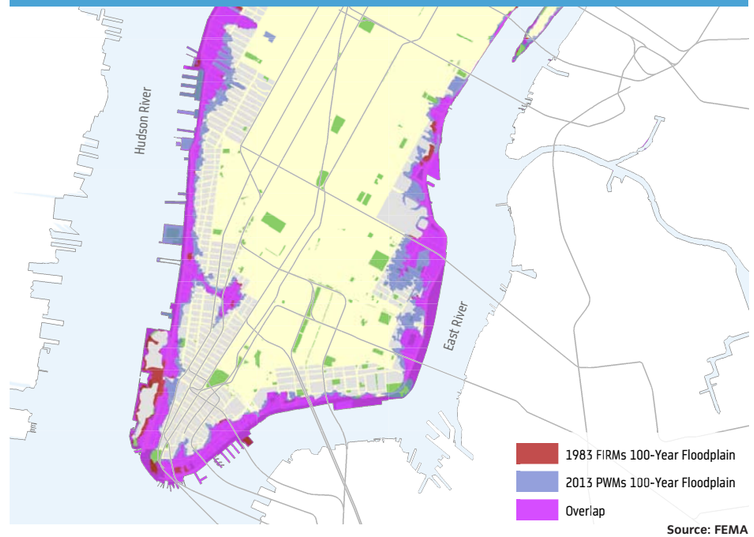
The floodplain on the PWMs includes 61,000 residents, over half of whom live in Chinatown and the Lower East Side. The built square footage in the Southern Manhattan floodplain has concurrently increased by 25 percent (from 105 million square feet to 132 million square feet).

Just as importantly, Base Flood Elevations (BFEs)—the height to which floodwaters could rise during a storm—have generally increased one to three feet throughout the area. These new BFEs show that the lowest-lying areas, along South Street from Lower Manhattan up to Chinatown, could experience flood heights from six to eight feet.

The increased BFEs present a particular challenge in Southern Manhattan with its multi-story and historic building stock. Elevation of ground floors, a possible response to higher BFEs in other parts of the country, is simply not possible or economically viable in Southern Manhattan—especially since the ground floors in many areas are devoted to retail, which adds to the vitality, safety, and economic well-being of these areas.

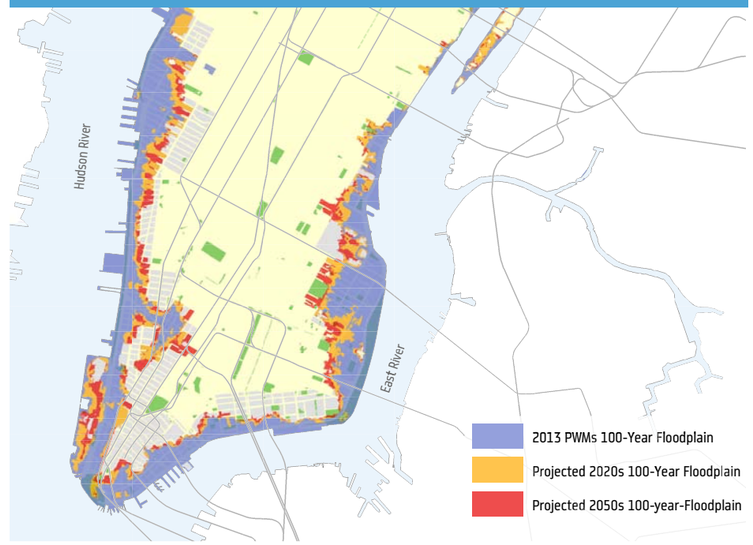
According to projections from the New York City Panel on Climate Change (NPCC), as described

Comparison of 1983 FIRMs and Preliminary Work Maps



Source: FEMA

Comparison of Preliminary Work Maps and Future Flooplains



Source: FEMA, CUNY Institute for Sustainable Cities

Buildings in the Floodplain

Buildings & Units	100-Year Floodplain			
	1983 FIRMs	2013 PWMs	Projected 2020s	Projected 2050s
Residential Buildings	450	940	1,400	1,650
Residential Units	32,000	42,000	60,800	68,000
Commercial and Other Buildings	480	670	910	1,080

Source: DCP PLUTO, FEMA, CUNY Institute for Sustainable Cities

Flooding of Battery Park Underpass

Credit: Michael Appleton/The New York Times

in Chapter 2 (*Climate Analysis*), sea levels are forecast to rise through the 2020s and 2050s. During this period, the floodplain will expand, and throughout the area, flood heights could increase, resulting in a risk of even higher floodwaters during storms. *(See map: Comparison of Preliminary Work Maps and Future Floodplains)*

The additional growth in the floodplains is anticipated in all Southern Manhattan areas including Battery Park City. According to NPCC's high-end projections, the 2050s floodplain may extend to First Avenue around Kips Bay and in some areas reach Second Avenue. In the Lower East Side, the projected floodplain would extend over a block inland and in some areas could reach Avenue A. In Lower Manhattan and Battery Park City, the floodplain is also expected to increase and encompass buildings at the lower tip of Manhattan. In Tribeca, the West Village, Chelsea, and Hudson Yards, the projected floodplain would extend inland nearly another block. Throughout Southern Manhattan, the number of at risk buildings could rise to approximately 2,300 buildings by the 2020s (a 43 percent increase over the PWMs) and to over 2,700 buildings by the 2050s (a further 18 percent increase over 2020). *(See table: Buildings in the Floodplain)*

Other Risks

The neighborhoods in Southern Manhattan face other climate risks as well. Sea level rise, for example, even without extreme weather events such as hurricanes, could, in some communities, lead to increased frequency and severity of street flooding on a chronic basis by the 2050s. This risk, which already exists for the areas to the north and south of the Brooklyn Bridge, is expected to increase in the decades to come.

Increased precipitation and more frequent and heavier downpours may result in some flooding. However, this risk is likely to be limited to localized areas. While future projections for changes in wind speeds are not available from the NPCC, a greater frequency of intense hurricanes by the 2050s could present a greater risk of high winds in the New York area. This may pose a threat to Southern Manhattan with its many densely packed high-rise structures and older buildings not constructed to modern wind standards.

Finally, higher average temperatures are not expected to cause meaningful impacts on the neighborhoods in Southern Manhattan. However, the increase in the number of heatwaves could lead to more frequent power outages.

Priorities from Public Engagement in Southern Manhattan

Since the Special Initiative for Rebuilding and Resiliency (SIRR) was launched in December 2012, the input of local stakeholders has helped shape an understanding of what happened during Sandy, what risks Southern Manhattan faces in relation to climate change, and what approaches make sense to address these risks.

Southern Manhattan is represented by a wide array of elected officials at the Federal, State, and local levels. It also is represented by five community boards. The area is further served by a large number of community-based organizations, civic groups, faith-based organizations, and other neighborhood stakeholders. All played an important role in relief and recovery efforts after Sandy. Throughout the process of developing this plan, SIRR staff benefited from numerous conversations—both formal and informal—with these groups and individuals, including, in Southern Manhattan, two task forces that met regularly.

SIRR also held a public workshop in March 2013 in Southern Manhattan, part of a series of such workshops held citywide in which over 1,000 New Yorkers participated to discuss issues affecting their neighborhoods and communicate their priorities for the future of their homes and communities. Generally, the on-the-ground insights provided at this public workshop helped SIRR staff to develop a deeper understanding of the specific priorities of, and challenges facing, the communities of Southern Manhattan.

Overall, out of the various task force and other meetings and public workshops attended by SIRR staff since January, several priorities for Southern Manhattan and the SIRR effort clearly emerged:

- Protect critical infrastructure–power, transit, telecommunications–from outages;
- Protect residential buildings and their vulnerable populations from building system outages;
- Protect retail and commercial businesses from flooding;
- Improve infrastructure to prevent future events from having widespread impacts; and
- Continue to strengthen post-event communication.

Southern Manhattan community outreach workshop

Task Force	Briefing Frequency	# of Stakeholders from Southern Manhattan
Elected Officials	Monthly	14 City, State, Federal elected officials
Community-Based Organizations	4 - 6 weeks	3 community boards 25+ faith-based, business, and community organizations

Southern Manhattan community outreach workshop

SOUTHERN MANHATTAN | Initiative Summary

Coastal Protection

Selected Citywide Measures

- A Install an integrated flood protection system in Lower Manhattan, including the Lower East Side
- B Install an integrated flood protection system at Hospital Row

* For additional Coastal Protection initiatives, see Coastal Protection section of Community Plan

- 1 Create an implementation plan and design for an integrated flood protection system for remaining Southern Manhattan areas
- 2 Conduct a study for a multi-purpose levee along Lower Manhattan's eastern edge to address coastal flooding and create economic development opportunities

Buildings

Selected Citywide Measures

- C Improve regulations for flood resiliency of new and substantially improved buildings in the 100-year floodplain
- D Rebuild and repair housing units destroyed and substantially damaged by Sandy
- E Study and implement zoning changes to encourage retrofits of existing buildings and construction of new resilient buildings in the 100-year floodplain
- F Amend the Building Code and complete studies to strengthen wind resiliency for new and substantially improved buildings
- G Encourage existing buildings in the 100-year floodplain to adopt flood resiliency measures through an incentive program and targeted mandate
- H Retrofit public housing units damaged by Sandy and increase future resiliency of public housing
- I Launch a sales tax abatement program for flood resiliency in industrial buildings
- J Clarify regulations relating to the retrofit of landmarked structures in the 100-year floodplain
- K Amend the Building Code to improve wind resiliency for existing buildings and complete studies of potential retrofits

* For additional Buildings initiatives, see Building section of Community Plan

Critical Infrastructure

Selected Citywide Measures

- L Work with utilities and the Public Service Commission (PSC) to harden key electric transmission and distribution infrastructure against flooding
- M Work with utilities, regulators, and gas pipeline operators to harden the natural gas system against flooding
- N Work with steam plant operators and the PSC to harden steam plants against flooding
- O Work with utilities and regulators to minimize electric outages in areas not directly affected by climate impacts
- P Require the retrofitting of existing hospitals in floodplains
- Q Support HHC's efforts to protect public hospital emergency departments from flooding
- R Require retrofitting of nursing homes in floodplains
- S Require retrofitting of adult care facilities in floodplains
- T Reconstruct and resurface key streets damaged by Sandy
- U Elevate traffic signals and provide backup electrical power
- V Protect NYCDOT tunnels in Lower Manhattan from flooding
- W Protect Staten Island Ferry and private ferry terminals from climate change-related threats
- X Call on non-City agencies to implement transportation strategies to address climate change threats
- Y Expand the city's Select Bus Service (SBS) network
- Z Harden or otherwise modify shoreline parks to protect adjacent communities
- AA Harden pumping stations

* For additional Critical Infrastructure initiatives, see Critical Infrastructure sections of Community Plan

- 3 Construct physical enhancements to Water Street

Community & Economic Recovery

Selected Citywide Measures

- BB Launch business recovery and resiliency programs
- CC Launch the Neighborhood Game Changer Competition
- Call for Neighborhood Retail Recovery Program
  - Lower Manhattan (Water St. corridor, South Street. Seaport district, and Greenwich St.)
  - Chinatown (East Broadway and Madison St.)
  - Lower East Side (Avenues B, C, and D)
  - Tribeca (Canal St., West St. and Greenwich St.)
  - West Village (West St. and Washington St.)
  - Chelsea (10th and 11th Aves. and 23rd St.)
- DD Support local merchants in improving and promoting local commercial corridors

* For additional Community & Economy Recovery initiatives, see Community & Economy Recovery section of Community Plan

- 4 Implement temporary programming of Water Street privately-owned public spaces (POPS)
- 5 Launch a program to enable permanent improvements to Water Street privately owned public spaces (POPS)
- 6 Implement planned and ongoing investments in South Street Seaport
- 7 Use the Job Creation & Retention Program to attract and retain businesses in Sandy-impacted areas of Lower Manhattan
- 8 Expand Take the HELM program (Hire and Expand in Lower Manhattan)
- 9 Implement planned and ongoing investments by the City and private partners
  - East River Waterfront
  - Pier 35 EcoPark
  - Pier 42 Waterfront Park
  - Battery Park Play Space
  - Peck Slip Park
  - Asser Levy Park
  - Hudson River Park
  - The High Line
  - Peck Slip Reconstruction
  - Battery Maritime Building
  - Pier A Renovation
  - Hudson Yards South Tower
  - Peck Slip School
  - National September 11th Memorial and Museum

This chapter contains a series of initiatives that are designed to mitigate the impacts of climate change on Southern Manhattan. In many cases, these initiatives are both ready to proceed and have identified funding sources assigned to cover their costs. With respect to these initiatives, the City intends to proceed with them as quickly as practicable, upon the receipt of identified funding.

Meanwhile, in the case of certain other initiatives described in this chapter, though these initiatives may be ready to proceed, they still do not have specific sources of funding assigned to them. In Chapter 19 (*Funding*), the City describes additional funding sources, which, if secured, would be sufficient to fund the full first phase of projects and programs described in this document over a 10-year period. The City will work aggressively on securing this funding and any necessary third-party approvals required in connection therewith (i.e., from the Federal or State governments). However, until such time as these sources are secured, the City will only proceed with those initiatives for which it has adequate funding.

Southern Manhattan Community Rebuilding and Resiliency Plan

Southern Manhattan is an iconic center of activity for the city, the nation, and the world. Its role as a hub for the city and beyond makes its resiliency and continued economic vitality critical.

The following is a multilayered plan that not only applies citywide strategies to Southern Manhattan but also provides strategies designed to address the area's specific needs and particular vulnerabilities. In anticipation of future climate change-related risks, this plan proposes ways that Southern Manhattan neighborhoods can adapt by: addressing inundation along the entire coastline; providing opportunities to retrofit the area's most vulnerable building stock; protecting and improving critical infrastructure; and focusing investments in strategic areas, such as the Water Street office district and the historic South Street Seaport, to advance a long-term and sustainable recovery.

Coastal Protection

As Sandy illustrated, the greatest extreme weather-related risk faced by New York City is storm surge, the effects of which are likely to increase given current projections of sea level rise. Going forward, it is anticipated that climate change will render coastal regions of the city, including Southern Manhattan, even more vulnerable to these risks.

While it is impossible to *eliminate* the chance of flooding in coastal areas, the City will seek to *reduce* its frequency and effects—mitigating the impacts of sea level rise, storm waves including erosion, and inundation on the coastline of the city generally and Southern Manhattan in particular. Among the strategies that the City will use to achieve these goals will be the following: increasing coastal edge elevations; minimizing upland wave zones; protecting against storm surge; and improving coastal design and governance. When evaluating coastal protection, other priorities including navigation and ongoing efforts to improve water quality and natural habitats also will be considered prior to implementation, where appropriate.

The initiatives described below provide important examples of how the City intends to advance its coastal protection agenda citywide. These initiatives will have a significant positive impact on the residents, businesses, and nonprofits of Southern Manhattan. Taken together, when completed, the first three coastal protection initiatives described below would provide enhanced protection for over 750 buildings representing nearly 27,000 housing units as well as many businesses and much of the critical infrastructure in Southern Manhattan.

For a full explanation of the following initiatives and a complete description of the City's comprehensive coastal protection plan, please refer to Chapter 3 (*Coastal Protection*).

Coastal Protection Initiative 6
Raise bulkheads in low-lying neighborhoods to minimize inland tidal flooding

Bulkheads provide the first line of defense against flooding in many neighborhoods, including Southern Manhattan, but throughout the city, many bulkheads are built to an elevation that may be insufficient given the latest projections of sea level rise by 2050. Subject to available funding, the City, therefore, will launch a program to raise bulkheads and other shoreline structures across the five boroughs in low-lying areas most at risk of daily or weekly tidal flooding, a phenomenon that could impact parts of Southern Manhattan's shoreline by the 2050s. The Mayor's Office of Long-Term Planning and Sustainability (OLTPS) will work with the New York City Economic Development Corporation (NYCEDC) to manage this program, to begin implementation in 2013, in conjunction with the new citywide waterfront inspections program described in Chapter 3.

Coastal Protection Initiative 21
Install an integrated flood protection system in Lower Manhattan, including the Lower East Side

Manhattan's East River edge from the Brooklyn Bridge up through the Lower East Side suffered the most extensive inland flooding in Southern Manhattan. The area, which includes parts of Chinatown and the Lower East Side, is already in the 100-year floodplain and the vulnerability of the area is expected to grow as the climate changes.

This area includes not only a very large residential population (70,000 people), but also a residential population that lives at among the highest densities in the United States (138 people per acre, versus a citywide average of 42 people per acre and 89 people per acre in the rest of Southern Manhattan). The area is also home to the largest number of low- and moderate-income households in Southern Manhattan, with over 9,000 NYCHA housing units alone. Meanwhile, critical infrastructure located in the area, which if compromised, could have citywide impacts. These assets include support structures for the subway system, Con Edison

Conceptual Rendering of Lower East Side Flood Protection System

Non-storm condition

Pre-storm condition

substations, a DEP pumping station, and the FDR Drive.

Subject to available funding, the City, therefore, will install the first phase of what is intended eventually to be an integrated flood protection system for all of Southern Manhattan, along the coast of the Lower East Side and Chinatown. This system will be composed of permanent features, temporary features, landscaping improvements, and drainage improvements to create a line of protection that would be fully deployed only during pre-storm conditions. The protection would be designed to produce only a minimal impact on, and generally to support, neighborhood fabric during non-storm conditions. The expected alignment of this first phase would start north of the Brooklyn Bridge and continue north along South Street to approximately East 14th Street. The goal is for design work on this first phase to begin in 2014, with completion in 2016. (See rendering: *Conceptual Rendering of Lower East Side Flood Protection System*)

In addition to the foregoing, the City also will consider extending the first phase of this integrated flood protection system south from the alignment described above to Lower Manhattan, including the Financial District. This is because, though the area contains a smaller and less economically vulnerable residential population and is less densely populated than the Lower East Side and Chinatown, it is a major hub of commercial activity for the region and, like the Lower East Side and Chinatown, contains vital infrastructure. Accordingly, the City will work with the local community, including the local business community and property owners, to explore alternative private financing sources for the aforementioned southern extension that could be leveraged to secure new sources of public financing. By way of example, such private sources could include a modest per-square-foot assessment on commercial space that would be protected by this extension. When completed, the expected alignment of this extension would start at the southern end of the system proposed for the Lower East Side and Chinatown and would run south along South Street to Battery Park, with a small section running along West Street, north of Battery Park City. If funding were identified, the timing for the southern extension could be consistent with the schedule above.

Coastal Protection Initiative 22
Install an integrated flood protection system at Hospital Row

Bellevue Hospital and neighboring healthcare facilities flooded during Sandy and remain at risk of flooding during extreme weather events in the future. Subject to available funding, the City, therefore, will install an integrated flood protection system at Hospital Row north of 23rd Street in Manhattan. OLTPS will work with multiple agencies to design and construct this project. The expected alignment will be along the service road of the FDR Drive, utilizing passive floodwalls and other localized measures where appropriate to integrate the system. The system will specifically enhance protection to Bellevue Hospital, a critical trauma facility, and could potentially integrate with existing plans by neighboring facilities operated by New York University and the Veterans Administration. The goal is to complete design in 2014 with project completion by 2016.

Beyond the priority coastal protection projects described in Chapter 3, including those summarized briefly above, the City is proposing

Conceptual Rendering of Lower Manhattan Multi-Purpose Levee

additional coastal protection initiatives specific to Southern Manhattan's vulnerabilities.

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Southern Manhattan Initiative 1

Create an implementation plan and design for an integrated flood protection system for remaining Southern Manhattan areas

As described above, Sandy showed that the entire shorefront of Southern Manhattan is vulnerable to coastal flooding. This vulnerability is expected to increase as the climate changes. Subject to available funding, the City, therefore, will create an implementation plan for an integrated flood protection system to protect the remainder of the Southern Manhattan shorefront, outside of the first phase system described above. The implementation plan and design work will focus on Tribeca, the West Village, Chelsea, Hudson Yards, Stuyvesant Town, and Kips Bay. The intent is for the entirety of the system (first and subsequent phases) to be fully integrated.

Southern Manhattan Initiative 2

Conduct a study for a multi-purpose levee along Lower Manhattan's eastern edge to address coastal flooding and create economic development opportunities

The eastern edge of Lower Manhattan, particularly from the Battery north to Chinatown, is one of the lowest-lying areas in Southern Manhattan and is, therefore, subject to flooding. This vulnerability, demonstrated during Sandy, is likely to get worse as the climate changes. Though the integrated flood protection system described above could provide substantial protection during extreme weather events, there may need to be a longer-term approach that not only could offer more permanent protection, but also, over time, could be self-financing. Subject to available funding, the City, therefore, will study the creation of a new multi-purpose levee along the eastern edge of Lower Manhattan from the Battery Maritime Building to Pier 35, which would provide protection against multiple climate change-related threats, including storm surge and sea level rise. This approach would provide the protective value of a traditional levee while also providing new land on which commercial and residential buildings could be constructed, both to accommodate the City's growth and to help finance the construction of the multi-purpose levee. The intention would be for this new East River neighborhood to serve much the same function as Battery Park City does along the Hudson River. *(See rendering: Conceptual Rendering of Lower Manhattan Multi-Purpose Levee)*

The multi-purpose levee to be studied could extend from the current East River shoreline out to the existing pierhead line, with the levee's elevation to be determined by current floodplain data, adjusted for expected sea level rise well beyond 2050. Such a protection system would be a major change to the coastal edge and require consideration of water quality, the river ecology, and integration into the existing urban fabric. The study will, therefore, have to explore integrating existing waterfront uses—such as Pier 17, the South Street Seaport Museum vessels, the heliport, and the Pier 11 ferry slips—into the design of the levee. Additionally, the study will explore the opportunities for reimaging the FDR Drive in the area to improve access to the waterfront and the new development area. Yet another component of the study will be an investigation of the potential to coordinate the construction of the levee with the extension of the Second Avenue Subway to its intended terminus at Hanover Square and Water Street. The goal is for NYCEDC to launch this study in 2013.

Buildings

The city's buildings give physical form to New York. As Sandy demonstrated, however, the building stock citywide, including in Southern Manhattan, is highly vulnerable to extreme weather events—a vulnerability that is expected to increase in the future. While the coastal protection measures outlined above are designed to reduce the effects of sea level rise, storm surge, and wave action on the city and the neighborhoods of Southern Manhattan, these measures will not completely eliminate those risks. They also will take time to design, fund, and build. It is equally important, therefore, to supplement these measures by pursuing resiliency at the *building* level.

To achieve building-level resiliency, the City will seek to protect structures in Southern Manhattan and throughout the five boroughs against a spectrum of climate risks, including not only flooding but also high winds and other extreme events. Among the strategies that the City will use to achieve these goals will be to construct new buildings to the highest resiliency standards and retrofit as many existing buildings as possible so that they will be significantly better prepared to handle the impacts of extreme weather events.

The initiatives described below provide important examples of how the City intends to advance building resiliency citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits of Southern Manhattan. For a full explanation of the following initiatives and a complete description of the City's five-borough building resiliency plan, please refer to Chapter 4 (*Buildings*).

Buildings Initiative 1

Improve regulations for flood resiliency of new and substantially improved buildings in the 100-year floodplain

Though buildings constructed to modern Construction Codes generally performed well in Sandy, given the increasing risk of flooding that is likely with climate change, modifications are warranted. The City, therefore, will seek to amend the Construction Codes and Zoning Resolution to provide for strengthened requirements that will, among other things, improve the design of new buildings through the application of appropriate resiliency measures that are calibrated to the best floodplain data available over time and that critical building systems are better-protected from flood risks. In 2013, the City—through OLTPS—will seek to implement these code changes and the Department of City Planning (DCP) will continue to take zoning changes through the public review process, with the goal of adoption before the end of the year. If adopted, they will improve resiliency for the significant amount of mixed-use development likely to take place within the 100-year floodplain over time throughout Southern Manhattan.

Buildings Initiative 2

Rebuild and repair housing units destroyed and substantially damaged by Sandy

Roughly 23,000 private residential buildings encompassing nearly 70,000 housing units were damaged or destroyed during Sandy. Subject to available funding, the City, therefore, through the Mayor's Office of Housing Recovery Operations (HRO), will provide financial and other assistance to owners of residential properties that were destroyed or substantially damaged during Sandy, including approximately 30 residential buildings encompassing approximately 400 housing units in Southern Manhattan. To address the damages sustained and to more effectively prepare these significantly damaged buildings for future storm events, the City either will assist owners or, in limited cases meeting City criteria, will facilitate the acquisition of properties by new owners whom it will assist, in rebuilding and substantially improving these properties based on the best floodplain data available over time. Additionally, the City is seeking to incorporate resiliency measures into approximately 500 to 600 multifamily properties that sustained minor damage including many publicly assisted buildings properties such as those developed pursuant to the Mitchell-Lama program and other affordable housing programs. The City, therefore, will support the retrofit of these publicly-assisted buildings, such as those developed pursuant to Mitchell-Lama and other affordable housing programs.

Buildings Initiative 3

Study and implement zoning changes to encourage retrofits of existing buildings and construction of new resilient buildings in the 100-year floodplain

The City, through DCP, will undertake a series of citywide and neighborhood-specific land use studies to address key planning issues in severely affected and vulnerable communities. As part of these studies, the City will identify ways to facilitate the voluntary construction of new, more resilient building stock, and to encourage voluntary retrofits of existing vulnerable buildings over time. To be undertaken in close consultation with local residents, elected officials, and other community stakeholders, these land use studies will focus on the challenges posed by the combination of flood exposure of the applicable neighborhoods; the vulnerability of the building types that are found in these neighborhoods; and site conditions in these areas that can make elevation or retrofit of vulnerable buildings expensive or complicated.

In Southern Manhattan, DCP, will examine neighborhoods with active-ground floor uses and adaptation challenges, including retail and mixed-use buildings in the greater Seaport area and in the neighborhoods along the East River from the East Village to Chinatown. Subject to available funding, the goal is for DCP to commence these studies in 2013. Thereafter, DCP would move to implement changes, if any, that it deems to be appropriate, based on the results.

Buildings Initiative 5

Work with New York State to identify eligible communities for the New York Smart Home Buyout Program

The City will evaluate opportunities for collaboration with the State in connection with its home buyout program, using an objective set of criteria developed by the City, including extreme vulnerability, consensus among a critical mass of contiguous local residents, and other relevant factors. It is anticipated that these criteria will be met in a limited number of areas citywide. As of the writing of this report, no areas have been identified for this program in Southern Manhattan.

Buildings Initiative 6

Amend the Building Code and complete studies to strengthen wind resiliency for new and substantially improved buildings

As noted above, buildings constructed to modern Building Code standards generally performed well during Sandy. Sandy, however, brought relatively weak winds, compared to other hurricanes. Given the possibility of more frequent or intense wind events in the future, modifications to the Building Code are warranted. The City, therefore, through OLTPS will seek to amend the Building Code to provide for strengthened requirements so that new buildings citywide can meet enhanced standards for wind resiliency. The City will further study whether additional wind resiliency standards should be required going forward. The amendments will be submitted to the City Council for adoption, and the study will commence, in 2013.

Buildings Initiative 7

Encourage existing buildings in the 100-year floodplain to adopt flood resiliency measures through an incentive program and targeted mandate

Even if every structure destroyed or damaged by Sandy were rebuilt to the highest resiliency standards, this would still leave tens of thousands of existing structures in the 100-year floodplain vulnerable—with more becoming vulnerable as the climate changes. Subject to available funding, the City, therefore, will launch a $1.2 billion program to provide incentives to owners of existing buildings in the 100-year floodplain to encourage them to make resiliency investments in those buildings. Of the up to $1.2 billion available through the program, the City will reserve up to $100 million for 1- to 3-family homes, up to $500 million for distribution across the five boroughs based on

each borough's share of vulnerable buildings citywide, and $100 million for affordable housing developments. The City also will mandate that large buildings (those with seven or more stories that are more than 300,000 square feet in size) undertake certain flood resiliency investments by 2030. If the City consistently achieves its stated goal of encouraging significant resiliency retrofit investments for the vast majority of the built floor area in the 100-year floodplain in the five boroughs, over 30,000 housing units encompassing approximately 90 million square feet of built space in Southern Manhattan would, over time, be made meaningfully less vulnerable. The goal is to launch these programs in 2013.

Buildings Initiative 8
Establish Community Design Centers to assist property owners in developing design solutions for reconstruction and retrofitting, and connect them to available City programs

The City, through HRO, will establish Community Design Centers in neighborhoods across the city, potentially including Southern Manhattan, to assist property owners in developing design solutions for reconstruction and retrofitting, and connect them to available City programs. The Centers would be managed by the City—through agencies such as HRO, HPD, DOB, DCP, and NYCEDC—with support from local partners.

Buildings Initiative 9
Retrofit public housing units damaged by Sandy and increase future resiliency of public housing

During Sandy, public housing developments owned and operated by NYCHA suffered significant damage throughout the city. Still more were not impacted by Sandy but remain vulnerable to extreme weather, with even more likely to become vulnerable as the climate changes. The City, therefore, will through NYCHA, repair public housing developments across the City that were damaged by Sandy, incorporating new flood resiliency measures. In Southern Manhattan, 84 buildings containing nearly 10,000 units will be repaired. NYCHA also will undertake a planning process to identify additional resiliency investments in developments that are vulnerable to weather-related events, even if they were unaffected by Sandy. In Southern Manhattan, NYCHA, subject to available funding, is evaluating resiliency investments, subject to available funding, in 12 buildings containing over 850 additional units.

Buildings Initiative 10
Launch a sales tax abatement program for flood resiliency in industrial buildings

As Sandy demonstrated, many industrial buildings are vulnerable to extreme weather, with more likely to become vulnerable as the climate changes. However, many industrial buildings operate on thin margins making it challenging to invest in resiliency. The City, through the New York City Industrial Development Agency (NYCIDA), therefore, will launch a $10 million program to provide incentives to owners of industrial buildings to encourage them to make resiliency investments in those buildings. The program will prioritize 1- to 2-story buildings with more than four feet between their actual ground elevation and the applicable BFE. In Southern Manhattan, approximately 27 industrial buildings with over 2 million square feet of floor area will be eligible for this program. This program will be launched in 2013.

Buildings Initiative 11
Launch a competition to increase flood resiliency in building systems

Many existing strategies for improving resiliency in buildings are either imperfect, expensive, or a combination of both. The City, through NYCEDC, therefore, will launch an approximately $40 million Resiliency Technologies Competition using allocated Community Development Block Grant (CDBG) funding to encourage the development, deployment, and testing of new resiliency technologies for building systems. In Southern Manhattan, 1,610 buildings will be eligible to benefit from this competition. The program will be launched in 2013.

Buildings Initiative 12
Clarify regulations relating to the retrofit of landmarked structures in the 100-year floodplain

The City, through the Landmarks Preservation Commission, will clarify the Commission's regulations to assist owners of landmarked buildings and properties in landmarked districts in the 100-year floodplain who are contemplating retrofit projects. In Southern Manhattan, there are over 170 landmarked buildings in the floodplain, including buildings in portions of 19 historic districts. The Commission will issue its clarifying regulations in 2013.

Buildings Initiative 13
Amend the Building Code to improve wind resiliency for existing buildings and complete studies of potential retrofits

As noted above, given the possibility for more frequent intense wind events in the future, modifications to the Building Code are warranted. The City, therefore, through OLTPS, will seek to amend the Building Code and expand the existing DOB Façade Inspection Safety Program for high-rise buildings to include rooftop structures and equipment. The City will further study whether additional wind resiliency standards are required going forward. These amendments will be submitted to the City Council for adoption and the study will commence in 2013.

Insurance

Insurance can help provide residents and businesses with financial protection against losses from climate change and other types of risks. Sandy not only highlighted the importance of insurance, it also revealed that many New Yorkers are exposed to flood losses, which are not covered in standard homeowners or small business property insurance policies. Citywide, 95 percent of homeowners carry homeowners insurance, but when Sandy struck less than 50 percent of residential buildings in the effective 100-year floodplain had coverage through the National Flood Insurance Program (NFIP), a Federal program, administered by FEMA that provides flood insurance to properties in participating communities like New York City. While larger properties, in particular large commercial properties, tend to purchase flood insurance through the private market, NFIP is the primary source of flood insurance for homeowners throughout the country. Furthermore, Sandy drew attention to the significant cost increases in flood insurance that many New Yorkers will soon face, resulting from recent reforms to the NFIP as required by the Biggert-Waters Flood Insurance Reform Act.

The City will use several strategies to encourage more New Yorkers to seek coverage and to help the NFIP meet the needs of policyholders citywide. Specifically, the City will work to: address affordability issues for the most financially vulnerable policyholders; define mitigation measures that are feasible in an urban environment such as the Southern Manhattan communities and create commensurate premium credits to lower the cost of insurance for property owners who invest in these measures; encourage the NFIP to expand pricing options (including options for higher deductibles) to give potential policyholders more flexibility to make choices about coverage; and launch efforts to improve consumer awareness, to help policyholders make informed choices. The initiatives described below are important examples of how the City will advance these strategies. These initiatives will have a positive impact on the residents, small businesses and nonprofits in this community. For a full explanation of the following initiatives and a complete description of the City's five-borough insurance reform plan, please refer to Chapter 5 (*Insurance*).

Insurance Initiative 1
Support Federal efforts to address affordability issues related to reform of the NFIP

The City will call on FEMA to work with the National Academy of Sciences to complete the study of flood insurance affordability, as required under the Biggert-Waters Act. The City will urge its Federal government partners to comply with this provision of the Act and take swift action to enact the recommendations.

Insurance Initiative 4
Call on FEMA to develop mitigation credits for resiliency measures

The NFIP provides few incentives for property owners to protect their buildings from flood damage and reduce their premiums, other than by elevating their buildings—actually lifting structures above flood elevation levels. In an urban environment such as Southern Manhattan, for a variety of reasons, elevation can be impractical, undesirable, and/or economically infeasible. Fortunately, other mitigation options are available. The City, therefore, will call upon FEMA to provide appropriate premium credits for mitigation measures other than elevation.

Insurance Initiative 6
Call on FEMA to allow residential policyholders to select higher deductibles

Flexible pricing options can encourage more people, especially those not required to carry insurance, to purchase insurance coverage that suits their needs. A higher-deductible option can substantially reduce premium costs to policyholders while remaining truly risk-based. Currently under the NFIP, deductibles up to $50,000 are allowed for commercial policies, but residential policies are limited to a maximum deductible of $5,000. The City, therefore, will call upon FEMA to allow homeowners that are not required to carry NFIP policies to purchase high-deductible policies that will protect them from catastrophic loss; initial estimates indicate that doing so could reduce insurance premiums by about half.

Critical Infrastructure

A resilient New York requires protection of its critical services and systems from extreme weather events and the impacts of climate change. This infrastructure includes the city's utilities and liquid fuel system, its hospitals and other healthcare facilities, telecommunications network, transportation system, parks, wastewater treatment and drainage systems, as well as other critical networks—all vital to keeping the city, including Southern Manhattan, running.

Utilities

The city's electric, natural gas, and steam systems are essential to everyday life in areas throughout the five boroughs, including Southern Manhattan. As Sandy proved, however, these systems are highly vulnerable to extreme weather events, with 800,000 customers losing electricity and 80,000 customers losing natural gas service during Sandy across the City, including approximately 230,000 that lost electricity service in the borough of Manhattan. This vulnerability will only grow as the climate changes.

Among the strategies that the City will use to address these challenges for residents of Southern Manhattan and other parts of the city will be to: call for risk-based analysis of low-probability but high-impact weather events to be incorporated into utility regulation and investment decision-making; call for capital investments that harden energy infrastructure and make systems more flexible in responding to disruptions and managing demand; and better diversify the city's sources of energy. The initiatives described below provide important examples of how the City intends to advance utilities resiliency citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits of Southern Manhattan. For a full explanation of the following initiatives and a complete description of the City's five-borough utilities resiliency plan, please refer to Chapter 6 (*Utilities*).

Utilities Initiative 5
Work with utilities and the Public Service Commission (PSC) to harden key electric transmission and distribution infrastructure against flooding

Various transmission substations, distribution substations, utility tunnels, and underground equipment in the city are at risk of flooding during extreme weather, including 5 substations in Southern Manhattan. For example, 40 percent of transmission substations are in the 100-year floodplain today, and 67 percent are likely to be in the 100-year floodplain by the 2050s. The City, through OLTPS, will work with Con Edison and the Long Island Power Authority (LIPA) to prioritize these assets based on their roles in system reliability and to harden them as appropriate. This effort will begin in 2013.

Utilities Initiative 7
Work with utilities, regulators, and gas pipeline operators to harden the natural gas system against flooding

Although the city's high-pressure gas transmission system performed relatively well during Sandy, there were instances where remote operation of parts of the system failed. Additionally, the distribution system had localized outages due to water infiltration. Seeking to limit the compromising effects of future floods on both the system's backbone and the ability of Con Edison and National Grid to control and monitor the system, the City, through OLTPS, will work with the PSC, Con Edison, and National Grid to harden control equipment against flooding. In addition, the City will call upon Con Edison and National Grid to take steps to prevent water from infiltrating its gas pipes. This effort will begin in 2013.

Utilities Initiative 8
Work with steam plant operators and the PSC to harden steam plants against flooding

Many buildings within Southern Manhattan—including critical hospitals—rely upon Con Edison steam service for heating and cooling. All of the plants providing this steam are in existing floodplains and are also vulnerable to non-flood-related power outages. The City, therefore, will call upon Con Edison and the PSC to increase the resiliency of these plants by taking flood-protection measures, including adding floodwalls, sealing building perimeters, raising equipment, and installing flood-protected back-up generators at each plant (to allow Con Edison to continue to deliver steam even during power outages).

Utilities Initiative 12
Work with utilities and regulators to minimize electric outages in areas not directly affected by climate impacts

Coastal flooding typically requires the shutdown of electrical feeder circuits that could potentially be exposed to floodwaters. In dense areas such as Southern Manhattan, this affects thousands of customers not directly in the floodplain. To reduce the incidence of these so-called sympathetic outages, the City will work with the utilities to design and implement new network

boundaries. In Southern Manhattan for example, had the network been configured in this manner, New York Downtown Hospital, which is outside of the flood zone, may have been able to avoid preemptive outages and thus the need to evacuate in advance of Sandy. In Southern Manhattan, a particular focus should be on hospitals and other critical facilities.

Utilities Initiative 14
Work with utilities and regulators to speed up service restoration for critical customers via system configuration

After extreme weather events, electric utilities may not be able to restore electrical circuits until all damaged customer equipment in an applicable area is repaired or replaced. For critical customers, this can mean a delay in the restoration of service even if that customer's own equipment is functional. The City, therefore, will work with Con Edison and LIPA to identify cost-effective ways to isolate critical customers, installing switches and other equipment along feeders that supply them.

Utilities Initiative 21
Work with public and private partners to scale up distributed generation (DG), including microgrids

The city's DG systems, including microgrids, have the potential for significant expansion—but are constrained by regulations, financing challenges, and lack of information. The City, through OLTPS and the New York City Distributed Generation Collaborative—a stakeholder group convened by the City in 2012—will continue efforts to achieve a PlaNYC goal of installing 800 megawatts of DG citywide by 2030. These efforts will include reform of PSC tariffs and other regulatory changes, expansion of low-cost financing, and provision of technical assistance to property owners and developers. This ongoing effort will continue in 2013.

Liquid Fuels

The liquid fuels supply chain is essential for everyday life throughout the five boroughs, including in Southern Manhattan. Sandy demonstrated the vulnerability of this system to extreme weather events. In the aftermath of Sandy, citywide—and particularly in Southern Manhattan—there were long lines at gas stations and other challenges for drivers, including emergency responders. The vulnerability of this system will only grow as the climate changes.
Among the strategies that the City will use to address these challenges for residents of Southern Manhattan and other parts of the city will be to: develop a strategy for the hardening of liquid fuel infrastructure along the supply chain; increase redundancy and fuel supply flexibility; and increase supply availability for vehicles critical to the city's infrastructure, safety, and recovery from significant weather events. The initiatives described below provide important examples of how the City intends to advance its liquid fuel resiliency agenda citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits of Southern Manhattan. For a full explanation of the following initiatives and a complete description of the City's five-borough liquid fuels resiliency plan, please refer to Chapter 7 (*Liquid Fuels*).

Liquid Fuels Initiative 1
Call on the Federal government to convene a regional working group to develop a fuel infrastructure hardening strategy

The fuel supply shortage after Sandy was caused mainly by damage to infrastructure in New Jersey and other states, where the City and State of New York have no regulatory or legislative authority or oversight. The City, through OLTPS, will call on the Federal Hurricane Sandy Rebuilding Task Force and the United States Department of Energy to convene regional stakeholders to develop a strategy for hardening key infrastructure against future extreme weather. This effort will be launched in 2013.

Liquid Fuels Initiative 4
Work with New York State to provide incentives for the hardening of gas stations to withstand extreme weather events

New York State's 2013–2014 budget required that certain retail fuel stations invest in equipment that would allow them to connect generators quickly in the event of a power loss, and enter into supply contracts for emergency generators. The City, through OLTPS, will support the State in the design and implementation of this generator program, an effort that will include working with the New York State Energy Research and Development Authority (NYSERDA) to develop an incentive program to minimize the financial impact of the requirements on the businesses involved. In addition, OLTPS will work with the State to develop incentives to encourage retail fuel stations to implement resiliency measures other than back-up power capability. This effort will be launched in 2013.

Liquid Fuels Initiative 5
Enable a subset of gas stations and terminals to have access to backup generators in case of widespread power outages

Gas stations are vulnerable to widespread power outages resulting from extreme weather events, which could prevent them from dispensing fuel. In New York State's 2013–2014 budget, NYSERDA was directed to develop a generator pool program for gas stations. The City, through its Office of Emergency Management (OEM), will work with NYSERDA, FEMA, and the USACE in 2013 and beyond to develop such a pool and to create a pre-event positioning plan to enable the ready deployment of generators to impacted areas in the wake of a disaster.

Liquid Fuels Initiative 8
Develop a package of City, State, and Federal regulatory actions to address liquid fuel shortages during emergencies

Various regulations relating to the transportation and consumption of fuels in New York City limit the flexibility of the market to respond to disruptions, including following extreme weather events. The City, through OEM, will work with the State and Federal governments to prepare an "off-the-shelf" package of regulatory measures for use in the event of a liquid fuels shortage to allow supply-demand imbalances in the fuel supply to be mitigated more quickly. This effort will be launched in 2013.

Liquid Fuels Initiative 9
Harden municipal fueling stations and enhance mobile fueling capability to support both City government and critical fleets

The City must be able to respond quickly to a fuel supply disruption, providing continuous fueling to vehicles that are critical for emergency response, infrastructure rebuilding, and disaster relief. The City, through the Department of Citywide Administrative Services (DCAS), will procure fuel trucks, generators, light towers, forklifts, and water pumps to permit the City to put in place emergency fueling operations immediately following a disruption in the fuel supply chain. DCAS also will issue a Request for Expressions of Interest (RFEI) to potential suppliers of liquid fuels to evaluate options for sourcing such fuel during emergencies. The procurement effort will be launched in 2013, with the RFEI to follow in 2014.

Healthcare

The city's healthcare system is critical to the well-being of New Yorkers throughout the five boroughs, including in Southern Manhattan. This system is also a major economic engine for the city as a whole. This is especially true for Southern Manhattan, with four hospitals, several nursing homes and adult care facilities, and a network of community-based facilities, doctors' offices, and pharmacies support the local area. Sandy exposed this system's vulnerabilities, which are expected to grow as the climate changes.

Among the strategies that the City will use to address these challenges for residents of Southern Manhattan and other parts of the city will be to: build new hospitals, nursing homes, and adult care facilities to higher resiliency standards and harden existing facilities to protect critical systems; seek to keep lines of communication open between patients and providers, even during extreme weather events; and enable community-based providers to reopen quickly after a disaster. The initiatives described below provide important examples of how the City intends to advance its healthcare resiliency agenda citywide. These initiatives will have a positive impact on the residents, and healthcare providers of Southern Manhattan. For a full explanation of the following initiatives and a complete description of the City's five-borough healthcare resiliency plan, please refer to Chapter 8 (*Healthcare*).

Healthcare Initiative 2
Require the retrofitting of existing hospitals in floodplains

Many existing hospital buildings in the floodplain remain vulnerable to the impact of storm surge, with more likely to become vulnerable as the climate changes. The City, through OLTPS, therefore, will seek to amend the Construction Code to require existing hospital buildings in the 500-year floodplain—including Bellevue Hospital, New York University's Langone Medical Center, and voluntarily the Veterans Administration Hospital—to meet by 2030 a subset of the amended Construction Code standards for flood-resistant design. To minimize the risk of emergency evacuations and extended closures, these hospitals will be required to protect their electrical equipment, emergency power system, and domestic water pumps to the 500-year flood elevation. These hospitals also will be required to install backup air-conditioning service for inpatient care areas in case of utility outages, pre-connections for temporary boilers and chillers if primary equipment is not elevated, and pre-connections for external generators as a backup power source. These facilities already have begun exploring a number of these and other flood mitigation measures as part of their post-Sandy rebuilding process. OLTPS will propose these requirements to the City Council in 2013.

Healthcare Initiative 3
Support HHC's efforts to protect public hospital emergency departments from flooding

Emergency departments (EDs) are critical points for patients in need of hospital services, and at three public hospitals citywide—including Bellevue which has the only designated regional trauma center below 68th Street—EDs are at risk of flooding due to storm surge. Subject to available funding, the City, therefore, through HHC, will invest in measures to flood-protect vulnerable EDs so they can remain available to provide care during extreme weather events. The goal is for this effort to begin in 2013.

Healthcare Initiative 4
Improve design and construction of new nursing homes and adult care facilities

New nursing homes and adult care facilities are at risk of power failures due to storm surge, which could result in patient evacuations. The City, through OLTPS, therefore, will seek to amend the Construction Codes to require that new facilities are constructed with additional resiliency measures for their emergency power systems. New nursing homes also will be required to have emergency generators and electrical pre-connections for external stand-by generators. Adult care facilities will be required to install either emergency generators that are adequately protected or pre-connections to external stand-by generators. OLTPS will propose these requirements to the City Council in 2013.

Healthcare Initiative 5
Require retrofitting of nursing homes in floodplains

Many existing nursing home facilities in the five boroughs are vulnerable to storm surge—a vulnerability that will only grow as the climate changes. The City, through OLTPS, therefore, will seek to amend the Construction Codes to require nursing homes in the 100-year floodplain to meet standards for the protection of electrical equipment, emergency power systems, and domestic water pumps (if applicable) by 2030. These systems will be protected to the 100-year flood elevation, in accordance with specifications already in the Construction Codes, and will help enable patients to shelter in place safely or reoccupy quickly after a storm. OLTPS will propose these requirements to the City Council in 2013.

Healthcare Initiative 6
Require retrofitting of adult care facilities in floodplains

Nineteen adult care facilities in the city are vulnerable to storm surge, including one in Southern Manhattan. The City, through OLTPS, will seek to amend the Construction Codes to require existing adult care facilities located in the floodplain to elevate or protect their electrical equipment to the 100-year flood elevation by 2030, in accordance with the specifications in the Construction Codes. In addition, the City will seek to require these providers to have either emergency generators that are adequately protected or electrical pre-connections to external generators. OLTPS will propose these requirements to the City Council in 2013.

Healthcare Initiative 7
Support nursing homes and adult care facilities with mitigation grants and loans

The primary challenge for most nursing homes and adult care facilities in implementing mitigation measures is obtaining financing. Subject to available funding, the City, through NYCEDC and the New York City Department of Health and Mental Hygiene (DOHMH), therefore, will administer competitive grants and subsidized loans to assist providers with mandated retrofit projects. The goal is for NYCEDC and DOHMH to launch the program when the proposed Construction Code amendments applicable to nursing homes and adult care facilities proposed in this report go into effect, likely in 2013.

Healthcare Initiative 8
Increase the air conditioning capacity of nursing homes and adult care facilities

Nursing homes and adult care facilities typically do not have enough emergency power capacity to run their air conditioning systems following the loss of power. This could cause some providers to evacuate during power outages that occur during hot summer months. The City, will offer sales tax waivers totaling $3 million city wide to assist eligible nursing homes and adult care facilities that install emergency power solutions for air conditioning systems

Healthcare Initiative 9
Harden primary care and mental health clinics.

In communities such as Southern Manhattan that are at risk of extensive flooding during extreme weather events, primary care and mental health services may be compromised for weeks after a disaster due to extended facility closures. Subject to available funding, the City, through DOHMH and a fiscal intermediary,

therefore, will administer a competitive financing program to harden large clinics providing primary care and mental health services in Southern Manhattan and other high-need communities. The program will include grants and interest-free loans for capital investments that enable faster recovery of services—for example, installation of emergency power systems, protection of other critical building systems, and wet flood-proofing of facilities. The goal is for this effort to be launched in late 2013 or early 2014.

Healthcare Initiative 10
Improve pharmacies' power resiliency

Pharmacies dispense life-saving medicines essential for those with chronic conditions. However, without power, pharmacists cannot access the necessary patient records or insurance information to dispense these medicines. The City, through DOHMH, will work with pharmacies to improve their ability to leverage generators for power resiliency and address their other emergency preparedness needs including the launch of an emergency preparedness website for pharmacies. This effort already has begun and will continue throughout 2013.

Healthcare Initiative 11
Encourage telecommunications resiliency in the healthcare system

In the aftermath of a disaster, it is important that New Yorkers be able to speak to their doctors for guidance on needed medical care. The City, through DOHMH, therefore, will develop a best practice guide and outreach plan to help community-based providers understand the importance of telecommunications resiliency. Resiliency solutions could include using back-up phone systems (such as a remote answering service that would not be affected by local weather hazards), Voice over Internet Protocol (VoIP) technology that allows office phone lines to be used off-site, and pre-disaster planning to inform patients of available emergency phone numbers. This effort will begin in 2013.

Healthcare Initiative 12
Encourage electronic health record-keeping

Doctors rely on patients' medical records to provide and track care, but paper records may be compromised or destroyed due to extreme weather events. The City, through existing DOHMH programs, therefore, will call upon community-based providers located in the 100-year floodplain and other disaster-prone areas to implement electronic health records (EHR) systems for resiliency. DOHMH's Primary Care Information Project will sponsor initiatives to provide primary care and mental health providers citywide with EHR technical assistance. This effort will begin in 2013.

Telecommunications

The city's telecommunications system is essential to individuals and businesses throughout the five boroughs, including in Southern Manhattan. While this is true at all times, it is especially true during emergencies. As Sandy demonstrated, however, this system is highly vulnerable to extreme weather events—precisely when telecommunications are most needed. Citywide and in Southern Manhattan, Sandy resulted in outages to landlines and mobile service, as well as to data service. The vulnerability of this system likely will grow as the climate changes.

Among the strategies that the City will use to address these challenges for residents, businesses and nonprofits of Southern Manhattan and other parts of the city will be to: increase accountability among providers to promote resiliency; use strengthened City regulatory powers and stronger relationships with providers to enable rapid recovery after extreme weather events; encourage hardening of facilities to reduce weather-related impacts; and increase redundancy to reduce the impact of outages. The initiatives described below provide important examples of how the City intends to advance its telecommunications resiliency agenda citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits of Southern Manhattan. For a full explanation of the following initiatives and a complete description of the City's five-borough telecommunications resiliency plan, please refer to Chapter 9 (*Telecommunications*).

Telecommunications Initiative 1
Establish an office within the Department of Information Technology and Telecommunications (DoITT) to focus on telecommunications regulation and resiliency planning

While the City has regulatory authority over some aspects of telecommunications service, it has no entity focused broadly on ensuring the resiliency of the public communications networks. The City, therefore, will form within DoITT a new Planning and Resiliency Office (PRO) that will have the resources needed to develop, monitor, and enforce resiliency standards, in close cooperation with State and Federal regulators and providers. DoITT will launch the new office in 2013.

Telecommunications Initiative 2
Establish new resiliency requirements for providers using scheduled renewals of the City's franchise agreements

Flooding caused outages during Sandy in facilities that did not follow the Federal Communication Commission's recommended best practices for resiliency, including flood protection measures. The City, through DoITT, therefore, will encourage and enforce resiliency standards for telecommunications providers through the franchise renewal process and through other agreements into which such providers enter with the City. The City will also seek to require standardized outage reporting and publishing. DoITT will launch this effort in 2014, in advance of 2020 franchise renewals.

Transportation

Without the city's expansive transportation system, New York would grind to a halt. This was illustrated starkly during Sandy when outages occurred across the system during and immediately following the storm. These outages severely impacted the residents of Southern Manhattan, which found themselves inaccessible and isolated by the shutdown of subway and other public transit systems, as well as by flooding on arterial and secondary roads. The vulnerability of this system will only grow as the climate changes.

Among the strategies that the City will use to address these challenges for residents of Southern Manhattan and other parts of the city will be to: make the system more flexible and more resilient; protect critical elements of the system from damage; and seek to maintain system operations during extreme weather events; and, following extreme events, to enable quick recovery, while also putting in place plans for back-up transportation options until regular service can be restored. The initiatives described below provide important examples of how the City intends to advance its transportation resiliency agenda citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits of Southern Manhattan. For a full explanation of the following initiatives and a complete description of the City's five-borough transportation resiliency plan, please refer to Chapter 10 (*Transportation*).

Transportation Initiative 1
Reconstruct and resurface key streets damaged by Sandy

Sandy's waves and flooding caused significant damage to area roadways. The City, through NYCDOT, will reconstruct 60 lane-miles of streets that were damaged severely, and will repave approximately 500 lane-miles of streets with damaged surfaces. In Southern Manhattan, this will include three linear miles of reconstructed streets, primarily in Tribeca and the West Village but also in Lower Manhattan and the Lower East Side. Wherever feasible, the reconstructed streets also will include resiliency features to prevent future damage. NYCDOT will launch this initiative in 2013 with funding from Federal and City sources.

Transportation Initiative 3
Elevate traffic signals and provide backup electrical power

New York's traffic signals—and particularly the controllers that operates these signals and communicate with the NYCDOT Traffic Management Center—are vulnerable to damage from flooding as well as to power loss from various extreme weather events. Accordingly, the City, through NYCDOT, will raise controllers at approximately 500 intersections in flood-vulnerable locations across the city, including in Southern Manhattan. In tandem with this effort to place electrical hardware above the 100-year floodplain elevation, NYCDOT also will install power inverters in approximately 500 NYPD vehicles to allow these vehicles to provide backup electrical power to critical traffic signals. This effort will begin in 2013.

Transportation Initiative 4
Protect NYCDOT tunnels in Lower Manhattan from flooding

The two tunnels controlled by NYCDOT in Lower Manhattan—the Battery Park Underpass and the West Street Tunnel—are vulnerable to flooding from both storm surge and heavy downpours. This vulnerability is likely to increase as the climate changes. The City, through NYCDOT, will, therefore, evaluate a series of potential flood protection strategies at these two tunnels (including installing permanent floodgates, raising entrances and ventilation structures, and using temporary inflatable tunnel closure plugs) and, subject to available funding, will implement the most appropriate solution or solutions within the next three years.

Transportation Initiative 6
Protect Staten Island Ferry and private ferry terminals from climate change-related threats

To allow for quicker restoration of service on the Staten Island Ferry, the East River Ferry, and other ferry services, the City will use Federal Transit Administration Emergency Relief funds to construct physical improvements to the floating infrastructure, loading bridges/gangways, pilings, and piers at both the Whitehall and Saint George ferry terminals and at additional ferry landings around the city including Southern Manhattan. NYCDOT will launch this investment immediately.

Transportation Initiative 8
Call on non-City transportation agencies to implement strategies to address climate change threats

Many non-City agencies that own and operate critical portions of New York City's transportation system have already announced resiliency and protection initiatives appropriate to their system. Without such action, these critical facilities managed by these agencies will remain vulnerable to damage and disruption from future weather-related events. The City, therefore, will call on these agencies to implement the initiatives that they have announced and take additional steps to protect their major transportation assets from climate change threats and prepare for quick restoration following an extreme weather event. Assets that may require hardening and/or preparation measures in Southern Manhattan include: subway stations and supporting elements in the 100-year floodplain; the PATH system; the Hugh L. Carey Tunnel; the Queens Midtown Tunnel; and the Holland Tunnel. The City will work with these agencies to advance these plans in 2013.

Transportation Initiative 9
Plan for temporary transit services in the event of subway system suspensions

When major portions of the subway system are out of service, there simply is not sufficient capacity in the rest of the transit network or the roadway system to carry the increased volume of commuters and other travelers. The City, through NYCDOT, therefore, will work with the MTA and other transportation partners to develop and regularly update formal plans to provide temporary transportation services in such an event, including following extreme weather. These services could take the form of temporary, high-capacity "bus bridges" of the type implemented during Sandy, linking, other boroughs to Manhattan (*see Initiative 16, below*) or temporary point-to-point ferry services, for example connecting coastal areas in Manhattan and other boroughs to Lower Manhattan. This planning effort will begin in 2013.

Transportation Initiative 10
Identify critical transportation network elements and improve transportation responses to major events through regular resiliency planning exercises

Many of the facilities critical to the City's ability to respond effectively to a disaster are vulnerable to disruption and damage during extreme weather events, potentially impairing delivery of emergency services and supplies, as well as impairing the restoration of critical non-transportation infrastructure and economic activity. This vulnerability is expected to increase as the climate changes. To respond better to a variety of different possible transportation outage and restoration scenarios, the City, through NYCDOT, will work with transportation agencies around the region to identify the critical elements of the surface transportation network that need to be available quickly following different types of events. The key tool to identify these networks will be an ongoing series of detailed and multi-disciplinary resiliency planning exercises that will allow NYCDOT and its partners to understand where resources need to be focused before, during, and after an event. This effort will begin in 2013.

Transportation Initiative 16
Expand the city's Select Bus Service (SBS) network

Parts of the city lack subway access or have slow and unreliable public transportation. In these areas, the City and the MTA have been deploying SBS routes to improve general mobility. These routes can form the backbone of high-capacity bus service in the event of major subway outages, including following extreme weather events. The City, through NYCDOT, will work with the MTA to expand the SBS network significantly, building on a plan developed jointly in 2010 and reinforced in the New York State 2100 Report issued in January 2013. Implementation of this plan has already begun in areas, with additional new SBS identified for Southern Manhattan.

Beyond the priority transportation resiliency projects described in Chapter 10, including those summarized briefly above, the City is proposing an additional transportation resiliency initiative specific to the vulnerabilities of Southern Manhattan. This initiative is described below.

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Southern Manhattan Initiative 3
Construct physical enhancements to Water Street

As the main vehicular corridor along the eastern edge of Lower Manhattan and a high-density district containing 19 million square feet of office space (the leases for 15 percent of which are scheduled to expire in the next two years) and 2 million square feet of residential space, Water Street is in need of significant streetscape improvements. These improvements would aim to improve both the roadway itself and the pedestrian environment. To this end, the City will implement both short-term and long-term improvements to the roadway and sidewalks along Water Street. NYCDOT will begin to implement short-term improvements along Water Street from Whitehall Plaza to Fulton Street during the summer of 2013 including new pedestrian-friendly sidewalk expansions and crosswalks, new seating and lighting, and new plazas in the public right of way. These short-term improvements also will include new and improved signage and wayfinding.

Upon completion of the short-term improvements described above, NYCEDC, in partnership with NYCDOT and the Alliance for Downtown New York will commence design work for a longer-term capital project for Water Street. This project will build upon NYCDOT's short-term improvements, creating permanent vibrant and attractive pedestrian spaces, and include sustainable and storm-resilient measures such as permeable paving and stormwater retention treatments to absorb water during heavy rain events. Once design is complete, NYCEDC will lead the construction effort in close coordination with NYCDOT. $20 million in funding commitments are in-place from the City and the Lower Manhattan Development Corporation (LMDC) for this project, the design of which is expected to begin in 2013.

Parks

During Sandy, it became clear that, in addition to serving as neighborhood front yards and recreation centers, in many places (including Southern Manhattan), the City's parks serve as the city's front line of defense when extreme weather events hit, buffering adjacent neighborhoods. As the climate changes, it will be even more critical that the city's parks are able to play all of these roles.

Among the strategies that the City will use to address these challenges for residents of Southern Manhattan and elsewhere in the City will be to: strengthen city's parks so that they are able to survive weather-related events more effectively and can act as stronger buffers for adjacent communities; and pursue technologies and approaches that will enable the City to monitor, analyze, and prepare the park system for its many roles in an era of increasing change. The initiatives described below provide important examples of how the City intends to advance its parks resiliency agenda citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits of Southern Manhattan. For a full explanation of the following initiatives and a complete description of the City's five-borough parks resiliency plan, please refer to Chapter 11 (*Parks*).

Parks Initiative 2
Harden or otherwise modify shoreline parks and adjacent roadways to protect adjacent communities

Approximately 24 percent of DPR parks and other open spaces are in the 100-year floodplain, which is expected to expand as sea levels rise—including in areas where parks front residential and commercial districts. Subject to available funding, the City, through DPR, will study and identify mitigation strategies, including cost-effective ways to use its park system to protect adjacent neighborhoods and the parks themselves. Strategies could include hardening or elevating park infrastructure, construction of levees or floodwalls to minimize flooding and attenuate waves, and using flood-tolerant materials in the construction of parks. Target sites in Southern Manhattan include East River Park, Battery Park, and Hudson River Park. The goal is to complete this study in 2014.

Parks Initiative 11
Improve the health and resiliency of the city's urban forest

The city's forests and trees provide an array of health and environmental benefits, but are vulnerable to a variety of climate change-related impacts, including storm surge, wind, and even changes in average temperatures. Subject to available funding, the City, through DPR, will undertake a variety of efforts to protect trees—whether located in natural areas and parks, or along streets. This would include adding forest management crews, identifying locations in which to expand tree beds, and modifying regular tree inspection and pruning efforts to prioritize trees in areas vulnerable to extreme weather events. The goal is for DPR to launch this effort in 2013.

Water and Wastewater

The city's water and wastewater system is one of the most complex in the world, not only supplying millions of New Yorkers with safe drinking water in all conditions, but also treating wastewater to enable the area's waterways to remain clean, while draining rainwater to minimize flooding. Sandy demonstrated the system's vulnerability to a whole host of weather-related threats, ranging from surge and sea level rise, to heavy downpours—threats that are expected to worsen as the climate changes.

Among the strategies that the City will use to address these challenges for residents of Southern Manhattan and other parts of the city will be to: protect wastewater facilities from storm surge; improve and expand drainage infrastructure; and promote redundancy and flexibility to make available a constant supply of high-quality drinking water. The initiatives described below provide important examples of how the City intends to advance its water and wastewater resiliency agenda citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits of Southern Manhattan. For a full explanation of the following initiatives and a complete description of the City's five-borough water and wastewater resiliency plan, please refer to Chapter 12 (*Water and Wastewater*).

Water and Wastewater Initiative 1
Adopt a wastewater facility design standard for storm surge and sea level rise

Sandy damaged wastewater treatment plants and pumping stations even though the design of City wastewater facilities typically has taken into account the highest historically recorded water height of nearby water bodies or the BFEs identified in FEMA maps. The City, therefore, will adopt an increased level of protection for design and construction of all wastewater facilities based on the latest FEMA maps, modified to reflect sea level rise projections for the 2050s. DEP will adopt the new design guidelines in 2013.

Water and Wastewater Initiative 2
Harden pumping stations

Many of the city's pumping stations are located in low-lying areas and are necessary to convey wastewater and stormwater out of communities; however, their location also increases their vulnerability to storm surge. Therefore, subject to available funding, the City, through DEP, will retrofit these pumping stations to improve their resiliency. These retrofits will include raising or flood-proofing critical equipment, constructing barriers, and installing backup power supplies. Preliminary estimates indicate that there are currently 58 at-risk pumping stations, of which several are already scheduled for capital improvements. DEP, subject to available funding, will pursue implementation of resiliency projects in conjunction with repairs and planned capital work, and as appropriate based on the level of risk, historical flooding, and potential community impacts, among other criteria. Among the pumping stations to be considered for hardening are two in Southern Manhattan. The goal is to begin implementation in 2014.

Water and Wastewater Initiative 3
Harden wastewater treatment plants

All 14 of the City's wastewater treatment facilities are located along the waterfront and are therefore at risk in the event of a coastal storm. Subject to available funding, the City, through DEP, will protect these critical treatment facilities by raising or flood-proofing assets that are critical to the treatment process, constructing barriers, improving waterfront infrastructure, or implementing redundancy measures to avoid failure of these critical treatment systems. DEP will target initially facilities that have been identified as either most at-risk, or most likely to create issues for adjacent communities and waterways, based on the findings of an in-depth study by DEP. The goal is for DEP to begin implementation of adaptation measures for these and other facilities in 2014 as part of repairs and other planned capital projects.

Water and Wastewater Initiative 8
Reduce combined sewer overflows (CSOs) with Green Infrastructure

As climate change brings increasing rainfall volume to the New York area, the city may also experience shifts in the frequency and volume of CSOs. The City will continue to implement its Green Infrastructure Plan and CSO Long-Term Control Plans (LTCPs) to reduce such CSOs. For this purpose, DEP, working with the DPR and NYCDOT, will continue to pursue its plan to capture the first inch of runoff in 10 percent of impervious surfaces citywide by 2030. At the same time, DEP also will continue to develop LTCPs to evaluate long-term solutions to reduce CSOs and improve water quality in New York City's waterways. DEP will issue 10 waterbody-specific LTCPs and one citywide LTCP to follow through 2017.

Other Critical Networks: Food Supply

Though the food supply chain generally emerged intact following Sandy, in certain local areas (including parts of Southern Manhattan), residents found themselves without access to basic sustenance after the storm. In addition, had Sandy played out just a little differently, it is possible that significant links in the food supply chain–including the food distribution center in Hunts Point in the Bronx—could have been seriously threatened. As the climate changes, it is likely that risks such as these will grow.

Although initiatives outlined in several other sections above are important contributors to the overall resiliency of the food supply network (including especially those addressing utilities, liquid fuels, and transportation), the City also will pursue food-specific strategies to meet this goal for the benefit of residents of Southern Manhattan and other parts of the city. These strategies will involve calling for resiliency investments at the most significant food wholesaling and distribution centers in the city and addressing issues relating to retail access in the event of extreme weather. The initiatives in Chapter 13 describe how the City intends to advance its food supply resiliency agenda citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits of Southern Manhattan. For a complete description of the City's five-borough food supply resiliency plan, please refer to Chapter 13 (*Other Critical Networks*).

Other Critical Networks: Solid Waste

On a daily basis, the solid waste collection system in New York disposes of more than 12,000 tons of waste and recycling in a safe and sanitary fashion. Unlike many other critical City systems, during Sandy this one proved remarkably resilient, resuming many of its normal functions almost immediately after the storm. In fact, thanks to the efforts of the City's Department of Sanitation, even as the agency was dealing with its own storm-related challenges, it was able to assist with the recovery of Southern Manhattan and the larger city by collecting the debris left by the storm in an organized and efficient manner.

However, the system does face real issues. For example, during Sandy, the city's solid waste disposal system experienced interruptions that interfered with its ability to convey refuse out of the city to its ultimate destination. Additionally, as the climate changes, it is likely that this system will become more vulnerable to extreme weather.

Among the strategies that the City will use to address these challenges for residents of Southern Manhattan and other parts of the city will be to: harden critical City-owned solid waste assets to protect them from extreme weather-related impacts; and seek to improve the resiliency of the broader solid waste network—both City- and third-party-owned—enabling it to resume operation quickly should disruptions occur. The initiatives in Chapter 13 describe how the City intends to advance its solid waste resiliency agenda citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits of Southern Manhattan. For a complete description of the City's five-borough solid waste resiliency plan, please refer to Chapter 13 (*Other Critical Networks*).

Environmental Protection and Remediation

Sandy showed that extreme weather events — which are likely to increase in severity with climate change—not only have the potential to impact the city's people, built environment, and critical systems, they also can have a deleterious impact on the natural environment. To help minimize the impact of future extreme weather on the environment, the City will advance a range of initiatives to protect open and enclosed industrial sites containing hazardous substances in an economically feasible way, and to encourage the cost effective remediation and redevelopment of brownfields in a resilient fashion. These initiatives will have a positive impact on the residents, businesses, and nonprofits of Southern Manhattan, which is home to approximately 600 industrial companies and 10 sites designated under the New York City Brownfield Cleanup Program. For a complete description of the City's five-borough environmental protection and remediation plan, please refer to *Environmental Protection and Remediation*.

Community and Economic Recovery

New York is a city of neighborhoods, and these neighborhoods vary widely in size and nature. Notwithstanding this variety, successful neighborhoods across the city tend to share certain traits. Two of these are: a formal and informal network of community members who help and support one another in good times and bad; and vibrant commercial and nonprofit sectors that employ and provide goods and services to the people of the community.

As Sandy demonstrated, however, both the network of community-based organizations and the commercial and nonprofit sectors in New York's neighborhoods can be sorely tested when extreme weather hits. During these times (when contributions from these networks and sectors are desperately needed) these organizations and businesses themselves are

frequently coping with the same set of challenges that the community at large is—a circumstance that can push even the most well-run organization or business to the breaking point. Even with these pressures, during and in the immediate aftermath of Sandy, New York's commercial and nonprofit sectors overcame many of their own difficulties, playing a critical role in the recovery of neighborhoods across the city, including Southern Manhattan. However, as the climate changes, difficulties such as these will likely arise more frequently, testing institutions mightily.

Among the strategies that the City will use to achieve the goal of making its neighborhoods and their critical institutions more resilient will be to: help build grassroots capacity and foster community leadership; help businesses and nonprofits impacted by Sandy to recover; help businesses and nonprofits in vulnerable locations to make resiliency investments that will better prepare them for future extreme weather; and bring new economic activity to neighborhoods recovering from the impacts of Sandy to enable these neighborhoods to come back even stronger than before.

The initiatives described below provide important examples of how the City intends to advance its community and economic recovery agenda citywide. These initiatives will have a positive impact on the residents, businesses, and nonprofits of Southern Manhattan. For a full explanation of the following initiatives and a complete description of the City's five-borough community and economic recovery plan, please refer to *Community and Economic Recovery*.

Community Disaster Preparedness Initiative 1
Identify and address gaps in community capacity

The capacity of a community to organize to aid businesses and residents after an extreme weather event or other disaster is a strong predictor of the success of that community's recovery. To improve the capacity of vulnerable communities, The City's Office of Emergency Management (OEM), working with the NYC Center for Economic Opportunity (CEO), will undertake a pilot assessment of the strengths and weaknesses of a Sandy-impacted community—which could be a neighborhood in Southern Manhattan—to inform the creation of a plan to address needs uncovered by the assessment. Subject to funding, the City, through OEM and CEO will choose a pilot community and begin their study in 2013.

Community Disaster Preparedness Initiative 2
Continue and expand OEM's Community Emergency Response Teams

OEM currently trains 54 teams of 1,500 volunteers across the city, which staff Community Emergency Response Teams (CERTs). Before, during, and after disasters, including extreme weather events, members of these teams help to organize community disaster preparedness and participate in emergency response and recovery. Going forward, OEM will work with communities to create additional teams, ensuring that the volunteers that staff them are as representative as possible of the communities that they serve. Towards the same end, OEM, working with the CEO, will also identify low-income young adults to be trained to lead their communities in disaster preparedness. OEM and CEO will launch this program by 2014.

Economic Recovery Initiative 1
Launch business recovery and resiliency programs

During Sandy, over 27,000 businesses citywide, including 6,500 in Southern Manhattan, were inundated by the storm. For many, recovery has been challenging. To assist with this recovery, immediately after the storm, the City launched the series of programs, described in *Community and Economic Recovery*, including a $25 million loan and grant program and a $25 million sales tax waiver program designed to help businesses get back on their feet. Building on the momentum of these programs, which have assisted over 2,500 businesses as of the writing of this report, the City, through NYCEDC, will launch the CDBG-funded Business Resiliency Investment Program of up to $100 million to help vulnerable businesses throughout the city make resiliency investments in their buildings and equipment, and the Business Loan and Grant Program of up to $80 million will assist businesses with recovery and rebuilding efforts. NYCEDC will launch these program in 2013.

Economic Recovery Initiative 2
Launch the Neighborhood Game Changer Competition

The recovery of many of the communities impacted by Sandy, including Southern Manhattan, has been hampered by a lack of opportunities for economic advancement and employment among significant populations that were impacted by the storm. In many cases, these challenges existed even before Sandy, but have been exacerbated by the impacts of the storm. To address this, the City, through NYCEDC, will launch the CDBG-funded Neighborhood Game Changer Competition to invest up to $20 million in public money in each of the five communities on which this report focuses, including Southern Manhattan. This funding will be available on a competitive basis to help finance transformational projects. To win the competition, a project will have to spur incremental economic activity, and match public funding with significant private capital. Projects that would be eligible to be funded in Southern Manhattan through this competition could include new attractions bringing new visitors, significant new operations of a major business or nonprofit, the revitalization of important commercial corridors, the expansion of an existing neighborhood institution or a major new transportation option. NYCEDC will launch this program in 2013.

Economic Recovery Initiative 3
Launch Neighborhood Retail Recovery Program

A the core of many Sandy-impacted neighborhoods are the local commercial corridors that provide employment opportunities and services to those who live and work around them. They include local retailers, institutions, and service providers—such as food markets, pharmacies, social service organizations, laundromats, and others. In many cases, though, these corridors were devastated by the storm. To address this, the City will call on the PSC and Con Edison to amend the preferential Business Incentive Rate (BIR) program which offers a discount on Con Edison's electric delivery charges, to allow it to be extended to impacted small businesses in the five communities on which this report focuses, including Southern Manhattan. Businesses and nonprofits with 10 or fewer employees that have received support from City-sponsored loan and grant programs will be eligible for the discount for five years up to a maximum discount of $50,000 per business or nonprofit. The maximum aggregate benefit available across Southern Manhattan will be $1 million. The goal is for NYCEDC to launch this effort in 2013. Among the corridors where the benefit will be available in Southern Manhattan include:

- Lower Manhattan (Water Street corridor, South Street Seaport district, and Greenwich Street)
- Chinatown (East Broadway and Madison Street)
- Lower East Side (Avenues B, C, and D)
- Tribeca (Canal Street, West Street and Greenwich Street)
- West Village (West Street and Washington Street)
- Chelsea (10th and 11th Avenues and 23rd Street)

Economic Recovery Initiative 4
Support local merchants in improving and promoting local commercial corridors

As mentioned above, Sandy highlighted the important role played by local commercial corridors in many of the communities impacted by the storm. The City, through the Department of Small Business Services (SBS), will provide financial and/or technical assistance to area business improvement districts (BIDs), merchant associations, and other groups that work to improve, market, maintain, and otherwise promote primary commercial corridors. Subject to review of applications received, SBS will prioritize Sandy-impacted commercial corridors. Such funding could be used for a variety of purposes, including capacity building, façade improvement programs, streetscape improvements, and business recruitment and marketing efforts. In Southern Manhattan, corridors that could receive this additional assistance include corridors in and around the historic Seaport District, Chinatown, the Lower East Side, and Hudson Square. SBS will provide this assistance beginning in 2013.

Economic Recovery Initiative 6
Reassess commercial properties citywide to reflect post-Sandy market values

After Sandy, many commercial properties were worth less than before the storm. To reflect this fact and to help with recovery from the storm, the City has reassessed more than 88,000 properties impacted by the storm citywide. Overall, these reassessments have lowered the tax burden on Sandy-impacted properties—including both commercial and residential properties—by over $90 million, with commercial properties in neighborhoods impacted by Sandy receiving a reduction, on average, of approximately 10 percent of their pre-storm assessed values.

In addition to the measures described above, the City will advance the following initiatives to address the community and economic recovery needs of Southern Manhattan.

Southern Manhattan Initiative 4
Implement temporary programming of Water Street privately owned public spaces (POPS)

Though the Water Street corridor is a high-density commercial and residential area, with over 21 million square feet of built floor area, because of zoning that was put in place in 1961, most of its buildings are set back from the street, with large public spaces with few amenities in front of them. As a result, street-level activity along this corridor is significantly less vibrant than it is in other parts of Lower Manhattan. As a first step towards enlivening this corridor and increasing pedestrian activity in the area, the City will adopt temporary zoning regulations that allow events and new amenities in existing POPS. In conjunction with and to complement these temporary modifications, the City will also select a partner to produce programming and events in these POPS, with the goal of bringing activity to the street level in the district. Example of activities that NYCEDC and its partner may seek to bring to Water Street POPS could include farmers markets, musical performances, outdoor fitness events, and food or wine tastings. The goal is for these events to run throughout the week, with a larger number of events scheduled during the summer months. DCP, NYCEDC, and the Office of the Mayor are working together to implement this initiative, which will be launched in July 2013.

Southern Manhattan Initiative 5
Launch a program to enable permanent improvements to Water Street privately owned public spaces (POPS)

As described above, Water Street has the potential to be a much more vibrant corridor on par with others in Lower Manhattan. The City, therefore, will launch a new program to encourage permanent physical improvements to buildings and associated POPS, with the goal of activating ground floor spaces, upgrading public spaces, and strengthening the flood resiliency of buildings. DCP, in partnership with NYCEDC, will identify design criteria that promote active uses such as ground-floor retail, improvements to underperforming POPS, and improved flood resiliency, and will solicit proposals from property owners for comprehensive upgrades to both their ground floors and adjacent POPS based on these criteria. For proposals that meet the design criteria, DCP will facilitate applications for land use actions needed to carry out these improvements, and consider developing a broader regulatory framework to accommodate similar upgrades for other buildings along the Water Street corridor, going forward. This program would target the 19 buildings and associated POPS in the Water Street corridor that are in the 100-year floodplain. The program will launch in 2013, with any land use actions to begin public review in 2014.

Southern Manhattan Initiative 6
Implement planned and ongoing investments in the South Street Seaport

The South Street Seaport area was one of the areas in Southern Manhattan that was most impacted by Sandy. As of the writing of this report, it is still recovering, due both to the extent of flooding and the fragility of the area's historic building stock. To support the recovery of the area and minimize the impacts of future extreme weather events, the City will make permanent resiliency investments in the mechanical systems in the City-owned buildings in the Seaport district, including the so-called Museum Block and Schermerhorn Row. The City's investments, to be made through NYCEDC, will total approximately $850,000 and will relocate electrical equipment and boilers above the BFE. To complement these efforts, the City will also continue to pursue expanded summer programming in the area to increase the number of visitors, and will continue to support private investment in the area, including the renovation planned by the Howard Hughes Corporation for Pier 17. NYCEDC will complete its resiliency investments in the area by the end of 2013. The Pier 17 redevelopment is expected to commence in the fall of 2013 and be completed in 2015.

Southern Manhattan Initiative 7
Use the Job Creation & Retention Program to attract and retain businesses in Sandy-impacted areas of Lower Manhattan

The Job Creation & Retention Program (JCRP) is a Federally funded program that was created after the 9/11 attacks to keep businesses in Lower Manhattan and to attract new businesses to the area. The program, by law, is focused on the portion of Lower Manhattan south of Canal Street. To date, the program has retained or attracted some 65,000 jobs in the area. There is currently funding remaining in JCRP, though the program is set to expire at the end of 2013.

Given the new awareness of extreme weather risks in Lower Manhattan, there is a concern that some businesses may now be reluctant to relocate to, or remain in the area—a concern that is reminiscent of concerns after 9/11. The City, through NYCEDC, therefore, will seek to work with LMDC and the Empire State Development Corporation (ESDC), to extend JCRP through at least 2017, and to focus $15 to $20 million of the remaining funds on a new program to stabilize and produce momentum in the marketplace for Sandy impacted buildings. The City will seek to target new leases (or extensions of existing leases) in buildings in the 100-year floodplain, constructed prior to 1983. Under this program, JCRP would offer incentives per employee higher than those typically offered under JCRP ($7,000 per retained employee and $10,000 per new employee) to mid- and large-sized companies (those over 500 employees) that commit to leases in this challenging sub-category of Lower Manhattan building

stock before the end of 2014. Companies relocating from other New York City boroughs or from north of 60th Street in Manhattan would not be eligible for the program.

Southern Manhattan Initiative 8
Expand Take the HELM program (Hire and Expand in Lower Manhattan)

Over the past decade, the City has sought to diversify the Lower Manhattan economy so that the area would be less singularly dependent on the financial services industry and the public sector. This goal is particularly important post-Sandy when many more traditional tenants in the area may be hesitant to sign new leases, given their experiences during and after the storm—even if building owners are making significant investments to reduce future vulnerability. To complement the efforts to date, subject to available funding, the City will expand subsequent rounds of its successful Take the HELM program, a program that offers cash prizes of $250,000 each to promising companies in the creative and technology fields that are willing to sign leases in Lower Manhattan south of Chambers Street, adding five new prizes during 2013 and 2014 specifically targeted at companies that agree to locate in the 100-year floodplain.

Southern Manhattan Initiative 9
Implement planned and ongoing investments by the City and private partners

Preservation and revitalization of neighborhoods most significantly impacted by Sandy will be hampered if the momentum of planned investments is lost. The City, therefore, will continue to pursue and execute planned investments in the neighborhood, and should continue to work with partners to facilitate private investment in Southern Manhattan. Such projects include but are not limited to:

Parks and Open Space
- *East River Waterfront*, a 2-mile long esplanade and piers project, extending from the Battery Maritime Building (at Broad Street) to Montgomery Place, just north of the Manhattan Bridge, the next phases of which (Broad Street to Old Slip, near Pier 11; and Pike and Allen Streets to Pier 35) are set to be completed by 2013.
- *Pier 35 EcoPark*, an open space and ecohabitat restoration project, planned for completion in 2013.
- *Pier 42 Waterfront Park*, an interim recreational park opened in May 2013, the long-term designs for which are underway.
- *Battery Park Playspace*, a renovation project for an existing play space in Battery Park being undertaken by the Battery Park Conservancy, using imaginative, interpretative, art–based design, combined with inventive water features, that is scheduled for construction in 2014.
- *Peck Slip Park*, a redesign project covering the portion of the Slip from Water to South Streets that will include seating, planting, and trees and is set to commence in spring 2014.
- *Asser Levy Park*, a project that will convert Asser Levy Place between 23rd and 25th Streets from a roadway into a park with seating, trees, and recreational facilities, expected to be completed in 2014.
- *Hudson River Park*, an ongoing park construction and planning project which is 70 percent complete, the next phases of which (a new boathouse and restaurant at Pier 26 and renovation of Pier 57 for a market with cultural and educational uses) are scheduled to be completed between 2013 and 2015.
- *The High Line*, an elevated park on the Far West Side, construction of the final section of which will bring the park to 34th Street and is to be completed in 2014.

Infrastructure and Transportation
- *Peck Slip Reconstruction*, an infrastructure repair project that will replace a water main and other vital utilities and rebuild roadways, curbs and sidewalks, anticipated to be completed by spring 2014.

Economic Development
- *Battery Maritime Building*, a mixed-used project containing a catering event space, a 67-room boutique hotel, and rooftop restaurant and bar, construction of which is expected to be completed in 2014.
- *Pier A Renovation*, a redevelopment project that will create a beer garden and casual dining area, as well as a restaurant and event space, and live entertainment and bar venue, scheduled for completion in 2014.
- *Hudson Yards South Tower*, an office tower that is the first in this rezoned area that will provide 1.7 million square feet of space and is scheduled for completion in 2015.

Community Facilities
- *Peck Slip School,* a conversion of a former US Post Office building into a 600+ seat elementary school that is to be opened in 2015.

Cultural
- *The National September 11 Memorial & Museum*, a 110,000 square feet exhibition space devoted to examining the implications of the events of 9/11, that is set to open in 2014.

Credit: James Willamor

Funding

This report outlines a variety of strategies and initiatives designed to make New York stronger and more resilient to climate change. Given a world of limited resources, the goal of this report is to begin *now* to make ambitious but targeted and cost-effective investments that will make New Yorkers materially safer than they were before Sandy. These investments also will ensure that when, from time to time, extreme weather events overwhelm the City's best-laid plans (which, because of nature's power, they sometimes will), New York will be able to bounce back more quickly than in the past.

The advantage of this approach is that it not only puts forward bold proposals, but also puts forward bold proposals that can be implemented starting immediately. It also reserves for future City leaders the ability to monitor changes in the climate over time and to make incremental investments based on observed experience as conditions warrant and further resources become available.

Because of the scale of the challenge posed by climate change, even a tailored plan scaled to available resources brings with it a significant price tag that will need to be borne by the public. In the case of the plan outlined in this report, this public price tag (which includes government-funded projects, as well as projects funded by broad populations, such as utility ratepayers) is projected to total almost $14 billion. This amount will cover both capital expenditures and study costs. When combined with various other housing, business, and City agency recovery and resiliency needs, the total grows to approximately $19.5 billion.

Though the needs are clearly significant, the good news for New Yorkers is that, as of the writing of this report, available public funding sources are significant too. For example, thanks to Sandy-related federal aid as well as a robust ongoing City capital program, much of the plan as outlined is already funded (approximately $10 billion), or is expected by the City to be funded (approximately $5 billion). However, even assuming the foregoing sources, the City's plan comes with a significant funding gap, estimated at approximately $4.5 billion.

As outlined in this chapter, the City proposes to address this gap in two ways. First, with the funding in hand or expected to become available, the City will start to implement the initiatives that can be covered by these sources—initiatives that will, even without more funding, result in a New York that is materially stronger and more resilient than it is today. The remaining unfunded initiatives in this report, however, remain critically important. That is why, as a second part of its strategy for addressing the funding gap, the City is putting forward proposals for meeting the shortfall. Enacting these funding proposals will require the cooperation of the State and Federal governments—cooperation that is essential for the sake of not just the city, but also the region and the country.

Uses of Funds

The uses of funds identified below include primarily capital costs over the next ten years, expressed in nominal terms, based on cost estimates as of the writing of this report. The total also includes identified study and planning costs, where recommended.

Special Initiative for Rebuilding and Resiliency ($14 billion)

As discussed above, it is currently estimated that the initiatives outlined in this report, will require total public funding of over $14 billion over a ten-year period. These costs are associated with only the first phase of the projects and programs that are described throughout this report. They do not include implementation costs for projects and programs that are identified as worthy of study or that are proposed for completion beyond the 10-year time horizon of this plan; these projects and programs will need to be funded separately with new sources. So, for example, the costs described in this chapter do include the proposed Phase 1 measures described in Chapter 3 (*Coastal Protection*), but do not include the incremental costs associated with completing the Full-Build measures described in that chapter.

While significant investments and other programs are called for throughout this report, certain chapters require particularly significant capital investments, including those focused on the water and wastewater system, coastal protection, the existing building stock, and energy utility systems. Anticipated funding under the plan also would be dispersed geographically, with over three-quarters of the allocated resources anticipated to be spent in vulnerable areas outside of Manhattan, including more than a third in Staten Island and Brooklyn, and over a quarter in Queens alone.

Other Recovery and Resiliency Needs

Generally, this report concentrates on resiliency investments, rather than investments intended purely to assist with recovery from Sandy (i.e., helping businesses and individuals impacted by the storm to repair damage and "get back on their feet"). The reason for this is that the City's recovery efforts have, by necessity, focused on short- to medium-term needs, rather than the medium- to long-term timeframe of this report. It is important to note, however, that this report and the City's recovery efforts, led by a combination of the Mayor's Office of Housing Recovery Operations (HRO), the Department of Housing Preservation and Development, the New York City Economic Development Corporation (NYCEDC), the Department of Small Business Services and an array of other City agencies, have been developed in parallel and with substantial coordination.

Notwithstanding the different timeframes of the City's recovery efforts and this report, because certain elements of the recovery efforts are so closely linked to the mission of this plan (e.g., housing recovery as it pertains to the most impacted communities), in certain cases these recovery efforts have been incorporated into this report by reference. In so doing, the City has sought to highlight these efforts and ensure that their connection to the City's longer-term efforts is clear to all.

Among the recovery efforts that are closely related to the focus of this report and that, therefore, are included in the total public cost estimate are the following:

Housing Recovery ($2.4 billion)
The mission of HRO is to return Sandy-impacted residents in New York City to permanent, safe and sustainable housing. This includes, in many cases, rebuilding destroyed homes and repairing homes that suffered substantial damage (greater than 50 percent loss), in each case ensuring—per Federal, State, and City requirements—that these homes are rebuilt to the highest resiliency standards (i.e., elevation). HRO also will seek to repair homes that suffered less-than-substantial damage. In these cases, repairs will involve primarily replacement in-kind, rather than mitigation measures such as elevation. The City currently estimates the total cost of these housing recovery efforts will be $2.5 billion, with about $100 million of this likely to come from private insurance payouts and philanthropic sources. The remaining $2.4 billion is likely to come from public sources, of which a portion has been secured (see below for further details).

Public Housing Resiliency ($1.1 billion)
Over 400 buildings owned by the New York City Housing Authority (NYCHA) were affected significantly by Sandy, including as a result of flooding and/or loss of power. In addition to repairing these facilities (which include community centers and NYCHA's Emergency Operations Center), NYCHA has identified a need of approximately $420 million to ensure the inclusion of resiliency measures in these repairs. Beyond those impacted by Sandy, there also are a significant number of additional NYCHA buildings that are found in the 100-year floodplain throughout the city and, therefore, remain vulnerable. NYCHA has estimated a total cost of $620 million to implement basic resiliency and mitigation measures in these buildings. NYCHA also has identified approximately 30 community centers located in undamaged buildings in flood-vulnerable areas that also require resiliency investments to enable them to serve as warming centers, information distribution sites, local command centers, phone-charging centers, or emergency shelters in future storms. NYCHA estimates that this effort will cost $60 million. All of these uses are likely to be funded through public sources, of which a portion has been secured (see below for further details).

Business Recovery ($300 million)
Hurricane Sandy caused significant damage to businesses across the five boroughs, including approximately 23,400 businesses that were located in flood-impacted areas and faced extensive damage from loss of inventory, and damaged equipment and personal property. While private insurers and federal agencies such as the Small Business Administration (SBA) have stepped in to provide assistance, the City has implemented its own loan and grant programs and expects to provide additional assistance going forward (please refer to *Economic Recovery* for additional details). It is currently anticipated that the City's comprehensive business recovery needs will total approximately $300 million. These uses are likely to be funded through public sources, of which a portion has been secured (see below for further details).

City Agency Recovery Needs ($1.2 billion)
In preparing for and responding to Hurricane Sandy, City agencies incurred an array of unexpected costs that must be reimbursed in order to avoid creating a hole in the City's operating budget, requiring unplanned cuts in other programmatic areas. Various agencies also saw damage to facilities that must be repaired. Though some of these costs are eligible for federal reimbursement, in other cases only a portion of these costs are eligible. Finally, some agencies—particularly the Health and Hospitals Corporation—must be reimbursed for staff and other expenses necessary to maintain their operational readiness to restore vital services to the community as quickly as possible. These and other agency recovery needs currently are estimated at approximately $1.2 billion. These are likely to be funded through public sources, of which a portion has been secured (see below for further details).

City Agency Resiliency Needs—First Phase ($500 million)
In the aftermath of Hurricane Sandy, at the request of the Mayor's Office, City agencies took stock of the resiliency investments that may be needed to ensure that the City can provide essential services over the long term, as the climate changes. While the City is continuing to gather and prioritize these needs, at least $100 million of these investments are a high priority and will be funded by an incremental addition to the City's capital budget. Another $400 million may be eligible for certain federal hazard mitigation funds provided as a supplement to FEMA Public Assistance grants (see below for further details).

Sources of Funds

Existing Sources

As stated above, the City has available to it, or is highly confident that it will receive, significant funding against the needs described in this report. These sources include amounts already funded through its capital plan and certain federal assistance. The total value of these existing sources is approximately $10 billion, calculated as follows:

City Capital ($5.5 billion)
The City's existing capital plan includes funding for a number of the initiatives included in this report. Among the initiatives funded through the City's capital budget are a variety of water and wastewater initiatives, as well as selected economic development, infrastructure, and cultural investments in impacted communities. This existing $5.5 billion investment program is a clear demonstration of the City's commitment to make vulnerable assets more resilient and accelerate recovery in the neighborhoods hit hardest by Sandy.

Community Development Block Grants—First Allocation ($1.8 billion)
On February 6, 2013, the Department of Housing and Urban Development (HUD) announced the allocation to the City of nearly $1.8 billion in funding from the Community Development Block Grant (CDBG) appropriation provided for in the Disaster Relief Appropriations Act of 2013. The passage of this Act, frequently referred to as the "Sandy Supplemental," was the result of an aggressive advocacy effort on the part of the Congressional delegations of New York and New Jersey in the wake of the disaster.

In accordance with federal regulations, the City detailed its proposed uses of this allocation in a Partial Action Plan, which HUD approved on May 10, 2013, after public comment (the City's partial action plan and other recovery resources are available at **www.nyc.gov/recovery**).

The initial funding allocations in this Partial Action Plan are:
- Housing recovery and resiliency programs ($648 million);
- Business recovery and resiliency programs ($293 million);
- Repair and restoration of City infrastructure and other City services ($360 million); and
- Planning and administration (up to $177 million of which any unused portion will be reallocated to programs).

The City's initial Partial Action Plan also reserved $294 million for resiliency investments, in addition to approximately $26 million of the funding for planning and administration costs noted above for a total resiliency allocation of $320 million. In anticipation of the completion of this report, the Partial Action Plan did not provide for the programming of these funds with specificity. The City now will seek approval from HUD for the following applications of these funds:
- Coastal Protection (at least $180 million), associated with the construction of an integrated floodwall system along "Hospital Row" in Manhattan, repair of and enhancements to bulkheads citywide, and armored revetments along the South Shore of Staten Island and Coney Island Creek, all as described in detail in Chapter 3 (*Coastal Protection*);
- Building Resiliency (at least $120 million), representing the first tranche of an incentive program intended to assist vulnerable buildings to implement the Core Flood Resiliency Measures, as described in Chapter 4 (*Buildings*); and
- Planning and Administration (up to $26 million), including funding for studies described in this report to be undertaken by the Office of Long-Term Planning and Sustainability, the Department of City Planning (DCP), the Department of Buildings, and other agencies.

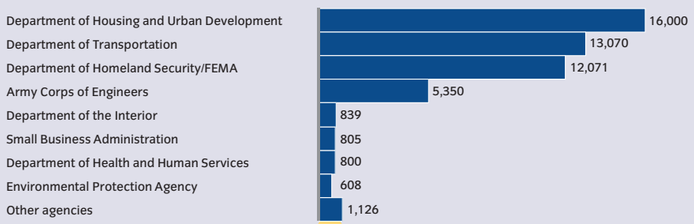
Housing Recovery Funding ($700 million)
As noted above, the City has identified housing recovery needs of approximately $2.5 billion, of which $2.4 billion is likely to come from public sources. In addition to the CDBG funding described above, the City estimates available public funding other than the CDBG funding above to be approximately $700 million. These public sources include payouts from the National Flood Insurance Program, as well as assistance from the Federal Emergency Management Agency (FEMA).

Sandy Supplemental Aid Package

Congress passed and the President signed into law two bills in the aftermath of Sandy. The first, passed in December 2012, provided for a $9.7 billion increase in the National Flood Insurance Program's borrowing authority in order to enable the program to make payouts to insured victims of Sandy and other storms. The second was the Disaster Relief Appropriations Act of 2013, a $50.7 billion aid package known alternatively as the Sandy Supplemental, which is dedicated primarily (though not exclusively) to Sandy disaster relief, recovery, and resiliency. The $50.7 billion aid package was subsequently reduced to approximately $48 billion due to the sequestration process resulting from ongoing negotiations to reduce the federal deficit. Although the Federal government may restore the sequestered funds after a successful resolution of future budget negotiations, there is no assurance that such restoration will occur.

The federal aid package includes funding for an array of uses, including most significantly: $16 billion in pre-sequestration CDBG funding, $13 billion in pre-sequestration Department of Transportation funding, $12 billion in pre-sequestration Department of Homeland Security/FEMA funding, and $5 billion in pre-sequestration USACE funding. With the exception of Section 406 and Section 404 funds described elsewhere in this chapter, the bulk of this funding is dedicated to help those whose homes and businesses were damaged or destroyed to rebuild and recover. Some of this rebuilding will include resiliency investments, but a significant majority of these funds will be dedicated to purposes other than the long-term resiliency measures that are the focus of this report.

Funding Provided by the Disaster Relief Appropriations Act of 2013



Recovery Funding for Other Agencies
$ in Millions

Department of Commerce	476	NASA	15
Department of Veterans Affairs	236	General Services Administration	7
Department of Agriculture	228	Smithsonian Institution	2
Department of Defense	113	Social Security Administration	2
Department of Labor	25	Legal Services Corporation	1
Department of Justice	21		

Source: Federal Hurricane Sandy Rebuilding Task Force

Other Federal Aid ($2.3 billion)
The City has received or is expected to receive additional federal funding from a variety of sources as a result of the Sandy Supplemental. A portion of these amounts can be used for resiliency investments called for in this report. This includes especially funding for a variety of US Army Corps of Engineers (USACE) projects in Brooklyn, Queens, and Staten Island as described in Chapter 3.

Other Sources ($40 million)
Immediately following Sandy, the City put in-place emergency recovery programs. These included $25 million in loan and grant programs for small businesses, as well as $15 million in mold removal programs for inundated housing. This money came from a combination of City sources, including NYCEDC, and matching funding from private organizations and philanthropies, such as the Mayor's Fund for the Advancement of New York City.

Expected Sources

In addition to the existing sources described above, the City also expects several other public sources of funding to be available to pay for the plan set forth in this report, including the following:

Additional Federal Sources (at least $4 billion)

1. Community Development Block Grants—Future Allocations (TBD)

The Sandy Supplemental includes a total CDBG allocation of $16 billion, primarily for Sandy-impacted areas, although the law instructs the HUD Secretary to reserve an unspecified portion for other natural disasters in the years 2011 through 2013. The law does not specify the process by which HUD should allocate the CDBG funds to particular grantees. Such allocation is left to the discretion of the HUD Secretary.

In the first allocation, the City received nearly $1.8 billion out of HUD's first allocation of $5.4 billion, or nearly 33 percent or that allocation. HUD noted that it based its first allocation on data from the FEMA Individual Assistance program and the SBA's disaster loan programs, which enabled HUD to identify the areas of greatest need.

With respect to the remaining $10.6 billion in CDBG funding available under the Sandy Supplemental, a portion of this amount has, unless remedied in Washington, been lost to sequestration (leaving nearly $9.3 billion available at present). At the same time, a portion is to be reserved for natural disasters other than Sandy. If HUD were to allocate a significant share of the available funds in the same proportion as the initial allocation, the City could receive billions of dollars in additional CDBG funds.

2. Section 404 and 406 Funding (TBD)

The Robert T. Stafford Disaster Relief and Emergency Assistance Act, as amended (Stafford Act) provides the authority for Federal disaster assistance activities, including not just assistance for response and recovery, but also for preparedness and mitigation. FEMA defines mitigation as any sustained action taken to reduce or eliminate long-term risk to life and property from a hazard event. In pursuit of mitigation, the Stafford Act authorizes post-disaster funding to help governments and certain nonprofit organizations reduce their risk of future loss.

The Stafford Act has two distinct hazard mitigation funding streams that are available post-disaster. First, FEMA may provide hazard mitigation funding as part of its Public Assistance program, as authorized by Section 406 of the Stafford Act. This funding pays for the inclusion of mitigation measures in the repair of damaged facilities and infrastructure. City agencies, led by the Office of Emergency Management (OEM) and the Office of Management and Budget, currently are in the process of identifying projects that are eligible for hazard mitigation funding as part of Public Assistance projects, pursuant to Section 406.

Eligibility for this funding is based on a set of objective criteria and project-specific limitations, though there is no program-level cap for the amount of funding available. Every project that receives Public Assistance from FEMA may also be eligible to receive additional mitigation funds under the Section 406 program for approved mitigation measures. By FEMA policy, funding under this program generally is available in an amount equal to up to 15 percent of the cost of the associated approved repair project (or, up to 100 percent if the project is on a list of predetermined, cost-effective mitigation measures).

Currently, the City estimates that agencies will receive approximately $3 billion in Public Assistance for capital-eligible work. At the 15 percent level, this would translate to more than $400 million in available Section 406 funding, though, as indicated above, the overall sum available to the City could be significantly more or less than this amount.

The second source of funding under the Stafford Act is Section 404 and is also known as Hazard Mitigation Grant Program (HMGP) funding. This program provides mitigation funding for undamaged facilities and infrastructure not covered by Section 406 hazard mitigation funding. Private building owners may apply through a government entity. Funding – which is capped at an amount set as a percentage of FEMA Individual Assistance and Public Assistance dispensed during a given disaster – is allocated pursuant to a State-led application process. Eligible sub-applicants, including local governments and certain nonprofit organizations providing a general government-like service, may submit projects for consideration by the State.

In order to be eligible for Section 404 funding, federal law requires that jurisdictions have a FEMA-approved Hazard Mitigation Plan ("HMP") in place. In New York City, OEM is responsible for the creation of the HMP, working in close partnership with a Mitigation Planning Council that includes nearly 40 City, State, and private entities, as well as extensive community input. The City's HMP, which received FEMA approval in 2009, includes 161 potential projects intended to address eight separate weather-related hazards and is now in the process of being updated by OEM in close partnership with DCP.

Based on the allocation of FEMA Individual Assistance and Public Assistance during and after Sandy, the City currently projects that New York State will be eligible to receive approximately $1 billion in Section 404 funding, though the actual amount may vary from this estimate. The State is, therefore, expected to launch a process that invites sub-applicants such as the City to propose projects suitable for funding. The City currently intends to submit funding requests for projects in the following four categories:

- Mitigation investments for destroyed or substantially damaged homes (e.g., elevation);
- Mitigation investments other than elevation for vulnerable buildings;
- Mitigation investments for vulnerable City-owned infrastructure; and
- Mitigation investments for vulnerable City-owned hospitals.

In addition, a number of nonprofit hospitals located in New York City are eligible to apply directly to the State for Section 404 funding—including several Staten Island institutions that have been prioritized by the Borough President. The City will support and provide technical assistance to these applications, as necessary and appropriate.

In total, given the distribution of Public Assistance and Individual Assistance claims across New York City and the rest of New York State, the City is seeking to receive allocations representing at least half of the State's Section 404 allocation.

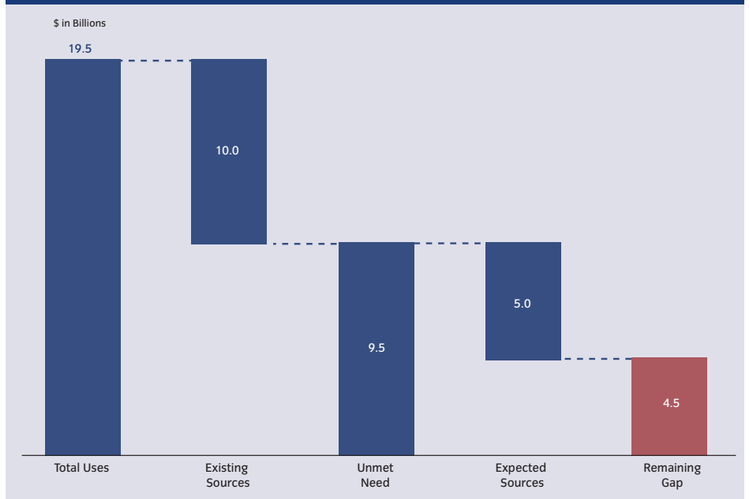
3. Summary of Additional Federal Sources

Based on the foregoing, the City currently estimates that between future CDBG allocations, Section 404 funding, and Section 406 funding, the City could be eligible to receive an additional $4 billion or more for use in funding the programs and projects described in this report. As indicated above, however, these amounts remain subject to processes and decision-making that generally are not within the City's control.

Utility Rate Base (at least $1 billion)
In Chapter 6 (*Utilities*), this report outlines a plan to support new resiliency standards for utilities, including significant hardening of key assets, increases to system flexibility, and projects to ensure faster service restoration. The City estimates that this plan would require significant capital investments in utility infrastructure over the next five to ten years. For example, Con Edison already has filed a proposal to spend $1 billion on resiliency investments over the next three years. These cost projections are preliminary however, and the plan is subject to approval by the New York State Public Service Commission (PSC). Other utility-related investments may be subject to the approval of the PSC or the Federal Energy Regulatory Commission, as well as acceptance by the utilities and generation asset owners.

The City expects that most, if not all, of approved resiliency costs will be recoverable from the utilities' existing rates through modifications to the utilities' budgets, reprioritization of projects, and cost reductions in other areas. To the extent there is a proven need for additions to the utilities' revenue requirements to achieve the goals of the plan, the City will support requests by the utilities for corresponding adjustments to their rates

Calculation of Estimated Funding Gap



(inclusive of a reasonable rate of return). Given the level of capital funding already included in rates, the City estimates that the impact to customers from any requests for rate adjustments will be minimal.

On May 31, 2013, the City provided detailed testimony on a rate case that Con Edison submitted to the PSC, including certain investments described in Chapter 6 of this report. While these measures will require additional funding, the City believes that they can be made within the parameters of Con Edison's proposed rate case. The PSC is expected to rule on Con Edison's proposal by the end of 2013.

Sizing the Gap

Based on the uses and sources identified above, the City currently faces a funding gap for the initiatives identified in this report of approximately $4.5 billion. This means that, without additional sources, a number of these initiatives and programs would need to be delayed, scaled back, or even eliminated. However, the challenge of climate change is too great, and the potential impact of these initiatives too significant, to simply accept this funding gap. That is why the City will continue to push aggressively to identify ways of filling this gap. Provided below are a series of strategies that would allow for the full implementation of the plan set forth in this report.

Strategies to Fill the Gap

The following are potential approaches for filling all or a significant portion of the identified funding gap associated with the plan outlined in this report. In the case of several approaches, the approval of another governmental entity (at the State or Federal level) would be required. However, because of the risks associated with the failure to implement this plan, the City is hopeful that it will find willing partners to secure the funding needed to make them a reality.

Additional Supplemental Appropriation
The Sandy Supplemental signed into law in January includes $5.4 billion in funds for the USACE. However, much of this funding provides merely for the repair and restoration of protections that existed before the storm hit, and were damaged. Only limited funding is available for the study, design, and implementation of new measures that reflect the risk New York City and its neighbors face now and in the future, with very limited funding available for implementing these measures.

Given this, it is clear that the initial USACE allocation in the Sandy Supplemental is inadequate to deal head on with the threats that climate change poses—especially taking into account the size of the area's population and its contribution to the national economy. Accordingly, an additional, significant USACE allocation would represent a valuable and necessary investment on the part of the Federal government. The City will work with the State, the Congressional delegation, and regional leaders to secure this necessary federal contribution. (*See sidebar: Additional Supplemental Appropriation Precedent*)

Lower Manhattan Tax Benefit Trade-In
In the months following the September 11, 2001 terrorist attacks, Congress provided $5 billion in tax benefits to help in the rebuilding and economic recovery of Lower Manhattan. However, subsequent analysis showed that New York never received at least $2 billion of this aid, due to technical issues in the design of the tax benefits. The City previously sought to work with Congress and the President to reprogram these unused tax benefits for investments in transportation infrastructure. In the wake of Hurricane Sandy, however, it is now appropriate to consider ways in which this promised but still-undelivered $2 billion in Federal assistance can be used for resiliency purposes, in order to prevent future damage in the City's vulnerable coastal areas, including Lower Manhattan.

Property & Casualty Insurance Resiliency Assurance Surcharge
Insurance exists to compensate policyholders for losses in the event that unfortunate events occur. While that compensation can help soften the blow of a loss, policyholders frequently do not receive full compensation— either for their losses, or for their non-financial costs, including lost time and anxiety. That is one reason why even those with insurance would prefer that losses not happen in the first place.

That is why, in the event that the City is unsuccessful in securing the supplemental federal appropriations described above, the City will work with the State, including the State legislature, to explore a "Resiliency Assurance Charge" (RAC) on property and casualty (P&C) insurance policies in New York City. This insurance includes automobile, homeowner, general liability, commercial multi-peril, and certain other forms of insurance. Because of the massive volume of P&C insurance premiums written for New York City exposure (over $33 billion in New York State in 2010 alone, according to the State Department of Financial Services, of which a majority is applicable to New York City), even a small surcharge would produce sufficient proceeds to fill the identified gap. For example, by bonding against a surcharge of approximately 1.5 percent, the City could generate more than enough in upfront bond issuance proceeds and excess revenues to cover the $5 billion shortfall. This surcharge would translate to just over a dollar a month for a homeowners insurance policy with a $1,000 annual premium.

To access this funding source, the City would need to obtain passage of State legislation. Models such as this one exist in other areas of the country that are vulnerable to climate change, including Florida, Louisiana, and Texas, though, in these jurisdictions, surcharges on P&C policies are generally assessed after an extreme weather event to pay for insured losses that cannot otherwise be covered, rather than, as proposed in this report, to minimize the chances that those losses will happen in the first place.

City Capital Contribution
As described above, the City's existing capital budget includes significant funds for projects with an important resiliency and community recovery component. Although the City believes that the Federal and other sources identified above could (and, especially in the case of the Federal sources, should) fill the bulk of the resiliency funding gap identified by this report, the City remains committed to making necessary investments that will protect New York and its residents. The Bloomberg Administration, therefore, is prepared to work with the City Council to make up to an additional $1 billion in capital available for resiliency efforts, as follows:

- Implementation of this plan ($150 million): The City will begin to invest immediately in selected resiliency measures included in this report that do not already have a dedicated funding source. This includes providing funding for the required "local match" for certain projects that are largely federally-funded, such as the USACE's plan to construct an armored dune along portions of the East Shore of Staten Island;
- Agency resiliency needs ($100 million): As described previously, the City has begun the process of identifying, and is prepared to fund, an initial set of $100 million high-priority agency investments that would protect critical City facilities and ensure the continued provision of City services, during and after future extreme events;
- City "match" for new sources (up to $750 million): Accessing the non-City sources described above will in each case require State or Federal approval. The City is prepared to allocate, on a contingent basis, additional funds to the extent that these approvals are obtained, on the basis of a 1-to-5 match, up to $750 million. For example, if the City were successful in obtaining an additional $3.75 billion in new funding, it would allocate the additional $750 million in City capital, bringing total funding to $4.75 billion (including the $150 and $100 million in new capital allocations described immediately above).

Other Sources
The options identified above represent the most significant and least speculative potential sources to fill the funding gap identified above. However, other potential sources that may be smaller in scale or more speculative are also available and worthy of consideration.

For example, Chapter 18 (*Southern Manhattan*) suggests studying the creation of a new multi-purpose levee along the eastern edge of Lower Manhattan from the Battery Maritime Building to Pier 35 to protect this at-risk area in the same way that Battery Park City helped to protect adjacent neighborhoods during Sandy, thanks to the area's elevation. In addition to offering this protection, the multi-purpose levee, if constructed, also would create new, developable parcels that could generate significant excess proceeds—as proved to be the case for Battery Park City—that, in turn, could be used for further resiliency investments. Given the extensive analysis, permitting, and construction that would be required before the multi-purpose levee were to become a reality, any proceeds from this project must be deemed to be highly speculative and unlikely to materialize for many years, if at all.

Another strategy for protecting Southern Manhattan, as described in Chapter 3, is an integrated floodwall system that would include both permanent measures (e.g., landscaping) and temporary, deployable floodwalls. The City is proposing to construct such a system as part of its Phase I coastal protection plan across a significant section of the Lower East Side and Chinatown. The Phase I plan could be extended south to the Financial District, below Chambers Street, were additional resources identified. Given the concentration of high-value real estate in the Financial District, a potential source to cover all or a portion of the cost of such an extension would be a modest per-square-foot assessment on some or all of the buildings in the area. Though such an assessment could obviate the need for some landlords to invest in certain building-level protections from extreme weather and could also result in lower insurance premiums for area buildings, such an assessment also could face opposition, meaning that this source too must be deemed a relatively speculative one.

Yet another potential source to fund the gap identified in this report is a concept known as mitigation banking. Mitigation banking is meant to address the sub-optimal outcome caused by the fact that, currently, developers in New York wishing to build on wetlands are required to restore adjacent wetlands in-kind. While this approach is laudable in theory, the reality is that the requirement often results in wetland restorations that are neither as cost-effective nor as environmentally desirable as they could be. To address a similar issue, 28 states— including New Jersey and Connecticut—have instituted mitigation banking programs, through which a third-party entity performs wetland restoration in offsite, environmentally significant areas, thereby generating "mitigation credits" that are sold to developers to offset the impacts of their activities. Such an approach typically enables the protection of more and more critical wetlands, but at a lower cost than onsite mitigation. This approach could be used to fund several of the wetlands-related proposals contained in Chapter 3. Currently, NYCEDC is piloting such a program (working with the Department of Environmental Protection and others), that if successful, would be expanded. As beneficial as a program such as this could be, however, it is expected to be a comparatively limited source for the proposals contained in this report.

Additional Supplemental Appropriation Precedent

There is a clear precedent for the proposed supplement to the initial USACE allocation for Sandy-impacted areas. In the year after Hurricane Katrina struck the Gulf Coast region, Congress appropriated over $6 billion to the USACE for coastal protection. However, recognizing the needs beyond this initial appropriation—much of which, like the Sandy Supplemental, targeted short-term investments to repair coastal infrastructure—Congress provided four additional USACE appropriations for Katrina-related work, including the creation of significant new defenses. These additional appropriations totaled over $9 billion.

An equivalent $9 billion allocation would enable the City and other area governments to begin to make significant progress on the type of coastal defenses described in this report, protecting residents, businesses, and critical infrastructure from extreme weather events. At a minimum, Congress should allocate to New York City the $3.7 billion necessary to fund the Phase 1 coastal protection initiatives set forth in Chapter 3 of this report.

Third-Party Proposal: MoveNY

Former Traffic Commissioner Sam Schwartz has introduced a plan called "MoveNY."In the plan, Schwartz identifies problems with area tolling, including that significant revenue is collected at bridges far from central business districts, in areas that lack transit alternatives. For example, every entry into Staten Island is tolled, and many Queens residents pay to travel within the borough. At the same time, there are untolled entrances into Manhattan, despite numerous transit options. According to Schwartz, these entrances lure drivers from highways that lead to tolled crossings instead to local streets that lead to free bridges.

To address these problems, Schwartz proposes tolls to enter the Manhattan central business district via the East River bridges and at 60th Street. The plan would use funds from these tolls to reduce tolls on the Verrazano Narrows, Gil Hodges, Cross Bay, Whitestone, and Throgs Neck bridges.

Schwartz projects that the plan would produce about $1.5 billion in new annual revenues, which he estimates could support a bond issuance of $12 to $15 billion. This sum could fund bridge maintenance, transit improvements, achievement of a "state of good repair" for MTA and City transportation assets, and more. According to Schwartz, the plan also offers other benefits including: traffic reduction, improvements to public health and the environment, and economic impacts from new construction.

As outlined in this chapter, the City will seek a number of sources to fill the funding gap identified in this report. If these sources are secured, additional funding would not be required for the initiatives detailed herein (though it could be required to pay for later phases of resiliency investment). As such, the City is not, in this report, calling for the implementation of MoveNY. However, the additional sources that the City is seeking require approvals that are far from certain. Accordingly, acknowledging the significant approvals that would be required to institute MoveNY as well, but given the fact that there is a nexus between auto usage and climate change, and that many of the areas that would benefit from toll reductions are also areas that are recovering from Sandy, the City believes it would be prudent for New Yorkers and their future leaders to evaluate the MoveNY proposal as a way, not just of achieving Schwartz's goals, but potentially funding resiliency investments as well.

Implementation

Since the launch of the Special Initiative for Rebuilding and Resiliency in December 2012, scores of City employees across a variety of agencies have invested thousands of hours in the development of *A Stronger, More Resilient New York*. But in many ways, the hard work really begins with the publication of this report. Only a focused, energetic, and sustained implementation effort can ensure that the strategies and initiatives outlined in this document are translated into specific actions that achieve the goal of increasing the resiliency of New York's buildings, infrastructure, and communities.

The 2007 PlaNYC report *A Greener, Greater New York* set similarly ambitious goals to improve the city's sustainability. The report noted, "This agenda will require tremendous effort: on the part of City officials and State legislators; by community leaders and our delegation in Washington; from the State government and from every New Yorker. It will not be easy, and it will not be free. But the payoff is real, and big; and the perils of inaction are far greater than the costs of action."

This statement is as true today as it was in 2007. Fortunately, the City's approach to PlaNYC provides a model for how to translate plans into results.

For example, in 2010, the international nonprofit ICLEI-Local Governments for Sustainability said, "Since the release of [PlaNYC], the City has made great strides towards implementing the plan—passing groundbreaking green buildings legislation, creating miles of bike lanes, opening acres of open space, cleaning the air, and reducing greenhouse gas emissions. PlaNYC is a success because it is not just a plan; it is an action-oriented agenda that provided the City with a framework for implementing bold changes." The organization went on to identify 10 factors contributing to PlaNYC's success.

The implementation of *A Stronger, More Resilient New York* will build on the systems and structures that have made PlaNYC a success, including four that will be particularly important in the months and years to come: assignment of clear accountability; development of regular, required reporting; identification of near-term milestones; and creation of a clear and compelling Federal agenda. (*See sidebar: Factors Contributing to PlaNYC's Success*)

Clear Accountability

An initiative without a clear owner is destined to fail. That is why the key to successful implementation of this plan is ensuring that each and every initiative is owned by a designated agency or office, with interagency working groups where appropriate and coordination by a single entity.

A number of topics in this report align primarily to a single responsible agency—including transportation (Department of Transportation, or NYCDOT), water and wastewater (Department of Environmental Protection, or DEP), solid waste (Department of Sanitation, or DSNY), telecommunications (Department of Information Technology and Telecommunications, or DoITT), and parks (Department of Parks & Recreation, or DPR). Each of these agencies therefore, will be responsible for driving the implementation of initiatives contained within their respective chapters. In some other chapters, only selected initiatives are aligned clearly to a single agency. This includes, for example, the land use actions within the Community Rebuilding and Resiliency Plans (Department of City Planning, or DCP) and the recommendations for City-owned hospitals within Chapter 8 (*Healthcare*) (Health and Hospitals Corporation, or HHC). With respect to the remaining initiatives (those without a natural "owner"), it will be necessary to identify an appropriate lead agency responsible for implementing each.

Even with different agencies assigned to each initiative, it is necessary to appoint a single entity as the overall steward of this plan and its implementation. That entity should be experienced in interagency coordination, informed about climate change and its impacts on New York City, and practiced in driving the development and implementation of long-term planning efforts.

Fortunately, the Mayor's Office of Long-Term Planning and Sustainability (OLTPS) is positioned perfectly to play this role, building on its success at driving the City's sustainability efforts during the last six years. OLTPS long has focused not just on making the city greener but also on identifying and protecting New York from climate change impacts. For example, well before Sandy, OLTPS staff had coordinated with the New York City Panel on Climate Change (NPCC) to develop local climate projections for New York City; engaged with the Federal Emergency Management Agency (FEMA) on the development of new flood maps (including forward-looking maps reflecting projected sea level rise); convened the Climate Change Adaptation Task Force to assess risks to critical infrastructure; and begun coordinating with the United States Army Corps of Engineers (USACE) on a study of potential protections for New York Harbor. During Sandy, OLTPS staff worked night and day to support recovery operations related to the City's energy and other critical infrastructure. Furthermore, as leaders and members of the Special Initiative for Rebuilding and Resiliency (SIRR), OLTPS staff members have been central to the creation of this report.

Factors Contributing to PlaNYC's Success

An independent organization, ICLEI-Local Governments for Sustainability, spent over a year researching and understanding the process New York City followed to develop PlaNYC, interviewing many of the key people involved. Through this research process, ICLEI identified the top 10 factors for PlaNYC's success:

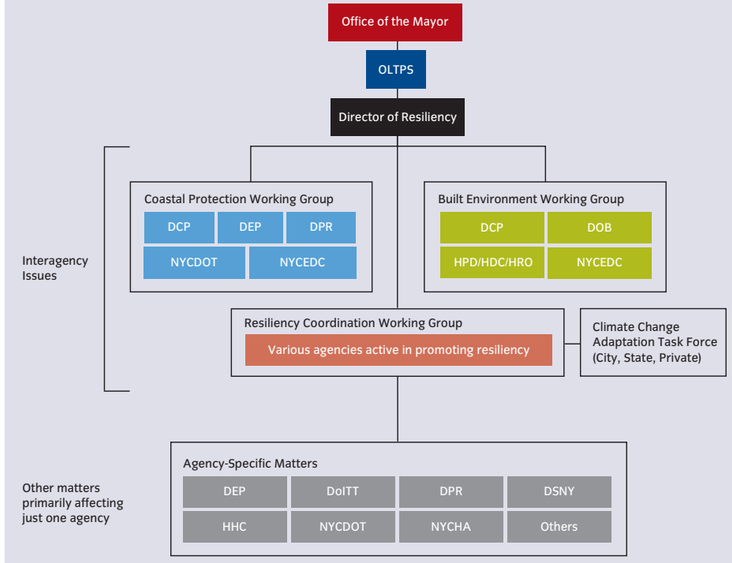
1. Strong **mayoral leadership** and **cooperation between** the Mayor's Office and City Council.
2. A group of dedicated City agency staff performed **in-depth research and analysis**, involving extensive **coordination and collaboration** between the agencies.
3. A **methodical, transparent, and inclusive planning process.**
4. **Central management and coordination** provided by the Mayor's Office of Long-Term Planning and Sustainability.
5. An external Sustainability Advisory Board provided **best practice advice and guidance**.
6. A **comprehensive public outreach process** generated broad public support and helped to educate the general public about climate change and sustainability issues.
7. The Mayor's Office of Long-Term Planning and Sustainability **strategically released** the plan by coordinating announcements with key stakeholders.
8. The plan included an **implementation plan** with a timeline and a funded budget.
9. Swift **transition from planning to action**: the City is actively implementing all 127 initiatives.
10. **Openness for innovation** and policy-making not driven by politics or business as usual.

interagency working groups that will be established to address high-priority initiatives that cut across the typical boundaries of City government. The first of these areas is coastal protection, which will involve further risk assessment, review of technologies and equipment, coordination with the USACE, and implementation. This working group—to include DCP, DEP, DPR, NYCDOT, and the New York City Economic Development Corporation (NYCEDC)—will pursue the implementation of the initiatives in Chapter 3 (*Coastal Protection*), including securing necessary funding.

The second critical interagency working group will coordinate the implementation of buildings-related recommendations, including the various initiatives contained within Chapter 4 (*Buildings*), Chapter 5 (*Insurance*), and Chapter 8 (*Healthcare*). The intersection of the building code, mitigation measures, Federal flood insurance, and zoning requires a close working relationship among various agencies, including DCP, NYCEDC, the Department of Buildings (DOB), the Department of Housing Preservation and Development (HPD), and the Mayor's Office of Housing Recovery Operations (HRO). OLTPS will coordinate this group and collaborate with the City Council to ensure sustained progress on the initiatives outlined herein.

The third interagency working group will provide operational support and coordination for citywide long-term recovery and resiliency efforts of all types, citywide. Made up of senior leaders from the most involved agencies, this working group will ensure cross-agency cooperation for various initiatives, particularly those assigned to one agency but needing support from others. In addition, this working group will seek to prevent duplication of efforts, promoting coordination between the resiliency efforts included herein and other post-Sandy recovery initiatives (such as implementation of the recommendations in the City's *Hurricane Sandy After Action Report*). This working group also will collaborate with the existing Climate Change Adaptation Task Force.(*See chart: High-Level Implementation Structure*)

High-Level Implementation Structure



In addition to leading these interagency working groups, OLTPS also will draw upon other lessons from its successful implementation of PlaNYC. For example, in order to solicit the continued input of third-party experts, OLTPS will consider supplementing the membership of the Sustainability Advisory Board to include expertise in resiliency and other fields needed to ensure that the latest science, research, and community input is brought to bear to make New York City more resilient.

With the tools outlined above and the necessary additional resources, OLTPS is well positioned to oversee the implementation of this plan, even as it continues to implement the entire PlaNYC sustainability agenda.

Required Reporting

Renowned management theorist Peter Drucker famously said, "What gets measured, gets

Select Local Laws Supporting PlaNYC	
Local Law 17 of 2008	• Establishes OLTPS in the City Charter • Requires OLTPS to issue an updated "comprehensive, long-term sustainability plan" every four years, and an annual progress update including sustainability indicators • Requires DCP to issue updated population projections every four years
Local Law 22 of 2008	• Requires a 30 percent reduction in citywide greenhouse gas emissions by 2030 and City government emissions by 2017 • Requires annual inventory and analysis of greenhouse gas emissions
Local Law 42 of 2012	• Codifies the NPCC and requires updates to climate projections at least every three years, and within one year of an Intergovernmental Panel on Climate Change update • Codifies the Climate Change Adaptation Task Force and requires an updated risk assessment within one year of new projections
Various Other Local Laws	• Includes the production of regular or one-time studies on a variety of topics, including stormwater management, recycling and composting, food distribution, and undergrounding of power lines • Creates the Office of Environmental Remediation and a "renewable energy portal"

managed." The history of PlaNYC demonstrates the power of establishing clear metrics and monitoring progress against them. Since 2007, the Administration has worked closely with the City Council to adopt legislation requiring City agencies to submit regular progress reports relating to the plan. For example, Local Law 17 of 2008 requires OLTPS to issue an updated "comprehensive, long-term sustainability plan" every four years, and an annual progress update including sustainability indicators. Local Law 22 of 2008 requires a 30 percent reduction in citywide greenhouse gas emissions by 2030 and City government emissions by 2017. Critically, it also requires an annual inventory and analysis of these emissions. (*See table: Selection of Local Laws Supporting PlaNYC*)

Subsequent planning efforts, including the *Sustainable Stormwater Management Plan* (2008), the *Green Infrastructure Plan* (2010), and the *New York City Wetlands Strategy* (2012) all require reporting and periodic updates. In short, the requirement to monitor and report on the progress of sustainability initiatives has enabled observers both within and outside government to assess progress and, if necessary, advocate for change.

The City believes the same rigor that applies to its sustainability efforts should apply equally to its resiliency efforts. To that end, the Administration will work with the City Council to pass a new local law that requires OLTPS to issue an updated "comprehensive, long-term resiliency plan" every four years, beginning in 2017, four years after the release of this plan. The local law should require that this update be developed in coordination with the City's regularly updated Hazard Mitigation Plan, which is compiled by OEM in close partnership with DCP and other City agencies based on FEMA regulations. In addition, the local law should require OLTPS to include resiliency indicators in the annual progress update already issued by the office. OLTPS will work closely with other involved City agencies to identify a list of appropriate metrics. (*See table: Selected Citywide Infrastructure and Built Environment Resiliency Metrics, Preliminary*)

Selected Citywide Infrastructure and Built Environment Resiliency Metrics, Preliminary

Category	Metrics
Coastal Protection	• Federal dollars secured for coastal protection projects • # of buildings with reduced coastal risk due to coastal protection projects
Buildings	• # of buildings implementing Core Flood Resiliency Measures • # of square feet of residential and non-residential buildings implementing Core Flood Resiliency Measures
Insurance	• % of residences in 100-year floodplain purchasing flood insurance • Average premium paid for NFIP policies
Utilities	• % of electric generation capacity in the 500-year floodplain able to remain online after a 500-year flood • Maximum % of peak load that could be lost due to failure of any one substation • % of assets at or above their loading limits during peak demand periods (e.g., during heat waves) • # of miles of cast iron and bare steel gas mains in the 500-year floodplain • % of steam generation capacity in the 500-year floodplain able to remain online after a 500-year flood
Liquid Fuels	• % of gas stations with quick-connects for generators • % of regional fuel terminal capacity in the 100-year floodplain hardened against a 100-year flood • % of regional refining capacity in the 100-year floodplain hardened against a 100-year flood
Healthcare	• % of hospital beds in 500-year floodplain meeting resiliency requirements • % of nursing homes and adult care beds in 100-year floodplain meeting resiliency requirements
Telecommunications	• # of critical telecommunications facilities implementing Core Flood Resiliency Measures
Transportation	• # of lane-miles reconstructed or resurfaced • % of New York City transportation assets adapted for climate change resiliency
Parks	• % of facilities in Sandy inundation zone upgraded for greater resiliency • # of trees inspected and pruned • # of cubic yards of beach sand nourishment
Water and Wastewater	• # of wastewater facilities or assets protected or raised above the 100-year floodplain • % of combined sewer area runoff managed by green infrastructure • # of new sewer miles built in areas with no or partial sewers • # of areas served by Bluebelt projects built citywide • % of water quality samples complying with Surface Water Treatment Rule standard for turbidity
Solid Waste	• # of DSNY facilities protected or raised above the 100-year floodplain
Food Supply	• # of grocery stores with generators or quick connects for generators • % of DCAS food procurement backstopped with more resilient distributors

Near-Term Milestones

In its 2010 report, ICLEI–Local Governments for Sustainability noted the importance of "swift transition from planning to action" as a factor contributing to PlaNYC's success. Within the first year of releasing PlaNYC, the City had launched 118 of its 127 initiatives (over 90 percent). These initiatives included creating the Office of Environmental Remediation and the Brownfield Opportunity Area grants program; opening more than 100 schoolyards as playgrounds; signing legislation to require ultra-low sulfur diesel in City-owned ferries; issuing Executive Order 109 directing agencies to take steps to reduce City government's energy consumption and CO_2 emissions by 30 percent from 2006 levels within 10 years; and launching the Mayor's Carbon Challenge at 10 leading universities that committed to matching the City's "30x17" goal (a 30 percent reduction in City government carbon emissions by 2017).

Climate change is a long-term problem, and many of the strategies and initiatives outlined in this report will evolve over a similarly long period of time. However, it is both possible and necessary to begin to make progress now. The achievement of near-term milestones can help build momentum for initiatives that take longer to implement, and generate lessons that can be applied across the entire plan.

To that end, the City has identified a series of resiliency milestones that can be achieved in 2013. These milestones include an array of concrete achievements that will result in material improvements to New York's resiliency, including, but not limited to, the following:

- launch of housing and building recovery programs;
- launch of Neighborhood Game Changer and Resiliency Technology Competitions:
- appointment of a member of the senior leadership team of each relevant City agency as the point person for resiliency matters;
- establishment of the DoITT Planning and Resiliency Office;
- launch of the USACE comprehensive coastal protection study with active City participation;
- completion of emergency beach nourishment projects in Brooklyn and Queens by the USACE, and Staten Island by DPR;
- implementation of DCP's Flood Resilience Text Amendment to facilitate flood-resistant new construction retrofits;
- approval of amendments to the Construction Codes to provide for resiliency improvements for new and existing buildings, including healthcare facilities;
- implementation of a resiliency incentive program for properties in the 100-year floodplain facing increased flood risk;
- launch of flood insurance-related studies with FEMA for the National Flood Insurance Program (NFIP);
- introduction of a legislative package (City, State, and Federal) to provide regulatory relief in the event of a liquid fuel emergency;
- launch of an emergency fueling equipment and generator procurement program for critical fleets; and
- submission of testimony calling for significant investment in resiliency and storm-hardening measures as part of the 2013 Con Edison rate cases for electric, gas, and steam before the New York State Public Service Commission (PSC).

These near-term milestones and others identified will demonstrate the City's commitment to protecting its coastal neighborhoods and all New Yorkers, and will represent a significant down payment on the years of hard work to come. (*See table: Selected 2013 Resiliency Milestones*)

Federal Agenda

Given the important role played by the Federal government in flood risk assessment, flood insurance, and coastal protection measures, a clear Federal agenda for the City to pursue (in partnership with the State and the Congressional delegation) is critical to the successful implementation of the plan outlined in this report.

The City, therefore, has developed a Federal Resiliency Agenda that it intends to bring to Washington immediately. While this list does not reflect all of New York City's needs from the Federal government, it does reflect a set of priorities that require immediate attention:

1. **Establish a Federal policy for using local climate projections**: Using different climate projections at the local and Federal levels will cause confusion and lead to conflicting measures for protecting against future risks. Federal policy should permit or require that, where local climate projections meet rigorous scientific standards, they should be deferred to by the Federal government within the applicable locality.

2. **Improve the national flood mapping program**: FEMA flood maps are one of the main tools for understanding coastal flood risks, but 30 years have passed since FEMA last completed a coastal flood study for New York—resulting in outdated maps that underestimate today's coastal flood risk. In addition to more frequent updates, improvements to the program should include clearer technical guidance, increased transparency, and the incorporation of future risks such as sea level rise.

3. **Better reflect coastal protection measures in flood maps**: A primary goal of coastal protection measures is to mitigate the risks to New Yorkers that are reflected in Federal flood maps. As such, neighborhood-and site-specific improvements that provide defenses against floods should result in flood map amendments.

4. **Ensure completion of key USACE coastal protection studies with the right priorities, and secure supplemental funding for implementation**: Recent Federal legislation instructs the USACE—and provides the necessary funding—to complete a series of high-priority assessments, including, most importantly, a comprehensive New York Harbor study. These studies should prioritize an analysis of the City's proposed coastal protection measures. In addition, the Federal government should ensure funding that will allow the recommendations of these studies to be implemented.

5. **Work with FEMA to update its requirements and best practices for flood protection to reflect the needs of a high-density urban environment**: New York City's built environment differs significantly from coastal communities in most of the rest of the country. Upgrading FEMA guidance, practices, and policies, where warranted, can aid and encourage

adaptation in New York City and other urban contexts.

6. **Develop NFIP mitigation credits for resiliency measures**: Many buildings in urban environments have structural characteristics or site conditions that pose a challenge to elevation. Other mitigation options that reduce the risk of flood damage are available and should be encouraged through commensurate insurance premium reductions.
7. **Address NFIP affordability**: Implementation of the Biggert-Waters flood insurance reform legislation will adversely affect many property owners, especially low-income populations, and is likely to have broader impacts on home ownership affordability and neighborhood stability. The legislation called for FEMA and the National Academy of Sciences to conduct a study of methods for addressing flood insurance affordability. This study must be completed and its recommendations must be implemented as soon as possible.
8. **Strengthen resiliency of the regional liquid fuel infrastructure**: The City lacks the regulatory power to monitor or require resiliency in much of the liquid fuels infrastructure that serves New York. The Federal government must convene stakeholders to identify ways of ensuring the resiliency of this infrastructure and preventing future supply chain breakdowns.

Selected 2013 Resiliency Milestones

Chapter	2013 Milestone
Climate Analysis	• Launch of interactive web platform for communicating flood-related risk information* • Release of NPCC climate projections for 2100, including humidity projections • Release of a set of metrics developed with the NPCC to measure actual climate change against predicted climate change
Coastal Protection	• Launch of USACE Harborwide coastal protection study with active City collaboration • Release of global competition to design integrated flood-protection systems* • Completion by USACE of emergency beach nourishment in the Rockaways, Coney Island, Brighton Beach and Plumb Island with active City collaboration • Completion by DPR of emergency beach nourishment at South Beach, New Dorp Beach, and Oakwood Beach in Staten Island
Buildings	• Approval of Construction Code amendments and zoning text amendments to provide for resiliency improvements for new and existing buildings • Launch of incentive program for properties in the 100-year floodplain facing increased to adopt Core Flood Resiliency Measures • Launch of Resiliency Technologies Competition, and Resilient Housing Design Competition* • Launch of sales tax abatement program for flood resiliency in industrial buildings • Initiation of studies related to wind risk and potential resiliency retrofit requirements*
Insurance	• Launch of mitigation credits study with FEMA • Launch of consumer education campaign on flood insurance*
Utilities	• Filing of comments in the Con Edison rate case, including proposals for a new approach to resiliency investment on the part of the PSC • Development of a generator plan with OEM, including coordination with the Federal government and with the State
Liquid Fuels	• Launch of discussions with the Federal government on liquid fuels infrastructure hardening • Introduction of a legislative package for liquid fuels emergency relief
Healthcare	• Amendments to Construction Code for new and existing facilities • Launch of resiliency incentive program for nursing homes and adult care facilities*
Telecommunications	• Establishment of the DoITT Planning and Resiliency Office* • Launch of WiredNYC and NYC Broadband Map programs to provide better information about building broadband access and resiliency
Transportation	• Raising of selected traffic signal controllers above flood elevations in vulnerable areas • Acquisition of power inverters to allow signals to operate on NYPD vehicle power during outages • First planning exercise for temporary measures to respond to extreme weather-related transit outage scenarios • Initiation of detailed planning for Select Bus Service bus rapid transit route on Woodhaven Boulevard
Parks	• Establishment of Jamaica Bay Science and Resilience Center • Expansion of DPR native plant seed collection

Selected 2013 Resiliency Milestones (Continued)

Chapter	2013 Milestone
Water and Wastewater	• Adoption of infrastructure guidelines for new wastewater facilities that include storm surge and sea level rise • Completion of detailed facility risk assessment and adaptation study, and release of final report • Start of construction of the Catskill and Delaware interconnection, completion of Ultraviolet Disinfection Facility, and revision of EPA filtration waiver
Solid Waste	• Completion of detailed facility risk assessment
Food Supply	• Launch of comprehensive food distribution study to identify supply chain vulnerabilities*
All Communities	• Launch of Business Recovery and Resiliency programs • Launch of Neighborhood Game Changer contest
Brooklyn-Queens Waterfront	• Launch of pilot summer weekend ferry service expansion from Manhattan to Red Hook • Completion of enhancements to Mill Street and the BQE underpass to improve the connection between Red Hook and the rest of Brooklyn • Announcement of Brooklyn Bridge Park designation for John Street site, including elevated building and coastal edges
East and South Shores of Staten Island	• Issuance of RFEI for new concessions and services at City-controlled beachfront • Launch of detailed land use studies to encourage retrofits of existing buildings and construction of new resilient buildings in severely impacted East Shore communities* • Launch of the first capital project for the Mid-Island Bluebelt in Midland Beach • Launch of Great Kills Harbor comprehensive revitalization study to increase resiliency and draw additional investments* • Implementation of roadway and sewer capital projects along Hylan Boulevard, especially in vulnerable South Shore areas
South Queens	• Launch of Beach 116th Street commercial revitalization study to develop detailed redevelopment plan* • Launch of Far Rockaway commercial revitalization study to develop detailed redevelopment plan* • Launch of detailed land use studies to encourage retrofits of existing buildings and construction of new resilient buildings in Hamilton Beach and Broad Channel* • Start of pilot summer extension of weekday ferry and expansion of weekend ferry from Manhattan to the Rockaways
Southern Brooklyn	• Start of construction on a new iconic rollercoaster in Coney Island's amusement area • Launch of detailed land use studies to encourage retrofits of existing buildings and construction of new resilient buildings in Gerritsen Beach* • Completion of emergency repairs to bulkhead/floodwall along the Belt Parkway • Continuation of construction of the first phase of area drainage improvements in Coney Island
Southern Manhattan	• Launch of incentive program targeting new and renewing tenants in the 100-year floodplain* • Launch of Take the HELM competition for Sandy-impacted areas* • Start of streetscape and safety improvements on Water Street • Launch of initiative to encourage comprehensive upgrades of ground floors and adjacent Privately Owned Public Spaces along Water Street
Implementation	• Passage of local law outlining resiliency requirements for OLTPS • Appointment of Citywide Director of Resiliency at OLTPS • Issuance of executive order requiring agencies to appoint a resiliency point person and to build new facilities to most recent available 100-year floodplain plus appropriate freeboard, or equivalent standard
Funding	• Inclusion of resiliency funding in City capital budget

* Subject to available funding

Appendix: Initiatives

	Initiative	Lead City Agency	Milestones for Completion, Assuming Funding		10-Year Capital / Study Cost (Preliminary Estimate, in $ Millions, Nominal)	Funding Source
			By End of 2014	By End of 2020		
Strengthen the quality of available climate analysis						
CLIMATE ANALYSIS	**1** Work with FEMA to improve the flood-mapping process	OLTPS	Implement technical and process improvements	--	N/A	N/A
	2 Work with FEMA to improve the communication of current flood risks	OLTPS	Launch a new interactive tool	--	N/A	N/A
	3 Call on the State and Federal governments to coordinate with the City on local climate change projections	OLTPS	Obtain Federal agreement to rely on NPCC	--	N/A	N/A
	4 Continue to refine local climate change projections to inform decision-making	OLTPS	Issue expanded NPCC projections; release evaluation metric for climate change	--	N/A	N/A
	5 Explore improved approaches for mapping future flood risks, incorporating sea level rise	OLTPS	Develop revised future flood maps	--	N/A	N/A
	6 Launch a pilot program to identify and test strategies for protecting vulnerable neighborhoods from extreme heat health impacts	OLTPS	Launch pilot program	Complete pilot and seek to expand it	<1	CDBG
Increase coastal edge elevations						
COASTAL PROTECTION	**1** Continue to work with the USACE to complete emergency beach nourishment in Coney Island	DPR	Complete beach nourishment projects	--	40–60	USACE
	2 Continue to work with the USACE to complete emergency beach nourishment on the Rockaway Peninsula	DPR	Complete beach nourishment projects	--	100–125	USACE
	3 Complete short-term beach nourishment, dune construction, and shoreline protection on Staten Island	DPR	Complete beach nourishment and related projects	--	10–20	FEMA
	4 Install armor stone shoreline protection (revetments) in Coney Island	OLTPS	Begin design	Complete project	20–40	CDBG
	5 Install armor stone shoreline protection (revetments) on Staten Island	OLTPS	Begin design	Complete project	20–40	CDBG
	6 Raise bulkheads in low-lying neighborhoods across the city to minimize inland tidal flooding	OLTPS	Launch study of low-lying neighborhoods; begin selected implementation	Complete initial work; pursue additional work subject to study results	80–100	CDBG
	7 Complete emergency bulkhead repairs adjacent to the Belt Parkway in Southern Brooklyn	DPR	Complete bulkhead repairs	--	1–10	FEMA
	8 Complete bulkhead repairs and roadway drainage improvements adjacent to Beach Channel Drive on the Rockaway Peninsula	NYCEDC	Complete bulkhead repairs and related drainage improvements	--	20–40	City
	9 Continue to work with the USACE to complete emergency floodgate repairs at Oakwood Beach, Staten Island	OLTPS	Complete floodgate repairs	--	1–10	USACE
	10 Complete tide gate repair study at Flushing Meadows Corona Park, Queens	DPR	Study tide gate repairs	Subject to study results	1–5	City

Note: As used herein, TBD means that a specific source has not yet been secured for the identified use; potential sources are described in Chapter 19 (*Funding*)

	Initiative	Lead City Agency	Milestones for Completion, Assuming Funding		10-Year Capital / Study Cost (Preliminary Estimate, in $ Millions, Nominal)	Funding Source
			By End of 2014	By End of 2020		
Minimize upland wave zones						
COASTAL PROTECTION	**11** Continue to work with the USACE to complete existing studies of the Rockaway Peninsula and implement coastal protection projects	DPR	Begin study of flood risk reduction projects; complete identified short-term dune improvements	Subject to study results	100–125	USACE
	12 Call on and work with the USACE to study and install primary and secondary dune systems in vulnerable Rockaway Peninsula neighborhoods (such as Breezy Point)	OLTPS/DPR	Begin study	Subject to study results	40–60	TBD
	13 Call on and work with the USACE to study and install offshore breakwaters adjacent to and south of Great Kills Harbor	OLTPS	Begin study	Subject to study results	200–250	TBD
	14 Call on and work with the USACE to study and install wetlands for wave attenuation in Howard Beach and to study further flood protection improvements within Jamaica Bay	DPR	Begin study	Subject to study results	250–300	TBD
	15 Call on and work with the USACE to study and install living shorelines for wave attenuation in Tottenville	DPR	Begin study	Subject to study results	60–80	TBD
	16 Continue to work with the USACE to complete its Plumb Beach breakwater and beach nourishment project in Southern Brooklyn	DPR	Complete construction	--	1–10	USACE
	17 Complete living shorelines and floating breakwaters for wave attenuation in Brant Point, Queens	DEP	Complete construction	--	1–10	City
	18 Continue to work with the USACE to complete its Sea Gate project in Southern Brooklyn	DPR	Complete construction	--	20–40	USACE
Protect against storm surge						
COASTAL PROTECTION	**19** Install an integrated flood protection system in Hunts Point	OLTPS	Begin design	Complete construction	150–175	TBD
	20 Install an integrated flood protection system in East Harlem	OLTPS	Begin design	Complete construction	175–200	TBD
	21 Install an integrated flood protection system in Lower Manhattan, including the Lower East Side	OLTPS	Begin design	Complete construction	300–350	TBD
	22 Install an integrated flood protection system at Hospital Row	OLTPS	Launch competition; begin design	Complete construction	60–80	CDBG
	23 Install an integrated flood protection system in Red Hook	OLTPS	Begin design	Complete construction	175–200	TBD
	24 Continue to work with the USACE to complete existing studies on Staten Island and implement coastal protection projects	DPR	Complete study	Subject to study results	400–450	USACE/TBD
	25 Continue to work with Con Edison to protect the Farragut substation	OLTPS	File comments on rate case	Subject to rate case outcome	40–60	Ratepayers
	26 Call on and work with the USACE to study and install local storm surge barriers at Newtown Creek	OLTPS	Begin study	Subject to study results	950–1000	TBD

Initiative	Lead City Agency	Milestones for Completion, Assuming Funding		10-Year Capital / Study Cost (Preliminary Estimate, in $ Millions, Nominal)	Funding Source
		By End of 2014	By End of 2020		
Improve coastal design and governance					
COASTAL PROTECTION					
27 Continue to work with the USACE to complete its comprehensive flood protection study of New York Harbor	OLTPS	Complete draft study, recommending projects ready for authorization by Congress	Subject to study results	10–20	USACE
28 Implement the WAVES Action Agenda	DCP	Complete scheduled projects	--	N/A	N/A
29 Implement citywide waterfront inspections to better manage the City's waterfront and coastal assets	NYCEDC	Implement program	--	1–10	TBD
30 Study design guidelines for waterfront and coastal assets to better mitigate the effects of flooding	DPR	Complete study	Subject to study results	N/A	N/A
31 Evaluate soft infrastructure as flood protection and study innovative coastal protection techniques	OLTPS	Partner with the planned Jamaica Bay Science and Resilience Center and others to begin studies	--	1–10	TBD
32 Evaluate the city's vulnerability to drainage pipe flooding and identify appropriate solutions to minimize those risks	OLTPS	Complete study as part of other coastal protection projects	Subject to study results	10–20	TBD
33 Evaluate strategies to fund wetland restoration and explore the feasibility of wetland mitigation banking structures	NYCEDC	Complete study of mitigation banking	Subject to study results	10–20	TBD
34 Work with agency partners to improve the in-water permitting process	NYCEDC	Launch website	--	<1	ESDC
35 Enhance waterfront construction oversight by strengthening the City's waterfront permit and dockmaster units	SBS	Explore options to enhance waterfront permitting and dockmaster function	--	N/A	N/A
36 Identify a lead entity for overseeing the collaboration on the USACE comprehensive study and for overseeing the implementation of coastal flood protection projects	OLTPS	Identity lead entity	--	N/A	N/A
37 Call on and work with the USACE and FEMA to collaborate more closely on flood protection project standards	OLTPS	Identify risk reduction standards	--	N/A	N/A
Strengthen new and substantially rebuilt structures to meet the highest resiliency standards moving forward					
BUILDINGS					
1 Improve regulations for flood resiliency of new and substantially improved buildings in the 100-year floodplain	OLTPS	Adopt changes to Construction Codes and zoning	Complete analysis of additional freeboard	N/A	N/A
2 Rebuild and repair housing units destroyed and substantially damaged by Sandy	HRO	Disburse funds to rebuild and repair 500 buildings	Disburse funds to rebuild and repair 100% of eligible buildings	950–1000	CDBG (Partial)/ TBD
3 Study and implement zoning changes to encourage retrofits of existing buildings and construction of new resilient buildings in the 100-year floodplain	DCP	Begin studies for 5-10 neighborhoods and citywide strategies	Complete all studies and implement zoning changes per study findings	20–40	CDBG (Partial)/ TBD
4 Launch a competition to encourage development of new, cost-effective housing types to replace vulnerable stock	HPD	Launch and award Phase I of competition and launch Phase II	Complete Phase II RFP for Phase I winners and complete resilient designs	10–20	TBD
5 Work with New York State to identify eligible communities for the New York Smart Home Buyout Program	HRO	Identify all projects and complete transactions	--	150–175	CDBG (NYS)
6 Amend the Building Code and complete studies to improve wind resiliency for new and substantially improved buildings	OLTPS	Implement initial Building Code changes	Complete wind studies	1–10	TBD

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Initiative	Lead City Agency	Milestones for Completion, Assuming Funding		10-Year Capital / Study Cost (Preliminary Estimate, in $ Millions, Nominal)	Funding Source
		By End of 2014	By End of 2020		
Retrofit as many buildings as possible so that they will be significantly more resilient than they are today					
BUILDINGS					
7 Encourage existing buildings in the 100-year floodplain to adopt flood resiliency measures through an incentive program and targeted requirements	NYCEDC	Implement code changes and launch incentive program	Complete Core Flood Resiliency Measures on >100M square feet	1150–1200	CDBG (Partial)/ TBD
8 Establish Community Design Centers to assist property owners in developing design solutions for reconstruction and retrofitting, and connect them to available City programs	HRO	Launch centers in targeted neighborhoods	--	N/A	NA
9 Retrofit public housing units damaged by Sandy and increase future resiliency	NYCHA	Install backup generators in vulnerable buildings; launch planning efforts for undamaged but vulnerable buildings	Complete repairs and resiliency retrofits in 40% of vulnerable buildings	700–750	CDBG (Partial)/ TBD
10 Launch sales tax abatement program for flood resiliency in industrial buildings	NYCIDA	Launch program	--	1–10	City
11 Launch a competition to increase flood resiliency in building systems	NYCEDC	Launch competition and select winners	--	40–60	CDBG
12 Clarify regulations relating to the retrofit of landmarked structures in the 100-year floodplain	LPC	Issue written guidance	--	N/A	N/A
13 Amend the Building Code to improve wind resiliency for existing buildings and complete studies of potential retrofits	OLTPS	Implement initial Building Code changes	Complete wind studies	1–10	TBD
14 Amend the Construction Codes and develop best practices to protect against utility service interruptions	OLTPS	Implement changes to Construction Codes	Develop best practices	1–10	TBD
Support community and economic recovery in impacted areas					
ECONOMIC RECOVERY					
1 Launch Business Recovery and Resiliency Programs	NYCEDC	Launch program and begin disbursing funds	Complete investments	150–175	CDBG
2 Launch Neighborhood Game Changer Competition	NYCEDC	Issue RFP and select winning proposals	Complete investments	80–100	CDBG
3 Launch Neighborhood Retail Recovery Program	NYCEDC	Launch Business Incentive Rate for retail and approve applications	--	1–10	Utilities/ City
4 Support local merchants in improving and promoting local commercial corridors	SBS	Provide technical assistance and funding	Continue support	N/A	N/A
5 Continue to support the FRESH program to increase the number of full-line grocers in underserved neighborhoods	NYCEDC	Pursue FRESH programs in Sandy-impacted neighborhoods	Continue FRESH program	N/A	City
6 Reassess commercial properties citywide to reflect post-Sandy market values	DOF	Establish new market values and lower property taxes	--	80–100	City
Target affordability solutions to low-income policyholders					
1 Support Federal efforts to address affordability issues related to reform of the NFIP	OLTPS	Complete affordability study	Subject to study findings	N/A	N/A
Define resiliency standards for existing buildings					
INSURANCE					
2 Develop FEMA-endorsed flood protection standards and certifications for existing urban buildings	OLTPS	Complete development of building standards and FEMA review	--	N/A	N/A
3 Call on FEMA to recognize mixed-use buildings as a distinct building category	OLTPS	Create a mixed-use building category within the NFIP	Obtain flood-proofing certifications	N/A	N/A

	Initiative	Lead City Agency	Milestones for Completion, Assuming Funding		10-Year Capital / Study Cost (Preliminary Estimate, in $ Millions, Nominal)	Funding Source
			By End of 2014	By End of 2020		
	Incorporate resiliency standards in insurance underwriting					
INSURANCE	**4** Call on FEMA to develop mitigation credits for resiliency measures	OLTPS	Complete study of mitigation options and risk reduction	Subject to study findings	<1	TBD
INSURANCE	**5** Study approaches for New York City to join FEMA's Community Rating System program	OLTPS	Complete study of City's ability to be admitted to CRS program and cost-benefit analysis	Subject to study findings	<1	TBD
	Expand pricing options for policyholders					
	6 Call on FEMA to allow residential policyholders to select higher deductibles	OLTPS	Complete evaluation of higher deductible options	Obtain FEMA approval to allow higher deductibles for residential policies	N/A	N/A
	Improve awareness and education about insurance					
INSURANCE	**7** Support the goals of the NYS 2100 Commission to protect New York State, consumers, and businesses	OLTPS	Support State efforts	--	N/A	N/A
INSURANCE	**8** Call on New York State to improve policyholder awareness at the point of sale or renewal	OLTPS	Support State efforts to improve policyholder awareness	--	N/A	N/A
INSURANCE	**9** Launch a consumer education campaign on flood insurance	DCA	Complete citywide campaign	--	<1	TBD
INSURANCE	**10** Launch an engagement campaign targeting insurers	OLTPS	Establish regular meetings with leading insurers	--	N/A	N/A
	Redesign the regulatory framework to support resiliency					
UTILITIES	**1** Work with utilities and regulators to develop a cost-effective system upgrade plan to address climate risks	OLTPS	Incorporate cost-benefit analysis tool into regulatory framework	--	N/A	N/A
UTILITIES	**2** Work with utilities and regulators to reflect climate risks in system design and equipment standards	OLTPS	Submit comments to 2014 NYISO Reliability Needs Assessment	--	N/A	N/A
UTILITIES	**3** Work with utilities and regulators to establish performance metrics for climate risk response	OLTPS	Complete Con Edison rate case proceeding	--	N/A	N/A
	Harden existing infrastructure to withstand climate events					
UTILITIES	**4** Work with power suppliers and regulators to harden key power generators against flooding	OLTPS	Launch effort with stakeholders	--	N/A	N/A
UTILITIES	**5** Work with utilities and the PSC to harden key electric transmission and distribution infrastructure against flooding	OLTPS	Complete Con Edison rate case proceeding	--	Subject to 2013 rate case decision	Ratepayers
UTILITIES	**6** Work with utilities and the PSC to harden vulnerable overhead lines against winds	OLTPS	Complete Con Edison rate case proceeding and Local Law 13 study	--	Subject to 2013 rate case decision	Ratepayers
UTILITIES	**7** Work with utilities, regulators, and gas pipeline operators to harden the natural gas system against flooding	OLTPS	Complete Con Edison rate case proceeding	--	Subject to 2013 rate case decision	Ratepayers
UTILITIES	**8** Work with steam plant operators and the PSC to harden steam plants against flooding	OLTPS	Complete Con Edison rate case proceeding	--	Subject to 2013 rate case decision	Ratepayers

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	Initiative	Lead City Agency	Milestones for Completion, Assuming Funding		10-Year Capital / Study Cost (Preliminary Estimate, in $ Millions, Nominal)	Funding Source
			By End of 2014	By End of 2020		
	Reconfigure utility networks to be redundant and resilient					
UTILITIES	**9** Work with industry partners, New York State, and regulators to strengthen New York City's power supply	OLTPS	Continue ongoing power supply efforts	--	N/A	N/A
UTILITIES	**10** Require more in-city plants to be able to restart quickly in the event of blackout	OLTPS	Continue ongoing efforts	--	N/A	N/A
UTILITIES	**11** Work with Con Edison and the PSC to develop a long-term resiliency plan for the electric distribution system	OLTPS	Complete Con Edison rate case proceeding	--	N/A	N/A
UTILITIES	**12** Work with utilities and regulators to minimize electric outages in areas not directly affected by climate impacts	OLTPS	Complete Con Edison rate case proceeding	--	Subject to 2013 rate case decision	Ratepayers
UTILITIES	**13** Work with utilities and regulators to implement smart grid technology to assess system conditions in real time	OLTPS	Complete Con Edison rate case proceeding	--	Subject to 2013 rate case decision	Ratepayers
UTILITIES	**14** Work with utilities and regulators to speed up service restoration for critical customers via system configuration	OLTPS	Complete Con Edison rate case proceeding	--	Subject to 2013 rate case decision	Ratepayers
UTILITIES	**15** Work with utilities and regulators to speed up service restoration via pre-connections for mobile substations	OLTPS	Complete Con Edison rate case proceeding	--	Subject to 2013 rate case decision	Ratepayers
UTILITIES	**16** Work with pipeline operators to expand and diversify natural gas supply	OLTPS	Continue ongoing efforts	--	N/A	N/A
UTILITIES	**17** Work with utilities and regulators to strengthen the in-city gas transmission and distribution system	OLTPS	Complete Con Edison rate case proceeding	--	Subject to 2013 rate case decision	Ratepayers
UTILITIES	**18** Launch energy infrastructure resiliency competition	NYCEDC	Select winners of competition	--	N/A	N/A
	Reduce energy demand					
UTILITIES	**19** Work with utilities and regulators to expand citywide demand response programs	OLTPS	Complete Con Edison rate case	Implement 50 MW of DR capacity at municipal buildings	Subject to 2013 rate case decision	Ratepayers
UTILITIES	**20** Work with government and private sector partners to expand the energy efficiency of buildings	OLTPS	Launch Green Light New York Center	--	N/A	N/A
	Diversify customer options in case of utility outage					
UTILITIES	**21** Work with public and private partners to scale up distributed generation (DG) and micro-grids	OLTPS	Launch micro-grid feasibility study	Installation of at least 55 MW of distributed generation in municipal buildings	N/A	N/A
UTILITIES	**22** Incorporate resiliency into the design of City electric vehicle initiatives and pilot storage technologies	OLTPS	Continue ongoing efforts; implement and pilot at Brooklyn Army Terminal	--	N/A	N/A
UTILITIES	**23** Improve backup generation for critical customers	OEM	Expand City emergency generator fleet by 20 to 30 units	--	N/A	N/A

	Initiative	Lead City Agency	Milestones for Completion, Assuming Funding		10-Year Capital / Study Cost (Preliminary Estimate, in $ Millions, Nominal)	Funding Source
			By End of 2014	By End of 2020		
Seek to harden the liquid fuels supply infrastructure						
LIQUID FUELS	**1** Call on the Federal government to convene a regional working group to develop a fuel infrastructure hardening strategy	OLTPS	Develop regional strategy	--	N/A	N/A
LIQUID FUELS	**2** Develop a reporting framework for fuel infrastructure operators to support post-emergency restoration	OLTPS	Ensure development of IT systems and information reporting framework	--	N/A	N/A
LIQUID FUELS	**3** Work with Buckeye and New York State to safely build pipeline booster stations in New York City to increase supply and withstand extreme weather events	OLTPS	Ensure booster stations to withstand climate change impacts	--	N/A	N/A
LIQUID FUELS	**4** Work with New York State to provide incentives for the hardening of gas stations to withstand extreme weather events	OLTPS	Assist in launching incentive program	--	N/A	N/A
LIQUID FUELS	**5** Ensure that a subset of gas stations and terminals have access to backup generators in case of widespread power outages	OEM	Ensure creation of a generator pool and pre-event positioning plan	--	N/A	N/A
Enhance the ability of the supply chain to respond to disruptions						
LIQUID FUELS	**6** Explore the creation of a transportation fuel reserve to temporarily supply the private market during disruptions	OLTPS	Evaluate feasibility and cost	--	N/A	N/A
LIQUID FUELS	**7** Call on New York State to modify price gouging laws and allow flexibility of gas station supply contracts to increase fuel availability during disruptions	OLTPS	Secure passage of legislation	--	N/A	N/A
LIQUID FUELS	**8** Develop a package of City, State, and Federal regulatory actions to address liquid fuel shortages during emergencies	OEM/DCAS	Complete rationing plan and package of regulatory waivers	--	N/A	N/A
Improve the City's ability to fuel first responders and private critical fleets						
	9 Harden municipal fueling stations and enhance mobile fueling capability to support both City government and critical fleets	DCAS	Procure equipment	Put flood protection standards in place	20–40	City
Ensure critical providers' operability through redundancy and the prevention of physical damage						
HEALTHCARE	**1** Improve design and construction of new hospitals	OLTPS	Amend Construction Codes		N/A	N/A
HEALTHCARE	**2** Require the retrofitting of existing hospitals in the 500-year floodplain	OLTPS	Amend Construction Codes	Confirm 100% compliance or plan to reach compliance by 2030	700–750	FEMA/VA/State/ (Partial) TBD
HEALTHCARE	**3** Support the Health and Hospital's Corporation effort to protect public hospital emergency departments (EDs) from flooding	HHC	Determine strategies and identify funding for each at-risk ED	Begin construction planning	N/A	N/A
HEALTHCARE	**4** Improve the design and construction of new nursing homes and adult care facilities	OLTPS	Amend Construction Codes	--	N/A	N/A
HEALTHCARE	**5** Require the retrofitting of existing nursing homes in the 100-year floodplain	OLTPS	Amend Construction Codes	Confirm 100% compliance or plan to reach compliance by 2030	80–100	FEMA (Partial) TBD
HEALTHCARE	**6** Require the retrofitting of existing adult care facilities in the 100-year floodplain	OLTPS	Amend Construction Codes	Confirm 100% compliance or plan to reach compliance by 2030	1–10	FEMA
HEALTHCARE	**7** Support nursing homes and adult care facilities with mitigation grants and loans	DOHMH	Develop and launch program	Disburse funds to ~60% of providers	40–60	TBD
HEALTHCARE	**8** Increase the air conditioning capacity of nursing homes and adult care facilities	NYCEDC	Develop and launch program	Disburse funds to ~60% of providers	1–10	TBD

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	Initiative	Lead City Agency	Milestones for Completion, Assuming Funding		10-Year Capital / Study Cost (Preliminary Estimate, in $ Millions, Nominal)	Funding Source
			By End of 2014	By End of 2020		
Reduce barriers to care during and after emergencies						
HEALTHCARE	**9** Harden primary care and mental health clinics	DOHMH	Develop and launch program	Disburse funds and complete mitigation projects	1–10	TBD
HEALTHCARE	**10** Improve pharmacies' power resiliency	DOHMH	Implement regulatory changes	--	N/A	N/A
HEALTHCARE	**11** Encourage telecommunications resiliency	DOHMH	Develop and distribute best practice guide	--	N/A	N/A
HEALTHCARE	**12** Encourage electronic health record-keeping	DOHMH	Incorporate resiliency into EHR programs and conduct outreach	--	N/A	N/A
Improve the ability of communities to prepare for and respond to disasters						
COMMUNITY PREPAREDNESS	**1** Launch pilot program to identify and address gaps in community capacity	OEM	Complete pilot assessment	Develop and implement plan to address gaps	<1	TBD
COMMUNITY PREPAREDNESS	**2** Continue and Expand OEM's Community Emergency Response Teams	OEM	Expand programs	--	<1	TBD
COMMUNITY PREPAREDNESS	**3** Expand the Worker Connect information technology tool to serve as an Emergency Services Portal	Office of Deputy Mayor for Health and Human Services	Create new emergency services portal and strengthen functionality of Worker Connect	--	1–10	TBD
COMMUNITY PREPAREDNESS	**4** Explore the creation of a new online Emergency Notification Contact System	HPD	Begin to create voluntary database	Launch fully functional database	1–10	TBD
Increase accountability to promote resiliency						
TELECOMMUNICATIONS	**1** Establish an office within DoITT to focus on telecommunications regulation and resiliency planning	DoITT	Establish and operationalize new office	--	N/A	N/A
TELECOMMUNICATIONS	**2** Establish new resiliency requirements for providers using scheduled renewals of the City's franchise agreements	DoITT	Establish framework of new resiliency requirements	Execute new franchise agreements including resiliency requirements	N/A	N/A
Enable rapid recovery after extreme weather events						
	3 Request business continuity plans from current City franchisees as permitted under existing franchise agreements	DoITT	Establish regular meetings with cell providers; develop criteria for hardening cell sites	Harden selected cell sites	N/A	N/A
Harden facilities to reduce weather-related impacts						
TELECOMMUNICATIONS	**4** Develop flood protection standards for placement of telecommunications equipment in buildings	OLTPS	Implement programs	Put flood protection standards in place	N/A	N/A
TELECOMMUNICATIONS	**5** Use the DoITT franchise agreements to ensure hardening of all critical facilities	DoITT	Audit all critical facilities and provide guidance for hardening	Establish requirements for facilities and equipment	N/A	N/A
TELECOMMUNICATIONS	**6** Work with cell providers to encourage hardening of cell sites	DoITT	Establish regular meetings with cell providers develop criteria for hardening cell sites	Harden selected cell sites	N/A	N/A

	Initiative	Lead City Agency	Milestones for Completion, Assuming Funding: By End of 2014	Milestones for Completion, Assuming Funding: By End of 2020	10-Year Capital / Study Cost (Preliminary Estimate, in $ Millions, Nominal)	Funding Source
Create redundancy to reduce risk of outages						
TELECOMMUNICATIONS	**7** Study options to increase conduit infrastructure redundancy and resiliency	DoITT	Launch study	Subject to study findings	N/A	N/A
TELECOMMUNICATIONS	**8** Continue implementation of ConnectNYC Fiber Access to create broadband redundancy	NYCEDC	Complete second round of applications and begin installing fiber connections	Complete fiber installations	N/A	N/A
TELECOMMUNICATIONS	**9** Add telecommunications provider quality and resiliency to the WiredNYC and NYC Broadband Map ratings	NYCEDC	Launch updated maps	Make available information about telecommunications resiliency	N/A	N/A
Protect assets to maintain system operations						
TRANSPORTATION	**1** Reconstruct and resurface key streets damaged by Sandy	NYCDOT	Begin reconstruction and resurfacing	Complete resurfacing and majority of reconstruction	450–500	FHWA / FEMA
TRANSPORTATION	**2** Integrate climate resiliency features into future capital projects	NYCDOT	Ongoing	Ongoing	175–200	FHWA (Partial)/ City
TRANSPORTATION	**3** Elevate traffic signals and provide backup electrical power	NYCDOT	Begin effort	Complete implementation	1–10	FEMA
TRANSPORTATION	**4** Protect NYCDOT tunnels in Lower Manhattan from flooding	NYCDOT	Launch design	Complete implementation	20–40	TBD
TRANSPORTATION	**5** Install watertight barriers to protect movable bridge machinery	NYCDOT	Launch design	Complete implementation	1–10	TBD
TRANSPORTATION	**6** Protect Staten Island Ferry and private ferry terminals from climate change-related threats	NYCDOT	Design underway	Complete implementation	10–20	FTA (Partial)/ TBD
TRANSPORTATION	**7** Integrate resiliency into planning and project development	NYCDOT	Begin effort	Ongoing	N/A	N/A
TRANSPORTATION	**8** Call on non-City agencies to implement strategies to address climate change threats	OLTPS	Engage with non-City agencies	Ongoing	N/A	N/A
Prepare the transportation system to restore service after extreme climate events						
TRANSPORTATION	**9** Plan for temporary transit services in the event of subway system suspensions	NYCDOT	Complete initial planning	Continue to update as necessary	1–10	FTA (Partial)/ TBD
TRANSPORTATION	**10** Identify critical transportation network elements and improve transportation responses to major events through regular resiliency planning exercises	NYCDOT	Complete initial planning, including multiple planning exercises and one live drill	Continue to update as necessary	<1	City
TRANSPORTATION	**11** Develop standard plans for implementing High-Occupancy Vehicle (HOV) requirements	NYCDOT	Complete plan	Continue to update as necessary	<1	City
TRANSPORTATION	**12** Plan for and install new pedestrian and bicycle facilities to improve connectivity to key transportation hubs	NYCDOT	Develop plan for improvements; begin implementation of most critical components	Implement first plan on improvements; pursue ongoing development of additional facilities	10–20	TBD
TRANSPORTATION	**13** Construct new ferry landings to support private ferry services	NYCEDC	Identify locations and launch design	Complete new ferry landings	20–40	FTA
TRANSPORTATION	**14** Deploy the Staten Island Ferry's Austen Class vessels on the East River Ferry and during transportation disruptions	NYCDOT	Complete operational plans for various types of deployment	Continue to update as necessary	<1	FTA
TRANSPORTATION	**15** Improve at all levels communications about the restoration of transportation services	NYCDOT	Put communications plan in place	Continue to update as necessary	N/A	N/A

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	Initiative	Lead City Agency	Milestones for Completion, Assuming Funding: By End of 2014	Milestones for Completion, Assuming Funding: By End of 2020	10-Year Capital / Study Cost (Preliminary Estimate, in $ Millions, Nominal)	Funding Source
Implement new and expanded services to increase system flexibility and redundancy						
TRANSPORTATION	**16** Expand the city's Select Bus Service network	NYCDOT	Implement four SBS routes	Implement four additional Phase II SBS routes	80–100	FTA (Partial)/ TBD
TRANSPORTATION	**17** Expand the network of bus priority strategies on arterial highways	NYCDOT	Initiate planning for first highway priority corridor	Implement first highway priority corridor and launch planning and design for two additional corridors	40–60	FTA (Partial)/ TBD
TRANSPORTATION	**18** Expand ferry services in locations citywide	NYCEDC	Complete Citywide Ferry Study	Implement additional viable ferry services as per study and through RFEIs	<1	City
Adapt parks and expand green infrastructure to shield adjacent communities from the impacts of extreme weather events						
PARKS	**1** Restore city beaches	DPR	Engage community and begin design options	Subject to study results	250–500	Federal/City/TBD
PARKS	**2** Harden or otherwise modify shoreline parks and adjacent roadways to protect adjacent community (See Coastal Protection Initiative 30)	DPR	Complete preliminary design investigation for pilot	Complete improvements	20–40 (Pilot)	Federal/TBD
PARKS	**3** Reinforce or redesign bulkheads in coastal parks (See Coastal Protection Initiative 6; see Coastal Protection Initiative 29)	DPR	Inspect damaged bulkheads on parkland and develop plan	Subject to development of plan	40–60 (Pilot)	Federal/TBD
PARKS	**4** Expand the City's greenstreets plan, including for Jamaica Bay	DPR	Expand program to area around Jamaica Bay	Expand program to 14 new neighborhoods	60–80	Federal/TBD
Retrofit or harden park facilities to withstand the impacts of climate change						
PARKS	**5** Fortify marinas and piers	DPR	Complete preliminary design investigation	Complete improvements	5–20 (Pilot)	Federal/City/TBD
PARKS	**6** Relocate or increase the resiliency of playgrounds and athletic fields	DPR	Complete preliminary design investigation	Complete improvements	125–150	Federal/City/TBD
PARKS	**7** Protect mechanical systems at major park facilities and buildings	DPR	Complete preliminary design investigation	Complete improvements	60–80 (Pilot)	Federal/City/TBD
PARKS	**8** Move or protect critical operations centers	DPR	Begin to construct protective measures	Complete protective measures	80–100	Federal/City/TBD
Protect wetlands, other natural areas, and the urban forest						
PARKS	**9** Work with the Federal government to transform Jamaica Bay	DPR	Continue to advance partnership and launch transformation	Implement transformation	N/A	N/A
PARKS	**10** Increase the health and resiliency of natural areas, including Tibbetts Brook	DPR	Launch projects in Alley Creek and Bronx River watersheds and tidal wetlands in Staten Island, Bronx, and Queens	--	20–40 (Pilot)	Federal/TBD
PARKS	**11** Improve the health and resiliency of the city's urban forest	DPR	Hire and train 10 foresters	Increase pruning operations and expand tree beds	N/A	N/A
PARKS	**12** Increase growth of local plant material for restoration work	DPR	Launch improvements to Greenbelt Native Plants Center	Expand operations	10–20	Federal/City/TBD

	Initiative	Lead City Agency	Milestones for Completion, Assuming Funding		10-Year Capital / Study Cost (Preliminary Estimate, in $ Millions, Nominal)	Funding Source
			By End of 2014	By End of 2020		
	Develop tools for comprehensive climate adaptation planning and design					
PARKS	**13** Establish a center for resiliency and restoration efforts in the Jamaica Bay-Rockaway Parks	DPR	Launch initial operations of center	- -	1–20	Federal/City/TBD
PARKS	**14** Quantify the benefits of the city's ecosystems and green infrastructure	DPR	Commission studies on the impact of the city's green infrastructure program	Subject to study findings	N/A	N/A
PARKS	**15** Create climate adaptation plans for all parks in the 100-year floodplain	DPR	Map and catalogue vulnerable sites	Develop and maintain updated climate adaptation plans	N/A	N/A
PARKS	**16** Map the city's overhead utilities and street trees	DPR	Launch mapping effort	Complete map	N/A	N/A
	Protect sites with hazardous substances and encourage brownfield redevelopment					
ENVIRONMENTAL PROTECTION AND REMEDIATION	**1** Identify cost-effective measures to safeguard exposed substances in the 100-year floodplain	DCP	Complete Open Industrial Uses study	Subject to study findings	N/A	N/A
ENVIRONMENTAL PROTECTION AND REMEDIATION	**2** Develop a catalogue of best practices for storing enclosed hazardous substances in the 100-year floodplain	OLTPS	Begin process of developing best practices	Complete catalogue	N/A	N/A
ENVIRONMENTAL PROTECTION AND REMEDIATION	**3** Accelerate brownfield cleanup in the 100-year floodplain to prevent release of pollutants	OER	Launch expansion of existing Brownfield Incentive Grant program	Subject to funding, complete cleanup of 150 tax lots in floodplain	1–10	Federal/City
ENVIRONMENTAL PROTECTION AND REMEDIATION	**4** Explore strengthened cleanup standards on industrial waterfront brownfields	OER	Examine existing soil cleanup standards and evaluate how to strengthen protections	Subject to study findings	N/A	N/A
ENVIRONMENTAL PROTECTION AND REMEDIATION	**5** Launch brownfield climate change resiliency audits and improve storm preparedness	OER	Begin audits of brownfield cleanup and publish report findings	Subject to study findings	<1	TBD
ENVIRONMENTAL PROTECTION AND REMEDIATION	**6** Launch full operations of the NYC Clean Soil Bank	OER	Launch NYC Clean Soil Bank	Reuse 600,000 tons of soil	N/A	N/A
ENVIRONMENTAL PROTECTION AND REMEDIATION	**7** Perform update of SPEED, the City's online environmental research engine	OER	Complete update to SPEED database	Continue periodic updates	<1	TBD
	Protect wastewater treatment facilities from storm surge					
WATER AND WASTEWATER	**1** Adopt a wastewater facility design standard for storm surge and sea level rise	DEP	Adopt new design guidelines	- -	N/A	N/A
WATER AND WASTEWATER	**2** Harden pumping stations	DEP	Incorporate resiliency measures in repairs and capital projects	Incorporate resiliency measures in repairs and capital projects	125–150	TBD
WATER AND WASTEWATER	**3** Harden wastewater treatment plants	DEP	Incorporate resiliency measures in repairs and capital projects	Incorporate resiliency measures in repairs and capital projects	700–750	TBD
WATER AND WASTEWATER	**4** Explore alternatives for the Rockaway Wastewater Treatment Plant	DEP	Initiate feasibility study	Subject to study findings	1–10	City
WATER AND WASTEWATER	**5** Develop cogeneration facilities at North River Wastewater Treatment Plant	DEP	Substantially complete design of cogeneration facilities	- -	200–250	City
WATER AND WASTEWATER	**6** Explore opportunities to expand cogeneration and other energy measures	DEP	Initiate feasibility study	Subject to study findings	N/A	N/A
WATER AND WASTEWATER	**7** Encourage regional resiliency planning	DEP	Share results of DEP's detailed wastewater risk and adaptation analysis	- -	N/A	N/A

Note: As used herein, TBD means that a specific source has not yet been secured for the identified use; potential sources are described in Chapter 19 (*Funding*)

	Initiative	Lead City Agency	Milestones for Completion, Assuming Funding		10-Year Capital / Study Cost (Preliminary Estimate, in $ Millions, Nominal)	Funding Source
			By End of 2014	By End of 2020		
	Improve and expand drainage infrastructure					
WATER AND WASTEWATER	**8** Reduce combined sewer overflows with Green Infrastructure	DEP	Complete four long-term control plans	Capture runoff in 4% of impervious areas and complete all long-term control plans	700–750	City
WATER AND WASTEWATER	**9** Reduce combined sewer overflows with high-level storm sewers citywide	DEP	Begin or continue construction of 4 high-level storm sewer capital projects	Substantially complete 10 high-level storm sewer capital projects	350–400	City
WATER AND WASTEWATER	**10** Continue to implement and accelerate investments in Bluebelts across the city	DEP	Continue build out of South Richmond Bluebelt and begin construction of Mid-Island Bluebelt	Substantially complete South Richmond Bluebelt and advance projects in Mid-Island and Twin Ponds, Queens	500–550	City (Partial)/ TBD
WATER AND WASTEWATER	**11** Build out stormwater sewers in areas of Queens with limited drainage systems	DEP	Begin or continue construction of three storm sewer build-out capital projects	Substantially complete 15 storm sewer build-out capital projects	125–150	City
WATER AND WASTEWATER	**12** Periodically review rainfall trends and implications for stormwater infrastructure	DEP	Create process to reassess precipitation data	Complete at least one data reassessment	N/A	N/A
	Promote redundancy and flexibility to ensure constant supply of high-quality water					
WATER AND WASTEWATER	**13** Repair the leak in the Delaware Aqueduct	DEP	Continue construction of bypass tunnel	Implement water augmentation and conservation measures in preparation for temporary shutdown of aqueduct	1050–1400	City
WATER AND WASTEWATER	**14** Improve interconnection between the Catskill and Delaware aqueducts and maximize capacity to deliver water from the Catskill/Delaware system	DEP	Begin construction of inter-connection	Complete construction of interconnection and design of Catskill Pressurization	550–600	City
WATER AND WASTEWATER	**15** Continue the Watershed Protection Program to maintain drinking water quality	DEP	Incorporate updates to Long-Term Watershed Protection Program	- -	250–300	City
	Identify and harden critical food distribution assets					
FOOD SUPPLY	**1** Study the food distribution system to identify other prospective vulnerabilities	OLTPS	Launch study	Subject to study findings	1–10	TBD
FOOD SUPPLY	**2** Expand upon prior energy studies, to explore options for cost-effective, continuous power for the Hunts Point Food Distribution Center	NYCEDC	Expand current study	Subject to study findings	N/A	N/A

	Initiative	Lead City Agency	Milestones for Completion, Assuming Funding		10-Year Capital / Study Cost (Preliminary Estimate, in $ Millions, Nominal)	Funding Source
			By End of 2014	By End of 2020		
Improve the resiliency of consumer access						
FOOD SUPPLY	**3** Call on New York State to issue preparedness guidelines to retailers in anticipation of extreme weather events	OLTPS	Disseminate State-issued preparedness guidelines	- -	N/A	N/A
	4 Call on the State legislature to pass City-sponsored legislation mandating electric generators for food retailers	OEM	Advance legislation	Secure passage	N/A	N/A
	5 Continue to support the FRESH program to increase the number of full-line grocers in underserved neighborhoods	NYCEDC	Continue to advance program	- -	N/A	N/A
	6 Expand DCAS food procurement pilots towards contracts with larger, more resilient distributors that have active New York operations	DCAS	Begin expansion of suppliers	- -	N/A	N/A
	7 Implement preparedness measures for continued availability of SNAP benefits for vulnerable consumers following large-scale power outages	HRA	Prepare waiver for immediate submission if necessary	- -	N/A	N/A
Protect solid waste facilities and disposal networks						
SOLID WASTE	**1** Harden critical City-owned facilities	DSNY	Incorporate resiliency measures in repairs and capital projects	Incorporate resiliency measures in repairs and capital projects	20–40	TBD
	2 Work with third-party owners to protect critical assets and networks	DSNY	Develop an inventory of critical system vulnerabilities and catalogue known risks	Develop contingency plans and implement resiliency measures	N/A	N/A
Coastal Protection						
BROOKLYN-QUEENS WATERFRONT	**1** Work with the Port Authority to continue a study of innovative coastal protection measures using clean dredge material in Southwest Brooklyn	NYCEDC	Complete study and launch pilot measures	Subject to study findings	N/A	N/A
	2 Call on and work with the USACE to develop an implementation plan and preliminary designs for a local storm surge barrier along the Gowanus Canal	OLTPS	Complete preliminary feasibility study and design and launch USACE study	Subject to study findings	1–10	TBD
	3 Implement strategies to protect Brooklyn Bridge Park and DUMBO	Brooklyn Bridge Park Corporation/ OLTPS	Begin construction of the John St. section of the park; designate developer for John St. lower site; complete study of DUMBO resiliency measures	Subject to DUMBO study findings	10–20	Brooklyn Bridge Park Corp./TBD
	4 Support private investments that reduce flood risk along Newtown Creek	NYCEDC	Advertise support to businesses; provide technical assistance	Continue to provide technical assistance	N/A	N/A
	5 Create an implementation plan for comprehensive flood-protection improvements on public and private property along the Williamsburg, Greenpoint, and Long Island City coastlines	OLTPS	Commence study	Subject to study findings	<1	TBD
Buildings						
	6 Implement planned upgrades to vulnerable City-owned, industrial properties	NYCEDC/ BNYDC	Commence property upgrades and substantially complete	Complete additional property upgrades	80–100	FEMA/Insurance Proceeds

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	Initiative	Lead City Agency	Milestones for Completion, Assuming Funding		10-Year Capital / Study Cost (Preliminary Estimate, in $ Millions, Nominal)	Funding Source
			By End of 2014	By End of 2020		
Critical Infrastructure						
BROOKLYN-QUEENS	**7** Improve connections between Red Hook and the rest of Brooklyn	NYCDOT	Complete enhancements to Mill Street connection and BQE underpass	- -	<1	City
	8 Call for the MTA to explore Red Hook-Lower Manhattan bus connections	NYCEDC	Complete assessment	Subject to findings from assessment	N/A	N/A
	9 Implement expanded free summer weekend ferry service from Manhattan to Red Hook in 2013	NYCEDC	Complete summer 2013 service and evaluate results	Extend service if justified	<1	City
Community and Economic Recovery						
BROOKLYN-QUEENS	**10** Create and implement a revitalization strategy for targeted retail and community spaces within Red Hook Houses	NYCEDC/ NYCHA	Complete assessment	Subject to results of assessment	1–10	TBD
	11 Implement planned and ongoing investments by the City and private partners	Varies	Complete first phase of Bush Terminal Park	Complete residential buildings for parcels A and B at Hunters Point South development	Varies	Varies
Coastal Protection						
SOUTHERN BROOKLYN	**1** Call on and work with the USACE to study additional Sea Gate oceanfront protections	OLTPS	Launch study	Subject to plan findings	N/A	N/A
	2 Continue to work with the USACE to study strengthening the Coney Island/Brighton Beach nourishment	OLTPS	Launch study	Subject to plan findings	N/A	N/A
	3 Call on and work with the USACE to study Manhattan Beach oceanfront protections	OLTPS	Launch study	Subject to plan findings	N/A	N/A
	4 Call on and work with the USACE to study mitigating inundation risks through Rockaway Inlet, exploring a surge barrier and alternative measures	OLTPS	Launch study	Subject to plan findings	N/A	N/A
	5 Develop an implementation plan and preliminary designs for new Coney Island Creek wetlands and tidal barrier	OLTPS	Complete preliminary feasibility study and design and identify next steps	Subject to study findings	1–10	TBD
Buildings						
	6 Study additional resiliency initiatives for ground-floor housing within NYCHA buildings	NYCHA	Complete outreach process and study	Subject to study findings	<1	TBD

SOUTHERN BROOKLYN

Critical Infrastructure

Initiative	Lead City Agency	Milestones for Completion, Assuming Funding: By End of 2014	Milestones for Completion, Assuming Funding: By End of 2020	10-Year Capital / Study Cost (Preliminary Estimate, in $ Millions, Nominal)	Funding Source
7 Support CUNY launch of study and pilot of new technologies for high-rise buildings	OLTPS	CUNY to identify site and launch study and pilot	Subject to study findings	N/A	N/A
8 Study options to ensure resiliency of private cogeneration facilities in the area	OLTPS	Launch study	Subject to study findings	N/A	N/A
9 Construct new Coney Island Hospital outpatient clinic to replace the destroyed Ida G. Israel facility	HHC	Open interim facility	Construct and make operational a permanent facility	10–20	FEMA (Partial)/ TBD
10 Call for the USACE to develop an implementation plan for the reinforcement of existing Belt Parkway edge protections	OLTPS	Complete study	Implementation subject to study findings	N/A	N/A
11 Restore recreational infrastructure along Southern Brooklyn beaches	DPR	Complete restoration of infrastructure and facilities	--	See Parks Initiative 1	See Parks Initiative 1
12 Complete planned drainage improvements in Coney Island to mitigate flooding	DEP	Commence first phases of construction and advance design for future phases	Complete construction	125–150	City
13 Provide technical assistance to support Sea Gate in repairing Sandy-damaged infrastructure	OLTPS/DDC	Work with Sea Gate Association to study private infrastructure and prepare scope for repairs	Subject to study findings	N/A	N/A

Community and Economic Recovery

Initiative	Lead City Agency	Milestones for Completion, Assuming Funding: By End of 2014	Milestones for Completion, Assuming Funding: By End of 2020	10-Year Capital / Study Cost (Preliminary Estimate, in $ Millions, Nominal)	Funding Source
14 Work with Brooklyn Chamber of Commerce to assist in organizing Sheepshead Bay businesses	SBS	Assist local merchant organizing efforts	Subject to local merchant organizing and planning	N/A	N/A
15 Support area recovery through the rebuilding and expansion of the entertainment district	NYCEDC/DCA	Complete phase 5 of amusement area expansion with new roller coaster; commence Aquarium expansion	Complete Aquarium expansion	175–200	FEMA/City
16 Study opportunities along Coney Island Creek to generate economic activity and facilitate resiliency investments	NYCEDC	Complete study of economic development opportunities	Subject to study findings	<1	TBD
17 Implement planned and ongoing investments by the City and private partners	Varies	Complete Calvert Vaux Park fields; West 8th Street Access Project; Coney Island Commons and YMCA	Implement Coney Island Comprehensive Plan	Varies	Varies

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SOUTHERN MANHATTAN

Coastal Protection

Initiative	Lead City Agency	Milestones for Completion, Assuming Funding: By End of 2014	Milestones for Completion, Assuming Funding: By End of 2020	10-Year Capital / Study Cost (Preliminary Estimate, in $ Millions, Nominal)	Funding Source
1 Create an implementation plan and design for an integrated flood protection system for remaining Southern Manhattan areas	OLTPS	Commence competition and design study	Subject to study findings and funding availability	1–10	TBD
2 Conduct a study for a multi-purpose levee along Lower Manhattan's eastern edge to address coastal flooding and create economic development opportunities	NYCEDC	Complete initial feasibility study	Subject to study findings	1–10	TBD

Critical Infrastructure

Initiative	Lead City Agency	Milestones for Completion, Assuming Funding: By End of 2014	Milestones for Completion, Assuming Funding: By End of 2020	10-Year Capital / Study Cost (Preliminary Estimate, in $ Millions, Nominal)	Funding Source
3 Construct physical enhancements to Water Street	NYCEDC/ NYCDOT	Complete temporary improvements and design permanent improvements	Complete permanent improvements	10–20	LMDC/ City

Community and Economic Recovery

Initiative	Lead City Agency	Milestones for Completion, Assuming Funding: By End of 2014	Milestones for Completion, Assuming Funding: By End of 2020	10-Year Capital / Study Cost (Preliminary Estimate, in $ Millions, Nominal)	Funding Source
4 Implement temporary programming of Water Street privately owned public spaces (POPS)	DCP/NYCEDC	Approve zoning changes, select programming partner, and commence programming	--	N/A	N/A
5 Launch a program to enable permanent improvements to Water Street privately owned public spaces (POPS)	DCP	Create design criteria and solicit design proposals; facilitate land use approvals	Enact permanent regulatory changes to facilitate improvements, as necessary	N/A	N/A
6 Implement planned and ongoing investments in the South Street Seaport	NYCEDC	Complete resiliency improvements to Schermerhorn Row and Museum Block	--	<1	City
7 Use the Job Creation & Retention Program to attract and retain businesses in Sandy-impacted areas of Lower Manhattan	NYCEDC	Extend and create a new program to make awards to new and renewing tenants	Make awards to new and renewing tenants	10–20	CDBG (ESDC)
8 Expand Take the HELM program (Hire and Expand in Lower Manhattan)	NYCEDC	Expand competition and make awards to businesses new to Lower Manhattan in the 100-year floodplain	--	1–10	TBD
9 Implement planned and ongoing investments by the City and private partners	Varies	Complete East River Waterfront, EcoPark, Pier 42 Waterfront Park, Battery Park Playspace, Peck Slip Park, Asser Levy Park, Hudson River Park, The High Line, Peck Slip reconstruction, Battery Maritime Building, Pier A renovation, 9/11 Museum	Complete Hudson Yards South Tower, Peck Slip School	Varies	Varies

	Initiative	Lead City Agency	Milestones for Completion, Assuming Funding: By End of 2014	Milestones for Completion, Assuming Funding: By End of 2020	10-Year Capital / Study Cost (Preliminary Estimate, in $ Millions, Nominal)	Funding Source
Coastal Protection						
	1 Call on and work with the USACE to study the construction of a floodgate at Mill Creek	OLTPS	Commence study	Subject to study findings	N/A	N/A
Critical Infrastructure						
EAST AND SOUTH SHORES STATEN ISLAND	**2** Assist Staten Island University Hospital (SIUH) in applying for hazard mitigation funding	OEM	Provide technical support to SIUH	- -	N/A	N/A
	3 Implement and expedite roadway and sewer capital projects along Hylan Boulevard, especially in vulnerable South Shore areas	NYCDOT/DEP	Commence sewer enhancement and paving projects; complete intersection improvements	Complete sewer enhancement and paving projects	40–60	City
	4 Call on and work with the MTA to create an implementation plan for the relocation of Richmond Valley SIR station to Page Avenue	NYCEDC	Commence relocation feasibility study	Subject to study findings	<1	TBD
	5 Study potential new ferry routes serving Staten Island and issue a Request for Expressions of Interest (RFEI) to gauge market interest	NYCEDC/ NYCDOT	Commence Comprehensive Citywide Ferry Study	Subject to study findings	See Transportation Initiative 18 for Ferry Study	See Transportation Initiative 18
	6 Secure available Federal funding to implement the Community Wildfire Protection Plan for fire-prone areas on the East Shore	DPR	Apply for relevant funding	Subject to funding	<1	TBD
	7 Launch the first capital project for the Mid-Island Bluebelt in Midland Beach	DEP	Finalize Environmental Impact Statement; obtain all necessary permits; begin property acquisition	Complete capital project located in the New Creek West Branch	1–10	City
	8 Explore expansion of the City's mitigation banking pilot as a funding mechanism to facilitate the construction of the Mid-Island and South Shore Bluebelts	NYCEDC/DEP	Develop pilot mitigation banking structure	Subject to implementation structure	<1	TBD
Community and Economic Recovery						
EAST AND SOUTH SHORES STATEN ISLAND	**9** Issue a Request for Expressions of Interest (RFEI) for new concessions and services at City-controlled beaches in the East Shore	NYCEDC/DPR	Issue RFEI; activities subject to RFEI response	Subject to RFEI response	<1	TBD
	10 Create a comprehensive revitalization plan for Great Kills Harbor to increase resiliency and to draw additional investment	NYCEDC	Complete plan	Subject to plan recommendations	<1	TBD
	11 Create a strategic plan for public recreational land, including the beachfront recreation areas and open space	NYCEDC	Complete plan	Subject to plan recommendations	<1	TBD
	12 Implement planned and ongoing investments by the City and private partners	Varies	Complete Ocean Breeze track and field athletic complex; select respondent for Brielle Avenue municipal site	Complete first phase of Charleston Mixed-Use Development, New Stapleton Waterfront development and former Coast Guard Site development; complete St. George waterfront redevelopment	Varies	Varies

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	Initiative	Lead City Agency	Milestones for Completion, Assuming Funding: By End of 2014	Milestones for Completion, Assuming Funding: By End of 2020	10-Year Capital / Study Cost (Preliminary Estimate, in $ Millions, Nominal)	Funding Source
Coastal Protection						
SOUTH QUEENS	**1** Call for USACE to develop an implementation plan to mitigate inundation risks through Rockaway Inlet, exploring a surge barrier and alternative measures	OLTPS	Launch study	Subject to study findings	N/A	N/A
	2 Develop an implementation plan to address frequent tidal inundation in Broad Channel and Hamilton Beach, incorporating international best practices	NYCEDC/ OLTPS	Complete study	Subject to study findings	1–10	TBD
	3 Complete short-term dune improvements on the Rockaway Peninsula	OLTPS	Complete dune improvements	- -	See Coastal Protection Initiative 3 for dune implementation cost	See Coastal Protection Initiative 3
Buildings						
	4 Complete design competition to enhance resiliency of planned Arverne East Project	HPD	Complete competition and announce winning submission	Subject to competition outcome	N/A	Private
Critical Infrastructure						
SOUTH QUEENS	**5** Build a new multi-specialty ambulatory surgical center on the Rockaway Peninsula	NYCEDC	With private developer, complete center and make operational	- -	N/A	Private
	6 Expand ferry service to the Rockaway Peninsula	NYCEDC	Construct flexible ferry infrastructure; commence comprehensive Citywide Ferry Study	Subject to study findings	10–20 See Transportation Initiative 18 for Ferry Study	Federal (Partial) TBD
Community and Economic Recovery						
SOUTH QUEENS	**7** Get New Yorkers "Back to the Beach" for summer 2013	DPR	Complete summer 2013 beach programs; complete near-term restoration of the boardwalk	- -	See Parks Initiative 1 for boardwalk restoration cost	See Parks Initiative 1
	8 Explore opportunities for long-term activation of the beachfront	DPR/NYCEDC	Continue to address substantially damaged areas of boardwalk; explore options for new beachfront destinations issue; RFEI for cultural programming partners	Subject to exploration of options	10 See Parks Initiative 1 for boardwalk restoration	See Parks Initiative 1
	9 Develop a revitalization strategy for the Beach 108th Street corridor	NYCEDC/DCP	Complete strategy	Subject to strategy recommendations	<1	TBD
	10 Develop a comprehensive commercial revitalization plan for Beach 116th Street	NYCEDC/DCP	Complete plan	Subject to plan recommendations	<1	TBD
	11 Develop a commercial revitalization strategy for Far Rockaway, potentially involving repositioning of City- and MTA-controlled sites	NYCEDC	Complete plan; issue RFP for NYC/DOT/MTA controlled sites; complete Beach 20th Street plaza	Subject to strategy recommendations and RFP response	<1	TBD
	12 Launch a satellite Workforce1 Career Center in Far Rockaway	SBS	Complete and open Center	- -	<1	TBD
	13 Implement planned and ongoing investments by the City and private partners	Varies	Launch Jamaica Bay/ Rockaway Restoration Corps; complete Beach 73rd Street YMCA	Complete Jamaica Bay Green Infrastructure Plan, Rockaway Institute for a Sustainable Environment	Varies	Varies

Industrial facilities on the Brooklyn-Queens Waterfront

Credit: Seth Pinsky

Appendix: Glossary

100-year floodplain	The geographical area with a 1 percent or greater chance of flooding in any given year
500-year floodplain	The geographical area with a 0.2 percent chance of flooding in any given year
ABFE	Advisory Base Flood Elevation
BFE	Base Flood Elevation
BID	Business Improvement District
BMP	Best Management Practices
BNYDC	Brooklyn Navy Yard Development Corporation
BPC	Battery Park City
BRT	Bus Rapid Transit
BRTF	Building Resiliency Task Force
BSA	Board of Standards and Appeals
CDBG	Community Development Block Grant
CEO	NYC Center for Economic Opportunity
CERT	Community Emergency Response Teams
CRS	Community Rating System
CSO	Combined Sewer Overflows
DCAS	Department of Citywide Administrative Services
DCP	NYC Department of City Planning
DEP	NYC Department of Environmental Protection
DFE	Design Flood Elevation
DMAT	Disaster Medical Assistance Teams
DOB	NYC Department of Buildings
DOC	NYC Department of Corrections
DOE	NYC Department of Education
DOHMH	NYC Department of Health and Mental Hygiene
DoITT	NYC Department of Information Technology and Telecommunications
DPR	NYC Department of Parks & Recreation
DSNY	NYC Department of Sanitation
DYFJ	NYC Division of Youth and Family Justice
EBT	Electronic Benefits Transfer
ED	Emergency department

EHR	Electronic health records
ESDC	Empire State Develoment Corporation
FCC	Federal Communications Commision
FDC	Food Distribution Center
FDNY	Fire Department of New York
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FIRM	Flood Insurance Rate Map
FRESH	Food Retail Expansion to Support Health
FTA	Federal Transit Administration
GDP	Gross Domestic Product
HEC	Healthcare Evacuation Center
HHC	NYC Health and Hospitals Corporation
HMGP	Hazard Mitigation Grant Program
HOV	High Occupancy Vehicle
HPD	NYC Department of Housing Preservation and Development
HRA	NYC Human Resources Administration
HRO	NYC Mayor's Office of Housing Recovery Operations
HVAC	Heating, ventilation, and air conditioning
IDA	NYC Industrial Development Agency
IRT	Interborough Rapid Transit
JCRP	Job Creation and Retention Program
LES	Lower East Side
LiDAR	Light Detection and Ranging
LiMWA	Limit of Moderate Wave Action
LIPA	Long Island Power Authority
LIRR	Long Island Rail Road
LMDC	Lower Manhattan Develoment Corporation
LPC	Landmarks Preservation Commission
LTCP	Long-Term Control Plan
MTA	Metropolitan Transportation Authority
NACCS	North Atlantic Coast Comprehensive Study
NAS	National Academy of Sciences
NAVD88	North American Vertical Datum 1988
NFIP	National Flood Insurance Program
NOAA	National Oceanic and Atmospheric Administration
NPCC	NYC Panel on Climate Change
NYCDOT	NYC Department of Transportation
NYCEDC	New York City Economic Development Corporation
NYCHA	NYC Housing Authority

NYPD	NYC Police Department
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
NYSDOT	New York State Department of Transportation
NYU	New York University
OEM	NYC Office of Emergency Management
OLTPS	NYC Mayor's Office of Long-Term Planning and Sustainability
PATH	Port Authority Trans-Hudson
PCIP	Primary Care Information Project
PlaNYC	The City's 2007 sustainability plan, updated in 2011
POPS	Publicly Owned Private Space
PRO	Planning and Resiliency Office
PSC	Public Service Commission
PWMs	Preliminary Work Maps released by FEMA on June 2013
RCP	Representative Concentration Pathway
RFEI	Request for Expression of Interest
SBS	NYC Department of Small Business Services
SIR	MTA Staten Island Railway
SIRR	Special Initiative for Rebuilding and Resiliency
SIUH	Staten Island University Hospital
SLR	Sea level rise
SNAP	Supplemental Nutrition Assistance Program
SWMP	Solid Waste Management Plan
Take the HELM	Take the Hire and Expand in Lower Manhattan
The Port Authority	The Port of Authority of New York & New Jersey
UHI	Urban Heat Island
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USDOT	United States Department of Transportation
UWAS	Urban Waterfront Adaptive Strategies
VoIP	Voice over Internet Protocol
WAVES	Waterfront Vision and Enhancement Strategy
WUI	Wildland-Urban Interface: a zone where homes are built near or among lands prone to wildland fire