Sewage Overflows

From Hurricane Sandy

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CLIMATE CENTRAL

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Contents

Executive Summary

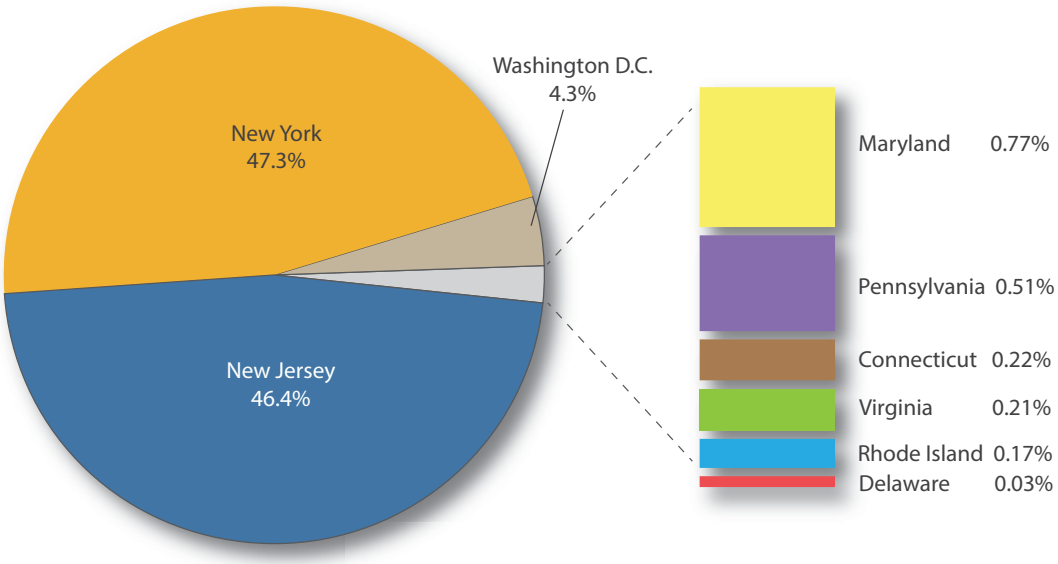
Hurricane Sandy was the largest storm to hit the northeast U.S. in recorded history, killing 159, knocking out power to millions, and causing $70 billion in damage in eight states. Sandy also put the vulnerability of critical infrastructure in stark relief by paralyzing subways, trains, road and air traffic, flooding hospitals, crippling electrical substations, and shutting down power and water to tens of millions of people. But one of the larger infrastructure failures is less appreciated: sewage overflow.

Six months after Sandy, data from the eight hardest hit states shows that 11 billion gallons of untreated and partially treated sewage flowed into rivers, bays, canals, and in some cases, city streets, largely as a result of record storm-surge flooding that swamped the region's major sewage treatment facilities. To put that in perspective, 11 billion gallons is equal to New York's Central Park stacked 41 feet high with sewage, or more than 50 times the BP Deepwater Horizon oil spill. The vast majority of that sewage flowed into the waters of New York City and northern New Jersey in the days and weeks during and after the storm.

Our analysis of sewage-spill data -- see interactive graphic -- provided by state agencies and individual treatment plant operators shows that:

- One third of the overflow (3.45 billion gallons) was untreated raw sewage. The remainder (7.45 billon gallons) was partially treated, meaning that it received at least some level of filtration and, perhaps, chlorination.
- 94 percent of the spilled sewage, well over 10 billion gallons, was the result of some form of damage caused by coastal flooding. In some cases, Sandy's storm surge simply flooded treatment plants and pumping stations, while in other cases a combination of power outages and flood conditions shuttered facilities or caused major diversions of sewage into receiving waters.

New York and New Jersey Had More Than 94 Percent of the Sewage Overflows From Sandy



- 93 percent of the volume of sewage overflows took place in New York (47 percent) and New Jersey (46 percent). Eighteen of the 20 largest spills ended up in New York and New Jersey waters, as did the four individual sewage overflows of more than 1 billion gallons each; two each from New York and New Jersey.

- The notable exception to storm-surge related sewage discharges was in Washington D.C., where instead, rainfall was the main culprit. Sandy produced 5.1 inches of rain in 24 hours, leading to the sixth-largest Sandy-related sewage overflow at 475 million gallons of untreated sewage and contaminated runoff. That was the only rain-related sewage spill in the top 30 overflows. Overall, heavy rainfall caused a reported 776 million gallons of sewage spills to waters in Mid-Atlantic States.

In addition to sewage overflows, Sandy severely damaged numerous treatment plants and pumping stations. Damage to a number of treatment plants kept largely untreated sewage flowing into local waterways for weeks, and in some cases, even months after the storm. The last known Sandy-related sewage overflow took place in January 2013.

Climate Central is unable to estimate the total costs of repairing sewage systems impacted by Sandy, but according to state authorities:

- The cost of repairing Sandy's damage to sewage treatment plants in New York is nearly $2 billion. The New Jersey Department of Environmental Protection plans to allocate nearly $1 billion for recovery and repair of facilities, and another $1.7 billion for building resilience into the system.

Highlights

New York

New York City reported six sewage spills larger than 100 million gallons, and 28 larger than 1 million gallons.

Long Island faced large spills from the Bay Park facility. When the plant was knocked out of service for 44 hours, roughly 100 million gallons of untreated sewage overflowed into Long Island's Hewlett Bay. Another 2.2 billion gallons of partially treated sewage flowed through the plant during the 44 days it took to fully restore operations.

In Westchester County, 49 million gallons of untreated sewage flowed from the Yonkers treatment plant during 14 hours at the peak of the storm. Another 1.2 billion gallons of partially treated sewage flowed from the plant in the ensuing four weeks.

New Jersey

The Passaic Valley Sewerage Commission in Newark reported the largest spill of all. During the week after the storm, 840 million gallons of untreated sewage flowed into Newark Bay. It took another two weeks to get most of the treatment up and running, and during that time another 3 billion gallons of partially treated sewage overflowed.

Middlesex County reported another 1.1 billions gallons of untreated sewage discharge to local waters, due to complications related to Hurricane Sandy.

Climate Change Means Rising Seas, Heavier Rainfalls, And More Sewage Overflows

Sewage treatment plants are usually placed near water in low-lying areas so that sewage can be piped to the plant via gravity and treated sewage can be easily discharged into receiving waters. These key factors in plant locations make them especially vulnerable to storm surges and coastal flooding. Compounding the inherent risk of their low-lying locations, many treatment plants have expansive, underground labyrinths of pipes, holding tanks and pumps that can remain waterlogged and incapacitated long after floodwaters recede. They also typically discharge their treated wastewater through large underwater pipes, which can cause facilities to flood from the inside as waters rise, long before the surface water levels overrun the outside of the structures.

Climate change is making sewage treatment plants more vulnerable to major failures and overflows due to rising seas, more intense coastal storms, and increasingly heavy precipitation events. In March 2012, Climate Central's comprehensive analysis of sea level rise, Surging Seas, reported that for more than two-thirds of the U.S. coastal locations analyzed, global warming has more than doubled the odds of a one in hundred year storm surge occurring within the next year.

Climate change that is already underway will lead to higher seas and more storms that can overwhelm coastal sewage treatment systems, resulting in massive overflows of partially or untreated sewage into waters surrounding many of our largest and most important coastal cities; water that millions of people rely on for food, health and recreation.

The EPA has already forecasted that heavy precipitation events may make current efforts to mitigate sewer overflows obsolete. Plans to mitigate future overflows must consider the effects of climate change on sea level rise, heavy precipitation, and storm intensity.

1. Introduction

When Hurricane Sandy slammed into the East Coast in October 2012, the strong winds, intense rainfall and record storm surge revealed the vulnerability of much of our infrastructure to extreme coastal storms. Among the most at-risk type of infrastructure: sewage treatment systems. Along much of the Atlantic coastline, treatment plants, pumping stations and pipelines were overwhelmed and billions of gallons of untreated sewage flowed into hundreds of rivers, streams, bays, and streets from Virginia to Rhode Island.

Some treatment plants were inundated by the high water, leaving them flooded and incapacitated. In other cases, plants were unable to handle the extra water flow resulting from heavy rainfall and floodwater that mixed with normal sewage flow, so operators diverted sewage around treatment plants and directly into receiving waters, a technique known as a bypass, in order to keep the plant operating. Still, other plants lost their pumping capacity as the storm knocked out power and cut them off from the grid. Even though plants have backup generators to maintain power during blackouts, in a number of cases generators ran out of fuel following Sandy after they were left without power for days.

Untreated sewage can have significant consequences on the environment and public health, and following these overflows, people can be exposed to harmful microbes in recreational water. In the future, increased storm surge risks from sea level rise and more bouts of heavy rains, particularly during storms, could lead to more treatment plants being inundated and more overflows throughout the entire sewage treatment system.

The goal of this report is to draw attention to the fact that our sewer infrastructure is at great risk to events like Hurricane Sandy, despite previous efforts to mitigate the impacts of these storms. In most of the cases where Sandy affected treatment plants, plant operators followed their best management practices to reduce the volume and quantity of the associated bypasses. But too often they found themselves overwhelmed by the sheer volume of sewage and wastewater runoff flowing through the system, or crippled because storm surge flooding inundated their facility or because power outages simply shut down the plant.

Figure 1. *Overflow from the Bay Park Sewage Treatment Plant in East Rockaway, N.Y. Hurricane Sandy resulted in over 2 billion gallons of sewage overflow from this facility. Some of this overflow (an estimated 68 million gallons) was released adjacent to the Western Long Island South Shore Estuary (above). Photo courtesy of Doug Kuntz.*

1.1 Rising Seas and Risk of Storm Surge

Rising sea levels are among the strongest signals of climate change. Higher temperatures are causing land ice to melt and ocean water to expand, both of which cause sea level to rise. Scientists have already observed about an 8-inch rise in global sea level since 1880, but that number is higher in places where the land is also sinking, such as in the Chesapeake Bay and New York City. Researchers now estimate that global sea level will rise between 2 and 7 feet by 2100.

Coastal storms become more dangerous as a result of sea level rise. When a major storm hits the coast, it pushes high waves and flooding inland. Higher seas mean those floods start from a higher launch pad and can be even more destructive. During Hurricane Sandy, for example, the storm surge was higher than it would have been decades ago because climate change has already caused about a foot of sea level rise in Lower Manhattan.

Most sewage treatment plants treat millions of gallons of sewage each day and constantly need to discharge the treated wastewater back into the watershed. The plants are usually placed near the water in low-lying areas so that sewage can be piped to the plant via gravity without expending any extra energy pumping it where it needs to go, and so that the effluent (treated sewage and wastewater) can be easily discharged into receiving waters.

But the same features that make coastal treatment plants efficient also make them especially vulnerable to storm surges and coastal flooding. Compounding the inherent risk of their low-lying elevation, many treatment plants have expansive, underground labyrinths of pipes, holding tanks and pumps that can remain waterlogged and incapacitated long after floodwaters recede. In addition, many plants discharge their treated wastewater through large underwater pipes, which can cause plants to flood from the inside as waters rise, long before the surface water levels overrun the outside of the structures.

Sewage plants can be vulnerable to sea level rise, even without the threat of a coastal storm. Peak high tides make it difficult for plants to discharge treated wastewater, since the plant's ability to discharge is based on the ability of water to follow the flow of gravity through the plant. Most coastal plants were designed around historic high tide levels, when even the highest water levels would be at a lower elevation than the outfalls. Rising seas upset the balance between water pressure inside the plant and water pressure outside, making it more difficult for plants to operate at high tide.

1.2 More Heavy Downpours

Heavy downpours are increasing across the U.S., partly as a result of global climate change. According to the publically released draft of the National Climate Assessment, heavy rainfall events have become 30 percent more frequent since 1991, when compared to the 1901-1960 average. The Northeast, Great Plains and Midwest have seen the greatest increases nationwide, with the Northeast seeing 75 percent more heavy downpours over that time.

More intense rainfall is placing a heavy burden on cities with combined sewer systems, which share the same pipes to carry storm water and sewage bound for a wastewater treatment plant. Too much rainfall in one of these sewers can overwhelm the pipes and lead to what's known as a combined sewage overflow (CSO). These CSOs can occur in manholes, along rivers, or at any point where there is a hole in the pipe to relieve pressure during heavy flows. CSOs can also occur at pump stations or treatment plants, which become the bottlenecks for transporting and treating the increased flow brought about by heavy rainfall.

1.3 Types of Sewage Overflows

1.3.1 Bypasses

When a plant stops working, sewage continues to flow through the plant, even though the capacity to treat that flow becomes greatly reduced. In these cases, the plants send the remaining flow through the facility without full treatment. This release of untreated, or partially treated, sewage is known as a "bypass."

According to the Clean Water Act, plants are permitted to bypass untreated wastewater under specific circumstances; this usually only occurs during emergencies. In order to legally bypass wastewater, the event must meet all of the following criteria:

- The bypass was "unavoidable to prevent loss of life, personal injury, or severe property damage;"
- There were no "feasible alternatives" to the bypass.
- The permit-holder submits notice of the bypass to the permitting authority (usually the local EPA region, or state environmental protection office).[2]

Bypasses can occur at any treatment stage at the plant, which means sewage may be released into waterways completely untreated (with minimal filtration), or after only basic filtration and disinfection.

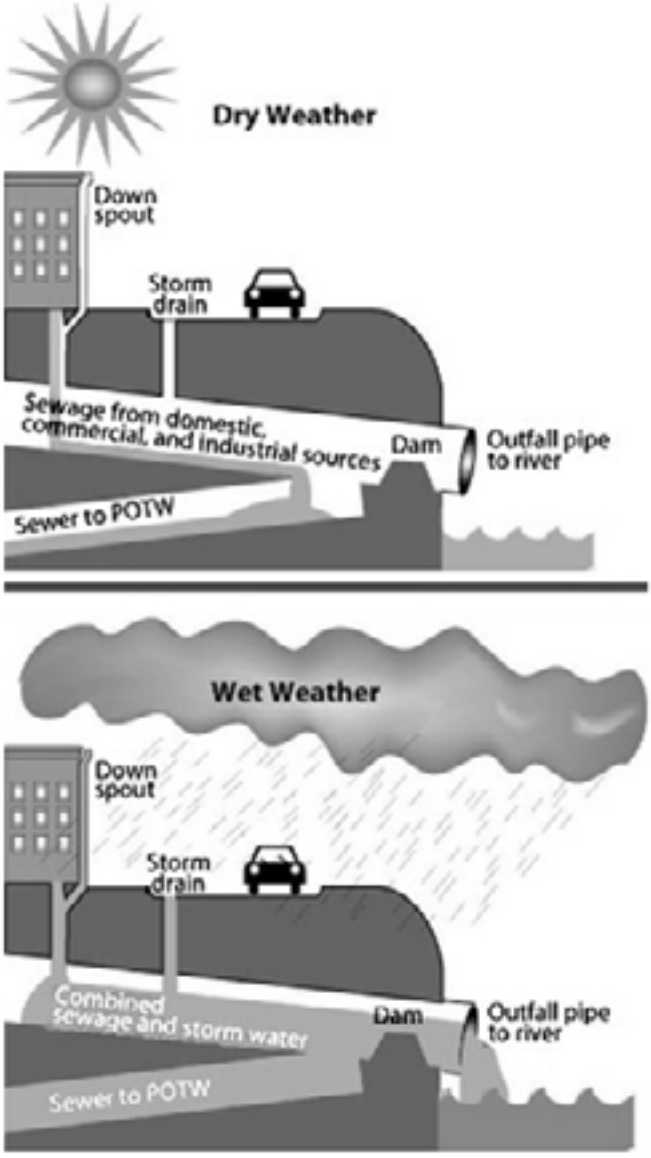


Figure 2. *Under normal conditions, a combined sewer system distributes all sewage to a treatment plant. Heavy rainfall can cause overflows, sending some untreated sewage into nearby waterways. Credit: EPA.*

Bypasses can also occur at pump stations. For sewer systems in large, or topographically complex municipalities, pump stations are placed at the lowest local elevation, so that waste can flow to the pump via gravity, before being mechanically pumped to a treatment plant. During periods of heavy flow, or when the pump station goes out of service, the pumping station becomes a choke point, and sewage can bypass that pump station and be discharged into an adjacent waterway, essentially untreated.

1.3.2 Combined Sewer Overflows (CSO)

Combined sewer systems exist primarily in cities built before the 20th century; in the late 1800s, these systems were the most technologically advanced way to keep sewage out of the street and away from sources of drinking water. Sewage and storm water collect in a single pipe, and the combined wastewater travels to a treatment plant, where it is treated and released into adjacent waterways. When it rains, more storm water flows into the pipes, and can overwhelm the system. Therefore, combined sewers are designed to overflow into the nearest river when it rains, in order to keep sewage from backing up into the streets or into peoples' homes. This is known as a combined sewer overflow (CSO).

However, as cities have expanded over the past two centuries, CSOs have become more frequent. A growing population leads to both more sewage and more paved surfaces that increase storm runoff. This increased sewage and runoff load is often being jammed into pipes built more than a century ago for smaller cities and smaller populations. When the combined load overflows a CSO occurs, and untreated sewage flows directly into waterways, along with other contaminants the storm water sweeps into the sewer, such as industrial waste and debris.

According to the EPA, there are 772 communities in the U.S. that rely on combined sewer systems to some extent. Most of these are in the Northeast, and Great Lakes regions, and in the Pacific Northwest. For example, there are 1,220 CSO outfalls in New York and New Jersey alone.[4]

The federal government regulates CSOs. In December 2000, Congress amended the Clean Water Act to require CSO communities to permit and minimize the impacts of overflows. Municipalities

are now required to improve their storm drainage systems, eliminate dry weather overflows from these sewers, and report the impacts of the spills to the public. However, the specific laws that dictate how CSOs are regulated are left to the states. Therefore, the degree to which different communities clean or report their CSOs varies from state to state.

Climate change may make it even harder to clean CSOs. Based on projections for an increase in heavy rainfall, the EPA projects that climate will lead to a large enough increase in the number of overflow events that current mitigation efforts will become obsolete.[5]

1.3.3 Sanitary Sewer Overflows (SSO)

Unlike combined sewers, sanitary sewers carry storm runoff and sewage in separate pipes. Sanitary sewers have the advantage of not overflowing every time it rains, but they can still overflow if there is some excess inflow into the system. Sanitary sewer overflows (SSO) are usually more concentrated than CSOs because they are not diluted by rainwater.

SSOs have a variety of causes. They can be triggered by the failure of sewer equipment, from too much storm water infiltrating the sewer system, or if some kind of blockage accumulates in the pipes.

Box 1: What is Sewage?

Sewage is the combination of human waste and other wastewater, including all bath and toilet waste, laundry wastewater, kitchen waste (anything that drains down the kitchen sink or through the dishwasher), and other similar waste that comes from domestic and commercial sources. “Raw sewage” describes this sewage mixture before it has received any filtration or chemical disinfection.

In cities and municipalities that rely on combined sewer systems, domestic and commerical sewage mixes with stormwater in underground pipes, and the entire mixture flows and is treated at a sewage plant (also known as a wastewater treatment plant). During heavy rainfall, stormwater can wash streetlevel chemicals and debris into the combined sewer system, adding more pollutants into the sewage. Sewage flowing in sanitary sewage systems (in places that don’t have combined sewer systems) is usually not diluted by stormwater, and is thus much more concentrated when it reaches a sewage plant.

2. Results

2.1 Overview

The analysis examines 1) how much wastewater overflowed as a result of the storm, 2) how much of that received treatment, and 3) what the leading causes were of those types of spills.

The numbers reported here are based on the best estimates of sewage flow volumes and plant damage provided by a variety of state agencies, municipal governments, plant operators, and the EPA.

States use different terms to describe overflow events so we classified overflows according to the most commonly used category names. In several cases, where was no assigned cause for an incident, we assigned one based on knowledge of rainfall amounts, power outages, floodwater heights, and location of each spill.

We collected data from eight states (and the District of Columbia) affected by Sandy:

- Connecticut
- Delaware
- Maryland
- New Jersey
- New York
- Pennsylvania
- Rhode Island
- Virginia
- Washington, D.C.

New York and New Jersey Had More Than 94 Percent of the Sewage Overflows From Sandy

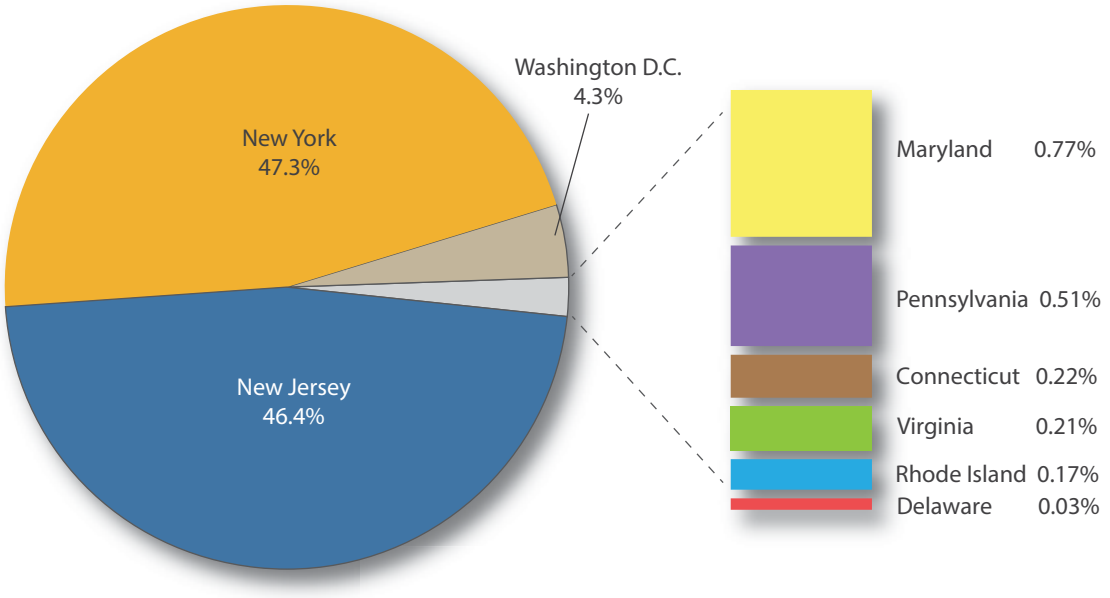


Figure 3. *New York and New Jersey comprised the vast majority of the total recorded spill volume during Sandy, with 5.2 billion gallons and 5.1 billion gallons, respectively. The other six states and Washington, D.C. had a combined 600 million gallons.*

Based on the data collected, we estimate that 10.9 billion gallons of wastewater overflowed as a result of the storm.

- Of that, 32 percent -- 3.45 billion gallons -- of the overflow was untreated. The other 7.45 billion gallons of partially treated wastewater received at least a degree of primary treatment. In most cases, this included filtration and disinfection.

- New Jersey and New York comprised the vast majority of the spill volume, with 46 percent and 47 percent, respectively.

- The leading causes of overflows were related to Sandy's enormous and unprecedented storm surge. Complications due to coastal flooding were responsible for 94 percent (10.2 billion gallons) of the volume of sewage that overflowed.

    - Of the remaining 6 percent (690 million gallons), 80 percent (549 million gallons) were the result of heavy precipitation, 14 percent (98 million gallons) were the result of power loss to plants and pumping stations, and 3 percent (22 million gallons) happened due to other types of equipment failure.

- Outside of New York and New Jersey (685 million gallons), the leading cause of a spill was heavy precipitation, which either overwhelmed a plant or flowed out of a CSO. In the remaining seven states, heavy precipitation was responsible for 549 million gallons of overflow.

These numbers do not include amounts that overflowed directly from combined sewer systems in New York and New Jersey. However, these two states were hit the hardest by Sandy's storm surge, and have the highest concentration of combined sewer systems in the country, since so many of the low-lying communities around New York Harbor had their sewer systems built in the 19th century (such as Manhattan, Brooklyn, Newark, Bayonne, Elizabeth, Jersey City, and Perth Amboy). When the streets flooded in these cities, the seawater would have flushed everything in those combined sewers into the waterways.

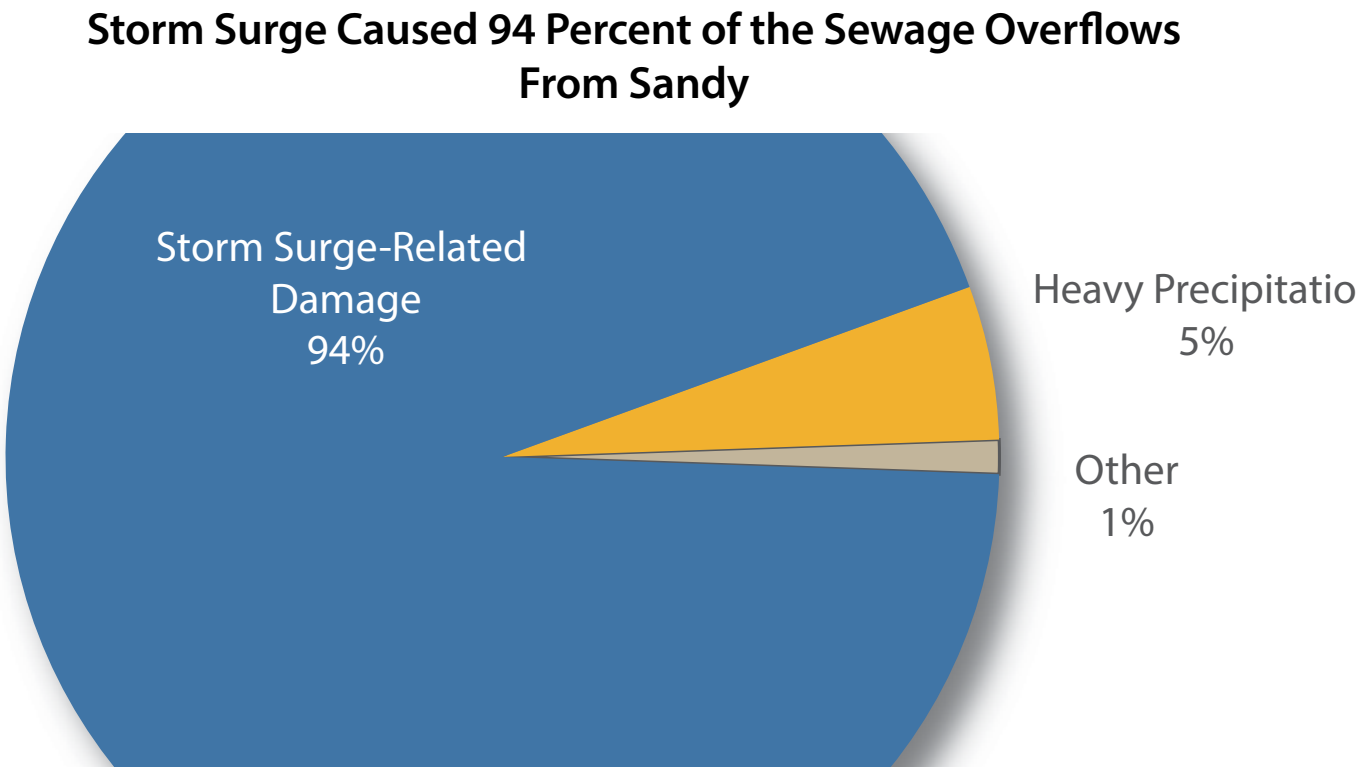


Figure 4. *Coastal flooding and power outages caused by the record storm surge during Sandy were responsible for almost all of the sewage overflow volume linked to Sandy. Most of the rest of the overflows is attributed to heavy precipitation.*

Box 2: Top Five Biggest Sewage Overflows During Superstorm Sandy

1. **Passaic Valley Sewage Commission, Newark, N.J.** – After a wall of water at least 5 feet high inundated this sewage treatment plant during the storm, 840 million gallons of untreated sewage flowed directly into Newark Bay between October 29 and November 3., when some treatment was restored. In addition, another 3 billion gallons of partially treated sewage was sent into the bay before secondary treatment was restored on November 16.

2. **Bay Park Sewage Treatment Plant, Bay Park, N.Y.** – We conservatively estimate that as much as 2.2 billion gallons of partially treated sewage flowed into Rockaway Channel from this plant between October 29 and December 21 (when this plant was once again fully operational). Tidal flooding in Bay Park was so severe that plant operators were unable to give us their estimate of the overflow volume, but based on daily average flows through the plant, we estimate 104 million gallons of untreated sewage was also sent into Rockaway Bay from Bay Park.

3. **Yonkers Joint Wastewater Treatment Plant, Yonkers, N.Y.** – High waters on the Hudson River flooded the Yonkers plant on October 29, knocking out the facility's power. Before initial treatment was restored, over 49 million gallons of untreated sewage emptied into the Hudson, but a total of 1.2 billion gallons of untreated sewage went into the river before operations were back to normal two weeks after the storm.

4. **Middlesex County Sewage Authority, Sayersville, N.J.** – Two pumping stations that service the MCUA treatment plant were severely damaged by Sandy, sending over 1 billion gallons of untreated sewage into Raritan River and Raritan Bay. These two pumps were in Sayersville and Edison, NJ, and the Sayersville pump was so badly damaged that it was still sending untreated sewage into the river as of January 2013.

5. **O Street Combined Sewer Overflow, Washington, D.C.** – More than 5 inches of heavy rain fell in Washington, D.C. during Superstorm Sandy, leading to an overflow in the city's combined sewer system. On October 29 and 30, 475 million gallons of untreated sewage and contaminated storm runoff flowed into the Anacostia River from a pump station near Washington Nationals Park.

Despite ubiquitous CSOs in New York and New Jersey during Sandy, the total volume is unknown. The volumes from New York discussed here only include overflows from treatment plants and pump stations.

2.2 State-by-State Overflows

2.2.1 Connecticut

The two largest spills in Connecticut came from two mid-sized sewage treatment plants in Bridgeport. As a result of the storm, both facilities faced increased flows to their plant due to flooding in the surrounding sewers. In order to stay in operation, the two plants were forced to bypass 17 million and 2.5 million gallons of partially treated sewage into the Long Island Sound and Bridgeport Harbor on the night of October 29th.

The sewage treatment plant in Mystic also suffered from a storm surge that overwhelmed three of its major treatment processes. The Mystic plant bypassed 2.3 million gallons of partially treated sewage into the Mystic River on October 29, while it waited for the extreme high tide to recede.

2.2.2 Delaware

The largest spill in Delaware came from the City of Lewes Wastewater Treatment Plant, which lies only a few hundred yards from a beach on the Delaware Bay. When Sandy hit, Lewes was evacuated. The plant operators decided to shut the facility for the duration of the storm, reasoning that bypassing highly diluted runoff from a mostly-evacuated town would have a smaller environmental impact than letting the storm flush out their biological reactors. By October 31, 2.4 million gallons had overflowed into the bay from the facility.

2.2.3 Maryland

Maryland received more rainfall than coastal flooding during Sandy, which meant that the majority of its spills came from combined sewer overflows, or from power outages caused by downed trees. Roughly 41.6 million gallons overflowed from sewer outfalls across the state. The majority of those were near the headwaters of the Potomac River, in Cumberland County.

A more concentrated spill took place at the Little Patuxent Water Reclamation Facility, near Savage. As a result of the torrential rains and high winds that battered the Delmarva Peninsula during Sandy, the facility lost power as the storm damaged one of the power lines leading to the plant. The on-site emergency generator ran out of fuel within a few hours, and the facility began bypassing untreated sewage into the Little Patuxent River. The total volume of the spill was close to 19.5 million gallons. Fortunately, Howard County officials reported that there was no immediate danger to the local ecosystem or drinking water after the storm, because the spill had been so diluted by the heavy rainfall.

Another similar spill was reported at the Town of Snow Hill Wastewater Treatment Plant in Worcester County. During the storm, the plant was flooded with water from the Pokomoke River, and bypassed more than 2.4 million gallons.

Baltimore City and Baltimore County recorded a series of CSOs and SSOs from various manholes and sewer mains. This amount did not exceed 6.7 million gallons.

2.2.4 New Jersey

Two of the biggest spills associated with Sandy came from northern New Jersey. These were at the Passaic Valley Sewerage Commission, in Newark, and from the Middlesex County Sewerage Authority, in Sayreville.

The Passaic Valley Sewerage Commission (PVSC), which has a plant in Newark, was hit with the full force of Sandy's storm surge. A wall of water at least 5 feet high overwhelmed the plant, leaving it flooded and completely out of service from October 29 through November 3. During that period, 840 million gallons of untreated sewage flowed through the plant and directly into Newark Bay. On November 3, workers were able to restore primary treatment, and disinfect what was flowing into the bay. It took until November

16 for workers to restore secondary treatment. During those three weeks, at least another 3 billion gallons of partially treated, disinfected sewage spilled into the bay.

The destruction at PVSC caused an estimated $200 million in damages. PVSC has an annual operating budget of $150 million.

The Middlesex County Sewerage Authority (MCUA), which serves 797,000 households and businesses, also faced significant damage to its facilities near Newark Bay. While its central treatment plant was largely unscathed by the storm, two pump stations (one in Edison and one in Sayreville) were severely damaged. The Sayreville pump station was so badly damaged that it was intermittently bypassing sewage into Newark Bay as late as January. The Sayreville pump is situated on the Washington Canal, a shallow channel near the mouth of Raritan River. The total volume of reported spills attributable to Sandy from facilities in the MCUA exceeded 1.1 billion gallons during a three-month period.

Dozens of other, smaller spills and SSOs were also reported across central and southern New Jersey, as a result of inundation, blockage, and the loss of power to essential pumping equipment.

2.2.5 New York

The sewer infrastructure in New York City, Long Island, and parts of the lower Hudson River north of the city all faced direct hits from Sandy. The combination of treated and partially treated sewage that overflowed from pump stations and treatment plants in New York State exceeded 5.1 billion gallons.

The largest single spill in New York State came likely from the Bay Park Treatment Plant in Nassau County, Long Island. The storm left this coastal plant completely out of operation for at least 42 hours after the storm. Since the tidal flooding was so severe, operators were unable to provide even conservative estimates as to the amount of non-salt water that escaped the plant. However, based on average daily flows through the plant, we estimate that at least 104 million gallons of untreated sewage overflowed into Rockaway Channel. After the first 42 hours, treatment levels came back online slowly. It took until December 21 (44 days) for secondary treatment to be

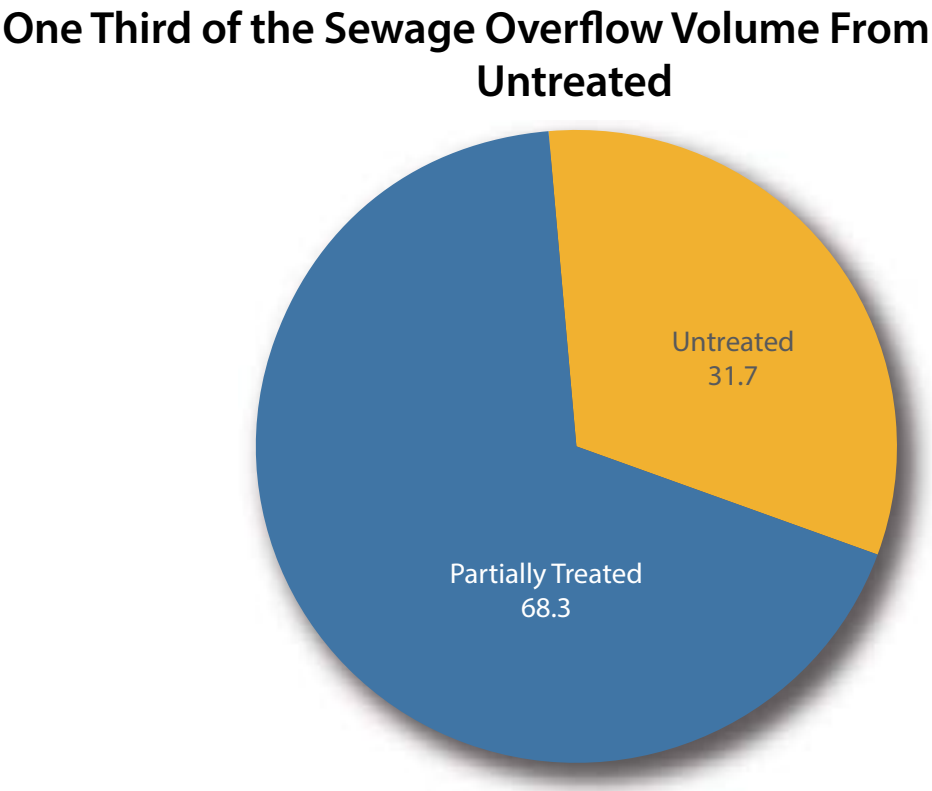


Figure 5. *Among the 32 percent of untreated sewage overflow during Sandy, there is no way to determine how dilute the sewage was. The other two thirds of overflows were partially treated, which included disinfection in most cases, but in rare instances may only have involved filtration.*

fully restored. During that time, we estimate that as many as 2.2 billion gallons of partially treated sewage flowed into that channel, and out into Hewlett Bay.

An additional 1.6 billion gallons came from pump stations and treatment plants in New York City. The city is served by 14 wastewater treatment plants. Nine of those plants had spills that exceeded 10 million gallons:

- The Coney Island Wastewater Treatment Plant on Sheepshead Bay had the most trouble. Despite the tireless efforts of plant workers throughout the storm to keep the extreme high tide and increased flow from overwhelming the plant, water eventually inundated the plant. The plant chief ordered the facility to shut down for two hours on the night of October 29 to minimize damage to personnel and electrical equipment. The plant was back in service by 12:30 a.m. on October 30. In total, 213 million gallons of raw sewage and CSO overflowed from the plant, in addition to another 284 million gallons that escaped with only a reduction in secondary treatment.

- The Oakwood Beach Wastewater Treatment Plant on Staten Island also faced significant flooding, but was able to maintain some treatment and disinfection throughout the course of the storm. The plant operated without key electrical equipment between October 29 and November 2, and overflowed 237.5 million gallons of mostly treated sewage.

- The Rockaway Wastewater Treatment Plant in Queens was also forced to shut down during the storm due to severe flooding. While a small degree of treatment was maintained throughout this time, the plant discharged 36 million gallons of mostly untreated sewage, and 165 million gallons of partially treated sewage.

- The Hunts Point Wastewater Treatment Plant in the Bronx was forced to bypass untreated sewage through its gates to prevent the flow from flooding the plant. Hunts Point discharged 153.8 million gallons of untreated, diluted sewage into the East River.

- Operators of the Newtown Creek Wastewater Treatment Plant in Greenpoint, Brooklyn were able to maintain power to the plant during Sandy by harnessing electricity from backup generators and electrical turbines. However, the extreme high tide and storm surge on the evening of October 29 caused 143 million gallons of untreated sewage to overflow from the submerged plant into Newtown Creek before the flow was brought under control.

- The 26th Ward Wastewater Treatment Plant in East New York, Brooklyn, bypassed 89 million gallons of wastewater that had only undergone partial secondary treatment. The New York City Department of Environmental Protection cut power to the plant as it flooded with water from the storm surge in order to prevent further damage to the equipment.

- The North River Wastewater Treatment Plant, which sits beneath Riverbank State Park on the Hudson River, saw significant flooding on the first floor of the plant that knocked out several pumps responsible for guiding the sewage through the facility. Between October 29 and October 31, the plant bypassed 83 million gallons of sewage into the river.

- The Owls Head Wastewater Treatment Plant in Bay Ridge, Brooklyn, lost power to its main pumps for several hours during the storm. Secondary treatment and disinfection systems remained online, and the plant bypassed 76.2 million gallons of partially treated and disinfected sewage.

- The Port Richmond Wastewater Treatment Plant experienced heavy flows and damaged equipment, but maintained its ability to disinfect waste. The facility bypassed 30 million gallons of partially treated sewage during the storm.

In New York City, a combined 102.6 million gallons overflowed from three more treatment plants (Tallman Island, Wards Island and Stony Point), and from 31 pump stations across the five boroughs.

At the Yonkers wastewater treatment plant, just north of New York City on the Hudson River, Hurricane Sandy overran the banks of the river, flooded the

plant's basement chambers, and cut power to all of the plant's equipment. The plant's engineers cut electricity before the storm hit in order to minimize damage, but the damage was still severe. The motors required for pumping sewage through different levels of treatment had to be removed, disassembled, dried, and put back together. Wires corroded by the salt water had to be completely replaced. The flow was again being disinfected by the morning of October 30, though it took three more days for the plant to restore primary treatment. Secondary treatment wasn't running until two weeks after the storm, In the meantime, the plant sent 120 million gallons of untreated, disinfected sewage into the Hudson River every day. The estimated total volume of partially treated sewage that flowed into the Hudson River is 49 million gallons untreated, and 1.2 billion gallons partially treated.

2.2.6 Pennsylvania

Heavy rainfall over Pennsylvania brought heavy flows to wastewater treatment plants in Harrisburg and York. As a result, these two plants were forced to bypass some parts of the treatment process during the storm. The two facilities discharged 22.8 million and 12.5 million gallons of partially treated sewage, respectively.

Another plant, in Hanover lost power as a result of the storm, and discharged 11 million gallons of untreated sewage into nearby Plum Creek between 2 p.m. on October 29 and 11 p.m. on October 30.

2.2.7 Rhode Island

While heavy rains spared most of the state, many plants in Rhode Island experienced heavy flows during the storm, primarily due to storm surge and localized flooding. The largest event was a discharge of partially treated sewage at the Bucklin Wastewater Treatment Facility in East Providence. As a result of increased flow from the storm, operators at the Bucklin facility hurried to redirect the increased flows through alternative channels in the plant, in order to prevent a bypass. Unfortunately, as they were doing so, the plant lost power, and the redirected partially treated sewage overflowed into the Seekonk River. The total amount of the overflow was recorded as more than 17.5 million gallons (which received primary treatment and disinfection). In smaller events, Newport's Wellington Avenue CSO structure experienced a 762,000-gallon overflow, and Middletown's Wave Avenue pumping station briefly bypassed 75,000 gallons.

2.2.8 Virginia

Sandy caused two major spills of raw sewage in Virginia. One was at the Front Royal Wastewater Treatment Plant in Warren County, where heavy rains increased the flow through the plant and overwhelmed its 12 million gallon capacity. 5.3 million gallons of untreated sewage overflowed from the plant into a creek that feeds into the Shenandoah River.

The other major spill happened when a sewer main in Suffolk broke and began spilling raw sewage into Shingle Creek, just 10 miles north of the mouth of the James River. More than 18.5 million gallons had flowed into the narrow waterway before the flow could be stopped.

2.2.9 Washington, D.C.

No bypasses were reported from the Blue Plains Wastewater Treatment Plant, which treats the majority of the wastewater from the greater D.C. metro area. However, more than 5 inches of heavy rainfall fell over the city during the storm, and that took a heavy toll on the combined sewer system. Between October 29-30, roughly 475 million gallons of untreated sewage and storm runoff flowed into the Anacostia River from a pump station near Washington Nationals Park. Officials at the District of Columbia Water and Sewage Authority believe that even more overflowed from sewer outfalls across the city, but had no way of measuring those overflows.

Bay Park Sewage Treatment Plant in East Rockaway, N.Y. (Credit: Doug Kuntz)

One overflow location (68 billion gallons) from the Bay Park Sewage Treatment Plant was adjacent to the Western Long Island South Shore Estuary (see images below). (Credit: Doug Kuntz)

3. Methods

The data represented here comes from the best available information compiled by state environmental protection agencies, municipal governments, individual plant operators, the EPA, and a collection of news reports. However, there are discrepancies in reporting techniques and quality controls between these sources, which influences the overall data quality. Consequently, we have refrained from drawing conclusions that go beyond basic estimates.

Furthermore, where data are incomplete, we marked it as such, and made educated guesses based on what was available. In these cases, the reported number is only a rough representation of an amount, rather than an official estimate.

3.1 Data collection

The EPA requires all treatment plants and sewer outfalls that release pollutants to apply for a National Pollutant Discharge Elimination System (NPDES) permit. NPDES permit holders are required to report all bypasses and overflows to the EPA. The majority of the data we collected come from these reports, which were either collected by state environmental agencies, or by the EPA itself.

However, the effects of storm knocked out many of the electronic monitoring sensors plants use to measure bypasses and flows. In these cases, volumes of bypasses come from testimonials from plant operators, who made estimates based on the plant's daily average flow, and the period of time the plant was out of operation for.

In several cases, the sheer volume of flooding at a plant made it impossible to distinguish what was salt water and what was wastewater. In these situations, the amount of overflow volume the plants provided to us is an estimate of what would have been treated by the plant in an average day. This number comes from multiplying the flow through the plant (in millions of gallons per day) by the number of hours (or days) the plant was out of service.

Due to the extent of the damage caused by Sandy in hundreds of communities, this report may not reflect every individual sewage overflow that occurred as a result of the storm in every part of the country. Our data reflects all the spills that were reported to a local or state authority, along with spills that we discovered through our own investigations.

CSOs and SSOs are often more difficult to estimate. While NPDES permits require states to collect this data, not all states keep this data centralized or publically available. Therefore, CSO and SSO data is wholly unavailable for Delaware, New York and Virginia, and partially available for Connecticut, New Jersey, Pennsylvania, and Rhode Island. Some states rely entirely on citizen reports for both the location and volume of some overflows, adding to the unreliability.

3.2 Data treatment

In cases where a state did not provide a full description of each incident, we used our best judgment, in consultation with other experts, as to the type of overflow, the general cause of the overflow, and the amount.

Many of the largest spills reported here are based on estimates developed in consultation with local plant operators, state agency officials and other experts. The estimates come from multiplying the average daily treated flow at that plant (in millions of gallons per day) by the length of time a plant was out of service for (in days). Below is a list of plants for which we calculated estimates:

- Passaic Valley Sewerage Commission, Newark, N.J.
- Bay Park Sewage Treatment Plant, Bay Park, N.Y.
- Yonkers Joint Wastewater Treatment Plant, Yonkers, N.Y.
- North Yonkers Pump Station, Yonkers, N.Y.

In most cases, we knew the type of sewer system (combined or seperate) in the location provided, and could estimate the type of damage Sandy would have had in that area, based on what we knew about the storm's track and impact. Where information about the cause was missing or incomplete, we occasionally relied on local news reports.

The categories of "untreated" and "partially treated" are very rough. "Untreated" includes all spills categorized as raw sewage, CSO, or SSO. "Partially treated" refers to sewage that received any degree of treatment at a wastewater plant, even if it was as little as large-scale filtration. While these categories are rough, they allow for comparisons between states with different treatment standards.

4. Conclusion

All told, the effort that went into keeping plants in operation during Sandy, and into bringing damaged plants back up to capacity following the storm is remarkable. Operators of wastewater plants did everything they could to minimize damage to the plant and treat sewage as well as possible. Even with the amount of damage done, nearly every plant was treating sewage, to some degree, within hours after the storm.

Nevertheless, Sandy revealed how vulnerable critical components of our sewer infrastructure are to storms that cause coastal flooding, carry heavy precipitation, and temporarily cut access to the electricity grid. The costs associated with a storm like this are enormous, and range from the cleanup that happens immediately after a disaster, to the added expense of operating damaged equipment months after a storm.

4.1 Impacts

The effects of this contamination were apparent immediately after the storm. Several local authorities issued health advisories warning citizens to stay away from waters that were contaminated by sewage overflows.[6-11] After the storm, the EPA warned people to stay away from flood waters in order to minimize the risk of exposure to raw sewage, and cautioned them to boil drinking water that may have been contaminated.[12]

Beyond the immediate consequences of foul smells, the sight of floating waste, and the cleanup associated with them, sewage overflows can have serious impacts on public health, and on the ecosystems in the receiving waterways.[13]

4.1.1 Health

Raw and inadequately treated sewage contains pathogens (both bacteria and viruses) that can lead to serious health problems. Recent studies suggest that there are nearly 20 million cases of waterborne illness from drinking water in the U.S. each year.[14] Since long-term data on sewage overflows are unreliable, it can be hard to definitively link diseases with patterns in sewer overflows. Moreover, the EPA has reported on the difficulty of connecting known outbreaks of waterborne-related illness with specific CSOs or other overflows. Nevertheless, the EPA also reports that sewage overflows greatly increase risks of waterborne illness via several channels. Firstly, coming in contact with contaminated water greatly increases the risk of contracting a waterborne disease. Secondly, fish and shellfish from contaminated waterways can carry pathogens released during sewage overflows. Finally, drinking water sources may be impacted by a sewage overflow, and municipal health departments often issue boil water notices immediately after a storm. Children, the elderly, and pregnant women are particularly vulnerable to illnesses caused by the pathogens in sewage overflows.

During major flooding events like those associated with Hurricane Sandy, there is an added health risk associated with contaminated standing water.

4.1.2 Environmental Impacts

In addition to pathogens and bacteria, inadequately treated sewage can impact the health of an aquatic ecosystem by depleting the available oxygen and creating an imbalance of nutrients for organisms living in the contaminated environment.

Similarly, untreated sewage contains high concentrations of phosphorous and nitrogen, which promote plant growth. With this sudden nutrient increase, algae in the contaminated waterways can grow very quickly, collect on the water surface in unattractive, green algae blooms, and drive away normal aquatic life.

4.2 Costs

All told, Sandy caused upwards of $50 billion in damages nationwide.[15] The total costs wrought on sewer infrastructure is not collected here, but the examples from a few affected plants provide context

for how expensive the storm was for affected sewer systems.

The Passaic Valley Sewerage Commission in Newark, N.J., expected the total cost of repairs to exceed $200 million dollars. That is $50 million more than their annual operating budget of $150 million.

The total cost of damage to the sewer system in Westchester County, N.Y., is estimated at $14.5 million. Federal relief money will only cover a fraction of that cost. The New York State legislature is attempting to raise $10 million in bonds, but is legally limited from raising any more than that.

In South Monmouth County, N.J., which lies right on the coast, the storm left two sewage pump stations completely out of service due to flooding, and caused $10 million in damages to sewer equipment. The South Monmouth Regional Sewage Authority has an annual budget of $6 million, and as of March 2013 was still looking for ways to finance its repairs.

New York State now estimates the sewage and wastewater system repair and recovery costs from Hurricane Sandy to be nearly $1.9 billion.

The New Jersey Department of Environmental Protection plans to allocate $2.6 billion dollars on water infrastructure damaged by the storm. Of that, $342 million will go to recovery, $553 million will be spent on repairs, and the remaining $1.7 will be spend on building resilience into the system.

4.3 Mitigation

The threats discussed here are not purely caused by climate change. Coastal storms, heavy rainfall and aging sewer infrastructure would cause overflows, even in an ordinary climate. However, rising seas and stronger storms exacerbate these problems, and make the need to adapt even more urgent.

Mitigating sewer overflows, from both combined sewer systems, and from damaged plants, is an expensive, and time-consuming process. However, if the frequency or severity of events like Sandy increases, the costs of cleaning up from each storm will eventually exceed the cost of extensive mitigation.

4.3.1 Mitigating CSOs

The national CSO Control Policy, part of the amendment to the Clean Water Act made in 2000, requires communities to implement nine minimum controls and to develop a long-term plan to reduce the frequency and adverse effects of sewage overflows. These nine controls include taking steps like reducing runoff by channeling more storm water into absorbent green spaces, eliminating dry weather overflows, and maximizing the amount of sewage that flows into a wastewater treatment plant. The CSO control policy also requires communities to let the public know about the impact of CSOs.

Eliminating CSOs altogether is an ongoing and expensive process. In 2004, the EPA compiled the expenditures that 48 communities (roughly 6 percent of the total number of CSO communities) had taken to update their sewer system. The costs totaled $6 billion, and ranged from $134,000 to $2.2 billion per

Figure 6. *Combined sewage overflow locations in the New York City Metro Area. Credit: EPA.*

community. The EPA estimates that the total costs of future CSO controls will exceed $50 billion over the coming decades.[16] The 2009 American Recovery and Reinvestment Act included more than $75 million in funding to help update sewer systems in New York and New Jersey.

The City of Portland, Ore., was able to eliminate more than 95 percent of its annual combined sewer overflows by completely updating its sewer infrastructure. Over the course of 20 years, the city added miles of underground pipes to carry 1.2 billion gallons of annual storm water and separate it from the city's municipal waste. The project was completed in 2011, and cost taxpayers an estimated $1.4 billion.[17]

4.3.2 Protecting Wastewater Treatment Plants

The vulnerability of wastewater treatment plants to rising sea levels and severe storms is not well-studied and the projected costs of protecting these facilities (or making them more resilient to storm surge events) is not well-understood. In 2008, the New York City Department of Environmental Protection published a report in which it identified the potential threat that sea level rise and coastal inundation could pose to the city's wastewater infrastructure. These include rising high tides, the increased frequency of storms, and the elevated risk of prolonged power outages.[18]

The NYC DEP report identifies several strategies to reduce the impacts of coastal flooding and the stress placed on treatment plants. These include:

- Improving the capacity of the storm collection system, so that less runoff from rainfall and flooding end up flowing to the plant, or overflowing as a CSO.
- Raising the elevation of key site-specific facilities (such as pumps, generators, and electrical equipment) above projected flood heights.
- The construction of watertight doors and windows to protect critical equipment.
- Installing pumps that can work underwater (known as "submersible pumps").
- Having additional backup emergency management equipment on site in order to prepare for prolonged power outages and minimize the amount of time the plant is out of service.
- Revising the design criteria of each plant, so that future renovations address the threat of sea level rise.

The damage caused by Sandy offers a chance to expand that advice. Additional suggestions for low-cost, short-term actions that plants could take include preparing for evacuations, giving early warnings, and improving emergency and operational preparedness at vulnerable locations.[20]

It is important to note that the tireless efforts from many plant operators kept these spills from being any more severe. For example, in North Carolina, a state that regularly faces damage from seasonal hurricanes, there were no overflows from sewage treatment plants for three reasons. First, due to their experience with hurricanes, residents and town utility officials have had practice shutting systems or evacuating if needed. Second, Sandy hit the northern coast of North Carolina, which is full of resort towns that tend to empty by the end of October, reducing the overall load on the system. Third, and most importantly, Sandy only dealt a glancing blow to the North Carolina coast on its way to the Northeast. However, in other states, the sheer magnitude of the storm and damage it caused overwhelmed most possible emergency procedures. This is an indication that the vulnerability of these plants is entirely a vulnerability of infrastructure to high seas and extreme storms, rather than a vulnerability of management.

New solutions to prevent future overflows should go beyond short-term fixes, and be conducted with the knowledge that the threats carried by Sandy – coastal flooding and heavy precipitation – will become more frequent over the coming decades.

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Glossary

Bypass – The process of intentionally diverting wastewater away from any portion of a treatment plant. The wastewater that is discharged from a treatment plant with no treatment, or only partial treatment, is also referred to as a bypass.

Combined Sewer – A sewer system build to carry domestic sewage and stormwater runoff in the same pipes.

Combined Sewer Overflow (CSO) – An overflow that occurs when heavy rainfall or flooding exceed the capacity of the storm system, and the sewer is forced to discharge into a nearby street or waterway. CSOs prevent raw sewage from backing up into peoples' homes, but carry large amounts of sewage and contaminated storm water into public waterways.

Discharge – A term that refers to any release of wastewater from a sewer system. Discharges can be fully treated or untreated, and may come from treatment plants, manholes, CSO outfalls, or any other point in a sewer system.

Disinfection – A basic level of treatment in which a chemical or applied to sewage to reduce the concentration of pathogens in the wastewater. Disinfection is included in many forms of secondary treatment, but is also applied to bypasses and overflows as a last-resort level of treatment. Chlorine is the most popular form of last-resort disinfectant, since it is a cheap and cost-effective way to kill most harmful bacteria, but can have health and environmental problems of its own.

Dry Weather Flow Conditions – The flow conditions within the sewer system that result from one or more of the following: flows of domestic sewage, ground water infiltration, commercial and industrial wastewaters, and any other non- precipitation event.

Dry Weather Flow Overflow – A combined sewer overflow that occurs during dry weather flow conditions. These overflows often result from blockage in the CSO system or from unusually heavy dry weather flow. Dry weather overflows are not diluted with storm water runoff, and can be much more damaging than a wet-weather CSO.

Indirect discharge – The introduction of pollutants into a municipal sewage treatment system from any non-domestic source (i.e. from industrial or commercial facility, or from hazardous street runoff).

Infiltration – Water other than wastewater that enters a wastewater system and building sewers from the ground through such means as defective pipes, pipe joints, connections or manholes. (Infiltration does not include inflow). Infiltration is a big problem when there is flooding on the street, since that floodwater can cause overflows in both CSO and SSO storm systems.

Inflow – Water other than wastewater that enters a wastewater system and building sewer from sources such as roof leaders, cellar drains, yard drains, area drains.

Peak Flow – The maximum flow that occurs over a specific length of time (e.g., daily, hourly, instantaneous).

Pollutant – Dredged spoil, solid waste, incinerator residue, filter backwash, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, certain radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt, and industrial, municipal, and agricultural waste discharged into water.

Primary Clarification or Equivalent – The level of treatment that would typically be provided by one or more treatment technologies under peak wet weather flow conditions. Options for defining primary clarification include a design standard. This treatment is site-specific and varies greatly depending on the system.

Primary Treatment – The initial removal of removing some portion of the suspended solids and organic matter in wastewater. Common usage of this term also includes preliminary treatment to remove wastewater constituents that may cause maintenance or operational problems in the system (i.e. grit removal, screenings for rags and debris, oil and grease removal, etc). Techniques include filtration, flotation and sedimentation.

Pump Station – A point in a sewer system that channels the flow of sewage to a WWTP. Pump stations are often located at low elevations, so that sewage can flow to the pump via gravity, before being redirected. During periods of heavy flow, the pump station can serve as a choke point

Sanitary Sewer – A pipe or conduit (sewer) that is intended to carry wastewater or water-borne wastes from homes businesses, and industries to the treatment plant. Not intended to carry stormwater.

Sanitary Sewer Overflow (SSO) – Untreated or partially treated sewage overflows from a sanitary sewer collection system. These are usually caused by the inflow or infiltration of stormwater or floodwater into the sanitary sewer, which overwhelm the sewer's capacity and force sewage to overflow from the pipes. SSOs leak out of manholes, sewer mains, or discharge backwards into peoples' homes. SSOs tend to be less diluted, and contain less volume than CSOs.

Secondary Treatment – Complex, technology-based methods of removing bacteria and other harmful organisms and chemicals from wastewater. Secondary treatment usually involves the use of biological reactors, which contain microorganisms that break down these contaminants. More advanced steps involve the removal of small particles and nitrogen, which can have negative effects on aquatic habitats. Levels of secondary treatment differ between WWTPs, and depend on local standards and regulations.

Sewage – The combination of human waste and other wastewater (including bath and toilet waste, laundry water, kitchen waste, and other similar waste from household or commercial sources).

Total Maximum Daily Load (TMDL) – The amount of pollutant, or property of a pollutant, from point, nonpoint, and natural background sources, that may be discharged to a water quality-limited receiving water. Any pollutant loading above the TMDL results in violation of applicable water quality standards.

Wastewater – Any combination of sewage, storm runoff, industrial waste, or other types of water that have been negatively affected in quality by anthropogenic influence.

Wastewater Treatment Plant (WWTP) – A facility that removes contaminants and pollutants from wastewater in order to make it safe for releasing. Also known as a Publically Owned Treatment Works (POTW).

Wet Weather flow Conditions – The flow conditions within a combined sewer system resulting from a precipitation event. This definition is site-specific and depends on the local climate. Wet weather most commonly includes rainfall, and snowmelt.

Appendix

Table A1. Top 25 Biggest Spills Sorted By Volume

Rank	State	City	Facility	Volume (gallons)	Cause	Type
1	NJ	Newark	Passaic Valley Sewerage Commission, Wilson Avenue, Newark	3,080,000,000	storm surge and flooding	partially treated
2	NY	Bay Park	Bay Park Sewage Treatment Plant, Harbor Road, Bay Park	2,200,000,000	storm surge and flooding	partially treated
3	NY	Yonkers	Yonkers Joint Wastewater Treatment Plant, Yonkers	1,174,000,000	storm surge and flooding	partially treated
4	NJ	Sayreville	Two pump stations, Middlesex County Utilities Authority, Sayreville	1,135,415,490	storm surge and flooding	untreated
5	NJ	Newark	Passaic Valley Sewerage Commission, Wilson Avenue, Newark	840,000,000	storm surge and flooding	untreated
6	DC	Washington	Combined Sewer Pump Station, O Street, Washington	475,000,000	heavy precipitation	untreated
7	NY	Brooklyn	Coney Island Wastewater Treatment Plant, Sheepshead Bay, Brooklyn	284,000,000	storm surge and flooding	partially treated
8	NY	Staten Island	Oakwood Beach Water Pollution Control Plant, Mill Road, Staten Island	237,500,000	storm surge and flooding	partially treated
9	NY	Brooklyn	Coney Island Wastewater Treatment Plant, Sheepshead Bay, Brooklyn	213,000,000	storm surge and flooding	untreated
10	NY	Queens	Rockaway Wastewater Treatment Plant, Rockaway Freeway, Queens	165,000,000	storm surge and flooding	partially treated
11	NY	Bronx	Hunt's Point Wastewater Treatment Plant, Ryawa Avenue, Hunts Point, Bronx	153,750,000	storm surge and flooding	untreated
12	NY	Brooklyn	Newtown Creek Wastewater Treatment Plant, Greenpoint Avenue, Brooklyn	143,000,000	storm surge and flooding	untreated
13	NY	Bay Park	Bay Park Sewage Treatment Plant, Harbor Road, Bay Park	104,000,000	storm surge and flooding	untreated
14	NY	Brooklyn	26th Ward Water Pollution Control Plant, Van Siclen Avenue, Brooklyn	89,000,000	storm surge and flooding	partially treated
15	NY	New York	North River Wastewater Treatment Plant, Henry Hudson Parkway, New York	83,000,000	storm surge and flooding	untreated
16	NY	Brooklyn	Owls Head Wastewater Treatment Plant, Bay Ridge, Brooklyn	76,200,000	storm surge and flooding	partially treated
17	NY	Yonkers	Yonkers Joint Wastewater Treatment Plant, Yonkers	49,000,000	storm surge and flooding	untreated
18	NY	Queens	Rockaway Wastewater Treatment Plant, Rockaway Freeway, Queens	36,000,000	storm surge and flooding	untreated
19	NY	Staten Island	Port Richmond Water Pollution Control Plant, Richmond Terrace, Staten Island	30,000,000	power loss	partially treated
20	PA	Harrisburg	Harrisburg Advanced Wastewater Treatment Facility, South Cameron Street, Harrisburg	22,827,000	power loss	partially treated
21	NY	Staten Island	Hannah Street Pump Station, Staten Island	21,360,000	storm surge and flooding	untreated
22	MD	Savage	Little Patuxent Water Reclamation Facility, Greenwood Place, Little Patuxent	19,500,000	power loss	partially treated
23	VA	Suffolk	Suffolk Pump Station, Wilroy Road, Suffolk	18,285,000	equipment failure	untreated
24	RI	East Providence	Bucklin Point Wastewater Treatment Facility, Campbell Avenue, East Providence	17,540,000	other/unknown	partially treated
25	CT	Bridgeport	West Side WWTP, Bridgeport	17,100,000	storm surge and flooding	partially treated

Appendix

Table A2. Sandy Sewage Overflows By State

State	City	Facility	Volume (gallons)	Cause	Type
CT	Branford	Three pump stations, Branford	50,000	power loss	untreated
CT	Bridgeport	West Side WWTP, Bridgeport	17,100,000	storm surge and flooding	partially treated
CT	Bridgeport	East Side WWTP, Bridgeport	2,480,000	storm surge and flooding	partially treated
CT	East Lyme	Bridebrook Pump Station, West Main St., East Lyme	131,100	heavy precipitation	untreated
CT	East Lyme	Pump Station, Atlantic St., East Lyme	6,000	heavy precipitation	untreated
CT	Hartford	Sewer outfall, North Branch River, Hartford	228,000	storm surge and flooding	untreated
CT	Ledyard	Manhole, Southwest Brook, Ledyard	24,000	heavy precipitation	untreated
CT	Mystic	Wastewater Treatment Plant, Edgemont Street, Mystic	2,263,350	storm surge and flooding	partially treated
CT	New Haven	Pump Station, Sea Street, New Haven	550	other/unknown	untreated
CT	Norwalk	Westport Avenue Pump Station, Norwalk	900	equipment failure	untreated
CT	Norwalk	Sewer main, Howard Ave, Norwalk	50	equipment failure	untreated
CT	Ridgefield	Quail Ridge pump station, Prospect St., Ridgefield	500	equipment failure	untreated
CT	Ridgefiled	Water Pollution Facility, Route 7, Ridgefiled	2,000	heavy precipitation	partially treated
CT	Stamford	Wastewater Treatment Plant, Magee Avenue, Stamford	1,260,000	other/unknown	partially treated
CT	Stamford	Wastewater treatment plant, Harbor View Avenue, Stamford	193,000	storm surge and flooding	partially treated
CT	West Haven	Pump Station, Dawson Avenue, West Haven	600,000	storm surge and flooding	untreated
CT	West Haven	Manhole, Templeton Street, West Haven	20	equipment failure	untreated
DC	Washington	Combined Sewer Pump Station, O Street, Washington	475,000,000	heavy precipitation	untreated
DE	Lewes	Lewes Wastewater Treatment Plant, American Legion Road, Lewes	2,416,000	storm surge and flooding	untreated
DE	Milford	Pump Station 3, Milford Neck Road, Milford	90,000	storm surge and precipitation	untreated
DE	Milford	Pump Station 4, Milford Neck Road, Milford	74,000	storm surge and precipitation	untreated
DE	Millsboro	Old Millsboro Wastewater Treatment Plant, Millsboro	474,608	storm surge and precipitation	partially treated
MD	Aberdeen	Manhole, Rigdon Rd, Aberdeen	50,000	heavy precipitation	untreated
MD	Aberdeen	Manhole, South Drive, Aberdeen	10,000	heavy precipitation	untreated
MD	Aberdeen	Manhole, 0949 Rigdon Rd, Aberdeen	4,500	heavy precipitation	untreated
MD	Abingdon	Pump station 5, Pamela Drive, Abingdon	1,800,000	storm surge and flooding	untreated
MD	Accoreek	Sewer main, Indian Head Highway, Accoreek	100,000	heavy precipitation	untreated
MD	Allegany	Mill Run Pump Station, Allegany	45,600	heavy precipitation	untreated
MD	Allegany County	Pump, locust grove lane, Allegany County	96,000	heavy precipitation	untreated
MD	Allegany County	Manhole, darrows lane, Allegany County	93,600	heavy precipitation	untreated

MD	Back River	Manhole, Overbrook Road, Back River	544,962	heavy precipitation	untreated
MD	Balitimore	Manhole, 7204 Croydon Road, Balitimore	57,448	heavy precipitation	untreated
MD	Baltimore	Manhole, 2800 Chesterfield Ave, Baltimore	8,100	heavy precipitation	untreated
MD	Baltimore	Sewer main, Clarinth Rd, Baltimore	3,417	heavy precipitation	untreated
MD	Baltimore	Sewer main, Penhurst Ave, Baltimore	1,928	blockage	untreated
MD	Baltimore	Manhole, 1250 E 25th St, Baltimore	600	blockage	untreated
MD	Baltimore	Manhole, 1300 E Baltimore St, Baltimore	360	blockage	untreated
MD	Baltimore	Sewer main, N Howard St, Baltimore	250	blockage	untreated
MD	Baltimore	Sewer main, Hillsdale Rd, Baltimore	224	blockage	untreated
MD	Baltimore	Sewer main, Ceddox St, Baltimore	195	blockage	untreated
MD	Baltimore	Sewer main, Collins Ave, Baltimore	180	blockage	untreated
MD	Baltimore	Sewer main, Mosher Street, Baltimore	111	blockage	untreated
MD	Baltimore	Manhole, 402 Key Hwy, Baltimore	60	blockage	untreated
MD	Baltimore	Sewer main, W North Ave, Baltimore	51	equipment failure	untreated
MD	Baltimore	Sewer main, Mathews St, Baltimore	15	blockage	untreated
MD	Baltimore	Manhole, Anneslie Road and Maplewood, Baltimore	98,104	heavy precipitation	untreated
MD	Baltimore	Sewer main, N Kenwood Ave, Baltimore	4,720	blockage	untreated
MD	Bel Alton	Manhole, 9225 Twinberry Dr, Bel Alton	4,500	heavy precipitation	untreated
MD	Berlin	Sewer main, Ocean Pkwy, Berlin	500	equipment failure	untreated
MD	Bethesda	Manhole, 4990 Sentinel Drive, Bethesda	8,000	blockage	untreated
MD	Bethesda	Sewer main, Brookeway Dr, Bethesda	40	other/unknown	untreated
MD	Boonsboro	Greenbrian State Park WWTP, National Pike, Boonsboro	105,500	heavy precipitation	untreated
MD	Brunswick	Manhole, 20 C & O Canal Tow Path Rd, Brunswick	50,000	heavy precipitation	partially treated
MD	Brunswick	Manhole, 20 C & O Canal Tow Path Rd, Brunswick	50,000	heavy precipitation	untreated
MD	Cambridge	Seven sewer outfalls, Cambridge	4,980,000	heavy precipitation	untreated
MD	Cambridge	Manhole, Southside Ave, Cambridge	5,000	heavy precipitation	untreated
MD	Cascade	Manhole, 25040 Pen Mar Rd, Cascade	50,000	heavy precipitation	untreated
MD	Catonsville	Private address, Catonsville	1,300,000	heavy precipitation	untreated
MD	Catonsville	Manhole, Overbrook Road, Catonsville	979,222	heavy precipitation	untreated
MD	Catonsville	Manhole, Frederick Road & Nunnery Lane, Catonsville	5,028	heavy precipitation	untreated
MD	Centreville	Centreville WWTP, Johnstown Lane, Centreville	696,000	heavy precipitation	untreated
MD	Cumberland	Cumberland Wastewater Treatment Plant, Candoc Lane, Cumberland	7,908,600	heavy precipitation	untreated
MD	Cumberland	Sewer outfall 11, Franklin Street, Cumberland	3,090,500	heavy precipitation	untreated
MD	Cumberland	Sewer outfall 5, Elizabeth Street, Cumberland	403,800	heavy precipitation	untreated
MD	Cumberland	Sewer outfall 2, Braddock Estates, Cumberland	199,200	storm surge and flooding	untreated
MD	Cumberland	Manhole, 10 N Mechanic St, Cumberland	85,700	heavy precipitation	untreated
MD	Cumberland	Pump, Wright's Crossing, Cumberland	76,800	heavy precipitation	untreated
MD	Cumberland	Manhole, Bedford Street, Cumberland	68,700	heavy precipitation	untreated
MD	Cumberland	Outfall, 003/E, Cumberland WWTP, Cumberland	20,000	heavy precipitation	untreated

MD	Cumberland	Outfall, 006/H, Cumberland WWTP, Cumberland	20,000	heavy precipitation	untreated
MD	Cumberland County	Corriganville Pump Station, Corriganville, Cumberland County	172,800	heavy precipitation	untreated
MD	Cumberland County	Sewer outfall 3, Grahamtown, Cumberland County	110,400	heavy precipitation	untreated
MD	Cumberland County	Pump station, Cresaptown, Cumberland County	105,600	heavy precipitation	untreated
MD	Emmitsburg	Manhole, Emmeit Gardens, Emmitsburg	6,000	heavy precipitation	untreated
MD	Essex	Manhole, 1900 Eastern Blvd, Essex	1,000	equipment failure	untreated
MD	Fort Meade	Tertiary Filters, WWTP, Fort Meade	4,423,000	heavy precipitation	partially treated
MD	Fort Washington	Sewer main, Livingston Rd, Fort Washington	90,000	heavy precipitation	untreated
MD	Fort Washington	Manhole, 12800 Monroe Ave, Fort Washington	58,000	heavy precipitation	untreated
MD	Fort Washington	Sewer main, Calhoun Street, Fort Washington	150	blockage	untreated
MD	Frederick	Manhole, 5 Quail Knob Lane, Frederick	51,160	heavy precipitation	untreated
MD	Frederick	Manhole, 7400 Marcie's Choice Lane, Frederick	13,890	heavy precipitation	untreated
MD	Frostburg	Pump, CentenniHill Pumping Station, Frostburg	17,000	power loss	untreated
MD	Frostburg	Pump Station 1, Cumberland	60,000	heavy precipitation	untreated
MD	Frostburg	Pump Station 2, City of Frostburg	45,000	heavy precipitation	untreated
MD	Frostburg	Outfall, 001/C, Cumberland WWTP, Cumberland	30,000	heavy precipitation	untreated
MD	Frostburg	Outfall, 010/Q, Cumberland WWTP, Cumberland	30,000	heavy precipitation	untreated
MD	Frostburg	Outfall, 011/R, Cumberland WWTP, Cumberland	30,000	heavy precipitation	untreated
MD	Frostburg	Outfall, 012/U, Cumberland WWTP, Cumberland	30,000	heavy precipitation	untreated
MD	Funkstown	Manhole, 20 Lagoon Rd., Funkstown	9,200	heavy precipitation	untreated
MD	Glen Burnie	Sewer main, Nabbs Creek Rd, Glen Burnie	1,000	equipment failure	untreated
MD	Glen Echo	Manhole, 26 Wellesley Cir, Glen Echo	190	blockage	untreated
MD	Harford	Manhole, 518 Law St, Aberdeen, Harford	1,500	heavy precipitation	untreated
MD	Harford	Manhole, James & Rogers Streets, Aberdeen, Harford	1,500	heavy precipitation	untreated
MD	Harford	Manhole, Service & Grant Street, Aberdeen, Harford	1,500	heavy precipitation	untreated
MD	Harwood	Manhole, 4600 Sands Rd, Harwood	5,000	heavy precipitation	untreated
MD	Hyattsville	Sewer main, E Spring Pl, Hyattsville	5	other/unknown	untreated
MD	Joppa	Pump, 500 Dembytowne, Joppa	27,900	heavy precipitation	untreated
MD	Knoxville	Sewer main, Jefferson Pike, Knoxville	2,530	equipment failure	untreated
MD	La Plata	Manhole, Hawthorne Road, La Plata	100,000	heavy precipitation	untreated
MD	La Plata	Manhole, Curley Hill Road, La Plata	45,000	heavy precipitation	untreated
MD	La Plata	Manhole, La Plata WWTP, La Plata	45,000	heavy precipitation	untreated
MD	LaVale	Sewer outfall 6, Red Hill Road, LaVale	9,260,650	heavy precipitation	untreated
MD	LaVale	Pump station 1, LaVale	8,506,580	heavy precipitation	untreated
MD	LaVale	Pump station 3, Mill Race, LaVale	6,688,000	heavy precipitation	untreated
MD	Lexington Park	Manhole, Chestnut Way, Lexington Park	50,000	heavy precipitation	untreated
MD	Lexington Park	Manhole, Old Missouri St, Lexington Park	50,000	heavy precipitation	untreated
MD	Lochearn	Manhole, Patterson Avenue, Lochearn	762,791	heavy precipitation	untreated

MD	Lochearn	Manhole, Southern Cross Drive, Lochearn	256,487	heavy precipitation	untreated
MD	Lochearn	Manhole, Parsons Drive, Lochearn	203,434	heavy precipitation	untreated
MD	Lochearn	Manhole, Montbel Avenue, Lochearn	162,526	heavy precipitation	untreated
MD	Lochearn	Manhole, Alter Street, Lochearn	152,667	heavy precipitation	untreated
MD	Milford Mill	Manhole, Abbie Place, Milford Mill, Baltimore	222,222	heavy precipitation	untreated
MD	Myersville	Myersville Wastewater Treatment Plant, Milt Summers Road, Myersville	1,922,300	heavy precipitation	untreated
MD	Myersville	Pump, Brethern Chruch Road, Myersville, Frederick	15,000	heavy precipitation	untreated
MD	Myersville	Pump, Canada Hill Rd, Myersville	3,000	heavy precipitation	untreated
MD	New Windsor	New Windsor Wastewater Treatment Plant, Water Street, New Windsor	417,000	heavy precipitation	partially treated
MD	Parkville	Manhole, Bagley Avenue, Parkville	465,925	heavy precipitation	untreated
MD	Parkville	Manhole, Hillcrest Avenue, Parkville	334,031	heavy precipitation	untreated
MD	Parkville	Manhole, Aiken Avenue, Parkville	175,877	heavy precipitation	untreated
MD	Pikesville	Manhole, Marnet Road, Pikesville	148,339	heavy precipitation	untreated
MD	Princess Anne	WWTP, 30353 Linden Ave, Princess Anne	5,000	heavy precipitation	untreated
MD	Randlestown	Pump, 8808 Stonehaven Rd, Randlestown	2,400	power loss	untreated
MD	Ridge	Manhole, 49671 Airedele Rd, Ridge	1,500	equipment failure	untreated
MD	Rockville	Sewer main, Enid Dr, Rockville	137	blockage	untreated
MD	Rosedale	Red House Run Pumping Station, Lake Drive, Rosedale	951,500	equipment failure	untreated
MD	Sabillasville	Foxville Gardens Wastewater Treatment Plant, Foxville Deerfield Rd., Sabillasville	299,230	heavy precipitation	untreated
MD	Sabillasville	Manhole, 14913 Foxville Deerfield Rd, Sabillasville	12,600	heavy precipitation	untreated
MD	Sabillasville	Pump, Manahan Road, Sabillasville	2,700	heavy precipitation	untreated
MD	Salisbury	Salisbury Sewage Treatment, Marine Road, Salisbury	500,694	heavy precipitation	untreated
MD	San Mar	Manhole, Route 66, San Mar	16,000	heavy precipitation	untreated
MD	Savage	Little Patuxent Water Reclamation Facility, Greenwood Place, Little Patuxent	19,500,000	power loss	partially treated
MD	Sparrows Point	Pump, Penwood Ave, Sparrows Point	12,139	heavy precipitation	untreated
MD	St. Mary's County	Naval Air Station Sewer, Patuxent River	50,000	heavy precipitation	untreated
MD	St. Michaels	Two manholes, Riverview Terrace, St. Michaels	201,000	heavy precipitation	untreated
MD	Town of Snow Hill	Snow Hill Wastewater Treatment Facility, Cypress Street, Town of Snow Hill	2,420,040	heavy precipitation	partially treated
MD	Upper Marlboro	Sewer main, Pitman Ave, Upper Marlboro	451	blockage	untreated
MD	Williamsport	Conococheague WWTP, Elliott Parkway, Williamsport	2,000,000	heavy precipitation	untreated
MD	Somerset County	Deal Island Pump Station, Somerset County	2,000	heavy precipitation	untreated
MD	Capitol Heights	Manhole, 6911 Central Ave, Capitol Heights	1,065	blockage	untreated
NJ	Atlantic City	Private address, Atlantic Avenue, Atlantic City	20	blockage	untreated
NJ	Atlantic City	Private address, Madison Avenue, Atlantic City	20	blockage	untreated
NJ	Atlantic City	Private address, Virginia Avenue, Atlantic City	15	blockage	untreated
NJ	Atlantic City	Private address, Atlantic Avenue, Atlantic City	10	blockage	untreated

NJ	Atlantic City	Private address, Madison Avenue, Atlantic City	6	blockage	untreated
NJ	Atlantic City	Iowa Avenue Pump Station, Atlantic Avenue	10	blockage	untreated
NJ	Atlantic City	Atlantic City Sewerage Company, Logan Avenue, Atlantic City	10	blockage	untreated
NJ	Atlantic City	Private address, Raleigh Avenue, Atlantic City	6	blockage	untreated
NJ	Atlantic City	Private address, Raleigh Avenue, Atlantic City	5	blockage	untreated
NJ	Avalon Borough	Private address, Ocean Avenue, Avalon Borough	1,000	power loss	untreated
NJ	Bayonne	City Line pump station, Bayonne	50,000	storm surge and flooding	untreated
NJ	Bayonne	1st Street Pump Station, Bayonne	10,000	power loss	untreated
NJ	Bergenfield Borough	Private address, Spring Avenue, Bergenfield Borough	100	other/unknown	untreated
NJ	Berkeley Township	Gem Avenue pump station, Berkeley Township	250,000	power loss	partially treated
NJ	Bridgewater Township	Manhole, Easy Street, Bridgewater Township	300	other/unknown	untreated
NJ	Brigantine	Mill Road Pump Station, Hagen Road, Brigantine	500	storm surge and flooding	untreated
NJ	Brigantine City	Hagen Road Pump Station, Brigantine City	500	equipment failure	untreated
NJ	Brigantine City	Jenkins Parkway Pump Station, Brigantine City	500	storm surge and flooding	untreated
NJ	Brigantine City	North Shore Drive Pump Station, Brigantine City	500	equipment failure	untreated
NJ	Cape May	Private address, Wildwood Avenue, Cape May	30	equipment failure	untreated
NJ	Cherry Hill	Manhole, Caldwell Rd., Cherry Hill	1,000	heavy precipitation	untreated
NJ	East Brunswick	Manhole, Somervilee Road, East Brunswick	75	power loss	untreated
NJ	Eatontown Borough	Manhole, Main Street, Eatontown Borough	200	blockage	untreated
NJ	Eatontown Borough	Manhole, Eaton Crest Road, Eatontown Borough	150	blockage	untreated
NJ	Evesham	Manhole, Lincoln Drive, Evesham	50	blockage	untreated
NJ	Evesham Township	Manhole, Yardmouth Road, Evesham Township	1,000	equipment failure	untreated
NJ	Evesham Township	Private address, Lincoln Drive, Evesham Township	100	blockage	untreated
NJ	Evesham Township	Lichenthan Street Pump Station, Evesham Township	50	other/unknown	untreated
NJ	Greenwich Township	Pump Station, Greenwich Township	40,000	other/unknown	untreated
NJ	Hackettstown Township	Private address, High Street, Hackettstown Township	5	other/unknown	untreated
NJ	Hoboken	Private address, Madison St., Hoboken	10,000	storm surge and flooding	untreated
NJ	Holmdel Township	Private address, Route 54, Holmdel Township	3,000	equipment failure	partially treated
NJ	Lacey Township	Manhole, Fairview Lane, Lacey Township	100	blockage	untreated
NJ	Lumberton Township	Mount Holly Municipal Utilities Authority, Maple Avenue, Lumberton Township	200	other/unknown	partially treated
NJ	Manalapan Township	Private address, Bloomfield Road,Manalapan Township	300	blockage	untreated
NJ	Mantua Township	Private address, Delsea Drive, Mantua Township	100	blockage	untreated

NJ	Marlboro Township	Private address, Newmans Springs Rd, Marlboro Township	100,000	equipment failure	untreated
NJ	Metuchen	Sewer outfall, McPherson Avenue, Metuchen	50	equipment failure	untreated
NJ	Middleton Township	Private address, Main Street, Middleton Township	290	other/unknown	untreated
NJ	Morrison Township	Manhole, Erskine Drive, Morrison Township	2,000	equipment failure	untreated
NJ	Neptune Township	Manhole, Route 33, Neptune Township	500	blockage	untreated
NJ	Neptune Township	Manhole, Oxonia Road, Neptune Township	500	storm surge and flooding	untreated
NJ	Neptune Township	Neptune Township Sewer Department, Heck Avenue, Neptune Township	250	power loss	untreated
NJ	Newark	Passaic Valley Sewerage Commission, Wilson Avenue, Newark	3,080,000,000	storm surge and flooding	partially treated
NJ	Newark	Passaic Valley Sewerage Commission, Wilson Avenue, Newark	840,000,000	storm surge and flooding	untreated
NJ	Ocean	Private address, Ocean Avenue, Ocean	50	other/unknown	untreated
NJ	Ocean City	Manhole, 5th street, Ocean City	100	blockage	untreated
NJ	Ocean City	Private address, Asbury Avenue, Ocean City	50	blockage	untreated
NJ	Patterson	Passaic River at Market Street, Patterson	5,000,000	storm surge and flooding	untreated
NJ	Princeton	Private address, Stockton St., Princeton	1,500	blockage	untreated
NJ	Sayreville	Two pump stations, Middlesex County Utilities Authority, Sayreville	1,135,415,490	storm surge and flooding	untreated
NJ	South Monmouth County	Two pump stations near Lake Como, South Monmouth County	2,852,000	storm surge and flooding	untreated
NJ	Tuckerton Borough	Carol Avenue Pump Station, Tuckerton Borough	500	storm surge and flooding	untreated
NJ	Vineland	Manhole, Delsea Drive, Vineland	250	blockage	untreated
NJ	Vineland	Private address, Lincoln Avenue, Vineland	250	blockage	untreated
NJ	Warren Township	Private address, Mountain Boulevard, Warren Township	25	blockage	untreated
NJ	Warren Township	Heather Lane Pump Station, Warren Township	25	equipment failure	untreated
NJ	Warren Township	William Penn Road Pump Station, Warren Township	10	equipment failure	untreated
NJ	Wharton Borough	Private address, Main Street, Wharton Borough	100	blockage	untreated
NJ	Winslow Township	Private Address, Eastmont Lane, Winslow Township	150	blockage	untreated
NJ	Winslow Township	Manhole, Tara Drive, Winslow Township	50	blockage	untreated
NJ	Winslow Township	Private address, Helmwood Court, Winslow Township	50	blockage	untreated
NJ	Winslow Township	Manhole, Pinewood Land, Winslow Township	50	heavy precipitation	untreated
NJ	Atlantic City	Michigan Avenue Pump Station, Atlantic City	15	blockage	untreated
NY	Bay Park	Bay Park Sewage Treatment Plant, Harbor Road, Bay Park	2,200,000,000	storm surge and flooding	partially treated
NY	Bay Park	Bay Park Sewage Treatment Plant, Harbor Road, Bay Park	104,000,000	storm surge and flooding	untreated
NY	Bay Park	Two Pump Stations, Barnes Avenue and Parsonage Creeek	1,000,000	storm surge and flooding	untreated
NY	Bronx	Hunt's Point Wastewater Treatment Plant, Ryawa Avenue, Hunts Point, Bronx	153,750,000	storm surge and flooding	untreated

NY	Bronx	Conner Street Pump Station, Hunts Point, Bronx	1,210,000	storm surge and flooding	untreated
NY	Bronx	Zerega Avenue Pump Station, Hunts Point, Bronx	230,000	storm surge and flooding	untreated
NY	Bronx	Orchard Beach Pump Station, Hunts Point, Bronx	120,000	storm surge and flooding	untreated
NY	Bronx	Ely Avenue Pump Station, Hunts Point, Bronx	30,000	storm surge and flooding	untreated
NY	Brooklyn	Coney Island Wastewater Treatment Plant, Sheepshead Bay, Brooklyn	284,000,000	storm surge and flooding	partially treated
NY	Brooklyn	Coney Island Wastewater Treatment Plant, Sheepshead Bay, Brooklyn	213,000,000	storm surge and flooding	untreated
NY	Brooklyn	Newtown Creek Wastewater Treatment Plant, Greenpoint Avenue, Brooklyn	143,000,000	storm surge and flooding	untreated
NY	Brooklyn	26th Ward Water Pollution Control Plant, Van Siclen Avenue, Brooklyn	89,000,000	storm surge and flooding	partially treated
NY	Brooklyn	Owls Head Wastewater Treatment Plant, Bay Ridge, Brooklyn	76,200,000	storm surge and flooding	partially treated
NY	Brooklyn	Gowanus Street Pump Station, Red Hook, Brooklyn	9,510,000	storm surge and flooding	untreated
NY	Brooklyn	Bush Terminal Pump, Sunset Park, Brooklyn	2,840,000	storm surge and flooding	untreated
NY	Brooklyn	2nd Avenue Pump, Sunset Park, Brooklyn	1,080,000	storm surge and flooding	untreated
NY	Brooklyn	49th Street Pump Station, Maspeth Creek, Brooklyn	1,040,000	storm surge and flooding	untreated
NY	Brooklyn	Nevins Street Pump Station, Red Hook, Brooklyn	540,000	storm surge and flooding	untreated
NY	Brooklyn	Van Brunt Street Pump Station, Red Hook, Brooklyn	450,000	storm surge and flooding	untreated
NY	New York	North River Wastewater Treatment Plant, Henry Hudson Parkway, New York	83,000,000	storm surge and flooding	untreated
NY	New York	Wards Island Wastewater Treatment Plant, Wards Island, New York	1,765,620	storm surge and flooding	untreated
NY	New York	Canal Street Pump Station, New York	550,000	storm surge and flooding	untreated
NY	Nyack	Nyack Pump Station, Spear Street, Nyack	2,700,000	equipment failure	untreated
NY	Orange	Pump station, Iron Wood Road, Warwick County, Orange	1,100	storm surge and flooding	untreated
NY	Queens	Rockaway Wastewater Treatment Plant, Rockaway Freeway, Queens	165,000,000	storm surge and flooding	partially treated
NY	Queens	Rockaway Wastewater Treatment Plant, Rockaway Freeway, Queens	36,000,000	storm surge and flooding	untreated
NY	Queens	Howard Beach Pump Station, Jamaica, Queens	12,010,000	storm surge and flooding	untreated
NY	Queens	Nameoke Avenue Pump Station, Rockaway, Queens	10,700,000	storm surge and flooding	untreated
NY	Queens	Tallman Island Wastewater Treatment Plant, 128th Street, Queens	7,500,000	storm surge and flooding	untreated
NY	Queens	Rosedale Pump Station, Jamaica, Queens	6,800,000	storm surge and flooding	untreated
NY	Queens	Seagirt Avenue Pump Station, Rockaway, Queens	5,160,000	storm surge and flooding	untreated
NY	Queens	Bayswater Avenue Pump Station, Rockaway, Queens	2,010,000	storm surge and flooding	untreated
NY	Queens	Broad Channel Pump Station, Rockaway, Queens	740,000	storm surge and flooding	untreated
NY	Queens	Little Neck Pump Station, Little Neck, Queens	240,000	storm surge and flooding	untreated

NY	Queens	Doug Bay Pump Station, Little Neck, Queens	200,000	storm surge and flooding	untreated
NY	Queens	Warnerville Pump Station, Jamaica, Queens	90,000	storm surge and flooding	untreated
NY	Roosevelt Island	Roosevelt Island North Pump Station, Roosevelt Island	1,150,000	storm surge and flooding	untreated
NY	Roosevelt Island	Roosevelt Island South Pump Station, Roosevelt Island	740,000	storm surge and flooding	untreated
NY	Staten Island	Oakwood Beach Water Pollution Control Plant, Mill Road, Staten Island	237,500,000	storm surge and flooding	partially treated
NY	Staten Island	Port Richmond Water Pollution Control Plant, Richmond Terrace, Staten Island	30,000,000	power loss	partially treated
NY	Staten Island	Hannah Street Pump Station, Staten Island	21,360,000	storm surge and flooding	untreated
NY	Staten Island	Richmond Hill Road Pump Station, Oakwood, Staten Island	7,170,000	storm surge and flooding	untreated
NY	Staten Island	Mason Avenue Pump Station, Oakwood, Staten Island	3,510,000	storm surge and flooding	untreated
NY	Staten Island	Nautilus Court Pump Station, Staten Island	1,850,000	storm surge and flooding	untreated
NY	Staten Island	South Beach Pump Station, Staten Island	790,000	storm surge and flooding	untreated
NY	Staten Island	Melvin Avenue Pump Station, Staten Island	390,000	storm surge and flooding	untreated
NY	Staten Island	Cannon Avenue Pump Station, Staten Island	170,000	storm surge and flooding	untreated
NY	Staten Island	Mark Street Pump Station, Staten Island	60,000	storm surge and flooding	untreated
NY	Stony Point	Stony Point Sewage Treatment Plant, North Street, Stony Point	600,000	storm surge and flooding	untreated
NY	Yonkers	Yonkers Joint Wastewater Treatment Plant, Yonkers	1,174,000,000	storm surge and flooding	partially treated
NY	Yonkers	Yonkers Joint Wastewater Treatment Plant, Yonkers	49,000,000	storm surge and flooding	untreated
NY	Yonkers	North Yonkers Pump Station, Yonkers	8,000,000	storm surge and flooding	partially treated
PA	Bally Borough	Manhole, Walnut Street, Bally Borough	11,250	heavy precipitation	untreated
PA	Bally Borough	Manhole, Main street, Bally Borough	8,280	heavy precipitation	untreated
PA	Blossburg	Blossburg Municipal Authority	1,750,000	heavy precipitation	untreated
PA	Brookville	Brookville Sewage Treatment Plant, Brookville	76,000	power loss	partially treated
PA	Clarion	American Clarion Sewage Treatment Plant	524,000	other/unknown	untreated
PA	Crawford County	Northwest Crawford County Sewage Authority	501,000	other/unknown	untreated
PA	Douglassville	Amity Township Wastewater Treatment Plant, Old Philadelphia Pike, Douglassville	11,000	power loss	partially treated
PA	Dover	Delwood Pump Station, Dover	47,000	heavy precipitation	untreated
PA	Dover Township	Eight various manholes, Dover Township	240,660	heavy precipitation	untreated
PA	East Manchester Township	Manhole, East Manchester Township	20,000	heavy precipitation	untreated
PA	East Pennsboro Township	Norfolk Southern Wastewater Treatment PLant, East Pennsboro Township	688,000	power loss	untreated
PA	Emlenton	Blue Ridge Pump Station, Emlenton Sewage Treatment Plant, Emlenton	6,714	power loss	untreated
PA	Everett	Everett Wastewater Treatment Plant, Sewer Plant Road, Everett	2,263,000	heavy precipitation	untreated
PA	Fort Indiantown	Fort Indiantown Gap Sewage Treatment Plant, Coulter Rd , Fort Indiantown Gap	52,713	power loss	untreated

PA	Girard Borough	Girard Borough Sewage Treatment Plant	26,000	power loss	untreated
PA	Greene Township	Three manholes, Greene Township	194,000	heavy precipitation	untreated
PA	Greenwich Township	Highland Estates, Greenwich Township	376,000	power loss	untreated
PA	Hanover	Two manholes, Hanover Borough wastewater treatment plant, O'Brien Lane, Hanover	11,030,000	power loss	untreated
PA	Harborcreek Township	Pump station, Harborcreek Township Sewer Authority,	750,000	heavy precipitation	untreated
PA	Harrisburg	Harrisburg Advanced Wastewater Treatment Facility, South Cameron Street, Harrisburg	22,827,000	power loss	partially treated
PA	Hereford	Hereford Estates pump station, Seisholtzville Road, Hereford	140,000	power loss	partially treated
PA	Hereford Township	Woodland Estates pump station, Hereford Township	26,300	power loss	untreated
PA	Lancaster	Lancaster City Wastewater Treatment Plant, New Danville Pike, Lancaster	1,400,000	heavy precipitation	untreated
PA	Letterkenny	Franklin County General Authority, Letterkenny	7,500	heavy precipitation	untreated
PA	Longswamp Township	Pump station, Mount Village Mobile Home Park, Longswamp Township	84,000	power loss	partially treated
PA	Millerstown Borough	Millerstown Wastewater Treatment plant, Millerstown Borough	8,000	power loss	untreated
PA	Montgomery Township	Valley Creek Estates Pump Station, Montgomery Township	29,000	power loss	untreated
PA	Mount Union	Mt. Union Sewage Treatment Plant, North Drake Street, Mount Union	50,000	power loss	untreated
PA	Mt. Carmel Borough	Mt. Carmel Borough sewer collection system	20,054	heavy precipitation	untreated
PA	South Wayne County	South Wayne County Sewage Authority	100,000	power loss	untreated
PA	South Williamsport	Main Street Pump Station, South Williamsport	256,607	heavy precipitation	untreated
PA	Washington Township		72,000	power loss	untreated
PA	York	York City Wastewater Treatment Plant, Toronita Street, York	12,487,500	power loss	partially treated
PA	Zerbe Township	Manhole, Zerbe Township	500	heavy precipitation	untreated
RI	East Providence	Bucklin Point Wastewater Treatment Facility, Campbell Avenue, East Providence	17,540,000	other/unknown	partially treated
RI	Middletown	Middletown Wastewater Treatment Facility, Middletown	75,000	power loss	untreated
RI	Newport	Sewer Outfall, Wellington Avenue, Newport	762,000	storm surge and flooding	untreated
VA	Front Royal	Front Royal Waste Water Treatment Plant, Manassas Avenue, Front Royal	5,261,000	heavy precipitation	untreated
VA	Suffolk	Suffolk Pump Station, Wilroy Road, Suffolk	18,285,000	equipment failure	untreated

Appendix

Table A3. Locations of Known Spills For Which No Data Was Available

State	City	Facility
CT	East Windsor	East Windsor Water Pollution Control Authority
CT	Fairfield	Fairfield Water Pollution Control Authority
CT	Middletown	
DE	Rehoboth Beach	City of Rehoboth Beach Wastewater Treatment Facility
NJ	Brick Township	Laurelton Pump Station, Bricktownship Municipal Utilities Authority
NJ	Mercer County	Stony Brook Regional Sewerage Authority
NJ	Millville	Millville Wastewater Treatment Plant, Fowser Road, Millville
NJ	Montgomery Township	Montgomery Township Water Plant
NJ	North Bergen	Woodcliff Treatment Plant
NJ	Secaucus	Secaucus Utilities Authority
NJ	Union Beach	Bayshore Regional Sewerage Authority, Union Beach
NY	Cedar Creek	Cedar Creek Water Pollution Control Plant
NY	Glenn Cove	Glenn Cove's Water Pollution Control/Nassau County
NY	Hudson River Cornwall Sewage Treatment Plant	Cornwall Sewage Treatment Plant
NY	Jones Beach	Jones Beach Waste Water Treatment Plant
NY	Kingston	Kingston Wastewater Facility
NY	Long Beach	Long Beach Water Pollution Control Plant
NY	New Windsor	New Windsor Wastewater Facility
NY	Peeskill	Peeskill Wastewater Treatment Plant
NY	Target Hill	Target Hill Wastewater Treatment Plant
NY	Town of Babylon	Town of Babylon
NY	Town of Hempstead	Hempstead Municipal Sewer District/Nassau County
NY	Town of Orangetown	Orangetown Wastewater Treatment Facility
NY	Village of Buchanan	Village of Buchanan WWTP
PA	Elizabethville Borough	Elizabethville Sewage Treatment Plant
PA	Millcreek Township	Millcreek Township Sewer Department
PA	Punxsutawney	Punxsutawney Sewage Treatment Plant
PA	Quincy Township	South Mt. Restoration Center
PA	Williamstown Borough	Williamstown Borough Sewage Treatment Plant
PA	North East Borough	North East Borough Sewage Treatment Plant

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