Water Infrastructure in New Jersey's CSO Cities:

Elevating the Importance of Upgrading New Jersey's Urban Water Systems

Prepared for New Jersey Future

May 2014 (Revised 23 June 2014)

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Contents

June 2014 Modifications

The May 2014 report was modified based on comments received and to reflect minor editing. Significant changes in the report are as follows:

- Table 3-5 was updated to reflect May 2014 information on Total Available Capacity and Net Available Capacity for water supply facilities serving CSO municipalities.
- Table 3-10 and related text were updated to reflect the modifications to Table 3-5, which significantly changed the findings regarding Newark and Jersey City, both of which shifted from potential future deficits based on growth to no projection of deficits through 2035.
- The detailed utility description for Bayonne in Chapter 4 was modified to reflect the change in Table 3-5 for North Jersey District Water Supply Commission.

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- Camden County Municipal Utilities Authority: Andrew Kricun, Executive Director
- Elizabeth City: Daniel Loomis, City Engineer; Steve Rinaldi
- Jersey City Municipal Utilities Authority: Rich Haytus, Senior Engineer; Rajiv Prakash, Water Engineer
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- Paterson City: Frederick Margron, City Engineer
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    - Kevin W. Chandler, Vice President North Division
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Executive Summary

Talk to managers for urban water supply or sewer utilities about their systems and a simple yet troubling word is commonly used – "**old**." Utility systems in our urban areas are constantly balancing the irreconcilable. They must maintain the long-term viability of rapidly aging utility assets while recognizing that increased rates are a major concern for customers and political leaders. The systems are old – often very old, as in a century or more – and getting older, while very often emergency repair costs are rising and capital projects are deferred for lack of funding. While treatment plants generally are well maintained to comply with State regulations for drinking water quality and wastewater effluent limits, the pipes that distribute water to customers and take the resulting wastewater from them are too often "out of sight, out of mind," at least for those who aren't responsible for keeping them going. After Hurricane Sandy, the primary public focus is perhaps even more strongly on the above ground buildings and structures that were damaged, with too little thought to the below-ground systems that support the above-ground development.

And yet, how can any urban area function effectively without sound water supply, sewer and stormwater systems? These utilities can be thought of as the arteries and veins of the city, supplying life-giving services to the body of the city. These water utilities are fundamentally important, along with transportation and energy infrastructure.

This report provides a review of available information on urban water infrastructure. It focuses on the 21 New Jersey municipalities that have combined sewer systems (CSS) that discharge through Combine Sewer Overflows (CSOs) in part or all of their area. However, the report also examines issues regarding water supply capacity and wastewater capacity for these municipalities. **Table ES-1** lists the 21 CSO municipalities, with those shown in bold having more than 10 CSOs (see also **Figures ES-1** and **ES-2**):

Table ES-1. New Jersey CSO Municipalities		
Bayonne	Hackensack	**Paterson**
Camden (City of)	Harrison	**Perth Amboy**
East Newark	Hoboken	Ridgefield Park
Elizabeth	**Jersey City**	Trenton
Fort Lee	Kearny	Union City
Gloucester City	**Newark**	Weehawken
Guttenberg	North Bergen	West New York

Combined sewers convey sewage to a treatment plant, just as separate sewers do. However, they also serve as the storm sewer system; flows rapidly increase during wet weather events as runoff from these urban areas enters the sewers. This technology dates originally from the Roman Empire but then fell out of favor; it was reapplied from the mid 1800's to around the 1920's as a method of getting all types of wastewaters out of the cities and into rivers and estuaries as fast as possible – without treatment, as there were no sewage treatment plants when combined sewers were initially constructed. The use of combined sewers is more common than people generally perceive; roughly 860 municipalities in the United States have such systems, mostly in the Northeast and Midwest. London and many other European cities have combined sewers, and some of the original Roman combined sewers are still in existence, indicating the endurance of the technology.

New Jersey's CSO municipalities are among the earliest urban places in New Jersey, often with very high populations densities (for example, Hoboken has over 50,000 people in one square mile). They include six of the 13 New Jersey municipalities with more than 75,000 people, and the four most populous municipalities (Newark, Jersey City, Paterson and Elizabeth). They are generally less wealthy than the New Jersey average (with Hoboken and Fort Lee being exceptions), and sometimes very poor. Several CSO municipalities have over 20% of their households below the poverty line as defined by the federal government, which probably understates the issue given the high cost of living in New Jersey. **Chapter 2** provides an overview of these municipalities regarding their population and employment trends, household incomes, tax ratables, home values and public

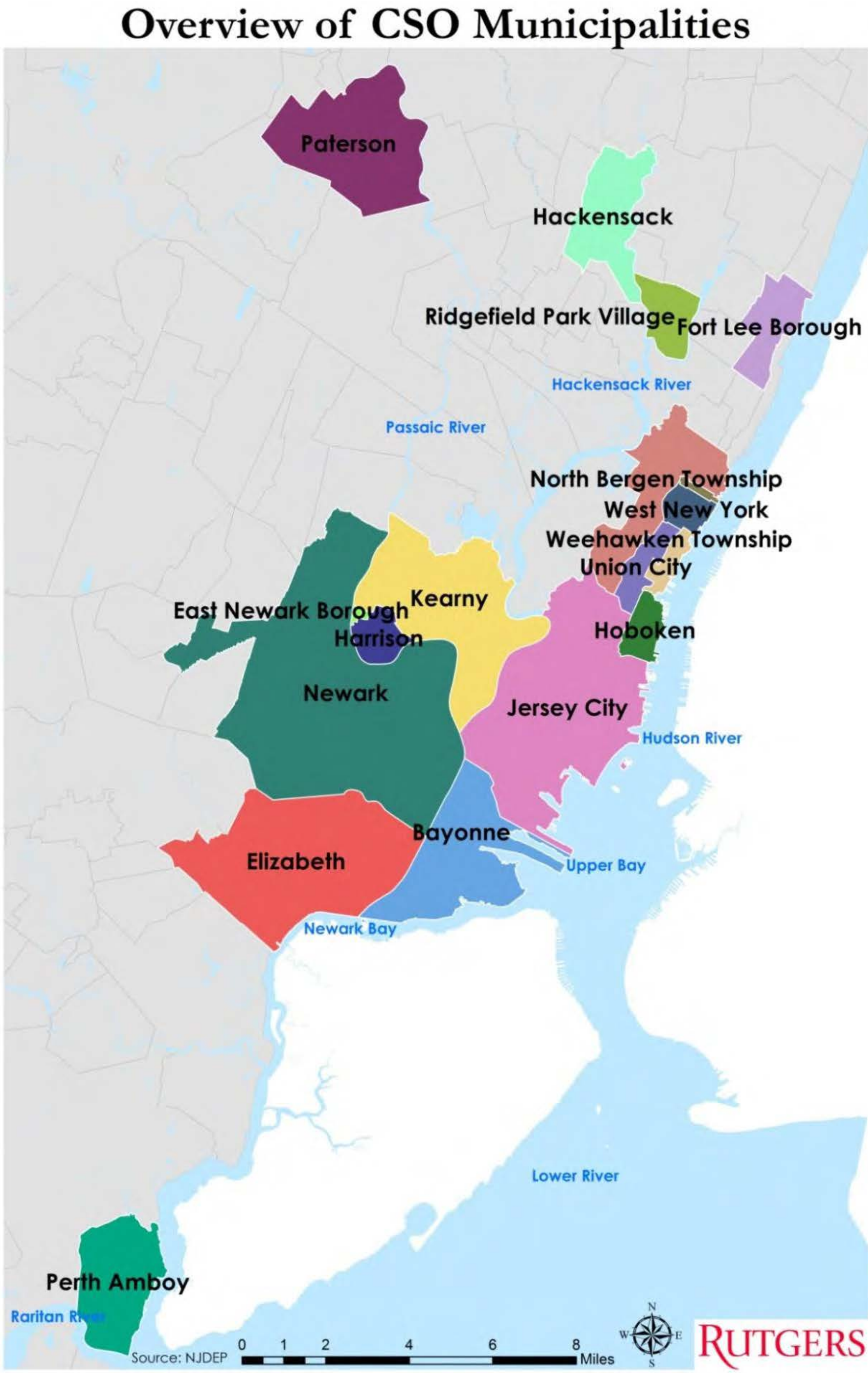


Figure ES-1. CSO Municipalities in Northeast New Jersey

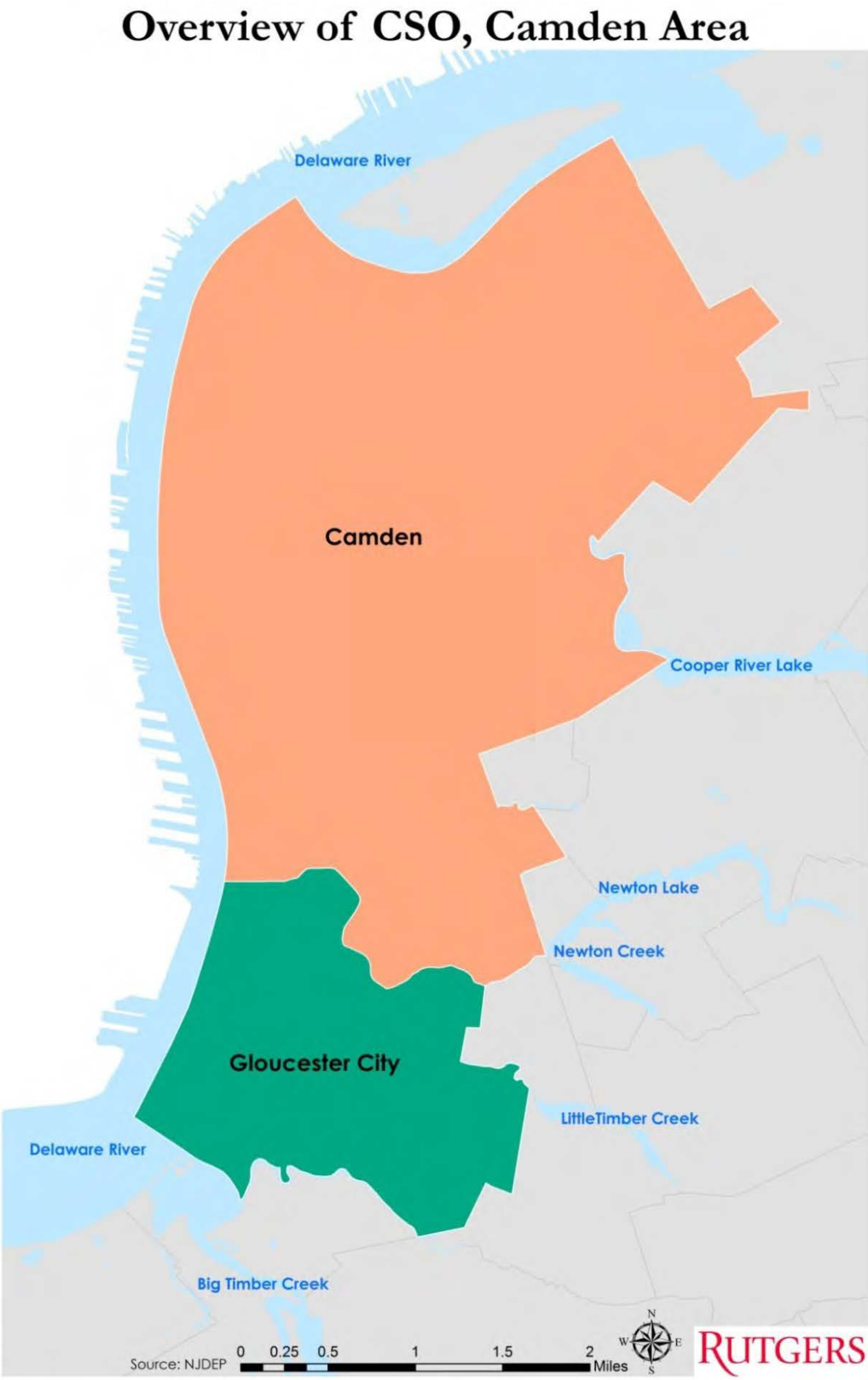


Figure ES-2. CSO Municipalities in the Camden Area transportation access. One important point is that these municipalities are not all the same – they have considerable diversity in terms of community type, density, economic base, socioeconomic status and recent trends. A number of the municipalities experienced major declines in population and households over the decades, but many of them are now showing a reversal of those trends, with population and jobs increasing at a rate higher than New Jersey averages. Overall, these positive trends are projected to continue. However, this shift in trends does not apply to all 21 towns, as some are still losing population and jobs.

Many of the CSO municipalities have excellent access to varied public transportation options, which can support new populations and employers. The CSO municipalities as a group have advantageous positions in specific components of the economy, such as wholesale trade, transportation and warehousing, utilities, and services. The overall situation is challenging for those responsible for managing water infrastructure systems in our CSO municipalities, but also shows considerable hope for economic improvement in many of these towns that could help support improved operations and maintenance. However, discussions with utility managers also emphasize that increased demands on these systems will result in even more line breaks and repair needs, as fragile pipelines are exposed to construction disturbances and faster flow rates. One point is clear – with aging water infrastructure, what can go wrong will go wrong at some point, unless preemptive action is taken. Looking the other way does not make the system work any better. Also, aging infrastructure loses integrity at an increasing rate over time – in other words, with each year of inadequate action, the problem gets worse faster.

Chapter 3 provides an overview of water infrastructure issues for our CSO municipalities. The primary waters affected by CSO discharges are the Delaware River (City of Camden and Gloucester City, but also Philadelphia which is implementing its own CSO control program), the Raritan River and Bay (Perth Amboy), the Elizabeth River and Kill van Kull (Elizabeth City), the Passaic River (Paterson and a variety of municipalities in the tidal area, especially Newark), the Hackensack River (a number of municipalities in Hudson and southern Bergen Counties), and the Hudson River (several municipalities along the Hudson County coast, especially Jersey City and Bayonne, but also New York City, especially in Staten Island and Manhattan, which is also implementing a CSO control program). CSOs introduce dilute but untreated sewage to these rivers and their tributaries, raising public health and environmental concerns. CSOs certainly are not the sole cause of water pollution in these areas, but contribute along with stormwater to major spikes in pollution levels associated with storm events.

All CSO municipalities are required by the New Jersey Department of Environmental Protection (NJDEP) to implement controls on the frequency and quality of discharges from their combined sewers, in compliance with federal policies. NJDEP has issued a series of permits to CSO municipalities in the past, and a new set of permits is being issued now, to achieve federal Clean Water Act requirements for CSO controls. The evolution of the national and State regulatory programs is discussed in **Chapter 1**, along with case examples of other cities that have major CSO control programs. All New Jersey municipalities have completed or are completing controls on solids and floatable wastes from these CSO discharges, the first major construction activity that was required by NJDEP. The municipalities have completed an initial set of engineering studies to estimate the costs of capturing additional flows for treatment, and for providing a certain level of treatment for all wastewater that still discharges from CSO outfalls. These preliminary estimates were evaluated and compiled where available, and are discussed in **Chapter 3**. The estimated long-term costs are clearly in the billions of dollars, quite consistent with what other cities have encountered in their CSO control efforts.

However, new techniques for CSO controls are being employed by various cities large (Philadelphia, New York City) and small (Syracuse) to both reduce costs and improve cities. These techniques are called "green infrastructure" to differentiate them from traditional "gray" infrastructure that relies on centralized, structural approaches that achieve "end of the pipe" controls. Green infrastructure works to control precipitation before it becomes runoff, stormwater or combined sewer flows. The concept is to use dispersed, small-scale projects to infiltrate, capture, evaporate or slow stormwater so that each area acts more like a natural hydrologic system. In practice, the results include the use of landscaping, plant materials, temporary storage (such as green roofs) and other features that not only address the CSO issues (by keeping the water out of the sewers) but also can beautify neighborhoods. Philadelphia is one city that championed this approach, focusing on a triple benefit of CSO control, neighborhood improvement and economic improvement. The Philadelphia approach is closely aligned to the concept of sustainability, with its focus on environmental quality, social equity and economic health. These techniques generally require a highly robust system of planning and coordination; they also do involve considerable expense though they can be more cost-effective than gray infrastructure. However, it is important to note that no city relies entirely on green infrastructure, as some problems require gray infrastructure as an adjunct, primary or even sole response, while others can take extensive advantage of green infrastructure.

Unfortunately, CSO control is not the only critical water infrastructure issue facing these municipalities. They must also consider their existing water infrastructure. A review of available capacity for growth indicates that most of the water supply and sewage treatment plants have adequate capacity to handle projected growth, as discussed in **Chapter 3**. However, utility managers raise a consistent issue: pipelines have deteriorated to the point where the major constraint often is not the capacity of the treatment plants, but rather the inability of distribution and collection pipes to safely and consistently handle the flows. Both water supply and sewer lines can and do clog, restricting flow in ways that further damage the lines and customer service. At worst, these lines can break, causing street collapses (especially where brick combined sewers collapse), street flooding (especially where water mains break or sewer lines clog), and loss of service to entire blocks. Cities with long aqueducts bringing water into their systems are often concerned about the potential for breaks to cut off water to the entire city, something that has occurred in the past. While not all municipalities have estimated the costs of upgrading their existing infrastructure to ensure system viability, enough have to know that the total costs will be in the billions of dollars as well, for just these 21 municipalities.

Discussions with utility managers emphasize the coming competition between CSO costs and other water infrastructure expenditures, not to mention non-water infrastructure expenditures that have been identified as priorities, such as transportation systems and electric energy utilities. As one example, Passaic Valley Sewerage Commissioners (PVSC) own and operate the nation's fifth-largest sewage treatment plant. PVSC faces $110 million in damages to the treatment plant from Hurricane Sandy, and a need for perhaps $250 million for improved resilience measures such as flood walls, protection of sensitive equipment, and backup power to achieve protection against both current flooding potential and future risks (using the 500-year or 0.2% probability flood as the risk benchmark). These costs are in addition to the anticipated costs of improving a 30-year old treatment facility that had a 25-year economic lifespan, and an aging interceptor line that was built in 1924.[1]

All of these issues were explored in more detail through in-depth evaluations and interviews with water utility managers for Bayonne, City of Camden (referred to in this report as "Camden" unless otherwise specified for clarity), Elizabeth, Jersey City, Newark and Paterson, as the six cities with the largest numbers of CSOs, comprising nearly 70% of all CSOs in the state. The results are provided in **Chapter 4**. These six cities have experienced all of the trends of population and employment decline and economic stress, but some are also experiencing significant redevelopment and more positive trends in population and employment. What comes clear from the evaluation and discussions is that each city, regardless of their intent, faces enormous challenges in keeping up with their water and sewer utilities within available financial resources. These cities attempt to optimize use of grants, low-interest loans from the NJ Environmental Infrastructure Finance Program, and upgrades associated with redevelopment. Several of these municipalities have contracted with private companies to operate their systems, in part as a way of ensuring routine capital improvements; Bayonne represents the most extensive use of this approach at this time. Experimentation with new technology and equipment is routine, to identify better ways of managing the system with lower costs. However, also pervasive is the sense that revenues are not keeping up with capital projects needs to replace and rehabilitate their systems.

Which brings us to the question of affordability. As mentioned, many CSO municipalities have significant poverty. This report evaluates in **Chapter 3** the existing water supply and sewer rates for CSO municipalities where available, and compares them to median household incomes to get a sense of how much flexibility might

[1] Interview by Chris Sturm, New Jersey Future, with Michael DiFranscisi, PVSC Executive Director, on 9 Dec 2013)

exist in the rates before they become unaffordable. USEPA's affordability thresholds (1.75% of median municipal household income as an indication of financial stress and 2% as unaffordable) are used as a guide. While none of the existing rates exceed the affordability threshold and some are well below it, a few are fairly close, providing little room for increased rates. More importantly, the costs of CSO controls were examined by some municipalities regarding their affordability. In a number of cases, full implementation of the CSO controls for disinfection and flow storage are projected to increase rates well over the threshold. Further, an examination of the income profiles of the CSO municipalities raises another concern. The median household income is an indicator of financial capacity, but those below the median can be slightly below or far below. A comparison of the larger cities and Hoboken points out that rates set at 1.75% of median household income will have very different effects on low income households in each city. In Hoboken, a rate at 1.75% of median income equates to nearly 9% of the income of a household earning $20,000, while in Camden a sewer rate set at the 1.75% level represents 2.4% of income for a similar household. Clearly, the USEPA threshold would have disparate impacts in multiple directions. It will limit the available system revenue (and the costs) in poorer cities, but it can affect poor households more severely in wealthier municipalities.

In summary, this report raises the following major points, which are discussed in more detail in **Chapter 5**:

- **Starting from behind**. CSO municipalities have old and aging water supply and sewer systems that will require extensive work and major expenditures if they are to remain viable. The longer we delay, the worse the problems will become at an accelerating rate.
- **Fiscally constrained**. CSO municipalities as a group are fiscally constrained and have a history of population and job losses. These financial constraints have often forced a process of infrastructure triage, where only the worst known issues are addressed.
- **Diversity with common attributes**. CSO municipalities are not uniform, but rather are characterized by different community types, population densities, economic bases and development trends. However, they also have many similarities, especially regarding their infrastructure issues.
- **Improving economic trends**. Some CSO municipalities are experiencing and expect to continue positive economic trends that could play a major role in funding infrastructure improvements, but also in exacerbating the deterioration of those same infrastructure systems through development disturbances and greater demands on fragile pipes.
- **The CSO issue is now**. The control of CSO discharges is the law of the land, and it is clear that New Jersey **municipalities should have no expectation of avoiding this issue**. Too many other cities in other states have acted, for USEPA to allow inaction here. While notable progress has been made on control of solids and floatable materials, New Jersey is lagging many other areas in addressing this issue. However, the delays have also provided important opportunities for innovation.
- **A turning point in action?** The new NJPDES CSO Individual Permits can legitimately be seen as a regulatory turning point, providing much more detailed direction and clear consequences for CSO municipalities. However, the feasibility of successful CSO control will depend heavily on the selected controls, fiscal capacity of the CSO municipalities and relevant funding sources, and political will.
- **Gray and Green**. Innovations in CSO controls, such as green infrastructure, provide more opportunities to New Jersey CSO municipalities than existed just ten years ago, but will require each municipality to become familiar with the opportunities and limitations of each approach. Doing so will be difficult for small systems and municipalities, and so cooperative approaches will be vital.
- **Competition for resources**. CSO municipalities will face major costs for the control of CSO discharges at the same time they must improve their existing infrastructure. While there may be many opportunities for addressing these priorities together, there will also be competition for resources.
- **Clear identification of benefits**. Given that New Jersey CSO control costs will likely be in the low billions of dollars, it will be critical that decision makers and ratepayers have a clear sense that the results will

be worth the costs. The benefits can be in cleaner water resources, improved conditions for redevelopment and for maintaining existing property values, and improved neighborhoods.

The most successful CSO programs in the nation occur where cities accept CSO controls as a challenge to be met in the broader context of urban revitalization, rather than as just another regulatory burden. Political leadership is critical to success. Addressing CSOs as an issue solely of engineering and utility management will not be sufficient to achieve the cost-effective, multi-faceted, multi-benefit successes being seen in other cities. The same is true of water supply systems. The various local sewer and water supply utilities cannot individually achieve the necessary level of coordination and cross-fertilization among city departments, regional and state agencies, and the private sector that high-level leadership can achieve. **Considerable innovation will be required in development practices, utility management, and State regulatory approaches to achieve the most cost-effective approach to the sustainability of water utility services and to improving our waters so that they can become a point of pride for New Jersey, and not just the recipients of our wastes.**

Chapter 1: Introduction

After streets and roads, the next major categories of public infrastructure developed in New Jersey were water supply and sewer systems. Urban development in the 1800's required new ways of providing water to people, and the density of development in urban areas required ways of removing waste waters from those same people. The alternatives were insufficient water supplies to support life, commerce and fire safety, and direct exposure to noxious wastes. In both cases, the early materials would now be considered primitive – wood pipes with iron bands around them, short sections of clay pipes, brick tunnels, and eventually cast iron. The water supply systems had no water treatment, and the sewage also received no treatment prior to discharge. In a number of the older cities, sewage from residences, businesses and manufacturing were piped directly into streams and estuaries along with stormwater through combined sewers, which not only transport sewage but also stormwater runoff. Water supplies were local, waterborne disease was epidemic, and cities still routinely suffered damage from fires due to limited supplies.

While we now have sophisticated water supply and sewage treatment systems to protect public health and the environment, **some of the original 1800's water infrastructure of our cities is still in place**, still serving (or perhaps underserving is the better word) the public. While most suburbs in New Jersey were created in the 1940's and beyond, our historic urban areas have many water supply lines that are over 100 years old, and likewise still have combined sewers made of bricks and mortar. New Jersey on the whole has underinvested in water infrastructure over the decades, focusing on those aspects of the system that are directly regulated (e.g., drinking water quality, water pressure, and effluent water quality) and not on the pipes that get the fluids to and from the customers. What is clear from the evidence is that many of these systems are degrading and will fail unless upgraded or replaced with more modern systems. In too many municipalities (though not all, as some systems have engaged in forward thinking and investment), emergency repair costs are increasing and service disruptions are occurring too frequently.

Further, the combined sewers are designed and operated, quite deliberately, to periodically discharge when rainfall causes total flows to exceed the capacity of the lines or the receiving sewage treatment plants. Combined sewer systems are not designed to handle large storms, and therefore they cause Combined Sewer Overflows (CSOs), in which combined sewage and stormwater discharge into streams and harbor waters essentially without treatment. In an average year, a CSO can experience upwards of 50 discharge events, with some as high as 100. Total annual average CSO discharges in New Jersey were estimated to be 23 billion gallons (USEPA, 2012), though municipal CSO reports indicate that this estimate may be high. New Jersey has 21 municipalities with Combined Sewer Overflows (CSOs). The NJ Department of Environmental Protection (NJDEP) has listed 217 CSO discharge locations in these 21 municipalities, with those shown in **bold** having more than 10 CSOs (see **Figures ES-1** and **ES-2**):

Table 1-1. New Jersey CSO Municipalities		
Bayonne	Hackensack	**Paterson**
Camden (City of)	Harrison	**Perth Amboy**
East Newark	Hoboken	Ridgefield Park
Elizabeth	**Jersey City**	Trenton
Fort Lee	Kearny	Union City
Gloucester City	**Newark**	Weehawken
Guttenberg	North Bergen	West New York

While some of these municipalities are relatively small, others are the largest or among the largest in New Jersey in terms of population and employment, and the 21 municipalities taken together play a critical role in the state economy. Many of them also have significant proportions of households below the poverty line, and as such have major fiscal constraints.

These municipalities are required by the federal Clean Water Act to control their CSOs as necessary to ensure attainment of applicable water quality standards and protection of designated water uses. Approximately 860 municipalities in the country have CSOs, all but 84 of which (including New Jersey's 21) have addressed their CSO issues or have Long Term Control Plans and been actively controlling their CSOs for years under USEPA or state enforcement orders and permitting.[2] While all New Jersey CSO municipalities have taken steps to collect solid and floatable materials from their discharges, as required by the NJDEP, New Jersey is otherwise lagging the nation in addressing the other pollutants from CSOs. This situation is now changing. NJDEP is embarking on a new regulatory path that will require additional actions to greatly reduce or treat the overflows. The objective is to attain water quality standards for the receiving waters and to support the appropriate public uses of those waters. In essence, the challenge is to limit the rate of wastewater flows in the combined sewers so that CSO frequency and volumes are minimized, while ensuring that what remaining CSO discharges do occur are treated through removal of solid and floatable materials and through an environmentally-protective method of disinfection. It is clear from experience elsewhere that the costs will be very high. The implementation process will take decades and will stretch the abilities of municipalities and sewer agencies to plan, design, implement and manage the required infrastructure.

The 21 New Jersey municipalities examined in this report have at least part of their developed areas served by combined sewer systems (CSS) that transport both sewage and stormwater to treatment plants. All CSS in New Jersey represent old methods of handling wastewaters, and would never be constructed now. They are relicts of a time when sewage treatment did not exist, and the priority was on moving wastewater away from development and into open waters as quickly as possible. However, once in existence, they have become extremely difficult and expensive to eliminate or even control, and can be the cause of street flooding and backup sewage in buildings. These antiquated sewer systems and their CSOs can greatly limit the growth potential, quality of life and environmental quality of cities. However, they aren't the only potential limit to growth and revitalization. In fact all of New Jersey's older cities and towns face challenges related to old, decaying water infrastructure.

The report also examines the issues related to water supply, as our cities will require sufficient supplies through well-maintained infrastructure if they are to both survive and thrive. Water supply systems are becoming more constrained in New Jersey due to increasing demands, loss of some resources to pollution, and poor maintenance of infrastructure that results in water leakage, service disruptions and inefficient water consumption. While the current water supplies available to the CSO municipalities appear adequate to support anticipated growth in demands, the distribution systems are aging and breaking with greater frequency in most cities.

The purpose of this report is to provide: a profile of the integrity of all three components of the water infrastructure systems of the 21 CSO municipalities – drinking water, wastewater and stormwater; evaluations of sewer and water supply infrastructure conditions and stresses; and economic stresses that could occur due to the need for improved management of all water infrastructure systems. The clear message is that improving our water infrastructure will be a challenge, but doing so will provide ongoing benefits to the municipalities and regions in terms of improved services, capacity for new development, urban amenities and public health and safety. In essence, New Jersey has been coasting on the investments of the past. To have a strong future, revitalization of our water infrastructure is required.

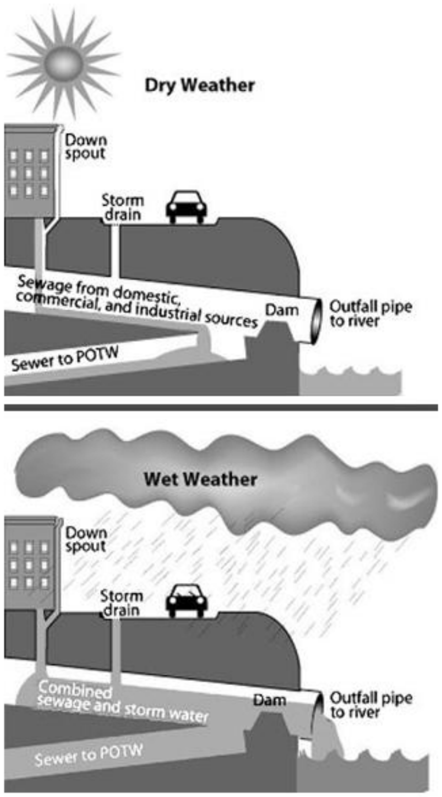
The Challenges of Combined Sewer Overflow Controls

The value of water cannot be understated as it is not only fundamental for sustaining life, but it plays a ubiquitous role in our daily activities. In order to meet those everyday demands for water, the necessary infrastructure must be in place to manage its water supply treatment and distribution, and wastewater collection and treatment. All three areas of water management (water supply, wastewater and stormwater) are

[2] Source: USEPA, Region 2. USEPA is directly responsible for pollutant discharge permits under the Clean Water Act in some states, while in other states such as New Jersey the permitting program has been delegated to a state agency.

essential in order to sustain any community. Water supply quality is essential for public health. Wastewater collection systems are particularly critical in ensuring the protection of the environment within and around communities, which in turn can subsequently affect overall public health. Combined Sewer Systems (CSS), pose a special problem - when there is heavy rain or snowmelt that overwhelms the sewer system and ultimately results in events known as Combined Sewer Overflows (CSOs), which are the discharge of untreated wastewater into neighboring waterways from overflow points connected to the system (see **Figure 1-1**). These overflows can be caused by several conditions. First, the collection pipes may be insufficient in size to convey all combined sewer flows to the treatment plant. Second, the collection pipes may be clogged or damaged, such that they cannot convey their design flows. Third, the collection pipes may be capable of conveying all flows to the treatment plant but the treatment plant itself cannot handle these flows, and so a regulator device is placed just before the collection pipes enter the treatment plant, restricting inflows to an acceptable level. Each of these issues requires a separate management response.

Potential health effects from exposure to raw sewage discharged from these outfall events (through the ingestion of contaminated water, inhalation of water vapors, the consumption of contaminated fish and shellfish, or contact from water recreation) include hepatitis, gastroenteritis, and several types of infections (affecting ears, respiratory system, skin, and wounds) (USEPA 2011, p. 4).



Combined Sewer System and Overflows (Source: USEPA)

NJDEP has issued CSO operating permits for 217 CSOs in the 21 municipalities. Those cities with the largest number of CSOs include Bayonne (30), Camden (28), Elizabeth (28), Paterson (24), Jersey City (21), and Newark (17), which together comprise 68% of the total. Federal law requires that the pollution discharged from these points be mitigated to ensure the protection of water supplies, public and environmental health, preservation of aquatic life, and the recreational use our waters.

In a 2008 USEPA report, CSO correction costs in New Jersey were estimated to be $9.3 billion (USEPA, 2008), which at the time was the largest in the Tri-State Area and did not include statewide upgrades and repairs to aging wastewater treatment and pipes that were estimated to cost $6.3 billion, a portion of which is for CSO communities. The independent and bi-partisan effort, *Facing Our Future*, has expressed the danger New Jersey faces in failing to make the necessary investments in its water infrastructure. *Facing Our Future* cites the liability that our water and wastewater infrastructure represents not only to the supply of safe drinking water and a clean environment but their potential to either promote or restrict economic growth in the state. As one could have expected, this lack of public investment became especially salient during Hurricane Sandy (Facing Our Future, 2013).

However, it should be noted that the costs expressed in these reports are preliminary and could be either higher or lower than the reality, depending on our ability to use innovative technical, redevelopment and financing methods to reduce costs, or the identification of currently unknown infrastructure needs. As examples (discussed below), both New York City and Philadelphia are using innovative CSO control methods that address some (but not all) of their needs in a way that could reduce costs but certainly will improve neighborhood viability and redevelopment potential. Each city has programmed well in excess of $1 billion (in constant dollars) for these programs, and each city has similar exposure to CSO issues as New Jersey.

Overview of New Jersey CSO Municipalities

As discussed in much greater detail in **Chapter 2**, the 21 CSO municipalities represent nearly 17% of New Jersey's population and 16% of employment, despite being only 3.7% of the 565 municipalities. Nearly two-thirds of their population is within just six cities: Newark, Jersey City, Paterson, Elizabeth, Trenton and Camden. After decades of population decline (over 20% as a group from 1950 to 1990), they accounted for 26% of total population growth in New Jersey from 2008-2012 (though four lost population). As a group, they have somewhat more than an even share of employment in construction, manufacturing, wholesale trade, transportation and warehousing, and "other services." Many of them also have good to excellent connections to public transportation facilities – airports, railroads, light rail, PATH, subways and bus service. While no New Jersey municipality can be considered a "dominant" city for the state in manner of Boston or Chicago, our CSO municipalities are densely populated and highly urbanized, for the most part with historic downtown centers, unlike some of the larger suburban municipalities but similar to other older urbanized areas that have downtown centers but no CSOs, such as Summit, Morristown and Atlantic City. However, as older urban areas, most of them have somewhat to very high concentrations of poverty. In five, more than 20% of their households are below the federal poverty line, and another 13 have between 10% and 20% at that level. Housing values are often well below the state median, as are median household incomes and per-capita property tax base. As such, nearly all of the 21 CSO municipalities are financially stressed, with Hoboken being the strongest exception.

In 2013, the EPA indicated in a draft report that many of the most flood prone communities located throughout their Region 2 study area (consisting of New York, New Jersey, Puerto Rico, and the U.S. Virgin Islands) were low-income and/or minority. The danger this situation poses for these communities are "the incidents of wastewater and stormwater sewer systems back-ups that could cause localized flooding and water inflows into basements in urban areas." Rising sea levels coupled with storm surges will exacerbate this situation. The situation becomes increasingly important when considering the fact that the residents of these communities do not have the means to relocate and are thus forced to deal with the worsening conditions that can include disruptions in the drinking water, plumbing, and electrical services that support homes and businesses (U.S. EPA, 2013). This situation not only highlights the urgent need to address the issue of CSOs on the basic grounds of quality of life for the at-risk residents of these communities, but also regarding detrimental effects on current and future economic value is we do not aggressively manage this public health and environmental liability. Several CSO communities, including Camden and Newark, clearly show the connection between CSOs, flood prone areas, and damage to buildings and neighborhoods from sewer backups.

These issues of unemployment, poverty and public risk do not bode well for the future capacity of these cities to aggressively address their CSOs, but two major counterpoints are possible. First, some of the CSO municipalities have been experience growth in population and employment that exceed the statewide rate, and projections through 2040 clearly anticipate that this trend will continue as a major reversal of past declines in both absolute terms and relative to the state as a whole. Improved economies would in turn strengthen their ability to address infrastructure needs. Second, these cities would experience major potential benefits upon resolving their water infrastructure issues. A report by the U.S. Conference of Mayors assesses the return on investment for water and sewer infrastructure development and maintenance. The report cites several studies that support the conclusion of increased private output resulting from public investment into general infrastructure improvements, highlighting one study by Moomaw et al. which found that "states [had] greater returns from investing in water and sewer systems than from investing in highways." The report goes on to include input-output estimates by the U.S. Bureau of Economic Analysis, which found that "across the United States as a whole, for each additional dollar's worth of output of the water and sewer industry in a year, the dollar value of the increase in output that occurs in all industries is $2.62 in the same year" (Krop, et al., 2008).

Overview of Federal and State Regulation of Combined Sewer Systems

USEPA's Combined Sewer Overflows Control Policy (1994) has provided a framework for managing Combined Sewer Systems and the occurrence of CSOs in 859 municipalities nationwide, through the National Pollution

Discharge Elimination System (NPDES).[3] From the outset, four principles were developed for the purpose of establishing some basic expectations for municipalities so that CSO control measures were not only cost-effective but would meet local environmental objectives. Those principles include (USEPA, 1994):

(1) clear levels of control to meet health and environmental objectives;
(2) flexibility to consider site-specific conditions of CSO points and to find the most cost-effective way to control them;
(3) a phased implementation of CSO controls to accommodate a community's financial capability; and
(4) the review and revision of water quality standards during the development of CSO control plans to reflect the site-specific wet weather impacts of CSOs.

The initial policy included a deadline of January 1997 for implementing nine minimum technology-based controls. Updates to the CSO Control Policy in 2000 included a new section requiring "each permit or enforcement document issued for a discharge from a municipal combined sewer system to 'conform' to the CSO Policy." The new requirements outlined three new objectives that were much more specific than the previous four principles:

(1) ensuring that if CSOs occur, they are only as a result of wet weather;
(2) bring all wet weather CSO discharge points into compliance with the technology and water quality based requirements of the Clean Water Act; and
(3) minimizing the impact of CSOs on water quality.

Furthermore, permit holders were required to immediately undertake a process of characterizing their combined sewer system and CSO discharges accurately and to demonstrate that they have implemented the *nine minimum technology-based controls* identified in the 1994 policy (which were intended to not require extensive engineering studies or significant construction cost and are prior to long-term intervention measures) (USEPA, 1995). **Table 1-2** lists the nine minimum technology based controls along with relevant methods for achieving each of the desired controls suggested by USEPA.

Table 1-2. Nine Minimum CSO Controls and Technical Methods (USEPA, 1995)

Control	Objective	Relevant Technical Methods
1	Proper operation and regular maintenance programs	• Maintaining /repairing flow regulator devices • Maintaining/repairing tidegates • Removing sediment/debris • Repairing pump stations • Developing inspection programs • Inspecting collection systems
2	Maximizing the use of the collection system for storage	• Maintaining / repairing tidegates • Adjusting flow regulator devices • Removing small system bottlenecks • Preventing surface water runoff • Removing flow obstructions • Upgrading/adjusting pumping operations
3	Reviewing and modifying pretreatment requirements to assure CSO impacts are minimized	• Volume control • Diversion of storage • Flow restrictions • Pollutant control • Process modification • Stormwater treatment • Reducing runoff

[3] Of these, according to USEPA Region 2, as of early 2014 over 90% (775) have either upgraded their sewage systems or developed approved plans that meet the requirements of the USEPA CSO Control Policy and the federal Clean Water Act.

Table 1-2. Nine Minimum CSO Controls and Technical Methods (USEPA, 1995)		
		• Installing curbs/dikes • Improving housekeeping • Implementing best management practices plan
4	Maximizing flow to the publicly owned treatment works for treatment	• Analyzing flows • Analyzing unit processes • Analyzing headloss[4] • Evaluating design capacity • Modifying internal piping • Using abandoned facilities
5	Elimination of CSOs during dry weather	• Performing routine inspections • Removing illicit connections • Adjusting/repairing flow regulation devices • Repairing tidegates • Cleaning/repairing the combined sewer system • Eliminating bottlenecks
6	Control of solid and floatable materials in CSOs	• Screening – Baffles, trash racks, screen (statics and mechanical), netting, catch basin modifications • Skimming – boom, skimmers boats, flow balancing • Source controls – street cleaning, anti–litter, public education, solid waste collections, recycling
7	Pollution prevention	• Source controls • Water conservation
8	Public notification to ensure that the public receives adequate notification of CSO occurrences and CSO impacts	• Posting (at outfalls, use areas public places) • TV/newspaper notification • Direct mail notification
9	Monitoring to effectively characterize CSO impact and the efficacy of CSO controls	• Identify all CSO outfalls • Recording the total number of CSO events and frequency and duration of CSOs for a representative number of events • Summarizing locations and designate the uses or receiving waters • Summarizing SCO impacts/incidents

Although New Jersey has had a long history of regulations managing water quality with the passage in 1977 of the Water Quality Planning Act (N.J.S.A. 58:11A-1 et seq.) and the Water Pollution Control Act (N.J.S.A. 58:10A-1 et seq.), it was not until after the introduction of the 1994 USEPA policy that Combined Sewer Systems became a priority. The state's responded by adopting amendments to the New Jersey Pollutant Discharge Elimination System (NJPDES) rules three years later in 1997. NJDEP began issuing NJPDES General Permits to relevant owners of CSOs in 1995 (based on a 1989 policy from USEPA), and again in 2000 based on the 1994 USEPA policy and new NJPDES rules, requiring control of pollutants from CSO discharges including USEPA's nine minimum controls. A General Permit applies specific requirements to all eligible facilities, rather than providing tailored requirements to specific facilities. Prior to the expiration of the second round of General Permits in February 28, 2005, a new General Permit was issued June 30, 2004 and subsequently expired on July 31, 2009.

Under the General Permits, municipalities examined and modeled their combined sewer systems and CSOs, preparing reports on the nature, frequency and severity of CSO event during a typical rainfall year, effluent quality and loadings, and various engineering approaches for controlling the CSOs. The engineering approaches

[4] This method reduces the amount of energy that is necessary to move a liquid from its original position to the required delivery position.

were focused on "gray" infrastructure controls such as separating the stormwater and sewage collection systems, combining CSOs, increasing treatment plant capacity, creating in-line or off-line storage to hold wastewaters until after the storm event (at which point the wastewaters are released to the treatment plant), removing solid and floatable materials, and disinfecting CSO effluent prior to discharge. The last of these reports were submitted in 2006 and 2007, for the most part. These reports are not Long Term Control Plans (LTCPs) themselves, but rather were developed to provide the basis for creating LTCPs. Through the General Permit process, NJDEP required implementation of the controls on solid and floatable materials, most of which have been completed and are operational. NJDEP estimates that CSOs discharged an average of three tons per year of solids and floatable materials per CSO, resulting in a net collection of 660 tons of material captured annually prior to discharge, upon completion of this phase of work, at a cost of over $300 million statewide (Cach, et al., 2010).

Prior to the expiration of the General Permit issued in 2004, an administrative extension of the permit beyond 2009 was granted by the NJDEP at the request of the regulated municipalities. This extension prompted a petition by the New York/ New Jersey Baykeeper, Hackensack Riverkeeper and Raritan Riverkeeper to the NJDEP to have the General Permit revoked and reissued with new conditions on April 15, 2011. The petition was denied on September 15, 2011. After an appeal was filed by the appellants, NJDEP announced that it was planning to replace the 2004 General Permit with individual permits that would be issued to each of the 21 municipalities with CSOs and "modify or renew the existing individual permits currently held by the nine affected sewage treatment plants." The decision to deny the appellants' request was affirmed by the Superior Court of New Jersey on March 7, 2013.[5] The first new draft individual permits were released in 2013 and the remainder in early 2014, with an expectation that all final permits would be in place by early 2015.[6] These individual permits are discussed in more detail below. In the meantime, USEPA initiated actions against Perth Amboy and Jersey City regarding their compliance with the Nine Minimum Controls, resulting in consent decrees for both cities that require certain CSO control actions and mitigation projects.

Options for CSO Controls

A wide array of approaches can be used to reduce the impacts of combined sewer overflows on receiving waters. **Table 1-3** provides a very brief overview of these techniques, divided into:

- **"Gray" infrastructure** – traditional and advanced engineering approaches that rely on centralized infrastructure such as sewer separation, mass storage and "end of the pipe" treatment; and
- **"Green" infrastructure** – decentralized techniques to either prevent stormwater from entering piped infrastructure, whether combined sewers or separate storm sewers, or to delay stormwater movement into piped systems until after peak wet weather flows have declined to levels that can be managed without overflows. In both cases, a goal of green infrastructure is to recreate a more natural hydrograph for stormwater flows into streams or pipes.

Table 1-3: Evaluation of Gray and Green CSO Control Techniques		
Gray Infrastructure Techniques	**Major Technical Advantages**	**Major Technical Disadvantages**
Sewer separation	• All sanitary sewage conveyed to treatment plant • CSO events eliminated	• Reduces amount of stormwater treated prior to discharge • Major disruption of traffic, business • Not always feasible
Solids and floatable materials controls (e.g., netting)	• Reduces visible solid materials discharging to surface waters • Required for all NJ outfalls	• Labor-intensive solid waste disposal

[5] In Re Petition To Revoke Statewide General CSO Permit. <www.njlawarchive.com/20130307101009494837754/>
[6] See <www.nj.gov/dep/dwq/cso.htm> for all of the draft CSO permits.

Table 1-3: Evaluation of Gray and Green CSO Control Techniques

Disinfection	• Reduces pathogen pollutant loads • Reduces other pollutant loads as an incidental but significant benefit	• Essentially requires a limited sewage treatment plant at each outfall • Use of chlorine requires dechlorination due to aquatic toxicity
System maintenance	• Maximizes available capacity	• None
Inline storage	• Makes use of existing infrastructure	• Can increase sewer backups • Highly sensitive to pipeline conditions
Off-line storage tanks (in the combined sewer system or at the treatment plant)	• Captures combined flows for later treatment for water quality benefit • Can group storage into fewer tanks	• Land requirements & visibility issues • Requires treatment of stored flows
Off-line storage tunnels	• Captures combined flows for later treatment for water quality benefit • Limited street-level impacts	• Requires treatment of stored flows
Increased line capacity	• Increase peak flow to treatment plant	• Can overwhelm treatment capacity
Infiltration reductions (i.e., flows from ground water into pipes)	• Reduce both dry & wet weather flows • Can help stabilize old sewers • Relatively simple technology	• Often a limited reduction in flows relative to total wet weather flows
Treatment plant bypass of peak flows after less than secondary treatment	• Achieves secondary treatment of all dry and part of wet weather flows • Achieves at least primary treatment of remaining wet weather flows	• Not currently allowed in NJ • Significant USEPA constraints • Partial treatment of major events
Green Infrastructure Techniques	**Major Technical Advantages**	**Major Technical Disadvantages**
All Techniques	• Dispersed systems provide scalable opportunities for focused benefits • Increased potential for partnerships and multiple funding sources • Increased potential for visible neighborhood street/park amenities	• Dispersed systems require system maintenance at many locations • Increased coordination complexity • Potential conflicts over neighborhood expectations for landscaping • Partial solution
Pervious surfaces (e.g., pavement, driveways, paths)	• Ground water recharge or below-grade storage with slow release	• Not viable for area with high loads of mobile/miscible pollutants • Often not viable for high traffic areas
Rain gardens	• Storage of precipitation with slow release, evaporation, transpiration	• Land requirements
Street drainage intercepts	• Storage of precipitation with slow release, evaporation, transpiration	• Potential conflicts with existing below-ground infrastructure
Infiltration devices (French drains, sumps)	• Ground water recharge • Delayed release of stormwater	• Potential water movement into below-ground structures
Green and Blue roofs	• Storage of precipitation with slow release, evaporation, transpiration	• Limited to roofs with sufficient structure load capacity
Rainwater catchment (rain barrels, cisterns)	• Storage of runoff for on-site use	• Seasonal use if for irrigation • Requires use prior to next rainfall
Bioswales/bioretention	• Slows runoff, increases absorption	• Land requirements
Wetlands	• Storage of runoff for ecosystem use	• Land requirements, with complex site requirements
Natural landscaping	• Slows runoff, increases absorption	• Land requirements • Limitation of sight lines in urban settings can raise security issues

These techniques have costs (per million gallons controlled) that range widely, depending on the existing infrastructure, the severity of CSO problems, the target water quality, the urban development matrix and level of redevelopment activity, topography and geology, etc. (**Chapter 3** addresses gray infrastructure costs identified by various New Jersey CSO municipalities.) Each technique can be most cost-effective in specific situations. In most urban areas, no one technique will be both sufficient to control CSO events and most cost-effective. Combinations of techniques are common in cities where comprehensive CSO control plans are being implemented. Though it is difficult to find a definitive study on this issue, some CSO control programs that have investigated the issue anticipate that green infrastructure will control roughly 10% of total wet weather flows into combined sewers (see **A New Jersey Case Study**, below). While that level of control may not seem like a lot, many rainfall events are small, with most of the increased sewer flows going to the treatment plant and only a relatively small portion released as an overflow. Green infrastructure that reduced total stormwater flows by 10% could provide larger reductions in the total number of overflow events and of CSO volumes. Even for large storms, a 10% capture rate could reduce peak flow rates in a cost-effective manner, reducing the size and cost of needed gray infrastructure.

CSO Control Lessons from Other Cities

USEPA has been implementing its guidance in a large number of cities around the country through court-approved consent decrees that commit the cities to action while protecting them enforcement penalties and third-party lawsuits under the Clean Water Act, so long as the cities are in compliance with the implementation schedules and requirements of the consent decrees. Both New York City and Philadelphia are parties to USEPA consent decrees. In the case of New Jersey, USEPA supports the approach of achieving the same objectives through individual permits, which carry the potential for enforcement action in the event of noncompliance. Critical lessons from other cities involved in CSO controls are:

1. CSO controls are very expensive.
2. Reliance on gray infrastructure addresses the CSO problems at the "end" of the system. They certainly can provide relief to the drainage areas in terms of reduced sewer backups, street flooding and CSO discharges. However, they do not address the intensity of runoff volume inherent in urban areas.
3. Green infrastructure can provide multiple benefits to a city in terms of:
    a. Environmental improvements through CSO reductions, reduced stress on CSO systems and reduced potential for sewer backups;
    b. Neighborhood improvements through the creation of green spaces, street trees, gardens;
    c. More naturalized uses of stormwater through infiltration, vegetation and other uses;
    d. Economic improvements through the neighborhood beautification activities that increase the market value of properties and encourage further private-sector investment.
4. Green infrastructure cannot entirely take the place of gray infrastructure, but can be more cost-effective up to a point. The cost curves are complicated by the existence of non-dollar social and environmental benefits and the difficult-to-assess economic benefits associated with green infrastructure. Regardless, the total CSO volumes involved can exceed the volume reductions that green infrastructure can address, and so green infrastructure becomes part of the solution, but not the entire solution.
5. CSO controls require extensive periods of time for design, financing and implementation.

Examples of these lessons are coming clear through national examples. The District of Columbia Water and Sewer Authority is spending $254 million to construct the Anacostia River Tunnel, one part of its overall $2.6 billion program to prevent CSO discharges to the Potomac River, Anacostia River and Rock Creek (www.dcwater.com). They are also pursuing green infrastructure options as part of the overall program.

Philadelphia has committed to a CSO Long Term Control Plan that involves $2.4 billion in capital construction plus operating and maintenance costs over a 25-year period, representing $1.2 billion in net present value. The plan focuses on green infrastructure with some gray infrastructure. Philadelphia has 164 CSO overflow points, roughly equal to the aggregate CSO outfalls in New Jersey's six top CSO municipalities. They are strongly committed to green infrastructure projects as a way to achieve a "triple bottom line" of water quality, neighborhood quality and economic benefits (Philadelphia, 2011).

Milwaukee Metropolitan Sewerage District has adopted a plan to capture the first 0.5 inches of each rainfall event through green infrastructure, which is "almost 1.5 times the storage capacity of the deep-storage tunnel the district completed two decades ago." (Water Environment & Technology, 2013.) The objective is 740 million gallons of storage capacity, to allow annual capture of 14.8 billion gallons of stormwater (slightly more than half of the New Jersey total), with a total cost of $1.3 billion (40% less than other options).

The following case studies provide a more detailed view of ongoing projects. **What becomes clear is that each city has combined green infrastructure with gray infrastructure, that many departments and organizations must coordinate efforts for success, that success requires decades of intensive focus, and that no single component of the management systems constitutes the "best" answer to CSO controls.**

Chicago, Illinois

There has been a longstanding effort to manage the city's combined stormwater overflows through a combination of large scale gray and green infrastructure projects. Chicago's commitment to stormwater management goes back to 1889 with the creation of the Sanitary District of Chicago (now the Metropolitan Water Reclamation District of Greater Chicago (MWRD)) by the Illinois General Assembly. MWRD has recently completed a 4-year project known as the "Greenest Street in America" in partnership with the City of Chicago that totaled $14 million. While the project considered other sustainability issues such as energy consumption and heat island conditions, a large portion of the project was devoted to stormwater management. Specifically, the project focused on the reconstruction of a two-mile stretch of Blue Island Avenue in the Pilsen neighborhood with sustainable materials and green amenities. The elements of the project included the use of permeable pavements, bioswales (**Figure 1-1**), subsurface infiltration basins, and the introduction of 95 drought resistant species in the bioswales. Simulations demonstrated the capture of "80 percent of the precipitation" from a single storm that produced 0.75 inches of rain in a five-hour period. The redevelopment effort resulted in a 131 percent increase in landscape and tree cover, and elimination of the need to use potable water for irrigation purposes.

Figure 1-1: Bioswale, Chicago, Illinois. (CE News, www.cenews.com/article/8895/turning_stormwater_into_a_resource)

The construction of gray CSO infrastructure has been underway since the 1970s with the initiation of the MWRD's Tunnel and Reservoir Plan (TARP) or "deep tunnel" project, which sought the construction of an underground system of tunnels and reservoirs to capture overflows and store polluted water for eventual treatment at water reclamation plants. The TARP project has been segmented into two phases with the first having already been completed in 2006 with the construction of 109.4 miles of tunnels and storage capacity of 2.3 billion gallons. The second phase of the project calls for the construction of three reservoirs of which one (Gloria Alitto Majewski/CUP) was completed by the U.S. Army Corp of Engineers in 1998. The next reservoir, the Thornton Composite, is scheduled to be completed in 2015 while the McCook Reservoir (segmented into two stages) is expected to be completed between 2017 and 2029. The total storage capacity of all three reservoirs will be over 18 billion gallons. Thus far, the use of completed infrastructure has resulted in a fifty percent reduction in the average number of days per year with CSO events and 85 percent removal of the pollutant load captured by the TARP system (Fore, 2013).

New York, New York

Similar to Chicago, New York City has instituted a stormwater and CSO mitigation plan that calls for major investments in both gray and green infrastructure. In addressing sewer capacity and health, the city has budgeted $3.7 billion to reduce the volume from outfalls by 8.3 billion gallons per year. To date, the city has spent $1.7 billion in construction projects, which are expected to reduce CSO volumes by 5.666 billion gallons per year. The city's CSO Reduction project includes five major gray infrastructure projects:

(1) the rehabilitation of a CSO detention facility at Spring Creek that is designed to store 20 million gallons;
(2) the construction of a detention facility at Flushing Creek that is expected to store 43 million gallons;
(3) the construction of a detention facility at Paerdegat Basin that will be able to store 50 million gallons of outfall flow and capture an annual volume of 1.278 billion gallons;
(4) make improvements to the preliminary treatment (i.e. headworks) at the West Water treatment plant in Hunt's Point and Bowery Bay; and
(5) increasing pumping station capacity at Avenue V by 50 million gallons per day.

Figure 1-2: NYC Bioswale Example. (NYC DEP. Types of Green Infrastructure. 2014. www.nyc.gov/html/dep/html/stormwater/combined_sewer_overflow_bmps.shtml)

Furthermore, the CSO management plan also includes an additional $150 million for dredging at the head of certain tributaries, the construction of "floatables controls at large CSO outfall points," the reconstruction of Gowanus Canal Flushing Tunnel, and the installation of "in-stream aeration and destratification facilities in tributaries with low dissolved oxygen levels" (NYC Department of Environmental Protection, 2014).

In the area of green infrastructure, the city's department of environmental protection announced plans in 2012 to invest $2.4 billion over 20 years in green infrastructure projects with the objective of managing one inch of stormwater from 1.5 percent of impermeable surface or $192 million by 2015 for projects on the right-of-way. As of 2011 and 2012, the city has constructed 14 bioswales (**Figure 1-2**) in addition to ongoing capital projects on 4th Avenue and Dean Street in Manhattan, Atlantic Avenue in Brooklyn, and College Point in Queens (NYC Department of Environmental Protection, 2012).

Portland, Oregon

Portland's efforts to reduce the volume of overflows from CSOs and implemented a stormwater management plan began in 1991 with the CSO Facilities Planning Project, which was followed by the construction of gray infrastructure improvements known as the "Cornerstone Projects" in 1993 that totaled $143 million (as shown in **Figure 1-3**). These projects

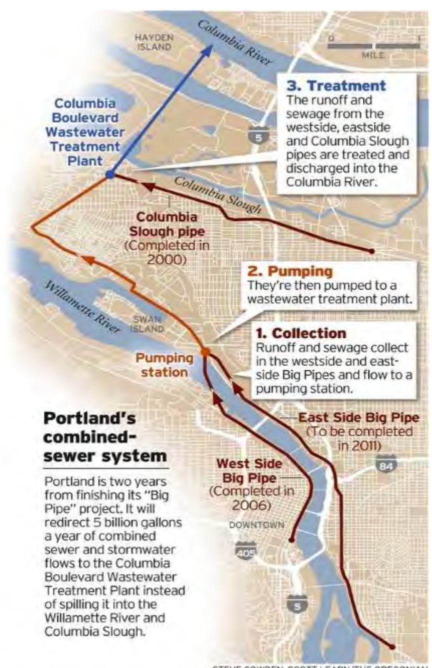


Figure 1-3: Portland, Oregon, CSO Project Components (The Oregonian)

consisted of sewer separation, the installation of 3,000 stormwater sumps (drywells), downspout disconnections and a stream diversion. Within seven years the city completed the construction of the Columbia Slough Big Pipe and other slough projects, which had the effect of reducing CSO volumes into the Columbia Slough waterway located near the floodplain of the Columbia River by 99%. In 2006, Portland completed construction of the West Side Big Pipe with a diameter of 14-feet and a pump station on Swan Island (located eight miles above the mouth of the Willamette River) (Willingham, n.d.). The following year the Downspout Disconnect Program was completed, which disconnected downspouts at more than 56,000 properties and removed over 1.2 billion gallons of stormwater from the city's combined sewer system annually. As of 2011, the construction of the East Side Big Pipe and the Balch Consolidation Conduit were completed in addition to the installation of a wet weather pump station in Sellwood that services the southeast region of the city (Portland (a), n.d.).

On the green infrastructure front, the city is recognized as a leader in sustainable stormwater management practices and has instituted a "Grey to Green Initiative" (G2G) as of 2008 under former Mayor Sam Adams. The elements of the G2G include the construction of eco-roofs and green streets, purchasing land in underdeveloped areas, removing culverts, removing invasive species and revegetation, as well as planting in natural areas. As of 2010, there were 172 eco-roofs throughout the city with plans for an additional 43 acres of eco-roofs. G2G has had a five-year plan in place to construct 920 green street facilities of which 700 have been built since 2009 resulting in the management of 48 million gallons of stormwater per year. Furthermore, an estimated 573 facilities (62%) will be located in CSO service areas. In regards to the expansion of tree coverage the city is planning to plant 33,000 yard trees and 50,000 that will provide a low-cost component to stormwater management strategy in addition to improving air quality and property values (Portland (b), n.d.).

Philadelphia, Pennsylvania

In 2011, the City of Philadelphia announced the approval of its amended "Green City, Clean Waters" Program that was first submitted to the Pennsylvania Department of Environmental Protection in 2009. Unlike the stormwater management plan seen in Portland that emphasizes gray infrastructure improvements with a more recent focus on expanding green infrastructure, Philadelphia's Green City, Clean Waters Program is a 25-year plan that primarily focuses on maximizing the use of green infrastructure. The plan is estimated to cost $2.4 billion ($1.2 billion in present worth) and calls for:

(1) large scale implementation of green stormwater infrastructure to manage runoff at the source on public land (including streets and parks) and reduce demands on sewer infrastructure;
(2) instituting requirements and incentives for green stormwater infrastructure to manage runoff at the source on private property to further reduce demands on sewer infrastructure;
(3) expanding street tree coverage;
(4) improving the access and quality of recreational areas along green and stream corridors in addition to waterfront areas;
(5) preserving open space;
(6) rededicating vacant lands and open lots as areas of open space or preparing those areas for responsible redevelopment;
(7) restoring water quality in the city's streams while providing physical enhancements that support aquatic life; and
(8) making necessary improvements in existing sewer infrastructure to meet water quality standards.

Figure 1-4. Artist's depiction of green infrastructure potential in Philadelphia (Philadelphia Water Department)

Although the city has clearly expressed that green infrastructure improvements would be a centerpiece of their stormwater management initiative, the plan provides $345 million to improve treatment plant capacity to handle additional stormwater flows. Those "traditional" infrastructure improvements include a 215 million gallon/day "secondary treatment bypass"[7] at the Northeast Water Pollution Control Plant (expanding wet weather capacity), a 60 million gallon/day increase in secondary treatment at the Southwest Water Pollution Control Plant, and a 50 million gallon/day increase in secondary treatment at the Southeast Water Pollution Control Plant.

The Green Infrastructure component will be a long-term investment of $1.67 billion, as the city seeks to go beyond merely mitigating stormwater runoff, but also improving the health and aesthetic experience of the city. The plan cites that publicly-owned land represents 45% of the city's total impervious surface, which provides a tremendous opportunity to substantially increase on-site stormwater retention through the use of eco-roofs (**Figure 1-4**). The plan also seeks to employ stormwater tree trenches (i.e. trees connected to an underground infiltration system), downspout planters, green roofing, rain barrels, pervious pavement, bump-outs (i.e. vegetated curb extensions), stormwater planters, rain gardens, and stormwater wetlands. Overall, the city has framed the green infrastructure mitigation impact in terms of "Greened Acres" representing management of one inch of precipitation from one acre of impervious surface. In total, the "Green Street, Clean Waters" Program has committed to converting a third of the city's existing impervious surface area (Philadelphia Water Department, 2011).

Philadelphia has determined that green stormwater infrastructure is efficient at reducing the volume of CSO and increasing percent capture of combined sewage. They expect the program will result in result in approximately 80% capture after 20 years. The 80% capture represents a reduction in volume of CSOs of between 5.2 and 8.0 billion gallons per year, a significant decrease in the amount of combined sewage discharged to Philadelphia's waterways. This also represents a mean reduction in the duration of overflows of between 37 to 44 hours per year across all outfalls in the city, a one third reduction in duration of CSOs. **Figure 1-5** shows the percent capture by watershed after implementation of the recommended program (Philadelphia, 2009).

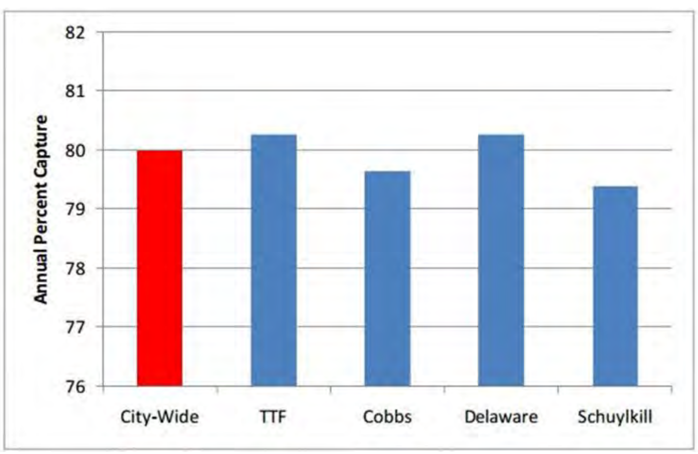


Figure 1-5: Average Annual Percent Capture, Philadelphia and Component Watersheds (Philadelphia)

Cost-Effectiveness of Green Infrastructure Measures

Along with determining where and how green infrastructure will work, a major question that CSO municipalities will investigate is the comparative cost-effectiveness of green versus gray infrastructure. A few cities with extensive experience in green infrastructure and major CSO control needs have investigated these issues in some detail. For instance, the Milwaukee Metropolitan Sewerage District found that landscaping and soil amendments were significantly less costly than green roofs, cisterns and street trees supplied with stormwater (Milwaukee, 2013), as shown in **Figure 1-6**.

[7] This term is used in the Philadelphia LTCP, which has been approved by USEPA. However, the LTCP does not explain the nature of the project beyond this statement.

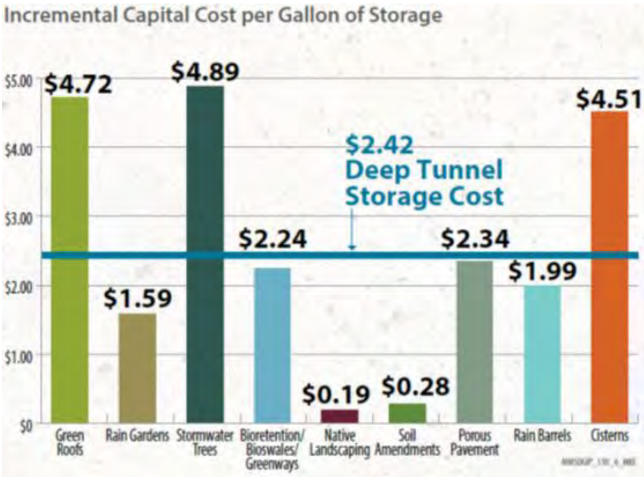


Figure 1-6: Comparison of CSO Control Costs (Milwaukee, 2013)

Philadelphia and others working with them have also developed studies exploring this issue. Philadelphia's situation is somewhat different from the New Jersey municipalities in that the city imposes an annual stormwater service fee on non-residential properties, related to the amount of impervious surface on each property. Landowners then can reduce that fee by engaging in measures that control the stormwater through green infrastructure and other on-site techniques. However, Philadelphia also requires that new development capture or treat the first inch of rainfall on-site, much of which will occur through the use of green infrastructure techniques. Valderrama et al. (2013) estimated that the costs of stormwater retrofits (i.e., changing stormwater management for existing development) as shown in **Figure 1-7**. New development that incorporates these techniques would have lower costs as the design and construction can be incorporated into the overall project.

Figure 1.1: Stormwater Management Practice Retrofits—Estimated Cost Ranges[14]

Stormwater Management Practice	SMP COST RANGE $/square foot of impervious area managed		SMP COST RANGE $/acre of impervious area managed	
	Mid-range	25% and 75% Quartiles	Mid-range	25% and 75% Quartiles
Downspout Disconnection (1)	$0.35	$0.33 - $0.38	$15,246	$14,377 - $16,450
Swales (2) (Vegetated Filtration, Retention, and Conveyance Structure)	$1.20	$0.64 - $2.13	$52,272	$27,878 - $92,783
Infiltration Trenches (3)	$1.46	$1.38 - $1.58	$63,598	$59,973 - $68,622
Rainwater Harvest & Reuse (2)	$3.28	$1.28 - $5.33	$142,877	$55,757 - $232,175
Rain Gardens (4)	$4.11	$3.88 - $4.43	$179,032	$168,827 - $193,175
Reducing Impervious (Hard) Surfaces (2)	$4.37	$3.94 - $4.58	$190,357	$171,626 - $199,505
Flow-Through Planters (2)"	$5.90	$3.84 - $7.68	$257,004	$167,270 - $334,541
Porous Pavements (5)	$5.17	$4.88 - $5.58	$225,205	$212,369 - $242,996
Green Roofs (2)	$34.98	$30.70 - $63.97	$1,523,729	$1,337,292 - $2,786,533

The above costs include materials, installation, design, and engineering, but do not include operations and maintenance costs. Cost ranges can vary greatly depending on site constraints. Data Soures:

1. AKRF Cost Estimate. Assumes disconnect is constructed as a do-it-yourself homeowner project.
2. Center for Watershed Protection 2007. *Urban Stormwater Retrofit Practices Manual.* CWP report costs were adjusted to 2012 dollars using a regional construction index. In addition, 20% was added for design and engineering and another 50% for contingency costs.
3. EPA 2004. "The Use of Best Management Practices (BMPs) in Urban Watersheds." EPA report costs were adjusted to 2012 dollars using a regional construction index. In addition, 20% was added for design and engineering and another 50% for contingency costs.
4. AKRF Cost Curve derived from built projects.
5. Urban Design Tools, Permeable Pavers, 2012. Low Impact Development Center, Inc. Urban Design Tools report costs were adjusted to 2012 dollars using a regional construction index. In addition, 20% was added for design and engineering and another 50% for contingency costs. In addition, it was assumed that any porous pavement retrofits would occur on previously paved areas. As a result, the cost of porous pavement installations also includes asphalt removal costs, which are anticipated to be $2.77/ft^2 of impervious area managed. Asphalt removal costs were derived from CWP 2007 Report Appendix E; costs were adjusted to 2012 dollars using a regional construction index. In addition, 20% was added for design and engineering and another 50% for contingency costs.

Figure 1-7: Stormwater Management Practice Retrofits – Estimated Cost Ranges (Valderrama et al. (2013)

The study then used these costs, the stormwater fees, and a cost of equity rate (8%) to estimate cost return curves. These curves would be different in New Jersey, where no stormwater fees are charged, but a similar approach can be used to determine returns on investment in green infrastructure on private lands as opposed to gray infrastructure in public ownership. The difference in costs, where favorable to green infrastructure, can be used as the basis for subsidy programs where public sewer utilities encourage private on-site investments beyond what regulations require (such as on-site retrofits where no development action is proposed); the subsidies would be set at a level that elicits private investment while reducing the overall costs to the utility's customers. **Figure 1-8** shows the example of how subsidies of various levels could improve the cost return for private sector actions and therefore the potential for Philadelphia green infrastructure benefits (Valderrama et al., 2013).

	Off-site Mitigation	Aggregation	$0.50/ft² Subsidy	$1.00/ft² Subsidy	$3.00/ft² Subsidy	$3.50/ft² Subsidy
Downspout Disconnection	■	■	■	■	■	■
Swales		◫	◧	■	■	■
Infiltration Trenches			◧	■	■	■
Rainwater Harvest & Reuse			◫	◫	◧	◧
Rain Gardens					◧	■
Reducing Impervious (Hard) Surfaces					◫	■
Flow-Through Planters					◫	◫
Porous Pavements						
Green Roofs						
New Potential Greened Acres	658	215	2,532	2,252	1,015	344
Total Potential Greened Acres	658	873	3,405	5,656	6,671	7,015
Progress to 9,564 Greened Acres Goal	7%	9%	36%	59%	70%	73%

Guide to Figure

Distinct policy strategies are listed across the top, and SMPs are listed down the left-hand column. "Off-site mitigation" refers to a program whereby nonresidential property owners could receive stormwater fee credits for investing in retrofits on residential properties. "Aggregation" refers to the use of governmental or quasi-governmental resources to aggregate projects, assuming that such aggregation would substantially reduce transaction costs and would yield economies of scale that reduce capital costs by about 10 percent.[29] "Subsidy" refers to a direct payment by PWD to a property owner to offset a portion of the up-front capital costs of a greened acre retrofit project.

The greened acre bars in each cell illustrate when a specific SMP retrofit type becomes economically viable for private investors, assuming implementation of the policy strategies listed across the top. An "economically viable" project is defined as one that reaches a discounted payback within 10 years, assuming a discount rate of 8 percent. A full acre bar (■)indicates that a substantial majority of projects—that is, those at or below the 75th percentile cost for a given SMP category—become economically viable when the policy strategy indicated is implemented. For example, all downspout disconnect projects would become economically viable if an off-site mitigation program were created. The quarter-acre bar (◫)and half-acre bar (◧) indicate that only 25 percent or 50 percent of retrofit projects for a given SMP category become economically viable when the policy strategy is implemented. For example, aggregation could make one-quarter of swale projects economically viable. The subsidy columns assume that aggregation programs have already been implemented, as this is considered a prerequisite to creation of a private investment market in stormwater retrofits.

Figure 1-8: Estimated Subsidy Rates for Building a "Greened Acre" Market (Valderrama et al., 2013)

A New Jersey Case Study

A recent study examined the effectiveness of green infrastructure systems in controlling combined sewer flows and therefore CSO discharge volumes (Sliwecki, 2014). The study used the new National Stormwater Calculator model (USEPA, 2014b) to calculate potential stormwater runoff reduction benefits of green infrastructure techniques in two CSO catchment areas with significantly different land uses in North Bergen Township, Hudson County. One catchment area (#4) is characterized by dense residential development, while the other (#9) is primarily industrial in nature (see **Figure 1-9**).

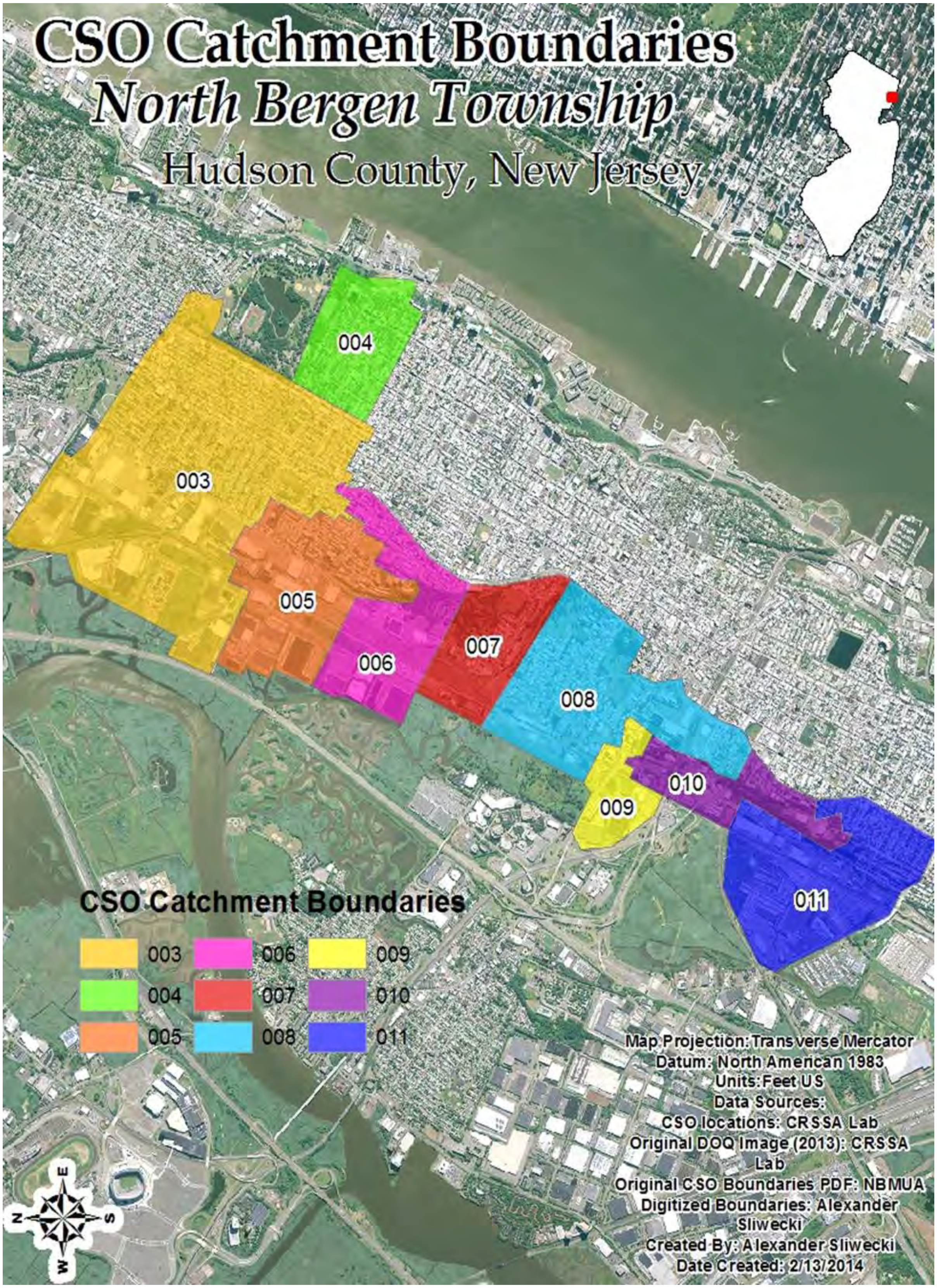


Figure 1-9: North Bergen Township CSO Catchment Areas (Sliwecki, 2014)

The Stormwater Calculator model requires an understanding of the various categories of pervious and impervious surfaces within the catchment area. **Figures 1-10** and **1-11** show the results for the two areas.

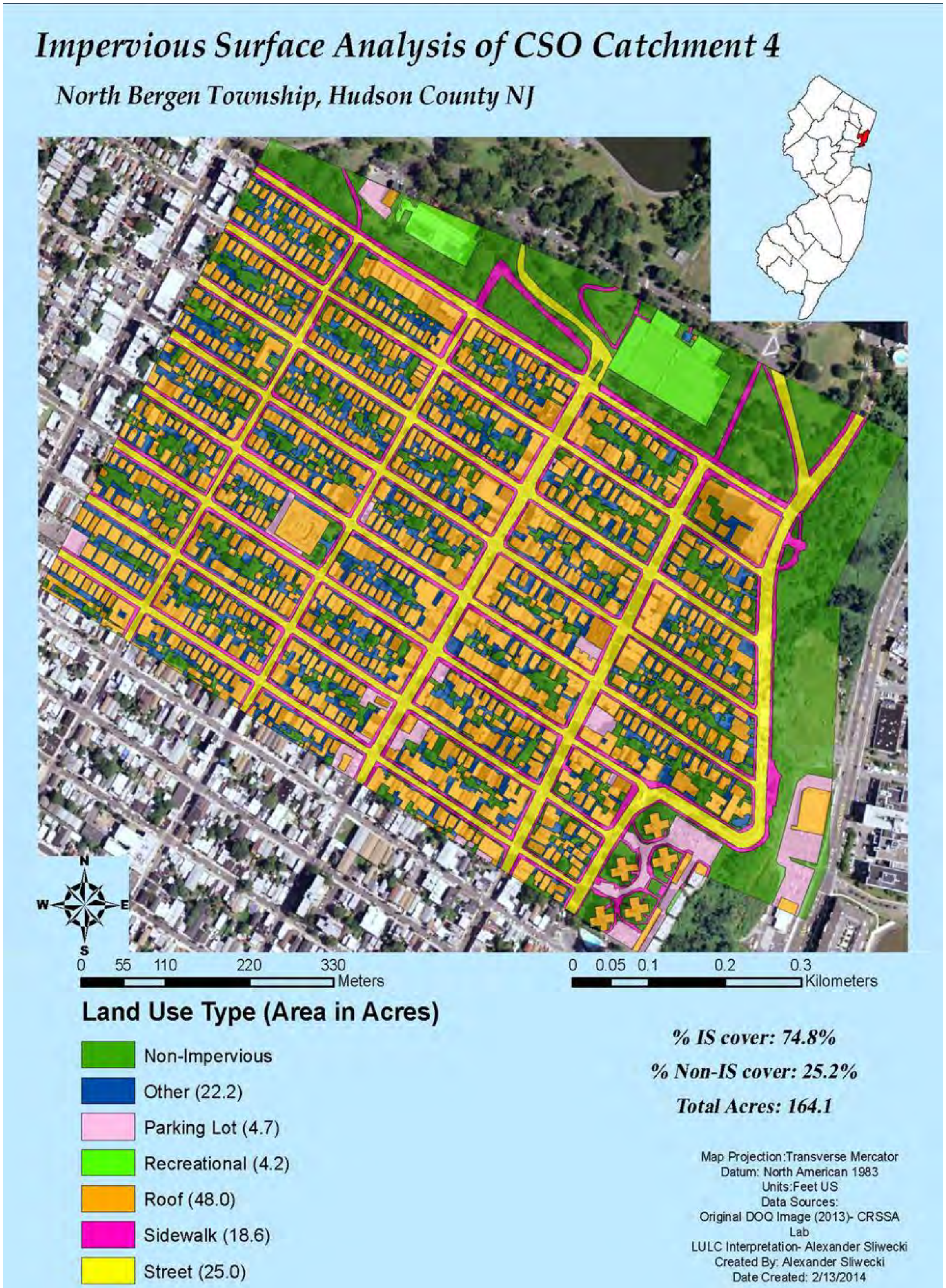


Figure 1-10: CSO Catchment Area #4, North Bergen Township (Sliwecki, 2014)

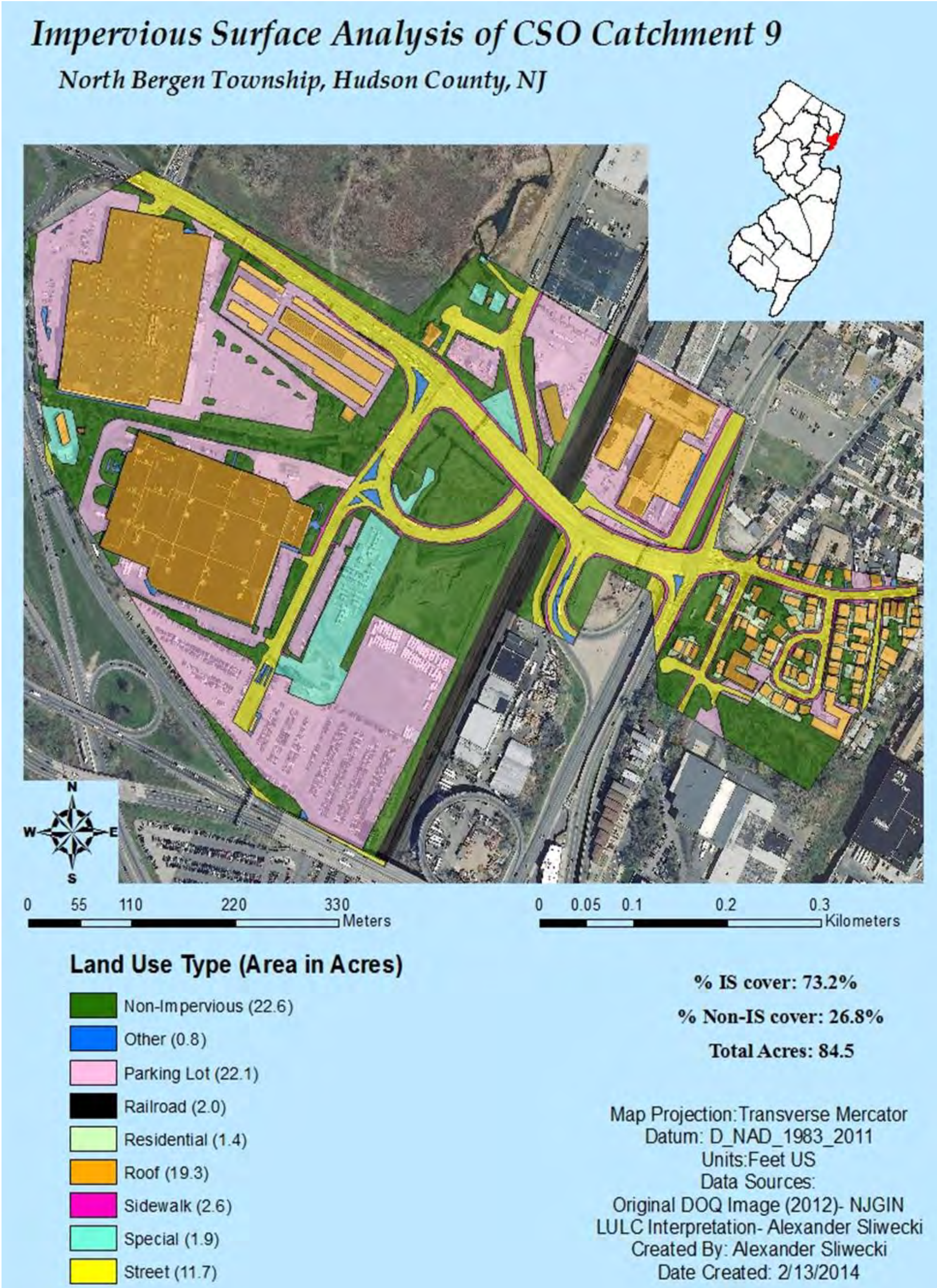


Figure 1-11: CSO Catchment Area #9, North Bergen Township (Sliwecki, 2014)

The Stormwater Calculator model incorporates recent rainfall data; for this project, the model used historic rainfall data from Central Park, New York City. The model runs estimated the effectiveness of green infrastructure in reducing total stormwater runoff, the number and percentage of wet days captured, and other outputs based on baseline (historic rainfall) conditions and on climate change impacts through 2050. The baseline rainfall conditions are the focus here, but the climate change is projected to increase total annual rainfall and rainfall severity, for which stormwater techniques should be designed to avoid under-predicting the necessary rates of capture. The model provides for two options in green infrastructure design, allowing capture of the first 0.5 or 1 inches of rainfall on the target surface. In addition, the modeling scenarios assumed that only 50% of total impervious surfaces would be treated in residential areas (due to likely limitations regarding roof runoff capture, participation and other issues), but that 100% of treatable areas would be addressed in the industrial areas. However, in both areas, the scenarios did not include treatment of street runoff, which as discussed above have been implemented in other cities. Therefore, the model scenarios are conservative in terms of treatable area, and may be conservative or not regarding how much of that treatable area can feasibly be addressed given local conditions.

Figure 1-12 shows that for a primarily residential urban area (Catchment #4) at 50% utilization of green infrastructure, stormwater runoff is reduced by 8% using a 0.5 inch storm design and a total of 10% using a 1 inch storm design. These rates translate into 4.4 to 5.6 inches of rainfall captured per year. In the case of an industrial area (Catchment #9) at 100% utilization, the reductions are 12% using a 0.5 inch storm design and a total of 18% using a 1 inch storm design. These rates translate into 5.8 to 8.4 inches of rainfall captured per year. These values are significant reductions in total runoff, which will translate into CSO volume reductions.

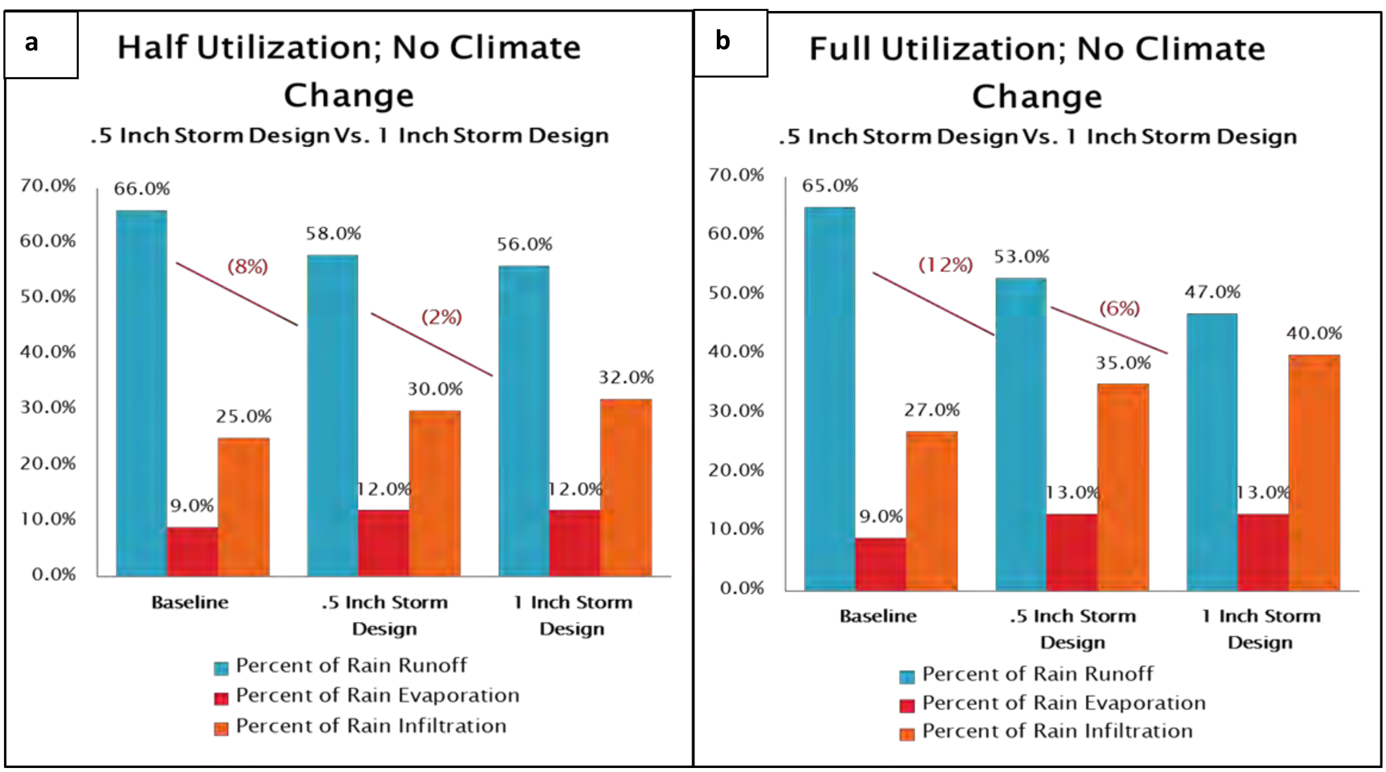


Figure 1-12: Effectiveness of Green Infrastructure in Reducing Total Stormwater Runoff: (a) CSO Catchment Area #4; (b) CSO Catchment Area #9, (Sliwecki, 2014)

Figure 1-13 shows a difference perspective, regarding the total percentage of wet days where the green infrastructure would capture the runoff for the full catchment area. Some wet days have insufficient rainfall to create runoff, which is calculated by the model as the baseline condition. Therefore, of greatest interest is the difference between the baseline rate and the rates with implementation of green infrastructure. The number of wet days retained increases by roughly 10% for Catchment #4 (50% utilization, 1 inch storm design) and 18% for

Catchment #9 (100% utilization, 1 inch storm design). Little change is shown between baseline and climate change scenarios. These results indicate that the use of green infrastructure can contribute significantly to the reduction of runoff into combined sewers, but also that green infrastructure is only a partial answer to the problem of CSO control.

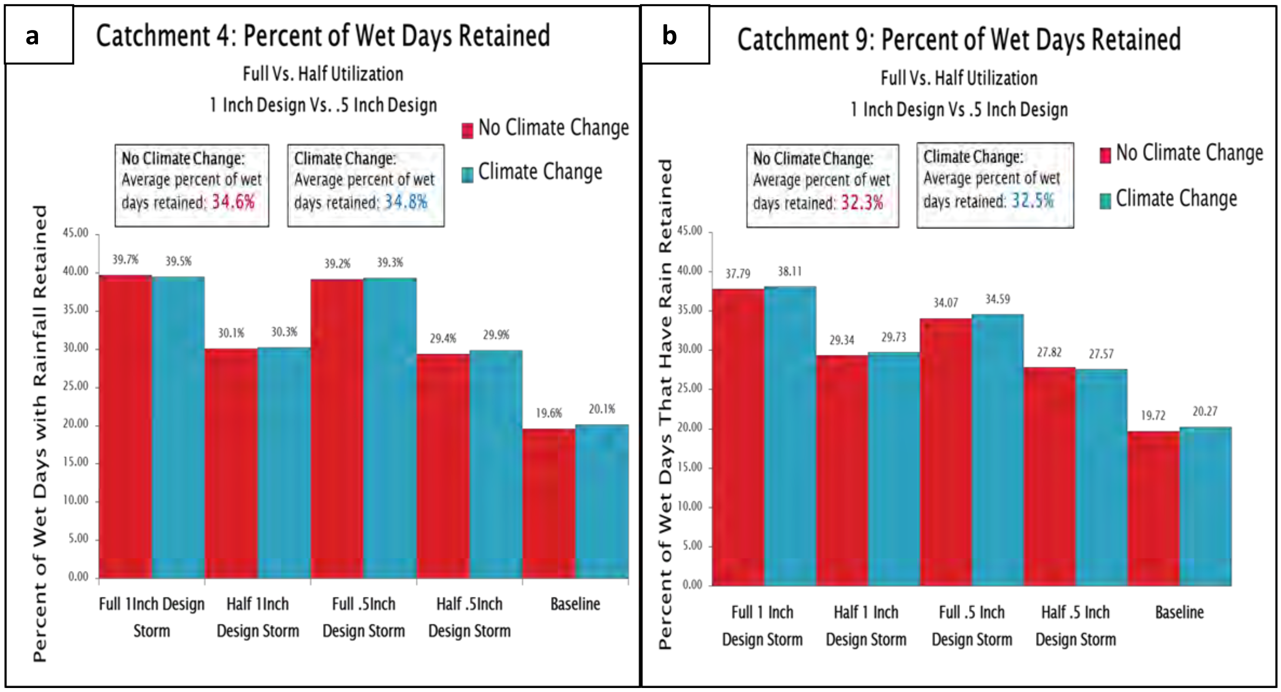


Figure 1-13: Effectiveness of Green Infrastructure in Reduction of Wet Weather Days Generating Runoff: (a) CSO Catchment Area #4; (b) CSO Catchment Area #9, (Sliwecki, 2014)

NJPDES Individual Permits for CSO Controls

The requirements and expectation for CSO controls in the new Individual Permits are far more robust than the 2004 General Permit and go well beyond ensuring control of solids and floatable materials for CSO permittees. More importantly, the new Individual Permits afford significant latitude in developing progressive local policies to mitigate or eliminate CSO events. Under the Summary of Permit Conditions, the section covering the Nine Minimum Controls (NMCs) begins by noting that "[p]ermitees are encouraged to be creative and explore innovative and cost-effective measures in implementing the NMC's to address their specific CSOs." Each of the Nine Minimum Controls is explained in greater detail in **Table 1-4**, comparing the previous requirements under the 2004 General Permits and new requirements of the draft Individual Permits.[8]

[8] See <www.nj.gov/dep/dwq/cso.htm> for all of the draft CSO permits

<table>
<tr><th colspan="2">Table 1-4: Overview of Changes in CSO Permit Requirements: Nine Minimum Controls (NJDEP, 2013)</th></tr>
<tr><th>CSO GP (2004)</th><th>Draft Individual CSO Permits (2013-2014)</th></tr>
<tr><td colspan="2">1. Proper Operation and Regular Program Requirements</td></tr>
<tr><td>"...[D]evelop and maintain a current Operations and Maintenance (O&M) Plan and Manual for their contributory collection system to the CSO outfalls."[9]</td><td>"…[C]ontinue to implement and annually update, an Operations & Maintenance (O&M) Program (and corresponding Manual), Emergency Plan, detailed Standard Operating Procedures (SOPs) and an Asset Management Plan to ensure that the treatment works, which are owned and/or operated by the permittee, are operated and maintained in a manner that achieves compliance with all terms and conditions of the permit."
"…[P]rovide an updated accurate characterization on a GIS map (including the capacity, dimensions, age, type of material, etc.) of the entire collection system owned and/or operated by the permittee that conveys flows to the treatment."
"…[O]ngoing Infiltration and Inflow (I/I) reduction strategies through the identification of I/I sources and the prioritization and implementation of I/I reduction projects."
"The permittee shall review its rules, ordinances and sewer use agreements with its customer and/or upstream municipalities and revise if necessary to require them to identify I/I and reduce where appropriate, and to identify and eliminate interconnections and cross-connections in storm sewers."</td></tr>
<tr><td colspan="2">2. Maximum Use of Collection System for Storage</td></tr>
<tr><td>"…[C]onduct a feasibility study to evaluate in-line and off-line storage technologies for incorporation into possible future control strategies to store flow for subsequent treatment at the STP [Sewage Treatment Plant] after downstream conveyance and treatment capacities were restored."</td><td>"…[M]inimize the introduction of sediment and obstructions…"
"…[R]egularly remove impediments to flows within the system…"
"…[I]dentify and implement minor modifications to enable the entire collection system owned/operated by the permittee that conveys flows to the treatment works to store additional wet weather flows to minimized CSO discharges (volume, frequency and duration), while not creating or increasing sewage overflows to basements, streets, and other public and private areas, until downstream sewers and treatment facilities can adequately convey and treat the flows."</td></tr>
<tr><td colspan="2">3. Review and Modification of Pretreatment Requirements to Assure CSO Impacts are Minimized</td></tr>
<tr><td>"…STP were required to explore various options to minimize discharges of non-domestic users during wet weather periods."</td><td>"[A]ll CSO permittees are required to determine the locations of the Significant Indirect/Industrial Users (SIUs) as it relates to the locations of its CSO outfall, and the discharge nature of the SIUs for the entire collection system which is owned and/or operated by the permittee."
"The permittee is to determine and prioritize the environmental impact of these SIUs by CSO outfall and include this information in the characterization portion of its Operation and Maintenance Program."</td></tr>
<tr><td colspan="2">4. Maximization of Flow to the POTW for Treatment</td></tr>
<tr><td>"[T]he permittee was required to operate and maintain the facilities to</td><td>2004 General Permit requirements continued.
"[T]he permittee is also required to evaluate and implement low-cost alternatives for increasing the flow to the STP, based upon capacity</td></tr>
</table>

[9] The initial purpose of the O&M Plan and Manual was to demonstrate that the permittee had met all the necessary financial, administrative, and institutional arrangement required in the permit.

Table 1-4: Overview of Changes in CSO Permit Requirements: Nine Minimum Controls (NJDEP, 2013)	
CSO GP (2004)	**Draft Individual CSO Permits (2013-2014)**
maximize the conveyance of wastewater to the STP for treatment…" • "…[M]inimize the frequency and duration of CSOs to the receiving waters."	evaluations for the permittee's collection system."
5. Prohibition of CSOs during Dry Weather	
"[D]ry weather overflows (DWOs) are prohibited from any CSO outfall."	• 2004 General Permit requirements continued. • "[T]he permittee is required to inspect the combined sewer system as part of its Operation & Maintenance Program to ensure there are no DWOs." • "[T]he permittee shall prohibit any connection, including but not limited to construction dewater, remediation activities or similar activities, downstream of a CSO regulator that will convey flow to the CSO during dry weather."
6. **Control of Solids and Floatable Materials in CSOs**[10]	
"[T]he permittee was required to capture and remove solids floatables from the CSO discharges."	• The continuation of the 2004 General Permit requirement. • "…[T]he permittee will also be required to report the amount of solids/floatables captured and removed from the CSO discharges." • "…[T]he permittee is also required to reduce solids floatables from entering the collection system through pollution prevention measures such as street sweeping and storm inlet retrofitting."
7. Pollution Prevention	
"…[T]he permittee was required to develop, implement, and maintain a Combined Sewer Overflow Pollution Prevention Plan (CSOPPP)."[11]	• "…[T]he permittee will be required to continue implement and upgrade pollution prevention measures necessary to prevent and limit contaminants from entering the entire collection system owned and/or operated by the permittee …"[12] • "…[R]etrofitting of storm drain inlets such that each horizontal grate meets the specifications for maximum opening size." • "…[The extension] of applicable stormwater management practices, ordinance and rules to combined sewer areas of their towns."[13]

[10] NJDEP notes that the General Permits simply required that "all CSOs provide for the capture of 'solids and floatables'… [by]…providing netting or bar screens at the point of discharge that will prevent the passage of any item through an opening smaller than ½ inch." (Combined Sewer Outfall (CSO) Individual NJPDES Discharge Permits FAQs 2013) As of late 2013, 88% of New Jersey's CSOs have primary treatment mechanisms for solid and floatable materials installed; the individual permit requires that the remaining 12% have such barriers installed.

[11] The Combined Sewer Overflow Pollution Prevention Plan (CSOPPP) required documentation of the procedure for the purpose of developing, evaluating, and implementing interim and long-term solids/floatables control measures.

[12] Those pollution prevention measures include the implementation of a regular street cleaning program, solid waste collection and recycling ordinances, and public education programs.

[13] Here the NJDEP clarifies with an example, "…for retrofitting the stormwater inlets and ensure that the same street sweeping schedule applies to all street sweeping schedules applies to all streets in the town, regardless of how the area is sewered [i.e. either Combined or Separate Sewer System]."

Table 1-4: Overview of Changes in CSO Permit Requirements: Nine Minimum Controls (NJDEP, 2013)	
CSO GP (2004)	**Draft Individual CSO Permits (2013-2014)**
8. Public Notification to Ensure that the Public Receives Adequate Notification of CSO Occurrences and CSO Impacts	
"…[M]ake CSOPPPs available to the public for inspection and duplication."	• "…[P]ost CSO Identification Signs (minimum 18" x 24") constructed out of reflective material at each of its CSO outfall locations providing its NJPDES Permit No., Discharge Serial No., phone numbers of the permittee and the NJDEP Hotline with language to report any dry weather discharges or discharges with foul odors or discoloration, and the general statement that there may be sewage overflows during the following wet weather with the possibility that contact with the water may cause illness." • "…[E]mploy measures such as the posting or leaflets/flyers /signs at affected use areas (.e., beaches, marina or docks, fishing piers, etc." and /or notifying residents by either the US Postal Services or email describing what CSOs are, the locations of the CSO outfalls , and public health and safety information." • "…[C]reate and maintain on a daily basis a telephone hot line or website to provide immediate /up-to-date information regarding where CSO discharges may be occurring."
9. Monitoring to Effectively Characterized CSO Impacts and the Efficacy of CSO Controls	
"…[C]haracterize its CSO discharges for quality, flow volume, duration, and frequency sufficient to calibrate and validate a computer model to predict the response of the permittee's CSO system to varied precipitation events."	• "…[U]pdate the characterization information as described above and monitor the CSO discharge events and record the date, time, duration, precipitation, and weight/volume of Solids/Floatables removed for each CSO discharge event through appropriate modeling or by an appropriately placed flow meter/totaling device, level sensor, or other appropriate measuring device, and report the required information on the DMR as required by Part III of this permit."

The draft individual permit also incorporates changes to requirements with respect to the state's compliance with the nine minimum elements of the National Long Term Control Plan (LTCP) Policy. **Table 1-5** outlines the enhancements made by the NJDEP from the 2004 General Permits, which apply to the development of Long Term Control Plans by each facility owner.

Table 1-5: Overview of Changes in CSO Permit Requirements: Nine Minimum Elements (NJDEP, 2013)	
CSO GP (2004)	**Draft Individual CSO Permits (2013)**
1. Characterization, monitoring, and modeling activities as the basis for section and design of effective CSO controls	
"…[S]ubmit a Combined Sewer Overflow Discharge Characterization Study consisting of a field calibrated and verified Combined Sewer Overflow Model designed to represent the combined sewer system's response to historical events of precipitation."	"…[S]ubit an updated characterization study of the combined sewer system to establish the existing baseline conditions evaluate the efficiency of the technology based controls, determine the baseline condition upon which the LTCP will be based and uniformly characterize the hydraulically connected system with respect to the requirement of the permit, specifically the number of events as defined in the permit."

Table 1-5: Overview of Changes in CSO Permit Requirements: Nine Minimum Elements (NJDEP, 2013)	
CSO GP (2004)	**Draft Individual CSO Permits (2013)**
2. A public participation process that actively involves the affected public in the decision-making to select long-term CSO controls.	
"…[C]reate a Public Participation Program that would ensure the opportunity for participation by the public in the LTCP development process."	"…[S]ubmit uploaded Public Participation Plan and to involve the public in the decision making process in determining the alternatives chosen under the LTCP."
3. Consideration of sensitive areas as the highest priority for controlling overflows	
	"…[G]ive the highest priority to controlling overflows in sensitive areas, The LTCP shall prohibit increased CSO overflows and climate/relocate CSO overflows in sensitive areas. If elimination/relocation is not possible, the permittee shall provide treatment necessary to meet the WQS."
4. Evaluation of alternatives that will enable the permittee, in consultation with the NPDES permitting authority, WQS authority, and the public, to select CSO controls that will meet Clean Water Act (CWA) requirements.	
"…[E]valuate specific alternative interim and long term control measures for the control of pathogens and formulate cost and performance relations for treatment of CSO discharges."	"…[E]valuate a broader range of control alternatives that meet WQS using either the Presumption Approach or Demonstration Approach. The control alternatives shall include: green infrastructure, increased storage in the collection system, STP expansion/storage, I/I reduction, sewer separation, discharge treatment and bypass or secondary treatment at the STP."[14]
5. Cost/performance considerations to demonstrate the relationships among a comprehensive set of reasonable control alternatives.	
"…[D]evelop cost and performance analysis report for specific control alternatives for each CSO."	"…[U]pdate and submit cost/performance considerations to determine where the increment of pollution reduction diminishes compare to the increased cost, often known as 'knee of the curve.'"
6. Operational plan revisions to include agreed-upon long–term CSO controls.	
"…[D]evelop an operational plan to implement control alternatives from continuous disinfection on outfalls that had been required to remove solids and floatables."	"…[M]odify the O&M Program and Manual to address the final LTCP CSO control facilities and operating strategies."
7. Maximization of treatment at the existing POTW treatment plant for wet weather flows.	
	"…[I]nvestigate the control alternative of maximizing flow through the STP, including the alternative of bypassing of secondary treatment at the STP."

[14] Under the 'Presumption Approach' the permittee "chooses to implement a minimum level of treatment (e.g., 4 or less overflow events per year, or primary clarification of at least 85 percent of the collected combined sewage flows) that is presumed to meet the water quality-based requirements of the CWA, unless data indicate otherwise." Under the 'Demonstration Approach' the permittee "demonstrates that its plan is adequate to meet the water quality-based requirements of the CWA."

Table 1-5: Overview of Changes in CSO Permit Requirements: Nine Minimum Elements (NJDEP, 2013)	
CSO GP (2004)	**Draft Individual CSO Permits (2013)**
8. **An implementation schedule for CSO controls.**	
	"…[S]ubmit a construction and financing schedule for implementation of the LTCP CSO controls. The scheduling may be phased and shall consider: addressing areas of overflows discharges to sensitive areas as highest priority, use impairment of receiving water, permittee's financial capability, grant/loan availability, user fees and rate structure, funding mechanisms and resources necessary to implement as asset management plan."
9. **A post-construction compliance monitoring program (CMP) adequate to verify compliance with water quality-based CWA requirements and ascertain the effectiveness of CSO controls**	
• "…[C]onduct an annual inspection of all combined sewer overflow control facilities owned and/or operated by the permittee." • "…[S]ubmit a rainfall monitoring study and a CSO monitoring study."[15]	"…[I]mplement a CMP to verify: baseline and existing conditions, effectiveness of controls, compliance with the WQS and protection of designated uses."[16]

The new Individual Permits provide a significant increase in clarity, specificity and rigor to the CSO requirements that had been in the 2004 General Permit. Moreover, the draft permit specifically calls for consideration of "green" infrastructure, a relatively new concept where the emphasis is on modifying stormwater management prior to the combined sewer system using techniques that mimic the natural hydrologic cycle, such as soil storage, transpiration, on-surface ponding, subsurface storage, and rain gardens (see www.nj.gov/dep/gi). The intent is to prevent stormwater from moving into combined sewers or separate stormwater sewers, or at least to delay stormwater introduction to the gray infrastructure until after peak flows have passed. For example, New York City approved an ordinance requiring developers to detain ten times more stormwater than the prior ordinance, which is driving innovation in site design.[17] As discussed above in the section "**Options for CSO Controls**," the general expectation is that a robust green infrastructure program could reduce total CSO volumes by perhaps 10 percent, reducing both the number of smaller discharges and the peak rate of larger events, while simultaneously improving quality of life through the use of urban amenities.

Of critical importance in the new Individual Permits are the two options for compliance with the substantive implementation of CSO controls:

- Presumption Approach: Achieve a minimum level of treatment "that is presumed to meet the water quality-based requirements of the CWA, unless data indicate otherwise."
    i. **Four (4) or less overflow events per year** from a hydraulically connected system, as averaged over a rolling 60 month period (though NJDEP may allow an additional two events per year), with an "event" defined as one or more overflows within a 24 hour period, regarding flows that do not receive the minimum treatment specified; or

[15] The NJDEP notes that the permittee was not required to monitor the water quality of a receiving water body.
[16] Studies that were previously submitted can be used in developing the compliance monitoring program, which will detail the monitoring protocols. While using the Demonstration Approach (mentioned under the fourth element of the LTCP) will require continuous monitoring every year, monitoring under the Presumption Approach may be reduced during the implementation of the CSO controls.
[17] Interview with Carter Strickland, then-Commissioner, NYC Department of Environmental Protection, 6 Dec 2013

ii. Elimination or capture for treatment of **no less than 85% by volume** of the combined sewage collected by a CSS on a system-wide annual average basis;[18] or
iii. Elimination or removal of the e**quivalent mass of pollutants** that would be removed under ii; or
iv. **Primary clarification, solids removal and disinfection** of remaining overflows after implementation of the Nine Minimum Controls and achievement of ii or iii.

- Demonstration Approach: demonstrates that its plan is adequate to meet the water quality-based requirements of the CWA through each of the following:
  i. **Achievement of water quality standard** unless natural background or other sources preclude;
  ii. Remaining discharges **will not preclude attainment of water quality standards or protection of designated uses**, or contribute to their impairment;
  iii. Provide **maximum pollution reduction benefits reasonably attainable**; and
  iv. The program allows **cost-effective expansion or retrofitting** if required.

The Presumption Approach has multiple options for showing a minimum level of treatment, but NJDEP retains the ability to determine that meeting one of the approaches is insufficient to protect specific sensitive areas or to meet water quality objectives based on any of the monitoring and modeling studies. Therefore, the presumption of compliance is conditional. Given the "sunk costs" involved if a discharger pursues the Presumption Approach and then is required to modify their approach, NJDEP will need to provide guidance to individual permittees as early in the process as is feasible. The Demonstration Approach would seem to require modeling of receiving waters to show that the water quality benefits are sufficient. Given that the Long Term Control Plans are required in 36 months, and given the time necessary to develop a sound water quality model, either schedule flexibility will be needed in some cases or modeling requirements will need to be simplified; otherwise systems will likely pursue the Presumption Approach to have a more definitive objective for their planning.

The requirements of the Individual Permits will necessitate reconsideration and reworking of the analyses previously submitted in compliance with the 1999 and 2004 General Permits. These new analyses will entail costs for the municipalities, but the expectation is that recent advances in CSO control practices will allow municipalities to achieve satisfactory controls in many instances with at least somewhat less costly methods than had been contemplated in the earlier reports. The extent to which this expectation is met will depend heavily on NJDEP, utility and municipal policy and management philosophy, local and consultant expertise, information and technology transfer among the municipalities and NJDEP, redevelopment trends in each municipality, and the ability for municipalities to address CSO control needs through non-traditional approaches that will require attention and involvement of many city departments, agencies and neighborhood organizations that are not normally involved with water infrastructure issues. For instance, NJDEP is working with Bayonne and a variety of vendors to test disinfection technology applicable to CSO overflows, so that a more cost-effective approach can be identified for use by many municipalities, reducing regulatory uncertainty, planning costs, and costs for bench testing and design (Cach et al., 2010). Regardless of the approach chosen, CSO control will be complex and costly for many systems. The draft permits requires implementable plans, but these plans can consider (among other things) financial capacity, user fees and rate structures, and availability of funding. While expectations will differ depending on the number of CSO outfalls and the complexity of solutions, some systems will require decades to complete all actions, as has been true in other cities where 20 years or more were required. However, Trenton has already reduced its CSO events to less than four per year (though verification of water quality protection is still required) and other cities may find that relatively straightforward actions can be implemented in much shorter schedules.

[18] The wording of this provision is interesting in that it refers to the entire combined sewer flows on an annual basis, rather than of the calculated overflow volumes. Many systems already transmit substantial portions of their total combined sewer flows to the treatment plants, even during significant storms. How this criterion works in operation will depend heavily on the particular configuration and characteristics of each system

Chapter 2: Demographic and Economic Overview of CSO Municipalities

This chapter provides an overview of the CSO municipalities regarding their population trends, employment, and economies. Demographic data regarding the 21 CSO municipalities show many significant differences from New Jersey as a whole. Many experienced population and employment losses as manufacturing industry declined, port facilities concentrated in Newark Bay, and suburbs expanded. This section provides an overview of the demographic changes and projections for 2040. CSO municipalities range from the most populous in New Jersey (Newark and Jersey City) to among the smallest (East Newark, 474th in population). **Table 2-1** lists all municipalities in New Jersey with 2010 populations greater than 75,000; CSO municipalities (in **bold**) comprise six of the thirteen, including the top four.

Table 2-1: New Jersey Municipalities with Populations Greater than 75,000		
Municipality	**County**	**2010 population**
1. **Newark**	Essex	277,140
2. **Jersey City**	Hudson	247,597
3. **Paterson**	Passaic	146,199
4. **Elizabeth**	Union	124,969
5. Edison	Middlesex	99,967
6. Woodbridge	Middlesex	99,585
7. Lakewood	Ocean	92,843
8. Toms River	Ocean	91,239
9. Hamilton township	Mercer	88,464
10. **Trenton**	Mercer	84,913
11. Clifton	Passaic	84,136
12. **Camden (City of)**	Camden	77,344
13. Brick	Ocean	75,072

Population and Housing Status and Past Trends

Socioeconomic data of the 21 CSO municipalities (**Table 2-2**) show a 2012 estimated population of 1.5 million, which represents 16.9% of New Jersey's total estimated population of 8,864,590 (U.S. Census Bureau). Nearly two-thirds of the CSO municipality population (64.3%) is accounted for just by the six largest: Newark, Jersey City, Paterson, Elizabeth, Trenton, and Camden. As shown in **Table 2-3**, many of these older, built-out places had long been stagnant or even losing population – from 1950 through 1990, the 21 CSO municipalities as a group lost nearly 300,000 residents (a 17.5% loss) and went from nearly 35% of total state population to 18%, though Fort Lee outpaced statewide growth during that period. In 1990, some of the CSO municipalities began to grow significantly, particularly in Hudson County. From 1990 to 2008, eight of them actually grew faster than the statewide rate as redevelopment began to happen, although together they accounted for only 6.9% of the total statewide population increase. But from 2008 to 2012, when redevelopment really gained steam after the recession, 14 of them grew faster than the statewide growth rate, and the whole group of 21 CSO municipalities accounted for 26% of the statewide population increase. As a group, the CSO municipalities look to be on the verge of regaining some of their lost historical economic importance, as the trend toward redevelopment becomes more widespread in New Jersey, though some continue to lose population, such as Camden, Gloucester City, Paterson and Trenton.

Table 2-2: Census Population of CSO Municipalities, 1950-2010 (*6 Largest as of 2010)								
Municipality	**1950**	**1960**	**1970**	**1980**	**1990**	**2000**	**2010**	**2012**
Bayonne	77,203	74,215	72,743	65,047	61,464	61,842	63,024	64,416
Camden*	124,555	117,159	102,551	84,910	87,460	79,904	77,344	77,250
East Newark	2,173	1,872	1,922	1,923	2,165	2,377	2,406	2,441
Elizabeth*	112,817	107,698	112,654	106,201	110,138	120,568	124,969	126,458
Fort Lee	11,648	21,815	30,631	32,449	31,894	35,404	35,345	35,732

Table 2-2: Census Population of CSO Municipalities, 1950-2010 (*6 Largest as of 2010)								
Municipality	**1950**	**1960**	**1970**	**1980**	**1990**	**2000**	**2010**	**2012**
Gloucester City	14,357	15,511	14,707	13,121	12,761	11,484	11,456	11,440
Guttenberg	5,566	5,118	5,754	7,340	8,263	10,807	11,176	11,356
Hackensack	29,219	30,521	36,008	36,039	37,087	42,677	43,010	43,845
Harrison	13,490	11,743	11,811	12,242	13,168	14,424	13,620	13,874
Hoboken	50,676	48,441	45,380	42,460	33,392	38,577	50,005	52,034
Jersey City*	299,017	276,101	260,350	223,532	228,475	240,055	247,597	254,441
Kearny	39,952	37,472	37,585	35,735	34,874	40,513	40,684	41,389
Newark*	438,776	405,220	381,930	329,248	275,291	272,533	277,140	277,727
North Bergen	41,560	42,387	47,751	47,019	48,075	58,092	60,773	61,960
Paterson*	139,336	143,663	144,824	137,970	158,019	149,222	146,199	145,219
Perth Amboy	41,330	38,007	38,798	38,951	41,868	47,308	50,814	51,744
Ridgefield Park	11,993	12,701	13,990	12,738	12,522	12,873	12,729	12,864
Trenton*	128,009	114,167	104,786	92,124	88,549	85,397	84,913	84,477
Union City	55,537	52,180	57,305	55,593	58,051	67,096	66,455	67,744
Weehawken	14,830	13,504	13,383	13,168	12,392	13,493	12,554	12,832
West New York	37,683	35,547	40,627	39,194	38,719	45,768	49,708	51,464
NJ total	**4,835,329**	**6,066,803**	**7,171,112**	**7,365,011**	**7,747,750**	**8,414,360**	**8,791,894**	**8,864,590**
CSO Municipal Totals	1,689,727	**1,605,042**	**1,575,490**	**1,427,004**	1,394,627	1,450,414	1,481,921	1,500,707
% of State	34.9%	**26.5%**	**22.0%**	**19.4%**	18.0%	17.2%	16.9%	16.9%
6 Largest CSO Cities	1,242,510	1,164,008	1,107,095	973,985	947,932	947,679	958,162	965,572

Table 2-3: Population of CSO Municipalities, 1950-2012 (*6 Largest as of 2010) (**Bold Green** indicates greater growth than New Jersey as a whole)				
Municipality	**Change 1950-2012 (%)**	**Change 1950-1990 (%)**	**Change 1990-2008 (%)**	**Change 2008-2012 (%)**
Bayonne	-16.6%	-20.4%	0.5%	**4.3%**
Camden*	-38.0%	-29.8%	-10.7%	-1.1%
East Newark	12.3%	-0.4%	9.3%	**3.1%**
Elizabeth*	12.1%	-2.4%	11.4%	**3.1%**
Fort Lee	**206.8%**	173.8%	10.1%	1.7%
Gloucester City	-20.3%	-11.1%	-10.0%	-0.4%
Guttenberg	**104.0%**	48.5%	**32.1%**	**4.0%**
Hackensack	50.1%	26.9%	15.0%	**2.8%**
Harrison	2.8%	-2.4%	2.7%	**2.6%**
Hoboken	2.7%	-34.1%	**41.5%**	**10.2%**
Jersey City*	-14.9%	-23.6%	6.0%	**5.0%**
Kearny	3.6%	-12.7%	**14.8%**	**3.4%**
Newark*	-36.7%	-37.3%	-0.5%	1.4%
North Bergen	49.1%	15.7%	**23.4%**	**4.5%**
Paterson*	4.2%	13.4%	-8.0%	-0.1%
Perth Amboy	25.2%	1.3%	**19.9%**	**3.1%**
Ridgefield Park	7.3%	4.4%	1.2%	1.5%
Trenton*	-34.0%	-30.8%	-3.9%	-0.7%
Union City	22.0%	4.5%	**12.8%**	**3.5%**
Weehawken	-13.5%	-16.4%	1.0%	**2.5%**
West New York	36.6%	2.7%	**24.5%**	**6.8%**
NJ total	**83.3%**	**60.2%**	**12.4%**	**1.8%**
CSO Municipal Totals	-11.2%	-17.5%	4.7%	2.7%
6 Largest CSO Cities	-22.3%	-23.7%	-0.1%	1.9%

Population loss does not always necessarily equate to economic decline. A decrease in average household size can cause population to decrease even as the number of housing units holds steady or even increases, because fewer people will be occupying each unit. Statistics for number of households are available for 1950 only for a few cities, as shown in **Table 2-4**, but they illustrate this phenomenon at work. The two cities with the largest population losses (Camden and Newark) also show a major loss in total households, over 20%. However, Jersey City actually gained households while losing population, due to a reduction in average household size. Elizabeth and Paterson both made modest population gains between 1950 and 2010 but posted larger growth rates – in Elizabeth's case, more than 3 times as large – when growth is measured in households rather than population.

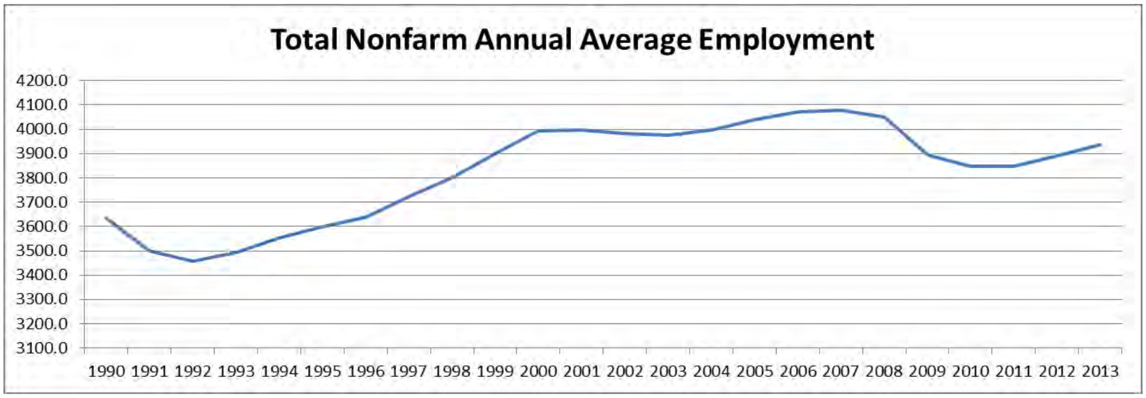
Table 2-4: Relationship of Population (Pop) and Household (HH) Statistics, Selected New Jersey CSO Cities (U.S. Census)				
Municipality	**Change in Pop 1950-2010 (%)**	**1950 HHs**	**2010 HHs**	**Change in HH 1950-2010 (%)**
Camden	-37.9%	34,055	24,475	-28.1%
Elizabeth	10.8%	30,500	41,596	36.4%
Jersey City	-17.2%	83,755	96,859	15.6%
Newark	-36.8%	121,285	94,542	-22.0%
Paterson	4.9%	41,035	44,329	8.0%

A comparison of 1990 and 2010 household demographics shows more recent trends. As shown in **Table 2-5**, while New Jersey as a whole experienced a 15% growth in total households, the CSO municipalities as a group saw an increase of only 8.5%, with the six largest of those showing only 5.1% growth. However, there are significant disparities in growth among the CSO municipalities. Three – all in the southern part of the state – lost 7% or more of total households (Camden, Gloucester City and Trenton), while five – all in Hudson County – exceeded the statewide average (Guttenberg, Hoboken, Jersey City, North Bergen and West New York), though of those five only Hoboken (with the largest relative gain of 66.5%) and Jersey City gained more than 10,000 households.

Table 2-5: Households (HHs) and Household Size in CSO Municipalities (**Bold Green** indicates greater growth than New Jersey as a whole)							
Municipality	**Change in Pop 1950-2010 (%)**	**1990 HHs**	**Avg HH Size 1990**	**2000 HHs**	**2010 HHs**	**Avg HH Size 2010**	**Change in HH 1990-2010 (%)**
Bayonne	-18.4%	25,309	2.42	25,545	25,237	2.49	-0.3%
Camden	-37.9%	26,626	3.12	24,177	24,475	3.02	-8.1%
East Newark	10.7%	719	3.10	767	759	3.17	5.6%
Elizabeth	10.8%	39,101	2.91	40,482	41,596	2.94	6.4%
Fort Lee	203.4%	15,236	2.14	16,544	16,371	2.16	7.4%
Gloucester City	-20.2%	4,601	2.72	4,213	4,248	2.70	-7.7%
Guttenberg	100.8%	3,518	2.38	4,493	4,473	2.48	**27.1%**
Hackensack	47.2%	16,464	2.26	18,113	18,142	2.30	10.2%
Harrison	1.0%	4,858	2.81	5,136	4,869	2.80	0.2%
Hoboken	-1.3%	15,036	1.92	19,418	25,041	1.93	**66.5%**
Jersey City	-17.2%	82,381	2.67	88,632	96,859	2.53	**17.6%**
Kearny	1.8%	12,470	2.81	13,539	13,462	2.83	8.0%
Newark	-36.8%	91,552	2.85	91,382	94,542	2.76	3.3%
North Bergen	46.2%	18,970	2.70	21,236	22,062	2.73	**16.3%**
Paterson	4.9%	43,946	3.25	44,710	44,329	3.24	0.9%
Perth Amboy	22.9%	14,207	3.20	14,562	15,419	3.25	8.5%
Ridgefield Park	6.1%	4,967	2.56	5,012	4,851	2.62	-2.3%
Trenton	-33.7%	30,744	2.75	29,437	28,578	2.79	-7.0%
Union City	19.7%	20,612	2.92	22,872	22,814	2.88	10.7%
Weehawken	-15.3%	5,055	2.26	5,975	5,712	2.20	13.0%
West New York	31.9%	14,419	2.74	16,719	18,852	2.64	**30.7%**
NJ total	**81.8%**	**2,794,711**	**2.70**	**3,064,645**	**3,214,360**	**2.68**	**15.0%**
CSO Municipal Totals	-12.3%	490,791		512,964	532,691		8.5%
% of State		17.6%		16.7%	16.6%		
6 Largest CSO Cities	-22.9%	314,350		318,820	330,379		5.1%

Employment Status and Past Trends

New Jersey has experienced a challenging period for employment since 2000 with essentially no growth, after a nearly 10% increase in total non-farm employment from 1990 to 2000, as shown in the two graphs of **Figure 2-1**.



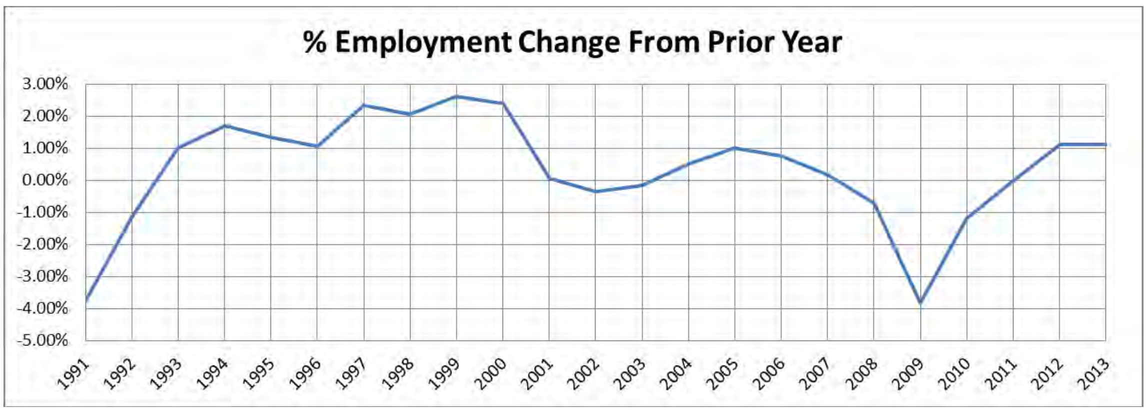


Figure 2-1. New Jersey Nonagricultural Wage and Salary Employment: 1990 to 2013
(NJ Department of Labor and Workforce Development. 2014).

Recent employment statistics in the CSO municipalities in many ways mirror their population and household shifts, but in other ways are fundamentally different. As shown in **Table 2-6**, New Jersey as a whole experienced a 1.37% decline in employment from 1999 to 2010 (though from 1999 to 2013, there is an overall increase of 0.86%). The CSO municipalities (excluding Trenton, for which comparisons over this time period are rendered invalid due to a change in the early 2000s in the way State employees are counted) as a group showed a gain of 2.0%, and actually gained as a percent of the statewide total. However, the five largest cities (Newark, Jersey City, Paterson, Elizabeth, and Camden, but again excluding Trenton) together posted a 6.0% gain – a major difference from the statewide trend. Paterson was the only one of these five cities to lose jobs during this period; the other four all gained, and all but Newark gained faster than the statewide rate, especially Jersey City, which grew by 15.9%. Also of note was the tremendous employment growth in Hoboken – an increase of 45.8% from 1999 to 2010, although Hoboken started out having relatively few jobs for its size. As with population growth, the rebound in job growth in the CSO municipalities seems to have started with Hoboken and Jersey City and expanded outward. Between 1999 and 2010, the experiences of the 21 CSO municipalities are mixed as far as employment change. Twelve of them lost jobs, some quite dramatically – East Newark, Harrison, Kearny, North Bergen, Weehawken, Ridgefield Park, and Gloucester City all experienced double-digit percentage losses. On the other hand, eight of the CSO municipalities gained jobs faster than the state as a whole, with the greatest gains tending to be the biggest cities (with the notable exception of Newark).

Table 2-6: Employment Changes in CSO Municipalities (**Bold Green** indicates greater growth than New Jersey as a whole)					
Municipality	**Change in Pop 1950-2012 (%)**	**1999 Total Employment (NJDOL)**	**2010 Total Employment (NJDOL)**	**Employment Change 1999-2010**	**Employment Change 1999-2010 (%)**
Bayonne	-18.4%	14,426	13,574	-852	-5.9%
Camden	-37.9%	31,671	32,967	1,296	**4.1%**
East Newark	10.7%	1,119	264	-855	-76.4%
Elizabeth	10.8%	43,413	46,421	3,008	**6.9%**
Fort Lee	**203.4%**	15,547	14,392	-1,155	-7.4%
Gloucester City	-20.2%	2,577	2,305	-272	-10.6%
Guttenberg	**100.8%**	1,307	1,291	-16	-1.2%
Hackensack	47.2%	42,802	43,591	789	**1.8%**
Harrison	1.0%	5,087	3,887	-1,200	-23.6%
Hoboken	-1.3%	12,146	17,707	5,561	**45.8%**
Jersey City	-17.2%	88,489	102,571	14,082	**15.9%**
Kearny	1.8%	20,249	14,666	-5,583	-27.6%
Newark	-36.8%	135,530	138,319	2,789	**2.1%**
North Bergen	46.2%	20,065	17,942	-2,123	-10.6%
Paterson	4.9%	39,661	38,875	-786	-2.0%
Perth Amboy	22.9%	11,880	12,688	808	**6.8%**
Ridgefield Park	6.1%	5,478	3,465	-2,013	-36.7%
Trenton	-33.7%	NA	NA	NA	NA
Union City	19.7%	9,467	10,391	924	**9.8%**
Weehawken	-15.3%	9,939	6,381	-3,558	-35.8%
West New York	31.9%	6,727	6,492	-235	-3.5%
NJ total	**81.8%**	**3,901,100**	**3,848,400**	**-52,700**	**-1.37%**
CSO Municipal Totals (excluding Trenton)	-12.3%	517,580	528,188	10,608	2.0%
% of State		13.3%	13.7%		
6 Largest CSO Cities (excluding Trenton)	-22.9%	338,764	359,154	20,390	6.0%

Source: NJ Department of Labor and Workforce Development

Table 2-7 provides aggregate employment figures of all CSO cities for every industry that is examined by the US Census as well as the total percentage of industry employment in relation to that industry's total employment throughout the state. Sectors are shown in **bold** where the CSO communities have a greater share than their share of total state population (16.9%). The importance of the Port of New York and New Jersey and Newark Liberty International Airport is emphasized by the employment in "wholesale trade" and in "transportation and warehousing and utilities."

Table 2-7: New Jersey and CSO Municipality Employment by Sector (2008-2012) (**Bold Green** indicates greater share than New Jersey as a whole)			
Industry	**New Jersey Employment Totals**	**CSO Municipality Totals**	**CSO Municipality Share**
Agriculture, forestry, fishing and hunting, mining	14,927	1,035	6.93%
Construction	241,514	39,580	**16.39%**
Manufacturing	382,554	62,272	**16.28%**
Wholesale trade	152,068	26,697	**17.56%**
Retail trade	471,686	74,039	15.70%
Transportation and warehousing, and utilities	237,214	53,477	**22.54%**
Information	126,468	17,379	13.74%
Finance and insurance; real estate, rental, leasing	374,873	56,816	15.16%
Professional, scientific, and management, and administrative and waste management services	526,798	82,722	15.70%

Table 2-7: New Jersey and CSO Municipality Employment by Sector (2008-2012) (**Bold Green** indicates greater share than New Jersey as a whole)			
Industry	**New Jersey Employment Totals**	**CSO Municipality Totals**	**CSO Municipality Share**
Educational services; health care and social assistance	973,233	138,416	14.22%
Arts, entertainment, and recreation, and accommodation and food services	339,135	56,587	**16.69%**
Other services, except public administration	187,763	35,608	**18.96%**
Public administration	191,444	26,206	13.69%
TOTALS	**4,219,677**	**670,834**	**15.90%**

Source: U.S. Census Bureau(c)

Population and Employment Projections

More recently, however, the trends have changed. As more evidence of the recent trend toward redevelopment of these older urban areas, the 21 CSO municipalities accounted for only 11.8% of residential certificates of occupancy (COs) from 2000 to 2007 but made up 19.4% of COs issued from 2008 to 2012. In fact, 10 of the 21 issued more COs annually from 2008 to 2012 than they had from 2000 to 2007, despite the economic slowdown. Such an increase only happened in 120 municipalities statewide – a little more than one in five.

Moreover, the trend toward redevelopment is expected to continue in the coming decades. Population and employment projections for 2040 prepared by the state's three Metropolitan Planning Organizations indicate that these 21 CSO municipalities are expected to account for fully 20% of total statewide population growth and 18% of employment growth from 2010 to 2040, both of which exceed their current share of state population. Every CSO municipality is expected to grow in both population and employment. The six largest cities account for nearly three-quarters (73%) of the total growth in CSO municipality population and 63% of employment growth; due to the difference between these values, they would actually yield relative employment share to the other CSO municipalities, dropping from 73% of all CSO municipal employment to 70%, while having approximately 66% of the total population.

Table 2-8: MPO Projected Population and Employment Changes 2010-2040 (**Bold** for >30,000 population or >15,000 employment change; **Bold Green %** for greater than statewide rate of increase)									
Municipality	**Change in Pop 1950-2012 (%)**	**MPO 2010 Population**	**MPO 2040 Population**	**Projected Change 2010-2040**		**MPO 2010 Employ-ment**[19]	**MPO 2040 Employ-ment**	**Projected Change 2010-2040**	
Bayonne	-16.6%	63,020	78,650	15,630	**24.8%**	14,540	23,840	9,300	**64.0%**
Camden	-38.0%	77,344	78,199	855	1.1%	51,435	55,409	3,974	7.7%
East Newark	12.3%	2,410	4,510	2,100	**87.1%**	380	680	300	**78.9%**
Elizabeth	12.1%	124,970	147,790	22,820	18.3%	48,130	63,750	**15,620**	**32.5%**
Fort Lee	206.8%	35,350	41,810	6,460	18.3%	15,820	19,510	3,690	23.3%
Gloucester City	-20.3%	11,456	11,488	32	0.3%	3,921	3,946	25	0.6%
Guttenberg	104.0%	11,180	11,650	470	4.2%	1,080	2,030	950	**88.0%**
Hackensack	50.1%	43,010	48,190	5,180	12.0%	44,250	51,670	7,420	16.8%
Harrison	2.8%	13,620	32,050	18,430	**135.3%**	4,540	15,920	11,380	**250.7%**
Hoboken	2.7%	50,010	57,630	7,620	15.2%	19,070	27,090	8,020	**42.1%**
Jersey City	-14.9%	247,640	356,250	**108,610**	**43.9%**	105,730	155,670	**49,940**	**47.2%**
Kearny	3.6%	40,680	43,000	2,320	5.7%	12,890	17,070	4,180	**32.4%**
Newark	-36.7%	277,140	345,180	**68,040**	**24.6%**	151,930	185,480	**33,550**	22.1%
North Bergen	49.1%	60,770	70,830	10,060	16.6%	18,950	25,890	6,940	**36.6%**

[19] Employment totals from the Metropolitan Planning Organizations shown here may not be consistent with those released in 2014 by the NJ Department of Labor and Workforce Development, as the new reports may include updates to previously-released employment statistics.

Table 2-8: MPO Projected Population and Employment Changes 2010-2040
(**Bold** for >30,000 population or >15,000 employment change; **Bold Green %** for greater than statewide rate of increase)

Municipality	Change in Pop 1950-2012 (%)	MPO 2010 Population	MPO 2040 Population	Projected Change 2010-2040		MPO 2010 Employ-ment[19]	MPO 2040 Employ-ment	Projected Change 2010-2040	
Paterson	4.2%	146,200	179,020	**32,820**	**22.4%**	41,570	59,470	**17,900**	**43.1%**
Perth Amboy	25.2%	50,810	58,390	7,580	14.9%	13,760	17,690	3,930	**28.6%**
Ridgefield Park	7.3%	12,730	14,070	1,340	10.5%	3,860	5,230	1,370	**35.5%**
Trenton	-34.0%	84,913	87,250	2,337	2.8%	71,711	71,925	214	0.3%
Union City	22.0%	66,440	69,870	3,430	5.2%	11,580	17,380	5,800	**50.1%**
Weehawken	-13.5%	12,550	17,200	4,650	**37.1%**	6,330	9,190	2,860	**45.2%**
West New York	36.6%	49,710	52,840	3,130	6.3%	7,380	11,360	3,980	**53.9%**
NJ total	83.3%	8,791,127	10,410,113	1,618,986	18.4%	3,970,512	5,033,241	1,062,729	26.8%
CSO Municipal Total	-11.2%	1,481,953	1,805,867	323,914	21.9%	648,857	840,200	191,343	29.5%
% of State		16.9%	17.3%	20.0%		16.3%	16.7%	18.0%	
6 Largest CSO Cities	-22.3%	958,207	1,193,689	235,482	24.6%	470,506	591,704	121,198	25.8%

Economic Stresses

While the CSO cities represent a substantial part of New Jersey's economy, with particular industries having more weight than for the state as a whole, unemployment and poverty figures suggest that these communities have a very limited financial capacity for to manage their combined sewer infrastructure on their own. A large majority of the 21 CSO cities currently struggle with poverty levels well above the state average of 9.4%, as shown in **Table 2-9**.

Table 2-9: Poverty Levels of CSO Municipalities (2008-2012 American Community Survey)

Over 20% of Population Below Poverty Line	10% to <20% of Population Below Poverty Line	
Camden (38.6%)	West New York (18.8%)	Hackensack (13.7%)
Newark (28.0%)	Elizabeth (18.8%)	Gloucester City (13.4%)
Paterson (27.6%)	Jersey City (17.6%)	Bayonne (12.6%)
Trenton (26.6%)	East Newark (17.1%)	North Bergen (11.9%)
Union City (22.4%)	Guttenberg (14.9%)	Weehawken (11.3%)
Perth Amboy (21.2%)	Harrison (14.9%)	Hoboken (10.9%)

Source: U.S. Census Bureau(b)

Further evidence of concentrated poverty is shown by the following:

- All but four municipalities (Fort Lee, Hoboken, Weehawken, and Ridgefield Park), representing 92.4% of all CSO municipality residents, have an average residential value that is less than the median over all 566 (now 565) municipalities. Eight (representing 46.6% of all CSO municipal residents) have average residential values that are less than 80% of the municipal median, including three (Gloucester City, Camden, and Trenton) that rank in the bottom 20 in the state in terms of average residential values.
- Looking at median household income from the 2006-2010 five-year American Community Survey, only one of the 21 CSO municipalities had a value higher than the statewide median household income – Hoboken. Fort Lee has the only other median household income that even manages to exceed 80% of the statewide median. Sixteen of the 21, containing 89.7% of all CSO municipal residents, are in the bottom quintile when all 566 (now 565) municipalities are sorted by median household income, and five of those (Union City, Trenton, Newark, Paterson, and Camden) have median household incomes that are less than half the statewide median.
- All but Fort Lee have rates of children on Temporary Assistance for Needy Families (TANF) that are higher than the median municipality's rate. In fact, all but Fort Lee, Hoboken, and Weehawken have rates of children on TANF that are more than double that of the median municipality. Nine of the 21,

containing 73.1% of all CSO municipal residents, rank in the top 50 municipalities in the state with the highest rates of children on TANF, including #1 Camden, #5 Trenton, and #8 Newark.

New Jersey Future created a **Municipal Stress Index** based on a national model by David Rusk, modified and adapted the variables and methodology to create an index that is unique to New Jersey. The Index uses three measures of municipal stress or opportunity that are roughly non-overlapping (i.e., not measuring essentially the same phenomenon) and for which data are publicly accessible:

- Children on Temporary Aid for Needy Families (TANF) per 1,000 population (2011)
- Per-capita property tax base (2010)
- Total jobs (private-sector + public) per housing unit (2010)

The data are grouped by six regions within the state, using county borders, as a way of accounting for regional economic differences:

- Region 1: Bergen, Passaic, Hudson
- Region 2: Essex, Union, Morris, Sussex, Warren
- Region 3: Middlesex, Somerset, Hunterdon, Mercer
- Region 4: Monmouth, Ocean
- Region 5: Burlington, Camden, Gloucester, Salem
- Region 6: Atlantic, Cape May, Cumberland

Each municipality is ranked within its region by each variable, with the "best" value of each variable being given the #1 rank (lowest rate of poor children, highest tax base, highest jobs/housing ratio). The ranks for each municipality are averaged across the three variables, and each regional list is then sorted by the composite ranks. Each of the six sorted regional lists is then partitioned into five subgroups, based on population quintiles (not on equal numbers of municipalities). Each municipality is then assigned to a category, numbered from 1 to 5 based on its quintile, with 1 being the highest-opportunity category and 5 being lowest. Because the category break points are based on population quintiles, each category will contain roughly 20 percent of the total population, both within each region and after summing to the state level.

Using this Municipal Stress Index, New Jersey Future, the 21 CSO municipalities score as follows:

Table 2-10: Municipal Stress Index for CSO Municipalities (New Jersey Future)

Municipal Stress Index Score	Municipalities	Share of CSO Municipal Population
5 (Most distressed)	Bayonne, Camden, East Newark, Elizabeth, Gloucester City, Guttenberg, Paterson, Perth Amboy, Trenton, Union City, and West New York	46.2%
4	Harrison, Jersey City, Newark, and North Bergen	40.5%
3	Kearny and Ridgefield Park	3.6%
2	Fort Lee, Hackensack, Hoboken, and Weehawken	9.6%

Many of the 21 CSO municipalities are ill-equipped to pay for completely upgrading their sewer infrastructure and addressing CSO requirements without outside help. Most of them are among the municipalities with the lowest property tax bases, per capita, in the state, impairing their ability to raise money, as shown in **Table 2-11**. Only Hoboken, Weehawken, and Fort Lee even rank in the top half of all New Jersey municipalities in terms of per-capita property tax base. In contrast, twelve of the 21 rank in the bottom fifth of municipalities, with Paterson, Newark, West New York, Union City, Trenton, and Camden ranking in the bottom 30 statewide. Those six, plus Gloucester City, East Newark, and Elizabeth, have per-capita property tax bases that are less than half the size of the median New Jersey municipality. Another seven (Perth Amboy, Jersey City, Harrison, Kearny, North Bergen, Guttenberg, and Bayonne) have per-capita tax bases that are less than two-thirds the size of the median municipality's. In general, these are places with very limited financial resources. However, a general review of Standard & Poor bond ratings for the municipalities and sewer utilities showed that while none were indicated as having a AAA rating, as of early 2014 all that had any ratings were within the investment grades of A or AA.[20] However, Moody's has since rated Newark general obligation bonds as Baa1 with a negative outlook.

Table 2-11: Household (HH) Income, Home Values and Property Tax Base for CSO Municipalities
(**Bold** for in Lowest 30 Municipalities; **Bold Green** for Higher than State Median)

Municipality	Median HH income, 2006-2010 ACS	Rank	% of Statewide Median	Average Home Value 2010	Rank	% of Median municipal value	Per capita property tax base 2010	Rank	% of Median municipal value
Bayonne	53,587	486	66.2%	313,529	287	99.5%	91,888	440	65.8%
Camden	27,027	**563**	33.4%	37,962	**564**	12.0%	14,534	**564**	**10.4%**
East Newark	54,722	479	67.6%	235,149	431	74.6%	59,681	533	42.8%
Elizabeth	43,770	532	54.0%	238,775	425	75.8%	61,379	529	44.0%
Fort Lee	72,341	315	89.3%	**503,370**	114	159.7%	181,575	189	130.1%
Gloucester City	52,222	499	64.5%	126,987	**553**	40.3%	59,517	534	42.6%
Guttenberg	49,981	514	61.7%	304,300	304	96.5%	90,901	446	65.1%
Hackensack	57,676	455	71.2%	283,465	341	89.9%	137,885	286	98.8%
Harrison	51,193	510	63.2%	299,244	317	94.9%	86,923	459	62.3%
Hoboken	**101,782**	122	125.7%	**452,349**	142	143.5%	**204,863**	145	146.8%
Jersey City	54,280	481	67.0%	274,099	358	87.0%	80,682	478	57.8%
Kearny	58,698	444	72.5%	308,915	296	98.0%	89,578	448	64.2%
Newark	35,659	553	44.0%	243,863	415	77.4%	57,735	**544**	**41.4%**
North Bergen	52,726	497	65.1%	286,660	334	91.0%	89,968	447	64.5%
Paterson	34,086	**554**	42.1%	261,469	381	83.0%	58,054	**542**	**41.6%**
Perth Amboy	47,696	519	58.9%	239,630	421	76.0%	73,546	497	52.7%
Ridgefield Park	60,656	424	74.9%	**323,377**	271	102.6%	113,494	374	81.3%
Trenton	36,601	**551**	45.2%	82,802	**562**	26.3%	35,484	**559**	**25.4%**
Union City	40,173	**544**	49.6%	222,981	447	70.7%	52,123	**552**	**37.3%**
Weehawken	62,435	405	77.1%	**415,637**	170	131.9%	**182,054**	188	130.4%
West New York	44,657	529	55.1%	258,997	389	82.2%	55,855	**546**	**40.0%**
NJ total	**80,992**			**315,174**			**139,582**		
CSO Municipal Totals	51,998			272,074			89,415		
% of State	64.2%			86.3%			64.1%		
6 Largest CSO Cities	38,571			189,828			51,311		

Public Transportation

By and large, the CSO municipalities are fairly centrally located with respect to New Jersey's extensive public transportation system, which includes an interconnected combination of rail, light rail, subway, bus and airport facilities. A majority of them (16 out of 21) have at least one transit station, hosting a total of 69 transit stations: 59 rail transit stations (including commuter rail, light rail, PATH and PATCO), seven bus terminals, and three ferry terminals. Nine of the 21 have at least one light rail station (Hudson-Bergen Light Rail, Newark Light Rail, or River Line from Trenton to Camden), seven have at least one commuter rail station, five have rapid transit (PATH or PATCO), seven host a bus terminal, and three host a ferry terminal. These station areas represent an immense opportunity for capturing future growth in transit-oriented development (TOD), growth that puts far less stress on the state's road network by allowing many trips to

[20] Ratings were accessed in April 2014 from Standard & Poors, <www.standardandpoors.com>. Some entities addressed in this report did not have ratings, such as the City of Camden.

be taken by means other than private automobile. The significant increase in development within some of these municipalities is likely associated with transit access, with transit ridership on the increase in New Jersey, as it is nationally. In addition, Newark and Elizabeth host Newark Liberty International Airport, which also is in close proximity to many other CSO municipalities and is transit-accessible by bus and via a connection to the NJ Transit rail system. Camden is across the river from the Philadelphia International Airport, which is also accessible by mass transit.

Some of the CSO municipalities are host to the busiest transit stations in the state, which is a testament to their accessibility. Newark Penn Station, Hoboken Terminal, four stations in Jersey City (Journal Square, Newport/Pavonia, Exchange Place, Grove Street (PATH)), the Harrison PATH station, Trenton Transit Center, the Walter Rand Transportation Center in Camden, the Newark Airport and Elizabeth commuter rail stations, and the Bergenline Ave station stop on the Hudson-Bergen Light Rail all have average weekday boardings in excess of 3,000, and some of them many times that number (e.g., Newark Penn Station and Hoboken Terminal exceed 50,000). Of the 13 transit stations in the state that exceed 5,000 average weekday riders, eight of them are in one of the CSO municipalities, including the six busiest in the state. Transit stations located in the 16 CSO municipalities that have them together account for nearly two-thirds (65.8%) of average weekday boardings for the entire state. If there is a move back toward putting jobs and people in transit-accessible locations, many of these CSO municipalities are strategically located, making it that much more important that their infrastructure systems be ready to absorb new growth.

Summary

The CSO municipalities contain almost 17% of New Jersey's population in 3.7% of its municipalities (21 of 565), but contained almost 35% of the state's total population in 1950. Many of them lost substantial population between 1950 and 1990, sharply diminishing their economic importance and their share of total state population. Newark lost nearly 40% or 160,000 people in those four decades, a number larger than any current municipal population in New Jersey other than Newark itself and Jersey City. Other large municipalities such as Jersey City and Bayonne lost more than 20% of their population. Camden and Newark also lost over one-fifth of total households from 1950 to 1990, but Jersey City experienced a loss of only 1.6 percent in number of households, as most of its population loss was attributable to shrinking household size rather than a reduction in the number of occupied housing units.

Some of the CSO municipalities are showing recent signs of reversing their decades-long declines. While housing trends from 1990 to 2010 show significant continuing housing losses in Camden, Gloucester City and Trenton, others are relatively stable or increasing quickly, with Hoboken and Jersey City having the largest net increase in households (10,000 and 14,000 respectively). While more than half (12 out of 21) of the CSO municipalities lost population between 1950 and 1990, only five continued to lose population from 1990 to 2008. Since the recession in 2008, only four CSO municipalities have lost population, while a remarkable 14 of them have actually grown faster than the statewide rate. Overall, the municipalities have very different demographic histories and cannot be treated as uniform group.

The same conclusion applies to employment and income. As a group, the CSO municipalities gained jobs from 1999 to 2010 while New Jersey as a whole declined slightly. However, within the group some municipalities lost 10% or more of their jobs while others gained 10% or more. Again, Hoboken and Jersey City had the largest net gains, while in this case Weehawken and Kearny show the largest losses. The largest loss in percentage terms is East Newark at 76%, while the largest gain is Hoboken at 46%. The Hudson River municipalities have prospered in recent years, in part related to development along the Hudson-Bergen Light Rail system. Other growing towns have access to PATH services or are waterfront municipalities.

Income in CSO municipalities lags the statewide median, with the sole exception of Hoboken, and several are among the lowest 30 in the state (Camden, Paterson, Trenton and Union City). Of the group, 18 have at least 10% of their population below the poverty line, with Camden, Newark, Paterson, Trenton, Union City and Perth Amboy all over 20%; of these six, all but Perth Amboy have median household incomes of less than half of the statewide median. Average home values and per capita tax base support the conclusion that many CSO municipalities are among the poorest of New Jersey's municipalities, while a few such as Hoboken and Fort Lee have stronger economies. Weehawken is an interesting case, having lost population since 1950, lost many jobs since 1999, with a per capita income well below the state median, and over 10% of its population below the poverty line, and yet it has a home value and per capita tax base that is above the state median. No other CSO municipality has this combination of lower income and higher property values, which may indicate a shifting demographic as housing values force a population shift to those who can afford the housing costs.

Finally, population and employment projections through 2040 paint a much better picture for some municipalities but at best stability for others. As a group, CSO municipalities are projected to outperform the state, with 20% of population growth and 18% of employment growth, with the largest six accounting for nearly three-quarters of that growth. The largest net increases in population (20,000 or more) are projected for Paterson and especially Jersey City and Newark. All three lost population from 1950 to 2010, and so these large growth projections are a major reversal in trends. The three plus Elizabeth are projected to increase employment by more than 15,000 each. As always, long-term projections are subject to uncertainty regarding the national, state and local economies, demographic shifts, immigration rates, redevelopment economics and personal preferences. In each case, access to mass transit will be important, given the number of lower-income households and the limitations of road congestion. The importance of transit to redevelopment, and vice versa, is underscored by a recent conceptual study indicating that "There is more than enough land, if properly developed within a 6 minute walk from existing and proposed train stations to meet the vast majority of the residential and commercial growth in a sustainable, green urban form for the State of New Jersey in the foreseeable future." (Nelessen, 2011) Still, the projections indicate that some municipalities (especially Camden and Gloucester City) that have high poverty and low property tax bases may at best stabilize, while other municipalities may have increasing economic resources available to address local service needs including CSO controls. **Table 2-12** on the following page provides an overview of the results by municipality.

As shown in the table, indicators for Camden and Gloucester City show an overall outlook that is highly challenging. These municipalities will therefore have the greatest hardship in supporting additional infrastructure costs. Trenton has similar stress indicators, but at least will not face the need for additional CSO infrastructure costs, as they already have complied with federal regulations (as discussed in **Chapter 3**). Paterson has nearly the same profile except for the projected growth in population and employment; should these trends not bear out over time, Paterson too will face significant challenges in supporting its infrastructure costs. A similar issue exists for Union City. Newark exhibits nearly as great a concern regarding the stress indicators. Elizabeth, North Bergen and Perth Amboy indicators show somewhat fewer stress indicators, but no strong positive indicators.

Water supply and sewer systems in these CSO municipalities represent a significant public investment, having at one time served 35% of the state's population and a major concentration of manufacturing facilities. While these 21 municipalities have declined in economic importance since 1950, the state now seems to be on the cusp of rediscovering the benefits of having population and employment growth occur in centralized locations, as these CSO municipalities mostly are. The trends just since 2008 are noteworthy, with the CSO municipalities arresting the long decline in their share of total state population and actually increasing it very slightly since 2008, a remarkable turnaround. But if these places are to function once again as focal points for population and employment growth, their infrastructure needs will need to be addressed. Doing so will position these municipalities for future economic, social and environmental improvements, of the sort being experienced in cities as varied as Syracuse, New York, Chicago and Philadelphia.

Table 2-12: Indicators of Municipal Demographic and Economic Stress

Municipality	Change in Population 1950-2012 (%)	Projected Population Change 2010-20140 (%)	Employment Change 1999-2010 (%)	Projected Employment Change 2010-2040 (%)	Poverty (% below Poverty Line)	New Jersey Future Economic Stress Index (5 is high)	Per capital property tax base (% of State Average)
Bayonne	-16.6%	24.8%	-5.91%	64.0%	12.6	5	65.8%
Camden	-38.0%	1.1%	4.09%	7.7%	38.6	5	10.4%
East Newark	12.3%	87.1%	-76.39%	78.9%	17.1	5	42.8%
Elizabeth	12.1%	18.3%	6.93%	32.5%	18.8	5	44.0%
Fort Lee	206.8%	18.3%	-7.43%	23.3%	<10%	2	130.1%
Gloucester City	-20.3%	0.3%	-10.57%	0.6%	13.4	5	42.6%
Guttenberg	104.0%	4.2%	-1.22%	88.0%	14.9	5	65.1%
Hackensack	50.1%	12.0%	1.84%	16.8%	13.7	2	98.8%
Harrison	2.8%	135.3%	-23.60%	250.7%	14.9	4	62.3%
Hoboken	2.7%	15.2%	45.78%	42.1%	10.9	2	146.8%
Jersey City	-14.9%	43.9%	15.91%	47.2%	17.6	4	57.8%
Kearny	3.6%	5.7%	-27.57%	32.4%	<10%	3	64.2%
Newark	-36.7%	24.6%	2.06%	22.1%	28.0	4	41.4%
North Bergen	49.1%	16.6%	-10.58%	36.6%	11.9	4	64.5%
Paterson	4.2%	22.4%	-1.98%	43.1%	27.6	5	41.6%
Perth Amboy	25.2%	14.9%	6.80%	28.6%	21.2	5	52.7%
Ridgefield Park	7.3%	10.5%	-36.75%	35.5%	<10%	3	81.3%
Trenton	-34.0%	2.8%	NA	0.3%	26.6	5	25.4%
Union City	22.0%	5.2%	9.75%	50.1%	22.4	5	37.3%
Weehawken	-13.5%	37.1%	-35.80%	45.2%	11.3	2	130.4%
West New York	36.6%	6.3%	-3.49%	53.9%	18.8	5	40.0%

Legend

Stress Level	Low	Neutral	Moderate	High

The Stress Level coloring used in the table is based on the following relative interpretations of the data:

Indicator	High Stress	Moderate Stress	Neutral	Low Stress
Change in Population 1950-2012 (%)	Negative %	0 to 30%	30.1% to 100%	>100%
Projected Population Change 2010-20140 (%)	<10%	10% to 18%	18.1% to 30%	>30%
Employment Change 1999-2010 (%)	Less than -7%	-7% to 3%	4% to 20%	>20%
Projected Employment Change 2010-2040 (%)	<10%	10% to 25%	25.1% to 40%	>40%
Poverty (% below Poverty Line)	18.1% or more	13.1% to 18%	10% to 13%	<10%
New Jersey Future Economic Stress Index (5 is high)	Index of 5	Index of 4	Index of 3	Index of 2
Per capital property tax base (% of State Median)	<40%	40% to 60%	60% to 99.9%	100% or more

Chapter 3: Water and Water Infrastructure Issues for CSO Municipalities

Waters Affected by CSO Discharges

The 21 CSO municipalities are listed in **Table 3-1** as provided by NJDEP, which lists the number of CSO discharge points, the receiving waters, the entity that actually will receive the CSO Individual Permit, and the relevant sewage treatment facility.

Table 3-1: CSO Municipalities and Affected Waters

Watershed(s)	Permittee	Municipality	Receiving Waters	CSOs*	STP
Delaware River	Camden (City)	Camden	Delaware River Newton Creek Cooper River	28	Camden County Municipal Utilities Authority (CCMUA)
	CCMUA	Camden	Delaware River	1	CCMUA
	Gloucester City	Gloucester City	Delaware River Newton Creek	7	CCMUA
	Trenton City	Trenton	Delaware River	1	Trenton Sewer Utility
Raritan River/Bay	Perth Amboy City	Perth Amboy	Raritan River	8	Middlesex County Utilities Authority (MCUA)
Hudson River Upper Bay	Bayonne MUA	Bayonne	Hudson River	3	Passaic Valley Sewerage Commissioners (PVSC)
	Fort Lee Borough	Fort Lee	Hudson River	2	Bergen County Utilities Authority (BCUA) - Little Ferry WTP
	Town of Guttenberg	Guttenberg	Hudson River	1	North Bergen Municipal Utilities Authority (NBUA) - Woodcliff WTP
	Jersey City MUA	Jersey City	Hudson River	9	PVSC
	NBMUA Woodcliff	North Bergen	Hudson River	1	NBUA - Woodcliff WTP
	NHSA Adams	Hoboken Union City Weehawken	Hudson River	8	North Hudson Sewerage Authority - Adams Street WTP
	NHSA W NY	West New York	Hudson River	2	NHSA - West New York WTP
Newark Bay Kill Van Kull Arthur Kill Elizabeth River Rahway River	Bayonne MUA	Bayonne	Newark Bay Kill Van Kull	27	PVSC
	Newark City	Newark	Peripheral Ditch to Newark Bay	4	PVSC
	Elizabeth City	Elizabeth	Elizabeth River Arthur Kill Elizabeth Channel	28	Joint Meeting of Essex and Union Counties
	Perth Amboy City	Perth Amboy	Arthur Kill	8	MCUA
	Jersey City MUA	Jersey City	Newark Bay NY/NJ Harbor	2	PVSC

Table 3-1: CSO Municipalities and Affected Waters

Watershed(s)	Permittee	Municipality	Receiving Waters	CSOs*	STP
Hackensack River	Jersey City MUA	Jersey City	Hackensack River	10	PVSC
	NBMUA Central	North Bergen	Hackensack River	9	PVSC
	Ridgefield Park Village	Ridgefield Park	Hackensack River Overpeck Brook	4 2	BCUA - Little Ferry WTP
	Hackensack City	Hackensack	Hackensack River	2	BCUA - Little Ferry WTP
Lower Passaic	East Newark Boro	East Newark	Passaic River	1	PVSC
	Harrison Town	Harrison	Passaic River	7	PVSC
	Kearny Town	Kearny	Passaic River	5	PVSC
	Newark City	Newark	Passaic River Second River	13	PVSC
Upper Passaic	Paterson City	Paterson	Passaic River	24	PVSC
			Total *	**217**	

* As of Fall 2013 per NJDEP and incorporated in draft CSO permits

CSO impacts can include adverse human health effects, beach closures, reduced fish survival, shellfish bed closures, aquatic life toxicity, and aesthetic impairment. According to USEPA (1994), "*CSOs consist of mixtures of domestic sewage, industrial and commercial wastewater, and storm runoff. CSOs often contain high levels of suspended solids, pathogenic microorganisms, toxic pollutants, floatables, nutrients, oxygen-demanding compounds, oil and grease, and other pollutants. CSOs can cause exceedances of water quality standards. Such exceedances may pose risk to human health, threaten aquatic life and its habitat, and impair the use and enjoyment of the Nation's waterways.*"

Waterborne transmission is a common way of spreading infectious agents to a population. Disease outcomes associated with waterborne infections can include hepatitis, gastroenteritis, as well as skin, wound, respiratory, and ear infections. Although in general waterborne diseases are considered to be a result of ingestion of contaminated water, they may also be contracted through inhalation of water vapors and eating contaminated fish and shellfish.

The majority of New Jersey CSOs discharge into the NY/NJ Harbor Estuary and the Delaware River (see **Figures ES-1 and ES-2**). New Jersey's waterways and coastal areas provide valuable goods and services to the State, including commodities such as billion dollar commercial and recreational fisheries, and a high level of eco-services. The NJDEP determined that freshwater wetlands and marine ecosystems are valued at $538 billion for their natural goods and natural services. Degrading these natural environments harms the state and local economies, citizens' wellbeing, and the health of New Jersey's wildlife.

Litter in New Jersey's coastal areas, also known as floatable debris, can lead to beach closures and harm recreational and commercial boating, which is a major reason that NJDEP focused first on controlling solid and floatable materials from CSOs. These controls are nearly all completed. Birds, mammals, and sea turtles are found seasonally throughout the New York Bight and portions of the NY/NJ Harbor, as well as the Delaware Bay. These living resources are vulnerable to entrapment in plastic waste including six pack rings, fishing line and nets. Turtles and mammals are also vulnerable to ingestion of plastic items, such as bags, that are mistaken for squid, jellyfish, or other prey. This ingestion often leads to suffocation or intestinal blockage and death. While the frequency of debris related deaths of marine wildlife is difficult to quantify, the fact that several of these species are threatened and endangered makes this issue significant for the region. In addition, accumulations of floatable debris in coastal marshes and shorelines can effectively smother productive vegetated areas.

As part of interstate efforts to improve water quality in the NY/NJ Harbor, the Harbor Estuary Program (including USEPA Region 2, New Jersey and New York) undertook the development of water quality models regarding contaminants of concern in the area, to determine the level and relative pollutant contributions for pathogens, nutrients and toxins. New Jersey's intent was to use the results of the pathogen study to adopt a TMDL (Total Maximum Daily Load, essentially a water pollution control plan) for the New Jersey part of the harbor that would in turn be used as the basis for CSO regulation. However, the resulting report was not accepted by NJDEP as sufficient for TMDL adoption for a variety of technical reasons. Further funding was not available for continuing the study. In the absence of further effort on the pathogens model, NJDEP decided to pursue (and USEPA agreed to support) the individual permit approach discussed in **Chapter 2** as an alternative to further wide-scale modeling, and as a method of reducing permittee costs for effluent and ambient water quality monitoring. Further action to improve baseline water quality information is possible but will require coordination and funding; the CSO monitoring modeling prepared for individual permits will also be beneficial in this regard. Direct administration of the Harbor Estuary Program itself is migrating from USEPA to a non-governmental organization, the Hudson River Foundation, which will play a coordinating role similar to the Partnership for the Delaware Estuary. The Harbor Estuary Program may be able to coordinate further work, and the Interstate Environmental Commission could provide monitoring services as an interstate compact agency of New York and New Jersey. However, USEPA remains interested in creation of TMDLs for nutrients and toxins in the Harbor Estuary region (USEPA, Region 2, interview of 4 March 2014).

As part of the Harbor Estuary Program effort, preliminary reports provide some sense of pathogen impacts, which primarily relate to recreational uses and shellfish contamination. **Figure 3-1** shows the location of beaches and CSO outfalls in the Harbor Estuary. The closest New Jersey bathing beach to New Jersey CSO outfalls is Ideal Beach, well east of Perth Amboy. There are New York City public beaches on Staten Island that are closer to New Jersey CSO outfalls, but Staten Island CSO outfalls are even closer, suggesting that the local outfalls will have the dominant effects on those beaches. However, there are non-bathing beaches in Perth Amboy, which has multiple CSO outfalls, and in several locations on the Raritan Bay in Middlesex and Monmouth Counties, west of Ideal Beach. Designation of a beach as "non-bathing" does not ensure that no recreational contact with the water occurs after a CSO event.

Under N.J A.C. 7:9B-1.4 of the NJDEP's rules on Surface Water Quality Standards, primary contact recreation is a designated use in FW2 and SE1 waters, and is defined as "water related recreational activities that involve significant ingestion risks that includes, but is not limited to, wading, swimming, diving, surfing, and skiing." Secondary (and not primary) contact recreation is a designated use in SE2 and SE3 waters, and is defined as "recreational activities where the probability of water ingestion is minimal and includes, but is not limited to, boating and fishing." Standards are more stringent for primary contact than secondary contact. The SWQS for pathogens are being re-evaluated by NJDEP based on USEPA proposed criteria. HydroQual prepared a report on pathogens in major receiving water bodies using available 2008-2009 data, which notes that in order to have met the water quality standards that were in place in 2008 and 2009, only the lower Passaic and upper Hackensack River would have required reduction in fecal coliform and enterococci, respectively. Within the context of a 3% and 10% reduction in stormwater, there would need to be a 1.32% and 1.28% reduction in the number of combined sewer overflows in order to meet existing water quality standards (HydroQual, 2009). This report was not endorsed by NJDEP, as previously discussed.

A 2012 draft report from the NJDEP provides a very different perspective.[21] It notes that there were 26 CSOs along the Hackensack River across four municipalities (Hackensack, Jersey City, North Bergen, and Ridgefield Park). The report also focused on the Lower Passaic River, which noted 30 CSOs also shared among four municipalities (Kearny, East Newark, Harrison, and Newark). The NJDEP notes that the Lower Passaic and Hackensack Rivers have been identified as an area of environmental concern; due to the urban nature of the Saddle, Hackensack, and Passaic watersheds there would be a greater potential for pathogen loading. The role that CSOs play in contributing to the degradation in water quality and the introducing pathogens such Enterococci is discussed as substantial. Rainfall data collected between 2000 and 2003 for modeling indicated

[21] This report is accessible to the public on the NY/NJ Harbor Estuary Program web site but is specifically noted as DRAFT – FOR INTERNAL DELIBERATIVE USE ONLY. NJDEP indicates that the report was prepared "at EPA's direction" (personal communication, 28 April 2014) and uses a model that was not endorsed by NJDEP, as previously noted.

that CSOs in the Passaic and Hackensack Rivers contribute significant loadings of total pathogen loads in these waters (NJDEP, 2012). However, the model and the report were not finalized or endorsed by NJDEP.

Figure 3-1: Beaches and CSO Outfalls in the New York/New Jersey Harbor Estuary

Two major reports have been released on the state of the Delaware River (DRBC, 2008) and the Delaware Estuary (PDE, 2012). These reports were not specifically focused on CSO issues but rather were comprehensive compilations of existing information on water resources integrity in the full basin and its estuarine portion. USEPA has also released water quality information on the Delaware Estuary.

In 2004 the Delaware Estuary Program and the Delaware River Basin Commission (DRBC) released a joint monitoring report (Santoro, 2004) that include a water quality review and organized the estuary into several study zones (see **Figure 3-2**). Zone 3 includes the CSOs in Camden and Gloucester City, along with those in Philadelphia across the river. As of that year, the water quality criteria for dissolved oxygen (DO) levels required that in a 24-hour period there is an average of 3.5 mg/L for Zones 3, 4, and 5, which is lower than the zones upstream and downstream.[22] Furthermore, the criteria for Zones 2, 3, 4, and 5 also included a seasonal average (April 1 through June 15; September 16 through December 3) that is not less than 6.5 mg/L.

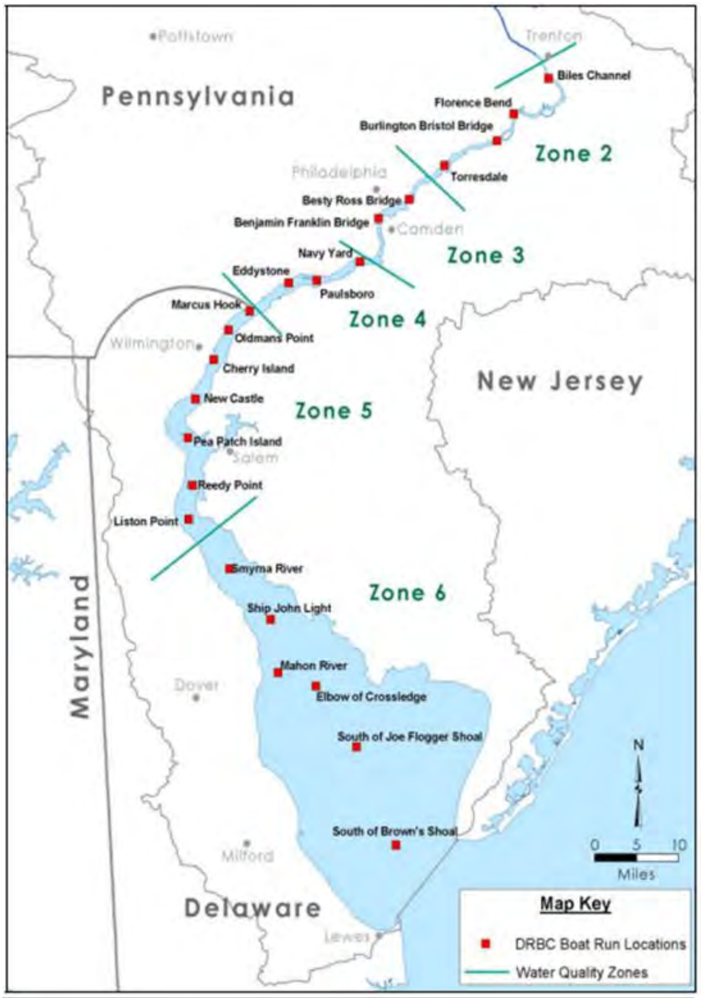


Figure 3-2: Delaware Estuary Study Zones (Santoro, 2004)

The report noted that bacteria data prior to 1999 showed a decline in concentrations in the main channel of the River between Trenton and Wilmington. However, with respect to federal criteria for primary contact recreation effective at that time there were some clear differences in concentration levels for the period of 1998 through 2003 depending on the study area: "water in the main channel does not exceed the federal primary contact recreation standards for bacteria, frequent exceedance of the standards persists in tributaries and in shallow areas near the shore, where recreational contact is more frequent (Santoro, 2004).

In 2007, the EPA released a report on the Delaware Estuary and provided a status update on dissolved oxygen concentration levels, stating that "[t]he Delaware Estuary is rated good for dissolved oxygen concentrations. Dissolved oxygen concentrations were rated good for 89% of the estuarine area and fair in 1% of the area. There were no areas where dissolved oxygen concentrations were rated poor. [National Coastal Assessment] data on dissolved oxygen concentrations were unavailable for 10% of the [Delaware Estuary]." (USEPA, 2007) This assessment is confirmed by a report issued by the Partnership for the Delaware Estuary in 2012, which examined dissolved oxygen levels for tidal and non-tidal waters in the estuary. The reports review tidal waters found that dissolved oxygen is "currently above (meeting) criteria, where measured most of the time." For non-tidal waters, data revealed that dissolved oxygen levels are "reasonably good in many locations, with a few areas of localized low DO. The trend at Trenton suggest that DO is stable at relatively high saturation, with some reduction on variability since the late 1960s (Partnership for the Delaware Estuary, 2012)."

[22] Revised DRBC regulations (18 CFR PART 410; 11/2013) for dissolved oxygen in Zone 5 are: 1) 3.5 mg/l at R.M. 78.8; 2) 4.5 mg/l at R.M. 70.0; and 3) 6.0 mg/l at R.M. 59.5. However, the seasonal requirements remain at 6.5 mg/L.

In summary, the Delaware Estuary conditions show enormous improvements in DO since the 1960's, with generally acceptable levels but some instances of DO levels that are lower than desired. The main channel of the Delaware River has acceptable pathogen levels, but many tributaries and near shore waters (which have a higher probability of recreational contact) do not.

By their nature, CSO overflows occur during wet-weather events. The logical assumption is that the pollutants discharged from CSO outfalls are then diluted by increasing stream or river flow, where the outfall is on a non-tidal river, or by the large expanse of waters where discharged into tidal waters. However, the former assumption is not always correct. To show how different events can have different effects, both of the following hydrographs in **Figures 3-3 and 3-4** are from the Passaic River Little Falls stream monitoring station in NJ, just upstream of Paterson.

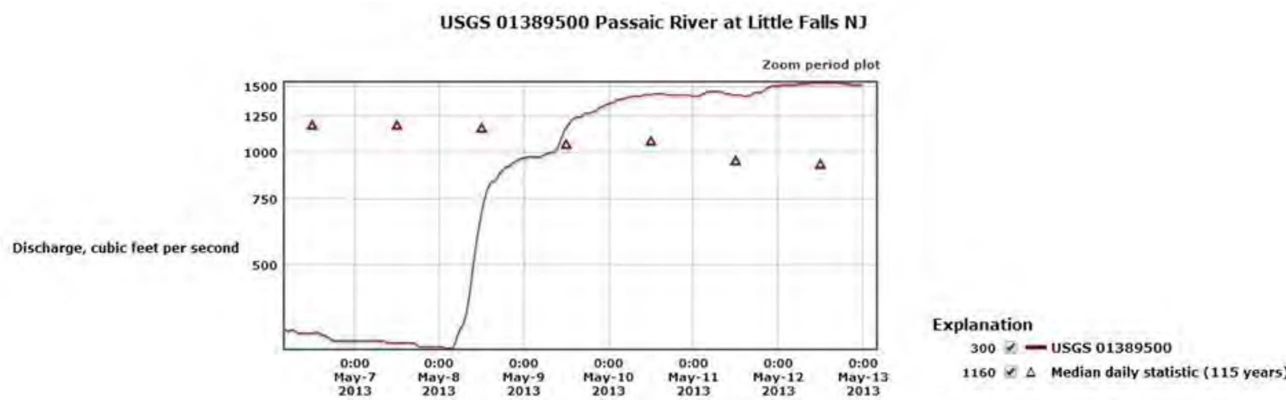


Figure 3-3: Hydrograph for Passaic River at Little Falls, NJ, 7-13 May 2013

As shown on **Figure 3-3**, on 8 May 2013, there was a significant rainfall event of 1.42 inches in the nearby area of Wayne, NJ, followed the next day by another 0.42 inches.[23] This multi-day rainfall event was ample to cause a discharge from Paterson CSOs, but also increased the river flow from well below to above median daily flows.[24] In this situation, a significant amount of dilution becomes available at nearly the same time as the CSO events, though an evaluation of any delays between the rainfall (triggering the CSO event) and the stream flow increase may show that the CSO event preceded the increased flow by some hours. Information was not readily available to test this possibility.

The **Figure 3-4** is from the same station.[25] On 20 October 2013, the Wayne weather station recorded a rainfall event of 0.35 inches, also sufficient to trigger a CSO event in Paterson. However, the Passaic River flows during the entire period were well below the median daily flows, indicating a low flow period. Further, the hydrograph shows only a minor increase in flow, which would provide very little dilution for the CSO-related pollutant loads downstream. Note that the <u>lowest</u> flow in **Figure 3-3** is greater than the <u>highest</u> flow shown in in **Figure 3-4**, emphasizing the limited dilution available for the 20 October 2013 CSO event.

[23] http://climate.rutgers.edu/njwxnet/
[24] http://nwis.waterdata.usgs.gov/nwis/uv?period=&begin_date=2013-05-06&end_date=2013-05-12&cb_00060=on&site_no=01389500&format=gif_mult_sites
[25] http://nwis.waterdata.usgs.gov/nwis/uv?period=&begin_date=2013-10-18&end_date=2013-10-24&cb_00060=on&site_no=01389500&format=gif_mult_sites

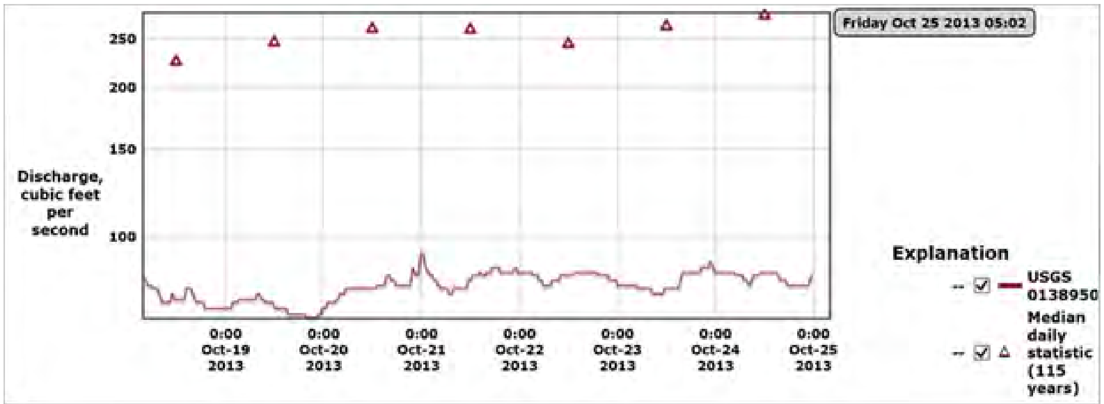


Figure 3-4: Hydrograph for Passaic River at Little Falls, NJ, 19-25 October 2013

Of concern also are discharges to small tidal tributaries, which will not have a significant downstream flow when a CSO event occurs as the tide is coming in, blocking outflow to the main estuarine river. Examples include Overpeck Brook in the Hackensack River watershed, Second River in Newark, and Newton Creek in the Camden area. Insufficient information is available to determine the extent and frequency at which these water quality impacts will occur, but they raise the question of whether the presumption approach will achieve the same benefits in all situations.

The available information on water quality in water bodies affected by CSOs indicate that CSO contribute significant loadings during outflow periods, but that other pollutant sources (including stormwater and non-point pollution sources) also contribute significantly to current water quality issues. While some waters have few CSO outfalls relative to the size of the water body such that CSO contributions are likely a small component of any water quality issues (e.g., Raritan Bay, Delaware River upstream of Camden), other waters have many CSO outfalls in relatively restricted areas, which would concentrate effects. However, the latter waters may also be heavily affected by other urban pollutant sources. It seems that insufficient information is available to determine the extent to which CSO controls (beyond the current controls of solids and floatable materials) will help achieve water quality standards for pathogens, nutrients and other contaminants associated with CSOs. However, it should be noted that while some pollutants (e.g., bacteria) have relatively short lifespans in open waters, other pollutants (e.g., nutrients) can exert impacts over long periods and large areas. Focusing on any single pollutant will not tell the full story. While published results of monitoring and modeling in the Harbor Estuary Program address these issues more directly than results from the Delaware Estuary, the Harbor Estuary models and reports were either not finalized (pathogens) or remain in development (nutrients, toxins).

Water Infrastructure Ownership and Capacity in CSO Municipalities

Water infrastructure systems in New Jersey are often not in common management within a single municipality. This is certainly true in the CSO municipalities. Municipalities are generally responsible for municipal separate storm sewer systems (MS4s) where they exist. Many of the CSO municipalities have at least some areas of MS4s, while other parts of the municipality are served by combined sewers (see **Table 3-12**).

Public community water supply (PCWS) systems may be owned by the municipality, a municipal utility authority, a regional agency or an investor-owned company such as NJ American Water or United Water New Jersey. Where either a municipality or municipal utilities authority owns the PCWS system, they may in turn contract out operations and maintenance of the system to a private firm. The distribution system may be owned by a different entity than the water supply source or water treatment plant. The source of the water may be controlled by the local PCWS system (e.g., Newark, Jersey City, Camden), or it may be in turn provided by a separate entity by contract. Regarding CSO municipalities, the two major sources of bulk water by contract are North Jersey District Water Supply Commission (NJDWSC; treated water) and New Jersey Water Supply Authority (NJWSA; untreated water), both of which were established by special State legislation and cannot by law operate distribution systems.

Public sewerage utilities have a fairly similar ownership and management pattern, with the major exception that no CSO municipality has sewer collection or treatment system that is owned by an investor-owned company. However, contracts for services do exist in the provision of public sewerage services. Sewage collection systems are often owned by a municipality or municipal utility authority, but in turn only Trenton directly owns and operates a sewage treatment facility; the others contribute flows to a regional facility owned by another agency.

Table 3-2 lists the CSO municipalities and the relevant owners/operators of PCWS and public sewerage systems, including the primary water source and the ultimate sewage treatment utility.

Table 3-2: Ownership and Operation of Water Supply and Sewer Systems in CSO Municipalities
(* Delaware River)

Municipality	PCWS Supply	Primary Water Source	Sewer Collection System	Sewage Treatment Utility
Bayonne City	Bayonne MUA: O&M by United Water-Jersey City	North Jersey District Water Supply Commission (NJDWSC)	Bayonne MUA	Passaic Valley Sewerage Commissioners (PVSC)
Camden City*	Camden (City): O&M by United Water	Ground Water	Camden (City): O&M by United Water	Camden County MUA (CCMUA)
East Newark Boro	East Newark Water Department	NJDWSC	East Newark Water Department	PVSC
Elizabeth City	Elizabeth: O&M by Liberty Water (American Water)	NJ Water Supply Authority-Raritan System (via NJ American Water); NJDWSC (via Newark)	Elizabeth: O&M by Elizabethtown Services LLC (American Water)	Joint Meeting of Essex & Union Counties
Fort Lee Borough	United Water-NJ	United Water (Hackensack System)	Fort Lee	Bergen County Utilities Authority (BCUA)
Gloucester City*	Gloucester City	Ground Water	Gloucester City	CCMUA
Guttenberg Town	United Water-NJ	United Water (Hackensack System)	Guttenberg	NBMUA – Woodcliff WWTP
Hackensack City	United Water-NJ	United Water (Hackensack System)	Hackensack	BCUA
Harrison Town	Harrison Water & Sewer Department	Passaic Valley Water Commission (PVWC)	Harrison Water & Sewer Department	PVSC
Hoboken City	Hoboken: O&M by United Water-Jersey City	Jersey City (Reservoirs)	North Hudson SA (NHSA): O&M by CH2M HILL	NHSA – Adams Street WWTP
Jersey City	Jersey City MUA: O&M by United Water-Jersey City	Jersey City (Reservoirs)	Jersey City MUA	PVSC
Kearny Town	Kearny Water Department	NJDWSC	Kearny, and Kearny MUA	PVSC
Newark City	Newark Water and Sewer Department	Newark (Pequannock Reservoirs); NJDWSC	Newark Water and Sewer Department	PVSC
North Bergen Twp	United Water-NJ (Hackensack)	United Water (Hackensack System)	North Bergen MUA	NBMUA – Woodcliff WWTP; PVSC
Paterson City	PVWC	PVWC	Paterson	PVSC
Perth Amboy City	Perth Amboy: O&M by Middlesex Water Company[26]	Ground Water (Runyon Well Field)	Perth Amboy: O&M by Middlesex Water Company	Middlesex County Utilities Authority
Ridgefield Park Village	United Water-NJ	United Water (Hackensack System)	Ridgefield Park	BCUA
Trenton City*	Trenton Water Department	Delaware River (Trenton Intake)	Trenton Sewer Utility	Trenton Sewer Utility

[26] Doing business as Utility Service Affiliates (Perth Amboy), Inc.

Table 3-2: Ownership and Operation of Water Supply and Sewer Systems in CSO Municipalities (* Delaware River)				
Municipality	**PCWS Supply**	**Primary Water Source**	**Sewer Collection System**	**Sewage Treatment Utility**
Union City	United Water-NJ	United Water (Hackensack System)	NHSA	NHSA – Adams Street WWTP
Weehawken	United Water-NJ	United Water (Hackensack System)	NHSA	NHSA – Adams Street WWTP
West New York	United Water-NJ	United Water (Hackensack System)	NHSA	NHSA –West NY WWTP

Public Community Water Supply Systems

A major issue for any CSO municipality is one of water supply capacity. Where a municipality owns their water supply and does not supply water to other municipalities, comparison of capacity to growth potential is fairly straightforward. However, among CSO municipalities this one-to-one relationship is uncommon, applying only to those municipalities dependent on ground water (Camden, Gloucester City and Perth Amboy) and to Trenton, which has its own intake on the Delaware River. Therefore, in most cases a municipality relies on a regional supply of some sort. The municipality may be the owner of the supply (e.g., Jersey City, Newark, PVWC) and contract to sell water to other municipalities, but most others are either contract purchasers or within the direct service area of regional systems. For this reason, an evaluation of available capacity is not straightforward.

The North Jersey District Water Supply Commission (NJDWSC) has contracts with the following member municipalities, where growth demands will compete with the additional needs of any of the other customers including CSO municipalities.

Table 3-3: North Jersey District Water Supply Commission Customers and Contractual Allocations[27]					
Customer	**MGD**	**Customer**	**MGD**	**Customer**	**MGD**
Bayonne	10.500	Kearny	13.000	Newark	49.400
Bloomfield	6.510	Montclair	4.700	Nutley	3.000
Cedar Grove	1.200	Nutley	3.000	Wayne	9.000
Clifton	6.345	Passaic	10.340	United Water	39.500
Glen Ridge	0.705	Paterson	18.800		

Some NJDWC customers in turn have their own supplies (e.g., Passaic and Clifton through the Passaic Valley Water Commission (PVWC); Newark through its Pequannock system; United Water through its Hackensack system). PVWC provides direct water supply service to the owner cities of Paterson, Passaic and Clifton, but also owns and operates the water systems in Prospect Park and North Arlington, and leases and operates the system in Lodi. PVWC provides wholesale treated water (some from its own supplies, some from NJDWSC supplies, and some mixed) to other municipalities, as follows:

Table 3-4: Passaic Valley Water Commission: Wholesale Water Customers		
Bloomingdale	Hawthorne	Southeast Morris County MUA
Cedar Grove	Lincoln Park	Totowa
Elmwood Park	Lyndhurst	Verona
Fairfield	NJ American Water Company	Wallington
Fair Lawn	North Caldwell	Wanaque Borough
Garfield	Nutley (water wheeling only)	West Caldwell
Haledon	Ringwood	Woodland Park (West Paterson)
Harrison	Riverdale	

[27] As of April 2014 from the NJDWSC web site at www.njdwsc.com. Clifton, Passaic and Paterson are represented by Passaic Valley Water Commission. NJDEP (personal communication) indicates that the allocation to United Water has been increased to 48 MGD, which is not yet reflected on the NJDWSC web site.

Most PVWC customers receive water from the PVWC water treatment plant in Little Falls, but in other cases the systems are completely separate from the main PVWC system (e.g., Ringwood, Wanaque Borough).

Newark provides bulk treated water to other municipalities as well, specifically Pequannock, Belleville, Bloomfield, East Orange and Elizabeth. United Water owns and operates water supply distribution to a large area of Bergen County and portions of Hudson County, with roughly 800,000 people directly served.

Using NJDEP's approach for PCWS Deficit/Surplus Analysis, **Net Available Capacity** reflects what remains after the highest monthly flow in the last five years and any reported commitments for future supplies are subtracted from total capacity (internal supplies plus contract purchases). The following table shows the water supply deficit or surplus for each water supply source, based on NJDEP data as of May 2014. Each system has a significant amount of net available capacity, with the apparent exception of Passaic Valley Water Commission. However, the values for PVWC may reflect only its base contract purchase from NJDWSC and not the contract provisions allowing for purchases beyond that base level. Therefore, the net deficit for PVWC may be an accounting issue. PVWC is engaged in discussions with NJDEP to address these issues. PVWC estimates that the correct current available supplies are roughly 5 MGD. No conclusions are available at this time.

Table 3-5: Net Available Capacity (May 2014) for Water Supply Facilities Serving CSO Municipalities

Primary Water Supply Sources	Total Capacity (MGM)^	Net Available Capacity (MGM)*	Net Available Capacity (MGD)
Camden (City) Water Department (GW)	664	235.770	7.756
Gloucester City (GW)	93	54.832	1.804
Newark Water Department (SW)	3806.49**	863.994	28.421
NJ American (Raritan) (SW)	6761.5***	885.418	29.126
North Jersey District Water Supply Commission (SW)	5700#	1649.620	54.987
Passaic Valley Water Commission (SW)	3425.5**	-578.069##	-19.015##
Perth Amboy (GW)	248	36.952	1.216
Trenton Water Department (SW)	1350	191.749	6.308
United Water-Jersey City (SW)	2635	663.924	22.132
United Water-NJ (Hackensack System) (SW)	5294**	553.409	18.204

^ Monthly Water Allocation plus Contract Purchases, in million gallons per month (MGM)
* Total Capacity minus (peak monthly demand + committed demand). Source: NJDEP Public Water System Deficit/Surplus, at http://www.nj.gov/dep/watersupply/pws.html
** Includes contract supplies from North Jersey District Water Supply Commission
*** Primary water source is NJ Water Supply Authority, with addition supplies from wells.
# NJDWSC is a bulk provider of treated drinking water. It has no retail service area within a CSO municipality. Total Capacity reflects modification of safe yield to 190 MGD.
PVWC bulk purchase contract (35.5 MGD/1100 MGM) from NJDWC includes 50% daily + 20% monthly overdraft provisions; the nominal net available capacity as shown reflects only the base amount.

Public Sewer Systems

Determination of the Net Available Capacity for public sewer systems requires consideration of similar issues. Of the CSO municipalities, only Trenton has its own sewage treatment plant with no other municipal customers. All others contribute to regional facilities. All of these besides the North Hudson Sewer Authority serve both CSO municipalities and many communities that do not have combined sewer systems. For instance, Joint Meeting of Essex and Union Counties serves portions or all of 15 municipalities: East Orange, Elizabeth, Hillside, Irvington, Livingston, Maplewood, Millburn, Newark, New Providence, Orange, Roselle Park, South Orange, Summit, Union and West Orange, as shown in **Figure 3-5**. Of these, only Elizabeth is a CSO community within the Joint Meeting service area. That portion of Newark served by Joint Meeting has no combined sewers.

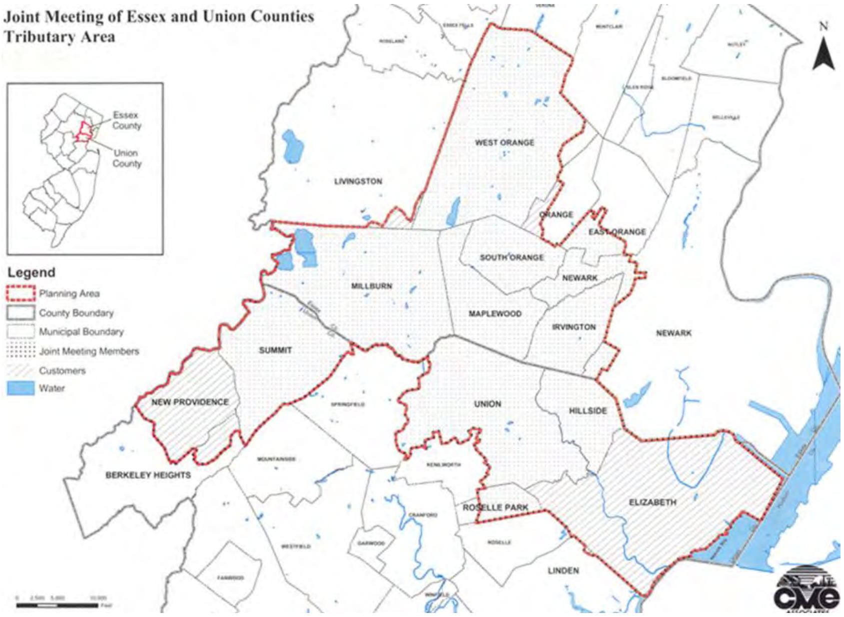


Figure 3-5: Municipalities Served by the Joint Meeting of Essex and Union Counties

PVSC provides sewage treatment services to 49 municipalities. These municipalities may be direct or indirect customers. The PVSC service area is shown on **Figure 3-6**. Eight of these are CSO municipalities or entities addressed by this report: Bayonne, East Newark, Harrison, Jersey City, Kearny, Newark, North Bergen Sewerage Authority, and Paterson.

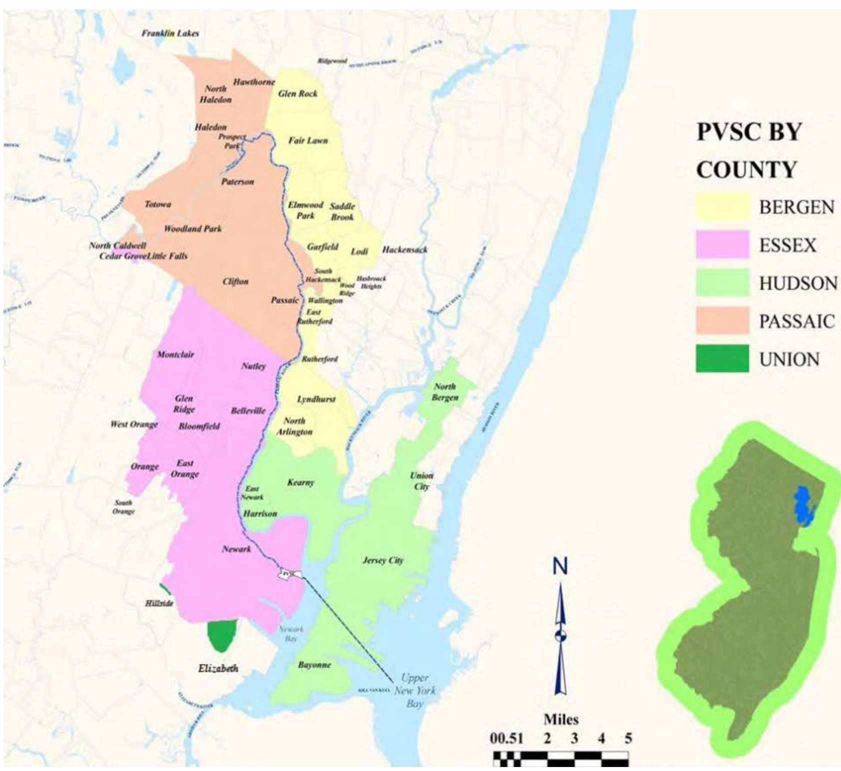


Figure 3-6: Municipalities Served by the Passaic Valley Sewerage Commissioners

The Bergen County Utilities Authority has 47 municipalities in its service area covering eastern Bergen County, of which Fort Lee, Hackensack and Ridgefield Part are CSO municipalities.

Table 3-6: Bergen County Utilities Authority: Member Municipalities (**Bold** is a CSO municipality)		
Bergenfield	Harrington Park	Park Ridge
Bogota	Hasbrouck Heights	Ridgefield
Carlstadt	Haworth	**Ridgefield Park**
Cliffside Park	Hillsdale	River Edge
Closter	Leonia	River Vale
Cresskill	Little Ferry	Rochelle Park
Demarest	Maywood	Rutherford
Dumont	Montvale	South Hackensack
East Rutherford	Moonachie	Teaneck
Edgewater	New Milford	Tenafly
Emerson	Northvale	Teterboro
Englewood	Norwood	Washington Twp
Englewood Cliffs	Old Tappan	Westwood
Fairview	Oradell	Woodcliff Lake
Fort Lee	Palisades Park	Wood-Ridge
Hackensack	Paramus	

Camden County Municipal Utilities Authority (CCMUA) treats wastewater from 40 customer municipalities, shown in **Table 3-7**, of which only two (City of Camden and Gloucester City) are CSO municipalities.

Table 3-7: Camden County Municipal Utilities Authority: Member Municipalities (**Bold** is a CSO municipality)		
Audubon	**Gloucester City**	Oaklyn
Audubon Park	Gloucester Township	Pennsauken
Barrington	Haddonfield	Pine Hill
Bellmawr	Haddon Township	Pine Valley
Berlin Township	Haddon Heights	Runnemede
Berlin Borough	Hi-Nella	Somerdale
Brooklawn	Laurel Springs	Stratford
Camden (City)	Lawnside	Tavistock
Cherry Hill	Lindenwold	Voorhees
Chesilhurst	Magnolia	Waterford
Clementon	Merchantville	Winslow
Collingswood	Mt. Ephraim	Winslow/Albion
Evesham	Mt. Laurel (via Cherry Hill)	Woodlynne
Gibbsboro		

Middlesex County Utilities Authority (MCUA) serves 35 municipalities in Middlesex, Union and Somerset Counties, only one of which – Perth Amboy – is a CSO municipality.

There are three methods of assessing **Net Available Capacity** in New Jersey. NJDEP's Capacity Assurance Program (CAP, which applies to utilities with CSOs) compares the "permitted capacity"[28] of a treatment facility to the "committed flow" (existing flow plus commitments to accept flow from additional connections). CAP uses a rolling three-month average (e.g., months 1 through 3, 2 through 4, and so on).[29] The Highlands Regional Master

[28] "Permitted Capacity" is defined by the NJPDES rules (N.J.A.C. 7:14A-1.2) as "a treatment work's maximum allowable flow (usually in million gallons per day, or other appropriate unit of flow such as gallons per day) as stated in the facility's NJPDES Permit or TWA [Treatment Works Approval] whichever is more stringent." Many NJPDES permits for sewage treatment plants do not have an enforceable flow limit, but do use the TWA permitted to determine pollutant discharge limits. In the absence of NJPDES permit limits for flow, the TWA value would apply.

[29] The capacity assurance program rules at N.J.A.C. 7:14A-22.16 do not specify the three-month averaging period, nor the time frame over which the rolling average is applied. The sewer ban imposition rules at N.J.A.C. 7:14A-22.17 do

Plan (which does not apply to any CSO municipality) also evaluates the rolling three-month average flow over a multi-year period, and compares the permitted capacity to the maximum of those rolling averages, or MAX3MO, to assess relatively short-term stresses on the system. The third approach is to use annual average flows, which is the method incorporated into NJDEP's wastewater management planning process (NJAC 7:15). Each of these methods focuses on capacity of the systems to accept additional wastewater flows during dry weather periods, known as "dry weather flows" even though they also are part of the wet weather flows. None of these three approaches provides a useful surrogate for capacity to address CSOs, as those flows commonly last for a day or less, and therefore the instantaneous peak flows are "hidden" within the long-term averages used by these methods. Actual capacity for wet weather flows is highly dependent upon the local conditions of each catchment area, collection system and treatment plant, as discussed in **Combined Sewer Systems, Outfalls and Catchment Areas** below.

For this study, only monthly treatment plant discharge flows were available, not including future commitments for flow, and so the CAP method could not be replicated. Therefore, the other two methods were used. Monthly flow data were compiled from the NJPDEP Data Miner web site for the nine treatment plants that serve CSO municipalities. Using the Highlands Council method, three-month average flows were calculated on a rolling basis for a five-year period (2009-2013). The highest of these values is considered the MAX3MO (maximum three-month average daily flow). Using the same data, the annual average daily flows were calculated for the same facilities on a calendar year basis.

Both values are provided in **Table 3-8**.[30] While some facilities have greater than 10% of their total capacity available using MAX3MO (CCMUA, NHSA-Adams Street, Trenton), several are showing deficits at MAX3MO only (BCUA, MCUA) or for both MAX3MO and annual flows (NHSA-West New York), indicating a more limited ability to handle additional dry weather flows. Of greatest interest are those facilities showing major differences in available capacity between the two methods, most notably the Woodcliff WWTP of North Bergen MUA, which shows a 36% deficit for the MAX3MO calculation but a 14% surplus using annual average flows (a swing of 50%). Camden County MUA shows a smaller swing (21%) but is a much larger regional facility with only two CSO municipalities (City of Camden and Gloucester City). These strong distinctions between the two measures of Net Available Capacity indicate that wet weather flows have a great impact on flows and capacity.

Table 3-8: Net Available Capacity for Sewage Treatment Facilities Serving CSO Municipalities (2009-2013)

Sewage Treatment Utility	Permitted Capacity (MGD)	Net Available Capacity (MGD): MAX3MO	Net Available Capacity	Net Available Capacity (MGD): Annual Average Flows	Net Available Capacity
Bergen County Utilities Authority	94[31]	**-9.494**	**-10%**	1.324	1%
Camden County MUA	80	9.733	17%	22.292	38%
Joint Meeting of Essex & Union Counties	75	8.649	10%	18.741	22%
Middlesex County Utilities Authority	147	**-5.293**	**-4%**	13.120	9%
North Bergen MUA – Woodcliff WWTP	2.91	**-1.053**	**-36%**	0.400	14%
North Hudson SA – Adams Street WWTP	20.8	5.827	28%	7.005	34%
North Hudson SA –West NY WWTP	10	**-1.157**	**-12%**	**-0.092**	**-1%**
Passaic Valley Sewerage Commissioners[32]	330	30.000	9%	54.500	17%
Trenton Sewer Utility	20	5.527	28%	7.661	38%

A second critical consideration is that these facilities all serve at least one CSO municipality. The CSOs occur because the combined sewage/stormwater effluent does not reach the sewage treatment plants either due to limitations of the collection system or to protect the treatment plant from excessive flows. Therefore, any surpluses in capacity at the treatment plants themselves (as shown in **Table 3-8**) may be misleading; a legitimate

use a consecutive three-month average, but only regarding a NJPDES permit violation. They also do not specify a time frame over which the rolling three-month average is to be assessed.

[30] NJDEP has begun an evaluation of appropriate indicators for treatment plant capacity utilization that may result in changes to existing regulations regarding this issue.

[31] BCUA has permit limits of 85 and 94 MGD, in the summer and winter, respectively

[32] PVSC has a permit limit based on a rolling 12-month average flow, unique among these facilities

question is whether any capacity would remain if the treatment plants received more of the combined sewer flows (e.g., if wet weather flows were stored temporarily within the catchment areas and then released to the treatment plants after the storm). As for those facilities with current deficits, the question is how much worse the situation would be if more flows reached the treatment plants. In either case, the addition of dry weather flows will limit the system's ability to accommodate flows associated with precipitation events. It should be noted that NJDEP would not impose a sewer connection ban in any of these situations, so long as the Capacity Assurance Program requirements are met for the treatment plant, and the CSO permit requirements are being met by the permittee. As discussed in **Chapter 1**, the CSO Individual Permits will require evaluations of how to retain more of the flow in the collection system for conveyance to the treatment plant, how to use available wet weather treatment plant capacity, and how to increase the treatment capacity of the plants themselves.

Growth Demands for Water Supply and Sewer Utilities

The following table shows the projected population increases of the CSO municipalities, which is then translated into estimated sewerage demands at 75 gallons per person per day (gpcd) and then water supply demands (combined Residential, Industrial, Commercial) using two different per capita use rates: 130 gpcd, representing the current statewide average; and 100 gpcd, representing a low industrial component, few outdoor water uses, and more aggressive conservation.[33] Several CSO municipalities are projected to have population growth of 15,000 or more through 2040, shown in **bold** on the table; most notable are Jersey City and Newark, which are already New Jersey's most populous municipalities. While there is no specific situation where available water supplies seem inadequate to meet the projected demands, this is not true for wastewater demands, where capacity issues have been shown above for NHSA-West New York, and potentially for BCUA (serving Hackensack and Ridgefield Park), MCUA (serving Perth Amboy), and North Bergen MUA. However, of these municipalities, the primary question would be the demands from Elizabeth, constituting a significant fraction (almost 20%) of the net available capacity at Joint Meeting using the MAX3MO flows, as Elizabeth is only one of the Joint Meeting member municipalities with CSOs.

Table 3-9: Water and Wastewater Generation from Population Growth Through 2040 in CSO Municipalities

Municipality	MPO 2010 Population	2040 Population	Pop Growth 2010-2040	Wastewater Demands @75 gpcd (MGD)	Water Demands @100 gpcd (MGD)	Water Demands @130 gpcd (MGD)
Bayonne City	63,020	78,650	15,630	1.172	1.563	2.032
Camden City	77,344	78,199	855	0.064	0.086	0.111
East Newark Borough	2,410	4,510	2,100	0.158	0.21	0.273
Elizabeth City	124,970	147,790	22,820	1.712	2.282	2.967
Fort Lee Borough	35,350	41,810	6,460	0.485	0.646	0.840
Gloucester City	11,456	11,488	32	0.002	0.0032	0.004
Guttenberg Town	11,180	11,650	470	0.035	0.047	0.061
Hackensack City	43,010	48,190	5,180	0.389	0.518	0.673
Harrison Town	13,620	32,050	18,430	1.382	1.843	2.396
Hoboken City	50,010	57,630	7,620	0.572	0.762	0.991
Jersey City	247,640	356,250	108,610	8.146	10.861	14.119
Kearny Town	40,680	43,000	2,320	0.174	0.232	0.302
Newark City	277,140	345,180	68,040	5.103	6.804	8.845
North Bergen Township	60,770	70,830	10,060	0.755	1.006	1.308
Paterson City	146,200	179,020	32,820	2.462	3.282	4.267
Perth Amboy City	50,810	58,390	7,580	0.569	0.758	0.985
Ridgefield Park Village	12,730	14,070	1,340	0.101	0.134	0.174
Trenton City	84,913	87,250	2,337	0.175	0.2337	0.304
Union City	66,440	69,870	3,430	0.257	0.343	0.446

[33] These rates are useful for planning purposes, but changes in residential water consumption, loss of industries with high water demands, and overall water conservation efforts may have decreased demands below these levels.

Table 3-9: Water and Wastewater Generation from Population Growth Through 2040 in CSO Municipalities						
Municipality	**MPO 2010 Population**	**2040 Population**	**Pop Growth 2010-2040**	**Wastewater Demands @75 gpcd (MGD)**	**Water Demands @100 gpcd (MGD)**	**Water Demands @130 gpcd (MGD)**
Weehawken Township	12,550	17,200	4,650	0.349	0.465	0.605
West New York Town	49,710	52,840	3,130	0.235	0.313	0.407

These demands often are just some of the demand pressures on water supply and sewer systems, except for municipalities with their own systems that are not also supporting other municipalities. A recent report for Together North Jersey (Van Abs, 2013) examined the potential for demand growth to exceed the capacity of water supply and sewer utilities in that area. The following tables are from that report (with the System Surplus updated to May 2014), focused on utilities that serve CSO municipalities. The first table examines water supply systems, and the results indicate that Passaic Valley Water Commission could face demands exceeding supply if the municipalities served by those systems grew at projected rates through 2035 and used 130 gpcd, but not at the lower demand rate. However, PVWC has major contracts with NJDWSC, which provides significant flexibility in their supplies. PVWC does not expect its demands to exceed supplies in the period, as they have been experiencing falling demands (see discussion in the **Chapter 4**: Paterson).

Table 3-10: Estimated Additional Potable Water Demands Through 2035 for High-Growth Municipalities Within the Seven Largest Surface Water Supply Systems (Adapted from Van Abs, 2013)					
Surface Water Source	**System % of Region Growth**	**May 2014 System Surplus (MGD)***	**Pop Growth**	**Demand at 130 gpcd (MGD)**	**Demand at 100 gpcd (MGD)**
NJWSA (Raritan) – including NJ American (Raritan)	13.6%	29.196	164,304	21.36	16.43
United Water (Jersey City)	9.1%	22.132	109,865	14.28	10.99
PVWC	7.2%	-19.015	87,337	**11.35**	**8.73**
United Water-NJ (Hackensack)	5.0%	18.204	60,461	7.86	6.05
Newark	3.7%	28.41	45,050	5.86	4.51
NJDWSC Customers	2.6%	54.987	31,615	4.11	3.16

* Values from Table 3-5

The second table provides similar information on the regional wastewater facilities in northern New Jersey, but in this case for a single demand flow as compared to both metrics for facility capacity. Two of the utilities show current deficits using the MAX3MO approach. Middlesex County Utility Authority has just enough capacity to handle projected growth if the "annual average flows" approach is used, but not if the MAX3MO approach is used. PVSC and Joint Meeting have adequate capacity under both methods. However, in each case the caveat exists that these values represent mostly dry weather flows, not the wet weather flows that are associated with peak daily flows and CSO events.

Table 3-11: Sewer Service Demand Contributions of High-Growth Municipalities in Northern New Jersey (Adapted from Van Abs, 2013)				
Sewage Treatment Provider	**System % of Regional Growth**	**2011 Available Capacity Based on MAX3MO (MGD)**	**2011 Available Capacity: Annual Avg Flows (MGD)**	**Demand at 75 gpcd (MGD)**
Passaic Valley Sewerage Commissioners	22.7%	30.00	54.500	20.60
Middlesex County Utilities Authority	14.3%	-5.293	13.120	13.03
Joint Meeting of Essex & Union	6.0%	8.649	18.741	5.48
Bergen County Utilities Authority	2.9%	-9.494	1.324	2.66

Combined Sewer Systems, Outfalls and Catchment Areas

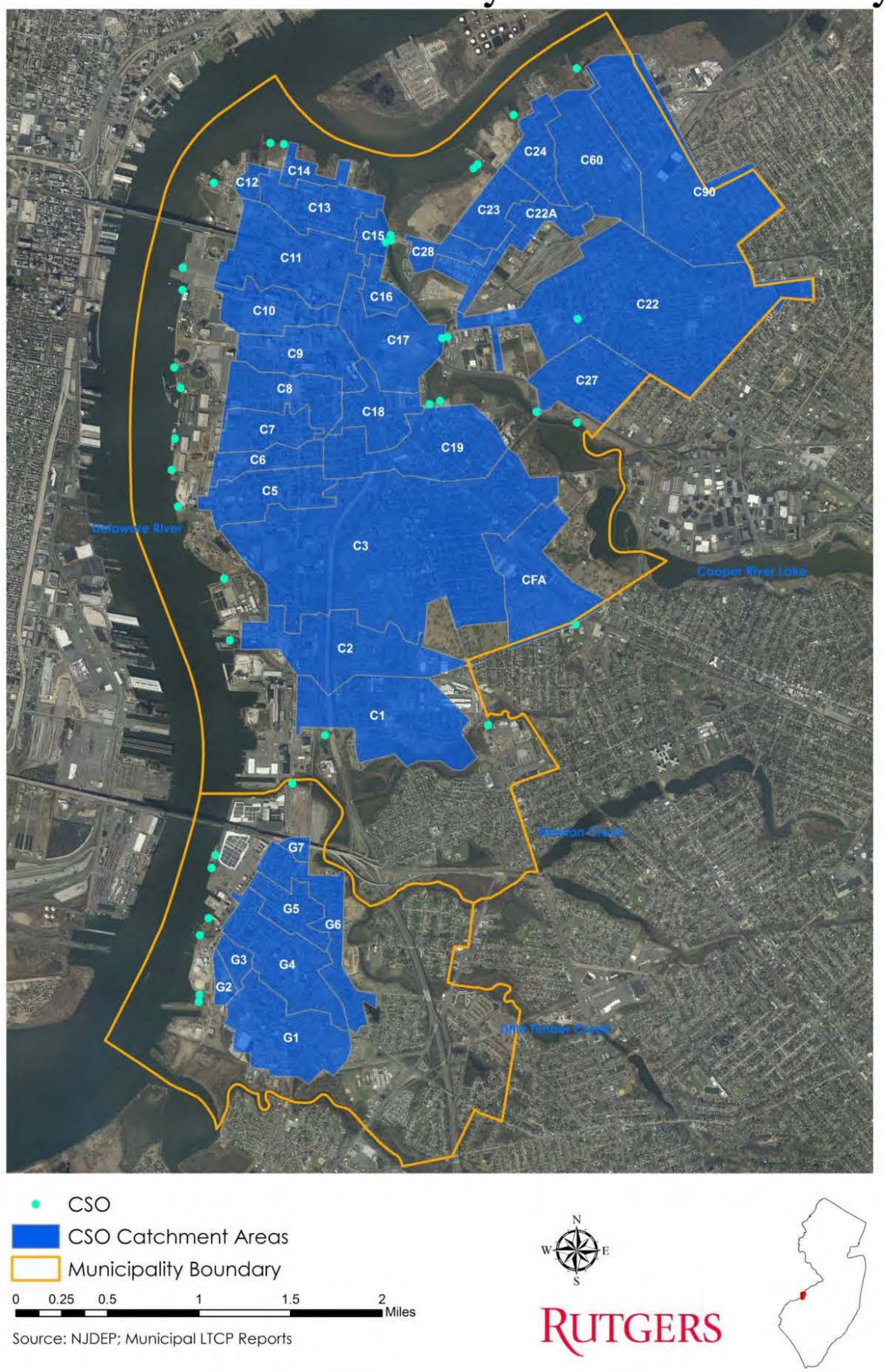
The listing of CSO municipalities, number of CSO points, receiving waters and relevant sewage treatment plants is provided at the beginning of this chapter. **Figure 3-7 through 3-10** show the location of the CSO discharge points and their contributing drainage areas, to the extent available. The CSO outfall locations are shown in **Figure 3-7** for the Camden area (Camden and Gloucester City), **Figure 3-8** for the NY/NJ Harbor area, **Figure 3-9** for Paterson and **Figure 3-10** for Perth Amboy. These maps also show the areas that drain to the CSOs, where information was available from the utilities or NJDEP files. In some cases the drainage areas are approximate but represent the best available information. **Table 3-12** provides a different viewpoint, listing the CSO permittees by number of CSO points and area. As can be seen, the seven systems with more than 15 CSO points comprise over 75% of the total CSO points in the state. Most of these municipalities are fiscally stressed, with Jersey City faring somewhat better than the others. The nine systems with at least 10 CSO points comprise nearly 85% of all CSO points. Kearny has the lowest percentage of CSO drainage area (less than 17%, as the entire Kearny MUA service area has none) while some towns have 100%.

The municipalities in **Table 3-12** with only one or two CSO points represent roughly 4% of all CSO points. One of those, Trenton, has already constructed off-line storage capacity of 20.3 MG, sufficient to reduce its CSO events to an average of less than one per year, which meets the event frequency requirements of the Presumption Approach. Historic tables of CSO outfalls indicate New Brunswick, Edgewater and Rahway as having CSOs, but these have been eliminated through control projects, primarily sewer separations.

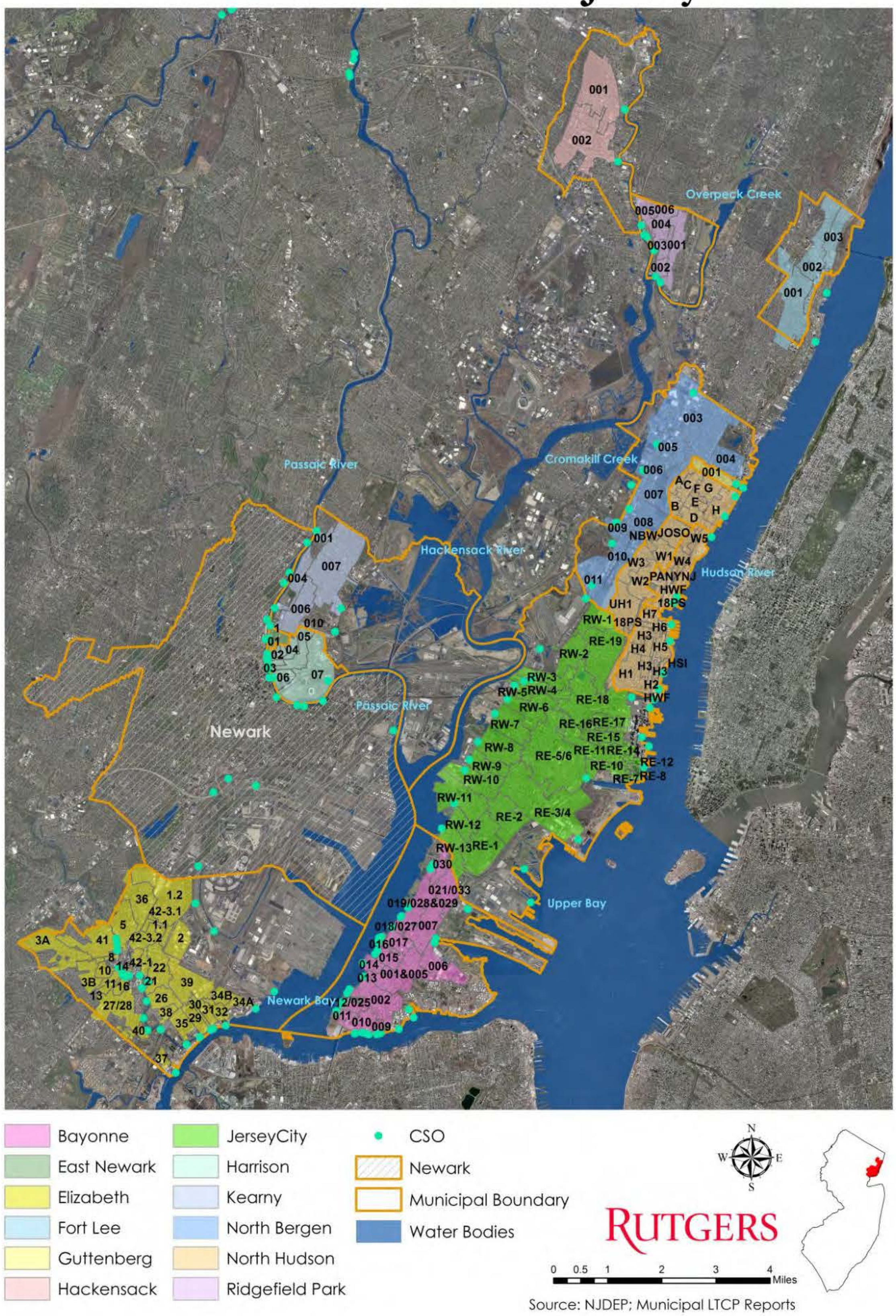
Table 3-12: CSO Municipalities and CSO Drainage Areas

CSO Permittee	# CSOs	Cumulative	Cumulative %	CSO Drainage Area	Percent of Municipality
Bayonne	30	30	13.8%	2001.67	40.70%
City of Camden	28	58	26.7%	3900.00	58.23%
Elizabeth City	28	86	39.6%	3589.54	40.31%
Paterson	24	110	50.7%	4571.19	82.17%
Jersey City	21	131	60.4%	6128.07	60.36%
Newark City	17	148	68.2%	N/A	N/A
Perth Amboy	16	164	75.6%	1330.06	40.16%
North Bergen MUA	10	174	80.2%	2567.99	75.90%
North Hudson SA	10	184	84.8%	2951.13	100%
Gloucester City	7	191	88.0%	494.64	27.69%
Harrison Town	7	198	91.2%	822.08	96.90%
Ridgefield Park	6	204	94.0%	514.79	41.86%
Kearny Town	5	209	96.3%	1077.03	16.52%
Fort Lee	2	211	97.2%	999.53	62.23%
Hackensack City	2	213	98.2%	1056.20	38.00%
CCMUA	1	214	98.6%	(In Camden)	(In Camden)
East Newark	1	215	99.1%	73.01	100%
Guttenberg	1	216	99.5%	110.43	89.23%
Trenton	1	217	100.0%	N/A	N/A
TOTALS (Available Data)		217		32,187.36	

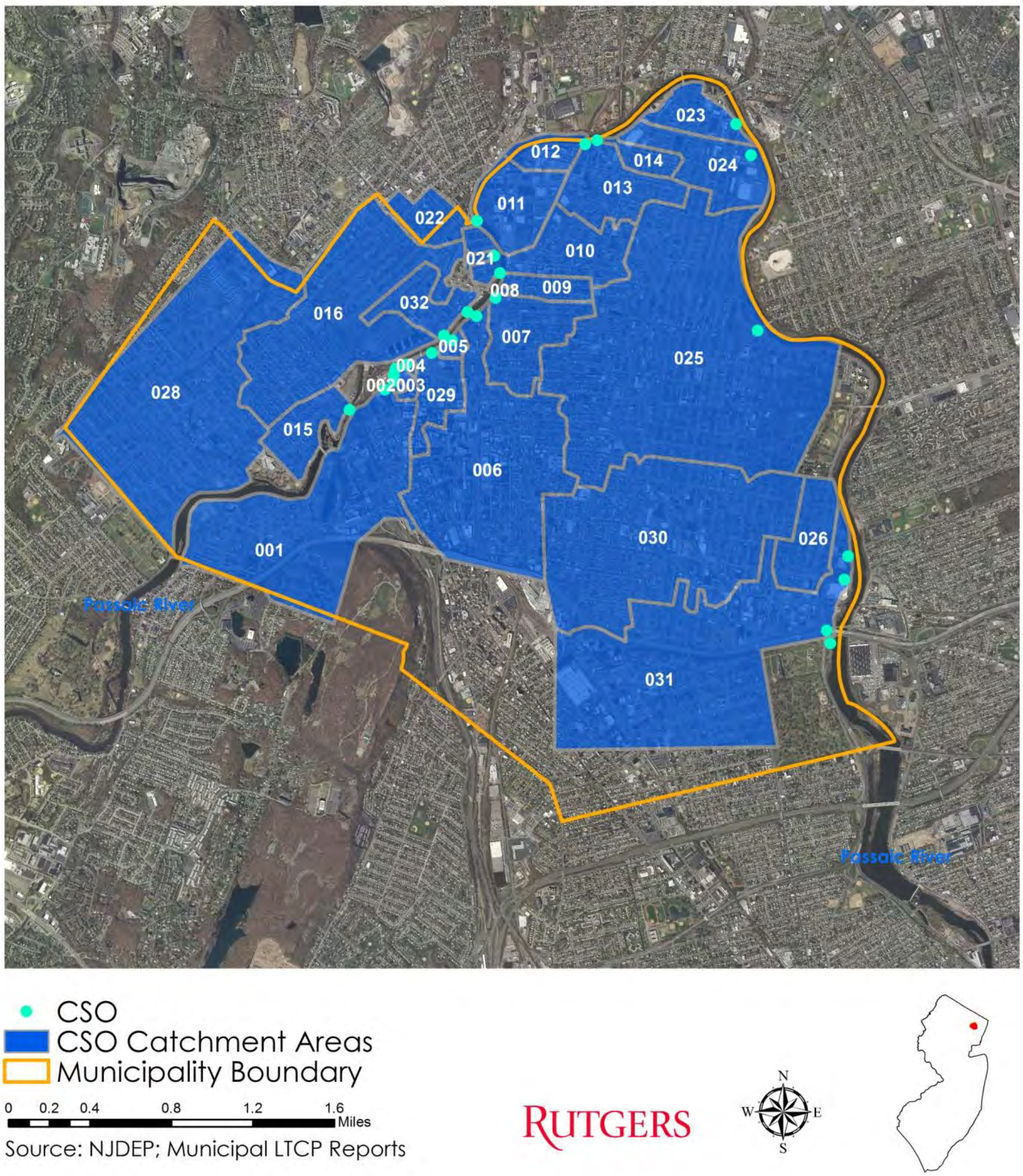
CSO Catchment Areas
CCMUA & Camden City & Gloucester City



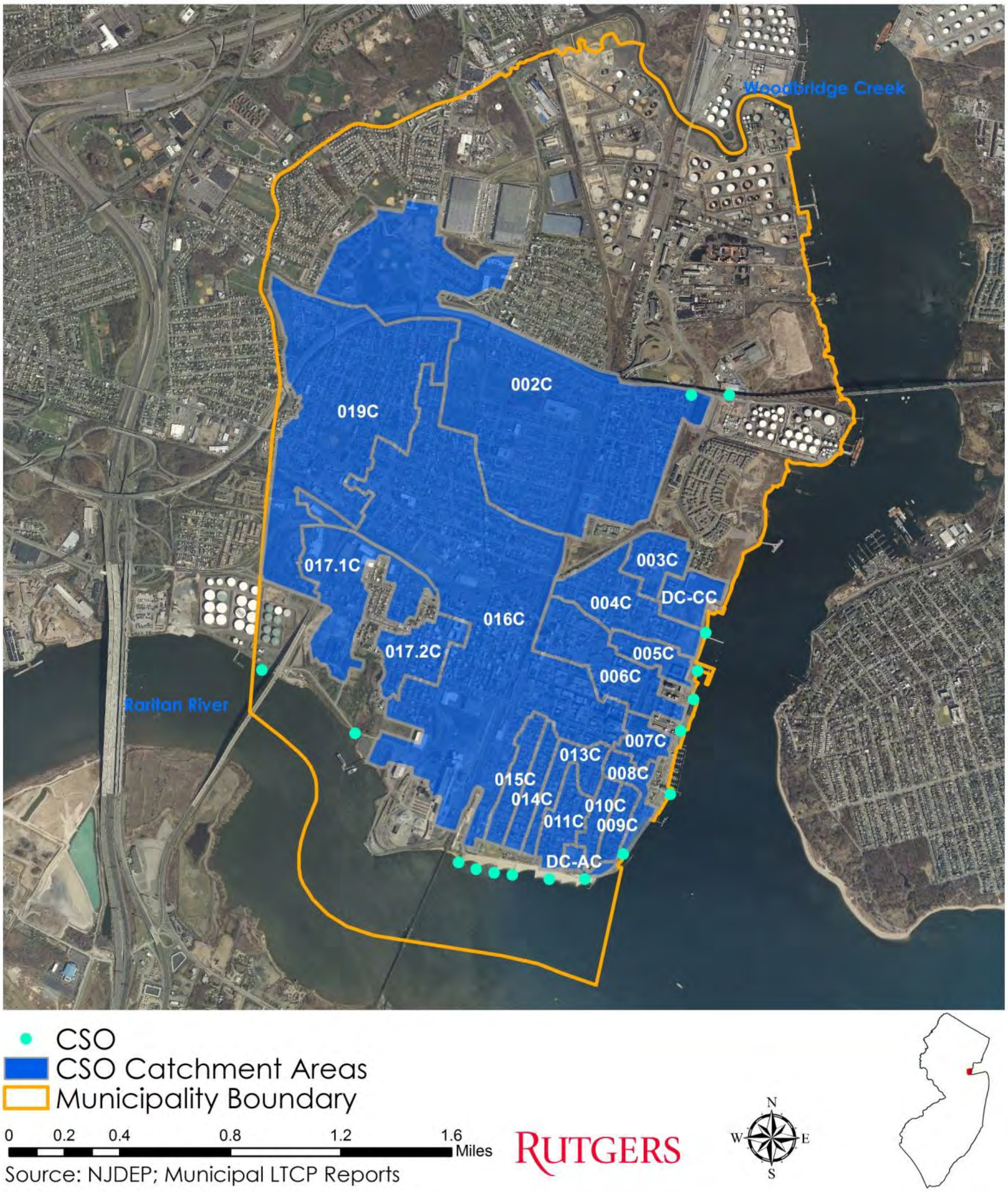
CSO Catchment Areas
Northeastern New Jersey



CSO Catchment Areas Paterson, New Jersey



CSO Catchment Areas
Perth Amboy, New Jersey



The Camden area CSOs are to the Delaware River and its tributaries, Cooper River and Newton Creek. The Harbor area CSOs are to the Elizabeth River, lower Passaic River, Hackensack River (and tributaries) and Hudson River. The Paterson CSOs are all to the Passaic River near the Great Falls and constitute the only New Jersey CSOs that are well upstream from tidal areas. The Perth Amboy CSOs are located at the mouth of the Raritan River. Efforts are continuing to complete mapping of the drainage areas for Newark.[34]

The CSO drainage area characteristics are provided in **Appendix A**, showing the drainage area, annual average volume per square mile, impervious surface and land use characteristics for each CSO where available. While the table is missing Newark, the total area of CSO drainage areas is 32,123 acres, over 50 square miles. The information is summarized in **Table 3-13**. As can be seen, the drainage area sizes range very widely, from a couple of acres to over a square mile. The annual average volume per square miles also has a very large range. This metric is used to normalize flows among the many drainage areas to provide a sense of flow density, as a small drainage area will generally have a smaller flow than a large area; however, the range seen here makes clear that this relationship does not always hold true. There are larger CSO drainage areas with relatively small flows and vice versa. These differences can be due to factors of pipe size, regulator type and operation, topography, location of the treatment plant relative to the CSOs, situations where a combined sewer receives flows from upstream separate sewers, synergies between CSOs, and even the current integrity of the combined sewer, where larger discharges may be due to blockages in the sewer system itself. The wide variation in flows makes clear the need, as required by the CSO permits, for flow models that are well developed to address the system complexities.

Table 3-13: Size and Land Use Characteristics of CSO Drainage Areas

	Drainage Area (Acres)	Volume/Area (MGY/Mi2)	Impervious Surface %	Urban %	Barren Land %	Forest %	Water %	Wetlands %
TOTALS	32,123		59.89%	95.28%	1.04%	2.52%	0.73%	0.42%
Minimum	1.91	1	22.16%	64.63%	0.00%	0.00%	0.00%	0.00%
Average	162.24	46	62.31%	95.67%	0.74%	2.05%	1.23%	0.30%
Maximum	874.00	104	96.43%	100.00%	16.60%	21.87%	26.26%	7.60%

Nearly all CSO drainage areas are characterized by high rates of urban land (average of 96% and a minimum of nearly 65%; only two have less than 75%) and impervious surfaces (average of 62%; only three have less than 40%). Other land uses constitute very low portions of the CSO drainage areas, with only a four having more than 15% significant forest area.[35] A few CSO drainage areas have significant surface waters within them, which may serve as temporary holding areas for stormwater.

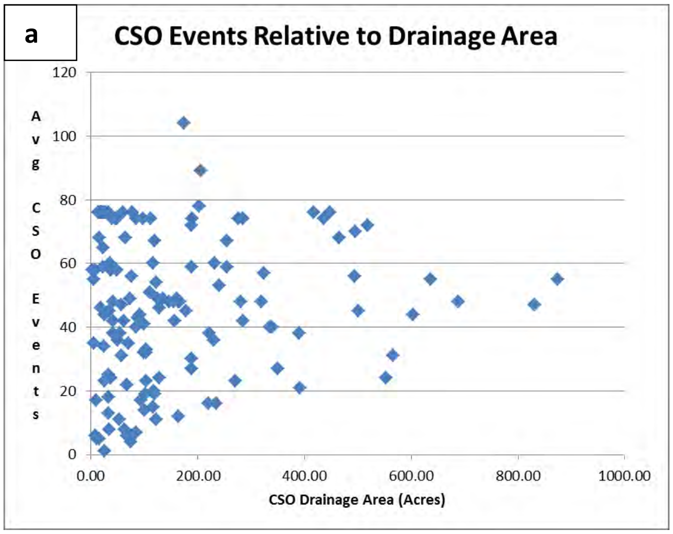
All CSO municipalities other than Trenton were required to assess the number, length and severity of CSO events during a specific rainfall pattern, using models developed by consultants for each regulated entity. The reports are not consistent in how they provided the information required by the NJPDES CSO general permit, and therefore some information was not uniformly available. The project team reviewed reports provided by the utilities and from NJDEP files to compile information regarding where it was identifiable in the reports; the results are provided in **Appendix A**. The project team did not have access to the stormwater models, but conducted an assessment of various concepts using GIS, as shown in the following graphs:

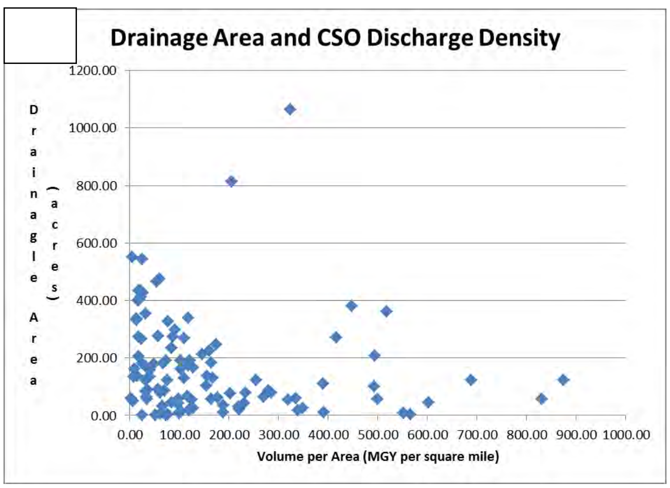
1. Whether the number of CSO annual events increases or decreases relative to drainage areas size
2. Whether the CSO discharge density (flows in million gallons per year (MGY) per square mile) increases or decreases relative to drainage area size
3. Whether the CSO discharge density (MGY per square mile) increases or decreases relative to the number of CSO annual events

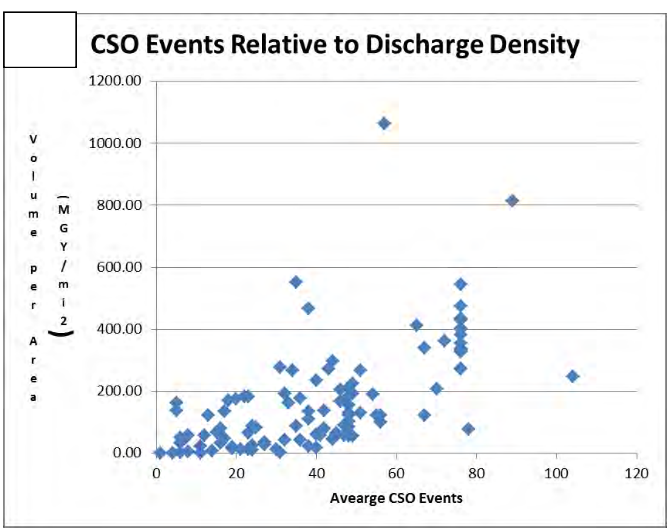
[34] The LTCP report for Newark includes a model schematic but not a representative map of CSO drainage areas.
[35] While these lands are shown as "forest" it is more appropriate to consider them areas with dense trees, such as parks, rather than as forest ecosystems.

4. Whether the number of CSO annual events increases or decreases relative to drainage area impervious surface

Where any of these comparisons show a strong relationship, it might be possible to project the available information to provide for missing information in Appendix A. The assessment started with a general assessment.







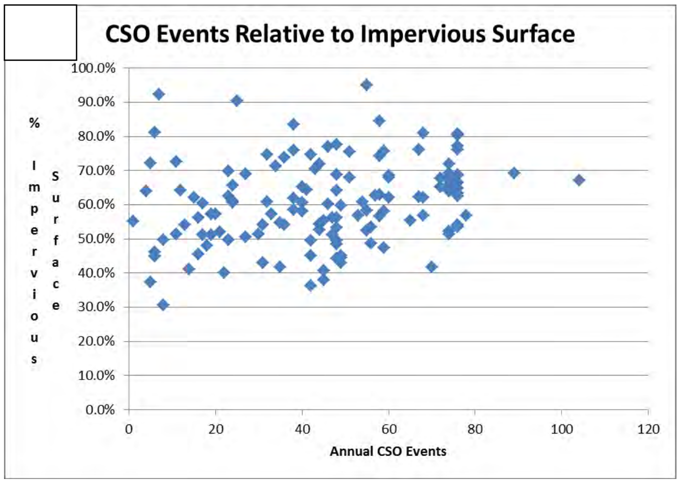


Figure 3-11 a-d. Comparisons of CSO Drainage Area Characteristics

Scatter graphs are used because the various CSO drainage areas are independent. As can be seen, there is considerable variation in the relationship of CSO events and drainage area size (**Figure 3-11a**), though the smallest drainage area also tend to have fewer events; only those areas near or less than 200 acres tend to have fewer than 20 events per year on average. However, in the mid-range of events (20 to 60 events) there are drainage areas of all sizes, from very small to the largest. The greatest number of events tends to occur in drainage areas less than 550 acres.

Discharge density is mostly less than 300 million gallons per year per square mile. As can be seen in **Figure 3-11b**, the smallest drainage areas have a very wide range of drainage densities, but larger drainage areas tend to have smaller discharge densities, perhaps reflecting a greater diversity of drainage area characteristics.

When CSO events are compared to discharge density (**Figure 3-11c**), there is a slight tendency for drainage areas with more CSO events to have higher discharge densities, but the tendency is not pronounced. Likewise, CSO events do not appear highly sensitive to impervious surface density (**Figure 3-11d**), perhaps reflecting the fact that the vast majority of drainage areas have high levels of impervious surfaces. Unfortunately, none of the relationships showed sufficient correlation to justify more detailed statistical analysis.

Asset Management Indicators

Asset management planning involves a wide range of activities, including: knowing the system (inventory); assessing the current status of the components; understanding which parts are most vulnerable and which are most critical; establishing and funding capital investment plans that keep up with system aging; employee capacity building and retention; and tracking results against the plan. Asset management plans have common components but are tailored to the type, size and age of each utility (NJCWC, 2010). NJDEP has published guidance for water supply and wastewater utilities related to asset management (NJDEP, 2014), some portions of which may be incorporated into regulatory changes to clarify existing rule provisions. Having a plan is irrelevant unless it is being implemented, so both aspects must be addressed. Indicators of success include declining average age of existing pipelines, water losses from water supply distribution lines, I&I (Infiltration and Inflow) in sewer lines, line breaks per linear mile, and emergency repair costs as a percentage of O&M costs.

Rates also can serve as an indicator, though it provides indications in two directions – whether a system is investing sufficiently in capital maintenance (which drives rates up) and whether a system is run efficiently (which drives rates down). The NJ Board of Public Utilities has established a rate-setting system for investor-owned utilities that encourages reinvestment to offset depreciation of assets, but also discourages excessive investment or profits. As such, the larger BPU-regulated facilities provide a good point of comparison to the government-owned systems that serve the CSO municipalities (even those that are operated by private companies under contract to the municipalities or authorities). The average residential household cost for the CSO municipalities is roughly $341 for water supply (with an average cost per 1000 gallons of $5.69 but a range from $2.83 to $7.28), but for the larger BPU-regulated systems it is $424 ($7.07 per thousand gallons), based on equal water use.[36] Given that the investor-owned facilities have an incentive to invest and BPU constrains those rates, this disparity reinforces the potential that the municipal systems are underinvesting. The same sort of comparison for sewers is not possible because there are so few that BPU regulates, and none are large. However, sewer service rates were compiled for CSO municipalities; average annual costs for a standard household were $314, and ranged from $225 to $448. (See **Appendix C** for details.)

Little information is available regarding asset management programs for water infrastructure in the CSO municipalities generally. On one hand, North Hudson Sewerage Authority uses a private contractor (CH2M HILL) to operate its system and considers that they have a strong asset management program that is essentially up-to-date on capital expenditures. On the other hand, Newark has conducted studies in recent years indicating that their maintenance requirements over the following ten years totaled approximately $500 million, though even this value is an extrapolation regarding the water distribution and sewer collection systems. The estimates for the City of Camden are in the same range, $400 to $500 million, based on an increasingly comprehensive asset management program. Combined sewers by their nature are old technology, and therefore the sewers tend to be in excess of 100 years old. However, CSO municipalities also retain water supply lines that are a century old or more, some of which are known to be of materials (e.g., wood, clay) that would never be approved now. **Chapter 4** includes information on asset management systems being developed by or for Bayonne, Camden, Elizabeth, Jersey City, Newark and Paterson for both water supply and sewer systems. While the systems have good information on the location of infrastructure, they are still in the process of generating, logging and mapping information about system construction and current integrity.

Different utilities use different approaches to estimating water losses. Many track non-revenue water, which is simply the difference between produced water and billed water charges; this calculation can include metered uses that are not charged (e.g., municipal facilities), non-metered but legitimate uses (e.g., firefighting and line flushing) and true water losses (e.g., leaks either from mains or from customer connections). Non-revenue water reported during interviews ranged widely as a percent of total water, from near 10% to nearly 30%. The Delaware River Basin Commission (Sayers, 2013) compiled non-revenue water results from 204 water purveyors, which averaged 15% but ranged in some systems to over 50%, with Philadelphia at nearly 40%.

The New Jersey Climate Adaptation Alliance (2013) cooperated with several professional and trade associations (Association of Environmental Authorities, American Water Works Association-NJ Chapter, and New Jersey Water Environment Association) to survey members of these organizations regarding the current status of asset management programs for water supply and wastewater utilities, and their thoughts on the future of asset management in New Jersey. The on-line survey was anonymous and voluntary, so the results must be considered qualitative. Most respondents indicated that their utilities have at least implemented asset management partially, with less than a tenth indicating full implementation. The greatest benefits anticipated for asset management heavily emphasized improved ability to manage the utilities, including knowledge retention and risk management. Worth noting is that managers were more optimistic than non-managers about these benefits. A significant issue is whether asset management should be a condition of financial aid or NJDEP permits. Over half of the respondents indicated that asset management is necessary for all systems, with another fifth basically agreeing but with the caveat that requirements should vary based on the size of the system. Managers were more likely to have one of these stronger responses that were others, indicating a willingness to be pushed to do what they already indicated was a necessity and major benefit. In interviews for this project, managers from Bayonne, Camden, Elizabeth, Jersey City, Newark and Paterson have indicated strong agreement with the long-term benefits of asset management programs; these are in various stages of implementation with for the most part sound knowledge of asset locations, original construction materials and treatment plant facilities, but none of the systems yet has a comprehensive evaluation of pipeline integrity.

[36] A nominal household demand of 60,000 gallons per year is used for all cost calculations. The Delaware River Basin Commission compiled rate information from 204 water purveyors submitting water loss reports; average rates were $5.35 per thousand gallons, comparable to New Jersey's CSO communities (Sayers, 2013).

The CSO municipalities are clearly engaging or intending to engage in work to improve their water and sewer systems, as evidenced by funding requests to the NJ Environmental Infrastructure Program. These funding requests are addressed in more detail in the section **Recent Request for State and Federal Financing**, below. **Chapter 4** explores this issue for Camden and five North Jersey municipalities with the most CSOs.

Vulnerability of Water Infrastructure to Flooding and Storm Surge

New Jersey's needs for assessments and upgrades to its infrastructure became more acute as a result of Hurricanes Irene and Sandy. On August 28, 2011 Hurricane Irene made landfall in New Jersey (a first for the state since 1903), where as much as 10-inches of rain was recorded during an 18-hour period and resulted in record levels of flooding. One salient point in the flood summary of Hurricane Irene by the U.S. Geological Survey notes that statewide analysis of 33 gages recorded peaks that were equivalent to or greater than the 100-year recurrence interval (≤1.0% annual exceedance probability). Specifically of importance to CSO municipalities, these locations include the Elizabeth, Hackensack, Passaic and Raritan Rivers (U.S Geological Survey, 2013). Tropical Storm Lee followed close behind Hurricane Irene and caused additional flooding and damages.

In 2012 Hurricane Sandy made landfall with far more devastating effects than the 2011 storms. In addition to the 159 lives that were lost and an estimated total of over $70 billion in damages across the northeast region of the United States, Hurricane Sandy represented a tremendous environmental and public health emergency with respect to its effect on cities with Combined Sewer Systems. Among the nine states that were affected by the storm, New Jersey accounted for 46.4% (or 5.1 billion gallons) of the estimated total 11 billion gallons of untreated sewage released into receiving water bodies. Middlesex County Utilities Authority (MCUA) discharged 1.1 billion gallons of untreated sewage into the confluence of the Raritan River and Raritan Bay due to flooding of its pumping station in Sayreville. The Passaic Valley Sewerage Commissioners (PVSC) discharged 840 million gallons of untreated sewage into the Newark Bay due to flooding of the treatment plant itself. An additional 3 billion gallons of partially treated sewage were released into the NY/NJ Harbor by PVSC during the following two weeks during repairs (Kenward, et al., 2013). A draft report by the USEPA noted that the PVSC treatment facility, alone, had ultimately suffered $300 million in damages. The report continues by explaining that the cost for infrastructure repairs after both storms were not exclusive to treatment plants, but also include conveyance systems (USEPA, 2013). PVSC and MCUA indicate the different threats. PVSC's treatment plant was inundated by storm surge. MCUA's treatment plant was untouched, but its pumping station was flooded and therefore could not boost incoming sewage to the treatment plant. MCUA has since received a $10.8 million grant for repairs to their pump station in Sayreville and other facilities in South Amboy and Edison (MCUA, 2014). Other sewer systems along the coast also lost pumps to flooding, but those utilities that had shifted to submersible pumps suffered less damage (though some had no available power source while electricity lines were down).

Since the storm, the NJDEP has identified almost $2.7 billion in needs for facility repairs and system enhancements to make them more resilient against future failures. In part as a response to the storms, NJDEP has published guidance for water supply and wastewater utilities related to flood protection, auxiliary power, and emergency response preparedness and planning (NJDEP, 2014).

Risks are expected to increase. USEPA (2014) anticipates an increase in the global average annual precipitation through the end of the century. Northern areas of this country are projected to become wetter, especially in the winter and spring, as shown in **Figure 3-12**. In some locations the expected frequency of heavy downpours is now expected to increase significantly. Climate models project that for every increase in the tropical sea surface temperature of 1.8 degrees Fahrenheit, the rainfall rates from hurricanes could increase by 6-8% with increases in wind speed from the strongest hurricanes of about 1-8%. Moreover, cold-season storms are expected to shift northward and become stronger and more frequent.

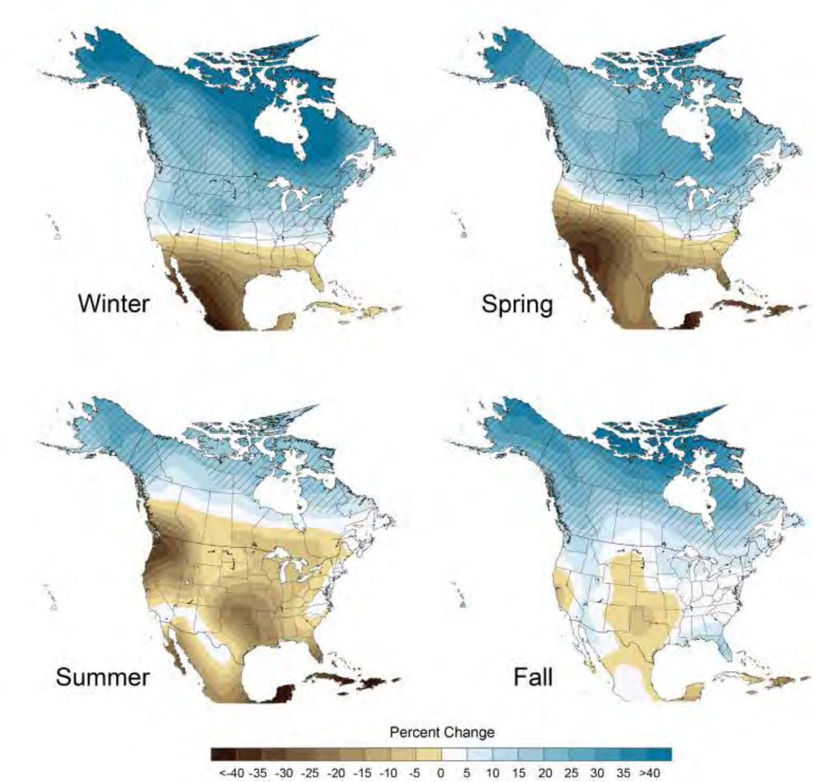


Figure 3-12. Projected Average Precipitation Changes by Season (USEPA. 2014)

With global temperatures increases there is a concomitant expansion of ocean water in addition to the melting of mountain glaciers and ice caps that will increase the volume of ocean water. USEPA (2014) expects that a 2-foot global seal-level rise by the end of the century would result in 2.3 foot increase in New York City, which suggests that surrounding areas would see a similar increase and should plan accordingly. **Figure 3-13** shows projected changes in global sea level, using results from the Intergovernmental Panel on Climate Change (IPCC) for three different emissions scenarios.

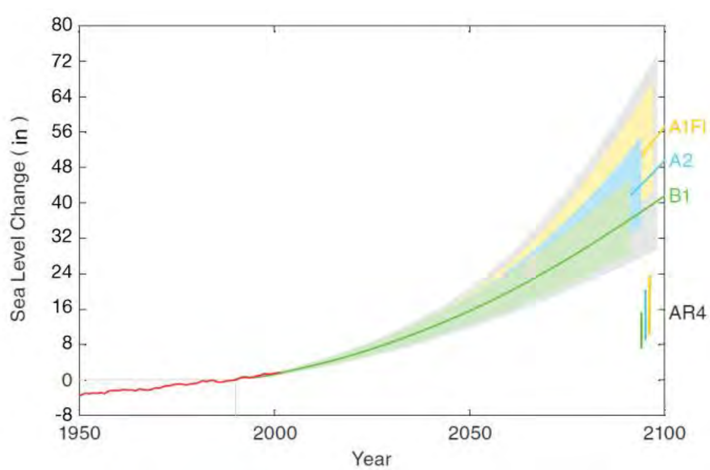


Figure 3-13. Projected Global Sea Level Rise (Vermeera & Rahmstort, 2009, as reported in USEPA, 2014)

When examining vulnerabilities that New Jersey's infrastructure face from weather and what to anticipate as the effects of climate change continue to intensify, it is important to begin by looking at the layout of our existing collection and treatment infrastructure. Treatment plants are generally placed near water bodies on low lying land by design for the purpose of utilizing gravity to facilitate the transportation of sewage to the plant and the discharge treated wastewater into neighboring water bodies. This layout obviously becomes an increasing liability in the event of heavy precipitation and rising sea levels (Kenward, et al., 2013).

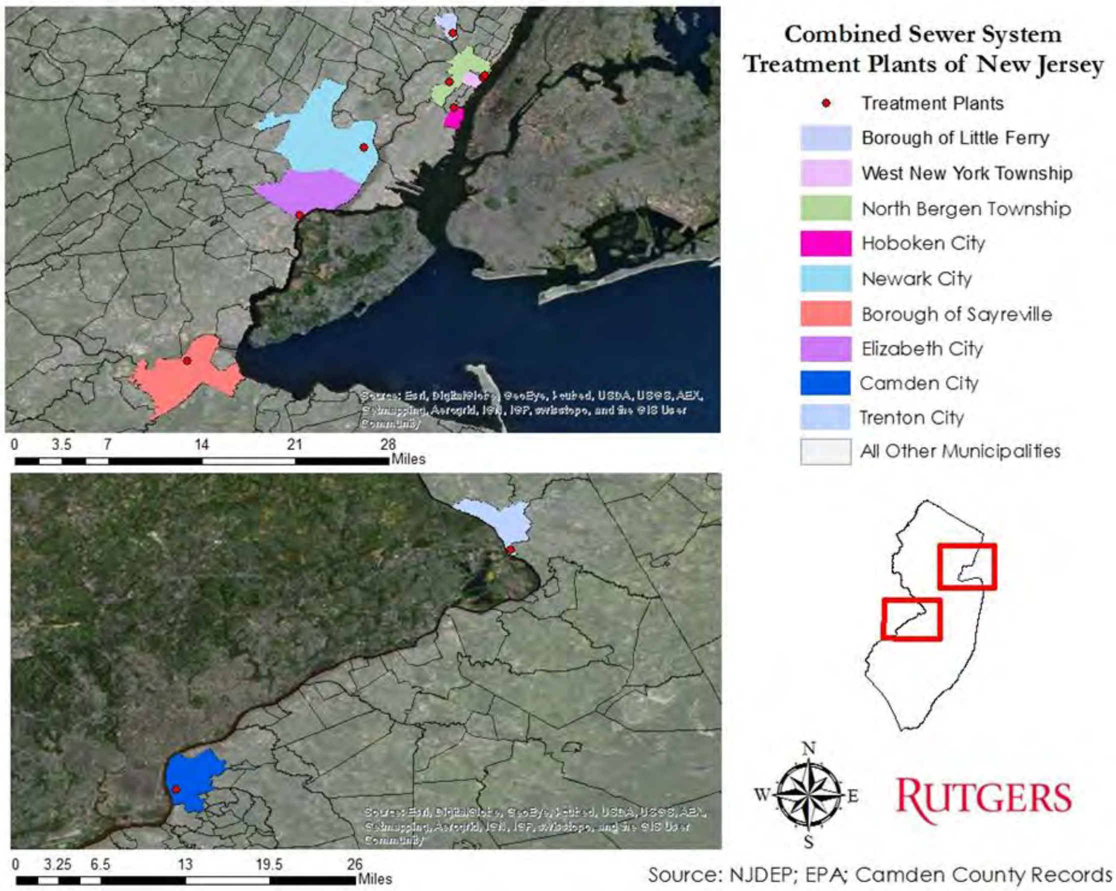


Figure 3-14. Location and Resident Municipality of Sewage Treatment Plants for CSO Municipalities

All nine of the sewage treatment facilities that serve CSO municipalities (see **Figure 3-14**) were evaluated using New Jersey Flood Mapper,[37] to demonstrate their vulnerability to a future sea level rise of two and three feet. These scenarios are based on the forecast increase in the sea level of over 2 feet by the end of the century. In most cases, the facilities did not show significant vulnerability to sea level rise per se. However, in some cases routine inundation would affect the surrounding municipalities or serve to isolate the treatment plants. More important is that an increase in sea level provides a higher starting point for storm surges related to tropical, sub-tropical and other storms. For instance, the PVSC facility in Newark shows no vulnerability to sea level rise of three feet, and yet this facility was taken off-line by storm surge from Hurricane Sandy. The same storm upon a higher sea level would have been that much more devastating. Others may face similar issues.

Several treatment plants in New Jersey or nearby neighborhoods are vulnerable to routine flooding based upon projected sea level rise. Storm surge effects would be in addition to these risks. For example, the Camden County Municipal Utility Authority facility is adjacent to the Delaware River, which is tidal at this location. Simulations demonstrate that the CCMUA facility is not directly vulnerable to an increase of 2 and 3 feet, however a portion of Camden is forecast to be routinely flooded at such sea levels, which could complicate CSO issues in addition to the direct neighborhood damages.

[37] Available at http://slrviewer.rutgers.edu/

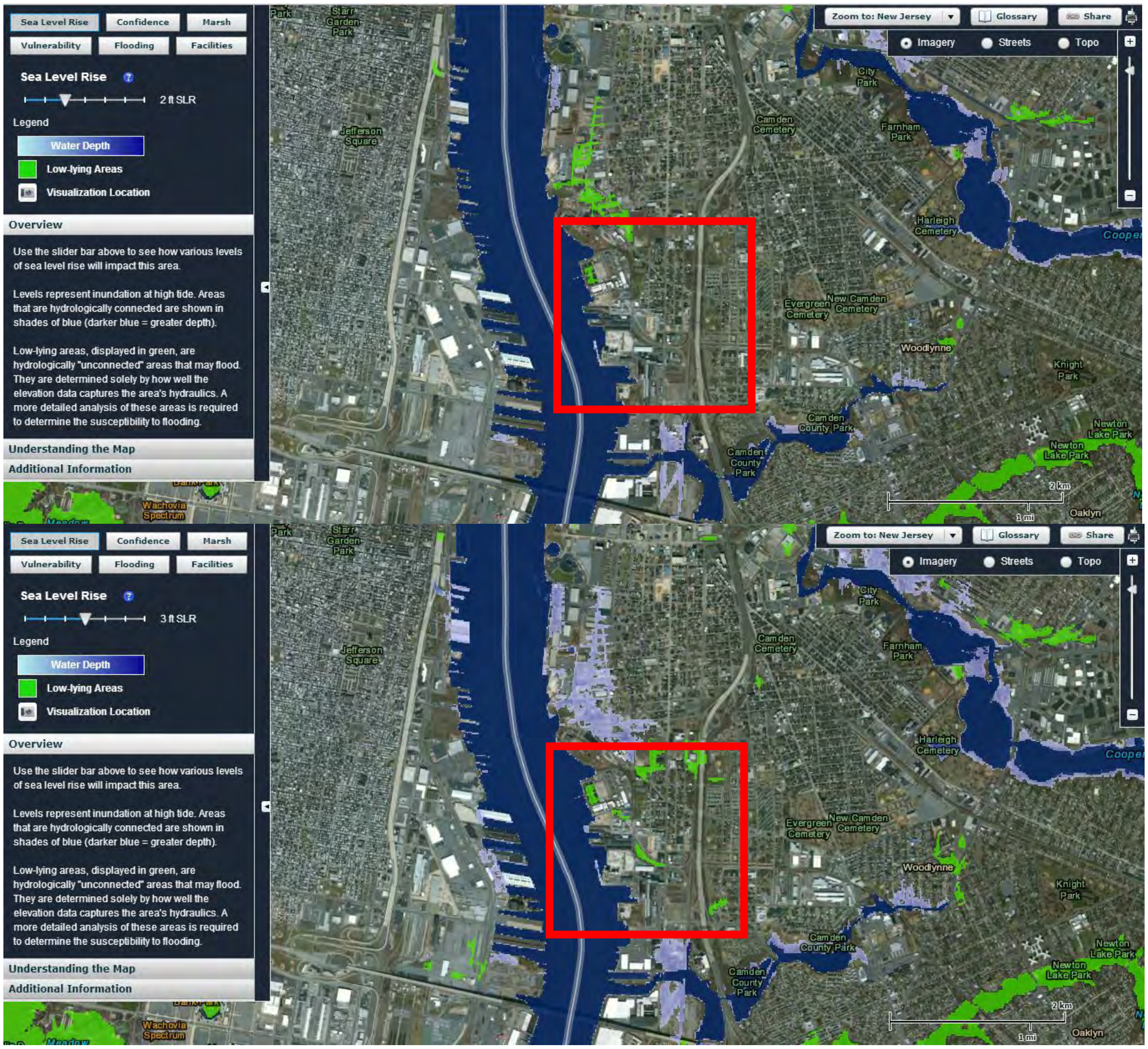


Figure 3-15. CCMUA and Camden Vulnerability to a Two and Three Foot Sea Level Rise

The Bergen County Utility Authority main treatment plant is located west of the Hackensack River in the Township of Little Ferry. As the simulations demonstrate, the facility might be in a precarious situation under a rising sea level conditions with water bodies on both sides steadily encroaching onto the site.

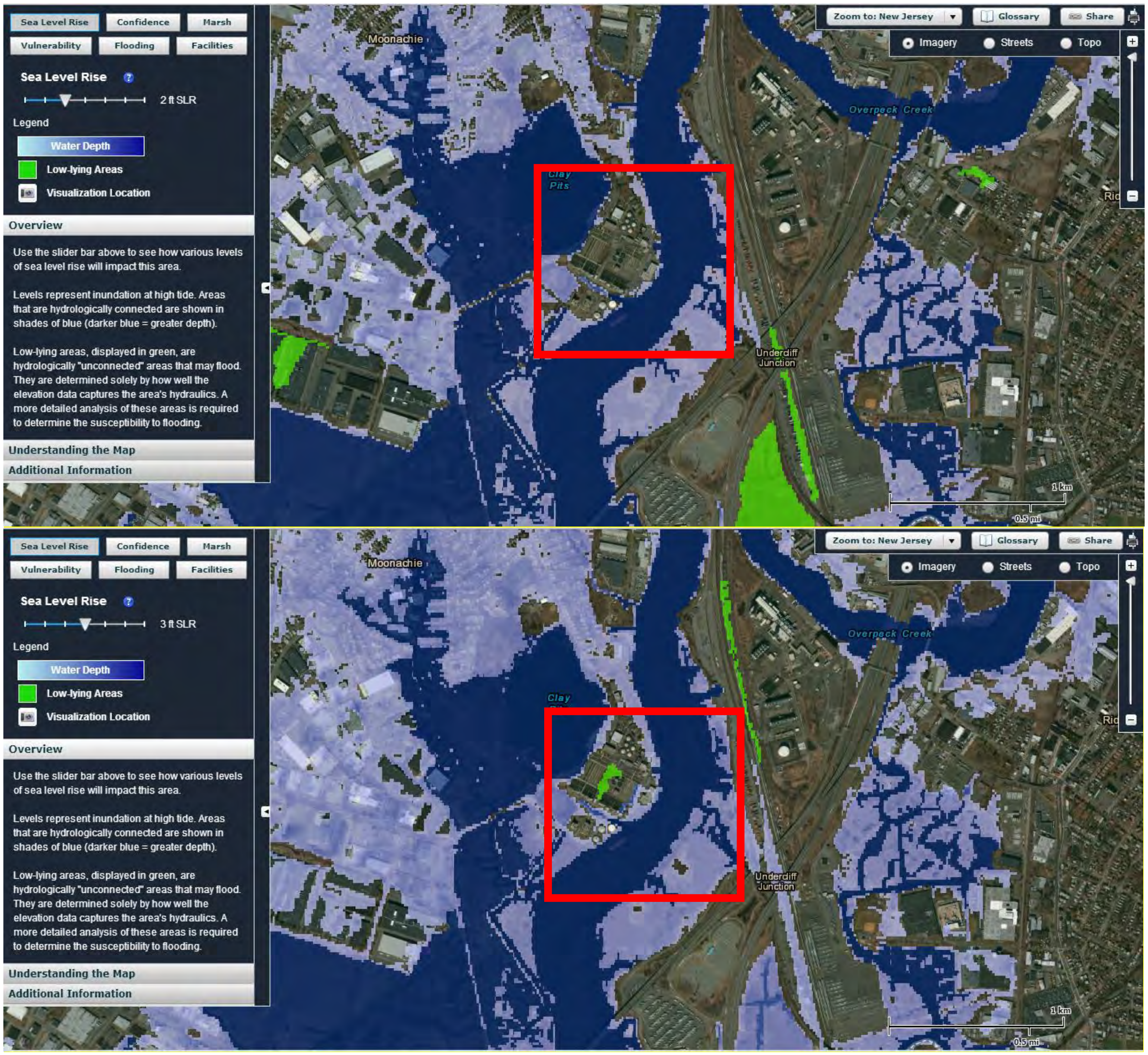


Figure 3-15. Bergen County Utility Authority Vulnerability to a Two and Three Foot Sea Level Rise

Costs and Affordability of CSO Controls

All municipalities other than Trenton were required to assess the costs involved with controlling the number, volume and pollutant loads associated with CSO events during a specific rainfall pattern, using models developed by consultants for each regulated entity. All costs are associated with infrastructure improvements to: disinfect overflows at the discharge point; increase in-line storage; create off-line storage; or separate the storm and sewer functions into separate pipelines. All of these actions are termed "gray infrastructure" as differentiated from "green infrastructure" that seeks to capture stormwater prior to its entry into either combined sewers or separate stormwater systems. Cost estimates have varied over time. The New Jersey Clean Watersheds Needs Survey 2008 (USEPA, 2008) estimated total costs for CSO controls as $8,176 million in 2008 dollars. A 2010 presentation by NJDEP (Cach et al., 2010) compiled costs from the municipal reports on CSO control options, totaling over $300 million for control of solids and floatable materials, $2.0 to $2.7 billion for disinfection, $3.3 billion to reduce CSO frequency to three events per year, and $6.5 billion for complete sewer separation. Projected costs will increase or decrease depending on the regulatory requirements, the compliance option used (Presumption versus Demonstration), the selection of gray and green infrastructure techniques, and innovations developed for each municipality.

As an indication of ongoing State interest in financing CSO control costs, on March 6, 2013 the New Jersey Environmental Infrastructure Trust published request for proposals in which the issues of funding for CSO mitigation were specifically addressed. Such funding would be directed toward CSO abatement projects and receive a maximum of $10 million for the purpose of providing "principal loan forgiveness for up to 50% of the allowable project cost (not to exceed $2 million per project sponsor)." Those CSO abatement projects are specifically focused on green infrastructure remedies that include the implementation of green roofs, porous pavement, rain gardens, and "other activities that maintain and restore hydrology" (NJEIT, 2013).

The NJPDES CSO General Permits from 1999 and 2004 did not specifically address green infrastructure, the potential benefits of which will now be evaluated under the new NJPDES Individual Permits for CSO systems. The disinfection assessments address a number of scenarios: The ability of treatment plants to accept and treat wastewater during wet weather events is addressed as a separate permit requirement for the treatment plant owners.

Table 3-14: CSO Treatment Objectives Under the 2004 CSO General Permit	
Treatment Objective	**Fecal Coliform Objective (MPN/100 ml)**
A	200 (E. coli 33)
B	200 (E. coli 35)
C	770
D	1500
	Fecal Coliform Objective (% Removal)
E	50%
F	85%
G	95%

The reports are not consistent in how they provided the information required by the NJPDES general permit for CSOs, and therefore some information was not uniformly available. The project team reviewed reports provided by the utilities and from NJDEP files to compile this information where it was identifiable in the reports. To simplify the analysis, the focus in this report is on one of the scenarios required by NJDEP, the costs of achieving less than four events per year (in this case, three events) in terms of Total Present Worth (TPW, based on Capital Costs and O&M Costs for a 20-year period) where available, or Capital Costs where TWP was not provided; the system-specific detailed results by CSO drainage area are provided in **Appendix B**.

The project team used the available information to aggregate costs by municipality as shown **Table 3-15**. The variability in average volume per square mile and average costs by volume controlled are very high, with the highest costs exceeding minimum costs by a factor of at least 7 and up to 19, and therefore there is no attempt to extrapolate cost information for systems for which cost estimates were not readily available. While information is not available for every municipality, the table provides a clear sense of cost magnitudes, with the least costly disinfection costs totaling over $1.6 billion in 12 permittees (15 municipalities), and off-line storage costs totaling nearly $4.6 billion for 15 permittees (18 municipalities). In general, sewer separation tended to be the most expensive method of reducing CSO outfall volumes and events, with a variety of off-line storage tanks and tunnels being somewhat less costly. Separate storage tanks for each outfall often were generally found to be less cost-effective than providing a smaller number of larger tanks to serve grouped CSOs. Tunnels are the underground version of grouped storage tanks, and municipalities assessed whether a single tunnel or multiple smaller tunnels would be more cost-effective, primarily driven by whether the CSOs all discharged to the same water body or were located near one another even if discharging to the same waters. In some cases, tunnels were less expensive than storage tank options, in part reflecting the land costs associated with storage tanks.

Table 3-15: Available CSO Costs By Municipalities from LTCP Reports for NJPDES CSO General Permits

Municipality or System	*CSO Discharge Volume (MGY)*	*Area (Acres)*	*Average Vol/Area (MGY/ Mi2)*	*Disinfection costs (Best) ($000's)*	*Average Costs Per MGY ($000's)*	*Off-line Storage Separate ($000's)*	*Average Costs Per MGY ($000's)*	*Sewer Separation Costs ($000's)*	*Average Costs Per MGY ($000's)*
Bayonne	930	2002	469	$225,282	$153.5	$138,423	$94.3	$246,412	$168
Camden	683	3900	112	$106,246	$155.6	$594,300	$870.5	$505,240	$740
East Newark	22	73	191	$10,700	$490.4	$8,740	$400.6	NA	NA
Elizabeth	NA	3590	NA	$116,142	NA	$477,530	NA	NA	NA
Fort Lee	87	1000	67	$5,400	$61.9	$19,050	$218.4	$60,000	$688
Gloucester City	74	495	96	NA	NA	$67,310	$907.1	$52,080	$702
Guttenberg	46	110	268	$3,875	$83.7	$2,360	$51.0	$3,060	$66
Hackensack	NA	1056	NA	NA	NA	NA	NA	NA	NA
Harrison	NA	822	NA	NA	NA	NA	NA	NA	NA
Jersey City	NA	6128	NA	$767,000	NA	$299,478	NA	NA	NA
Kearny	NA	1077	NA	$34,001	NA	$92,970	NA	$255,000	NA
Newark	2,021	NA	NA	$164,755	$81.5	$1,052,340	$520.8	$513,514	$254
North Bergen	410	2568	102	$44,429	$108.4	$132,339	$323.0	$232,500	$568
North Hudson SA[38]	1,088	2951	439	$156,700	$144.0	$647,600	$595.1	$260,000	$239
Paterson	702	4571	101	NA	NA	$161,390	$229.8	NA	NA
Perth Amboy	840	1330	404	NA	NA	$837,200	$996.2	NA	NA
Ridgefield Park	64	515	79	$24,741	$386.9	$37,842	$591.8	$74,836	$1,170
Totals (Averages) (Available Data)	**6968**	**32,187**	**197**	**$1,659,272**	**$126.0**	**$4,568,873**	**$492.9**	**$2,202,642**	**$328**
Minimum	22	73	56	$3,875	$61.9	$2,360	$51.0	$3,060	$66
Average	581	2,008	176	$138,273	$195.1	$304,592	$487.8	$220,264	$521.3
Maximum	2,021	6129	404	$767,000	$490.4	$1,052,340	$996.2	$513,514	$1,170

Each system was also expected to provide information regarding the affordability of implementing the various solutions, based on USEPA guidance, however, many did not. The Rutgers project team collected the information where available from the reports, and also conducted an on-line search for water and sewer rates applicable to residential customers to identify where USEPA thresholds for affordability where already exceeded and where systems had at least some potential for rate increases to address the costs of CSO controls. These costs are based on a nominal household using 60,000 gallons per year of water, as most rates are related to volume of water used, given that no residences have meters to measure sewage from individual households. Actual costs will vary by household depending on the number of occupants, water conservation efforts, etc. It is also important to note that rate increases may also be required in some systems to address current needs of the system due to deferred maintenance, ongoing deterioration of the system, etc. Therefore, CSO and normal asset management costs may be in competition for available fiscal capacity of specific municipalities.

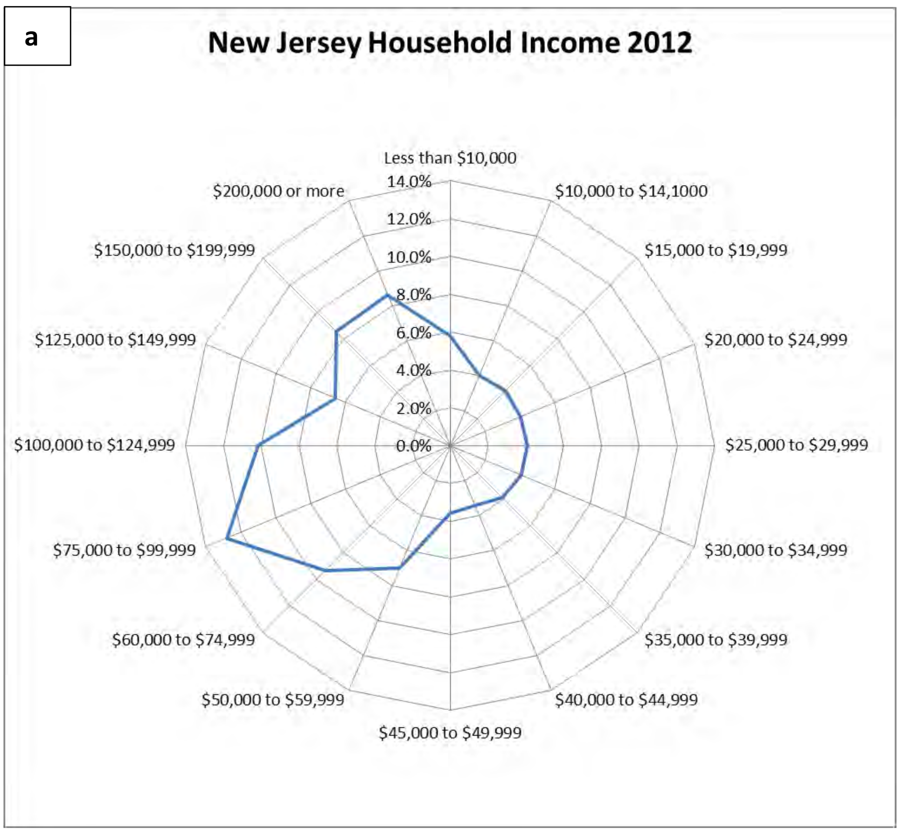
The USEPA guidance for sewer system affordability recommends that total annual sewer costs not exceed 1.75% of the household median income for the municipality or system, and that costs exceeding 2% be considered unaffordable. The results by municipality are provided in **Appendix C**. As shown on the table, for our nominal household the greatest annual costs as a percentage of municipal median income are in Camden, for both water supply and sewer costs at 1.40% and 1.66% respectively. Camden faces major capital needs to address current problems in both utility systems. The only other municipalities at greater than 1% for water supply are Newark (1.08%) and Paterson (1.14%), both of which are known to face major capital costs for improvement of their existing water supply systems. Most residential water costs are between $330 and $430 per household, with the notable exceptions of Trenton ($170) and Kearny ($213). By comparison, for largest of the public water supply systems (mostly investor-owned companies) regulated by the NJ Board of Public Utilities (BPU), the average is $424, which is on the high side of the range for CSO municipalities. No municipalities other than Camden have sewer costs greater than 1% of median household income. Sewer costs are generally $225 to $315, with the notable exception of Camden at over $400.

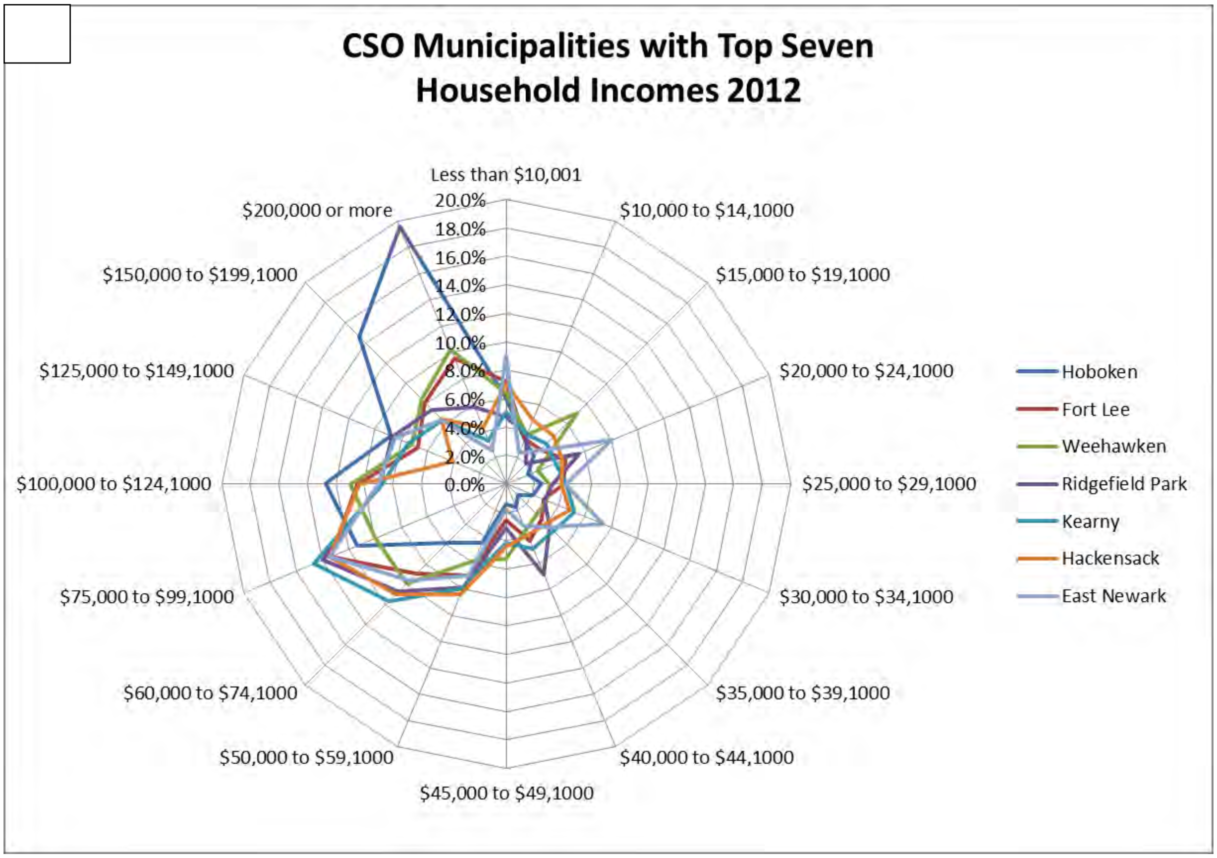
However, a significant issue with the USEPA guidance is that median household income only represents the 50th percentile of all incomes; in other words, 50% of all households will earn above that amount and 50% below.

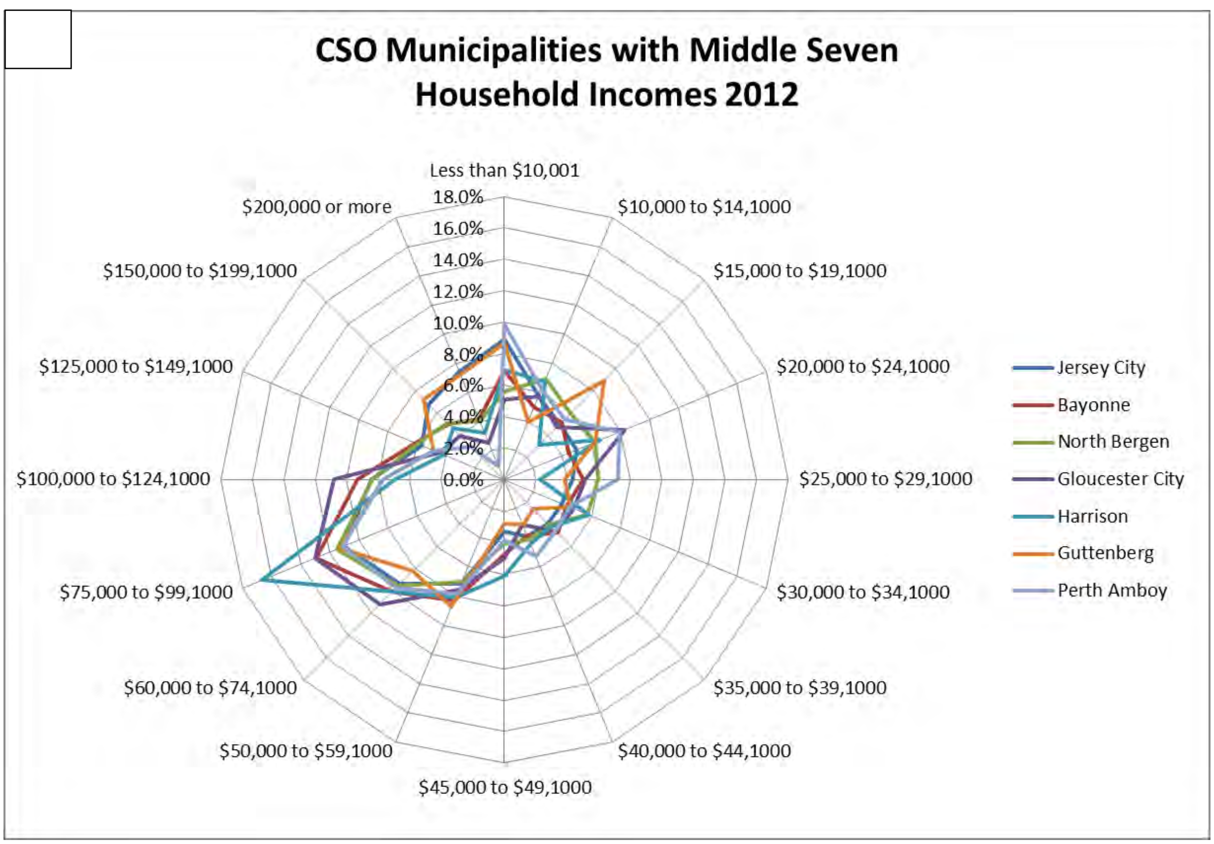
[38] Includes information for Hoboken, Union City, Weehawken and West New York

Use of the median does not provide a good sense of the income distribution above or below the median. Therefore, New Jersey Future collected available data from the U.S. Bureau of the Census on household income in New Jersey and the CSO municipalities, which were examined for patterns in income distribution. The charts in **Figure 3-8** provide an easy method to compare income distributions. The first chart shows the distribution for New Jersey as a whole. The other charts provide the same information for three sets of CSO municipalities, from the highest to lowest in terms of the household income.

The New Jersey pattern shows a clear dominance of incomes from $50,000 up, with the largest cohort at "$75,000 to $99,999." The same cohort is evident in the CSO cities with the highest median household incomes with the exception of Hoboken, which has a higher percentage of households with incomes of "$200,000 or more" than any other CSO municipality (the Hoboken rate is more than double that of New Jersey as a whole). For comparison, Fort Lee is similar to New Jersey as a whole regarding the top income rank. The middle group of municipalities has very similar income patterns to the state, though the upper ranges are less prevalent in Jersey City. For the lowest group, what is immediately noticeable is the high prevalence of households at "Less than $10,000" in Camden, Newark and Paterson, and that upper income households are nearly absent in all but West New York.




CSO Municipalities with Top Seven Household Incomes 2012
Less than $10,001
$10,000 to $14,1000
$15,000 to $19,1000
$20,000 to $24,1000
$25,000 to $29,1000
$30,000 to $34,1000
$35,000 to $39,1000
$40,000 to $44,1000
$45,000 to $49,1000
$50,000 to $59,1000
$60,000 to $74,1000
$75,000 to $99,1000
$100,000 to $124,1000
$125,000 to $149,1000
$150,000 to $199,1000
$200,000 or more
20.0%
18.0%
16.0%
14.0%
12.0%
10.0%
8.0%
6.0%
4.0%
2.0%
0.0%
Hoboken
Fort Lee
Weehawken
Ridgefield Park
Kearny
Hackensack
East Newark


CSO Municipalities with Middle Seven Household Incomes 2012
Less than $10,001
$10,000 to $14,1000
$15,000 to $19,1000
$20,000 to $24,1000
$25,000 to $29,1000
$30,000 to $34,1000
$35,000 to $39,1000
$40,000 to $44,1000
$45,000 to $49,1000
$50,000 to $59,1000
$60,000 to $74,1000
$75,000 to $99,1000
$100,000 to $124,1000
$125,000 to $149,1000
$150,000 to $199,1000
$200,000 or more
18.0%
16.0%
14.0%
12.0%
10.0%
8.0%
6.0%
4.0%
2.0%
0.0%
Jersey City
Bayonne
North Bergen
Gloucester City
Harrison
Guttenberg
Perth Amboy

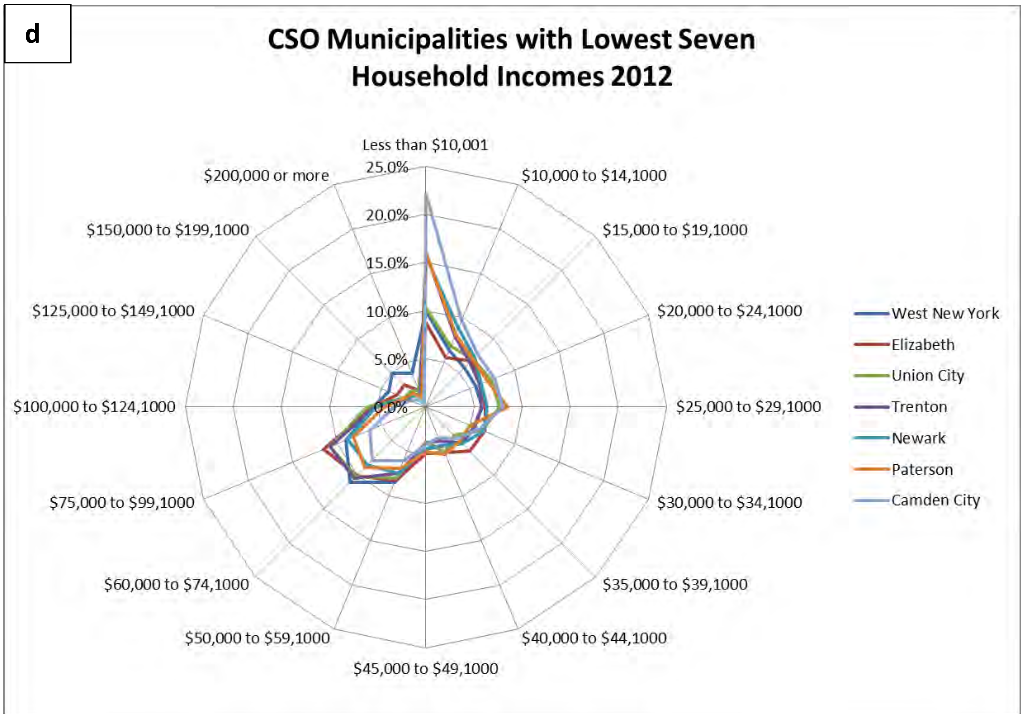


Figure 3-8 a-d: Household Income Cohorts of New Jersey and CSO Municipalities

What these graphs tell us is that many households in municipalities such as Newark, Paterson and Camden, all of which have relatively low median household incomes, will confront particularly difficult financial stresses due to the disproportionate number that have the very lowest incomes. Other municipalities have more even distributions of household income, where the USEPA threshold probably works best. On the other hand, municipalities such as Hoboken could place their lower income households in great financial stress if sewer costs rose to their higher median household income. Even with Hoboken's large cohort of high-income households, the median income only ranks 242 out of 565 municipalities.

Looking at the table below for New Jersey, Hoboken and the six municipalities with the greatest number of CSO outfalls, there are concerning effects associated with the relationship of median household income and the distribution of household incomes below the median. For New Jersey as a whole, an affordable sewer rate at 1.75% of median HH income would be over $1400. Roughly 14% of New Jersey households have incomes below $20,000 and these households would put at least 7% of their income into sewer charges at the Sewer Affordability Index (SAI). The percentage of Hoboken's households with incomes below $20,000 is only slightly lower than for New Jersey as a whole, and yet the SAI for Hoboken represents a larger share of their income, at least 8.9%, due to Hoboken's higher median HH income and SAI. For Camden, the median household income and therefore SAI are much lower, so while a much larger percentage of Camden households earn less than $20,000, the maximum sewer payments would represent a smaller fraction of their income, at 2.4%.

Table 3-16: Sewer Affordability Index (SAI) Calculations for Selected CSO Municipalities

Municipality	median HH Income, 2006-2010 ACS	SAI as 1.75% of Median HH Income	SAI as % of $19,999	% Population <$20,000
Hoboken	$101,782	$1,781	8.9%	12.15%
Jersey City	$54,280	$950	4.7%	19.68%
Bayonne	$53,587	$938	4.7%	17.07%
Elizabeth	$43,770	$766	3.8%	20.97%
Newark	$35,659	$624	3.1%	31.63%
Paterson	$34,086	$597	3.0%	30.95%
Camden	$27,027	$473	2.4%	39.40%
New Jersey	**$80,992**	**$1,417**	**7.1%**	**13.97%**

(HH = Household)

These distinctions call into question the "one size fits all" applicability of USEPA's affordability metric and threshold. Households with the same incomes but in municipalities with different median HH incomes will be affected differently. Perversely, poor households in wealthier municipalities could pay a higher percentage of their income in sewer fees than similar households in poor municipalities, creating a further economic disincentive for de-concentration of poverty. While the USEPA affordability threshold is useful as a general approach, further evaluation should look at the relative impacts within municipalities. The smaller the poor municipality, the fewer resources (in terms of higher income ratepayers or property tax ratables) they will have to provide income support for poor households. The current programs for household assistance regarding energy utilities only work because the utilities serve a large and economically diverse customer base. These conditions do not apply to sewer utilities, where the collection systems are generally operated on a municipal basis and the treatment facilities are often regional and operated by other entities.

Recent Requests for State and Federal Financing

Based on interviews, recent surveys of utility managers and anecdotal information, few water supply and sewer utilities have comprehensive information regarding the total capital project needs of their systems, and the costs of CSO controls will be evaluated through the new permits. As shown in **Appendix D**, CSO municipalities have indicated a need (based on filed requests for funding) for over $1.5 billion from the Clean Water State Revolving Fund (SRF), as listed in the SFY2014 Intended Use Plan. Of particular note are the requests in Categories 3, 5 and 6, which are most relevant to CSO issues:

- Category 1: Secondary/ Sludge/Septage Treatment ($348 million)
- Category 2: Advanced Treatment ($30 million)
- **Category 3**: Sewer System Rehabilitation ($145 million)
- Category 4: New Collectors, Interceptors etc. ($54 million)
- **Category 5**: Correction of CSOs ($251 million)
- **Category 6**: Stormwater Management ($38 million)
- Category 7: Nonpoint Source Management ($348 million)

The requests for Categories 3, 5 and 6 total $344 million for just the CSO municipalities. NJDEP anticipates awarding approximately $350 million (SFY 2014) and $480 million (SFY 2015) in total funding from the NJ Environmental Infrastructure Financing Program (including funds from the NJ Environmental Infrastructure Trust) for all CWSRF projects statewide under the baseline program (NJDEP, 2013a, pp. 10-11). The "Rank" shown on the first column in **Appendix D** is of some importance to applicants, as low-ranked project might not be funded.[39]

There is another source of funding available to water supply and sewer utilities, from the Federal Disaster Recovery Act related to Hurricane Sandy damages. This funding supplements the Clean Water and Drinking Water State Revolving Funds, along with matching State funds. **Appendix E** lists proposed Sandy-related projects from CSO municipalities, totaling nearly $1 billion. NJDEP anticipates approximately $300 million of funding for all Hurricane Sandy needs statewide (NJDEP, 2013a, pp. 10-11), though costs beyond available SRF financing may be addressed by other federal funding under the Sandy recovery legislation, such as FEMA grants, Community Development Block Grants, etc. Many of the listed projects are for repair or replacement of pump stations that were damaged by the storm, but the largest single project ($526 million) is for the PVSC regional biosolids facility that handles sludge for a large number of utilities in addition to PVSC itself. Total PVSC requests under this funding source are 89% of all listings from CSO municipalities.

Funds from the NJ Environmental Infrastructure Financing Program are also available to address drinking water utility needs (NJDEP, 2013b). **Appendix F** lists projects in CSO municipalities that have been funded in the past from the State Revolving Fund under the Smart Growth Initiative (no longer active), which targets urban municipalities among others. Many CSO municipalities took advantage of this initiative, with many projects

[39] NJDEP (personal communication, April 2014) indicates that project rank has not been an issue for years, as many projects do not move forward due to local sponsorship priorities, technical design issues or missed filing deadlines.

focused on pipeline upgrades and repairs, but also projects for treatment plant and energy projects. The projects totalled more than $255 million. Finally, **Appendix G** provides a listing of projects in CSO municipalities that have applied for SFY 2014 funds from the Drinking Water SRF, totaling nearly $69 million. These projects have a range of purposes ranging from water meters to pipeline repairs to water treatment plant upgrades. Under the SFY2014 Intended Use Plan, NJDEP anticipates availability of $45 million statewide (NJDEP, 2013b, p. 29).

These funding requests reflect the enormous costs of maintaining water supply and sewer systems in our older urban areas, needs that will become more challenging with the advent of CSO control costs.

Chapter 4: Water Infrastructure Analysis for Selected Municipalities

To provide a more detailed sense of water infrastructure issues in CSO municipalities, this chapter focuses on six municipalities that together have more than 70% of all CSO outfalls in New Jersey. They are Bayonne, Camden, Elizabeth, Jersey City, Newark and Paterson. Information is provided for each city regarding demographic change, the existing water infrastructure, current plans for infrastructure improvements, the nature and severity of CSO events, findings regarding CSO control feasibility and costs, institutional capacity for utility management, and obstacles to infrastructure improvements. The information provided in this chapter is from a variety of sources, including NJDEP data and evaluations, reports, web site information, and interviews with managers associated with the various water supply and sewer utilities. The interviews were conducted by the principal investigator, and were based on a consistent set of questions regarding utility assets, total and current available capacity, capacity expansion plans, asset management programs, utility governance (for publicly-owned utilities) and utility rates and revenues. Information provided from the interviews was not subject to further verification and represents each utility's perception of their issues.

Bayonne

Bayonne is a densely developed urban municipality of 11.2 square miles just south of Jersey City on a peninsula between Newark Bay and the Hudson River. In the 20th Century it was a major base of operations for Eastern Standard Oil (ESSO)/Exxon refineries, since removed.

Population and Employment Projections

Bayonne lost nearly 15% of its population between 1970 and 1990, stabilized, and then experienced a slight increase in population to 2010. Projections through 2040 provide a clear expectation that the city has turned a corner in both population and employment trends, with projected increases of nearly 25% and over 60%, respectively. However, Bayonne has the highest ratio of population to jobs of any municipality highlighted in this chapter, and even the great increase in employment projected for the city will not change that status. As such, Bayonne would not be considered a major job center, even though it is not truly a bedroom community. As discussed in **Chapter 2**, Bayonne has a fairly high poverty rate (12.6% below the poverty line), a per capita tax base less than two-thirds the statewide median, and a median household income well below the statewide median; however, its average home value is nearly equal to the statewide median. Local concerns include whether current residents can afford to remain; the combination of median home values and below-median per capita tax base places property tax burdens more on residential owners, who generally lack the income to support high taxes. Bayonne is considered a most distressed urban municipality by New Jersey Future (Rank 5 of 5). The overall picture is one of a city that has stabilized after some decline, but with significant projected improvement that will both improve its finances and place considerable stress on existing infrastructure.

Table 4-1: Bayonne Population Status and Trends

	1970	1980	1990	2000	2010 (MPO)	Projected 2040	Projected Growth 2010-2040	Projected Growth 2010-2040
Population	72,743	65,047	61,464	61,842	63,020	78,650	15,630	24.8%
Employment					14,540	23,840	9,300	64.0%
Ratio Pop:Jobs					4.33	3.30		

Detailed Utility System Descriptions[40]

Bayonne is dependent on regional sources of both water supply and wastewater treatment. Within the city, Bayonne Municipal Utilities Authority (BMUA) has a public-private partnership contract with United Water to operate and maintain Bayonne's water supply and sewer systems. This contract is a 40-year agreement with unusual features, in that it involves a private equity firm as a partner with United Water, is longer than the norm, provided the BMUA with sufficient funds to retire over $100 million in debt (which improved the bond ratings of the City of Bayonne as the guarantor) in addition to $25 million in reserve funds, guarantees $2.5 million per year in capital projects in addition to the smaller emergency repair costs, and required installation of new customer meters to improve billing (resulting in an estimated 7% increase in revenues).

Bayonne's drinking water is obtained from the North Jersey District Water Supply Commission (NJDWSC), which operates a system comprised of Wanaque Reservoir, Monksville Reservoir, two pump stations drawing from the Pompton and Ramapo Rivers, and a Water Treatment Plant. NJDWSC has a net available capacity for its entire service area of 54.987 MGD, not all of which is contracted to its various members and customers as part of its 173 MGD in total contracts. Bayonne's contract is for 10.5 MGD, with a peak month of 12.6 MGD. Bayonne demands periodically exceed 10.5 MGD but not 12.6 MGD; low months are roughly 8.5 MGD. There are two cogeneration facilities in Bayonne – one is generating electricity routinely but the other is a peaking

[40] Sources include: www.unitedwater.com/uploadedFiles/Localized_Content/UW_Bayonne/20/l13_bayonne.pdf; www.njdwsc.com/index.aspx?nid=118; www.bayonnenj.org/residents/bayonne-municipal-utilities-authority/; www.nj.gov/pvsc/what/; interview with Bayonne MUA and United Water on 17 March 2014

Figure 4-1: Bayonne CSOs and Drainage Areas

facility that uses significant potable water when it is on; peak demands are in part related to this facility. Importantly for Bayonne, should it require additional capacity, NJDWSC received NJDEP approval in 2013 of an increase in its overall safe yield to 190 MGD, which will provide additional capacity for contracting to customers. Bayonne's projected growth could require somewhere between 1.5 and 2 MGD of additional demands, which could require an increase in its contract from 10.5 MGD and also would exceed its firm capacity (peak month) of 12.6 MGD.

The last complete report on non-revenue water was some years ago, with an estimate of roughly 15% non-revenue water, indicating a fairly "tight" system. At the time municipal buildings, schools and churches were not billed, but now only municipal buildings are not billed. The water supply system is all gravity-fed, with no pumps. The major aqueduct (7 miles through Kearny and under the Hackensack River) is considered "antiquated" (Rogers, 2013) and experiencing significant leaks of perhaps 1 MGD. Correction of the leaks through a thorough replacement (instead of patches) would supply much of the water needed for the future. In the past, Bayonne had issues with lead (Pb) but NJDWSC adds a phosphorus-based anti-corrosion agent to the water, eliminating the issue.

The Bayonne sewage collection system is almost entirely comprised of combined sewers (66 miles), except for an industrial section on Constable Hook. The combined sewers were constructed 80-100 years ago and are considered well beyond their anticipated useful life. Sewage is transmitted by a pump station with a rating of 17.6 MGD through a force main (owned by the Passaic Valley Sewerage Commissioners (PVSC), Bayonne MUA, Jersey City MUA and Kearny MUA) to the PVSC sewage treatment facility in Newark (BMUA, 2007). Sewage is collected at the south side of Bayonne (the old primary treatment plant site) and then pumped upstream (north) to Jersey City to the force main to PVSC. Interestingly, the treated effluent from PVSC is then pumped to a discharge point in the harbor through a pipeline that runs back under Bayonne.

Non-rainfall period sewage flows are roughly 8.5 MGD, reflecting the water demands in similar periods. Infiltration has not been estimated but is likely low based on recent inspections and where line work has been performed. Much of Bayonne is on dense bedrock, limiting ground water flow. The sewer pumps are all relatively new. A concern is that the sewer main has no redundancy. Bayonne uses the old primary STP site as a holding area should the sewer main have a problem, which allows 6-8 hours to rectify the problem before discharges would occur to receiving waters. Other priorities have been areas that flooded, where BMUA has taken action over the years to reroute stormwater flows as needed. Generally any surcharges and backups are caused by blockages, more often during dry periods than storms.[41] However, the combination of a very intense storm and high tide can cause backups and surcharges in the lowest areas. For example, 1st Street is only seven (7) feet above msl; BMUA purchased and installed backflow preventers so that buildings would not get sewage backups. There were other areas where some problems occurred, and BMUA changed the system where feasible using low-cost approaches. One example was 9th Street, where the system was changed to improve catch basins so that street flooding from blocked intakes was eliminated. All controls for solids and floatables were completed by roughly 2005. No other capital projects have been implemented for CSO controls.

The PVSC facility has a net available capacity for its entire service area of 30 MGD (see the section **Public Sewer Systems** in Chapter 3 above), less than 10% of its design capacity. That would indicate an ability to provide Bayonne with additional capacity during dry weather periods; the city may require nearly 1.2 MGD to meet projected demands through 2040. However, Bayonne currently has 30 CSO discharges per NJDEP (but 27 that actually discharge, according to BMUA, 2007), indicating that it essentially has no capacity for additional sewerage during wet weather periods, as each gallon of additional sewage from development will result in a similar increase in CSO volumes. CSO volume reductions will significantly improve surface water pollution levels and neighborhood quality related to sewer backups and street flooding in developed areas. Options include storage (with subsequent release to PVSC, using available dry weather capacity) and preventing stormwater from coming into the lines (e.g., through I&I reductions and stormwater management techniques that redirect

[41] A surcharge is a sewer system overload where sewage can flow up through a manhole into the streets. This issue is differentiated from street flooding caused by an inability of runoff to enter a storm sewer or combined sewer.

the water). Tidal influx is not currently considered a problem due to the valves or tidal gates on the CSO outfalls, and infiltration during dry weather periods is below regulatory norms (BMUA, 2007). Inflow is a normal component of flow in combined sewers.

Prior to the United Water contract, BMUA focused on doing what was clearly needed, using the simplest possible technology for each project. BMUA used federal ARRA funds to build a wind turbine at the main pumping station, which now defrays pumping costs. BMUA also did complete relining of a few combined sewers, and installed back-up generators on all sewer pumps during the last 5-10 years, with the result that they maintained power through Hurricane Sandy and had minimal issues.

Planned Water Supply System Upgrades

Based on discussions with Bayonne MUA and United Water personnel, BMUA anticipates that a new aqueduct will be required from Kearny to Bayonne (under the Hackensack River) at a cost of $5 million. Under the new contract, United Water will determine total needs for the distribution system, to which the $2.5 million annual capital allocation will be applied. Bayonne has received Drinking Water SRF loans under the Smart Growth Initiatives to rehabilitate local water mains and part of its aqueduct, totaling roughly $3.5 million.

Planned Sewer System Upgrades and CSO Controls

Based on discussions with Bayonne MUA and United Water personnel, the sewer system collection system in Bayonne is old and in need of improvements. Under the new contract, United Water will determine total needs, to which the $2.5 million annual capital allocation will be applied. Capital costs beyond that level will be the responsibility of BMUA. Bayonne has made and intends to make extensive use of available financing through the NJ Environmental Infrastructure Financing Program. Bayonne MUA and the Bayonne Local Redevelopment Authority have both applied for Clean Water SRF loans for a combination of CSO controls and new collector lines (MUA) and stormwater and nonpoint source control (LRA). The BMUA projects ($7.1 million) rank very high on the priority list while the BLRA projects (over $10 million) rank very low. Bayonne is not listed for Sandy funding from the Clean Water SRF.

CSO characteristics in Bayonne are highly diverse. The Long Term Control Plan documents submitted by Bayonne MUA (BMUA, 2007) indicate that the 27 CSO outfalls that discharge vary from four to 78 discharges per year, with an average of 28. CSO volumes also range widely. Volumes for individual CSOs range from 0.1 to nearly 500 million gallons (MG), with a total volume of 899 MG for the model year. The largest outfall is located at the site of the old primary STP. Although modelled pollutant concentrations are relatively consistent among the various CSO outfalls, reflecting the city's relatively homogeneous land use, discharge quality varies significantly from storm to storm and month to month. All of these variations complicate the analysis. For instance, the storage volume (on-line or off-line) needed to achieve no more than three events per year range from a low of 0.04 MG to a high of 20.6 MG, with a total storage of 56 MG needed for all CSO outfalls and an average 17.89 MG storage per square mile of CSO drainage area. **Table 4-2** presents aggregated costs for various control approaches:

Table 4-2: Bayonne CSO Cost Estimates	
Control Category **(**3 events/year for storage approaches)	**Costs (Total Present Worth in $ millions)**
Disinfection (separate outfall treatments)	138-225
Disinfection (10 grouped outfall treatments)	127-198
In-line Storage (existing or larger-volume pipelines)	Not feasible
Off-line Storage Tanks (separate outfall treatments)	246
Off-line Storage Tanks (10 grouped outfall treatments)	193
Deep Storage Tunnels (3)	258
Complete Sewer Separation ($1100 per linear foot)	380

For both disinfection and storage, consolidation of CSO outfalls into common treatment systems yielded a reduction in costs, especially regarding off-line storage tanks. None of these costs should be taken as definitive, as a number of assumptions were used in the modeling process, definitions of CSO "events" may not fully match current guidance, the combined sewer systems may have had existing structural problems that would affect the monitoring and modeling results, no detailed designs were completed, and no bench or pilot project evaluations were used. As such, these values are representative of the general range of costs for implementation. As CSO controls are chosen, more rigorous analyses, designs and cost estimates will be required.

The report also discusses the pollutant loading reductions from these alternatives, recognizing that CSO Outfall 001 accounts for 40% of total pollutant loads through the former primary STP site, and so control of that one site would provide the greatest benefits. Disinfection requires pretreatment to reduce total suspended solids (TSS) levels so that the disinfection is effective. Depending on the method selected, reduction of non-pathogen pollutant loads could range from 45% to 85%. However, it should be noted that chlorine disinfection methods (which are commonly used in sewage treatment) also require dechlorination to avoid unacceptable levels of effluent toxicity. Dechlorination is standard in wastewater treatment plants, but requires space that often will not be available at CSO outfalls. Storage options reduce total discharge volume and therefore total pollutant loads in an essentially linear manner.

Bayonne personnel raise the question of whether there is in fact a water quality "problem" in their area, which is primarily used as shipping lanes in Kill van Kull and Newark Bay – their concern is that these are not waters with existing or realistic potential recreational use for safety reasons. According to Bayonne, PVSC has been sampling the area and finding that SWQS are met 99% of the time, which translates into a few days per year where they are not met. They are aware of the fact that NJDEP and EPA decided not to complete the Harbor Pathogens TMDL, which is a concern to Bayonne as it was supposed to provide the basis for further CSO controls. Also, Hatch Mott ran the modeling for Ridgefield Park to test the likely pollutant loads if the entire town was in separate sewers. While <u>pathogen</u> loads were lower, the other major parameters (e.g., nutrients, TSS) were all higher due to the lack of controls on pollutants in separate storm sewer areas (BMUA, 2007), which they feel points to tradeoffs involved. Bayonne is working with NJDEP to test pretreatment (fast solids removal) and disinfection systems (peracetic acid versus UV) using vendor involvement. The intent is to determine what works best in one location so that other cities can take advantage of the information.

Bayonne is very interested in the concept of green infrastructure and has been working with the Hackensack Riverkeeper organization and Rutgers Cooperative Extension. However, several factors limit the potential for green infrastructure in Bayonne, which is a predominantly low-rise city. Most buildings are wood frame, which means that green and blue roofs won't work as the buildings can't handle the significant weight. Green and blue roofs will only be possible on new buildings where the roofs are designed for that purpose. In addition, roughly a quarter of Bayonne was a major refinery area for ESSO/Exxon and has intense soil contamination; the area has no underground stormwater infrastructure at all, but relies on ditches to avoid the contamination. Finally, much of the remainder of Bayonne has clay soils or shallow depth to bedrock, making infiltration difficult. That said, they are pursuing the concept of green infrastructure, though they expect that such techniques might remove no more than 10-15% of stormwater at best.

Institutional Capacity for Utility Management

The United Water contract was put in place a year ago. United Water is developing a formal asset management inventory (using in-house software), an assessment of assets over five years, and an implementation process. Current location information for lines is based on prior paper maps, and so is approximate but not yet GPS-verified. The contract was prompted by a combination of existing debt, BMUA staffing issues, and the need for more investment in the system. Staff aging and the ability to hire qualified replacements (especially Licensed Operators) at reasonable salaries were among the major reasons for the United Water contract. BMUA also recognized that at times they needed more staff (and equipment) than was available but couldn't afford to have that level of staffing and equipment at all times. They needed a "collapsible" organization that could flex staffing levels as needed. BMUA now has two part-time staff (Executive Director and Attorney) and two full-time staff.

Bayonne MUA was highly leveraged prior to the contract with United Water: "It had approximately $105 to $110 million of outstanding debt, which it had accumulated over a number of years, in part from its acquisition of the wastewater system from the city when it was first created. It also had a history of deferred investment in system assets." The 40-year concession fee contract allowed the city and MUA to pay off all BMUA debts plus the $25 million reserve fund, and provides for over $100 million in investments ($2.5 million per year for 40 years) and development of an asset management plan (Bauman and Sugarman, 2013).

Historically, Bayonne created its primary STP in the 1950's. No sewer rates were charged from then until 1990 when Bayonne was forced to act on secondary treatment by NJDEP imposition of sewer connection ban in the 1980's that halted development at a critical time. Instead of improving its STP, Bayonne decided to become a customer of PVSC, which triggered the need for sewer rates (but then these rates did not increase for 18 years).

Under the contract with United Water, rates and a rate escalation process were established up front. The rates cover emergency repairs as part of the operations costs, and establish a non-lapsing capital investment account of $2.5 million per year for the larger projects. However, any capital needs beyond what can be funding through the contract will result in renegotiating that aspect of the contract.

Obstacles to Upgrading Water Infrastructure

1) **Municipal and utility fiscal capacity**: In this case, the municipality owns the infrastructure but the operating utility is United Water, which operates under a concession contract from the City of Bayonne. As such, any additional capital and operating costs not provided for in the contract would represent a cause for an agreement regarding who will pay the costs and how they would be reflected in the rates. United Water is sufficiently large to have no particular constraints on fiscal capacity as long as rates are adjusted appropriately. Bayonne has the option of agreeing with United Water to incorporate all capital and operating costs into the contract, avoiding issues with regard to municipal fiscal capacity. However, Bayonne is concerned that sewer rates will rise to the point where they are unaffordable, and yet they are concerned that existing water quality concerns won't be improved significantly by very costly CSO control actions. These costs will compete with other priorities for system maintenance and rehabilitation.

2) **Household financial stress**: USEPA has affordability criteria that sewer service costs should not exceed 1.75% of median household income, and if above 2% would be considered financially prohibitive. Bayonne compared 2006 sewer rates of $345 per household to a median income of $62,414 to achieve a 0.55% level. Based on the cost analysis for the various CSO control projects, total annual costs per household ranged from $240 to $720, and total sewer rates would be $580 to $1100, or 0.9% to 1.71%, and thus would be considered affordable (BMUA, 2007). However, this analysis does not incorporate potential rate increases necessary to address deferred maintenance of the existing system, which are not known at this time. Current sewer rates are $3.80 per 100 cubic feet ($5.08 per 1,000 gallons) which equates to approximately $305 for a nominal household using 60,000 gallons of water per year. More importantly, a median household income of $53,587 is reported by the American Community Survey (2006-2010) by the Bureau of the Census, nearly 15% lower than the level used in the CSO report. Using the Census figure, the current sewer rates would be 0.57%, and the projected rates would be 1.02% to 1.91%. Further analysis could result in either greater or lower CSO control costs, the sewer rates will be affected by the 2012 contract with United Water, and median income may have changed as well. Still, there is some potential for CSO control costs to increase sewer rates to an unacceptable level based on USEPA guidelines.

3) **Availability of space for CSO controls**: The CSO report (BMUA, 2007) notes that Bayonne is fully developed with no available open space near the CSO outfalls. However, it suggested that parking lots could be used for treatment facilities and off-line storage tanks. On-line storage and deep tunnels would require minimal surface land after construction. Land is a major issue for Bayonne officials, as most of the controls will require land on the waterfront, which is very expensive and mostly developed in much of the city. Bayonne had major problems getting sufficient land for putting in some of the controls for solids and floatable materials, and question where storage tanks and disinfection treatment systems can go.

4) **Development and redevelopment market limitations**: The projected addition of 15,000 people by 2040 is considered reasonable by Bayonne. The peak population was 91,000, decades ago. Development was occurring in Bayonne prior to the recession and then slowed. However, development is occurring along the waterfronts, and development will be boosted by the Hudson Light Rail. Bayonne has extensive waterfront land, though on both the Kill van Kull and Newark Bay the primary use is as shipping and port area. Bayonne has been a low-rise city, with most buildings being wood frame. Developers are now seeking higher densities in projects.

City of Camden

Camden is a densely developed urban municipality in the Philadelphia metropolitan area and, with Gloucester City, may be the only area in southern New Jersey with CSOs that will require additional controls under the NJPDES CSO Individual Permits, assuming that Trenton is able to verify that its current controls are sufficient.

Population and Employment Projections

Population and employment trends and projections provide two contrasting pictures of Camden. On one hand, population has dropped nearly 25% from 1970 to 2010 and is not projected to rise from 2010 to 2040. On the other hand, Camden has a low ratio of population to jobs, indicating that it is a major employment hub relative to its residential base. No other municipality highlighted in this chapter has such a favorable ratio, and Newark is the only other city with a ratio of less than 2.0. However, a strong ratio of population to jobs is beneficial to Camden municipal finances primarily if the jobs are accessible to its residents and are in business sectors that provide financial support to the city and school system through property taxes. As discussed in **Chapter 2**, Camden has a very high poverty rate (38.6% below the poverty line, the highest among CSO municipalities), a median household income less than half of the statewide median, a per capita tax base in the bottom 30 of all municipalities, and an average housing value among the bottom 20 of 565 municipalities. It is considered a most distressed urban municipality by New Jersey Future (Rank 5 of 5). The city school district is under State control and is heavily dependent on State funds, and the State also plays a major role in financing the City government. The population overall has low education attainment and the City has very high crime rates. The overall picture is one of a city that has experienced a long decline with little projected improvement, indicating major fiscal constraints on CSO improvements.

Table 4-3: Camden Population Status and Trends

	1970	1980	1990	2000	2010 (MPO)	Projected 2040	Projected Growth 2010-2040	Projected Growth 2010-2040
Population	102,551	84,910	87,460	79,904	77,344	78,199	855	1.11%
Employment					51,435	55,409	3,974	7.73%
Ratio Pop:Jobs					1.5	1.41		

Detailed Utility System Descriptions[42]

The Camden Water System is operated through a public-private partnership contract between United Water and the City of Camden, under a 15-year contract that ends January 2015. The Camden Water System serves all portions of Camden except the area east of the Cooper River (approximately one-third of the City area, which is supplied by NJ American Water), providing water to 50,000 people in the city. Water is derived from 26 wells located near the Delaware River, with 158 miles of mains. Camden is the largest Delaware River municipality in New Jersey that does not rely directly on the river for its water supply. The water supply system includes two treatment plants:

- The Morris-Delair Treatment Plant, the city's largest water treatment facility, can produce up to 18 million gallons of water per day (MGD). It is the primary source of supply for the city.
- The Parkside Water Treatment Plant, the secondary source, is rated to produce 3 MGD, but has an effective production capacity of 2 MGD. It has treatment to address VOCs in the raw water supply.

[42] Sources include: www.unitedwater.com/eBooks/camden12_CCR/camden_CCR_12.html#/4/zoomed; www.unitedwater.com/camden/water.aspx; www.ccmua.org/?p=165; www.ncppp.org/resources/case-studies/operation-and-managementmaintenance-contracts/city-of-camden-nj-waster-and-wastewater-system/; interviews with United Water (7 March 2014) and Camden (28 March 2014).

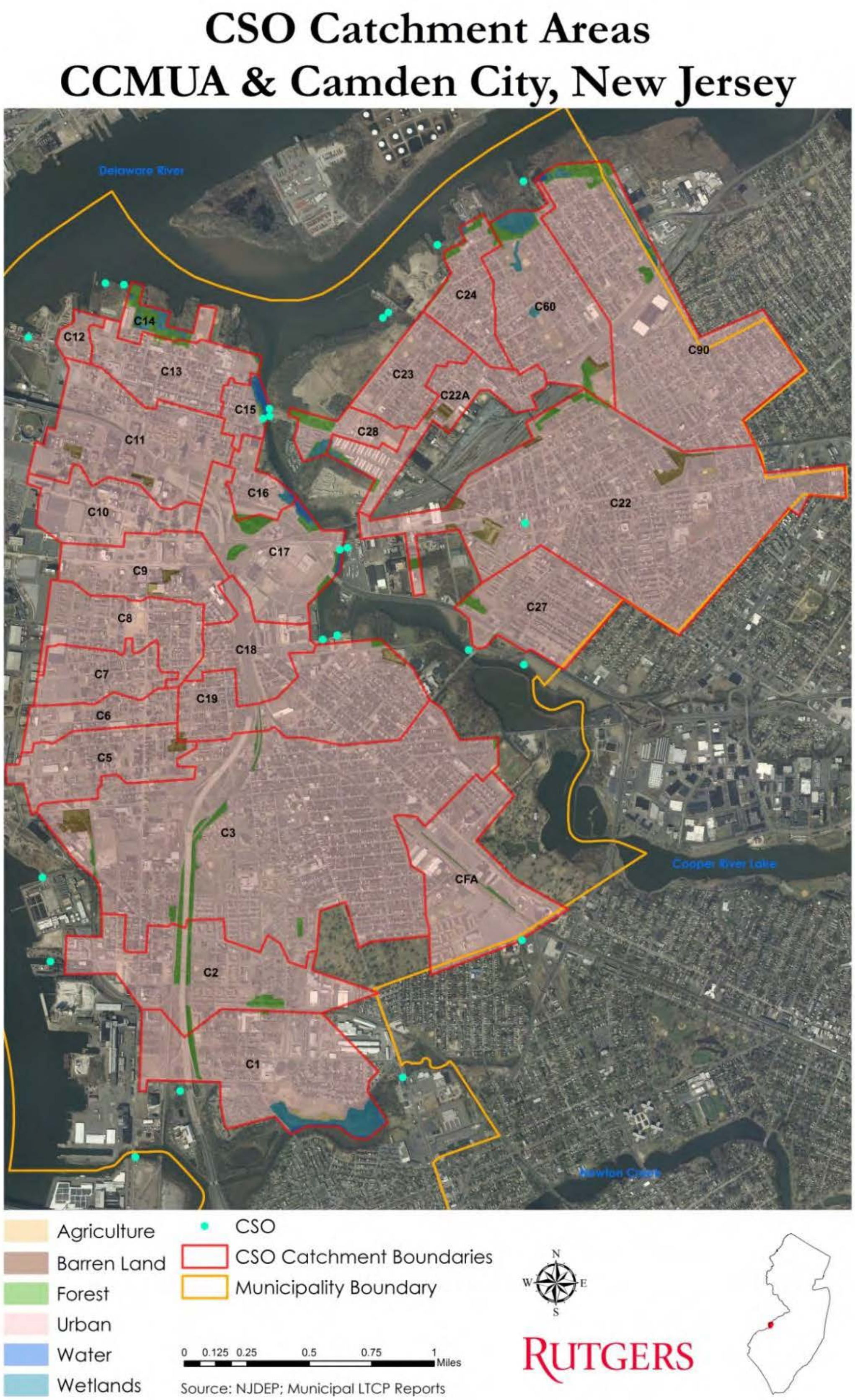


Figure 4-2: Camden CSOs and Drainage Areas

The Morris-Delair Treatment Plant was recently upgraded. Parkside is off-line as of this report, as United Water and the city investigate a recent violation for VOCs, but will be placed on-line once the problem is rectified. Both facilities are relatively new. Conversely, the water distribution system is generally very old (built primarily in the early 1900's), and though it experiences relatively few breaks the mains have for the most part not be modified or rehabilitated since the 1950's and suffer from the lack of maintenance.

No specific figures are available, but a recent County study indicated a demand of 60 gpcd for residential users, and the City is likely close to this. City total demands are strongly affected by the large daytime user populations in higher education and employment centers. The system is delivering approximately 12 MGD on average, ranging from 10 MGD in winter to peak days of 14 MGD in the summer. During the summer, open hydrants in the residential areas are a major issue, offsetting the fact that Camden has relatively few lawns.

Non-revenue water is roughly 36% of water produced at the treatment plants, in part because the city exempts a wide variety of non-government organizations from rates. In such cases, the delivered water does not result in revenue but is not "lost" water. In addition, significant water losses occur due to theft of interior copper pipes, illicit hydrant uses and theft of water services. Water meters were replaced over the last two years, improving collections. United Water is deploying a more detailed in-house system for water loss evaluations. On the other hand, the system uses a lower water pressure and there is little construction activity and no increases in demand that would stress the system. Camden has some instances where brick sewers were built around water lines, creating a highly corrosive situation that can cause water line breaks. United Water is working with Camden to address these conflicts.

As discussed in **Chapter 3**, the Camden water supply system currently has a net available capacity of 7.756 MGD (235.77 MGM), which is well above the level required to accommodate the projected 2040 population, of 0.086 to 0.111 MGD. No increase is needed in system capacity to accommodate projected needs. However, a significant concern for the city is that the existing lines may not be able to provide sufficient flow to new development, even though the water treatment plants have ample capacity. The lines are seen as the limiting factor. Camden has cleaned and relined some of its water lines but needs to do more. All the water treatment plant upgrades and repairs were programmed capital projects, as are upcoming water tower improvements. The City received approximately $20 million in ARRA funds for water and sewer projects, to address projects that were previously identified and ready for construction.

United Water's contract with the City of Camden also includes the operation and maintenance of the city's 150-mile sewage collection system with a flow limit of 18 million gallons per day, 8 pumping stations and the 28 Combined Sewer Overflow (CSO) outfall sites. As with the water supply distribution system, the sewer collection system is old. The combined sewers were all built in the latter half of the 1800's. Dry weather discharges from the CSO outfalls in Camden were corrected in the 1990's through regulator improvements but other problems persist. The system age, topography and other issues result in sewer surcharges and flooding in parts of the City. The waterfront area experiences backups in the Light Rail and Victor Building areas. The City and CCMUA recently found and cleared two clogged CSO outfalls just downstream of these areas, which should mitigate some problems. River Road along the Delaware also has problems, which they plan to address through a $2 million dedicated separate storm sewer. The Cramer Hill and East Camden areas are also of concern; Pennsauken separate storm sewers contribute flows into that area.

All of the wastewater during dry weather periods is treated at the Delaware No. 1 Water Pollution Control Facility owned and operated by the Camden County MUA (CCMUA), which has a design capacity of 80 million gallons per day (Camden et al., 2007). CCMUA has upgraded all five major components of its system over the last 10 years. As discussed in the section on **Public Sewer Systems** in Chapter 3 above, CCMUA currently has a net available capacity of 22.292 MGD, which is well above the level required to accommodate the minimal projected increase in demands through 2040. No increase is needed in the treatment plant capacity to accommodate projected needs. The CCMUA facility can handle peak daily flows to 120 MGD with secondary treatment (50% beyond its design flow of 80 MGD) and so influent rates are limited to that rate, with any excess flows being discharged through the various CSO outfalls in the City of Camden or Gloucester City (Camden et al., 2007). Sewage from the suburbs does displace wet weather flows from the City of Camden and Gloucester City.

No study has been completed for the city, but CCMUA has estimated that 10-12 MGD of dry weather flow is related to I&I from the suburbs, by comparing normal flows during dry weather periods (55 MGD) with flows during extended droughts when the water table is lower (closer to 40 MGD). Wet weather I&I rates from the suburbs are even higher. City of Camden I&I rates might be similar to those of the suburbs. Reducing the I&I flows would reduce CCMUA operational costs at the treatment plant on a routine basis, and would provide more capacity for wet weather flows.

The City of Camden itself contributes just over 10 MGD as of 2007 and has a planning flow of 20 MGD by 2025 (Camden et al., 2007), though if the population projections provided above are correct, that large increase in flow would not be realized. However, it must be emphasized that the City of Camden, with 28 CSO outfalls (in addition to one CSO outfall owned by CCCMUA), essentially has no line capacity for additional sewerage during wet weather periods, as each gallon of additional sewage from development will result in a similar increase in CSO volumes. CSO volume reductions will significantly improve surface water pollution levels and neighborhood quality related to sewer backups and street flooding in developed areas. Options include storage (with subsequent release to CCMUA, using available dry weather capacity) and preventing stormwater from coming into the lines (e.g., through I&I reductions and stormwater management techniques that redirect the water). Tidal inflow is controlled by tide gates on each of the CSO regulators (Camden, 2007).

The age and historic lack of maintenance and improvements is reflected in recent estimates of total capital projects needed to improve operations. Based on the available information regarding known components of the system, the combined backlog of projects for water and sewer is likely in the range of $400-500 million, not including any CSO compliance costs.

Planned Water Supply System Upgrades

Based on discussions with Camden and United Water personnel, the water supply distribution system in Camden will need continued upgrades to address aging pipes and the conflicts between water lines within sewers. The water treatment plant was recently upgraded. The City has wanted to clean and reline its water lines to address tuberculation. The lines were built in the early 1900's and last rehabilitated in the 1950's. They were able to clean and reline a couple of lines (in part with Drinking Water SRF loans through the Smart Growth Initiative), but need to do more, and also to address system valves. The water line replacements greatly improved the operations of those lines, reducing complaints about brown water, etc. The City also replaced a large number of service lines to individual properties to address lead and brown water complaints, using NJEIFP financing. The City will be rehabilitating its water tanks at a cost of $6 million, and has applied for Drinking Water SRF loans from the NJ Environmental Infrastructure Financing Program.

Planned Sewer System Upgrades and CSO Controls

Based on discussions with Camden, United Water and CCMUA personnel, the sewer system collection system in Camden will require extensive and expensive upgrades to address CSOs, street flooding and other issues related to an aging combined sewer system. Nearly the entire city is served by combined sewers. The City with CCMUA committed to implement controls on solids and floatable materials from their CSO outfalls. In the process of doing so, Camden originally planned to consolidate and eliminate outfalls from the existing 28 locations to 21 (Camden, 2007), but implementation decisions are resulting in 22 locations plus the CCMUA outfall (which is physically in the City). Solids removal due to sewer cleaning will help with PCB removal, a major issue for the Delaware River Basin Commission (DRBC); all point sources to the Delaware River combined contribute 12% of the load, with CSO events being part of that load. However, consolidating outfalls does not necessarily equate to a reduction in overflow volumes, though the discharge quality will be improved through the control measures. CCMUA will be upgrading its headworks, to allow more flow from Camden during wet-weather events. Camden has applied for $78 million and CCMUA $5 million in Clean Water SRF loans from the NJ Environmental Infrastructure Financing Program, for the purposes of sewer rehabilitation and CSO controls, and CCMUA another $4 million for secondary treatment improvements, all of which are ranked high in the priority list. CCMUA is also listed for $15 million in Sandy recovery funds from the Clean Water SRF, for sewer reconstruction and treatment plant improvements. The City and Camden County have also applied for Clean Water SRF funding for other purposes such as nonpoint source control, none of which are ranked high.

The Camden CSO report (Camden, 2007) indicated that the 28 CSO outfalls are highly diverse, having annual discharge volumes ranging from 2.2 to 132 MG for a total of 757 MG, and from 6 to 67 discharges per year and an average of 26 events, indicating that the CSOs have different responses to rainfall. Three of those outfalls represent 50% of total CSO volumes (of which CCMUA's outfall, C32, is the largest), with the largest ten comprising 80% of total volume (Camden et al., 2007).

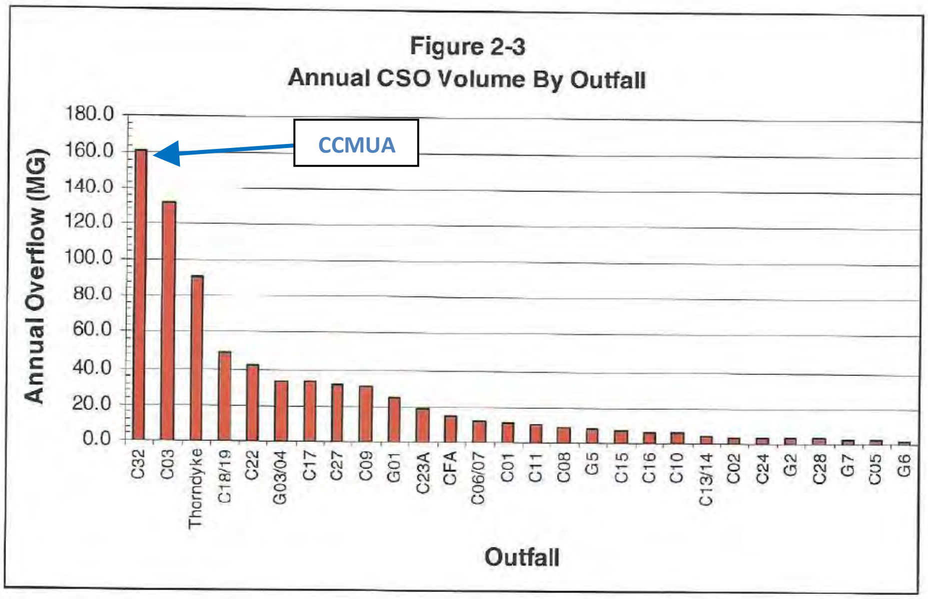


Figure 4-3: Camden Annual CSO Volumes by Outfall (Source: Camden, 2007).

Modeled discharge quality varies significantly from storm to storm and month to month. All of these variations complicate the analysis. For instance, the storage volume (on-line or off-line) needed to achieve no more than three events per year range from a low of 0.33 million gallons (MG) to a high of 9.07 MG, with a total storage of 45 MG needed for all CSO outfalls and an average 7.39 MG storage per square mile of CSO drainage area. **Table 4-4** presents the aggregate costs for various control approaches (Camden, 2007; Camden et al., 2007):

Table 4-4: Camden CSO Cost Estimates	
Control Category (3 events/year for storage approaches)	**Costs (Total Present Worth in $ millions)**
Disinfection (21 outfalls; coarse screen/disinfection)	106
In-line Storage (existing pipelines)	Not feasible
Off-line Storage Tanks (21 outfalls)	495 (Not feasible)
Complete Sewer Separation ($127,000 per acre)	505

The in-line storage option was considered technically infeasible due to existing flooding issues, while the off-line storage tank option was considered technically feasible but infeasible in practice for Camden due to lack of available land and high costs. An option considered feasible is reduction of I&I in upstream (non-CSO) municipalities within the CCMUA service area, which would provide additional room for flows from Camden and Gloucester City (Camden et al., 2007). Costs were not available for this approach, but as noted above, CCMUA estimates that more than 10 MGD of I&I flows emanate from the upstream municipalities. The report also recommended that NJDEP allow CCMUA to provide primary treatment for another 30 MGD of flow (beyond the 120 MGD limit for secondary treatment) as preferable to CSO discharges with no treatment. Expansion of the CCMUA facility or creation of large equalization tanks at the treatment plant were considered infeasible due to space constraints and high costs.

None of these costs should be taken as definitive, as a number of assumptions were used in the modeling process, definitions of CSO "events" may not fully match current guidance, the combined sewer systems may have had existing structural problems that would affect the monitoring and modeling results, no detailed designs were completed, and no bench or pilot project evaluations were used. As such, these values are representative of the general range of costs for implementation. As CSO controls are chosen, more rigorous analyses, designs and cost estimates will be required.

The report also discusses the pollutant loading reductions from these alternatives. Disinfection requires pretreatment to reduce total suspended solids (TSS) levels so that the disinfection is effective. Depending on the method selected, reduction of non-pathogen pollutant loads could range from 15% to 90% (Camden, 2007). Storage options reduce total discharge volume and therefore total pollutant loads in an essentially linear manner. In all cases, United Water will be involved in design for CSO controls that affect the sewer system, but otherwise Camden and CCMUA are responsible for CSO controls.

Other efforts are being taken to reduce CSO flows. Camden passed a water conservation ordinance to reduce flows during all periods. CCMUA and the City are cooperating on a $1 million daylighting of Baldwins Run, which was covered and piped back in the 1920's. They estimate a reduction of 23 million gallons per year (MGY) in stormwater to the sewer system. They are working on sewer separation along the waterfront. CCMUA is working with Coopers Ferry, Rutgers, the City and others through the Camden SMART initiative. They have constructed 30 rain gardens using CCMUA funds, which are estimated to control 3 MGY in stormwater flows (far less than will be accomplished by the Baldwins Run project). They focused on flooding problem areas so that the benefits are concentrated. They are seeking NJEIFP funding this year for 20 more rain gardens, plus the Baldwins Run project, sewer separations and other gray infrastructure projects. In 2015 they will seek funding for 10 more rain gardens, additional gray infrastructure work, and work in the North Camden Waterfront Park. Rain garden maintenance is by affected landowners or through a contract with Camden Special Services District, a division of Coopers Ferry, at minimal cost. CCMUA and the City are also looking at the possibility of green infrastructure associated with redevelopment of contaminated sites, in cooperation with the Nature Conservancy and others. A Drexel University team looked at the potential for green/blue roofs, but did not find many opportunities, due in large part to the nature of buildings in Camden (e.g., wooden frame buildings, old roofs, inadequate roof loading capacity). The LTCP will examine the potential for green infrastructure to reduce peak sewer flows. The expectation is that green infrastructure will be helpful in specific local situations, but will not solve problems alone and may at best reduce peak flows. Of note are the anticipated benefits from the projects note here, relative to the annual CSO volumes of 522 MG. However, reductions in CSO areas with some of the smallest discharges could have more significant impacts, reducing the frequency of overflow events.

CCMUA reports that many sewer lines in Camden have been found to be either clogged, partially collapsed, etc. The overall CSO strategy for the partnership of CCMUA, the City and United Water is to implement:

1. Water conservation to reduce the sewage component of combined flow;
2. Green infrastructure to reduce the stormwater component of combined flow;
3. Rehabilitation or cleaning of clogged, collapsed and silted up lines; and
4. Replacement of failing infrastructure on a prioritized basis.

Institutional Capacity for Utility Management

For both water and sewer services, United Water is responsible for operation of full water supply system (including well field, treatment system and distribution) and sewer collection system. United Water assumed responsibility for the City of Camden's 1999 contract with U.S. Water, which was purchased by United Water. A renegotiated contract extends through January 2015, at which point it must be extended or rebid. CCMUA and the City are working with NJDEP to develop a request for proposals that represents "best practices" for the industry including operations optimization, green and gray infrastructure approaches, etc.

The current contract includes a fixed fee for United Water's services, with specific funds allocated for maintenance and emergency repairs for both the water and sewer systems. United Water completed a 2013 asset management report to the City with a full inventory of assets, evaluation of many components (including all of the sewer lines), and a capital plan. The system uses United Water's in-house CMMS software with GIS; the two components do not interact as well as desired but they are moving forward on improvements to the system assessment. Water lines are not all evaluated yet, and valve operations are being evaluated. Based on the available information regarding known components of the system, the combined backlog of projects for water and sewer is likely in the range of **$400-500 million**. Asset integrity evaluations are being added as information is available, but does not yet include a comprehensive evaluation of asset quality. For example, some parts of the sewer system are being found that were not previously mapped ("ghost" components – there but not seen). United Water provides 5-year recommendations for capital projects, based on its operational knowledge, and Camden then selects priorities and implements them based on the availability of funds. Capital projects are the responsibility of the City.

As mentioned above, emergency repairs are implemented by United Water as a requirement and specifically funded component of its contract with Camden. Water supply distribution system breaks are relatively few. However, leakage from within buildings is a significant problem due to theft of interior copper piping and meters. United Water in the past has experienced difficulties with crew safety in some areas of the city; improvements due to the new regional police system are apparent but more experience with the new system will be needed to draw long-term conclusions. Emergency repairs are mostly for sewer collapses, which occur routinely at a rate of one to three per year.

Important to both Camden and Gloucester City, CCMUA will be the lead agency for LTCP development on behalf of all three entities, which will help the two cities address the permit needs (at least through the planning process) in a cost-effective manner.

Obstacles to Upgrading Water Infrastructure

1) **Municipal and utility fiscal capacity**: In this case, the City of Camden owns the infrastructure but the operating utility is United Water, which operates under a service contract. As such, any additional capital and operating costs not provided for in the contract would represent a cause for a revised agreement regarding who will pay the costs and how they would be reflected in the rates. United Water is sufficiently large to have no particular constraints on fiscal capacity as long as rates are adjusted appropriately. Camden has the option of agreeing with United Water to incorporate all capital and operating costs into the contract, avoiding issues with regard to municipal fiscal capacity. The last Camden rate increase was in 2007, the first in 14 years. The City Council refused to approve it, but the State (which was then in charge of City finances) forced the rate increase through. The rate hike was phased in over five years, through 2012. The City is looking into whether a rate increase will be required in 2015, with no conclusions as of this point. CCMUA adopted a minor increase in 2013 ($9 per year), without issue. Camden uses NJEIFP financing due to its 75% zero-interest component, which is also available to CCMUA for work performed in the City.

2) **Household financial stress**: USEPA has affordability criteria that sewer service costs should not exceed 1.75% of median household income, and if above 2% would be considered financially prohibitive. Using a nominal household with 60,000 gallons of water demand per year, Camden's current sewer rates are approximately $448 per household per year.[43] Compared to a median income of $27,027, the current sewer rate is 1.66% of median household income. The feasibility report did not include a final cost estimate for the most cost-effective CSO control projects, nor did it discuss affordability based on total annual costs per household (Camden et al., 2007). However, based on the current 1.66% level, the USEPA guidance would indicate that household sewer rates could rise by only $24 and still be at 1.75%, or $92 to reach 2%. In either case, the resulting revenue will be <u>entirely insufficient to address CSO costs</u>. However, this analysis does not incorporate potential rate increases necessary to address deferred maintenance of the existing system; a rate increase is being contemplated for 2015 but is not certain. Further analysis could result in either greater or lower CSO control costs, sewer rates may have changed, and median income may have

[43] The City of Camden charges $17.80 per quarter plus $2.94 per 1,000 gallons of water use. CCMUA collects a separate sewer charge for its treatment system, as a $200 flat fee for residences. Actual sewer costs will vary by household depending on total water use.

changed as well. As such, household financial stress in Camden is already high with very little flexibility to support the costs of CSO controls.

3) **Availability of space for CSO controls**: The disinfection feasibility report (Camden, 2007) notes that Camden has many vacant lots that could be used for disinfection treatment facilities. Due to the low elevation of the city relative to the rivers, pump stations will be required to make the treatment systems operational without increased back-flooding of Camden streets and homes. Similarly, parking lots could be used for off-line storage tanks. The report notes the potential conflict between land needs for these facilities and the desire for redevelopment. The City and CCMUA are concerned that disinfection may be technically feasible but requires land in places where land is least available. To be viable, they need a disinfection technique with a very low contact time to reduce the required system footprint. Otherwise each CSO outfall will in essence require its own limited sewage treatment system, which will be in conflict with redevelopment potential in key locations.

4) **Development and redevelopment market limitations**: Investment has been occurring in Camden, especially related to Rowan University, Rutgers-The State University of New Jersey and Cooper University Health Care. Unfortunately, the city is experiencing little unsubsidized private-sector development that would increase property tax revenues. There are no approved but unbuilt projects that require major new flows at this time. Population has been dropping, not increasing, as did the total number of residential units until 2000, at which point the number of households stabilized. The data, trends and available projections do not indicate a high potential for private-sector, market-based development in the near future. However, increased development subsidies are possible under the revised NJ Economic Opportunity Act passed in 2013, with Camden as a Garden State Growth Zone. Planning and discussions are ongoing for a Haddon Avenue transit district and a North Camden redevelopment effort.

Elizabeth

Elizabeth is a highly developed urban municipality of 11.7 square miles with commercial, industrial, and high-density residential development, including industrial areas along the Arthur Kill and a portion of Newark Liberty International Airport. It is one of the oldest settlements in New Jersey.

Population and Employment Projections

Elizabeth had a fairly stable population from 1970 to 1990, and subsequently experienced an increase through 2010. Population projections through 2040 anticipate a continuation of this population trend, with over 18% growth from 2010 to 2040. Employment is projected to increase even more quickly. The ratio of population to jobs as of 2010 (2.6) was in the middle of the municipalities highlighted in this chapter and is projected to improve somewhat through 2040, indicating that Elizabeth is roughly equivalent to New York City (2.39) as a strong job center and is not a predominantly bedroom community. As discussed in **Chapter 2**, Elizabeth has a high poverty rate (18.8% below the poverty line), per capital tax base less than half the statewide median, and both median household income and average housing values below the statewide median. It is considered a most distressed urban municipality by New Jersey Future (Rank 5 of 5). The overall picture is one of a city that has experienced some recent positive trends and substantial projected improvements, but with a relatively high concentration of poverty among NJ municipalities. Fiscal stresses are likely to remain a concern into the future.

Table 4-5: Elizabeth Population Status and Trends

	1970	1980	1990	2000	2010 (MPO)	Projected 2040	Projected Growth 2010-2040	Projected Growth 2010-2040
Population	112,654	106,201	110,138	120,568	124,970	147,790	22,820	18.3%
Employment					48,130	63,750	15,620	32.5%
Ratio Pop:Jobs					2.60	2.32		

Detailed Utility System Descriptions[44]

As with Bayonne, Elizabeth relies on regional systems for both water supply and wastewater services. The water supply is provided by NJ American Water (a subsidiary of American Water, an investor-owned company), which derives its supplies mostly from the Raritan System of the NJ Water Supply Authority, a state agency, but also from Newark (using a portion of Newark's contract with NJDWSC). The Raritan System has amply available capacity to address the projected needs of Elizabeth (from 2.3 to nearly 3 MGD), with NJ American Water itself having over 29 MGD in net available capacity. The water supply distribution system within the city is operated by Liberty Water (another subsidiary of American Water) under a 40-year concession contract from June 1998. Average demand is approximately 12.47 MGD and the peak demand is approximately 13.95 MGD, primarily in summer months and related to lawn watering and pools. Liberty Water handles all day-to-day operations, maintenance, emergency repairs, billing and collections. On the water side, Liberty has significantly improved the system, through hydrant and meter replacements, hydrant locks, etc. Water loss rates are approximately 16% per Liberty Water, which indicates a fairly tight system as some water "losses" actually represent legitimate water uses that are not billed (e.g., firefighting).

Nearly the entire city is served by combined sewers that discharge through CSO outfalls, except for a few areas of combined sewers that are immediately adjacent to and discharge to the interceptor sewers, and few small areas of separate sanitary sewers. CSO drainage areas range from 4.4 to 420 acres (Elizabeth 2006).

[44] Sources include: Interview with Elizabeth City Engineer, 5 March 2014; American Water, 2011; American Water, 2012; Elizabeth, 2006; Elizabeth, 2007; www.jmeuc.com

Figure 4-4: Elizabeth CSOs and Drainage Areas

Elizabethtown Services (also a division of American Water) is the service contractor for the sewer system through a 20-year contract from March 2002. However, Elizabeth remains responsible for CSO controls under the NJPDES permit. Infiltration is likely an issue due to the nature of the collection system, with some clay pipe (6 foot lengths) and some brick, but no recent study has been conducted to estimate levels or major areas of concern. Repairs are roughly $4 million per year, and have been rising recently. Elizabeth targets areas needing repairs and assesses the nearby sections and facilities that may also need repair, as a way of achieving cost savings. Mobilization is a large part of the cost, and so they see savings by addressing as much as seems reasonable while working at a site. Elizabeth is not aware of system surcharges (i.e., backups that cause sewage to flow to streets, streams or within buildings; CSOs are not considered surcharges).

Wastewater treatment is provided by the Joint Meeting of Essex and Union Counties, which owns and operates the Edward P. Decher Secondary Wastewater Treatment Facility located in Elizabeth, New Jersey, serving a 65 square mile area in the two counties. Originally designed and constructed as a 75 million gallon per day (MGD) secondary treatment facility in the late 1970s, the plant was subsequently re-rated to 85 million gallons per day (MGD). Elizabeth's peak average dry weather flows are just under 20 MGD (of which approximately 6% is from industry), while the pump station to the treatment plant force main is rated at 55 MGD but limited to 36 MGD by agreement with Joint Meeting (Elizabeth, 2007). As discussed in the section on **Public Sewer Systems** in Chapter 3 above, at 85 MGD total capacity, the Joint Meeting facility has capacity for additional demands from Elizabeth (1.7 MGD by 2040) and other municipalities based on both the MAX3MO flows and annual average flows. However, the 28 CSO outfalls in Elizabeth (27 per Elizabeth, 2007) with an annual average discharge of nearly 1050 MG clearly indicate it essentially has no capacity for additional sewerage during wet weather periods, as each gallon of additional sewage from development will result in a similar increase in CSO volumes. CSO volume reductions will significantly improve surface water pollution levels and neighborhood quality related to sewer backups and street flooding in developed areas. Options include increasing Joint Meeting's capacity to accept additional flows during wet weather events, storage (with subsequent release to Joint Meeting, using available dry weather capacity) and preventing stormwater from coming into the lines (e.g., through I&I reductions and stormwater management techniques that redirect the water).

Planned Water Supply System Upgrades

Based on discussions with Elizabeth personnel, there are no plans for major capital upgrades to the water supply distribution system in Elizabeth. Line maintenance and replacement will occur as necessary.

Planned Sewer System Upgrades and CSO Controls

Based on discussions with Elizabeth personnel, the sewer system collection system has been the focus of a number of capital projects (roughly $15 million over the last 5 years) to address ongoing issues, mostly of flooding in specific neighborhoods. Projects include:

1) Sewer separation and storage in the north end of town, at $6.5 million;
2) Series of $1-3 million projects for flooding remedies including sewer separation for South Street, creation of storage to avoid flooding of a bridge crossing at North Avenue; and
3) Midtown sewer separation.

In addition, 2014 projects include creation of underground storage to reduce flooding, with release to the sewer after peak flows subside. Some other projects are not sewer related, such as the installation of generators for the pump stations behind the levee along the Elizabeth River (due to electricity loss during Sandy). Elizabeth has also been preparing to implement a $10 million upgrade of the Western Interceptor. However, a proposal from the reports prepared for the CSO General Permit suggested that Elizabeth and Joint Meeting consider an increase in how much sewage flow goes to Joint Meeting; decisions on this issue, which would involve Joint Meeting accepting more flows than the current 36 MGD daily peak, will affect design parameters regarding the amount needed for storage versus flow increases. Elizabeth has applied for $10.6 million in Clean Water SRF loans from the NJ Environmental Infrastructure Financing Program, for the purposes of CSO controls, which is ranked high in the priority list. Other requests for nonpoint source controls are ranked low.

The Long Term Control Plan documents submitted by Elizabeth (Elizabeth, 2007) indicate that the 28 CSO outfalls that discharge (i.e., some have no annual discharge) vary from 56 to 76 discharges per year, with an average of 67, indicating that the CSOs have fairly uniform responses to rainfall. Other CSO characteristics are highly diverse. Modeled discharge quality varies significantly from storm to storm and month to month. CSO volumes also range widely. All of these variations complicate the analysis. For instance, the storage volume (on-line or off-line) needed to achieve no more than three events per year range from a low of 0.06 million gallons (MG) to a high of 9.82 MG, with a total storage of 84 MG needed for all CSO outfalls and an average 14.97 MG storage per square mile of CSO drainage area. **Table 4-6** presents aggregated costs for various control approaches:

Table 4-6: Elizabeth CSO Cost Estimates	
Control Category **(**3 events/year for storage approaches)	**Costs (Total Present Worth in $ millions)**
Disinfection (separate outfall treatments)	116-241
Disinfection (9 grouped, 4 separate)	71-193
In-line Storage (existing or larger-volume pipelines)	Not feasible
Off-line Storage Tanks (separate outfall treatments)	478
Off-line Storage Tanks (9 grouped, 4 separate)	445
Deep Storage Tunnels (3)	199
Complete Sewer Separation ($1100 per linear foot)	748

For both disinfection and storage, consolidation of CSO outfalls into common treatment systems yielded a reduction in costs. None of these costs should be taken as definitive, as a number of assumptions were used in the modeling process, definitions of CSO "events" may not fully match current guidance, the combined sewer systems may have had existing structural problems that would affect the monitoring and modeling results, no detailed designs were completed, and no bench or pilot project evaluations were used. As such, these values are representative of the general range of costs for implementation. As CSO controls are chosen, more rigorous analyses, designs and cost estimates will be required.

The report also discusses the pollutant loading reductions from these alternatives. Disinfection requires pretreatment to reduce total suspended solids (TSS) levels so that the disinfection is effective. Depending on the method selected, reduction of non-pathogen pollutant loads could range from 45% to 85%. Storage options reduce total discharge volume and therefore total pollutant loads in an essentially linear manner.

At this time and subject to modification based on the new reports developed for the CSO Individual Permit, Elizabeth sees the best approach for CSO control as the ability to increase interceptor flow to Joint Meeting, closing the CSO discharge points and treating all of the combined sewage. Treatment costs would increase but less than the cost of capital projects, and maintenance requirements would be minimal. Elizabeth is separating sewers where feasible, but is concerned about future requirements of NJPDES MS4 permits for separate storm sewers. Otherwise, CSO storage seems feasible for most areas. Green Infrastructure will be assessed as part of the CSO permit, but Elizabeth has little experience with it and is concerned about feasibility in high-traffic areas, maintenance issues and costs. Another issue of interest is that all City open space is protected through Green Acres and the Statehouse Commission process. Use of park land for Green Infrastructure approaches to stormwater management currently is permitted only to address stormwater generated within the parks. Other stormwater projects would be considered a diversion of open space lands requiring Statehouse Commission approval. In other states and cities, such as Philadelphia, park land is being used for artificial wetlands, stream restoration and other Green Infrastructure projects that can both address off-site stormwater and provide park amenities. Guidance is needed as to what Green Infrastructure approaches are compatible with State restrictions on the use of public lands on the Recreational and Open Space Inventory (ROSI) (e.g., water amenities using stormwater; addressing stormwater from roads that are either within or adjacent to the parks) and which are not. However, the City does want to ensure that redevelopment projects provide runoff reductions, and expects to revamp their stormwater ordinance to achieve this.

Institutional Capacity for Utility Management

Liberty Water, as the contract operator, maintains information related to the water system. As a subsidiary of one of the nation's largest investor-owned water companies, Liberty Water has access to extensive in-house expertise. However, details on their asset management program were not available for this report.

Elizabeth has not implemented a formal asset management approach to date for the sewer system, but doing so is required under the CSO individual permit. The city did limited work to establish a system inventory under the CSO General Permit and has good-quality paper maps of the system that will be translated to GIS with additional data. The locations of the 169 miles of sewer lines are well known, but their condition is not except where recent work has been done. The draft CSO Individual Permit allows 3 months for a complete inventory and integrity assessment. The information does not exist and Elizabeth has formally requested more time for this aspect of the permit.

Most services are provided through service contracts, with oversight by Department of Public Works. The total city staff effort is perhaps 1-2 FTE depending on the projects of the year. Elizabethtown Services has perhaps 6-7 staff addressing sewer system operations. Liberty Water staffing levels were not available but are likely in the same range as for Elizabethtown Services.

The City Council approves policy, budget and service contracts. City Administration through the Department of Public Works oversees service contracts and handles larger-scale capital projects. The Department of Public Works and City Engineer also handle capital projects for the Recreation Department, providing good potential for cooperative efforts. To address needs under the CSO permit, Engineering expects to interact with the Planning & Community Development Department and the City Planner, especially regarding redevelopment issues.

All revenues beyond contract costs (including emergency repairs of roughly $4 million per year for the sewer system, a value that has been increasing in recent years) go into the Water and Sewer Funds to support capital projects and bond repayment. Capital projects for flooding reduction, Western Interceptor upgrades, etc., are reasonably considered programmed capital projects, not repairs. These larger projects require bonding, which recently has been entirely through NJEIFP (roughly $15 million in 5 years). These bonds are repaid through the rates.

Obstacles to Upgrading Water Infrastructure

1) **Municipal and utility fiscal capacity**: In this case, the municipality owns the water and sewer infrastructure but the operating entities are Liberty Water and Elizabethtown Services, each of which operates under a concession contract from the City of Elizabeth. As such, any additional capital and operating costs not provided for in the contract would represent a cause for an agreement regarding who will pay the costs and how they would be reflected in the rates. Liberty Water and Elizabethtown Services as divisions of American Water are sufficiently large to have no particular constraints on fiscal capacity as long as rates are adjusted appropriately. Elizabeth has the option of agreeing with them to incorporate all capital and operating costs into the contract, avoiding issues with regard to municipal fiscal capacity. However, the City is very concerned about potentially high costs of CSO controls if an increase in flows to Joint Meeting is not feasible or acceptable. The City Council ideally wants stable rates, but the increasing repair needs plus CSO costs likely will require rate increases. The intent is for the utility system to be entirely self-supporting, with no contributions to the general budget or vice versa.

2) **Household financial stress**: Based on USEPA criteria that sewer service costs should not exceed 1.75% of median household income, and if above 2% would be considered financially prohibitive, Elizabeth (2007) compared 2006 sewer rates of $161 per household to a median income of $40,413 to achieve a 0.40% level. Based on the cost analysis for the various CSO control projects, total annual costs per household ranged from $255 to $464, and total sewer rates would be $416 to $625, or 0.91% to 1.54%, and thus would be considered affordable (Elizabeth, 2007). However, this analysis does not incorporate potential rate increases necessary to address increasing maintenance and repair needs of the existing system. The current

sewer rate is $278 for a nominal household that uses 60,000 gallons per year of water (sewer rates are $3.463 per 100 cubic feet or $4.62 per 1000 gallons). Also, a median household income of $43,770 is reported by the American Community Survey (2006-2010) by the Bureau of the Census, somewhat higher than the level used in the CSO report, which (assuming stable sewer rates) would provide some buffer for CSO control costs. Based on the current rate of $278, the existing costs are 0.64% of median household income, with the increases shifting to a range of 1.22% to 1.70%. Further analysis could result in either greater or lower CSO control costs, sewer rates may have changed, and median income may have changed as well. Still, it seems feasible for increased sewer rates due to CSO control costs to remain at an acceptable level based on USEPA guidelines, though at the current median household income the implied maximum rate at the 1.75% threshold is $766.

3) **Availability of space for CSO controls**: The CSO report (Elizabeth, 2007) notes that Elizabeth is fully developed with no available open space near the CSO outfalls. However, parking lots could be used for treatment facilities and off-line storage tanks. On-line storage and deep tunnels would require minimal surface land after construction.

4) **Development and redevelopment market limitations**: According to Elizabeth personnel, the development market is picking up in the city, with more high density residential projects as a recent shift from the duplex developments previously seen. Warehousing and transport development is also occurring. Some of the larger residential projects are near transit (generally as mixed-use projects) but other projects are spread around the city where land is available. Portions of Elizabeth are subject to flooding from the Elizabeth River and storm surge from the Arthur Kill. Elizabeth submitted requests for nearly $58 million in funding under the Sandy recovery funds in the Drinking Water SRF program, primarily for flood control pump stations and flood prevention work. Sea level rise will exacerbate these problems, resulting in some limitations on available land for redevelopment.

Jersey City

Jersey City is a highly developed urban municipality on the Hudson River and is the second most populous municipality in New Jersey. It has been gradually evolving from an industrial waterfront to one dominated by high-rise office and residential developments taking advantage of the Bergen-Hudson Light Rail, PATH access to New York City, and views of and across the Hudson River.

Population and Employment Projections

Jersey City lost less than 10% of its population between 1970 and 1990 but as of 2010 has nearly recovered to its 1970 level, though it has not recovered to its peak population of 316,715 in 1930. Projected growth of over 40% through 2040 would make the city the most populous in New Jersey, significantly exceeding its prior peak. Employment growth is projected to occur at a similar rate. The ratio of population to jobs as of 2010 (2.34) was in the middle of the municipalities highlighted in this chapter and is projected to improve somewhat through 2040, indicating that Jersey City is roughly equivalent to New York City (2.39) as a strong job center and is not a predominantly bedroom community. As discussed in **Chapter 2**, Jersey City has a high poverty rate (17.6% below the poverty line), per capital tax base less than two-thirds the statewide median, and both average housing values and median household income below the statewide median. It is considered a distressed urban municipality by New Jersey Future (Rank 4 of 5). The overall picture is one of a city with a high concentration of poverty that has experienced some recent positive trends and very substantial projected improvements. If realized, the increased population and employment could have a profound effect on municipal finances.

Table 4-7: Jersey City Population Status and Trends

	1970	1980	1990	2000	2010 (MPO)	Projected 2040	Projected Growth 2010-2040	Projected Growth 2010-2040
Population	260,350	223,532	228,475	240,055	247,640	356,250	108,610	43.9%
Employment					105,730	155,670	49,940	47.2%
Ratio Pop:Jobs					2.34	2.29		

Detailed Utility System Descriptions[45]

Jersey City owns its primary water supply sources, the Jersey City Reservoir (aka the Boonton Reservoir, at 7.3 billion gallons) and Splitrock Reservoirs in the Rockaway River watershed of Morris County. The Jersey City Municipal Utilities Authority (JCMUA) has a public-private partnership contract with United Water-Jersey City to manage operation and maintenance of the water supply facilities and systems, including the reservoirs, water treatment plant, aqueduct and distribution system. The contract was initiated in 1996 with Jersey City directly, and then a new 8-year contract was written with JCMUA in 2000, when JCMUA was formed, followed by a new 10-year contract in 2008. Within a set fee, United Water conducts standard operations & maintenance and emergency repairs, while JCMUA is responsible for all capital projects. The Jersey City Reservoir is connected with Jersey City by means of 26 miles of tunnels, conduits and steel pipe. The present system is capable of delivering 87.5 MGD to the city and its other municipal customers, serving more than 239,000 people in Jersey City itself. As discussed in **Chapter 3**, Net Available Capacity for the system is over 22 MGD, which is sufficient to serve the projected additional demand through 2040 of roughly 11 to 14 MGD. In addition, most of their bulk supply contracts are for relatively short periods (e.g., 5 years) and so if the city needs more water, it can reduce its bulk sales (JCMUA interview, 2014).

[45] Sources include: http://jcmua.com/PDF's/Untied%20Water%20Agreement.PDF; http://www.jcmua.com/About%20the%20JCMUA.htm; www.unitedwater.com/eBooks/UWClientNewsletterFinal/uwclientnews.html; www.cityofjerseycity.org/commission/water.shtml; http://jcmua.com/PDF's/SewerRulesRegs_2011.pdf; Interview with Jersey City MUA 9 April 2014; Interview with United Water 7 March 2014

Figure 4-5: Jersey City CSOs and Drainage Areas

The water distribution system has 240 miles of mostly cast iron mains and is old. Non-revenue water is 20% or more, as measured from treatment plant production to customer meters, and so this value includes aqueduct losses. The aqueduct is a combination of concrete and steel. JCMUA has conducted assessments and major repairs in the concrete sections. They are now preparing to assess the current condition of the steel sections, with the possibility of rehabilitation or replacement. The water system has been subject to significant increases in demand, which adds to flow-based stresses. Development also entails opening up streets to work on buried infrastructure, with the result that breaks occur due to contractor error, exposure of aging lines, etc. Clusters of breaks are occurring around initial damage areas, as the fluctuations in pressure from the first break cause a ripple effect of problems. Jersey City has some instances where brick sewers were built around water lines, creating a highly corrosive situation. United Water is working with JCMUA to resolve these conflicts. However, total breaks have been fairly steady over the years at roughly 100 per year (130 in the most recent period due to a severe winter), which is somewhat higher (0.4 per linear mile) than the national average (0.24 per linear mile for cast iron, Folkman, 2012). Jersey City requested that United Water educate city residents and businesses about the reasons for line breaks; this program is in progress. JCMUA wants to reduce the frequency of breaks numbers, as emergency repairs are in general three to four times the costs of equivalent programmed capital projects. The water treatment plant is a 1970's conventional treatment facility that over the last ten years has been subject to routine capital projects to maintain the system. Recent improvements include filters, valves, backwash tank and sedimentation basin upgrades.

JCMUA operates the sewer collection system within the city with 230 miles of lines. It was originally formed as the Jersey City Sewerage Authority (JCSA) in 1949, which operated two sewage treatment plants. In 1990, these treatment plants were converted to pumping stations and a transmission line was constructed to the Passaic Valley Sewerage Commissioners (PVSC) wastewater treatment plant in Newark. The combined sewer system serves roughly 65% of the city, and has problems with backups during periods of high tides, which may require pumps to avoid damage to developed areas. Two of the 21 outfalls now have submersible pumps, which has been a major benefit to street flooding and residences. The separate sewers are primarily in former industrial areas that have been redeveloped. Under a 2011 Consent Decree with USEPA, Jersey City agreed to undertake sewer separations in some areas, visual (video) inspection of all combined sewers, outfall upgrades, high-pressure sewer cleaning, repair, lining and replacement, and work to address problems in low-lying areas, at a cost of $150-160 million, which does not include the additional capital costs identified through the later (post-2010) phases of the sewer assessment.

In 2009, JCMUA began a complete inventory and assessment, which was then incorporated into the 2011 Consent Decree. The sewer assessment started with the worst problem areas based on system knowledge and public complaints, in Phases 1 and 2. JCMUA uses a special truck that takes video from each manhole using a zoom lens, which is capable of capturing the condition for roughly 300 feet. Typical manhole spacing allows for a nearly complete visualization of the sewer in most areas. By using this process instead of the normal approach of physically propelling a video device through the pipe, the assessment is occurring much faster. The inventory of sewer line locations is complete. There were seven planned phases, and six are complete. Phase 7 will occur in 2014, and then a new Phase 8 will be used to address any manholes that were missed in prior phases. Each segment is then graded, using the NASSCO (National Association of Sewer Service Companies) assessment system from Grade 1 (good) to 5 (very poor). Capital projects are then developed to focus on the Grade 4 and 5 segments. Where problem segments are near others, linked segments are addressed in the same project to minimize the potential for later problems and customer/street disruptions. These projects all result in in-kind replacement. The intent is to conduct a new round of assessments upon completion of the current round, to see whether and how quickly any Grade 3 or 2 segments are degrading.

The sewer system is old, but generally functional in dry weather conditions. Part of the system is in very good shape, while others are falling apart. The sewers are often frail due to disruptions, extension of other pipes through them, contractor excavations, etc. In some places, the process of cleaning the lines has resulted in problems, because the build-up of sediment was actually supporting the structure. The capital projects have been beneficial. For example, the 10th Street area had multiple sewer collapses, and has been replaced. Now, no problems are evident.

As discussed in the section on **Public Sewer Systems** in Chapter 3 above, PVSC has a net available capacity for its entire service area of 30 MGD, less than 10% of its design capacity. While that would indicate an ability to provide additional capacity to Jersey City, which may require over 8 MGD to meet projected demands through 2040, Jersey City currently has 21 CSO outfalls, indicating that it essentially has no line capacity for additional sewerage during wet weather periods, as each gallon of additional sewage from development will result in a similar increase in CSO volumes. CSO volume reductions will significantly improve surface water pollution levels and neighborhood quality related to sewer backups and street flooding in developed areas. Options include storage (with subsequent release to PVSC, using available dry weather capacity) and preventing stormwater from coming into the lines (e.g., through I&I reductions and stormwater management techniques that redirect the water). Tidal influx is being addressed through the construction of tidal gates on the CSO outfalls, and infiltration during dry weather periods is considered minor (JCMUA, 2007). Inflow is a normal component of flow in combined sewers.

JCMUA notes that both their water and sewer systems are sized for a time when Jersey City had 320,000 people and a lot of water-intensive industry, dating back to the 1930's. They don't anticipate a need for more total capacity – the critical issue is maintaining the capacity of the existing systems.

Planned Water Supply System Upgrades

Based on discussions with United Water personnel, JCMUA makes routine investments in the water treatment plant and aqueduct, and has been investing $2.5 million per year in the distribution system. JCMUA intends to increase this to $5 million per year, according to United Water. In the past, the emphasis has been on cleaning and relining water lines, but more effort is going into replacement as they find lines that are too damaged to be worth relining. JCMUA will be replacing around 21,750 feet of pipe (mostly 8 or 12 inch but also some large transmission mains) in the downtown area, in two phases totaling around $12 million. Jersey City has applied for $16.33 million in Drinking Water SRF loans from the NJ Environmental Infrastructure Financing Program, for the purposes of water main upgrades. Jersey City has received nearly $107 million in Drinking Water SRF loans under the Smart Growth Initiative, for a variety of water main and water treatment plant improvements.

Planned Sewer System Upgrades and CSO Controls

Based on discussions with JCMUA personnel, the sewer system collection system will be receiving upgrades based on the 2009 Consent Decree with USEPA. Capital projects resulting from Phases 1 and 2 of the combine sewer evaluation cost $17 million, while Phases 3 and 4 resulted in $30 million in replacement costs. Phases 5 through 8 will also result in significant capital costs but no estimate is currently available for the Phase 5 and 6 assessments that have been completed. For sewers, Jersey City is required under the consent decree to separate sewers in specific streets. Otherwise, the sewers are replaced in-kind when problems are identified through the assessment. In addition, all developers are required to separate the sewers in their project area. However, the separated storm sewers currently flow into the combined sewers, other than in the waterfront area where the storm sewers discharge to the river. For the sewers, emergency costs had been $1-2 million per year, but recently declined slightly. One result of the sewer cleaning program is that more damage is done to the sewers, but for the most part these issues are addressed through the capital project process, rather than as emergency repairs. Jersey City has applied for $61.8 million in Clean Water SRF loans from the NJ Environmental Infrastructure Financing Program, for CSO Controls and stormwater management, which rank high. It also has applied for additional stormwater and nonpoint source pollution control funds that rank relatively low.

The Jersey City Long Term Control Plan documents (Jersey City, 2007) indicate that CSO characteristics are highly diverse. All of these variations complicate the analysis. For instance, the storage volumes (on-line or off-line) needed to achieve no more than three events per year range were interpolated using the report information for one and seven events per year (Jersey City, 2007), and range from a low of 0.65 million gallons (MG) to a high of 12.7 MG, with a total storage of 118 MG needed for all CSO outfalls and an average 12.3 MG storage per square mile of CSO drainage area. **Table 4-8** presents aggregated costs for various control approaches:

Table 4-8: Jersey City CSO Cost Estimates	
Control Category (3 events/year for storage approaches)	**Costs (Total Present Worth in $ millions)**
Disinfection (separate outfall treatments)	767
Disinfection (2 facilities)	526-723
In-line Storage	Not feasible
Off-line Storage Tanks (separate outfall treatments)	$1,055[46]
Off-line Storage Tanks (9 grouped)	1011
Deep Storage Tunnels (3)	491
Complete Sewer Separation ($1766 per linear foot)	1,910

For disinfection, consolidation of CSO outfalls into common treatment systems yielded a reduction in costs for the most expensive approaches, but not for the lower-cost options. Storage tank costs differed little between individual and grouped options, indicating that the primary driver in selecting options would be availability of land for acceptable tanks. However, tunnels were significantly less expensive than storage tanks. None of these costs should be taken as definitive, as a number of assumptions were used in the modeling process, definitions of CSO "events" may not fully match current guidance, the combined sewer systems may have had existing structural problems that would affect the monitoring and modeling results, no detailed designs were completed, and no bench or pilot project evaluations were used. As such, these values are representative of the general range of costs for implementation. As CSO controls are chosen, more rigorous analyses, designs and cost estimates will be required.

The report also discusses the pollutant loading reductions from these alternatives. Disinfection requires pretreatment to reduce total suspended solids (TSS) levels so that the disinfection is effective. Depending on the method selected, reduction of non-pathogen pollutant loads could range from 45% to 85%. Storage options reduce total discharge volume and therefore total pollutant loads in an essentially linear manner.

JCMUA engineers anticipate that different approaches will work best in different areas. They are assessing the use of vertical shafts in some areas with available vacant land; the volume stored will depend on land availability and which CSOs can be addressed. Jersey City may be able to use the sedimentation tanks at a former sewage treatment plant to capture 12 MG. Tunnels may be most appropriate in the downtown area, which is flat. All of these concepts are being explored and the most appropriate approaches will be identified in the Long Term Control Plan. To date there hasn't been a lot of municipal reaction, as the issue is not much noticed. However, the costs are major regardless of the approach uses, as even having PVSC treat more flows will be a significant expense.

Jersey City's report also discussed Low Impact Development (LID) alternatives that divert stormwater from entering the combined sewer system and would reduce CSO volumes. The report provided a short summary of techniques available to Jersey City (Jersey City, 2007). More importantly, it evaluated results from LID scenarios using SWMM (Storm Water Management Model), finding that 10% reductions in CSO flows were potentially feasible, but that research on LID effectiveness was limited (at the time). However, both the Philadelphia and New York City Long Term Control Plans have since been approved by USEPA with a significant reliance on LID (now more often called green infrastructure) techniques along with standard gray infrastructure approaches. JCMUA has mixed views of green infrastructure, both positive and negative, in part due to city development patterns and characteristics, and in part due to lack of familiarity with the technology and maintenance issues. They also will be purchasing a boat to conduct water sampling, in part to address the CSO permit requirements for monitoring and also to see whether there really is a water quality problem caused by the CSO events.

[46] Cost estimates for reductions to three events per year are not provided in the report. The values for off-line storage (21 facilities, 9 grouped facilities and two tunnels) were interpolated using the report information for one and seven events per year (Jersey City, 2007).

Institutional Capacity for Utility Management

United Water maintains a GIS-linked database with complete information on the location of the water supply system assets. Addition of asset quality occurs as United Water needs to conduct work in specific areas of the system; results are added to the data base, but a comprehensive evaluation is not yet available. JCMUA is highly involved in the selection of capital projects, using a combination of United Water recommendations and JCMUA consultant studies. JCMUA makes routine investments in the WTP and aqueduct, and has been investing $2.5 million/year in the distribution system. The system is apparently neither declining in quality nor getting significantly better, based on the steady level of line breaks. According to United Water, JCMUA intends to increase distribution system capital investments to $5 million/year to address ongoing system needs.

United Water provides billing and collection services for JCMUA; all funds are provided to JCMUA which then pays a service fee to United Water. Revenue collection has increased from roughly 60% to 98% of billed amounts over the life of the contract. United Water is rolling out a new water loss assessment approach called AquaCircle, developed internally, which provide similar information to the approach developed by the International Water Association and the American Water Works Association (AWWA Manual 36). The method helps to differentiate apparent water losses from actual. It is sensitive to data quality, and therefore provides better results where modern metering systems are in place.

Obstacles to Upgrading Water Infrastructure

1) **Municipal and utility fiscal capacity**: In this case, the municipality owns the infrastructure but the operating utility for the water system is United Water, which operates under a contract from Jersey City. As such, any additional capital and operating costs for that system not provided for in the contract would represent a cause for an agreement regarding who will pay the costs and how they would be reflected in the rates. United Water is sufficiently large to have no particular constraints on fiscal capacity as long as rates are adjusted appropriately. Jersey City has the option of agreeing with United Water to incorporate all capital and operating costs into the contract, avoiding issues with regard to municipal fiscal capacity. However, the sewer system is operated by JCMUA; to the extent that the city backs the indebtedness of JCMUA, municipal fiscal capacity may be stressed.

2) **Household financial stress**: USEPA affordability criteria suggest that sewer service costs should not exceed 1.75% of median household income, and if above 2% would be considered financially prohibitive. Jersey City's sewer rates are $437 per household, which based on a median household income of $54,280 yield a current affordability index of 0.81%, which would allow for an increase in sewer rates of $513 before the 1.75% threshold is exceeded at $950 per year. The Jersey City CSO report did not provide per household estimates of CSO control costs. Further analysis could result in either greater or lower CSO control costs, sewer rates may need to change to address needs other than CSO controls, and median income may have changed as well. Still, it seems feasible for increased sewer rates due to CSO control costs to remain at an acceptable level based on USEPA guidelines, primarily due to the low baseline sewer rate relative to median household income. JCMUA has not considered a major increase to its rate schedule in recent years, as the current schedule incorporates inflation adjustments into the rates. A rate study always precedes any proposal for rate increases, after which the JCMUA leadership meets with the city leadership to discuss needs.

3) **Availability of space for CSO controls**: Jersey City is fully developed with limited available space near the CSO outfalls. On-line storage and deep tunnels would require minimal surface land after construction.

4) **Development and redevelopment market limitations**: Jersey City has experienced major redevelopment along the previously industrial waterfront, particularly in the areas served by the Hudson Light Rail, and parts of its downtown areas such as Journal Square. Further redevelopment activities are anticipated. The projected population and employment gains are an indicator of the potential for Jersey City, which would provide additional rate base for utility improvements.

Newark

Newark is a highly developed urban municipality of 26.11 square miles. It is one of New Jersey's oldest urban settlements and is the most populous municipality in the state.

Population and Employment Projections

Newark lost over 27% of its population between 1970 and 2000 and over one-third from 1950, but showed a slight increase between 2000 and 2010. Population projections through 2040 are for a nearly 25% gain to 345,000, which still would be significantly below its 1970 population and even further below its 1950 population of nearly 440,000. If these projections are realized along with those for Jersey City, then Newark could become the second most populous city of New Jersey for the first time since 1830 (when it surpassed Trenton). Employment projections indicate improvement at 22% from 2010 to 2040, a somewhat slower pace than is projected for Jersey City. A significant difference from Jersey City is that Newark has a much lower ratio of population to jobs (1.82), second only to Camden among the municipalities highlighted in this chapter. The low ratio indicates that Newark is a strong job center relative to its resident population. As with Camden, however, a strong ratio of population to jobs is most beneficial to Newark municipal finances if the jobs are accessible to its residents and are in business sectors that provide financial support to the city and school system through property taxes. As discussed in **Chapter 2**, Newark has a very high poverty rate (28% below the poverty line), a median household income less than half of the statewide median, a per capita tax base in the bottom 30 of all New Jersey municipalities, and average housing values lower than the state median. It is considered a distressed urban municipality by New Jersey Future (Rank 4 of 5). The city school district is under State control and receives a large portion of its budget from the State, and the State also plays a major role in financing the City government and in controlling the use of City funds. The overall picture is one of a city that has experienced extensive decline, with significant projected improvement but no return to its peak periods of the early to mid-20th Century.

Table 4-9: Newark Population Status and Trends

	1970	1980	1990	2000	2010 (MPO)	Projected 2040	Projected Growth 2010-2040	Projected Growth 2010-2040
Population	381,930	329,248	275,291	273,546	277,140	345,180	68,040	24.6%
Employment					151,930	185,480	33,550	22.1%
Ratio Pop:Jobs					1.82	1.86		

Detailed Utility System Descriptions[47]

Both water and wastewater utility systems are directly operated by the Newark Department of Water and Sewer Utilities. Newark operates its own water supply sources, treatment plant and distribution system, but also has a contract for 49.4 MGD of additional supplies with North Jersey District Water Supply Commission (NJDWSC). Five reservoirs in the Pequannock River watershed provide over half of Newark's total supply, for total capacity from all sources of nearly 115 MGD.[48] However, Newark also is the contract provider of bulk water to a number of other municipalities in its area. As discussed in **Chapter 3**, net available capacity is currently over 28 MGD, based on NJDEP's Water Supply System Deficit/Surplus program, including the baseline contract between NJDWSC and Newark. This amount should be ample to address the additional demand of 6.8 to 8.8 MGD projected to 2040. No significant peak water demands are seen on a monthly basis, but there are daily peaks due to summer weather.

[47] Sources: Interview with Newark Water & Sewer Department 11 March 2014; Newark, 2007a; Newark, 2007b.
[48] NJDEP's Public Water System Deficit/Surplus system, accessed April 2014, lists Newark's Firm Capacity as 115 MGD: <www.nj.gov/cgi-bin/dep/watersupply/pwsdetail.pl?id=0714001>. However, based on water allocations and contracts on a monthly basis, the total would be approximately 123 MGD, or 3806 MGM.

Non-revenue water is approximately 20-25%, which includes both water that is delivered to customers but not billed and actual losses between the water treatment plants and the customers. All city facilities and some State facilities are not billed (though most are metered), and so the 20-25% partly represents non-revenue but legitimate uses. Newark has good data on monthly water demands per customer, having installed digital meters with readings picked up by mobile units in neighborhoods. They have considered fully digital systems, but centralized collection system would require complete replacement of meters at a high cost (perhaps $10-15 million), which may not be cost-effective given the current rate of non-revenue water. The Newark water treatment plant in West Milford is roughly 20 years old, but Newark anticipates no need for major work at this time given routine projects to maintain and improve the system (e.g., modifications to sludge management and disinfection processes). Newark reports no regulatory issues regarding its drinking water quality or system. However, NJDEP notes that the treatment plant has had issues with periods of high turbidity.

Newark engages in capital projects to maintain water system integrity, as needs are identified. Recent projects include routine hydrant replacement (often related to damage), replacing all pressure-reducing valves due to age, and four phases of cleaning/lining for the largest water lines in the City, with a new phase focused on the next largest size. Also, Newark had a lot of 4-inch water mains providing insufficient flow to support new development that required fire-suppression systems. Federal ARRA funds (roughly $7-8 million) were used to change the mains to 8-inch pipes, providing support for more dense development. There have been few main breaks over this winter despite the severe conditions.

Newark owns and operates its local sewer collection system, half of which is combined sewers and the other half separate sanitary sewers. Mapping of the CSO catchment areas was not available for this report. Much of the city's 300 miles of sewers were constructed over 100 years ago, indicating that they have extended well beyond their anticipated economic life (Newark, 2007a). The separate sewers are primarily in the industrial and airport area, the northeastern section of the city, and the Vailsburg area (which discharges to Joint Meeting of Essex & Union Counties). One complication is that a significant portion of the separate sewers flow into the combined sewers and so can contribute to CSO events. The sewers then discharge to a Newark interceptor (near the airport) and the main interceptor line (along the Passaic River) of the Passaic Valley Sewerage Commissioners (PVSC), both of which flow to the PVSC treatment plant in Newark. As discussing in the section on **Public Sewer Systems** in **Chapter 3** above, PVSC has a net available capacity for its entire service area of 30 MGD, less than 10% of its design capacity. While that would indicate an ability to provide additional capacity to Newark, which may require over 5 MGD to meet projected demands through 2040, Newark currently has 17 CSO discharges according to NJDEP,[49] indicating that it essentially has no capacity for additional sewerage during wet weather periods, as each gallon of additional sewage from development will result in a similar increase in CSO volumes. CSO volume reductions will significantly improve surface water pollution levels and neighborhood quality in developed areas. PVSC operates the regulator devises for 12 of the outfalls (Newark, 2007b) and restricts total peak flows to its plant from all customers at 480 MGD (Newark, 2007a), which is 150 MGD above its design capacity.

CSO control options include storage (with subsequent release to PVSC, using available dry weather capacity) and preventing stormwater from coming into the lines (e.g., through I&I reductions and stormwater management techniques that redirect the water). Tidal influx is being addressed through tidal gates on the CSO outfalls, and infiltration during dry weather periods is considered minor (Newark, 2007b). No recent I&I studies have been performed, but Newark will do so under the CSO permit. Inflow is a normal component of flow in combined sewers. Newark has begun lining brick combined sewers and making other improvements to the sewer system (Newark, 2007b). Of the 66 miles of brick sewers, 36 miles have now been lined with cured in place pipe (CIPP) to protect against collapse. Brick sewer projects have resulted in major reduction in collapses, and some (unmeasured) I&I reductions. Newark reports no sewer surcharges or backups into buildings, other than where caused by failure or blockage of the building service line. However, certain neighborhoods (e.g., West Ward)

[49] Newark's report states that there are 15 "active" CSO discharge points (see Section 2.1, page 2-1), but then lists 17 CSO outfalls in Table 2-1 (Newark, 2007b).

can experience flooding in major storms (e.g., Hurricane Irene) due high I&I rates. This area is not seen as an issue in smaller storms.

Planned Water Supply System Upgrades

Based on discussions with Newark personnel, the water supply distribution system will require continuing investment. Newark contracted for development of a 10-year strategic plan, which estimated $500 million in needs, about evenly split between water supply and sewer systems. The costs were a combination of specific projects (e.g., water treatment plant upgrades) and an extrapolation of recent capital project costs forward for ten years. The latter was not based on a detailed asset inventory and quality analysis. Newark's asset management approach has not evolved to the point of providing a complete picture of maintenance and capital replacement needs. Newark has applied for $21 million in Drinking Water SRF loans from the NJ Environmental Infrastructure Financing Program, for the purposes of water main and water treatment plant upgrades. Newark has received nearly $29 million in Drinking Water SRF loans under the Smart Growth Initiative, for a variety of water main and water treatment plant improvements.

Planned Sewer System Upgrades and CSO Controls

Based on discussions with Newark personnel, the sewer system collection system lining of the remaining combined sewers will be required to continue addressing the potential for street collapses. The 10-year Strategic Plan also addresses sewer needs. Controls for solids and floatable materials are still being constructed, with four more to complete (one is under construction now). Otherwise, the City has been waiting for more detailed guidance from NJDEP to ensure that money is focused on what is necessary to comply with permits. Newark has applied for $10.8 million in Clean Water SRF loans from the NJ Environmental Infrastructure Financing Program, for CSO Controls and sewer system rehabilitation, which rank high, and an additional $8 million for sewer system rehabilitation and nonpoint source pollution control, which ranked fairly high. It also has applied for additional stormwater and nonpoint source pollution control funds that rank relatively low.

The Newark Long Term Control Plan documents (Newark, 2007b) indicate that the 17 CSO outfalls that discharge vary from 31 to 78 discharges per year, with an average of 54, indicating that the CSOs have somewhat different responses to rainfall. Other CSO characteristics are highly diverse. Modeled discharge quality varies significantly from storm to storm and month to month. Annual average CSO volumes also range widely among the outfalls, from to 21 to 670 MG (with the Peddie CSO being the largest, at 33% of total volume) for a total of more than 2000 MG in the model year. All of these variations complicate the analysis. For instance, the storage volume (on-line or off-line) needed to achieve no more than three events per year range from a reduction of 72% to 84% of flow. **Table 4-10** presents aggregated costs for various control approaches:

Table 4-10: Newark CSO Cost Estimates	
Control Category **(**3 events/year for storage approaches)	**Costs (Total Present Worth in $ millions)**
Disinfection (separate outfall treatments)	165[50]
In-line Storage	Inadequate Storage[51]
Off-line Storage Tanks (separate outfall treatments)	1052[52]
Complete Sewer Separation	514

It is worth noting that the costs per million gallons treated for these activities vary considerably from one CSO outfall to another. The lowest disinfections costs range from $37,000 to $387,000 per MG, the off-line storage tanks (for zero discharges) range from $373,000 to $1,409,000 per MG, and average sewer separation costs were

[50] The largest single outfall, the Peddie, comprises $25 million of this cost (Newark, 2007b).
[51] This alternative was not capable of meeting any of the performance objectives but in certain outfalls could be combined with other alternatives for cost-effective results (Newark, 2007b).
[52] This value is for total cessation of CSO events. A value for reduction to 3 events, as used for the other cities, was not available from the report.

$254,000 per MG but with much lower costs in residential areas than in downtown areas. Therefore, the most appropriate action for each CSO area may differ. None of these costs should be taken as definitive, as a number of assumptions were used in the modeling process, definitions of CSO "events" may not fully match current guidance, the combined sewer systems may have had existing structural problems that would affect the monitoring and modeling results, no detailed designs were completed, and no bench or pilot project evaluations were used. As such, these values are representative of the general range of costs for implementation. As CSO controls are chosen, more rigorous analyses, designs and cost estimates will be required.

The Newark report (2007b) suggests that the PVSC interceptor line has hydraulic capacity that would allow for more flow from Newark, but that the PVSC treatment plant would have to be expanded so that flows beyond the current maximum rate of 480 MGD could be properly treated. As such, this option would require action beyond just Newark, but additional capacity at PVSC would directly reduce CSO outfall volumes. Newark notes that while the option of sending more flow to PVSC would be the least expensive and least complicated for Newark, it relies on PVSC agreement to and NJDEP permit for increases in PVSC treatment plant capacity. This option has been discussed among the agencies but no decisions have been made. By the nature of PVSC, this would be a complicated, multi-party negotiation with NJDEP as a major player; a regional agreement would be required among all PVSC customers.

The report also discusses the pollutant loading reductions from these alternatives. Disinfection requires pretreatment to reduce total suspended solids (TSS) levels so that the disinfection is effective. Depending on the method selected, reduction of non-pathogen pollutant loads could range from 45% to 85%. Storage options reduce total discharge volume and therefore total pollutant loads in an essentially linear manner.

Newark is beginning to explore the viability of green infrastructure, and has had meetings with Philadelphia personnel. Newark's Sustainability Officer is managing a contract to explore the potential for green infrastructure implementation. Pilot projects are in progress in cooperation with PVSC and Rutgers Cooperative Extension. There is potential to tie green infrastructure to streetscape projects. In short, Newark is interested, exploring the potential, but not yet committed to the green infrastructure approach pending further information.

Institutional Capacity for Utility Management

As noted, Newark contracted for development of a 10-year strategic plan for both systems, which estimated $500 million in needs, about evenly split between water supply and sewer systems. The costs were a combination of specific projects (e.g., water treatment plant upgrades) and an extrapolation of recent capital project costs forward for ten years. The latter was not based on a detailed asset inventory and quality analysis. To date the city government has not taken action on implementing rate changes to fund more aggressive maintenance efforts, but discussions are in progress.

Newark is building an in-house GIS-based system for asset inventory, quality evaluation, etc., using a combination of consultants and in-house staff. Newark has a sound inventory of asset locations and descriptions, except where they are adding in the most recent modifications to infrastructure due to development projects. Asset integrity is available for parts of the system, in part from prior CSO studies, as are a full evaluation of the brick sewers (66 miles) and an assessment of the largest water lines. The assessment of the brick sewers was to prevent street collapses, and of the largest water lines was to provide information needed for cleaning and lining projects. They are now moving to the next set of water lines in size. The current asset management system is not far enough along to provide the full extent of maintenance needs or cause-effect information.

Newark contracted for a rate study, resulting in a new rate system in 2005 that incorporated a 40% jump in sewer rates, inflation adjustments to rates in following years, and special rates for seniors/disabled (using eligibility for the NJ Tax Rebate program as the criterion). The bill format was also changed to provide more information for ratepayers, rather than a simple water/sewer breakdown. The 2005 rate increase was the most recent formal rate action, with no major political issues being raised. The Department is now working on a new rate ordinance for City Council consideration. The Council is aware of the importance of ongoing capital project needs. Such is not the case regarding more recent organizational proposals.

Newark's water and sewer system historically operated as a department of city government. In recent years, functions were increasingly outsourced through service contracts to the Newark Watershed Conservation and Development Corporation (NWCDC), a non-profit organization created by the city, originally to manage its watershed lands in the Pequannock River watershed. During some of the same period, the administration of Mayor Cory Booker promoted consideration of a municipal utilities authority to handle the functions, but this approach was not approved by City Council. In 2013, a decision was made to reabsorb all utility management functions into the city government and dissolve NWCDC, and the NJ State Comptroller (2014) released an investigation report that excoriated Newark for lack of control over the NWCDC and the non-profit for improper spending and poor internal controls. The repercussions of that report will play out over time. However, the net result is that Newark's water and sewer utilities have been the subject of administrative stresses that will affect its ability to operate until the situation settles. At this time, the Department of Water and Sewer Utilities is a single administrative unit that handles two independent self-supporting utilities. It has three divisions, each of which has people who are dedicated to either water or sewer. The Department Director reports to the Business Administrator, who reports to the Mayor. The city council approves rates, budgets and contracts but is not involved with administrative decisions or operations.

Newark has used grants where available (e.g., ARRA, early phases of the brick sewer project), and has used sewer bonds in the past. However, in recent years most capital project financing has been procured through the NJEIFP to take advantage of the 20% principal forgiveness provisions. Newark only charges the utility budgets for related direct and indirect costs, such as administrative and legal support, office space, utilities, etc. There are no exactions or contributions to the general budget that are not specific to utility operations in some way.

Newark contracts for some types of emergency repairs on a routine basis, with biennial contracts of $1.5 million for sewer and $3 million for water. Department staff handles other emergency repairs as well. Newark does track emergency repair trends over the years.

Many senior technicians and engineers in the Department are within 5 years of retirement; awareness of this has led to development and implementation of a succession plan to ensure that all programs transition over. Newark has not had difficulty hiring at the junior levels to date – public benefits seem to be a significant incentive to hiring. According to the Department, they had an influx of new engineers through the dissolution of the NWCDC, who are mostly performing tasks similar to their functions for the NWCDC. The salary range associated with the junior level engineers may be inadequate to attract and then maintain those employees.

Obstacles to Upgrading Water Infrastructure

1) **Municipal and utility fiscal stress**: In this case, the municipality owns the infrastructure. As such, any additional capital and operating costs for the utility functions will be reflected in the water and sewer rates and will affect the city's bonding capacity. Newark has a very high poverty rate (second highest among CSO municipalities after Camden) and a per capita tax base below the median for the state (41.4%), both of which indicate the level of fiscal stress involved. Newark's school system is controlled by the State, which provides most of the funding as well. However, projected population and employment growth may provide some protection against municipal fiscal stress if the projections are correct.

2) **Household financial stress**: USEPA affordability criteria indicate that sewer service costs should not exceed 1.75% of median household income, and if above 2% would be considered financially prohibitive. Newark's median household income is $35,659, and its sewer rates for a nominal household (based on 60,000 gallons per year of water demand) are $385 in 2014, or 1.08% of median household income. The Cost & Performance Analysis Report (Newark 2007b) did not estimate total annual costs per household for the various CSO control projects. However, based on the 1.75% threshold, the total available increase in sewer rates would be 0.67% of household median income, or $238 per year. However, this value would need to address also the potential rate increases necessary to address deferred maintenance of the existing system.

Newark is concerned that the anticipated CSO control costs are very high and affordability for ratepayers is a major issue.

3) **Availability of space for CSO controls**: The CSO report (Newark, 2007b) notes that Newark is fully developed with no available open space near the CSO outfalls. However, parking lots and abandoned or underutilized industrial space could be used for treatment facilities and off-line storage tanks.

4) **Development and redevelopment market limitations**: Newark is experiencing significant redevelopment, associated in some cases with public/private partnerships (e.g., Teachers Village in the University Heights area; Rutgers student housing in modified existing building) or State financial incentives (e.g., Panasonic headquarters building). While taxpayer-assisted projects are likely to continue, including the use of Payment in Lieu of Taxes (PILOT) programs, private-sector financing seems to be increasing.

Paterson

Paterson is a highly developed urban community, originally organized around an industrial development program undertaken by the Society of Useful Manufactures (SUM) founded by Alexander Hamilton, among others, to make use of hydropower provided by the Passaic River at the Great Falls.

Population and Employment Projections

The population of Paterson has remained stable over the four decades of 1970 through 2010, and is little changed from 1950. A shift in trends is anticipated, with projected population for 2040 representing an increase of greater than 22%, as discussed in **Chapter 2**. Employment is projected to grow even faster, more than 40%. The ratio of population to jobs was relatively high in 2010, at over 3.5, indicating that Paterson does not have a very strong employment base relative to its population, though it is not a bedroom community. Even with a considerable increase in employment, its ratio would remain higher than any municipality highlighted in this chapter except Bayonne. As discussed in **Chapter 2**, Paterson has a very high poverty rate (27.6% below the poverty line, the third highest among CSO municipalities), a median household income less than half of the statewide median, a per capita tax base in the bottom 30 of all New Jersey municipalities, and average housing values lower than the state median. It is considered a most distressed urban municipality by New Jersey Future (Rank 5 of 5). The city school district is under State control and receives much of its funding from the State. The overall picture is one of a city that has experienced stable population but extensive fiscal stress, though with significant projected improvement.

Table 4-11: Paterson Population Status and Trends

	1970	1980	1990	2000	2010 (MPO)	Projected 2040	Projected Growth 2010-2040	Projected Growth 2010-2040
Population	144,824	137,970	158,019	149,222	146,200	179,020	32,820	22.4%
Employment					41,570	59,470	17,900	43.1%
Ratio Pop:Jobs					3.52	3.01		

Detailed Utility System Descriptions[53]

Paterson receives its water supply from the Passaic Valley Water Commission (PVWC), which owns and operates the Water Treatment Plant (WTP) at Little Falls and the water distribution system for its member municipalities: Paterson, Passaic and Clifton. It also supplies a number of communities with wholesale treated water. PVWC uses Passaic River intakes as direct water supply sources; PVWC also receives water from the North Jersey District Water Supply Commission (NJDWSC). Annual average daily distribution is roughly 82 MGD, with demands of roughly 73 MGD in winter and 93 MGD in summer. The member municipalities are highly urbanized, with very limited outdoor use in the summer. The wholesale customers are more suburban and have different peaks. As discussed in the section on **Public Community Water Supply Systems** in **Chapter 3**, PVWC shows a negative available capacity based on NJDEP's Water Supply System Deficit/Surplus program, using the baseline contract between NJDWSC and PVWC, in annual average daily demand. However, PVWC is engaged in discussions with NJDEP to address these issues. PVWC estimates that the correct current available supplies are roughly 5 MGD. No conclusions are available at this time.

PVWC's service area has been experiencing a loss in major industrial customers for years, especially in Paterson but also in Passaic. In addition, residential demands have declined from roughly 100 gpcd to approximately 75-80 gpcd as water conservation fixtures and appliances have been adopted by customers. Non-revenue water is estimated at 10-11%, indicative of a fairly tight system; only part of this fraction can be considered "lost" water, as some reflects legitimate uses that are not billable. Anticipated Paterson additional water demands due to the

[53] Sources: Interview with Paterson 11 March 2014; Paterson (2007); Interview with PVWC 21 March 2014; www.pvwc.com/water%20quality/PVWC_1605002_2013CCR_2012WQReport.pdf

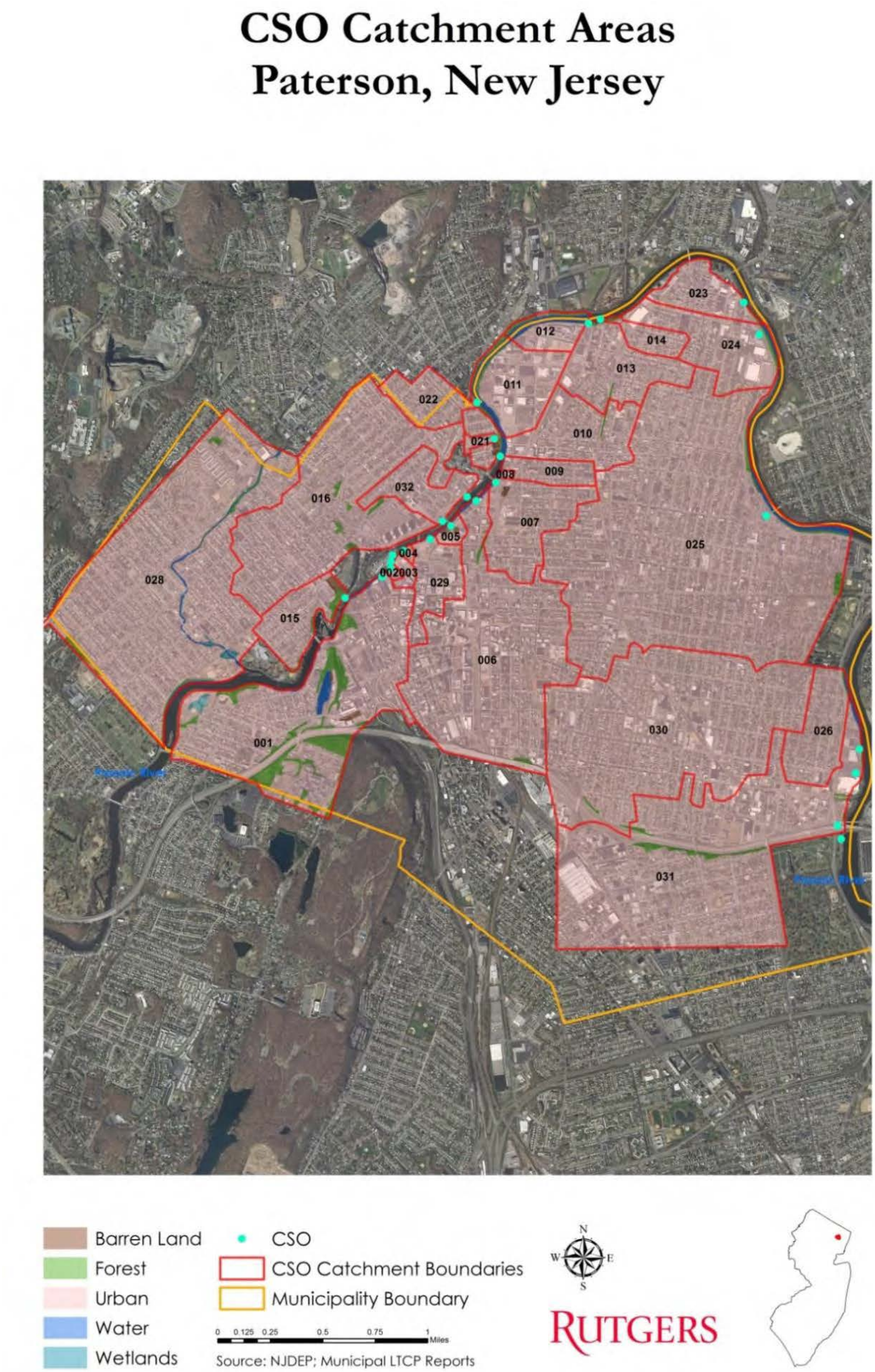


Figure 4-6: Paterson CSOs and Drainage Areas

2040 projections are roughly 3 to 4 MGD. However, PVWC expects that overall system demands will continue to decline, offsetting some of these increased demands should Paterson develop in line with projections.

The PVWC water treatment plant was upgraded in 2004 to "state of the art" and receives investment as needed. The distribution system, however, is for the most part a century or more in age and is considered in serious need of rehabilitation or replacement. Most of the mains were put in approximately the same time. Main breaks are starting to accelerate in number and severity, and are expected to increase further. When an area experiences multiple breaks, PVWC targets the line for major repair or replacement. PVWC experienced an all-time record of over 120 breaks in January and February 2014 alone, in its member municipalities plus North Arlington and Prospect Park, of which perhaps two-thirds were in PVWC mains and the remainder in service connections.

Paterson owns and operates its local sewer collection system, which then discharges to the main interceptor line of the Passaic Valley Sewerage Commissioners (PVSC). Almost 90% of the municipality is served by combined sewers (Paterson, 2007). Paterson has some areas where the original combined sewers have been separated (including some in the northwest and southwest areas). Some separate storm sewers in the southwest discharge directly to the Passaic River, but many others (including in the northwest) still flow back into existing combined sewers. The intent is to continue sewer separations where appropriate so that in the future separate stormwater discharges can be created where feasible by linking the segments.

The Paterson combined sewer system (CSS) was constructed from 1860's to the 1920's. The older sections are brick and the last sections are mostly VCP (vitrified clay pipe, in 4-foot sections). Infiltration is significant but not specifically measured. However, inflow of stormwater dwarfs infiltration during wet weather events. As rehabilitation is needed, the City does more than spot repair; instead, it replaces the pipes for a complete city block to minimize the need for future repairs in the same area. Sewer surcharges and backups occur very rarely, primarily near the river and associated with intense storms that occur when the river is high. Parts of the Paterson CSS also carry separate sewer flows from Haledon (on Paterson's northwest border), which has very high I&I flows and therefore in many ways acts like a CSS, reportedly exacerbating CSO events within Paterson. The Paterson system is highly dynamic and has areas of high slopes, making surcharges very hard to predict. Other surcharges or backups are related to system clogs, which are then repaired.

Paterson will have 24 CSOs when the required controls on solids and floatable materials are completed. PVSC owns all of the CSO regulators, which are weir-type controls, and so controls the accepted level of flows to its interceptor. Paterson has a maximum monthly flow contract with PVSC, but is well below that threshold due to a major loss of industry flows over the years. Current PVSC charges to Paterson are approximately $10 million per year.

PVSC has a net available capacity (see the section **Public Sewer Systems** in Chapter 3 above) for its entire service area of 30 MGD, less than 10% of its design capacity. While that would indicate an ability to provide additional capacity to Paterson, which may require nearly 2.5 MGD to meet projected demands through 2040, Paterson's 24 CSO outfalls indicate that it essentially has no capacity for additional sewerage during wet weather periods, as each gallon of additional sewage from development will result in a similar increase in CSO volumes. CSO volume reductions will significantly improve surface water pollution levels and neighborhood quality related to sewer backups and street flooding in developed areas. These CSO points are of special concern because they discharge to the non-tidal Passaic River, which flows to Dundee Lake. As such, Paterson's combined sewer system could constrain growth in the municipality if not addressed. Options include storage (with subsequent release to PVSC, using available dry weather capacity) and preventing stormwater from coming into the lines (e.g., through I&I reductions and stormwater management techniques that redirect the water).

Planned Water Supply System Upgrades

PVWC indicates that the water supply distribution system requires major improvements. A major project required under both federal and State regulations is the closure of its open-air distribution system (finished drinking water) reservoirs, under the Long-Term Phase 2 Disinfection Rule. PVWC owns three of only five such reservoirs in New Jersey; these reservoirs contain finished drinking water that then flows directly into the distribution system. As uncovered facilities, they are subject to recontamination from a variety of sources including wildlife. PVWC is under enforcement order to close or replace these reservoirs with closed systems to protect public health, an anticipated $135 million project to be completed over a ten-year period. However, these reservoirs are also considered public amenities, leading to recent opposition to the closure (Cowen, 2014).

PVWC also experiences lead (Pb) levels at the tap that routinely approach or (in 2012, but not 2013) exceed regulatory action levels. Lead enters the drinking water in the last few feet of the delivery system – the lines from the street into the house and the lead solder used in pipes within the buildings. Modern buildings do not have this problem, as recent standards control the use of lead fixtures, pipes and solder. Standard practice for water supplies is to adjust pH and add orthophosphate to the drinking water at the treatment plant so that the lead in service and internal lines and in solder joints is coated to reduce leaching into the water within buildings. However, PVWC cannot commence this treatment for all parts of its system while the open air reservoirs are in use, as the added orthophosphate would trigger eutrophication (primarily algae blooms) of the reservoirs, which in turn would contaminate the drinking water delivered to customers. At this time, PVWC routinely engages in customer education regarding the need to run water prior to use, until such time as a more permanent corrosion control can be implemented.

PVWC also recognizes that the pipelines are in major need of rehabilitation and repair after a century of use. The pipelines are of nearly equal age, and so PVWC focuses a combination of cleaning/lining and pipe replacement on lines with the most main breaks.

Planned Sewer System Upgrades and CSO Controls

Based on discussions with Paterson personnel, the city has no expected need for capacity increases, given that dry weather flows have declined over time. The major anticipated expenditures involve CSO controls and system rehabilitation. Sewer rehabilitation projects are considered maintenance, rather than major capital projects. The only major capital projects recently have been controls of solids and floatable materials under the CSO general permit. Of the control systems, all are constructed except for three, one of which is going through local construction permit review and the other two have reportedly encountered permit approval issues with NJDEP. The city staff changes the nets, while the contractors handle any maintenance and repairs. Total capital costs for those controls are roughly $40 million, an amount equivalent to approximately ten years of sewer rehabilitation under current budget trends. There was considerable municipal opposition to these costs; though the City Council approved the project, continuing questions about its benefits to Paterson are raised. Paterson has applied for $22.1 million in Clean Water SRF loans from the NJ Environmental Infrastructure Financing Program, for sewer system rehabilitation, which rank relatively high.

The Paterson Long Term Control Plan documents (Paterson, 2007) indicate that Paterson originally had 28 CSOs, but five were closed (CSO points 012, 017, 018, 019 and 020), and that an additional five (CSO points 002, 004, 008, 009, 011) are scheduled for closure as part of the project to control the discharge of solids and floatable materials, leaving 18 CSO discharge points to be addressed by the CSO Long Term Control Plan. The consolidation of CSOs does not necessarily result in a reduction in total discharge volumes, though it is possible depending on in-line storage capacity. However, NJDEP records show 24 CSO outfalls as of late 2013. The report finds that 22 CSOs actively discharge, with 1 to 58 discharges per year and an average of 27, indicating that the CSOs have <u>highly</u> diverse responses to rainfall. Other CSO characteristics are also highly diverse. Modeled discharge quality varies significantly from storm to storm and month to month. CSO volumes also range widely, from 0.1 to 341 MG, with a total of 702 MG during the model year; one CSO (027, at the far downstream end of Paterson) is responsible for almost half of total flows and the top three comprise 69% of total flows. All of these variations plus the flow of Haledon and separate storm and sanitary sewers into the combined sewer system complicate the analysis. For instance, the storage volume (on-line or off-line) needed to achieve no more than three events per year range from a low of 0.01 million gallons (MG) to a high of 15.67 MG (with the top three representing almost 60% of total storage), with a total storage of 44 MG needed for all CSO outfalls and an average 6.16 MG storage per square mile of CSO drainage area. **Table 4-12** presents aggregated costs for various control approaches:

Table 4-12: Paterson CSO Cost Estimates	
Control Category (3 events/year for storage approaches)	**Costs ($ millions)***
Disinfection (separate outfall treatments, best option)	170 (TPW)
In-line Storage	302 (CC)
Off-line Storage Tanks (separate outfall treatments)	196 (CC)
Deep Storage Tunnels	203 (CC)
Most Cost Effective Storage (separate outfalls)	161 (CC)
Most Cost Effective Storage (with consolidation)	134 (CC); 159 (TPW)
Complete Sewer Separation	173 (CC)[54]

* TPW = Total Present Worth; CC = Capital Costs. Not all costs include land acquisition

None of these costs should be taken as definitive, as a number of assumptions were used in the modeling process, definitions of CSO "events" may not fully match current guidance, the combined sewer systems may have had existing structural problems that would affect the monitoring and modeling results, no detailed designs were completed, and no bench or pilot project evaluations were used. As such, these values are representative of the general range of costs for implementation. As CSO controls are chosen, more rigorous analyses, designs and cost estimates will be required.

The report also discusses the pollutant loading reductions from these alternatives. Disinfection requires pretreatment to reduce total suspended solids (TSS) levels so that the disinfection is effective. Depending on the method selected, reduction of non-pathogen pollutant loads could range from 45% to 85%. Storage options reduce total discharge volume and therefore total pollutant loads in an essentially linear manner.

From Paterson's perspective, NJDEP was focused on disinfection and the Harbor Pathogen TMDL as the major approach under the general permits, but now has shifted to controlling the number of events per year from each outfall. None of the approaches in the 2007 report look financially feasible to Paterson. Paterson supported the TMDL approach but that has now been discontinued.[55] They aren't sure that the CSO controls will make a sufficient difference in river water quality for the costs. However, Paterson does see a potential for improved stormwater management approaches. For over ten years, Paterson has required that redevelopment ensure that stormwater runoff not be increased. Infiltration to ground water is used most often. They are working with Rutgers Cooperative Extension and PVSC on other opportunities, and are discussing further ordinance changes. They are favorable to the concept of green infrastructure approaches and recognize the potential for neighborhood improvements, so that Paterson residents directly benefit from the CSO controls beyond the benefits to the Passaic River.

Institutional Capacity for Utility Management

PVWC is operated by a professional staff under the direction of commissioners from the three owner cities (Clifton, Paterson and Passaic). It owns and operates additional municipal systems and provides bulk treated water to many communities (see **Chapter 3**). As such, PVWC has considerable in-house expertise. PVWC is developing a GIS-linked formal asset management system for the distribution assets, with locations and construction materials well documented and asset integrity assumed to be low except where improvements have already been completed. PVWC has a competitive bidding contract process for specific types of emergency work needs, with unit bid and total bid pricing, as part of its effort to reduce costs. They use in-house staff to the maximum extent possible, and then use contractors and consultants to assist as needed. Depending on the emergency situation, they may do additional work (e.g., replacing nearby valves) along with the specific emergency work.

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[54] However, Paterson (2007) also notes that additional issues such as flooding could cause total sewer separation costs to range from $400 to $500 million. The value noted here is from Table 33.

[55] Paterson CSOs are well upstream of the tidal area, raising the question of whether the Harbor Estuary pathogen study would have been applicable to Paterson even if completed.

PVWC has been expending $2 million per year for cleaning/lining and $2 million per year for pipe replacement, but expects to fund pipe replacement at a higher rate than cleaning/lining because with increasing frequency the latter is not viable – the pipes are too damaged for repair to be cost-effective. A major issue facing PVWC is how to finance both the replacement of its finished water reservoirs, as required by law, and continued replacement and rehabilitation of its distribution lines, as necessary due to their deteriorating conditions. During years with high water sales, PVWC directs "excess" revenues toward planned capital projects as a way of reducing impacts on rates. Rates are currently competitive within the state, but could be significantly affected by the upcoming capital costs. PVWC has received $2.1 million in Drinking Water SRF loans under the Smart Growth Initiative, for previous cleaning and lining projects for water mains in Paterson.

PVWC has an aging work force in the distribution system; many people have 25-30 years of service. They are bringing in a younger cohort of replacement staff as people retire, but also are using alternative equipment that reduces staffing needs and health impacts (e.g., moving from jackhammers to machines that do the same work) and are addressing personnel needs such as an evolution of job titles to reflect current functions, increased use of digital records, training needs, etc.

The Paterson sewer division is within the Department of Public Works. The City Council approves rates, contracts and the budget, and the division operates and oversees all work on the system. The general policy is to avoid rate increases and minimize costs. In 2012, the City Council approved a phased increase from $140 to $225 per equivalent dwelling unit (EDU) in 2015.[56] There was very strong opposition to the increase, but it was mandated by the NJDCA-Division of Local Government Services as a condition of State financial aid, to make the utility more self-financing; previously a significant portion of utility costs was supported by the municipal general budget. Utility funding by the City was standard practice, changing only as circumstances forced it despite large areas of tax-exempt lands (e.g., city, county and educational institutions). The sewer utility is not charged for city costs outside of the sewer division. However, the utility is not yet self-sustaining. The Paterson general budget contributes to the utility, not the other way around. Some utility debt service is through the general budget and the rest is through the utility budget.

Over the last two years, Paterson has been moving to a computerized system of asset inventory, integrity logging and project tracking, with record-keeping much improved. The city contracts for video evaluations of the sewers in trouble spots that are known to staff or identified through customer complaints, and is looking to increase this effort so that asset integrity can be evaluated in advance of problems and to comply with the new CSO permit. As issues are identified, projects are assigned priorities and completed as funding is available. The full sewer system is mapped on paper and will be moved to GIS as part of the CSO permit process. Asset age is known through the system, but asset material is only partially known. Asset integrity is also partially documented, and again will be completed through the CSO permit. Major lines and line condition are priorities for assessment. The asset inventory and assessment work is mostly done by contractors.

Paterson has two contracts for repairs, one for emergency repairs (roughly two-thirds) and the other for non-emergency work (roughly one-third). Total costs for the two contracts have been $2.5 to $4.5 million per year over the last several years. All sewer rehabilitation work is conducted through the contracts. Because replacement is generally in-situ and in-kind, engineering design issues are minimal. Increasing the contracts is desired to reduce the existing backlog and respond to new issues identified through the assessment process. In some cases, sewer separation has been possible, but Paterson is rarely able to create separate storm sewer outfalls. Roughly $30 million in projects have been identified but not constructed. The current rehabilitation level of effort is keeping pace with the identification of new issues, but not reducing the backlog. The repair contracts are part of the cash flow budgets rather than NJEIFP loans; financing through the NJEIFP would require additional design and other costs and also adherence to the NJEIFP approval schedule. Emergency repairs (constituting most of the work) are especially difficult to program through NJEIFP, as designs are not feasible ahead of time. However, the CSO control projects for solids and floatable materials were financed through

[56] The rate is not tied to water demand because the City does not have water demand information. PVWC owns and operates the water supply system, with a separate billing process.

NJEIFP, and consideration could be given to NJEIFP financing once a complete asset evaluation is completed and a schedule of programmed capital projects is planned.

The city has five sewer operators and also a contracted licensed operator with three or four staff, plus the repair contractors. One key staff person is nearing retirement, which raises an issue because the city cannot afford to hire a new replacement and have that person overlap with the current supervisor to learn the system. Other city staff members represent a good range of ages allowing for transition over time.

Obstacles to Upgrading Water Infrastructure

1) **Municipal and utility fiscal stress**: In this case, PVWC owns the water supply infrastructure while Paterson owns the sewer infrastructure. As such, any additional capital and operating costs for the water supply system will be reflected in the PVWC rates. PVWC is sufficiently large to have no particular constraints on fiscal capacity as long as rates are adjusted appropriately. However, any additional capital and operating costs for the sewer utility functions will be reflected in the sewer rates and will affect the city's bonding capacity. Paterson has a very high poverty rate (third highest among CSO municipalities) and a per capita tax base below the median for the state (41.6%), both of which indicate the level of fiscal stress involved. Paterson has also received State fiscal aid to the municipal government (which triggered the sewer rate increase), and its school system is heavily dependent on State funding. Projected population and employment growth may provide some protection against municipal fiscal stress if the projections are correct, but recent development activity is not promising regarding these trends (see below).

2) **Household financial stress**: Based on USEPA criteria that sewer service costs should not exceed 1.75% of median household income, and if above 2% would be considered financially prohibitive, Paterson (2007) compared estimated 2006 sewer rates of $250 per household to an estimated median income of $46,121 to achieve a 0.54% level.[57] Total sewer separation costs ($173 million) would add $780 per year to the household rate on the same assumptions, resulting in an index value of **2.23%** (Paterson, 2007), which would be considered an excessive household financial burden. No other cost comparisons were provided in the report, but using the "best scenario" costs of $159.2 million and the same assumptions, the increased rate would be roughly $720 per year. This analysis does not incorporate potential rate increases necessary to address deferred maintenance of the existing system, and additional CSO control costs for land acquisition will need to be determined. Also, an actual household sewer rate was not calculated and a median household income of **$34,086** is reported by the American Community Survey (2006-2010) of the Bureau of the Census, much lower than the level used in the CSO report, both of which would modify the existing cost index.

   Using the actual $225 per year household sewer rate for 2015, the current index would be 0.66%, significantly higher than the 0.54% index used in Paterson (2007), and the anticipated rate using the "best case" scenario would be $945 with an index of **2.77%**, far above the USEPA thresholds. Further analysis could result in either greater or lower CSO control costs, and it is apparent that the current sewer rate does not include all debt service costs, some of which are financed through the municipal general budget. Put another way, at an index of 1.75% and a household income of $34,086, the highest acceptable sewer rate per household is $597 per year (265% of current rates), which is less than just the additional "best case" costs of CSO control of $720, not including existing rates.[58] Translated backwards to project costs, a sewer rate increase of $372 (from $225 to $597) is 52% of the roughly $720 increase needed for the "best case" scenario, representing roughly $82.25 million of the $159.2 million estimated need. Therefore, unless

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[57] The $250 per household sewer rate was estimated by assuming that all sewer costs for the municipality were paid by households, with no contribution from the commercial and industrial land uses that comprise over 30% of the municipal land area, as what they considered a "conservative approach." The median income was estimated by multiplying the 2000 level of $32,778 by the Consumer Price Index. While the report states a calculated index of 0.005%, the actual value using these figures would be 0.54%, indicating a typographic error.

[58] At the 2% threshold, the maximum acceptable household rate would be $682 per year.

Paterson can create CSO control alternatives at a greatly reduced cost than those posited by the 2007 report, the costs of CSO control will not be affordable based on USEPA guidance, even at the 2% threshold.

3) **Availability of space for CSO controls**: Paterson is fully developed with no available open space near the CSO outfalls. However, parking lots could be used for treatment facilities and off-line storage tanks. On-line storage and deep tunnels would require minimal surface land after construction. Such space will incur land acquisition costs.

4) **Development and redevelopment market limitations**: Paterson is completely developed, and so the municipal focus is on redevelopment and specifically on commercial and office redevelopment to increase the number of jobs available within the municipality. According to Paterson, new development prior to the recession was fairly balanced among commercial (especially along the Route 20 corridor with big box stores) and residential, but with no industrial development. Since the recession, very little redevelopment has been occurring. In the past, the public housing high-rise projects were replaced by townhouses, which reduced housing density. Given the developed nature of the city and recent trends, the significant growth in population and employment noted above may not be realistic. However, Paterson has been attempting to improve employment through redevelopment through repurposing of the historic Paterson mills. There are few projects within Paterson that have committed but unrealized flows; the one major project is an expansion of St. Joseph Hospital and an associated mixed-use redevelopment project adjacent to the hospital.

Summary from the Case Study Municipalities

These six case studies are based on interviews, on-line information, prior reports, and the reports submitted in compliance with the NJPDES CSO General Permits, in support of Long Term Control Plan development. As such, they provide a good snapshot of existing conditions, concerns, expectations and challenges facing the water supply and sewer systems of these municipalities. Several themes come through the discussions.

1. None of the systems consider their pipeline infrastructure to be of sufficiently sound condition; all related concerns regarding aging infrastructure that has a significant potential for failure.
2. All systems are constrained or highly constrained in their ability to finance upgrades that will occur fast enough to substantially reduce the total level of deferred infrastructure maintenance in the near future (say, 10 years).
3. Most do not expect finances to significantly improve in the near future.
4. The sewer systems anticipate a significant conflict between management of the existing systems and implementation of CSO controls.
5. While redevelopment is anticipated to help in some municipalities, there are few expectations that the redevelopment will drastically change their fiscal situation, and in some cases may actually exacerbate line breaks as construction disturbs fragile lines.

However, incremental progress is expected and occurring in all the systems. It is worth noting that every system manager interviewed through this process is well aware of the technical needs and appropriate responses. The constraints are twofold – the sheer volume of work needed to bring the aging systems up to appropriate standards, and the fiscal impacts on the utilities and their customers. In addition, while the organizational structure of the systems differed considerably (municipally operated, contracted services, regional utility operated, and investor-owned systems), all are subject to the same requirements regarding the end results for the quality of drinking water and treated wastewater, and all must address the CSO requirements in a manner that meets regulatory requirements.

Chapter 5: Findings and Considerations

This report was developed to provide a broad foundation for discussion about the water infrastructure systems in New Jersey's CSO municipalities. It draws from a wide range of available information, supplemented by detailed interviews with system managers. A number of critical points can be drawn from the chapters.

1. **Starting from behind**. CSO municipalities have old (and mostly, quite old) and aging water supply and sewer systems that will require extensive work and major expenditures if they are to remain viable. These issues are current and costly. Even if no other regulatory requirements were to be imposed, it is clear that the total costs of upgrading the existing infrastructure will be very high, probably in the billions of dollars across the 21 municipalities and requiring decades to complete. Further, these issues are present not just in CSO municipalities, but in all municipalities that have older infrastructure. Even what could be regarded as fairly "new" suburbs are now starting to face these issues as their pipe systems reach 50-60 years of age.

2. **Diversity with common attributes**. It is important to recognize that CSO municipalities are not uniform, but rather are characterized by different community types, population densities, economic bases and development trends. This report has frequently noted where the use of averages for a particular metric or characterization can mask significant diversity. Some CSO municipalities face far more challenging circumstances than averages indicate, and their specific issues should be recognized and addressed.

3. **Fiscally constrained**. CSO municipalities as a group are fiscally constrained and have a history of population and job losses. The few with more robust finances are still not wealthy. One reason for deferred infrastructure investments is that property tax ratables in many of the municipalities have declined due to loss of both industries and higher-income populations. Even with a reversal of decline, many of these municipalities must address deferred capital expenditures for many public services, not just water. Even if more development comes into these municipalities, they will still have significant low-income populations who will struggle with utility bills.

4. **Improving economic trends**. Some CSO municipalities are experiencing and expect to continue positive economic trends that could play a major role in funding infrastructure improvements, but also in exacerbating the deterioration of those same infrastructure systems. One of the more interesting issues from the interviews is that development results in both benefits and costs. The aging water infrastructure is often described as being "fragile" or "frail." The very process of development can upset a very brittle equilibrium, causing water or sewer lines to collapse that might have otherwise been able to remain viable for a few more years. However, it is recognized that these lines were on their way to eventual collapse – the development activities merely hastened that moment.

5. **The CSO issue is now**. The control of CSO discharges is the law of the land, and given the track record nationally, it is clear that New Jersey **municipalities should have no expectation of avoiding this issue**. While notable progress has been made on control of solids and floatable materials, New Jersey is lagging many other parts of the country in addressing this issue for a variety of reasons that really are no longer relevant. However, there is a counterpoint, in that the delays have also provided important opportunities for innovation in CSO control. The nation is far advanced from where it was in 1994 when the USEPA released its policy guidance on CSO controls. New Jersey can take full advantage of the advances in technology and programmatic approaches.

6. **A turning point in action?** The new NJPDES CSO Individual Permits can legitimately be seen as a regulatory turning point, providing much more detailed direction and clear consequences for CSO municipalities. We must recognize that these permits will lead to action only if both NJDEP and the regulated entities take the process seriously over many years of time. There is no way to predict the sustainability of any regulatory program through multiple State and municipal administrations, but the permits at least provide a sound framework for action. Ultimately, the feasibility of successful CSO control will depend heavily on the

selected techniques and programs, the fiscal capacity of the CSO municipalities and relevant funding sources, and political will. It would be trite to suggest that it all rests on political will, because political will is linked at least in part to feasibility and fiscal capacity. All three legs of the stool must be present for a properly seated program.

7. **Gray and Green**. Innovations in CSO controls, such as green infrastructure, provide more opportunities to New Jersey CSO municipalities than existed just ten years ago. Every city in the U.S. that is pursuing green infrastructure is complementing those approaches with appropriate gray infrastructure. New Jersey should and will do likewise. It is even possible to use gray infrastructure as a temporary (albeit long-lived) solution, while green infrastructure projects are implemented over time as a replacement (e.g., a storage tank that could later be removed to make room for redevelopment). It will also be necessary to consider how the CSO program and these methods should apply to areas of separate storm sewers and sanitary sewers in a non-CSO municipality that contributes flows to downstream combined sewers in a CSO municipality, an issue that is apparently not addressed by the new CSO permits.

   Successful use of green infrastructure will require that each municipality becomes familiar with the opportunities and limitations of the approach. Doing so will be daunting for small municipalities and those with very limited resources. Cooperative and collaborative approaches (such as through regional entities) could reduce the number of people who need to develop expertise, broaden the capabilities for action, and convince those who are skeptical of green infrastructure that capable people are in charge and truly do know how to make it work. Even with such regional cooperation, a great deal of innovation will be needed within each municipality to ensure the involvement of all relevant local offices and agencies, as well as other agencies such as NJ Department of Transportation, as state highways serve as important infrastructure in CSO municipalities.

8. **Competition for resources**. CSO municipalities will face major costs for the control of CSO discharges at the same time they must improve their existing infrastructure – water, roads, municipal buildings, schools, and more. While there may be many opportunities for addressing these priorities together, to increase the cost-effectiveness of projects, there also will be competition for resources. No regulation exists in isolation – all requirements exist in context with many other societal issues and priorities.

9. **Clear identification of benefits**. Given that New Jersey CSO control costs will likely be in the low billions of dollars, it will be critical that decision makers and ratepayers have a clear sense that the results will be worth the costs. The benefits can be in cleaner water resources, improved conditions for redevelopment and for maintaining existing property values (e.g., fewer street collapses and service disruptions), and improved neighborhoods (e.g., reduced street flooding, more green spaces). Of these, the link between CSO controls and water quality will require routine monitoring and better models at a time when federal and state agencies have been reducing such expenditures due to funding constraints. Water utility managers will have an easier time overcoming local resistance to costs if they can point to clear local benefits, and not just to the potential costs of enforcement action. State and federal agencies will need to be partners in proving these benefits.

The most successful CSO programs in the nation occur where cities accept CSO controls as a challenge to be met in the broader context of urban revitalization, rather than as just another regulatory burden. Political leadership is critical to success. Addressing CSOs as an issue solely of engineering and utility management will not be sufficient to achieve the cost-effective, multi-faceted, multi-benefit successes being seen in other cities. The same is true of water supply systems. The various sewer and water supply utilities cannot individually achieve the necessary level of coordination and cross-fertilization among city departments, regional and state agencies, and the private sector that high-level leadership can achieve. Considerable innovation will be required in development practices, utility management, and State regulatory approaches to achieve the most cost-effective approach to the sustainability of water utility services and to improving our waters so that they can become a point of pride for New Jersey, and not just the recipients of our wastes.

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Appendix A: CSO Drainage Area Characterization

Size and Land Use Characteristics of CSO Drainage Areas															
CSO Identifier	Drainage Area (Acres)	Events /Year	Vol/Area (MGY/Mi2)	Impervious Surface		Urban		Barren Land		Forest		Water		Wetlands	
				Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
B_001&005	323.28	57	1062.97	202.43	62.62%	321.68	99.50%	0.00	0.00%	1.60	0.50%	0.00	0.00%	0.00	0.00%
B_002	269.76	23	63.58	188.23	69.78%	268.78	99.64%	0.00	0.00%	0.57	0.21%	0.41	0.15%	0.00	0.00%
B_006	202.42	78	76.51	114.85	56.74%	198.62	98.12%	0.00	0.00%	3.69	1.82%	0.11	0.05%	0.00	0.00%
B_007	230.37	36	42.37	169.83	73.72%	227.23	98.64%	0.00	0.00%	3.13	1.36%	0.00	0.00%	0.00	0.00%
B_009	31.79	18	170.30	15.24	47.93%	30.27	95.22%	0.00	0.00%	0.00	0.00%	1.52	4.78%	0.00	0.00%
B_010	121.38	54	190.34	73.72	60.73%	120.84	99.55%	0.00	0.00%	0.00	0.00%	0.55	0.45%	0.00	0.00%
B_011	36.42	24	87.86	22.07	60.60%	36.42	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
B_012/025	41.21	38	135.12	25.54	61.97%	41.21	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
B_013/014	70.62	35	87.00	29.54	41.83%	59.69	84.53%	0.00	0.00%	1.75	2.48%	9.17	12.99%	0.00	0.00%
B_015	87.16	43	273.16	61.51	70.57%	83.47	95.77%	0.00	0.00%	1.20	1.38%	2.49	2.85%	0.00	0.00%
B_016	17.83	46	204.62	13.72	76.95%	17.78	99.74%	0.00	0.00%	0.00	0.00%	0.05	0.26%	0.00	0.00%
B_017	91.27	44	297.31	65.57	71.84%	90.40	99.04%	0.00	0.00%	0.00	0.00%	0.87	0.96%	0.00	0.00%
B_018/027	24.29	34	266.11	17.33	71.34%	22.55	92.83%	0.00	0.00%	0.00	0.00%	1.74	7.17%	0.00	0.00%
B_019/028 &029	233.97	16	78.78	131.63	56.26%	187.68	80.22%	1.42	0.61%	40.27	17.21%	1.52	0.65%	3.08	1.32%
B_021/033	146.33	48	213.00	113.47	77.55%	145.49	99.43%	0.00	0.00%	0.84	0.57%	0.00	0.00%	0.00	0.00%
B_030	73.57	4	0.87	47.05	63.96%	64.74	87.99%	2.15	2.92%	6.49	8.82%	0.00	0.00%	0.20	0.27%
C_01	219.73	16	31.46	100.07	45.54%	195.33	88.90%	0.00	0.00%	2.78	1.27%	2.58	1.17%	16.71	7.60%
C_02	188.15	30	11.91	96.57	51.33%	176.37	93.74%	0.00	0.00%	11.64	6.19%	0.00	0.00%	0.14	0.07%
C_03	688.42	48	122.72	366.43	53.23%	667.52	96.96%	6.79	0.99%	14.10	2.05%	0.00	0.00%	0.00	0.00%
C_05	101.37	19	13.89	51.95	51.25%	99.37	98.02%	2.00	1.98%	0.00	0.00%	0.00	0.00%	0.00	0.00%
C_06/07	116.71	15	66.90	72.36	62.00%	116.71	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
C_08	98.50	41	57.18	63.48	64.44%	98.50	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
C_09	102.87	32	191.00	76.73	74.59%	99.92	97.13%	2.95	2.87%	0.00	0.00%	0.00	0.00%	0.00	0.00%
C_10	83.74	7	45.09	77.21	92.20%	83.74	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
C_11	188.33	27	34.32	130.05	69.06%	184.89	98.17%	3.39	1.80%	0.00	0.00%	0.05	0.03%	0.00	0.00%
C_13/14	122.03	11	22.03	62.59	51.29%	104.74	85.83%	0.00	0.00%	10.81	8.86%	0.43	0.35%	6.06	4.96%
C_15	25.69	23	181.87	12.76	49.67%	20.63	80.29%	0.00	0.00%	0.69	2.67%	3.34	13.01%	1.03	4.02%
C_16	32.99	13	122.23	17.84	54.08%	30.40	92.16%	0.00	0.00%	0.71	2.16%	0.48	1.45%	1.39	4.23%
C_17	128.01	46	166.99	76.98	60.14%	114.34	89.32%	0.00	0.00%	9.81	7.66%	3.00	2.34%	0.87	0.68%
C_18/19	255.07	67	122.94	158.69	62.22%	250.60	98.25%	3.14	1.23%	1.33	0.52%	0.00	0.00%	0.00	0.00%
C_22	602.82	44	45.01	327.66	54.35%	575.23	95.42%	17.61	2.92%	7.29	1.21%	0.00	0.00%	1.68	0.28%

Size and Land Use Characteristics of CSO Drainage Areas

CSO Identifier	Drainage Area (Acres)	Events /Year	Vol/Area (MGY/Mi2)	Impervious Surface		Urban		Barren Land		Forest		Water		Wetlands	
				Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
C_23A	67.17	22	181.99	26.89	40.03%	66.94	99.65%	0.19	0.28%	0.00	0.00%	0.00	0.00%	0.04	0.06%
C_24	66.63	6	33.62	29.91	44.89%	60.83	91.28%	1.10	1.65%	4.28	6.43%	0.00	0.00%	0.42	0.64%
C_27	117.99	20	173.57	67.44	57.16%	115.23	97.66%	0.00	0.00%	2.76	2.34%	0.00	0.00%	0.00	0.00%
C_28	34.64	8	57.28	10.60	30.59%	26.45	76.35%	0.00	0.00%	5.93	17.12%	0.00	0.00%	2.26	6.53%
C_32	494.89	70	208.21	206.59	41.74%	457.38	92.42%	1.64	0.33%	22.47	4.54%	0.72	0.15%	12.69	2.56%
CFA	164.25	12	57.67	105.42	64.18%	162.21	98.75%	0.00	0.00%	2.00	1.21%	0.00	0.00%	0.05	0.03%
EN_01	73.01	49	191.26	43.63	59.76%	63.98	87.63%	0.00	0.00%	0.03	0.04%	9.00	12.33%	0.00	0.00%
E_01	464.76	68	NA	264.19	56.84%	462.57	99.53%	0.00	0.00%	2.19	0.47%	0.00	0.00%	0.00	0.00%
E_02	201.29		NA	144.87	71.97%	201.29	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
E_03	435.60	74	NA	223.96	51.41%	434.61	99.77%	0.00	0.00%	1.00	0.23%	0.00	0.00%	0.00	0.00%
E_05	188.80	59	NA	109.65	58.08%	188.66	99.93%	0.00	0.00%	0.00	0.00%	0.14	0.07%	0.00	0.00%
E_08	15.88	68	NA	12.86	80.98%	15.86	99.92%	0.00	0.00%	0.00	0.00%	0.01	0.08%	0.00	0.00%
E_10	49.03	58	NA	27.78	56.67%	49.03	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
E_11	35.90	60	NA	24.65	68.68%	35.90	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
E_12	5.38	55	NA	5.11	95.00%	5.38	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
E_13	31.80	76	NA	17.02	53.53%	31.08	97.74%	0.00	0.00%	0.72	2.26%	0.00	0.00%	0.00	0.00%
E_14	7.50	58	NA	6.34	84.52%	7.50	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
E_16	36.86	58	NA	23.21	62.96%	36.50	99.03%	0.00	0.00%	0.36	0.97%	0.00	0.00%	0.00	0.00%
E_21	2.71	58	NA	2.01	74.19%	2.71	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
E_22	189.54	74	NA	124.24	65.55%	187.14	98.74%	2.36	1.24%	0.00	0.00%	0.04	0.02%	0.00	0.00%
E_26	115.84	60	NA	78.65	67.89%	115.84	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
E_27/28	285.00	74	NA	197.44	69.28%	284.92	99.97%	0.00	0.00%	0.07	0.03%	0.00	0.00%	0.00	0.00%
E_29	83.80	74	NA	57.08	68.12%	80.21	95.71%	3.59	4.29%	0.00	0.00%	0.00	0.00%	0.00	0.00%
E_30	21.78	59	NA	16.48	75.67%	21.78	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
E_31	64.55	60	NA	41.88	64.88%	64.55	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
E_32	63.63	68	NA	39.44	61.98%	59.02	92.76%	4.61	7.24%	0.00	0.00%	0.00	0.00%	0.00	0.00%
E_34	111.09	74	NA	80.01	72.02%	105.78	95.21%	0.00	0.00%	4.45	4.00%	0.00	0.00%	0.87	0.78%
E_35	96.83	74	NA	63.82	65.91%	96.31	99.46%	0.00	0.00%	0.52	0.54%	0.00	0.00%	0.00	0.00%
E_36	230.79	60	NA	143.37	62.12%	230.79	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
E_37	39.29	74	NA	20.52	52.22%	39.29	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
E_38	47.73	74	NA	32.06	67.17%	46.91	98.28%	0.00	0.00%	0.82	1.72%	0.00	0.00%	0.00	0.00%
E_39	276.36	74	NA	177.00	64.05%	269.69	97.59%	1.53	0.55%	5.14	1.86%	0.00	0.00%	0.00	0.00%
E_40	45.25	74	NA	28.95	63.98%	45.25	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
E_41	254.63	59	NA	120.93	47.49%	239.69	94.13%	2.59	1.02%	0.42	0.17%	2.89	1.14%	9.04	3.55%
E_42	187.93	72	NA	122.69	65.29%	187.93	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
FL_001	493.41	56	100.73	240.59	48.76%	484.00	98.09%	1.09	0.22%	8.33	1.69%	0.00	0.00%	0.00	0.00%
FL_002	339.42	40	18.04	205.44	60.53%	325.97	96.04%	0.00	0.00%	12.91	3.80%	0.00	0.00%	0.55	0.16%

Size and Land Use Characteristics of CSO Drainage Areas

CSO Identifier	Drainage Area (Acres)	Events /Year	Vol/Area (MGY/Mi2)	Impervious Surface		Urban		Barren Land		Forest		Water		Wetlands	
				Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
FL_003	166.70	NA	NA	92.94	55.75%	139.93	83.94%	12.20	7.32%	13.83	8.30%	0.00	0.00%	0.74	0.44%
GI_01	155.23	48	103.48	76.95	49.57%	153.35	98.79%	0.00	0.00%	0.49	0.32%	0.00	0.00%	1.39	0.90%
GI_02	15.74	5	138.24	11.37	72.21%	15.74	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
GI_03/04	156.07	42	138.19	77.26	49.50%	156.07	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
GI_05	57.61	47	89.99	32.32	56.11%	57.61	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
GI_06	99.75	14	8.34	40.94	41.05%	97.63	97.88%	0.00	0.00%	0.00	0.00%	1.63	1.63%	0.49	0.49%
GI_07	10.24	5	162.53	3.83	37.39%	10.06	98.22%	0.00	0.00%	0.09	0.86%	0.00	0.00%	0.09	0.91%
Gu_01	39.86	51	NA	27.58	69.19%	39.86	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
Gu_02	32.81	NA	NA	21.44	65.34%	32.81	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
Gu_03	5.87	NA	NA	3.26	55.57%	5.87	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
Gu_04	3.62	NA	NA	1.99	55.02%	3.62	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
Gu_05	3.94	NA	NA	2.86	72.56%	3.94	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
Gu_06	3.92	NA	NA	2.73	69.80%	3.92	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
Gu_07	4.24	NA	NA	3.25	76.65%	4.24	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
Gu_08	9.90	NA	NA	7.91	79.86%	9.90	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
Gu_09	3.90	NA	NA	2.53	64.91%	3.90	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
Gu_10	2.37	NA	NA	1.54	64.71%	2.37	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
H_01	483.05	NA	NA	257.33	53.27%	481.57	99.69%	1.29	0.27%	0.19	0.04%	0.00	0.00%	0.00	0.00%
H_02	573.15	NA	NA	388.41	67.77%	561.87	98.03%	4.41	0.77%	6.87	1.20%	0.00	0.00%	0.00	0.00%
J_RE-1	351.30	NA	NA	214.04	60.93%	342.21	97.41%	6.87	1.95%	2.21	0.63%	0.00	0.00%	0.00	0.00%
J_RE-2	250.95	NA	NA	146.46	58.36%	230.55	91.87%	0.00	0.00%	17.73	7.06%	0.00	0.00%	2.68	1.07%
J_RE-3/4	767.75	NA	NA	434.81	56.63%	633.60	82.53%	30.01	3.91%	94.31	12.28%	3.21	0.42%	6.62	0.86%
J_RE-5/6	755.47	NA	NA	541.63	71.69%	738.26	97.72%	8.97	1.19%	8.24	1.09%	0.00	0.00%	0.00	0.00%
J_RE-7	20.73	NA	NA	16.88	81.42%	20.36	98.21%	0.00	0.00%	0.00	0.00%	0.37	1.79%	0.00	0.00%
J_RE-8	19.28	NA	NA	15.03	77.96%	18.86	97.84%	0.00	0.00%	0.00	0.00%	0.42	2.16%	0.00	0.00%
J_RE-9	5.07	NA	NA	4.76	93.93%	5.07	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
J_RE-10	117.22	NA	NA	69.36	59.17%	105.34	89.87%	3.25	2.77%	8.58	7.32%	0.05	0.04%	0.00	0.00%
J_RE-11	227.80	NA	NA	153.39	67.33%	225.73	99.09%	0.00	0.00%	2.08	0.91%	0.00	0.00%	0.00	0.00%
J_RE-12	19.66	NA	NA	18.96	96.43%	19.66	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
J_RE-13	22.29	NA	NA	19.65	88.15%	22.29	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
J_RE-14	64.56	NA	NA	53.40	82.72%	64.56	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
J_RE-15	112.81	NA	NA	78.11	69.25%	108.65	96.32%	0.00	0.00%	4.15	3.68%	0.00	0.00%	0.00	0.00%
J_RE-16	50.05	NA	NA	28.74	57.42%	40.83	81.58%	0.00	0.00%	9.22	18.42%	0.00	0.00%	0.00	0.00%
J_RE-17	93.33	NA	NA	58.67	62.86%	92.80	99.43%	0.04	0.04%	0.50	0.53%	0.00	0.00%	0.00	0.00%
J_RE-18	509.09	NA	NA	326.48	64.13%	464.72	91.28%	6.53	1.28%	29.56	5.81%	8.28	1.63%	0.00	0.00%
J_RE-19	380.50	NA	NA	244.46	64.25%	374.73	98.48%	2.57	0.68%	3.20	0.84%	0.00	0.00%	0.00	0.00%
J_RW-1	165.05	NA	NA	96.44	58.43%	164.32	99.55%	0.00	0.00%	0.74	0.45%	0.00	0.00%	0.00	0.00%

Size and Land Use Characteristics of CSO Drainage Areas

CSO Identifier	Drainage Area (Acres)	Events /Year	Vol/Area (MGY/Mi2)	Impervious Surface		Urban		Barren Land		Forest		Water		Wetlands	
				Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
J_RW-2	178.39	NA	NA	95.30	53.42%	174.80	97.99%	0.00	0.00%	3.58	2.01%	0.01	0.00%	0.00	0.00%
J_RW-3	152.25	NA	NA	88.76	58.30%	145.79	95.76%	0.00	0.00%	6.46	4.24%	0.00	0.00%	0.00	0.00%
J_RW-4	117.44	NA	NA	86.47	73.63%	115.14	98.04%	0.00	0.00%	0.73	0.62%	1.56	1.33%	0.00	0.00%
J_RW-5	61.59	NA	NA	47.27	76.76%	61.59	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
J_RW-6	248.21	NA	NA	161.58	65.10%	248.11	99.96%	0.00	0.00%	0.05	0.02%	0.00	0.00%	0.05	0.02%
J_RW-7	208.55	NA	NA	80.56	38.63%	191.00	91.59%	4.51	2.16%	10.39	4.98%	0.00	0.00%	2.64	1.27%
J_RW-8	248.27	NA	NA	155.85	62.78%	241.06	97.09%	0.00	0.00%	3.88	1.56%	3.33	1.34%	0.01	0.00%
J_RW-9	131.89	NA	NA	101.05	76.62%	131.79	99.92%	0.00	0.00%	0.00	0.00%	0.10	0.08%	0.00	0.00%
J_RW-10	239.18	NA	NA	167.99	70.24%	224.01	93.66%	15.17	6.34%	0.00	0.00%	0.00	0.00%	0.00	0.00%
J_RW-11	328.95	NA	NA	247.04	75.10%	310.03	94.25%	16.71	5.08%	2.21	0.67%	0.00	0.00%	0.00	0.00%
J_RW-12	103.90	NA	NA	77.85	74.93%	103.90	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
J_RW-13	176.55	NA	NA	124.43	70.48%	171.80	97.31%	0.00	0.00%	4.75	2.69%	0.00	0.00%	0.00	0.00%
K_001	41.64	42	NA	15.10	36.25%	41.18	98.90%	0.00	0.00%	0.00	0.00%	0.46	1.10%	0.00	0.00%
K_004	134.67	49	NA	59.85	44.44%	128.20	95.19%	1.25	0.92%	2.03	1.51%	3.19	2.37%	0.00	0.00%
K_006	240.10	53	NA	136.51	56.86%	239.14	99.60%	0.47	0.20%	0.48	0.20%	0.00	0.00%	0.00	0.00%
K_007	635.95	55	NA	333.46	52.43%	625.91	98.42%	0.69	0.11%	9.33	1.47%	0.00	0.00%	0.02	0.00%
K_010	24.67	44	NA	12.98	52.62%	24.67	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
NB_003	874.00	55	122.11	509.12	58.25%	750.61	85.88%	39.90	4.56%	42.82	4.90%	15.67	1.79%	24.95	2.86%
NB_004	164.08	48	184.36	79.56	48.49%	155.15	94.56%	0.00	0.00%	8.93	5.44%	0.00	0.00%	0.00	0.00%
NB_005	280.60	48	85.21	193.19	68.85%	262.90	93.69%	0.00	0.00%	9.50	3.38%	0.69	0.25%	7.52	2.68%
NB_006	221.10	38	21.71	129.46	58.55%	201.19	91.00%	2.38	1.08%	9.96	4.50%	2.07	0.94%	5.50	2.49%
NB_007	160.85	49	225.06	69.07	42.94%	152.46	94.78%	0.00	0.00%	5.57	3.46%	0.35	0.22%	2.48	1.54%
NB_008	335.22	40	59.27	194.99	58.17%	317.85	94.82%	3.48	1.04%	8.76	2.61%	0.47	0.14%	4.66	1.39%
NB_009	84.42	40	234.91	55.05	65.20%	81.62	96.67%	0.52	0.62%	2.19	2.60%	0.09	0.11%	0.00	0.00%
NB_010	127.86	24	25.72	83.85	65.58%	109.91	85.96%	1.36	1.07%	16.58	12.97%	0.00	0.00%	0.00	0.00%
NB_011	319.85	48	54.20	205.18	64.15%	291.21	91.05%	0.00	0.00%	13.82	4.32%	1.66	0.52%	13.15	4.11%
NH_14VO	15.19	NA	NA	6.08	40.05%	13.74	90.47%	0.00	0.00%	1.45	9.53%	0.00	0.00%	0.00	0.00%
NH_012	93.48	17	47.93	47.90	51.24%	72.32	77.36%	0.72	0.77%	20.44	21.87%	0.00	0.00%	0.00	0.00%
NH_A	53.44	NA	NA	38.30	71.66%	53.25	99.65%	0.19	0.35%	0.00	0.00%	0.00	0.00%	0.00	0.00%
NH_B	53.54	NA	NA	43.75	81.73%	51.41	96.03%	2.13	3.97%	0.00	0.00%	0.00	0.00%	0.00	0.00%
NH_C	85.85	NA	NA	59.23	69.00%	85.85	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
NH_D	122.08	NA	NA	85.13	69.73%	115.40	94.53%	0.00	0.00%	5.50	4.50%	1.18	0.97%	0.00	0.00%
NH_E	44.06	NA	NA	31.50	71.48%	44.06	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
NH_F	22.44	NA	NA	15.45	68.86%	22.44	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
NH_G	108.91	NA	NA	79.76	73.23%	108.91	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
NH_000	167.21	48	130.91	93.95	56.19%	135.31	80.92%	10.56	6.31%	18.74	11.21%	2.60	1.55%	0.00	0.00%
NH_002	285.10	42	78.12	212.74	74.62%	275.28	96.55%	0.00	0.00%	9.83	3.45%	0.00	0.00%	0.00	0.00%

Size and Land Use Characteristics of CSO Drainage Areas

CSO Identifier	Drainage Area (Acres)	Events /Year	Vol/Area (MGY/Mi2)	Impervious Surface		Urban		Barren Land		Forest		Water		Wetlands	
				Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
NH_003	32.48	25	82.77	29.35	90.36%	31.96	98.42%	0.50	1.53%	0.00	0.00%	0.02	0.05%	0.00	0.00%
NH_005	174.21	104	247.61	116.96	67.14%	170.22	97.71%	0.00	0.00%	3.99	2.29%	0.00	0.00%	0.00	0.00%
NH_H5	151.06	NA	NA	103.32	68.39%	147.75	97.81%	0.00	0.00%	3.31	2.19%	0.00	0.00%	0.00	0.00%
NH_008	110.38	51	129.88	83.38	75.54%	109.75	99.42%	0.00	0.00%	0.63	0.58%	0.00	0.00%	0.00	0.00%
NH_HWF	304.41	NA	NA	178.09	58.50%	257.56	84.61%	10.87	3.57%	30.04	9.87%	5.94	1.95%	0.00	0.00%
NH_JOSO	205.36	89	814.72	142.22	69.26%	205.36	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
NH_NBW	22.08	NA	NA	13.73	62.19%	22.08	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
NH_PANYNJ	25.45	NA	NA	17.12	67.27%	25.45	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
NH_UH1	333.19	NA	NA	227.19	68.19%	330.27	99.12%	0.00	0.00%	2.92	0.88%	0.00	0.00%	0.00	0.00%
NH_013	518.81	72	361.44	351.75	67.80%	502.13	96.78%	1.51	0.29%	3.64	0.70%	11.52	2.22%	0.00	0.00%
NH_015	22.42	65	411.07	12.40	55.32%	20.79	92.75%	0.00	0.00%	1.62	7.25%	0.00	0.00%	0.00	0.00%
P_001	391.23	21	11.86	203.23	51.95%	328.77	84.03%	1.92	0.49%	49.64	12.69%	8.16	2.09%	2.74	0.70%
P_002	2.46	NA	59.94	2.10	85.63%	2.30	93.62%	0.00	0.00%	0.00	0.00%	0.16	6.38%	0.00	0.00%
P_003	7.54	6	50.06	6.12	81.19%	7.42	98.32%	0.00	0.00%	0.00	0.00%	0.13	1.68%	0.00	0.00%
P_004	2.41	NA	NA	0.53	22.16%	2.35	97.53%	0.00	0.00%	0.00	0.00%	0.06	2.47%	0.00	0.00%
P_005	8.72	17	135.84	5.26	60.38%	6.33	72.60%	1.45	16.60%	0.00	0.00%	0.94	10.80%	0.00	0.00%
P_006	389.54	38	109.87	296.11	76.01%	385.34	98.92%	0.58	0.15%	1.99	0.51%	1.63	0.42%	0.00	0.00%
P_007	102.40	33	162.04	58.60	57.22%	100.69	98.33%	0.94	0.92%	0.29	0.28%	0.48	0.47%	0.00	0.00%
P_008	1.91	NA	NA	1.37	71.73%	1.61	84.38%	0.00	0.00%	0.00	0.00%	0.30	15.62%	0.00	0.00%
P_009	31.18	NA	NA	18.15	58.20%	30.84	98.90%	0.00	0.00%	0.00	0.00%	0.34	1.10%	0.00	0.00%
P_010	119.34	19	18.88	68.41	57.32%	114.23	95.72%	1.60	1.34%	1.93	1.62%	1.58	1.32%	0.00	0.00%
P_011	92.39	NA	NA	67.81	73.39%	78.65	85.13%	0.00	0.00%	4.55	4.92%	9.20	9.95%	0.00	0.00%
P_012	36.34	NA	NA	20.64	56.81%	23.49	64.63%	0.00	0.00%	3.31	9.11%	9.54	26.26%	0.00	0.00%
P_013	98.59	32	41.61	59.97	60.83%	97.05	98.45%	0.00	0.00%	1.07	1.09%	0.46	0.46%	0.00	0.00%
P_014	25.41	1	0.25	14.03	55.24%	24.50	96.44%	0.00	0.00%	0.61	2.40%	0.30	1.17%	0.00	0.00%
P_015	62.35	8	4.82	30.98	49.68%	55.23	88.58%	2.30	3.69%	4.66	7.47%	0.16	0.26%	0.00	0.00%
P_016	349.57	27	26.16	177.00	50.63%	344.98	98.69%	0.00	0.00%	4.59	1.31%	0.00	0.00%	0.00	0.00%
P_021	5.64	35	550.55	3.09	54.74%	5.41	95.87%	0.23	4.13%	0.00	0.00%	0.00	0.00%	0.00	0.00%
P_022	49.84	36	177.84	26.94	54.06%	49.62	99.56%	0.00	0.00%	0.22	0.44%	0.00	0.00%	0.00	0.00%
P_023	52.22	11	1.10	37.87	72.53%	50.92	97.52%	0.00	0.00%	0.94	1.80%	0.36	0.68%	0.00	0.00%
P_024	103.55	23	13.16	64.72	62.50%	98.83	95.44%	0.00	0.00%	2.57	2.48%	2.15	2.08%	0.00	0.00%
P_025	830.37	47	57.58	424.35	51.10%	812.40	97.84%	0.00	0.00%	7.02	0.85%	10.38	1.25%	0.57	0.07%
P_026	77.09	6	2.41	35.52	46.08%	75.61	98.08%	0.00	0.00%	0.69	0.90%	0.79	1.02%	0.00	0.00%
P_028	565.87	31	2.74	243.79	43.08%	543.82	96.10%	0.00	0.00%	10.44	1.85%	9.02	1.59%	2.59	0.46%
P_029	54.75	38	465.61	45.70	83.48%	54.24	99.07%	0.00	0.00%	0.00	0.00%	0.51	0.93%	0.00	0.00%
P_030	500.43	45	57.86	276.60	55.27%	499.42	99.80%	0.00	0.00%	1.00	0.20%	0.00	0.00%	0.00	0.00%
P_031	552.56	24	9.54	337.43	61.07%	540.86	97.88%	0.00	0.00%	9.33	1.69%	2.37	0.43%	0.00	0.00%

Size and Land Use Characteristics of CSO Drainage Areas

CSO Identifier	Drainage Area (Acres)	Events /Year	Vol/Area (MGY/Mi2)	Impervious Surface		Urban		Barren Land		Forest		Water		Wetlands	
				Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
P_032	57.51	31	276.44	31.08	54.04%	57.50	99.99%	0.00	0.00%	0.00	0.01%	0.00	0.00%	0.00	0.00%
PA_002C	417.08	76	271.14	225.20	53.99%	399.89	95.88%	3.75	0.90%	9.41	2.26%	4.01	0.96%	0.03	0.01%
PA_003C	25.28	76	544.35	17.31	68.49%	24.10	95.33%	0.00	0.00%	1.18	4.67%	0.00	0.00%	0.00	0.00%
PA_004C	77.32	76	326.94	53.18	68.77%	73.85	95.50%	0.17	0.22%	3.30	4.27%	0.00	0.00%	0.00	0.00%
PA_005C	18.88	76	433.95	12.56	66.52%	18.87	99.97%	0.00	0.00%	0.00	0.00%	0.01	0.03%	0.00	0.00%
PA_006C	60.30	76	474.44	48.75	80.84%	60.30	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
PA_007C	16.52	76	399.02	11.34	68.66%	16.52	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
PA_008C	18.04	76	273.15	9.78	54.22%	16.84	93.33%	0.00	0.00%	0.00	0.00%	1.16	6.45%	0.00	0.00%
PA_009C	14.23	76	332.90	8.89	62.48%	14.23	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
PA_010C	14.09	76	336.16	8.91	63.26%	14.09	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
PA_011C	32.80	76	353.15	21.78	66.40%	32.50	99.09%	0.30	0.91%	0.00	0.00%	0.00	0.00%	0.00	0.00%
PA_013C	26.61	76	428.06	21.40	80.41%	26.61	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
PA_014C	20.18	76	402.79	15.35	76.07%	20.18	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
PA_015C	22.59	76	433.50	17.45	77.24%	22.59	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
PA_016C	447.31	76	381.16	290.27	64.89%	428.37	95.77%	13.72	3.07%	5.22	1.17%	0.00	0.00%	0.00	0.00%
PA_017C	118.83	67	338.76	90.35	76.03%	114.39	96.26%	1.25	1.06%	3.19	2.68%	0.00	0.00%	0.00	0.00%
RP_001	177.34	45	63.12	67.30	37.95%	177.09	99.86%	0.00	0.00%	0.25	0.14%	0.00	0.00%	0.00	0.00%
RP_002	40.70	48	155.82	18.02	44.27%	40.70	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
RP_003	61.61	42	78.95	27.80	45.13%	61.53	99.87%	0.00	0.00%	0.08	0.13%	0.00	0.00%	0.00	0.00%
RP_004	125.22	49	55.76	56.41	45.05%	124.86	99.72%	0.00	0.00%	0.36	0.28%	0.00	0.00%	0.00	0.00%
RP_005	76.03	56	122.56	40.64	53.45%	74.37	97.82%	0.00	0.00%	1.66	2.18%	0.00	0.00%	0.00	0.00%
RP_006	33.89	45	65.54	13.79	40.68%	33.89	100.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
TOTALS	**32,187**			**19,279**	**59.90%**	**30,671**	**95.29%**	**333**	**1.03%**	**808**	**2.51%**	**236**	**0.73%**	**136**	**0.42%**
Minimum	2	1	0.25	0.53	22.16%	1.61	64.63%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
Average	162	46	179.71	96.88	62.32%	154.12	95.69%	1.67	0.74%	4.06	2.04%	1.19	1.22%	0.68	0.30%
Maximum	874	104	1062.97	541.63	96.43%	812.40	100.00%	49.56	16.60%	94.31	21.87%	44.36	26.26%	24.95	7.60%

CSO Identifiers – Municipality/Sewer Agency by Starting Initial(s)

B = Bayonne	C = City of Camden (with C_32 being Camden County MUA within the City)
EN = East Newark	E = Elizabeth
FL = Fort Lee	Gl = Gloucester City
Gu = Guttenberg	H = Hackensack
J = Jersey City	K = Kearny
N = Newark	NB = North Bergen Sewerage Authority
NH = North Hudson Sewerage Authority	P = Paterson
PA = Perth Amboy	RP = Ridgefield Park

Appendix B: CSO Cost Estimates

Compilation of CSO Cost Information by CSO (Target of 3 Events for Storage)									
Overflow No.	**CSO Volume**	**Area (Acres)**	**Vol/Area (MGY/Mi2)**	**Disinfection costs (Best)**	**Costs Per MGY**	**Off-line Storage Separate**	**Costs Per MGY**	**Sewer Separation Costs**	**Costs Per MGY**
B-001	495.82	296.56	1070.02	$17,232,231	$34,755	$52,923,591	$106,740	NA	NA
B-005	41.12	26.82	981.18	$10,115,596	$246,016	$17,999,035	$437,745	NA	NA
B-002	26.80	269.76	63.58	$20,621,307	$769,452	$19,126,126	$713,661	NA	NA
B-003	19.74	NA	NA	$3,363,750	$170,418	$7,364,162	$373,092	NA	NA
B-004 and B-009	3.80	31.79	76.51	$4,675,018	$1,230,268	$5,264,660	$1,385,437	NA	NA
B-006	13.40	202.42	42.37	$4,980,057	$371,646	$8,151,695	$608,335	NA	NA
B-007	61.30	230.37	170.30	$7,169,507	$116,958	$18,628,764	$303,895	NA	NA
B-008	27.00	NA	NA	$7,943,127	$294,190	$14,034,784	$519,807	NA	NA
B-010	36.10	121.38	190.34	$4,973,521	$137,771	$8,998,596	$249,269	NA	NA
B-011	5.00	36.42	87.86	$4,765,115	$953,023	$4,884,474	$976,895	NA	NA
B-012/025	8.70	41.21	135.12	$3,708,023	$426,210	$7,127,893	$819,298	NA	NA
B-013 and 014	9.60	70.62	87.00	$3,758,081	$391,467	$8,157,220	$849,710	NA	NA
B-015	37.20	87.16	273.16	$5,809,571	$156,171	$11,036,543	$296,681	NA	NA
B-016	5.70	17.83	204.62	$4,167,627	$731,163	$4,051,326	$710,759	NA	NA
B-017	42.40	91.27	297.31	$4,262,309	$100,526	$10,862,993	$256,203	NA	NA
B-018/027	10.10	24.29	266.11	$4,437,198	$439,327	$7,126,518	$705,596	NA	NA
B-019	28.80	233.97	78.78	$5,431,474	$188,593	$12,626,134	$438,407	NA	NA
B-020	5.60	NA	NA	$4,527,796	$808,535	$5,664,923	$1,011,593	NA	NA
B-0021/033	48.70	146.33	213.00	$7,239,206	$148,649	$13,942,754	$286,299	NA	NA
B-024	0.60	NA	NA	$2,948,391	$4,913,985	$2,024,081	$3,373,468	NA	NA
B-029	3.00	NA	NA	$3,404,496	$1,134,832	$5,088,493	$1,696,164	NA	NA
B-030	0.10	73.57	0.87	$2,889,946	$28,899,460	$1,327,619	$13,276,190	NA	NA
C01	10.80	219.73	31.46	$4,878,103	$451,676	$15,500,000	$1,435,185	$29,610,000	$2,741,667
C02	3.50	188.15	11.91	$4,225,715	$1,207,347	$3,700,000	$1,057,143	$24,910,000	$7,117,143
C03	132	688.42	122.72	$7,421,690	$56,225	$109,800,000	$831,818	$89,130,000	$675,227
C05	2.20	101.37	13.89	$4,207,240	$1,912,382	$3,200,000	$1,454,545	$13,290,000	$6,040,909
C06/07	12.20	116.71	66.90	$3,918,729	$321,207	$17,200,000	$1,409,836	$15,320,000	$1,255,738
C08	8.8	98.50	57.18	$4,901,305	$556,966	$7,300,000	$829,545	$12,720,000	$1,445,455
C09	30.7	102.87	191.00	$3,846,998	$125,309	$28,300,000	$921,824	$13,480,000	$439,088
C10	5.9	83.74	45.09	$4,688,261	$794,621	$9,800,000	$1,661,017	$11,000,000	$1,864,407
C11	10.1	188.33	34.32	$5,573,521	$551,834	$10,600,000	$1,049,505	$22,640,000	$2,241,584
C13/C14	4.2	122.03	22.03	$5,740,093	$1,366,689	$5,900,000	$1,404,762	$15,470,000	$3,683,333
C15	7.3	25.69	181.87	$4,177,263	$572,228	$7,600,000	$1,041,096	$3,240,000	$443,836

Compilation of CSO Cost Information by CSO (Target of 3 Events for Storage)									
Overflow No.	**CSO Volume**	**Area (Acres)**	**Vol/Area (MGY/Mi2)**	**Disinfection costs (Best)**	**Costs Per MGY**	**Off-line Storage Separate**	**Costs Per MGY**	**Sewer Separation Costs**	**Costs Per MGY**
C16	6.3	32.99	122.23	$4,031,463	$639,915	$8,900,000	$1,412,698	$4,220,000	$669,841
C17	33.4	128.01	166.99	$4,005,099	$119,913	$27,800,000	$832,335	$16,500,000	$494,012
C18/C19	49	255.07	122.94	$7,556,157	$154,207	$30,400,000	$620,408	$33,320,000	$680,000
C22	42.4	602.82	45.01	$7,281,291	$171,729	$35,300,000	$832,547	$47,160,000	$1,112,264
C23A	19.1	67.17	181.99	$5,235,515	$274,111	$20,100,000	$1,052,356	$8,620,000	$451,309
C24	3.5	66.63	33.62	$4,144,014	$1,184,004	$6,400,000	$1,828,571	$8,590,000	$2,454,286
C27	32	117.99	173.57	$4,091,631	$127,863	$45,800,000	$1,431,250	$15,330,000	$479,063
C28	3.1	34.64	57.28	$4,163,789	$1,343,158	$4,700,000	$1,516,129	$4,310,000	$1,390,323
Thorndyke	90.4	NA	NA	$7,067,229	$78,177	$75,200,000	$831,858	$30,930,000	$342,146
CFA	14.8	164.25	57.67	$5,090,811	$343,974	$21,000,000	$1,418,919	$21,290,000	$1,438,514
C32	161.0	494.89	208.21	NA	NA	$99,800,000	$619,876	$64,160,000	$398,509
EN001	21.82	73.0135	191.26	$10,700,000	$490,376	$8,740,000	$400,550	NA	NA
E001	NA	464.76	NA	$7,347,876	NA	$49,000,000	NA	NA	NA
E003	NA	435.60	NA	$5,970,918	NA	$50,070,000	NA	NA	NA
E005	NA	188.80	NA	$4,354,531	NA	$26,180,000	NA	NA	NA
E008	NA	15.88	NA	$3,282,387	NA	$3,880,000	NA	NA	NA
E010	NA	49.03	NA	$3,652,786	NA	$8,910,000	NA	NA	NA
E011	NA	35.90	NA	$3,513,811	NA	$7,270,000	NA	NA	NA
E012	NA	5.38	NA	$4,546,412	NA	$1,970,000	NA	NA	NA
E013	NA	31.80	NA	$3,499,714	NA	$6,400,000	NA	NA	NA
E014	NA	7.50	NA	$2,830,098	NA	$2,390,000	NA	NA	NA
E016	NA	36.86	NA	$3,308,715	NA	$6,900,000	NA	NA	NA
E021	NA	2.71	NA	$2,872,467	NA	$1,590,000	NA	NA	NA
E022	NA	189.54	NA	$4,582,739	NA	$25,070,000	NA	NA	NA
E026	NA	115.84	NA	$4,255,881	NA	$17,220,000	NA	NA	NA
E028	NA	285.00	NA	$6,708,382	NA	$36,430,000	NA	NA	NA
E029	NA	83.80	NA	$3,934,700	NA	$16,060,000	NA	NA	NA
E030	NA	21.78	NA	$2,892,368	NA	$4,420,000	NA	NA	NA
E031	NA	64.55	NA	$3,527,905	NA	$10,130,000	NA	NA	NA
E032	NA	63.63	NA	$3,689,337	NA	$11,530,000	NA	NA	NA
E034	NA	111.09	NA	$4,048,821	NA	$19,230,000	NA	NA	NA
E035	NA	96.83	NA	$4,068,995	NA	$18,170,000	NA	NA	NA
E036	NA	230.79	NA	$5,198,128	NA	$27,920,000	NA	NA	NA
E037	NA	39.29	NA	$4,192,542	NA	$24,700,000	NA	NA	NA
E038	NA	47.73	NA	$3,472,783	NA	$8,920,000	NA	NA	NA
E039	NA	276.36	NA	$6,989,954	NA	$36,290,000	NA	NA	NA
E040	NA	45.25	NA	$4,367,861	NA	$10,740,000	NA	NA	NA
E041	NA	254.63	NA	$4,237,936	NA	$22,120,000	NA	NA	NA

Compilation of CSO Cost Information by CSO (Target of 3 Events for Storage)									
Overflow No.	**CSO Volume**	**Area (Acres)**	**Vol/Area (MGY/Mi2)**	**Disinfection costs (Best)**	**Costs Per MGY**	**Off-line Storage Separate**	**Costs Per MGY**	**Sewer Separation Costs**	**Costs Per MGY**
E042	NA	187.93	NA	$4,794,105	NA	$24,020,000	NA	NA	NA
FL-001	77.66	493.41	100.73	$4,000,000	$51,507	$13,540,000	$174,350	NA	NA
FL-002	9.57	339.42	18.04	$1,400,000	$146,290	$5,510,000	$575,758	NA	NA
G01	25.1	155.23	103.48	NA	NA	$20,880,000	$831,873	$20,350,000	$810,757
G02	3.4	15.74	138.24	NA	NA	$5,550,000	$1,632,353	$2,070,000	$608,824
G03/G04	33.7	156.07	138.19	NA	NA	$28,060,000	$832,641	$19,880,000	$589,911
G05	8.1	57.61	89.99	NA	NA	$6,740,000	$832,099	$7,310,000	$902,469
G06	1.3	99.75	8.34	NA	NA	$1,840,000	$1,415,385	$1,110,000	$853,846
G07	2.6	10.24	162.53	NA	NA	$4,240,000	$1,630,769	$1,360,000	$523,077
Gu_001	46.27	110.43	268.15	$3,875,000	$83,748	$2,360,000	$51,005	$3,060,000	$66,134
JC-RW-1	NA	165.05	NA	$58,000,000	NA	$7,821,580	NA	NA	NA
JC-RW-2	NA	178.39	NA	$27,000,000	NA	$17,200,000	NA	NA	NA
JC-RW-3	NA	152.25	NA	$29,000,000	NA	$12,819,225	NA	NA	NA
JC-RW-4	NA	117.44	NA	$10,000,000	NA	$18,484,848	NA	NA	NA
JC-RW-5	NA	61.59	NA	$7,000,000	NA	$24,166,667	NA	NA	NA
JC-RW-6	NA	248.21	NA	$34,000,000	NA	$9,042,998	NA	NA	NA
JC-RW-7	NA	208.55	NA	$19,000,000	NA	$29,500,000	NA	NA	NA
JC-RW-8	NA	248.27	NA	$53,000,000	NA	$6,554,726	NA	NA	NA
JC-RW-9	NA	131.89	NA	$19,000,000	NA	$10,288,462	NA	NA	NA
JC-RW-10	NA	239.18	NA	$42,000,000	NA	$8,111,111	NA	NA	NA
JC-RW-11/12	NA	432.86	NA	$57,000,000	NA	$7,825,226	NA	NA	NA
JC-RW-13	NA	176.55	NA	$26,000,000	NA	$16,704,545	NA	NA	NA
JC-RE-1	NA	351.30	NA	$27,000,000	NA	$13,502,155	NA	NA	NA
JC-RE-2	NA	250.95	NA	$14,000,000	NA	$21,035,714	NA	NA	NA
JC-RE-3/4	NA	767.75	NA	$40,000,000	NA	$7,516,292	NA	NA	NA
JC-RE- 5/6	NA	755.47	NA	$75,000,000	NA	$7,367,885	NA	NA	NA
JC-RE- 10/11	NA	345.02	NA	$27,000,000	NA	$7,272,727	NA	NA	NA
JC-RE-15	NA	112.81	NA	$45,000,000	NA	$7,285,115	NA	NA	NA
JC-RE-16/17	NA	143.38	NA	$36,000,000	NA	$52,954,545	NA	NA	NA
JC-RE- 18	NA	509.09	NA	$42,000,000	NA	$6,517,295	NA	NA	NA
JC-RE-19	NA	380.50	NA	$80,000,000	NA	$7,507,310	NA	NA	NA
K-001	NA	41.64	NA	$4,359,607	NA	NA	NA	NA	NA
K-004	NA	134.67	NA	$6,184,199	NA	NA	NA	NA	NA
K-006	NA	240.10	NA	$7,325,815	NA	NA	NA	NA	NA
K-007	NA	635.95	NA	$12,090,527	NA	NA	NA	NA	NA
K-010	NA	24.67	NA	$4,041,302	NA	NA	NA	NA	NA
N-002	33.02	NA	NA	$8,185,604	$247,898	$34,590,000	$1,047,547	NA	NA
N-003	73.86	NA	NA	$8,644,776	$117,043	$30,270,000	$409,829	NA	NA

Compilation of CSO Cost Information by CSO (Target of 3 Events for Storage)									
Overflow No.	CSO Volume	Area (Acres)	Vol/Area (MGY/Mi2)	Disinfection costs (Best)	Costs Per MGY	Off-line Storage Separate	Costs Per MGY	Sewer Separation Costs	Costs Per MGY
N-004/005	28.45	NA	NA	$8,046,684	$282,836	$39,280,000	$1,380,668	NA	NA
N-008	89.69	NA	NA	$8,351,616	$93,116	$46,040,000	$513,324	NA	NA
N-009/010	403.96	NA	NA	$16,381,313	$40,552	$219,610,000	$543,643	NA	NA
N-013/014	135.75	NA	NA	$13,785,038	$101,547	$79,550,000	$586,004	NA	NA
N-015	139.36	NA	NA	$9,141,237	$65,594	$78,030,000	$559,917	NA	NA
N-016	43.68	NA	NA	$8,160,727	$186,830	$22,120,000	$506,410	NA	NA
N-017	90.72	NA	NA	$7,825,524	$86,260	$33,870,000	$373,347	NA	NA
N-018	20.78	NA	NA	$8,042,612	$387,036	$29,280,000	$1,409,047	NA	NA
N-022	35.41	NA	NA	$8,147,471	$230,090	$22,890,000	$646,428	NA	NA
N-023	123.89	NA	NA	$8,919,191	$71,993	$55,530,000	$448,220	NA	NA
N-024/030	72.25	NA	NA	$9,065,884	$125,479	$46,600,000	$644,983	NA	NA
N-025	669.38	NA	NA	$24,931,387	$37,245	$254,110,000	$379,620	NA	NA
N-026	NA	NA	NA	$8,219,183	NA	NA	NA	NA	NA
N-027/029	60.51	NA	NA	$8,906,689	$147,194	$60,570,000	$1,000,992	NA	NA
NB-003	166.76	874.00	122.11	$8,750,658	$52,474	$44,069,610	$264,265	NA	NA
NB-004	47.27	164.08	184.36	$5,765,687	$121,981	$13,139,855	$277,992	NA	NA
NB-005	37.36	280.60	85.21	$4,619,815	$123,660	$12,801,281	$342,656	NA	NA
NB-006	7.50	221.10	21.71	$3,279,553	$437,274	$10,042,309	$1,338,975	NA	NA
NB-007	56.57	160.85	225.06	$6,246,216	$110,425	$16,883,920	$298,487	NA	NA
NB-008	31.04	335.22	59.27	$3,953,042	$127,345	$10,742,996	$346,079	NA	NA
NB-009	30.99	84.42	234.91	$3,344,783	$107,941	$11,603,830	$374,474	NA	NA
NB-010	5.14	127.86	25.72	$2,881,818	$560,883	$3,047,400	$593,110	NA	NA
NB-011	27.09	319.85	54.20	$5,587,522	$206,273	$10,007,692	$369,451	NA	NA
NH-WNY-1	324.00			$26,700,000	$82,407	$138,800,000	$428,395	NA	NA
NH-JOSO	261.42	205.36	814.72	$27,700,000	$105,960	$125,800,000	$481,218	NA	NA
NH-000	34.20	167.21	130.91	$6,600,000	$192,982	$46,800,000	$1,368,421	NA	NA
NH-002	34.80	285.10	78.12	$7,800,000	$224,138	$31,000,000	$890,805	NA	NA
NH-003	4.20	32.48	82.77	$7,600,000	$1,809,524	$13,300,000	$3,166,667	NA	NA
NH-005	67.40	174.21	247.61	$28,300,000	$419,881	$54,300,000	$805,638	NA	NA
NH-006	25.40			$17,100,000	$673,228	$38,400,000	$1,511,811	NA	NA
NH-008	22.40	110.38	129.88	$17,400,000	$776,786	$38,400,000	$1,714,286	NA	NA
NH-012	7.00	93.48	47.93	$12,700,000	$1,814,286	$14,800,000	$2,114,286	NA	NA
NH-013	293.00	518.81	361.44	$4,800,000	$16,382	$146,000,000	$498,294	NA	NA
NH-015	14.40	22.42	411.07	$7,000,000	$486,111	$27,800,000	$1,930,556	NA	NA
P-001	7.25	391.23	11.86	NA	NA	$5,250,000	$724,138	NA	NA
P-002	0.23	2.46	59.94	NA	NA	$1,410,000	$6,130,435	NA	NA
P-003	0.59	7.54	50.06	NA	NA	$1,750,000	$2,966,102	NA	NA
P-005	1.85	8.72	135.84	NA	NA	$2,520,000	$1,362,162	NA	NA

Compilation of CSO Cost Information by CSO (Target of 3 Events for Storage)									
Overflow No.	**CSO Volume**	**Area (Acres)**	**Vol/Area (MGY/Mi2)**	**Disinfection costs (Best)**	**Costs Per MGY**	**Off-line Storage Separate**	**Costs Per MGY**	**Sewer Separation Costs**	**Costs Per MGY**
P=006	66.87	389.54	109.87	NA	NA	$12,790,000	$191,267	NA	NA
P-007	26.41	104.31	162.04	NA	NA	$9,070,000	$343,431	NA	NA
P-010	4.44	150.52	18.88	NA	NA	$4,390,000	$988,739	NA	NA
P-013	6.41	98.59	41.61	NA	NA	$4,820,000	$751,950	NA	NA
P-014	0.01	25.41	0.25	NA	NA	Complies	Complies	NA	NA
P-015	0.47	62.35	4.82	NA	NA	$1,810,000	$3,851,064	NA	NA
P-016	14.29	349.57	26.16	NA	NA	$7,610,000	$532,540	NA	NA
P-017	15.37	NA	NA	NA	NA	$6,650,000	$432,661	NA	NA
P-021	4.85	5.64	550.55	NA	NA	$3,350,000	$690,722	NA	NA
P-022	13.85	49.84	177.84	NA	NA	$6,760,000	$488,087	NA	NA
P-023	0.09	52.22	1.10	NA	NA	$1,120,000	$12,444,444	NA	NA
P-024	2.13	103.55	13.16	NA	NA	$2,980,000	$1,399,061	NA	NA
P-025	74.71	830.37	57.58	NA	NA	$17,590,000	$235,444	NA	NA
P-026	0.29	77.09	2.41	NA	NA	$1,490,000	$5,137,931	NA	NA
P-027	341.49	NA	NA	NA	NA	$28,190,000	$82,550	NA	NA
P-028	2.42	565.87	2.74	NA	NA	$2,690,000	$1,111,570	NA	NA
P-029	39.83	54.75	465.61	NA	NA	$11,730,000	$294,502	NA	NA
P-030	45.24	500.43	57.86	NA	NA	$11,660,000	$257,737	NA	NA
P-031	8.24	552.56	9.54	NA	NA	$6,830,000	$828,883	NA	NA
P-032	24.84	57.51	276.44	NA	NA	$8,930,000	$359,501	NA	NA
PA-CSO02	176.70	417.08	271.14	NA	NA	$157,800,000	$893,039	NA	NA
PA-CSO03	21.50	25.28	544.35	NA	NA	$19,900,000	$925,581	NA	NA
PA-CSO04	39.50	77.32	326.94	NA	NA	$34,500,000	$873,418	NA	NA
PA-CSO05	12.80	18.88	433.95	NA	NA	$9,200,000	$718,750	NA	NA
PA-CSO06	44.70	60.30	474.44	NA	NA	$35,500,000	$794,183	NA	NA
PA-CSO07	10.30	16.52	399.02	NA	NA	$8,100,000	$786,408	NA	NA
PA-CSO08	7.70	18.04	273.15	NA	NA	$9,600,000	$1,246,753	NA	NA
PA-CSO09	7.40	14.23	332.90	NA	NA	$6,100,000	$824,324	NA	NA
PA-CSO10	7.40	14.09	336.16	NA	NA	$6,800,000	$918,919	NA	NA
PA-CSO11	18.10	32.80	353.15	NA	NA	$23,400,000	$1,292,818	NA	NA
PA-CSO13	17.80	26.61	428.06	NA	NA	$16,400,000	$921,348	NA	NA
PA-CSO14	12.70	20.18	402.79	NA	NA	$13,200,000	$1,039,370	NA	NA
PA-CSO15	15.30	22.59	433.50	NA	NA	$16,400,000	$1,071,895	NA	NA
PA-CSO16	266.40	447.31	381.16	NA	NA	$281,300,000	$1,055,931	NA	NA
PA-CSO17	62.90	118.83	338.76	NA	NA	$79,100,000	$1,257,552	NA	NA
PA-CSO19	119.20	NA	NA	NA	NA	$119,900,000	$1,005,872	NA	NA
RP-001	17.49	177.34	63.12	$4,147,359	$237,127	$9,776,093	$558,953	$28,130,737	$1,608,390
RP-002	9.91	40.70	155.82	$3,563,212	$359,557	$6,050,811	$610,576	$5,085,215	$513,140

Compilation of CSO Cost Information by CSO (Target of 3 Events for Storage)									
Overflow No.	**CSO Volume**	**Area (Acres)**	**Vol/Area (MGY/Mi2)**	**Disinfection costs (Best)**	**Costs Per MGY**	**Off-line Storage Separate**	**Costs Per MGY**	**Sewer Separation Costs**	**Costs Per MGY**
RP-003	7.60	61.61	78.95	$3,467,644	$456,269	$5,687,044	$748,295	$8,980,343	$1,181,624
RP-004	10.91	125.22	55.76	$3,166,898	$290,275	$7,228,706	$662,576	$20,040,511	$1,836,894
RP-005	14.56	76.03	122.56	$2,959,085	$203,234	$9,099,203	$504,670	$11,047,432	$758,752
RP-006	3.47	33.89	65.54	$7,436,866	$2,143,189	With RP-005	With RP-006	$1,551,327	$447,068
Minimum	0.01	2.46	0.25	$1,400,000	$16,382	$1,120,000	$51,005	$1,110,000	$66,134
Average	51.61	174.79	176.42	$11,122,626	$797,150	$25,478,959	$1,151,483	$18,149,016	$1,387,415
Maximum	669.38	874.00	1070.02	$80,000,000	$28,899,460	$281,300,000	$13,276,190	$89,130,000	$7,117,143

B = Bayonne	JC = Jersey City
C = City of Camden and CCMUA (C32)	K = Kearny
EN = East Newark	N = Newark
E = Elizabeth	NB = North Bergen SA
FL = Fort Lee	NH = North Hudson SA
Gl = Gloucester City	P = Paterson
Gu = Guttenberg	PA = Perth Amboy
	RP = Ridgefield Park

Appendix C: Municipal Water Supply and Sewer Utility Residential Costs and Affordability Indices (CSO Municipalities)

Municipality	Median Income	Annual Water Costs (1 EDU)*	% Median Income	Annual Sewer Costs (1 EDU)*	% Median Income
Bayonne	$53,587	$373	0.70%	$305	0.57%
Camden	$27,027	$377	**1.40%**	$448	**1.66%**
East Newark	$54,722				
Elizabeth	$43,770	$323	0.74%	$277	0.63%
Fort Lee (United Water)	$72,341	$432	0.60%		
Gloucester City	$52,222	$365	0.70%	$316	0.61%
Guttenberg (United Water)	$49,981	$432	0.86%		
Hackensack (United Water)	$57,676	$432	0.75%		
Harrison	$51,193				
Hoboken	$101,782	$344	0.34%		
Jersey City	$54,280	$393	0.72%	$437	0.81%
Kearny	$58,698	$213	0.36%		
Newark	$35,659	$385	**1.08%**	$248	0.70%
North Bergen	$52,726	$432	0.82%		
Paterson	$34,086	$389	**1.14%**	$225	0.66%
Perth Amboy	$47,696	$437	0.92%		
Ridgefield Park (United Water)	$60,656	$432	0.71%		
Trenton	$36,601	$170	0.46%	$253	0.69%
Union City (United Water)	$40,173	$330	0.82%		
Weehawken (United Water)	$62,435	$432	0.69%		
West New York (United Water)	$44,657	$432	0.97%		
Statistics (not including United Water franchise areas)					
Maximum	$101,782	$437	1.40%	$448	1.66%
Average	$51,998	$341	0.78%	$314	0.79%
Minimum	$27,027	$170	0.36%	$225	0.57%
BPU Average (Large PCWS Systems, including United Water) - $424					

* Specific utility rates where used where available on utility web sites or provided directly. BPU water supply system rates were derived from information provided by the NJ Board of Public Utilities for the larger systems, which are more directly comparable to the municipal systems addressed by this report. There are no large sewer systems regulated by BPU. All household costs are calculated assuming a nominal household using $60,000 gallons per day. Actual household costs will vary, except where costs are assessed as a fixed fee per household and do not vary by water demand (e.g., Paterson).

Appendix D: NJDEP Intended Use Plan Rankings, SFY2014 for Clean Water State Revolving Fund (CSO Municipalities)

Rank	Recipient	Cat 1: Secondary/ Sludge/Septage Treatment	Cat 2: Advanced Treatment	Cat 3: Sewer System Rehabilitation	Cat 4: New Collectors, Interceptors etc.	Cat 5: Correction of CSOs	Cat 6: Stormwater Management	Cat 7: Nonpoint Source Management	Total Eligible Project Costs ('000's)	Total State Amount ('000's)
621	BAYONNE LOCAL REDEVELOPMENT							2,957	3,941	
696	BAYONNE LRA						1,800		2,451	
696	BAYONNE LRA						2,600		3,471	
696	BAYONNE LRA						5,400		7,111	
29	BAYONNE MUA					4,100			5,439	
29	BAYONNE MUA				3,000				3,997	
77	BERGEN COUNTY UA			25,000					31,783	
105	BERGEN COUNTY UA	4,500							5,962	
105	BERGEN COUNTY UA	12,000							15,439	15,439
105	BERGEN COUNTY UA	10,000							13,000	13,000
105	BERGEN COUNTY UA	10,000							13,000	
174	BERGEN COUNTY UA			12,184					15,673	
342	BERGEN COUNTY UA	29,802							37,834	
218	BERGEN COUNTY UA (TRIBORO)			1,150					1,584	
9	Camden City			7,949					10,361	
9	Camden City					46,353			58,648	
9	Camden City			15,000					19,257	
9	Camden City					7,949			10,361	10,361
9	Camden City					500			708	
337	CAMDEN CITY	470							667	
428	CAMDEN CITY						1,500		2,049	
620	CAMDEN CITY							5,000	6,614	
511	CAMDEN COUNTY BOARD OF							560	792	

Rank	Recipient	Cat 1: Secondary/ Sludge/Septage Treatment	Cat 2: Advanced Treatment	Cat 3: Sewer System Rehabilitation	Cat 4: New Collectors, Interceptors etc.	Cat 5: Correction of CSOs	Cat 6: Stormwater Management	Cat 7: Nonpoint Source Management	Total Eligible Project Costs ('000's)	Total State Amount ('000's)
511	CAMDEN COUNTY BOARD OF							1,235	1,693	
511	CAMDEN COUNTY BOARD OF							552	781	
2	Camden County MUA					5,000			6,614	6,614
38	CAMDEN COUNTY MUA	4,000							5,308	
695	CAMDEN REDEVELOPMENT AGENCY							137,500	172,309	
702	CAMDEN REDEVELOPMENT AGENCY			16,300	19,500				45,383	
702	CAMDEN REDEVELOPMENT AGENCY							10,000	13,000	
20	ELIZABETH CITY					9,500			12,357	12,357
20	ELIZABETH CITY					1,100			1,522	
699	ELIZABETH CITY							2,500	3,340	
699	ELIZABETH CITY						275	7,325	9,911	
88	ESSEX UNION JOINT MEETING	8,600							11,199	
343	ESSEX-UNION JOINT MEETING	15,000							19,257	
75	GLOUCESTER CITY					1,523			2,081	2,081
75	GLOUCESTER CITY					397			566	566
436	GLOUCESTER CITY				76				112	112
34	GUTTENBERG TOWN					280			376	
58	HACKENSACK CITY						2,801		3,736	3,736
654	HACKENSACK CITY							519	735	
722	HACKENSACK CITY						1,000	6,350	9,589	
706	HARRISON TOWN/ HUDSON COUNTY IA							25,000	31,783	
70	HARRISON TOWNSHIP	794							1,114	
276	HARRISON TOWNSHIP			790	714				2,054	
481	HARRISON TOWNSHIP	16,630							21,330	21,330
429	HOBOKEN CITY						50		73	
623	HOBOKEN CITY							3,705	4,922	
629	HUDSON COUNTY IA							5,000	6,614	
345	HUDSON COUNTY UA	15,603							20,024	

Rank	Recipient	Cat 1: Secondary/ Sludge/Septage Treatment	Cat 2: Advanced Treatment	Cat 3: Sewer System Rehabilitation	Cat 4: New Collectors, Interceptors etc.	Cat 5: Correction of CSOs	Cat 6: Stormwater Management	Cat 7: Nonpoint Source Management	Total Eligible Project Costs ('000's)	Total State Amount ('000's)
346	HUDSON COUNTY UA (AREA I)				21,091				26,962	
39	HUDSON COUNTY UA (HOBOKEN)					10,846			14,038	
619	JERSEY CITY							10,000	13,000	
22	JERSEY CITY MUA					37,122			47,046	
22	JERSEY CITY MUA					1,790			2,437	
22	JERSEY CITY MUA					2,504			3,345	
22	JERSEY CITY MUA					4,500			5,962	5,962
22	JERSEY CITY MUA					6,684			8,730	8,730
22	JERSEY CITY MUA						7,491		9,771	9,771
22	JERSEY CITY MUA						1,680		2,290	2,290
357	JERSEY CITY RA						2,224		3,000	
32	KEARNY MUA				4,000				5,308	
111	KEARNY MUA			500					708	
139	KEARNY MUA			4,600					6,093	
7	Newark City			7,400					9,653	9,653
7	Newark City					3,400			4,522	4,522
89	NEWARK CITY							4,470	5,923	
89	NEWARK CITY			3,500					4,653	
517	NEWARK CITY				51		2,175	17,201	24,882	
617	NEWARK CITY					433	1,547	10,555	16,123	
617	NEWARK CITY							21,375	27,315	
16	NORTH BERGEN MUA					2,500			3,340	
31	NORTH BERGEN MUA	1,534				2,583			5,463	5,463
42	NORTH BERGEN MUA		30,000						38,083	
405	NORTH BERGEN MUA				3,000				3,997	
720	NORTH BERGEN MUA	1,813							2,468	
137	NORTH BERGEN TOWNSHIP			450					639	
704	NORTH BERGEN TOWNSHIP							3,000	3,997	
52	NORTH BERGEN TOWNSHIP/				2,800	200			3,997	

Rank	Recipient	Cat 1: Secondary/ Sludge/Septage Treatment	Cat 2: Advanced Treatment	Cat 3: Sewer System Rehabilitation	Cat 4: New Collectors, Interceptors etc.	Cat 5: Correction of CSOs	Cat 6: Stormwater Management	Cat 7: Nonpoint Source Management	Total Eligible Project Costs ('000's)	Total State Amount ('000's)
	HUDSON CO									
137	NORTH BERGEN UA							1,225	1,679	
49	NORTH HUDSON SA			24,320					30,948	
49	NORTH HUDSON SA					357			510	
49	NORTH HUDSON SA					5,700			7,480	7,480
334	PASSAIC VALLEY SC	105,400							132,505	
334	PASSAIC VALLEY SC	50,000							63,223	
66	PASSAIC VALLEY SEWERAGE			2,010					2,731	2,731
81	PASSAIC VALLEY SEWERAGE	10,000							13,000	
81	PASSAIC VALLEY SEWERAGE	50,000							63,223	
81	PASSAIC VALLEY SEWERAGE	1,745							2,377	2,377
427	PASSAIC VALLEY SEWERAGE							2,268	3,054	
637	PASSAIC VALLEY WC							1,200	1,645	
135	PATERSON CITY			22,136					28,256	
54	PERTH AMBOY CITY					2,533			3,383	3,383
713	PERTH AMBOY RA							29,000	36,825	
721	PERTH AMBOY RA							15,000	19,257	
1	PVSC					79,793			100,557	
33	RIDGEFIELD PARK VILLAGE					13,000			16,713	
136	TRENTON CITY			2,000					2,718	
694	TRENTON CITY							7,740	10,091	
701	TRENTON CITY/MCIA						1,300	800	2,844	
514	UNION COUNTY						3,776		5,015	
707	UNION COUNTY IA						2,000	16,000	23,069	
	TOTALS	347,891	30,000	**145,289**	54,232	**250,647**	**37,619**	**348,037**	1,552,773	

Source: NJDEP. July 2013. Clean Water Financing Proposed Priority System, Intended Use Plan, and Project Priority List for Federal Fiscal Year 2014 (including the Proposed Intended Use Plan for Superstorm Sandy CWSRF Financing)

Appendix E: NJDEP Listing of Proposed Projects for Sandy Funding, Clean Water SRF (CSO Municipalities)

Sponsor Name	Project Name	Cost	Special Cost	Aggregate Cost
Camden City	Sewer Reconstruction Phase 5 and Rehabilitation of Waste	$0	$15,284,582	$15,284,582
Elizabeth City	Trenton Avenue Pump Station Repairs and Improvements	$896,000	$0	$896,000
Elizabeth City	Mattano Park Stormwater Pump Station Repairs and Improvement	$0	$1,300,000	$1,300,000
Elizabeth City	Kapkowski Road Pump Station Repairs and Improvements	$1,855,000	$0	$1,855,000
Elizabeth City	Maintenance of the Elizabeth River Flood Control Project	$0	$22,000,000	$22,000,000
Elizabeth City	CSO Netting Facilities Repairs	$640,000	$0	$640,000
Elizabeth City	South Street Flood Control Project	$4,730,000	$0	$4,730,000
Elizabeth City	Dowd Avenue Flood Reduction Project	$9,330,000	$0	$9,330,000
Elizabeth City	Trumbull Street Stormwater Management Project	$17,080,000	$0	$17,080,000
Hoboken City	Hoboken Wet Weather Pump Station H5	$11,280,040	$0	$11,280,040
Kearny MUA	Kearny Point Pump Station and Harrison Avenue Pump Station Rep	$4,850,000	$0	$4,850,000
Kearny MUA	Kearny Point and Harrison Avenue Pump Station Improvements	$0	$1,127,000	$1,127,000
Kearny Town	Dukes Street Pumping Station	$10,171,200	$0	$10,171,200
Kearny Town	Rehabilitation of Existing Pumping Stations	$3,465,800	$0	$3,465,800
PVSC	Flood Protection	$98,830,000	$0	$98,830,000
PVSC	On Site Primary Power	$71,580,000	$0	$71,580,000
PVSC	Headworks Grit and Screens Electrical and Conveying Systems	$0	$48,600,000	$48,600,000
PVSC	Plant Wide Pump Replacement	$0	$6,000,000	$6,000,000
PVSC	Sump Pump Control Panel Elevation Change	$0	$6,000,000	$6,000,000
PVSC	MCC Replacement Project	$33,430,000	$0	$33,430,000
PVSC	Substation #1 Upgrades	$0	$3,000,000	$3,000,000
PVSC	Administration Building Rehabilitation	$0	$5,000,000	$5,000,000
PVSC	Upgrade of Substations Nos. 17A & 17B	$0	$5,000,000	$5,000,000
PVSC	Sustained Dewatering of PVSC (Emergency Standby Power)	$49,780,000	$0	$49,780,000
PVSC	Rehabilitation of Existing Dewatering Centrifuges	$0	$5,000,000	$5,000,000
PVSC	Regional Biosolids Facility	$0	$526,300,000	$526,300,000
	TOTALS	$317,918,040	$644,611,582	**$962,529,622**

Source: NJDEP. July 2013. Clean Water Financing Proposed Priority System, Intended Use Plan, and Project Priority List for Federal Fiscal Year 2014 (including the Proposed Intended Use Plan for Superstorm Sandy CWSRF Financing)

Appendix F: NJ Drinking Water Revolving Fund Projects with Executed Loans in the Smart Growth Initiative (CSO Municipalities)

Project Sponsor	Project Description	Project Number	Year Financed	Project Amount
Bayonne	Rehabilitation of water mains- Phase 2	0901001-002-0-0	7-Nov	$355,135
Bayonne	Rehabilitation of water mains- Phase 1	0901001-001-0-0	7-Nov	$1,419,555
Bayonne MUA	Slip line 2,600 LF of 48-inch Aqueduct-Phase 1	0901001-003-0-0	10-Mar	$1,696,480
Camden City	Cleaning & Lining of large transmission mains	0408001-010-0-0	3-Nov	$10,317,372
Camden City**	Rehabilitate the Morris-Delair treatment plant	0408001-003-1-0	3-Nov	$6,655,299
Jersey City MUA	Replacement of Traveling Bridge and Tube Settler system	0906001-002	7-Nov	$6,070,000
Jersey City MUA	Cleaning and Lining of Mains	0906001-004	7-Nov	$1,846,000
Jersey City MUA	Large Valve Replacement	0906001-003	7-Nov	$4,841,608
Jersey City MUA**	Replacement of tube settler, valve replacement & clean and line mains	0906001-002/003/004-1	8-Nov	$10,540,000
Harrison Water Dept	Brownfield designated site, 626 LF of 8-inch water main upgrades between 3rd St and Frank E. Rodgers Blvd-Harrison Commons	0904001-003-0-0	9-Dec	$720,011
Harrison Water Dept/Hudson County IA	Brownfield designated site, 5,700 LF of 12-inch water main upgrade on Cape May street and Frank E. Rogers Blvd.--Metro Centre	0904001-002-0-0	9-Dec	$1,820,154
Jersey City MUA	Clean and line 30,000 LF of 6", 8", 10" and 12" and 6,000 LF of 36" main, including the replacement of 1,800 LF of 8: main	0906001-007	May-13	$7,670,000
Jersey City MUA	Improvements to gravity feed raw water to WTP to save on energy Improvements to gravity feed raw water to WTP to save on energy costs	0906001-008	May-13	$6,959,200.00
Jersey City MUA	Clean and line 30,000 LF of 6", 8", 10" and 12" and 6,000 LF of 36" main, including the replacement of 1,800 LF of 8: main	0906001-007	May-13	$7,670,000.00
Jersey City MUA	Improvements to gravity feed raw water to WTP to save on energy costs	0906001-008	May-13	$6,959,200.00
Jersey City MUA	Clean and line 30,000 LF of 6", 8", 10" and 12" and 6,000 LF of 36" main, including the replacement of 1,800 LF of 8: main	0906001-007	May-13	$7,670,000.00
Jersey City MUA	Improvements to gravity feed raw water to WTP to save on energy costs	0906001-008	May-13	$6,959,200.00
Jersey City MUA	Clean and line 30,000 LF of 6", 8", 10" and 12" and 6,000 LF of 36" main, including the replacement of 1,800 LF of 8: main	0906001-007	May-13	$7,670,000.00
Jersey City MUA	Improvements to gravity feed raw water to WTP to save on energy costs	0906001-008	May-13	$6,959,200.00
Jersey City MUA	Clean and line 30,000 LF of 6", 8", 10" and 12" and 6,000 LF of 36" main, including the replacement of 1,800 LF of 8: main	0906001-007	May-13	$7,670,000.00
Jersey City MUA	Improvements to gravity feed raw water to WTP to save on energy costs	0906001-008	May-13	$6,959,200.00

Project Sponsor	Project Description	Project Number	Year Financed	Project Amount
Jersey City/Jersey City MUA	Upgrades at the Boonton Reservoir Treatment Plant	0906001-001-0-0	10-Mar	$10,376,040
Newark City	Replacement of 32,000 LF of water mains	0714001-006	10-Dec	$8,816,311
Newark City	Clean and cement line Pequannock Aqueduct 1 and 2	0714001-003	7-Nov	$4,090,000
Newark City	Clean and line water mains	0714001-004	7-Nov	$4,090,000
Newark**	Cleaning and Lining of the Pequannock Aqueducts No. 1 and 2	0714001-003-1-0	8-Nov	$4,894,140
Newark**	Cleaning and Lining of 56,800 LF of 6,8 and 12-inch distribution mains	0714001-004-1-0	8-Nov	$4,894,140
Passaic Valley WC	Cleaning & Lining of mains in Paterson	1605002-006	7-Nov	$2,110,000
Trenton City	Floating Cover for Pennington Reservoir	1111001-009	10-Dec	$13,082,500
Trenton City	Addition of 2 natural gas generators at the Central Pumping Station	1111001-006-0-0	10-Mar	$8,550,000
Trenton City	Pre-treatment and facilities improvement projects	1111001-004-0-0	6-Nov	$48,893,604
Trenton City	Water main rehabilitation including cleaning and lining	1111001-003-0-0	4-Nov	$12,481,572
Trenton City**	Pre-treatment and facilities improvement projects	1111001-004-0-0	7-Nov	$12,881,160
			TOTAL	**$254,587,081**

**supplemental

All projects were funded 75% from NJDEP and 25% from NJEIT.

Source: NJDEP. July 2013. Drinking Water State Revolving Fund, Proposed FFY2014 Priority System, Intended Use Plan, and Project Priority List.

Appendix G: NJDEP Intended Use Plan SFY 2014, Drinking Water State Revolving Fund (CSO Municipalities)

Proposed Master FFY2013/SFY2014 Project Priority List							
Rank	**System Name**	**Project Description**	**Project #**	**Population Served**	**Building Cost**	**Support Cost**	**Total Project Cost**
55	Camden City	Rehabilitation and painting of a 5 MG standpipe (North Camden Tank) and two 2 MG elevated tanks (Kaighn Avenue and Whitman Park Tank)	0408001-018	53,000	$4,000,000	$1,332,222	$5,332,222
126	Gloucester City	Replacement of 3,740 LF of water mains @ Monmouth, Hudson, Water & Freedom Pier	0414001-017	11,484	$935,272	$420,872	$1,356,144
294	Gloucester City	Replacement of water meters with automatic read meters	0414001-016	11,484	$756,200	$166,364	$922,564
97	Jersey City MUA	Installation of 8,600 LF of 24" & 30" transmission main for looping	0906001-006	247,000	$13,500,000	$2,830,000	$16,330,000
19	Newark City	Backwash, chlorination system & sludge lagoon upgrades at Pequannock WTP	0714001-016	280,000	$6,658,000	$2,260,600	$8,918,600
22	Newark City	Cleaning & lining of 61,000 LF of 6, 8 & 12-inch water mains	0714001-015	280,000	$8,000,000	$2,690,000	$10,690,000
23	Newark City	Upgrade transmission mains to gravity feed 260A Zone to 360 Zone	0714001-017	280,000	$971,100	$437,000	$1,408,100
141	Trenton City	Cleaning and lining of approx 128,000 LF of 4-12 inch water mains, replace 5,500 LF of 4 inch main with 4,000 LF of looping	1111001-008	255,000	$18,714,750	$5,065,066	$23,779,816
						TOTAL	**$68,737,446**

Source: NJDEP. July 2013. Drinking Water State Revolving Fund, Proposed FFY2014 Priority System, Intended Use Plan, and Project Priority List.