



Improved water quality and access have contributed to a boom in kayaking and other small-craft watersports on the Hudson, bringing a new life to the water.



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NEW YORK HARBOUR: A LOCAL TREASURE

As New York reactivates and rediscovers its waterfront, the Department of Environmental Planning works to promote and maintain the health of waterways citywide.

Early settlers of what would become New York City looked out at a landscape abundant with beaver, sturgeon, oysters, and other native flora and fauna sustained by extensive wetlands and a pristine harbor. And it was natural resources that secured the City's central role in America's growing economy as its waters facilitated both commerce and immigration.

The population explosion that resulted is well known – beginning in 1700 the population of New York City grew from approximately 5,000 to over 2 million by 1900; and today, New York City is home to more than 8 million people, with millions more commuters every day from the larger metropolitan area. (There are, in addition, several hundred million tourists a year.) As the City grew, residents needed additional sources of drinking water and also generated significantly more waste. At first, little effort was made to protect the land and the surrounding waterways from the negative impacts of population growth and the massive development that came with it.

For more than a century, most garbage and sanitary waste was discharged into open trenches that ran down city streets and emptied into New York City's surrounding waterways. The effects of these discharges were not immediately apparent due to the harbor's natural ability to assimilate waste; as a result, the City and surrounding areas were able to grow without investing in wastewater treatment. Though several epidemics forced New York City to upgrade its drinking water system in 1842 to draw water from remote Westchester County, it was not until much later in the 19th century that the need for systems to manage and treat solid waste and wastewater became obvious. By the late 1800s, the City's network of sewers was dumping more than 600 million gallons of raw sewage into the harbor every day. Decomposing waste, industrial pollutants, and residential garbage dumped regularly made the harbor a noxious eye-



regularly closing beaches and killing much of the City's once rich life and natural beauty. To address the various public health issues caused by these discharges, the City started investing in its first rudimentary wastewater treatment plants in 1886, but these plants only treated a fraction of the City's total wastewater flow.

Throughout the following century, as concern for the environment and public health grew, the City invested tens of billions of dollars more in expanding the sewer networks and constructing wastewater treatment plants in all five boroughs. Over the past eight years under Mayor Bloomberg and the Department of Environmental Protection (DEP), approximately USD\$7 billion was committed solely to improving harbor water quality through enhanced treatment and better capture of combined sewer discharges. Today, New Yorkers produce more than 1.3 billion gallons of wastewater every day that is collected through 7,400 miles of laterals that flow into large interceptor sewers, which lead directly to the City's 14 wastewater treatment plants. These plants have plenty of capacity to handle the City wastewater generated on a "dry weather" and are designed to handle more than 2.6 billion gallons in wet weather. As a result, New York City's harbor waters are now at their best in more than a century, with daily testing showing that water oxygen levels are continually improving and the level of contaminants associated with human activity are declining steadily. Most areas in the harbor are now safe for recreational activities year-round, giving the public meaningful access to water and providing for the revitalization of New

York City's far too long neglected waterfront for sustainable development and residential activity. In 2010 over 14 miles of public bathing beaches were able to accommodate 18 million visitors.

Despite this stunning turnaround, challenges remain. Seven percent of the City's waterways, the smallest tributaries, still do not meet recreational water quality standards set forth by the federal government. Much of those areas support manufacturing and shipping, including the largest tugboat fleet and maritime services industry on the East Coast, the largest commuter ferry system in the country, distribution and warehouse districts, and the remnants of New York City's manufacturing sector. Achieving recreational water quality standards in these tributaries will require billions of dollars in additional public and private investments. To address such issues, DEP is currently targeting two main environmental challenges that still impact harbor water quality: limiting combined sewer overflows and reducing discharges of nitrogen from DEP's wastewater treatment plants.

Overcoming combined sewer overflows

New York City, like most older cities in the Northeast and the Midwest of the United States, has a combined sewer system. A combined sewer system collects wastewater – what typically gets flushed down a drain in a residential home – and stormwater runoff – what flows into drainage systems when it rains – together in the same pipe from properties and



streets. About two-thirds of New York City's sewered areas operate as combined systems. This often presents an issue during rainstorms when treatment plants can reach their capacity due to the tremendous increase in rainwater that flows into sewers. To relieve pressure on the system during these high-flow periods, the largest city sewers have "regulators" equipped with overflow devices that divert combined stormwater and wastewater into New York City's surrounding waterways at 422 locations around the City. This is known as a combined sewer overflow, or CSO.

Solving this century old environmental problem is a complicated challenge. The 422 CSO outfalls cannot be simply "plugged up", if they were, the combined flow would destroy elements of the system and would cause even greater discharges over time. And redesigning the combined sewer system to have separate rainwater and wastewater pipes would cost tens of billions of dollars, take decades to complete, and require massive construction that would tear up virtually all of New York City's streets. Instead, over the past 20 years, DEP's upgrades to its plants and sewers and its construction of storage tanks, which store wastewater during storms before pumping it back to treatment plants when the rain subsides, have allowed the capture of an ever greater amount of overall CSO volume, from approximately 30 percent annually in the 1980s to more than 72 percent today.

But these traditional solutions have limitations. As the most densely developed city in the United States, New York City generates a tremendous volume of runoff from rooftops, streets, and other impervious sur-

Projects that significantly improve access to the water lend a to the environmental management of this considerable asset. traversed only by ferries and commercial traffic, New Yorkers the harbor and surrounding areas.



every time it rains. If the root cause of runoff – impermeable surfaces – is not addressed, DEP will have to continue to build these expensive tanks and tunnels, also known as “grey” infrastructure because of their reliance on great amounts of steel and concrete, to manage stormwater. Although these facilities are effective at managing CSOs, they are extremely expensive to build and operate, only serve a purpose during the heaviest times of the year, and provide the surrounding communities with few additional benefits. In fact, it can be difficult to find sites.

Green infrastructure, a new approach to a decades old problem

Last year, New York City released the NYC Green Infrastructure Plan, a bold and innovative vision to improve water quality by integrating investments of USD\$4 billion in “green infrastructure,” ranging from such key features as green roofs and structural designs, including porous pavement and infiltration wells as well as storage in tree pits, to absorb and retain stormwater before it enters and potentially overwhelms the City’s sewer system. This approach will be combined with investments in upgrading the existing system to build USD\$2.9 billion in targeted, cost-effective “grey” or traditional infrastructure. The USD\$2.4 billion in green infrastructure includes USD\$1.5 billion in City-funded green projects, and USD\$900 million in private investments through new regulations that require new developments to capture more stormwater on site. By supplementing the current “grey” strategy with the Green Infrastructure Plan, the City will

cut CSOs by more than 12 billion gallons per year by 2030 and that is two billion gallons more per year than under the current plan. And the Green Infrastructure Plan will cost New Yorkers USD\$2.4 billion less in City infrastructure than comparative tanks and tunnels that would serve only a single purpose and would require significant amounts of energy to operate. But the benefits of this approach are not just limited to water quality improvements. Green infrastructure also improves air quality, lowers energy bills, increases green space and offers greater shade, and enhances property values. When funding is tight, it is imperative that every public dollar do as much as possible.

To “soften” the City’s hard surfaces by a distributed system is to return, a little bit, to pre-colonial hydrology that allowed the landscape to manage water. Creating natural systems and harnessing ecosystem services will improve water quality, cool the air, and make the City a more attractive and pleasant place to live. DEP has already established more than 30 demonstration projects across the City and will be testing their performance and costs over time and fine-tune its approach as it scales up to meet the goals of the Green Infrastructure Plan. To meet its goals of capturing the first inch of storm water from 10 percent of impervious surfaces in combined sewer areas, DEP is targeting two of the largest impervious surfaces, roadways and rooftops:

Roadways: Streets and sidewalks comprise more than a quarter of New York City’s land area and make up a little more than a third of the impervious area of the City. In combined sewer drainage areas, the areas



where CSOs can occur, there are more than 27,000 acres of streets and sidewalks that direct stormwater to wastewater treatment plants and waterways. The opportunities for green infrastructure in these areas are immense. In these spaces the City is using enhanced tree pits, street-side bio-retention basins, stormwater capturing Greenstreets, and even a prototype “sponge park” on a canal-side street – all projects that naturally allow toxins to be broken down in soil and plant tissue and water to be absorbed by the ground instead of having it flow from the curb to the sewer’s catch basin.

In order to integrate green infrastructure throughout the right-of-way in combined sewer drainage areas, the City has founded a Green Infrastructure Task Force made up of key City agencies. With the help of the task force, DEP has already approved more than 75 potential green infrastructure opportunities in ongoing roadway capital projects that will break ground within the coming year.

Rooftops: Covering more than 46 percent of impervious surfaces in New York City, buildings and lots offer a ripe opportunity for integrating green infrastructure into existing and developing ultra-urban environment. Approximately 75 percent of all rooftops in the City have a flat or low slope, making them ideal for green infrastructure. There are various techniques for detaining stormwater on these relatively flat rooftops. Green roofs consist of a vegetative layer that grows in specially-designed containers and can provide valuable benefits such as longer roof-life, reduced energy costs, and most of all, a beautiful, verdant ecosystem in a place where there once was none. Blue roofs are non-vegetated source controls

An overview of the extensive network of waterways reveals a patchwork of spaces. Because of the diversity of challenges, the DEP is actively pursuing responses through a multiplicity of innovative means.



that use simple mechanical devices to gradually release water – an inexpensive and lightweight option for many building owners.

The opportunity to install green infrastructure in City properties is matched by the opportunities to install green infrastructure by the public. Through the Green Infrastructure Grants Program, this year DEP is offering USD\$3 million for the public to put towards whatever creative stormwater management solutions they can invent. The Grants Program is designed to generate new ideas to the green infrastructure world and to give the public meaningful opportunities to shape their communities.

Reducing nitrogen in city waterways

Nitrogen is a natural component of human waste that poses no public health threat, but does increase algae growth, which blocks sunlight that plants need to grow, and also decreases the levels of dissolved ox-

ygen in water that fish need to thrive. To improve the ecology of local waterways, the City is committed to investing USD\$1 billion in advanced treatment systems at eight treatment plants to remove oxygen-depleting nitrogen from wastewater.

In October 2010 DEP entered an historic agreement between the City, the New York State Department of Environmental Conservation, the Natural Resources Defense Council, and other environmental stakeholders to protect, preserve, and restore marshlands in Jamaica Bay by reducing nitrogen discharges that accelerate algae growth and degrade the harbor's natural ecosystem; DEP is also upgrading wastewater facilities that discharge into the East River and the Long Island Sound. As part of this effort, cutting-edge technologies will be installed at two plants: SHARON (single reactor system for high activity ammonia removal over nitrite) and ARP (ammonia removal process). Both nutrient removal systems use patented processes with smaller carbon

footprints, lower energy consumption, and fewer chemicals than conventional biological nitrogen removal processes. These investments are projected to reduce nitrogen amounts flowing into Jamaica Bay and the East River by approximately 50 percent.

In addition to removing nitrogen from entering the City's waterways, DEP has established multiple pilot studies to help restore the harbor. The Eelgrass Restoration Project will help to improve the ecosystems of the harbor. The project consists of 1,000 plantings of eelgrass, a type of submerged aquatic vegetation that grows in estuarine and shallow bays and is important for fish and shellfish as shelter and habitat. The City is also piloting an oyster bed and a field of reef balls to evaluate oyster growth, survival, reproduction, water quality, and ecological benefits. Oyster reefs once thrived in the City's harbor, forming an important habitat for many species and filtering harbor water from contaminants like nitrogen. The City is piloting another study on the ribbed mussels' ability to filter nutrients and other pollutants from the water. Similar to the oyster study, the ribbed mussel study may be expanded if the results show an improvement in water quality due to their presence.

Improving waterways and increasing New Yorkers' access to the harbor's more than 520 miles of waterfront is a key part of the comprehensive waterfront plan, a blueprint to reclaim New York City's standing as a premier waterfront city. Since a vibrant waterfront supporting residential, commercial, and industrial growth depends on the health of New York Harbor, the City will continue to invest in the most innovative initiatives to improve the harbor in ways that enhance everyday life and open up more opportunities for the next generation of New Yorkers to enjoy the City's restored natural beauty.

Conclusion

In reactivating the waterfront and restoring biodiversity to parks, in addition to establishing public plazas and managing stormwater overflow, New York City is engaged in an across the boards campaign to dynamically and intelligently incorporate environmentally-friendly practices into every aspect of City management, life, and development. And as it becomes clearer that the well-designed city is the best path to a sustainable lifestyle, New York City is at the forefront of a green urban age, engaging its citizens and visitors into a more harmonious and mutually enriching relationship with nature and its precious resources. In the process, New York City hopes to establish the methods, technologies, and projects that can serve as models for other cities interested in pursuing their own sustainable goals.



Page 62: Oysters are thought to be capable of metabolizing pollutants and are part of the DEP's comprehensive range of test-projects to improve water quality throughout the harbor.

Hands-on projects to promote the health of New York's waterways encourage a dynamic and direct response to environmental issues at a range of scales throughout the city.