CASE STUDY: BATTERY PARK CITY URBAN WATER REUSE

SYSTEM DESCRIPTION

Location: New York City (latitude: 40° 42' 10" N; longitude: 74° 00' 59" W)

Collection: Each building in Battery Park City has its own internal wastewater collection system that is interconnected to the New York City (NYC) sanitary wastewater collection and treatment system. This system consists of pipes in the public right-of-way that existed before construction of these buildings. The NYC water and sewer systems were upgraded or relocated where necessary, but their previous function and capacity remained unchanged. The stormwater system was built independently and discharges directly to the Hudson River. The sanitary wastewater system discharges to a NYC combined sewer that serves the lower portion of Manhattan.

Treatment: Each project provides adequate treatment for the intended use of the reclaimed rainwater or wastewater. Rainwater is collected from vegetated green roofs and membrane roofs and stored in tanks that include varying degrees of filtration and disinfection. Wastewater and, in certain cases, combined rainwater and wastewater, is treated using membrane bioreactor (MBR) technology. The primary means of disinfection is UV and ozone which is used primarily to eliminate color by oxidizing any remaining low-concentration organic compounds, and it also provides an additional means of disinfection.

Product disposition: Product reuse water is typically stored in individual reservoirs located in each building and subsequently distributed based on demand. The nonpotable water distribution system draws water from the reservoirs, which are then replenished with additional reuse water from the treatment process. Reclaimed water is used for toilet flushing, cooling, laundry, and irrigation. Potable water is provided by the NYC public water supply system.

Flowrate: The total reclaimed water flow within Battery Park City will be 662 m^3/d (175 000 gpd) from six separate systems when all of the buildings are complete.

Service Area: A mixed-use community of residential, commercial, and institutional properties. There is no defined service area because each building provides its own internal nonpotable

water reuse services. In the case of onewater reuse system, The Solaire/Verdesian(Site 23/24), two adjoining buildings share one common system but these two buildings are rental properties under common ownership. Similarly, Liberty Lux and Liberty View and sister buildings presently under construction which will also share a common water reuse system. Other buildings in Battery Park City are individual residential condominiums with stand-alone water reuse systems owned by each condominium association.

Case Study Type: High-density urban building-scale reuse and rainwater harvesting with sewer interconnection.

Management Type: Contracted private operations.

Cost: Variable from project to project.

DESCRIPTION

Battery Park City is a mixed-use community of residential, commercial, and institutional properties constructed on 37 ha (92 ac) of land that was created along the Hudson River on the southern end of Manhattan. Approximately 14 ha (35 ac) of this land serves as public waterfront parks; the remainder comprises high-rise buildings. The community contains approximately 1 km^2 (10 million sq ft) of building space, which includes schools, a library, public gathering spaces, and commercial development properties. The Battery Park City Authority (BPCA) owns and manages the land, and the Battery Park Conservancy operates the park. Approximately 10,000 residents and 35,000 transient daytime workers populate the area.

The BPCA is a state authority that was created in 1970 to develop this land for the highest and best use for New York City. Developers competed for long-term land leases to build and operate various buildings built in accordance with architectural guidelines. The Environmental Residential and Environmental Commercial Guidelines (see www.batteryparkcity.org) established goals and objectives for a sustainable urban development, which included energy, water, and air quality and conservation attributes.

Water conservation is an important aspect of the Battery Park City Environmental Guidelines and has been incorporated into each building project in various ways, such as through the use of water conserving fixtures and appliances, rainwater capture and reuse, and wastewater reclamation and reuse. The stated goal is to: “Minimize the impact on New York City’s sewer system and reduce the use of potable water by treating and reclaiming water from lavatories, toilets, showers, sinks, laundry, and dishwashing facilities.”

Although the various water reuse systems are similar in nature and function, each have individual designs with slightly varying operational characteristics. Nonpotable reuse water is provided for toilet flushing, cooling, laundry, and irrigation in varying degrees in each project. System sizes range from 57 to 151 m^3/d (15 000 to 40 000 gpd). The individual systems are owned by the building owners and are operated by a private utility company, Applied Water Management (AWM), under operating agreements with the owners. While AWM is not mandated to be the system operator, all systems have been provided via design-build-operate contracts, which included AWM for operations.

The water reuse systems in Battery Park City were all built as part of the construction of new buildings over the past 10 years. The buildings also are served by traditional potable water taps and sanitary sewer laterals; accordingly, the buildings can function normally should the water reuse systems be decommissioned for any reason. Wastewater residuals are discharged to the sewers only when it is not raining and there are no combined sewer overflows (CSOs) occurring. The wastewater reuse system only treats the quantity of wastewater needed to satisfy demand for nonpotable reclaimed water, with excess wastewater discharged to the sanitary sewer.

Two groups of buildings use shared reuse distribution systems: The Solaire and The Visionaire share water reuse distribution systems; the Liberty Lux and Liberty View buildings, presently under construction, also will share these systems. Systems for the other buildings in Battery Park City are not interconnected.

PROJECT GOALS

The BPCA Environmental Guidelines establish goals that demonstrate sustainable urban development in a broad sense and include a wide array of initiatives in the areas of water, energy, materials, site, and indoor air quality. All of the projects in Battery Park City have also followed the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) program for new construction and have earned LEED Gold or Platinum certification. The overarching objective of the BPCA is to generate the most income from the lease of the underlying land in Battery Park City while establishing a mixed-use community that performs with less environmental effect than traditional urban communities.

TIMELINE

The BPCA implemented the Environmental Development Guidelines in 1999. The Solaire was the first of the projects to compete under this bid structure in 2000. Dates of completion of the projects are as follows: The Solaire, 2003; Verdesian, 2006; Tribeca Green, 2005; Millennium Tower, 2008; Visionaire, 2009; Riverhouse, 2009; and Liberty Luxe/Liberty View, under construction with completion scheduled for 2010.

DECISION MAKING

The BPCA developed the initial Environmental Development Guidelines during a one-year collaboration with a team of architects, engineers, and nongovernmental organizations (NGOs) under the direction of Robert Fox, then of Fox and Fowle Architects. External public organizations and all city agencies were engaged to ensure that the guidelines and programs developed would be accepted and embraced.

The rights to develop each specific site subsequently were granted to developers based on a competitive bid process that included submission of a detailed description of the environmental attributes to be incorporated into the building and site plus the financial price bid. Environmental and financial performance were weighed equally and the developers were driven to balance cost/benefits of economic factors with environmental features to win the rights to build at these sites. The BPCA had a strong educational motivation to create a model for urban infrastructure that would yield reduced environmental effects. This was driven by the need to consider ways to accommodate future growth without expanding regional infrastructure.

The BPCA reviewed all bids and negotiated specific system details with the bidder submitting the most attractive bid package. Typically, decisions regarding system design were made by a professional team of consultants working for the developers with designs subsequently reviewed by the BPCA and the respective NYC agencies including the Department of Buildings, Department of Health and Department of Environmental Protection. The guidelines subsequently were updated for each new building site that was released.

Regarding the water aspects of each project, consideration was given for various water conservation and pollution abatement concepts. Graywater reuse originally was considered but then eliminated because of the high cost of constructing a dual collection system. Graywater (steam condensate) reclamation and reuse is subsequently being installed in one commercial building being constructed for Goldman Sachs; other passive treatment systems such as the Living Machine were considered originally but later eliminated because of space constraints. Wastewater reuse (or blackwater reclamation and reuse as it is often called) was selected as a more cost-effective alternative in these cases. Stormwater reuse also was included in each project, typically incorporating the collection of rainwater from green roofs after filtration through soil media. In each case, stormwater supply is stored separately from wastewater and is processed according to need and characteristics.

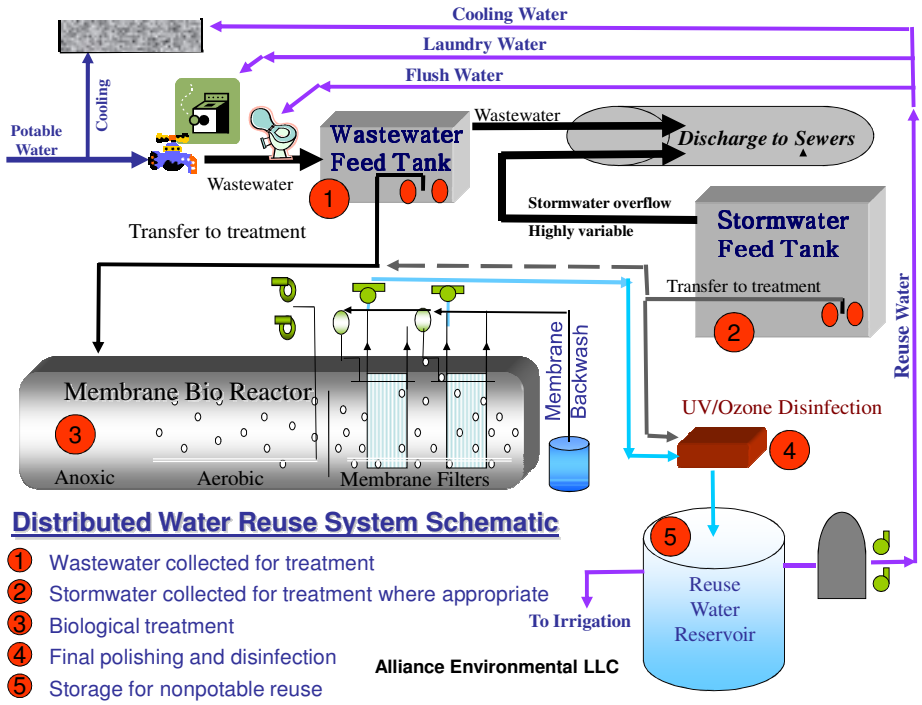
Uses for recycled water were considered in each project. At The Solaire, treated water is used for toilet flushing and cooling tower make-up, and a portion is diverted to the Battery Park Conservatory where it is used for subsurface drip irrigation. The water reuse system is sized for 95 m^3/d (25 000 gpd) and provides approximately 30% of the total water use in the building on an annual average basis. Precipitate-sensitive absorption chillers at The Solaire require removal of phosphorous to a level of 2 mg/L, which is accomplished by adding

aluminum hydrochloride prior to the membrane filters. Reuse water is fed to the cooling towers as a 50/50 blend with potable water. During peak demand, the cooling towers use up to 114 kL/d (30 000 gpd), which exceeds the supply of the water reuse system.

Later projects use similar technology but blend reuse water for cooling tower purposes differently as dictated by differing heat exchanger equipment. At the Riverhouse project, reuse water also feeds centralized laundry facilities in addition to toilets and cooling towers.

All technology selections were based on the developer's employed teams of experts, including architects and engineers with special expertise in landscape vegetation, plumbing, and wastewater treatment. Design concepts were developed by the design teams and submitted to BPCA for review and comment. Concepts were reviewed in design meetings and included economic and environmental attributes.

Water conservation was the overriding driver to select water reuse with the objective being demonstration of lower overall water infrastructure and resource demands.



CHALLENGES

The lack of state water reuse standards was the most significant hurdle this project had to overcome. New York State does not have water reuse standards, and the city referenced other published state standards to establish appropriate water quality requirements. Having a state standard for water reuse would have been helpful.

Regulation of water reuse systems originally was discussed among all city agencies and was delegated to the Department of Health at the outset. This is now transitioning to the

Department of Buildings. Good cooperation of all city agencies was required to overcome permit issues. Overall support for green building initiatives from the mayor's office was instrumental.

Because of the urban nature of these properties and associated restrictions on available land for siting wastewater systems, one unique element of the systems serving buildings in Battery Park City is that they are built into the internal infrastructure of the buildings, including process tanks that are part of the building structure and water reuse plumbing which is integral to the building. These constraints can make it difficult for existing systems to expand or change configuration. Certain economy of scale would have been gained if neighborhood-scale systems had been used; however, the individual-building approach offers the most flexibility and developer freedom to meet environmental requirements independently. In certain cases, existing buildings could add reuse systems, and it is possible that a neighborhood system could be configured to serve multiple buildings, but this has not yet occurred in Battery Park City.

The energy aspects of the water reuse systems need refinement and there is the potential of extracting heat energy from the warm water that is recycled. This would have helped achieve a higher level of energy conservation. Current work with the New York State Energy Research Development Authority (NYSERDA) is focusing on the energy aspects of water reuse.

There was no direct citizen involvement in this program other than typical for public projects. The only concern expressed by residents was about pets drinking from toilets that were supplied with nonpotable reuse water. Once water quality characteristics were established and communicated, this concern was mitigated.

Stormwater components are not well integrated into the systems and in some cases only serve drought tolerant green roof vegetation that does not require much water; therefore, these systems do not get used adequately. Better integration of the rainwater and wastewater reclamation systems would improve overall system performance.

FINANCING

Although there was some government-supported financing for a portion of individual projects, the developers arranged all of the financing for each project directly. Specific financing arrangements varied between projects and among developers. Some 80/20 financing was used where low- to moderate-income housing was provided. Albanese Development, for example, used Liberty Bonds, which required providing a minimum of 5% moderate income housing. The New York State Green Building Tax Credit also was used to help abate some of the additional costs associated with sustainable design features. This provided a $25 million fund to offset a percentage of green building costs. It provided a means for developers to earn back some of the cost associated with the sustainable components through tax credits.

Early projects yielded lower revenues to the BPCA than did subsequent projects. Land lease rates were lower because of the uncertainty about the cost for the green features. Once it was evident that the green buildings were successful, the land lease bids increased.

MANAGEMENT

It was decided at the outset that the city would oversee performance of the systems but in no way own or manage them. As a result, all of the water reuse systems are owned privately by the building owners – developers and/or condo associations. The owners are responsible for operating the systems and contract this service to a local service provider.

The building owners bid for the required services and manage this cost as part of operation of the buildings. They collect revenues via rent or association fees.

The NYC DEP, which owns the wastewater and water systems in the public right-of-ways, subsequently instituted a Comprehensive Water Reuse Incentive Program to offset the costs of water reuse system operation by providing a 25% reduction in the rates charged by the city for water and sewer service, if the system achieved a minimum reuse rate equal to 25% of total water use. This incentive program has helped offset the cost of system operation incurred by the building owners.

Customer service has not been an issue. Any resident concerns would first be expressed to the building owner and then failing resolution would be presented to the appropriate city agency.

PERMITS

Board of Health approval was obtained along with building and plumbing permits. For The Solaire, which irrigates Teardrop Park, a State Pollution Discharge Elimination System permit was issued by the New York State Department of Environmental Conservation.

Permits typically are administered by the Board of Health and the Building Department. Going forward, this will be managed by the Building Department solely. Permits are enforced by the Department of Health and Department of Buildings.

A commissioning period is conducted at the start-up of each system, which includes a two-week daily sampling and testing regime. During this commissioning period, all reuse water is discharged to the sanitary sewer. A professional engineer must first test the system and certify performance and subsequently the NYC DOB monitors water meters for verification that systems are in conformance with the Comprehensive Water Reuse Incentive Program requirements. Monthly water quality reports are submitted to the DOH/ DOB where they are reviewed for conformance with water quality requirements.

Once all tests are passed, approval is given to reuse the water. Subsequently, monitoring continues on a monthly basis assuming all parameters are within performance requirements. System installation is inspected as part of the plumbing permit to assure appropriate construction.

The permit fee is insignificant.

PERFORMANCE

The projects are compliance with all permits and are meeting water quality objectives, which include the following minimum performance standards:

BOD < 10 mg/l
SS < 10 mg/l
Fecal Coliform < 100 per 100 ml
E. Coli < 2.2 per 100 ml
pH = 6.5 to 8.0
Turbidity < 0.5 NTU for 95% of samples; < 5 NTU at all times

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LINKS

www.thesolaire.com/documents/green_building.html

www.batteryparkcity.org/pdf/BPCA_GreenGuidelines.pdf (Residential and Commercial Environmental Guidelines)

www.dec.ny.gov/energy/1540.html (New York State Green Building Tax Credit)