DC Water Ft. Reno Green Roof Project

Introduction

The District of Columbia Water and Sewer Authority (DC Water) is implementing its Long Term Control Plan (LTCP) through the DC Clean Rivers (DCCR) Project to control combined sewer overflows (CSOs) to the District's waterways. The DCCR is comprised of multiple projects designed to meet CSO control objectives and water quality standards in the District. Over the course of a 20-year period, DCCR will design and construct large-diameter underground storage tunnels to capture CSO flows during storm events. In addition to the new grey urban infrastructure, DC Water has completed a project to retrofit existing DC Water facilities with Green Infrastructure (GI) measures as part of the LTCP requirements.

DC Water assessed the entire inventory of facilities for GI implementation consideration and a variety of measures were designed based on the unique features at the existing facilities. The most prominent element of this project, due to its size, complexity and sensitive location, is a 42,390 square foot green roof that was installed over an existing drinking water reservoir located at Fort Reno in Washington, DC.

The Fort Reno green roof project, completed in December 2013, is being submitted in the Operations and Environmental Performance category and meets the criteria for innovation and effectiveness and environmental compliance and restoration as exemplified in the project narrative below.

Background

Due to siting the green roof over a drinking water reservoir, a very conservative design approach was employed to ensure the integrity of the drinking water supply within the reservoir. The Fort Reno Reservoir is a covered 5.8 million gallon reservoir system that was constructed in the early 1900's. The roof of the Reservoir is made up of an 8-inch thick reinforced concrete slab

topped with a built-up roof to protect it (and the treated drinking water) from the elements. Major concerns upon siting the green roof included: integrity of the existing concrete slab (potential for leakage); compressive strength of the existing concrete slab; tensile strength of the structural steel reinforcing in the roof slab; protection of the potable water stored within the reservoir; presence of contaminants in the concrete and built-up roofing system; and perception of constructing a green roof over a potable water reservoir.

Even though the site presented unique challenges for implementing a green roof, it was viewed as a prime candidate for GI retrofit. The existing 3.5-acre site has a high percentage of impervious area that includes impervious paved parking areas, access roads, buildings and the 1.0-acre reservoir roof. The location of the reservoir was also a driving factor in its selection for GI. The reservoir sits on a historic hillside site above Washington, DC's historic Tenleytown neighborhood and is visible from the neighborhood by residents and those passing through the area. The completed green roof will aid in creating awareness of GI in the District and its capacity to reduce stormwater runoff and assist in controlling CSO events along with its other ancillary benefits.

The new green roof, with its carefully designed undulating form, visually connects what was once a visually harsh one-acre impervious Reservoir rooftop with the surrounding open green fields. In addition, the roof is less than two feet off the surrounding ground. The combination of low elevation (relative to surrounding grade) and integrated permeable paver walkways enable its use as a safe and accessible green roof education and training facility. The green roof at Fort Reno will serve as a demonstration project site to monitor performance of the practice and to build on DC Water's GI experience for potential large-scale implementation in CSO areas through DC Water's Long Term Control Plan Modification.

Design

A complete structural analysis of the existing reservoir roof slab was completed prior to proceeding with the design of the green roof. In order to evaluate the structural integrity of the roof, a testing program to determine the compressive concrete strength and tensile strength of the existing roof slab was completed. This program also provided insight into the makeup of the existing built-up roofing system, which differed from the available record drawings. The structural analysis determined that the green roof system could not exert a loading in excess of 50 pounds per square foot (psf). Since the existing built-up roof contributed 30 of the 50 psf available, it was decided to completely demolish the existing roofing system (down to the bare concrete slab) to make the full 50 psf available for the green roof system.

Two key drivers dictated the design of the green roof at Fort Reno: total green roof system weight and ensuring against leaks in the green roof system assembly. These factors guided every design decision to create a lightweight and "leak-proof" green roof. The complete green roof system is represented in the attached supporting materials.

To achieve the structural loading requirements required at Fort Reno Reservoir, all of the green roof assembly materials were carefully selected. The soil media formulation was selected to provide just enough organic material to sustain the green roof plantings while meeting the strict weight requirements. The insulation specified for the green roof is composed of extruded polystyrene due to its hydrophobic properties, low water absorption, and, most importantly, its low weight. Incorporating this material into the green roof assembly allowed the designers to create a rolling topography for added visual interest on the roof and allowed for planting diversity that complemented the topography. Lastly, through the incorporation of a ½ inch thick capillary fabric (which facilitates water absorption and distribution), the designers were able to minimize the soil media depth while maintaining diversity in the plant selection.

To ensure a "leak-proof" green roof, the designers employed a series of multiple waterproofing layers in conjunction with a continuously-operating leak detection system. A mod-bit waterproofing membrane, a two-ply fiberglass reinforced waterproofing product, as well as a thermoplastic membrane, were installed as part of the green roof assembly. Unlike most green roof installations which employ a single waterproofing layer, the use of two waterproofing layers together serves as an additional line of defense to protect the reservoir. In addition, a vapor barrier was applied directly to the concrete roof slab to inhibit moisture within the reservoir from migrating up through the green roof system. In the unlikely event of penetrations to both the mod-bit waterproofing membrane and the thermoplastic waterproofing membrane, the vapor barrier layer also protects the drinking water supply from green roof infiltration. In conjunction with the multi-layer waterproofing, a 40-mil High-Density Polyethylene (HDPE) root barrier tops the mounding insulation to inhibit root growth through the barrier and protect the waterproofing membranes. A continuously-operating leak detection system was installed to actively monitor the roof for any potential leaks and is linked to DC Water's Supervisory Control and Data Acquisition System to provide 24-hour monitoring of the roof and protection of the drinking water supply.

Project Significance

The Fort Reno green roof and other GI measures installed under the same contract (bioretention, permeable pavers, and an additional green roof) will be evaluated for their effectiveness by comparing pre- and post-retrofit data. The overall project will also serve as a showcase to create public awareness and promote the benefits of GI and how it can be implemented successfully. The lessons learned from this project will be applied to future GI measures that are proposed as part of DC Water's Long Term Control Plan Modification to implement $90 Million of GI in the Rock Creek and Potomac River drainage areas (see dcwater.com/green for additional information).