LANDSCAPE PERFORMANCE SERIES

Canal Park
Methodology for Landscape Performance Benefits

Case Study Brief Prepared by:
Research Assistant: *Jennifer Salazar, University of Maryland*
Firm Liaisons: *Michael Miller, OLIN; Meghan Talarowski, OLIN; Karl-Rainer Blumenthal, OLIN*

Landscape Performance Benefits and Methodologies

ENVIRONMENTAL BENEFITS

Canal Park achieved a Three-Star Certification in the Sustainable Sites Initiative™ (SITES™) Pilot Program and Gold Certification in Leadership in Energy & Environmental Design (LEED) for Building Design and Construction: New Construction v3. The submittal documentation for these certification processes provided a significant source of data for evaluating the environmental performance of the park. This data was utilized in combination with site visits, discussions with park management, and additional research to measure the park's performance.

- ***Captures and treats 95% of average annual runoff from the site and neighboring streets, approximately 3 million gallons per year, helping to prevent combined sewer overflows to the Anacostia River.***

Method

The stormwater treatment system for the 3-acre site was designed to collect, filter, and reuse runoff for the non-potable water needs of the park. The water collected by the system falls into three different categories: surface runoff from the site that is treated and reused, rainwater from on-site roof drains and in the future, off-site roof drains that is treated and reused, and surface runoff from the site and streets that is treated and returned to the existing city stormwater system (Figure 1).

Runoff from approximately 69,000 sf of the site's surface is captured and directed to an aqua-swirl system for sediment removal through vortex separation. From there, the stormwater enters one of the two 40,000 gallon cisterns located below the southern block referred to as the pre-treatment cistern. Stormwater leaves the pre-treatment cistern and is sent to the linear rain gardens along the eastern edge of the park to undergo bio-filtration. This treated water is then returned to the second cistern, referred to as the clean water cistern. Rainwater collected from the roofs of the pavilions on-site is piped directly to the clean water cistern, and when the parcels adjacent to the park have been developed, the system is designed to collect rainwater from these off-site roof drains, which will be sent to the clean water cistern as well. Treated stormwater leaves this cistern and undergoes a micro-filtration process and disinfection using ultraviolet (UV) light to prepare it for reuse. Water is reused on-site for irrigation, make-up water for the ice rink and in the park's two interactive fountains, saving a significant amount of potable water (Figure 2).

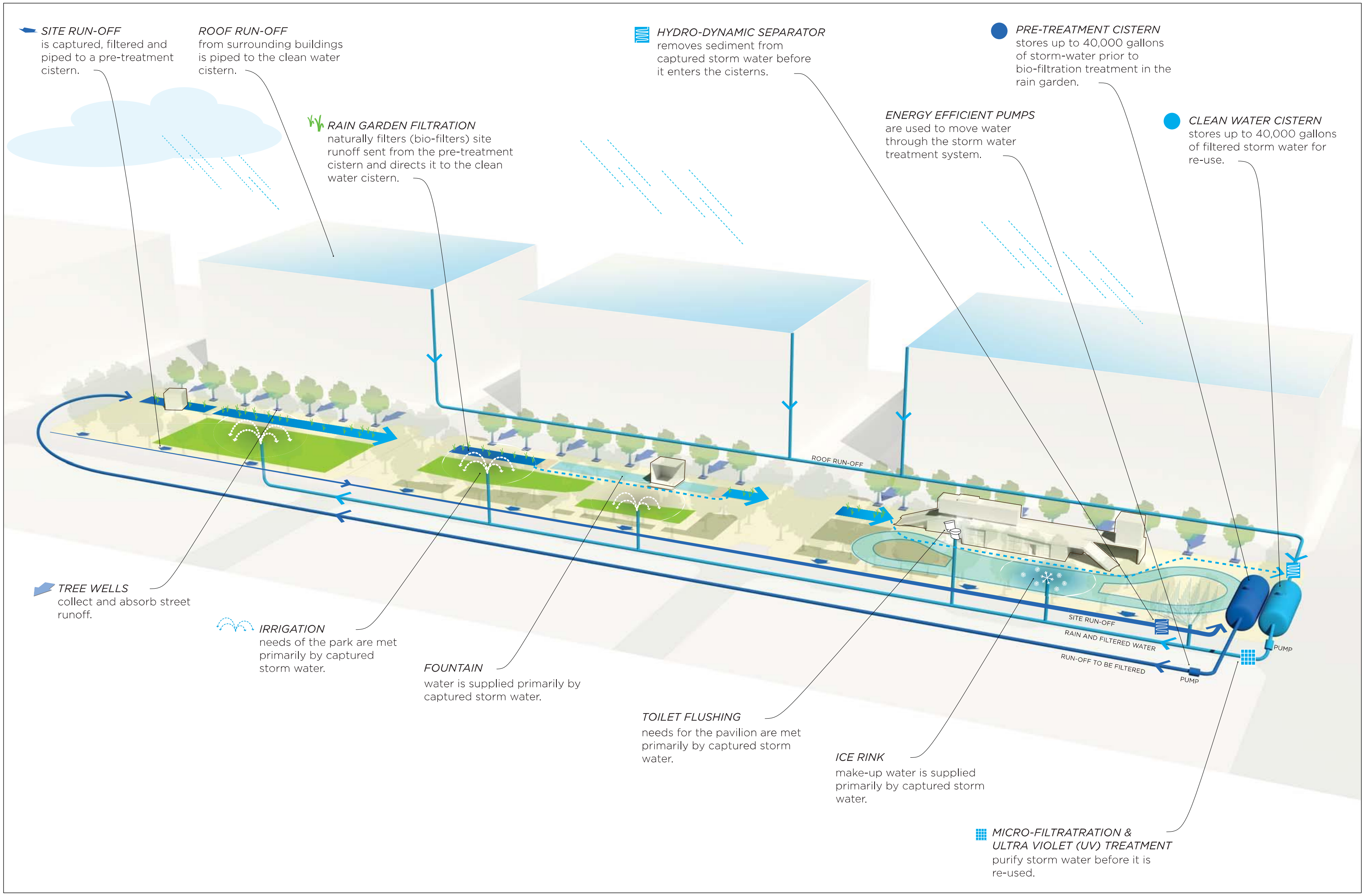

Figure 1: Diagram of stormwater system (Source: OLIN)

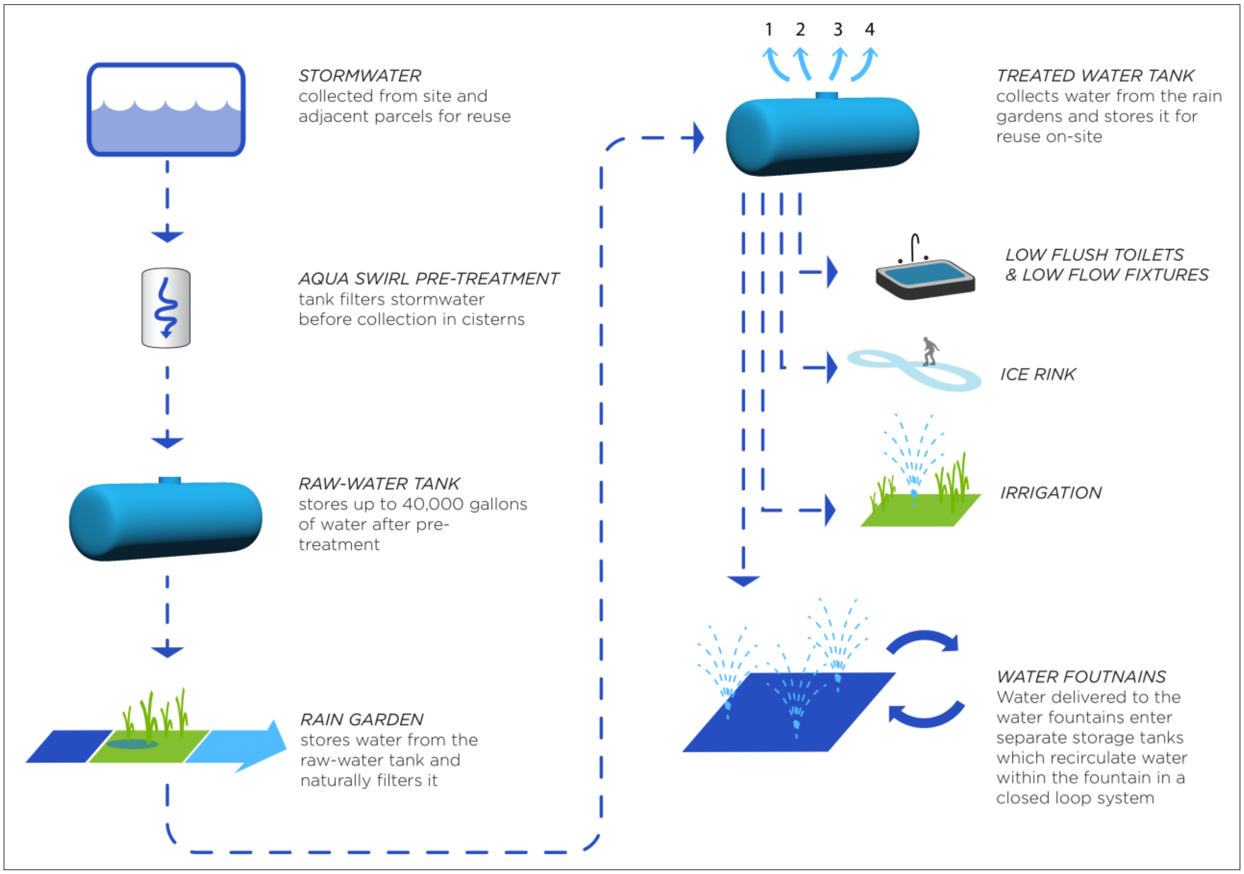

Figure 2: Path of stormwater through filtration and reuse system (Source: OLIN)

The 46 bioretention tree pits along the perimeter of the site capture surface and street runoff from the remainder of the site, roughly 57,000 sf. The tree pits retain and treat the stormwater, filtering out contaminants before allowing it to infiltrate or returning it to the existing city drainage system. This treatment slows the water and reduces the volume entering the city's combined sewer system, helping to avoid sewer overflows during heavy rains.

The District Department of the Environment (DDOE) stormwater regulations require a minimum retention capacity of all rainfall events up to 1.2 in. The retention capacity of the stormwater filtration and reuse system totals about 88,500 gallons, including 80,000 gallons available in the two cisterns and 8,500 gallons available in the rain gardens while the bioretention tree pits have a capacity of approximately 68,000 gallons. Based on the drainage areas and retention capacities on-site, the park's stormwater system completely retains and treats up to approximately 2 in. of runoff from the site, exceeding the city requirements.

In order to determine the average annual runoff treated on-site, all storm events from 2007 – 2011 recorded at the weather station closest to the site (Washington Reagan National Airport, VA) were analyzed. During this time period, 98% of all storm events recorded a rainfall of 2 in. or less, and based on the stormwater system's retention capacity, it is assumed that the site captured and treated all of the runoff from these events. For the remaining 2% of storm events, the first 2 in. of runoff from each event was also retained. This accounted for 95% of the total volume of rainfall during this period. Using this information, it is estimated that 95% of the average annual site runoff, approximately 3 million gallons, is captured and treated.

Calculations

Volume available in two 40,000 gallon cisterns = 80,000 gallons
Volume available in rain gardens = 8,500 gallons
Retention capacity of filtration & reuse system = 80,000 + 8,500 = 88,500 gallons = 11,831 cu ft
(*Volume available in Water Quality Treatment Unit = 21,500 gallons – excluded from calculation because provides no retention capacity)
Area of site draining to filtration & reuse system = 69,000 sf
Retention depth of filtration & reuse system = 11,831/69,000 = 0.17 ft = 2.04 in

Volume available in 6 ft by 6 ft tree pits:
Volume within tree pit (4 in ponded depth) = 6 ft X 6 ft X 0.33 ft = 11.88 cu ft
Volume within soil (30% void volume) = 6 ft X 26 ft X 4 ft X 0.30 = 187.2 cu ft
Volume within stone underdrain (40% void volume) = 7.5 ft X 7.5 ft X 0.75 ft X 0.40 = 16.88 cu ft
Total volume in tree pit = 11.88 + 187.2 + 16.88 = 215.96 cu ft

Volume available in 8 ft by 4 ft tree pits:
Volume within tree pit (4 in ponded depth) = 8 ft X 4 ft X 0.33 ft = 10.56 cu ft
Volume within soil (30% void volume) = 4 ft X 28 ft X 4 ft X 0.30 = 134.4 cu ft
Volume within stone underdrain (40% void volume) = 9.5 ft X 5.5 ft X 0.75 ft X 0.40 = 15.68 cu ft
Total volume in tree pit = 10.56 + 134.4 + 15.68 = 160.64 cu ft
Retention capacity of tree pits = (215.96 X 31) + (160.64 X 15) = 9,104 cu ft = 68,100 gallons
Area of site draining to tree pits = 57,000 sf
Retention depth of tree pits = 9,104/57,000 = 0.16 ft = 1.92 in

Volume of all rain events up to 2 in from 2005 to 2011 = 198.62 in
Total volume of rainfall from 2005 to 2011 = 207.99 in
% Average annual site runoff captured = (198.62/207.99) X 100 = 95%

Average annual rainfall on site = 39.74 in = 3.3 ft
Area of site = 69,000 + 57,000 = 126,000 sf
Volume of annual site runoff captured = 3.3 ft X 126,000 sf X 0.95 = 395,000 cu ft = 2.95 million gallons

Sources

- Center for Neighborhood Technology, *The Value of Green Infrastructure: A Guide to Recognizing Its Economic, Environmental and Social Benefits*, 2010
  http://www.cnt.org/repository/gi-values-guide.pdf
- District Department of the Environment, Stormwater Management
  http://ddoe.dc.gov/stormwater
- EPA, *Integrating Stormwater Management and Public Amenities through a Public-Private Partnership: Canal Park – Washington, D.C.*, April 2014
  http://water.epa.gov/polwaste/green/upload/lid_canal_park_dc.pdf
- NOAA National Climatic Data Center, Climate Summaries & Climate Normals 1981-2010
  http://www.ncdc.noaa.gov/cdo-web/
- OLIN, *SITES Submittal Documentation – Credit 3.5: Manage stormwater on site*, January 2012
- OLIN, *SITES Submittal Documentation – Credit 3.6: Protect and enhance on-site water resources and receiving water quality*, October 2012
- OLIN, *SITES Submittal Documentation – Credit 3.8: Maintain water features to conserve water and other resources*, September 2013

Limitations

The amount of stormwater captured and treated by the site is an estimate based on simplified calculations that do not take into account the different runoff properties of the various surfaces of the park. The calculations assume that all of the rain falling on the site becomes runoff and that the full retention capacity of the stormwater system is available for each rain event. When calculating the volume available for runoff retention within the tree pits, assumptions are also made about the ponded depth within the pits and the void volume in the soil and stone underdrains.

- ***Saves 886,000 gallons of potable water each year by meeting 88% of the park's needs for landscape irrigation, fountains, and the ice skating rink through stormwater reuse. When adjacent parcels are developed in the future and tied into the system, 99% of the park's water needs could be met. Reusing stormwater currently saves $4,600 annually and could ultimately save $5,200 annually.***

Method

The stormwater system is designed to reuse some of runoff captured and treated on-site to meet the park's non-potable water needs. The site runoff captured by the stormwater filtration and reuse system follows the path outlined above in Figure 2. The runoff undergoes a multi-step treatment process of filtration and disinfection in preparation for reuse on-site. Treated stormwater is reused for landscape irrigation, in the two interactive fountains, and as make-up water for the ice skating rink in the winter. This reuse reduces the volume of potable water used for the park's operation.

To calculate the amount of potable water saved through reuse, the first step was approximating the daily and monthly demand for each site use. Based on these estimates, the total water demand for the site was determined to be around 1 million gallons per year. The next step, completed by one of the design team consultants, was determining the amount of runoff that could be captured and reused from the site based on the drainage area, surface cover type, local historical rainfall data, and storage capacity of the stormwater system. The volume of stormwater currently available for reuse was estimated at 886,000 gallons per year, enough to meet about 88% of the park's annual demand.

In order to further decrease the use of potable water in the park, additional stormwater had to be captured off-site. To do this, the stormwater system was designed to integrate with adjacent parcels as they were redeveloped in the future. The system has the infrastructure and storage capacity to connect to the roofs of the buildings that will be built on the lots adjacent to the park (Figure 3). The additional volume of stormwater provided by off-site roof runoff will allow the park to meet almost all of its demand through reuse, highlighting the park's main objective of the sustainable management of water. If the runoff from just 20,000 sf of roof area is added to the system, it is projected that 998,000 gallons of stormwater will be available for reuse per year, close to 100% of the park's current annual demand.

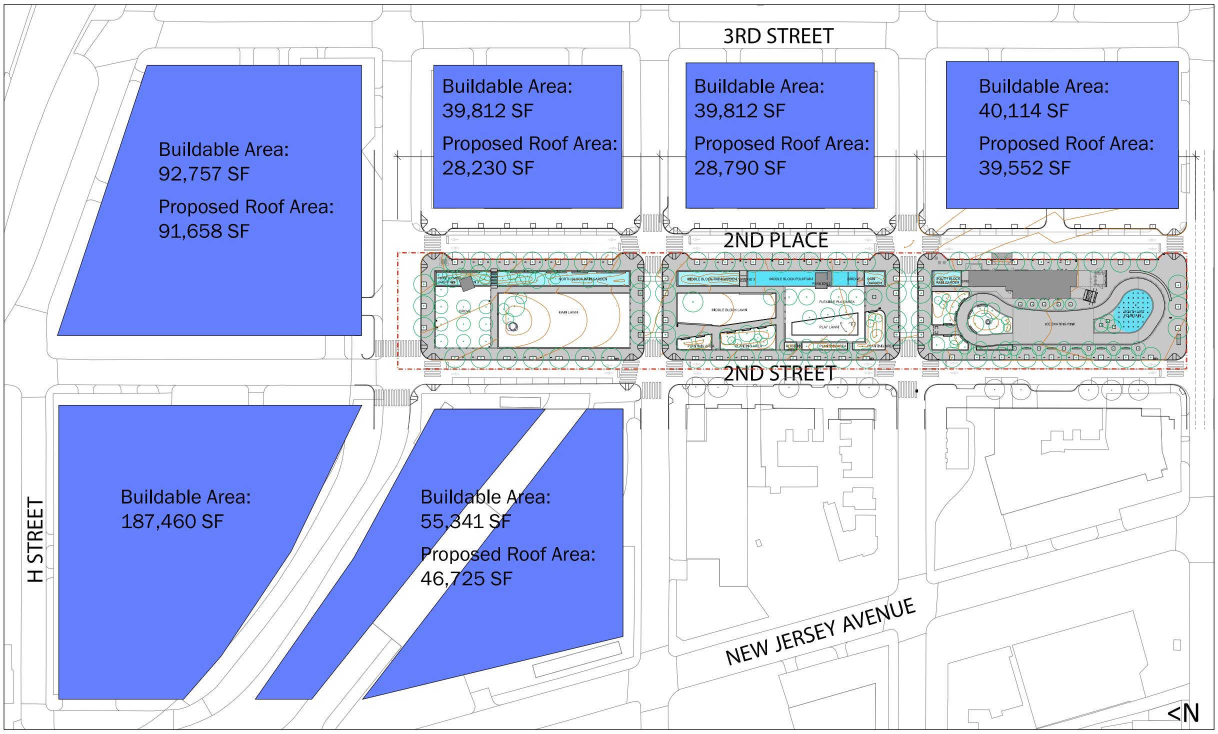

Figure 3: Adjacent parcels identified for potential integration with park stormwater reuse system (Source: OLIN)

Calculations

Type of Use	Annual Demand (gallons)
Landscape Irrigation	580,584
Interactive Jet Fountain	155,000
Interactive Skim Fountain	144,996
Ice Rink make-up water	129,700
ALL USES	1,010,280

Annual water demand = 1,010,280 gallons
Annual volume of stormwater available for reuse:
Captured from site = 885,681 gallons
Captured from site + 20,000 sf roof area off-site = 998,108 gallons
% of Annual demand met by current reuse = (885,681/1,010,280) X 100 = 88%
% of Annual demand met by future reuse = (998,108/1,010,280) X 100 = 99%

2015 DC Water Rate = $5.19 per 1,000 gallons
Annual cost savings with current reuse = (885,681/1,000) X 5.19 = $4,597
Annual cost savings with future reuse = (998,108/1,000) X 5.19 = $5,180

Sources

- District of Columbia Water and Sewer Authority, Rates & Metering http://www.dcwater.com/customercare/rates.cfm
- OLIN, *SITES Submittal Documentation – Credit 3.6: Protect and enhance on-site water resources and receiving water quality*, October 2012
- OLIN, *SITES Submittal Documentation – Credit 3.8: Maintain water features to conserve water and other resources*, September 2013
- Personal communication, Janet Weston, Park Manager, February 2015

Limitations

In addition to the site uses listed above, it is important to note that the system was designed and sized to provide treated stormwater for reuse in the pavilion toilets as well (Figures 1 & 2). When the park first began operation, treated runoff was being used for toilet flushing, however, management received constant complaints from the public regarding the “dirty” appearance of the water in the toilets. Despite their best efforts to explain this sustainable practice through signage and other methods, public dissatisfaction remained high and park management decided to return to the conventional method of using city water in the toilets. This switch means that the approximately 600,000 gallons per year required for toilet flushing is no longer being supplied by reused stormwater. All of the calculations performed to estimate demand and availability for reuse were adjusted accordingly, however, this may have affected the accuracy of the predictions.

The likelihood that the park will connect to adjacent parcels in the future and be able to collect additional stormwater from off-site roof runoff is currently unknown. Since the park was completed, the parcel to its north was redeveloped, but the renovated building was not connected to the park’s stormwater system during the process. Another parcel at the northwest corner of the park is currently being redeveloped, but again, there is no indication that it will connect to the system (Figure 3). Because switching the toilets to city water decreased the park’s current demand for reused stormwater, runoff from the site can provide for most of its non-potable needs. While this makes it less important for the system to connect to off-site sources at the present time, circumstances may change in the future.

Additional Water Information:

Method

Prior to this project, the city of DC did not allow stormwater to be reused for interactive fountains or spray irrigation due to concerns over the potential risks to human health when people came in contact with the water. Using the project as a test case, the DDOE collaborated with the design team to identify and address the risks associated with the reuse of stormwater runoff in areas of high human exposure. The first step required was on-site stormwater reuse risk assessment completed by a consultant on the design team that determined the baseline conditions of the site. This assessment was used to discover what contaminants were found within the stormwater that would potentially be reused on the site and may pose a risk to human health. The risk analysis identified several pollutants of concern on the site including arsenic and lead, and also found high levels of biological organisms. To eliminate the risks to human health, the stormwater treatment and reuse system was designed using Best Management Practices (BMPs) chosen to reduce the specific pollutants of concern identified in the risk analysis.

The stormwater captured in the park’s reuse system undergoes two major processes, sediment removal and UV disinfection. Sediment is removed through vortex separation in an aqua-swirl system, through bioretention in the park’s rain gardens and through micro-filtration performed by bag filters. This removal properly prepares the stormwater for effective UV disinfection, the final process undergone before the water is reused. The sediment removal process reduces the TSS concentration of the stormwater by over 99% and subsequently reduces arsenic and lead concentrations, which are predominantly particle-bound. Using the Mixed Open Space land use category from the National Stormwater Quality Database, the baseline TSS concentration for site runoff is 78 mg/L. This concentration is reduced to 0.14 mg/L through the sediment removal process and UV disinfection removes 100% of the contamination by biological organisms, eliminating the risks to human health associated with exposure to arsenic, lead, and bacteria.

Park management confirms that an outside company is used to monitor the stormwater filtration and reuse system. The company performs weekly water quality tests to verify standards are being met and contaminants remain below acceptable levels, making adjustments to the system as necessary. The results of these tests are available to the DDOE upon request to confirm the park is meeting the city requirements for water quality. In order to avoid contributing any additional contaminants to the stormwater runoff that may pose risks to human health, park management verifies that no chemical pesticides are used on-site. All products used for weed control and other vegetation maintenance are organic and biodegradable.

The DDOE considered the park's stormwater filtration and reuse system a success and utilized what was learned from their collaboration with the design team to create new city guidelines for assessing the potential risks to human health when reusing stormwater runoff in areas of high possible exposure. The park also acts as a demonstration project for the DDOE, providing a model for other projects with similar goals of sustainable stormwater management.

Calculations

Initial TSS load of site runoff = 1.0
TSS load removed by vortex separation = 1.0 X 91% removal rate = 0.91
Remaining TSS load after vortex separation = 1.0 – 0.91 = 0.09
TSS load removed by bio-retention = 0.09 X 90% removal rate = 0.081
Remaining TSS load after bio-retention = 0.09 – 0.081 = 0.009
TSS load removed by micro-filtration = 0.009 X 80% removal rate = 0.0072
Final TSS load after micro-filtration = 0.009 – 0.0072 = 0.0018
Total TSS removal rate of stormwater filtration & reuse system = 1.0 – 0.0018 = 0.9982 = 99.82%

Baseline TSS concentration for site runoff = 78 mg/L
Final TSS concentration for site runoff after treatment process = 78 X (1 – 0.9982) = 0.14 mg/L

Sources

- District Department of the Environment, *Stormwater Management Guidebook*, "Appendix M – Tiered Risk Assessment Management (TRAM): Water Quality End Use Standards for Harvested Stormwater for Non-Potable Uses," July 2013
  http://ddoe.dc.gov/swguidebook
- Environmental Consultants and Contractors, Inc., *On-Site Stormwater Reuse Risk Assessment: Canal Park Property*, August 2010
- *New Jersey Stormwater Best Management Practices Manual*, "Chapter 4: Stormwater Pollutant Removal Criteria," February 2004
  http://www.nj.gov/dep/stormwater/bmp_manual/NJ_SWBMP_4%20print.pdf
- OLIN, *SITES Submittal Documentation – Credit 3.6: Protect and enhance on-site water resources and receiving water quality*, October 2012
- Personal communication, Janet Weston, Park Manager, February 2015

Limitations

Results from the on-site weekly water quality testing were not available to verify if the actual reduction in contaminants matched what was projected for the site runoff.

- ***Reduces annual energy consumption in the park by 12.6%, saving almost $26,000 per year in utility costs by using geothermal ground source heat pumps for heating and cooling the pavilion and restaurant, and exterior light fixtures that use 67% less power.***

Method

The client's original vision for the project was to create a zero-energy park demonstrating sustainable strategies. Although the project did not achieve this ambitious net zero goal, the client's vision did make sustainability a priority in the design. Sustainable solutions were utilized throughout the park, with the 28 geothermal wells located beneath the southern block included in the design to help reduce energy consumption. The geothermal wells are used to transfer heat to and from the earth to provide more energy-efficient heating and cooling for the large pavilion and restaurant.

To estimate the savings in energy use and utility costs for the park as part of the LEED certification process, an energy analysis was conducted for the park buildings and site by one of the design team consultants. Modeling was used to compare the proposed design for the park against a baseline case built according to the requirements of ASHRAE 90.1-2007 Appendix G. Included in the analysis was the large pavilion building with restaurant, ice rink, fountain pumps, site lighting, and the two smaller pavilions. The model demonstrated that the proposed design was 12.6% more efficient in annual energy consumption and 15.9% more efficient in annual energy cost than the baseline case (Figures 4 & 5). Increased energy efficiency in the proposed design was attributed to the use of geothermal ground source heat pumps for heating and cooling the main pavilion, a high efficiency hot water heater, and using energy efficient interior and exterior lighting. The exterior light fixtures used in the site design require only 8.94 kW of power to operate compared to the baseline case of 27.105 kW, a reduction of 67% in aggregate lighting power.

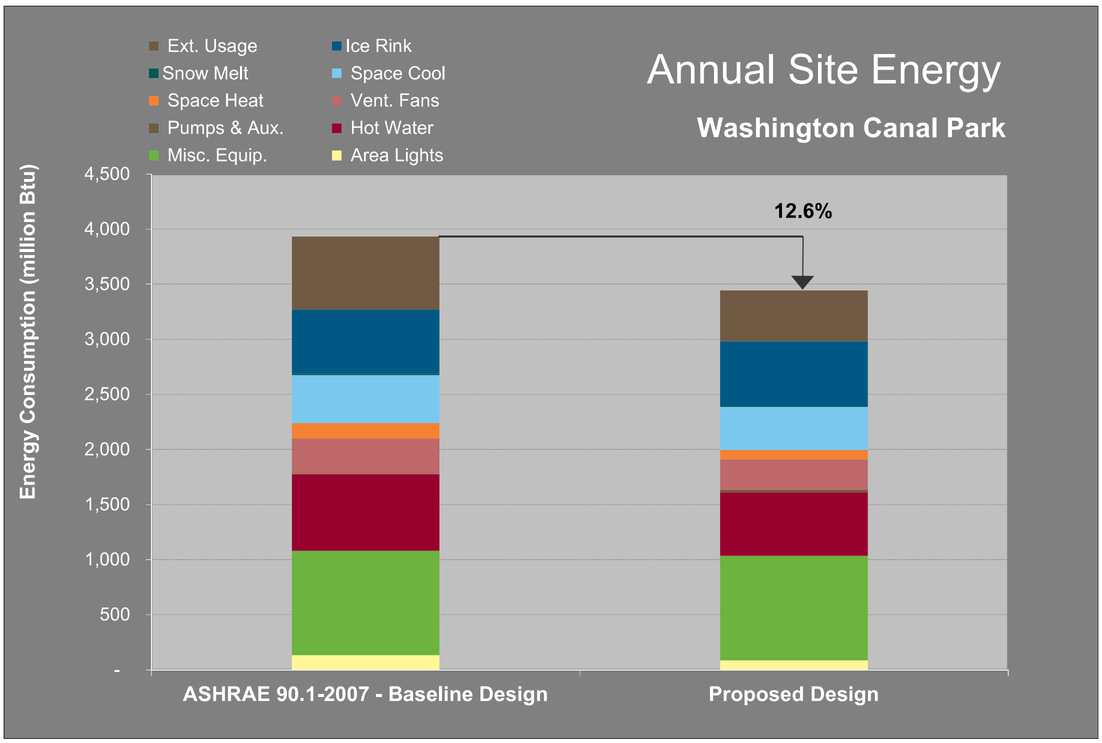

Figure 4: Annual energy consumption comparison (Source: Atelier Ten, *Final LEED Energy Analysis Report*)

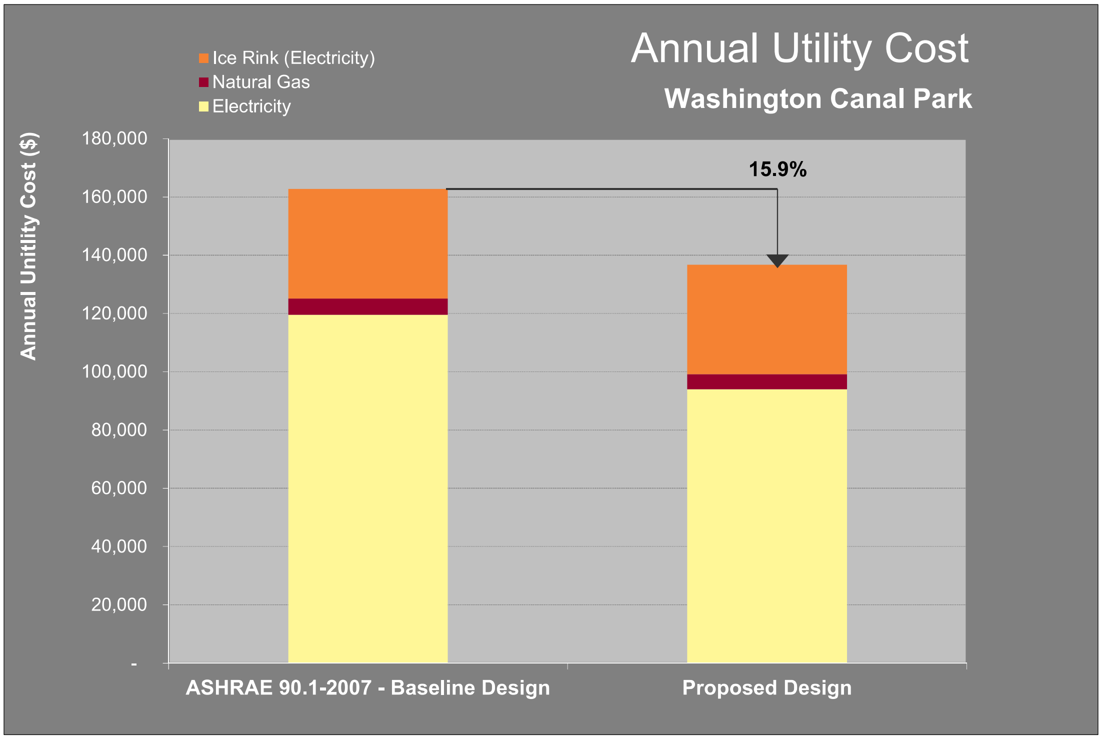

Figure 5: Annual utility cost comparison (Source: Atelier Ten, *Final LEED Energy Analysis Report*)

Calculations

Baseline Design Annual Energy Consumption = 3,935 million Btu
Proposed Design Annual Energy Consumption = 3,440 million Btu
% Annual Energy Reduction = ((3,935-3,440)/3,935) X 100 = 12.6%

Baseline Design Annual Utility Cost = $162,700
Proposed Design Annual Utility Cost = $136,800
Annual Cost Savings = $25,900
% Annual Cost Savings = (25,900/162,700) X 100 = 15.9%

Baseline Design Exterior Lighting Power = 27.105 kW
Proposed Design Exterior Lighting Power = 8.94 kW
% Power Reduction = ((27.105 – 8.94)/27.105) X 100 = 67%

Sources

- Atelier Ten, *Final LEED Energy Analysis Report: Washington Canal Park,* October 2011
- OLIN, *SITES Submittal Documentation – Credit 8.4: Reduce outdoor energy consumption for all landscape and exterior operations*, October 2012
- Personal communication, Janet Weston, Park Manager, February 2015

Limitations

Because the energy model is based on the proposed park design, certain assumptions about future performance had to be made to complete the analysis. The energy assumptions were verified with the design team to create the most accurate model possible, however, the actual energy savings may differ from what was predicted. Figures on the current energy use for the park were not available, however, the park manager estimated that the energy savings were close to the predicted performance.

- ***Diverted 1,782 tons of material from landfills by recycling 100% of concrete, brick, block, and asphalt during construction and demolition. This reduced greenhouse gas emissions by an estimated 157 metric tons, equivalent to the annual emissions from 33 passenger vehicles.***

Method

As part of the LEED and SITES certification processes, a waste management plan was developed and implemented during construction to minimize the amount of waste created by the project. The plan identified the disposal method of all waste materials generated on-site with the majority of materials to be recycled or salvaged for reuse. A procedure for tracking and documenting the disposal of all materials removed from the site was put into place to verify the amount of waste diverted from landfills. The documentation demonstrates that 774 tons of Concrete, Brick, and Block, and 1,008 tons of Asphalt were recycled and no material was sent to landfills.

To estimate the reduction in greenhouse gas emissions, the EPA Waste Reduction Model (WARM) was utilized to compare a baseline case where 774 tons of concrete and 1,008 tons of asphalt concrete were landfilled to the alternative case where 100% of the materials were recycled. The EPA Greenhouse Gas Equivalencies Calculator was then used to determine the emissions equivalent.

Calculations

Concrete, Brick, Block recycled = 774 tons
Asphalt recycled = 1,008 tons
Total material recycled = 774 + 1,008 = 1,782 tons

Sources

- EPA Greenhouse Gas Equivalencies Calculator
  http://www.epa.gov/cleanenergy/energy-resources/calculator.html
- EPA Waste Reduction Model (WARM)
  http://epa.gov/epawaste/conserve/tools/warm/index.html
- James G. Davis Construction Corporation, *Waste Management Plan*, March 2011
- OLIN, *SITES Submittal Documentation – Credit 7.4: Divert construction and demolition materials from disposal*, October 2012

Limitations

When estimating the emissions reduction, data on the amount of each material recycled within the 774 tons of concrete, brick, and block was not available. The full 774 tons was entered into the WARM model as concrete possibly affecting the calculation.

SOCIAL BENEFITS

The landscape architect and design team leader for the project (OLIN) conducted an in-depth post-occupancy evaluation of the park over a year-long period from May 2013 to April 2014. The study was designed to monitor the performance of three credits that fall under the Human health and well-being category of SITES certification; credits 6.5, 6.7, and 6.8, and to obtain a more in-depth understanding of how the park was functioning for people (See the PERFORMANCE MONITORING tab in the Case Study Brief for more details).

A variety of methods were utilized to provide a wide range of information on park operation and performance, as well as visitor use and perception. Interviews were conducted with key park stakeholders and a survey was developed and administered to visitors on-site and online. Environmental monitoring of light and sound levels was conducted and hourly weather conditions were recorded. On-site observations and time-lapse photography of park activity supplied additional information to support data collected through surveys. A pilot study completed in May 2013 helped to refine the survey instrument and observation techniques utilized for the evaluation. Data was collected over a period of ten days, chosen to cover a range of different seasonal use, and different weekday and weekend use:

- Thursday – Saturday, August 8-10, 2013 (Summer)
- Tuesday, October 29 & Sunday, November 3, 2013 (Fall)
- Friday – Saturday, February 14-15 & Thursday, February 20, 2014 (Winter)
- Friday – Saturday, April 11-12, 2014 (Spring)

For the survey, over 400 visitors were engaged and 217 surveys were completed, providing much of the data used to quantify the social performance of the park. Data collected from the interviews, time-lapse photography and direct observations were also analyzed to measure performance. The park is a part of a rapidly developing 500-acre neighborhood known as the Capitol Riverfront, and a yearly survey conducted by the local Business Improvement District (BID) provided additional data for evaluating the park's social benefits.

- ***Draws almost 28,000 annual visitors through year-round programming and special events. Over 20,000 skaters use the ice rink during the winter months and 5,000 visitors participate in a 3-day outdoor holiday market. A summer movie series attracts 2,200 attendees, with 38% of neighborhood residents attending at least one movie screening per season.***

Method

One of the park's main objectives was to attract local residents as well as citywide visitors year-round. This is accomplished partly through park programming and special events hosted throughout the year. Annual attendance estimates for park events and programs were derived from data collected by the Capitol Riverfront BID and verified by on-site observations when possible.

The seasonal ice-skating rink operates from November through March and in its first year of operation (2012-2013) it drew more than 20,000 visitors. Numerous special events take place in the park and attract visitors from throughout the city as well as local residents. The PARCEL Market, a 3-day outdoor holiday market, took place in December 2014 with 5,000 participants and will return in 2015. Outdoor movies are screened every Thursday night from June through August, and attracted an estimated 2,200 attendees in the summer of 2014, an average of 200 people per week. Estimated attendance was confirmed through on-site observations, with 267 participants recorded at one screening in August 2013 (Figure 6). The Capitol Riverfront BID annual neighborhood perception study conducted in October and November 2014 also asked respondents if they had attended any of the summer movie screenings in the past year. 38% of the 260 resident respondents and 12% of the 331 employee respondents replied yes.

Figure 6: Visitors enjoying a summer movie screening in the park (Source: OLIN)

In addition to these larger public events, the park also hosts smaller neighborhood functions and private events. Weekly functions include a farmers market that takes place from May through October and noontime concerts from May through July. Starting in 2015, the Capitol Riverfront BID will be taking over full event coordination for the park. An increase in the number of events and attendance is anticipated in the future, as the BID is able to integrate the park's functions with other neighborhood events and the park becomes better known to visitors.

Calculations

Total Annual Visitors drawn by programming & special events = 20,000 + 5,000 + 2,200 = 27,200
% Neighborhood Residents attending at least one park movie per year = 38% of 260 residents

Sources

- Capitol Riverfront BID, *2014 Annual Meeting Presentation Slides*, January 2015 http://www.capitolriverfront.org/_files/docs/nual-meeting-2014-presentation-final---for-web.pdf
- Capitol Riverfront BID, *2014 Perception Survey*, February 2015 http://www.capitolriverfront.org/_files/docs/2014_perception-survey_final.pdf
- Capitol Riverfront BID, *Annual Report 2013*, January 2014 http://www.capitolriverfront.org/_files/docs/crbid_ar2013_low.pdf
- Capitol Riverfront BID, *Annual Report 2014*, January 2015 http://www.capitolriverfront.org/_files/docs/2014_annualreport_final.pdf
- OLIN, *SITES Submittal Documentation – Credit 9.1: Monitor performance of sustainable design practices*, October 2013
- Personal communication, Janet Weston, Park Manager, February 2015

Limitations

The number of attendees at private events, as well as smaller informal events such as the farmers market and noontime concerts is unknown, and therefore not included in the annual attendance estimate. Attendance for park events and programs are estimations based on data collected by the Capitol Riverfront BID and may not be as accurate for the free public events, such as the holiday market and summer movie screenings, where the number of visitors is more difficult to track. In addition, the Capitol Riverfront BID study reflects the attendance of those respondents who chose to participate in the survey and may not be representative of all neighborhood residents.

- ***Attracts an average daily peak of 58 visitors, ranging from a high of 88 average peak users during summer days, to a low of 25 average peak users during fall days.***

Method

To determine whether the park was meeting its goal of attracting visitors throughout the day and year-round, data was collected on park use for two to three days per season. Direct observations and time-lapse photography were used to determine the peak number of people using the park for nine study days (see details of study above). During each study day, a count of the number of people using the park was conducted approximately once per hour for roughly 10-12 hours. As seen in Figure 7, the number of park users varies throughout the day as well as seasonally. The highest peak use comes during the summer days while the lowest peak use occurs in the fall. Peak use tends to fall near the middle of the day during weekdays and towards the evening on weekends with the exception of the summer season when special events are occurring on many weeknights, including outdoor movies every Thursday.

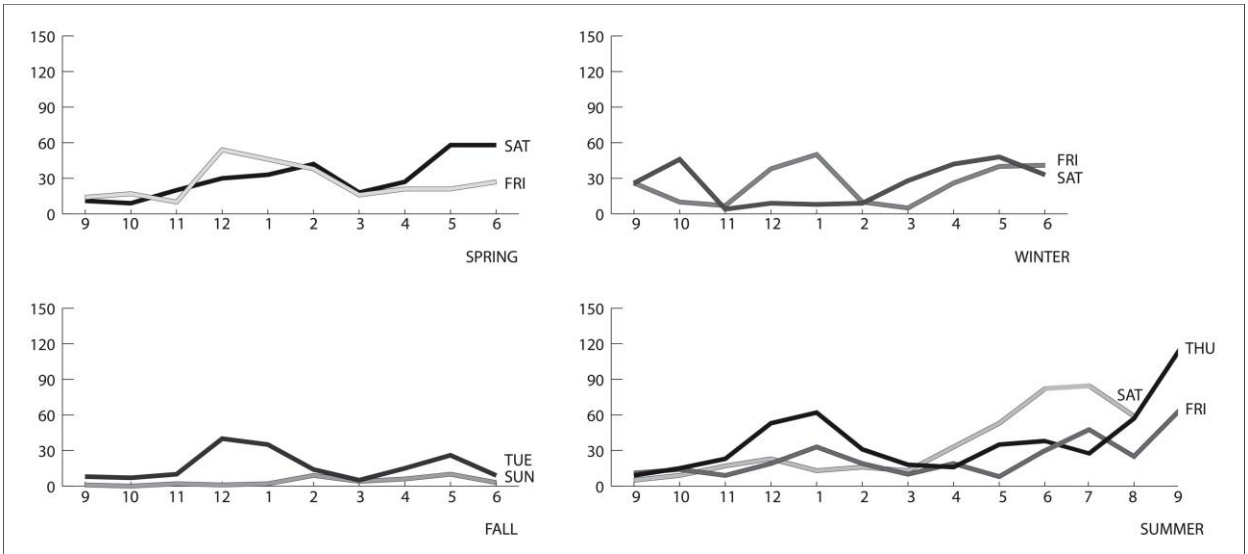

Figure 7: Number of park visitors observed during hourly counts in different seasons (Source: OLIN, *Canal Park Post-Occupancy Social Performance Evaluation*)

During the hourly counts, the location of each person within the park was also recorded on a map. This provides some insight into how the different areas of the park are being used during different seasons (Figure 8). Winter and spring use are heaviest in the southern block of the park where the ice skating rink operates in the winter and the restaurant's outdoor seating attracts people in the warmer months. Summer park use appears to be concentrated in the areas of the water features in the southern and middle block, and in the lawn area of the northern block where the outdoor movies are screened.

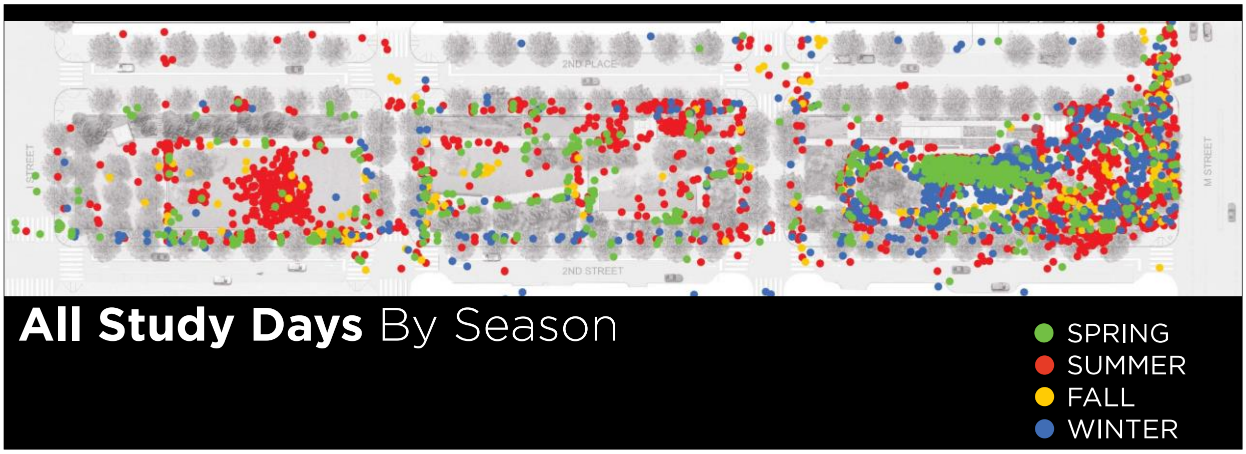

Figure 8: Location of park visitors observed during hourly counts in different seasons (Source: OLIN, *Canal Park Post-Occupancy Social Performance Evaluation*)

Calculations

The peak use during each study day was used to determine the year-round and seasonal averages:

Day	Season	Peak Use (# of visitors)	Peak Time
August 8 (Thursday)	summer	115	9:00pm
August 9 (Friday)	summer	64	9:00pm
August 10 (Saturday)	summer	85	7:00pm
October 29 (Tuesday)	fall	40	12:00pm
November 3 (Sunday)	fall	10	5:00pm
February 15 (Saturday)	winter	48	5:00pm
February 20 (Thursday)	winter	50	1:00pm
April 11 (Friday)	spring	54	12:00pm
April 12 (Saturday)	spring	58	5:00pm & 6:00pm

Average daily peak use (# of visitors)	Season
88	summer
25	fall
49	winter
56	spring
58	year-round

Sources

- OLIN, *Canal Park Post-Occupancy Social Performance Evaluation*, August 2014

Limitations

In order to examine differences in seasonal park use, data had to be collected throughout the year, which meant that there were only two to three days of observation per season. Because the number of visitors observed in the park on any single day could be influenced by a variety of external factors including weather conditions or neighborhood events, an increased number of observation days per season would create a more accurate seasonal average peak use.

- ***Provides well-designed space for visitors with 86% of survey respondents describing the park in positive terms and 44% saying they would not change anything about the park.***

Method

As part of the process to evaluate the social performance of the park, a survey was developed to collect data on how the park was functioning for people. Over 400 visitors were engaged and 217 surveys were completed, with 194 surveys administered by researchers on-site and an additional 23 surveys completed online.

To gain a better understanding of how visitors perceived the park and its design, respondents were asked how they would describe the park in one or a few words. An analysis of the responses showed that 86% of visitors described the park in positive terms, using words such as beautiful, relaxing, and awesome. The survey also asked respondents if there was anything they would change about the park and 44% replied they would not change anything. The responses to these two questions seem to indicate that the majority of visitors have a positive view of the park space and believe it was well-designed.

Calculations

% Respondents describing the park in positive terms = 86% of 217 visitors
% Respondents that would change nothing about the park = 44% of 217 visitors

Sources

- OLIN, *Canal Park Post-Occupancy Social Performance Evaluation*, August 2014

Limitations

Researchers analyzing the survey data had to decide whether the terms used by visitors to describe the park were positive, a process that could depend on interpretation. To aid in the classification, a follow up question was included on the survey that asked visitors if the descriptors they provided about the park were good or bad. This follow up question was asked if it was not clear to the individual administering the on-site survey whether the descriptive terms used by the visitor were considered positive or negative. Although the follow up question helped to clarify which visitors described the park in positive terms, in cases where the question was not asked, the classification was still subject to the researchers' interpretation.

The survey data collected reflects the views of the visitors who were present and willing to participate during on-site administration and those who chose to complete the online survey, and may not fully represent the views of all park users.

- ***Provides an inviting space that encourages social interaction between visitors, with 90% of survey respondents agreeing that they felt welcome in all parts of the park and more than 25% confirming they have made new acquaintances in the park.***

Method

To evaluate the post-occupancy performance of the park in relation to SITES Credit 6.5: *Provide for optimum site accessibility, safety, and wayfinding*, and Credit 6.8: *Provide outdoor spaces for social interaction*, the survey included questions about perception of the park's inclusiveness and experience with social interactions. When asked if they felt welcome in all parts of the park, 90% of respondents replied "yes," and when asked who they thought the park was designed for, over one-third (34%) answered "everybody." Demographic information was also collected with the survey and it is important to note that a variety of different ages, races, and income levels were represented. To assess the impact of the park on visitors' social interactions, respondents were asked if they had made any new acquaintances at the park and if so, how they met. 27% of visitors confirmed they had made new acquaintances in the park, and the most common way they met was through children (Figure 9). The data collected suggests that the design team was successful in meeting the goal of creating an inviting public space that welcomes all visitors and encourages social interaction.

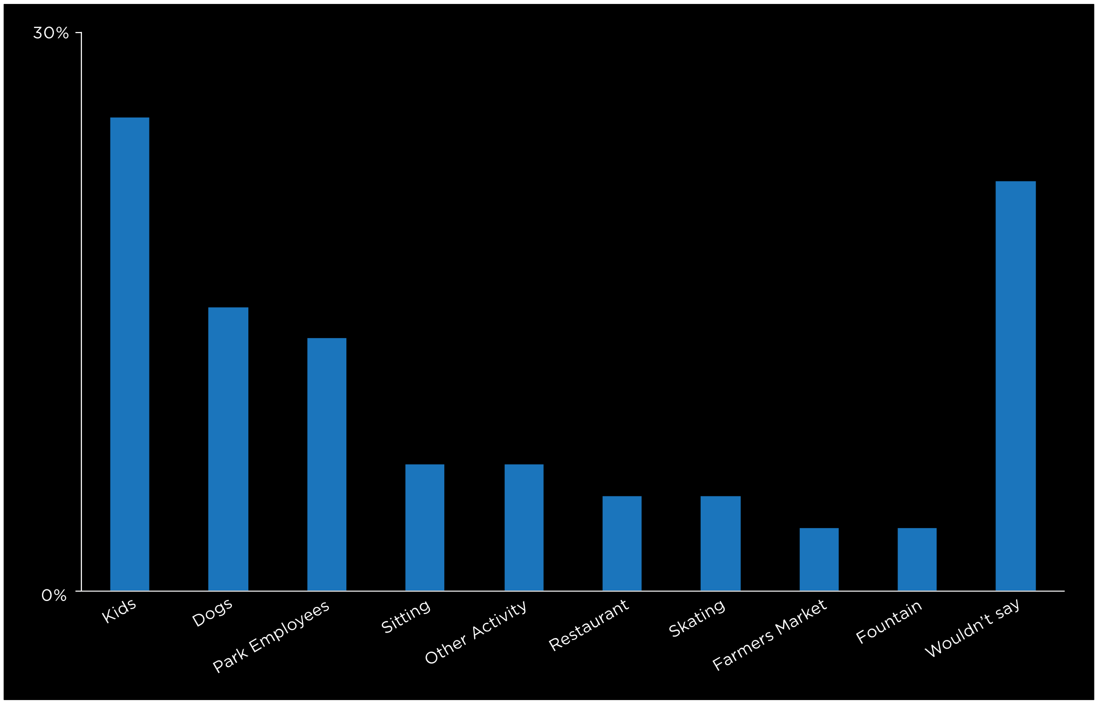

Figure 9: How visitors met new acquaintances in the park (Source: OLIN, *Canal Park Post-Occupancy Social Performance Evaluation*)

Calculations

% Respondents that felt welcome in all parts of the park = 90% of 217 visitors
% Respondents that made new acquaintances in the park = 27% of 217 visitors

Sources

- OLIN, *Canal Park Post-Occupancy Social Performance Evaluation*, August 2014
- OLIN, *SITES Submittal Documentation – Credit 9.1: Monitor performance of sustainable design practices*, October 2013

Limitations

The survey data collected reflects the views of the visitors who were present and willing to participate during on-site administration and those who chose to complete the online survey, and may not fully represent the views of all park users.

- ***Provides a safe space for 94% of survey respondents who had been to the park at night. The park also contributes to perceptions of neighborhood safety with 70% of respondents perceiving the neighborhood as safe in 2014 compared to only 6% in 2007.***

Method

As part of SITES Credit 6.5: *Provide for optimum site accessibility, safety, and wayfinding*, ensuring visitor safety was a key objective in the design of the park. Extensive lighting studies were performed by one of the design team consultants to maximize nighttime visibility and the park layout was arranged to be open and encourage natural surveillance from adjacent streets and buildings. To evaluate visitor safety, light metering was conducted at night to verify all park spaces met the minimum levels of vertical illuminance recommended by the Illuminating Engineering Society's standard for pedestrian mixed-use areas. In addition, survey respondents were questioned about their perception of safety within the park. When asked if they did or would feel safe in the park at night, 94% of respondents who had been to the park after dark and 78% of all respondents confirmed that they felt safe.

Data from the Capitol Riverfront BID annual perception survey also confirms that the perceived safety of the neighborhood surrounding the park has significantly increased over the past seven years (Figure 10). Respondents were asked about their perception of cleanliness and safety in the Capitol Riverfront and in 2014, 70% of the people who participated in the survey perceived the neighborhood as safe or very safe compared to just 6% in 2007. Respondents who perceived the area as safe rose from approximately 63% in 2010 when construction on the park began, to 76% in 2012 when it was completed, suggesting that the park may have contributed to the increased perception of safety within the neighborhood. In 2014, perceived safety decreased slightly from the previous year- however this may be due to the recent increase in construction activity, which several respondents mentioned had affected their perception of the neighborhood.

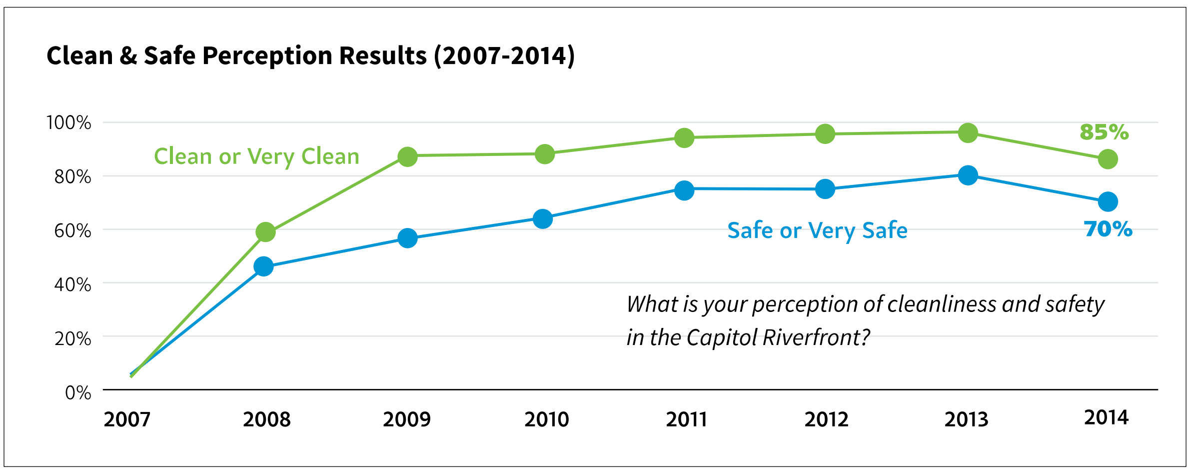

Figure 10: Perception of safety in the neighborhood surrounding the park from 2007-2014 (Source: Capitol Riverfront BID, *2014 Perception Survey*)

Calculations

% Respondents that felt safe in the park at night = 94% of visitors who had been to the park at night
% Neighborhood Respondents who perceived the surrounding area as safe = 6% in 2007 & 70% in 2014

Sources

- Capitol Riverfront BID, *Annual Report 2014*, January 2015
  http://www.capitolriverfront.org/_files/docs/2014_annualreport_final.pdf
- Capitol Riverfront BID, *2014 Perception Survey*, February 2015
  http://www.capitolriverfront.org/_files/docs/2014_perception-survey_final.pdf
- OLIN, *Canal Park Post-Occupancy Social Performance Evaluation*, August 2014
- OLIN, *SITES Submittal Documentation – Credit 9.1: Monitor performance of sustainable design practices*, October 2013

Limitations

The survey data collected on perceived safety in the park at night reflects the views of the visitors who were present and willing to participate during on-site administration and those who chose to complete the online survey, and may not fully represent the views of all park users. The most recent data from the Capitol Riverfront BID annual perception survey came from 819 residents, employees, and visitors who completed the survey in 2014, however the number of respondents in previous years is unknown. Smaller participant numbers are likely in the prior years, especially the first year the survey was conducted in 2007, which may have affected the results. In addition, although the data suggests that the park may have contributed to the increased perception of safety within the Capitol Riverfront neighborhood, it is most likely due to a combination of influences. Factors such as the significant amount of new development and subsequent increase in foot traffic in the area over the past seven years probably played an important role in the increase in perceived safety.

- ***Contributes to an 18% decrease in vehicular speed through the park compared to the adjacent block by narrowing the streets and extending park paving materials to create table-top crosswalks.***

Method

With two streets bisecting the three-block park, several different design strategies were employed to calm vehicular traffic and enhance pedestrian safety in and around the park. Streets passing through the park were narrowed to 22 ft and park hardscape materials were extended across them to create table-top crosswalks. Curb bump-outs were also added to the intersections surrounding the park (Figure 11).

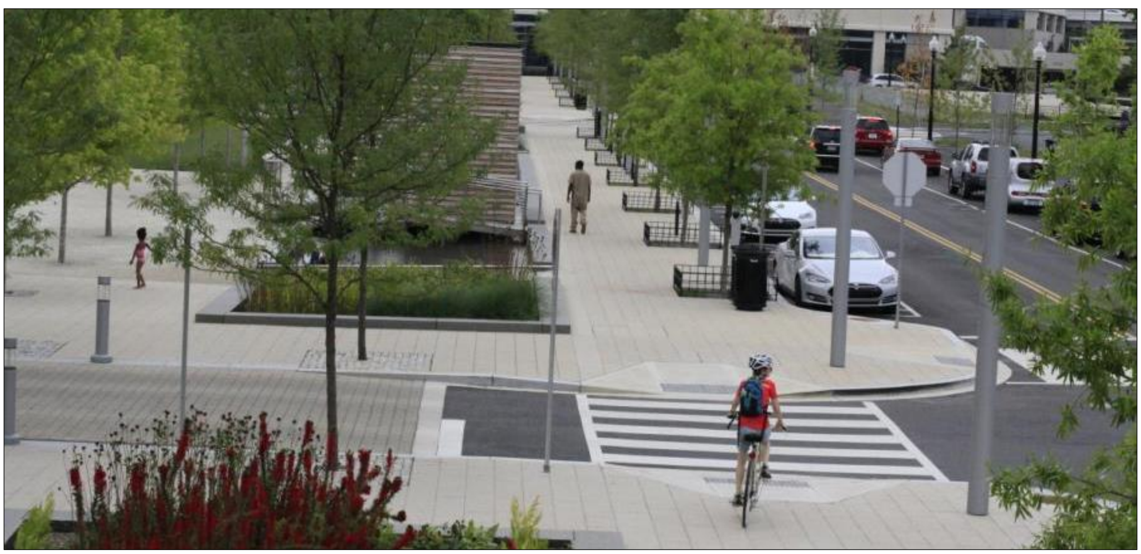

Figure 11: Table-top crossing within park and curb bump-out added to adjacent intersection (Source: OLIN)

To assess the park's impact on vehicular traffic and pedestrian safety, the average speed of vehicles traveling through the park on L Street was compared to the average speed of vehicles traveling through the adjacent block on the same street (Figure 12). On-site measurements were taken to determine that the length of L Street between the intersections at 2nd Street and 2nd Place is 89.25 ft, and the length between the intersections at 2nd Place and 3rd Street is 192.5 ft. Time-lapse photography taken over the course of one day at the park was analyzed to estimate the time it took for vehicles to travel the distances measured. Data was collected for over 100 vehicles for each section of L Street to determine that the average speed of vehicles passing through the park was 17.3 ft/s and that the average speed of vehicles passing through the adjacent block was 21 ft/s. The decreased vehicular speed within the park suggests that traffic accidents are less likely to occur, and if they do happen, will be less likely to result in pedestrian fatalities.

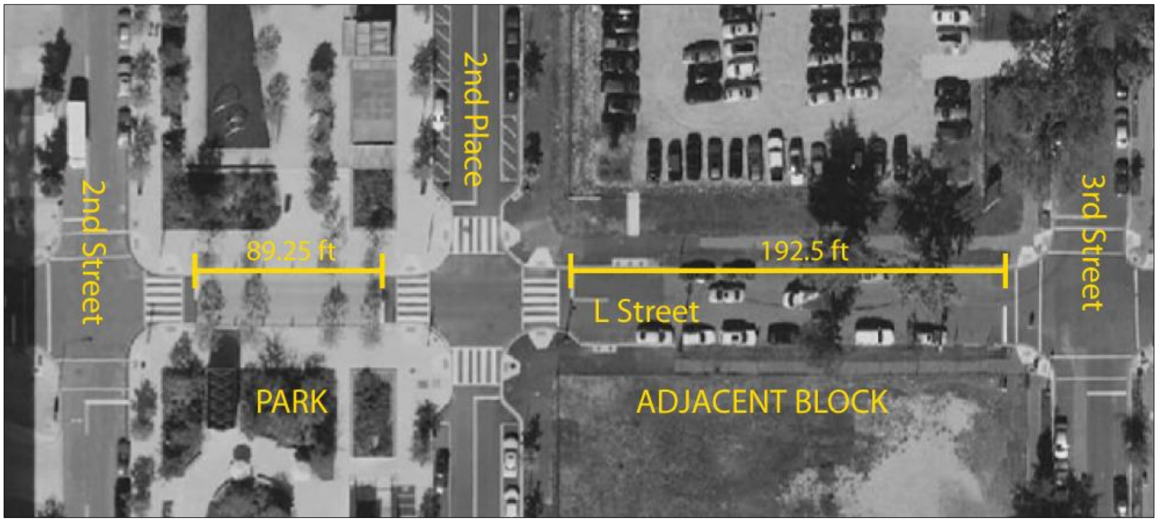

Figure 12: Sections of L Street analyzed to determine average vehicular speed within park and adjacent block (Source: DC Atlas Plus)

Calculations

Distance along L Street through park (between 2nd Street & 2nd Place intersections) = 89.25 ft
Average Time for vehicles to travel distance through park = 5.17 seconds
Average Speed of vehicles traveling through park = 89.25/5.17 = 17.26 ft/s

Distance along L Street through adjacent block (between 2nd Place & 3rd Street intersections) = 192.5 ft
Average Time for vehicles to travel distance through adjacent block = 9.17 seconds
Average Speed of vehicles traveling through adjacent block = 192.5/9.17 = 20.99 ft/s

% Decrease in Vehicular Speed through park = ((20.99 – 17.26)/20.99) X 100 = 17.7%

Sources

- OLIN, *Canal Park Post-Occupancy Social Performance Evaluation*, August 2014
- OLIN, *SITES Submittal Documentation – Credit 9.1: Monitor performance of sustainable design practices*, October 2013

Limitations

It is important to note that there are other factors that may have contributed to the decreased vehicular speed observed within the park. The short distance between the intersections of 2nd Street and 2nd Place probably influenced how fast vehicles were able to travel on this section of L Street compared to the longer adjacent block. Because of the distance differences and other contributing factors, it is not known what portion of the decrease in speed can be attributed to the park's design strategies.

The time it took for a vehicle to travel the analyzed distance was estimated using time-lapse photography that contained 1 frame every 3 seconds. Although cases where it was too difficult to estimate how long it took a vehicle to travel the distance were not included in the analysis, the accuracy of those estimates included was still limited by the images available, which may have affected the results. The data collected to calculate the average speed was also limited to vehicles observed on a single day. Expanding the analysis to include multiple days may offer a more accurate representation of average vehicle speeds.

ECONOMIC BENEFITS

The park is part of a rapidly developing 500-acre area of southeast D.C. known as the Capitol Riverfront (Figure 16). Planning for the park began during the early stages of neighborhood revitalization. Since completion, the park has played an important role in the area's continued growth. The park contributes to the local economy by providing a destination for those visiting the neighborhood and supplying a recreational and cultural amenity to attract new residents, commercial uses, and retail businesses. Measuring the economic performance of the park was accomplished by collecting data from a variety of sources including park management, the Capitol Riverfront Business Improvement District (BID) and the D.C. Office of Tax and Revenue.

- ***Provides 43 jobs, with a minimum of 6 reserved for low-income persons residing in public housing and members of the local community. Currently, low-income persons living in public housing hold 47% of the park positions and members of the local community hold another 37%.***

Method

One of the main objectives of the park is to enhance the quality of life for local residents, including those residing in the nearby D.C. Housing Authority's (DCHA) HOPE VI redevelopment of the Arthur Capper and Carrollsburg public housing communities (Figure 13). Early in the planning process, the DCHA agreed to allocate $13.5 million in New Markets Tax Credits for the park's funding in expectation of the positive impacts the project would have on these public housing communities. A Community Benefits Agreement (CBA) was put in place to outline the range of benefits the park would provide to local residents. The park serves as the principle open space in the community, supplying: recreational opportunities, a venue for a farmers' market and other cultural events, free entertainment, and an environmentally sustainable outdoor area. Jobs were also created by the park and as part of the CBA, 16 of the anticipated 150-160 construction jobs and 6 of the anticipated 30-40 post-construction jobs should be reserved for low-income persons residing in the nearby public housing development or any other public housing development in the city. These jobs provide opportunities for public housing residents to develop skills, earn living wages, and improve their lives.

Discussions with the park manager confirmed that in 2015, the park itself employed one person, and the restaurant and ice-skating rink employed 21 people each, for a total of 43 jobs. An outside company manages the skating rink and they fill the seasonal positions available each year, working with the DCHA to hire public housing residents. This process has worked well, with 13 of their employees for the 2014 skating season being rehires from the previous year and 7 of their new hires coming through a DCHA job fair. In 2012, the first year of operation, 15 of the 25 skating rink positions went to public housing residents. The restaurant is a separate, autonomous entity. While the company operating the restaurant does regularly report their employee information to park management, the park has no control over their hiring process. In 2015, the restaurant reported that they had 21 total employees, 16 of which were local community members.

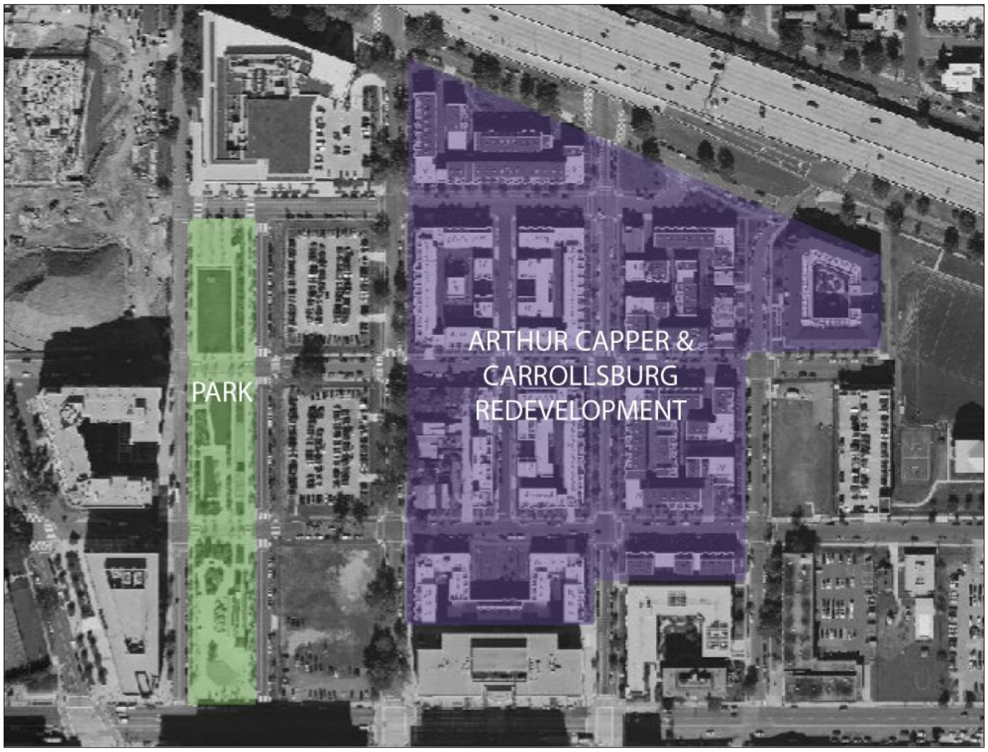

Figure 13: Location of park relative to completed portion of DCHA HOPE VI Arthur Capper and Carrollsburg redevelopment (Source: DC Atlas Plus)

Calculations

Park employee = 1
Restaurant employees = 21 (16 local community members)
Seasonal ice-skating rink employees = 21 (20 low-income persons living in public housing)
Total jobs = 1 + 21 + 21 = 43
% Jobs filled by low-income persons living in public housing = (20/43) X 100 = 47%
% Jobs filled by local community members = (16/43) X 100 = 37%

Sources

- *Community Benefits Agreement*, March 2001
- DC Atlas Plus
  http://atlasplus.dcgis.dc.gov/
- District of Columbia Housing Authority
  http://www.dchousing.org/
- JDLand.com community blog
  http://www.jdland.com/dc/
- OLIN, *SITES Submittal Documentation – Credit 6.2: Promote equitable site use*, October 2013
- Personal communication, Janet Weston, Park Manager, February 2015

Limitations

All of the current positions filled by low-income persons are seasonal, however, that is most likely due to the fact that park management has control over the hiring process for those positions and not for the restaurant positions which are assumed to be year-round. For this calculation, all of the 13 seasonal skating rink employees rehired from the previous year were considered public housing residents. While the park manager believed that was most likely true, it could not be confirmed. The CBA originally called for 16 of the anticipated 150-160 construction jobs to be reserved for low-income persons. While the information was not available to confirm how many were actually hired, it is known that the general contractor and DCHA hosted a job fair that drew over 400 public housing and low-income applicants for construction jobs.

- ***Generates 100% of the funds for standard park operation and maintenance through ice-skating rink revenues, rental fees, and special events.***

Method

An outside management company hired by the park operates the seasonal ice-skating rink. The park pays the management company a fee for this service and a percentage of the revenues generated by the skating rink as a performance incentive, with the remainder of all skating rink revenues going to the park's budget. The company owning and operating the restaurant within the park pays a flat rental fee and fees are also charged for the public and private events held in the park. The Capitol Riverfront BID provides basic services such as trash removal and security for the park. All of the fee revenues plus skating rink revenues make up 100% of the park's standard operating budget.

Calculations

Skating rink revenue + Restaurant rental income + Event fee revenues = Total park revenues
Park standard operating budget is supplied 100% by Total park revenues

Sources

- EPA, *Integrating Stormwater Management and Public Amenities through a Public-Private Partnership: Canal Park – Washington, D.C.*, April 2014 http://water.epa.gov/polwaste/green/upload/lid_canal_park_dc.pdf
- Personal communication, Janet Weston, Park Manager, February 2015

Limitations

Since the park was completed in late 2012, it has been generating enough revenue to fully cover its normal operating budget. During this time period, however, there have also been several unexpected major maintenance issues. In 2013, a pipe burst in the room housing the refrigeration equipment for the skating rink, leading to extremely costly repairs and lost revenue because the rink opening had to be delayed. As the park began operation, it also took some time to get the stormwater system adjusted to run smoothly. When issues with too much sediment in the system forced it to be shut down, there was no reclaimed stormwater to use for the park's irrigation, fountains and skating rink, so the park had to buy city water to keep the features operating. Because the park was just getting started, there was no reserve fund built up to cover these kinds of unexpected major repairs and losses in revenue, which meant that the developer currently in charge of managing the park had to supplement the park's budget with additional funds. The park manager is confident that without these unforeseen incidents, the revenues generated by the park would be sufficient. In the future, when the park becomes better known and begins to host more events, the additional funds generated will provide a safety net for any unexpected issues or emergency repairs that arise. Starting in 2015, the Capitol Riverfront BID will be taking over event coordination for the park and an increase in park events is anticipated. Additional detailed information on park revenues, expenses, and supplemental funds were not available to verify park management's estimations.

- ***Increased property values of the parcels adjacent to the park by 14.5%, compared to a citywide increase of 13.6% during the same time period.***

Method

Two parcels adjacent to the western edge of the park were included in the analysis because they were fully redeveloped prior to park completion in 2012 (Figure 14). Parcel 1 contains a residential tower and hotel built in 2006, and a coffee shop built in 2011, and Parcel 2 contains an office building completed in 2004. Assessment data from the D.C. Office of Tax and Revenue was used to compare the value of these properties before the park was built to their value after the park was completed. The total value of the properties increased by 14.5% between 2010 and 2014, demonstrating a greater change than the 13.6% increase in the value of all properties in the city of D.C.

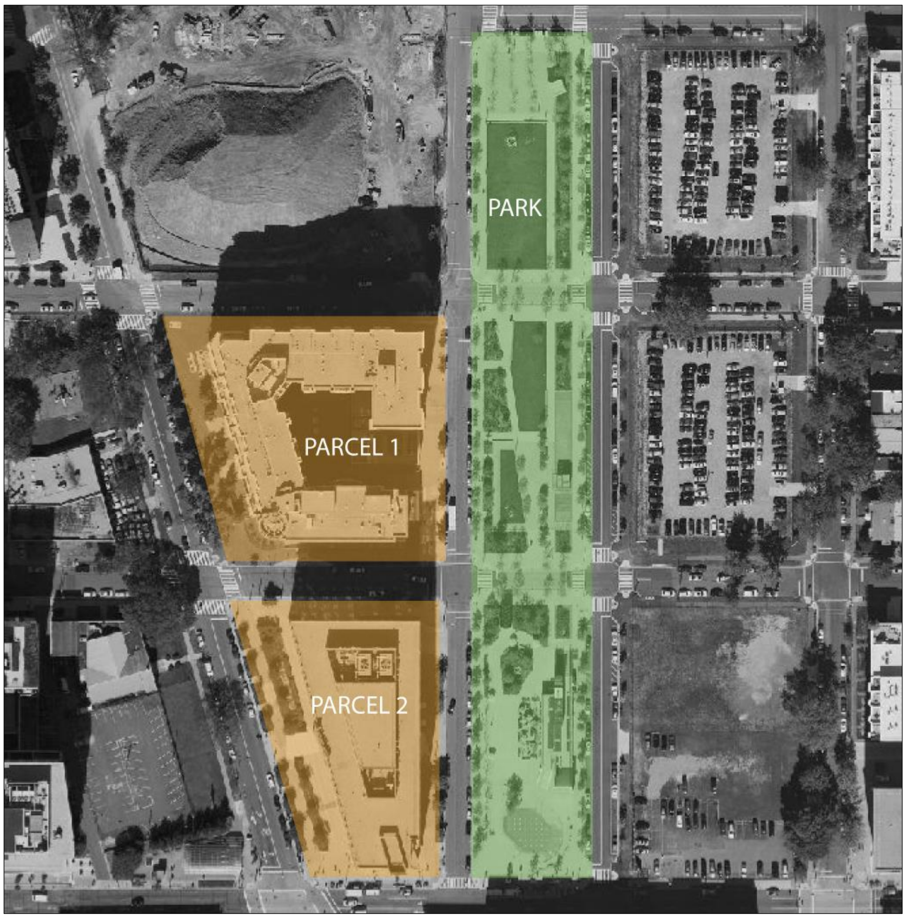

Figure 14: Two parcels demonstrating increased property values after park was completed (Source: DC Atlas Plus)

Calculations

	2010 Assessed Value	2014 Assessed Value	% Increase
Parcel 1: Hotel	$35,876,120	$41,933,990	16.9%
Parcel 1: Residential	$70,186,282	$74,970,621	6.8%
Parcel 1: Coffee Shop	$525,470	$814,590	55.0%
Parcel 2: Office	$121,400,000	$143,256,600	18.0%
ALL PROPERTIES	$227,987,872	$260,975,801	14.5%

District of Columbia Total Property Assessment 2010 = $150,117.3 ($Millions)
District of Columbia Total Property Assessment 2014 = $170,596.7 ($Millions)
% Increase in Property Value = ((170,596.7 – 150,117.3)/150,117.3) X 100 = 13.6%

Sources

- DC Atlas Plus
  http://atlasplus.dcgis.dc.gov/
- DC Office of Tax and Revenue, Real Property Tax Database
  http://otr.cfo.dc.gov/page/real-property-tax-database-search
- JDLand.com community blog
  http://www.jdland.com/dc/
- Versel, D. E., *Real Property Assessment Trends in the Washington Region, 2005-2014*, Working Paper No. 2014-03, George Mason University Center for Regional Analysis, December 2014
  http://cra.gmu.edu/pdfs/CRA2014-03_DVersel.pdf

Limitations

The small number of properties included in the analysis and the short time frame examined limits the conclusions that can be drawn from the calculation. Property value increases varied greatly between each individual property and between the different classes of property. The commercial properties exhibited an average increase in value close to 18% while the single residential property demonstrated a 7% increase, however, citywide data was not available by class for comparison. The remaining parcels immediately adjacent to the park were excluded from the analysis because they were either vacant or owned by the city and tax information was unavailable. The time frame examined was chosen to try to minimize the effects of the 2008 financial crisis, however, property values were still in the process of recovering in 2010, which may have influenced the calculation results. Because the park is located in a rapidly growing area of the city, this may also be the reason for the higher than average property value increases seen in the adjacent properties.

- ***Contributes to the continuing growth of the area with new development in the surrounding ¼ mile neighborhood projected to generate $1.05 billion in tax revenue and create over 10,000 jobs by the year 2030. Within the larger 500-acre neighborhood, it is estimated that projected new development will produce $2.28 billion in tax revenue and more than 21,000 jobs.***

Method

As part of the ¼ mile neighborhood surrounding the Navy Yard – Ballpark metro stop, the park plays an important role in bringing new development to the area (Figure 15). The park provides a public open space close to transit, making the neighborhood unique and attractive to developers. As a destination, the park entices new retail businesses and commercial uses. By providing recreational and cultural opportunities, the park draws new residential development to the area. The park's distinctive design and connection to local heritage helps create a neighborhood identity, another feature important for attracting new growth. In the 20-year period from 2012 to 2031, the neighborhood is projected to add 2,400 new residential units, close to 2.8 million square feet of new office and retail space, and more than 500 hotel rooms. It is estimated that this growth will generate approximately $1.05 billion in tax revenue and create over 10,000 permanent jobs in the area (Figure 17).

The park is an important feature of the 500-acre Capitol Riverfront neighborhood and contributes to new growth at this larger scale as well (Figure 16). In the next 15 to 20 years, it is projected that 6,000 new residential units, 5.6 million square feet of office and retail, and 1,000 hotel rooms will be added to the Capitol Riverfront neighborhood. This significant growth will provide $2.28 billion in tax revenue and 21,000 new jobs in the area (Figure 18).

Figure 15: The area within ¼ mile of the Navy Yard-Ballpark metro station (Source: DC Atlas Plus)

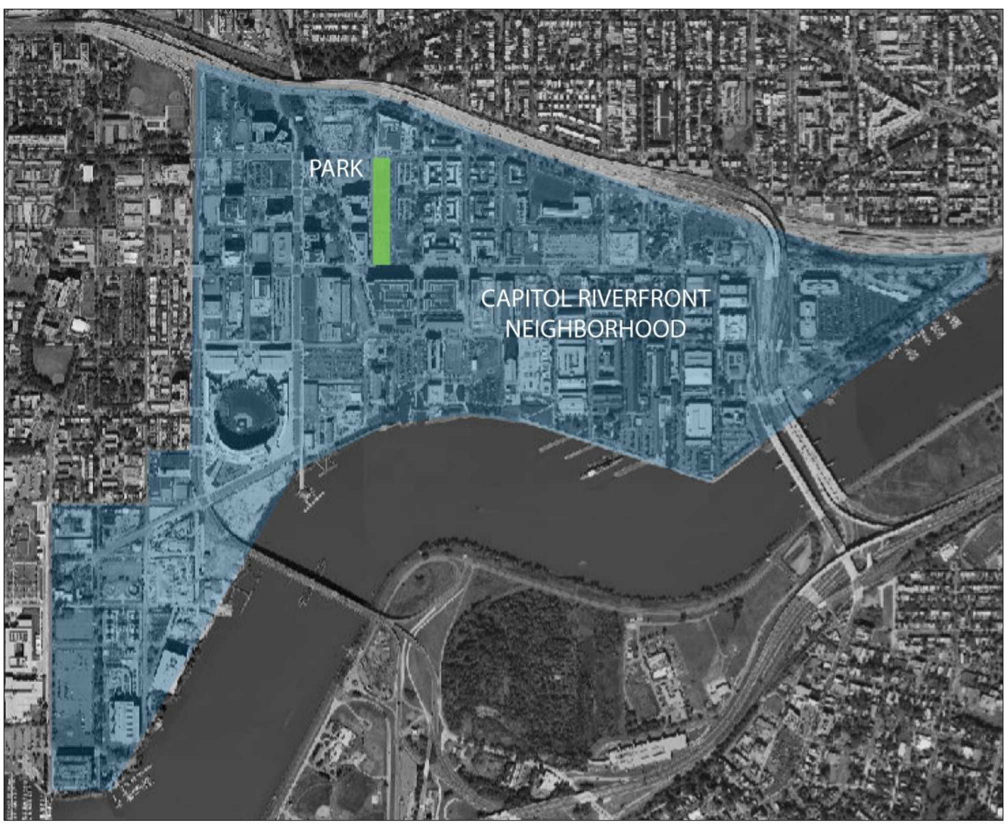

Figure 16: The 500-acre Capitol Riverfront neighborhood (Source: DC Atlas Plus)

Calculations

YEAR	REVENUES	CUMULATIVE REVENUES	REVENUES	CUMULATIVE REVENUES
2012	$4,771,000	$4,771,000	$8,595,000	$8,595,000
2013	$7,412,000	$12,183,000	$14,689,000	$23,284,000
2014	$11,257,000	$23,440,000	$23,019,000	$46,303,000
2015	$19,907,000	$43,347,000	$36,303,000	$82,606,000
2016	$18,520,000	$61,867,000	$39,845,000	$122,451,000
2017	$22,834,000	$84,701,000	$49,400,000	$171,851,000
2018	$27,422,000	$112,123,000	$59,552,000	$231,403,000
2019	$32,297,000	$144,420,000	$70,329,000	$301,732,000
2020	$37,475,000	$181,895,000	$81,764,000	$383,496,000
2021	$42,967,000	$224,862,000	$93,884,000	$477,380,000
2022	$49,043,000	$273,905,000	$107,074,000	$584,454,000
2023	$55,461,000	$329,366,000	$121,007,000	$705,461,000
2024	$62,235,000	$391,601,000	$135,715,000	$841,176,000
2025	$69,380,000	$460,981,000	$151,231,000	$992,407,000
2026	$76,911,000	$537,892,000	$167,591,000	$1,159,998,000
2027	$84,846,000	$622,738,000	$184,830,000	$1,344,828,000
2028	$93,202,000	$715,940,000	$202,984,000	$1,547,812,000
2029	$101,996,000	$817,936,000	$222,095,000	$1,769,907,000
2030	$111,246,000	$929,182,000	$242,200,000	$2,012,107,000
2031	$120,975,000	$1,050,157,000	$263,349,000	$2,275,456,000

Figures 17 & 18: Cumulative tax revenues generated by projected new development within ¼ mile of the Navy Yard-Ballpark metro station & within the full Capitol Riverfront neighborhood (Source: RCLCO, *GreenPrint of Growth*)

Sources

- Capitol Riverfront Business Improvement District
  http://www.capitolriverfront.org
- DC Atlas Plus
  http://atlasplus.dcgis.dc.gov/
- RCLCO, *GreenPrint of Growth: A Decade of Population Growth, Job Creation, and Investment Along D.C.'s Green Line Corridor*, January 2012
  http://www.capitolriverfront.org/_files/docs/fullreportgreenprintgrowth.pdf

Limitations

These projections are estimates of the maximum potential new development that may occur in the area around the park and assume that growth will remain constant over the 20-year period. Although the park may be contributing to the current and projected growth within the ¼ mile surrounding area and larger neighborhood, there are also many other factors at work. It is not known what portion of the projected growth can be directly attributed to the park's influence.

Cost Comparison

- ***The total cost for wood-based materials used in construction of the park was $269,500. All of the wood products were obtained from responsibly managed forests certified by the Forest Stewardship Council (FSC). The price of FSC-certified materials is generally estimated to be 10 – 20% more than conventional wood products, which meant a cost increase in the range of approximately $25,000 to $45,000 for the project. Although the cost was higher, the use of FSC-certified wood promotes the health of the world's forests and provides environmental, social, and economic benefits beyond the site.***

Total cost of all FSC-certified wood-based materials/products = $269,500
Cost premium of FSC-certified wood = 10 – 20% more than conventional wood
Estimated Cost of conventional wood:
    Estimated Cost if 10% cost premium for FSC-certified = (269,500/(100 + 10)) X 100 = $245,000
    Estimated Cost if 20% cost premium for FSC-certified = (269,500/(100 + 20)) X 100 = $224,583
Estimated Cost increase for FSC-certified:
    Estimated Cost increase if 10% cost premium for FSC-certified = $269,500 - $245,000 = $24,500
    Estimated Cost increase if 20% cost premium for FSC-certified = $269,500 - $224,583 = $44,917

By setting standards for responsible management of the world's forests, the FSC certification system provides numerous benefits including restricting deforestation, limiting clearcuts, protecting the resources of local communities, and promoting equitable access. It is important to note that the cost increases due to the use of FSC-certified products are estimates based on generally accepted percentages. The range and availability of FSC-certified products has improved significantly over time and in some cases, the price of FSC-certified wood may be the same, or less than the price of conventional wood products.

Sources

- Forest Stewardship Council
  https://us.fsc.org/index.htm
- OLIN, *SITES Submittal Documentation – Credit 5.6: Use certified wood*, March 2013
- Sustainable Northwest Wood blog
  http://www.snwwood.com/blog/Is-FSC-wood-more-expensive

- ***Reusing stormwater collected on-site for landscape irrigation, park fountains, and the ice skating rink provides an annual cost savings of $4,600. If treated stormwater was also used for toilet flushing in the park pavilion, instead of the conventional city water, the annual cost savings would increase to $5,400. If the system is able to collect additional stormwater from off-site roof area in the future by connecting to all new development on adjacent parcels, and reuse stormwater for toilet flushing, the cost savings could be as much as $8,400 annually.***

Type of Use	**Annual Demand (gallons)**
Landscape Irrigation	580,584
Interactive Jet Fountain	155,000
Interactive Skim Fountain	144,996
Ice Rink make-up water	129,700
ALL CURRENT USES	1,010,280
Toilet flushing	664,272
ALL POTENTIAL USES	1,674,552

Annual water demand = 1,010,280 gallons

Annual volume of on-site stormwater reused = 885,681 gallons

Annual water demand with toilet flushing = 1,010,280 + 664,272 = 1,674,552 gallons
Annual volume of on-site stormwater reused with toilet flushing = 1,031,579 gallons

Future off-site roof area available for stormwater collection = 175,000 sf
Annual volume of on-site plus off-site stormwater reused with toilet flushing = 1,616,410 gallons

2015 DC Water Rate = $5.19 per 1,000 gallons
Annual cost savings from on-site stormwater reuse = (885,681/1,000) X 5.19 = $4,597
Annual cost savings from on-site stormwater reuse with toilet flushing =
(1,031,579/1,000) X 5.19 = $5,354
Annual cost savings from on-site plus off-site stormwater reuse with toilet flushing =
(1,616,410/1,000) X 5.19 = $8,389

The stormwater system is designed and sized to provide treated stormwater for reuse in the pavilion toilets, and to integrate with adjacent parcels as they were redeveloped in the future. While city water is currently used for toilet flushing in the park and the system is not connected to any roofs on adjacent parcels, the system has the infrastructure and storage capacity to do both. Taking advantage of these sustainable opportunities could provide additional cost savings for the project.

Sources

- See details of Landscape Performance Benefits regarding stormwater collection and reuse above

- ***Unit pavers were utilized instead of cast-in-place concrete for the majority of the park's hardscape to allow for easier maintenance. The total cost for the pavers was $108,000, approximately 5% more than the estimated cost of using poured concrete. Although the pavers were a higher initial expense, the cost for ongoing maintenance is approximately $2 to $7 per sf less than poured concrete, offering significant long-term savings for the project.***

Total area of unit pavers = 60,000 sf
Total cost of unit pavers = $108,000

Average thickness of medium to heavy duty poured concrete = 6 in = 0.5 ft
Estimated volume of poured concrete needed = 60,000 sf X 0.5 ft = 30,000 cu ft = 1,111 cubic yards
Average cost of poured concrete = $93 per cubic yard
Estimated cost of using poured concrete = 93 X 1,111 = $103,323

% Increase in cost of pavers versus poured concrete = ((108,000-103,323)/103,323) X 100 = 4.5%

Estimated cost per sf of pavers = 108,000/60,000 = $1.80 per sf
Estimated cost per sf of poured concrete = 103,323/60,000 = $1.72 per sf
Average cost per sf to demolish and remove concrete = $2.00 – $7.00 per sf

Estimated cost per sf to replace pavers = $1.80 per sf
Estimated cost per sf to demolish, remove, and replace poured concrete:
Estimated cost per sf at low end of range = 1.72 + 2.00 = $3.72 per sf
Estimated cost per sf at high end of range = 1.72 + 7.00 = $8.72 per sf

Estimated cost savings per sf of maintaining pavers versus poured concrete:
Estimated cost savings per sf at low end of range = 3.72 – 1.80 = $1.92 per sf
Estimated cost savings per sf at high end of range = 8.72 – 1.80 = $6.92 per sf
(*Estimates do not include installation/labor costs)

Unit pavers were utilized in place of poured concrete for most of the park's hardscape areas with the goal of reducing maintenance costs over the long-term, thereby improving the material sustainability of the project. Although cast-in-place concrete is a less expensive material than pavers, it can crack, stain, or discolor over time and costs more to repair and replace once installed. While pavers can be easily replaced individually, damaged concrete must be removed and re-poured. If repairs or routine maintenance of underground utilities is necessary, pavers can be removed to access the problem and returned when work is completed, while poured concrete must be demolished and replaced. In many cases, small patches are difficult to match to the existing concrete and it becomes necessary to replace the entire slab, further increasing maintenance costs.

Sources

- Concrete Costs & Prices
  http://concrete.promatcher.com/cost/
- Concrete Network
  http://www.concretenetwork.com/concrete-prices.html
- Dines, N. T., & K. D. Brown, *Landscape Architect's Portable Handbook*, New York: McGraw-Hill, 2001
- OLIN, *SITES Submittal Documentation – Credit 4.12: Reduce urban heat island effects*, October 2013
- OLIN, *SITES Submittal Documentation – Credit 5.7: Use regional materials*, March 2013
- Whittaker, L., "Pavers vs. Concrete Slabs – Quick Snapshot", INSTALL-IT-DIRECT
  http://www.installitdirect.com/pavers/pavers-vs-concrete-slabs/