CHAPTER 4:

DESIGN GUIDELINES

BROOKLYN WATERFRONT GREENWAY

chapter 4

The goal of this chapter is to identify and recommend construction materials, site furnishings and design treatments that may be considered in final design and construction documents for future Greenway projects. The underlying design intent is to construct a facility that is safe to use, ecologically sustainable, attractive, and contextually harmonious with the surrounding environment.

The Brooklyn waterfront is a dynamic urban landscape. Each design should respond to the unique urban fabric along the Greenway route, meeting the needs of the rapidly changing waterfront and addressing the environmental challenges of each location. Creativity is to be encouraged when designing projects along the Greenway. At the same time, design components should be cost-effective, durable, require minimal maintenance and be responsive to the City's sustainability goals.

Design materials have been categorized as "historic" or "contemporary" as well as "standard" or "non-standard".

Style–Historic vs. Contemporary

The history of this stretch of Brooklyn's waterfront is that of a densely developed, working waterfront. Some areas have remained industrial, like parts of Red Hook and Sunset Park, while other sections have seen dramatic changes in land use, like parts of DUMBO and Williamsburg. Stylistically, this has lead to varying types of architecture; modern residential and office buildings coexist with older warehouses and industrial facilities.

These guidelines contain examples of both historic and contemporary site furnishings and materials.

Standard vs. Non-standard

The majority of the preferred route is on New York City streets with a few smaller segments in New York City Parks. It is expected that the majority of the Greenway will be constructed with standard, or "typical" building materials (pavements, curbs, etc.). At certain locations, however, a design may call for a non-standard, or "customized" design treatment.

Standard: Items referred to herein as "standard" are those which one or more City agency has the ability to install and maintain using in-house and/or regularly contracted maintenance and operations resources.

Non-standard: Items referred to herein as "non-standard" are those whose use is contingent on receipt of special permission from the owner of the Greenway right-of-way (such as installation and maintenance of a cobblestone roadway or an historic light fixture on a NYCDOT street). In the case of non-standard items, a maintenance entity must be identified (such as a Business Improvement District, Merchant's Association, private business or individual).

The significance of the standard vs. non-standard distinction pertains largely to the issue of maintenance cost. These guidelines recommend the use of applicable standard NYCDOT, Department of Parks and Recreation (DPR) and Department of Environmental Protection (DEP) items as well as non-standard items. Non-standard materials and design treatments are presented for use at specific locations or in specific areas where one or both of the following are true:

- The specific location or portion of the route possesses a unique character that warrants the additional expense. For example, designated historic districts like Vinegar Hill in Downtown Brooklyn.
- The specific location or portion of the route has a responsible partner who has requested such items and has agreed to accept maintenance responsibility.

Design Guideline Categories:

- Streetscape Elements
- Pedestrian Accommodations
- Bicycle Accommodations
- Traffic Calming
- Sustainable Storm Water Management Techniques

On the following pages, the Greenway route is broken down into three waterfront urban design character classifications; Transitional, Working Industrial and Park/Open Space. This map is meant to initiate a discourse when using these guidelines. There are many different styles of streets, land uses and building types along the waterfront. The Greenway will be built in stages as a series of discreet capital projects. As each project is undertaken, designers will need to reference the unique context of the immediate surroundings, while at the same time creating a route that is visually cohesive end to end, across all neighborhoods. The Greenway will become a bridge between neighborhoods, not only connecting people, but mimicking styles and creating an eclectic space that represents the diverse and dynamic Brooklyn waterfront.

Transitional Waterfront

The style of streetscape elements in Transitional Waterfront sections of the Greenway route should remain reflective of the history and the context of the industrial architecture while responding to the contemporary style of new developments. The stylistic appeal of contemporary design is explored in these areas, often borrowing materials and styles from modern and post-modern architecture.

Modern residential development (left) across From 19th century brick factory (right) in Greenpoint, Brooklyn

Working Industrial Waterfront

The Working Industrial Waterfront includes portions of the Greenway route directly adjacent to active industrial land uses that are expected to remain, as well as portions of the waterfront where expansion of port related industrial activity is planned.

The aesthetic character of the Working Industrial Waterfront segments of the Greenway should be functional and utilitarian, with an industrial style. Elements taken directly from surrounding sites, such as nautical elements, machine parts and/or train architecture, can reference the historic industrial character. Historic design may be warranted when the Greenway passes areas with historic structures.

Photo: Bing

Active industrial area on 39th Street in Sunset Park, Brooklyn

Park/Open Space Waterfront

Portions of the Greenway will travel through or alongside waterfront parks and esplanades. The nature of park design allows for a flexible approach to design of the Greenway.

Design of the Greenway in the Park/Open Space Waterfront areas may incorporate historic or contemporary design elements depending on the desired aesthetic. For instance, a waterfront open space that has a rich industrial history may be designed with materials reminiscent of that neighborhood's past. Conversely, when the Greenway path passes alongside or through a newly constructed contemporary park such as Brooklyn Bridge Park, a clean and modern design aesthetic may be adopted.

Brooklyn Bridge Park, Downtown Brooklyn

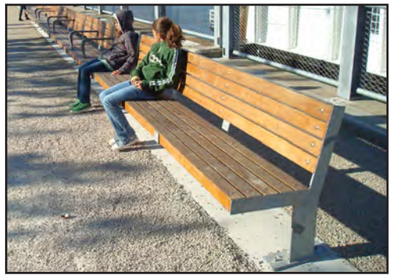
4.1 Streetscape Elements

The Greenway will be a linear public space. When the route is located on a street, the Greenway should "feel" different than a typical city street. Streetscape elements that give the Greenway a sense of place and an identity as a public space should be used. The streetscape elements that follow will enhance comfort, safety and aesthetic appeal along the Greenway.

Movable tables and chairs, Brooklyn Bridge Park

4.1.1 Street Furniture

Benches create successful sitting environments; they allow people to gather, rest and take-in their surroundings. Benches should be placed in areas of heavy pedestrian traffic, areas of special interest and along view corridors. The placement of benches should be convenient but should not impede travel. The design and materials used should depend on the surrounding land uses, landscape, and users. A variety of seating should be offered including seats with backs and without, and moveable and fixed chairs. Both formal (proper benches and chairs) and informal (seat walls and steps) seating options should be provided.



Non-Standard contemporary bench design, Brooklyn Bridge Park

DPR standard historic Hoof Bench

DPR standard historic 1939 World's Fair Bench

Example of formal seating

Example of informal seating

Trash receptacles should be placed on each street corner in high-traffic pedestrian areas. The installation of recycling containers and self-compacting trash receptacles should be considered.

Contemporary

Non-Standard waste receptacle that conform to department of sanitation requirements

Historic

Functional

Standard wire mesh trash receptacle

Solar powered self-compacting trash receptacle

Cleat bench, Brooklyn

Standard recycling receptacle

Standard paper recycling receptacle

Example of non-standard, artistic, integrated street furniture design–Subway Grate/Bike Rack/Bench, Manhattan

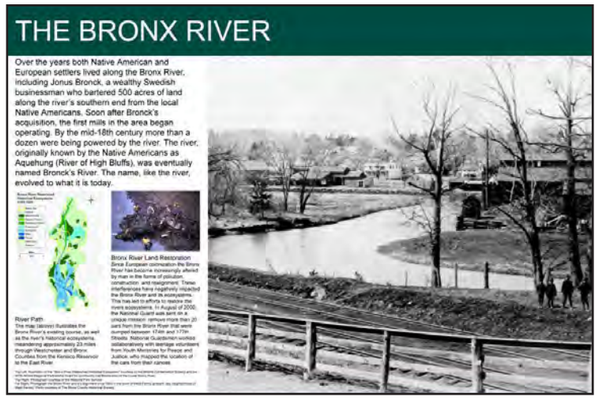
Large stone blocks serve as barriers and Seating

4.1.2 Wayfinding Signs and Kiosks

Wayfinding signs/maps and information kiosks provide useful information about nearby destinations and public places including parks, historic, and cultural sites. Interpretive signs can help enliven a place by educating visitors about local history and ecology. When designed with with engaging content and located correctly, they can help encourage people to stop and linger a little longer than usual in a particular place. Special care should be taken when designing wayfinding and interpretive signs to ensure that they are attractive, legible, pedestrian-scale and blend well with the overall streetscape character.

DPR Standard Greenway wayfinding signage

NYCDOT Standard Greenway wayfinding signage, Brooklyn Bridge Park



Proposed interpretive/informational sign, Bronx River Greenway, Bronx

Inlaid interpretive/informational historic marker, Fulton Landing, Brooklyn

Manhattan Waterfront Greenway informational sign and kiosk

4.1.3 Public Art

Public art should be considered to both anchor and highlight important nodes within public open spaces. Public art can include traditional sculpture or more playful designs. Attention should be paid to the use of art to enliven long stretches of the Greenway, using linear elements such as decorative fences, light pole banners and wall murals. When designed and installed by local talent, public art is also a good mechanism for engaging the immediate community and encouraging a sense of ownership of a particular segment of the route. Proposals should be reviewed and approved by an arts committee in accordance with existing Department of Cultural Affairs (DCLA) artist selection guidelines. Art will also need to be reviewed and approved by the Public Design Commission.

NYCDOT urban art installation within seating and planting area, Brooklyn

NYCDOT urban art installation, Bronx

Public art can appeal to children

NYCDOT urban art installation–Andy Warhol Statue, Manhattan

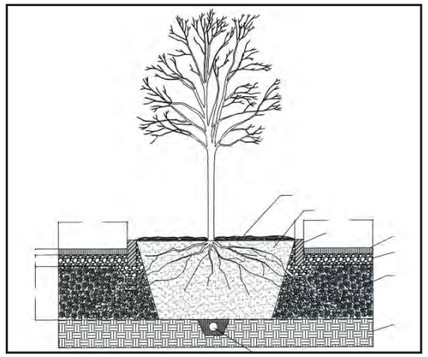
4.1.4 Street Trees

Street trees should be planted along the Greenway route at regular intervals in medians and on sidewalks.

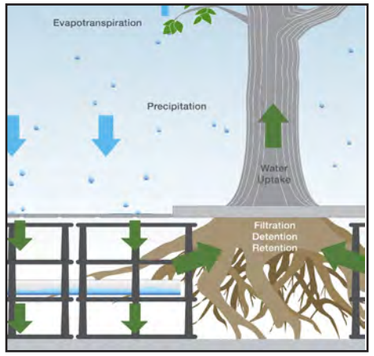
Trees create a link to the natural environment, provide shade for Greenway users and reduce the urban heat island effect. They also function as a traffic calming measure by visually narrowing the roadway and provide a buffer between vehicular and pedestrian traffic. Tree canopies should be dense and continuous.

Trees can be planted at-grade in individual or connected tree pits, with or without pavers and grates, or they can be planted in raised planters.

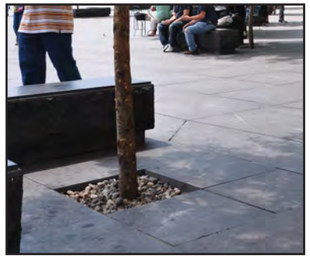
Root barriers prevent the roots from lifting the sidewalk but curtail growth



Bare root tree



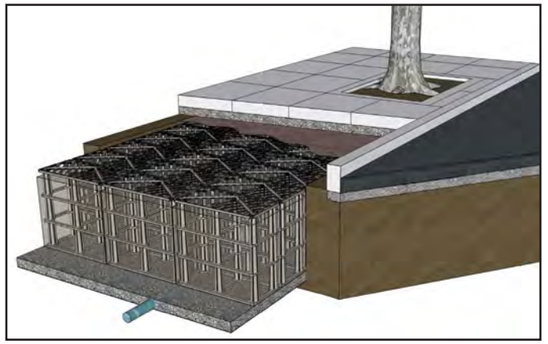
Silva Cells can greatly improve root growth



Paver grate suspension system with pavers installed, Battery Place, Manhattan

Paver grate suspension system without pavers installed, Battery Place, Manhattan

Structural soil



Silva Cells support the surface above while leaving space for root growth and water infiltration in the root zone

4.1.5 Tree Pit Design

Urban trees are subjected to great stress and few reach maturity due to a variety of factors including soil compaction, lack of air, water and nutrients and exposure to polluted air, noise and salt splash. The scarcity of high quality soil and soil compaction impede drainage and inhibit access to nutrients and oxygen.

There are many ways to allow more water and air to reach roots including using porous pavers over root zones and expanding the size of the tree pit by using structural soil (mix of load-bearing rock and organic soil) under the pavement between tree pits. Connected tree pits give roots more space and should be used wherever possible to improve tree health and longevity. In areas with heavy pedestrian volumes, the trench of connected tree pits can be bridged by sidewalk slabs supported either by structural soil or a subsurface frame system. Grates should be used only where sidewalk width is limited and pedestrian traffic is high, such as at building entrances and in outdoor dining areas.

Non-standard tree grate, Union Square, Manhattan

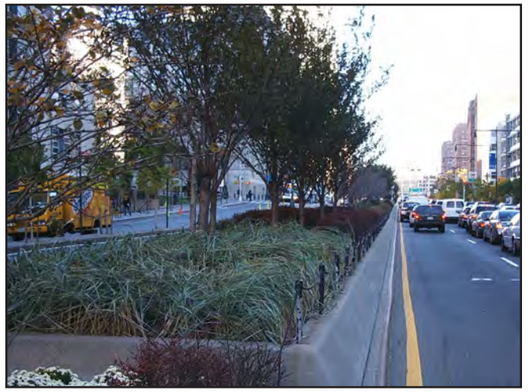
Standard tree pit with wicket fence and flowers, 9th Street, Brooklyn

Continuous tree canopy planted in Silva Cells, Lincoln Center, Manhattan

4.1.6 Planted Islands and Moveable Planters

Plant material should be incorporated into street design as much as possible to infuse color and texture into the urban landscape. Landscaping can be used to separate pedestrians from vehicles and to decorate and enhance the appearance of neighborhood gateways. Hanging planters, planting beds, and large containers can be used to display flowers and shrubs. Plant material also altenuates noise and absorbs air pollution.

Similar to street trees, planted islands and moveable planters can reduce the urban heat island effect and function as a traffic calming measure.



Planted median provides enough soil depth above-grade to support large root structures, Adams Street, Brooklyn

NYCDOT standard pedestrian plaza, Schermerhorn Street, Brooklyn

Landscaped buffer separating bicycle path from moving lanes, Route 9A, Manhattan

DPR Greenstreets program installation, Fulton Landing, Brooklyn

Planted roadway medians, Route 9A, Manhattan

Pre-fabricated panelized plant container, Park Avenue South, Manhattan

4.1.7 Street Lighting

Street lighting should be provided to illuminate the road for vehicular travel and to brighten and define paths for pedestrians and cyclists. Lighting, along with landscaping, can be used to define travel corridors intended for different travel modes, distinguishing cartways designated for use by vehicles from those designated for pedestrians and cyclists.

Pedestrian-scale light sources should be positioned 15-20 feet above sidewalks and should be designed in context with surrounding land uses. Light-emitting diode (LED) bulbs or solar powered lights can be used for energy conservation. Both street and pedestrian lighting can be solar powered. Lighting along the Greenway should provide a minimum 0.5 footcandle per square foot level of illumination, depending on surrounding uses and security concerns.

Reflective lighting , Queens West

NYCDOT historic bishops crook

NYCDOT typical historic Type M with pedestrian-scale light head, Route 9A Bikeway, Manhattan

Solar powered LED plaza lighting, Spain

NYCDOT standard historic Type F street light pole

Vehicular- and pedestrian-scale lighting, Manhattan

NYCDOT standard cobra

DPR/NYCDOT standard historic Type B pedestrian scale light pole- used for park paths

Day and night shots of the wind/solar powered street lights installed recently at the Brooklyn Navy Yard

4.1.8 Barriers and Bollards

Barriers and bollards can function as important separators between different modes along the Greenway, protecting cyclists and pedestrians from motor vehicle traffic and enhancing the comfort level of Greenway users. They can also be used as decorative informal seating elements.

Barrier and bollard applications can range from low-cost, improvements to costly capital projects. Use of these features should fit the need for safety and aesthetic enhancements.

Some existing bicycle facilities in New York City and along the Greenway are separated by a 'barrier-curb' to provide a substantial and permanent treatment. Many have railings mounted to provide the 42 -inch height recommended by the American Association of State Highway and Transportation Officials (AASHTO) for separation of bikeways from traffic on grade changes.

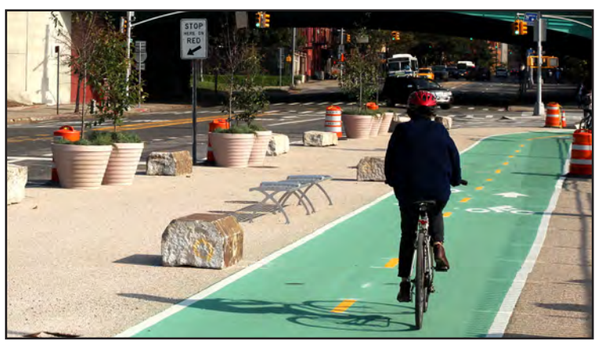
Granite blocks used as bollards, Madison Square, Manhattan

Reinforced concrete divider with railing, Sands Street, Brooklyn

Reinforced concrete divider with railing, Manhattan Bridge Approach, Brooklyn

Combination bollard and railing, Manhattan Bridge Approach, Manhattan

Pedestrian refuge with cast Iron bollards, Route 9A, Manhattan



Movable planters as bollards

Nautical cleats used as bollards, Brooklyn Waterfront

Bollards, New York Stock Exchange/Wall Street, Manhattan

4.1.9 Non-Standard Distinctive Pavements

Sidewalks should be constructed with a firm and durable surface such as concrete or pavers. Dark gray tinted concrete is preferred in commercial areas and in historic districts.

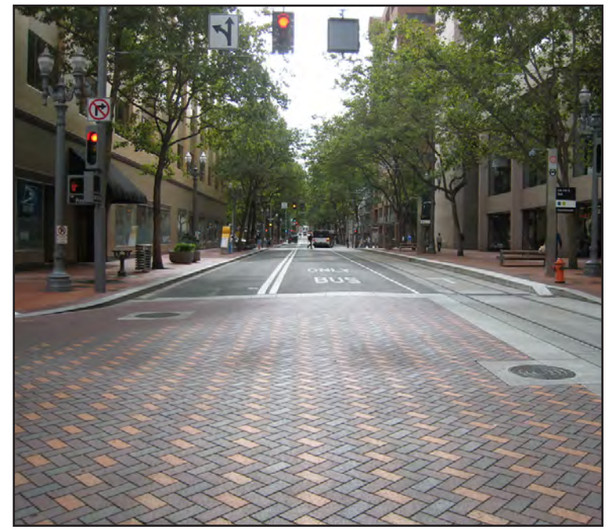
Tinted concrete sidewalks can be surfaced with colored pebble-sized aggregate to create a textured surface. High-albido (light-colored) exposed-aggregate surfaces help reduce the urban heat island effect by increasing reflectivity. Poured concrete pavement can also be surfaced with silicon carbide to add sparkle and increase slip resistance.

Excessive texturing such as deep imprinting to simulate unit pavers can be problematic and may impede ADA compliance.

Authentic slabs of bluestone or granite should be preserved where possible, particularly when in designated historic districts.

For details on distinctive paving for bicycle facilities, see Section 4.3.7.

Granite and cobblestone crosswalk, DUMBO, Brooklyn



Decorative brick paved intersection at transit mall, Portland, Oregon

Red, white and gray colored concrete pavement on widened sidewalk on Greenwich Street, Manhattan

Decorative pavement materials (bluestone paving and square asphalt pavers on the sidewalk, extra wide granite curb and granite block in the road bed), Union Square West, Manhattan

Decorative brick plaza pavement, Bard College, Manhattan

Detail of exposed aggregate concrete pavement

4.2 Pedestrian Accommodations

The pedestrian component of the Greenway must be safe and comfortable to function well as an important public space. At a minimum, sidewalks along the Greenway route should be in good repair and provide at least 7 feet of unobstructed pedestrian space.

When possible, distinctive treatments should be considered in order to provide enhanced visibility and priority to pedestrians alongside bicycle facilities, vehicular thoroughfares and industrial areas.

4.2.1 Crosswalks

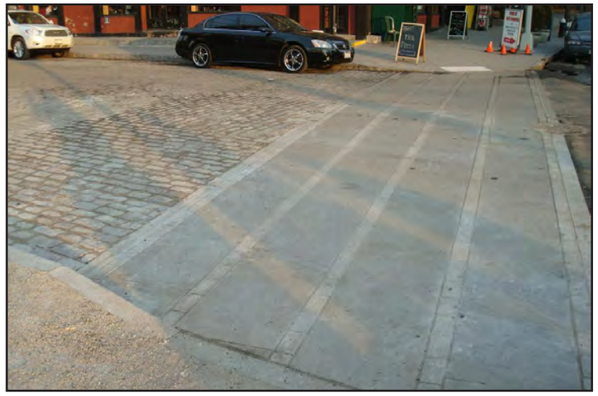
Crosswalks make pedestrian actions more predictable for motorists by indicating accepted crossing locations. The design of crosswalks should be consistent throughout an area. Non-standard crosswalks should utilize materials, textures and colors that are compatible with the materials and furnishings included in the overall streetscape design.

NYCDOT standard pedestrian crosswalk, Manhattan

NYCDOT high-visibility crosswalk–used only in areas with heavy pedestrian and vehicular volumes, Manhattan

NYCDOT school safety (ladder style) crosswalk–used only along designated walk to school routes, Manhattan

Granite block crosswalk, Stone Street, Manhattan



Granite slab crosswalk, DUMBO, Brooklyn

Mix of unit paver types defining a crosswalk, Barcelona, Spain

4.2.2 Pedestrian Islands

Pedestrian islands may be applicable on roads wider than 55 feet. They provide a safe place for pedestrians to wait while crossing so that the entire intersection does not have to be crossed in one signal cycle.

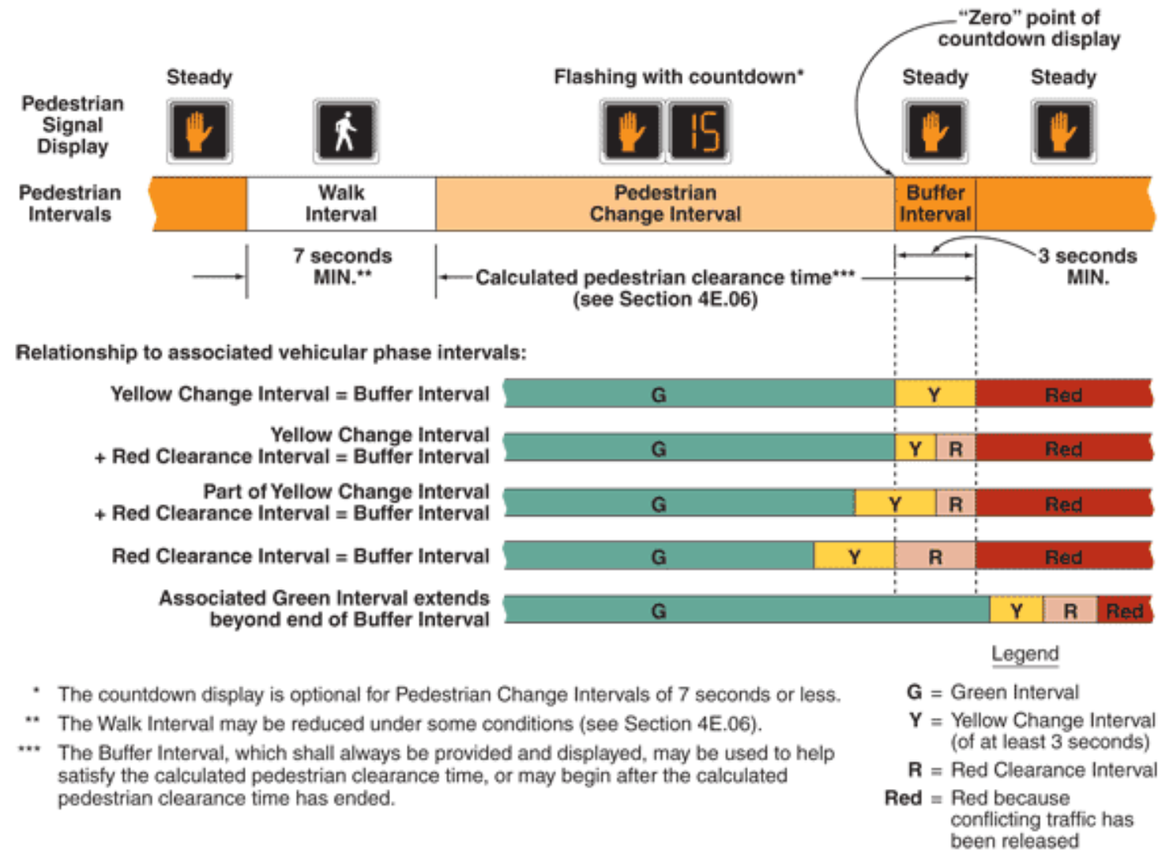
In some locations, the plans for the Greenway may include medians, particularly on wider roads. Curb ramps or cut-throughs must be provided for ADA compliance.

Pedestrian island with bollards, Brooklyn

4.2.3 Pedestrian Countdown Signals

Pedestrian countdown signals should be installed at certain signalized intersections to notify pedestrians when it is safe to cross and how much time remains in the pedestrian phase. It is recommended that pedestrian countdown signals be used where there are high vehicular and/or high pedestrian volumes.

Standard pedestrian countdown signal



Pedestrian island with planting and flexible bollards, Manhattan

4.2.4 H.A.W.K Pedestrian Signals

The HAWK (High-intensity Activated Crosswalk) signal is a combination of a flashing beacon and traffic signal used at marked crosswalks. Unless activated, the HAWK signal remains dark. When pedestrians wish to cross, they push a button, and a traffic signal for motorists flashes yellow, then solid yellow, then red. Pedestrians then recieve a "Walk" signal, followed by a "Don't Walk" signal with a countdown. The motorist signal switches to flashing red, which requires a stop but allows motorists to proceed when pedestrians have cleared the crosswalk.This signal should only be installed at marked crosswalks with applicable warning signs. It should not be used at crosswalks controlled by YIELD signs, STOP signs, or existing traffic control signals. This signal can be helpful in areas of frequent pedestrian crashes or where pedestrians have difficulty obtaining a gap in continually flowing traffic.

HAWK signal, Phoenix, Arizona, Photo: PBIC

Pedestrian actuated signal, Calgary, Canada, Photo: PBIC

4.3 Bicycle Accommodations

The Greenway's bicycle facilities should be suitable for users of all ages and experience levels. When designing on-street bicycle accommodations, protected facilities should be considered when the right-of-way is available. Protected facilities are those with physical separation such as parked cars, jersey barriers, striped buffers with flexible bollards, and landscaped areas.

High-visibility markings should be used on bicycle facilities when crossing pedestrian paths, driveways and intersections. Better visibility between modes provides a safer and more comfortable experience for Greenway users.

Bicycle parking should be provided at key destinations and waterfront or open space access points.

4.3.1 Physically Separated On-Street Bicycle Paths (Class I)

Physically separated on-street bicycle facilities provide a dedicated space for cyclists within the street cross-section, and can carry one-way or two-way bicycle traffic. Throughout New York City, parking-protected bicycle paths provide a low-cost means of separating cyclists from moving vehicles without major infrastructure improvements. Alternately at some locations where roadway width is limited, barrier curbs can be placed between the bicycle path and vehicular traffic.

A major design consideration for these facilities is the treatment of intersections which, like all bicycle facilities, must be designed with turning conflicts in mind. However, because physical separation also visually distances cyclists from drivers, the provision of a mixing zone at intersection approaches should be considered. Reducing the separation between vehicles and cyclists increases visibility and reduces the potential for conflict. Alternatively, separate signal phases for bicycles and turning vehicles may be used.

Many existing physically separated facilities also include pedestrian islands, high-visibility markings through intersections and signage alerting turning vehicles to the presence of cyclists.

4.3.2 On-Street Bicycle Lanes (Class II)

On-street bicycle lanes are a portion of a roadway that is designated by pavement striping, logos and signs. Bicycle lanes are typically provided for each direction of travel, either one on each side of a two-way street or as a one-way pair along two adjacent one-way streets.

4.3.3 On-Street Shared Lanes (Class III)

On-street shared lanes are shared by bicycles and motor vehicles. Shared lanes are typically identified through the placement of a shared lane marking, or 'sharrow'. These markings alert motorists that they are sharing the roadway and indicate to cyclists where they are expected to ride. Shared lane facilities can also include supplemental "Share the Lane" or "Bicyclist Allowed Full Use of Lane" signs.

Two-way parking protected bike path on a one-way street, Prospect Park West, Brooklyn

Striped bicycle lane (no color), Bedford Avenue, Brooklyn

Grade-separated bicycle lanes alongside a raised median, Sands Street, Brooklyn

Jersey barrier separated two-way path, Columbia Street, Brooklyn

Curbside Class II Bike Lane (color), 9th Street, Brooklyn

Shared lane pavement markings, Brooklyn

4.3.4 Off-Street Paths (Class I)

Off-street paths located away from the street grid, primarily along the waterfront and within parks, have few intersections and as a result, are safer for bicyclists and pedestrians than bicycle and pedestrian facilities located alongside or on roadways.

Special attention must be paid, however, to accommodating both pedestrians and bikes when they share the same space on two-way paths. Locations where pedestrians must cross dedicated bike paths to reach pedestrian only paths or sidewalks should be well marked. Adequate buffer space between modes should be provided, where possible, to increase visibility and channelize conflicting or opposing streams of traffic. Also, pavement markings and signs should be clear, making use of accepted symbology and designed in accordance with recognized standards.

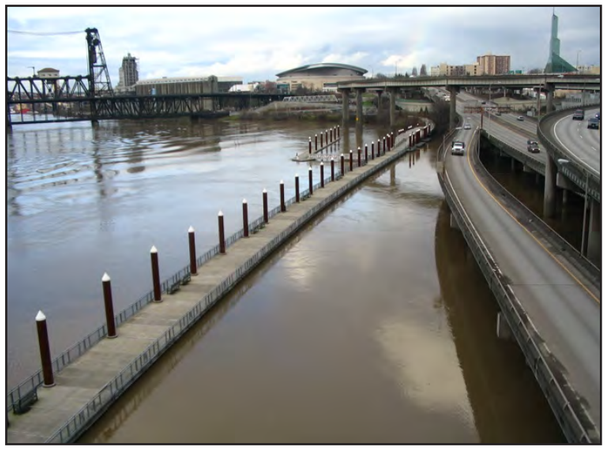
Pedestrian crosswalk across route 9A bikeway, Manhattan

Off-street multi-use pathway with separation between bikes and pedestrians, Route 9A Bikeway/Walkway, Manhattan

Off-Street bike path, Brooklyn Bridge Park, Brooklyn

Manhattan Waterfront Greenway underneath the FDR Drive South, Manhattan

Pedestrian crosswalk across Route 9A Bikeway, Manhattan



Floating bikeway on the Willamette River, Portland, Oregon

Multi-use path connection built on a pile-supported structure over the open water in Riverside Park, Manhattan

Riverside Park, Manhattan

4.3.5 Drainage Grates

Drainage grates with long and wide openings running parallel to the curb can catch or deflect narrow bicycle wheels causing safety issues. Care must be taken to ensure drainage grates are safe with openings small enough to prevent a bicycle wheel from falling into the slots of the grate. Another way to avoid drainage grate problems is to eliminate them entirely with the use of inlets in the curb face. This may require more inlets per mile to handle bypass flow.

4.3.6 Bicycle Parking

Providing safe and secure bicycle parking can help encourage cycling. NYCDOT currently has two standard bicycle rack designs, the "hoop" design and the "meter rack," designed to turn existing non-used parking meter poles into bike racks.

Other examples of bicycle parking include sheltered racks that have been installed throughout New York City. Private property owners may also provide non-standard racks.

Bicycle-safe drainage grate

Drainage grate with large openings are unsafe for cyclists

NYC bus shelter with bicycle parking

Standard NYC Cityracks new "hoop" design

Standard NYC parking meter conversion to bike rack

NYC Cityracks original design (standard until 2009)

Non-Standard stainless steel racks (catalogue)

4.3.7 Bicycle Lanes on Rough Stone Streets

Cobblestone and other rough stone streets provide many aesthetic and traffic calming benefits, but they make cycling difficult. When the Greenway route runs along streets paved with rough stone, a strip of smooth stone blocks or another smooth surface should be installed to create a "lane within a lane" for cyclists to ride on. In historic districts, this provides an ideal way to preserve stone streets, while providing bicycle access.

A bicycle logo may be inlaid or applied on the smooth surface with thermoplastic paint, and signage can be added to highlight the bicycle route.

Stone Street with smooth paved surface for bicycle lane, Amsterdam

Stone and Belgium block patterns provide smooth surface for cyclists, Queens West

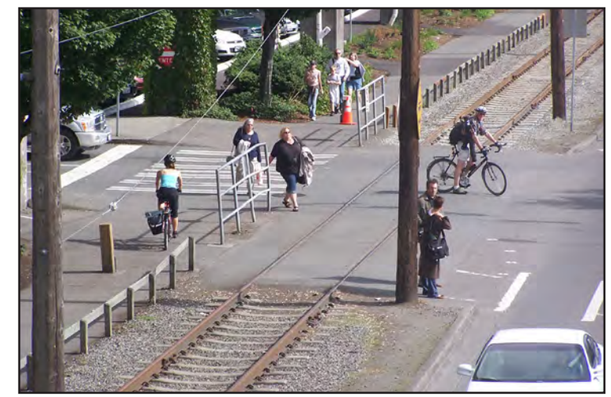
Belgium block street with stone slabs for cyclists with metal bicycle logo inlaid, Stockholm

Shared lane treatment with smooth cobbles in the middle of the street and rough cobbles in the parking lanes, DUMBO, Brooklyn

4.3.8 Rail with Trail

When designed properly, the linear nature of rail corridors can work well with bicycle and pedestrian facilities. When siting trails in the vicinity of railways, the preffered design will depend on operational considerations. Barriers may or may not be used depending on the volume of both rail and trail users as well as the speed of rail cars. Over 240 miles of successful rail with trail paths exist across the United States, many in urban areas.

Alaskan Way Trail, Seattle, WA



Rail with trail, Seattle, WA

Rail with trail, Portland, OR

4.4 Traffic Calming

The Greenway traverses varying roadway and land use conditions; traffic calming measures may be needed at certain locations. As the Greenway is built out, special attention will be paid to calming traffic at key intersections and potential points of conflict. Traffic calming may also be beneficial along the inland connectors, identified in Chapter 2, to enhance access to the Greenway from nearby communities.

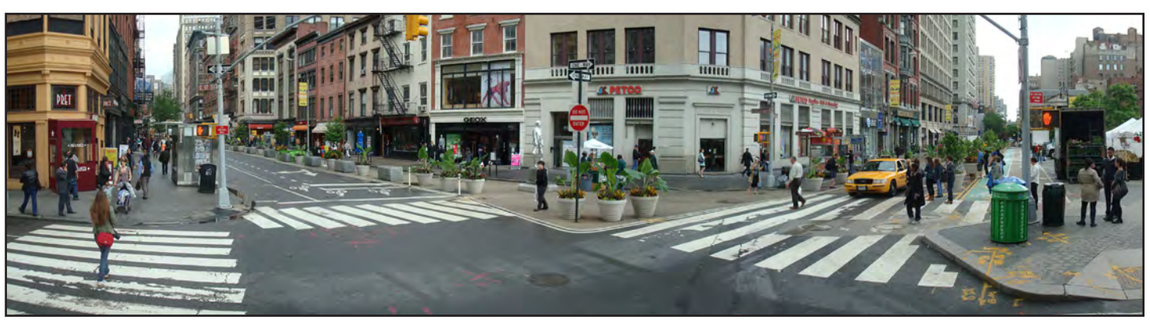
4.4.1 Curb Extensions

Curb extensions refer to an extension of the sidewalk into the street in order to enhance pedestrian safety. They are also sometimes referred to as neck-downs or bulb-outs. The benefits of curb extensions include narrower pedestrian crossings, reduced motor vehicle speeds, added space for sidewalk furniture and improved visibility between pedestrians and drivers. Special attention should be paid to placement along bike routes to avoid narrowing the width of the roadway and forcing bicycles and vehicles into an unnecessary shared lane configuration.

Pedestrian crossing distances can be shortened quickly and inexpensively by implementing curb extensions at intersections. A less permanent option is to use colored epoxy gravel, thermoplastic line striping and flexible plastic bollards to create extended pedestrian areas, which should also have reduced curb radii to calm traffic.

Curb extension implemented in conjunction with school crosswalks, Manhattan

Curb extension implemented in epoxy gravel with flexible bollards, Manhattan

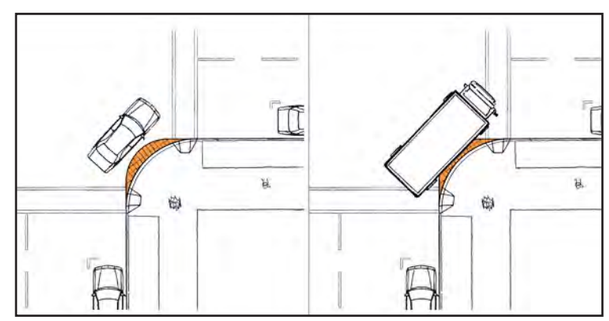


Sidewalk extension implemented in conjunction with high-visibility crosswalk striping, Union Square, Manhattan

4.4.2 Curb Radius Reduction

Reducing curb radii slows down turning vehicles and shortens pedestrian crossing distances. During design, curb radii should be tested by designers to provide the tightest possible radius at each intersection. Standard unit vehicle specifications should be tested to ensure that emergency vehicles and other vehicles with limited maneuverability can make all allowable turning movements through each intersection. On truck routes, reduction of curb radii may not be feasible due to the need to accommodate larger vehicles.

Street corner with reduced curb radius, Union Square West, Manhattan



At-grade reduced turn radius at street corner, San Francisco, Image Credit: City of San Francisco

4.4.3 Narrow Travel Lanes

Narrow travel lanes slow operational speeds. By constraining lane width visually or physically, drivers intuitively slow down to safely navigate the road.

Mid-block narrowing, 94th Street, Manhattan

4.4.4 On-Street Parking

On-street parking slows traffic speed and reduces the severity of crashes. Cars parked on the street act as a buffer between vehicular traffic and pedestrians. Parking can also be used to separate vehicular traffic from a bicycle path, but this requires sufficient width that cyclists can maneuver around open car doors and the path can be cleaned with a mechanical sweeper.

Parking along Kent Avenue slows traffic and protects cyclists, Brooklyn

4.4.5 Forced Turn Islands

Forced turn islands act to divert through traffic using street geometry to force motorists to make a turn at an intersection. Traffic volumes and speeds can be reduced, however this treatment should be reserved for residential or local streets. Diagonal diverters force turns on both approaches to intersections. These treatments should allow an opening for cyclists to pass through, and sidewalks should be provided.

4.4.6 Shared Streets (Woonerf)

A Woonerf (Dutch for 'Living Street') is a street where the conveyance of motor vehicles is secondary in importance to pedestrians and cyclists. The concepts of shared spaces, traffic calming and low speed limits are enforced to improve pedestrian, bicycle, and automobile safety. Design characteristics of a Woonerf often include: decorative pavement, street trees and landscaping, limited parking clustered along the street, low vehicular speeds and other traffic calming measures to prioritize the safety and comfort of pedestrians over the importance of accomodating high travel speed. Design speeds of 5-10 miles per hour can be achieved by introducing textured paving surfaces, roadway geometry that causes lateral or vertical shifts, lane surroundings and other high visibility traffic calming measures.

4.4.7 Temporary Street Closures

To create a temporary community space, street closures can be considered. Examples of street closures in New York City include Summer Streets, during which streets are closed for several hours on weekends in the summer and Play Streets, which closes streets on weekdays to provide a public place for children to play. Car-free events can also be held citywide, closing streets to provide entire communities with a temporary public space.

By closing sections of streets for regular hours on a daily or weekly basis, area residents are given the opportunity to enjoy public space in communities that are often underserved with open space.

Diagonal diverter

Woonerf, Amsterdam

Shared street with bicycle parking, Copenhagen

Car free 78th Street temporary closure, Jackson Heights, Queens

Shared street along retail corridor, Copenhagen

Car free 78th Street, Jackson Heights, Queens

4.5 Sustainable Stormwater Management

Conventional urban infrastructure routes stormwater through catch basins and pipes to a treatment facility, where particulate matter and toxins are removed before it is released back into natural water bodies. Sustainable stormwater management relies on natural absorption and filtration systems (vegetation, soil, and rock) to absorb and filter stormwater before it enters the sewage system, so that it does not need to be piped to treatment facilities.

In New York City, sustainable stormwater management is especially important because stormwater runoff currently mixes with sanitary sewage in a combined sewer system. During heavy rain events, wastewater treatment plants become overwhelmed, causing untreated stormwater to flow directly into the City's rivers and harbor, carrying raw sewage with it. Sustainable stormwater management reduces the burden on the City's treatment plants during storm events and can therefore help improve water quality in local water bodies.

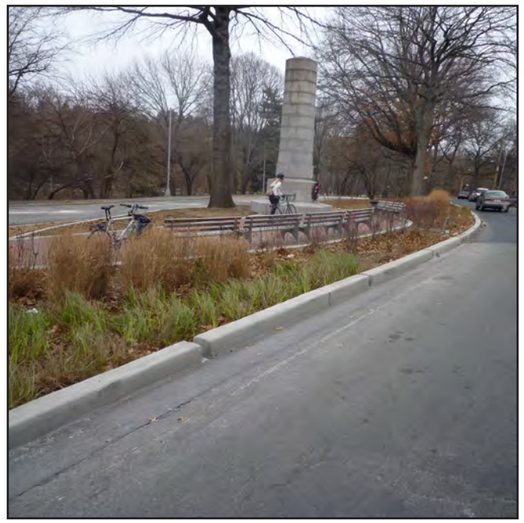
The DEP, in partnership with the rest of the City's Mayoral Agencies (NYCDOT, DPR, Department of Design and Construction (DDC), etc.) has begun implementing an aggressive plan to reduce the rate and quantity of stormwater runoff that enters the sewer system during storm events through the introduction of sustainable stormwater management interventions. Many of these interventions are aimed at the redesign of the City's 40,000 miles of roadways. The replacement of impervious pavement with vegetation and/or porous pavement will allow more water to percolate into the ground and recharge the aquifer instead of flowing to storm drains. The City's goal is to redesign and rebuild urban infrastructure such that the first inch of rain in a two-hour storm event is retained instead of entering the sewer system.

Given its proximity to the waterfront, inclusion of sustainable stormwater management techniques in the design of the Greenway is a primary goal of the project. Development of the Greenway offers many opportunities to integrate sustainable stormwater interventions into the redesign of the 14 miles of City streets and paths that comprise the route. Implementation of thee interventions has the potential to positively impact water quality in the East River, Newtown Creek, Gowanus Canal, and New York Harbor, especially since areas adjacent to water bodies are typically low-lying and close to the water table, which allows stormwater to quickly return to the ecosystem. Advances in the design of rain gardens and bioswales enable the capture and infiltration of large quantities of water in very small spaces.

4.5.1 Rain Gardens and Bioswales

Through design of the Greenway, opportunities should be sought to include large tree pits, amenity strips and planted buffer areas adjacent to the path. Locations where roadway geometry results in excess capacity should be documented and plans developed to convert this space, currently paved with asphalt and concrete, to large planting areas.

Rain gardens and bioswales are not the same as conventional planted areas. A cross-section through a properly designed rain-garden or bioswale shows a deep section filled with layers of sand and gravel and soil. This composition resists compaction and thus allows water to percolate easily. The spaces in the sand and gravel allow for retention of high volumes of water and the various densities of the different layers are extremely effective at filtering the water as it percolates to the aquifer below. Proper planning and design of rain gardens and bioswales dictates that soil borings must be taken to analyze existing soil composition and determine depth to ground water and/or bedrock. Species of vegetation planted in a rain garden or bioswale must be moisture tolerant, adaptable to the soil type used and resilient in the New York City environment.



Slotted curb for natural percolation, Bronx River Greenway

Slotted curb allows stormwater capture, Portland, OR

Stormwater tree pit with slotted curb, Portland, OR

Storm drain outfall to rain garden, Portland, OR

Slotted curb rain garden, Portland, OR

NYCDEP rain garden tree pit, Brooklyn

4.5.2 Porous Surfaces

When possible, porous surfaces should replace impervious surfaces to minimize stormwater runoff, there by increasing groundwater recharge and lessoning the burden of stormwater on the sewage system. Porous pavement may be used on sidewalks and bicycle paths, low-volume travel lanes, parking areas, and other low-traffic areas.

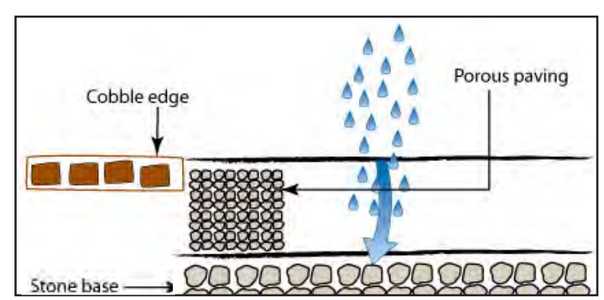
Porous surfaces can be pavers, cement, or structural soil designed to allow water to infiltrate through the hard surface. Under the paving material, a stone base holds water during rain events, gradually allowing it to seep into the ground below and ultimately circulate back into the groundwater system without entering the combined sewer system.

Porous pavers in amenity strip

Porous pavers in parking lane

Porous pavers in parking lot, Brooklyn Navy Yard, Brooklyn

Cobblestone pavement with porous sand joints, Columbia Street, Brooklyn



Graphic depicting how porous paving works