



## West Side Flats Greenway Conceptual Green Infrastructure Design

## About the Green Infrastructure Technical Assistance Program

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Stormwater runoff is a major cause of water pollution in urban areas. When rain falls in undeveloped areas, soil and plants absorb and filter the water. When rain falls on our roofs, streets, and parking lots, however, the water cannot soak into the ground. In most urban areas, stormwater is drained through engineered collection systems and discharged into nearby water bodies. The stormwater carries trash, bacteria, heavy metals, and other pollutants from the urban landscape, polluting the receiving waters. Higher flows also can cause erosion and flooding in urban streams, damaging habitat, property, and infrastructure.

Green infrastructure uses vegetation, soils, and natural processes to manage water and create healthier urban environments. At the scale of a city or county, *green infrastructure* refers to the patchwork of natural areas that provides habitat, flood protection, cleaner air, and cleaner water. At the scale of a neighborhood or site, green infrastructure refers to stormwater management systems that mimic nature by soaking up and storing water. Green infrastructure can be a cost-effective approach for improving water quality and helping communities stretch their infrastructure investments further by providing multiple environmental, economic, and community benefits. This multi-benefit approach creates sustainable and resilient water infrastructure that supports and revitalizes urban communities.

The U.S. Environmental Protection Agency (EPA) encourages communities to use green infrastructure to help manage stormwater runoff, reduce sewer overflows, and improve water quality. EPA recognizes the value of working collaboratively with communities to support broader adoption of green infrastructure approaches. Technical assistance is a key component to accelerating the implementation of green infrastructure across the nation and aligns with EPA's commitment to provide community focused outreach and support in the President's *Priority Agenda Enhancing the Climate Resilience of America's Natural Resources*. Creating more resilient systems will become increasingly important in the face of climate change. As more intense weather events or dwindling water supplies stress the performance of the nation's water infrastructure, green infrastructure offers an approach to increase resiliency and adaptability.

For more information, visit <http://www.epa.gov/greeninfrastructure>

## Acknowledgements

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### Principal USEPA Team

Jamie Piziali, USEPA  
Christopher Kloss, USEPA  
Tamara Mittman, USEPA  
Eva Birk - ORISE, USEPA  
Bob Newport, USEPA, Region 5

### Community Team

Lucy Thompson, City of Saint Paul  
Marie Franchett, City of Saint Paul  
Wes Saunders-Pearce, City of Saint Paul  
Karin Misiewicz, City of Saint Paul  
Don Ganje, City of Saint Paul  
Anne Weber, City of Saint Paul  
Tim Griffin, Saint Paul Riverfront Corporation

### Consultant Team

Martina Frey, Tetra Tech  
Anne Thomas, Tetra Tech  
Jennifer Olson, Tetra Tech  
Dan Christian, Tetra Tech  
Brad Aldrich, Emmons & Olivier Resources, Inc.  
John Kosco, Tetra Tech

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Cost-Recovery Options – West Side Flats Greenway Memorandum

## I Introduction

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The West Side Flats Greenway project offers an opportunity for private property owners within the West Side Flats neighborhood to partner with the City of Saint Paul on a shared stacked-function green infrastructure concept. In lieu of meeting stormwater requirements on each individual site, this shared project will have multiple, “stacked” benefits including incentivizing redevelopment, treating stormwater, providing recreational space and cooling and filtering the air. The greenway will be the first application of a shared public-private stormwater management facility using green infrastructure in the city. Additionally, this project will help pilot the shared stacked-function green infrastructure concepts evaluated as part of the Twin Cities’ Light Rail Transit Green Line project [see *Strategic Stormwater Solutions for Transit-Oriented Development* (December 2013)]<sup>1</sup>. The West Side Flats Study Area is approximately 120 acres and is located directly across the Mississippi River from Downtown Saint Paul. It is situated between the Mississippi River, Plato Boulevard, Wabasha Street, and Lafayette Road. The proposed West Side Flats Greenway is located along a working railroad that divides the West Side Flats Study Area. The parcel, adjacent to the railroad right-of-way, within which the proposed greenway lies is currently privately-owned and for sale. The City of Saint Paul is exploring options to facilitate creation of the greenway, including purchasing the greenway parcel independently or in partnership with a private developer. The City is also evaluating if establishing a regional stormwater management facility comprised of green infrastructure in the greenway and an expanded tributary storm sewer network can open new funding options for land acquisition.

Saint Paul is the Capitol and the second-most populous city in Minnesota with a population of nearly 300,000. It is part of the Minneapolis-Saint Paul metropolitan area, which includes a population of about 3.5 million residents. The city surrounds the confluence of the Mississippi River and the Minnesota River, a feature integral to the settlement of this area. Temperatures are typically below freezing during the winter and 70 to 80 degrees Fahrenheit in the summer. Annual precipitation is approximately 32 inches.

The history of West Side Flats is marked by a thriving riverfront neighborhood and market place in the late 1800’s transitioning to an industrial park in the 1960’s due primarily to frequent river flooding. A levee and floodwall were also built to address flooding during the 1950’s. In recent decades with decreasing river and railway transport, this area has begun to see new housing and office development, and industrial uses are changing to meet new market demand. With its potential to be transformed into an urban riverfront village, the West Side Flats neighborhood has been targeted

### Shared Stacked-Function Green Infrastructure

Shared stacked-function green infrastructure means that the project will not only assist public and private property owners in meeting local stormwater management goals, it will have multiple benefits including:

- incentivizing redevelopment
- treating stormwater
- reestablishing a social connection to the Mississippi River
- providing recreational space
- promoting beautification
- cooling and filtering the air

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<sup>1</sup> Strategic Stormwater Solutions for Transit-Oriented Development (December 2013). Web Address (last accessed: February 3, 2015). [http://www.corridorsofopportunity.org/sites/default/files/Strategic\\_Stormwater\\_Solutions\\_for\\_TOD\\_Final\\_Report.pdf](http://www.corridorsofopportunity.org/sites/default/files/Strategic_Stormwater_Solutions_for_TOD_Final_Report.pdf)

for revitalization within various planning documents over the past two decades<sup>2, 3, 4</sup>. The vision is a riverfront urban village comprised of a mix of residential, commercial, industrial, office, institutional, entertainment, and recreational uses. Common goals of the various planning documents are to manage stormwater naturally and to incorporate a green space network within the urban realm connecting residents to the Mississippi River. The City of Saint Paul and its collaborators understand the significant role green infrastructure plays in integrating these two goals.

This project has substantial value in that it will function as a pilot project for implementing shared stacked-function green infrastructure. It will be a catalytic public investment to stimulate private investment, and it will help spark development in the area as laid out in the *West Side Flats Master Plan & Development Guidelines, Draft* (March 2014). The West Side Flats Master Plan & Development Guidelines document is expected to be formally adopted by City Council in April 2015. This conceptual green infrastructure design report has already spurred a purchase offer on a 13.5-acre parcel that includes the proposed greenway and 780 planned housing units as laid out in the Master Plan.

Although implementation of green infrastructure in this area will likely not address the Mississippi River's impairments for mercury, PCB, and perfluorooctane sulfonate in fish tissue, it may address the impairments for fecal coliform and turbidity in addition to reducing nutrient and sediment loads. More generally, it will demonstrate a shared stormwater management approach for similar areas around the country targeted for revitalization in the urban environment. To further this project and the City's overall commitment to green infrastructure, the City of Saint Paul applied for U.S. Environmental Protection Agency (USEPA) Technical Assistance to explore the technical feasibility of incorporating green infrastructure within the proposed greenway.

The project focus is to investigate the extent to which the greenway can reasonably host surface water features and to a lesser extent subsurface storage features to treat stormwater and manage potential flooding while serving as an amenity to the community. Surface water features refer to practices that treat and manage stormwater runoff above ground such as bioretention and retention ponds. Subsurface storage features include below grade storage practices primarily used to manage runoff from large rain events. Methods to fund the construction, operation, and maintenance of the shared stormwater management features were also evaluated and are summarized in a memorandum in the appendix. Prior community engagement efforts revealed that there is an interest in incorporating surface water features within the West Side Flats study area<sup>5</sup>. Incorporation of surface water and subsurface storage features will be defined by community input, topography, West Side Flats master planning, existing storm sewer attributes, potential soil contamination, groundwater, Saint Paul's municipal stormwater retention standard, a rate control standard, and other planned park programming. Providing input on this wide range of subjects, specifically for this USEPA technical assistance project, was the City's steering committee comprised of staff from a variety of departments within the City of Saint Paul and the Saint Paul Riverfront Corporation. This report presents options for

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<sup>2</sup> West Side Flats Master Plan and Development Guidelines (2001). Web Address (last accessed: February 3, 2015). <http://www.stpaul.gov/index.aspx?NID=3446>

<sup>3</sup> West Side Flats Master Plan and Development Guidelines, Draft (March 2014). Web Address (last accessed: February 3, 2015). <http://www.stpaul.gov/westsidedeflats>

<sup>4</sup> The West Side Community Plan (Addendum to the Saint Paul Comprehensive Plan) (February 2013). Web Address (last accessed: February 3, 2015). <http://www.stpaul.gov/index.aspx?NID=3446>

<sup>5</sup> May 2013 West Side Flats Design Charrette. Web Address (last accessed: February 3, 2015). <http://www.stpaul.gov/westsidedeflats>



including green infrastructure concepts within the greenway. Options were informed by both a baseline stormwater analysis of the drainage area, as well as a series of discussions with the steering committee.

The information contained herein is intended to guide forthcoming phases in the project, which include the following:

- Securing the 13.5-acre parcel for the greenway and housing development as laid out in the West Side Flats Master Plan & Development Guidelines
- Procuring a USEPA brownfields area-wide planning grant for the proposed greenway
- Determining the financial mechanisms to establish the greenway and associated tributary storm sewers.



## 2 Greenway Drainage Area Site Conditions

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The 120-acre West Side Flats study area is part of the Riverview Subwatershed (3,326 acres). The study area is further divided amongst the Custer (176 acres) and the Chester (330 acres) subwatersheds, subsets of the Riverview Subwatershed. To further refine the study area to a “greenway drainage area,” an analysis of what land area could feasibly drain to the proposed greenway was conducted. The analysis evaluated approaches to direct stormwater to the greenway including:

- intercepting drainage from existing storm sewers,
- proposing new shallow storm sewers, and
- capturing sheet flow around the perimeter of the greenway.

The resulting greenway drainage area is approximately 39 acres and is situated entirely within the Custer Subwatershed (Figure 3). The drainage area is generally flat with a gradual slope toward the greenway from northeast to southwest along Fillmore Avenue and then toward the levee from Fillmore Avenue. The existing storm sewers drain toward the greenway to a 90-inch storm sewer that discharges to the river just east of Wabasha Street. The Custer lift station is in service to pump flows from the 90-inch sewer over the levee when the river level is higher than the outfall gate. The last time this situation occurred was in 2011. The drainage area is roughly between Wabasha Street and Robert Street and between Plato Boulevard and the Mississippi River (termed “Riverview West” by the Saint Paul Port Authority). The drainage area excludes the West Side Flat Apartments and the US Bank properties, both recently redeveloped properties with on-site stormwater controls. The portion of Fillmore Avenue west of the railroad and Harriet Island Boulevard adjacent to the West Side Flats Apartments are publically-owned rights-of-way. Stormwater runoff from these roads is treated through the City’s tree trench design. This area was included in the greenway drainage area as discharge from the tree trenches can be directed to the greenway.



Figure 1 Saint Paul Housing and Redevelopment Authority Parcel  
(looking northeast from Fillmore Avenue)



Figure 2 West Side Flats Apartments



Figure 3 Greenway Drainage Area Site Conditions



The proposed greenway delineation is approximately 6 acres with an average width of 175 feet and an approximate length of 1,450 feet from the levee to Plato Boulevard. There is approximately 600 feet of existing open space bordering the levee and the existing river walk, which extends from Harriet Island Regional Park on the west side of Wabasha Street. This land is currently apportioned into three segments due to road crossings including Fillmore Avenue and the proposed extension of Fairfield Avenue. The length of the greenway borders a railroad corridor. Except for the City's active lift station in the northwest portion of the greenway, the land has been vacated and is predominately cleared of structures. Grasses, brush and a few trees remain. It has unobstructed views of the Saint Paul skyline to the north as well as the Robert Street bridge and the Wabasha Street bridge.

Properties within the greenway drainage area and the proposed greenway itself are predominately under private ownership. The City of Saint Paul owns the interior roadways and the Saint Paul Housing and Redevelopment Authority owns the parcel east of the railroad between Livingston Avenue and Fillmore Avenue. This parcel is expected to be sold for redevelopment. Robert Street/Hwy 52 is under Minnesota Department of Transportation jurisdiction, Plato Boulevard is owned by Ramsey County, and the railroad is owned by Union Pacific Railroad Company.

Limited geotechnical information in this area suggests that the soil is primarily 8 to 10 feet of fill over sandy deposits with clayey layers. The soil in the greenway and its drainage area are expected to be contaminated due to former industrial uses in the area. The parcel east of Harriet Island Road and west of the railroad tracks was recently remediated for lead. The groundwater table is approximately 15 feet below grade. A recently sealed artesian well (July 2012) is located just outside the southern end of the greenway<sup>6</sup>. There are no wellhead protection issues in this area since it does not serve a public water system. Well testing data is unavailable regarding the possibility of contamination.



**Figure 4 Greenway**  
*(looking southwest from Livingston Ave. and Fillmore Ave.)*



**Figure 5 Saint Paul Housing and Redevelopment Authority Parcel**  
*(looking northwest from Livingston Ave. and Fillmore Ave.)*

<sup>6</sup> Minnesota Unique Well No. 272117. Web Address (last accessed February 6, 2015). <http://mdh-agua.health.state.mn.us/cwi/cwiViewer.htm>

### 3 Master Plan Framework

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The West Side Flats area has been addressed within several planning documents over the past two decades. The focus of these efforts has been on revitalizing the area and reconnecting neighborhoods to the Mississippi River. The vision produced by these various efforts is that of a mixed-use urban village with both public amenities and an integral connection to the Mississippi River. Relevant planning documents include the following:

- Saint Paul on the Mississippi Development Framework (1997)
- West Side Flats Master Plan and Development Guidelines (2001)
- The West Side Community Plan (Addendum to the Saint Paul Comprehensive Plan) (February 2013)
- Great River Passage Master Plan (Addendum to the Saint Paul Comprehensive Plan) (April 2013)
- Strategic Stormwater Solutions for Transit-Oriented Development (December 2013)
- West Side Flats Master Plan and Development Guidelines (WSF Master Plan) , Draft (March 2014)
- Draft Stormwater Appendix to the West Side Flats Master Plan and Development Guidelines (April 2014)

With regard to stormwater management, the various planning documents all emphasize the incorporation of natural stormwater management and a network of green spaces. In addition, community members indicated desire for water quality projects that will reduce pollution to the river. The most recent documents (Strategic Stormwater Solutions for Transit-Oriented Development and the WSF Master Plan) focus on the use of green infrastructure as an amenity to meet environmental, economic, and social goals in shared public-private green infrastructure practices.

The West Side Flats greenway concept is specifically addressed in the WSF Master Plan. In addition, the draft stormwater appendix to the WSF Master Plan recommends the use of green infrastructure as development occurs to reduce the probability of flooding when the river level is above the gravity outfall and the lift station is not able to keep up with storm flows. The WSF Master Plan outlines a modified street layout, greenway, and changes to building types/uses within the delineated greenway drainage area. This initial master plan layout will be carried forward within this report as a basis for presenting and analyzing alternative green infrastructure concepts for the greenway (Figure 6).



Figure 6 West Side Flats Master Plan Concept

## 4 Project Approach

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This section notes the goals, objectives, and key design elements for the greenway project. Using these goals and objectives as a guide, designers and city staff developed three conceptual design options for green infrastructure within the greenway. Typical green infrastructure project typologies are also discussed in this section to help visualize the end product.

### 4.1 Project Goals

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With implementation of the West Side Flats Greenway project, the City hopes to achieve the following goals:

- Attract investors to the West Side Flats area.
- Reduce runoff from the area proposed as greenway, which might otherwise have been largely impervious.
- Demonstrate the feasibility of creating shared stacked-function green infrastructure practices for public and private stormwater management within Saint Paul in lieu of managing stormwater on individual sites. Additionally, this project will help explore and support the concepts presented in the Strategic Stormwater Solutions for Transit-Oriented Development (December 2013) and build upon the concepts implemented as part of the Twin Cities' Light Rail Transit Green Line project.
- Connect the West Side neighborhood to the Mississippi River.
- Provide welcoming green space for residents to enjoy.
- Reduce pollutants to the Mississippi River.
- Help manage local flooding during storm events.

### 4.2 Project Objectives

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The specific objectives of the conceptual green infrastructure design within the proposed greenway are as follows:

- Provide viable concepts for integrating stacked-function green infrastructure with greenway programming typical of an active recreational park.
- Determine the feasible public and private tributary drainage areas to the greenway to help inform recovery of capital and operation & maintenance costs of the greenway and sizing of the practices to meet the stormwater design criteria.
- Intercept storm flows from the existing stormwater piping network to the greenway as much as practicable to avoid the cost of constructing new sewer to convey stormwater to the greenway.

### 4.3 Key Design Elements

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The following represents key design elements that were relevant throughout conceptual design. As design for this project progresses, some design elements may become more prevalent than others.

- Emphasize surface water features as much as practicable.

- Consider depth of the existing sewer system (varies) and groundwater table (~10 feet below grade) when determining green infrastructure practice depths and overflow back to the existing sewer system.
- Consider the WSF Master Plan when determining future land uses.
- Allocate approximately 60 percent of the greenway to recreational space. This would not prohibit subsurface stormwater storage beneath the recreational space.
- When analyzing the drainage area, differentiate between private and public areas. Include areas likely to be developed over the next 10 to 15 years.
- Assume soils are contaminated and green infrastructure practices will likely be lined to prevent infiltration and the migration of pollutants. Further discussion will be needed to determine how lining a practice due to soil contamination will be reconciled with regard to the existing 1.1-inch retention standard per the Minnesota Minimal Impact Design Standards (MIDS).<sup>7</sup>
- Consider the railroad easement (~30 feet) a hydrologic barrier due to the permissions needed for directing drainage beneath the railroad. Further investigation with the Union Pacific Railroad Company would be necessary to further pursue this option. If permitted, directing drainage beneath the railroad could potentially allow the practices along the greenway to be hydraulically connected with flow toward the river.
- Preserve the downtown skyline views.

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<sup>7</sup> Minnesota Minimal Impact Design Standards (MIDS). Web Address (last accessed February 2, 2015): <http://www.pca.state.mn.us/index.php/water/water-types-and-programs/stormwater/stormwater-minimal-impact-design-standards-mids.html>



## 5 Stormwater Modeling

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An XP-SWMM model of the Riverview Subwatershed, developed in 2010 for a prior project, was modified and used to calculate the stormwater runoff from the area tributary to the proposed greenway and to route the flows through a pipe network made of existing and proposed storm sewers. Storm sewers are proposed as part of this conceptual design to convey flows from the tributary area to the proposed greenway. The existing pipe network within the West Side Flats neighborhood was reviewed for locations where shallow pipe could be intercepted and rerouted into the either a surface or subsurface practice depending on the sewer depth and topography. Figure 7 shows the locations of proposed storm sewer and existing utilized storm sewer.

The tributary drainage area was divided into three subcatchments, each draining to one of three green infrastructure practice areas as shown in Figure 7. The existing model used the NRCS curve number method to calculate runoff. This hydrologic method continued to be used to model the conceptual design, but the imperviousness and drainage delineations were modified within the 39-acre greenway tributary area to reflect possible future changes to land use and drainage. Modifications to the original model also included proposed storm sewers and green infrastructure practices used to retain and detain stormwater runoff. The proposed storm sewers were sized for a 5-year design storm assuming no attenuation of stormwater from the adjacent properties. Because the green infrastructure proposed in the greenway is providing a regional stormwater management system for the tributary drainage area, the criterion for sizing the proposed storm sewers differs from the City's standard, which is to design for a 5-year design storm assuming a runoff coefficient of 0.4 from the tributary properties. A runoff coefficient of 0.4 represents the required attenuation of stormwater from individual properties. Additional modeling will be necessary to understand how the downstream storm water system (i.e. Custer lift station and deep 90-inch sewer) will function in response to a regional stormwater management facility during high river stages.

Three park areas within the greenway, totaling approximately six acres, where the green infrastructure practices will be located were assumed to have no impervious area, while the remaining catchment areas contributing to the green infrastructure practices were assumed to have 100 percent impervious area in accordance with future development plans (Figure 6). Infiltration from the green infrastructure practices during storm events was assumed to be zero to reflect the likelihood that infiltration will not be allowed due to soil contamination.

For modeling purposes, each of the proposed green infrastructure practices is sized to retain (not to be released from the site) the runoff from the first 1.10 inches of rainfall and detain the runoff generated by the 100-year, 24-hour design storm with a release rate of 1.64 cfs per acre (City of Saint Paul standard). It is assumed that the green infrastructure practices would be a combination of surface and subsurface practices to handle the required volume, as surface practices alone would not have capacity. All rainfalls simulated in the model are based on the rainfall depths in NOAA Atlas 14 Volume 8 Version 2 and use the SCS Type II rainfall distribution. The following design storms were simulated in the model.

### **The stormwater design standards used for this analysis are as follows:**

- Retain 1.1 inches of runoff from impervious surfaces (MIDS).
- Limit the discharge rate to 1.64 cfs/acre per City standard.
- Use NOAA Atlas 14 rainfall for Saint Paul
- Provide analysis for storm events up to the 100-year 24-hour event

- 1.10-inch rainfall (used to quantify the required retention volume)
- 1-year, 24-hour rainfall = 2.45 inches
- 2-year, 24-hour rainfall = 2.80 inches
- 5-year, 24-hour rainfall = 3.49 inches
- 10-year, 24-hour rainfall = 4.18 inches
- 100-year, 24-hour rainfall = 7.40 inches

Water stored in the green infrastructure practices in excess of the retention volume is released back into the 90-inch diameter storm sewer running parallel to the railroad right-of-way on the east side.

Stormwater within the 90-inch storm sewer discharges into the Mississippi River directly or is pumped over the levee during high river stages. Table 1 provides the required practice retention and detention volumes to meet the stormwater design standards for the range of design storms. Volumes are divided between two categories, “Public” and “Private” to reflect the origination of the runoff.

Table I Retention and Detention Volume Modeling Results

Description	Practice Area 1					
	Retention Volume ft <sup>3</sup>		Detention Volume ft <sup>3</sup>		Total Volume ft <sup>3</sup>	
	Private	Public	Private	Public	Private	Public
1.10-inch	0	12,000	0	0	0	12,000
1-year, 24-hour	0	12,000	0	3,000	0	15,000
2-year, 24-hour	0	12,000	0	5,000	0	17,000
5-year, 24-hour	0	12,000	0	8,000	0	20,000
10-year, 24-hour	0	12,000	0	12,000	0	24,000
100-year, 24-hour	0	12,000	0	32,000	0	44,000
Tributary Drainage Area = 6.6 ac (Private = 0 ac; Public = 3.6 ac; Park=3 ac)						

Description	Practice Area 2					
	Retention Volume ft <sup>3</sup>		Detention Volume ft <sup>3</sup>		Total Volume ft <sup>3</sup>	
	Private	Public	Private	Public	Private	Public
1.10-inch	34,000	11,000	0	0	34,000	11,000
1-year, 24-hour	34,000	11,000	5,000	3,000	39,000	14,000
2-year, 24-hour	34,000	11,000	11,000	4,000	45,000	15,000
5-year, 24-hour	34,000	11,000	19,000	8,000	53,000	19,000
10-year, 24-hour	34,000	11,000	28,000	11,000	62,000	22,000
100-year, 24-hour	34,000	11,000	76,000	27,000	110,000	38,000
Tributary Drainage Area = 15.1 ac (Private = 10.5 ac; Public = 3.5 ac; Park = 1.1 ac)						

Description	Practice Area 3					
	Retention Volume ft <sup>3</sup>		Detention Volume ft <sup>3</sup>		Total Volume ft <sup>3</sup>	
	Private	Public	Private	Public	Private	Public
1.10-inch	31,000	18,000	0	0	31,000	18,000
1-year, 24-hour	31,000	18,000	4,000	4,000	35,000	22,000
2-year, 24-hour	31,000	18,000	7,000	6,000	38,000	24,000
5-year, 24-hour	31,000	18,000	16,000	10,000	47,000	28,000
10-year, 24-hour	31,000	18,000	25,000	16,000	56,000	34,000
100-year, 24-hour	31,000	18,000	72,000	45,000	103,000	63,000
Tributary Drainage Area = 17.2 ac (Private = 9.6 ac; Public = 5.7 ac; Park = 1.9 ac)						

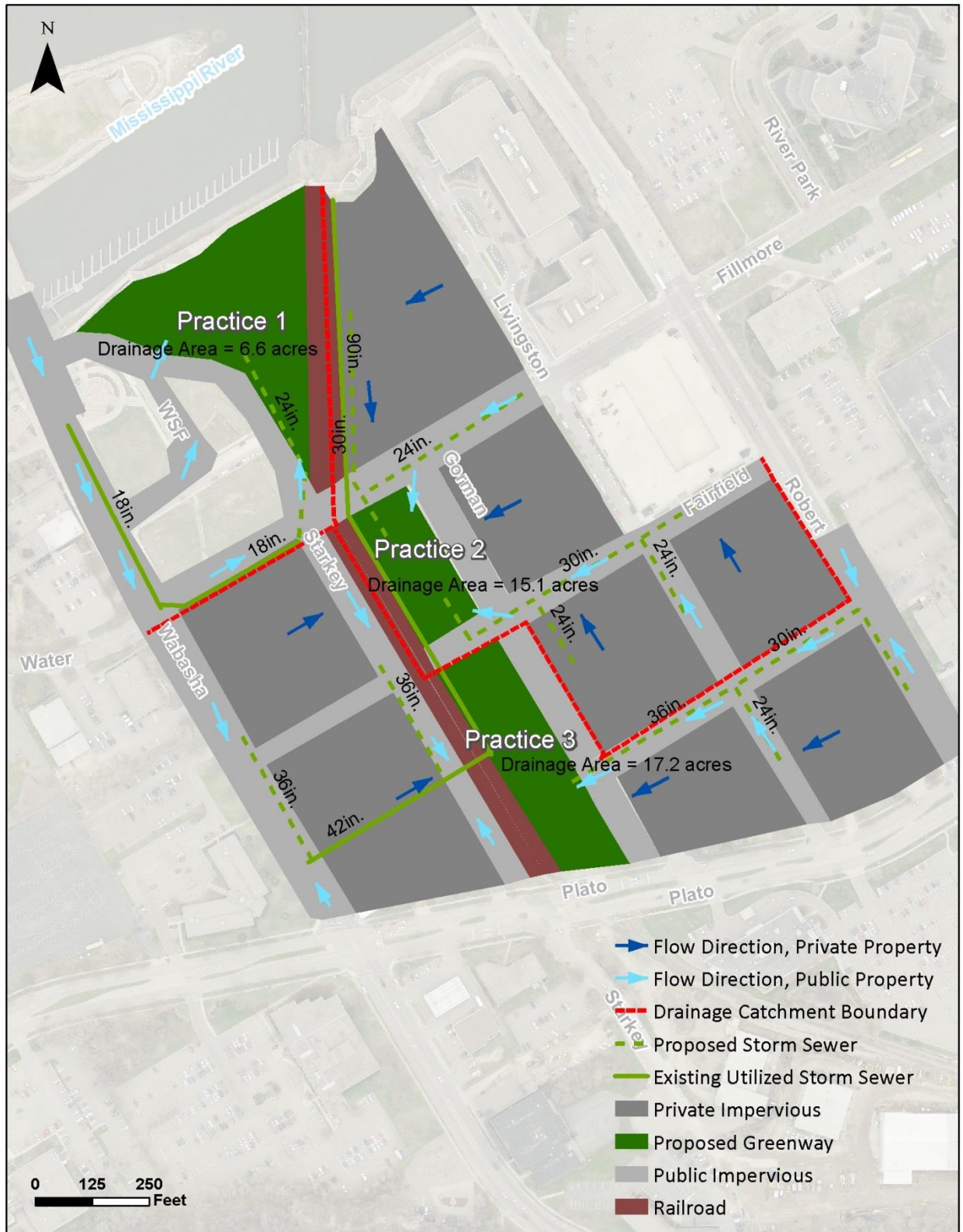


Figure 7 Greenway Tributary Drainage Areas



## 6 Green Infrastructure Toolbox

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As the green infrastructure concepts were being developed, precedent projects were used to help define the function and overall look of potential practices within the greenway. The following projects are primarily regional park projects that collect stormwater from urban areas adjacent to the park for treatment and storage within the park. Surface water features are a key element of the designs. The project team felt that projects with these characteristics most closely represent the vision for the West Side Flats Greenway, and are presented here as part of a toolbox for shared, stacked-function green infrastructure. Detailed design information regarding specific practices (e.g. biofiltration, tree boxes, iron enhanced sand filter, stormwater pond, stormwater wetland) is located in the Minnesota Stormwater Manual.



Courtesy of Waterfront Toronto

### **Corktown Common Park – Toronto, Ontario**

Set on old riverfront industrial lands, Corktown Common Park is a centerpiece for an emerging urban neighborhood. Stormwater wetlands are used to treat the adjacent land.

[http://www.waterfrontontario.ca/explore\\_projects2/west\\_don\\_land/corktown\\_common](http://www.waterfrontontario.ca/explore_projects2/west_don_land/corktown_common)



Courtesy of Neil Price, Wellington City Council



Courtesy of the City of Vancouver

**(Top) Waitangi Park – Wellington, New Zealand**

Waitangi Park emphasizes water quality including daylighting of Waitangi Stream, treatment of stormwater, and water re-use for irrigation.

<http://www.waal.co.nz/our-projects/urban/waitangi-park/>

**(Bottom) Hinge Park – Vancouver, British Columbia**

The wetlands within the park treat stormwater runoff and function as an amenity to a vibrant recreational area.

[https://cfapp.vancouver.ca/parkfinder\\_wa/index.cfm?fuseaction=FAC.ParkDetails&park\\_id=240](https://cfapp.vancouver.ca/parkfinder_wa/index.cfm?fuseaction=FAC.ParkDetails&park_id=240)





**Historic Fourth Ward Park – Atlanta, Georgia**

A large stormwater pond is featured in this urban park. It provides a venue for concerts and an amenity for the pedestrian trail.

<http://www.h4wpc.com/>



## 7 Conceptual Design

Early discussions with the steering committee revealed the desire to lay out two distinct concepts for integrating green infrastructure into the proposed greenway; a linear and natural waterway concept and a central and urban water feature concept. Later in the process, a third concept was developed which combined the linear waterway with the central water feature. The conceptual green infrastructure layout and stormwater analysis proceeded with these concepts to meet the goals, objectives, and key design elements. A cost analysis was not completed as part of this conceptual design.

A description, conceptual plan view, cross-section, and example photo are presented in this section for each concept. The primary differentiators between the concepts include the aesthetics of the greenway itself (urban versus natural) and the resulting available space for other park programming elements.

### 7.1 Concept 1: Linear and Natural

The linear and natural concept focuses on providing approximately 1.35 acres of man-made waterway resembling a natural stream-like water feature with adjacent stormwater wetlands in Practice Areas 2 and 3 (Figure 8 and Figure 9). The average storage depth is envisioned to be approximately 2.5 feet providing approximately 146,000 cubic feet of surface storage. The preferred method for feeding the stream is restoration of the nearby artesian well. However, given that the well (i.e. spring) was recently sealed and restoration of the well is unlikely due to cost, the stream itself would be completely dependent on stormwater flows. The waterway would be designed with vegetation adaptive to variable wet and dry periods. The waterway location is adjacent to the railroad, which provides a buffer between the tracks and the proposed active recreational park space and trail. A bridge is proposed across Fairfield Avenue to hydraulically connect the southern and central park areas. In addition, a 0.35-acre shallow biofiltration basin is proposed in the low area on the northwest end of the greenway, Practice Area 1.

To keep the proposed practices shallow, stormwater is collected from the adjacent streets through curb cuts or ribbon curbs and runnels (i.e. a narrow channel). The drainage area beyond the adjacent streets is

#### Linear and Natural Concept Approximate Surface Practice Sizes

##### Surface Practice Area 1

Area: 15,000 square feet

Depth: 2.5 feet

Volume: 37,500 cubic feet

Practice Volume/Total Volume: 85%

##### Surface Practice Area 2

Area: 22,400 square feet

Depth: 2.5 feet

Volume: 56,000 cubic feet

Practice Volume/Total Volume: 38%

##### Surface Practice Area 3

Area: 36,000 square feet

Depth: 2.5 feet

Volume: 90,000 cubic feet

Practice Volume/Total Volume: 54%

\* "Total Volume" is the total runoff for a 100-yr 24-hr storm.

#### Linear and Natural Concept Approximate Subsurface Practice Sizes

##### Subsurface Practice Area 1

Volume: 6,500 cubic feet

Practice Volume/Total Volume: 15%

##### Subsurface Practice Area 2

Volume: 92,000 cubic feet

Practice Volume/Total Volume: 62%

##### Subsurface Practice Area 3

Volume: 76,000 cubic feet

Practice Volume/Total Volume: 46%

\*\* Subsurface practice sizes reflect what is needed for a 100-yr 24-hr storm in addition to the surface storage.

served by a proposed stormwater pipe network (and portions of the existing stormwater pipe network if feasible) discharging to subsurface storage practices within the three practice areas. Within the collection system, prior to discharging to the practices, pretreatment should be installed to remove sediment and trash from the runoff. Pretreatment mechanisms might include a tree trench, swale, or a hydrodynamic device upstream of each practice. The Linear and Natural Concept provides approximately 1.7 acres of surface water features equating to approximately 30 percent of the greenway space. To accommodate a 100-yr 24-hr storm event meeting the design criteria, subsurface storage practices within the greenway would equal approximately 174,500 cubic feet.

Having a stacked function is a key objective of the green infrastructure practices. In addition to providing stormwater management, the surface practices are envisioned to be integral to the experience one has in the greenway with attractive vegetation and access points. Assuming the restoration of the artesian well is not feasible, these practices would be dry outside of rain events. The subsurface practices, although not visible, could be used for irrigation and for building functions.

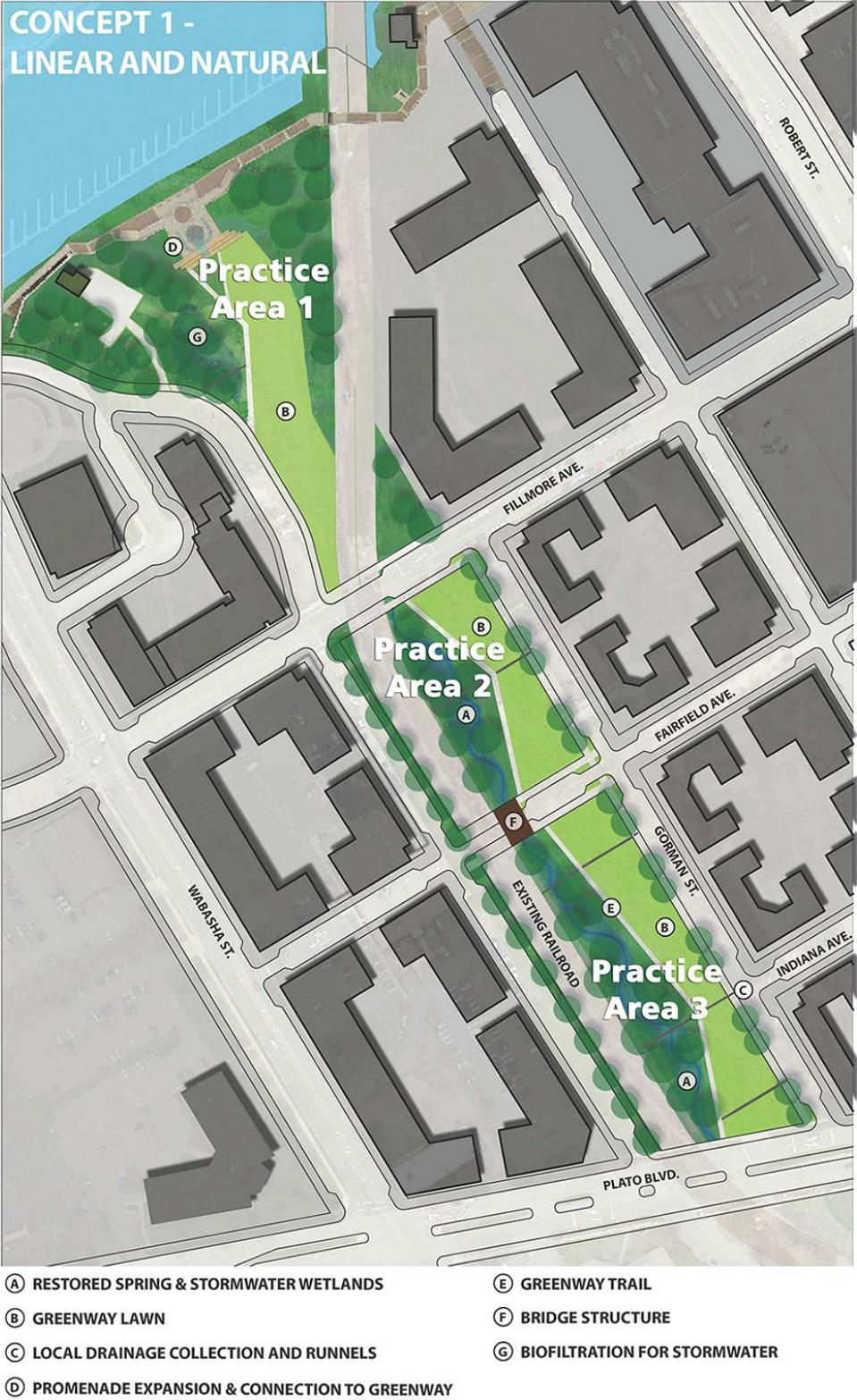


Figure 8 Concept I Plan View

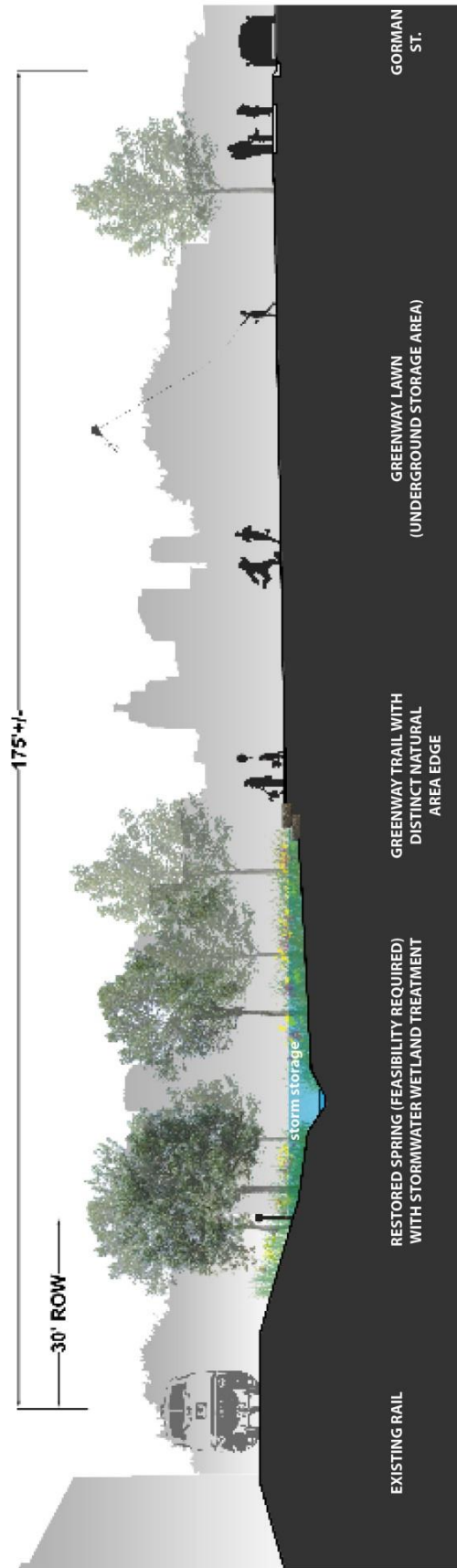


Figure 9 Concept I Cross-Section





**Fairview Park, Lansing Township, Michigan**



**Towar Gardens, East Lansing, Michigan**

**Figure 10 Biofiltration Examples**

## 7.2 Concept 2: Central and Urban

In contrast to the linear green infrastructure practices in Concept 1, the Central and Urban Concept highlights a central green infrastructure practice in Practice Area 2 that has a permanent pool and enough storage capacity for the 10-year 24-hour storm event (Figure 11 and Figure 12). The vision for the 0.6-acre central pond emphasizes an urban form with a floating island, pond overlook, and tree trench plaza with spray jet fountains. The feasibility of spray jet fountains with regard to public health requirements will need to be further investigated. At flood stage, water in the pond would come into contact with an iron-sand filter bench and floodplain forest for further treatment. Six feet of storage depth provides capacity for about 110,000 cubic feet of stormwater. Like Concept 1, Concept 2 takes advantage of the low area in Practice Area 1 by incorporating 0.35 acre of biofiltration basin. A surface practice was not included in Practice Area 3 in lieu of leaving it open for other park programming possibilities. A drawback in removing the surface practice is that there is typically less effective water quality treatment with subsurface practices than with surface practices.

The greater depth of the pond allows for greater tributary area to the surface feature than the shallow wetland concept allowed. A shallow conveyance network is proposed to collect water from the streets to discharge to the pond. Water in excess of the pond capacity would be directed to subsurface storage with overflow to the 90-inch storm sewer.

Concept 2 provides approximately 1 acre of surface water features equating to approximately 16 percent of the greenway space. To accommodate a 100-yr 24-hr storm event meeting the design criteria, subsurface storage practices within the greenway would equal approximately 210,500 cubic feet.

Similar to Concept 1, the Central and Urban Concept strives for stacked function green infrastructure. The urban pond provides considerable flood storage volume and water quality treatment via settling, the iron-sand filter bench, and the wetland forest. It is also intended to be a prominent focal point of the greenway.

### Central and Urban Concept Approximate Surface Practice Sizes

#### Surface Practice Area 1

Area: 15,000 square feet  
Depth: 2.5 feet  
Volume: 37,500 cubic feet  
Practice Volume/Total Volume: 85%

#### Surface Practice Area 2

Area: 27,400 square feet  
Depth: 6 feet  
Volume: 110,000 cubic feet  
Practice Volume/Total Volume: 74%

#### Surface Practice Area 3

Area: 0 square feet  
Depth: 0 feet  
Volume: 0 cubic feet  
Practice Volume/Total Volume: 0%

\* "Total Volume" is the total runoff for a 100-yr 24-hr storm.

### Central and Urban Concept Approximate Subsurface Practice Sizes

#### Subsurface Practice Area 1

Volume: 6,500 cubic feet  
Practice Volume/Total Volume: 15%

#### Subsurface Practice Area 2

Volume: 38,000 cubic feet  
Practice Volume/Total Volume: 26%

#### Subsurface Practice Area 3

Volume: 166,000 cubic feet  
Practice Volume/Total Volume: 100%

\*\* Subsurface practice sizes reflect what is needed for a 100-yr 24-hr storm in addition to the surface storage.





Figure 11 Concept 2 Plan View



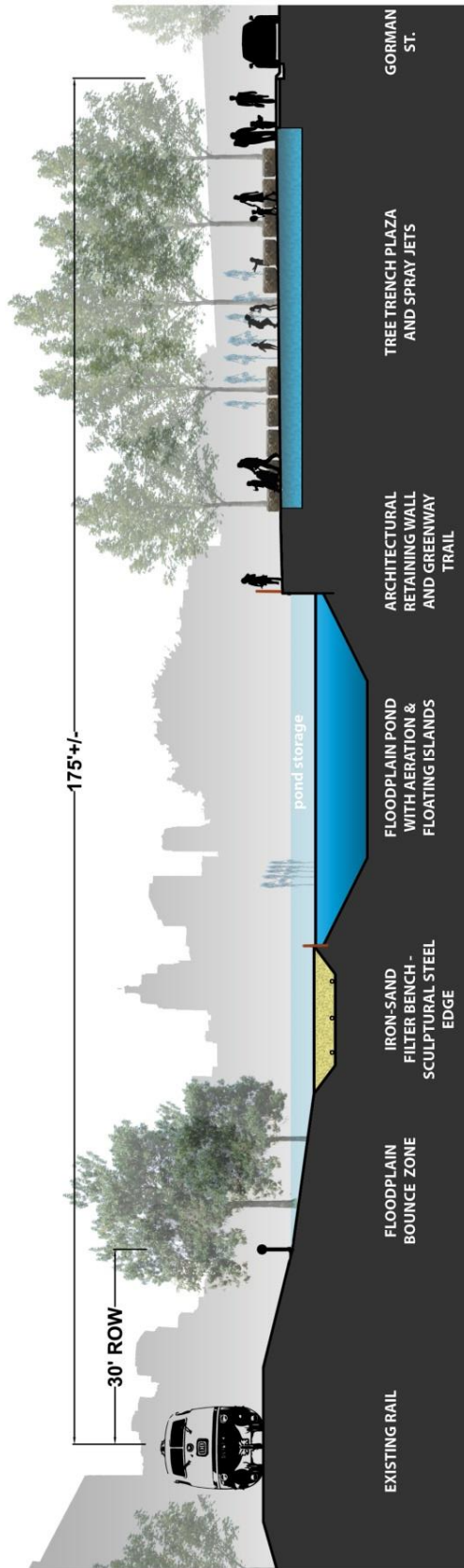
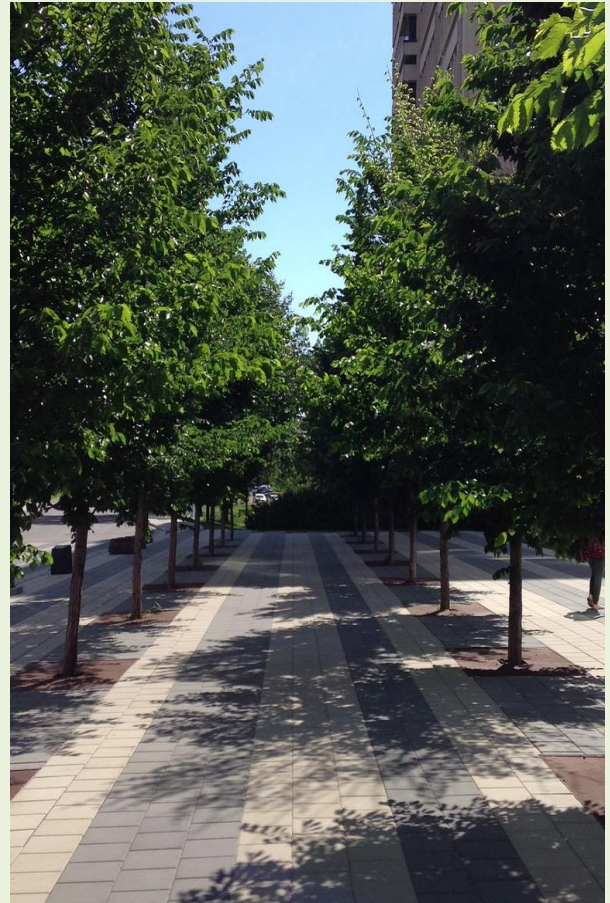


Figure 12 Concept 2 Cross-Section



Courtesy of Waterfront Toronto



Courtesy of DeepRoot (Flickr: DeepRoot Green Infrastructure)



**(Top) Spray Jet Fountains - Corktown Common Park, Toronto, Ontario**

**(Bottom) Urban Pond - Historic Fourth Ward Park, Atlanta, Georgia**



**(Top) Silva Cell Tree Plaza – University of Calgary EEEL Building, Calgary, Alberta**

**(Bottom) Iron-Sand Filter - Trout Brook Nature Sanctuary, Saint Paul, Minnesota**

Figure 13 Urban Pond Feature Examples

### 7.3 Concept 3: Combined

Concept 3 is the result of merging the stream-like surface feature in Concept 1 with the central urban pond feature in Concept 2 (Figure 14). This combination essentially incorporates the highlights from the first two concepts and provides approximately 1.8 acres of surface water features equating to approximately 30 percent of the greenway space, similar to Concept 1. To accommodate a 100-yr 24-hr storm event meeting the design criteria, subsurface storage practices within the greenway would equal approximately 120,500 cubic feet.

#### Combined Concept Approximate Surface Practice Sizes

##### Surface Practice Area 1 (from Concept 1 and 2)

Area: 15,000 square feet

Depth: 2.5 feet

Volume: 37,500 cubic feet

Practice Volume/Total Volume: 85%

##### Surface Practice Area 2 (from Concept 2)

Area: 27,400 square feet

Depth: 6 feet

Volume: 110,000 cubic feet

Practice Volume/Total Volume: 74%

##### Surface Practice Area 3 (from Concept 1)

Area: 36,000 square feet

Depth: 2.5 feet

Volume: 90,000 cubic feet

Practice Volume/Total Volume: 54%

#### Combined Concept Approximate Subsurface Practice Sizes

##### Subsurface Practice Area 1

Volume: 6,500 cubic feet

Practice Volume/Total Volume: 15%

##### Subsurface Practice Area 2

Volume: 38,000 cubic feet

Practice Volume/Total Volume: 26%

##### Subsurface Practice Area 3

Volume: 76,000 cubic feet

Practice Volume/Total Volume: 46%

\* "Total Volume" is the total runoff for a 100-yr 24-hr storm.

\*\* Subsurface practice sizes reflect what is needed for a 100-yr 24-hr storm in addition to the surface storage.

#### Concept Variations

While developing the three concepts, it was clear that there are design variations that may be preferred with further discussions and investigation. They include but are not limited to the following:

- Routing the drainage area west of the railroad tracks between Plato Blvd and Fillmore Avenue into a subsurface storage within Practice Area 1 instead of intercepting the existing storm sewer within Practice Area 3. This may be a more costly option as new storm sewer would be needed to route flow to the north.
- Assuming the bottom elevation of the pond is fixed due to design constraints, the design depth of the permanent pool can be adjusted by raising the surface elevation. This would affect the available capacity above the pool for storm storage.
- With further investigation, it may be feasible to direct stormwater through a culvert beneath the railroad tracks. This could potentially allow water to flow from the south of Fillmore Avenue to north of Fillmore Avenue in a continuous stream.
- Further investigation of utilizing the recently capped artesian well along Plato Blvd will help determine whether the stream-concept is feasible. Either way, the stormwater management capacity of that surface feature will remain the same.
- Soil investigations within the greenway will be necessary to determine whether the design of the practices, such as adding an impermeable liner, needs to accommodate contaminated soils.





Figure 14 Concept 3 Plan View

## 8 Conclusion

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The incorporation of green space into the urban fabric amidst pressure to develop and revitalize the West Side Flats neighborhood is a significant achievement on its own. Enhancing green space to not only provide water quality treatment and flood management benefits, but also serve as a unique amenity for residents is an example for cities worldwide.

Key takeaway messages:

- Interdepartmental input is required for successful planning and implementation of green infrastructure projects within the public realm. The City of Saint Paul created a steering committee dedicated to the West Side Flats Greenway concept. Steering committee members included the city's Water Resource Coordinator and staff from the Department of Planning and Economic Development, Department of Parks and Recreation, and Department of Public Works. The Saint Paul Riverfront Corporation, an urban design resource for community redevelopment projects, was also a key member of this steering committee.
- Including green infrastructure as part of a master planning process provides the opportunity to incorporate the public's vision for green infrastructure and its shared stacked functions. It also provides the opportunity to understand the important technical aspects of incorporating green infrastructure, such as defining the tributary drainage area and determining how stormwater will be conveyed to the green infrastructure practices. As a result of this conceptual design, it became clear that new shallow storm sewers would be needed to convey stormwater from the future densely-built area to the proposed greenway. It was also found that some existing sewers could easily be re-routed to the proposed greenway, a more cost-effective means of conveying stormwater than installing new sewer.

Additionally, it was recognized that the city's current stormwater design standards should be reviewed for applicability within the West Side Flats neighborhood. The proposed green infrastructure within the greenway provides a regional stormwater facility while the existing design standards were developed for individual on-site stormwater management.

- The technical aspects of the project need to advise the form and vice versa. For example, the flat topography of the tributary area is not conducive to capturing stormwater runoff from a large catchment area within a shallow waterway, but the urban pond design allows for deeper inlets while maintaining a visible amenity for the public. The steering committee recognized this and indicated preference for the urban pond concept while still trying to incorporate a shallow waterway from overland flow as much as practicable. This combination of deep and shallow surface water features is reflected in Concept 3.

To move this project forward, there are several additional items that should be investigated. These include:

- Completing a detailed XP-SWMM model of the final design concept to determine the impact to the City's storm sewer infrastructure, including the Custer lift station.
- Developing a fair and equitable funding mechanism that addresses construction, operation and maintenance, and replacement costs.

- Completing a project cost estimate for aspects of the greenway that would be funded by private and public partners. This piece would tie into the funding mechanism for the area.
- Completing a soil investigation throughout the drainage area but particularly within the greenway where water will be directed. Pertinent information includes the extent and depth of contamination, the depth to groundwater, soil type, and soil infiltration rate.
- Determining the feasibility of utilizing the recently capped artesian well near the southern end of the greenway as a constant water source for the proposed stream/wetland.
- Purchase of the greenway parcels by the city or other entity in cooperation with the city.