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City of Saint Paul
Saint Paul, Minnesota

West Side Flats Greenway Conceptual Green Infrastructure Design

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Cover Image: West Side Flats, St. Paul, Greenway Concept

About the Green Infrastructure Technical Assistance Program

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*.

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1 Introduction

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)][1]. 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

[1] 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*

for revitalization within various planning documents over the past two decades[2, 3, 4]. 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[5]. 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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[2] West Side Flats Master Plan and Development Guidelines (2001). Web Address (last accessed: February 3, 2015). *http://www.stpaul.gov/index.aspx?NID=3446*

[3] West Side Flats Master Plan and Development Guidelines, Draft (March 2014). Web Address (last accessed: February 3, 2015). *http://www.stpaul.gov/westsideflats*

[4] 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*

[5] May 2013 West Side Flats Design Charrette. Web Address (last accessed: February 3, 2015). *http://www.stpaul.gov/westsideflats*

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

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.

(looking northeast from Fillmore Avenue)

Figure 1. Saint Paul Housing and Redevelopment Authority Parcel

Figure 2. West Side Flats Apartments

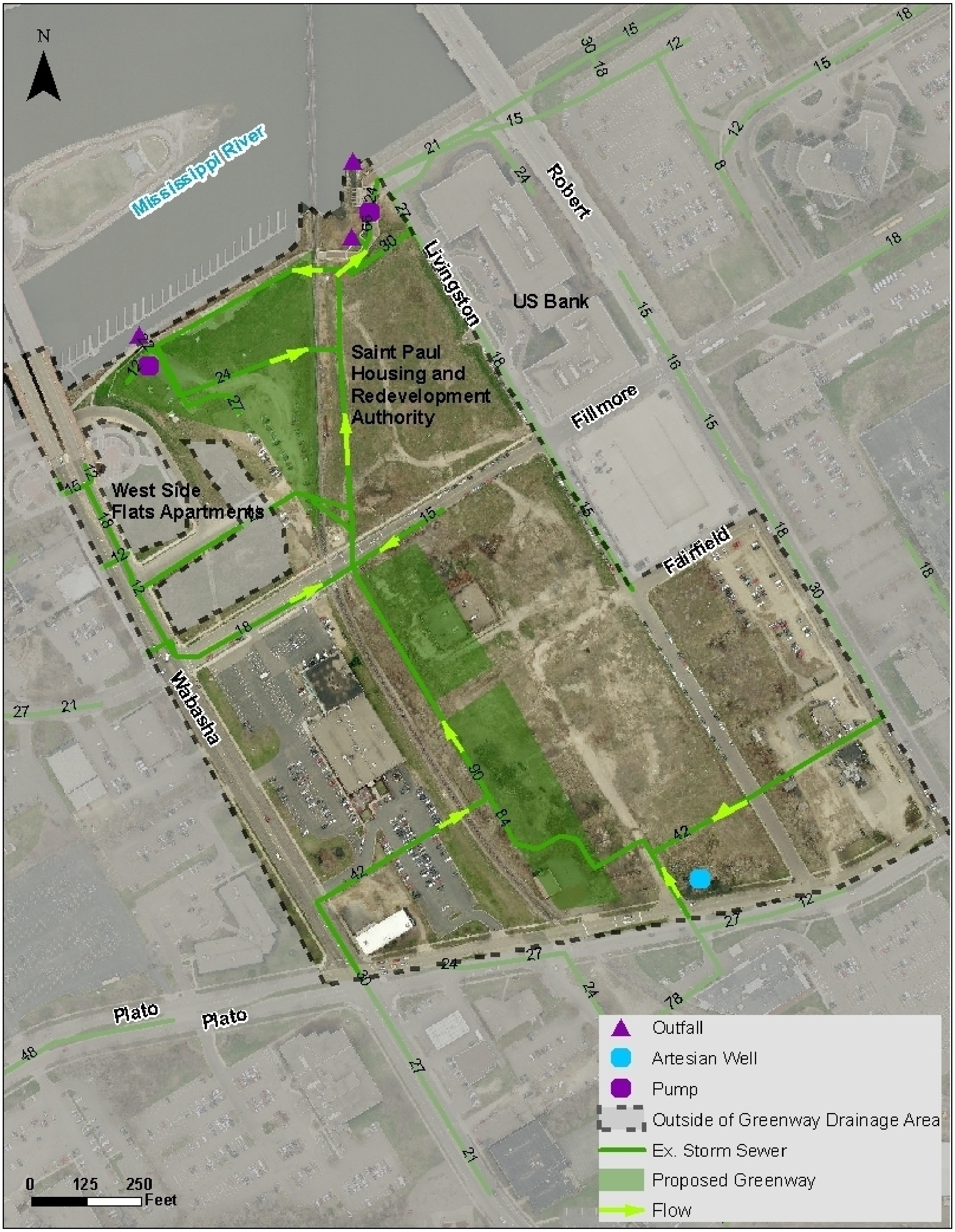

Figure 3. Greenway Drainage Area Site Conditions

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[6]. 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.

(looking southwest from Livingston Ave. and Fillmore Ave.)

Figure 4. Greenway

(looking northwest from Livingston Ave. and Fillmore Ave.)

Figure 5. Saint Paul Housing and Redevelopment Authority Parcel

[6] 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

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

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

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

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 capitol 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

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). [7]
- 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.

[7] 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

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.

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

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.

- 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 1. Retention and Detention Volume Modeling Results

Description	Practice Area 1					
	Retention Volume ft^3		Detention Volume ft^3		Total Volume ft^3	
	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^3		Detention Volume ft^3		Total Volume ft^3	
	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^3		Detention Volume ft^3		Total Volume ft^3	
	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)						

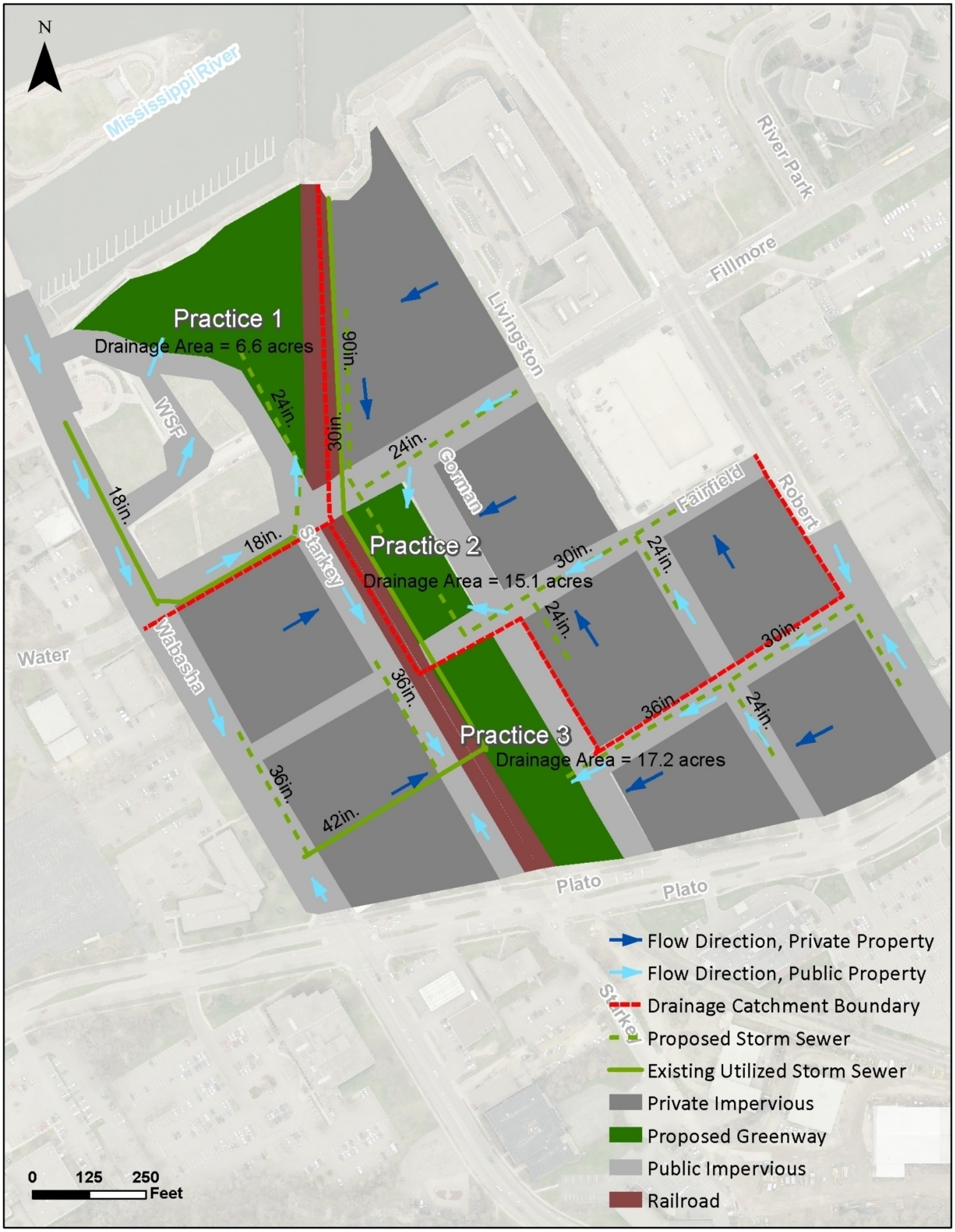

Figure 7. Greenway Tributary Drainage Areas

6 Green Infrastructure Toolbox

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.waterfrontoronto.ca/explore_projects2/west_don_lands/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

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.

Linear and Natural Concept Approximate Surface Practice Sizes

<u>Surface Practice Area 1</u>
Area: 15,000 square feet
Depth: 2.5 feet
Volume: 37,500 cubic feet
Practice Volume/Total Volume: 85%

<u>Surface Practice Area 2</u>
Area: 22,400 square feet
Depth: 2.5 feet
Volume: 56,000 cubic feet
Practice Volume/Total Volume: 38%

<u>Surface Practice Area 3</u>
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

<u>Subsurface Practice Area 1</u>
Volume: 6,500 cubic feet
Practice Volume/Total Volume: 15%

<u>Subsurface Practice Area 2</u>
Volume: 92,000 cubic feet
Practice Volume/Total Volume: 62%

<u>Subsurface Practice Area 3</u>
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.

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 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 addion 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.

Ⓐ RESTORED SPRING & STORMWATER WETLANDS
Ⓑ GREENWAY LAWN
Ⓒ LOCAL DRAINAGE COLLECTION AND RUNNELS
Ⓓ PROMENADE EXPANSION & CONNECTION TO GREENWAY
Ⓔ GREENWAY TRAIL
Ⓕ BRIDGE STRUCTURE
Ⓖ BIOFILTRATION FOR STORMWATER

Figure 8. Concept 1 Plan View

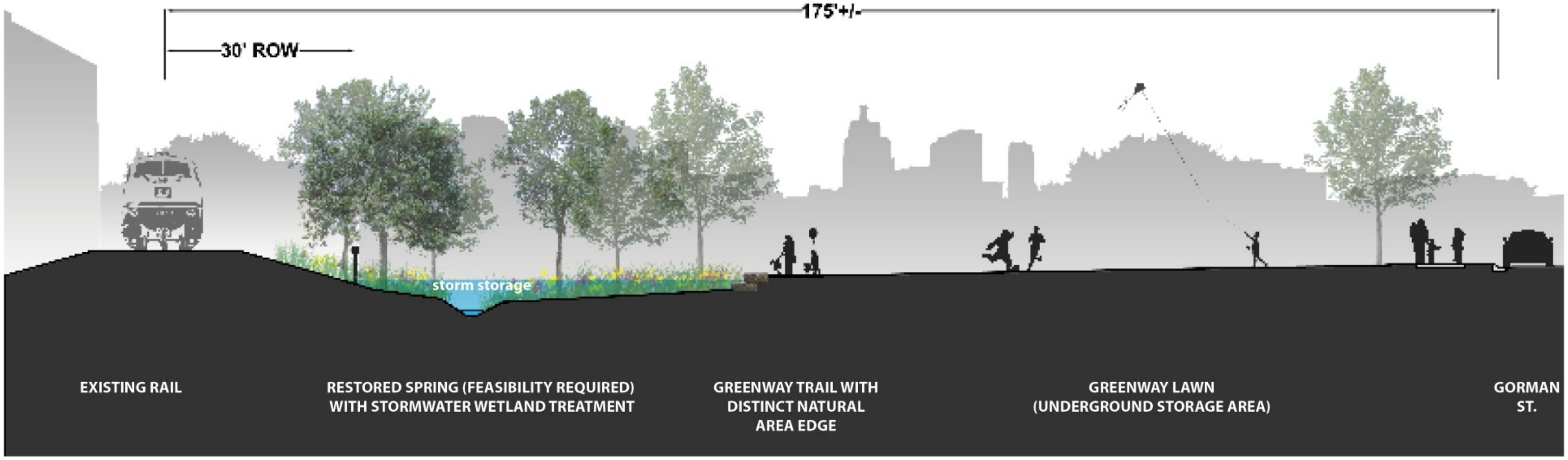

Figure 9. Concept 1 Cross-Section

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.

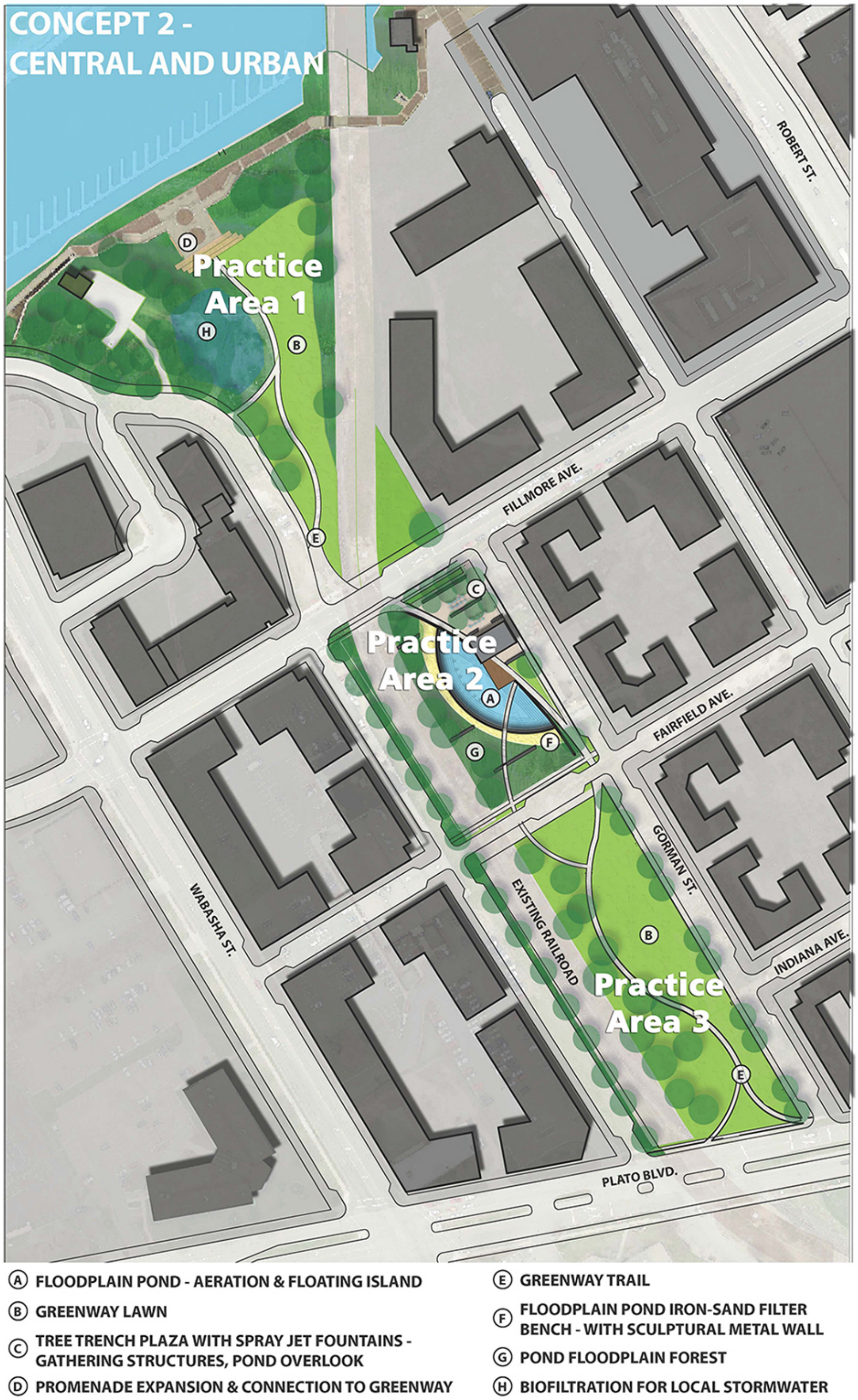

Figure 11. Concept 2 Plan View

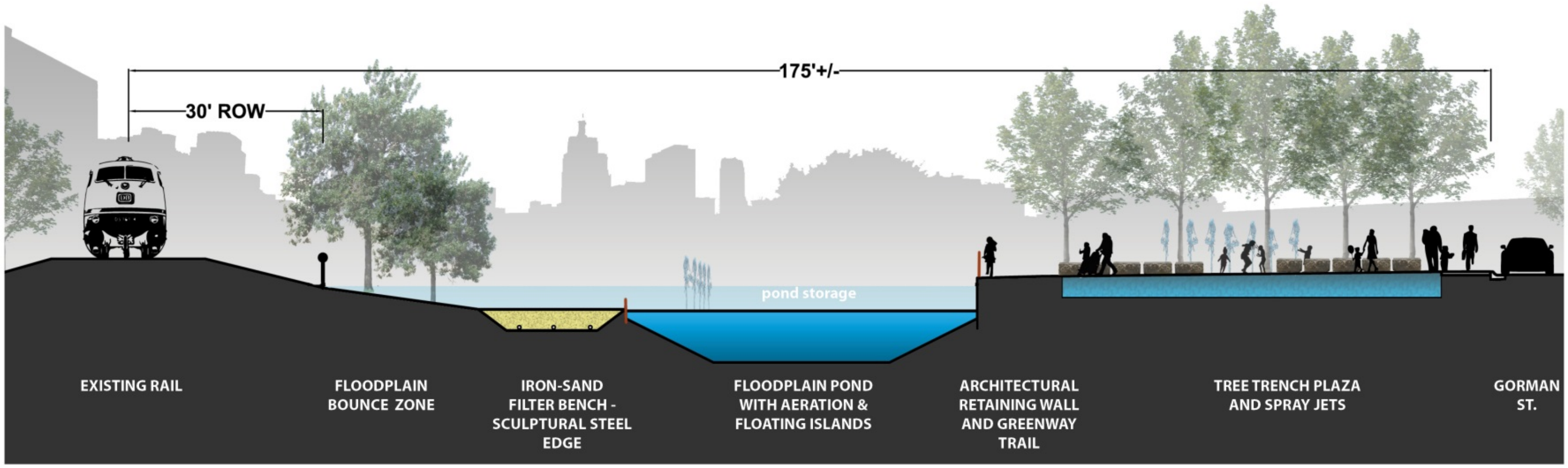

Figure 12. Concept 2 Cross-Section

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.

Ⓐ FLOODPLAIN POND - AERATION & FLOATING ISLAND
Ⓑ GREENWAY LAWN
Ⓒ TREE TRENCH PLAZA WITH SPRAY JET FOUNTAINS - GATHERING STRUCTURES, POND OVERLOOK
Ⓓ PROMENADE EXPANSION & CONNECTION TO GREENWAY
Ⓔ GREENWAY TRAIL
Ⓕ FLOODPLAIN POND IRON-SAND FILTER BENCH - WITH SCULPTURAL METAL WALL
Ⓖ POND FLOODPLAIN FOREST
Ⓗ STORMWATER WETLANDS & POTENTIAL RESTORED STREAM - REQUIRES FEASIBILITY ANALYSIS

Figure 14. Concept 3 Plan View

8 Conclusion

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. See Appendix A for a discussion of cost recovery mechanisms.

- 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.

Appendix A: Cost Recovery Options

Introduction

The City of Saint Paul is evaluating options to install and fund regional shared stormwater facilities in West Side Flats Greenway. The proposed shared stormwater project will provide for stormwater controls to be used by contributing properties, potentially in lieu of meeting stormwater requirements on each individual site. The project will provide flood and rate control and water quality benefits, and will provide recreational, aesthetic, and other benefits associated with the greenway. The West Side Flats Greenway is assumed to be publically owned in the future; the Strategic Stormwater Solutions for Transit-Oriented Development report includes a framework for either public or private ownership of open space for shared, staked green infrastructure.

The drainage area that is tributary to the planned shared stormwater project is comprised of developed parcels in multi-family, commercial, industrial or vacant use. The parcels are, for all intents, covered fully by impervious surfaces, and the anticipated redeveloped condition will be similarly dominated by impervious surfaces. Under the current conceptual plan, contributing and benefiting properties include both potential public and private ownership (Table A-1 and Figure A-1). Properties that are not expected to redevelop in the next 10 to 15 years are not included, for example the West Side Flats Apartments. The expected total public land area is 18.6 acres compared with 20.1 acres of privately owned land. An important consideration will be determining which properties are benefiting from the shared stormwater project. Both private and public properties are required to implement stormwater management controls for new and re-developed sites through the state general construction permit; therefore, some level of benefit could be assigned to all contributing parcels. For the purposes of this analysis, only private contributing and benefiting properties are included.

Another important issue will be timing of construction of the regional stormwater facilities. As new projects are developed in the contributing area prior to construction of the regional facilities, these projects will be required to meet the state stormwater construction permit requirements, and will likely no longer be potential benefiting properties. These properties will likely need to be removed from the contributing and benefiting properties, potentially increasing the burden on the remaining properties. A possible option could be explored with the state to determine if stormwater requirements could be deferred in lieu of expected regional facilities.

This memorandum presents an evaluation of the various methods available to the City to fund the construction, operation and maintenance of a shared regional stormwater facility. The memorandum first describes available mechanisms for establishing rates and charging properties. This is followed by discussion of the rate structure options for allocating costs among properties in the contributing area. In addition, examples of existing regional stormwater programs from both the Twin Cities area and nationally are provided.

Table A-1. Property ownership of contributing area

Property Ownership	Area (acres)
Greenway (park)	6
Private	20.1
Public	12.8

Figure A-1. Contributing area and current potential benefiting properties.

Available Implementing Mechanisms

An implementing or funding mechanism should take into account the different funding requirements for a project. The West Side Flats Greenway stormwater project will require initial capital costs for design and construction which occur once. Operation and maintenance of the shared stormwater facility are typically recurring annual costs. Different implementing mechanisms can be better suited towards either one time or recurring costs. A comparison of the different implementation mechanisms is provided below along with recommendations.

Available implementing mechanisms have been documented in a memo dated May 3, 2012 (LeFevere 2012). Each relevant funding mechanism is presented below based on the memo. Jurisdiction-wide ad valorem taxes are not considered as a relevant funding mechanism and are not presented herein.

Stormwater Utility

Cities are authorized to operate storm sewer utilities under MN Statute 444. The City's existing storm sewer utility has latitude to allocate costs to system users in a just and equitable manner, and charges can be applied to users based on use of the system, availability of the system to serve a property, and for connection to the system. Authority to establish utility charges (MN Statute 444.075) encompasses consideration of a parcel's area, land use classification, and runoff water quality. The City also has authority to modify the charges to reflect adjustments in runoff, which would be applicable to reflecting various levels of benefit or regional facility use. A reclassification of properties within the watershed, and an adjustment of rates for parcels within that reclassification reflecting the benefits received, could be considered to provide greater equity among system users. As noted above, rates can be charged for system use as well as availability; hence, charges could be applied in advance of a watershed property undergoing redevelopment. A similar rate surcharge approach has been used for a defined district within the City of Redmond, Washington to fund planned regional stormwater collection and water quality treatment improvements to facilitate redevelopment of the downtown area. This surcharge was in addition to the established City-wide stormwater utility fee.

Special District Ad Valorem Taxes or Charges

Special Assessments: In the state of Minnesota, cities designated as "first class cities" have authority to fund storm drainage improvements through special assessments against the properties benefiting from the facilities (MN Statute 435.017-019). The special assessments can be put into effect by council resolution. The city has latitude to define the types and degrees of benefit to the properties. Benefits in this case would include stormwater management. There are limitations on assessments against state-owned or city-owned properties.

Special Service Districts: The cost of area-specific stormwater services to watershed parcels may be administered under provisions of a Special Service District as described in MN Statute 428A. There is flexibility in establishing the basis for charges as long as they are equitable. Because of petition and veto requirements, this authority requires substantial support from the businesses and residents affected.

Storm Sewer Improvement District: Cities are authorized to establish storm sewer improvement districts within the city and levy ad valorem taxes for storm water management projects within the district under MN Statute Sections 444.16-444.20 (LeFevere 2012). The storm sewer improvement district, locally referred to as an eco-district, is established by ordinance and requires two-thirds vote and a public hearing process. Because the affected parcels will likely be impervious following redevelopment, the determinant of a property's use of the stormwater improvements is its gross area, rather than its assessed valuation. If an assessed valuation is used, the revenue base (assessed value) will increase over time as the properties redevelop, and the assessment rate would require periodic readjustment to maintain appropriate revenue levels. This funding mechanism can be applied to both construction and maintenance of the storm sewer system and related facilities in the district.

Comparative Analysis and Recommendations for Mechanism

Selecting an appropriate funding mechanism should include evaluation of several factors such as complexity, equity, flexibility in structuring charges, data requirements, and applicability of funding option to capital and recurring costs for each option (Table A-2). An overall recommendation is provided for each funding option. Funding options can be combined; for example, a stormwater utility could be used to fund recurring maintenance costs, while a special assessment could be used to fund construction activities.

Table A-2. Comparison of funding mechanisms

Fee Structure Alternative	Stormwater Utility	Special District - Special Assessment	Special District – Special Service District	Special District –Storm Sewer Improvement District (Ad Valorem)
Complexity	Moderate - Existing utility already in place, would require coordination amongst several city departments	Low	High – requires substantial support from businesses and residents	Low
Equity	Equitable - Depending on rate structure, can be equitable for all contributing and benefiting properties	Equitable - Depending on rate structure, can be equitable for all contributing and benefiting properties	Equitable - Depending on rate structure, can be equitable for all contributing and benefiting properties	Not Equitable - Charges are poorly correlated to benefits
Flexibility to Structure Charges	Moderate – ability to reflect adjustments in runoff and water quality	High – ability to consider stormwater- and greenway-related benefits	High – ability to consider stormwater- and greenway-related benefits	Low – restricted to assessed valuation
Data Requirements	Moderate - Parcel and assessor's databases, total project costs, other data needs dependent on revenue basis and rate structure	Low - Total project costs, other data needs dependent on revenue basis and rate structure	Low - Total project costs, other data needs dependent on revenue basis and rate structure	Low - Total project costs, assessed valuation
Applicability to Capital Costs	Moderate – can recover costs over time through rates	High	High	High
Applicability to Recurring Costs	High	Low	Low (property owners expected to change over time)	High
Overall Recommendation	**Recommended**	**Recommended**	**Not Recommended**	**Not Recommended**

Rate Structure

Depending on the selected funding mechanism, a variety of fee structures can be considered for allocating costs to the properties within the contributing area.

Flat Rate

The flat rate structure applies a uniform charge to each land parcel, regardless of parcel size, land use, or improvements. This approach is most appropriately applied to programs largely engaged in planning efforts across broad areas rather than for construction of local projects.

The primary advantage to the flat rate approach is its ease of application, requiring minimal cost to implement and administer the charges. The primary shortcoming to the flat rate approach is that it is not equitable when considered against the relative demands of the parcels, as larger parcels contribute more runoff to a facility than smaller parcels and consume a greater share of the facilities' capacity.

Ad Valorem

An ad valorem rate structure applies a uniform percentage fee to the assessed value of each parcel. The assessed value reflects the value of the land itself as well as the value of improvements. Value is partially related to the size of the property, and hence the amount of runoff contributed to the drainage facilities; however, it also largely reflects how the property is used, how it is developed, and features of its location (nearby amenities, infrastructure). As such, this method charges more for developed properties than similar sized vacant parcels which contribute similar runoff volumes to the drainage improvements.

Similar to the flat rate structure, the ad valorem rate structure is relatively easy to establish initially, as the assessed values are readily available from the assessor's office. The ad valorem structure, however, does not provide an equitable distribution of costs to properties as the assessed value is not closely related to the relative runoff contributed by respective parcels. Another complication with the use of the ad valorem method is the evolving rate base: as parcels redevelop, the assessed value increases for those parcels, which results in a shifting allocation of charges between parcels.

Runoff Contribution

A runoff contribution (sometimes referred to as "graduated") rate structure allocates costs of the drainage improvements to properties in proportion to the relative proportion of runoff from each parcel to the facilities. The relative contribution of runoff is typically determined based on the impervious surface area on each property, as the amount of impervious surface relates directly to the volume and the rate of runoff discharged from a parcel and to stormwater facilities. This approach is often applied to the allocation of stormwater utility charges as a strongly equitable means of distributing costs among stormwater system users and beneficiaries.

A primary advantage of the runoff contribution rate structure is that the resulting charges are related to the share of facility capacity consumed by runoff from a given parcel. In most instances, the drawback to the rate structure is the effort and expense required to develop the database of parcel impervious area. In this instance, however, the parcels are assumed fully impervious, a parcel's impervious area equates to its gross area, and the charges can be apportioned based on gross area to achieve an equivalent result. The gross area of each parcel is readily obtainable from assessor data. For the conceptual modeling, it was suitable and most conservative to assume all contributing parcels are impervious, but going forward with the rate structure, this assumption may not be applicable.

Hybrid

To provide a greater level of equity in cost allocation, it may be suitable to employ a hybridized two-component rate structure. This has been employed in some jurisdictions to allocate the costs from distinct program elements in different ways to better reflect how parcels benefit from each element. In Maryland's Prince George's County, the operation and maintenance costs for the watershed retrofit program are allocated on a flat rate basis, whereas the capital program costs are allocated using the runoff contribution approach.

Such a hybrid method may provide a greater degree of equity between parcels in the watershed through:

- Using the **Flat Rate** method to distribute programmatic, administrative, and maintenance costs associated with common and shared benefits of improved stormwater management and greenway-related benefits, and
- Allocating capital costs for facilities construction, the size and capacities of which are driven by the runoff discharged to them, using the **Runoff Contribution** approach.

The two rate components could be combined into a single fee charged to the parcel.

Comparative Analysis and Recommendations for Rate Structure

Features of the foregoing alternative fee structures are compared with respect to several criteria, summarized in Table A-3. This comparison is considered preliminary, and it is recommended the suitability of the various rate structures be further evaluated using project cost estimates and parcel data when available.

A hypothetical cost-recovery analysis was completed using a hybrid fee structure (maintenance per parcel and capital based on impervious area) to determine the potential range of parcel charges necessary to recover a financial investment (Table A-4). Scenarios are provided for both a 20-year and 30-year bond. The assumptions and inputs to this scenario can be adjusted by the City using the accompanying spreadsheet.

The following assumptions were made in this analysis:

1. Real estate costs range from $6,000,000 - $8,000,000
2. Construction costs range from $5,000,000 - $10,000,000
3. Annual maintenance is $10,000
4. Design, permitting, legal, administrative, construction management, and contingency are approximately 25 percent of construction costs
5. 20 benefiting private parcels in the future at 100 percent impervious (total area equals 20.1 acres)

The estimated annual cost per parcel ranges from $31,594 to $67,166 ($0.73 - $1.54 per square foot) assuming all costs are included, depending on the scenario and life of the bond.

Table A-3. Comparison of fee structures

Fee Structure Alternative	Flat Rate	Ad Valorem	Runoff Contribution	Hybrid
Description	Each parcel is charged a uniform fee, regardless of gross area, impervious area, land use, or assessed value	Each parcel is charged a uniform rate based on the assessed value	Each parcel is charged a rate based on its impervious area	Costs for operation and maintenance, planning, administration, etc. charged by the Flat Rate Costs of capital improvements charged by the Runoff Contribution
Implementation				
Complexity	Low	High - Rate base changes over time as properties are improved	Moderate	Moderate - Segregate costs into 2 components
Data required to support	Low - Number of parcels	Moderate – Parcel database	Low - Gross parcel area (assumes gross parcel area = impervious area)	Low - Number of parcels and gross parcel area (assumes gross parcel area = impervious area)
Equity				
Between larger and smaller parcels	Not Equitable - Does not distinguish between parcels' demands for drainage system capacity	Somewhat Equitable - Only to degree that assessed value reflects parcel size and impervious area	Equitable - Proportional to parcels' demands for drainage system capacity/ benefit received	Equitable - Provide high level of equity reflecting levels of general benefit and capacity demand
Fee related to parcel's consumption of drainage improvement capacity	Not Equitable - Poor correlation between fee amount and a parcel's runoff discharge	Somewhat Equitable - Assessed value has limited correlation to parcel's gross/ impervious area and, hence, runoff discharge	Equitable - Directly related to parcel's runoff discharge	Equitable - Directly related to parcel's runoff discharge
Recommendation	**Not Recommended**	**Not Recommended**	**Recommended**	**Recommended**

Table A-4. Hypothetical rate scenario

			ALL CAPITAL COSTS BONDED				DESIGN COSTS EXCLUDED [g]			
			LOW-END COST ESTIMATE		HIGH-END COST ESTIMATE		LOW-END COST ESTIMATE		HIGH-END COST ESTIMATE	
			20-year Bond	30-year Bond	20-year Bond	30-year Bond	20-year Bond	30-year Bond	20-year Bond	30-year Bond
EXPENDITURES	Real Estate Acquisition		6,000,000	6,000,000	8,000,000	8,000,000	6,000,000	6,000,000	8,000,000	8,000,000
	Design, permitting, legal/admin, const mgt, contingency		1,250,000	1,250,000	2,500,000	2,500,000				
	Construction		5,000,000	5,000,000	10,000,000	10,000,000	5,000,000	5,000,000	10,000,000	10,000,000
	Total Capital Improvements	(1)	12,250,000	12,250,000	20,500,000	20,500,000	11,000,000	11,000,000	18,000,000	18,000,000
	Annual Facility Maintenance [a]	(2)	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
	Capital Amount Financed by Bond Sale	(3)	12,250,000	12,250,000	20,500,000	20,500,000	11,000,000	11,000,000	18,000,000	18,000,000
	Bond Interest Rate (%) [b]		2.70%	3.00%	2.70%	3.00%	2.70%	3.00%	2.70%	3.00%
	Bond Term (years)		20	30	20	30	20	30	20	30
	Annual Debt Service Incurred	(4)	800,724	624,986	1,339,988	1,045,895	719,018	561,212	1,176,575	918,347
	Remaining Direct Capital Expenditure (1-3)	(5)	-	-	-	-	-	-	-	-
	Total Annual Expenditures (2+4+5)	(6)	810,724	634,986	1,349,988	1,055,895	729,018	571,212	1,186,575	928,347
BENEFIT AREA	Number of Benefited Parcels	(7)	20	20	20	20	20	20	20	20
	Total Parcel Area Benefitted (acres)	(8)	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1
	Total ROW Area Benefitted (acres)	(9)	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8
	Total Park Area (acres)	(10)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
	Total Tributary Area (acres)	(11)	38.9	38.9	38.9	38.9	38.9	38.9	38.9	38.9
RATES	Total Annual Revenue / Parcel (6/7) [c]	(12)	40,536	31,749	67,499	52,795	36,451	28,561	59,329	46,417
	Total Cost over Term of Bond [c]		810,724	952,479	1,349,988	1,583,842	729,018	856,818	1,186,575	1,392,520
	Total Annual Revenue / Parcel Acre (6/8) [d]	(13)	40,335	31,591	67,164	52,532	36,270	28,419	59,034	46,186
	Total Cost over Term of Bond [d]		806,691	947,740	1,343,271	1,575,962	725,391	852,555	1,180,671	1,385,592
	Total Annual Revenue / Impervious Acre (6/(8+9)) [e]	(14)	24,642	19,300	41,033	32,094	22,159	17,362	36,066	28,217
	Total Cost over Term of Bond [e]		492,842	579,015	820,661	962,822	443,172	520,862	721,322	846,517
	Hybrid: Maintenance /Parcel; Capital /Acre (16+17) [f]	(15)	40,337	31,594	67,166	52,535	36,272	28,421	59,036	46,189
	Maintenance / Parcel (2/7) [f]	(16)	500	500	500	500	500	500	500	500
	Capital / Parcel Acre (4+5)/8 [f]	(17)	39,837	31,094	66,666	52,035	35,772	27,921	58,536	45,689
	Total Cost over Term of Bond [f]		806,741	947,815	1,343,321	1,576,037	725,441	852,630	1,180,721	1,385,667

a. Assumed value
b. Based on National AAA rates, Dec 2014
c. Distributing costs equally between parcels, irrespective of area
d. Distributing costs based on impervious area, excluding ROW
e. Equivalent basis if costs were distributed over both private and public benefitted areas
f. Distributing maintenance cost equally to parcels; distributing capital costs based on impervious area. Assumes parcel area of 1.0 acres
g. Scenario assumes design, permitting and administrative costs are paid from outside sources

Examples

The following examples provide relevant information on cost-recovery approaches for the West Side Flats Greenway shared stormwater project.

Oakdale, Minnesota

Oakdale maintains a Surface Water Management Fund (Fund) for the purpose of providing for the acquisition and development of storm water retention areas within the City of Oakdale. The Fund is funded with a fee on building permits based on the additional runoff generated from a site (commercial, industrial, or institutional properties only). Additional runoff is based on the difference between the pre- and post-development condition for the 100-year rainfall event. The City has the option to require either on-site stormwater facilities, a cash contribution to the Fund, or a combination of both. The requirements are codified in Section 5-6 of City Code. Operation and maintenance of regional facilities are funded through the city's stormwater utility.

When the City Council decides that an owner platting property and/or developing commercial, industrial or institutional property cannot or should not meet all city stormwater requirements on site, that owner shall pay an amount based on deriving the required storage and the cost associated with providing that storage elsewhere in the city. The following formulas are used by the City:

The required storage shall be calculated as:

S = A (in acres) x .5 feet x (Q2 - Q1)

(The assumed rainfall of .5 feet or 6.0 inches in 24 hours is comparable to a 100-year frequency, 24-hour duration storm based upon U.S. Weather Bureau statistical data compiled in Technical Report No. 40, dated May, 1961).

S is the required storage

A means the total area of the development site, measured in acres.

Q1 means the composite coefficient of run-off (weighted average) for the entire site or development area, based upon the predevelopment land use and the coefficient of runoff as prescribed by the city.

Q2 means the composite coefficient of run-off (weighted average) for the entire site or development area, based upon the post-development land use and the coefficient of runoff as prescribed by the city.

Payment = L (acres) x C

Where

L = S/D

L means area of land (in acres) required to provide for the storage of excess surface water run-off created by the owner's plat or development

S means the volume of storage required, measured in acre-feet, defined as the increased surface water run-off and computed as the difference between the calculated surface water run-off after the development is completed and the calculated surface water run-off from the site at the time of application.

D means depth of water measured in feet that can be accommodated in a proposed retention area. When specific information is not available to the Public Works Director/City Engineer for an accurate determination of such depth, it shall be assumed to be three (3) feet.

C means the cost basis (per acre) for the acquisition and physical development of storm water retention areas. This amount shall be stated on a per acre basis and shall be determined by and revised by the City Council from time to time by resolution of the Council.

Redmond, Washington

Becoming an NPDES-regulated community in 2005, the City of Redmond embarked on a two-pronged approach to complying with development and redevelopment stormwater controls. Most development and redevelopment projects build stormwater flow control and runoff treatment facilities within their project site. In some areas, however, regional facilities are being used to meet flow control and runoff treatment minimum requirements for entire subbasins, effectively treating the entire tributary area as a "site". In addition to meeting requirements for individual development and redevelopment projects, these facilities are retrofitting many high pollution-generating land uses (such as roads).

The downtown regional facilities were also viewed as facilitating redevelopment and supporting city land use policies. Initially the project was supported by a surcharge on the stormwater utility rate for properties within the tributary subbasin. Later, the costs were translated into a stormwater capital facilities charge allocated based on the impervious area of a parcel. There are credits available against this fee for sites that infiltrate stormwater in private on-site systems.

Prince George's County, Maryland

Under Maryland HB 987, the County must establish a watershed protection and restoration program that includes a Stormwater Remediation Fee ("Fee") and a Local Watershed Protection and Restoration Fund ("Fund") directed towards restoring water quality in Chesapeake Bay and local receiving waters. The Fund finances the accelerated rehabilitation of storm water facilities and infrastructure to provide water quality control of runoff from developed areas currently without, or underserved by, water quality controls.

Prince George's County elected to implement a hybrid fee structure, allocating operating and maintenance costs to accounts on a flat fee basis, and distributing the capital program costs based on impervious area coverage. The hybrid fee structure offered the following features found by the County to be favorable:

- The hybrid method provided a high level of equity, as all property owners uniformly benefit from ongoing maintenance and operation, and those properties generating greater volumes of runoff from larger impervious areas proportionally contribute to the capital solutions for restoring the watershed.
- The hybrid method is strongly consistent with the proportionality sought in the state legislation.

- Case studies of the rates resulting from the various fee structures demonstrated that distributing operation and maintenance costs uniformly, rather than on a graduated basis, substantially eased the financial burden on larger properties while only slightly increasing costs for all properties.
- Employing a 3-tiered structure for single family detached residences, based upon zoning, enhanced equity between the various scales of housing. Offering a lower rate for smaller parcels was consistent with other County land use policies encouraging smart growth and access to mass transit.
- A 3-tiered structure for single family detached residences avoided the need to directly measure impervious area on 88 percent of the accounts, thereby enabling implementation under a very tight schedule.

Despite the data-intensive effort required to implement an impervious area-based charge across 300,000 accounts, the County implemented the hybrid method due to its high level of equity among customers.

Philadelphia, Pennsylvania

The Philadelphia Water Department is currently evaluating the use of Stormwater Management Enhancement Districts (SMED) in the city to support implementation of the department's Long-term Control Plan for their combined sewer system. SMEDs are areas that could be served by large scale, centralized green infrastructure. Project work on evaluating SMEDs began in 2012 and is not yet complete. Part of this work will include evaluation of funding mechanisms.

Cost-Recovery Options Summary

Selection of a cost-recovery option will be dependent on numerous factors including equity, complexity, flexibility, data requirements, and applicability to capital versus recurring costs. This memorandum outlines possible options and recommends the following for additional consideration by the city:

- Special District – Special Assessment
- Stormwater Utility

A rate structure based on runoff contribution is recommended, with the possibility of a flat rate per parcel for annual operation and maintenance costs (hybrid approach). To remain highly equitable, actual runoff contribution should be determined if parcels are expected to be less than 100 percent impervious, increasing the complexity and data requirements for this option. A hypothetical cost-recovery analysis was completed using a hybrid fee structure. Various scenarios are provided to determine a range of potential costs to benefitting properties. Assumptions should be noted and adjusted as additional information becomes available.

This analysis did not take into account a developer's fee or fee in lieu such as that being used by Oakdale. These mechanisms could be further considered if desired by the city.

References

LeFevere, C., 2012. Central Corridor Stormwater and Green Infrastructure Plan: Governmental Authority Relating to Stormwater Infrastructure. Memorandum to Central Corridor Stormwater and Green Infrastructure SAC. May 3, 2012.