SRF Consulting Group, Inc. Engineers Planners Designers

SRF No. 7687.00170

MEMORANDUM

TO: Wes Saunders-Pearce
Water Resource Coordinator, City of Saint Paul

FROM: David Filipiak, P.E., SRF Consulting Group, Inc.
Joni Giese, ASLA, AICP, SRF Consulting Group, Inc.

DATE: December 23, 2013

SUBJECT: Advanced Design Concepts For Shared, Stacked-Function, Green Infrastructure

Referenced Memorandums

- Technical Memorandum: Existing Stormwater Rules and Regulations
- White Paper: Shared, Stacked-Function Green Infrastructure Policy Investigation
- White Paper: FLUXion ≈ gARTens
- Technical Memorandum: Analysis and Evaluation For Shared, Stacked-Function, Green Infrastructure

Introduction

Based on the findings from the investigation of different development scales, it was deemed appropriate to continue investigating the four potential shared, stack-function green infrastructure (SSGI) approaches and to further test two of the SSGI approaches on potential development sites along the corridor. One of the sites, referred to as the Boeser Site, was selected to test the street right-of-way SSGI approach. The second site, Curfew Commons Park, was selected to test the park/open space SSGI approach. Concepts developed for these sites were based on their actual location and site conditions, but were theoretical in nature and do not imply that development reflecting the concept will ultimately occur.

For the following two sites, or any other potential site to be considered, a thorough engineering feasibility study is absolutely critical to ensure constructability, refine estimates of probable cost, and provide adequate specificity to inform final design. The discussion that follows provides the site context and analysis, design concepts, and findings for the two advance design sites.

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Boeser Site

Project Context

The Boeser Site is located near the Prospect Park/29th Avenue Green Line station in Minneapolis and is generally bounded by University Avenue on the south, 29th Avenue SE on the west, the University of Minnesota transitway on the north and 30th Avenue SE on the east. A local developer is pursuing the redevelopment of an obsolete industrial site into a multi-family apartment building. The City of Minneapolis is planning a phased reconstruction of 4th Street between 23rd Avenue SE to Malcolm Avenue SE.

The concept explored for the study was based on the premise that runoff from the Boeser Site, 4th Street, and the site south of 4th Street could be managed in the 4th Street right-of-way. The SSGI concept developed for purposes of this study, though based on the actual location and site conditions, is theoretical and does not imply that the City of Minneapolis will ultimately approve any or all of the concept elements.

Project Background and Analysis

<u>Previous Studies</u>
The development program for the Boeser Site SSGI concept was based on the following studies:

- Green Fourth - Building a Great Neighborhood Street, Cuningham Group and Prospect Park 2020 (2013)
- University District Alliance Urban Design Framework Phase II: Using Greenways and Green Infrastructure as a Vital Design Strategy to Achieve Sustainable Communities, Metropolitan Design Center, University of Minnesota, College of Design (August, 2012)
- Boeser Property, The Cornerstone Group and Close Associates Inc. Architects (January 29, 2013)
- Boeser Site Stormwater Feasibility Study, MWMO and Barr Engineering (May 8, 2013)

<u>Drainage Concept</u>
The stormwater design concept includes the treatment of the entire Boeser parcel, 4th Street between 29th Avenue SE and 30th Avenue SE and approximately 75 percent of the block south of 4th Street based on available topographic mapping. The division of treatment volume is roughly 83 percent private development and 17 percent public street right-of-way (see Figure 1).

<u>Regulatory Requirements</u>
The primary stormwater requirements are found in Chapter 54 of the City of Minneapolis's Code of Ordinances, which requires 70 percent TSS removal from the runoff generated by the site from a 1.25-inch rainfall. This removal rate for a single event storm equates to 80 percent removal when analyzing average annual storm data.

In addition, the rate of runoff from the site needs to be limited to the existing conditions for the 2-, 10-, and 100-year, 24-hour Type II storm event.

The Boeser Site Stormwater Feasibility Study (Barr, 2013) computed the treatment volume required to achieve higher levels of treatment by maximizing the area of the treatment BMP. While not required of a new development, the study looked to increase the treatment while balancing out the shared functions of the street system.

Design Assumptions

The concept developed was based on the following assumptions and do not imply any have received approval by the City of Minneapolis or private utilities:

- According to the Boeser Site Stormwater Feasibility Study (Barr, 2013), the Boeser parcel will result in 79.1 percent impervious cover. This impervious percentage was also applied to the block south of 4th Street.
- The site south of 4th Street will also have comparable residential development density as the Boeser parcel.
- Water volume requirements are to meet or exceed the 70 percent total suspended solids (TSS) Minneapolis removal requirements as computed in the Boeser Site Stormwater Feasibility Study (Barr, 2013).
- Bioretention basins would provide space for active storage to achieve some level of rate control, but because the site and roadway reduce impervious surfaces from existing conditions, it was assumed (but not verified) that rate control would not be required.
- The presence of contaminated soils in this area will not allow infiltration, as such, the systems are designed as filtration facilities.
- 4th Street is a Municipal State Aid (MSA) Street and will comply with the following MSA street design standards based on a projected ADT <10,000.
    - 11-foot travel lanes
    - 8-foot. parking lanes
    - 2-foot. curb reaction area if no parking lane
    - 300-foot. horizontal road radius
- Existing sanitary sewer (southern side of the right-of-way) and watermain will need to be accommodated. New storm sewer will likely be necessary.
- Private utilities will be housed in a vault system under the sidewalk areas.

Boeser Site Design SSGI Concept

The Boeser Site concept envisions a high amenity street that accommodates pedestrians, bicycles and cars (see Figures 2 and 3). The road could function as a convertible street incorporating different paving patterns that extend between the street and sidewalks to visually connect the space as a whole.

A designated bikeway is not shown as the University of Minnesota Transitway that includes a multi-use trail is located one block north of the project area. Low projected traffic volumes will allow bicyclists to share the road with cars. If a serpentine alignment of 4th Street were possible, it could allow for the creation of larger outdoor gathering areas and stacked-function bioretention basins within the street right-of-way.

The walkway weaves through deep and shallow rain gardens creating a wide variety of spaces for gathering. The bioretention basins not only manage stormwater, but also define and enhance user comfort of the outdoor gathering spaces by providing greenery and shade. Seat walls connected to the deep bioretention basins provide an element of pedestrian safety while also creating flexible spaces for resting.

Stormwater runoff from the private development rooftops is directed to the bioretention basins either through raised planters, then conveyed under the public sidewalk. (In the winter, stormwater runoff from the rooftops could bypass directly into the storm drain system to minimize the risk of freezing runoff impacting the sidewalk.) Water from the road could also enter the deep bioretention basins through curb cuts or modified catch basins. There would be 18-inches of storage above the soil in the deep bioretention basins. Shallow bioretention basins would also filter water from the sidewalks. Any overflow will be directed into a storm drain system within the street right-of-way.

Public art concepts for the Boeser Site focus on creating a sensory experience, a place for celebrating and interacting with water. Water is taken from the rooftops interacts with a kinetic sculpture, creating sound and reflecting light. (see Figure 4).

Estimated Capital and Operations & Maintenance Costs

Although a theoretical exercise, to foster an initial discussion an estimate of probable construction and Operations & Maintenance (O&M) costs were assembled including all of the elements needed to achieve the stormwater goals. Earthwork needed to install engineered soils, drain tile, outfalls, etc. were included in the estimate. The preparation of estimated capital costs for the SSGI concept was based on recent construction bids. Additional assumptions used to develop of the estimated costs can be found in Figure 5. The City of Minneapolis prepared comments regarding the cost estimates prepared for the Boeser Site and can be found as an attachment to this memorandum.

An estimated capital cost of $112,000 was developed for the Boeser Site SSGI concept (see Table 1). As a point of comparison, estimated capital costs of $246,000 was developed assuming that stormwater facilities would be developed on an individual parcel basis. The individual basis concepts and costs were taken from the Boeser Site Stormwater Feasibility Study (Barr, 2013), where stormwater was managed in bioretention basins located above structured parking.

As a point of investigation to see how cost recovery might function, the Boeser Site SSGI estimated costs were allocated between the contributing private and public parcels based on the volume of runoff contributed to the system, which resulted in $93,000 of the estimated SSGI costs allocated to the private parcels and $19,000 of the estimated SSGI costs allocated to the public right-of-way (see Table 1). As bioretention basins are assumed to be used in both the individual and SSGI scenarios, no O&M cost differential is anticipated between the individual and SSGI approaches (see Table 2).

Table 1: Boeser Site Estimated Capital Cost Allocation

Runoff Source	Individual Basis	Shared	Difference	Percent Change
Private (A) Future Residential	$231,000	$93,000	$138,000	60%
Public (B) 4th Street R/W	$15,000	$19,000	($4,000)	(27%)
Total	**$246,000**	**$112,000**	**$134,000**	**54%**

Table 2: Boeser Site Estimated O&M Cost Allocation

Runoff Source	Individual	Shared	Difference
Private (A) Future Residential	$2,924	$2,924	$0
Public (B) 4th Street R/W	$602	$602	$0
Total	**$3,526**	**$3,526**	**$0**

Findings and Triple Bottom Line Benefits

Key findings and triple bottom line benefits associated with the Boeser Site SSGI concept include:

Economic: A comparison of the individual basis estimated costs to conceptual SSGI estimated costs indicated that SSGI results in net capital cost efficiencies overall. Much of the savings resulted from relocating bioretention basins from over the structured parking to the street right-of-way, thereby eliminating flood control/lining costs associated with the underground parking in the private developments.

However, a cost recovery analysis revealed complexities, particularly when allocating costs based on contributing runoff volume (or impervious surface). Using this cost allocation approach, the developer realized a disproportionate amount of savings relative to the City in the shared system, resulting in inequity. This allocation method is one possibility; there may be other suitable allocation methods, depending on how SSGI is approached. Therefore, careful consideration must be given when determining funding sources and developing cost recovery approaches for SSGI to ensure a balanced distribution of costs and benefits.

Full consensus was not achieved regarding the site analysis and outputs. The SSGI concept of addressing redevelopment stormwater management responsibilities in the public right-of-way as a shared system needs additional study to fully consider all the possible alternatives and costs. While this study begins that assessment, consideration of how SSGI impacts overall project costs and benefits will vary project to project and may include costs not considered here; such as, opportunity costs of stormwater management site elements versus density or placement of utilities, or the equitable distribution of ongoing operation and

maintenance responsibilities and costs among public and private participants, or the impact on stormwater utility fees and credits.

Environmental: The bioretention filtration systems shown in the concepts provide the volume required to meet the current requirements. Additional treatment could be achieved in the same footprint if additional retaining walls were added, particularly to the shallow basins, at an additional cost.

Beyond the environmental benefits of stormwater management, the bioretention basins and new street trees irrigated with harvested stormwater provide numerous environmental benefits, such as habitat creation, urban heat island mitigation, and air quality improvements.

Social: The provision of stormwater supported vegetation in the street right-of-way improves livability by creating comfortable outdoor environments for walking and recreating. Increasing street activity strengthens the social fabric of the city and improves safety.

Curfew Commons Park

Project Context

Curfew Commons Park is located approximately two blocks south of the Green Line Westgate Station in Saint Paul. The site is currently comprised of industrial and commercial uses. The City's plans call for this area to transition to residential, office and parkland uses. With the recent development of multi-family residential adjacent to the site and anticipated new residential development, this area will be underserved by parkland.

Project Background and Analysis

Previous Studies

The development program used the Curfew Commons Site SSGI concept was informed by the following studies:

- Westgate Station Area Master Plan, Central Corridor Design Center
- Curfew Commons: Potential Park Configurations, City of Saint Paul, Department of Parks and Recreation (December, 2012)

Contributing Subwatershed Analysis

Surface drainage to the site is generally from the north, as the topography generally falls from the north/northwest to the south east. (Figure 6). The area north of the site is relatively flat, with the existing subwatersheds served by a storm sewer system that crosses the proposed park site roughly 12 feet below the surface (see Figure 6). Due to the depth of the storm sewer it was determined that the contributing subwatershed available for treatment within the site would be limited to the surface drainage in the blocks adjacent to the park and not all areas served by the storm sewer, resulting in a total drainage area of 23 acres that can be directed to the park. While the existing storm sewer is too deep for stormwater harvesting from the pipeshed, it does provide a fair amount of vertical flexibility for the new systems.

The park concept is based on the premise that stormwater runoff from the future adjacent multi-family redevelopment site and from the new streets is directed to the new park. Due to topographic constraints, runoff from the proposed office redevelopment site east of the park cannot be accommodated in the design without significant excavation.

Existing residential lots facing Curfew Street between the site and Franklin Avenue that do not currently receive stormwater treatment are likely to remain. Stormwater runoff from this street can be easily intercepted and treated in the park.

Regulatory Requirements

Stormwater requirements for water quality, runoff volume control, and runoff rate control are found in the Capitol Region Watershed District (CRWD) rules and City of Saint Paul ordinances respectively. Water quality and runoff volume control are required when a site disturbs one acre or more. The CRWD rules require 90 percent TSS removal for the runoff generated by a 2.5-inch rainfall. With regards to runoff volume control, sites disturbing more than one acre are required to infiltrate runoff from a 1-inch rainfall (0.9 inches) from impervious surfaces, with a 30 percent increase in volume for filtration-type devices. BMP's that meet the volume control requirements typically meet the water quality requirements.

The City of Saint Paul also requires runoff from sites disturbing greater than 0.25 acres to discharge from their site at no more than 1.64 cfs/acre for all storm events.

The stormwater volume required to meet the CRWD regulations for each of the contributing land uses is shown in Figure 7. The existing residential area draining to Curfew Street is been tabulated separately, as this area could be kept separate from the new park via the existing trunk storm sewer.

Design Assumptions

The concept developed was based on the following assumptions:

- The design is based on previous park configuration studies prepared by the Saint Paul Parks and Recreation Department. The concept park size (4.9 acres) and shape was influenced by a number of factors, including street connectivity, parcel configurations, and estimated future population. In particular, the park was configured to allow for two-phased implementation that correlates to underlying parcel ownership and configurations (see Figure 8).
- The concept assumes the City's acquisition of land for the park with the construction of new streets that bound three sides of the park. All of the new streets are configured in accordance with City of Saint Paul standards for residential streets (66-foot right-of-way, 30-foot pavement section for two=-way travel and parking on both sides of the street) with intersections spaced at a minimum of 75 feet.
- The concept also assumes that the development of new multi-family housing on the west side of the park and office uses on the east side of the park. Redevelopment is assumed to occur at a similar density as the multifamily housing north of Franklin Avenue (95 percent impervious).
- Based on soil borings for an adjacent road project it is believed that the underlying soils are clay/clay loams, and as such, volume reduction requirements would be met using a filtration system approach.
- The north-south street runoff would be conveyed within the street section and then enter a shallow storm sewer at the intersections adjacent to the park. Storms pipes then outfall into the park bioretention basins.

Design Charrette

A design charrette was conducted with a portion of the SAC to brainstorm how stormwater features could be integrated into potential park programming. From this exercise two concepts were developed. The first concept envisioned the creation of interactive water features using harvested stormwater within the park (Figure 9). The second concept envisioned a more passive stormwater system where vegetated filtration basins surround and contribute irrigation water to a great lawn (Figure 10). The first concept may be appropriate for a high visibility park located directly on University Avenue where high park usage would be expected. Treating the harvested water to a potable standard, as assumed in the first concept, is anticipated to be more expensive to construct and operate than a more passive system. The second concept takes a more traditional vegetated filtration basin approach that may be more appropriate for proposed new parks located a block or two off of University Avenue. The primary function of these parks is to provide recreational space for new corridor residents. This concept assumes that park users will not interact with the harvested water, with standing water filtrating through the soil no longer than 48 hours after a rain event. It was decided to move forward with the passive system approach for the advance design site, as it would be replicable for more of the proposed new parks along the corridor.

Curfew Commons SSGI Concept

Design Goals

There are a number of overarching design goals that influenced the concept development for the Curfew Commons site:

- Celebrate the presence and movement of water in the park.
- Create a design that could be replicable for other future parks along the corridor with moderate construction and O&M costs.
- Create a design that is flexible enough to respond to variable programming needs as the surrounding land redevelops.

SSGI Concept Description

The concept depicts stormwater management within the park taking the form of filtration basins (see Figures 11-14). Figure 15 depicts the various subwatersheds that are treated within the park. The stormwater system as shown meets or exceeds the regulatory requirements for volume control, which with the filtration mechanisms will meet the water quality goals as well.

The basins are designed to provide quiet passive park uses when they are dry, which is a majority of the time, and surround a great lawn. A filtration basin located in the NW corner of the park is comprised of three terraces, separated by ornamental weirs that can be used as seat walls when the basin is dry. If water fills up the first terrace, it will spill through a slot in the weir to the adjacent terrace in the basin (see Figures 13 and 14).

Three micro graded filtration basins are located in the SW, North, and SE portions of the park. The micro grading is part of an art piece that responds to the volume of stormwater in the basin. Fluctuating water levels associated with various rainfall events will make the basins appear to change shape. The micro grading and associated varying intensities of flooding in the basins will also influence vegetation varieties and patterns within the basins, thereby producing a variety of hydrologic regimes and varied habitat.

Water that filters through the filtration basins is piped into the underground irrigation system of the great lawn, and only when it is full will the system discharge to the trunk storm sewer. The underground irrigation system is an integral part of the system, in that the volume stored in the underground soil media is counted in meeting the CRWD volume control measures. It typically consists of a sandy soil media over an impermeable liner, interconnected with a piping system that distributes water throughout the lawn. An overflow is built into the pipe system to ensure the correct amount of water is stored for the plant system.

This overall drainage system will also meet the City's rate control requirement through temporary storage in the filtration basins and for larger events, in the great lawn. Based on historic rainfall data, the filtration basins will overflow onto the great lawn only once a month during the summer when heavier rains typically occur. The great lawn will contain a highly permeable soil media that will absorb most minor overflow events, and an overflow inlet is incorporated at the southeast corner of the lawn for extreme storm events. Figures 16 and 17 illustrate the surface water expected for various storm events. All vegetated surfaces are expected to be dry within 48 hours of a storm event.

The following describes other park design elements:

- A playground area is located in the SW corner to serve future residential anticipated to be located immediately west of the park.
- A plaza and pavilion located in the NE corner will serve future office/retail uses by providing space for markets, kiosks, food trucks, and outdoor dining.
- A wooded hill located in the SE corner of the park would serve as a buffer from the highway and provide a backdrop to great lawn events.

Public Art Integration

The intent of the FLUXion ≈ gARTens concept for Curfew Commons was to delight, educate and reinforce the triple bottom line benefits provided by SSGI. Proposed artworks for the park include:

- Park plantings that recall pre-European settlement plantings (most likely Oak Savanna habitat). Native materials will help interpret and educate about the natural landscape and create a connection to the Mississippi River (see Figure 18).
- Terraced retaining walls, seating elements, and/or spillways incorporate public art and are designed to enliven and animate water.
- Playground area located in the SW corner would be integrated into the larger concept of the park to celebrate water and teach children about different ecosystems.
- Micro graded basins highlight runoff volumes resulting from varying rainfall events.

Water Budget

The design of Curfew Commons provides a benefit beyond standard volume reduction measures, as plants in the vegetated spaces and great lawn will uptake stormwater, thereby reducing discharges into the storm sewer system, and ultimately to the Mississippi River. As shown in Tables 3 and 4, for an average year, 12 percent of the runoff would be reused as passive irrigation water for the great lawn. For an average dry year, 40 percent of runoff would be reused as irrigation.

Table 3: Water Budget for an Average Year (2006)

Annual Precipitation-April-October (in)	21.48
Total Runoff (cu.ft.)	789,529
Runoff Reused (cu.ft.)	91,259
Percentage Reused (%)	12 %

Table 4: Water Budget for a Dry Year (1976)

Annual Precipitation (in)	11.54
Total Runoff (cu.ft.)	255,188
Runoff Reused (cu.ft.)	101,715
Percentage Reused (%)	40 %

Estimated Capital and Operations & Maintenance Costs

Several estimates of probable construction and O&M costs were assembled examining various shared BMPs within the park to estimated construction and O&M costs assuming stormwater is treated on an individual parcel basis. The estimated costs included all of the elements needed to achieve the stormwater goals. Earthwork needed to install engineered soils, drain tile, outfalls, etc. were included in the estimate. Land costs and mass grading for the site were not included as the costs are extremely variable depending on if the park is part of a larger development or not. Additional assumptions used to develop of the estimated costs can be found in Figure 19.

Shared BMP Alternatives

This exercise compared estimated construction and O&M costs of the shared scenarios included:

- Shared gray infrastructure
- Shared green infrastructure with pervious pavers in the street parking bays adjacent to the park
- Shared green infrastructure without pervious pavers

As shown in Tables 5 - 8, compared to the individual basis, all of the shared infrastructure alternatives showed lower construction costs. The analysis also indicated that the O&M costs for green infrastructure are higher than O&M costs for gray infrastructure.

Table 5: Individual Cost Basis

Runoff Source	Capital Cost	Percent	Annualized O & M Cost	Percent	BMP Strategy
Streets	$214,740	33%	$5,450	29%	Perforated pipe gallery with filtration
Park	10,340	2%	1,400	7%	Rain garden/filtration
New Development	325,540	51%	9,530	50%	Perforated pipe gallery with filtration
Existing Residential	92,323	14%	2,540	14%	Perforated pipe gallery with filtration
Total	**$642,940**	**100%**	**$18,920**	**100%**	

Table 6: Individual vs. Shared Gray Infrastructure

	Capital Cost	Annualized O&M Cost	BMP Strategy
Individual Basis	$642,940	$18,920	Individual Basis
Shared Gray Infrastructure	$577,960	$7,410	Underground filtration system (using Triton or similar system)
Savings	$64,980	$11,510	
Savings Percentage	10%	61%	

Table 7: Individual vs. Shared Green Infrastructure with Pervious Pavers in the Street Parking Bays

	Capital Cost	Annualized O&M Cost	BMP Strategy
Individual Basis	$642,940	$18,920	Individual Basis
Shared Green Infrastructure with Pavers	$591,030	$31,460	• Pavers/grit chambers for pretreatment • Filtration basins • Irrigation system under great lawn
Savings (Increase)	$51,910	($12,540)	
Savings (Increase) Percentage	8%	(66%)	

Table 8: Individual vs. Shared Green Infrastructure without Pervious Pavers

	Capital Cost	Annualized O&M Cost	BMP Strategy
Individual Basis	$642,940	$18,920	Individual Basis
Shared Green Infrastructure with Pavers	$508,340	$32,150	• Grit chambers for pretreatment • Filtration basins • Irrigation system under great lawn
Savings (Increase)	$134,600	($13,230)	
Savings (Increase) Percentage	21%	(70%)	

While the underground irrigation system benefits the great lawn, it is fairly expensive to construct. Therefore, another analysis was performed later in the project (see Tables 9 – 10) using refined estimated costs that better reflected costs associated with filtration basin excavation to examine the implications of removing the underground irrigation system.

Table 9: Individual vs. Shared Green Infrastructure with Underground Irrigation

	Capital Cost	Annualized O&M Cost	BMP Strategy
Individual Basis	$759,030	$8,060	Individual Basis
Shared Green Infrastructure with Underground Irrigation	$548,380	$25,160	• Grit chambers for pretreatment • Filtration basins • Irrigation system under great lawn
Savings (Increase)	$210,650	($17,100)	
Savings (Increase) Percentage	28%	(212%)	

Table 10: Individual vs. Shared Green Infrastructure without Underground Irrigation

	Capital Cost	Annualized O&M Cost	BMP Strategy
Individual Basis	$759,030	$8,060	Individual Basis
Shared Green Infrastructure w/o Underground Irrigation	$342,770	$25,160	• Grit chambers for pretreatment • Filtration basins
Savings (Increase)	$416,260	($17,100)	
Savings (Increase) Percentage	55%	(212%)	

Treatment of Existing Residential on Curfew Street

The Curfew Commons design exercise revealed that SSGI opened the opportunity to provide stormwater treatment for parcels that are not likely to redevelop in the near future in a cost efficient manner. Figure 7 depicts the subwatersheds that can be harvested and treated in the park. The area denoted as Curfew Street/Contributing Residential (E) currently does not receive treatment and does not require treatment as it is not being redeveloped. Yet, it can easily be captured and cost efficiently treated in the park. The City can also let the water bypass the park and enter the storm sewer untreated, consistent with current conditions. Tables 11 and 12 compare the cost of treating this water with not treating it for the various BMP alternatives investigated above.

Table 11: Cost of Treating vs. Not Treating Curfew Street Residential

Alternative	With Curfew St /Residential	Without Curfew St/ Residential	Cost Change ($)	Percent Change
Gray Infrastructure	$691,892	$615,674	$76,218	11%
Green Infrastructure	$548,374	$495,882	$52,492	10%
Green Infrastructure w/o Underground Irrigation	$342,768	$293,482	$49,286	14%

Table 12: Cost/Cubic Foot of Treating vs. Not Treating Curfew Street Residential

Alternative	With Residential $/CF	Without Residential $/CF	Change $/CF
Gray Infrastructure	$9.66	$9.63	**$0.03**
Green Infrastructure	$7.66	$7.82	($0.16)
Green Infrastructure w/o Underground Irrigation	$4.79	$4.63	$0.16

As a point of investigation to see how cost recovery might function, the Curfew Commons SSGI estimated construction and O&M costs (including underground irrigation) were allocated between the contributing private and public parcels based on the volume of runoff contributed to the system, as shown in Tables 13 and 14.

Table 13: Curfew Commons Capital Cost Allocation

Runoff Source	Individual	Shared	Difference	Percent Change
Streets (A)	$247,000	$164,510	$82,490	33%
Park (B)	$13,600	$16,450	($2,850)	(21%)
New Development (C)	$390,900	$290,640	$100,260	26%
Existing Residential (D) & (E)	$107,500	$76,780	$30,720	29%
Total	**$759,000**	**$548,380**	**$210,620**	**28%**

Table 14: Curfew Commons O&M Cost Allocation

Runoff Source	Individual	Shared	Difference	Percent Change
Streets (A)	$2,180	$7,549	($5,369)	(246%)
Park (B)	$1,050	$755	$295	28%
New Development (C)	$3,811	$13,336	($9,525)	(250%)
Existing Residential (D) & (E)	$1,018	$3,523	($2,505)	(246%)
Total	**$8,059**	**$25,162**	**($17,103)**	**(212%)**

Findings and Triple Bottom Line Benefits

Key findings and triple bottom line benefits associated with the Curfew Commons SSGI concept include:

Economic: Similar to the Boeser Site, a comparison of the individual basis estimated costs to conceptual SSGI estimated costs indicated that SSGI results in net capital cost efficiencies overall. However, a cost recovery analysis that allocated costs based on contributing runoff volume (or impervious surface) indicated the developer receiving a disproportionate amount of savings relative to the city in the shared system, resulting in inequity.

The cost comparisons also indicated that O&M costs associated with green infrastructure exceed gray infrastructure O&M costs.

By taking stormwater into a park facility, the City obtains a capital and maintenance funding source that will help finance the shared, stacked-function portion of park construction and maintenance. For a majority of the time, the stormwater facility will be dry and will serve a recreational use, yet the funds used to construct and maintain the facility are derived by its stormwater function.

While not empirically established through this study, discussions with the development community indicated that creation of new open spaces will make development parcels along the corridor more attractive to developers in comparison to other potential redevelopment parcels in the city that are not adjacent to open space. Developers prefer parcels adjacent to open spaces as they expect to receive higher returns on their investment through increased rents or unit sale prices. In turn, redevelopment of underperforming parcels increases the city's tax base.

Environmental: Beyond the environmental benefits of stormwater management, the vegetated filtration basins in the park will introduce new habitat to the urban core. The conversion of pavement to vegetated surfaces will also help mitigate the urban heat island effect.

Social: Using stormwater features to facilitate parkland development will provide needed open space amenities for an underserved area. The stormwater supported irrigation of the great lawn, enhances the visual appeal and turf health for an area that is anticipated to receive heavy use. This will heighten livability by providing a place for exercise and recreation.

Additional Considerations: The findings also indicated that runoff from smaller parcels currently not receiving treatment can be effectively included in SSGI projects.

Finally, the investigation and resulting SAC discussion of findings suggested that the strongest benefit derived from SSGI implementation may be the community enhancements and associated improved livability, as these are key redevelopment outcomes desired.

Attachment:
City of Minneapolis Water Resources Administrator Memorandum dated December 23, 2013

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MEMORANDUM

DATE: December 23, 2013

TO: Wes Saunders-Pearce, Water Resource Coordinator, City of Saint Paul

FROM: Lois Eberhart, Water Resources Administrator, City of Minneapolis

SUBJECT: Boeser Site Analysis in SRF Consulting Group Memorandum No. 7687.00170, Appendix E [or Appendix E1] of the Report titled Strategic Stormwater Solutions for Transit-Oriented Development

Please include this Memorandum in the Report, and make reference to it from the SRF Memorandum cited above. Cities are regulated under the federal Clean Water Act, through Municipal Separate Storm Sewer System (MS4) Permits, to require development and redevelopment projects to reduce post-construction runoff and pollutant loading from project areas. This Study explored whether there are shared, stacked-function green infrastructure (SSGI) methods that can successfully substitute for meeting requirements on individual development and redevelopment properties.

Regarding the Boeser Site in Minneapolis, City of Minneapolis staff did not participate in the development of cost estimates for this study. While we recognize the creative and conceptual nature of this report, we note that many factors and costs of actual right-of-way reconstruction that incorporates green infrastructure components were left out of the cost analysis presented for this theoretical design concept. If they had been included, a considerably higher differential cost between the "individual basis" and the "shared" would have been the result.

Minneapolis is very mindful of cost-benefit in its selection of locations where green infrastructure is used in right-of-way projects, and considers the need based on many factors, including (but not limited to) the cost-benefit of pollutant load reductions, street flooding issues, aging infrastructure, spatial constraints, stormwater system capacity, and averting combined sewer overflow conditions. If a redevelopment proposal for the Boeser site or any other site were to include a request for special consideration of stormwater requirements, the request would be considered on a case-by-case basis.

FIGURE 1 Boeser Site Drainage Concept

FIGURE 2 Boeser Site Conceptual Design Plan View

FIGURE 3 Boeser Site Conceptual Design Section Perspective- Stormwater Diagram

- *Top- Green Streets of Portland, Oregon. Land Perspectives, landperspectives.wordpress.com*
- *Middle- 'Water Brand' by Hartness Vision*
  Photo: AECCafe-ArchShowcase Summit Singhai
- *Bottom- Holalokka, Oslo, Norway. Atelier Dreiseitl.*

FIGURE 4 Boeser Site Conceptual Design Public Art Concepts

Project wide

- Volume Control Criteria = As defined in the Boeser Site Stormwater Feasibility Study (Barr, 2013)
- Rate control is assumed to occur within the bioretention areas.
- All soils are classified as urban. C soils were used with initial abstractions of 0.2.
- Land use ratios for the potential development on the opposite side of 4th Street assumed to have similar density and runoff requirements.
- All costs are in 2012 values, with the exception of costs based on MnDOT average bid prices (2011). Estimated annual interest = 4%.
- Design, administration, legal costs are 15% of total cost.
- All costs include 20% contingency.

Shared Green Infrastructure

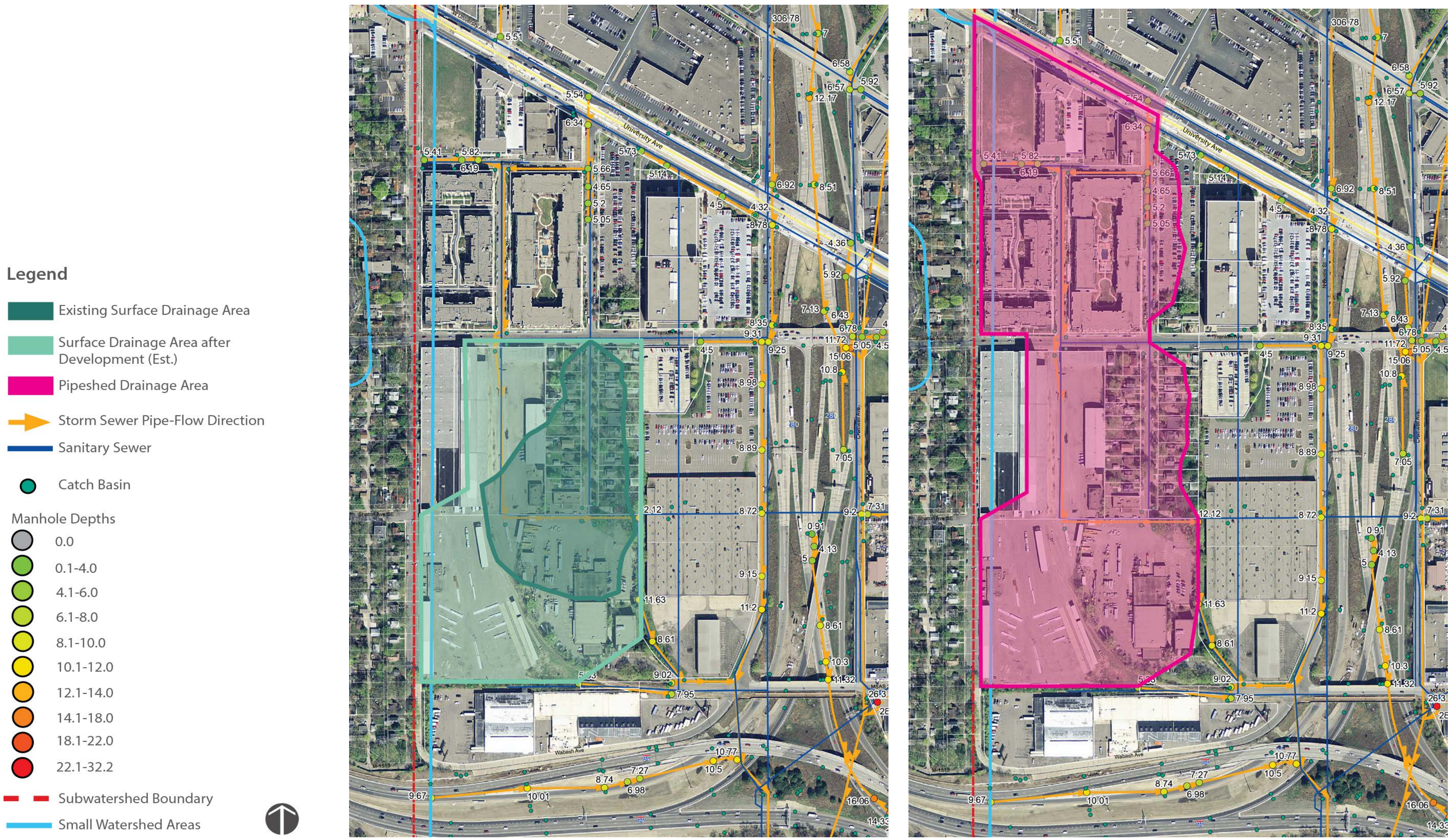
Bioretention

- Bioretention capital cost based on average bids from previous projects
- Resulting costs of $17.60/cf of volume which includes overflow structures
- Bioretention Annual O&M: $0.50/sq ft (Multiple studies, including a CRWD Rain Garden Study)
- Bioretention – 15” to 18” of ponding
- Designed as filtration basins with drain tile due to the potential for contaminated soil

Individual Development Treatment

- Capital costs for the site based on the Boeser Site Stormwater Feasibility Study (Barr, May, 2013)
- Bioretention Annual O&M: $0.50/sq ft (Multiple studies, including a CRWD Rain Garden Study)

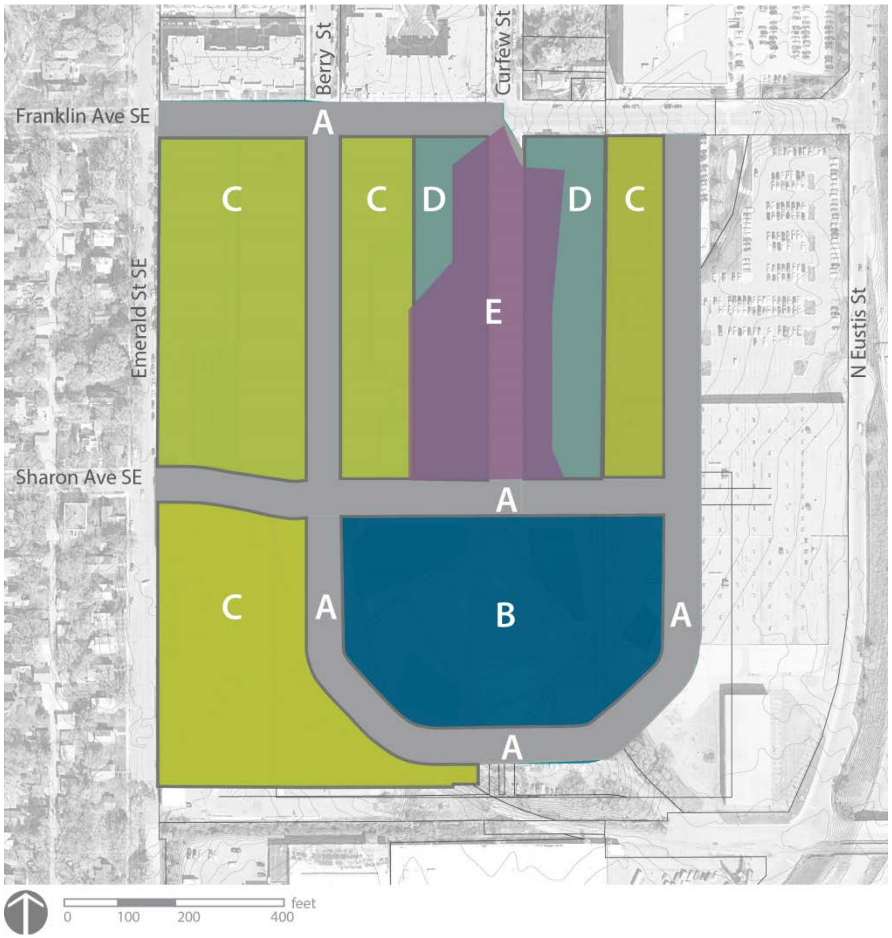
FIGURE 5 Boeser Site Cost Assumptions



Surface Drainage Area

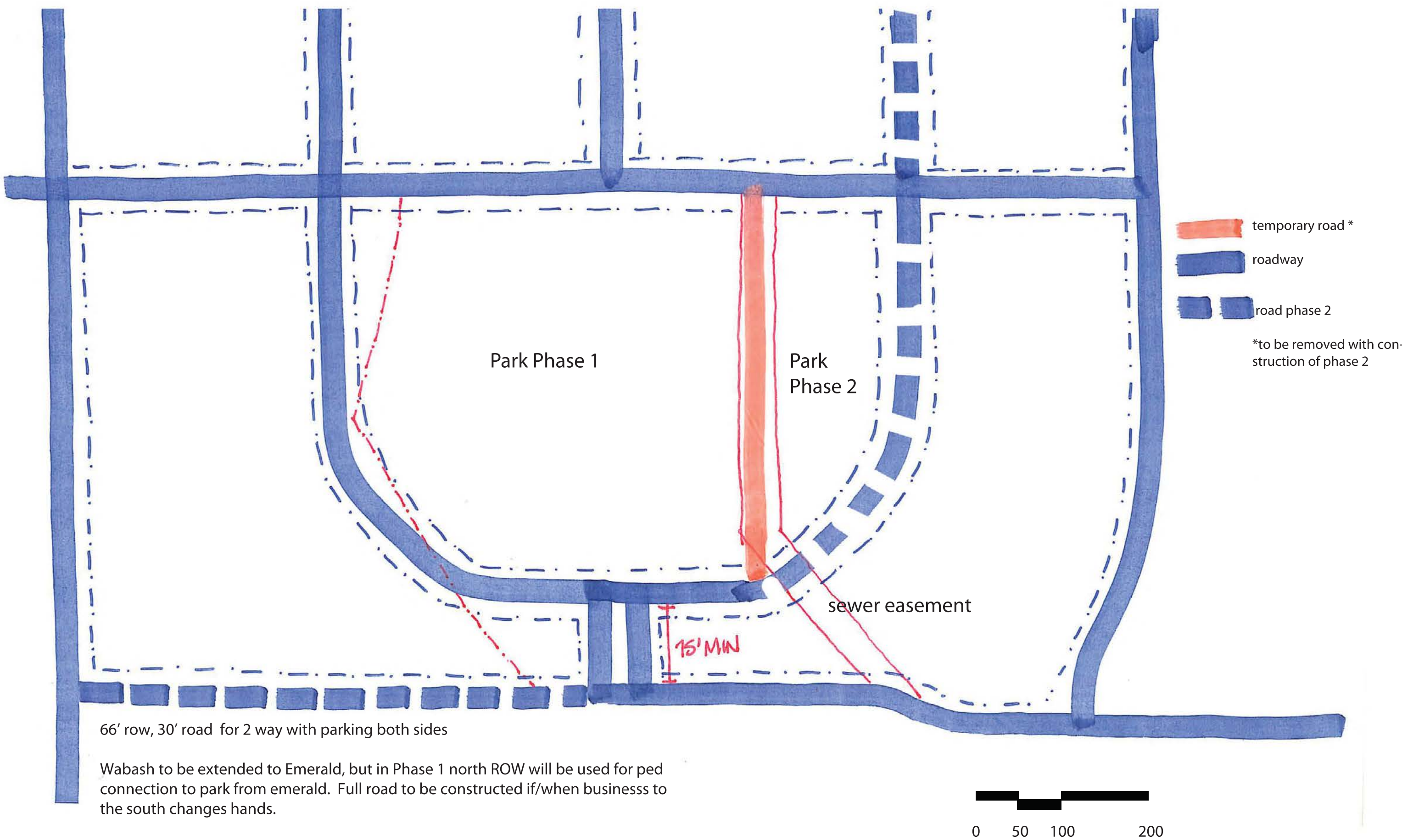
Pipe Drainage Area

FIGURE 6 Curfew Commons Existing Drainage Areas



Runoff Source	Revised Required Volume (Cu. Ft.)	Percent
Streets (A)	18,913	26%
Park (B)	2,051	3%
New Development (C)	37,810	53%
Existing Residential (draining to new development) (D)	4,656	7%
Curfew St/Contributing Residential (E)	8,157	11%
Total	**71,587**	**100%**

FIGURE 7 Stormwater Volume Required to Meet Regulations



66' row, 30' road for 2 way with parking both sides

Wabash to be extended to Emerald, but in Phase 1 north ROW will be used for ped connection to park from emerald. Full road to be constructed if/when businesss to the south changes hands.

Areas south of the park permitere drive and within the Radke property can be used for stormwater.

FIGURE 8 Additional Design Factors- Received from Saint Paul Parks

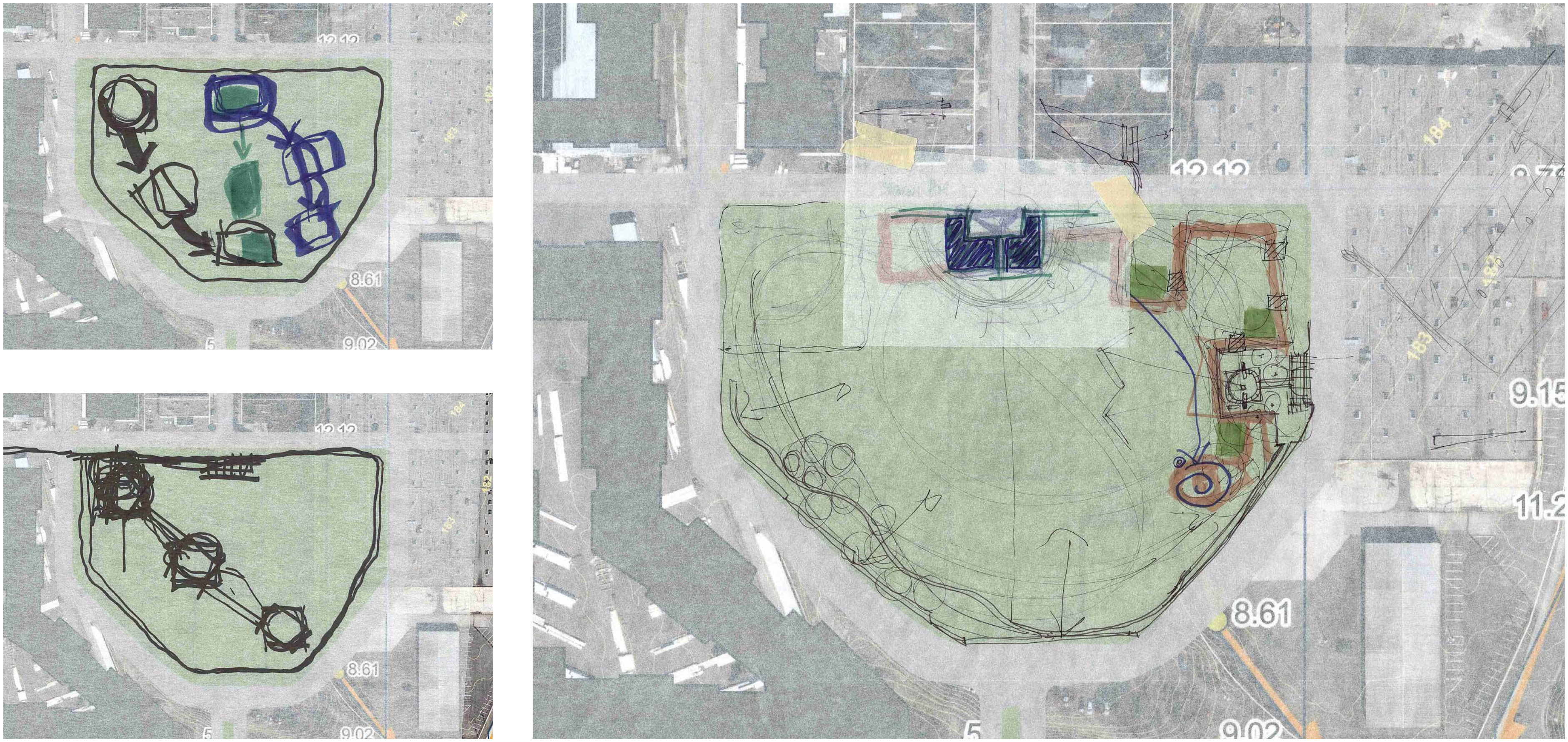


FIGURE 9 Curfew Commons Design Charrette Concepts

FIGURE 10 Curfew Commons Design Charrette Concepts

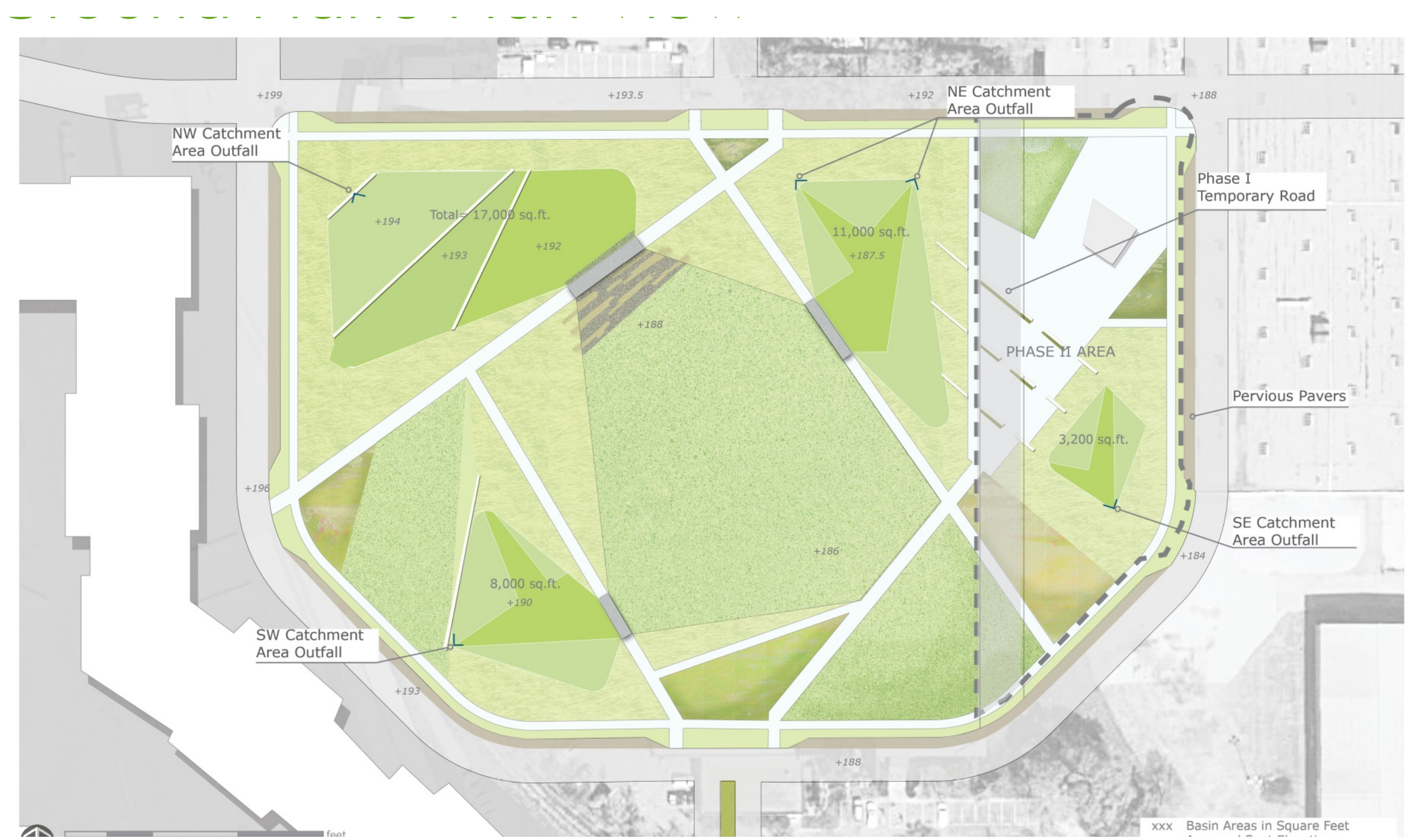


FIGURE 11 Curfew Commons Design Concept- Ground Plane View

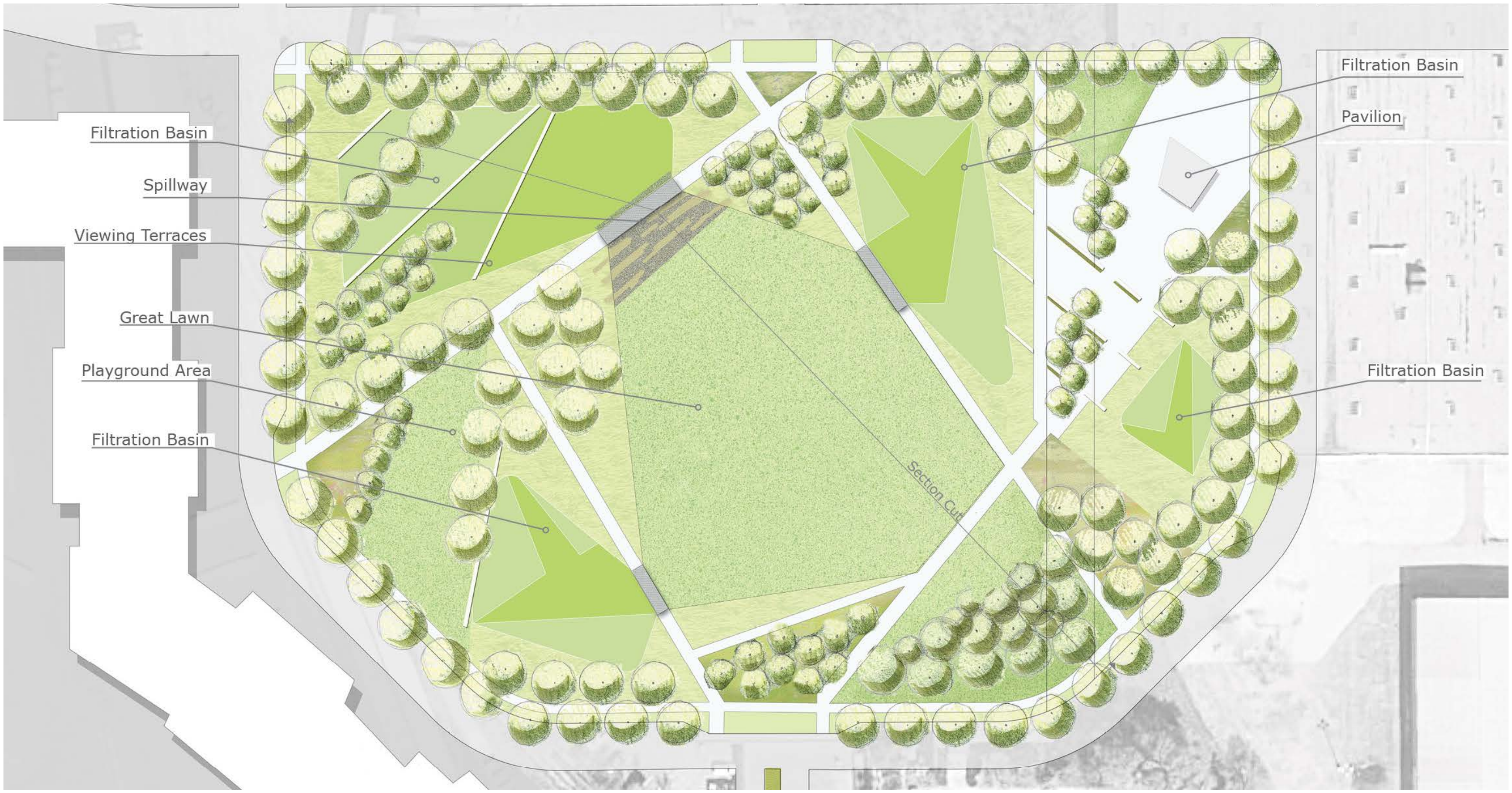


FIGURE 12 Curfew Commons Design Concept- Canopy View

FIGURE 13 Curfew Commons Design Concept- Section View

FIGURE 14 Curfew Commons Design Concept- Section Detail

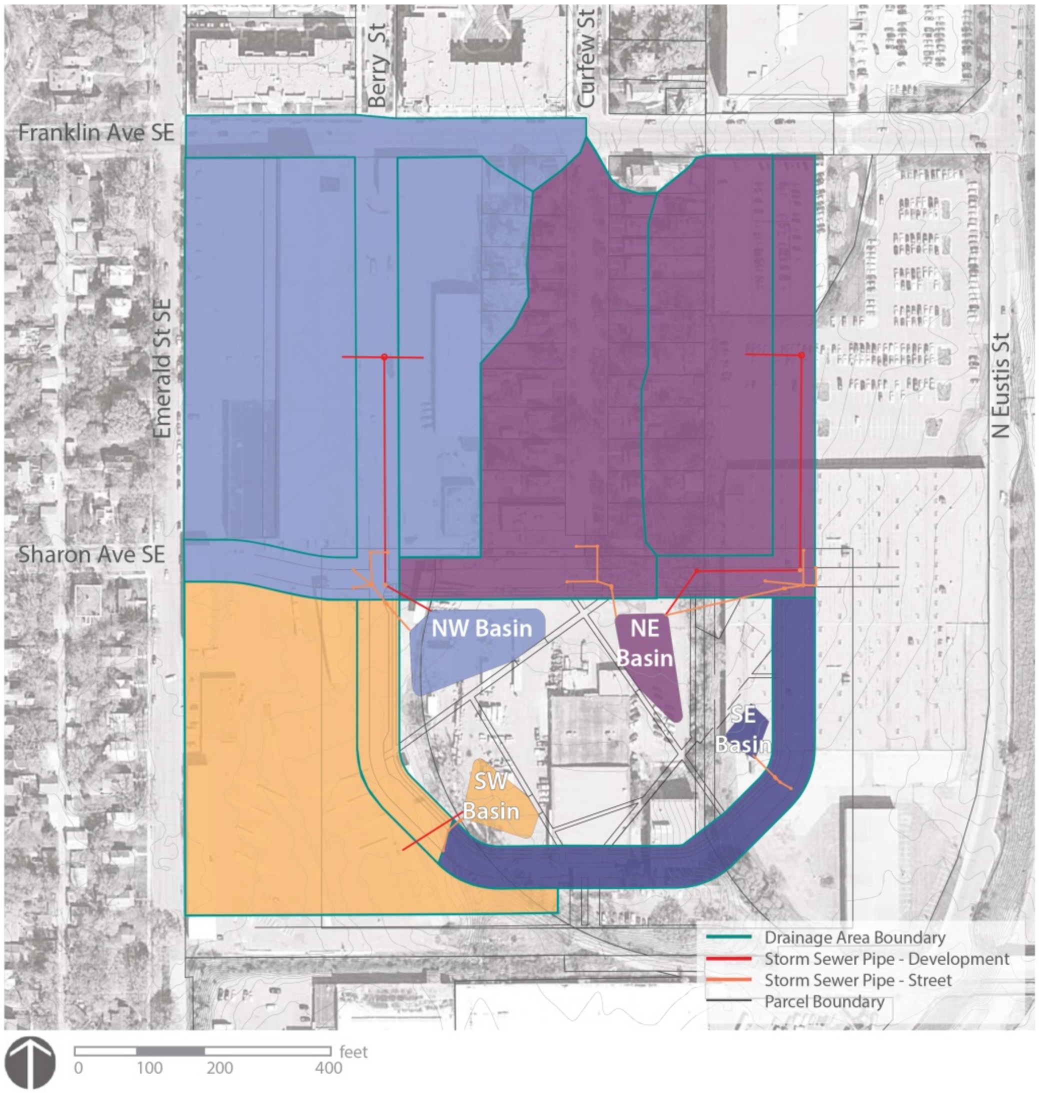
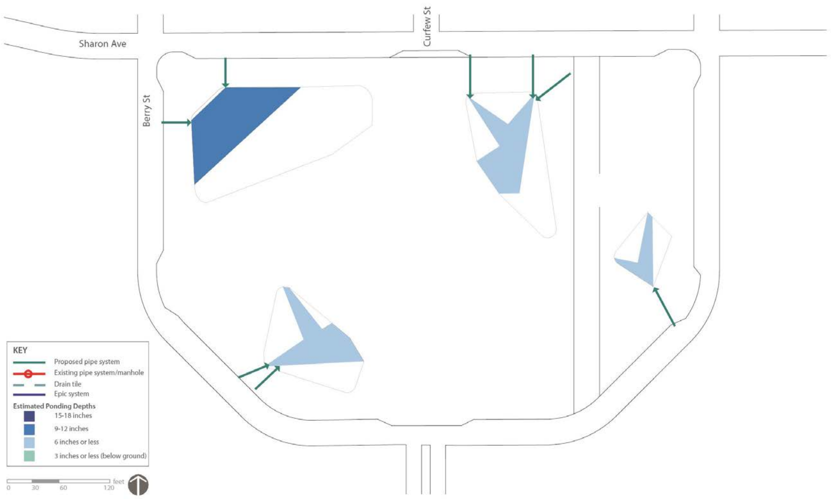
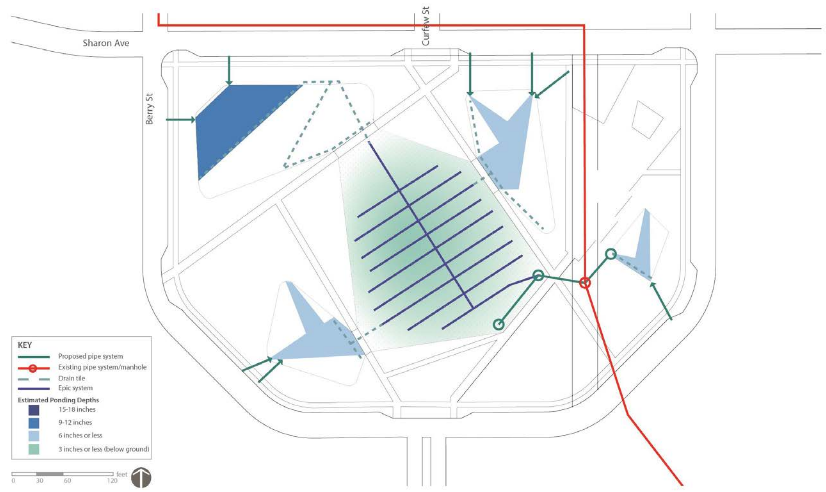


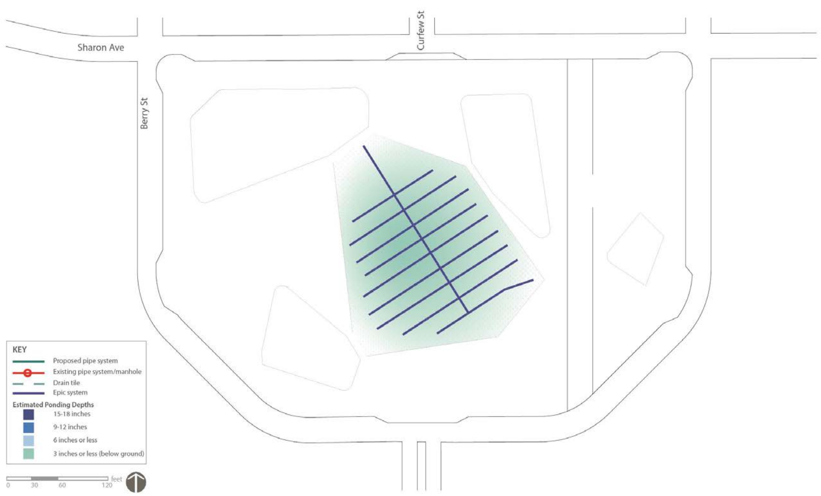
FIGURE 15 Curfew Commons Treatment Areas



Basin ponding for Typical Summer rain event (.33 inches)

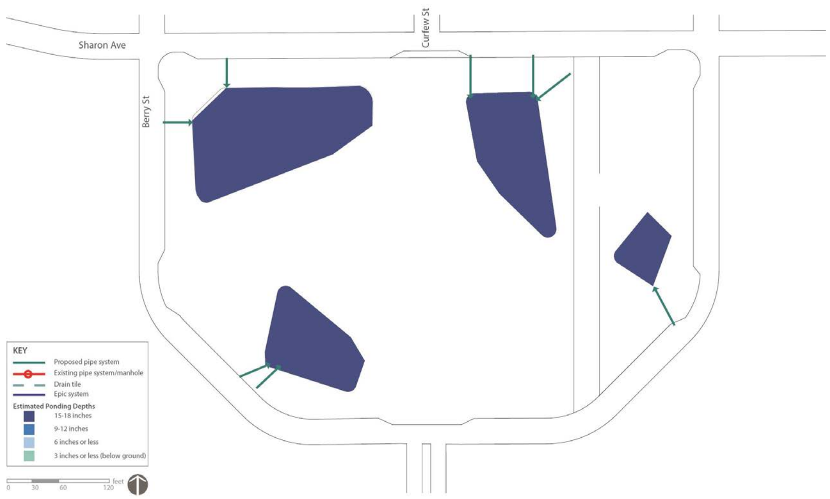


Basin draw down

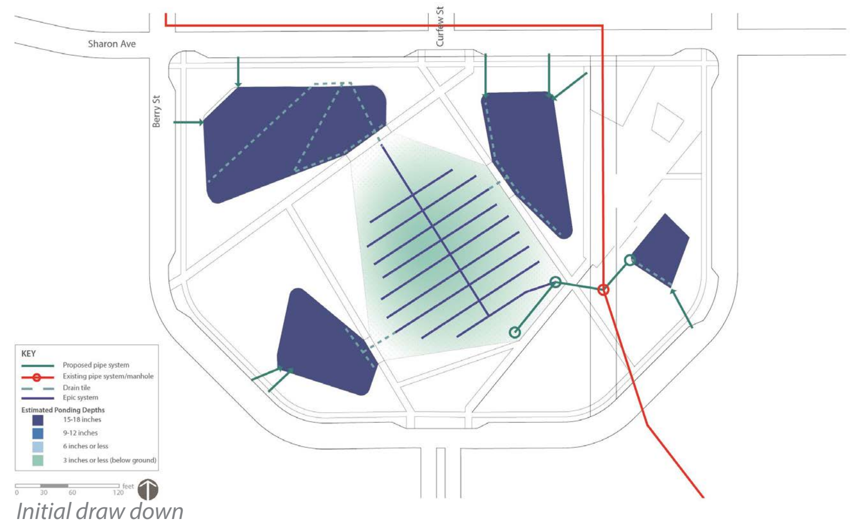


Runoff Stored Underground (3" depth) for Great Lawn Uptake

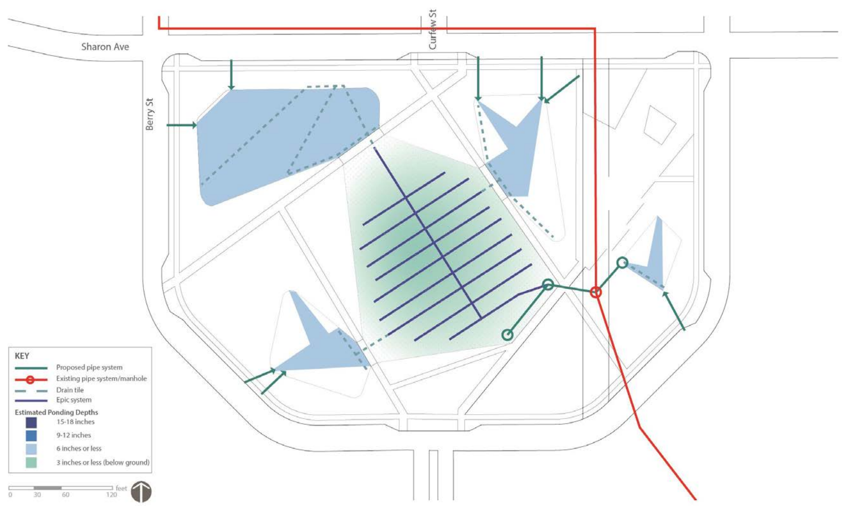
FIGURE 16 Curfew Commons Typical Summer Rain Event



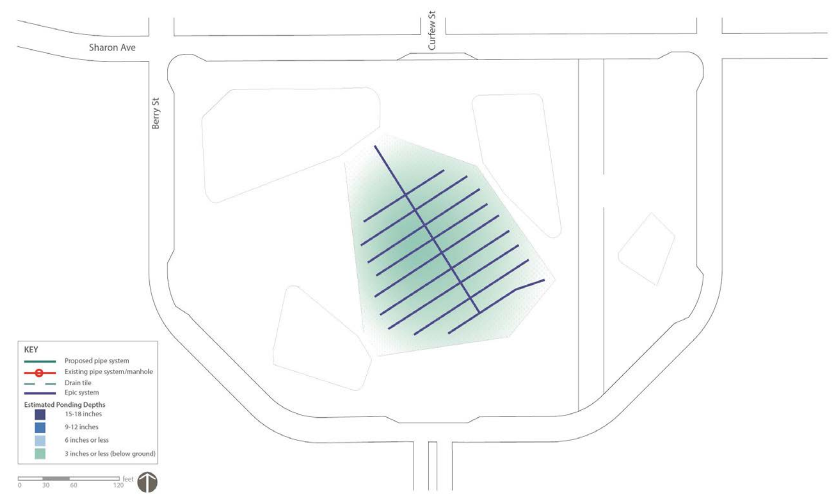
Basin ponding to meet regulatory requirements



Initial draw down



Later draw down



Runoff Stored Underground (3" depth) for Great Lawn Uptake

FIGURE 17 To Meet Regulatory Requirements

- *Top Row- Rainwater Sculpture, Herbert Dreiseitl. Waterworks Garden, Lorna Jordan. Freres-Charon Plaza, Affleck and de la Riva*
- *Middle Row- Public art sketch concepts for Curfew Commons, Craig David.*
- *Bottom Row- 'The Living Water Garden'. Chengdu Schuan Province, China, 1999. Public art sketch concepts for Curfew Commons, Craig David.*

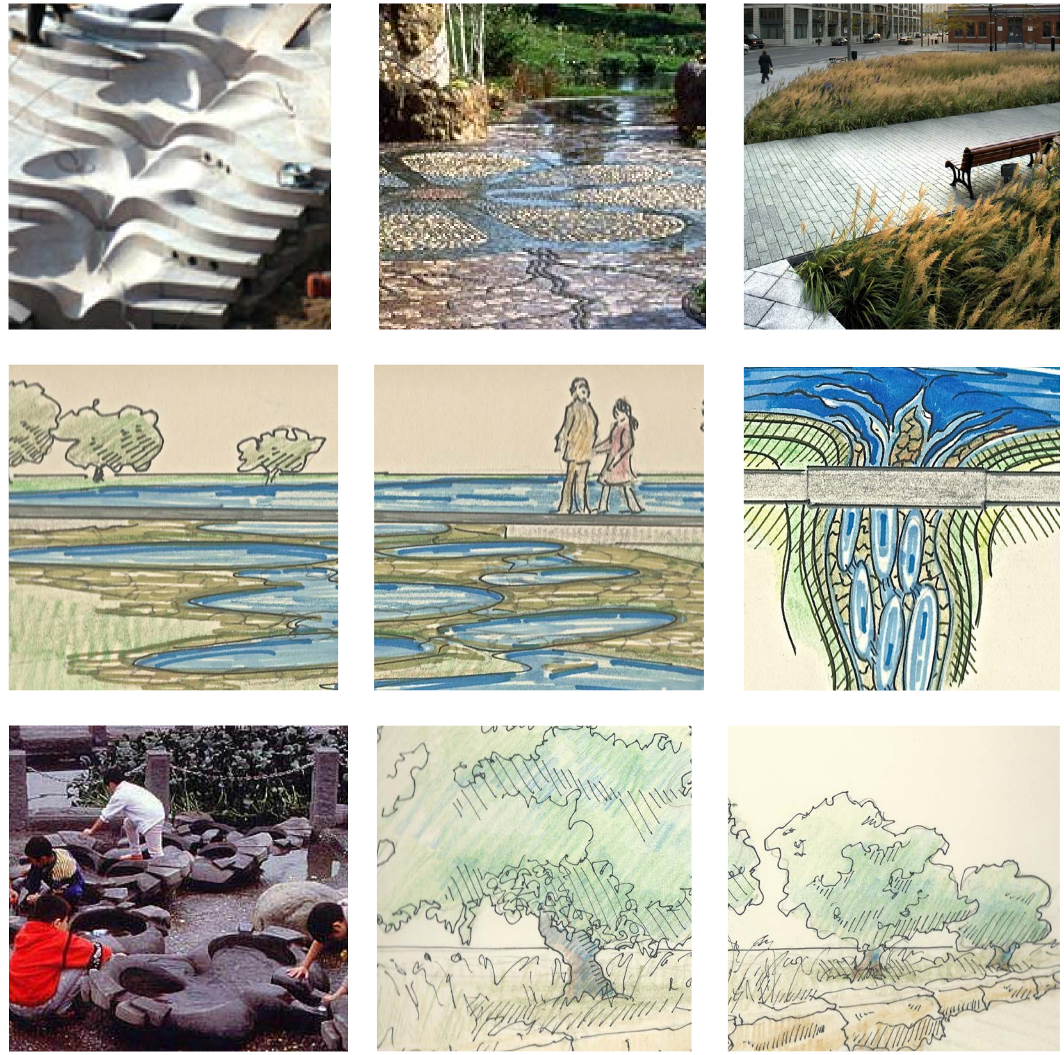


FIGURE 18 Curfew Commons Public Art Concepts

Project wide

- Volume Control Criteria = 1.3 in. rainfall due to clay soils throughout site. Filtration requires an extra 30%.
- Rate Control Criteria based on 1.64 cfs/acre of drainage area.
- All soils are classified as urban. C soils were used with initial abstractions of 0.2.
- Land use ratios for the new developments are based on an example block between Emerald St. and Berry St. from Ellis Ave. to Franklin Ave.
- R/W does not need to meet rate control requirements.
- R/W runoff will be pretreated in grit chambers before entering the park.
- Design, administration, legal costs are 15% of total cost.
- All costs include 20% contingency.
- Costs do not include land or mass grading. Disposal of excavated material from BMP placement is $15/CY.
- 2013 Construction

Shared Green Infrastructure	Shared Gray Infrastructure
Bioretention • Bioretention capital cost based on average bids from previous projects. • Bioretention Annual O&M: $0.64/sq ft, • NW Bioretention: 15” ponding, Others: 18” ponding • NW Bioretention has rock drainage layer, others have drain tile • Requires 3 grit chambers where pavers do not pretreat road runoff.	**Open Space – Pipe Gallery** • Capital costs based on manufacturers suggested installed unit cost ($5.50/cu ft) and the addition of drain tile and sand for filtration. • Solid Wall Underground Pipe Gallery O&M: $1.26/cu ft WQV (Barr) • Pipe gallery isolator row (1/5 of volume) is jetted out every 2.5 years.

FIGURE 19 Curfew Commons Costing Assumptions

Shared Green Infrastructure
Underground Irrigation- Great Lawn • Installed capital cost: $7/sq ft (EPIC suggested installed price), includes netlon turf reinforcement, turf, piping, EPDM liner, sand, EPIC chambers • Annual O&M: $75/2000 sq ft and $10/ additional 1000 sq ft for aeration (kompareit landscaping quote)
Individual Development Treatment
Individual - Pipe Gallery • Capital costs based on manufacturers suggested installed unit cost and the addition of drain tile and sand for filtration. Unit costs adjusted to reflect economy of scale. $5.64/ cu ft for medium system, $5.78 for small system. • Solid Wall Underground Pipe Gallery O&M: $1.26/cu ft WQV (Barr) • Pipe galleries are jetted out every 5 years. • If additional rate control is needed to meet discharge requirements, it will occur on the building roof. • Public R/W and park require same grit chambers as shared scenario. • Individual developments do not require grit chambers.

FIGURE 19 Curfew Commons Costing Assumptions, cont.