DRAFT

Greener Belltown = Bluer Sound

A Neighborhood Green Stormwater Management Project by the Seattle 2030 District

December 2017

SEATTLE 2030 DISTRICT

DRAFT

Acknowledgements

This project was made possible with funding from the Boeing Company. We also want to thank King County and the Bullitt Foundation for their additional support. We greatly appreciate the participation of the following organizations in contributing to the success of the workshops and the resulting report: City of Seattle, Friends of the Waterfront, Growing Vine Street, Project Belltown, The Nature Conservancy, Herrera Environmental Consultants for in-kind technical inputs, and Magnusson Klemencic Associates (MKA) for their substantial in-kind analytical contributions.

Our third workshop depended heavily on the creative involvement of UW Professor Nancy Rottle in the Department of Landscape Architecture and her Scan/Design Studio students who gave life to a number of the proposed strategies included in this report.

We also want to recognize the leadership of former Seattle 2030 District Green Stormwater Program Manager Amy Waterman in organizing the project and the work of Robin Thaler at Mayfly Engineering & Design in producing this report.

Figure 1 Belltown Study Area

INTRODUCTION

Greener Belltown=Bluer Sound (GBBS) came about as an initiative under a Boeing-funded project, *Urban GSI: Quantifying the Benefits and Leveraging Public/Private Partnerships*. It was conceived as a community engagement effort to develop a visionary plan for managing 50% of Belltown's stormwater runoff and serve as a model that could be replicated in other areas of the Seattle 2030 District. In addition, the goal was to build the case for more investment in Green Stormwater Infrastructure (GSI) and to identify practical GSI solutions at the neighborhood scale that could also mesh with local priorities.

Several criteria were used to select Belltown as the focus of the initiative: Combined Sewer Overflow (CSO) issues; a mix of commercial and multifamily residential properties with 2030 District members; some potential for using right-of-way spaces (e.g., streets, alleys); active neighborhood and business organizations; and an openness to GSI and a planning process involving outside groups. The Belltown neighborhood was chosen because of the large number of upcoming projects and programs that provide opportunity through new construction, community interest and the momentum in this area to reduce stormwater runoff and resulting CSOs. These include the Waterfront redevelopment, Seattle Public Utilities' (SPU) focus on the Vine Street CSO and SPU's RainWise program that overlaps with Belltown, the Battery Street tunnel decommissioning, and the Market to MOHAI and Lake2Bay corridors.

The GBBS project was executed through a series of three stakeholder workshops held in May, August and November 2017. The first was organized in conjunction with the Congress for the New Urbanism (CNU)'s national conference. Members of the community and designers and planners from around the country took a tour of Belltown's "opportunity sites," focused on a particular area within Belltown (towards the Waterfront), and mapped out creative stormwater management ideas through a "mini-charrette." The second workshop broadened participation and included City Councilmember Sally Bagshaw, Chief Sealth descendant Ken Workman, a representative from County Councilmember

Jeanne Kohl-Welles' office, representatives from Seattle Department of Transportation (SDOT), Seattle Public Utilities (SPU), Growing Vine Street, Project Belltown, several green stormwater designers, and community members. The District presented on some neighborhood-level designs developed with MKA engineers with stormwater volume managed from rainwater harvesting, green roofs, bioretention, and engineered wetlands. Participants also played the Stormwater Game, led by Herrera, where teams maximized GSI on a building parcel with other goals such as cost efficiency. They also rated six different ideas that emerged from the earlier and present workshops, with the top two as developing some type of Stormwater Treatment Park and incorporating stormwater management into street planning.

The third workshop featured student presentations from the University of Washington (UW) Scan/Design Master Studio, who adopted GBBS and the 50% stormwater management goal as their framework. Their concepts focused on managing stormwater in relation to buildings, streets, sidewalks and alleys, social spaces, historic buildings and art and habitat. Small groups considered each approach and the merits of advancing them to achieve GSI as well as other community interests. A full-group discussion at the end allowed participants to provide feedback on those best positioned to meet Belltown community goals for a sustainable, livable community, meet City and County goals for reducing stormwater pollution from combined sewer overflows, make the best of land use changes as a result of Waterfront and other major projects, and provide momentum to community organizations.

CURRENT STORMWATER INFRASTRUCTURE

The rainwater that falls in the Belltown neighborhood primarily drains to the City of Seattle's Vine Street combined sewer basin, which is then directed to the main King County interceptor. The majority of this flow is then conveyed to the West Point Treatment Plant in the Magnolia neighborhood before receiving advanced treatment and then being released into the Puget Sound. The estimated annual flow for this basin is 167 MG/year, or 457,000 gallons/day. High flow events from this basin discharges at NPDES CSO outfall 069 on the Elliott Bay waterfront, adjacent to the corner of Alaskan Way and Vine Street. These high flows convey minimally treated sewage into Elliott Bay.
The 2015 Seattle Comprehensive Plan Update Draft EIS states that, "The water released by combined sewer overflows (CSOs) is 10 percent sewage and 90 percent stormwater." Reducing the stormwater input to the combined sewer will reduce overflows, minimize related Capital Improvement Project Costs to build storage that reduces overflows and reduce pollutants entering the Puget Sound.

SEATTLE 2030 DISTRICT GOAL

The Seattle 2030 District stormwater goal is to manage stormwater to 50% below the Belltown neighborhood baseline.

"Manage" is defined as keeping the stormwater runoff resulting from rainfall from entering the combined sewer system or delaying this stormwater in order to reduce the occurrence of CSOs into the Puget Sound. In the following discussion, the Belltown neighborhood area is referred to as the "basin." This report includes a range of solutions considered to meet the Seattle 2030 District stormwater goal

Baseline Metrics

The neighborhood baseline is based on the following:

- The total basin area is 165 acres or 7,187,400 square feet.
- The annual stormwater runoff within the basin is 134,000,000 gallons per year.
- The average daily rainfall in the basin is 457,000 gallons per day.
- Approximately 40% of the basin is public right of way.
- Approximately 60% of the basin is privately or publicly owned parcels.

The stormwater-based metrics were obtained from an SPU report that established an average annual flow rate by modeling flows at CSO outfall 069 based on the results of an analysis performed for a long-term control plan for Seattle's CSO system. It should be noted that the estimated daily flow rate provided from this SPU report is an estimated average, and significant variation may be expected depending on season and due to errors in the model. SPU has started a project to investigate options for minimizing combined sewer overflows in this basin, starting with monitoring this outfall to determine more accurate flow rates. Current estimates are that 130,000 gallons of storage are needed to prevent CSO's at outfall 069.

Additional Benefits

It is recognized that some of the solutions considered provide stormwater management but do not include the entire host of benefits that other GSI solutions provide. The range of possible additional GSI benefits includes:

- providing habitat for humans and other organisms
- a calming environment
- reduced air pollution
- increased property value
- water quality treatment
- potable water use reduction
- greenhouse gas emission reduction
- increased building energy efficiency

SOLUTIONS

The solutions that will be examined in more detail throughout this report were conceived in the workshops the 2030 District held in the Belltown neighborhood to get feedback from the community, design professionals and developers in in the area. The ideas that received the most positive feedback were then explored in more detail to provide a gallons-managed number for each solution. Between the work done by the UW students, the community feedback and the stormwater managed, the 2030 District has selected solutions that will achieve the goal as well as provide additional community benefits.

Scale and Ownership of Solutions Considered:

Solutions that occupy public right of way, privately and publicly owned parcels and combinations are considered. The solutions generated range from smaller localized solutions to solutions that could be applied to the entire neighborhood.

- Neighborhood-Scale solutions can be applied to all or most areas in the study areas. Some of these solutions can be built piece-by-piece as funds are available and some require larger-scale infrastructure to function.
- Localized-Scale solutions can be applied in specific locations and serve the adjacent areas or areas upstream that can contribute stormwater runoff.
- Spot-Scale solutions can be applied to specific locations or buildings and provide treatment for a single building or less than ½ a block.

Community Input

Some of the main themes that resulted from the community at the workshops included:

- keep stormwater on-site
- reuse water in buildings
- incorporate water into streetscape and parks
- potential "green corridor" through Belltown

These themes were used to narrow down the range of options considered at community workshops as well as those investigated by the UW Scan/Design Studio class and Magnusson W Associates (MKA). The 2030 District Calculator, developed by Herrera Environmental, was also used as a tool to estimate rainwater management.

DRAFT

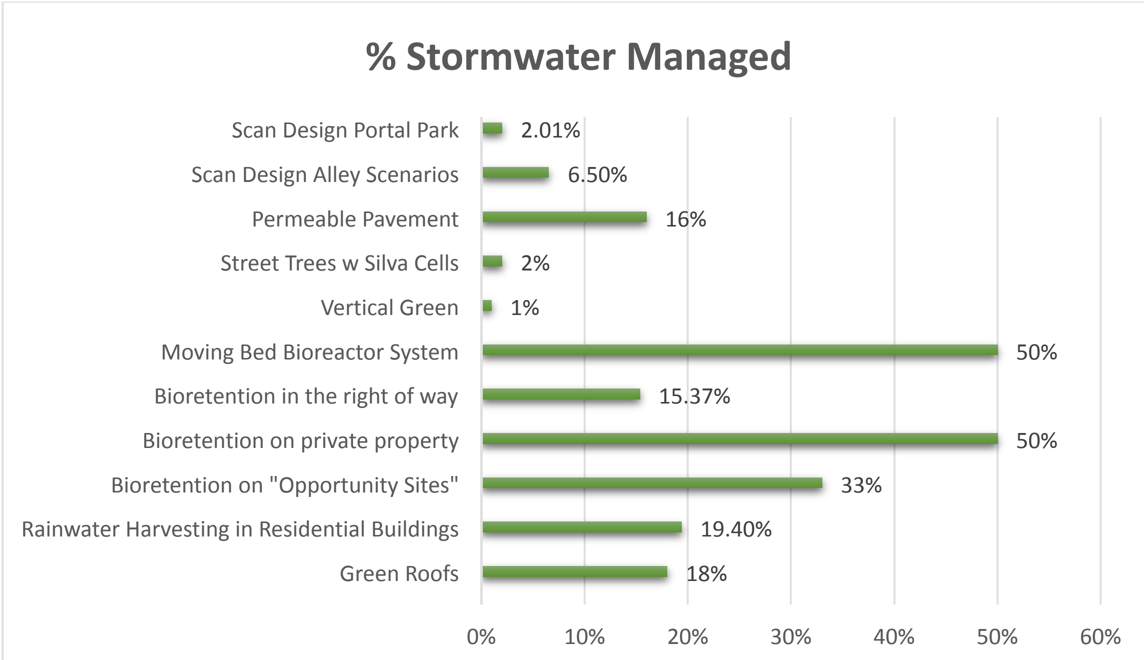

Figure 2 % Stormwater Reduction of Baseline Goal

It is not envisioned that any single solution meets the goal on its own. Instead a thoughtful combination of solutions can meet the 2030 District goal while enlivening and improving the overall environment of the neighborhood. The following solutions were considered in helping the 2030 District understand how it might reach its stormwater goal to manage 50% of the stormwater that falls in the Belltown neighborhood.

1. **Green Roofs**- MKA provided a study showing that if 100% of all property not located in the right of way had 80% green roof coverage that stormwater runoff would be reduced by approximately 22%.
2. **Rainwater Harvesting for Buildings**- If each building met a goal to harvest and reuse 50% of the rainfall that fell on its rooftop then rainwater harvesting would reduce stormwater runoff in the basin by 24%. Approaching rainwater harvesting from another direction, MKA took a detailed look at how one residential building could maximize reuse to meet all of its reuse needs. The study showed that for the single residential building studied- The Avalon Bay property- that the building could reuse up to 2,600,000 gallons of stormwater runoff annually. This requires harvesting rainwater from surrounding blocks. This results in a total reduction of stormwater runoff in the Belltown neighborhood of approximately 2% for this building alone. If this solution was scaled up and applied to 10 new buildings then the total reduction of stormwater runoff in the Belltown neighborhood would be approximately 19%.
3. **Bioretention on "Opportunity Sites"**- MKA provided a study showing that if bioretention was integrated into the identified "Opportunity Sites" that stormwater runoff could be reduced by up to 33%.
4. **Bioretention on Parcels**- MKA provided a study that reports that if 2.45% of the total land area was converted to infiltrating bioretention that it would reduce stormwater runoff by 50%. This indicates that if each parcel dedicated 4.9% of their parcel area to infiltrating bioretention that the basin would reduce its stormwater runoff by up to 60%.
5. **Bioretention in the Right-of-Way**- The UW Scan/Design Class provided a study showing that the existing right of way could be retrofitted with 54,120 square feet of bioretention systems. This number was entered into the 2030 District Calculator to calculate the related stormwater runoff reduction of approximately 15%.
6. **Moving Bed Bioreactor System**- MKA provided a study showing that if 66,000 square feet was available to install a Moving Bed Bioreactor System (MBBR) that this system would be able to treat the estimated average daily flow rate from the Vine Street combined sewer system. Based on the estimated average daily flow rate, the stormwater runoff would be reduced by approximately 100%.

7. **Vertical Green**- The UW Scan/Design Class provided a study showing that stormwater planters with vertical green could consume 1,328,600 gallons of rainwater a year in the basin. This equates to the total basin stormwater runoff reduced by approximately 1%.
8. **Street Trees**- The 2030 District Calculator notes that every deciduous tree planted annually removes 300 gallons of stormwater from the downstream pipe and that for every evergreen tree planted annually 800 gallons of stormwater are removed from the downstream pipe. The UW Scan Design Class also looked at using Silva Cells as a foundation for street trees. Silva Cells are a modular suspended pavement system that uses soil volumes to support large tree growth and provide on-site stormwater management through absorption, evapotranspiration, and interception. The City of Seattle requires street trees to be integrated into street improvement plans adjacent to new development. While the numbers above reflect a stormwater savings in the neighborhood of 1%, it should be recognized the host of other benefits that street trees provide that include shade, improved air quality and habitat.
9. **Permeable Pavement in the Right of Way**- The 2030 District Calculator calculates that for every 1000 square feet of permeable pavement there is 1,500 gallons of stormwater treated every year. If you were to assume the right of way is 40% of the entire area and that 50% of the right of way could be permeable pavement then the total reduction of stormwater runoff in the Belltown neighborhood would be approximately 16%.
10. **Scan/Design Alley Development**- The UW Scan/Design Class provided a study that showed two blocks of alleys and an adjacent parking lot developed to encourage pedestrians and stormwater treatment. It was reported that together these two alleys managed 670,012 gallons of stormwater per year with a combination of planters, rain gardens and permeable pavement. The proposed alley scenarios resulted in a total reduction of stormwater runoff in the Belltown neighborhood of approximately 0.5%. If this type of alley development was applied to approximately 50% of the alleys in the neighborhood, you would achieve a stormwater runoff reduction between 6.5% and 13%.
11. **Scan/Design Portal Park**- The UW Scan/Design Class provided a study that showed the Battery Street Tunnel Portal lot developed with a park that integrated stormwater treatment. It was reported that the park plan included 461,050 gallons of stormwater storage. When input as a detention tank into the 2030 Calculator, it was shown that Belltown neighborhood stormwater runoff would be reduced by approximately 2%.
12. **Other Options**- These concepts were presented and discussed during the workshops but because their GSI benefits are less understood or are fairly minimal or are particularly challenging in other ways, they were not seriously considered. That said, they are included to illustrate the broad range of options that surfaced.
    a. The beach-to-bluff idea to recreate the pre-construction landscape of a beach up to an upland forest edge would have serious challenges, including getting the Port of Seattle to be a partner and identifying project development funds. The Cloud Bridge concept that focuses on the pedestrian overpass along Bell Street is one that would make the area outside of the Bell Harbor International Conference Center more inviting and project a more attractive image to cruise ship passengers using the facility. It would also potentially hide the passing train traffic and provide a stormwater benefit while reclaiming some of the area for pedestrians.
    b. A smaller-scale idea that came out of the third workshop is to install green roofs on all the bus stops in the area. There are 17 bus stops in Belltown and placing a green roof on all of them would result in an estimated 22,600 gallons of stormwater managed per year. There would also be the educational benefit of people seeing a green roof every time they catch a bus.
    c. The P-Patch, located at Elliott and Vine, presents an opportunity for a productive public space in a rapidly densifying neighborhood. The lot adjacent to the existing P-Patch is currently a parking lot that could be converted to expand the P-Patch (which the community needs) in order to provide more public space and more stormwater management infrastructure.
    d. Adapting historical buildings with GSI would mean environmental and cultural capital coming to Belltown. There are a number of historic buildings in Belltown that the community would like maintain as part of the neighborhood. These could install an external cistern or rain garden. If all 23 of these buildings installed an external cistern, the neighborhood would manage 69,000 gallons a year. This would also provide a valuable educational benefit to the neighborhood and pedestrians.

WHAT WE CAN BUILD TODAY

A number of the solutions discussed above are already included in the City of Seattle Stormwater Manual and are sometimes required for new development. Green roofs, rainwater harvesting, bioretention facilities and permeable pavement are all current options for new construction to use to meet their stormwater control requirements. Detailed design requirements and feasibility considerations are included in the City of Seattle Stormwater Manual. These solutions are discussed in greater detail below.

GREEN ROOFS

The City of Seattle Stormwater Manual provides the following description for Vegetated Roof Systems:

> *Vegetated roofs are areas of living vegetation installed on top of buildings, or other above grade impervious surfaces. Vegetated roofs are also known as ecoroofs, green roofs, and roof gardens. A vegetated roof consists of a system in which several materials are layered to achieve the desired vegetative cover and stormwater management function. Design components vary depending on the vegetated roof type and site constraints, but may include a waterproofing material, a root barrier, a drainage layer, a separation fabric, a growth media (soil), and vegetation.*

Green roofs provide a host of benefits beyond stormwater management. These benefits include habitat for humans and other organisms, improved air quality, and building insulation with resulting increased energy efficiency. Green roofs can also be used to grow food. Existing buildings can often be retrofitted with green roofs if the underlying structure can support the proposed loading. The depth of green roofs varies depending on the proposed stormwater management goals, design goals and proposed location.

MKA provided a green roof study based on 80% green roof coverage on zero-lot line buildings. Their analysis results reflected a total 18% annual reduction in stormwater runoff within the basin. They found that about 10 million gallons/year of stormwater would be removed from the combined sewer every year.

Additional Benefits:

- Green roofs provide a host of benefits including habitat, improved air quality, a calming environment, greenhouse gas emission reduction and increased building energy efficiency.
- Many existing buildings can be retrofit with green roofs.

Additional Investigation:

- Verify study assumptions.
- Clearly identify how realistic it is to retrofit existing buildings.

RAINWATER HARVESTING

The City of Seattle Stormwater Manual provides the following description for Rainwater Harvesting:

> *Rainwater harvesting is the capture and storage of rainwater for subsequent use. Runoff from roofs may be routed to cisterns for storage and beneficial non-potable uses, such as irrigation, mechanical equipment, industrial process uses, toilet flushing, and the cold water supply for laundry. The potable use of collected rainwater may be used for single-family residences with proper design and approval from Public Health – Seattle & King County.*

The design of rainwater harvesting systems is a balancing act. The following design criteria vary from project to project and is the basis of every design.

- What in the intended use for the harvested rainwater?
- How much space do you have available for storage, or can you make available?
- How much space can you collect rainwater runoff from?

Answers to the above questions have a huge influence on treatment requirements prior to reuse as well as storage volumes and the conveyance piping needed to get the treated water to the location of its intended use. For example, minimal treatment is required for reuse for irrigation but when irrigation is needed, there is typically little rainfall. This condition results in large storage volume facilities used to store rainfall until it is used. Reuse of rainwater for toilet flushing has similar treatment requirements but since toilets are flushed year round there is more opportunity, with less storage, to reuse rainfall throughout the year. A secondary piping system would be needed in the building to deliver the harvested water to the toilets in the scenario resulting in additional cost. Reuse of rainwater for potable uses such as drinking and showers requires more stringent treatment and is not currently allowed by City of Seattle Code.

To start to understand how rainwater harvesting could meet the 2030 District goal, a general goal of 50% rainfall harvest of all rain falling on rooftops was considered. It was calculated that rainwater harvesting could theoretically manage 24% of the rainfall that fell in the basin based on the following design criteria:

- 60% of the basin area is assumed to be parcels
- 80% of each parcel is assumed to be rooftop
- 100% of those parcels in the basin harvest 50% of the rainfall that falls on their rooftop

While a general goal is set, it is left up to the developer to identify the best solution that meets their needs and reduces resulting costs while maximizing reuse of harvested rainwater.

MKA provided another study that looked at the rainwater harvesting potential of one residential building in the Belltown neighborhood. This scenario assumes that residential buildings could harvest rainwater from their roofs as well as the surrounding rooftops and use it to satisfy 100% of their non-potable demands, including toilet flushing and laundry. This scenario is based on a new residential building under construction in the Belltown neighborhood at 2nd and Wall Street; the Avalon Bay building. Based on the estimated occupancy, this 283-unit building would require approximately 116,000 square feet of total roof area in order to harvest a sufficient volume of rainwater to meet 100% of their annual non-potable water needs. This area is roughly equivalent to the area of four city blocks. This means that a new development would need to strategically intercept the stormwater runoff from three adjacent blocks to fully satisfy its non-potable water demand. A rainwater harvesting system of this scale would require a large water storage facility that must be considered in the building design as well as new dedicated stormwater infrastructure in the surrounding city right of way to convey runoff from the surrounding blocks.

If 10 new residential buildings the size of Avalon Bay set their plumbing up for rainwater re-use, they would need 1,160,000 sq. ft. of roof area- about 40 city blocks or 2/3 of the Belltown basin- to satisfy 100% of their non-potable water needs.

Based on the above described scenario, the Avalon Bay building would reuse 2,600,000 gallons of harvested rainwater a year. This results in a single building reducing the stormwater runoff in the Belltown neighborhood by approximately 2%. Multiplied by 10 new buildings the total reduction of stormwater runoff in the Belltown neighborhood would be approximately 19%.

Additional Benefits:

- Rainwater harvesting minimizes potable water being used for non-potable uses while reducing stormwater simultaneously.
- Reduced potable water and sanitary sewer bills.

Additional Investigation:

- Understand the pros and cons of individual and regional systems.
- How do direct “dedicate” adjacent buildings to proposed rainwater harvesting sites? And how does the new dedicated storm drainage conveyance fit into the surrounding right of way?
- Should we push the envelope for reuse for potable water use? While finding a way to make this happen in the city would be beneficial to projects with smaller potable water needs, there is currently barely enough rainfall in the Belltown neighborhood to provide for non-potable uses.

BIORETENTION FACILITIES

The City of Seattle Stormwater Manual provides the following description for Bioretention facilities:

> *Infiltrating bioretention facilities are shallow earthen depressions or vertical walled open bottom boxes with a designed soil mix and plants adapted to the local climate and soil moisture conditions. Stormwater is stored as surface ponding before it filters through the underlying bioretention soil. Stormwater that exceeds the surface storage capacity overflows to an adjacent drainage system. Treated water is infiltrated into the underlying soil or, in soils with lower infiltration rates, collected by an underdrain and discharged to the drainage system. Bioretention facilities can be individual cells or multiple cells connected in series.*

With a wide range design options, bioretention facilities can fit within a variety of spaces and were considered in the following locations:

- opportunity sites
- in the right of way
- within parcels

MKA provided a study that based on input from the City of Seattle Stormwater Manual showed that a bioretention area needs to be 2.45% of the total contributing area to fully satisfy the 2030 District requirements of 50% stormwater management. The results of this study are used to consider bioretention at all locations.

Bioretention on Opportunity Sites

An analysis was done on the use of some current and future public spaces that are likely to come from the proposed rerouting of roads, changed uses of the Battery Street tunnel area and other projects in the Waterfront redevelopment. Areas where infiltrating bioretention might be possible were identified in the first GBBS workshop with local participants and designers. Locations were partly based on earlier Waterfront Plan maps shared by Friends of the Waterfront. Key opportunity sites include an area at the bottom of Blanchard Street, the area in front of Battery Street tunnel- also referred to as the Battery Street Tunnel Portal Park, an area formerly referred to as the Belltown Bluff, Post Alley- especially between Vine Street and Battery Street, Bell Street Park extension and the Battery Street Tunnel itself. One of the observations that came out of the design charrette was that the mapping of the Opportunity Sites resulted in the formation of a green corridor. The total area of the “Opportunity Sites” from the map developed from the charrette, is estimated to be 115,000 square feet (2.64 acres).

The 115,000 square feet space available within the Opportunity Sites could possibly provide enough space to locate biofiltration facilities that would provide up to a 33% reduction of stormwater runoff within the basin. A new dedicated stormwater conveyance system would be required to deliver stormwater to these bioretention facilities. It still needs to be confirmed that there is adequate upstream contributing flow to each opportunity site in order to maximize treatment potential. Redirecting stormwater, construction in the right of way and possible new parks would require coordination and approval with various City of Seattle departments including SPU, Seattle Parks and SDOT. If and where the project touched on King County Metro systems, King County would also need to be included in the conversation.

Bioretention in the Right of Way

It was calculated that bioretention facilities in the right of way could theoretically manage more than 15% of the rainfall that fell in the basin. This is based on the following design criteria:

- The UW Scan/Design Class reported that 54,120 square feet of right of way was available for bioretention facilities. These calculations were based on the placement of bioretention cells along sidewalks on the north side of avenues within the study area.
- 54,120 square feet is 15% of the total space required to provide a 100% reduction of rainwater in the basin. This is based on MKA’s study noted above.

Additional work needs to be done to identify the space available for bioretention and to ensure that adequate rainwater runoff is conveyed to the bioretention locations to ensure stormwater treatment. Bioretention facility locations should integrate slopes, infiltration potential and the minimum distance from building basements and utility trenches to protect from flooding. Other competing right of way uses such as utilities and pedestrian space must be considered as well.

Bioretention on Parcels

It was calculated that bioretention facilities on-site, located on parcels, could theoretically manage approximately 60% of the rainfall that fell in the basin. This is based on the following design criteria:

- 60% of the basin area is assumed to be parcels
- Each parcel sets aside at least 4.9% of its total area for infiltrating bioretention and related building setbacks.

Many existing parcels may not have the space available to provide the bioretention facilities noted above or meet the requirements for infiltration or slope. If only half of the parcels could provide less than 5% of their total area for a facility then this solution would manage 30% of the rainfall that falls in the basin.

Additional Benefits:

- Bioretention facilities provide a host of other amenities including water quality treatment, habitat and improved air quality.
- Facilities in the right of way can provide pedestrians protection from vehicles.
- Signage can educate the public on why stormwater management is important in their neighborhood.

Additional Investigation:

- Verify the infiltration rates at each opportunity site and ensure that the infiltrating flow will not create damage to the surrounding neighborhood as it moves through the soil.

- Verify space appropriate for bioretention facilities in the right of way.
- Understand viable options for parcel locations including on parcel and possible collaborations with adjacent right of way.

PERMEABLE PAVEMENT IN THE RIGHT OF WAY

The City of Seattle Stormwater Manual provides the following description for permeable pavement facilities:

> *Permeable pavement is a paving system that allows rainfall to infiltrate into an underlying aggregate storage reservoir, where stormwater is stored and infiltrated to the underlying subgrade or removed by an overflow drainage system.*

The 2030 District Calculator calculates that 1000 square feet of pervious pavement provided 14,500 gallons of stormwater management per year. If you assume that 40% of the basin area is right of way and that 50% of the right of way area could be replaced with pervious pavement then the total reduction of stormwater runoff in the Belltown neighborhood would be approximately 16%.

Benefits:

- Additional benefits include possible water quality treatment.

Additional Investigation:

- Explore whether to reduce the 2000 square feet that is the minimum space required by Seattle code for pervious pavement. This relatively large area keeps developers from constructing these facilities, even if they own an entire city block. Changing this requirement will likely lead to more voluntary GSI installed and help the City meet its goals, as often there are developers who want to do the right thing but rules such as this make it difficult for them to do what they had planned.

WHAT MAY BE POSSIBLE IN FUTURE

Another GSI solution that was proposed as part of the GBBS initiative was the Moving Bed Bioreactor (MBBR) system. There are over 700 such systems installed worldwide, including at the Cervecera Brewery in Puerto Rico and treatment plant in Batesville, Arkansas. MBBR offers a relatively new approach to wastewater treatment on a smaller footprint and through biological processes.

Moving Bed Bioreactor System

MKA provided the following information as part of their study and analysis about the MBBR. This system treats sanitary sewage so that flow can be reused or released. The MBBR is a system which has a tank full of small “chips” of plastic media. These “chips” have a high surface area that allows significant microbial growth. During operation, the media is continuously suspended in the water via mixing or aeration, allowing the microorganisms to break down organic materials in the incoming wastewater; this is the primary way MBBR’s treat influent. MKA recommended MBBR systems as they may have a much smaller footprint than other methods. They tend to generate less sludge than conventional systems and these systems can include additional treatment methods before or after passing through the primary MBBR treatment basins.

A conservative estimate of the required area to treat the Vine Street combined sewer basin with an estimated flow rate of 457,000 gallons per day is 66,000 square feet. This estimate is based on the footprint of a municipal MBBR system constructed in Fairfield, PA, which provides similar throughput (estimated 3 MGD average, or 6 MGD peak). This system has an estimated footprint of 44,000 square feet, which was scaled by an additional 50 percent to get the final estimate of 66,000 square feet. This accounts for the 50% larger average flow rate expected for the Vine Street basin as compared with the Fairfield, PA facility. If you were to apply this same scaling to understand how big a facility would be that treated 50% of the estimated average daily rate you would need a space approximately 33,000 square feet.

An MBBR system could be placed on one of the opportunity sites such as the interior of the Battery Street Tunnel. One of the drawbacks of this location is that only approximately one third of the Belltown neighborhood flows towards this location and that additional flow would need to be pumped in. The most straightforward location would be near the terminus of the Vine Street combined sewer, a location that the majority of the Belltown neighborhood flows towards, at the bottom of the hill. This location would facilitate a much simpler delivery to the facility without pumping.

CONCLUSIONS AND NEXT STEPS

The GBBS initiative under the 2030 District's *Urban GSI* project exceeded expectations in terms of the quality and relevance of the GSI solutions proposed, the level of community engagement, and the contributions of 2030 District partners and allies. The discussions and presentations coming out of the three workshops yielded a wide range of GSI solutions – from well-understood approaches like green roofs and rainwater harvesting at a large scale to different forms of bioretention to a more radical strategy like MBBR. While examined in some detail in this report, more analysis will be useful to determining whether these solutions can be practically and affordably implemented. The "Additional Investigation" issues will be a good starting point for specific GSI measures, but such analysis may also explore more generally:

- Verification of assumptions used in estimating cost savings from avoided potable water use and stormwater fees and gallons of stormwater managed
- The costs associated with the projects, including pre-feasibility studies, permitting, construction, and operation and maintenance
- The benefits from projects for the developer, community and City
- Potential for right-of-way and multi-parcel solutions where there may be feasibility, regulatory and political concerns
- Availability of project financing options including incentives, loans and grants

The three GBBS workshops attracted over 100 designers and planners, community advocates, city officials, and students. Their participation in a walking tour, mini-charrette, the Stormwater Game, presentations, and small-group discussions stimulated numerous ideas and strong support for maximizing GSI opportunities in the Belltown neighborhood. In particular, representatives from Project Belltown and Growing Vine Street engaged with 2030 District staff and others to help ensure that the process and dialogue were inclusive and relevant to the community's needs and interests. There is some alignment with the ongoing visioning exercise that Project Belltown has been conducting and one element is even called "Greener Belltown." Follow-up efforts will surely focus on further strengthening the ties between the emerging neighborhood plan and GSI measures and how they can support broader local goals (e.g., livability, air quality, well-being).

Other partners and allies also contributed to GBBS's success. The Nature Conservancy (TNC) hosted the first and third workshops and participated substantively as an interested Belltown stakeholder, given the location of their headquarters. Another group, Friends of the Waterfront, helped make linkages to the Waterfront redevelopment project during and outside of the workshops and provided outreach support. Getting the first workshop proposal accepted by the Congress for the New Urbanism's national conference provided a national platform for outside experts to engage with the GBBS project, and it benefitted from their broader perspectives. The UW students contributed their creative and professional presentations on GSI opportunities at the third workshop. MKA and Hererra donated their time to provide technical analysis and assistance. Lastly, multiple City agencies (OSE, OW, SPU, SDOT) participated in a number of ways through attending the workshops, making presentations and sharing data. The 2030 District plans to continue to nurture these relationships as the diverse and deep support of these organizations will be critical to translating the proposals into actual projects.

Moving forward, the 2030 District will be sharing this report with all relevant City agencies to show the stormwater management potential and the value of investing in GSI in Belltown. One positive outcome would be to achieve alignment between codes and incentives with developers' interests to increase the number of GSI projects. A second would be more flexibility to use the right of way in a manner consistent with other public priorities. In addition, the 2030 District will work with developers to educate them about the opportunities and show them the value of GSI, not only to their projects but also to the community in which they are building and renovating. An important additional step will be to benchmark the existing green stormwater infrastructure in Belltown so that an accurate census can be taken, case studies can be shared, and the future impacts measured more effectively. The 2030 District will continue to track development in Belltown to show the project teams the benefits of GSI and feed that progress into the City's processes to promote even more GSI.

A major goal of GBBS was to develop a replicable model for engaging other neighborhoods on GSI solutions within the 2030 District. The community groups' receptivity and support reinforced one of the key selection criteria that a neighborhood champion is critical. Capitol Hill, with the involvement of the EcoDistrict, would be a good next candidate.