

**A STUDY OF THE CURRENT STATE OF GREEN STREET PRACTICE
FOR SUCCESSFUL IMPLEMENTATION**

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ABSTRACT

Green Streets, a stormwater management practice that is implemented within the public right of way, can effectively treat stormwater runoff on-site by closely mimicking natural processes. By providing multiple benefits, Green Streets can, purportedly, be a more sustainable alternative compared to conventional storm systems. However, there is no empirical research that evaluates how, or to what extent, the supposed or potential benefits of Green Streets are actually realized in projects built to date. Thus, planners and designers (or the public who are concerned about their watersheds) will find the literature on the subject to be of limited assistance in assessing many aspects of Green Street projects: their cost in terms of time, money, and resources; challenges; and whether the projects actually achieve the benefits touted by their proponents. This study is conducted to address these issues through two analyses. The first analysis looks at Green Street projects that were nominated by experts as the most successful additions to their communities. This portion of the study reveals that, in current practice, for a Green Street project to be successful, not only does it have to treat stormwater runoff but it also has to offer additional benefits, particularly in relation to the social aspects. The second analysis examines Green Street implementation processes in six sample cities, and four successful Green Street projects that appear to offer additional benefits were chosen for more detailed studies. Finally, a model process was developed with emphasis on the following: site analyses on multiple scales, the formation of interdisciplinary teams, and public outreach throughout the implementation process. The case studies elucidate the given challenges and suggest best practices for ensuring more sustainable outcomes in future projects. The study sheds light on the importance of incorporating multiple benefits in the implementation process and presents eight recommendations for successful Green Street implementation regarding the need for individuals who champion the project, interdisciplinary collaboration, opportunities for the public to voice their concerns, need of expanding the design scope, securing funds as delivering benefits, consideration of the maintenance plan, documentation of knowledge, and development of a model process.

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Chapter 1. Introduction

1.1. Background

The dissertation is a descriptive study of the current status of green street planning and design practice as viewed by a sample of practicing experts. The study's findings are both timely and important because Green Streets are beginning to make a critical contribution to municipal green infrastructure plans. They are one of the green infrastructure strategies recommended by the United States Environmental Protection Agency (EPA)-which in turn relate to help cities built in the 20th century as well as future cities become more sustainable in the 21st.

The state of disrepair of America's aging infrastructure, combined with a growing awareness of the environmental and quality of life concerns associated with urbanization, is elevating the nation's interest in green infrastructure systems in the United States. According to advocates, green infrastructure "provides a framework for conservation and development that acknowledges the need for providing places for people to live, work, shop, and enjoy nature" (Benedict & McMahon, 2006, p. 2). The EPA has strongly recommended integrating green infrastructure into the urban planning process to meet federal regulations regarding water quality and also to improve the "quality of life attributes that enhance the vitality of communities" (Stoner & Giles, 2012, P. 2).

As a landscape designer, the author values a sustainable approach that promotes multiple benefits and considers the larger environmental context of individual projects. While all Green Streets may not address all three aspects (environmental, social, economic) of sustainability the author's intention is to investigate better ways to understand and promote successful implementation of Green Streets. The Green Street practice, as an important component of green infrastructure systems, is suited to controlling and treating runoff from impervious surfaces and can be uniquely implemented within the public right of way. As an important component of urban settlement, the Green Street practice can be utilized as a community development strategy that provides better quality of life to surrounding communities (see Figure 1.1).

The following sections (1.2 and 1.3) explain these two aspects of Green Streets and the potential multiple benefits this approach provides.

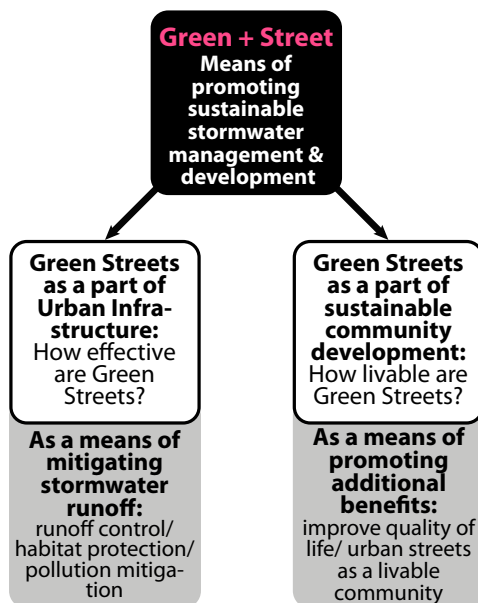


Figure 1.1. Two aspects of Green Streets.

1.2. Green Streets as Part of the Urban Infrastructure

Research has shown that impervious surfaces are an indicator of the degree of development in urban areas (Brabec, Schulte, & Richards, 2002; Espy, Morgan, & Masch, 1966; Stankowski, 1972) as well as a way of measuring environmental health, especially regarding surface waters, so-called hydrologic impacts. As land development patterns become increasingly dense, the amount of impervious surface per unit of land area and the degree to which these surfaces are interconnected typically increase. Increases in impervious surface have also been directly related to reduced water quality and the degradation of urban riparian zones and water bodies. Since nearly half of the land area in U.S. cities is covered by impervious surfaces related to automated transportation, controlling runoff from these is key to dealing with surface water pollution (Southworth & Ben-Joseph, 2003). Other common impervious surfaces are parking lots and rooftops (Environmental Protection Agency, 2012), both of which can potentially be integrated with street spaces either directly or indirectly. If these were added to the

nation's roads, these would constitute 65% of the total impervious surfaces in the U.S (Frazer, 2005).

It is commonly the case that as development density increases the amount of green space is reduced. This means that often where runoff reduction and treatment are most needed, there is only limited space to accommodate them. Where land (re)development is concerned, localities often seek to offset these impacts by requiring low impact development (LID) strategies or the establishment of municipal stormwater treatment utilities. The developer pays the cost of impacts associated with impervious surfaces located on private landholdings.

Streets and sidewalks, which comprise a considerable percentage of the impervious surface in most urban areas, are a different matter. First, as they exist within the public domain, a municipality cannot transfer responsibility for the runoff they generate to a private entity. Second, street corridors must satisfy many functional demands and the amount of space available to meet water quality goals is thus limited. Finally, land values are typically elevated in highly developed areas, which tends to limit off-street opportunities for treating and storing stormwater generated in the public domain. Consequently, within the total spectrum of green infrastructure possibilities, Green Streets occupy a fairly unique position. Since many cities are now beginning to incorporate green infrastructure systems into their plans for the future, both regulatory and economic realities of stormwater management will drive them to include Green Streets as a critical portion of their plan.

In contemporary parlance, a Green Street practice incorporates facilities capable of capturing and treating the runoff from adjacent impervious surfaces. These facilities, which are generally sized to capture the first inch of runoff from a rainfall event, are designed to treat surface water pollution (mostly infiltration with plants and soils). Depending on their design and construction, they may also act as storage areas to reduce the volume of runoff from a given storm event by controlling excessive effluent into storm or sewer systems or natural water bodies.

1.3. Green Streets as Part of a Sustainable Community Development

While Green Streets can effectively reduce the environmental impacts associated with imperviousness, as described above, they also provide another equally important benefit as a result of their contribution to community development strategies. According to proponents, they can provide traffic calming, streetscape improvement, and other amenities that promote “more vibrant, livable communities” (Carlson, Caughey, & Ward, 2014, para. 4). These additional benefits may be one of the most critical roles of Green Streets because streets, in general, are a “primary structural element of the city” (S. Marshall, 2005, p. 10). Simply put, streets affect people’s impressions of the city (Jacobs, 1989).

It is generally agreed that urban sustainability must take into account the social, economic and environmental aspects of a city. Advocates for green streets frequently describe them in exactly these terms – as seen in the following quotes:

Green streets provide a source control for a main contributor of stormwater runoff and pollutant load. In addition, green infrastructure approaches complement street facility upgrades, street aesthetic improvements, and urban tree canopy efforts that also make use of the right-of-way and allow it to achieve multiple goals and benefits (Lukes, Kloss, & the Low Impact Development Center, 2008, p. 2).

Green Streets is a sustainable stormwater management strategy that also contributes to community redevelopment (Environmental Protection Agency, 2015, para. 1).

Green Streets achieve multiple benefits, such as improved water quality and more livable communities, through the integration of stormwater treatment techniques which use natural processes and landscaping (Low Impact Development Center, 2008, para. 1).

For all of these reasons, according to advocates, a city’s interest in Green Streets is likely to increase in line with its desire to build a sustainable future.

1.4. Problem Statement

The Green Street approach is now being adopted by many localities, and this trend is likely to continue given the critical role green infrastructure systems can play. These projects are widely recognized as providing effective and “affordable solutions that meet many objectives at once” (American Rivers, The Center for Neighborhood Technology, & The Great Lakes and St. Lawrence Cities Initiative, n.d.). However, there are also some issues and barriers that can discourage their application. For example, there is little comprehensive guidance regarding how to implement best Green Streets and green infrastructure systems in general. This concern is evident in the literature, as shown in the following:

Lack of comprehensive guidance and standards may discourage designers from proposing green infrastructure (Doyle, 2013, p. 45) ... Issues, barriers, & opportunities: Lack of Guidance and Standards for Green Streets (Doyle, 2013, p. 52).

Yet, unwillingness to fully embrace green infrastructure is a limiting factor to the fulfillment of these ideas of connectivity and inter-municipal collaboration. This government push-back against implementation may be due to the lack of information and understanding of the environmental benefits and funding opportunities for green infrastructure. (Reeve & Kone, 2015, p. 27).

One of the biggest challenges municipalities that are interested in green infrastructure face is the lack of a predetermined method for integrating green infrastructure into stormwater management plans (Carlson, Caughey, & Ward, 2014, p. 59).

Green infrastructure has been proven to provide economic, social, and environmental benefits to communities. But it is still new and poorly understood. Despite all these benefits – there is uncertainty and a lack of implementation. ... Many studies have described the multiple triple-bottom line benefits of green infrastructure, yet barriers often block the adoption of green infrastructure and practices. ... [Including a] lack of understanding and knowledge of what green infrastructure is and the benefits it provides (Abhold, Loken, & Grumbles, n.d., p. 2).

The currently available professional knowledge database of peer-reviewed journals, books, and conference and workshop proceedings contains little discussion of

what Green Streets are or how they can be implemented; a search on April 4, 2015 for “Green Street” combined with “stormwater” in scholarly journals using the professional search engine EBSCO (Academic Databases for Colleges and Universities) restricted to “environmental complete” (peer reviewed, recommended online resources from Virginia Tech University Libraries) produced only five results and a search using EBSCO concentrating more broadly on “academic complete” (peer reviewed) papers produced only eight. Among these eight results, only two articles specifically discussed subjects directly related to Green Streets. Five others mentioned Green Streets as an element of larger development strategies (such as Low Impact Development), and the remaining article did not mention Green Streets in this context at all. EBSCO produced no results when books were searched. A search for “Green+Street” combined with “stormwater” through the search engine Environmental Sciences and Pollution Management (peer reviewed, 52 databases) was more productive, yielding thirty-four results, but of these, eleven did not mention Green Streets at all, while thirteen did so only very briefly; only five articles discussed Green Streets in depth, three of which considered concerns related to additional benefits or social aspects.

Green Streets are accepted by many cities as the most effective and affordable way to treat stormwater and improve the quality of life in quite a few cities (Portland Environmental Services, 2015; Philadelphia Water Department, 2014). However, only limited information has been published on the actual success of the green streets that have been constructed to date. The consistency with which, and the extent to which, Green Streets actually provide the wide variety of benefits and services that proponents claim is not entirely clear. In addition, there is a lack of published guidance on Green Street implementation. This may discourage additional localities from incorporating Green Streets into green infrastructure or development plans, or result in unnecessary trial and error trials where best planning and design practices that are actually well understood have not been widely shared. Given their unique role in green infrastructure systems and their reported potential for promoting urban sustainability and livability this is regrettable. As we approach the planning and design of the next generation of American cities, we cannot afford to revert to expensive single-purpose traditional

stormwater management simply because of a lack of knowledge or information sharing with regard to viable alternatives. A study of successful cases and experts' experiences in implementing them may help to avoid the need to waste time inventing new approaches for each new project by enabling practitioners to make more effective use of past experience in this area (Hammond, 1990).

To this end, the research conducted for this dissertation examines the current status of practice with respect to Green Streets, focusing on identifying successful schemes and identifying the benefits they provide and the practices that are required to implement them successfully. The findings will be used to provide useful information and guidance for designers and planners based on an effective analysis of current Green Street practices. They also can provide a framework that demonstrates a way of building Green Streets and outlining the various considerations that must be taken into account at each stage of the implementation process. When properly applied, these findings are expected to help planners "create a safe and sustainable built environment for the community" (Standards Australia, 2015, para. 4).

1.5. Research Questions

Based on a consideration of the statements in the previous section, this dissertation research focused on two key dimensions of current practice as reported by a panel of expert practitioners: 1) What attributes contribute to the success of currently constructed Green Streets? And 2) How can Green Streets be successfully implemented? These two main questions incorporate a number of sub-questions, as follows:

1. What attributes contribute to the success of currently constructed Green Streets?
 - 1.1. What are the attributes of current successful Green Streets and what benefits are associated with them?
 - 1.2. What attributes do experts consider as being more helpful for the success of Green Street implementations?

1.3. How do the attributes associated with existing projects compare with the potential benefits suggested by advocates?

2. How can Green Streets be successfully implemented?

2.1. What planning and design considerations and actions are associated with successful Green Street implementations?

2.2. How can these attributes be discussed and performed within a procedural framework?

A combination of a thorough literature review, case study research, and interviews with a panel of expert practitioners was used to address these questions. Experts participated in two rounds of interviews plus a member check process. Following the literature and case study research, the assessment of Research Question 1 was based solely on the results from the first round of interviews; those for Research Question 2 were derived from the data gathered during both the first and second rounds of interviews. The content of the first round interviews addressed general concerns and considerations in contemporary practice, while the second round considered the specific planning and design processes associated with some of the most successful Green Street projects built to date.

1.6. Organization of the Dissertation

This dissertation consists of seven chapters. “Chapter 1. Introduction” presents the background for the research and defines the problems addressed and the research questions. “Chapter 2. Literature Review” discusses related theories such as the characteristics of Green Streets, livable communities and streets that promote better quality of life, planning and design processes, and methodologies. Chapters 3 and 4 present the research methods used and the analysis of the data associated with the first research question. The scope of this stage of the research is limited to the attributes and benefits associated with successful currently constructed projects, so these

chapters incorporate a portion of the data from the first round of interviews only. Chapters 5 and 6 present the methods and analysis of the data pertaining to the second research question. These chapters incorporate data from both the first and second rounds of interviews. The general framework of the dissertation is illustrated below (see Figure 1.2).

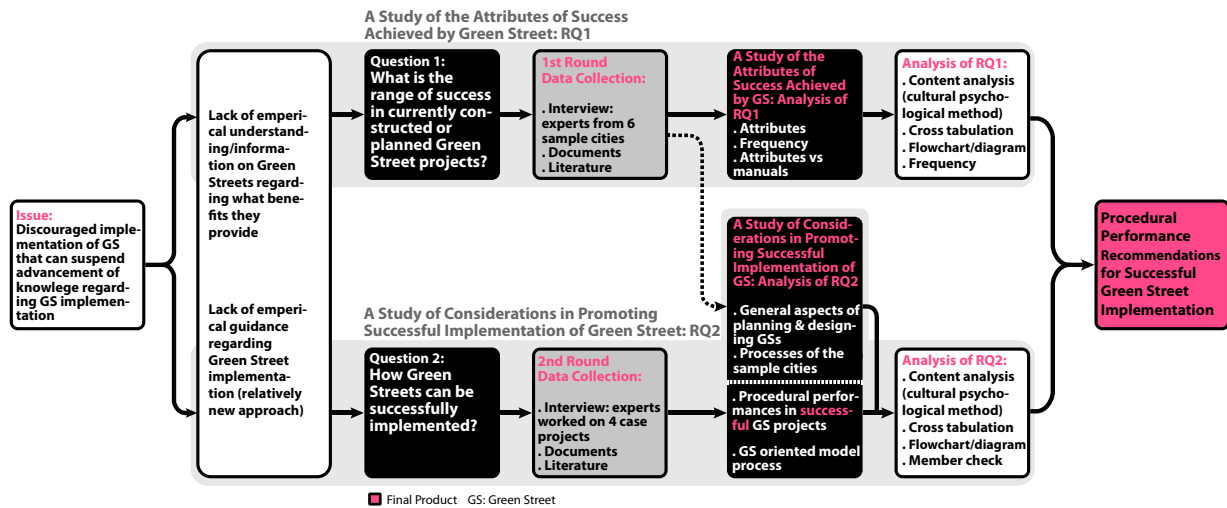


Figure 1.2. Organization of the research

Finally, “Chapter 7. Recommendations” presents a model process, and makes procedural performance recommendations for successful Green Street implementations; the findings reported in this chapter will be of particular interest to planners and designers.

1.7. Definition of Terms

All relevant and important terminology and vocabulary used in this research will be defined and described in detail in the following chapter. This is done in order to help distinguish between the ideas and concepts involved in Green Street/Green Street projects, the Green Street practice or approach, and Green Street facilities.

Chapter 2. Literature Review

This research focuses on identifying the elements that have contributed to the success of the Green Street projects that have already been constructed and considers effective ways to promote the successful implementation of future projects. This chapter examines the relevant knowledge presented in the existing literature. After defining the relevant terms encountered during this research, Section 2.1 discusses the current status of the Green Street approach to establish the potential for delivering the multiple benefits described in the literature. Section 2.2 addresses the elements of livability that convey community benefits and how these can be promoted via a Green Street implementation. Section 2.3 examines the planning and design processes that contribute to the development of an initial framework for developing a Green Street oriented process. Finally, Section 2.4 discusses the methods utilized for this research, focusing specifically on the qualitative research approach adopted.

2.1. What is Green Street?

In this section, different aspects of Green Streets are evaluated to provide a better understanding of the overall concept of Green Streets. First, the way Green Streets are defined in various sources is discussed to determine the precise definition of the term that will be applied in this dissertation. Next, the differences between traditional streets and Green Streets are investigated, after which various types of Green Street practices are considered and how Green Streets can be perceived from the point of view of different development strategies is discussed. Finally, the role Green Streets can play and the way they function as streets is examined.

2.1.1. Definition of Green Street

Table 2.1 lists the definitions of “Green Street” that are applied by a number of different cities and agencies across the nation. Among these definitions, the most prominent and generally agreed aspects of a Green Street project are that: 1) it treats stormwater runoff; 2) it is implemented within the right of way; and 3) it includes

vegetation. The great majority of the definitions (with the sole exception of Seattle’s) define a “Green Street” as a sustainable stormwater treatment practice that is mainly implemented in the right of way and includes the utilization of plants for this purpose.

Seattle and Portland are typical of the cities that adopted Green Streets at an early stage, with their first Green Streets being implemented as early as 2000 and 2005, respectively. However, each city uses a slightly different definition of Green Streets, with Seattle focusing on providing open spaces and transportation functions, while Portland places a stronger emphasis on the stormwater treatment function with natural systems. Most other cities who are now adopting Green Streets have adopted definitions that are similar to Portland’s, suggesting that the most common reason for implementing Green Streets is stormwater management. There is thus some variability in the objectives of Green Street projects across the country, depending on the goals of the individual cities.

Table 2.1

Definitions of Green Street.

Source	Definition of Green Street
“Green Street” (Arlington Department of Environmental Services, 2015) <small>(http://projects.arlingtonva.us/programs/stormwater-management/green-streets/)</small>	“A Green Street is a street with a vegetated area in the public right-of-way that reduces the volume of stormwater and stormwater pollutants that enter our local streams, the Potomac River, and Chesapeake Bay.”
“Green Streets and Alleys” (Environmental Protection Agency, 2014a) <small>(http://www.epa.gov/green-infrastructure/what-green-infrastructure#greenstreetsandalleys)</small>	“Green streets and alleys are created by integrating green infrastructure elements into their design to store, infiltrate, and evapotranspire stormwater. Permeable pavement, bioswales, planter boxes, and trees are among the elements that can be woven into street or alley design.”
“Green Streets” (Lukes, Kloss, and the Low Impact Development Center, 2008) <small>(http://www.lowimpactdevelopment.org/greenstreets/background.htm)</small>	“Urban transportation right-of- ways integrated with green techniques are often called “green streets.”
“Green Streets: Innovative solutions for stormwater and stream crossing” (Metro, 2002, p. 2)	“A ‘green’ street: <ul style="list-style-type: none"> • is one component of a larger watershed approach to improving the region’s water quality

	<ul style="list-style-type: none"> • is designed to incorporate a system of stormwater treatment within its right of way • minimizes the quantity of water that is piped directly to streams and rivers • incorporates the stormwater system into the aesthetics of the community • at points where it crosses a stream or other sensitive area, a “green” street is located and designed to ensure the least impact on its surroundings • requires a more broad-based alliance for its planning, funding, maintenance and monitoring.”
<p>“Portland Green Streets Program” (Portland Environmental Services, 2015) <small>(https://www.portlandoregon.gov/bes/45386)</small></p>	<p>“A street that uses vegetated facilities to manage stormwater runoff at its source is referred to as a Green Street. A Green Street is a sustainable stormwater strategy that meets regulatory compliance and resource protection goals by using a natural systems approach to manage stormwater, reduce flows, improve water quality and enhance watershed health.”</p>
<p>“Right-of-Way Improvements Manual” (Seattle, 2012) <small>(http://www.seattle.gov/transportation/rowmanual/manual/6_2.asp)</small></p>	<p>“A Green Street is a street right-of-way that, through a variety of design and operational treatments, gives priority to pedestrian circulation and open space over other transportation uses. The treatments may include sidewalk widening, landscaping, traffic calming, and other pedestrian-oriented features. The purpose of a Green Street is to enhance and expand public open space, and to reinforce desired land use and transportation patterns on appropriate City street rights-of-way.”</p>
<p>“Green Streets Basics and Design” (Water Environment Research Foundation, 2009) <small>(https://www.werf.org/liveablecommunities/toolbox/gst_design.htm)</small></p>	<p>“Green streets are an example of how individual stormwater BMPs are used as elements of a broader program aimed at mitigating a significant source of stormwater pollution.”</p>

The goals and objectives in these different manuals are presented in Table 2.2. Each achieves a slightly different balance between the various considerations regarding stormwater management, pollution reduction, environmental improvement, monitoring, pedestrian safety, aesthetic improvement, streetscape improvement, provision of green, street connectivity, multiple functionality, flexible application of street design elements, public education, and cost benefits, according to the needs of the locality. These

considerations are not limited solely to stormwater treatment but also include a range of environmental, social, and economic aspects, indicating that Green Streets are clearly expected to provide a number of benefits in addition to stormwater treatment.

Table 2.2

Goals and Objectives stated in Green Street implementation manuals.

Manuals	Goals & Objectives
“City of Philadelphia Green Streets Design Manual” (City of Philadelphia, 2014, p. 24)	<ul style="list-style-type: none"> • Water filters through the planting soil, improving water quality. • Provides a physical buffer between pedestrians and the street. • Creates aesthetic improvements to streetscape. • Can be sized and placed to fit between existing surface features such as driveways, signs, street furnishings, and street trees. • Provides an area within the right-of-way for smaller plantings in addition to street trees.
“A Conceptual Guide to Effective Green Streets Design Solutions” (EPA, 2009, p. 1)	<p>Through various combinations of plants and soils</p> <ul style="list-style-type: none"> • Reduce stormwater flow • Improve water quality • Reduce urban heating • Enhance pedestrian safety • Reduce carbon footprints • Beautify neighborhoods
Managing Wet Weather with Green Infrastructure. Municipal Handbook: Green Streets” (Lukes, Kloss & the Low Impact Development Center, 2008, p. 2)	<ul style="list-style-type: none"> • Achieves multiple benefits through an integration of stormwater treatment techniques: <ul style="list-style-type: none"> - improved water quality - livable community • A source control for a main contributor of stormwater runoff and pollutant load • Street facility upgrades • Street aesthetic improvements • Urban tree canopy efforts that also make use of the right-of-way and allow it to achieve multiple goals and benefits • Using the right-of-way for treatment also links green with gray infrastructure by making use of the engineered conveyance of roads and providing connections to conveyance systems when needed

“Green Streets: Innovative solutions for stormwater and stream crossing” (Metro, 2002, pp. 9- 10)	<ul style="list-style-type: none"> • Maintain and restore natural processes • Conserve, protect and restore habitat • Improve water quality • Promote local street connectivity • Use the public right of way for multiple purposes • Provide permittable, cost-effective solutions • Foster unique and attractive streetscapes that protect and enhance neighborhood livability • Educate the public and monitor environmental benefits through pilot projects
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Hence, Green Streets can be defined for the purpose of this research as follows:

- **Green Streets** are incorporated as portions of green infrastructure systems to mimic the natural process of treating rainwater by utilizing natural materials such as plants and soils.

- **Green Streets** are intended to treat stormwater runoff across various scales as implemented within the right of way. This makes Green Streets both useful and easy to retrofit into the surrounding environment, especially in densely developed urban areas, to provide the various benefits listed in the various Green Street manuals, including supporting pedestrian safety and enhancing the aesthetic qualities of the local area.

In this research, commonly used terms are defined as follows:

- 1) *Green Street/Green Street projects*: an implemented Green Street project. This includes the entire street envelope where the Green Street approach has been applied.
- 2) *Green Street approach or practice*: a development strategy that includes a stormwater treatment function.
- 3) *Green Street facility*: a stormwater treatment facility incorporated in a Green Street project.



2.1.2. The Differences Between Green Streets and Typical Streets

The preceding descriptions of Green Streets show that they differ in important ways from the streets typically found in most urban areas. The definition of a street shown in the Cambridge Dictionaries Online is “a road in a city or town, usually with buildings along one or both sides.” Conventionally, streets are comprised of vehicular and pedestrian paths, often with vegetation strips, on-site parking, pedestrian crossings, and street furniture. Green Streets can be distinguished from typical streets in a number of respects. As noted by the Environmental Protection Agency (2014a), Green Streets incorporate integral stormwater treatment systems that are designed to improve the water quality and quantity. In most cases, they also connect with open spaces (Seattle, 2012) and are intended to be pedestrian oriented to support a safer and healthier community (Philadelphia Water, 2014; Portland Environmental Services, 2008). Green Streets are implemented with fewer impervious surfaces due to their narrower road width and wider planting beds and more available permeable surface, and provide a safer walking environment for local residents (Environmental Protection Agency, 2009). Lastly, Green Streets allow more creative integration to meet local needs by adapting resilient standards. For instance, integrated stormwater treatment facilities can be of different sizes and the plants used can be varied to suit the local climate conditions, as suggested in the various Green Street manuals.

In contrast, conventional streets are seldom integrated with stormwater treatment systems or connected to open spaces; are auto-oriented roads with a high proportion of impervious surfaces and decreased pedestrian safety; and utilize prescribed street standards that limit the type of multifunctional adaptation that is commonly found in Green Streets. Table 2.3 summarizes the differences between the two street types and shows representative images of relevant street scenes taken by the author.

Table 2.3

Comparison of Green Streets and conventional streets.

Typical Streets (Nongreen Streets)	Green Streets
 <p>Typical street 1, Portland, OR</p>	 <p>Fremont Streets, Portland, OR</p>
 <p>Typical street 2, Seattle, WA</p>	 <p>Maynard Street, Seattle, WA</p>
 <p>Typical residential street 3, Seattle, WA</p>	 <p>Green Street, High Point, Seattle, WA</p>
<ul style="list-style-type: none"> • No application of stormwater management • No connection to open space • Auto oriented (wider streets) • Large impervious surfaces 	<ul style="list-style-type: none"> • Integrated with stormwater treatment facilities • Integrated with public open space • Pedestrian oriented • Large permeable surfaces (narrower streets)

2.1.3. Green Street Practice Types, Manuals, and Design Processes

Many municipalities that are adopting Green Streets describe their design, specifications, and applications in a set of manuals, standards, municipal plans, and online databases. These often include examples of completed Green Street projects: Philadelphia has a Green Streets Design Manual and the Philadelphia Water Department website provides information regarding Green Streets; New York publishes Green Street information under the NYC Green Infrastructure Plan, along with design standards from the city's Parks Department and Environmental Protection Agency; Portland Oregon's Green Street information is provided under their Sustainable Stormwater Management initiative; and Seattle defines Green Street in its Right-of-Way Improvement Manual, which also covers its Green Stormwater Infrastructure approach. Neither Arlington nor Washington D.C. have official manuals and standards, although Arlington does have a set of preliminary standards created by the Center for Watershed Protection.

The standards published by the various municipal agencies provide technical designs for the Green Street facilities that generally include items such as the sizes of the different types of facilities involved, the inlet design, plant selection, and other related technical specifications. However, most of the standards only define the Green Street facility itself and do not include drawings or specifications that define or show the relationship between the Green Street facilities and adjacent roads, structures, and users. Potential benefits are frequently discussed in the manuals and related websites, although these cannot be delivered without specifying an implementation tool. It is not easy to standardize design applications that can deliver these benefits since every site has its own conditions, and such an approach may not in fact be desirable as it could unnecessarily limit the consideration of the multiple benefits that can potentially be gained through a Green Street implementation.

Each of the cities selected for this research has adopted different types of Green Street practices that they refer to using different names (see Table 2.4). However, all can be categorized according to where the practice is located within the right of way and its structural shape because each city actually shares quite similar types of Green

Street facilities, despite the different ways they are referred to. A list of Green Street practice types was therefore created for this study to help develop a better understanding of the practices involved in the First Analysis (Chapter 3 and 4) and thus facilitate communications among designers and planners based on the different facility types in the six sample cities and other governmental institutions.

Table 2.4

Green Street terms and typologies.

Manuals	Green Street Typology & Terms
“City of Philadelphia Green Streets Design Manual” (City of Philadelphia, 2014, p. 24)	<ul style="list-style-type: none"> • Stormwater planter • Stormwater bump-out • Stormwater tree • Stormwater tree trench • Permeable pavement • Green gutter • Stormwater drainage well
“Greening DC Streets” (District Department of Transport, 2014)	<ul style="list-style-type: none"> • Permeable pavement: permeable unit pavers, pervious concrete, porous asphalt, porous rubber • Bioretention: bioretention planter adjacent to roadway, curb extension, bioretention in open area, bioswale • Tree Space: small, medium, large trees * Bioretention offers landscape amenity to the streetscape
“Standards for Green Infrastructure” (City of New York, Department of Environmental Protection, Office of Green Infrastructure, 2012)	<ul style="list-style-type: none"> • Right of way bioswale • Right of way bioswale with stone columns • Right of way bioswale with stormwater inlet • Right of way bioswale with steel guard * Standards are suggested to fit in various street conditions (sidewalk width, placement)
“Green Streets: Stormwater management for clean rivers” (Portland Environmental Services, 2008, p. 2)	<ul style="list-style-type: none"> • Stormwater curb extension • Stormwater street planter • Rain gardens • Simple Green Street
“Green Stormwater Infrastructure” (Seattle, 2015)	<ul style="list-style-type: none"> • Biofiltration swale • Stair-stepped swale

<p>“Managing Wet Weather with Green Infrastructure Municipal Handbook: Green Streets” (Lukes, Kloss & the Low Impact Development Center, 2008, p. 2) (recommended by the Center for Watershed Protection)</p>	<ul style="list-style-type: none"> • Swale • Bioretention curb extension and sidewalk planter • Permeable pavement • Sidewalk trees and tree boxes
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Figure 2.1 demonstrates how different types of Green Street practices can be integrated into street network systems. Here, the types are divided first according to whether the practice is applied at an intersection, midblock, or both (combination) and then subdivided based on whether the facility was located within the sidewalk or extended outward from the curb towards the roadway. After the different shapes of facilities have been listed, permeable pavers, runnels, fountains/ open water surface, and cisterns are then categorized as special applications of Green Street practices.

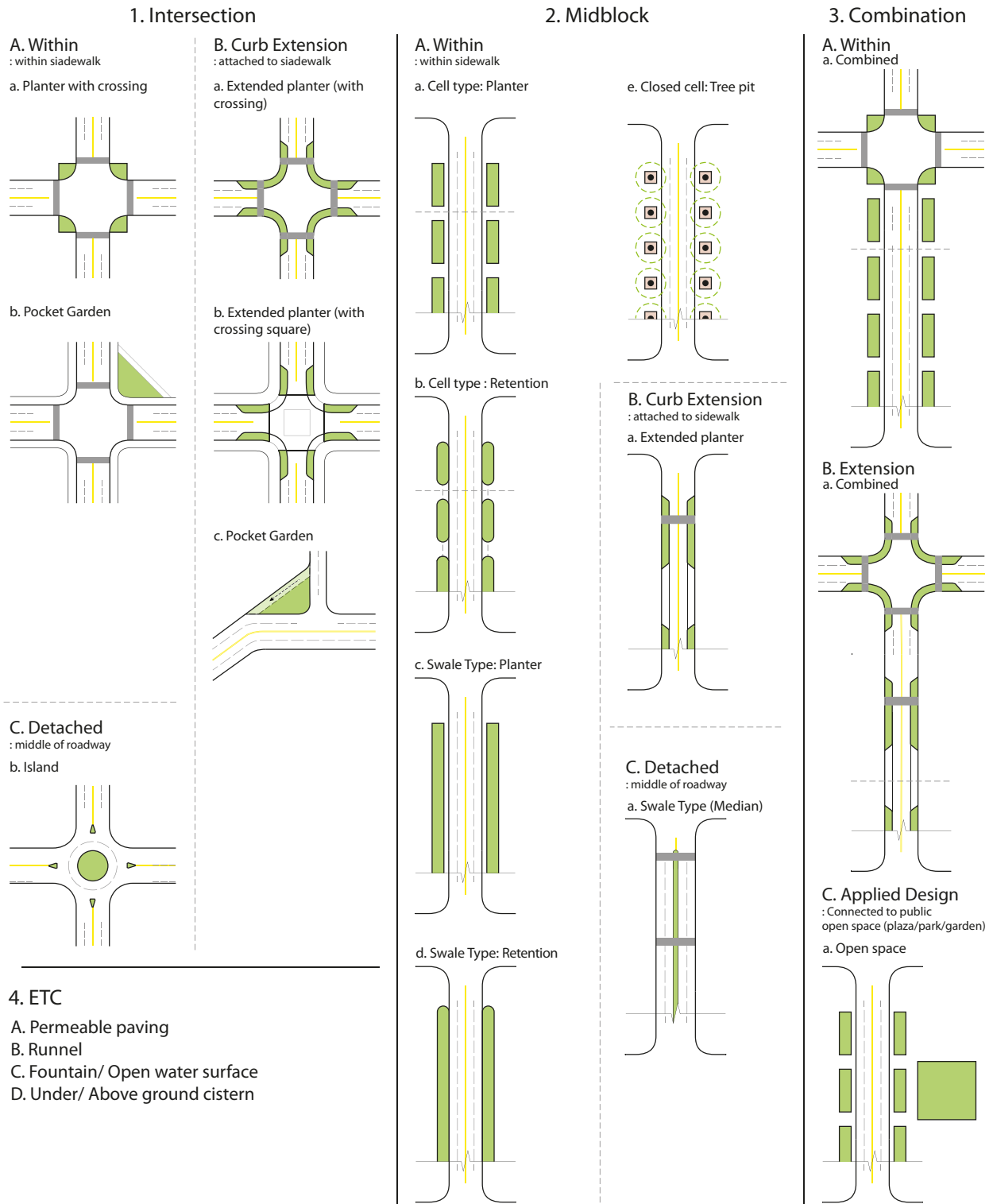






Figure 2.1. Green Street practice types. Author's illustration adapted from *Managing Wet Weather with Green Infrastructure Municipal Handbook: Green Streets* (Lukes et al., 2008); Philadelphia's *Green Streets Design Manual* (City of Philadelphia, 2014); *Greening DC Streets* (District Department of Transportation, 2014); and reports on constructed Green Streets projects.

In Figure 2.1, the green areas indicate where stormwater treatment structures are located. In these areas, stormwater runoff is treated with plants and soils. If a facility is small and repeated in one block, it is referred to as a Cell Type, which can be divided into two forms: a stormwater planter or a retention facility. Stormwater planters have constructed walls made of hard materials such as concrete and are often rectangular in shape. Retention facilities are constructed with more natural materials such as soils and stones and have more natural shapes than the planters. If the stormwater treatment structure is a Cell Type but has a more arbitrary shape than the usual rectangular shape, it is called a Pocket Garden. These are typically found in isolated areas such as traffic islands and areas that extend away from intersections rather than along the street. If the stormwater treatment structure is linear and long, it is labeled a Swale type facility, and these can again be subdivided into planters and retention facilities according to their wall features (see Table 2.5).

Table 2.5

Types of Green Street stormwater treatment structures.

	Cell Type Smaller footprint	Swale Type Linear and longer footprint
<p>Planter Walls are defined with:</p> <ul style="list-style-type: none"> • hard materials • curbs 	<p>curb extension</p> 	<p>within sidewalk</p> 
	<p>within sidewalk</p> 	<p>median</p> 

Retention

The structure for holding runoff is like a depression in the ground

- Without curbs

within sidewalk



within sidewalk

**Pocket Garden**

- has a more arbitrary shape than a retention
- is usually located in an isolated place (such as a traffic island)

curb extension



2.1.4. Objectives of Green Street in Three Development Paradigms

Green Streets have been implemented primarily to manage stormwater runoff as one of the strategies of green (stormwater) infrastructures in the built environment. The term *Green Street* has been “adopted by many cities to refer to streets that emphasize environmental quality in numerous ways, including reducing pavement widths, increasing tree planting, and incorporating stormwater treatment” (Girling & Kellett, 2005, p. 83). However, this stormwater management function is only one component of Green Streets. For instance, the City of Seattle’s definition of Green Streets in its *Right-of-way Improvement Manual* (2012) includes considerations such as promoting pedestrian-oriented streets, enhancing open spaces, managing traffic speed, and adapting to individual localities. Stormwater treatment is mentioned in the manual, but only as one of the possible applications of a Green Street system, along with solar access, the preservation of historic buildings or street features, and better utilization of the topographical conditions of the site. The other manuals and reports on Green Streets and green infrastructure that were discussed earlier also describe multifunctional applications of Green Streets in a community, although it appears that

the primary reason for including Green Streets in these reports is still their ability to deal with stormwater.

This indicates that Green Streets need to be understood as satisfying a number of diverse strategic characteristics, which can be divided into three categories: a strategy for stormwater treatment, a strategy for green infrastructure, and a strategy for sustainable development.

2.1.4.1. Green Street as a Stormwater Treatment System

First, as a component of stormwater treatment systems, Green Streets are usually integrated with stormwater best management practices (BMPs) such as storm tree planters, bioswales, and permeable paving. BMPs are effective treatments for the improvement of stormwater quantity and quality that utilize “natural drainage mechanisms” with “the infiltration and storage properties of semi-natural features” (Butler & Davies, 2011, p. 17). The Virginia Runoff Reduction Method (2011) lists the following possible BMPs:

- Reducing treatment volume: Vegetated roof, rooftop disconnection, permeable pavement, grass channel, dry swale, bioretention, infiltration, extended detention pond, sheetflow to filter/open space
- Reducing pollutants: Wet swale, filtering practices, constructed wetland, wet ponds, manufactured BMP

In our cities, extensive tracts of natural lands have been converted into impervious surfaces because of urban development, and these prevent the stormwater runoff from infiltrating into the ground (Bowles, 2013). Without some consideration of where and how the runoff flows, problems such as polluted water, erosion, and flooding will eventually arise (Sung, Yi, & Li, 2013). Green Streets can provide effective networks for stormwater runoff conveyance and release, especially when implemented in environmentally sensitive areas.

Others have suggested that when Green Streets are considered for treating stormwater, a watershed approach needs to be adopted, with no regard to political boundaries. On-site treatment to enable effective protection of the water quality and protect downstream sites is important, and the plans should consider human health and property as well as ecological preservation (Randolph, 2004; Roy et al., 2008).

2.1.4.2. Green Street as Green Infrastructure

Green Streets also provide green infrastructure—which recognizes the larger scope of environmental issues in addition to BMPs when treating stormwater runoff. Boyle et al. (2012) described green infrastructure as “natural and engineered ecological systems which integrate with the built environment to provide the widest possible range of ecological, community and infrastructure services” (p. 5). Similarly, Benedict and McMahon (2006) stated that green infrastructure is “an interconnected network of natural areas and other open spaces that conserves natural ecosystem values and functions, sustains clean air and water, and provides a wide array of benefits to people and wildlife. ... [It] is the ecological framework for environmental, social, and economic health” (p. 1).

Thus, green infrastructure can be defined as interconnected networks consisting of natural and constructed systems that often mimic natural processes to protect or utilize available resources for *smart* development and to improve the experience of humans and nature in the environment. As a part of the green infrastructure approach, Green Streets should be applied as a *network*, reflecting local needs. They play an important role in the larger landscape as a way of improving and protecting the built and natural environments to which the larger ecological conception is applied.

The goals of green infrastructure are to improve water quality and quantity, to mitigate poor air quality, to conserve energy and resist climate change, to enhance the habitat for wildlife, and to promote a better community. The American Society of Landscape Architects (ASLA, 2011) describes green infrastructure as “a conceptual framework for understanding the ‘valuable services nature provides the human environment.’” The ASLA also characterizes green infrastructure on three scales: 1) at

the national or regional level, with a consideration of networks of parks and wildlife corridors; 2) at the urban level, with a consideration of parks and urban forestry as ecologically central hubs; and 3) at the level of buildings, with a consideration of smaller applications such as green roofs and green walls. The ASLA also cites multiple benefits of green infrastructure, such as reducing energy use, improving water and air quality, decreasing solar heat within a city, providing a wildlife habitat, controlling floods, reducing the cost of stormwater treatment facilities, and preventing erosion.

2.1.4.3. Green Street as Sustainable Development

Lastly, Green Streets can be discussed in the context of sustainable development. Sustainable development follows a holistic approach that promotes balance between human settlements and natural environments in planning. The United Nations (1987) defined sustainable development in their report “Our Common Future” as development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (p. 37). Similarly, the Department for Environment, Transport and the Regions (DETR) in the UK defined it as follows: “sustainability is about ensuring a better quality of life for everyone—now and for generations to come” (DETR, as cited in Mell, 2009). These definitions do not mention a specific scope for the concept of sustainable development, although it can be inferred that sustainable development is extensively interconnected with phenomena on the earth that are caused by humans and nature. This could be in the same context as other descriptions of sustainable development that say that it is “elusive ... [but] important and does deserve attention.... the core of the idea of sustainability is the concept that current decisions should not damage prospects for maintaining or improving living standards in the future” (Pearson, as cited in Brown et al., 1987). Ritchie and Thomas (2009) describe sustainability in urban design as planning a city with more consideration for people. In this sense, “creating pedestrian, cyclists and public transport is a key aspect of sustainable development” (Ritchie & Thomas, 2009, p. 3), a clear contrast to existing built environments that are overwhelmingly auto-oriented.

Ritchie and Thomas (2009) also describe two more aspects of urban sustainability: making a city greener for biodiversity as well as human well-being, and creating a more delightful environment to keep people “secure and happy” (p. 3). The specific scope of sustainable elements can be described as follows: 1) to protect natural resources, 2) to use resources efficiently, 3) to strengthen the sense of community, and 4) to consider the regional context (Randolph, 2004, p. 111). Moreover, sustainable development is frequently recognized as development that is “ecologically sustainable or environmentally sound” (Tolba, 1984; Lele, 1991, p. 608). Consequently, successful achievement and balance among three aspects of sustainability – economy, environment, and society (Mell, 2009)– in the larger scope of the environment can be promoted by adopting a sustainable development approach.

In conclusion, sustainable urban development does not always include a green infrastructure approach, and a green infrastructure approach does not always include stormwater management considerations (see Figure 2.2). However, the planning and implementation of stormwater management and a green infrastructure do need to be discussed in the context of sustainability, where sustainability means more holistic and renewable strategies for improving and protecting a built and natural environment. As Odum (2005) states, humans have forgotten that ultimately they depend for everything on nature, and they are likely to continue to forget this “as long as life support services [from nature] are considered free” (p. 3). Therefore, pursuing sustainable development does not just involve taking into account the well-being of humans or the reclamation of one part of a river corridor but is more about realizing how the elements of an environment are integrated on a larger scale. When we are planning and developing new projects, we need to realize what kind of impact we ourselves, as parts of the environment, will have on the whole environmental system. In this sense, *sustainability* does not always mean *green*, while *green* tries to achieve *sustainability*.

As an element of green infrastructure, an ideal Green Street project seems to be one that is designed using a complex strategy for pursuing sustainability. It can “act as a synthesis of a number of other areas of planning (greenways, green spaces, high-density planning) to promote a coherent discipline for future development” (Mell, 2009,

p. 24). Therefore, a Green Street is different from a conventional stormwater treatment system, which is solely designed to target a very specific goal such as treating stormwater or preventing local flooding. In contrast, the multiple objectives of sustainable development are the ultimate goal for Green Streets in relation to a given site. This means that Green Streets need to emphasize *a network system* approach that can successfully integrate multifunctional disciplines to promote their influence throughout the site.

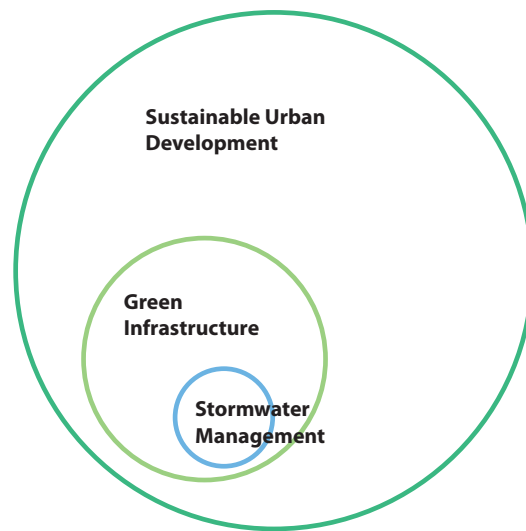


Figure 2.2. Relationship between three paradigms.

2.1.5. Green Street as a Street

Green Streets also need to retain their traditional function as streets because although they may have design applications for a better community, they are implemented in the right of way. Therefore, this section discusses the characteristics of a street that need to be addressed when implementing a Green Street project.

Streets are one of the key elements that physically comprise a city and can be exciting places “where people walk, shop, meet, and generally engage in the diverse array of social and recreational activities that, for many, are what makes urban living enjoyable” (Dumbaugh & Gattis, 2005, p. 283). Therefore, streets can help form the character of a city, as well as influencing its culture and history. As important features of

a city, streets comprise one of the largest areas of impervious surfaces within an urban area, along with building footprints. Impervious surfaces are a useful measure for other features such as the water quality in local streams (Schueler et al., 2009). Therefore, applying the green and creative approach of Green Street should be an effective strategy for resolving urban runoff problems in a more sustainable way.

Streets are also important elements that connect one point to another, substantially forming and shaping a city. Streets run between private and public spaces, conveying both pedestrians and vehicles from one place to another. Thus, the benefits of integrated elements of a street will be distributed throughout adjacent communities and to all the people who move along the street as well as those who live there. The flow of water is also affected by the patterns of streets (Lukes, Kloss, & the LIDCenter, 2008). Therefore, proper facilities (stormwater management, street furniture, vegetation strips, and other recommended facilities) need to be considered within the context of the entire street network.

2.1.6. Sustainable Street Design: Complete Streets and Context Sensitive Design

Complete Streets and Context Sensitive Design are similar and often compared to Green Streets because they take sustainable approaches to transportation and street designs. In this sub-section, Complete Streets and Context Sensitive Design are studied to see how they differ from Green Street practices.

Complete Streets is one element of the Smart Growth initiative. Smart Growth promotes “local economies and protects the environment” (Smart Growth America, 2016. para. 1) by carefully considering economic regeneration and providing housing and transportation options. Complete Streets focuses more on transportation approaches regarding “*accessibility*—our ability to reach desired goods, services, and activities safely” (Burden & Litman, 2011, p. 36) rather than addressing “mobility.” According to Burden and Litman (2011), Complete Streets reduces emissions, congestion, and the number of accidents by replacing car traffic with alternative transportation options, such as walking, biking, and public transportation that can promote investment and tourism. The Complete Streets initiative offers quality-of-life

improvements by promoting safety and health, walkability, social equity, and a sustainable use of environmental resources. The approach considers not only users of automobiles but also pedestrians, bicyclists, and passengers on public transportation. The multimodal considerations in Complete Streets emphasize the integration of those different users when planning and designing streets (Elias, 2011). Accordingly, the design elements include street parking, bike lanes, sidewalks, transportation stops, safe crossing, curb extensions, and narrower roads (National Complete Streets Coalition, n/a). Complete Streets features no single design approach because each project reflects the specific site context. Thus, Complete Streets is sometimes integrated with the Context Sensitive Design approach.

Context Sensitive Design (CSD) or Context Sensitive Solution (CSS) refers to “a collaborative, interdisciplinary, holistic approach to the development of transportation projects” (Federal Highway Administration, 2005, para 1). CSD or CSS can be integrated with Complete Streets when designing transportation and street (with sustainable approach). Context Sensitive Solution.org (2005) states that “[f]itting a transportation solution into the community and environmental contexts while at the same time satisfying transportation needs” is one of the “fundamentals” of CSS (para 5). CSD or CSS involves the public, highway agencies (and other public agencies), alternative design approaches, different fields of designers (other than highway), and various collaborative approaches to discuss the designs (Hilton, Landphair, Harwood, & National Research Council, 2004). CSD or CSS is intended to provide integration with communities; preservation of social, historic, and natural resources; safety for all users; solutions that can satisfy involved stakeholders; quality improvement of a community, environment, and transportation system; and great use of available resources (“people, time, budget”) (Context Sensitive Solution.org, 2005). The design considerations involve land use classification, design speed, travel lane width, parking lane width, and curb radius (Kueper, 2010). The design elements of CSD projects vary according to site contexts, which can include multimodal considerations, road lane reduction, safe sidewalks, pedestrian crossings and ramps, green space preservation, transportation stops, roundabouts, and more (Hilton et al., 2004).

These two approaches are intended to provide safer and healthier communities from the point of view of transportation by modifying road width, redesigning road shapes, and creating safe pedestrian crossings and sidewalks with other street design elements (street furniture, lightings, planters). CSS or CSD is “a project-oriented approach” that focuses on interdisciplinary projects that combine the social, environmental, and economic considerations of site contexts; Complete Streets is more of “a process-oriented approach” that focuses on the provision of safety and better accommodation for all users of transportation with an effort to improve the design and construction of streets by promoting political and public assists (Toronto Centre for Active Transportation, 2015).

Green Streets consider stormwater treatment as a big part of a holistic approach while Complete Streets and CSD/CSS do not. Stormwater consideration was seldom part of the case projects of Complete Streets or CSS and strategies used such as changing the width, shape of a road, and incorporating bike lanes would be small portions of addressing the environmental and social needs. Green Street approach entails the critical analysis of affected watersheds. The inclusion of watershed analysis brings not only effective stormwater management but also additional environmental benefits when treating stormwater related issues while Complete Streets and CSS approaches present little concerns for it. Green Streets can be applied on various scales, but (unlike CSS projects especially) work toward addressing local needs. Overall Green Street practices incorporate the design considerations of Complete Streets and CSD/CSS in a more flexible and versatile approach (less obligation for delivering transportation related issues), addressing efficiency in treating stormwater runoff related issues while also designing streets and attending to community needs.

2.1.7. Summary

While a number of different definitions for the concept were found, Green Streets are most commonly described in terms of the way they treat stormwater using plants and soils and are generally implemented in the right of way. Green Streets differ from conventional streets because they include stormwater treatment facilities and promote

pedestrian safety and the aesthetic qualities of the environment by utilizing larger landscape areas and narrower roads. Types of stormwater treatment facilities vary according to the needs of particular locations and the available space in the right of way. The most popular facility types are stormwater planters and curb extensions. Stormwater planters are usually implemented within sidewalks, while curb extensions are mostly implemented in extended portions of existing sidewalks. Green Streets are not only designed to treat stormwater runoff but also have the potential to promote other benefits for users and the surrounding communities. This means that Green Streets can be utilized as a sustainable development approach, fulfilling a variety of environmental, social, and economic objectives. They also maintain all the functions of normal streets by forming the image of a city, connecting destinations, and affecting the flow of water. This leads naturally to the study of urban livability at the street-level presented in the next section.

2.2. Livability and the Green Street Approach

In order to understand the breadth of potential benefits that Green Streets can provide, especially regarding the quality of life, this section discusses the elements of livability in relation to the Green Street approach. In general, a Green Street approach is a development strategy that includes a stormwater treatment function, as discussed in the previous section. However, consideration of livability in Green Street planning and design can promote better quality of life for users and surrounding communities. Livability can be defined in many different ways, since it carries within itself multidimensional perspectives. This section discusses why livability matters in Green Streets and looks into the broad range of meanings of *livability* to determine the potential scope that can be addressed by the Green Street approach, followed by a discussion of how Green Street can promote livability.

2.2.1. Why is Livability Important for Green Street?

Green Street projects are mostly implemented in rights of way that are under public jurisdiction. The public right of way incorporates “the traveled portion of the public

streets and alleys, as well as the border area, which includes, but is not limited to, any sidewalks, planting strips, traffic circles, or medians” (City of Tacoma, 2013). Also, as streets are defined by “buildings found in settlements” (Moudon, 1991, p. 81), they are not simply separate linear conduits. Rather, streets and the surrounding environment (or urban settings) are mutually influential, as streets are located adjacent to private and public plots such as residential buildings, shops, offices, and public open spaces. Additionally, when the connectivity between places is discussed, streets have been characterized as complex places in which social exchanges and additional activities take place (Anderson, 1978; Jacobs, 1989; Moudon, 1991). Given that streets (as a type of “path”) are an important element of a city that provide a primary component of the image of the city, both physically and socially (Lynch, 1960), this aspect emphasizes the notion of the street as a place for people to enjoy life with various activities, social relationships, and a well-managed streetscape.

It is therefore important to understand Green Streets as part of a street system rather than simply as a tool to treat stormwater runoff. Also, it is important to recognize Green Streets as places where people’s lives are extended, both as parts of an urban form contributing to movement and the built environment (the urban setting) and as places that support diverse activities for residents. These roles of Green Streets in the context of a city or a community can have a major influence on the quality of life that people experience. Therefore, the livability that can be achieved by the implementation of Green Streets should be one of important elements that Green Streets address, in addition to their primary role of stormwater mitigation.

2.2.2. What is Livability?

With increased interest in livability, governments have provided “the framework, tools and data to plan and build livable communities” (Miller, Witlox, & Tribby, 2013, p. 51). Livability also appears as one of the important objectives in most Green Street manuals and reports on Green Street strategies. However, livability is defined in various ways, and the livability that Green Streets are intended to support is seldom depicted in

detail. Therefore, it is important to examine the following definitions of livability from various articles:

In the urban regeneration literature, livability has come to mean the ability of a centre to maintain and improve its viability and vitality. These two terms mean the capacity of a city centre to attract investment continuously and to remain alive (Fabish & Hass, 2011, p. 101).

Livable places in a city are thought to be spaces in which one can locate respect for the past as manifested in buildings, landscapes, the spatial layout of an area, and care for the modern standard of living of a community and its individual members (Kotus & Rzeszewski, 2013, p. 124).

These ideal [livable] communities are typically moderately dense, diverse, walkable, safe, affordable, accessible and well-served by public transit systems.... (Miller et al., 2013, p. 52)

Livability refers to the subset of sustainability impacts that directly affect people in a community, such as economic development, affordability, public health, social equity and pollution exposure. (Litman, 2011, para.1)

One thing that will be clear is that the quality of urban life and the livability of the city as expressed in the environmental images are made up of a combination of a plethora of cognitive maps or mental perceptions, which translate directly into a spatial expression. These cognitive maps of the urban environment can then be examined in relation to the characteristics of the people in various parts of the city. (Omuta, 1988, p. 420)

Livability is about the human requirement for social amenity, health and well being and includes both individual and community well-being. Livability is about the human environment though it can never be separated from the natural environment. Sustainability for a city is thus not only the reduction in metabolic flows (resource inputs and waste outputs), it must also be about increasing human livability (social amenity and health). (Newman, 1999, p. 222)

More importantly, Wagner and Roger (2012, p.1) stated that livability involves “traditional city planning ideals of economy, ecology, and equity” that pursue sustainable development as well as “the use of public space, transportation systems, and building design” while including social aspects. Moreover, Ruth and Franklin (2014) suggested two elements that comprise livable cities in the sense of “fit to live in” or “inhabitable”:

[1] goods and services ... from this vantage point livability is judged through the lens of the needs and wants of those who do or may live in cities.... [2] City's environment, as defined by its physical and biological characteristics—the built infrastructure and ecosystems that provide the goods and services on which lives and livelihoods in the city depend.... Specifically, since both the social and environmental elements that define livability vary across space and through time, any effort to promote livability must be based on an understanding of underlying geographic and dynamic behaviors of society and its biophysical environment, as well as their interactions. (Ruth & Franklin. 2014, p. 18)

These definitions present a multifaceted concept that includes various aspects of city life and its form and environment. According to the definitions above, livability concerns the environment, including both built (public open space, buildings, city infrastructure, transportation) and ecological spaces. The people who settle in these environments form communities, and these communities and their members are critical social ingredients of livability with respect to the quality of life. As the environments and communities are integrated, the places where members of the community live, work, and play create layers of history that enhance their attachment. There is a need to consider how all of the elements mentioned so far can be maintained and improved, taking into consideration each city's or community's social/cultural, environmental, and economic diversity. Therefore, for the realization of livability, all of the aspects that are critical to improving the quality of life for humans and their settlement in relation to the environment must be considered.

Since livability also concerns improving the overall aspect of people's lives and environment, it is often compared to sustainability. Livability is therefore discussed, in a sense, in a similar way to sustainability, involving the "satisfaction of needs, justice or solidarity with the poor and quality of the living environment" (Assche, Block, & Reynaert, 2010, p. 345) or a "subset of sustainability" (Litman, 2011, p. 1) that has an immediate influence on a community. One difference that has been pointed out by several researchers is that livability tends to focus more on short-term impact, while sustainability is designed to have a long-term impact (Assche et al., 2010; Litman, 2011). However, this does not mean that livability invariably means a short-term trend

(which changes frequently) in life but rather refers to a greater focus on local needs, with an interest in improving the general quality of life.

Table 2.6 shows the elements/indicators of livability that were derived from the literature described above in order to study the range and variety of the elements of livability.

Table 2.6

Indicators of livability from the literature.

Article	Category (- Indicator)	
Ruth & Franklin (2014)	<ul style="list-style-type: none"> • <i>Goods and services</i> <ul style="list-style-type: none"> - Shelter, energy, water and food, waste management and assimilation, health and public safety, education, entertainment, social engagement, economic contributions, creativity (lens of the needs and wants of those who do or may live in cities) • <i>Physical and biological characteristics</i> (that provide the goods and services) <ul style="list-style-type: none"> - Built infrastructures - Ecosystems - Green spaces and water bodies (amenities, economic value, valuable contributions such as local climate regulation, air quality, flood control) 	
Miller et al. (2013); ICF International (n.d.)	<ul style="list-style-type: none"> • Transportation choices <ul style="list-style-type: none"> - Transportation cost - Reduced oil consumption - Reduced CO2 emission • Equitable, affordable housing <ul style="list-style-type: none"> - Energy efficiency - Universal design - Affordability • Economic competitiveness <ul style="list-style-type: none"> - Employment - Educational opportunities - Expanded business access 	<ul style="list-style-type: none"> • Existing community support <ul style="list-style-type: none"> - Federal funding for the community • Policies and investment <ul style="list-style-type: none"> - Elimination of barriers to collaboration - Renewable energy • Communities and neighborhoods <ul style="list-style-type: none"> - Enhanced characteristics - Healthy, safe, and walkable neighborhoods
Litman (2011)	<ul style="list-style-type: none"> • Public health • Social equity 	<ul style="list-style-type: none"> • Affordability • Pollution exposure

Newman (1999)	<ul style="list-style-type: none"> • Health • Employment • Income • Education • Housing 	<ul style="list-style-type: none"> • Leisure activities • Accessibility • Urban design quality • Community
Omuta (1988)	<ul style="list-style-type: none"> • Amenity environment <ul style="list-style-type: none"> - Right amount and amounts of utilities - Provision of public/social services • Educational environment <ul style="list-style-type: none"> - Schools in neighborhoods • Employment environment <ul style="list-style-type: none"> - Job opportunities - Reduced commuting distance 	<ul style="list-style-type: none"> • Housing environment <ul style="list-style-type: none"> - Safe structures - Monthly budget • Socioeconomic environment <ul style="list-style-type: none"> - Housing component • Nuisance dimension <ul style="list-style-type: none"> - Reduction of environmental pollution

The definitions of these indicators also include a wide variety of characteristics. The categories and indicators have been briefly synthesized in order to measure the breadth of the livability elements. Overall, these elements can be divided into two groups: those that concern human well-being (health, safety, public/social services, activity, and leisure) and those that involving physical provision, which can then be divided into the built environment (amenity, housing, public open space) and the ecological environment (urban forest, water body, wildlife habitat) that support human well-being. These elements need to be prioritized according to the specific needs of individual communities.

2.2.3. Livable Streets

The previous section examined livability by considering the broader aspects of the quality of life. This section goes on to address livable streets in particular, focusing on the life of the street itself and how a better quality of life can be realized through various approaches. General aspects of Livable Streets are discussed based on the extant literature that addresses various theoretical approaches developed by academic experts and professionals in the field.

Lee’s Summit: Park (2013)

The Livable Streets Policy in Lee’s Summit, Missouri, is based on smart growth. As the first Livable Streets Policy in Kansas City, initiated in 2007, it became known throughout the nation and serves as an example for other cities. The approach for the Livable Streets was bottom-up, “a resident-driven citywide strategic planning effort” (Park, 2013, p. 38). This was an appropriate approach because elected city officials were initially unwilling to take the risk of pursuing this relatively new policy.

Livable Streets were defined by the policy as follows:

Livable Streets are streets for everyone—planned, designed, and operated to enable a network of safe access for all users including pedestrians, bicyclists, motorists, and transit riders of all ages and abilities. Livable Streets is an increasingly important holistic placemaking approach to transportation. The need for Livable Street is well rooted in public health, safety, and welfare—tenets of government responsibility. Livable Streets can also improve environmental sustainability, economic vitality, and the efficiency of basic transportation choices. (Park, 2013, p. 36)

As Park (2013) describes it, this definition of Livable Streets mainly addresses livability related to transportation accessibility through actions such as providing multimodal choices, improving mobility on roads, and promoting non-motorized trips and public transportation. The elements of Livable Streets are listed in Table 2.7.

Table 2.7

Livable Street elements identified by Park (2013).

Livable Street Elements	
• Sidewalks	• Roundabouts
• Shared-use paths	• Bus stops
• Street lighting	• Bus shelters
• Landscaping/streetscape	• Wide-curb lanes, accessibility (ADA) accommodations
• Street trees, crosswalks	• Traffic calming
• Bus/transit lanes	• Cycle tracks
• Bicycle racks	

-
- Pedestrian benches
 - Shade structures
 - Paved shoulders
 - Bicycle lanes
 - Access management/medians, various types of traffic signal control treatments
 - Traffic signal control technologies
-

These elements all support the safety and convenience of pedestrians. Park (2013) suggests that a sense of place can be developed by applying a combination of these elements and a land use plan that connects people with the streets.

For funding, Park (2013) suggests utilizing existing transportation budgets with the incorporation of “low-cost/high-impact Livable streets elements” (p. 36) that might require a small amount of additional funding, explaining that this could be made possible “through reprioritizing projects, coordinating maintenance, and targeting projects that improve overall mobility” (p. 36).

According to Park (2013), there were two primary challenges when adopting this Livable Street Project in Lee’s Summit—both of which were eventually resolved. The first was the need to alter existing transportation strategies to create a new pedestrian-oriented approach; planners and engineers succeeded in designing Livable Streets for every transportation project. The second challenge arose due to a partnership between the city traffic engineer and a local family physician. Here, the outcome was that through their successful collaboration, transportation and healthcare professionals were able to achieve synergetic outcomes as shared common goals.

This Livable Streets Policy focused on providing a better quality of pedestrian experiences through improving elements related to transportation. Its emphasis was on universal users of all ages and genders, and its proponents strongly recommended that the Livable Streets Policy be incorporated into other municipal plans. The Livable Streets Policy also emphasized selecting the right advocates who would support the process and educating stakeholders prior to meeting with officials who might have doubts about the efficacy of the Livable Streets approach. Both these aspects will also be important when implementing Green Street projects since this is another relatively new approach.

Livable Streets: Appleyard (1980)

Appleyard (1980) focused on residential streets that were closely connected with people's everyday lives and served as growing places for children. In his article "Livable Streets," the author asks the questions, 'what could a street be like for all users, whether young or old', and 'what are the rights of street dwellers?' (Appleyard, 1980, p. 107). Regarding Livable Streets, Appleyard states, "Streets need to be redefined as sanctuaries; as livable places; as communities; as resident territory; as places for play, greenery, and local history. Neighborhoods should be protected, though not to the point of being exclusionary" (1980, p. 106). This statement emphasizes the importance of recognizing streets as places where people can enjoy social exchanges and their role as an extension of their dwellings. Appleyard went on to identify seven aspects of "the rights of street dwellers" (1980, p. 107; see Table 2.8). It should be noted that these elements focus on the quality of life for pedestrians and those living adjacent to a street; Livable Streets are not a singular objective strategy in this context, but rather a multi-dimensional strategy that cares for people's lives and needs.

Table 2.8

Categories of Livable Streets identified by Appleyard (1980).

Category	Indicator
1. The street as a safe sanctuary (especially for children)	<ul style="list-style-type: none">• safe from cars• walk or cycle safely to nearby destinations• drivers' awareness• access for an emergency vehicle
2. The street as a livable, healthy environment	<ul style="list-style-type: none">• protected from traffic noise• protected from night-time noise or passing headlights• people talk with normal voice tones on the street• protected from traffic and comfortable in their homes• air is breathable and not polluted• safe from dirt on the street• a place to sit, converse, and play
3. The street as a community	<ul style="list-style-type: none">• reduces the anomie of urban life

	<ul style="list-style-type: none"> • street activity • clean street • engages common actions • detailed street design
4. The street as neighborly territory	<ul style="list-style-type: none"> • residents feel belongingness (sense of pride and responsibility) • the residents are more likely to take care of their streets
5. The street as a place for play and learning	<ul style="list-style-type: none"> • adequate spaces for children to play • street is a learning environment: nature, social life
6. The street as a green and pleasant land	<ul style="list-style-type: none"> • green provides relief, shading • green shows seasons, cycles of life
7. The street as a unique historic place	<ul style="list-style-type: none"> • unique quality due to a particular subject • residents see it as a place rather than a channel

2.2.4. Summary

Even though streets are defined by boundaries (usually in the form of property lines) and appear to be a limited space, they are actually an extension of the space and life where all human activities occur. As Appleyard (1981, p. 1) pointed out, “People have always lived on streets,” and streets are parts of our lives and need to be treated as such. As part of the street system, Green Streets provide multiple forms of benefits that would be helpful for improving and maintaining the livability of the surrounding communities, along with the environmental benefits delivered through their implementation. In contrast, conventional street systems are mostly planned taking into account “traffic engineering considerations” for vehicles (Metro, 2002, p. 9). The emphasis on the integration of livable elements with Green Street implementations reinforces its effectiveness in a community, enabling social, environmental, and economic issues to be addressed in addition to their primary purpose of treating stormwater runoff.

In order to achieve this objective, a careful consideration of the multiple benefits and the selection of appropriate working processes that would address the community’s

needs is required. To successfully promote the benefits that would enhance community livability, the Green Street approach needs to be recognized as a broader concept that treats streets as places where people's lives matter rather than as a single concept (i.e. its stormwater treatment facility function). Therefore, a study of livability was conducted, reported in this chapter, in order to investigate better ways to plan and design Green Streets and to promote their implementation as a development strategy in cities.

Two different approaches to Livable Streets were presented in the earlier part of this chapter. The first approach focused on the improvement of street features related to transportation to support activities on the street with regard to pedestrians' safety and convenience, while the other placed a greater emphasis on various aspects of a street as a place where an extension of life occurs. These approaches and their associated livability elements should be recognized as desirable in Green Street practices and receive more attention from planners and designers to ensure projects both resolve community needs and address stormwater runoff issues.

For the purpose of this research, achieving livability through Green Street implementations focuses specifically on addressing the multiple benefits associated with successful Green Street projects, as nominated by the experts interviewed. The following section addresses how the elements of livability can be planned and delivered within the planning and design process.

2.3. Planning and Design Process

This section examines a variety of different planning and design processes reported in the literature. Here the focus is on (a) exploring why the process is important and (b) formulating a preliminary process prior to creating a Green Street oriented planning and design process.

2.3.1. Why Does the Planning and Design Process Matter for Green Streets?

As described in the previous section, Green Streets are an important part of the street network as well as part of the urban environment. Moreover, Green Streets are integrated with stormwater treatment facilities, which are not normally implemented on

streets. They can therefore be categorized as an alternative stormwater management approach that differs from conventional stormwater systems that simply convey stormwater runoff away from the area via constructed pipes and engineered systems, as well as a community development strategy. These two aspects—integration with street systems and inclusion of stormwater treatment facilities—increase the complexity of the Green Street approach in terms of the applied policies, funding sources, collaboration among different departments, technical applications, design strategies, and so on. Attempts to promote the multiple benefits achievable through the Green Street approach make it even more complicated, thus strongly suggesting that the Green Street approach to development may require a new or modified process that is specifically designed to obtain the results desired by planners and designers. An effective planning and design process is based on a strategic and inclusive protocol that helps designers and planners consider every aspect that is critical for implementing Green Street projects to ensure that the appropriate action is taken for a given task. For successful project implementation, every aspect and condition of the site needs to be analyzed and planned, and accurate construction practices followed, after which the project must be subsequently supported by regular maintenance (Hannebaum, 1990). Because a strong process creates more predictable outcomes (Shirvani, 1985), a study focusing on this aspect also addresses the second research question: “How can Green Streets be successfully implemented?” Therefore, the following sections examine planning and design processes in detail as part of the effort to develop a framework for the Green Street oriented process discussed later in Chapter 6.

2.3.2. Protocols of Planning and Design Processes

It is important to understand the planning and implementation process to investigate how projects are successfully implemented. For the purposes of this research, it was deemed necessary to investigate appropriate criteria or protocols with which to evaluate the different Green Street implementation processes conducted in various cities. In this section, the planning and design processes of landscape architecture and urban planning are discussed. It will help the author to develop a

framework for the further study of processes and development of a model process based on the summary and analysis of the different processes provided here.

Hannenbaum (1990) states that “good landscaping” needs to be aesthetically pleasing while practically functional, asserting that landscape design should be recognized as “an investment” because it can “provide an excellent return if properly designed, implemented, and maintained” (1990, p. 2). The author also suggests “three distinct steps: design, installation, and maintenance” (1990, p. 17; see Table 2.9) for a good design. Of the three stages, Hannenbaum mainly discussed the design process. This starts with design analysis, which analyzes the site conditions and people’s needs. The design concept is then formulated, initially by a general concept, after which more specific design decisions concerning materials and site compositions are developed. For the installation stages, Hannenbaum talks about a bidding process and the need to set the scope of the work and optimize the material quality control. Seasonal timing for plants is also an important element of the process. For the maintenance process, Hannenbaum points out that designers need to consider ways to maintain the landscape at the design stage and to provide adequate maintenance information. Hannenbaum stresses that the stages in the process are closely interconnected and must therefore be considered simultaneously, even though there is a certain order to follow to make sure the necessary elements are all considered.

Table 2.9

Study of a Process 1. Based on Hannenbaum (1990).

Stages	Design	Installation	Maintenance
Substages	<ul style="list-style-type: none"> • Design analysis: site analysis / people’s needs, site condition, usable areas • Design concept: shade, wind protection, screening, enclosure, general choices (area size and shape, environmental requirements, circulation routes); then detailed design 	<ul style="list-style-type: none"> • Bid: set scope of work, material, and plants qualification • Seasonal timing 	<ul style="list-style-type: none"> • Attention to ease of maintenance during the design process • Supplying maintenance information to clients

Simonds (1983) took these ideas further, arguing that an environment is “dynamic and expanding, changing as our requirements change,” and that planners deal “not only with areas, spaces, and materials, not only with instincts and feelings, but also with ideas, the stuff of the mind” (p. 7) in order to achieve a more delightful and inspired design. Simonds thought that the main purpose of “all physical planning is to create a more salubrious living environment—a more secure, effective, pleasant, and rewarding way of life” (p. 7) and listed six stages of “the planning-design process,” namely “commission, research, analysis, synthesis, construction, and operation” (pp. 106–107; see Table 2.10).

A project is initiated via a commission process, where the commission is awarded to consultants who have good reputations and experience in the type of project being planned. In the research stage, various data collection actions are conducted, such as a topographic survey, interviews with stakeholders, and a site visit. These are analyzed during the analysis stage, along with a consideration of other site constraints and the relevant governmental regulations. During the synthesis stage, a comprehensive program is created and the design is completed by eliminating unsuitable elements, improving concepts, including reviews, increasing the benefits,

and mitigating environmental impacts. For the construction stage, construction documents are prepared, including plans, details, specifications, bidding forms, and cost estimates. The bidding process is also included in this stage. Supervision is provided and field adjustments may also be implemented, subject to agreement and the guarantee of improvement. Finally, the operation stage is when designers provide instructions concerning how to operate and maintain the site. Simonds recommends that both planners and designers maintain an interest in the project, even after the construction is completed, to ensure its success.

Table 2.10

Study of a Process 2. Based on Simonds (1983, pp. 106–107).

Stages	Commission	Research	Analysis	Synthesis	Construction	Operation
Sub-stages	<ul style="list-style-type: none"> • Client statement of need • Definition of services • Execution of agreement 	<ul style="list-style-type: none"> • Survey • Data collection • Interviews • Observation • Photography 	<ul style="list-style-type: none"> • Site analysis • Review of governing regulations • Constraints • Possibilities • Program development 	<ul style="list-style-type: none"> • Schematic studies • Comparative analysis • Impact assessment • Accommodation • Consolidation • Method or methods of implementation 	<ul style="list-style-type: none"> • Preparation of construction documents • Contract award • Supervision of construction • Punch list checkout 	<ul style="list-style-type: none"> • Periodic visits • Adjustment; improvement • Performance observation
Output	Initial meeting	Professional service agreement	Base maps; supporting file data	Comprehensive program	Develop preliminaries and estimate of cost	Completed project

Dinep and Schwab (2010) developed a design process focused on satisfying six agendas, namely “program development, stakeholder influence, regional and site assessment, form-making, design efficiency, and user experience” (pp. vii–viii) from a sustainable site design standpoint. Unlike the previous authors, they did not discuss specific processes, but their six agendas address the critical factors that are required in

a planning and design process. The main strategies for each factor are summarized in Table 2.11.

For program development, Dinep and Schwab (2010) state that “Programming’ is visioning and determining key features” (p. 18) in site design. Regarding stakeholders’ influence, it is important to recognize the different needs of public and private projects and to identify who the stakeholders are and when they should be involved. Promoting stewardship is also important. Regarding regional and site assessment, Dinep and Schwab (2010) emphasize the relationship between a site and its context, which can be studied using a site inventory. The authors emphasize the creation of “social and cultural meaning and function” (p. 144) for the form-making factor, which concerns the realization of what was conceptualized, designed, and programmed as a form on the ground. To ensure design efficiency, the authors stress the importance of cost effectiveness and resource conservation, both for sustainable design and to maintain the site’s attractiveness. Finally, the authors state that the user experience is “the cornerstone of landscape programming” (p. 224) and that it is important to incorporate meaning into the site for users’ enhanced experience.

Table 2.11

Factors of Sustainable Site Design. Based on Dinep & Schwab (2010).

Factors	Program Development	Stakeholder Influence	Regional and Site Assessment	Form-making	Design Efficiency	User Experience
Strategies	<ul style="list-style-type: none"> • Assess client's needs and desires • Refer to precedents • Estimate regulatory opportunity and constraints • Write a manifesto to guide the course of the design process • Employ a collaborative approach 	<ul style="list-style-type: none"> • Recognize different needs (public vs. private projects) • Identify stakeholders • Hold public meetings • Identify general issues • Promote stewardship plan 	<ul style="list-style-type: none"> • Inventory site systems • Investigate site stability and maturity 	<ul style="list-style-type: none"> • Create space with sustainable materials • Enhance unique quality of the site • Create flexible form 	<ul style="list-style-type: none"> • Efficient use of resources: vegetation soils hydrology energy cultural connectivity 	<ul style="list-style-type: none"> • Comprehend who the users are • Understand the site • Multiple options

2.3.3. Summary: Creation of a Framework for a Green Street Oriented process

The processes discussed in the previous subsections present different stages with multiple strategies that could be incorporated throughout the various stages of the planning and design process. The planning and design processes that are included in the new framework should provide a protocol that needs to be considered across the entire process to ensure that all the critical elements are analyzed and included for the study of a particular process. These stages are closely interrelated, so planners and designers need to maintain their awareness of how different elements interact and how this will impact the scheme as a whole at all times.

As part of a green infrastructure strategy, it is desirable that the design of a Green Street project be conducted carefully, following an approach similar to that used

for planning more traditional projects (Benedict & McMahon, 2001). Moreover, Green Street benefit from a process that is dedicated to their procedures, involving various areas of expertise such as landscape architecture, urban design, stormwater engineering, civil engineering, traffic engineering, and historical knowledge, among others. Therefore, the final design and construction of Green Streets is not the result of the isolated action of a single party or procedure, but rather the result of integrated approaches. Related criteria include the involvement of various parties (interdisciplinary teams, stakeholders, and local communities), different scales (ranging from an entire watershed down to a local street or even a single household), spatial considerations (plane and vertical; above ground and underground), necessary infrastructure (stormwater facilities, drainage systems), municipal and federal regulations (covering topics ranging from transportation- to stormwater-related aspects of the project), social requirements (local needs), and so on. A well-defined process can guide designers and planners through the complex steps required to achieve the efficient and effective completion of the project. From a landscape design standpoint, if Green Streets are designed well, this can resolve many of the difficulties associated with a given site (Hannebaum, 1990).

Therefore, this section ends by presenting a proposed framework for developing a Green Street oriented process aimed at the better implementation of Green Street projects (Figure 2.3). The process created by Simonds (1983) that was presented in the previous section provides the basis for the development of this framework since it presents a comprehensive overview of the planning and design process. The six stages listed by Simonds (shown in Table 2.10) were simplified and rationalized to create a total of four stages, namely project initiation, project design, project construction, and maintenance and operation. This was done because the processes in the sample cities studied for this research vary somewhat and their categorization into four stages was deemed more applicable in this instance than six stages, with more subdivisions being added to the process in later chapters of this dissertation as needed.

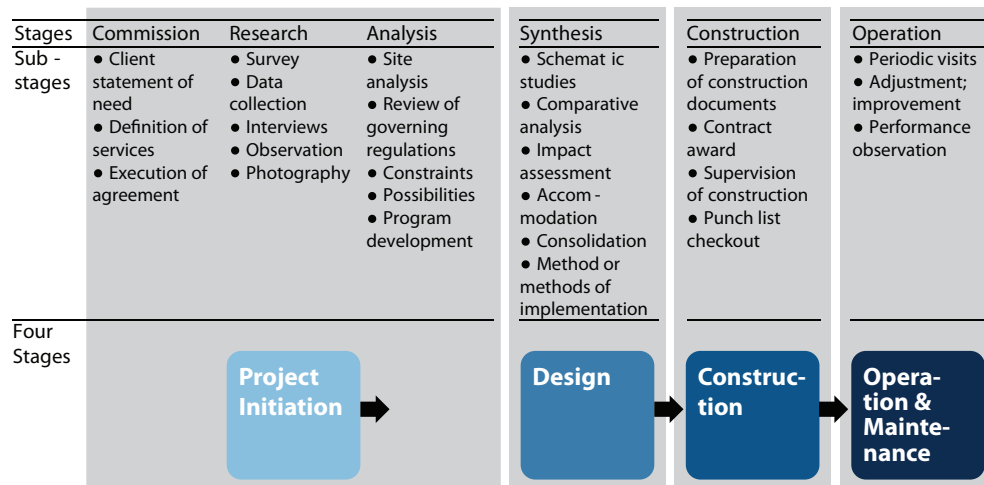


Figure 2.3. Four-stage process used as a framework for analyses of Green Street implementation processes (the first row adapted from Simonds, 1983).

2.4. Methodological Literature Review

The primary method utilized for the study conducted for this dissertation was a qualitative research approach. There is little literature regarding Green Streets, so the experiences and insights of experts who have worked on Green Street projects are a valuable source of data for studying and investigating successful implementations. One way of obtaining these insights is qualitative research, which is “related to understanding some aspect of social life and its methods which (in general) generates words rather than numbers as data for analysis” (Bricki & Green, 2007, p. 2). In the following sections, qualitative interviews, content analysis, and member checks are discussed as the selected method approaches applied here. All are important procedural approaches that can be usefully deployed for the rigorous collection and analysis of qualitative data.

2.4.1. Qualitative Interviews

Qualitative interviews are a useful way to garner insights regarding a given issue because “interviewing ... engage[s] participants directly in a conversation with the researcher in order to generate deeply contextual, nuanced and authentic accounts of participants' outer and inner worlds, that is, their experiences and how they interpret

them.” (Schultze & Avital, 2011, p. 1). This research focuses on defining Green Streets and investigating current “performances” in the context of Green Street implementations and is based on the experiences of experts from several different municipalities. For this reason, qualitative interviews were selected as the primary research method to provide the researcher with an opportunity to gain a more profound understanding related to the subject matter than is possible using only survey questions. In this dissertation, “performance” is intended to be any analyses, considerations, and actions related to decision making in the course of implementing a Green Street project.

Qualitative interviews can be categorized into one of three forms: (a) informal conversational interviews, (b) general interview guide approaches, and (c) standardized open-ended interviews (Turner, 2010, p. 754; Gall, Gall, & Borg, 2003). *Informal conversational interviews* do not include a particular question or structured procedure. Rather, the interview protocol is more flexible, so the researcher “construct[s] questions as [she or he] move[s] forward” (Turner, 2010, p. 755). This form of interview allows the researcher to have more freedom, but the data collected must to some extent be treated as unreliable due to its inconsistency when coding the data (Turner, 2010; Creswell & Clark, 2007). *General interview guide approaches* have more structure than informal conversational interviews but still retain some flexibility. This may be useful because the researcher can maintain the structure while altering questions as needed to gain deeper insights in areas that appear promising. *Standardized open-ended interviews* are most structured, utilizing a questionnaire to guide the interview process. This is the most widely used form of qualitative interview because it can provide more highly standardized data and is thus easier to code; by contrast, coding for the data collected through open-ended interviews may be difficult because the data can include too much detail.

Myers and Newman (2007) also suggest three forms of interview processes, namely structured interviews, unstructured or semi-structured interviews, and group interviews. Structured interviews include a prescribed script and do not allow any improvisation, while unstructured or semi-structured interviews start with a somewhat

structured script but provide room for alteration in the process. The interviewer is assumed to be the researcher or a member of the research team.

Myers and Newman (2007) draw attention to several issues and concerns regarding qualitative interview research. For example, there could be some pressure exerted on the interviewees due to time limitations, which can also result in incomplete data collection if the limited time available is exceeded. The interviewee may not completely trust the researcher, who is likely to be unknown to them, and so may choose not to share sensitive stories with him or her. There could also be problems due to limited access to a wide variety of the interviewees in terms of the levels of positions or when access to a certain group is obstructed for whatever reason. In such cases, data can only be collected from certain groups and thus does not represent the broader aspects of the topic under consideration. Words used in the conversation may also be ambiguous, implying different things to different people.

Hence, in order to construct rigorous interview questions, the questionnaire should avoid imposing a researcher's assumptions on the process (Turner, 2010), instead allowing participants to express their thoughts and experiences without any bias. The minimum procedure that can be followed is: opening (self introduction), introduction of the research, key questions, and a closing script (Myers & Newman, 2007). Other steps that need to be considered are checking the recording machine prior to starting each interview to ensure it is working properly and questions need to be asked one at a time. The interviewer should exercise self-control and avoid becoming emotional, but also react to respondents to let them know they are being heard, avoid distracting participants unnecessarily, make smooth transitions between questions, and retain control over the interview session (Turner, 2010).

Sample selection in qualitative research is more deliberate than random (Tuckett, 2004; Reed et al., 1996; Mays & Pope, 1995; Ezzy, 2002) and sample sizes also differ from those needed for large sampling strategies. Sample sizes for qualitative research tend to be small, with an appropriate size being "one that adequately answers the research question" (M. N. Marshall, 1996, p. 523), which is potentially in single figures. A small sample size of around twelve is assumed to be manageable, at the same time

permitting an in-depth analysis “depending on the initial and emergent research questions and how the researcher conducted the study” (Baker & Edwards, 2012, p. 22) In sum, qualitative research interviews have a much greater potential for providing useful information for in-depth investigations, as the individual interactions with participants allows researchers to delve more deeply to expose the “truth.” This aspect is particularly important here since this research investigates the participants’ experiences and insights.

2.4.2. Content Analysis Based on Cultural Psychology

Content analysis is used to identify salient aspects in written forms and may even explain participants’ attitudes and perceptions regarding the text (U.S. Government Accountability Office. Program Evaluation and Methodology Division, 1996). For an effective analysis of interview statements, the collected data in this research was analyzed using content analysis based on a cultural psychological approach, the so-called “phenomenological method,” as suggested by Ratner (2002) (see Table 2.12.). Cultural psychology has been described as the branch of psychology that seeks to “understand the varieties of normal human consciousness across those historically and culturally constructed worlds” (Shweder & Sullivan, 1993, p. 498). The phenomenological method is to “accurately [identify] and [summarize] themes in verbal accounts” (Ratner, 2002, p. 168) with more rigorous procedures because an individual researcher’s interpretation of an interview’s content is often subject to inaccuracies. Ratner (2002) emphasizes the importance of “[u]sing concrete terms for all the codes” (p.177) in the analysis when applying the phenomenological method. The procedure is described in more detail below.

First, in order to apply the phenomenological method, “meaning units” need to be identified. These units must be consistent and particular while at the same time containing the specific meaning of a certain idea. Ratner (2002) also stated that the research question should guide the selection of meaning units by causing researchers to highlight only those responses related to the question. Selecting and identifying accurate meaning units is vital because the meaning units serve as the foundation and

are applied throughout the analysis procedure. It is also necessary “to avoid arbitrary, subjective impressions being imposed on the subject” (p. 170).

Second, the identified meaning units are restated by the researcher as “central themes.” Ratner gave several examples, including the following:

- No moral obligation to drive/help (meaning unit: “I don’t think he has any obligation)
- Don’t help distant social relations (meaning unit: “Don’t know him well”) (2002, p.170)

Since this analysis is grounded in cultural psychology, the central theme needs to “represent [the] psychological significance of the meaning units” (Ratner 2002, p.170). At the same time, Ratner emphasized significant meanings hidden between the lines that might not be immediately obvious, so that the meaning could be overlooked or misinterpreted. However, for the purpose of this research, meaning units were identified that focused on descriptions of procedural performances rather than the psychological states of the interviewees.

Third, after central themes have been defined, they are grouped and categorized as “general themes” according to their relative agendas. General themes can have very different labels than central themes because they represent a higher level of the central themes but at the same time summarize specific aspects of central themes that belong to the lower stage. Finally, there are “general structures” that summarize each general theme, followed by a “general summary” that explains the overall relationships among meaning units, central themes, and general themes.

The phenomenological method also includes quantification of the analysis. Ratner (2002) considers the calculation (of percentages) of each central theme or general theme to be especially useful when presenting different themes. It helps if each theme can be compared to another with clear objectives.

Each stage of the phenomenological method contains and emphasizes summaries and salient meanings from previous stages. In order to deliver specific and

accurate results, Ratner (2002) suggests using descriptive terms rather than abstract ones, arguing that abstract terms “preclude apprehending their specific psychological and cultural character” (p.175) (See Table 2.12):

Central themes express the specific psychological meaning of the meaning units; general themes express the meaning of central themes; general structures convey the meaning of general themes; and the general summary explains how all the general structures are interrelated. The summary explains whether structures complement or contradict each other (Ratner, 2002, p.173).

Table 2.12

“Phenomenological method.”

Statement	Central theme	General theme	General structure	General summary
Xxx [xxxxxxxx]	1	C.T. 1 C.T. 3 C.T. 5	Gen. theme 1 Xx xxxx xxxxxxxx xx xxxxx.	Xx xxxx xx x xxxxxx xxxxxx.
Xxxx xxxxx xxxxxx [x] xxxx	2			
xx [xxx xxxxx x xxxxxx]	3		Gen. theme 2 Xxxx xxx xxxxxxxx x xxx.	Xxxxxx xxxxxx xx xxx.
[Xxxx xxxx xxxxxx] [xxx]	4 5	C.T. 2 C.T. 4		
xxxxxx [xxxx xxx xxxxxx]	6	C.T. 6	Gen. theme 3 Xx xxxxx xxxxxx xxxxxxxx. Xxxx xxxxxx.	

Note. From Cultural Psychology: Theory and Method (Chapter 5. Analyzing cultural themes in verbal accounts, p. 172), by C. Ratner, 2002, New York, NY: Kluwer Academic / Plenum Publishers. Copyright 2002 by Kluwer Academic / Plenum Publishers. With permission of Springer.

Qualitative research methods are often criticized as being overly simplistic (Elo & Kyngas, 2008), since when used in isolation they may not clearly deliver a firm and exhaustive analysis. Consequently, this study adopts the phenomenological method suggested by Ratner (2002) to provide reliability by forming staged structures that require a rigorous analysis of the interview content.

2.4.3. Member Check Process

The member check process is another qualitative analysis method utilized in this research. It has even been argued that this process can be considered “the most crucial technique for establishing credibility” (Lincoln & Guba, 1985, p. 314). In the member check process, the “persons who provided information are able to determine if the researcher has accurately reported their stories” (Koelsch, 2013, p. 170) regarding “analytic categories, interpretations, and conclusions” (Lincoln & Guba, 1985, p. 314). Therefore, member check analysis is a good way to determine, with a higher confidence, whether the researcher’s interpretation does indeed “reflect the respondents’ realities” (Hoffart, 1991, p. 523). It is also used to check consistency in the interpretation related to “textual evidence” (Hsieh & Shannon, 2005, p. 1285; Weber, 1990). One example of this process comes from Koelsch (2013), whose study utilized a member check interview. Here, related parts of a research report were given to participants who were then asked to evaluate whether the extract was accurate by focusing on “the content of the participant’s experiences, emotions, and thoughts” (p. 170). In a member check interview, participants may also be asked to evaluate the analysis.

However, there are some relevant cautions related to this approach. Member checks “can be misleading if all of the members share some common myth or front, or conspire to mislead or cover up” (Lincoln & Guba, 1985). In addition, there could be a problem when the researcher and participants are affiliated with the research procedure. Participants may be afraid of stating the truth, they may be stubborn in a certain belief, or their interest can be diverted (Sandelowski, 1993).

Despite these precautions, this approach can be a useful way of constructing credibility if findings and interpretation can gain agreement from the participants, and then readers can be specifically persuaded (Lincoln & Guba, 1985). So, the member check process conducted for the present study was performed to assist in constructing the validity of a comprehensive analysis for the qualitative research approach and can thus “contribute to the overall rigor of the research endeavor” (Hoffart, 1991, p. 533).

2.4.4. Summary

The dissertation was a qualitative research approach, as qualitative interviews are useful for investigating in-depth data regarding participants' experiences and thoughts and can thus help researchers closely examine the essential aspects of given issues. However, researchers must also select appropriate sample groups, sizes and interview protocols; and conduct rigorous qualitative analyses.

The data collected was analyzed using content analysis based on a cultural psychological approach. The "phenomenological method" introduced by Ratner (2002) provides rigorous procedural structures with which to analyze the contents. The analysis consists of meaning units, central themes, and general themes, and each stage is closely interrelated. A member check process was also included in the later stages in order to achieve a comprehensive picture of a Green Street oriented planning and design process for the successful implementations that the study interviewees had participated in.

2.5. Summary of the Chapter

Streets are parts of the built environment that structure human settlements, support various forms of human activity, and enhance the general quality of life of those who use them. It is thus recommended that Green Streets be designed to address these needs as they pertain to surrounding communities. In order to do this, multiple benefits and appropriate working processes that can deliver what the community needs are enhanced by the adoption of Green Street practices. In order to promote more benefits for community livability, the Green Street approach should be recognized as a broader concept that treats streets as places where people's lives matter rather than simply as a single concept problem solving opportunity (i.e., the stormwater treatment facility).

Where complex and emerging forms of practice are concerned, model planning and design processes may provide valuable guidance. Since streets influence the legibility and livability of cities and towns, processes cannot be thought of as an absolute framework. Landscape architect Steve Krog emphasizes "facing the great

risk—by recognizing that creation/invention is an emotion, intuition, intellect, and energy-intensive task”(Krog, 1983, as cited in Dinep & Schwab, 2010) as opposed to a simple reliance on process in achieving a creative design solution. Therefore, the model process suggested in this study is intended only as guidance for designers and planners seeking to enhance their ability to integrate multiple benefits into future Green Street implementations. Practitioners must still develop individualized expertise and not allow their creativity and imagination to be unduly limited by the process.

Qualitative research is a primary approach employed here to study the current state of Green Street practices and to develop a model process based on the experiences of experts in the field. The study adopted multiple methods, including interviews, content analysis, and a member check process. These methods are effective ways of gathering personal experiences and thoughts and making them available for in-depth analysis. The results are discussed in the following chapters.

Chapter 3. Methodology for a Study of the Attributes of Success Achieved by Green Street: Analysis of research question 1

This chapter consists of two sections focusing on the first research question: What attributes contribute to the success of currently constructed Green Streets? The first section discusses the methods and underlying rationale for the data collection, while the second section presents the methods applied for the data analysis.

3.1. Data Collection Methods

This section first presents the rationale for the selection of sample cities and discusses the methods utilized to conduct interviews (Sub-section 3.1.1). And then it describes methods for the recruitment and qualifications of participating experts (Sub-section 3.1.2). The section concludes by outlining the interview protocol to describe the scope of the collected data (Sub-section 3.1.3).

3.1.1. Rationale behind the Selection of Sample Cities and the Semi-structured Interview Method

The principal research method chosen for this study of current Green Street practice consisted of interviews with selected experts in the field. These interviews were the preferred approach due to their ability to provide insights based on the experts' experiences and their opinions of their practice "as it is lived, felt, undergone, made sense of and accomplished by human beings" (Schultze & Avital, 2011, p. 1; Schwandt, 2001, p.84).

Among different types of qualitative interview strategies, a semi-structured approach was adopted for constructing empirical knowledge on various aspects of the Green Street approach and the related procedural performance (how experts made decisions and what actions they took based on those decisions). Therefore, the data collected was analyzed using the content analysis approach developed in cultural psychology.

The identification of the expert participants began with an investigation of various completed projects through online and library research. The author then gathered

further information on the backgrounds of the municipalities where the Green Street projects were located.

In order to obtain a overall perspective on the Green Street approach, six sample cities were chosen through purposeful sampling based on each city's experience (Creswell & Clark, 2011) of Green Streets implementations: Seattle, WA; Portland, OR; New York, NY; Philadelphia, PA; Washington D.C. and Arlington, VA. The selection criteria were the following:

- 1) Cities with a relatively long history of implementing Green Streets, with Green Street projects completed more than a year previously.
- 2) Cities allowing convenient access to rich documentation on the projects.
- 3) The city must be willing to make available experts who had worked on Green Street projects in their respective municipal departments (which could include Parks & Recreation, Environmental Protection, or Planning and Development, for example).

Several of the selected sample cities, particularly Seattle, Portland, New York, and Philadelphia, were frequently brought up when the author searched for Green Street projects to obtain preliminary information prior to conducting the interviews with experts. The selected cities had either implemented Green Streets for a longer time than other cities, or had published a range of plans or policies dedicated to implementing Green Streets. A brief account of each sample city's history with Green Street implementation follows.

3.1.1.1. Seattle, WA

In addition to its various policies and plans dedicated to Green Street implementation, Seattle has the oldest Green Street project among the six sample cities, namely SEA (Street Edge Alternative) Street, which was a pilot Green Street project. It is also referred to as a representative example in many Green Street manuals and reports. This project was constructed in 2000 and the city has since implemented

additional projects such as Broadview Green Grid and Pinehurst Green Grid. Both these latter projects are part of the city's overall Green Stormwater Infrastructure model, which is intended to produce "modest to grand transformations of Seattle's urban landscape" (Seattle, 2015) by treating stormwater runoff.

3.1.1.2. Portland, OR

Portland is another city that is frequently referenced by others in the context of Green Streets, including the other cities sampled in this research. Portland's major concerns are related to combined sewer overflows (CSOs) and the city's aging sewer systems, which are over eighty years old. Green Street is part of Sustainable Stormwater Management to resolve those problems. The city has an interdisciplinary team dedicated to the development of Green Street projects, Cross-Bureau Team. To date, the city has built more than 1,400 individual Green Streets facilities.

3.1.1.3. New York City, NY

New York City was chosen because it has a strong Green Infrastructure Plan, of which Green Streets is a part. New York City has been implementing Green Streets since 1996, although Green Streets were not originally intended to treat stormwater runoff. New York City started building Green Streets for the purpose of treating stormwater runoff since adopting its Green Infrastructure Plan in 2010.

3.1.1.4. Philadelphia, PA

Philadelphia's long-term green infrastructure plan was initiated in 2011 and is called Green City, Clean Waters. The Philadelphia Water Department is responsible for Green Streets projects and they have recently published the City of Philadelphia Green Streets Design Manual (2014) as part of this effort.

3.1.1.5. Washington, DC

The Anacostia Waterfront Initiative was conceived as part of Washington's sustainable stormwater management plan, with Green Streets being constructed as part

of this initiative. Later, the city established policies that promoted further Green Streets implementations such as the DDOT (DC Dept. of Transportation) LID (Low Impact Development) Action Plan in 2010. In particular, the Sustainable DC Plan recommended installing green infrastructure in the public right of way.

3.1.1.6. Arlington, VA

At the time of the study, Arlington did not have a dedicated green infrastructure plan and was in the early stages of implementing Green Streets. However, the city had prioritized watershed analysis for implementing Green Streets and was promoting Green Streets as a means of treating stormwater runoff within the city limits.

3.1.2. Recruitment and Qualification of Participating Experts

The seven experts participating in the study were all government officials who had managed or worked on Green Street implementations in one of the six sample cities. They were affiliated with departments such as the Department of Transportation, Department of Environmental Services, Department of Parks & Recreation, and Water Department in their respective cities. Table 3.1 describes the backgrounds of interviewees, identifying the city in which each participant worked, their departmental affiliation within city government, their disciplinary expertise and years of experience.

The participants were identified through searches of municipality staff directories, conversations with an acquaintance who was working at the municipality, or from the names associated with the contact information in city Green Street factsheets, manuals, and reports. This process on occasion required several rounds of enquiry before the officials who had been managing or implementing Green Streets were found. Subsequently, email recruitment requests were sent to the experts identified inviting them to participate in an interview. Once one of the contacts agreed to participate, the interview with them was scheduled to suit their convenience. Approval was obtained from Virginia Tech's Institutional Review Board and Informed Consent forms were completed by all the participants prior to the start of the interview.

Table 3.1

Interviewees' background for the first round data collection.

	Identification Number	Affiliation	Position	Years Of Experience
Seattle, WA	3A	Dept. of Transportation	Landscape Architect	25
	3B	Dept. of Transportation	Urban designer	1
Portland, OR	1	Dept. of Environmental Services	Program coordinator	11
New York, NY	2	Dept. of Parks & Recreation	Engineer	4
Philadelphia, PA	6	Water Dept.	Program manager	7
DC	4	Dept. of Transportation	Program manager	6
Arlington, VA	5	Dept. of Environmental Services	Program manager	5

3.1.3. Interview Protocol Design

Data related to the first research question was collected using semi-structured interviews. The first round interviews were intended to provide general insights into each of the two major research questions. In order to gain a broad perspective on current practice, open-ended questions were used to obtain participants' opinions while attempting to avoid unduly shaping their thoughts and responses (Creswell & Clark, 2011). The interview protocol provided guidance to the interviewer, while specific questions were tailored to ensure the inclusion of important issues that needed to be discussed during the interview. The participants were also encouraged to provide opinions on the overall aspects of the projects and insights based on their experiences before, during and after implementation. Additional questions were asked to elicit further details based on participants' responses.

Figure 3.1. depicts the questions that were asked during this initial round of interviews. Only the data pertaining to the first question, "What are the characteristics of successful Green Streets projects", is considered in the first section of the analysis conducted for this research (Chapters 3 and 4). The experts were asked to nominate 2-3 successful Green Street projects in their cities. They were then asked to describe why they thought the nominated projects were successful. Since the remaining data from the

initial interviews addresses the planning and design process, this is examined in the second stage of the analysis, described in Chapters 5 and 6.

Successful GS	Holistic Research on Current Status of Green Street							
1. What are the characteristics of successful GS ?	2. What is the current status of GS?	3. When did GS start to be implemented?	4. Who is involved in implementing GS?	5. Why are GSs implemented?	6. How are GS planned and implemented?	7. Where are GSs implemented?	8. Are there any challenges ?	9. Are there other types of potential utilization of GS?
A. Can you name the most successful Green Street projects that are presently in use in your city and why do you think they are successful?	A. Do you have any green infrastructure plan for managing city-wide environmental issues? (Is the Green Street part of green infrastructure or stand alone project?) B. Do you know how many Green Streets have been in place in your city?	A. Has the concept of Green Streets been evolved over time? (What is the history of Green Street implementation?)	A. Who would initiate it? (city/ public/ private) B. Involved Departments: Who would be involved and how they work together? C. Would you say that the leader of the GS project is your department? (Who would be the leader of the GS projects?)	A. Setting Priority: Can I know how priorities set and what are the driving factors of implementing Green Street projects? (purpose, location, typology, etc) B. Green Streets as a development approach: How experts use Green Streets for their cities? (retrofitting, redevelopment, and new development?)	A. Do you have the standard for GS? B. Were there any differences in designing Green Street elements depending on land use, urban context, or surrounding communities? C. When you place green streets do you have preferred land use to put in? D. Do you outsource the design or use in-house designers? E. Do you have public involvement during the design development? F. Did you have any kind of feedback from residents or users of the GS? G. What is main funding source? H. Can you describe what would be the typical process of implementing Green Streets? I. Who would maintain GS projects? Do you do monitoring after construction?	A. When you implement Green Streets, are you only concerned about public streets?	A. What are the major challenges in implementing GS?	A. Have you considered implementing Green Street as an interconnected system throughout the city to improve the urban environment. (i.e. the green street is a part of the green way contribute in urban eco system)
First Set (Ch. 3 & 4)	Second Set (Ch. 5 & 6)							

Figure 3.1. The interview protocol for the first round data collection

3.2. Analysis Method: Content analysis

Content analysis is useful in capturing a “view of the meanings someone - a group or a culture - attributes to them” (Krippendorff, 1989, p. 403) through “a specific context” (Krippendorff, 1989, p. 403). The first round data collection was based on a qualitative interview method and content analysis was then applied to categorize and

interpret the data related to Question One, as suggested by Ratner (2002) and discussed in Chapter 2. This approach facilitates a more rigorous analysis of the interview conversations collected because they “serve as a basis and justification for all further interpretations” (Ratner, 2002, p. 170). Participants’ views regarding current successful Green Streets and how they can be categorized are brought to a sharper focus as a result of this analysis.

A specific example is presented in Figure 3.2 using the data collected from the first round interviews. In the figure, interview responses regarding the question, “what does make them (the nominated successful Green Streets projects) successful?” are used as an example here to demonstrate the methodology.

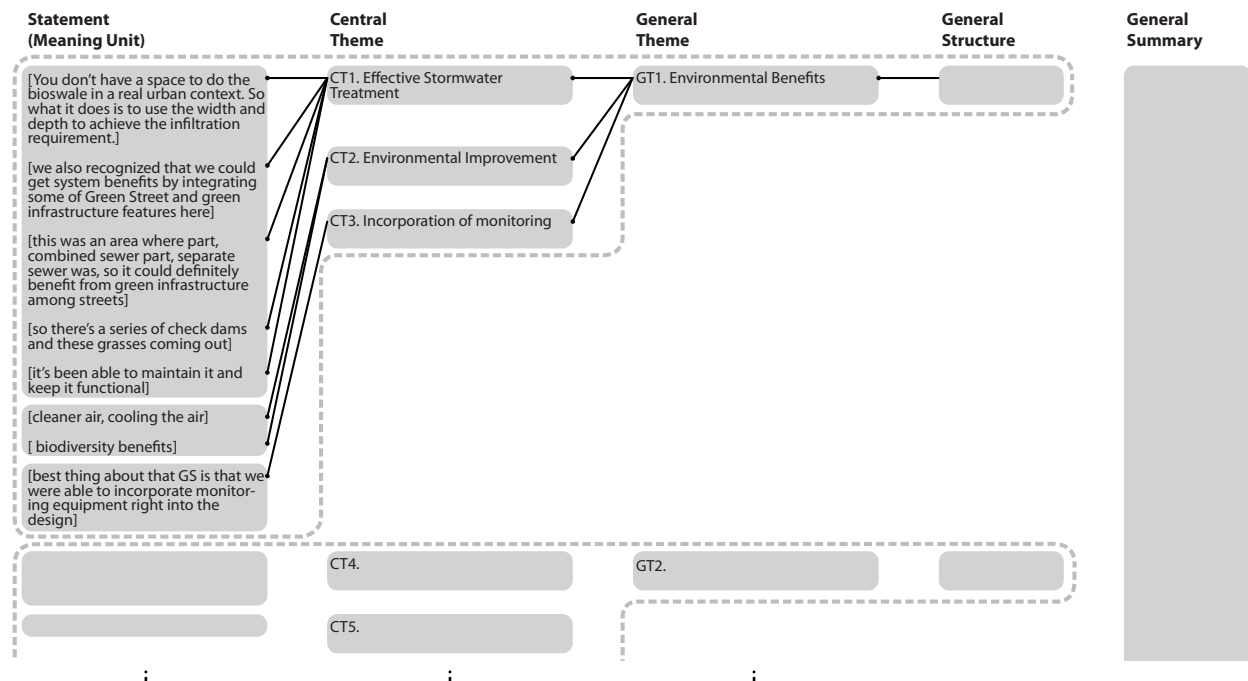


Figure 3.2. An example of content analysis using the data collected in the first round interviews following the phenomenological method by Ratner (2002). Adapted from *Cultural Psychology: Theory and Method* (Chapter 5. Analyzing cultural themes in verbal accounts, p. 172), by C. Ratner, 2002, New York, NY: Kluwer Academic / Plenum Publishers. Copyright 2002 by Kluwer Academic / Plenum Publishers. With permission of Springer.

In this analysis, the Statement, Central Theme, General Theme, General Structure, and General Summary are primary categories. First, relevant Statement(s)

were identified in each of the interview conversations. In each case, these statements refer to attributes of the nominated projects the expert considered to be successful. For example, there was a conversation where the participant explained, “This was an area where [the] combined sewer pipe was, so it could definitely benefit from green infrastructure. We also had an opportunity to include [an] art component in that. There was some funding from [the] arts commission.” (Expert 1, personal communication, March 11, 2014) In this conversation, there are two statements. One relates to stormwater management namely, “This was an area where [the] combined sewer pipe was, so it could definitely benefit from green infrastructure” and the other was related to the inclusion of an art component in the project: “We also had an opportunity to include an art component in that”. Excerpts from transcripts, such as these, were placed into the first column of Figure 3.2 - Statement. This protocol was applied throughout the entire conversation (regarding Question One) with all the interviewees. After statements were placed in the first column, they were then grouped according to their similar aspects. Hence, the statement, “This was an area where [the] combined sewer pipe was, so it could definitely benefit from green infrastructure” was grouped with other statements mentioning stormwater management such as “So, what it does is to use the width and depth to achieve the infiltration requirement” (Expert 3B, personal communication, April 17, 2014). This group was labelled Effective Stormwater Treatment and entered as such under the second column, Central Theme (CT). In Figure 3.2, there are two additional Central Themes (Environmental Improvement, Inclusion of Monitoring) which were also derived from the interview conversations. These three Central Themes were all related to environmental aspects of the project, so were grouped and named as Environmental Benefits in the third column, General Theme (GT). General Structure is a summary of General Theme, while General Summary describes the overall summarization of all the specified General Themes.

As a landscape designer who was trained and has practiced sustainable design, the author’s objective of this research is to investigate how Green Street practice can be applied with multiple benefits in relation to sustainability. The author acknowledges that her own concepts of success and processes in design projects may affect the results of

the research. So the research is primarily based on multiple experts' insight and how they define success. To minimize subjectivity in research analyses and foster reflexivity the author preformed frequency rating and cross-tab analysis to compare proposed benefits suggested in the literature and practical benefits highlighted by the experts so that the analyses present relative importance among identified elements. The frequency rating or quantification was obtained by calculating the "percentage of individuals in each group" (Ratner, 2002, p. 183) who touched on a particular idea during the interviews. A member check process, which engaged multiple experts, was also utilized later in the second analysis to increase validity of the Green Street oriented model process by taking into account the author's subjectivity in the analyses but also potential bias from experts who have different disciplinary backgrounds and departmental affiliations.

3.3. Summary of the Chapter

Qualitative interviews were adopted as the primary method for obtaining insights from the experts who participated in this study. Content analysis of the interview transcripts, as described by Ratner (2002), resulted in an in-depth qualitative analysis of the data collected. This was supplemented with documentary literature and case study research. The methods utilized can be summarized as follows:

- Data collection
 - 1) Semi-structured interviews with experts who worked on Green Street projects
 - 2) Literature review (construction documents, project reports, fact sheets, websites)

- Data analysis
 - 1) Content analysis (cultural psychology)
 - 2) Frequency rating
 - 3) Cross-tab analysis

A content analysis was conducted to investigate the participants' experience and insights in depth. In order to obtain a detailed comparison among the categorical groups, frequency rating was used and a cross-tab analysis applied to compare the differences between the attributes of success found in the collected data and in the Green Street literature.

Chapter 4. Study of Attributes of Success Achieved by Green Street: Analysis of research question 1

This chapter investigates the attributes of success exhibited by successful Green Street projects to identify what they are and what benefits are actually achieved. The study is intended to help designers and planners better understand what makes Green Streets successful so that they can be more consistently designed to provide full benefits to the public. Study participants were asked to describe why they think the selected projects have been successful. This chapter consists of six sections, including the summary of the chapter, that analyze and interpret the data that was gathered for this research. The first section presents physical descriptions of the nominated successful Green Streets, with images of each. The second section describes the features of the nominated successful Green Streets providing an overview of each of the selected projects. The third section identifies the attributes of the nominated streets that contribute to their success and relate to the benefits they provide. The fourth section considers the meaning of the data that has been gathered; this includes, but is not limited to, frequency-based interpretations of the outcomes. In the fifth section, the attributes cited by experts in reference to the nominated successful projects are compared to the range of possible attributes (and related benefits) cited by proponents in the literature. Finally, a discussion of the previous sections is presented, followed by a summary of the material presented in this chapter.

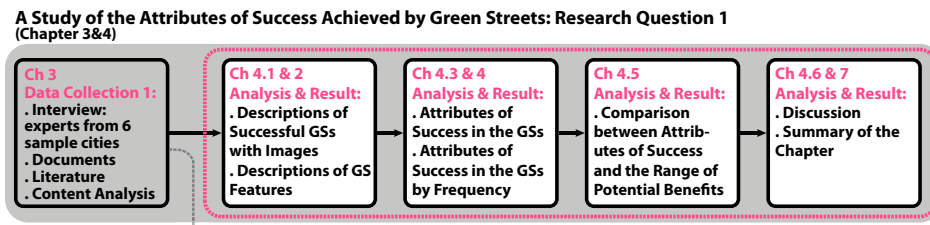


Figure 4.1. Analysis of the first research question.

4.1. Nominated Successful Green Streets by City

A total of nineteen successful projects were nominated by the interviewees and these are arranged by city in Table 4.1. The table contains photographs of each project, an illustration of Green Street facility types (from Chapter 2, Section 1), and specific design applications to provide a physical description of each project.

Table 4.1

Characteristics of the nominated successful Green Streets by city.

Project/ Street Name	Plan Image & Street View	Green Street Types & Particular Design Applications
Seattle, WA		
a. SEA Street (2 nd Ave. NW and NW 117th Street) (2000)	 <p>Project area. ©2016 Google</p>	 <ul style="list-style-type: none"> • Serpentine road design • Clustered mailboxes • Sidewalks • Narrow roadways • Angled parking spaces
 <p>Plan view. Map data ©2016 Google</p>		

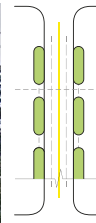
b. Broadview Green Grid (2nd Ave. NW, 1st Ave. NW, Palatine Ave. NW between NW 107th St. and 110th St. Cascade) (2004)



Project area. ©2016 Google



Plan view. Imagery ©2016 DigitalGlobe, U.S. Geological Survey. Map data ©2016 Google

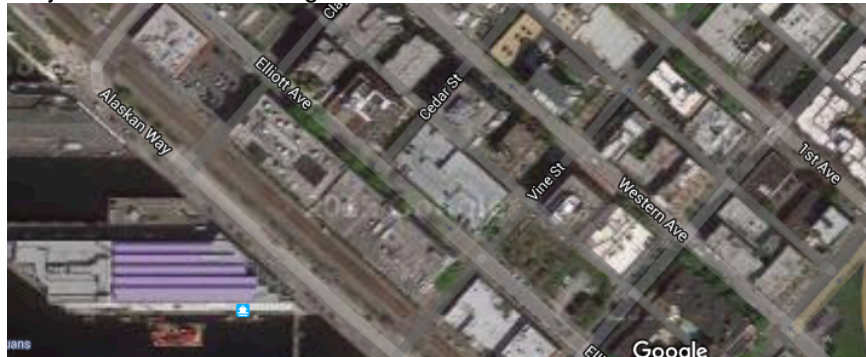


- Serpentine road design
- Clustered mailboxes
- Sidewalks
- Narrow roadways
- Street parking

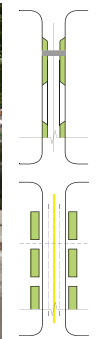
c. Growing Vine St. (between Alaskan Way and Denny Way) (2004)



Project area. ©2016 Google



Plan view. Imagery ©2016 DigitalGlobe, U.S. Geological Survey. USDA Farm Service Agency. Map data ©2016 Google

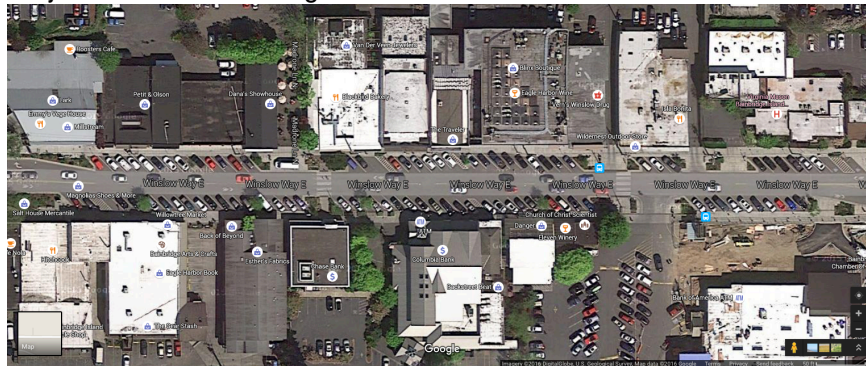


- Cascades
- Runnel
- Cisterns
- Seat walls
- Various street designs corresponding to the urban context

d. Winslow Way Reconstruction in Bainbridge Island (between Ericksen Ave and Madison Ave N) (2011)



Project area. ©2016 Google

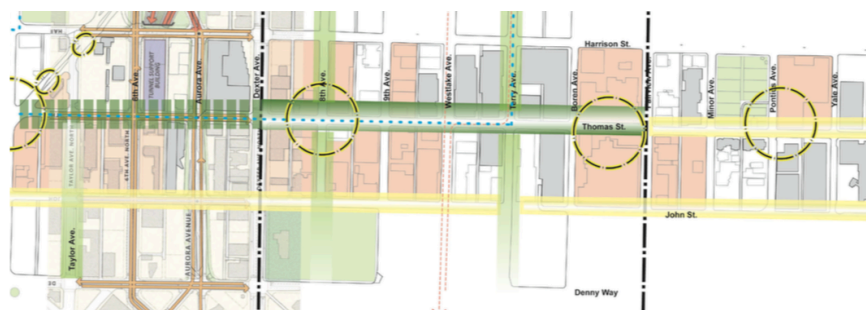
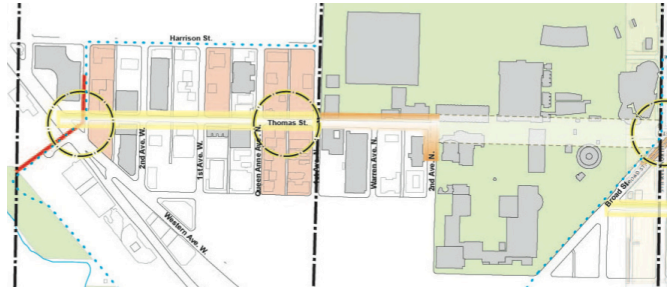


Plan view. Imagery ©2016 DigitalGlobe, U.S. Geological Survey. Map data ©2016 Google



- Street parking
- Safe pedestrian crossing
- Benches

e. Thomas Green Street Concept Plan (between Western Ave. W. and Yale Ave.) (since 2013) – in progress



The concept plan. Reprinted from Thomas Green Street Concept Plan (p. I.2 – I.3), by Seattle Department of Planning and Development, 2013. Copyright by City of Seattle, WA. Reprinted with permission.



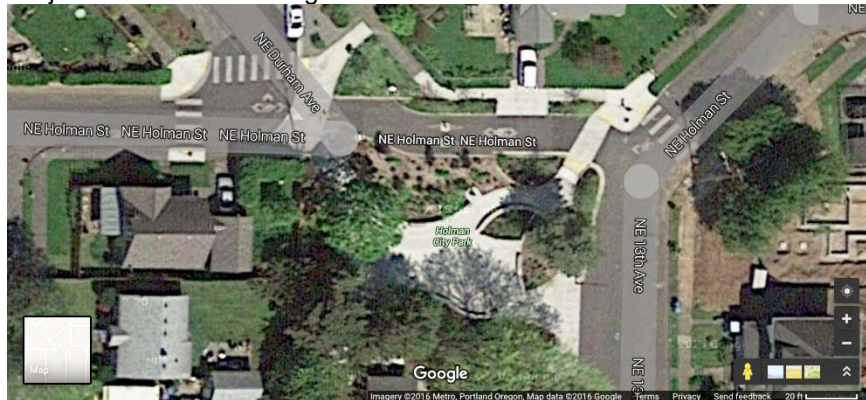
- Green promenade
- Wide sidewalks
- Various street designs corresponding to the urban context

Portland, OR

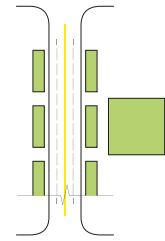
a. Holman Pocket Park and Green Street Bike Blvd. Project (NE Holman St. at NE 13th Ave.) (2011)



Project area. ©2016 Google



Plan view. Imagery ©2016 Metro, Portland Oregon. Map data ©2016 Google



- Seat walls
- Restricted vehicle access
- Bike path

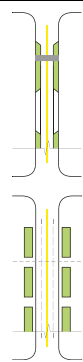
b. SE Clay Green Street Project (between SE Ladd Ave. and SE Water Ave) (2012)



Map data ©2016 Google

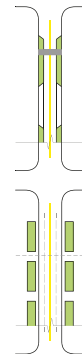
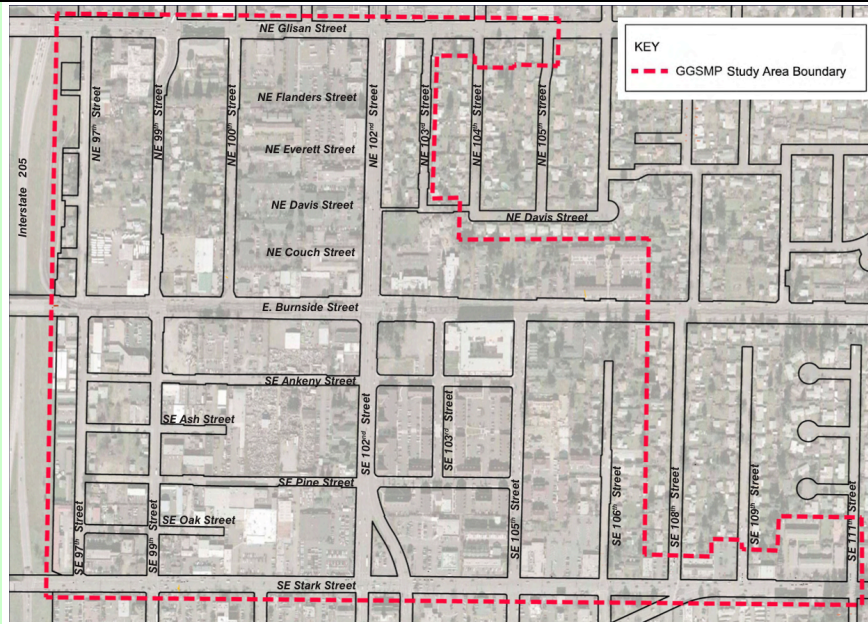


Project area. Reprinted from SE Clay Green Street Project: Route to the river (p. 5), by City of Portland. Copyright by City of Portland, OR, courtesy Bureau of Environmental Services. Reprinted with permission.



- Route to the river
- Safe pedestrian crossing
- Bike path
- Artworks
- Various street designs corresponding to the urban context

c. Gateway Green Street Master Plan (2008)

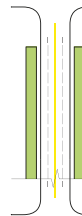


- Various street designs corresponding to the urban context

Project area. Reprinted from Gateway Green Streets Master Plan (p. 4), by Portland Bureau of Environmental Services, 2008. Copyright by City of Portland, OR, courtesy Bureau of Environmental Services. Reprinted with permission.

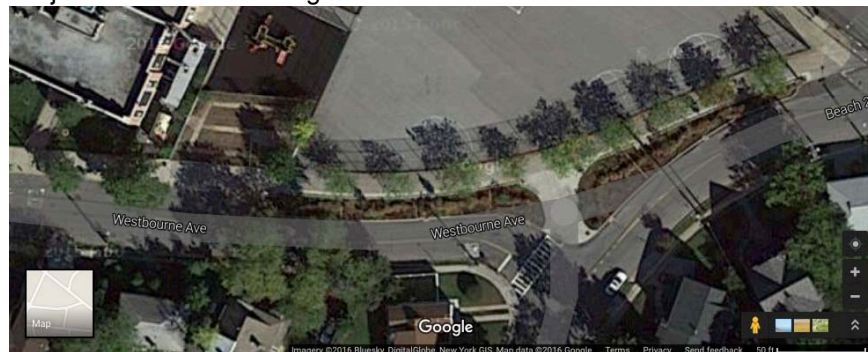
NY, NY

a. Westbourne Ave. and Bay 25th St. Stormwater Green Street



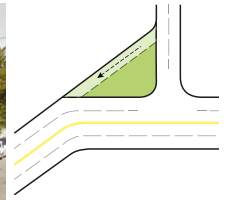
- Safe pedestrian crossing

Project area. ©2016 Google



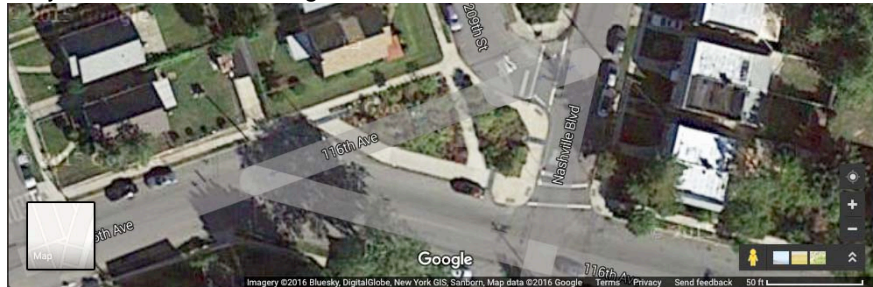
Plan view. Imagery ©2016 Bluesky, New York GIS. Map data ©2016 Google

b. Nashville Blvd. and 116th Ave
stormwater
Green Street



- ADA ramp
- Monitoring equipment

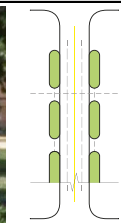
Project area. ©2016 Google



Plan view. Imagery ©2016 Bluesky, DigitalGlobe, New York GIS, Sanborn. Map data ©2016 Google

Philadelphia, PA

a. Columbus Square (at 13th St.)



- Information signage

Project area. ©2016 Google



Plan view. Imagery ©2016 DigitalGlobe, U.S. Geological Survey, USDA Farm Service Agency. Map data ©2016 Google

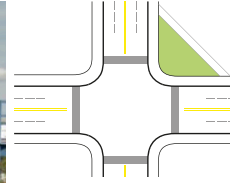
b. Pedestrian Plaza (at Stenton Ave. and E Washington Ln.)



Project area. ©2016 Google



Plan view. Imagery ©2016 DigitalGlobe. Map data ©2016 Google

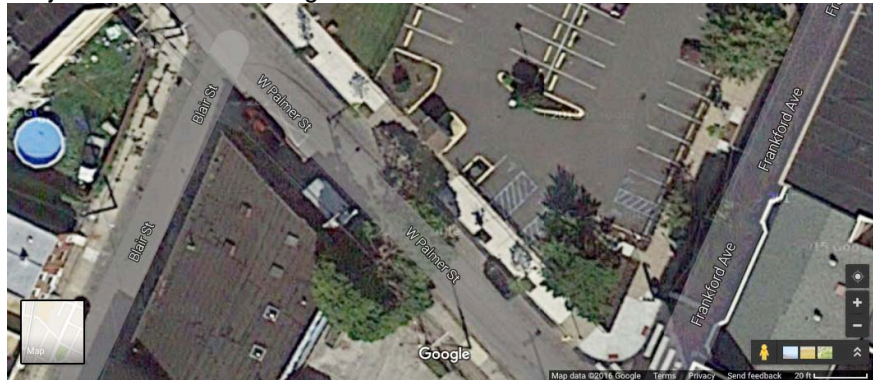


- Large planting area

c. Tree Trench (W Palmer St. at Blair St.)



Project area. ©2016 Google



Plan view. Map data ©2016 Google



- Tree pits

Washington DC

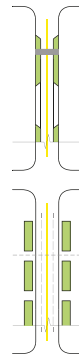
a. Georgia Avenue Great Street (between Kansas Ave. NW and Rhode Island Ave. NW) (since 2008)



Project area. ©2016 Google



Project area. ©2016 Google



- Bike path
- Various street designs corresponding to the urban context

b. Nannie Helen Burroughs Ave. Great Street (since 2010)



Project area. ©2016 Google

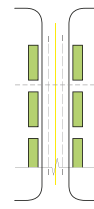


Project area. ©2016 Google



- Various street designs corresponding to the urban context

c. Constitution Sq. (at First St. NE) (2010)



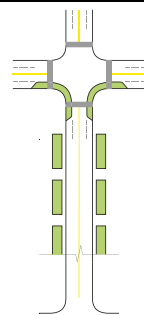
- Bench
- Outdoor sitting

Project area. ©2016 Google



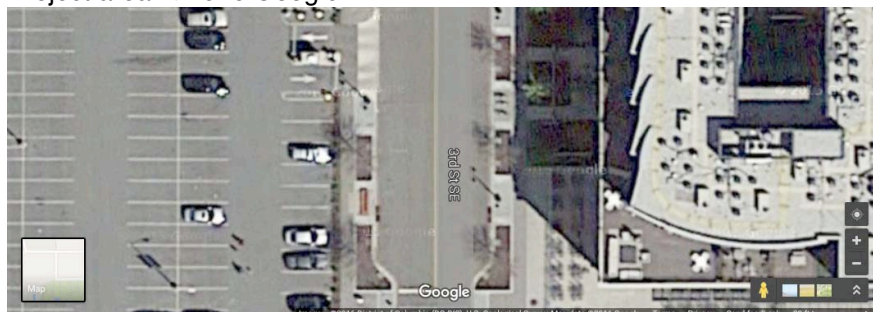
Plan view. Imagery ©2016 Commonwealth of Virginia, DigitalGlobe, District of Columbia (DC GIS), Sanborn, U.S. Geological Survey. Map data ©2016 Google

d. The Yards (3rd SE St. and Water St. SE)



- Bench
- Outdoor seating

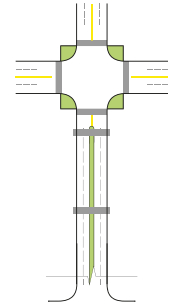
Project area. ©2016 Google



Plan view. Imagery ©2016 District of Columbia (DC GIS), U.S. Geological Survey. Map data ©2016 Google

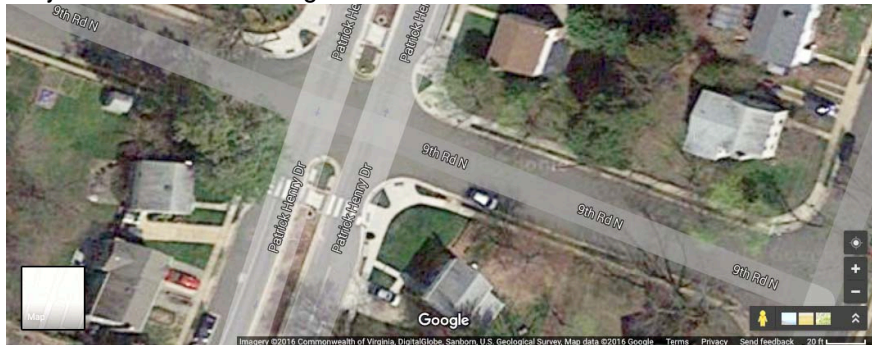
Arlington, VA

a. Patrick Henry Dr. (2011)



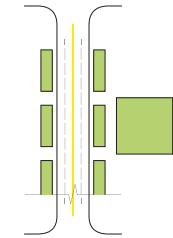
- Safe pedestrian crossing

Project area. ©2016 Google



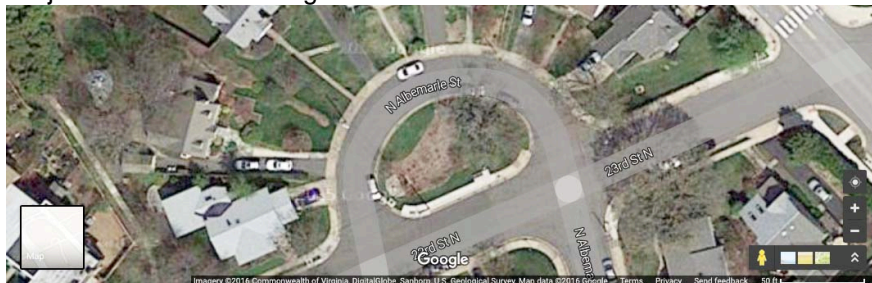
Plan view. Imagery ©2016 Commonwealth of Virginia, DigitalGlobe, Sanborn, U.S. Geological Survey. Map data ©2016 Google

b. Albemarle St. at 23rd St. (2011)



- Bench

Project area. ©2016 Google



Plan view. Imagery ©2016 Commonwealth of Virginia, DigitalGlobe, Sanborn, U.S. Geological Survey. Map data ©2016 Google

* Green shading in the first column indicates a Green Street that was applied over multiple blocks.
 * Sources: experts' interviews, reports and websites related to each Green Streets project, Google Map, and Google Street View.

4.2. Typological Summary of Nominated Green Streets

Before examining the attributes of individual streets it seemed fitting to gain an overview of the characteristics of the nominated projects as a group. This sort of overview could be useful in determining the breadth of reach of current Green Street practice, as well as possibly gauging how well the palette of nominated projects represents the current status of practice in this area.

Table 4.2. summarizes the land use contexts in which the nineteen nominated projects are located and the nature of the stormwater management practices that incorporated into each. The nominated Green Streets projects cover a wide range of land use types. Streets in residential land use contexts were nominated most frequently (14 of the 19 projects), while the next most frequently cited land use was commercial areas. Because some of the nominated projects span more than a single land use category, other land use areas that related to the nominated streets include mixed use, institutional, industrial, public open space, and waterfront areas.

Among the types of stormwater treatment practices incorporated in the nominated projects, the Green Streets planter type was the most frequently applied facility. This might be because the planters can easily be made to fit smaller spaces by adjusting their width and depth (Expert 3B, 2014). Green Streets projects that were spread across multiple blocks frequently tended to incorporate multiple types of treatment practices. This may be due to the more variable site contexts and the greater area available for implementations.

Almost half of the stormwater management practices in the nominated projects were located in the mid-block area and within sidewalks. This corresponds to the frequent use of street planter type practices (Table 4.2), as these are used in both single block projects and those spanning multiple blocks, whether linear or a series of blocks in larger areas. Green Streets used in larger areas included the Gateway Green Street Master Plan, Tabor to the River, and Thomas Green Street Concept Plan (marked with light green shading in Table 4.1). These are all relatively recent projects, with phased plans that were still in the process of completion at the time the interviews were being conducted.

Table 4.2

Description of nominated successful Green Streets, with land use and practice types (see Figure 2.1).

Project/ Street Name	Land Use								GS Location on Street	Extended or Not		Size of the Structure	Shape Of the Structure		Scale						
	Parks & Open Space	Residential	Commercial	Mixed Use	Downtown	Business	Industrial	Institution		Water Front	Midblock		Intersection	Within Sidewalk		Extended From Sidewalk	Median	Cell Type	Swale Type	Planter: structured container	Retention
Seattle, WA																					
a. SEA Street (2 nd Ave. NW & NW 117th Street) (2000)																					
b. Broadview Green Grid																					
c. Growing Vine St. (btwn Alaskan Way & Denny Way) (2004)																					
d. Winslow Way Reconstruction in Bainbridge Island (btwn Ericksen Ave & Madison Ave N) (2011)																					
e. Thomas Green Street Concept Plan (since 2013) – in progress																					
Portland, OR																					
a. Holman Pocket Park and Green Street Bike Blvd. Project (NE Holman St. at NE 13 th Ave.) (2011)																					
b. SE Clay Green Street Project (btwn SE Ladd Ave. & SE Water Ave) (2012)																					
c. Gateway Green Street Master Plan (2008)																					
New York, NY																					
a. Westbourne Ave. & Bay 25 th St. Stormwater Green Street																					
b. Nashville Blvd. & 116 th Ave Stormwater Green Street																					
Philadelphia, PA																					
a. Columbus Square (at 13 th St.)																					
b. Pedestrian Plaza (at Stenton Ave. & E Washington Ln.)																					
Washington, DC																					
a. Georgia Avenue Great Street (since 2008)																					
b. Nannie Helen Burroughs Ave. Great Street (since 2010)																					
c. Constitution Sq. (at First St. NE) (2010)																					
d. The Yards (3 rd SE St. & Water St. SE)																					
Arlington, VA																					
a. Patrick Henry Dr. (2011)																					
b. Albemarle St. at 23 rd St. (2011)																					

4.3. Attributes of Nominated Successful Green Streets

The experts cited 18 attributes that they considered as contributing to the success of the projects they chose to nominate. These attributes are identified as “central themes” (CT) that derive from interview statements having similar meaning units. The central themes can be further categorized into “general themes” (GT), as explained in Chapter 3 and shown in Figure 4.2.

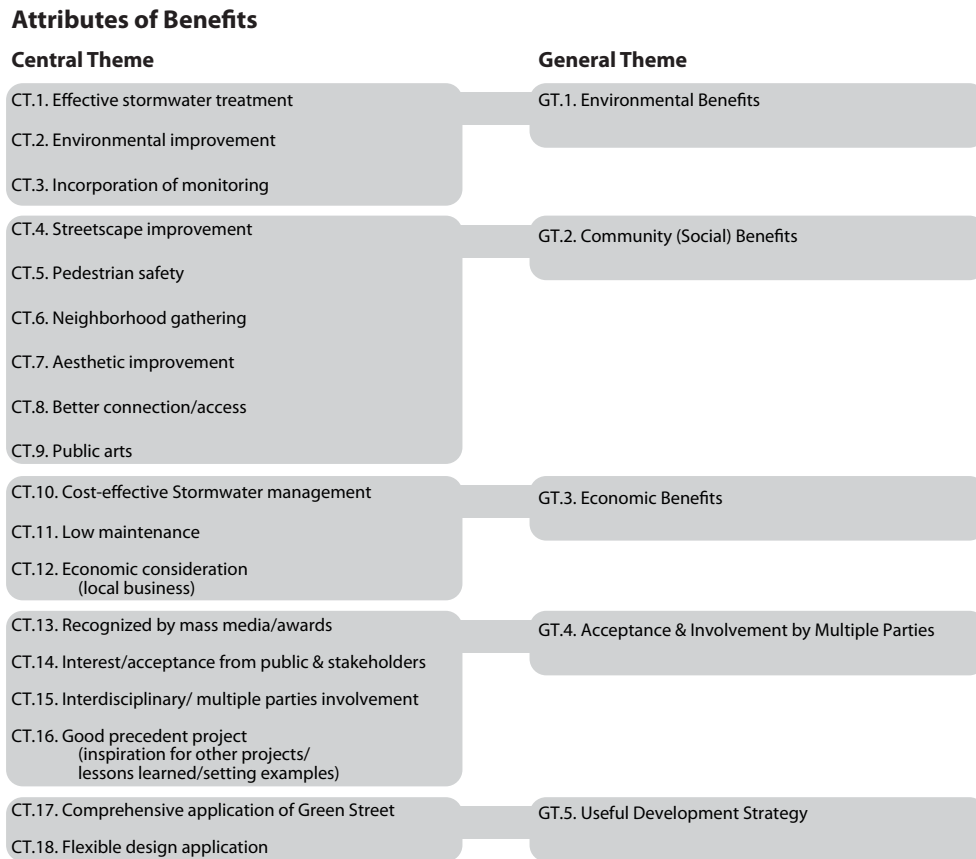


Figure 4.2. Summary of content analysis of successful Green Streets (See Appendix D-1 for details of the content analysis)

The first general theme identified with success is GT.1. Environmental Benefits. These benefits are expressed under three central themes: CT.1. Effective Stormwater Treatment; CT.2. Environmental Improvement; and CT.3. Incorporation of Monitoring. Considerations that are grouped under CT.1. include comments noting that Green Streets were located in places that required effective stormwater treatment, involving some consideration of the need to secure the available space to place stormwater

facilities in an urban setting (Expert 3A, 2014) and managing combined sewer overflows (Expert 1, 2014). Considerations that are grouped under CT.2. include: Green Streets were implemented for environmental improvement, specifically including the promotion of cleaner air, cooling air, and biodiversity benefits (Expert 2, 2014). Considerations that are grouped under CT.3. include: Green Streets incorporated monitoring equipment in the design (Expert 2, 2014).

The second general theme identified with success is GT.2. Community Benefits. These benefits are expressed under six central themes: CT.4. Streetscape Improvement; CT.5. Pedestrian Safety; CT.6. Neighborhood Gathering; CT.7. Aesthetic Improvement; CT.8. Better Connection/Access; and CT.9. Public Arts. All these are closely related to the promotion of the need to create better living environments for communities (Experts 1; 2; 3A; 4; 5; 6, 2014).

The third general theme identified with success is GT.3. Economic Benefits. These benefits are expressed under three central themes: CT.10. Cost Efficient Stormwater Management; CT.11. Low Maintenance; and CT.12. Economic Benefits. Considerations that are grouped under CT.10. include: A cost efficient approach could be achieved by optimizing the efficiency of stormwater treatment with lower cost materials and minimizing construction fees (Expert 5, 2014). An example of this was given as the use of trees for low cost construction (Expert 1, 2014). Considerations that are grouped under CT.11. include: Low maintenance techniques such as considering the locations of inlets and how soil replacement can be utilized in stormwater facility designs (Expert 2, 2014). Considerations that are grouped under CT.12. include: Concentrating on streetscape enhancement can be applied in Green Streets designs for the economic revitalization of a neighborhood (Expert 4, 2014).

The fourth general theme identified with success is GT.4. Acceptance & Involvement by Multiple Parties. These attributes are expressed under four central themes: CT.13. Recognized by Mass Media/Award; CT.14. Interest/acceptance from Public & Stakeholders; CT.15. Interdisciplinary/Multiple Party Involvement; and CT.16. Good Precedent Project. Considerations that are grouped under CT.13. include: Green Streets projects are recognized as successful when they receive awards or appear in a

magazine (Expert 3A, 2014). Considerations that are grouped under CT.14. include: Earning interest or acceptance from the public, which was also considered a sign of success (Experts 1; 3A; 5, 2014). Considerations that are grouped under CT.15. include: An interdisciplinary approach could be one of major characteristics in Green Street process, which was also treated as an aspect of success (Experts 1; 5; 6, 2014). Considerations that are grouped under CT.16. include: If a constructed project provides a good influence supporting the implementation of future Green Streets projects it is considered as successful (Experts 2; 4; 5; 6, 2014).

The final general theme identified with success is GT.5. Useful Development Strategy. These attributes are expressed under two central themes, namely CT.17. Comprehensive Application of Green Streets and CT.18. Flexible Design Application. Considerations that are grouped under CT.17. include: Green Street s' role as a comprehensive development approach could achieve a "wide range of benefits" (Expert 3A, 2014). Considerations that are grouped under CT.18. include: Green Streets were also integrated with existing city development plans as providing visions and were able to fit into various urban contexts (Expert 6, 2014).

The first three general themes (GT.1. Environmental Benefits, GT.2. Community (Social) Benefits, GT.3. Economic Benefits) clearly correspond to the well known "triple bottom line" dimensions of environmental sustainability (environmental, social, economic). The General Themes GT.4. Acceptance & Involvement by Multiple Parties, and GT.5. Useful Development Strategy address attributes of successful projects that render them more acceptable to the public and/or to the community of planners and designers. These are, of course, dimensions of social sustainability that extend beyond the immediate experience of a particular street and speak to the effectiveness of Green Streets as an approach to community development.

4.4. Frequency Counts of the Attributes of Nominated Green Streets

Table 4.3 summarizes the frequency with which each of the 18 central themes was cited in reference to the nominated successful projects. In data produced from structured interviews frequency counts must be carefully interpreted. They cannot be

taken as a direct measure of importance but instead represent some degree of the relative importance among the derived attributes. However, each attribute can still be considered one of the necessary elements for implementing Green Streets projects successfully.

Among the statements by experts referring to successful projects, only 10.4% (n=5) pertain to the central theme “Stormwater Management.” A slightly higher number (14.5% (n=7)) pertain to general theme “Environmental Benefits.” Yet, elsewhere in this research experts explicitly identified stormwater treatment as the primary goal to be achieved through the implementation of Green Streets (see Section 6.1.1). This may mean that experts take for granted its importance when speaking about successful projects. However, it is just as likely to point to the importance, in the minds of the experts interviewed, of various other attributes (or additional benefits) achieved due to the success of the Green Street projects implemented in their cities.

Surprisingly, the most frequently cited attributes of success fell within GT.4. Acceptance & Involvement by Multiple Parties, with 31% (n=15). This was followed closely by GT.2. Community Benefits, which captures the second largest portion of statements relating to attributes of success (29%, n=14). The content analysis was helpful in revealing a number of other attributes associated with success, including CT.14. Interest/Acceptance from the Public & Stakeholders, CT.15. Interdisciplinary/Multiple parties involvement, and CT.16. Good Precedent Project. More interesting still, these attributes cannot be found in the list of potential benefits or goals of Green Streets derived from the literature. Among the experts, economic considerations were the least frequently cited attribute of a successful project (0.1% (n=5)).

Table 4.3

Summary of content analysis for attributes of success in Green Streets provided by experts (including the reasons why the experts deemed these projects successful).

	Categories (General Theme)	Elements of Benefits/Success (Central Theme)	3. Seattle					1. Portland			2. NYC		6. Philadelphia			4. DC				5. Arlington		Frequency (CT)	Total (GT)	
			a	b	c	d	e	a	b	c	a	b	a	b	c	a	b	c	d	a	b			
Benefits	GT.1. Environmental Benefits	CT.1. Effective stormwater treatment				o		o	o		o									o		5	7	
		CT.2. Environmental improvement								o														1
		CT.3. Incorporation of monitoring									o													1
	GT.2. Community (Social) Benefits	CT.4. Streetscape improvement													o								1	14
		CT.5. Pedestrian safety				o					o												2	
		CT.6. Neighborhood gathering							o														1	
		CT.7. Aesthetic improvement							o	o		o			o						o		5	
		CT.8. Better connection/access					o	o	o											o			4	
		CT.9. Public arts								o													1	
GT.3. Economic Benefits	CT.10. Cost-effective Stormwater management								o											o		2	5	
	CT.11. Low maintenance										o											1		
	CT.12. Economic consideration (local business)													o				o				2		
Other Aspects	GT.4. Acceptance & Involvement by Multiple Parties	CT.13. Recognized by mass media/awards	o																			1	15	
		CT.14. Interest/acceptance from public & stakeholders	o		o		o	o												o		5		
		CT.15. Interdisciplinary/multiple parties involvement							o				o	o							o			4
		CT.16. Good precedent project (inspiration for other projects/ lessons learned/ setting examples)										o		o				o		o	o			5
	GT.5. Useful Development Strategy	CT.17. Comprehensive application of Green Street	o	o							o					o						4	5	
CT.18. Flexible design application													o								1			

4.5. Comparison of Attributes Cited by Experts with the Potential Benefits Identified in the Literature

In this section, the attributes of benefits/success achieved by the nominated successful Green Streets from Section 4.2 are compared with the range of possible benefits previously identified in the literature. The purpose here is to analyze which of

the possible benefits were actually delivered in the nominated successful projects. A list of potential benefits, goals and objectives associated with Green Streets was derived from the literature. The body of literature searched included, but was not limited to, manuals created by federal agencies such as the EPA and the LID Center (an EPA affiliated institution) and by municipalities with established reputations in this area such as the City of Portland (Metro) and Philadelphia (two of the sample cities for this study) were analyzed. The list of attributes derived from the literature are shown in Figure 4.3.

As the figure shows, most of the attributes cited in the literature were also cited by the experts with regard to their nominated projects. The only central theme present in the literature that did not appear in the interviews was CT9. Multiple Functionalities. In the projects nominated by the experts multimodal or recreational functions were not mentioned as an attribute of success.

On the other hand, the experts cited seven attributes of success that were not mentioned in the literature, namely CT.9. Public Arts, CT.11. Low Maintenance, CT.12. Economic Considerations (local business), CT.13. Recognized by Mass Media/Awards, CT.15. Interdisciplinary/Multiple Parties Involvement, CT.16. Good Precedent Project (inspiration for other projects/ lessons learned/ setting examples), and CT.17. Comprehensive application of Green Streets.

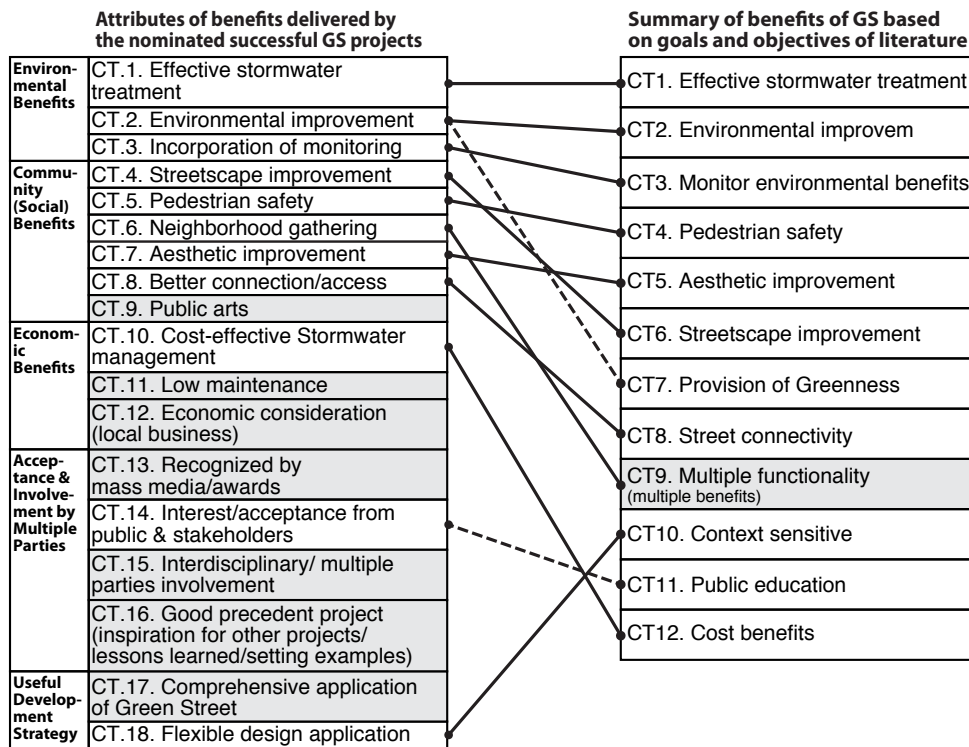


Figure 4.3. Attributes of benefits achieved by the nominated successful Green Streets by experts vs. attributes of benefits of Green Streets based on goals and objectives from literature.

4.6. Discussion

The results presented above demonstrate that only some of the attributes were addressed when frequency was counted for each city, despite the diverse range of attributes. For instance, in Seattle, CT. 13. Interest/Acceptance from the Public & Stakeholders was most mentioned in three of the five nominated projects. Although this was not mentioned in the literature, the experts clearly deemed it important for successful Green Street implementations. It can be inferred that as one of cities that has implemented a Green Street approach for the longest period of time, the experts have had a chance to realize that public interest and acceptance is important for such projects. Moreover, the Green Street projects in Seattle are mainly located on non-arterial roads and are typically placed in residential areas with relatively lower traffic and consequently lower concentrations of contaminants in their stormwater runoff. Residents are generally sensitive to changes in their living environments, thus

highlighting the importance of feedback from the public and stakeholders when implementing Green Streets in communities.

In relation to putting emphasis on the public acceptance, the Green Street projects in Seattle present a number of different design elements that could trigger public interest. For instance, the SEA Street and Broadview Green Grid incorporates a serpentine street that could help treat stormwater effectively and at the same time creates a unique spatial experience (see Table 4.1); the Winslow Way Reconstruction integrates street parking with stormwater planters as well as creating a pedestrian friendly environment by providing amenities such as benches and bike racks; the Growing Vine Street and Thomas Green Street Plan integrate various design elements into Green Streets, such as cisterns for harvesting stormwater, cascades for sloped streets, and works of art for cultural and social reflection.

When elements of success were compared with benefits suggested from Green Street implementation manuals, there was a case where the expert and the manual came from the same city. While many experts agree that there are common views toward success, the identified elements of success showed more variety than the benefits suggested in the current implementation manuals. This may suggest that more empirical research on Green Streets would be needed to identify the full range of potential benefits in practical applications to date. It also may imply that as Green Street practice becomes adopted in more localities there it will become necessary to update manuals to reflect current practical knowledge.

In Portland, CT.1. Effective Stormwater Treatment, CT.7. Aesthetic Improvement, and CT.8. Better Connection/Access were mentioned in two out of the three nominated Green Street projects. Of these, one includes an adjacent pocket park (Holman Pocket Park and the Green Street Bike Boulevard) and the other, which is connected to a waterfront area, spans multiple blocks (the Thomas Green Street Concept Plan). This may explain why connection/access (CT.8) was mentioned as one of important aspects by the local expert.

In DC, CT.12. Economic Considerations regarding the promotion of local business was mentioned in two of the four nominated projects. Both projects are located

in mixed use areas and incorporate outdoor furniture or patios that could encourage people to spend time in these places.

In Arlington, CT.16. Good Precedent Project was commonly mentioned in relation to both of the nominated projects. This might be explained by their relatively short history of implementing Green Streets, with few having been completed at the time of the interview. This could increase the importance of learning from past projects.

4.7. Summary: A Study of Attributes of Success Achieved by Green Streets

The attributes of the nominated successful Green Street projects varied somewhat but could be assigned to five general themes: environmental benefits, community benefits, economic benefits, acceptance & involvement by multiple parties, and useful development strategies (See Figure 4.2). The results indicate that for successful Green Street implementations, community (social) benefits and acceptance & involvement by multiple parties were cited more often than environmental benefits, economic benefits, and useful development strategy, with the number of elements listed in each category being n= 14, n=15, n=7, n=5, n=5, respectively) (see Table 4.3). Moreover, the elements that appeared with the highest frequencies appeared more often under the community benefits category (aesthetic improvement and better connection/access) and acceptance & involvement by multiple parties (interest/acceptance from the public, interdisciplinary/multiple parties involvement, and good precedent project), while stormwater treatment was the only element that had a relatively high frequency among elements with an environmental aspect. Those elements of success that are cited more often are clearly recognized as preferable goals and could thus serve as indicators for successful implementations.

When identified attributes of success in nominated projects were compared with the possible benefits of these projects suggested in the literature, seven more attributes of success emerged: three of these attributes (interdisciplinary or multiple-party involvement, being a good precedent project, and comprehensive application of Green Streets) had even higher frequency, as identified in Table 4.3. These seven additional benefits that were not found in the literature and that derived from experts' interviews

might be considered as goals and objectives in future projects, depending on the needs and contexts of the given sites.

Advocates of green infrastructure often state that the green infrastructure approach will be developed and continuously applied when it can achieve overall ecological, social, and economic sustainability goals. Green Street projects will also continue to be applied if they can keep providing sustainable benefits. The results (identified attributes of success achieved by the nominated Green Street projects) positively support that Green Streets can be planned and designed to provide those benefits. The nominated successful Green Street projects have provided multiple benefits that include sustainability considerations. These benefits can be seen as important elements of successful Green Street implementation with implications for continued future application by city planners and designers.

So far this study has looked at the attributes of success that Green Streets has achieved through built projects. In Chapters 5 and 6 (A Study of Considerations in Promoting Successful Implementation of Green Street), the focus will turn to how Green Streets can be implemented successfully to promote these benefits. The following two chapters also include a study of challenges and issues that arise during the implementation process.

Chapter 5. Methodology for a Study of Considerations in Promoting the Successful Implementation of Green Street: Analysis of research question 2

The first round of interviews included questions intended to provide an overview of the current status of Green Street planning and design practices. Analysis of that data suggests that an ability to manage and complete the implementation process has a great deal to do with the level of success experts achieved in their work. This observation changed the initial direction of the dissertation research from a focus on the physical design of successful Green Streets to a closer look at the implementation processes and actions required to bring them into a multi-step protocol. This chapter records the methods in each subsequent phase of the study as laid out in Chapter 6. The subsequent phases (see Figure 5.1) are described in the following paragraph.

The first section of Chapter 6 uses the first round of interviews to investigate experts' responses to general questions about Green Street implementation practices. This information is useful for understanding the considerations that go into the planning and design processes for Green Street implementation. The second section focuses more specifically on the experts' descriptions of the planning and design processes from the first round of interviews. It brings into focus how these overall considerations were integrated throughout different planning and design stages. The third section investigates four selected successful cases. The purpose of these more detailed interviews is to provide insights into what constitutes a successful project focusing on considerations that have not been found from the first round interviews. In the fourth section, a Green Street oriented process is derived based on the three analyses conducted in Sections 1 through 3. The object is to develop a framework that can be used when organizing considerations according to specific stages in the planning and design process. Planners and designers can refer to this framework for successful implementation of Green Streets, which can help to promote more Green Street implementation and further advancement of its knowledge as discussed in Chapter 1.

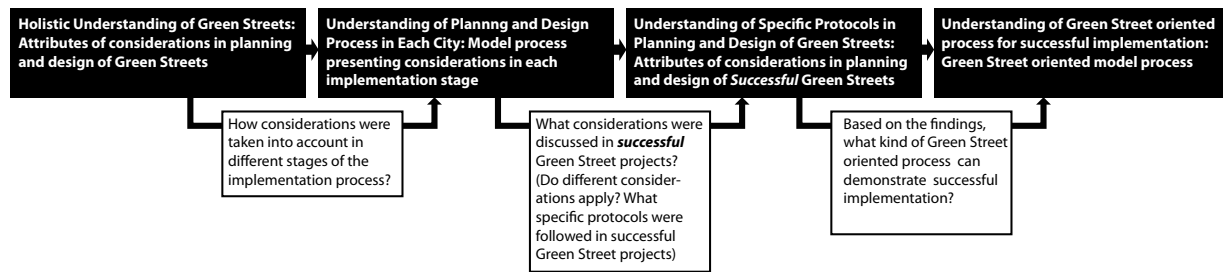


Figure 5.1. Successive steps of Chapter 6

This chapter consists of two sections focusing on the second research question: How can Green Streets be implemented successfully? The first section discusses how and why the data was collected while the second section presents methods of analysis.

5.1. Data Collection Methods

This section mainly describes methods used in the second round interviews. This sub-section first presents the rationale for the selection of sample cities and data collection methods (Sub-section 5.1.1). And then, it describes methods for the recruitment and qualifications of participating experts (Sub-section 5.1.2). The section concludes by outlining the interview protocol to describe the scope of the collected data (Sub-section 5.1.3).

5.1.1. Rationale behind Selection of Sample Green Streets for Case Studies and Data Collection Methods

Parts of the first round and second round interview data were analyzed to study considerations in the implementation of Green Streets: The parts of first round data collection is intended to present the variety, scope, and character of current planning and design practices for Green Streets in the six sample cities. The data also was used to study Green Street implementation processes in each sample city. The responses to these first round questions are reported in Chapter 6 Sections 1 and 2.

The second round data collection was designed to provide more detailed insights through four *successful* case studies. The case study approach was used “to build a body of criticism and critical theory” (Francis, 1999, p. 16) for studying specific

processes of the successful case projects and deriving a Green Street oriented planning and design process intended to achieve successful implementation. The study of four case projects included multiple data collection approaches (Eisenhardt, 1989), such as qualitative interviews (see Chapter 3 Section 1.1 for the qualitative interview method) and a literature review.

The four case projects were selected from the list of successful Green Street projects nominated by experts from the first round interviews. In addition, other successful projects frequently mentioned through websites of design firms or municipalities were included to allow for a variety of sample projects (e.g., using different topological conditions and stormwater facility types) and convenient data access (as in the case of a local sample project with sidewalk redevelopment). The selection criteria were the following:

- 1) Green Street projects nominated by experts from First Analysis.
- 2) Projects that received public praise from the media and local officials.
- 3) Projects presenting diverse characteristics regarding site contexts, design applications, and policies for breadth of planning and design.

The four selected cases of successful Green Street projects are: Broadview Green Grid, Holman Pocket Park/Green Street Bike Boulevard Project, Maynard Avenue Green Street Project, and College Avenue Promenade. The following brief descriptions introduce each sample project.

5.1.1.1. Broadview Green Grid

The Broadview Green Grid project in Seattle, WA, has a unique curvilinear street design that provides a different appearance from other typical residential areas. It included new sidewalks for pedestrian safety and measures to calm traffic. Clustered mailboxes were built to promote social exchange. Green Street stormwater treatment facilities were located between residential houses and the public right of way. A preliminary site visit allowed a view of how the drainage system works, with a network of

culverts connecting the Green Street facilities in front of each individual house to the stormwater drainage system.

5.1.1.2. Holman Pocket Park and Green Street Bike Boulevard Project

The Holman Pocket Park project in Portland, OR, creatively integrates an existing pocket park with a design that improves community safety. The new park was used for social gatherings, and children were able to come out and play in the street. In terms of stormwater treatment, diverse types of facilities were integrated into the design, providing various visual and spatial experiences. The design intervention (seat walls and a closed street) supported social gatherings at the park (Portland, 2011) and thereby addressed community needs despite limited funds for building additional amenities other than stormwater treatment.

5.1.1.3. Maynard Avenue Green Street Project

The Maynard Avenue Green Street project in Seattle, WA, is located in the international district. Its priority is to provide streetscape improvement by adding more green elements and integrating the arts and historical design into the project plan.

The project was built on a slope. Its topographical features provided a challenge to designers, but the project turned out to have a unique design: circular planters were connected with concrete conduits so that the rainwater was delivered into upper planters with a step down to a lower level of planters. The planters provided much-needed vegetation, which was otherwise lacking in this area. The street's design also focused on cultural and historical aspects of the area by integrating artistic tiles into seat walls, information signs, and the Japanese hand pump on the top of the system which were connected to the underground cistern and also helped irrigate the entire system of planters.

5.1.1.4. College Avenue Promenade

The College Avenue Promenade in Blacksburg, VA, is located in the downtown area adjacent to Virginia Polytechnic Institute and State University. The project focused

on improving the pedestrian experience, enhancing a sense of community by considering all users and activities, and promoting sustainable strategies and environmental stewardship. The main priorities were to improve the streetscape of College Avenue and to revitalize the area.

The project turned the originally two-way street into a one-way street with wider sidewalks. Wide sidewalks with large planters (majority of them were stormwater planters) were utilized as an outdoor sitting area for local restaurants. The stormwater planters were implemented along the street with raised walls all around them. The existing curbs were removed in order to provide easier pedestrian movement. More seats were added and the right of way was newly paved.

5.1.2. Recruitment and Qualification of Participating Experts

Participating experts were governmental officials who had managed or worked on Green Street implementation in selected successful cases. The experts were affiliated with various departments (as was the case in the first round interviews), including private firms and a non-profit organization. Table 5.1 presents descriptions of interview participants and details their experience in Green Street implementation or related tasks within their affiliated departments.

Target participants were sought through a protocol similar to that of the first round interviews. The participants were identified by experts interviewed in the first round and from lists of names printed in projects' reports and websites. Recruitment emails were sent to the participants to describe the research and set up interview dates. If the person contacted decided to participate, the interview was scheduled at a convenient time for the participant.

Table 5.1

Interviewees' background for the second round data collection.

	Identification Number	Affiliation	Position	Years Of Experience
Broadview Green Grid	7A	Public Utility	Strategic Communications Manager	5
	7B	Public Utility	Project Designer	25
Holman Pocket Park	8	Sustainable Stormwater Management	Project Designer	7
Maynard	9A	Dept. of Transportation	Project Manager	14
	9B	Depart. of Planning and Development	Project Manager	6
	9C	Nonprofit Organization	Project Manager	10
College Ave. Promenade	10A	Engineering	Director	26
	10B	Engineering Firm	Associate	35
	10C	Planning & Design Firm	Landscape Architect	.

5.1.3. Interview Protocol Design

As mentioned, parts of the first round data collection were used for a Study of Considerations in Promoting the Successful Implementation of Green Street: Analysis of research question 2. The interview protocol can be found in Chapter 3, Section 1 (Figure 3.1). The second round data collection was conducted for the selected *successful* Green Street projects. The framework for the questionnaire focused on investigating specific decision-making protocols of each case study: semi-structured qualitative interviews were conducted over the phone with open-ended questions. Based on the protocol, questions were geared toward individual projects to reflect their unique objectives, site contexts, and community needs (see Appendix B). The participants (i.e., governmental officials who worked on the selected successful projects) were interviewed by phone. In addition to the interviews, supporting documents, requested for each case study project, served as the basis for the analysis outlined in the next section.

5.2. Analysis

This section mainly discusses how the data was managed for a Study of Considerations in Promoting the Successful Implementation of Green Street: Analysis of research question 2. First, a content analysis was conducted to study aspects of Green Street implementation, with a focus on how Green Streets were planned and applied on the ground. Unlike the analysis in Chapters 3 and 4 (which focused on one question), the interview conversations corresponding to the first round interview questions were brought together first and grouped with similar themes. This was done because the content of each individual interview conversation was not always directly related to the question that was asked (see Figure 5.2). For instance, when asked, “Has the concept or priority (of Green Streets) evolved as time has passed in your city?,” one interviewee answered,

Yes, mostly in terms of design and how they are constructed. So the early one, the first one we put in in 2003, that was our curb extension on Siskiyu Street. And we have been looking at how they function. We needed to monitor to make sure that this was going to function and be effective for its intended purpose. ... We were able to adapt the design a little more. So we've certainly got through different iterations of [designing] the curb extension in terms of opening, how water gets in, dam materials, what kind of plants are really going to work for us, what plants do well [in] both wet and drought conditions, and inundated condition. ... We work closely with our Department of Transportation because these are in the right of way. They [green streets] have evolved over the year so they have wanted to see certain things happen, too. ... They want to ensure that these are going to last 100 years. ... And we've also worked with the Fire Department, too. Initially, they wanted a certain clearance for their vehicles. We have to make sure that we give at least 20 feet, curb to curb. ... About 11 years ago we started with one facility and now we are up to about 1400 individual green street facilities and in part of that it's because we also work closely with our partners in planning (Expert 1, March 11, 2014).

Two aspects of the conversation can be derived here. There first was some advancement in making Green Streets function better, but no real change of concept or priority had taken place because their Green Street projects were primarily put in as a solution for the problem of treating stormwater. Secondly, the acknowledgement that different departments were involved in the project indicates that it is interdisciplinary in

nature. The two aspects derived from this conversation are designated as central themes, “CT. Change in Priority Setting” and “CT. Involvement of Multiple Departments.” After this kind of first categorization for central themes, general themes (“GT”) were derived as grouping central themes.

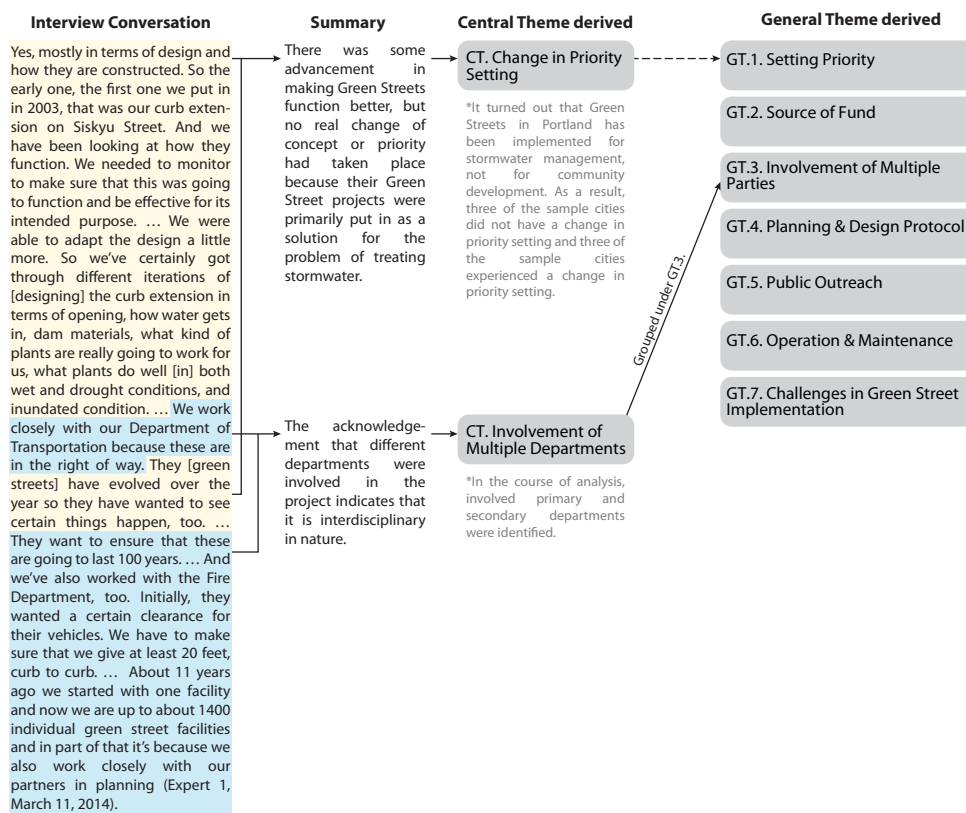


Figure 5.2. Content analysis protocol for Chapter 6 Section 1 based on the phenomenological method by Ratner (2002). Adapted from Cultural Psychology: Theory and Method (Chapter 5. Analyzing cultural themes in verbal accounts, p. 172), by C. Ratner, 2002, New York, NY: Kluwer Academic / Plenum Publishers. Copyright 2002 by Kluwer Academic / Plenum Publishers. With permission of Springer. (see Figure 6.2 and Appendix D-2 through D-8 for the complete content analysis).

Second, after the analysis of considerations in the planning and design of Green Street implementation, typical processes from each sample city are derived (see Figure 5.3). Data are based on the interview responses to the question, “What is a typical process of implementing Green Streets in your city?” In addition, some responses to other questions are also included if they relate to the implementation process. These data are organized following the simplified four-stage landscape planning protocol in

Chapter 2: project initiation, design, construction, and operation & maintenance (see Figure 2.4) with an inductive approach. This model makes it possible to thoroughly and easily present and compare derived processes.

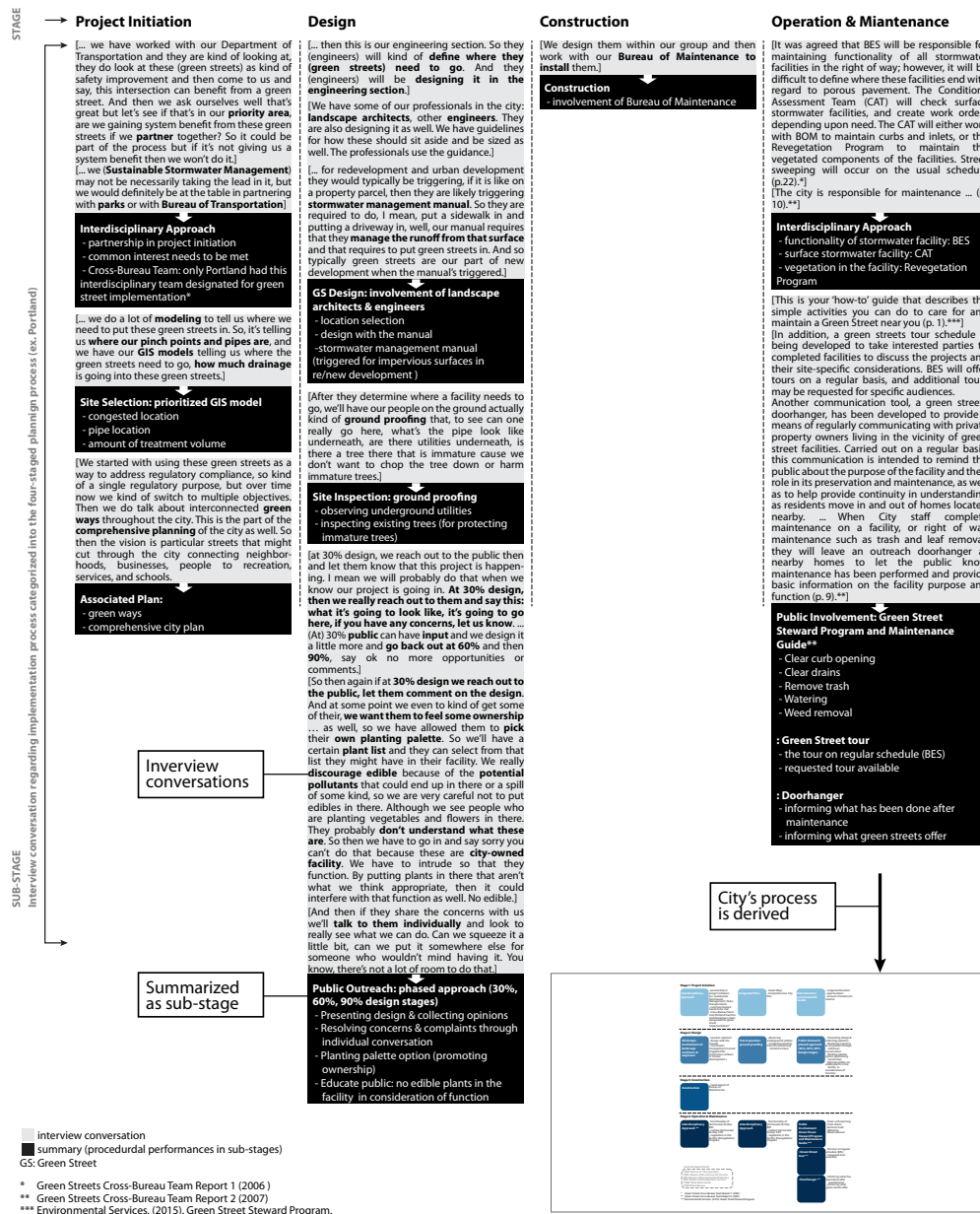


Figure 5.3. Protocol of summarizing project implementation process for sample cities (an example of Portland).

Third, the discussion of the second round interview focuses on distinguishing specific performances (actions in the decision-making process) that have been

conducted for four successful Green Street cases. These insights may only come to light upon consideration of particular protocols or actions that were not discussed in the first round of interviews involving an inductive analysis.

Finally, one general Green Street oriented process is singled out for analysis. It is based on the considerations identified, the six processes derived, and interviews with experts who worked on the selected *successful* Green Street cases. Figure 5.4 shows how results are derived from each section and put together into one process again, following the four-stage planning process: The process from each city was put together according to each stage; In each stage, sub-stages were grouped according to similar meaning groups; And, results from the second interview conversations were also categorized according to each stage and then grouped with similar sub-stages. A member check analysis was adopted in the process of creating it not only to increase validity (Hoffart, 1991), but also to develop the Green Street oriented planning and design process. The Green Street oriented process emerged from the data collected in the first and second rounds was presented to the experts. They were asked to evaluate the refined process, and the process was modified and finalized based on their judgments and recommendations.

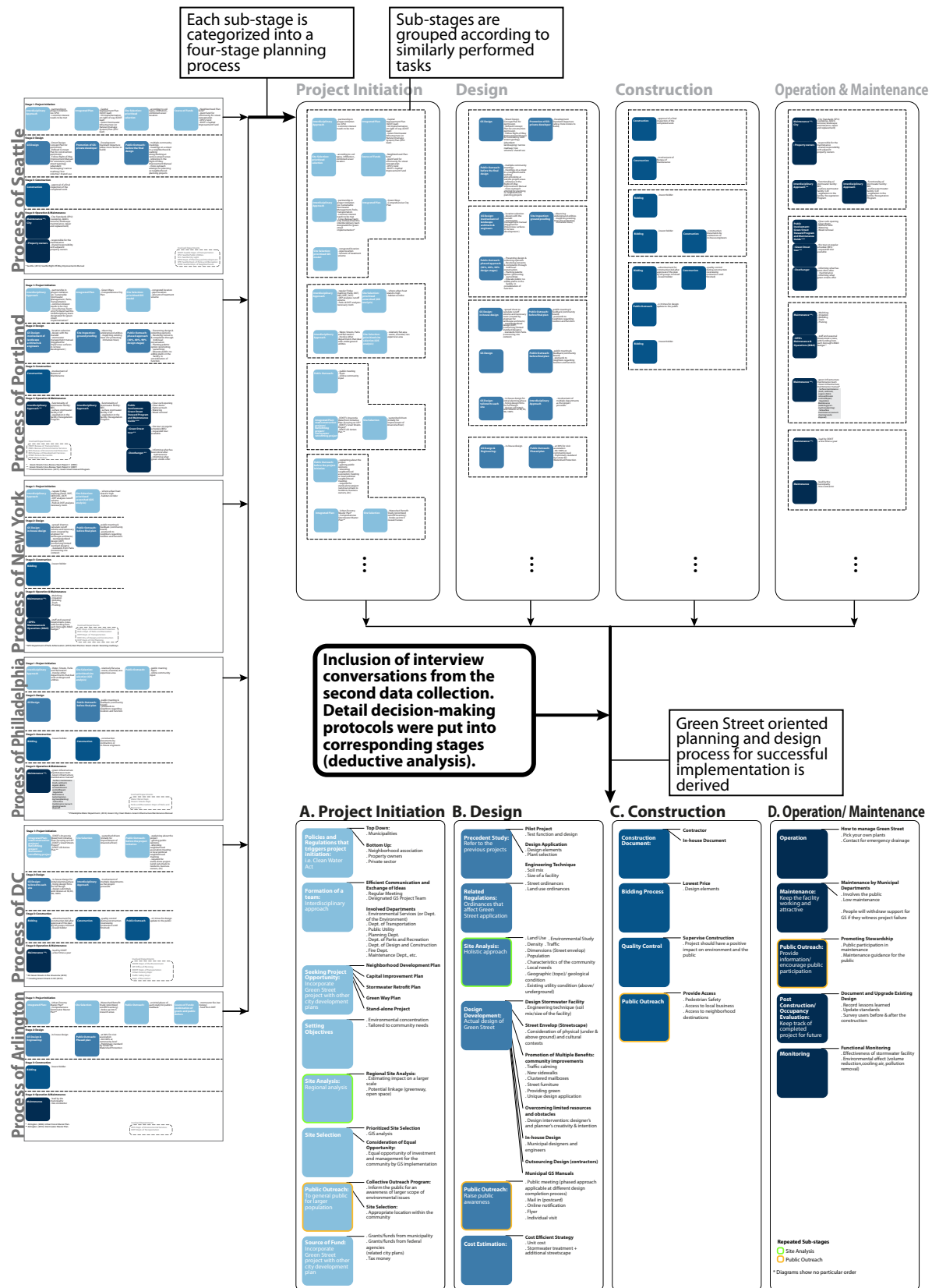


Figure 5.4. Protocol of developing Green Street oriented planning and design process.

5.3. Summary of the Chapter

Conducting qualitative interviews was the primary means of collecting data from experts for investigating general considerations concerning Green Street implementation and detailing considerations and actions taken in relation to implementing sample projects. Content analyses were mainly used as conducted in Chapter 3 using Ratner (2002) for in-depth qualitative analysis including inductive and deductive approaches. Documentary literature and case study research were used as supplements. The methods used here can be summarized as follows:

. Data collection

- 1) Semi-structured interviews with experts who worked on four successful sample projects
- 2) Literature review (construction document, project reports, etc.)

. Data analysis

- 1) Content analysis (cultural psychology, deductive, inductive)
- 2) Flow chart/diagram
- 3) Member check analysis

The content analysis was conducted to investigate participants' experience and insights in depth. Flow charts described the organization of the research. Diagrams were used for detailed summarization and comparison among different processes. Member check analysis was conducted to provide more validity in the final model process.

Chapter 6. A Study of Considerations in Promoting the Successful Implementation of Green Street: Analysis of research question 2

The study is intended to provide better understanding of necessary actions and protocols during different stages of an implementation process for successful results. It uses materials from the first round and second round interviews. The data from the first round interviews concentrate on considerations affecting overall Green Street implementation. The second round interviews focus more on detailed information regarding the four selected case projects. The chapter consists of four sections (see Figure 6.1). First, the current status of Green Street implementation in six sample cities is examined through a study of elements that need to be considered in the implementation process. The second section presents a model for successful Green Street implementation in the six sample cities. The third section is based on an in-depth study of the Green Street implementation processes that have been employed, focusing particularly on four successful Green Street cases. Finally, a Green Street oriented planning and design process is derived to provide understanding of successful implementation process for designers and planners based on the first section through the third section.

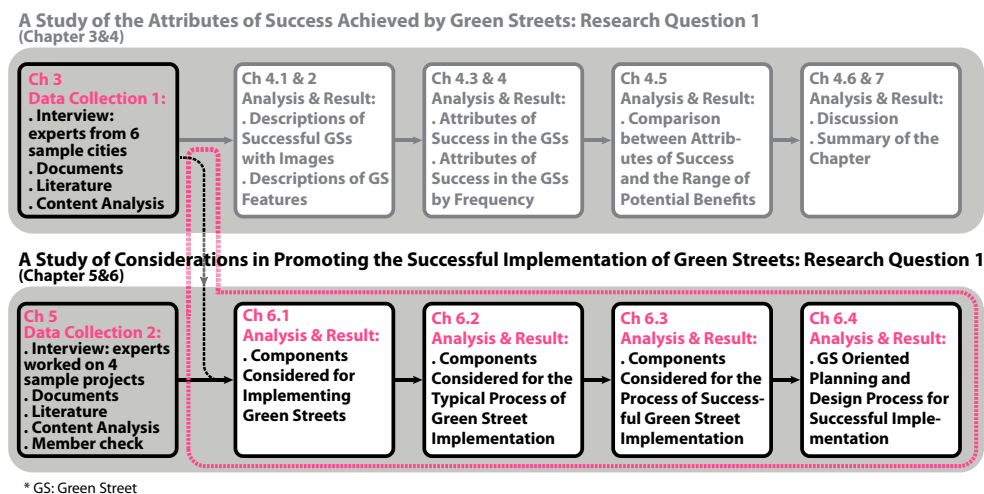


Figure 6.1. Composition of a Study of Considerations in Promoting the Successful Implementation of Green Street: Analysis of research question 2 (marked with the pink dotted line)

6.1. Attributes of Considerations in the Planning and Design of Green Streets

This section focuses on developing an understanding of Green Street approaches and identifying the considered elements that have affected the outcomes of Green Street projects. The elements are derived from the information gathered in the first round interviews with experts from the six sample cities (Seattle; New York; Washington, DC; Portland; Philadelphia; and Arlington, VA). Study participants were asked to describe various aspects of Green Street projects in their cities. The data were summarized first as central themes. There were thirty-one central themes, and these were subdivided into seven general themes (see Figure 6.2). Figure 6.2 presents what was discussed for Green Street implementation. A thorough examination of supporting documents such as municipal reports on Green Street projects and their web pages supplemented the discussion. The following sub-sections discuss specifics regarding the central and general themes derived from the analysis.

Attributes of Considerations in Planning and Design of Green Streets

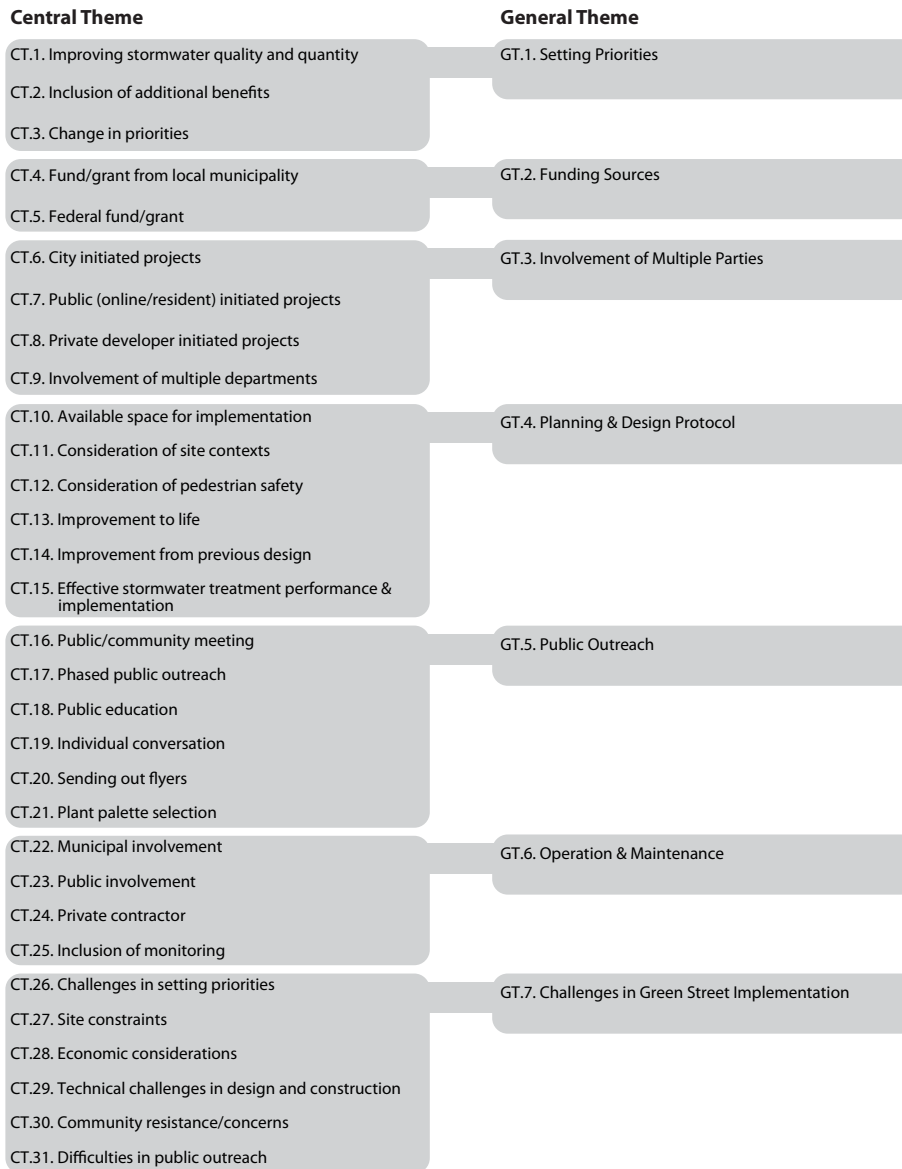


Figure 6.2. Attributes of Considerations in the Planning and Design Protocol of Green Streets

6.1.1. Attributes of Considerations in the Planning and Design of Green Streets: Setting Priorities. Central themes 1 to 3 (see Appendix D-2 for detail)

The first general theme identified with considerations in Green Street implementation is GT.1. Setting Priorities. The goals and objectives of a project are influenced by how priorities are set. Therefore, the study of these priorities could aid in understanding the actual reasons why the sample cities have implemented Green Streets. The considerations regarding GT.1 are expressed under four central themes:

CT.1. Improving Stormwater Quality and Quantity; CT.2. Inclusion of Additional Benefits; and CT.3. Change in Priorities. Descriptions of the interview contents will be followed by summaries of the central themes derived from the interviews.

In the case of Seattle, the expert interviewed first brought up the shift in priorities for the location's development as a Green Streets site. The expert explained that the project's initial goal was to provide a green space for the residents living and working near the site and to provide "social and health benefits." The site did not have a stormwater treatment function at that time. However, Natural Drainage Infrastructure Projects, initiated around 2000, began to shift the focus to stormwater treatment.

Green street was initially back in 1985. Program emphasis on making streets green was largely because to resolve the adequate park areas accessible to the wide range of people who live and work in this Seattle area. So we wanted to use street right-of-way to create linear park so that people who work and live in close proximity to park land still have an ability to enjoy green areas around their living and working environment and could have the environmental, social and health benefits of having close access to green, trees, parks, and just a nice balanced urban environment. So primarily just to have a green space, back in 1985 and since then, probably around in 2000, Seattle Public Utilities initiated what we called Natural Drainage Infrastructure Projects ... what we got is an evolution of green elements implemented in the right-of-way [that] began back in 1985, but has evolved over time and most recently taken on stormwater as a major aspect in 2011, 2012, 2013, time frame (Expert 3A, personal communication, March 20, 2014).

The Natural Drainage Infrastructure Projects focused mostly on treating stormwater, and many projects have been constructed under the plan. In addition to pursuing the treatment of stormwater runoff, it was also found that these projects address environmental considerations, as discussed below. These environmental considerations focused on additional benefits that Green Streets could provide other than stormwater management for promoting a better community environment.

I was a landscape architect in the project called SEA Streets and a subsequent project called Broadview Green Grid and Pine Hurst Green Grid. These were projects, [the] primary goal of them was to process stormwater but to do it in a way environmentally balanced to people: better neighborhood, better place to live, slow down traffic, give people as much space as could be,

afforded for pedestrian accessibility and pretty [much] discouraged driving (Expert 3A, personal communication, March 20, 2014).

Planning considerations now went beyond achieving environmental balance and included the additional benefits of meeting transportation needs since Green Street projects are implemented within rights of way. Considerations of sustainability and acceptance by the community were also mentioned:

I would have to say, and that [environmentally balanced approach] was sort of middle ground now, we are working on sort of I would call them templates, a general layout for use for any large agency like Seattle Public Utilities, King County Installation of Green Infrastructure in Neighborhood, doing it in a way that meets our transportation responsibilities because right-of-way is catered primarily for transportation. So we have to make sure transportation needs are met but at the same time we need to make sure these installations are maintainable and sustainable and that they are acceptable to the community (Expert 3A, personal communication, March 20, 2014).

New York was also one of the cities that experienced changes in its priorities regarding a Green Street project: the shift was from providing greenness using the right of way to stormwater runoff treatment. The initial green streets were geared more toward “horticultural goals, beautification, and promoting open spaces,” as mentioned below. Their priority did not begin to shift toward stormwater treatment until the Sustainable Stormwater Management Plan came out alongside the Green Infrastructure Plan (2010), which was a long-term plan published by the New York City Department of Environmental Protection.

Since 1996, [the] New York City Parks Department was building green streets, but those green streets actually were not designed to catch the stormwater from the street. We were actually designing with more of a horticultural goal, pedestrian safety and working with NYC Transportation, so [we tried to] make intersections more safe, beautify the city, and harvest more open spaces. And it’s more after Mayor Bloomberg’s Sustainability Plan, called PlanNYC, came out in 2007. So that Sustainability Plan really pushed stormwater capture and was made to increase incentives to capture stormwater, so part of that PlanNYC there was the plan called

Sustainable Stormwater Management Plan in the following year, 2008, that plan really pushed the stormwater management. So in my division, that's around when I started, 2008 during my internship. And my boss sort of asked me to figure out whether there is a little technique that we begin working with. They started to put in little turf plots and try to bring a little more water into it throughout the city (Expert 2, personal communication, March 17, 2014).

With an emphasis on treating stormwater, the Green Infrastructure Plan focused on a new set of priorities: sewersheds, enhancing the city's stormwater capturing capacity, relationships with other infrastructure elements, maintenance and connectivity to green spaces, etc. (NYC Department of Parks & Recreation, 2014).

They start coming up with a priority sewershed and they negotiated with NY State DEC (Dept. of Environmental Conservation). They developed their plan with green infrastructure, approved it with the state, to meet the water quality goal. Because our city has to report to the state for meeting the federal water quality goals (Expert 2, personal communication, March 17, 2014).

According to the expert, Green Street projects were intended to be implemented as much as possible within the priority sewershed. This kind of aggressive approach to stormwater mitigation and stand-alone type Green Streets has resulted in more than 2,000 Green Streets in New York City alone.

It [Green Streets] is not just about redevelopment. What we are building is going block by block, down every single street, in the priority sewershed (Expert 2, personal communication, March 17, 2014).

Washington, DC, was another city that first adopted a street improvement approach without the stormwater treatment consideration, only to include one more recently. The Great Streets initially focused on improving streets rather than stormwater treatment. Over time, as the approach began to consider sustainability, the Green Street approach was included (as mentioned below). Additional benefits may have been promoted in relation to road improvement and economic development.

So there is another big road improvement initiative, called Great Streets Project with DC where we are looking at some corridors, road corridors that were disadvantaged lower income. The city focused on the road improvement, and streetscape improvement, and economic development into those corridors. And sustainability was also a component of that program, so that created green streets on those roads as part of the road improvement and economic development. We also focused on making them Green Streets, so that was the driver for improvement, for economic development, where the city wants to focus on development. One very successful corridor, H Street NE corridor where it had been in decline for 30 to 40 years, probably 30 years. And it was one of the first great street programs, the road improvement, neighborhood improvement and it's a really thriving corridor. Now that has a lot of businesses and a lot of new residential areas. It's a very hot place for people - someone to live within DC. It doesn't have a stormwater management like we think of now the street would capture the stormwater, but it did focus on improving street planting and green space, and parks. ... It does not have the stormwater facilities. That was an early Green street. So the early green street didn't include all the stormwater management that we include now, but it helped push other projects along (Expert 4, personal communication, April 1, 2014).

There was other plan called Anacostia Waterfront Initiative, which mainly focused on treating stormwater runoff in order to improve water quality in the river. This project was more concerned with watershed and the improvement of the river with a low impact development approach. Therefore, it was more focused on managing stormwater runoff than the Great Street Projects.

One of the early drivers, really focusing on cleaning up the rivers, it's called Anacostia Waterfront Initiative and there was a big planning effort in the city that focused on putting development and [improved] infrastructure, roads, and bridges around the Anacostia River. And a core component of that effort was sustainability. And so that started about 15 years ago. That plan was adopted in 2000 and from that, DDOT, our Department of Transportation, developed an Anacostia Waterfront Initiative Plan, which included standards, architectural standards, which focused on low impact development. ... A lot of initial work has been watershed driven, so the watershed has defined the priority, initially looking to improve the Anacostia River. (Expert 4, personal communication, April 1, 2014).

According to an expert, priority for Green Streets in Portland was given to treating stormwater runoff with consideration of their combined sewer overflows. The Green Street concept in Portland has been implemented as an integral part of the city's five-year program, the Capital Improvement Program (CIP) (2010) and Comprehensive Plan (1980) of the city. Portland has a relatively long history of Green Streets, along with Seattle, compared to other cities in the United States. The city's reasons for choosing to treat stormwater using the Green Street approach were to reduce combined overflow (CSO) events, save money, and improve water quality as described below.

... we are obligated to put Green Streets in where they will give us the system benefits, so for example, our combined sewer overflows, we were implementing Green Streets and green infrastructure to reduce our CSO events to the river. So by putting Green Streets in we are able to keep stormwater out of the pipe and save repair dollars at the same time. We don't have to treat as much of this, essentially cleaner water than the wastewater, so we save our costs with Green Streets. We also put them in for water quality purposes as well, where there may be an impact on some of our rivers and streams. If that runoff goes into it, a system that would receive [a] stream, we are getting water quality benefits. And now our CSO, [a] big pipe fix to CSO with [a] 20-year project, it ended in 2012, I think. And so now our big focus in continuing with our pipe system work is integrating Green Streets along with this gray or pipe solution. We have areas of town where the pipe is just not big enough to carry both stormwater and wastewater from homes and businesses. So we can save money by putting Green Streets in rather than going in, digging up the pipe, and putting in a bigger pipe to manage all that (Expert 1, personal communication, March 11, 2014).

As in Seattle's Green Street approach, Green Streets in Portland focuses first on treating stormwater and then on how other potential benefits could be added. Additional benefits discussed mostly came from vegetation used in the stormwater facility. However, the city will not proceed with Green Street projects if they do not contribute to stormwater management.

Our primary use of the green street is to benefit our system and then knowing that these are green features, we know that we are getting additional benefits out of the plants that we are putting in. [It] helps cool the air, evapotranspiration of the runoff, and beautification in

neighborhood which increases livability. And we also say that if you were to choose to walk down [a] street that has vegetation versus one that doesn't, I think you are more inclined to walk down the one with the vegetation. In doing so we are creating avenues of green. That's another benefit, getting people out, walking or biking and doing it safely because it also provides [a safety] element. If a green street was at the corner of the block, rather than parked cars, then pedestrians can actually see around the green street more easily when they are crossing the street than if the car is parked there. So [Green Street provides] safety features for pedestrians and also helps slow down the traffic, too (Expert 1, personal communication, March 11, 2014).

Philadelphia has also emphasized stormwater treatment in Green Street projects. As with NYC's long-term green infrastructure plan, the Philadelphia Water Department initiated Green City Clean Waters, which was a 25-year plan to improve their watersheds using green infrastructure, with Green Streets as part of its plan. Like Portland, Philadelphia made CSO mitigation their priority, as the comments below indicate. The green infrastructure plan also stated other social and environmental benefits, but the main priority remains treating stormwater runoff.

Our primary driving factor in Philadelphia is on CSO regularly. We are regulatory driven in terms of installation of any green infrastructure. ... That program (Green Stormwater Infrastructure Implementation Program) is just applicable for the identification, clarification, and the design of our publically funded green stormwater infrastructure. So, [it is] basically infrastructure that the department ends up owning. This is the reason that we are installing this part of our Green City Clean Waters plan, but it's essentially our long-term control plan in terms of compliance for our CSO overflow mitigation. That agreement includes a requirement over the next 25 years for [the] construction of green stormwater infrastructure in Philadelphia. ... And we have to construct 9500 green acres over the 25 years of the plan. So we use green streets as well as a number of other different programs to reach this goal (Expert 6, personal communication, July 10, 2014).

Priority in the last program examined here, Green Streets for Arlington, was initially given to treating stormwater runoff. A Watershed Retrofit Study (completed in 2013) in Arlington was conducted to add stormwater facilities to areas where they were needed (Expert 5, April 3, 2014). Green Streets can be a useful approach for a watershed retrofit, with site selection prioritized according to runoff reduction, pollutant

removal, alleviation of drainage problems, education and outreach, constructability, and maintenance (Arlington, 2015a). A Green Street in Arlington may also be part of a Neighborhood Conservation Project (Patrick Henry Green Street, 2011). However, as of yet, the city's Green Street plans are at an early stage, with only a few projects being constructed—and here again the focus is on stormwater mitigation. Other benefits such as streetscape improvement have, however, been considered in other plans, such as Complete Streets.

We have [a] prioritization matrix that we used to rank projects. There are several factors included in that. One of them was a potential phosphorous [contaminant] that could be removed. Another was constructability, so there were utility conflicts. Then there were other factors such as where we're also meeting another county's need, such as solving a drainage problem. Then there was education, [which] was a component of that prioritization process. When we were in the field what we were looking for was sites that had a drainage area of half an acre or more, and we are looking for them to have a slope of less than 5%, enough surface area for the Green Street facility, and available connection to our stormwater structure. ... Green Streets from our stormwater perspective is, it's solely streets that have a vegetated stormwater component. And they may also have a permeable pavement component. But they are primarily stormwater projects in the larger context of Arlington. We refer to streetscapes as Complete Streets, and I think for other localities the term Green Streets might be used instead of Complete Streets (Expert 5, personal communication, April 3, 2014).

To summarize, stormwater management was a common priority for all of the six sample cities. It includes reducing combined overflows, improving water quality, and cleaning up rivers by considering site conditions or watersheds. The introduction of Green Streets in general is primarily based on the requirements laid down by the new Federal Water Quality Standards, which "are the foundation for a wide range of programs under the Clean Water Act" (Environmental Protection Agency, 2014c. para. 3), with the main objective being to treat stormwater runoff on site. The Clean Water Act (CWA) program specifies Total Maximum Daily Loads (TMDL) and requires states to control their water quality and to have in place a control plan to accomplish this. It also requires a Nonpoint Source (NPS) Program to be implemented to mitigate nonpoint

source pollution, for which Green Street projects are particularly well suited. Therefore, these regulations at both federal and state levels would have inevitably influenced the process of setting the priorities in all the Green Street projects. These interview contents were categorized as the first component considered: CT.1, Improving Stormwater Quality and Quantity.

In addition to the stormwater management consideration, additional benefits were also mentioned as priorities in building Green Streets in Seattle, Portland, and Philadelphia. The most prominent benefits were neighborhood improvement, traffic calming, traffic functionality, environmental improvement, public acceptance, maintenance, and cost effectiveness. It appeared that Seattle would be the city that considered stormwater treatment on an equal footing with these additional benefits. Seattle's land use designation for Green Streets, which emphasizes right of way improvement, may also have influenced the city's priorities in promoting other benefits in addition to stormwater treatment (Expert 3A, 2014). However, two cities, Portland and Philadelphia, presented relatively passive plans with respect to these additional benefits. Portland pointed to the additional benefits of designing their projects to include vegetation, which was originally used for treating water (Expert 1): "we are getting additional benefits out of the plants that we are putting in." The additional benefits were: cooling the air, evapotranspiration, and neighborhood beautification (Expert 1, personal communication, March 11, 2014). However, this expert also mentioned that "if it's not giving us a system benefit then we won't do it" (Expert 1, personal communication, March 11, 2014). In the case of Portland, the expert emphasizes that stormwater management is the main priority, with additional benefits such as the positive effects of including plants in the stormwater facility playing an incidental role. In the case of the Philadelphia project, the expert only briefly mentioned cost effectiveness as an additional benefit.

Other benefit the experts mentioned was the cost effectiveness of treating stormwater directly. Green Streets could treat stormwater runoff before it got into storm/sewer systems; therefore, treatment money could be saved by reducing

pollutants in the runoff. Green Streets also helped save money by obviating the need for big pipes to treat stormwater (Expert 1; Expert 6, 2014).

The additional benefits that accrue from the Green Street projects in most of the sample cities were not seen as proactive components of these projects in the eyes of the experts when discussing project priorities. This result somewhat conflicted with the conclusion in Chapter 4 Section 1 that additional benefits were as important as stormwater treatment for successful Green Street implementation. The findings of Section 4.1 suggest that additional benefits also need to be treated as primary priorities for successful Green Street implementation. This theme was categorized as CT.2, Inclusion of Additional Benefits.

Some of the cities examined here changed the priorities of their Green Streets projects over time. Seattle, New York, and DC had Green Street programs that did not serve a stormwater management function. Rather, they focused on other benefits, such as pedestrian safety, beautification, and health benefits, by creating green areas using right of way. Only later were stormwater facilities installed after priorities shifted to treating stormwater, in compliance with stringent stormwater management laws. In the case of Seattle, the initial intentions of improving streetscapes and providing a better living environment appear to have remained intact, even after the priority for their Green Streets has shifted to stormwater management. These themes were categorized as CT.3, Change in Priorities.

Table 6.1.

Priorities of Green Street implementation and initiation of Green Streets (the orange color indicates cities with a longer history).

	New York	DC	Seattle	Portland	Philadelphia	Arlington
Change of Priority (concerns)	Streetscape improvement ↓ Stormwater Mitigation (CSOs)	Streetscape improvement ↓ Stormwater mitigation	Streetscape improvement ↓ Stormwater Mitigation (CSOs)	Stormwater Mitigation (CSOs)	Stormwater Mitigation (CSOs)	Stormwater Mitigation (volume/quality)
First Green Street Project Constructed/Introduction of Green Street Plan	Furmanville Ave., 80th St., & Dry Harbor Rd. Queens, NY (2010)/ Green Infrastructure Plan (2010)	F St SE between 33rd St & Minnesota Ave SE (2005)/ DC Plan (2013):	SEA (Street Edge Alternative) Street project, Seattle, WA (2000)/ Natural Drainage System (2000)	NE Siskiyou Green street Project, Portland, OR (2005)/ Sustainable Stormwater Management (2007)	. / Green City Clean Waters (2009)	Patrick Henry Drive Green Street (2011)/

Again, in terms of setting a priority, stormwater management was the most important goal to achieve—with some secondary considerations of promoting additional benefits for surrounding communities. This change of concept due to the growing awareness of the need to place a higher priority on stormwater management has been a big driver for each municipality to introduce Green Streets, although this might have had the side effect of skewing the concept toward a single purpose.



Figure 6.3. Attributes of considerations in the planning and design protocol for green streets: Setting priorities

6.1.2. Attributes of Considerations in the Planning and Design of Green Streets: Funding Sources. Central themes 4 to 5 (see Appendix D-3 for detail)

The second general theme identified with considerations in Green Street implementation is GT.2. Funding Sources. According to the Environmental Protection

Agency (2014b), limited funding opportunities are a common impediment to implementing green infrastructure. However, the agency also states that green infrastructure can provide various benefits and can therefore qualify for funding through various direct and alternative channels. Moreover, funding is one of critical elements that influences setting priorities and enabling successful completion of a design project. Therefore, the study of funding sources and related plans can provide an opportunity for looking into how sample cities secured funds to complete Green Street projects and why the priorities were geared toward stormwater management. The considerations regarding GT.2 are expressed under two central themes: CT.4. Fund/Grant from Local Municipality and CT.5. Federal Fund/Grant. Following a description of each city's funding and related plans, a summary of the central themes will be used to organize a run-down of possible funding sources.

City development plans, including Green Streets, are often linked with funding sources. The primary municipal plans that included Green Streets in each of the sample cities according to the experts were: the Green Stormwater Infrastructure Plan and Capital Improvement Plan (Seattle); the Natural Drainage Infrastructure and Comprehensive Plan (Portland); the Green Infrastructure Plan (NYC); Green City Clean Waters and large construction projects by the Streets Department (Philadelphia); the Complete Street Plan, the Sustainable Plan, and the LID Action Plan (Washington, DC); and the Stormwater Master Plan and Urban Forest Master Plan (Arlington). Although they have all adopted the Green Street approach, these plans generally consist of a mix of stormwater driven objectives and other complicated municipal development objectives (see Table 6.2).

Table 6.2.

Municipal plans integrated with Green Streets.

City	Municipal <i>Stormwater</i> Driven Plans	Municipal <i>Community Improvement Plans</i>
Seattle, WA	<ul style="list-style-type: none"> • Green Stormwater Infrastructure (Natural Drainage Systems) • Neighborhood Plan 	<ul style="list-style-type: none"> • Capital Improvement Plan
Portland, OR	<ul style="list-style-type: none"> • Sustainable Stormwater Management 	<ul style="list-style-type: none"> • Comprehensive Plan
NYC	<ul style="list-style-type: none"> • Green Infrastructure Plan 	<ul style="list-style-type: none"> • N/A
Philadelphia PA	<ul style="list-style-type: none"> • Green City Clean Waters 	<ul style="list-style-type: none"> • Construction Project from Streets Dept.
Washington DC	<ul style="list-style-type: none"> • LID Action Plan (2010) 	<ul style="list-style-type: none"> • Complete Street Plan • Sustainable Plan
Arlington, VA	<ul style="list-style-type: none"> • Stormwater Master Plan 	<ul style="list-style-type: none"> • Urban Forest Master Plan (Environmental improvement oriented)

Often, stormwater mitigation oriented projects were funded by municipal departments responsible for environmental management (such as Seattle’s Public Utility and Portland’s Bureau of Environmental Service), while other funding could be raised through sewer or stormwater management fees. Experts from New York, DC, and Arlington stated that part of their funding came from stormwater related bills. Some of the municipal plans mentioned above were funded by money for right of way construction from the Department of Transportation and grants from the EPA, such as the Wet Weather Fund, described below.

Seattle: Often times it comes from neighborhood plan and we would either be asked if it’s initiated by the community, often times, they’ll get grants funding to develop the street concept plan or Seattle Planning & Development (DPD) already has funds as part of the planning process for the neighborhood plan to contribute to the development of the street concept plan. Or, if it aligns with a capital project, Seattle Department of Transportation (SDOT) will put force money for that planning effort (Expert 3A, personal communication, March 20, 2014).

Portland: We are Stormwater (SW) and Wastewater (WW) Utility. A lot of our funding comes from repairs and so our number one obligation to repairs is to use their dollars effectively that will manage the urban runoff and provide the multiple benefits (Expert 1, personal communication, March 11, 2014).

New York: ... after Green Infrastructure Plan, DEP started to build green infrastructure sites. They started to fund Park Service to build green streets in the priority sewershed. They start coming up with a priority sewershed and they negotiated with NY State DEC (Dept. of Environmental Conservation) (Expert 2, personal communication, March 17, 2014).

Philadelphia: For the projects that I'm specifically working on are publicly funded projects. This is our capital funding for the department. We do get a few grants. That's part of having a regulatory compliance driven program. The department, as part of the compliance agreement, it's going to spend about [a] billion dollars on green infrastructure over 25 years. So in addition to that, our stormwater regulation development, obviously that gives public funding, no private funding involved because that will be as part of development (Expert 6, personal communication, July 10, 2014).

DC: If it's a part of the road construction project, it will come from the road construction budget. And most of that is funded by Federal Highways. Most of our road projects are funded by the Federal Highways Administration. When they are stand-alone projects, almost always come from local funding. The district has a stormwater runoff fee and stormwater management fee that residents pay on their water bill. ... We also get projects from EPA, that's where we take funding from EPA through the Clean Water State Revolving Fund, so we usually are pulling together, lots of different funding sources to make the projects happened (Expert 4, personal communication, April 1, 2014).

Arlington: As a main funding source is public dollars. We have a stormwater fee, which is a tax. It's a part of the real estate tax. And that is used to fund the stormwater projects. To [a] large extent, some of the transportation project, initiated by our Department of Transportation has been partially granted on that (Expert 5, personal communication, April 3, 2014).

New York and DC reported receiving federal funds and grants from the EPA and Federal Highways Administration. The federal stimulus money New York received in the early stages of its Green Street projects later became the basis for further

implementation of Green Streets in the city: “I applied to the federal [government] for Stimulus Money to build 26 green streets in [the] Bronx, Queens, and Staten Island. So, that, kind of, gave us a lot more practice with building stormwater capturing for me and landscape architects” (Expert 2, Personal communication, 2014).

In summary, experts identified two primary groups of funding sources: fund and grant opportunities from municipalities and similar opportunities from federal agencies. Much of the funding received was relatively flexible, enabling the Green Street approach to either stand-alone or be integrated with various other municipal plans. All six sample cities received funds and grants from their municipalities regarding city development plans such as capital improvement plans, neighborhood development plans, which were not strictly limited to stormwater related plans, and of course stormwater management plans. Funding for the projects also tend to be a mix of funds and grants from different agencies. Additionally, federal agencies that provide funds and grants for constructing green infrastructure also offer communities expertise and resources. Examples of such agencies include the EPA, DOT, USDA (Dept. of Agriculture), DOI (Dept. of the Interior), DOD (Dept. of Defense), and DOE (Dept. of Energy) (Environmental Protection Agency, 2014a).



Figure 6.4. Attributes of considerations in the planning and design protocol of green streets: Funding sources

6.1.3. Attributes of Considerations in the Planning and Design Protocol of Green Street: Involvement of Multiple Parties. Central themes 6 to 9 (see Appendix D-4 for detail)

The third general theme identified with Green Street implementation is GT.3. Involvement of Multiple Parties. The leadership of a design or landscape project can influence the character of the project, and “design leadership can come in different styles and with different faces” (Joziassse, 2011, p. 36). Green Street projects typically involve different municipal departments and stakeholders; therefore, the direction of the

project can be influenced by both who is involved and how the parties work together to resolve conflicts that may emerge in the course of planning and designing. The considerations regarding GT.3 are expressed under four central themes: CT.6. City Initiated Projects; CT.7. Public (online/resident) Initiated Projects; CT.8. Private Developer Initiated Projects; and CT.9. Projects Involving Multiple Departments.

According to the experts interviewed for all of the sample cities, municipalities were the main agents initiating Green Street projects. This is understandable considering that the projects were mainly located in the public right of way. However, some of the Green Street projects were implemented in individual communities at residents' requests. For example, the expert in DC mentioned a group of publicly initiated projects called the Green Alley Program, which was mostly initiated by area residents. The expert from Philadelphia pointed to the many ideas and suggestions for Green Street locations that planners there receive from communities via an online platform. However, sometimes misunderstandings have arisen between planners and communities over Green Street projects, as in the case described by the expert below, in which residents failed to appreciate that a new project would endanger the green solution that was already in place.

We get a lot of ideas from the community. That's one of, I think that's always kind of difficult one for us cause the communities all will [know], them knowing part of ideas, just a level of construction. So, we often have neighbors that are already essentially a green street because they got beautiful trees on their block. They are coming to us saying we would like to be a green street. We have to say, "Well, the kind of construction we would have to do would kill your trees." We don't wanna go there. But what we've created was because we do have a lot of community groups we work with (Expert 6, personal communication, July 10, 2014).

In addition, Seattle, Philadelphia, and Arlington stated that Green Street projects were also initiated by private developers. In the case of Seattle, the city promoted Green Street implementation for private development by providing bonuses such as a permission to build additional floors. They called these bonuses "departures" for their private development.

When asked about who would lead Green Street projects, experts from Seattle, Portland, and New York stated that several different departments could be leaders, depending on the intention of the project and the related municipal plans. In Seattle, the Department of Transportation (SDOT) would be in charge of implementing Green Streets if capital projects were involved, whereas the Department of Planning & Development (DPD) would lead the project if the project was designated as a Green Street that dealt with part of the land use code. Public Utilities (SPU) also worked on Green Street projects, but less often than SDOT.

... so because it's a street if the capital project is developed, the SDOT project is down on the green street, then we would follow, we would follow the right-of-way improvement manual so that the street is generous for consistency with that street typology. So either making sure that there is abundant landscaping that we incorporate green street stormwater infrastructure where feasible, we narrow the roadway for consistency with the low volumes and shared street. ... The difference from the way we interpret green street versus [how] the Department of Planning and Development would define green street, that's pertaining to the land use code. So the land use code specifies green street [projects] as well. ... It's interesting, SPU, they do one capital project per a year and we do many many more. I don't have numbers, but I'm pretty sure, I think if you look at our department chance to put down more green streets, they are probably smaller in nature so the capital projects are sophisticated (Expert 3B, personal communication, April 17, 2014).

In Portland, the expert explained that the Division of Sustainable Stormwater Management (in Environmental Services) worked on the policies, research, design, and monitoring of green infrastructure and Green Streets. The same agency also had the final word before construction could begin on Green Street projects. After this, the Bureau of Maintenance would construct the Green Streets. Other departments who would be in charge throughout the projects included the Bureau of Transportation—especially regarding capital improvement projects.

[T]he division I work in, Sustainable Stormwater Management, we kind of consider ourselves ... research development and monitoring, coming up with a policy for green infrastructure and green street is one piece of that. And we initially were the ones that were implementing them. We

design them within our group and then work with our Bureau of Maintenance to install them. Now it's also, the Bureau of Transportation is using them in their planning. But well I guess we have the ultimate decision before anything [is] put into the ground, yeah. We would be the ones that say that this meets our needs. We are not necessarily managing every project though. So sometimes our Bureau of Transportation is managing a project. They will be closely working with the BES. BES might be managing a green street project for a capital improvement, so when we need a pipe upgrade or resolve some ... pipe issues, then we would be in a charge. ... If the park is redesigned, they would probably trigger the manual. So we would need to be part of that planning. Again, we may not be necessarily taking the lead in it, but we would definitely be at the table in partnering with parks or with Bureau of the Transportation. (Expert 1, personal communication, March 11, 2014).

In the case of New York, the main agency working on Green Street projects was the Department of Parks and Recreation. However, the Department of Environmental Protection (DEP) started to fund the Parks Department with more money. Expert 2 of this study stated that since the DEP had more funds, it was able to take over the leadership position from the Parks Department as described by the expert's statement included below. Meanwhile, in Philadelphia, the Water Department might be considered a leader especially in stormwater management. Likewise, the Department of Transportation would be a leader in DC for Green Street implementation.

[The] Parks Department really paved the way, but now I really think the leading department is DEP, mainly because they have all the money, because all the water bills, all the stormwater bills go to DEP. So they are the ones who started funding the Parks Department to build these, and they are the ones who wrote the green infrastructure plan in 2010. And yes, by far, they are the leading agency right now (Expert 2, personal communication, March 11, 2014).

In general, Green Street projects involve multiple departments during the implementation process. When asked about who was involved in the design and construction process of Green Street projects and how individuals collaborated, the experts pointed to the frequent opportunities these projects provided different departments for collaboration. For instance, in Seattle, the Department of Transportation (SDOT) had the opportunity to work with Seattle Public Utilities (SPU)

when the Capital Improvement Project was overlaid with SPU's project that concerned stormwater treatment. In another case, as describe by the expert below, SDOT was able to join with SPU's GSI project when their projects served a common purpose.

Often ... Seattle Department of Transportation (SDOT) has its Capital Improvement Project list and every year we prioritize those and build them. Whether they are green street or not, there could be partnership opportunities with Seattle Public Utilities (SPU) if one of those capital projects aligns with one of Seattle Public Utilities' projects. That's where you see [a] kind of partnership in the future. ... We could collaborate with Public Utilities in order to do another practice, a kind of Green Stormwater Infrastructure (GSI) project, so that's under way. ... More recently, recent use of green street specifically has been to meet transportation multimodal objectives and Seattle Public Utilities' interest in GSI has [been] overlaid at the corridors that DOT has identified candidates for green streets so that we can work together. And, some other things we might do to make it a better corridor for bikes and pedestrians ... also have the benefit of providing stormwater amenities. So that's where the two green street and GSI overlap in the very recent time frame. So it's like a history of changes that have occurred (Expert 3B, personal communication, April 17, 2014).

Portland has formed the Green Street Cross-Bureau Team, which has been described as "comprised of staff members from ten different City bureaus and offices with interdisciplinary expertise in stormwater engineering, transportation, planning, utilities, parks, sustainability, and maintenance" (Portland, 2006. para. 5), to promote and support Green Street implementation. This was the only formal interdisciplinary team specifically designated for Green Street implementation among the six sample cities. The team published phase 1 and 2 reports that discussed related policies, planning strategies, outreach programs, funding opportunities, maintenance, and other aspects of improved Green Street implementation by identifying issues and challenges along with solutions (Portland, 2007).

New York had an interdisciplinary weekly meeting, called the "Friday Meeting" among different municipal departments, according to the expert's statement included below. It was interesting to see how different agencies prioritized different aspects of the planned projects. For instance, the Department of Parks and Recreation focused more

on providing nutrients for plants with silty soils in the stormwater treatment facility, while DEP wanted to put porous soils in the facility since they were more focused on the drainage function. The Friday Meeting was a place for communication and resolving differences to find better solutions for planning and designing Green Street projects.

Every Friday, we have this Friday meeting. We call them ... Friday's with **** because **** is the assistant commissioner of the green infrastructure. So he hosts this meeting. Parks Department, DOT, DEP (Department of Environmental Protection), DDC (Division of Design and Construction, they build sidewalks, street construction). ... What I'm saying is that all four agencies have to agree on one standardized design. So this Friday meeting, we try to negotiate and it was debatable. So one example is that the Parks Department wanted to make sure the plants have enough nutrients, so we were trying to push for more clays and fine soils so it will hold more nutrients actually like clay and silt while DEP wanted more drainage and they were pushing for ... sandier soil. So we sort of really had to negotiate. We had a big debate on the soil specification. And then DOT had concerns like how long [they stormwater facility] it could be so that people can get out of their cars. And DDC has the most construction experience. Yes, so it's all debate and this Friday meeting [keeps making] small changes, and ultimately our final design ... since a year and half ago we have started to implement that into priority sewershed. (Expert 2, personal communication, March 17, 2014).

In Philadelphia the Streets Department and Parks and Recreation Department collaborated to coordinate the street tree program. The street tree program plants free trees for different land uses and helps maintain planted trees to increase the number of trees in the city (Philadelphia Parks & Recreation, n.d.). The expert in this case describes efforts similar to those in Seattle to incorporate Green Street projects with their capital program so that collaborative work could take place.

... We [the Water Department] work very closely with the Streets Department obviously. The first few years of working on green street there [was] a lot of coordination ... and our Street Department was heavily involved in that as well as the Parks Department, because they really manage our street tree programs in Philadelphia. The utilities, our gas department, our electronic communication, those kinds of things, anybody who got underground utilities that may be affected by construction is involved in the review of the planning, not much of the planning but the review. ... If our street department is doing a large construction project, we will look at what they're

planning as well. So, we will try to line it up with our capital program as best as we can (Expert 6, personal communication, July 10, 2014).

The expert from DC points to the possible leadership role in developing Green Street projects taken by the Department of Transportation. The Department of Environment and Office of Planning also took part in the program's implementation, along with the Urban Forestry Department and National Forest Service.

We think so (DOT is the leader). We work closely with our Department of Environment and the Office of Planning. ... And then we bring in Urban Forestry Department, we have a Planning Department, we have Traffic Safety Department, we have Pedestrian, Bike Team, ADA Coordinators, so we'll coordinate all the groups who may have an impact role in that project. We also include other external stakeholders, so the Department of Environment would be an external stakeholder [including the] Office of Planning. We also include our Washington Metropolitan Transit Authority. We might have to include National Park Service because there's a lot of national park service land in the city. We might have to include Department of Recreation ... (Expert 4, April 1, 2014).

In Arlington, the Office of Sustainability and Environmental Management is always involved in Green Street implementation. The projects can be initiated by either the Department of Environmental Services or the Department of Transportation:

The Department Of Environmental Services includes my office, which is the Office of Sustainability and Environmental Management and then it includes the Department of Transportation for Arlington County, and both groups initiate projects that may have a green street component, but our office has been always involved in their implementation in one way or another today (Expert 5, April 3, 2014).

Table 6.3 shows which departments were mainly involved in the process of Green Street implementation based on the interviews of experts from the sample cities. While the interviewees most frequently mentioned departments whose work is related to environmental considerations and transportation, they also cited the involvement of other departments that deal with planning, parks and recreation, and public utilities.

Table 6.3.

Involved Departments.

City	Department	category	Total
3. Seattle	Environmental Services	Environmental	6
1. Portland	Environmental Services		
2. New York	Department of Environmental Protection		
4. DC	Department of Environment		
5. Arlington	Department of Environmental Services, Office of Sustainability		
6. Philadelphia	Water Department		
3. Seattle	Department of Planning & Development	Planning	3
2. New York	Department of City Planning		
4. DC	Office of Planning		
3. Seattle	Department of Transportation	Transportation	6
1. Portland	Department of Transportation		
2. New York	Department of Transportation		
4. DC	Department of Transportation, Traffic Safety Department		
5. Arlington	Department of Transportation		
6. Philadelphia	Streets Department		
2. New York	Department of Parks & Recreation	Parks	2
6. Philadelphia	Department of Parks & Recreation		
3. Seattle	Public Utilities	Utilities & Maintenance	2
6. Philadelphia	Utility Department		
1. Portland	Bureau of Maintenance		
3. Seattle	Department of Neighborhood, City Light	ETC	.
1. Portland	Fire Department		
2. New York	Division of Design and Construction		
4. DC	Urban Forestry Department		

In addition to the municipal departments mentioned above, other agencies were also involved, such as federal agencies where Green Street projects included federal properties (Expert 4, 2014). Private contractors were also involved in mostly design and engineering stages (Expert 4; Expert 6, 2014) and sometimes maintenance (Expert 2; Expert 5, 2014).

In summary, four central themes emerged as significant factors in project initiation: CT.6. City Initiated Projects; CT.7. Public (online/resident) Initiated Projects; CT.8. Private Developer Initiated Projects; and CT.9. Involvement of Multiple Departments. Green Street projects were mainly initiated by municipalities, but the community's involvement and private developers' participation was also encouraged. Projects initiated by the public could be helpful in finding locations where Green Streets were needed; however, in some cases a lack of public understanding of all that is involved in these projects could also lead to misconceptions about their purposes and

functions. Providing incentives to encourage private developers to include Green Street ideas in their new development projects also shows potential as a means of securing funding and also increasing the presence of Green Streets.

In the six sample cities, the interdisciplinary approach meant that various departments were involved, particularly environmental departments (mainly with a stormwater management focus) and transportation departments (mainly with a city improvement focus), followed by parks and utilities. An interdisciplinary approach to projects allowed for new ideas and professional collaborations, but it also often caused conflicts of interests or confusion. However, such problems were resolvable through regular meetings (as in New York), or through formal interdisciplinary project teams (as in Portland, the Cross-Bureau Team for Green Street projects), which are collaborative groups from multiple departments.



Figure 6.5. Attributes of considerations in the planning and design protocol of green streets: Involvement of multiple parties

6.1.4. Attributes of Considerations in the Planning and Design Protocol of Green Street: Design Process. Central themes 10 to 15 (see Appendix D-5 for detail)

The fourth general theme identified with considerations in Green Street implementation is GT.4. Planning & Design Protocol. Planning and design is a critical stage where, according to Simonds (1983), “all constructive ideas and recommendations are accommodated, negative environmental impacts ameliorated, and benefits increased” (Simonds, 1983, p. 107). Thus, it provides an understanding of how Green Streets are planned and what aspects need to be considered during the design stages. This section investigates how sample cities designed Green Streets and overcame the limitations they encountered. The considerations regarding GT.4 are expressed under six central themes: CT.10. Available Space for Implementation; CT.11.

Consideration of Site Contexts; CT.12. Consideration of Pedestrian Safety; CT.13. Improvement to Life; CT.14. Improvement from Previous Design; CT.15. Effective Stormwater Treatment Performance & Implementation.

When asked what elements were important in the planning and designing a Green Street project, the experts in the six sample cities cited the consideration of available space. The expert from Portland suggested that the planter type they used (see Figure 2.1) could fit better in densely developed urban areas; the expert from New York mentioned that parts of streets or parking strip spaces could be utilized for Green Street practices. The expert from DC also stated that how people utilized streets, the volume and size of streets, and the types of streets need to be considered. In terms of physical conditions, specific concerns included topological condition, street width, and transportation function:

You have to look at what properties are there, is it commercial, is it residential, what volume of pedestrian circulation you have, are people parking on the street, and you need to get from the street to the sidewalk or from street to their houses [because] widths of the sidewalks on the streets vary widely (Expert 4, personal communication, April 1, 2014).

Where the driveways come in, where the intersections are, how the topography is, all of those have affected the design of each project (Expert 5, personal communication, April 3, 2014).

Experts mentioned design elements that focused on efforts to include additional benefits, such as improving pedestrian safety or promoting better living. In the case of Seattle, Green Street projects were mainly implemented in residential areas, so traffic calming to promote pedestrian safety and the inclusion of neighborhood greenway systems were desired aspects of the design. Philadelphia aimed for multiple benefits from Green Streets, including safe crossing for pedestrians:

Seattle: Majority of green streets are on none arterials. So those none arterials are typically areas of residential development. That's predominant land use. So traffic calming is always desired in residential areas. That will be a consideration of safe crossing, and neighborhood greenways (Expert 3B, personal communication, April 17, 2014).

Philadelphia: But I think a good example where we try to get multiple benefits are, ... we are building a green street around a school. There's a campus ... where we will prioritize the idea of doing bump out in that location, then kids that [are] walking to school have smaller street [crossings]. So you get that added pedestrian benefit, and you are expecting a lot of young pedestrians in those areas (Expert 6, personal communication, July 10, 2014).

Green Street design was modified and reinforced based on lessons learned from previously completed projects. Cities such as Portland and New York tried to change and improve their design application for better functionality.

Portland: We've kind of done some different changes in [the] design of our check dam elements, ... we do sort of dirt with rock over them. Now we don't do that anymore. [It] just doesn't really keep up with capacity and doesn't really fit into urban context well and it starts [to] erode. So it doesn't work effectively. We started putting in the bar over the opening when we found cars were ending up driving into it (Expert 1, personal communication, March 11, 2014).

New York: It's an ongoing process. I don't think any of us are very happy with our standard design. So I think we'll keep improving, keep coming up with the new design. So yes, I think over time, they keep coming with the modification, keep improving our design (Expert 2, March 17, 2014).

Green Streets also can simply provide effective stormwater management by rigorously utilizing available space in the right of way, as the New York expert mentioned: "What we found was, that design actually eliminates the bypass in the inlet. ...But we don't have a different design for land use. ... They are gonna kind of build those, like hundreds or thousands of those in the priority sewershed" (Expert 2, personal communication, March 17, 2014). Designs of Green Street facilities can be simple and involve little more than modifications of design standards for particular spaces. This approach, however, is not ideal for the promotion of livable communities that may have very specific social, economic, and environmental requirements that need to be addressed.

To summarize, the interviews and literature review revealed that Green Streets' design, specifications, and applications are described in a set of manuals, standards, municipal plans, and online databases created independently by the six sample cities. Moreover, even though the six sample cities had design standards and manuals, experts tried to consider various aspects beyond the manuals and standards. In the planning and design stage, particular importance was placed upon CT.10. Available Space for Implementation, and CT.11. Consideration of Site Contexts. Among additional benefits, experts also mentioned CT.12. Consideration of Pedestrian Safety, and CT.13. Improvement to Life. Consideration was also given to CT.14. Improvement from Previous Design, in Portland and New York, where planners were looking to improve existing Green Streets or anticipate future implementation of Green Streets. Where priority was given to stormwater management, as in New York, standardized Green Street designs focused on CT.16. Effective Stormwater Treatment Performance and Implementation, with the result that less emphasis was placed on additional benefits.

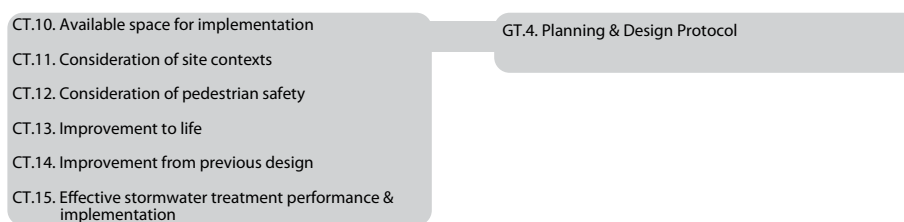


Figure 6.6. Attributes of considerations in the planning and design protocol of green streets: Planning and design protocol

6.1.5. Attributes of Considerations in the Planning and Design Protocol of Green Street: Public Outreach. Central themes 16 to 21 (see Appendix D-6 for detail)

The fifth general theme identified with considerations in Green Street implementation is GT.5. Public Outreach. Green Streets are implemented mainly in the public right of way. Therefore, the implementation process can be easier than proceeding with construction on private lands. However, since streets are located close to where people live, work, and play, communities' opinions matter and affect projects both directly and indirectly. Looking into the means of public outreach used in each city

provided an understanding of how the public and communities were treated and involved during the development of Green Street projects. The considerations regarding GT.5 are expressed under six central themes: CT.16. Public/Community Meeting; CT.17. Phased Public Outreach; CT.18. Public Education; CT.19. Individual Conversation; CT.20. Sending out Flyers; and CT.21. Plant Palette Selection.

Community meetings were held in Seattle, New York, Philadelphia, and Arlington to get feedback from community members. In the case of Seattle, public outreach was included in the Seattle Right-Of-Way Improvements Manual. The Seattle expert said that there would be more public involvement if Green Streets were part of a planning process.

... there were multiple community meetings and meeting was in a sort of community center setting (Expert 3A, personal communication, March 20, 2014).

You can reference the street concept process in the right-of-way improvement manual. It spells out with the public outreach expectations. That provides basis [of public outreach]. Then, we [will] have more public outreach associated [protocols] if it's [Green Street] a part of a planning process or a neighborhood planning process (Expert 3B, personal communication, April 17, 2014)

New York has attempted public outreach before developing the final plan in partnership with community organizations. However, the New York expert was not sure whether public outreach has been successful. Nevertheless, public outreach is still desirable for making projects more sustainable:

There was a period when people comment and incorporate them before the final plan is released. ... I think all of us at the city understand [public outreach is] important. I mean if it's gonna be sustainable, it should be used by people living there. I don't know if we've been that successful in it. It's always something that we know. I don't think anybody in a city would say it's unhelpful. But I'm just not sure how successful we've been. There's a [group of] community organizations that the city partners with a lot of times. But ultimately it's gotta be sustainable (Expert 2, personal communication, March 17, 2014)

Philadelphia's public outreach was especially geared toward adjacent property owners. They were not looking for community permission to implement a Green Street project simply because the project was being implemented in the public right of way. According to the Philadelphia expert, they focused more on sending out notification and held community meetings infrequently:

I would say that for GS we do outreach. Typically ... the outreach will be very focused on the property owners that were mostly adjacent to [the project]. So, like I said we are doing a green street in front of some large single property owner, industry, or business, or something. We work very closely with them and we tend to do kind of flyer sent to our neighbors. ... We held community meetings around green street, [but] we don't do that as much now because it is the public right of way. So we do a lot of notification, but not as much [as we] should have, I mean we really [do] not ask for permission. (Expert 6, personal communication, July 10, 2014).

In the case of Washington, DC, public outreach was carried out before the project was started and during the construction to inform the public regarding the construction plan. Moreover, the expert from DC thought that the public outreach was quite helpful because of insights from community members as described below. In general, it was thought to provide important information about what was actually going on and what the community wanted.

[Public involvement is] definitely helpful. The residents have a lot of insights that you don't see just visiting on occasion. They can tell you what's going on. ... We have to [do public involvement] because we are building things right on people's street. Sometimes people oppose what we are doing, and if they oppose what we are doing they are gonna continue to oppose ... it's better to have them approved earlier in the process than during the construction because you can change earlier in the process before you go to the construction (Expert 4, personal communication, April 1, 2014).

In addition to community meetings, the meetings could be planned in phases as needed, as Portland and Arlington have done. During their Green Street design process those two cities met with the community at different design completion stages and

reflected community feedback in their modifications of the plans. The public outreach for a larger public includes meetings with community members or stakeholders.

Portland: At 30% design, then we really reach out to them and say what it's going to look like, it's going to go here, if you have any concerns, let us know. ... At 30%, [the] public can have input and we design it a little more and go back out at 60% and then 90%, [after which we] say ok no more opportunities or comments. And then start kind of proceeding with the construction (Expert 1, personal communication, March 11, 2014)

Arlington: We had public meetings in the initial phase of each study and then after we have identified all the projects to share them with the public and to invite their feedback. If we initiate the projects from our office, we initiate the project by doing a meeting with the adjacent residents. And then at probably about 30% design, we go to the civic association then we have check-ins at the community level at about 60% design, and then close to 100% design (Expert 5, April 3, 2014).

Experts from Seattle and Portland mentioned public outreach to targeted individuals. This outreach focused mainly on personal communication with community members. In particular, the experts described that they had had conversations with people who needed individual attention and wanted to provide their opinions regarding the Green Street construction as mentioned below. Other means of communication was through flyers, postcards, or emails to people who live adjacent to the target site.

... also meetings on a street in the neighborhood, [walking] along the street and looking at various project areas. I spent time in their living rooms [in] almost every property on all these projects who felt they need individual attention and wanted to have an input on their own drainage on their property that they own and manage. So [a] huge amount of public involvement (Expert 3A, personal communication, April 17, 2014).

... if they share [their] concerns with us we'll talk to them individually and look to really see what we can do. Can we squeeze it a little bit, can we put it somewhere else for someone who wouldn't mind having it (Expert 1, personal communication, March 11, 2014).

As for other outreach programs, public education regarding stormwater management was carried out in Philadelphia and a Plant Palette was created in Portland to encourage residents' engagement with public Green Street maintenance and to promote a sense of ownership among the adjacent communities.

They often have a separate program just about the residential storm water educational opportunity. And they do a lot of outreach on a very broad scale (Expert 6, personal communication, July 10, 2014).

... we want them to feel some ownership as well, so we have allowed them to pick their own planting palette. So we'll have a certain plant list and they can select from that list they might have in their facility (Expert 1, personal communication, March 11, 2014).

To summarize, public outreach was conducted in all sample cities. Public outreach may include various levels of approaches that address concerns of both the general public and individuals. There were six forms of public outreach derived from the interviews: CT.16. Public/Community Meeting; CT.17. Phased Public Outreach; CT.18. Public Education (regarding stormwater management); CT.19. Individual Conversation; and CT.20, Plant Palette Selection.

Public outreach was an important process of obtaining insights from the public as well as informing the public regarding what would happen so that they could prepare for Green Street construction in their neighborhood. Moreover, it was an opportunity to get consent from the public for the project. The public outreach could take the form of public meetings with communities or local community groups regarding design decisions, collecting opinions, informing about construction schedules, and/or visiting individual homes to hear opinions. Other forms of communication include flyers, postcards, and emails for people who live and work adjacent to Green Street projects. One means of promoting ownership of a Green Street project was to provide members of the public with plant palettes so that they could select plant species on their own.



Figure 6.7. Attributes of considerations in the planning and design protocol of green streets: Public outreach

6.1.6. Attributes of Considerations in the Planning and Design Protocol of Green Street: Operation and Maintenance. Central themes 22 to 25 (see Appendix D-7 for detail)

The sixth general theme identified with considerations in Green Street implementation is GT.6. Operation & Maintenance. Green Streets usually require routine maintenance to ensure adequate stormwater management over time because they comprise a number of different materials, including soil and plants, and must deal with stormwater that includes diverse contaminants (NVRC, 2007). The considerations regarding GT.6 are expressed under four central themes: CT.22. Municipal Involvement; CT.23. Public Involvement; CT.24. Private Contractor; and CT.25. Inclusion of Monitoring.

This maintenance could consist of “short term” activities, such as trash removal, irrigation, and weeding (mostly related to managing vegetation), and “long term” actions, such as removing sediments, clearing inlets, and replacing soil media (mostly related to managing stormwater facilities). In addition, communities might also carry out “non-specialized” maintenance:

For substages, you can separate maintenance into short term and long term maintenance. Short term is picking up trash, watering, weeding, and long term is mulching, pruning, removing sedimentation, fixing erosion. Or you can separate maintenance into specialized maintenance for gardeners, and non-specialized maintenance can be done by untrained people who live nearby. (Expert 2, personal communication, March 17, 2014).

Maintenance can affect acceptance of Green Streets by the public or a community if it is not executed appropriately. Poorly maintained Green Streets could rouse antipathy among the public and cast a project in a negative light, as the statement below attests. Sometimes complaints were reported regarding trash or weeds in the facility.

Philadelphia: I would say one of main concerns that is really common in any public meeting is maintenance. People don't want us to build something in a space they use that isn't gonna be maintained well (Expert 6, personal communication, July 10, 2014).

DC: A lot of people think it's not maintained well and see them as trash, see a lot of weeds. They see a lot of bad things, then complain to us about all the bad things (Expert 4, personal communication, April 1, 2014).

In terms of designated parties for maintenance, each of the sample cities delegated this responsibility to different departments. Philadelphia had a maintenance team under the Water Department; Public Utilities maintained Green Streets in Seattle (as long as they included Green Stormwater Infrastructure facilities); the Parks Department would manage Green Streets with designated maintenance funding in New York; and the Department of Transportation was involved in maintenance in DC.

Philadelphia: We have a green infrastructure maintenance team. (Expert 6, personal communication, July 10, 2014).

Seattle: Seattle Public Utility would, they maintain GSI. Basically, if it's an actual Green Stormwater Infrastructure (GSI) facility, then they will maintain it. We would build it and they will maintain it (Expert 3B, personal communication, April 17, 2014)

New York: As part of the green infrastructure plan, there's actually dedicated maintenance funding. So Parks Department is actually getting money for maintenance (Expert 2, personal communication, March 17, 2014).

DC: We are maintaining with DDOT. But we are only there for a few times a year. And they can call it trash, and that's actually part of their goal. They are supposed to collect trash. The trash goes there instead of going to the river. So most of the time people don't see that (Expert 4, personal communication, April 1, 2014).

In Arlington, the county managed the maintenance contract for the Green Street projects, whereas in New York the Department of Environmental Protection sought a cost-effective maintenance plan and potentially hired a private contractor for the maintenance.

Arlington: The county does. We have a contract for maintenance (Expert 5, personal communication, April 3, 2014).

New York: DEP is also interested in pursuing other ways to maintain it, to see what's most cost effective. So, they ... it's a little bit ... debatable. I think they might prioritize it. They also [think a] private maintenance contractor will be more cost effective. We may try both Park's maintenance fund and private contractors (Expert 2, personal communication, March 17).

According to experts from Philadelphia and DC, only light maintenance was apparently performed. Crews went out for maintenance only a few times a year. Light maintenance could refer to an "as needed" basis, which generally consisted of weeding at a certain time of the year and responding to users' requests for additional maintenance such as inundated facilities, damage to facilities, and dying plants (Expert 3C, personal communication, June 1, 2012: preliminary site visit, 2012).

Philadelphia: They do it monthly. And I think actually they don't do maintenance every month. They do inspection every month. They actually just a couple of months ago produced our Green Infrastructure Maintenance Manual. It's now deliverable on the website (Expert 6, personal communication, July 10, 2014).

DC: But we are only there for a few times a year (Expert 4, personal communication, April 1, 2014).

Portland, New York, and DC have installed monitoring equipment to test whether the sites function well. The main purpose is to test stormwater treatment function regarding infiltration of water and removal of contaminants in the water. The data could be useful for future implementation of stormwater facilities for Green Street projects.

So the early one, the first one we put in in 2003, that was our curb extension on Siskyu Street. And we have been looking at how they function. So, part of putting Green Streets in initially we needed to monitor to make sure that this is going to function and be effective for its intended purpose (Expert 1, personal communication, March 11, 2014).

When it comes to monitoring for performance, either it's water quality improvement or water volume reduction. That takes funding and takes a lot more oversight and then expertise (Expert 4, personal communication, April 1, 2014).

In summary, maintenance was mainly conducted with CT.22. Municipal Involvement, though no significant responsibilities were given to particular parties. Also, in some cases only "light maintenance" was used. Some programs made an attempt to include CT.23. Public Involvement, in their maintenance programs, but this mostly entailed simple tasks such as weeding and collecting trash. Some cities have considered or hired CT.24. Private Contractors, for maintenance. And some of the programs made use of CT.25. Inclusion of Monitoring, to test how Green Streets were functioning in relation to current use and future improvement.



Figure 6.8. Attributes of considerations in the planning and design protocol of green streets: Operation & maintenance

6.1.7. Attributes of Considerations in the Planning and Design of Green Street: Challenges. Central themes 26 to 31 (see Appendix D-8 for detail)

The last general theme identified with considerations in Green Street implementation is GT.7. Challenges in Green Street Implementation. Considerations regarding GT.7 are expressed under six central themes: CT.26. Challenges in Setting Priorities; CT.27. Site Constraints; CT.28. Economic Considerations; CT.29. Technical Challenges in Design and Construction; CT.30. Community Resistance/Concerns; and CT.31. Difficulties in Public Outreach. Design projects contain difficulties and issues that need to be resolved or carefully considered during the decision-making process—and Green Street projects are no exception. In addition, the integration of stormwater treatment facilities with street designs could entail various concerns and issues influencing designers, planners, and the public as revealed in a preliminary site visit. This Green Street site visit with an expert¹ from Public Utility in Seattle in 2012 revealed that there were concerns over parking spaces because Green Streets were often implemented by taking over parking strips in residential areas. People also worried about the water in the bioretention cells because residents thought it might cause wet basements or pose a danger to children, who might fall into the water (in fact, the deepest water level was less than 1 foot, and the water inside the facility was designed to drain within 12-24 hours). Finally, they were also concerned about maintenance because leaves constantly fell into the system and blocked runoff from draining into the stormwater facilities. In addition to the findings from the preliminary site visit, Figure 6.9 describes the concerns and challenges mentioned by experts from each sample city regarding their Green Street implementations.

Philadelphia had some difficulties in delivering objectives for the projects. Communities around Green Street projects were mostly interested in safety and lighting, whereas the city's chief concerns were stormwater related issues as described below.

¹ The expert was from Seattle Public Utility and worked in the Maintenance Division. The sites visited were Pinehurst Green Grid, Broadview Green Grid, and High Point, which was one of the notable low impact development sites in the US.

Stormwater is simply not their priority. What they [the neighborhood] really wanna talk about is safety and lighting, and what we wanna talk about is stormwater management. So, it can just be kind of difficult to focus (Expert 6, personal communication, July 10, 2014).

There were physical challenges related to site conditions. In the case of New York, the shallow bedrock and groundwater table in target areas made construction challenging. Underground utilities were also a challenge to the construction in Philadelphia and DC:

Philadelphia: One of our main challenges is right now a residential street. From the design point of a view, I think we're really trying hard to think of what's appropriate when you are in a residential area. Certainly it's because of underground utility. You are working next to people's basement (Expert 6, personal communication, July 10, 2014).

DC: Working around the utilities, figuring out where we can place stormwater facilities, and if they can go over utilities, how close to the utility they can go, that's been challenging (Expert 4, personal communication, April 1, 2014).

For Seattle, securing funding for the projects was one of the biggest challenges. (As the local expert put it, "Funding is always a challenge.") The funding issue also raises concerns about fairness in the distribution of Green Streets. These projects tend to attract interests that can bring potential investment to the adjacent communities.

One of the major challenges is making it as affordable as possible, making it fair. ... They have a tendency to generate interest from neighborhoods that are adjacent to the project area. ... [H]aving logical and fair [processes] to choose [locations] for ... investment as well as management is (sic) really important to me (Expert 3A, personal communication, March 20, 2014).

Other challenges encountered by some programs are related to inadequate information or experience to deal with the design and implementation of Green Streets. This was the case in Philadelphia and Arlington. People who were working on the

projects were not familiar with Green Streets and did not have expertise in this relatively new approach to urban design and construction, with its unique requirements.

Philadelphia: [F]rom the construction point of a view, [green street is] fairly new for the folks that we work with. Then they have really different installation requirements, so construction is challenging (Expert 6, personal communication, July 10, 2014).

Arlington: We have done all the design for these, today in house, so other challenges have been training and educating our engineering staff (Expert 5, personal communication, April 3, 2014).

In all six sample cities, adjacent communities expressed some concerns or resistance to Green Streets. One reason was residents' resistance to having a new facility implemented in their neighborhood. This was especially true where Green Streets took up the spaces they use. A loss of parking space was the major concern for most of the cities (Seattle, Portland, New York, and Arlington):

Seattle: Public doesn't wanna lose parking spaces (Expert 3B, personal communication, April 17, 2014).

Portland: Some people will of course have some concerns particularly over loss of parking. That has been kind of one of the biggest concerns people have (Expert 1, personal communication, March 11, 2014).

New York: Parking is an issue in some bureaus more than others (Expert 2, personal communication, March 17, 2014).

Arlington: Parking lots may be compromised so we had some struggles with residents dealing with some of those issues (Expert 5, personal communication, April 3, 2014).

While public outreach was one of important stages in Green Street implementation (as discussed in the previous section), it was one of the challenges in Arlington. Community education was especially challenging. Some programs, such as the one in DC, faced other challenges, such as difficulties in creating design standards.

In summary, CT.26. Challenges in Setting Priorities, arose from disagreement between municipalities and the public in the decision-making process. Much of this disagreement arose from the different goals and priorities of the parties involved (Expert 6, 2014). Because Green Street facilities typically need to contain a certain amount of water and underground installations, CT.27. Site Constraints, especially concerning underground conditions, could cause difficulties. Other challenges were CT.28. Economic Considerations: these projects often depended upon obtaining the needed funds and pursuing affordable construction. Since Green Streets were a relatively new approach, CT.29. Technical Challenges in Design and Construction, also came into play. Some of the projects met with CT.30. Community Resistance or Concerns, regarding having Green Streets in their neighborhoods and enduring the disruptions of construction. Lastly, challenges also took the form of CT.31. Difficulties in Public Outreach concerning community education.

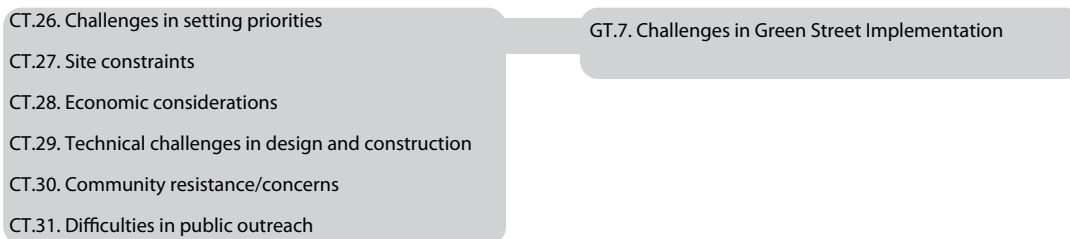


Figure 6.9. Attributes of considerations in the planning and design protocol of green streets: Challenges

6.1.8. Additional Attributes of Considerations in the Planning and Design of Green Streets

In this section, the author discusses additional attributes derived from the conversation. These attributes were not discussed rigorously, but enough to include them in this consideration of Green Street implementation. There are two sub-sections. The first one discusses bidding and construction, and the second one infers future applications of Green Streets based on the interview conversations.

6.1.8.1. Attributes of Considerations in the Planning and Design of Green Street: Bidding and Construction

A bidding process was needed before construction could be initiated. For most of the sample cities, the lowest bidder would generally be awarded the contract. Construction documents were also prepared using both methods as in the design stage, depending on whether they were provided by consultants or in-house engineers (Expert 6, 2014). Expert 6 also mentioned the challenges involved during construction, such as maintaining access to businesses and new construction techniques, both of which require a high level of expertise from contractors. In the case of DC, the expert explained that they considered quality control and engaged in public outreach at an early stage of construction to help gain public support for the project (Expert 4, 2014).

The economic benefits of Green Street construction were not discussed in the interviews conducted for this study, but Green Street projects are known to have lower construction costs compared to the traditional stormwater management strategies. Integrating the Green Street approach into larger transportation improvement plans can be a useful way of reducing the cost of stormwater treatment (Lukes et al., 2008).

During the construction stage, public outreach can be maintained to keep the public up to date regarding the construction schedule and to resolve problems at an early stage of construction. It is also important to consider the needs of local businesses to maintain access to their premises and ensure that they can operate relatively normally in spite of the construction going on in front of their doors.

6.1.8.2. Potential Future of Green Street

Among the six sample cities, Seattle and Portland seem to present the highest level of awareness of the potential for pursuing multiple benefits from Green Street projects because they had large-scale in-progress Green Street implementation plans (See Table 4.1 for selected successful Green Street projects) while their main priority for installing Green Streets may have remained stormwater mitigation. Portland utilized Green Streets to address issues related to regulatory compliance for a single regulatory purpose, but later the city extended the program to encompass multiple objectives.

They were interested in developing a network of interconnected greenways throughout the city as part of the city's Comprehensive Plan.

Well, our manual requires that they manage the runoff from that surface and that requires us to put green streets in. And so typically green streets are a part of new development when the manual's triggered. We do see these as a new way of developing our urban infrastructure as well. The new way of realizing street design improves safety for pedestrians, bicyclists, and vehicles. So we would love to have these green streets everywhere and green corridors that have green streets along them. But again we are limited by where we put these in. We are limited by our bureau's strategic planning mission (Expert 1, personal communication, March 11, 2014).

Seattle also sought to integrate Green Streets into their more systematic development strategies for larger areas of the city by incorporating the Green Street approach into larger municipal plans such as transportation implementation.

We have [a] Complete Street Program that basically is a 14-page checklist at the moment. And it accepts a variety of things, primarily compliance or consistency with our local modal plan, our transit master plan, bicycle master plan and our pedestrian master plan. So for most, we want to make sure all modes are accommodated if they can be on that particular roadway, and then it also includes things such as stormwater structure (Expert 3B, personal communication, April 17, 2014).

These two cities, Seattle and Portland, take into account Green Streets' potential as a community development strategy. Both cities undertake projects of various scales, from a single stormwater planter to multi-block development. In most cases, Green Streets can be used much more rigorously than they are currently being adopted in the sample cities, especially if one looks into projects such as Growing Vine Green Street, Clay Street, Tabor to the River, and more. These projects potentially prove that Green Streets is capable of dealing with problems of various scales and creating projects that can be integrated with other larger city plans.

6.1.9. Summary

The strong priority of managing stormwater runoff clearly derived from the need to protect water bodies and the health of urban watersheds in all of these cities. This factor resulted in much of the initial driving force behind Green Street projects being directed toward pursuing a single objective: stormwater mitigation. However, although the Green Street initiatives originated as a way to manage stormwater, as they began to be adopted and implemented in each city, they evolved in terms of their concepts and roles to encompass objectives that included improving the quality of life for those living in urban watersheds. As it currently stands, it seems the role of Green Street approach has not yet been defined rigorously in terms of how they can be utilized in a community and what they can offer; its fundamental concepts and the way they are implemented are in a constant state of flux as these dynamic and complicated issues seek a new balance that is acceptable to all the parties concerned.

In this section, the considerations of Green Street implementation were presented and discussed in relation to the general planning and design processes in six sample cities. Eight General themes and thirty-one central themes were derived from the collected data. The data presented here suggest that the Green Street approach requires a wide range of knowledge and numerous steps to build a single project including GT.1. Setting Priorities; GT2. Funding Sources; GT.3. Involvement of Multiple Parties; GT.4. Planning & Design Protocol; GT.5. Public Outreach; GT6. Operation & Maintenance; and GT.7. Challenges in Green Street Implementation. Accordingly, the entire process used to implement Green Streets plays an important role. It entails identifying the necessary protocols, determining what needs to be performed, deciding how to resolve many difficulties and issues that inevitably arise during the process, involving a range of people with different areas of expertise, and acknowledging any unexpected consequences. The following section will conduct a more specific study of the processes for implementing successful Green Street projects.

6.2. A Study of the Green Street Implementation Processes in the Sample Cities

In Section 6.1, the attributes of the considerations affecting the design and planning of Green Street projects were extrapolated from interviews with experts. This section will take a closer look at how those attributes were performed and discussed during the implementation processes in the six sample cities. This section considers only the most distinctive aspects of the implementation processes, and each subsection will summarize them outlined for each city. The processes described here are categorized using the four-stage planning process derived in Chapter 2, Section 3.3. Public documents and the webpages of each municipality are used as supplements.

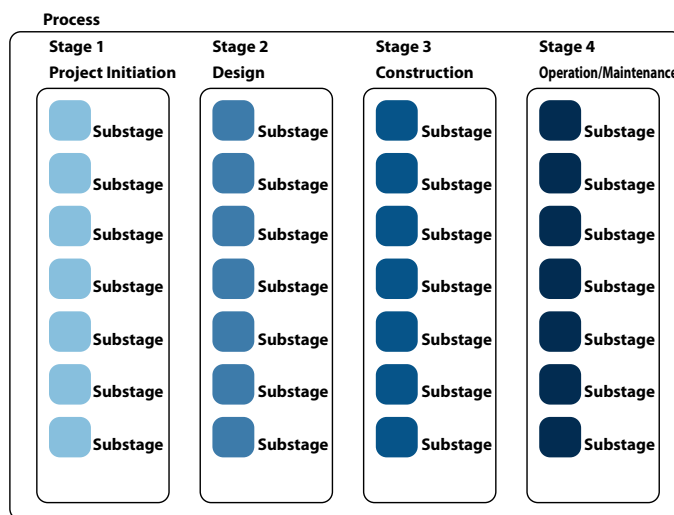


Figure 6.10. Diagram of the four-stage process for Green Street implementation (sub-stages are the detailed protocols of each stage).

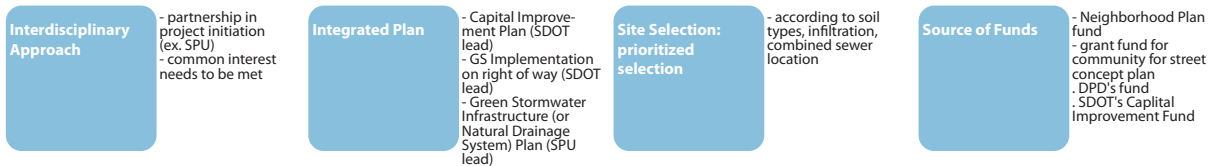
6.2.1. The Green Street Implementation Process in Seattle, WA

As discussed in Chapter 6, Section 1.5, public outreach was usually required for Green Street projects in all of the sample cities. The most common settings for public outreach included community meetings with stakeholders (such as community boards, historic boards, residents, or business owners who would be affected by the construction). Seattle added one more step to the process and visited individuals to receive their input:

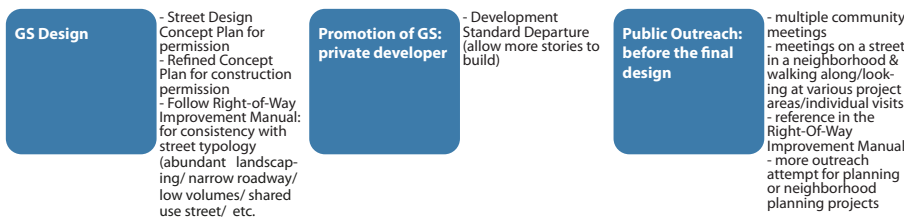
I spent time in their living rooms [in] almost every property on all these projects who felt they need individual attention and wanted to have an input on their own drainage on their property that they own and manage, so huge amounts of public involvement (Expert 3A, personal communication, April 17, 2014).

The prominent features of Seattle’s Green Street implementation process were their standards/manuals, which emphasized additional benefits such as the provision of open space and the transportation function (City of Seattle, 2012), along with public outreach, including visits with individuals.

Stage 1: Project Initiation



Stage 2: Design



Stage 3: Construction



Stage 4: Operation & Maintenance



Involved Departments

- SDOT: Seattle Dept. of Transportation
- SPU: Seattle Public Utilities
- SCL: Seattle City Light
- DPD: Dept. of Planning and Development
- SPR: Seattle Dept. of Parks and Recreation
- DON: Seattle Dept. of Neighborhoods

* Seattle. (2012). Seattle Right-Of-Way Improvements Manual

Figure 6.11. Considerations at each stage of the Green Street process, Seattle, WA

6.2.2. The Green Street Implementation Process in Portland, OR

A prominent aspect of Portland's Green Street process was their procedure for public outreach during the design stage. It was divided into three phases at 30%, 60%, and 90% of design completion.

At 30%, [the] public can have input and we design it a little more and go back out at 60% and then 90%, [after which we] say ok no more opportunities or comments. And then start kind of proceeding with the construction (Expert 1, personal communication, March 11, 2014).

As in Seattle, Portland also talked to individuals and tried to incorporate some of their ideas and opinions.

And then if they share the concerns with us we'll talk to them individually and look to really see what we can do. Can we squeeze it a little bit, can we put it somewhere else for someone who wouldn't mind having it (Expert 1, personal communication, March 11, 2014).

During those phases, the public had a chance to express opinions on the design and concerns regarding the construction. For planners and designers, this type of outreach provides opportunities to acknowledge what is needed and to adjust the design accordingly. As part of promoting the ownership of Green Street projects, the city gives residents a say in the choice of planting palettes.

The Cross-Bureau Team was a designated interdisciplinary team for Green Street implementations that was unique to Portland. The city's Cross-Bureau Team was created specifically to deal with Green Street projects and consists of officials from different departments who are assigned to seven sub-groups: outreach, technical guidance, gateway, multiple interests, maintenance, infrastructure, and resources (Portland, 2006).

Forming this specialized team facilitates the city's systematic approach to Green Street implementations as its members have developed Green Street-specific technical guidance, provided outreach plans, developed a stormwater master plan, specified the bureau's maintenance responsibilities, and identified potential funding sources

(Portland, 2007). This has enabled Portland to build more than 1,400 Green Streets, with more plans on the way.

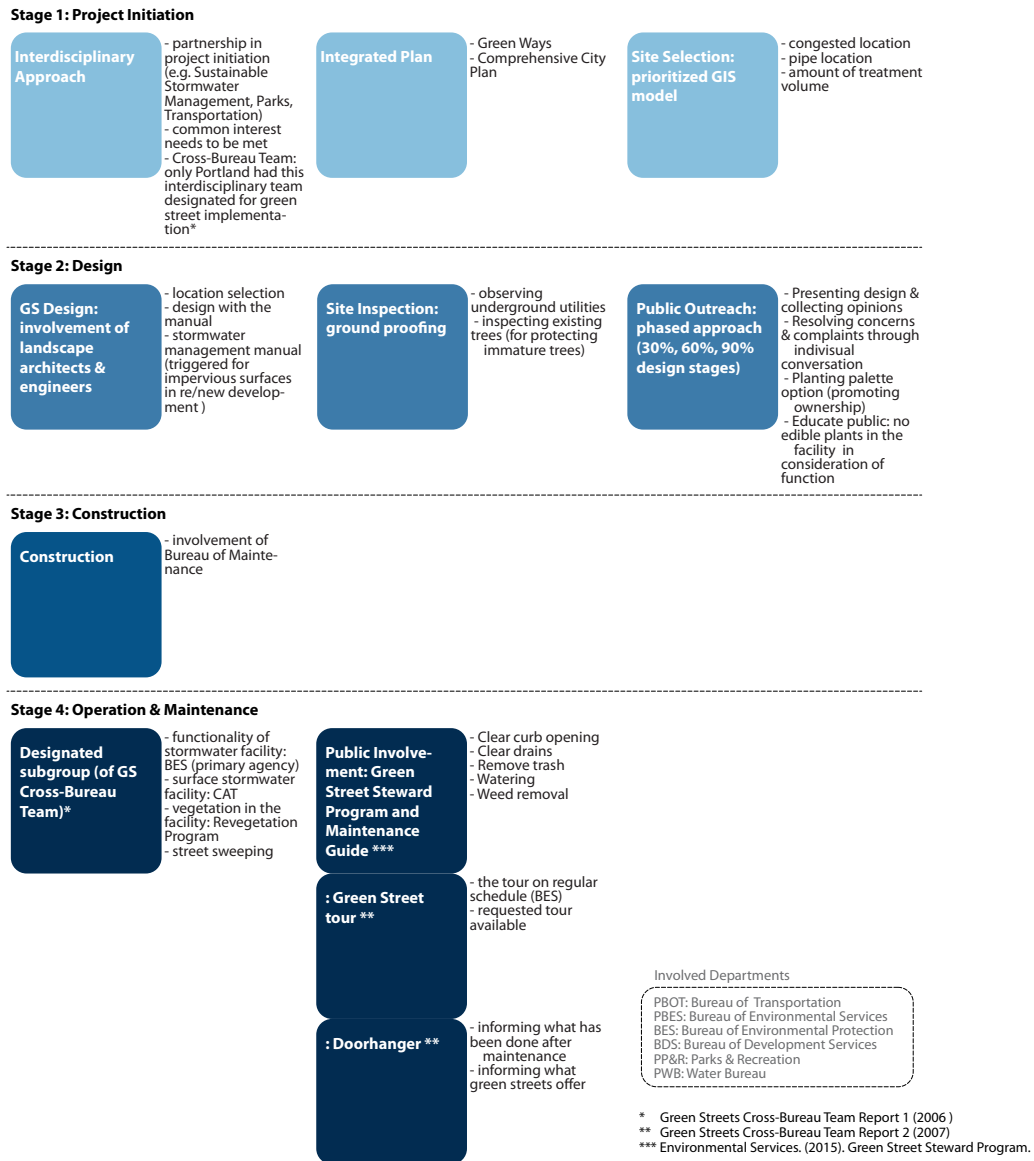


Figure 6.12. Considerations in each stage of Green Street process, Portland, OR

6.2.3. The Green Street Implementation Process in New York, NY

New York City also had interdisciplinary teams, with each team dedicated to fulfilling a specific role. These multiple departments such as the Parks Department, Department of Transportation, Department of Environmental Protection, and Division of Design and Construction (sidewalks and street construction) hold weekly meetings to

hash out any conflicts of interest and debate any issues that may arise among the different departments:

So one example is that the Parks Department wanted to make sure the plants have enough nutrients, so we were trying to push for more clays and fine soils so it will hold more nutrients actually like clay and silt, while DEP wanted more drainage and they were pushing for ... sandier soil. So we sort of really had to negotiate (Expert 2, personal communication, March 17, 2014).

These weekly meetings among related departments regarding the design of the Green Street practices being implemented also provide opportunities to disclose their different concerns and perspectives toward Green Street projects. After a potential issue is discussed, a consensus is reached and ways to address the issue are identified. The expert clearly considered that this contributed to improving the standards and design of the city's Green Street practices.

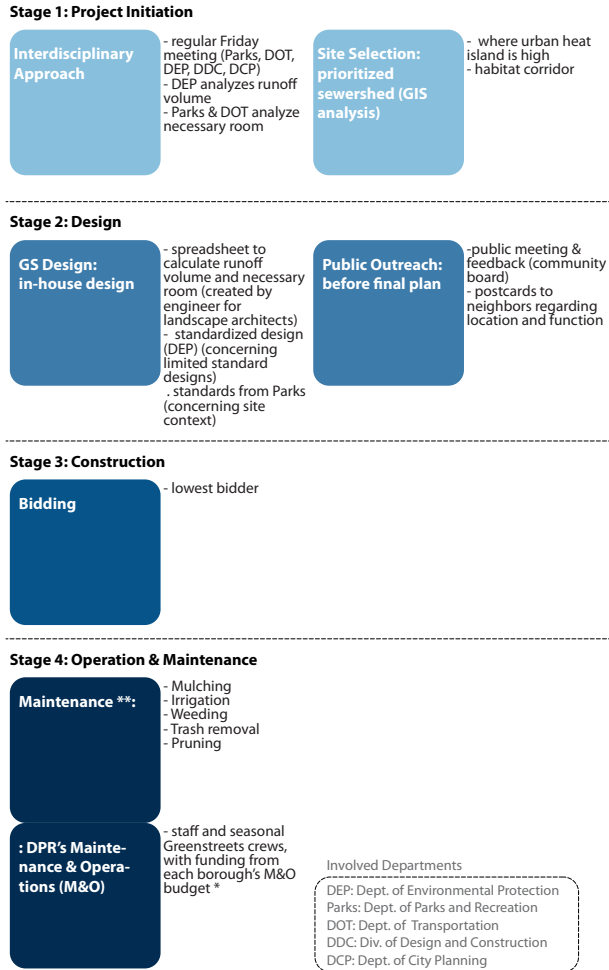
So yes, I think over time, they keep coming with the modification, keep improving our design, because the city keeps having this weekly meeting with all the agencies and everyone has to be happy with the design (Expert 2, personal communication, March 17, 2014).

These interactions allowed specialists in different professions to collaborate, sharing their expertise to the benefit of the projects on which they were working. For example, the New York expert who participated in the interview was an engineer who created a spreadsheet for landscape architects so that they could more easily make calculations to size stormwater facilities:

The landscape architects are more helpful now. They are able to do the calculation for themselves now. Usually the calculations are for sizing, they are pretty easy. I give them like a excel spreadsheet, so I don't need to be there whole time (Expert 2, personal communication, March 17, 2014).

In sum, the case in New York demonstrated how different departments and professions worked together (see Figure 6.13). This example of regular meetings

between related departments demonstrates one of the ways successful communication and collaboration can lead to successful work toward shared goals, even when priorities differ, and design improvements for future projects.



* NYC Department of Parks & Recreation. (2010). Best Practice: Green streets: Greening roadways.

Figure 6.13. Considerations in each stage of Green Street process, New York, NY

6.2.4. The Green Street Implementation Process in Philadelphia, PA

Philadelphia seems to place a great deal of emphasis on outreach programs. Their strategy is to minimize problems by avoiding putting large projects in the public right of way wherever possible. However, when they do become involved with larger projects and a concerned community, they aim to provide diverse outreach programs such as community meetings and flyers. The city has a public outreach unit dedicated

specifically to this effort, which often becomes involved in residential stormwater educational opportunities.

If we are working in parks, or doing something a bit more impactful like making a traffic triangle over to like a large garden space, we will do a lot more coordination of those. Then we have parks, that's where we need to have a good understanding of how the users of parks are using that space so that we can put in [an] appropriate design together, and schools obviously, we are working with [the] school community as well as the neighbors. We do have a lot of outreach. We have a public outreach unit that has been set up to do that (Expert 6, personal communication, July 10, 2014).

In addition, they provide online forms that community members can use to submit their opinions on planning-related matters. The public forum is capable of accepting as many requests from communities as residents care to submit, and people do not have to come in to City Hall to fill out forms. All local residents need in order to make their voices heard is a computer and an internet connection.

We created an online public community input form, so you can go online if you have an idea about where to do a GS, or really any kind of green project (Expert 6, personal communication, July 10, 2014).

Another specific element in Philadelphia's process is the way they select primary Green Street project sites. Unlike the other sample cities, they were having difficulties in implementing Green Streets within residential areas. So they preferred to locate Green Street projects where they can instead utilize public rights of way on institutional/commercial/business sites, thereby avoiding conflicts with underground utilities and the expense incurred in dealing with them.

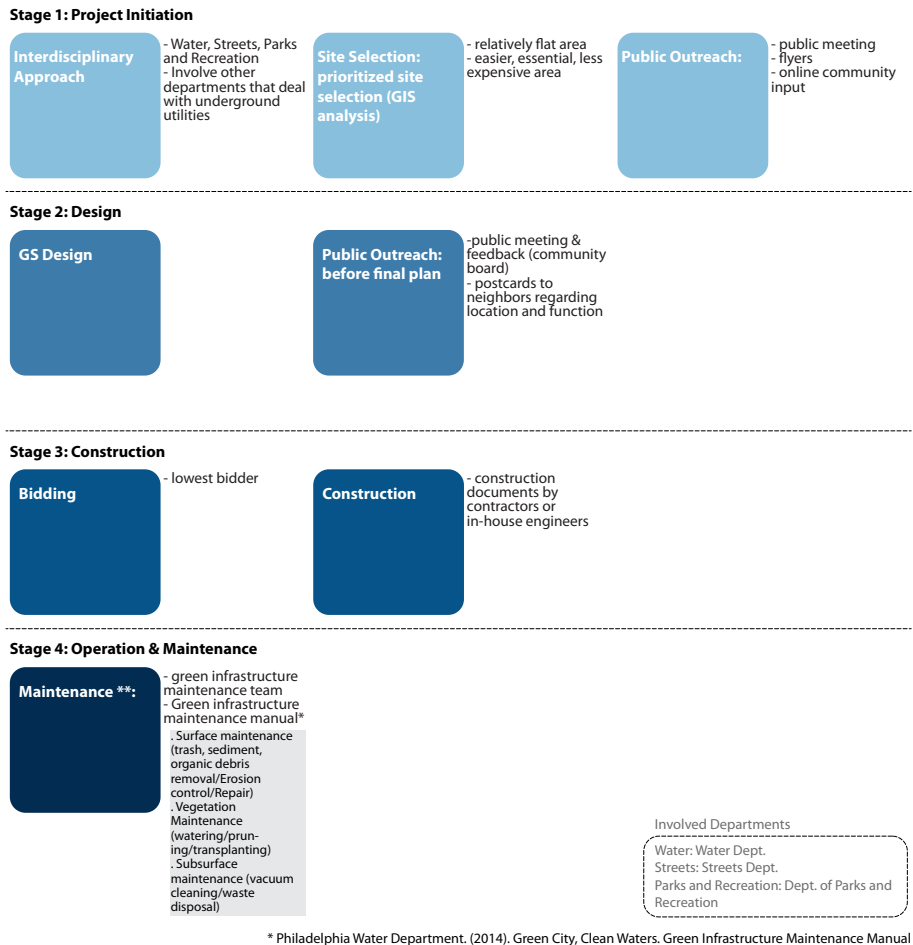


Figure 6.14. Considerations in each stage of the Green Street process, Philadelphia, PA

6.2.5. The Green Street Implementation Process in Washington, DC

Washington, DC incorporated a quality control process during the construction stage of its Green Street implementation in order to manage the construction procedure and ensure that the design could be realized as planned.

We have quality control where we oversee what the contractors are doing all the way through until the construction project is finished (Expert 4, personal communication, April 1, 2014).

The city also engaged in a rigorous public outreach effort, holding public meetings both before and during the construction of Green Street projects and conducting meetings at the local and political neighborhood levels. The city considered

public outreach to be important since it could provide insights that simple site inspection could not have uncovered.

It's definitely helpful. The residents have a lot of insights that you don't see just visiting on occasion. They can tell you what's going on. ... It's better to have them approved earlier in the process than during the construction because you can change earlier in the process before you go to the construction (Expert 4, personal communication, April 1, 2014).

Washington, DC was the only sample city where experts stated they did not have any difficulties in getting funds to proceed with Green Street projects. The expert said that most of their road projects were funded by the Federal Highways Administration, while most of their stand-alone projects were funded by local funding sources such as stormwater runoff fees and stormwater management fees, along with the EPA's Clean Water State Revolving Fund.

The district has a stormwater runoff fee and stormwater management fee that residents pay on their water bill. And so that's collected and that funds a lot of our projects. We also get projects from EPA, that's where we take funding from EPA, through the Clean Water State Revolving Fund, so we usually are pulling together lots of different funding sources to make the projects happen (Expert 4, personal communication, April 1, 2014).

The quality control process during construction could be useful for ensuring that intended designs were successfully realized. And if funding proved inadequate during the planning stage, the city could seek funds/grants from federal agencies.

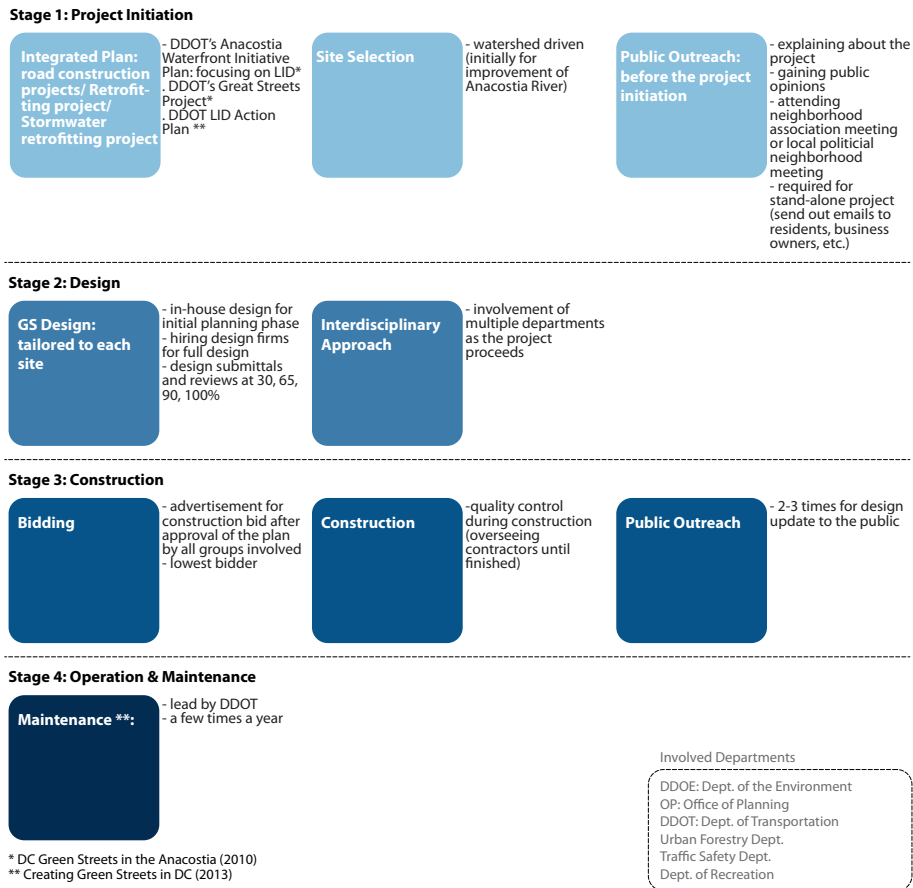


Figure 6.15. Considerations in each stage of the Green Street process, Washington, DC

6.2.6. The Green Street Implementation Process in Arlington, VA

Even though Arlington does not have a citywide green infrastructure plan that specifically promotes Green Street implementations such as the ones in New York and Philadelphia, they have adopted a systematic public outreach program similar to the one used in Portland. They also hold a series of public meetings at different design stages, in this case at the 30%, 60%, and 100% design stages, and also keep local residents groups informed about projects.

And there's a pretty significant public involvement process there. If we initiate the projects from our office, we initiate the project meeting with the adjacent residents. And then at probably about 30% design, we go to the civic association then we have meetings at the community level at about 60% and then 100% design (Expert 5, personal communication, April 3, 2014).

Arlington also utilized a thorough Watershed Retrofit Study (2013) when selecting sites, with sites being prioritized and broken up into five research areas. The prioritization concerned: “Runoff reduction”; “Pollutant removal”; “Alleviation of drainage problems”; “Education and outreach” (concerning the public); “Construction” (concerning site constraints); and “Maintenance” (Arlington, 2015b). Public feedback is also sought in relation to site selection:

We have public involvement during the watershed retrofit study, which is where we actually identified all the project locations. ... We broke the county up into six research areas and two of these have been combined, so we ended up having basically five separate studies (Expert 5, personal communication, April 3, 2014).

As a new Green Street site, Arlington had little experience with such projects. However, as Portland’s experience suggests, phased public outreach can serve as an effective way to anticipate problems and deal with various concerns from the public.

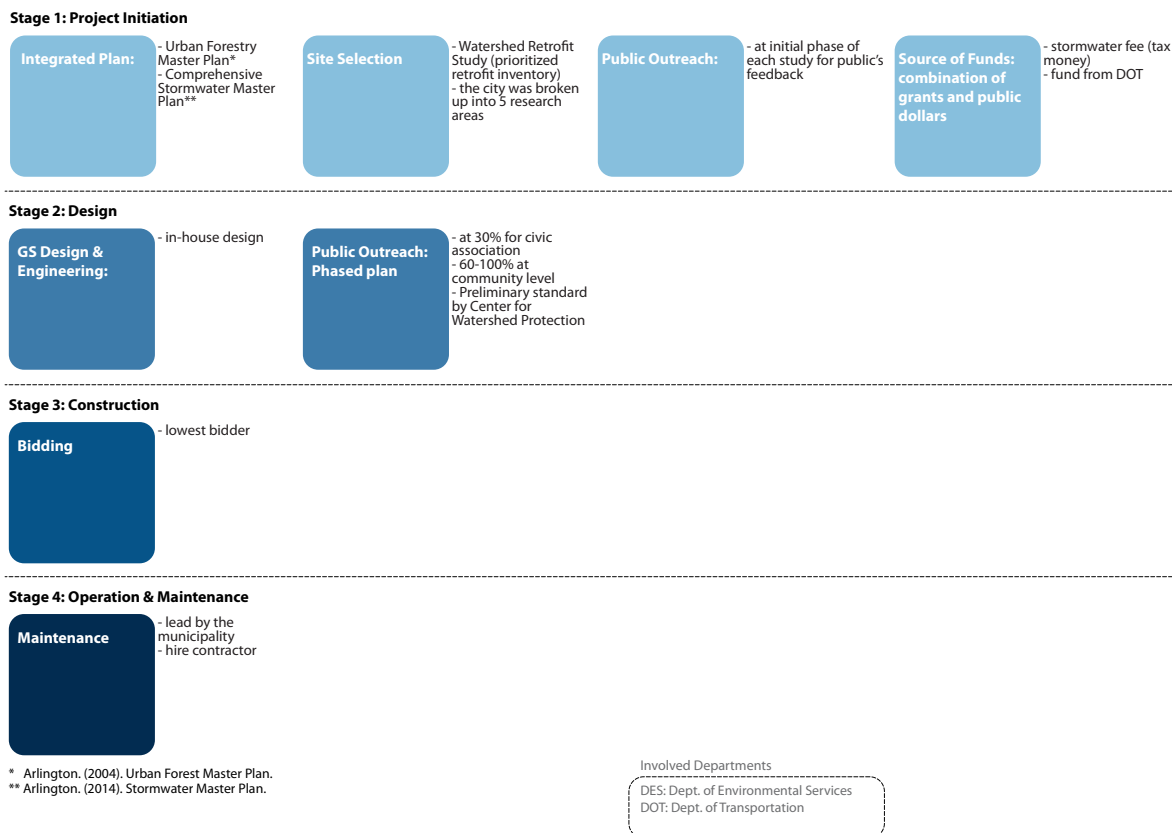


Figure 6.16. Considerations in each stage of Green Street process, Arlington, VA

6.2.7. Summary

So far, each city's process and distinctive procedural performances were examined individually. Through a deductive analysis the overall performances in each city were categorized into a four-stage process: project initiation, design, construction, operation & maintenance. Among four stages more sub-stages were described under project initiation and design stages by the experts while a few sub-stages were described under construction and maintenance stages.

Sub-stages under each stage presented similar contents throughout the sample cities. Especially in the case of project initiation stages, the discussion centered on how the sample cities prioritize site selection, seek project opportunities, and work with other departments (interdisciplinary approach). In the discussion of design stages, the sub-stage of public outreach was discussed as an important means of receiving feedback from the public and getting residents involved in the design procedure. In the discussion of construction stages, bidding procedure (in which the lowest bidder wins the contract for a given project) was described. Maintenance stage has not shown any particular sub-stages to be discussed.

6.3. Components of Successful Green Street Implementation

In this section, four sample Green Street projects are analyzed to investigate successful Green Street oriented processes and procedural performances in sub-stages. Specific aspects of performance during these processes are described project by project.

6.3.1. Broadview Green Grid, Seattle, WA

Seattle has a number of interesting Green Street projects. The city promotes Green Streets as a major component of their creek restoration strategies since creeks run through every type of land use and the city is unable to build on private property. Green Streets has become a part of Seattle's important environmental strategies of working with Natural Drainage Systems to restore the city's creeks:

We ... try to restore the creek by resizing the creek where water gets really shallow and fish cannot come in to spawn. We needed to do a lot of work in the creek but we don't own the creek and many times the creek goes behind people's backyards. So this is like a very limited opportunity for us to actually go in and fix the creek; therefore it [restoration work] has to be in the right of way (Expert 7B, personal communication, December 3, 2014).

The Broadview Green Grid, which is part of the Natural Drainage System project, was initiated mainly for treating and controlling stormwater runoff. The Broadview Green Grid has a unique serpentine street design with well-maintained Green Street practices. The reason they were able to put in this unusual serpentine street (see Figures 6.17 to 6.20) was, according to Expert 9A (2014), because of the need to efficiently direct stormwater runoff to bioretention cells along the street. At the same time there was a need to slow down traffic to deliver the "livability benefits that are often a reason why people support it" (Expert 9A, personal communication, December 3, 2014). New sidewalks and clustered mailboxes provided additional benefits in consideration of pedestrian safety and social exchange.

Before the Broadview Green Grid's construction, the SEA Green Street was built as a pilot study, and the design of the Broadview Green Grid project was upgraded based on the lessons learned from the pilot study. Unnecessary design applications such as the inclusion of filter fabric in the stormwater facilities and serpentine streets were modified.

What's interesting is in some cases we overdesigned, for example, in the SEA Street [project], we overdesigned by putting a liner underneath the swales. And we did that as a preemptive measure to make sure we didn't have any claims of wet basements as a result of the project. Well in fact you don't have the problem, so it was more kind of a placebo for the community. But [the preemptive design] brought up the custom design, so [for] the Broadview Green Grid, we didn't have any liners, we made sure we have ... good infiltrating soils, and those swales always have worked really well (Expert 7A, personal communication, December 3, 2014).

The city tracked the completed Green Street projects and documented the lessons learned from them through the division responsible for evaluating constructed

projects and updating their standards for future reference. A post-occupancy survey conducted with residents some years after the completion of Green Street projects and including the Broadview Green Grid project revealed that residents were generally satisfied with the city’s Green Street program. The results of the survey provide some legitimacy to the Green Street initiative, especially in the eyes of stakeholders or governmental officials who hesitated to locate these projects in neighborhoods.



Figure 6.17. Typical residential street before Green Street construction.



Figure 6.18. Broadview Green Grid with curvilinear street and sidewalk.



Figure 6.19. Clustered mail boxes.



Figure 6.20. Bioswale implemented in front of houses and one-sided street parking.

6.3.2. Holman Pocket Park, Portland, OR

The priority of the Holman Pocket Park project was to create a bike route as part of the Neighborhood Greenways, built by the city’s Bureau of Transportation. As the project was entirely funded by stormwater funding, it was mandatory for the treatment of stormwater runoff to be included.

This project in particular was politically driven because the Bureau of Transportation was implementing neighborhood greenways, the bike routes, and they had a political mandate to use stormwater money to help build the neighborhood greenways (Expert 8, personal communication, December 10, 2014).

Due to funding constraints, there were limited options for including design elements other than facilities that were related to treating stormwater runoff. However, it was possible to incorporate design interventions such as seat walls, a kiosk, improved vegetation, and closed off roadway access (Figures 6.22, 6.23, and 6.24).

They [residents] were interested in having more seating. We couldn't necessarily buy lots of benches cause that's not really a stormwater use, but we did incorporate some short walls that also can be seating. The park also had the city's sidewalk [going] to ... private property instead of a route next to the road. ... We removed some trees that were sort of in decline, and replaced some trees, and just generally updated the vegetation, and put [in] some nicer native plants and other vegetation. We also put in [an] irrigation system (Expert 8, personal communication, December 10, 2014).

Even though the restrictions on the available funding for the project and the lack of funding from the Parks Department severely limited their options (i.e., they did not have support for the additional design elements they wanted), the designer's efforts enabled interventions such as seat walls. The community was involved in deciding the location of the site and determining how the stormwater runoff from the residential street would be directed to the park and treated. The EPA's Innovative Wet Weather fund also affected the result since the fund had some flexibility in providing additional design elements even though its primary intent was stormwater treatment.

The location for the pocket park was a community that had been suffering from unsafe streets, but the Green Street project and redevelopment of the connected pocket park made it a safer place where children could come out and ride their bikes and community meetings could be held.

People would come to the park and do drug deals and once the park was redone and the neighbors gathered there more, then the crime went down (Expert 8, personal communication, December 10, 2014).

This project is a good example of how Green Street projects can help local residents achieve a better quality of life by devoting some effort to addressing the community's needs and finding ways to achieve them, even with limited funding sources. It shows the important role of decision-making in the process and how a relatively small Green Street intervention can greatly improve the quality of life in a community.



Figure 6.21. Catchment areas. Reprinted from Holman Pocket Park and Green Street Bike Boulevard Project (p. 1), by City of Portland. Copyright by City of Portland, OR, courtesy Bureau of Environmental Services. Reprinted with permission.



Figure 6.22. Infiltration basin with seat walls and newly paved pathways. Reprinted from Holman Pocket Park and Green Street Bike Boulevard Project (p. 2), by City of Portland. Copyright by City of Portland, OR, courtesy Bureau of Environmental Services. Reprinted with permission.



Figure 6.23. “Overview of park and ROW work looking west after construction”. Reprinted from Holman Pocket Park and Green Street Bike Boulevard Project (p. 5), by City of Portland. Copyright by City of Portland, OR, courtesy Bureau of Environmental Services. Reprinted with permission.

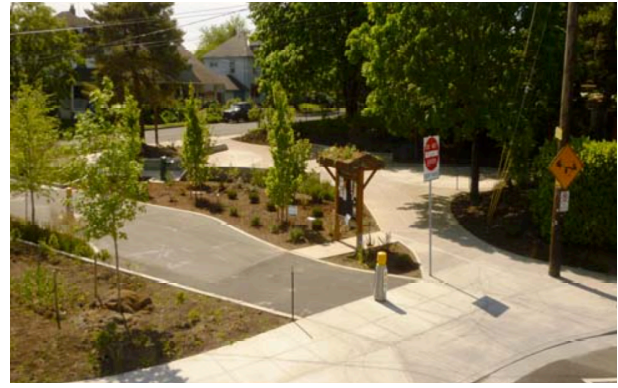


Figure 6.24. “Looking east after construction” with kiosk for neighborhood news. Reprinted from Holman Pocket Park and Green Street Bike Boulevard Project (p. 4), by City of Portland. Copyright by City of Portland, courtesy Bureau of Environmental Services. Reprinted with permission.

6.3.3. Maynard Avenue, Seattle, WA

This community-driven project is located in the international district of Seattle, and in this case, somewhat unusually, stormwater treatment was not required. However, the Green Street approach was adopted for the project in order to improve the aesthetics and “highlight stormwater runoff for the community” (Expert 9B, personal communication, December 10, 2014). This Green Street practice has a unique design as it is located on a steeply sloping site and thus consists of a series of round stormwater planters that step down and are connected with conduits. Japanese traditional hand pumps are placed on top of the planters (Figure 6.25) and connected to an underground cistern, where roof runoff is collected (Figure 6.26). The hand pump irrigates the planters as water flows down from the top to the lowest planter. Other design elements integrated into the scheme include seat walls topped with historic pictures and an information kiosk describing the Japanese history of the street (Figures 6.27 and 6.28). When asked how these unique designs came to be implemented, Expert 9B explained that the community development work was a collaborative effort involving community members, nonprofit organizations, and a landscape architectural consultant. The community actively participated in the process, especially regarding the

integration of the community's historic characteristics. Artists and landscape architects participated in incorporating ideas into the project design.

The community wanted to see that link to the cultural history integrated in the project. So those ideas were brought forward in the concept [stage] by the community and by nonprofits operating in the neighborhood and then kind of helped to be realized by the design team (Expert 9B, personal communication, December 10, 2014).

This project demonstrates how Green Streets can also be applied under challenging geographic conditions like steep slopes since most Green Street projects are implemented on relatively flat ground for easy construction. The project was not affected by stormwater codes, but the project objectives valued stormwater treatment, and planners and designers included the Green Street approach in their street improvement plan. This project is also an excellent example of integrating the historic identity of a place into a Green Street design as a result of a strong collaboration among artists, planners, designers, and community members who care about the site's identity as an international district.



Figure 6.25. Japanese hand pump connected to the underground cistern for irrigation.



Figure 6.26. Downspout from the building and grated drain connected to the underground cistern.



Figure 6.27. Stormwater planters connected with conduit and seating with historical art tiles.



Figure 6.28. Maynard Avenue Green Street Project on a slope with stepping-down planters and information signs about Japanese history.

6.3.4. College Avenue Promenade, Blacksburg, VA

The College Avenue Promenade was the first project that integrated street improvement with the Green Street approach in the town of Blacksburg, VA, so its planning and implementation received a great deal of attention from the city. First, the design consultant and construction contractor for the project were selected through a request for proposal (RFP), after which they accepted several proposals and selected firms to carry out the work. The lowest bidder for the construction was not necessarily their first choice as the bidding process was different from that used by the other cities. According to the expert interviewed, the construction contractor was selected based on experience with similar projects and the quality of the proposal, thus increasing the likelihood of the project's successful completion.

We selected a contractor not through the low bid process but through a request for proposals process so that we could select [the] best-qualified contractor on the basis of a combination of price, personal experience, and their construction plan, because the impact on all those businesses was far more [important] than just a low bid [for the] construction (Expert 10A, personal communication, December 3, 2014).

The public outreach approach also played a prominent role in the process since the public was concerned about keeping businesses open and accessible during

construction. According to the same expert, they sent out notices regarding construction schedules to keep the public and business owners informed about what was going on and had signs on the site redirecting customers to the entrances to the businesses (Figure 6.29-6.34). The city maintained a blog with construction information and allowed anyone to leave questions or comments.

And if there was big change in the zone of construction we would tell them that changes are happening so be prepared. ... And then we also had signs along the street saying business is still open and come on by, things like that (Expert 10A, personal communication, December 3, 2014).

When the project was constructed, although there was no stormwater code in place that they needed to follow, stormwater planters were included right from the project initiation stage because a sustainable approach was one of the town's priorities. The Green Street approach was actively applied throughout and became one of the project's major design elements.

For this project, the objectives appear to have been well understood among the different disciplines involved and sustained throughout the process. Although experts from various fields played different roles in the course of the implementation of the project, they worked together well, communicating and collaborating effectively. Expert 10B commented that the collaboration among different departments was successful and satisfying (personal communication, February 27, 2015) as a result of the collaborative attitudes of all the parties involved.



Figure 6.29. College Avenue in front of Squires Center with stormwater planters, benches, and hanging baskets.



Figure 6.30. College Avenue in front of retail stores with outdoor seating area and stormwater planters.



Figure 6.31. Information sign for downtown.



Figure 6.32. Bike chained to a tree.



Figure 6.33. Stormwater planter in detail.



Figure 6.34. Maintaining access to local businesses during construction.

6.3.5. Summary

These four successful Green Street projects had different site contexts and needs. What made them all unique and different from other typical Green Streets were their efforts to resolve site constraints and address needs while also providing additional benefits. Rather than simply turn their attention to putting in stormwater facilities, they departed from the practice of traditional stormwater management strategies by coming up with ideas to treat stormwater as resource and not just waste.

Stormwater management in these sample projects was integrated with creative design elements (e.g., the Japanese hand pump for irrigation and the serpentine streets for capturing stormwater and calming traffic). These projects often featured unique design languages that made them stand out among urban Green Street designs.

One finding of this study is that community interest in environmental improvement can be used to actively promote Green Street implementation within the context of a community development plan. Bidding processes can differ from the typical ones, which simply go to the lowest bidder. Planners can seek out contractors with experience and knowledge in constructing Green Streets who can bring quality assurance to their work. Post-construction evaluation and documentation of the project are additional measures that can improve the design and functionality of future projects through information for future reference about lessons learned. These findings are summarized in Table 6.4 and go into this study’s reflections on establishing a successful and comprehensive Green Street oriented process.

Table 6.4

Procedural performances with distinctive aspects identified in four selected successful Green Street projects (categorized into the four-stage process).

	Project Initiation Stage	Design Stage	Construction Stage	Operation & Maintenance Stage
Broadview Green Grid	<ul style="list-style-type: none"> • Integration with Other Plans: - Creek restoration 	<ul style="list-style-type: none"> • Design Development for Multiple Benefits - Unique design (serpentine shape) for efficient 		<ul style="list-style-type: none"> • Post Construction/ Occupancy Evaluation

		stormwater treatment and pedestrian safety	
		<ul style="list-style-type: none"> • Pilot Project <ul style="list-style-type: none"> - Test function and design - Design update for future implementation 	<ul style="list-style-type: none"> - Record lessons learned - Update standard - Survey users before & after the construction
Holman Pocket Park Green Street Project	<ul style="list-style-type: none"> • Integration with Other Plans: <ul style="list-style-type: none"> - Neighborhood Greenways 	<ul style="list-style-type: none"> • Design Development for overcoming limited resources and obstacles <ul style="list-style-type: none"> - Design intervention by designer's creativity and intention • Design Development for community improvement <ul style="list-style-type: none"> - Pedestrian safety - Gathering place 	
Maynard Avenue Green Street Project	<ul style="list-style-type: none"> • Seeking Project Opportunity <ul style="list-style-type: none"> - Community-driven project 	<ul style="list-style-type: none"> • Design Development <ul style="list-style-type: none"> - Unique design to overcome topographical obstacle - Reflection of cultural background 	
College Avenue Promenade	<ul style="list-style-type: none"> • Setting Objectives <ul style="list-style-type: none"> - Environmental concentration - Tailored to community needs . Formation of a Team - Good relationship and communication 	<ul style="list-style-type: none"> • Design Development <ul style="list-style-type: none"> - Stormwater planter to provide green - Reflection of local culture through materials 	<ul style="list-style-type: none"> • Bidding Process <ul style="list-style-type: none"> - Through RFP, finding experienced contractors (not lowest bidder) • Quality Control <ul style="list-style-type: none"> - Access to local businesses

6.4. The Green Street Oriented Planning and Design Process: Successful Implementation

In the previous sections, the following aspects were discussed: attributes of considerations for implementing Green Streets in six sample cities (Section 6.1), processes in each of the six sample cities (Section 6.2), and procedural performances regarding successful Green Street implementation (Section 6.3). Based on the findings in these three sections, a comprehensive process for successful Green Street oriented

planning and design is discussed in Chapter 6, Section 4.1. Following this, a finalized process is derived after the member check. This study of process formation can provide an overarching perspective on Green Street implementation at different stages of the process. This perspective assists in identifying what needs to be considered and performed for success throughout the implementation process.

6.4.1. Developing a Green Street Oriented Process for Successful Implementation

In this section, a Green Street oriented planning and design process for successful implementation was derived based on the findings in Sections 6.1 through 6.3 as described above. The project initiation stage was found to comprise the following sub-stages: establishing how a project will be initiated (bottom-up/top-down), forming an interdisciplinary team (potential departments), setting objectives, carrying out site analysis and selection, creating integrated plans with Green Streets, reaching out to the public, and finding funding sources. For the design stage the sub-stages are as follows: investigating precedent studies, referencing regulatory obligations, analyzing the site, working on design development, reaching out to the public, and estimating costs. During the construction stage, the sub-stages consist of creating construction documents, engaging in the bidding process, and conducting quality control. For the operation & maintenance stage, the sub-stages are determining how to maintain Green Streets, providing stewardship, conducting public outreach, evaluating post construction, and monitoring. Figure 6.35 presents the first draft of a four-stage Green Street oriented process. The sub-stages do not have a particular order since they can occur as needed. This process is critiqued by experts from six sample cities and experts who worked on four successful sample projects for member check analysis in the next section.

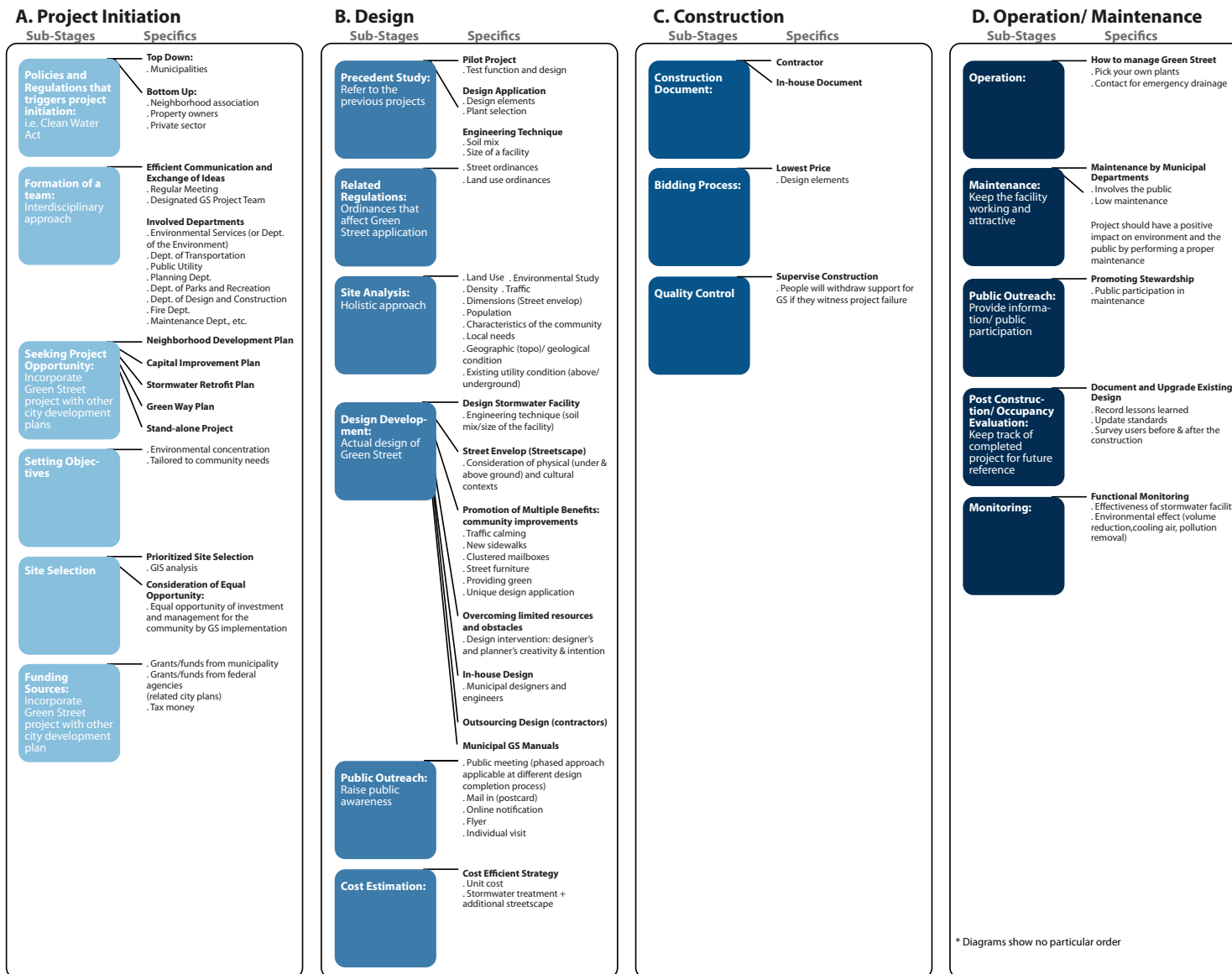


Figure 6.35. Summary of successful comprehensive Green Street oriented process.

6.4.2. Recommendation and Amendment of Comprehensive Successful Process for Green Street Implementation based on Member Check

Experts from data collection phases 1 and 2 of this research (n=13) were asked to comment on the Green Street oriented process previously identified (see Figure 6.35). The experts were given the process diagram and asked to add or remove the sub-stages in each stage according to what they considered successful Green Street implementation given their experience. For each stage, experts suggested various opinions.

The first item the experts noted was that public outreach could take place more than once and fulfilled different purposes at different stages in the process. Public outreach could be applied to each stage as follows: In the project initiation stages, public outreach can be used when selecting a site. For the design phase, outreach can be a helpful way of collecting the public's opinions and preferences concerning alternative designs. For the construction stage, outreach can be used to inform the public, for their convenience, regarding the construction schedule. In the maintenance and operation stage, it can be used to promote public participation in maintenance or for educational purposes. These opinions were voiced by three different experts.

I think probably I just kind of start from the project initiation and go through to the end of construction with public outreach. ... During the construction time, it's really affecting their daily life, cause usually it may take like 6 months or something. You see the equipment everyday so it's important to have that and communicating with the affected residents about the progress of the project and what's coming and what's happening is important (Expert 7B, personal communication, December 26, 2014).

I think our public outreach is a lot bigger than the one box you have. ... [in] the Tabor to the River program, for example, [we] have a whole outreach program about general watershed health and data messaging. ... So that's just a high level outreach and then we also do specific project site by site outreach where we work a lot with property owners on the design in front of their homes, plants they want, what kind of tree, where they park, things like that (Expert 8, personal communication, December 10, 2014).

I think there should be public outreach in the project initiation, too. Because the site selection like that, whether it's a priority [for] the community in the area, it's probably important (Expert 9B, personal communication, December 10, 2014).

The second point raised was that the site analysis could be done in two stages: project initiation and design. These could also entail both regional analysis and local site analysis, if appropriate.

I think that some site analysis is also included in project initiation but then you would probably do it again during design. So there could be overlap or larger scale site analysis might be done during implementation and then in more detail during design (Expert 8, personal communication, December 10, 2014).

Thirdly, the order of the sub-stages could be changed according to the local circumstances and the situation of an individual project. The order of the sub-stages needs to be decided according to priorities and how the project is initiated.

I think a lot of these could be case by case. Projects, I think the orders you got here is pretty good, but in my experience it's very case-by-case (Expert 9B, personal communication, December 10, 2014).

I think your order makes a lot of sense in general. I'm not sure if it's applicable to every project. It is like for instance, the site selection might actually come early on in the process. In our project it was very early on because it wasn't regulations [that] triggered the project (Expert 10C, personal communication, March 13, 2015).

Finally, when the experts were asked which sub-stages should be more carefully considered in order to deliver multiple benefits, public outreach, design development, and construction sub-stages were all mentioned. Public outreach was needed to obtain public support for the project, design development was to provide actual benefits to the community, and the construction sub-stage was to ensure the design was built as intended.

Definitely the outreach again. Also design process. Specific design treatments are really important in terms of whether they will really provide some livability benefits or place making benefits. ... You need to have community support and kind of engage that all along the overall phases of the project (Expert 9B, personal communication, December 10, 2014).

Here [construction sub-stage] you have to be really aware of what the impacts are going to be. ... If you get to construction and the contractor is not particularly good at what they do, unfortunately you made [the] wrong selection. Construction takes longer, they don't meet the schedule, it drags on. That can ruin the entire project (Expert 10B, personal communication, February 27, 2015).

All the experts approved of the division into four stages (project initiation, design, construction, maintenance & operation) for the overall process, but there were various opinions on the sub-stages included in each stage. Consideration was given to all the arguments put forward, and after reflection, specific sub-stages were added to the framework. The final version of the proposed successful comprehensive Green Street oriented planning and design process is described and presented diagrammatically in Figure 6.36.

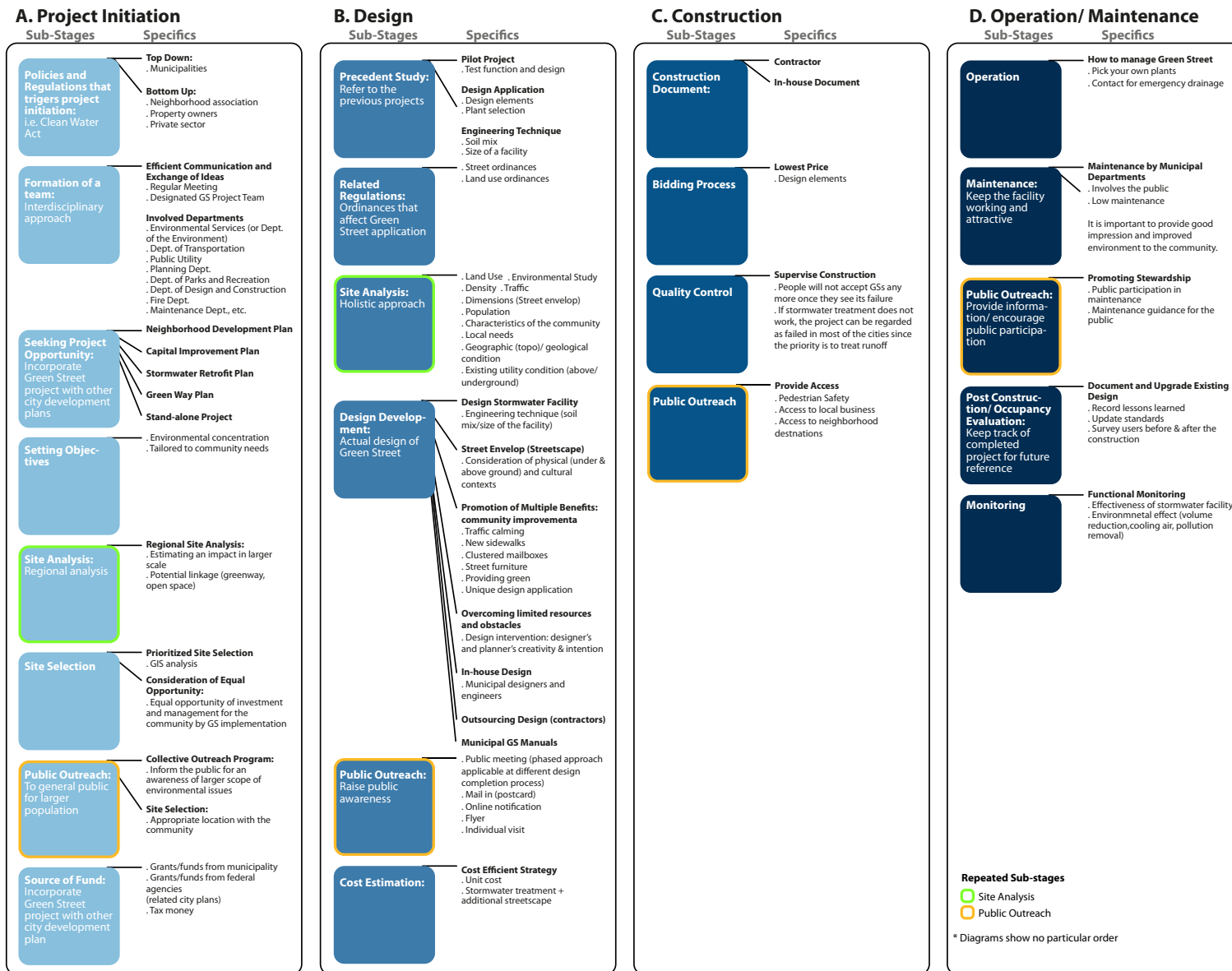


Figure 6.36. Green Street oriented planning and design process: Final.

The final version of this Green Street oriented process presents several unique points compared to Simonds' (1983) planning-design process presented in Chapter 2, Section 3.2 (see Table 6.5). Unlike Simonds' planning-design process, the Green Street oriented process places its focus on an interdisciplinary approach and seeking project opportunities with other city development plans. Site analysis requires both regional and local approaches, but Simonds' process used only one site analysis. There was little mention of the possibility of interviewing users during the planning-design process, but the Green Street oriented process required more sophisticated strategies in terms of public outreach and even allowed for the inclusion of public input throughout each stage of the project and for different purposes. The post-construction evaluation was not discussed in the context of the planning-design process, but in the Green Street process it was one of critical steps because planners and designers tend to learn from previous projects, and the short history of Green Streets makes the need to continually update design standards of the utmost importance.

Table 6.5

Comparison between the Planning-Design Process (Simonds, 1983) and the Green Street oriented process.

The Planning-Design Process (adapted from Simonds, 1983, pp. 106–107)						
Stages	Commission	Research	Analysis	Synthesis	Construction	Operation
Sub-stages	<ul style="list-style-type: none"> . Client statement of need . Definition of services . Execution of agreement 	<ul style="list-style-type: none"> . Survey . Data collection . Interviews . Observation . Photography 	<ul style="list-style-type: none"> . Site analysis . Review of governing regulations . Constraints . Possibilities . Program development 	<ul style="list-style-type: none"> . Schematic studies . Comparative analysis . Impact assessment . Accommodation . Consolidation . Method or methods of implementation 	<ul style="list-style-type: none"> . Preparation of construction documents . Contract award . Supervision of construction . Punch list checkout 	<ul style="list-style-type: none"> . Periodic visits . Adjustment; improvement . Performance observation
Green Street Oriented Process						
Stages	Project Initiation	Design			Construction	Operation & Maintenance
Sub-stages	<ul style="list-style-type: none"> . Policies and Regulations . Formation of a Team: interdisciplinary approach . Seeking Project Opportunity: incorporate Green Street project with other city development plan . Setting Objectives . Site Selection: prioritization . Site Analysis . Public Outreach . Funding Source: incorporate Green Street project with other city development plans 	<ul style="list-style-type: none"> . Precedent Study: learn from the previous projects . Related Regulations: local ordinances . Site Analysis: holistic approach (land use, environmental study, dimensions, population, local needs, geographic/geological condition, existing utility condition [above/underground]) . Design Development: design stormwater facility, design street envelope, promotion of multiple benefits, overcoming limited resources and obstacles, in-house design, and outsourcing design . Public Outreach: public meeting (phased approach applicable), mail, online, flyer, individual visit . Cost Estimation 			<ul style="list-style-type: none"> . Construction Document . Bidding Process . Quality Control . Public Outreach 	<ul style="list-style-type: none"> . Operation . Maintenance: keep the facility working and attractive . Public Outreach . Post Construction/ Occupancy Evaluation . Monitoring

6.5. Discussion

Green Street projects have truly involved multiple departments, regardless of where they were placed or who designed them, and no one department is assumed to be the designated leader in implementing them. In general, the question of which department takes the lead on a Green Street project depends largely on the nature of the project in terms of who initiated it, what its objectives are, and how it fits the plans of the city with which it is affiliated. In any case multiple departments and parties are involved in these projects and have something to contribute or to take away from it. So it is important to make sure that these parties can be involved throughout the entire Green Street implementation process, as in the case of Portland, which has led the way on Green Street policy, research, design, and monitoring.

Four selected successful cases presented complex design applications including incorporation of cultural backgrounds, invention of unique stormwater planter designs, promotion of social exchange, provision of pedestrian safety, and aesthetic improvement. However, not all projects presented the same degree of design applications even though they were nominated by experts as successful projects. There were 19 projects nominated and eight projects show a similar degree of complexity as presented in the four selected cases. The eight projects include but are not limited to support for street activities (sitting, waiting, eating), creative design (serpentine roads and sidewalks, round-shape stormwater planters, cascades), incorporation of arts and cultural elements (sculpture, decorative tiles, hand pumps), and integration of open space (a pocket park) in their designs. The other projects have simple stormwater planters with minimum design elements such as new pedestrian crossings and ADA ramps. More design elements may provide more benefits, however users' needs, site contexts, and available resources need to be reflected simultaneously in the design process.

The analysis of the process of setting priorities contradicted the analysis of attributes of success in Green Street projects (presented in the Analysis of research question 1). Benefits other than stormwater treatment were the critical elements of success in planning and evaluating Green Streets. One interpretation of this is that

stormwater treatment may be a motivation or trigger for seeking to develop Green Streets in a given city, but the actual objectives and standards that residents hope to achieve in their cities are more in line with the additional multiple benefits that can result from Green Street implementation. The following interview shows that the intent of designers often has more to do with these additional benefits than it does with stormwater management.

I would just say that the goal for me as a landscape architect and working on these projects is to achieve the wide range of benefits they provide not just drainage benefits but traffic calming and creating neighborhood character that [haven't] really existed before (Expert 3A, personal communication, March 20, 2014).

Maintenance Stages were seldom mentioned by the experts, and the implicit reasons for that may appear to have two components. The first is that maintenance may be less important than design to the parties involved. The second is that conducting maintenance may be problematic due to lack of funding or resources. Nevertheless, maintenance can be very important because Green Streets includes stormwater treatment facilities that require constant management such as weeding, clearing inlets, and picking up trash. Also, the public's perception and acceptance of Green Street projects may depend on proper maintenance of project sites. Hence, the maintenance needs for Green Streets are likely to increase. One promising maintenance approach is to promote community participation (or stewardship) through trash removal, weeding, and watering, as suggested by the experts in DC and Portland (District Department of Transportation, 2014; Services, 2015).

The Green Street approach is a relatively new strategy and uses natural materials that may require time before they yield tangible results. Therefore, keeping track of results and feedback, and relaying them during the design and development process, can be one way of improving design application for Green Street projects. In the same sense, there is little understanding by the public regarding what Green Street is. So, public education regarding stormwater management and Green Streets would

also be helpful for Green Street installation. Studying concerns and challenges can help designers and planners to anticipate impediments to successful completion of Green Street projects. Moreover, studying challenges allows those implementing these projects to observe the current status of Green Streets and consider possible conflicts and problems that can arise in all stages of the implementation process.

The Green Street approach also showed potential as a larger city development strategy considering its transitioning application from small stand-alone projects to current multiple-block projects. This study put forth a set of processes that can be applied on any scale.

6.6. Summary: A study of Considerations in Promoting Successful Implementation of Green Street

The results presented in this chapter were based on findings from three sections in a Study of Considerations in Promoting Successful Implementation of Green Street: Analysis of research question 2, which were considerations in implementing Green Streets, analysis of processes in six sample cities, and analysis of procedural performances in four sample projects.

Chapter 6 Section 1 provided specific insights regarding how Green Street projects were implemented in their cities. The elements considered in relation to the implementation process were setting priorities, finding funding sources, involving multiple parties, establishing planning & design protocol, conducting public outreach, and carrying out operations & maintenance.

In Chapter 6 Section 2, each process from six sample cities was summarized to study common and different procedures that each city utilized. An interdisciplinary approach and public outreach were the most frequent sub-stages in these processes, and the rest of the sub-stages showed variations in performance options. The outlined stages and sub-stages in this section helped to form the overall framework of the Green Street oriented process. The processes were summarized with diagrams for easier understanding.

Chapter 6, Section 3 investigated successful Green Street projects regarding procedural performances. A more specific investigation focused on the performance that each city has adopted to promote additional benefits from their Green Street projects and to resolve issues. The findings from Sections 6.1 through 6.3 formed the basis for the Green Street oriented process outlined in Section 6.4.

Based on these three sections, the overall Green Street oriented processes were arranged into one four-stage process (Figure 6.35), which was modified after a member check analysis. The finalized Green Street oriented planning and design process for successful implementation was then presented (Figure 6.36).

Promoting successful Green Streets is not limited to one aspect of benefits (especially stormwater management), but also includes additional benefits that can meet the community's needs and concerns. Moreover, it is not constrained to one specific stage of the project, but depends on considerations that arise throughout the process. The design implications identified need to be considered throughout the Green Street implementation process as they focus on critical elements of various strategies for enhancing the quality of community life.

In terms of the comprehensive process, some sub-stages were also repeated in different stages with different purposes. Again, the process created here is not intended to serve as an exhaustive protocol that planners and designers must follow, but rather as a guide to help them follow an appropriate path from the initiation of the project to the construction and maintenance stages. Moreover, the procedural performance discussed throughout this research should be emphasized more than the created process. The process is a framework to discuss the essential procedural performances. The next chapter will conclude this study with recommendations for successful Green Street implementation based on the procedural performances identified throughout the research.

Chapter 7. Summary and Conclusion

Both analyses conducted in the previous chapters (*a Study of the Attributes of Success Achieved by Green Street: Analysis of research question 1* and *a Study of Considerations in Promoting Successful Implementation of Green Street: Analysis of research question 2*) are presented in this chapter. Then, they are followed by a discussion on design and construction implications for successful Green Street implementation. The chapter concludes with recommendations for future research.

7.1. A Study of the Attributes of Success Achieved by Green Street: Analysis of research question 1

Attributes that contributed the design of successful Green Street projects were derived from the first round data. It could provide insights into the current state of Green Streets. The data was collected mainly through interviews with experts from six sample cities and additionally through a review of literature and other materials (government reports, factsheets, and websites). The primary analytic tool was content analysis, but cross tabulation, flowcharts/diagrams, and frequency analysis were also used.

Successful Green Street projects exhibit a wide variety of characteristics, and the measures adopted to study them differ slightly, depending on each municipality's available resources and prioritization of Green Street implementation. However, the experts who participated in a variety of Green Street projects from each municipality converged upon the same answer when asked which elements of the project they worked on led to its success. The experts largely agreed that the primary stated benefit of these Green Street projects, dealing with storm runoff, was not the only chief concern of the users, and that the keys to a successful project were the additional benefits users accrued from the projects. These elements of successful projects were more related to community (social) benefits than to environmental and economic ones, and they included streetscape improvement, pedestrian safety, creating neighborhood gathering places, aesthetic improvement, better connections/access (to adjacent neighborhoods, amenities, open spaces, etc.), and incorporation of public arts. Acceptance and

involvement by multiple parties was also frequently discussed as an element of success. Success was defined as a Green Street project that garnered interest or acceptance from the public or stakeholders, involved interdisciplinary/multiple parties, and performed as a good precedent project that provided lessons learned.

Compared to the objectives and goals stated in the manuals, successful Green Streets exhibited many additional benefits. Clearly Green Streets provided a variety of benefits beyond what the manuals presented and therefore showed potential as a community development strategy rather than merely a means of dealing with storm runoff. These additional attributes of success can be considered as potential goals or objectives for future implementation.

7. 2. A Study of Considerations in Promoting the Successful Implementation of Green Streets: Analysis of research question 2

Elements of considerations and general processes in Green Street implementation were investigated based on the parts of the first round of data. The second round of data used in this study centered more on the question of how Green Street projects can be implemented successfully: detailed study on decision-making protocols and actions taken in successful cases were investigated, and a four-stage Green Street oriented implementation process for successful implementation were derived from the data. The research was conducted through qualitative interviews with experts from six sample cities and with experts who worked on four successful Green street projects, a literature review, content analysis, cross tabulation, a flowchart/diagram, and a member check.

Green Street projects involve a wide range of necessary elements, each of which is composed of multiple aspects including Setting Priorities, Funding Sources, Involvement of Multiple Parties, Planning & Design Protocol, Public Outreach, Operation & Maintenance, and Challenges in Green Street Implementation. Different human resources, techniques, and materials are therefore required at each stage of the planning and design process, from the initial project planning and design development, through the construction phase, to the final completion and maintenance of the project.

Among many considerations in the four-stage Green Street oriented process, the following sub-stages stood out more: collaborative work in interdisciplinary approach, multi-scaled site analyses, public outreach considered in all four stages, and post-occupancy evaluation for advancement of current and future Green Street implementations.

Since multiple elements are involved, it is important to have a suitable framework to guide the entire process that clearly shows necessary steps and decisions that must be taken, and the potential procedures to be implemented at every stage of the Green Street implementation process. The Green Street oriented planning and design process developed in Chapter 6 (see Figure 6.36) can be used as guide for planners and designers who work on Green Street projects.

7.3. Procedural Performance Recommendations for Successful Green Street Implementation

The procedural performance recommendations for successful Green Street implementation can be described by a set of eight application principles/commandments. The eight principles encompass the critical considerations for promoting additional benefits and successful Green Street implementation. They focus on procedural performances within the framework of the Green Street oriented implementation process.

7.3.1. Accommodate Multiple Visions and Designate a Champion for the Project

Green Street projects are more likely to provide the additional benefits to the community on which their success depends if they include multiple perspectives in their implementation and if they have parties who will champion those projects and see them through to completion. As the interviews indicated, the main priority of most Green Street projects is primarily stormwater mitigation, but in fact many of these projects have a range of objectives and differing degrees of complexity. The presence of a stakeholder or interested party whose strong vision and clear objectives guide the program can help to ensure that all those involved remain on track as they progress

through the various stages of implementation (especially considering collaboration among multiple departments in a municipality as well as involvement of private contractors to accomplish design, construction, and maintenance). When establishing a vision, it is important to consider the critical needs of the community and to prioritize each element accordingly. This will ensure that Green Street projects comprise valid and successful community development strategies with diverse characteristics.

Although a clear vision of the desired endpoint is important, having a champion (either an individual or an agency) who takes responsibility throughout the process is critical for the success of a project since “goodwill [to continue a program] seems to be most effectively garnered by influential individuals within the implementing organization acting as program advocates or ‘champions’”(Shediak-Rizkallah & Bone, 1998, p. 102). However, a champion in the shape of a department or person was hardly ever to be seen in the sample cities examined, and sometimes involved multiple parties of a program caused difficulties because it complicated the processes of decision making and overseeing the project. A champion needs to have a wide range of skills to deal with the various situations that often arise during Green Street implementation. The Holman Pocket Park Green Street Project in Portland (one of four cases) could be a good example. The project was funded only by stormwater-related money, so it had no budget for additional amenities such as street furniture. The community wanted to have benches and a playground, but it was not possible because of the funding restrictions. However, the municipal designer was able to come up with an idea. She raised the walls of the planters so that they could function as seat walls. Another example was found in the College Avenue Promenade (one of four case projects). The engineer who participated in the project noted that because of regular communication led by the town official among the city’s residents, their company, and other private contractors, they were able to collaborate to resolve a problem that arose when they unexpectedly came upon underground utilities.

This example illustrates how having someone with the management skills to address a community’s needs can be a crucial component in guiding a project to its successful completion. Based on the concerns identified in Chapter 4, a champion of

this kind must not only have a vision (a focused mind), but also knowledge of how to work with different disciplines (the ability to work with everyone) and the ability to deal with unexpected situations (a readiness of wit); such a champion must be capable of seeing details and the big picture at the same time (i.e., must have a wide range of perspective) and also be decisive at crucial points (i.e., must possess a bold attitude).

7.3.2. Maintain Good Communication Among Related Departments for Effective Interdisciplinary Collaboration

It was clear from the interviews of the first and second round data collection that Green Street projects were truly interdisciplinary in nature due to the fact that they are implemented in a public right of way and deal with stormwater runoff. The departments related to Transportation and Environmental Services are likely to be the most heavily involved. Planning and Parks Departments come in a close second, and other departments, such as Utilities, Maintenance, and Fire Departments, may also be included. Expert 2 (2014) from New York revealed in an interview that each department involved in developing Green Street standards presented a different set of priorities. The departments involved—the Department of Parks and Recreation, Department of Transportation, Department of Environmental Protection, and Division of Design and Construction—resolved the differences through regular meetings in which they exchanged their thoughts and strategies. Good communication among these various departments appeared to play a vital role in the program’s success. The funds, plans, and priorities of Green Street projects inevitably differ from one project to another, and any conflict of interest that arises needs to be resolved through free-flowing interdepartmental communication channels. Each department can play its part in successful communication by remaining constantly aware of the potential for conflicting objectives and misunderstandings, and conflicts can be resolved by regular meetings or forming formal interdisciplinary Green Street teams, as Portland has done in the case of its Cross-Bureau Team. Portland’s team consists of different departments dedicated to Green Street implementation. Their tasks are to contribute to the program’s work by conducting analyses of funding, policies, designs, and maintenance.

7.3.3. Understand and Respond to Needs of the Public and Stakeholders

As the study of attributes of success suggests (see Table 4.3), the public was one of the critical components for implementing successful Green Street projects. Because local people are the ones who will be utilizing the street and interacting with the design elements selected by the planners and designers, these projects will affect the quality of life in their communities. It is therefore important to know what the residents need and expect from a given project.

In fact, Green Street projects, especially ones that were implemented in the public right of way, do not require consent from the public. However, holding face-to-face meetings with the public is still important for communicating the intended functions and details of these projects and promoting the projects' acceptance in the affected communities. Expert 4 (2014) from DC said the general public was "always afraid of" new initiatives, which can result in difficulties to obtain public consents. For another example in Seattle, a Green Street was put in a place, but the system in it failed, resulting in what resembled "a flooded mess." Failed systems can have negative impact for public approval on Green Street practices (Expert 3B, 2014).

Designers and planners who are unable to convince users that a Green Street project is needed in their neighborhoods for a particular purpose will find it helpful to use more familiar subjects to persuade and get residents on board. For example, Expert 7A (2014) in Seattle said that in one instance a group of residents was not convinced that they needed Green Streets to improve a creek basin by removing pollutants. So, the planners and designers decided to use a different approach when trying to persuade them: they pointed out that pollutants in the creek could affect the salmon there. Seattle has dedicated many efforts to protect salmon, and the public is well aware of that. So this approach was successful in convincing the residents to sign off on the project.

It is hard to satisfy every agency and individual who might be affected by Green Street construction, which is the reason involving multiple stakeholders in Green Street projects can have a positive impact on how these projects are implemented. And as the previous chapter concludes, public outreach should be considered not only at the design stage but also during all of the stages of a Green Street implementation process.

For instance, in the project initiation stage, public outreach can help planners to set realistic goals for the project that adequately address stakeholders' diverse interests; outreach can provide residents with general information on what Green Street is and specific information about the design ideas during the design stage. Public outreach also provides a means of collecting opinions from residents and explaining the rationale behind the selection of a project site. A phased outreach approach that syncs with different design completion stages appears to have enjoyed particular success. At the construction stage, public outreach can be used to inform residents about the construction schedule and what amenities will be available during construction. These efforts can help to keep local businesses operating despite the disruptions. During the operation & maintenance stage, public involvement in maintenance can be promoted as part of a stewardship program. A maintenance manual can be provided for this purpose. This provision of various measures for each stage of implementation can help to promote good public understanding of and involvement in the Green Street project.

In addition, public participation can even lead to making Green Street initiatives more of a bottom-to-top approach to urban design than the traditional, top-down model of active designers and planners creating projects that benefit a passive public. For example, neighborhood-initiated Green Street practices can be useful for identifying salient locations when city officials lack the ability to scout out sites. This approach can be especially appropriate for small towns that have few resources for identifying prioritized sites. The neighborhood groups that undertake Green Street implementation can seek help from non-profit organizations in getting started and delivering their proposals to their municipalities (e.g., the Maynard Avenue Green Street Project in Seattle, discussed in 6.3.3). The process of initiation by neighborhoods will help the public to better understand the implementation process. And, their deeper involvement with Green Streets will also promote their participation in operating and maintaining the project sites.

7.3.4. Consider the Whole Street Envelope When Planning and Designing Green Street

In order to maximize the potential benefits of Green Street practices, a project should be considered together with the street envelope as a whole rather than simply as an isolated system for treating stormwater runoff (see Figure 7.1). This is the case because Green Streets are located adjacent to where people live, work, play, and exercise, and those activities also happen on the street.

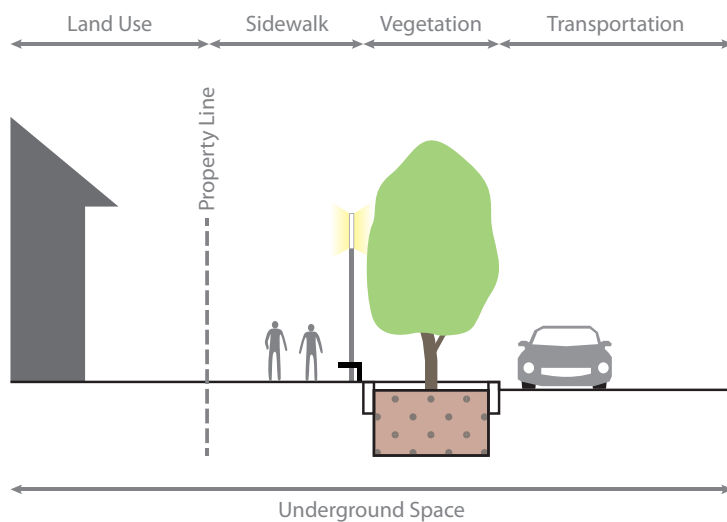


Figure 7.1. An example of a street envelope: design considerations in Green Street practices including land use, sidewalk, planting area, roadway, and underground space.

However, in the current manuals and design standards, drawings seldom include site context objects such as buildings and street furniture or dimensions of the sidewalk/roadway, along with other factors that support users' activities. Moreover, stormwater treatment facilities need to perform infiltration, provide planting beds, and incorporate underdrain pipes if necessary. Consequently, especially for Green Street practices, underground conditions need to be investigated through on-site inspections because they can differ from what is recorded in existing documentation. If there is no available room for the underground part of a Green Street project, it cannot be implemented in the first place. Thus, not only the surface areas of a site, but also its

underground conditions (i.e. whether it has a shallow groundwater level and bedrock layers or underground utilities) must be taken into account to ensure the success of a Green Street project. Figure 7.2 shows examples of Green Street application that consider the contexts of sites. Different types of Green Street facilities can be integrated instead of the facilities suggested in the examples, and the types correspond to those in Figure 2.1.

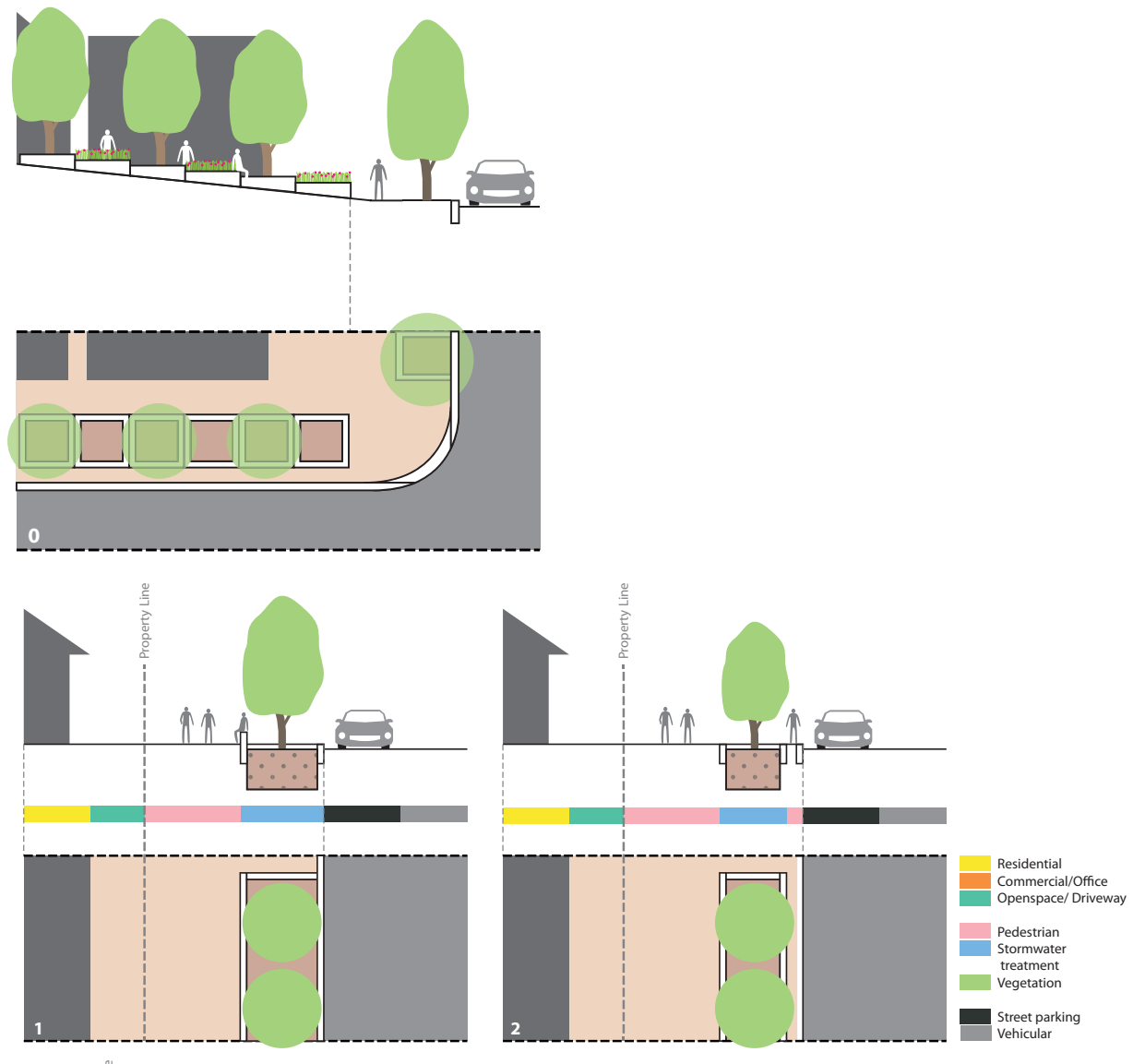


Figure 7.2. Examples of Green Street practice: 0. Green Street on slope with planter type cascades; 1. Green Street with wider sidewalk and seat wall; 2. Green Street with wider sidewalk and landing space for street parking;

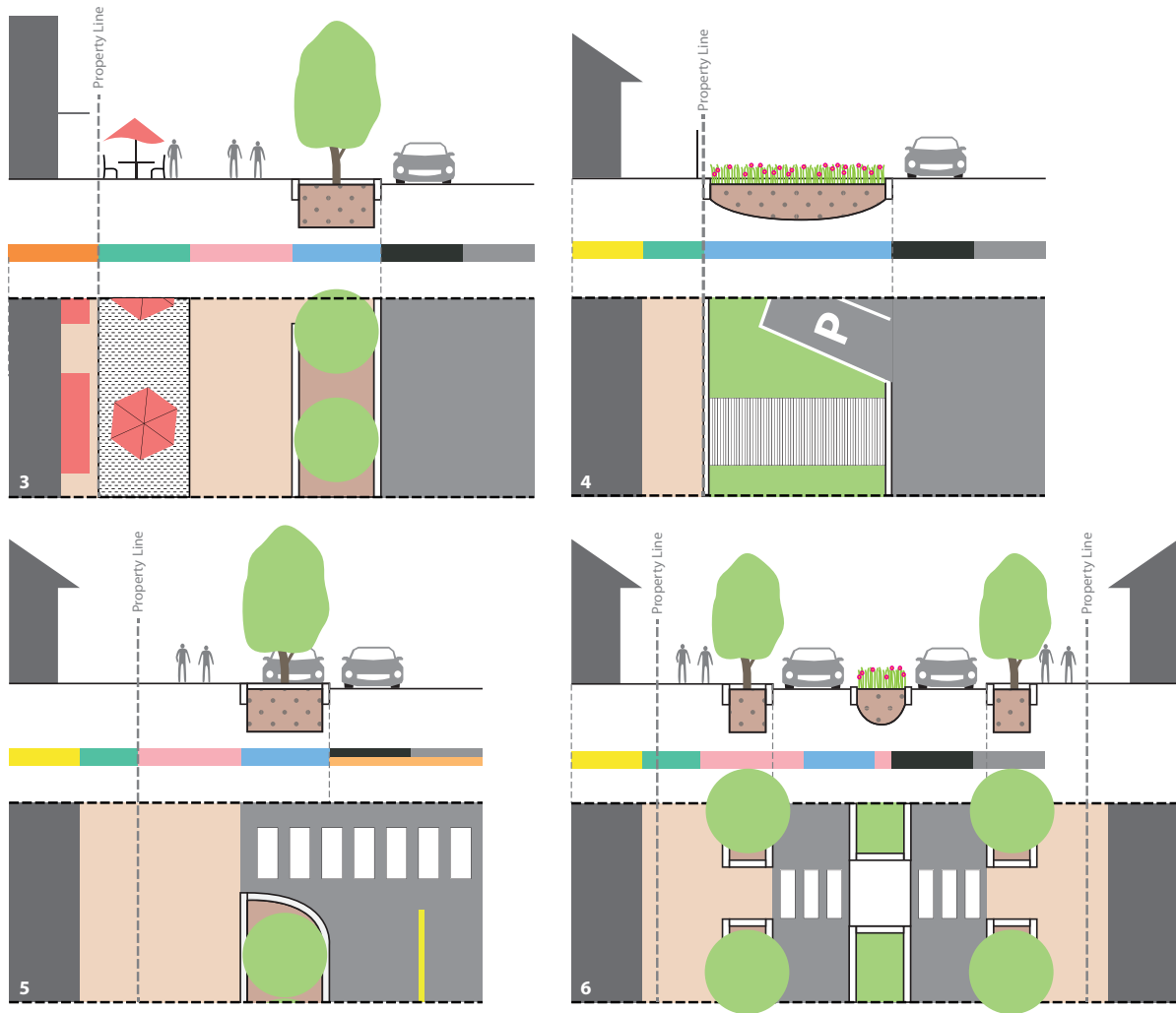


Figure 7.3. Examples of Green Street practice (Cont'd): 3. Green Street with outdoor activity area in conjunction with sidewalk; 4. Green Street with wider and leveled stormwater planter; access to the building; and diagonal parking space; 5. Green Street with extended stormwater planter for traffic calming; 6. Green Street with stormwater planter in median for safe crossing.

The selected successful Green Street projects in Chapter 6 commonly presented context-sensitive Green Street design elements by integrating various aspects of the locations (e.g. the art installation informing the public about the area’s historical background in the Maynard Avenue Green Street Project) and meeting the surrounding community’s needs (e.g. the community gathering place in the Holman Park Green Street Project). Therefore, what can be seen from those projects is not simply a set of stormwater treatment solutions, but rather design applications integrated with site

conditions (topographic conditions, available spaces, functions) and contexts (history, needs of a community). As these examples demonstrate, the successful design of a Green Street project often depends on specific ideas for integrating both the physical and social aspects of the site conditions.

In other words, Green Streets needs to be considered as a complex development strategy rather than a simple stormwater treatment solution. Looking at Green Streets in this way can enable those planning and designing the projects to ensure that every aspect of social and cultural contexts is considered along with all of the physical elements and conditions on and under the street. This kind of comprehensive design system can be applied to a wide range of Green Street project scales, from a single Green Street practice to a complex urban development strategy. Within an urban development strategy, single practices can be applied in multiple places to cover larger areas (especially where stormwater runoff-related issues are critical along with the need to regenerate the quality of life in a community). These practices can then connect to a network system that provides not only runoff solutions but also social, environmental, and economic benefits.

7.3.5. Integrate Green Street Practice with Primary Municipal Plans and Other City Development Plans to Secure Funds and Address Multiple Benefits

In terms of promoting the multiple benefits that can be achieved, integration of Green Streets with larger development plans can be an effective strategy. Adding the Green Street approach to municipal plans can provide useful opportunities to obtain stormwater management-related funds, freeing up municipal funds to pay for other streetscape improvements. Thus, if any neighborhood has stormwater-related issues but cannot find any funding sources, seeking an opportunity for an integration of Green Street practice with municipal development plans can be one of the solutions.

Indeed, Green Street projects in Seattle, Portland, and DC were integrated with city improvement plans. Expert interviewees from Seattle, Portland, Philadelphia, DC, and Arlington stated that some Green Streets were integrated with the city's overall improvement plan—such as transportation improvement plans or greenway plans—

since it is more cost efficient and a more convenient way to implement Green Streets. Stand-alone Green Street projects that focus solely on what is achievable using stormwater management funds can limit the potential benefits by putting too much emphasis on the efficiency of stormwater treatment. Moreover, if a funding shortage is experienced, designers and planners may be able to find other funding opportunities since Green Streets usually promotes multiple benefits that might trigger interest from other agencies, such as the U.S. Environmental Protection Agency (EPA), U.S. Department of Transportation (DOT), U.S. Department of Housing and Urban Development (HUD), U.S. Department of Agriculture (USDA), U.S. Department of the Interior (DOI), and more (Environmental Protection Agency, 2014).

7.3.6. Integrate Maintenance Plans into Green Street Master Plans

Once the construction stage is complete, maintenance becomes the most important aspect of Green Street projects because they all require a certain level of maintenance. Considering that Green Street practices include plants, soils, underground structures, and integrated furniture and equipment, they typically require a number of different maintenance procedures. Plants need to be pruned and irrigated during dry weather, weeds have to be removed, soil substrates need to be replaced and replenished, and drainage systems should be monitored. Due to the fact that plants are one of the most important elements visually and functionally in Green Streets, maintenance of the plants assumes a much greater importance than for other construction projects.

Despite its importance, maintenance represented a surprisingly low priority for those implementing Green Street projects (see the discussion in Chapter 6.1). Experts 2 and 9A (2014) even stated that maintenance was a huge problem due to lack of attention to it from their agencies. Their cities, Philadelphia and DC, had simple maintenance plans that sent crews out to manage Green Streets several times a year, which might not be enough to maintain the facilities properly. This low interest in maintenance can also affect public acceptance of a Green Street. The public tends to pay attention to the physical conditions of such projects instead of what they offer the

neighborhood. If they see withered or overgrown plants, trash, or malfunctioning drain systems due to a lack of maintenance, they are unlikely to view Green Streets in a positive light.

Green Street facilities especially require attention to inlet/outlet and infiltration systems. Whether or not these systems are working properly relates directly to public concerns about the projects in their areas. People are sometimes fearful of problems with or danger from the water in these irrigation systems. Stormwater occasionally flows into or out of a given facility, causing erosion, sedimentation, or ponding. Typically, Green Street facilities are designed to drain stored stormwater runoff within 12 to 24 hours (typical water depth is between 6 to 12 inches). However, if the runoff fails to drain or overflows, the users around the facility may be concerned about safety (i.e., pedestrians may slip because of wet conditions), wet basements, or insect breeding grounds (where mosquitoes in particular might multiply). The users may contact their municipality and ask for emergency drains to deal with facility malfunctions. In terms of mosquito problems and wet basement concerns, experts in Seattle (2014; 2012) said that these concerns were mainly conceptual: the water in the facility kept moving and there was very little chance of spawning, and Green Streets helped stormwater runoff drain better so that few problems with wet basements occurred. Public misconceptions of this nature can be resolved through public education about why Green Street projects are needed and how they function in particular neighborhoods. Meanwhile, drainage and infiltration systems require constant care to deal with the public's concerns and keep Green Street facilities running smoothly. If these facilities are not maintained well, residents may see them as dumping grounds and complain (Expert 4, April 1, 2014).

A clearly needed change is to incorporate a maintenance plan into the design and construction of Green Streets for easier operation and improved public acceptance. Low maintenance strategies can also be incorporated into the selection of plants and facility designs to reduce the need for labor-intensive and expensive maintenance. Additionally, deciding on a principal agency for the maintenance could be helpful for developing improved responses to problems that arise by clarifying the matter of responsibility for all related problems or issues. Moreover, public outreach is again

important for explaining aspects of the projects to residents and resolving their concerns. Public outreach can also be useful for promoting stewardship for Green Streets; promoting public participation in maintenance is a good way of maintaining Green Streets (regarding simple maintenance such as weeding, sweeping, removing trash from the stormwater facilities, etc.). Developing a maintenance manual for the public is another measure that would help local people to properly execute their maintenance duties (e.g. the public may not be able to distinguish difference between functioning plants and weeds in the facility). The manuals also can be a means of educating the public regarding functions of Green Street practices. Another approach, which has proved successful, is creating a plant palette that allows users to select the plants they would prefer to have near their homes and in their neighborhoods. A list of plants should not be exhaustive, but rather contain a limited number of species considering efficient maintenance. Public participation in maintenance has the benefit of securing residents' interest in and engagement with the projects in their neighborhoods.

7.3.7. Archive and Share Related Research and Knowledge by Conducting Post-Construction/Occupancy Evaluation and Monitoring

Green Streets is a relatively new strategy, with the oldest project in the United States (the SEA Street project in Seattle) going back only about fifteen years. Since Green Street practices typically include plant materials, which are living things, the techniques adopted need to consider the suitability of plant species in terms of the particular climate and living environment where Green Street projects are implemented. The drainage system in a given facility also needs to be carefully designed considering site conditions, types of practices implemented, target pollutants, and users' preferences.

Thus, the techniques and knowledge are still in the development stage. One way of advancing and achieving a successful Green Street installation is to learn from previous projects. Accordingly, this was one of the most frequently discussed elements of success in Green Streets derived in Chapter 4.1 (See Table 4.3). Post-construction evaluation or monitoring was seldom mentioned by the experts throughout the interview

responses. Moreover, those projects that were monitored mainly performed technical evaluations involving aspects such as water quality and the volume of water flowing in and out. However, except for Seattle and Portland, none of the cities had gone back to the communities and asked users to comment on the completed Green Street Projects. Since previous projects become reference points for new projects with less experience, post-construction monitoring and evaluations are important steps toward minimizing problems for future projects.

Comprehensive documentation and monitoring after construction should be rigorously enforced. Better documentation can provide opportunities to investigate what worked and what did not work and use that information as a basis for improving current and future Green Street development strategies. If a municipality has enough resources, a division can be designated for keeping track of current design strategies—as Seattle has done with its own division for documenting and keeping records of current projects. Keeping these records makes it easier to update standards and techniques regarding related strategies. Well-documented archives of field experiences and post-construction evaluations can contribute to the development of more advanced techniques and minimize the potential for mistakes and bad practices in future projects.

7.3.8. Develop and Provide an Appropriate Green Street-Oriented Process for Each Municipality based on the Derived Model Process in This Research

Planners and designers can use the model process (see Figure 6.36) developed in this research as a checklist to ensure that the necessary protocols and resources are in place to maximize the additional benefits for successful Green Street implementation. The sub-stages that are listed under the four main stages in the model are collective elements, and planners and designers should choose the sub-stages that most closely match their local conditions and available resources at both the municipal and site levels.

The proposed process provides a framework and offers guidance, but it does not represent an absolute list of sub-stages. In a similar vein, each municipality can develop its own processes based on the Green Street oriented process developed in the course

of this research. New processes that pertain to specific urban contexts, available resources, social and environmental conditions, and municipal organizational ability can be added as needed. The provision of a process that has been tailored to suit the needs of a particular municipality and local community will contribute to the achievement of a successful Green Street project.

7.4. Limitations and Recommendations for Future Research

The subjectivity of a researcher with experience in sustainable landscape design can have influence in biased interpretation of certain data, weighing into some more than other collected data. It was considered and discussed in the methodology section. To minimize the subjectivity a reflexive statement from the author, member check, frequency counting, cross tabulation, and diagrams were used in addition to the content analysis based on cultural psychological study.

The Green Street oriented planning and design process presented in this thesis was created primarily to assist municipal officials who work on Green Street projects. It is designed to help them make decisions throughout the process as they resolve issues, collaborate with different groups, apply relevant technical skills, create effective designs, and develop suitable management plans. Both public and private developers can also refer to the process to understand what is planned and acquire information about specific actions that they need to take when they are contacted during the initiation of a Green Street project. However, the process should not be considered as representing an exhaustive list of required procedures, but rather as providing guidance to help planners and designers identify potential actions they can undertake to enhance the benefits for surrounding communities as a result of implementing Green Street projects. As the proposed process was created based primarily on the opinions of experts who have been involved in carrying out these projects, future study can include interviews with other agencies and stakeholders who also participated in the projects. They can provide diverse perspectives toward Green Street planning and design process that leads to more successful implementation.

The study is limited to investigating successful cases (21 projects in total) nominated only by experts as city officials. It could have included biased data toward defining success in projects because the city officials could have been more favorable to their own projects or ignore unexpected results. A future in-depth study investigating users' perceptions of Green Street projects would provide valuable additional insights into identifying success in Green Street projects. A post-occupancy evaluation that pays particular attention to a specific aspect of these projects, such as livability and the quality of life of those living and working in surrounding neighborhoods could yield useful information that advances the current body of knowledge about Green Street implementation. As an additional future research the author can also closely look into individual cases especially from landscape design perspective to provide design critique of the cases. Moreover, selected case projects are located primarily on the East and West coasts in the US. As more localities include green streets in their green infrastructure planning, future research can include a broader spectrum of geographic and geophysical landscape contexts. If the findings in this study need to be applied to other countries, a future study of their cultural backgrounds and available resources needs to be combined because Green Streets will be accepted differently and need to be designed accordingly.

The disciplinary backgrounds and affiliated departments of interview participants varied. Values and perspectives toward success in Green Street projects can be treated differently. Investigating the different perspectives on success of the projects with regard to the disciplinary backgrounds and affiliations of the experts may provide additional insight into the current state of Green Street implementation.

Another potentially useful direction for future research would be to evaluate Green Street practice types and functionality in the context of different urban environments. Green Streets are generally implemented in urban and suburban areas with a variety of types of street networks and urban forms. It would be useful to examine how Green Street practices can be utilized as part of a holistic urban development strategy.

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Appendix A. 1st Round Data Collection Interview Protocol

1. Do you have a green infrastructure plan that manages city-wide environmental issues?
2. If you have green infrastructure plan, how long has the green infrastructure plan and projects been in place?
 - What are the components of the plan?
 - Does it include Green Street?
 - Who was involved in development of the plan? What department?
3. If you don't have green infrastructure, how green technologies or designs been planed?
4. Has there been public involvement in the green infrastructure plan and also for Green Street projects?
 - How has it been implemented in the plan?
 - How important to have public involvement in GI or GS plan?
5. Have the function and intention of green infrastructure (Green Street) been changed during that period of time?
6. Please describe how priorities set and what the driving factors of implementing Green Street projects are? (purpose, location, typology, etc)
 - What would be the number one priority among you mentioned?
7. What is the major purpose of Green Street implementation?
 - Is it retrofit, urban redevelopment or new development?
 - Are you only concerned with public streets?
8. Has the concept of Green Street been evolved as time goes by?
9. Who are involved in the Green Street projects?
10. Can you describe the process of planning and implementing Green Street projects?
 - Do you outsource the design of Green Street?
 - Do you have public involvement in Green Street plan?
 - Did you have any feedback from users?
 - How are the Green Street projects initiated?
 - Are they mostly city-initiated public projects? Retrofitting?
11. Do you know how many Green Street projects have been in place and in which land use?
12. Have you consider implementing Green Streets as an interconnected system throughout the city to improve the urban environment?

13. Who does maintain the Green Street? (plants, stormwater systems, paving)

- Which department?

- Have there been maintenance problems?

14. What would be the main funding source of Green Street projects?

15. Can you name the most successful green street projects that are presently in use in your city?

- What does make them successful?

- What is unique about the design?

- What eco-system (ecological/economic/social) benefits do they provide?

- Does it provide any particular benefits to the surrounding environment or community?

16. What is the major challenge you have when planning and implementing Green Street projects in your city?

17. Is there monitoring or maintenance plan?

Appendix B. 2nd Round Data Collection Interview Protocol

1. Can you tell me more about the multiple design objectives addressed through this project?
 - How did you decide that they were important?
 - Who were involved in initiating the project and establishing design objectives?
 - How did those agencies work together to address multiple benefits?
 - Were there agencies that had leading position for the project? If yes, what were their roles?
2. Can you tell me how these multiple objectives were achieved in the final design and construction of the project, which included Green Street storm planter and streetscape design?
3. Did you have to redesign the project to optimize benefits to the community?
 - If you did, can you tell me how you decided to redesign and how you changed the original design?
4. How well do you think these multiple goals were achieved through the final design and construction?
 - Were there any unexpected benefits?
 - If yes, what were they?
 - Was there any feedback from users/ designers/ planners/ engineers/ other stakeholders?
5. Are there any outcomes that have not been successful to achieve goals as intended?
6. Can you tell me what factors influenced for the choice of stormwater facilities for the project?
7. Did you encounter legal impediments that caused you to alter the design of the project?
 - If you did, can you describe what they were?
 - Can you tell me how you have resolved them?
8. Were there any difficulties in assembling funds for the project?
 - Was the primary funding for the project stormwater management related?
 - Did the inclusion of non-stormwater related objectives influence the financing of this project?
9. Were there important maintenance considerations that were accounted for during the course of design for this project?
10. Were opportunities for public involvement included in the design stage of this project?
 - How did the public input influence the final design and construction of the project?
11. Was there post construction monitoring for this project?
 - Has it been used as a precedent study for other similar projects?
 - Have you used precedent study for this project?

12. Do you have any educational program for the public or incorporated with school program?

13. Would you like to see more of Green Streets throughout the city?

- If you would, can you explain why you think so?

14. How successful do you think this project is regarding stormwater treatment function? (scale 1-10). Why do you think so? Did you monitor?

- How successful do you think this project is regarding improving the quality of life or livability of the community? (safety, social interaction, attachment, 1-10) why do you think so?

15. Were opportunities for economic benefits for the business owners on the street or town of Blacksburg considered during the course of design for this project?

16. Do you think the project offered any kind of impact to the area regarding economical development of the place? What are they?

Appendix C. Content Analysis of Goals and Objectives in Green Street Literature

Manuals	Goals & Objectives	Central Theme	General Theme
City of Philadelphia Green Streets Design Manual (City of Philadelphia, 2014, p. 24)	<ul style="list-style-type: none"> Water filters through the planting soil, improving water quality. 	CT1. Stormwater management	GS1. Environmental
A Conceptual Guide to Effective Green Streets Design Solutions (EPA, 2009, p. 1)	<ul style="list-style-type: none"> Reduce stormwater flow Improve water quality 		
Managing Wet Weather with Green Infrastructure. Municipal Handbook. (Green Streets by Robb Lukes, Christopher Kloss, Low Impact Development Center, 2008, p. 2)	<ul style="list-style-type: none"> Achieves multiple benefits through an integration of stormwater treatment techniques improved water quality A source control for a main contributor of stormwater runoff and pollutant load Using the right-of-way for treatment also links green with gray infrastructure by making use of the engineered conveyance of roads and providing connections to conveyance systems when needed 		
Green Streets: Innovative solutions for stormwater and stream crossing (Metro, 2002, p. 9-10)	<ul style="list-style-type: none"> Improve water quality 		
A Conceptual Guide to Effective Green Streets Design Solutions (EPA, 2009, p. 1)	<ul style="list-style-type: none"> Reduce carbon footprints 	CT2. Environmental improvement	
Green Streets: Innovative solutions for stormwater and stream crossing (Metro, 2002, p. 9-10)	<ul style="list-style-type: none"> Maintain and restore natural processes Conserve, protect and restore habitat 		
A Conceptual Guide to Effective Green Streets Design Solutions (EPA, 2009, p. 1)	<ul style="list-style-type: none"> Reduce urban heating 		
Green Streets: Innovative solutions for stormwater and stream crossing (Metro, 2002, p. 9-10)	<ul style="list-style-type: none"> Monitor environmental benefits 	CT3. Monitor environmental benefits	
City of Philadelphia Green Streets Design Manual (City of Philadelphia, 2014, p. 24)	<ul style="list-style-type: none"> Provides a physical buffer between pedestrians and the street. 	CT4. Pedestrian Safety	GT2. Social
A Conceptual Guide to Effective Green Streets Design Solutions (EPA, 2009, p. 1)	<ul style="list-style-type: none"> Enhance pedestrian safety 		
City of Philadelphia Green Streets Design Manual (City of Philadelphia, 2014, p. 24)	<ul style="list-style-type: none"> Creates aesthetic improvement to streetscape 	CT5. Aesthetic improvement	
A Conceptual Guide to Effective Green Streets Design Solutions (EPA, 2009, p. 1)	<ul style="list-style-type: none"> Beautify neighborhood 		
Managing Wet Weather with Green Infrastructure. Municipal Handbook. (Green Streets by Robb Lukes, Christopher Kloss, Low Impact Development Center, 2008, p. 2)	<ul style="list-style-type: none"> Street aesthetic improvements 		
Managing Wet Weather with Green Infrastructure. Municipal Handbook. (Green Streets by	<ul style="list-style-type: none"> Street facility upgrades 	CT6. Streetscape improvement	

Robb Lukes, Christopher Kloss, Low Impact Development Center, 2008, p. 2)			
Green Streets: Innovative solutions for stormwater and stream crossing (Metro, 2002, p. 9-10)	<ul style="list-style-type: none"> Foster unique and attractive streetscapes that protect and enhance neighborhood livability 		
City of Philadelphia Green Streets Design Manual (City of Philadelphia, 2014, p. 24)	<ul style="list-style-type: none"> Provides an area within the right-of-way for smaller plantings in addition to street trees 	CT7. Provision of greenness	
Green Streets: Innovative solutions for stormwater and stream crossing (Metro, 2002, p. 9-10)	<ul style="list-style-type: none"> Promote local street connectivity 	CT8. Street connectivity	
Green Streets: Innovative solutions for stormwater and stream crossing (Metro, 2002, p. 9-10)5	<ul style="list-style-type: none"> Use the public right of way for multiple purposes 	CT9. Multiple functionality	
Managing Wet Weather with Green Infrastructure. Municipal Handbook. (Green Streets by Robb Lukes, Christopher Kloss, Low Impact Development Center, 2008, p. 2)	<ul style="list-style-type: none"> Urban tree canopy efforts that also make use of the right-of-way and allow it to achieve multiple goals and benefits 		
City of Philadelphia Green Streets Design Manual (City of Philadelphia, 2014, p. 24)	<ul style="list-style-type: none"> Can be sized and placed to fit between existing surface features such as driveways, signs, street furnishings, and street trees 	CT10. Context sensitive design	
Green Streets: Innovative solutions for stormwater and stream crossing (Metro, 2002, p. 9-10)	<ul style="list-style-type: none"> Educate the public 	CT11. Public education	
Green Streets: Innovative solutions for stormwater and stream crossing (Metro, 2002, p. 9-10)	<ul style="list-style-type: none"> Provide permissible, cost-effective solutions 	CT12. Cost benefits	GT3. Economic

Appendix D. Content Analysis of Successful Green Street Projects

D-1. Attributes of success

City	Statement (meaning units)	Central Theme	General Theme	General Structure	General summary
3. Seattle	d. Winslow Way in New Bridge Island: [9. You don't have a space to do the bioswale in a real urban context. So what it does is to use the width and depth to achieve the infiltration requirement.]	CT.1. Effective stormwater treatment	GT.1. Environmental benefits: CT.1. - CT.3	GT.1. In consideration of environmental benefits, effective stormwater treatment, environmental improvement, and incorporation of monitoring were found to be central themes. Green Streets were put in places for effective stormwater treatment with a consideration of securing available spaces to put stormwater facilities in an urban setting and managing combined sewer overflows. Green Streets were also implemented for environmental improvement specifically including promotion of cleaner air, cooling air, and biodiversity benefits.	Aspects of successful Green Streets vary and can be summarized into three pillars of sustainability. Quite broad range of successful aspects was covered while more elements were derived as social aspects among three general themes.
1. Portland	a. Holman Pocket Park project: [2. we also recognized that we can get system benefits by being involved and integrating some of the Green Street and green infrastructure features here.] b. Clay Street project: [9. This was an area where part, combined sewer part, separate sewer was, so it could definitely benefit from green infrastructure among streets.]				
2. New York	a. Westbourne Avenue at Bay 25th Street in SE Queens: [3. So what it does is water is coming in, there's a series of check dam that slow the water coming in and water level is slowly increasing and there's planted grasses in between check dams. So there's a series of check dams and these grasses coming out.]				
5. Arlington	a. Patrick Henry Green Street: [2-2. it's been able to maintain it and keep it functional.]				
2. New York	a. Westbourne Avenue at Bay 25th Street in SE Queens: [7. cleaner air, cooling the air] [9. biodiversity benefits]				
2. New York	b. Nashville Avenue on 116th Street: [11. best thing about that GS is that we were able to incorporate monitoring equipment right into the design].	CT.2. Environmental improvement			
2. New York	b. Nashville Avenue on 116th Street: [11. best thing about that GS is that we were able to incorporate monitoring equipment right into the design].	CT.3. Incorporation of monitoring			
4. DC	a. Georgia Avenue: [streetscape development have led to more revitalization of that neighborhood.]	CT.4. Streetscape improvement	GT.2. Community benefits: CT.4 –CT.9	GT.2. Community benefits of successful Green Streets presented the widest range of benefits/success among three general themes. A total of six elements were derived as central themes: streetscape improvement, pedestrian safety, neighborhood gathering, aesthetic improvement, better connection/access, and public arts. These attributes were closely related to promotion of creating better	
3. Seattle	e. Thomas Green Street Concept Plan : [Ensuring quality streetscapes]				
3. Seattle	d. Winslow Way in New Bridge Island: [10. they provide pedestrian safety.]	CT.5. Pedestrian safety			
2. New York	a. Westbourne Avenue at Bay 25th Street in SE Queens: [8. pedestrian benefits]				
1. Portland	a. Holman Pocket Park project: [7. it became this night feature, neighborhood gathering feature for community members, so it was a win on many levels.]	CT.6. Neighborhood gathering			
1. Portland	a. Holman Pocket Park project: [6. attractive integration of Green Street features] b. Clay Street project: [13. It looks really nice.]	CT.7. Aesthetic improvement			
2. New York	a. Westbourne Avenue at Bay 25th Street in SE Queens: [2. I think it just looks nice]				
6. Philadelphia	b. Stenton Washington Intersection: [2. it also at the end of the day looks nice.]				
5. Arlington	b. Albemarle Street at 23rd street: [5. it's the most aesthetically pleasing.]				
3. Seattle	e. Thomas Green Street Concept Plan: ["Thomas Street presents a valuable opportunity for an improved east-west connection for pedestrians				
3. Seattle	e. Thomas Green Street Concept Plan: ["Thomas Street presents a valuable opportunity for an improved east-west connection for pedestrians	CT.8. Better connection/ access			

	and bicycles between neighborhoods and to access open space. Ensuring quality streetscapes that contribute to connection between neighborhoods and to open space are the intent of the concept plan” (Thomas Green Street Concept Plan, 2013, p. 1).]			living environment for the community	
1. Portland	a. Holman Pocket Park project: [4. better transportation], [5. bike features] b. Clay Street project: [14. functional to the neighborhood and many other bicyclists.] [15. It's a great way to connect neighborhood to recreation and resources.]				
4. DC	d. The Yard: [They are on the edge of the park]				
1. Portland	b. Clay Street project: [10. We also had an opportunity to include an art component in that] [11. neat artistic element that reflected history of the area]	CT.9. Public arts			
1. Portland	b. Clay Street project: [11. trees are low cost management stormwater]	CT.10. Cost-effective Stormwater management	GT.3. Economic benefits: CT.10-12	GT.3. Economic benefits of successful Green Streets is to promote cost efficient stormwater management, low maintenance, and local economic benefits. A cost efficient approach could be achieved by optimizing the efficiency of stormwater treatment, but with lower cost materials and construction fees. Low maintenance could be achieved by designing stormwater facilities utilizing low maintenance techniques (i.e. location of inlet, soil replacement, etc.). Economic benefits could be achieved by concentrating on streetscape enhancement.	
5. Arlington	a. Patrick Henry Green Street: [2. for the cost of the construction the stormwater treatment benefits have been relatively high.]				
2. New York	a. Westbourne Avenue at Bay 25th Street in SE Queens: [6. by concentrating all the inlets in one spot you may have to replace that area after a few years, maybe called like a sacrificial area, but it allows for the rest of the GS to be maintained or not needing to be replaced.]	CT.11. Low maintenance			
4. DC	a. Georgia Avenue: [economic development and the streetscape developments have led to more revitalization of that neighborhood.] d. The Yard: [it's in the area of economic revitalization]	CT.12. Economic benefit (local business)			
3. Seattle	a. SEA Street: [1. it was a project that received an award from the Kennedy School of an award for innovative design] [2. it also was written about in Landscape Architecture Magazine]	CT.13. Recognized by mass media/awards	GT.4. Acceptance & Involvement by Multiple Parties: CT.13 – CT.16	GT.4. Green Street projects were recognized as successful when it received awards or appeared in a magazine. Earning interest or acceptance from the public was also thought as successful. An interdisciplinary approach could be one of major	
3. Seattle	a. SEA Street: [3. had a lot of attention from people all around the country] c. Growing Vine Street in Bell Town: [11. it's earned public interest] e. Thomas Green Street Concept Plan: [“In light of numerous planning and community outreach efforts and the physical changes described above ...” (Thomas Green Street Concept Plan, 2013, p. 1)]	CT.14. Interest/acceptance from public & stakeholders			
1. Portland	a. Holman Pocket Park project: [8. we call it a success and particularly when community members feel it's successful.] [3. better usability]				

5. Arlington	a. Patrick Henry Green Street: [1. publicly accepted]			characteristics in Green Street process and it was also treated as an aspect of success. If the project was successfully constructed and provided a good influence for implementation of future Green Streets, then it was considered as successful.		
1. Portland	a. Holman Pocket Park project: [1. I think part of the success is having multiple partners involved.]	CT.15. Interdisciplinary / multiple parties involvement				
6. Philadelphia	b. Stenton Washington Intersection: [1. it was one of those Street Department actually came to me and said we have the space we want to use it for stormwater] a. Columbus Square Project : [5. The local park group was very involved and talking about what planting material would be, what the design look like, how big will the planters would be.]					
2. New York	a. Westbourne Avenue at Bay 25th Street in SE Queens: [4. It was sort of street pilot and it was really successful, so now they build it everywhere these inlets.]					CT.16. Good precedent project (Inspiration for other projects/ Lessons learned)
6. Philadelphia	a. Columbus Square Project: [4. What we've learned is tones of process.]					
4. DC	c. Constitution Square: [1. it created a lot of inspiration.] [2. It showed you could incorporated stormwater management within the streetscape.]					
5. Arlington	a. Patrick Henry Drive: [it's been able to maintain it and keep it functional.] b. Albemarle Street at 23rd street: [6. it's a good educational example from the point of view of being something that people would welcome potentially into their neighborhood.]					
3. Seattle	a. SEA Street, b. Broadview Green Grid: [4. it's fairly clear that there's significant differences between both designs and traditional street designs.] [Our streets are generating less runoff. They did generate cleaner and wide range of benefits associated with these projects far beyond the drainage benefits.]	CT.17. Comprehensive application of Green Street	GT.5. Useful development strategy: CT.17 –CT.18	GT.5 Green Street's role as a comprehensive development approach was also recognized as success when Green Streets achieved "wide range of benefits", were integrated with existing projects as providing visions, and were able to fit into various urban contexts.		
1. Portland	c. Gateway: [15. To design master plan, green street plans for the area are coincided with one of the new street plan grid that was going on at that time] [16. it was a way to start to create visions out there.]					
4. DC	b. Nannie Helen Burroughs Avenue: [It's a more comprehensive application of green streets.]					
6. Philadelphia	c. A tree trench in front of Palmer Street: [3. it can fit into so many different types of settings.]					CT.18. Flexible design application

D-2. Priority setting

City	Statement (meaning units)	Central Theme	General Theme	General Structure
3. Seattle	<p>[I was a landscape architect in the project called SEA Streets and subsequent project called Broadview Green Grid and Pine Hurst Green Grid, these were projects, primary goal of them was to process stormwater]</p> <p>[Green street came in play in around 1985. And the two primary departments were responsible for the implementation of green streets for Department of Planning and Development and department I am in, now just called Seattle Department of Transportation. The far more recent programs implement green stormwater infrastructure include substantial participation by our two departments in, we have much stronger participation by Seattle Public Utilities because they are associated responsible for stormwater management and court requirements. They actually intend what the Department of Planning and Development and make sure drainage court requirements are met by new construction. So GSI is implemented both through our enforcement of our drainage code and is an obligation of the private development projects. Additionally it is program area great importance to both Seattle Public Utilities and to our, the county, within which Seattle exists, King County, they also have very strong requirements and obligations to meet stormwater management mandates. So I guess I will just say what we got is an evolution of green elements implemented in the right-of-way [that] began back in 1985, but has evolved over time and most recently taken on stormwater as a major aspect in 2011, 2012, 2013, time frame.]</p>	<p>CT.1. Improving stormwater quality and quantity</p>	<p>GT.1. Priority setting</p>	<p>Stormwater treatment was the most primary priority to put Green Streets in for six sample cities. Additional benefits also considered. Those benefits were neighborhood improvement, traffic calming, traffic functionality, environmental improvement, and cost effectiveness. The change of direction in setting a priority and regulatory obligations also influenced sample cities to focus more on stormwater management through Green Street implementation.</p>
1. Portland	<p>[1. A lot of our funding comes from repairs and so our number one obligation to repairs is to use their dollars effectively that will manage the urban runoff and provide the multiple benefits], [2. but we are obligated to put green streets (GS) in where they will give us the system benefits, so for example, our combined sewer overflows (CSOs), we were implementing GSs and green infrastructure (GI) to reduce our CSO events to the river.] [4. We also put them in for water quality purposes as well, so where there may be an impact to some of our rivers and streams. If that runoff goes into a system that would receive stream we are getting water quality benefit.] [5. And now our CSO, big pipe fix to CSO with 20 year project it ended in 2012 and so now our big focus in continuing to our pipe system working is integrating Green Street along with this gray or pipe solution.]</p> <p>[14. if it's not giving us a system benefit then we won't do it.]</p>			

2. New York	[3. Sustainability Plan really pushed stormwater capture and made to increase incentives to capture stormwater, so part of that PlaNYC], [4. there was the plan called Sustainable Stormwater Management Plan in the following year, 2008. That plan really pushed the stormwater management.] [7.They developed their plan with green infrastructure, approved with the state, to meet the water quality goal because every so often our city has to report to the state for meeting the federal water quality goals.]			
6. Philadelphia	[1. Our primary driving factor in Philadelphia is on CSO regularly. We are regulatory driven in terms of installation of any green infrastructure.] [2. When it comes to specifically to green street, it's about the opportunity that the street presents.] [3. If a street is where we feel like we can construct a green street: we have the space and the right condition to conduct a green street] and [4-(2). ... then we'll put in a green street.] 2A6-1(2). [1. what we are regulated to do is to construct over the 25 years of that long-term control plan. It's just basically in an acre of an area with first inch of stormwater being managed through one of green strategies. And we have to construct 9500 green acres over the 25 years of the plan. So we use green streets as well as number of other different programs to meet the goal.] 4A6-1(2). [6. the city of Philadelphia is regulated on their CSO overflows. This is not a local stormwater regulations. We do have stormwater regulations for development and any development over 15,000 square feet in Philadelphia requires to do stormwater management. But they are not required to do street management.]			
4. DC	[2. One of the early drivers, really focusing on cleaning up the rivers], [3. it's called Anacostia Waterfront Initiative and there was a big planning effort in the city that focused on putting development and improving infrastructure, roads, bridges around the Anacostia River. And core component of that effort was sustainability ... which focused on low impact development..] [4. a lot of initial work has been watershed driven, so the watershed has defined the priority, initially looking to improve the Anacostia River.] [14.The other thing that I wanna mention about some of the plans and drivers, so the stormwater permit of the city has come from EPA, the MS4 permit, that has required us to include Low Impact Development on street projects. And the most, we have to repermit, they are generally 5-year permit issued from EPA, the first one is in 1999, the second one is in 2004, and the third one was issued in 2011. The one in 2011 has requirement for us to retrofit streets to essentially make them green streets and also that all new projects will have to retain stormwater. So that's been a big driver. Now all of our road construction projects include stormwater management and they will become green streets.] 2A4-1(2). [1. there were a lot of work for that DDOT, set up Complete Street Policies and Sustainable Plans and LID Action Plan and those have been drivers on moving green streets forward.]			
5. Arlington	[1. One of them was a potential phosphorous that could be removed.] [3. Then there were other factors of, such as where we're also meeting another county's need, such as solving a drainage problem.] [2. Another was constructability, so were there utility conflict.]			
3. Seattle	[6. I was a landscape architect in the project called SEA Streets and subsequent project called Broadview Green Grid and Pine Hurst Green Grid, these were projects, but to do it in a way environmentally balanced to people: better neighborhood, better place to live, slow down traffics, give people as much space as could be afforded for pedestrian accessibility and pretty discouraged driving.] I would have to say, and that was sort of middle ground now, we are working on sort of I would call them templates, a general layout for use for any large agency like Seattle Public Utilities, King County Installation of Green Infrastructure in Neighborhood, doing it in a way that meets our transportation responsibilities because right-of-way is catered primarily for transportation. So we have make sure transportation	CT.2. Inclusion of additional benefits (other than stormwater treatment)		

	needs are met but at the same time we need to make sure these installations are maintainable and sustainable and that they are acceptable to the community to put into.	
1. Portland	[7. Our primary use of GS is to benefit our system and then knowing that these are green features we know that we are getting additional benefits out of the plants that we are putting in]; [8. helps cool the air, evapotranspiration the runoff, and beautification in neighborhood which increases livability.]	
1. Portland	[3. So by putting green streets in we are able to keep stormwater out of the pipe and save repair dollars at the same time. We don't have to treat as much of this essentially cleaner water than the wastewater so we save our cost with green street.] [6. So we can save money by putting green streets in rather than going in, digging up the pipe, and putting in a bigger pipe to manage all that.]	
6. Philadelphia	[4. [if] we can also do a cost effectively, then we'll put in a green street.]	
3. Seattle	2A3A-1(2). [1. would you want me to talk a little about the Green Street application to city planning? I can go back in time a little bit and cover that. Because after much, it certainly predates anything having to do with green stormwater infrastructure.] [1. Green street was initially back in 1985, program emphasis on making streets green was largely because resolve the adequate park areas accessible to the wide range of people who live and work in this Seattle area.] [2. So we wanted to use street right-of-way to create linear park and make it so that people who work and live in close proximity to park land still have an ability to enjoy green areas around their living and working environment and could have the environmental, social and health benefits of having close access to green, trees, parks, and just a nice balanced urban environment.] [3(2). So primarily just to have a green space, back in 1985]	CT.3. Change in priorities: Creating green areas using right of way (in an earlier period: followed with various benefits)
2. New York	0A2. [2. Since 1996, New York City Parks Department was building green streets, but those green streets actually were not designed to catch the stormwater from the street. We were actually designing with more horticultural goal, pedestrian safety and working with NYC Transportation, so make intersection more safe, beautify the city and, harvest more open space.] 3A2-1. [1. After we started our relationship with DEP after Green Infrastructure Plan the Parks Department only build the GS that captures stormwater. So it's different than the ones before.]	
4. DC	[10. One very successful corridor, H Street NE corridor where it had been declined for 30 to 40 years, probably 30 years. And it was one of the first great street program, the road improvement, neighborhood improvement and it's really thriving corridor now that has a lot of businesses, a lot of new residential areas. It's a very hot place for people someone to live within DC. So it had that Green Street component, it doesn't have a stormwater management, like we think of now the street would capture the stormwater, but it did focus on improve street planting and green spaces, and parks.] [11. So the overall project is called Great Street, that was in that H Street NE.] [12. It does not have the stormwater facilities. That was an early Green street.] [13 So the early green street didn't include all the stormwater management that we include now, but it helped push for other projects along.]	

D-3. Source of fund

City	Statement (meaning units)	Central Theme	General Theme	General Structure
3. Seattle	[3. Seattle Planning & Development (DPD) already has funds as part of the planning process for the neighborhood plan to contribute to the development of the street concept plan.] [4. if it aligns with a capital project, Seattle Department of Transportation (SDOT) will put force money for that planning effort.]	CT.4. Fund/grant from local municipality	GT.2. Source of fund	Six sample cities utilized mixed use of funds and grants from their own municipalities and federal agencies. It appeared that the project objectives of the Green Streets initiatives in each city were influence by the characteristics of these municipal plans and the objectives of the funding sources. Mixed use of funds and grants may provide ways to make sure implementation of Green Streets completed successfully than relying on a single financing means.
1. Portland	[1. We are Stormwater (SW) and Wastewater (WW) Utility. A lot of our funding comes from repairs and so our number one obligation to repairs is to use their dollars effectively that will manage the urban runoff and provide the multiple benefits]			
2. New York	0A2(2). [New York City DEP, Department of Environmental Protection, released New York City Green Infrastructure Plan. So as a part of that plan, ... so that was a kind of a change for DEP. DEP ... I mean, they have more expertise in sort of green solution. New York City Park has been building a lot of green streets. But, after Green Infrastructure Plan, DEP started to build green infrastructure sites. They started to fund Park Service to build green street in the priority sewershed. They start coming up with a priority sewershed and they negotiated with NY State DEC (Dept. of Environmental Conservation).] [New York City Park has been building a lot of green streets. But, after Green Infrastructure Plan, NYC Department of Environmental Protection (DEP) started to build green infrastructure sites. They started to fund Park Service to build green street in the priority sewershed.] [Mainly because they have all the money. Because all the water bills, all the stormwater bills go to DEP. So they are the one who started funding the Parks Department to build these, and they are the ones who wrote green infrastructure plan in 2010.]			
6. Philadelphia	[1. For the projects that I specifically working are publicly funded projects. This is our capital funding for the department.] [4. but the projects that I oversee and most of the green street projects are capital improvement project.]			
4. DC	[2. When they are stand-alone projects, almost always come from local funding. The district has a stormwater runoff fee and stormwater management fee that residents pay on their water bill. And so that's collected and that funds a lot of our projects.]			
5. Arlington	[1. A main funding source is public dollars. We have a stormwater fee, which is a tax. It's a part of the real estate tax. And that is used to fund the stormwater projects.] [2. To large extent, some of the transportation projects, initiated by our Department of Transportation have been partially granted on that.]			
3. Seattle	[2. if it's initiated by the community, often times, they'll get grants funding to develop the street concept plan]			
6. Philadelphia	[2. We do get a few grants. That's part of having a regulatory compliance driven program. The department, as part of the compliance agreement, it's going to spend about billion dollars on green infrastructure over 25 years.]			
5. Arlington	[2. To large extent, some of the transportation project, initiated by our Department of Transportation have been partially granted on that.] [3. It's been a combination of grants and public dollars.]			
2. New York	0A2. [We got the grant in 2009 and 2010, and 2011, we had stimulus grant to build this 26 sites. So that kind of gave us a lot more experience and at that time] [I applied Federal for Stimulus Money to build 26 green streets in Bronx, Queens, and Staten Island. So that kind of, gave us a lot more practice with building stormwater capturing for me and landscape architects.]			

4. DC	... [1. if it's a part of the road construction project, it will come from the road construction budget. And most of that is funded by Federal Highways. Most of our road projects are funded by the Federal Highways Administration.] [3. We also get projects from Environmental Protection Agency (EPA), that's where we take funding from EPA through the Clean Water State Revolving Fund.]			
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D-4. Involvement of multiple parties

City	Statement (meaning units)	Central Theme	General Theme	General summary
3. Seattle	[1. It's city-initiated public projects]	CT.6. City initiated projects	GT.3. Involvement of multiple parties	The three domains who are involved in initiation of Green Street projects: municipalities, the public, and private developers. It showed that project initiation by the public would be helpful but could also lead to wrong conception due to lack of understanding. In addition, it also revealed a potential way to encourage private developers to include Green Streets for their new development projects.
1. Portland	[1. I would say that most of the green streets going in is mostly city-initiated. Again, part of our Capital Improvement Project. We are incorporating our Capital Improvement Project.]			
2. New York	[New York City Park has been building a lot of green streets. But, after Green Infrastructure Plan, DEP started to build green infrastructure sites. They started to fund Park Service to build green street in the priority sewershed.]			
6. Philadelphia	[1. The majority of the work is initiated by our team]			
4. DC	[1. They are city-initiated project]			
5. Arlington	[1. They are city-initiated]	CT.7. Public (online/resident) initiated projects		
6. Philadelphia	[5. We created an online public community input form, so you can go online if you have an idea aware about where to do a green street, or really any kind of green projects, it's park or whatever. You can go on there and say "we think you should do this spot", and we'll take a look at it and make a recommendation and get back to them.]			
4. DC	[2. We have had projects have come from residents. They hear about the green streets, "hey I want green streets in my street or in my neighborhood." We are doing green alleys. Right now my green allies nominations are almost all from residents. So we are looking at them to determine if they can be green allies]			
3. Seattle	[2. there's private development that they do the public realm improvement [like] green streets.] [4. ... for private development, people can get what's called departures for their private development. So basically additional building heights or that kind of thing if they build green street. So there's a higher expectation for the development when they build the green street and they can get additional bonuses if they build even more.]	CT.8. Private developer initiated projects		
6. Philadelphia	[2. ... but we do have developers coming every now and then. ... I would say huge number. We definitely have had some developers come and say during the large development I'm caring of this whole block how do we work together and we'd like to work with them.]			
5. Arlington	[2. We have had stormwater elements in the public right of way initiated by private development also.]			
Seattle	[More recently, ... Seattle Public Utilities' interest in GSI has overlaid the corridors that Seattle Department of Transportation has identified candidates for green streets so that we can work together. And some other things we might do to make it better corridor for bikes and pedestrians were also have benefit of providing stormwater amenities.]	CT.9. Involvement of multiple departments		
Portland	[We work closely with our Department of Transportation because these are in the right of way.] [And we've also worked with the Fire Department, too. Initially, they wanted a certain clearance for their vehicles.]			
New York	[Since 1996, New York City Parks Department were building green streets] [So he hosts this meeting with Parks Department, DOT, DEP, DDC (Division of Design and Construction, they build sidewalks, street construction)]			
Philadelphia	[We work very closely with the Streets Department obviously.] [our Street Department was heavily involved in that as well as the Parks Department, because they really manage our street tree programs in Philadelphia.]			
DC	[we bring in Urban Forestry Department, we have a Planning Department, we have Traffic Safety Department, we have Pedestrian, Bike Team, ADA Coordinators, so we'll coordinate all the groups who may have an impact role in that project]			

	[Department of Environment would be an external stakeholder] [We might have to include Department of Recreation, we might have to include other federal agencies because within DC we often touch other federal properties.]			
Arlington	The Department of Environmental Services includes my office, which is the Office of Sustainability and Environmental Management. And then it includes the Department of Transportation for Arlington County, and both groups initiate projects that may have green street component, but our office has been always involved in their implementation in one way or another today.			

D-5. Design protocol

City	Statement (meaning units)	Central Theme	General Theme	General Structure
1. Portland	[2. We have, for example, we have what we call the green street planter that fits more to dense urban context, like downtown areas rather than curb extension perhaps, so with the planter you can fit it into tighter areas. It might be a step out zone and with the place have a flat bottom so you can make them a little smaller with the same drainage area as it would be a swale.] [5. In Tabor to the River, we have a variety of different designs, too where somebody's home has like a 10-foot wide grassy area, it's called furnishing zone, but the parking strip, and that, that's prime. We transfer that into a swale, dig up the grass, and allow the water to go into that area, not it is really attractive for the residential home, it almost looks like they are different yard, kind of part of their garden.] [6. So depending on the context, land use, we would design with that in mind.]	CT.10. Available space for implementation	GT.4. Planning and design protocol	Even with design standards, experts tried to consider various aspects in designing and planning Green Streets. Additional benefits can be considered, especially pedestrian safety, and generally improvement of people's life. Finding available spaces and appropriate site conditions need to be considered. Modification of a design was conducted which could contribute to improve Green Street design. However, if the priority was certainly stormwater management, like New York, standard Green Street practice could be applied and put less weight on additional benefits.
2. New York	[3. For example, DEP has sort of taking out parking for stormwater green street design that bump into the street and they try to customize to come up with like a standard green street design. I think they've already done that. So they come up with standard bump out green street.]			
4. DC	[2. you have to look at what properties are there, is it commercial, is it residential], [3. what volume of pedestrian circulation do you have], [4. are people parking on the street, and you need to get from the street to the sidewalk or from street to their houses, the widths of the sidewalks on the streets vary widely.] [5. I think almost every street is different.] [6. And you have to look at how much space you have, what are the existing conditions, what are the needs of the street.] [8. We can use from street to street. You know what common practices are going to be from street to street, how they are actually placed. Then, what we can allow is based on widths and things that always changing.]	CT.11 Consideration of site context		
5. Arlington	[2. Where the driveways come in, where the intersections are], [3. how the topography is, all of those have affected the design of each project].			
3. Seattle	[1. majority of green streets are on none arterials. So those none arterials are typically areas of residential development, that's predominant land use. So traffic calming is always desired in residential areas. That will be a consideration of safe crossing, and neighborhood greenways.]	CT.12. Pedestrian safety		
6. Philadelphia	[3. But I think good example where we try to get multiple benefits are, ... we are building a green street around a school. There's a campus that where we will prioritize the idea of doing bump out in that location, then kids that walking to school have smaller street crossing. So you get that added pedestrian benefit, and you are expecting a lot of young pedestrians in those areas. That's the type of the way we layer those things out.]			
4. DC	[9. When we design it I'm trying to find better way or better implementation of green street to improve people's life.]	CT.13 Improving life		
1. Portland	[So we've certainly got through different iterations of the curb extension in terms of opening, how water gets in, check dam materials, what kind of plants are really going to work for us, what plants do well both wet and drought conditions, and inundated condition.][3. We've kind of done some different changes in design of our check dam elements, ... we do sort of dirt with rock over them, now we don't do that any more, just doesn't really keep up capacity and doesn't really fit into urban context well and it starts erode. So It doesn't work effectively.] [4. We started putting in the bar over the opening when we found cars were ending up driving into it. Because of, ... it may have been in next	CT.14 Improvement from previous design		

	to a business where there was high parking turn over. Then in those areas, where cars were coming and going a lot, they are not seeing it or they are hurting it. It might just accidentally drive into these things. So we start putting bars across all of our curb openings now, the green street facility.]			
2. New York	[2. It's an ongoing process. I don't think any of us are very happy with our standard design. So I think we'll keep improving, keep coming up with the new design.] [10. So yes, I think overtime, they keep coming with the modification, keep improving our design.]			
2. New York	[3. Now we really have only a few standards. There's a couple of modifications of it but they don't depend on the land use.] [4. If there's enough infiltration, so for example, if there's a impermeable layer right underneath the green street, you might put deeper column within the green street and fill it with large stones, so kind of creating this channel. So it's deeper like an extra permeability there. So the green street is up here you might have two columns that is connected to a permeable layer. And then we have another design standard, curb cut. What we found was, that design actually eliminates the bypass in the inlet we found,] [6. But we don't have different design for land use.] [10. They are gonna kind of building those, like hundreds or thousands of those in the priority sewershed.]	CT.15. Effective stormwater treatment performance & implementation		

D-6. Public outreach

City	Statement (meaning units)	Central Theme	General Theme	General Structure
3A. Seattle	[1. there were multiple community meetings and meeting was in a sort of community center settings] [2. meetings on a street in the neighborhood, walk along the street and looking at various project areas.]	CT.16. Public/ community meeting	GT.5. Public outreach	Public outreach was conducted in all sample cities. It is an important process of obtaining insights from the public. In addition, individual approach is also useful in drawing consents from the public by showing them their individual concerns matter. Therefore, public outreach may include various levels of approaches by concerning general public as well as by taking care of individual concerns.
2. New York	[1. when city released Sustainable Stormwater Management Plan and Green Infrastructure Plan they published drafts of it and they held a period of public feedback and had this public meeting.] [2. there was a period when people comment and incorporate them before the final plan is released.] [3. before green infrastructure was implemented in a neighborhood, there's meeting for the community board and there's a discussion there.]			
6. Philadelphia	[2. We held community meetings around Green Street, we don't do that as much now, because it is the public right of way.] [3. We'll go to, we might go to the neighborhood association meeting, may go to some of the local, political neighborhood meetings.] [4. There's elected officials called advisory neighborhood commissioners and see them for sure.] [5. We might have a stand-alone direct project meeting where we all get required out to residences, businesses, send out emails and just talk about the project at that meeting.]			
4. DC	[1. We usually go out to the public, sometimes we go out before the project starts to tell them what we are planning and to get input.] [2. Usually at least 2 or 3 times during construction we'll take design updates out to the public.] [3. We'll go to, we might go to the neighborhood association meeting, may go to some of the local, political neighborhood meetings.] [4. There's elected officials called advisory neighborhood commissioners and see them for sure.] [5. We might have a stand-alone direct project meeting where we all get required out to residences, businesses, send out emails and just talk about the project at that meeting.]	CT.17. Phased public outreach		
5. Arlington	2. The neighborhood conservation program when we do projects through them, those projects are initiated with the community. And there's public involvement process there.]			
1. Portland	[2. At 30% design, then we really reach out to them and say this what it's going to look like, it's going to go here, if you have any concerns, let us know.] [4.(2) 30% design we reach out to the public, let them comment on the design.] [6. (At) 30% public can have input and we design it a little more and go back out at 60% and then 90%, say ok no more opportunities or comments.]			
5. Arlington	[1. we had public meetings in the initial phase of each study and then after we have identified all the projects to share them with the public and to invite their feedback.] [If we initiate the projects from our office, we initiate the project by doing a meeting with the adjacent residents. And then at probably about 30% design, we go to the civic association then we have check-ins of the community level at about 60% design, and then close to 100% design. [so, do you find it helpful?] I believe so.	CT.18. Public education		
6. Philadelphia	[They often have separate program just about the residential storm water educational opportunity. And they do a lot of outreach on a very broad scale.]			

3AB. Seattle	[3. I spent time in their living rooms almost every property on all these projects who felt they need individual attention and wanted to have an input on their own drainage on their property that they own and manage, so huge amount of public involvement.]	CT.19. Individual conversation		
1. Portland	[3. And then if they share the concerns with us we'll talk to them individually and look to really see what we can do.]			
2. New York	[4. DEP sends out a postcard nearby the street corridors, explaining where they are gonna be, and how they work]	CT.20. Sending out flyers		
6. Philadelphia	[1. We work very closely with them and we tend to do kind of flyer sending our neighbors.] [3. So we do a lot of notification, but not as much should have]			
4. DC	[send out emails]			
1. Portland	[5. we want them to feel some ownership as well, so we have allowed them to pick their own planting palette. So we'll have a certain plant list and they can select from that list they might have in their facility.]	CT.21. Plant palette selection		

D-7. Operation & maintenance

City	Statement (meaning units)	Central Theme	General Theme	General Structure
Seattle	[Seattle Public Utility would ... they maintain GSI (Green Stormwater Infrastructure). Basically, if it's in actual GSI facility, then they will maintain it. We (DOT) would build it and they will maintain it.]	CT.22. Municipal involvement	GT.7. Operation & Maintenance	
New York	[There's no maintenance department. So Parks Department is basically maintaining it. So, Parks Department has crews that have been going around with green streets. They have basically a checklist of 5 things: Mulching, watering, weeding, removing trash, and pruning. And then for the stormwater sites, they additionally make sure that the inlets are clear. That's the main thing.]			
DC	[We (Stormwater Management Branch) are maintaining with DDOT. But we are only there for a few times a year. And they can call it trash, and that's actually part of their goal. They are supposed to collect trash. The trash goes there instead of going to the river.]			
New York	[I think residents can even help with the maintenance]	CT.23. Public Involvement		
New York	[They also see private maintenance contractor will be more cost effective.]	CT.24. Private contractor		
Arlington	[We have a contract for maintenance]			
DC	[After the construction is finished we have done some water quality monitoring, but it didn't produce useful results. It turns just visual monitoring and monitoring for maintenance. When it comes to monitoring for performance, either it's water quality improvement or water volume reduction that takes funding and takes a lot more oversight and then expertise. We have coordinated with a professor from the University of Maryland to do the monitoring of our pervious concrete.]	CT.25. Inclusion of Monitoring		

D-8. Challenges

City	Statement (meaning units)	Central Theme	General Theme	General summary
6. Philadelphia	[8. Stormwater is simply not their priority.] [9. What they really wanna talk about is safety and lighting and what we wanna talk about is stormwater management, so it can just be kind of difficult to focus.]	CT.26. Challenges in setting priority	GT1. Challenges during Green Street implementation	Studying concerns and challenges is important because it can help designers and planners avoid difficulties and be prepared for potential impediments for successful implementation of Green Streets. And it is another way of observing current status of Green Streets. The challenges exist not only in one stage but also every stage of the implementation process. Therefore, challenges and concerns need to be considered throughout the process.
2. New York	[1. they have shallow bedrock.]	GT.27. Site constraints		
2. New York	[2. there's a shallow groundwater table.]			
6. Philadelphia	[One of our main challenges is right now a residential street. From the design point of a view, I think we're really trying hard to think of what's appropriate when you are in a residential area. Certainly it's because of underground utility. You are working next to people's basement]			
4. DC	[3. Working around the utilities, figuring out where we can place stormwater facilities, and if they can go over utilities, how close to the utility they can go, that's been challenging.]			
3. Seattle	[2. Funding is always a challenge]	GT.28. Economic considerations		
3. Seattle	[One of the major challenges is making it as affordable as possible, making it fair.] [They have a tendency to generate interest from neighborhoods that are adjacent to the project area] [having logical and fair process to choose location for the investment as well as management is really important to me.]			
6. Philadelphia	[4. from the construction point of a view, fairly new for the folks that we work with] [5. Then they have really different installation requirements, so construction is challenging.]	GT.29. Technical challenges in design and construction		
5. Arlington	[3. We have done all the design for these today in house, so other challenges have been training and educating our engineering staff.]			
6. Philadelphia	[7. People don't want us to build something in their space they use.]	GT.30. Community resistance/concerns		
4. DC	[1. They are very hesitant to allow water into the soil next to a road.] [2. People, the general public is always afraid of what you are putting in there.]			
3. Seattle	[1. public doesn't wanna lose parking spaces, so often times, when you are looking to meet the interests of the green street by providing that abundance of landscaping areas is where you wanna do the parking lanes.]			
1. Portland	[1. Some people will of course have some concerns particularly over loss of parking maybe. That has been kind of one of the biggest concerns people have.]			
2. New York	[3. Parking is an issue in some boroughs more than others.]			
5. Arlington	[2. parking lots may be compromised so we had some struggles with residents dealing with some of those issues.]			
3. Seattle	[making sure that the installations are well maintainable is also high on the list.] [4. So getting it right the first time is important and making sure you have public interest, engineered properly.]			
6. Philadelphia	[6. really common in any public meeting is maintenance.]			

6. Philadelphia	[3. during construction, like the access: you are working on the sidewalk and so on.]			
5. Arlington	[1. I think that we have a number of challenges. I think one of them is community education.]	GT.31. Difficulties in public outreach		

Appendix E. IRB Approval

E-1. First term



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MEMORANDUM

DATE: February 19, 2014
TO: Patrick Miller, Joo Won Im, Dean Bork
FROM: Virginia Tech Institutional Review Board (FWA00000572, expires April 25, 2018)
PROTOCOL TITLE: Green Street: An integrated strategy for a community livability
IRB NUMBER: 14-035

Effective February 19, 2014, the Virginia Tech Institutional Review Board (IRB) Chair, David M Moore, approved the New Application request for the above-mentioned research protocol.

This approval provides permission to begin the human subject activities outlined in the IRB-approved protocol and supporting documents.

Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB as an amendment request and approved by the IRB prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the subjects. Report within 5 business days to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

All investigators (listed above) are required to comply with the researcher requirements outlined at:

<http://www.irb.vt.edu/pages/responsibilities.htm>

(Please review responsibilities before the commencement of your research.)

PROTOCOL INFORMATION:

Approved As: **Expedited, under 45 CFR 46.110 category(ies) 5,6,7**
Protocol Approval Date: **February 19, 2014**
Protocol Expiration Date: **February 18, 2015**
Continuing Review Due Date*: **February 4, 2015**

*Date a Continuing Review application is due to the IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

FEDERALLY FUNDED RESEARCH REQUIREMENTS:

Per federal regulations, 45 CFR 46.103(f), the IRB is required to compare all federally funded grant proposals/work statements to the IRB protocol(s) which cover the human research activities included in the proposal / work statement before funds are released. Note that this requirement does not apply to Exempt and Interim IRB protocols, or grants for which VT is not the primary awardee.

The table on the following page indicates whether grant proposals are related to this IRB protocol, and which of the listed proposals, if any, have been compared to this IRB protocol, if required.

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E-2. Amended



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MEMORANDUM

DATE: October 29, 2014
TO: Patrick Miller, Joo Won Im, Dean Bork
FROM: Virginia Tech Institutional Review Board (FWA00000572, expires April 25, 2018)
PROTOCOL TITLE: Green Street: An integrated strategy for a community livability
IRB NUMBER: 14-035

Effective October 29, 2014, the Virginia Tech Institutional Review Board (IRB) Chair, David M Moore, approved the Amendment request for the above-mentioned research protocol.

This approval provides permission to begin the human subject activities outlined in the IRB-approved protocol and supporting documents.

Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB as an amendment request and approved by the IRB prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the subjects. Report within 5 business days to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

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(Please review responsibilities before the commencement of your research.)

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Approved As: **Expedited, under 45 CFR 46.110 category(ies) 5,6,7**
Protocol Approval Date: **February 19, 2014**
Protocol Expiration Date: **February 18, 2015**
Continuing Review Due Date*: **February 4, 2015**

*Date a Continuing Review application is due to the IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

FEDERALLY FUNDED RESEARCH REQUIREMENTS:

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E-3. Extended term



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MEMORANDUM

DATE: January 28, 2015
TO: Patrick Miller, Joo Won Im, Dean Bork
FROM: Virginia Tech Institutional Review Board (FWA00000572, expires April 25, 2018)
PROTOCOL TITLE: Green Street: An integrated strategy for a community livability
IRB NUMBER: 14-035

Effective January 28, 2015, the Virginia Tech Institution Review Board (IRB) Chair, David M Moore, approved the Continuing Review request for the above-mentioned research protocol.

This approval provides permission to begin the human subject activities outlined in the IRB-approved protocol and supporting documents.

Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB as an amendment request and approved by the IRB prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the subjects. Report within 5 business days to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

All investigators (listed above) are required to comply with the researcher requirements outlined at:

<http://www.irb.vt.edu/pages/responsibilities.htm>

(Please review responsibilities before the commencement of your research.)

PROTOCOL INFORMATION:

Approved As: **Expedited, under 45 CFR 46.110 category(ies) 5,6,7**
Protocol Approval Date: **February 19, 2015**
Protocol Expiration Date: **February 18, 2016**
Continuing Review Due Date*: **February 4, 2016**

*Date a Continuing Review application is due to the IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

FEDERALLY FUNDED RESEARCH REQUIREMENTS:

Per federal regulations, 45 CFR 46.103(f), the IRB is required to compare all federally funded grant proposals/work statements to the IRB protocol(s) which cover the human research activities included in the proposal / work statement before funds are released. Note that this requirement does not apply to Exempt and Interim IRB protocols, or grants for which VT is not the primary awardee.

The table on the following page indicates whether grant proposals are related to this IRB protocol, and which of the listed proposals, if any, have been compared to this IRB protocol, if required.

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E-4. Extended term



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MEMORANDUM

DATE: February 9, 2016
TO: Patrick Miller, Joo Won Im, Dean Bork
FROM: Virginia Tech Institutional Review Board (FWA00000572, expires January 29, 2021)
PROTOCOL TITLE: Green Street: An integrated strategy for a community livability
IRB NUMBER: 14-035

Effective February 9, 2016, the Virginia Tech Institutional Review Board (IRB) Chair, David M Moore, approved the Continuing Review request for the above-mentioned research protocol.

This approval provides permission to begin the human subject activities outlined in the IRB-approved protocol and supporting documents.

Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB as an amendment request and approved by the IRB prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the subjects. Report within 5 business days to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

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(Please review responsibilities before the commencement of your research.)

PROTOCOL INFORMATION:

Approved As: **Expedited, under 45 CFR 46.110 category(ies) 5,6,7**
Protocol Approval Date: **February 19, 2016**
Protocol Expiration Date: **February 18, 2017**
Continuing Review Due Date*: **February 4, 2017**

*Date a Continuing Review application is due to the IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

FEDERALLY FUNDED RESEARCH REQUIREMENTS:

Per federal regulations, 45 CFR 46.103(f), the IRB is required to compare all federally funded grant proposals/work statements to the IRB protocol(s) which cover the human research activities included in the proposal / work statement before funds are released. Note that this requirement does not apply to Exempt and Interim IRB protocols, or grants for which VT is not the primary awardee.

The table on the following page indicates whether grant proposals are related to this IRB protocol, and which of the listed proposals, if any, have been compared to this IRB protocol, if required.

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