Seeing Green

An Evaluation of Social Benefits & Public Perception of Green Walls

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Abstract:

Due to increasing urbanization, cities including Seattle are seeking creative means of increasing the amount of greenspace in their urban environments. Green walls are one example of including natural elements on vertical surfaces that are often left unutilized. Green walls have been linked to a wide range of benefits regarding sustainability. Compared to the social elements of sustainability, much more attention has been given to the environmental and economic factors. This project explores the public social benefits of green walls in order to determine if green walls are a feasible means of creatively including more sustainable greenspace in urban areas. The identified benefits are individually explained regarding their connections to sustainability. TAn additional component of this project is a set of site evaluations and a survey exploring public opinions on the benefits of green walls. This results in a report that addresses the potential benefits of green walls, in addition to the challenges, with specific examples in Seattle. This product is intended to provide insight on the feasibility of using green walls to contribute to the public social benefit while simultaneously incorporating necessary greenspace into urban areas.

Introduction:

Seattle is growing at an exceptional rate, both in the downtown area and its surrounding neighborhoods. This can be seen by the 2.3 percent population increase from July 2014 to 2015 (Balk, 2016). In addition to this population growth, a large amount of new infrastructure is being constructed. According to a Seattle Times article from summer of 2016, Seattle had 58 cranes working on projects throughout the city. This is the highest number in the entire United States, and 18 cranes more than second-place Los Angeles (Rosenberg, 2016). This increasing urbanization requires strategic planning for how to maintain Seattle's culture and identity. Seattle is traditionally a very environmentally-conscious city and the current development is providing opportunities to incorporate more sustainable features into the urban landscape.

This project will evaluate the potential for the city of Seattle to use green walls in order to provide more greenspace. Ideally, green walls will become successful additions that will promote sustainability. However, sustainability can be a difficult term to define. A commonly agreed-upon approach to sustainability is the Triple Bottom Line. This states that sustainability consists equally of environmental, economic, and social factors (Miranda, 2016). The 'bottom line' approach is often used to describe economic profit, while the term 'sustainability' is most closely associated with environmental factors. However, these terms combined dictate that sustainability consists of three main factors; people, planet and profit. This third aspect of people and social elements is often overlooked, yet it is given equal value according to this definition of sustainability.

Regarding green walls, environmental and economic factors have been more extensively researched. However, social elements have received far less attention, yet they are equally important. For my research, I will focus on the impacts of green walls regarding the public social benefit. This is intended to provide a more thorough perspective on the feasibility of using green walls to provide public benefits related to sustainability.

Social Life, a London-based organization that researches the social life of communities, offers a clear definition for the social aspect of sustainability. They state that social sustainability is, "a process for creating sustainable, successful places that promote wellbeing, by understanding what people need from the places they live and work. Social sustainability combines design of the physical realm with design of the social world – infrastructure to support social and cultural life, social amenities, systems for citizen engagement and space for people and places to evolve" (Woodcraft, 2011). This concept of utilizing infrastructure to promote the social aspect of communities is what I will be focusing on, as opposed to the economic and environmental aspects of sustainability that have been more thoroughly researched.

In order to be considered truly sustainable, green walls must successfully fit into communities and provide public social benefits. The result of this project is a report that identifies factors to consider when implementing a green wall that relate to the public social benefit. In addition to the toolkit, it will also include site evaluation analyses and report on a

public survey regarding the benefits of green walls. These products will help determine if green walls are a feasible means of providing sustainable urban greenspace, with an emphasis on public social benefit.

Significance:

Negative environmental damage will increasingly impact all community members. A large contributor to this environmental degradation is increasing urbanization and densifying of urban areas. This growth does contribute to significant damage to the environment, but it also provides opportunities for eco-friendly innovations. In order to combat increasing pollution, cities must consider themselves obligated to explore innovative ways to reduce or offset destructive environmental behaviors.

Citizens in urban areas are surrounded by more pollution and suffer disproportionate health issues. All residents should be concerned about the negative effects of pollution, especially air pollution in densely-populated areas. The addition of more greenspace can alleviate these negative aspects of urban environments. The goal of my project is to provide a positive and legitimate suggestion for incorporating the natural environment, by installing a green wall, into a dense urban space.

Context:

Green walls are a relatively new and emerging technology. Currently, they have a larger presence in other countries, yet they are not particularly popular or widespread in the United States. One of many examples of international green walls can be found in London. One of the larger living walls was installed in the Mint Hotel and it spans from the second to the eleventh floor on an exterior wall (Zimmer, 2011). This is one of the largest examples of international green walls. There is an absence of living walls at this scale in the United States.

The technology used for installing and maintaining green walls is continually being improved. In that process, extensive research has been done on the economic and environmental impacts of green wall installations. However, there has been much less research on the social impacts of these sustainable features. Specifically, economic benefits such as increased property values and decreased energy bills have been identified (Green Over Grey, 2009). Environmental benefits have also been thoroughly explored. These include improved air quality, the potential to earn LEED credits, and increased biodiversity (GRHC, 2016). These factors have and continue to receive plenty of attention, while social factors are generally overlooked.

Thus, it is an opportune time to explore the existing green walls to identify what has made those successful and how they could be improved. Arguments have been made regarding the economic feasibility and environmental benefits but it is also imperative to explore social factors as well. A variety of benefits have been proposed and tested. These include mental health, improved social interactions and community engagement (LiveWall, 2016). A variety of benefits have been identified and a compiled set of recommendations can assist in the strategic planning an implementation of green walls that can contribute to the public social benefit.

Seattle currently has an Urban Forest Stewardship Plan, which states their plan to increase canopy coverage within the city. The Stewardship Plan includes a tangible goal of achieving 30 percent canopy cover by the year 2037 (Seattle Office of Sustainability & Environment, 2016). However, this proves difficult with the new infrastructure being constructed to provide for the growing population. This will force the city to be creative and explore potentially unconventional options for bringing the natural world to a largely urban environment. This current effort to incorporate more greenspace into public areas provides an ideal opportunity to incorporate green walls into the city and its surrounding neighborhoods. Although green walls do not constitute as canopy coverage, they could potentially become feasible options when an increase in authentic canopy coverage becomes challenging within the city.

Additionally, Seattle released a green infrastructure strategy in 2015. The goal of this plan is to ensure the continual pursuit of green infrastructure in order to reap a variety of benefits (WaterWorld, 2015). This plan was partially created to address stormwater runoff in the city. Examples of green infrastructure that are currently being pursued include bioretention swales, green roofs, rain gardens, and permeable pavement (in addition to green walls). These plans to increase the presence of green infrastructure can benefit from further exploration regarding the feasibility of utilizing green walls to provide natural elements in urban areas.

Literature Review:

- *Introduction:*

Green building is becoming much more prevalent in urban areas. This literature review will specifically be exploring the prevalence of green walls. These structures have the capability to provide much-needed greenspace in densely urban environments. These structures have several challenges regarding their successful application, but there are a variety of benefits that are associated with them as well. These benefits address the three facets of sustainability; environmental, economic, and social factors.

Identified environmental and economic benefits have been more extensively explored and enticing for developers and property owners. However, the social factors have received far less attention. These social benefits are more difficult to measure or quantify, yet they are arguably and equally important. The following literature review addresses some of the social factors that have been previously identified and need to be further explored, in the context of public social benefit.

I will begin by addressing the value of incorporating green infrastructure into urban environments. Then I will address some of the identified social benefits that result from having green walls in communities. I will then explore several cautionary approaches regarding the installations. These issues range from design and approach to equity and maintenance. From there, I will address several blatantly skeptical perspectives that question the validity of these green wall benefits. Overall, this literature review will provide a thorough analysis regarding the feasibility of utilizing green walls to improve the public social benefit.

- *Importance of Green Infrastructure:*

Green building is becoming a more common application in the pursuit of sustainable communities. These sources address the importance of incorporating natural elements into communities. Urban environments are especially lacking in greenspace and they provide spaces to seek innovative means of incorporating these elements into these areas.

Kathleen Wolf, a social scientist with a Ph. D. in Landscape Architecture, argues that ergonomics must be a priority for growing cities. This is an inherent part of planning according to her definition of "the process of translating human actions and needs into the physical forms of engineered or built systems" (Wolf, 2003). It is necessary for cities to create tangible infrastructure to accommodate human needs and make efforts to improve productivity. She makes the point that sustainable features in building are able to foster community growth and development more efficiently than projects requiring extensive infrastructure. She makes the bold claim that "systems composed of key ecological and cultural features are essential to sustainable growth and productivity" (Wolf, 2003). Wolf discusses green building in general, but authors I will later discuss more specifically address green walls.

Similar to Wolf, Susan Loh, a member of the Australian Council of Built Environment Design Professionals, expresses concerns for the current state of urban environments. She specifically addresses increased emissions and degrading air quality due to diminishing biodiversity in urban areas. With the current urbanization, she asserts the need for new and innovative changes to compensate for the negative environmental and health impacts. She specifically focuses on living walls as a minimal consideration for designers. Loh focuses on economic feasibility of green walls, but she briefly mentions potential benefits more concerned with the social realm. She states, "The ability of a living wall to offer a more pleasant, healthier, and more productive workplace together with lower building energy bills, are incentives that should have particular appeal to both building owners and developers" (Loh, 2009). She acknowledges that living walls are a relatively new technology that are continually being improved. She advocates for living walls as introductory components of raising public awareness and support of creatively incorporating more natural elements in urban spaces.

I agree that both of these sources make valid and alarming points about the current direction of society. Loh's acknowledgement of the necessity for incremental steps towards more sustainable systems is very pragmatic and realistic. It seems clear that more sustainable options are going to become more of a necessity and they will require intentionality and clearly-defined goals. Thus, further exploration of potential benefits of green walls in particular, must be conducted in order to determine if they can be feasible resources for societal benefits.

- *Social Benefits:*

As mentioned, there have already been environmental and economic benefits of green walls that contribute to sustainability. However, the social benefits have received disproportionately less attention yet they are arguably equally important. The social benefits extend beyond those who install the walls onto their properties, but contribute to the public social benefit as well.

A plethora of positive factors regarding green walls have been identified. LiveWall, a popular vertical garden enterprise, has an extensive list of potential benefits for installing green walls. They place a heavy emphasis on economic and health benefits, but they are unique from other living wall companies due to the fact that they also place heavy emphasis on inherently social factors as well. Several of the categories mentioned are that the walls boost productivity, and result in good moods and social health (LiveWall, 2016). Although LiveWall does a more thorough job than other organizations of identifying a wide scope of benefits, they lack specificity and clear recommendations for ensuring that these potential benefits are taken advantage of.

While Loh placed a heavy emphasis on economic factors of green walls, Timothy Beatley, an internationally-recognized sustainable city researcher, discusses the concept of biophilia. Within his book, *Biophilic Cities: Integrating Nature into Urban Design and Planning*, he explains the innate social need for humans to be around natural elements. He

explains, “Nature in our lives is not optional but essential. … It is not a thing or a place that we periodically visit but a surrounding condition, an ideally ubiquitous context that delights, relaxes, soothes, replenishes, inspires, and uplifts us in our daily urban lives” (Beatley, 2010). These beliefs align with Wolf’s suggestions of incorporating more natural elements into areas that are currently lacking these features. However, Beatley’s concept of biophilia provides a greater sense of social urgency, as opposed to highlighting the potential economic benefits that Loh emphasizes. Beatley continues to specifically address green walls and the ability to incorporate them into areas that do not generally have natural elements present.

In support of Beatley’s concept of biophilia, Henn et al describe the results of interviewing the public on existing living walls, “Respondents’ statements that people are often drawn to their living walls and the building spaces they occupy suggests living walls can indirectly enhance social interactions, promote community engagement, and increase exposure for the building and organizations where they are located” (Henn, 2013). They specifically refer to the success of living walls and suggest that their incorporation into urban areas assists with the fulfillment of biophilia. They describe the concept themselves, “We have an ingrained need to associate with other living things and experience beautiful places. Furthermore, we are psychologically fulfilled and physically healthier when this happens” (Henn, 2013). Overall, this is evidence of Beatley’s argument that humans innately desire to interact with natural elements.

Overall, green walls provide some much needed exposure to natural elements within urban areas. The social benefits are more difficult to quantify than the economic and environmental impacts, yet they allow for overall improvements in mood and productivity for those that encounter them in their environment.

- *Risks of Green Wall Installations:*

Green walls have considerable support, yet there are plenty of warnings provided regarding their potential for maximum success and equity. It must be acknowledged that green walls must be uniquely addressed for each proposed location. Not only are there specific issues such as which plants will thrive in various environments, but perhaps less intuitive issues of equity and community engagement must be considered as well. The following sources provide cautionary advice regarding social aspects to consider in the implantation of green walls.

In order to reap the social benefits of biophilia through the use of green walls, they must be strategically implemented. In an article in the *Journal of Environmental Management*, Robert Francis commends efforts to expand the use of living walls and roofs. However, he takes a much more cautionary approach than has been previously discussed. He warns, “noting that despite a move to ‘community-based’ conservation in many developed regions, lack of biodiversity experience, conservation knowledge and co-ordination of action between garden owners can lead to ineffective conservation efforts or, in the worst case, decisions that are detrimental to biodiversity overall but may be perceived to be beneficial” (Francis, 2011). He acknowledges that these living walls can prove to be successful, but they are not guaranteed to provide benefits to communities. He advocates for a very intentional approach that seeks input from professionals

in order to maximize efficiency. The potential benefits receive much more attention, in order to garner more widespread support, but it is equally important to consider the potential detrimental results, as Francis suggests.

Zhao et al explores the incorporation of community participation into the application of green building. The ideas suggested somewhat contrast with Francis' warnings of the risks of 'community-based' conservation. Zhao et al argue that community input is an integral part of green installations, such as green walls. In the article, *Social Problems of Green Buildings: From the Humanistic Needs to Social Acceptance*, they explain "Social processes with consumer engagement and participation needs to be considered in aspects of conceptual design, planning and design, operation and maintenance to improve users′ happiness and productivity" (Zhao et al, 2015). It is determined that social acceptance and a basic public knowledge of ecological systems is necessary for the success of green building. Zhao et al make the argument that ecological systems can have more benefits when the citizens are knowledgeable about the intent and processes at work. Ultimately, this provides a more optimistic and social perspective for community-driven ecological systems such as green walls, contrary to Francis' cautionary narrative.

Lynne Westphal, who has received a M.A. in Geography and Environmental Studies in addition to a Ph.D. in Public Policy Analysis and Urban Planning, provides another cautionary perspective regarding green wall applications. She discusses the issue of empowerment when it comes to introducing green space in urban areas. The previous examples advocate for the positive impacts of green walls, but they do not specify who is receiving these benefits. She questions if it is individuals or larger organizations that these greenspaces are impacting most. Westpahl mentions issues of equity and accessibility to these green walls and what constitutes as public benefits. She provides a warning that, "Social benefits from urban and community forestry and related greening programs are a possible, but not automatic, outcome of these projects' (Westphal, 2003). She advises that developers of green walls be strategic and intentional in their applications, while considering the unique context of each project in order to ensure maximum social benefit.

Westphal, Zhao et al, and Francis all acknowledge and advocate for the potential benefits of green walls. However, each of these authors also provide cautionary advice regarding the process of utilizing them in order to ensure success, equity, and maximum possible social benefit. Thus there is a need for more extensive research regarding the improvements to public social benefit resulting from sustainable installations, such as green walls. I had not previously considered some of the social issues mentioned by these authors, but all provide valid points of contemplation regarding these installations.

- *Arguments Against Green Walls:*

As mentioned by Francis, green walls require extensive knowledge and strategy when it comes to implementation. Location, climate, and irrigation are all issues that must be adequately addressed in order to ensure their success. There are plenty of skeptics that believe it is too

difficult and unlikely to successfully address all of these issues and allow for a fairly cheap and unobtrusive maintenance system. For these reasons, there are certainly individuals that disagree that green walls can effectively and simultaneously provide environmental, economic, and social benefits. The following sources provide more skeptical opinions regarding the success of green walls.

Arguments against these installations primarily include large upfront costs and maintenance issues. Bruce Vorak emphasizes the downfall of delayed results when installing green walls. Ideally, after facing the initial costs, we would immediately be able to see positive results. However, due to the time it takes to not only install a green wall, but also allow the plants to grow, there is often disappointment at the duration of time spent waiting for tangible results. Vorak explains, "It is important to remember these time-scales when we think about sustainability, whether in terms of projects or in terms of developing sustainability at a social level" (Vorak, 2015). He goes on to describe the application of a green wall as an evolutionary process in order to help establish a green society. Green walls are an investment that require intentionality and a commitment to the space, not only when the wall is flourishing, but also at times in which it will not be as aesthetically-pleasing. This can result from the initial installation process or even seasonal changes that influence plant growth. For these reasons, green walls can be assessed to be more trouble than they are worth, although, under ideal conditions, they have the potential to lead to positive improvements.

Green walls require an upfront investment for potential future benefits. Those interested in installing a green wall must be willing to pay for it, and be willing to pay to ensure that it is done correctly. Skeptical of green wall benefits, columnist George Irwin remarks, "The amount of knowledge needed for success in this arena is overwhelming. You have to be an expert in design, irrigation, indoor and outdoor plants, growth media, lighting, pest and disease management and fertilizers; this doesn't sound like your average contractor." (Irwin, 2011). This would require a willingness to pay for knowledgeable professionals in a variety of fields, or companies that specialize in these installations. Irwin also questions whether the materials used are indeed sustainable. Overall, he makes so valid points regarding the feasibility of successful green walls.

However, I think that Irwin makes a very valid statement that green walls are often difficult to correctly implement, yet there are still some innate benefits. He claims, "I do agree the walls provide a wow factor and benefit employee production, improved air quality, improved acoustics and can be a viable use for urban agriculture, but that's only if they don't fail, require high numbers of plant replacements, or just outright become a burden" (Irwin, 2011). Despite his skepticism, he acknowledges that these walls can provide various benefits when done correctly. I also find it interesting that he emphasizes innately social benefits, as opposed to economic and environmental aspects. According to Irwin, it is more difficult to reap the economic and environmental benefits while the social benefits are more easily achieved.

These sources provide more negative perspectives regarding green walls. However, even Irwin cannot deny the positive benefits when done correctly. His perspective results from a deep

skepticism regarding the success of these well-intentioned green walls due to the fact that they require extensive amounts of planning and maintenance. While these sources make valid arguments, the initial mistakes in green wall implementation will become learning opportunities and will continually become less frequent. The process of developing successful green wall strategies may be challenging, but I am optimistic that they can prove to be rewarding and beneficial contributions to urban landscapes.

- *Conclusion:*

This literature review was conducted in order to provide information regarding the current application of a growing facet of green infrastructure. Green walls are one example of sustainable designs that can provide important greenspace in urban areas that are lacking natural elements. These walls are linked to a wide variety of benefits which address the three facets of sustainability (environmental, economic, and social). Economic and environmental benefits are more quantifiable compared to the social benefits, which have received less attention. It is the collection of potential social benefits that I am focusing on in order to determine how to maximize the public social benefit of communities in which these green walls are applied.

These authors have a variety of opinions regarding the application of green infrastructure, and green walls in particular. Wolf and Loh both advocate for a larger presence of green infrastructure and determine that green walls are a feasible starting point for urban areas. While these two authors advocate for ecological systems in urban areas, they focus on more economic and environmental benefits. However, Beatley and Henn place much more attention on biophilia, the social and inherent human need to be around the natural environment. Francis, Westphal, and Zhao et al each provide more specific advice to green wall applications. Additionally, Irwin and Vorak deny the likelihood of their success altogether. Overall, a variety of opinions regarding green walls have been explored and, in my opinion, they still seem to be a feasible (albeit challenging) opportunity to incorporate natural elements into urban areas.

Ultimately, these sources have affirmed the concept that humans can socially benefit from green walls in urban areas. However, they also raise concerns regarding the process of implementation in order to ensure their maximum possible contribution to public social benefit. There are those that are explicitly skeptical of their success. They most commonly cite issues regarding proper design and installation or lack of adequate maintenance. Despite these perspectives, I remain confident that as green walls will becomes increasingly successful as they become more widely-adopted.

The sources that advocate for more biophilic and ecological infrastructure provide an encouraging assurance that these green walls can have significant social benefits, in addition to environmental and economic as well. These sources support the idea that these green walls are worthwhile means of increasing human exposure to the natural environment. The strategic implementation of green walls is continually improving and I believe they will prove to be valuable assets to communities as a whole, especially in urban areas that could use the increased exposure to natural elements.

Methodology:

This project consists of two major components. In this methodology, I will explain the process of completing each portion and how they are tied together to produce a final product. The first component consists of research, while the second component involves site visits and evaluations. In addition to these personal evaluations, the development and distribution of an informal public survey at the locations is included as well. These components are then brought together to provide several conclusions and recommendations .

In order to complete my project, preliminary research was conducted to determine the scope. It was determined that it would be focusing on sustainability and how it can be incorporated into the built environment. Introductory research was conducted on the various types of green infrastructure. Green walls were selected as the specific type of green building that would be focused on.

- *Part 1: Research*

After specifying the scope of my research, continual information on the previously-identified benefits of green walls were sought out. Factors related to sustainability were emphasized, specifically as they related to the triple bottom line approach. This specifies that there are three main components that contribute to sustainability. These are environmental, economic, and social factors. Benefits were generally categorized according to these three categories.

The scope was influenced by the disparity between the amount of academic research on environmental and economic factors, compared to social factors. This facilitated an emphasis of research on the social facet of sustainability, as applicable to green walls. It was determined that the research would be primarily concerned with the arguments for green infrastructure, specifically green walls, and their contributions to public social benefit.

It was imperative to gain an understanding of the current climate of green building and the presence of greenspace in urban environments. I explored Seattle specifically and how the city is currently undergoing change, specifically new infrastructure and an increasing population. This included information on the tangible goals for the incorporation of natural elements into the city.

A portion of the research has contributed to a thorough literature review that has been reviewed and expanded throughout this entire process. This research consists of several categories. These categories include advocacy approaches for green infrastructure in general. Then previously identified social benefits were explored, including the argument that human

beings have an innate need to be around natural elements, known as *biophilia* (Beatley, 2010). In order to get a more well-rounded knowledge of green walls, Challenges and warnings regarding elements that must be considered in their application were then addressed. I then went further to find perspectives that vehemently disagree with the use of green walls. These skeptical approaches gave me a better idea of the extensive issues that can arise from green wall installations and how they can be improved.

The four sections of my literature review are as follows:

1. Importance of Green Infrastructure
2. Social Benefits
3. Risks of Green Wall Installations
4. Arguments Against Green Walls

After conducting the literature review, I then spent more time thoroughly exploring potential social benefits of green walls. These were gathered from a variety of sources and there are several social issues that are often tied to primarily environmental and economic factors. Although, environmental and economic factors were explored as well but in less depth. This was in order to provide a holistic perspective on the potential benefits of green walls.

After compiling a list of contributors to the public social benefit, I explored each concept in depth. Additionally, I determined how to organize these benefits using a thorough definition of social sustainability. I used Social Life and their description of social sustainability. They specify four elements that create a framework for design that contribute to social sustainability. These elements are; amenities & infrastructure, social & cultural life, voice & influence, and space to grow. However, this organization primarily uses these four elements when considering design of small residential communities and their design. Therefore, I consulted my research and developed four corresponding factors that pertain to green walls specifically.

Here the Social Life social sustainability design elements can be seen with their corresponding elements as they apply to green walls:

1. Amenities & Infrastructure	Location & Sense of Place
2. Social & Cultural Life	Accessibility & Equity
3. Voice & Influence	Civic Engagement
4. Space to Grow	Intentionality & Maintenance

The research component of this project is critical to a successful final product that be can be used to determine the feasibility of using green walls to contribute to the public social benefit. Using the framework provided by Social Life, I was able to portray the breadth of benefits that green walls provide, specific to the social realm of sustainability.

- *Part 2: Site Visits & Evaluations*

In addition to conducting research on the sustainability of green infrastructure,

particularly living walls, I chose to conduct some additional fieldwork of my own. Once I had a list of identified benefits related to these installations and I was curious if successful examples could be found in Seattle. Additionally, I was curious if the public was aware of the benefits of green walls. This led me to include an informal survey as a part of my site visits. I had been researching the factors related to sustainability, but I was curious if the larger community was aware of the breadth of positive factors attributed to green walls. This process allowed me to go out and see existing green walls and learn more about how the public interacts with them.

In order to visit existing green walls, it was necessary to explore and identify where they are located within Seattle. This process required consulting information available on architectural and design firms that install green walls. Additionally, local news publications and personal blogs were explored. Furthermore, I consulted my mentor and other professionals in order to identify existing green walls and more specifically, the terminology used to describe and differentiate these features from other forms of green infrastructure. I elected to visit locations that were located on exterior surfaces and in public spaces, because these would be the most accessible to the general public. This was somewhat limiting for the available green walls that would be appropriate for site visits. Ultimately, three locations were selected.

Site Visit locations are as follows:

1. SODO Starbucks
2. South Lake Union Amazon Facility
3. Georgetown CDL Recycling Facility

Prior to conducting site visits in March and April, an evaluation criteria was determined. I utilized the Social Life design framework and corresponding green wall factors that I specified in my research. I used a Likert scale system that ranged from one to four stars that indicated each green wall's success according to each of the four elements. Site evaluations and full explanations were conducted after visiting each of the three locations.

In addition to my evaluations, a brief public survey was included. The initial draft survey was developed after a preliminary list of benefits had been identified through my research. After viewing surveys from similar studies related to sustainable infrastructure, two types of questions were identified. First, I included several questions concerning demographic information. These included the age range of the participant and level of education completed. I elected to include a brief section of demographic information so I could explore any trends regarding age or education level and their relationship to knowledge of sustainability concepts. (The full survey can be seen in Appendix II). The second portion of the survey contains questions concerning green walls specifically. For example, one question asks out of the three facets of sustainability (environmental, economic, and social), which is the most relevant to green walls.

After reviewing the initial draft and considering my research, another question was added to clarify what is meant by a 'green wall'. There is some variability in the lexicon used to describe these features. For example, green walls can also be referred to as living walls, vertical gardens, green facades, etc. This could potentially lead to some confusion so I included a

question asking respondents what term they would use to describe the wall. Additionally, I had several pictures of other examples of green walls to provide further clarity for the participants.

Once the locations were determined, I established guidelines for conducting my survey in the field. I considered factors such as weather and time of day. Additionally, these factors are expanded upon in the *Survey Report* section. I attempted to select days in which it was not raining and ideally on days that were warm and sunny, in the hopes that more people would be outside an in proximity to the green walls. However, I was somewhat limited by these weather and time constraints. The survey was conducted in March and April 2017.

Due to scheduling I resolved to conduct my site visits on weekday afternoons. I acknowledge that this did not allow for a true random sample, but this survey was specifically targeting those who have had some experience with green walls. Additionally, I set a goal to collect at least 15 responses at each location. I spent between one and three hours at each location. I was able to meet my goal at two locations, with the exception of the Georgetown location (details of which can be found in the *Survey Report*).

Overall, I was able to collect 41 responses between the three locations. I approached individuals sitting or walking in proximity to each green wall. I paid attention to social cues and tried to only approach individuals who did not appear to be in a hurry or uninterested in participating. I prefaced the survey by explaining that I am a student at the University of Washington conducting a survey as part of my senior project. I explained that I was conducting a survey on the public perception of green walls. Additionally, I had my draft abstract available if they wanted further information.

After conducting the survey at each location, the results were compiled and compared to identify themes. Additionally, trends in demographic information were explored in order to extract any relevant patterns. I counted the frequency for each response and used this evidence to explain the current perception of green walls. However, I acknowledge that the sample size is somewhat limited and the selection of participants was not truly random. However, this introductory survey gave me valuable experience and some broad insight regarding public perception of green walls. The findings from the survey are explained more in-depth in the *Survey Report*.

- *Final Product:*

These two components previously described have provided the resources to produce my final report. This report includes information on the benefits identified through my research, in addition to the design framework used to measure social sustainability. These are followed by my corresponding design framework of green walls with explanations and evaluation criteria.

A component of the report is dedicated to summarizing and explaining the results of my survey. A description is provided regarding the goals of the survey. Each survey location is explained, both the process of selecting the locations and the experience conducting the survey.

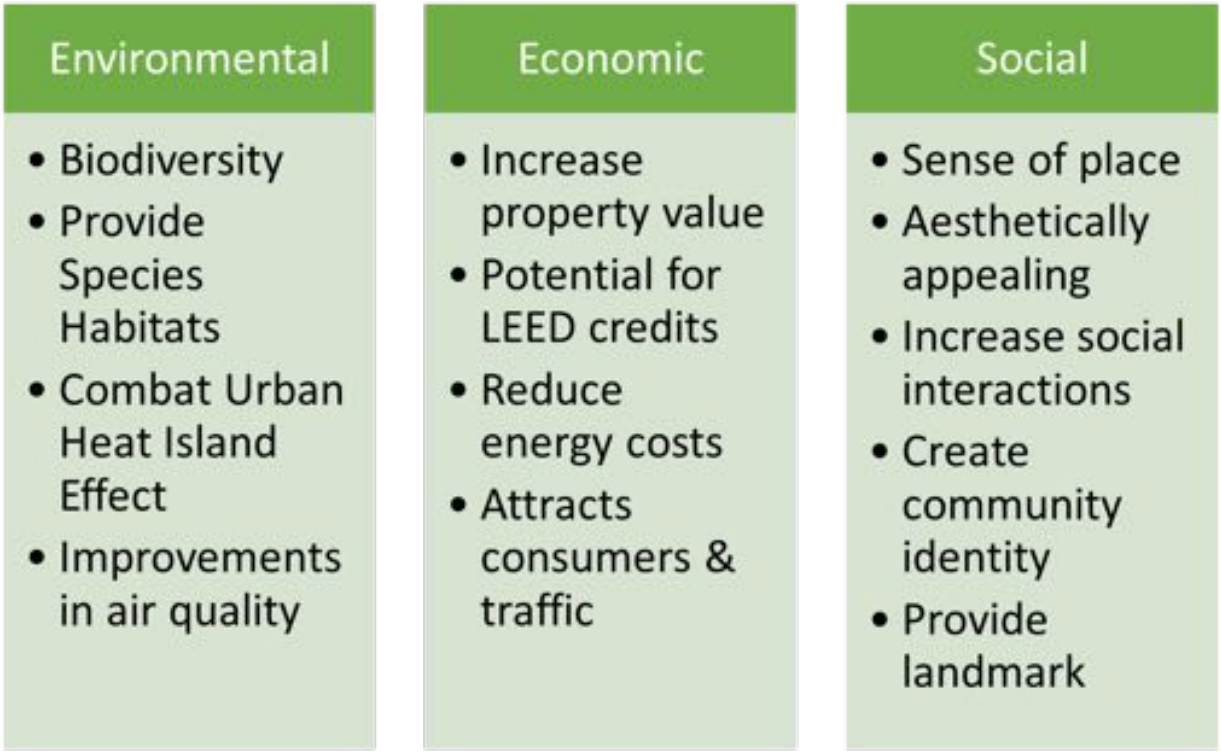
Using the data collected, several graphs have been created that display the most pertinent information and themes from the responses.

These components help identify and provide valuable insight regarding the current status of green walls. The report provides a greater understanding of the ability of green walls to contribute to the public social benefit, while incorporating more greenspace into urban areas. The survey provides information on the public perception of green walls and provides evidence of the work that still needs to be accomplished. Overall, both components can be useful in the pursuit of increasing the prevalence of green walls as elements of urban greenspace.

Results:

Overview of Green Wall Benefits & Challenges:

This section contains a brief overview of the primary benefits of green walls. They are differentiated according to the three elements of sustainability (economic, environmental, and social). The purpose is to provide a holistic perspective on the potential benefits that can be reaped from successful green walls. However, these are not guaranteed outcomes of green wall installations. Challenges can arise regarding poor location choice, maintenance issues, fiscal resources, and accessibility & equity.



Environmental

The listed environmental benefits cover a variety of factors. However, all are similar in the respect that they address challenges that are inherent to dense and urban areas. Several of them can be easily linked to other benefits, especially in the economic realm.

- **Biodiversity:** Green walls have the potential to incorporate a variety of plant species into urban areas that do not have many natural elements. These can include either native or non-native plants. However, it is advised to use native plants for the sake of plant health

and success. Non-native plants could potentially lead to harmful ecological impacts by upsetting the existing local ecosystems.

(Green Futures Lab, n.d.)

- **Provide Species Habitat:** Depending on location and the corresponding climate and ecology, green walls can potentially provide urban habitats for local species. These can most commonly include birds and insects. This can be critical in urban areas since it is more likely that animal habitats are less frequent than in more rural areas.

  (Green Futures Lab, n.d.)

- **Combat Urban Heat Island Effect:** Urban areas are particularly dense and this results in increased temperatures, compared to nearby suburban areas. Green walls are able to naturally reduce temperatures since the plants are able to absorb the heat and prevent urban heat islands.

  (Peck, 2009)

- **Improvements in Air Quality:** Green walls create an increase in plants and as a result, they are able to reduce the amount of pollutants in the air. Plants can naturally filter air and remove pollutants, therefore improving urban air quality in the process.

  (Green Over Grey, 2009)

Economic

These factors all have the potential to result in economic prosperity. However, these can vary from increasing the value of the property itself to increasing building exposure and potential increases in business as a result. Economic factors are consistently entwined with environmental and social factors, indicating the complexity and overlap of the three elements of sustainability.

- **Increase property value:** Green walls, when designed and maintained successfully, have the potential to improve the property value of the larger structures on which they are located. This can include certifications, such as LEED credits, that increase credibility and result in economic value.

  (Green Over Grey, 2009)

- **Reduce energy costs:** By creating space for natural elements on vertical surfaces, the plants are able to absorb heat and naturally cool the surface. This effect permeates the surface and facilitates lower interior temperatures as well. With this natural cooling, it decreases the necessity for manually cooling the building. This has the potential to accumulate and reduce the energy costs used to manage the building temperatures. Green

walls could potentially be viewed as an investment in temperature control, as opposed to air conditioning.

(Green Over Grey, 2009)

- **Attracts consumers and traffic:** The potential to attract consumers is a less apparent benefit of green walls. Depending on the green wall location, they can potentially be used as explicit or subliminal tools to attract the public. This can be used strategically for business that depend on pedestrian traffic for the prosperity of business.

  (Solterra, 2017)

Social

The following social benefits are much more challenging to quantify. These more qualitative factors do not result in definitively tangible results. However, they are imperative to issues of community contentment and identity.

- **Sense of place:** Green walls can be used as identifiable landmarks that facilitate increased public interaction. They can create unique spaces, especially in urban areas. Their vertical nature can allow for increased visibility compared to other landmarks.

  (Vujakovic, 2014)

- **Aesthetically-pleasing:** The incorporation of a variety of plant species in urban areas can incorporate unique aesthetic elements into public spaces. These unique and attention-grabbing features, when designed successfully, act as works of art that can provide intrigue to the spaces in which they are located. In order to deter attention from unappealing features, such as mechanical equipment, green walls can act as a shield in order to improve visual appeal.

  (Green roofs for Healthy Cities, 2008)

- **Community identity:** It is common for communities to identify with local landmarks and tangible spaces. This can include common gathering spaces or visible symbols that help the members identify with their larger communities.

  (Scuri, 2015)

- **Increased social interactions:** Green walls not only provide unique landmarks, but the fact that they consist of natural elements has an inherent draw for the public. This inclination for humans to be around natural elements, can attract people to centralized spaces and naturally facilitate an increase in social interactions.

  (Sheweka, 2011)

Evaluation Criteria:

The site evaluation criteria is informed by the research component of the methodology. It was done to prepare for conducting site visits and evaluations that are based on the foundational research. I utilized the Social Life definition of social sustainability that is stated as follows:

> "A process for creating sustainable, successful places that promote wellbeing, by understanding what people need from the places they live and work. Social Sustainability combines design of the physical realm with design of the social world – infrastructure to support social and cultural life, social amenities, and systems for citizen engagement and space for people and places to evolve."

In addition to this overall definition, Social Life also provides a design framework that addresses social sustainability. These four components can be seen here:

1. Amenities & Infrastructure
2. Social & Cultural Life
3. Voice & Influence
4. Space for Growth

Although these elements are generally applied to residential communities, they have the potential to be applied to other types of infrastructure. Using the research on social sustainability and green infrastructure, these four corresponding elements were developed in order to apply this framework to green walls.

These four elements are defined as follows:

1. Location & Sense of Place
   The location of each green wall should be strategic and successful in its ability to create a tangible and inviting space for the public to interact with. The space is aesthetically-pleasing and allows for social interactions to occur in the space.

2. Accessibility & Equity
   The green wall is equally accessible to the public and does not exclude marginalized groups from the space. The green wall provides a safe and calming space for all demographics.

3. Civic Engagement
   Public participation and input were sought out and consulted in the process of design, installation and maintenance of the feature. A goal of green walls should be community empowerment and reinforcing a unified community identity.

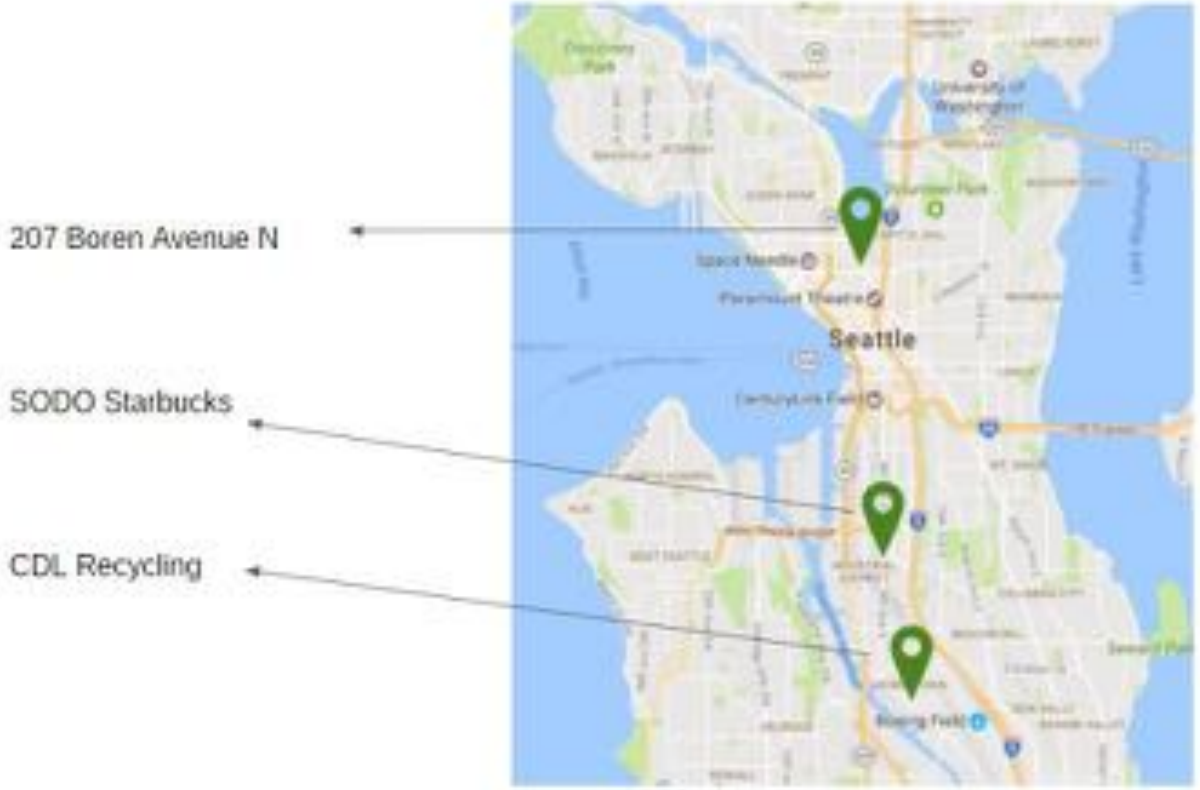
4. Intentionality & Maintenance

The green wall has been successfully maintained since installation. The decision to install a green wall is strategic and clear in its goals and ability to potentially expand in size and influence.

In order to evaluate the locations according to each of these four design elements, a Likert scale was used to provide an overall indication of performance for each factor. The scale can be seen as follows:

The scale is intentionally vague, due to the wide variety of ways that green walls can address elements of social sustainability. The Likert scale is just a brief indicator of performance and each element for the three locations possesses further explanation within the individual site evaluations.

The locations evaluated can be seen on the following map:



Site Evaluations:

- ***Site #1: SODO***

The first location was a Starbucks coffee shop in SODO. The street address is 4115 4th Ave S, Seattle, WA 98134. I found this location be looking at the website for GSKY (GSKY, 2008). This organization specializes in green wall installations and they have worked throughout the country. They have several walls in Seattle, but the Starbucks location is the only one that is an exterior wall that is accessible to the general public. Others are smaller in scale and can be found at locations such as the Bertschi School and several Microsoft buildings.

Location & Sense of Place - Adequate

The green wall located on the SODO coffee shop does an adequate job of creating a sense of place. It is located on an exterior, street-facing surface of the coffee shop. This helps the space stand out compared to the nearby brick buildings. However, this location is a missed opportunity at creating a more recreational space. The wall is most visible from the sidewalk or drive-thru lane. However, there is a patio with public seating on an adjacent surface. It seems as though the green wall is not located on the most ideal surface and therefore does not create the most inviting space available for the given location.

Accessibility & Equity - Good

The green wall is made equally accessible for the public. It is in an open and exposed space. Even though it is located on a privately-owned business establishment, it is visible from the sidewalk. Even though the space is not designed to allow for long durations of interacting with the green wall, it must be acknowledged that it is equally accessible for the public. Although, drive-thru customers do have slightly improved access to the features, compared to the rest of the public.

Civic Engagement - Poor

This green wall was privately-funded and did not take public participation into account at any point during the process of design, installation, and maintenance. It was installed by GSKY, a private company that specializes in green walls. However, it does not allow for active public participation and input.

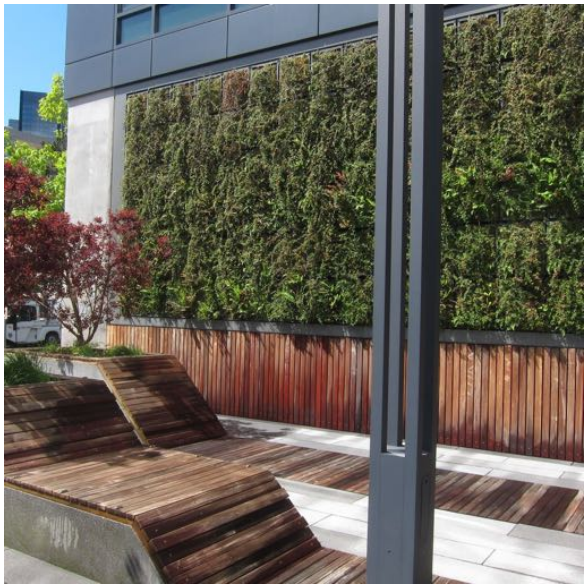
Intentionality & Maintenance - Poor

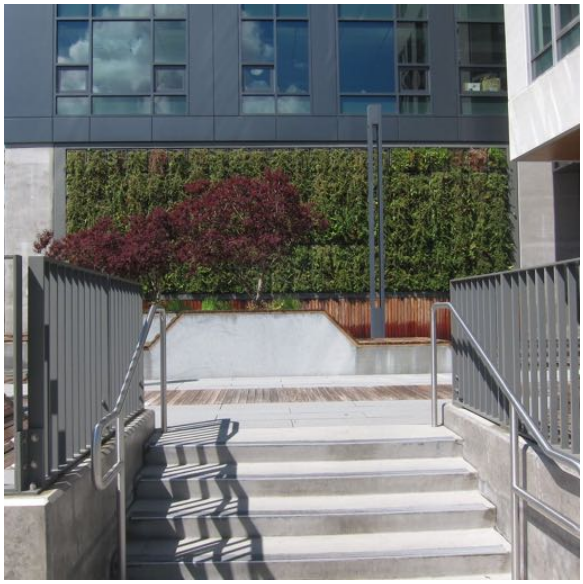
Although this green wall was installed by a professional company that specializes in these features, the wall has been very poorly-maintained. The plants have been replaced several times and are consistently left in poor condition. There is no plan for continual maintenance and the wall has been largely neglected since the plants initially failed to thrive. This inability for the wall to remain well-maintained has limited any considerations of potential expansion.

Site Conclusions:

Overall, this wall was most successful in its ability to remain equally-accessible for the general public, with the exception of improved accessibility for drive-thru customers at the coffee shop. This is due to the design and the fact that the wall is privately-owned and intended to allow the business to stand out amidst other business establishments. The wall does an adequate job of creating a welcoming space, but continual problems with a lack of consistent maintenance prevent this feature from providing the full extent of potential benefits of green walls, especially pertaining to the social element of sustainability.

- ***Site #2: South Lake Union***





The second location I visited was a green wall along a public seating area at an Amazon facility in South Lake Union. The street address is 201 Boren Ave N, Seattle, WA 98109. I had heard about efforts by Amazon to install sustainable and natural features within their South Lake Union campus. For example, they are currently working on a 'biosphere' in Seattle. It consists of enclosed domes that will include plant species from around the globe (Cassell, 2016). The existing green wall is much more modest feature, compared to the current biosphere project, and it has already been implemented and maintained for several years.

Location & Sense of Place – Successful

This location does a very successful job of creating an inviting public space. The wall is located in a small public plaza on a street corner at the ground floor of a commercial office building. The greater context of the green wall is that it is amidst Amazon buildings in South Lake Union. In its immediate proximity, the green wall provides an extension to the sidewalks and provides a significant amount of natural elements along a more traditional urban commercial building.

Accessibility & Equity - Good

The green wall is in a small plaza that is open to the public and fairly accessible. It is somewhat limited in size and seating, which potentially creates an unspoken hierarchy of who has greater claim to the space. For example, a restaurant is located adjacent to the wall and subtly asserts dominance over the space. However, the green wall plaza makes a fairly successful attempt to facilitate a smooth transition from the public sidewalk to the privately-owned plaza. The sidewalk smoothly transition into the plaza space and an informational sign is placed to indicate public access.

Civic Engagement – Poor

This green wall is privately-funded and although it has the luxury of extensive financial resources, it does not allow for public participation or input from community members. The private installation, although it is meant to create a welcoming and public space, did not and continues not to seek any input or participation from community members. It is a partially-altruistic feature, but it is a privately-prescribed landmark in the local community.

Intentionality & Maintenance - Successful

The Amazon facility has taken measures to successfully maintain the integrity of the green wall. They have been able to make use of private resources in order to maintain the aesthetic appeal of the space. Although, the plants have been replaced since their initial installation, they are continually tended to in order to ensure the visual and public appeal. Additionally, the wall is very intentional in its effort to create a unique and inviting space, in the urban area. This green wall is an example of the green infrastructure that Amazon is currently exploring.

Site Conclusions:

Ultimately, the Amazon facility green wall is an example of an aesthetically-appealing

installation that is very successful in its ability to create an inviting sense of place and an opportune location to reap potential benefits of green walls related to improving social interactions and improved moods and increased contentment. However, these benefits come at a high fiscal cost and as a result, other elements of sustainability have been neglected. A primary concern pertaining to social sustainability is the lack of civic engagement.

- ***Site #3: Georgetown***

The final location proved to be the most challenging, although it did highlight the important issue of consistent terminology. I visited what has been advertised by Seattle Weekly as 'The largest Green Wall in Seattle' (Bernard et al, 2016). However, this green wall would be referred to as a façade, opposed to a wall. It has been designed to allow plants to grow traditionally from the ground up, but there is framing for the plants to grow vertically along a fence-structure. Although this structure is technically a green façade, it has many things in common with more elaborate green walls. In fact, elements of this structure address aspects of social sustainability that the other sites do not.

This green wall was recently installed in the Georgetown neighborhood. It is located along East Marginal Way outside of the abandoned CDL Recycling facility (7201 E Marginal Way S, Seattle, WA 98108).

Location & Sense of Place – Poor

The Georgetown green wall is by far the least successful regarding its ability to create a tangible and inviting space. It is located on a heavily automobile-oriented road. The side of the road that hosts the wall contains a railroad track in the place of a sidewalk. The nearest point of

accessibility for pedestrians is a bus stop several hundred feet from the actual wall.

Accessibility & Equity - Good

Although the green wall is not very easily-accessible for the public, it addresses issues of equity in an exceptionally creative manner. The green wall is meant to highlight the close proximity of the community to the Duwamish River, which is a Superfund Site (Duwamish River Cleanup Coalition, 2016). The public attention and involvement resulting from this installation strives to highlight the greater issue of equity within the Georgetown neighborhood.

Civic Engagement - Successful

The Georgetown green wall was a wholeheartedly community-driven project Unique to the other locations, the Georgetown green wall is a publicly-initiated and funded project. It was designed by community members and installed by volunteers. It was created as an intentional installation to address the environmental damage near the closed recycling facility.

Intentionality & Maintenance – Good

The Georgetown green wall is an extremely calculated and intentional project. The Georgetown community used the green wall installation as an opportunity to encourage public participation, in order to remediate the area and educate the community on the importance of preserving the natural elements of the area. Additionally, the long-term purpose of this green wall is to make use of phytoremediation (using plants to naturally remove pollutants from soil), in order to reduce the negative public health concerns resulting from the pollutants. This location is an exceptional example of intentionality, it is difficult to gauge maintenance of the green wall, considering the fact that is has been installed in the past year. This feature consists of horizontally-originating plants, meaning that they require time to grow vertically and cover a vertical surface.

Site Conclusions:

The Georgetown green wall is a unique example of green infrastructure, compared to the other locations. Although the terminology has created some confusion regarding the nature of the feature, it is very successful according to several elements of social sustainability. It significantly lacks a tangible space that is inviting for the public and able to foster social interactions. Although it is lacking in this seemingly essential component of socially-sustainable infrastructure, it performs exceptionally well pertaining to other elements. The wall is a successful example of public participation and engagement. Additionally, its intentionality in addressing issues of equity and health concerns near a superfund site are highly commendable.

Survey Report:

The public survey was conducted at three existing green walls throughout the Seattle area. The purpose was for me to get some field experience and see existing green walls throughout the city. I designed my survey to get a better understanding of public awareness of green walls and how they can be used to benefits communities. I was curious about the public perception of green walls and their overall understanding of the term 'sustainability'.

While visiting the various green wall sites, I first took pictures and notes on my evaluation according to the criteria explained previously. Once that portion had been completed, I then conducted my survey. I had the survey response sheets printed and I approached small groups and individuals in close proximity to the green walls. The intent was to get an idea of public perception of green walls. However, I acknowledge that this survey is not a true random public survey. This is due to the fact that I was limited in my times of visitation and conduction of the survey. Additionally, it was not feasible to distribute the survey to a random sample of community members.

I visited each location on two separate occasions, all on weekday afternoons. This may have had a significant influence on the demographic information. Additionally I elected not to use open-ended questions in order to ensure maximum willingness to participate and minimize the amount of time it would take for individuals to complete the survey. After drafting my questions, a final six question survey was determined. The questions are split between demographic information and questions specific to green walls. [The survey can be found in Appendix II].

- *Survey Collection*

Location #1:

The SODO coffee shop location was fairly simple to collect survey responses. The green wall exterior is placed on the street-side of the Starbucks, lining part of the drive-thru. However, public seating is located on an adjacent wall facing the parking lot, and out of immediate proximity to the green wall. This made the survey process slightly more difficult, since some participants were not aware that the coffee shop had a green wall on the exterior. However, the fact that it was located at the well-known coffee shop facilitated frequent public visitation and a fairly leisurely atmosphere. I was able to collect seventeen survey responses intermittently over the two visits. A majority of responses were from individuals visiting the Starbucks and several from pedestrians using the sidewalk along 4th Ave.

Location #2:

The Amazon green wall location was different from the Starbucks due to the fact that the green wall was located in an open plaza with space for seating. This made the feature much more accessible for pedestrians and provided beneficial context. This made is much easier while conducting the survey to reference the visible wall within the plaza. Ultimately, eighteen survey

responses were collected at the public the plaza. Approximately half of the participants were customers at the restaurant (Thai Thani Kitchen) along the other wall of the plaza. The other half of responses were collected by individuals sitting in the plaza or walking along the bordering sidewalk. I considered that many of the respondents could work in the nearby office buildings and could therefore have very frequent interaction with the green wall.

Location #3:

The Georgetown location is along a heavily automobile-oriented road. As a result, there were very few pedestrians, making it difficult to collect survey responses. Ultimately, I was only able to collect six responses in close proximity to the green wall. I ended up collecting a majority of the responses at a gas station across the street. The area does not necessarily allow for certain social benefits, such as placemaking. This made it particularly challenging in the process of survey conduction, since community members were not likely to spend necessary durations of time at the location.

- *Survey Statistics*

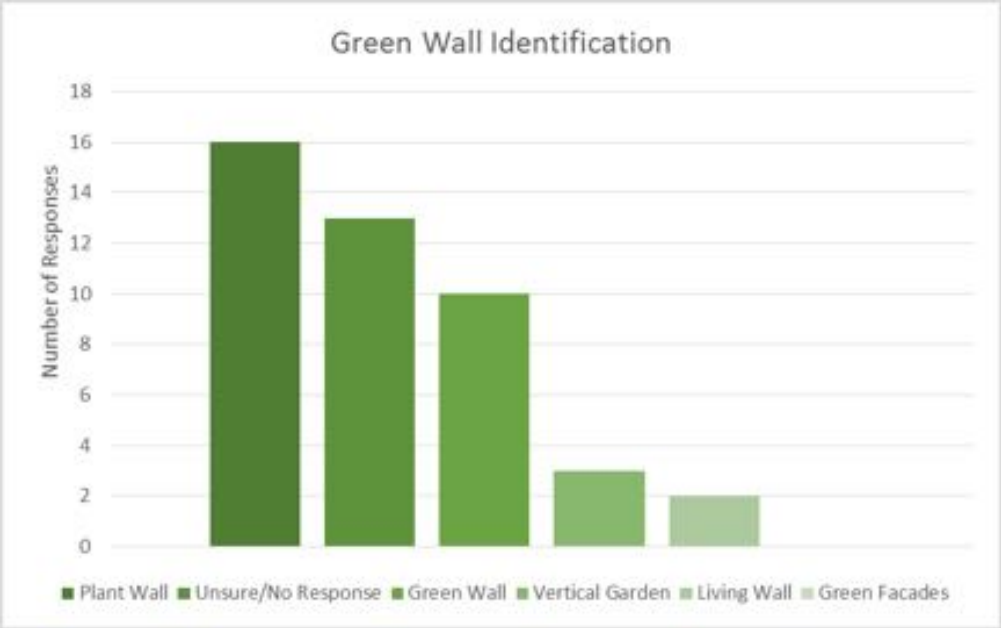
In addition to making personal observations about the green wall locations, I analyzed the survey data in order to identify interesting patterns and trends. Here is a brief explanation of my findings.

Through my research and the development of my survey, I came across the issue that green walls can be referenced by a variety of phrases. Prior to this project, I did not consider the extent to which these installations can vary. A distinction must be recognized between green walls and green facades. Not only was this applicable for me in my research, but it proved to be a pertinent topics when it came to conducting my survey. In addition to this distinction between two different types of infrastructure, it is imperative to note the other terms used to define these features. Green walls can also be referred to as living walls or vertical gardens. It is important that the public understands that there are multiple terms that could be referring to the same object. Additionally, it can be helpful in the process of going forward with green walls to know which terms are most commonly recognized by the general public.

Technically, green walls are features that are self-sufficient gardens that are attached to a vertical surface. Similarly, green facades feature vertical plant elements. However, facades have significant differences, “Green façades differ from green walls in that their vegetative layer is rooted in the ground and grows up. The plants use a vertical surface, such as a wall, for structural support but do not receive any moisture or nutrients from it.” (Green Over Grey, 2016). This showed up in the process of conducting my survey due to the fact that the Georgetown ‘green wall’ turned out to be a ‘façade’. This is proof that there is a lack of public knowledge on the nuances of these features and that is currently leading to some confusion, thus indicating a need for more successful outreach, education, and general awareness.

Additionally, one of my survey questions asked participants to state what term they would use to describe the local feature (Additional pictures of other green walls were provided for further clarification). Several terms were continually provided among the 41 responses. Figure 1 depicts the number of responses received for each phrase.

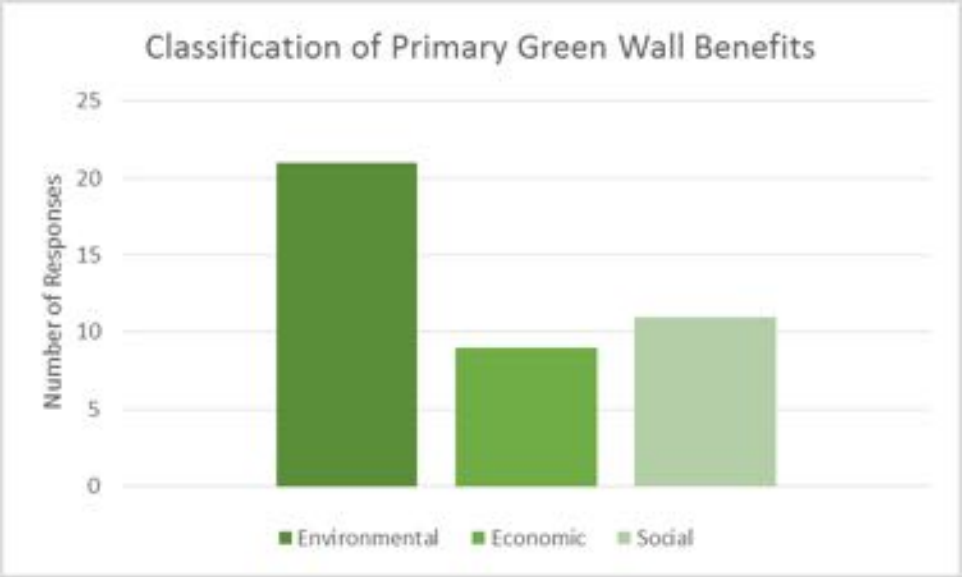
Figure 1:



Interestingly, the term with the highest frequency is not one of the traditional terms used to identify green walls. The phrase with the highest number of responses was 'Plant Wall', with sixteen occurrences. Although this term provides a very literal description of the features, it is not generally used in the professional realm. A significant portion of participants were hesitant to provide an answer and simply stated that they were unsure. The traditional term 'Green Wall' received ten responses, rounding out the top three phrases. Vertical Garden and Living Wall received 3 and 2 responses, respectively. Additionally, it was somewhat surprising that 'Green facades' did not receive any responses. This is fairly surprising considering the fact that green facades occur much more frequently than green walls. The frequency of several terms is a good indication that the academic and professional community makes use of different terms than are utilized by the general public.

An additional survey question addressed the Triple Bottom Line approach to sustainability. The question prompted participants to select which element (economic, environmental, or social) would be most relevant regarding the benefits of green walls. The results can be seen in Figure 2.

Figure 2:



Expectedly, environmental factors were most commonly selected as the primary category of benefits related to green walls. Environmental factors were cited by approximately half of the total participants. Economic and social factors received similar numbers of responses. It was not surprising that environmental factors received the most responses, considering the inherent connection to natural environmental elements.

The final component of the survey asked participants to select out of a list of benefits, which are applicable to green walls. Seven benefits were included in the list and these choices can be seen below:

Which of the following do you think are characteristics of green walls?

Aesthetically-pleasing
Reduce stress
Increase productivity
Reduce Pollution
Increase biodiversity
Reduce energy costs (electricity, gas)
Improve Property Value

These benefits can each be attributed to at least one facet of sustainability. Social factors include aesthetically-pleasing, reduce stress, and increase productivity. Environmental factors include reducing pollution and increasing biodiversity. Finally, economic factors are energy saving and increase in property value.

After conducting the survey, I compiled the frequency of each individual benefit. Two of them notably stood out with higher frequencies than the others. Aesthetically-pleasing and increase in biodiversity were commonly-understood to be positive attributes of green walls, receiving 29 and 33 responses, respectively. Stress reduction, pollution reduction, and improved property value received between 23 and 10 responses each. The factors that received the least recognition were increasing productivity and energy savings. These both received less than 10 responses. While conducting the survey it seemed apparent that participants had not previously considered the variety of green wall benefits in much detail. Many participants seemed somewhat skeptical that these green walls could have very significant impacts on factors such as pollution or energy savings.

After analyzing the frequency of each individual benefit, I grouped them according to their facet of sustainability (environmental, economic, and social). Expectedly, environmental factors received the most recognition. This corresponds with the previous question that asked participants to categorize the primary benefits of green walls. Social factors received a lower amount of recognition, but the high frequency of 'aesthetically-pleasing' greatly increased the occurrences. Economic factors clearly received the least amount of recognition. Interestingly, several participants indicated their skepticism that green walls could provide economic benefits, considering the costs of maintenance.

- *Summary and Significance*

Overall, these results indicate that the general public primarily associates green walls with environmental benefits. This is not particularly surprising but it does provide some evidence that there can be improvements in outreach and education regarding green walls.

It also exemplifies some of the confusion regarding the concept of 'sustainability'. The term currently has a significant association with strictly environmental factors, especially by the general public. Sustainability is a complex concept and according to the data from this particular survey, the public is most aware of the environmental aspect, more than the social and economic factors.

Reflecting upon the methodology of this survey, I recognize that several factors may have influenced the results. This is by no means an exhaustive process, but it allowed me to conduct some field work and get evidence for public perceptions. I was able to collect 41 responses so that sample is somewhat limited in size. Additionally, I only distributed to survey to individuals within close proximity to green walls. This was helpful in providing some context, but it is not necessarily a random sample of participants. Furthermore, my time was limited and I was only able to visit these sites in the afternoon.

In addition to this survey process, I think that the weather may have had an impact on the quality and quantity of my responses. I conducted the survey in March and April 2017. I intentionally selected days in which it was not raining, so there would be more people outside an

in close proximity to the green walls. However, I could not control the temperature and I think that this survey could be more successful in more ideal weather conditions or at a generally warmer time of year. Related to weather, I think that the current status and maintenance of the plants potentially impacted the results. For example, the Georgetown green wall had been fairly recently installed and participants did not necessarily consider potential future benefits, if the plants are maintained.

Overall, this survey provided some valuable insights and allowed me to observe how the public understands and interacts with green walls. This process has convinced me that there is a need to educate the public on green walls and the complex topic of sustainability in general.

Conclusions & Recommendations:

My methodology has led to several conclusions. My research has reinforced the concept that the social element of sustainability has received less attention compared to environmental and economic factors. Additionally, there is a lack of a clear and uniform definition of the term. Analysis and evaluation of social sustainability can be applied to a variety of situations. In my report, I have applied the concept to the design of infrastructure, specifically green walls. This reinforced the idea that social sustainability is a very complex and broad term that may be addresses in a variety of ways.

The definitions I chose to use as the basis of my evaluations were provided by Social Life. Even their simplified definition includes four different elements of social sustainability (amenities & infrastructure, social & cultural life, voice & influence, and space for growth). Compared to environmental and economic indicators, these social factors are difficult to quantify and require extensive qualitative analysis and broad considerations. Another challenge in differentiating the components of sustainability is that there is significant overlap between them. For example, in order to take advantage of several potential social benefits, such as creating an aesthetically-pleasing space, extensive economic resources are required. It seems that social sustainability is often the least-prioritized element, partially due to its complicated and poorly-understood nature.

I have determined that green walls do have potential to provide natural elements in dense urban areas. However, this requires extensive economic resources in order to remain visually-appealing. Green walls require extensive upfront costs, and continual maintenance throughout their existence. These are high-risk features that must be continually tended to, in order to ensure their long-term success. Other elements of social sustainability can be addressed with less economic resources. However, these are more specific to community engagement and the potential to address issues related to equity. This exemplifies the differences between public and privately-funded green walls.

Privately-owned walls are often more aesthetically-appealing but they have much higher costs and their primary concerns are with increasing traffic and drawing the public to strategic locations. Public green walls generally have fewer resources and are less elaborate in design. However, they provide more engaging opportunities for community members.

Green walls have the potential to provide an extensive array of benefits. In order to ensure their success, it is imperative that several factors are considered. The following recommendations are intended to inform individuals about the potential to make green walls successful.

As noted from research and site visits, it is important to remain informed on correct terminology, specifically between green walls and green facades. These features are somewhat similar, but they have critical differences regarding costs and maintenance. It is critical to consider the differences between the two and to select the one which would be most successful for each particular locations.

If horizontal space is available, green facades can potentially assist with phytoremediation or reducing storm water runoff. However, these features do require more horizontal space and time to grow naturally along vertical surfaces, as evidenced by the Georgetown green wall. On the other hand, green walls allow for upfront aesthetic appeal, but they have much higher costs and require more effort to manually maintain successfully. These factors related to costs, time, and potential maintenance issues are critical when considering a green wall (or façade) installation.

Once the type of installation has been specified, it is important to evaluate the proposed location. Accessibility and ease of access are critical. This applies to both public interaction and maintenance. Ideally, the process would include some form of public outreach, especially if the proposed location is in a public space. The context will vary between locations, intentions, and sources of funding. The case studies selected provided examples of varying resources.

Based on my studies, if the goal is to create an accessible and public space by creating an aesthetically-appealing piece of infrastructure, it requires extensive funding. This tends to require private funding and al altruistic commitment to creating a public feature. This is not a common occurrence, especially in Seattle. Through researching possible locations to evaluate, it was revealed that a majority of aesthetic green walls are privately funded and frequently located in private spaces that are not accessible for entire communities. Green walls that are publicly-funded often lack the resources to ensure the consistent visual appeal of green walls. They are often unable to adapt when issues arise related to maintenance and result in unexpected costs.

In summary, it is imperative to acknowledge the attention and resources required to ensure that green walls can be successful. These features result in high upfront costs which could potentially continue throughout the duration of their existence. Some benefits can be achieved upfront, such as aesthetic appeal. However, others take time such as reducing energy costs by

helping to naturally lower interior temperatures inside the buildings that host the green walls. A holistic picture must be considered and the various potential benefits must generally be prioritized.

The ability for them to prove to be socially sustainable rely heavily on the economic resources available. This has reinforced the concept that the three elements of sustainability cannot be easily differentiated or exist in isolation of one another. Green walls have extensive potential benefits, but the process of achieving those can be difficult, especially in the pursuit of simultaneously addressing social, economic, and environmental concerns.

Analysis & Reflection:

The process of completing this project required continual adaption and reconsideration. The open-ended nature of structuring a senior project was somewhat intimidating to create. I knew that I wanted to explore one element related to the intersection between the built and natural environments. I selected green walls because I knew that these features were exceptionally complicated and challenging, but have been continually explored throughout the world in order to incorporate natural elements in less traditional places.

Reflecting upon my project choice, I think that it would have been helpful to have slightly more pre-existing knowledge on the complexity and status of green walls, especially in Seattle. I did not know much about green walls specifically and I wish I had been able to produce more innovative results. A big portion of my project consisted of learning more and getting a better understanding of their current status. I wish I had more pre-existing knowledge in order to add more.

Early in the process, I was unsure what direction the project would take. I was trying to learn as much as possible through my literature review and additional research, but I was hesitant to definitively determine what form my product would take. It was sometimes frustrating, but it felt like a more realistic project, compared to others I have completed at the University of Washington. I feel as though I learned most from the process and the necessity to determine methodology and compile a cohesive product. It felt like a helpful transition from undergraduate academics and being told what to do or how to complete an assignment. This project was reinforcement that when I am no longer in school, there will be more ambiguity and necessity to take initiative and determine a course of action. The ambiguity of the project was at time frustrating, but it was a helpful process and transition from the comfort of clearly-defined expectations to a more open-ended process that requires initiative and intentionality.

Reflecting on my methodology, I wish that I had been able to determine a more cohesive vision for my final product earlier on in the process. It felt as though I was sometimes unsure of the direction I would take my project. I struggled to feel confident enough in the amount of

research I conducted and my knowledge of the content in order to definitively determine my final results and recommendations. I found that research elements, such as getting a thorough understanding of the term 'social sustainability', proved to be much more challenging than expected. I wanted to expose myself to a wide range of sources, but that made the process of compilation and analysis more challenging.

I am proud of the fact that I conducted a public survey. I think that provided me with valuable experience and forced me to explore outside of my general comfort zone. Reflecting back several years, I would not have anticipated that I would be able to create and administer a survey to the public. However, I wanted to push myself and I felt more confident after working in outreach within the last year with organizations outside of school.

There are some elements, especially pertaining to my site evaluations and survey that were not necessarily ideal. For example, when it came to selecting my case studies, I expected that there would be more existing green walls to visit. However, I found it difficult to find examples that were accessible. Seattle is a leader in sustainability and I assumed that I would not have such a challenge identifying locations to evaluate. However, it seems as though green walls are not yet as frequent in Seattle as I would have anticipated. I think that this reinforced my findings that public and equitable green walls are exceptionally challenge to bring to fruition.

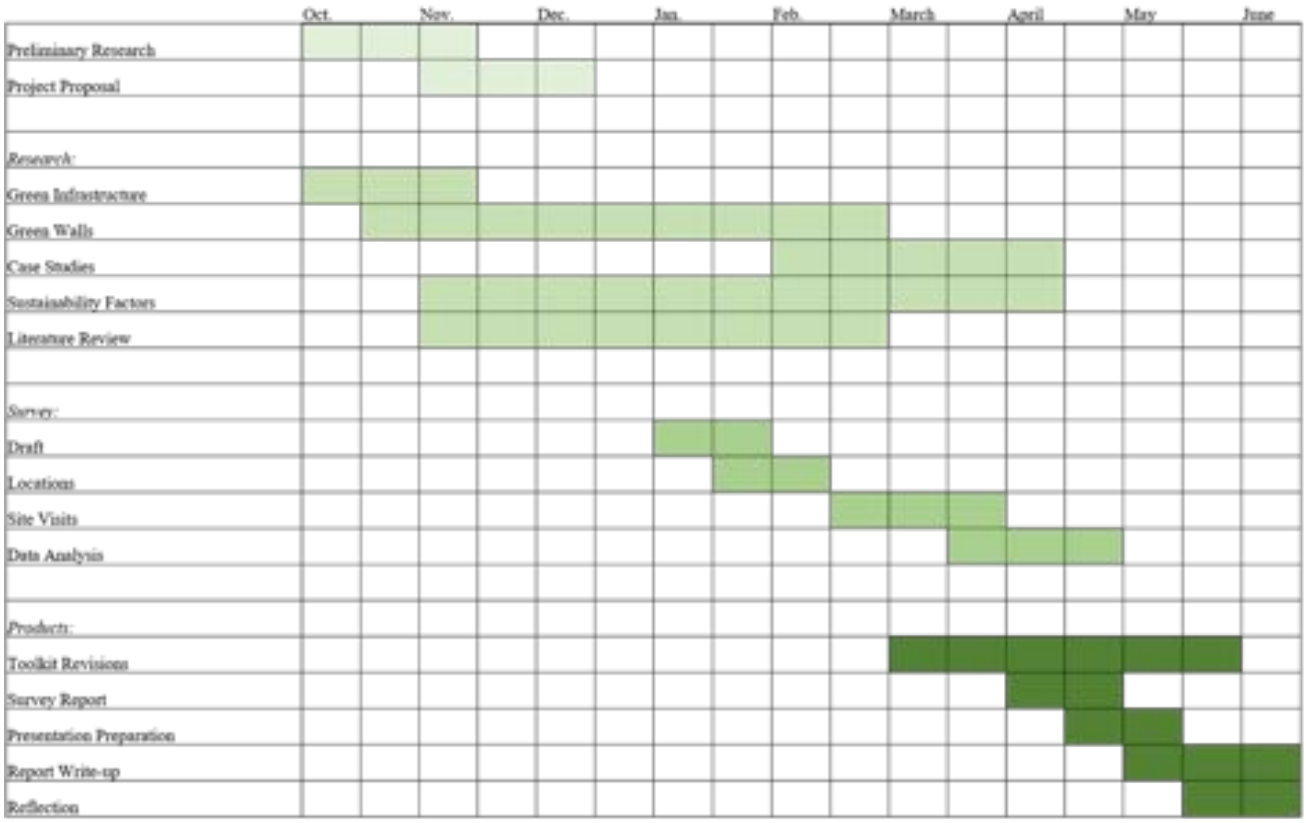
Regarding my survey, there were several caveats. Although I do not think I necessarily would have changed my methodology and process, I think it is important that they are acknowledged. For example, the intent was to gain some insight on public knowledge and perception of green walls. The participants were not selected randomly, since they were located in fairly close proximity to the three locations I was able to visit. In addition to location, the time and dates in which I conducted my survey had some patterns and limitations. Ideally, I would have been able to visit at a variety of times, but due to scheduling and collecting maximum responses, it was distributed on weekday afternoons in March and April. When considering the time limitations, it is also important to consider that fact that weather and time of year may have influenced the number of responses. I would expect that it would be easier to collect responses with warm and sunny weather. However, I was somewhat limited due to the timeline and progression of my project.

This process has reinforced the idea that time management is critical, especially in a project that has extended throughout the whole academic year. I found that the overall concept was daunting, but it was helpful to break it down into smaller individual tasks. It was a unique experience to attempt to estimate how much time it would take not only to complete my methodology, but also to specify exactly what my process would be. I think I underestimated the time necessary to determine what the next steps would be and how to approach the project.

Overall, I think that this project provided some valuable experiences, in addition to some challenges. I feel as though I challenged myself especially through the addition of a survey component. I also feel as though I have a greater understanding of the process of determining the scope and process of completing a project that is open-ended and lacks much external direction.

Although at time it felt frustrating and unclear, looking back on the process I can easily see the value in creating and completing an academic project independently. I now feel as though I have a more realistic grasp of the type of work that I plan to contribute to in my professional career.

Appendix I: Timeline



Appendix II: Survey

Survey Questions:

Part 1: Demographic Information

1. What is your gender?
   Male Female Other

2. What is your age?
   Under 18 18 – 25 25 – 35 35 – 45 45 – 55 56+

3. What is your education level?
   - High School or Below
   - Some college
   - Bachelor Degree
   - Master Degree
   - PhD or Above

Part 2:

4. What phrase would you use to identify this type of infrastructure?
   (See back of page for pictures)

5. Would you categorize the benefits as primarily economic, environmental, or social?
   - Economic
   - Environmental
   - Social

6. Which of the following do you think are characteristics of green walls?
   - Aesthetically-pleasing
   - Reduce stress
   - Increase productivity
   - Reduce Pollution
   - Increase biodiversity
   - Save energy (electricity, gas)
   - Improve Property Value

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