What is Green Infrastructure?

Green infrastructure is an approach to water management that protects, restores, or mimics the natural water cycle. Green infrastructure is effective, economical, and enhances community safety and quality of life. It means planting trees and restoring wetlands, rather than building a costly new water treatment plant. Green infrastructure incorporates both the natural environment and engineered systems to provide clean water, conserve ecosystem values and functions, and provide a wide array of benefits to people and wildlife. Green infrastructure can be beneficial for many kinds of communities, even those located in cities like Philadelphia such as Overbrook.

The purpose of this project was to present the benefits of green infrastructure to the community of Overbrook, gage their opinion on whether or not they wanted green infrastructure in their community, find out what kinds of green infrastructure they wanted, and then provide a recommendation to Overbrook based on that information.

I. Executive Summary

The first week of our project was spent learning about what obstacles the city of Philadelphia and the Water Department were facing with the traditional gray water systems in place. During this time, we also started to research different types of green infrastructure and learn more about how they work, what they do and how they fit into an old city like Philadelphia. From there, we learned more about the tasks that the Overbrook Arts and Education Center would like us to fulfill. We were charged with both presenting types of Green Infrastructure to the community and creating ways to learn what types of Green Infrastructure the community would want. We also engaged the community to find out what areas we should know about as far as problem areas and what they thought we were missing in our work. The types of Green Infrastructure that the Water Department wants implemented in it's goal to transition Philadelphia to 100%GI are a mixture of simple and complicated. The simpler types are water collection, planter boxes, and rain gardens. What could be described as more difficult types of GI are things like permeable pavements and interlocking pavers, street trees and bioswales. Many of these types of GI can be combined to create green streets and green parking lots, or create urban canopy.

In section II. of this report, "Green Infrastructure Types and Benefits," we provided detailed explanations for each type of GI mentioned above. The information gathered for this section of the report was obtained from thoroughly written peer reviewed sources. This section also includes a matrix table of 0's and 1's to show which

types of GI's have which benefits. If there is a 1 listed for a certain benefit under a specific GI, the GI has that benefit, if there is a 0 listed it does not.

In section III. "Community Input," we used information from peer reviewed sources to discuss the significance of getting the community involved when it comes to planning projects within a neighborhood. At the end of the day it is their homes, and they deserve a say on the type of environment they live in. We also provided information on the different types of methods planners can be used to get the community involved.

In section IV. "Application Design for Community Input," we designed an ideal app that could be used to get the community members involved in the planning process. Because we did not have the technology to create an actual app, we designed what we would want it to look like on Microsoft Powerpoint. The app is basically a survey asking community members to vote on a scale of 1-5 how important each GI benefit is to them. At the end of the survey it tells the participant which type of GI they would most likely prefer in their community, based on how they rated the importance of each benefit.

In section V. "Recommendations for Overbrook," we provided recommendations, based on our research, and the results of the voting during the Overbrook community meeting, suggesting which types of GI's would be best for the Overbrook community. We described the process of the voting system that took place at the community meeting, along with tables and a picture from the meeting displaying the results.

II. Green Infrastructure Types and Benefits

Green Infrastructure can be defined as a framework used to evaluate, design and implement environmentally and economically conscious approaches for promoting urban sustainability. Green stormwater infrastructure is a type of GI that aims to mitigate the effects of excessive flooding, water erosion and polluted runoff that enters municipal waterways and watersheds. Green stormwater management often takes the form of bioswales, rain gardens, tree canopies, at home rain collection systems and more, most of which can be utilized at any scale of implementation. Most stormwater infrastructure can be fitted to serve the residential, commercial and institutional sectors of urban areas (Chini, 2017). This means all land use types including individual households, local businesses and even massive educational or municipal properties have potential to relieve the footprint of their own impervious surfaces while benefiting the community and environment. All green stormwater infrastructure is versatile and serves a range of community purposes. This is why many planners prefer GI over various types of grey

infrastructure methods. GI is a more passive approach towards stormwater management in that it allows natural biotic cycles to mitigate issues that surround urban environments opposed to combating urban issues with additional urbanization. Green infrastructure, in most cases, establishes the same stormwater management outcomes as grey infrastructure, often with reduced costs while also simultaneously aiding in the restoration and expansion of natural ecosystems and sustainability. Common benefits shared between GI types include but are not limited to; reduced flooding and flow rate, groundwater recharge, water filtration and treatment and increased aesthetics as well as a myriad of other ways in which water systems are conserved and protected whereas grey infrastructure serves more singular purposes.

Planter boxes are a form of green infrastructure that acts as a simple way to aid in stormwater management while serving a diverse range of purposes. Planter boxes, or stormwater planters, are closed structures filled with plants that utilize bioretention to filter and streat stormwater through soils, root systems and mulches. The newly treated stormwater is then typically absorbed as groundwater whether it is a flow through planter box or an infiltration planter box. Planter boxes may be constructed on nearly all impervious surfaces which is why they are so often used in highly urbanized areas. There are three types of planter boxes that vary in design and purpose. The flow-through planter box directs flow off to the side of the box so it can be implemented directly next to buildings as long as there is a discharge channel for the water to go through like a sewer grate. The infiltration planter box is constructed on top of green spaces so the newly filtered stormwater can be directly absorbed into soil as groundwater. The contained planter box can be implemented virtually anywhere because it is a closed system and all the water is absorbed into the vegetation and soils instead of being redistributed elsewhere. Contained planter boxes can be hung outside windows and along walls but being that there is no additional storage for flooding waters, it should not be placed along the foundation of buildings or above pedestrian walkways (Planter Boxes, 2016). All three variations of planter boxes can be strategically sized and shaped to fit any area. The benefits of this type of green infrastructure include providing a natural way to filter and treat stormwater by removing pollutants while also reducing the flow rate. Planter boxes are arguably the most aesthetic form of green infrastructure being that they are not limited to being filled only by certain species of vegetation. Research collected by an environmental organization called 3 Rivers Wet Weather, a group that assists the city of Pittsburg as well as 80+ Allegheny municipalities in tackling their stormwater overflow problems, identified six main pollutants that planter boxes effectively remove from runoff (Planter Box, 2017). Planter boxes filter bacteria, oils, greases, heavy metals, trash and organics like nitrogen and phosphorus from runoff that would otherwise be introduced into water

systems from elevated impervious surfaces like rooftops and gutters (Stormwater Planters, (n.d.)).

Another type of green infrastructure includes rain barrels and cisterns, a form of at home water collection that can be implemented virtually anywhere and adjusted to scale. A rain barrel is a water storage tank that collects stormwater, typically through a system of gutters, channels or pipes. A cistern is a significantly larger rain barrel with a greater storage capacity and is most often used on an industrial or commercial level. The general purpose of rain barrels and cisterns is to collect rainwater runoff from buildings or impervious surfaces and store it for future use (Widjojo, 2018). The water collected can be used for almost all household water needs from filling pools or fountains, watering gardens, bathing pets, etc. This type of green infrastructure also reduces the volume of runoff while alleviating a significant portion of one's at home water needs. In doing so, the owner of rain barrels or cisterns become self-sustaining in their water demand and have a sufficient supply of water in times of crisis making it unnecessary to rely on commercial vendors. After the initial startup and installation costs, rain barrels require little maintenance and allow access to relatively clean rainwater, a free and limitless resource. In growing urban areas especially, rain barrels and cisterns help sustain the balance between supply and demand. This type of green infrastructure alleviates the extraction pressure we put on our dwindling groundwater supply by instead, utilizing surface water (Rahman, 2014). Rain barrels and cisterns also help mitigate issues of flooding and nonpoint pollutants in nearby bodies of water caused by runoff. The simple technologies of rain barrels and cisterns make this form of stormwater management applicable to most households, schools and businesses while providing a combination of economic and environmental benefits.

Rain gardens consist of deeply rooted native vegetation, planted in shallow landscaped depressions that are strategically located in areas surrounded by impervious surfaces for the purpose of capturing stormwater runoff. Rain gardens hold the broad appeal of mitigating the water footprints of buildings, infrastructure and other impervious surfaces that otherwise collectively increase flooding in urban areas (Rain Garden Fact Sheet (n.d.)). Through natural cycles and bioretention, rain gardens promote benefits including stormwater mitigation, groundwater recharge, reduce flooding, water pollution and more. Microbial activity, nutrient uptake and infiltration occurs in the root zone. Root systems of plants in rain gardens utilize pollutants like nitrogen and phosphorus for growth, filtering these nutrients and acting as soil stabilizers which in turn, helps detoxify runoff before it reaches nearby bodies of water. Storm water collected in a rain garden depression gives the water time to percolate through natural processes, resulting in ground water recharge. This process occurs in the top layer, the ponding zone, where pollutants in the water have time to settle and

organic matter to accumulate. Not only do the native flowers, shrubs and grasses in rain gardens enhance aesthetics of nature and greenspace in heavily developed areas, but they also introduce and expand bird, butterfly and natural pollinator habitats (Yuan, 2018). This introduces beneficial insects that in turn, eliminate pests like mosquitos (McManus, 2020). Depending on the design and location, rain gardens are a relatively low maintenance form of green infrastructure that may be applied in multiple levels of scale, (residential, commercial, institutional) given the flexibility in construction factors like size and shape. As in any region, rain gardens work best when filled with native plant species. This is because native species are more accustomed and durable to seasonal weather changes as well as spread quicker to open space which reduces the cost of planting. According to the Stroud Water Research Center, in Pennsylvania, the best rain gardens are planted with species including but not limited to; *Amelanchier leavis, Pennstemon digitalis, Panicm virgatum, Osmunda claytoniana, etc* (Stroud Water Research Center, 2020).

Bioswales are another common application of Green Infrastructure.Bioswales are vegetated ditches with sloped sides, which allow for the collection, conveyance, filtration and infiltration of stormwater. They go by many other names too, such as "grass swales," "vegetated swales," or "filter strips". This form of green stormwater infrastructure captures the stormwater runoff and holds it until the vegetation, aggregates and soil can filter the water (Kondo et al,2016). It also serves as a holding point so that stormwater runoff does not overwhelm drains and sewer treatment plants. In Urban areas, runoff may contain high levels of pesticides, metals, nutrients, suspended solids and hydrocarbons (Anderson et al., 2016). Research has established that bioswales are effective at slowing and filtering urban runoff of these contaminants (Anderson, B.S. et al, 2016). One study conducted by the University of California, Davis campus, found that bioswales could reduce total suspended solids between 29%-100%, metal concentration was reduced by 85%-98%, and of the single sample bioswale that was found to contain pesticides, 100% reduction was obtained (Anderson et al, 2016). The removal of these pollutants is important to fish and marine life that are living in the watersheds that our runoff will eventually reach. Bioswales are also used alongside other types of green infrastructure where Low Impact Development (LID) is encouraged (Anderson et al, 2016). Low impact development is a new strategy of stormwater management that attempts to maintain or restore the natural hydrologic functions of watersheds by using features like bioswales that greatly reduce the rate of runoff, filter any pollutants, and allow for greater groundwater infiltration (Anderson et al, 2016). One of the many benefits of bioswales is the reduction in flooding. The cost of bioswales can vary greatly depending on the cost of the land, the cost of the aggregates, soils and plants used, but this cost would likely be less than the current costs of maintaining outdated sewer systems. The addition of more plants and tall

grasses in the city will also create habitat for creatures like frogs, squirrels and birds. The plants will also improve air quality and reduce temperatures. Vegetation (especially trees) clean the air through taking dry particles onto their leaves (dry deposition) and they also absorb gaseous pollutants through their stomata (Kumar et al, 2019). Trees especially provide shade and create a cooling effect, but any plant species will provide some cooling as it conducts the natural process of evapotranspiration (Kumar et al, 2019).

Trees are used heavily in green infrastructure. They are used in combination with bioswales or smaller versions of bioswales, called bioretention basins and porous pavement to create green streets and green parking lots. When we discuss trees in an urban setting, often we are talking about street trees or urban canopy. As with all other forms of green infrastructure, the way that the street trees are planted and what species they are matter quite a bit. Choosing a street tree that does not grow very tall will not cool the air as much as a tall tree with thick foliage. Adding trees that flower can create issues for residents that experience asthma or seasonal allergies and may also be a mess for the streets department to clean up when the flowers drop from the tree. Choosing a native species is also important because it will tolerate the soil and weather conditions of the area better than a non-native tree. Native trees also provide habitat to a much wider species of birds and bugs than non-natives species can. When street trees are proposed, many people raise concerns over their root systems tearing up existing sidewalks and creating tripping hazards. The Philadelphia water department would like to have street trees planted in stormwater tree trenches to avoid root systems doing damage to sidewalks. More trees will reduce flooding and help clean the air. In New York City, street trees annually contribute an estimated total benefit of $122 million, which includes mitigating 900 million gallons of stormwater (1500 gal per tree) through absorption and removing 2200 tons of air pollutants (Laia & Kontokosta, 2019). A study conducted in Australia on the efficiency of certain tree species in removing pollutants from stormwater found that all experimental models reported 83%-86% load removal of total suspended solids, which included ammonia, metals and phosphorus (Barron et al, 2018). Another added benefit of street trees is their creation of habitat. Trees, especially mature ones, perform a keystone role in terrestrial ecosystems and are critically important in urban areas, as they provide food and habitat for birds, invertebrates, mammals, and plants (Turner & Cavender,2019). Studies show that mature trees incorporated into the built environment can reduce a city's temperature by 9°C (Turner & Cavender,2019). The U.S. Department of Agriculture claims that," the net cooling effect of a young, healthy tree is equivalent to ten room-size air conditioners operating 20 hours a day" (arborday.org,2020). This cooling effect can lower the incidence of heat related illnesses, especially on elderly and medically complex populations. Trees can also add beauty to a city and increase property values. Dr.

Kathleen Wolf from the University of Washington wrote that Having large trees in yards along streets increases a home's value from 3 percent to 15 percent. How the City of Philadelphia would like to implement the use of street trees is unique. The city along with the water department would like to plant street trees in a series with a deep trench underneath that contains a pipe that pulls water from the storm grate in the street to the trench underneath the trees, releasing water which will be taken up by the tree roots and any excess water will be routed to an existing sewer system(Philly Watersheds.Org,2018).This method will increase the amount of sequestered rainwater and keep the roots of the street trees from tearing up sidewalks.

There is one last type of infrastructure that combined with bioswales and street trees, can make a huge difference in an urban area. Pervious or porous pavement can be used in place of both concrete and asphalt. It allows stormwater runoff to absorb through it by having tiny pores that allow the water to flow through. Like all other forms of green infrastructure, the way that it is implemented is very important to performance. This sort of pavement requires several layers of aggregate and stone underneath it to help filter through the stormwater. There are also interlocking pavers that can be used to create a porous surface. These are better suited for streets or alleyways where the speed limit is slower, because they can create a bumpy ride in a car. An advantage of their use could be to slow down traffic in a school or church zone. Another advantage of the interlocking pavers is that they can be easily replaced if they are damaged, without having to replace a large area. The U.S. Department of Transportation points out that pavers are capable of being repaired in winter, which is a limitation for asphalt. Like the two kinds of green infrastructure listed above, permeable pavement stops flooding. It does this by stopping the stormwater from pooling and flowing away (University of Maryland,2016). Water flows faster on slick surfaces like roads, making major storm events dangerous for drivers. Depending on the design, material, soil and amount of rainfall, permeable pavement may be able to filter as much as 70%-80% of annual rainfall (University of Maryland,2016). This type of pavement and pavers also improve water quality by removing pollutants like phosphorus, nitrogen, zinc, motor oil leaked from cars and metals (University of Maryland,2016). Permeable pavements also mitigate the urban heat island effect. The EPA explains that, "Moisture within the pavement structure evaporates as the surface heats, thus drawing heat out of the pavement, similar to evaporative cooling from vegetated land cover." (EPA.gov, 2015). These forms of green infrastructure can make great environmental improvements on their own but combining all three to create green streets and alleyways can make a neighborhood more welcoming and help the environment at the same time.

Figure 1a.

Green Infrastructure Type	Green Streets and Alleyways	Green Parking Lots	Rain Garden	Bioswales	Planter Boxes	Urban Tree Canopy	Rain Barrels	Permeable Pavement/Interlocking Pavers
Reduced Flooding	1	1	1	1	0	1	1	1
Improved Water Quality	1	1	1	1	1	1	0	1
Expanded/Restored Habitat	0	1	1	1	0	1	0	0
Increased Air Quality	0	1	1	1	0	1	0	0
Decreased Air Temperature	0	1	1	1	0	1	0	1
Aesthetics	1	1	1	1	1	1	0	1
Enhanced Socialization	1	1	0	0	1	1	0	0
Recreation/Community Use	1	0	1	0	1	0	0	0
Job Creation	1	1	1	1	1	1	1	1
Low Maintenance Cost	0	0	1	0	1	0	1	1

Increased Property Values	**1**	**1**	**1**	**0**	**0**	**1**	**0**	**0**

0 = Does Not Benefit
1 = Does Benefit

Figure 1a. is a matrix showing which forms of GI provide which benefits. It is important to note that each type of GI is assigned to a benefit category using a 1 or 0, 1 meaning the GI type results in the benefit, 0 meaning the GI type does not result in the benefit. This method of assigning benefits to GI types was chosen because the location, design and implementation of various forms of GI is unique to an area and community need. Because of this, the benefits a type of GI produces cannot be ranked or compared to another.

2- Traditionally cities have used what is commonly referred to as “grey infrastructure” to clean and filter stormwater and runoff. These systems usually employ sewage treatment plants that may only accommodate so much storm water at a time. As our environment changes, there is a movement toward implementing what is known as green infrastructure. Green infrastructure uses vegetation and soil to combat excess water immediately instead of letting it flow to a different location(2018;Sakar,et al.).

III. **Community Input**

Any proposed project, whether it’s a form of green infrastructure, a new business, a new housing development or even just an extension of an already existing structure, will generally garner various reactions from members of the community that the project is set in. Planners, even to this day, still debate the significance of public participation in the planning process, with some arguing that citizen involvement can inhibit the planning process as a whole and that the public lacks expertise and misunderstands science (Armeni, 2016). However, it is extremely important to have community involvement in the planning process, especially when it comes to achieving both environmental and procedural justice. Procedural justice refers to the people’s concerns about the fairness of decision making procedures used to determine outcomes, and it is a concept that most modern-day planners have been trying to strive for (Gilland,Steiner, Skarlicki, 2001). This section, with the use of several peer reviewed sources, will cover the reasons why it is important to have input from the community during the planning process as well as go over the methods that planners can use to gain input from community members and achieve procedural justice.

It's always important for planners to remember that it is the people living within a community that will be most impacted by a plan/project. They are the ones that are going to have to deal with both the potential positive and negative effects of a plan, be it; Enjoying the benefits of a more environmentally friendly community with better access to jobs, schools and other public utilities, or the problems of having to deal with a community with high traffic volumes, noise and air pollution, and sub-par access to public utilities. In order to create a plan that better serves a community, planners require information on the community's needs and inner-workings. If planners or the local government were to keep community members out of the planning process, it would, as Salkin and Levine (2016) put it, obscure a local government's perception of the social and environmental needs of particular communities, thus throwing complications into the planning process. Involving the community avoids this problem as, according to Rinaudo and Garin (2003), citizen participation gives planners access to practical knowledge and experience, which can help planners better identify the issues at stake, the formulation of a generally complex and unstructured problem and the identification of a large panel of alternative solutions. In other words, community members can inform planners on the issues they believe are of highest priority (access to jobs, more schools, sites for historic preservation, more parks and open space etc.) and planners can develop a plan that meets those needs. Planners can also better implement such plans by coordinating with local agencies, businesses and organizations. These entities can inform planners on how a plan should be carried out, and collaborate with them to help carry out the plan. When implementing projects like rain gardens or swales, planners can work with organizations like the Pennsylvania Resources Council (PRC) to locate areas that allow for proper drainage and to help install the projects. If a plan involves demolishing certain structures, planners can check with local organizations, like a historic preservation society, to see if the structures are a part of the community's history/character and shouldn't be torn down. If a plan is more geared toward helping businesses, planners can meet with small business owners to see what they think would be right for the business community and even coordinate with them to carry out the plan, as such development may need to be delivered by market-led bodies and business-led approaches (OECD.org, 2009). Community involvement is also critical when it comes to achieving environmental justice, the idea that there should be fair treatment and meaningful involvement of all people in environmental planning, regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies (energy.gov). Low-income communities and communities of color have to deal with a disproportionate burden of environmental pollution and degradation as a result of pollution sites like coal plants, landfills and hazardous waste facilities being built in places that are largely made up of low-income and minority communities

(Minkler,Vazques, Tajik, Peterson, 2008). This phenomenon is what is known as environmental racism, which is racial discrimation and class segregation in environmental policy making (Mohai, Pellow, Roberts, 2009). Leaving minority and low-income constituencies out of the planning process would do nothing to improve their situation. If they don't have a voice in the process, then there's no way of guaranteeing that the issues they want the community to take on will be heard or considered, allowing the policies that have ruined their lives to continue doing so uncontested. Thus, environmental justice is a necessary aspect of the planning process, not only to improve and maintain a clean and healthy environment for all members of a community, but to also combat environmental racism. Planners will also be making their own lives easier using community involvement. In the long run, if a community does not approve something that planners have already put in place, it could potentially be reversed. This could also alienate members of the community and cause them to walk away from the process all together. Thus, planners have to make sure to work hand-in-hand with community members so as to come up with the best plan possible for the community. Neglecting to do so would, in addition to being an irresponsible, corner cutting move, be failing to live up to the idea of procedural justice. In planning, procedural justice is the idea that there should be fairness in decision making procedures involving dispute resolution and resource allocation. Procedural justice is an important component of planning because, as posited by Baxamusa (2008), planning is "aimed at redistribution of power, and is about empowering those demographics that have been disempowered by society. Excluding community members from the planning process only disempowers a community as a whole. It is only fair that planners involve community members in any development performed in a community. The planners involved are not always the people living in these places, the community members most certainly are. A plan without the involvement of the people living in that place is not a true plan. It is the goal of planners to take a place that could use improvements to the current situation and implement those improvements. These changes by nature are improvements to the way of life for the community, so it is only right that we involve these members. Plus,as alluded to earlier, procedural justice is also critical for achieving environmental justice. As Walker (2010) mentions, discourses of procedural justice have been shown to run through many cases of environmental contestation, including those related to transport infrastructure, energy generation and waste disposal. Community involvement/procedural justice can only be achieved if we determine methods to get people interested and involved.

Gaining input from a community can, unfortunately, be quite a challenge. It may not be possible to engage all members of a community, and communities in general can be fairly diverse in opinion. There are, however, several methods that a planner can use to gage a community's interests, and there are even ways in which a community can get

more directly involved in the planning process. Planners can try to push for the formation of an advisory group of about 6 to 12 representatives from agencies and the community to assist with public outreach (lgc.org, 2013).These advisory groups can inform planners of stakeholders that they should be aware of, as well as how to communicate and interact with certain groups within the community. When this is achieved, planners can then engage in what's known as values-based messaging, which is messaging based on framing an issue in terms of someone else's values. It basically answers the question "how does this affect me?" (lcg.org, 2013). Planners can also try and set up events to engage community members directly. It's imperative that these events be precisely timed and accessible for all or most people in the community (not everyone starts and gets off from work at the same time and not everyone may have access to a car), be able to involve all groups within the community (including those for whom english is not their first language), provides food, celebrates the local culture and involves the youths of the community. These events can range from advisory meetings, to participatory budgets, wherein community members directly decide how to spend part of the public budget, to holding workshops where stakeholders from all across the community can identify what they want to see improved and come up with design ideas for how to improve those things (lcg.org, 2013). Planners can also try to engage people in other ways, such as focus groups, community surveys, online engagement and participatory mapping, wherein community members can go up to a labeled map of the community and, with either a sticker or writing utensil, identify community needs, assets and opportunities. Communities can also be involved in the process in more direct ways as well. As mentioned in the previous paragraph, community organizations, businesses and other groups within the community can in addition to identifying areas for improvement, also help carry out said plan. Communities can also form binding agreements with developers to ensure that their interests are represented within a plan. An example of such an agreement is a community benefits agreement (CBA). CBAs, in their purest form, are private contracts between a developer and a coalition of community interest groups (Salkin, Levine, 2016). CBAs can serve as a powerful tool to ensure that community interests, particularly those of historically excluded constituencies within a community, are represented. It binds developers to their promises through legally enforceable contract terms (Salkin, Levine, 2016). This then empowers a community to speak more freely and make decisions for itself on a myriad of issues including negotiating for community amenities that have traditionally been within the purview of the comprehensive planning regime. The 2006 Gates Cherokee CBA, for example, was an agreement involving interest groups like the Forest and Rangeland Ecosystem Science Center (FRESC) and the Campaign for Responsible Development and the developers Cherokee investment partners. It's main goal was to clean up a brownfield near where the Gates rubber factory was and redevelop the site into a mixed-use, transit-oriented development that

will include retail, offices, housing and open space (somervillecdc.org). Community engagement in research is a process of inclusive participation that supports mutual respect of values, strategies, and actions for authentic partnership of people affiliated with or self-identified by geographic proximity, special interest, or similar situations to address issues affecting the well-being of the community of focus" (Ahmed & Palermo, 2010).

In conclusion, community engagement is not the only thing necessary for a plan, but it is certainly necessary. Without this input, plans would simply not be for the best of the community. Plans obviously involve many moving parts and people who have studied how to implement them, but if not for the people we are planning for, what is the point of a plan? Community input is paramount and should be treated as such when it comes to developing the places we all live. This starts one community member at a time.

IV. **Application Design for Community Input**

This app is to determine what the wants and needs are for the community. On the app, there will be green infrastructures with benefits that correlate to said infrastructure. The job of the user is to rate based on what benefits are most important to the user via a 1 to 5 scale. The lower the number the less important those benefits are to you. A rating of 1 will be given a score of .2, and each rating will be increased by .2 until 5, which is a score of 1. After the user completes the first section, the app will tell the user what green infrastructures matched the benefits that were most important to that user.

The next section evaluates what the user thinks about aesthetics. There will be two different green infrastructures on the screen at once and the user's job is to say which one is more beautiful to them. There is an option to say that both are beautiful as well. We learned that aesthetics is very important to a community and wanted to dedicate a whole different section to see what the community thought was beautiful.

At the end of the survey, the app will gather all the information of the different users, and determine what is the best green infrastructure for the community.

Overbrook Community Benefits

Overbrook Environmental Education Center

What Do YOU Want For Your Community?

Vote on Benefits

-On each following page you will find a benefit and examples of green infrastructure that correlate with it.

-We will have you vote on a scale of 1 to 5.

-1 means the benefit isn't very important to you, 5 means that you would really like to see this benefit implemented.

-Click on the circle above the number you feel the benefit deserves.

Reduced Flooding

1 2 3 4 5

-Green Streets and Alleyways

-Green Parking Lots

-Rain Gardens

-Bioswales

-Urban Tree Canopy

-Rain Barrels

-Permeable Pavement/Pavers

Improved Water Quality

1 2 3 4 5

-Green Streets and Alleyways
-Green Parking Lots
-Rain Gardens
-Bioswales
-Planter Boxes
-Urban Tree Canopy
-Permeable Pavement/Pavers

Expanded/Restored Habitat

1 2 3 4 5

-Green Parking Lots
-Rain Gardens
-Bioswales
-Urban Tree Canopy

Increased Air Quality

1 2 3 4 5

-Green Parking Lots
-Rain Gardens
-Bioswales
-Urban Tree Canopy

Decreased Air Temperature

1 2 3 4 5

-Green Parking Lots
-Rain Gardens
-Bioswales
-Urban Tree Canopy
-Permeable Pavement/Pavers

Urban Heat Island

Enhanced Socialization

1 2 3 4 5

-Green Streets and Alleyways

-Planter Boxes

-Urban Tree Canopy

Recreation/Community Use

1 2 3 4 5

-Green Streets and Alleyways

-Rain Gardens

-Planter Boxes

Job Creation

1 2 3 4 5

-Green Streets and Alleyways

-Green Parking Lots

-Rain Gardens

-Bioswales

-Planter Boxes

-Urban Tree Canopy

-Permeable Pavement/Pavers

-Rain Barrels

Low Maintenance Cost

1 2 3 4 5

-Rain Gardens

-Planter Boxes

-Rain Barrels

-Permeable Pavement/Pavers

Increased Property Values

1 2 3 4 5

-Green Streets and Alleyways

-Green Parking Lots

-Rain Gardens

-Urban Tree Canopy

Aesthetics

1 2 3 4 5

-Green Streets and Alleyways

-Green Parking Lots

-Rain Gardens

-Bioswales

-Planter Boxes

-Urban Tree Canopy

-Permeable Pavement/Pavers

Based on your answers, these are for you!

Green Infrastructure #1

Green Infrastructure #2

Green Infrastructure #3

Green Infrastructure #4

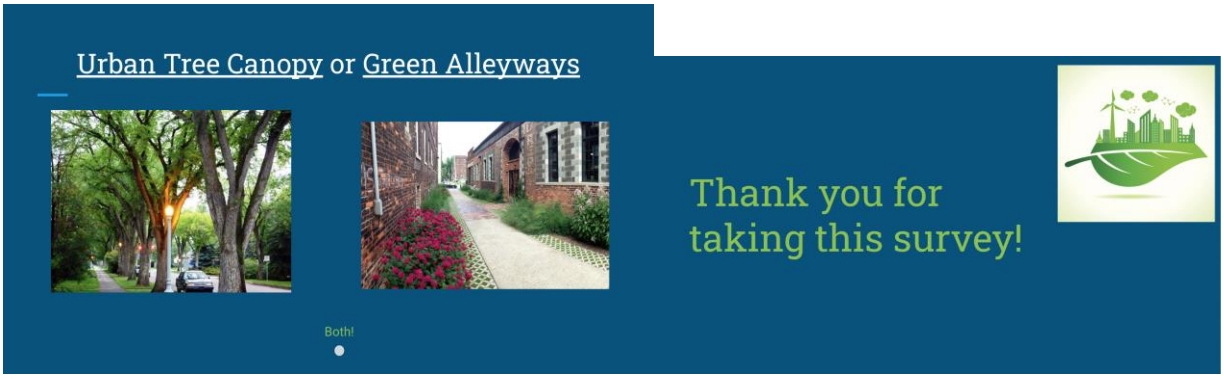
Green Infrastructure #5

Aesthetics Survey

- Aesthetics are clearly important to you so we would like you to take this Aesthetics Survey.

- Choose the option that you believe is more beautiful. You can do so by clicking on the name of the infrastructure.

-If you think both are beautiful there is a both button near the bottom of each page.



V. **Recommendations for Overbrook**

Floods have caused more fatalities and property damage than any other type of natural disaster in the United States during the twentieth century (Kousky et al, 2013). It is thought that our changing climate will increase instances of flooding (Kousky et al, 2013). In 2009, the Philadelphia Water Department proposed a new way to approach stormwater management within the city. The plan is called, “Green City, Clean Waters” and it proposed a system completely reliant on green infrastructure to fix Philadelphia’s stormwater troubles. The plan not only remedies overflow and flooding, but it also aims to provide economic, social and environmental benefits (Philadelphia Water Department,2009). The plan refers to these benefits as the “triple bottom line” (Philadelphia Water Department,2009). The economic benefits the plan will provide to the city are in the form of employment. It estimates that this new infrastructure program will provide about 250 new jobs per year in the city (Philadelphia Water Department,2009). Social benefits of the new GI plan include an increase of recreational opportunities, reduction of approximately 140 deaths caused by excessive heat over the next 40 years, and an increase in property values between 2% and 5% in greened neighborhoods (Philadelphia Water Department,2009). Another very important social benefit of the plan is the promotion of stewardship of urban waterways with a focus on communities that have not been historically targeted by environmental outreach, like low income neighborhoods (Philadelphia Water Department,2009). The environmental benefits that this switch to GI will provide will be massive. The Water Department estimates that 1.5 billion pounds of carbon dioxide emissions will be avoided or absorbed (Philadelphia Water Department,2009). The benefits of this cleaner air could lead to less premature or avoided deaths, 20 avoided asthma attacks, and 250 fewer missed days of school or work per year (Philadelphia Water Department,2009). The improvements also include 190 acres of created or restored wetlands and 11 miles of restored streams within Philadelphia (Philadelphia Water Department,2009). The estimated 5-8 billion gallons of combined sewer overflow avoided per year under the plan will make the streams and rivers swimmable and fishable again, increasing quality of life for all of the residents of Philadelphia (Philadelphia Water Department,2009). The last environmental benefit of the plan is the reduction of fuel and electricity traditionally used to treat water (Philadelphia Water Department,2009). It is estimated that approximately 6 million kilowatt hours of electricity and 8 million kBtu’s of fuel will be spared per year (Philadelphia Water Department,2009). The city and its water department have set forth an impressive plan with attainable goals. Using that plan as our base, we applied basic community planning strategies to engage the Overbrook community to find out what the citizen’s goals and opinions are for and about their neighborhood.

Participatory planning was used to engage the stakeholders in the Overbrook neighborhood during a meeting held at the Arts and Education Center on March 4th,

2020. Our goals for the evening were to find out what benefits were most important to the people of Overbrook and what kinds of green infrastructure they found most aesthetically pleasing. Engaging the community was important to us because in the end, the community will be the stewards of their environment, and they should benefit the most from any change to it. Imposing changes on a neighborhood or community without input from that community negates trust and breaks down any long-term benefits that these proposed changes could bring.

The Overbrook Arts and Education Center acquired a building and lot next to their existing building. Three local universities were asked to help the Arts and Education Center decide on how to use the land around the new building and help engage the local community in how green infrastructure could change their neighborhood. With our app unfinished, we engaged the community members in voting by way of colored stickers. We also had some maps available to let the community show us what areas they were concerned about and which areas had issues like flooding that we were not aware of. We had pictures of different types of green infrastructure printed and posted on a board where the community could vote by placing a sticker next to what they felt looked attractive or what they wanted to see in their community. The types of green infrastructure shown were: Rain gardens, Stormwater planters (small bioswales), Green Parking Lots, Home plant boxes, rain barrels to collect water at home, and street trees. We also had photographs and space for the community to place a sticker on the types of benefits that GI can provide that were most important to them. Each person was given more stickers than there were categories, so if someone felt that certain benefits were very important, they could give it several votes by placing more than one sticker next to it. To find out what benefits of green

infrastructure were most important to the community members, we created voting blocks on pieces of paper and used stickers again for votes. Each green infrastructure benefit had its own paper and three students were there to assist with any questions or concerns that the voters may have had. Below are the results from the voting that took place on March 4th.

WHAT BENEFITS ARE MOST IMPORTANT TO YOU?	
Benefit	**Number of Votes**
Neighborhood Interaction	11
Beautification	11
Recreation/Community Use	6
Reduced Flooding	5
Increased Property Values	6
Low Maintenance	4
Job Creation	8
Improved Water Quality	9
Expanded/Restored Habitat	5
Improved Air Quality	11
Cooling Summer Temperatures/Creating Shade	4

WHICH TYPES OF GREEN INFRASTRUCTURE ARE MOST AESTHETICALLY PLEASING?

Type of Green Infrastructure	**Number of Votes**
Rain Gardens	12
StormWater Planters	8
Green Parking Lots	9
Planter Boxes	8
Rain Barrels	3
Street Trees	17

Tallying the Results

Community Votes Combined with Infrastructure benefits Formula: A(Aesthetic Votes)+B(Important benefit votes) X C(whether or not a GI provides a certain benefit)

	Green Parking Lots	Rain Garden	Bioswales/Stormwater Planter	Plant Boxes	Urban Tree Canopy	Rain Barrels
Reduced Flooding	(9+5)1=**14**	(12+5)1= **17**	(8+5)0= **0**	(8+5)0= **0**	(17+5)1= **22**	(3+5)1= **8**
Improved Water Quality	(9+9)1=**18**	(12+9)1= **21**	(8+9)1= **17**	(8+9)1= **17**	(17+9)1= **26**	(3+9)0= **0**
Expanded/restored Habitat	(9+5)1= **14**	(12+5)1= **17**	(8+5)1= **13**	(8+5)0=**0**	(17+5)1= **22**	(3+5)0=**0**
Increased Air Quality	(9+11)1= **20**	(12+11)1= **23**	(8+11)1= **19**	(8+11)0=**0**	(17+11)1= **28**	(3+11)0=**0**
Decreased Air Temp.	(9+4)1= **13**	(12+4)1= **16**	(8+4)1=**12**	(8+4)0=**0**	(17+4)1= **21**	(3+4)0=**0**
Aesthetics	(9+11)1=	(12+11)1=	(8+11)1=	(8+11)1=	(17+11)1=	(3+11)0=**0**

	20	**23**	**19**	**19**	**28**	
Enhanced Socialization	(9+11)1= **20**	(12+11)0= **0**	(8+11)0=**0**	(8+11)1= **19**	(17+11)1= **28**	(3+11)0=**0**
Neighborhood use /recreation	(9+6)0=**0**	(12+6)1= **18**	(8+6)0=**0**	(8+6)1=**14**	(17+6)0=**0**	(3+6)0=**0**
Job creation	(9+8)1= **17**	(12+8)1= **20**	(8+8)1= **16**	(8+8)1= **16**	(17+8)1= **25**	(3+8)1= **11**
Low Maintenance Cost	(9+4)0=**0**	(12+4)1= **16**	(8+4)0=**0**	(8+4)1= **12**	(17+4)0=**0**	(3+4)1= **7**
Increased property Values	(9+6)1= **15**	(12+6)1= **18**	(8+6)0=**0**	(8+6)0=**0**	(17+6)1= **23**	(3+6)0=**0**
Total Scores	**151**	**189**	**96**	**97**	**223**	**26**

Our recommendation for Overbrook is to create rain gardens and green parking lots where it is reasonable to do so and also to add street trees. Green parking lots are a combination of permeable pavement, shade trees and curbside swales to collect runoff. The community expressed that improved air quality was important to them, along with beautification, and neighborhood interaction. The plants used for the rain gardens and the trees planted on the streets will remove air pollution through dry deposition. This means that the broad and sometimes waxy leaves on these plants will catch the pollutant particles from the air and hold them in place until water washes the pollutant into the soil where it is filtered. Studies show that in the United States, urban vegetation occupies 3.5% of the land area and absorb about 0.711Tg(teragram, an SI unit of mass equal to 10^{12} grams) of pollutants, which would cost an estimated 3.8 billion to filter from the air without green infrastructure in place(Xing,Y. & Brimblecombe, P., 2019). The attendees of the meeting also voted for street trees, green parking lots, and rain gardens as the types of GI that they find most aesthetically pleasing. The street trees had the highest score of all of the green infrastructure voted on, and they also provide the most important benefits to the people of Overbrook. Street trees are also aesthetically pleasing, as they received the most votes in that category at the meeting. These types of GI will add much needed nature and greening to Overbrook. Nature may help prevent and mitigate stress, anxiety and depression(Kondo,M.C., Low,S.C., et al., 2015). Overbrook has a few areas that contain a large amount of concrete and pavement, especially along the commercial corridor. Creating green parking lots in

Overbrook, especially in areas like the commercial corridor will greatly improve the look and feel of the neighborhood while improving the health of the residents. Not only will trees in these lots provide much needed shade, but the leaves of both the trees and plants will catch emissions and pollution from the high level of traffic that passes through. The addition of rain gardens in the community will not only contribute to stormwater management and add more green space, but it is also an opportunity to add more flowers and color to the neighborhood. These improvements are also likely to improve property values in Overbrook. The Green City, Clean Water plan estimates that green neighborhoods can see an increase in property values between 2% and 5%,(Philadelphia Water Department,2009). This equity in homes can help, albeit a small amount to aid in keeping people out of poverty.

We feel that these are the best green infrastructure recommendations for the Overbrook because they are cost effective, not too hard to maintain, and they embody all of the traits that the community members said were most important to them at the March 4th meeting.

VI. **References**

Sarkar, S., Butcher, J. B., Johnson, T. E., & Clark, C. M. (2018). Simulated Sensitivity of Urban Green Infrastructure Practices to Climate Change. *Earth Interactions*, *22*(13), 1–37. https://doi.org/10.1175/EI-D-17-0015.1

Anderson,B.S., Phillips,B.M., Hoorhees,J.P., Siegler,K., Tjeerdema,R.;(2016). Bioswales Reduce Contaminants Associated with Toxicity in Urban Storm Water. Environmental Toxicology and Chemistry,35(12). 3124-3134.

Chini, C. M., & Canning, J. F. (2017, January 12). The Green Experiment: Cities, Green Stormwater Infrastructure, and Sustainability. Sustainability. https://www.mdpi.com/2071-1050/9/1/105/htm

Elaine, Kauffman, & Gerald. (2007, February 1). The University of Delaware Rain Garden: Environmental Mitigation of a Building Footprint. *Journal of greenbuilding*. https://meridian.allenpress.com/jgb/article/2/1/53/200066/The-University-of-Delaware-Rain-Garden

Kondo,M.C., Low, S.C., Henning,J., Branas, C.C., (2015). The Impact of Green Stormwater Infrastructure Installation on Surrounding Health and Safety. Research and Practice. American Journal of Public Health. 105(3).

Kousky, C., Olmstead, S.M., Walls, M.A., Macauley, M. (2013). Strategically Placing Green Infrastructure: Cost-Effective Land Conservation in the Floodplain. Environmental Science and Technology. American Chemical Society. Vol.47. 3563-3570.

Phila.gov, Wastewater Treatment. (n.d.) City of Philadelphia. Retrieved from: https://www.phila.gov/water/wu/wastewater/Pages/WastewaterTreatment.aspx

Aval, J., Demuynck, J., Zenou, E., Fabre, S., Sheeren, D., Fauvel, M., Adeline, K., & Briottet, X. (2018). Detection of individual trees in urban alignment from airborne data and contextual information: A marked point process approach. *ISPRS Journal of Photogrammetry & Remote Sensing*, *146*, 197–210. https://doi.org/10.1016/j.isprsjprs.2018.09.016

Kumar, P., Druckman, A., Gallagher, J., Gatersleben, B., Allison, S., Eisenman, T. S., Hoang, U., Hama, S., Tiwari, A., Sharma, A., Abhijith, K. V., Adlakha, D., McNabola, A., Astell-Burt, T., Feng, X., Skeldon, A. C., de Lusignan, S., & Morawska, L. (2019). The nexus between air

pollution, green infrastructure and human health. *Environment International*, *133*, N.PAG. https://doi.org/10.1016/j.envint.2019.105181

Laia, Yuan & Kontokosta, Constantine E.. (2019). The impact of urban street tree species on air quality and respiratory illness: A spatial analysis of large-scale, high-resolution urban data. Journal of Health and Place, 56, 80-87.

Natural Resources Conservation Service: Rain Garden Fact Sheet. (n.d.). USDA. https://www.nrcs.usda.gov/wps/portal/nrcs/detail/null/?cid=nrcs142p2_008528

Willis, Katherine J. & Petrokofsky, Gillian. (2017). The Natural Capital of City Trees: City trees can help to deuce pollution and improve human health. Science Magazine. Vol.354(6336).

Barron,N.J., Deletic,A., Jung,J., Fowdar,H., Chen,Y., Hatt, B.E.(2018). Dual-mode stormwater-greywater biofilters: The impact of alternating water sources on treatment performance. Journal of Water Research. 159, 521-537.

Planter Boxes: Structural Stormwater Control. (2016). *City of Portland, Oregon*. https://www.murfreesborotn.gov/DocumentCenter/View/2748/Planter-Boxes-2214-?bidId=

Planter Box. (2017). 3 *Rivers Wet Weather*. https://www.3riverswetweather.org/green/green-solution-planter-box

Rahman, S., Khan, M. T. R., & Akib, S. (2014, February 18). Sustainability of rainwater harvesting system in terms of water quality. *Scientific World Journal*. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3948194/

Turner, S. J. B., & Cavender, N. (2019). The benefits of trees for livable and sustainable communities. *Plants, People, Planet*, *1*(4), 323–335. https://doi.org/10.1002/ppp3.39

The Benefits of Trees. (2020). Retrieved from: https://www.arborday.org/trees/benefits.cfm

Wolf, Kathleen L, PhD, University of Washington (2007) City Trees and Property Values. Arborist News. 16, 4:34-36.

Permeable Pavement Fact Sheet Information for Howard County, Maryland Homeowners. (2016). University of Maryland.

McManus, J. (2020). Rain Gardens & Barrels. Clermont County, Ohio Gov. https://www.clermontswcd.org/rain-gardens-barrels/

Rain Garden Plants. (2020). *Stroud Water Research Center*. https://stroudcenter.org/about/facilities/mec/stormwater/rain-garden-plants/

Reducing Urban Heat Islands: Compendium of Strategies Cool Pavements. (2015). United States Environmental Protection Agency. Retrieved from https://www.epa.gov/sites/production/files/2014-06/documents/coolpavescompendium.pdf

Stormwater Planters. (2016). *Green Building Alliance*. https://www.go-gba.org/resources/green-building-methods/stormwater-planters/

Widjojo, Rosita, Raharjo, & Agus, I. (2018, July 14). Rain Barrel Project: Rainwater Harvesting for Sustainable Water Supply in Urban Households. *SSRN*. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3201115

Yuan, J. (2018, August). The influence of vegetation on rain garden hydrological performance. *Urban Water Journal*. Pages 1083-1089. https://www.tandfonline.com/doi/abs/10.1080/1573062X.2017.1363251?journalCode=nurw20

Xing, Y., & Brimblecombe, P. (2019). Role of vegetation in deposition and dispersion of air pollution in urban parks. *Atmospheric Environment*, *201*, 73–83. https://doi.org/10.1016/j.atmosenv.2018.12.027

Armeni, Chiara (2016) Participation in Environmental Decision-making: Reflecting on Planning and Community Benefits for Major Wind Farms. *Journal of Environmental Law*. Page 1 https://watermark.silverchair.com/eqw021.pdf?token=AQECAHi208BE49Ooan9kkhW_Ercy7Dm3ZL_9Cf3qfKAc485ysgAAAlMwggJPBgkqhkiG9w0BBwagggJAMIICPAIBADCCAjUGCSqGSIb3DQEHATAeBglghkgBZQMEAS4wEQQMNOCz0--S4x0uq5WMAgEQgIICBg2SvHmGX3w4V2bYclcvYmsHfJgiF35Z4bGl-7ztX8l9wg9q-Wqip2Cr6OFvM92GPe1j2cR-T_xwYbXV4lUHEweDZrxg7QLfqVc5DTGPDj5zr9ecMe7UEKNLOR2RID4KjNbB16Q5v19IBaMn7hMkduuW3gHx7YnaJ5Yp4W_lQxVt6gK-n4PzTDrEbdiI2u03GZNWCtmUh3Fcvd6YwsSvEjqzc_Rg-XLqaeLVVh6ERR4PMlaoiF_NXeNgLN7AiHyJa6I5ozAVnZF4hXp-S_u2b0fDOg3YXcrh31jHTg8-8WFL1tZ8y1KzMu5GJcqBOlP3BORJhpphRkK8koJIC6egpyZQ9JcPwel0p2gCu0p3Q5BuZ9V7ONWRfb73ARZ15n86qmqsnJ7OSxSpivwXvts49hzJLCYvDjeTVOfASS1RFk9-cDCXxVNgSAuwgRfu_6EXXIDf97E-gZJw0EwLOZprFpZOAFxlrh7uPAmYpoJVkzTF_bq66AHJtIFMXl3Ge5Ph2IcocQqAag4SZR1jRG4D2fukr2LWoVqEdp5Gckj3ITS6_pXrhp4y82oeAXJ7EXTwrLumt2LyV83fdJqDYQ0rpS5tICGj9DEYPAHYEPckuxF9ybJInvRi2cU9c8lQVPv1i7aZ1OQuU47dkWgS_fthNe5nmgM90LKIa1TTpN2GjDsBfCr0Lf-A

Local Government Commission (2013, November) Participation Tools for Better Community Planning. Pages 4-35.

http://www.lgc.org/wordpress/docs/freepub/community_design/guides/Participation_Tools_for_Better_Community_Planning.pdf

Salkin, Patricia, E. Levine, Amy (2016) Community Benefits Agreements and Comprehensive Planning: Balancing Community Empowerment and Police Power. *Journal of Law and Policy*. Pages 157-160. https://heinonline.org/HOL/Page?collection=journals&handle=hein.journals/jlawp18&id=164&men_tab=srchresults

Rinaudo, Jean, D, Garin, Patrice (2003, November) The benefits of combining lay and expert input for water-management planning at the watershed level *Water Policy 7.* Pages 279-280. https://watermark.silverchair.com/279.pdf?token=AQECAHi208BE49Ooan9kkhW_Ercy7Dm3ZL_9Cf3qfKAc485ysgAAAgcwggIDBgkqhkiG9w0BBwagggH0MIIB8AIBADCCAekGCSqGSIb3DQEHATAeBglghkgBZQMEAS4wEQQM7ONhWd9bfWP_AAv9AgEQgIIBuh3guHOE_vnE5E8gzOpFnplFXl002tdQK2QT8pFPnRgezAh7SvT4hr62E35TSqIQJS2VX-zJLTnGcjY-IDSK1DTyTzFDmF98vWKkhejltWs5VPE7EQCApDlrh9FybNSMHkI-WIw-h8bZ7umHhJ9pLCjX9fAzMBjb4BpnkJXcaxHjzj7yDmi5_fr-ehSnC1_miGwiqsSTJ37-W5ySbiOE91M6C7kNqpNAxqoBAuIYVZoISOziHsIJxHRNQjSYnCKvKi4Tyv_nKtxhKPA4sYFer-tkZmkwYuh1DJrfs6ex0B5ebAXg8VKRttgGUUQKzHESVQVm6vT37HALM8M5iIC9laRERbjFa7Lde_Xf28cb4NUItn4LHHc9ifqBdINfea3bUWoEKTrNCuFZEKEDM6lpbtzN-TAA3ad9FhI7MwQlAaunEq-x34a0tW2P1p0WOSuIQtKyTWFzAI3D5JuDSAlXqL67wLnZ_tfSw5y6SZaTZ-eKkdjJLIE5fRG4fGDwxlNYwrJRNkd2jhuso4ApkUCUQLZw_ek-etQ2nHSRPuQQlE_2ABd-w_66FyNScri3mQ_FuWlQNiyjboHL6wk

Organization for Economic Co-operation and Development (2009, November) Summary Report. Page 2. https://www.oecd.org/regional/leed/44682618.pdf

Baxamusa, Murtaza, H, (2008, March) Empowering Communities through Deliberation The Model of Community Benefits Agreements *Sage Journal: Journal of Planning, Education, and Research*. Pages 261-262. https://journals.sagepub.com/doi/pdf/10.1177/0739456X07308448?casa_token=Zuu2fhwqghAAAAAA:Dl57wC0G2Ae1aGyDlV1sNYePIKnVRLvV1yioRSHBQ7KSJbZbdX14BCjTbQGcPgGUIwx1RJ5hFhQ

Somerville cdc (2006, February) Page 2 http://somervillecdc.org/sites/default/files/scc-minimal/files/national_examples_of_community_benefits_agreements_cbas.pdf

Ahmed, Syed M, and Ann-Gel S Palermo. “Community Engagement in Research: Frameworks for Education.” *American Journal of Public Health*, American Public Health Association, Aug. 2010, www.ncbi.nlm.nih.gov/pmc/articles/PMC2901283/.

Energy.gov office of legacy management *What is Environmental Justice* https://www.energy.gov/lm/services/environmental-justice/what-environmental-justice

Mohai, Paul, Pellow, Devid, Roberts, Timmons, J. (2009) Environmental Justice *Annual Reviews*. Pages 406-407 https://www.annualreviews.org/doi/pdf/10.1146/annurev-environ-082508-094348

Minkler, Meredith, Vasquez, Victoria, B, Tajik, Mansoureh, Petersen, Dana (2008, February) Promoting Environmental Justice Through Community-Based Participatory Research: The Role of Community and Partnership Capacity. *Sage Journal: Journal of Planning, Education, and Research*. Pages 119-120 https://journals.sagepub.com/doi/pdf/10.1177/1090198106287692?casa_token=2VbsWTNecv0AAAAA:s7r3kUjWy-YGGWOXq00dFV8DKR4ogxewZ9OwiDh_8P4-oVDULOxMSRVv-o-3D4bFJ8VN-FMUMKE

Philly Watersheds.Org.(2018). Stormwater Tree Trench. Retrieved from: http://archive.phillywatersheds.org/what_were_doing/green_infrastructure/tools/stormwater_tree_trench

The Philadelphia Water Department.(2009). Green City Clean Waters. http://archive.phillywatersheds.org/doc/GCCW_AmendedJune2011_LOWRES-web.pdf

Walker, Gordon (2010, September). Environmental justice, impact assessment and the politics of knowledge: The implications of assessing the social distribution of environmental outcomes. *Environmental Impact Assessment Review*. https://www.sciencedirect.com/science/article/pii/S0195925510000661?casa_token=EqF9UqSnLhYAAAAA:yQl5UnhgrxLeLeyqo7Se7ehqQHnawYFOsEyudyZMFPd5ksNPWRH8LRwySSoBUgtjVOOyqUOv

Gilland, Stephen, W, Steiner, Dirk, D, Skarlicki, Daniel, P (2001). *Theoretical and Cultural Perspectives on Organizational Justice.* Pages 85-86. https://books.google.com/books?hl=en&lr=&id=zPgnDwAAQBAJ&oi=fnd&pg=PA85&dq=definition+of+procedural+justice&ots=6CKKwWWS2z&sig=4ExWBPdUN8vteP1DQZsI78JS3ac#v=onepage&q=definition%20of%20procedural%20justice&f=false