Redeveloping Gas Station Sites to Pocket Parks in the City of Seattle – A Benefit-Cost Analysis

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Abstract

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The City of Seattle has little vacant land to accommodate its projected growth in population and jobs. Due to this lack of land, developers are looking to redevelop land that is currently being used or is underutilized. One type of property that is becoming more available for redevelopment is gas station sites. However, gas station sites are categorized as brownfields, meaning that on-site contaminants must be removed from the sites before they can be redeveloped. Also, these sites are small and will not provide many additional residential housing units and commercial space. Due to these limitations, this thesis proposes that the City of Seattle purchase gas station sites and redevelop them as pocket parks. A Benefit-Cost Analysis (BCA) was run on three existing gas station sites to compare the monetary cost and benefits that redeveloping gas station sites to pocket parks would have on the City of Seattle. The three gas station site's BCAs resulted in a negative net benefit, which suggests that purchasing gas station sites and redeveloping them as pocket parks would not benefit the City. However, the City should consider possible alternatives to reduce the costs of redeveloping gas stations site to pocket parks

because this redevelopment strategy would benefit the surrounding residents and environment and implement the current planning theory.

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1.0 Introduction

1.1 Problem Statement

In 2017, the City of Seattle found that less than 5% of the land within its city limits had a current use classification of "vacant" (City of Seattle 2017)**.** Due to this lack of vacant land, developers are looking to redevelop land that is currently being used or is underutilized. This is an issue because some of the land being considered for redevelopment is classified as a brownfield and is contaminated from its previous use.

The United States Environmental Protection Agency (EPA) defines a brownfield as "properties that are or may be contaminated with hazardous substances, pollutants, petroleum, or other contaminants" (2019). This means that before brownfields can be redeveloped, the existing contaminants need to be removed, so they no longer provide a harmful risk to the environment and humans. Gas station sites are one type of site that fit under the definition of a brownfield that are becoming more available for redevelopment. Their increased availability is due to drivers switching to cars that use alternative fuel sources like electricity. These sites are also attractive to developers because they are usually within commercial areas and located on street corners (Yasenchak 2009; EPA 2019). However, the soils underneath gas station sites are contaminated due to leaks from the gas station's underground petroleum storage tanks (UST) and from above-ground spills. This means that before gas station sites are redeveloped, costly measures will need to be taken to remove contaminants, like decommissioning UST, removing the UST, removing the contaminated soil, or constructing environmental mitigation.

When redeveloping brownfields, like gas stations, the use the site is redeveloped to should also be considered. The City of Seattle needs more housing and commercial space to accommodate its projected population and employment growth; however, it also needs to provide public services

for that growth. When considering a gas station site, due to its relatively small size, not many public services can be located on it; however, a pocket park could fit on the site. Pocket parks can fit in a relatively small piece of land and provide new recreation opportunities and green space within areas of the City that currently don't have any. It has also been found that parks offer benefits to the City, like increases in residential property values, stormwater retention/dispersion, urban heat island reduction, etc. (De Sousa, Wu, and Westphal 2009; Balai Kerishnan and Maruthaveeran 2021; Bardos et al. 2016; Grilli, Mohan, and Curtis 2020; Yao et al. 2022). These benefits provide justification for the City of Seattle to consider purchasing gas station sites and redeveloping them into pocket parks.

1.2 Purpose of the Thesis

The Purpose of this thesis was to determine if purchasing gas station sites and redeveloping them as pocket parks would benefit the City of Seattle. To determine if there is a benefit, a hypothetical benefit-cost-analysis (BCA) was used, which compared the costs and benefits that redeveloping gas station sites to pocket parks would have on the City. The analysis was run on three existing gas station sites within the City of Seattle to determine if specific characteristics of a site would affect the magnitude of the provided costs and benefits.

1.3 Research Question

The research question for this thesis is: Will there be a benefit to the City of Seattle if the City chooses to purchase gas station sites and redevelop them as pocket parks? To answer this question, the following sub-question will be addressed:

1. What are the costs associated with purchasing gas station sites and redeveloping them as pocket parks?

2. What are the benefits associated with purchasing gas station sites and redeveloping them as pocket parks?
3. Can all of the identified costs and benefits be placed in monetary values?
4. Does redeveloping gas station sites to pocket parks provide a greater net benefit in different locations within the City of Seattle?
5. What characteristics of a gas station site increase the benefits and costs?

This thesis used the following hypotheses to answer the research question and sub-questions: If the City of Seattle chooses to purchase gas station sites and redevelop them as pocket parks, then there will be a benefit to the City. This redevelopment strategy will be a benefit to the City because the monetary benefit of redeveloping gas station sites to pocket parks will be greater than the monetary costs. However, certain gas station sites will offer greater benefits and costs due to certain characteristics of the gas station site, like its size and proximity to residential housing.

1.4 Thesis Layout

The remainder of this thesis will be divided into the following five chapters:

- Chapter 2 – Literature Review: Context to the research topic is provided by summarizing the existing planning and urban design theory, empirical literature, and literature of practice on brownfield redevelopment and parks. A brief explanation of what BCA is also included in this section.
- Chapter 3 – Methods: A description of the BCA analysis and data used to answer the research question. The limitations of the analysis are also discussed.
- Chapter 4 – Results: The results from each gas station site's BCAs will be provided.

- Chapter 5 – Discussion: The final results from the included gas station sites BCAs will be compared to the existing literature on brownfield redevelopment.
- Chapter 6 – Conclusion: This thesis concludes with a summary of the findings and how the results provide implications for future researchers and planners.

2.0 Literature Review

The purpose of this literature review is to provide a summary of the existing literature on the research topic and methods. This chapter is split into three sections: The first covers the theory behind the research question and methods. The second section summarizes the existing empirical research on the cost and benefits of brownfield redevelopment and parks. Then the final section gives a brief analysis of the existing regulations and plans that drive gas station to park redevelopment projects.

2.1 Theory

The theory section of this chapter is split into two parts. First, the planning and urban design theory behind the research topic is summarized. Then, the theory behind policy analysis and BCA is provided. Both planning and design theory and BCA must be discussed in this section because they provide the knowledge behind the research topic and methods.

2.1.1 Planning and Urban Design Theory

Urban Decay

Throughout history, plenty of planning literature has been written critiquing past planning strategies and how successful they were. This thesis uses the planning and urban design failures that Jane Jacob identified in her book, "*Life and Death of the Great American Cities"* (1961), along with the environmental failures that present-day urban ecologists are trying to fix (McHarg 1969; Spirn 1984). All of the failures that Jacobs and the urban ecologist have found contributed to the decay of many United States urban cities starting in the mid-twentieth century and continuing into the present day.

One of the main points that Jacobs identifies is that planners and urban designers in the early to mid-twentieth century mis-prioritized urban problems due to not understanding the full extent of the problem. For instance, Jacobs states:

> *"*The simple need for automobiles are more easily understood and satisfied than the complex needs of cities, and growing numbers of planners and designers have come to believe that if they can solve the problem of traffic, they will thereby have solved the major problem of cities. Cities have much more intricate economic and social concerns than automobile traffic. How can you know what to try with traffic until you know how the city itself works, and what else it needs to do with its streets?" (Jacobs 1961, 7)

Jacobs then explains that this mis-prioritization has led to failed projects and has worsened other deep-seated social and economic problems.

Jacobs also identifies that due to planners and designers not understanding the full extent of the problem, the fixes they implemented don't suit the needs of the people they were meant to help. For instance, Jacobs used an example of a grass field that was included in an affordable housing project in New York's East Harlem neighborhood. Jacobs explains that tenets despised the gas field because a coffee shop, store, or bank near their home would have better served their needs than added open space. Jacobs explains that this example shows a failure in the housing project because if the designers understood the full social needs of the people who they were trying to house, they would have known that added open space was not what they needed (Jacobs 1961, 15).

Another factor that has led to the decay of urban cities is the lack of attention to the natural environment. Many urban ecologists have identified that cities were developed as economic machines and did not consider the environment (Spirn 1984). Ecologists have determined that by

not including the environment in the design of early twentieth-century cities has led to environmental problems, like increased flooding and reduced air quality (McHarg 1969). Ecologists have also identified that people want to live near nature. The combination of less nature in cities and increased natural problems has led people to move out of urban cities and to suburbs (McHarg 1969; Spirn 1984).

Finally, both Jacobs and urban ecologists agree that it was common practice for early twentieth-century projects to only address one problem instead of providing a fix for many problems, leading to failed projects and urban decay. For example, twentieth-century planners and designers would construct affordable housing units without constructing nearby commercial uses or building a large office building for a new industry, without addressing emissions that the building would produce (Jacobs 1961; Spirn 1984). This practice of addressing only one problem instead of multiple has worsened other city problems, like fewer services for residents and creating a worse environment for people to live in. This has ultimately led to failed projects and people moving away from urban cities.

Urban Revitalization

Many critics, planners, and designers are proposing new strategies to revitalize urban cities to fix the social and environmental failures from the early twentieth century. For example, Jacobs suggests cities prioritize mixed-use development with residential, commercial use, and green spaces. Jacobs explains that a mixture of uses would ensure that residents have the services they need in proximity to where they live and that economic activity can still occur within those areas (1961).

Another theory planners and designers use to revitalize urban cities is including urban ecology and nature when designing projects. This idea of urban ecology and designing with nature has been used since the mid-twentieth century; however, McHarg was one of the first researchers to bring it into the spotlight and identify how cities have developed without nature and need to so that environmental problems are addressed (1969). From McHarg, Spirn took his thinking one step further and identified specific environmental attributes that projects need to address. These attributes include air, earth, water, and life (1984). All of these attributes combined make up the urban ecosystem. Spirn also included the below overarching goals that all projects should meet to make sure they address urban ecology:

1. "Address the place of the site within the urban ecosystem as a whole, including its relationship to the City's most critical problems.
2. Respond to the problems and the opportunities posed by the site and its immediate neighborhood.
3. Design buildings and the landscape to conserve energy and reduce waste.
4. Exploit the site's distinctive microclimatic, geological, hydrologic, and biological character." (Spirn 1984, 261)

Ultimately, the critical part of both Jacobs and Spirn's approaches to revitalization is that projects should address multiple urban problems. For example, if a new park is proposed, it should provide pervious surface so the park can infiltrate stormwater. This, as a result, will make it, so the park is filling the resident's social need for more recreation and gathering space and also address and reduce the city's problems with stormwater conveyance and flooding (Spirn 1984).

New Urbanism

New Urbanism is a planning and urban design theory introduced in the last twentieth century that implements the urban revitalization strategies that both Jacobs and urban ecologists suggest. The theory works on the principle that "community planning and design must assert the importance of public over private values" and that new development and infill projects should ensure that “public spaces like streets, squares and parks should be a setting for the conduct of daily life; a neighborhood should accommodate the diverse types of people and actives; it should be possible to get to work, accomplish everyday tasks and travel to surrounding communities without a car” (Katz 1994, xxx-xxv).

To provide these design elements, the theory of new urbanism suggests that new development and infill projects be done at many scales, but mainly on a neighborhood scale. Neighborhoods should be designed with multiple uses that provide residents with the desired services. New Urbanism design is also centered around community spaces like parks and green spaces, which offer social opportunities and benefits that Jacobs describes a city needs, along with the environmental benefits that urban ecologists are working to implement (Bressi 1994).

2.1.2 Benefit-Cost Analysis

Benefit-cost analysis is a policy analysis tool that measures the economic efficiency of public projects and “aims to ensure that resources are put to their most valuable use, including the significant possibility of leaving them in private hands”(Stokey and Zeckhauser 1978, 134). This tool compares a project's costs and benefits and determines if its benefits outweigh its costs (Stokey and Zeckhauser 1978; Weimer and Vining 1992).

Two academic works about BCA were reviewed to provide context: A Primer for Policy Analysis by Edith Stockey and Richard Zechhauser (1978) and Policy Analysis by David Weimer and Aidan Vinning (1992). In both books, the authors identified a similar BCA structure, which

includes identifying a project's impacts, categorizing the impacts as benefits or costs, putting the benefits and costs into similar units, and then comparing the costs and benefits to determine a project's net benefit. Below is a further explanation of each piece of the BCA that the authors describe.

Benefits and costs

Both book's authors agree that to run a proper BCA, all of the project's impacts should be identified and that the "favorable impacts will be registered as benefits, [and] unfavorable ones as cost" (Stokey and Zeckhauser 1978, 136). The authors believe that all costs and benefits should be included in the BCA, which is important so that the whole picture of the project can be obtained. Weimer and Vinning, however, do warn that using costs and benefits that are focused on personal preference should not be included in the analysis because personal preference can vary over time (Weimer and Vining 1992).

Similar Units

The authors of both books require that the cost and benefits of the analysis should be put into similar units so they can be compared. Stokey and Zechkhauser's BCA methodology does not suggest an exact unit that the benefits and costs should be put in but does imply that they should be put into monetary values, and Weimer and Vinning's methodology does require benefits and costs to be put into monetary values. The difference in these two methodologies is that Weimer and Vinning take a much more economical approach to BCA and looks at a consumer's willingness to pay for a project compared to Stockey and Zechkhauser do not go as deep into economic theory in their narrative.

Length and Discounting

The authors of both books provide BCA methodology that can be run over multiple years so that all benefits and costs from the project's lifespan can be taken into account. The authors also include discounting in their analysis. Discounting is a “compounded interest rate” that is applied to the net benefit of a project to account for the project's present value and expected value (Stokey and Zeckhauser 1978). The rationale behind present value is that "a sum of money in hand is worth more than a promise of the same sum at a specified time in the intervening time" (Stokey and Zeckhauser 1978, 160). This means that consumers place a greater value on money now than in the future, so a discount rate that takes this preference into account is essential when evaluating future costs and benefits. Also, the concept behind the expected value is that "future costs and benefits can never be known with absolute certainty" (Weimer and Vining 1992, 281). This means that applying a discount rate will allow the analysis to take into account any unknown variables that may affect the value of the cost and benefits over the project’s lifetime.

Decision Rule and Comparing Multiple Projects

The BCA methodology presented by both books authors presents a relatively simple decision rule focused on the fundamental rule of "in any choice situation, select the alternative that produces the greatest net benefit" (Stockey, 1978, p. 137). This means that these decision rules should apply if a project’s net benefit is positive, it should be considered to be implemented, and if it’s negative, the project should not be considered.

The authors of both books also provide a methodology for using BCA to choose from multiple projects. Both authors suggest that the project that provides the greatest net benefit should be

implemented. Weimer identifies that some public policy analysts use a benefit-cost ratio when comparing the magnitude of cost and benefits between projects by dividing the benefits by the costs to determine the amount larger a project's benefits are than its costs. Then the project with the largest ratio is selected to be implemented. Wiemer does, however, state that the benefit-cost ratio does tend to confuse people and recommends that "you should avoid using benefit-cost ratios altogether" (1992, p. 285).

2.2 Empirical Research

This section summarized the existing empirical research on brownfield redevelopment projects and parks.

2.2.1 Gas Station Redevelopment

There has been relatively little research done on gas station redevelopment projects. The only relevant article was by Yasenchak, who used two case study cities, Trenton and Plainfield, New Jersey, to determine what past gas station sites were redeveloped to (Yasenchak 2009). The analysis found that in Trenton and Plainfield, New Jersey, gas station sites were most commonly redevelopment to other automotive uses, like auto repair shops and new gas stations. The results also showed that many surveyed gas station sites were redeveloped as vacant land. Yasenchack concluded by stating that the issue with redeveloping gas station sites to auto-related redevelopment and vacant land is that auto-related redevelopment could continue to pollute the surrounding environment, and vacant land does not provide any benefits.

2.2.2 Brownfield Redevelopment

Due to the lack of research on gas station site redevelopment, the remainder of the empirical research section will be on other types of brownfield redevelopment projects and parks.

Impacts Fundamentals

The objective of most research on brownfield redevelopment projects and parks is focused on the impacts that a project will have. Many researchers split the impacts into "primary, secondary, and tertiary impacts" (Hou et al. 2018, 1397). Where primary impacts are "assisted with the physical state of the brownfield site," secondary impacts are "associated with remediation activities at the brownfield site, and tertiary impacts are "associated with post-remediation usage of the brownfield sites" (Hou et al. 2018, 1396).

To properly analyze a brownfield redevelopment project's impacts, many researchers will also categorize these impacts as tangible and intangible. For instance, Kotval-K identified costs, and benefits that can be easily measured in monetary values, like the cost of remediating the brownfield site, are tangible, and the cost and benefits that cannot be easily measured in monetary values, like a community's feelings towards the removal of the brownfield site, are categorized as intangible (2016). Researchers agree that it is essential to recognize all costs and benefits that a project will have on a site to obtain a whole picture of the brownfield redevelopment project.

To analyze the impacts a brownfield redevelopment project will have, researchers will use multiple methods to compare the tangible and intangible costs and benefits of the project's primary, secondary, and tertiary impacts. For example, Lesage et al. used a life cycle assessment (LCA) to compare a project's tangible and intangible costs and benefits(Lesage, Deschênes, and Samson 2007). The LSA that the authors used also took into account when the impacts occurred in the brownfield redevelopment project to ensure that the primary, secondary, and tertiary effects were included.

Costs

When considering the cost of brownfield redevelopment and park projects, researchers focus on the tangible costs and benefits of a project's primary, secondary, and tertiary impacts. For instance, De Sousa found that the costs associated with brownfield redevelopment projects are buying the property, remediating the property to remove the contaminated soils, permitting fees, redevelopment fees, and the cost of any required environmental studies that the jurisdiction may require (2003).

Park researchers have also found that there are tangible expenses when developing parks as well. For instance, Floyd et al. found that park projects include costs associated with designing, constructing, and maintaining the park. The authors also found that these costs are not the same for all parks and are variable based on what elements are included in the park's design, like a playground or basketball court, and their size (Floyd et al., 2015).

Due to the large required costs that brownfield to park redevelopment projects have, researchers have found that the costs are why this redevelopment strategy is not consistently implemented. For instance, De Sousa surveyed developers in the City of Toronto, Canada, and found that they do not choose to redevelop brownfields to parks because the project's monetary benefits are not greater than their costs (2003). Due to this non-existent benefit, researchers have also found that it disincentives developers from doing brownfield to park redevelopment projects (Sousa 2003; Siikamäki and Wernstedt 2008).

Aesthetics

One benefit that has been found when brownfields are redeveloped to parks is an aesthetic benefit. For instance, in De Sousa's analysis of the brownfield to park redevelopment project in the City

of Toronto, Canada, he found that removing a brownfield from a neighborhood and replacing it with green space beautified the surrounding neighborhood and that residents and city leaders gained a benefit from the change in aesthetics (Sousa 2003). This kind of use change from brownfield to park also is consistent with the theory of New Urbanism and urban ecology because it brings green space to a neighborhood and breaks up a commercial or industrial area.

Urban Heat Islands

Researchers have also looked at how parks can reduce temperatures within a city and reduce Urban Heat Islands (UHI). For example, Chen et al. analyzed the City of Berlin, Germany's park system and found that temperatures in areas within a city close to parks were lower than in areas that did not have parks. The authors also found that parks of all sizes helped reduce heat within the City, especially when the parks were included in a larger park system (Chen et al., 2021). Finally, the authors suggest to further reduce temperatures within a city, brownfield to park redevelopment projects should take place due to brownfields being located in areas within a city that lack parks.

Other researchers have come to the same conclusion as Chen et al. in their research on how parks reduce UHI. For instance, Yao et al. found that areas near parks within Fuzhou, China had temperatures that were up to 8 degrees Celsius lower than areas within the City that didn't have park space (Yao et al. 2022). The authors also found that longer parks with a large perimeter length had the greatest impact on temperatures within the City.

Researchers have also examined how different park materials and ground cover reduced UHI. For example, Loughner et al. investigated how trees within parks and streets right-of-way reduce UHI. To determine the impact trees had, the authors ran multiple temperature simulators in Washington, DC, with the different amounts of tree cover. The analysis found that temperatures

were lower in places with trees because trees provide shade and other natural processes that reduce heat (2012).

Another attribute of parks that researchers have found that reduces UHI is that parks have few materials that abort heat. Vahmani and Weiss reviewed areas within Los Angeles, California, that had a vegetation ground cover and found that they had a temperature that was 27% lower than areas with a ground cover that absorbed heat like concrete and asphalt (Vahmani and Ban-Weiss 2016). They concluded that including vegetation and materials with albedo is a good thing to have in the design of new development because they reduce both daytime and nighttime temperature.

Stormwater

Researchers have also found that parks help fix stormwater problems within a city. Feldman et al. reviewed the effectiveness of the previable ground cover included in the design of Shoelace Park in the City of New York. The author's analysis found that the previous ground cover outperformed its expectation and retained and infatuated more stormwater than expected. The authors concluded that parks are good stormwater infrastructure and can assist a city with managing stormwater runoff from surrounding roads and impervious surfaces (Feldman, Foti, and Montalto, 2019). This is important when analyzing brownfield to park redevelopment projects because the project is removing a commercial or industrial use with impervious surfaces and replacing it with a park that has permeable surfaces.

Mental Health

Parks have also been proven to help people with mental help. To determine the impacts that parks have on people's mental health, Grilli et al. ran a study that interviewed people who lived near parks in Ireland. Their study found that people do credit parks with helping their mental health because parks give them a place to gather, recreate, and rest (2020).

Property Value

Due to the positive impacts listed above, researchers have also found that brownfield to park redevelopment projects positively benefit surrounding residential property values. For instance, De Sous et al. found that when brownfields were redeveloped to parks in Milwaukee and Minneapolis, the surrounding residential property values increased by 4.4% - 11.4%. The authors also found that this increase in property value could be observed up to 2,500 feet away from the redevelopment project (2009). Also, researchers have found that residential properties have a higher residential property value when located near a park, even when they weren't redeveloped from a brownfield, compared to residential properties that are not. For example, a study by Crompton and Nicholls found that residential property values adjacent to parks were 8% - 20% greater than residential property values not near parks. In addition, Crompton and Nicholls found that multi-family building property values were 22% when located near a park. Finally, the authors found that the magnitude of the property value increase for residential properties relied on the park's size (Crompton and Nicholls 2020). Even though governments cannot use public funds to increase private gain, the increase in property values surrounding parks indicates increased livability for residents because residents want to live near a park instead of a brownfield. Also, an increase in property value can be used to determine the rise in property taxes collected by a city because property values are used to calculate property taxes.

2.3 Literature of Practice

There are no existing laws or plans that place a priority on a gas station or brownfield to park redevelopment projects. In the United States, the Federal and State governments provide

environmental requirements and financial assistance for redeveloping gas stations and brownfield sites, and local jurisdictions provide park plans that drive new park development.

2.3.1 Federal

The United States Environmental Protection Agency (EPA) has a handful of programs and legislation that assist with gas stations and brownfield redevelopment. The first is the 2002 Small Business Liability Relief and Brownfield Revitalization Act (Public Law 107-118), which purpose is to:

> "To provide certain relief for small businesses from liability under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, and to amend such Acts to promote the cleanup and reuse of brownfields, to provide financially assistance for brownfields revitalization, enhance State response programs, and for other purposes."

This relief that the Act provides are grants that states and individuals can apply for, which include the Brownfields Assessment Gant, Brownfield Revolving Loan Fund Grant, Brownfield Cleanup Grant, etc.

The EPA also implements gas station site cleanup legislation, which focuses on cleaning up leaks from a gas station's underground storage tanks. These Acts include the Solid Waste Disposal Act, Energy Policy Act, and American Recovery and Reinvestment Act. These Acts provide environmental regulations for UST and leaking UST cleanup and federal funding for the cleanup of gas station sites. For example, the EPA has the UST Financial Assurance Funds that they can distribute to state governments so states can provide UST owners financial assistance with cleaning up leaks and contaminates from leaking UST (Enviormental Protection Agency 2012)

2.3.2 Washington State

Washington State has regulations and grants that help with the gas station and brownfield redevelopment projects, both of which are administered by the Department of Ecology. For instance, RCW 70A.355 requires the Department of Ecology to "establish an underground storage tank program designed, operated, and enforced in a manner that, at a minimum, meets the requirements for delegation of the federal underground storage tank program." Also, Ecology administers the Oversight Remedial Action Grants, which helps UST owners pay for the costs associated with cleaning up leaking USTs (Washington State Department of Ecology 2020).

2.3.3 City of Seattle

The City of Seattle does not provide any gas station and brownfield redevelopment regulations. The City does, however, have a Park Strategic Plan that has strategies that drive new park construction. Some of the applicable strategies from the plan are:

"HP2. Make all parks, facilities, and programs accessible and inclusive, utilizing universal design principles with the goal of in of including people of all ages and abilities.

HP5. Prioritize land acquisitions and park enhancements to ensure that all Seattle residents live within a 10-minute walk from an accessible public space and/or high-quality recreational program.

HP6. Connect children, youth, and adults to nature, with a focus on historically underserved communities.

HE10. Continue to acquire land and responsibly develop new parks to increase availability of open space, with a focus on urban villages and communities historically lacking access." (City of Seattle 2020)

The City of Seattle also constructs new parks and maintains its existing parks. To fund the construction of new parks and to maintain the existing parks, the City of Seattle has established the Seattle Metropolitan Park District, which is classified as a special district. Due to the SMPD special district classification, the SMPD can collect annual property taxes to help fund park construction, maintenance, and services. SMPD's current tax levy rate is $0.20401 per $1,000 taxable property value (King County 2022). The City also uses funds from its general fund to pay for park construction maintenance and services (City of Seattle 2020).

3.0 Methods

The purpose of this chapter is to describe the methods used to answer the research question, Will there be a benefit to the City of Seattle if the City chooses to purchase gas station sites and redevelop them as pocket parks? To answer this question, the following sub-question will be addressed:

1. What are the costs associated with purchasing gas station sites and redeveloping them as pocket parks?
2. What are the benefits associated with purchasing gas station sites and redeveloping them as pocket parks?
3. Can all of the identified costs and benefits be placed in monetary values?
4. Does redeveloping gas station sites to pocket parks provide a greater net benefit in different locations within the City of Seattle?
5. What characteristics of a gas station site increase the benefits and costs?

3.1 Benefit-Cost Analysis

A benefit-cost analysis (BCA) was used to answer the research question and sub-questions. A BCA was used because it is a simple tool that can be utilized to compare the benefits and cost that redeveloping gas station sites to pocket parks will have on the City of Seattle (Stokey and Zeckhauser 1978; Weimer and Vining 1992). The BCA analyzed the associated impacts that redeveloping gas station sites to pocket parks will have on the City itself and not on the residents surrounding the redeveloped sites. Only the impacts on the City itself were included in the BCA because this analysis is interested in whether or not redeveloping gas station sites to pocket parks is an efficient use of the City's money and will ultimately pay for it itself.

The BCA format used was based on the BCA methodology for multiple projects described in *A Primer for Policy Analysis by* Edith Stockey and Richard Zechhauser (1978). Below are the five basic steps for a BCA as described by Stokey and Zechhauser:

1. "The project or projects to be analyzed are identified.
2. All the impacts, both favorable and unfavorable, present and future, on all of society are determined.
3. Values, usually in dollars, are assigned to these impacts. Favorable impacts will be registered as benefits and unfavorable ones as costs.
4. The net benefit [total benefit minus total cost] is calculated.
5. The choice is made [evaluation criteria]." (Stokey and Zeckhauser 1978, 136)

3.2 Projects

3.2.1 Site Selection

BCA was run on three gas station sites within the City of Seattle. The following criteria were used to select the three gas station sites:

1. One site is located within north, central, and south Seattle**.** See **Figure 1** for the boundaries of each region. The reason for running the test on three gas station sites is to determine if different locations within the City will provide the City with a greater net benefit.
2. Registered petroleum underground storage tank(s) (UST) with the Washington State Department of Ecology. These criteria helped identify sites with UST.
3. Corner lot. A corner lot provides the most perimeter along the border of the park, which could provide a greater benefit to the area surrounding the park.
4. At least one side of the lot borders a residential area. This criteria ensures that the parks are near residents who could use it and not within a soley business/commercial area.

5. At least 1000 feet away from an existing park. This distance is being used because the BCA will include a park service area of 500 feet surrounding the pocket park, and choosing a site that is 1000 feet away from other parks will ensure that the cost and benefits associated with an existing park won't affect the properties within 500-feet of the new park.

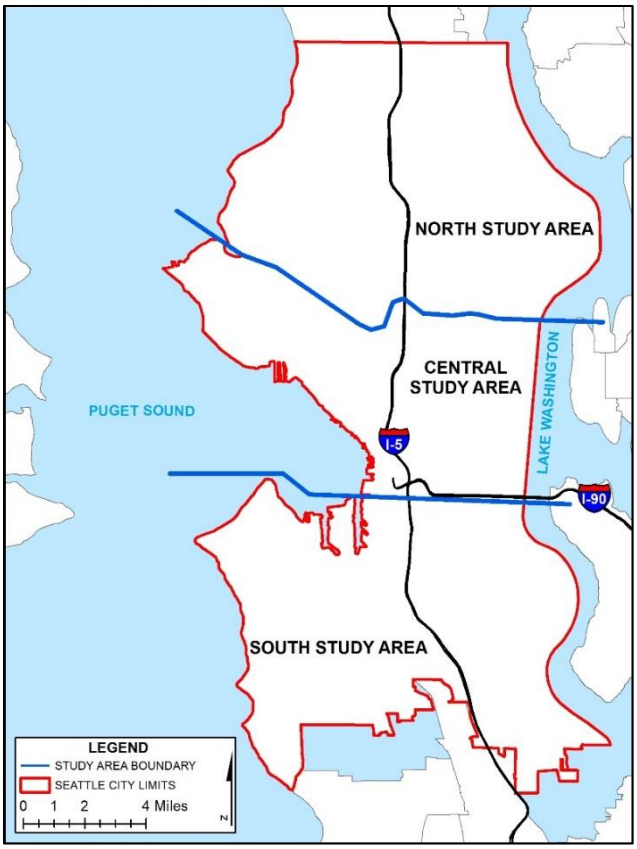

Figure 1: Gas Station Site Study Areas

3.2.2 Site Design

Figure 2 shows the basic pocket park design applied to each site, which includes a medium-sized playground, a small open area, and exterior trees. Further descriptions of the design elements are described in **Table 1**. The design elements were chosen so that the pocket park would meet the needs of different demographic groups. For example, a playground was included so the parks would provide a recreation area for children, and an open area and shade trees were chosen to

provide a resting and gathering spot for adults and senior citizens (Kerishnan and Maruthaveeran 2021; Nordh and Østby 2013).

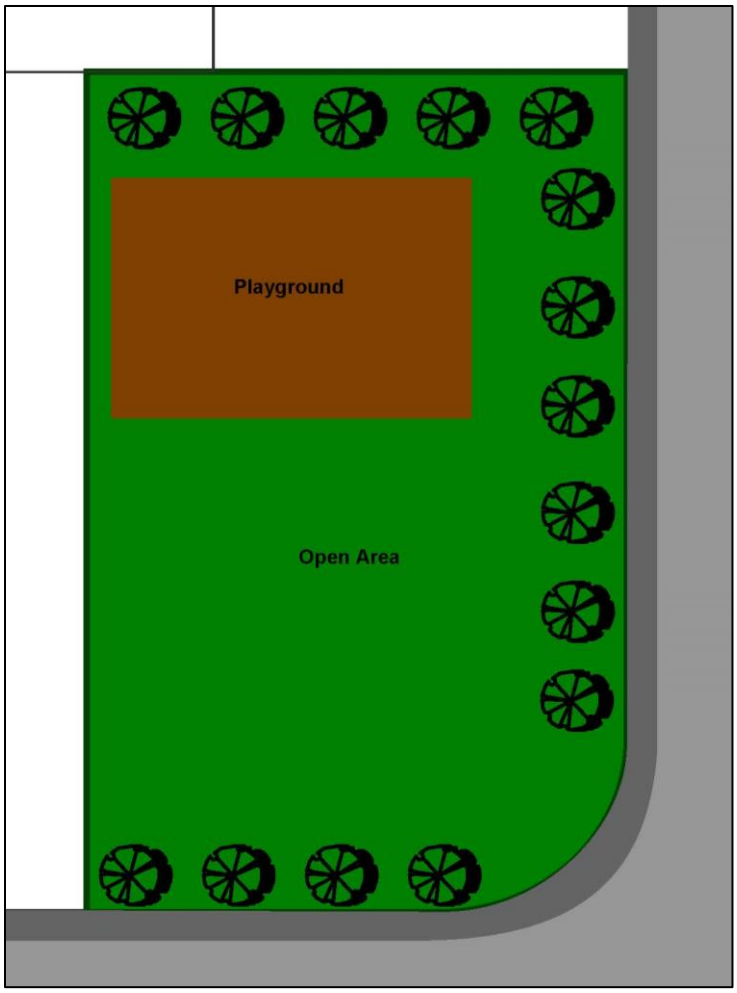

Figure 2: Basic Pocket Park Design

Table 1: Basic Park Features	
Design elements	Description
Medium playground	"Medium-sized playgrounds included a play structure and a set of swings. Swings had two or three seats. The structures were prefabricated and situated with a safety surface of approximately 85 ft in diameter. Sizes ranged between 4,162.79 and 9,271 sq ft." (Floyd et al., 2015)
Small open area	"Small open area zones consisted of a grassy area with no built features. In some cases, fencing was present. Such zones ranged between 651.75 and 9,682.14 sq ft. These were typically 70 ft × 70 ft, showed signs of frequent mowing, and included irrigation." (Floyd et al. 2015)
Shade Trees	Sugar Maple will be planted every 40' along the site's boundaries. The Norwegian Sunset Maple tree is a deciduous tree that is commonly used in parks and for street trees. (Brun 2016)

3.3 Impacts

Table 2 identifies the impacts that redeveloping gas station sites to pocket parks could have on the City of Seattle and its residents. Favorable impacts were categorized as benefits, and unfavorable impacts were categorized as costs. Also, the impacts on the City itself have been identified in bold font.

Table 2: Gas Station to Pocket Park Impacts	
Costs	Benefits

• **Site Acquisition**
  ○ **Cost to purchase the site**
  ○ **Legal fees**
• **Environmental Review**
  ○ **Contamination testing**
  ○ **Environmental survey**
  ○ **Geotechnical survey**
• **Site preparation**
  ○ **Contamination clean-up**
  ○ **Tank removal/caping**
  ○ **Site clearing activities**
• **Park construction**
  ○ **Installing playground**
  ○ **Installing picnic area**
  ○ **Planting grass for open area**
  ○ **Planting trees**
• **Park maintenance**
  ○ **Making fixes and improvements to the playground**
  ○ **Making fixes and improvements to the picnic area**
  ○ **Mowing grass**
  ○ **Pruning trees**
• Loss of a needed service
  ○ Gas station
  ○ Convenience store
	• Increased Property Value (wellness index)
	  ○ Assessors land valuation
	  ○ **Property Tax**
	• Added service in the City
	  ○ Open space
	  ○ Playground
	  ○ Eating/sitting area
	• Added social opportunities
	  ○ Recreation
	  ○ Gathering
	  ○ Resting
	• Break from the existing commercial environment
	  ○ Green space in a commercial and residential environment
	  ○ Removal of a use that could be considered an "eye-sore" with more aesthetically pleasing use
	• **Stormwater improvements**
	  ○ **Added pervious surface/infiltration area**
	  ○ **Trees water retention**
	• **Air quality improvement**
	  ○ **CO2 reduction**
	  ○ **Harmful vaper and air pollutants reduction**
	• Urban Heat Island Reduction
	  ○ Added Shade
	  ○ Removal of heat-producing buildings
	  ○ Removal of heat-absorbing driving surface materials
	• Environmental Improvements
	  ○ Removing contaminates from UST leaks from the soil and groundwater
	  ○ Mitigation for any negative impact UST leaks could have had
	• Risk Reduction
	  ○ Removes risks of UST leaks
	  ○ Ensures needed use is on the land
	  ○ The City can patrol who uses the land

3.4 Valuation

Below are descriptions of how the impacts identified in **Table 2** were assigned a monetary value. Due to the limited nature of the BCA, only tangible impacts were used in the BCA. It is important to note that this study is a hypothetical analysis and is supposed to provide a baseline study of the cost and benefits that are associated with redeveloping gas station sites to gas stations. National averages were used to compensate for this unknown, and general valuations were applied.

3.4.1 Costs

Site acquisition*:* The current King County Assessor's Office taxable property value was used as the acquisition cost for each gas station site. It was assumed that the City would be able to purchase the site for less than the property value because it is contaminated and would require cleaning up. This means that the remainder of the assessed value will go towards any additional fees associated with purchasing the land, such as legal fees and closing costs.

UST Clean Up*:* $167,469.70 was applied to each site to cover the costs of decommissioning each site's underground storage tanks and removing the harmful contaminants. This cost is from a survey that the Association of State and Territorial Solid Waste Management Officials did in 2020, asking States how much UST site cleanup projects cost that applied for state financial assistance (2021). The results of ASTSWMO found that the national average cost of cleaning up a site with USTs was $153,664.00, which for the use of this analysis, was increased to account for inflation and put into 2022 dollars. The United States Bureau of Labor Statistics Inflation Calculator was used to determine cost increase due to inflation (US Bureau of Labor Statistics n.d.).

Demolition: A multiplier of $7.50 per square foot of structure area was used to determine the cost of demolishing existing buildings and structures on the gas station site. This cost was found through a survey of Puget Sound Region demolition companies, which estimates that the cost to demolish a commercial building in the Puget Sound Region is between $3 and $12 (Demo Man, INC n.d.; Hometown Demolition n.d.). The square footage of the structures on the site was found using the King County Assessor's Office property records and area measurements taken from aerial photographs.

Build: To calculate the cost to build the pocket park, national average construction costs for the different park elements were used. **Table 3** identifies the national average cost to construct a medium size playground and small open area. These nation estimates were obtained from a research project by Floyd et al. where they asked parks departments around the United States how much it costs to construct certain park elements (Floyd et al. 2015). For this analysis, the costs that Floyd et al. found were increased to account for inflation and put into 2022 dollars. The United States Bureau of Labor Statistics Inflation Calculator was used to determine cost increase due to inflation (US Bureau of Labor Statistics n.d.).

Table 3: Park Element Construction Costs

	Area Range (square feet)	Average Construction Cost – 2012	Average Construction Cost – 2022	Average Maintenance Cost – 2012	Average Maintenance Cost – 2022
Small Open Area	651.75 – 9,682.14	$8,013.00	$9,939.07	$1,282.00	$1,590.15
Medium Playground	4,162.79 – 9,271	$267,094	$331,294.84	$13,355	$16,565.11

Also, a cost of $179.86 was applied for each tree planted. This valuation is from a 2005 survey that McPherson et al. did, asking arborists how much it costs to plant a publicly owned tree (McPherson et al. 2005). The survey results found that the average cost to plant a publicly owned tree is $122.00, including purchasing and planting the tree. For this analysis, the cost was increased to account for inflation and put into 2022 dollars. The United States Bureau of Labor Statistics Inflation Calculator was used to determine cost increase due to inflation (US Bureau of Labor Statistics n.d.).

Maintenance: The annual maintenance cost for each park element is listed in **Table 3.** The maintenance cost is a national average determined by Floyd et al. and was increased to account for inflation (2015). The BCA will apply the cost annually once the park element is constructed. The United States Bureau of Labor Statistics Inflation Calculator was used to determine cost increase due to inflation (US Bureau of Labor Statistics n.d.).

A cost of $165.12 per tree was also applied annually to account for the annual maintenance cost of the tree. This valuation was determined by McPherson et al. in 2005, who surveyed arborists about the average annual price to prune and maintain a publicly owned tree. The survey results found that maintaining one publicly owned tree costs an average of $112.00 per year, and for this analysis, the cost was increased to account for inflation and put into 2022 dollars. The United States Bureau of Labor Statistics Inflation Calculator was used to determine cost increase due to inflation (US Bureau of Labor Statistics n.d.).

3.4.2 Benefits

Residential Property Tax Increase: To determine the additional residential property tax's collected due to the gas station site being redeveloped to a pocket park, the difference between the projected property tax collected if the site stayed the same and if it was redeveloped to a pocket

park was used. The first step in determining the projected residential property taxes collected if the gas station remained was to determine the future annual property value of each single-family and multi-family property within the gas station site's 500-foot service area over the project's lifespan. The projected property value of each single-family and multi-family property was determined by increasing their property value at a rate equal to the average annual increase each property had between 2012 and 2021. Next, to determine the project property taxes collected, the current City of Seattle tax levy rate of 2.16635 per $1,000 of taxable property value and the Seattle Metropolitan Park Districts tax levy rate of 0.20401 per $1,000 of taxable property value was applied to each property's annual property value.

The next step was determining the property taxes collected if the site was redeveloped to a pocket park. In this scenario, the projected property value for the single-family and multifamily properties was increased by 4.4% after the year the park's construction was completed. Then to determine the property taxes collected, the current City of Seattle and Seattle Metropolitan Park Districts tax levy rates were applied. Finally, to determine the residential property tax benefit, the total annual taxes collected if the gas station site stayed the same were subtracted from those collected if the gas station site was redeveloped to a pocket park.

The 4.4% property value increase that was used to determine the increase of property taxes collected if the gas station site was redeveloped to a pocket park is consistent with a study that De Sousa et al. did on residential property values surrounding brownfield to park redevelopment projects, where the authors found that surrounding property values of residential properties increased by 11.7% in Milwaukee and 4.4% in Minneapolis and that increase could be seen up to 2500 feet from the redeveloped site (2009). De Sousa et al. did not specify what they meant by residential properties. For this report, residential properties mean properties regularly on the

market for the average household to purchase, like detached single-family homes, duplexes, townhomes, and condominiums. The 4.4% multiplier was also applied to multi-family because it has been found that multi-family buildings have a greater value when they are closer to park space. This price increase is due to tenants placing a higher demand on multi-family units near park space because of the lack of open space provided in the design of multifamily buildings. A larger increase in multi-family property values was applied because of the relatively small size of the pocket park.

Trees: The computer software i-Tree Design was used to determine the benefits of the planted trees. i-Tree Design was created by public and private entities, including the United States Forest Service. i-Tree Design is being used because other past researchers have determined it to be an appropriate tool to determine the benefits a tree will have (Song et al. 2018). The benefits that i-Tree Design calculates that were used are stormwater retention, CO2 reduction, and air pollution reduction (CO, NO2, PM10, and SO2).

To calculate the annual stormwater benefit a tree will have, i-Tree Design uses a three-dimensional physically based stochastic model that Xiao et al. developed in their 1998 research article "A New Approach to Modeling Tree Rainfall interception." The model determines the annual stormwater rainfall interception of a tree's canopy will have, in gallons, based on the climate zone the tree is located in, what type of tree it is, and its diameter. Then i-Tree Design puts the annual stormwater benefit into monetary values by multiplying the tree's annual rainfall interception rate by $20.79/Ccf ($0.02779/gal [$.00011/m3]). i-Tree Design obtained this multiplier from "Western Washington and Oregon Community Tree Guide: Benefits, Costs and Strategic Planting" (2005), which determined a tree's stormwater benefit based on its rainfall

interception rate and how much it costs to treat stormwater in Washington and Oregon (i-Tree 2014).

To determine the annual Carbon Dioxide reduction benefit a tree will have, i-Tree Design looks at the annual carbon dioxide sequestered a tree will have. To determine the annual carbon dioxide sequestration a tree will have, i-Tree Design uses species-specific carbon equations. Then i-Tree Design multiplies a tree's annual carbon dioxide sequestration rate by $78.50, the social costs that the Interagency Working Group on Social Cost of Carbon has placed on carbon (i-Tree 2014).

Finally, to determine the air pollutants (VOCs, NO2, PM10, SO2) removal benefit each tree will have, i-Tree uses lookup tables similar to what it uses to calculate the CO2 reduction benefit. These tables were proposed based on an analysis done by the US forest service that determined the amount of pollution a tree removed based on what United States county they were located in. Next, i-Tree Design multiplies the amount of pollutants removed by monetary values determined by the EPA and from existing research for each pollutant (i-Tree 2014).

3.2.4 Net Benefit

BCA Analysis Layout

Table 3 shows the layout of the BCA that the analysis used. The main operation of the BCA is subtracting the project's total cost from the total benefits over 28 years to determine the net benefit of the project. The reason for running the project for 28 years is to account for the time it takes to acquire the gas station site (year 1), clean up and development the site (year 2-3), and the lifespan of the park (years 4-28).

The BCA also included a discount rate of 3.5%, which was applied to each year's net benefit. This discount rate was pulled from a research study by Moore et al., which determined that an appropriate discount rate for a public project that is not intergenerational (>50 years) and does not block private investment is 3.5%. (Moore et al. 2004). Moore et al. determined the discount rate using an optimal growth rate model. This is an appropriate discount rate for the project because, as identified above, the project is not intergenerational because it only has a duration of 28 years and does not block out private investment because there are other properties in the City that private firms can invest in.

Table 4: Example Benefit-Cost Analysis

		Year 1-0	Year 2-3	Year 4-28
Costs	Land Acquisition			
	Clean Up			
	Construction			
	Maintenance			
	Total Cost			
Benefits	Property Tax			
	Stormwater			
	Trees			
	Total Benefit			
	Annual Net Benefits (Total Benefit minus Total Cost)			
	Discounted Annual Net Benefits (Discount Rate = 3.5%)			
	Final Net Benefit (Sum of all Discounted Annual Net Benefits)			

3.2.5 Evaluation Criteria

The final part of the BCA is to determine the final net benefit of the project and determine if the project should be implemented. The final net benefit was determined by summing up the annual

net benefits over the project's lifespan. Then to determine if the project should be implemented, the below decision rules were used.

- Negative total benefit: If the total net benefit comes out to be negative, the BCA suggests that City should not consider redeveloping gas station sites as pocket parks. The reason for this decision is if the total net benefit is negative, the project costs out weight the benefits, and the project will ultimately cost the City money.
- Zero total benefits: If the total benefit comes out to zero, the BCA suggests that the City should consider redeveloping gas station sites into pocket parks.
- Positive total benefit: If the total benefit comes out as positive, the BCA suggests, that the City should redevelop gas station sites into pocket parks. This decision is because if the total benefit is positive, the benefits outweigh the costs, and the City would profit from the park project.

3.3 Limitations

The proposed analysis does have some limitations that are important to discuss before moving forward in the analysis.

1. *Time*: The allotted time for this project is only six months, which hinders the amount of detail that the analysis can include. For example, there is a possibility that not all impacts associated with redeveloping a gas station site into a pocket park were included in the analysis due to the amount of time it would take to collect the needed data and create the methodology to place the impacts into monetary values.
2. *Hypothetical*: The analysis is hypothetical, and not all variables are known. For example, this analysis assumes that all gas station sites are contaminated; however, it is unknown to

what extent they are contaminated. This means that the cost to clean up the site could be greater than or less than the national average used in the analysis.

3. *Site Selection*: Due to the site selection criteria that the methodology uses, this could limit the outcome of the BCA. The included sites were selected on the provided criteria, but due to these criteria, a site that could provide a greater net benefit to the City could have been overlooked. For example, a site that is in the middle of a block or does not share a border with a residential area could provide a greater benefit than the selected sites.
4. *Using multipliers and valuations others*: Using multipliers and valuation calculations from existing research could be a limitation to this analysis because they are subject to the limitation and errors from the studies that created these multipliers and calculations.
5. *Not including intangible cost and benefits:* This could be a limitation because intangible cost and benefits could provide reasoning for the City to choose to or not to purchase gas station sites and redevelop them as pocket parks further than the monetary incentive.
6. *Not including cost and benefits to the residents:* This could be a limiting factor to the analysis because redeveloping gas station sites to pocket parks would have costs and benefits to the residents, which may incentivize or disincentivize the City of Seattle to take on this type of redevelopment project. For example, the loss of a gas station in a neighborhood could provide a cost to the residents that outweigh all potential benefits. Also, adding a park in a neighborhood with no park space or historical injustices could benefit the residents and outweigh the costs.
7. *Limited Scope:* The scope is based on the City of Seattle's current state and does not consider possible future implications. For example, increased flooding or property value could affect how the City values a gas station to park redevelopment project.

4.0 Results

The results section aims to identify the essential outcomes of the analysis. This section is split into two parts. The first section compares the outcomes of the BCAs for each gas station site. Then the second section uses the final net benefit from the BCA's for the three gas station sites to answer the research question and sub-questions and determine if the hypothesis is correct.

4.1 Site Characteristics and Design

4.1.1 Site Selection

Three gas station sites were chosen using the site selection criteria provided in the methods section. All three sites are located on corner lots within a commercial area, and at least one of the site's boundaries borders residential properties. The sites are also more than 1000 feet away from an existing City of Seattle park and have underground storage tanks registered with the Washington State Department of Ecology. **Figure 3** is a map showing where the three selected sites are located within the City, and **Table 5** provides a further description of each site.

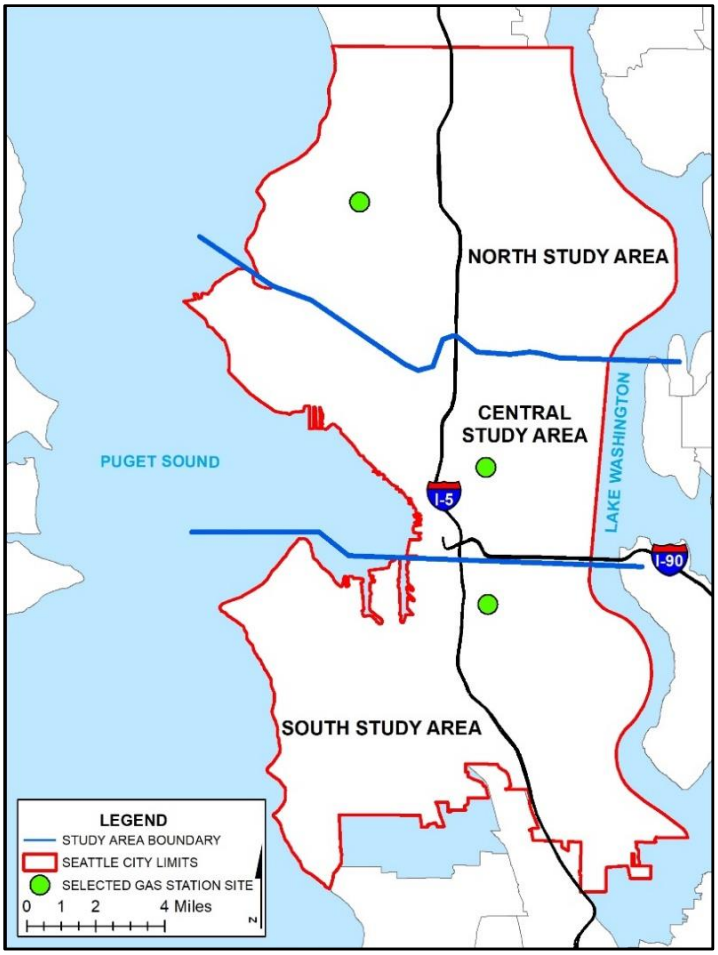

Figure 3: Selected Gas Station Site Vicinity Map
Data Source: King County GIS & WsDOT

Table 5: Selected Gas Station Sites

	Address	Existing Use	Site Area	Site Perimeter	Onsite Structure Area	Number of UST
North Site	355 NW 85th St Seattle, WA 98117	Gas Station	10,913 sqft	418 ft	~4,777 sqft	3
Central Site	1701 E Madison St Seattle, WA 98122	Gas Station	8,832 sqft	383 ft	~2,872 sqft	3
South Site	3002 Beacon Ave S Seattle, WA 98144	Gas Station	10,948 sqft	440 feet	~2080 sqft	2

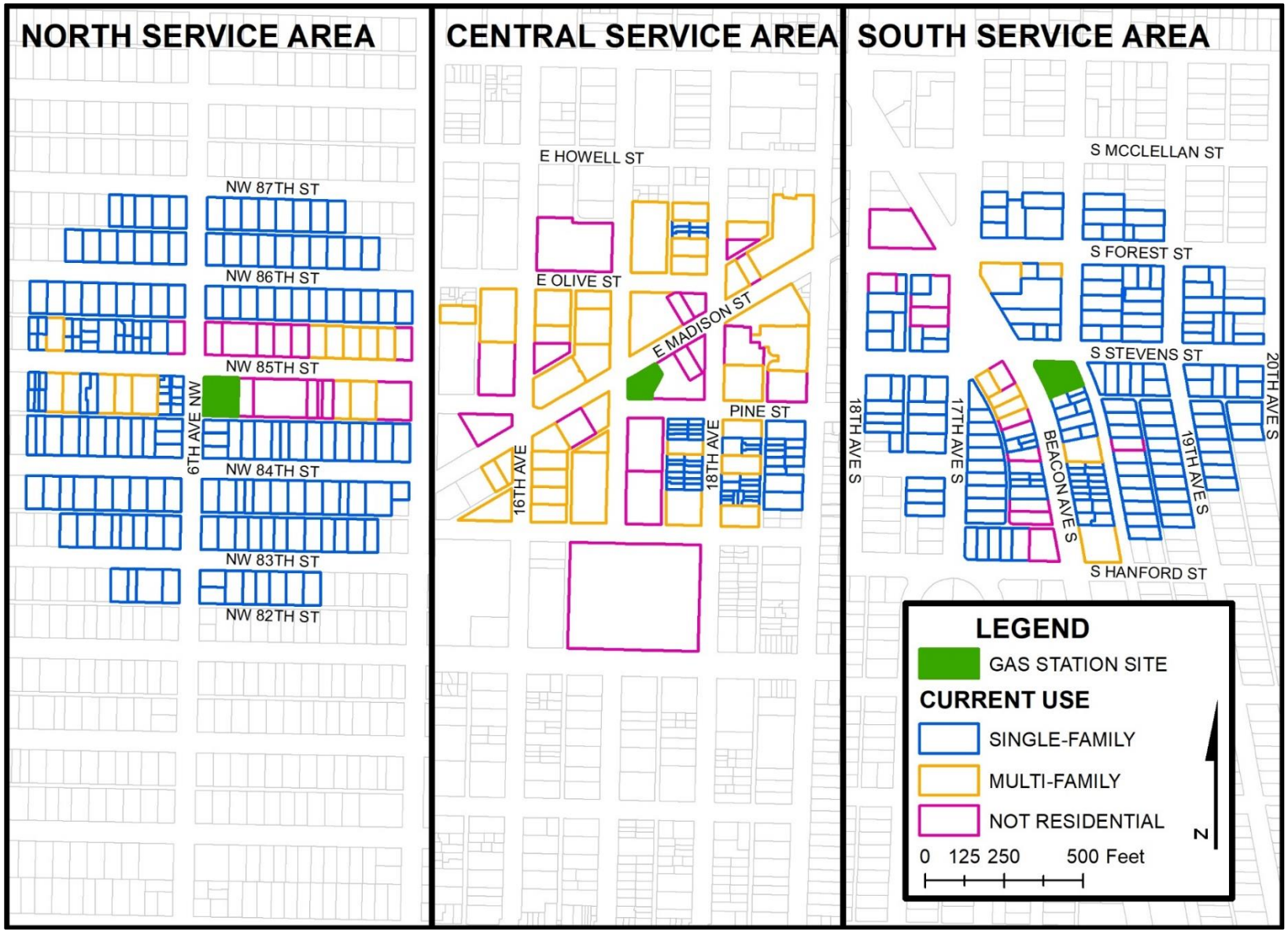

Figure 4: Pocket Park Service Area Data Source: King County GIS & King County Assessors

4.1.2 Site Service Area

Figure 4 shows the properties within 500 feet of each gas station site. The map also categorizes the surrounding properties by single-family, multi-family (buildings with 3+ units), and other uses (commercial, industrial, etc.). Only single-family and multi-family properties were included in the analysis, as described in the methods section. As shown in **Table 6**, the north gas station site has the most residential properties within its 500-foot service areas compared to the central and south gas station sites.

Table 6: Uses in Service Area			
Use Type	North	Central	South
Single-Family Properties	171	54	157
Condominiums	6	109	2
Multi-family buildings	15	27	5
Other Uses	15	18	12
Total	207	208	176

4.1.3 Applied Park Design

The park design was applied to each of the project sites. **Figure 5, 6, and 7** shows the conceptual layout for all three gas station sites. As shown, each site has a medium size park with an area between 4,700 and 5,200 square feet and a small open area between 4,132 and 5,948 square feet.

Trees were also placed on along the perimeter of each of the sites. As the design criteria for the parks required, a tree was placed every 40 feet of the site's perimeter. This means that the north and south gas station sites had 11 trees placed along their perimeter and the central site had 10.

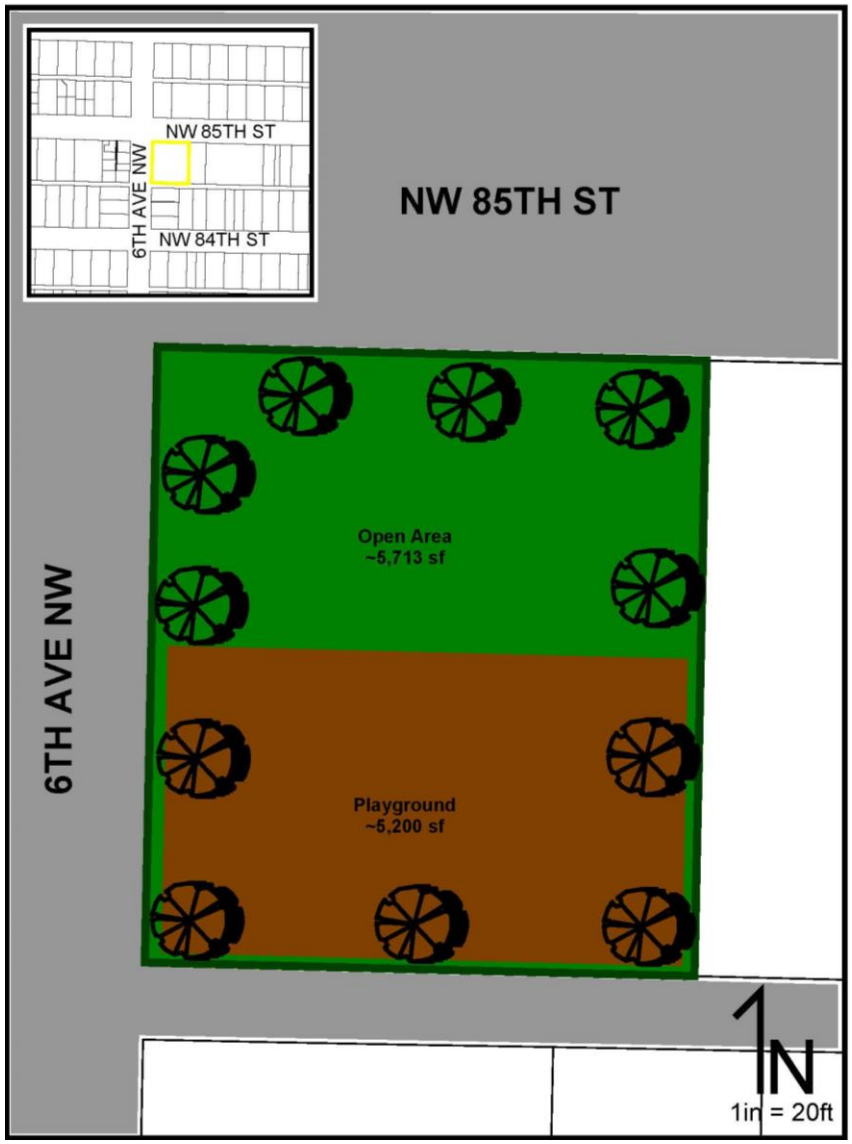

Figure 5: North Gas Station Site Pocket Park Layout

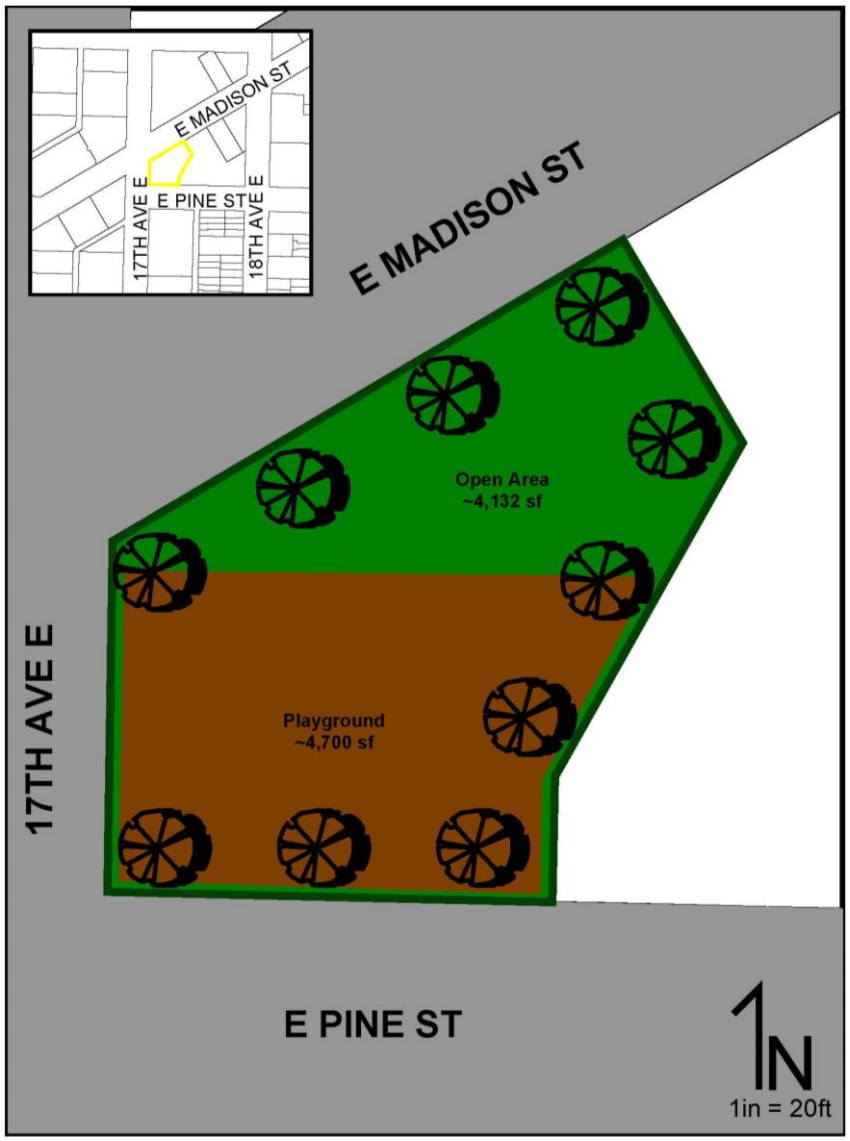

Figure 6: Central Gas Station Site Pocket Park Layout

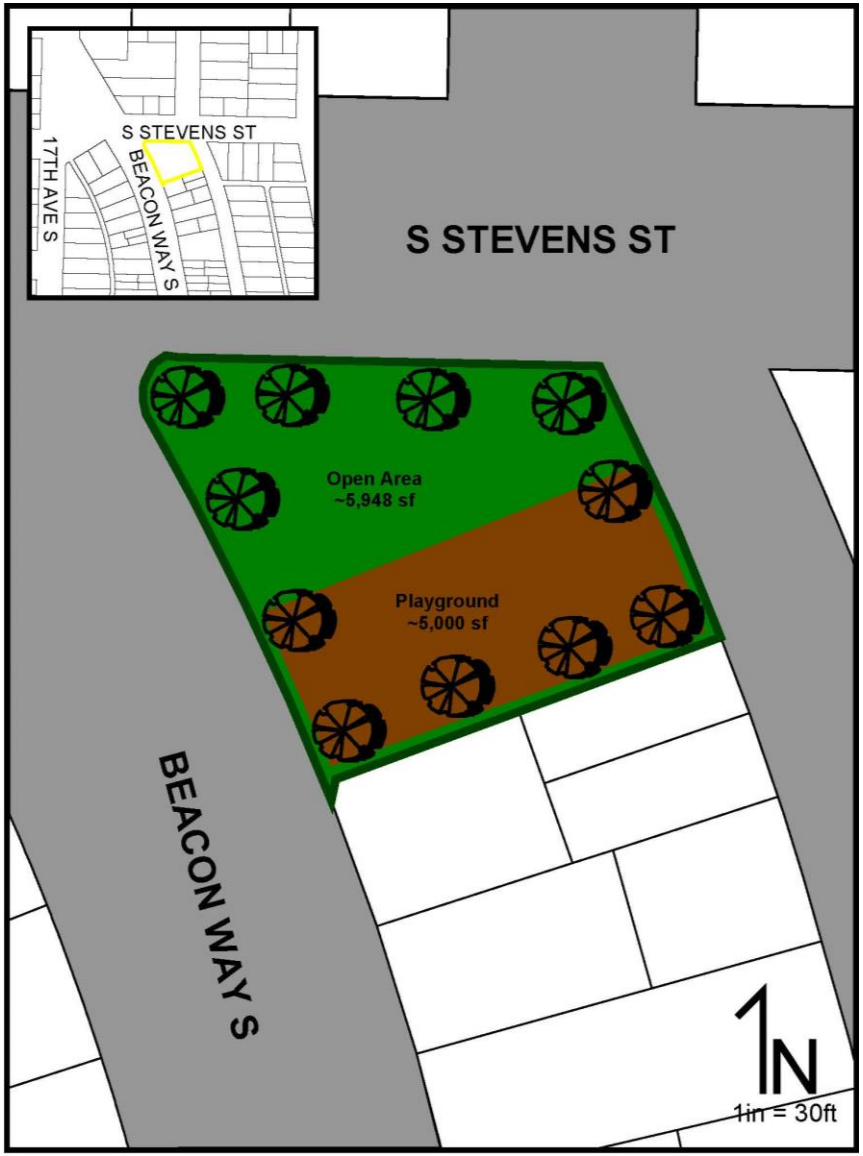

Figure 7: South Gas Station Site Pocket Park Layout

4.2 Benefits and Costs Valuations

After the site characteristics and design were determined, the next step was to determine the cost and benefits of redeveloping each gas station site to a pocket-pocket park. **Tables 7, 8, and 9** are the BCAs for each site. Below is a further discussion about the results of the three sites BCAs.

4.2.1 Site Acquisition

The site acquisition cost for each gas station site differed. For instance, the central gas station site was the most expensive, with a total taxable value of $4,353,200.00. The reason for the difference in assessed taxable value was not researched; however, the difference could be due to the zoning of each site and the site's best possible use.

4.2.2 Gas Station Removal

The cost of removing the existing gas station from each gas station site was relatively similar. As stated in the methods section, a standard cost of $167,469.70 was applied to each site to account for the cost of removing the underground storage tanks and cleaning up the environmental impacts that the USTs could have caused on the site.

The factor that made the gas station removal cost differ between the gas station sites was the cost of demolishing the existing structures. For the analysis, the cost was determined by multiplying the square footage of the existing on-site structures by $7.50 per square foot. The demolition cost for the north gas station site was $35,827.50, which is more than twice as much as that of the central and south gas station sites.

Table 7: North Site Benefit-Cost-Analysis

	Year	0	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Costs	Land Acquisition	$2,788,400.00																												
	Gas Station Clean Up		$167,469.70																											
	Building Demolishing (~4,777 sqft)		$35,827.50																											
	Park Construction			$343,212.37																										
	Medium Playground			$331,294.84																										
	Small Open Area			$9,939.07																										
	Trees (11)			$1,978.46																										
	Maintenance				$19,971.58	$19,971.58	$19,971.58	$19,971.58	$19,971.58	$19,971.58	$19,971.58	$19,971.58	$19,971.58	$19,971.58	$19,971.58	$19,971.58	$19,971.58	$19,971.58	$19,971.58	$19,971.58	$19,971.58	$19,971.58	$19,971.58	$19,971.58	$19,971.58	$19,971.58	$19,971.58	$19,971.58	$19,971.58	$19,971.58	$19,971.58
	Medium Playground				$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11
	Small Open Area				$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15
	Trees (11)				$1,816.32	$1,816.32	$1,816.32	$1,816.32	$1,816.32	$1,816.32	$1,816.32	$1,816.32	$1,816.32	$1,816.32	$1,816.32	$1,816.32	$1,816.32	$1,816.32	$1,816.32	$1,816.32	$1,816.32	$1,816.32	$1,816.32	$1,816.32	$1,816.32	$1,816.32	$1,816.32	$1,816.32	$1,816.32	$1,816.32	$1,816.32
	Total Cost	**$2,788,400.00**	**$203,297.20**	**$343,212.37**	**$19,971.58**	**$19,971.58**	**$19,971.58**	**$19,971.58**	**$19,971.58**	**$19,971.58**	**$19,971.58**	**$19,971.58**	**$19,971.58**	**$19,971.58**	**$19,971.58**	**$19,971.58**	**$19,971.58**	**$19,971.58**	**$19,971.58**	**$19,971.58**	**$19,971.58**	**$19,971.58**	**$19,971.58**	**$19,971.58**	**$19,971.58**	**$19,971.58**	**$19,971.58**	**$19,971.58**	**$19,971.58**	**$19,971.58**	**$19,971.58**
Benefits	Property Tax				$0.00	$16,277.36	$16,277.36	$16,277.36	$16,277.36	$16,277.36	$16,277.36	$16,277.36	$16,277.36	$16,277.36	$16,277.36	$16,277.36	$16,277.36	$16,277.36	$16,277.36	$16,277.36	$16,277.36	$16,277.36	$16,277.36	$16,277.36	$16,277.36	$16,277.36	$16,277.36	$16,277.36	$16,277.36	$16,277.36	$16,277.36
	Seattle Park District Tax				$0.00	$1,532.88	$1,532.88	$1,532.88	$1,532.88	$1,532.88	$1,532.88	$1,532.88	$1,532.88	$1,532.88	$1,532.88	$1,532.88	$1,532.88	$1,532.88	$1,532.88	$1,532.88	$1,532.88	$1,532.88	$1,532.88	$1,532.88	$1,532.88	$1,532.88	$1,532.88	$1,532.88	$1,532.88	$1,532.88	$1,532.88	$1,532.88
	Trees				$99.46	$99.46	$99.46	$99.46	$99.46	$99.46	$99.46	$99.46	$99.46	$99.46	$99.46	$99.46	$99.46	$99.46	$99.46	$99.46	$99.46	$99.46	$99.46	$99.46	$99.46	$99.46	$99.46	$99.46	$99.46	$99.46	$99.46	$99.46
	Stormwater				$56.08	$56.08	$56.08	$56.08	$56.08	$56.08	$56.08	$56.08	$56.08	$56.08	$56.08	$56.08	$56.08	$56.08	$56.08	$56.08	$56.08	$56.08	$56.08	$56.08	$56.08	$56.08	$56.08	$56.08	$56.08	$56.08	$56.08	$56.08
	Air Quality				$17.55	$17.55	$17.55	$17.55	$17.55	$17.55	$17.55	$17.55	$17.55	$17.55	$17.55	$17.55	$17.55	$17.55	$17.55	$17.55	$17.55	$17.55	$17.55	$17.55	$17.55	$17.55	$17.55	$17.55	$17.55	$17.55	$17.55	$17.55
	CO2 reduction				$25.83	$25.83	$25.83	$25.83	$25.83	$25.83	$25.83	$25.83	$25.83	$25.83	$25.83	$25.83	$25.83	$25.83	$25.83	$25.83	$25.83	$25.83	$25.83	$25.83	$25.83	$25.83	$25.83	$25.83	$25.83	$25.83	$25.83	$25.83
	Total Benefit	**$0.00**	**$0.00**	**$0.00**	**$99.46**	**$17,909.69**	**$17,909.69**	**$17,909.69**	**$17,909.69**	**$17,909.69**	**$17,909.69**	**$17,909.69**	**$17,909.69**	**$17,909.69**	**$17,909.69**	**$17,909.69**	**$17,909.69**	**$17,909.69**	**$17,909.69**	**$17,909.69**	**$17,909.69**	**$17,909.69**	**$17,909.69**	**$17,909.69**	**$17,909.69**	**$17,909.69**	**$17,909.69**	**$17,909.69**	**$17,909.69**	**$17,909.69**	**$17,909.69**
	Annual Net Benefits (Total Benefit minus Total Cost)	-$2,788,400.00	-$203,297.20	-$343,212.37	-$19,872.12	-$2,061.89	-$2,061.89	-$2,061.89	-$2,061.89	-$2,061.89	-$2,061.89	-$2,061.89	-$2,061.89	-$2,061.89	-$2,061.89	-$2,061.89	-$2,061.89	-$2,061.89	-$2,061.89	-$2,061.89	-$2,061.89	-$2,061.89	-$2,061.89	-$2,061.89	-$2,061.89	-$2,061.89	-$2,061.89	-$2,061.89	-$2,061.89	-$2,061.89	-$2,061.89
	Discounted Annual Net Benefits (Discount Rate = 3.5%)	-$2,788,400.00	-$196,422.42	-$320,392.42	-$17,923.51	-$1,796.82	-$1,736.05	-$1,677.35	-$1,620.62	-$1,565.82	-$1,512.87	-$1,461.71	-$1,412.28	-$1,364.52	-$1,318.38	-$1,273.80	-$1,230.72	-$1,189.10	-$1,148.89	-$1,110.04	-$1,072.50	-$1,036.23	-$1,001.19	-$967.34	-$934.62	-$903.02	-$872.48	-$842.98	-$814.47	-$786.93
	Final Net Benefit (Sum of all Discounted Annual Net Benefits)	**-$3,353,789.09**																												

Table 8: Central Site Benefit-Cost-Analysis

	Year	0	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Costs	Land Acquisition	$4,353,200.00																												
	Gas Station Clean Up		$167,469.70																											
	Building Demolishing (~2,872 sqft)		$21,540.00																											
	Park Construction			$343,029.91																										
	Medium Playground			$331,294.84																										
	Small Open Area			$9,939.07																										
	Trees (10)			$1,796.00																										
	Maintenance				$19,806.46	$19,806.46	$19,806.46	$19,806.46	$19,806.46	$19,806.46	$19,806.46	$19,806.46	$19,806.46	$19,806.46	$19,806.46	$19,806.46	$19,806.46	$19,806.46	$19,806.46	$19,806.46	$19,806.46	$19,806.46	$19,806.46	$19,806.46	$19,806.46	$19,806.46	$19,806.46	$19,806.46	$19,806.46	$19,806.46	$19,806.46
	Medium Playground				$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11
	Small Open Area				$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15
	Trees (10)				$1,651.20	$1,651.20	$1,651.20	$1,651.20	$1,651.20	$1,651.20	$1,651.20	$1,651.20	$1,651.20	$1,651.20	$1,651.20	$1,651.20	$1,651.20	$1,651.20	$1,651.20	$1,651.20	$1,651.20	$1,651.20	$1,651.20	$1,651.20	$1,651.20	$1,651.20	$1,651.20	$1,651.20	$1,651.20	$1,651.20	$1,651.20
	Total Cost	**$4,353,200.00**	**$189,009.70**	**$343,029.91**	**$19,806.46**	**$19,806.46**	**$19,806.46**	**$19,806.46**	**$19,806.46**	**$19,806.46**	**$19,806.46**	**$19,806.46**	**$19,806.46**	**$19,806.46**	**$19,806.46**	**$19,806.46**	**$19,806.46**	**$19,806.46**	**$19,806.46**	**$19,806.46**	**$19,806.46**	**$19,806.46**	**$19,806.46**	**$19,806.46**	**$19,806.46**	**$19,806.46**	**$19,806.46**	**$19,806.46**	**$19,806.46**	**$19,806.46**	**$19,806.46**
Benefits	Property Tax				$0.00	$25,322.92	$25,322.92	$25,322.92	$25,322.92	$25,322.92	$25,322.92	$25,322.92	$25,322.92	$25,322.92	$25,322.92	$25,322.92	$25,322.92	$25,322.92	$25,322.92	$25,322.92	$25,322.92	$25,322.92	$25,322.92	$25,322.92	$25,322.92	$25,322.92	$25,322.92	$25,322.92	$25,322.92	$25,322.92	$25,322.92	$25,322.92
	Seattle Park District Tax				$0.00	$2,384.72	$2,384.72	$2,384.72	$2,384.72	$2,384.72	$2,384.72	$2,384.72	$2,384.72	$2,384.72	$2,384.72	$2,384.72	$2,384.72	$2,384.72	$2,384.72	$2,384.72	$2,384.72	$2,384.72	$2,384.72	$2,384.72	$2,384.72	$2,384.72	$2,384.72	$2,384.72	$2,384.72	$2,384.72	$2,384.72	$2,384.72
	Trees				$90.41	$90.41	$90.41	$90.41	$90.41	$90.41	$90.41	$90.41	$90.41	$90.41	$90.41	$90.41	$90.41	$90.41	$90.41	$90.41	$90.41	$90.41	$90.41	$90.41	$90.41	$90.41	$90.41	$90.41	$90.41	$90.41	$90.41	$90.41
	Stormwater				$50.98	$50.98	$50.98	$50.98	$50.98	$50.98	$50.98	$50.98	$50.98	$50.98	$50.98	$50.98	$50.98	$50.98	$50.98	$50.98	$50.98	$50.98	$50.98	$50.98	$50.98	$50.98	$50.98	$50.98	$50.98	$50.98	$50.98	$50.98
	Air Quality				$15.95	$15.95	$15.95	$15.95	$15.95	$15.95	$15.95	$15.95	$15.95	$15.95	$15.95	$15.95	$15.95	$15.95	$15.95	$15.95	$15.95	$15.95	$15.95	$15.95	$15.95	$15.95	$15.95	$15.95	$15.95	$15.95	$15.95	$15.95
	CO2 reduction				$23.48	$23.48	$23.48	$23.48	$23.48	$23.48	$23.48	$23.48	$23.48	$23.48	$23.48	$23.48	$23.48	$23.48	$23.48	$23.48	$23.48	$23.48	$23.48	$23.48	$23.48	$23.48	$23.48	$23.48	$23.48	$23.48	$23.48	$23.48
	Total Benefit	**$0.00**	**$0.00**	**$0.00**	**$90.41**	**$27,798.05**	**$27,798.05**	**$27,798.05**	**$27,798.05**	**$27,798.05**	**$27,798.05**	**$27,798.05**	**$27,798.05**	**$27,798.05**	**$27,798.05**	**$27,798.05**	**$27,798.05**	**$27,798.05**	**$27,798.05**	**$27,798.05**	**$27,798.05**	**$27,798.05**	**$27,798.05**	**$27,798.05**	**$27,798.05**	**$27,798.05**	**$27,798.05**	**$27,798.05**	**$27,798.05**	**$27,798.05**	**$27,798.05**
	Annual Net Benefits (Total Benefit minus Total Cost)	-$4,353,200.00	-$189,009.70	-$343,029.91	-$19,716.05	$7,991.59	$7,991.59	$7,991.59	$7,991.59	$7,991.59	$7,991.59	$7,991.59	$7,991.59	$7,991.59	$7,991.59	$7,991.59	$7,991.59	$7,991.59	$7,991.59	$7,991.59	$7,991.59	$7,991.59	$7,991.59	$7,991.59	$7,991.59	$7,991.59	$7,991.59	$7,991.59	$7,991.59	$7,991.59	$7,991.59
	Discounted Annual Net Benefits (Discount Rate = 3.5%)	-$4,353,200.00	-$182,618.07	-$320,222.09	-$17,782.75	$6,964.21	$6,728.70	$6,501.16	$6,281.31	$6,068.90	$5,863.67	$5,665.39	$5,473.80	$5,288.70	$5,109.85	$4,937.06	$4,770.10	$4,608.79	$4,452.94	$4,302.36	$4,156.87	$4,016.30	$3,880.48	$3,749.26	$3,622.47	$3,499.97	$3,381.62	$3,267.26	$3,156.77	$3,050.02
	Final Net Benefit (Sum of all Discounted Annual Net Benefits)	**-$4,755,024.93**																												

Table 9: South Site Benefit-Cost-Analysis

		2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Costs	Land Acquisition	$1,723,300.00			$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
	Gas Station Clean Up		$167,469.70		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
	Building Demolishing (~2080 sqft)		$15,600.00		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
	Park Construction			$343,212.37	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
	Medium Playground			$331,294.84	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
	Small Open Area			$9,939.07	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
	Trees (11)			$1,978.46	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
	Maintenance				$19,971.58	$19,971.58	$19,971.58	$19,971.58	$19,971.58	$19,971.58	$19,971.58	$19,971.58	$19,971.58	$19,971.58	$19,971.58	$19,971.58	$19,971.58	$19,971.58	$19,971.58	$19,971.58	$19,971.58	$19,971.58	$19,971.58	$19,971.58	$19,971.58	$19,971.58	$19,971.58	$19,971.58	$19,971.58	$19,971.58	$19,971.58	$19,971.58
	Medium Playground				$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11	$16,565.11
	Small Open Area				$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15	$1,590.15
	Trees (11)				$1,816.32	$1,816.32	$1,816.32	$1,816.32	$1,816.32	$1,816.32	$1,816.32	$1,816.32	$1,816.32	$1,816.32	$1,816.32	$1,816.32	$1,816.32	$1,816.32	$1,816.32	$1,816.32	$1,816.32	$1,816.32	$1,816.32	$1,816.32	$1,816.32	$1,816.32	$1,816.32	$1,816.32	$1,816.32	$1,816.32	$1,816.32	$1,816.32
	Total Cost	**$1,723,300.00**	**$183,069.70**	**$343,212.37**	**$19,971.58**	**$19,971.58**	**$19,971.58**	**$19,971.58**	**$19,971.58**	**$19,971.58**	**$19,971.58**	**$19,971.58**	**$19,971.58**	**$19,971.58**	**$19,971.58**	**$19,971.58**	**$19,971.58**	**$19,971.58**	**$19,971.58**	**$19,971.58**	**$19,971.58**	**$19,971.58**	**$19,971.58**	**$19,971.58**	**$19,971.58**	**$19,971.58**	**$19,971.58**	**$19,971.58**	**$19,971.58**	**$19,971.58**	**$19,971.58**
Benefits	Property Tax				$0.00	$13,314.15	$13,314.15	$13,314.15	$13,314.15	$13,314.15	$13,314.15	$13,314.15	$13,314.15	$13,314.15	$13,314.15	$13,314.15	$13,314.15	$13,314.15	$13,314.15	$13,314.15	$13,314.15	$13,314.15	$13,314.15	$13,314.15	$13,314.15	$13,314.15	$13,314.15	$13,314.15	$13,314.15	$13,314.15	$13,314.15	$13,314.15
	Seattle Park District Tax				$0.00	$1,253.82	$1,253.82	$1,253.82	$1,253.82	$1,253.82	$1,253.82	$1,253.82	$1,253.82	$1,253.82	$1,253.82	$1,253.82	$1,253.82	$1,253.82	$1,253.82	$1,253.82	$1,253.82	$1,253.82	$1,253.82	$1,253.82	$1,253.82	$1,253.82	$1,253.82	$1,253.82	$1,253.82	$1,253.82	$1,253.82	$1,253.82
	Trees				$99.46	$99.46	$99.46	$99.46	$99.46	$99.46	$99.46	$99.46	$99.46	$99.46	$99.46	$99.46	$99.46	$99.46	$99.46	$99.46	$99.46	$99.46	$99.46	$99.46	$99.46	$99.46	$99.46	$99.46	$99.46	$99.46	$99.46	$99.46
	Stormwater				$56.08	$56.08	$56.08	$56.08	$56.08	$56.08	$56.08	$56.08	$56.08	$56.08	$56.08	$56.08	$56.08	$56.08	$56.08	$56.08	$56.08	$56.08	$56.08	$56.08	$56.08	$56.08	$56.08	$56.08	$56.08	$56.08	$56.08	$56.08
	Air Quality				$17.55	$17.55	$17.55	$17.55	$17.55	$17.55	$17.55	$17.55	$17.55	$17.55	$17.55	$17.55	$17.55	$17.55	$17.55	$17.55	$17.55	$17.55	$17.55	$17.55	$17.55	$17.55	$17.55	$17.55	$17.55	$17.55	$17.55	$17.55
	CO2 reduction				$25.83	$25.83	$25.83	$25.83	$25.83	$25.83	$25.83	$25.83	$25.83	$25.83	$25.83	$25.83	$25.83	$25.83	$25.83	$25.83	$25.83	$25.83	$25.83	$25.83	$25.83	$25.83	$25.83	$25.83	$25.83	$25.83	$25.83	$25.83
	Total Benefit	**$0.00**	**$0.00**	**$0.00**	**$99.46**	**$14,667.44**	**$14,667.44**	**$14,667.44**	**$14,667.44**	**$14,667.44**	**$14,667.44**	**$14,667.44**	**$14,667.44**	**$14,667.44**	**$14,667.44**	**$14,667.44**	**$14,667.44**	**$14,667.44**	**$14,667.44**	**$14,667.44**	**$14,667.44**	**$14,667.44**	**$14,667.44**	**$14,667.44**	**$14,667.44**	**$14,667.44**	**$14,667.44**	**$14,667.44**	**$14,667.44**	**$14,667.44**	**$14,667.44**
	Annual Net Benefits (Total Benefit minus Total Cost)	-$1,723,300.00	-$183,069.70	-$343,212.37	-$19,872.12	-$5,304.14	-$5,304.14	-$5,304.14	-$5,304.14	-$5,304.14	-$5,304.14	-$5,304.14	-$5,304.14	-$5,304.14	-$5,304.14	-$5,304.14	-$5,304.14	-$5,304.14	-$5,304.14	-$5,304.14	-$5,304.14	-$5,304.14	-$5,304.14	-$5,304.14	-$5,304.14	-$5,304.14	-$5,304.14	-$5,304.14	-$5,304.14	-$5,304.14	-$5,304.14
	Discounted Annual Net Benefits (Discount Rate = 3.5%)	-$1,723,300.00	-$176,878.94	-$320,392.42	-$17,923.51	-$4,622.25	-$4,465.95	-$4,314.92	-$4,169.01	-$4,028.03	-$3,891.81	-$3,760.21	-$3,633.05	-$3,510.19	-$3,391.49	-$3,276.80	-$3,165.99	-$3,058.93	-$2,955.49	-$2,855.54	-$2,758.98	-$2,665.68	-$2,575.54	-$2,488.44	-$2,404.29	-$2,322.99	-$2,244.43	-$2,168.53	-$2,095.20	-$2,024.35
	Final Net Benefit (Sum of all Discounted Annual Net Benefits)	**-$2,317,342.99**																												

4.2.3 Park Construction and Maintenance

The cost to construct and maintain each pocket park was similar. **Tables 7, 8, and 9** show that it costs $343,212.37 to construct a pocket park on the north and south gas station sites and $343,029.91 on the central gas station site. The annual cost to maintain the north and south gas station sites was $19,971.58, and the annual cost to maintain the central gas station site was $19,806.46. The construction and maintenance costs of each gas station site are similar because each site has the same park design, and the only difference is that the central gas station site has one fewer tree than the other two sites.

4.2.4 Annual Property Tax Increase

The additional annual City of Seattle property taxes and Seattle Metropolitan Park District property taxes received from residential properties due to redeveloping the gas station to a pocket park differed for each gas station site. The central gas station site collected the most additional property tax per year, with an annual additional collection of $27,707.64. The north gas station site had the second highest additional annual property tax collected with $17,810.23, and the south gas station site had the least with only $14,567.98.

4.2.5 Tree Benefit

The annual benefit each park's trees provided was then determined using the i-Tree Design computer software. **Tables 7, 8, and 9** show the annual benefit that each park's trees had on stormwater retention, CO2 retention, and air pollutant cleanup. The north and south gas station site trees had the greatest annual benefit of $99.46 compared to the central site trees, which had a benefit of $90.41. This difference is due to the north and south sites having one more tree than the central gas station site.

4.3 Benefit-Cost Analysis Results

As shown in **Tables 7, 8, and 9**, all three sites had a negative net benefit (with the discount rate applied). For instance, the park with the lowest negative net benefit was the south gas station site, with a net benefit of -$2,317,342.99. The north gas station site had the second lowest negative net benefit of -$3,353,789.09, and the north had the highest negative net benefit of -$4,755,024.93. With all three sites having a negative net benefit, the costs associated with redeveloping a gas station site to a pocket park were greater than the benefits.

One of the factors that made it so the costs were higher than the benefits was the price to purchase each site. All three sites had assessed values greater than $1,000,000, with the central gas station site having the highest assessed value of $4,353,200.00. This means that the annual benefits needed to be greater than the annual costs so that the net annual benefit could make up for the initial acquisition cost. However, this was not the case; the annual benefits for all sites were less than the annual cost. In return, this caused each site's net benefit to increase throughout the project's lifespan.

4.4 Findings

Due to each gas station site's BCA resulting in a negative net benefit, it means that the answer to the research question is that if the City of Seattle chooses to purchase gas station sites and redevelop them as pocket parks, it will not provide the city with a benefit because the monetary value of the benefits do not outweigh the monetary value of the costs. The results also mean that the hypothesized answer to the research question was incorrect. **Table 10** provides answers to the research question and its sub-questions.

Table 10: Answers to Research Questions and Hypotheses		
	Question	Answer
Research Question	Will there be a benefit to the City of Seattle if the City chooses to purchase gas station sites and redevelop them as pocket parks?	There is a negative net benefit to the City of Seattle if it chooses to purchase gas station sites and redevelop them as pocket parks.
Sub-question 1	What are the costs associated with purchasing gas station sites and redeveloping them as pocket parks?	**Table 2** identifies the cost associated with purchasing gas station sites
Sub-question 2	What are the benefits associated with purchasing gas station sites and redeveloping them as pocket parks?	**Table 2** identifies the benefits associated with purchasing gas station sites
Sub-question 3	Can all of the identified costs and benefits be placed in monetary values?	No, there are tangible and intangible costs and benefits. Table 2 identifies what benefits are tangible and intangible.
Sub-question 4	Does redeveloping gas station sites to pocket parks provide a greater net benefit in different locations within the City of Seattle?	Yes, redeveloping a gas station site in south Seattle provided a greater net benefit than developing a gas station site in north or central Seattle.
Sub-question 5	What characteristics about a gas station site increase the benefits and costs?	Yes, if a gas station site is closer to more residential homes, there will be more additional property taxes collected.

5.0 Discussion

The purpose of the discussion section is to relate the outcomes and findings of each gas station site's BCA to the existing literature on brownfield redevelopment and parks. Also, at the end of this section, possible alternatives will be discussed that could change the outcomes of the BCAs.

5.1 Large Costs

The acquisition cost to purchase a gas station site was the most limiting factor and was why BCAs resulted in a negative net benefit for each gas station site. The final result, however, is consistent with other research on brownfield redevelopment. For instance, much of De Sousa's research on brownfield redevelopment has focused on the cost and benefits of brownfield redevelopment projects and how the costs limit the success or implantation of those projects. For example, in one of De Sousa's research articles, he reviewed three brownfields to green space redevelopment projects, Elmhurst Park New York City, South Waterfront Portland, and Menomonee Valley Milwaukee, and found that the limiting factor to all three projects was the land acquisition cost, the initial unknown soil contamination cleanup cost and the long term cost to maintain the parks, all of which were limiting factors to the three gas station sites project that are included in this thesis (De Sousa 2014).

In another of De Sousa's articles, he found that developers in the City of Toronto, Canada, would not take on brownfield to park redevelopment projects because they do not provide any economic benefit (Sousa 2003). In other words, developers have found that the monetary costs of redeveloping brownfields in the City of Toronto are greater than the monetary value of their benefits. This finding is consistent with the results of this thesis, where the annual benefit of redeveloping gas station sites into pocket parks was less than the annual costs. This means the

findings of this thesis further support the claim of the developers and that the City of Seattle should think of other uses for gas station sites to be redeveloped to.

One solution, however, that would assist with removing some of the associated costs of redeveloping gas station sites and other brownfield sites into parks is if there was additional government assistance for the acquisition of the brownfield sites and the cleanup of these sites. As the literature review identifies, the United States Environmental Protection Agency and the Washington State Department of Ecology provide financial assistance for cleaning brownfield sites, like the Oversight Remedial Action Grants UST Financial Assurance Funds. However, there needs to be additional research done to determine if these grants are alleviating the financial impacts that cleaning up the site has and what other government funding is needed to remove these projects' financial barriers.

5.2 The Need For Other Impacts

One of the limitations of this thesis is that it only used tangible cost and benefit to the City of Seattle itself. This could be an issue because the intangible cost and benefits could provide further reasoning for why the City should or should not move forward with purchasing gas station sites and redeveloping them as pocket parks. For instance, the City of Seattle is trying to become more equitable and address some of its past social and environmental injustices (City of Seattle 2016). This means that a new park in an area of the City that has been historically overlooked due to racial biases could provide a greater benefit than the monetary value of the costs associated with purchasing the gas station site and redeveloping it into a pocket park. The issue with using these

intangible impacts is that further research would need to be done to place a monetary value on these impacts or to justify how these intangible impacts outweigh tangible impacts.

Other impacts left out of this analysis were those redeveloping a gas station site to a pocket park would have on the surrounding residents. Some examples of impacts to the surrounding residents would be the benefit of living closer to a recreational opportunity and the cost of losing the gas station (Cohen et al. 2014). However, these impacts were not included due to how different people value living near a park and a gas station. For instance, this thesis used national averages from existing literature and practice to place the included impacts into monetized values, but national averages could not be used to determine how a resident near one of the gas station sites felt about the project because they may place a higher value on living close to a gas station or park than someone in Denver, Colorado, for example. This means that to place a monetary value to the impacts to the surrounding residents, further analysis would need to be done, like surveying the residents surrounding each gas station site to determine what kind of value they place on living near a gas station or pocket park.

As identified above, the BCA this thesis used did not include intangible impacts the projects would have on the City, surrounding residents, and the environment. This is a limitation of a BCA, which is why some researchers use other analysis tools to include intangible impacts. For example, Lesage et al. used a life cycle analysis (LSA) to assess the impacts of brownfield redeveloped projects (2007). The authors chose to use an LSA because it is a tool that can compare

the inputs and outputs of a brownfield redevelopment project. Also, the LSA could include intangible impacts to the environment and surrounding neighborhoods, which cannot be included in a BCA. As a result of the LSA providing an option to compare intangible impacts, it may be a creditable alternative method that could be used in future research on whether redeveloping gas station sites into pocket parks would provide a benefit.

5.3 Implementation of Theory

Even though the analysis results suggested that redeveloping gas station sites to pocket parks would not be an effective redeveloping option for gas station sites, it may still provide a benefit because it implements the planning and urban design theories that were discussed in the literature review. For example, As Spirn highlights, cities should not be designed to be economic machines but instead for the people (Spirn 1984). This means a city should value the benefits to its residents, not just the profit that a project will bring to the city. In context with this thesis, redeveloping a gas station site into pocket parks and having that project provide a monetary net benefit to the City of Seattle should not be the project's goal because the pocket park could provide the surrounding residents and environment a greater benefit than a gas station or other use can provide.

Also, both Jacobs and Spirn identify that projects in a city should address more than one problem that a city is currently facing (Spirn 1984; Jacobs 1961). Redeveloping a gas station site to a pocket park in a city would address multiple problems because it would address the environmental issues that a gas station poses on the surrounding environment and provide a park space to an area of the city that does not currently have any. This is important because if another gas station site is redeveloped to another use, it may fill a city’s need for more commercial or residential space but may increase the site's impact on the environment and surrounding residents.

Additionally, by providing new park space in a city, it would implement the goals of new Urbanism and urban ecology. For instance, New Urbanism implements a city design strategy that includes multiple uses and the natural environment, and by redeveloping gas station sites into pocket parks, it would provide green space to commercial and residential areas within a city. Also, as addressed in **Table 11**, this kind of project would implement the four urban ecology goals that Spirn identified that all projects need to address.

Table 11: Implementation of Urban Ecology Goals

Urban Ecology Goals (Spirn 1984, 261)	Implementation
Address the place of the site within the urban ecosystem as a whole, including its relationship to the city's most critical problems	Redeveloping gas station sites into pocket parks would provide new park space to a place in the city that currently doesn't have any. This would provide residents surrounding the site with new recreation, resting, and gathering opportunities.
Respond to the problems and the opportunities posed by the site and its immediate neighborhood	Redeveloping gas station sites to pocket parks would remove harmful environmental pollutants due to leaks from the gas station's underground storage tanks and consumer spills.
Design buildings and the landscape to conserve energy and reduce waste	The proposal would not include any buildings, but a pocket park would provide trees and other land covers that could reduce temperatures in the city. This means that the building surrounding the park may not need to use as much electricity to cool the building.
Exploit the site's distinctive microclimatic, geological, hydrologic, and biological character."	If a pocket park is placed on a gas station site, it could have benefits like reducing surrounding temperatures, providing habitat for small animals, and it could be designed to take advantage of the surrounding microclimate and geologic character.

Finally, even though redeveloping gas station sites into pocket parks would implement the identified planning and urban design theory, it is important to mention one of Jacobs overarching ideas that when a city is working on a project, it should include the surrounding resident's input to make sure the project is filling the resident's needs and not just what the city planners think the residents need (1961). This means that a pocket park may not be what the residents surrounding

the gas station site need; they may need a grocery store or a public bathroom. In return, if a city chooses to purchase gas station sites and redevelop them as pocket parks, the city would need to talk with the surrounding residents and determine if a pocket park is what the residents need or if another use would better fit their needs.

5.4 Sensitivity Tests

Table 12 identifies the results of sensitivity tests that were run to determine if different alternatives would affect the outcome of the BCAs for each gas station site included in this thesis. The first consideration that was taken into account was reducing the purchase price of each gas station site by half its assessed taxable value. A reduced purchase price was considered because it is likely that the price of the gas station sites would be less than their taxable value due to the need to clean up the onsite contaminants. As shown in **Table 12**, by reducing each gas station's purchase price by half its assessed taxable value, each site's BCA's final negative net benefit was reduced by almost half. The reduction in the final net benefits is due to the purchase price of each site being the most expensive cost of each redevelopment project.

The next consideration that was reviewed was if the current property owner of each gas station site was required to pay to clean up the onsite contaminants and demolish the existing structures before the City purchased the site gas station sites. This consideration is important because it places the responsibility on the current owner to pay for the impacts their business has had on the surrounding environment. When the cost to clean up the contaminants and demolish the existing structure was removed from each gas station site's BCA, the final net benefit was of each BCA was reduced by approximately $270,000.

Table 12: Sensitivity Test Considerations			
Consideration	North Gas Station Site Net Benefit	Central Gas Station Site Net Benefit	South Gas Station Site Net Benefit
No Considerations	-$3,353,789.09	-$4,755,024.93	-$2,317,342.99
Purchase gas station site for 50% of assessed taxable value	-$1,959,589.09	-$2,578,424.93	-$1,455,692.99
Existing property owner does clean up	-$3,170,280.50	-$4,580,079.11	-$2,155,064.80
Population Increase	-$3,081,836.15	-$4,290,195.56	-$2,072,947.43
Zero Discount Rate	-$3,406,328.86	-$4,705,166.02	-$2,402,057.78

The third consideration that was taken into account was if the annual additional property taxes collected increased by 5% due to an increase in residential density surrounding the gas station site. Increased property tax revenue due to an increased density is essential to consider because it is likely that during each project's lifespan, some of the properties surrounding each gas station site will be redeveloped to a higher density residential use to accommodate the City's projected population growth. When the 5% increase was applied to the additional annual property tax revenue benefit for each site, it reduced all of the site's final negative net benefit. The additional property tax benefit had the most significant reduction on the central gas station site's final negative net benefit by reducing it by $464,829.37.

The final consideration that was reviewed was using a discount rate of zero. Using a zero discount rate was a consideration because its standard practice for a BCA to use a zero discount rate when evaluating environmental projects like redeveloping gas station sites to pocket parks. A zero discount rate is used for environmental projects because environmental projects are "non-time-degradable commitment" due to the benefits that the project will provide future generations

(Hasselmann et al. 1997). As shown in **Table 12**, when the zero discount rate was applied, it increased the final negative net benefit for each gas station site. The increase in the final negative net benefit is due to each gas station site's annual negative net benefits no longer being discounted over time. Due to a zero discount rate increasing the final negative net benefit for each project, it suggests the City should only use a discount rate of zero if the annual net benefit is positive.

6.0 Conclusion

The purpose of this thesis was to answer the research question, will there be a benefit to the City of Seattle if the City chooses to purchase gas station sites and redevelop them as pocket parks? To answer the question, a benefit-cost analysis (BCA) was used to compare the monetary costs and benefits redeveloping three gas station sites to pocket parks would have on the City of Seattle. The analysis found that the costs associated with redeveloping gas station sites to pocket parks were much greater than the benefits, and the outcome of each gas station sites BCA was a negative net benefit. With all three gas station site's BCAs resulting in a negative net benefit, it suggests that the City should not purchase gas station sites and redevelop them to pocket parks. For future BCAs on redeveloping gas station sites to pocket parks, the City should consider alternatives to reduce the project's costs, like purchasing the gas station site for a reduced price and having the current property owner clean up the onsite contaminants before purchasing a gas station site.

The results of this analysis provide some implications for future academic researchers. The first is that more research needs to be done on the intangible impacts of redeveloping gas station sites to pocket parks so they can be converted into monetary value and used in the BCA. Also, the thesis brings to light that a BCA may not be the best analysis tool to compare the impact that redeveloping gas station sites to pocket parks would have. This means that future researchers should look at alternative research methods that compare both tangible and intangible impacts.

Finally, this thesis provides some implications for planning professionals. The main implication is that the monetary benefits of redeveloping gas station sites into pocket parks will not outweigh the monetary costs, and this redevelopment strategy will ultimately cost the jurisdiction money. However, this thesis argues that redeveloping gas station sites to pocket parks

would benefit the surrounding environment and residents and implement the current planning theory. This means that planners should look further into the intangible impacts that redeveloping gas station sites to pocket parks will have on the surrounding environment and residents and consider possible alternatives to reduce the costs.

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