Identifying the Potential for Intensive Green Roof Farming in New York City

Prepared by Sierra McComas

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Abstract

Climate change, capitalism, globalism, densification of cities, and the rise of large scale monocrop farming have created an environmental landscape of food instability and a lost opportunity for human connection to and through food, especially in dense urban landscapes like New York City.[1] One solution to cultivate healthy human connections with and through food, while also addressing economic and environmental pressures is through the practice of rooftop farming. This research presents a guide to selecting potential sites for rooftop farm development in NYC and what design typologies might be implemented. This work incorporates the three elements of a sustainable business through the lens of the triple bottom line (people, planet, and profit). This work uses a three phase process of GIS analysis and ground truthing, typological classification schema via site visitation of case studies, and research by design to produce potential projective designs pulling from the locations identified through GIS and the typologies discovered. Through these methods, thousands of sites and many design potentials were identified and categorized with relation to how they most strongly relate to one of the three motivational elements of the triple bottom line and how each element influences a rooftop farm development. This work intends to serve as a resource that will lead to the expansion and proliferation of rooftop farming in urban environments.

[1] Lyson, Thomas A. *Civic Agriculture : Reconnecting Farm, Food, and Community*. Civil Society. (Medford, Mass.: Lebanon, NH: Tufts University Press; University Press of New England, 2004), Kindle.

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Preface

Description of Vision

More people now than ever are moving into urban areas, and while cities become more dense, rural areas traditionally designated for farming become more corporate and mechanized as the number of farmers dwindle.[2] This combination of occurrences has led to a disconnect between people and their food in a way that has never been experienced at such a scale before. Easy access to processed foods, high prices on organic produce, large scale monoculture production, factory farming, and geographic dissonance has created an environment that has cultivated negative externalities for both people and the planet.

Visiting New York City today is a bustling experience in the paradigm of American urban architectural form. Towering levels of glass, steel and concrete overwhelm the human scale of perception. In this urban context, the opportunities for green spaces at street level are confined to designated areas and a scattering of parks to provide relief from the enclosure of the overwhelming built world.

Now imagine adding a second level of landscape to this environment. If all the space at ground level is currently occupied and unable to support greenery due to polluted soils, shading by structures, and exorbitant value of property, one promising solution is to move the presence of green spaces to rooftops. In this environment, rooftop gardens have many benefits. Not only do rooftops have more access to sunlight, the implementation of green roofs takes unused spaces and turns them into constructive and dynamic environments as urban habitat.

Rooftop farms, specifically, provide a unique and extremely productive solution to many of the environmental and social issues that are present within New York City and many cities across the world. Often, environmental and social issues can be ignored in United States where capitalism is the driving force of decision-making. This thesis makes the argument for intensive green roof farming through a framework of an encompassing ideology of production assessment called the triple bottom line, which in addition to the traditional evaluation of profit, incorporates the impacts of a business through the lenses of people and planet as well. This research is intended to create a resource for those interested in rooftop agriculture in New York City. A document that can be used as a guide to assist in identifying sites for rooftop farming and provide design typologies and ideas that could be translated to future rooftop farm projects, all through the lens of the triple bottom line.

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[2] Lyson, Thomas A. *Civic Agriculture : Reconnecting Farm, Food, and Community*. Civil Society. (Medford, Mass.: Lebanon, NH: Tufts University Press; University Press of New England, 2004), Kindle.

Background

Defining of Key Terminologies

Key terminologies that will be used throughout this paper include:

- Rooftop farm: Rooftop farm can refer to many types of agricultural activities being conducted on the roof of a building or other built structure. Such activities might include edible annuals and perennials, small animal agriculture, bee keeping, edible flowers and pollinator species to support bee keeping and encourage pollination of crops.
- Intensive green roof: An intensive green roof is contrasted to "extensive" green roof and is the more complex version of a green roof. Intensive green roofs feature deeper soil (approximately 12 inches or more in soil depth) than extensive green roofs and therefore require more structural support. [3] Due to the deeper depth of the soil strata, intensive green roofs can support a more diverse range of plants including trees and shrubs.[4]
- Intensive green roof farm: This is a term developed for the specific research conducted within this paper. This research focuses on locating and investigating the design of rooftop farms that use full soil coverage (intensive green roof), thus maximizing environmental, social and profit related benefits simultaneously.
- The Triple Bottom Line: The Triple Bottom Line is a term used to address the performances of a business on three levels, the financial, social and environmental. It is often referred to as the "three P's" corresponding to profit, people and planet.[5] It was conceptualized to more fully and accurately account for the full impact of a business and to promote more sustainable practices.
- GIS: GIS stands for Geographic Information System. It is a computer program that, "It analyzes spatial location and organizes layers of information into visualizations using maps and 3D scenes".[6] One standard file type that it uses and is referenced often within this paper is called a "shapefile". A shapefile is a "vector data storage format for storing the location, shape, and attributes of geographic features."[7]

Types of Rooftop Farming

Rooftop farms come in many different varieties, with many different management and ownership structures. Factors that contribute to the type of farm and how it is managed include whether it is commercial based or community based, and if the availability of capital is high or low. There are also variances in the type of medium that plants can be grown in on a roof. Current existing forms of rooftop farming include, soil based farming, hydroponic farming, aquaponic farming and aeroponic farming. Within the practice of soil based farming, there are options for planter based farming, raised bed farming and row crop farming. This thesis focuses

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[3] "Green Roofs-Federal Technology Alert". United States Department of Energy, Office of Energy Efficiency and Renewable Energy. Published 2004, accessed April 1, 2019, https://www.energy.gov/eere/femp/downloads-green-roofs-federal-technology-alert.

[4] "Green Roofs-Federal Technology Alert". *United States Department of Energy.*

[5] "Triple Bottom Line." The Economist. November 17, 2009. Accessed January 10, 2019. https://www.economist.com/news/2009/11/17/triple-bottom-line.

[6] "What Is GIS?" Geographic Information System Mapping Technology. Accessed May 15, 2019. https://www.esri.com/en-us/what-is-gis/overview.

[7] "Shapefiles." ArcGIS. Accessed May 17, 2019. https://doc.arcgis.com/en/arcgis-online/reference/shapefiles.htm.

on soil-based row cropping farms because of their ability to have significant positive benefits regarding all elements of the triple bottom line.

Benefits of Intensive Green Roof Farming

There are many benefits of having an intensive green roof. Combining green roof technology with urban agriculture to create rooftop farms expands even further upon the benefits of both of these fields. Rooftop farming has positive effects for human health (people), environmental sustainability (planet), and economic gains (profit), thereby addressing all three areas of the triple bottom line. These benefits are discussed as follows:

Social

Intensive soil based rooftop farming provides many mental and physical health related benefits. The physical benefits include obvious consequences of production like increased access and availability to fresh fruits, vegetables and herbs. Increased consumption of whole foods, like those produced on rooftop farms, leads to health benefits including but not limited to reduced obesity and increased cardiovascular health.[8] The mental benefits of gardening are also widely ranging. Urban rooftop agriculture fosters community by engaging members of the community through a common practice and space.[9] The opportunity for education and exposure to agriculture that rooftop farming provides in urban contexts addresses the issue of disconnection with food systems that is widespread in society today. In the words of Aldo Leopold, "There are two spiritual dangers in not owning a farm. One is the danger of supposing that breakfast comes from the grocery, and the other that heat comes from the furnace."[10] When given the opportunity to engage with a garden, people develop healthier eating habits, make connections with other community members involved in urban agriculture, and the increased access to green space may lower rates of anxiety and depression.[11]

Rooftop agriculture also has the potential to address food justice issues. In urban contexts there are often areas with low to no local access to whole foods and produce, these are labeled as "food deserts".[12] Typically these areas are composed of at least 20% or more of the population living below the poverty line who are not able to afford to travel to purchase more expensive groceries outside of their neighborhoods.[13] Rooftop agriculture can be practiced by many demographics, and it presents an attainable solution to bringing fresh produce into communities that may currently lack access.

Environmental

The environmental benefits of having an intensive green roof farm are significant and wide ranging. The most notable benefits include creation on habitat, storm water mitigation, reduction of urban heat island effect, improvement of air quality, and reduction of food miles and packaging. These benefits are described in more detail in the following paragraphs.

[8] Mandel, Lauren. *EAT UP*, Kindle Edition..

[9] Mandel, Lauren. EAT UP, Kindle Edition.

[10] Leopold, Aldo, and Schwartz, Charles Walsh. A Sand County Almanac. With Other Essays on Conservation from Round River. Enl. Ed.]. ed. (New York: Oxford University Press, 1966), 6.

[11] Mandel, Lauren. EAT UP, Kindle Edition.

[12] Mandel, Lauren. EAT UP, Kindle Edition.

[13] Mandel, Lauren. EAT UP, Kindle Edition.

Existing intensive green roof agriculture projects have proven to be successful sites for creating natural habitat for bird and insect species. At the Brooklyn Grange rooftop farm, the retention of water in the soil creates a microclimate that attracts monarch butterflies and other insects.[14] There has even been research conducted in NYC on green roofs, which included Eagle Street Rooftop farm that concluded that "both birds and arthropods were more abundant and rich on green roofs than conventional roofs" and that "Establishing green roofs in urban landscapes increases the amount of habitat available for migrating and breeding birds and can partially mitigate the loss of habitat due to increasing urbanization."[15] Not only do green roofs create green space for humans, but they support other animals as well.

Intensive green roof farms provide the most storm water mitigation out of all the forms of rooftop agriculture. The plants and porous soil that make up a rooftop farm absorb rainwater as it falls and allow time for evaporation and evapotranspiration to occur before drainage.[16] These processes significantly reduce the amount of storm water runoff that flows into the sewer systems.[17] Additionally, the soil from rooftop agriculture has potential to retain more water than traditional green roofs due to the higher content of organic matter, which absorbs and retains greater amounts of water than typical green roof growing mediums.[18] Storm water mitigation in New York City is especially important as the city uses a combined sewage system.[19] This means that sewage waste water and storm water flow through the same pipe and drainage systems and in times of high runoff, untreated sewage overflows into the ocean, polluting the environment and causing health hazards.[20] In this densely populated city, 1/10 inch of rain is enough to cause the sewage system to overload and overflow raw effluent into the waterways.[21] The combined nature of the city's sewage system lends even greater importance to the benefits of storm water mitigation that intensive green roof farms provide.

Intensive green roof farming is also a successful solution to addressing urban heat island effect. Urban heat island effect is the phenomenon of urban areas maintaining higher temperatures than surrounding rural areas. This effect is caused by excess heat generated from people, cars, industry and other expenditures of energy.[22] These increased temperatures can lead to issues of human welfare, water quality, and air quality.[23] Plants release water vapor, which has a cooling effect, and soil has the capability to store and transpire water into the atmosphere, which cools the surrounding area. As the water in the soil gains and loses heat at a much slower pace than bare rooftop surfaces, it maintains cooler temperatures and also works to insulate the building below.[24] Through these processes intensive green roof farms create cooler microclimates

[14] Ornstein, Joe. "Brooklyn Grange Tour." Site Tour, 261 Moore St, Brooklyn, NY 11206, May 2nd, 2018.

[15] Partridge DR, Clark JA. "Urban green roofs provide habitat for migrating and breeding birds and their arthropod prey." *PLoS One*. Published 2018 Aug 29. doi:10.1371/journal.pone.0202298

[16] Mandel, Lauren. EAT UP, Kindle Edition.

[17] Mandel, Lauren. EAT UP, Kindle Edition.

[18] Mandel, Lauren. EAT UP, Kindle Edition.

[19] Ornstein, Joe. "Brooklyn Grange Tour." Site Tour, 261 Moore St, Brooklyn, NY 11206, May 2nd, 2018.

[20] Ornstein, Joe. "Brooklyn Grange Tour."

[21] Ornstein, Joe. "Brooklyn Grange Tour."

[22] National Geographic Society. "Urban Heat Island." National Geographic Society. October 09, 2012. Accessed May 04, 2019. https://www.nationalgeographic.org/encyclopedia/urban-heat-island/.

[23] National Geographic Society. "Urban Heat Island."

[24] Mandel, Lauren. EAT UP, Kindle Edition.

in urban areas and as a network can have a more encompassing cooling effect.[25]

Related to the natural processes of vegetation, potential increased air quality is a benefit of rooftop agriculture as vegetation has the ability to uptake and filter particulate matter from the air.[26] Plants also release oxygen and water vapor through their leaves, thus improving air quality and contributing to lower ambient temperatures.[27]

Rooftop agriculture also contributes to environmental and social benefits through reducing food miles.[28] Food miles refer to the number of miles that food is transported before sale.[29] By producing food locally, the amount of greenhouse gases released through transport of imported goods is reduced, thus improving air quality and reducing the impact of food systems on climate change.[30] Local food also typically requires less packaging and uses fewer pesticides, herbicides and fertilizers, leading to less waste and pollution and creating a healthier environment.[31]

Economic

Financial gains possible from rooftop farming include the support of local economies, increases in property values, possible access to subsidies for building owners, and savings in heating and cooling bills and waterproofing expenses. These qualities are explained as follows.

Urban agriculture supports local economies by creating channels for currency to recirculate locally, through the support of local businesses.[32] Intensive green roof farming may also save money for those who take home produce from the farm and has the potential to support economies through the provision of green jobs training.[33] In urban environments there are few opportunities for residents to develop professional agricultural training and rooftop farms provide an economically productive environment for training that may otherwise be difficult to obtain.[34]

Rooftop farming also has potential to increase property values through creating novelty environments for perspective tenants and neighbors. Building owners may increase their revenues through renting rooftop spaces to rooftop farm developers or renting plots to tenants directly.[35] Green roofs may also increase the value of a building by contributing to sustainability rating system credits (i.e. LEED, Sites, Living Building Challenge).[36] Furthermore, intensive green roof farming benefits building owners in the form of related savings from subsidies and tax incentives.[37]

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[25] Mandel, Lauren. EAT UP, Kindle Edition.

[26] Mandel, Lauren. EAT UP, Kindle Edition.

[27] Mandel, Lauren. EAT UP, Kindle Edition.

[28] Mandel, Lauren. EAT UP, Kindle Edition.

[29] Leavens, Molly. "Do Food Miles Really Matter?" Sustainability at Harvard. March 07, 2017. Accessed May 09, 2019. https://green.harvard.edu/news/do-food-miles-really-matter.

[30] Mandel, Lauren. EAT UP, Kindle Edition..

[31] Mandel, Lauren. EAT UP, Kindle Edition.

[32] Mandel, Lauren. *EAT UP*, Kindle Edition.

[33] Mandel, Lauren. *EAT UP*, Kindle Edition.

[34] Mandel, Lauren. *EAT UP*, Kindle Edition..

[35] Mandel, Lauren. *EAT UP*, Kindle Edition.

[36] Meyer, Molly, Brendan Shea, and Lauren Mandel. "The Edible Skyline: Pushing the Limits of Rooftop Agriculture" (presentation, Annual ASLA Meeting and EXPO, Philadelphia, PA) October 22, 2018).

[37] Mandel, Lauren. *EAT UP*, Kindle Edition.

Finally, intensive green roof farming saves building owners and tenants money through reducing heating, cooling and rooftop waterproofing bills. The insulating properties of the rooftop soil buffers against daily temperature fluctuations and reduces costs in heating and cooling utilities.[38] Additionally, soil from intensive green roof farming acts as a protective layer for rooftop waterproofing, doubling to tripling the lifetime performance.[39] This saves building owners in costs related to re-waterproofing their rooftops.

Summary:

Together, these economic, social and environmental benefits lay a strong foundation for the arguments for supporting and proliferating intensive green roof farming throughout New York City and other urban environments.

Why New York?

New York was selected as the chosen location for this research because of its dense urban environment and the existing presence of rooftop agriculture in the city. New York is the most populated city in the United States and as of census bureau estimations in July 2017, approximately 8,622,698 people reside within the five boroughs.[40] In addition, according to 2010 US census data, New York City is the 6th densest city in the US.[41] These factors contribute to making New York home to some of the most expensive real estate per square foot in the country.[42]

Green roofs are a large investment and can be extremely costly to install, thus making them less common in areas where economies are weak or there is already ample green space the street level. An extensive green roof can cost on average somewhere between $18 and $24 per square foot to install, thus limiting their installation when a standard (non-green) roof would only cost approximately $9 per square foot.[43] Due to the high cost of real estate in NYC, the premium of green space, and the untapped potential of space on existing rooftops, New York is a prime location for the expansion of the field of rooftop farming.

Finally, New York City was chosen because of its existing palette of rooftop agriculture. Throughout the city there are thousands of street level community gardens and a growing movement of green roofs and edible gardening cropping up throughout the city. This existing and growing demand makes NYC a prime location for the investigations explored through this research.

A map of the city and the locations of the five boroughs, which includes Manhattan, Brooklyn, Queens, The Bronx, and Staten Island can be seen on the following page in Figure 1.1.

Overview of NYC Rooftop Farms Existing

Some of the most famous and successful rooftop farms in the country are located in

[38] Meyer, Molly, Brendan Shea, and Lauren Mandel. “The Edible Skyline”.

[39] Meyer, Molly, Brendan Shea, and Lauren Mandel. “The Edible Skyline”.

[40] Illsley, C.L. “The Largest Cities in the US.” World Atlas. June 20, 2016. Accessed January 17, 2019. https://www.worldatlas.com/articles/largest-cities-in-the-united-states.html.

[41] Omondi, Sharon. “The Most Dense Cities in the United States.” World Atlas. September 27, 2017. Accessed January 20, 2019. https://www.worldatlas.com/articles/the-most-dense-cities-in-the-united-states.html.

[42] “This 3D Map Shows America’s Most Expensive Housing Markets.” *Metrocosm*. February

[43] Rosenzweig, Cynthia, Stuart Gaffin and Parshall. “Green Roofs in the New York Metropolitan Region Research Report.” (Columbia University Center for Climate Systems Research, 2006), 43-44.

Context Map of New York City

Figure 1.1

New York City. Many of them are creative in form and technique and do not use a soil based growing medium. They vary in ownership, use and management styles, which creates unique environments at each location.

The three most notable and publicly accessible intensive green roof rooftop farms in New York City include Eagle Street Rooftop Farm and the two currently existing locations of the Brooklyn Grange. Eagle Street Rooftop Farm was the first commercial soil based rooftop farm in the country.[44] One of the most famous companies that specializes in rooftop farming is perhaps the Brooklyn Grange. They currently have two soil based farms in New York City and are in the process of opening a third location. These three farms were the first commercially operated intensive green roof farms in New York City and have been a proof of concept for the expansion of the industry as is being currently witnessed.

Urban Agriculture Policy and History

In New York City, agricultural and commercial agricultural uses are allowed in "all residential districts, the vast majority of commercial districts and all manufacturing districts".[45] Amusement park C7 is the only zoning code that prohibits agricultural use.[46] The city defines agricultural uses to include, "personal gardening, community gardening, commercial farming, indoor farming such as hydroponics and aquaponics, rooftop greenhouses and more."[47] The zoning codes concerning agricultural use include Section 22-14 and Section 42-14 of the NYC Zoning Resolution.[48] According to NYC Health Code, Article 161.19 and Article 161.01, Section 12, both chickens and bees are allowed as forms of animal agriculture within the city limits; however, roosters and other fowl are not permitted.[49]   This creates an urban environment politically receptive and ready for the further implementation of rooftop agriculture.

In 2017, the New York City Department of City Planning launched a set of zoning code amendments dubbed, "Zone Green".[50] These amendments aimed at removing " impediments to the construction and retrofitting of green buildings", which includes amendments to promote rooftop urban agriculture in the city.[51] New York City also offers a one-time tax property abatement of up to $100,000 to property owners who install green roofs.[52] With these policies in place, owners of buildings are presented with substantial motives to support the development of rooftop farming throughout New York City.

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[44] Novak, Annie. *The Rooftop Growing Guide : How to Transform Your Roof into a Vegetable Garden or Farm*. First ed. (Berkeley: Ten Speed Press, 2016), Kindle.

[45] NYC Urban Agriculture. "Frequently Asked Questions." FAQs - Urban Agriculture. Accessed April 23, 2019. https://www1.nyc.gov/site/agriculture/faqs/frequently-asked-questions.page.

[46] NYC Urban Agriculture. "Frequently Asked Questions." FAQs - Urban Agriculture. Accessed April 23, 2019. https://www1.nyc.gov/site/agriculture/faqs/frequently-asked-questions.page.

[47] NYC Urban Agriculture. "Frequently Asked Questions."

[48] NYC Urban Agriculture. "Frequently Asked Questions."

[49] NYC Urban Agriculture. "Frequently Asked Questions."

[50] NYC Urban Agriculture. "Frequently Asked Questions."

[51] NYC Urban Agriculture. "Frequently Asked Questions."

[52] Green Roof Tax Abatement. Accessed April 27, 2019. https://www1.nyc.gov/site/finance/benefits/landlords-green-roof.page.

Research Structure

Research Questions

This thesis will investigate the identification of potential sites and typologies of intensive green roof farming in the five boroughs of New York City. The overarching investigation of this work is to address how an individual would go about creating an intensive green roof farm in New York City with consideration given to the principles of the triple bottom line. This investigation is broken down into two research questions:

1. Where in NYC are the best buildings for intensive green roof farming to be located depending on the primary motivation of the potential organizer relating to the triple bottom line (people, place or profit)?
2. What is the potential for design typologies of intensive green roof farming in NYC depending on the primary motivation of the potential organizer relating to the triple bottom line (people, place or profit)?

How these research questions will be addressed is discussed in the methodology section of this chapter.

Significance of Research

This research intends to contribute knowledge to the field of landscape architecture through site identification, and exploration of the potential for design in soil based, intensive green roof agriculture. Currently, the largest farms constructed in this manner have been designed and constructed by people outside of the field of landscape architecture. While there are firms that are beginning to specialize in this type of design, creating increased publicly accessible knowledge on this subject, as this thesis aims to do, will lead to more resilient and sustainable cities.

Overview of Layout

This thesis is organized through three phases of research. The first phase will serve to direct and inform people on finding suitable rooftops in NYC for siting rooftop farms based on their motivating factors within the triple bottom line (people, planet, and profit). The second phase will serve to inspire ideas and provide typologies for designs of intensive green roof farms categorized by motivation within the triple bottom line. Finally, the third phase will serve as a motivational element and closing to the paper, showing the potential for rooftop farm design and how the first two phases work together.

Phase I of this research will include a GIS investigation of the rooftops in NYC that have potential to be utilized for intensive green roof farms. The criteria for this GIS investigation were derived from existing shapefile data using knowledge of existing case studies as well as published and non-published material on successful rooftop farm site selection in NYC. This section contains four maps. One map that specifically addresses through selected criteria each aspect of the triple bottom line (profit, people, and planet), and one map showing buildings that meet the GIS criteria for or all three elements. Ten buildings from these maps were visited and inspected as thoroughly as possible given available access. This element of ground truthing adds an additional level of landscape understanding that previous research has not included.

Phase II includes uses case study site visit documentation from which design typologies are identified and categorized. Through this research three matrices were produced based on the three elements of the triple bottom line. These matrices intend to provide a design guide to those interested in creating rooftop farms in NYC.

The third and final phase will be a design exploration of rooftop farming potentials in New York City. Three rooftops identified in Phase I are selected and paired with their corresponding triple bottom line rooftop farm design typologies identified in Phase II. Two diagrammatic designs are presented as well as one full, in-depth, exemplary design. These designs are exploratory and investigate the possibilities of what intensive green roof farming could be through the framework of Phase I and II of this research.

Significance of the Triple Bottom Line

The typical bottom line of business is solely concerned with profit margins, but the triple bottom line was constructed to encourage the development of more sustainable business practices. One of the most famous rooftop farm companies in the country, The Brooklyn Grange, uses the triple bottom line to guide the practices of their business.[53] The success of their business lends credibility to the value of incorporating the triple bottom line into future rooftop farm developments.

When referring to the motivational elements of the triple bottom line and how they relate to the development of rooftop farms, the meaning lies within the driving intention behind the creation of a rooftop farming business. Ideally all businesses should strive to address all three elements of people, profit and planet. However, every business has a different vision, especially rooftop farms. Examples of how a rooftop farm motivated by each element of the triple bottom line may operate are provided below:

- A profit motivated venture would have its main focus on the production of revenue. They may still make efforts to engage the community and will be creating positive environmental externalities solely through normal operations, but monetary gain would be the main incentive behind decisions.
- A planet motivated rooftop farm may be an entity (non-profit, educational institution or otherwise), whose main goal is to create environmental benefits through the development of a rooftop farm. They may also involve the community as part of their program and they may generate revenue from their crops and practices, but environmental goals are the driving motivation behind operation.
- A people motivated enterprise would be a rooftop farm developer whose main goals lay in connecting with and providing benefits for the members of a community. The related environmental and economic benefits of operating a rooftop farm would be secondary to their main goal of providing amenities and services for the community.

How these motivations shaped the research within this paper will be further discussed in latter chapters. This is not to say that developers of rooftop farms can only be motivated by one element of the triple bottom line, they could be driven by all three or a combination of a couple. Developers should pursue their passions and create their own visions as they are able and see fit. The incorporation of the triple bottom line into this research was intended to provide a greater array of specialized decision making aids and information to a diverse group of entities who may

[53] "Sustainability." Brooklyn Grange. Accessed April 04, 2019. https://www.brooklyngrangefarm.com/sustainability-1.

be interested in pursuing rooftop farming in New York City.

Methodologies

The overarching methodological approach of research throughout this thesis will be research through design. As per Deming and Swaffield in *Landscape Architecture Research*, "Design only becomes an autonomous research strategy when it produces new generalizable knowledge about the world through its protocols."[54] This category of research is considered both inductive and deductive, "because theoretical knowledge emerges inductively from the design setting or context and deductively from the testing and challenging of established concepts."[55] The work of this thesis aligns with these notions because it both produces and tests its own conclusions through its inherent structure. Research by design is also considered to be an investigation of "what might be", where exploration is conducted in systematic manner where investigations enhance the understanding of the "relationships between the world as it is and the possibility of what it might become."[56] This thesis will address this element of the methodology through its typological exploration and design projection.

Within this overarching framework of research by design, other methodologies will be used to create the supporting structure. The first phase will use modeling spatial classifications paired with landscape evaluation. The second phase will focus on the typological classification schema also paired with landscape evaluation. Finally, the third phase will tie the first two phases together using projective design. A diagram showing the methodological research flow of this work is shown in Figure 2.1 on the following page spread.

Phase I Methodology: Modeling Spatial Classifications paired with Landscape Evaluation

The GIS modeling portion of this research is meant to be a simplification of reality. It will use analysis of existing knowledge and interpret it into spatial representation. As is discussed in *Landscape Architecture Research: Inquiry, Strategy, Design* this phase of research will be "synthetic and focus on integrating a range of data sources to represent a landscape" and will "provide the basis for more extended strategies of investigation."[57] This falls into the category of what Deming and Swaffield describe as "descriptive modeling". Ten samples of the GIS modeling results were then ground truthed through site visit evaluations. This evaluation aspect of the research is meant to complement and test the products of the spatial classification modeling. As research, the evaluation will assist in revealing insights and further understanding to the modeling outputs.[58]

Phase II Methodology: Typological Classification Schema

This section of the research will create a typological matrices based on case study

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[54] Deming, M. Elen, and Swaffield, Simon R. *Landscape Architecture Research: Inquiry, Strategy, Design*. (Hoboken, N.J.: Wiley, 2011), 206.

[55] Deming, M. Elen, and Swaffield, Simon R. *Landscape Architecture Research,* 208.

[56] Deming, M. Elen, and Swaffield, Simon R. *Landscape Architecture Research*, 209

[57] Deming, M. Elen, and Swaffield, Simon R. *Landscape Architecture Research: Inquiry, Strategy, Design*. (Hoboken, N.J.: Wiley, 2011), 111.

[58] Deming, M. Elen, and Swaffield, Simon R. *Landscape Architecture Research*,189.

research, precedent designs and landscape evaluation. The matrices will be categorized by site size and related programs, agricultural products, management structures, and infrastructure that would be best suited for each corresponding element of people, profit or planet. It will be as *Landscape Architecture Research* describes, a "systematic study of types" in reference to site conditions, forms, and concepts.[59]

Phase III Methodology: Research by Design via Projective Design

The final phase of this paper will investigate the design potentials of intensive green roof farming through research by design. It will draw on conclusions from the other two phases of this thesis to create three designs, which will be examples of what could be in the future of rooftop farming. The design process will become research as the process and product has the potential to be referenced by other designers and individuals interested in the field of rooftop agriculture. Thus meeting the description from Deming and Swaffield of becoming an "autonomous research strategy when it produces new generalizable knowledge about the world through its purposes, protocols, and outcomes."[60]

Strategy:

Through using a combination of modeling spatial classifications and landscape evaluation (Phase I), typological classification schema paired with landscape evaluation (Phase II), and research by design via projective design (Phase III), the goal of this work is to create a resource that will lead to the expansion and proliferation of intensive green roof farms. The methods are specifically applied to New York City but are intended to serve as a resource and template for any person interested in rooftop farming. I chose the above listed research methods because in combination, they create both a subjective and objective encompassing data source on rooftop farming that is intended to be built upon and modified to fit the specific scenarios pertaining to any future users of this information.

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[59] Deming, M. Elen, and Swaffield, Simon R. *Landscape Architecture Research*,133.

[60] Deming, M. Elen, and Swaffield, Simon R. *Landscape Architecture Research*, 206.

Diagram of Research Structure

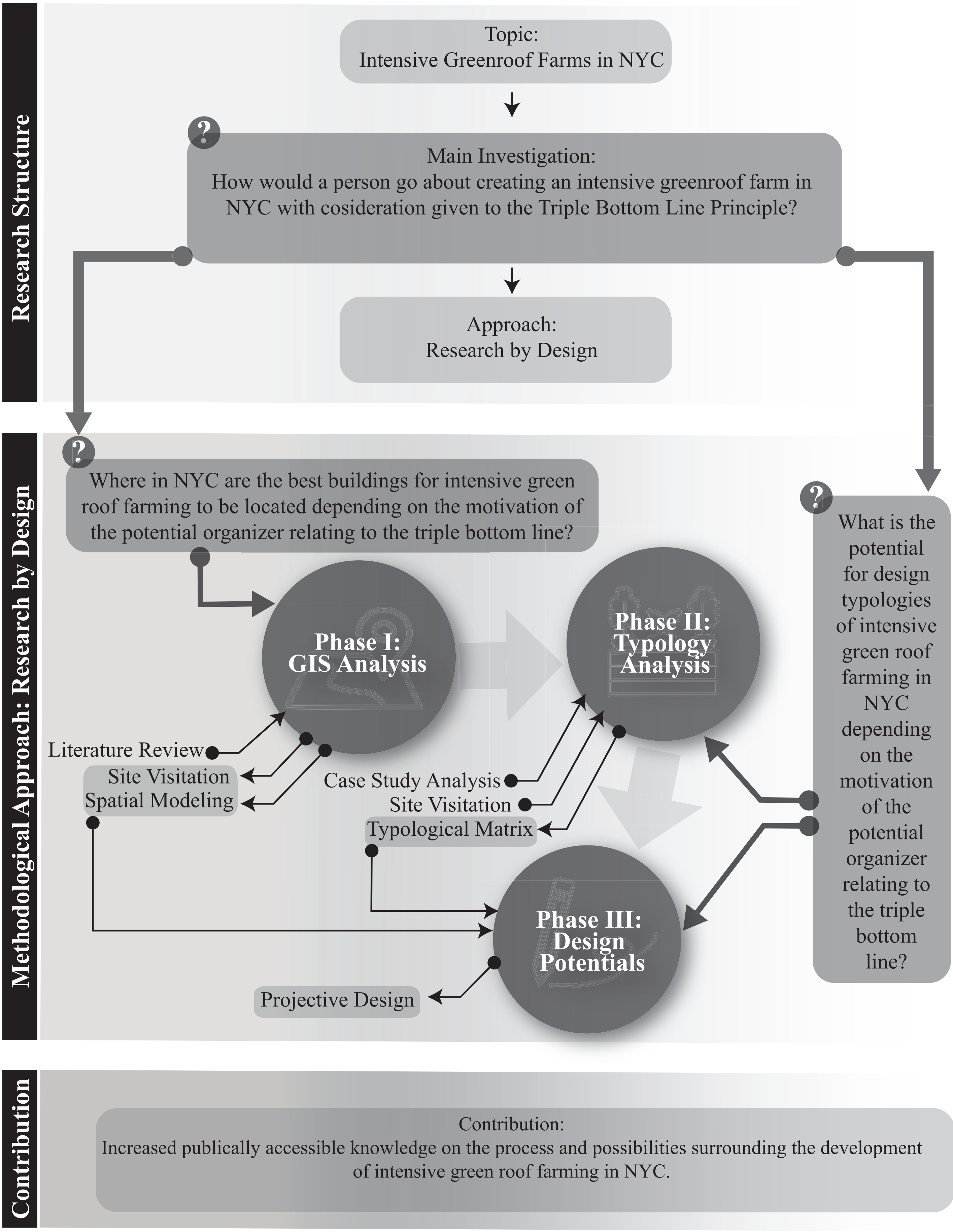

Figure 2.1

Phase I: GIS Analysis

Overview

Phase I of this research, was inspired by the lack of data found available during an initial investigation of the topic of rooftop agriculture. While there are many resources detailing the methods, experiences, pros, cons, and construction of rooftop farms and gardens, there was not much information available concerning appropriate host buildings. Only a small sample of work that has addressed the siting of rooftop agriculture using GIS. Four papers in particular stood out to me, one published by Danielle Berger[61], a second by Saha Mithun and Matthew J Eckelman[62], another by Columbia University[63], and the last by Ana Stoudt.[64] Most notably, the work of Columbia University and Danielle Berger utilized more generalized, broader GIS criteria to identify sites for agriculture and/or rooftop agriculture in NYC. This work furthers the investigation of rooftop agriculture site identification by creating a new, unique set of GIS criteria using more focused specifications for the identification of buildings via incorporating the three elements of the triple bottom line. Research from case studies, published work on rooftop farming, and personal observations from site visitations were used to determine what GIS data would be used for each map.

The maps created in this portion of the research can be accessed and utilized at arcgis.com under the title "NYC Potential Buildings for Rooftop Farming". This online map allows users to zoom into locations, select and view tax lots identified as suitable for rooftop farming through this research, and view lists through the attribute tables of each map layer, which include data concerning each selected tax lot.

Significance of Research

As mentioned, this research builds from existing similar studies and adds to the existing work a deeper level of on site investigation and ground truthing. Existing studies lacked the further step of investigating the results of their GIS findings. Also, existing work used different combinations of GIS criteria to select sites. This research is unique in that it incorporates floor-to-area ratio (FAR) availability to help determine sites where a rooftop farm would be less likely to become out-shaded by future development. This research is also unique in that instead of solely seeking to locate buildings that would be structurally capable of supporting a green roof, it includes factors to indicate buildings that may be more suitable for different motivations behind the programming of the site related to either people, profit or planet.

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[61] Berger, Danielle. "A Gis Suitability Analysis of the Potential for Rooftop Agriculture in New York City." PhD diss., Columbia University, 2013. Publisher Not Identified, 2013.

[62] Saha, Mithun, and Matthew J Eckelman. "Growing Fresh Fruits and Vegetables in an Urban Landscape: A Geospatial Assessment of Ground Level and Rooftop Urban Agriculture Potential in Boston, Usa." Landscape and Urban Planning, 165 (2017): 130-41. doi:10.1016/j.landurbplan.2017.04.015.

[63] Ackerman, Kubi, Richard Plunz, Ruth Katz, Eric Dahlgren, and Patricia Culligan. "The Potential for Urban Agriculture in New York City: growing capacity, food security & green infrastructure." New York: Urban Design Lab, Columbia University, 2011. 10.13140/2.1.4748.7683.

[64] Stoudt, Ana E, Arts and Sciences College of Letters, and Daniel N Warshawsky. Redefining Urban Food Systems to Identify Optimal Rooftop Community Garden Locations: A Site Suitability Analysis in Seattle, Washington. PhD diss., 2015. University of Southern California, 2015.

Contribution to Knowledge

This research is meant to:

- Provide a resource for identifying potential sites for intensive green roof farming to anyone who may wish to develop a rooftop farm themselves.
- Provide a source of data and criteria concerning rooftop farm site selection for any person interested in rooftop farming in New York City or otherwise.
- Create a framework of GIS criteria for others to build upon in further GIS analysis and research.

GIS Constraints

The GIS criteria used to identify existing buildings in NYC that would hold the highest potential to support rooftop farms were constrained by two factors. The first factor was the availability of existing GIS data. The second factor was the availability of experiential knowledge published on how to successfully locate a building with enough structural integrity to support a rooftop farm. This research strives to build upon and combine existing and available information into one document that can be built upon as the field of rooftop agriculture expands and the availability of GIS data increases.

Map Sources and Inputs

After a thorough investigation of available GIS data, files were selected that corresponded with rooftop farm site identification criteria that have been used by owners of existing rooftop farms as well as criteria identified by previous research. From the inventory of available GIS files, different data sets were used depending on the motivation behind the particular map, whether it be profit, people, or planet, derived from the three elements of the triple bottom line.

From available GIS shapefiles, a total of eight attributes were selected as criteria. These attributes included: industrial/manufacturing usage, constructed prior to 1968, rooftop footprint size, floors, a buffer of hazardous sites, a buffer of vacant lots, available floor-to-area-ratio, and a buffer of subway stations. These attributes were derived from multiple sources of literature and research. Below, each of these factors and the reasoning behind their selection is discussed in depth:

- Industrial/manufacturing: Filtering for existing buildings with marked usage as industrial or manufacturing was a criterion derived from the experience of the owners of the Brooklyn Grange. In their book, *The Farm on the Roof*, the author Anastasia Plakias, notes that, "Typically, when it comes to buildings the old adage is true: they don't make them like they used to. This is especially true of big buildings, the size of which indicates they were built as manufacturing centers or warehouses." The book also states, "During the first half of the twentieth century, most industrial buildings were erected with a continuous frame from the ground up made of concrete-encased structural steel and densely spaced columns: perfect for our purposes."[65] Plakias then continues to divulge that their current method of identifying potential rooftop buildings included "scanning

[65] Plakias, Anastasia Cole. *The Farm on the Roof : What Brooklyn Grange Taught Us About Entrepreneurship, Community, and Growing a Sustainable Business*. (New York: Avery, an Imprint of Penguin Random House, 2016), Kindle.

the industrial areas of the city on a Google satellite map."[66] This GIS analysis is intended to assist people in finding potential rooftop farm sites in a more streamlined and efficient manner.

  - This selection criterion had several limitations that should be noted. First, the GIS software applied this criterion through land use data provided via MapPLUTO data. This data may change rapidly in NYC as zoning changes and construction projects occur often. Another limitation of mapping this criterion is that there was no data available to show buildings that were originally constructed for industrial and manufacturing purposes, but have since been rezoned. Site visits to rooftop gardens throughout the city revealed many industrial buildings that had since been converted to residential, commercial or office spaces. These buildings could all hold potential for hosting rooftop farms, however, they are not included in the results provided by the GIS analysis of this research.

- <u>Built prior to 1968</u>: This criterion was selected because of a change in NYC city building codes in 1968. Buildings with roofs with a pitch of 20 degrees or less constructed prior to 1968 met buildings codes for 1938 or 1916 code requirements, which mandated minimum required live loads of 40 pounds per square foot.[67] Buildings with flat roofs constructed post 1968 were only required to support a live load of 30 pounds per square foot.[68] Live load refers to how much weight the roof can support per square foot in temporary objects and is one element of structural integrity that determines whether or not an existing building would be able to support the additional weight of an intensive green roof.[69] This criterion for older buildings also has foundations in the advice of the founders of the Brooklyn Grange. In their book, *The Farm on the Roof*, they note that, "We found that a prewar construction date is a good indication that underneath the facade, the structure is rock solid." [70] Drawing from this evidence, this GIS selection criterion is intended to select for buildings with the highest likelihood to be able to support the added weight of an intensive green roof farm.

- <u>Size</u>: Two different criteria for rooftop size were defined within the GIS analyses used to create the three maps in this document. The two sizes used were one acre and 6000 square feet. These sizes were derived from precedent intensive green roof farm developments in New York City. The first precedent being Eagle Street Rooftop Farm in NYC, which as the first commercial rooftop farm in the nation, was constructed at 6,000 square feet.[71] This farm was constructed as a proof of concept for intensive green

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[66] Plakias, Anastasia Cole. *The Farm on the Roof*, Kindle.

[67] Berger, Danielle. "A Gis Suitability Analysis of the Potential for Rooftop Agriculture in New York City." PhD diss., Columbia University, 2013. (Publisher Not Identified, 2013), 14.

[68] Berger, Danielle. "A Gis Suitability Analysis", 14.

[69] Berger, Danielle. A Gis Suitability Analysis of the Potential for Rooftop Agriculture in New York City. PhD diss., Columbia University, 2013. (Publisher Not Identified, 2013), 14.

[70] Plakias, Anastasia Cole. *The Farm on the Roof : What Brooklyn Grange Taught Us About Entrepreneurship, Community, and Growing a Sustainable Business*. (New York: Avery, an Imprint of Penguin Random House, 2016), Kindle.

[71] Novak, Annie. *The Rooftop Growing Guide : How to Transform Your Roof into a Vegetable Garden or Farm*.

roof farms and other farms constructed since have sized up in their operations.[72] The second precedents are the rooftop farms in Brooklyn and Queens owned by the Brooklyn Grange. Both of these sites are approximately 1 acre.[73] In their book, *Farm on the Roof,* the author notes that after comparing installation costs and anticipating overhead costs of per-square foot revenue, that rooftops of roughly one acre in size were necessary to generate a desirable profit.[74]

- Floors: Number of floors in a building was chosen as a criterion for two reasons. The first reason was wind speed and soil desiccation. Rooftop farmers like Annie Novak have identified that "the higher the rooftop, the harsher the wind."[75] The second reason for selecting for number of floors was related to accessibility. Many grassroots rooftop farms are implemented on buildings without elevators, leaving stair access the only option for rooftop entry. Selecting for buildings with fewer staircases to climb for visitors is meant to increase the amount of people who would be able to successfully access a rooftop farm. The number of staircases selected for varies per map based on the motives of people, profit, or planet and is discussed more in depth within the following discussions of the specific criteria for each map.

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- Buffer hazardous sites: Creating a 0.1 mile buffer of hazardous sites was included as a precautionary measure. The sites buffered for are locations with (E) Designations assigned by the City of New York in relation to the Environmental Requirements of the Zoning Resolution.[76] The sites buffered include areas of, "potential hazardous materials contamination, high ambient noise levels or air emission concerns on a particular tax lot."[77] E Designations, "are established in connection with a change in zoning or an action pursuant to a provision of the Zoning Resolution that would allow additional development to occur on property, or would permit uses not currently allowed."[78] By buffering these sites, the goal is to reduce the likelihood of rooftop soil contamination and select for sites with more pleasant surrounding urban environments. As plants filter particulate matter from the air through their leaves, nearness to sources of polluted air quality may lead to a fall in the quality of produce grown on a rooftop. The 0.1 mile distance was chosen because it relates to the approximate distance of about two North to South Manhattan city blocks, which would allow for a buffer of buildings and other environmental factors between the existing hazard and a potential rooftop farm site.[79]

First ed. (Berkeley: Ten Speed Press, 2016), Kindle.

[72] Novak, Annie. *The Rooftop Growing Guide*, Kindle.

[73] Plakias, Anastasia Cole. *The Farm on the Roof*, Kindle.

[74] Plakias, Anastasia Cole. *The Farm on the Roof*, Kindle.

[75] Novak, Annie. *The Rooftop Growing Guide*, Kindle.

[76] "(E) Designations - Frequently Asked Questions." *NYC.gov*. Accessed April 23, 2019. https://www1.nyc.gov/site/planning/applicants/e-faq.page.

[77] "(E) Designations - Frequently Asked Questions." *NYC.gov*.

[78] "(E) Designations - Frequently Asked Questions." *NYC.gov*.

[79] Pollak, Michael. "Knowing the Distance." *The New York Times*. September 17, 2006. Accessed April 16, 2019. https://www.nytimes.com/2006/09/17/nyregion/thecity/17fyi.html.

- Buffer vacant lots: Creating a 0.1 mile buffer surrounding vacant sites aimed to reduce the likelihood that a rooftop farm might become shaded out by a future development. If one was to develop an intensive green roof farm on a building next to a vacant lot, and then the vacant lot was subsequently developed into a larger building, it could potentially shade out the garden and make null the time and monetary investment of developing a productive rooftop farm. This is not to say that out-shading cannot happen in areas where existing buildings may be torn down and redeveloped, but vacant lots hold an unknown potential that may be prudent to avoid when selecting a green roof location. Again, the 0.1 (two block) buffer was chosen to create enough distance so that any sites selected using this criterion would not be adjacent to a new development of a potentially out-shading building.

- Floor to Area Ratio: Accounting for available Floor to Area Ratio (FAR) intends to reduce the likelihood that new developments may shade out a rooftop farm. FAR is a tool introduced in the 1961 New York Zoning Resolution to control building bulk and density.[80] It expresses the relationship between the "total amount of usable floor area that a building has, or has been permitted to have and the total area of the lot on which the building stands".[81] A low FAR typically is a deterrent to construction and a higher ratio is indicative of a dense or urban construction area.[82] FAR was calculated for this research using MapPLUTO data, the process for which can be referenced in Appendix A of this document. For this research, properties were categorized into three levels of available FAR and the lower one third of all FAR values were selected.

- Buffer subway stations: Creating a buffer around subway stations and selecting for locations that were within 0.5 miles of a station intended to select for potential locations that would be accessible by public transportation and walking. This distance was selected based on research indicating "typical transit riders will walk up to a quarter-mile to a bus stop and a half-mile to a train station."[83] This filtering criterion was used specifically in reference to people focused motivations and creating equity in accessibility.

Two shapefiles were used as the main sources from which data was pulled and combined to create the final maps corresponding to people, planet and profit. One shapefile was taken from the NYC Department of City Planning website and is called "MapPLUTO". As the website describes, this source "merges PLUTO tax lot data with tax lot features from the Department of Finances Digital Tax Map (DTM)" and "It contains extensive land use and geographic data at the tax lot level in ESRI shapefile and File Geodatabase formats."[84] PLUTO tax lot data is

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80 "Accidental Skyline." MAS. (Accessed January 15, 2019), 13. https://www.mas.org/initiatives/accidental-skyline/.

81 Hargrave, Marshall. "What the Floor Area Ratio (FAR) Tells Us." *Investopedia*. April 19, 2019. Accessed April 27, 2019. https://www.investopedia.com/terms/f/floor-area-ratio.asp.

82 Hargrave, Marshall. "What the Floor Area Ratio (FAR) Tells Us."

83 Litman, Todd, Steele, Rowan. "Land use impacts on transport : how land use factors affect travel behavior." Melbourne, Vic.Victoria Transport Policy Institute, 2012. Accessed April 17, 2019.

84 "NYC Planning." *NYC.gov*, Accessed January 28, 2019. https://www1.nyc.gov/site/planning/data-maps/open-data/dwn-pluto-mappluto.page.

"extensive land use and geographic data at the tax lot level in comma separated values (CSV) file format. The PLUTO files contain more than seventy fields derived from data maintained by city agencies."[85] This shapefile was also used to locate vacant lots within NYC. The other important shapefile used in this research was sourced from the website, NYC Open Data and provided the building footprint areas from which rooftop footprints were estimated and used.[86] Maps created using the information from this shapefile were then combined with maps made from other shapefiles, also sourced from NYC Open Data, including a point shapefile of hazardous areas[87] in the city and a point shapefile of subway stations.[88] Diagrams showing the breakdown of how each map was created in GIS are available in Appendix B.

How Data Sets were Chosen and Refined

Drawing from these shapefiles, I chose unique combinations of criteria for each element of the triple bottom line. A map was created for each triple bottom line focus: people, profit and planet. See Appendix B for diagrammatic representations of what shapefiles and GIS functions were used to create each map. See Appendix C for axonometric diagrams visually representing the mapping criterion built into each final map. The following pages describe the selection of criteria used to create each map.

<u>Profit Focused Map</u>

The profit focused map was created based on available data that would most thoroughly guarantee the success and protection of an investment in an intensive green roof farm. Locations identified through this GIS analysis would be best suited for individuals interested in running a rooftop farm focused on sales and production. Avenues of revenue from such a location would include wholesale of produce, farmers markets on and off site, tours given on site, rental of rooftop spaces for events, and organization of marketable events on site. Selecting rooftops to ensure productivity of crops and a pleasant surrounding urban context were important factors in selecting the following GIS criteria:

- Industrial/manufacturing
- Constructed prior to 1968
- One acre or more
- 15 stories or less
- 0.1 mile buffer of hazardous sites
- 0.1 mile buffer of vacant lots
- FAR value of five or less

These criteria include the selection for basic structural elements like industrial/manufacturing use and construction prior to 1968, as well as filters for elements of a rooftop that would most likely assure its economic success. The size of one acre or more was based on the minimum profitable size of an intensive green roof farm as defined by the owners of the Brooklyn Grange,

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85 "NYC Planning." *NYC.gov*, Accessed January 28, 2019.

86 Building Footprints." NYC Open Data. Accessed January 28, 2019. https://data.cityofnewyork.us/Housing-Development/Building-Footprints/nqwf-w8eh.

87 "E Designations: Shapefile." NYC Open Data. Accessed January 28, 2019. https://data.cityofnewyork.us/Environment/E-Designations-shapefile/mzjp-98aw.

88 "Subway Stations." NYC Open Data. Accessed January 28, 2019. https://data.cityofnewyork.us/Transportation/Subway-Stations/arq3-7z49.

who currently dominate the New York rooftop agriculture scene. The height of 15 stories or less was based on a precedent set by the owners of the Brooklyn Grange in combination with other research. The Brooklyn Grange currently operates their Navy Yard rooftop farm on top of an eleven-story building and is opening a farm in Sunset Park that sits on a 14-story building.[89] This sets a precedent for lower building heights and is similar to restrictions set by other GIS investigations of rooftop farming in NYC that have used restrictions such as ten stories.[90] However, according to green infrastructure expert, Molly Meyer, the tallest known rooftop farm in the United States sits at 30 stories.[91] Using these examples, 15 stories was selected as a median tolerance for profit based rooftop farm heights. At this level, winds and access challenges faced by operating at this elevation have been accomplished and successful. A 0.1 mile buffer of hazardous sites was used for this mapping process to ensure that selected rooftops would not be contaminated by air pollutants that may affect the marketability of crops grown. This buffer also accounts for noise hazards that may detract from the value of the space for events and rental as an additional form of revenue. A 0.1 mile buffer of vacant lots was selected for in this map to reduce the likelihood that a rooftop farm development would become shaded out by a new construction project, thus an additional layer of investment insurance for the developer of a profit focused rooftop farm. The final criterion for this map was the selection of locations with a FAR value of five or less. This specification was included as a further precaution to protect the investment of a rooftop farm developer, as areas with low FAR are less likely to experience adjacent new construction.[92] All of the above listed criteria work together to select sites that have the highest potential to succeed as profit focused intensive green roof farm developments.

Figure 3.1 on the following page shows all potential rooftop farm locations identified in New York City using these GIS criteria for profit motivated developments.

[89] Knott, Danielle. "Flagship Farm Brooklyn Grange Tour." Site Tour, 37-18 Northern Blvd, Long Island City, NY 11101, September 8, 2018.

[90] Berger, Danielle. "A Gis Suitability Analysis of the Potential for Rooftop Agriculture in New York City." PhD diss., Columbia University, 2013. Publisher Not Identified, 2013.

[91] Meyer, Molly, Brendan Shea, and Lauren Mandel. "The Edible Skyline: Pushing the Limits of Rooftop Agriculture" (Presentation, Annual ASLA Meeting and EXPO, Philadelphia, PA, October 22, 2018).

[92] Hargrave, Marshall. "What the Floor Area Ratio (FAR) Tells Us." Investopedia. April 19, 2019. Accessed April 27, 2019. https://www.investopedia.com/terms/f/floor-area-ratio.asp.

Final Map Product for PROFIT Focused Development Motivation:
Potential Buildings for Intensive Rooftop Agriculture

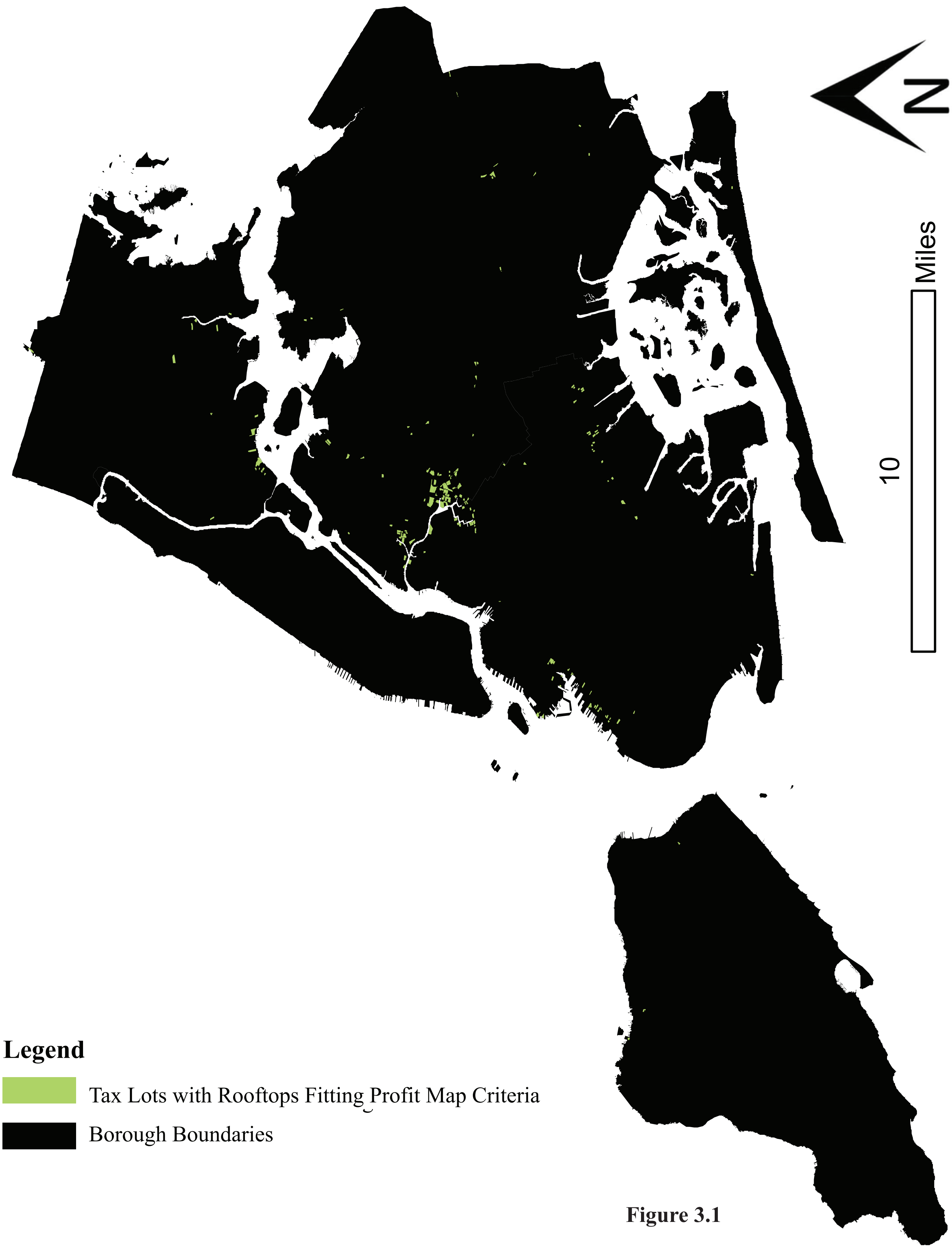


Figure 3.1

People Focused Map

The people focused map used available GIS data to select sites that would create optimal locations and conditions for rooftop farms intended to benefit the surrounding community. Locations identified through this GIS analysis would be most suited for individuals interested in providing resources and amenities for community members. Criteria used in this analysis focused on selecting accessible locations away from potentially hazardous or out-shading buildings. A people motivated rooftop farm endeavor may focus on creating an educational space, providing access to healthy and affordable food, and/or creating additional green space for recreation and health. The organizer behind such a rooftop farm may be funded through outside sources so that creating revenue is not a prime concern and social benefits are able to take top priority. To locate suitable sites for this motivational element behind rooftop farm development, the following criteria were selected for:

- Industrial/manufacturing
- Built prior to 1968
- 6,000 square feet or more
- Five stories or less
- 0.1 mile buffer of hazardous sites
- 0.5 mile buffer of subway stations
- FAR value of five or less

This map included criteria for structural integrity (industrial/manufacturing and construction prior to 1968) as well as other qualifications intended to select locations that would be productive, healthy sites, and easily accessible to community members. The specification for roofs over 6,000 square feet was used based on the precedent of Eagle Street Rooftop Farm, which was the first and smallest commercially operated intensive green roof farm developed in NYC.[93] As a people focused development, having a larger size for growing space to generate revenue was not a primary concern. For this map, a height limitation of five stories was defined to increase the accessibility of a site. Five stories was chosen from the precedent farm of Hell's Kitchen Rooftop Farm Project. Here volunteers carry all supplies to the rooftop via fire escape, and interior access is by stairwell only.[94] While people of all ages are able to participate and engage with the rooftop farm, having any higher of a rooftop to access solely via staircase would likely limit the accessibility of a site. There was no way to identify and select buildings that had elevators, which would ensure greater accessibility, so limiting the number of floors intended to select for buildings with reasonable accessibility by staircase. Without an elevator, limiting the number of stairs necessary to climb also reduces strain when delivering items between the roof and ground level. A 0.1 mile buffer of hazardous sites was also included to select for sites with the least amount of risk to participating community health as well as the edibility of produce. A 0.5 mile buffer of subway stations was included in the mapping criteria to select for locations that would be accessible to the largest number of community members, without excluding people due to their lack of independent mobility or vehicular access. Sites with a FAR value of five or less were selected to ensure that if a community focused organization, non-profit, or grassroots

[93] Novak, Annie. *The Rooftop Growing Guide : How to Transform Your Roof into a Vegetable Garden or Farm*. (First ed. Berkeley: Ten Speed Press, 2016), Kindle.

[94] Stukane, Eileen. "Rooftop Farm Feeds Those Struggling to Stay in Hell's Kitchen." The Villager. November 30, 2018. Accessed May 03, 2019. https://www.thevillager.com/2013/09/rooftop-farm-feeds-those-struggling-to-stay-in-hells-kitchen/.

movement invested in leasing a rooftop space and developing an intensive green roof farm, that the location would not be out-shaded by new construction. This factor was included to ensure maximum productivity of a rooftop site and maximum benefits for community members. Together these criteria were combined in GIS to identify rooftops in NYC that have the strongest potential to support community focused intensive green roof farm operations. The qualifications for this map did not include areas considered to be food deserts because there were no GIS files available identifying such areas. However, it may be an opportunity for future research investigation.

Figure 3.2 on the following page shows all potential rooftop farm locations identified in New York City using these GIS criteria for people motivated developments.

Final Map Product for PEOPLE Focused Development Motivation :
Potential Buildings for Intensive Rooftop Agriculture

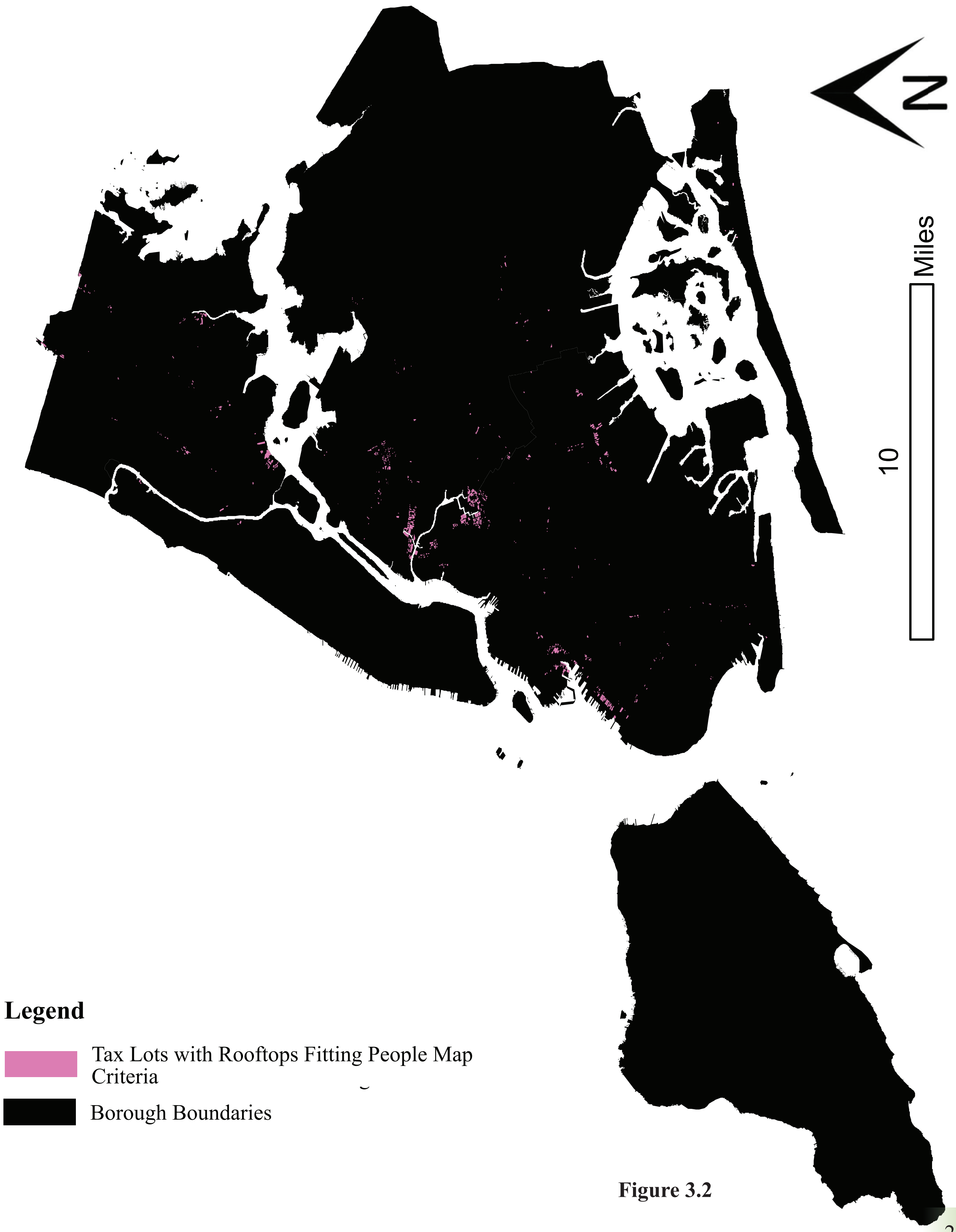


Figure 3.2

Planet Focused Map

The criteria used for this map were the least stringent. Locations identified for this motivation through GIS analysis would be best suited for developers most interested in the environmental benefits that intensive green roof farms provide. The sites identified through this map are the most simple in their criteria because the main focus is not people or profit, but instead environmental benefits, which can be produced in many contexts. Developers of environmentally focused rooftop farms may acquire funding from outside sources so that production and revenue generated from operations is not solely relied upon and environmental benefits may remain the operational focus. Benefits that a developer may seek from such a rooftop farm include storm water management, habitat creation, urban heat island effect reduction, creation of environmental education space, improvement of air quality, and reduction of packaging waste and food miles. The criteria used in creating this map included:

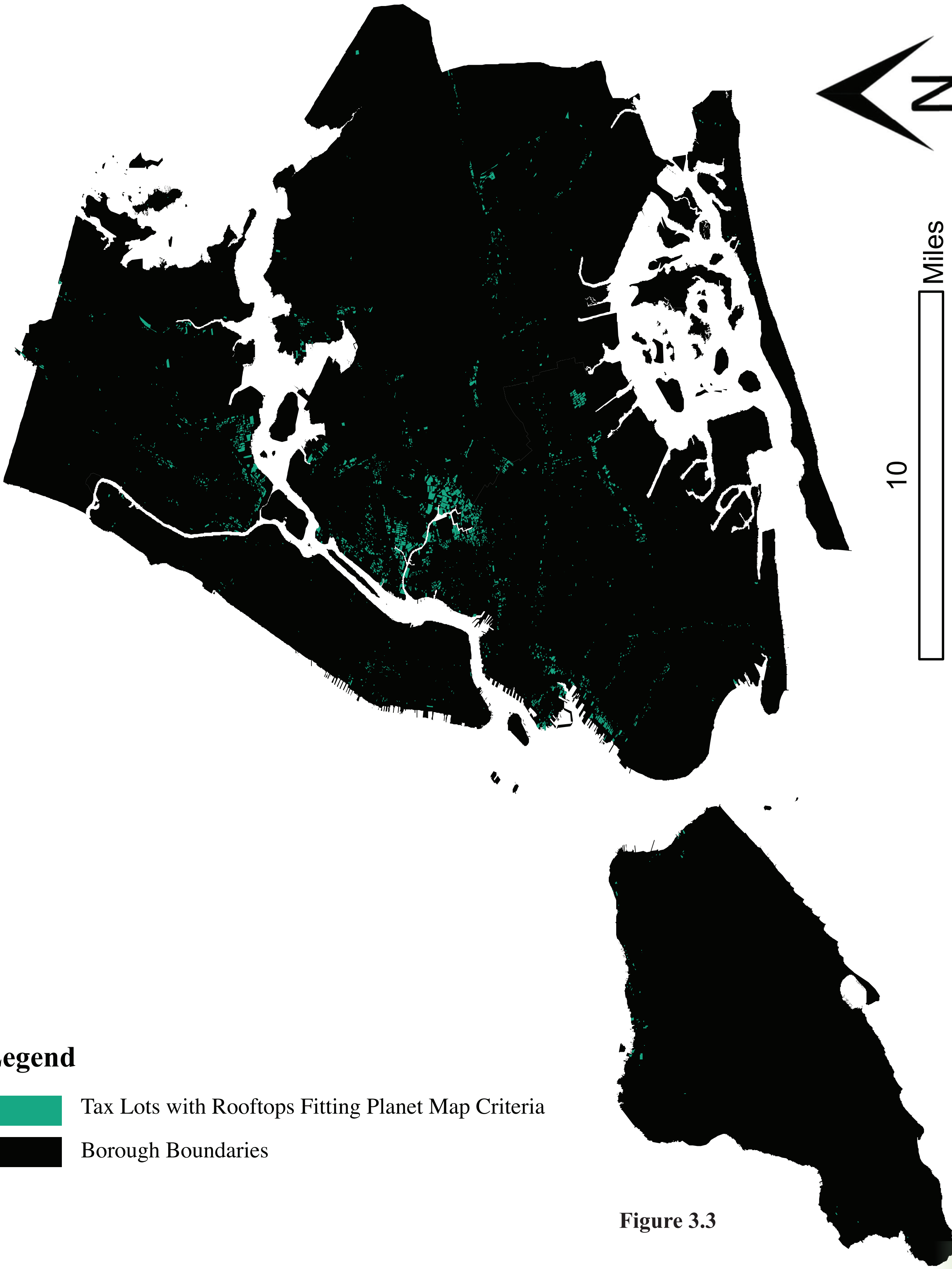
- Industrial/manufacturing
- Built prior to 1968
- 6,000 square feet or more
- 30 stories or less

These criteria include only structural restrictions (industrial/ manufacturing, constructed prior to 1968) and building sizing constraints. The small size of 6,000 square feet was chosen to identify as many potential rooftops as possible. If the purpose of a rooftop farm is focused on environmental sustainability, production of profitable goods is not the main priority and a large roof is not a necessity. Also, as production on this rooftop is considered a secondary benefit, a more flexible building height restriction was considered. The 30 story restriction was chosen based on a precedent rooftop farm discussed by green infrastructure expert at Omni Ecosystems, Molly Meyer. In a presentation at the 2018 National ASLA conference in Philadelphia at a lecture on the edible skyline, Molly cited the tallest rooftop farm to her knowledge to be a site in downtown Chicago that was approximately 30 stories high.[95] This precedent indicates that while rooftops of this height may face challenges due to wind, their success is still possible. While rooftop farms may have potential to flourish at higher elevations of buildings, for the purposes of this research, a maximum building height of 30 stories was set. This height of building may not create the most agriculturally productive environment, but the environmental benefits will be present. In combination, these factors were chosen to select buildings most likely to be structurally capable of supporting an intensive rooftop farm, with less focus on ensuring profitability and productivity and higher focus on reaping the environmental benefits that intensive green roof farming provides.

Figure 3.3 on the following page shows all potential rooftop farm locations identified in New York City using these GIS criteria for planet motivated developments.

[95] Meyer, Molly, Brendan Shea, and Lauren Mandel. "The Edible Skyline:Pushing the Limits of Rooftop Agriculture" (Presentation, Annual ASLA Meeting and EXPO, Philadelphia, PA October 22, 2018).

Final Map Product for PLANET Focused Development Motivation:
Potential Buildings for Intensive Rooftop Agriculture



Legend

Tax Lots with Rooftops Fitting Planet Map Criteria

Borough Boundaries

Figure 3.3

Ground Truthing of Sites

From these three maps, ten sites were selected to be ground truthed. The selected sites were chosen by two factors. The first factor was selection so that each borough would be represented. The second factor was accessibility via public transport (due to research funding limitations). Several of the sites included more than one building that were attached, but held different addresses. The sites that were visited can be seen in Figure 3.4. The following pages include images of the sites visited as well as annotations concerning the context and conditions of each location.

When ground truthing these sites, notes were included on surrounding neighborhood context, and structural elements of the buildings. A structural engineer should always be consulted when seriously considering the selection of a building for placement a rooftop farm, but suitability indicators that can be scouted for independently include:

- Dense spacing between structural columns and beams: Search for a spacing of 20 feet or less between columns and beams throughout all levels of the building, as this is a promising indicator of structural integrity.[96]
- The presence of an elevator within the building or if there is stair or elevator access to the rooftop.
- The surrounding neighborhood context and other place-based observations of the site that may contribute or detract from the success of a potential rooftop farm. Such observations might include factors such as: access to public transport, surrounding zoning and use of nearby land and buildings, community interests, proximity to possible hazards like highways or factories, views from rooftop locations, rooftop shading from adjacent buildings, and potential construction sites that may affect the successfulness and shading of a rooftop farm.

The above qualities were scouted for in the following analysis of sites. Additional photographs and contextual plan images of these sites can be found in Appendix D.

[96] Plakias, Anastasia Cole. *The Farm on the Roof : What Brooklyn Grange Taught Us About Entrepreneurship, Community, and Growing a Sustainable Business*. (New York: Avery, an Imprint of Penguin Random House, 2016), Kindle.

Ground-Truthed Phase I GIS Potential Instensive Rooftop Farm Locations :


330 Tompkins Ave, Staten Island, NY


220 South St, New York, NY


16 Cooper Square, New York, NY


56 2nd Ave, Brooklyn, NY


40 Hall Street, Brooklyn, NY
55 Washington Avenue, Brooklyn, NY
30 Hall Street, Brooklyn, NY
220 Flushing Avenue, Brooklyn NY


246 Meserole Street, Brooklyn, NY


4746 30th St, Long Island City, NY
4720 30th St, Long Island City, NY


3100 47th Ave, Long Island City, NY 11101


865 E 138th St, Bronx, NY


825 E 141st St, Bronx, NY

Figure 3.4

1. 330 Tompkins Ave, Staten Island, NY
Met GIS criteria for: **Planet and Profit**

This location was one of the few sites identified in Staten Island. It fit the GIS constraints for both planet and profit based development motivations. The surrounding physical environment and infrastructure of Staten Island was very unique compared to the other sites visited. It required a subway ride, ferry, a second subway ride, and a short walk to reach this location. The suburban context of the surrounding neighborhood and relative difficulty of access most defined this site.

The building had an open ground floor and keycard access freight elevators to the top floor. The building appeared to be an industrial factory converted to a self-storage facility called "American Self-Storage". The structure of the building seemed to consist of concrete pillars with large steel beams throughout every floor.

The structural composition of this building combined with the large footprint and presence of freight elevators makes this location a very viable site for potential profit or planet based rooftop farm design. However, the remote location of this building may make it less of a desirable location for a profit based development. This location fittingly did not fall into the qualifications for a people focused rooftop farm, as it was difficult to access by public transportation and was in a low density area.

Figure 3.5 below shows the size and layout of the building as seen from a nearby overpass. For more pictures and corresponding GIS map context, see Appendix D.

Figure 3.5

2. 220 South St, New York, NY
Met GIS criteria for: **Planet**

This location was currently being used as a self storage facility under the company "Manhattan mini storage". The building appeared relatively modern compared to other locations visited. The building was locked and doors and elevators were accessible only by keycard access. The location of this site next to the Brooklyn Bridge made it easy to locate and gave it a very notable view.

Inside, the visible structural elements appeared to be concrete pillars, but the beams were hidden by the ceiling elements. The rooftop was large, had a parapet, and expansive views of the Manhattan and Brooklyn skylines, as well as the East River.

Although this site was not identified through the GIS process as a potential site for a profit focused rooftop farm, it has strong potential as an event space and centrally located venue. The rooftop views have the potential to make the space a very desirable location for leasing for events within a rooftop farm environment. The possible reason that this location was not identified as a suitable site for profit based development is likely because the available FAR in the area is above the specified limits to reduce the chance of out-shading. However, this waterfront property will always have availability of southern lighting, making the issue less of a concern.

Figure 3.6 below shows the street view of the building as seen from a nearby intersection. For more pictures and corresponding GIS map context, see Appendix D.

Figure 3.6

3. 16 Cooper Square, New York, NY
Met GIS criteria for: **Planet and Profit**

This site was perhaps the most centrally located building of all the locations visited. Its site in the NoHo Arts District of Manhattan gave it a bustling, cosmopolitan feel. It is a building that is owned by New York University and is surrounded by other commercial and university developments. The connection to the university creates a fantastic opportunity for the development of a planet focused rooftop farm that could be linked to an education program through the school. The roof is accessible by an interior staircase that opens to a door on the roof. The building is keycard access only with tinted lower windows and is used by the university for their journalism program. The rooftop could provide a lounging and educational space for students and the public if converted to a rooftop farm. The interior structure was not visible from the exterior of the building.

Figure 3.7 below shows the view of the building as seen from across the street. For more pictures and corresponding GIS map context, see Appendix D.

Figure 3.7

4. 56 2nd Ave, Brooklyn, NY
Met GIS criteria for: **Planet, People and Profit**

This site was located in an area that seemed to be mostly industrial use with a bit of commercial development mixed in. It was located close to a well trafficked highway, which could be useful for distribution of produce and delivery of materials for initial construction of an intensive green roof farm. It also is adjacent to many other buildings identified in the GIS research, creating potential for connectivity between the rooftops of the buildings. It is a two floor building with obvious current manufacturing use. The visible interior structure consisted of relatively widely spaced concrete columns and steel beams. Due to the industrial and manufacturing context of this location, it may be a prime site for a planet or people focused rooftop development, as it may not be as desirable of a location for private parties and events associated with profit focused rooftop farm developments.

Figure 3.8 below shows the view of the building as seen from the street. For more pictures and corresponding GIS map context, see Appendix D

Figure 3.8

5. 40 Hall Street, Brooklyn, NY
Met GIS criteria for: **Planet and Profit**
30 Hall Street, Brooklyn, NY
Met GIS criteria for: **Planet and Profit**
55 Washington Avenue, Brooklyn, NY
Met GIS criteria for: **Planet**
220 Flushing Avenue, Brooklyn NY
Met GIS criteria for: **Planet**

This site was located in an area that seemed to be transitioning from industrial use to include more commercial and residential development. These buildings all seemed to be owned by one entity, which appeared to be a commercial storage facility. There was very little activity in the vicinity and all doors to the buildings were locked. With no windows at ground level the interior structural support was not visible.

There was a site adjacent to the eastern side of the buildings where a new commercial development was being prepared. This is unlikely to affect the potential productivity of an intensive green roof farm sited here as most sun comes from southern and western angles.

One structural element of note is that these buildings all had varying levels of roof heights. The majority of the taller buildings were located near the southern end of the block. This may cause unwanted shading on the other, lower roofs located to the north.

Figure 3.9 below shows the street view of one corner of the buildings as seen from a nearby intersection. For more pictures and corresponding GIS map context, see Appendix D.

Figure 3.9

6. 246 Meserole Street, Brooklyn, NY
Met GIS criteria for: **Planet and Profit**

This site was located in a very industrial area. It was difficult to access via public transportation and there were few commercial or residential developments in nearby areas. Public foot traffic was low and there were mostly delivery trucks trafficking the streets. The building's current use seemed to be an industrial warehouse with delivery trucks housed in the facility. The building appeared to be tiered with a small portion being a one story parking garage and the rest being a three story storage facility of some variety. Interior structure appeared to consist of concrete columns and beams.

Figure 3.10 below shows the view of the building as seen from the street. For more pictures and corresponding GIS map context, see Appendix D

Figure 3.10

7. 4746 30th St, Long Island City, NY
Met GIS criteria for: **People and Planet**
4720 30th St, Long Island City, NY
Met GIS criteria for: **People and Profit**

These buildings were located in a seemingly commercial and industrial usage neighborhood. The streets were moderately populated with foot traffic. The buildings themselves were located next to Newton Creek. Both buildings appeared to be one story with potential for connecting intensive green roof farms to be developed. There was a small community garden approximately half of a block away, indicating that a rooftop farm may be well received in the community.

The interior structural support appeared to be steel columns and beams. There appears to be no door to access the roof, so fire escape or other improvised access may be the only options. All other buildings in the area were relatively low to the ground, indicating out-shading would not be of concern. This may be a good location for a profit focused rooftop farm endeavor, as the views of Newton Creek can be clearly seen from the site and provide interest. The industrial and commercial context also indicate that packaging and transporting produce from these roofs may be easier than it would be in a denser, more residentially trafficked area.

Figure 3.11 below shows the view of the building as seen from the street. For more pictures and corresponding GIS map context, see Appendix D

Figure 3.11

8. 3100 47th Ave, Long Island City, NY
Met GIS criteria for: **Planet and Profit**

This site was located in a mixed industrial and commercial area in Queens, near the boundary of Brooklyn, marked by Newton Creek. The neighborhood seemed to be transitioning from industrial use to commercial use. The building itself was called the Falchi Building, and appears to be an old factory that has been transitioned to a mixed use building. Part of the bottom floor was for restaurants and pop up food stands. The upper floors of the building seemed to be office spaces and factory usage. There were freight elevators that reached the top floor and a staircase that lead to the roof, which was accessible but the door to access the roof was locked. The interior structural support appeared to be concrete pillars that decreased in circumference with the increase in floors. Large steel beams appeared to be the cross support, but were only visible in some portions of the building dedicated to shipping and manufacturing. Throughout the rest of the building, ceilings covered the beam structure.

There was substantial foot traffic along the streets and within the building. This building would be a prime site for rooftop farm development with either a planet or profit based focus. If planet based, it could provide a space for employees to engage with agriculture, improve environmental air and water quality, and reduce heating and cooling costs of the building. If profit based, its use could tie into the food court usage of the bottom floor of the building.

Figure 3.12 below shows the street view of the building as seen from a nearby intersection. For more pictures and corresponding GIS map context, see Appendix D.

Figure 3.12

9. 865 E 138th St, Bronx, NY
Met GIS criteria for: **Planet, People and Profit**

This site was located in an industrial neighborhood in the South Bronx. There was little foot traffic on the street and moderate vehicular and delivery truck presence. It was not a far walk from a nearby subway station, and there were some mixed commercial and residential developments along the walk. The interior structure of the building appeared to be concrete columns and the beam structure was not visible. There also appeared to be no apparent access to the roof through the building, indicating outside temporary or added structures may be needed to do so. It is also located in an area in which this GIS research has identified many other suitable rooftops for intensive green roof farming, thus creating the potential for a future network of green roofs.

Figure 3.13 below shows the street view of the building as seen from a nearby intersection. For more pictures and corresponding GIS map context, see Appendix D.

Figure 3.13

10. 825 E 141st St, Bronx, NY
Met GIS criteria for: **Planet and Profit**

This building is located in an industrial area near the waterfront in the South Bronx. It is currently under construction being converted from an old factory into a commercial use building. It is located next to an overpass and has the potential to draw in the eye of the people on the road at rooftop level. The support structure appears to be concrete pillars throughout the building. It is taller than many of the buildings around it, indicating the rooftop would receive ample sun exposure throughout the day.

Figure 3.5 below shows the size and layout of the building as seen from a nearby overpass. For more pictures and corresponding GIS map context, see Appendix D.

Figure 3.14

Phase I Conclusions

All of these locations held qualities that indicated potential for rooftop farm development. Whether or not they are actually structurally capable of supporting the weight of an intensive green roof farm would have to be assessed by a structural engineer. When determining if a building is right for developing a rooftop farm it realistically comes down to the decision of the interested developing party, the contextual physical and financial circumstances, and an engineer's verification of structural integrity. This research is intended to serve as a base starting point for those interested in intensive green roof farm development to begin scouting potential sites.

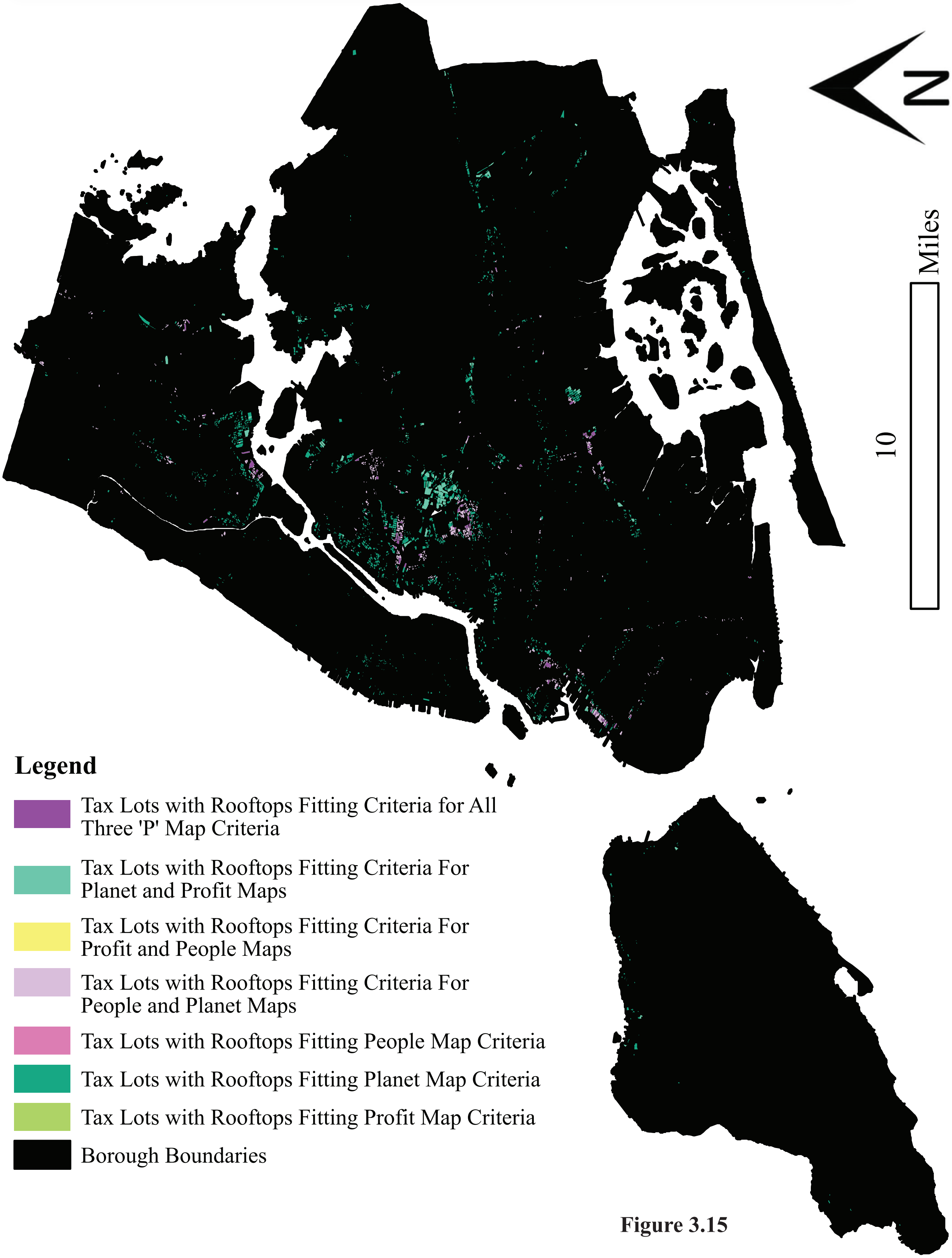
The sites ground truthed also yielded the possibility that storage facilities could be good buildings to support intensive green roof farming. Three out of the ten sites ground truthed were currently being used as storage facilities, which may indicate a trend. When searching for locations to implement intensive green roof farms on, developers may have luck seeking out this type of building usage. The next step in this assertion would be to consult the opinion of a structural engineer.

One significantly impactful element of the results of this GIS analysis was the integration of FAR as a search criterion. While this selection criterion assisted in identifying buildings with a lower likelihood of experiencing construction around them, it also greatly limited the amount of area within the GIS analysis. It resulted in excluding most of Manhattan and significant areas of the Bronx and Brooklyn. The planet motivation based map, which did not use FAR as a selection criterion, had much wider identifying results than the other two maps. While this criterion may reduce the likelihood of a rooftop farm becoming shaded out by a larger, newly constructed building, its manner of incorporation may have been more limiting than needed.

It appears that there is great potential for adding intensive green roof farms throughout all boroughs of New York City. Specific areas identified that appear to have high concentrations of buildings with promising rooftop farm development potential include areas in and around Newton Creek, the South Bronx, and East Brooklyn. These areas may have been identified with higher potential due to their current industrial/manufacturing use and the "industrial or manufacturing" GIS criteria utilized. One item of note related to this pattern is that buildings not identified through this process that were previously used for industrial and manufacturing purposes may also have high potential for rooftop farm development, but may currently be being used as residential or commercial buildings.

While each of the three maps presented in this research are catered in their criteria to the motivations corresponding to one of the three elements of the triple bottom line, all businesses should aim to address all three "P's" in their operations. One element of the three "P's" may be of more interest to a particular rooftop farm founder, but maintaining a balance of all three elements is essential to creating a viable long term and positive externality based business. How all three maps overlap and intersect is presented on the following page in Figure 3.15. In this figure, sites that meet the motivational criteria for all three elements of the triple bottom line are identified. This map and all of the maps within this chapter can be accessed online with available related site data at arcgis.com under the title "NYC Potential Buildings for Rooftop Farming".

Final Map Product Displaying Overlapping Motivation-Based Locations :
Potential Buildings for Intensive Rooftop Agriculture



Legend

- Tax Lots with Rooftops Fitting Criteria for All Three 'P' Map Criteria
- Tax Lots with Rooftops Fitting Criteria For Planet and Profit Maps
- Tax Lots with Rooftops Fitting Criteria For Profit and People Maps
- Tax Lots with Rooftops Fitting Criteria For People and Planet Maps
- Tax Lots with Rooftops Fitting People Map Criteria
- Tax Lots with Rooftops Fitting Planet Map Criteria
- Tax Lots with Rooftops Fitting Profit Map Criteria
- Borough Boundaries

Figure 3.15

Future Research Potentials

This work was meant to serve as a building block for further research and investigations to be built upon. Other considerations that future individuals may wish to incorporate into their own explorations include:

- Wind rose data to account more fully for desiccation of soil
- Shadow analysis of existing rooftop structures
- Further identification of structural integrity of buildings possibly through further engineer-verified ground truthing that could be built on principles explored within this research.
- Raising or not including the limits of the FAR analysis and/or added analyses of how zoning can change over time
- Other criterion specified by speaking with a structural engineer

Phase II: Design Typology Identification

Overview

This second phase of research is meant to create a three easily digestible matrices representing design solutions. Each matrix is differentiated by relating to one of the three elements of the triple bottom line. These matrices are intended to serve as a basic design guide for those interested in rooftop farm development. It also has the possibility to be paired with the site identification research produced in Phase I. Examples of these two phases being combined are explored through projective design in Phase III.

The Concept of Typologies

There is a broad reaching and ever evolving nature of design and rooftop agriculture in New York City. Through analysis of case study site visitations, this research has classified various rooftop farm design characteristics into design typology matrices relating to the elements of the triple bottom line. As part of this process, the meaning of "typology" is reviewed in the following paragraph.

Typology is defined as the "systematic study of types" that is developed "when the logic of taxonomy is applied to a more comprehensive catalogue of phenomena such as site conditions, forms, or concepts".[97] Typologies may address studies of patterns or precedents and are essentially classification schema "applied comprehensively to categories of built form, relative to cultural values and practices."[98] Through typological analysis, the researcher identifies and describes specific qualities and characteristics, which allows them to "establish patterns of association that relate design elements hierarchically across scales."[99] The following discussion and landscape evaluation of designs at visited case studies culminates into the three typological matrices presented in this Phase II of research.

Site Visits to New York

The work for this thesis began with and included several trips to New York City in 2018. The first visit in May of 2018 included conducting site visits of existing rooftop farms. Subsequent trips in September and October of 2018 included the ground truthing process of the Phase I GIS analysis as well as visitation of multiple community gardens, parks, urban farming incubator spaces, and rooftop farms. The intentions behind visiting and volunteering at these locations were:

- To gage the level of community involvement with these various types of urban agriculture.
- Observe which types of locations were most successful.
- Experience and learn about the different types of design layouts most common and how designs varied.
- Make connections with people involved with urban agriculture in New York.
- Note anecdotal demographics and characteristics of people involved with urban

[97] Deming, M. Elen, and Swaffield, Simon R. *Landscape Architecture Research: Inquiry, Strategy, Design*. (Hoboken, N.J.: Wiley, 2011), 133.

[98] Deming, M. Elen, and Swaffield, Simon R. *Landscape Architecture Research,*133.

[99] Deming, M. Elen, and Swaffield, Simon R. *Landscape Architecture Research,* 133.

agriculture.

Below is a list of locations that were visited in the research conducted for this thesis related to urban agriculture and rooftop farming in New York City. This list is intended to serve as a networking or design inspiration resource for individuals wanting to become involved with urban agriculture and rooftop farming. These locations are also of note because they assisted in inspiring the design and typology development within this paper.

Locations Visited Include:

- Project Farmhouse
- Moore Street Market Farm
- Community Gardens throughout the City
- Ag Tech X
- The Brooklyn Grange Rooftop Farm Navy Yard location
- Prospect Heights Community Farm
- Gotham Greens Rooftop Greenhouse
- Q. Street Community Garden
- Hell's Kitchen Rooftop Farm Project
- Randall's Island Park Urban Farm
- School gardens
- Tinyfield Rooftop
- The Brooklyn Botanic Garden and urban farm
- Eagle Street Rooftop Farm
- The green roof systems and farm at the Five Borough Parks Department Building
- Residential rooftop gardens
- The Brooklyn Grange Rooftop Farm in Long Island City
- The Governors Island Urban Farm
- The Science Barge
- The Forage Barge
- North Brooklyn Farms
- Roberta's Pizza Rooftop Shipping Container Farm
- Rosemary's Restaurant Rooftop Garden
- Rooftop Reds rooftop vineyard
- Hell's Gate Rooftop Farm

Rooftop Farm Sites from which Design Typologies were Derived

From this list of locations visited, the sites pertaining specifically to rooftop farming have been selected for further analysis. In total, twelve rooftop farm locations were visited. Not all of the sites were soil-based intensive green roof farms, but each had elements of design and management that were of note and could be useful to those interested in rooftop farm development. The locations and names of each of these sites can be seen in the Figure 4.1. The following pages provide photographs of each site and a brief text description of the site and its operations. Further photographic documentation of the sites and plan view context maps can be viewed in Appendix E of this document.

Visited and Reviewed Rooftop Farm Case Study Locations :

1. The Brooklyn Grange Rooftop Farm Navy Yard location,
63 Flushing Ave, Brooklyn, NY 11205

2. The Brooklyn Grange Rooftop Farm in Long Island City,
37-18 Northern Blvd, Long Island City, NY 11101

3. Eagle Street Rooftop Farm,
44 Eagle St, Brooklyn, NY 11222

4. The greenroof systems and farm at the Five Borough Parks Department Building,
20 Bronx Shore Rd, New York, NY 10035

5. Hell's Kitchen Rooftop Farm Project
410 W 40th St, New York, NY 10018

6. Gotham Greens rooftop greenhouse,
214 3rd St, Brooklyn, NY 11215

7. Rooftop Reds rooftop vineyard,
299 Sands St BLDG #275, Brooklyn, NY 11205

8. Hellgate Rooftop Farm,
4211 9th St, Long Island City, NY 11101

9. Tinyfield Roofhop Farm,
630 Flushing Ave, Brooklyn, NY 11206

10. A residential rooftop garden in Brooklyn Heights,
170 Tillary St, Brooklyn, NY 11201

11. Rosemary's Restaurant Rooftop Garden,
18 Greenwich Ave, New York, NY 10011

12. Roberta's Pizza Rooftop Shipping Container Farm,
261 Moore St, Brooklyn, NY 11206

Figure 4.1

1. The Brooklyn Grange Rooftop Farm Navy Yard location

- Address: 261 Moore St, Brooklyn, NY 11206
- Interpreted primary motive/s of the triple bottom line: **Planet, People and Profit**

Site Visitation Analysis:

This site is an example of the type of rooftop farm that this research focuses on (i.e. an intensive green roof farm). The company, The Brooklyn Grange, currently owns and operates two soil based rooftop farms. On this rooftop, the soil is approximately 11-12 inches deep and features a layered green roof system consisting of a hard plastic composite root barrier, a drainage layer to retain and slow rainwater runoff, a felt layer to absorb and release water into the drainage aggregate, and the rooftop soil mix.[100] The approximate live load weight of these elements with the additional weight of people and plants equates to 40-50 pounds per square foot, while the rooftop is structurally capable of supporting 90-110 pounds per square foot.[101] In 2017, the farm saved approximately one million gallons of storm water from entering the sewer and drainage systems of NYC through retention and evapotranspiration.[102]

This site creates habitat for birds, bats, and pollinator insects including monarch butterflies, which can sense and are attracted to the lower temperature microclimate generated by the green roof farm.[103] The farm uses cacao beans and husks from a local chocolate company as mulch to reduce waste and prevent soil desiccation and erosion.[104] Due to the high wind exposure on top of the roof, seeds are planted deeper than what they would be at ground level to prevent them from being blown away with the top layer of soil.[105] The farm uses a combination of sprinklers and drip tape for irrigation.[106]

This site in the Navy Yard was moderately difficult to access via public transportation. The rooftop had access via elevator to the top floor and stair access to the rooftop. On site the rooftop farm featured a small chicken coop, two small greenhouses, a covered area for gathering and hosting events, one bee hive, and row crop style farming of annual fruits, vegetables and flowers. The crop areas were laid out in rows with a full coverage of soil across the roof. The most profitable crop on the rooftop was microgreens, which can be grown in the greenhouses throughout the entire year.[107] The farm generates revenue from selling the produce through a CSA, at farmers markets, and wholesale to restaurants throughout New York City as well as by renting out the rooftop for events and weddings.[108]

Figure 4.2 to the right is a photograph of the site taken during a tour. The image shows planted and unplanted row crops with the Manhattan skyline visible in the background. For more pictures and corresponding GIS map context, see Appendix E.

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[100] Ornstein, Joe. "Brooklyn Grange Tour." Site Tour, 261 Moore St, Brooklyn, NY 11206, May 2nd, 2018.

[101] Ornstein, Joe. "Brooklyn Grange Tour."

[102] Ornstein, Joe. "Brooklyn Grange Tour."

[103] Ornstein, Joe. "Brooklyn Grange Tour."

[104] Ornstein, Joe. "Brooklyn Grange Tour."

[105] Ornstein, Joe. "Brooklyn Grange Tour."

[106] Ornstein, Joe. "Brooklyn Grange Tour."

[107] Ornstein, Joe. "Brooklyn Grange Tour."

[108] Ornstein, Joe. "Brooklyn Grange Tour."

Figure 4.2

2. The Brooklyn Grange Rooftop Farm in Long Island City

- Address: 37-18 Northern Blvd, Long Island City, NY 11101
- Interpreted primary motive/s of the triple bottom line: **Planet, People and Profit**

Site Visitation Analysis:

This site was the first of the two current existing rooftop farms owned and operated by the Brooklyn Grange. This farm was funded mostly through Kickstarter and private investors and the site was located through a search on Google Maps.[109] The green roof layering system consists of a flat plastic root barrier, thick layer of felt, a plastic root barrier in an egg carton shape to act as a water reservoir, a thin layer of felt, and a top soil of at least 10 inches.[110] The lifetime of the green roof system is estimated to last 10 to 20 years.[111] In terms of return on investment, this farm broke even in its first year of operation, greatly surpassing anticipations.[112]

On site, row crops are planted with cover crops in winter, and roots of larger flowers and annuals are left in the soil for maximum stabilization.[113] Corn is not grown on site because of its deeper taproot, but sunflowers, hot peppers, flowers, and annual vegetables and fruits cover the rest of the space.[114] There is a large banquet style picnic table, a space for a farm stand, a forced air compost area powered by a solar panel, and a chicken coop on site as well. The manure from the chickens is used on site, but they no longer produce eggs.[115] There are also beehives on site, however, there are issues with the beehives surviving, and sudden colony collapse caused all hives to be lost last year.[116] Spent barley from nearby industry is used as mulch on site; straw is avoided as it can bring in spider mites and does not break down easily.[117]

Organic farming practices used on site include: ladybugs to control aphids in greenhouses, spraying a light mixture of Doctor Bronner's soap on aphid infested plants, and a biodegradable fertilizer mix of potash and fish base administered through a drip irrigation system.[118] The Brooklyn Grange also hosts a non-profit organization called City Growers at both farm locations. The non-profit operates through field trips and after school programs aimed at engaging with and teaching kids about "where their food comes from, why it matters, and how they can change the world."[119]

Figure 4.3 to the right is a photograph of the site taken during a tour. The image shows the central path through the farm as well as planted and unplanted row crops with the Manhattan skyline visible in the background. For more pictures and corresponding GIS map context, see Appendix E.

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109 Knott, Danielle. "Flagship Farm Brooklyn Grange Tour." Site Tour, 37-18 Northern Blvd, Long Island City, NY 11101, September 8, 2018.

110 Knott, Danielle. "Flagship Farm Brooklyn Grange Tour."

111 Knott, Danielle. "Flagship Farm Brooklyn Grange Tour."

112 Knott, Danielle. "Flagship Farm Brooklyn Grange Tour."

113 Knott, Danielle. "Flagship Farm Brooklyn Grange Tour."

114 Knott, Danielle. "Flagship Farm Brooklyn Grange Tour."

115 Knott, Danielle. "Flagship Farm Brooklyn Grange Tour."

116 Knott, Danielle. "Flagship Farm Brooklyn Grange Tour."

117 Knott, Danielle. "Flagship Farm Brooklyn Grange Tour."

118 Knott, Danielle. "Flagship Farm Brooklyn Grange Tour."

119 "About." City Growers. Accessed May 22, 2019. https://citygrowers.org/about/.

Figure 4.3

3. Eagle Street Rooftop Farm

- Address: 44 Eagle St, Brooklyn, NY 11222
- Interpreted primary motive/s of the triple bottom line: **Planet, People and Profit**

<u>Site Visitation Analysis:</u>

This was the first commercial intensive green roof farm in the United States.[120] It was financed by the owners of the building and developed to fruition by Annie Novak and Ben Flanner, who is now one of the founders of the Brooklyn Grange.[121]

It served as a proof of concept for other farms and operations to follow. It has since fallen out of use but the layout of the site usage remains. During operation, experimental crops were grown and sold at an on site market and to chefs throughout the city.[122] Volunteers and interns were an integral part of the operation and created an educational and community building environment.[123]

The rooftop is accessible by a staircase through an existing commercial use building, which leads to a small rooftop, which then has a fire escape staircase that leads to the rooftop farm. Its building is a historic warehouse crafted from brick and steel.[124] At the far end of the roof there is a small platform deck with planters from which there is a clear view of the East River and the Manhattan skyline. Some larger shrubs were planted in containers on top of the wooden deck. There is a central pathway down the middle of the rectangular site with horizontal row crops along the sides of the path. There was no tool storage on the same level of the rooftop farm; instead tools appeared to be stored in the room at the top of the stairs leading to a lower rooftop level. The surrounding neighborhood was largely mixed commercial and industrial with little foot traffic on the ground.

Figure 4.4 to the right is a photograph taken during a site visit. The image shows row crops that have yet to be planted and the Manhattan skyline is visible in the background. For more pictures and corresponding GIS map context, see Appendix E.

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[120] Novak, Annie. *The Rooftop Growing Guide : How to Transform Your Roof into a Vegetable Garden or Farm*. First ed. (Berkeley: Ten Speed Press, 2016), Kindle.

[121] Novak, Annie. *The Rooftop Growing Guide*, Kindle.

[122] Novak, Annie. *The Rooftop Growing Guide*, Kindle.

[123] Novak, Annie. *The Rooftop Growing Guide*, Kindle.

[124] Novak, Annie. *The Rooftop Growing Guide*, Kindle.

Figure 4.4

4. The green roof systems and farm at the Five Borough Parks Department Building

- Address: 20 Bronx Shore Rd, New York, NY 10035
- Interpreted primary motive/s of the triple bottom line: **Planet and People**

<u>Site Visitation Analysis:</u>

This location features the largest multi-system green roof in the world.[125] A portion of the roof is dedicated to agricultural production and during the harvest season it produces up to five boxes of produce per day, which are donated to a soup kitchen in Manhattan.[126] This green roof not only produces food, but also provides a relaxation space for Parks department employees and an educational space for visitors. Produce here is grown using a variety of methods, including hydroponically, soil based row cropping, and soil based planters. This roof also houses several bee hives and several rotating composting bins. Crops grown on the roof include tomatoes, peppers, cucumbers, zucchini, strawberries, cantaloupe, and corn, which help to screen wind.[127] Organizers of the farm noted that they avoid growing root crops such as potatoes and carrots due to concerns about pollution in the soil from the urban environment.[128] This location was a bit difficult to access by public transportation, but the walk through the surrounding Randall's Island creates an environment that seems fitting of a green roof.

Figure 4.5 to the right is a photograph taken during a site visit. The image shows row crops, hydroponic growing towers, and bee boxes in the background. For more pictures and corresponding GIS map context, see Appendix E.

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[125] Bindelglass, Evan. "Inaccessible New York Earth Day Special: The 5 Boro Green Roof Garden." CBS New York. April 22, 2013. Accessed April 17, 2019. https://newyork.cbslocal.com/guide/inaccessible-new-york-earth-day-special-the-5-boro-green-roof-garden/.

[126] Bindelglass, Evan. "Inaccessible New York Earth Day Special: The 5 Boro Green Roof Garden." CBS New York. April 22, 2013. Accessed April 17, 2019. https://newyork.cbslocal.com/guide/inaccessible-new-york-earth-day-special-the-5-boro-green-roof-garden/.

[127] Bindelglass, Evan. "Inaccessible New York Earth Day Special: The 5 Boro Green Roof Garden."

[128] Bindelglass, Evan. "Inaccessible New York Earth Day Special: The 5 Boro Green Roof Garden."

Figure 4.5

5. Hell's Kitchen Rooftop Farm Project

- Address: 410 W 40th St, New York, NY 10018
- Interpreted primary motive/s of the triple bottom line: **People**

Site Visitation Analysis:

This rooftop farm was a vibrant example of grassroots agriculture. This farm was originally founded in 2010 to address access to affordable healthy food and fresh produce by four neighborhood organizations including: Clinton Housing Development Company, Metro Baptist Church, Rauschenbush Metro Ministries, and Metropolitan Community Church.[129] It provides an urban escape, educational and social opportunities for community volunteers and a source of local produce for the church pantry. In 2018, the site produced approximately 350 pounds of produce, which was distributed through the Rauschenbush Metro Ministries Food Pantry program.[130]

Located on top of a church roof in Manhattan, this site is easy to access by public transportation. One access issue with this site is the accessibility to the roof only by stairs or fire escape. The fire escape provides a clean way to transport soil from the roof to the ground level, but the lack of elevator access limits the abilities of some to assist in carrying materials to the rooftop or even access the rooftop at all.

This location used the area in the stair access room to the roof to store tools, and had a hose watering system for the plants throughout the site. Kiddie pools and ceramic and plastic planters were used to grow various crops throughout the site. Plants included lettuces, beans, blueberries and even some small apple trees. The kiddie pools were subject to some soil erosion, and a broom was used to gently sweep the soil from the rooftop and drainage points near the edges of the roof. Birds also presented an issue with eating produce and seeds so volunteers improvised wire cages with netting over the top that lift off over the soil filled pools. While there was no direct soil on the rooftop, rubber mats delineated main paths throughout the site and led to a central raised deck. The deck featured a picnic table with a shade umbrella and several benches for seating. Plastic compost bins were located in one corner of the roof.

Figure 4.6 to the right is a photograph taken during a volunteering site visit. The image shows planted kiddie pools covered by wire and netting, volunteers meeting near a central gathering area and part of the Manhattan skyline in the background. For more pictures and corresponding GIS map context, see Appendix E.

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[129] "Farm History." *Hell's Kitchen Farm Project*. Accessed April 17, 2019. https://www.hkfp.org/history.

[130] "Food Pantry." *Hell's Kitchen Farm Project*. Accessed April 19, 2019. https://www.hkfp.org/food-pantry.

Figure 4.6

6. Gotham Greens rooftop greenhouse

- Address: 214 3rd St, Brooklyn, NY 11215
- Interpreted primary motive/s of the triple bottom line: **Planet and Profit**

Site Visitation Analysis:

Gotham Greens is a completely contained rooftop greenhouse. It is not accessible to the public and their main produce is various cultivars of lettuce and basil. This greenhouse is located on top of a Whole Foods in Brooklyn and their produce is sold in the grocery store below. Unlike the rooftop farms discussed in this research, the growing medium for this location is not soil. Instead, all of the lettuce and basil is grown hydroponically. Due to the contained nature of this type of rooftop farming, the benefits to the environment and opportunities for people to engage with growing their own food is lower than what would be available with an intensive green roof farm. However, this type of development is highly productive and requires little fertilization, watering and pest management, compared to open air-exposed rooftop farms.

Figure 4.7 to the right is a photograph taken during a site tour. The image shows basil being grown hydroponically inside of the greenhouse on top of Whole Foods. For more pictures and corresponding GIS map context, see Appendix E.

Figure 4.7

7. Rooftop Reds rooftop vineyard

- Address: 299 Sands St BLDG #275, Brooklyn, NY 11205
- Interpreted primary motive/s of the triple bottom line: **Profit**

Site Visitation Analysis:

Rooftop Reds is the world's first commercially viable rooftop winery.[131] It is accessible by reservation through Eventbrite only or purchasing of a ticket to a curated event on site.[132] This farm features large metal planters holding grape vines that are covered by thin netting to prevent birds from eating all of the grapes. Smaller grape vine starts are planted in five gallon buckets on site. There are hammocks for lounging near the edges of the roof and a large deck area for events. There is also a small room used for serving food and drinks adjacent to the deck area. Due to the lack of soil coverage, this area serves less as a green roof and more as an agricultural event space. The grapes harvested from the vines on the roof are combined with grapes harvested at other vineyards in upstate New York and made into wine that is served on site at this rooftop venue.

Figure 4.8 to the right is a photograph taken during a site tour. The image shows grape vine starts in five gallon buckets and vineyard grapes being grown under protective netting in metal containers. For more pictures and corresponding GIS map context, see Appendix E.

[131] Rinn, Natalie, and Natalie Rinn. "The World's Only Rooftop Hops Farm Lives on Top of the Pfizer Building." Brooklyn Magazine. August 31, 2016. Accessed April 17, 2019. http://www.bkmag.com/2016/08/30/top-old-pharmaceutical-building-worlds-rooftop-hops-farm/.

[132] "Visit Us." Rooftop Reds | Rooftop Vineyard, Rooftop Winery, Wedding Venue and Wine Bar. Accessed April 17, 2019. http://www.rooftopreds.com/how-to-visit-the-roof.

Figure 4.8

8. Hellgate Rooftop Farm

- Address: 4211 9th St, Long Island City, NY 11101
- Interpreted primary motive/s of the triple bottom line: **Planet, People and Profit**

Site Visitation Analysis:

Hellgate Rooftop Farm is part of a network of urban agriculture in backyards and rooftops in Queens.[133] The mission behind Hellgate Farm is "to promote urban gardening and a permaculture lifestyle within our community, providing opportunities for people interested in these practices to connect and learn, as well as share in the abundance of the harvest."[134] The farm was started by an Astoria, Queens community member, Rob McGarth, who started farming in his backyard.[135] As a side project, McGarth gradually started expanding his urban farming projects to willing community member's unused spaces, leading to a pop-up farm stand, the development of a CSA, and other marketable produce-based products from these spaces.[136]

This site was located on top of a two story building in a mixed industrial and commercial neighborhood. This rooftop farm featured raised planter beds made from salvaged wood. Most planters were planted with hot peppers and basil, with carrots in other beds. Hot sauce is made from the peppers harvested, and other produce is distributed to volunteers and sold at weekly farm stand events. Mushrooms are also a crop that is being experimentally grown on this rooftop in the mulch surrounding larger plants in containers. Volunteers are welcome to join the work on a bi-weekly basis and the sense of community was strong at this farm. This site also hosted several large compost piles and bee boxes.

Figure 4.9 to the right is a photograph taken during a volunteering site visit. The image shows a monarch butterfly landing on basil planted in custom built wood planters. The Ed Koch Queensboro Bridge is visible in the background. For more pictures and corresponding GIS map context, see Appendix E.

133 Hellgate Farm." Hellgate Farm. Accessed April 17, 2019. https://www.hellgatefarm.com/.

134 "Hellgate Farm." Hellgate Farm.

135 Altamirano, Angie. "Astoria Community Farm Brings Fresh, Organic Produce to Backyards and Roofs." QNS.com. Accessed April 17, 2019. https://qns.com/story/2015/03/16/astoria-community-farm-brings-fresh-organic-produce-to-backyards-and-roofs/.

136 Altamirano, Angie. "Astoria Community Farm Brings Fresh, Organic Produce to Backyards and Roofs."

Figure 4.9

9. Tinyfield Rooftop Farm

- Address: 630 Flushing Ave, Brooklyn, NY 11206
- Interpreted primary motive/s of the triple bottom line: **Profit**

<u>Site Visitation Analysis:</u>

This was the most informal of all of the rooftop gardens visited. It is the world's only rooftop hop farm.[137] It grows hops and microgreens that are distributed to breweries and restaurants throughout the city and the owner, Keely Gerhold, uses the location to host events, which serve as additional income.[138] The hops use existing infrastructure on the building as trellising.[139] It is located on the roof of the old Pfizer manufacturing building in Brooklyn. The building is currently being used by startup businesses as work spaces and offices. It featured several planter beds with no visible waterproofing beneath them, many planted five gallon buckets, and a small hoop greenhouse.

Figure 4.10 to the right is a photograph taken during a site visit. The image shows a wood planter on top of the roofing material and planted hops in five gallon buckets. For more pictures and corresponding GIS map context, see Appendix E.

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[137] Rinn, Natalie. "The World's Only Rooftop Hops Farm Lives on Top of the Pfizer Building." Brooklyn Magazine. August 31, 2016. Accessed April 17, 2019. http://www.bkmag.com/2016/08/30/top-old-pharmaceutical-building-worlds-rooftop-hops-farm/.

[138] Rinn, Natalie. "The World's Only Rooftop Hops Farm Lives on Top of the Pfizer Building."

[139] Rinn, Natalie. "The World's Only Rooftop Hops Farm Lives on Top of the Pfizer Building."

Figure 4.10

10. A residential rooftop garden in Brooklyn Heights

- Address: 170 Tillary St, Brooklyn, NY 11201
- Interpreted primary motive/s of the triple bottom line: **People**

Site Visitation Analysis:

This rooftop garden in Dumbo was located on top of a residential building that had been converted from an existing factory building. It featured a turf area, paver area with furniture, gravel covered areas, several planter boxes, a composting bin, and many pots. It provided an amenity for the people residing in the building and an opportunity for people to engage with growing their own food and reducing their waste through composting. The space seemed regularly used and the views of the surrounding neighborhood were pleasant. Adjacent taller buildings did not seem to have a negative impact on shading out the plants.

Figure 4.11 to the right is a photograph taken during a site visit. The image shows a turf bocce ball area, rotating compost bin, and containers planted with both edible and non-edible plants. A partial view of neighboring buildings is visible in the background. For more pictures and corresponding GIS map context, see Appendix E.

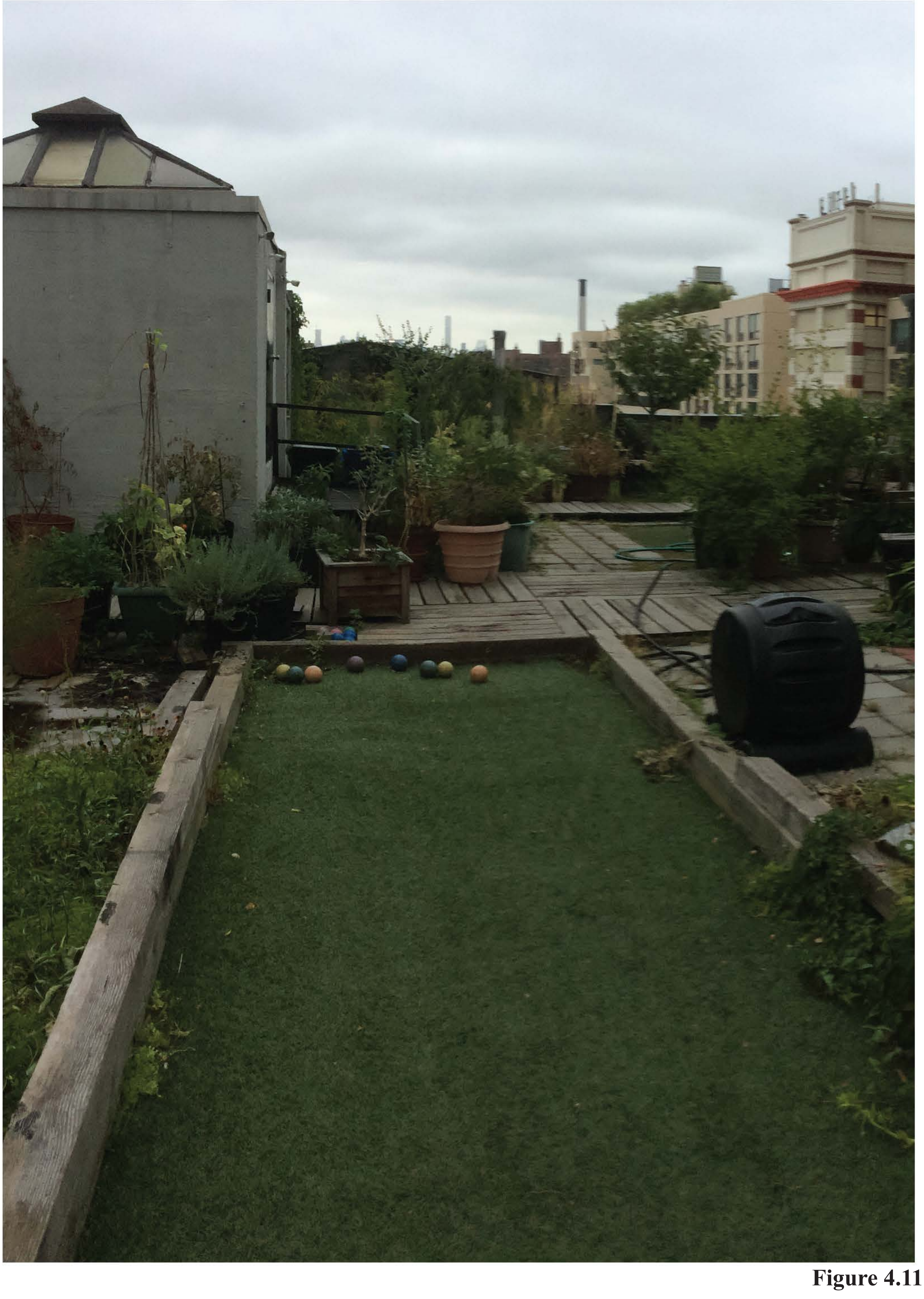


Figure 4.11

11. Rosemary's Restaurant Rooftop Garden

- Address: 18 Greenwich Ave, New York, NY 10011
- Interpreted primary motive/s of the triple bottom line: **Profit**

<u>Site Visitation Analysis:</u>

This small rooftop farm was located in Manhattan in Greenwich Village. It occupied the small rooftop space of a restaurant called Rosemary's**.** It features several large, slightly raised beds, surrounded by rock ground cover and benches for seating. It is closed to the public when raining for safety reasons, but is accessible to customers during the warm seasons. Herbs and produce from the garden are used in the cuisine of the restaurant. This garden adds both environmental and capital benefits to the restaurant in the form of an additional private, productive landscape.

Figure 4.12 to the right is a photograph taken during a site visit. The image shows a raised bed planted with herbs, tomatoes, and edible flowers as well as a gravel walkway. A partial view of neighboring buildings is visible in the background. For more pictures and corresponding GIS map context, see Appendix E.

Figure 4.12

12. Roberta's Pizza Rooftop Shipping Container Farm

- Address: 4211 9th St, Long Island City, NY 11101
- Interpreted primary motive/s of the triple bottom line: **Profit**

Site Visitation Analysis:

This Brooklyn location featured two hoop greenhouse planter boxes on top of shipping containers that are used as part of the neighboring restaurant, Roberta's Pizza. The shipping containers below are also occasionally used as a radio broadcasting station.[140] The greenhouses were not accessible to the public, but provide an interesting combination of rooftop space use and materials. They also add aesthetic interest and value to the outdoor space of the restaurant and create a niche amenity for the restaurant to capitalize upon. The produce grown in the greenhouses is used in Roberta's Pizza restaurant.

Figure 4.13 to the right is a photograph taken during a site visit. The image shows two greenhouses made of wood, PVC pipe, and plastic on top of shipping containers located adjacent to Roberta's Pizza restaurant. For more pictures and corresponding GIS map context, see Appendix E.

[140] Knapik, Michelle. "Roberta's Pizzeria in Brooklyn Has a Rooftop Greenhouse." City Farmer News RSS. Accessed April 17, 2019. https://cityfarmer.info/robertas-pizzeria-in-brooklyn-has-a-rooftop-greenhouse/.

Figure 4.13

Typological Matrices

The analysis of the above described rooftop agriculture sites in New York City were used in the creation of typological matrices. There are three matrices presented, one for each motivation of the triple bottom line (people, planet, and profit). Within each matrix, typologies are organized by rooftop scale (small, medium, or large) and by major design influencing factors including: management, agricultural practices, program, and infrastructure. The scales of rooftop size were derived from precedent case studies as discussed previously in this research. Small scale sites are determined to be 6,000 square feet to 20,000 square feet. Medium scale are determined to be between 20,000 square feet and one acre and large scale sites are determined to be one acre or larger. The design suggestions for these matrices were created using a variety of types and scales of rooftop farm case studies as evaluated in this phase of research.

People focused design typologies were selected to identify design elements for creating benefits and amenities for community members. Examples of visited rooftop farms that exhibited design elements related to people motivated development included: Hell's Kitchen Rooftop Farm Project, the residential rooftop garden in Brooklyn Heights, Hellgate Rooftop Farm, the green roof systems at the Five Borough Parks Department, Eagle Street Rooftop Farm, and the two rooftop farms owned by the Brooklyn Grange. From these case studies, elements of design relating to site accessibility and usability, spaces to create opportunity for social bonding and education, and production spaces for growing a diversity and abundance of crops for community consumption were used to develop the people focused matrix. The design elements identified in this matrix focus on the potential of intensive green roof farms to create social benefits for the members of the surrounding community.

Planet focused design typologies were selected to produce maximum environmental benefits through design and composition. Examples of analyzed rooftop farms that displayed planet motivated design elements included: Five Borough Parks Department Green Roof Facility, Gotham Greens rooftop greenhouse, and the two farms owned by the Brooklyn Grange. From these locations, elements of design relating to environmental education, maximizing reduction of storm water runoff and urban heat island effect, and habitat creation were used to develop the planet focused matrix. The design elements identified in this matrix focus on the potential of intensive green roof farms to create and maximize positive environmental externalities.

Profit focused design typologies were selected to maximize revenue through design and site layout. Examples of profit motivated rooftop farms visited and analyzed in this research included: Roberta's Pizza Rooftop Shipping Container Farm, Rosemary's Restaurant Rooftop Garden, TinyField Rooftop Farm, Hellgate Rooftop Farm, Rooftop Reds rooftop vineyard, Gotham Greens rooftop greenhouse, Eagle Street Rooftop Farm and the two rooftop farms owned by the Brooklyn Grange. From these case studies, elements of design relating to maximizing crop production, rental of spaces for events, and balancing aesthetic amenities with high production were used to develop the profit focused matrix. The design elements identified in this matrix focus on the potential of intensive green roof farms to generate revenue via production of goods and use of spaces for events, tours and other profit oriented activities.

The following three pages display each matrix for people, planet, or profit motivated development and related design potentials as identified from the visited case study sites. As typological studies, these matrices identify and describe specific qualities and characteristics from the visited case studies and "establish patterns of association that relate design elements hierarchically across scales".[141]

[141] Deming, M. Elen, and Swaffield, Simon R. *Landscape Architecture Research*,133.

Potential for Programatic Design Typoolgies for People focused Intensive Green Roof Farm According to Scale

People	**Small Scale** (Approximately 6,000 sq ft to 20,000 sq ft)	**Medium Scale** (Approximately 20,000 sq ft to 43,560 sq ft)	**Large Scale** (Approximately 43,560 sq ft (1 Acre) or greater)
Management	• Grassroots • Cooperative	• Grassroots • Non-profit	• Educational institution • Non-profit
Agricultural Practices	• Annual fruits and vegetables • Herbs • Pollinator flowers • Honey bees	• Small scale typology agricultural practices • Perennial fruiting trees and shrubs • Chickens	• Medium scale typology agricultural practices • Edible flowers • Grains
Program	• Education • Health • Community bonding	• Small scale typology programs • Equal access to healthy food	• Medium scale typology programs • Environmental justice • Public open space
Infrastructure	• Tool storage • Row crops • Raised beds • Planters • Compost areas • Covered beds • Trellises • Permaculture	• Small scale typology infrastructure • Central paths • Gathering area • Seating areas • Food preparation and cleaning areas • Learning spaces • Chicken coop • Apiary	• Medium scale typology infrastructure • Green house • Cooking spaces

Potential for Programatic Design Typoolgies for Planet focused Intensive Green Roof Farm According to Scale

Planet	**Small Scale** (Approximately 6,000 sq ft to 20,000 sq ft)	**Medium Scale** (Approximately 20,000 sq ft to 43,560 sq ft)	**Large Scale** (Approximately 43,560 sq ft (1 Acre) or greater)
Management	• Non-profit • Educational institution	• Non-profit • Government • Educational institution	• Non-profit • Government • Educational institution
Agricultural Practices	• Permaculture focused plantings of annual fruits and vegetables, orchards, perennial fruits and vegetables, herbs, pollinator and edible flowers, and grains • Honey bees	• Small scale typology agricultural practices • Small scale mimicry of an agriforest, agricultural prairie or savannah	• Medium scale typology agricultural practices • Ecostystem scale mimicry of an agriforest, agricultural prairie or savannah
Program	• Education • Pollinator habitat • Stormwater reduction • Experimental rooftop • Permaculture	• Small scale typology Programs • Urban heat island reduction • Avian/insect habitat	• Medium scale typology programs • Habitat network addition
Infrastructure	• Water filtration system • Greywater reuse infrastructure • Rainwater collection system • Learning spaces • Food cleaning area • Planters for trees • Compost • Apiary	• Small scale typology infrastructure • Covered learning spaces	• Medium scale typology infrastructure • Varied topography for creation of micro-habitats

Potential for Programatic Design Typoolgies for Profit focused Intensive Green Roof Farm According to Scale

Profit	**Small Scale** (Approximately 6,000 sq ft to 20,000 sq ft)	**Medium Scale** (Approximately 20,000 sq ft to 43,560 sq ft)	**Large Scale** (Approximately 43,560 sq ft (1 Acre) or greater)
Management	• LLC	• LLC • Corporation	• LLC • Corporation
Agricultural Practices	• Microgreens and annual vegetables and fruits • Herbs • Edible flowers • Mushrooms • Honey bees	• Small scale typology agricultural practices • Perennial fruiting trees and shrubs • Pollinator plants • Chickens	• Medium scale typology agricultural practices • Vineyard
Program	• Production focus on high profit margin produce (peppers, microgreens, herbs, mushrooms) • Edible flower garden • Adult educational area • Resturant garden • Rentable picnic area	• Small scale typology programs • Yoga and health retreat • Winery • Rentable private event space • Farmers market • Wedding venue	• Medium scale typology programs • Orchard • Homesteading practices workshop space
Infrastructure	• Tool storage area • Compost • Shaded area for gathering/food preparation • Planting beds • Small greenhouse • Apiary	• Small scale typology infrastructure • Covered or shaded area for gathering/food preparation • Small greenhouses or larger greenhouse • Small event spaces • Seating • Chicken coop	• Medium scale typology infrastructure • Composting area • Food preparation space and facilities • Greenhouses or mixed event and production greenhouse • Event gathering spaces

Phase II Conclusions

These matrices presented typologies of design identified through site visitation of case studies and subsequent landscape evaluation. Elements of design were identified through case study analysis and classified into easily interpretable diagrams delineated by scale, management, agricultural practices, programming, and infrastructure relating to the three motivational elements of the triple bottom line. As presented, these matrices are intended to provide a basic design guide and inspirational source of information for potential rooftop farm developers.

These typological matrices are far from comprehensive of the potential of intensive green roof farming design in New York City. As the field is still new and expanding, experimenting with design and crops is an exciting and important new element of development. Site investigations revealed an array of different types of rooftop agriculture being practiced at various scales and levels of investment both socially and financially. Rooftop farm owners may draw from the successes and examples of case studies and typologies found in the presented matrices, but should also experiment themselves and feel free to push the boundaries of what already exists.

Phase III: Design Potentials

Introduction

This phase of research focuses on creating a visual representation and investigation of the potentials for intensive green roof farming in New York City. In this phase, three locations identified in Phase I were selected and paired with typologies of design identified in Phase II. Two of the locations include diagrammatic plan designs of potential program and pedestrian flow and one design includes diagrammatic plans of program and pedestrian flow, a rendered site plan, planting suggestions, and three perspective renderings. Each design correlates to a driving motivation of the triple bottom line (people, planet, or profit) and uses the corresponding typological attributes to create an exemplary design. Through engaging the process of research by design this phase investigates and produces potential locations and designs for intensive green roof farming in New York City; thereby visually addressing and exploring the research questions of this work.

Goals of Phase III Research

This research is meant to:

- Provide a working example of how the first two phases of this research can be used in combination.
- Provide illustrative and diagrammatic examples of designed intensive green roof farms.
- Present a potential design that could be created or modified by individuals interested in developing a rooftop farm.
- Produce knowledge through the process of design and the resulting illustrative imagery.

The Concept of Research by Design

Research by design is a fluid and controversial field of landscape architecture research. As per Deming and Swaffield, some "design theorists and educators have increasingly argued that the core activities of the field- including design, critical thinking, and critique- are valid forms of research."[142] However, other design theorists have posed that while landscape architecture design processes involve research tasks such as inventory, analysis, and evaluation, they do not equate to the standards of quantitative or qualitative research conducted in other fields.[143] Research by design is a research method derived to address the perceived disparity between research in other fields and research conducted in the field of landscape architecture relating to the design process.

Design processes are often informed by research strategies and "may directly apply, test, or extend the results of empirical evidence, case precedents, and design guidelines produced in other studies."[144] However, as previously mentioned in the methodology section of the "Research Structure" chapter of this work, "Design only becomes an autonomous research strategy when it produces new generalizable knowledge about the world through its purposes, protocols and outcomes."[145] Projective design, as conducted in this phase of research, focuses on "the unique agency of design process for research outcomes."[146] Phase I and Phase II of this work

[142] Deming, M. Elen, and Swaffield, Simon R. *Landscape Architecture Research*, 205.
[143] Deming, M. Elen, and Swaffield, Simon R. *Landscape Architecture Research*, 205.
[144] Deming, M. Elen, and Swaffield, Simon R. *Landscape Architecture Research*, 206.
[145] Deming, M. Elen, and Swaffield, Simon R. *Landscape Architecture Research*, 206.
[146] Deming, M. Elen, and Swaffield, Simon R. *Landscape Architecture Research*, 206.

consisted of design research where evaluation, classification, and typological analysis were used to produce conclusions.[147] This third phase of research uses the design process to draw from these conclusions and to produce further answers to the research questions of this work.

Of the various forms of research by design discussed in *Landscape Architecture Research*, this phase of research aligns most closely with design interpretations.[148] This type of research process takes place operationally through "conjecture, proposition, projection, and other tactics, but its consequences and outcomes are expressed in landscape experience."[149] Girot describes the series of stages related to this design process as, "Landing (a direct first encounter with place), Grounding (inventory/data collection and secondary investigation), Finding (discovery of a propositional or operative strategy) and Founding (generative design)."[150] This process leads to new understandings of how landscapes may be transformed.[151]

This phase of research follows these design processes. The "Landing", "Grounding" and "Finding" stages include the research conducted in Phase I and II of this work. This third phase aligns with the "Founding" stage of this form of research by design. In this phase of research, data from site visits and secondary investigations used to generate operative strategies from Phase I and II are combined to create generative design.

Landscape Architecture Research asserts that through this methodology of research by design, " imagery is employed both as a method to investigate and as a form to communicate a research study."[152] This phase of research uses design imagery to investigate form and produce new knowledge concerning the research questions of "where and what are the potentials for intensive green roof farming site identification and design as motivated by the elements of the triple bottom line". Through illustratively exploring these questions using the research from Phase I and II, this phase produces new knowledge of the potentials for intensive green roof farming in New York City.

How Sites and Typologies were Selected

The sites that were chosen for this design exploration were sites that were ground truthed within different boroughs of New York City and met the qualifications for different motivations behind the triple bottom line Phase I mapping research. The three sites that I selected were drawn from areas that showed concentrations of potential buildings suitable for rooftop farming within the boroughs of Queens, the Bronx and Manhattan. The site selected for the motivation of "planet" is a building owned by New York University in Manhattan. The site chosen for the motivation of "people" is a small industrial building located in the Bronx. Lastly, the third site selected for the "profit" motivation themed projective design is a building in Queens called the Falchi Building.

These three locations selected from the Phase I ground truthing were then revisited in GIS to verify rooftop surface area. From the determined scale of the rooftop, design typologies were selected from the Phase II matrices for each related element of the triple bottom line. Figures 5.1, 5.2, and 5.3 on the following three pages display the typological design elements chosen for each of the three designs presented in this chapter. The design choices are further discussed in short text descriptions for each of the three designs. The first design presented is the planet motivated potential design, which is discussed subsequently.

[147] Deming, M. Elen, and Swaffield, Simon R. *Landscape Architecture Research*, 206.
[148] Deming, M. Elen, and Swaffield, Simon R. *Landscape Architecture Research*, 215.
[149] Deming, M. Elen, and Swaffield, Simon R. *Landscape Architecture Research*, 215.
[150] Deming, M. Elen, and Swaffield, Simon R. *Landscape Architecture Research*, 216.
[151] Deming, M. Elen, and Swaffield, Simon R. *Landscape Architecture Research*, 216.
[152] Deming, M. Elen, and Swaffield, Simon R. *Landscape Architecture Research*, 217.

Phase II: Typological elements of design for Potential Planet Motivated Design

Potential for Programatic Design Typoolgies for Planet focused Intensive Green Roof Farm According to Scale

Planet	Small Scale (Approximately 6,000 sq ft to 20,000 sq ft)	Medium Scale (Approximately 20,000 sq ft to 43,560 sq ft)	Large Scale (Approximately 43,560 sq ft (1 Acre) or greater)
Management	• Non-profit • Educational institution	• Non-profit • Government • Educational institution	• Non-profit • Government • Educational institution
Agricultural Practices	• Permaculture focused plantings of annual fruits and vegetables, orchards, perennial fruits and vegetables, herbs, pollinator and edible flowers, and grains • Honey bees	• Small scale typology agricultural practices • Small scale mimicry of an agriforest, agricultural prairie or savannah	• Medium scale typology agricultural practices • Ecostystem scale mimicry of an agriforest, agricultural prairie or savannah
Program	• Education • Pollinator habitat • Stormwater reduction • Experimental rooftop • Permaculture	• Small scale typology Programs • Urban heat island reduction • Avian/insect habitat	• Medium scale typology programs • Habitat network addition
Infrastructure	• Water filtration system • Greywater reuse infrastructure • Rainwater collection system • Learning spaces • Food cleaning area • Planters for trees • Compost • Apiary	• Small scale typology infrastructure • Covered learning spaces	• Medium scale typology infrastructure • Varied topography for creation of micro-habitats

• Permaculture focused plantings of annual fruits and vegetables, orchards, perennial fruits and vegetables, herbs, pollinator and edible flowers, and grains • Honey bees	• Small scale typology agricultural practices • Small scale mimicry of an agriforest, agricultural prairie or savannah	• Medium scale typology agricultural practices • Ecostystem scale mimicry of an agriforest, agricultural prairie or savannah
• Education • Pollinator habitat • Stormwater reduction • Experimental rooftop • Permaculture	• Small scale typology Programs • Urban heat island reduction • Avian/insect habitat	• Medium scale typology programs • Habitat network addition
• Water filtration system • Greywater reuse infrastructure • Rainwater collection system • Learning spaces • Food cleaning area • Planters for trees • Compost • Apiary	• Small scale typology infrastructure • Covered learning spaces	• Medium scale typology infrastructure • Varied topography for creation of micro-habitats

Figure 5.1

Phase II: Typological Elements of Design for Potential People Motivated Design

Potential for Programatic Design Typoolgies for People focused Intensive Green Roof Farm According to Scale

People	Small Scale (Approximately 6,000 sq ft to 20,000 sq ft)	Medium Scale (Approximately 20,000 sq ft to 43,560 sq ft)	Large Scale (Approximately 43,560 sq ft (1 Acre) or greater)
Management	• Grassroots • Cooperative	• Grassroots • Non-profit	• Educational institution • Non-profit
Agricultural Practices	• Annual fruits and vegetables • Herbs • Pollinator flowers • Honey bees	• Small scale typology agricultural practices • Perennial fruiting trees and shrubs • Chickens	• Medium scale typology agricultural practices • Edible flowers • Grains
Program	• Education • Health • Community bonding	• Small scale typology programs • Equal access to healthy food	• Medium scale typology programs • Environmental justice • Public open space
Infrastructure	• Tool storage • Row crops • Raised beds • Planters • Compost areas • Covered beds • Trellises • Permaculture	• Small scale typology infrastructure • Central paths • Gathering area • Seating areas • Food preparation and cleaning areas • Learning spaces • Chicken coop • Apiary	• Medium scale typology infrastructure • Green house • Cooking spaces

• Annual fruits and vegetables • Herbs • Pollinator flowers • Honey bees	• Medium scale typology agricultural practices • Edible flowers • Grains	• Small scale typology agricultural practices • Perennial fruiting trees and shrubs • Chickens
• Education • Health • Community bonding	• Small scale typology programs • Equal access to healthy food	• Medium scale typology programs • Environmental justice • Public open space
• Tool storage • Row crops • Raised beds • Planters • Compost areas • Covered beds • Trellises • Permaculture	• Small scale typology infrastructure • Central paths • Gathering area • Seating areas • Food preparation and cleaning areas • Learning spaces • Chicken coop • Apiary	• Medium scale typology infrastructure • Green house • Cooking spaces

Figure 5.2

Phase II: Typological Elements of Design for Potential Profit Motivated Design

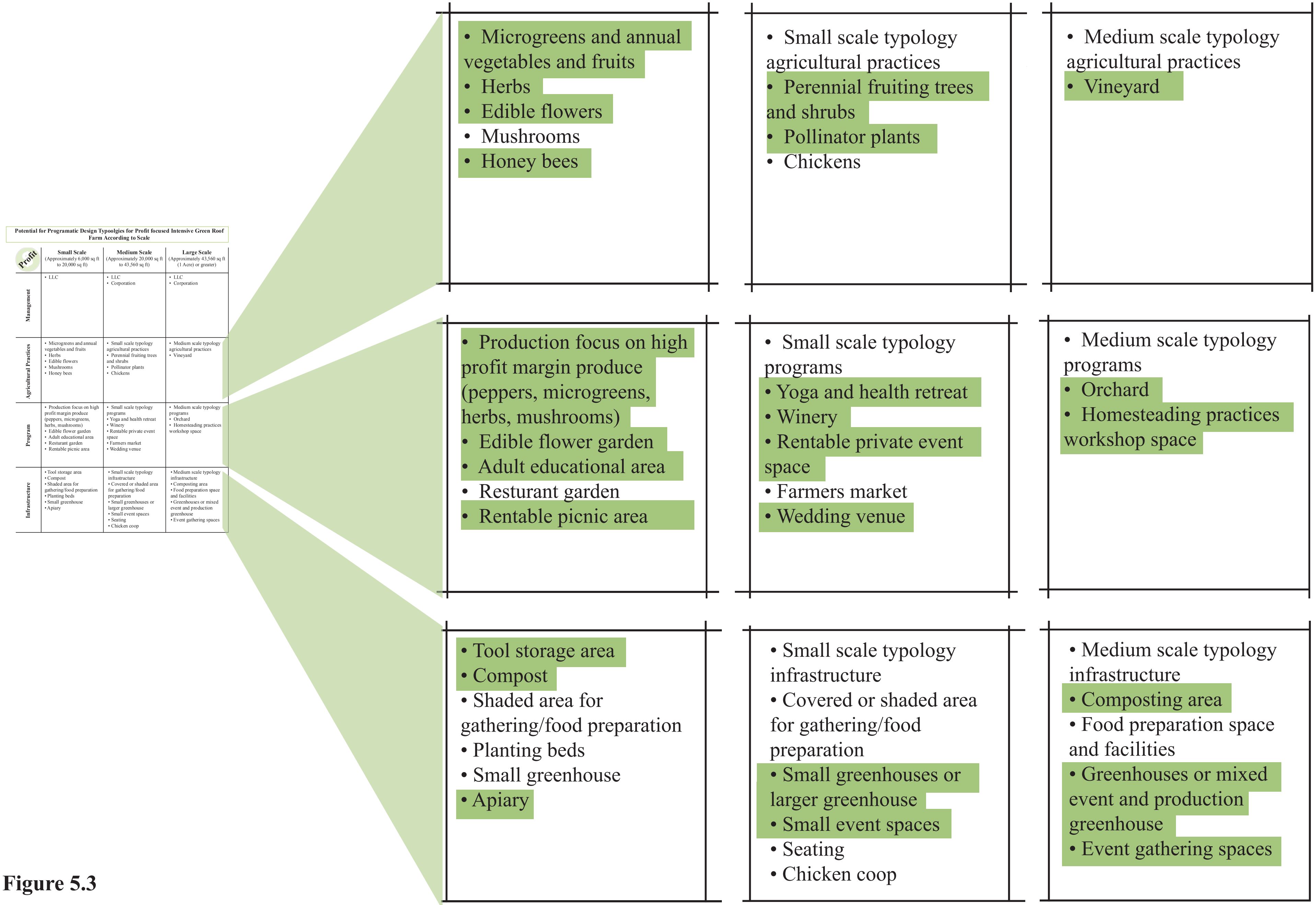


Figure 5.3

Planet Motivated Potential Design

From the locations ground truthed, 16 Cooper Square, Manhattan was chosen for a planet motivated projective design analysis. This site was chosen because of its central location and owner. The building has a footprint of approximately 16,117 square feet, is owned by New York University, and is located between the neighborhoods of Noho and Bowery in Manhattan. The area is densely populated and its association with an educational institution could provide a viable source of funding as well as amplify the benefits that a rooftop farm is capable of providing.

Design Intention

The proposed design intention behind this site is centered on creating a low maintenance, free form area for habitat, storm water retention, composting, and education. The focus on education was included because of the building's ties with the University and its potential to be integrated into the fabric of the NYU campus and facilities. While production of food will be an added benefit of the intensive green roof, the main focus of this design is the environmental benefits that it will provide. The proposed design includes a prairie style form of planting that incorporates root vegetables and wheat. This combination will produce summer and fall crops and will retain winter structure, thus providing bird, bat and insect habitat year round. This form of planting will also reduce the amount of maintenance needed. Leaving roots undisturbed will hold together the soil in a more complete mat during all seasons and weeding can be selectively performed. To preserve green space, a central gathering area in the form of a vegetated dome is proposed, similar to the designs seen at the California Academy of Sciences. The harvesting and growth cycles of the crops can be included in educational activities related to the rooftop. The proposed apiary and compost facilities located on the rooftop may also be incorporated into learning activities. In addition to these benefits, this rooftop will also reduce storm water runoff and combat the urban heat island effect.

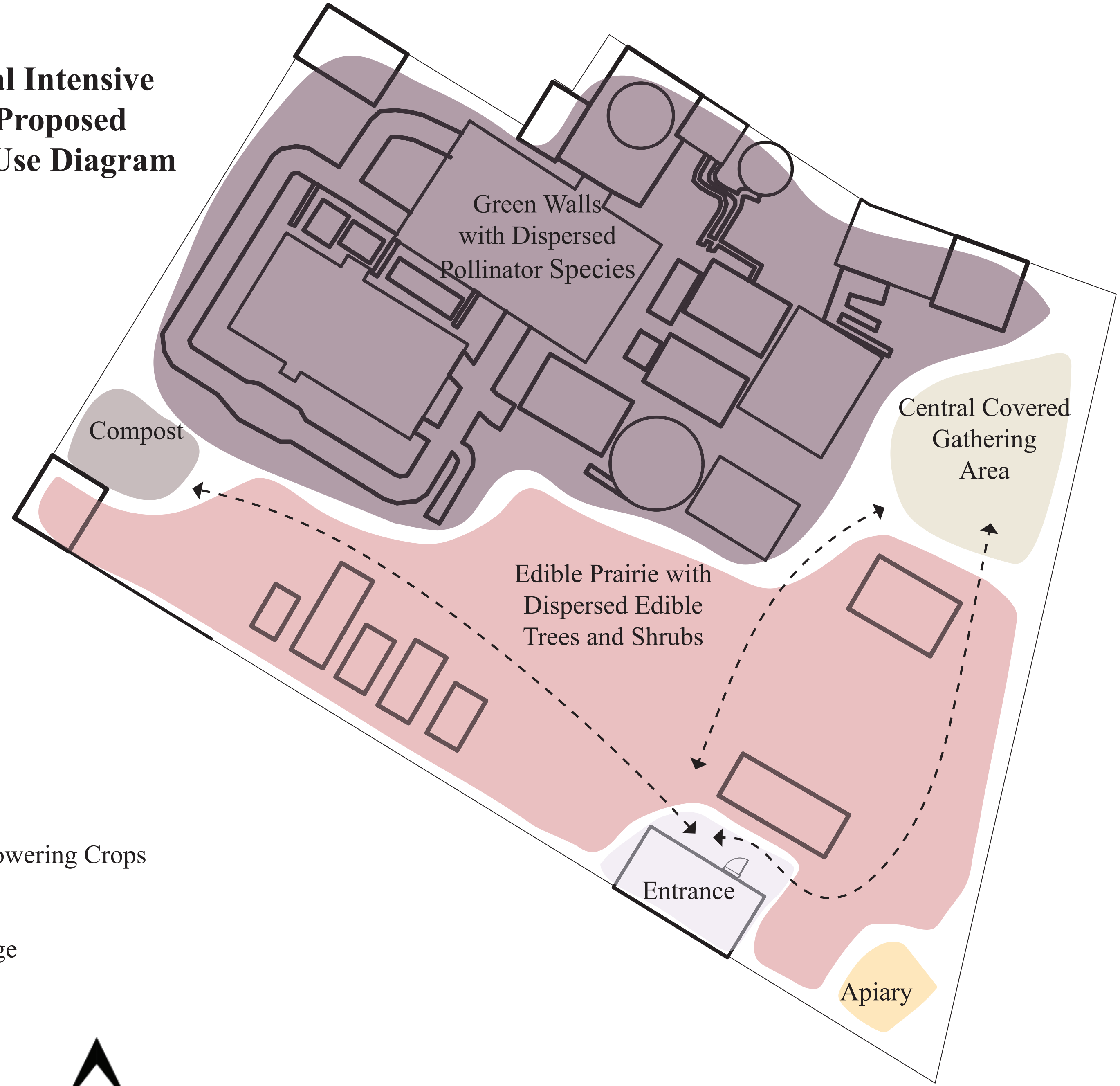
If implemented, a design such as this could create a vibrant educational space. Students and community members could take courses in agricultural practices, and learn more about the environmental, social and economic benefits of agriculture and rooftop farming. Produce from the rooftop could be given to students, employees of the building, sold to restaurants, or incorporated into event catering for the university. It would create an environment for students to interact with green space in a productive and beautiful environment. The potential a site like this holds for reconnecting people with food systems is incredible. Investing in making this design both modern and sustainable has the potential to draw attention to environmental issues that intensive green roof farming can address in a creative and innovative manner. The creation of this design would also provide an opportunity for research and collaboration with other entities and academic institutions. This site would be a unique amenity to the University that would put them at the forefront of the field of rooftop agriculture.

Presentation of design

The following four pages display images intended to relay the intent of the planet motivated potential design to the reader. The designs are presented in a loose and interpretable manner. They are meant to serve as a vision of what could occur on the rooftop using the site selection and design typology research of phases I and II. Images include diagrams of pedestrian flow and zonal usage, as well as related images of precedent design potentials. The design elements are based on the matrix for small scale "planet" motivated design typologies presented in Phase II of this research.

The following pages display three figures used to convey the basic elements of the proposed design. Figure 5.4 displays a diagrammatic plan view of pedestrian flow and potential zones of usage for the rooftop design. Figure 5.5 shows how the diagrammatic design shown in Figure 5.4 is overlaid onto the existing rooftop and infrastructure. Figure 5.6 is an illustrative diagrammatic representation of potential design elements proposed in the Figure 5.4 plan.

Planet Motivated Potential Intensive Greenroof Farm Design Proposed Pedestrian Flow and Zonal Use Diagram



Legend
- Proposed Flow
- Main Planting Zone
- Gathering Zone
- HVAC Zones Planted with Flowering Crops
- Composting Area
- Honey Bee Boxes
- Entrance Area and Tool Storage

Figure 5.4

Planet Motivated Potential Intensive Greenroof Farm Design Diagrammatic Axon

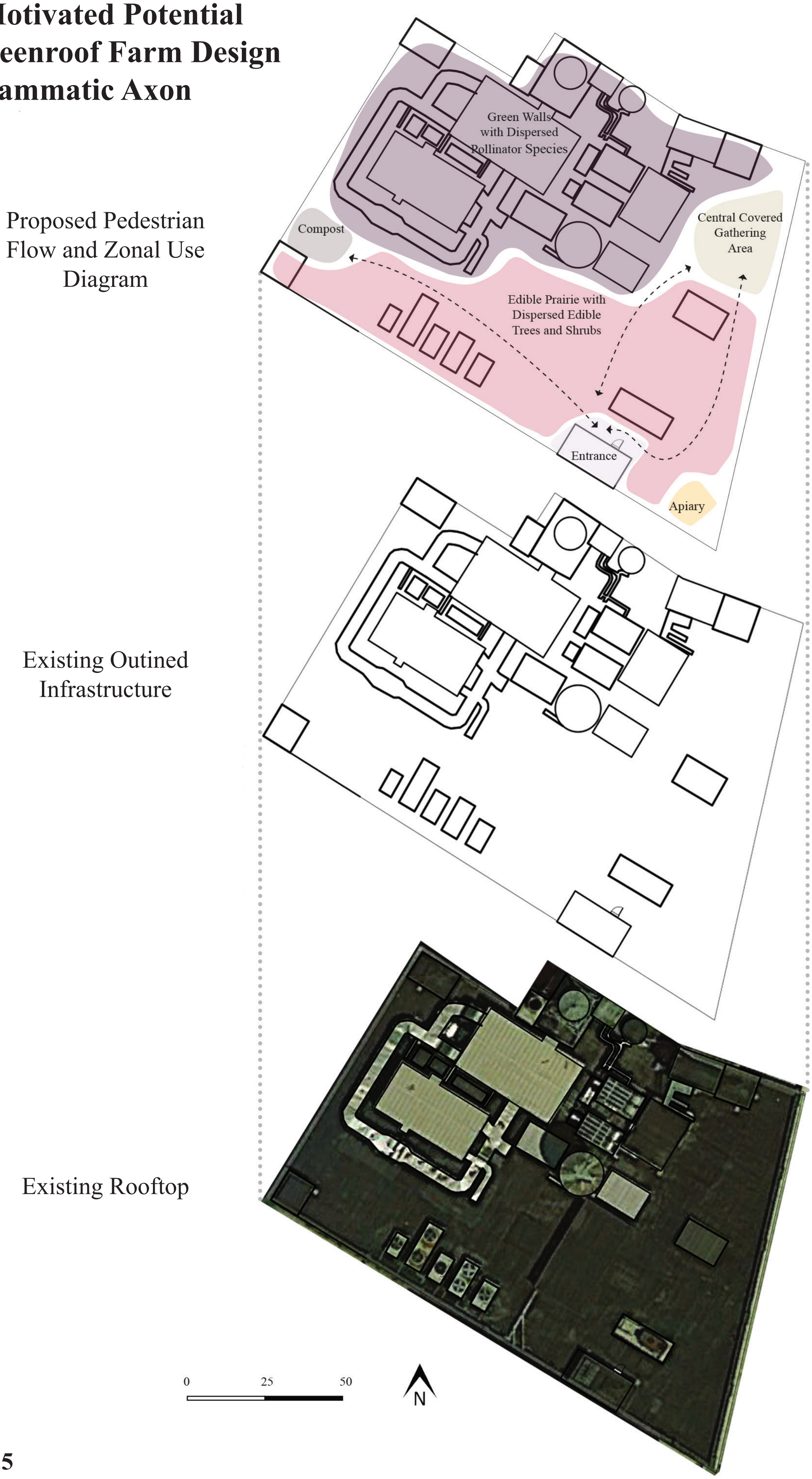


Figure 5.5

Diagrammatic Design Imagery for Planet Motivated Potential Intensive Greenroof Farm

Apiary

Edible Prairie with Dispersed Edible Trees and Shrubs

Edible Prairie with Dispersed Edible Trees and Shrubs

Forced Air Solar Compost

Green Walls

Dispersed Pollinator Species

Central Covered Gathering Area

Figure 5.6

Design Process Takeaways

One challenging element of this design included working around the existing and complicated HVAC system. For future designs, talking to an HVAC specialist to determine if existing units could be downsized would be beneficial. Freeing up space by reducing the area of the HVAC would create greater opportunity for design as well as greater harvest and environmental benefits. Overall, this rooftop could provide an exciting and well functioning addition to the NYU campus and inspire other building owners and campuses to follow their example.

People Motivated Potential Design

The location identified in Phase I that was selected for the people motivated projective design is located at 865 E 138th St in the Bronx. This site was chosen because of the large roof with little HVAC components to disrupt rooftop farming practices. The total area of the building footprint is approximately 58,550 square feet. It is located not far from a subway station making it a pedestrian accessible destination. The immediate surroundings were industrial and manufacturing only. There is a train track adjacent to the roof, which may need to be blocked with a green wall for sound and particulate matter management. The one story building does not have any access to the rooftop from the interior so an additional outside stair case, fire escape or construction elevator would be a necessary element of the design. The rooftop and surrounding context is similar to the existing Hellgate Farm. It has the potential to start a network of rooftop agriculture in a mixed commercial and industrial area that currently holds ample unused rooftop space.

Design Intention

The design intention for this rooftop centered around a low budget, adaptive design concept that could be implemented by a grassroots organization or non-profit. The zones are largely interpretive. The apiary is located away from the train tracks so as not to disturb the bees. Less frequented areas like the entrance, tool shed, and compost are located in a grouping near the train track. Near the entrance, leading to the central gathering area there are raised beds to include space for people with accessibility issues who may not be able to bend over to work at ground level. The center of the space is suggested to be used as a central covered gathering area. This zone may include a covered deck, areas for cleaning and preparing produce and a greenhouse for growing space, events, classes, or gathering. The rest of the rooftop is left open for community garden plots and covered beds. The covered beds are located on the far western side to ensure ample sun, while the southern and northern sides are reserved for community beds. More shade tolerant plants should be planted on the northern side adjacent to the train tracks, which is proposed to be buffered by a green wall.

The implementation of such a design in this space would create a vibrant opportunity for community engagement, food production, and expression of creativity. The open plan of much of the proposed design is intended to allow for exploration of growing methods, forms and plant types. This is meant to be a space that cultivates expression, bonding and healthy food for individuals who may not have access or are interested in growing and learning about their own food. With the variety of activities available, presence of raised beds, and one story stair case access, individuals of many levels of abilities and ages would be able to engage with the space. Depending on the form of management, crops could be distributed to volunteers and food banks, plots could be rented to community members, or a mix of selling products from the rooftop and local food distribution could be combined. The main goal of this location would be to provide an opportunity for community members to engage with green space in a productive environment that produces the social and economic benefits of access to local, affordable, healthy food, as well as positive environmental externalities.

Presentation of Design

The following pages show diagrammatic layouts for the basic pedestrian flow and use of the potential intensive green roof farm design for 865 E 138th St. The design elements proposed are based off of the typological design matrix for large scale "people" motivated development presented in Phase II of this research.

The following four pages display three figures used to convey the layout and potential design of the site. Figure 5.7 displays a diagrammatic plan view of the rooftop with proposed pedestrian flow and design usage by zones. Figure 5.8 shows how the diagrammatic plan in Figure 5.7 relates to the existing rooftop and HVAC infrastructure. Figure 5.9 is an illustrative diagrammatic representation of potential design elements proposed in the Figure 5.7 plan.

People Motivated Potential Intensive Greenroof Farm Design Proposed Pedestrian Flow and Zonal Use Diagram

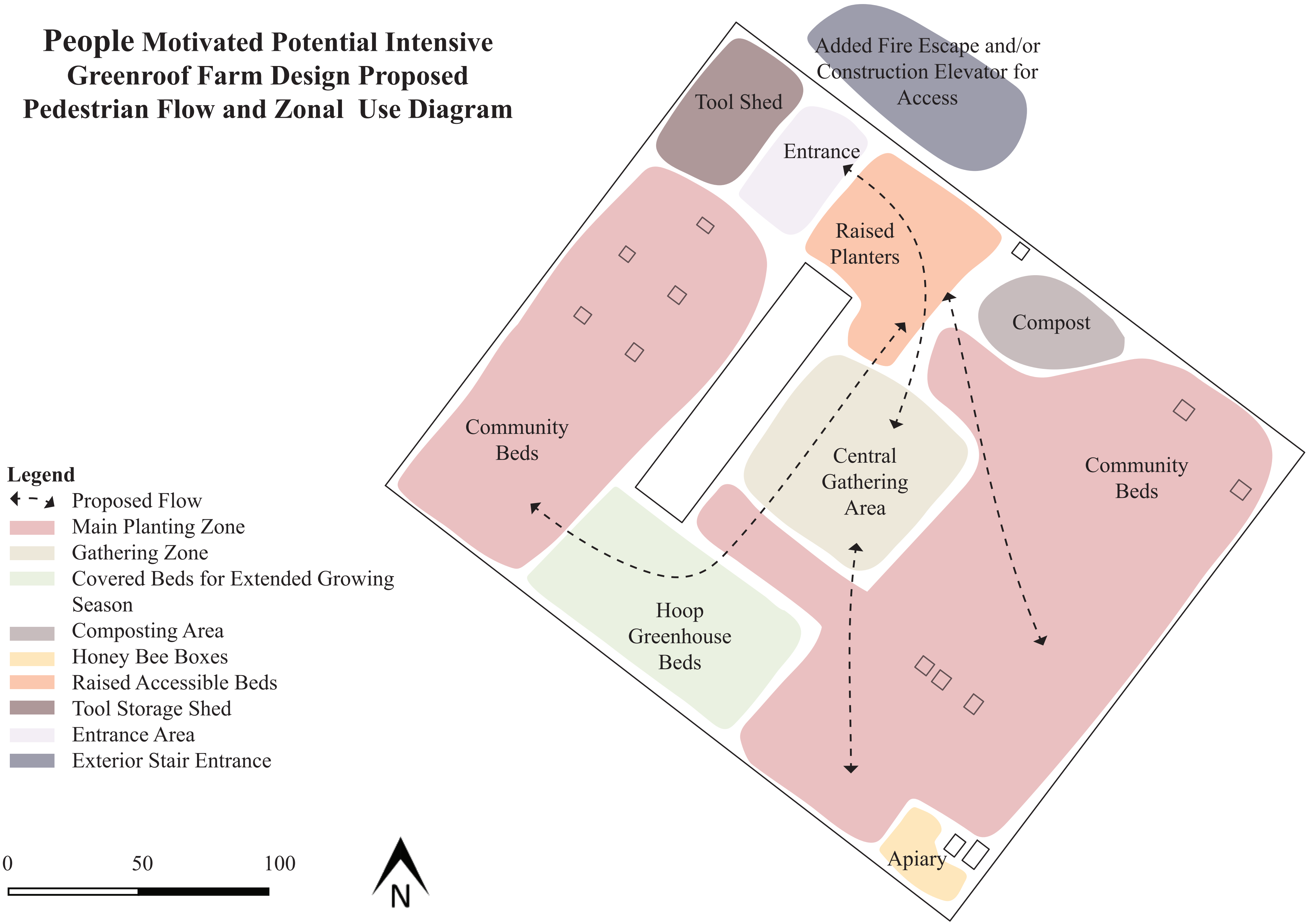


Figure 5.7

People Motivated Potential Intensive Greenroof Farm Design Diagrammatic Axon

Proposed Pedestrian Flow and Zonal Use Diagram

Existing Outined Infrastructure

Existing Rooftop

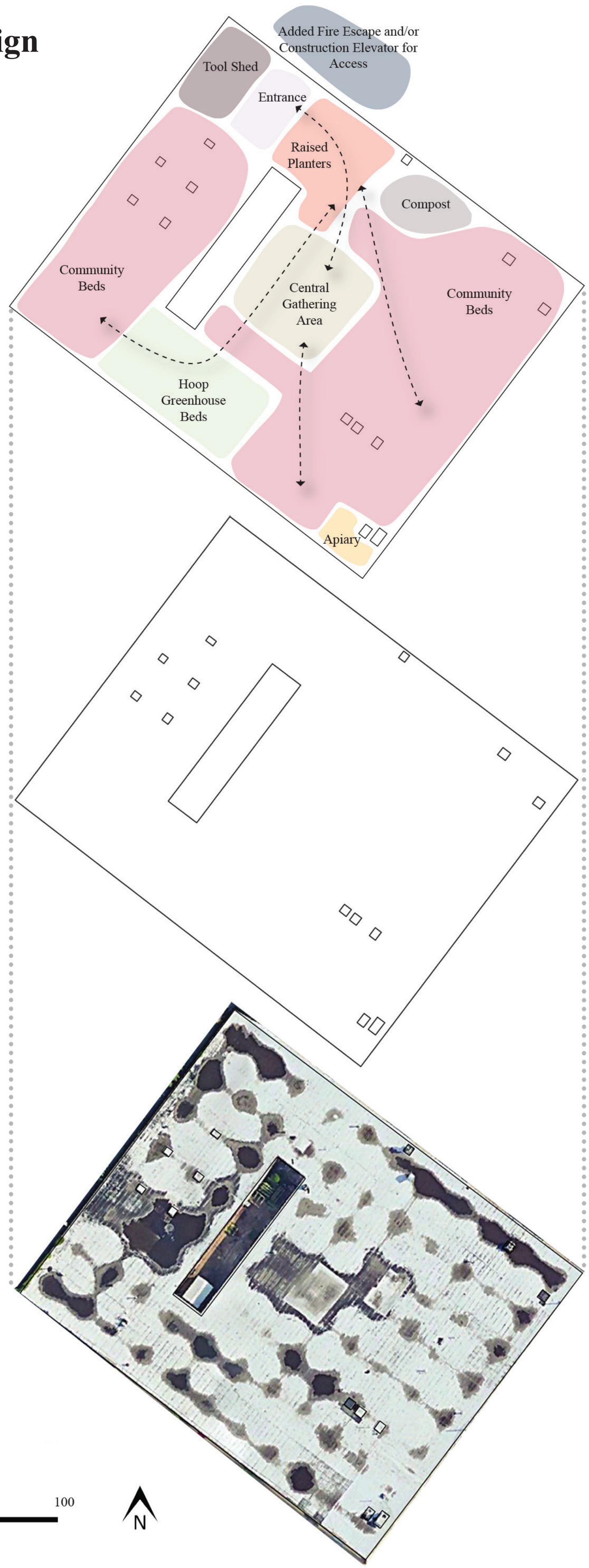


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Figure 5.8

Diagrammatic Design Imagery for People Motivated Potential Intensive Greenroof Farm

Central Gathering Area

Tool Shed

Added Spiral Stair Case

Community Beds

Central Gathering Area/ Greenhouse

Raised Planters

Compost

Hoop Greenhouse Beds

Apiary

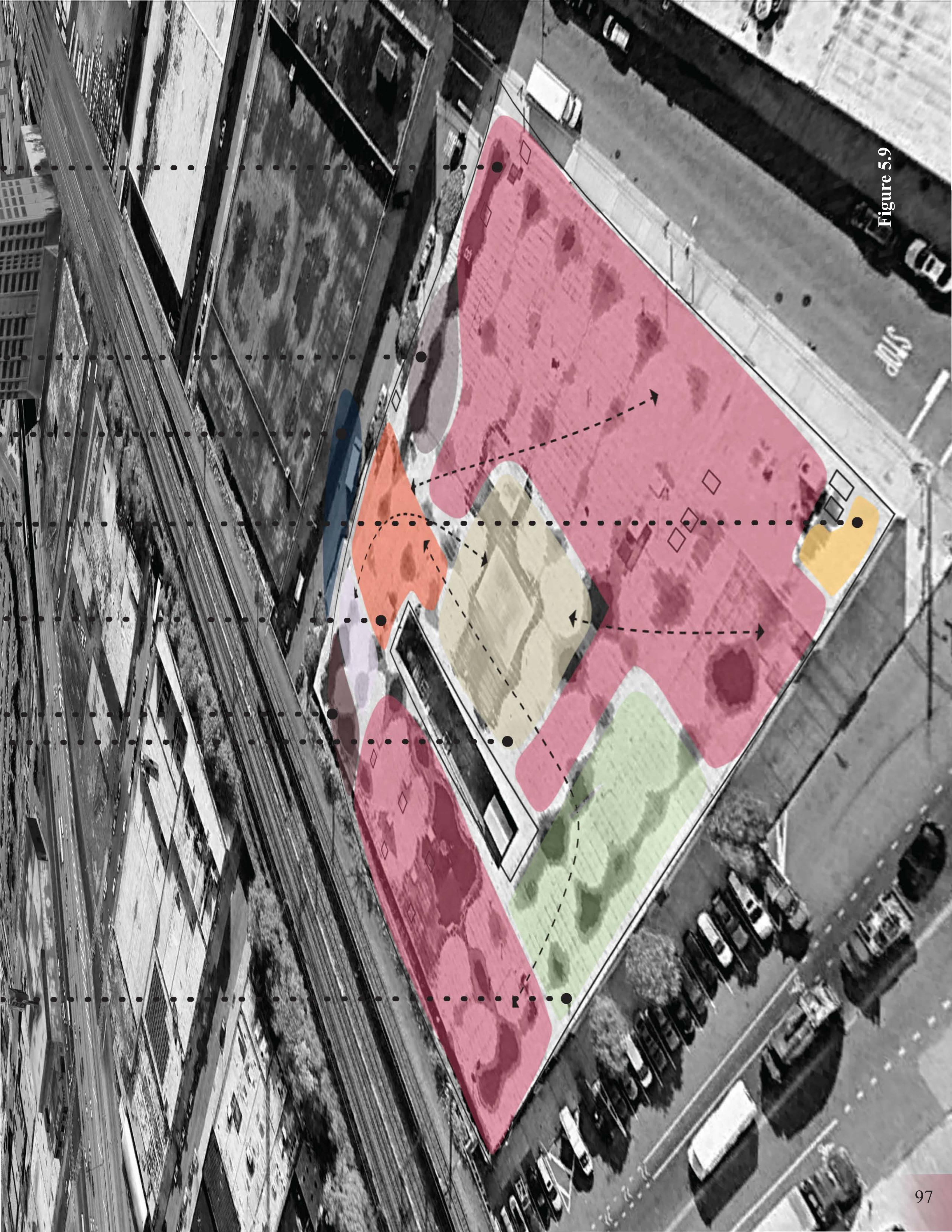


Figure 5.9

Design Process Takeaways

The design process for this location included considering how to address the nearby train tracks, the existing HVAC, and access to the rooftop. To address the train tracks, a green wall was proposed to buffer the site. In other designs, it may not make sense to develop a rooftop farm next to a train track if the noise and air pollution from the train is too great. Designing a site with more condensed HVAC infrastructure on the rooftop was much easier and allowed for more freedom of layout. The existing HVAC should be an element that is considered when selecting a rooftop for intensive green roof farming. The accessibility of the site was also another consideration of design. With no existing access to the roof currently available, adding additional exterior access was necessary. This may be a unique scenario, but it should be noted that it is an option for design. Regulations and codes regarding the matter should be consulted before implementation. This site provides an example of how a flat, open rooftop has vast potential for design that could be interpreted in many ways and will still yield benefits for the community, regardless of the structured form.

Profit Motivated Potential Design

For the profit focused motivational element of the triple bottom line relating to development, the Falchi Building at 3100 47th Ave, Long Island City in Queens was selected for a more in depth projected design. The size of the building footprint is approximately 114,757 square feet. This site and motivation were chosen for a more detailed design because of its plausibility for realization. The presence of food based businesses already thriving within the building has positive business related indications. This site was also chosen because of its location in an area that is quickly developing and many other suitable sites for intensive green roof farming as identified in the Phase I GIS analysis surround it. The size, use, and context of this building make it an extremely promising option for developing a rooftop farm.

Design Intention

The intention behind this design is to create a rooftop farm focused on maximizing profitability. It focuses on creating a productive space with utility based areas that also functions aesthetically as a rentable space for events to generate additional revenue. The design includes four planting zones based on rooftop layout, proposed use, and solar considerations. The design includes two greenhouses that can be used for covered events as well as spaces for starting seeds and growing microgreens year round. There are also three decks that can be used for viewing tours, or rentable event spaces. In addition, the design includes green walls of hops to screen large elements of the HVAC system on the rooftop. Inside of the visual coverage that the green walls provide, extra tools can be stored and pollinator species planted. Covered hoop beds are also proposed to assist in elongating the growing season and maximizing crops. The apiary, compost and tool shed are located in the less frequented area of the site in the Southeast corner. This area is located behind the main entrance to the roof, and can be accessed by visitors, but is located away from main event spaces. This is to prevent issues with people who may be allergic to bees, or offended by the smell of compost. The compost is suggested to be a forced air, solar powered system, so that the smell and labor required is reduced. An example of this type of system can be seen at Randall's Island Urban Farm. Small perennial bushes and grape vines are proposed to be planted around areas where smaller HVAC components are located to further screen these elements.

If implemented, this design would function both as a farm and as an event space. It would create opportunities for agricultural employment in the city, a space for community members to learn more and engage with agriculture through site tours, and an aesthetic space for events. The screening elements of trees, bushes, and green walls all contribute to the productivity of the farm, but also create a more aesthetic and pastoral atmosphere, thus adding to the value of the roof as an event space. The site could be rented for weddings, private parties, corporate events, educational classes, yoga retreats and much more. Renting of the space for events would not only generate additional income, but would also create opportunities for people to engage with and learn more about food systems. The size of the farm would create its own microclimate, thus creating a cooler space for people and animals to enjoy during the warm season. Pollinator species attracted to the farm would not only benefit the crops, but also create interest for visitors to the rooftop. Honey produced from bees housed on site could be sold as a novelty product that would contribute to increased revenue. Overall, this space holds great potential as a site for intensive green roof farming and in addition to generating ample revenue, would create environmental and social benefits as well.

Presentation of Design

The following pages show the design layout for The Falchi Building. The design documents include a plan and axonometric view of the proposed zonal usage and pedestrian flow of movement throughout the site. A scaled plan of the site is included as well as three renderings of what the proposed design has potential to look like. As the other two design investigations have, this proposed potential design, draws on the work of Phase I and II of this research. The design elements utilized are based off of the typological design matrix for large scale “profit” motivated development presented in Phase II of this research.

The following twelve pages contain figures used to communicate the elements of the proposed design. Figure 5.10 displays a diagrammatic plan view of the rooftop with proposed pedestrian flow and design usage by zones. Figure 5.11 shows how the diagrammatic plan in Figure 5.10 relates to the existing rooftop and HVAC infrastructure. Figure 5.12 is a scaled plan of the site layout including beds, greenhouses, gathering areas, trees, shrubs, a compost area, apiary and tool shed. Figure 5.13 displays an illustrative diagrammatic representation of potential design elements proposed in the Figure 5.12 plan. Figure 5.14 is a panorama photo-realistic rendering of the proposed design of the rooftop. Figure 5.15 is a planting chart of potential crops to grow in the four proposed planting zones seen in Figure 5.11. The plantings are roughly placed over where they would be located in the illustrative rendering seen in Figure 5.14. Figure 5.16 is an illustrative rendering of the proposed Zone 1 plantings and how green walls of hops can be used to screen HVAC elements on site. Figure 5.17 is an illustrative rendering of the proposed Zone 2 planting area and greenhouse central gathering area. The image shows the potential of the space to be used for events such as weddings, and the aesthetic value of how the proposed vineyard and edible flower plantings may combine visually.

Profit Motivated Potential Intensive Greenroof Farm Design Proposed Pedestrian Flow and Zonal Use Diagram

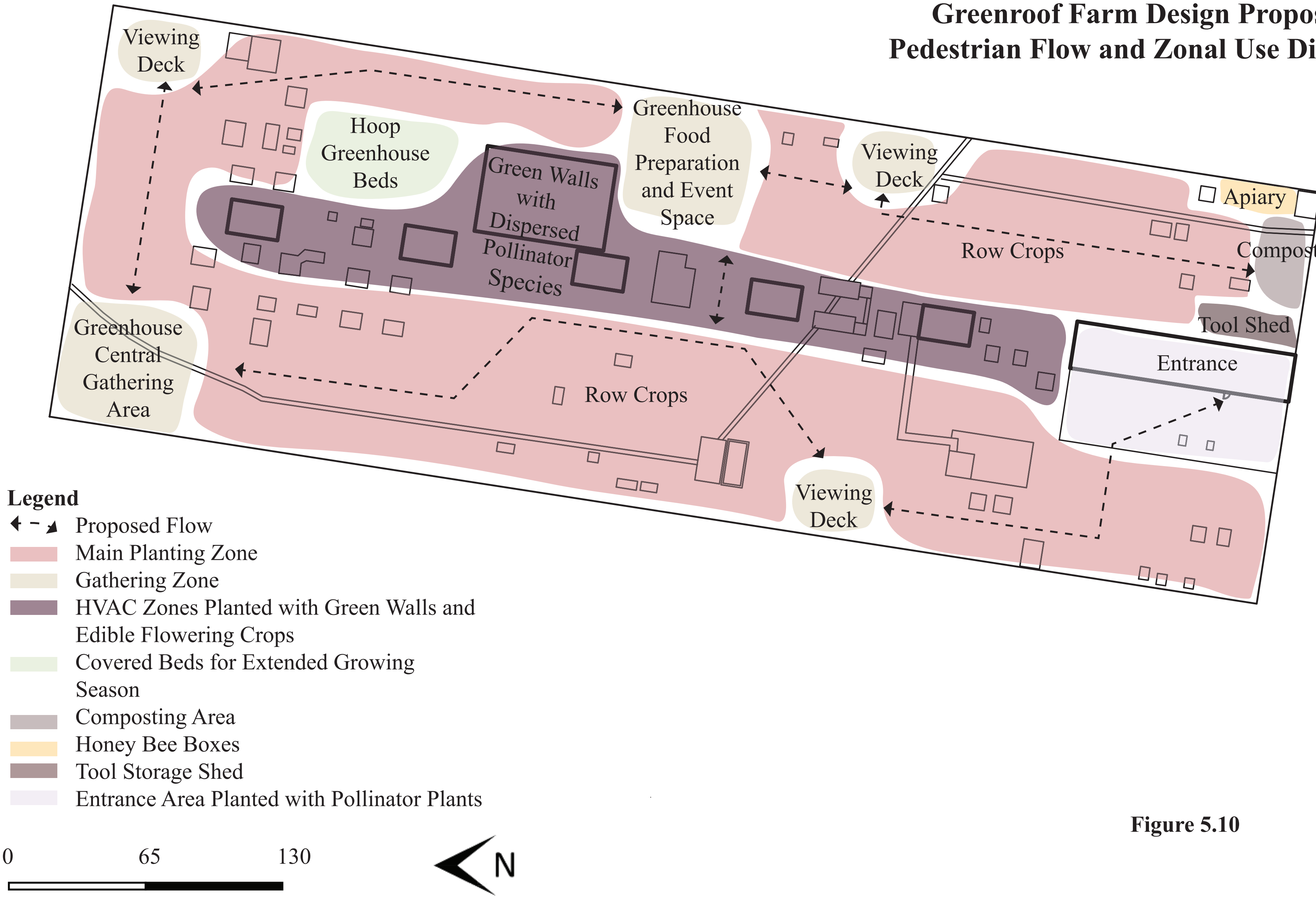


Figure 5.10

Profit Motivated Potential Intensive Greenroof Farm Design Diagrammatic Axon

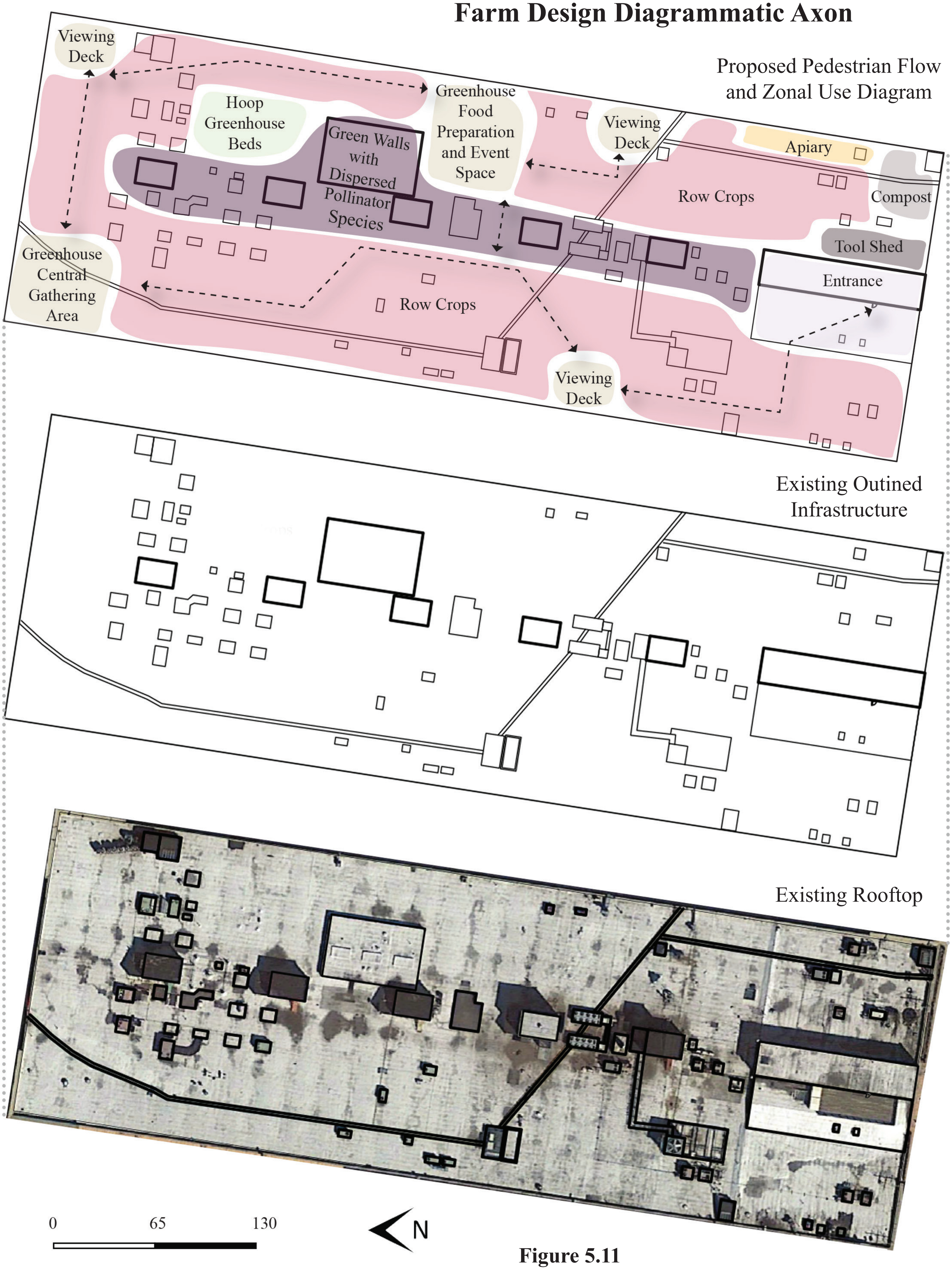
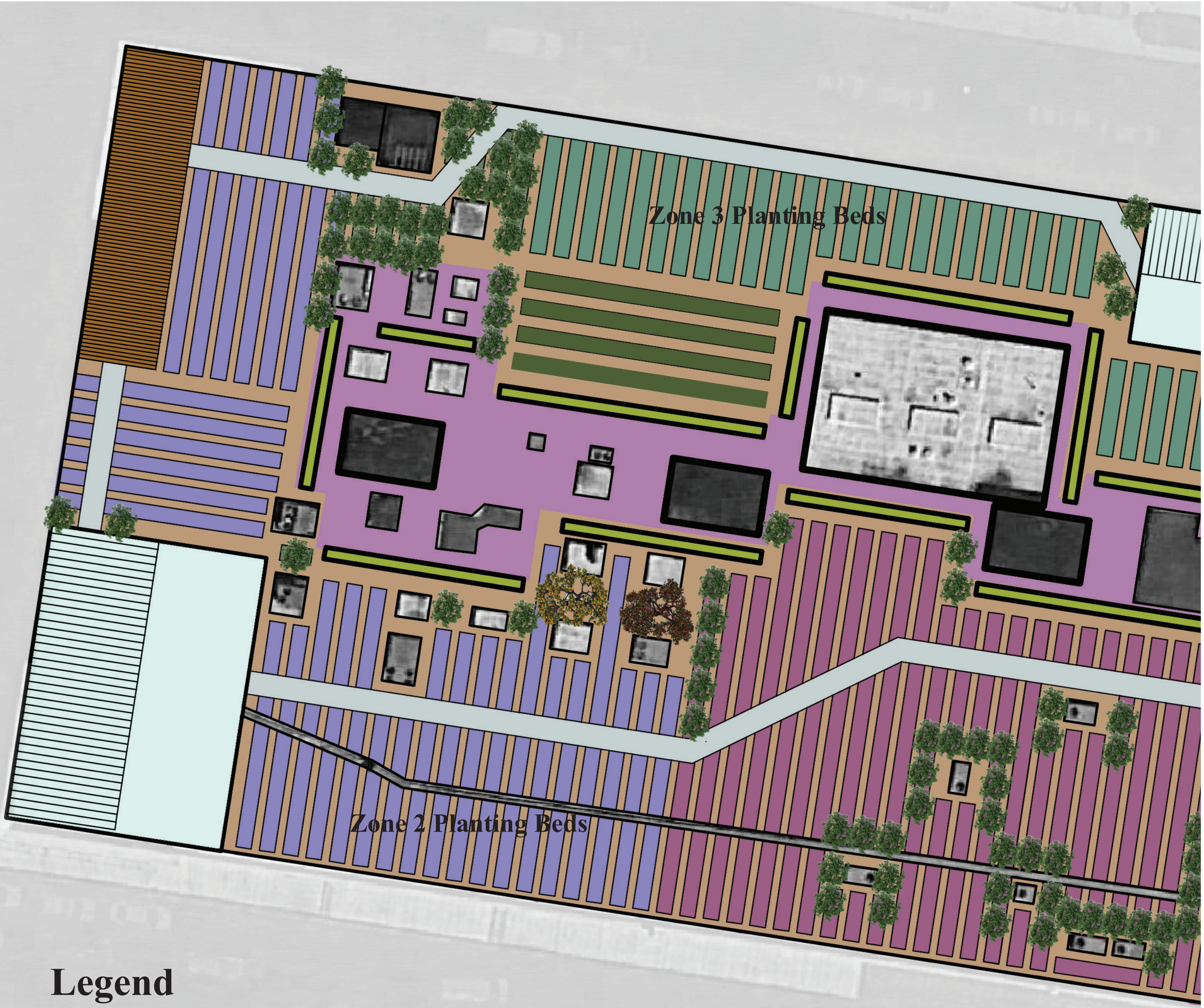


Figure 5.11

Profit Motivated Potential Intensive Greenroof Farm Design in Plan View



Legend

- Pollinator Plants and Additional Equipment Storage Area
- Greenhouses for Growing Starts, Microgreens and to be Used as Event Spaces
- Covered Beds for Extended Growing Season
- Composting Area
- Honey Bee Boxes
- Mulched Paths
- Tool Storage Shed
- Rooftop Soil Coverage
- Event Space Deck
- Edible Flowers and Herbs
- Hop Supporting Green Walls
- Zone 1 Planting Beds: Full Sun Annual Fruit and Vegetable Crops
- Zone 2 Planting Beds: Edible Flower Crops Mixed with Vineyard
- Zone 3 Planting Beds: Full Sun to Partial Sun Annual Fruit and Vegetable Crops
- Zone 4 Planting Beds: Full Sun to Partial Sun Mixed Perennial and Annual Vegetables and Herbs
- Perennial Fruiting Shrubs
- Apple Tree
- Cherry Tree

3100 47th Ave, Long Island City, NY

Figure 5.12

Diagrammatic Design Imagery for Profit Motivated Potential Intensive Greenroof Farm


Greenhouse Food Preparation and Event Space
Viewing Deck and Event Space
Solar Powered Forced Air Compost
Apiary
Zone 4 Row Crops
Tool Shed
Edible Flowers and Herbs
Zone 1 Row Crops
Viewing Deck and Event Space

Figure 5.13

Figure 5.14

Zone 2 Potential Plants: Edible Flower Crops Mixed with Vineyard

Flowers:
Bee Balm
Borage
Daylilies
Nasturtium
Strawberries (for their flowers)
Violas

Grapes:
Red varietals: Cabernet Franc, Merlot, Malbec, Pinot Noir, Syrah, Blaufrankisch
White varietals: Chardonnay, Sauvignon Blanc

Zone 1 Potential Plants: Full Sun Annual Fruit and Vegetable Crops

Hot Peppers: Jalapenos, Habaneros, Chili and many other wide ranging cultivars
Tomatoes
Melons
Cucumbers
Beans
Squash
Artichokes
Asparagus
Eggplant
Strawberries
Peas
Sunflowers
Garlic
Onions
Basil
Rhubarb
Zucchini

Zone 3 Potential Plants: Full Sun to Partial Sun Annual Fruit and Vegetable Crops

See Zone 1 full sun plant list

Partial shade plants:
Beets
Kale
Broccoli
Cauliflower
Arugula
Carrots
Potatoes
Radishes
Turnips
Lettuce

Zone 4 Potential Plants: Full Sun to Partial Sun Mixed Perennial and Annual Vegetables and Herbs

See Zone 1 full sun plant list

Herbs:
Rosemary
Sage
Oregano
Thyme
Basil
Chives

Partial shade plants:
Beets
Kale
Broccoli
Cauliflower
Arugula
Carrots
Potatoes
Radishes
Turnips
Lettuce

Figure 5.15

Figure 5.16

Figure 5.17

Design Process Takeaways

One element of this design to note is that while Figure 5.12 displays potential crops for planting, other for profit rooftop farms visited in Phase II reported the most efficient manner for crop selection to be direct communication with chefs and other wholesale buyers within New York City. So while the crops suggested were chosen based on Phase II case studies and plant knowledge of the New York City climate, if a similar farm were to be developed, collaboration with local buyers may be the best tactic for plant selection. Also, Figure 5.12 does not display cover crop options for winter plantings. Cover crop choices are wide ranging and could include many varieties of clover or for profit options like winter wheat, fava beans, and rye.

Another design choice to be noted is that while some rooftop farms grow root vegetables, studies have not been conducted on the effect of urban air pollution on the soil of rooftop farms. Root vegetables are more directly exposed to the contents and potential contaminants in soil than fruiting plants and leafy vegetables. There is no official consensus on best practices concerning this topic, and is a decision left up to the rooftop farmer themself.

The largest design challenge for this location and motivation concerned how to conceal and design around the HVAC systems. Having such large structures on the rooftop left unscreened would detract from the aesthetic agrarian value of the site as a rentable space. The design had to work around and was highly influenced by the existing HVAC infrastructure. Future rooftop design research would benefit from more thoroughly addressing and investigating the potentials related to HVAC movement, placement, and downsizing. As a whole, this rooftop appears to be a prime candidate for intensive green roof farm implementation and holds potential for great success, monetary and otherwise.

Phase III Conclusions

This final phase of research has combined the first two phases to create inspiration and design potential for what could be realistically developed. It also shows how these two phases of research could be utilized by individuals to develop their own rooftop farms. Research through design was employed in this phase through the use of projective designs that addressed the overarching questions of this research including "where and what are the design potentials for intensive green roof farming in NYC". Through the process of design, and the production of illustrative and plan images, knowledge was produced showing what potentials are held for rooftop farming and how the research of phases I and II can be combined and tested.

In addition to the creation of new design potentials, this research by design produced knowledge concerning common challenges that arise in intensive green roof farm design. Through proposing and working through these projective designs, the difficulty of operating around existing HVAC systems became clear. Using plants and green walls to screen these elements seems to be an effective way to create a more aesthetic environment while also increasing growing space vertically. Access onto the roof also plays a large role in dictating the flow into a site. In real practice, communicating with the building owner, structural engineer, city code, and conducting many site visits will be large factors in determining how the design of a rooftop farm is constructed.

The intention of Phase III has been to provide exemplary design potentials of intensive rooftop farms in NYC by combining the first two phases of this work. It has used projective design based on the research of phases I and II to answer the research questions posed in this work. Moving forward, this research should be built upon and may serve as a design reference as the field of rooftop agriculture continues expanding in urban environments.

Conclusion

Results

This thesis has provided a resource for those interested in implementing intensive green roof farming in New York City. It has provided a guide for how to select a site, what design typologies might be implemented, and illustrative exemplary designs. The research that went into creating this guide built upon existing research and has ample room for improvement and translation. With access to the proper information, this research could be developed upon and applied to create design proposals for cities throughout the world.

Phase I of this research showed the thousands of rooftops in New York City that have potential to support intensive green roof farming. Four maps were produced, one for each motivational element of the triple bottom line as well as a map showing an overlay of the combined three maps. Concentrated areas with high potential for rooftop agriculture were identified in multiple zones across the city, including areas surrounding Newton Creek, the South Bronx, and East Brooklyn. The maps produced in this phase of research can be accessed at arcgis.com under the title "NYC Potential Buildings for Rooftop Farming" and contain additional information related to each site.

Phase II drew upon site visitations of case study rooftop farms to develop a design matrix for each element of the triple bottom line. Site visitations revealed that there are many types of innovative rooftop agriculture happening in the city at various scales. From these site visitations, design elements were extracted and broken down into design typology matrices for the motivational elements of people, planet, or profit. The purpose of the matrices is to provide guidance for what management, agricultural practices, program, and infrastructure aligns most closely with each element of the triple bottom line.

Phase III drew upon the research and products of the first two phases to produce projective designs of potential rooftop farms. This phase was intended to show three examples of design potentials; one design proposal for each element of the triple bottom line. Two of the designs remained diagrammatic, while one design was taken to a more detailed scale. These designs showed how Phase I and II of this research can be combined together and also were intended to create inspirational exemplary images for people interested in rooftop farm development. The largest takeaway that came from working through these designs was the need and opportunity for collaboration with architects, engineers and HVAC specialists in the future of intensive green roof farm design.

These three phases of research and methodologies culminated under the umbrella of research by design to answer the questions posed by this investigation including:

1. Where in NYC are the best buildings for intensive green roof farming to be located depending on the primary motivation of the potential organizer relating to the triple bottom line (people, place or profit)?
2. What is the potential for design typologies of intensive green roof farming in NYC depending on the primary motivation of the potential organizer relating to the triple bottom line (people, place or profit)?

The Phase I methodology of modeling spatial classifications paired with landscape evaluation provided the context for the research by design. The Phase II methodology of typological classification schema derived from landscape evaluation of case studies provided the propositional operative strategies of design. Phase III drew upon the results of these two phases to address the questions posed by this research and to produce new knowledge in the form of design process and communicative imagery. The illustrative and diagrammatic design images produced in this phase of work communicate answers to the overarching research investigation, which was to address how an individual would go about creating an intensive green roof farm in New York City with consideration given to the principles of the triple bottom line. This research is intended to continue to be built upon as the potentials for intensive green roof farming and rooftop agriculture have immense room for growth and experimentation.

Finally, while this research has singled out elements of the triple bottom line that developers may be more focused on, all businesses should consider all three P's. People, planet and profit are all essential elements of creating a healthy and sustainable business. While rooftop farmers may find themselves motivated more or less by certain elements of the triple bottom line, finding ways to incorporate the benefits of all three will create more balanced businesses and a better world for everyone to live in.

Future Vision

This work and other research discussed throughout this paper has shown the great potential for rooftop farm development in New York City. If acted upon, there is an untapped potential for creating a new landscape on top of the existing one. Rooftops and rooftop agriculture in the future could work to connect cities in new ways. This is especially relevant with the ever looming threats of climate change. Green roofs and rooftop farming have potential create a new pedestrian system in areas of the city that will become affected by sea level rise. They have potential to insulate buildings as temperatures begin to fluctuate more drastically throughout the seasons. They also have the ability to bring people together in a healthy and educational environment. Green roofs and rooftop farms could create a living network of habitat for humans, animals, plants, and pollinators throughout the vast expanse that is New York City.

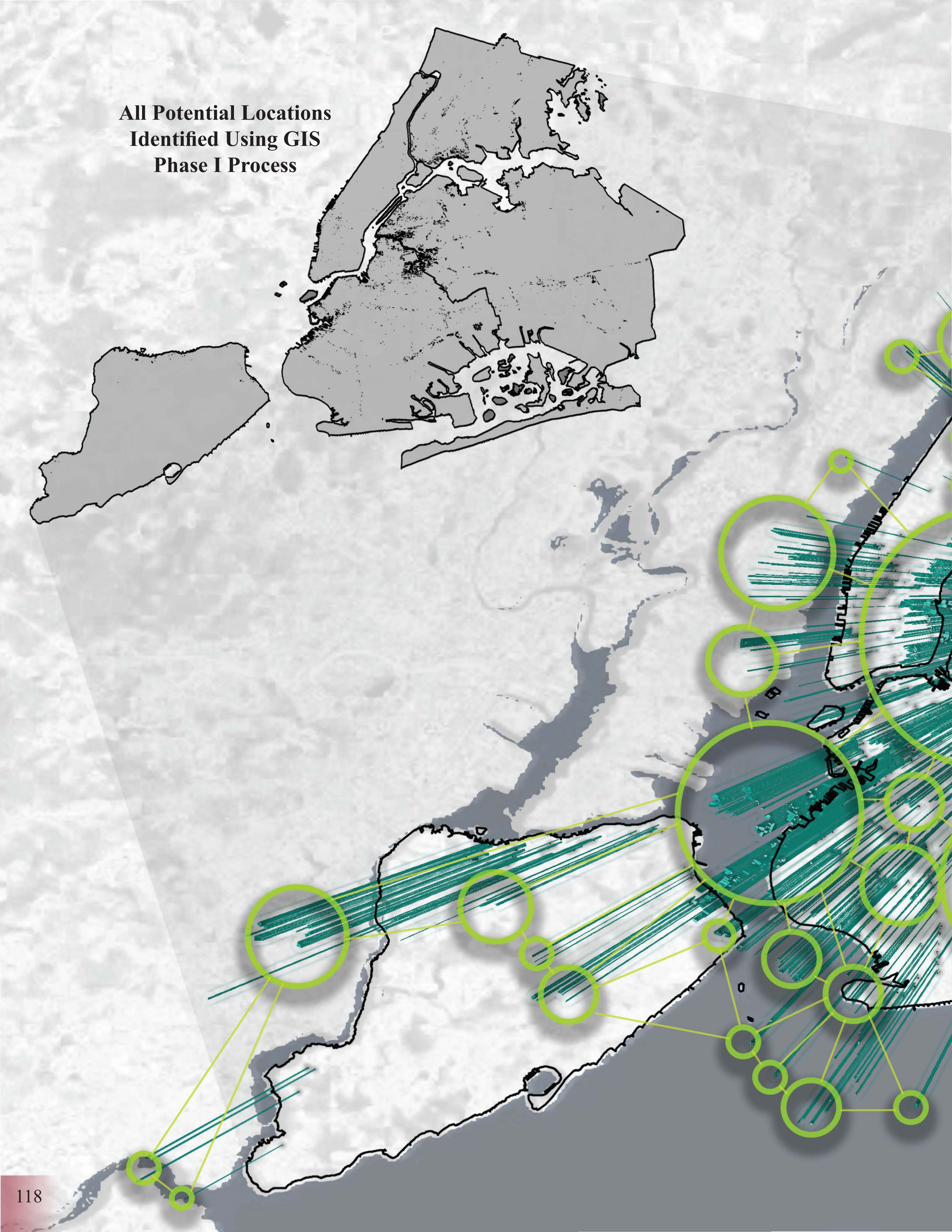
Figure 6.1 on the following page spread shows an extruded image of all potential locations for intensive green roof farming identified in Phase I of this research. Areas of concentrated sites are highlighted with green circles to communicate locations of potential high network connectivity. Overall, the mapping process used in this research identified tens of thousands of rooftops throughout the city that hold potential for use as intensive green roof farms. These roofs if developed into intensive green roof farms hold potential for connecting physically, socially, economically and environmentally as a network to benefit both the people and the ecological systems of NYC.

Looking forward, I hope that cities will be more utopian places. I imagine healthy people breathing fresh air, living in a climate that is more naturally regulated, exposed to greenery and plant life all around them, with options for healthy food produced locally, and an education system that incorporates food based knowledge with hands-on learning. I envision a place where there is more green both at the street level and across the skyline. In this reality, pedestrians could connect to different destinations via skywalks between rooftops. Roofs would not only produce food for the city, but would also provide green spaces. The work of this thesis has identified the potential for such networks of rooftop connections as well as various potentials for design.

A future such as this would be more resilient and foster healthy connections socially, environmentally and educationally. It would become a practice of creative restorative landscape development. Where soils and environments at the ground level may not be able to support food production, developing an additional skyline landscape would lead to opportunities for green spaces and production that has not yet been experienced in any American city. The planet, children, adults, animals and insects would all benefit from such a network. Creation of this network of intensive green roof farms would lead to the re-establishment and rehabilitation of an ecosystem disrupted for hundreds of years by unsustainable development and consumption. The research conducted through this work has produced guidance and evidence for how this future can be achieved and pursued.

Ultimately, I envision a more symbiotic living experience between the demands of modern human living and what can be sustained over the long term by natural ecosystems. I firmly believe that intensive green roof farming is and can be a viable and effective solution to creating this reality. It is time that as a society, we step back from the driving forces of capitalism and begin investing in ourselves as a connected community that includes the environment we live in.

All Potential Locations Identified Using GIS Phase I Process



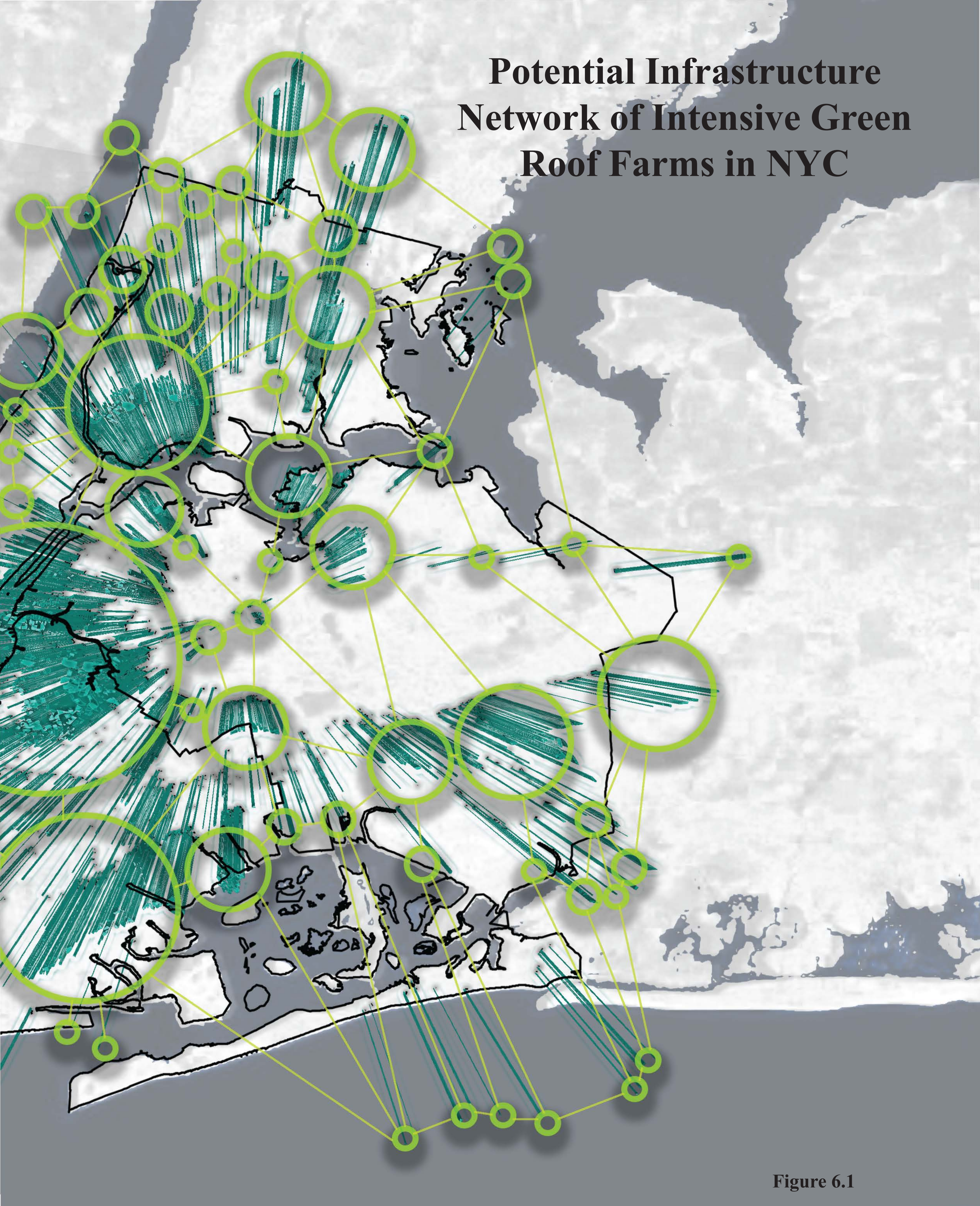

Potential Infrastructure
Network of Intensive Green
Roof Farms in NYC

Figure 6.1

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Appendix A

GIS Processes Used to Create Input Shapefiles Used in Multiple Maps

Supplemental Map Content	**Industrial/Manufacturing and Minimal Unbuilt FAR**			
GIS Function	Merge	Add Data Field	Add Data Field	Select by attribute
GIS Function Specified Input and Output Data	MNMapPLUTO BKMapPLUTO QNMapPLUTO SIMapPLUTO BXMapPLUTO Output File: Map_PLUTO	Attribute Table: Map_PLUTO New Field: SUM_FAR Field Calculator: = Maximim Allowable Residential FAR (ResidFAR) + Maximim Allowable Commercial FAR (CommFAR) + Maximim Allowable Facility FAR (FacilFAR)	Attribute Table: Map_PLUTO New Field: Available FAR (AvailFAR) Field Calculator: = SUM_FAR - BuiltFAR	Layer: MapPLUTO Select: LandUse = 06 (Industrial/ Manufacturing) AND AvailFAR <= 5 Output File: **IM_5FAR**

GIS Processes Used to Create Input Shapefiles Used in Multiple Maps

Supplemental Map Content	**.1 Mile Buffer of Vacant Lots:**		
GIS Function	Select by attribute	Export to new shapefile	Buffer Wizard
GIS Function Specified Input and Output Data	Layer: MapPLUTO Select: LandUse = 11 (Vacant)	File Name Vacant Lots	File Vacant Lots .1 mile Buffer (approximately 1 city block) Output File: **Buffer_Vacant**

Supplemental Map Content	**.1 Mile Buffer of Hazardous Sites**	
GIS Function	Buffer Wizard	Buffer Wizard
GIS Function Specified Input and Output Data	File Subway Stations .5 mile Buffer New Shapefile Buffer_Subway	File E Hazard Sites .1 mile Buffer (approximately 1 city block) Output File: **Buffer_Hazard**

GIS Processes Used to Create Input Shapefiles Used in Multiple Maps

Supplemental Map Content	**All Overlapping Locations**
GIS Function	Analysis Tools > Overlay > Intersect
GIS Function Specified Input and Output Data	Files: 1968_6000_30f_IM 68_1acre_15f_IM_5FAR_BH_BV 68_6000_5f_IM_5FAR_BH_BS Output File: **Merge All**

Supplemental Map Content	**Planet and People Overlapping Locations**
GIS Function	Analysis Tools > Overlay > Intersect
GIS Function Specified Input and Output Data	Files: 1968_6000_30f_IM 68_6000_5f_IM_5FAR_BH_BS Output File: **Merge Planet_People**

Supplemental Map Content	**People and Profit Overlapping Locations**
GIS Function	Analysis Tools > Overlay > Intersect
GIS Function Specified Input and Output Data	Files: 68_1acre_15f_IM_5FAR_BH_BV 68_6000_5f_IM_5FAR_BH_BS Output File: **Merge People_Profit**

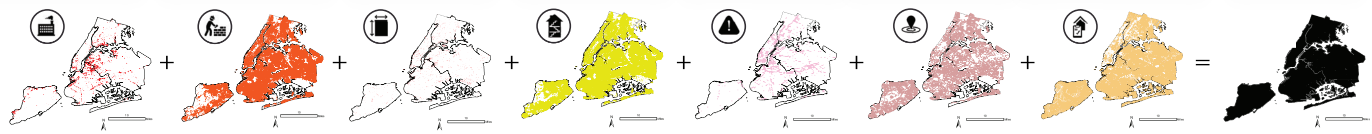
Supplemental Map Content	**Profit and Planet Overlapping Locations**
GIS Function	Analysis Tools > Overlay > Intersect
GIS Function Specified Input and Output Data	Files: 1968_6000_30f_IM 68_1acre_15f_IM_5FAR_BH_BV Output File: **Merge Profit_Planet**

Appendix B

GIS Processes Used to Create Final Map Product for **PROFIT** Focused Development Motivation

Criteria							
Industrial/ Manufac- turing	Built Prior to 1968	1 Acre or More	15 stories or less	Buffer Hazardous Sites	Buffer Vacant lots	Value of 5 FAR or Less	Profit Focused Map

Map

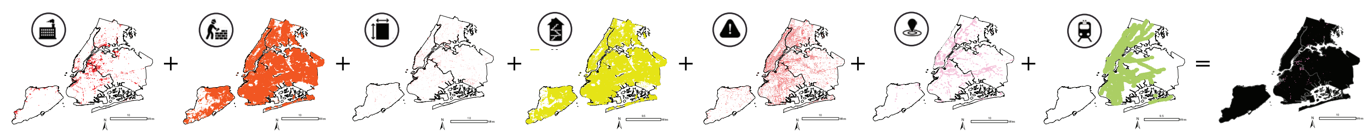


	Select by attribute	Select by Location	Select by Location	Select Inverse	Select by Location	
GIS Function	Select by attribute	Select by Location	Select by Location	Select Inverse	Select by Location	
GIS Function Specified Input and Output Data	Layer: Building footprints Select: “cnstrct_yr” < 1968 AND “num_floors” <= 15 AND “shape_ area” >= 43560 Output File: 68_1acre_15F	Target Layer: IM_5FAR Source layer: 68_1acre_15f Have their centroid in the source layer feature Output File: 68_1acre_15f_ IM_5FAR	Target Layer: 68_1acre_15f_ IM_5FAR Source layer: Buffer_of_ Hazard Intersect the source layer feature	Switch Attribute Table Selection: 68_1acre_15f_ IM_5FAR Export to new shapefile: Output File 68_1acre_15f_ IM_5FAR_BH	Target Layer: 68_1acre_15f_ IM_5FAR_BH Source layer: Buffer_Vacant Intersect the source layer feature Export to new shapefile: Output File 68_1acre_15f_ IM_5FAR_BH_ BV	File Name: 68_1acre_15f_ IM_5FAR_BH_ BV = **Profit Focused Map**

GIS Processes Used to Create Final Map Product for **PROFIT** Focused Development Motivation

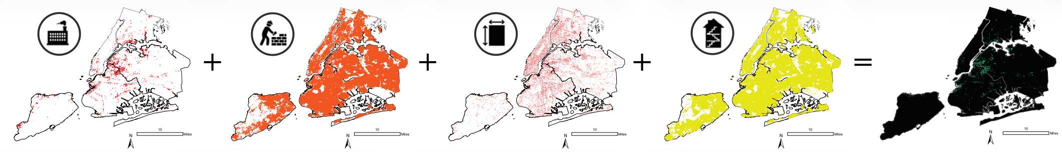
Criteria	Industrial/ Manufac- turing	Built Prior to 1968	6,000 Square Feet or More	5 Stories or Less	Buffer Hazardous Sites	Buffer Subway Stations	Value of 5 FAR or Less	People Focused Map

Map



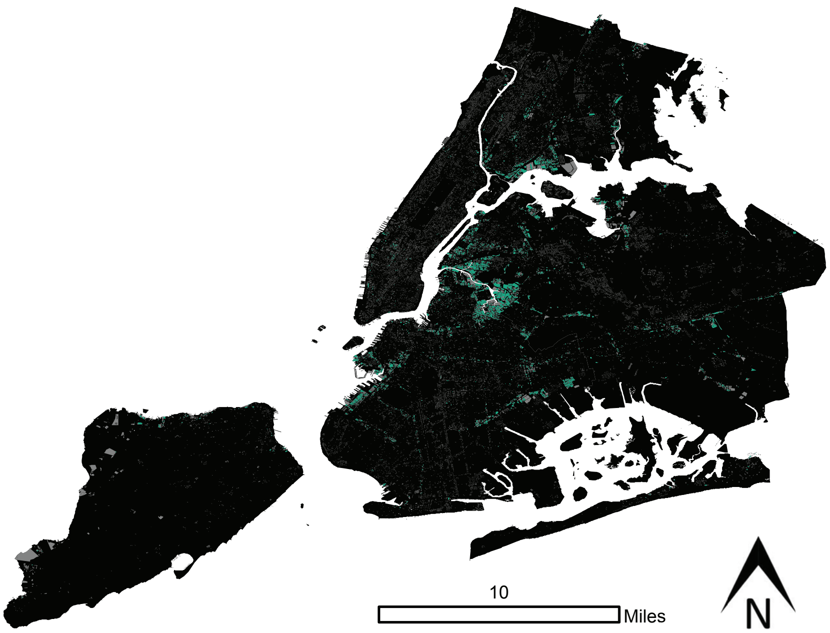
GIS Function	Select by attribute	Select by Location	Select by Location	Select Inverse	Select by Location	
GIS Function Specified Input and Output Data	Layer: Building footprints Select: “cnstrct_yr” < 1968 AND “num_floors” <= 5 AND “shape_ area” >= 6000 Output File 68_6000_15F	Target Layer: IM_5FAR Source layer: 68_6000_5f Have their centroid in the source layer feature Output File 68_6000_5f_ IM_5FAR	Target Layer: 68_6000_5f_ IM_5FAR Source layer: Buffer_of_ Hazard Intersect the source layer feature	Switch Attribute Table Selection 68_6000_5f_ IM_5FAR export to new shapefile Output File 68_6000_5f_ IM_5FAR_BH	Target Layer: 68_6000_5f_ IM_5FAR_BH Source layer: Buffer_Subway Intersect the source layer feature export to new shapefile Output File 68_6000_5f_ IM_5FAR_BH_ BS	File Name: 68_6000_5f_ IM_5FAR_BH_ BS = People Focused Map

GIS Processes Used to Create Final Map Product for **PLANET** Focused Development Motivation

Criteria	**Industrial/ Manufacturing**	**Built Prior to 1968**	**6,000 Square Feet or More**	**30 Stories or Less**	**Planet Focused Map**
Map		+	+	+	=
GIS Function	Select by attribute	Merge	Select by attribute	Select by Location	
GIS Function Specified Input and Output Data	Layer: Building footprints Select: “cnstrct_yr” < ‘1968’ AND “shape_area” >= ‘6000’ AND “num_floors” <= ‘30’ Output File: 1968_6000_30F	MNMapPLUTO BKMapPLUTO QNMapPLUTO SIMapPLUTO BXMapPLUTO Output File: Map_PLUTO	Layer: MapPLUTO Select: LandUse = ‘06’ (Industrial/ Manufacturing) Output File: Industrial_ Manuafacturing	Target Layer: Industrial_ Manuafacturing Source layer: 1968_6000_30f Have their centroid in the source layer feature Output File: 1968_6000_30f _IM	File Name: Output File 1968_6000_30f _IM = **Planet Focused Map**

Appendix C

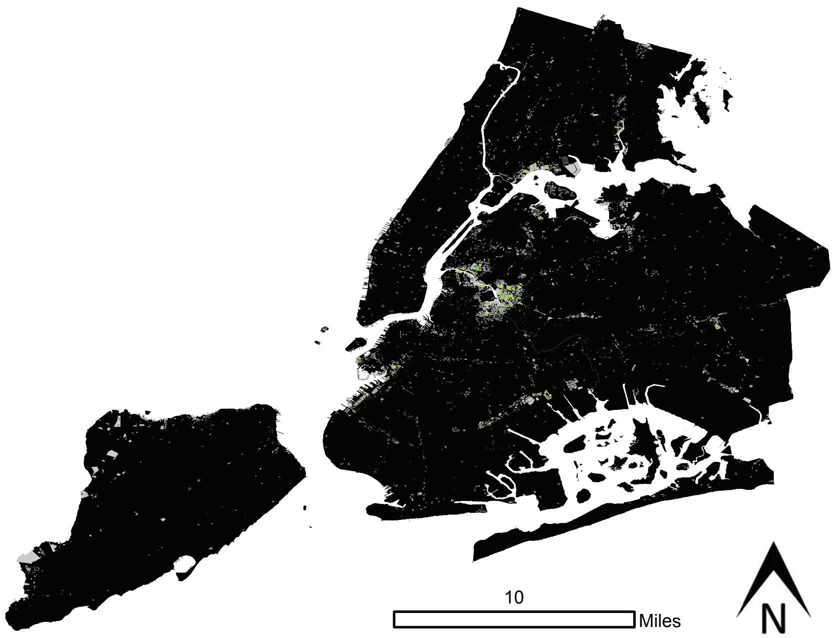
GIS Mapping Process Diagrams: Showing map development with progession of added inputs to mapping criteria for final maps created to display potential buildings for intensive rooftop agriculture for people, place, and profit based motives



Legend

- Tax Lots with Rooftops Fitting Planet Map Criteria
- Buildings Built Pre-1968, 6000 sq ft or Greater and 30 Floors or Less
- Tax Lots with Industrial or Manufacturing Land Use
- Borough Boundaries

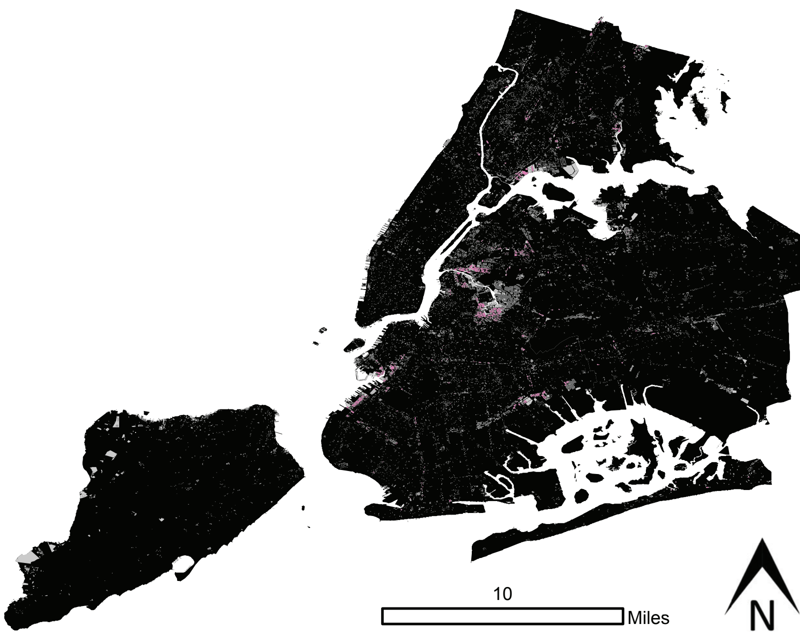
GIS Mapping Process Diagrams: Showing map development with progession of added inputs to mapping criteria for final maps created to display potential buildings for intensive rooftop agriculture for profit based motives



Legend

- Tax Lots with Rooftops Fitting Profit Map Criteria
- Buildings Built Pre-1968, 6000 sq ft or Greater, 15 Floors or Less and Tax Lots with Value of 5 or Less Available FAR, and Industrial or Manufacturing Land Use, and a .1 Mi Buffer of Hazardous Sites
- Buildings Built Pre-1968, 6000 sq ft or Greater, 15 Floors or Less and Tax Lots with Value of 5 or Less Available FAR, and Industrial or Manufacturing Land Use
- Buildings Built Pre-1968, 6000 sq ft or Greater and 15 Floors or Less
- Tax Lots with Value of 5 or Less Available FAR, and Industrial or Manufacturing Land Use
- Borough Boundaries

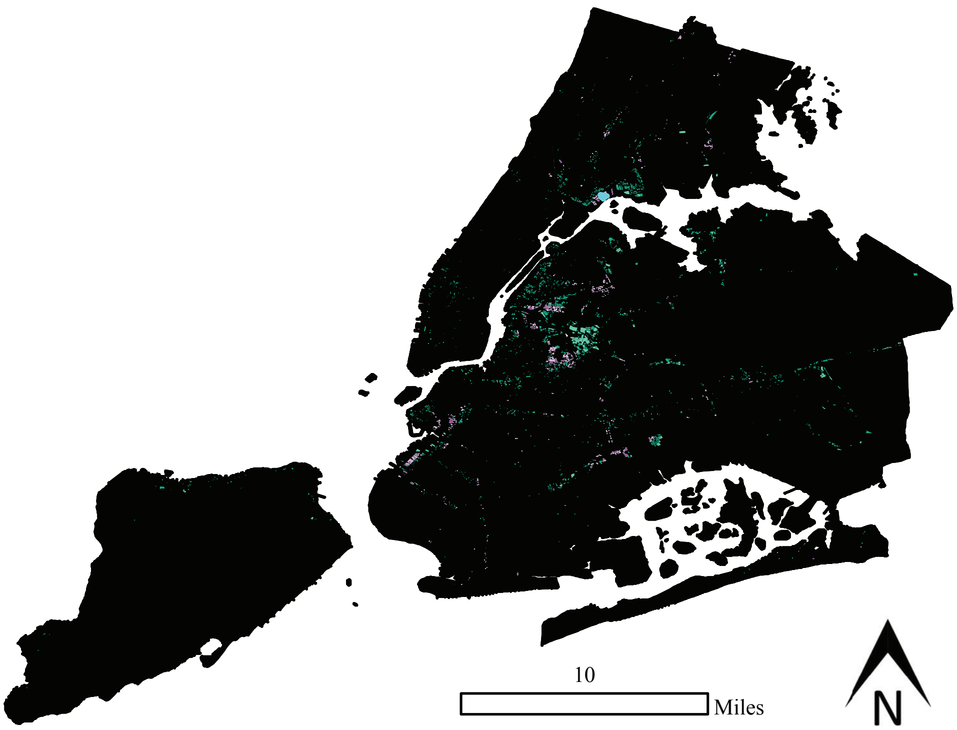
GIS Mapping Process Diagrams: Showing map development with progession of added inputs to mapping criteria for final maps created to display potential buildings for intensive rooftop agriculture for people based motives



Legend

- Tax Lots with Rooftops Fitting People Map Criteria
- Buildings Built Pre-1968, 1 Acre or Greater, 5 Floors or Less and Tax Lots with Value of 5 or Less Available FAR, Industrial or Manufacturing Land Use, and a .1 Mi Buffer of Hazardous Sites
- Buildings Built Pre-1968, 1 Acre or Greater, 5 Floors or Less and Tax Lots with Value of 5 or Less Available FAR, and Industrial or Manufacturing Land Use
- Buildings Built Pre-1968, 1 Acre or Greater and 5 Floors or Less
- Tax Lots with Value of 5 or Less Available FAR, and Industrial or Manufacturing Land Use
- Borough Boundaries

GIS Mapping Process Diagrams: Showing map development with progession of added inputs to mapping criteria for final maps created to display potential buildings for intensive rooftop agriculture for all Overlapping Motivation-Based Locations



Legend

Tax Lots with Rooftops Fitting Criteria for All Three 'P' Map Criteria

Tax Lots with Rooftops Fitting Criteria For Planet and Profit Maps

Tax Lots with Rooftops Fitting Criteria For Profit and People Maps

Tax Lots with Rooftops Fitting Criteria For People and Planet Maps

Tax Lots with Rooftops Fitting People Map Criteria

Tax Lots with Rooftops Fitting Planet Map Criteria

Tax Lots with Rooftops Fitting Profit Map Criteria

Borough Boundaries

GIS Mapping Process Diagrams:

Showing map development with progession of added inputs to mapping criteria for final maps created to display potential buildings for intensive rooftop agriculture for all Overlapping Motivation-Based Locations

Legend

- Tax Lots with Rooftops Fitting Criteria for All Three 'P' Map Criteria
- Tax Lots with Rooftops Fitting People Map Criteria
- Tax Lots with Rooftops Fitting Planet Map Criteria
- Tax Lots with Rooftops Fitting Profit Map Criteria
- Borough Boundaries

Appendix D

330 Tompkins Ave, Staten Island, NY

Legend

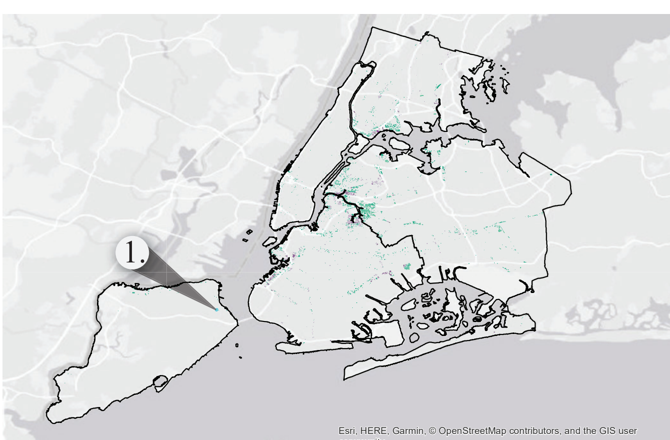
Tax Lot Outline

N .050000000 Miles

NYC Context

Legend

- Borough Boundaries
- Tax Lots with Rooftops Fitting Criteria for All Three 'P' Map Criteria
- Tax Lots with Rooftops Fitting Criteria For Planet and Profit Maps
- Tax Lots with Rooftops Fitting Criteria For Profit and People Maps
- Tax Lots with Rooftops Fitting Criteria For People and Planet Maps
- Tax Lots with Rooftops Fitting People Map Criteria
- Tax Lots with Rooftops Fitting Planet Map Criteria
- Tax Lots with Rooftops Fitting Profit Map Criteria



N 10 Miles

Localized Context

Legend

- Building Footprints
- Tax Lots with Rooftops Fitting Criteria for All Three 'P' Map Criteria
- Tax Lots with Rooftops Fitting Criteria For Planet and Profit Maps
- Tax Lots with Rooftops Fitting Criteria For Profit and People Maps
- Tax Lots with Rooftops Fitting Criteria For People and Planet Maps
- Tax Lots with Rooftops Fitting People Map Criteria
- Tax Lots with Rooftops Fitting Planet Map Criteria
- Tax Lots with Rooftops Fitting Profit Map Criteria
- Streets

N .200000000 Miles

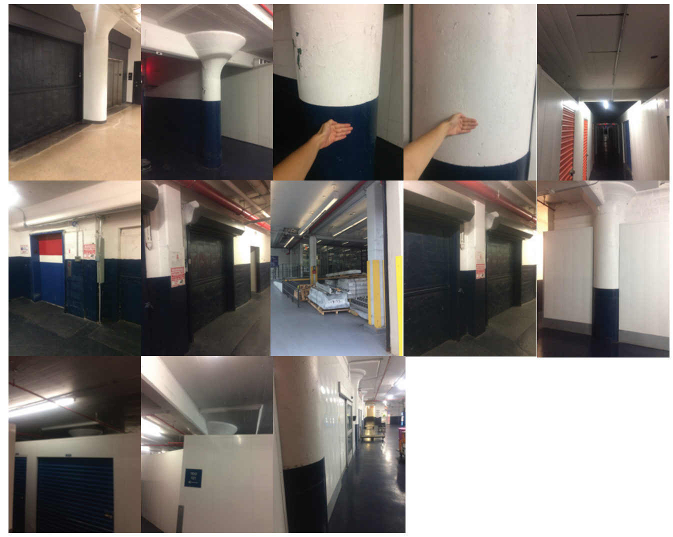
1.

330 Tompkins Ave, Staten Island, NY

Site Visitation Photos

Exterior

Interior



View from Interior

Google Street Views

220 South St, New York, NY

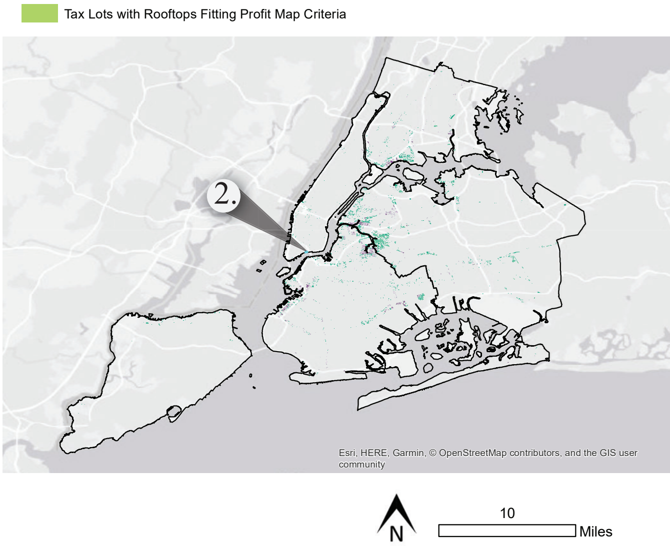
Legend

Tax Lot Outline

NYC Context

Legend

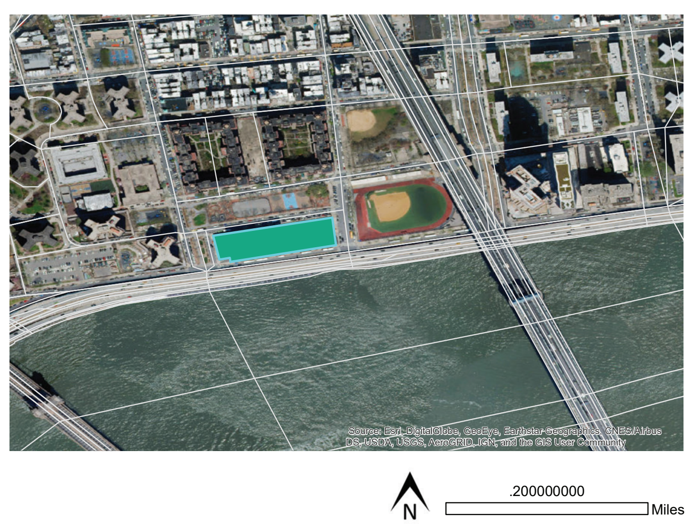
- Borough Boundaries
- Tax Lots with Rooftops Fitting Criteria for All Three 'P' Map Criteria
- Tax Lots with Rooftops Fitting Criteria For Planet and Profit Maps
- Tax Lots with Rooftops Fitting Criteria For Profit and People Maps
- Tax Lots with Rooftops Fitting Criteria For People and Planet Maps
- Tax Lots with Rooftops Fitting People Map Criteria
- Tax Lots with Rooftops Fitting Planet Map Criteria
- Tax Lots with Rooftops Fitting Profit Map Criteria



Localized Context

Legend

- Tax Lots with Rooftops Fitting Criteria for All Three 'P' Map Criteria
- Tax Lots with Rooftops Fitting Criteria For Planet and Profit Maps
- Tax Lots with Rooftops Fitting Criteria For Profit and People Maps
- Tax Lots with Rooftops Fitting Criteria For People and Planet Maps
- Tax Lots with Rooftops Fitting People Map Criteria
- Tax Lots with Rooftops Fitting Planet Map Criteria
- Tax Lots with Rooftops Fitting Profit Map Criteria
- Streets

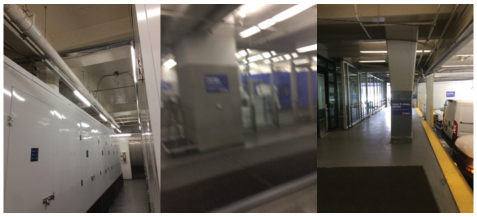


220 South St, New York, NY

Site Visitation Photos

Exterior

Interior



Rooftop

Google Street Views

16 Cooper Square, New York, NY

Legend

Tax Lot Outline

N

.015000000 Miles

NYC Context

Legend

- Borough Boundaries
- Tax Lots with Rooftops Fitting Criteria for All Three 'P' Map Criteria
- Tax Lots with Rooftops Fitting Criteria For Planet and Profit Maps
- Tax Lots with Rooftops Fitting Criteria For Profit and People Maps
- Tax Lots with Rooftops Fitting Criteria For People and Planet Maps
- Tax Lots with Rooftops Fitting People Map Criteria
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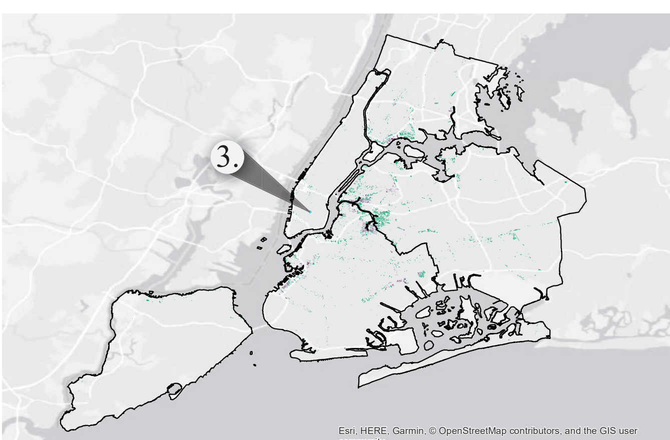
- Tax Lots with Rooftops Fitting Profit Map Criteria



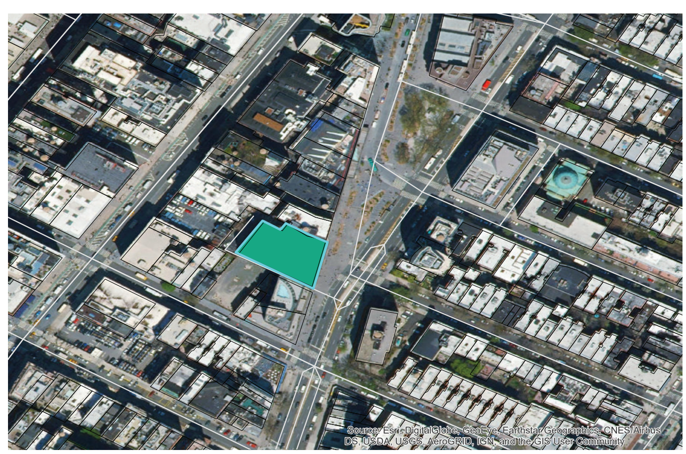
N

10 Miles

Localized Context

Legend

- Building Footprints
- Tax Lots with Rooftops Fitting Criteria for All Three 'P' Map Criteria
- Tax Lots with Rooftops Fitting Criteria For Planet and Profit Maps
- Tax Lots with Rooftops Fitting Criteria For Profit and People Maps
- Tax Lots with Rooftops Fitting Criteria For People and Planet Maps
- Tax Lots with Rooftops Fitting People Map Criteria
- Tax Lots with Rooftops Fitting Planet Map Criteria
- Tax Lots with Rooftops Fitting Profit Map Criteria
- Streets



N

.100000000 Miles

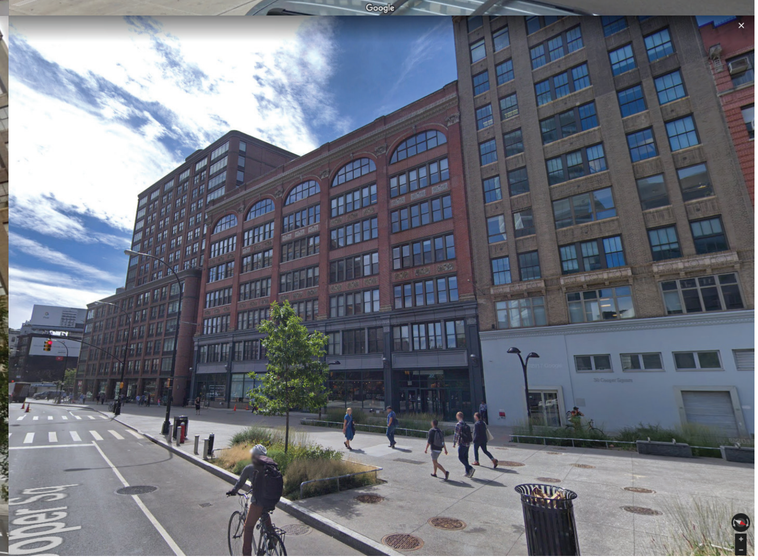
3.

16 Cooper Square, New York, NY

Site Visitation Photos

Exterior

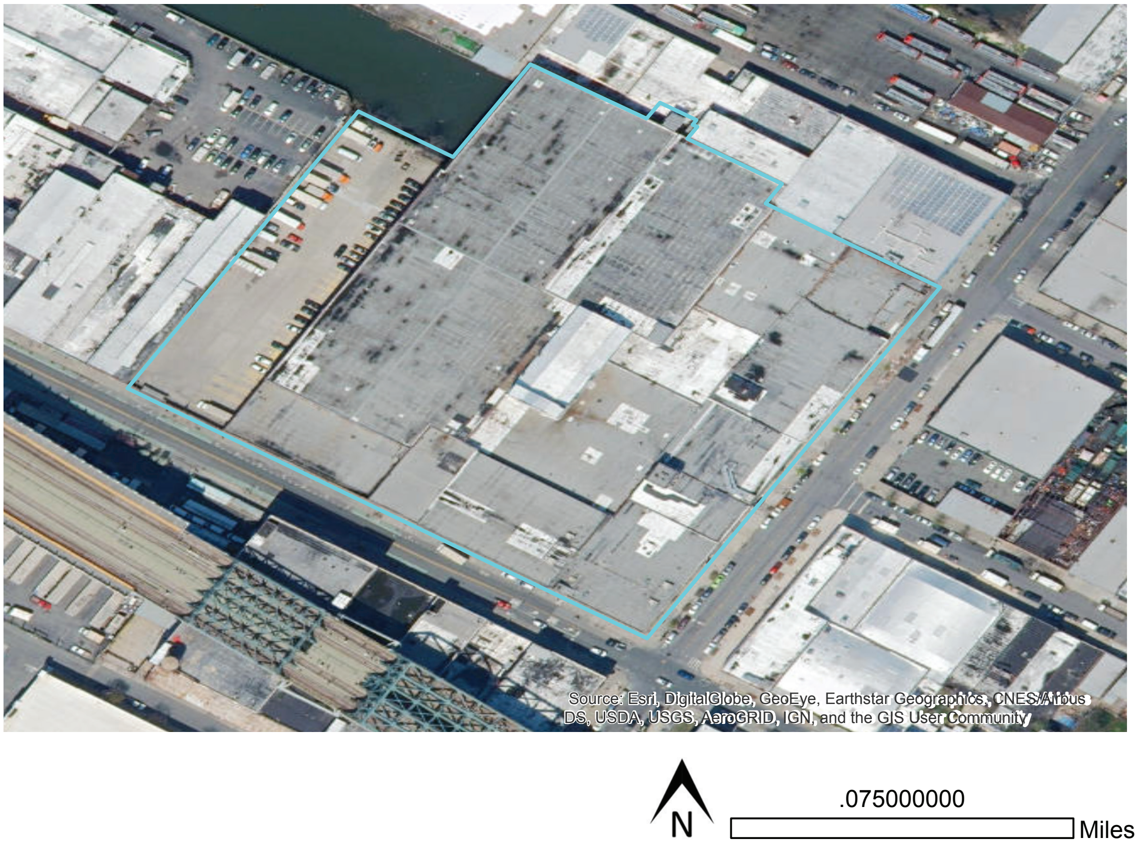
Google Street Views



56 2nd Ave, Brooklyn, NY

Legend

Tax Lot Outline



NYC Context

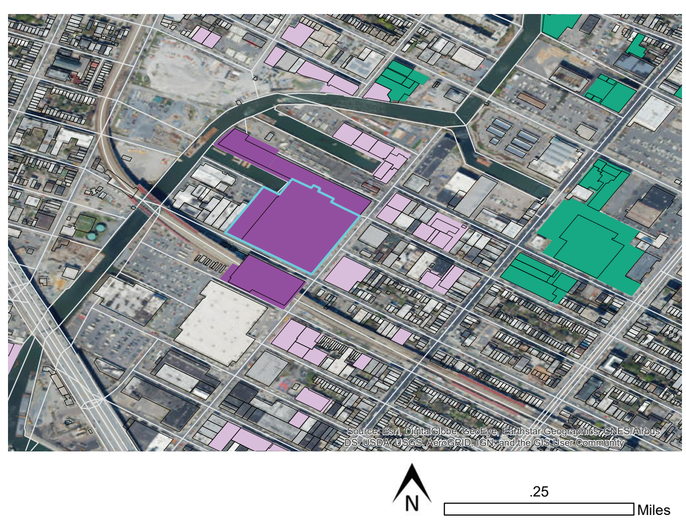
Legend

- Borough Boundaries
- Tax Lots with Rooftops Fitting Criteria for All Three 'P' Map Criteria
- Tax Lots with Rooftops Fitting Criteria For Planet and Profit Maps
- Tax Lots with Rooftops Fitting Criteria For Profit and People Maps
- Tax Lots with Rooftops Fitting Criteria For People and Planet Maps
- Tax Lots with Rooftops Fitting People Map Criteria
- Tax Lots with Rooftops Fitting Planet Map Criteria
- Tax Lots with Rooftops Fitting Profit Map Criteria

Localized Context

Legend

- Building Footprints
- Tax Lots with Rooftops Fitting Criteria for All Three 'P' Map Criteria
- Tax Lots with Rooftops Fitting Criteria For Planet and Profit Maps
- Tax Lots with Rooftops Fitting Criteria For Profit and People Maps
- Tax Lots with Rooftops Fitting Criteria For People and Planet Maps
- Tax Lots with Rooftops Fitting People Map Criteria
- Tax Lots with Rooftops Fitting Planet Map Criteria
- Tax Lots with Rooftops Fitting Profit Map Criteria
- Streets



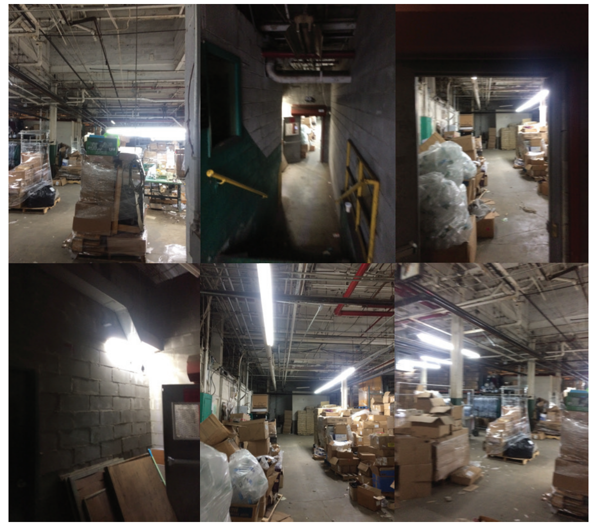
4.

56 2nd Ave, Brooklyn, NY

Site Visitation Photos

Exterior

Interior



Google Street View

40 Hall Street, Brooklyn, NY _ planet
55 Washington Avenue, Brooklyn, NY - planet and profit
30 Hall Street, Brooklyn, NY - planet and profit
220 Flushing Avenue, Brooklyn NY- planet

Legend

Tax Lot Outline

N

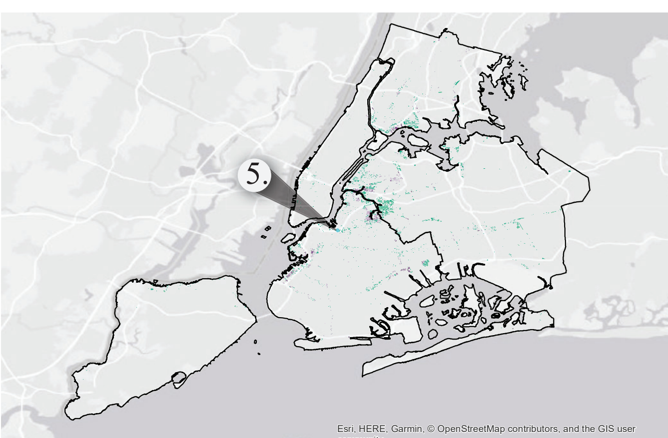
.055

Miles

NYC Context

Legend

- Borough Boundaries
- Tax Lots with Rooftops Fitting Criteria for All Three 'P' Map Criteria
- Tax Lots with Rooftops Fitting Criteria For Planet and Profit Maps
- Tax Lots with Rooftops Fitting Criteria For Profit and People Maps
- Tax Lots with Rooftops Fitting Criteria For People and Planet Maps
- Tax Lots with Rooftops Fitting People Map Criteria
- Tax Lots with Rooftops Fitting Planet Map Criteria
- Tax Lots with Rooftops Fitting Profit Map Criteria



N

10

Miles

Localized Context

Legend

- Building Footprints
- Tax Lots with Rooftops Fitting Criteria for All Three 'P' Map Criteria
- Tax Lots with Rooftops Fitting Criteria For Planet and Profit Maps
- Tax Lots with Rooftops Fitting Criteria For Profit and People Maps
- Tax Lots with Rooftops Fitting Criteria For People and Planet Maps
- Tax Lots with Rooftops Fitting People Map Criteria
- Tax Lots with Rooftops Fitting Planet Map Criteria
- Tax Lots with Rooftops Fitting Profit Map Criteria
- Streets

N

.150000000

Miles

5.

40 Hall Street, Brooklyn, NY _ planet
55 Washington Avenue, Brooklyn, NY - planet and profit
30 Hall Street, Brooklyn, NY - planet and profit
220 Flushing Avenue, Brooklyn NY- planet

Site Visitation Photos

Exterior

Site Adjacent

Google Street Views

6. 246 Meserole Street, Brooklyn, NY

Legend

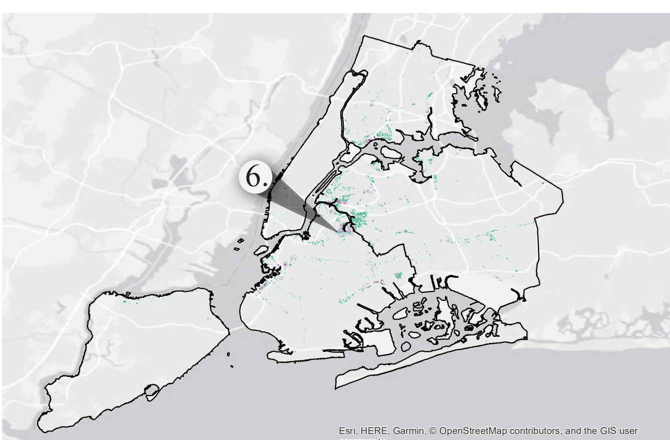
Tax Lot Outline

N .030000000 Miles

NYC Context

Legend

- Borough Boundaries
- Tax Lots with Rooftops Fitting Criteria for All Three 'P' Map Criteria
- Tax Lots with Rooftops Fitting Criteria For Planet and Profit Maps
- Tax Lots with Rooftops Fitting Criteria For Profit and People Maps
- Tax Lots with Rooftops Fitting Criteria For People and Planet Maps
- Tax Lots with Rooftops Fitting People Map Criteria
- Tax Lots with Rooftops Fitting Planet Map Criteria
- Tax Lots with Rooftops Fitting Profit Map Criteria



N 10 Miles

Localized Context

Legend

- Building Footprints
- Tax Lots with Rooftops Fitting Criteria for All Three 'P' Map Criteria
- Tax Lots with Rooftops Fitting Criteria For Planet and Profit Maps
- Tax Lots with Rooftops Fitting Criteria For Profit and People Maps
- Tax Lots with Rooftops Fitting Criteria For People and Planet Maps
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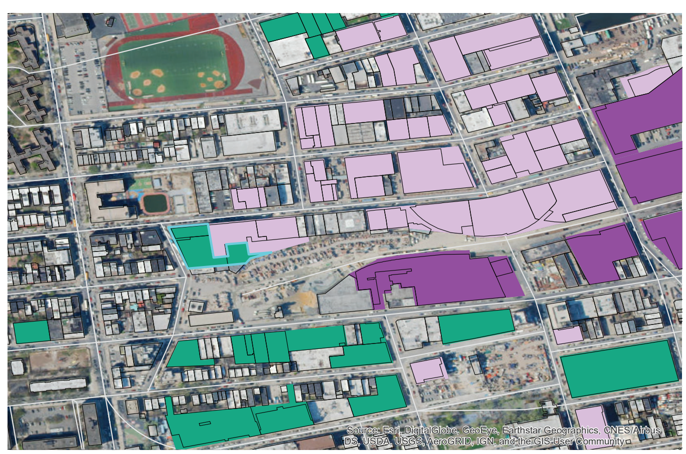
- Tax Lots with Rooftops Fitting Planet Map Criteria
- Tax Lots with Rooftops Fitting Profit Map Criteria
- Streets



N .150000000 Miles

6. 246 Meserole Street, Brooklyn, NY

Site Visitation Photos

Exterior

Interior

Google Street Views

4746 30th St, Long Island City, NY
4720 30th St, Long Island City, NY

Legend

Tax Lot Outline

N

.035000000 Miles

NYC Context

Legend

- Borough Boundaries
- Tax Lots with Rooftops Fitting Criteria for All Three 'P' Map Criteria
- Tax Lots with Rooftops Fitting Criteria For Planet and Profit Maps
- Tax Lots with Rooftops Fitting Criteria For Profit and People Maps
- Tax Lots with Rooftops Fitting Criteria For People and Planet Maps
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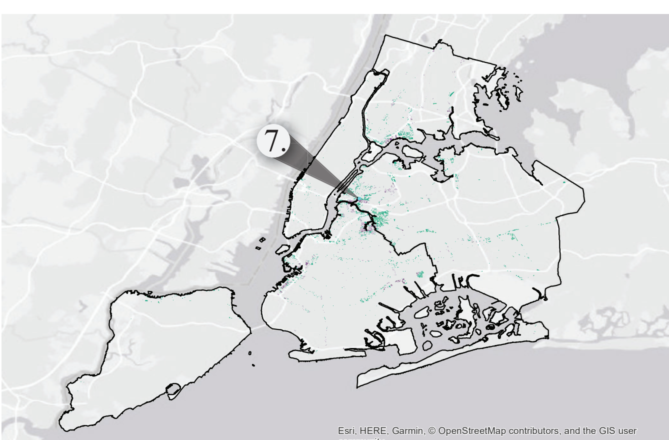
- Tax Lots with Rooftops Fitting Profit Map Criteria



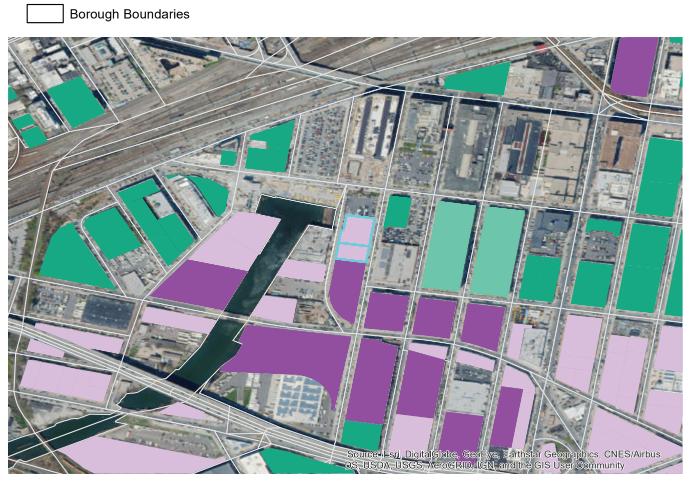
N

10 Miles

Localized Context

Legend

- Tax Lots with Rooftops Fitting Criteria for All Three 'P' Map Criteria
- Tax Lots with Rooftops Fitting Criteria For Planet and Profit Maps
- Tax Lots with Rooftops Fitting Criteria For Profit and People Maps
- Tax Lots with Rooftops Fitting Criteria For People and Planet Maps
- Tax Lots with Rooftops Fitting People Map Criteria
- Tax Lots with Rooftops Fitting Planet Map Criteria
- Tax Lots with Rooftops Fitting Profit Map Criteria
- Streets
- Borough Boundaries



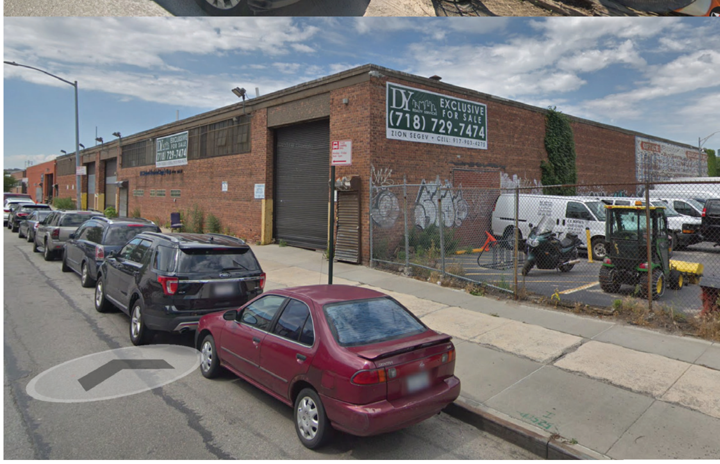
N

.25 Miles

4746 30th St, Long Island City, NY
4720 30th St, Long Island City, NY

Site Visitation Photos
Exterior

Google Street Views

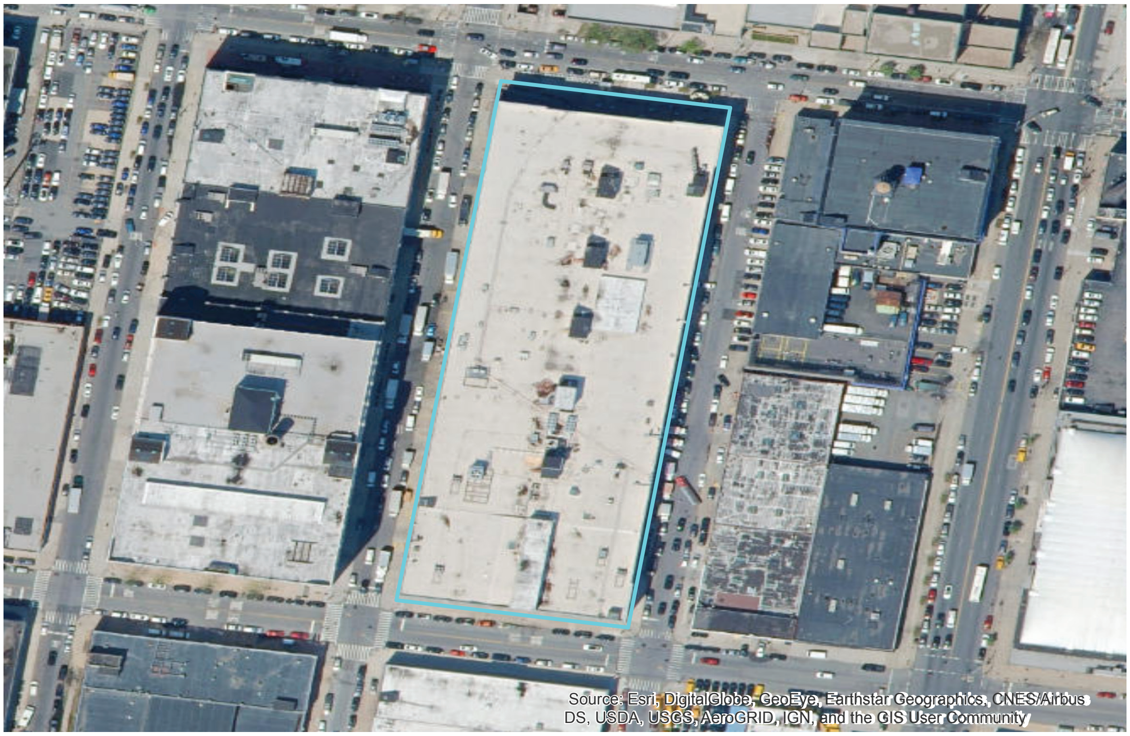


8.

3100 47th Ave, Long Island City, NY 11101

Legend

825 E 141st St Tax Lot Outline



N .075000000 Miles

NYC Context

Legend

- Borough Boundaries
- Tax Lots with Rooftops Fitting Criteria for All Three 'P' Map Criteria
- Tax Lots with Rooftops Fitting Criteria For Planet and Profit Maps
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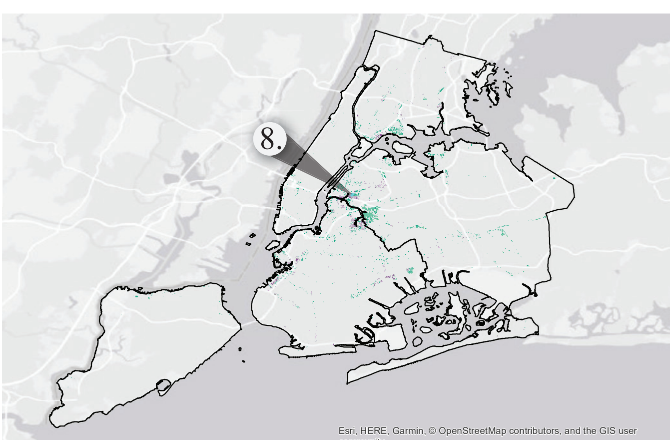
- Tax Lots with Rooftops Fitting Criteria For People and Planet Maps
- Tax Lots with Rooftops Fitting People Map Criteria
- Tax Lots with Rooftops Fitting Planet Map Criteria
- Tax Lots with Rooftops Fitting Profit Map Criteria



N 10 Miles

Localized Context

Legend

- Building Footprints
- Tax Lots with Rooftops Fitting Criteria for All Three 'P' Map Criteria
- Tax Lots with Rooftops Fitting Criteria For Planet and Profit Maps
- Tax Lots with Rooftops Fitting Criteria For Profit and People Maps
- Tax Lots with Rooftops Fitting Criteria For People and Planet Maps
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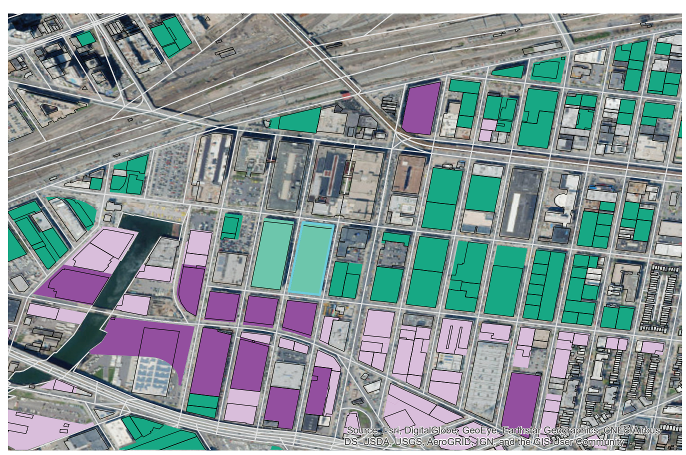
- Tax Lots with Rooftops Fitting Planet Map Criteria
- Tax Lots with Rooftops Fitting Profit Map Criteria
- Streets



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8.

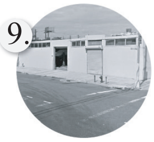
3100 47th Ave, Long Island City, NY 11101

Site Visitation Photos

Exterior

Interior

Google Street Views



865 E 138th St, Bronx, NY

Legend

825 E 141st St Tax Lot Outline

N
.035000000
Miles

NYC Context

Legend

- Borough Boundaries
- Tax Lots with Rooftops Fitting Criteria for All Three 'P' Map Criteria
- Tax Lots with Rooftops Fitting Criteria For Planet and Profit Maps
- Tax Lots with Rooftops Fitting Criteria For Profit and People Maps
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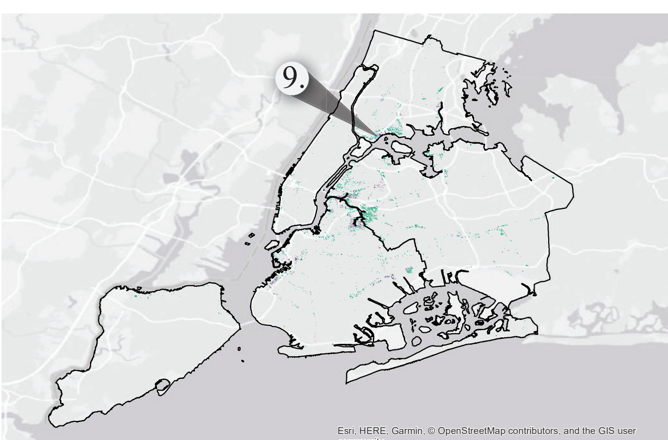
- Tax Lots with Rooftops Fitting Planet Map Criteria
- Tax Lots with Rooftops Fitting Profit Map Criteria



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Miles

Localized Context

Legend

- Building Footprints
- Tax Lots with Rooftops Fitting Criteria for All Three 'P' Map Criteria
- Tax Lots with Rooftops Fitting Criteria For Planet and Profit Maps
- Tax Lots with Rooftops Fitting Criteria For Profit and People Maps
- Tax Lots with Rooftops Fitting Criteria For People and Planet Maps
- Tax Lots with Rooftops Fitting People Map Criteria
- Tax Lots with Rooftops Fitting Planet Map Criteria
- Tax Lots with Rooftops Fitting Profit Map Criteria
- Streets

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.300000000
Miles

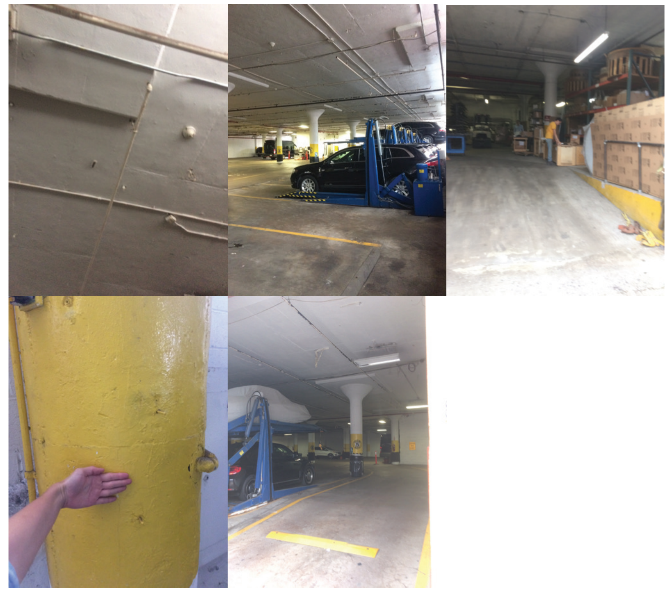
9. 

865 E 138th St, Bronx, NY

Site Visitation Photos

Exterior

Interior



Google Street Views

825 E 141st St, Bronx, NY

Legend

825 E 141st St Tax Lot Outline

N

.030000000

Miles

NYC Context

Legend

- Borough Boundaries
- Tax Lots with Rooftops Fitting Criteria for All Three 'P' Map Criteria
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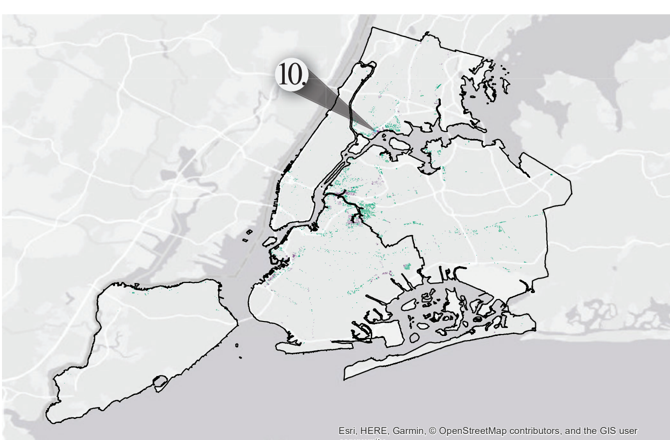
- Tax Lots with Rooftops Fitting Profit Map Criteria



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Miles

Localized Context

Legend

- Building Footprints
- Tax Lots with Rooftops Fitting Criteria for All Three 'P' Map Criteria
- Tax Lots with Rooftops Fitting Criteria For Planet and Profit Maps
- Tax Lots with Rooftops Fitting Criteria For Profit and People Maps
- Tax Lots with Rooftops Fitting Criteria For People and Planet Maps
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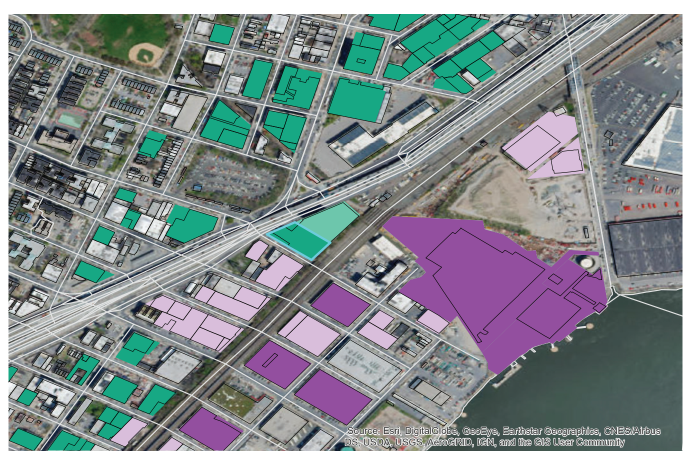
- Tax Lots with Rooftops Fitting Planet Map Criteria
- Tax Lots with Rooftops Fitting Profit Map Criteria
- Streets



N

.25

Miles

10.

825 E 141st St, Bronx, NY

Site Visitation Photos

Exterior

Google Street Views

Appendix E

1. The Brooklyn Grange Rooftop Farm Navy Yard location

Site Visitation Photos










Local Context

Selected Building Footprint

2. The Brooklyn Grange Rooftop Farm in Long Island City

Site Visitation Photos












Local Context

☐ Selected Building Footprint

3. Eagle Street Rooftop Farm

Site Visitation Photos










Local Context

Selected Building Footprint

4. The greenroof systems and farm at the Five Borough Parks Department Building

Site Visitation Photos



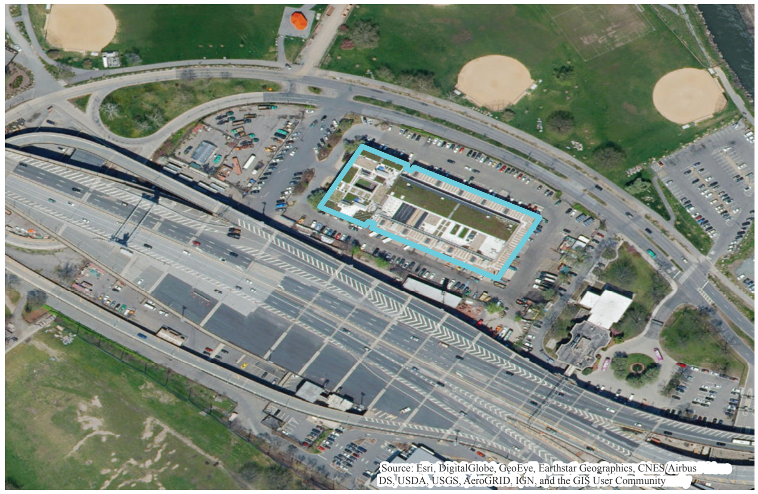







Local Context

Selected Building Footprint



N

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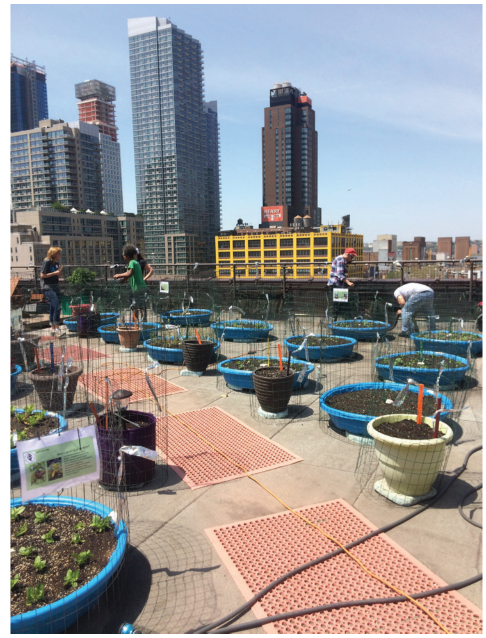
Miles

5. Hell’s Kitchen Rooftop Farm Project

Site Visitation Photos



Local Context

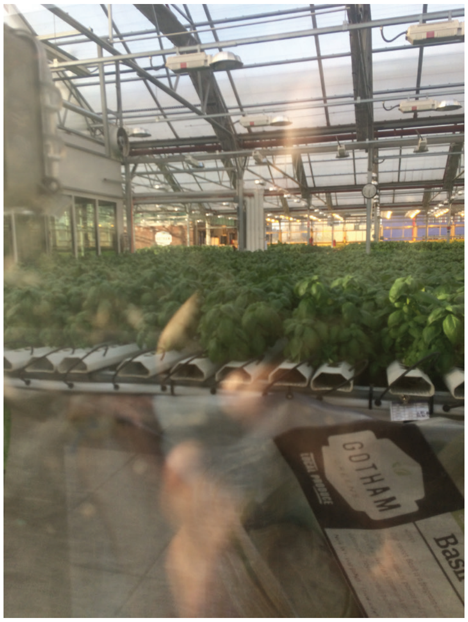
Selected Building Footprint

N

.035000000 Miles

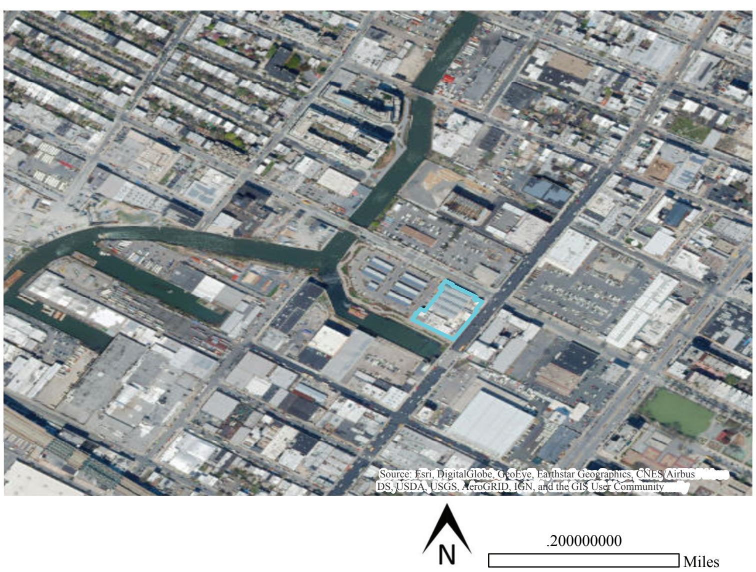
6. Gotham Greens rooftop greenhouse

Site Visitation Photos



Local Context

Selected Building Footprint



7. Rooftop Reds rooftop vineyard

Site Visitation Photos

Local Context

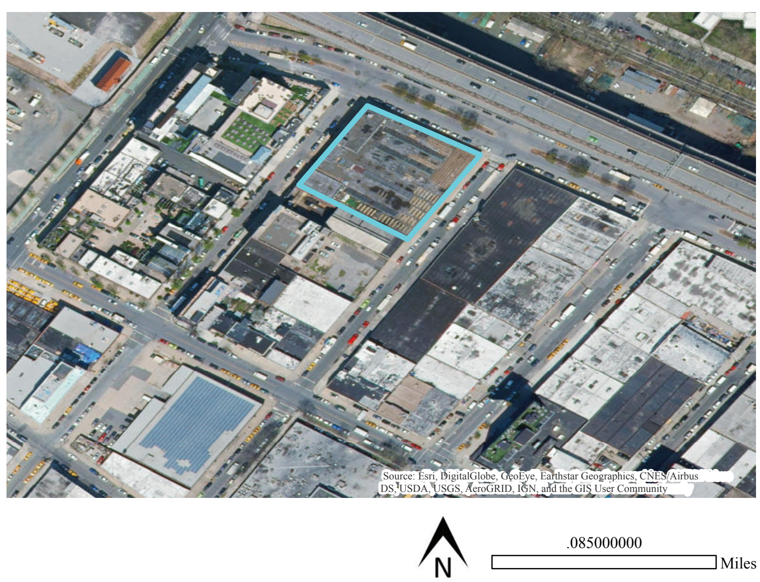
Selected Building Footprint

8. Hellgate Rooftop Farm

Site Visitation Photos

Local Context

Selected Building Footprint



9. Tinyfield Roofhop Farm

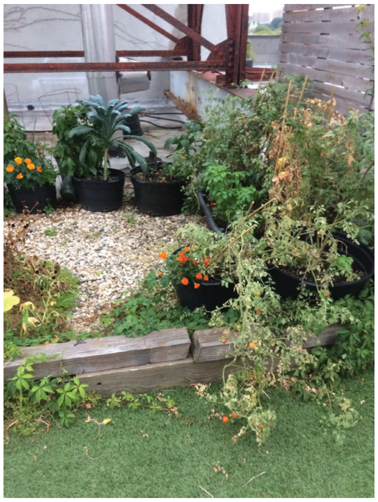
Site Visitation Photos

Local Context

☐ Selected Building Footprint

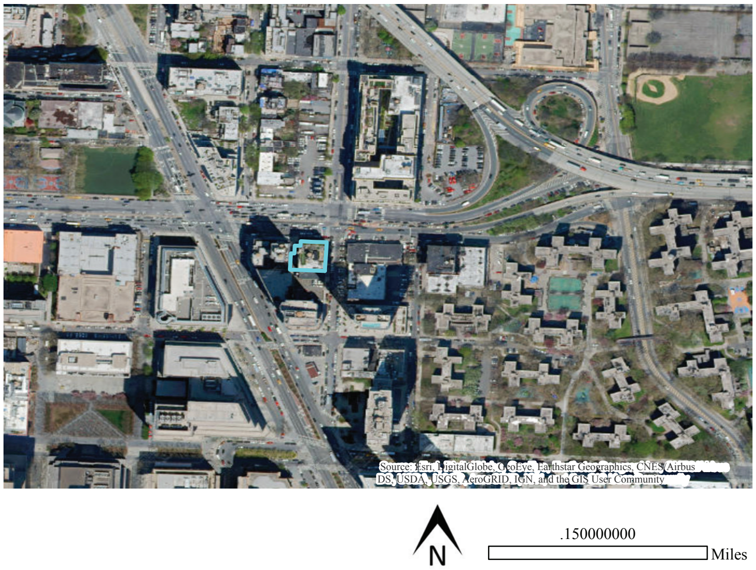
10. A residential rooftop garden in Brooklyn Heights

Site Visitation Photos



Local Context

Selected Building Footprint



11. Rosemary's Restaurant Rooftop Garden

Site Visitation Photos

Local Context

Selected Building Footprint

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Miles

12. Roberta’s Pizza Rooftop Shipping Container Farm

Site Visitation Photos

Local Context

Selected Building Footprint