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Jaques Avenue Bioshelter Report: An Assessment of Needs, Potential Uses and Partnerships in Worcester, MA

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A Master's Research Paper

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Abstract

Jaques Avenue Bioshelter Report: An Assessment of Needs, Potential Uses and Partnerships in Worcester, MA

Joseph Hersh

This report has been generated for Worcester Common Ground, Inc., (WCG) Community Development Corporation to support their vision of transforming a formerly vacant parcel of land into a community bioshelter. A bioshelter is a specialized greenhouse, powered by passive energy (solar, wind, rainwater), that is capable of year-round food production. This research is rooted within a conceptual framework of urban agriculture, ecological design and community development. Approximately twenty-five interviews were conducted with a range of stakeholders in order to determine community needs, potential uses and feasibility for a bioshelter. The first section of findings of this report highlights shared themes from stakeholders including prospective partnerships, long-term sustainability and broader impacts of the project. Finally, the report recommends an educational orientation for the bioshelter and illustrates corresponding management structures and actionable next steps in the planning process.

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1.0 Introduction

Food is an inextricable aspect of our existence, one which is valued and understood in a myriad of ways, across diverse cultures and homelands. It is not only necessary for physiological health and survival, but also shapes millions of livelihoods, land uses and traditions. In the 21st century, rising populations, an intensification of agribusiness and more intense impacts of climate change have had profound effects on how we view food. Increasingly, food insecurity coupled with rising social and economic inequality, have driven an array of stakeholders to rethink how our food systems can become more sustainable and resilient in light of the many challenges we will continue to face. Some of the most promising alternatives to industrially produced food have emerged from community-based grassroots efforts in areas that previously had little role in food production. Many examples of efforts to alter food supply chains and food systems can be seen here in Worcester inside the collaborative work of non-profits, institutions, community members, farmers, the private sector and universities. This project seeks to add a dynamic new element to the diverse stock of food-related activities in Worcester by exploring the social needs and potential uses of creative, community-based, renewable energy oriented technology in a historically distressed and blighted area of the city.

In order to advance towards these above mentioned goals, I have produced this document for Worcester Common Ground (WCG), Community Development Corporation to assist in the planning process of transforming a formerly vacant lot into a community asset. Since 2014, WCG has been working with Worcester Polytechnic Institute (WPI) to design and construct a bioshelter at 7 & 9 Jaques Avenue in Worcester. A bioshelter is a type of specialized greenhouse that relies on passive energy from the sun, rainwater catchment and other natural processes to create an environment that is suitable to grow food year-round. Throughout this project, the research questions are:

- Is the bioshelter plan a useful project?
- If so, what could be some of the potential uses for this bioshelter?
- In what ways would specific uses of a bioshelter engender different impacts for its end-users and necessitate varied management structures?

In order to answer these questions, this document first frames the proposed bioshelter within a broader conceptual framework of urban agriculture, food systems, and ecological design. This report then draws from relevant case studies to illustrate some potential agricultural, community space oriented, and educational uses of bioshelters and urban community gardens. These case studies and other secondary data make up one component of the research methodology, which also included conducting 25 semi-structured interviews with an assortment of stakeholders. Section 4.0 describes the detailed geographic, historical, social and institutional contexts of the Piedmont

neighborhood, where the proposed bioshelter would be located. The subsequent section analyzes the origins, existing design and gaps in knowledge around the bioshelter. Section 6.0 draws from existing studies and primary data from interviews to highlight the educational, food-related and community space needs in the distressed neighborhoods around the site of the planned bioshelter. The ensuing piece of the report, Section 7.0 Findings, does not offer a fixed set of uses and management strategies, but instead presents previously unexplored ideas and shared aspirations that might help catalyze future plans in new directions. These findings weave together a number of themes that came directly from the interviewees— including a range of uses of the space, community perspectives, management scenarios, fresh partnerships and concerns. The concluding section of this report draws from valuable insights from interviewees to recommend an educational use of the space, a specific management structure and actionable next steps.

2.0 Conceptual Framework

The concept of a bioshelter intersects topics in fields such as urban agriculture, food systems, sustainability, community development, and ecological design. To further these linkages, it is critical to explore the role of Community Development Corporations as potential drivers of more sustainable and ecologically sensitive strategies. In addition, this report examines several case studies which illustrate models of community-based,

agricultural and educational uses of bioshelters and urban gardens, all of which highlight possible foundations for the 7 & 9 Jaques Avenue project.

2.1 Urban Agriculture and Food Systems

In the pre-industrial era, the conventional food supply chain was one in which core areas, such as cities or towns, relied on rural areas in the hinterland for agricultural products and food. With rapid industrialization, migration to the urban areas and shifting consumption patterns, this model has been transformed and replaced by a global industrialized food system. This industrial arrangement is built upon vertical integration, bioengineering of food, large-scale agriculture and market dominance, often ignoring external costs, land rights or food safety (Campbell 2004). By contrast, urban agriculture, which is often defined as "growing plants and the raising of animals for food and other uses within and around cities and towns" (Van Veenhuizen 2006) has emerged as a micro-level alternative to the global model, with a renewed focus on more regional and/or local food supply chains. Some of the numerous benefits of urban agriculture include: increased access to healthy food, greater social inclusion, less food waste, developing positive perceptions and stewardship of the natural environment, expansion of green space, providing more nutritious food, improved health and psychological well-being, more equitable institutions/structures, and increased resilience against climate change (Kameshwari and Kaufman 1999) (Brown and Jameton 2000) (Kaufman and Baikley 2000) (Litt et al. 2011).

2.2 Community Development Corporations and Urban Agriculture

Over the last several decades, Community Development Corporations (CDCs) across the United States have been focused on projects that have built affordable housing or engaged in economic development activities (Glickman and Servon 1998). CDCs often operate in catchment areas with heightened disinvestment, blight, and numerous vacant lots. Historically, redeveloping these spaces into a site of urban agriculture has not been widely practiced by CDCs. Kaufman attributes this to CDCs viewing green space development to urban agricultural as a "non-traditional" (2000) activity for which these organizations sometimes lack the knowledge or internal capacity. Furthermore, other practitioners have advocated that CDCs or other development entities utilize an Asset-Based Community development approach that "mobilizes existing (but often unrecognized) assets, thereby responding to and creating local economic opportunity" (Mathie and Cunningham 2003), which can be seen as a strategic approach to integrate vacant lot development, green space creation and urban agriculture into the forefront of CDC projects. Kaufman encourage CDCs to be more supportive of urban agriculture, as they are well positioned to transform vacant lots into sites of economic opportunity (2000). On the other hand, even when CDCs are committed revitalizing vacant lots for community space or agricultural uses, they often face acquisition and cash flow obstacles as a result of municipal government hesitancy to remove these vacant lots from the tax roll.

2.3 Ecological Design

Ecological design stems from the permaculture movement, which like urban agriculture, was grounded on providing an alternative to consumption, industrialization and environmental degradation. The New Alchemy Institute, founded in Cape Cod in 1969, set out to explore innovative technological designs that could reshape human interactions with the earth, relying on biology as a new basis for design. Their work, which helped to envision a "post- or meta-industrial society" (Todd and Todd 1994), has been influential for many future generations who have come to see ecological design as a path to "meet needs of humans, move towards resource sustainability, maintain ecological integrity, emulate natural ecosystems, protect natural habitat and increase enviro-literacy" (Shu-Yang et al. 2004). Proponents for ecological design have long been interested in exploring, "how elements can work together to create functional interconnections that work like a natural ecosystem" (Toensmeier and Bates 2013). This case study will concentrate on one of the New Alchemy Institutes major accomplishments— the bioshelter.

2.4 Bioshelters: Origins and Principles

In an effort to conceptualize a new design of living and food-production, the New Alchemy Institute began to explore the idea of solar-heated greenhouses which they dubbed 'Arks' or 'Bioshelters' (Wolfe 1982). Early iterations of bioshelters, such as the Prince Edward Island and Cape Cod Ark in the 1970s (Figure 1), began to lay out the early

principles of a bioshelter which included utilizing renewable energy sources and incorporating year-round growing areas for plants and fish (Todd and Todd 1994).

FIGURE 2: THE NEW ALCHEMY INSTITUTE'S 'CAPE COD ARK' FROM 1976. (PHOTO: EARLE BANHART)

Bioshelters can be seen as different from greenhouses as they are "well integrated ecological wholes" (Todd and Todd 1994) that can be differentiated around many features, including the role of water which, "symbolizes the contrast between conventional greenhouses and bioshelters. In conventional greenhouses there is no standing water, while in bioshelters, silos of water store solar heat, raise fish protein, and supply warm fertile water to hydroponic and terrestrial agriculture" (Wolfe 1982).

In the past several decades many bioshelters have been built such as the Three Sisters Bioshelter (PA) (Figure 2), Garfield Farms (PA), Greenfield Bioshelter (MA) Food Forest Farms (MA), Radix Ecological Sustainability Center (NY), and Growing Power (WI) which have all furthered the function and design of bioshelters. According to Darrell Frey, the author of *Bioshelter: Market Garden*, and builder of Three Sisters, bioshelters can act as a "solution to humans' relationships to the planet without the use of fossil fuels"

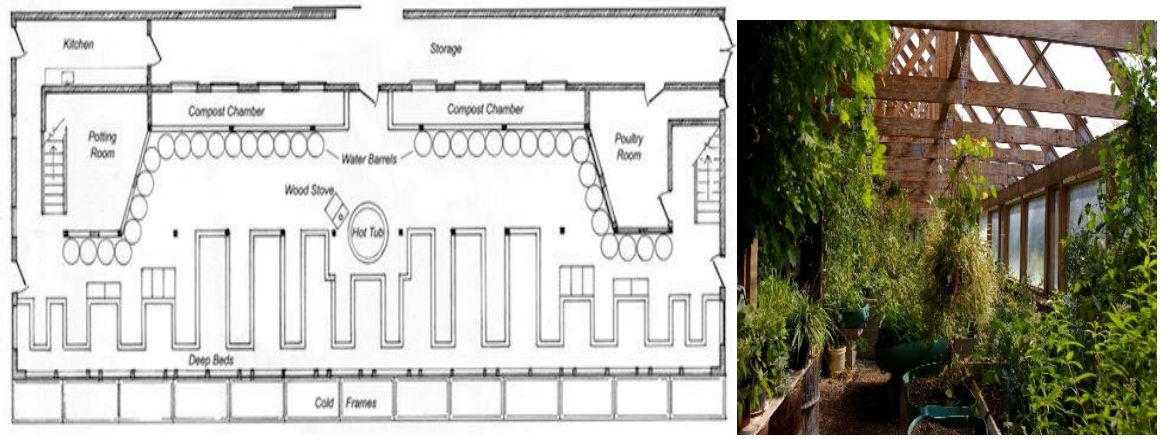

FIGURE 2: THE FLOOR PLAN AND INTERIOR OF THREE SISTERS BIOSHELTER, PA. (SOURCE: FREY, 2011)

(2011).

According to a Worcester Polytechnic Institute student report, some of the recent bioshelter advancements include: rainwater collection, thermal mass for heat storage, crop rotation, consumption of waste, glazed and transparent roofs that allow for solar heating, drums of water to store thermal mass, compost piles as a heat source, new

forms of insulation, ventilation to moderate humidity and airflow, solar panels, raised beds and aquaponics systems (Killoy et al. 2012). All in all, bioshelters offer a sustainable alternative to fossil-fuel heavy means of food production.

2.5 Patterns of Bioshelter/Community Garden Use

This section will draw from case studies and larger trends from across the United States to highlight some of the potential uses for bioshelters, and more broadly for green space or community gardens. This research provides a conceptual understanding of the range uses and programs that might be applied to a bioshelter project at 7 & 9 Jaques Avenue.

Community Space

Countless community gardens, green spaces and bioshelters stem from broader community efforts, and as such are often designed in order to act as a community gathering place. A few local examples, such the ReVision urban farm (Figure 3) in Dorchester and Peace Park in Worcester, were designed by mothers and other women

FIGURE 3: A GAZEBO AT THE REVISION FARM IN DORCHESTER, MA. (VPI.ORG)

FIGURE 4: FRUIT TREES BEAUTIFYING 7 & 9 JAQUES AVENUE LOT. PHOTO: JOSEPH HERSH, 2015.

who wanted more recreational space for families and children (Revision Urban Farm).

Community-oriented gardens and green spaces often have many positive effects for residents, beyond merely being a place to congregate and socialize. A bioshelter or community garden which is designed to serve community needs can ameliorate the perception of that place—both internally by residents and externally by the broader community (Hynes 2002). Public places can also contribute to collective memories of a space, a view expounded upon by Dolores Hayden, a Yale University professor of Urban Studies, who writes:

> "The power of place—the power of ordinary urban landscapes to nurture citizens' public memory, to encompass shared time in the form of shared territory—remains untapped for most working people's neighborhoods in most American cities, and for more ethnic history and most women's history" (1995).

On a more quantifiable level, studies have found that community gardens and green space can contribute to increasing property values, in some cases by as much as 10% within five years (Voicu and Breen 2008). Although less calculable, multi-year ethnographic studies have found that green spaces can help build social cohesion, shared interests and broader neighborhood participation (Gotham and Brumley 2002) and reduce interracial tensions (Shinew et al. 2004). Community green space also often beautifies an area (Figure 4), which can yield benefits including less stress, higher life satisfaction, and increased mental health (van den Berg et al. 2010) (Hynes 2002).

Agricultural Use

Although many bioshelters in urban locations offer services to the surrounding community, they are mostly centered on agricultural uses that generate revenue, produce crops and can offer economic employment (Van Veenhuizen 2006). According to the Food and Agriculture Organization, horticulture can generate one job for every 100 square meters of garden space in the production, input supply, marketing and value-addition processes (Food and Agriculture Organization 2016). Bioshelters or community gardens with agricultural missions often have a lot of potential to generate revenue, contribute to greater food access and tie in to more regional food justice initiatives.

One of the most striking and successful examples an agriculturally-driven site is the Greensgrow Farm in Philadelphia, which began as a non-profit in 1997. In 1998 it sold a little over $5,000 of hydroponically grown lettuce blends and after years of rapid growth and scaling up its small lettuce production operation, it now sells over $1,000,000 of produce per year. The farm employs many community members and also developed a unique program, SNAP Box, which provides fresh produce, nutritional information and food preparation tips to low-income residents. This program has grown over the last several years and in 2015, it served over 280 families (Greesngrow). Several other examples at a smaller scale, closer to the size of the 7 & 9 Jaques Avenue lot, indicate that agricultural uses of community gardens and bioshelters are not limited to large operations. The City Farm in South Providence, RI, is a ¾ acre farm and education site that

operates on a community land trust. The farm produces over 4,000 pounds of produce per year with over 80 different crops which are sold to local businesses and donated to community partners (Southside Community Land Trust). According to an interview with the owner, the 40' x 105' Three Sisters Bioshelter in Pennsylvania sells leafy greens and microgreens year-round, to restaurants for up to $15/pound for a gourmet salad blend.

In a WPI study on bioshelters, conducted in 2012, the students teamed up with an experienced New England Farmer and consulted with Small Plot Intensive Farming guidelines to chart the most effective crop rotation for a small-scale bioshelter (Appendix 1). They settled on a variety of crops, but with a balance of leafy greens and herbs in order to maximize earnings, which they predicted at around $37,500 to $57,000 revenue from a 1,100 square foot space. They reached these numbers from average retail prices from the United States Department of Agriculture and crop yields form National Centre for Appropriate Technology (Killoy et al. 2012). Ultimately, the potential for a small to medium sized bioshelter to have economic value as small scale agriculture should not be overlooked.

Educational Space

The intrinsically complex design of a bioshelter, which relies on interconnections between solar energy, water catchment, and thermal mass, make it a natural fit for educational opportunities for both school-aged students and adults. Some bioshelters have an educational component, most commonly seen in the form of permaculture

workshops or tours, but rarely with a direct connection to schools. Many schools do have gardens as sites for experiential learning, and these offer a diverse array of benefits to elementary and middle school aged children.

On a national level, legislation such as the No Child Left Behind Act has resulted in hands-on science-based learning giving way to curriculums geared around test results (Applebee and Langer 2006). In her book*, Ripe for Change: Garden Based Learning in Schools*, Jane Hirschi, one of the founders of the City Sprouts Initiative in Cambridge, MA, expands upon the benefits of garden-based learning. In general, Hirschi sees a growing disconnect between children and nature coupled with less science education, which have adverse effects on children, leaving them with worse nutritional habits, and less knowledge of nature and health (2015, 8). From her extensive research on garden-based learning, Hirschi finds that, "children with the least access to nature, learners most in need of experiential learning opportunities, and those at highest risk for diet-related illnesses are the least likely to spend time in school gardens" (2015, 9). The author also believes that learning through hands-on garden-based activities has benefits beyond academic results and can lead to more observation, communication and behavioral development in children (2015, 22). This finding is mirrored by a study that analyzed 20 years of research from 48 studies about school gardens—analyzing many methodologies and metrics of benefits such as grades, behavior, eating, physical activity and more— and

ultimately determining the overwhelming benefits of such educational opportunities (Williams and Dixon 2013).

Hirschi's case study chronicling the City Sprouts program in Cambridge is a worthwhile example of the impact outdoor curricular activities can have. City Sprouts is a non-profit that began in 1999 and served over 20 schools with 6,000 total students. It hired a garden coordinator to help develop curricular activities, facilitate visits to gardens, maintain the gardens and assist the teachers. This program has proved to be very successful, and more than 80% of teachers used the site. The program has now been incorporated into a summer program and is a service site for Food Corps, a branch of AmeriCorps.

Other organizations such as Growing Power in Milwaukee have utilized gardens and bioshelters to not only produce food but also act as an "idea factory" for all ages, to provide training on topics including: acid-digestion, bio-phyto remediation, soil health, aquaculture, vermiculture, marketing, value-added product development, leadership development and many other subjects (Growing Power).

Greensgrow Farms and Growing Power are two of the most successful urban agriculture sites that feature a bioshelter and a strong educational component. A survey of the literature and other existing bioshelters has shown that there are relatively few other examples of bioshelters that have such a strong educational use (Van Veenhuizen

2006). In conclusion, while community and school gardens provide a range of educational services to youth and families, there appears to be a lack of bioshelters used by schools. While this may be in part due to the complex planning process and capital cost of a bioshelter, its year round-use and advanced technologies would be a valuable asset for a school or school district.

3.0 Methodological Approach

In order to determine the suitability, stakeholder involvement and potential management structure of a bioshelter at Jaques Avenue, the research synthesizes existing demographic data, analysis of case studies and primary data gathered from interviews. Before carrying out this research, Clark University Institutional Review Board (IRB) approved the research design of this project.

3.1 Preliminary Phase

The initial phase of this project relied on assembling secondary data from sources such as organizational reports, bioshelter/solar greenhouse cases studies in other urban areas, and United States Census. This information frames similar projects, community engagement processes and the social, historical and institutional contexts of the Piedmont neighborhood.

3.2 Interviews

The subsequent methodological step was to conduct semi-structured interviews with a diverse range of stakeholders. The long-standing institutional connections between WCG and other stakeholders were invaluable in recruiting participants for the interviews, which was a purposeful and snowball sampling approach. The interviews were grounded in an interview guide arranged around themes such as perceived community needs, organizational goals, avenues of programmatic collaboration and positive or negative outcomes that might stem from a bioshelter. Other questions were more open-ended and fluid, changing with the interviewees' particular work experience, interaction with WCG, or involvement in food policy. Over the course of six weeks, 25 individuals were interviewed, both in person and over the phone. These interviewees included representatives from:

- **Schools**: Jacob Hiatt Magnet school (teachers and administrators), Chandler Elementary (teachers and administrators), Worcester Polytechnic Institute, Clark University
- **Non-Profits**: Worcester Roots, Ascentria Care Alliance, Main South YMCA, Worcester Tree Initiative
- **Worcester Common Ground**: executive director, outreach coordinator, board members

- **Food Groups**: Regional Environmental Council, urban famers and bioshelter owners, Worcester Food and Active Living Policy Council, Worcester Food Bank
- **Residents**: Wellington Community Apartments, Wellington Apartments, local gardeners
- **City Officials**

The interviews were not recorded, but were summarized in detailed field notes. These notes were then analyzed by a round of free-coding in order to develop themes between the rich and wide-ranging perspectives of the interviewees. Ultimately, this free coding analysis enabled the discovery of commonalities in narratives of the interviews, which represent some of the more encompassing and distilled findings.

4.0 Study Area/Context

This section will provide contextual information about the demographic composition, geography, zoning, history, crime rates and institutional anchors of the area.

4.1 Demographic Profile

The Piedmont neighborhood, which contains 7 & 9 Jaques Avenue and is demarcated by Census Tract 7314, is among the most diverse and impoverished parts of Worcester. According to the 2010 United States Census and the 2010-2014 5 Year American Community Survey, Census tract 7314 is home to 4574 people and 905 families. Of these people, approximately 51.4% are Hispanic or Latino and more than 66.3% speak

a language other than English at home— which is respectively double and triple the city averages. Many residents of this area are foreign born (31.5%) predominantly from Latin American countries such as the Dominican Republic, Mexico, El Salvador, Ecuador and Brazil. Strikingly, almost 1/3 of the residents in the area moved into their current home since 2010— which points to a lot of turnover and a constant influx of new residents into the area.

Though this section of the city is one of the most ethnically and racially varied areas in the Worcester, its inhabitants face almost unmatched levels of poverty. This census tract has a median family income of $25,660 which is almost half the city average. Additionally, over 49.1% of adults were below the poverty line— which is almost three times more than Worcester as a whole. This can perhaps be attributed to poor educational attainment with 39.3% of the population not having a high school diploma, but can also be ascribed to a shockingly high unemployment rate of 20.9%, or double the city average. Moreover, African Americans in the area have a 48.4% unemployment rate (four times the City average) and females with children under 6 years old have an unemployment rate of 30.1%. It is clear that the Piedmont neighborhood is among the most distressed parts of Worcester, and that continued efforts to stabilize and revitalize the community are needed.

4.2 Geography

As illustrated in Figure 5, the proposed location for the bioshelter is at 7 & 9 Jaques Avenue is in close proximity to the downtown, large local universities (WPI, Clark University), many small businesses and major roadways (Chandler Street, Pleasant Street, Route 290). This area sits in the heart of the Piedmont Neighborhoods, which consist of

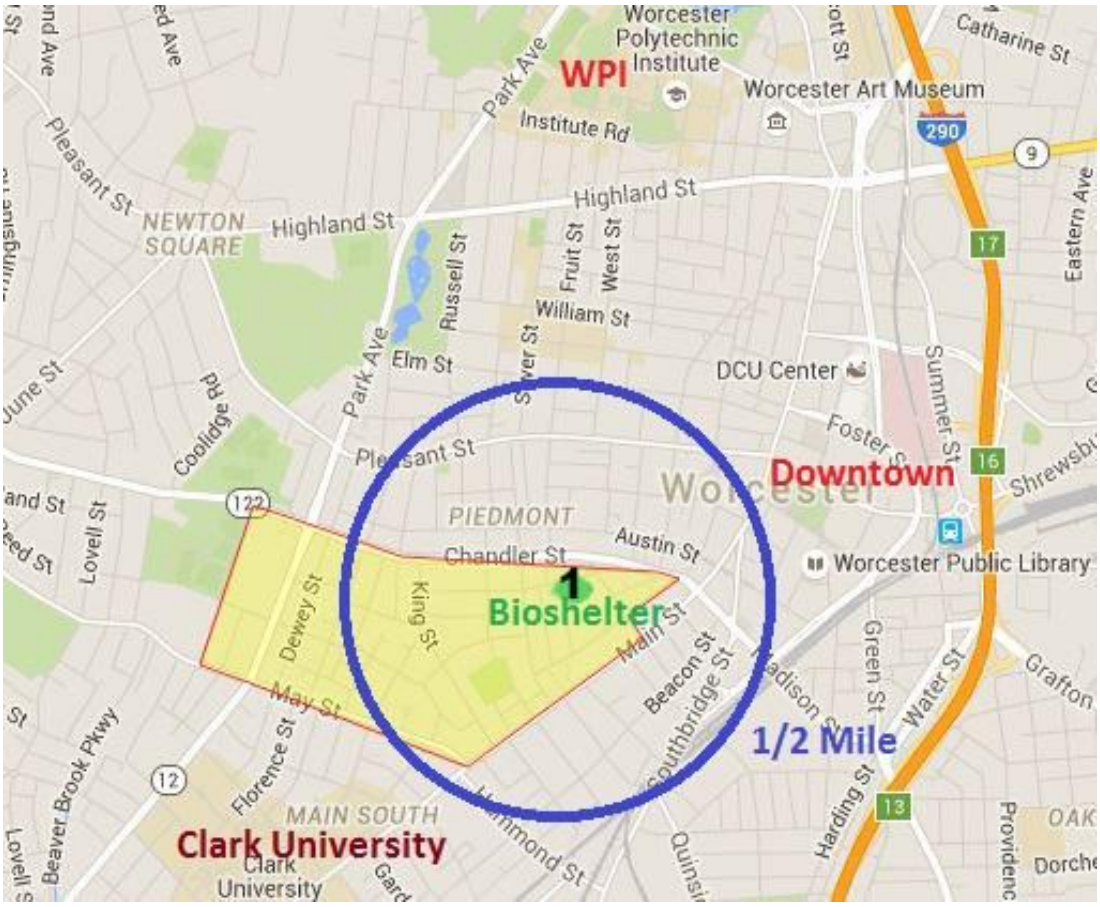

FIGURE 5: MAP CENSUS TRACT 7314 (YELLOW), WITH 7 & 9 JAQUES AVENUE (LABELLED 1) IN THE CENTER OF A 1/2 MILE WALKING DISTANCE (BLUE) SOURCE: GOOGLE MAPS, 2015

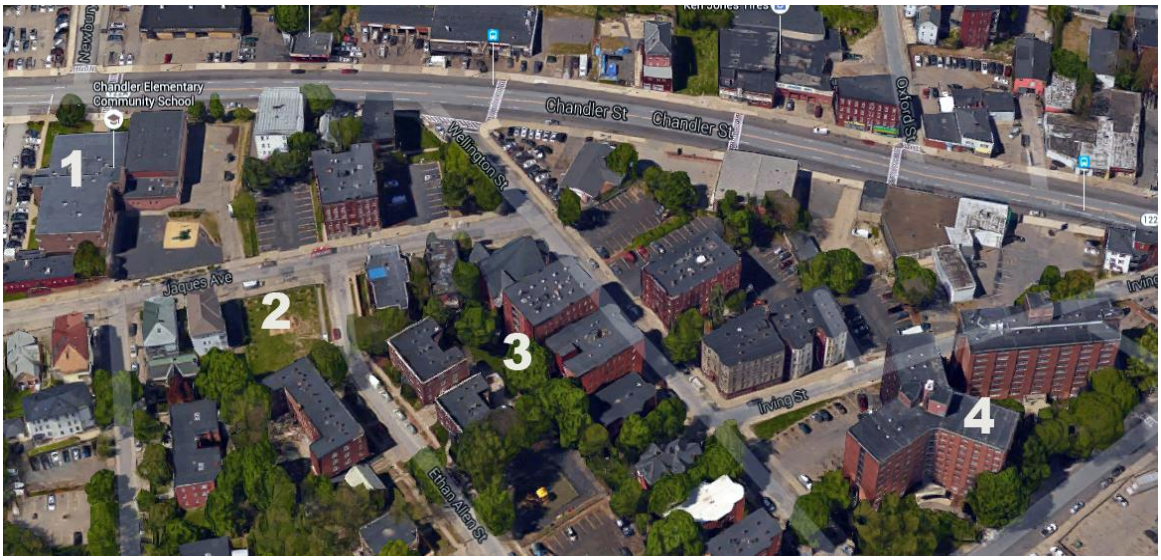

FIGURE 6: THIS AERIAL IMAGE SHOWS 7 & 9 JAQUES AVENUE (2), CHANDLER ELEMENTARY (1), WELLINGTON COMMUNITY APARTMENTS (3) AND WORCESTER HOUSING AUTHORITY UNITS (4). SOURCE: GOOGLE MAPS 2015

Elm Park, Piedmont, Crown Hill and Castle Street.

The lot itself is approximately 8,500 square feet or 1/5 of an acre. It is approximately 75 feet away from Chandler Elementary school, between 500-650 feet away from the 180 scattered Wellington Community Apartments, Worcester Housing Authority elderly apartment units, and it borders a WCG First Time Homebuyer property located at 11 Jaques Street (Figure 6) (see Appendix 2 for WCG property map). The lot also has a slight downward slope from the Ethan Allen Street side, is contained by a wire link fence and according to a year-long project conducted by WPI students, it has adequate sunlight for agriculture (Breen et al. 2015) (Figure 7).

FIGURE 7: IMAGE OF 7& 9 JAQUES AVENUE. PHOTO: JOSEPH HERSH, 2015

4.3 Zoning

The 7 & 9 Jaques Avenue lot, is zoned as BG-3.0 or Business, General (Vision Government Solutions 2014). Under this classification, its permitted uses include: agriculture, horticulture, viticulture, floriculture, recreational/service facility (non-profit), schools (non-profit) (City of Worcester Zoning Ordinance). Additionally, under the Dover Amendment in the Massachusetts General Law, any agricultural building would be exempt from local zoning laws as long as long as it is uses by a non-profit and education acts as the "primary or dominant purpose" (Massachusetts General Laws). Finally, after

WCG purchased the land from the City of Worcester in 2014, the lot was also designated with a 958V Charitable Recreation land use. WCG pays a minimal property tax. (See Appendix 2 for Tax Parcel Map)

4.4 Historical Context

When envisaging future uses for the 7 & 9 Jaques Avenue lot, it is critical to understand some of the economic and historical trends that have shaped the built environment in the Piedmont neighborhood. Worcester's history has real significance in terms of the physical density of the area, the current housing stock and problems associated with legacy pollution. From the mid-19th Century until after WWI, Worcester was a national industrial force, with unparalleled diversity of manufacturing. The early development of the Blackstone Canal helped link Worcester with other areas in the Northeast and rapidly brought a wide range of immigrants into the city. During the height of industry between the 1880s and 1920s, approximately 24% of the city's residents worked in manufacturing (Sinha 2010). This expanding workforce faced a shortage of housing options, which stimulated the construction of triple-decker housing, or "a new building type designated to accommodate several families in a single dwelling" (Worcester Historical Museum) (Figure 8).

FIGURE 8: TWO OF WCG'S REVITALIZED TRIPLE-DECKER HOUSES IN THE PIEDMONT NEIGHBORHOOD. PHOTO: JOSEPH HERSH, 2015.

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According to the early 20th century Worcester playwright, Samuel Behrman, many houses had "yards in the back that had fruit trees—cherry and pear and apple" (Worcester Historical Museum). After a sharp decline during the Great Depression, Worcester's industry began to fall even further in the 1960s and 70s as many factory jobs were outsourced to other countries, a trend that was mirrored in many small to mid-sized cities in the Northeast.

Today, the housing stock is still largely comprised of the same multi-family triple-decker homes that were built in the late 19th century. According to the 2010-2014 American Community Survey 5 year estimates, more than 95% of the homes in this area comprised of at least two units, and over 2/3 of these houses were built before 1939.

There is little impetus for change in the area as there are very low rents compared the rest of the city and there is a very low owner-occupancy rate of 11.2%. Conversely, on a rare and encouraging note, the number of vacant houses in surrounding Jaques Avenue has decreased from 12% to 7% over the last 15 years (U.S. Census 2000, ACS 2010-2014). All in all, while many triple-deckers continue to serve as a relatively affordable housing option for low to middle income families, numerous others have fallen into disrepair due to generations of neglect by absentee landlords, and one would be hard pressed to see fruit trees in backyards.

4.5 Crime

In order to understand this area fully, the influence of crime and safety concerns in the neighborhood cannot be underestimated. Many interviewees made reference to concerns of vandalism, break-ins and safety. Furthermore, field observations revealed significant drug use and illegal activity outside of several homes in the area.

These perceptions align with the data, as this area has one of the highest number of arrests for violent crimes and simple assaults (Downs et al. 2011). As true for many other parts of the city, many structural issues and results of poverty such as joblessness, housing insecurity, distressed built environment, lack of recreational activities, and trauma can feed into patterns of drugs use, crime and youth gang involvement (Ross and Foley 2014).

4.6 Institutional Anchors

This area is supported by a visible presence of non-profits and other institutions that seek to ameliorate some of the problems of this area. There are a number of resources such as UMass Memorial, Health and Family Services and Community Healthlink that provide primary care to members of the community, including vulnerable homeless populations. This area is also buttressed by the YMCA of Greater Worcester, which is involved in a range of activities and partnerships from youth activities, family health and job development. Finally, WCG plays a very important role in stabilizing this neighborhood. Since its inception in 1988, WCG has created 136 rental units in this area as well as 25 First Time Homebuyer opportunities. While affordable housing is one of the major components of WCGs mission, the group also has an impact on public safety, green space development, youth leadership building, recreation, community arts, and business development.

5.0 Jaques Avenue Bioshelter Analysis

This section summarizes the original motivations for building a bioshelter and initial partnerships that were formed for this project— as interpreted from WCG documents and interviews. This portion of the report will introduce some of the detailed design work conducted by WPI students. Finally, this segment will highlight some of the problems and gaps in information about the bioshelter that have existed.

5.1 Origin of Jaques Avenue Bioshelter

Well before the notion of a bioshelter, WCG had been engaging residents to manage green spaces and produce healthy food for consumption. The organization has tried to ensure all its affordable housing projects incorporate some type of raised bed or green space (Figure 9).

FIGURE 9: RAISED BEDS AT WCGS 5 PIEDMONT STREET. PHOTO: JOSEPH HERSH, 2015.

FIGURE 10: PRESTON STREET EAT CENTER. PHOTO: JOSEPH HERSH, 2015.

In 2011, WCG joined with the City of Worcester, the Regional Environmental Council and Ascentria Care Alliance to turn three vacant lots into small farming spaces for refugee farmers (Figure 10). These lots became known as EAT Centers, or Education, Agricultural Training Centers. According to interviews with residents and others who work in the area find these lots to be very well kept and a positive aspect of the neighborhood even if they do not directly reap economic benefits. Aside from beautifying the neighborhoods, these EAT centers have been very successful in terms of agricultural

output, with over 2200 pounds of food grown, 43% ethnic crops and reaching over 7000 consumers through the REC mobile market, and other outlets.

The 7 & 9 Jacques Avenue project materialized in a different fashion from the other EAT centers, due to pre-existing conditions of the lot. Unlike the other EAT centers, soil testing revealed the site to be too contaminated for growing crops directly in the soil. This problem created an opening for the idea of a bioshelter, as an imaginative solution for developing a polluted, vacant lot. Thus, the initial idea for a bioshelter, which was formed collaboratively between WCG and WPI, is grounded and shaped by site-specific constraints and obstacles.

The planning process began in earnest after the 7 & 9 Jaques Avenue lot was purchased, established as the 4th EAT center, and planted with 19 fruit trees by the Worcester Tree Initiative (Figure 11 and Figure 12). At the early phase of the project (2011-2013), WCG's goal was to "transform the lot into attractive space with an urban farm, communal wood-fired oven, garden and bioshelter" (Worcester Common Ground 2015). The assumed management of the space was one in which Ascentria farmers harvested the orchards and ran the bioshelters and were supported by the REC. Additionally, from the beginning, WCG made it be known that it didn't have the internal capacity or technical ability to manage a bioshelter.

FIGURE 11: RIBBON CUTTING CEREMONY FOR 7 & 9 JAQUES AVENUE ORCHARD. SOURCE: TELEGRAM AND GAZETTE STAFF

FIGURE 12: APPLE TREE AT 7 & 9 JAQUES AVENUE. PHOTO: JOSEPH HERSH, 2015

5.2 WPI Projects: Design and Community Use

The WPI team (Breen et al. 2015), tasked with coming up with a design for a potential bioshelter, used several site visits and extensive research to provide some useful models for the Jaques Avenue lot (Figure 13). Their analysis of the site for soil quality, rain capture rate, rates of sunlight and temperature data is information that is

FIGURE 13: TWO RENDERINGS OF A VISUALIZATION OF THE WPI TEAM'S DESIGNS. SOURCE: BREEN ET AL. 2015

helpful for future plans. In terms of their design, the team focused their efforts on a rainwater catchment system, a heating system and structural design components. Their heating system, which would allow for year-round growing, would rely on thermal mass, a climate battery that stores and releases warm water, and a Jean Pain mound—or large compost pile. Teachers and administrators, interviewed for this project, have been very excited by the range of heating systems and their potential incorporation into science education.

The WPI students also generated itemized equipment costs, buildout costs and other capital expenses to estimate a project budget of $70,000, which some stakeholders expressed as overly high. Conversely, bioshelter builders interviewed for the project have suggested this is an appropriate amount, even on the conservative side. At the time of this report (March 2016), WCG has raised $27,500 in funds for the urban orchard and bioshelter from the Fuller Foundation, Eastern Bank, TJX, and Santander. In summary, the WPI students involved in the design work have synthesized many designs and generated a prototype that serves as a good foundation for a more inclusive design process.

5.3 Gaps in Knowledge

Although the WPI student team's designs are highly detailed and of use to WCG, they do little to predict or model the potential uses of the interior and exterior of the bioshelter. A WPI faculty member regretted the fact that the WPI projects were unable to glean a sense of the surrounding community or facilitate new partnerships between

stakeholders, due to a lack of successful outreach or engagement with community organizations. Although WCG and WPI had both viewed this bioshelter as an opportunity for education, there had been no concrete conversations with schools or teachers. Furthermore, while the WPI students had tried to make a connection with the 500-600 residents at Wellington Community Apartments, they had been largely unsuccessful. As it stood, there was little sense how this bioshelter project could be anything more than a building on an EAT center site.

Therefore, this report has been developed to address and answer some of the unknown uses and stakeholder perceptions about the project. From a process perspective, this has been accomplished by a commitment to increase stakeholder engagement between professionals, organizations, and community members. This engagement has highlighted new ideas and prompted new connections that demarcate some of the previous gaps in knowledge around community need, potential uses and management.

6.0 Evidence of Community Need

The demographic profile in the preceding section illustrates the level of poverty and distress in the Piedmont neighborhood. This segment will draw from both secondary data and qualitative assessments from 25 interviews to illustrate the most persistent

problems that affect Piedmont residents including: need for more educational opportunities, food insecurity/poor nutrition, and inadequate green space.

6.1 Education

After speaking with numerous teachers and administrators with many years of experience working in Chandler Elementary and Jacob Hiatt Magnet School, it is clear that education is an inexorable need— with constant tension between improvement and new hurdles. An illustrative example exists at Chandler Elementary whose students recently improved their standardized test scores and in the process moved the school from a Level 4 to a Level 1 school, which essentially means that it is reaching goals that were set by the state of Massachusetts after a period of low scores. Concurrently, its enrollment rose from 347 in 2009-2010 to 501 this year (Worcester Public Schools) which has necessitated 5th and 6th grade classes being moved to the YMCA. Administrators highlighted that while this move doesn't affect the quality of education, it poses logistical challenges for teachers and results in larger class sizes. In addition, 91.1% of Chandler Elementary students have high needs, and in both Chandler Elementary and Jacob Hiatt there are many difficulties with 50-70% of students having a first language other than English. This highlights the need for specialized English Language Learner teaching for 43% of students at Jacob Hiatt and 65% at Chandler Elementary – which are both higher than the city-wide average (Massachusetts Department of Education). These trends point to the constant vacillation that schools often face—trying to meet education standards while dealing with

a rising population of students who have high needs academically and face a myriad of poverty related problems with their families, food security, substance abuse, crime and housing insecurity outside of the classroom.

Within the schools themselves, all of the interviewed educators reiterated the need for more hands-on educational opportunities for their students. According to interviews, the desire for experiential science and technology activities is often expressed by both students and parents. Many of the students live in apartments and have limited experience learning about the natural world. Many teachers and long-tenured administrators explained that outdoor learning offers a rare opportunity for cross-curricular learning. One interviewee also emphasized that highly impoverished neighborhoods are often overlooked as centers for technological or creative learning, which should be inverted as “folks are poor but they aren’t stupid”.

6.2 Food and Nutrition

One interviewee, who has been involved with food-related policy in Worcester for close to a decade, reiterated that although there is increased awareness for the importance of food access, hunger and food insecurity are continually getting worse. She also described the rising obesity problem in Worcester along with other issues pertaining to inadequate culturally relevant food and barriers for those with disabilities to get food. In addition, the Piedmont neighborhood is heavily Hispanic, and Hispanic youth have higher rates of obesity than any other group in the city (Massachusetts Department of

Public Health 2011). Many educators echoed these concerns and described how many parents lack time, money or nutritional education, which left children with a poor understanding of healthy foods.

Regional trends and statistics, from a Worcester County Food Bank 2010 Report, paint a stark picture of food insecurity. In 2013, Worcester County Food Bank served almost 100,000 people in Worcester County—or roughly 12% of the population (Worcester County Food Bank). Approximately 40% of those served are under 18 years old, and among households with children, 91% are food insecure and 33% have a very low level of food security (Worcester County Food Bank 2010). Food insecurity is also often very much linked to poor health outcomes (Coleman-Jensen et al. 2014) and in Worcester, almost 1/3 of households served by the Food Bank reported having at least one family member in poor health. Across the nation, many clinical studies continually draw direct connections between economic distress, unemployment and access to healthy food (Cook 2002). The neighborhood around Jaques Avenue has some of the highest rates of unemployment and poverty and by extension, food insecurity. Therefore, as stated by many interviewees, any way of increasing access to and education about food by any means is an urgent need.

6.3 Green Space/Community Assets

American cities, especially those in the former industrial core in the Northeast, are seeing increasing expanses of vacant lots. In fact, a recent study estimates that around

23% of an average American city is vacant (Van Veehuizen 2006). From field observation, there are many vacant lots in the WCG target area most are in poor shape, serving as unofficial community trash dumps (see Appendix 2 for City-wide map of vacant lots)

With low homeownership, low owner-occupancy, and rapid turnover it is difficult for individuals to change these spaces. In the Piedmont neighborhood, there is a preponderance of underutilized lots, yet only 1.2% of the land, or 3.2 acres of green space (Housing Report in Downs et al. 2011). Many people in this area live in large apartment buildings, and a resident service coordinator remarked that "the thing that people ask for the most is a place for cookouts in the summer, as they aren't allowed to here". Other residents expressed the desire for green space, including an elder resident who took three buses to go to Home Depot to purchase equipment and plants for a very small garden outside of her apartment.

7.0 Findings

The previous two sections, 5.0 Jaques Avenue Bioshelter Analysis and 6.0 Evidence of Community Need, are interspersed with discoveries from secondary data and interviews. This section represents pulls together the many different themes that interviewees brought up with regards to bioshelter uses, concerns, and management. The major themes are as follows:

- Multi-Stakeholder Interest in Educational Bioshelter

- Community Perspectives and Participation
- Bioshelter Suitability for After School/Summer Programming
- Long-Term Financial Sustainability
- Internal WCG Support
- Management/Partnership
- Concerns

7.1 Multi-Stakeholder Interest in Educational Bioshelter

In order build the bioshelter, it needs to have an 'educational use' to meet the exempt use of the Dover Agreement (see 3.3 Zoning section). At the early stages of this project, WCG and WPI were eager to have an educational use, but there was uncertainty at whether this interest would be reciprocated by schools. After conducting interviews with teachers, administrators, youth program providers, and city officials, it is clear that there is a widespread enthusiasm and eagerness for an education-oriented bioshelter.

Although many stakeholders were not initially familiar with the specificities of a bioshelter, after learning about their interconnected systems of heating, plant growth and water cycling, many teachers and administrators excitedly brought up the potential for experiential learning and cross-curricular learning. The bioshelter is seen an clear way to liven up science and technology curriculums, but many teachers spoke of its potential to incorporate art in the form of sculptures, mosaics and other activities. One interviewee who has worked with Worcester youth for over two decades described how "outdoor

education can be a spiritual-like experience for kids and once they are exposed to it they can better explore other subjects and be exposed to other ideas". Most teachers agreed that the target grades for a bioshelter-related activities would be 4-6, but that potential for K-8 engagement was strong. Finally, one administrator viewed the bioshelter as being more "accessible" than the school gardens in the area— as it would be operational year round.

7.2 Bioshelter Suitability for After School/Summer Programs

Many of the same stakeholders who were passionate about incorporating bioshelters into the local schools also expressed the potential for the bioshelter as an asset for after school or summer programs. In addition, organizations/institutions that provide services to the youth, namely the YMCA and City of Worcester Office of Youth Opportunities, viewed the bioshelter as being a nexus for year-round learning.

The Office of Youth Opportunities launched the RecWorcester summer program in 2014 and has been funded to continue its model during the school year in the recent pilot program with six schools including Chandler Elementary. Essentially, this program which runs from February 1st until the end of the year, focuses on providing arts, athletics and academic education for youth. This program is funded by $100,000, none of which comes from tax-payer dollars (Petrishen 2016). The program has dedicated administrators, employed by the City of Worcester, who were formerly in the school district. One of the creators of this program was very keen to explore the possibility of having the bioshelter

tied into this programming. An additional link with after-school programming was raised by a resident services coordinator at one of the large apartment buildings near Jaques Avenue. Presently, the apartment complex runs a community computer lab which is staffed in the afternoon by a teacher. This lab sits within 500 feet of the 7 & 9 Jaques Avenue lot— and due to its proximity, could enhance learning opportunities for youth and adults in the community by building computer skills through activities linked to the bioshelter (for example: charting plant growth on Microsoft Excel, designing planting layouts in Adobe Illustrator or AutoCAD, or building language skills).

7.3 Community Perspectives and Participation

Residents and community members expressed a shared passion, optimism and willingness to volunteer in the future. A few of the residents had been trying to become more involved in community gardening and urban agriculture, but were limited by the lack of available green space. One stakeholder, with experience planning and operating a community park in Worcester, plans on drawing from her community-wide network to draw volunteers and people who might use the space. She also raised the potential of using the perimeter of the lot as community gardening space for those without yards or adequate sunlight. Another resident, from the Worcester Housing Authority's Wellington Apartments, viewed the bioshelter as a space where the elderly could feel less isolated and help mentor children. The resident service provider envisioned the bioshelter as having space dedicated to community members to congregate and relax and have BBQs.

In terms of participation and commitment, many interviewees expressed the need for a lot of outreach and familiarizing people to the idea. Some recommended connecting to any of the local churches in the area. Additionally, many of the residents in this area are Spanish-speakers and thus, any outreach must be attuned to that. Some interviewees expressed hope that the bioshelter could act as an agent to join residents together and increase resident mobilization. Another major source of community engagement would be through activities geared at children such as seed plantings, harvests, communal dinners, art shows, poster designs and other events. A majority of interviewees expressed the view that connecting to adults must come though engagement of their children.

7.4 Changing Perceptions

The earlier sections of this report highlighted some of the existing conditions in this area, including high rates of poverty, crime and blight. A number of interviewees believed that the bioshelter would help to shift the perception of the area, both internally amongst residents and from the outside. A WCG Board member felt that a bioshelter could be a "very creative use of green space. It could generate a lot interest and pride in the community, the media, the city and the funders".

Another exciting way a bioshelter could renovate the image of the area is through collaborative programming with other sustainable and environmental projects, such as the existing EAT centers and newly constructed greenhouse at Stone Soup Community Center, which is very close to Jaques Avenue. By connecting to a network of other green

initiatives, this area could eventually become seen as a hotbed of community-driven sustainable development and a site for urban agriculture tours and workshops.

7.5 Long-Term Financial Sustainability

Even if the bioshelter were utilized largely for educational purposes, the sizeable investment required to build the bioshelter suggests there should be a plan for some means of generating revenue in order to cover operational costs, at the very minimum. While it would be ideal for this bioshelter to allow for revenue generation for its users, it is first and foremost critical to ensure that this project is not a drain in the long-term. In the future, there could be expected costs for compost, plant material, repairs, signage, water, and other equipment. These costs could be covered by growing specific crops and preserving sections of the interior of the bioshelter for agricultural use.

Interviews with other bioshelter owners and urban farmers highlighted the economic value of producing a rotating crop of leafy greens and micro-greens such as pea shoots or sprouts. Furthermore, the lot is presently home to nineteen apple, pear and peach trees which were planted by Worcester Tree Initiative (WTI) in 2013. These fruit trees are expected to produce even more fruit in the coming years and will continue to be a source of profit for Ascentria farmers or community members. Another possibility could be the production of seedlings that could be sold at plant sales, or shared with those who need them for a nominal fee. Ultimately, ensuring that the bioshelter is able to produce revenue to cover operational costs is an important factor for many stakeholders.

7.6 Internal WCG Support

Despite being outside the scope of more conventional CDC activities, the proposed plan for a bioshelter is very much supported in the organization of WCG at the Board Level. While some Board Members expressed concerns about the scale of the site and the costs of the project, there was a general agreement among interviewed Board Members that this project met the core values of WCG. Board Members viewed it as an opportunity to form partnerships that would bring a range of ideas and creative opportunities to the area. One Board Member summed it up well in the remark that this project would be "a chance for organizational growth and a chance to be on the cutting edge of community development". In addition, in much research about bioshelters, there are very few examples of CDC involvement with this innovative technology. Ultimately, creative and complex projects like these could position CDCs at the forefront of urban food production and education—further differentiating CDCs from conventional, private developers.

7.7 Management/Partnerships

The interviews and research point to some useful advice and best practices for managing the bioshelter and the outside space. In general, stakeholders felt that the metal fence and ability to lock the lot was an important feature and would necessitate decisions about access and shared use. Additionally, all management scenarios must take into account the potential language barriers between users of the bioshelter and exterior space.

In a more agricultural use of the bioshelter, there would need to be a specialized manager of the interior space, like a permaculture specialist or trained Ascentria refugee farmer, to ensure proper crop rotation and maintenance. In an agricultural model, there would have to be decisions made that established how the residents versus the manager/farmer would use the space. With this type of use, community participation might take the role of individual raised bed lots that people are able to use to grow plants for sale and consumption.

A community-oriented use, would also need a trained person to run and oversee the bioshelter. As a community use would focus heavily on greater access to the space, and coordinating its potential use for neighborhood events, it is logical that the coordinator might be a resident, church leader or dedicated volunteer with strong ties to other residents. As such the general use of the interior of the bioshelter and exterior could be more influenced by a community group. In this model, several community leaders or well-known members, would need to act as de-facto managers of the space to ensure open access to the space.

Finally, an educational use of the space would be best served with a coordinator to manage the school and afterschool uses of the space. Furthermore, in an educational context a farmer could still use a certain amount of the bioshelter, in order to not fully sacrifice generating revenue, and thus it would be important for a coordinator to facilitate this process. In all of the aforementioned scenarios, interviewees pointed to the

need for a coordinator and advisory board or governance body. Ultimately, these suggestions are further unexplored possibilities that could serve as a starting point for brainstorming sessions for stakeholders to think about the complexities and potential arrangements necessary to run this proposed bioshelter.

Many interviews pointed to new partnerships in the future that might be useful for management purposes, including: connection to local farms in Worcester, using one of the large apartment's maintenance crews to take care of grass and leaves, using YouthBuild to provide jobs for youth to build the bioshelter and make any necessary repairs, taking advantage of year-round work-study internships through the City of Worcester Office of Youth Opportunities, connecting with the REC and other environmental groups for educational programming and working with the Worcester Educational Collaborative.

7.8 Concerns

Despite the positive response to the bioshelter plan, many interviewees expressed a range of concerns for the project. The most common issue was the challenge of ensuring the bioshelter is safe and not a site of vandalism or drug use. Another widely expressed concern was the need for an institutional backbone for this bioshelter to ensure that it lasts. A few interviewees expressed unease that this plan has so far been very top-down with little impetus or input from the community. Some administrators and teachers also wanted to let it be known that a bioshelter could not fall squarely on

teachers who often don't have the time. A final major concern revolved around the notion of fairness and tradeoffs in terms of future use of the space.

8.0 Conclusion/Recommendations

The final component of this report builds upon the antecedent piece of the report (7.0 Findings), which laid out a number of common themes and shared visions. In short, this section maps out a recommended use, a potential management structure and an actionable series of next steps. These recommendations are firmly grounded in interviews with stakeholders and are envisioned as a launching point for future planning efforts.

8.1 Recommended Use

Ever since 7 & 9 Jaques Avenue bioshelter plan's inception, this idea has embodied an inventive technological solution that meets social needs, for a parcel of land without many viable alternatives. Furthermore, the geographic location of the site, close to schools and high density apartments, is decisive advantage for this project. In order to make best use of the lot's advantages, a community bioshelter with strong links to schools such as Chandler Elementary and Jacob Hiatt is the greatest possible model. In general, most interviewees were highly favorable of education as the primary focus for the bioshelter. A few stakeholders felt that schools are not always the most robust foundation for such a project due to questions of liability, inadequate resources, and teacher turnover. While an educationally-centered bioshelter is certainly not without challenges, it offers the most potential for sparking meaningful change in the

neighborhood with its ability to reach children, teachers and parents. An educational model is not mutually exclusive with agricultural or communal designs for the bioshelter, as both aspects can be integrated into an education-centric model through joint use of the bioshelter and clearly outlined roles.

8.2 Management Model

Earlier in this report, Section 7.7 Management/Partnerships outlines some of the collective ideas how the bioshelter might be sustained and managed over time. These findings clarify the choice of management arrangements that could exist at 7 & 9 Jaques Avenue. Across all uses for the bioshelter, it is essential for there to be a funded coordinator to oversee the bioshelter and work with several dedicated resident partners. This position would most likely be a part-time one, especially during the early phase of the project. A coordinator would preferably have a background in education and ecology similar to the model in the Food Corps, a branch of Americorps, which places volunteers in urban agricultural projects across the country. In order to flesh out a concrete structure of management beyond an advisory board and a coordinator, it is critical to create a model charting roles and responsibilities, based on interest and potential partnerships that emerged from interviews (Figure 14, below).

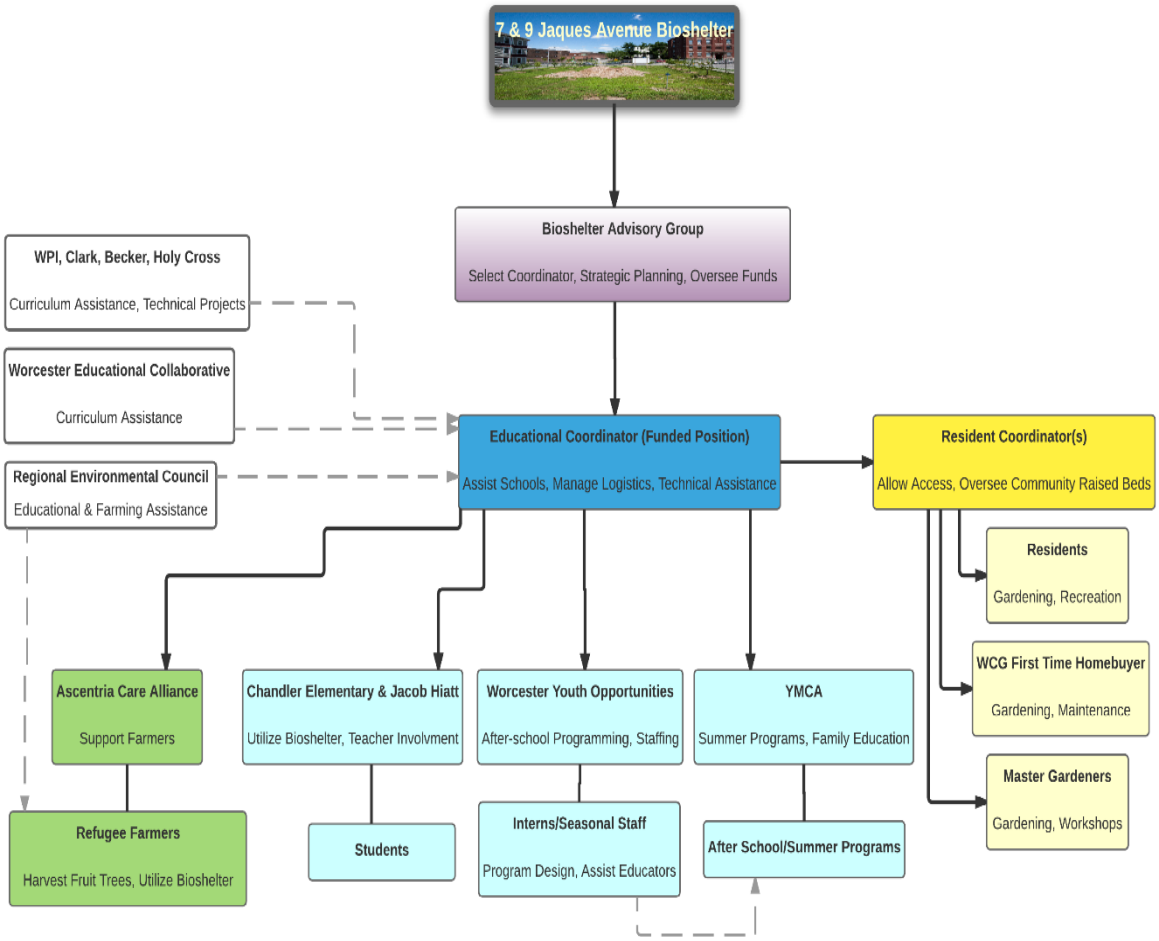

FIGURE 14: A MODEL FOR MANAGING THE BIOSHELTER.

This model lays out one of many potential management structures and roles for a collection of stakeholders. At the top of this model sits a multi-stakeholder advisory board, tasked with selecting a coordinator for the program, shaping the mission of the bioshelter and overseeing expenses and funding. The most crucial person for sustaining and managing the bioshelter will be the 'Educational Coordinator', who will assist schools, support teachers, and orchestrate logistics. They will also act as a contact person

between involved stakeholders and the advisory group. This coordinator will also work closely with the REC, who specialize in agricultural training and youth gardening or the Worcester Educational Collaborative for curriculum development. In addition, university students from WPI and other universities will assist the coordinator by carrying out projects that upgrade and strengthen the bioshelter.

Under the coordinator, in the blue boxes in the organization chart, are the schools in the area, the City of Worcester Office of Youth Opportunities and the Main South YMCA. Chandler Elementary and Jacob Hiatt Magnet School, the closest schools to the lot, will be able to incorporate the bioshelter into their curriculum year-round. Other schools in Worcester could also benefit from the bioshelter through field trips. The bioshelter will also be used by children in after-school programs run by the Office of Youth Opportunities, who have implemented a free pilot afterschool program that occurs at Chandler Elementary already. Finally, the YMCA and Office of Youth Opportunities provide extensive summer programs for Worcester youth, and expressed interest in summer programming at 7 & 9 Jaques Avenue that will emphasize nutrition and science.

In order to ensure that the bioshelter is valued by residents in the area, it is important to have a resident coordinator who will be able to facilitate community events, support the education coordinator, provide access to the lot and organize community use of potential raised beds. This position can be rotated between several residents and perhaps a WCG First Time Homebuyer, and will most likely be on a volunteer basis. Lastly,

a network of Master Gardeners, who are specially trained in horticulture, will assist in landscaping and maintaining the land surrounding the bioshelter, ensuring that it beautifies the neighborhood.

As a final point, it is worthwhile to consider how the bioshelter and the surrounding land can be productively farmed without forfeiting educational or community uses. Utilizing this lot solely for agriculture would not benefit the surrounding community to the extent of an educational use, but an agreed upon portion of the bioshelter should be used for growing crops to pay for operational costs and generating revenue and food. Ascentria Care Alliance's Refugee farmers, who already tend to the fruit trees, are well-suited to continue this activity and could be trained to help maintain the bioshelter.

8.3 Next Steps

The planning process for this project moving forward is one that should draw together organizations, universities and community members into a participatory process shaped by "building of trust, experiential learning, and spontaneity" (Hou and Kinoshita 2007). The first step to achieve this will be to organize a charrette that brings together a diverse range of stakeholders, with varying familiarity of this project. This charrette is tentatively scheduled for the late spring/early summer of 2016 and community members are being recruited through outreach, a blog and flyers. To ensure that the stakeholders

who have been involved in this report are able to stay connected with the project, an executive summary of this report will be circulated soon after the completion of this report. After the initial charrette, there should be a follow-up meeting to develop more fixed design plans and a more formal governance body. This process will help participants to get a sense of each other's commitment, coordinate funding and think about important questions pertaining to overall sustainability, use, naming, and management of the space (see Appendix 3 for guiding questions for the charrette). The summer months of 2016 will be critical augmenting community engagement with the planning process through block parties, flyers, events at the 7 & 9 Jaques Avenue lot, sending information home through school children, tabling at community events. Concurrently, WCG will continue to identify grant funding for this project, as they hear back from several already completed grants. Applying to foundational and private funding sources is of paramount importance in order to fully begin the planning process. Optimistically, the winter of 2016/Spring 2017 will be heart of the planning process, where designs are finalized and different stakeholder roles are cemented.

All in all, this project is well positioned due to advantages of widespread stakeholder enthusiasm, land tenure, technical support, and proximity to schools. This idea has the potential to act as a focal point for many different stakeholders, which— like the interconnected ecosystems within a bioshelter—can begin to lessen some of the complex problems in this area, flexibly and imaginatively.

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Appendix/Figures:

Appendix 1: WPI Crops Rotations

These excerpts from the WPI Report: Killoy, Zachary., Pruden, Jeffrey., Thomas, Christopher., and Wyman, Jeffrey. "Urban Bioshelters in New England: Development of a Bioshelter Design Concept for use in an Urban Environment". Worcester Polytechnic Institute. (2012), provides useful details on crop rotation and potential profits.

a city hookup or an on-site well, depending on what is available.

Compost and Vermiculture

Our initial goal aimed to accommodate a "future without oil," utilizing alternative heat production methods, but also included creating our own quality compost. To accomplish this we recommend one area designated for vermicompost production, and the other for "standard" compost production. Vermicompost techniques, which rely on the chemical and biological interactions of earthworms, mesophilic bacteria, and fungi, generate far more nutritive soil compared to conventional methods characterized by thermophilic bacteria.[80] The vermicompost bins serve as the main supply of soil production for the bioshelter, an area to which Darrel Frey contributes his key to success.[81]

With the support of highly insulated walls and glazing, the heat generated by thermophilic bacteria, in combination with a ground-source heat pump, allows the bioshelter to remain independent of gas, oil, or electric heat (electricity via solar panels is used to run the pump). The "conventional" compost bins function as a heat-generation platform in colder months, in addition to producing composted soil which can be used in secondary areas (outside orchard or gardens) or sold to the local community. By using our own compost, above ground, we avoid the risk of soil contamination commonly found in urban environments.[82]

According to figures provided by Darrel Frey,[83] along with calculations used for a ground-source heat-pump, the minimum amount of compost needed to maintain 55°F in January (with an average temperature of 24°F, typically the coldest month in New England[84]) is approximately 90 cubic ft. We recommend a slightly larger footprint to account for any imperfections, to which organic matter can be added as needed to increase temperature. The space required to supplement soil consumption from crop growth is much less (20 cubic ft.), however the excess soil can be marketed to the public as "bioshelter quality compost." We also recommend converting the traditional compost bins to vermicompost during warmer months to avoid excess heat in the bioshelter.

Optimum Plant Selection

With the right information it is possible to grow crops which meet specific demands in the area, as some small plot intensive (SPIN) farmers[85] recommend, in order to maximize earnings. However, sales to high-end restaurants remain a stable and lucrative choice, especially as more locations are "skirting the increase in fuel and commodities prices by buying locally grown food."[86] Leafy greens and herbs are among the highest profit margins in this market, but crops that are in demand can yield higher margins. We suggest growing a mixture of 80% leafy greens (salad greens, arugula, spinach, kale, chard, mache, Asian greens), and 20% herbs (cilantro, fennel, rosemary, dill, parsley, thyme), with an exception to some vegetables that may be in demand (tomatoes, radish, beets, scallions, carrots). This allows room for large scale production of greens while maintaining some diversity with high-margin herbs.

A varied selection of plants (we recommend three different crops for each growing season) supports biodiversity within the bioshelter, decreasing susceptibility to diseases and pests.[87] Plants can be germinated in a warm, dark area such as a short, light-proof container above the compost bins (heat from thermophilic bacteria in compost will help speed germination). Some greens may be clipped periodically and sold in "salad mix" like containers instead of directly harvesting the whole plant, a method many growers

Table 4. Crop Selection

Month	80% Leafy Greens	20% Herbs
January	Spinach, Arugula	Parsley
February	Spinach, Arugula	Fennel, Rosemary
March	Spinach, Kale	Parsley
April	Spinach, Arugula	Thyme, Dill
May	Spinach, Arugula	Fennel, Parsley
June	Tomatoes	Dill
July	Tomatoes	Parsley
August	Tomatoes	Fennel, Dill
September	Spinach, Kale	Parsley
October	Spinach	Dill
November	Spinach	Parsley
December	Spinach	Parsley

Table 3. Planting and Harvesting Schedule

Plant Name	Seed or Transplant	Harvest	Special Notes
Spinach	Every week	After 21-40 days	N/A in Jun., Jul., Aug.
Arugula	Every two weeks	After 28 days	Minimal spacing between plants
Kale	Early Spring & Fall	Every 28 days	Keeps growing after harvest
Dill	Every 50 days	Every 40-50 days	Can be harvested several times
Fennel	Every 80 days	After 80 days	N/A in Feb., Mar., Apr.
Parsley	Twice a year	After 75 days	Can be harvested several times
Rosemary	Once	After re-growth	Perennial, planted once
Thyme	Once	After 90-95 days	Perennial, planted once
Tomatoes	Once	After 60-80 days	Good alternative in the Summer

(including Growing Power) adapt to increase efficiency and revenue. This is more efficient because it takes much longer for a plant to grow from seed than to grow after being clipped. Finding local prices of vegetables and herbs will aid in choosing the most profitable crops; an example crop schedule is shown in Table 4. This table shows which vegetables and herbs are in production for each month.

Each plant has a different seed, transplant, and harvest schedule. This information can be found in the Table 4, although it is left to the discretion of the grower. Most plants will be germinated in a separate area and then transplanted to the growing platform. When the plant has reached optimum size, it may be clipped and sold as "baby greens" or in a salad mix, or nurtured until a total harvest.

This table is based upon information provided by Andy Pressman, an experienced grower in New England, who uses similar planting regimens based on weather and time of year.

Table 6. Estimated Yearly Revenue by Crop

Plant Category	Plant Name	Targeted Yearly Revenue*
Greens		
	Spinach	$21,000 – $30,000
	Arugula	$3,500 – $7,000
	Kale	$2,000 – $3,500
Herbs		
	Parsley	$5,000 – $7,000
	Rosemary	$1,000 – $2,000
	Dill	$2,000 – $4,000
Other	Tomatoes	$3,000 – $3,500
Total		$37,500 – $57,000

*Estimate based on USDA retail prices and information provided by ATTRA

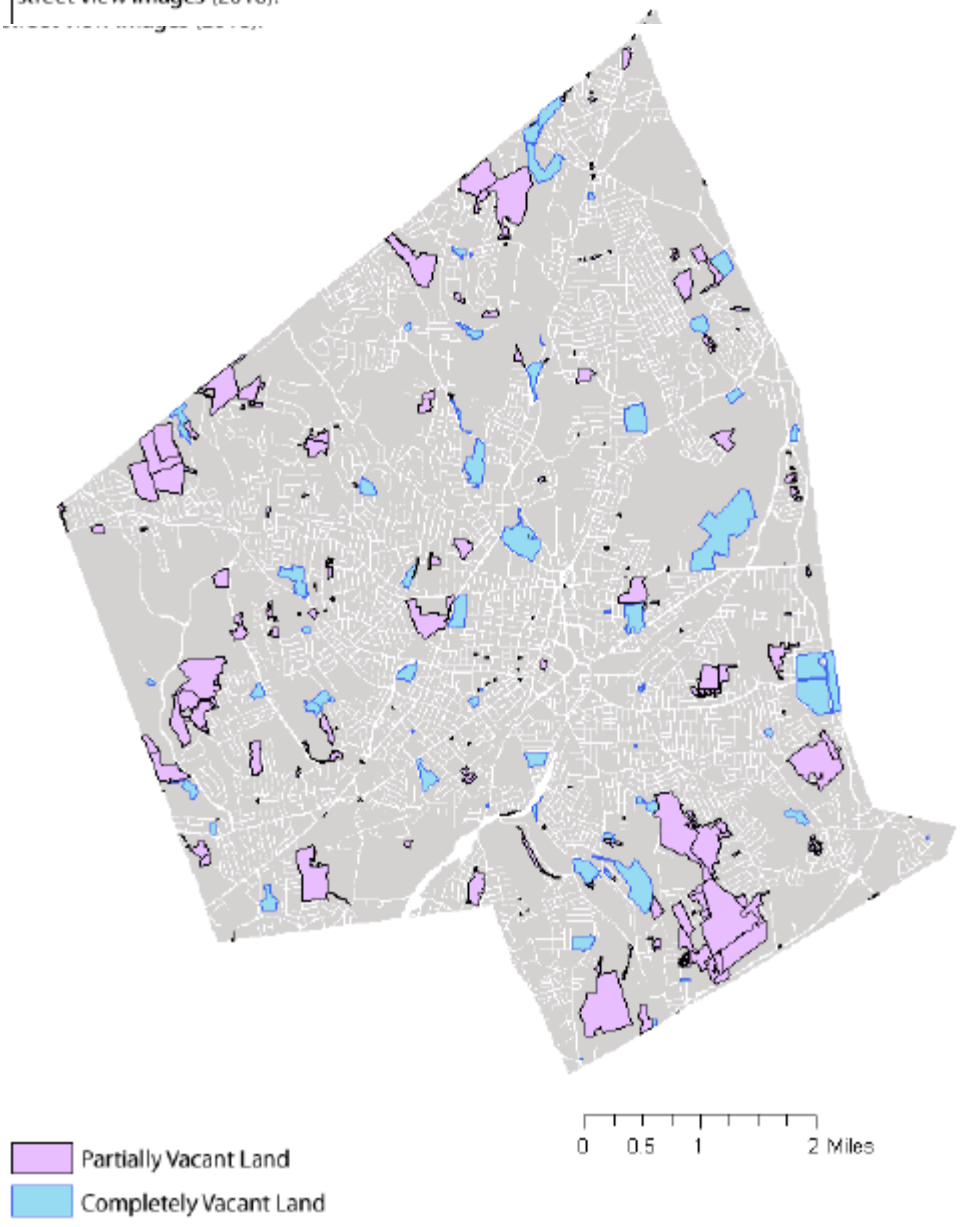
Appendix 2: Maps

TAX PARCEL MAP OF 7 & 9 JAQUES AVENUE (CIRCLED IN GREEN) FROM CITY OF WORCESTER.

Worcester Common Ground Managed Properties

Vacant Publicly Owned Properties in Worcester

Below is a map of completely vacant and partially vacant publicly owned parcels in Worcester. Vacant land does not have any type of development or man-made improvements. This map was generated by visually classifying each parcel cross-referencing NAIP imagery (2012) with GoogleEarth street view images (2010).



SOURCE: MAPPING THE POTENTIAL FOR URBAN AGRICULTURE IN WORCESTER. WPI IQP REPORT 2012.

Appendix 3: Preliminary Charrette Questions

- Why a bioshelter? What makes it a good or bad choice for this space? What do you know about a bioshelter
- How does one make it sustainable long-term? Who is responsible for paying for operational sides of things?
- How do you ensure all parties feel fairly treated? How do you fairly navigate tradeoffs?
- How to prevent vandalism/ensure safety?
- How does it vary seasonally?
- What will the value be for residents (ie individual value proposition)?
- How to establish rules? How can you measure rules?
- What is the best use?
- How to get around the locked fences/is this important?
- If there is profit from bioshelter, how will it be used/distributed?
- Where to get compost/water?
- Questions of liability?
- What will phasing look like?
- Who should be leading this project?
- How can you foster community support?